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SUPPLEMENTARY WORLD MAPS OF F2 CRITICAL FREQUENCIES AND MAXIMUM USABLE FREQUENCY FACTORS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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SUPPLEMENTARY WORLD MAPS OF F2 CRITICAL FREQUENCIES AND MAXIMUM USABLE FREQUENCY FACTORS

Donald H. Zacharisen

This work was prepared in response to Study Program 60 and Recommendation 176 of the International Radio Consultative Committee (CCIR). This Technical Note supplements Technical Note 2 and together they present F2-layer prediction material for all months of the year.

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SUPPLEMENTARY WORLD MAPS OF F2 CRITICAL FREQUENCIES AND MAXIMUM USABLE FREQUENCY FACTORS

by

Donald H. Zacharisen

Summary

This report supplements National Bureau of Standards Technical Note Number 2, April 1959, and completes the basic data required for F2-layer maximum usable frequency predictions. Prediction charts are given for the months of February, April, May, August, October and November. Auxiliary charts are included to aid in predicting F2-layer MUFs.

The four parameters used for predicting MUFs are foF2 and the 4000 km MUF factor for a twelve-month running average Zurich sunspot number of 50, and the rates of change of foF2 and 4000 km MUF factor with sunspot number. The first three parameters are presented in map form for each even hour of Greenwich Mean Time. The fourth parameter is presented on a chart of geomagnetic latitude and local time.

1. INTRODUCTION

This report completes the twelve-month set of world prediction maps and charts for use in predicting median maximum usable frequencies (MUFs) for F2-layer transmission. The basic parameters in this report for February, April, May, August, October, and November include most of the data taken during the IGY. National Bureau of Standards Technical Note Number 2[1], which presents the same basic data for January, March, June, July, September, and December, includes only a small amount of IGY data. All of the prediction maps and charts are prepared for average conditions. Each prediction map corresponds to an even hour of Greenwich Mean Time (GMT) which is also known as Universal Time (UT).

The results of a pilot study[2] cover most of the considerations involved in producing these prediction maps. The history of the preparation of these maps is covered in two sources.[1,3]

II. A DESCRIPTION OF WORLD PREDICTION MAPS, PREDICTION CHARTS AND AIDS

Figure 3 shows the map projection used in producing the world prediction maps. This map will be used in determining the location of the desired communication path endpoints. Figure 4, a great circle chart, is based on the same projection used in the above map of the world. Figures 3 and 4 are used to determine the great circle communication path between the transmitting and receiving terminals. The <u>world</u> prediction <u>maps</u> are all presented for each even hour of the day. The prediction charts of slope of regression line of M-4000 factor on the twelve-month running average Zurich sunspot number (RASSN) have time of day rather than longitude as the abscissa. Hence there are fewer charts to represent this parameter than there are maps to represent the other parameters. It was determined, from the results of a pilot study[2], that it would be of doubtful value to attempt to specify this parameter in more detail.

Figure 5 and Figure 6* are used to interpolate between the values of F2-zero-MUF and F2-4000-MUF provided by the world prediction maps and prediction charts. Figure 5 is generally used. Figure 6 is to be used during certain daylight hours indicated in the accompanying Table. The nomogram in Figure 6 will, in general, give lower values of MUF than the nomogram in Figure 5. It is felt that the prescribed use of two distance nomograms (Figure 5, Figure 6) will give predictions which are more nearly consistent throughout the year. Both nomograms have F2-zero-MUF along the left vertical axis. F2-zero-MUF is obtained by adding one-half of the gyrofrequency (f_H) to the foF2. An approximate value of $f_H/2$ is obtained from Table 1 as a function of geomagnetic latitude. The geomagnetic latitude, for a given geographic latitude and longitude, may be obtained from Table 2.[4]

The prediction maps for foF2 at RASSN 50 and M-4000 factor at RASSN 50 are used respectively with those for the slope of regression of foF2 on RASSN and the prediction charts of the slope of regression of M-4000 factor on RASSN. The first two parameters above give the value of foF2 or M-4000 factor at a RASSN of 50. The third and fourth parameters give the rates of change of foF2 or M-4000 factor with RASSN. For example, a value from the map of foF2 at RASSN 50 used with a corresponding value from the map of the rate of change of foF2 with RASSN will give, for a given geographical location, the value of foF2 for essentially all values of RASSN.

In addition to the above prediction material a predicted value of RASSN, such as is supplied five months in advance of the month in question by CRPL using the McNish-Lincoln method,[5] is required to predict F2-layer MUFs.

It should be kept in mind that these maps will provide predictions only for F2-layer propagation. For low sunspot numbers, during local summer at middle latitudes,

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the E- and F1-layers may permit propagation at a somewhat higher frequency than the F2-layer. Also, at anytime, other factors, such as sporadic-E, scatter, layer tilts, etc., may also permit propagation at higher frequencies than predicted from these maps.

A simple set of equations are used to predict MUFs and optimum traffic frequencies (FOTs)* from the prediction maps and charts, the aids, and a predicted RASSN. The following symbols are used in presenting these equations:

R = predicted RASSN.

f(R) = median ordinary-wave critical frequency (median foF2) at RASSN R (denotes median foF2 as a function of R).

f(50) = median foF2 at RASSN 50.

b_f = slope of the regression line of median foF2 on RASSN (the rate of change of median foF2 with RASSN).

M(R) = median maximum usable frequency factor for a transmission distance of 4000 kilometers (median M-4000) at RASSN R.

M(50) = median M-4000 at RASSN 50.

b_M = slope of the regression line of median M-4000 factor on RASSN (rate of change of median M-4000 factor with RASSN).

*The term FOT supersedes OWF which appears in the report[1] presenting the first six months of maps.

F2-zero-MUF(R) = maximum usable frequency for a transmission distance of zero kilometers at RASSN R.

F2-4000-MUF(R) = maximum usable frequency for a transmission distance of 4000 kilometers at RASSN R.

f_H = gyrofrequency.

$f(R) = f(50) + (R-50)b_f$.

$M(R) = M(50) + (R-50)b_M$.

$f(R) + f_H/2$ = median F2-zero-MUF(R).

$[f(R)]\,[M(R)]$ = median F2-4000-MUF(R).

f(50), b_f, and M(50) are read from their respective maps at the geographical location of the control points of the great-circle path between the transmitting and receiving terminals. For circuits 4000 km or less, the control point is at the great-circle midpoint. For circuits greater than 4000 km, ionospheric conditions 2000 km from each terminal are assumed to control. b_M is read from a chart at the geomagnetic latitude of the control points. The predicted value of RASSN used with this report should be one that will give the best MUF predictions rather than one that will predict a correct value of RASSN. The above value of RASSN should follow closely the predicted or expected value of RASSN.

The world prediction maps of foF2 at RASSN 50 and

M-4000 factor at RASSN 50 were drawn from median values and the use of the values from these maps in the above equations will result in median values of F2-4000-MUF(R) and F2-zero-MUF(R). The median value is of course the middle value when the observed data are arranged in order of magnitude. Propagation at the MUF calculated from these prediction maps and charts should be possible on approximately 50% of the days of the month.

A frequency that should be propagated via the F2-layer approximately 90% of the time (FOT) may be easily obtained from the above median F2-MUF. It might be found by taking 85% of the median F2-4000-MUF(R) and 85% of the median F2-zero-MUF(R), but it is simpler just to take 85% of the median F2-MUF for which the distance interpolation has already been made. Both methods can be seen to yield the same results.

III. INSTRUCTIONS FOR USE OF WORLD PREDICTION MAPS, PREDICTION CHARTS AND AIDS

Much of the material in this section is similar to that in National Bureau of Standards Circular 465[6] which is probably familiar to many users of this report and therefore the use of a similar text should aid in determining F2-layer MUFs from the material included herein. It is suggested that if repeated use is to be made of this report, the staples be removed and the report placed in a looseleaf notebook so that the pages will lie flat.

1. Determination of Great-Circle Distances and Locations of Transmission Control Points

Figure 3 is a map of the world. Figure 4 is a chart to the same scale as Figure 3, on which the solid-line curves crossing the equator at two points 180° apart represent great circles. The numbered dot-dash lines crossing the great circles indicate distances along them in thousands of kilometers. In using Figures 3 and 4, proceed as follows:

(a) Place a piece of transparent paper over the map, Figure 3, and draw the equatorial line and the 120°W longitude line. Place dots over the locations of the transmitting and receiving terminals. Also mark the 0° meridian for use in determining GMT from the prediction charts of slope of regression line of M-4000 factor on RASSN.

(b) Place this transparency over Figure 4 and, keeping the equatorial line of the transparency always on the equatorial line of Figure 4, slide the transparency horizontally until the terminal points marked on it either fall on the same great circle or are the same proportional distance between adjacent great-circle curves. Draw a great-circle path through the terminal points. Paths between Washington, D.C. and Miami, Florida, and Washington, D.C. and Trieste are shown in Figure 4.

(c) For paths shorter than 4000 km, locate the midpoint of the path by keeping the transparency in position on Figure 4 and using the numbered lines as a distance scale. The midpoint of the Washington-Miami path is at M on Figure 4.

(d) For paths longer than 4000 km, locate the following "control points" on the great circle transmission path:

Point "A" 2000 km from the transmitter

Point "B" 2000 km from the receiver

These control points for the Washington-Trieste path are shown in Figure 4.

2. Prediction of Maximum Usable Frequencies and Optimum Traffic Frequencies

2.1 Prediction of MUF and FOT for distances less than or equal to 4000 km

(a) A work sheet similar to that of Figure 7 is suggested.

(b) To predict the MUF:

(1) Place the great circle transparency over the map of foF2 at RASSN 50 for 0000 hours GMT for the month of interest and keep the equatorial line of the transparency over the equatorial line of the map and the 120°W line of the transparency over the 120°W line of the map.

(2) Read the value of foF2 for the midpoint of the path and record as f(50) in Column a. of Figure 7.

(3) Repeat for the 0200, 0400, 0600, etc. maps.

(4) Repeat steps (1), (2), and (3) for the maps of the slope of the regression line of foF2 on RASSN and again for the maps of M-4000 factor at RASSN 50 and record values as b_f in Column b. and as M(50) in Column e., respectively, of Figure 7.

(5) Compute (R-50), using the predicted value of R for the desired month, and record this value in Column c. of Figure 7.

(6) From Figure 3, determine the geographical coordinates of the path midpoint located in Section

1 (c) above. Table 2 is then used to find the geomagnetic latitude of the midpoint. Geographic latitude is located along the vertical axis of Table 2 and geographic longitude is located along the horizontal axis. 180°E to 360° E longitude on Table 2 corresponds to 180°W to 0° longitude.

(7) If the geomagnetic latitude differs from the geographic latitude, place a dot on the geographic meridian of the great-circle midpoint at a geographic latitude equal to the geomagnetic latitude found in (6) above.

(8) Place the transparency over the chart of the slope of the regression line of M-4000 factor on RASSN and keep the equatorial line of the transparency over the equatorial line of the chart. Slide the transparency horizontally until the Greenwich meridian of the transparency coincides with 0000 hours on the local time (LT) scale.

Note that all points on the great-circle path are in their proper LT relationship to Greenwich.

(9) Read the slope of the regression line of M-4000 factor on RASSN for the location of the dot determined in Instruction (7) above and record as b_M in Column f. of Figure 7.

Note that on the prediction chart (-) refers to an algebraic increase (e.g. -.0040 to -.0050) of values inside the contour so specified while (+) refers to an algebraic decrease (e.g. -.0040 to -.0030) of values inside of the contour so specified.

(10) Repeat for 0200, 0400, 0600, etc. on the time scale. Frequently it will be necessary to make the Greenwich meridian of the transparency coincide with an imagined 2600, 2800, 3000, etc. on the time scale. A convenient aid is to place marks at two hour intervals on the equatorial line of the transparency.

(11) Compute the values for Columns d., g., and h. of Figure 7 from the equation at the heading of each of these columns. The equation for Column d. is f(R) = Column a. + (Column b.)(Column c.).

(12) Use the geomagnetic latitude of the path midpoint found in Instruction (6) above to obtain one-half of the gyrofrequency (f_H) from Table 1. Add this value of $f_H/2$ to the median foF2 for all even hours to obtain median F2-zero-MUF(R) and record the values in column i. of Figure 7.

(13) For each hour place a straightedge between the values of F2-zero-MUF(R) and F2-4000-MUF(R) at the left-hand and right-hand sides, respectively, of the appropriate grid nomogram, Figure 5 or Figure 6, and read the MUF for the actual path length at the intersection point of the straightedge with the appropriate vertical distance line, interpolating between the oblique lines. Use the nomogram in Figure 6 as indicated by the accompanying Table. Otherwise use the nomogram in Figure 5. Record the values in Column j. of Figure 7.

(14) Calculate the F2-FOT by multiplying each median F2-MUF in Column j. of Figure 7 by the factor 0.85 or by using the conversion scale contained in Figure 5. Record the values in Column k. of Figure 7.

2.2 Prediction of MUF and FOT for distances greater than 4000 km

(a) General Considerations:

The long distance F2-layer MUF predictions are based on the assumptions:

(1) That there are F2-layer control points A and B.

(2) That the highest frequency that can be propagated from the A-end to the B-end is the lower of the two frequencies of A and B above.

(3) That the frequency obtained in (2) is the same for propagation from the B-end to the A-end.

(b) A work sheet similar to Figure 8 is suggested. Scaled values and computations for control point A and control point B should be recorded in Columns a. through h. and Columns i. through o., respectively, on Figure 8. In the following instructions, the first designated column letter will apply to control point A and the one in parenthesis to control point B. The lower of A and B is entered in Column p. and the FOT is computed from this and entered in Column q.

(c) Locate the control points A and B as explained in Section 1. For very long paths the "short route" (minor arc of the great-circle path) and the "long route" (major arc) may both need to be considered.

(d) To determine the MUF:

(1) Place the great circle transparency over the map of foF2 at RASSN 50 for 0000 hours GMT for the month of interest and keep the equatorial line of the transparency over the equatorial line of the map and the 120°W line of the transparency over the 120°W line of the map.

(2) Read the value of foF2 for control point A and record as f(50) in Column a. (i.) of Figure 8.

(3) Repeat for the 0200, 0400, 0600, etc. maps.

(4) Repeat steps (1), (2), and (3) for the maps of the slope of the regression line of foF2 on RASSN and again for the maps of M-4000 factor at RASSN 50 and record values as b_f in Column b. (j.) and as M(50) in Column e. (ℓ.), respectively, of Figure 8.

(5) Compute (R-50), using the predicted value of R for the desired month, and record this value in Column c. of Figure 8.

(6) From Figure 3, determine the geographical coordinates of the location of control point A which was located in Section 1 (d) above. Table 2 is then used to find the geomagnetic latitude of A. Geographic latitude is located along the vertical axis of Table 2 and geographic longitude is located along the horizontal axis. 180°E to 360°E longitude on this chart corresponds to 180°W to 0° longitude.

(7) If the geomagnetic latitude differs from the geographic latitude, place a dot on the geographic meridian of control point A at a geographic latitude equal to the geomagnetic latitude found in (6) above.

(8) Place the transparency over the chart of the slope of the regression line of M-4000 factor on RASSN and keep the equatorial line of the transparency over the equatorial line of the chart. Slide the transparency horizontally until the Greenwich meridian of the transparency coincides with 0000 hours on the local time (LT) scale.

Note that all points on the great-circle path are in their proper LT relationship to Greenwich.

(9) Read the value of the slope of the regression line of M-4000 factor on RASSN for the location of the dot determined in Instruction (7) above and record as b_M in column f. (m.) of Figure 8.

Note that on the prediction chart (-) refers to an algebraic increase (e.g. -.0040 to -.0050) of values inside of the contour so specified while (+) refers to an algebraic decrease (e.g. -.0040 to -.0030) of values inside of the contour so specified.

(10) Repeat for 0200, 0400, 0600, etc. on the time scale. Frequently it will be necessary to make the Greenwich meridian of the transparency coincide with an imagined 2600, 2800, 3000, etc. on the time scale. A convenient aid is to place marks at two-hour intervals on the equatorial line of the transparency.

(11) Compute the values for Columns d. (k.), g. (n.), and h. (o.) of Figure 8 from the equation at the heading of each of these columns.

(12) Repeat steps (1) through (11) for control point B using Columns i. through o. on the work sheet as indicated in the parenthesis.

(13) For each of the even hours compare the two values of median F2-4000-MUF(R) in Columns h. and o. of Figure 8 representing control point A and control point B, respectively. The lower of the two values is the MUF for a given even hour for the transmission path. Record this median F2-MUF for the path in Column p.

(14) Calculate the F2-FOT by multiplying each median F2-MUF in Column p. of Figure 8 by the factor 0.85 or by using the conversion scale in Figure 5. The values obtained are recorded in Column q. of Figure 8.

IV. SAMPLE MUF AND FOT PREDICTIONS

1. Short Path

The MUF and FOT for the great-circle communication path between Washington, D.C. (39.0°N, 77.5°W) and Miami, Florida (25.7°N, 80.5°W), have been predicted for average conditions for the month of April using a RASSN of 119. This was the observed RASSN for April of 1956 and the values that have been predicted would be applicable to the propagation conditions encountered during that period. It is possible that a predicted value of RASSN would fit the propagation conditions encountered more precisely than the observed RASSN.

The values that have been calculated are shown in Figure 1. It will be noted here that the values recorded in Columns a., b., e., and f. of Figure 1 will always apply for the above communication path for the month of April. The values in Column c. will vary from year to year with changes in the value of RASSN. The values for Columns a., b., e., and f. could therefore be scaled, for a given month and transmission path, well in advance of the receipt of the predicted value of RASSN.

The geographic latitude of the midpoint of the above path is included in the limits indicated in the Table in Figure 6 and therefore the distance nomogram in Figure 6 is used for the period 0700 to 1700 hours local time at the path midpoint. The nomogram in Table 5 is used for all other hours of the day.

2. Long Path

The MUF and FOT for the great-circle communication path between Washington, D.C. (39.0°N, 77.5°W) and Trieste (45.7°N, 13.8°E) have been predicted for average conditions for the month of October using a RASSN of 8. This was the observed RASSN for October of 1954 and the values that have been predicted would be applicable to the propagation conditions encountered during that period. It is again possible that a predicted value of RASSN would fit the propagation conditions encountered more precisely than the observed RASSN.

The values that have been calculated for the control point A are shown in Columns a. through h. of Figure 2 and the values calculated for control point B are shown in Columns i. through o. of Figure 2. Again, it will be noted that the values recorded in Columns a., b., e., and f. and Columns i., j., ℓ., and m. will always apply for the above communication path for the month of October. The values in Column c. will vary from year to year with changes in the value of RASSN. The values for Columns a., b., e., and f. and Columns i., j., ℓ., and m. could therefore be scaled, for a given month and transmission path, well in advance of the receipt of the predicted value of RASSN.

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SOLUTION OF F2-LAYER TRANSMISSION PROBLEM FOR A PATH LESS THAN OR EQUAL TO 4000 KM

From Washington, D.C. To Miami, Florida Distance 1500 km Predicted for April 19__

Geomagnetic latitude for path midpoint 43°N

One-half gyrofrequency ($f_H/2$) for path midpoint 0.6 Mc

Note: All frequencies are in Megacycles

Procedure	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Compute	Compute	Scale - use Fig.	Compute
	f(50)	b_f	(R-50)	f(R) = a + bc	M(50)	b_M	M(R) = e + cf	median F2-4000-MUF(R) = dg	median F2-zero-MUF(R) = d + $f_H/2$	median F2-MUF for path	F2-FOT for path = 0.85j
GMT	a	b	c	d	e	f	g	h	i	j	k
00	7.3	.034	69	9.6	3.41	-.0036	3.16	30.3	10.2	18.2*	15.5
02	5.9	.030	69	8.0	3.27	-.0033	3.04	24.3	8.6	14.8*	12.6
04	4.9	.030	69	7.0	3.09	-.0029	2.89	20.2	7.6	12.6*	10.7
06	4.6	.031	69	6.7	3.11	-.0028	2.92	19.6	7.3	12.2*	10.4
08	4.3	.027	69	6.2	3.14	-.0028	2.95	18.3	6.8	11.4*	9.7
10	3.8	.024	69	5.5	3.20	-.0032	2.98	16.4	6.1	10.2*	8.7
12	5.7	.029	69	7.7	3.51	-.0034	3.28	25.3	8.3	15.1*	12.8
14	7.1	.036	69	9.6	3.40	-.0033	3.17	30.4	10.2	17.0**	14.4
16	7.7	.042	69	10.6	3.15	-.0029	2.95	31.3	11.2	18.0**	15.3
18	8.3	.043	69	11.3	3.14	-.0029	2.94	33.2	11.9	19.1**	16.2
20	8.3	.040	69	11.1	3.20	-.0030	2.99	33.2	11.7	19.0**	16.2
22	8.1	.035	69	10.5	3.30	-.0034	3.07	32.2	11.1	18.2**	15.5
Done by											
Checked											

* The distance nomogram in Figure 5 was used

** The distance nomogram in Figure 6 was used

FIGURE 1

SOLUTION OF F2-LAYER TRANSMISSION PROBLEM FOR A PATH GREATER THAN 4000 KM

From Washington, D.C. To Trieste Distance 7100 km Predicted for October 19__

Geomagnetic latitude for control point A 60°N and control point B 57°N

Note: All frequencies are in Megacycles

Procedure	Control Point A								Control Point B								
	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Scale	Scale	Compute	Compute	Lower of h and o	Compute
	f(50)	b_f	(R-50)	f(R) = a + bc	M(50)	b_M	M(R) = e + cf	median F2-4000-MUF(R) = dg	f(50)	b_f	f(R) = i + cj	M(50)	b_M	M(R) = ℓ + cm	median F2-4000-MUF(R) = kn	median F2-MUF for path	F2-FOT for path = 0.85p
GMT	a	b	c	d	e	f	g	h	i	j	k	ℓ	m	n	o	p	q
00	4.7	.027	-42	3.6	3.19	-.0035	3.34	12.0	4.0	.022	3.1	3.05	-.0032	3.18	9.9	9.9	8.4
02	4.1	.024	-42	3.1	3.14	-.0033	3.28	10.2	3.6	.018	2.8	2.99	-.0032	3.12	8.7	8.7	7.4
04	3.6	.024	-42	2.6	3.09	-.0033	3.23	8.4	3.2	.018	2.4	2.99	-.0032	3.12	7.5	7.5	6.4
06	3.1	.021	-42	2.2	3.06	-.0033	3.20	7.0	2.8	.019	2.0	3.08	-.0032	3.21	6.4	6.4	5.4
08	2.7	.019	-42	1.9	3.07	-.0033	3.21	6.1	5.3	.027	4.2	3.52	-.0034	3.66	15.4	6.1	5.2
10	3.6	.019	-42	2.8	3.33	-.0033	3.47	9.7	7.1	.038	5.5	3.55	-.0036	3.70	20.4	9.7	8.2
12	6.4	.032	-42	5.1	3.63	-.0035	3.78	19.3	8.0	.043	6.2	3.48	-.0038	3.64	22.6	19.3	16.4
14	7.4	.040	-42	5.7	3.50	-.0037	3.66	20.9	8.1	.042	6.3	3.46	-.0038	3.62	22.8	20.9	17.8
16	7.9	.040	-42	6.2	3.40	-.0038	3.56	22.1	7.9	.044	6.1	3.51	-.0042	3.69	22.5	22.1	18.8
18	7.8	.042	-42	6.0	3.37	-.0040	3.54	21.2	7.0	.037	5.4	3.50	-.0039	3.66	19.8	19.8	16.8
20	7.3	.037	-42	5.7	3.46	-.0040	3.63	20.7	5.6	.026	4.5	3.35	-.0036	3.50	15.8	15.8	13.4
22	6.1	.032	-42	4.8	3.35	-.0037	3.51	16.8	4.2	.024	3.2	3.13	-.0033	3.27	10.5	10.5	8.9
Done by																	
Checked																	

FIGURE 2

V. FIGURE AND TABLES

MAP OF THE WORLD

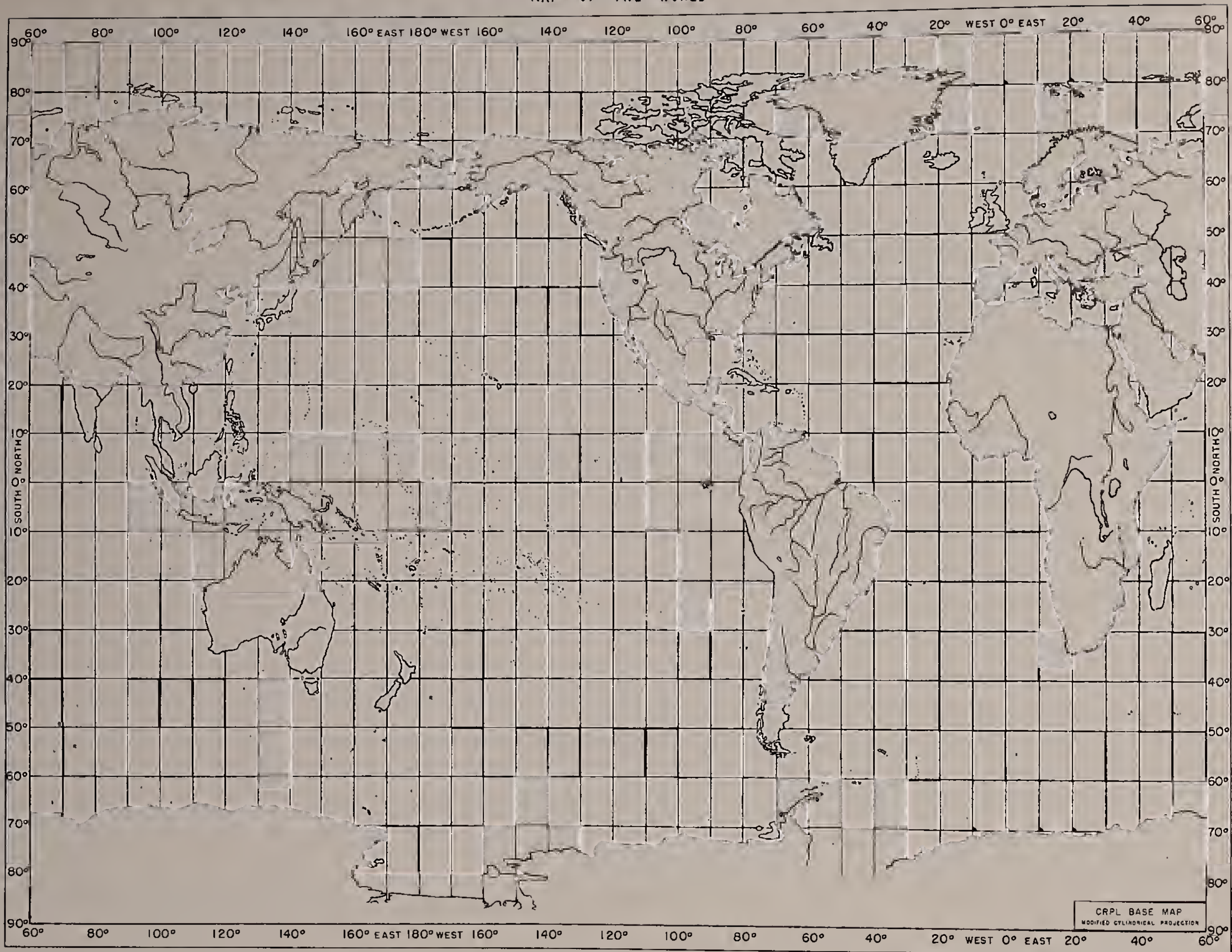
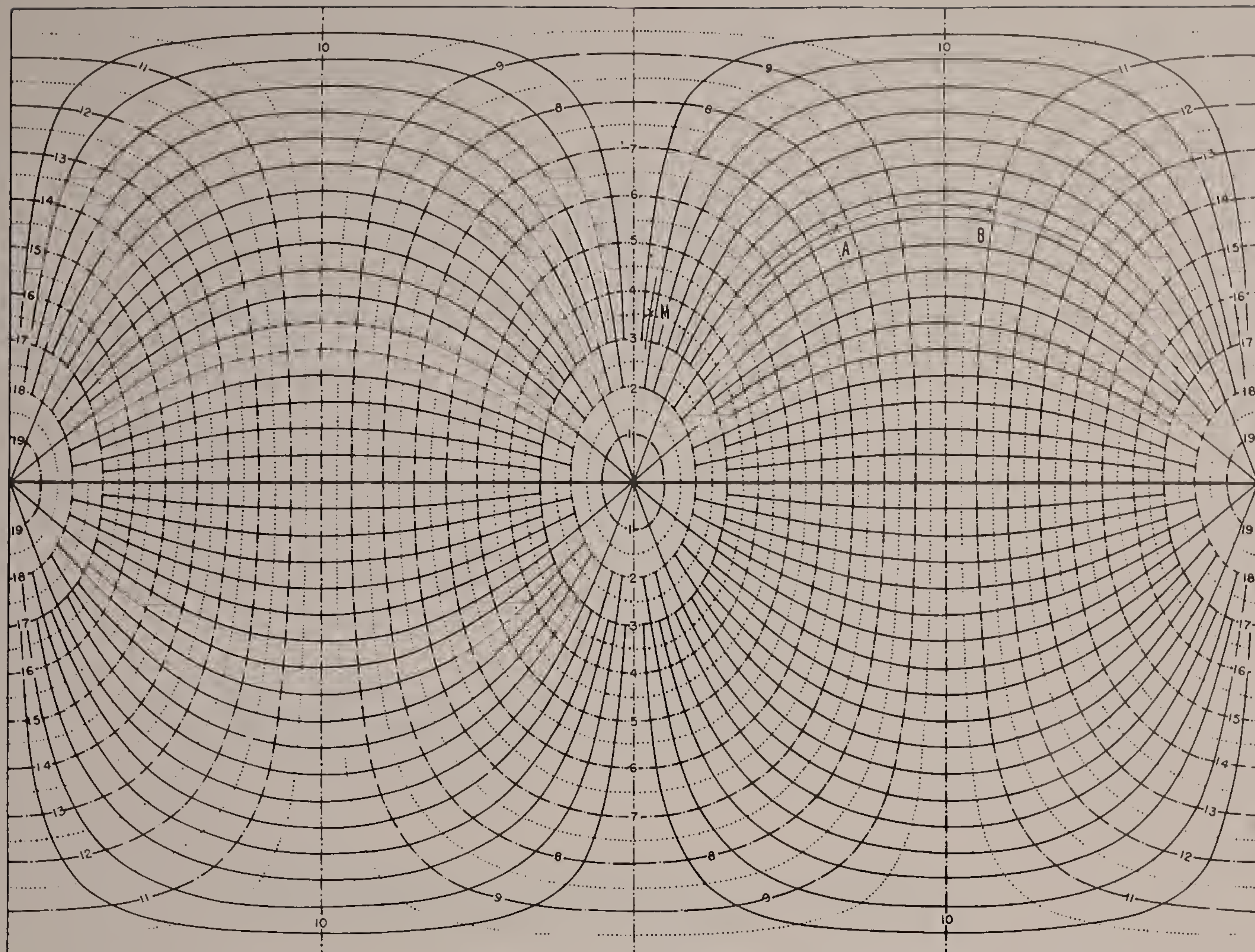
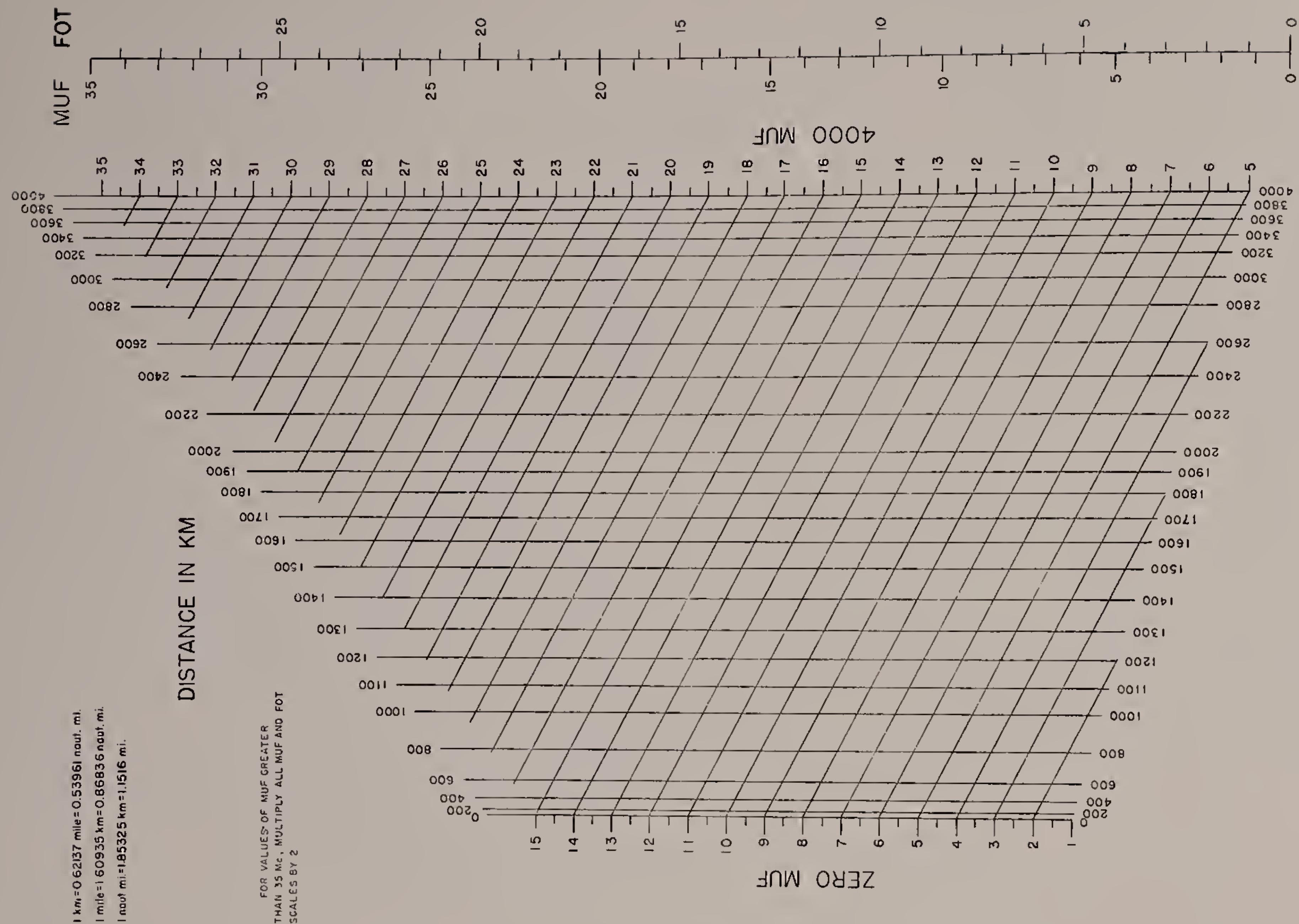


FIGURE 3



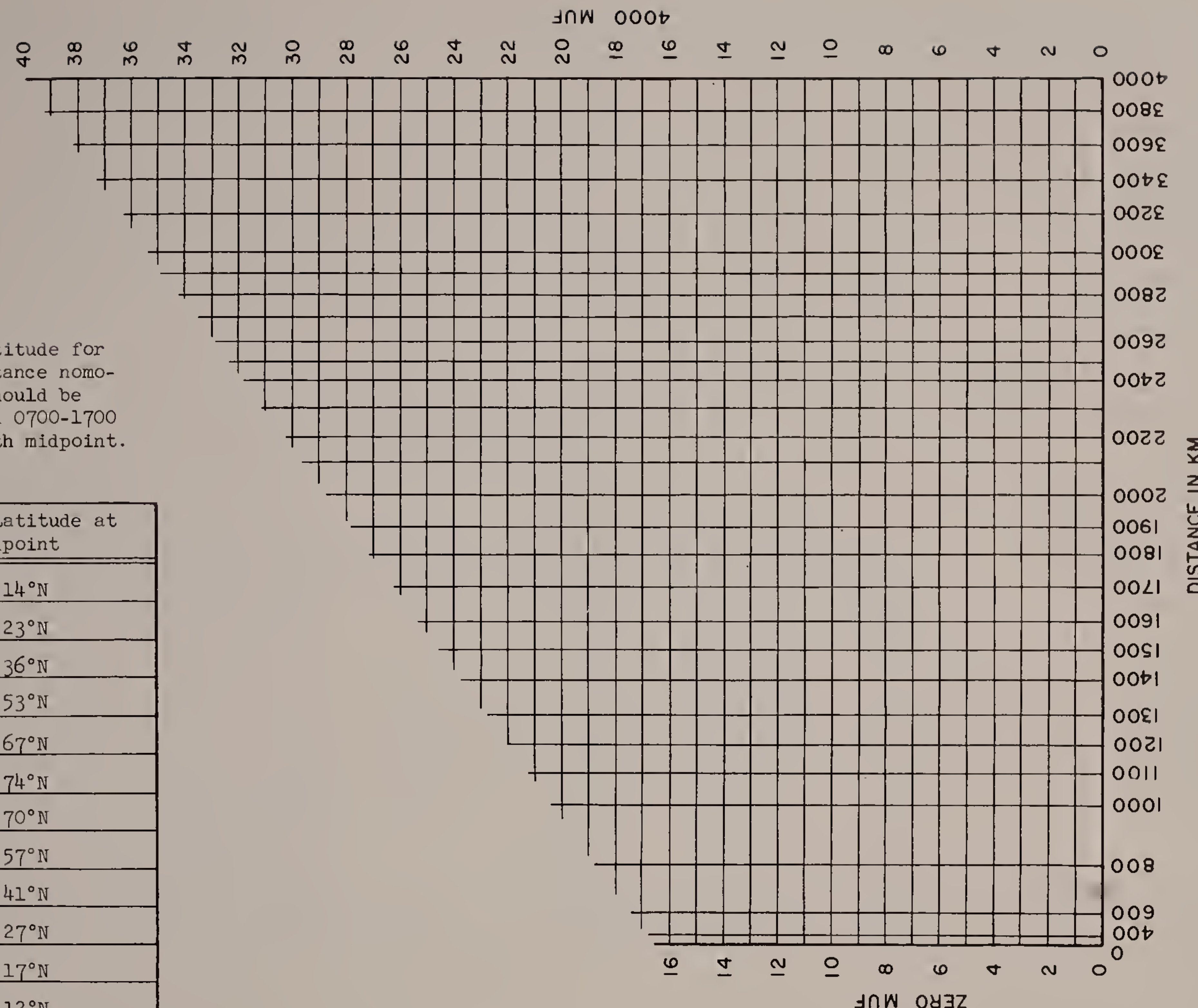
GREAT CIRCLE CHART CENTERED ON EQUATOR. SOLID LINES REPRESENT GREAT CIRCLES. NUMBERED DOT-DASH LINES INDICATE DISTANCES IN THOUSANDS OF KILOMETERS.

FIGURE 4



NOMOGRAM FOR TRANSFORMING F2-ZERO-MUF AND F2-4000-MUF TO EQUIVALENT MAXIMUM USABLE FREQUENCIES AT INTERMEDIATE TRANSMISSION DISTANCES; CONVERSION SCALE FOR OBTAINING OPTIMUM TRAFFIC FREQUENCIES (FOT).

FIGURE 5



An approximate value of latitude for the zone in which this distance nomogram should be used. It should be used only during the period 0700-1700 hours local time at the path midpoint.

Month	Geographic Latitude at Path Midpoint
January	70°S to 14°N
February	57°S to 23°N
March	41°S to 36°N
April	27°S to 53°N
May	17°S to 67°N
June	12°S to 74°N
July	14°S to 70°N
August	23°S to 57°N
September	36°S to 41°N
October	53°S to 27°N
November	67°S to 17°N
December	74°S to 12°N

NOMOGRAM FOR TRANSFORMING F2-ZERO-MUF AND F2-4000-MUF TO EQUIVALENT MUFS AT INTERMEDIATE DISTANCES.

FIGURE 6

An Approximate Value of One-half
the Gyrofrequency (f_H) as a Function
of Geomagnetic Latitude

$\frac{1}{2}$ Gyrofrequency (f_H)	Geomagnetic Latitude
0.8	81°N - 90°N
0.7	60°N - 80°N
0.6	40°N - 59°N
0.5	21°N - 39°N
0.4	20°N - 20°S
0.5	21°S - 39°S
0.6	40°S - 59°S
0.7	60°S - 80°S
0.8	81°S - 90°S

TABLE 1

GEOMAGNETIC LATITUDES OF POINTS ON THE EARTH IN VARIOUS GEOGRAPHIC LATITUDES AND LONGITUDES

Geographic latitude*	Geographic east longitude in degrees																																				
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	65	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	160
+88	79	79	79	79	78	78	78	78	78	78	77	77	77	77	77	77	77	77	77	77	77	77	76	76	77	77	77	77	77	77	77	77	77	77	77	78	78
+86	79	79	79	78	78	78	77	77	77	76	76	76	76	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	78	76	76	78	77
+84	79	79	78	78	77	77	76	76	75	75	75	74	74	74	74	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	74	74	74	75	75	75
+82	79	78	77	77	76	76	75	75	74	74	73	73	72	72	72	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	72	72	72	73	73	73	74
+80	78	77	76	76	75	74	74	73	73	72	71	71	71	70	70	70	89	69	69	69	69	69	69	69	69	69	69	69	69	69	70	70	70	71	71	72	72
+78	77	76	75	74	74	73	72	72	71	70	70	69	69	68	68	66	67	67	67	67	67	67	67	67	67	67	67	67	67	68	68	68	69	69	70	70	71
+76	75	75	74	73	72	71	71	70	69	69	68	68	67	67	66	66	65	65	65	65	65	65	65	65	65	55	65	65	65	66	66	66	67	67	68	68	69
+74	74	73	72	71	71	70	69	68	68	67	66	66	65	65	64	64	64	63	63	63	63	63	63	63	63	63	63	63	63	64	64	64	65	65	66	67	67
+72	73	72	71	70	69	68	67	86	66	65	64	64	63	63	62	82	62	61	81	61	61	81	61	61	61	61	61	61	61	62	62	63	63	64	64	65	65
+70	71	70	89	68	67	66	66	65	64	63	63	62	61	61	60	60	60	59	59	59	59	59	59	59	59	59	59	59	59	60	60	81	61	62	62	63	64
+68	89	68	67	66	65	65	64	63	62	61	61	60	60	59	58	58	58	57	57	57	57	57	57	57	57	57	57	57	57	58	58	59	59	60	60	61	62
+66	68	67	66	65	64	63	62	61	60	60	59	58	58	57	57	56	56	55	55	55	55	55	55	55	55	55	55	55	56	58	56	57	57	58	59	59	60
+64	86	65	64	83	62	61	60	59	58	58	57	56	56	55	55	54	54	53	53	53	53	53	53	53	53	53	53	53	54	54	54	55	55	56	57	57	58
+62	64	63	62	61	60	59	58	57	57	56	55	54	54	53	53	52	52	51	51	51	51	51	51	51	51	51	51	51	52	52	52	53	54	54	55	56	56
+60	62	61	60	59	58	57	58	56	55	54	53	52	52	51	51	50	50	49	49	49	49	49	49	49	49	49	49	49	50	50	50	51	52	52	53	54	54
+58	60	59	58	57	56	55	55	54	53	52	51	51	50	49	49	46	48	47	47	47	47	47	47	47	47	47	47	47	48	46	49	49	50	50	51	52	52
+55	58	57	56	56	55	54	53	52	51	50	49	49	48	47	47	46	46	45	45	45	45	45	45	45	45	45	45	45	46	46	47	47	48	46	49	50	51
+54	57	56	55	54	53	52	51	50	49	48	47	47	46	45	45	44	44	43	43	43	43	43	43	43	43	43	43	43	44	44	45	45	46	46	47	48	49
+52	55	54	53	52	51	50	49	48	47	46	45	45	44	43	43	42	42	41	41	41	41	41	41	41	41	41	41	41	42	42	43	43	44	44	45	46	47
+50	53	52	51	50	49	48	47	46	45	44	44	43	42	41	41	40	40	39	39	39	39	39	39	39	39	39	39	39	40	40	41	41	42	42	43	44	45
+48	51	50	49	48	47	46	45	44	43	42	42	41	40	39	39	38	38	37	37	37	37	37	37	37	37	37	37	37	38	38	39	39	40	41	41	42	43
+46	49	48	47	46	45	44	43	42	41	40	40	39	38	36	37	36	38	35	35	35	35	35	35	35	35	35	35	35	36	36	37	37	38	39	39	40	41
+44	47	46	45	44	43	42	41	40	39	38	38	37	36	36	35	34	34	34	33	33	33	33	33	33	33	33	33	33	34	34	35	35	36	37	37	38	39
+42	45	44	43	42	41	40	39	38	37	37	36	35	34	34	33	32	32	32	31	31	31	31	31	31	31	31	31	31	32	32	33	33	34	35	35	36	37
+40	43	42	41	40	39	38	37	36	35	35	34	33	32	32	31	30	30	30	29	29	29	29	29	29	29	29	29	29	30	30	31	31	32	33	33	34	35
+38	41	40	39	38	37	36	35	34	34	33	32	31	30	30	29	28	28	28	27	27	27	27	27	27	27	27	27	27	28	28	29	29	30	31	31	32	33
+36	39	38	37	36	35	34	33	32	32	31	30	29	28	28	27	26	26	26	25	25	25	25	25	25	25	25	25	25	26	26	27	27	26	29	30	30	31
+34	37	36	35	34	33	32	31	31	30	29	28	27	26	26	25	24	24	24	23	23	23	23	23	23	23	23	23	23	24	24	25	25	26	27	28	28	29
+32	35	34	33	32	31	30	30	29	28	27	26	25	24	24	23	23	22	22	21	21	21	21	21	21	21	21	21	21	22	22	23	23	24	25	26	26	27
+30	33	33	32	31	30	29	28	27	26	25	24	23	22	22	21	21	20	20	19	19	19	19	19	19	19	19	19	19	20	20	21	21	22	23	24	24	25
+28	32	31	30	29	28	27	26	25	24	23	22	21	20	20	19	19	18	18	17	17	17	17	17	17	17	17	17	17	18	18	19	19	20	21	22	23	23
+26	30	29	28	27	26	25	24	23	22	21	20	19	18	18	17	17	16	16	15	15	15	15	15	15	15	15	15	15	16	16	17	18	18	19	20	21	21
+24	28	27	26	25	24	23	22	21	20	19	18	17	17	16	15	15	14	14	13	13	13	13	13	13	13	13	13	13	14	14	15	16	16	17	18	19	19
+22	26	25	24	23	22	21	20	19	18	17	16	15	15	14	13	13	12	12	11	11	11	11	11	11	11	11	11	11	12	12	13	14	14	15	16	17	18
+20	24	23	22	21	20	19	18	17	16	15	14	13	13	12	11	11	10	10	9	9	9	9	9	9	9	9	9	9	10	10	11	12	12	13	14	15	16
+18	22·	21	20	19	18	17	16	15	14	13	12	11	11	10	9	9	8	8	7	7	7	7	7	7	7	7	7	7	8	8	9	10	10	11	12	13	14
+16	20	19	18	17	16	15	14	13	12	11	10	9	9	8	7	7	6	6	5	5	5	5	5	5	5	5	5	5	6	6	7	8	8	9	10	11	12
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+12	16	15	14	13	12	11	10	9	8	7	6	5	5	4	3	3	2	2	1	1	1	1	1	1	1	1	1	1	2	2	3	4	4	5	6	7	8
+10	14	13	12	11	10	9	8	7	6	5	4	3	3	2	1	1	0	0	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	0	0	1	2	2	3	4	5	6
+ 8	12	11	10	9	8	7	6	5	4	3	2	1	1	0	- 1	- 1	- 2	- 2	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 2	- 2	- 1	0	0	1	2	3	4
+ 6	10	9	8	7	6	5	4	3	2	1	0	0	- 1	- 2	- 3	- 3	- 4	- 4	- 5	- 5	- 5	- 5	- 5	- 5	- 5	- 5	- 5	- 4	- 4	- 4	- 3	- 2	- 2	- 1	0	1	2
+ 4	8	7	6	5	4	3	2	1	0	- 1	- 2	- 2	- 3	- 4	- 5	- 5	- 6	- 6	- 7	- 7	- 7	- 7	- 7	- 7	- 7	- 7	- 7	- 6	- 6	- 6	- 5	- 4	- 4	- 3	- 2	- 1	0
+ 2	6	5	4	3	2	1	0	- 1	- 2	- 3	- 4	- 4	- 5	- 6	- 7	- 7	- 8	- 8	- 9	- 9	- 9	- 9	- 9	- 9	- 9	- 9	- 9	- 8	- 8	- 8	- 7	- 6	- 6	- 5	- 4	- 3	- 2
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-32	-27	-28	-29	-30	-31	-32	-33	-34	-35	-36	-37	-38	-39	-40	-40	-41	-42	-42	-43	-43	-43	-43	-43	-43	-43	-43	-43	-42	-42	-41	-41	-40	-39	-38	-37	-36	-35
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-36	-31	-32	-33	-34	-35	-36	-37	-38	-39	-40	-41	-42	-43	-43	-44	-45	-46	-46	-47	-47	-47	-47	-47	-47	-47	-47	-47	-46	-46	-45	-45	-44	-43	-42	-41	-40	-39
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-40	-35	-36	-37	-38	-39	-40	-41	-42	-43	-44	-45	-46	-47	-47	-48	-49	-50	-50	-51	-51	-51	-51	-51	-61	-51	-51	-51	-50	-50	-49	-48	-48	-47	-46	-45	-44	-43
-42	-37	-38	-39	-40	-41	-42	-43	-44	-45	-46	-47	-48	-48	-49	-60	-51	-51	-52	-63	-53	-53	-53	-53	-63	-53	-53	-53	-52	-52	-51	-50	-50	-49	-48	-47	-46	-45
-44	-39	-40	-41	-42	-43	-44	-45	-46	-47	-48	-49	-50	-50	-51	-52	-53	-53	-54	-65	-55	-55	-55	-65	-55	-55	-55	-55	-54	-54	-53	-52	-52	-51	-50	-49	-48	-47
-48	-41	-42	-43	-44	-45	-48	-47	-48	-49	-50	-51	-51	-52	-53	-54	-55	-55	-56	-57	-57	-57	-57	-57	-67	-57	-57	-57	-56	-56	-55	-64	-54	-63	-52	-51	-50	-49
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-54	-49	-60	-50	-51	-52	-53	-54	-55	-56	-57	-58	-59	-60	-51	-62	-63	-63	-64	-84	-65	-65	-65	-65	-65	-65	-65	-65	-64	-64	-63	-62	-61	-60	-59	-59	-58	-57
-56	-51	-51	-52	-53	-54	-55	-56	-57	-58	-59	-50	-81	-62	-63	-54	-64	-65	-66	-66	-67	-67	-67	-67	-67	-67	-67	-67	-66	-55	-65	-64	-63	-62	-61	-60	-59	-58
-58	-52	-53	-54	-55	-56	-57	-58	-59	-60	-61	-62	-63	-64	-65	-68	-66	-67	-68	-68	-69	-69	-69	-69	-69	-69	-69	-69	-68	-67	-57	-66	-65	-64	-63	-62	-61	-60
-60	-54	-55	-56	-57	-58	-59	-60	-81	-62	-63	-64	-65	-66	-67	-67	-68	-69	-70	-70	-71	-71	-71	-71	-71	-71	-71	-71	-70	-69	-69	-68	-67	-66	-65	-64	-83	-62
-82	-56	-57	-58	-59	-60	-61	-62	-63	-64	-65	-66	-67	-68	-68	-69	-70	-71	-72	-72	-73	-73	-73	-73	-73	-73	-73	-72	-72	-71	-71	-70	-69	-68	-67	-66	-65	-64
-64	-58	-59	-50	-61	-62	-62	-63	-64	-65	-66	-67	-68	-69	-70	-71	-72	-73	-74	-74	-75	-75	-75	-75	-75	-75	-75	-74	-74	-73	-72	-72	-71	-70	-69	-68	-57	-66
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-68	-62	-63	-63	-84	-65	-66	-67	-68	-69	-70	-71	-72	-73	-74	-75	-76	-77	-77	-78	-79	-79	-79	-79	-79	-79	-79	-78	-78	-77	-76	-75	-74	-73	-72	-71	-70	-69
-70	-64	-64	-65	-66	-67	-68	-69	-70	-71	-72	-73	-74	-75	-76	-76	-77	-78	-79	-80	-80	-81	-81	-81	-81	-81	-81	-80	-79	-79	-78	-77	-78	-75	-74	-73	-72	-71
-72	-85	-66	-67	-68	-69	-69	-70	-71	-72	-73	-74	-75	-75	-77	-78	-79	-80	-81	-82	-82	-83	-83	-83	-83	-83	-83	-82	-81	-80	-79	-78	-77	-76	-78	-75	-74	-73
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-76	-69	-70	-70	-71	-72	-73	-73	-74	-75	-76	-77	-78	-79	-80	-81	-82	-83	-84	-85	-86	-86	-87	-87	-87	-87	-86	-65	-84	-83	-82	-81	-80	-79	-78	-77	-76	-75
-78	-71	-71	-72	-73	-73	-74	-75	-78	-76	-77	-78	-79	-80	-81	-82	-83	-84	-85	-86	-87	-88	-88	-89	-89	-88	-87	-86	-85	-84	-83	-82	-81	-80	-79	-78	-78	-77
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-82	-74	-74	-75	-75	-76	-76	-77	-78	-78	-79	-80	-80	-81	-82	-82	-83	-84	-84	-85	-86	-86	-86	-86	-86	-86	-86	-65	-85	-84	-83	-83	-82	-81	-81	-80	-79	-79
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-88	-78	-78	-78	-78	-78	-78	-79	-79	-79	-79	-79	-79	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-80	-79	-79	-79

*North latitudes positive, south latitudes negative

TABLE 2

GEOMAGNETIC LATITUDES OF POINTS ON THE EARTH IN VARIOUS GEOGRAPHIC LATITUDES AND LONGITUDES (CONTINUED)

Geographic latitude	Geographic east longitude in degrees																																				
	180	185	190	195	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305	310	315	320	325	330	335	340	345	350	355	360
+88	78	78	78	78	78	78	79	79	79	79	79	79	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	79	79	79
+86	77	77	77	77	78	78	78	79	79	79	80	80	80	81	81	81	82	82	82	82	82	82	83	82	82	82	82	82	82	82	81	81	81	80	80	80	79
+84	75	76	76	76	77	77	78	78	79	79	80	80	81	82	82	82	83	83	84	84	[illegible]	84	84	84	84	84	84	83	63	83	82	82	81	81	80	80	79
+82	74	74	75	75	76	76	77	78	78	79	80	80	81	82	82	63	84	84	85	86	86	86	88	86	86	86	85	85	84	83	83	82	81	81	80	79	79
+80	72	73	73	74	75	75	76	77	77	78	79	80	81	82	82	83	84	65	86	87	[illegible]	88	88	88	88	87	86	65	85	84	83	82	81	80	79	79	78
+78	71	71	72	73	73	74	75	76	78	77	78	79	80	81	82	83	64	65	86	87	88	88	89	89	88	87	88	85	84	83	82	81	80	79	78	78	77
+76	69	70	70	71	72	73	73	74	75	76	77	78	79	80	81	82	83	84	85	86	86	87	87	87	87	86	65	84	83	82	81	80	79	78	77	76	75
+74	67	68	69	69	70	71	72	73	74	75	76	77	78	79	80	81	82	82	83	84	[illegible]	65	65	86	65	64	64	83	82	81	80	79	78	77	76	75	74
+72	65	66	67	68	69	69	70	71	72	73	74	75	76	77	78	79	80	81	82	82	[illegible]	83	83	83	83	83	82	81	80	79	78	77	76	76	75	74	73
+70	64	64	65	66	67	68	69	70	71	72	73	74	75	76	76	77	78	79	80	80	81	81	81	81	81	81	80	79	79	78	77	76	75	74	73	72	71
+68	62	63	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	77	78	79	79	79	79	79	79	79	78	78	77	76	75	74	73	72	71	70	69
+66	60	61	62	62	63	64	65	66	67	68	69	70	71	72	73	74	75	75	76	77	77	77	77	77	77	77	76	76	75	74	73	72	72	71	70	69	68
+64	58	59	60	61	62	62	63	64	65	66	67	68	69	70	71	72	73	74	74	75	75	75	75	76	75	75	74	74	73	72	72	71	70	69	68	67	66
+62	56	57	58	59	60	61	62	63	64	65	66	67	68	68	69	70	71	72	72	73	73	73	73	73	73	73	72	72	71	71	70	69	68	67	66	65	64
+60	54	56	56	67	58	59	60	61	62	63	64	65	66	67	67	68	69	70	70	71	71	71	71	71	71	71	71	70	69	69	68	67	66	65	64	63	62
+58	52	53	54	56	56	57	58	59	60	61	62	63	64	65	66	66	67	68	68	69	69	69	69	69	69	69	69	68	67	67	66	65	64	63	62	61	60
+56	51	61	52	63	54	65	56	57	58	59	60	61	62	63	64	64	65	66	66	67	67	67	67	67	67	67	67	66	65	65	64	63	62	61	60	59	58
+54	49	50	50	51	52	53	54	55	56	57	58	59	60	61	62	63	63	64	64	65	65	65	65	65	65	65	65	64	64	63	62	61	60	69	59	58	57
+52	47	48	48	49	50	51	52	53	54	55	56	57	58	69	60	61	61	62	62	63	63	63	63	63	63	83	63	62	62	61	60	59	58	58	57	66	55
+50	45	46	47	48	48	49	50	51	52	53	54	55	56	57	58	59	59	60	60	61	61	61	61	61	81	61	61	60	60	59	58	57	57	56	55	64	53
+48	43	44	46	46	47	48	49	50	50	51	52	53	54	55	56	57	57	58	58	59	59	59	59	59	59	59	59	58	58	57	56	55	55	54	53	52	51
+46	41	42	43	44	45	46	47	48	49	50	51	51	52	53	54	55	55	66	57	57	57	57	57	57	57	57	57	56	56	55	54	54	53	52	51	50	49
+44	39	40	41	42	43	44	45	46	47	48	49	50	50	51	52	53	63	54	55	55	[illegible]	55	56	55	55	56	55	54	54	53	52	52	51	50	49	48	47
+42	37	38	39	40	41	42	43	44	45	46	47	48	48	49	60	51	51	52	53	53	53	53	53	63	53	53	53	52	52	51	50	50	49	48	47	46	45
+40	35	38	37	38	39	40	41	42	43	44	45	46	47	47	48	49	50	50	51	51	51	51	61	51	51	51	51	50	50	49	48	48	47	46	45	44	43
+38	33	34	35	36	37	38	39	40	41	42	43	44	45	45	46	47	48	48	49	49	49	49	49	49	49	49	49	48	48	47	46	46	45	44	43	42	41
+36	31	32	33	34	35	36	37	38	39	40	41	42	43	43	44	45	46	46	47	47	47	47	47	47	47	47	47	46	46	45	45	44	43	42	41	40	39
+34	29	30	31	32	33	34	35	36	37	38	39	40	41	42	42	43	44	44	45	45	45	45	45	45	45	45	45	44	44	43	43	42	41	40	39	38	37
+32	27	28	29	30	31	32	33	34	35	36	37	38	39	40	40	41	42	42	43	43	43	43	43	43	43	43	43	42	42	41	41	49	39	38	37	38	35
+30	25	26	27	28	29	30	31	32	33	34	35	36	37	38	38	39	40	40	41	41	41	41	41	41	41	41	41	40	40	39	39	38	37	38	35	34	33
+28	23	24	25	26	27	28	29	30	31	32	33	34	35	36	38	37	38	38	39	39	39	39	39	39	39	39	39	38	38	37	37	38	35	34	33	32	32
+26	21	22	23	24	25	26	27	28	29	30	31	32	33	34	34	35	36	36	37	37	37	37	37	37	37	37	37	36	36	35	35	34	33	32	31	31	30
+24	19	20	21	22	23	24	25	26	27	28	29	30	31	32	32	33	34	34	35	35	35	35	35	36	35	35	35	34	34	33	33	32	31	30	29	29	28
+22	18	18	19	20	21	22	23	24	25	26	27	28	29	30	30	31	32	32	33	33	33	33	33	33	33	33	33	32	32	31	31	30	29	28	28	27	26
+20	16	16	17	18	19	20	21	22	23	24	25	26	27	28	28	29	30	30	31	31	31	31	31	31	31	31	31	30	30	29	29	28	27	26	26	25	24
+18	14	15	15	16	17	18	19	20	21	22	23	24	25	26	26	27	28	28	29	29	29	29	29	29	29	29	29	28	28	27	27	26	25	24	24	23	22
+16	12	13	14	14	15	16	17	18	19	20	21	22	23	24	24	25	26	26	27	27	27	27	27	27	27	27	27	26	26	25	25	24	23	22	22	21	20
+14	10	11	12	13	14	15	16	16	17	18	19	20	21	22	23	23	24	24	25	25	25	25	25	25	25	25	25	24	24	23	23	22	21	21	20	19	18
+12	8	9	10	11	12	13	14	15	15	16	17	18	19	20	21	21	22	22	23	23	23	23	23	23	23	23	23	22	22	21	21	20	19	19	18	17	16
+10	6	7	8	9	10	11	12	13	14	14	15	16	17	18	19	19	20	20	21	21	21	21	21	21	21	21	21	20	20	19	19	18	17	17	16	15	14
+ 8	4	5	6	7	8	9	10	11	12	13	13	14	15	16	17	17	18	18	19	19	19	19	19	19	19	19	19	18	18	17	17	16	15	15	14	13	12
+ 6	2	3	4	5	6	7	8	9	10	11	11	12	13	14	15	15	16	16	17	17	17	17	17	17	17	17	17	16	16	15	15	14	13	13	12	11	10
+ 4	0	1	2	3	4	5	6	7	8	9	9	10	11	12	13	13	14	14	15	15	15	15	15	15	15	15	15	14	14	13	13	12	11	11	10	9	8
+ 2	- 2	- 1	0	1	2	3	4	5	6	7	8	8	9	10	11	11	12	12	13	13	13	13	13	13	13	13	13	12	12	11	11	10	9	9	8	7	6
0	- 4	- 3	- 2	- 1	0	1	2	3	4	5	6	6	7	8	9	9	10	10	11	11	11	11	11	11	11	11	11	10	10	10	9	8	8	7	6	5	4
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- 4	- 8	- 7	- 6	- 5	- 4	- 3	- 2	- 1	0	1	2	2	3	4	5	5	6	6	7	7	7	7	7	7	7	7	7	6	6	6	5	4	4	3	2	1	0
- 6	-10	- 9	- 8	- 7	- 6	- 5	- 4	- 3	- 2	- 1	0	0	1	2	3	3	4	4	5	5	5	5	5	5	5	5	5	4	4	4	3	2	2	1	0	- 1	- 2
- 8	-12	-11	-10	- 9	- 8	- 7	- 6	- 5	- 4	- 3	- 2	- 1	- 1	0	1	1	2	2	3	3	3	3	3	3	3	3	3	3	2	2	1	0	0	- 1	- 2	- 3	- 4
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-38	-41	-40	-39	-38	-37	-36	-35	-34	-34	-33	-32	-31	-30	-30	-29	-28	-28	-28	-27	-27	-27	-27	-27	-27	-27	-27	-27	-27	-28	-28	-29	-29	-30	-31	-31	-32	-33
-40	-43	-42	-41	-40	-39	-38	-37	-36	-35	-35	-34	-33	-32	-32	-31	-30	-30	-30	-29	-29	-29	-29	-29	-29	-29	-29	-29	-29	-30	-30	-31	-31	-32	-33	-33	-34	-35
-42	-45	-44	-43	-42	-41	-40	-39	-38	-37	-37	-36	-35	-34	-34	-33	-32	-32	-32	-31	-31	-31	-31	-31	-31	-31	-31	-31	-31	-32	-32	-33	-33	-34	-35	-35	-36	-37
-44	-47	-46	-45	-44	-43	-42	-41	-40	-39	-38	-38	-37	-36	-36	-35	-34	-34	-34	-33	-33	-33	-33	-33	-33	-33	-33	-33	-33	-34	-34	-35	-35	-36	-37	-37	-38	-39
-46	-49	-48	-47	-46	-45	-44	-43	-42	-41	-40	-40	-39	-38	-38	-37	-36	-38	-35	-35	-35	-35	-36	-35	-35	-35	-35	-35	-35	-36	-36	-37	-37	-38	-39	-39	-40	-41
-48	-51	-50	-49	-48	-47	-46	-45	-44	-43	-42	-42	-41	-40	-39	-39	-38	-38	-37	-37	-37	-37	-37	-37	-37	-37	-37	-37	-37	-38	-38	-39	-39	-40	-41	-41	-42	-43
-50	-53	-52	-51	-50	-49	-48	-47	-46	-45	-44	-44	-43	-42	-41	-41	-40	-40	-39	-39	-39	-39	-39	-39	-39	-39	-39	-39	-39	-40	-40	-41	-41	-42	-42	-43	-44	-45
-52	-55	-54	-53	-52	-51	-50	-49	-48	-47	-46	-45	-45	-44	-43	-43	-42	-42	-41	-41	-41	-41	-41	-41	-41	-41	-41	-41	-41	-42	-42	-43	-43	-44	-44	-45	-46	-47
-54	-57	-56	-55	-54	-53	-52	-51	-50	-49	-48	-47	-47	-46	-45	-45	-44	-44	-43	-43	-43	-43	-43	-43	-43	-43	-43	-43	-43	-44	-44	-45	-45	-46	-46	-47	-48	-49
-56	-58	-57	-56	-55	-55	-54	-53	-52	-51	-50	-49	-49	-48	-47	-47	-46	-46	-45	-45	-45	-45	-45	-45	-45	-45	-45	-45	-45	-46	-46	-47	-47	-48	-48	-49	-50	-51
-58	-60	-59	-58	-57	-56	-55	-55	-54	-53	-52	-51	-51	-50	-49	-49	-48	-48	-47	-47	-47	-47	-47	-47	-47	-47	-47	-47	-47	-48	-48	-49	-49	-50	-50	-51	-62	-52
-60	-62	-61	-80	-59	-68	-67	-56	-56	-55	-54	-53	-52	-52	-51	-51	-50	-50	-49	-49	-49	-49	-49	-49	-49	-49	-49	-49	-49	-50	-50	-50	-51	-52	-52	-53	-54	-54
-62	-64	-63	-62	-81	-80	-59	-58	-67	-57	-56	-55	-54	-54	-53	-53	-52	-52	-51	-51	-51	-51	-51	-51	-51	-51	-51	-51	-51	-52	-52	-52	-53	-54	-54	-55	-56	-56
-64	-66	-65	-64	-63	-62	-61	-60	-59	-58	-58	-57	-66	-56	-55	-55	-54	-54	-53	-53	-53	-53	-53	-53	-53	-53	-53	-53	-53	-54	-54	-64	-65	-55	-56	-57	-67	-58
-66	-68	-67	-66	-65	-64	-63	-62	-61	-60	-60	-59	-58	-58	-57	-57	-66	-66	-55	-55	-55	-55	-55	-55	-55	-55	-55	-55	-56	-56	-56	-58	-57	-57	-58	-59	-59	-60
-68	-69	-68	-67	-66	-65	-66	-64	-63	-62	-61	-61	-60	-60	-59	-58	-58	-58	-57	-57	-57	-57	-57	-57	-57	-57	-57	-57	-57	-57	-58	-58	-59	-69	-60	-60	-61	-62
-70	-71	-70	-69	-68	-67	-66	-66	-65	-64	-63	-63	-62	-61	-61	-60	-60	-60	-59	-59	-59	-59	-59	-59	-59	-69	-59	-69	-69	-59	-60	-60	-61	-61	-62	-62	-63	-64
-72	-73	-72	-71	-70	-69	-68	-67	-66	-66	-65	-64	-64	-63	-63	-62	-62	-62	-61	-61	-61	-61	-61	-61	-81	-61	-61	-81	-61	-61	-62	-62	-63	-63	-84	-64	-65	-65
-74	-74	-73	-72	-71	-71	-70	-69	-68	-88	-67	-66	-66	-65	-65	-64	-64	-64	-63	-63	-63	-63	-83	-63	-63	-63	-63	-63	-63	-63	-64	-64	-64	-65	-65	-66	-67	-67
-76	-75	-75	-74	-73	-72	-71	-71	-70	-69	-69	-68	-68	-67	-67	-66	-66	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-66	-66	-66	-67	-67	-68	-68	-69
-78	-77	-76	-75	-74	-74	-73	-72	-72	-71	-70	-70	-69	-69	-68	-68	-68	-67	-67	-67	-67	-67	-67	-67	-67	-67	-67	-67	-67	-67	-68	-66	-68	-69	-69	-70	-70	-71
-80	-78	-77	-76	-76	-75	-74	-74	-73	-73	-72	-71	-71	-71	-70	-70	-70	-69	-69	-69	-69	-69	-69	-69	-69	-69	-69	-69	-69	-69	-69	-70	-70	-70	-71	-71	-72	-72
-82	-79	-78	-77	-77	-76	-76	-75	-75	-74	-74	-73	-73	-72	-72	-72	-71	-71	-71	-71	-71	-71	-71	-71	-71	-71	-71	-71	-71	-71	-71	-72	-72	-72	-73	-73	-73	-74
-84	-79	-79	-78	-78	-77	-77	-76	-76	-75	-75	-75	-74	-74	-74	-74	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-73	-74	-74	-74	-75	-75	-75
-86	-79	-79	-79	-78	-78	-78	-77	-77	-77	-76	-76	-76	-76	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-75	-76	-76	-76	-76	-77
-88	-79	-79	-79	-79	-78	-78	-78	-78	-78	-78	-77	-77	-77	-77	-77	-77	-77	-77	-77	-77	-77	-77	-76	-76	-77	-77	-77	-77	-77	-77	-77	-77	-77	-77	-77	-78	-78

*North latitudes positive, south latitudes negative

TABLE 2

SOLUTION OF F2-LAYER TRANSMISSION PROBLEM FOR A PATH LESS THAN OR EQUAL TO 4000 KM

From ______________________ To ______________________ Distance __________ km Predicted for ________ 19 __

Geomagnetic latitude for path midpoint ________

One-half gyrofrequency ($f_H/2$) for path midpoint _____

Note: All frequencies are in Megacycles

Procedure	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Compute	Compute	Scale - use Fig.	Compute
	f(50)	b_f	(R-50)	f(R) = a + bc	M(50)	b_M	M(R) = e + cf	median F2-4000-MUF(R) = dg	median F2-zero-MUF(R) = d + $f_H/2$	median F2-MUF for path	F2-FOT for path = 0.85j
GMT	a	b	c	d	e	f	g	h	i	j	k
00											
02											
04											
06											
08											
10											
12											
14											
16											
18											
20											
22											
Done by											
Checked											

FIGURE 7

SOLUTION OF F2-LAYER TRANSMISSION PROBLEM FOR A PATH GREATER THAN 4000 KM

From ______________ To ______________ Distance __________ km Predicted for __________ 19 __

Geomagnetic latitude for control point A __________ and control point B __________

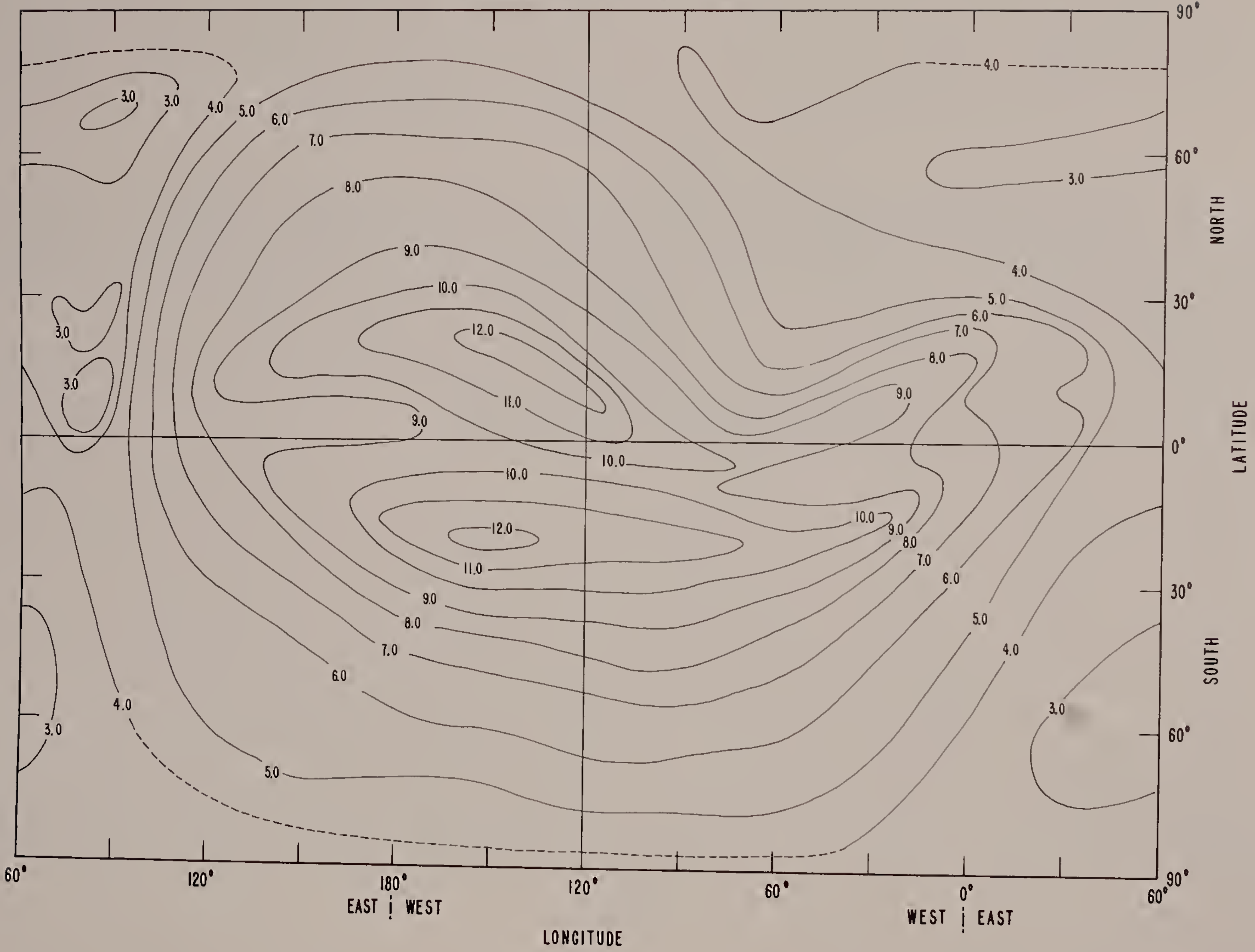
Note: All frequencies are in Megacycles

Procedure	Control Point A								Control Point B							Lower of h and o	Compute
	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Scale	Scale	Compute	Compute		
	f(50)	b_f	(R-50)	f(R) = a + bc	M(50)	b_M	M(R) = e + cf	median F2-4000-MUF(R) = dg	f(50)	b_f	f(R) = i + cj	M(50)	b_M	M(R) = ℓ + cm	median F2-4000-MUF(R) = kn	median F2-MUF for path	F2-FOT for path = 0.85p
GMT	a	b	c	d	e	f	g	h	i	j	k	ℓ	m	n	o	p	q
00																	
02																	
04																	
06																	
08																	
10																	
12																	
14																	
16																	
18																	
20																	
22																	
Done by																	
checked																	

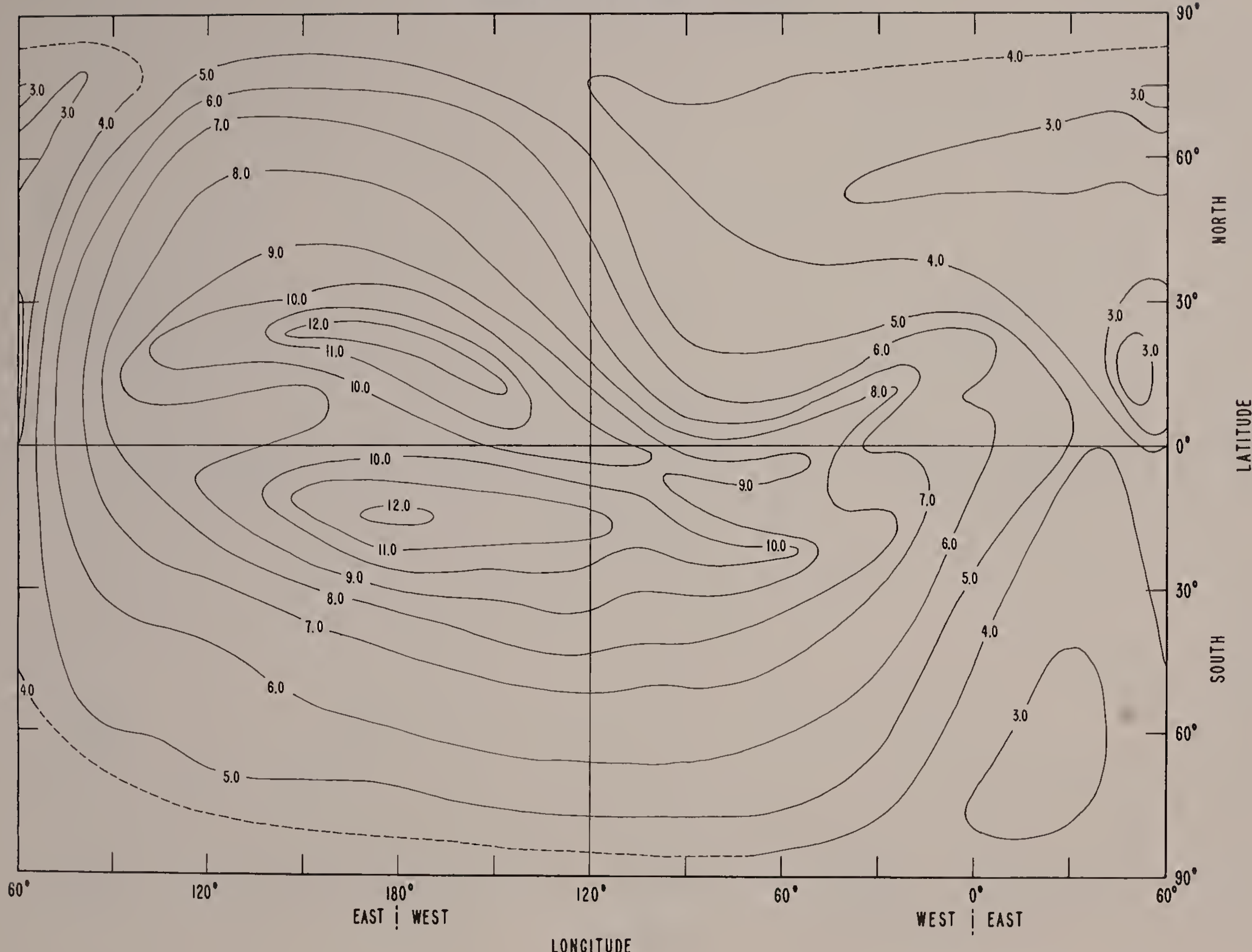
FIGURE 8

VI. WORLD PREDICTION MAPS AND PREDICTION CHARTS

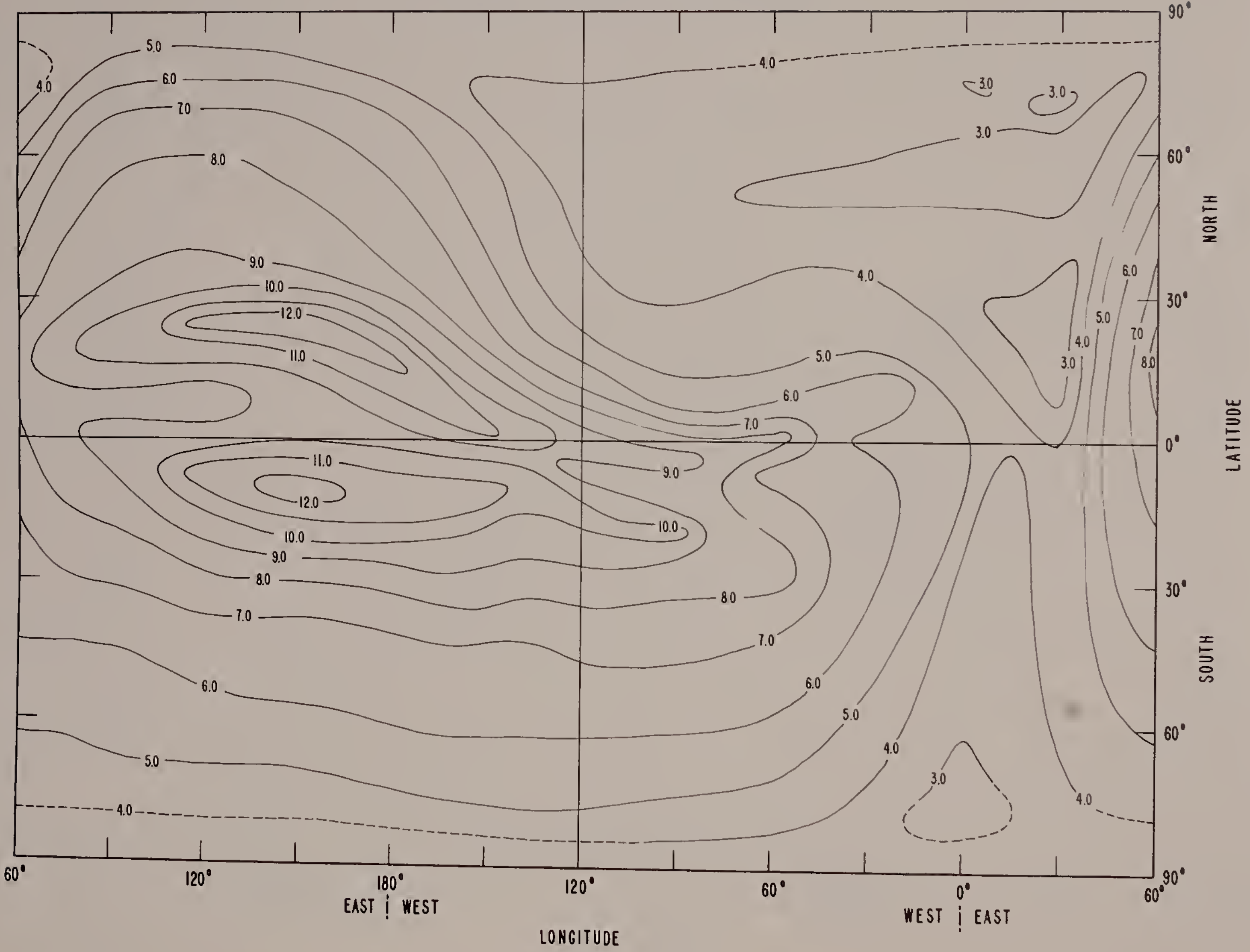
f_oF2 AT RASSN 50
FEBRUARY 0000 HOURS GMT



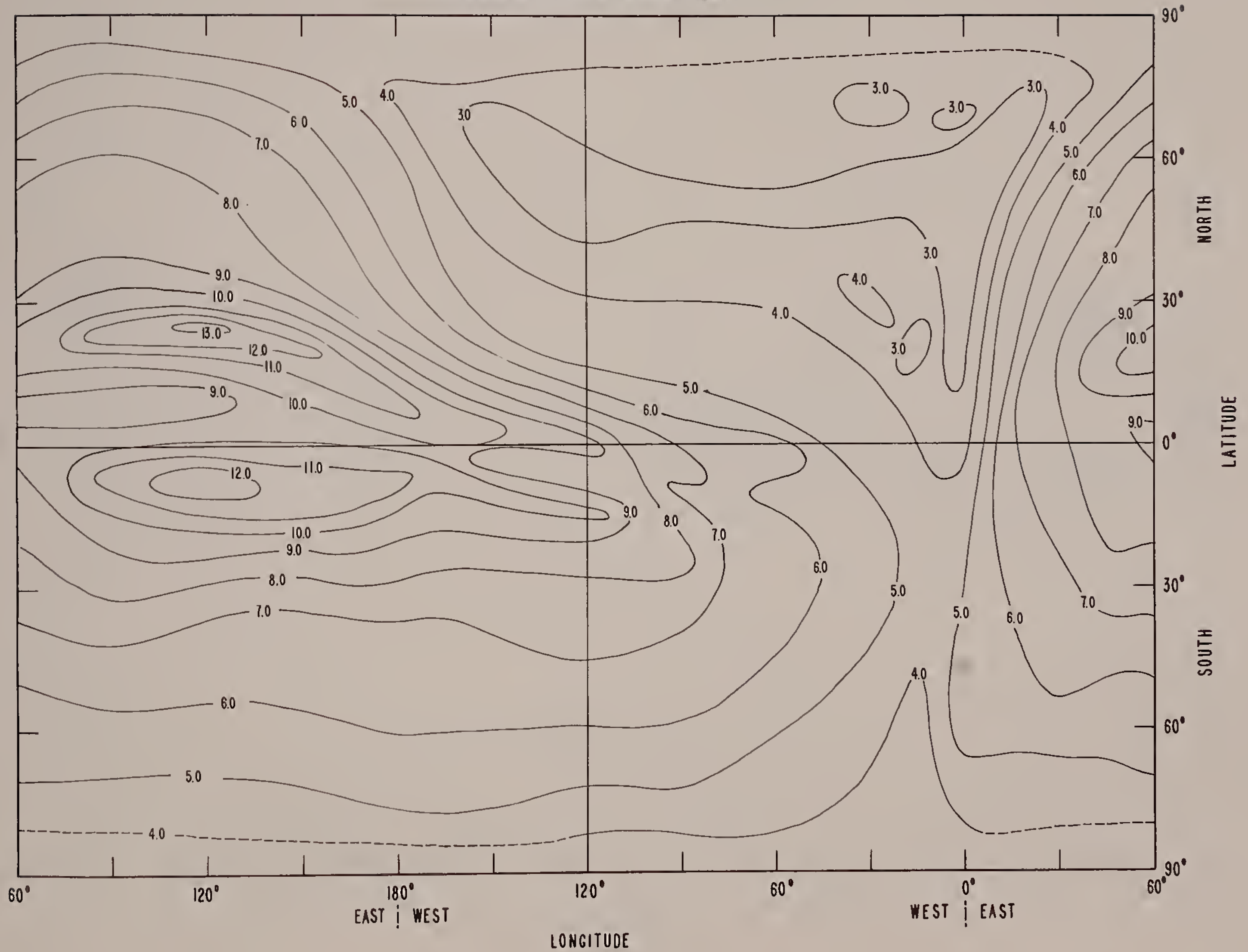
foF2 AT RASSN 50
FEBRUARY 0200 HOURS GMT



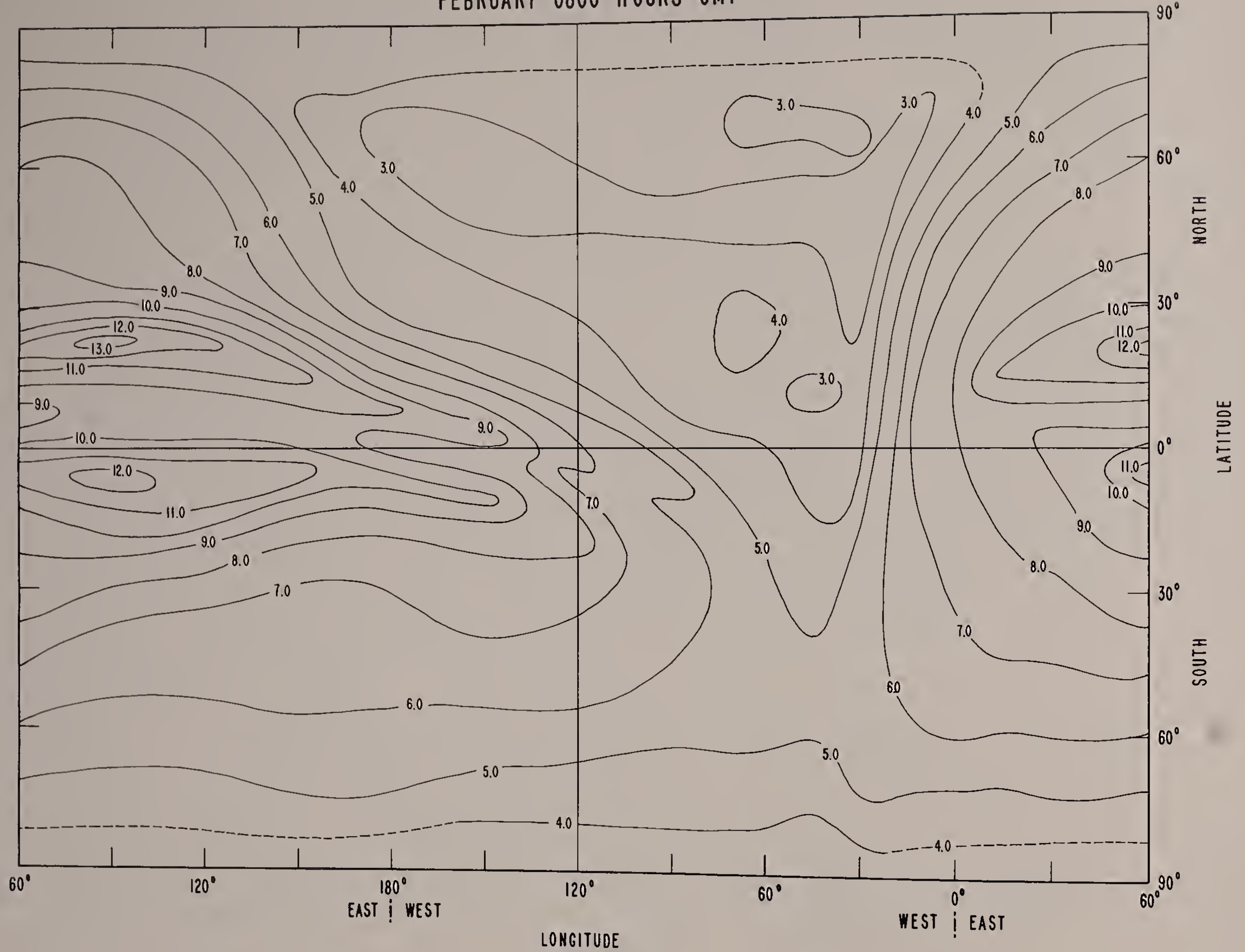
f_oF2 AT RASSN 50
FEBRUARY 0400 HOURS GMT



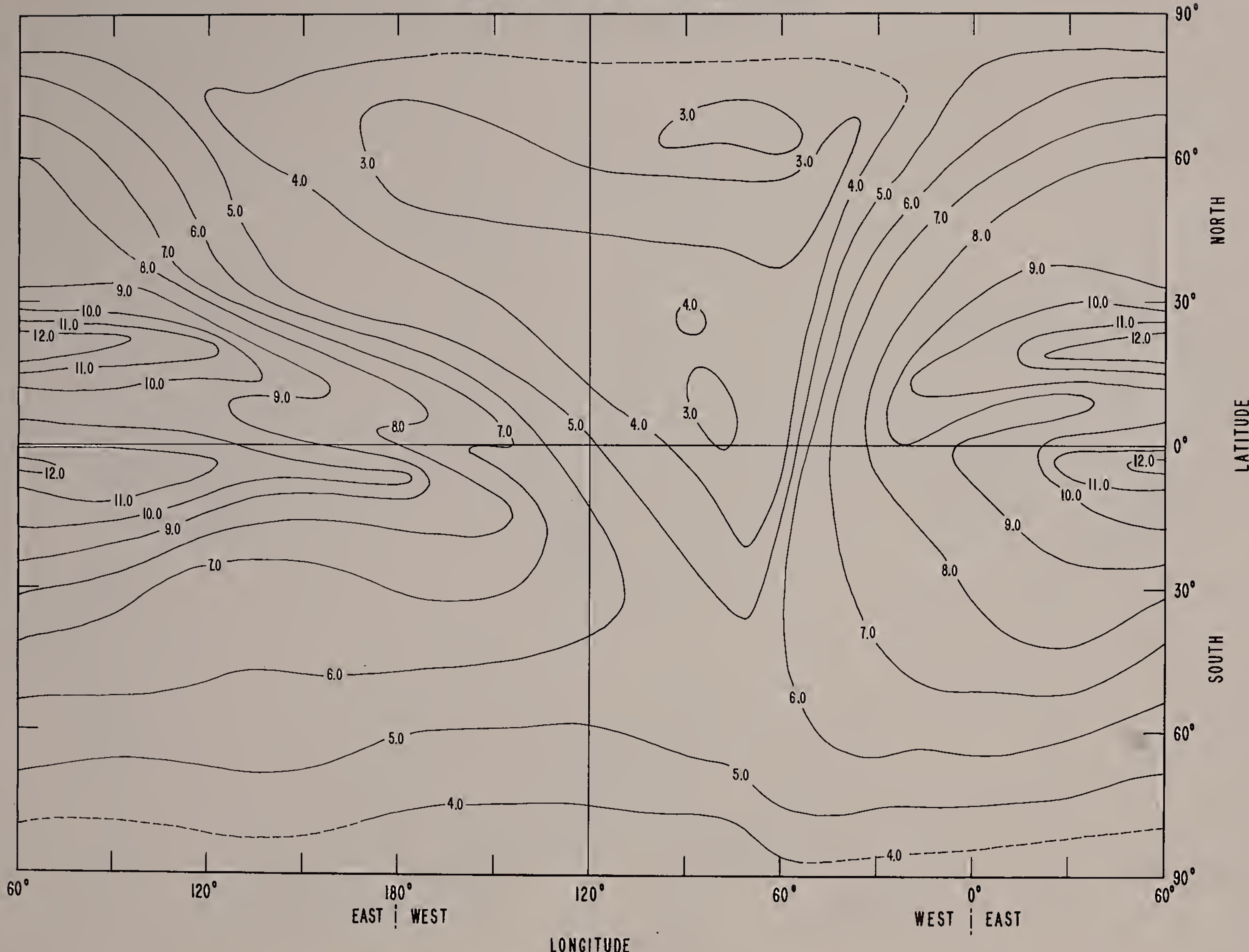
fₒF2 AT RASSN 50
FEBRUARY 0600 HOURS GMT



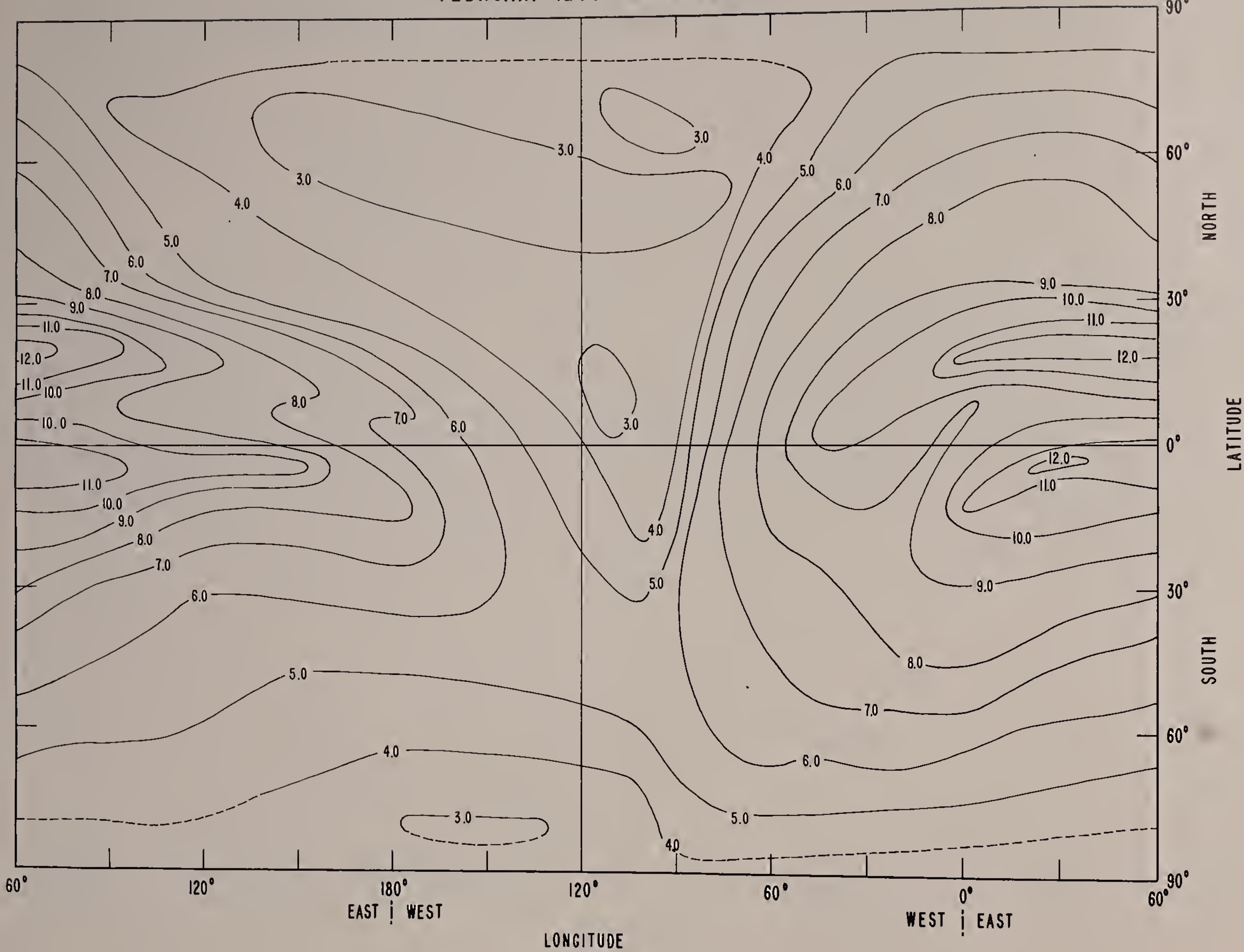
f_oF2 AT RASSN 50
FEBRUARY 0800 HOURS GMT



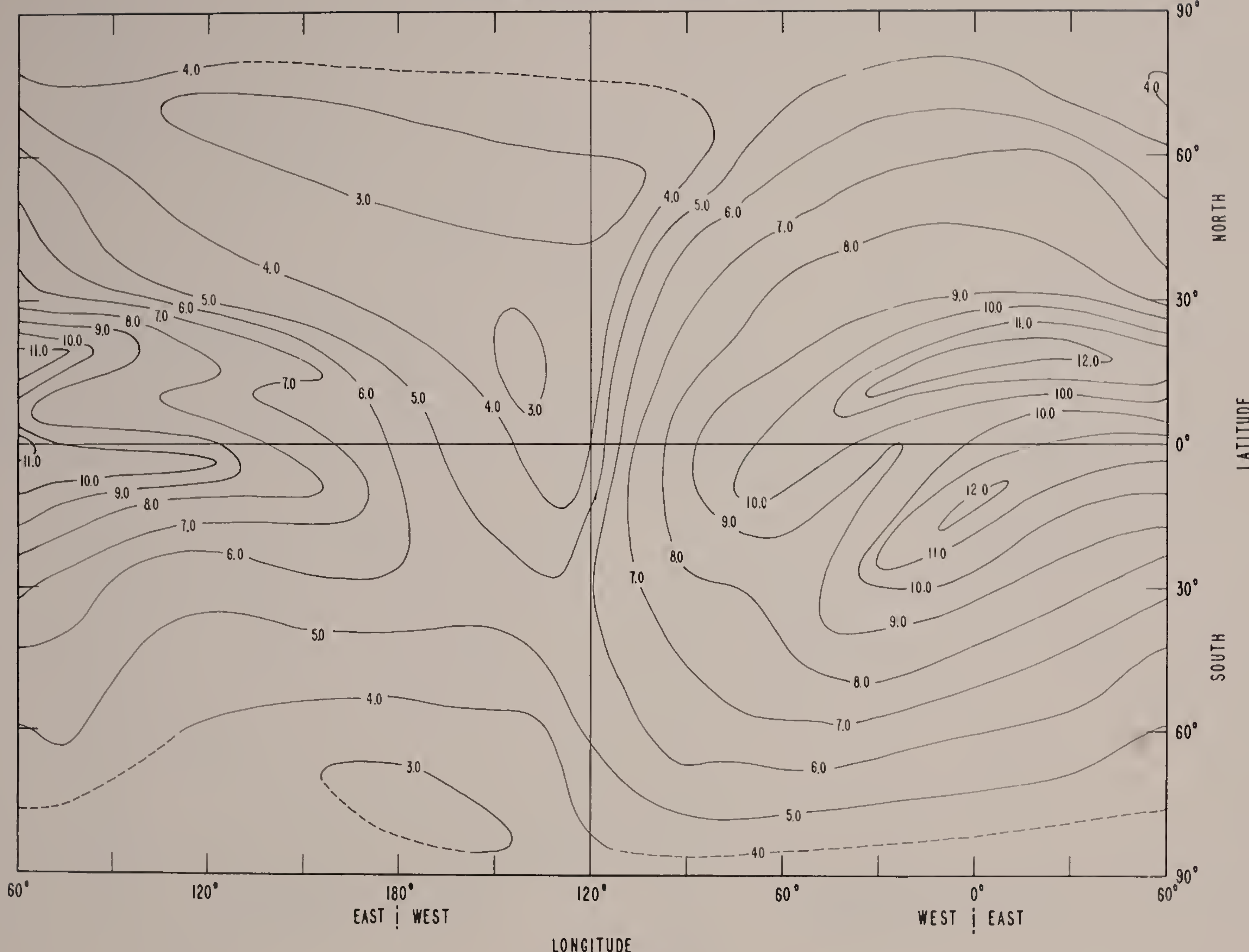
f_oF2 AT RASSN 50
FEBRUARY 1000 HOURS GMT



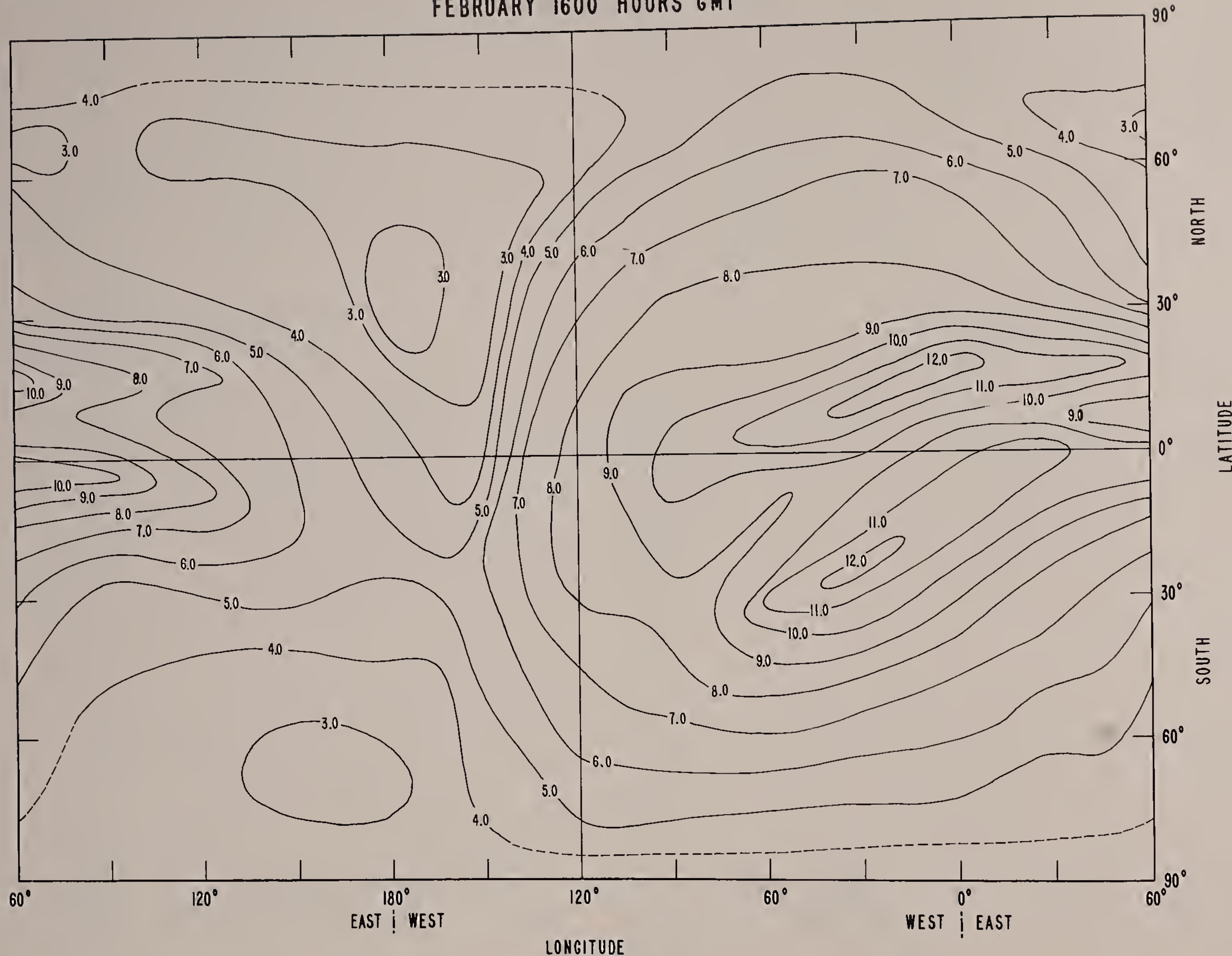
f_oF2 AT RASSN 50
FEBRUARY 1200 HOURS GMT



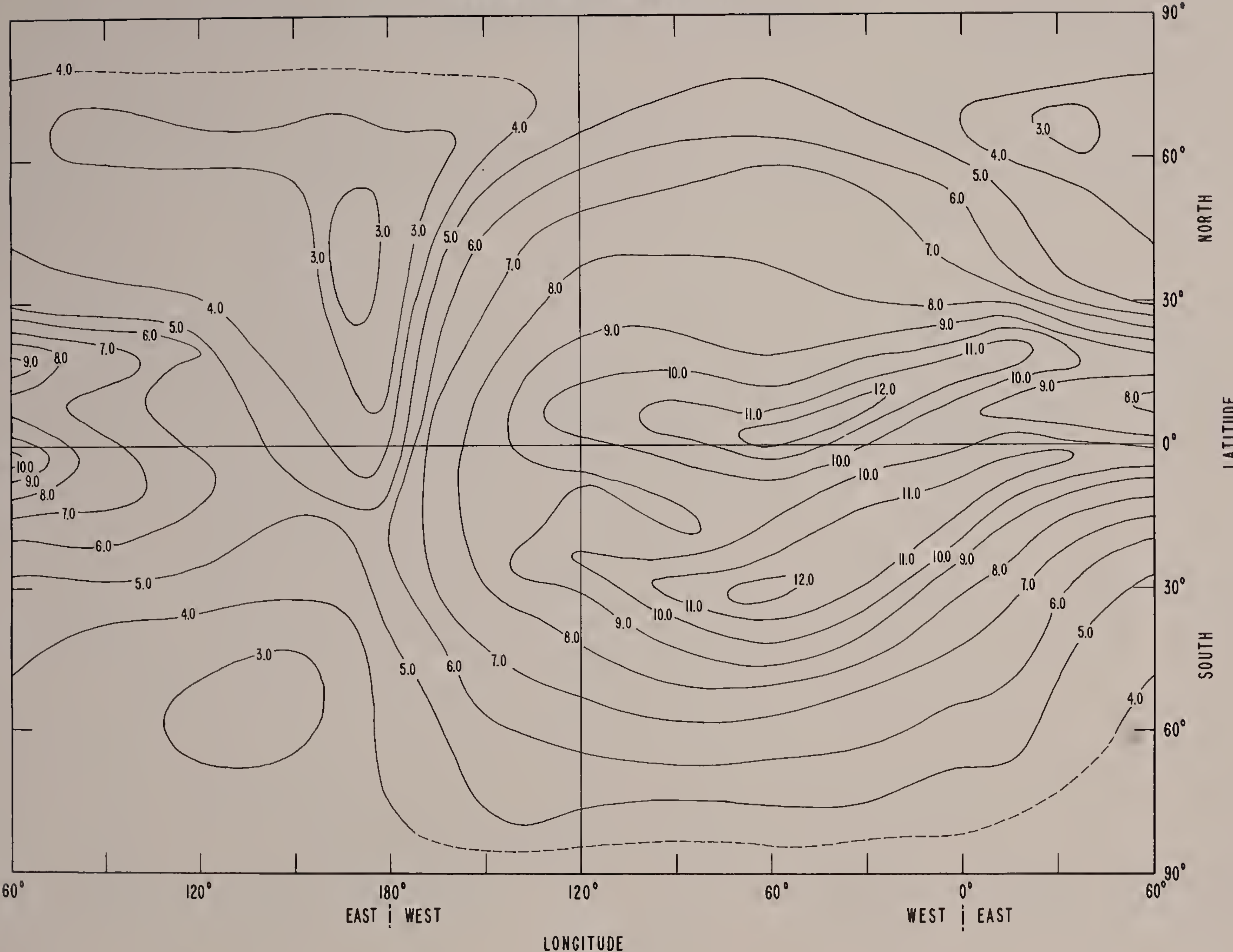
f_oF2 AT RASSN 50
FEBRUARY 1400 HOURS GMT



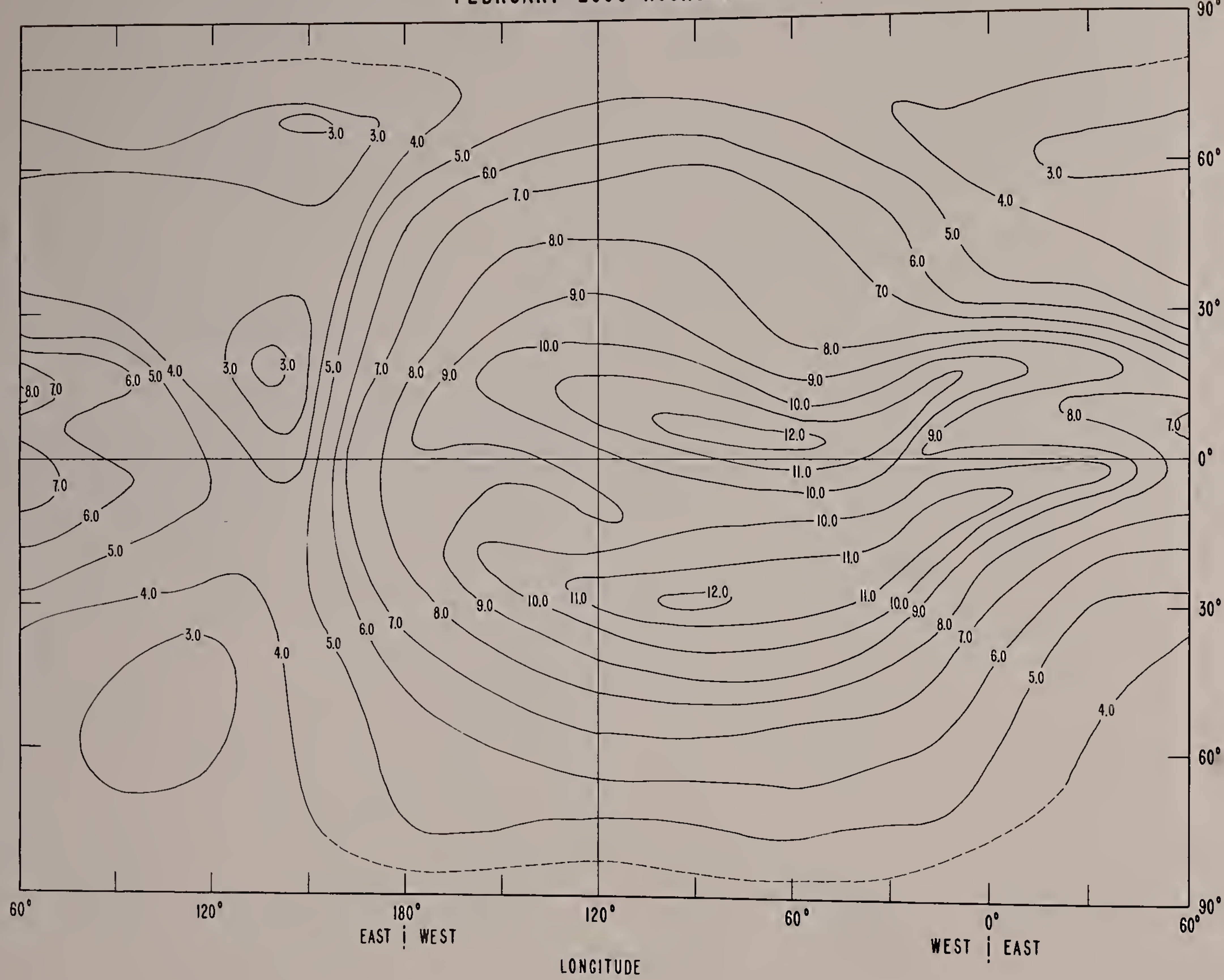
foF2 AT RASSN 50
FEBRUARY 1600 HOURS GMT



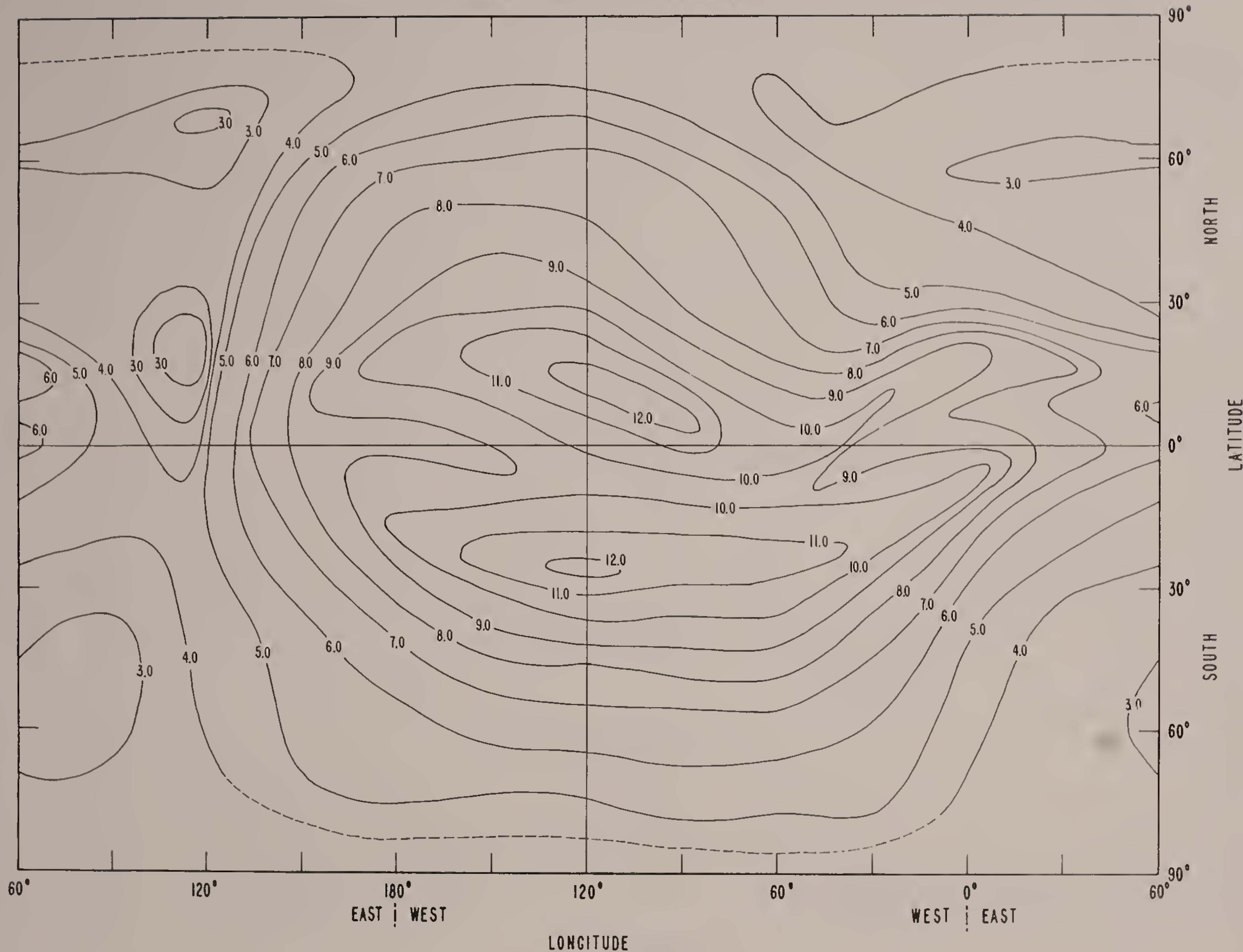
f₀F2 AT RASSN 50
FEBRUARY 1800 HOURS GMT



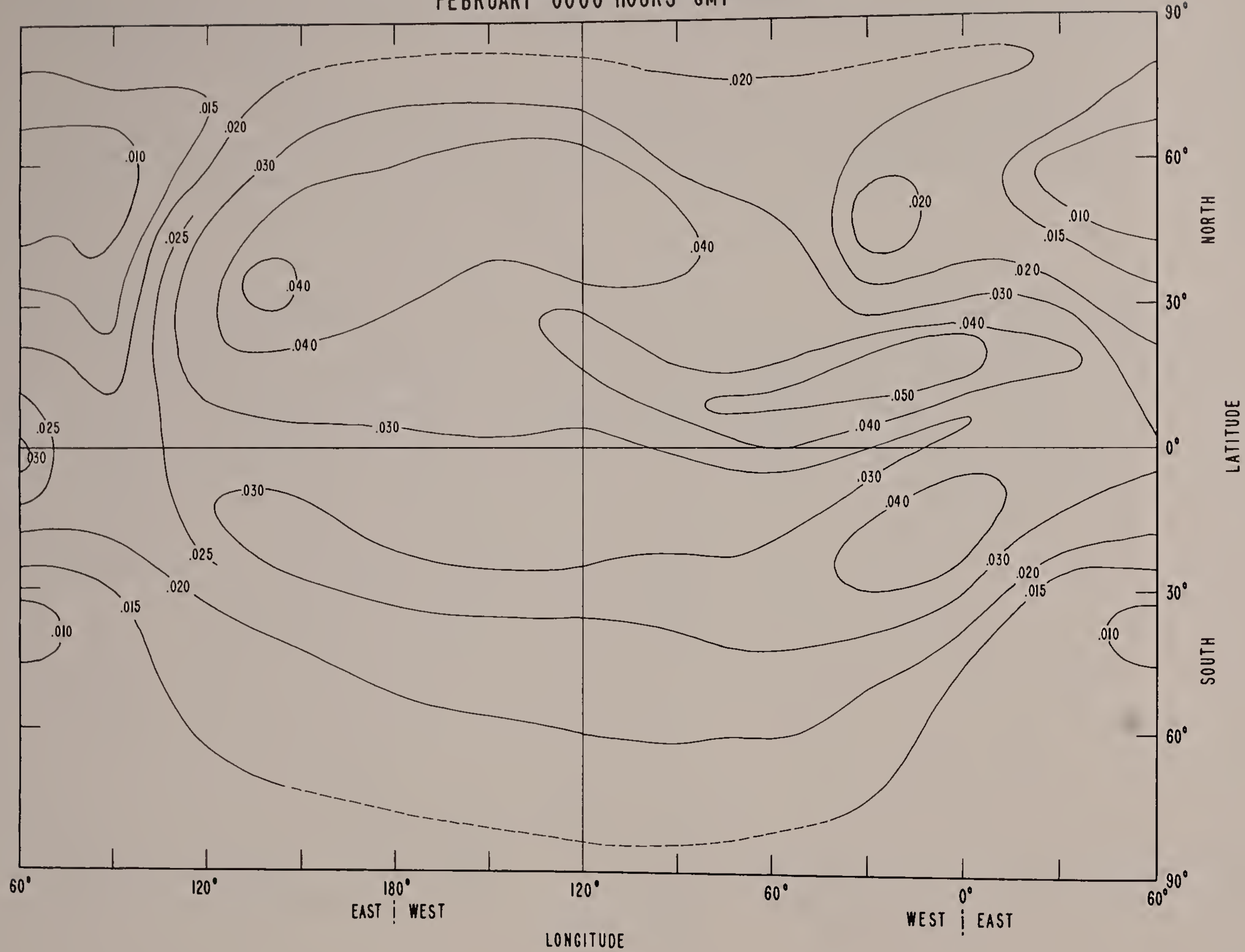
f_oF2 AT RASSN 50
FEBRUARY 2000 HOURS GMT



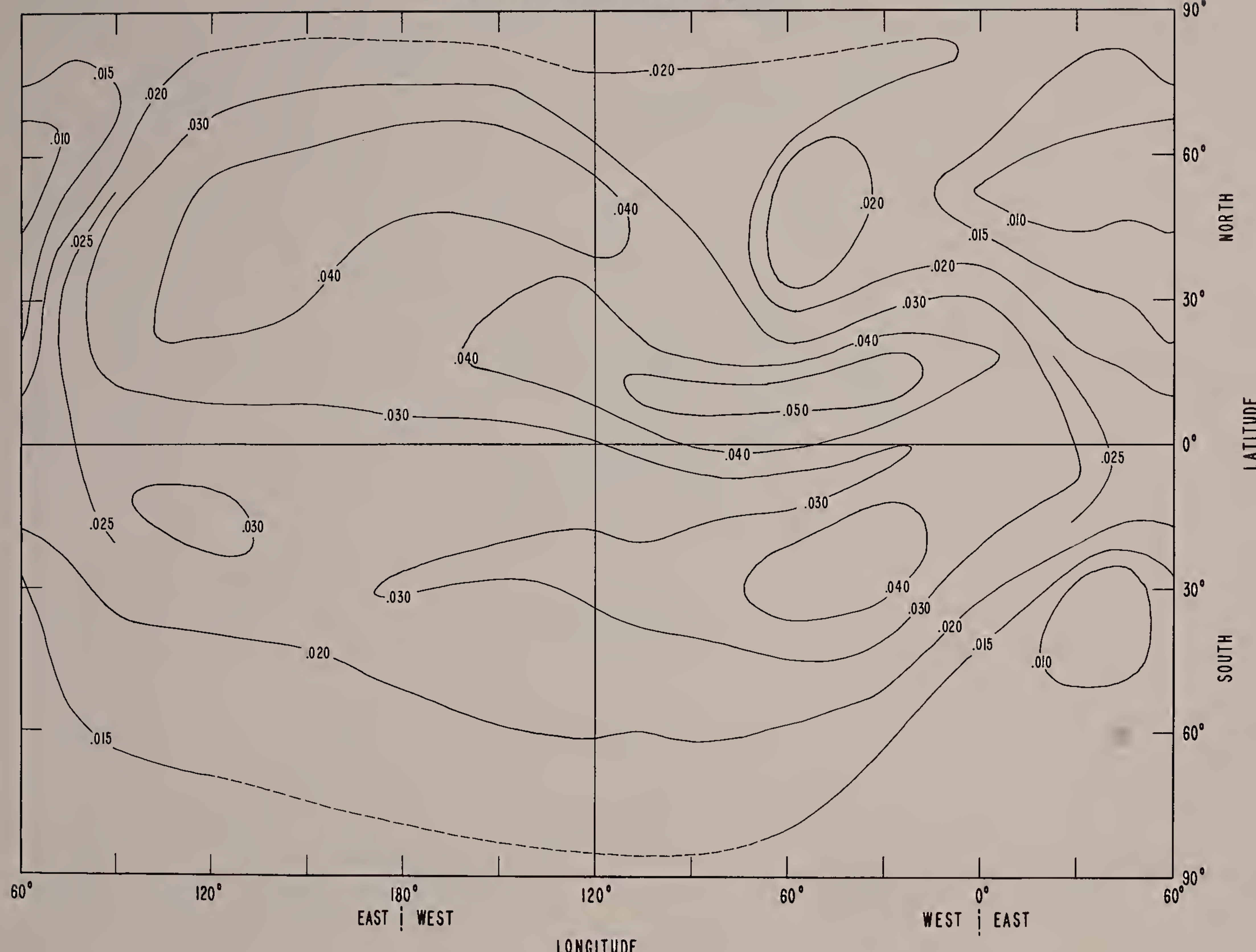
foF2 AT RASSN 50
FEBRUARY 2200 HOURS GMT



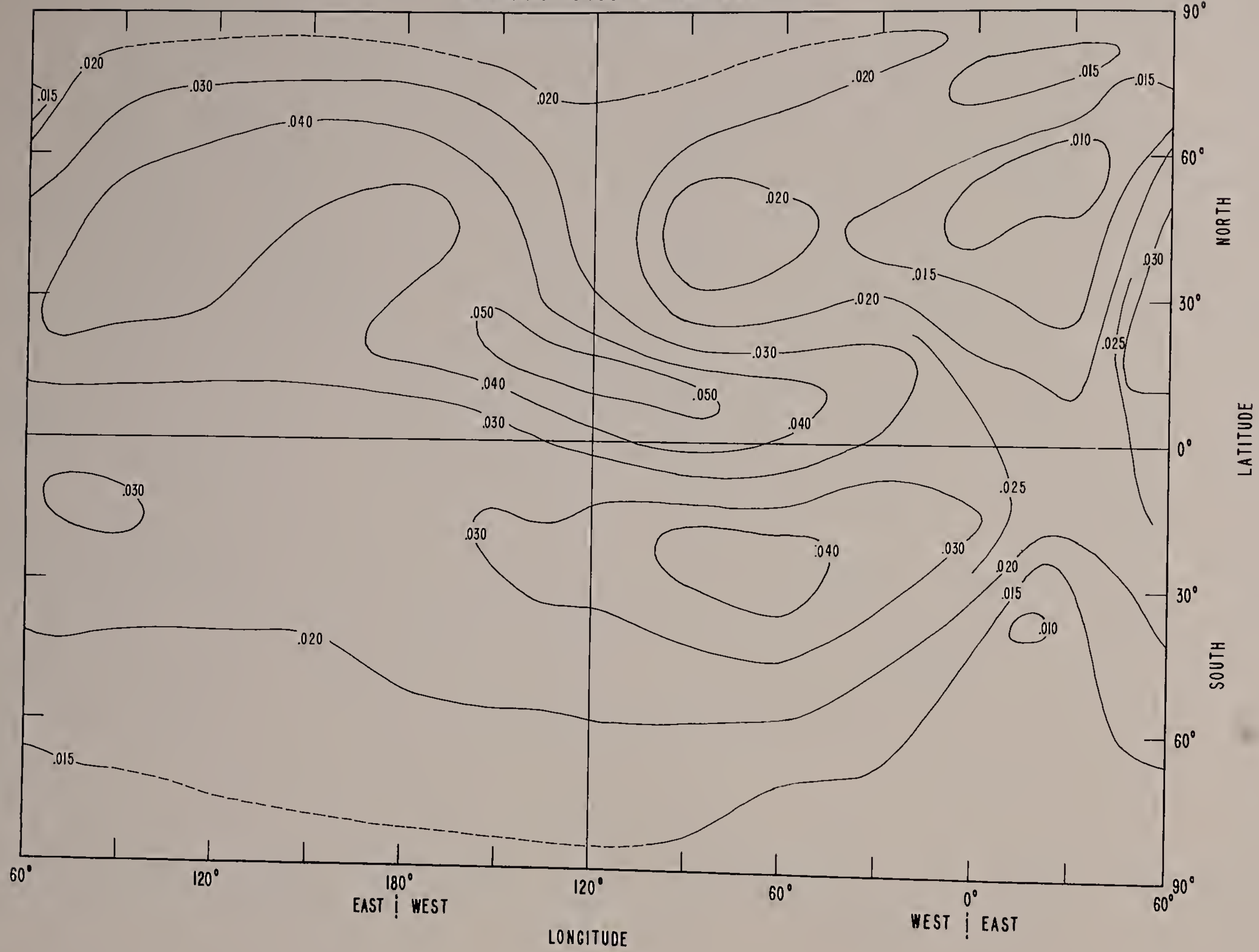
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 0000 HOURS GMT



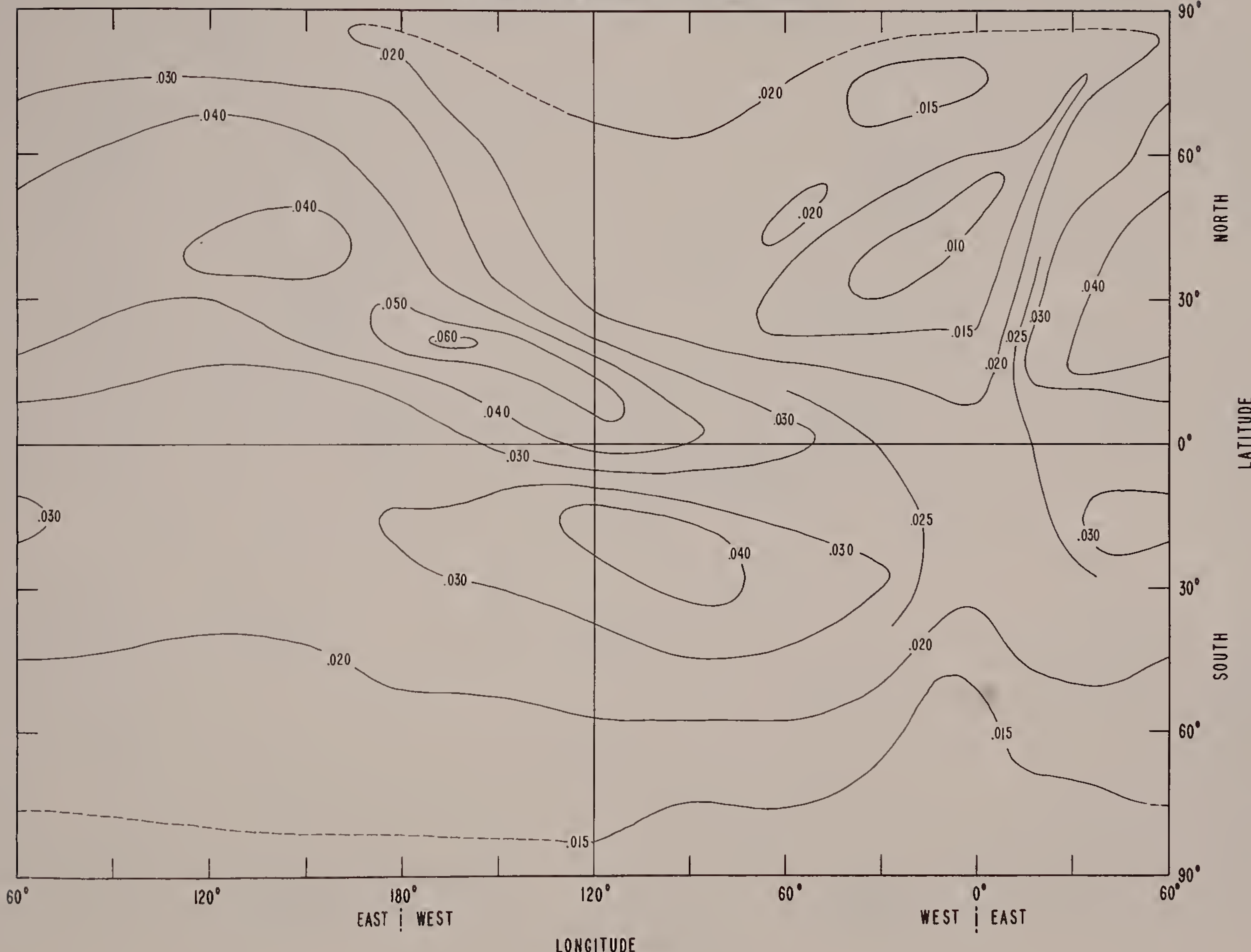
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 0200 HOURS GMT



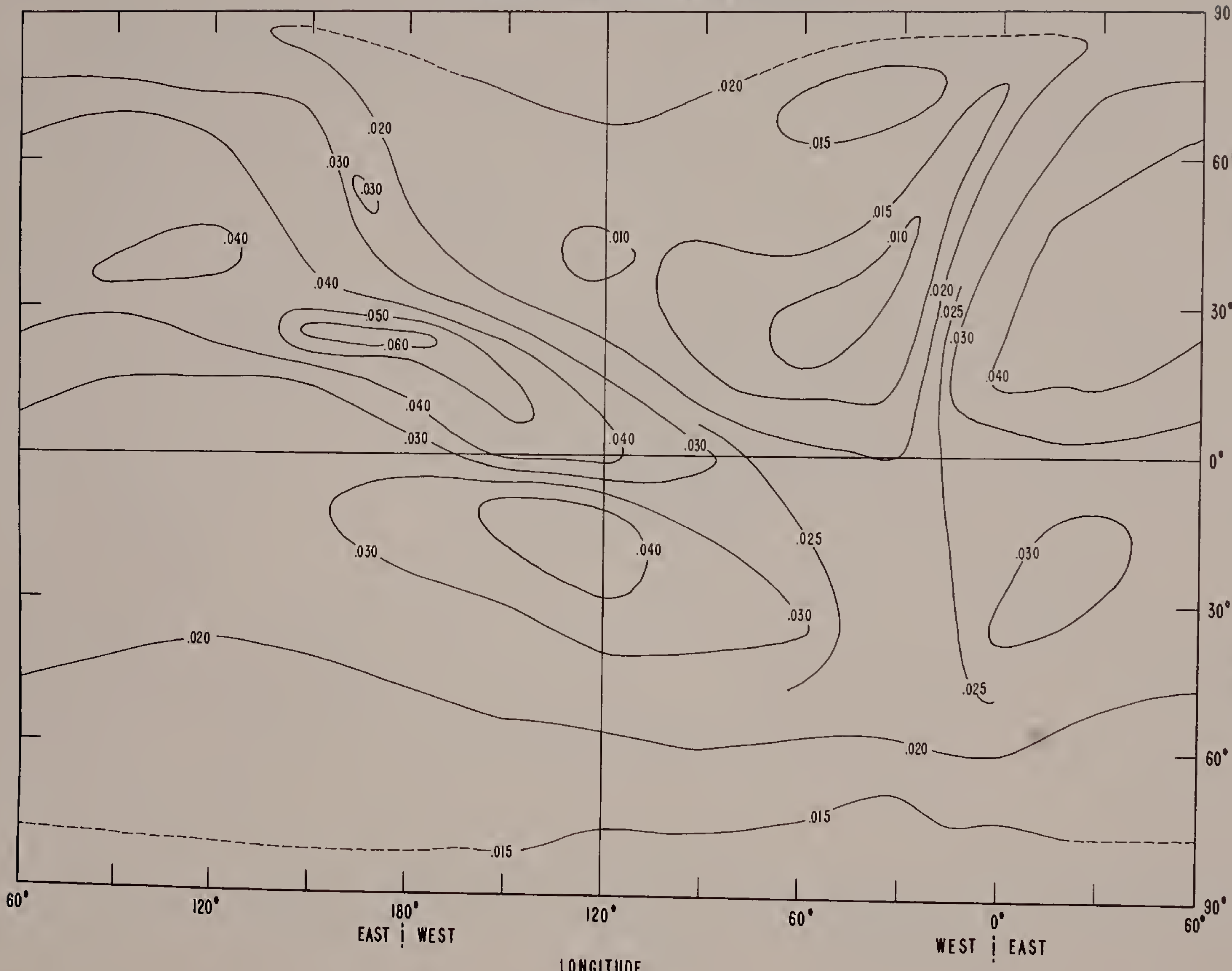
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 0400 HOURS GMT



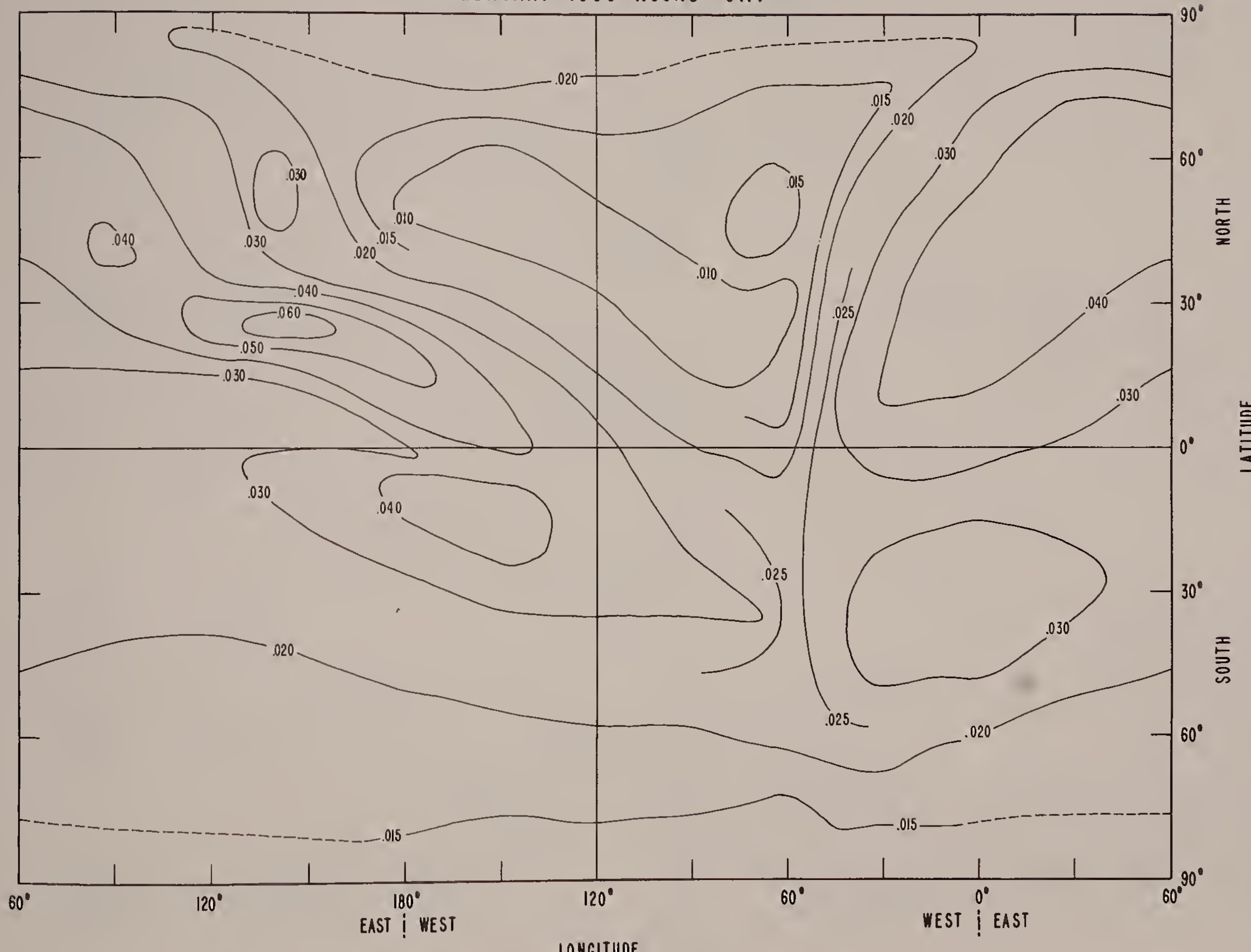
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 0600 HOURS GMT



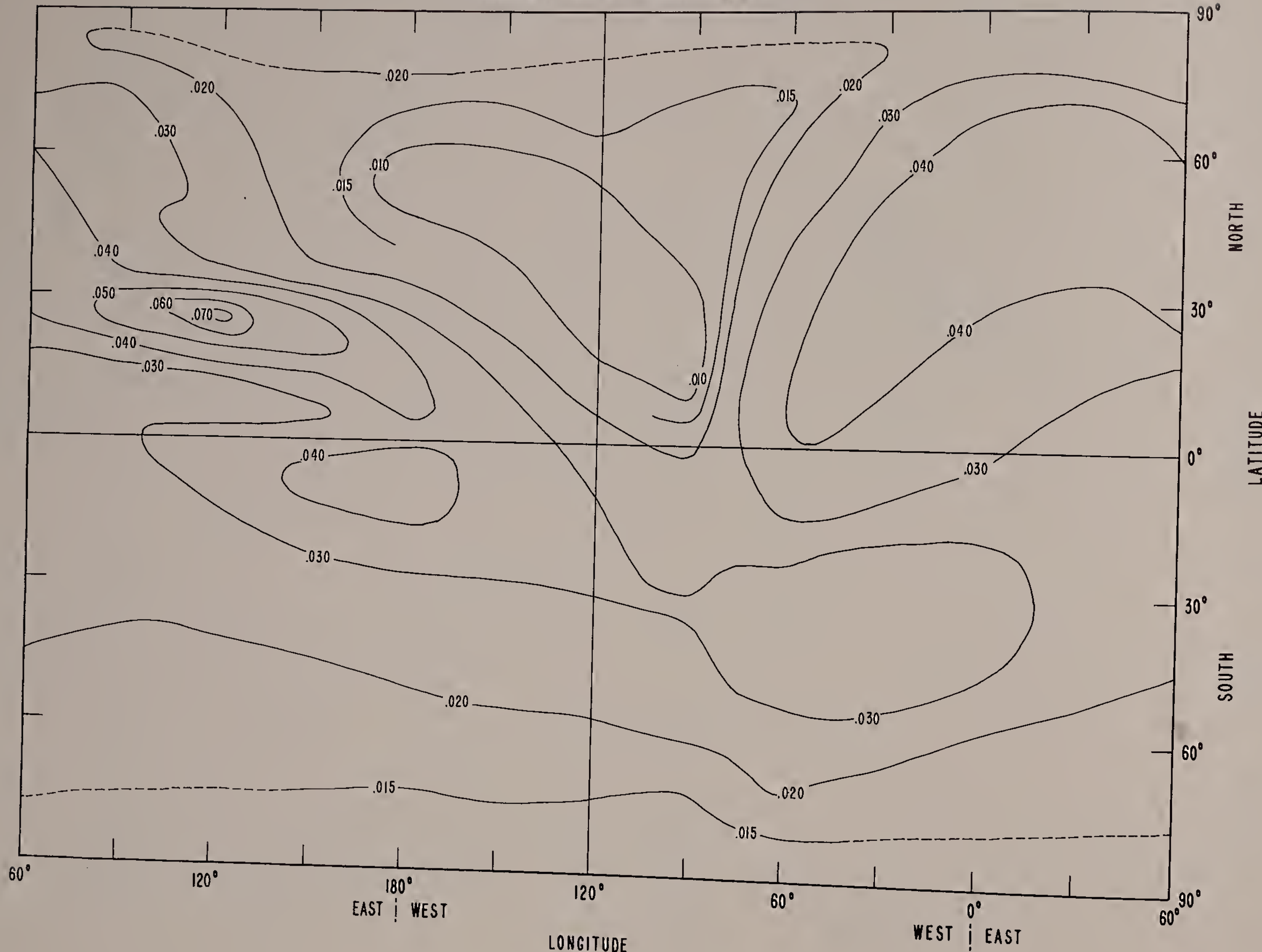
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 0800 HOURS GMT



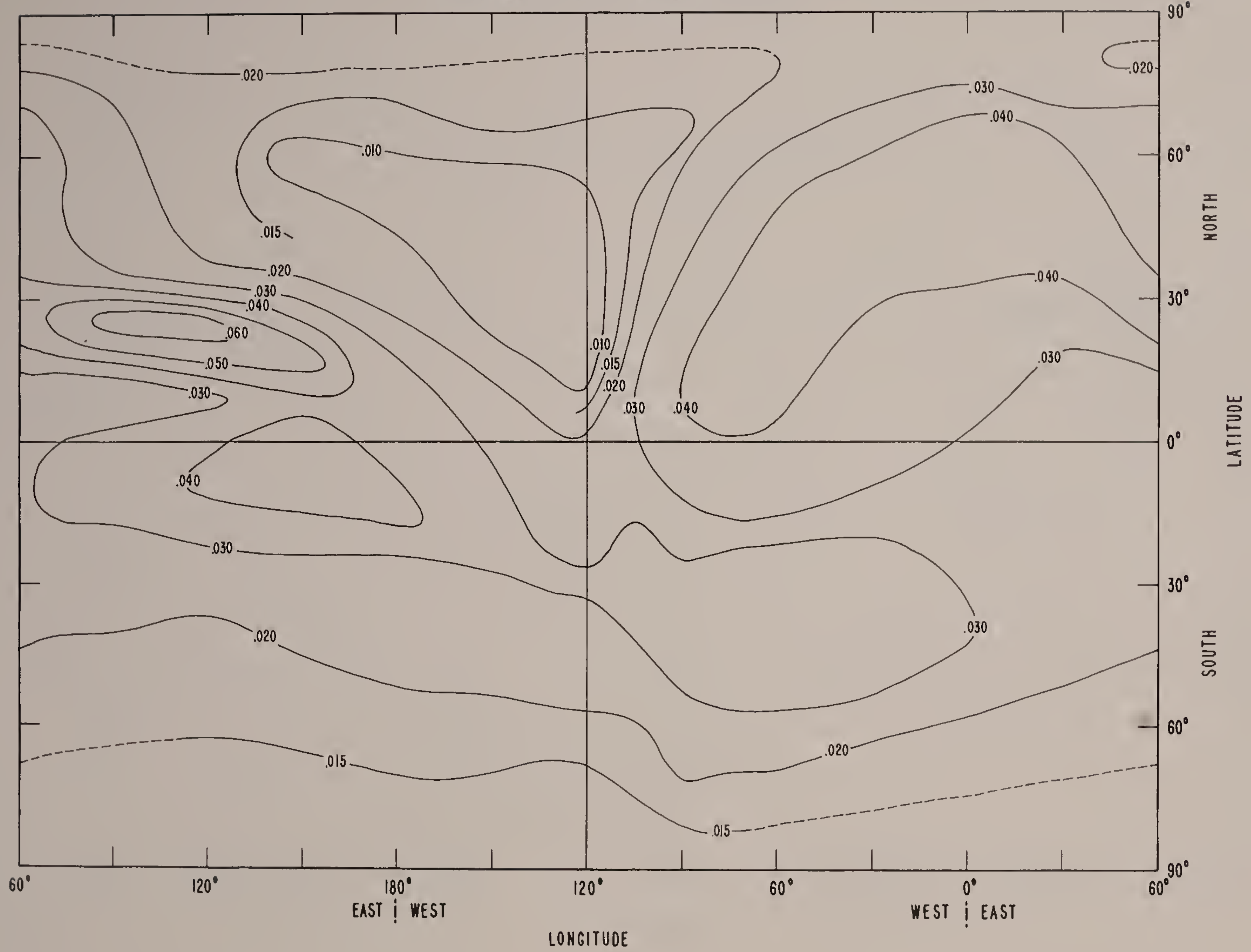
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 1000 HOURS GMT



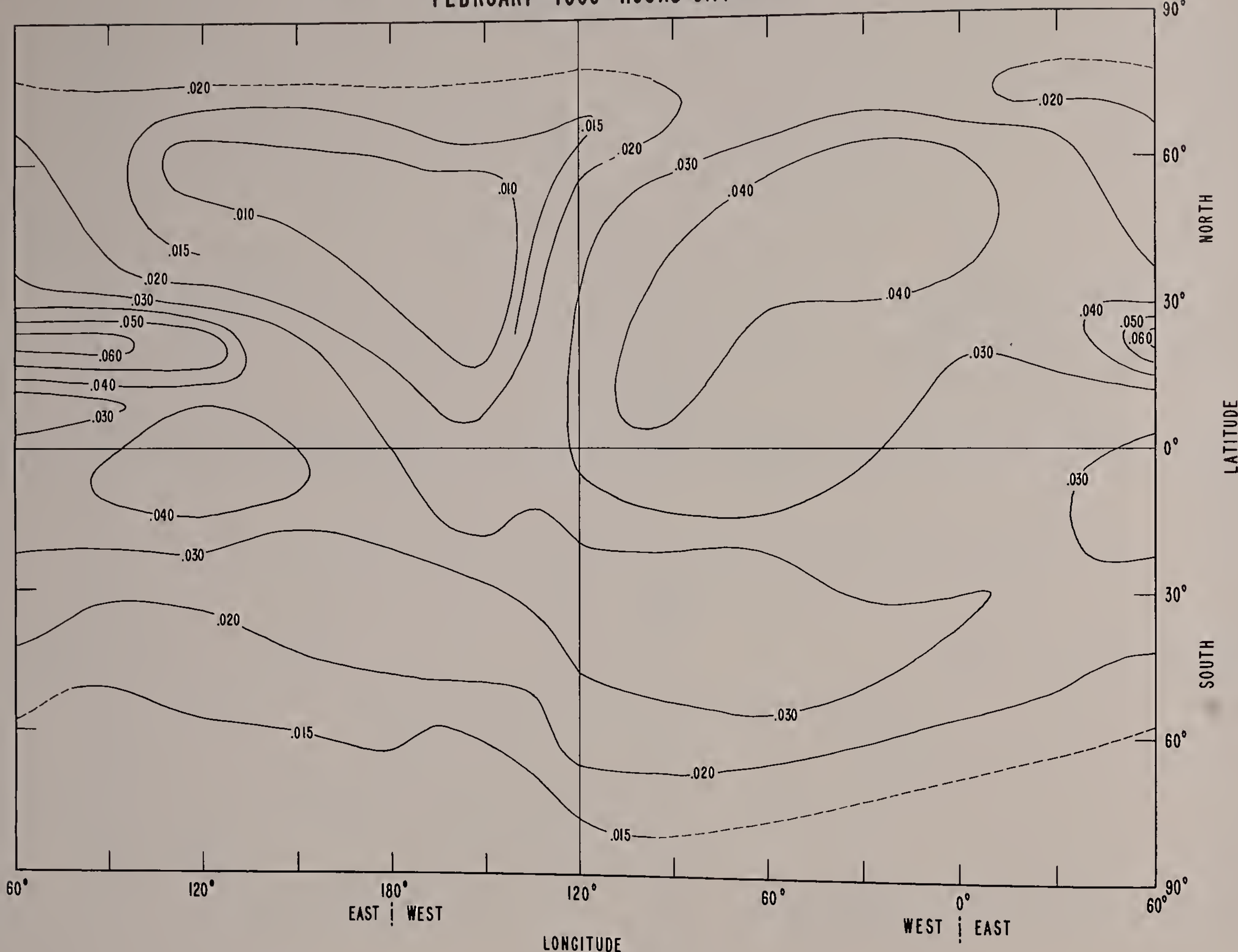
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 1200 HOURS GMT



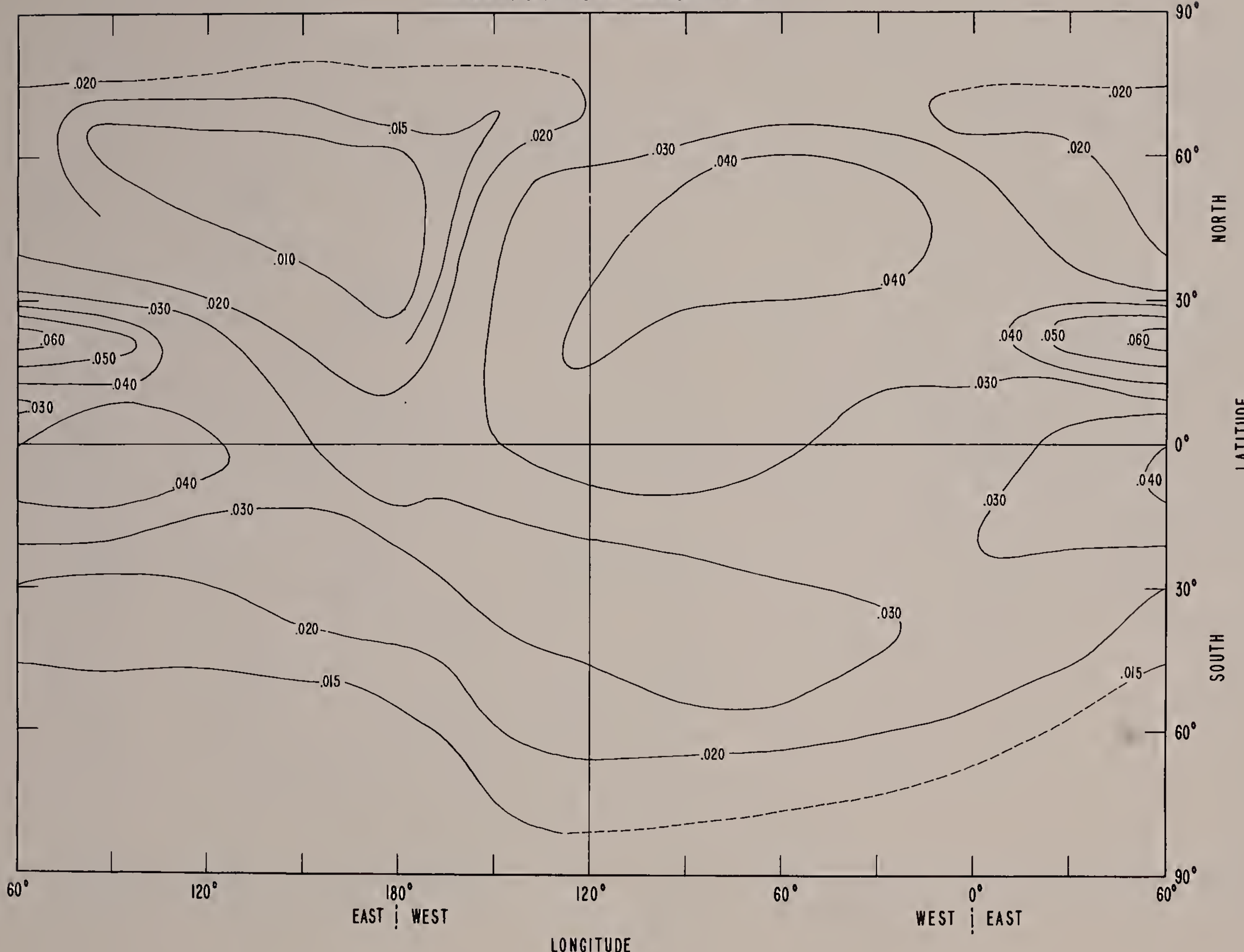
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 1400 HOURS GMT



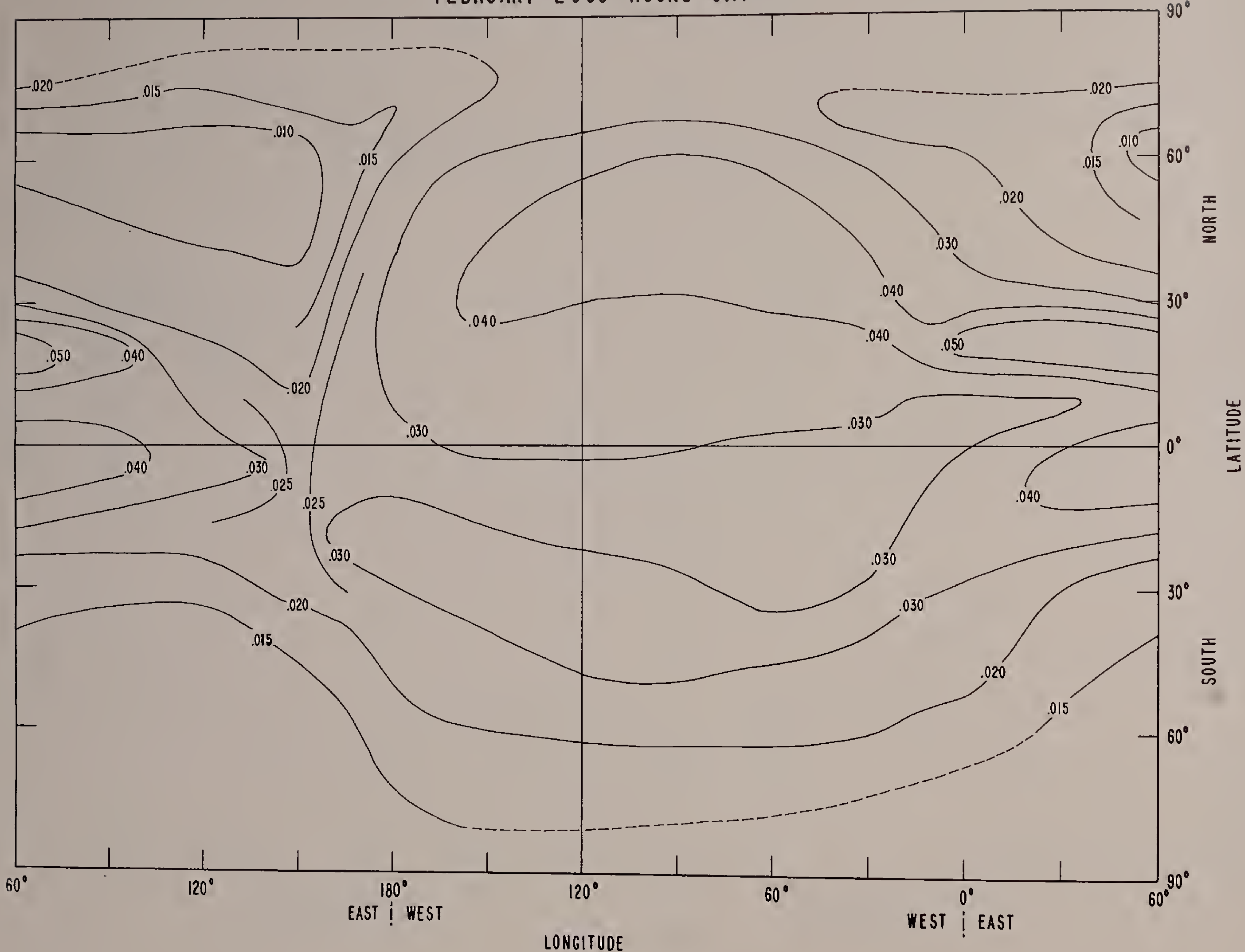
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 1600 HOURS GMT



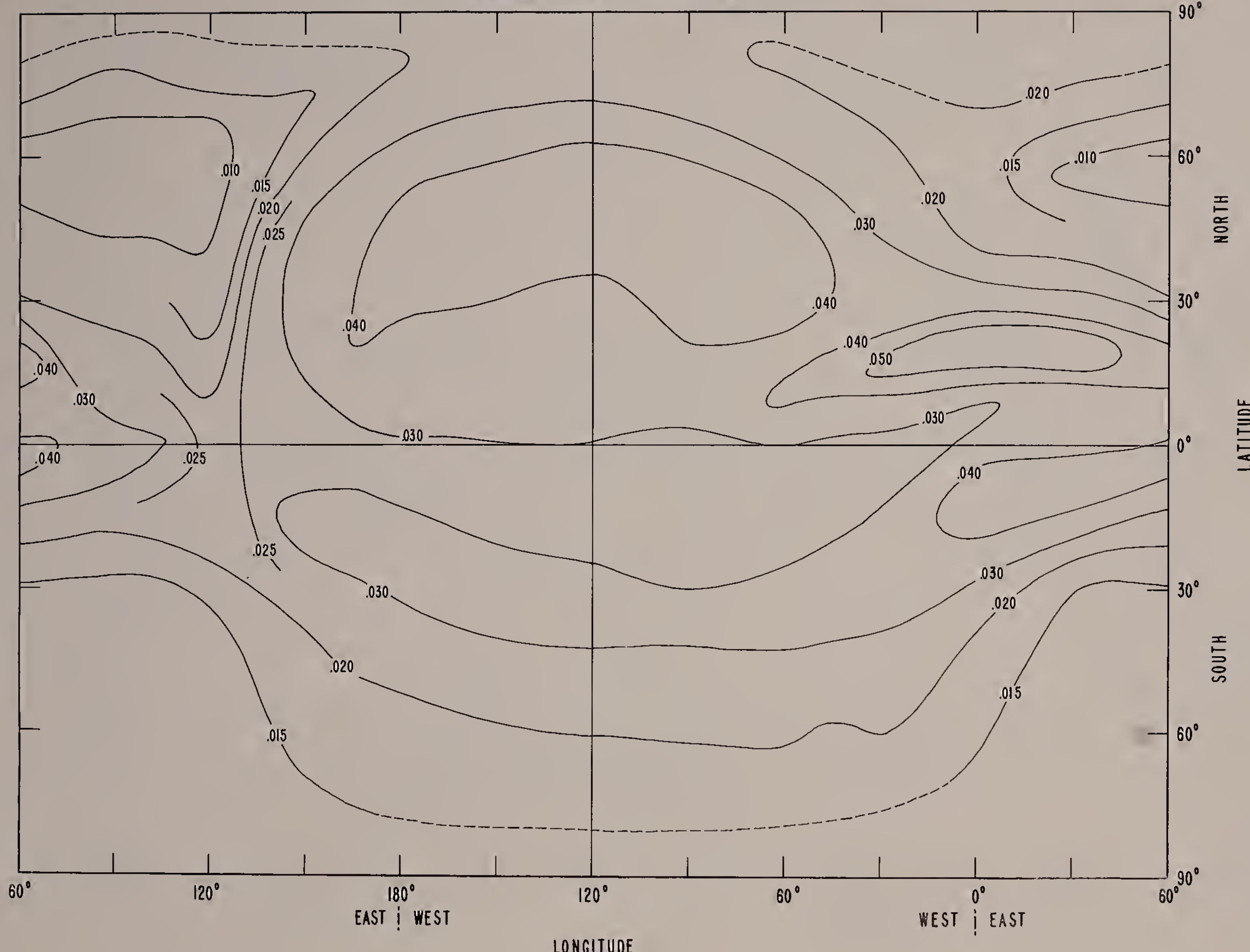
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 1800 HOURS GMT



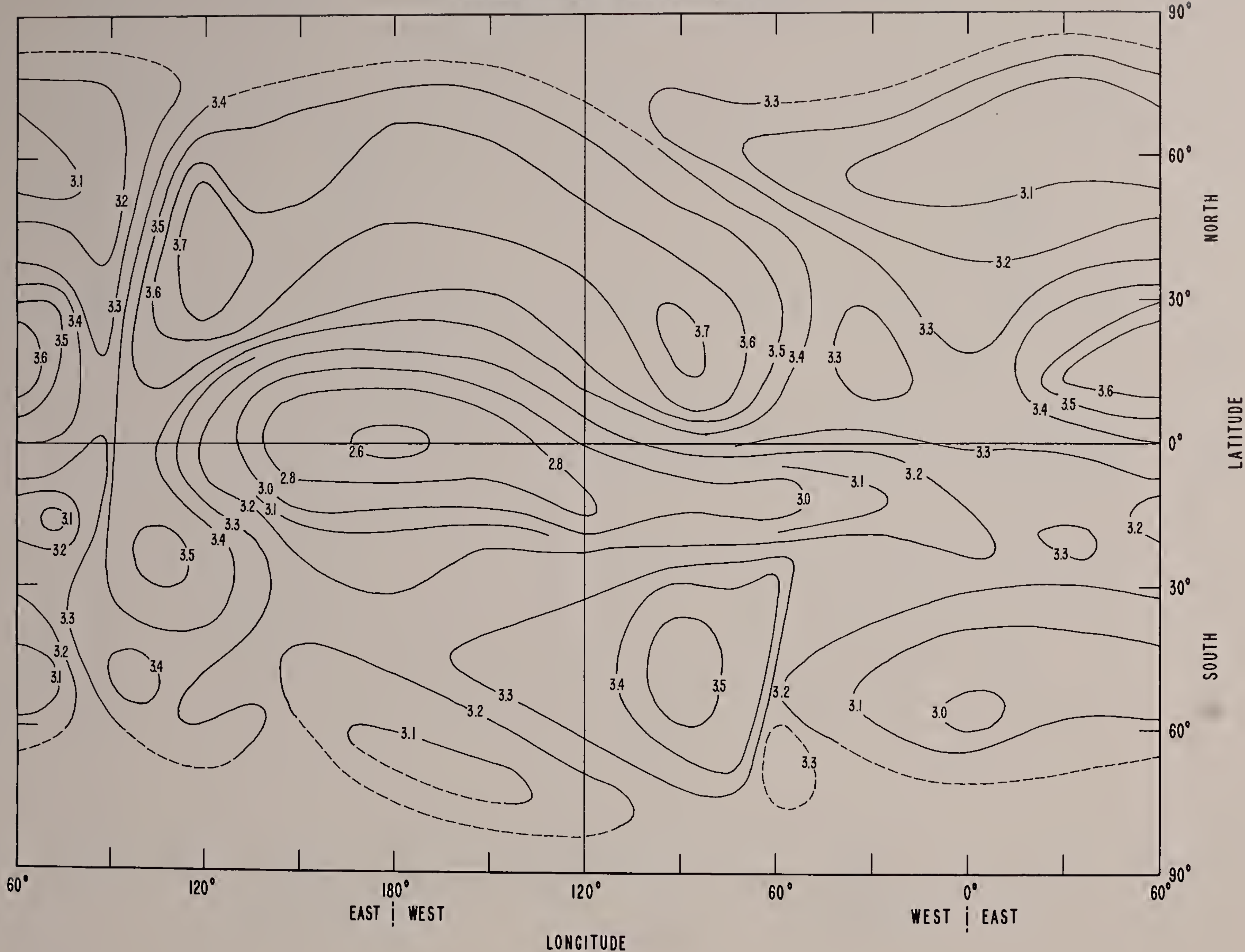
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 2000 HOURS GMT



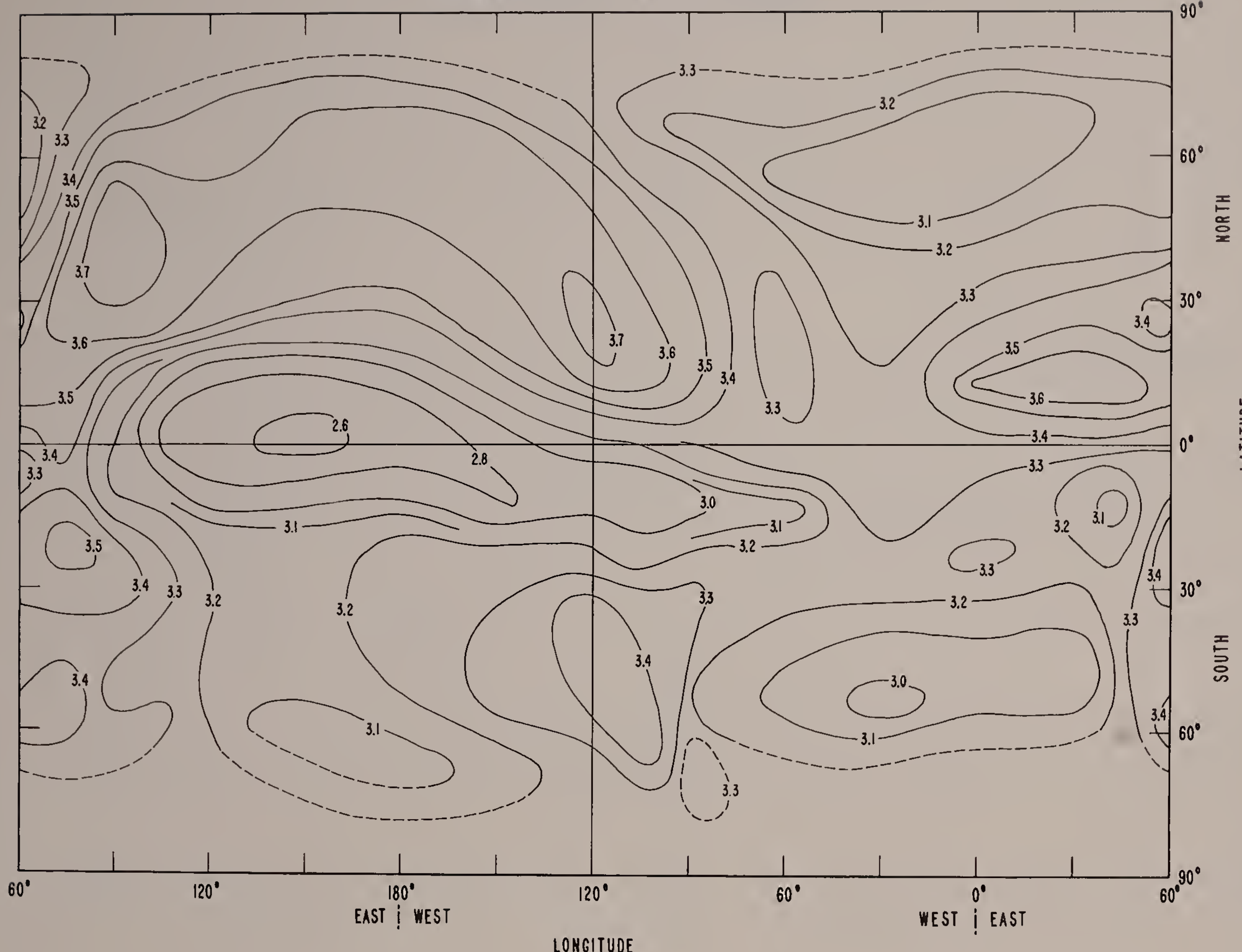
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
FEBRUARY 2200 HOURS GMT



M-4000 FACTOR AT RASSN 50
FEBRUARY 0000 HOURS GMT



M-4000 FACTOR AT RASSN 50
FEBRUARY 0200 HOURS GMT



M-4000 FACTOR AT RASSN 50
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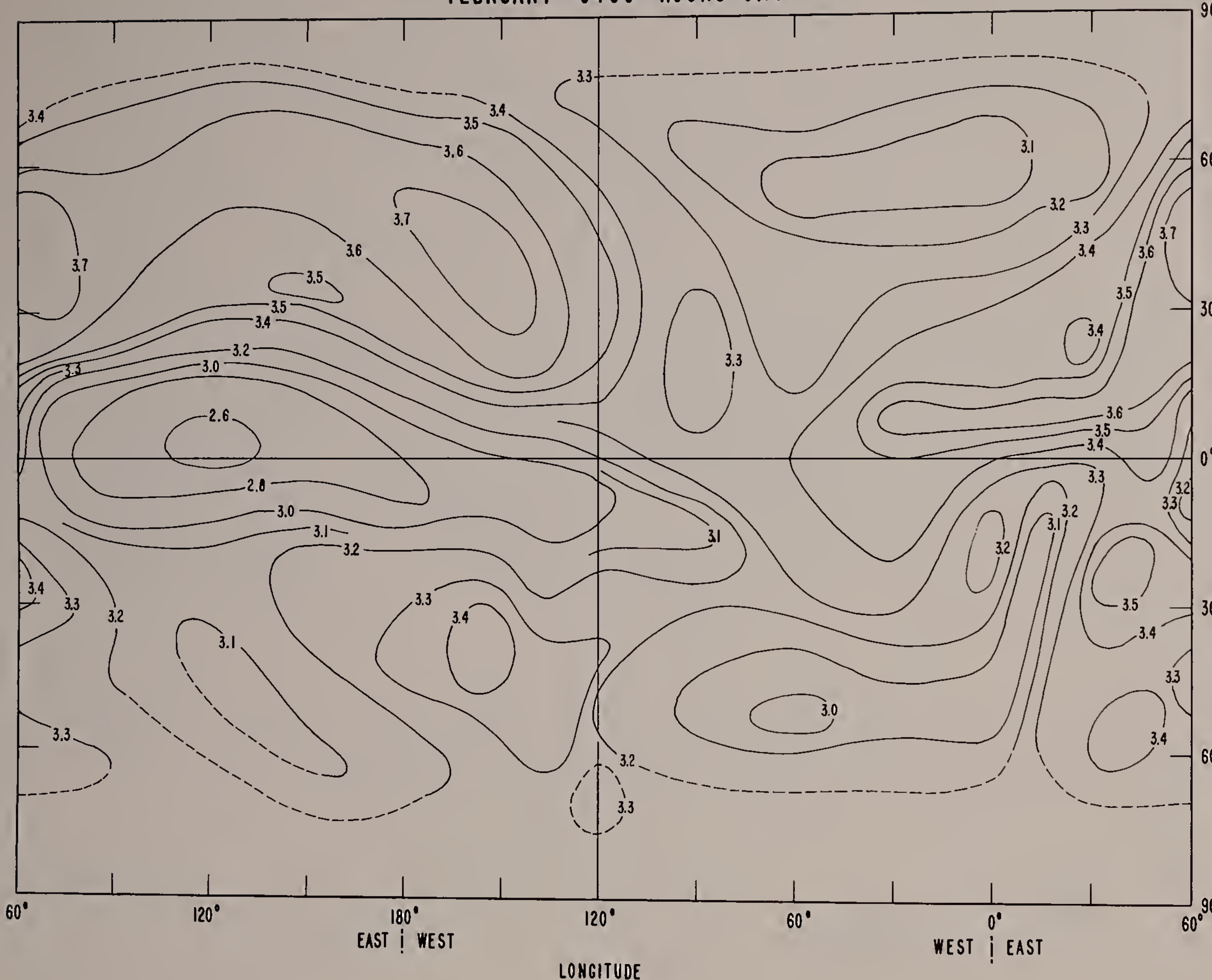
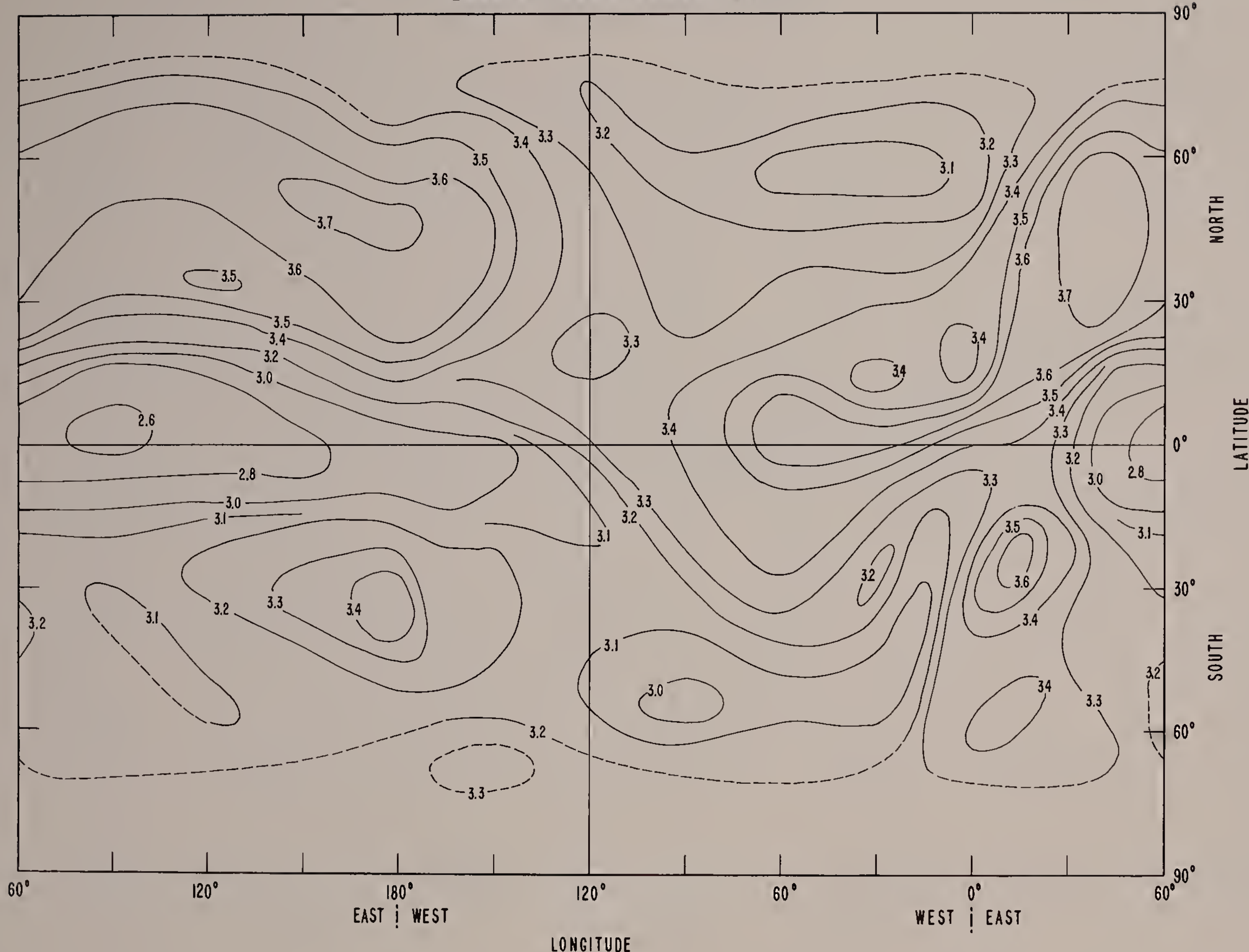
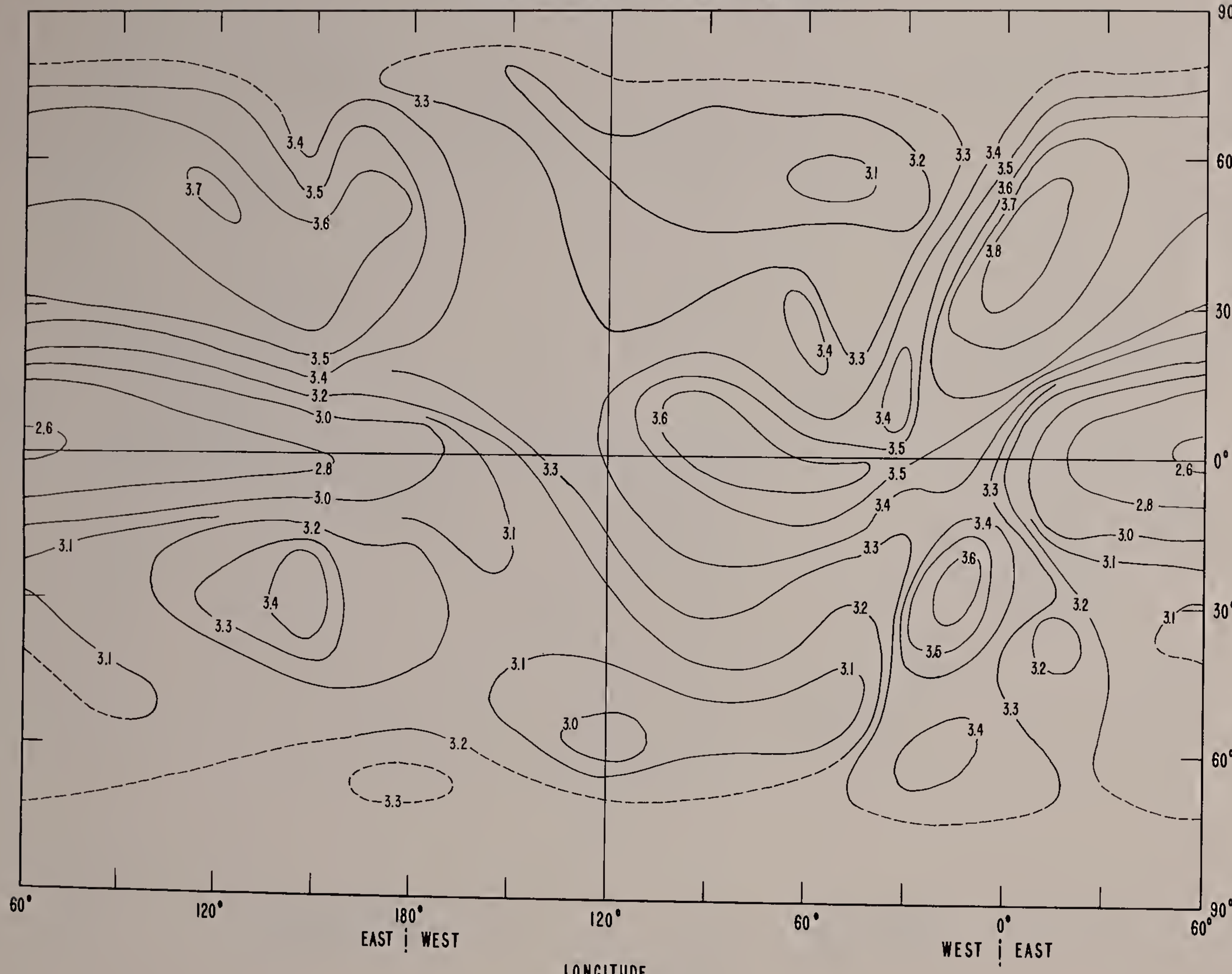


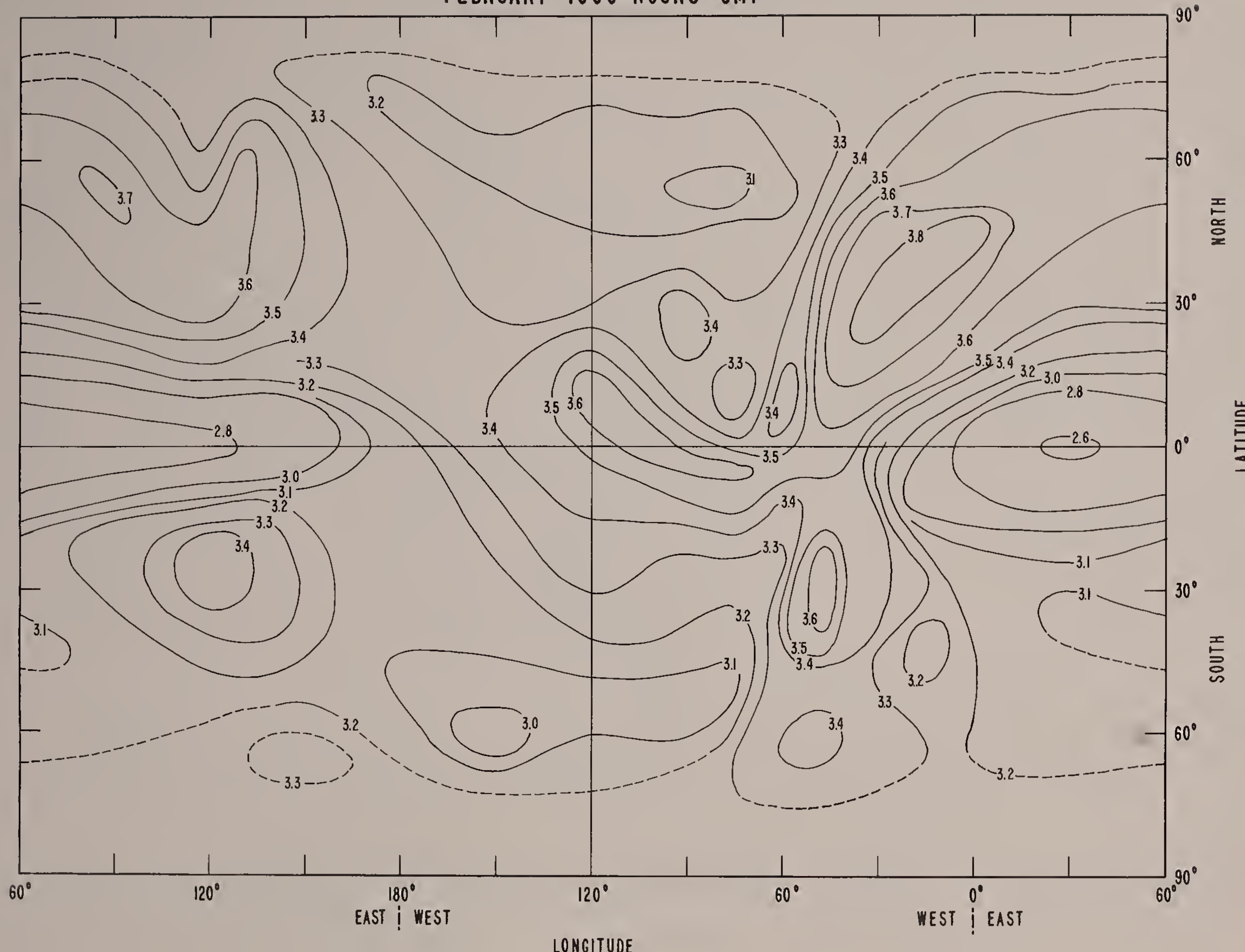
M-4000 FACTOR AT RASSN 50
FEBRUARY 0600 HOURS GMT



M-4000 FACTOR AT RASSN 50
FEBRUARY 0800 HOURS GMT



M-4000 FACTOR AT RASSN 50
FEBRUARY 1000 HOURS GMT



M-4000 FACTOR AT RASSN 50
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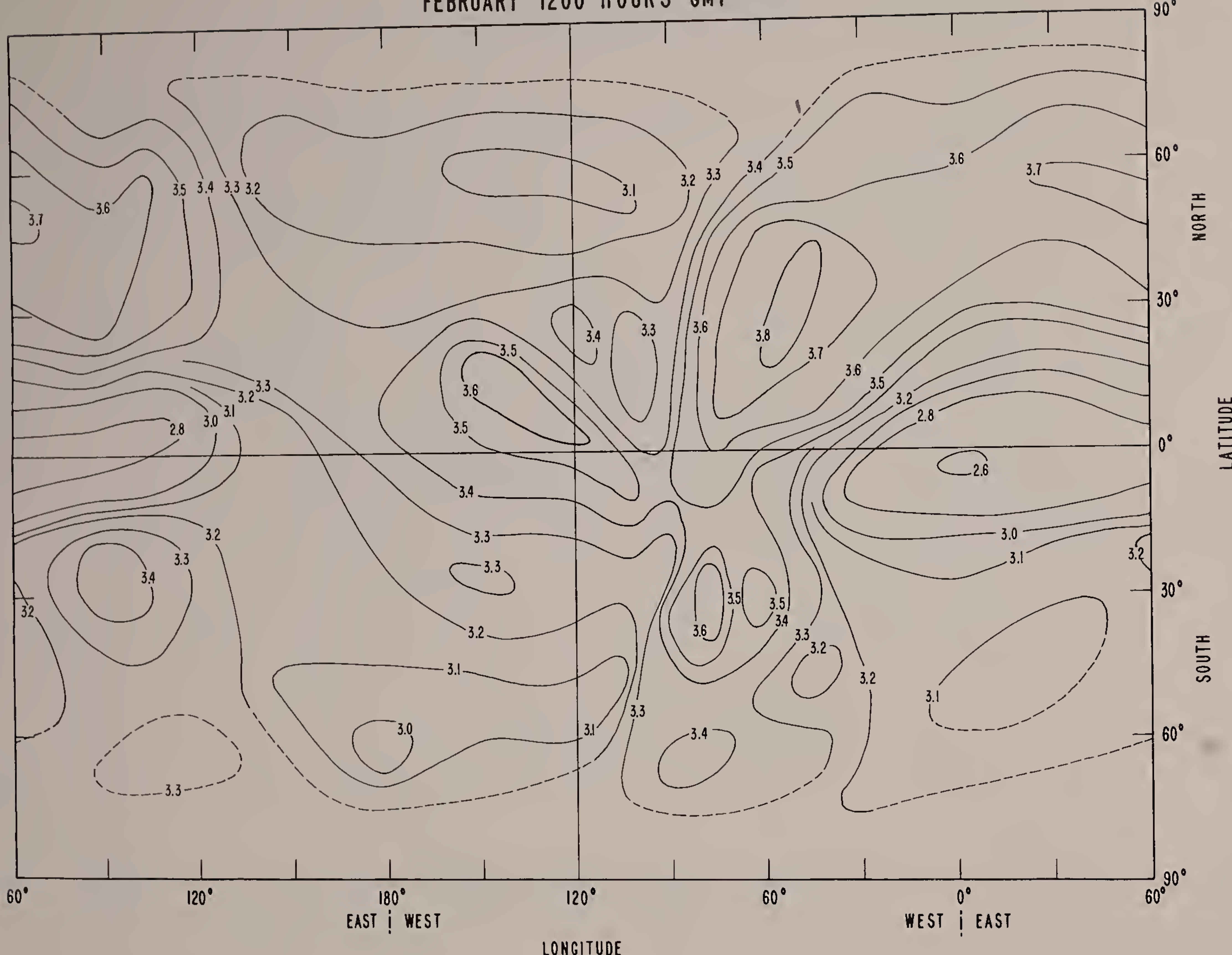

M-4000 FACTOR AT RASSN 50
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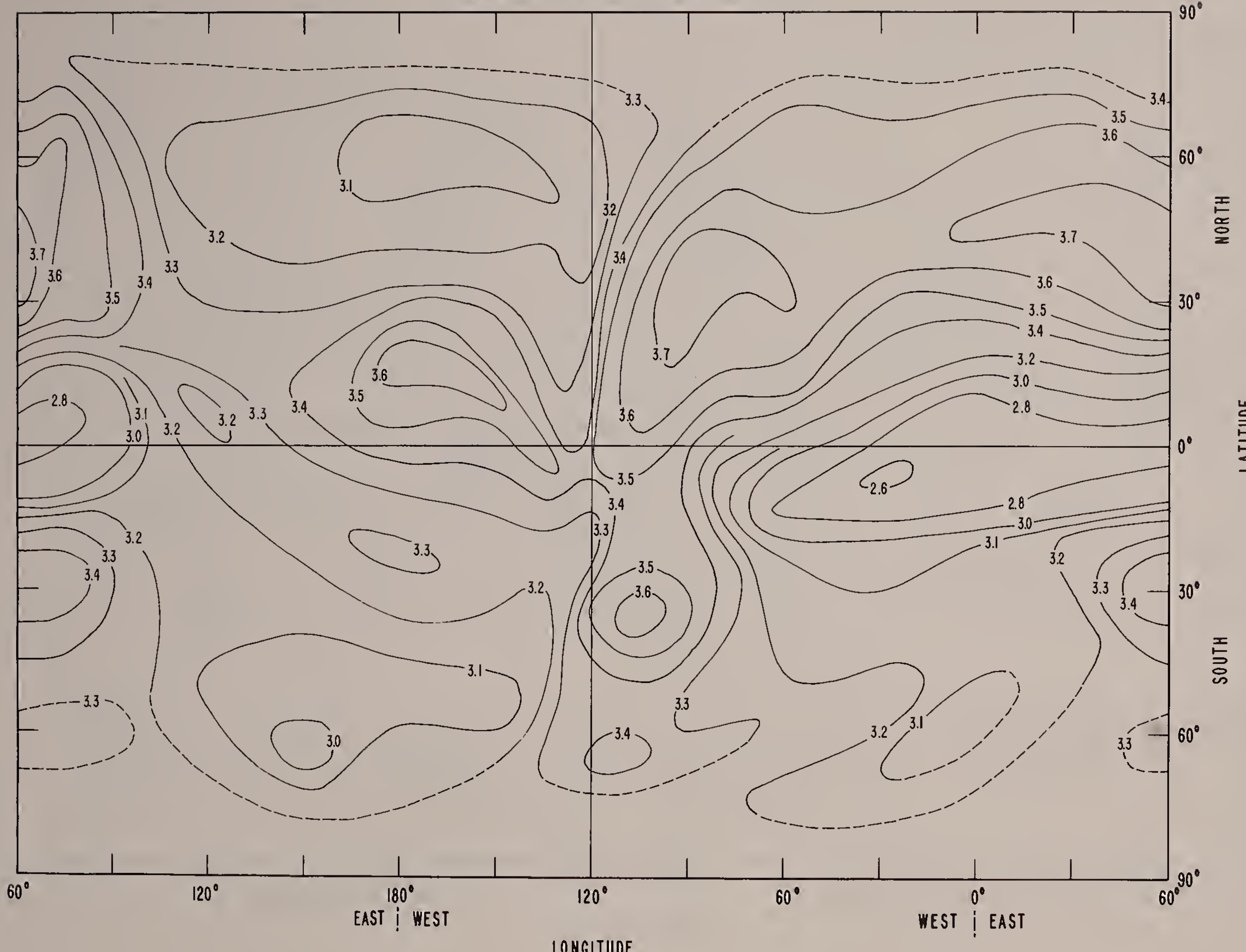

M-4000 FACTOR AT RASSN 50
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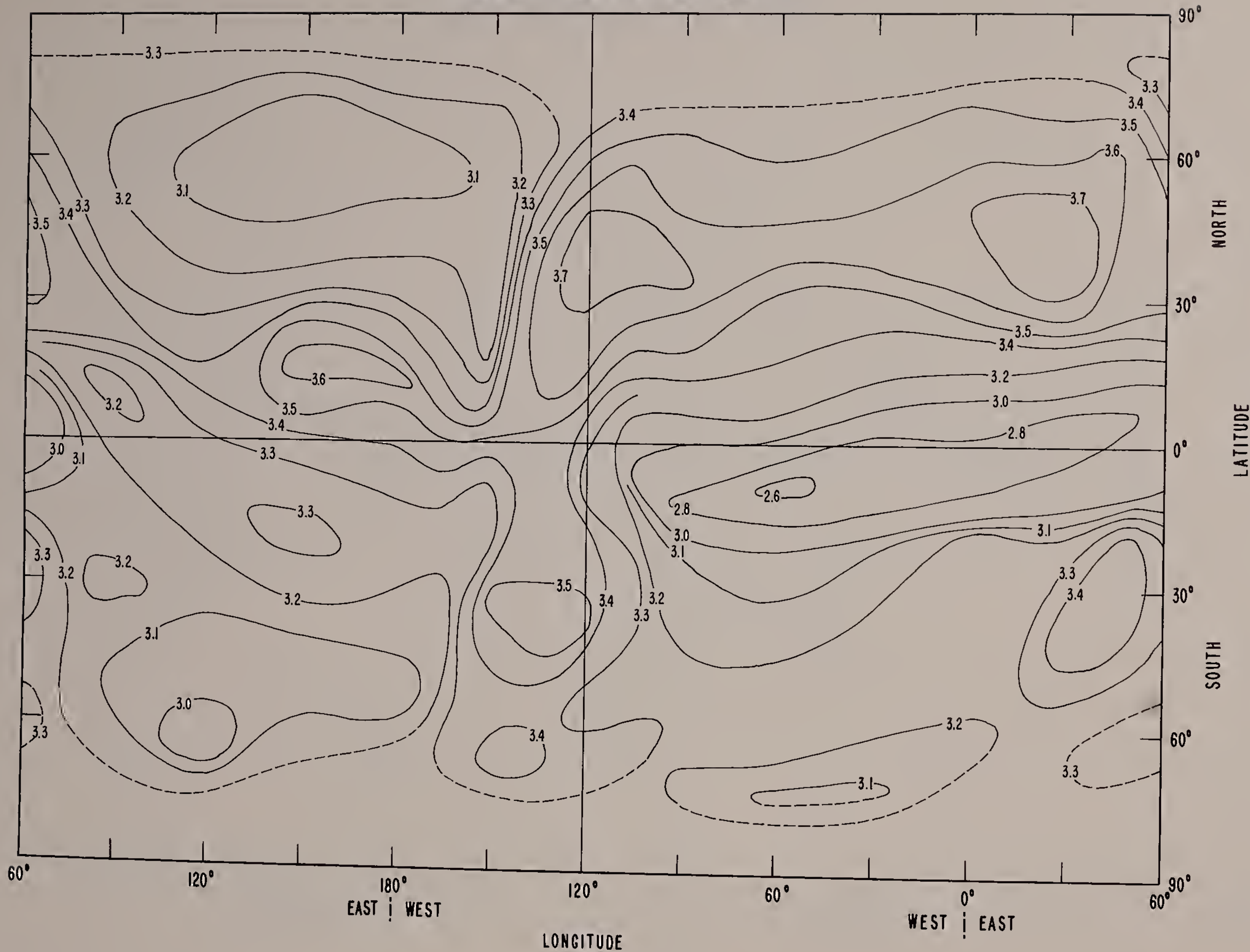

M-4000 FACTOR AT RASSN 50
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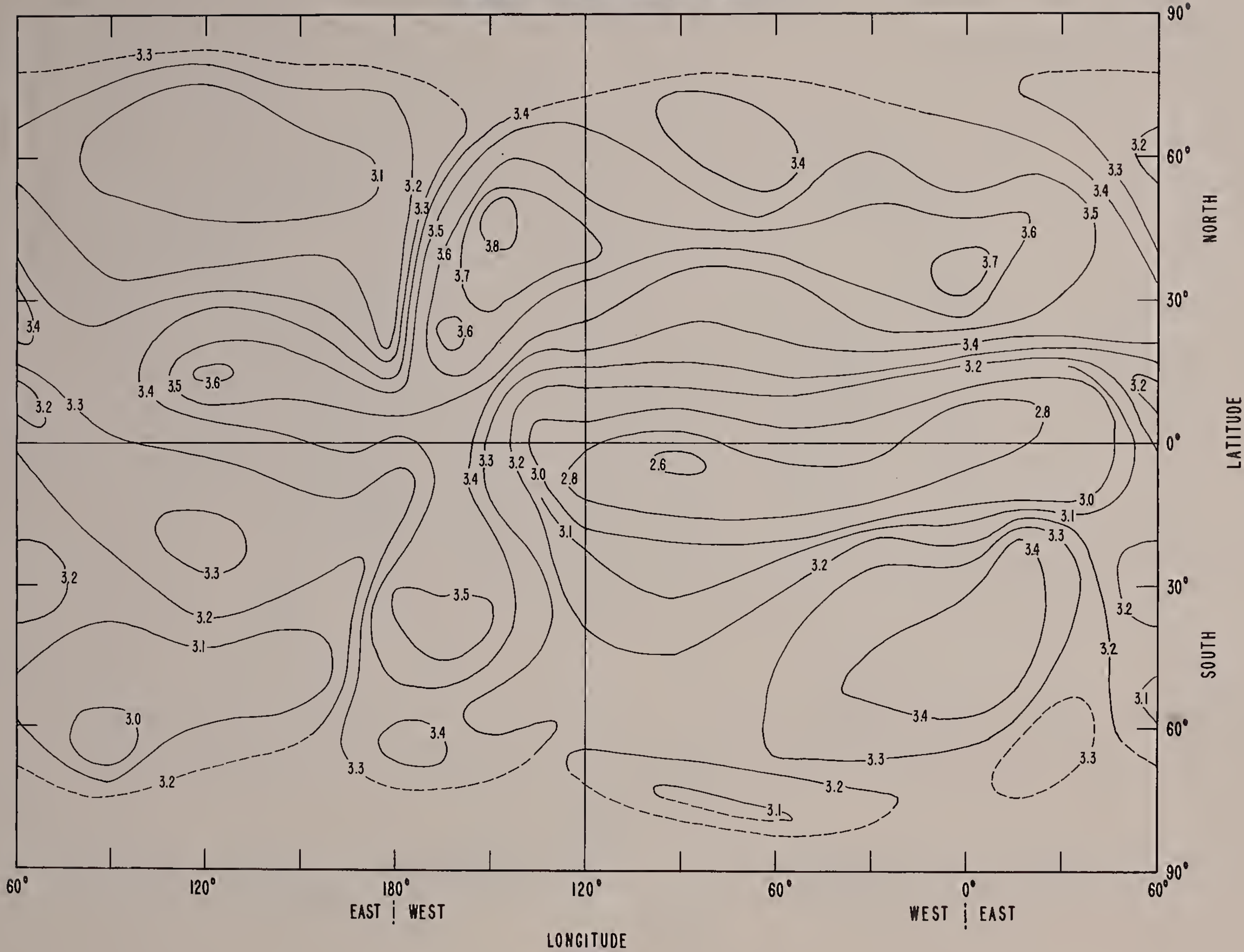
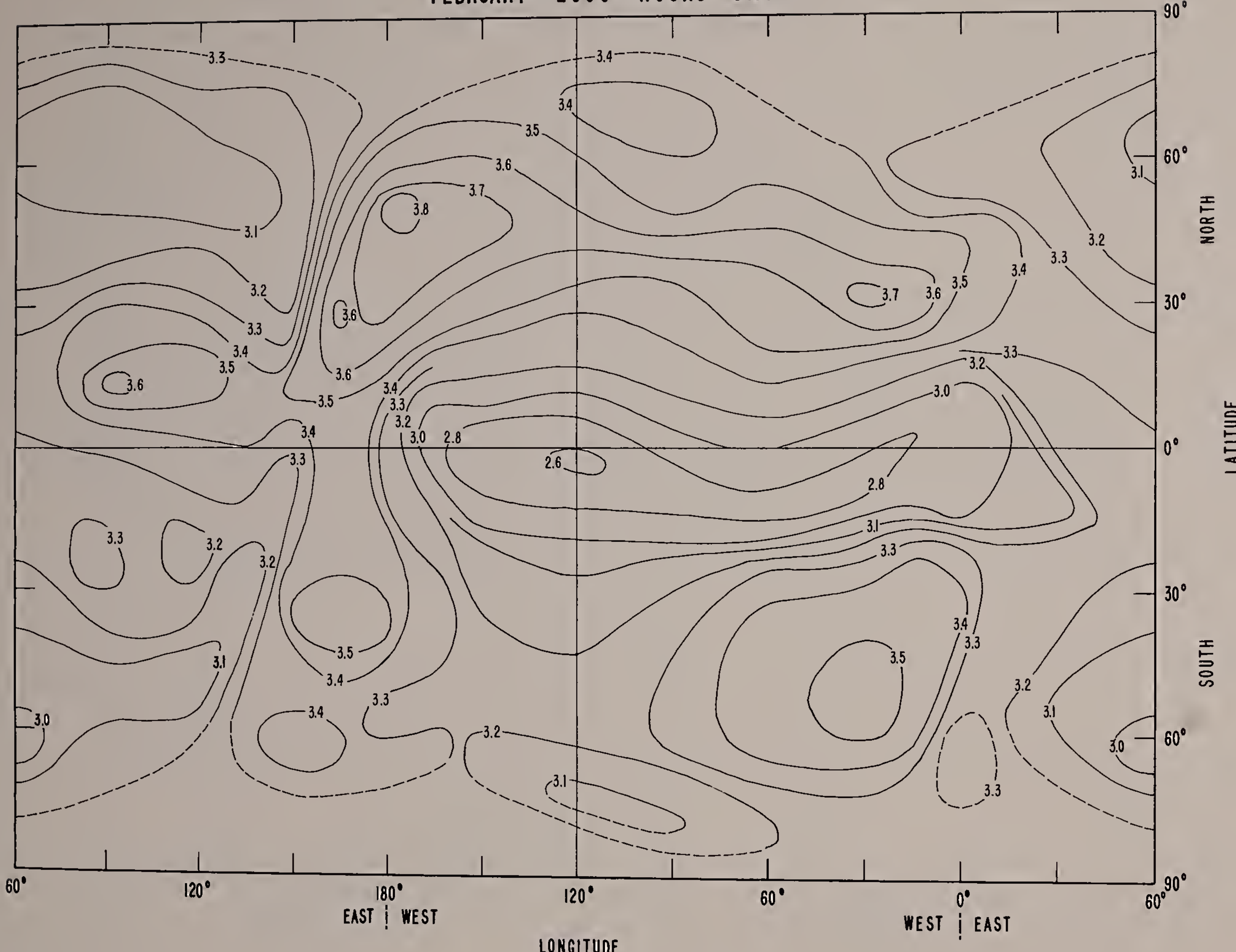
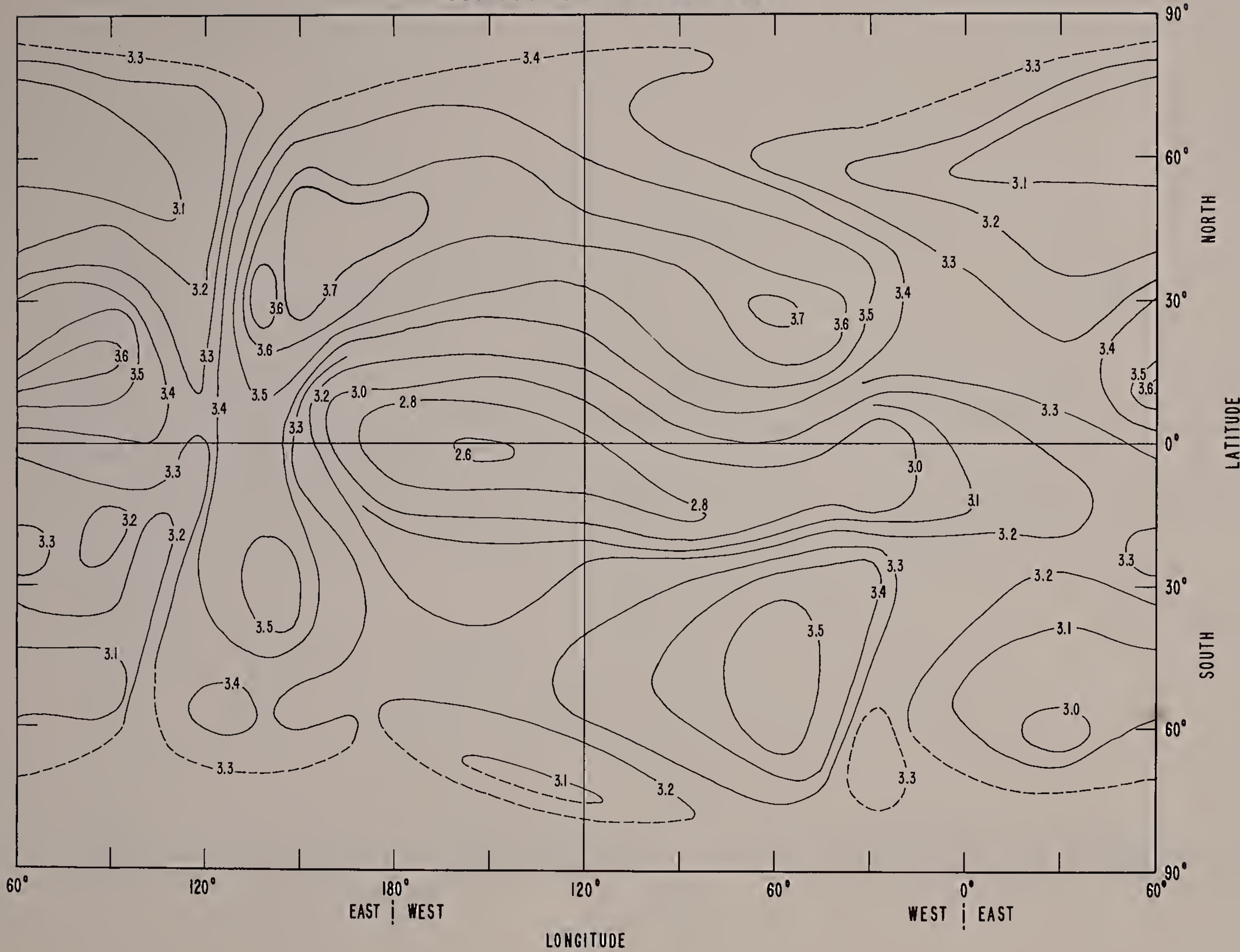


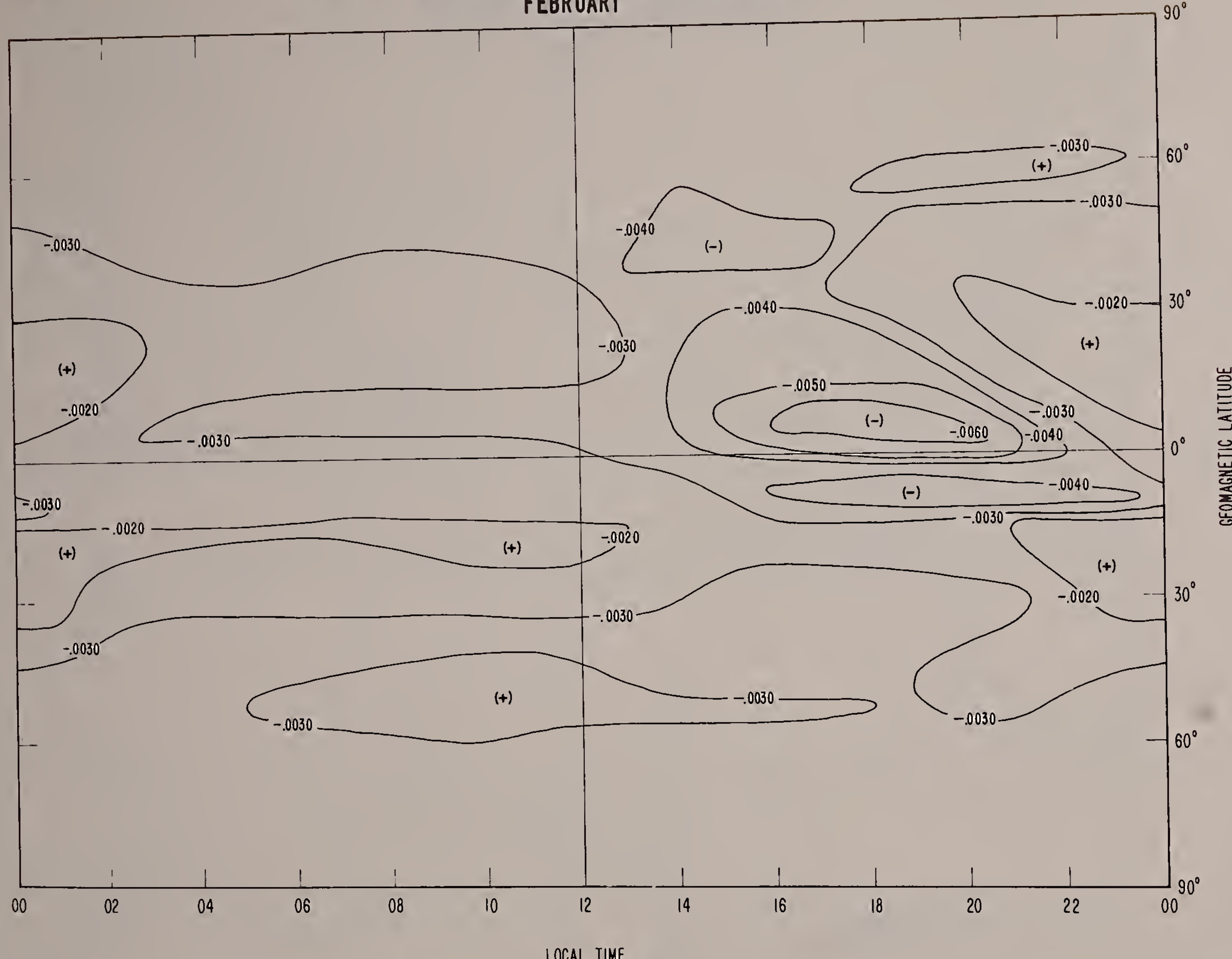
M-4000 FACTOR AT RASSN 50
FEBRUARY 2000 HOURS GMT



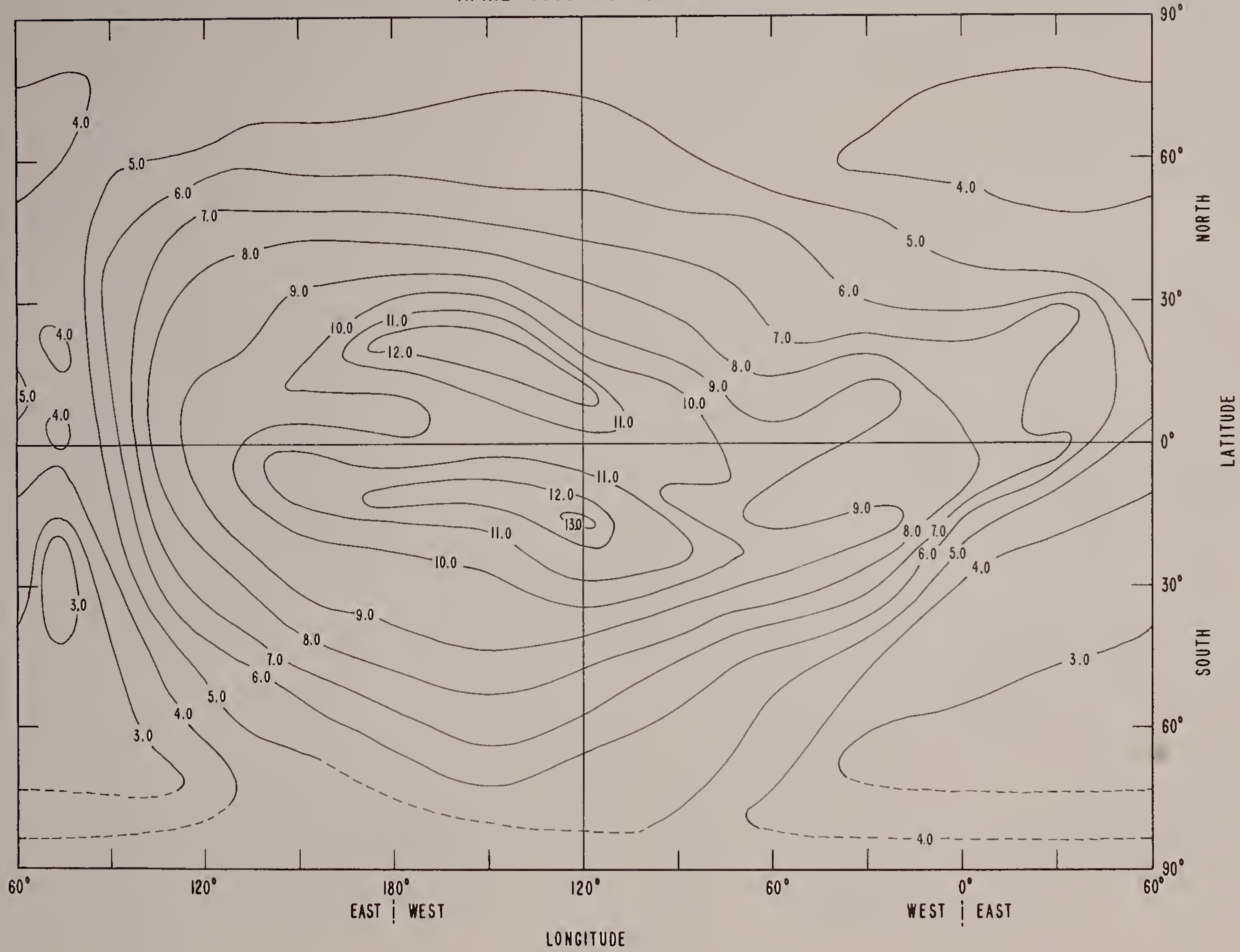
M-4000 FACTOR AT RASSN 50
FEBRUARY 2200 HOURS GMT



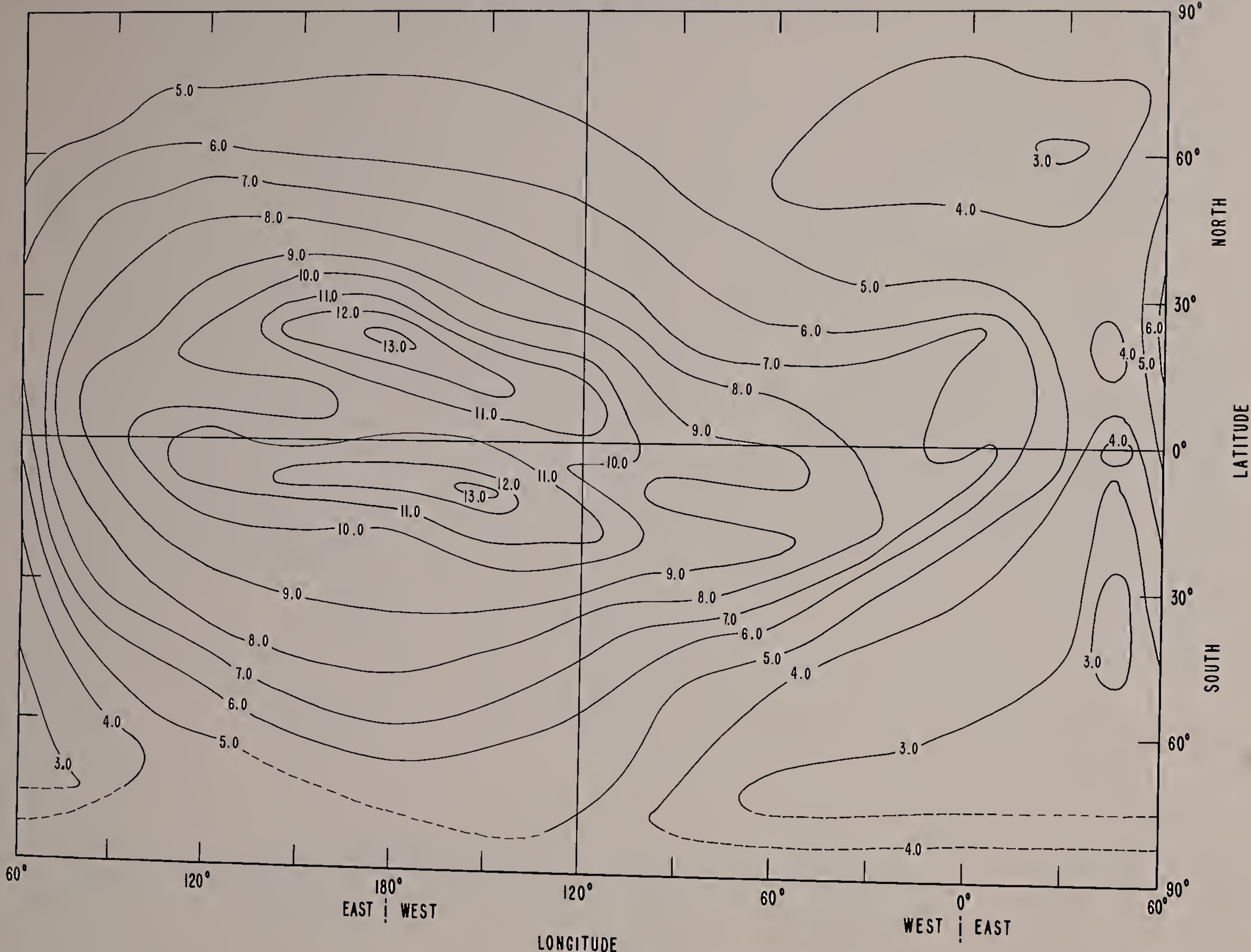
SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN
FEBRUARY



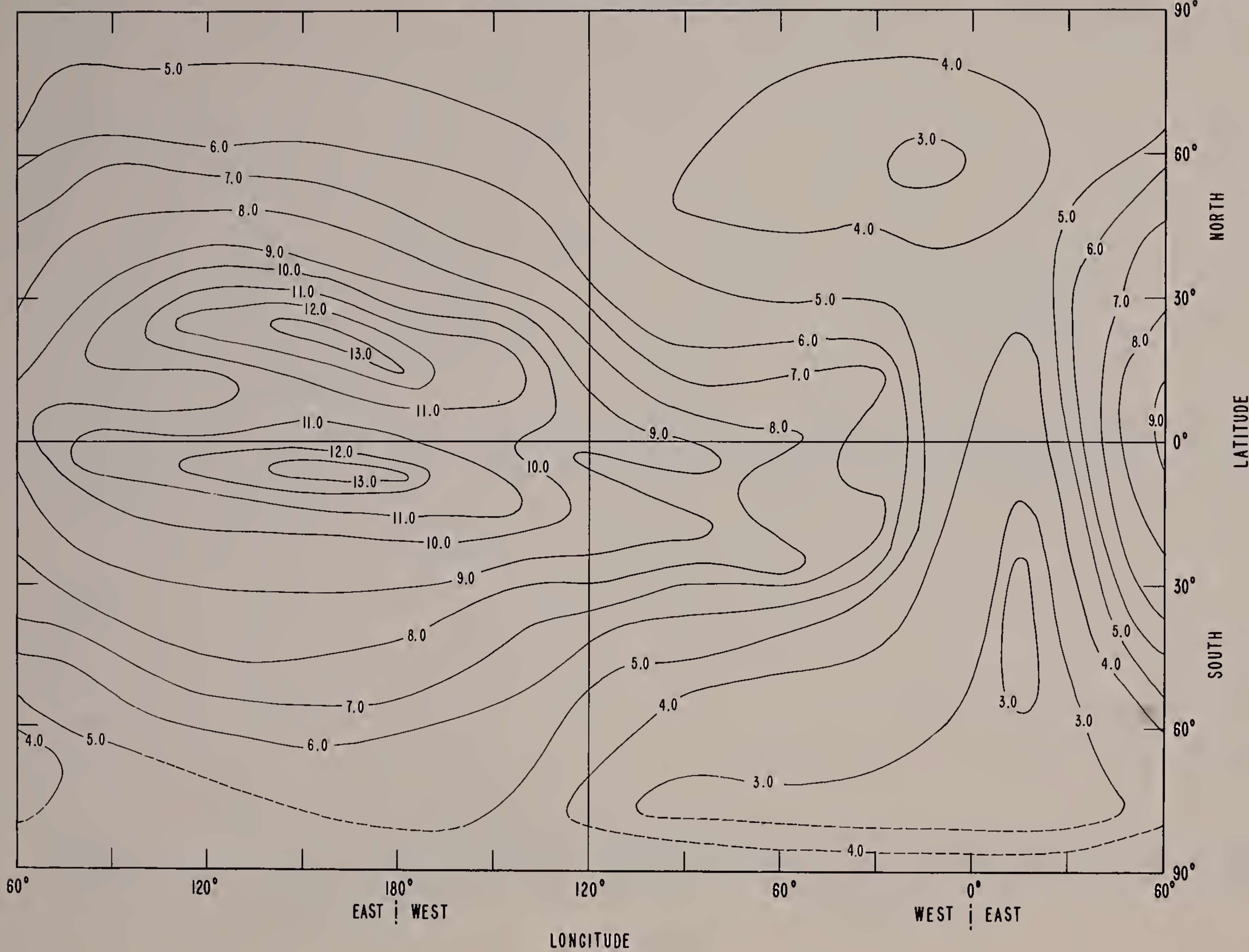
f_oF2 AT RASSN 50
APRIL 0000 HOURS GMT



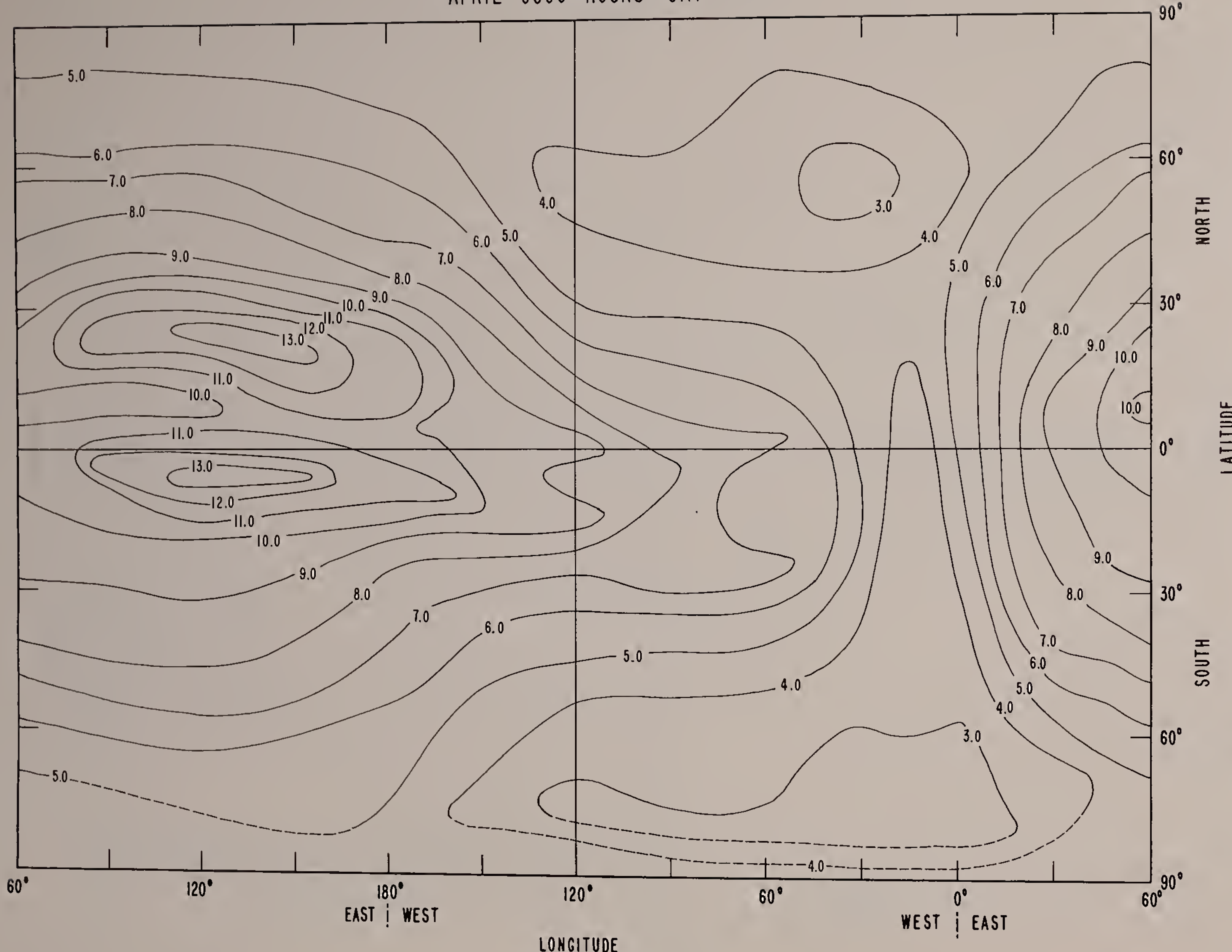
f_oF2 AT RASSN 50
APRIL 0200 HOURS GMT



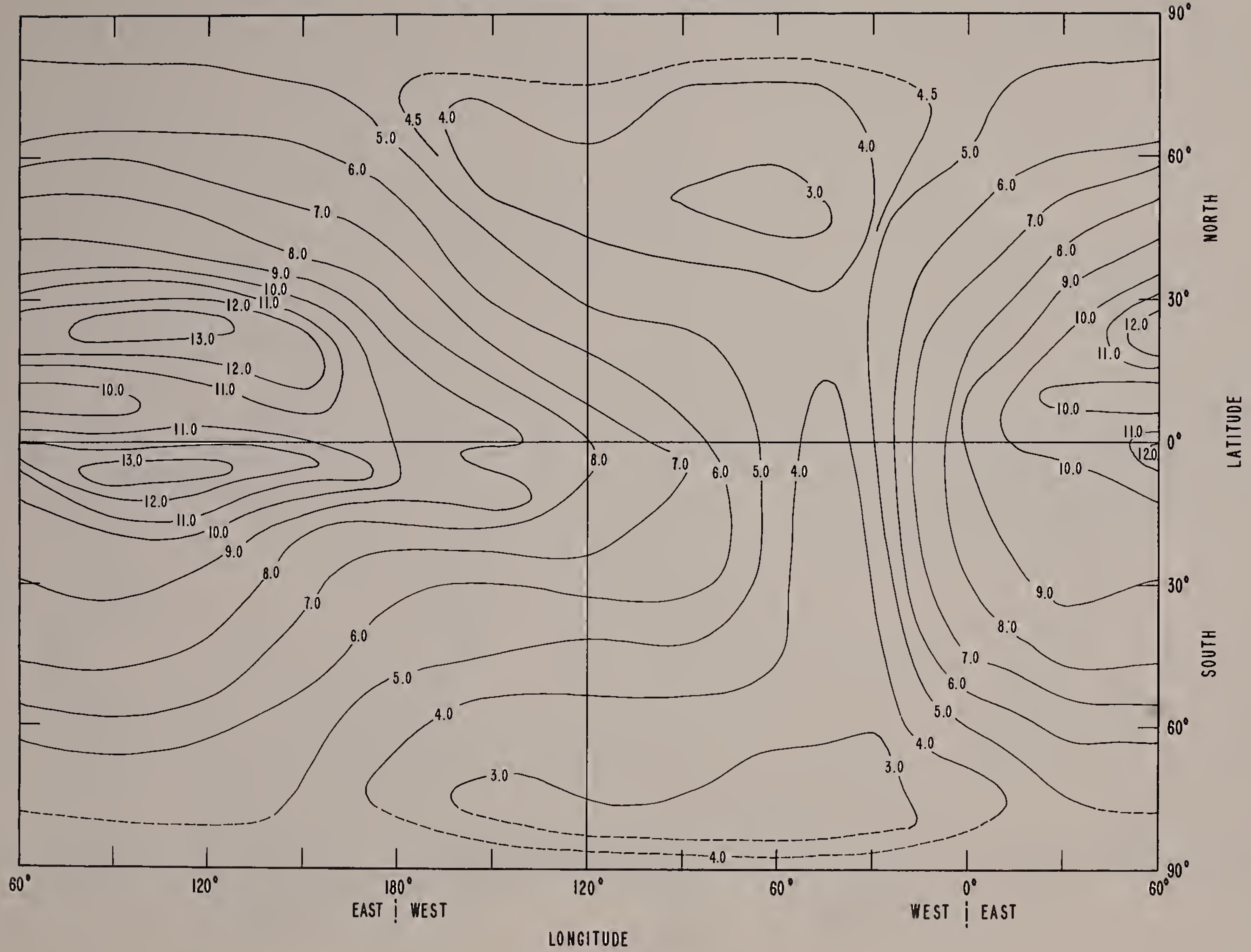
f_oF2 AT RASSN 50
APRIL 0400 HOURS GMT



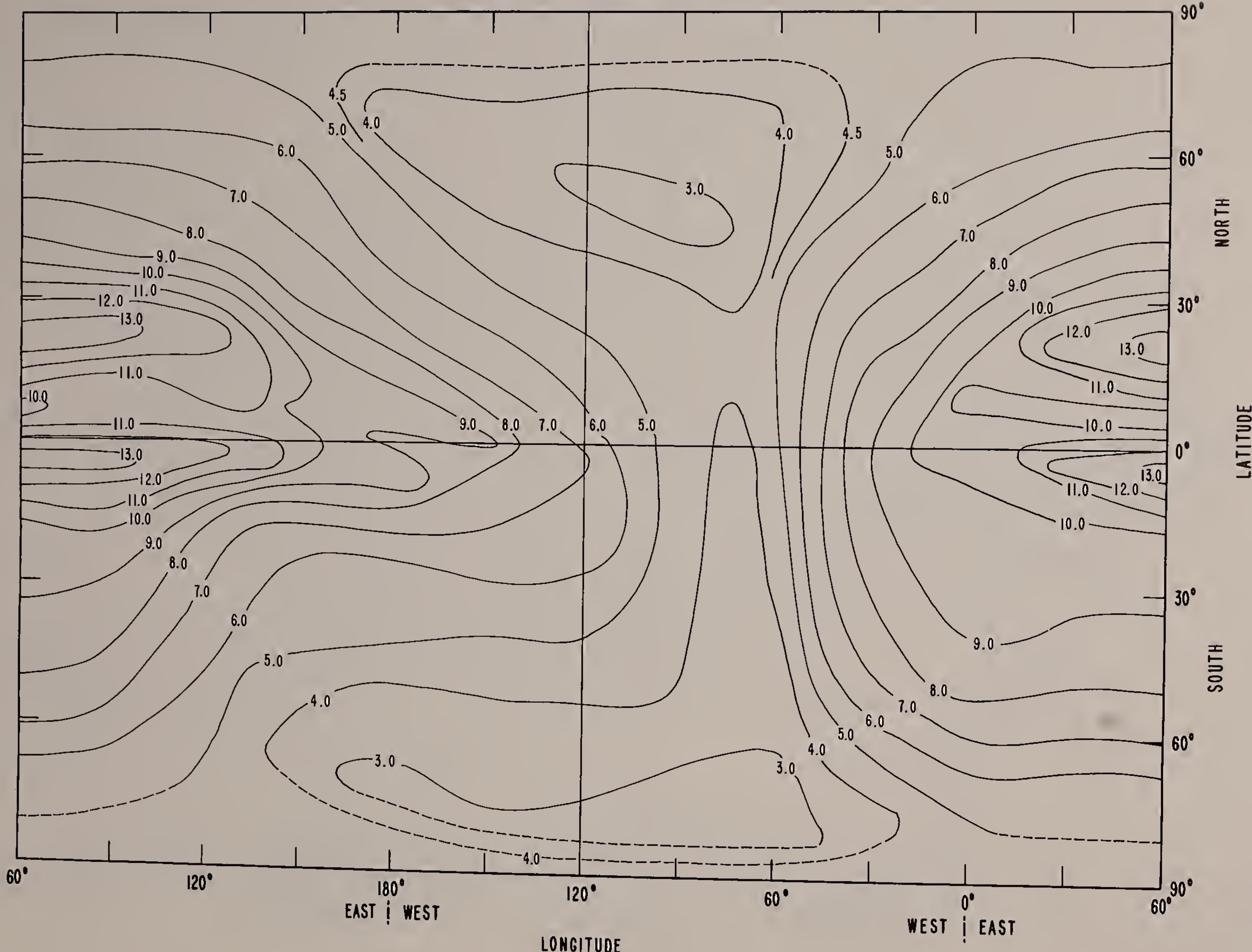
f_oF2 AT RASSN 50
APRIL 0600 HOURS GMT



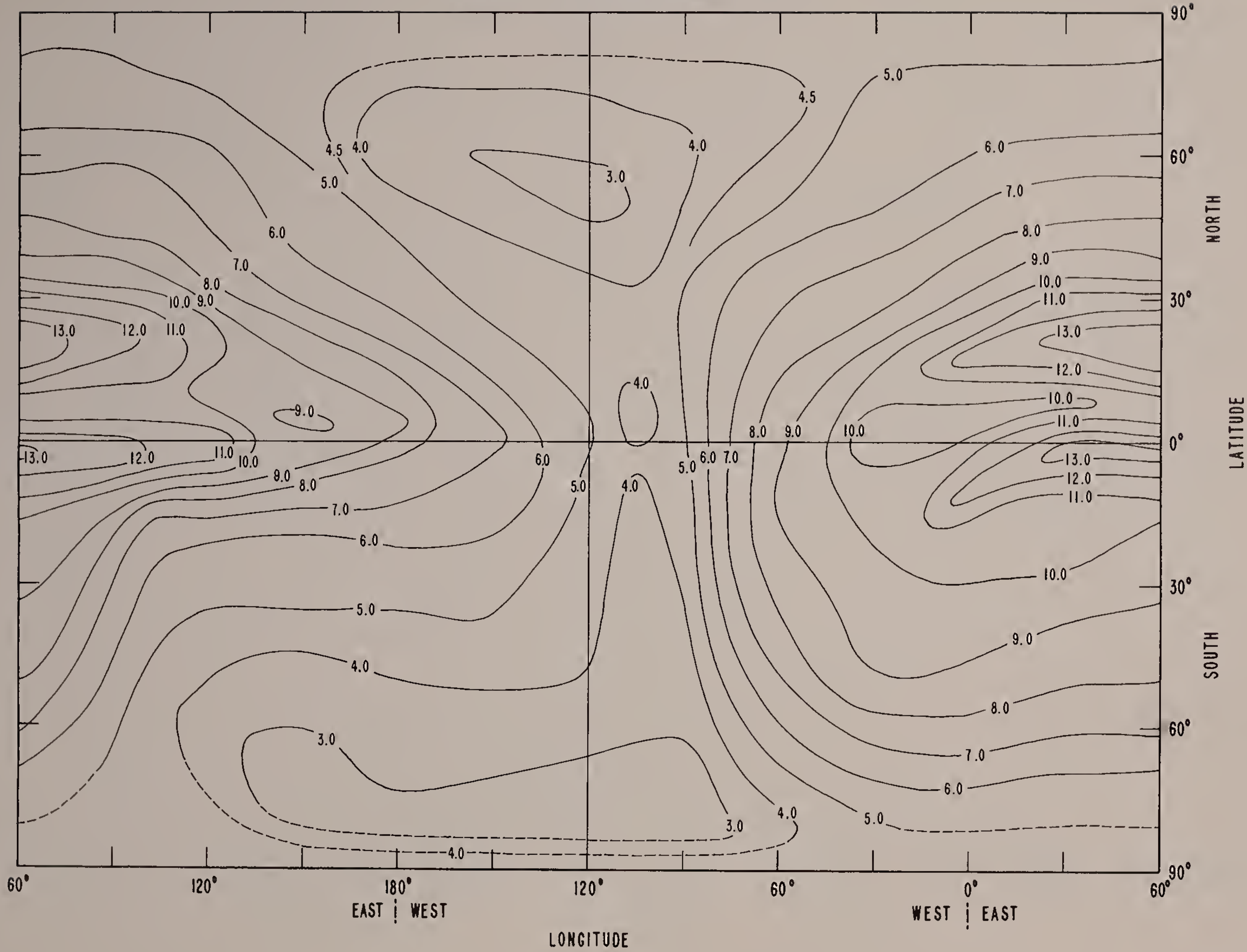
f_oF2 AT RASSN 50
APRIL 0800 HOURS GMT



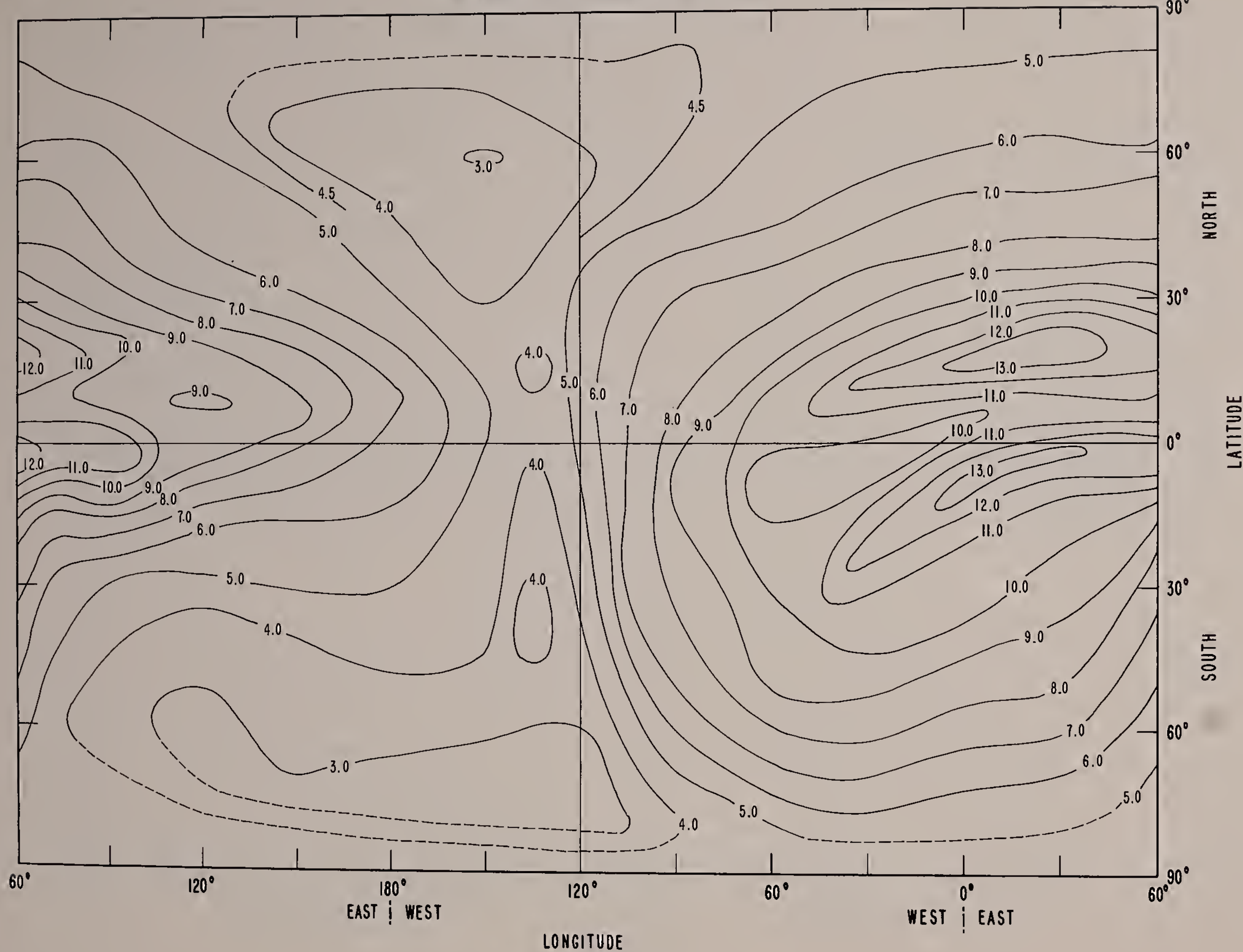
f_oF2 AT RASSN 50
APRIL 1000 HOURS GMT



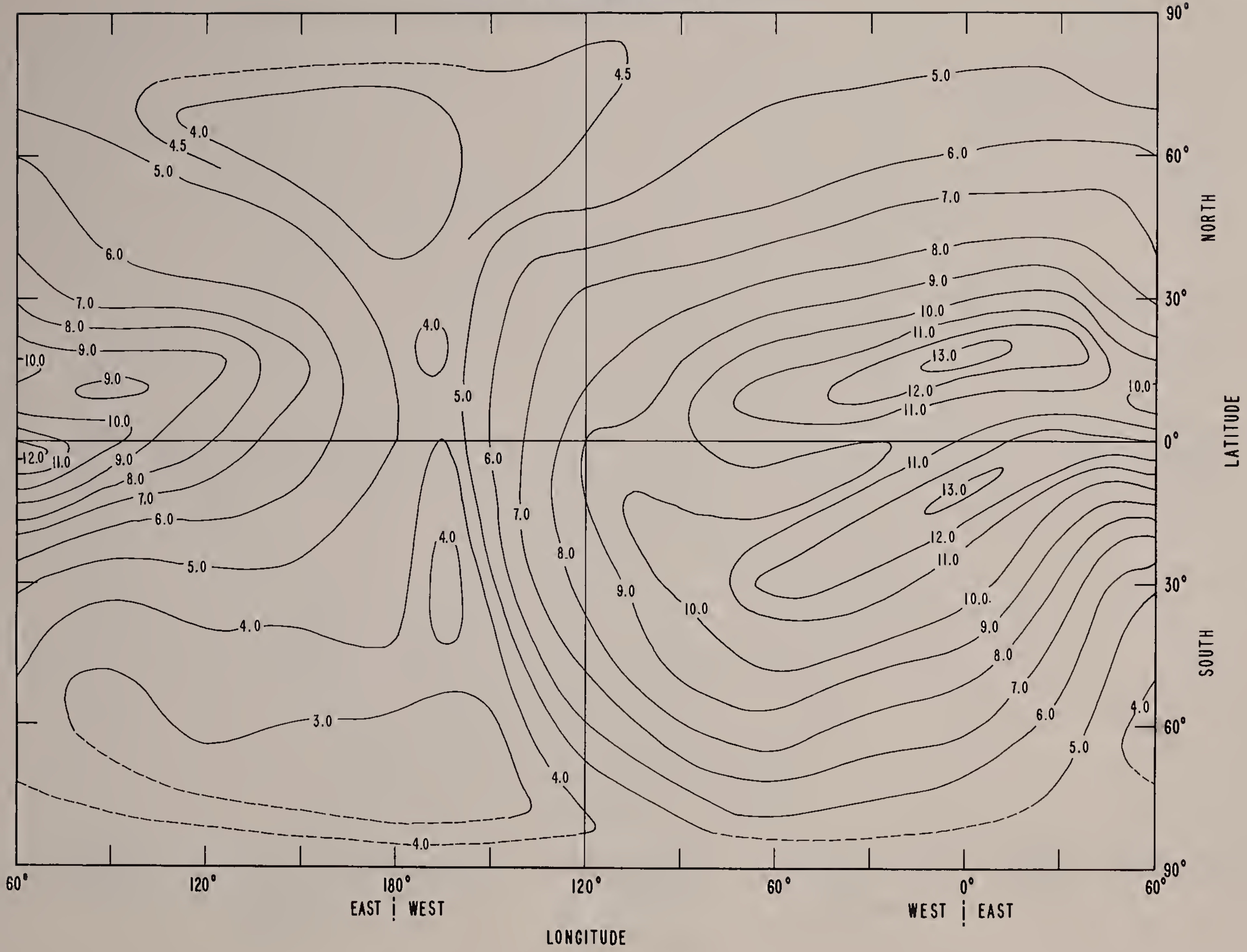
f_oF2 AT RASSN 50
APRIL 1200 HOURS GMT



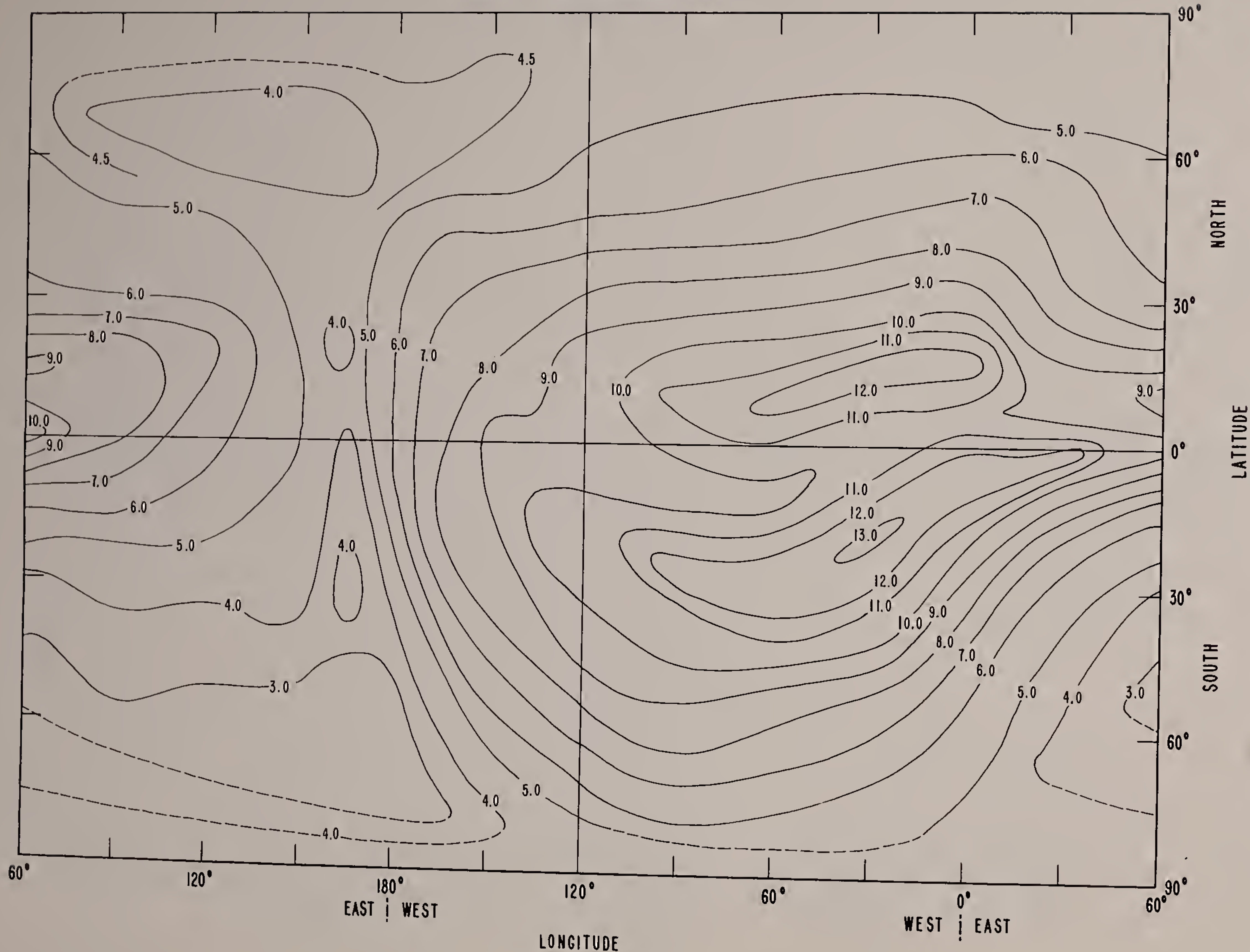
f_oF2 AT RASSN 50
APRIL 1400 HOURS GMT



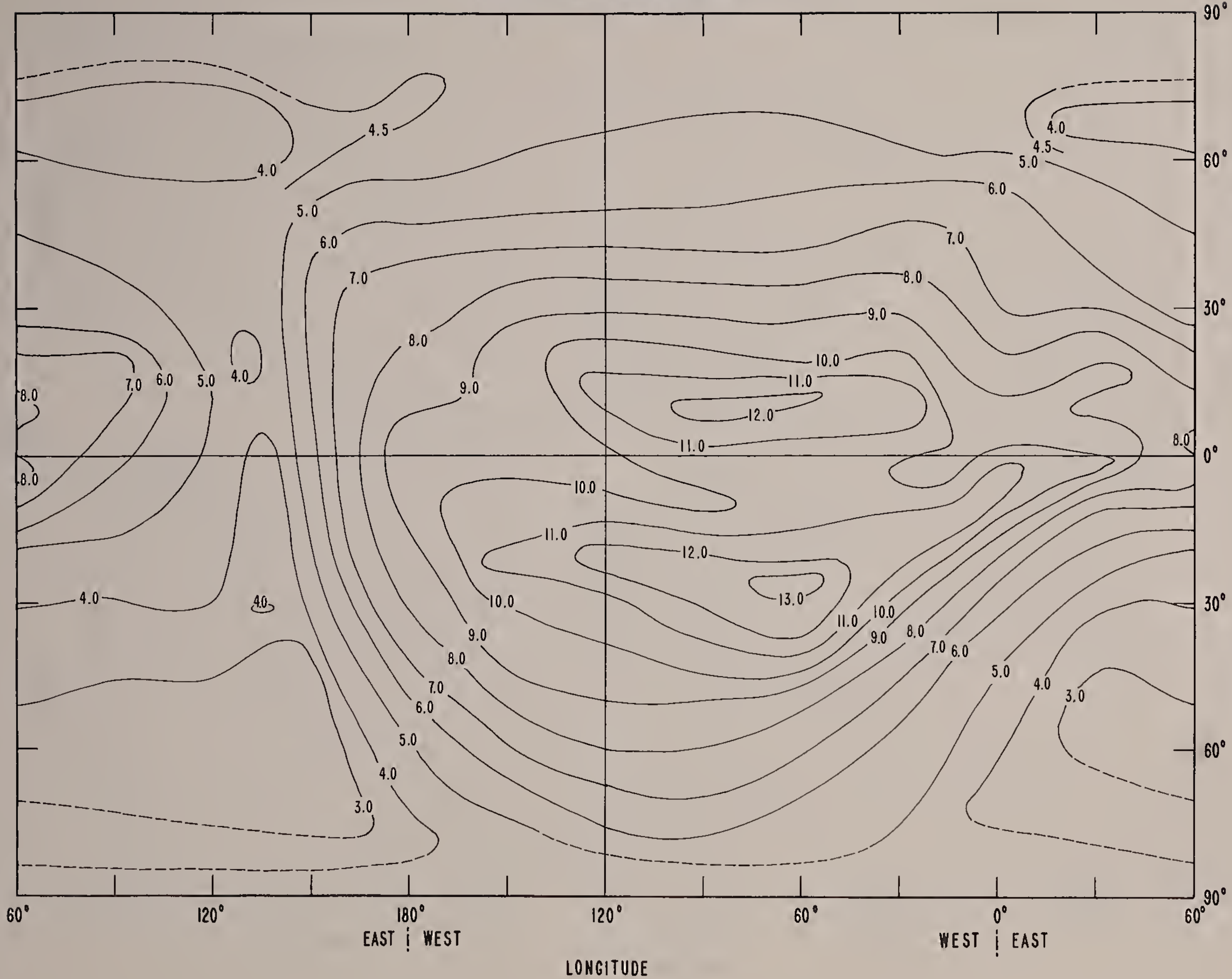
f_oF2 AT RASSN 50
APRIL 1600 HOURS GMT



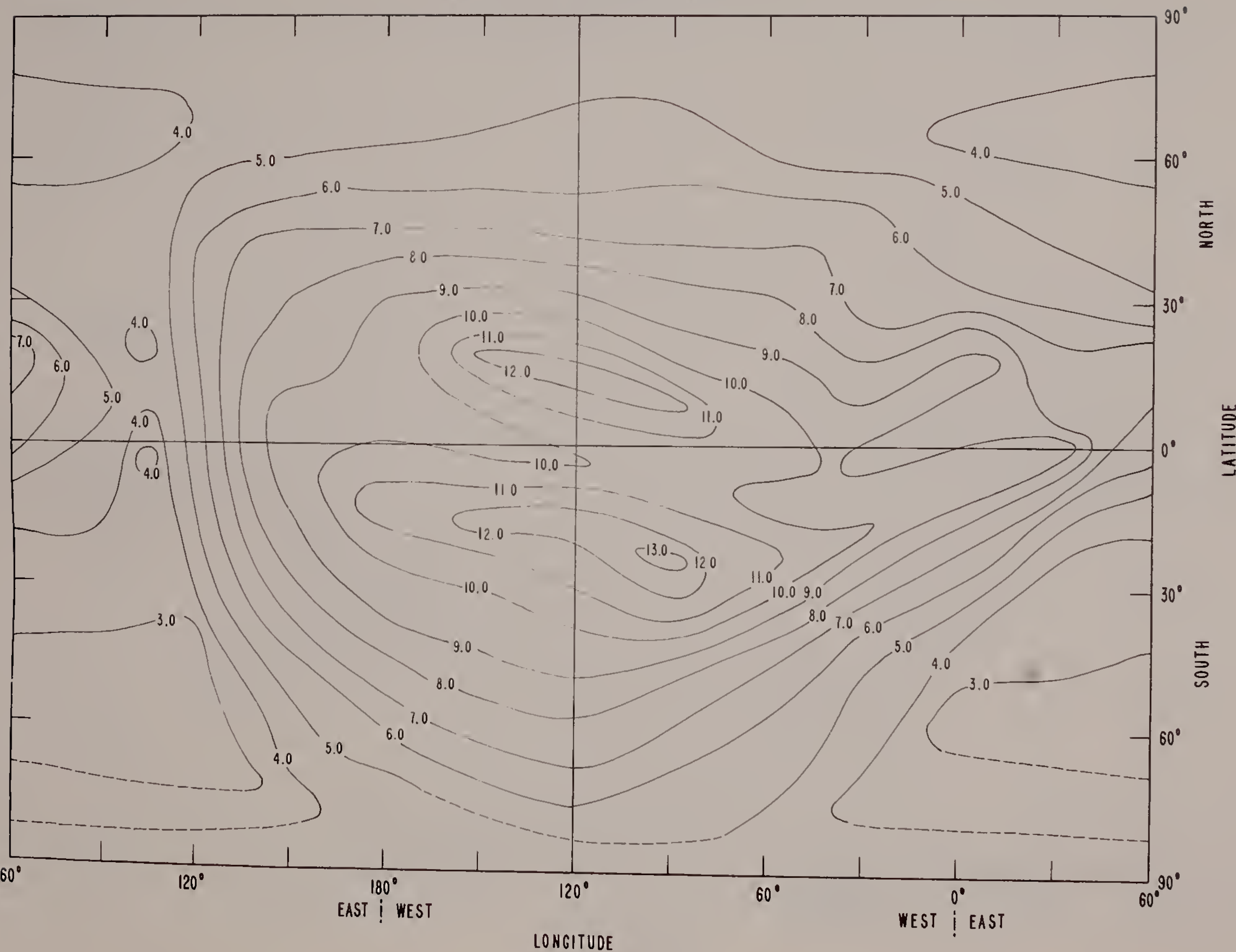
f_oF2 AT RASSN 50
APRIL 1800 HOURS GMT



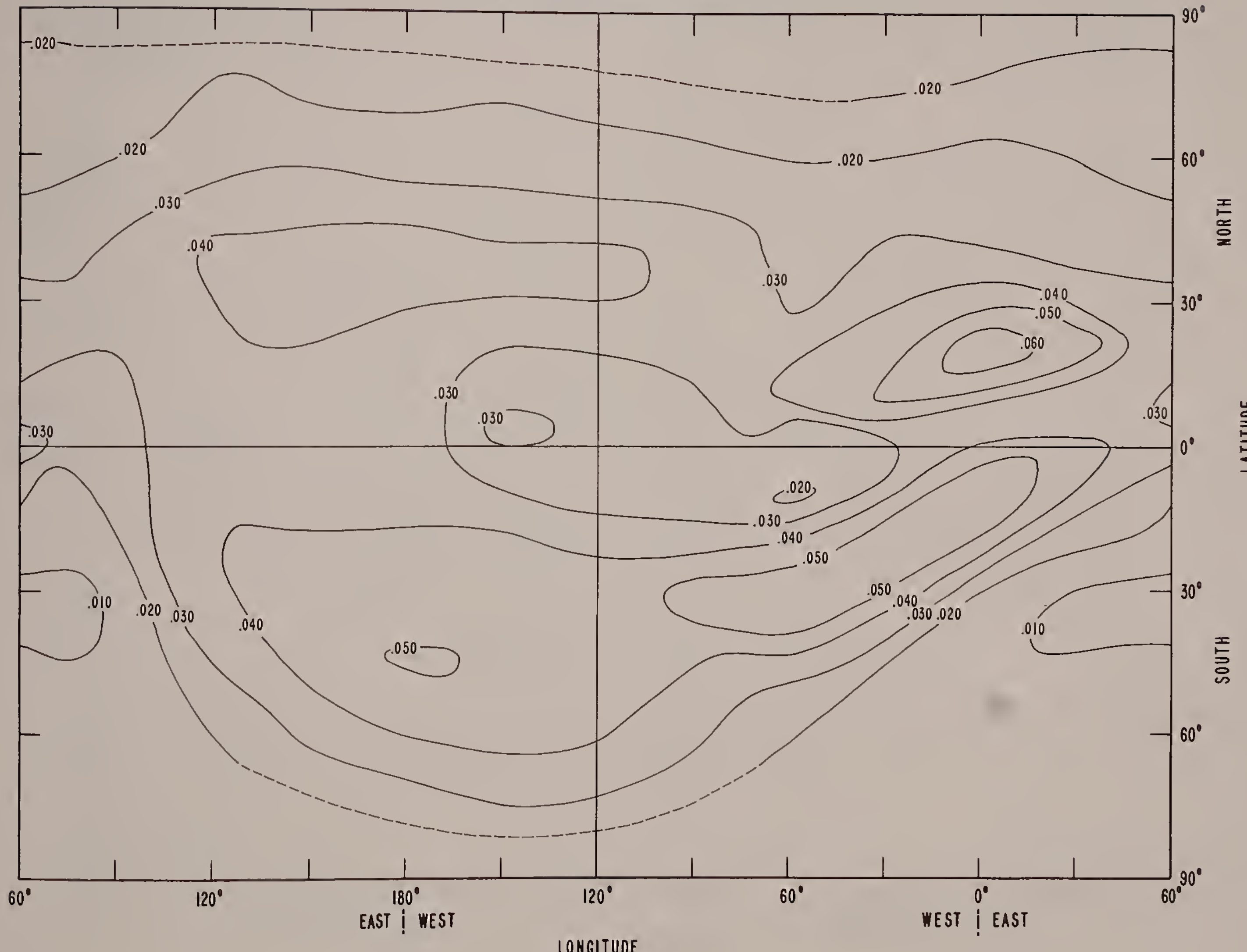
f$_o$F2 AT RASSN 50
APRIL 2000 HOURS GMT



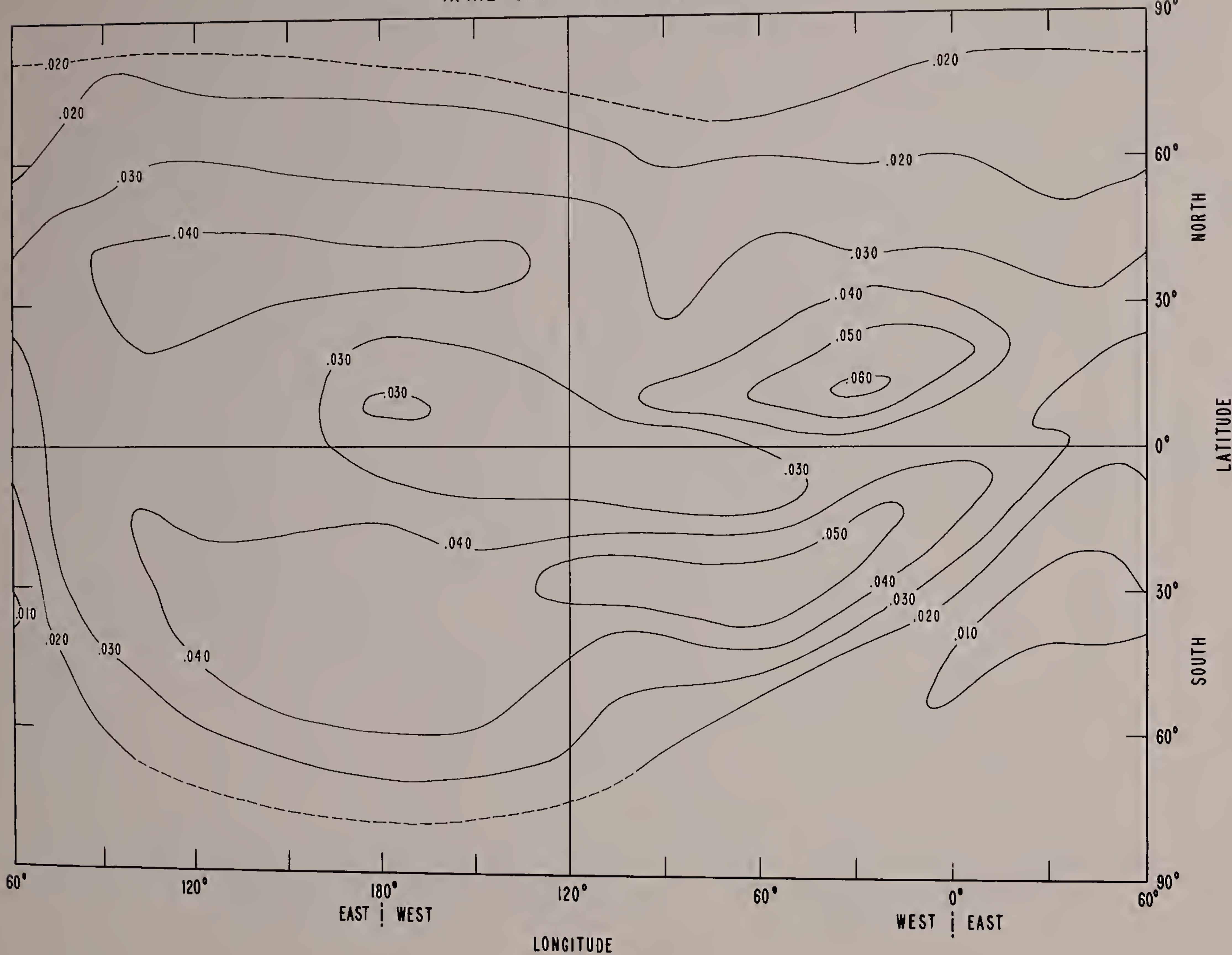
f_oF2 AT RASSN 50
APRIL 2200 HOURS GMT



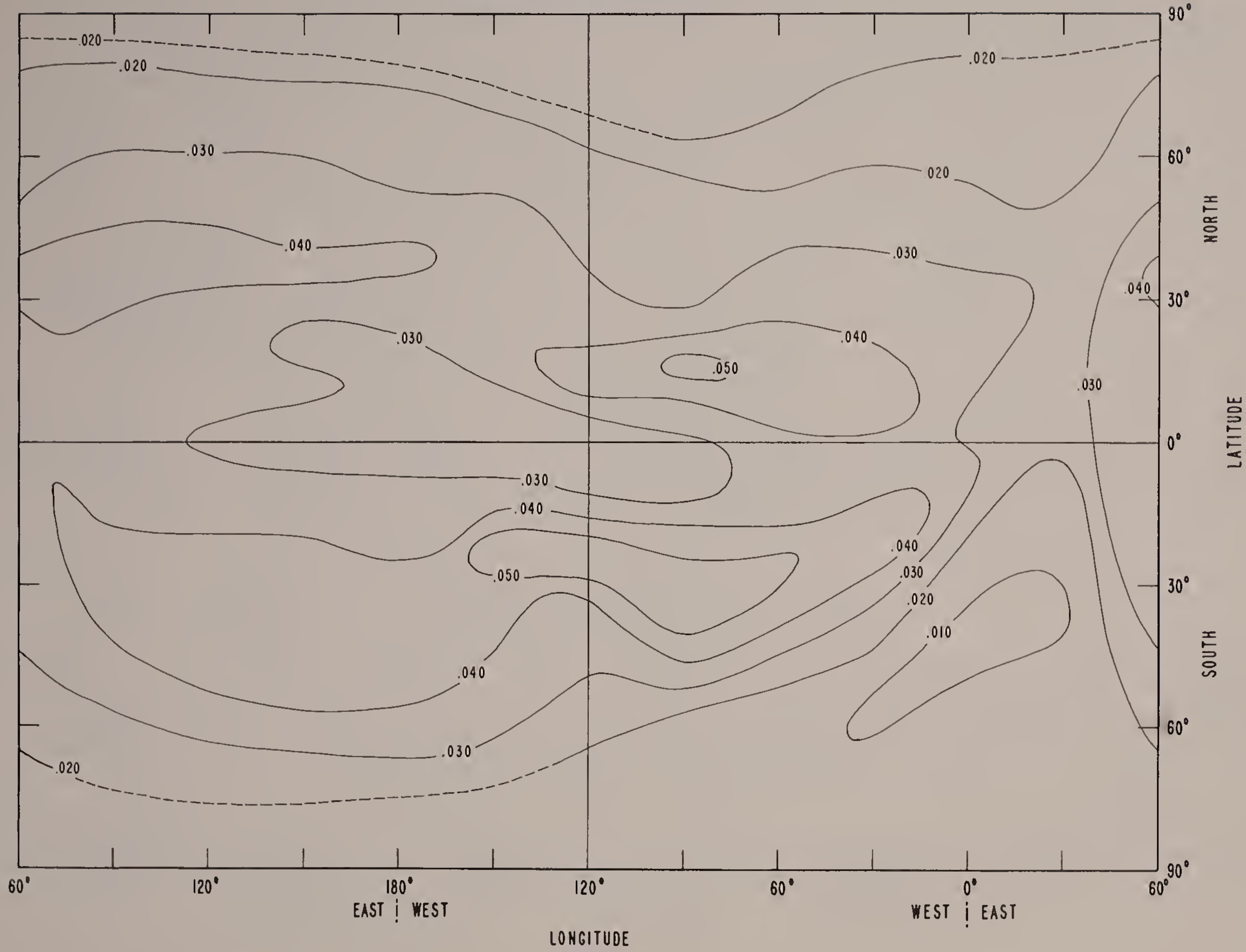
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 0000 HOURS GMT



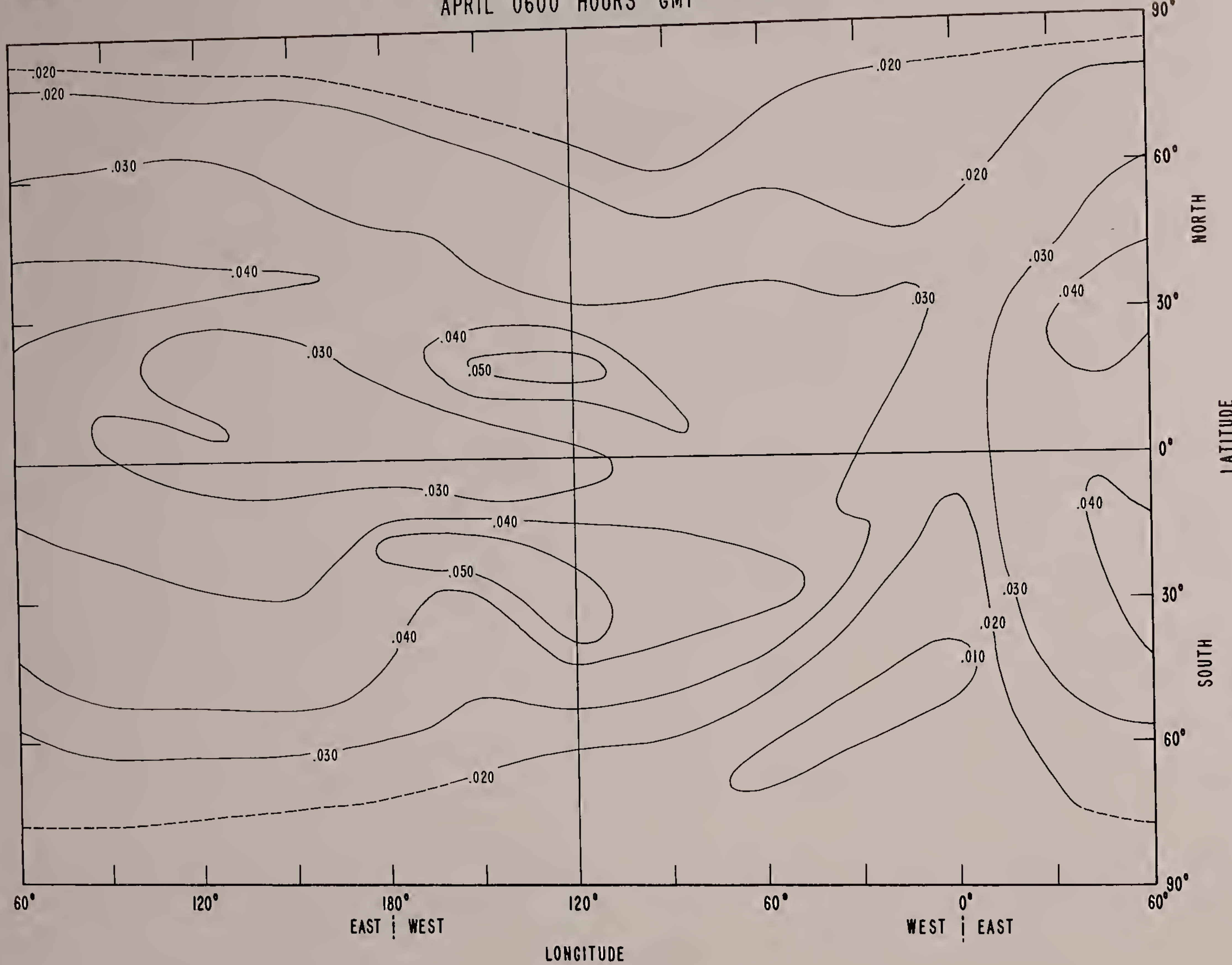
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 0200 HOURS GMT



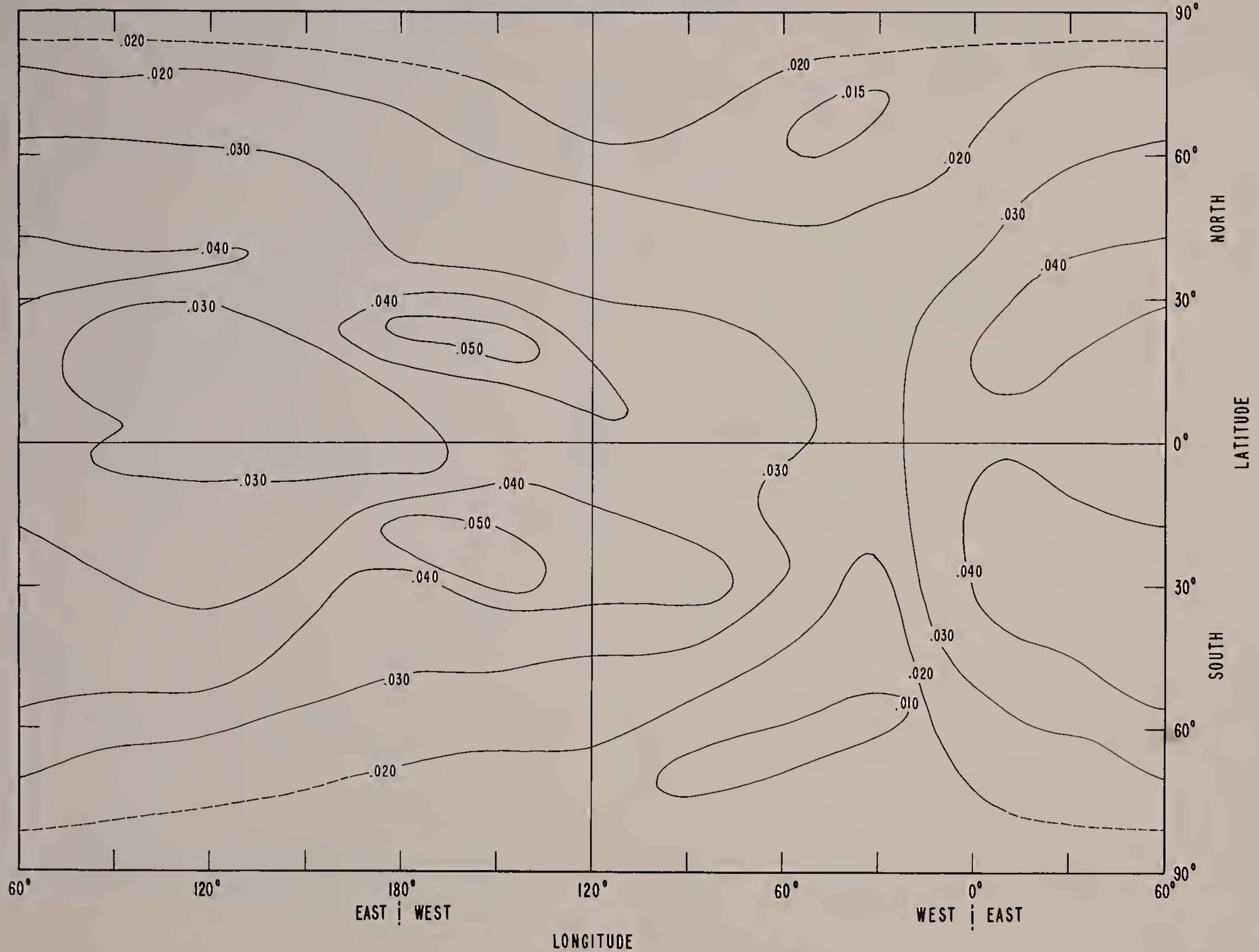
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 0400 HOURS GMT



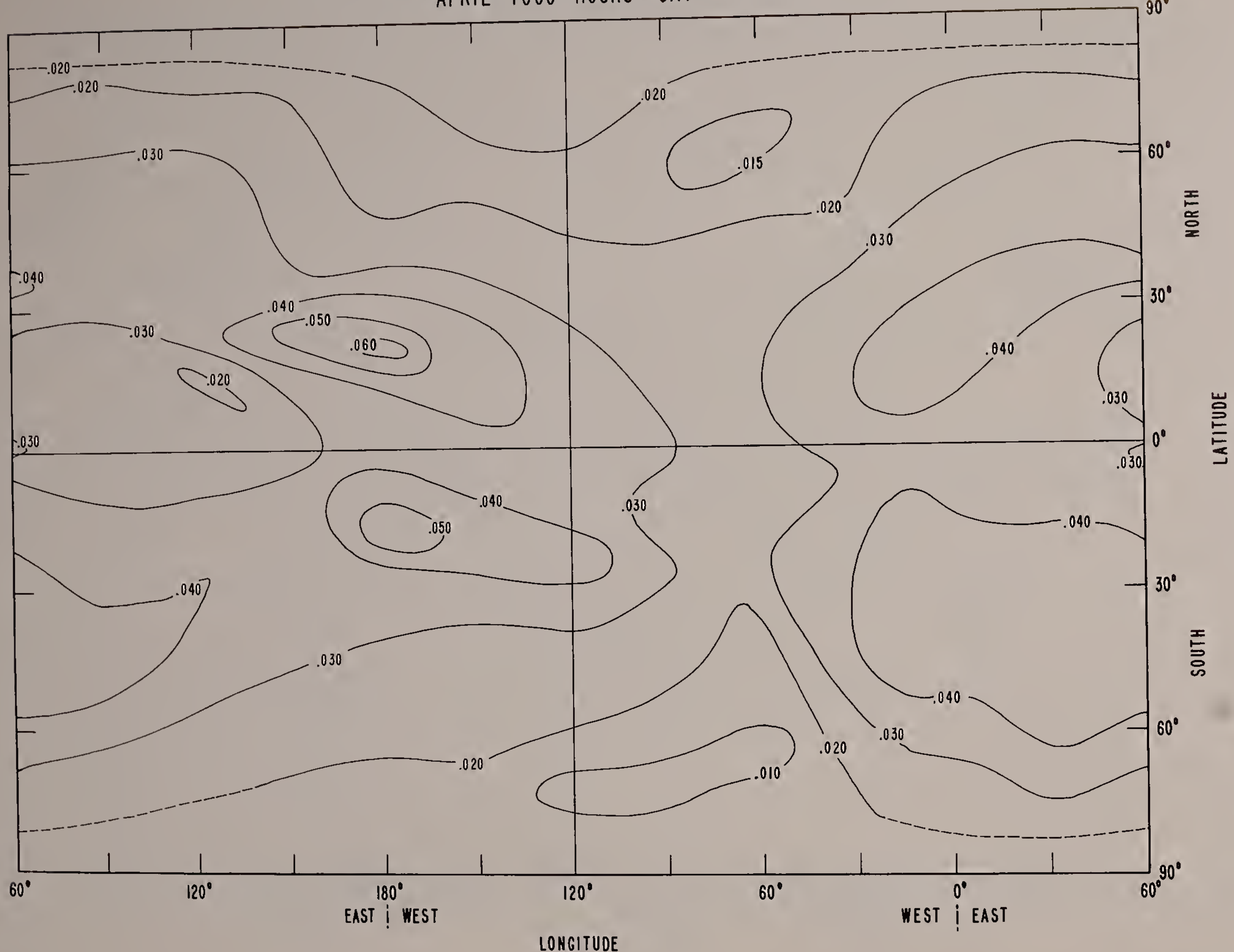
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 0600 HOURS GMT



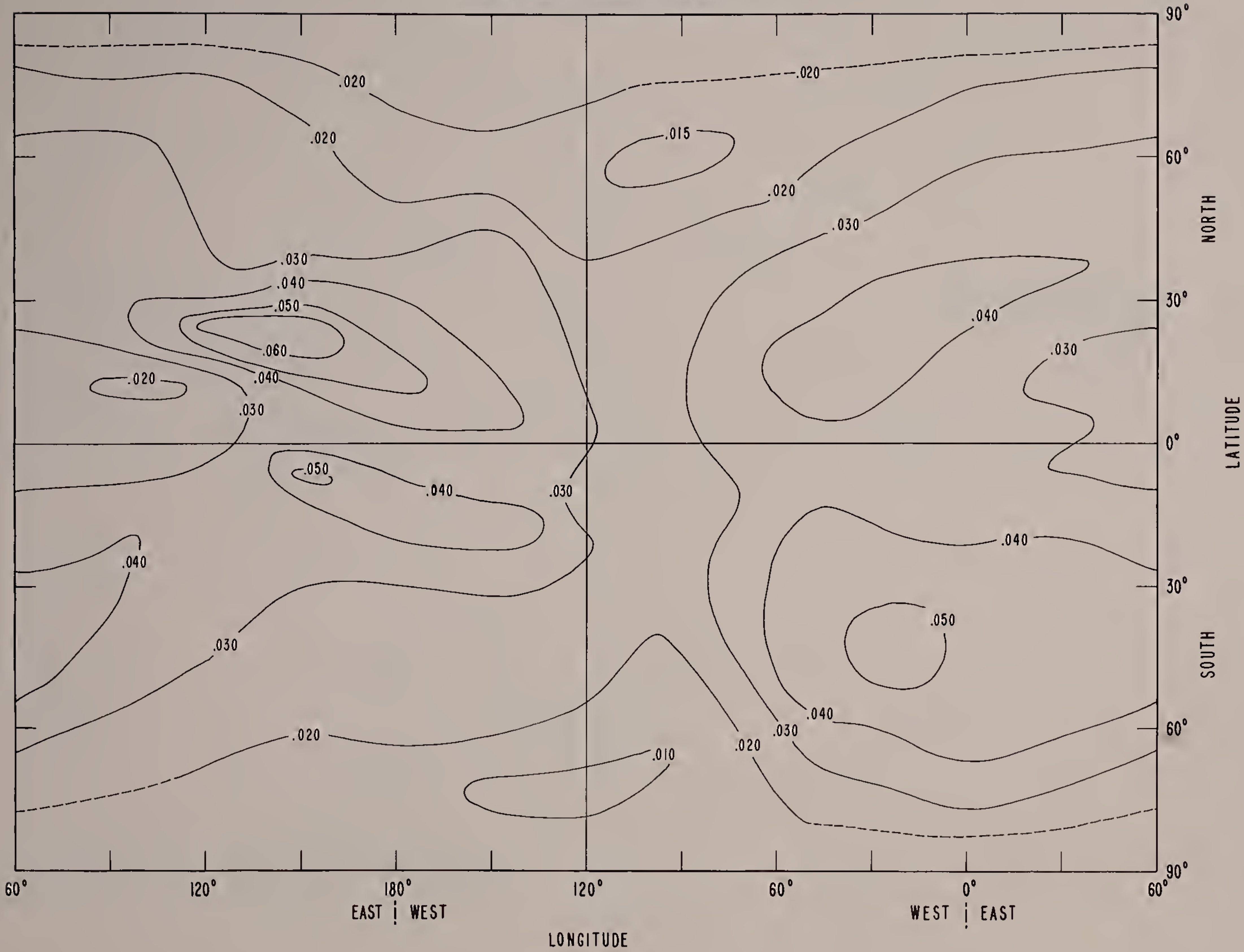
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 0800 HOURS GMT



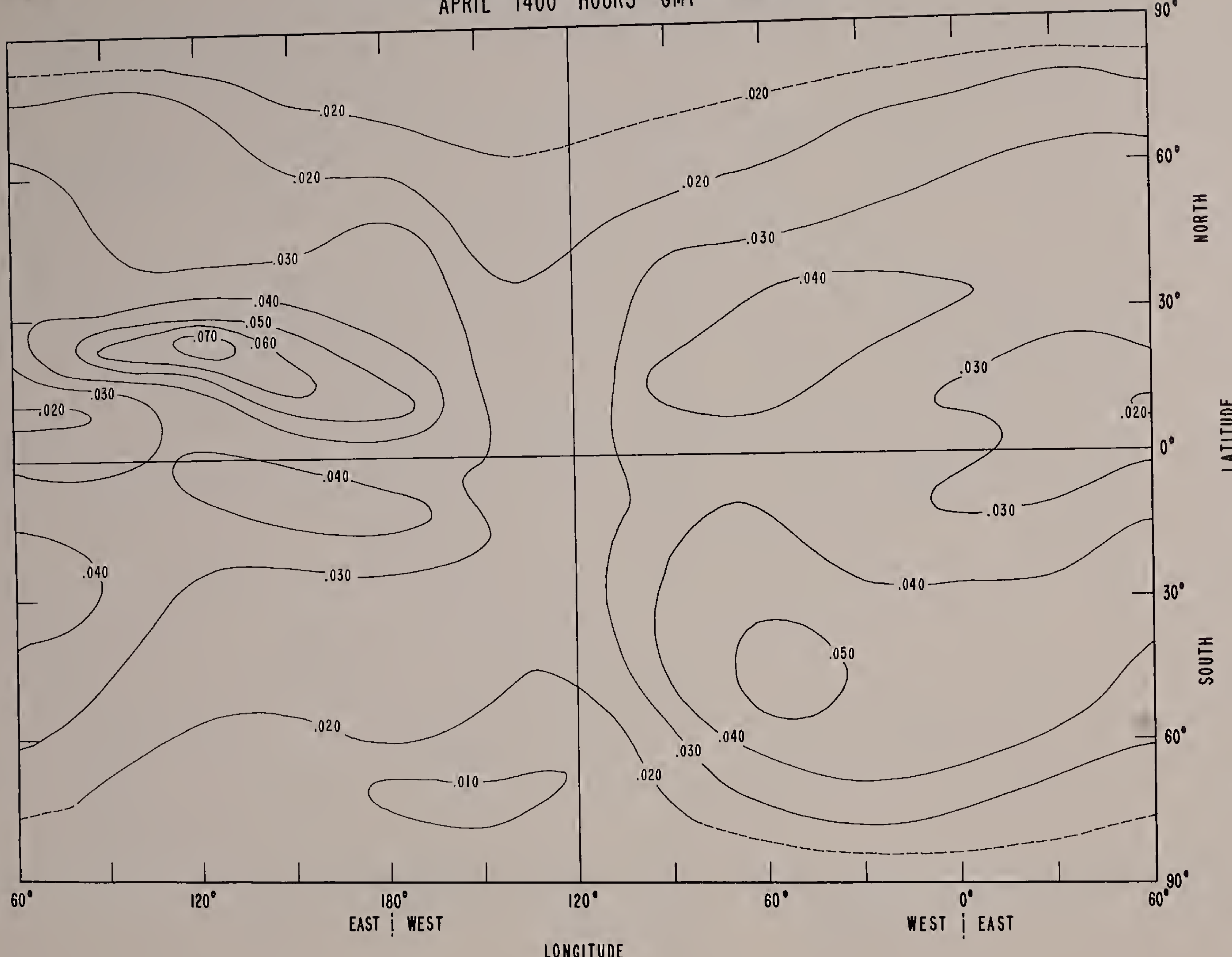
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 1000 HOURS GMT



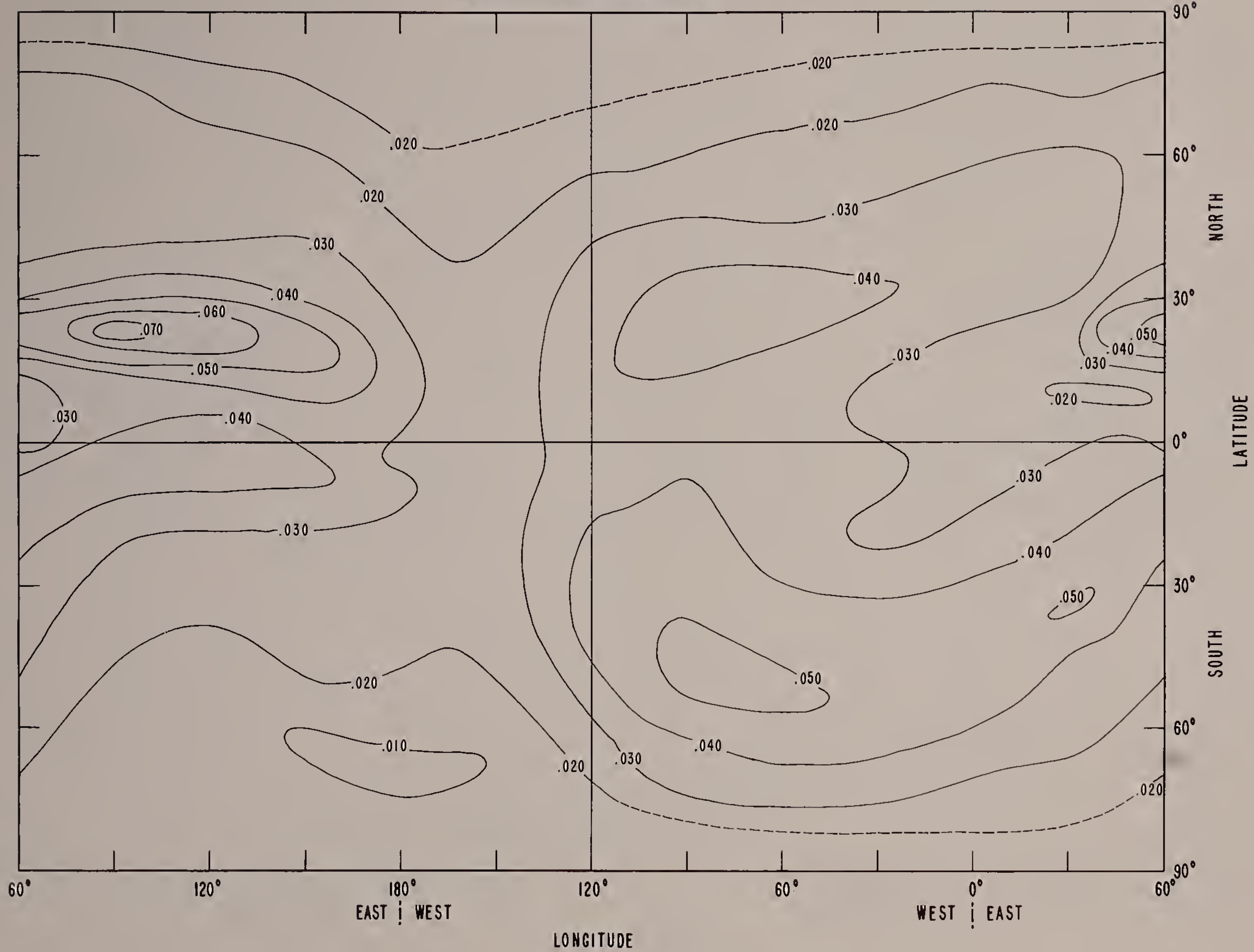
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 1200 HOURS GMT



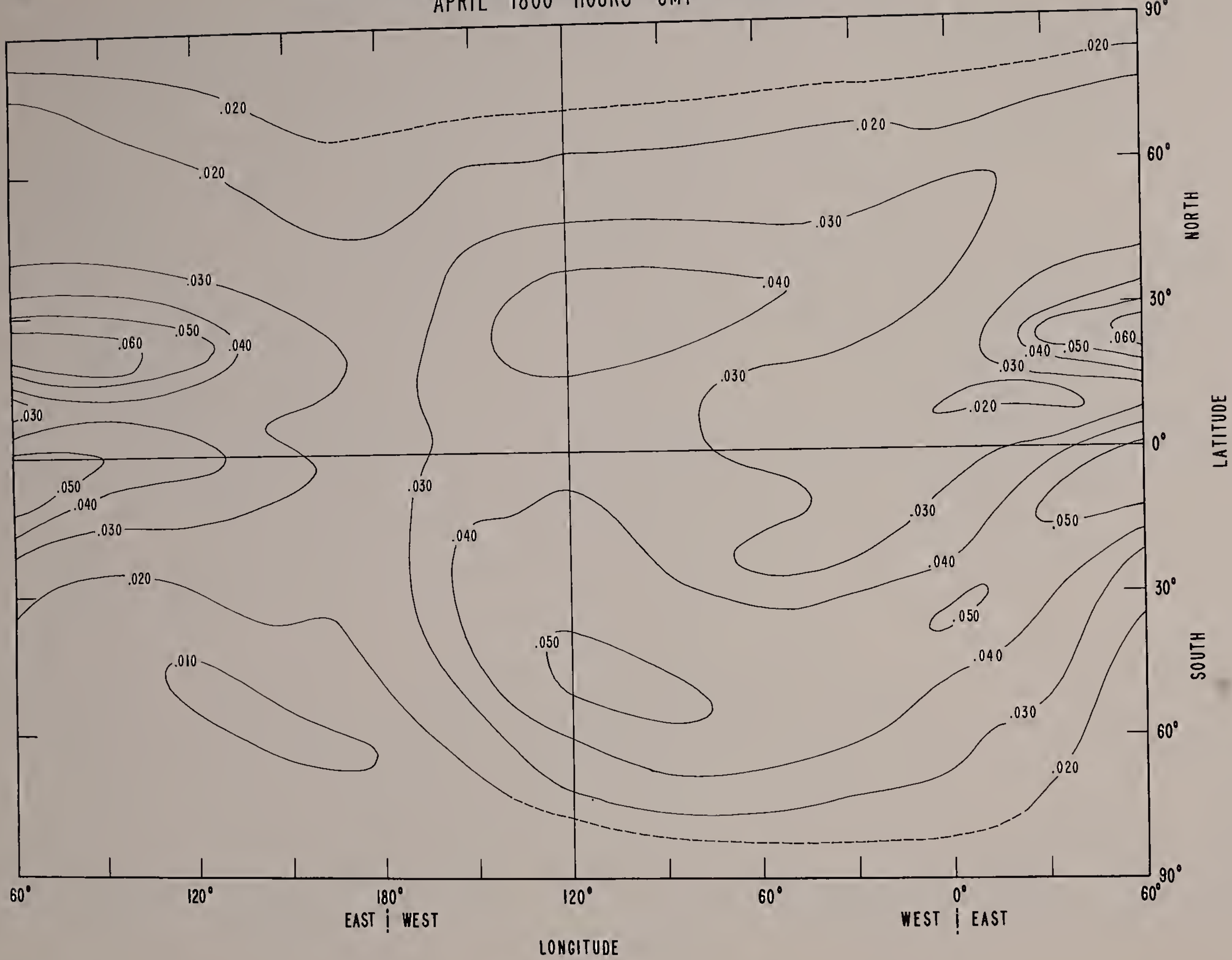
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 1400 HOURS GMT



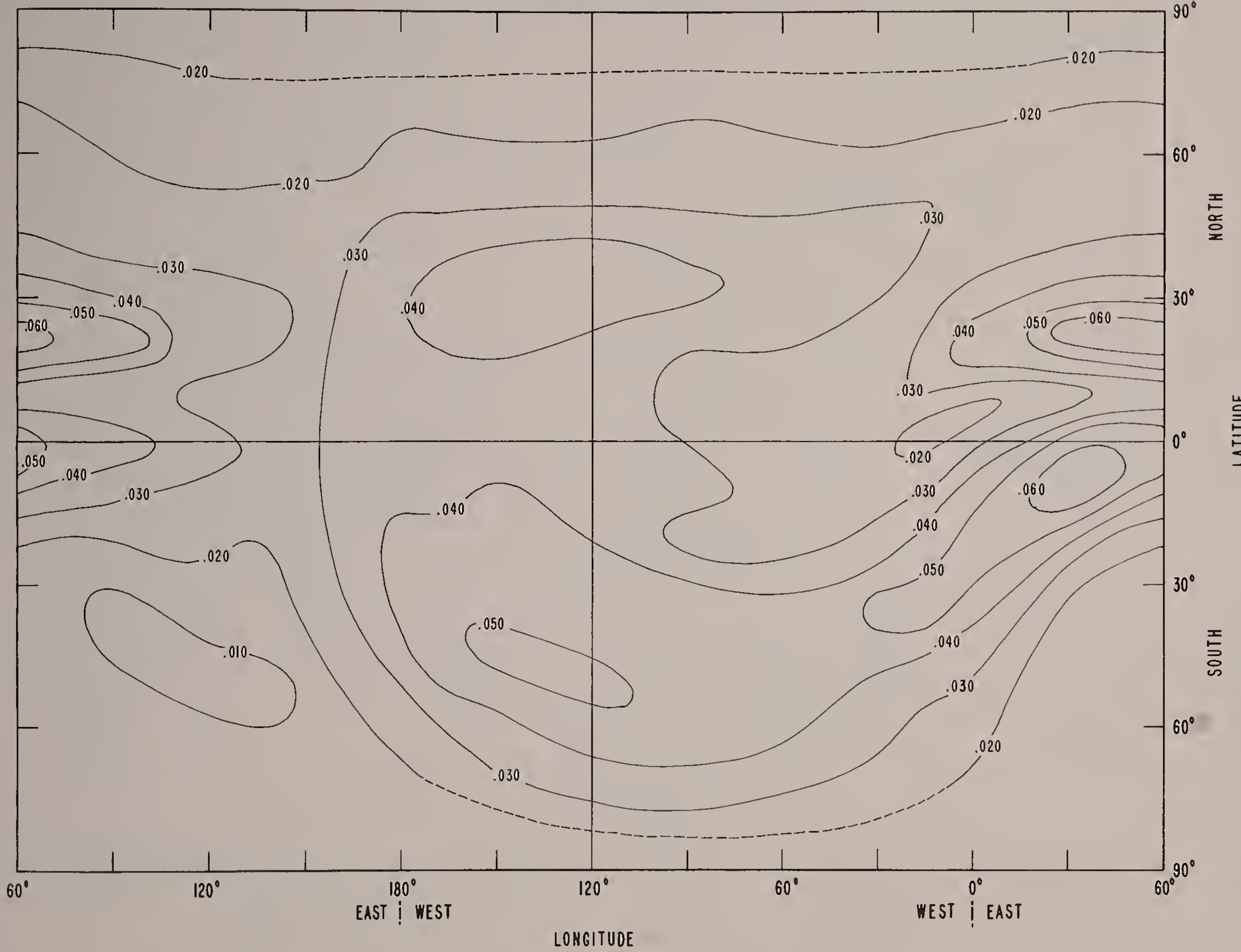
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 1600 HOURS GMT



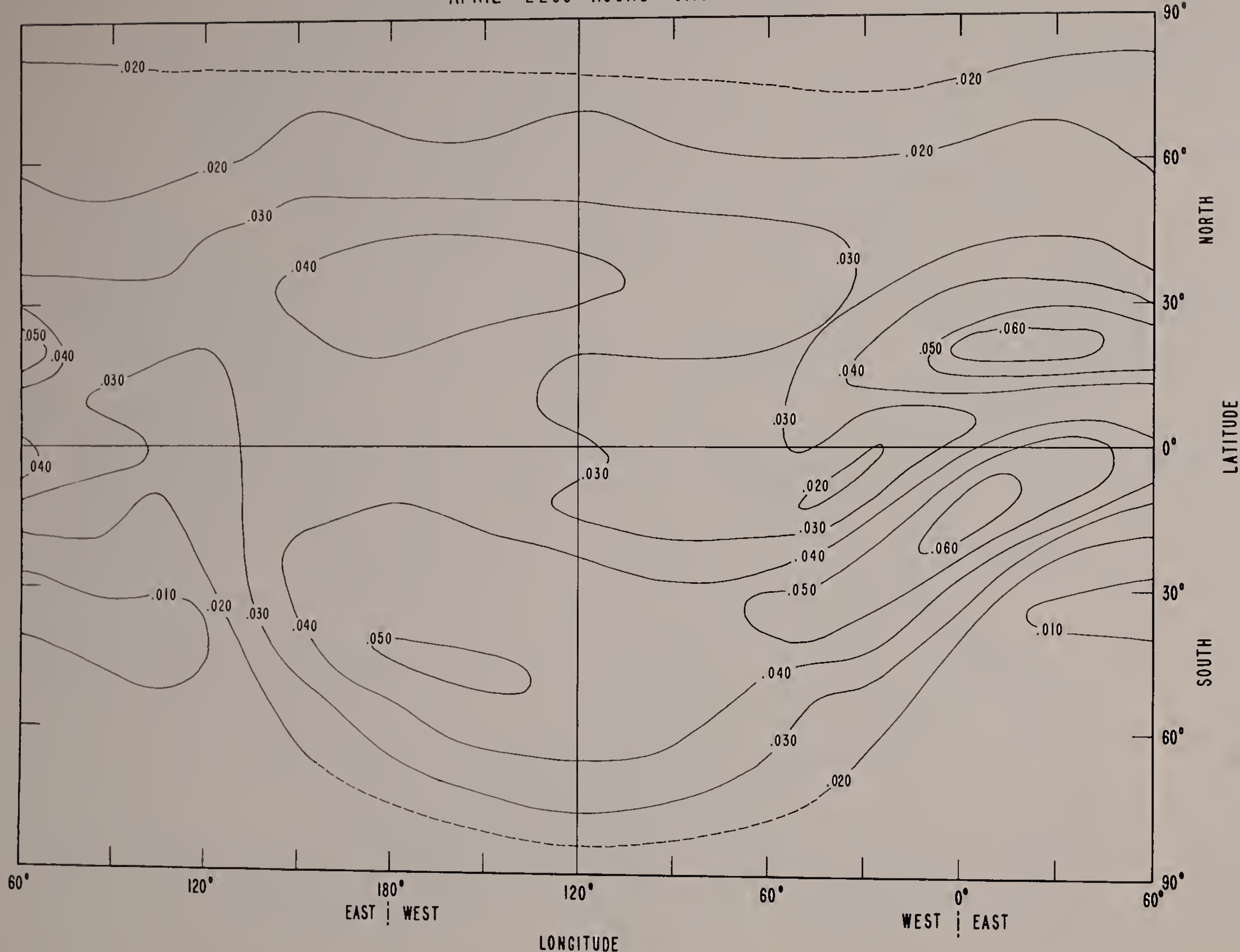
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 1800 HOURS GMT



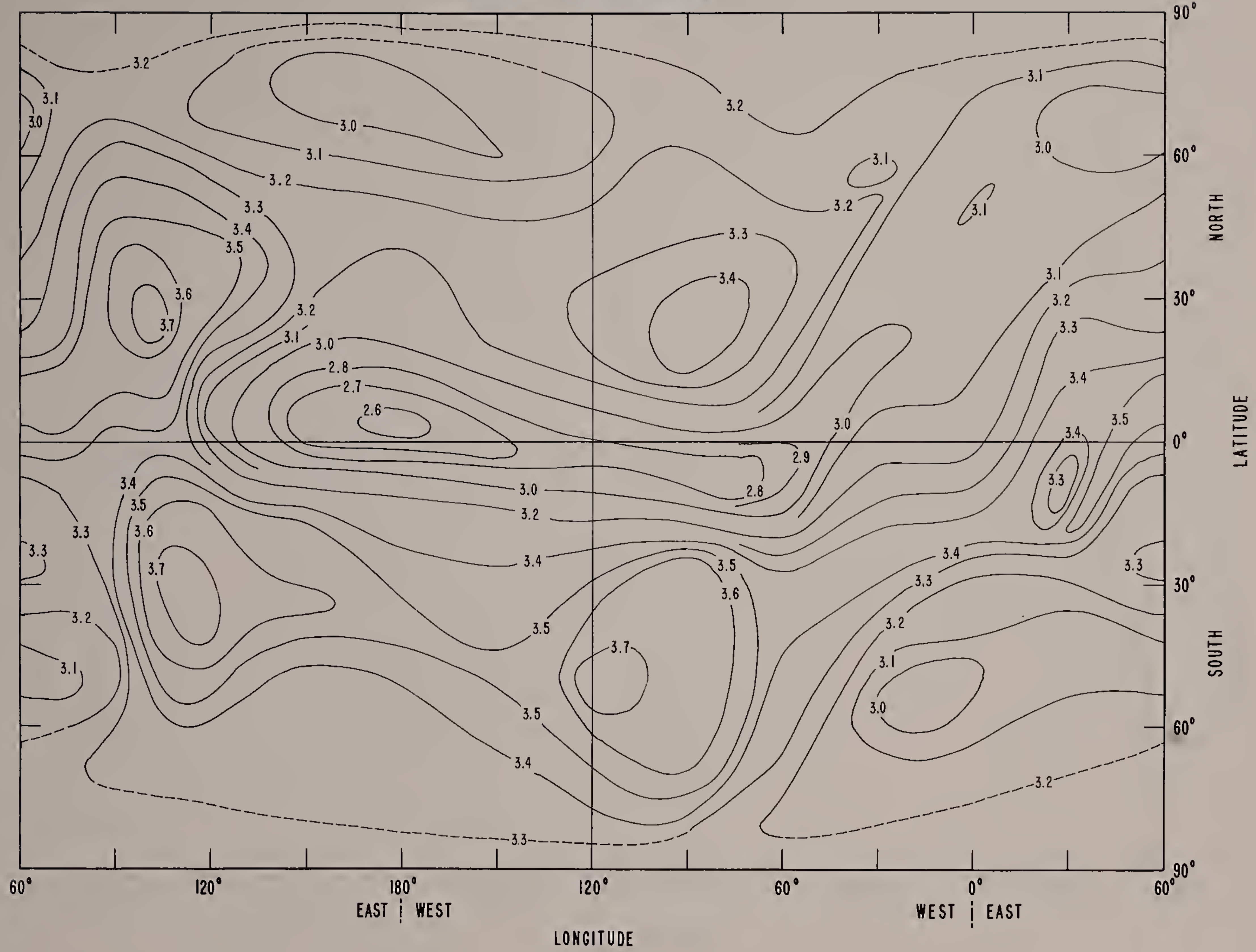
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 2000 HOURS GMT



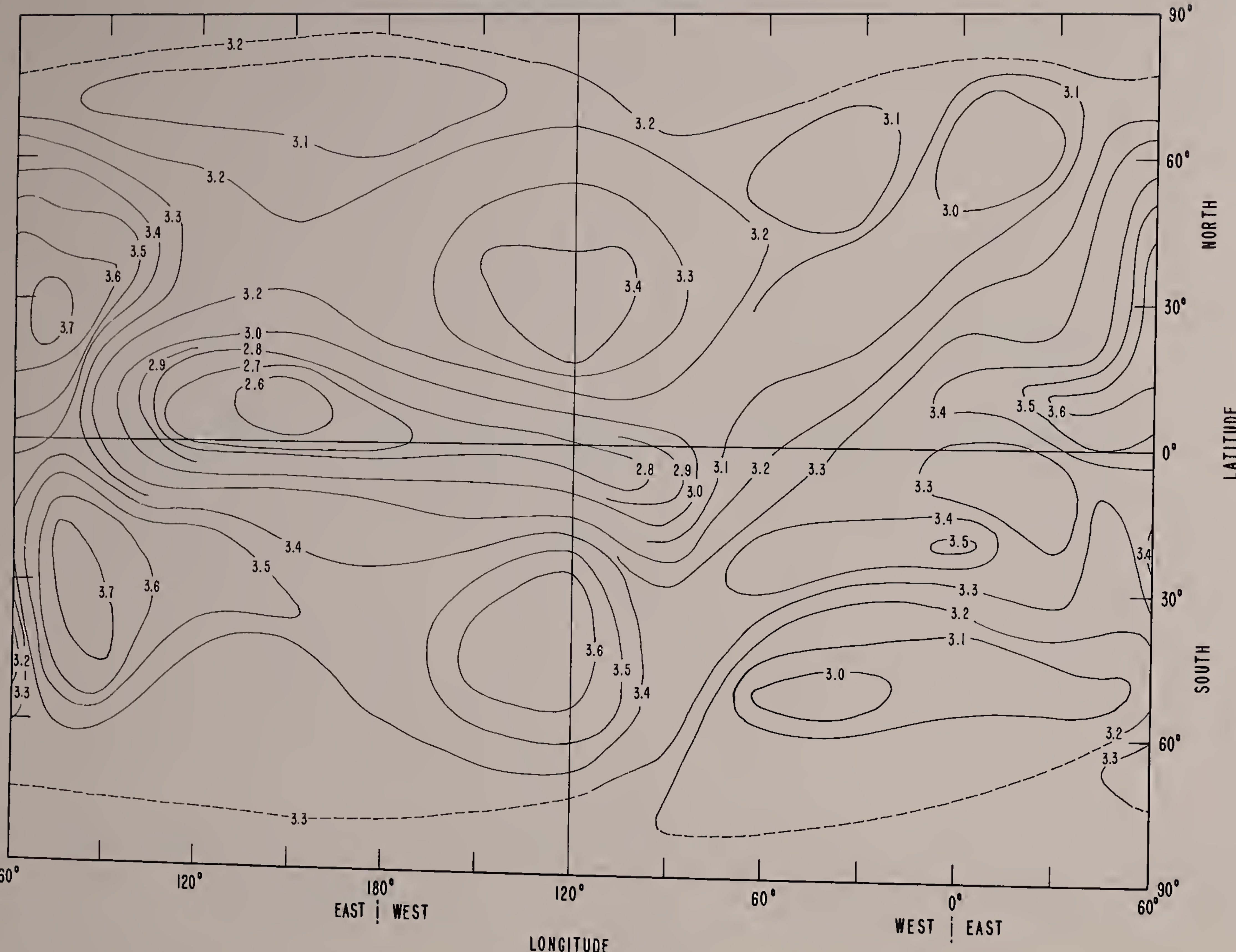
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
APRIL 2200 HOURS GMT



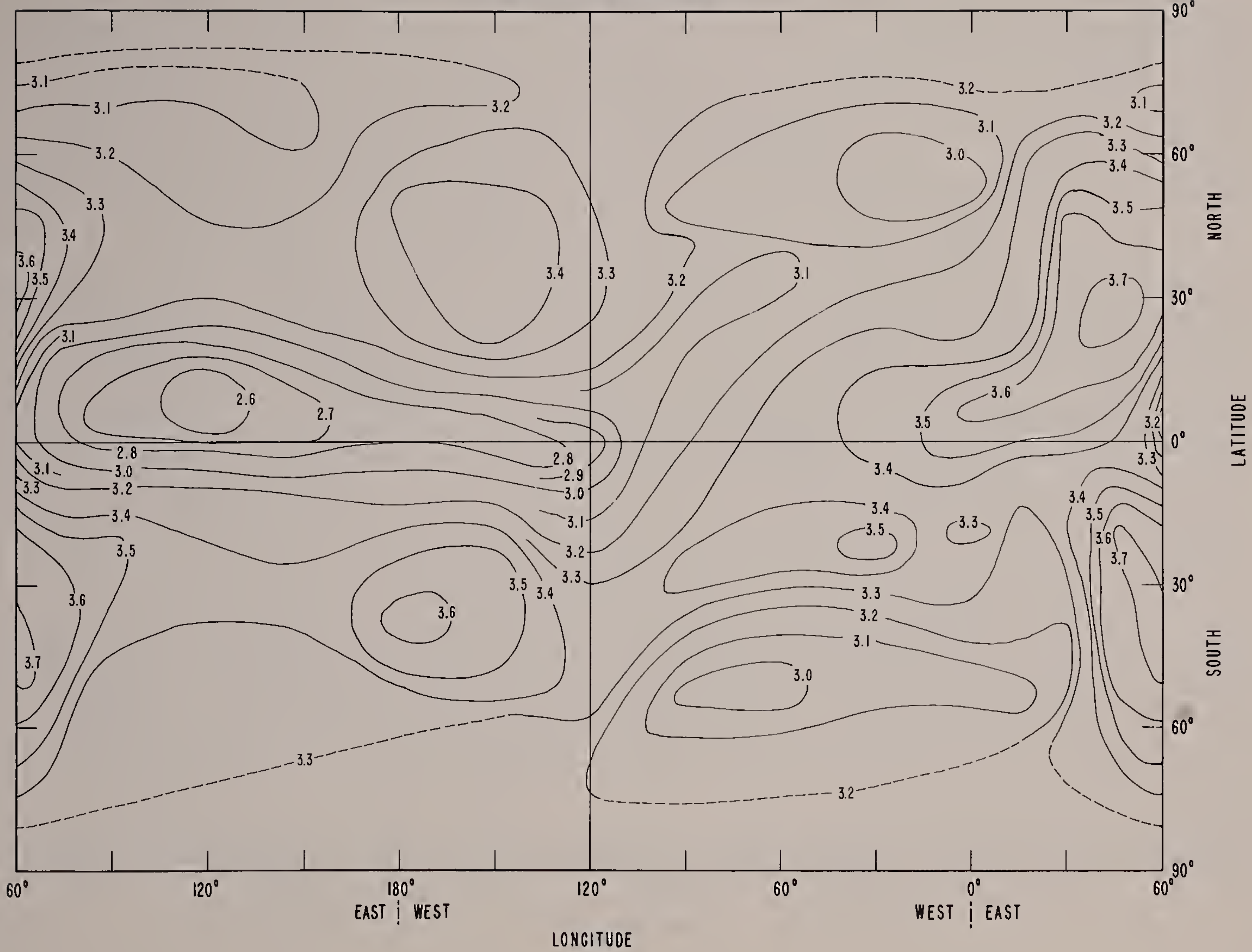
M-4000 FACTOR AT RASSN 50
APRIL 0000 HOURS GMT



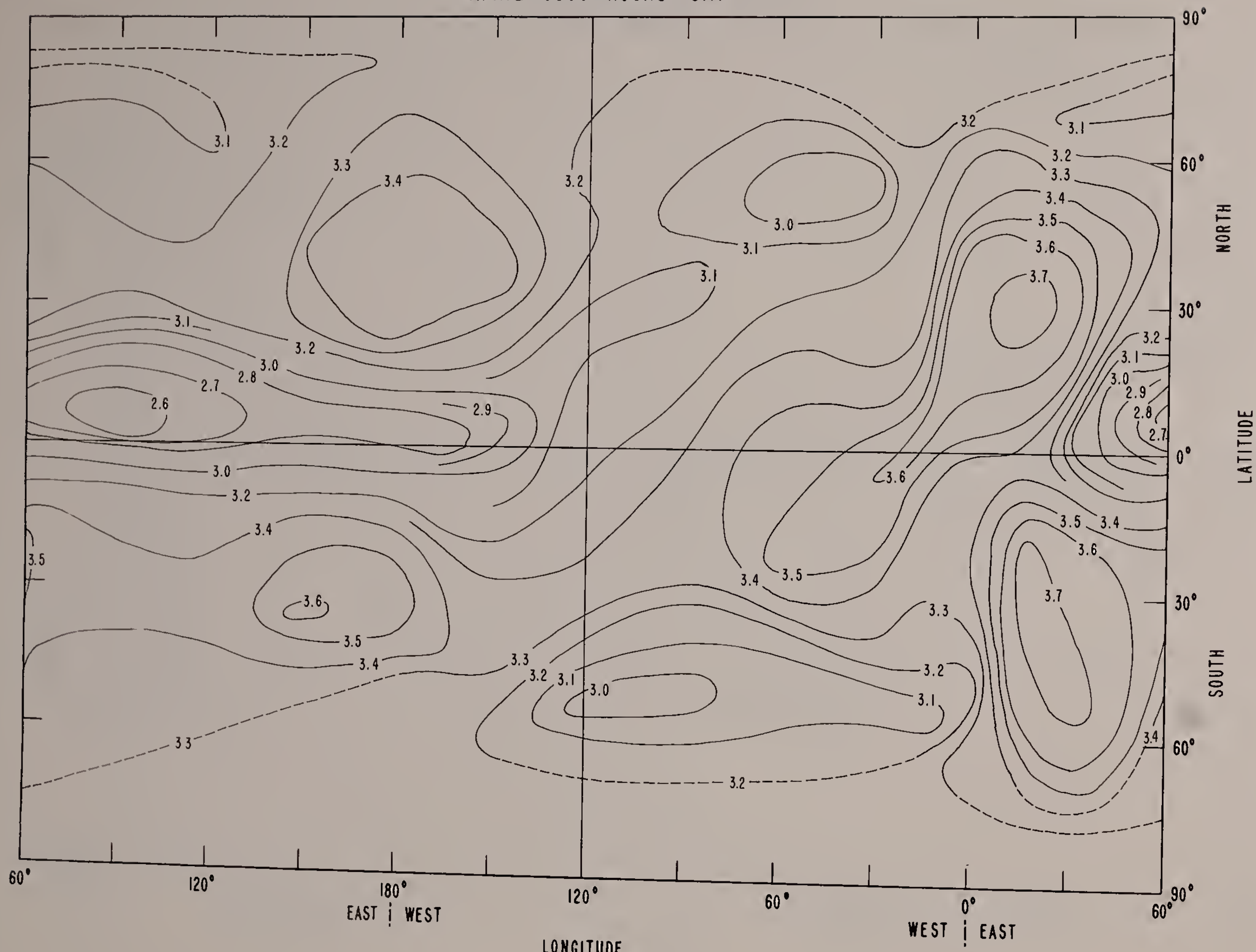
M-4000 FACTOR AT RASSN 50
APRIL 0200 HOURS GMT



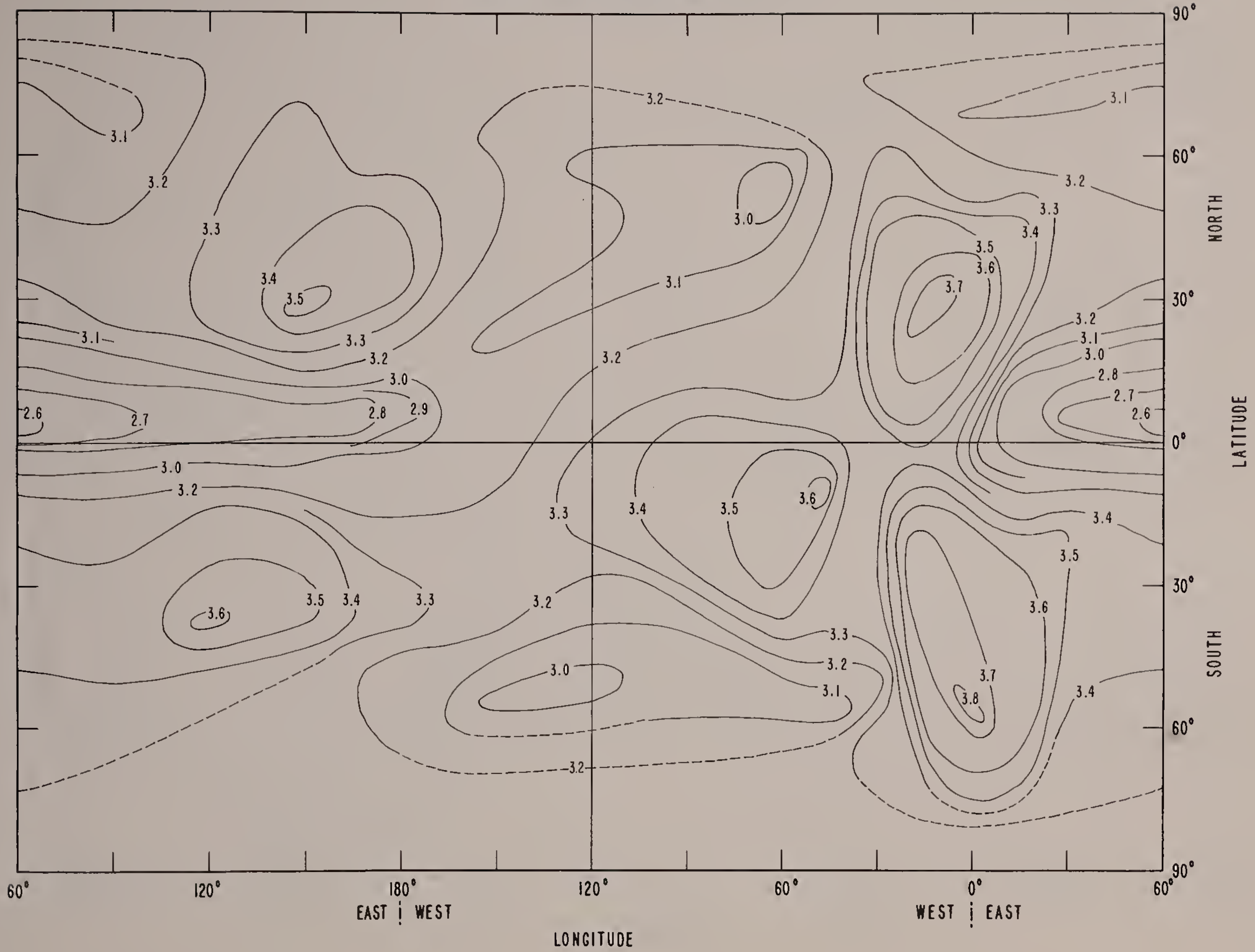
M-4000 FACTOR AT RASSN 50
APRIL 0400 HOURS GMT



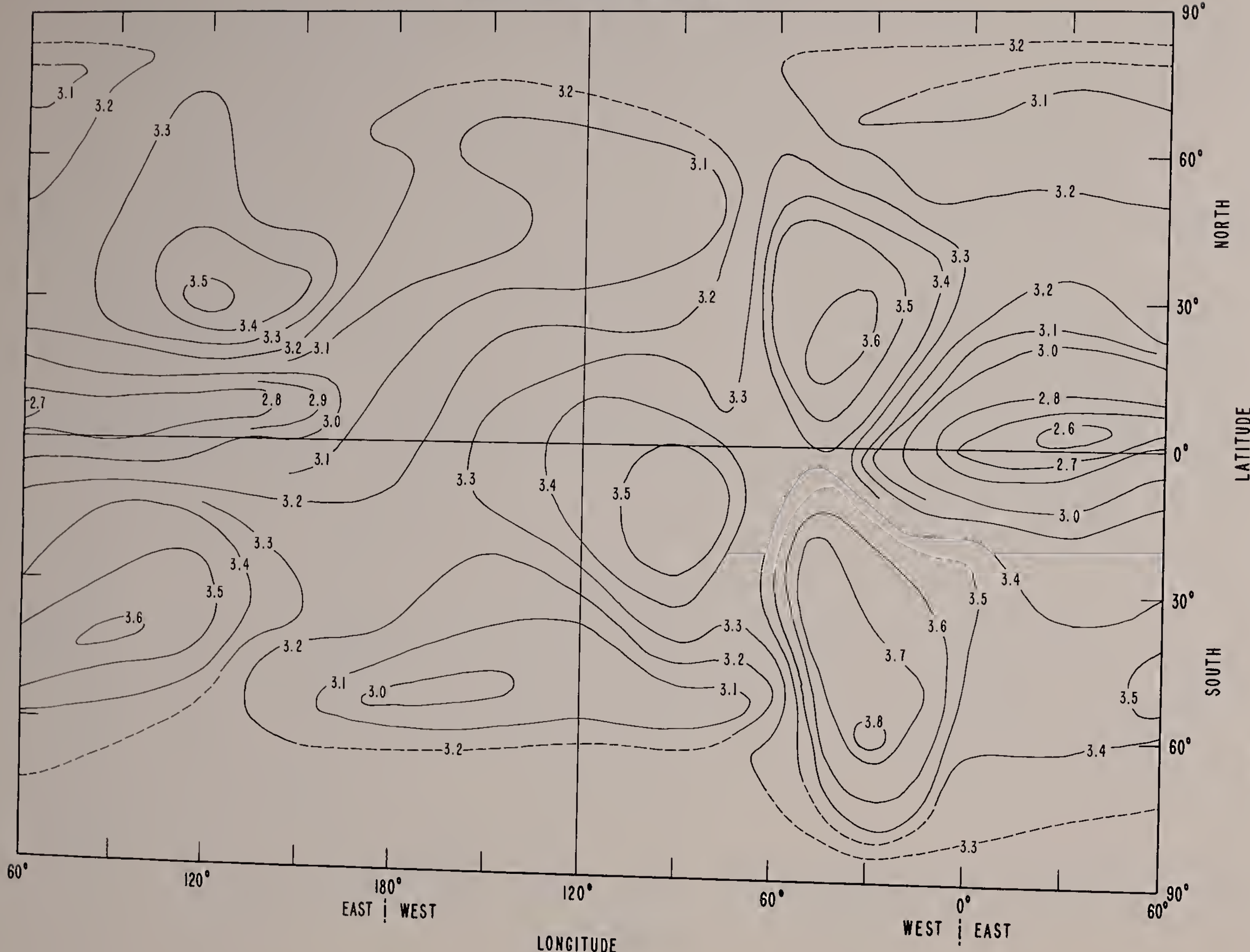
M-4000 FACTOR AT RASSN 50
APRIL 0600 HOURS GMT



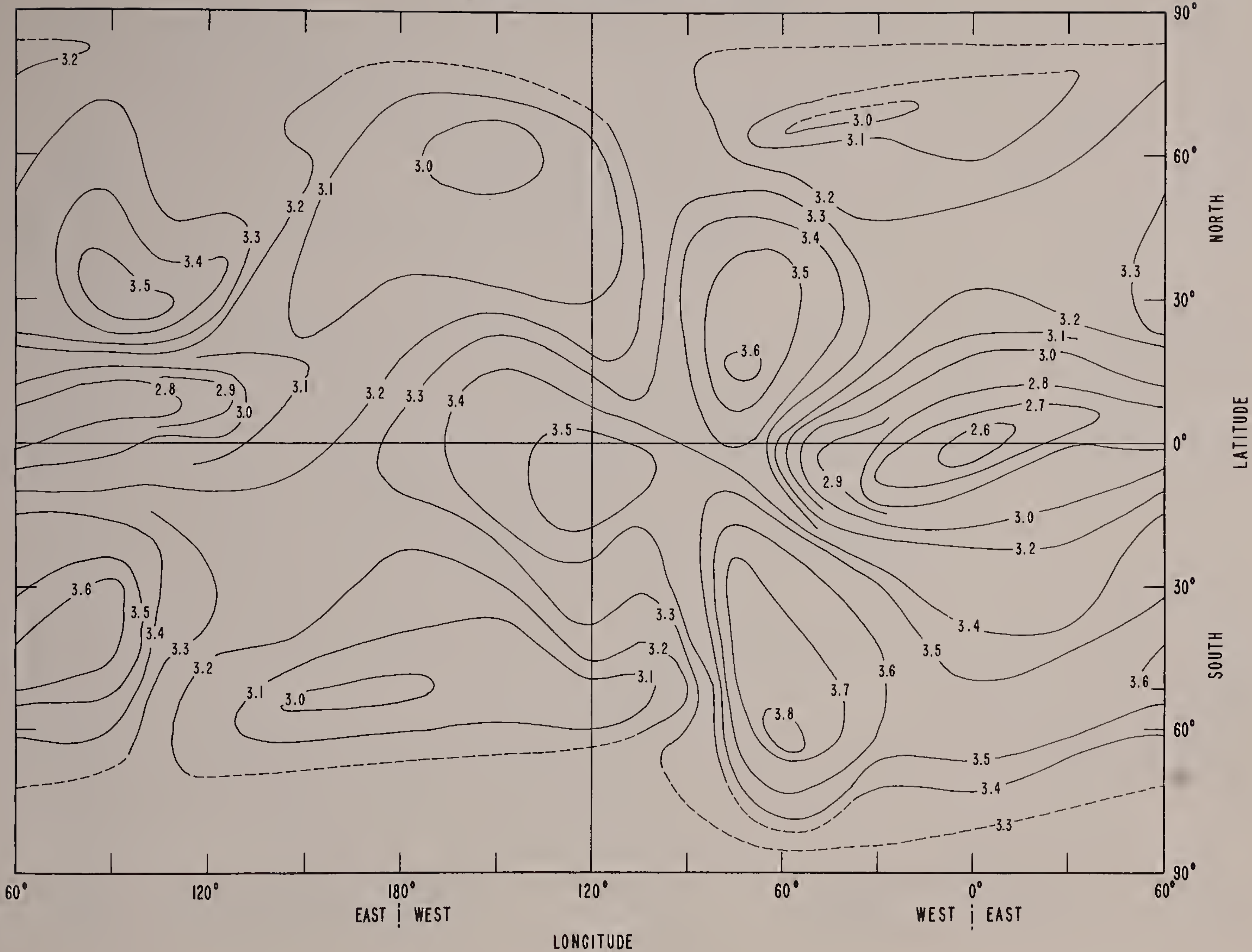
M-4000 FACTOR AT RASSN 50
APRIL 0800 HOURS GMT



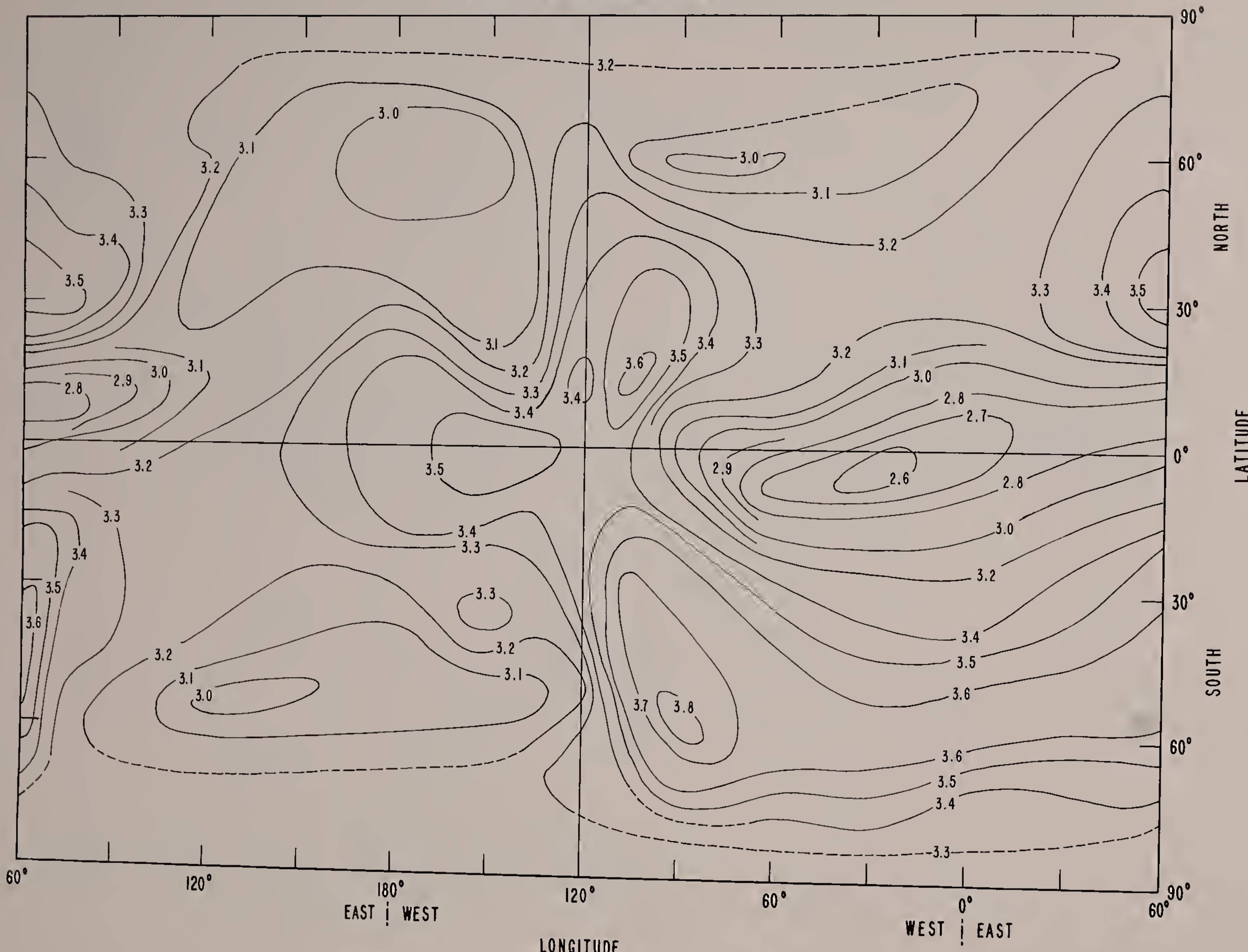
M-4000 FACTOR AT RASSN 50
APRIL 1000 HOURS GMT



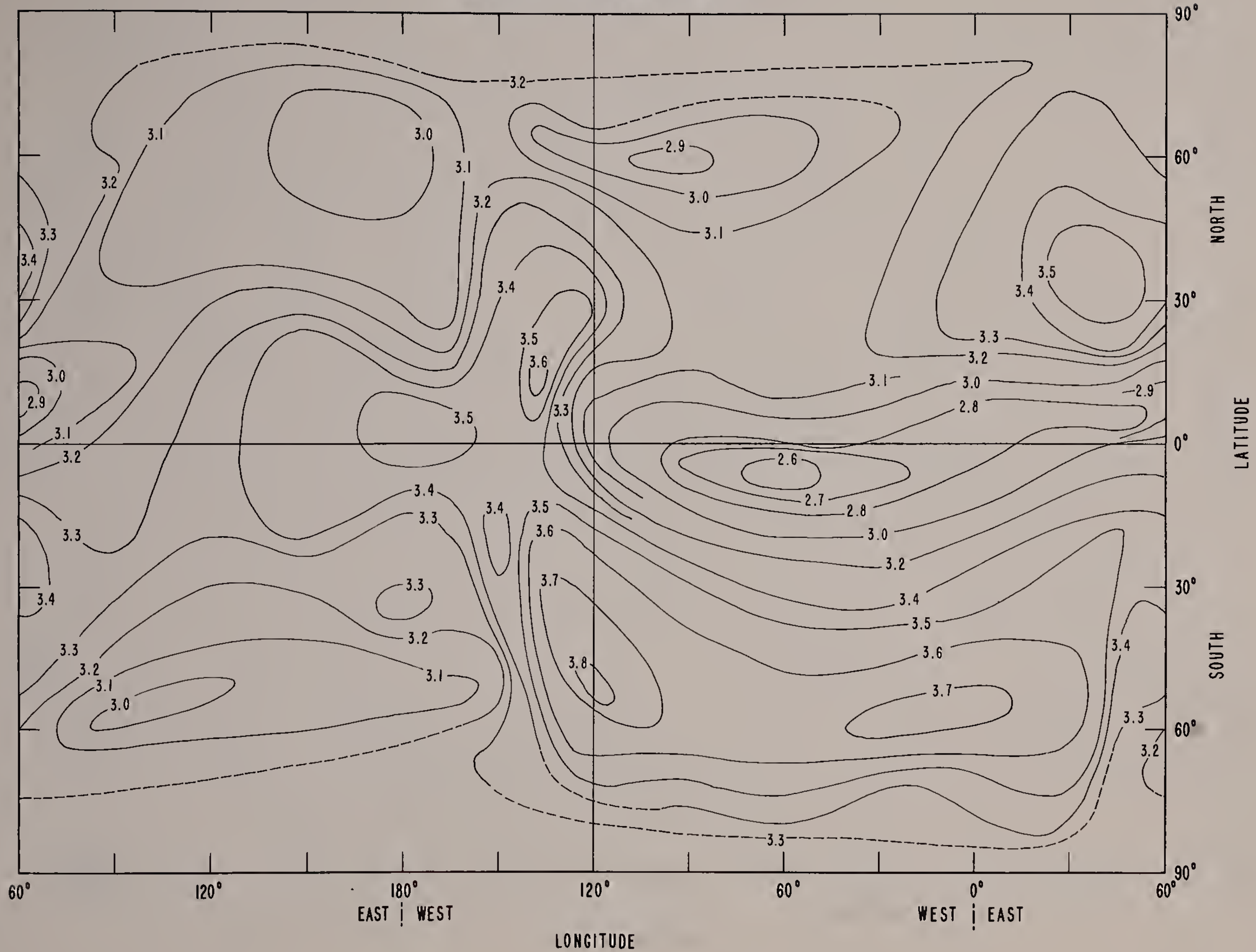
M-4000 FACTOR AT RASSN 50
APRIL 1200 HOURS GMT



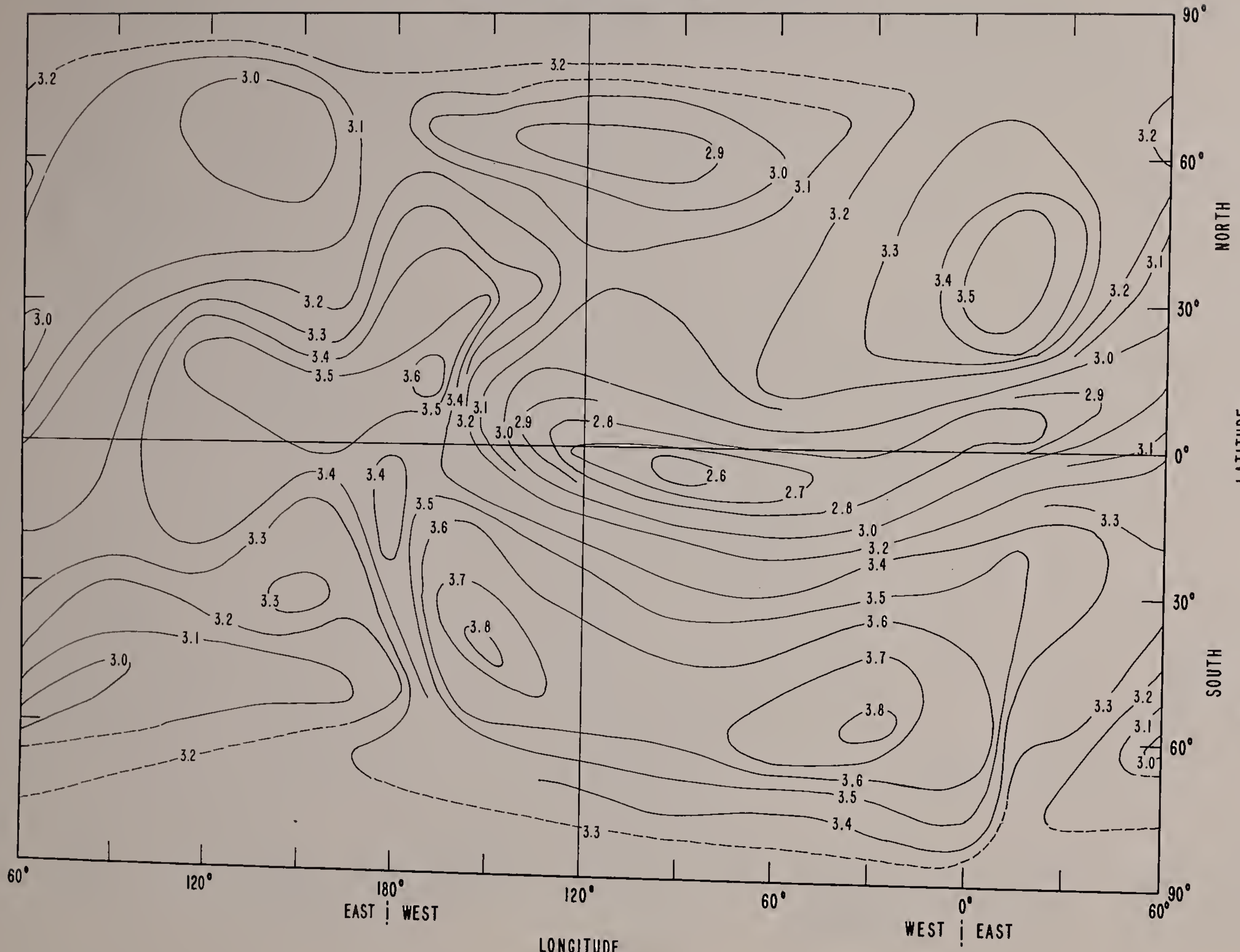
M-4000 FACTOR AT RASSN 50
APRIL 1400 HOURS GMT



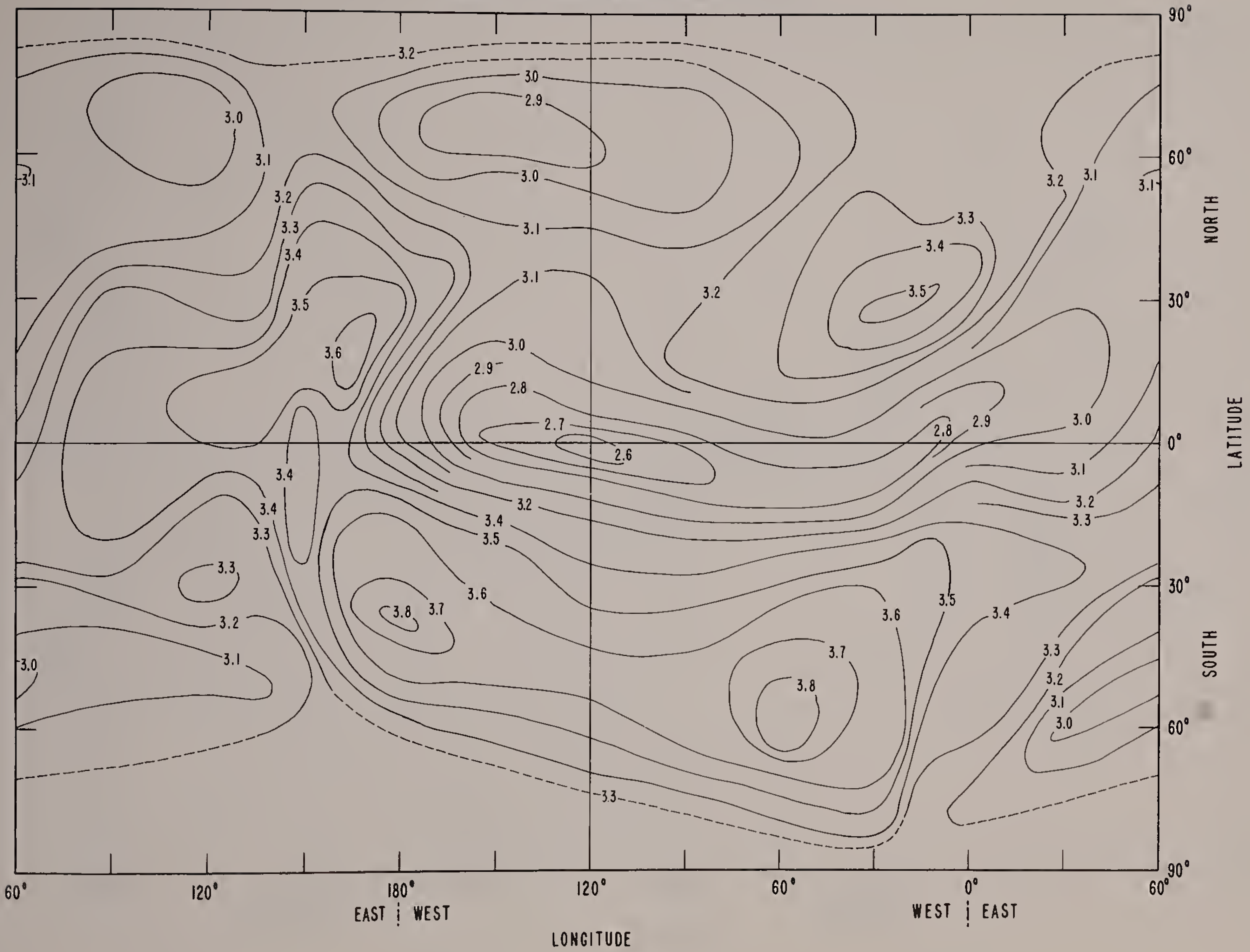
M-4000 FACTOR AT RASSN 50
APRIL 1600 HOURS GMT



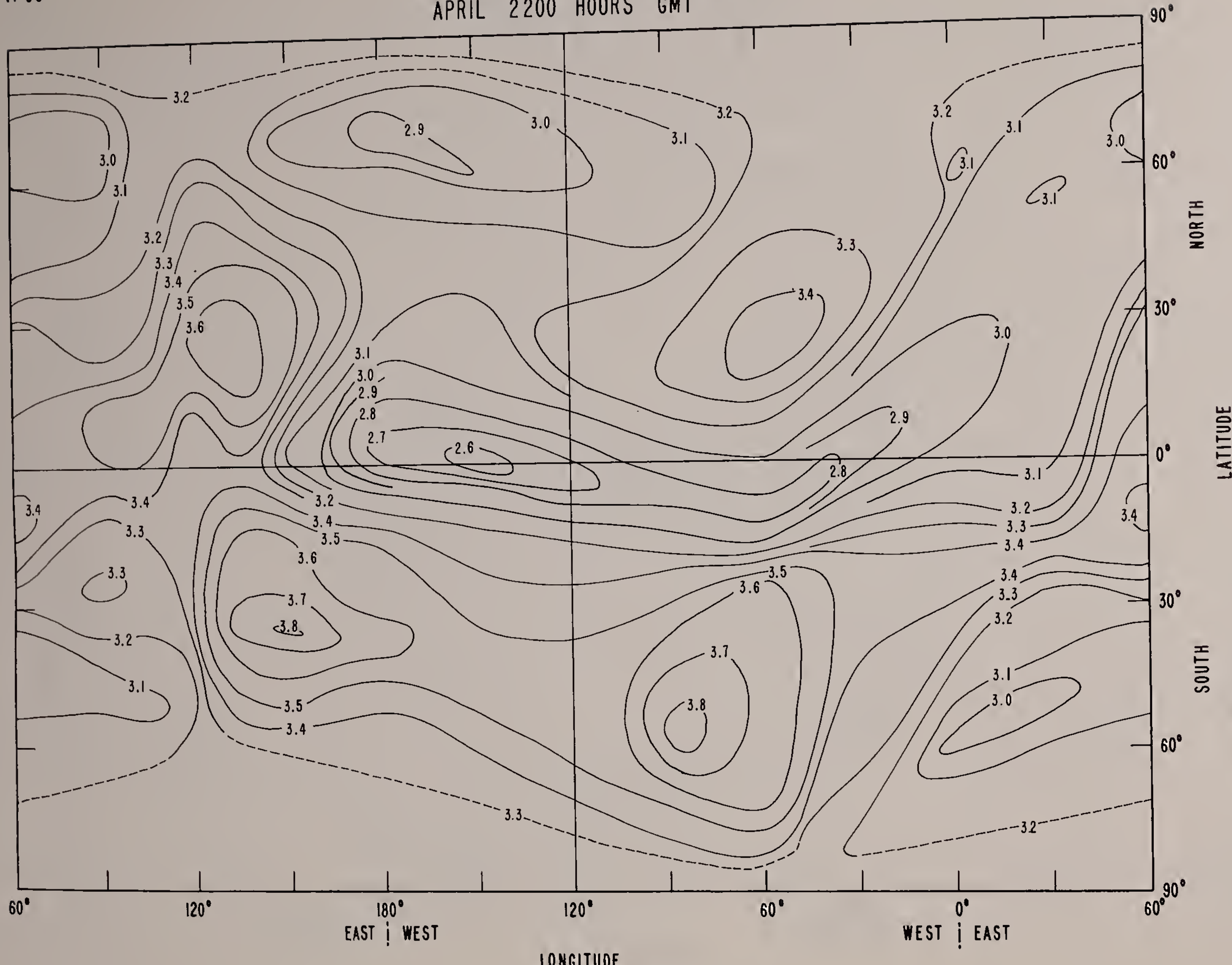
M-4000 FACTOR AT RASSN 50
APRIL 1800 HOURS GMT



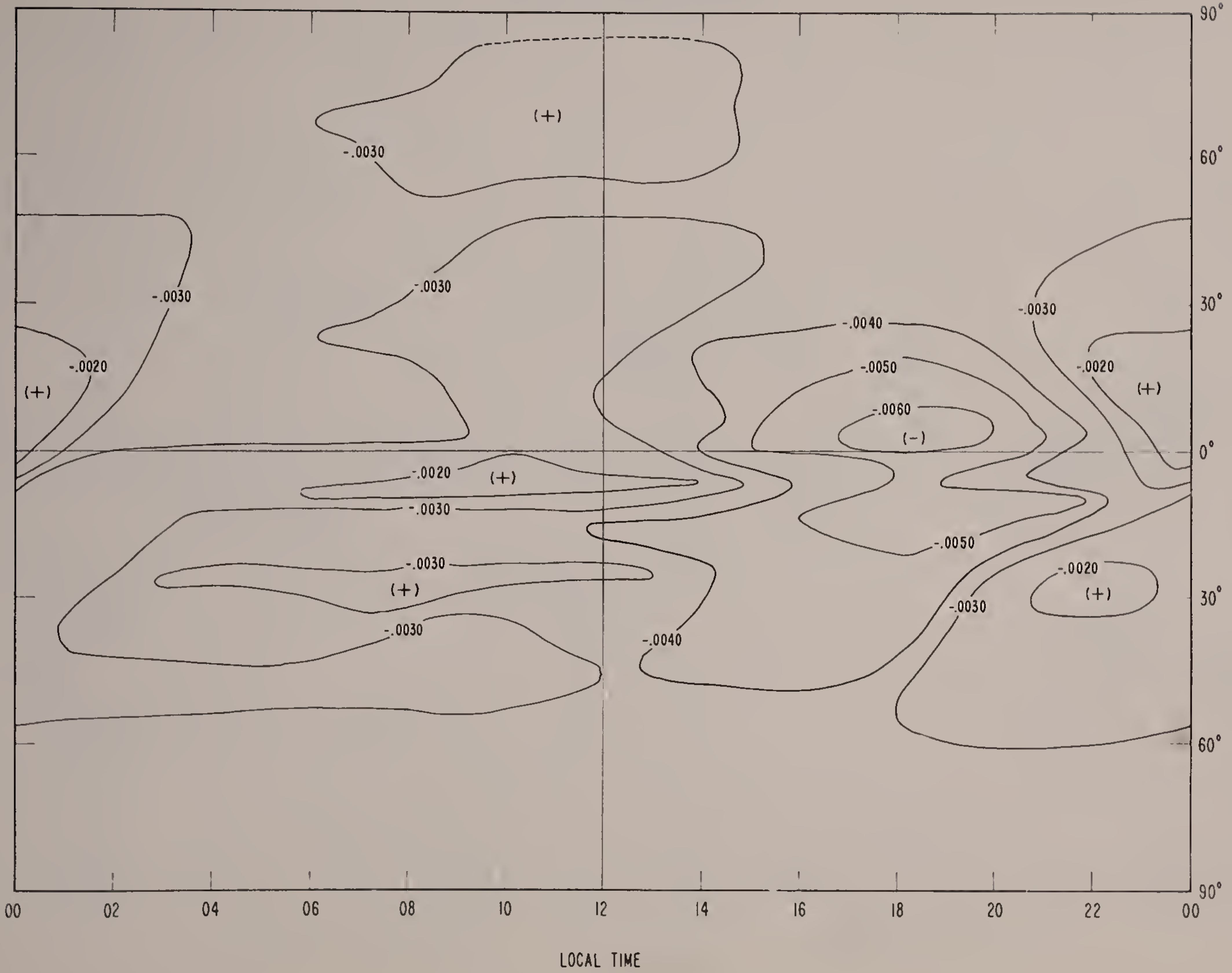
M-4000 FACTOR AT RASSN 50
APRIL 2000 HOURS GMT



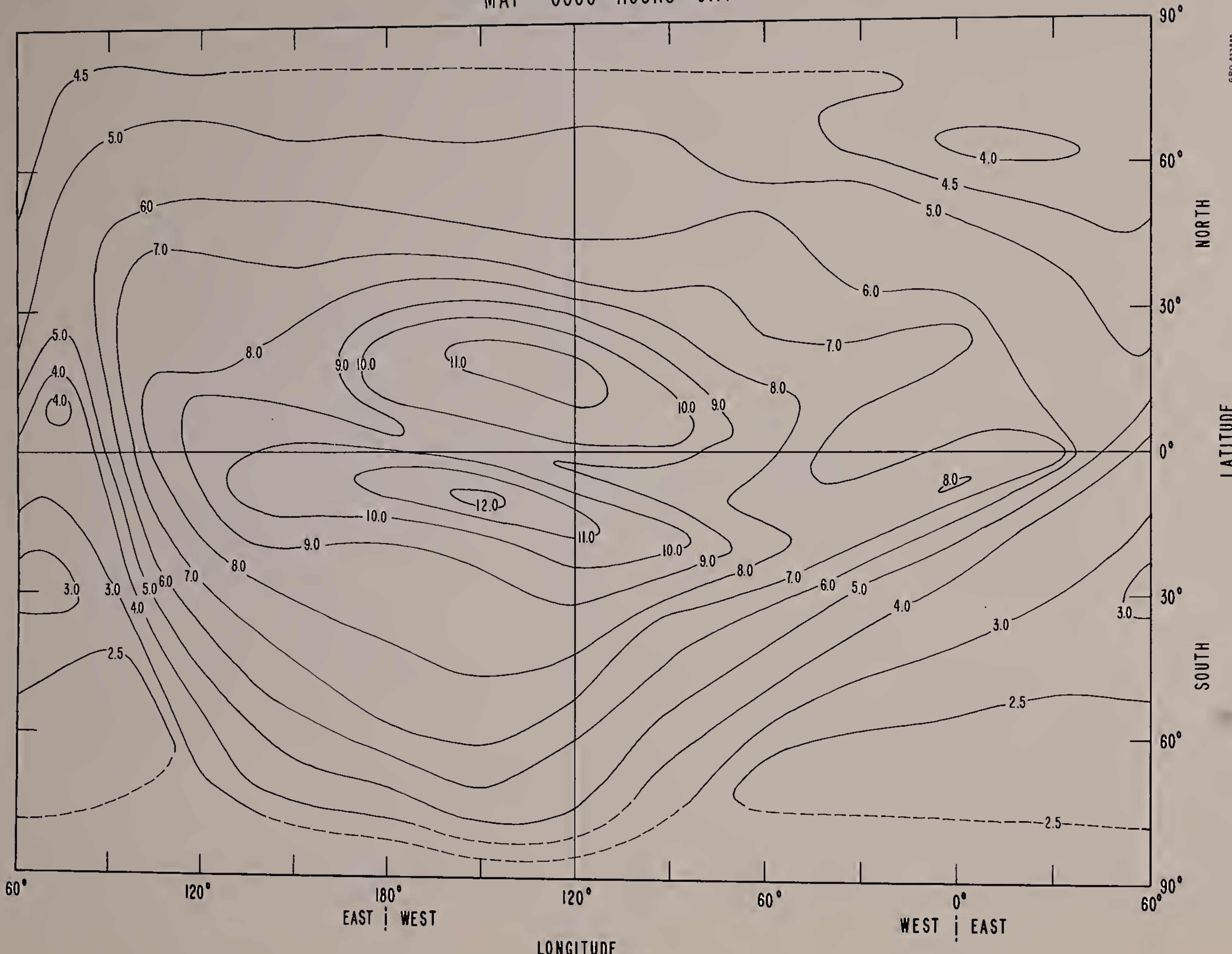
M-4000 FACTOR AT RASSN 50
APRIL 2200 HOURS GMT



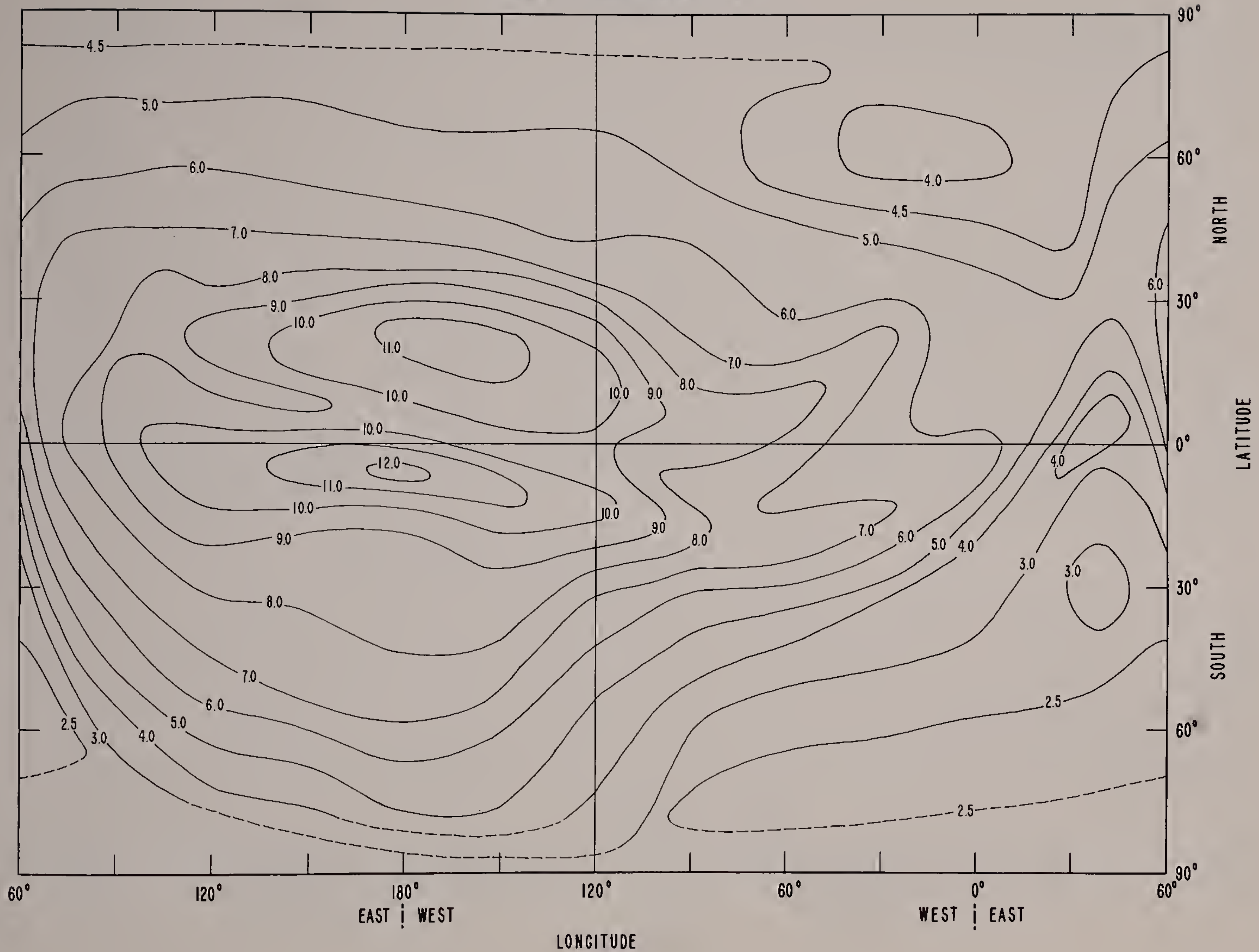
SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN
APRIL



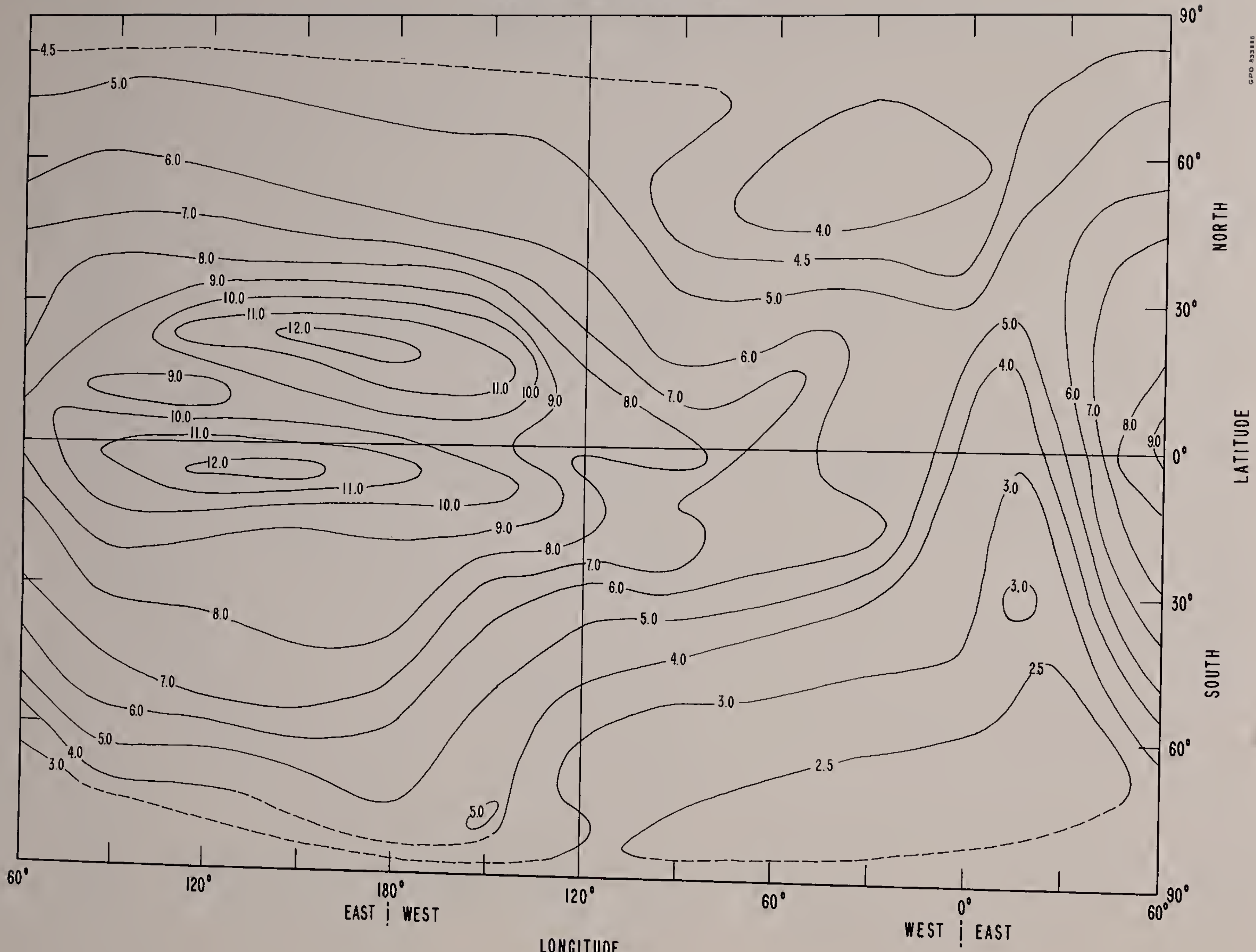
f_oF2 AT RASSN 50
MAY 0000 HOURS GMT



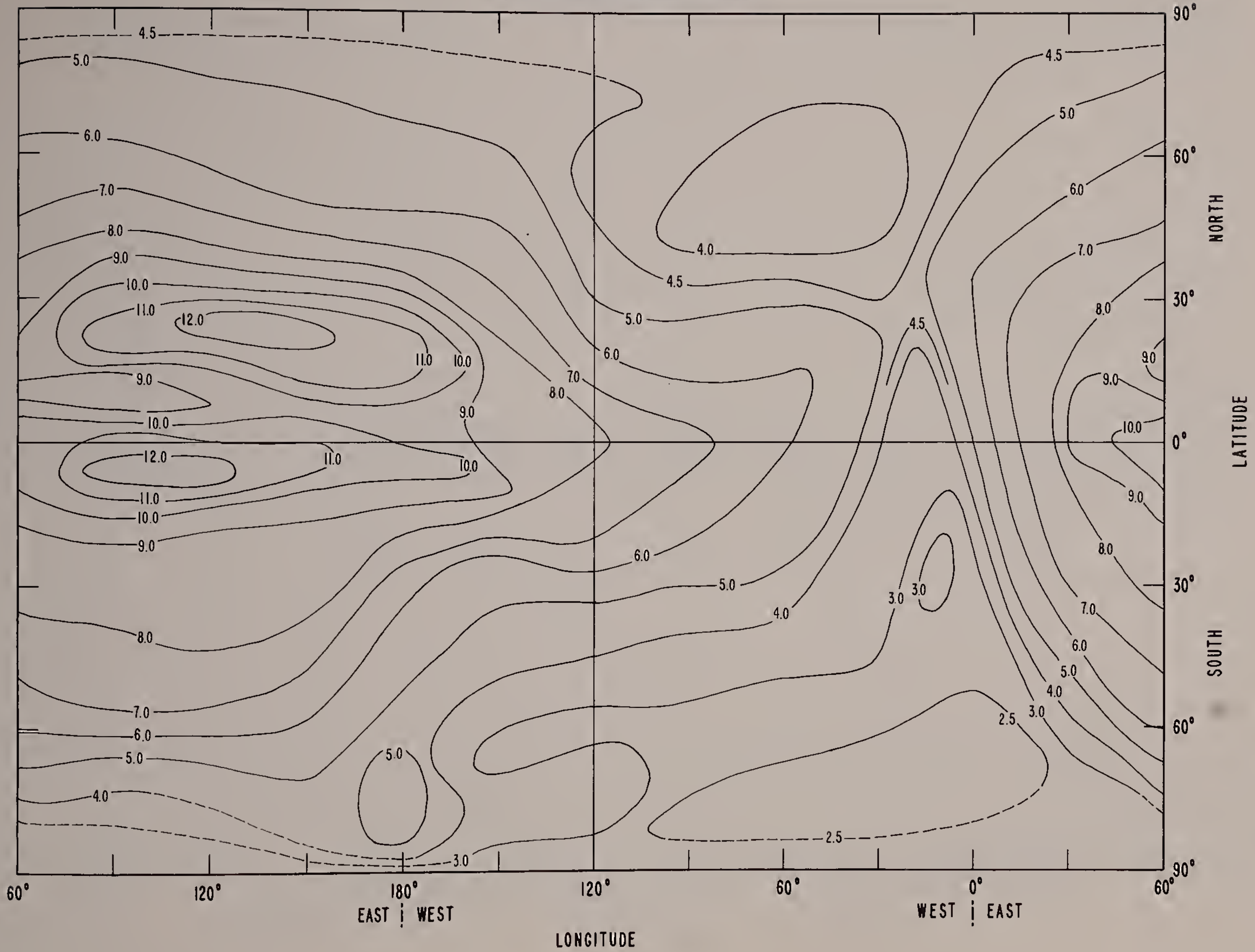
f_oF2 AT RASSN 50
MAY 0200 HOURS GMT



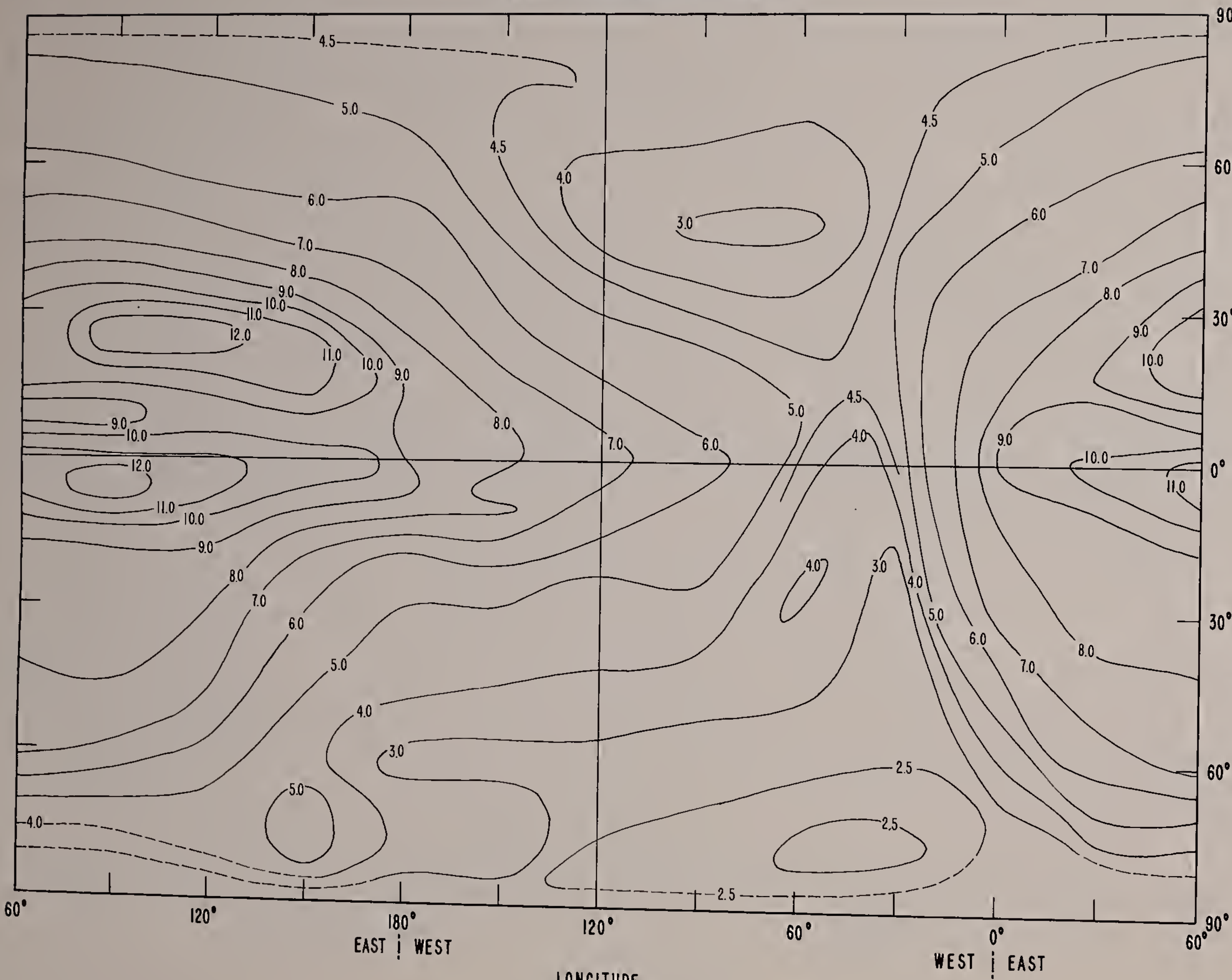
f_oF2 AT RASSN 50
MAY 0400 HOURS GMT



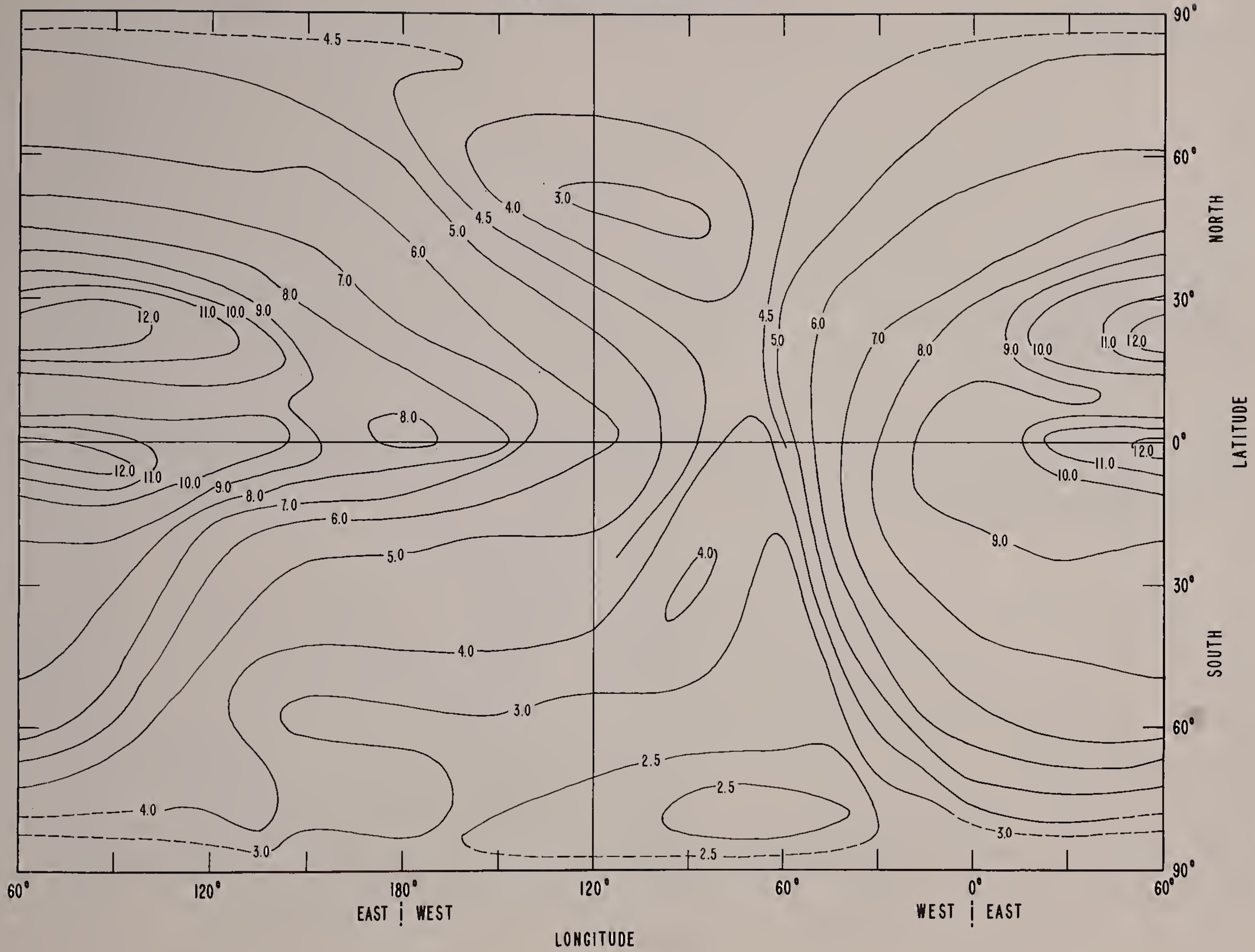
f₀F2 AT RASSN 50
MAY 0600 HOURS GMT



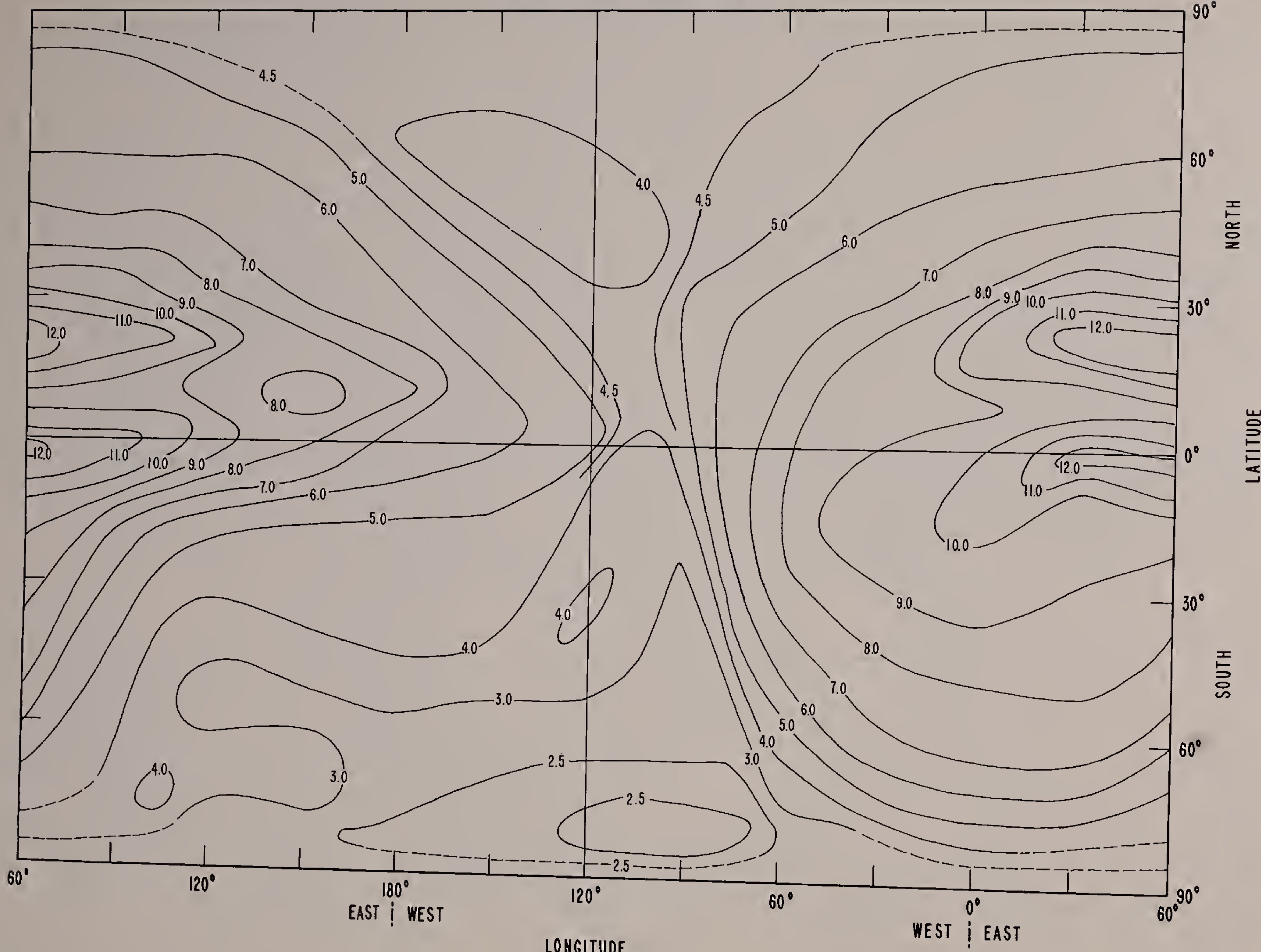
f_oF2 AT RASSN 50
MAY 0800 HOURS GMT



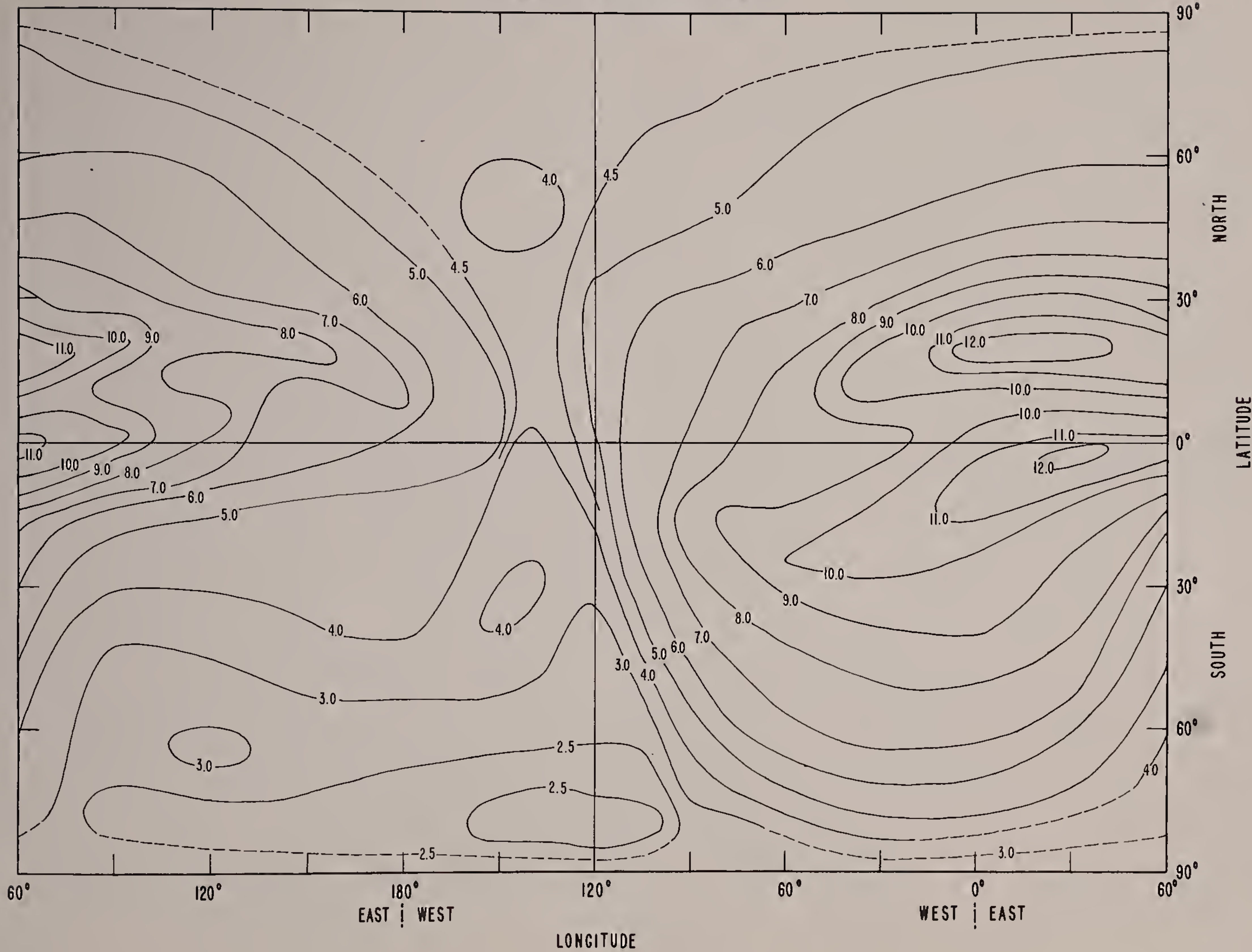
f_oF2 AT RASSN 50
MAY 1000 HOURS GMT



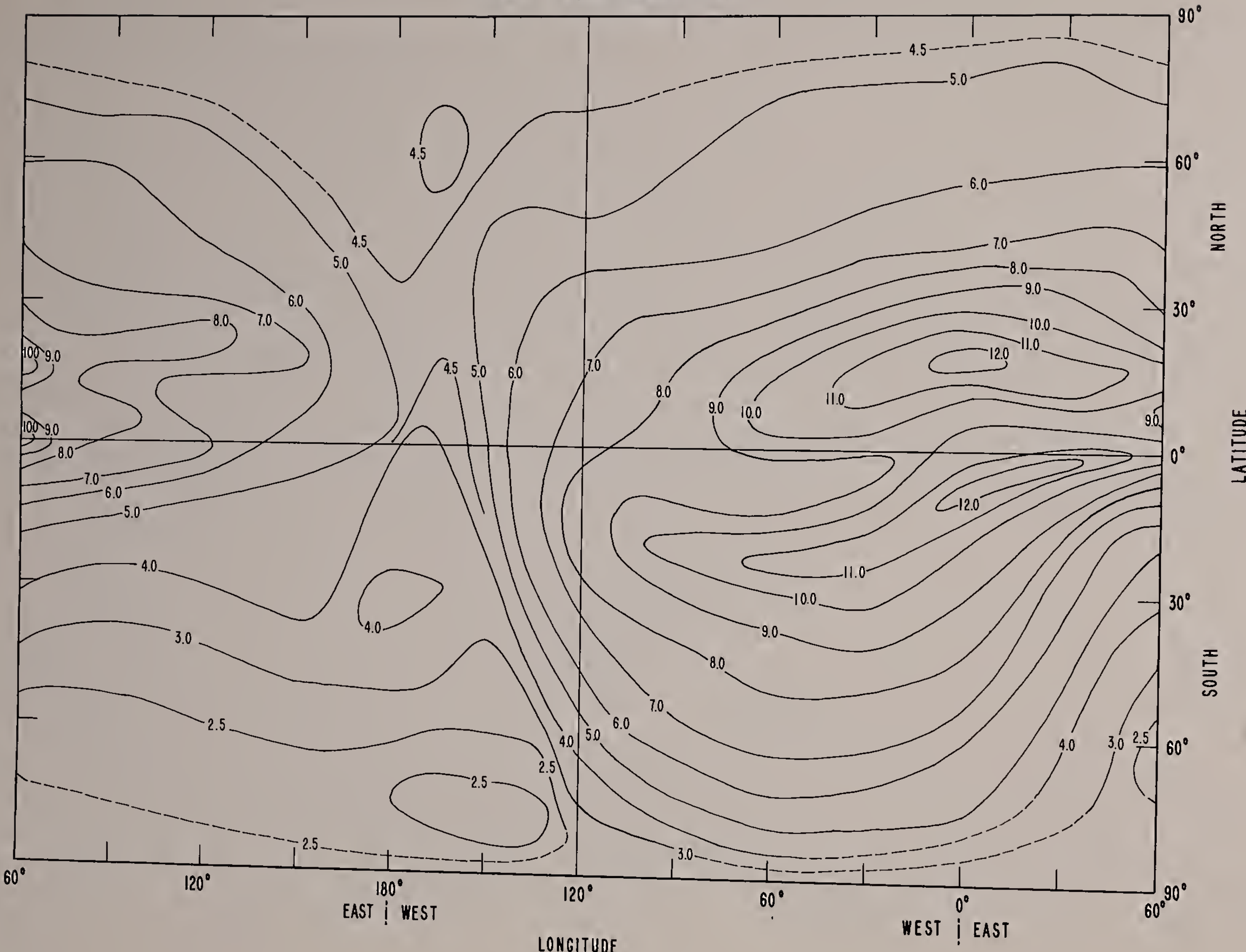
f_oF2 AT RASSN 50
MAY 1200 HOURS GMT



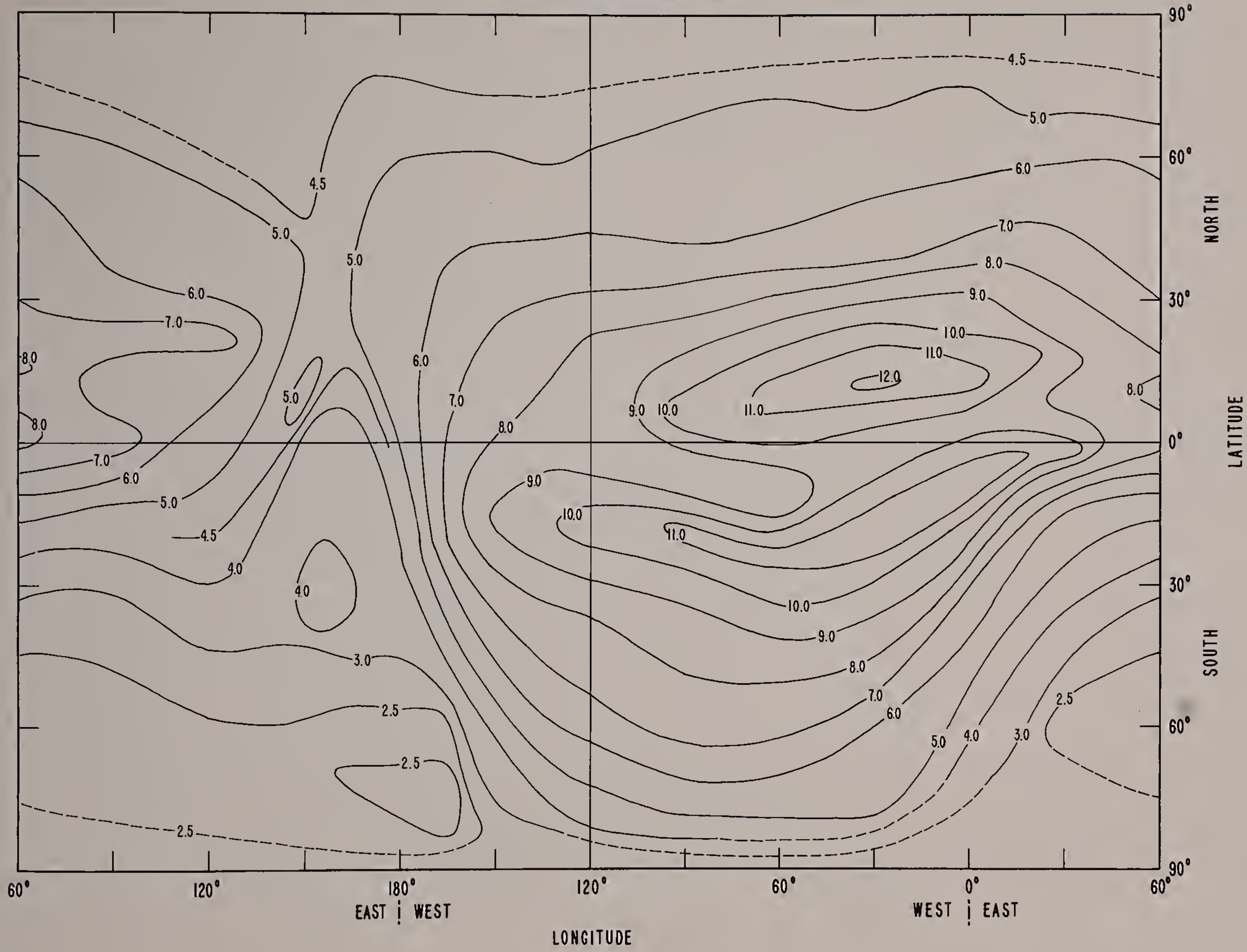
f_oF2 AT RASSN 50
MAY 1400 HOURS GMT



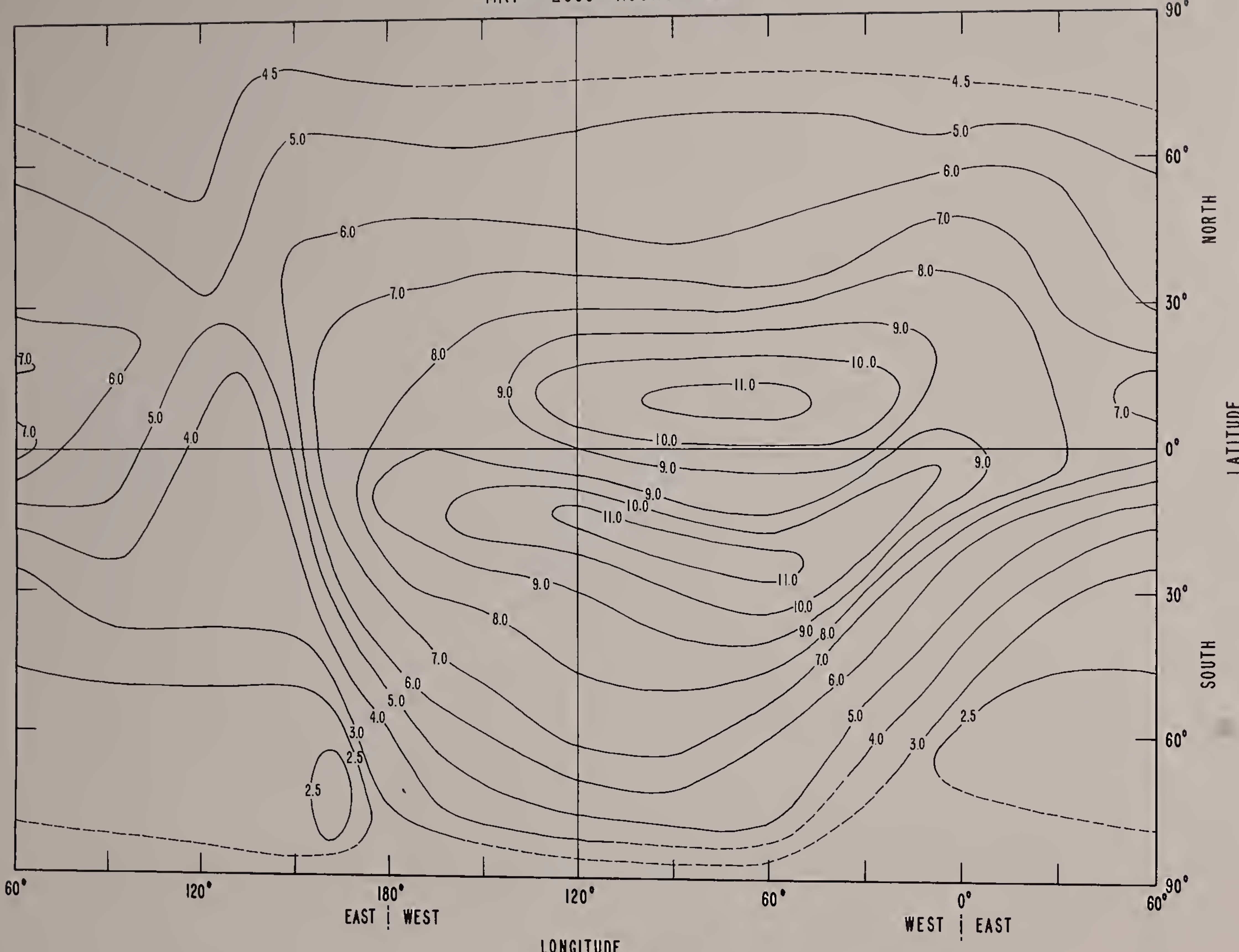
f_oF2 AT RASSN 50
MAY 1600 HOURS GMT



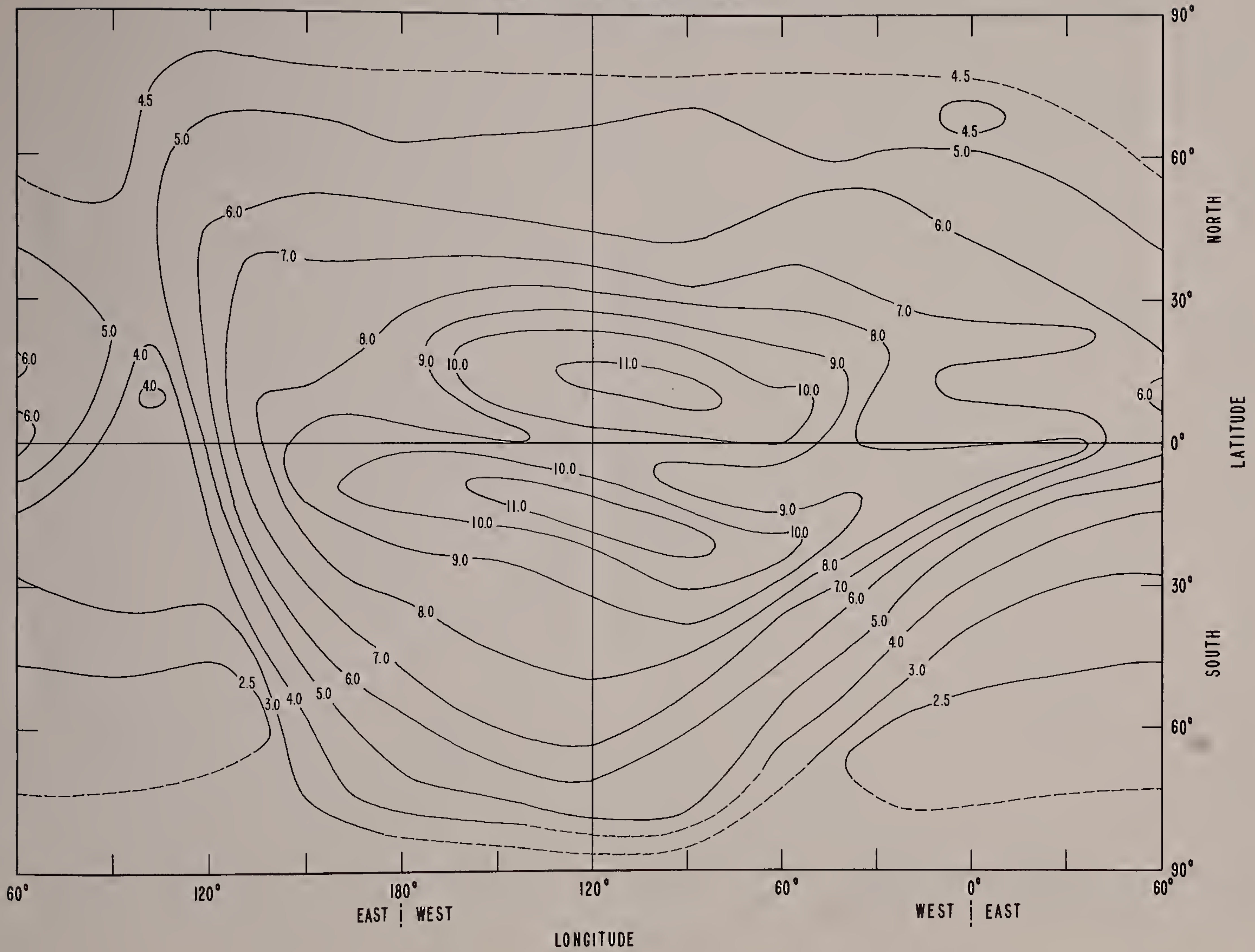
f_oF2 AT RASSN 50
MAY 1800 HOURS GMT



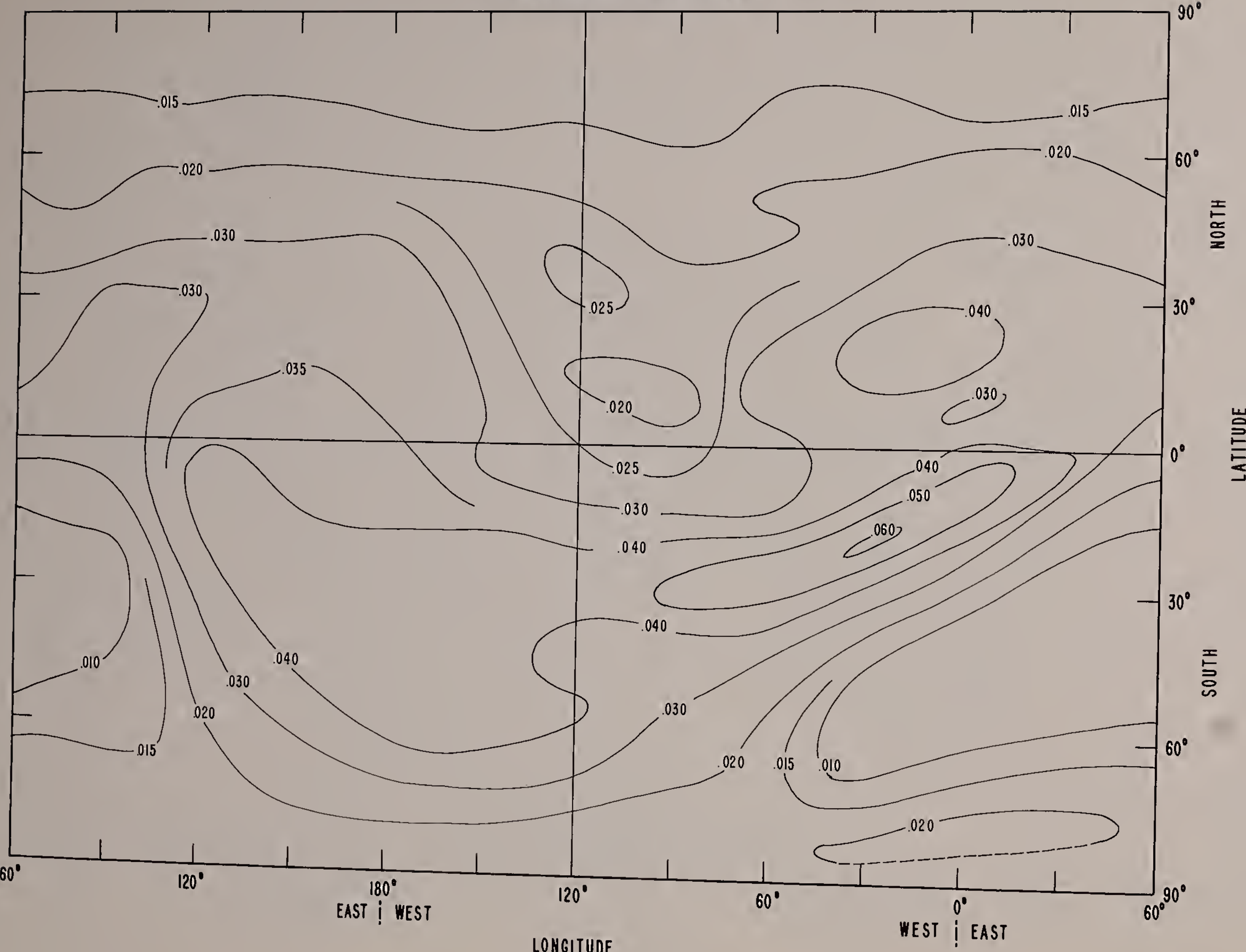
f_oF2 AT RASSN 50
MAY 2000 HOURS GMT



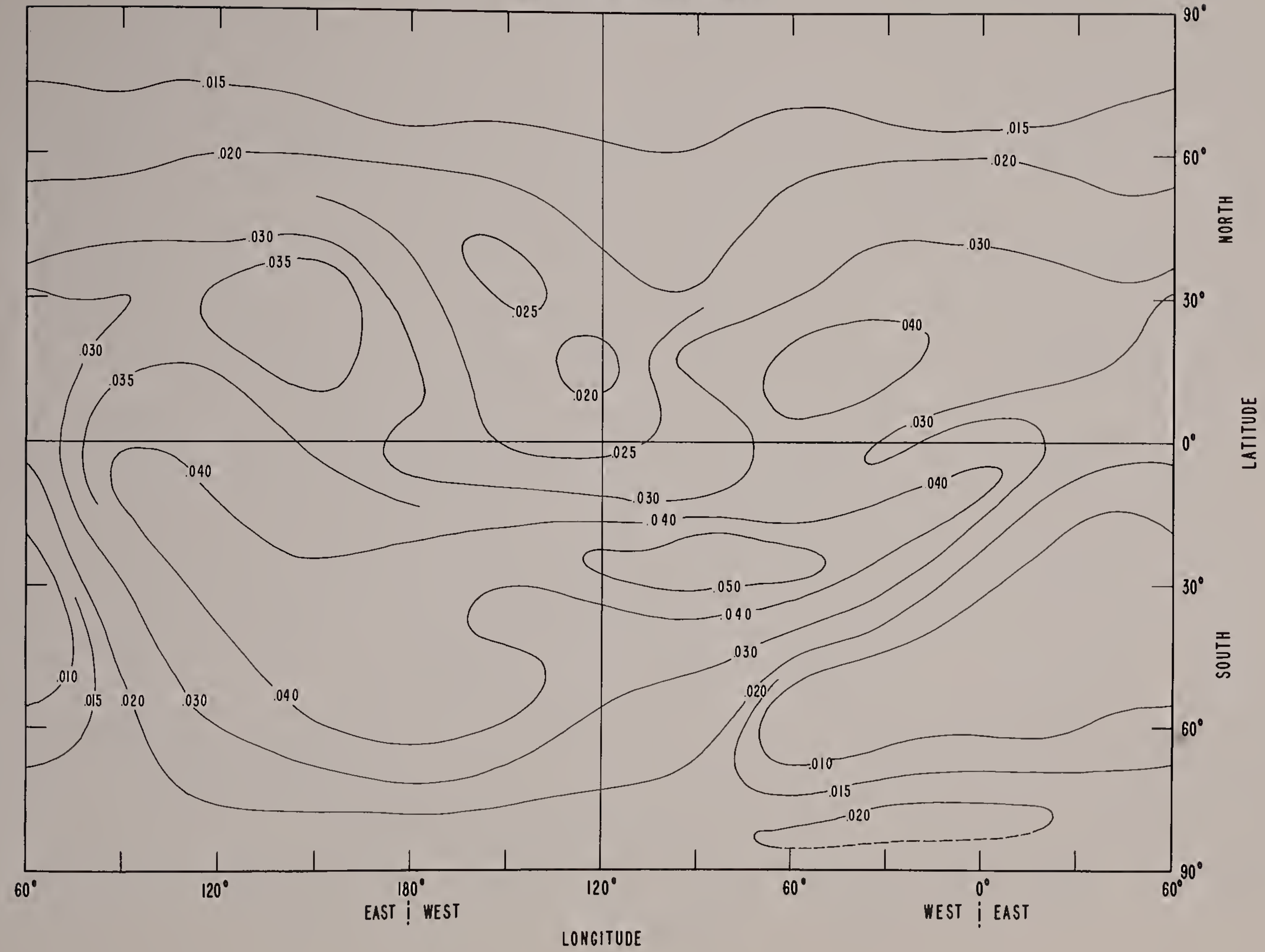
f_oF2 AT RASSN 50
MAY 2200 HOURS GMT



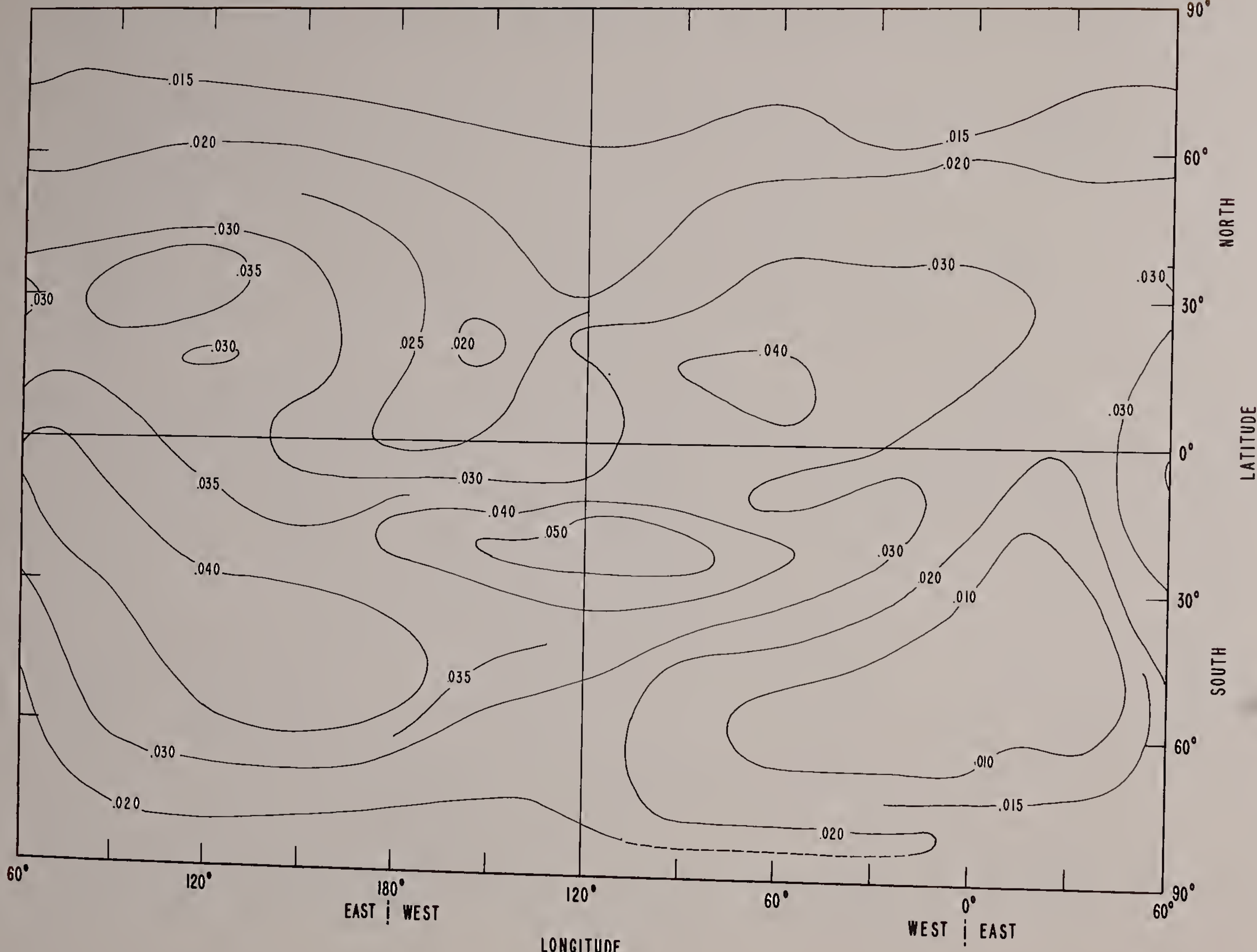
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 0000 HOURS GMT



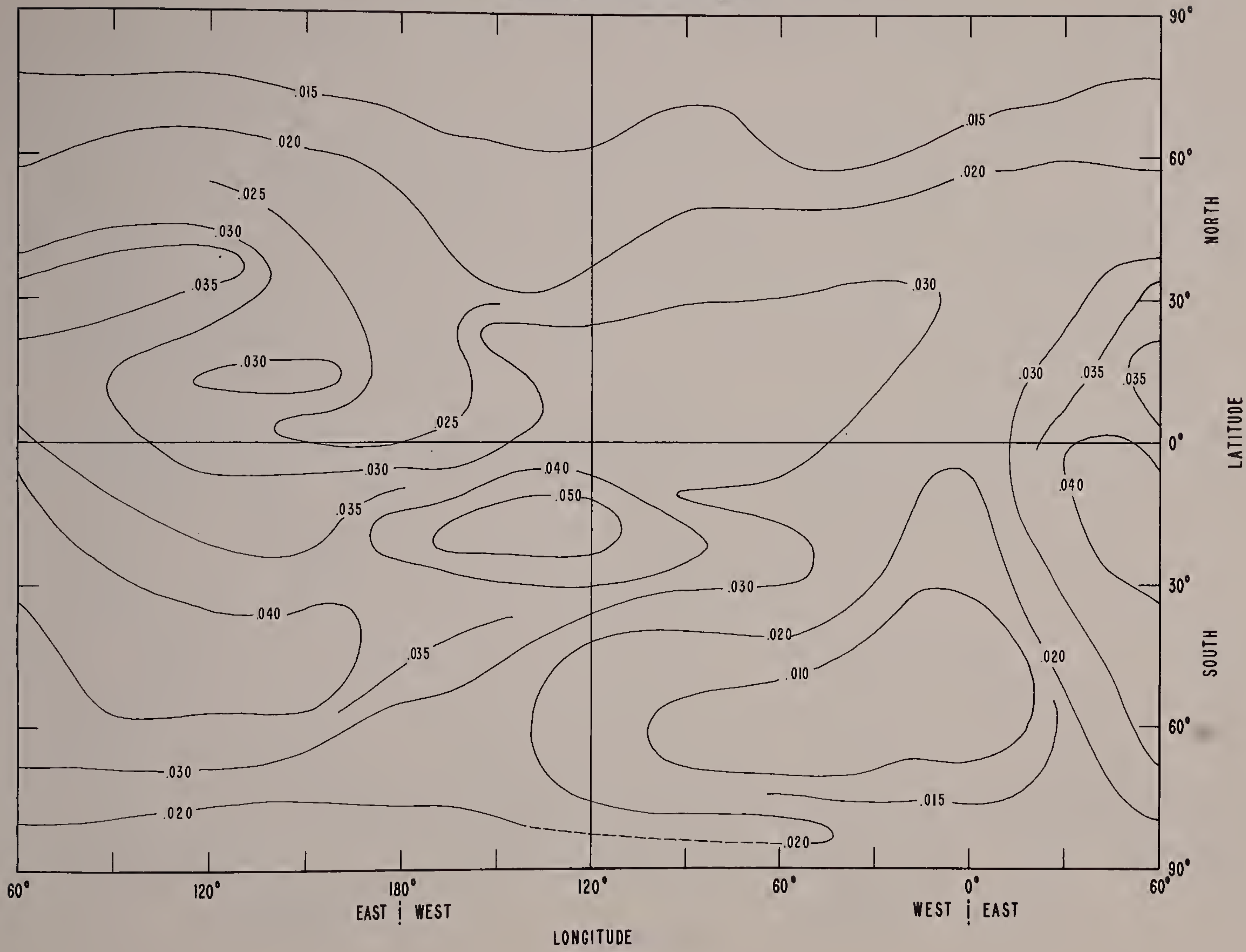
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 0200 HOURS GMT



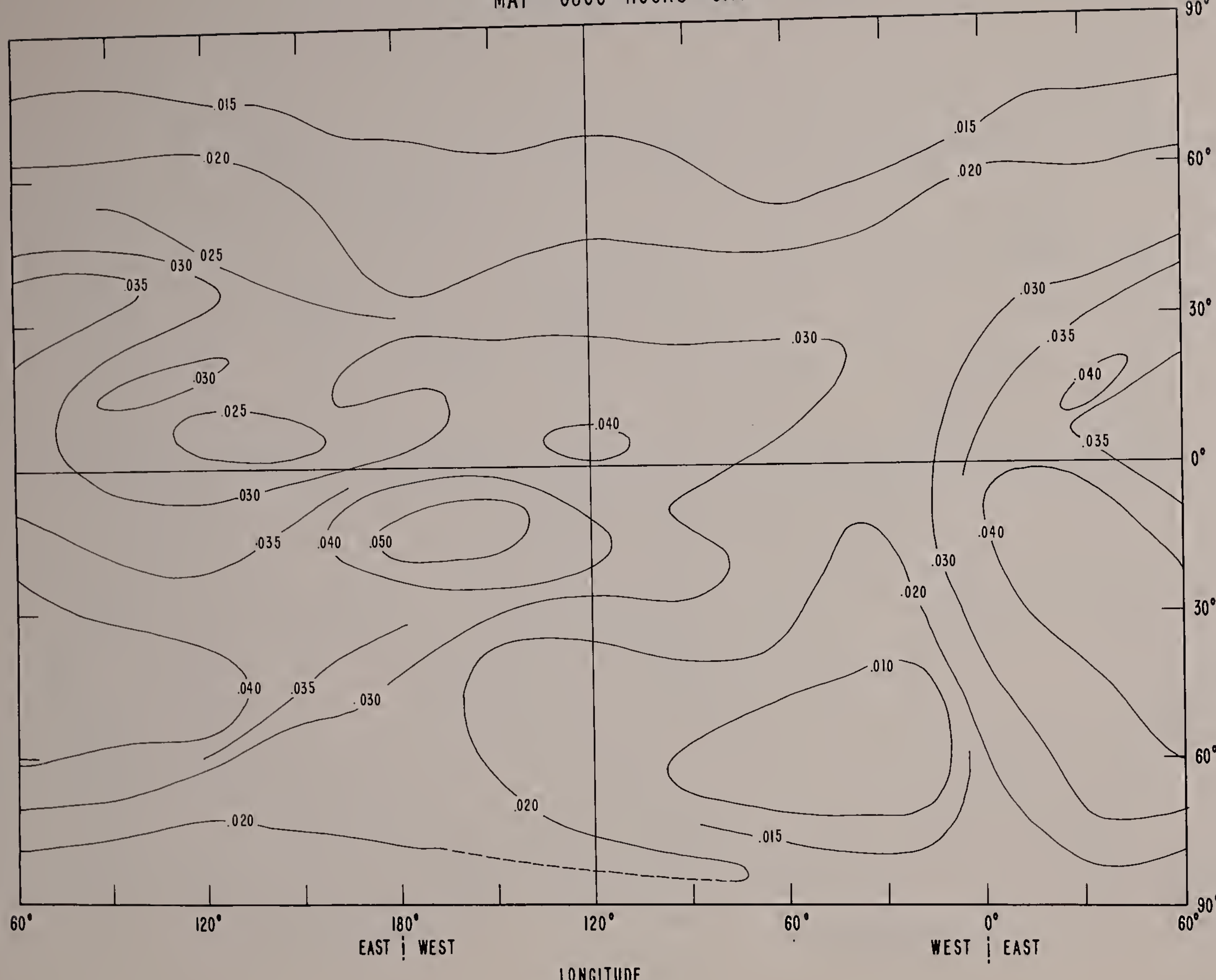
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 0400 HOURS GMT



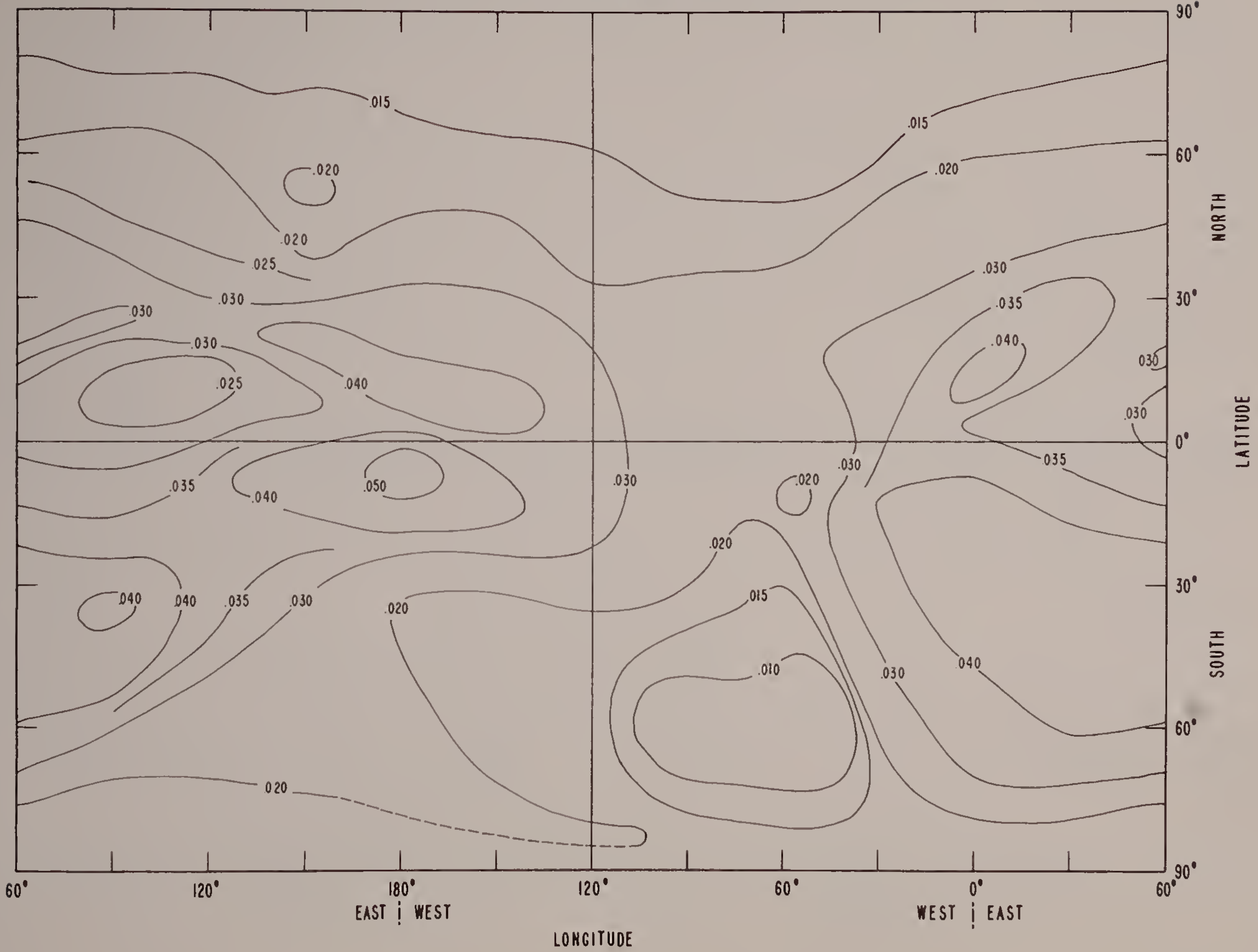
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 0600 HOURS GMT



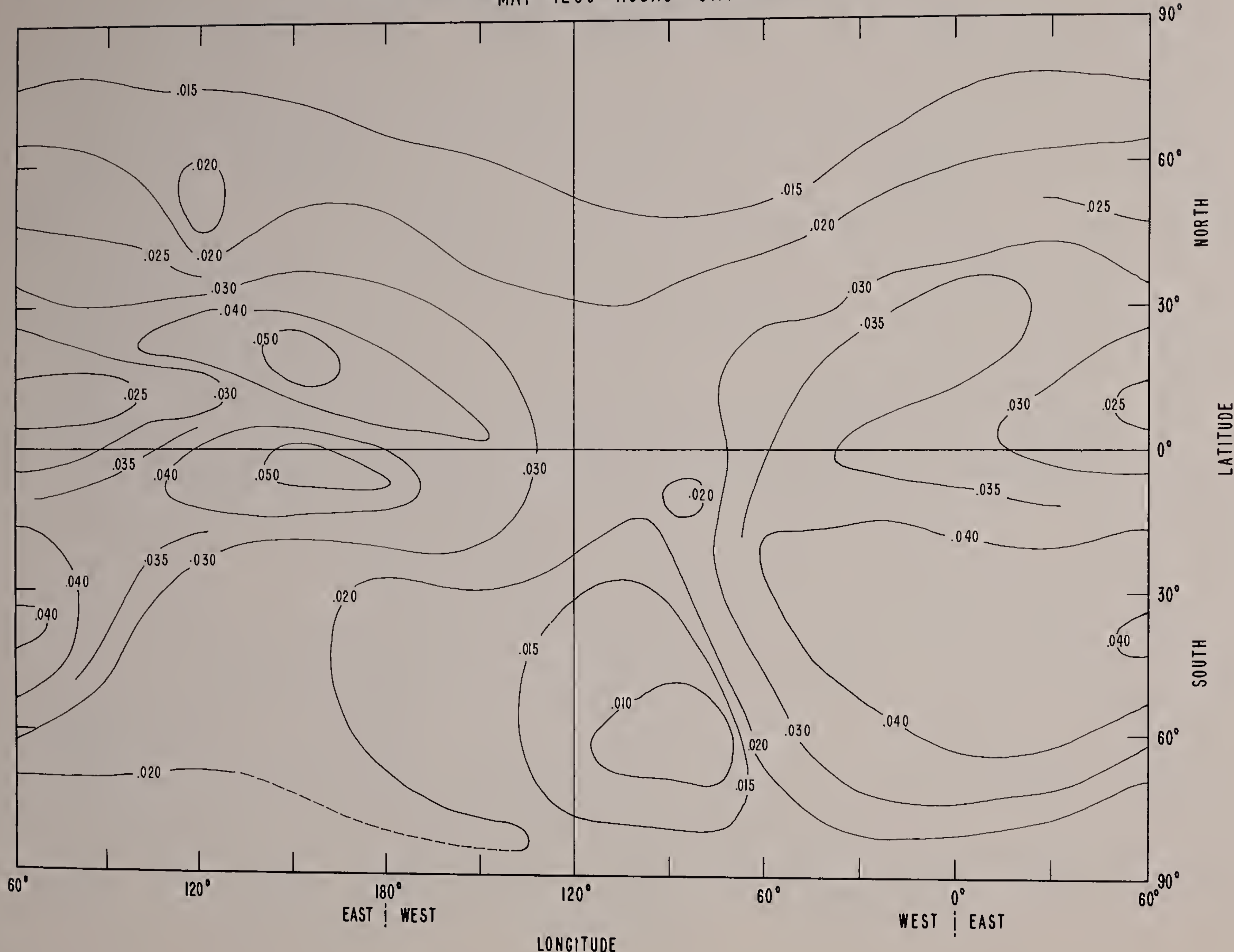
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 0800 HOURS GMT



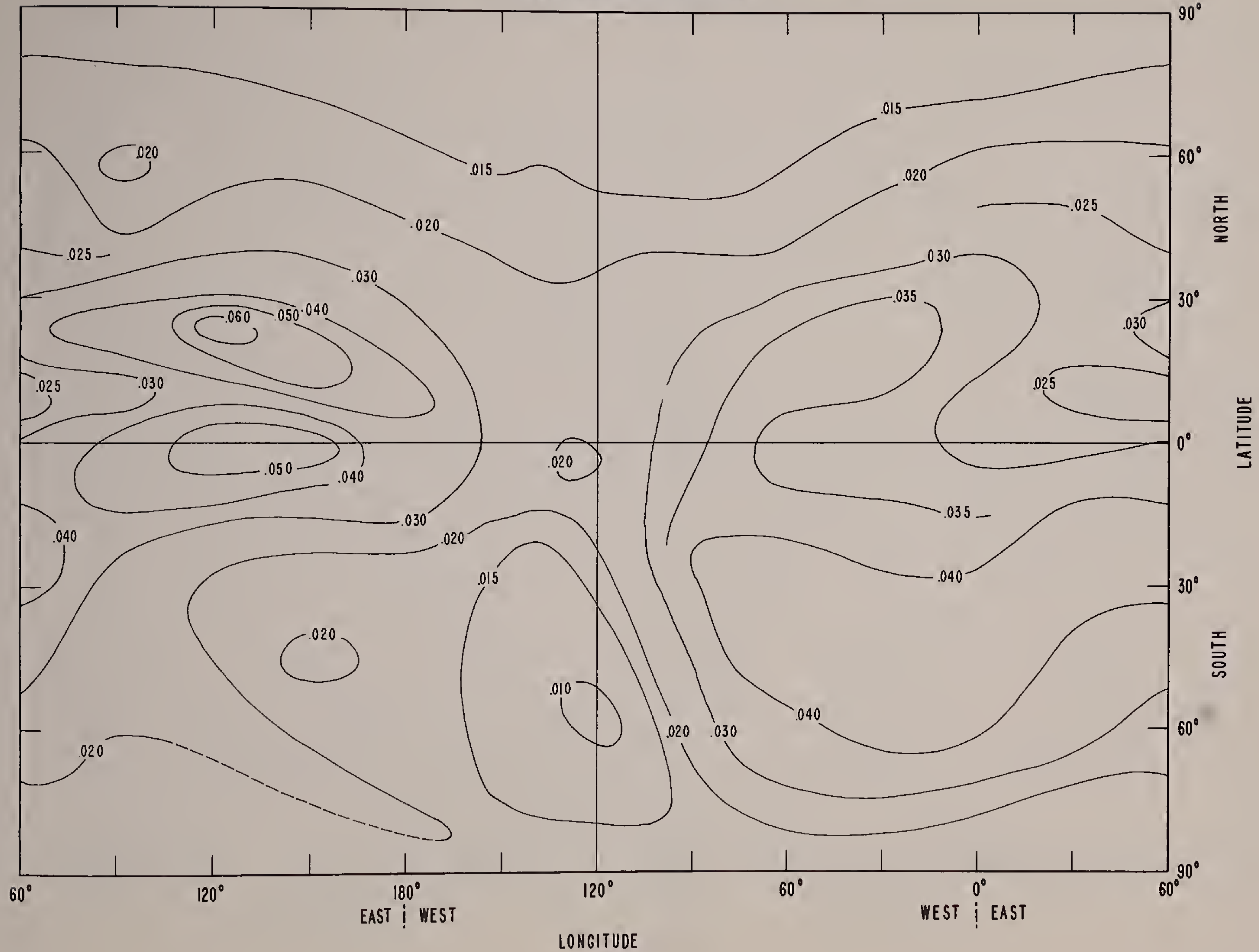
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 1000 HOURS GMT



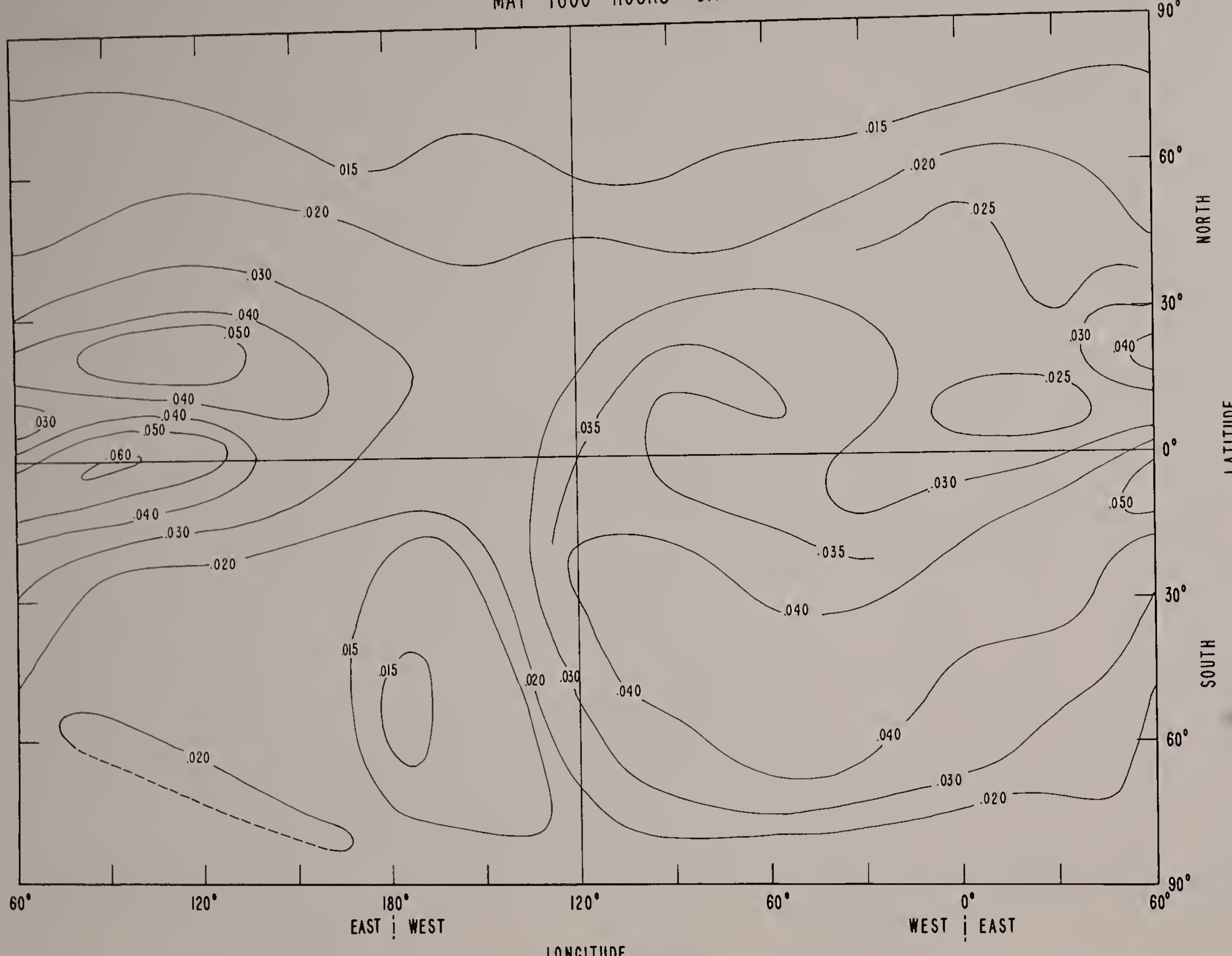
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 1200 HOURS GMT



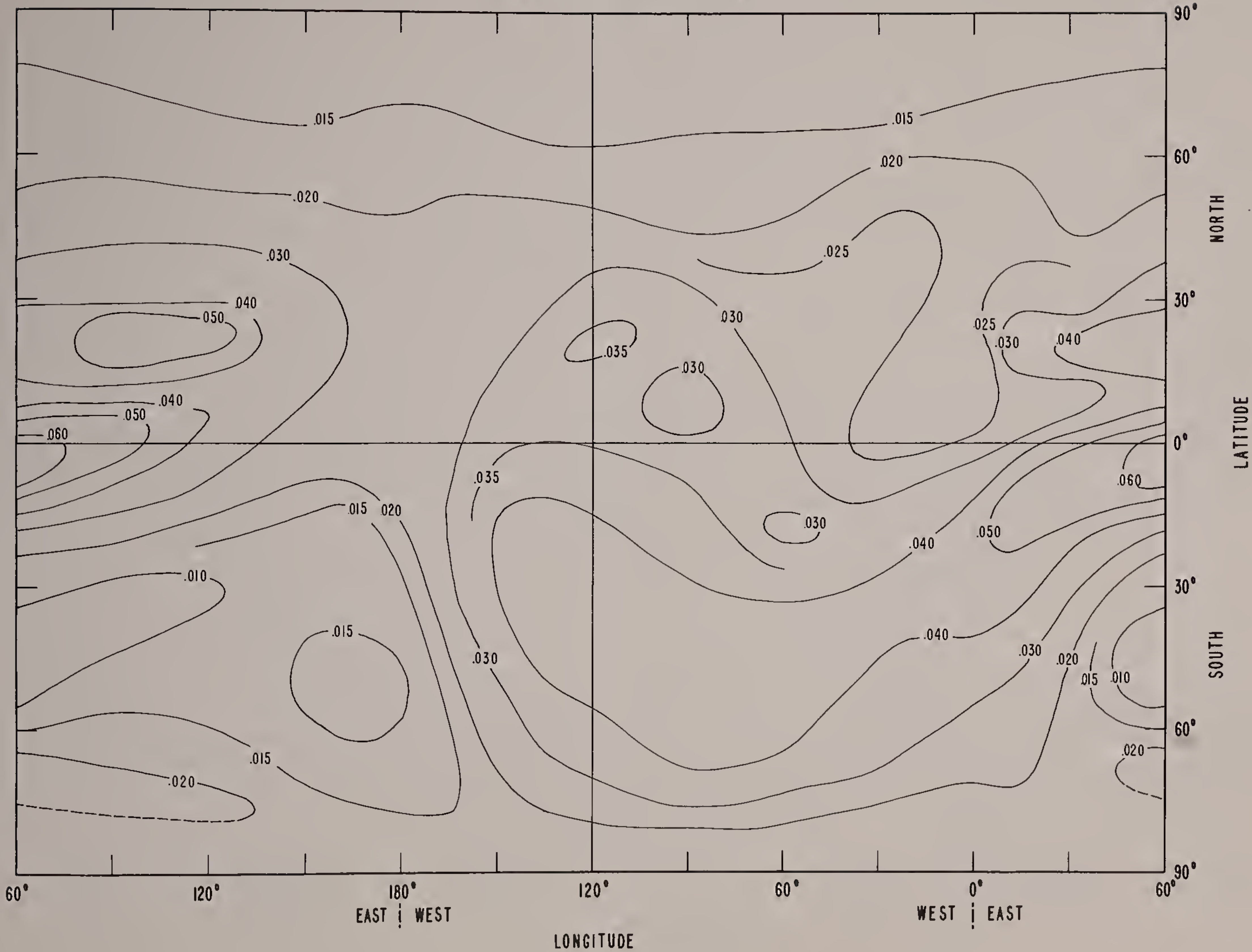
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 1400 HOURS GMT



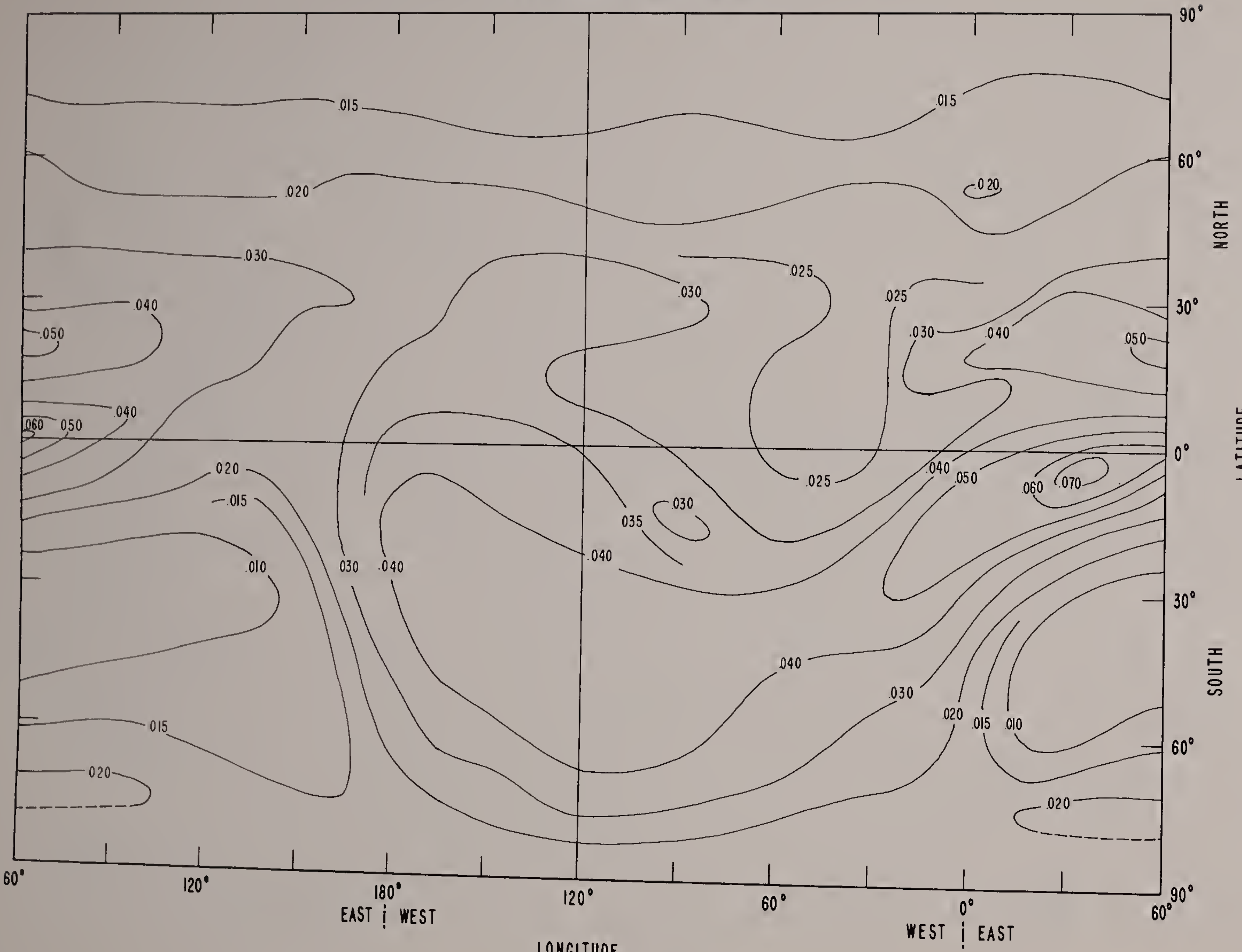
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 1600 HOURS GMT



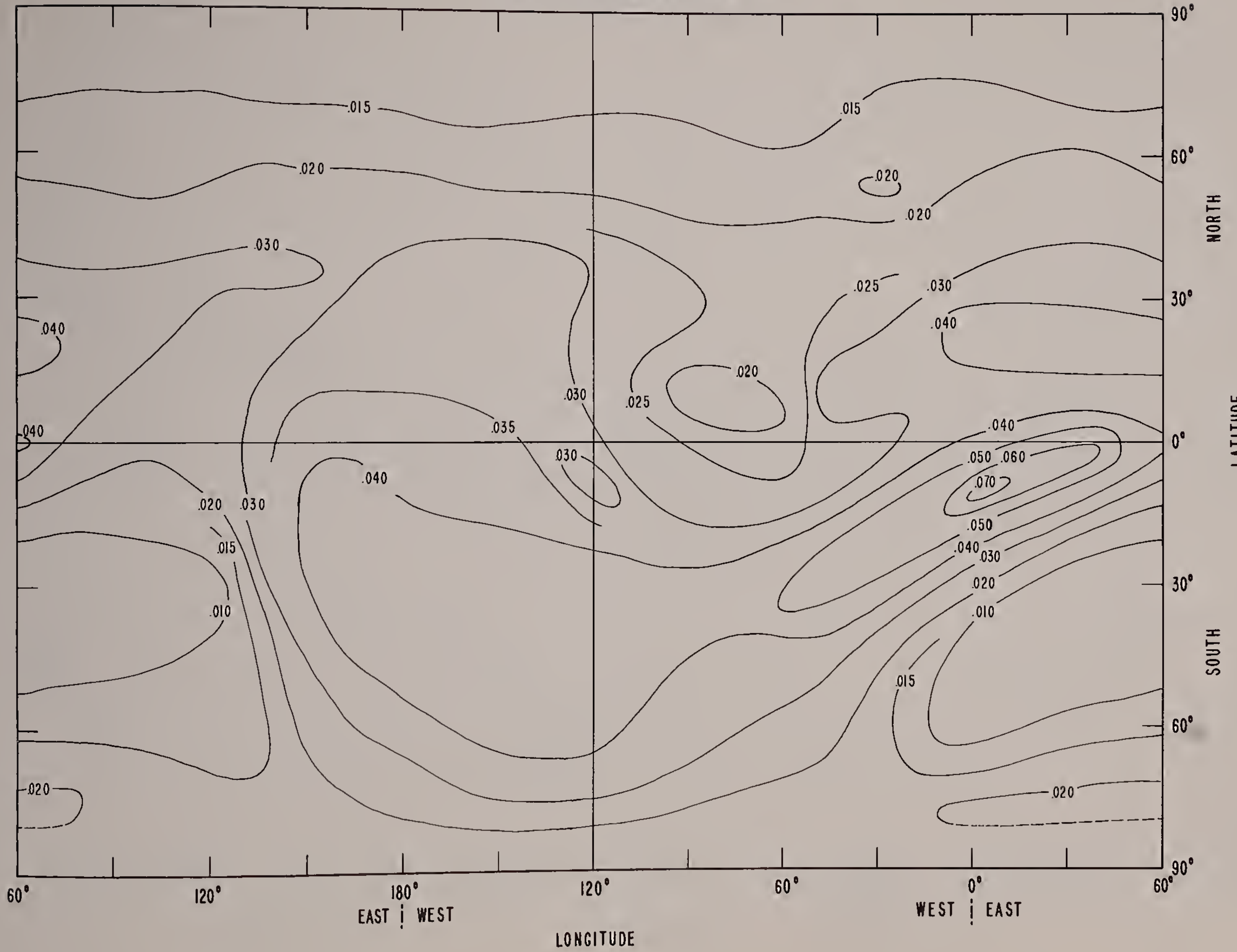
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 1800 HOURS GMT



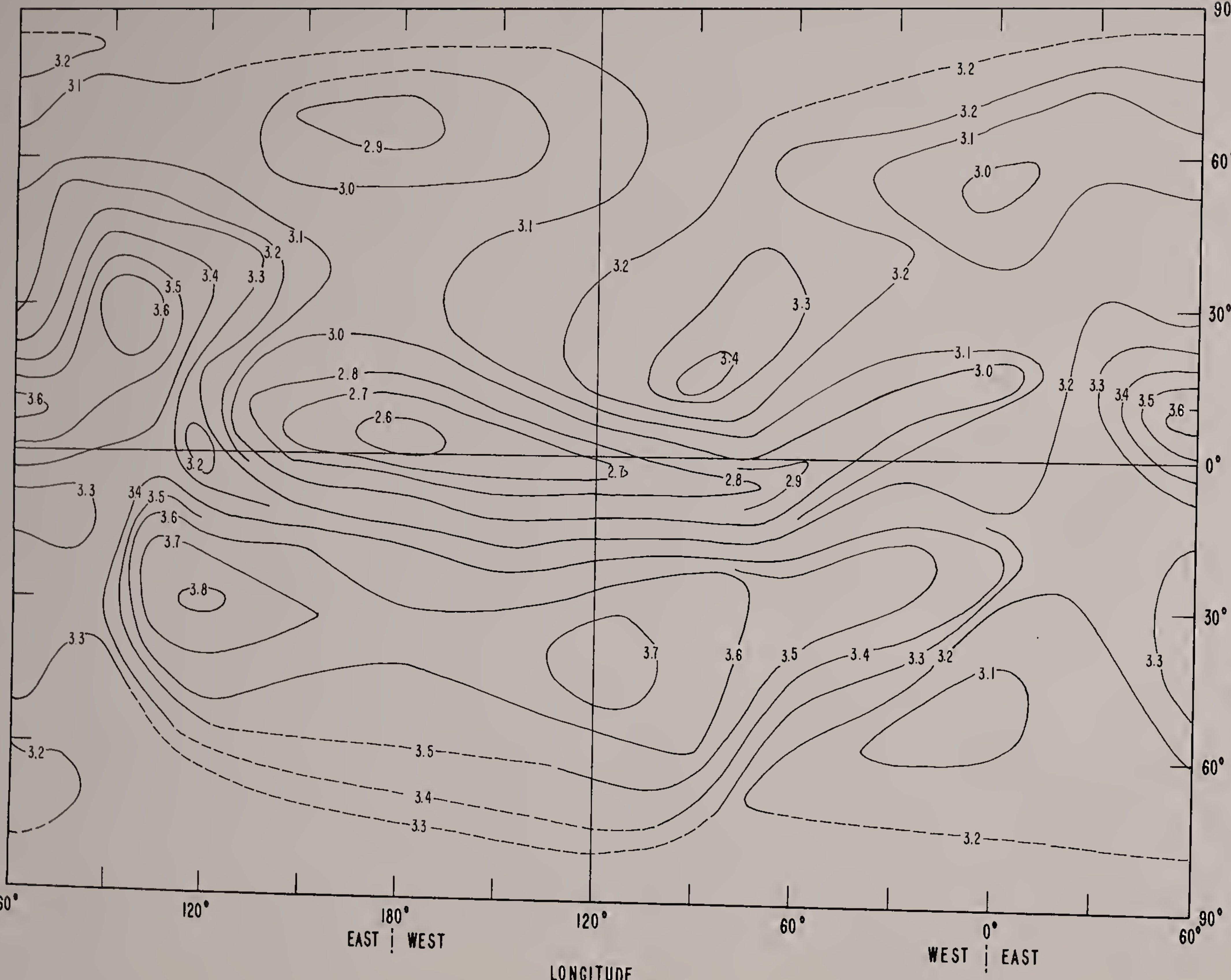
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 2000 HOURS GMT



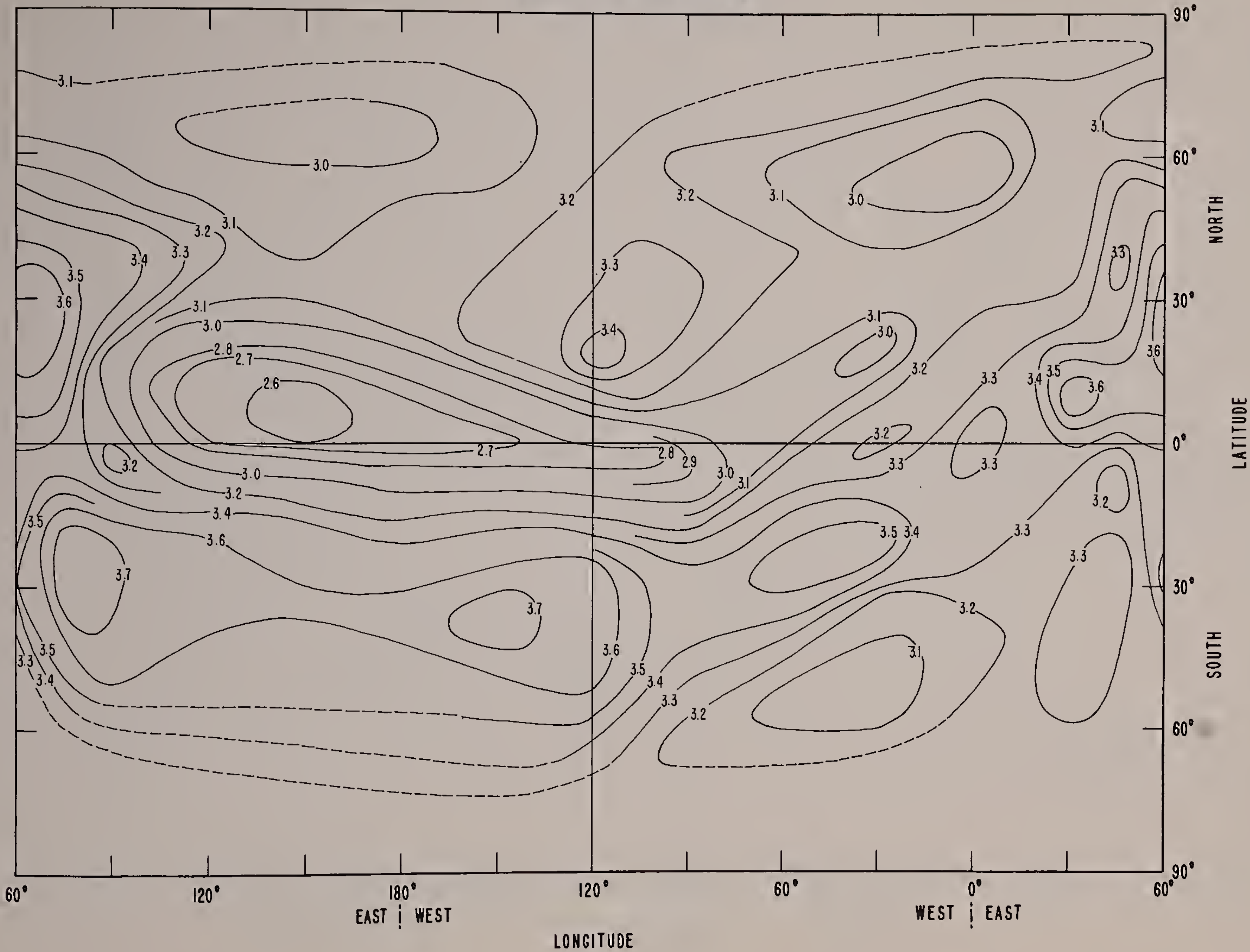
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
MAY 2200 HOURS GMT



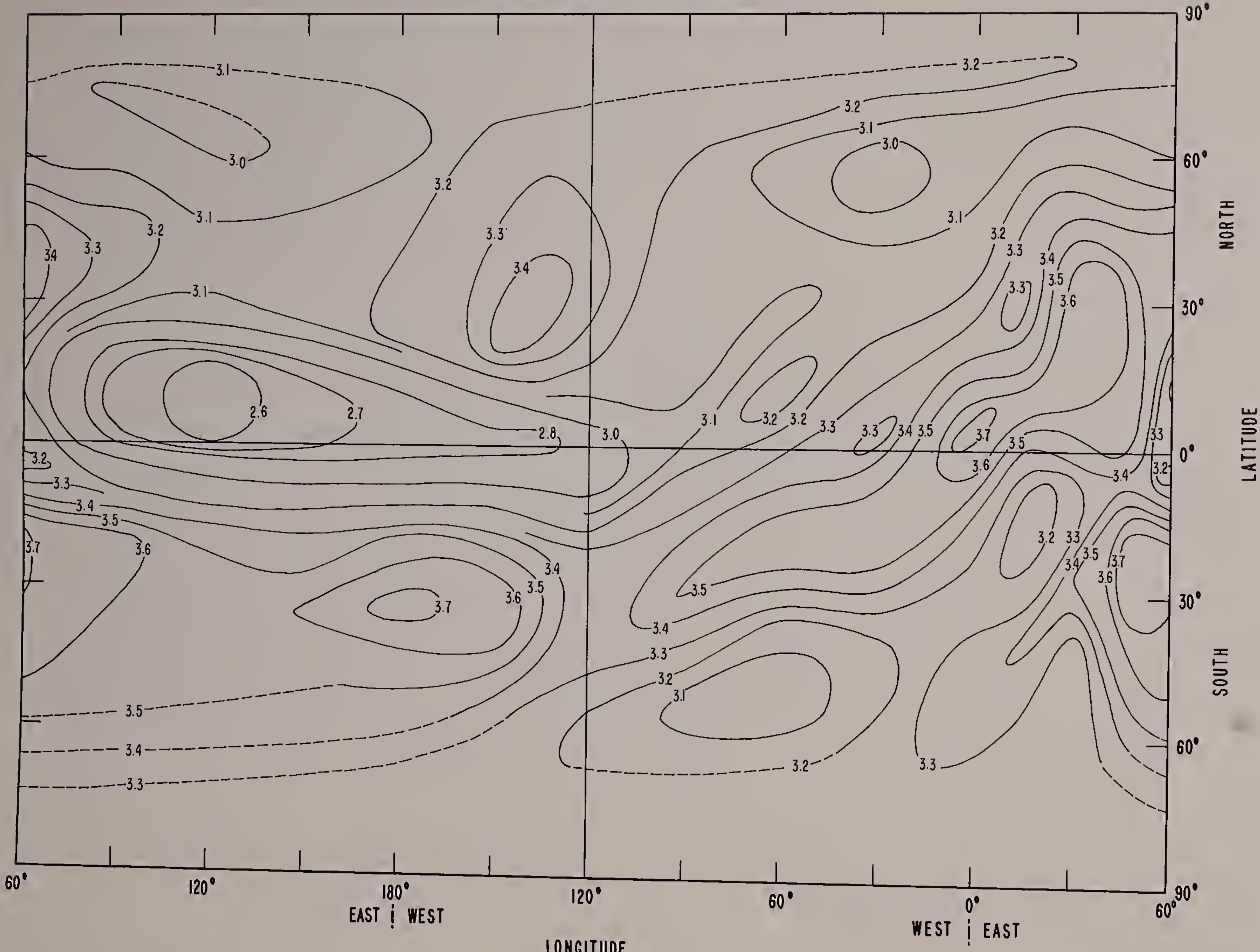
M-4000 FACTOR AT RASSN 50
MAY 0000 HOURS GMT



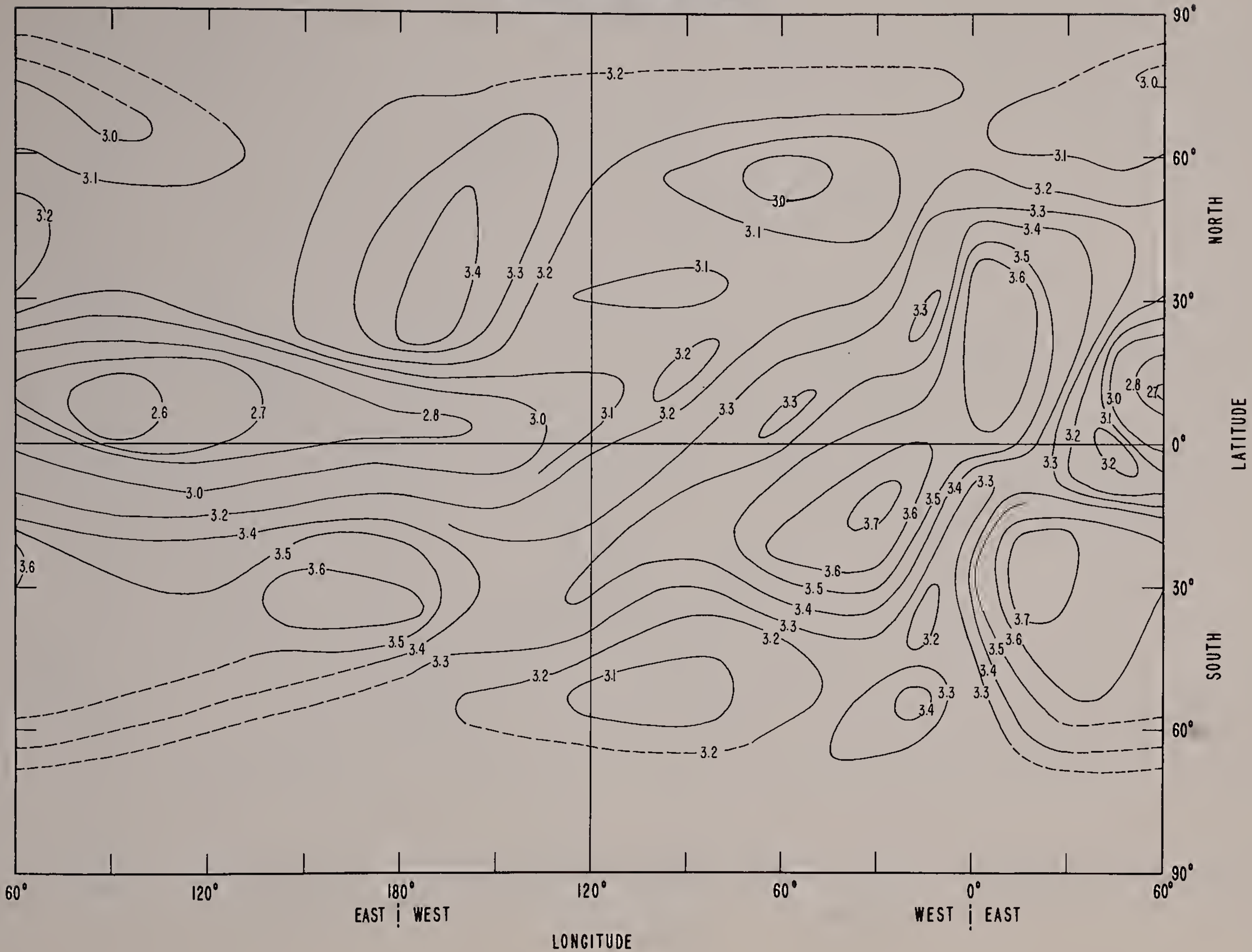
M-4000 FACTOR AT RASSN 50
MAY 0200 HOURS GMT



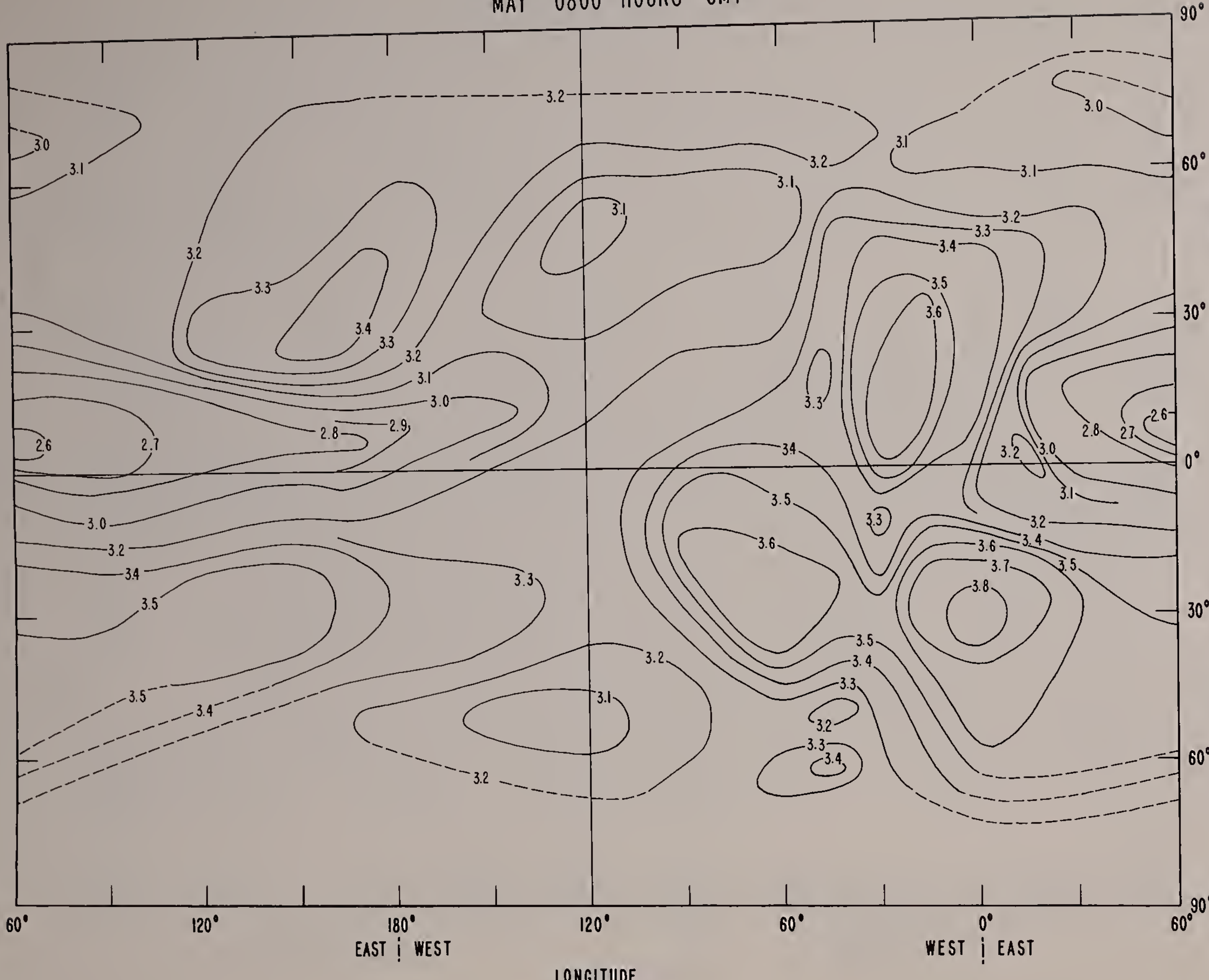
M-4000 FACTOR AT RASSN 50
MAY 0400 HOURS GMT



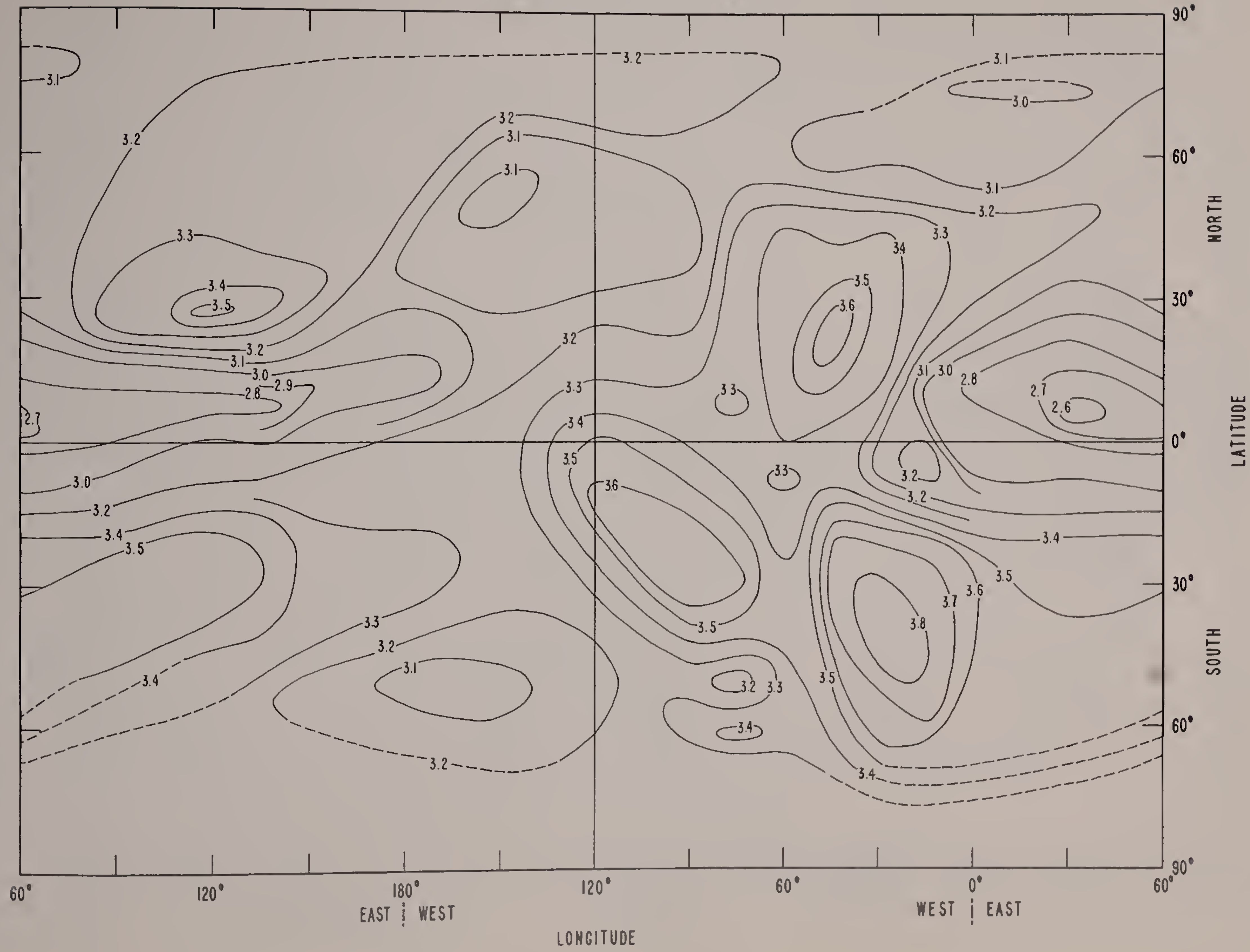
M-4000 FACTOR AT RASSN 50
MAY 0600 HOURS GMT



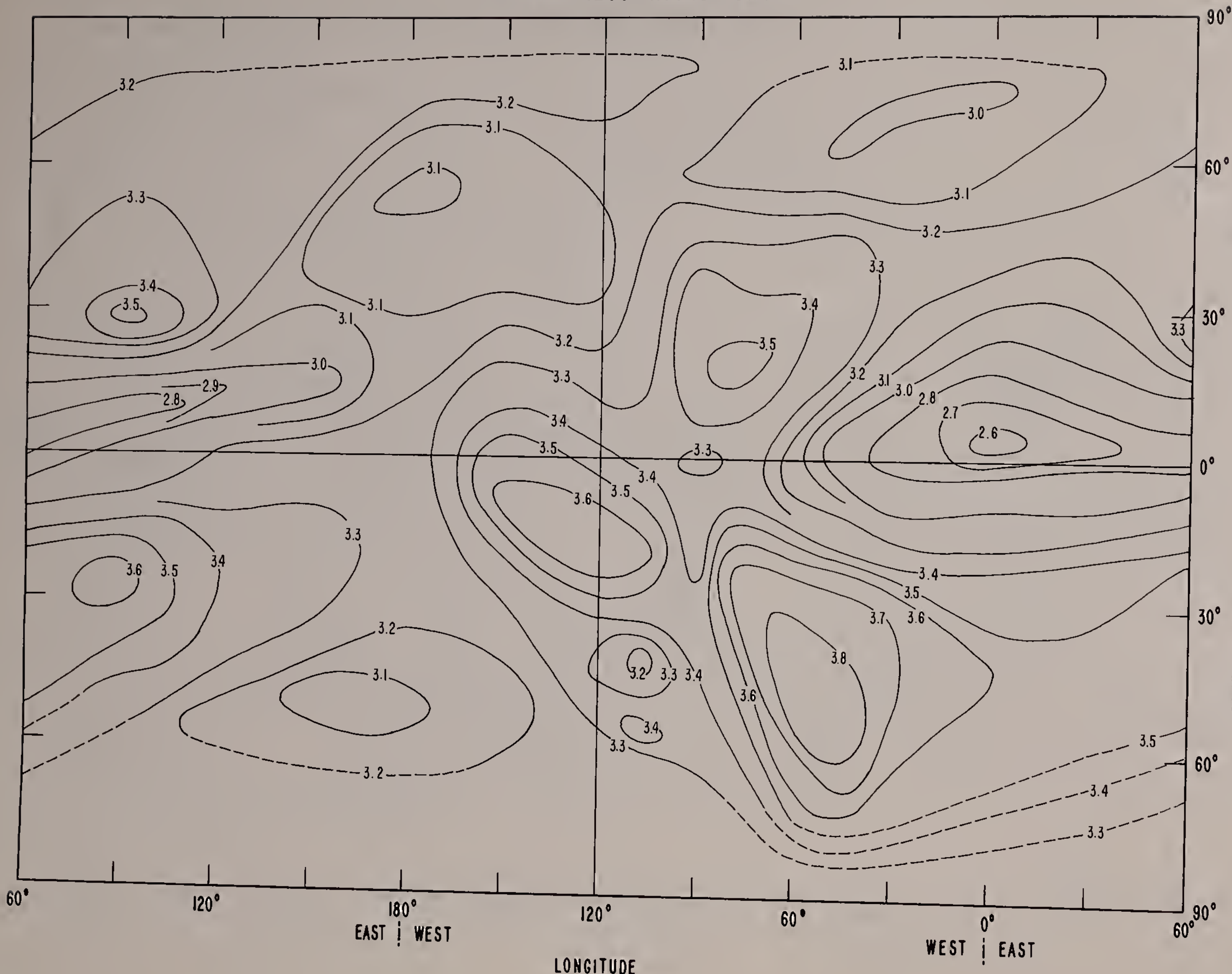
M-4000 FACTOR AT RASSN 50
MAY 0800 HOURS GMT



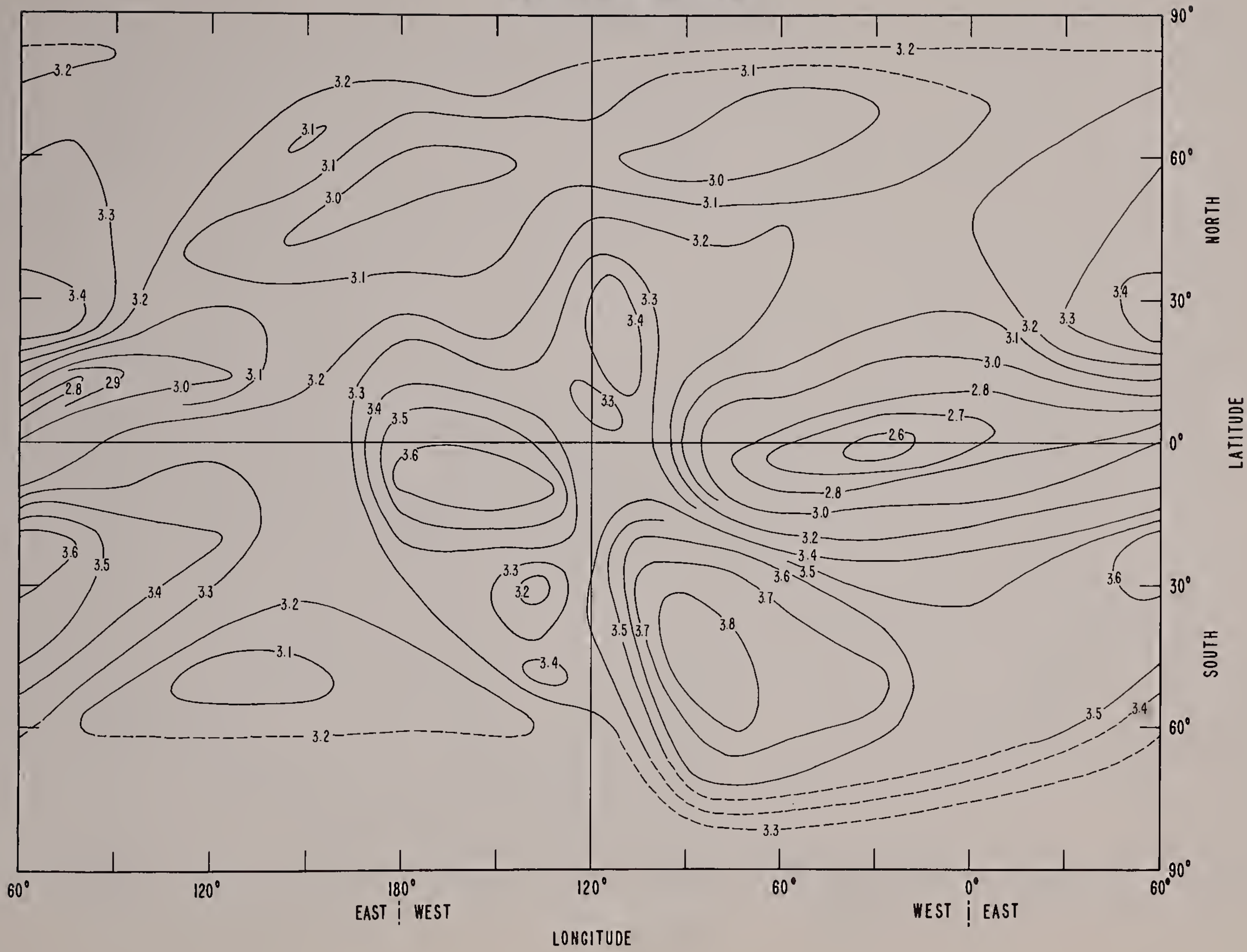
M-4000 FACTOR AT RASSN 50
MAY 1000 HOURS GMT



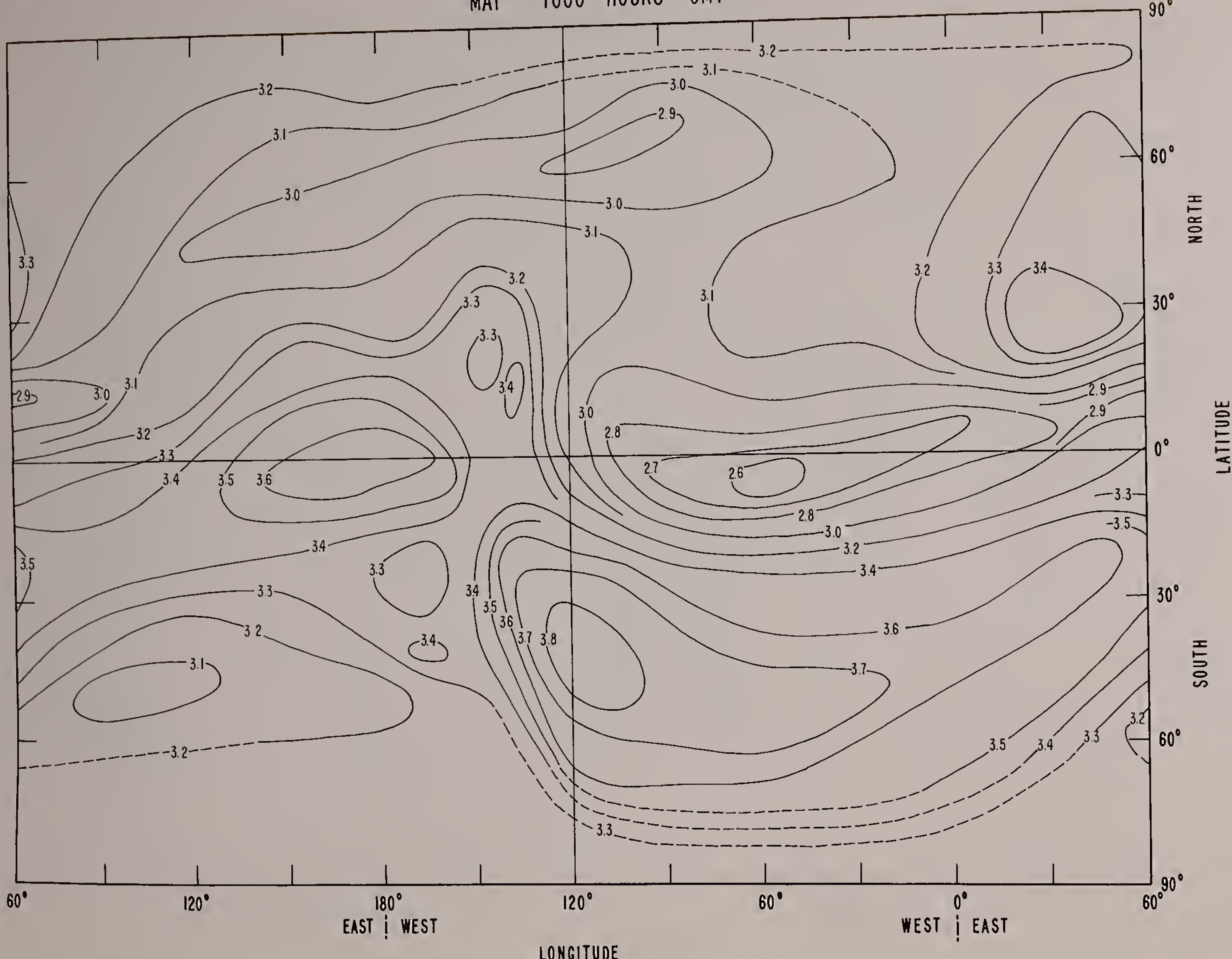
M-4000 FACTOR AT RASSN 50
MAY 1200 HOURS GMT



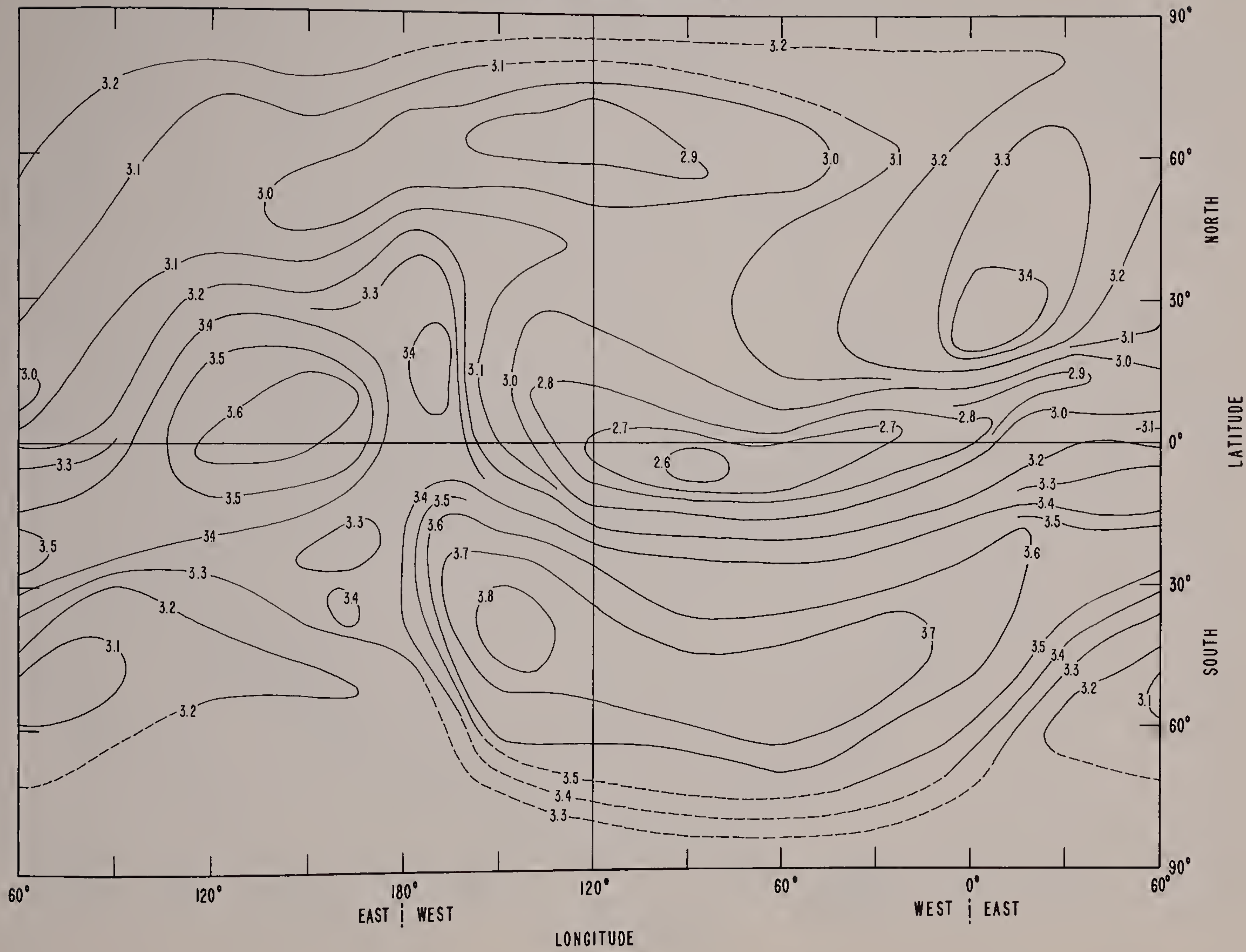
M-4000 FACTOR AT RASSN 50
MAY 1400 HOURS GMT



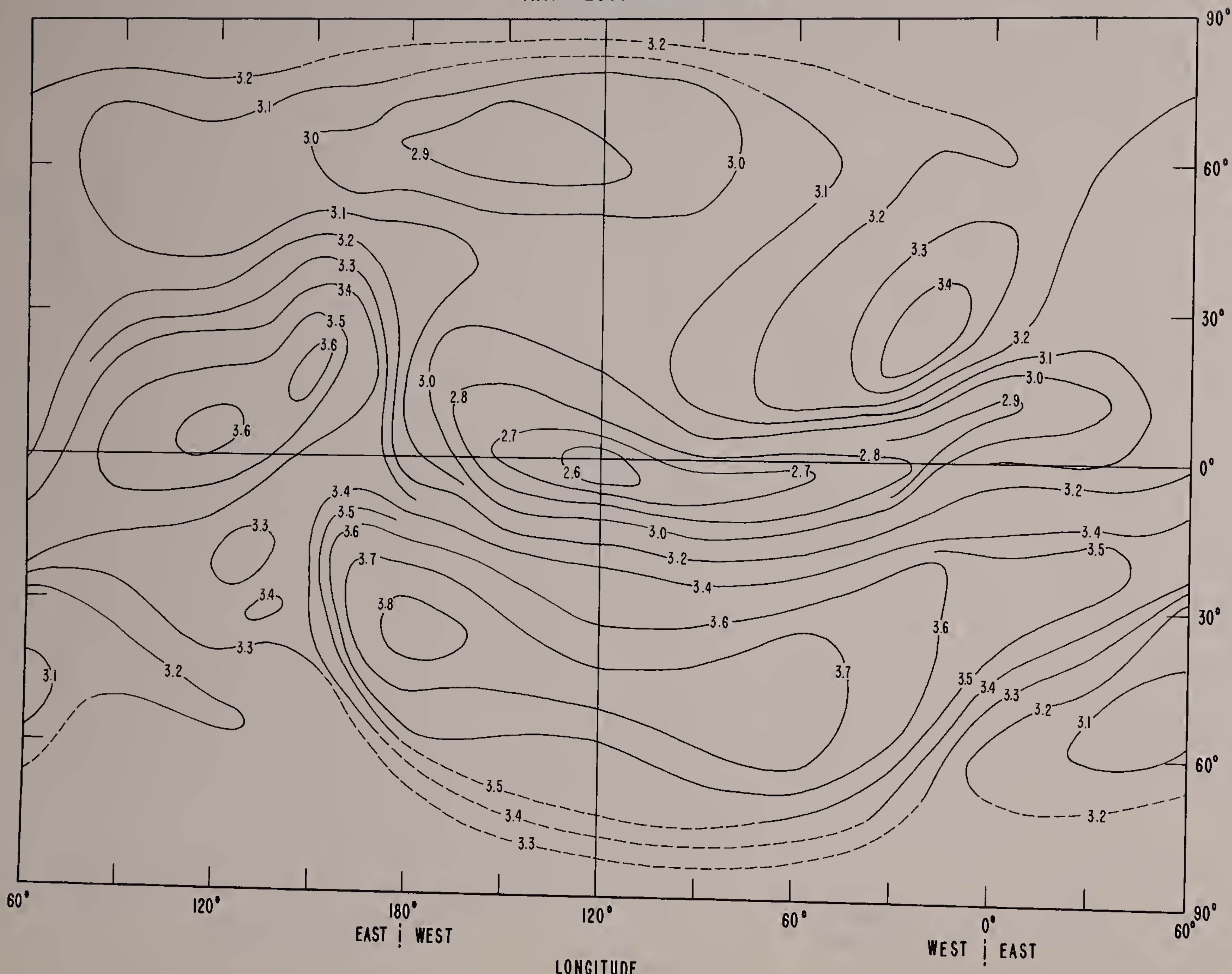
M-4000 FACTOR AT RASSN 50
MAY 1600 HOURS GMT



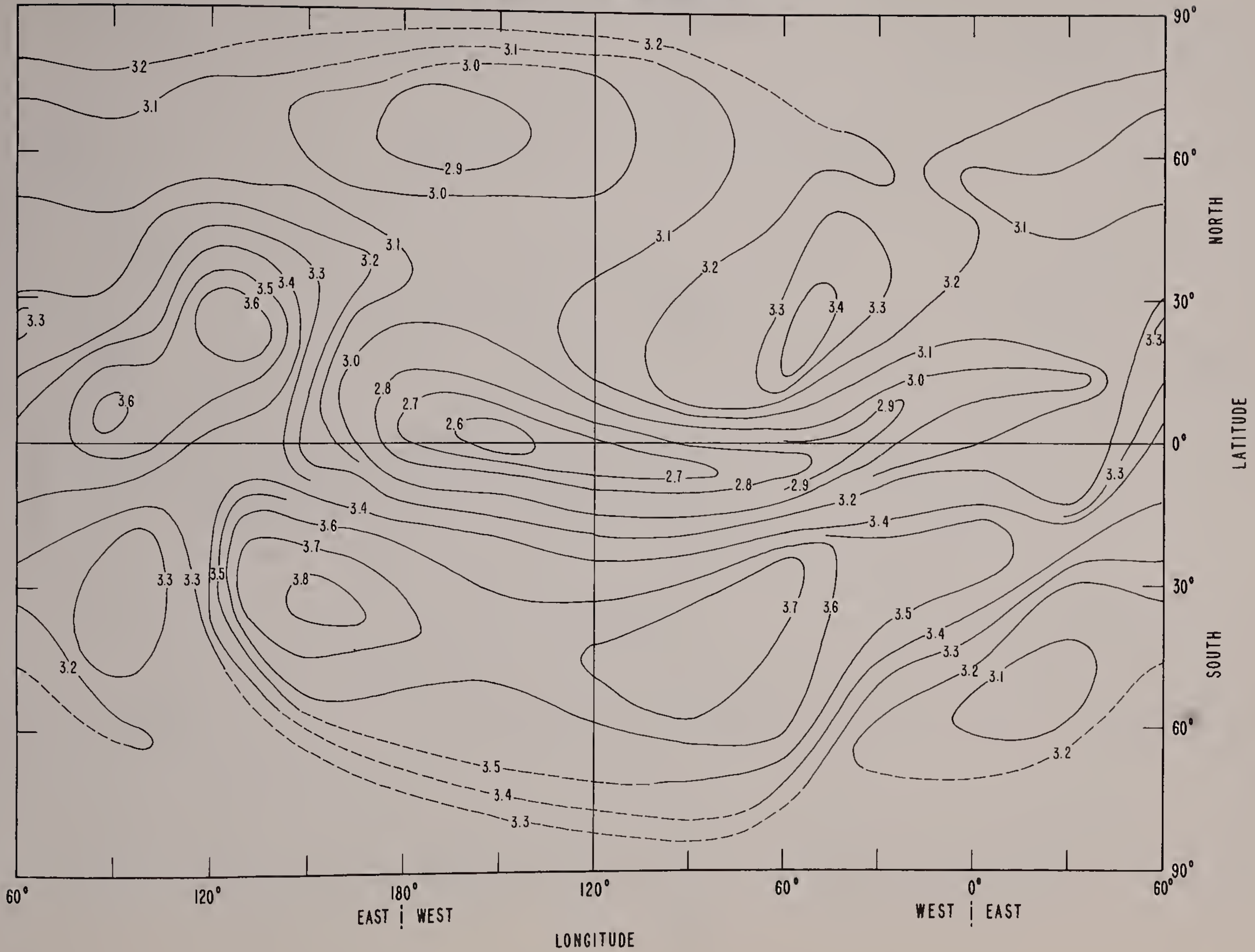
M-4000 FACTOR AT RASSN 50
MAY 1800 HOURS GMT



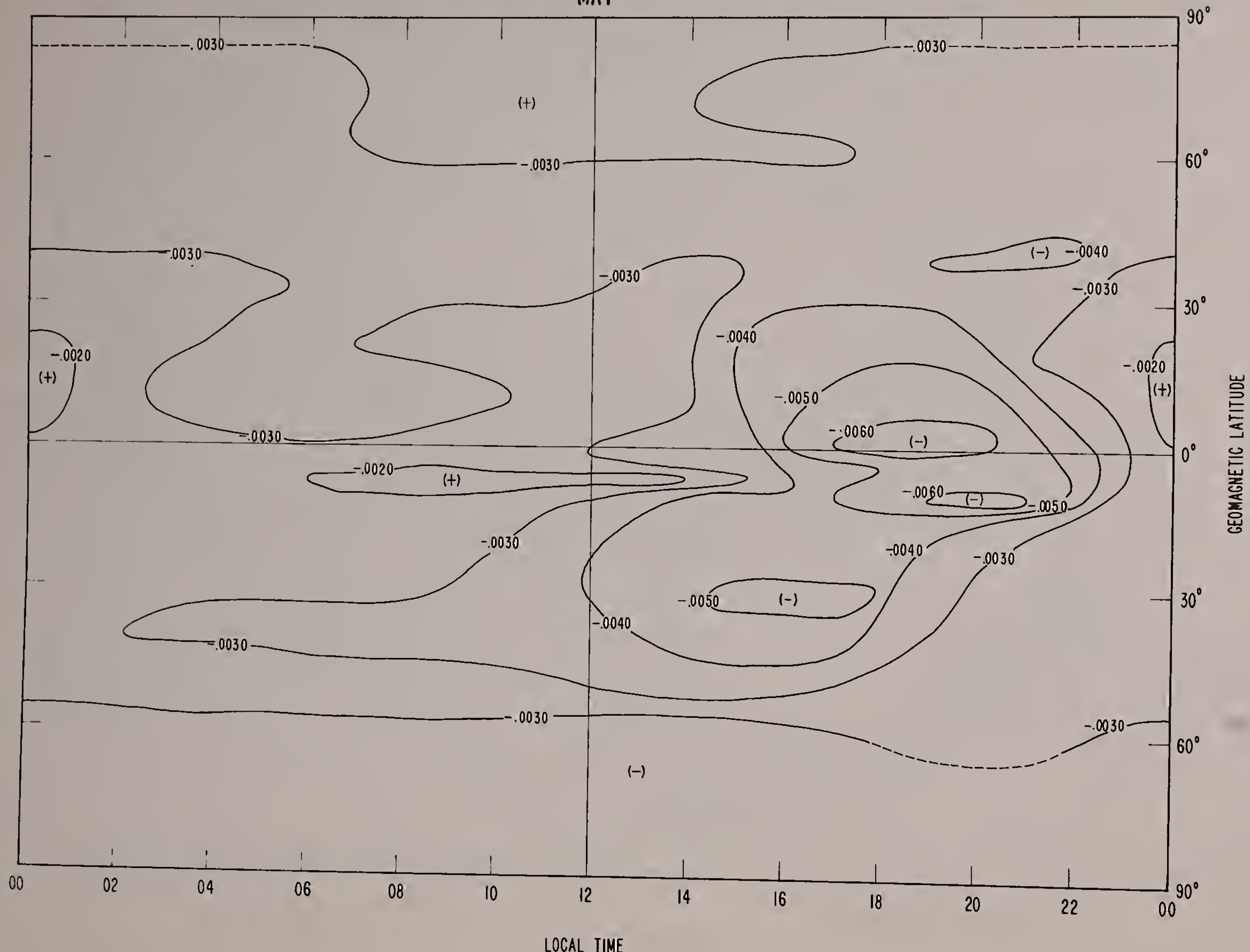
M-4000 FACTOR AT RASSN 50
MAY 2000 HOURS GMT



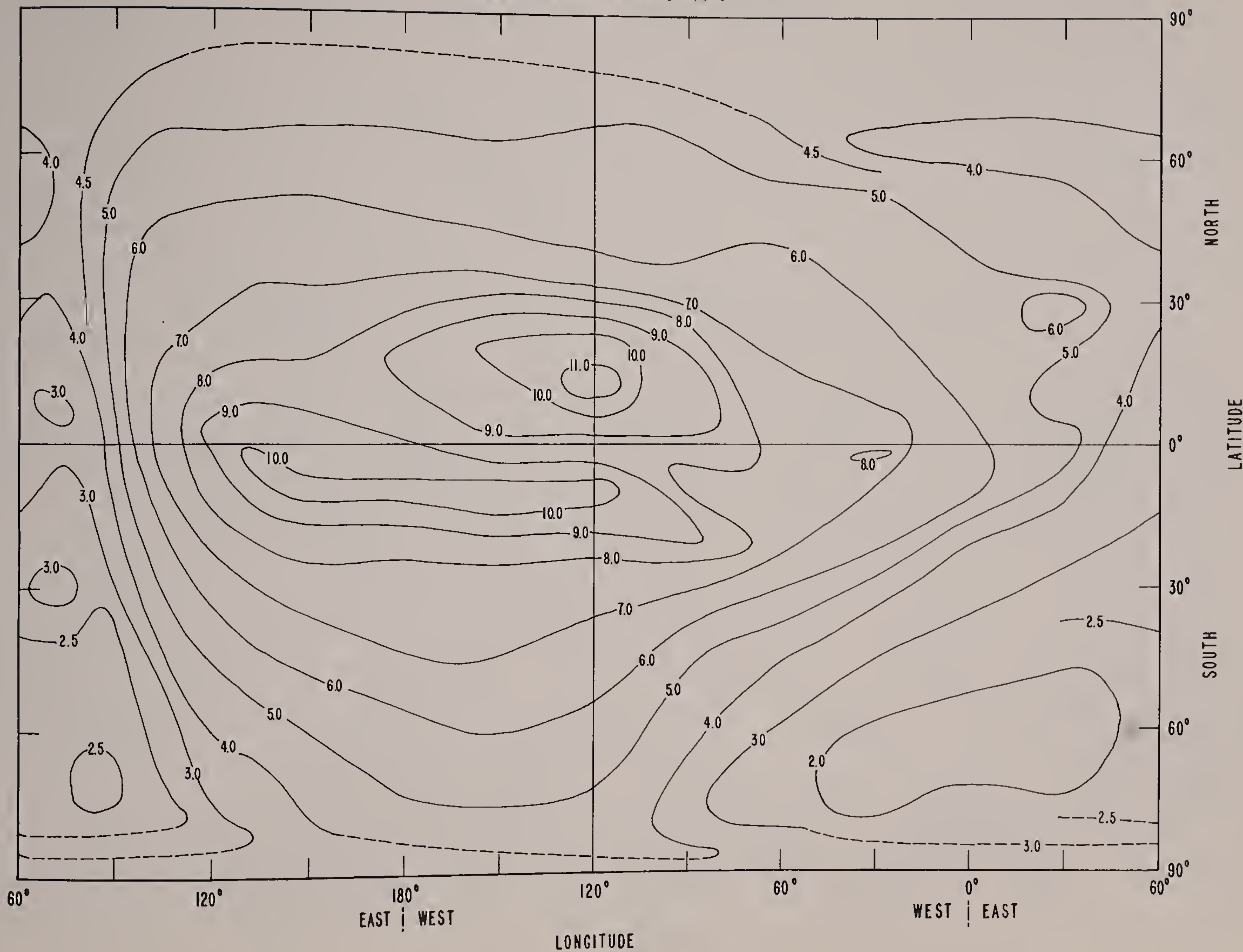
M-4000 FACTOR AT RASSN 50
MAY 2200 HOURS GMT



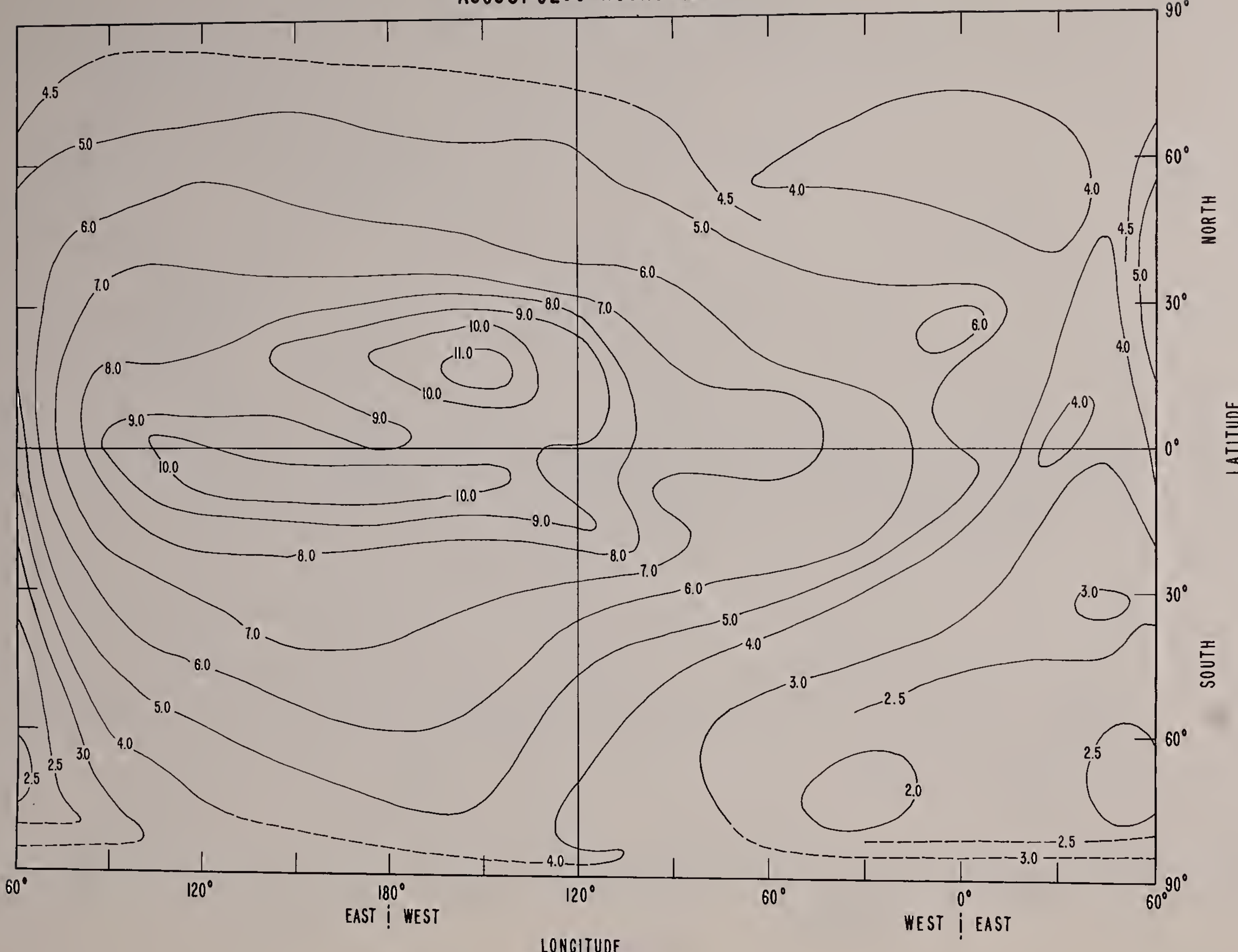
SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN
MAY



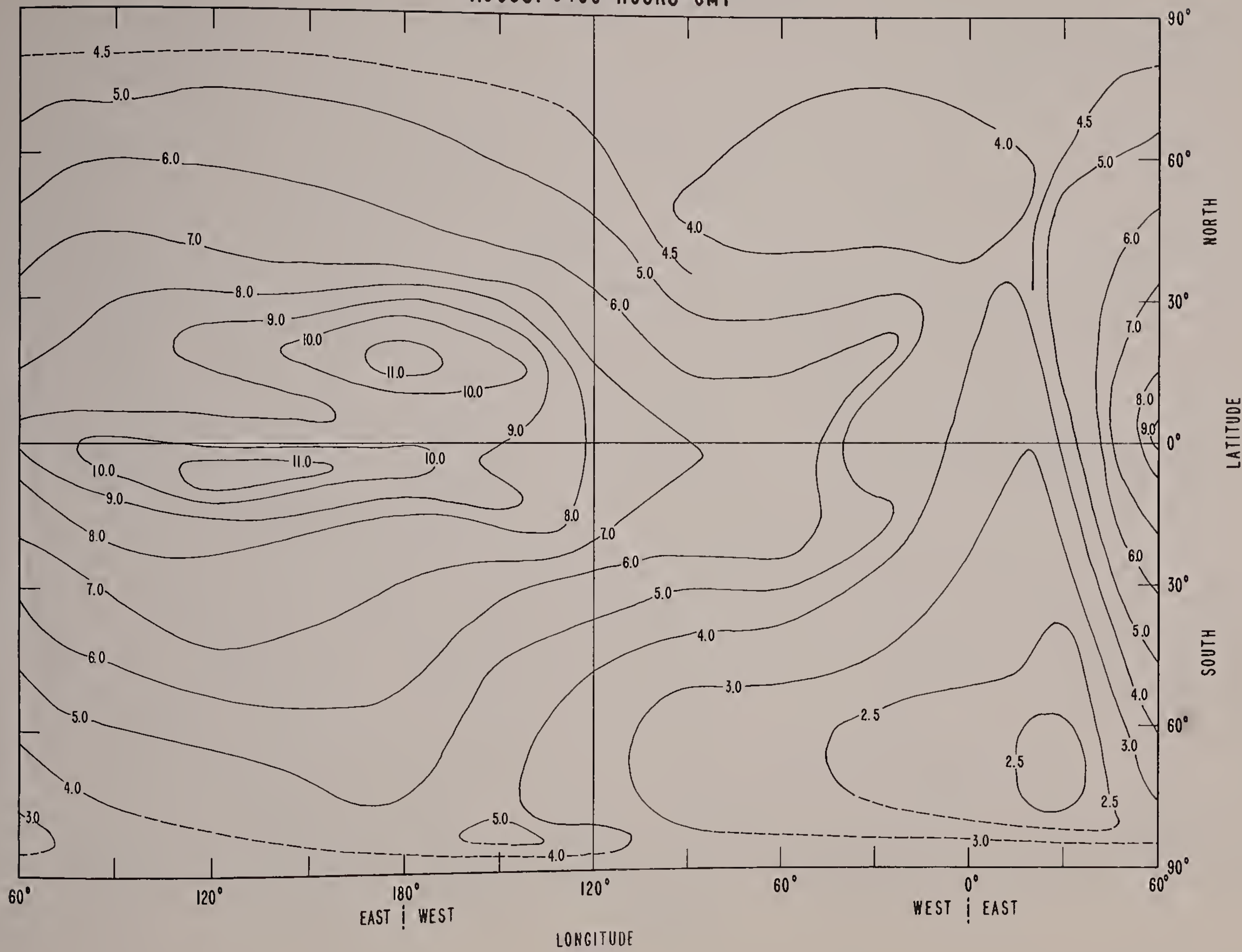
f₀F2 AT RASSN 50
AUGUST 0000 HOURS GMT



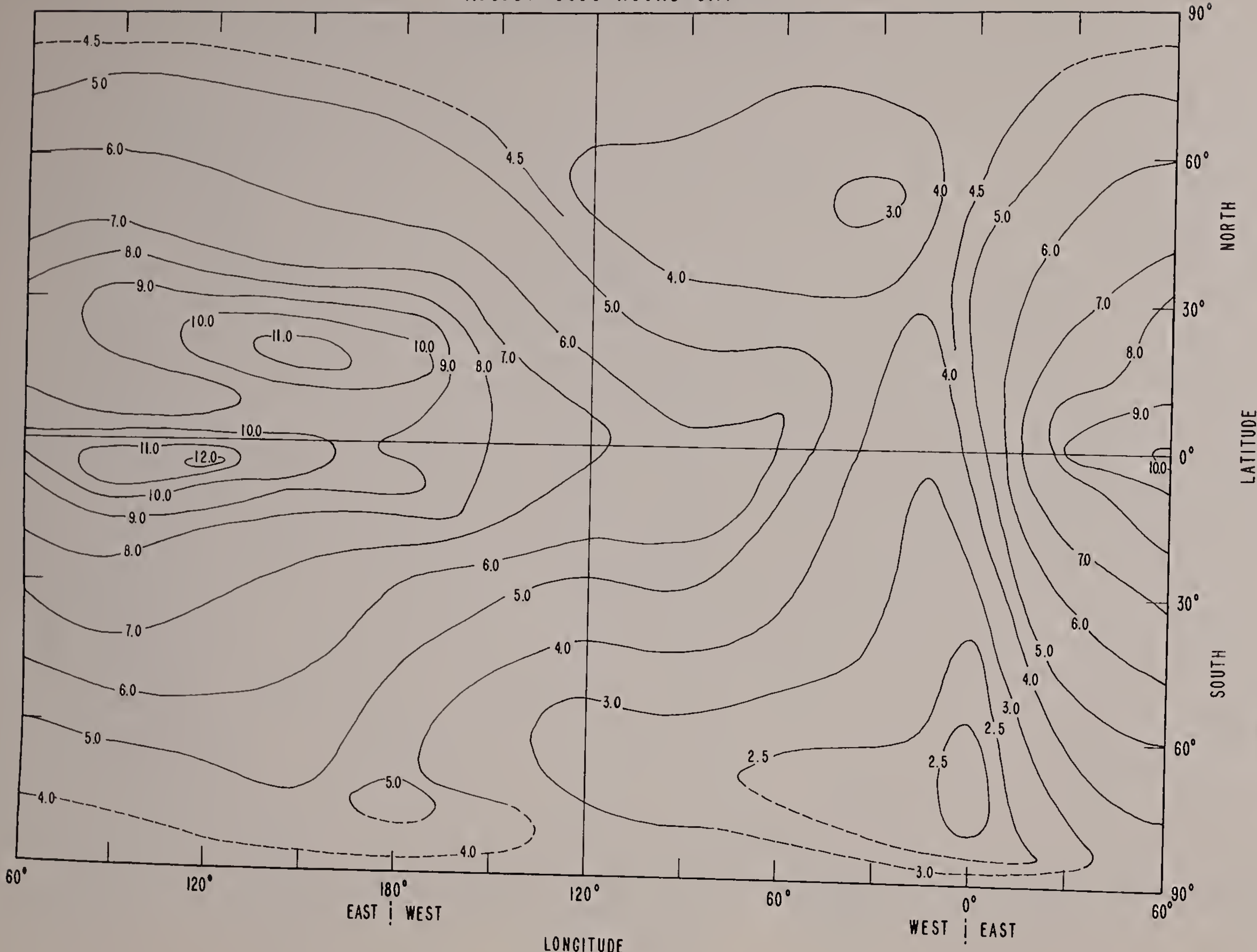
f_oF2 AT RASSN 50
AUGUST 0200 HOURS GMT



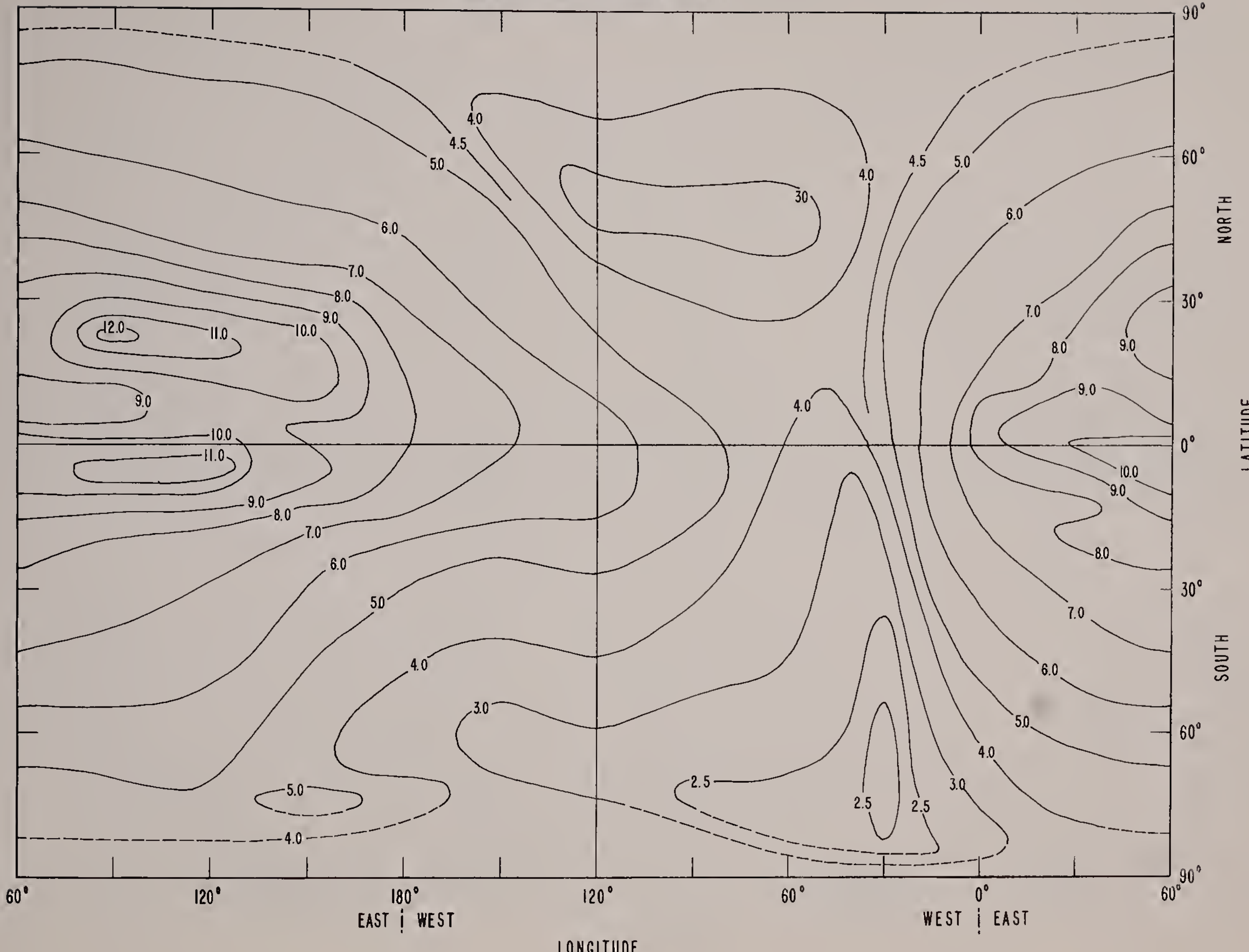
f₀F2 AT RASSN 50
AUGUST 0400 HOURS GMT



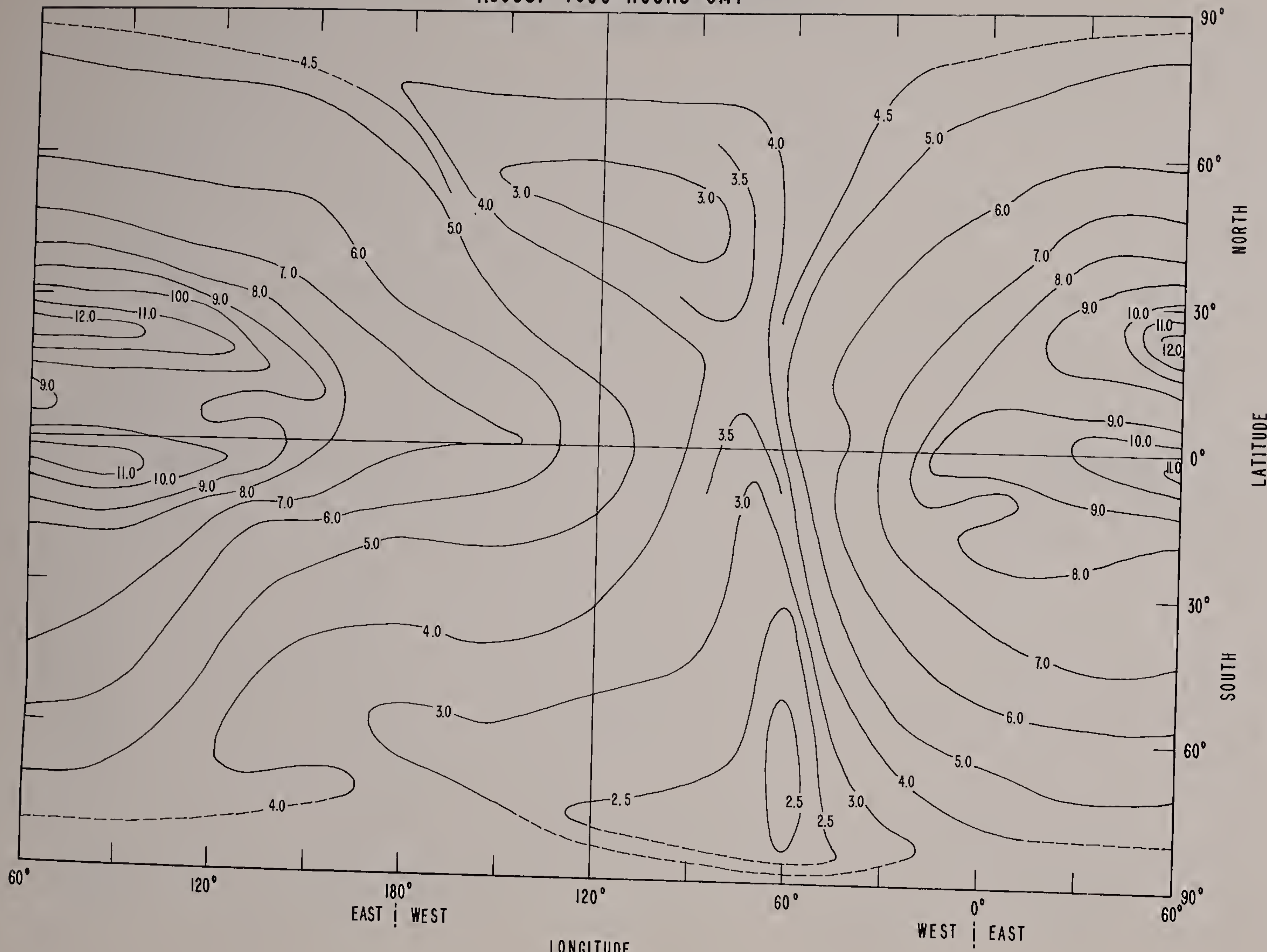
f_oF2 AT RASSN 50
AUGUST 0600 HOURS GMT



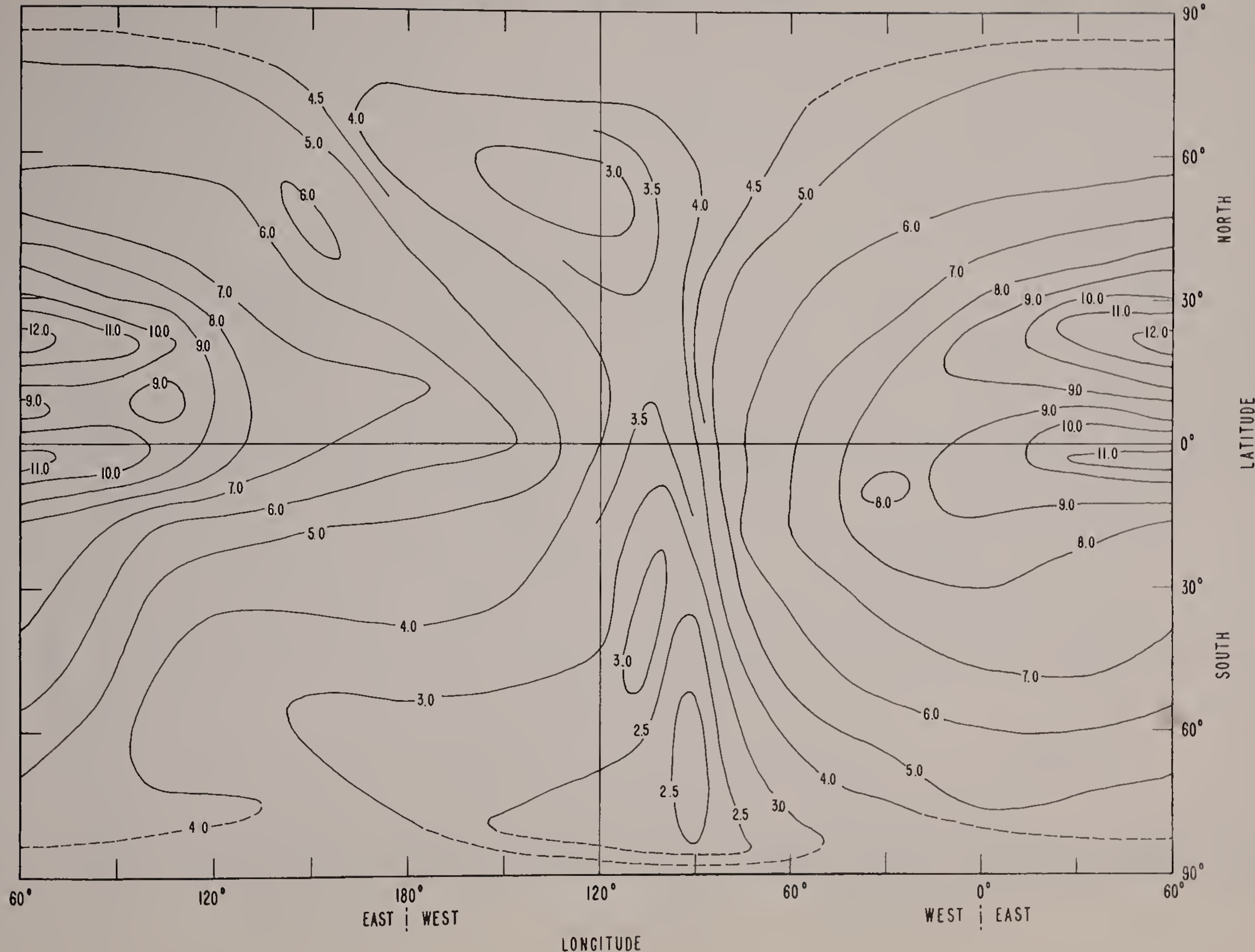
f_oF2 AT RASSN 50
AUGUST 0800 HOURS GMT



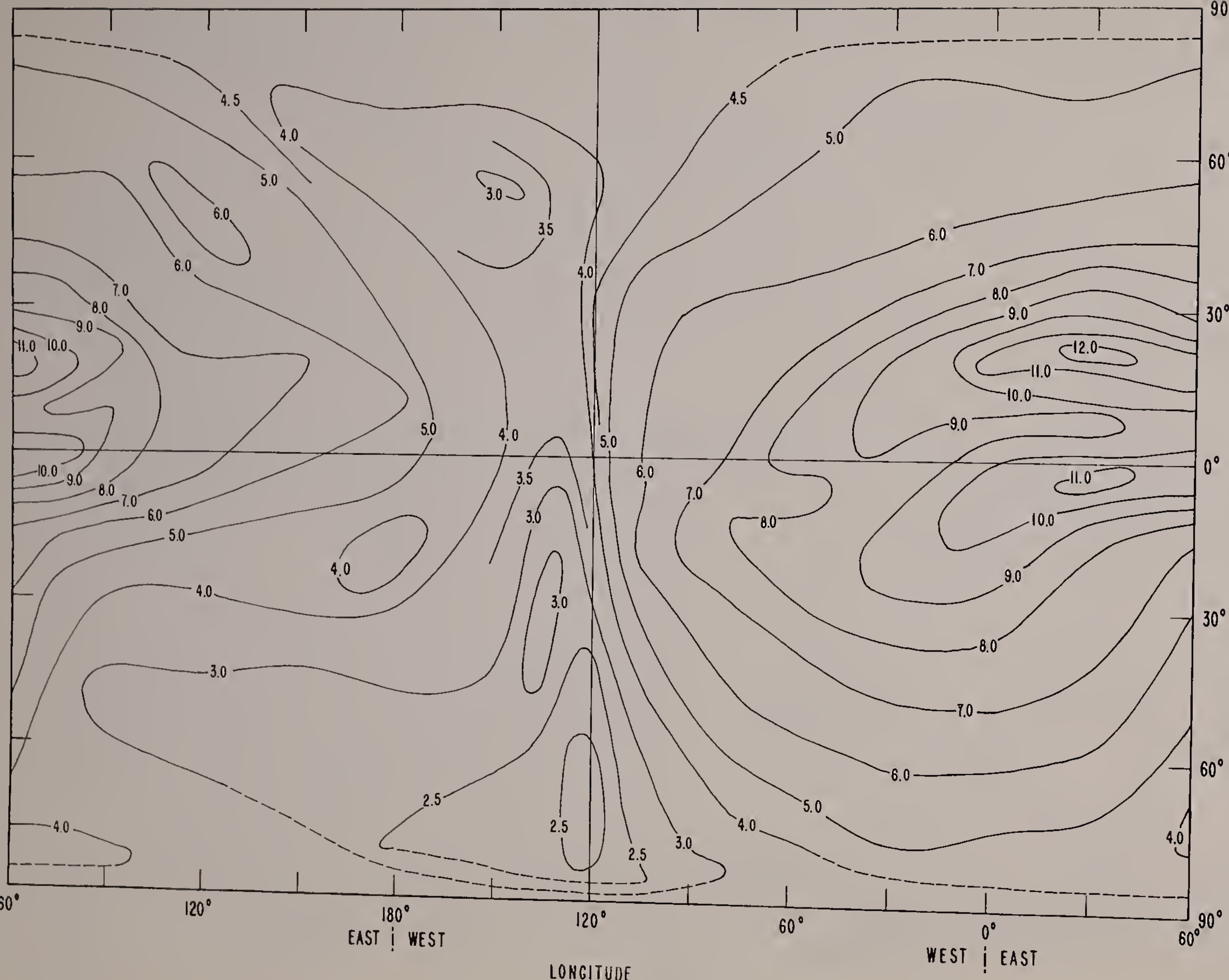
f_oF2 AT RASSN 50
AUGUST 1000 HOURS GMT



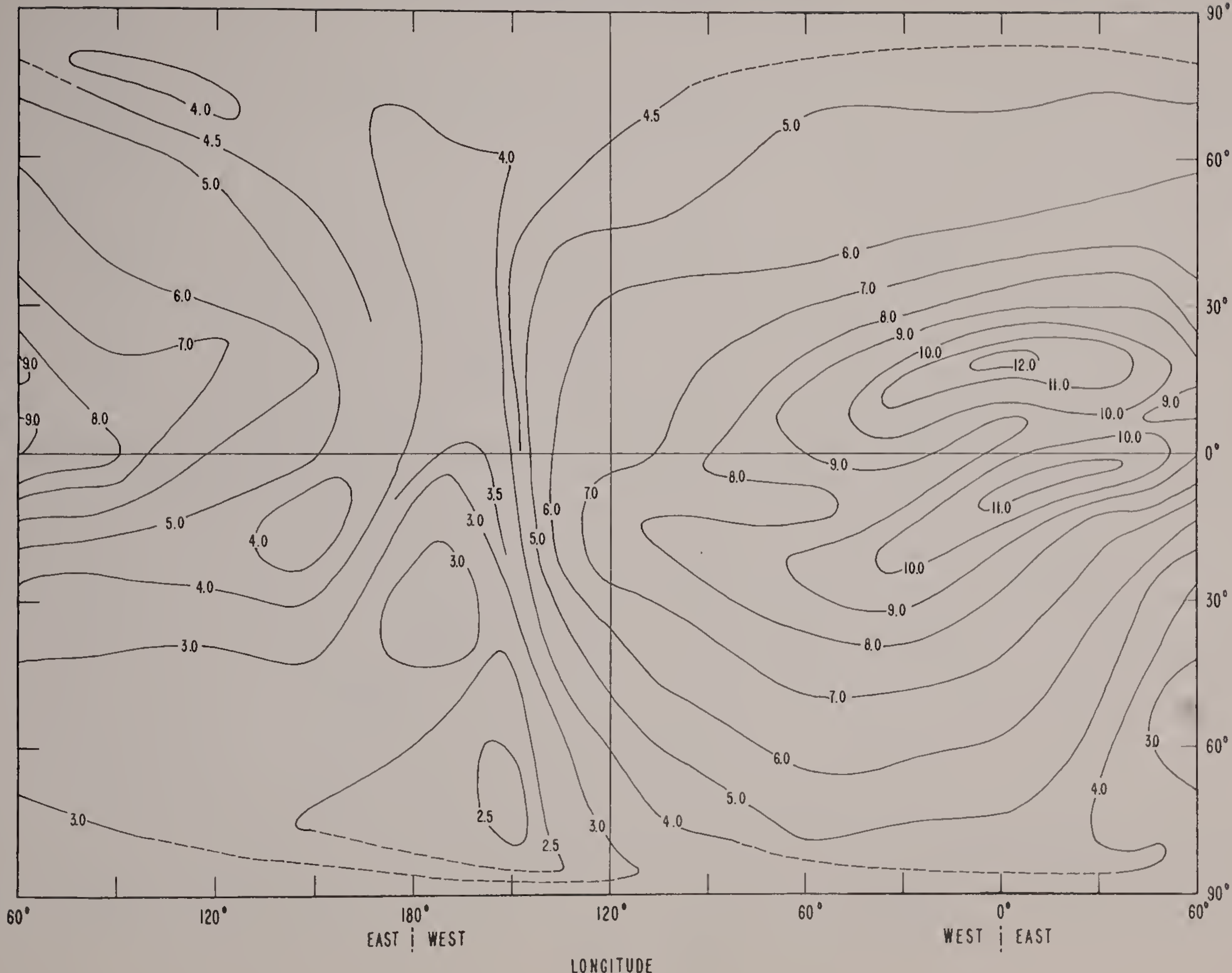
f₀F2 AT RASSN 50
AUGUST 1200 HOURS GMT



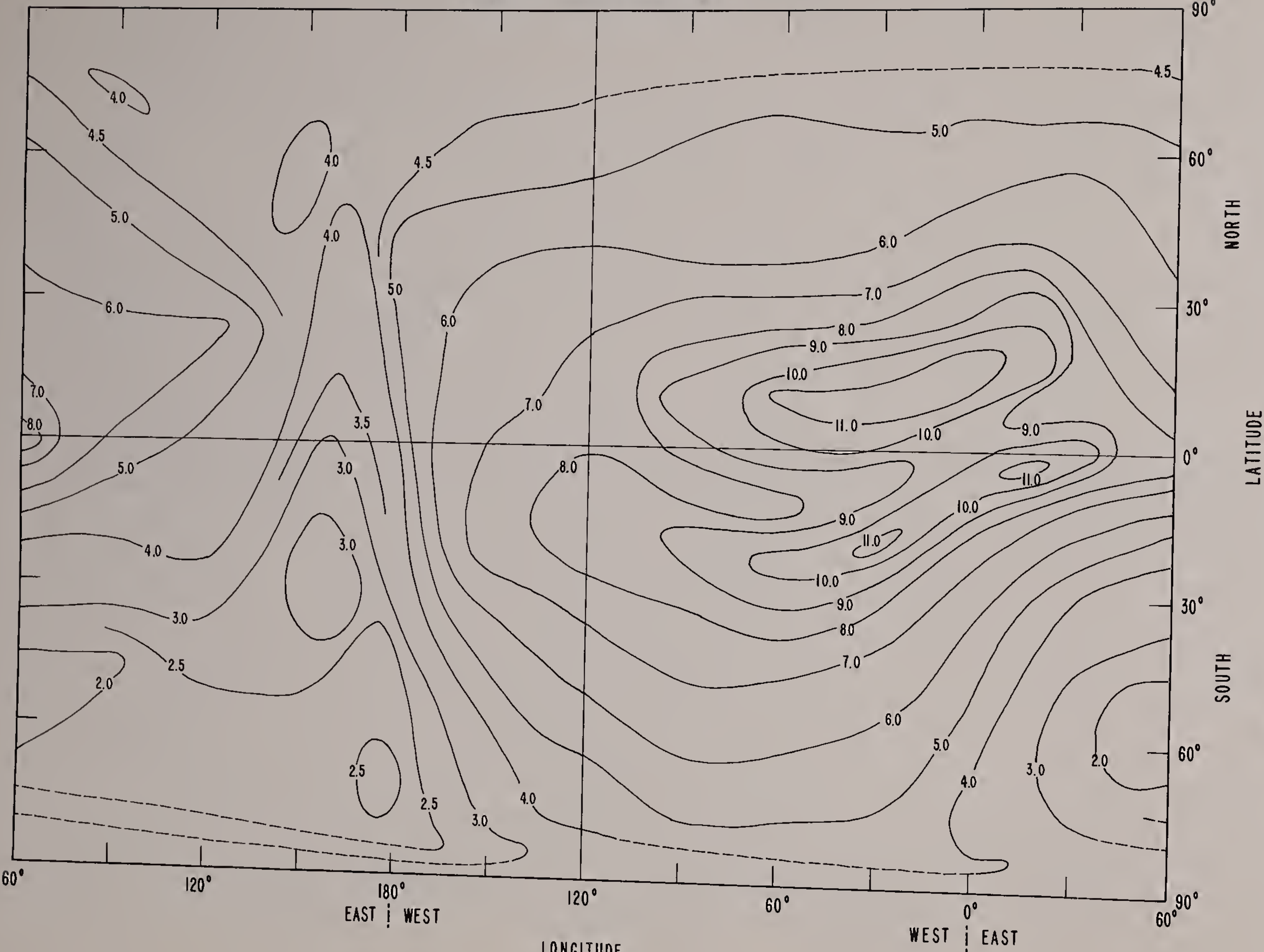
f_oF2 AT RASSN 50
AUGUST 1400 HOURS GMT



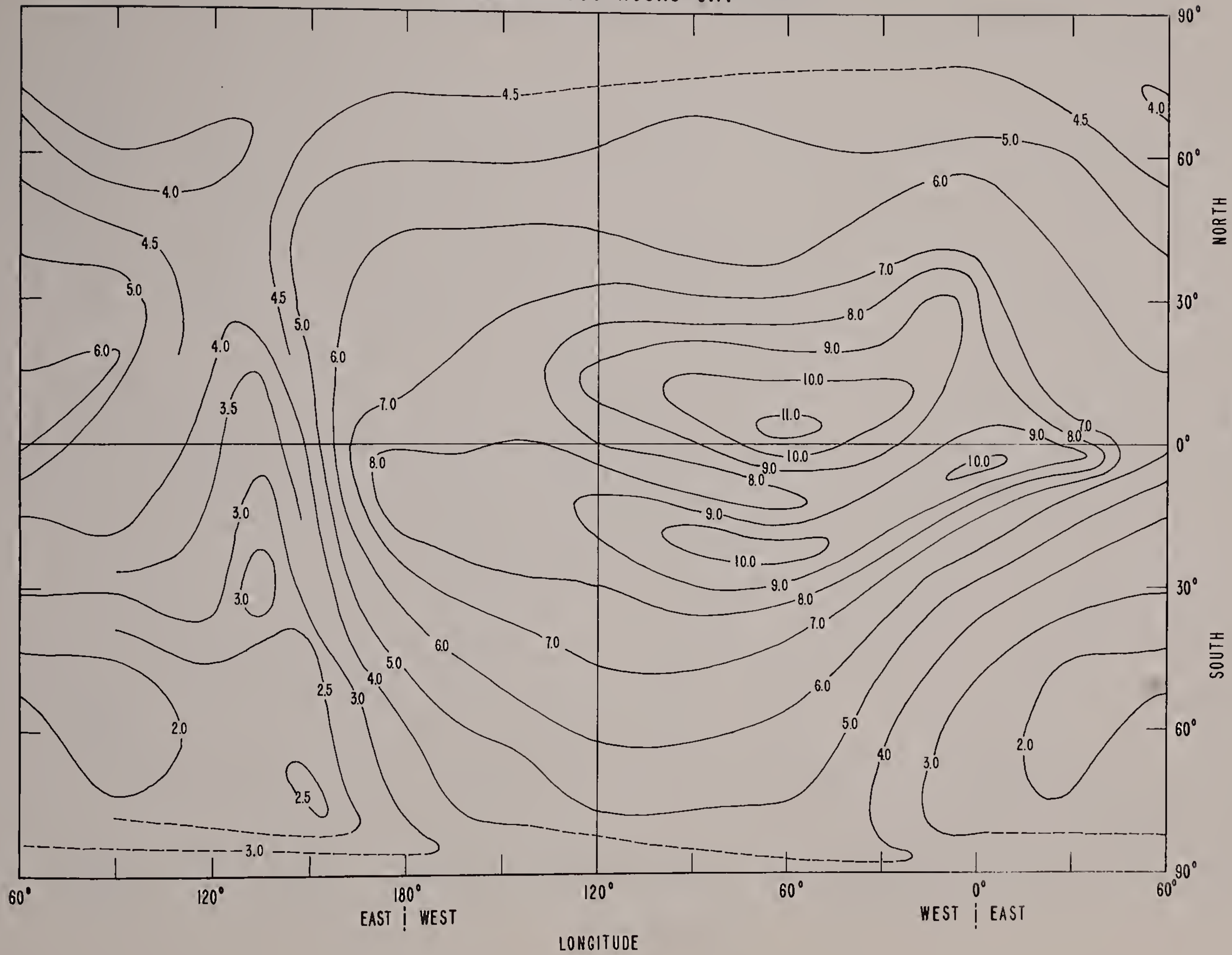
f_oF2 AT RASSN 50
AUGUST 1600 HOURS GMT



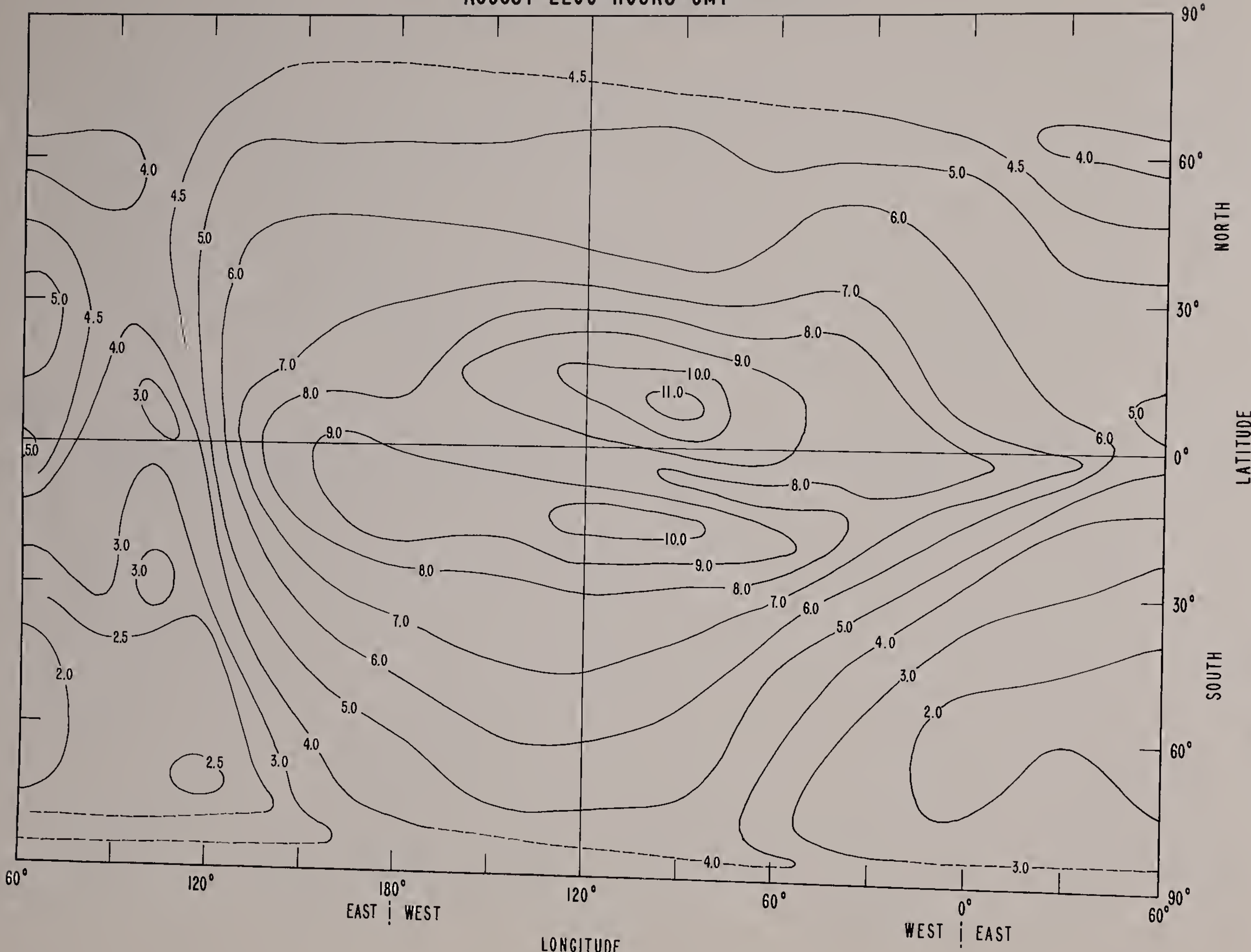
foF2 AT RASSN 50
AUGUST 1800 HOURS GMT



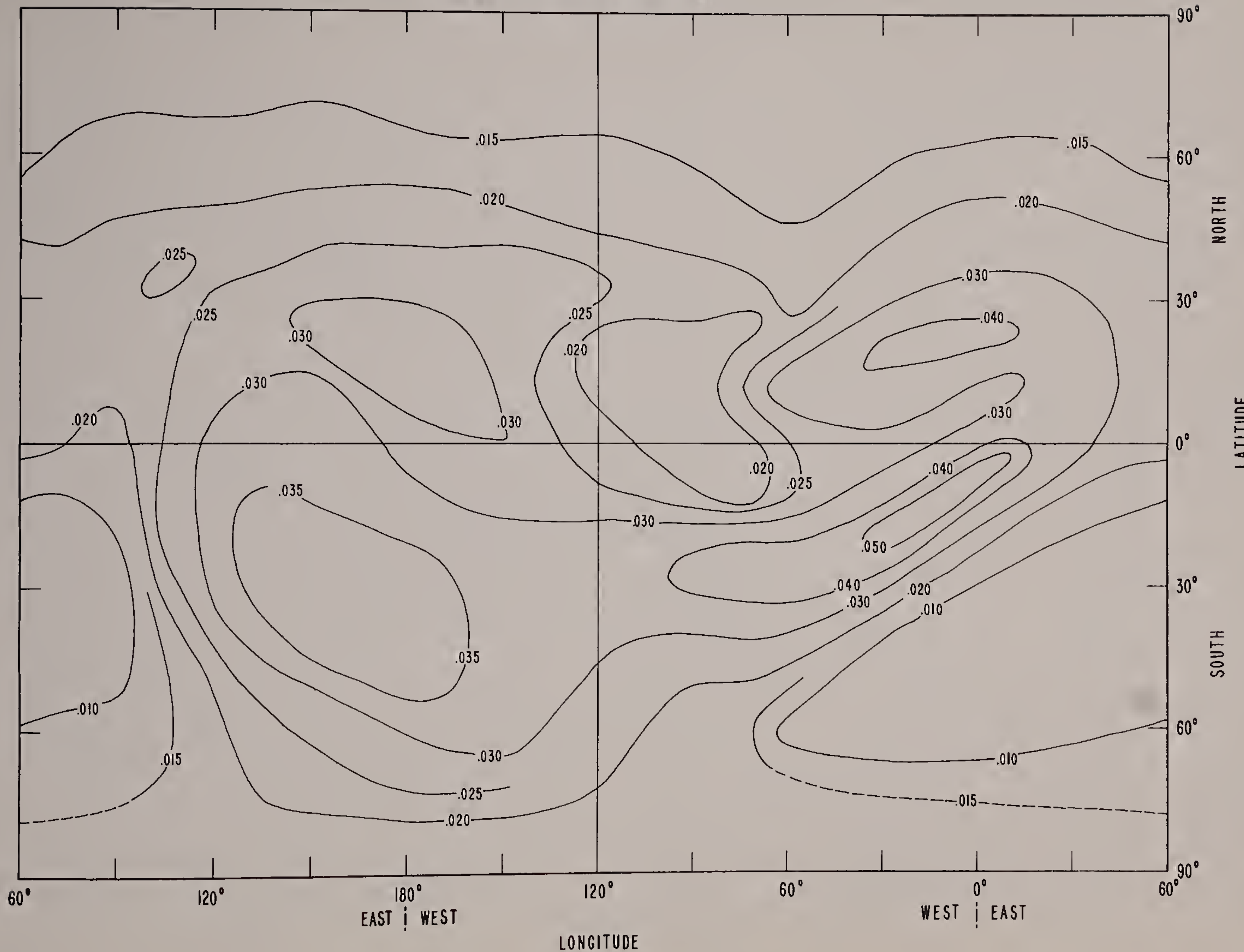
f_oF2 AT RASSN 50
AUGUST 2000 HOURS GMT



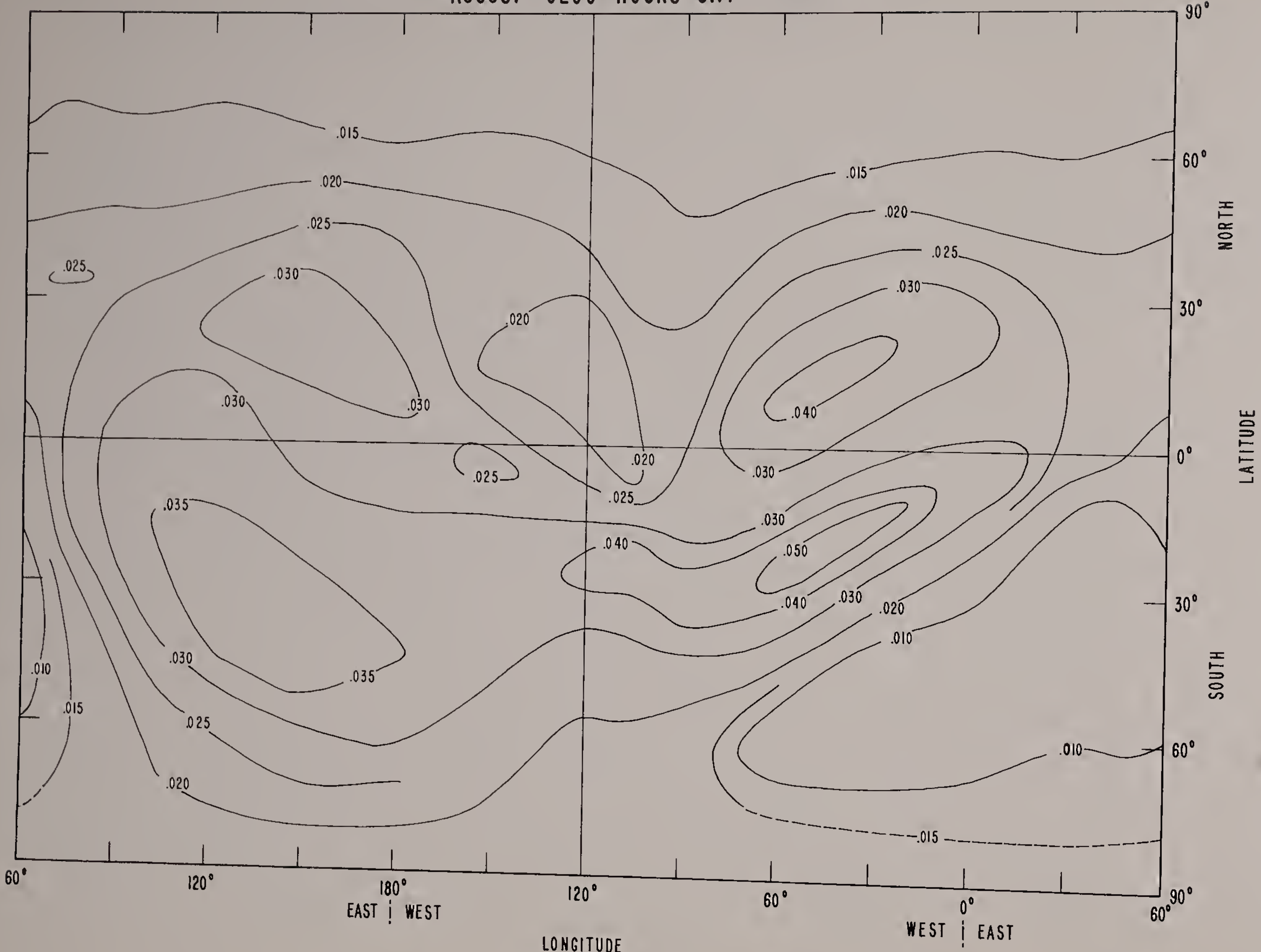
foF2 AT RASSN 50
AUGUST 2200 HOURS GMT



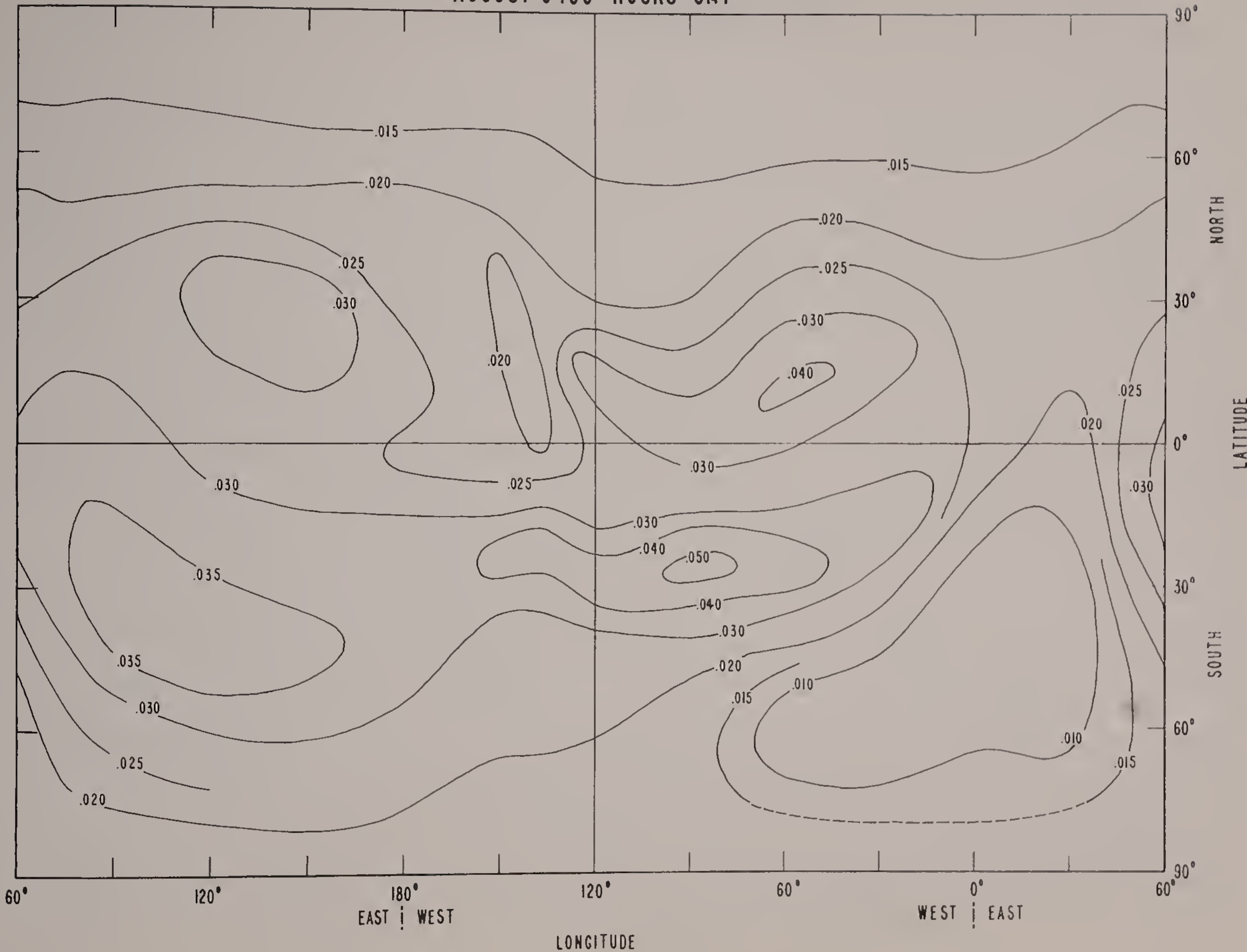
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 0000 HOURS GMT



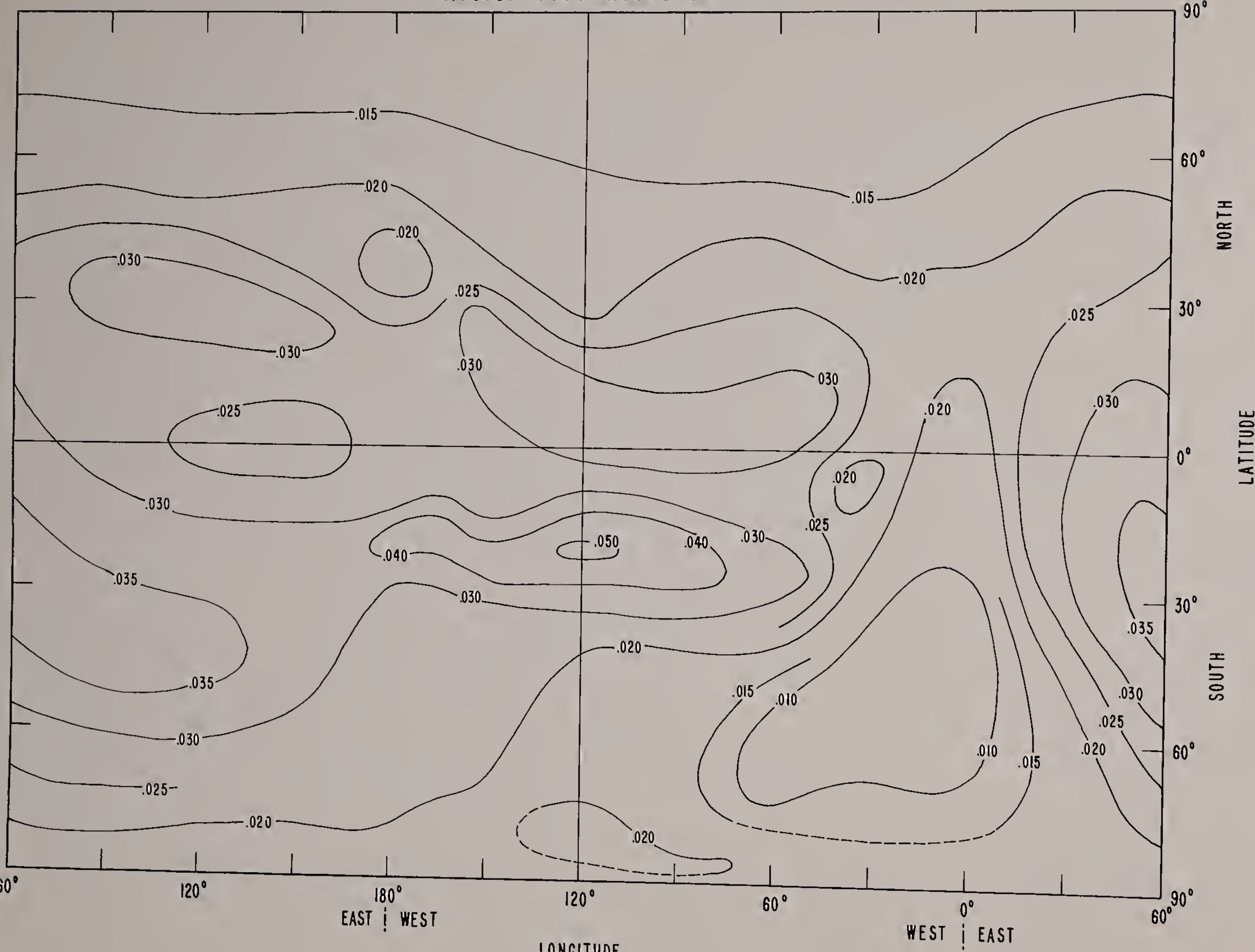
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 0200 HOURS GMT



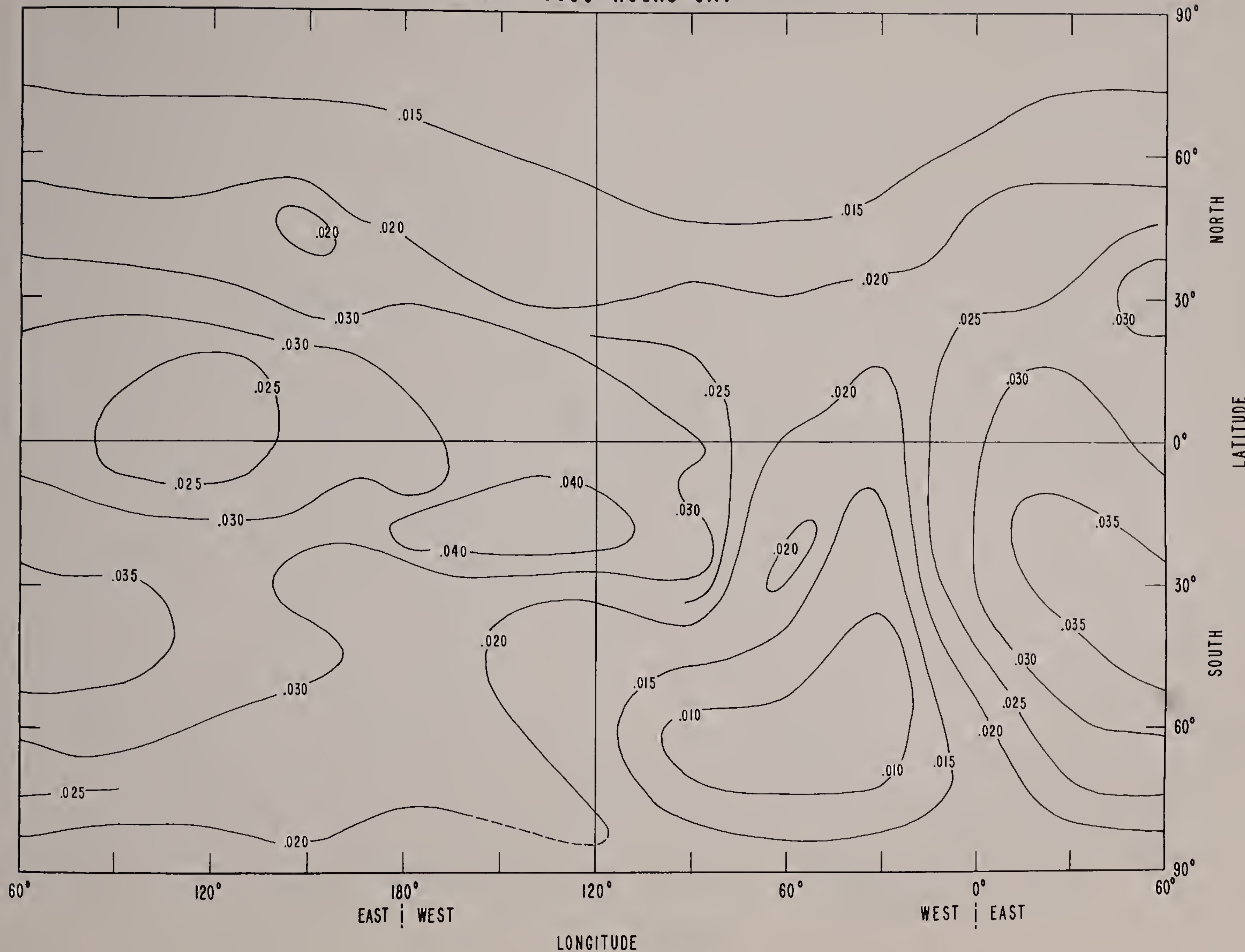
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 0400 HOURS GMT



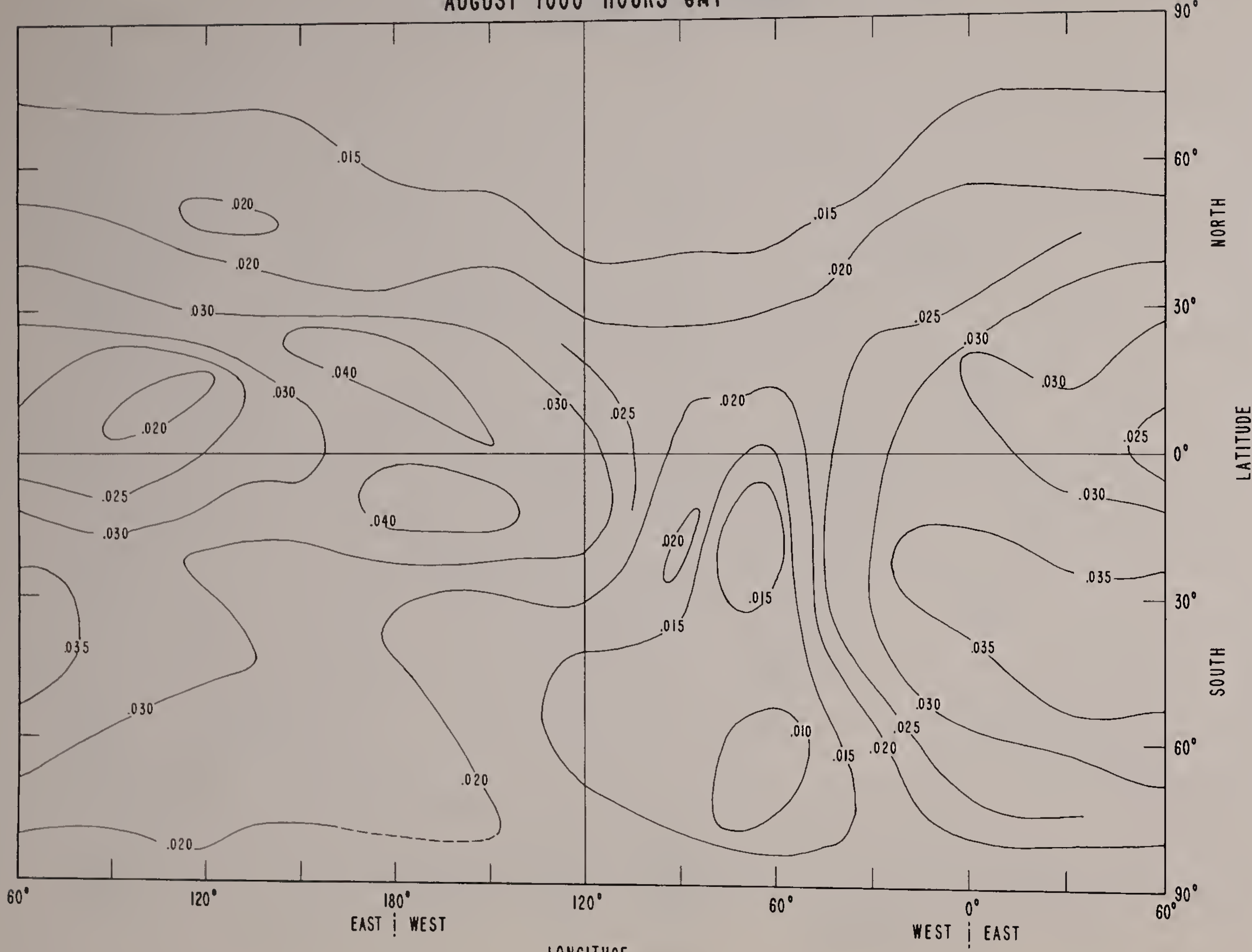
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 0600 HOURS GMT



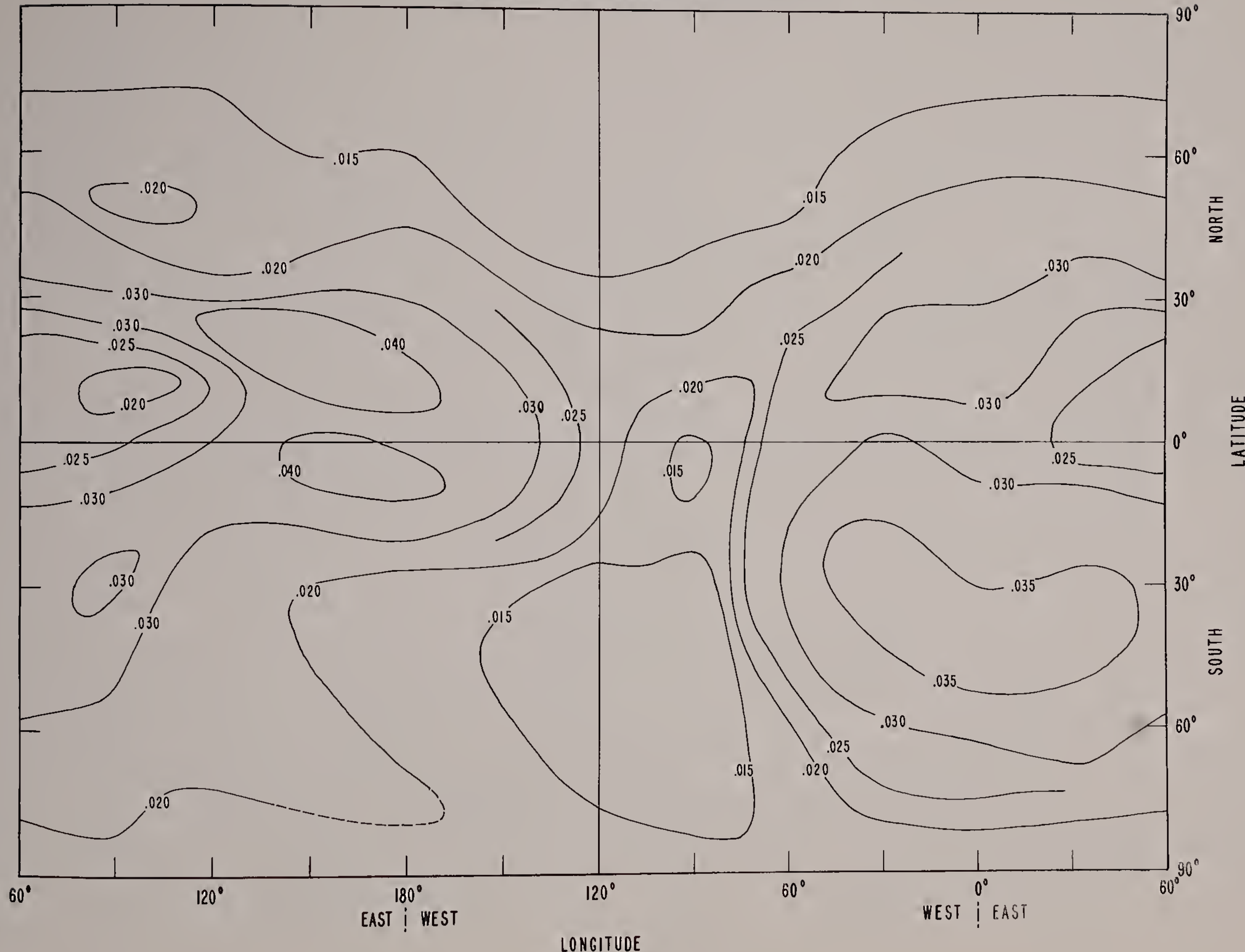
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 0800 HOURS GMT



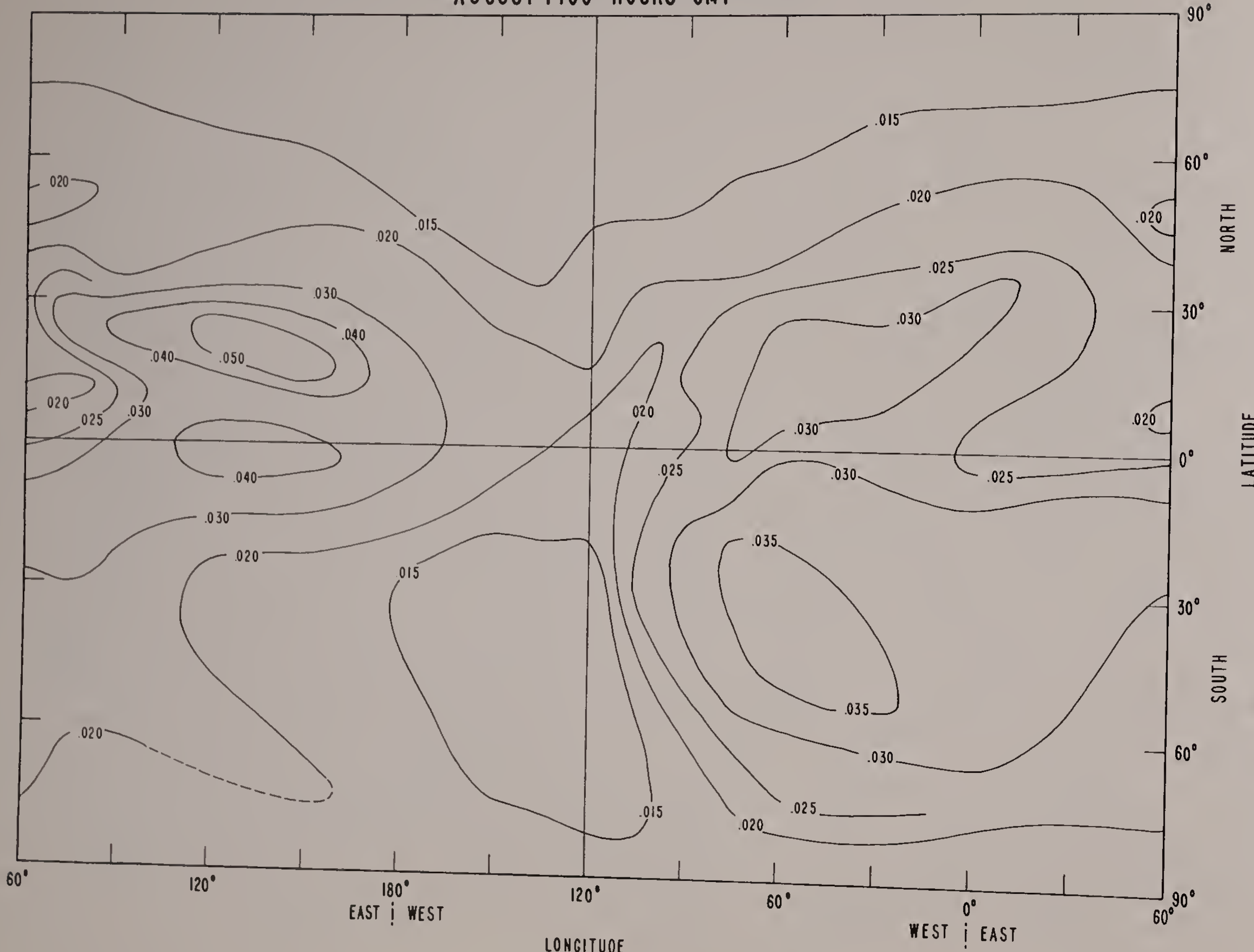
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 1000 HOURS GMT



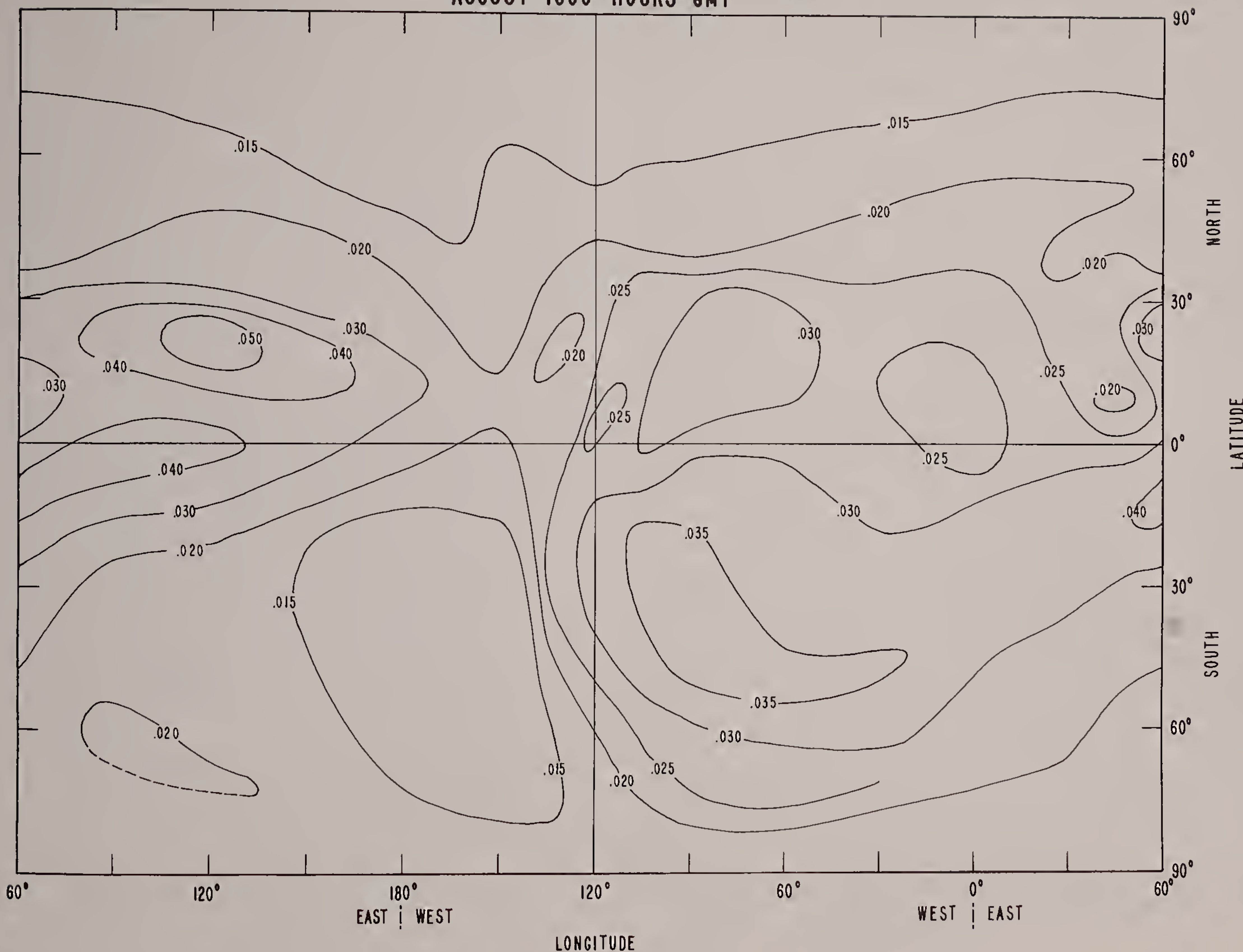
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 1200 HOURS GMT



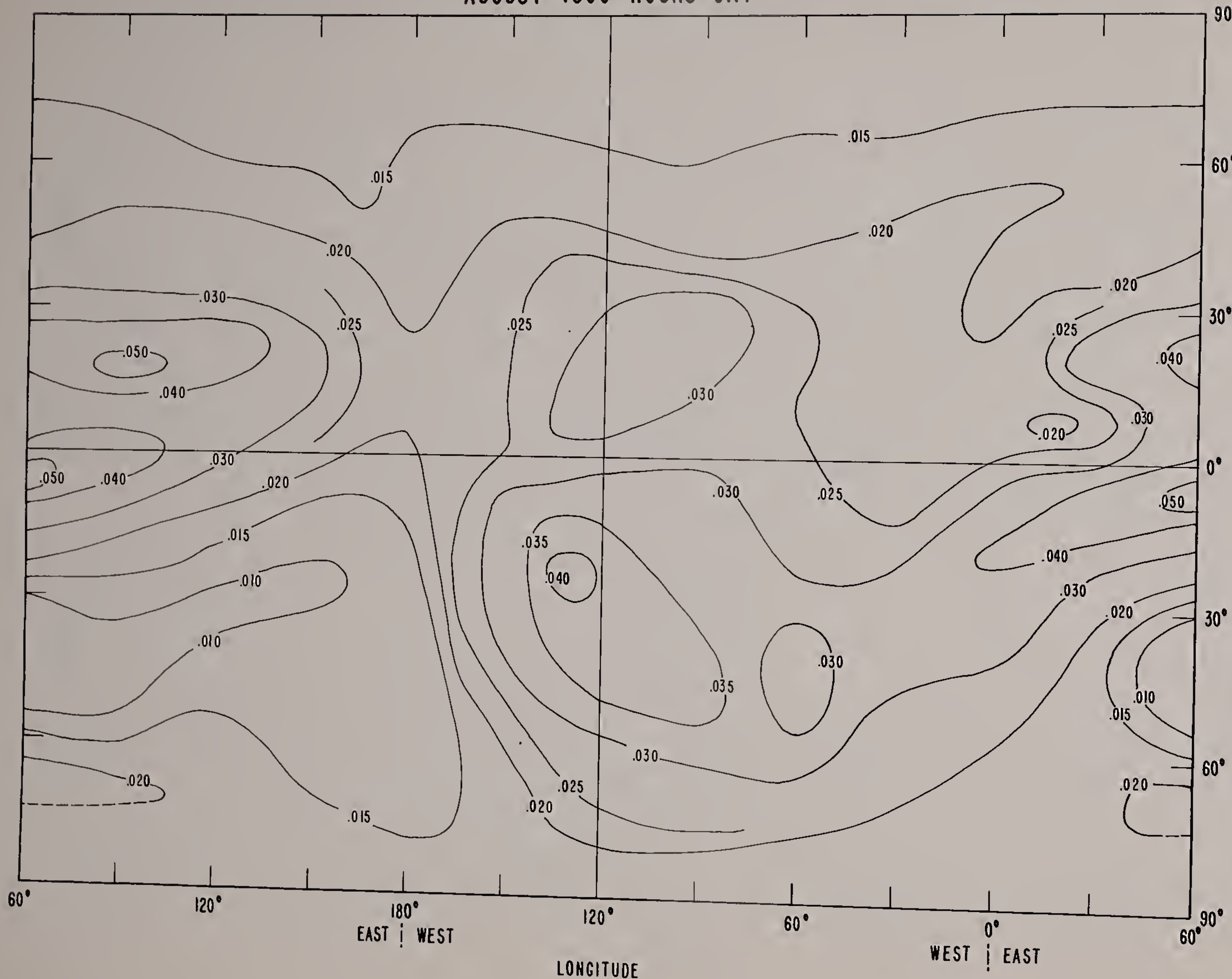
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 1400 HOURS GMT



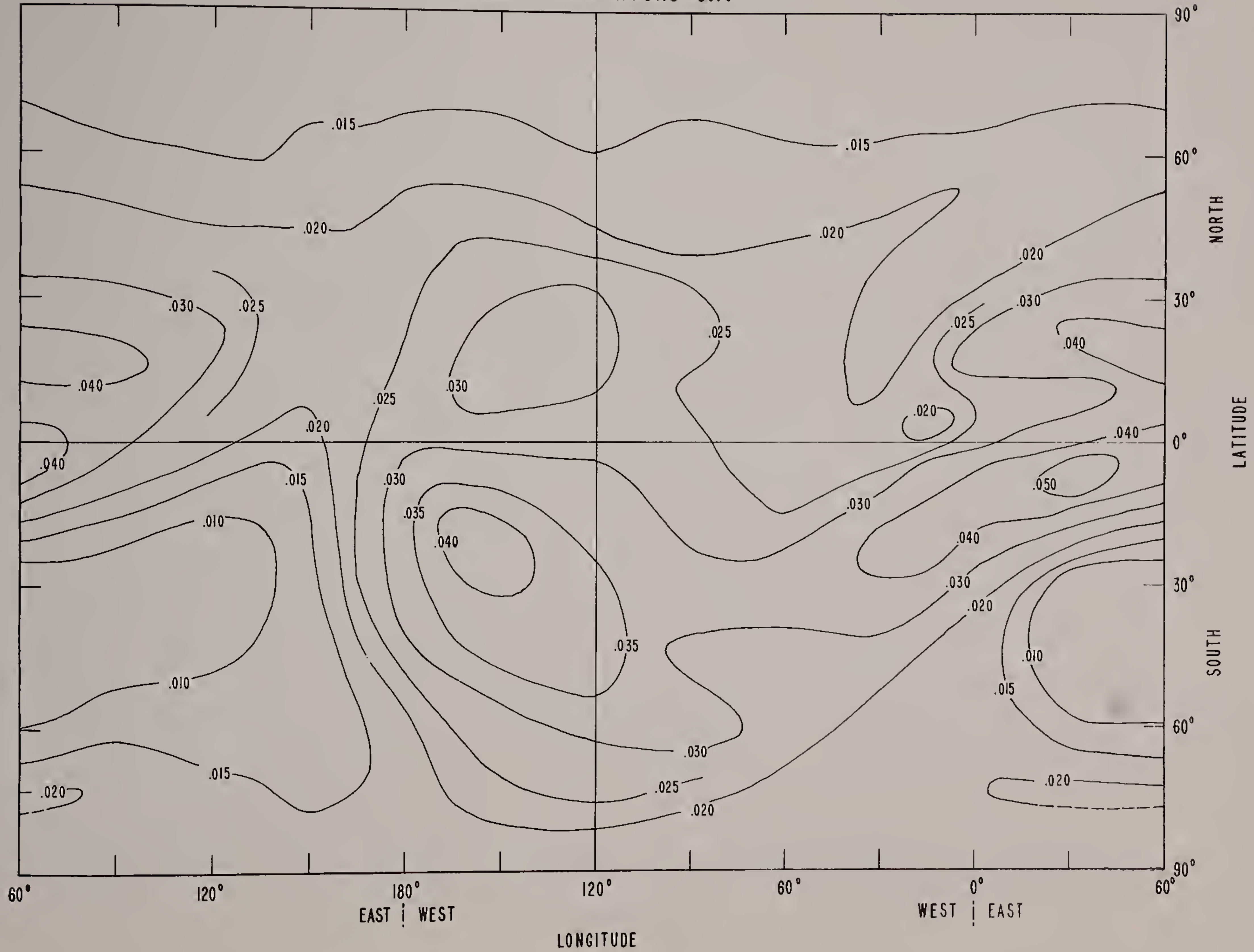
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 1600 HOURS GMT



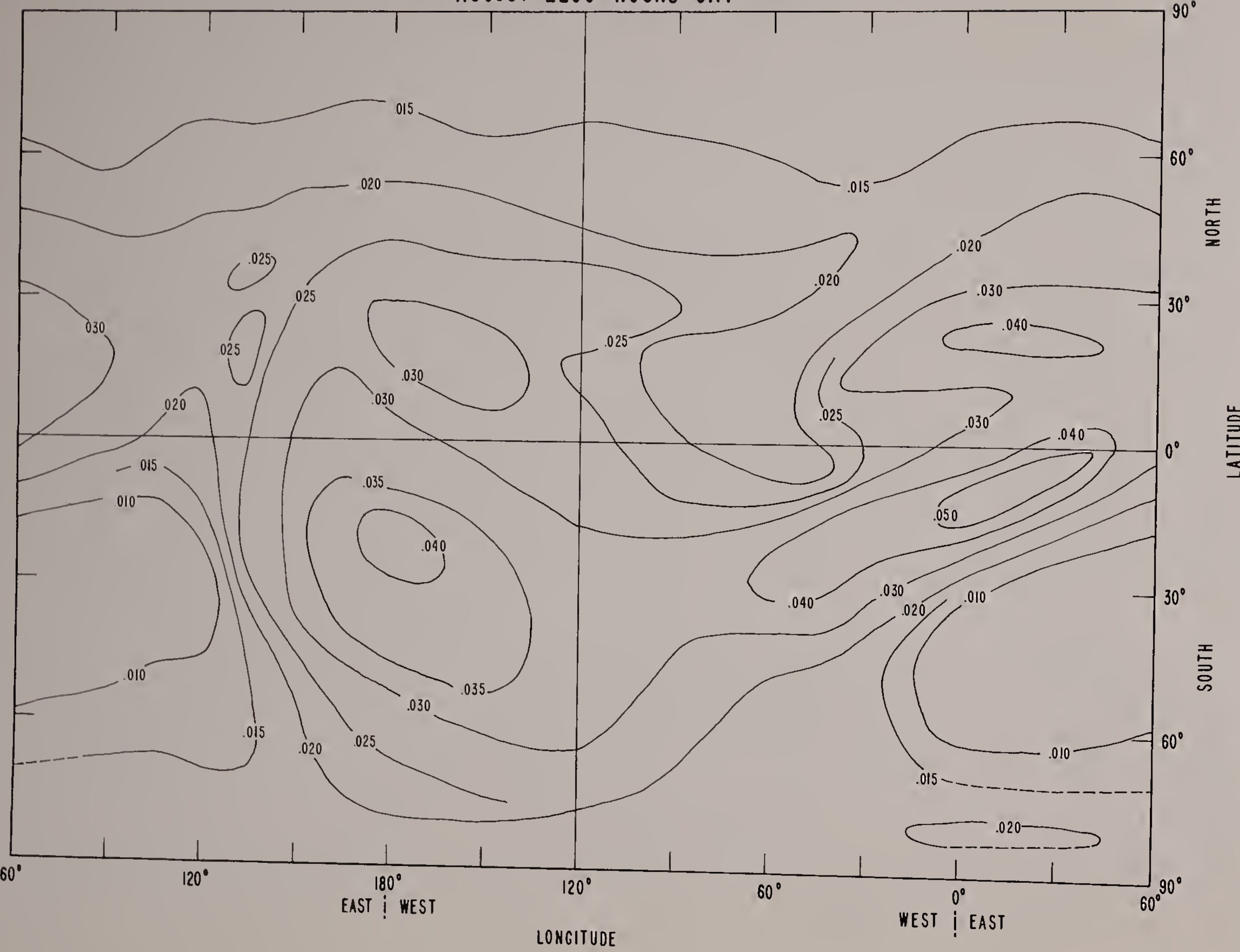
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 1800 HOURS GMT



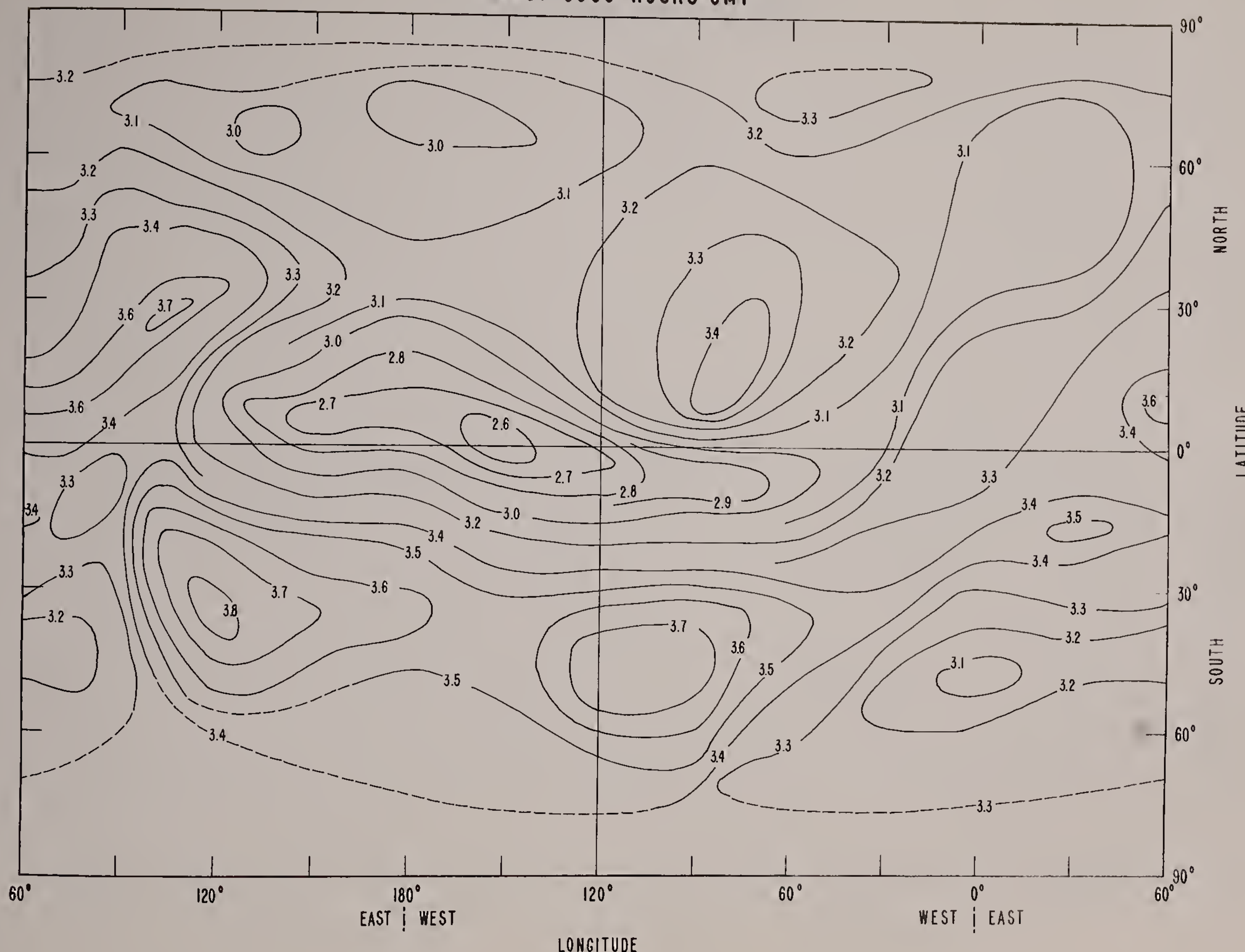
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 2000 HOURS GMT



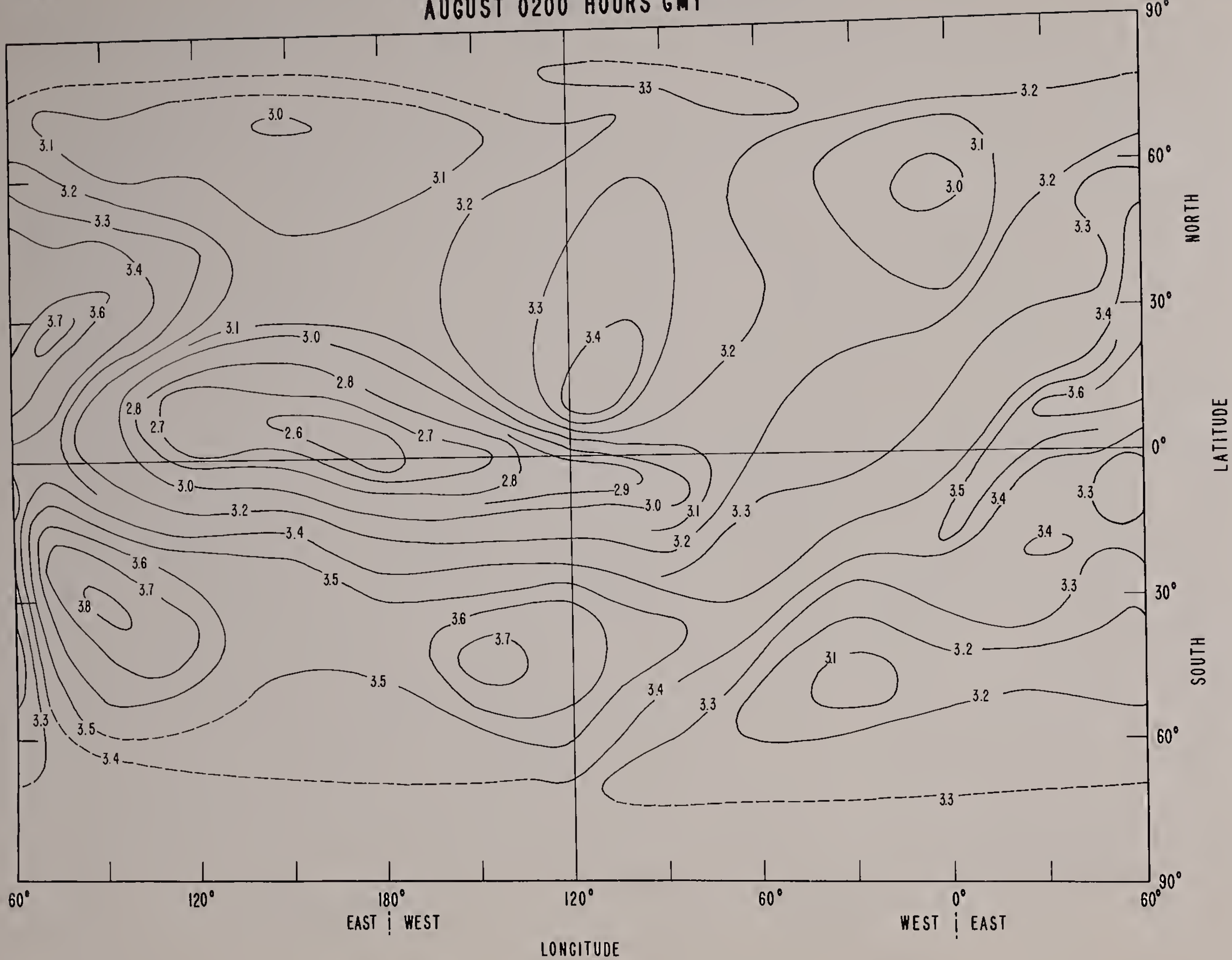
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
AUGUST 2200 HOURS GMT



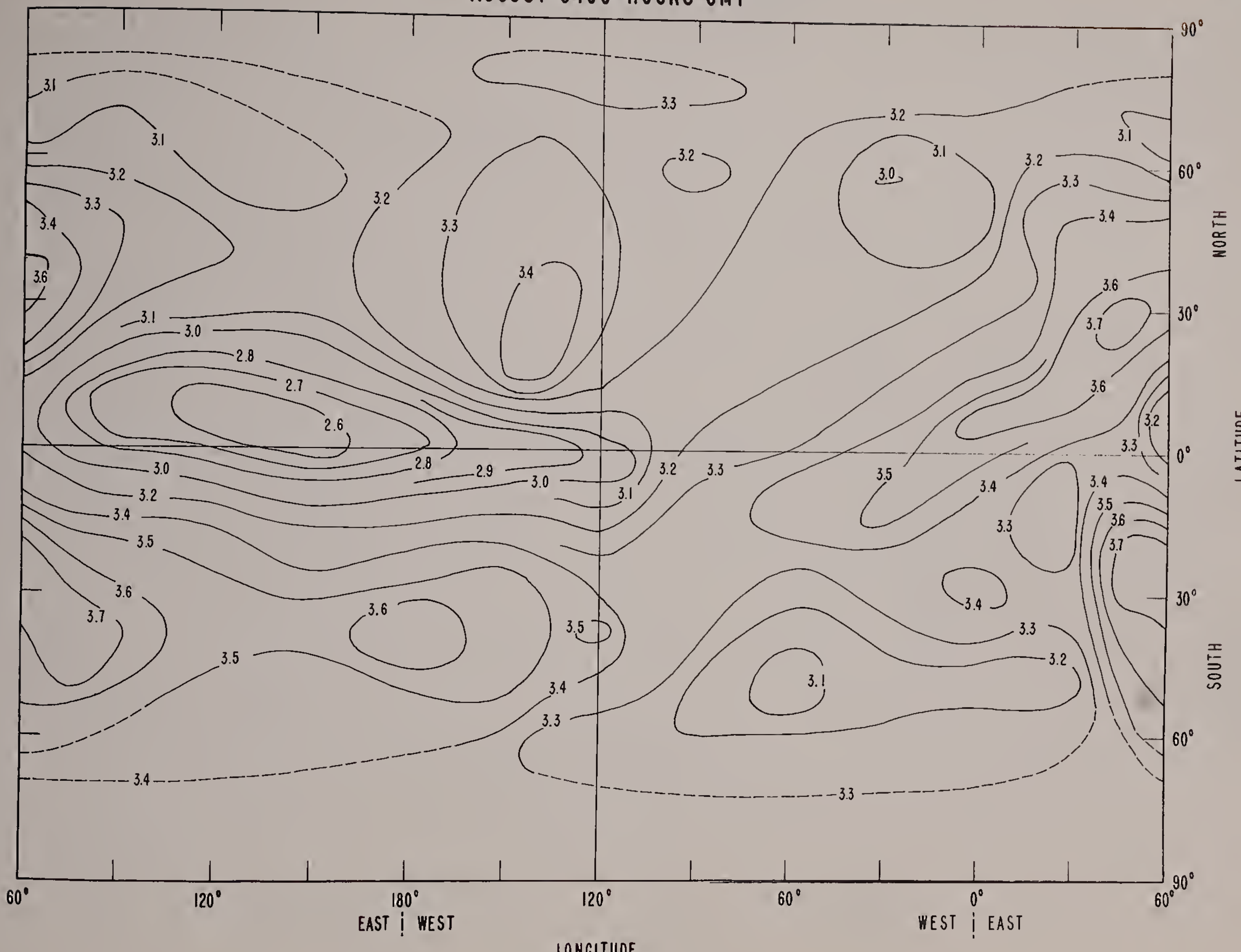
M—4000 FACTOR AT RASSN 50
AUGUST 0000 HOURS GMT



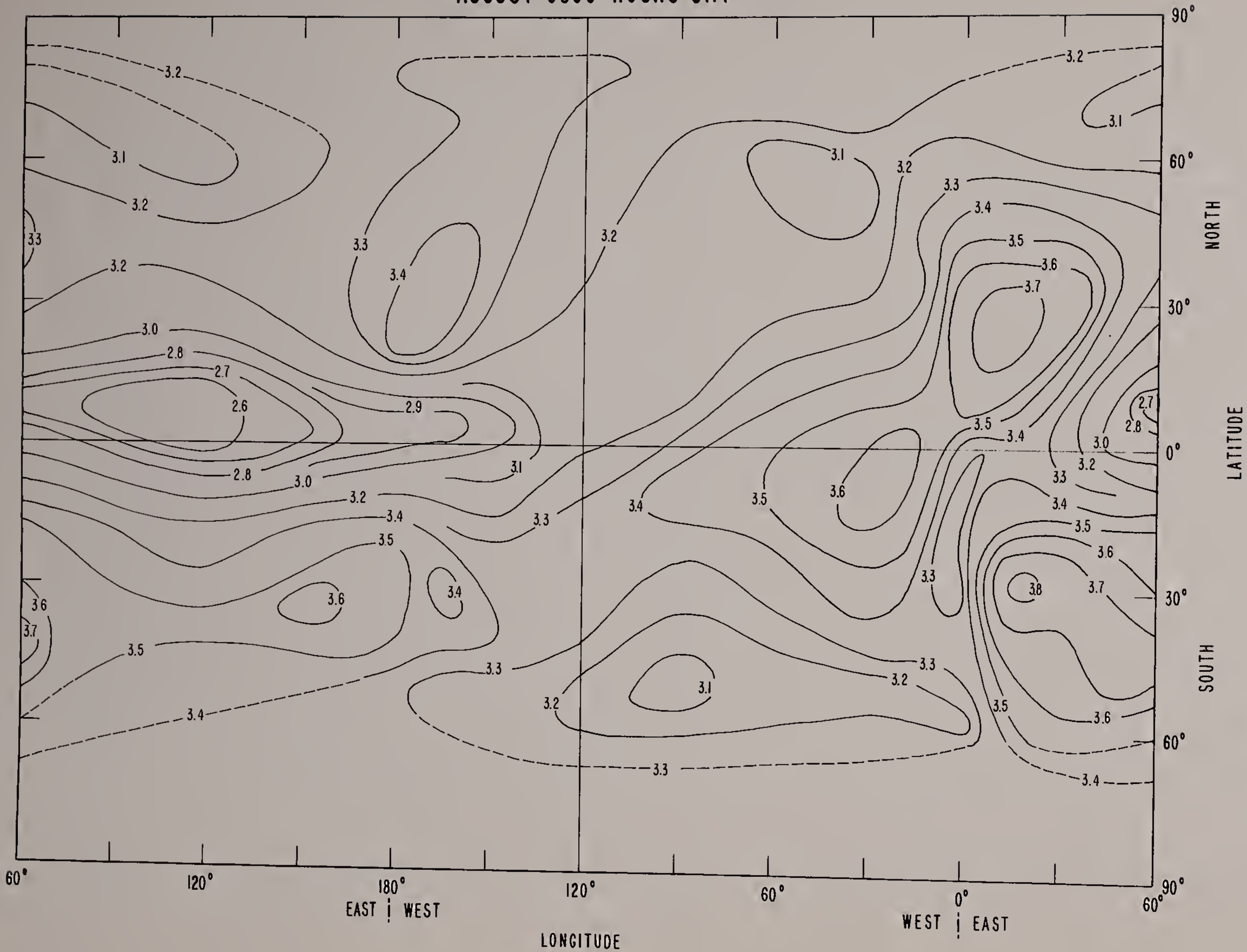
M – 4000 FACTOR AT RASSN 50
AUGUST 0200 HOURS GMT



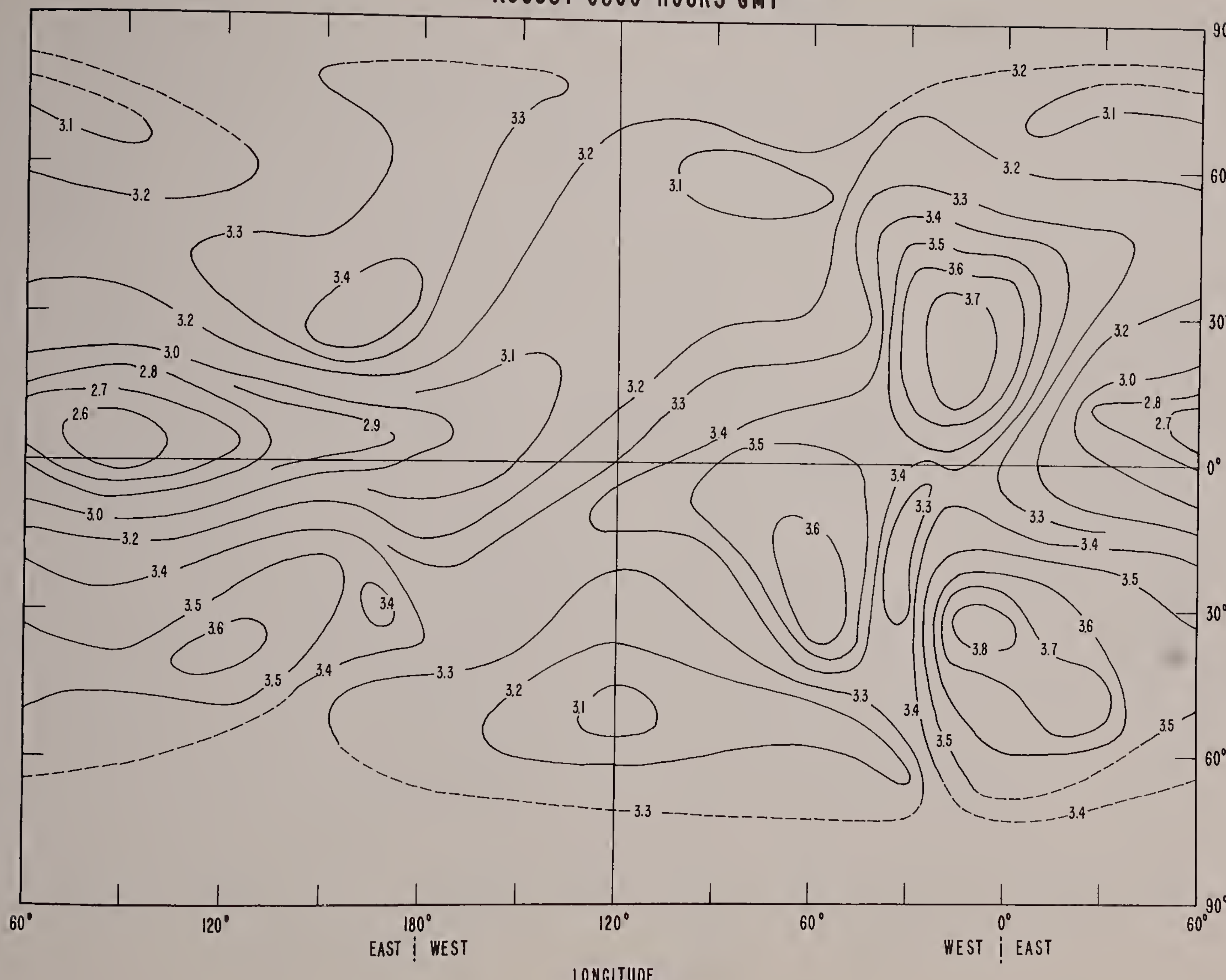
M — 4000 FACTOR AT RASSN 50
AUGUST 0400 HOURS GMT



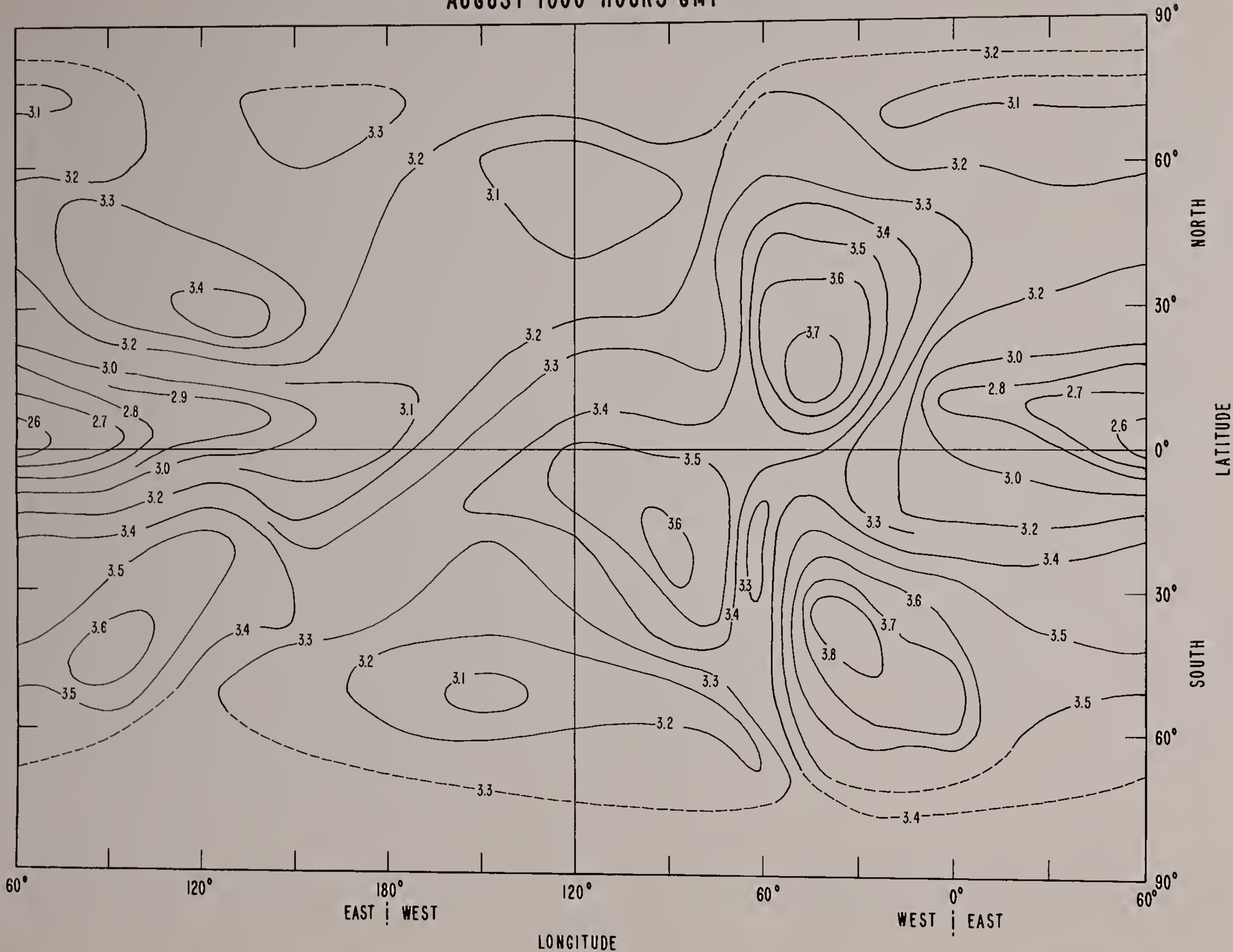
M — 4000 FACTOR AT RASSN 50
AUGUST 0600 HOURS GMT



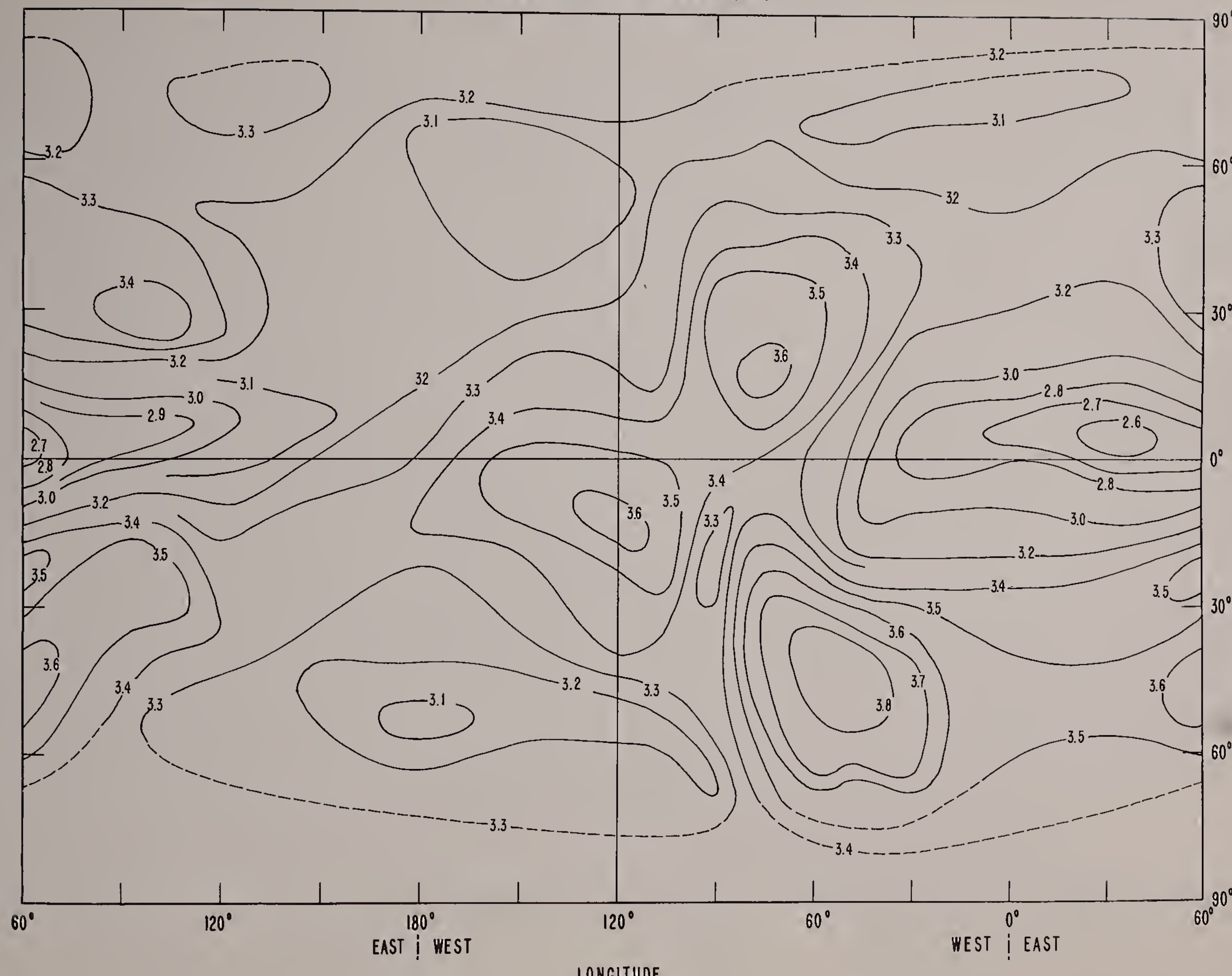
M — 4000 FACTOR AT RASSN 50
AUGUST 0800 HOURS GMT



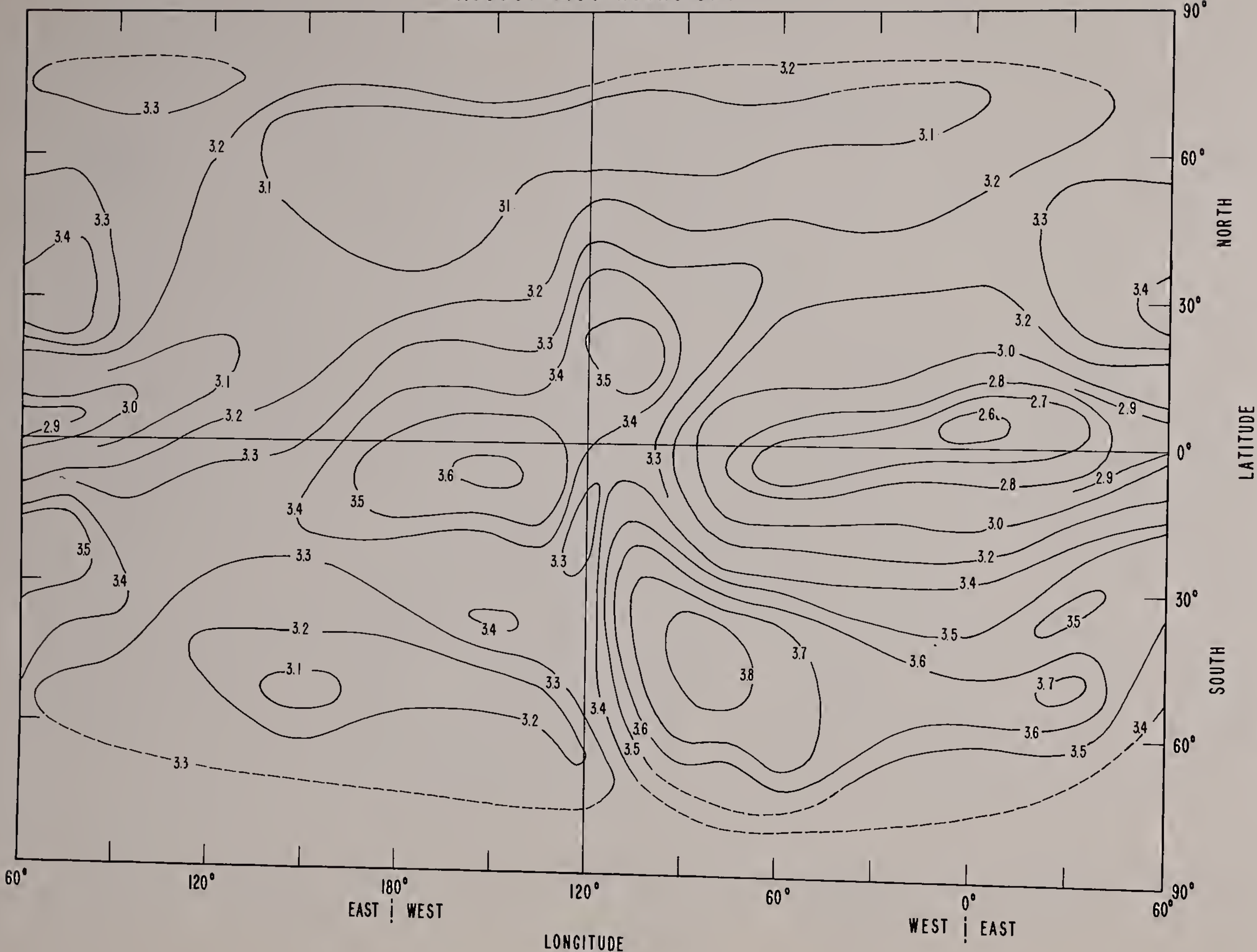
M — 4000 FACTOR AT RASSN 50
AUGUST 1000 HOURS GMT



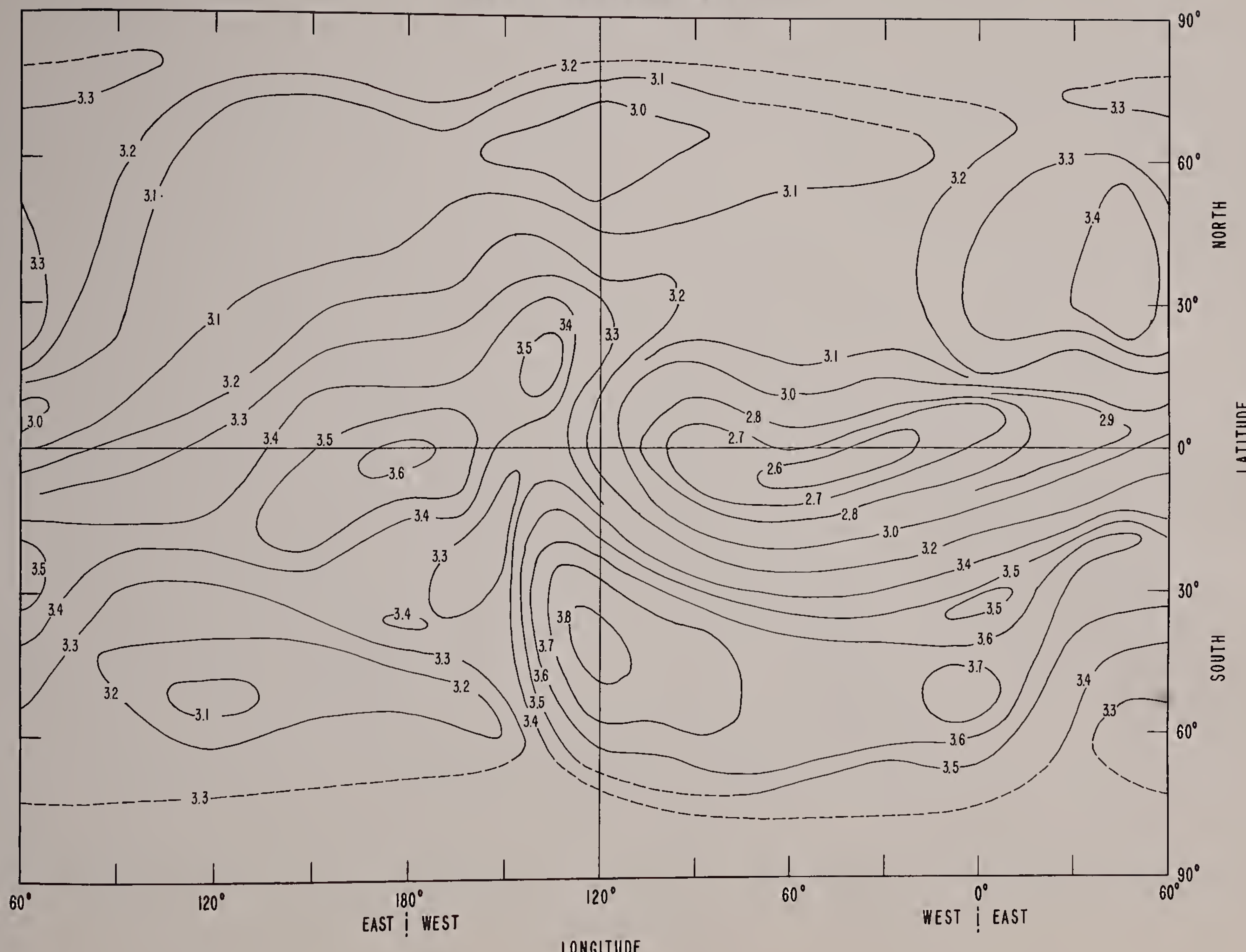
M — 4000 FACTOR AT RASSN 50
AUGUST 1200 HOURS GMT



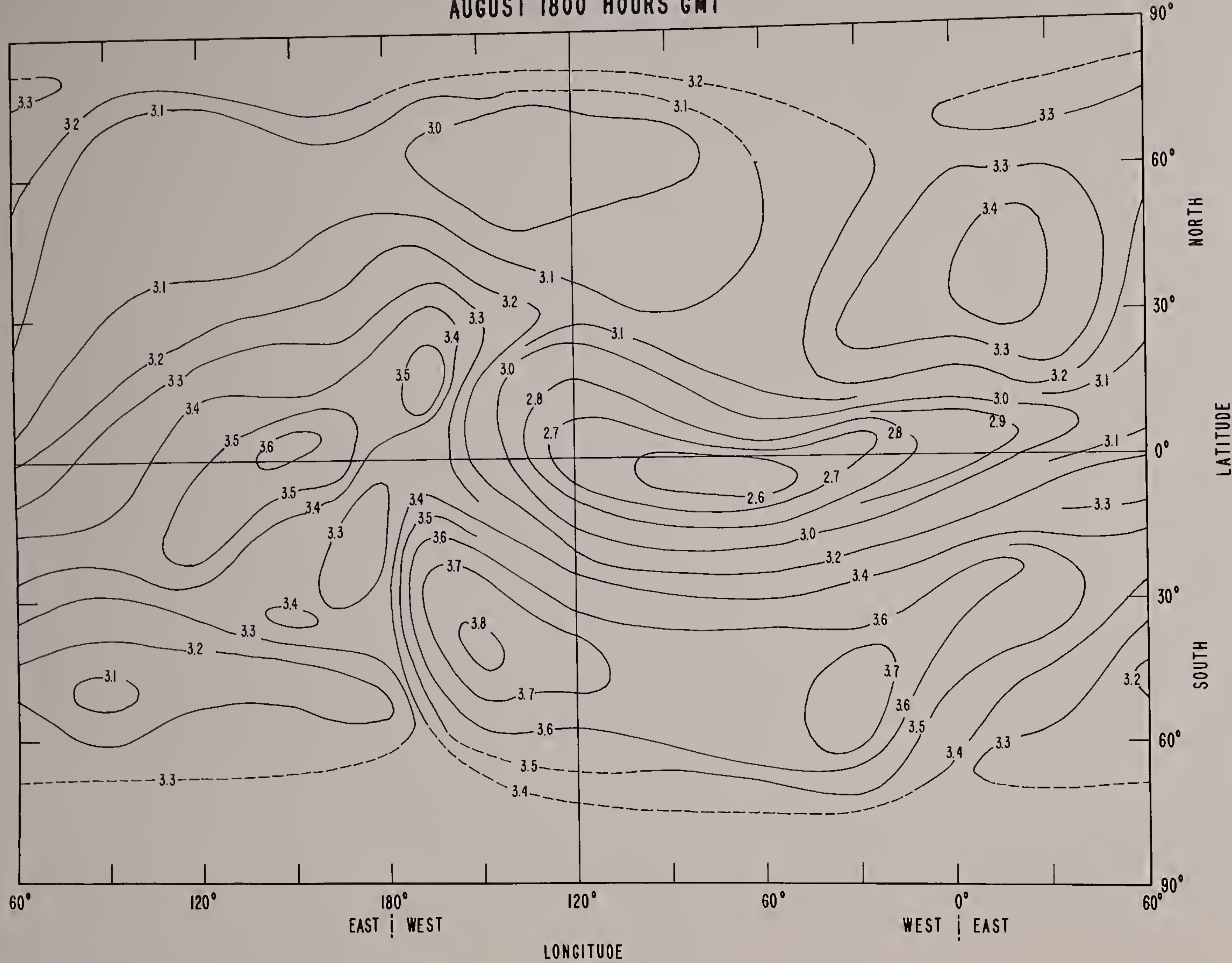
M – 4000 FACTOR AT RASSN 50
AUGUST 1400 HOURS GMT



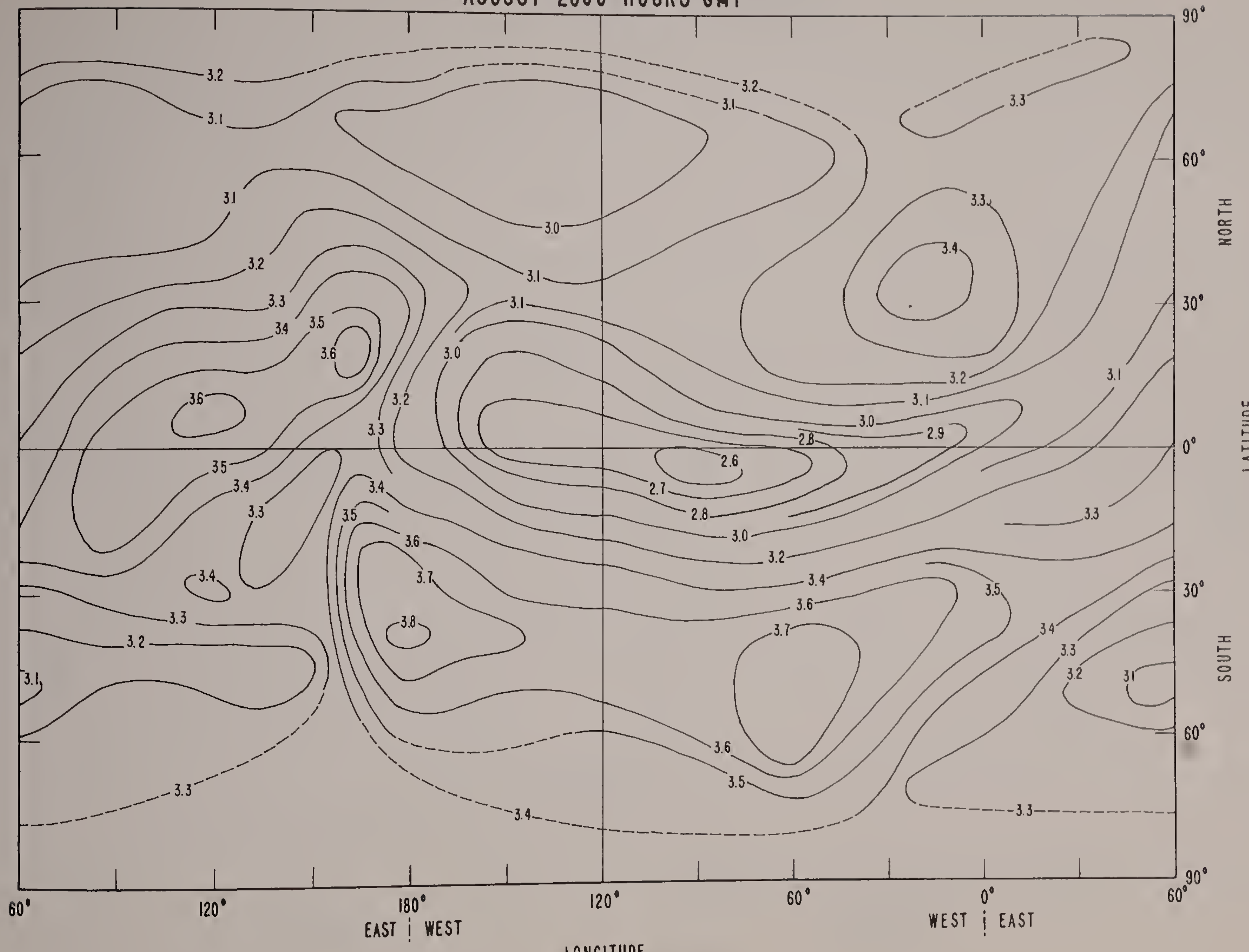
M — 4000 FACTOR AT RASSN 50
AUGUST 1600 HOURS GMT



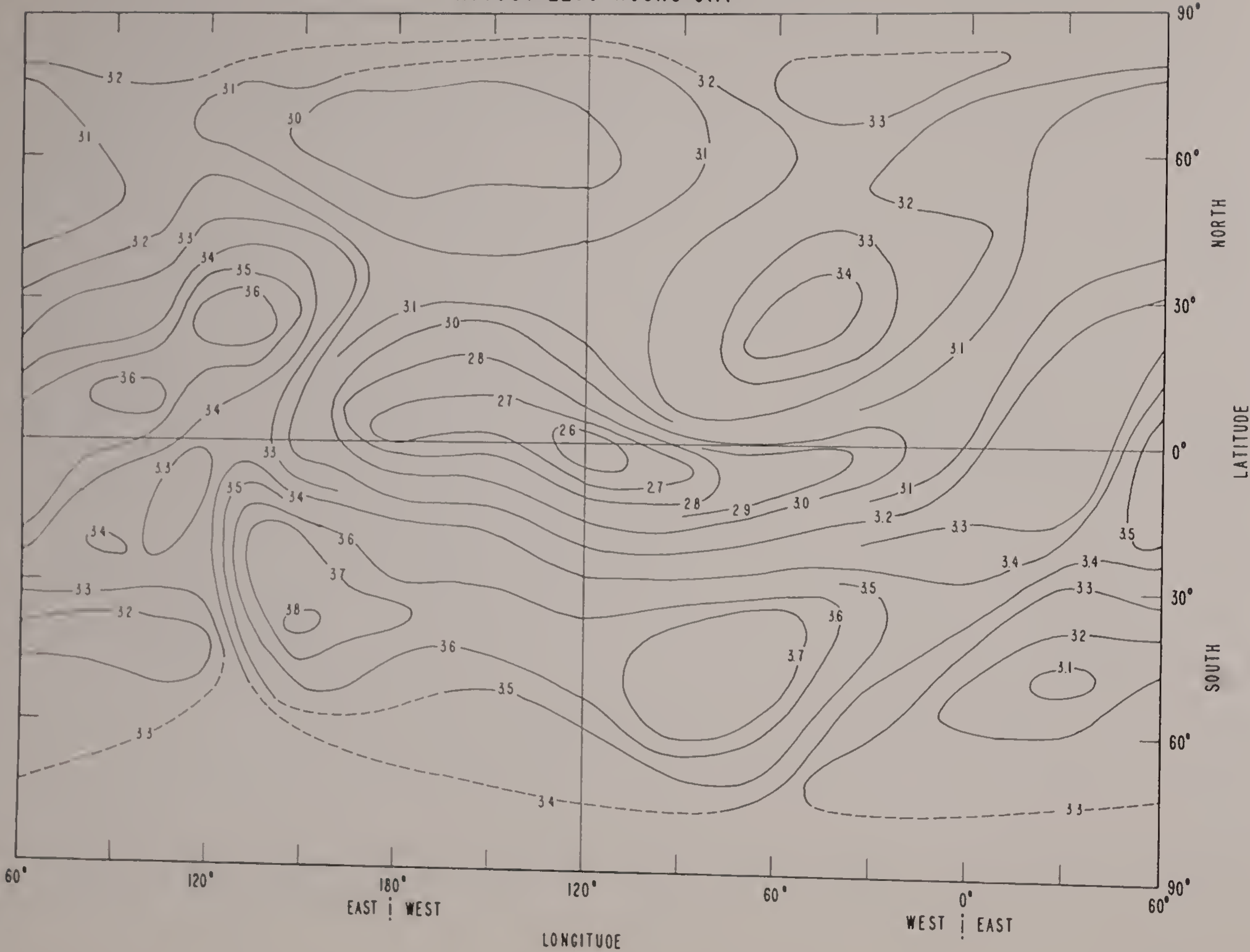
M — 4000 FACTOR AT RASSN 50
AUGUST 1800 HOURS GMT



M — 4000 FACTOR AT RASSN 50
AUGUST 2000 HOURS GMT

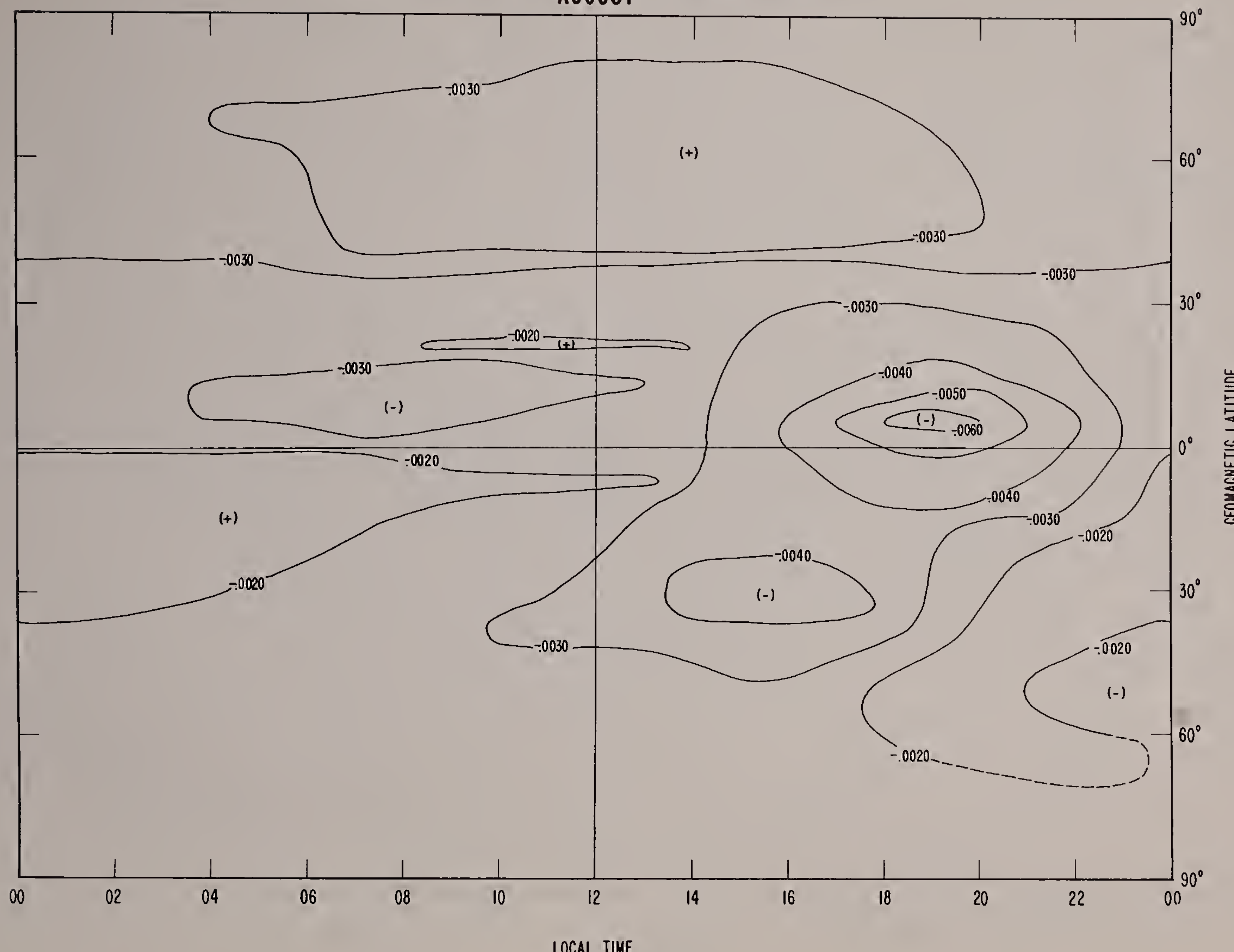


M — 4000 FACTOR AT RASSN 50
AUGUST 2200 HOURS GMT

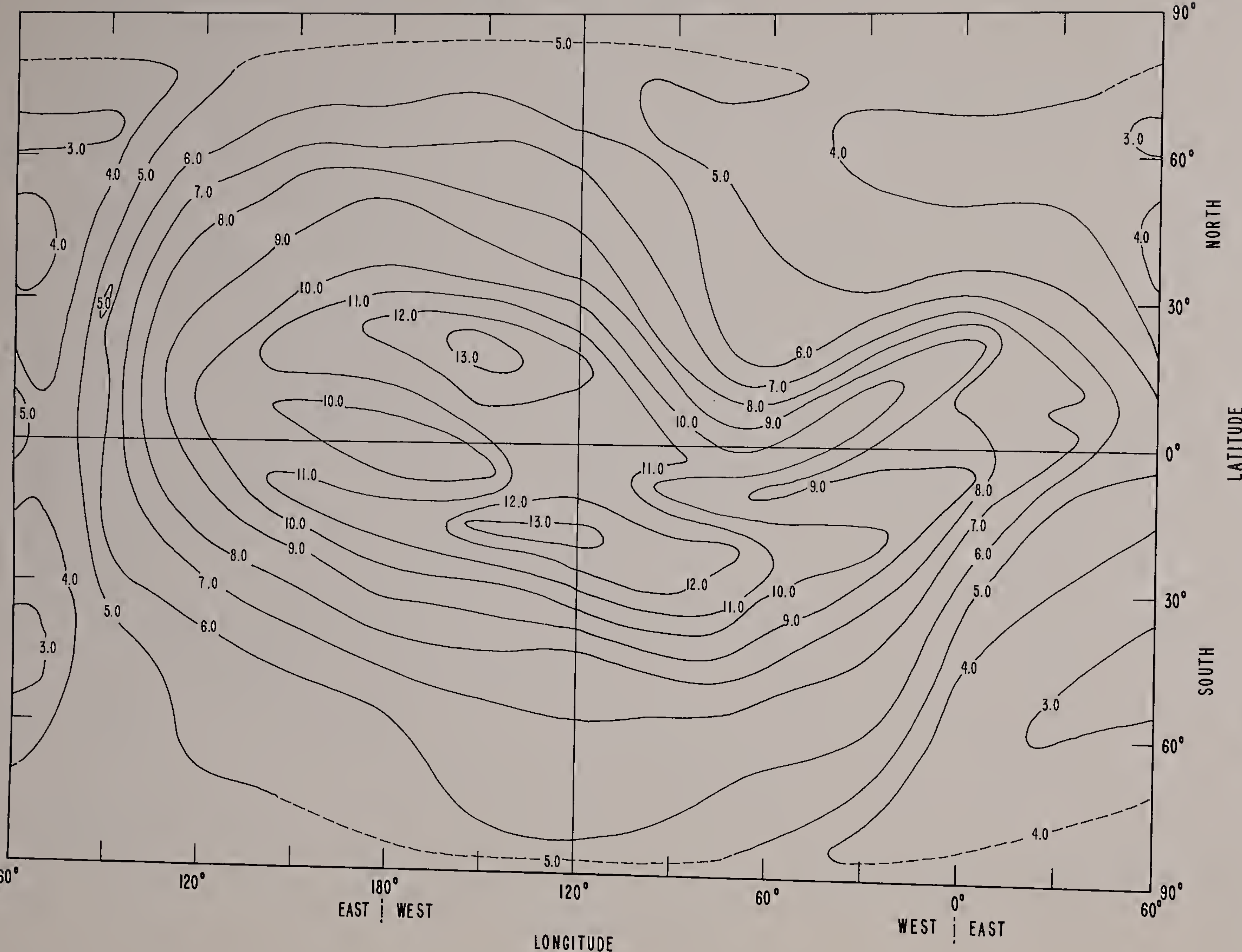


SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN

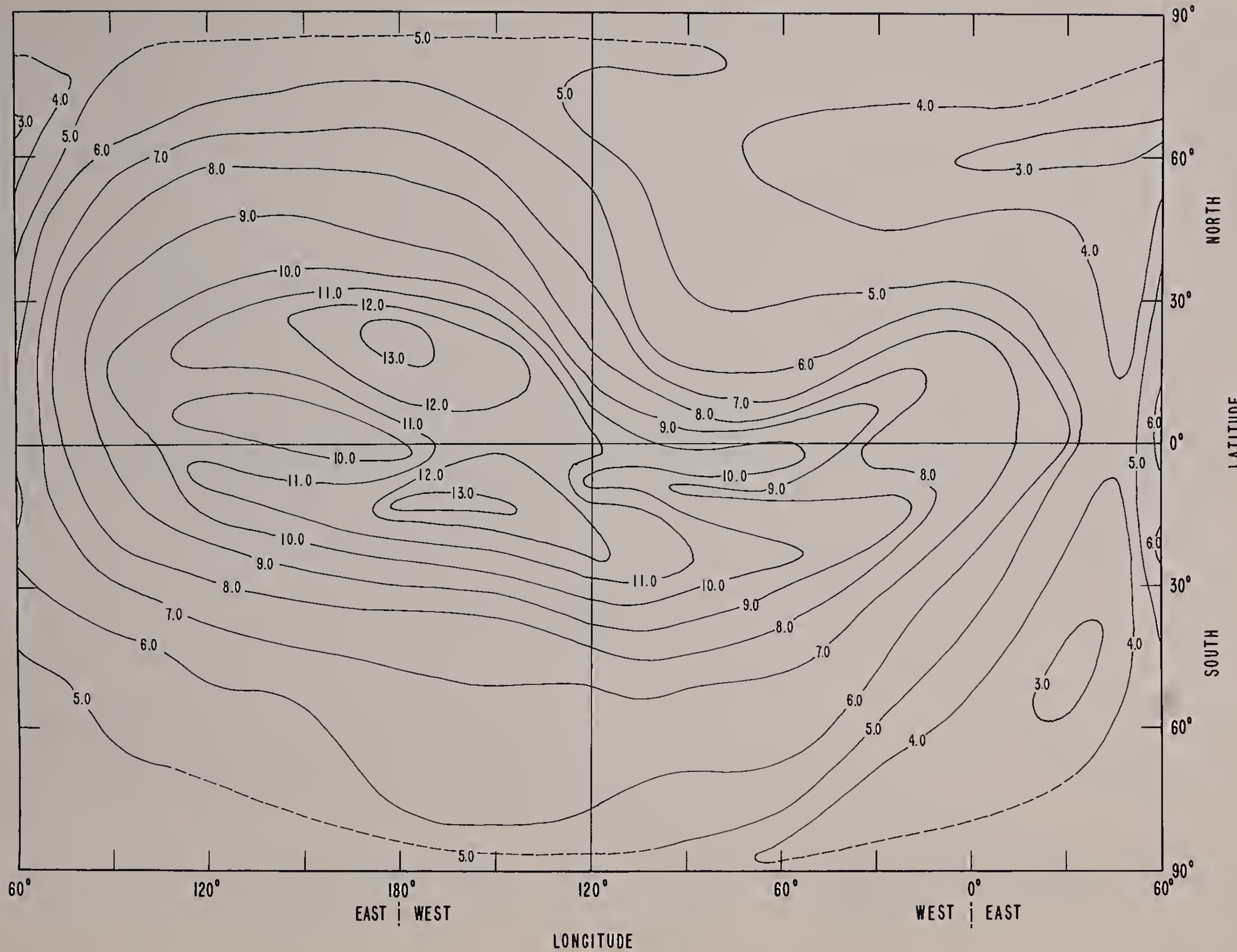
AUGUST



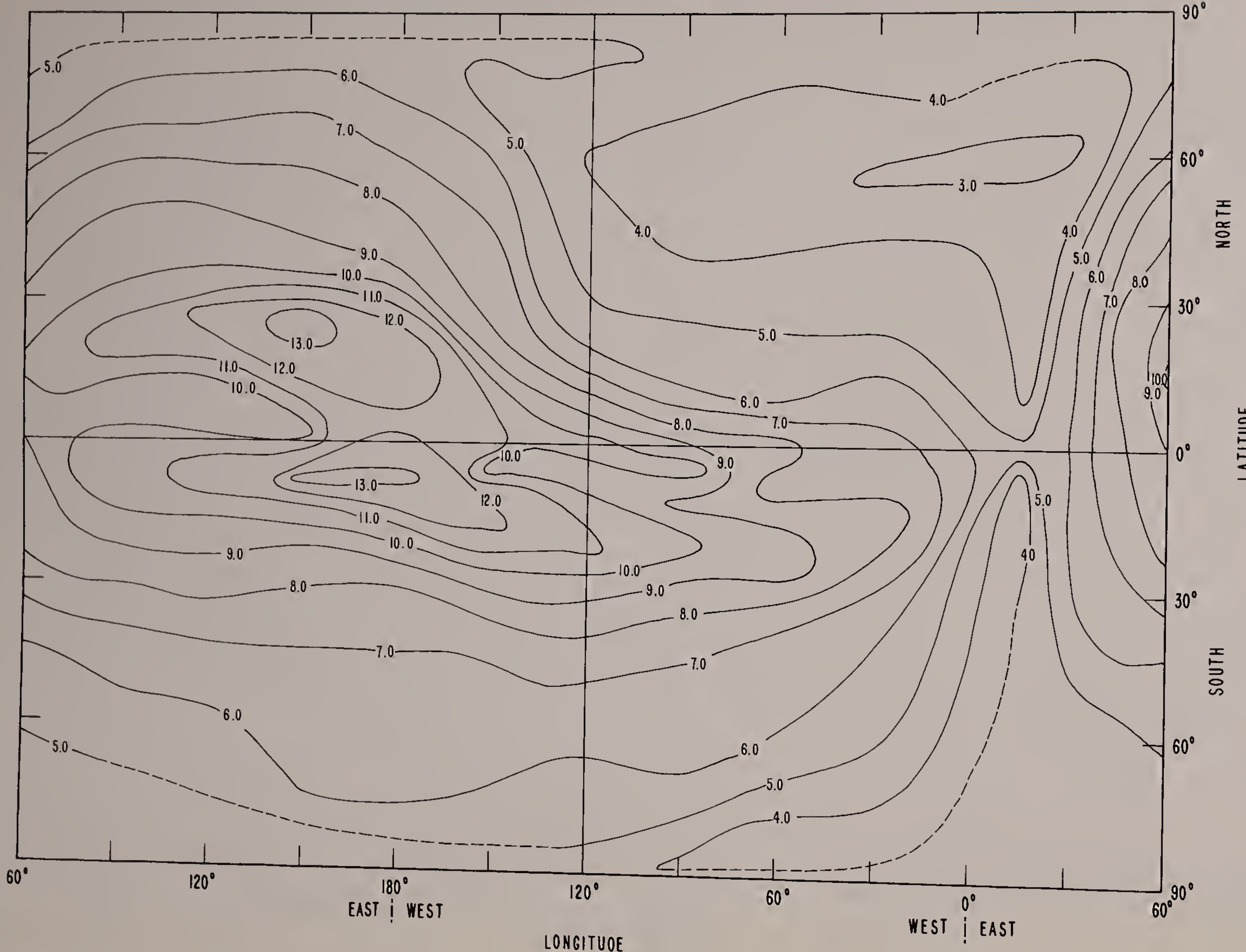
f_oF2 AT RASSN 50
OCTOBER 0000 HOURS GMT



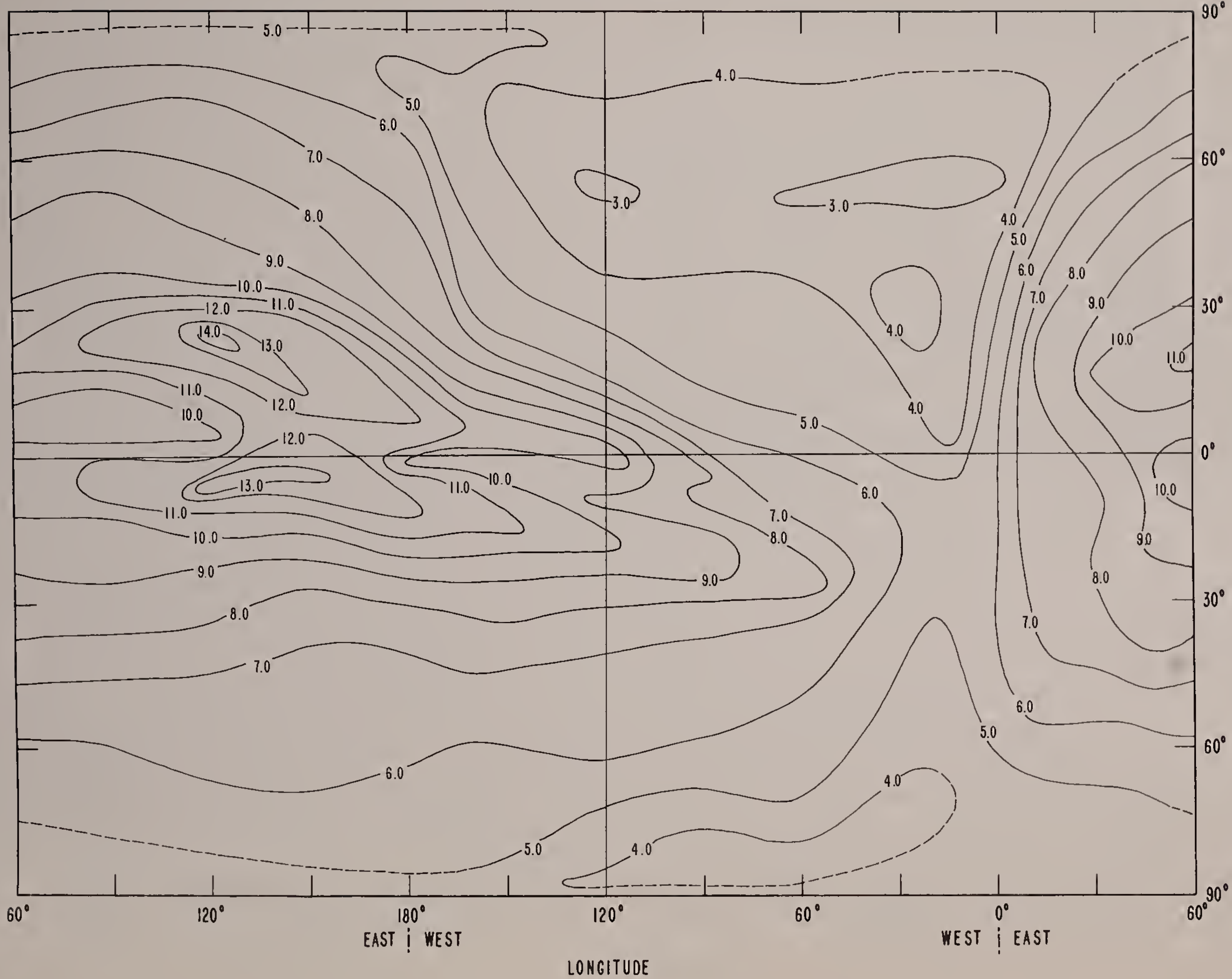
f_oF2 AT RASSN 50
OCTOBER 0200 HOURS GMT



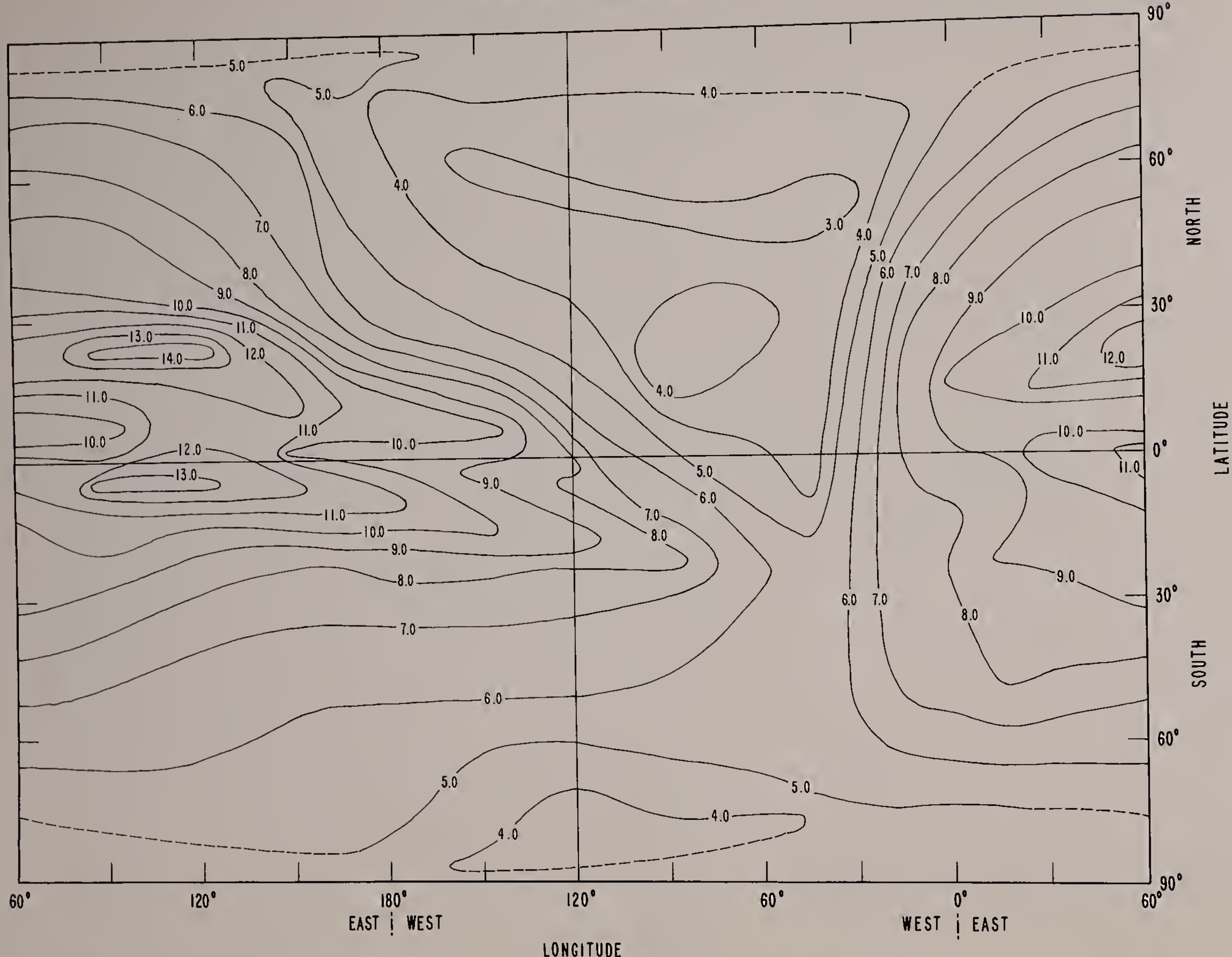
f_oF2 AT RASSN 50
OCTOBER 0400 HOURS GMT



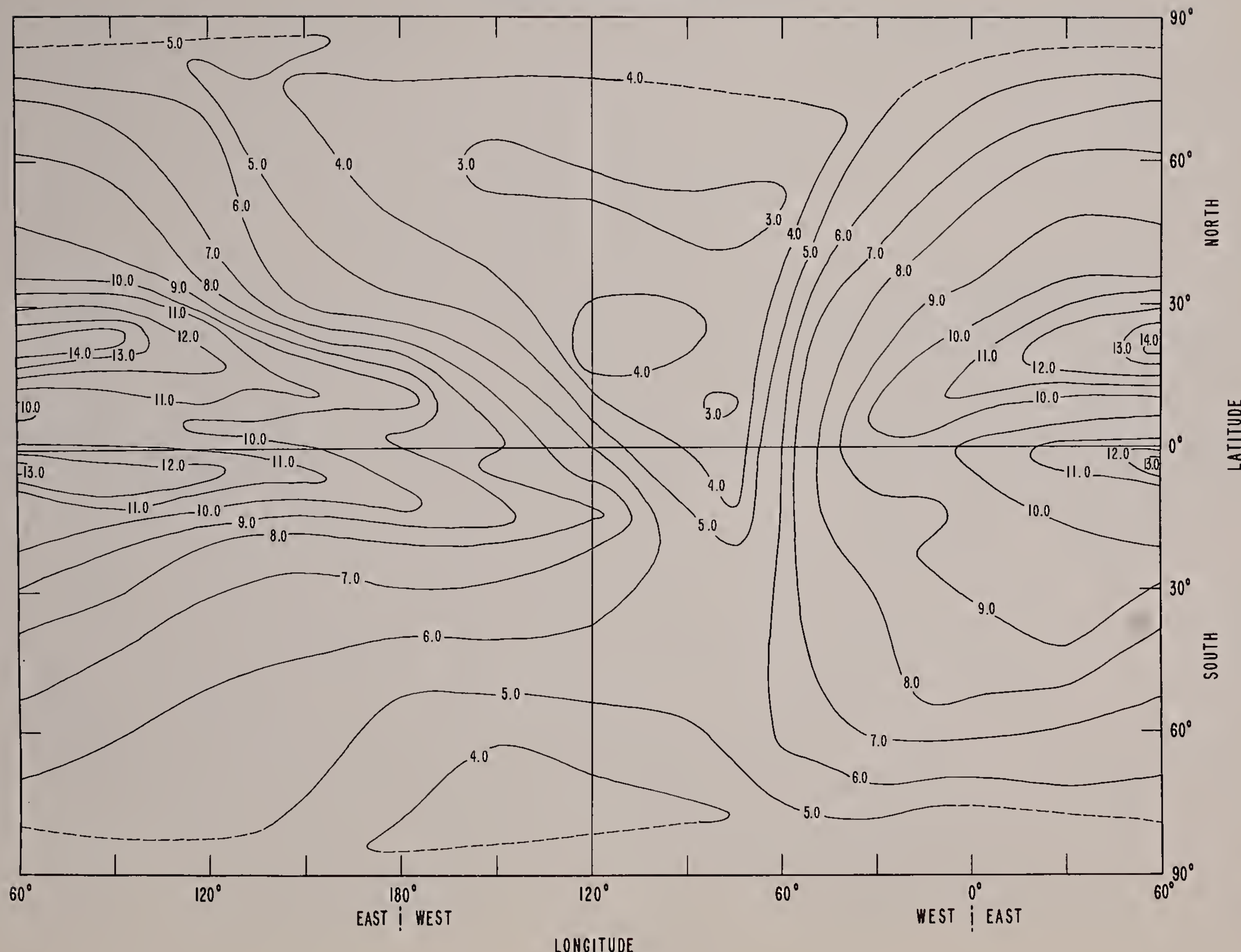
f_oF2 AT RASSN 50
OCTOBER 0600 HOURS GMT



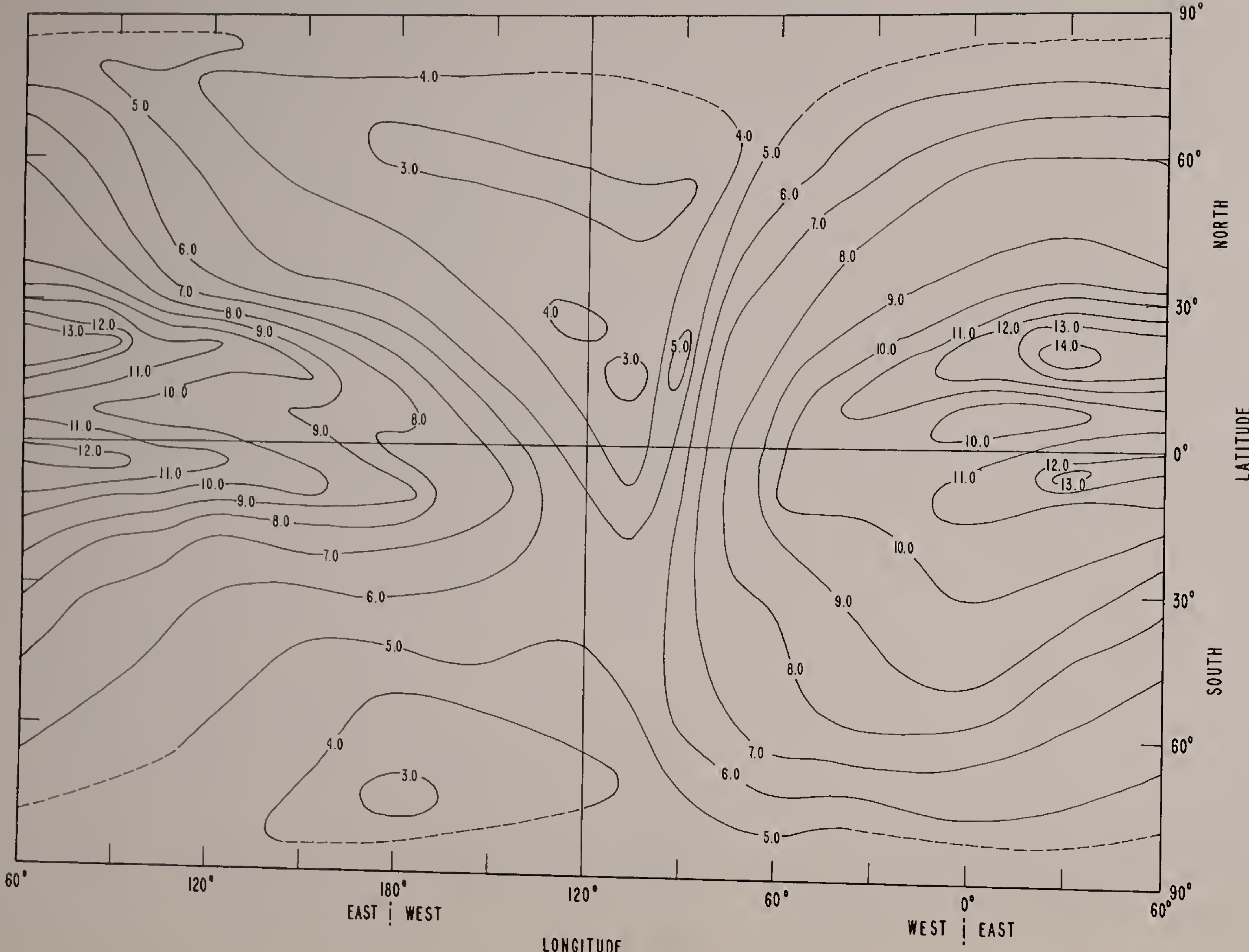
f_oF2 AT RASSN 50
OCTOBER 0800 HOURS GMT



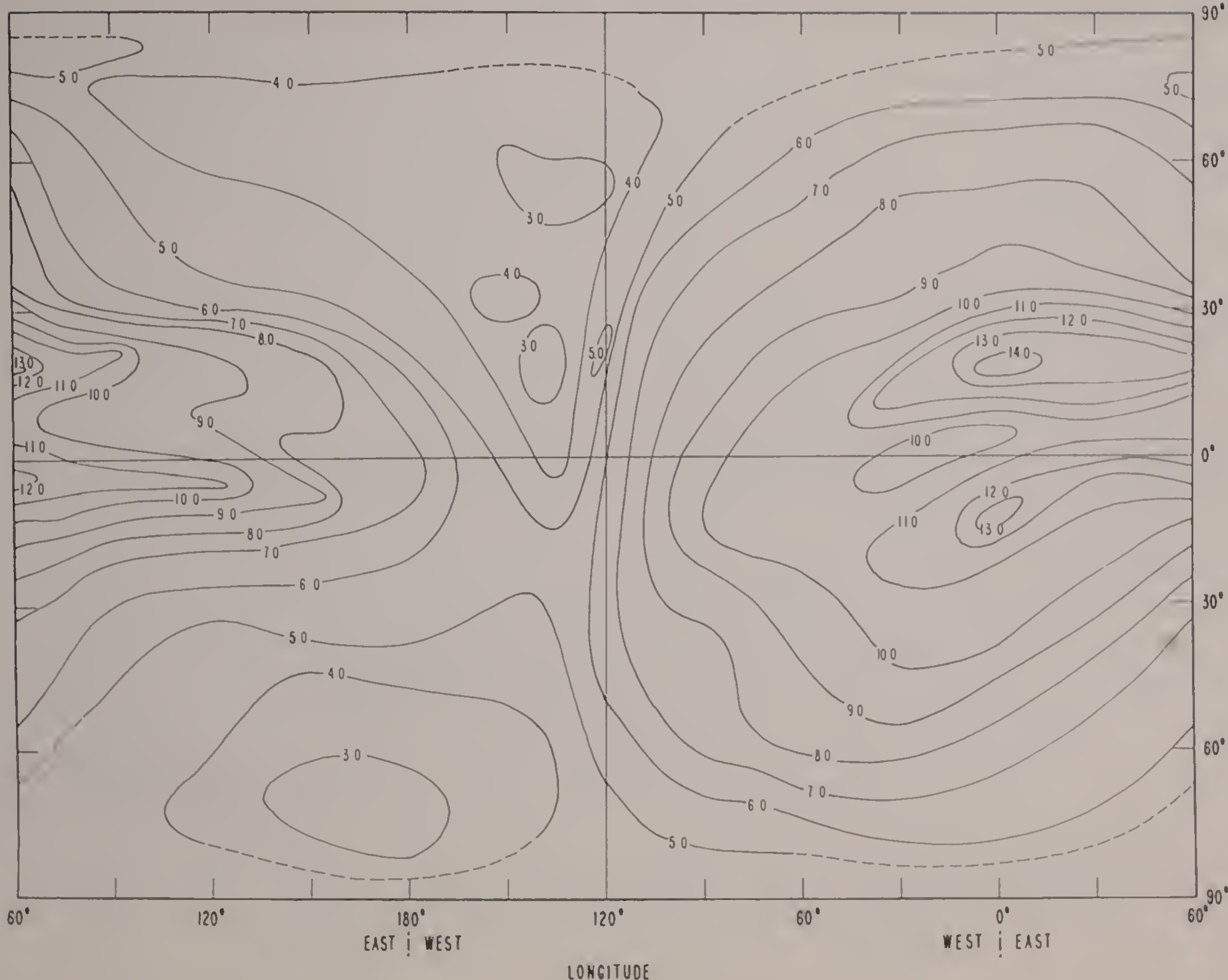
f₀F2 AT RASSN 50
OCTOBER 1000 HOURS GMT



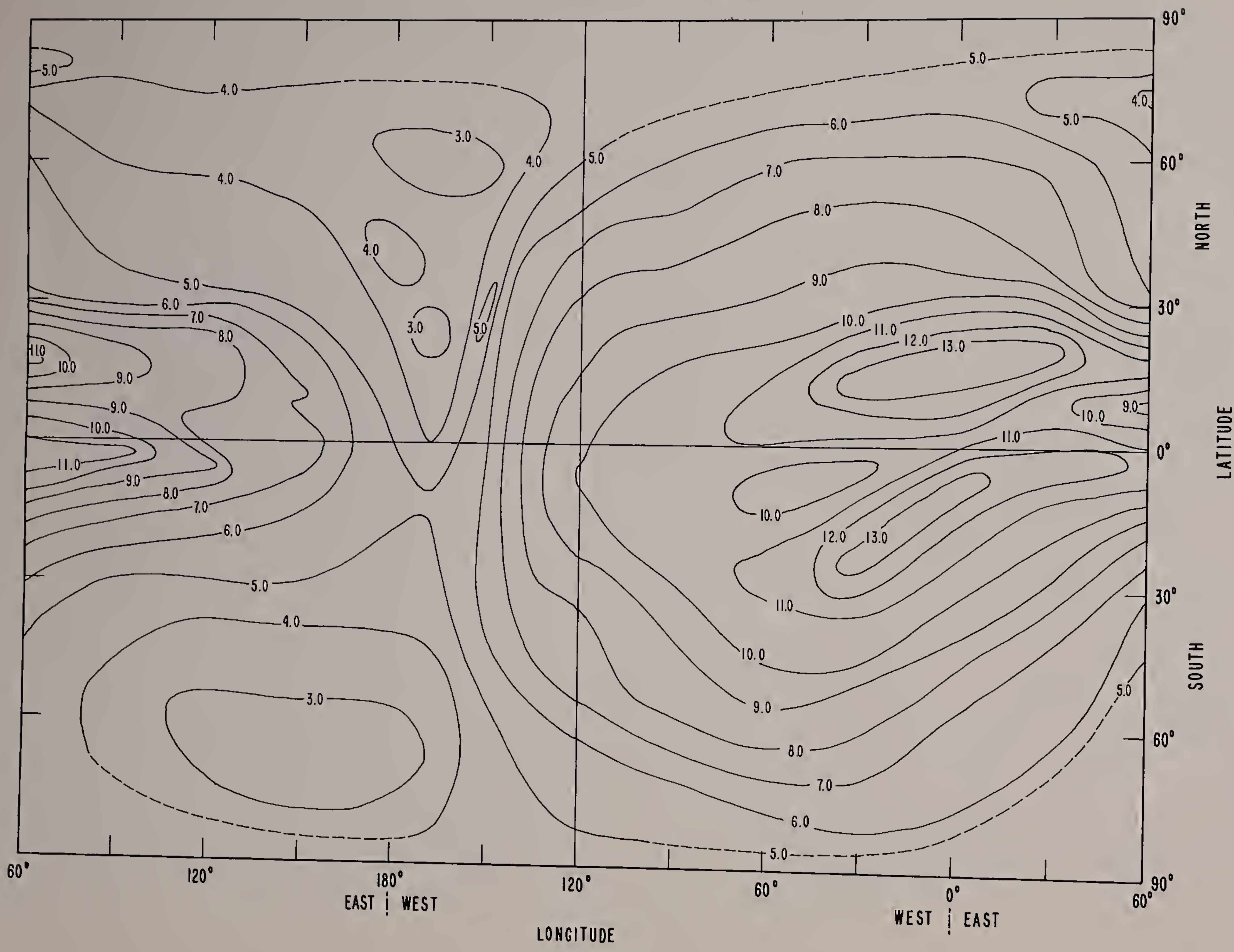
f_oF2 AT RASSN 50
OCTOBER 1200 HOURS GMT



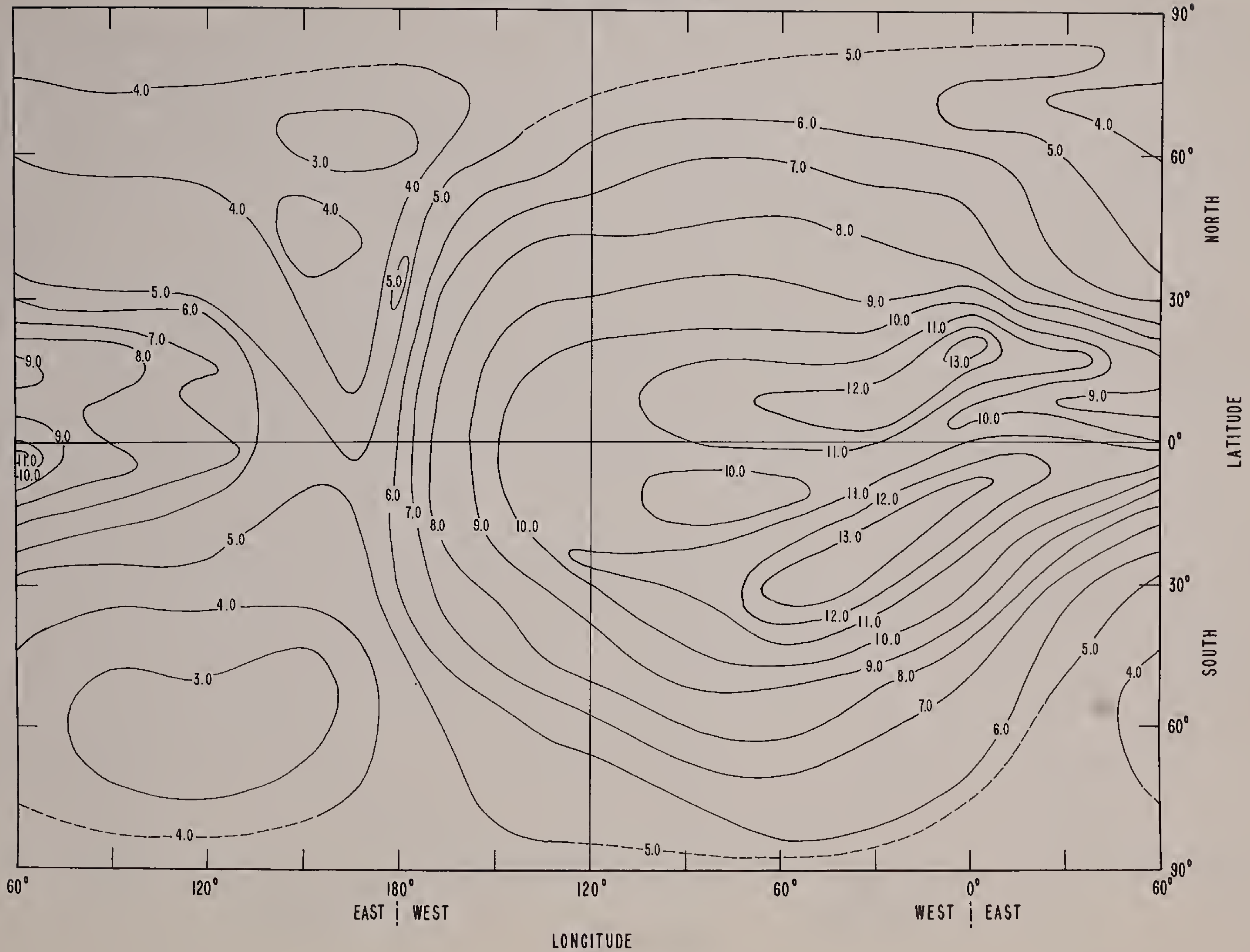
f_oF2 AT RASSN 50
OCTOBER 1400 HOURS GMT



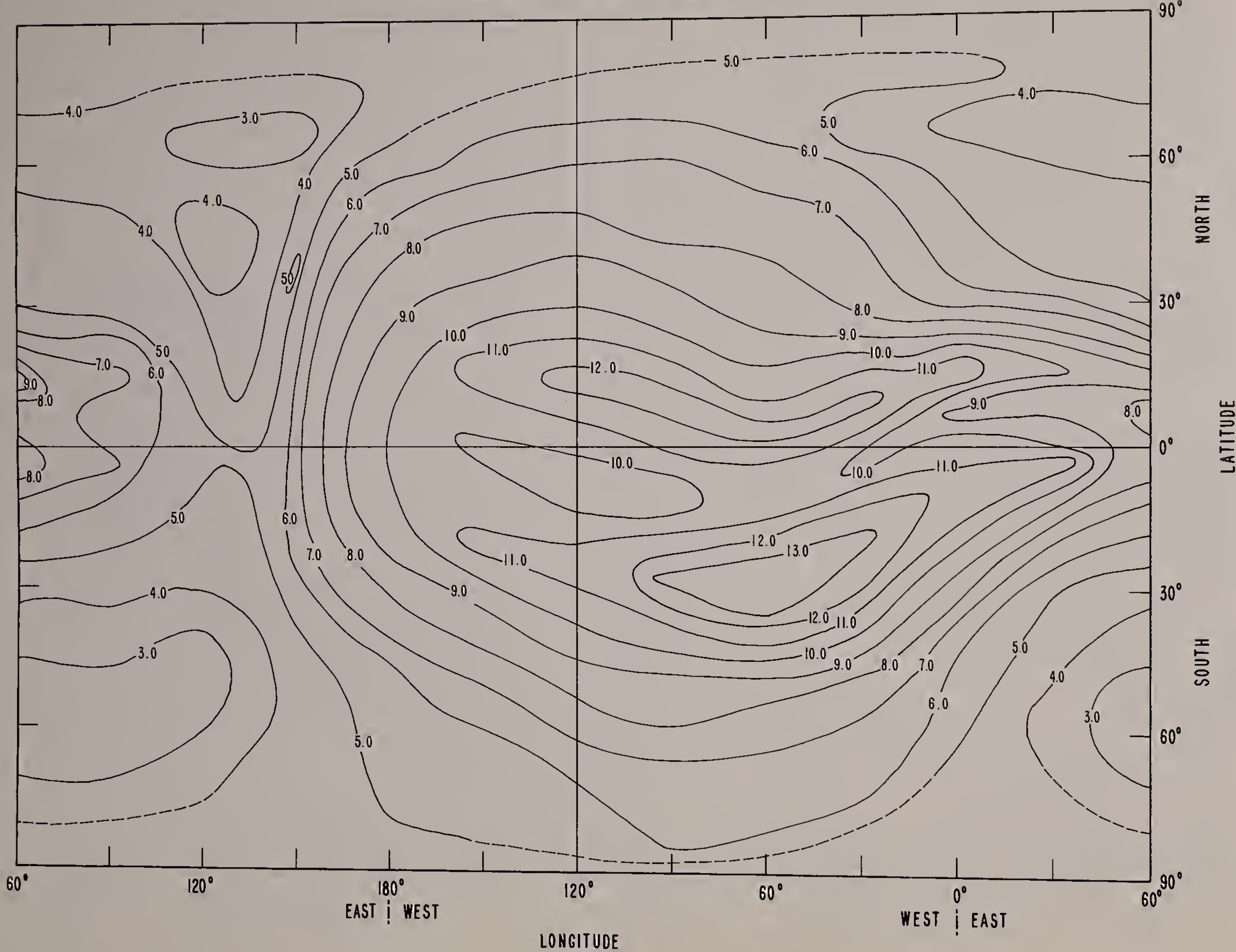
f₀F2 AT RASSN 50
OCTOBER 1600 HOURS GMT



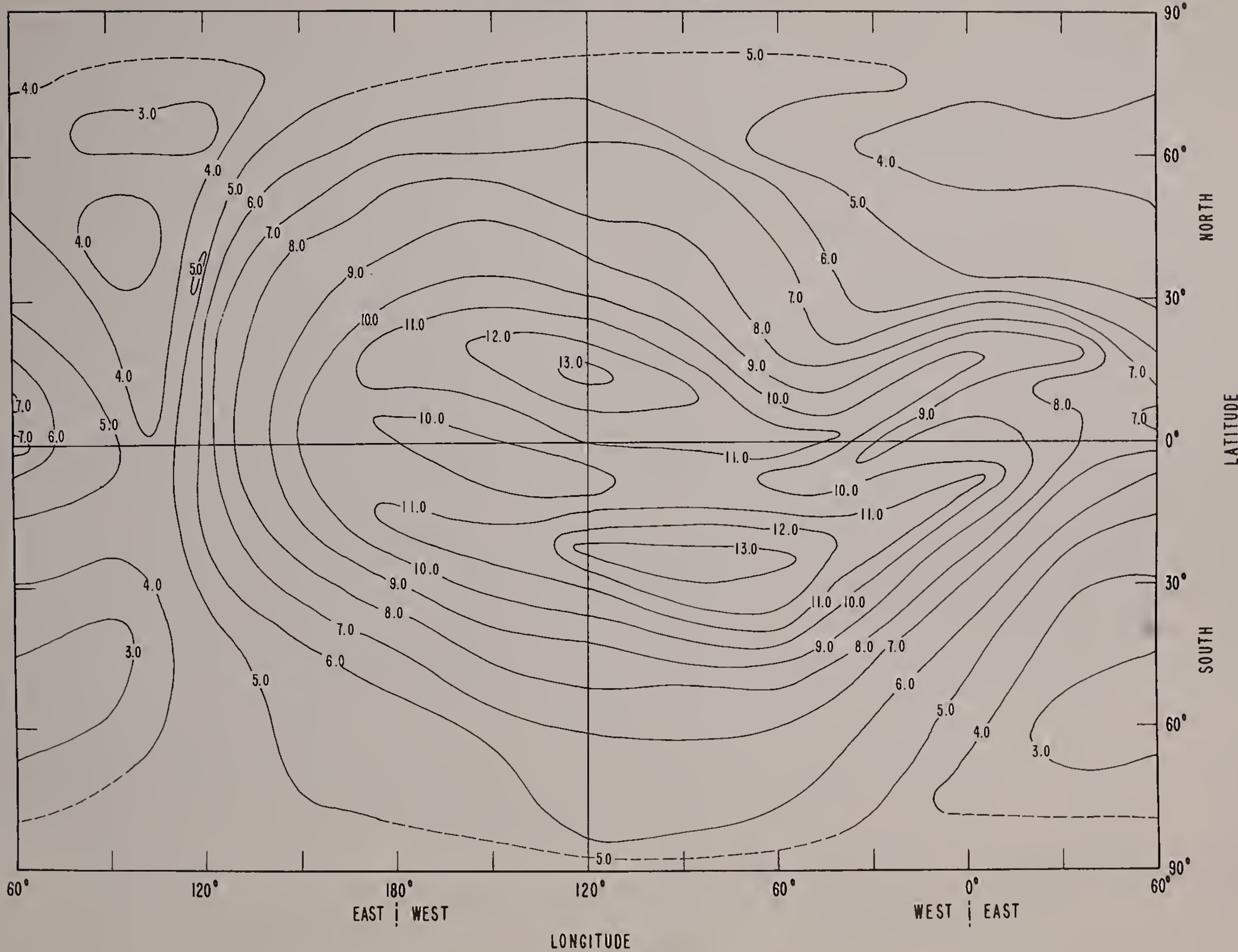
f_oF2 AT RASSN 50
OCTOBER 1800 HOURS GMT



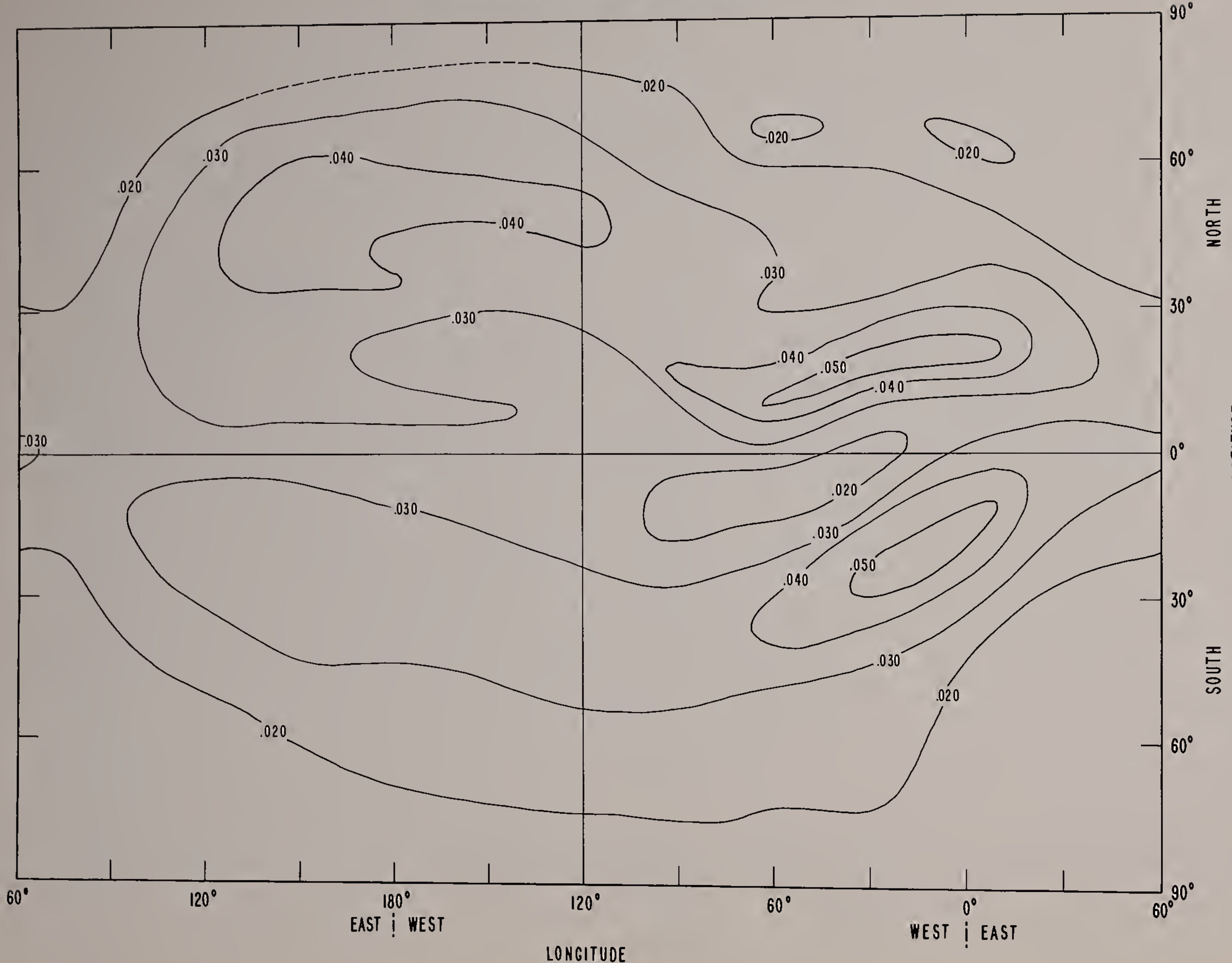
f_oF2 AT RASSN 50
OCTOBER 2000 HOURS GMT



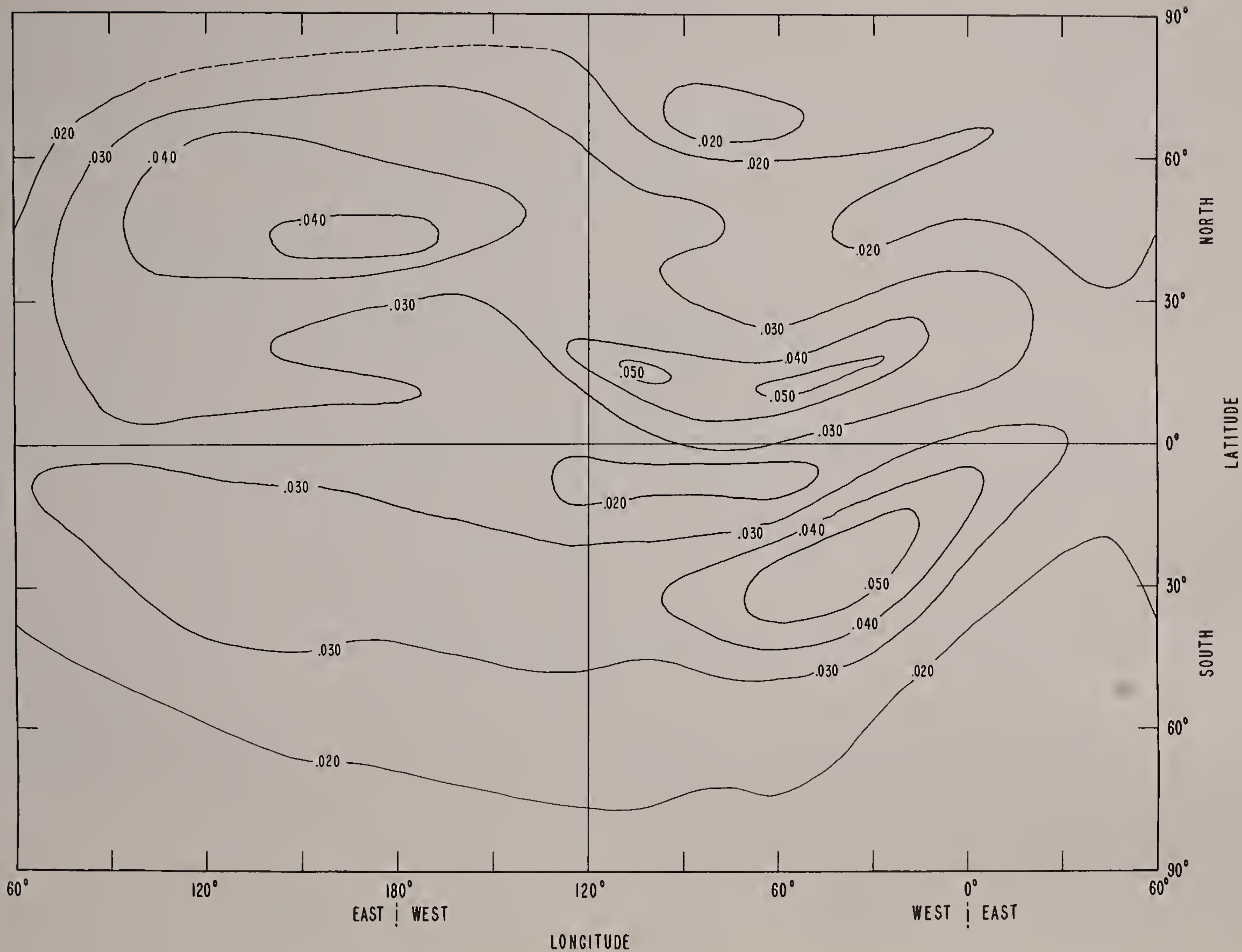
f_oF2 AT RASSN 50
OCTOBER 2200 HOURS GMT



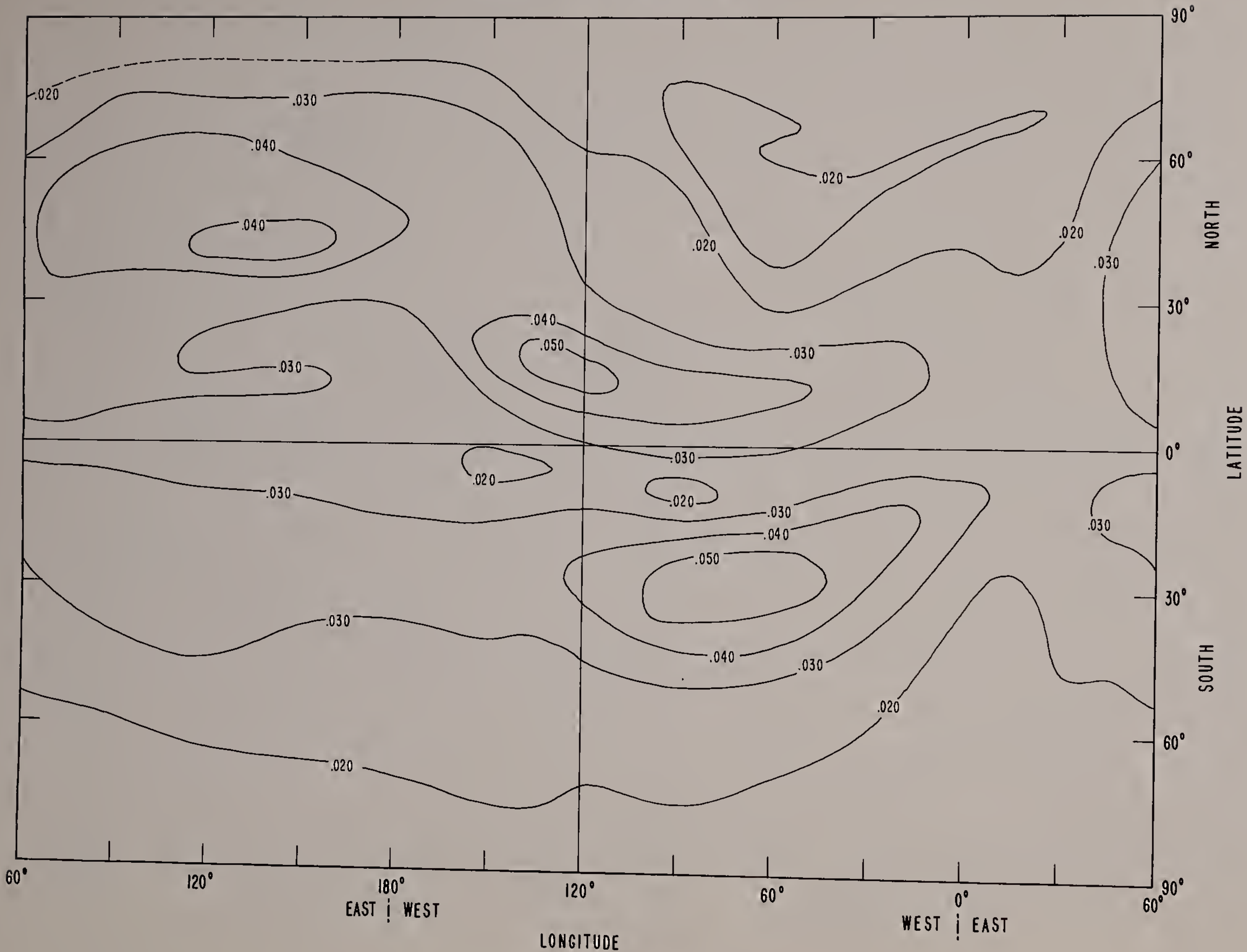
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 0000 HOURS GMT



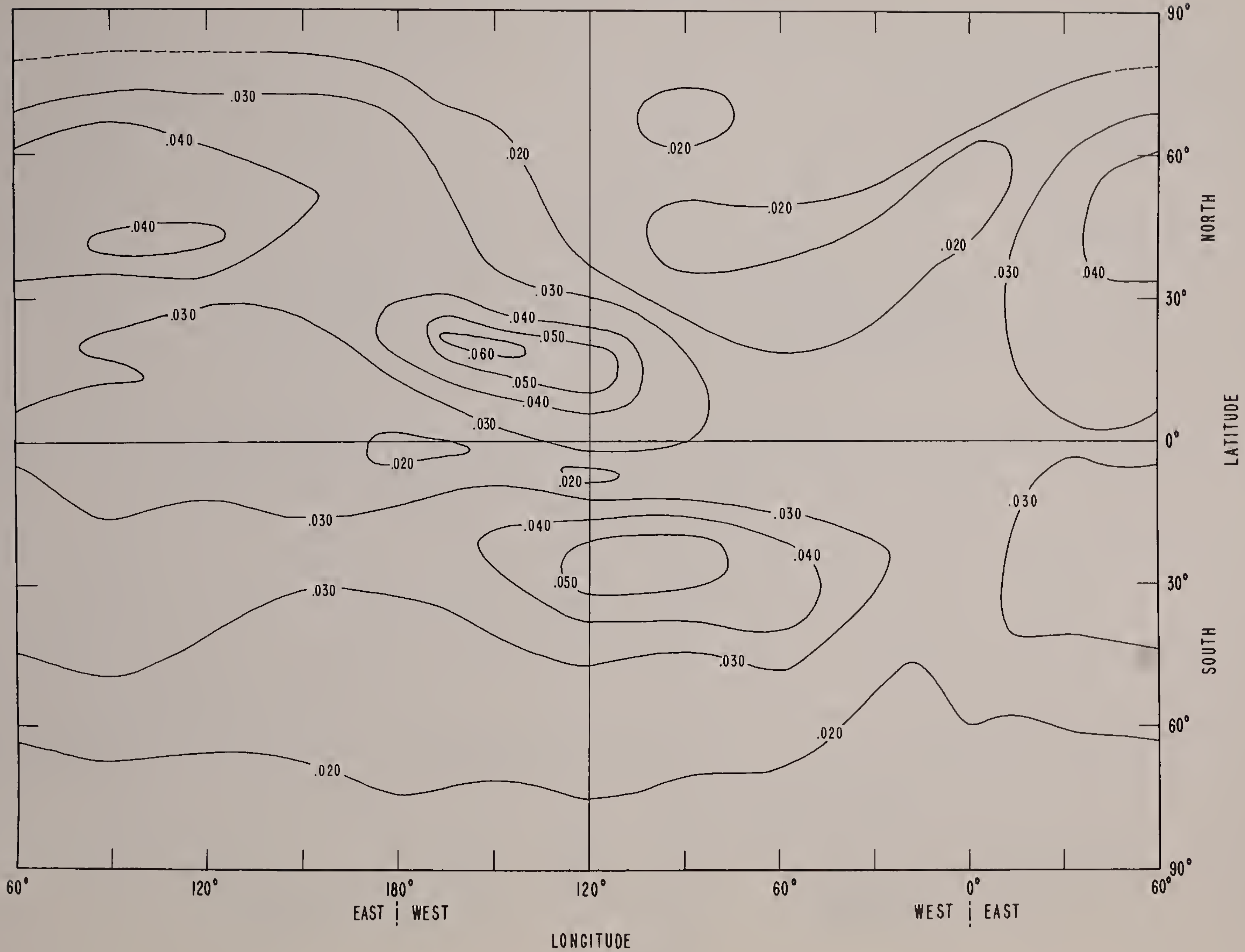
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 0200 HOURS GMT



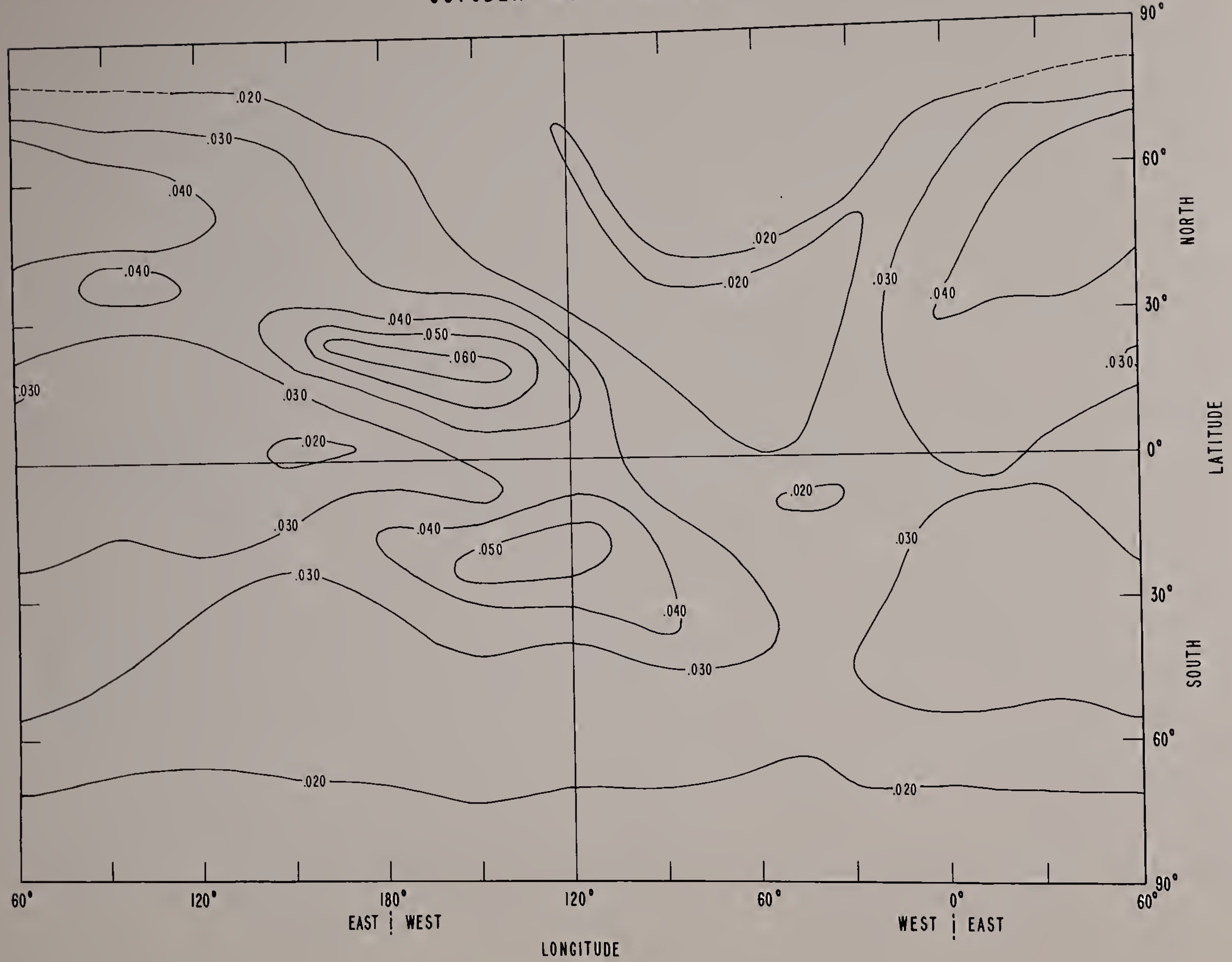
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 0400 HOURS GMT



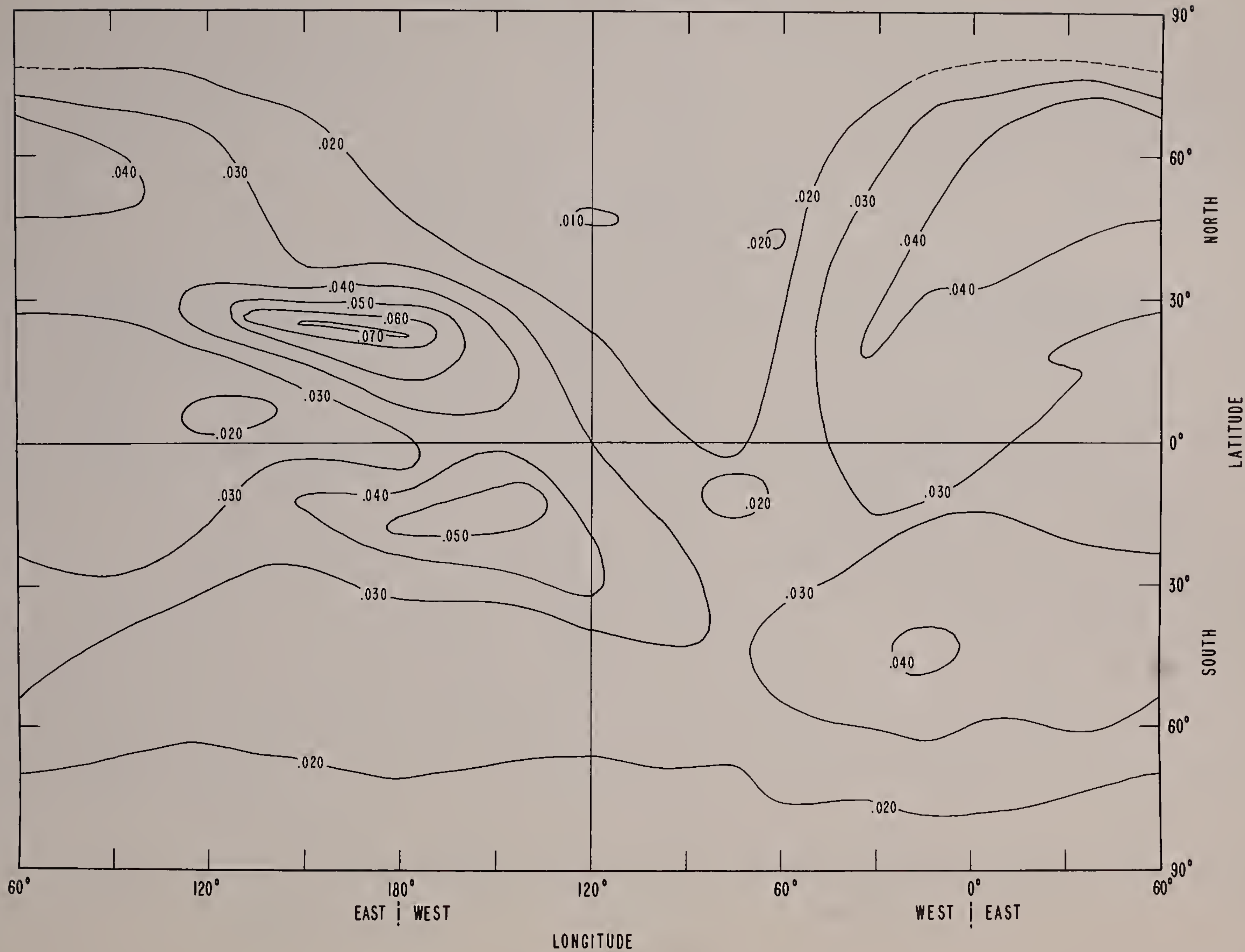
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 0600 HOURS GMT



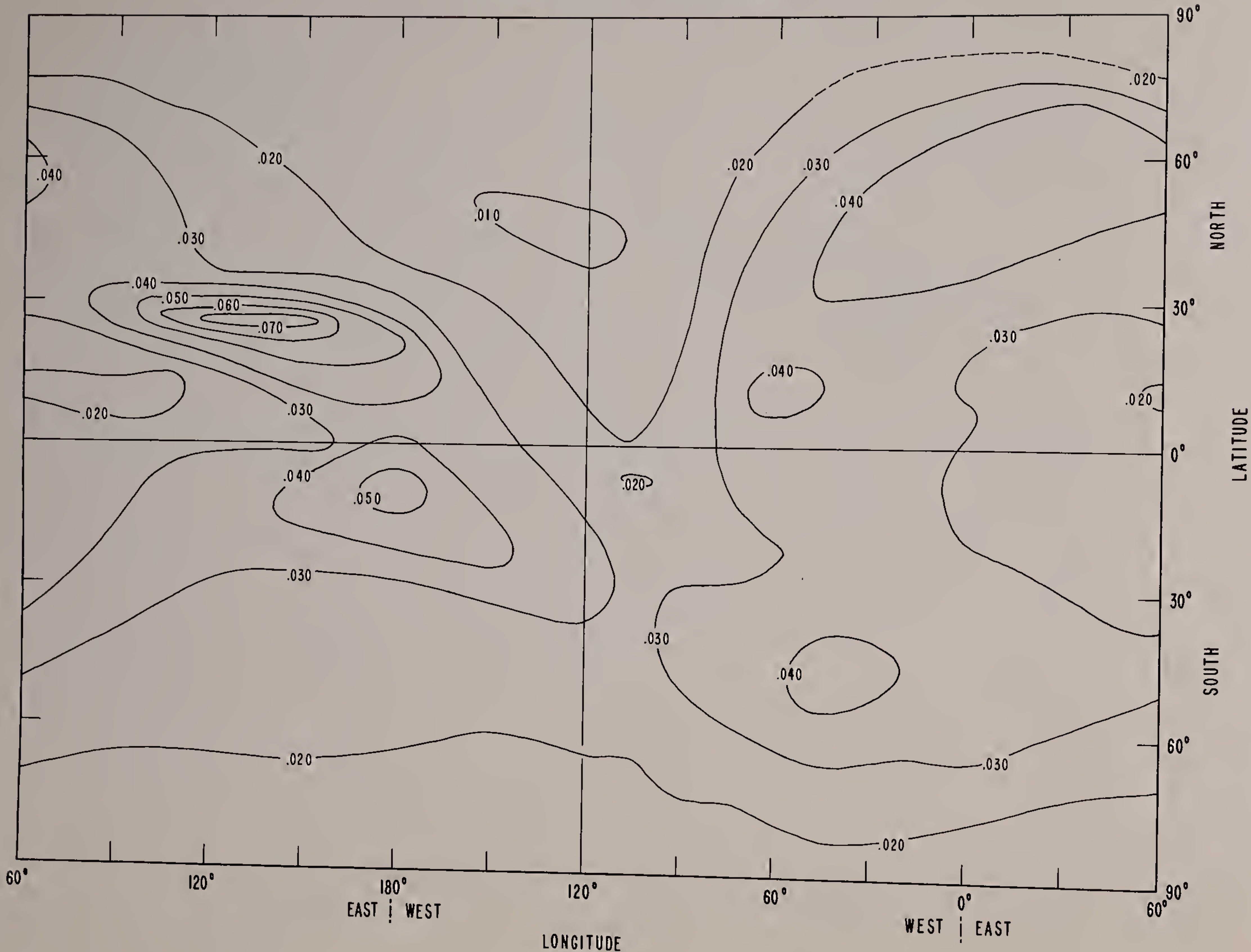
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 0800 HOURS GMT



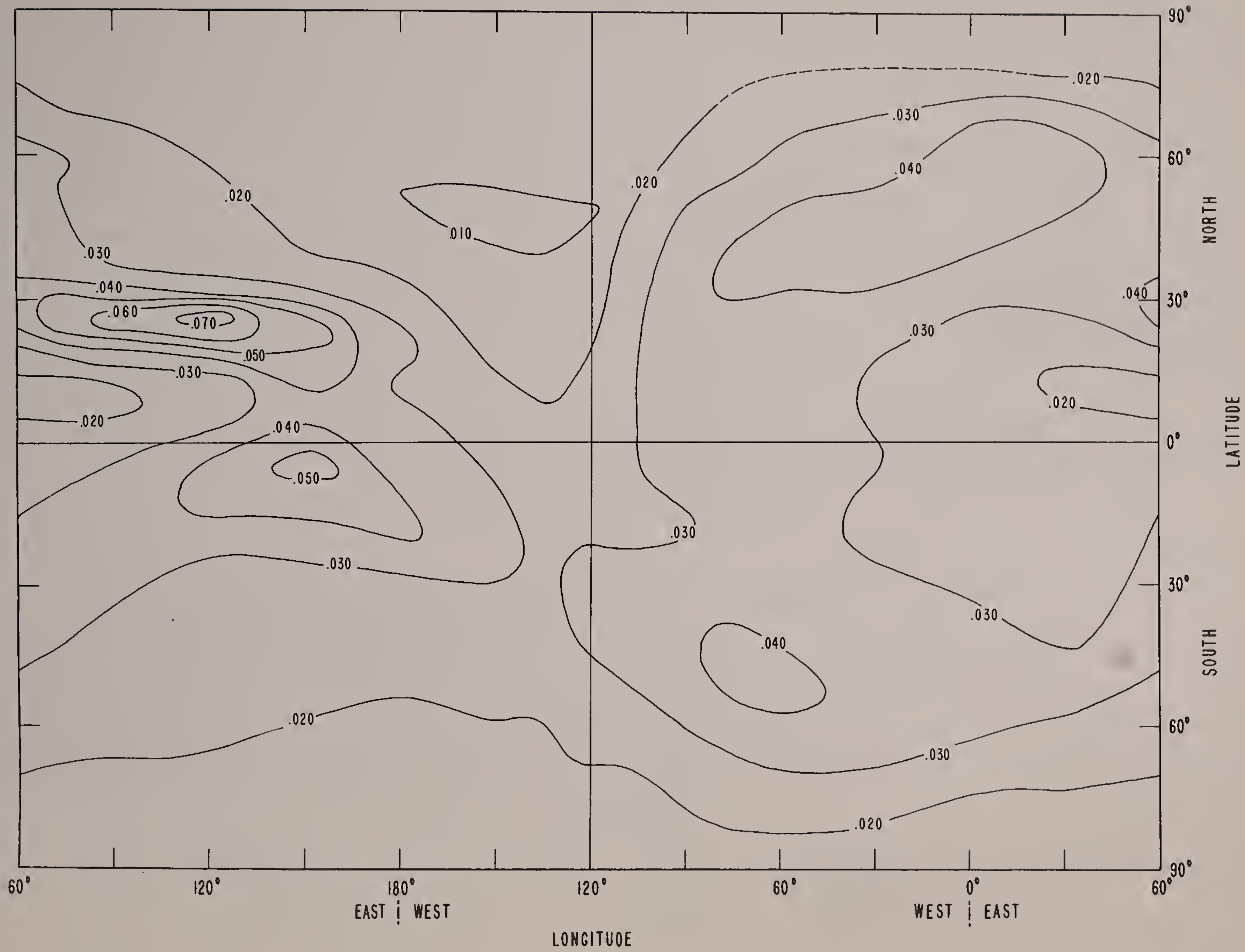
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 1000 HOURS GMT



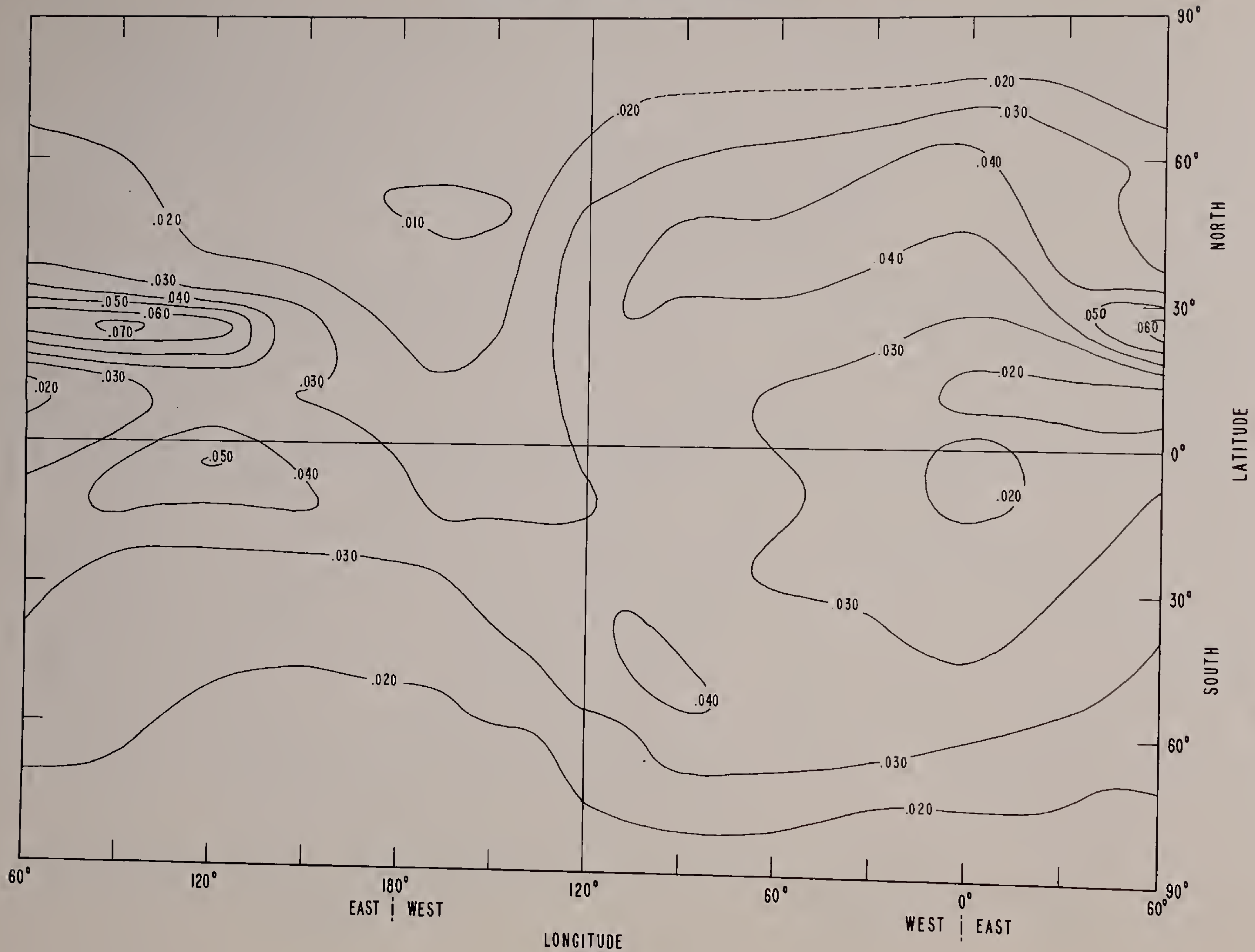
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 1200 HOURS GMT



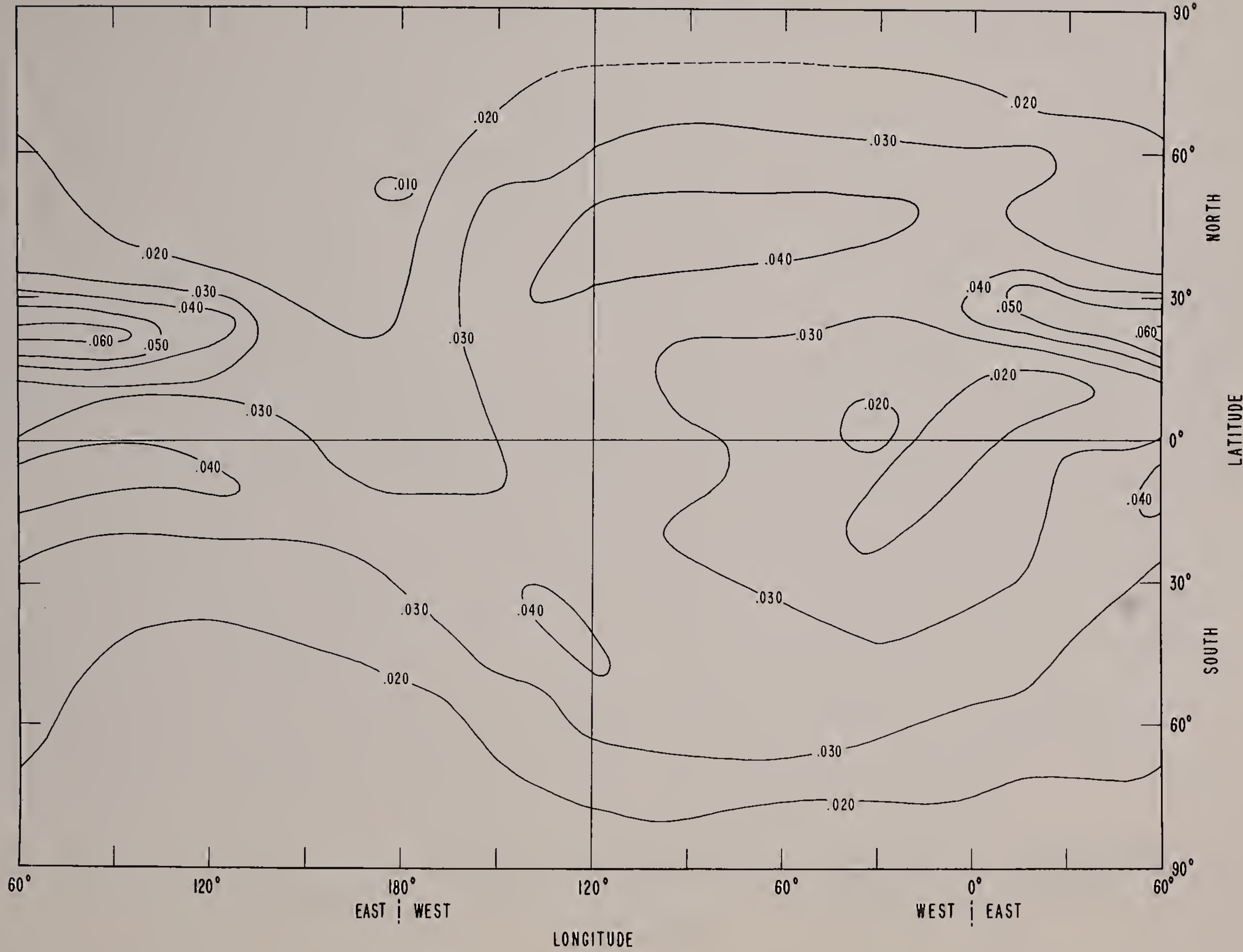
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 1400 HOURS GMT



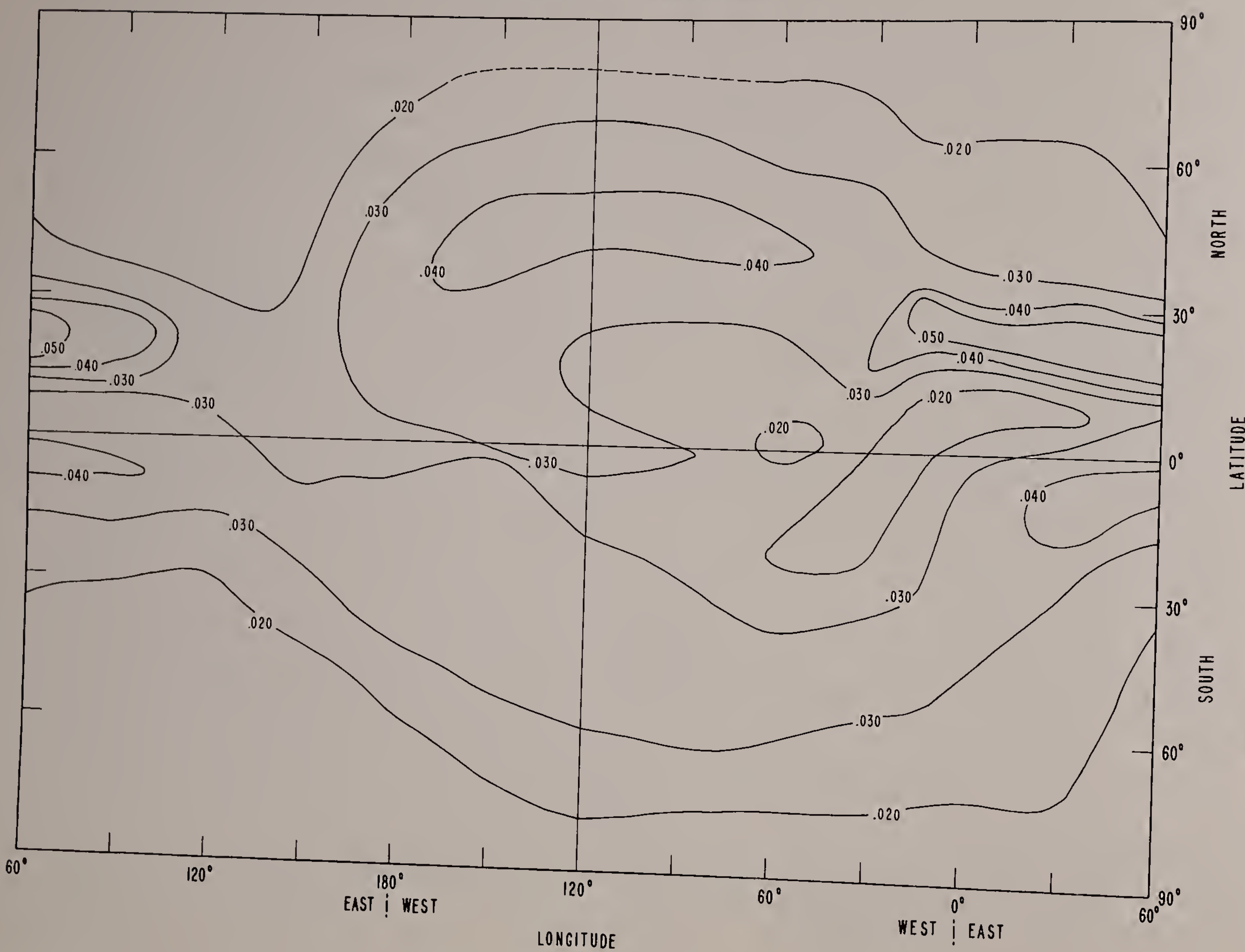
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 1600 HOURS GMT



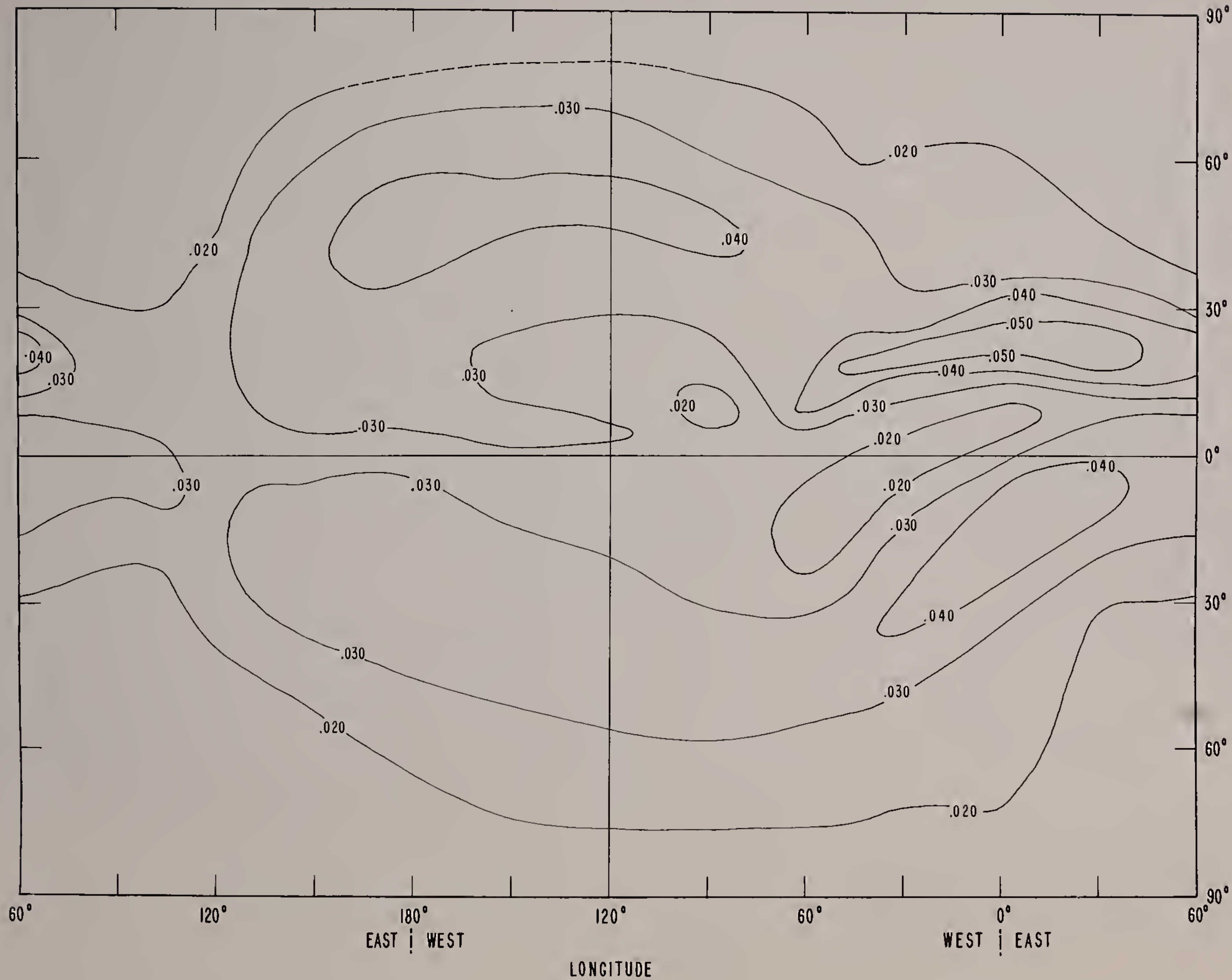
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 1800 HOURS GMT



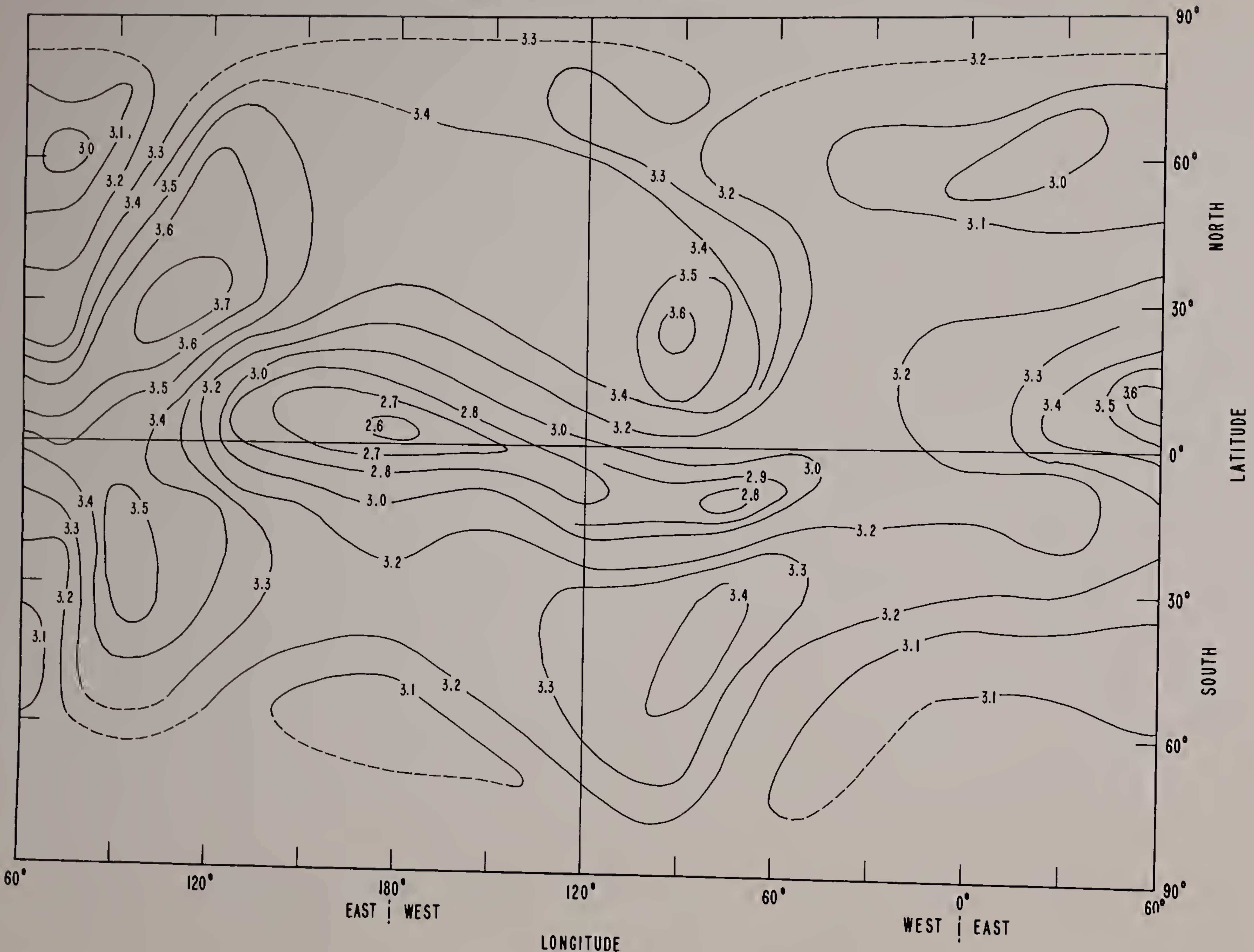
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 2000 HOURS GMT



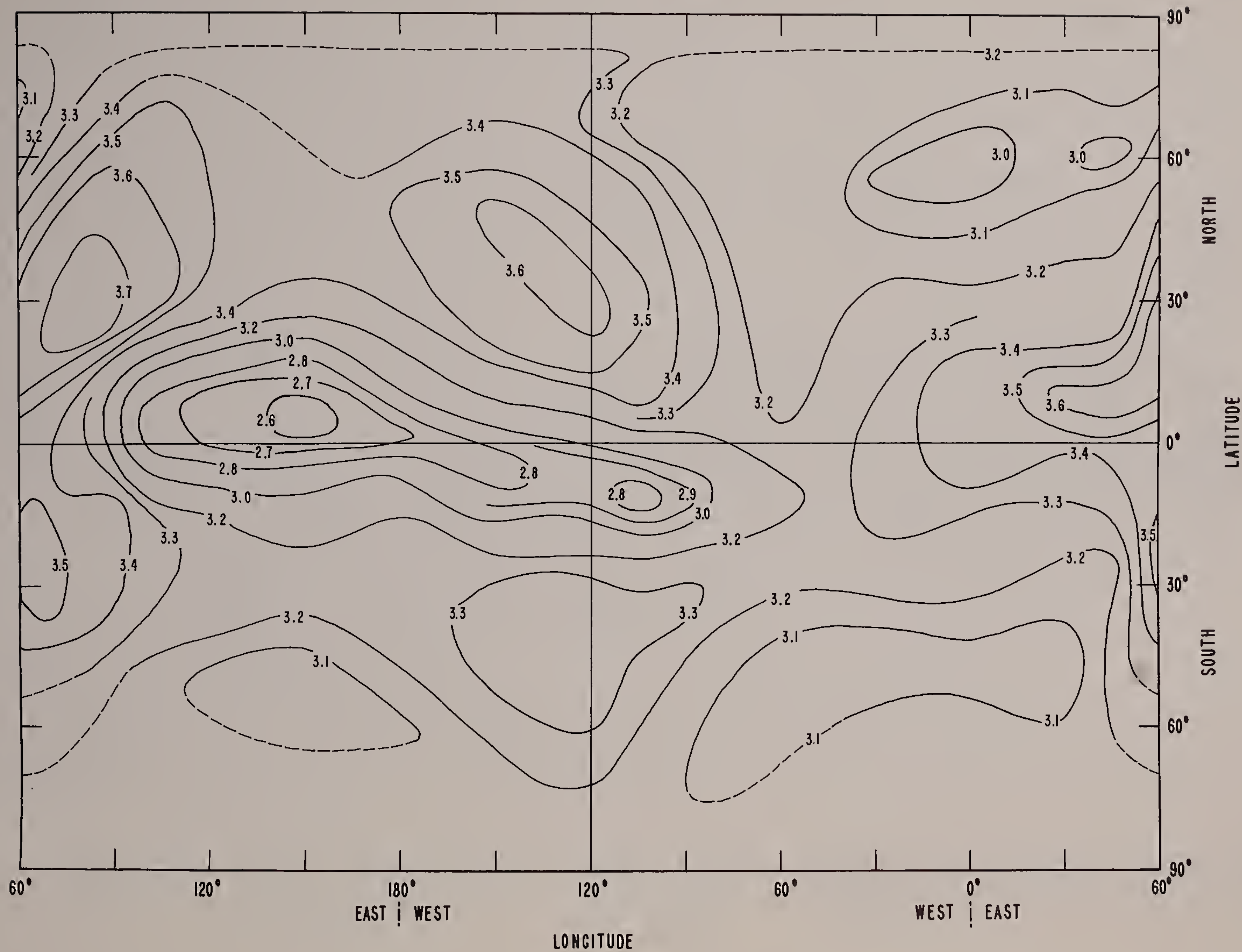
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
OCTOBER 2200 HOURS GMT



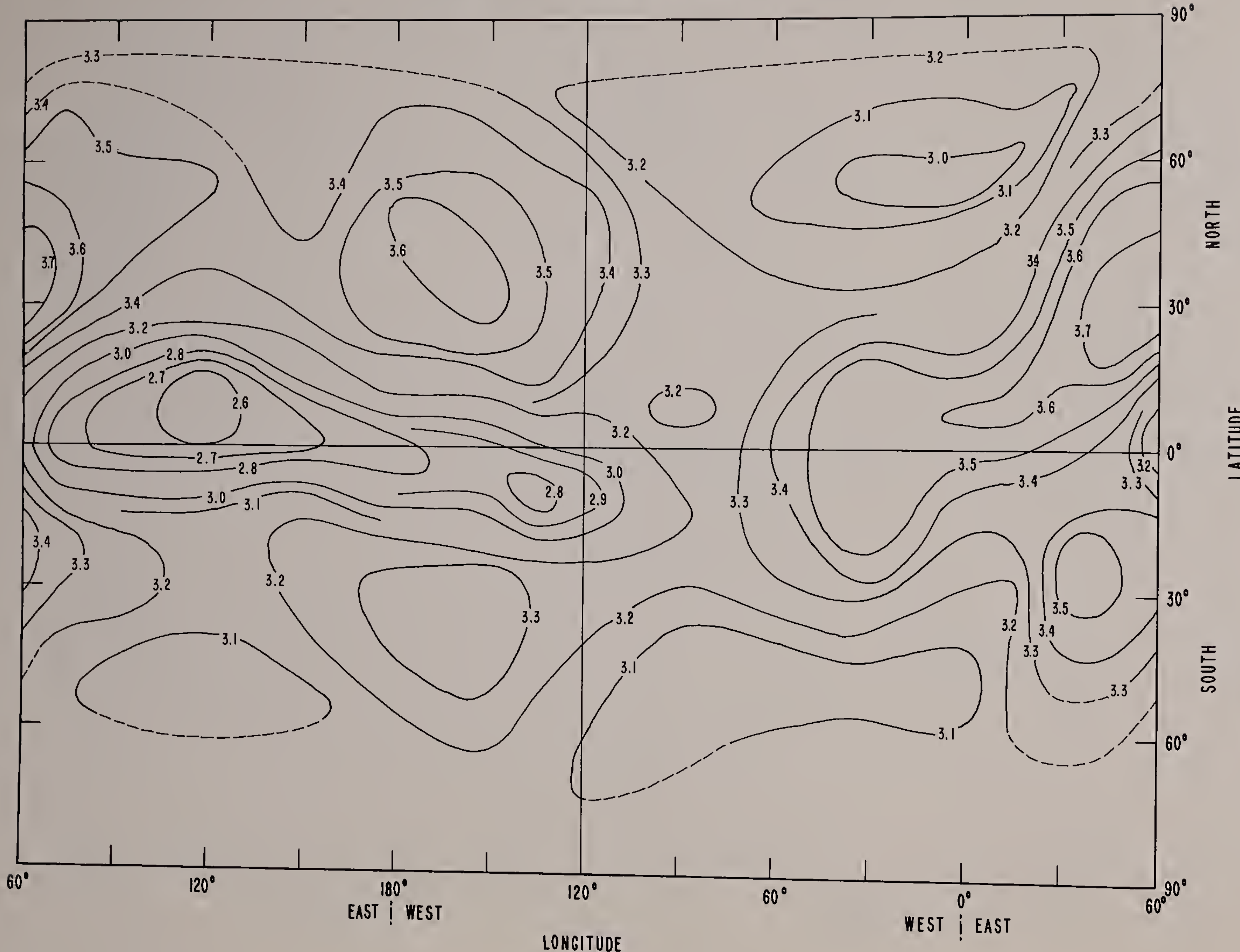
M—4000 FACTOR AT RASSN 50
OCTOBER 0000 HOURS GMT



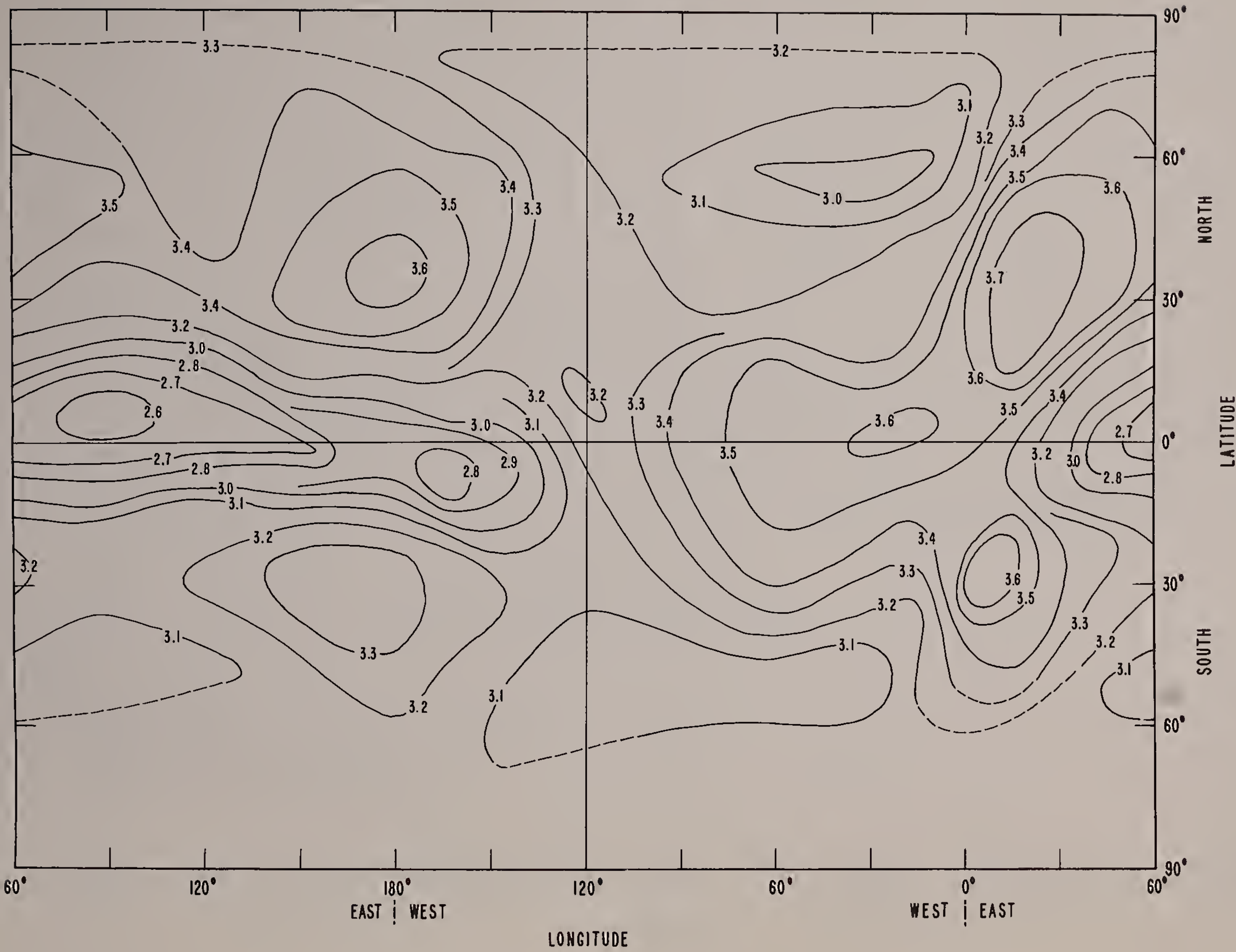
M — 4000 FACTOR AT RASSN 50
OCTOBER 0200 HOURS GMT



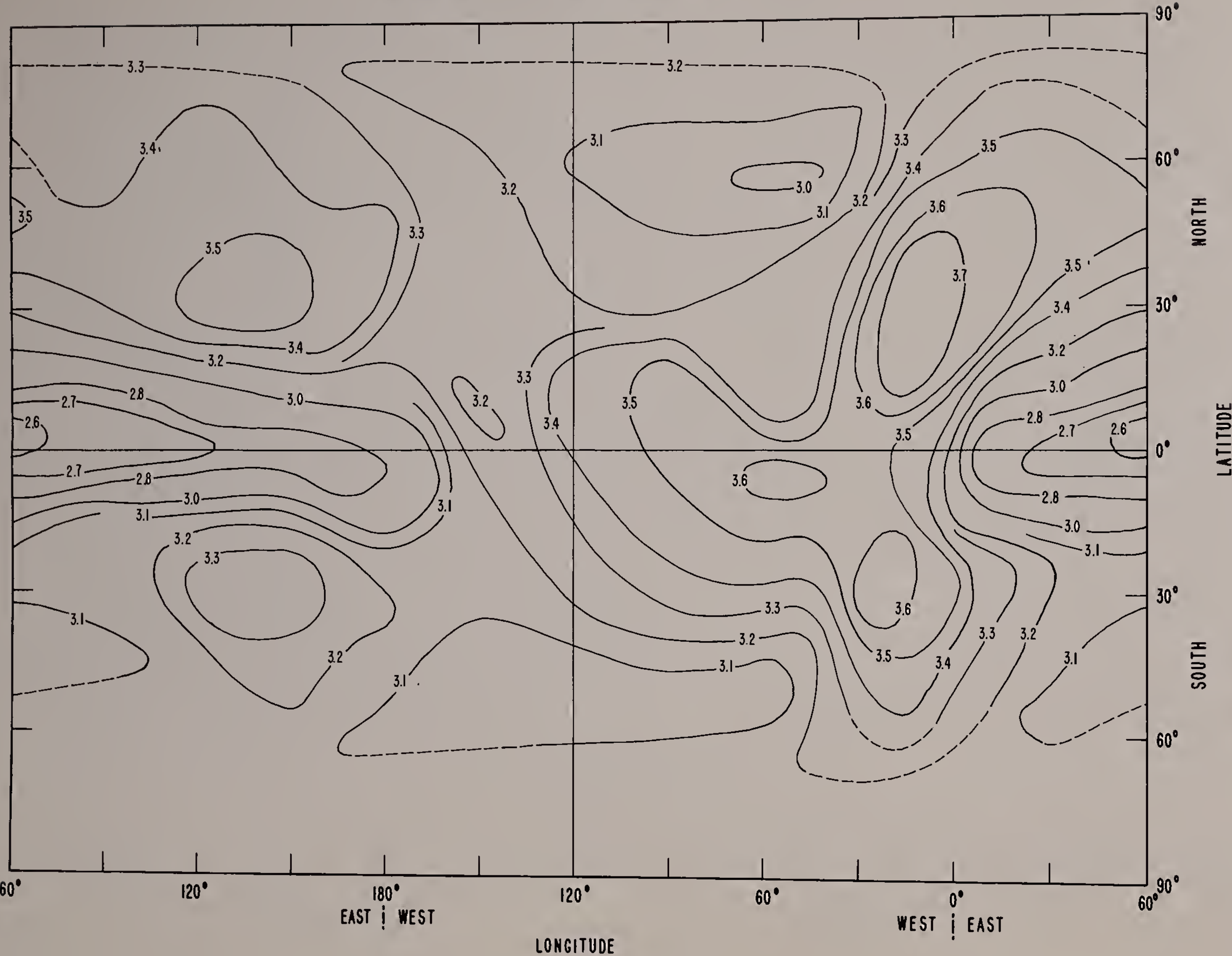
M — 4000 FACTOR AT RASSN 50
OCTOBER 0400 HOURS GMT



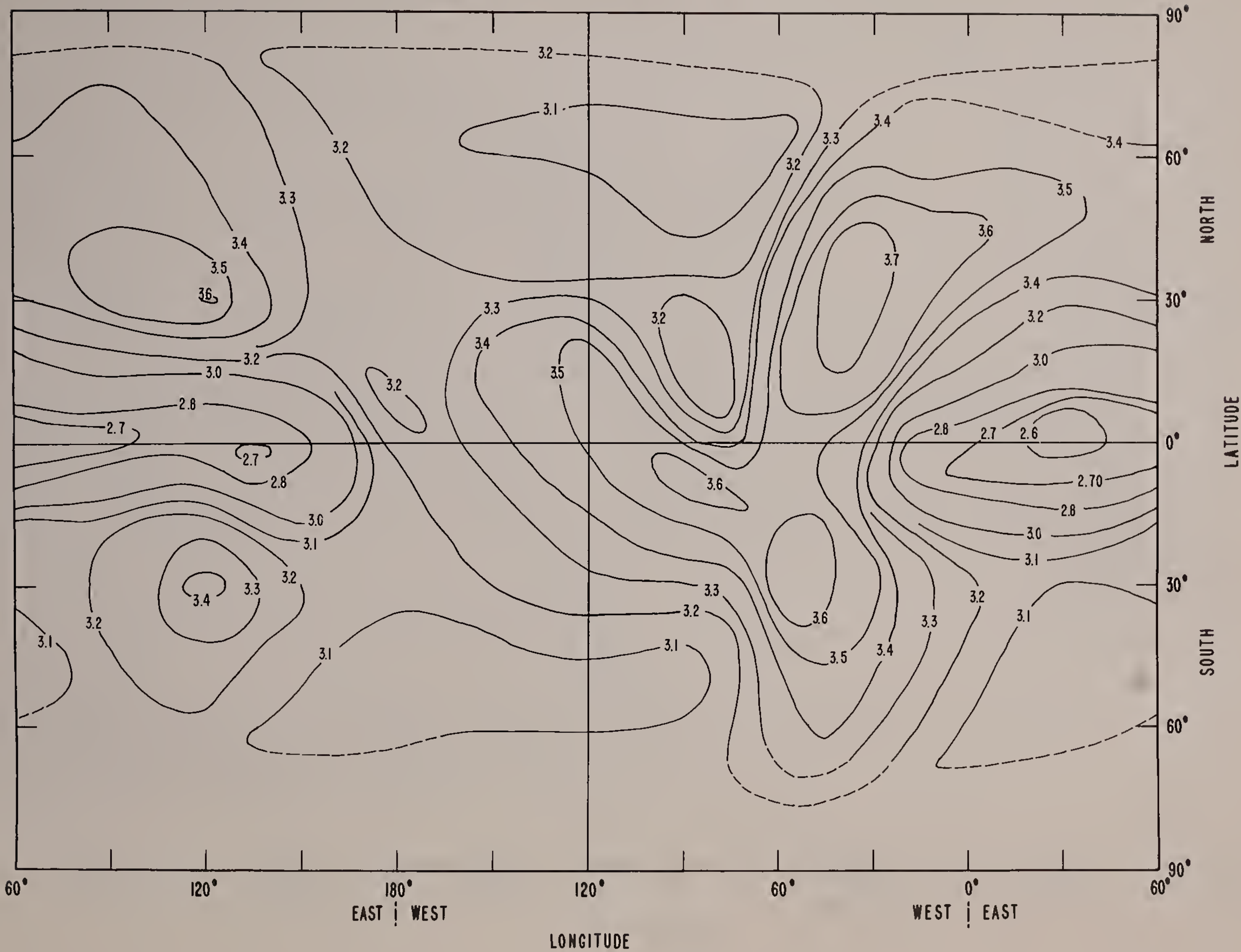
M — 4000 FACTOR AT RASSN 50
OCTOBER 0600 HOURS GMT



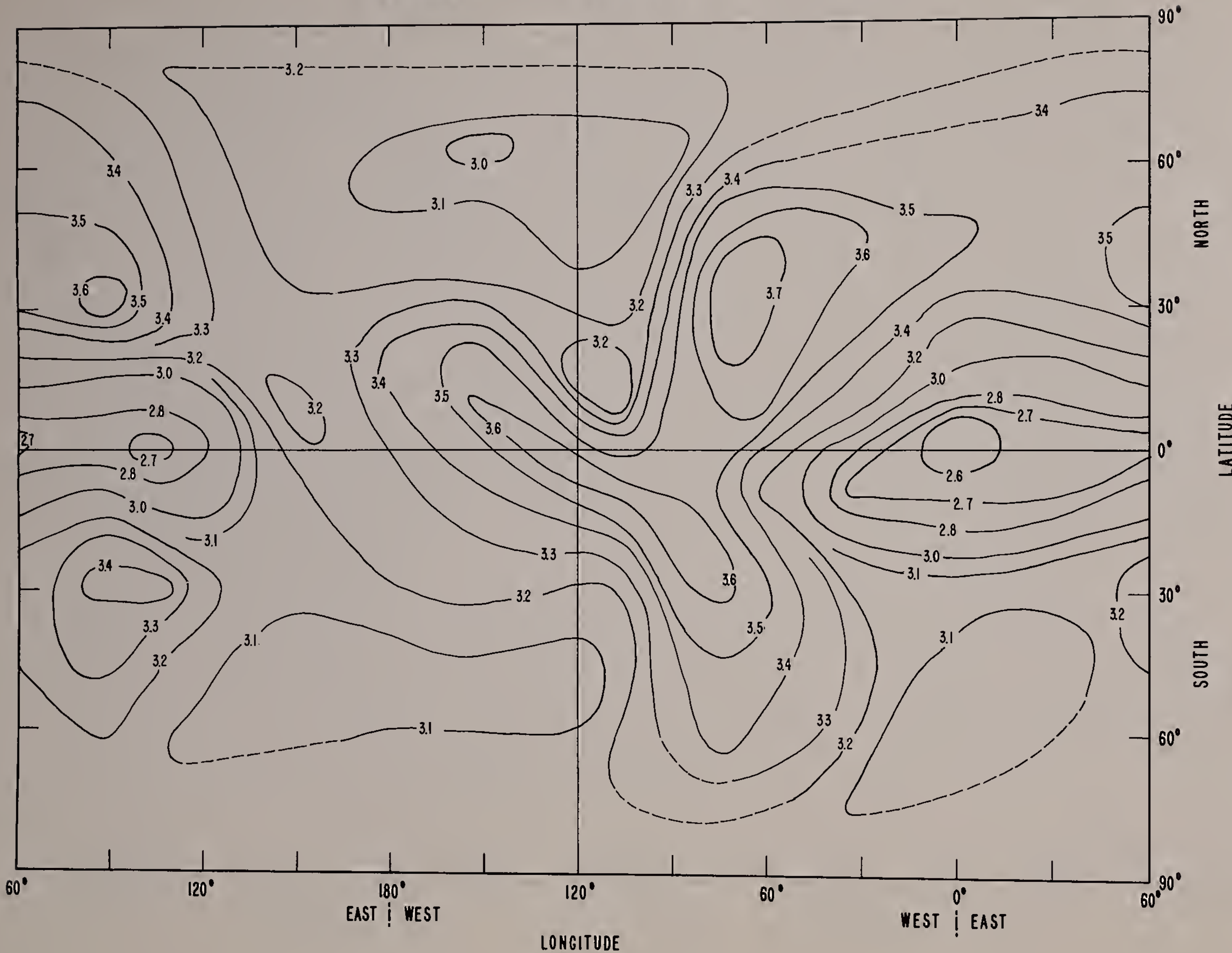
M — 4000 FACTOR AT RASSN 50
OCTOBER 0800 HOURS GMT



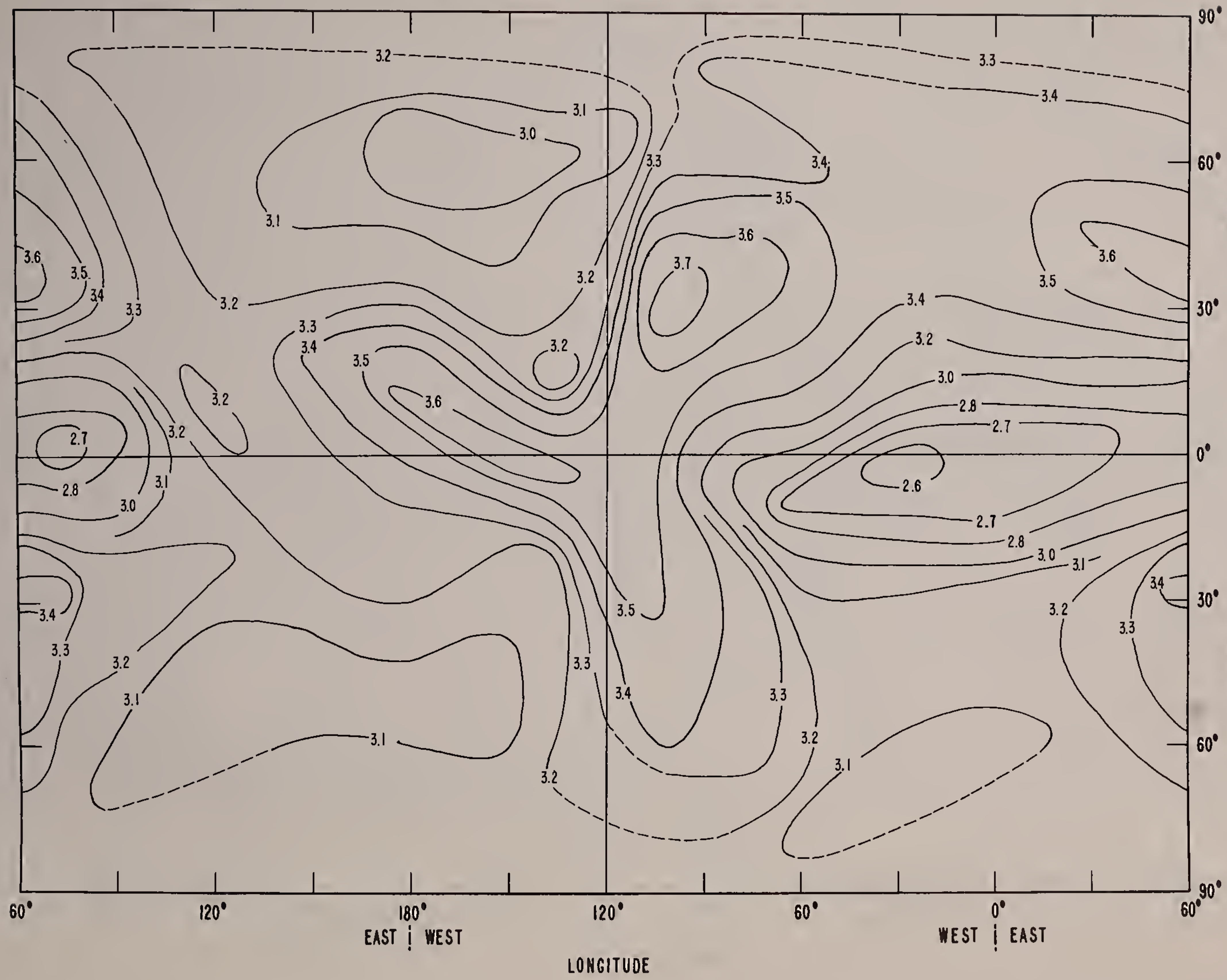
M — 4000 FACTOR AT RASSN 50
OCTOBER 1000 HOURS GMT



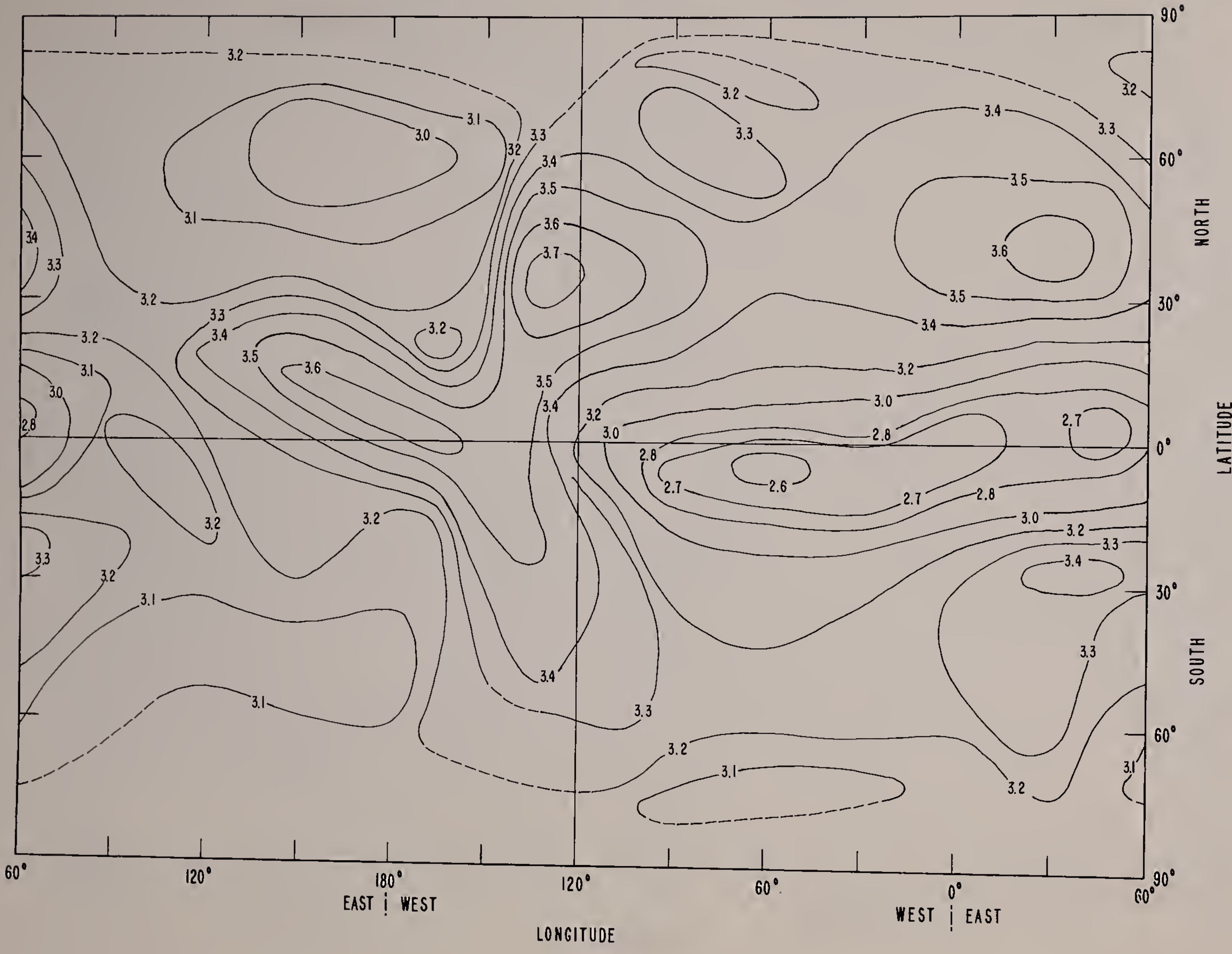
M – 4000 FACTOR AT RASSN 50
OCTOBER 1200 HOURS GMT



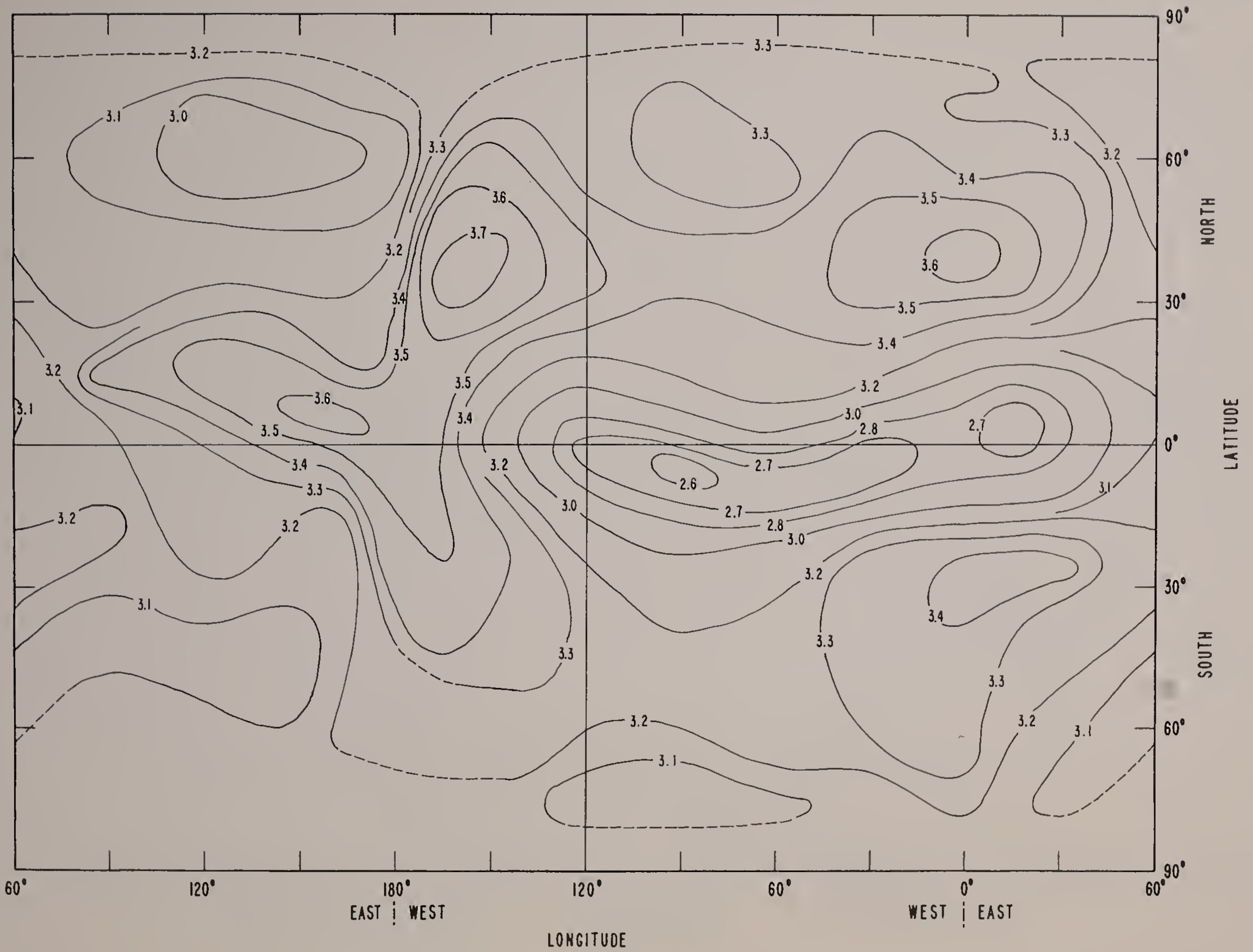
M — 4000 FACTOR AT RASSN 50
OCTOBER 1400 HOURS GMT



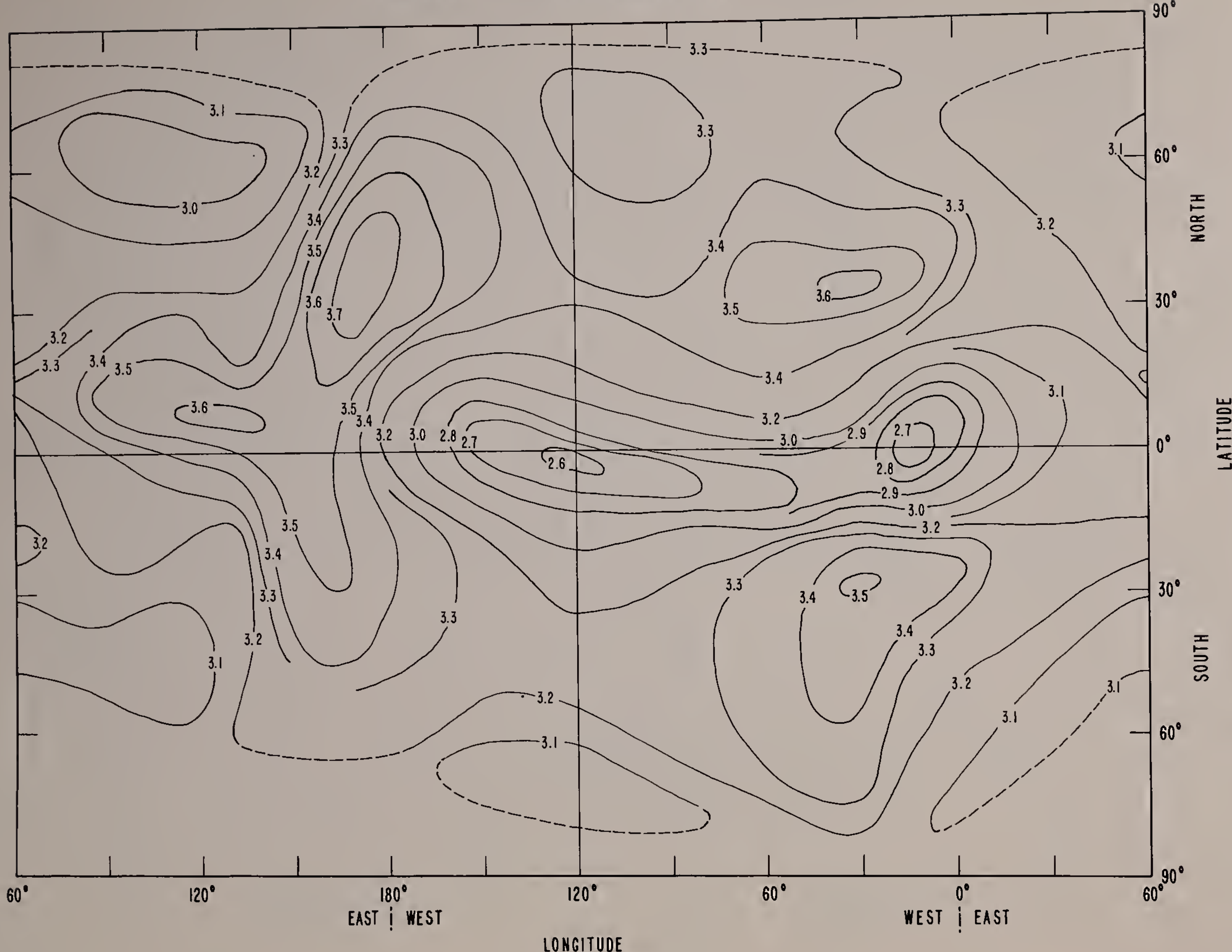
M — 4000 FACTOR AT RASSN 50
OCTOBER 1600 HOURS GMT



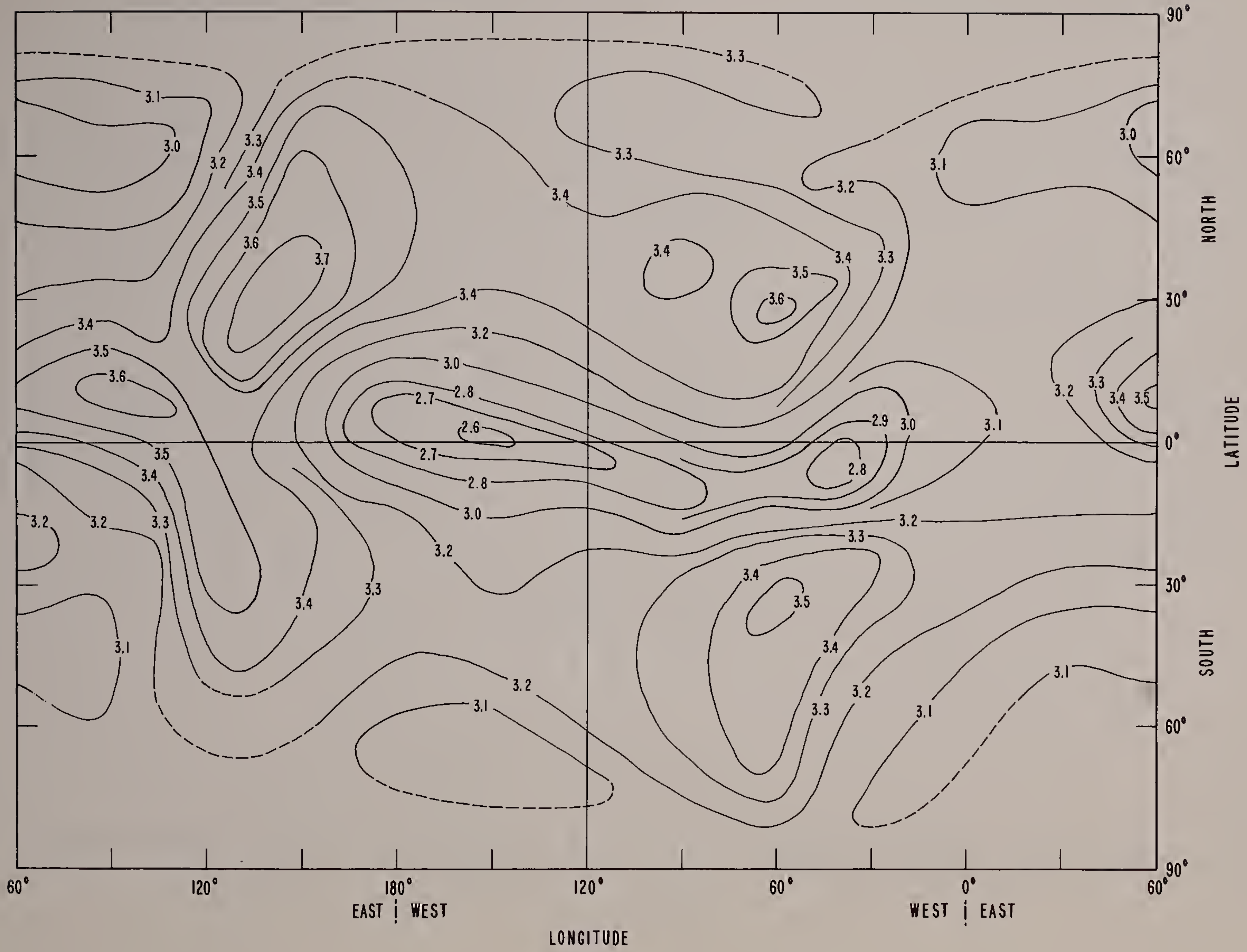
M − 4000 FACTOR AT RASSN 50
OCTOBER 1800 HOURS GMT



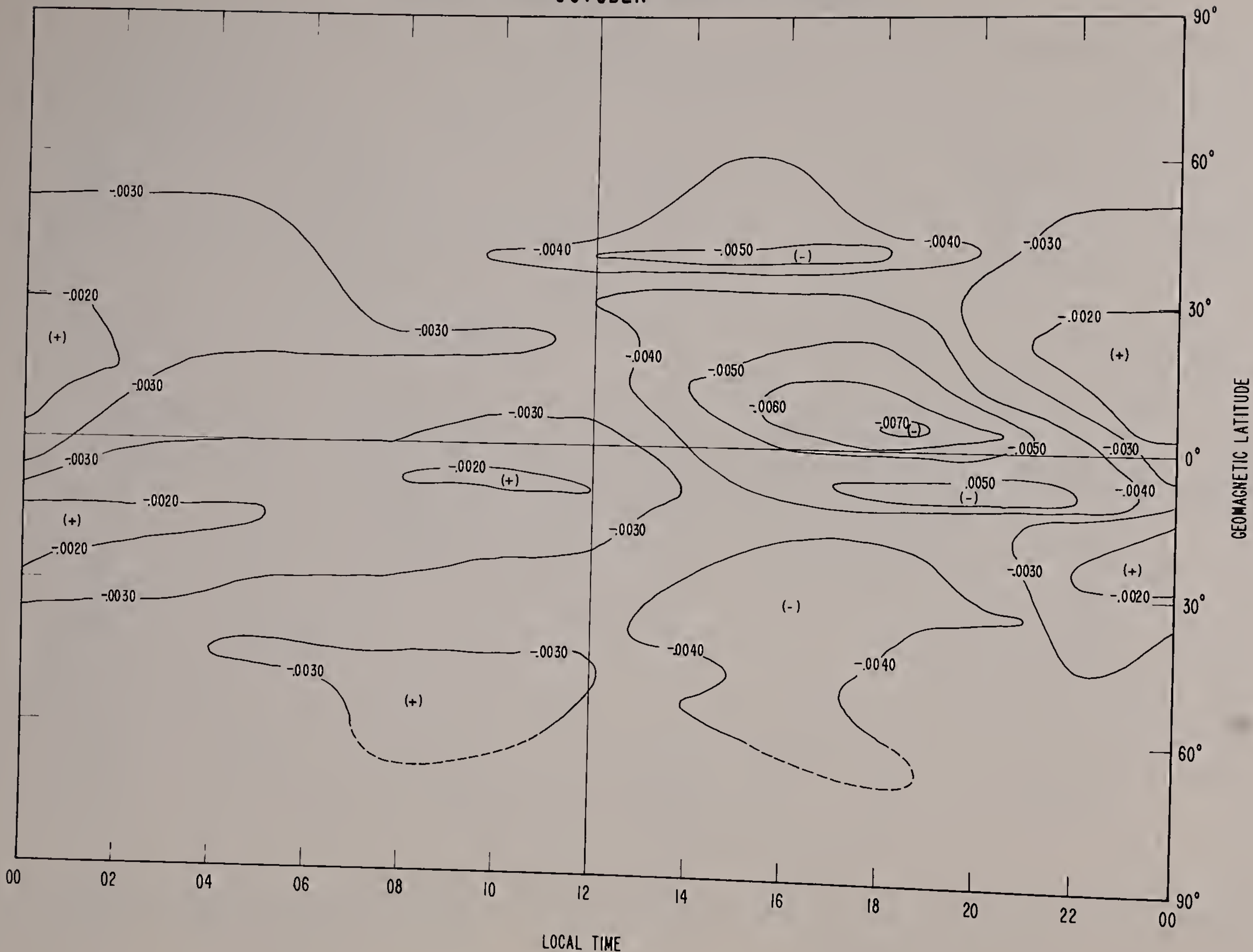
M — 4000 FACTOR AT RASSN 50
OCTOBER 2000 HOURS GMT



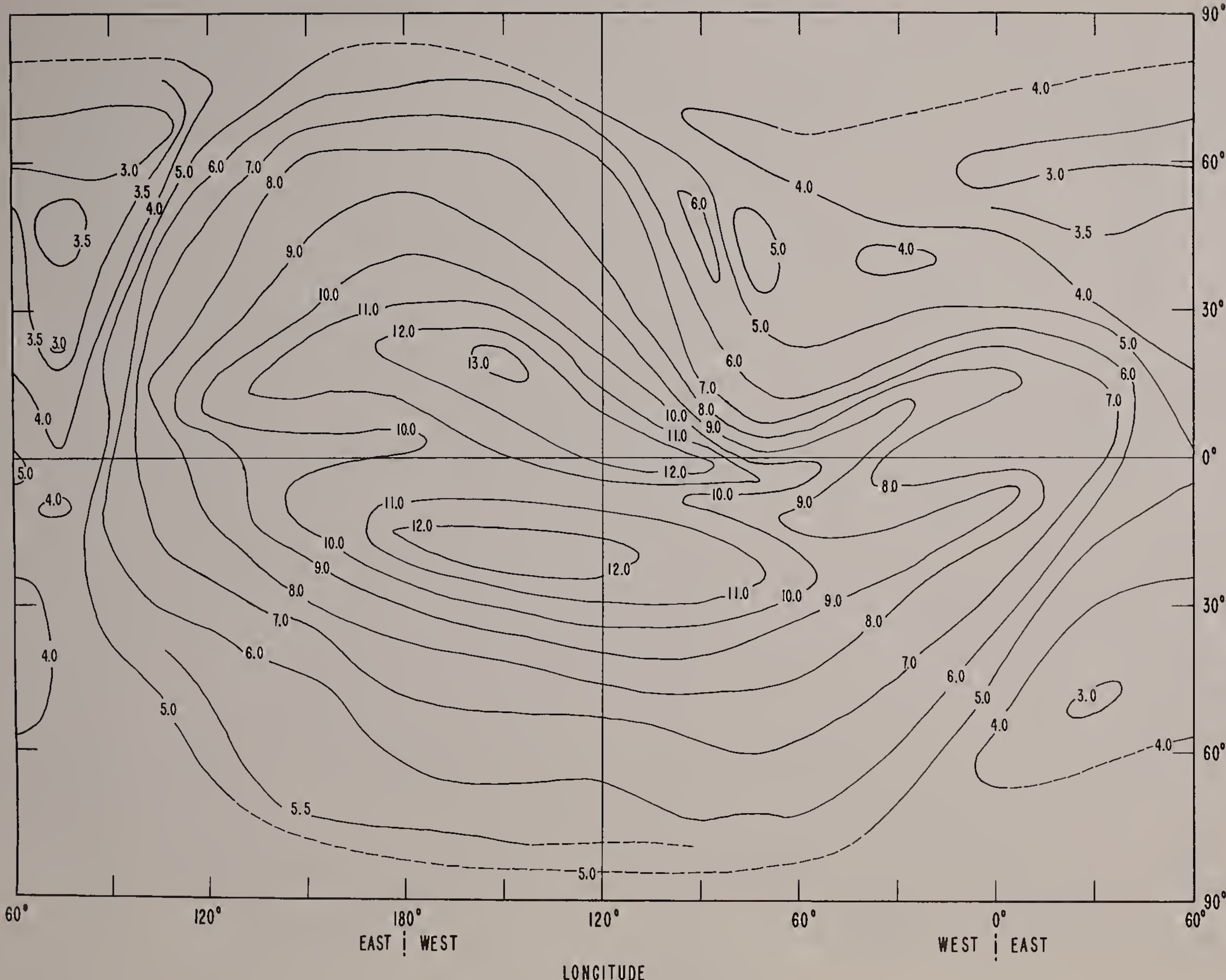
M — 4000 FACTOR AT RASSN 50
OCTOBER 2200 HOURS GMT



SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN
OCTOBER

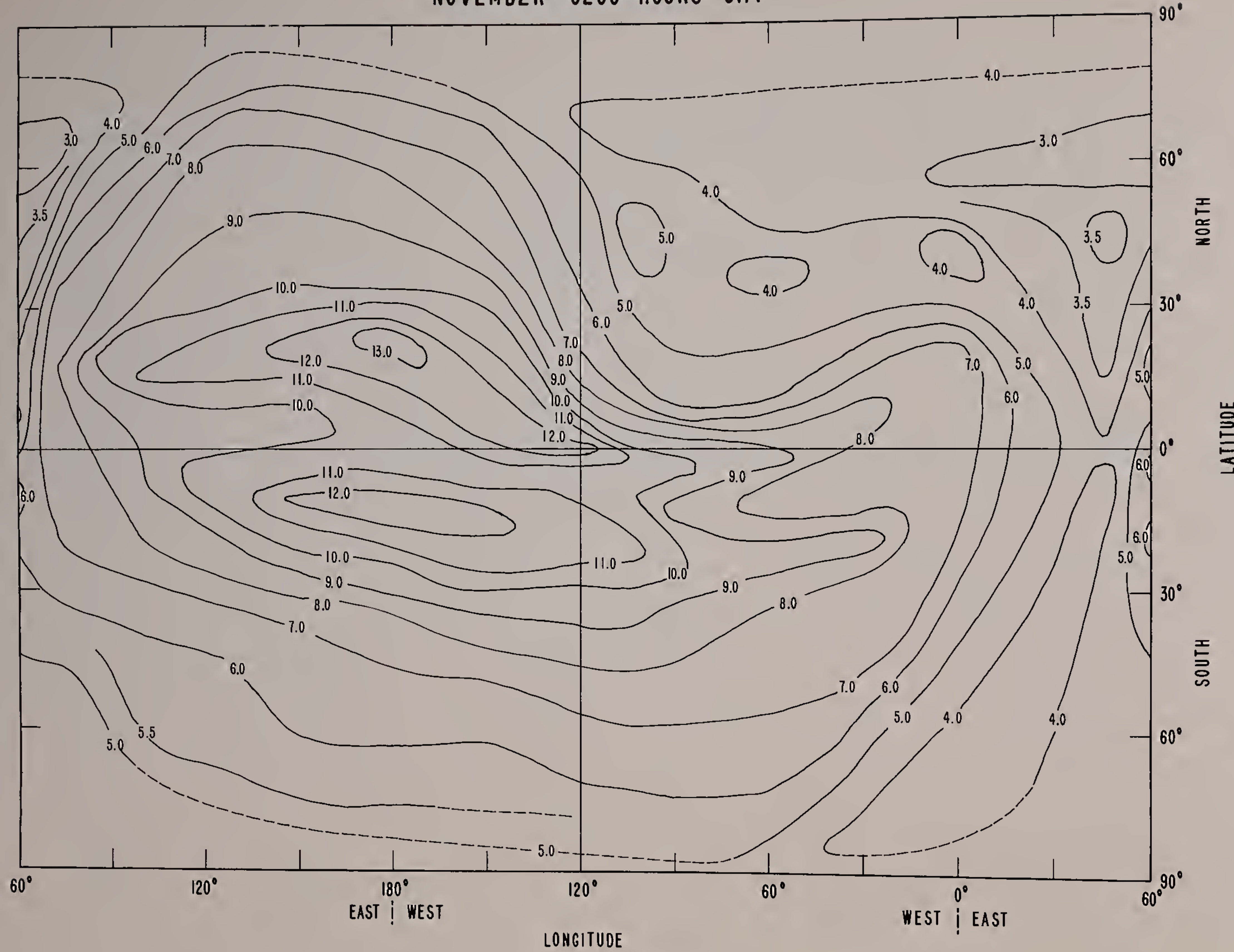


f_oF2 AT RASSN 50
NOVEMBER 0000 HOURS GMT

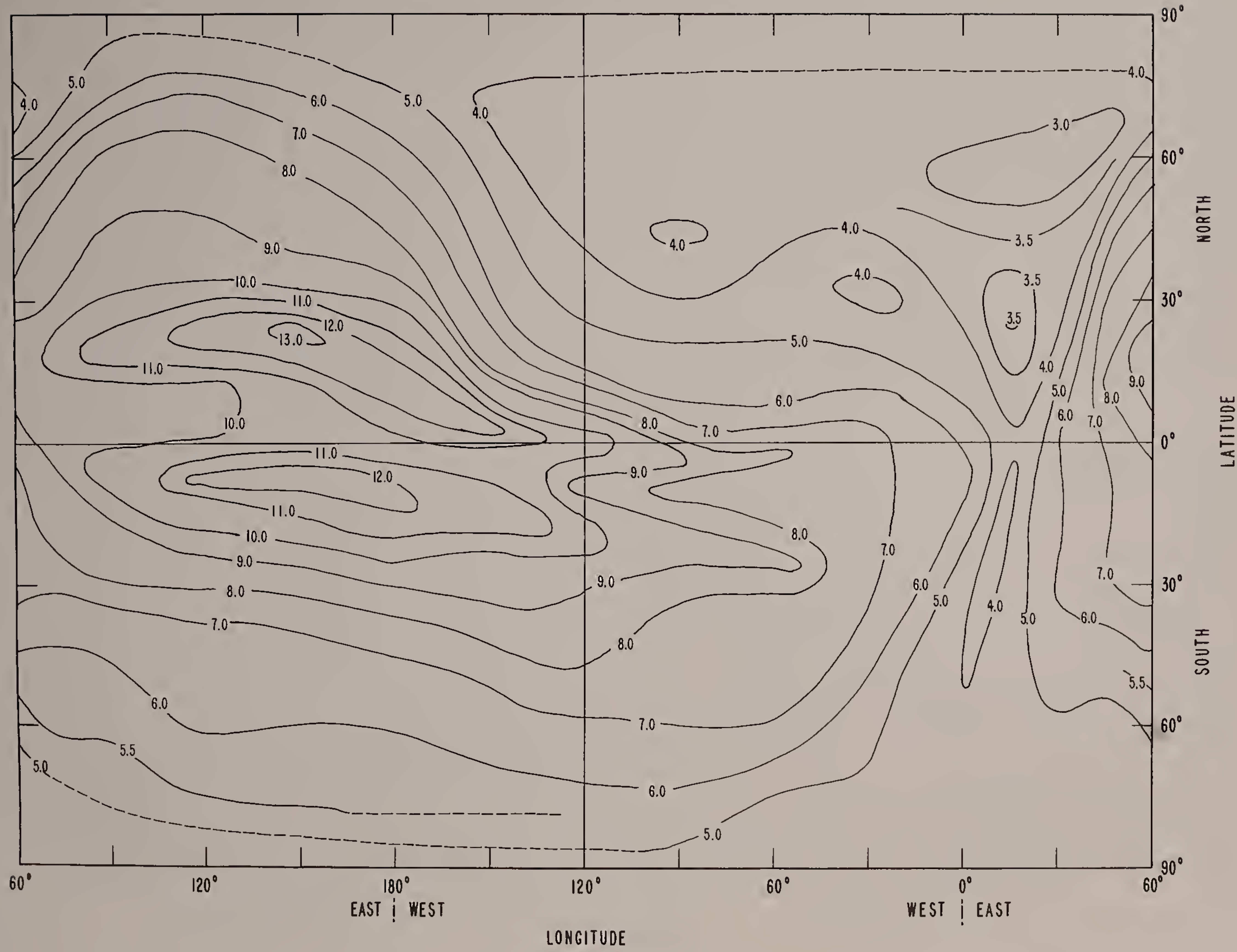


FoF2 AT RASSN 50

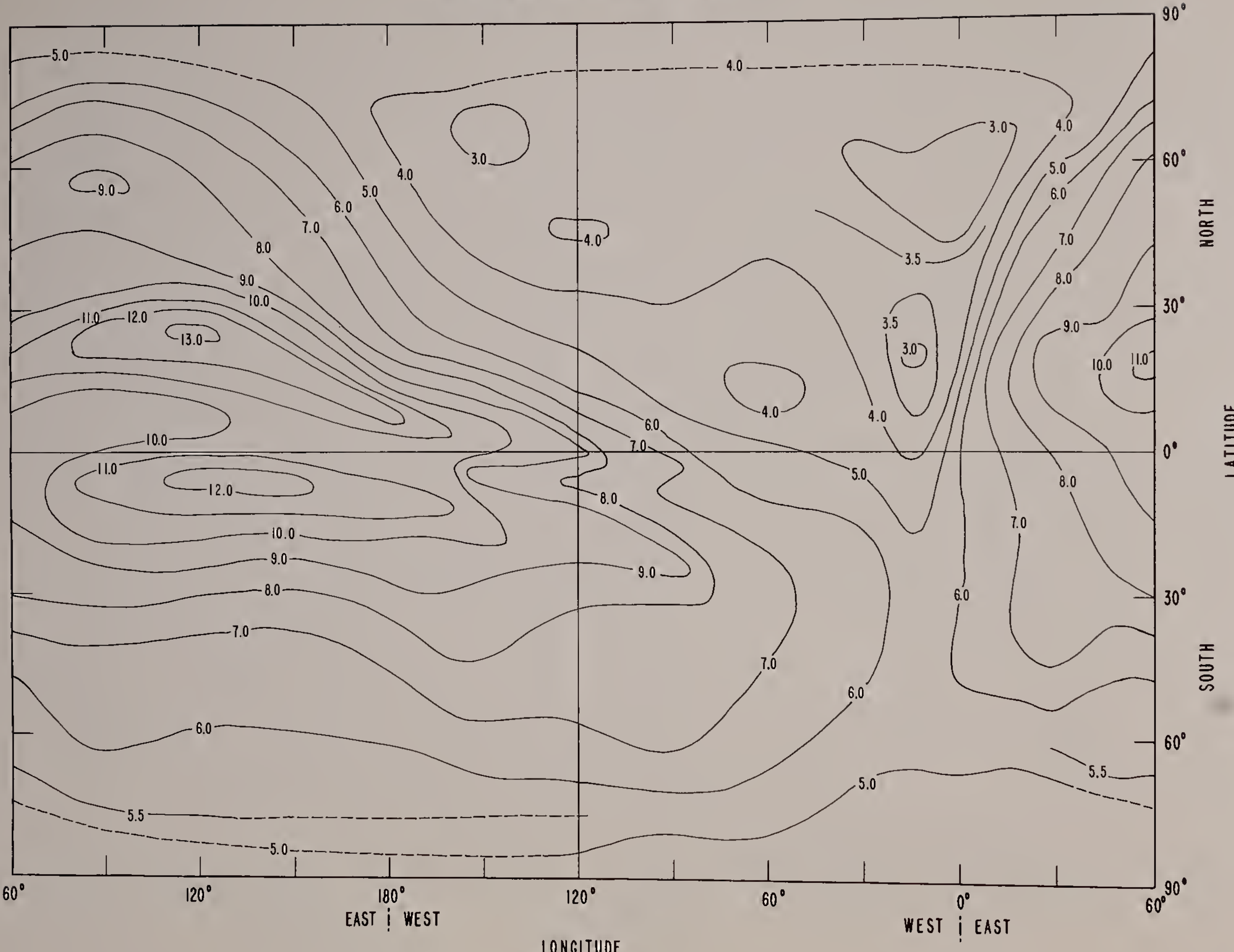
NOVEMBER 0200 HOURS GMT



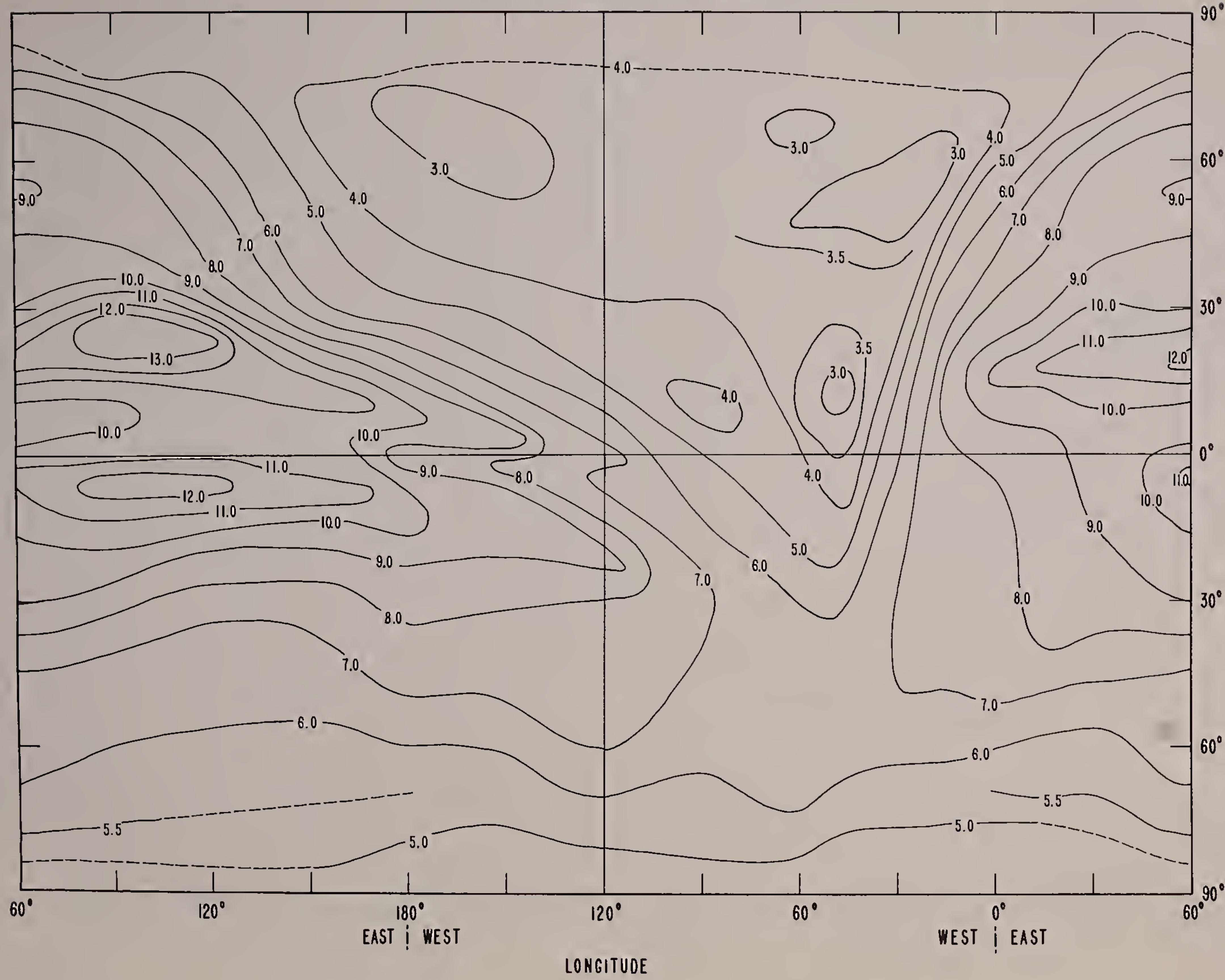
f_oF2 AT RASSN 50
NOVEMBER 0400 HOURS GMT



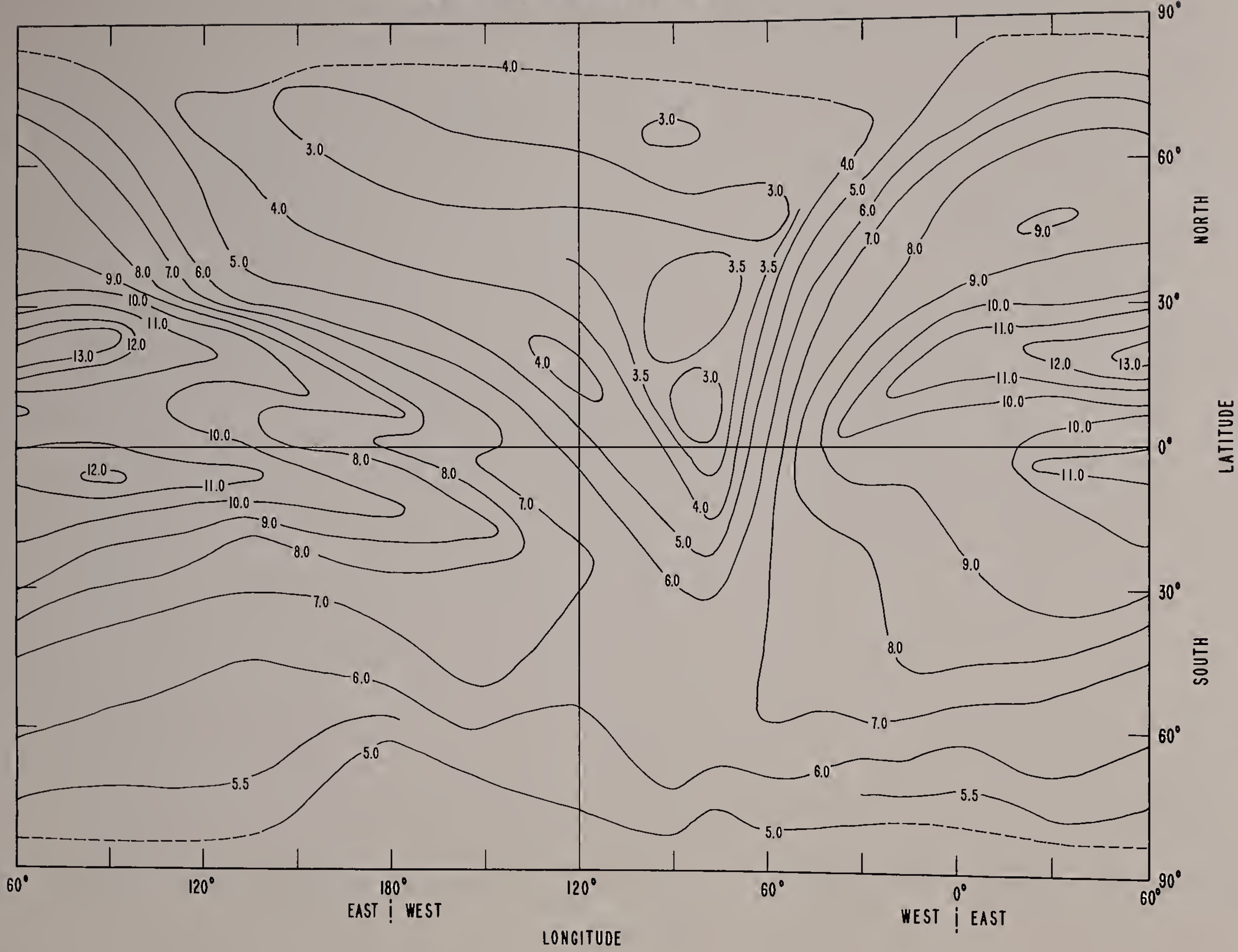
f₀F2 AT RASSN 50
NOVEMBER 0600 HOURS GMT



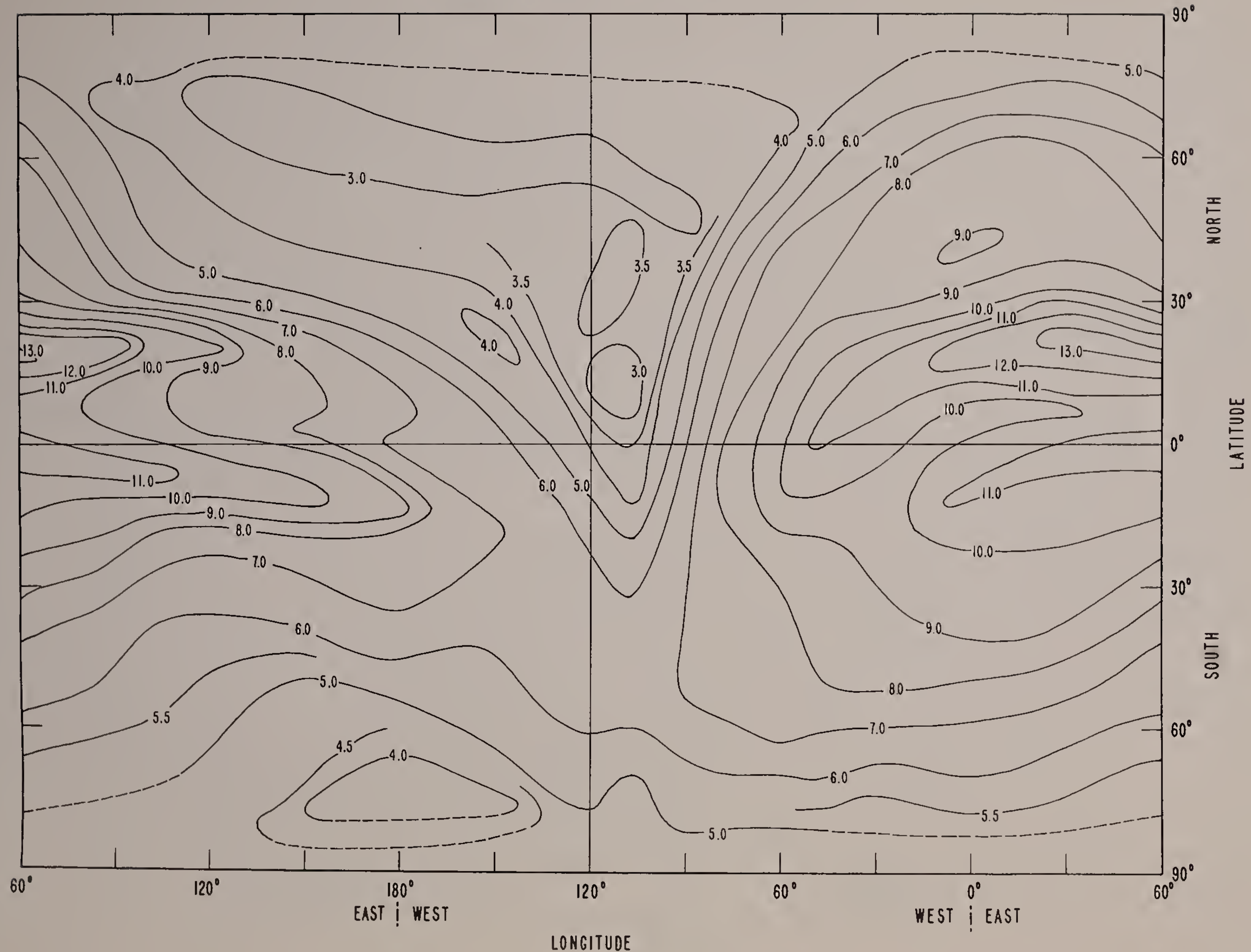
f_oF2 AT RASSN 50
NOVEMBER 0800 HOURS GMT



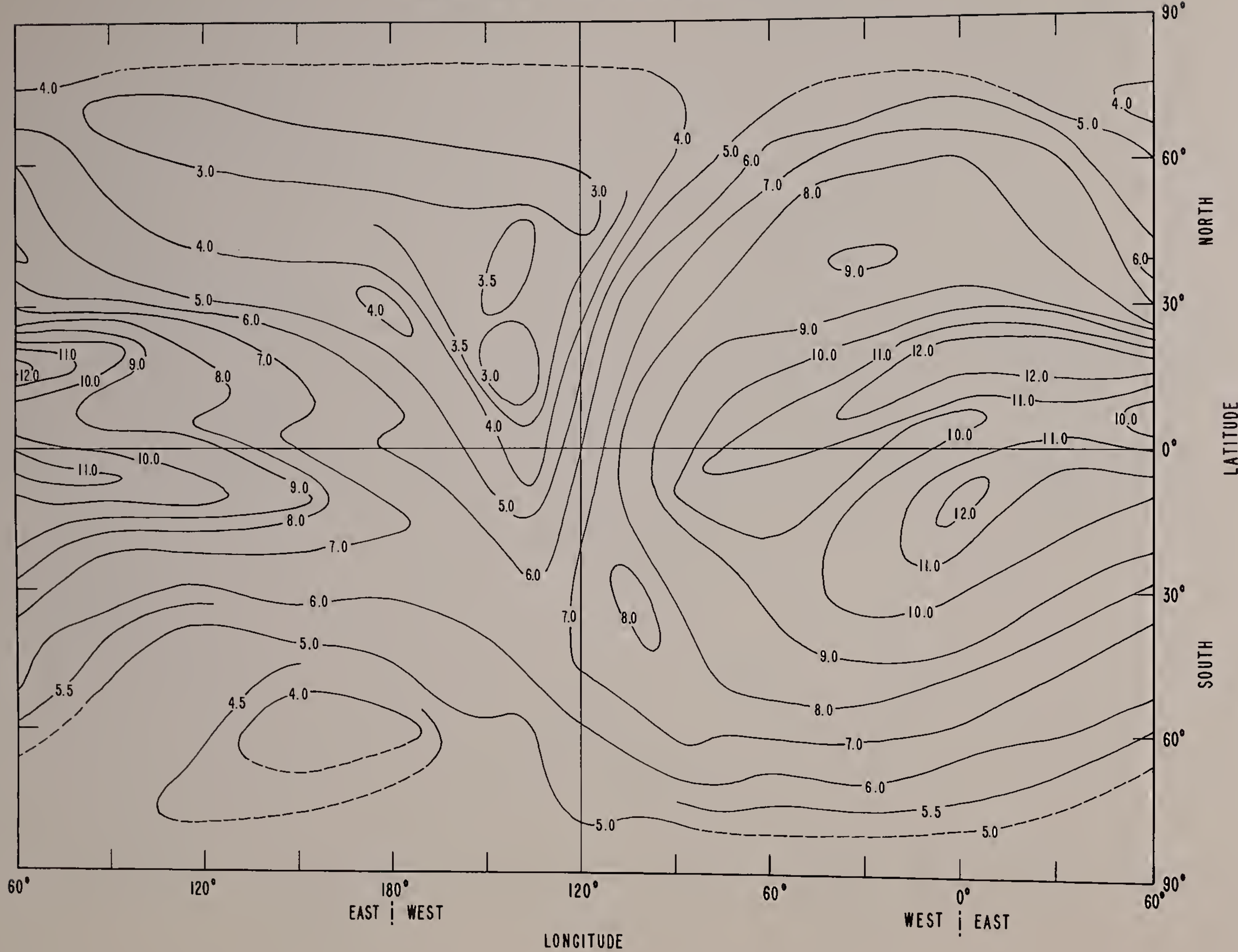
f_oF2 AT RASSN 50
NOVEMBER 1000 HOURS GMT



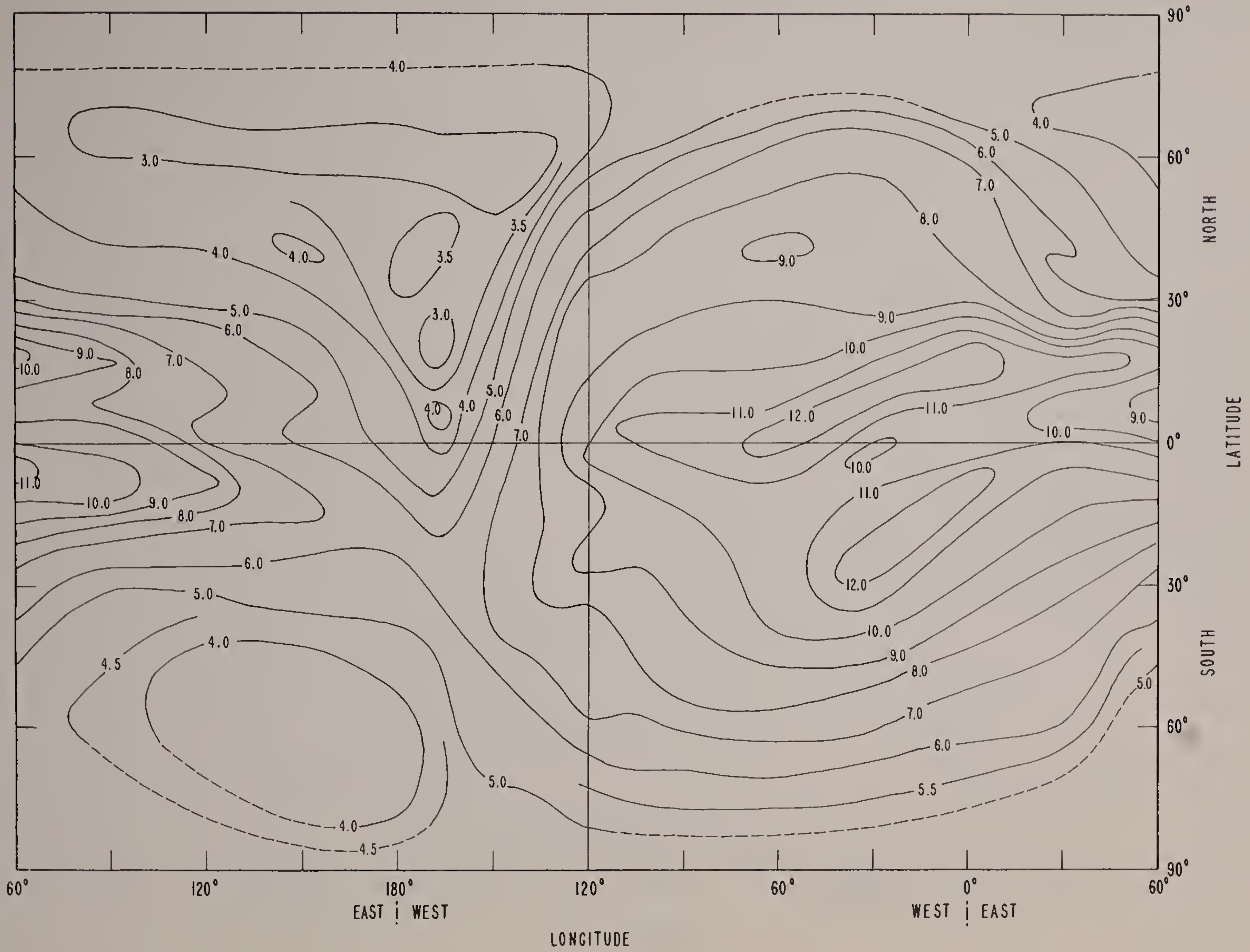
f_oF2 AT RASSN 50
NOVEMBER 1200 HOURS GMT



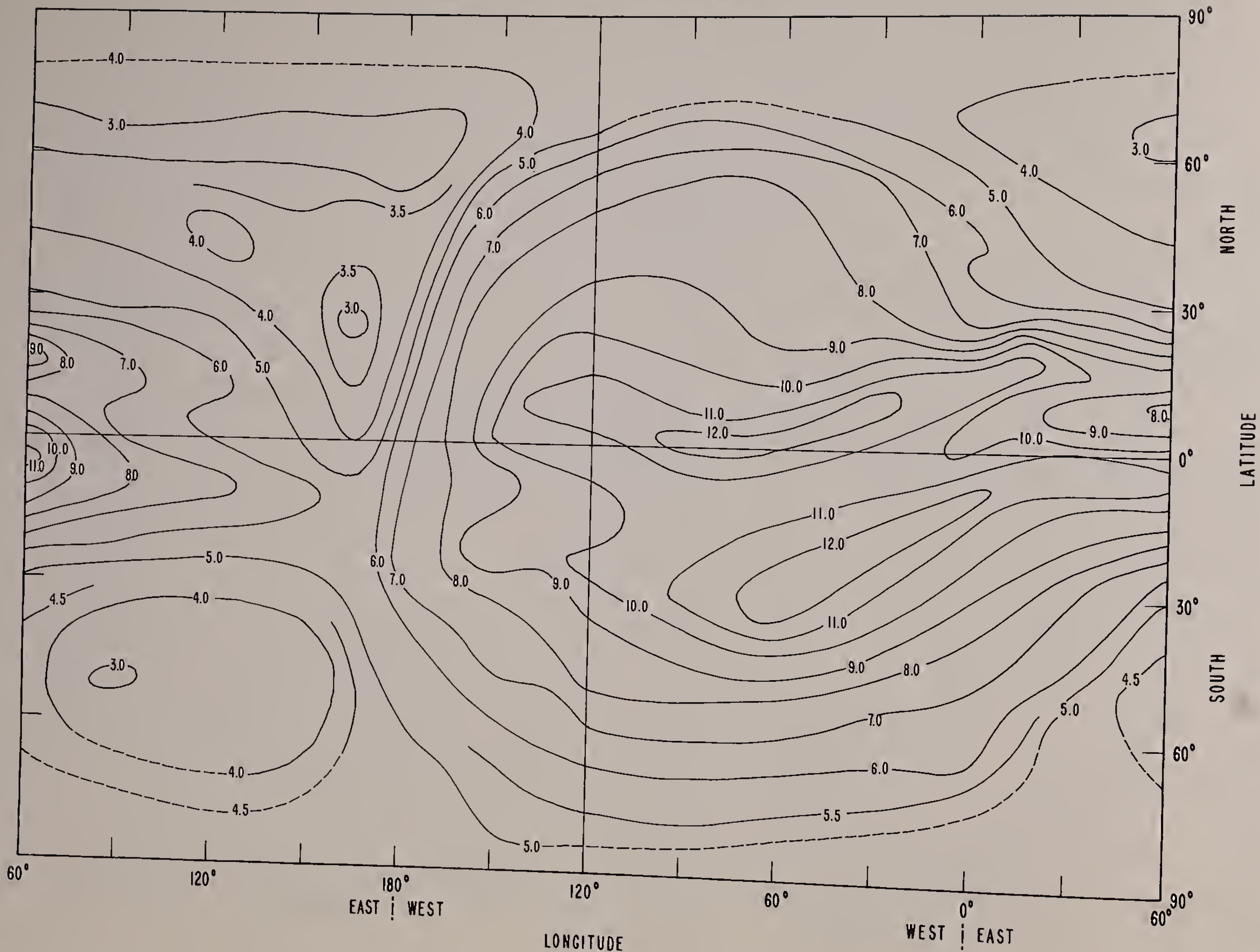
f_oF2 AT RASSN 50
NOVEMBER 1400 HOURS GMT



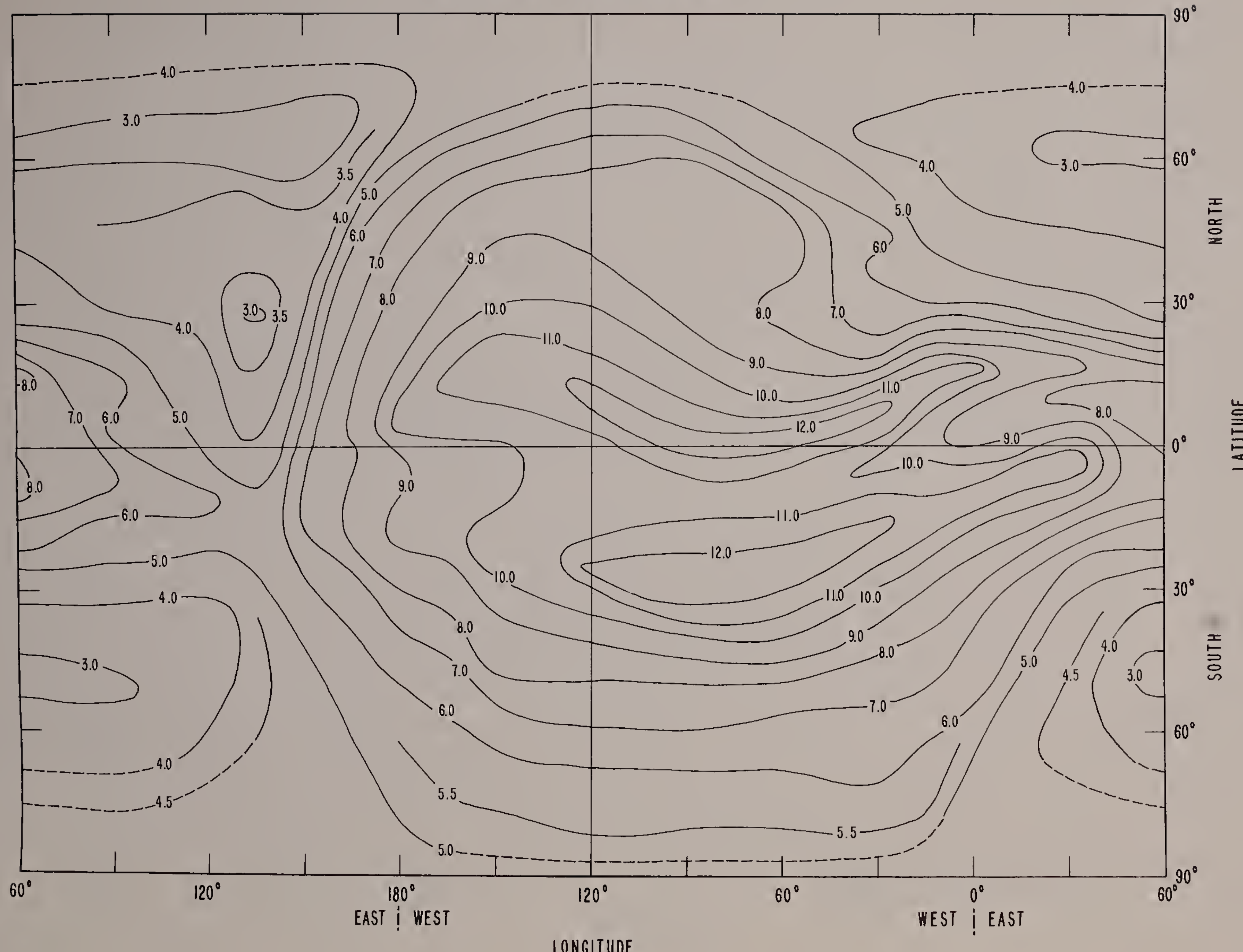
f_oF2 AT RASSN 50
NOVEMBER 1600 HOURS GMT



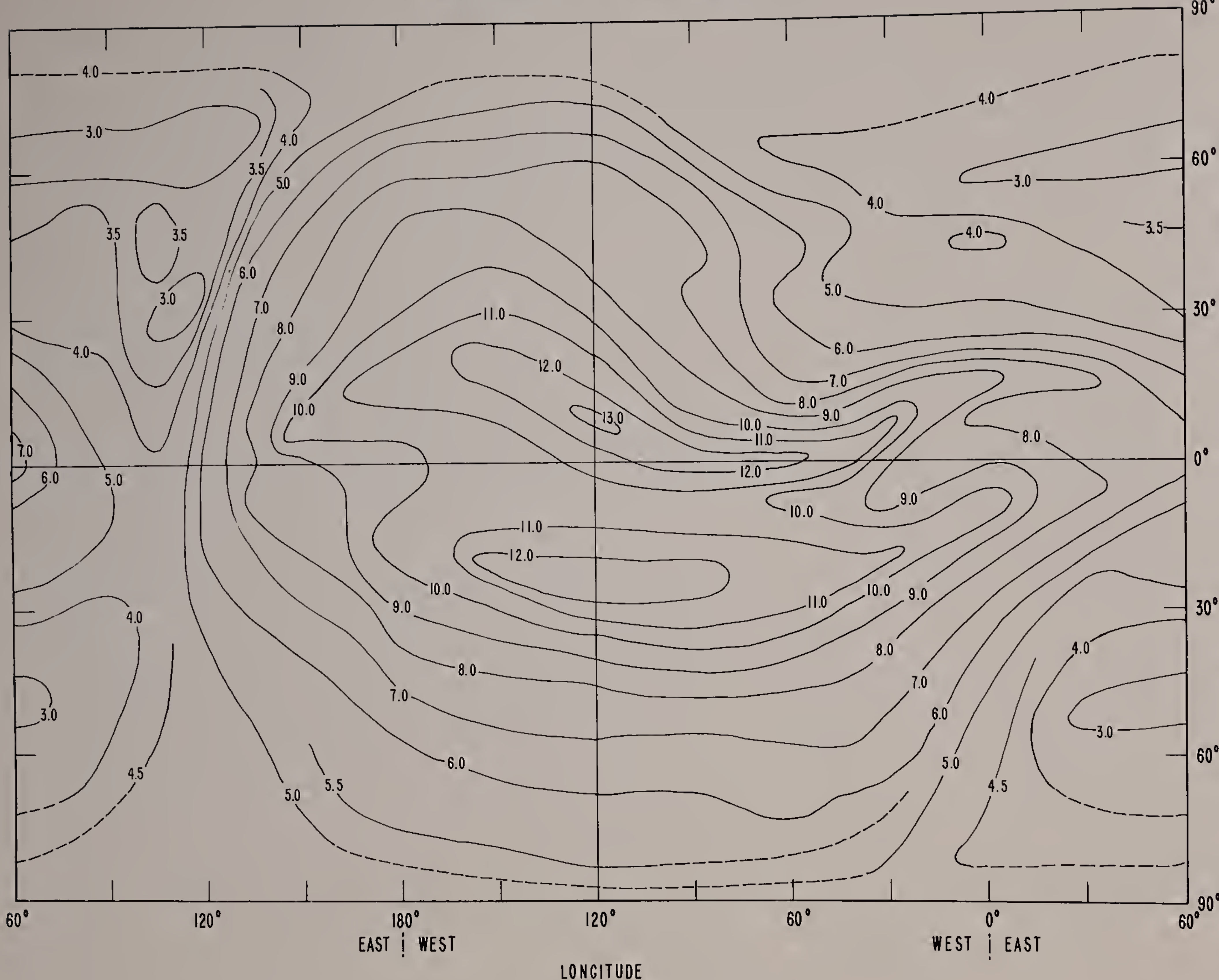
f₀F2 AT RASSN 50
NOVEMBER 1800 HOURS GMT



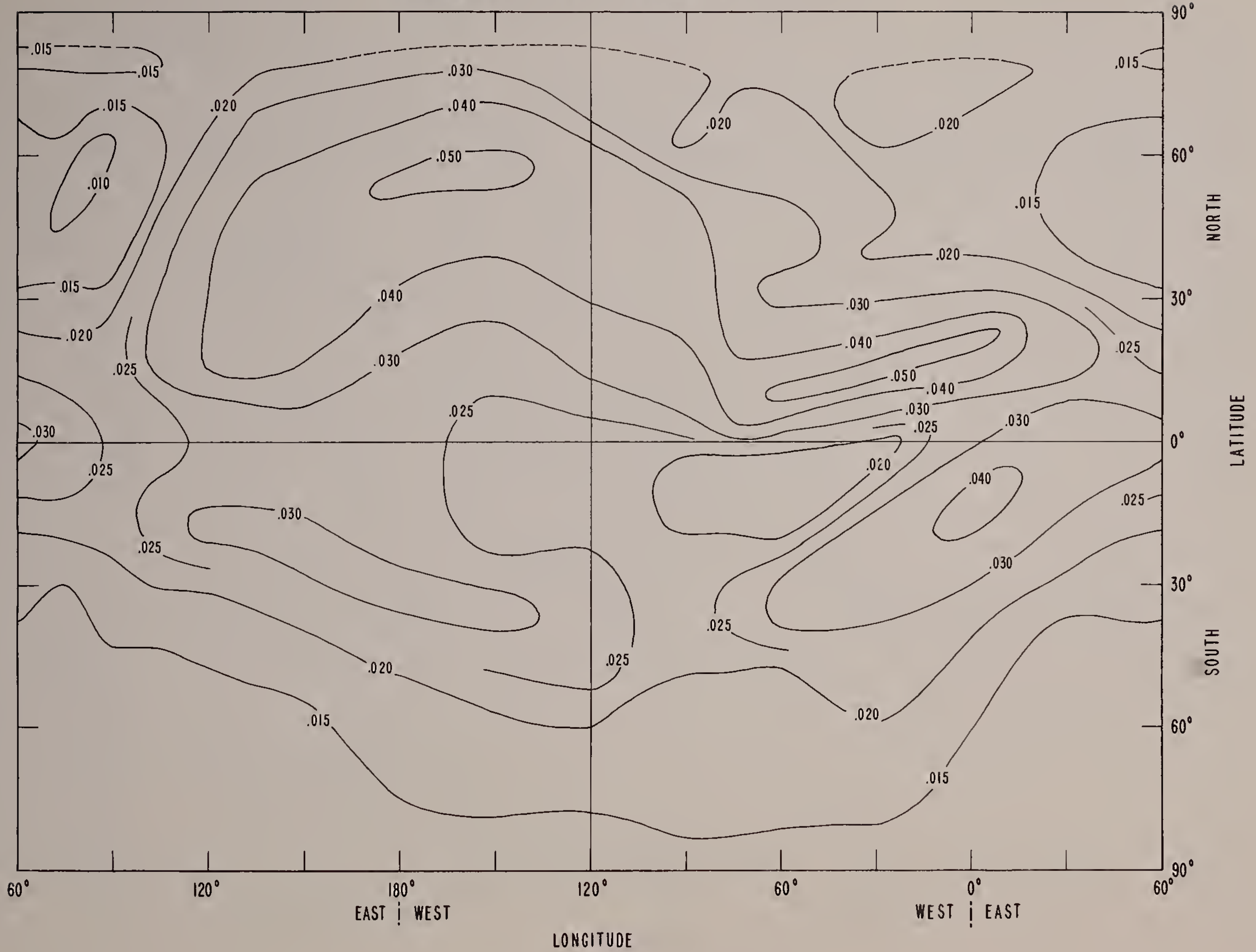
f_oF2 AT RASSN 50
NOVEMBER 2000 HOURS GMT



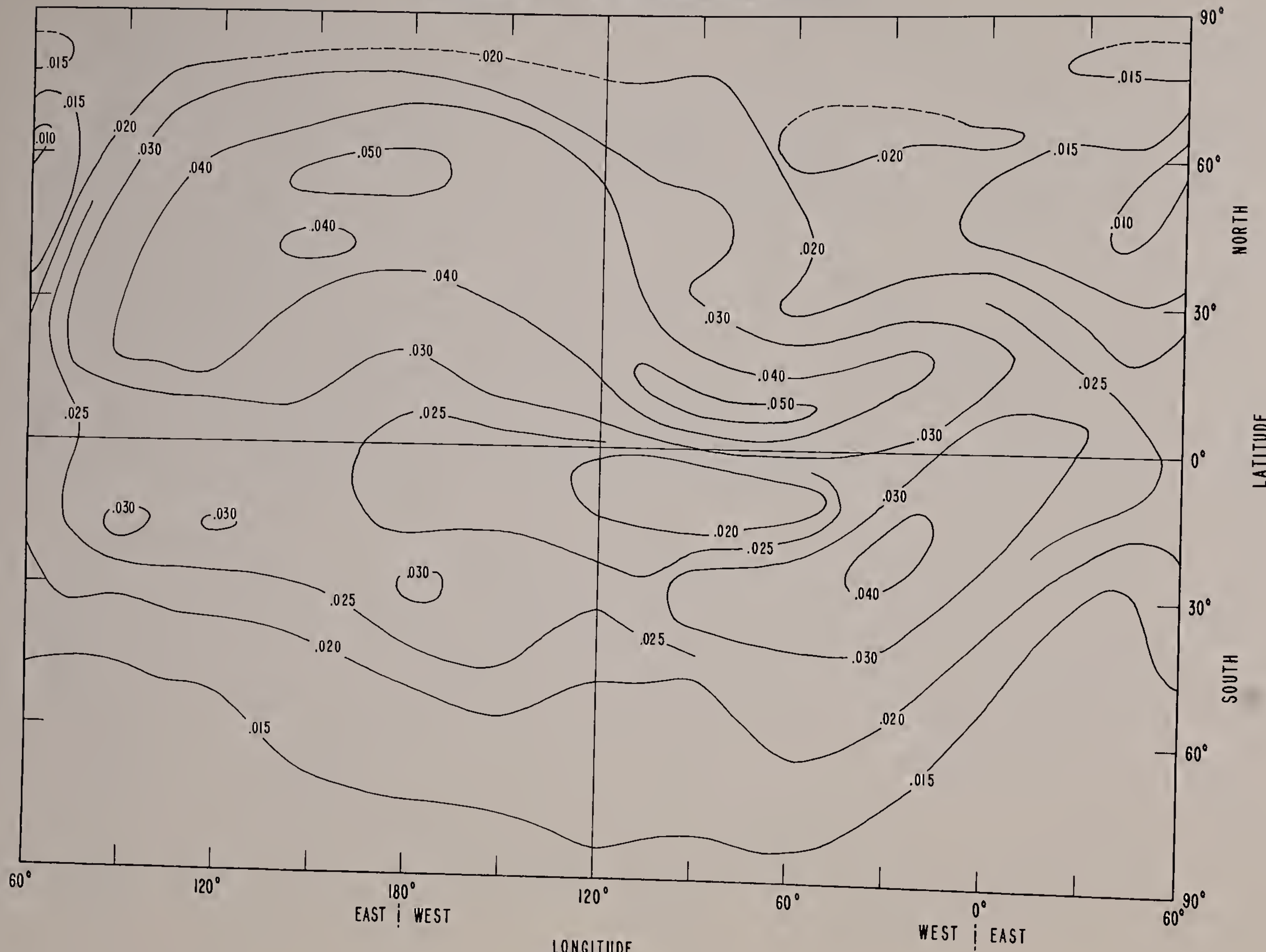
f_oF2 AT RASSN 50
NOVEMBER 2200 HOURS GMT



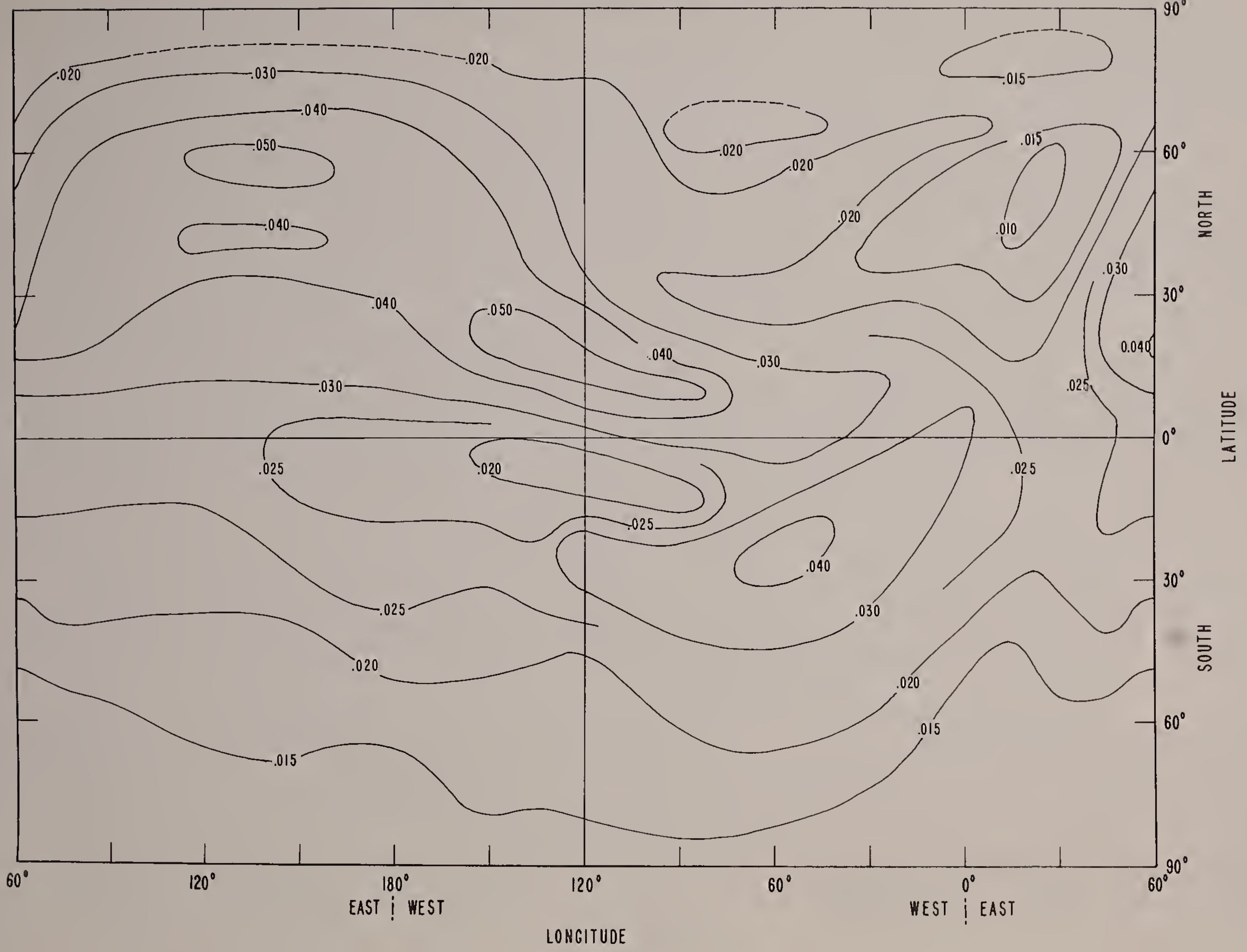
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 0000 HOURS GMT



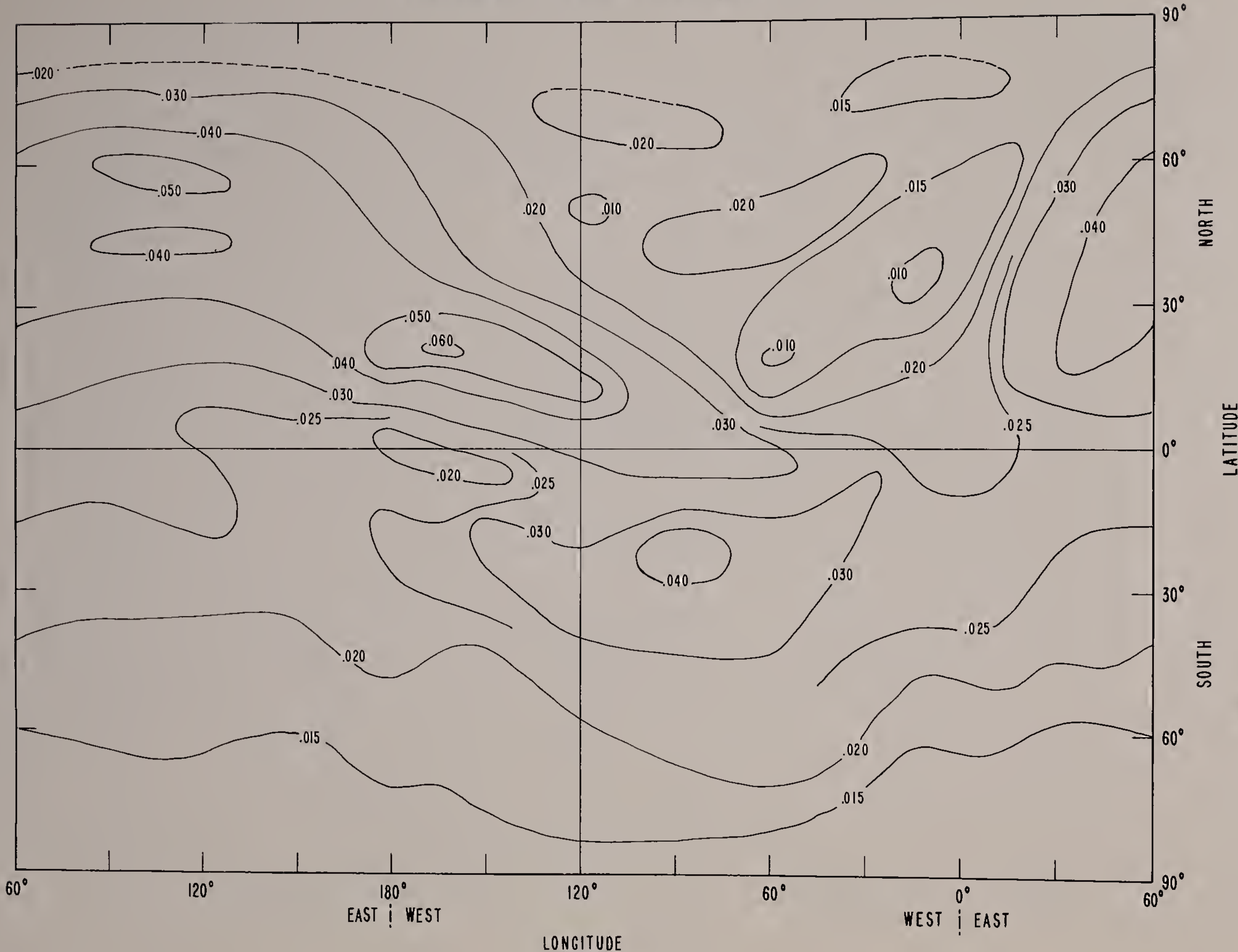
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 0200 HOURS GMT



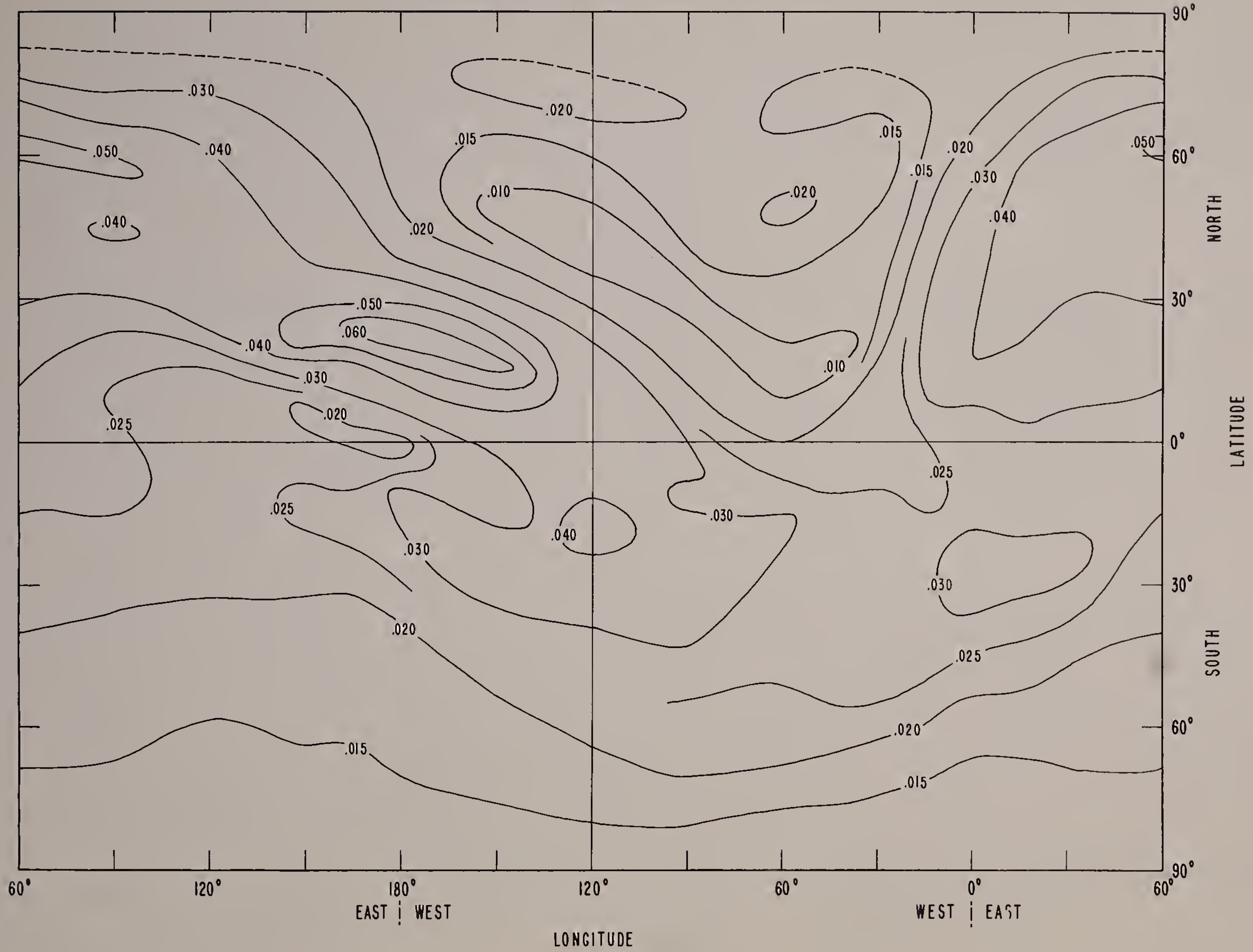
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 0400 HOURS GMT



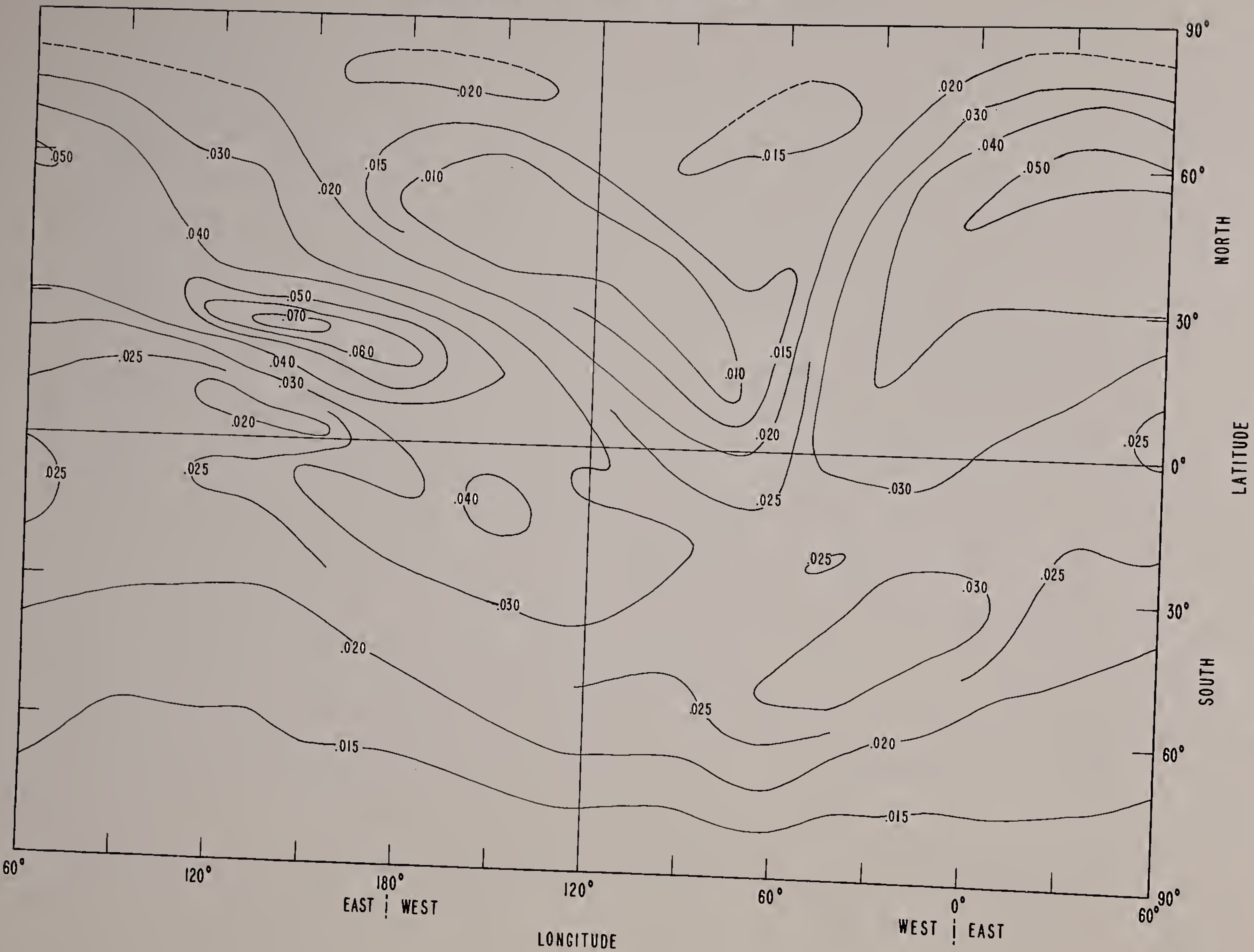
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 0600 HOURS GMT



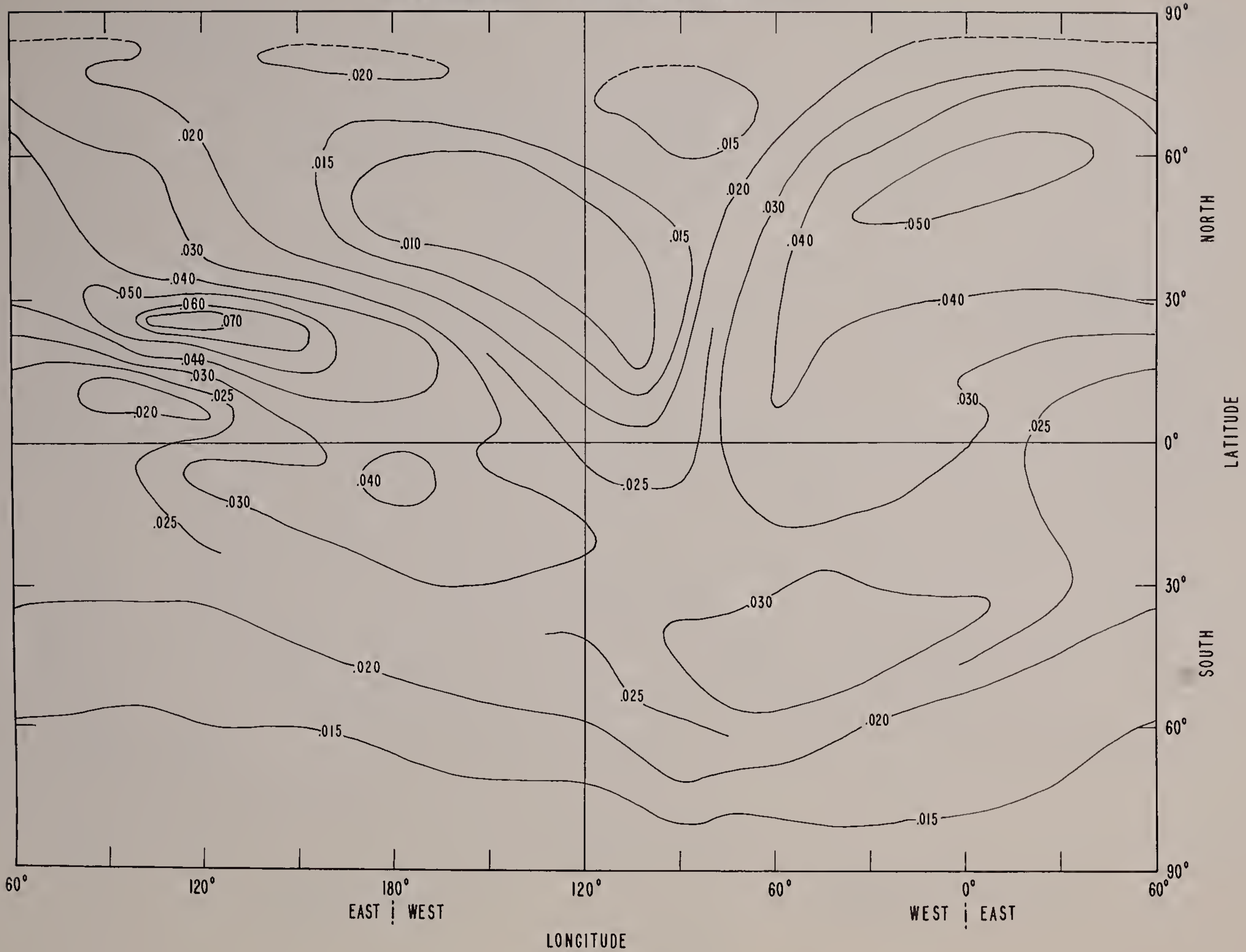
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 0800 HOURS GMT



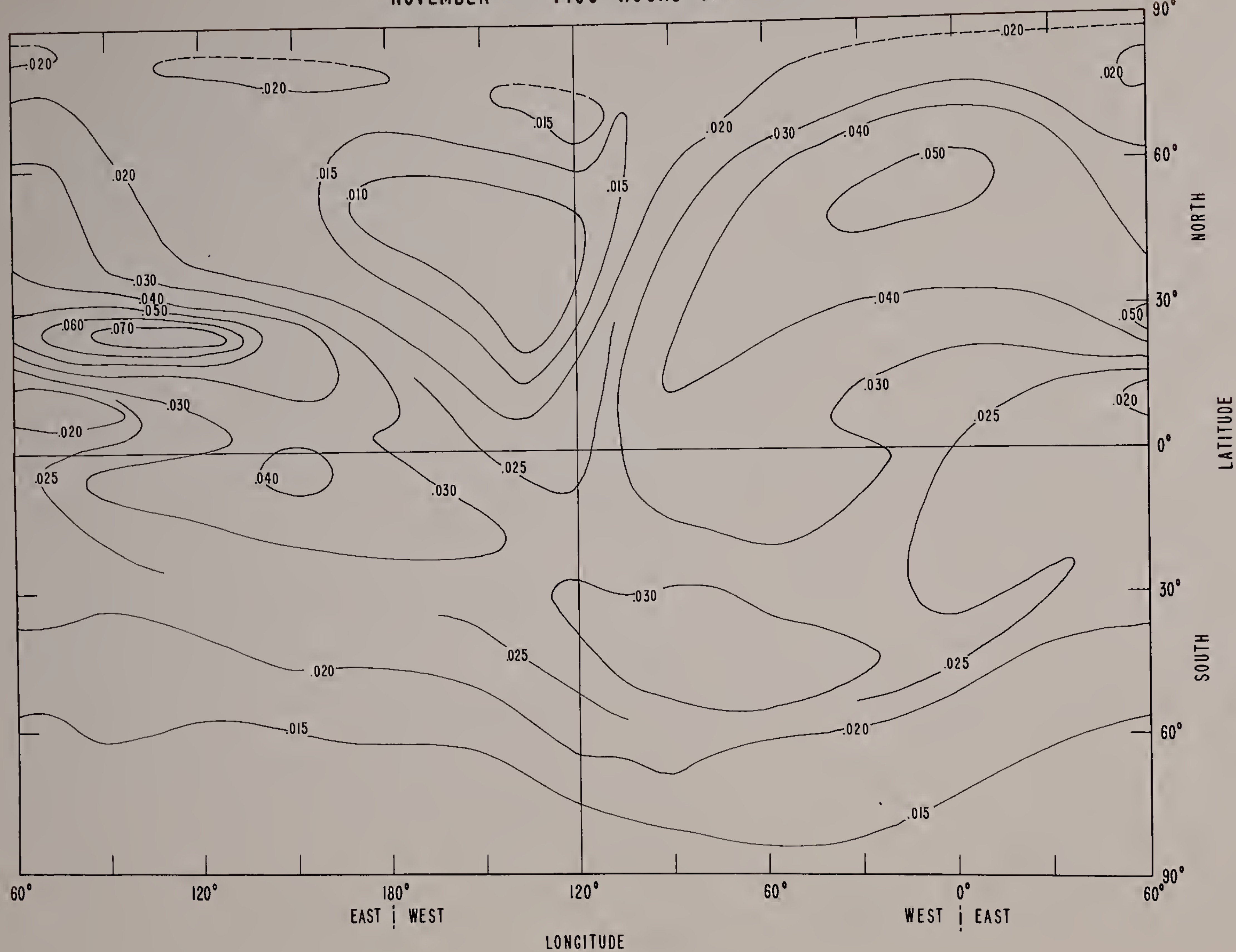
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 1000 HOURS GMT



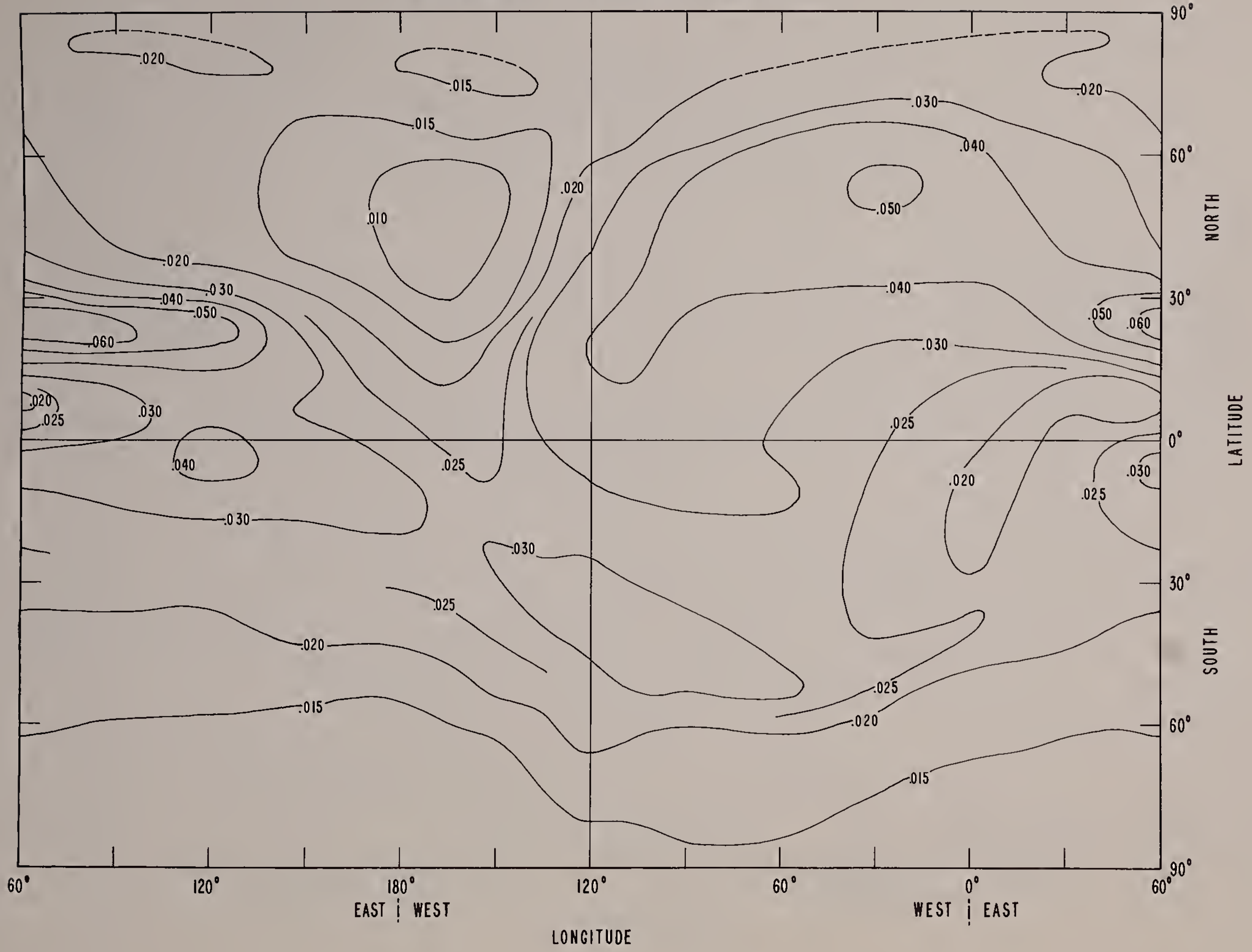
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 1200 HOURS GMT



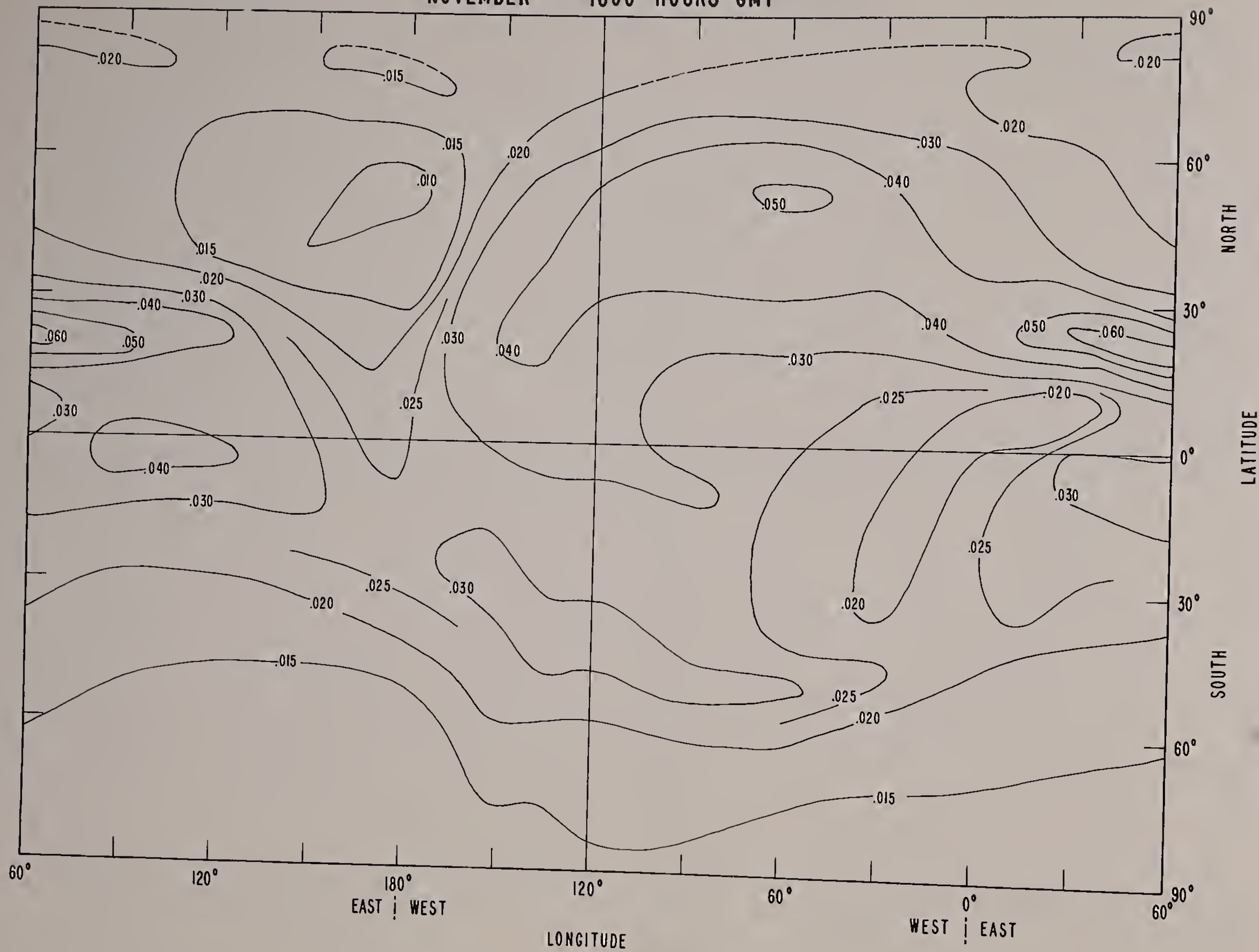
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 1400 HOURS GMT

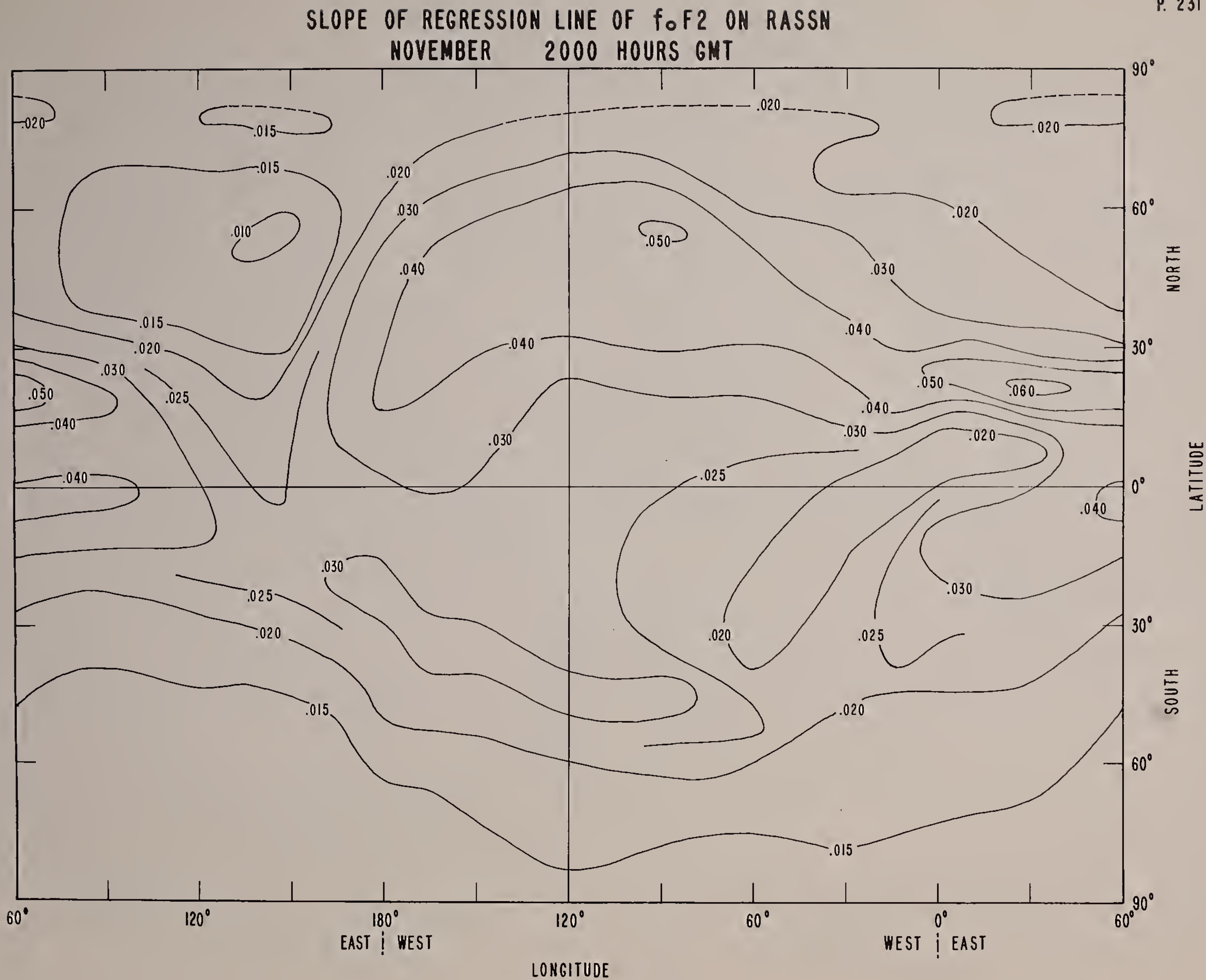


SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 1600 HOURS GMT

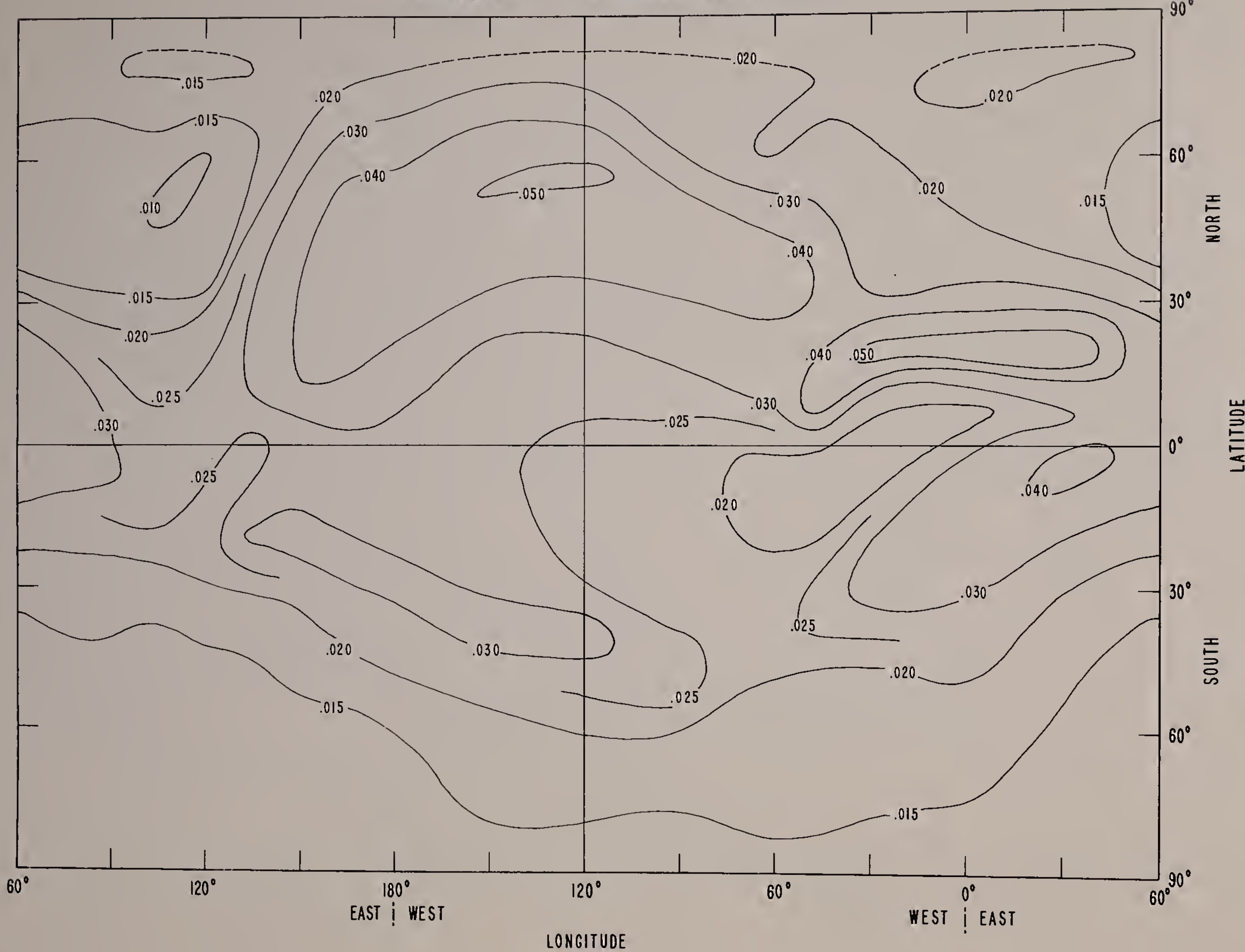


SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 1800 HOURS GMT

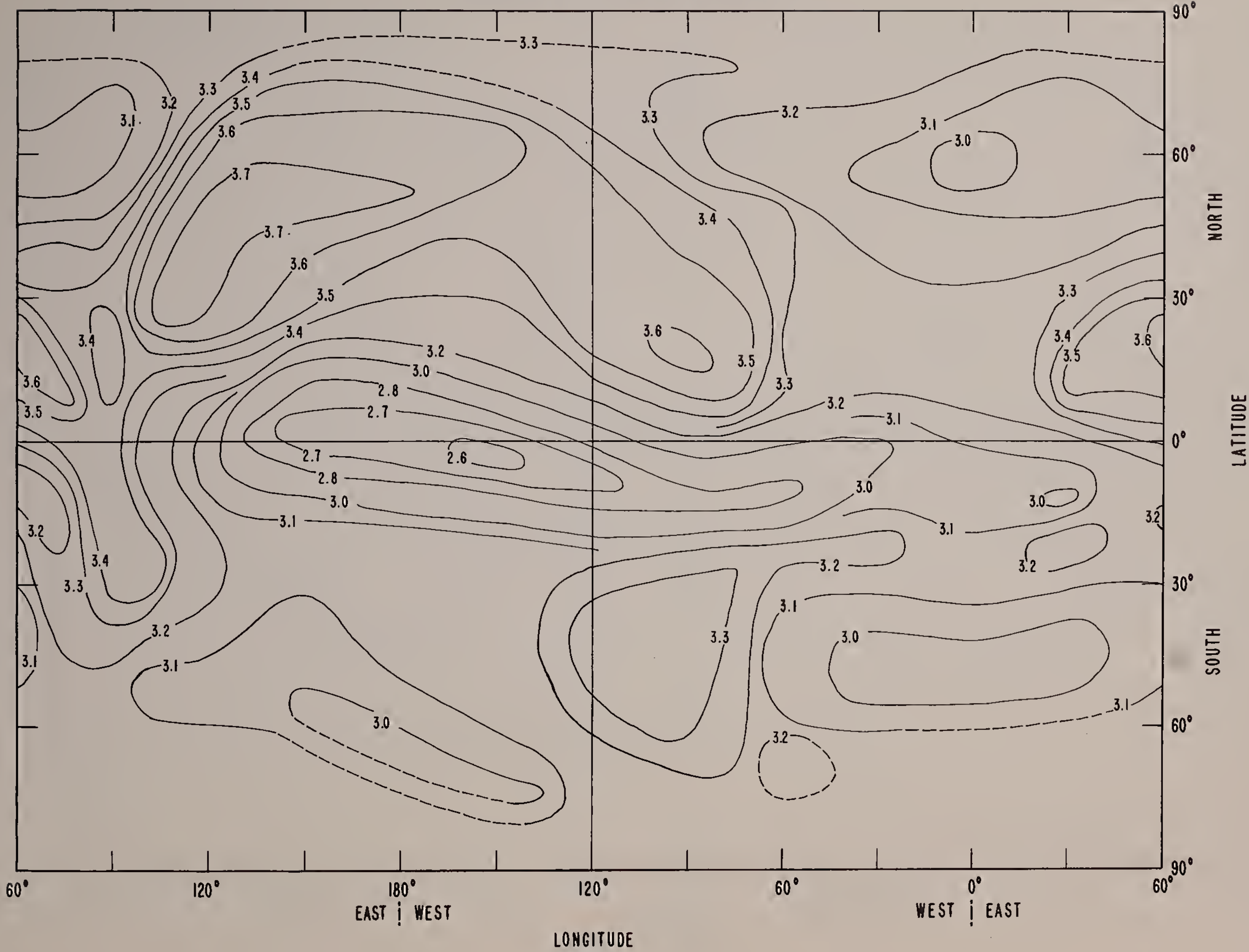



SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 2000 HOURS GMT
.010
.015
.020
.025
.030
.040
.050
.060
90°
60°
30°
0°
30°
60°
90°
NORTH
SOUTH
LATITUDE
60°
120°
180°
120°
60°
0°
60°
EAST ¦ WEST
WEST ¦ EAST
LONGITUDE

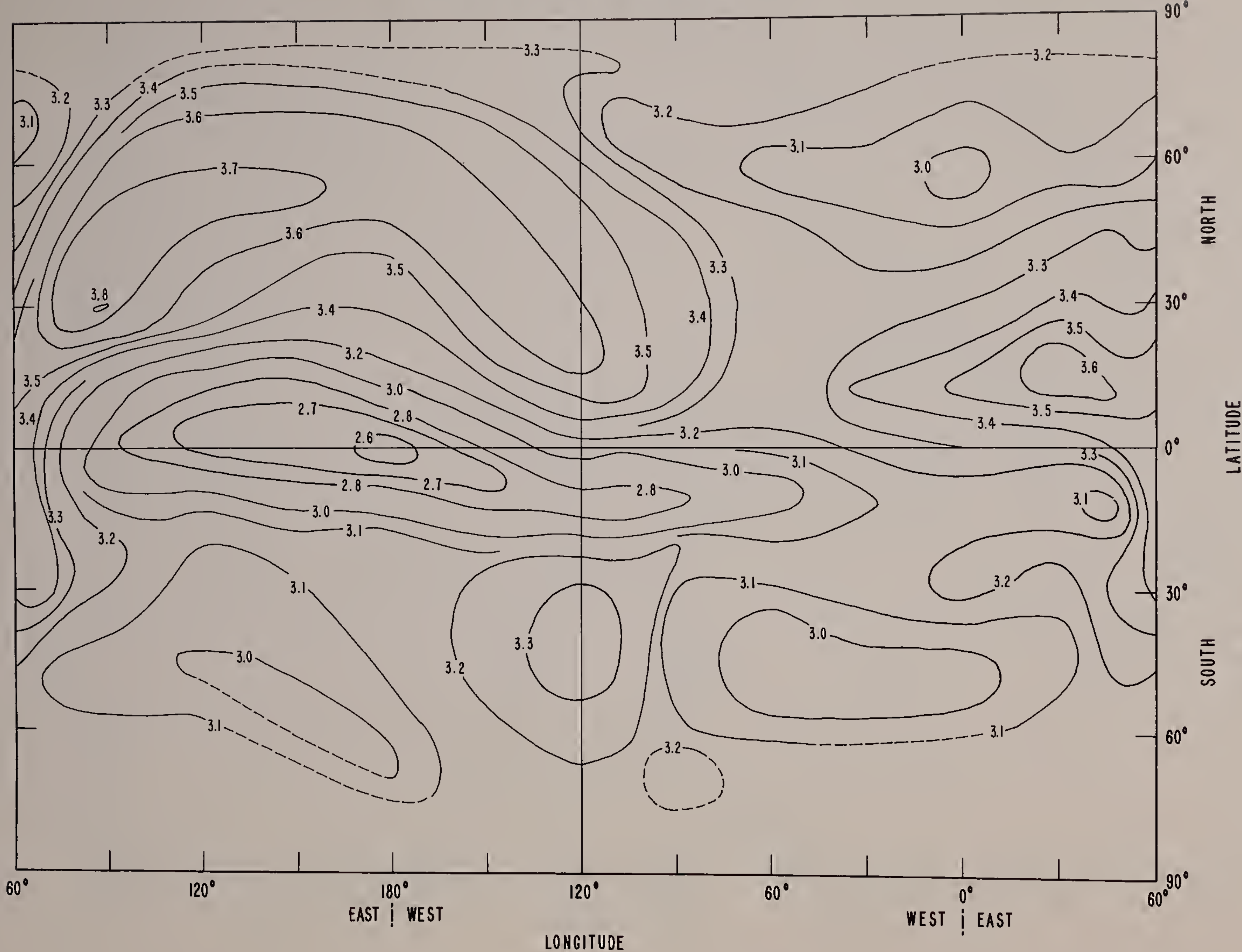
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
NOVEMBER 2200 HOURS GMT



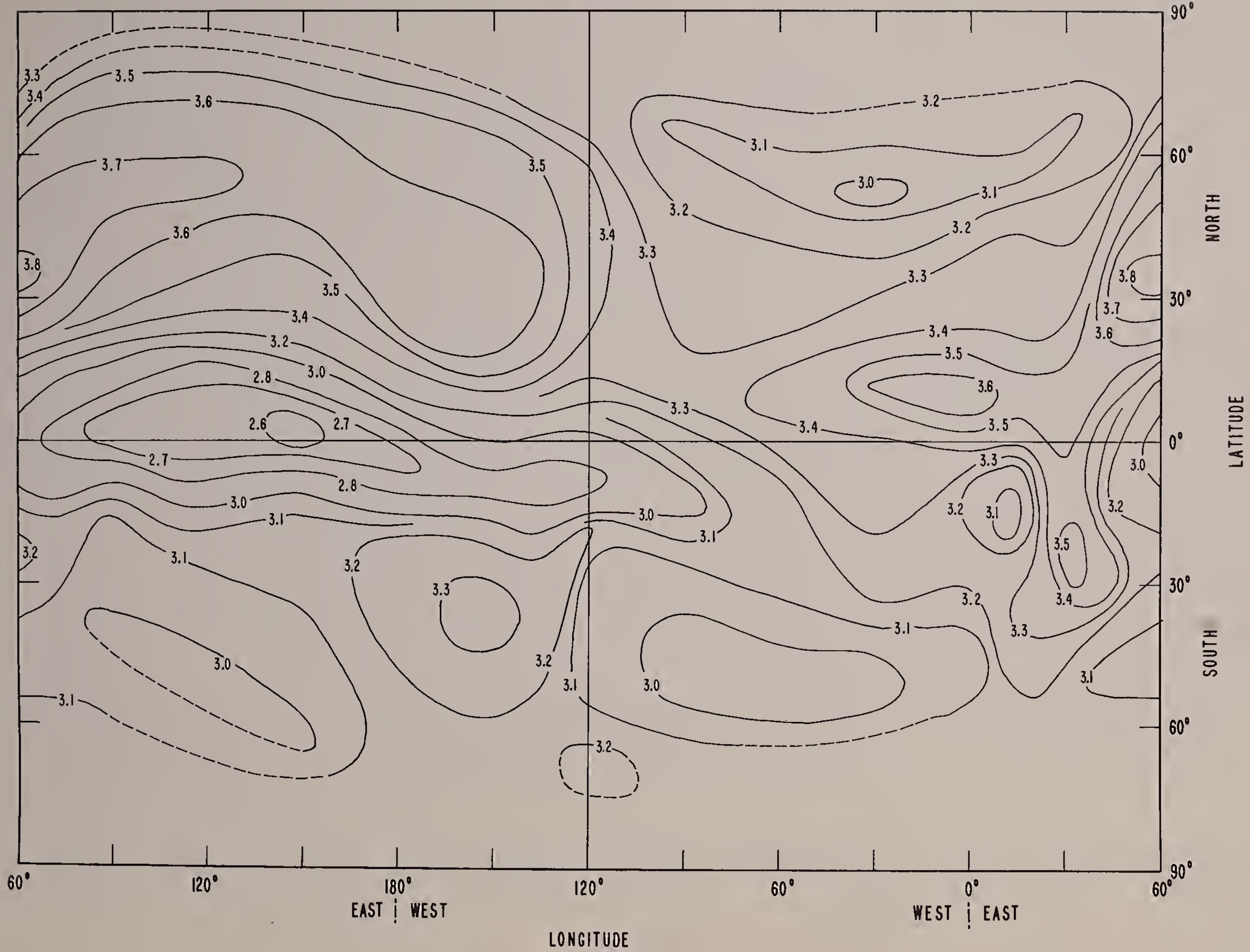
M — 4000 FACTOR AT RASSN 50
NOVEMBER 0000 HOURS GMT



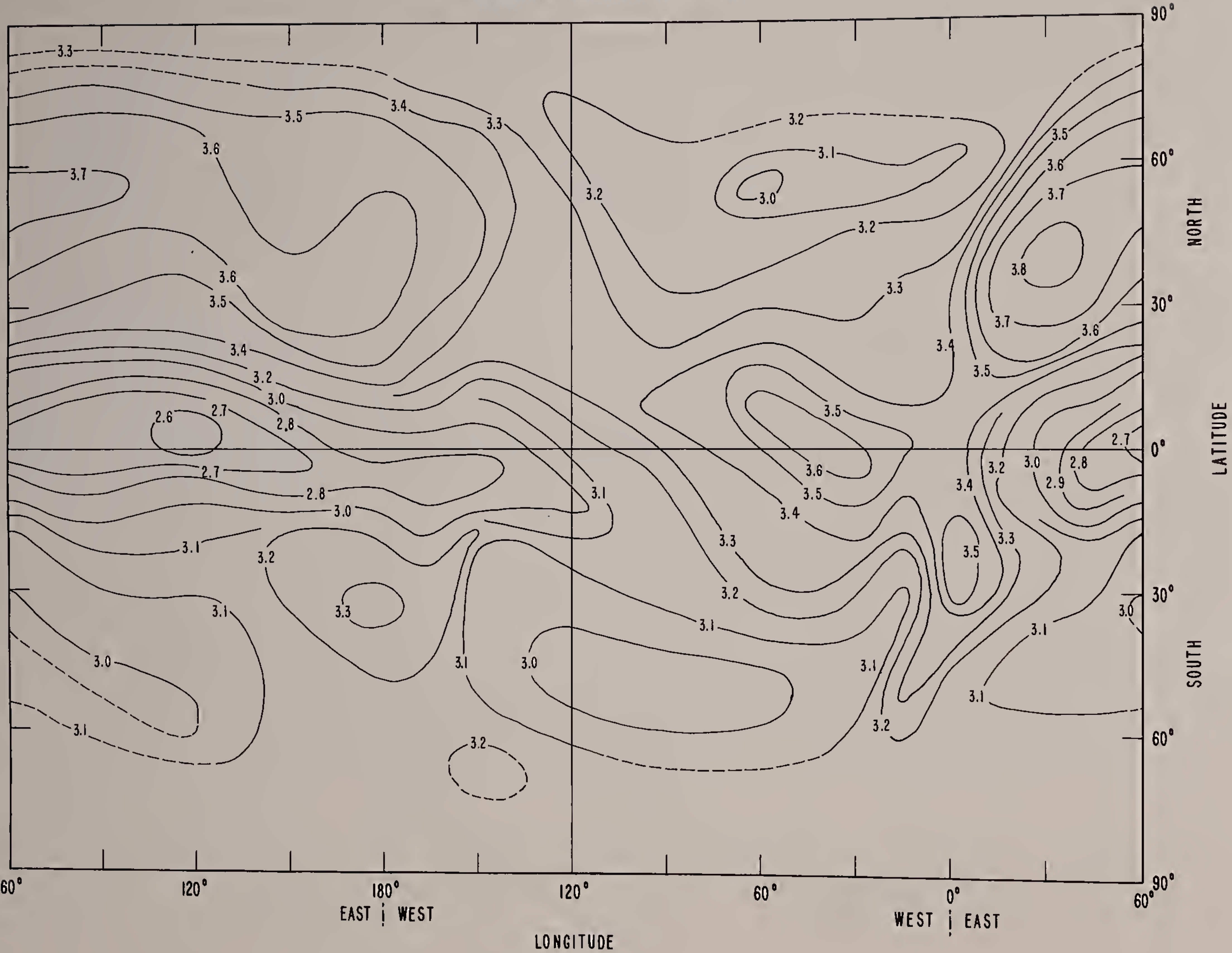
M — 4000 FACTOR AT RASSN 50
NOVEMBER 0200 HOURS GMT



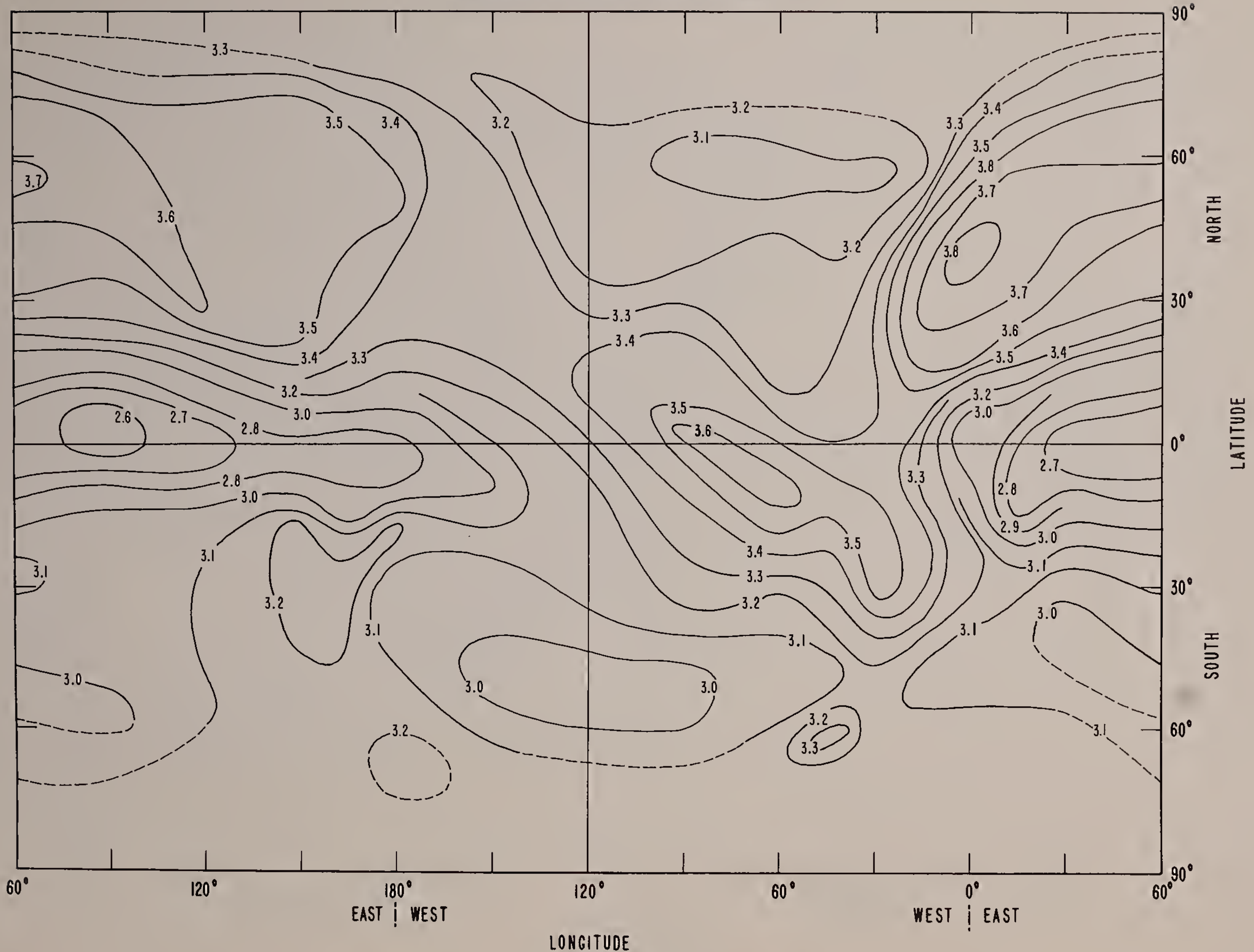
M — 4000 FACTOR AT RASSN 50
NOVEMBER 0400 HOURS GMT



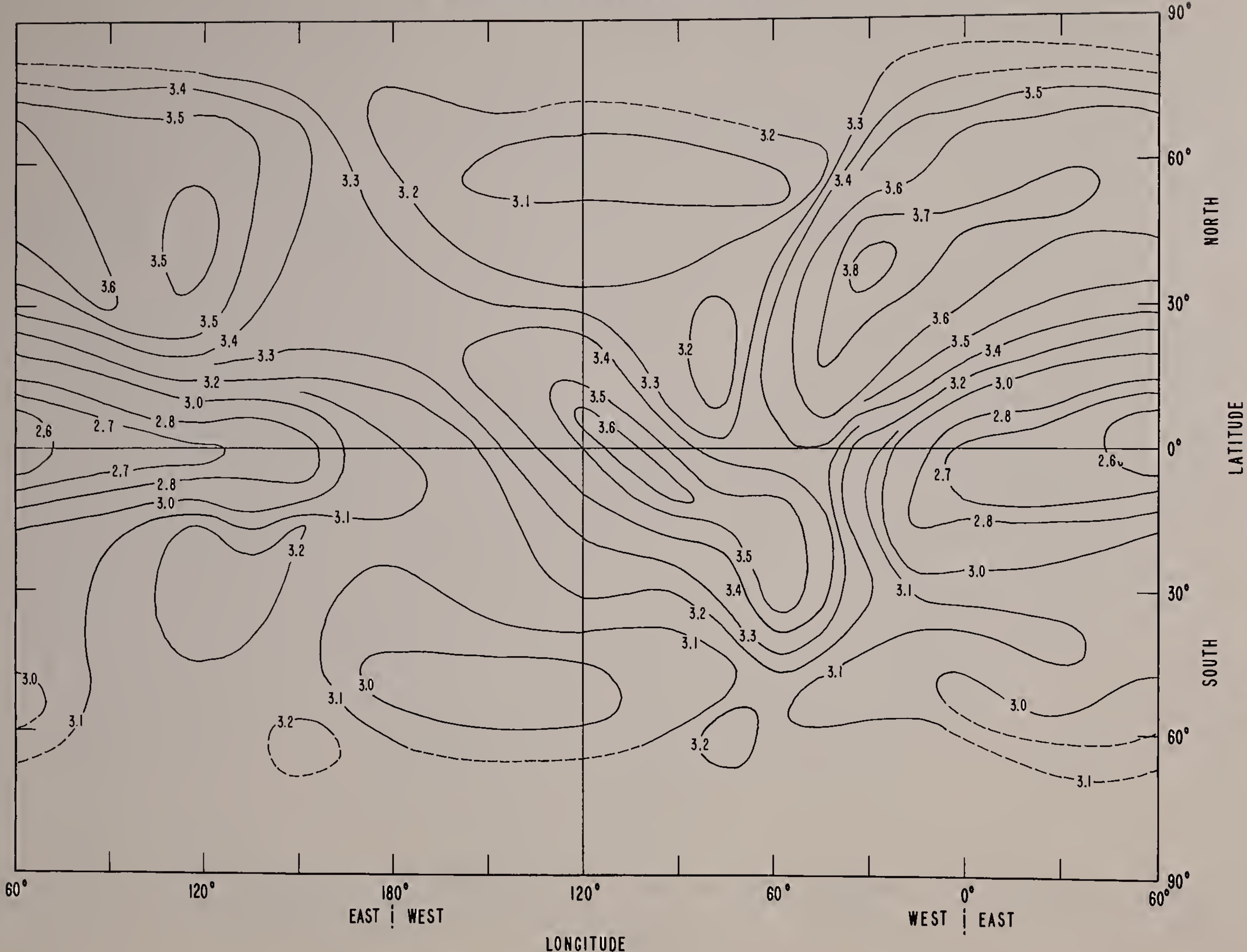
M — 4000 FACTOR AT RASSN 50
NOVEMBER 0600 HOURS GMT



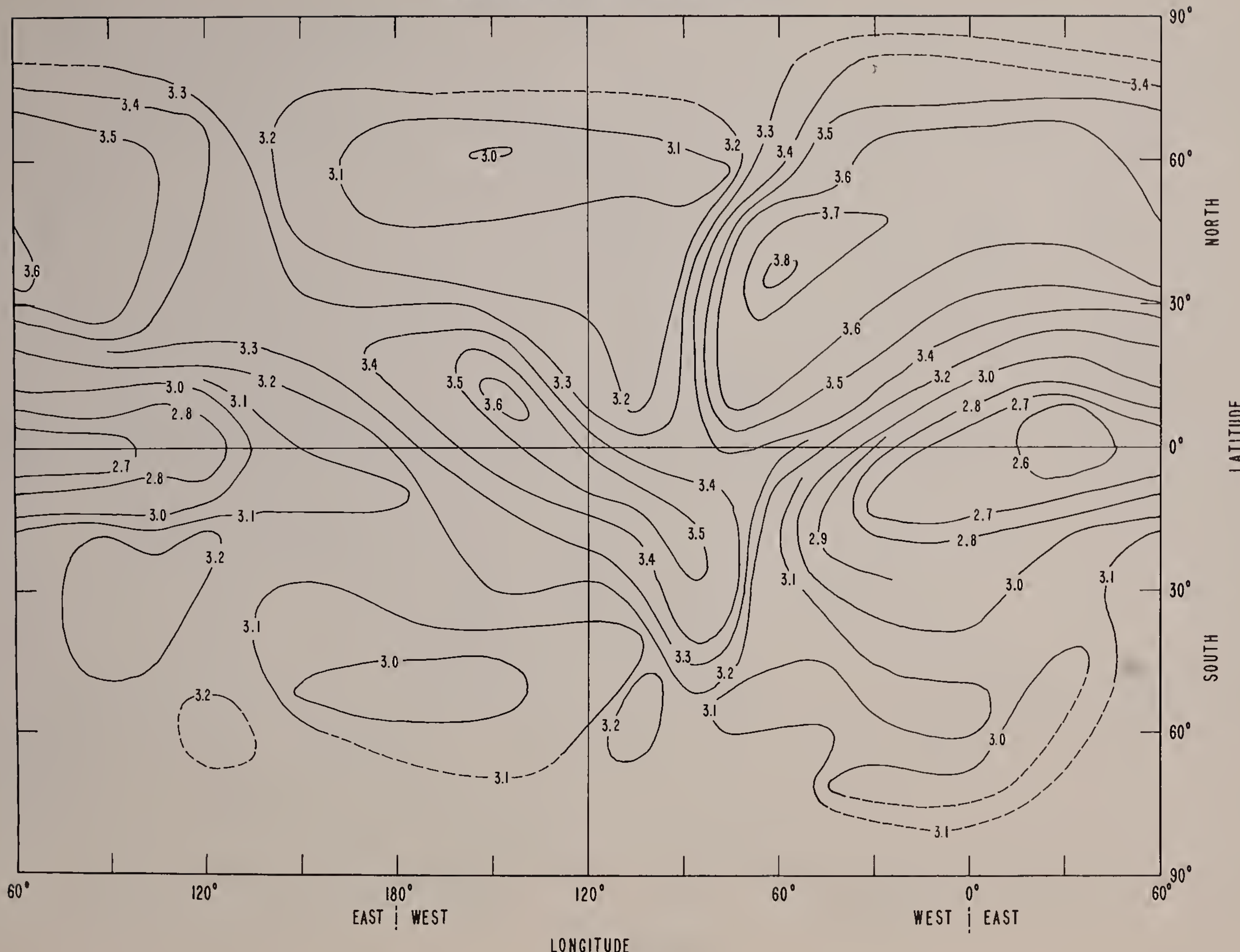
M — 4000 FACTOR AT RASSN 50
NOVEMBER 0800 HOURS GMT



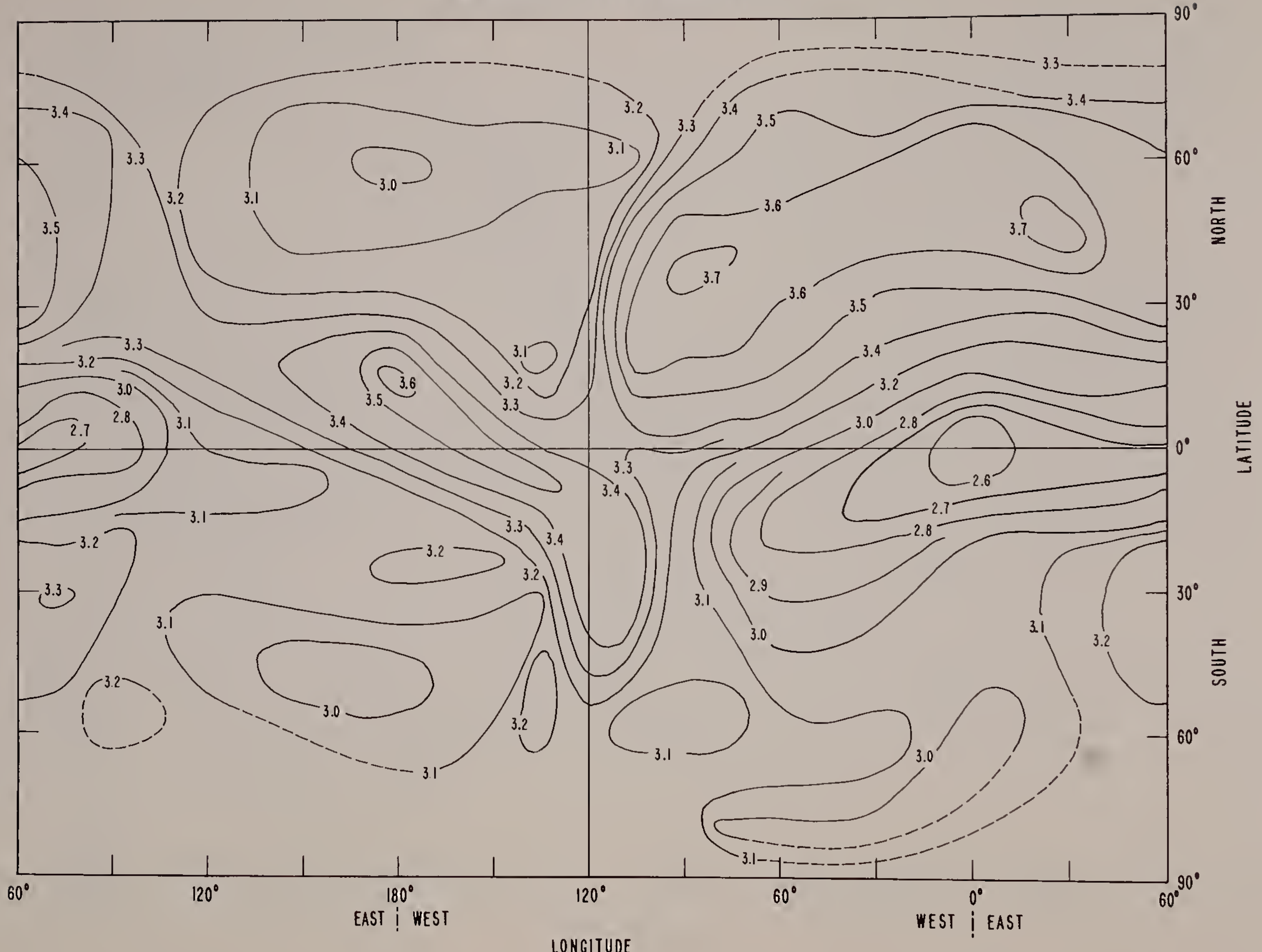
M — 4000 FACTOR AT RASSN 50
NOVEMBER 1000 HOURS GMT



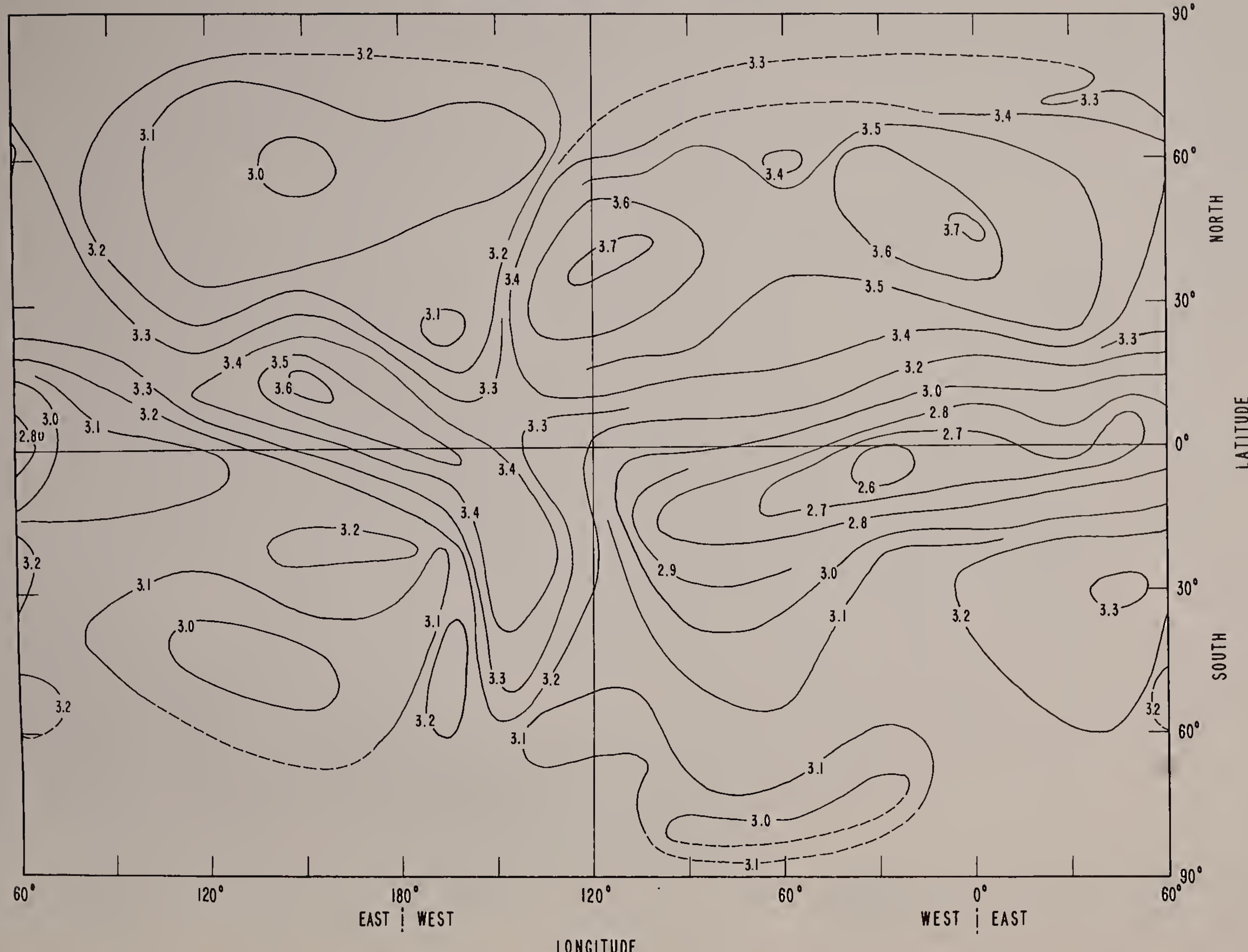
M — 4000 FACTOR AT RASSN 50
NOVEMBER 1200 HOURS GMT



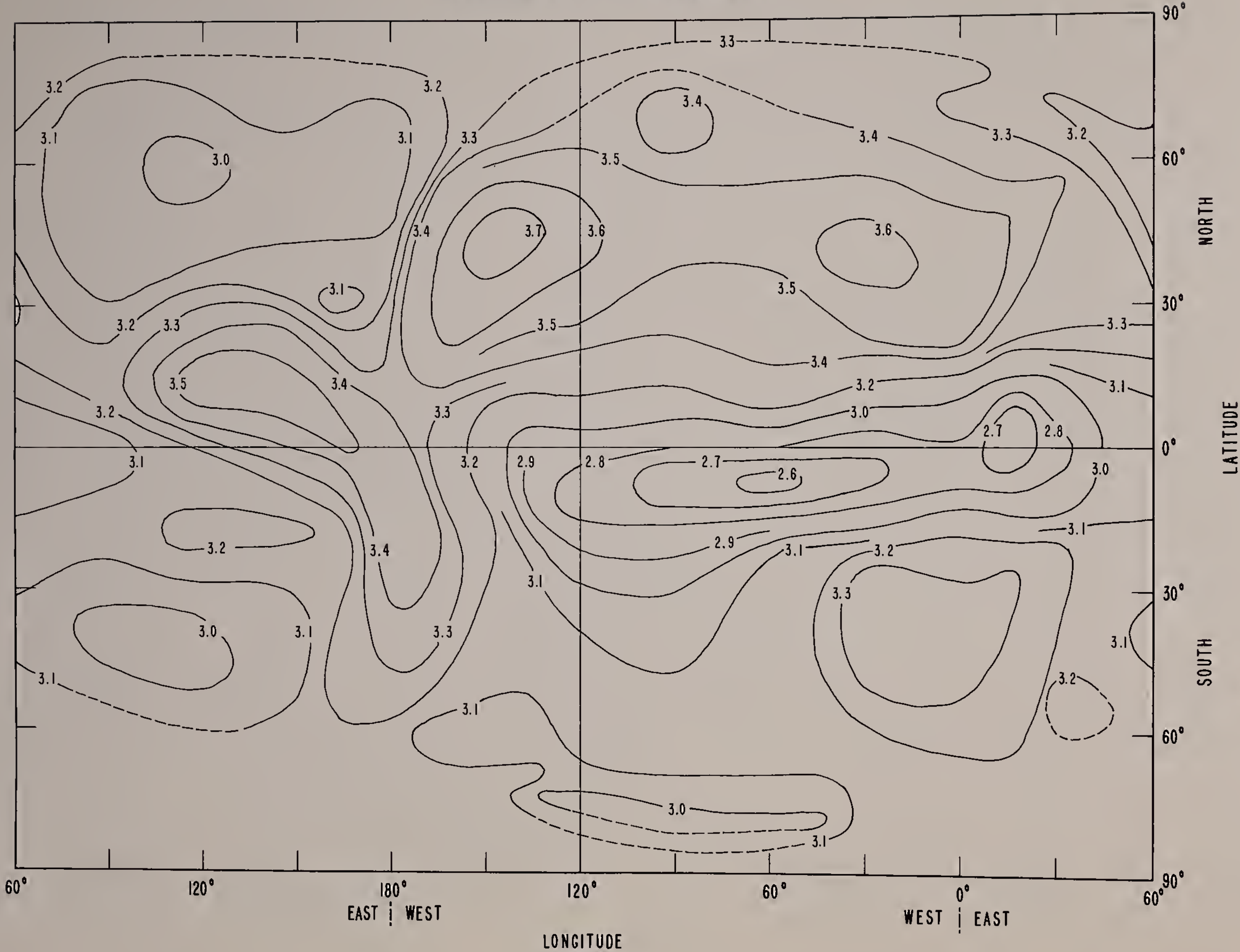
M – 4000 FACTOR AT RASSN 50
NOVEMBER 1400 HOURS GMT



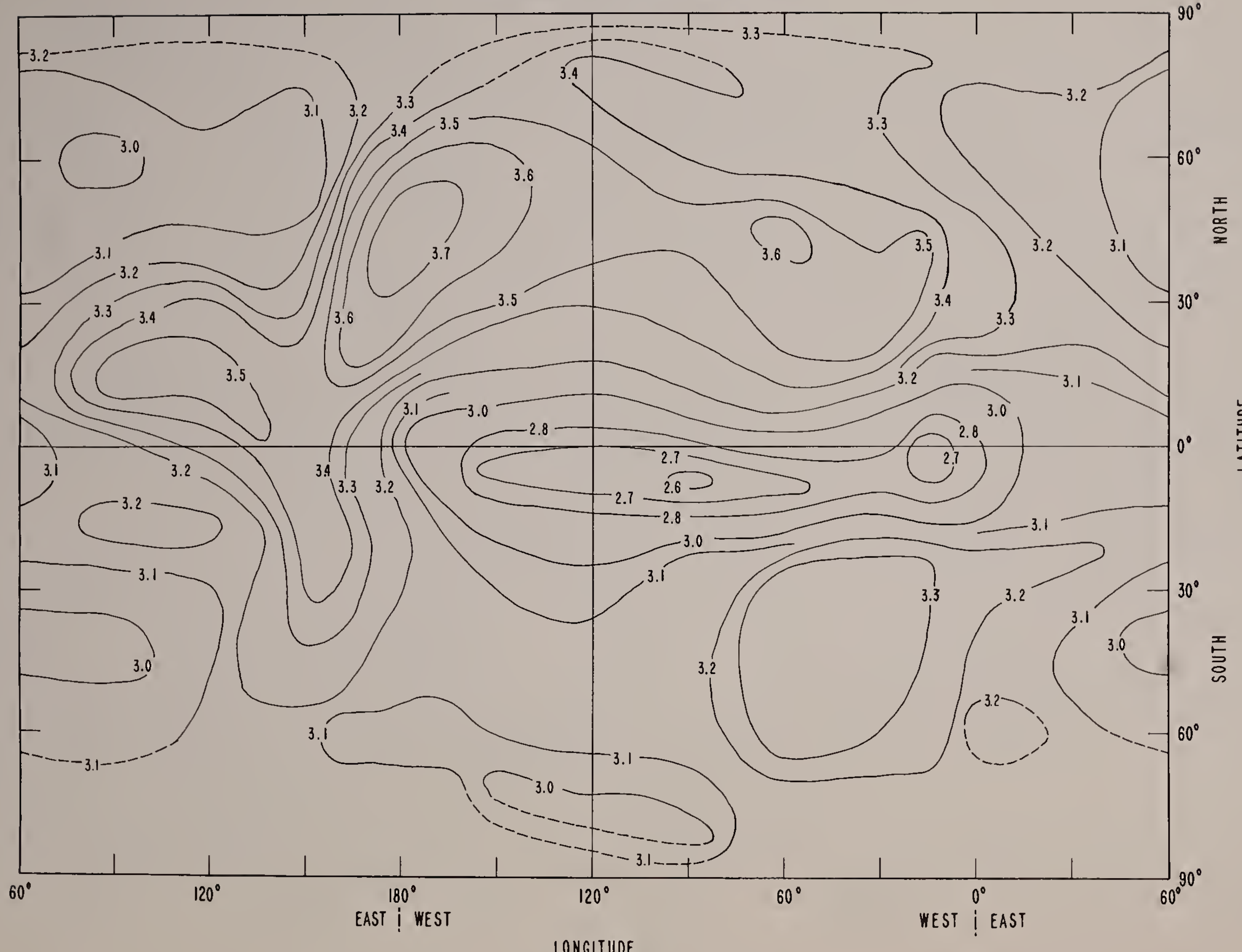
M — 4000 FACTOR AT RASSN 50
NOVEMBER 1600 HOURS GMT



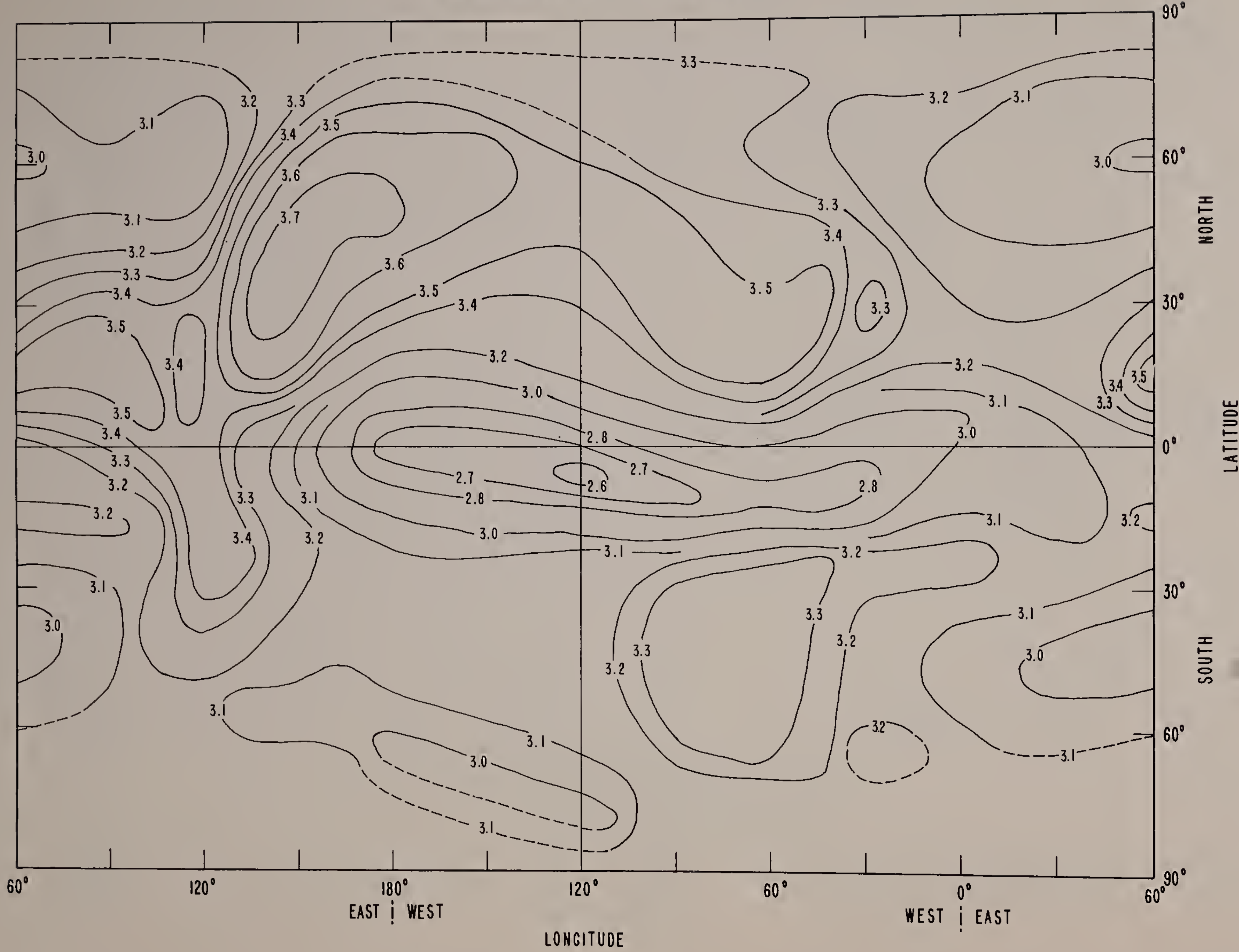
M — 4000 FACTOR AT RASSN 50
NOVEMBER 1800 HOURS GMT



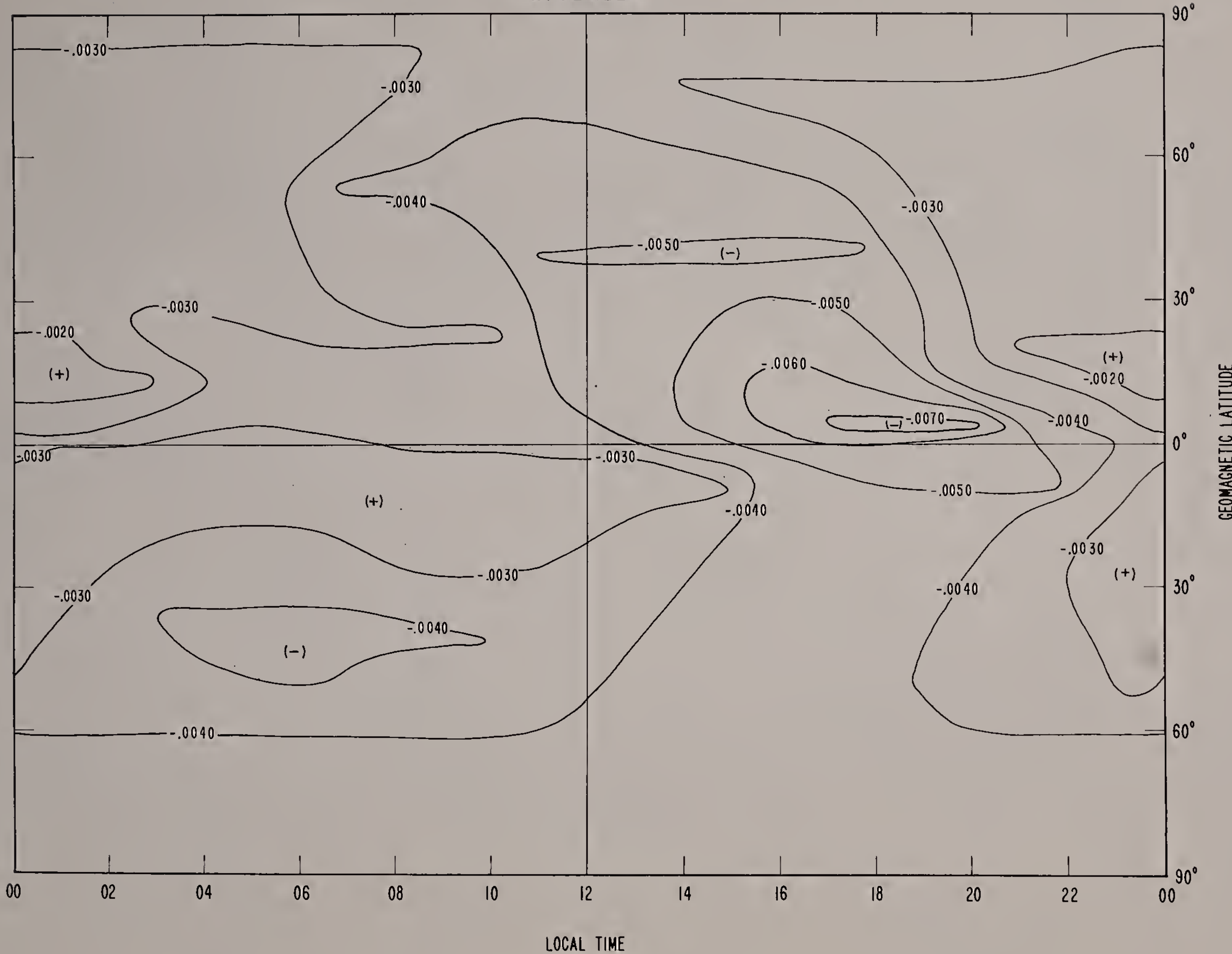
M — 4000 FACTOR AT RASSN 50
NOVEMBER 2000 HOURS GMT



M — 4000 FACTOR AT RASSN 50
NOVEMBER 2200 HOURS GMT



SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN
NOVEMBER



U. S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colo., is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

ELECTRICITY. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics.

METROLOGY. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Scale. Volumetry and Densimetry.

HEAT. Temperature Physics. Heat Measurements. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research. Equation of State. Statistical Physics. Molecular Spectroscopy.

RADIATION PHYSICS. X-Ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

CHEMISTRY. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

MECHANICS. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Combustion Controls.

ORGANIC AND FIBROUS MATERIALS. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

METALLURGY. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

MINERAL PRODUCTS. Engineering Ceramics. Glass. Refractories. Enameled Metals. Constitution and Microstructure.

BUILDING RESEARCH. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials.

APPLIED MATHEMATICS. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

DATA PROCESSING SYSTEMS. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Applications Engineering.

ATOMIC PHYSICS. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics.

INSTRUMENTATION. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction

IONOSPHERE RESEARCH AND PROPAGATION. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services.

RADIO PROPAGATION ENGINEERING. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation-Terrain Effects. Radio-Meteorology. Lower Atmosphere Physics.

RADIO STANDARDS. High frequency Electrical Standards. Radio Broadcast Service. Radio and Microwave Materials. Atomic Frequency and Time Standards. Electronic Calibration Center. Millimeter-Wave Research. Microwave Circuit Standards.

RADIO SYSTEMS. High Frequency and Very High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Space Telecommunications.

UPPER ATMOSPHERE AND SPACE PHYSICS. Upper Atmosphere and Plasma Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

NBS