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Technical Note 2

WORLD MAPS OF F2 CRITICAL FREQUENCIES AND MAXIMUM USABLE FREQUENCY FACTORS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Technical Note

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WORLD MAPS OF F2 CRITICAL FREQUENCIES AND MAXIMUM USABLE FREQUENCY FACTORS

Donald H. Zacharisen

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WORLD MAPS OF F2 CRITICAL FREQUENCIES AND MAXIMUM USABLE FREQUENCY FACTORS

by

Donald H. Zacharisen

Abstract

This report was prepared for the purpose of presenting six months of contour maps and charts for use in predicting F2-layer maximum usable frequencies. Prediction maps for each even hour of Greenwich Mean Time and charts in which time is continuous along the abscissa are given for the months of January, March, June, July, September and December.

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 use a map presentation with GMT constant over the surface of the map. The fourth parameter uses a chart presentation in which the ordinate is geomagnetic latitude and the abscissa is local time.

1. INTRODUCTION AND HISTORY

The preparation of world prediction maps for use in predicting median maximum usable frequencies (MUFs) for F2-layer transmission has been undertaken at the Central Radio Propagation Laboratory and it is the purpose of this report to present the first six months of maps. The prediction maps are prepared for average conditions.

Construction of these prediction maps is based on the observed regression of F2 ordinary-wave critical frequency (foF2) and F2 maximum usable frequency factor (M-4000, the MUF factor for a transmission distance of 4000 km, in particular) on the twelve-month running-average Zurich sunspot number (RASSN) at a given location, month of the year, and time of day as estimated from the data collected at many ionospheric sounding stations. The regression curves are not known precisely, but by now up to 15 points (one for each year) are available for estimating them, and this information has been considered sufficient to warrant the construction of world maps of foF2 and M-4000 factor covering essentially all sunspot numbers. Since the regression curves are observed to be essentially straight lines over a wide range of RASSN, every RASSN in that range can be included by giving, for example, the ordinate to the line (foF2 or M-4000) at RASSN 50 and the slope of the line.

Each final prediction map corresponds to an even hour of Greenwich Mean Time (GMT) which is also known as Universal Time (UT), Zebra Time (ZT), or 0° longitude time. To plot the value of one of the four parameters at any given station for the given GMT directly from the regression lines, which are given for each hour of local time (LT), requires an interpolation between adjacent hours of LT in general. Linear interpolation would introduce a systematic error, or bias, which may be substantial due to the rapid non-linear diurnal variation of foF2. An alternative, and the method used, is to draw contour "maps" for each of which the LT, rather than the GMT, is constant and the abscissa is GMT as well as longitude and subsequently to draw the final GMT prediction maps uaing aa many points as desired from the LT maps. This procedure is used by Naismith with the monthly predictions of the Radio Research Station (Bulletin A), Slough, England. A study of the errors of the procedure described above has been considered by Crow and Zacharisen.[1] Prediction tables for points on the surface of the earth at latitudes greater than 35° North have been prepared by the Radio Physics Laboratory of Canada.[2]

Construction of the prediction maps has been greatly facilitated by the availability of data collected from many ionospheric sounding stations for the years beginning about 1943 or later. (Earlier data are not always used because of changes in instrumentation and methods of scaling.) These data were in a form suitable for preparing world prediction maps because of their previous or simultaneous inclusion in the monthly Basic Radio Propagation Predictions (CRPL Series D), which the Central Radio Propagation Laboratory has been publishing since July 1, 1946 (published as IRPL Series D from September 1, 1944 to June 1, 1946). A description of the preparation and use of these predictions may be found in Sections 6.4 and 6.6 of Reference 3 and in Reference 4.

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

Figure 4 shows the map projection that was used in producing all of the world prediction maps. This map will be used in determining the location of the desired communication path endpoints. Figure 5, a great circle chart centered on the equator, is based on the same projection used in the above map of the world. The two will be used together in order to determine the great circle communication path lying between a transmitting and receiving station that are of interest to the user. The world prediction maps are all presented for each even hour of the day. The prediction charts of slope of regression line of M-4000 factor on RASSN do not utilize a map of the world but instead 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,[1] that it would be of doubtful value to attempt to specify this parameter in much detail.

Figure 6, a distance nomogram, is used to obtain F2-layer MUFs for communication paths of intermediate distances (0 to 4000 km) between the values of foF2 and F2-4000 MUF provided by the world prediction maps and prediction charts. The nomogram has F2-zero-MUF rather than foF2 along the left vertical axis. The required value of F2-zero-MUF may be obtained by adding an approximate value of one-half of the gyrofrequency (f_H) to the value of foF2 obtained from the prediction maps. This value of

$\frac{1}{2} f_H$ is obtained from Table 1 in which it is assumed that f_H depends only on geomagnetic latitude. The geomagnetic latitude, for a given geographic latitude and longitude, may be obtained from Table 2.[5]

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 prediction maps of the first two parameters above give the value of foF2 or M-4000 factor at a RASSN of 50 for a given geographical location. The prediction maps of the third parameter give the rate of change of foF2 with RASSN for a given geographical location. The prediction charts of the fourth parameter give the rate of change of M-4000 factor with RASSN for a given geomagnetic latitude. 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 the value of foF2 for essentially all values of RASSN.

The prediction maps and aids included in this report are seen to require an additional factor before the desired MUFs can be calculated. This missing factor is 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.[6]

There is a rather simple set of equations that may be used to obtain MUFs and optimum working frequencies (OWFs) from the world prediction maps, prediction charts, and aids included in this report and a predicted value of RASSN. The following symbols, some abbreviated from regular usage, will be defined for their use 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).

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.

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

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

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

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

f(50), b_f, and M(50) are read from their respective maps at the geographical location of the midpoint of the great-circle path between the transmitting and receiving stations. b_M is read from a chart at the geomagnetic latitude of the midpoint of the great circle path between the transmitting and receiving stations. The predicted value of RASSN sent out to the users of this report will be one that would be expected to give the user the best results in predicting MUFs rather than one that will predict most closely a correct value of RASSN. Even with this condition, the value of RASSN that will be sent to the user will 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 so using 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. Communications at the MUF calculated from these prediction maps and charts should be effective approximately 50% of the time.

A value of F2-MUF that should be effective approximately 90% of the time 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

A good deal of the material in this section has been taken directly from National Bureau of Standards Circular 465.[4] This circular is probably familiar to many users of this report and it was felt that as it has stood the test of many years of service that, where applicable, the use of the same text would aid in determining F2-layer MUFs from the material included herein. It is suggested that this report be placed in a standard three-ring, looseleaf notebook and the staples removed so that the pages will lie flat.

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

Figure 4 is a map of the world. Figure 5 is a chart to the same scale as Figure 4, 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 4 and 5, proceed as follows:

(a) Place a piece of transparent paper over the map, Figure 4, and draw the equatorial line (zero degrees) and the 120°W longitude line. Place dots over the locations of the transmitting and receiving stations. Also mark the Greenwich meridian (0°) 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 the chart, Figure 5, and, keeping the equatorial line of the transparency always on the equatorial line of Figure 5, 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 in the great-circle path which passes through the terminal points. The paths between Washington, D. C. and Miami, Florida, and Washington, D. C. and Trieste are shown in their correct positions on Figure 2.

(c) For paths shorter than 4000 km, locate the midpoint of the path, keeping the transparency in position on Figure 5 and using as a distance scale the points at which the numbered lines in Figure 5 cross the path as drawn on the transparency. The midpoint of the Washington-Miami path is at M on Figure 5.

(d) For paths longer than 4000 km, designating the ends as the A-end and B-end, respectively, locate on the path and mark with a dot the following "control points", scaling the distances as in (c) above:

Points A and B, 2000 km from each end. These points for the Washington Trieste path are shown in Figure 5.

2. Calculation of Maximum Usable Frequencies and Optimum Working Frequencies

2.1 Determination of MUF and OWF for distances less than or equal to 4000 km

(a) The use of a work sheet similar to that of Figure 7 is suggested. Put a check in the space "Path less than or equal to 4000 km ______".

(b) To determine the MUF:

(1) Place the great circle transparency over the map of foF2 at RASSN 50 for 0000 hours GMT 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 (ignoring the Greenwich meridian for the present).

(2) Read the value of foF2 for the midpoint of the path and enter 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 enter values as b_f in Column b. and as M(50) in Column e., respectively, of Figure 7.

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

(6) From Figure 4, determine the geographical coordinates of the communication path midpoint which was 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. From 180°E to 360°E longitude on Table 2 corresponds to the same segment of the earth as from 180°W to 0° longitude.

(7) Place the great circle transparency over the prediction chart of the slope of the regression line of M-4000 factor on RASSN and keeping the equatorial line of the transparency over the equatorial line of the chart, mark the geomagnetic latitude by a dot on the meridian passing through the midpoint determined in Section 1(c). In other words,

place the dot at the correct geomagnetic latitude, using the vertical scale of the prediction chart as a guide, on a line perpendicular to the equatorial line and passing through the path midpoint, already on the transparency.

(8) Again keeping 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 because 24 hours on the time scale of the prediction chart is drawn to the same scale as 360° of longitude on the world map.

(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 enter as b_M in Column f. of Figure 7.

Note that on the prediction chart (-) refers to an algebraic increase in a negative direction of values inside the contour so specified while (+) refers to an algebraic decrease in a negative direction 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, h, and i. of Figure 7 from the equation at the heading of each of these columns. The equation from Column d. is $f(R) = f(50) + (R-50)b_f$. It might be noted that f(R) and f(50) indicate the median foF2 as a <u>function</u> of RASSN R and RASSN 50, respectively, while $(R-50)b_f$ indicates a <u>multiplication</u> of the factor (R-50) times b_f, the rate of change of median foF2 with RASSN.

(12) Use the value of 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 value of median foF2 for all even hours to obtain median F2-zero-MUF(R) and insert the values in Column j. 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 grid nomogram, Figure 6, and read the value of 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. Enter the values in Column k. of Figure 7.

(14) Calculate the F2-OWF by multiplying each value of median F2-MUF in Column k. by the factor 0.85 or by

using the conversion scale contained in Figure 6. Enter the values in Column l. of Figure 7.

2.2 Determination of MUF and OWF for distances greater than 4000 km

(a) General Considerations:

The procedure outlined below is based on the following 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) The use of a work sheet similar to Figure 7 is suggested. Two sheets should be used with one for the A-end and one for the B-end. Put a check on both sheets in the space on the top of the sheet entitled "Path greater than 4000 km _____". For the first sheet, place a check in "A-end ______" and for the second sheet, place a check in "B-end ______". Column j. will not be used in either sheet. The lower of A and B will be entered in Column k. of one of the sheets and the OWF will be computed from this and entered in Column l. of the same sheet. Columns k. and l. in the second sheet can remain blank or be filled in with the same information as the first sheet in order to provide a more complete record.

(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) need 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 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 (ignoring the Greenwich meridian for the present).

(2) Read the value of foF2 for control point A and enter as f(50) in Column a. of Figure 7. The designation "A-end" at the top of the work sheet will have been checked for this work sheet in Instruction 2.2(b) above.

(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 enter values as b_f in Column b. and as M(50) in Column e, respectively, of Figure 7.

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

(6) From Figure 4, 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. From 180°E to 360°E longitude on this chart corresponds to the same segment of the earth as from 180 W to 0° longitude.

(7) Place the great circle transparency over the prediction chart of the slope of the regression line of M-4000 factor on RASSN and keeping the equatorial line of the transparency over the equatorial line of the chart, mark the geomagnetic latitude by a dot on the meridian passing through control point A determined in Section 1(d). In other words, place the dot at the correct geomagnetic latitude, using the vertical scale of the prediction chart as a guide, on a line perpendicular to the equatorial line and passing through control point A, already on the transparency.

(8) Again keeping 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 because 24 hours on the time scale of the prediction chart is drawn to the same scale as 360° of longitude on the world map.

(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 enter as b_M in Column f. of Figure 7.

Note that on the prediction chart (-) refers to an algebraic increase in a negative direction of values inside of the contour so specified while (+) refers to an algebraic decrease in a negative direction 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, h, and i. of Figure 7 from the equation at the heading of each of these columns.

(12) Repeat steps (1) through (11) for control point B. The second work sheet which has a check, from Instruction 2.2(b) above, in the designation "B-end ____" at the top of the work sheet will be used to record the values from control point B.

(13) For each of the even hours compare the two values of median F2-4000-MUF(R), Column i. of Figure 7, from the two work sheets representing control point A and control point B. The lower of the two values, the MUF for the A-end and the MUF for the B-end, is the MUF for a given even hour for the transmission path. Record this median F2-MUF for the path in Column k. of one of the two work sheets. The same information may be recorded in Column k. of the other work sheet for a more complete record.

(14) The values in Column k. are then multiplied by 0.85 or fitted to the conversion scale in Figure 6 in order to find the F2-OWF for the path. The values obtained are inserted in Column l. of the one sheet (or both sheets if desired) that has the values of median F2-MUF for the path in Column k.

IV. SAMPLE MUF AND OWF CALCULATIONS

1. Short Path

The MUF and OWF 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 determined for average conditions for the month of June using a RASSN of 35. This was the observed RASSN for June of 1955 and so the values that have been computed would correspond to the conditions encountered during that period. This of course does not mean that this is the value of RASSN that would have been predicted. It is possible that the predicted value would fit the 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 June. The values in Columns c. and g. 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.

2. Long Path

The MUF and OWF 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 determined for average conditions for the month of December using a RASSN of 81. This was the observed RASSN for December of 1955 and so the values that have been computed would correspond to the conditions encountered during that period. Again, this does not mean that this is the value of RASSN that would have been predicted. It is again possible that the predicted value would fit the conditions encountered more precisely than the observed RASSN.

The values that have been calculated for the control point A are shown in Figure 2 and the values calculated for control point B are shown in Figure 3. Column j. is not used and Columns k. and l. contain the same values for both sheets.

Again, it will be noted that the values recorded in Columns a, b, e, and f. of both Figures 2 and 3 will always apply for the above communication path for the month of December. The values in Columns c, and g. 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.

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SOLUTION OF F2-LAYER TRANSMISSION PROBLEM

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

Check correct ones: Path less than or equal to (≤) 4000 km. X
Path greater than (>) km ___; A-end _____ or B-end _____

Geomagnetic latitude for path midpoint 43°N ; or for control point A ________ or control point B ________
One-half gyrofrequency for path midpoing 0.6 Mc; or for control point A _____Mc or control point B _____Mc

Note: All frequencies are in Megacycles

GMT	f(50)	b_f	(R-50)	f(R) = f(50) + (R-50)b_f	M(50)	b_M	(R-50)	M(R) = M(50) + (R-50)b_M	[f(R)][M(R)] = median F2-4000-MUF(R)	f(R) + $f_H/2$ = median F2-zero-MUF(R)	median F2-MUF for path	F2-OWF for path
	a	b	c	d	e	f	g	h	i	j	k	l
Procedure	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Compute	Compute	Compute	Scale for ≤ 4000 km. Lower of A and B for > 4000 km.	Compute
00	7.2	.023	-15	6.9	3.42	-.0043	-15	3.48	24.0	7.5	14.0	11.9
02	6.5	.026	-15	6.1	3.35	-.0051	-15	3.43	20.9	6.7	12.3	10.5
04	5.2	.029	-15	4.8	3.25	-.0052	-15	3.33	16.0	5.4	9.6	8.2
06	4.7	.030	-15	4.2	3.21	-.0042	-15	3.27	13.7	4.8	8.3	7.1
08	4.2	.025	-15	3.8	3.32	-.0042	-15	3.38	12.8	4.4	7.8	6.6
10	4.0	.021	-15	3.7	3.35	-.0043	-15	3.41	12.6	4.3	7.6	6.5
12	5.3	.019	-15	5.0	3.40	-.0042	-15	3.46	17.3	5.6	10.3	8.8
14	6.1	.021	-15	5.8	3.23	-.0042	-15	3.29	19.1	6.4	11.4	9.7
16	6.4	.024	-15	6.0	3.14	-.0043	-15	3.20	19.2	6.6	11.6	9.9
18	6.7	.025	-15	6.3	3.16	-.0041	-15	3.22	20.6	6.9	12.3	10.5
20	6.7	.025	-15	6.3	3.18	-.0039	-15	3.24	20.4	6.9	12.3	10.5
22	7.1	.023	-15	6.8	3.25	-.0040	-15	3.31	22.5	7.4	13.4	11.4
Done by												
Checked												

Solution of short-path transmission problem (less than or equal to 4000 km) - use one work sheet.
Solution of long-path transmission problem (greater than 4000 km) - use two sheets, one for control point A and one for control point B.

FIGURE 1

SOLUTION OF F2-LAYER TRANSMISSION PROBLEM

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

Check correct ones: Path less than or equal to (≤) 4000 km ____
Path greater than (>) 4000 km X ; A-end X or B-end ____

Geomagnetic latitude for path midpoint ________; or for control point A 60°N or control point B ________
One-half gyrofrequency for path midpoint ____Mc; or for control point A 0.7 Mc or control point B ____Mc

Note: All frequencies are in Megacycles

GMT	f(50)	b_f	(R-50)	f(R) = f(50) + (R-50)b_f	M(50)	b_M	(R-50)	M(R) = M(50) + (R-50)b_M	[f(R)][M(R)] = median F2-4000-MUF(R)	f(R) + $f_H/2$ = median F2-zero-MUF(R)	median F2-MUF for path	F2-OWF for path
	a	b	c	d	e	f	g	h	i	j	k	l
Procedure	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Compute	Compute	Compute	Scale for ≤ 4000 km. Lower of A and B for > 4000 km.	Compute
00	3.7	.028	31	4.6	3.30	-.0028	31	3.21	14.8		9.5	8.1
02	3.0	.015	31	3.5	3.21	-.0029	31	3.12	10.9		10.0	8.5
04	2.9	.013	31	3.3	3.21	-.0029	31	3.12	10.3		9.4	8.0
06	2.8	.016	31	3.3	3.23	-.0029	31	3.14	10.4		8.5	7.2
08	2.8	.016	31	3.3	3.30	-.0029	31	3.21	10.6		10.6	9.0
10	2.7	.015	31	3.2	3.34	-.0029	31	3.25	10.4		10.4	8.8
12	5.2	.029	31	6.1	3.70	-.0030	31	3.61	22.0		22.0	18.7
14	7.6	.048	31	9.1	3.76	-.0040	31	3.64	33.1		33.1	28.1
16	8.1	.051	31	9.7	3.68	-.0041	31	3.55	34.4		31.4	26.7
18	8.1	.051	31	9.7	3.65	-.0041	31	3.52	34.1		20.3	17.3
20	6.7	.047	31	8.2	3.62	-.0035	31	3.51	28.8		13.6	11.6
22	4.8	.039	31	6.0	3.50	-.0029	31	3.41	20.5		10.5	8.9
Done by												
Checked												

Solution of short-path transmission problem (less than or equal to 4000 km) - use one work sheet.
Solution of long-path transmission problem (greater than 4000 km) - use two sheets, one for control point A and one for control point B.

FIGURE 2

SOLUTION OF F2-LAYER TRANSMISSION PROBLEM

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

Check correct ones: Path less than or equal to (≤) 4000 km.______
Path greater than (>) 4000 km. X ; A-end______ or B-end X

Geomagnetic latitude for path midpoint ________; or for control point A________ or control point B 57°N
One-half gyrofrequency for path midpoint______Mc; or for control point A ______Mc or control point B 0.6 Mc

Note: All frequencies are in Megacycles

GMT	f(50)	b_f	(R-50)	f(R) = f(50) + (R-50)b_f	M(50)	b_M	(R-50)	M(R) = M(50) + (R-50) b_M	[f(R)][M(R)] = median F2-4000-MUF(R)	f(R) + f_H/2 = median F2-zero-MUF(R)	median F2-MUF for path	F2-OWF for path
	a	b	c	d	e	f	g	h	i	j	k	l
Procedure	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Compute	Compute	Compute	Scale for ≤ 4000 km. Lower of A and B for > 4000 km.	Compute
00	2.9	.008	31	3.1	3.16	-.0030	31	3.07	9.5		9.5	8.1
02	3.0	.009	31	3.3	3.13	-.0030	31	3.04	10.0		10.0	8.5
04	2.8	.010	31	3.1	3.12	-.0030	31	3.03	9.4		9.4	8.0
06	2.4	.011	31	2.7	3.24	-.0030	31	3.15	8.5		8.5	7.2
08	2.9	.018	31	3.5	3.31	-.0030	31	3.22	11.3		10.6	9.0
10	6.5	.038	31	7.7	3.79	-.0040	31	3.67	28.3		10.4	8.8
12	8.0	.050	31	9.5	3.83	-.0042	31	3.70	35.2		22.0	18.7
14	7.9	.052	31	9.5	3.73	-.0043	31	3.60	34.2		33.1	28.1
16	7.3	.048	31	8.8	3.70	-.0042	31	3.57	31.4		31.4	26.7
18	4.7	.037	31	5.8	3.60	-.0032	31	3.50	20.3		20.3	17.3
20	3.5	.022	31	4.2	3.34	-.0029	31	3.25	13.6		13.6	11.6
22	3.0	.014	31	3.4	3.19	-.0029	31	3.10	10.5		10.5	8.9
Done by												
Checked												

Solution of short-path transmission problem (less than or equal to 4000 km) - use one work sheet.
Solution of long-path transmission problem (greater than 4000 km) - use two sheets, one for control point A and one for control point B.

FIGURE 3

V. FIGURE AND TABLES

MAP OF THE WORLD

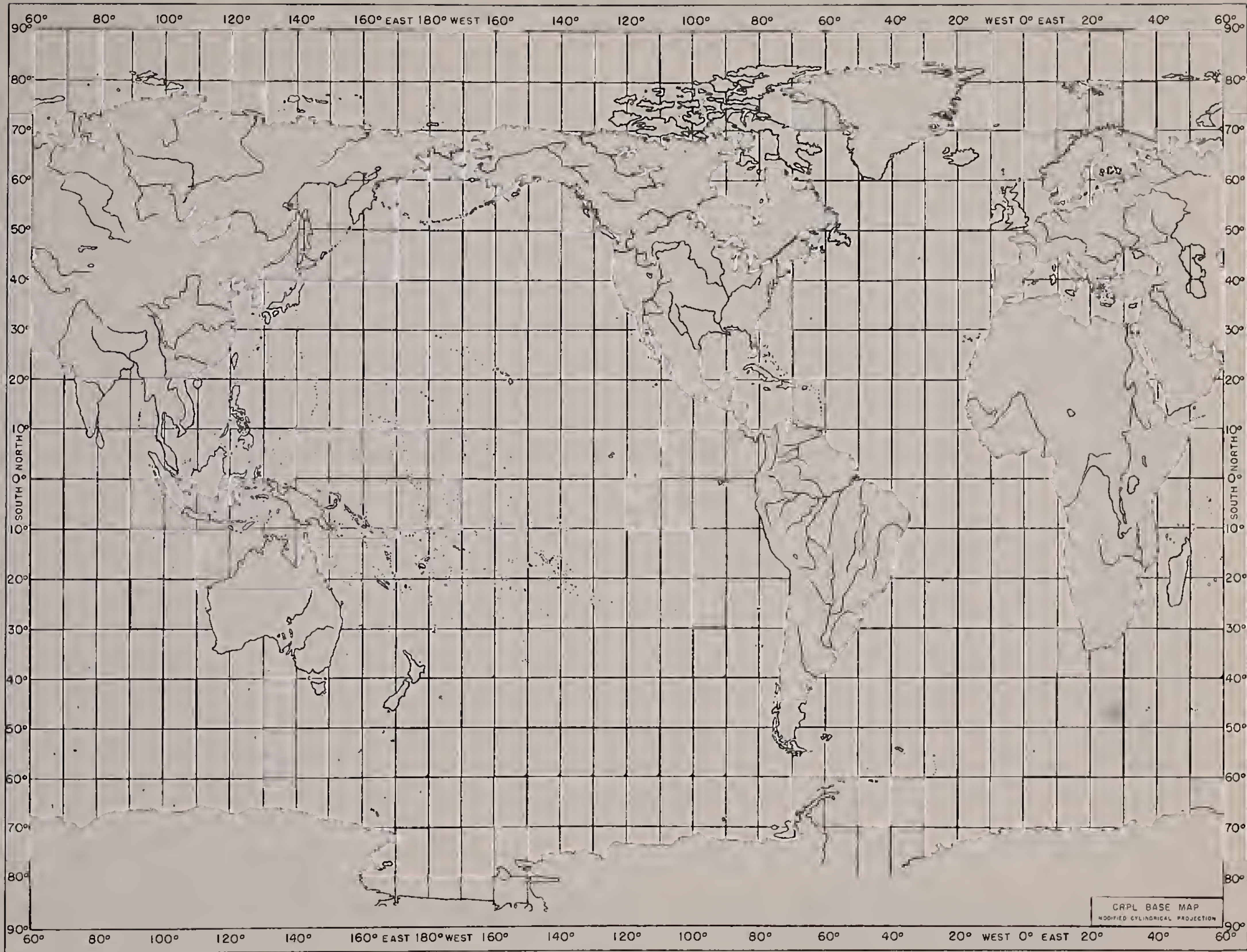
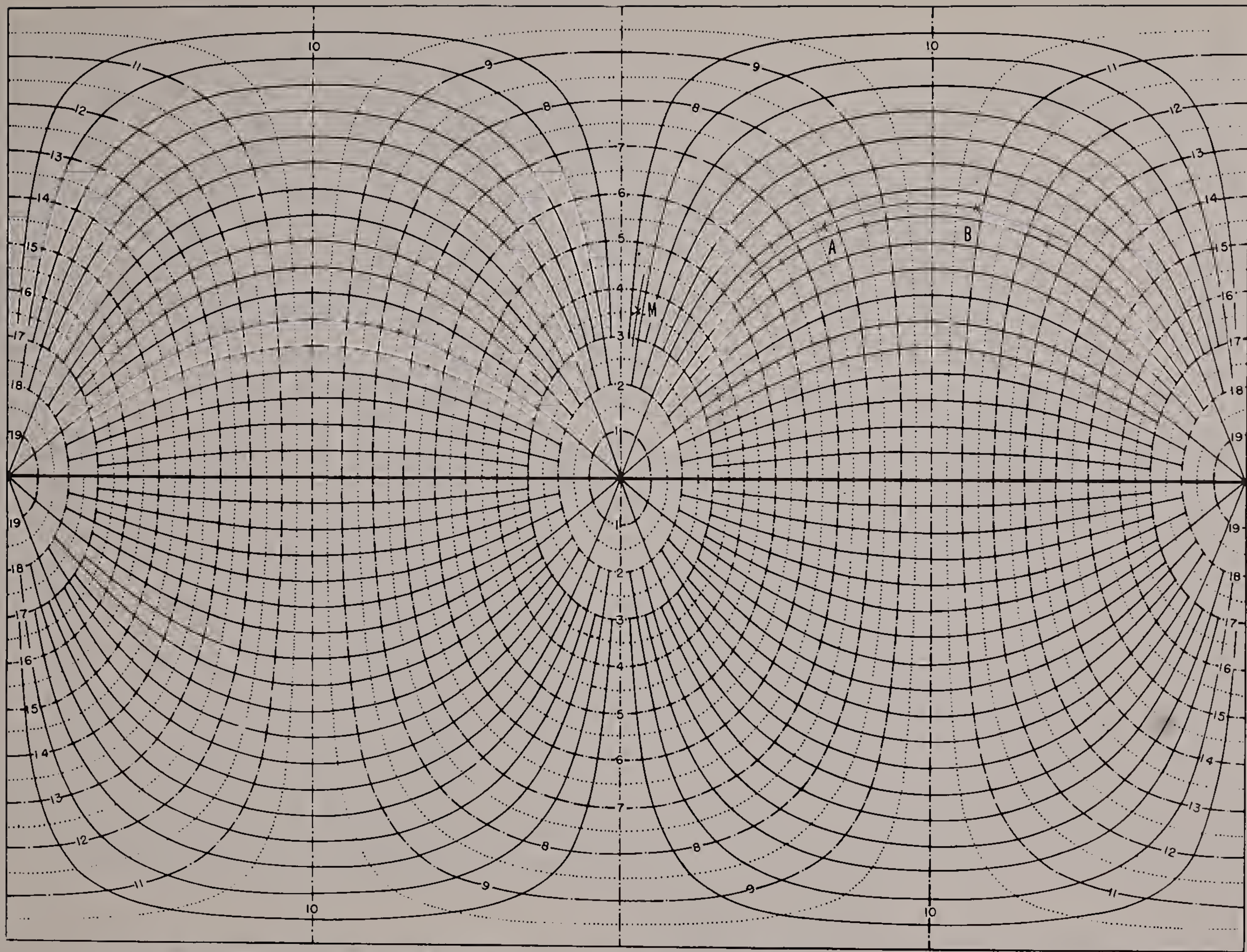
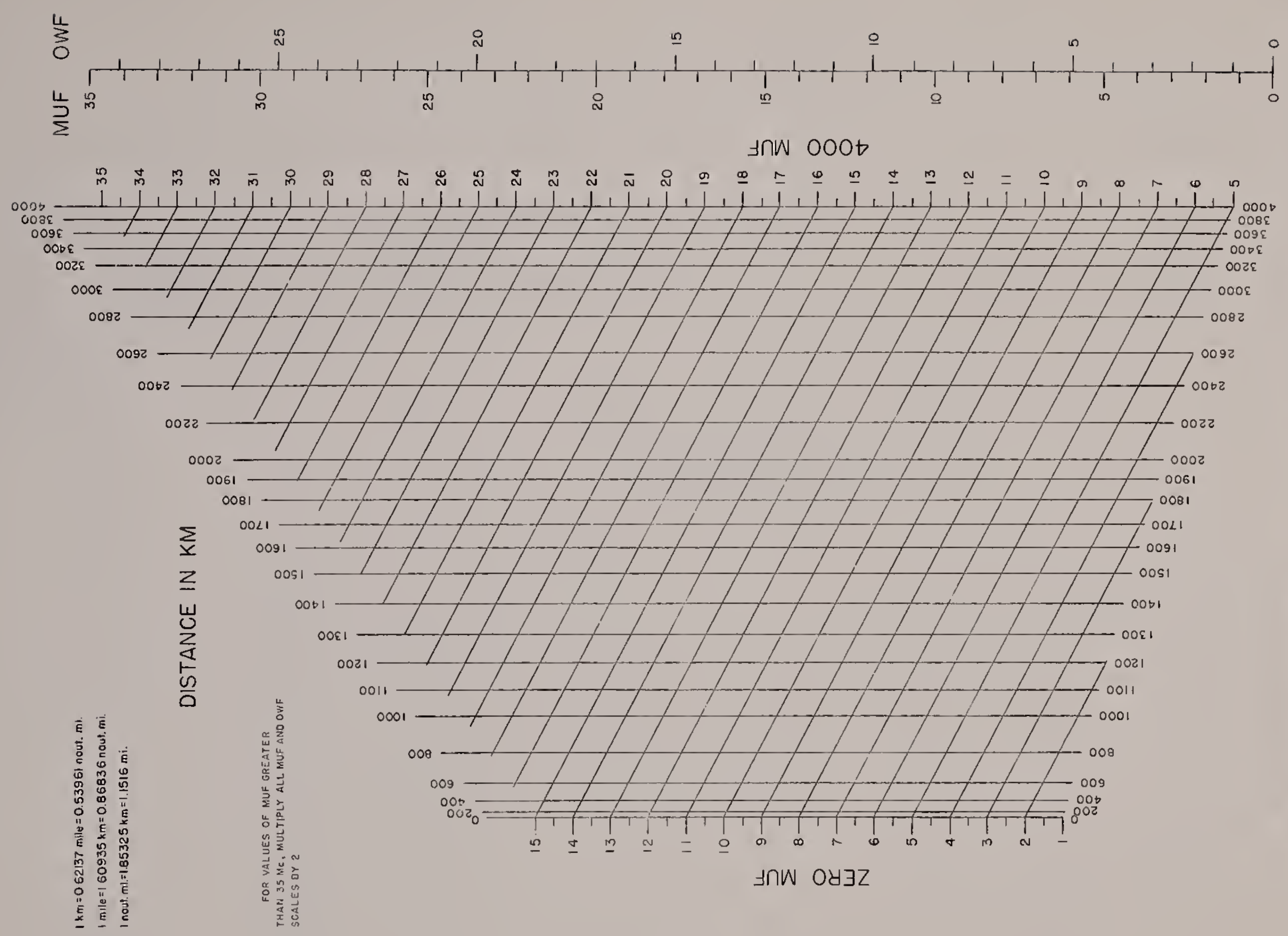


FIGURE 4



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

FIGURE 5



NOMOGRAM FOR TRANSFORMING F_2-ZERO-MUF AND F_2-4000-MUF TO EQUIVALENT MAXIMUM USABLE FREQUENCIES AT INTERMEDIATE TRANSMISSION DISTANCES; CONVERSION SCALE FOR OBTAINING OPTIMUM WORKING FREQUENCIES.

FIGURE 6

SOLUTION OF F2-LAYER TRANSMISSION PROBLEM

From ______________________ To ______________________ Distance, __________km. Predicted for __________ 19___

Check correct ones: Path less than or equal to (≤) 4000 km.____
Path greater than (>) 4000 km.____; A-end ____ or B-end ____

Geomagnetic latitude for path midpoint ________; or for control point A __________ or control point B __________
One-half gyrofrequency for path midpoint _____Mc; or for control point A _____ Mc or control point B ______ Mc

Note: All frequencies are in Megacycles

GMT	f(50)	b_f	(R-50)	f(R) = f(50) + (R-50)b_f	M(50)	b_M	(R-50)	M(R) = M(50) + (R-50)b_M	[f(R)][M(R)] = median F2-4000-MUF(R)	f(R) + $f_H/2$ = median F2-zero-MUF(R)	median F2-MUF for path	F2-OWF for path
	a	b	c	d	e	f	g	h	i	j	k	l
Procedure	Scale	Scale	Compute	Compute	Scale	Scale	Compute	Compute	Compute	Compute	Scale for ≤ 4000 km. Lower of A and B for > 4000 km.	Compute
00												
02												
04												
06												
08												
10												
12												
14												
16												
18												
20												
22												
Done by												
Checked												

Solution of short-path transmission problem (less than or equal to 4000 km) - use one work sheet.
Solution of long-path transmission problem (greater than 4000 km) - use two sheets, one for control point A and one for control point B.

FIGURE 7

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

(For use with values of foF2 sufficiently large with respect to f_H)

$\frac{1}{2}$ 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	180
+88	79	79	79	79	76	78	78	78	78	76	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	76	76	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	78	76	77
+84	79	79	78	76	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	78	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
+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	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	65	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	84	64	64	63	83	63	63	63	63	63	63	63	63	63	63	64	64	64	65	65	66	67	67
+72	73	72	71	70	89	68	67	66	66	65	64	84	63	63	62	62	62	61	61	61	61	81	61	81	61	61	61	61	61	62	62	63	63	64	64	65	65
+70	71	70	89	66	67	66	66	65	64	63	63	82	61	61	60	60	60	59	59	59	59	59	59	59	59	59	59	59	59	60	60	61	61	62	62	83	64
+68	89	68	67	66	65	65	84	63	62	6I	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	81	82
+66	88	67	66	65	64	83	62	61	60	60	59	56	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	63	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	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
+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	48	49	49	50	50	51	52	52
+56	58	57	56	56	55	54	53	52	51	50	49	49	46	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	38	37	36	36	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	36	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	28	29	30	30	31
+34	37	36	35	34	33	32	31	31	30	29	26	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	6	6	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
+14	18	17	16	15	14	13	12	11	10	9	6	7	7	6	5	5	4	4	3	3	3	3	3	3	3	3	3	3	4	4	5	6	6	7	8	9	10
+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	-5	-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	-6	-8	-9	-9	-9	-9	-9	-9	-9	-9	-9	-8	-8	-8	-7	-6	-6	-5	-4	-3	-2
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
-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
-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
-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
-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
-10	-6	-7	-8	-9	-10	-11	-12	-13	-14	-14	-15	-16	-17	-16	-19	-19	-20	-20	-21	-21	-21	-21	-21	-21	-21	-21	-21	-20	-20	-19	-19	-18	-17	-17	-16	-15	-14
-12	-8	-9	-10	-11	-12	-13	-14	-15	-15	-16	-17	-16	-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
-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
-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	-28	-25	-25	-24	-23	-22	-22	-21	-20
-18	-14	-15	-15	-16	-17	-18	-19	-20	-21	-22	-23	-24	-25	-26	-26	-27	-26	-28	-29	-29	-29	-29	-29	-29	-29	-29	-29	-28	-28	-27	-27	-26	-25	-24	-24	-23	-22
-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
-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
-24	-19	-20	-21	-22	-23	-24	-25	-26	-27	-28	-29	-30	-31	-32	-32	-33	-34	-34	-35	-35	-35	-35	-35	-35	-35	-35	-35	-34	-34	-33	-33	-32	-31	-30	-29	-29	-28
-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
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-48	-43	-44	-45	-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
-50	-45	-46	-47	-46	-48	-49	-50	-51	-52	-53	-54	-55	-56	-57	-58	-59	-59	-60	-60	-61	-81	-81	-61	-61	-61	-61	-61	-60	-60	-59	-58	-57	-57	-58	-55	-54	-53
-52	-47	-48	-48	-49	-50	-51	-52	-53	-54	-55	-56	-57	-58	-59	-60	-61	-61	-62	-62	-63	-63	-63	-63	-63	-63	-63	-83	-82	-62	-61	-80	-59	-58	-58	-57	-56	-55
-54	-49	-60	-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	-80	-59	-59	-58	-57
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-58	-52	-53	-54	-55	-56	-57	-58	-59	-60	-61	-62	-63	-64	-85	-66	-66	-67	-68	-68	-69	-69	-69	-69	-69	-69	-69	-69	-68	-87	-67	-66	-65	-64	-63	-62	-61	-60
-60	-54	-55	-56	-57	-58	-59	-60	-61	-62	-63	-64	-65	-66	-67	-67	-68	-69	-70	-70	-71	-71	-71	-71	-71	-71	-71	-71	-70	-89	-69	-68	-87	-66	-65	-64	-83	-62
-62	-58	-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	-60	-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	-67	-66
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-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
-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
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-78	-71	-71	-72	-73	-73	-74	-75	-76	-76	-77	-78	-79	-80	-61	-82	-83	-84	-85	-86	-67	-88	-88	-89	-89	-88	-87	-86	-85	-84	-83	-82	-81	-80	-79	-78	-78	-77
-80	-72	-73	-73	-74	-75	-75	-76	-77	-77	-78	-79	-80	-61	-82	-82	-63	-84	-85	-86	-87	-67	-86	-88	-66	-88	-87	-86	-85	-84	-84	-83	-82	-81	-80	-79	-79	-78
-82	-74	-74	-75	-75	-76	-76	-77	-78	-78	-79	-80	-80	-81	-62	-82	-83	-64	-84	-85	-86	-66	-88	-66	-86	-88	-66	-85	-85	-84	-83	-83	-82	-81	-81	-80	-79	-79
-84	-75	-78	-76	-76	-77	-77	-76	-78	-79	-79	-80	-80	-81	-62	-62	-82	-83	-83	-84	-84	-84	-84	-64	-84	-84	-84	-84	-83	-83	-83	-82	-82	-81	-81	-80	-80	-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	285	270	275	280	285	290	295	300	306	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	60	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	84	84	84	84	84	84	84	83	83	83	82	82	81	81	80	80	79
+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	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	85	86	87	87	88	88	88	88	87	86	85	85	84	83	82	81	80	79	79	78
+78	71	71	72	73	73	74	75	76	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
+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	85	84	83	82	81	80	79	78	77	78	75
+74	67	68	69	69	70	71	72	73	74	75	76	77	78	79	80	81	82	82	83	84	85	85	85	85	85	84	84	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	83	83	83	83	83	83	82	81	80	79	78	77	78	78	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	78	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	78	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	75	75	75	74	74	73	72	72	71	70	69	68	67	88
+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	87	66	85	84
+60	54	56	56	57	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	82
+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	83	62	61	60
+56	51	51	52	53	54	55	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	56	56	57	58	59	60	61	62	63	63	64	84	65	65	65	65	65	65	65	65	64	64	83	62	61	60	59	59	58	57
+52	47	48	48	49	50	51	52	53	54	55	56	57	58	59	60	61	61	62	62	63	63	63	63	63	63	63	63	62	62	61	60	59	58	58	57	56	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	61	61	61	60	60	59	58	57	57	56	55	54	53
+48	43	44	45	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	[illegible]	49	50	51	51	52	53	54	55	55	56	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	53	54	55	55	55	55	55	55	55	55	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	50	51	51	52	53	53	53	53	53	53	53	53	53	52	52	51	50	50	49	48	47	48	45
+40	35	36	37	38	39	40	41	42	43	44	45	46	47	47	48	49	50	50	51	51	51	51	51	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	40	39	38	37	36	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	36	37	38	38	39	39	39	39	39	39	39	39	39	38	38	37	37	36	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	35	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	28
+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	28	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
- 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
- 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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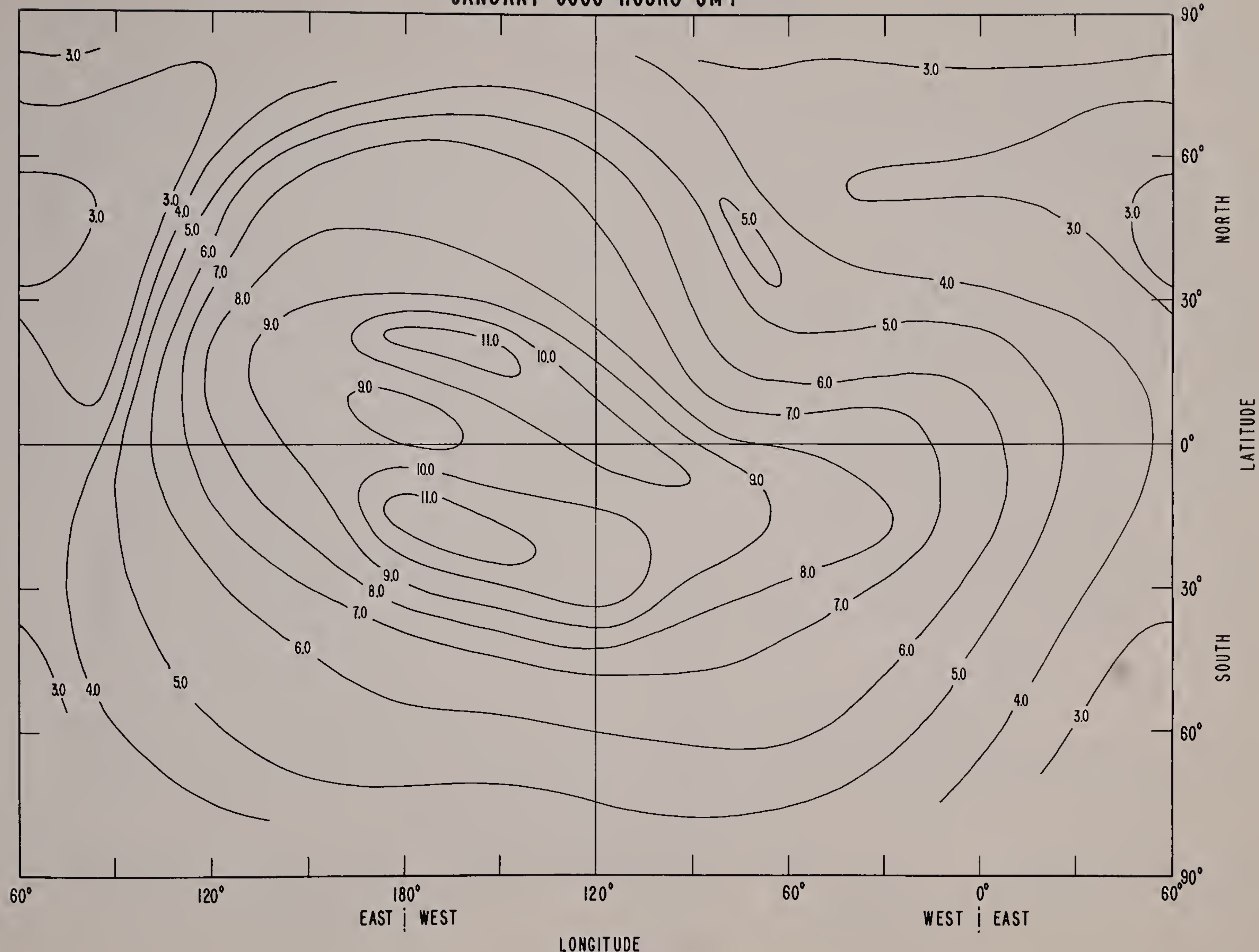
-12	-16	-15	-14	-13	-12	-11	-10	- 9	- 8	- 7	- 6	- 5	- 5	- 4	- 3	- 3	- 2	- 2	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 2	- 2	- 3	- 4	- 4	- 5	- 6	- 7	- 8
-14	-18	-17	-16	-15	-14	-13	-12	-11	-10	- 9	- 8	- 7	- 7	- 6	- 5	- 5	- 4	- 4	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 4	- 4	- 5	- 6	- 6	- 7	- 8	- 9	-10
-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
-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
-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
-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
-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
-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
-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
-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
-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	-28	-26	-27
-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
-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	-28	-29	-30	-30	-31
-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	-36	-35	-35	-35	-35	-35	-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	-52	-52
-60	-62	-61	-60	-59	-58	-57	-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	-63	-54	-54
-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
-64	-66	-65	-64	-63	-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
-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	-56	-56	-56	-56	-57	-57	-58	-59	-59	-60
-68	-69	-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
-70	-71	-70	-69	-68	-67	-66	-66	-65	-64	-63	-63	-62	-61	-61	-60	-60	-60	-69	-59	-59	-59	-59	-59	-59	-69	-59	-69	-69	-59	-60	-80	-81	-81	-62	-62	-83	-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	-61	-61	-61	-61	-61	-61	-62	-62	-83	-63	-64	-64	-65	-65
-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
-76	-75	-75	-74	-73	-72	-71	-71	-70	-69	-69	-68	-67	-67	-67	-66	-66	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-65	-66	-66	-88	-67	-67	-68	-68	-89
-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	-68	-88	-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

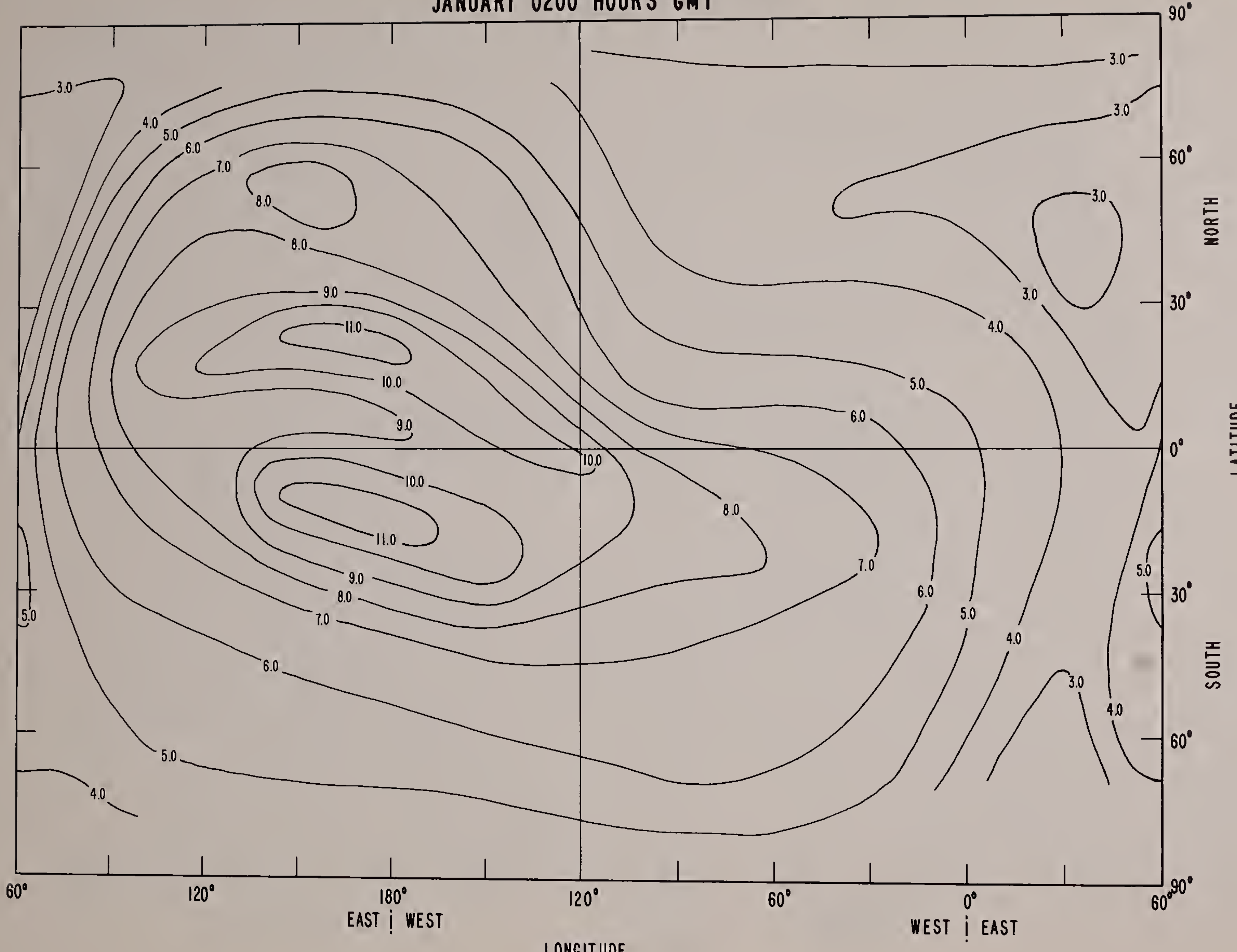
TABLE 2

VI. WORLD PREDICTION MAPS AND PREDICTION CHARTS

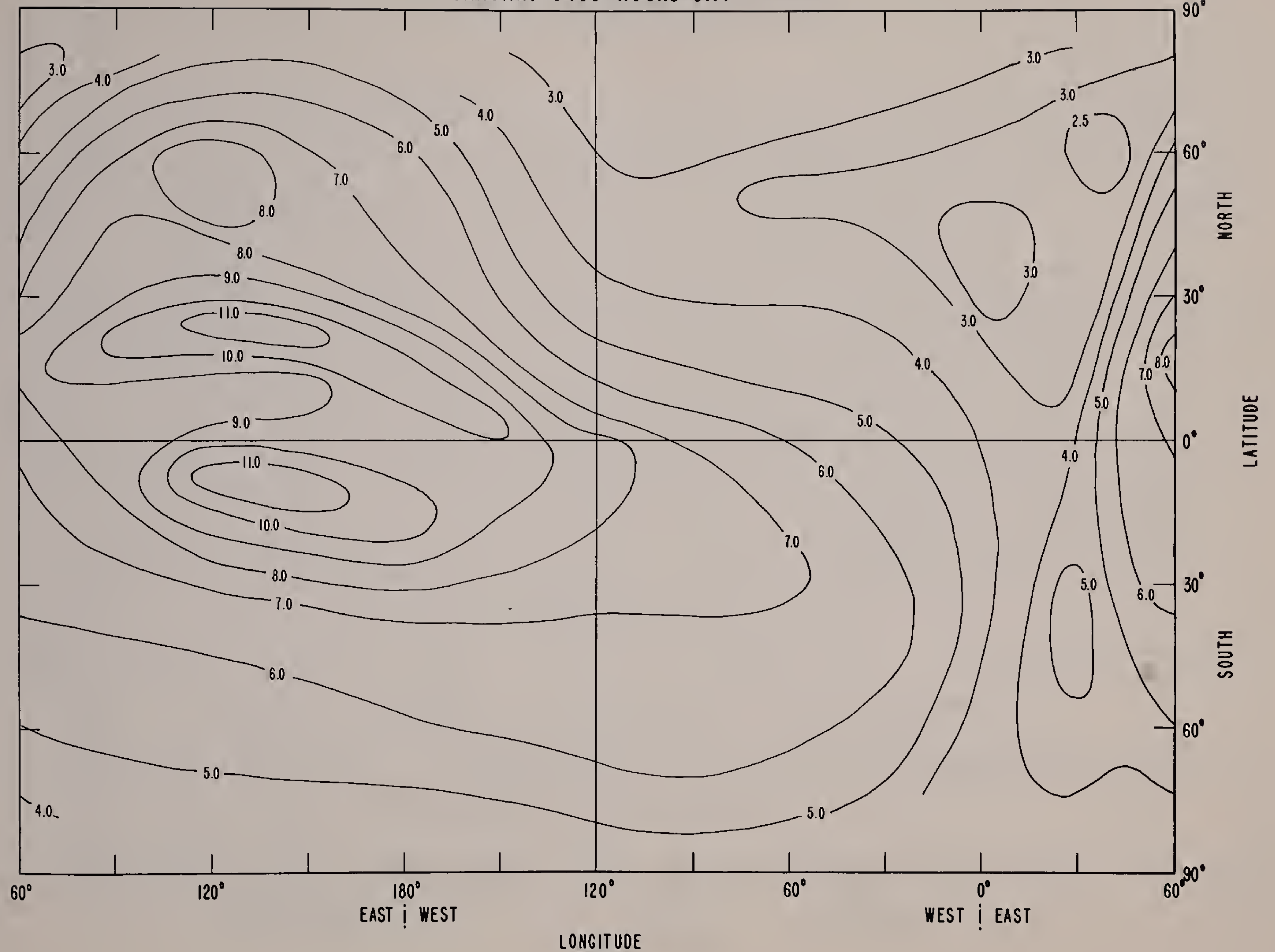
foF2 AT RASSN 50
JANUARY 0000 HOURS GMT



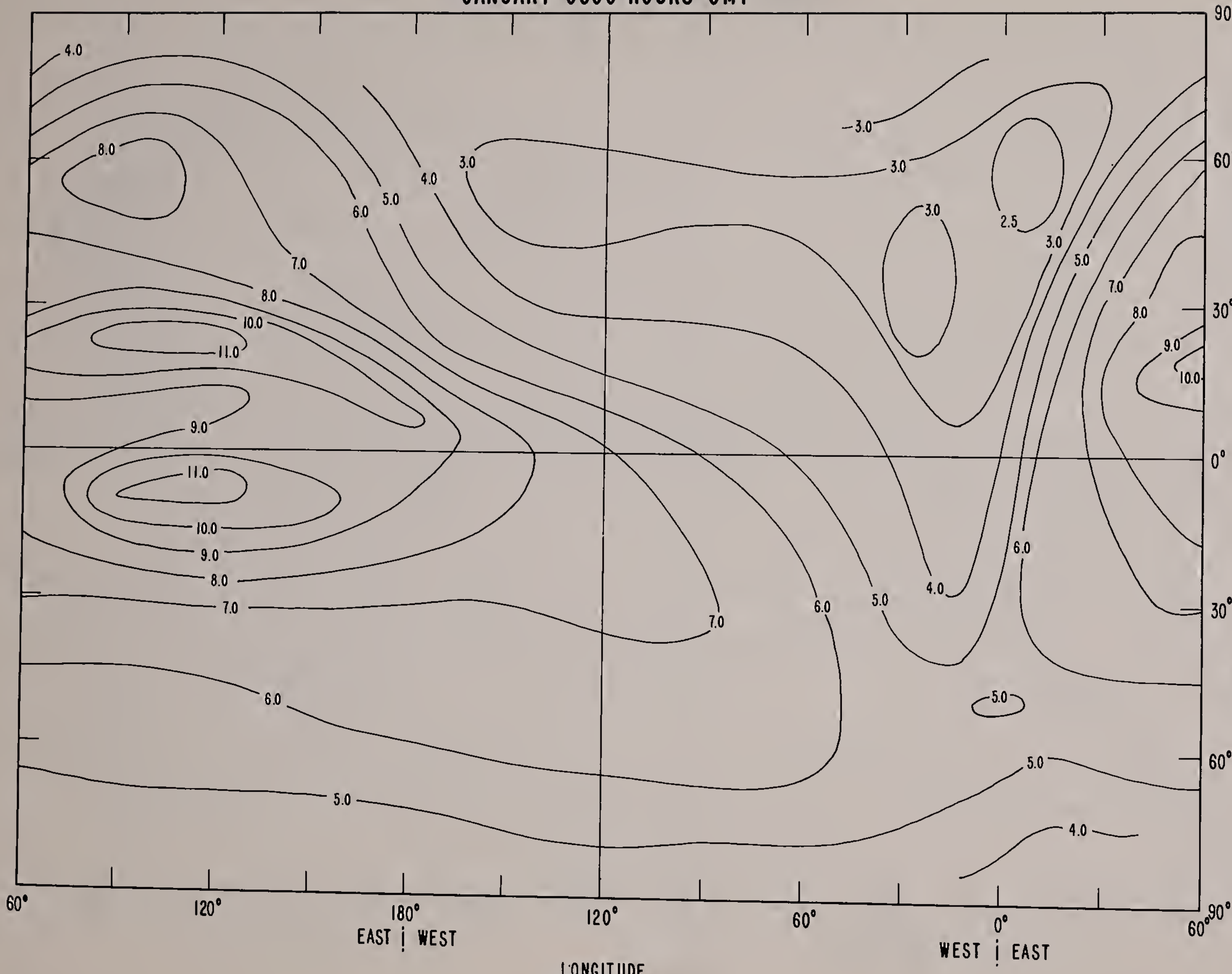
foF2 AT RASSN 50
JANUARY 0200 HOURS GMT



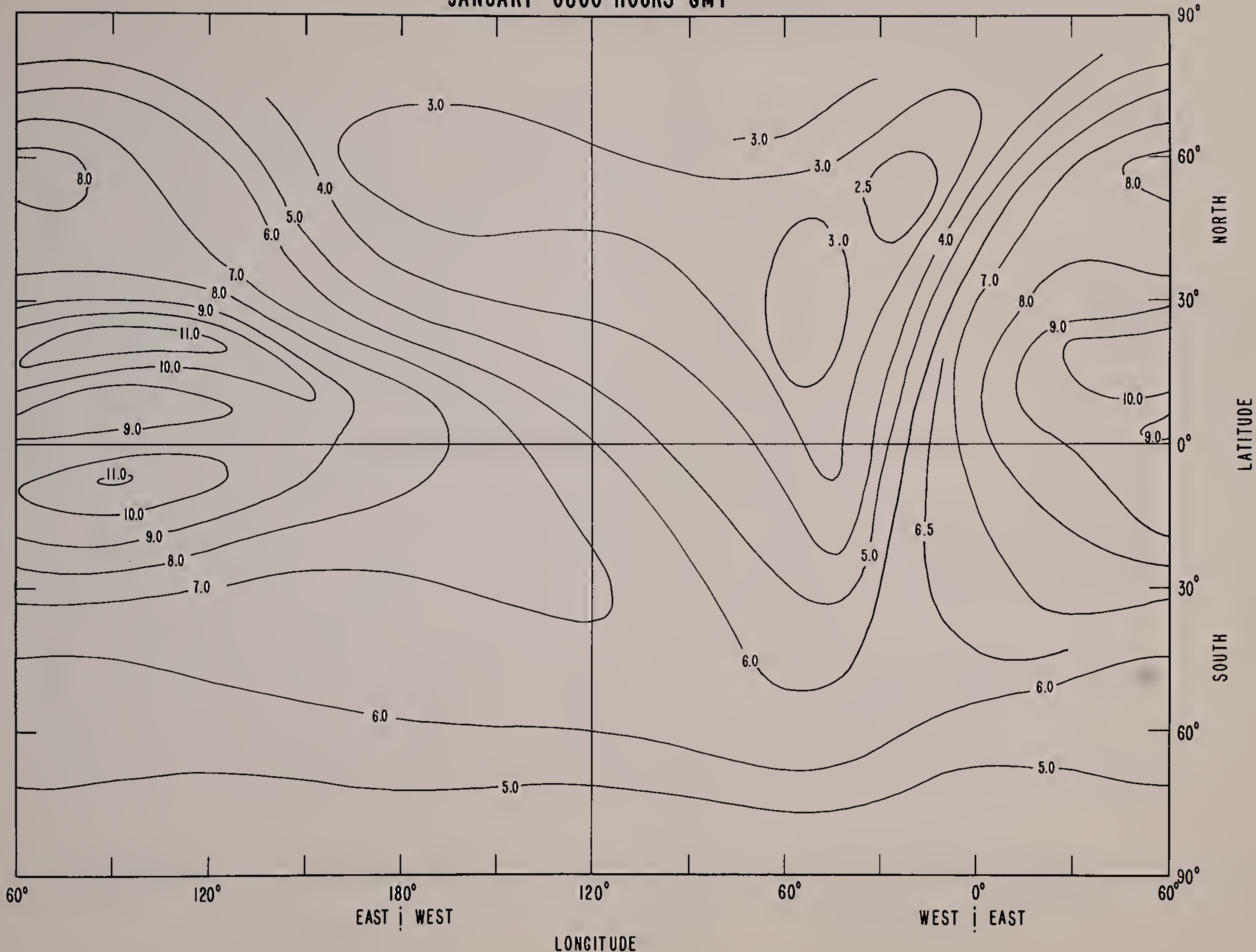
foF2 AT RASSN 50
JANUARY 0400 HOURS GMT

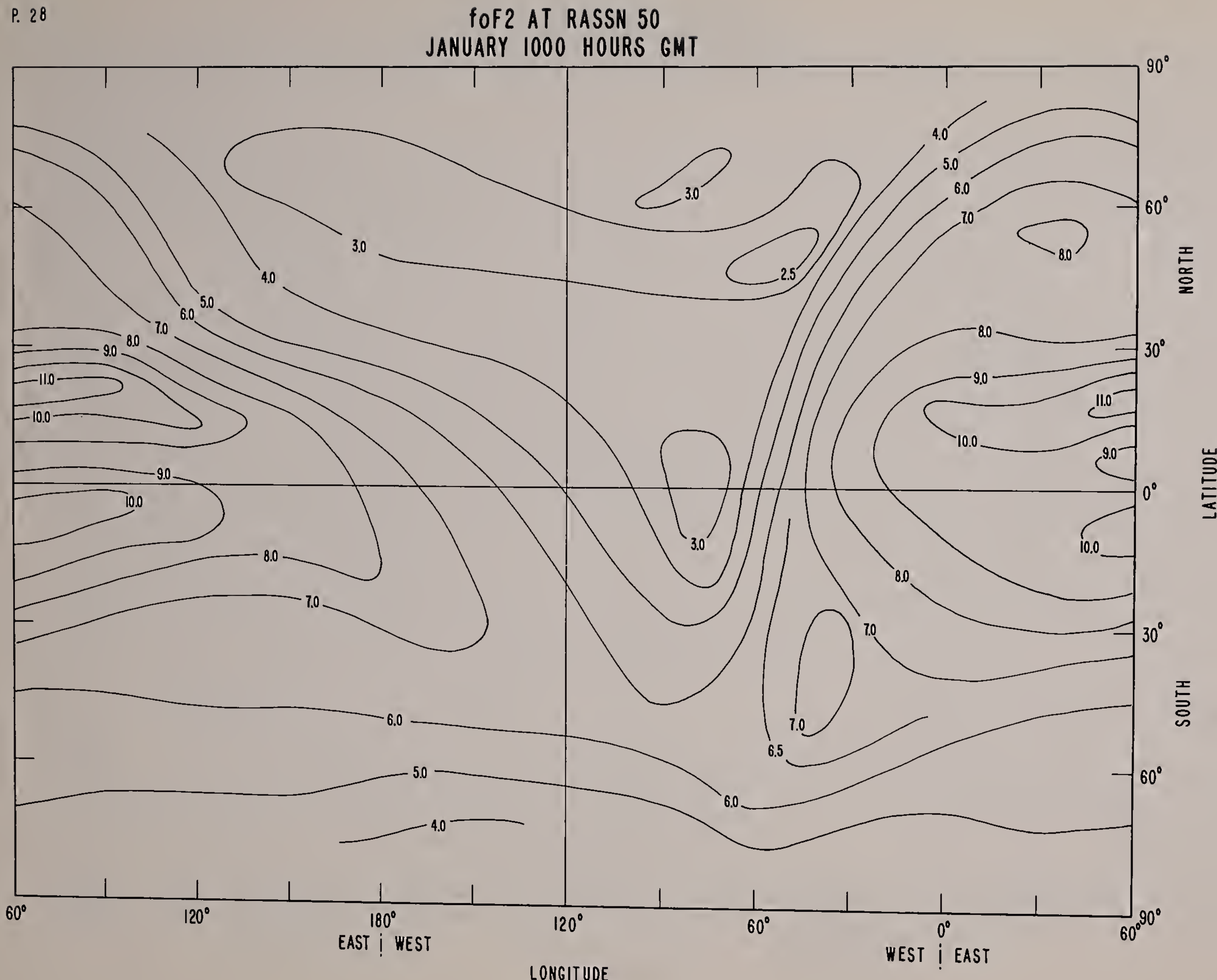


foF2 AT RASSN 50
JANUARY 0600 HOURS GMT

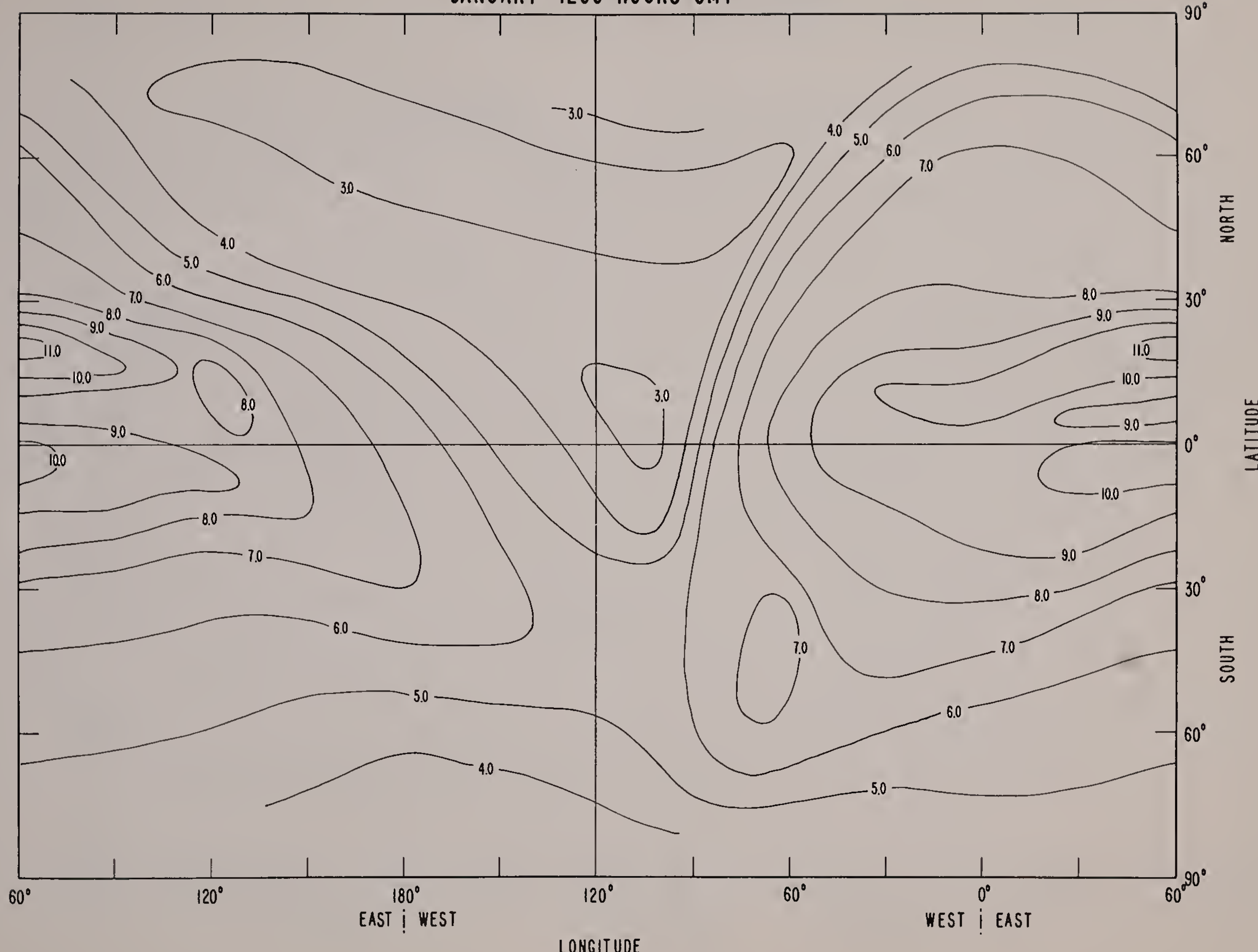


foF2 AT RASSN 50
JANUARY 0800 HOURS GMT

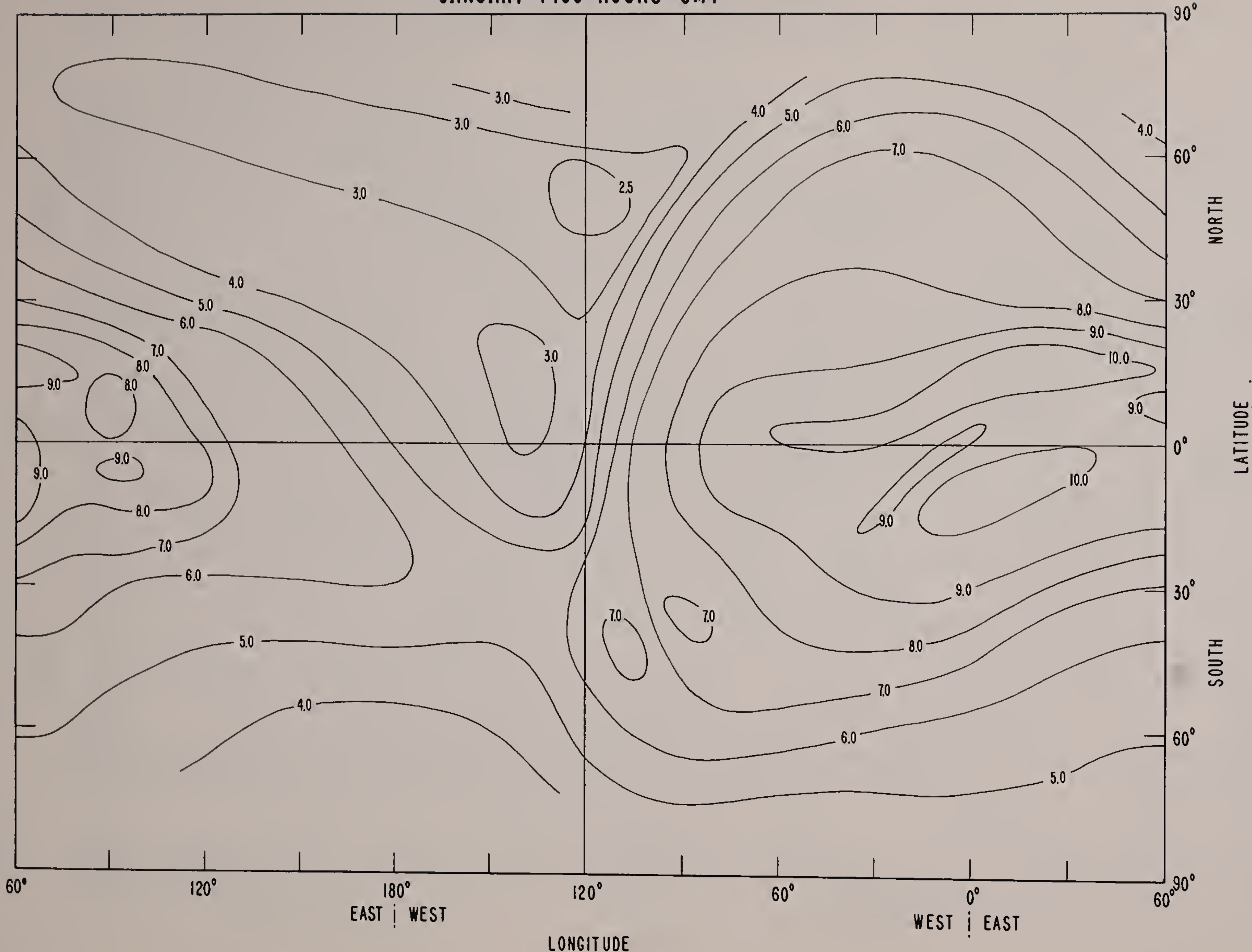



foF2 AT RASSN 50
JANUARY 1000 HOURS GMT
90°
60°
30°
0°
30°
60°
90°
NORTH
LATITUDE
SOUTH
60°
120°
180°
120°
60°
0°
60°
EAST | WEST
WEST | EAST
LONGITUDE
2.5
3.0
4.0
5.0
6.0
6.5
7.0
8.0
9.0
10.0
11.0

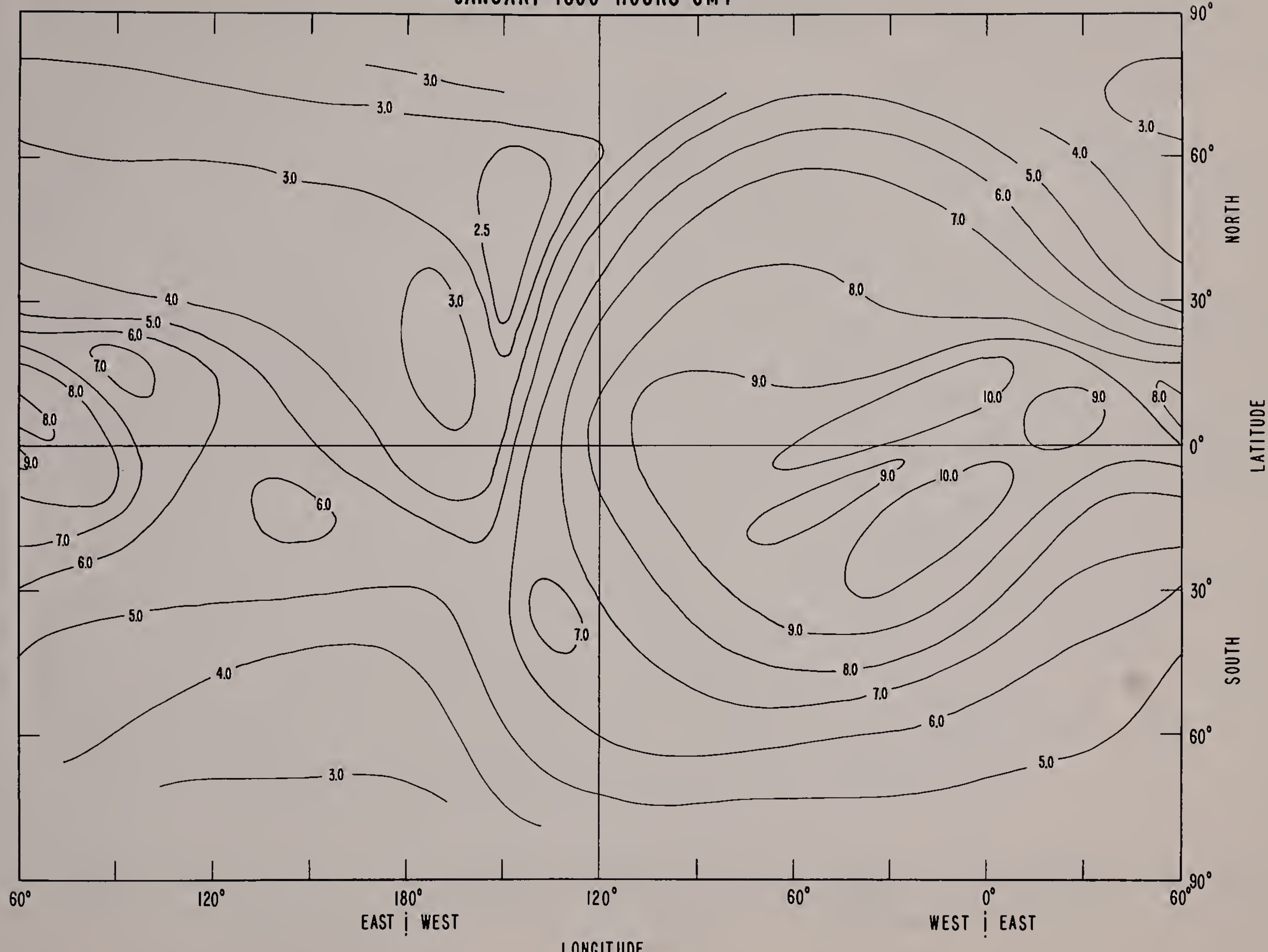
foF2 AT RASSN 50
JANUARY 1200 HOURS GMT



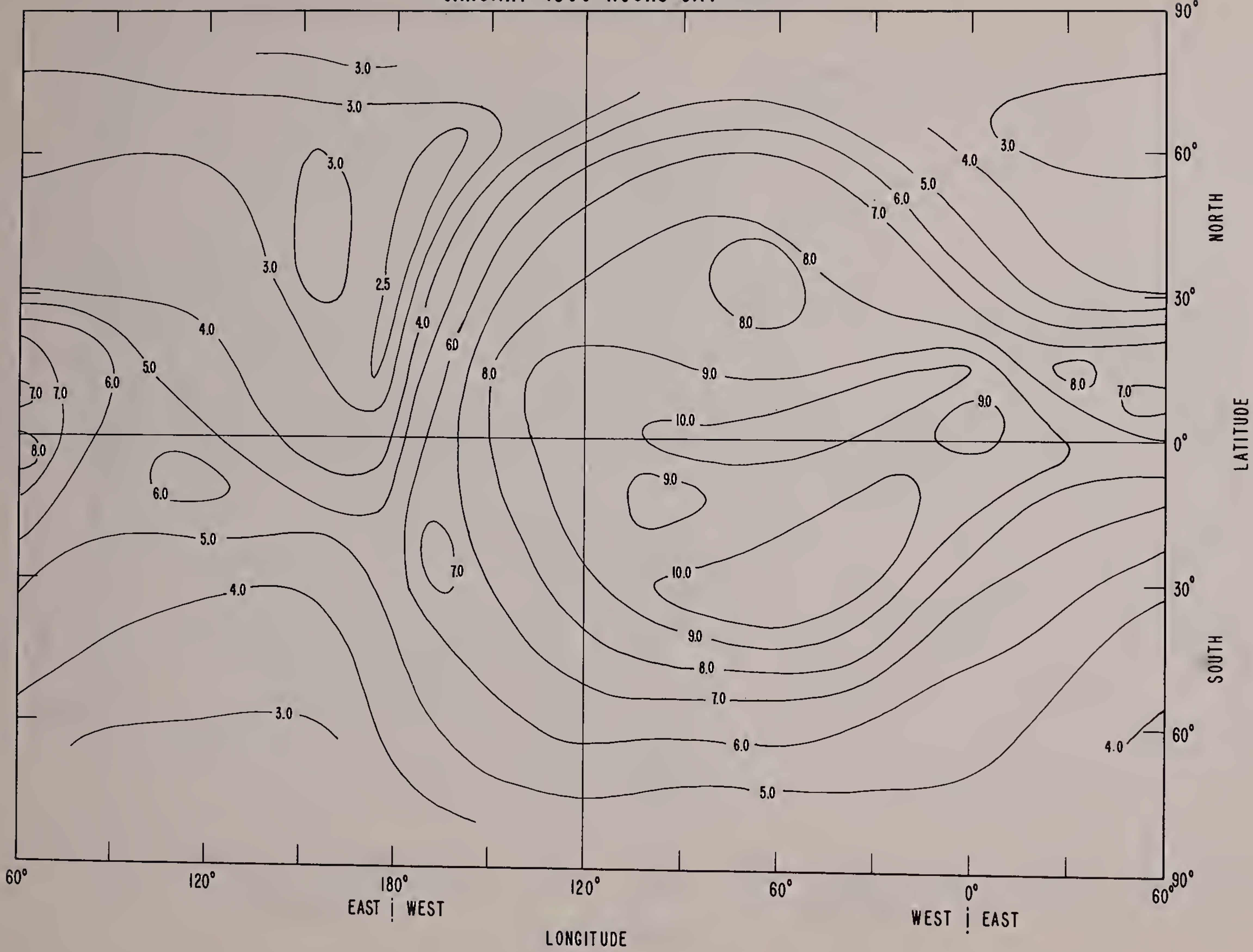
foF2 AT RASSN 50
JANUARY 1400 HOURS GMT



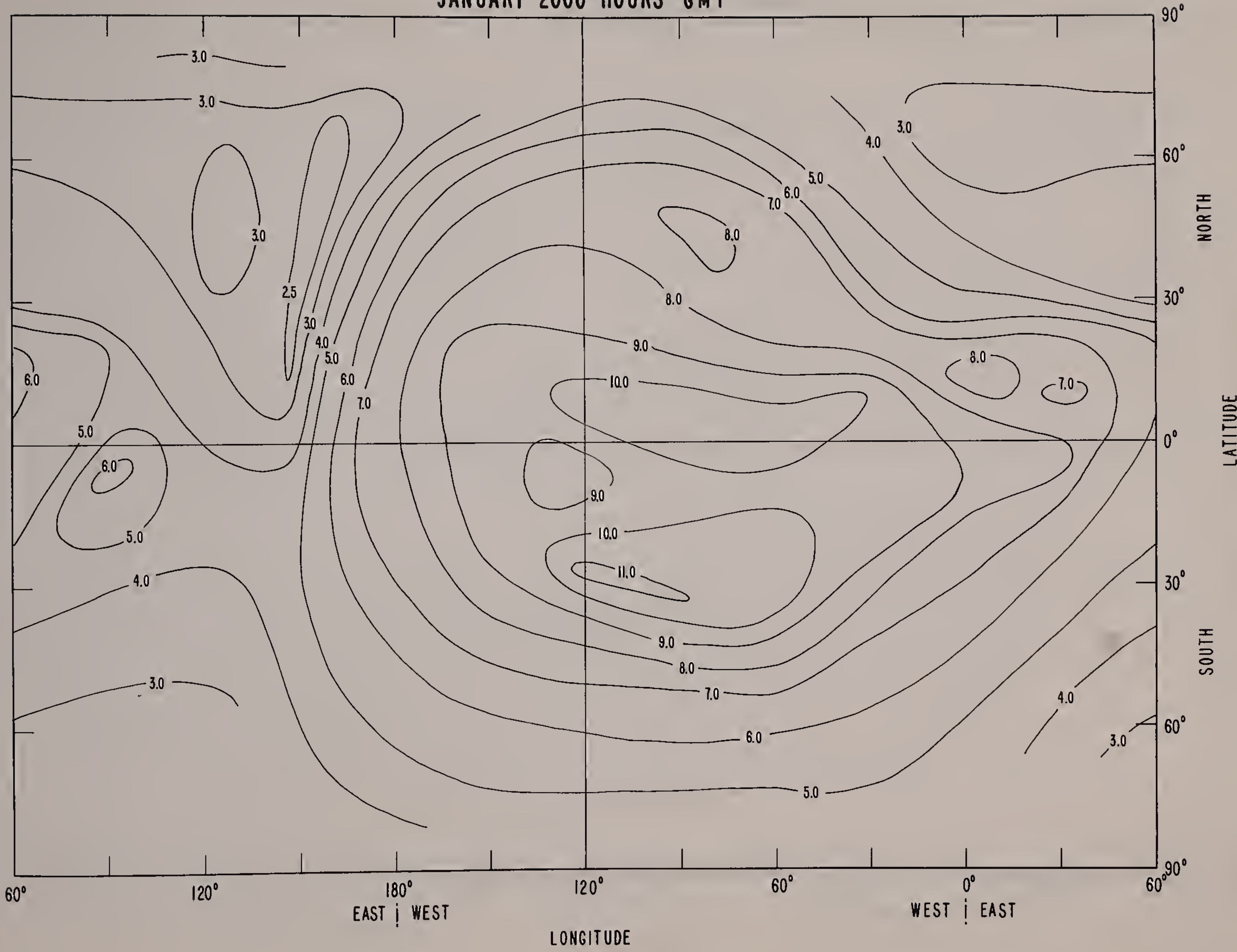
foF2 AT RASSN 50
JANUARY 1600 HOURS GMT



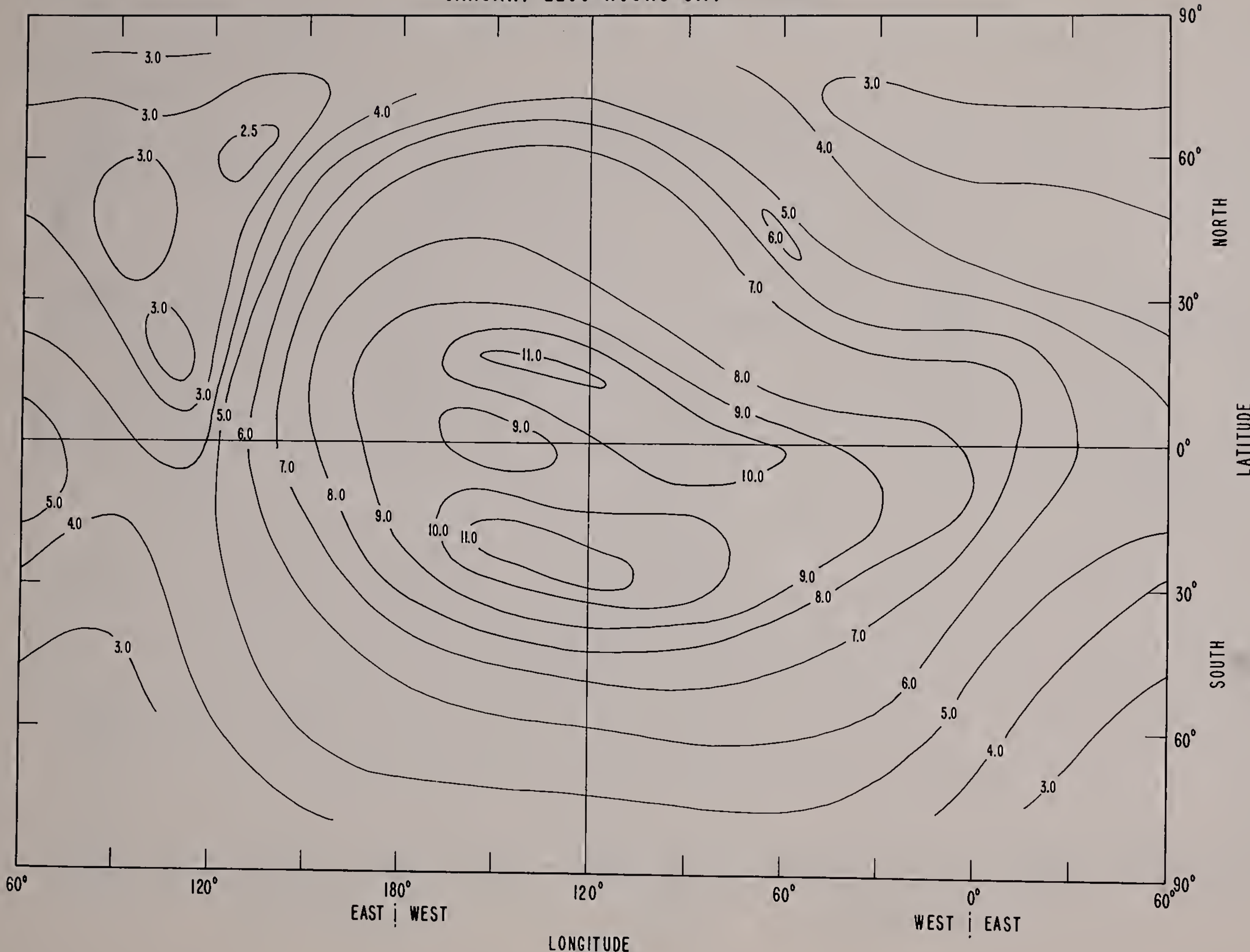
foF2 AT RASSN 50
JANUARY 1800 HOURS GMT



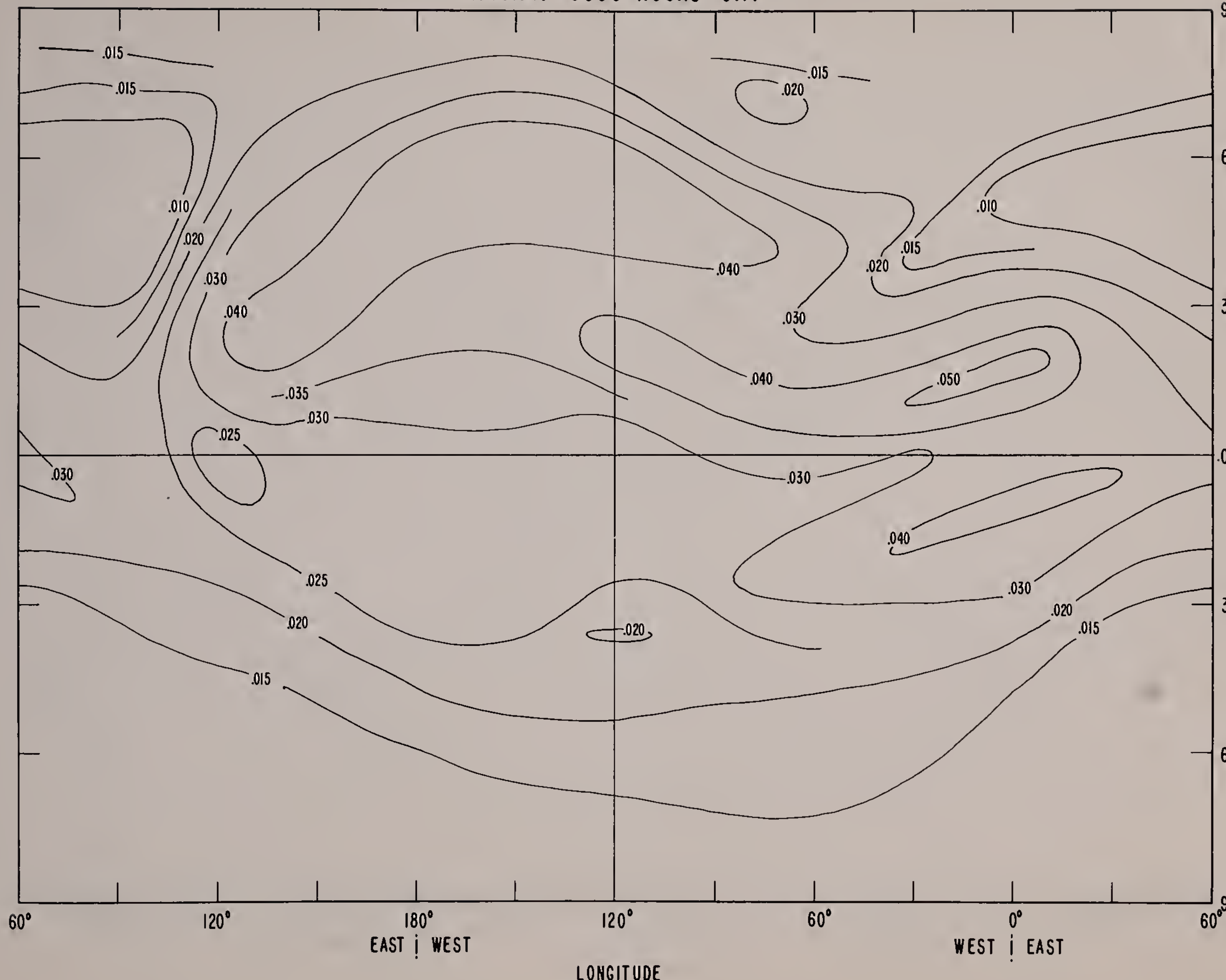
foF2 AT RASSN 50
JANUARY 2000 HOURS GMT



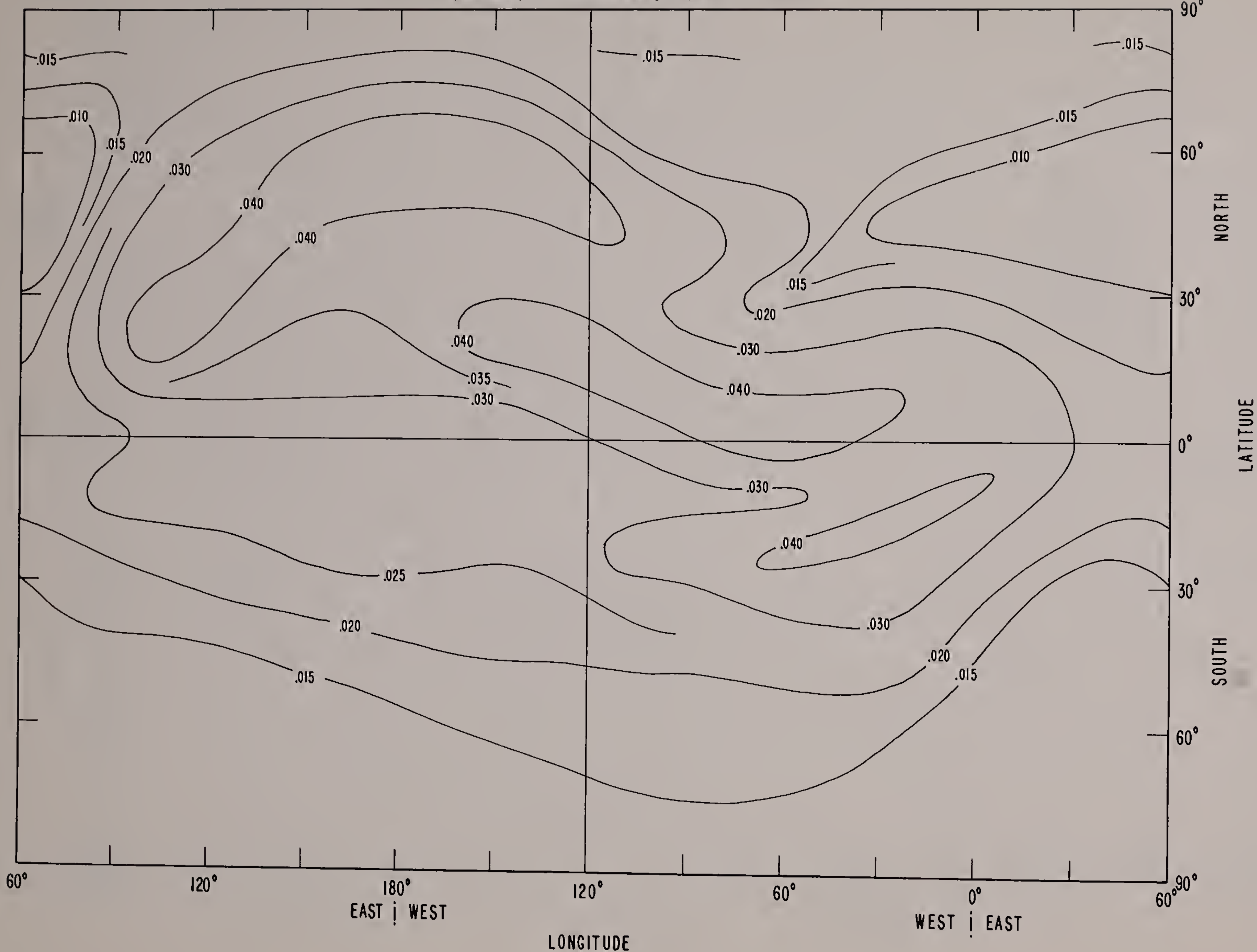
foF2 AT RASSN 50
JANUARY 2200 HOURS GMT



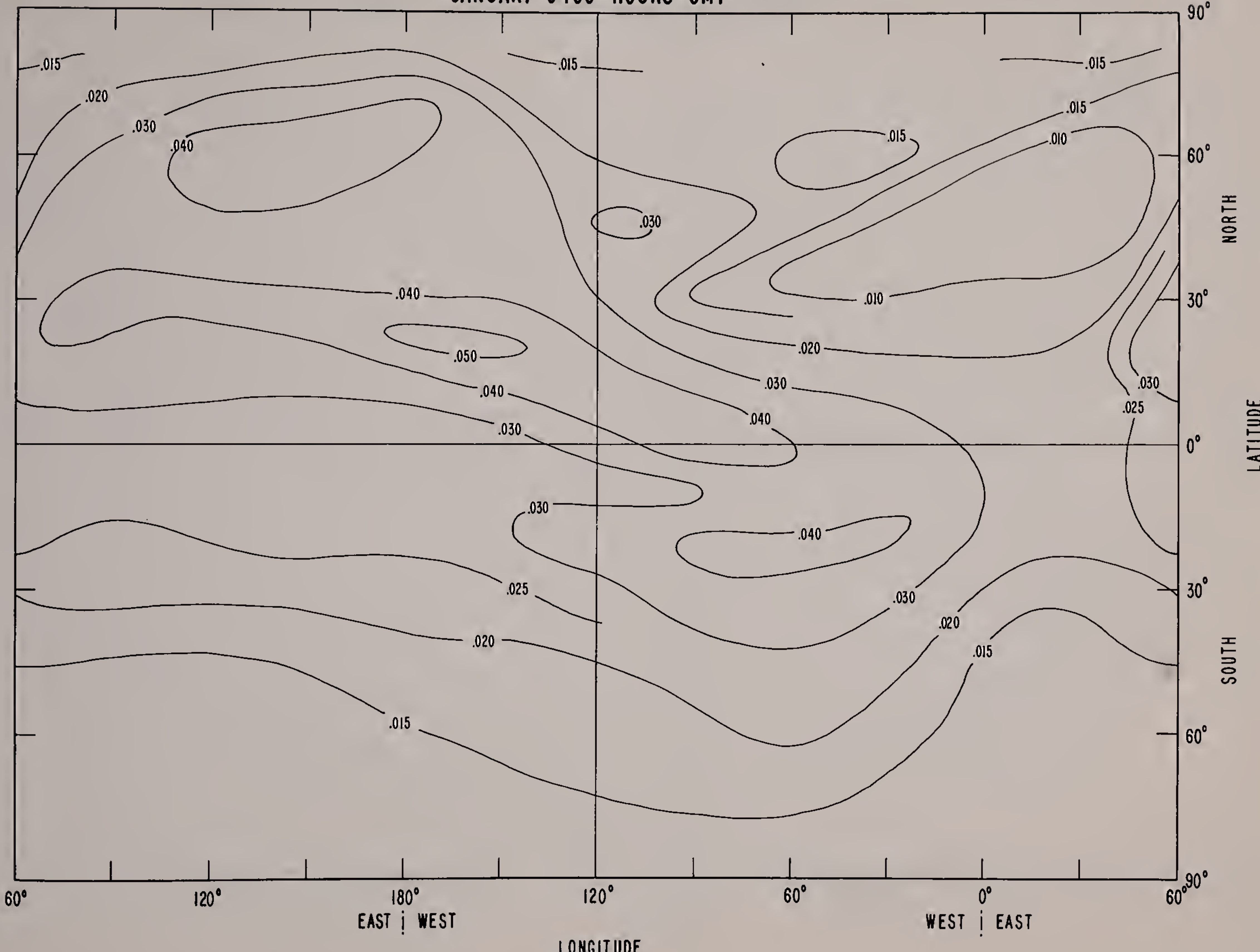
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 0000 HOURS GMT



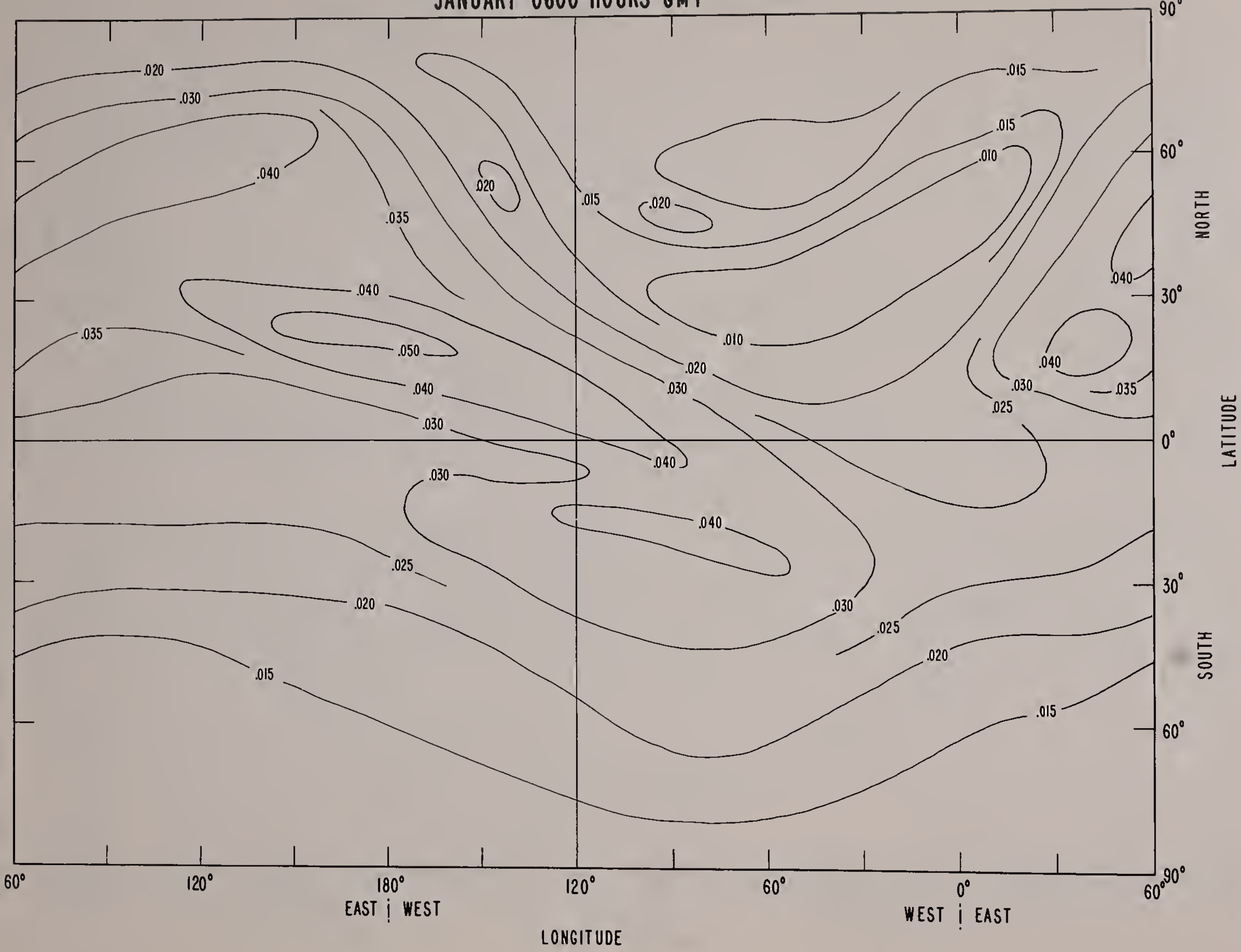
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 0200 HOURS GMT



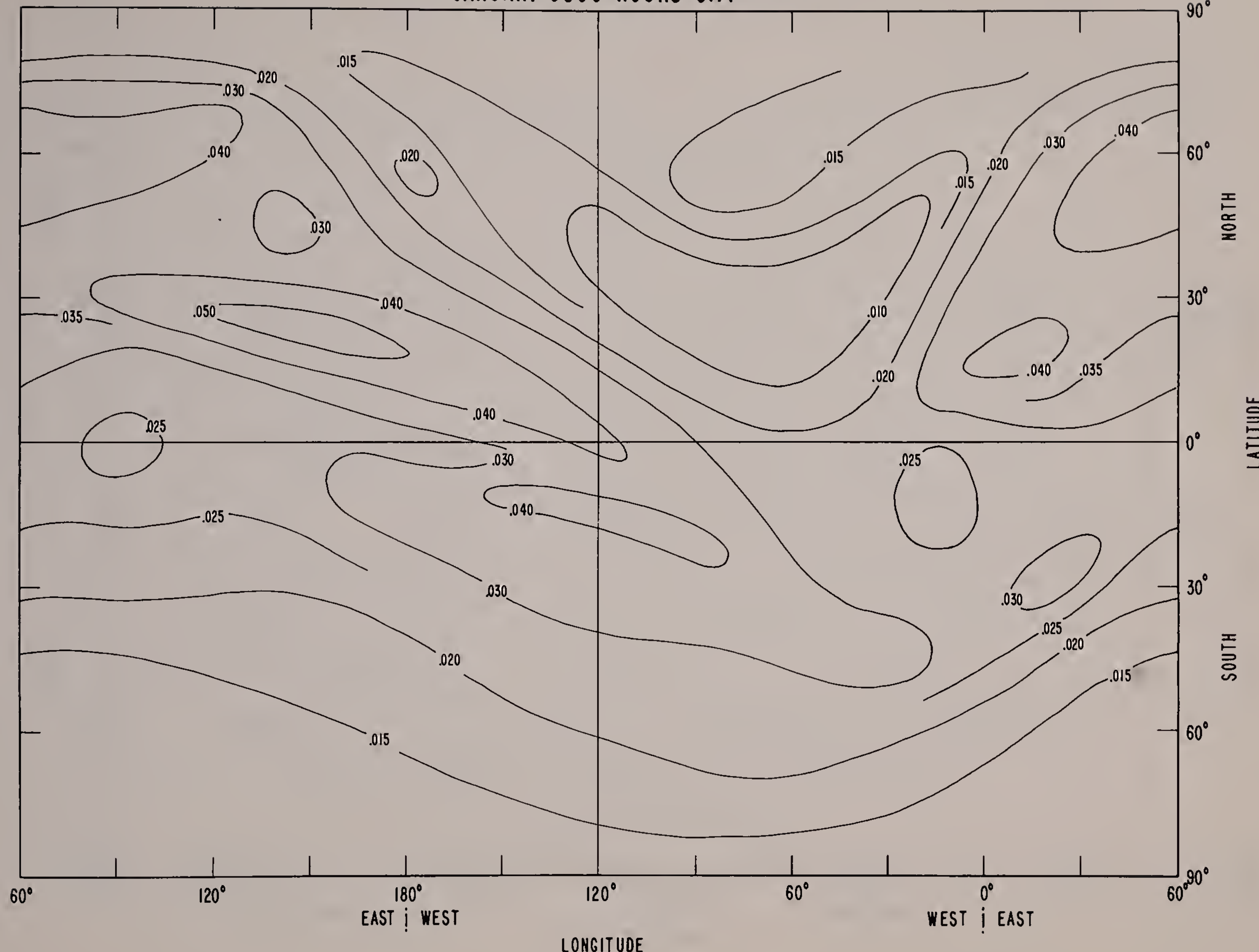
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 0400 HOURS GMT



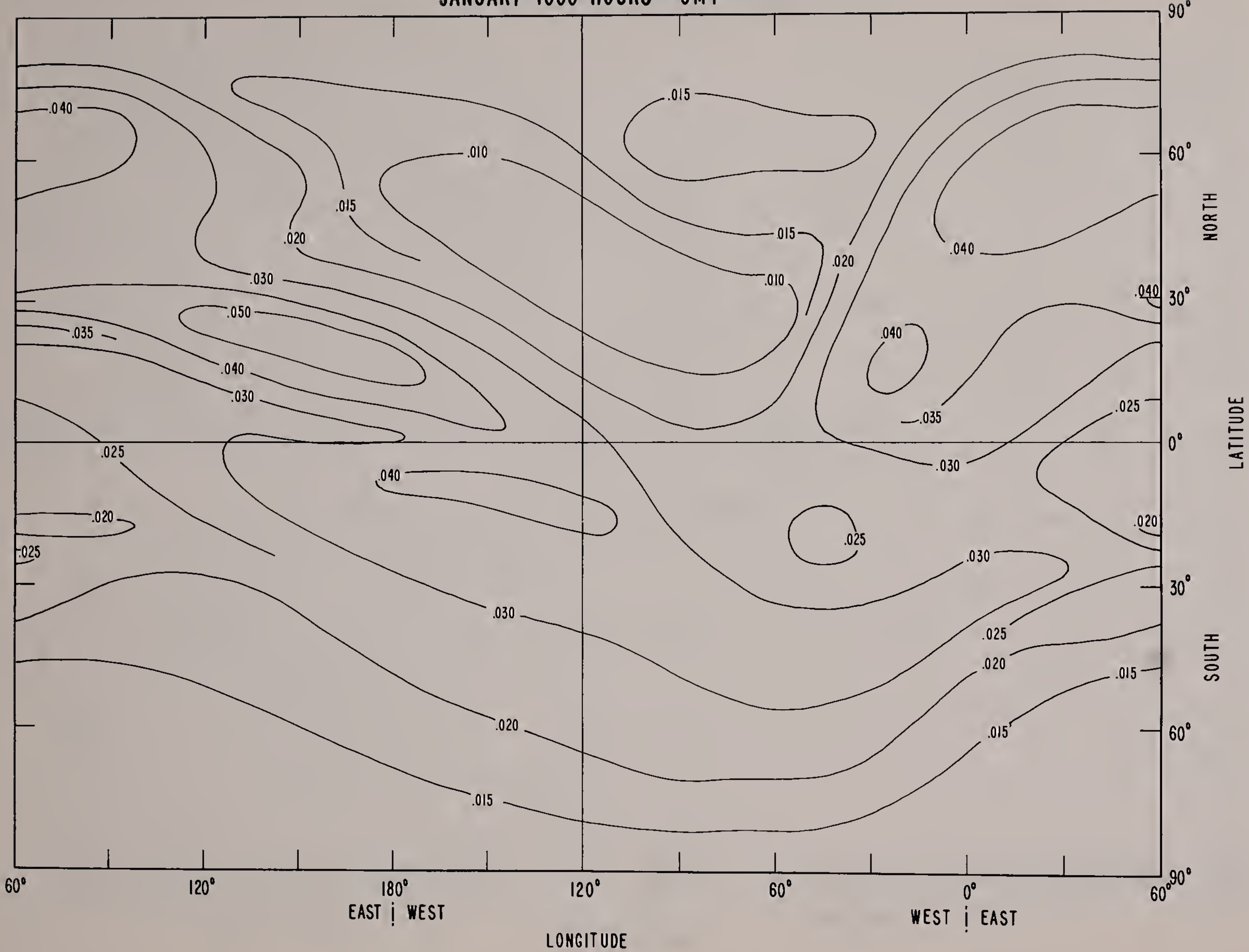
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 0600 HOURS GMT



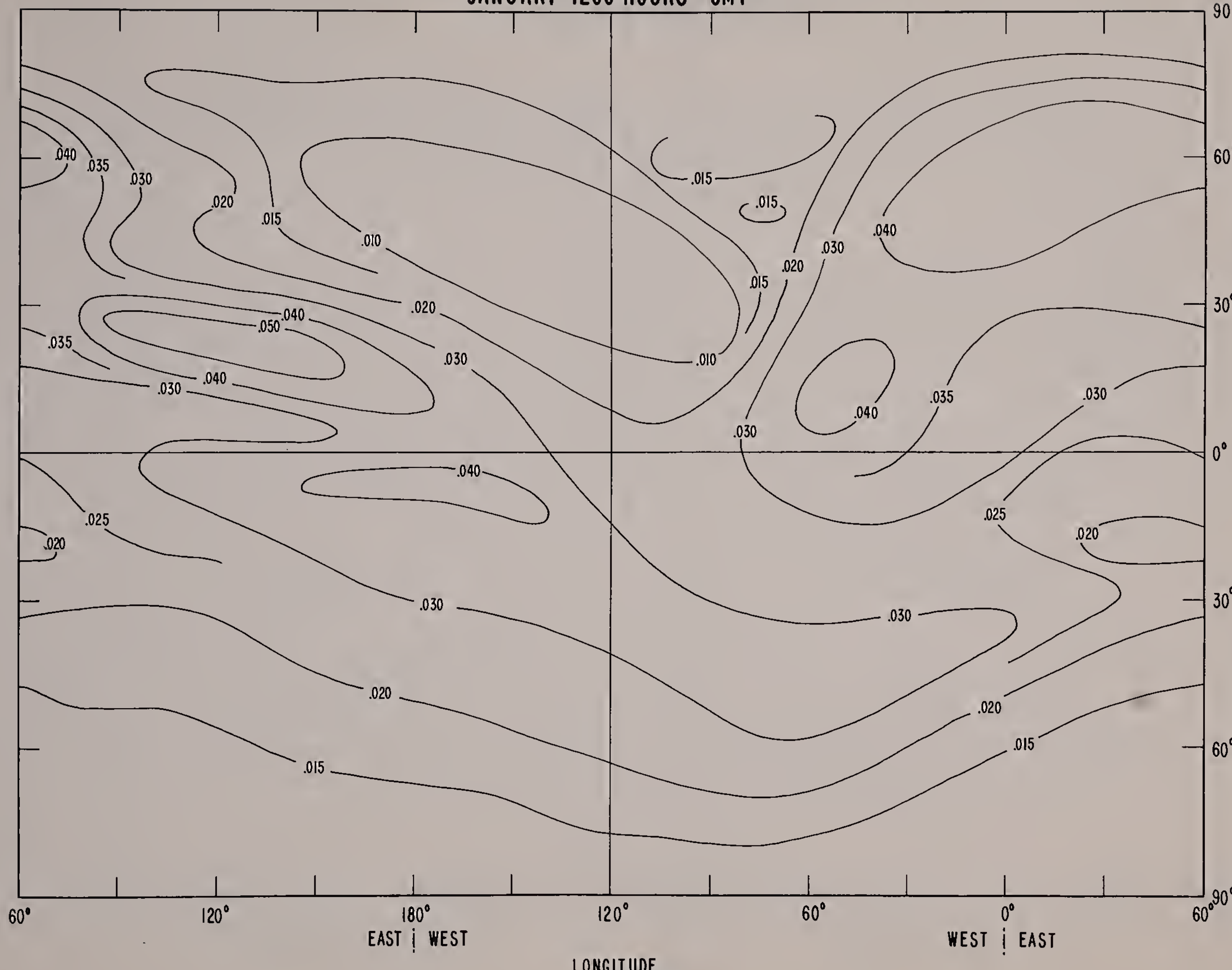
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 0800 HOURS GMT



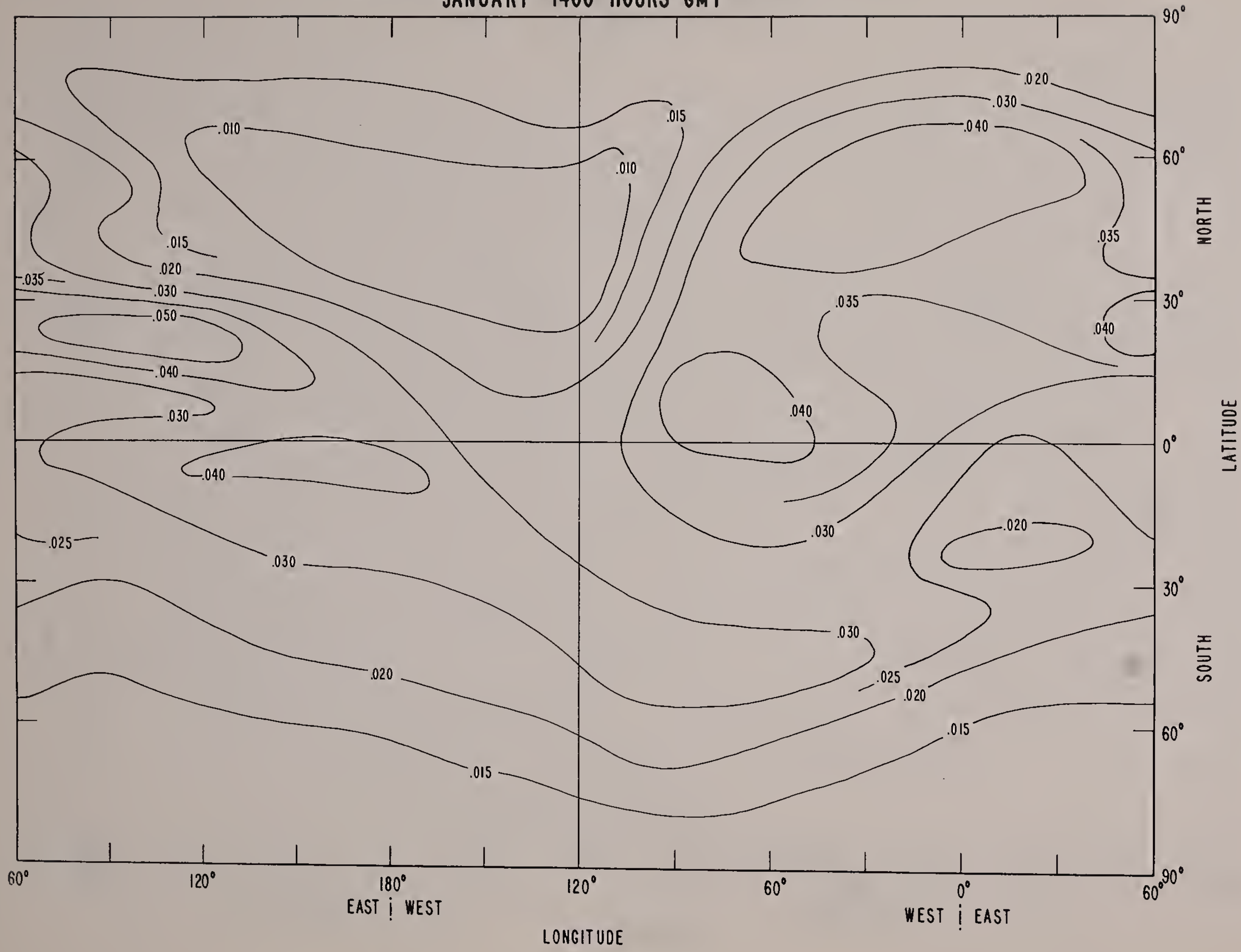
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 1000 HOURS GMT



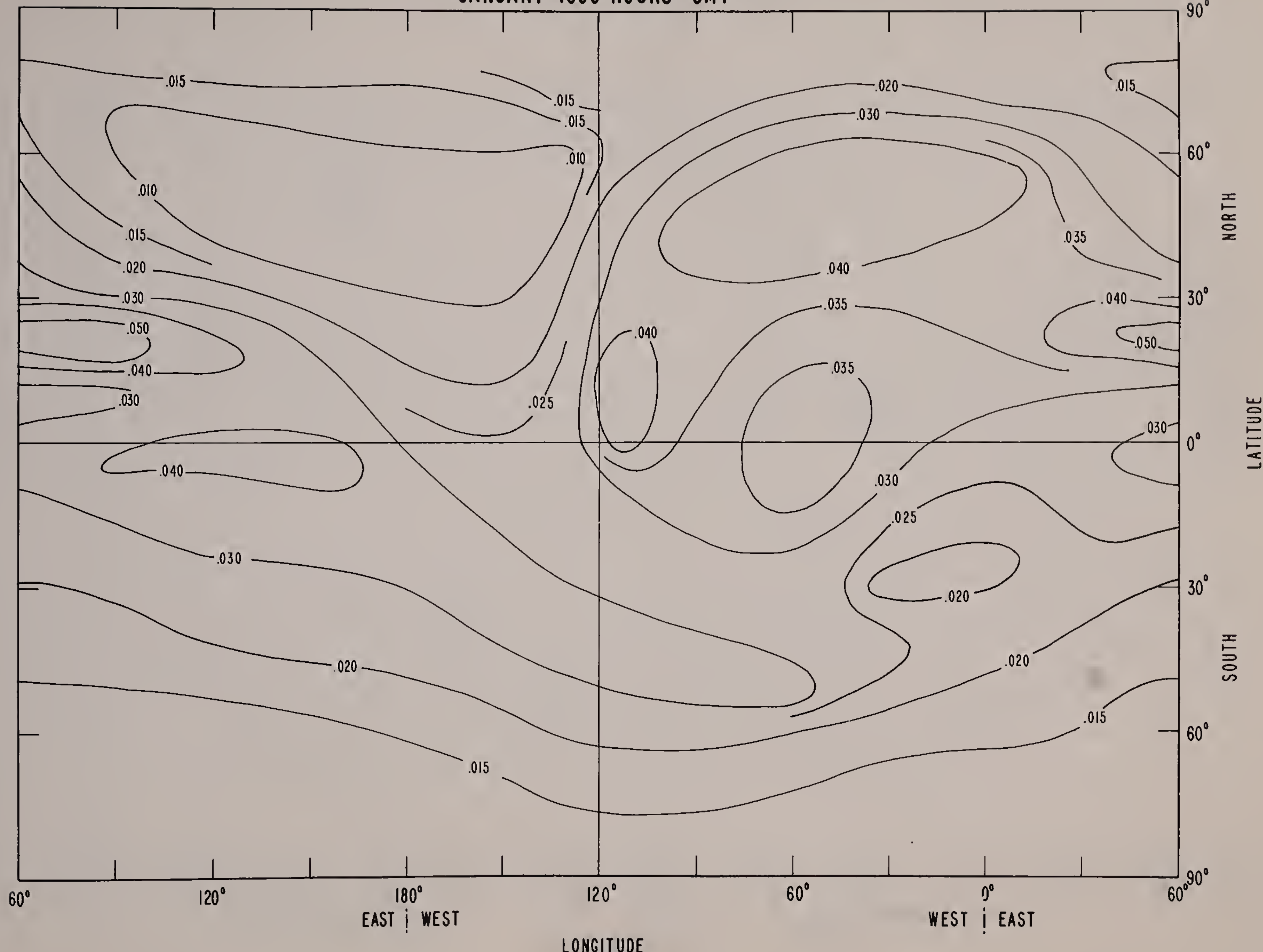
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 1200 HOURS GMT



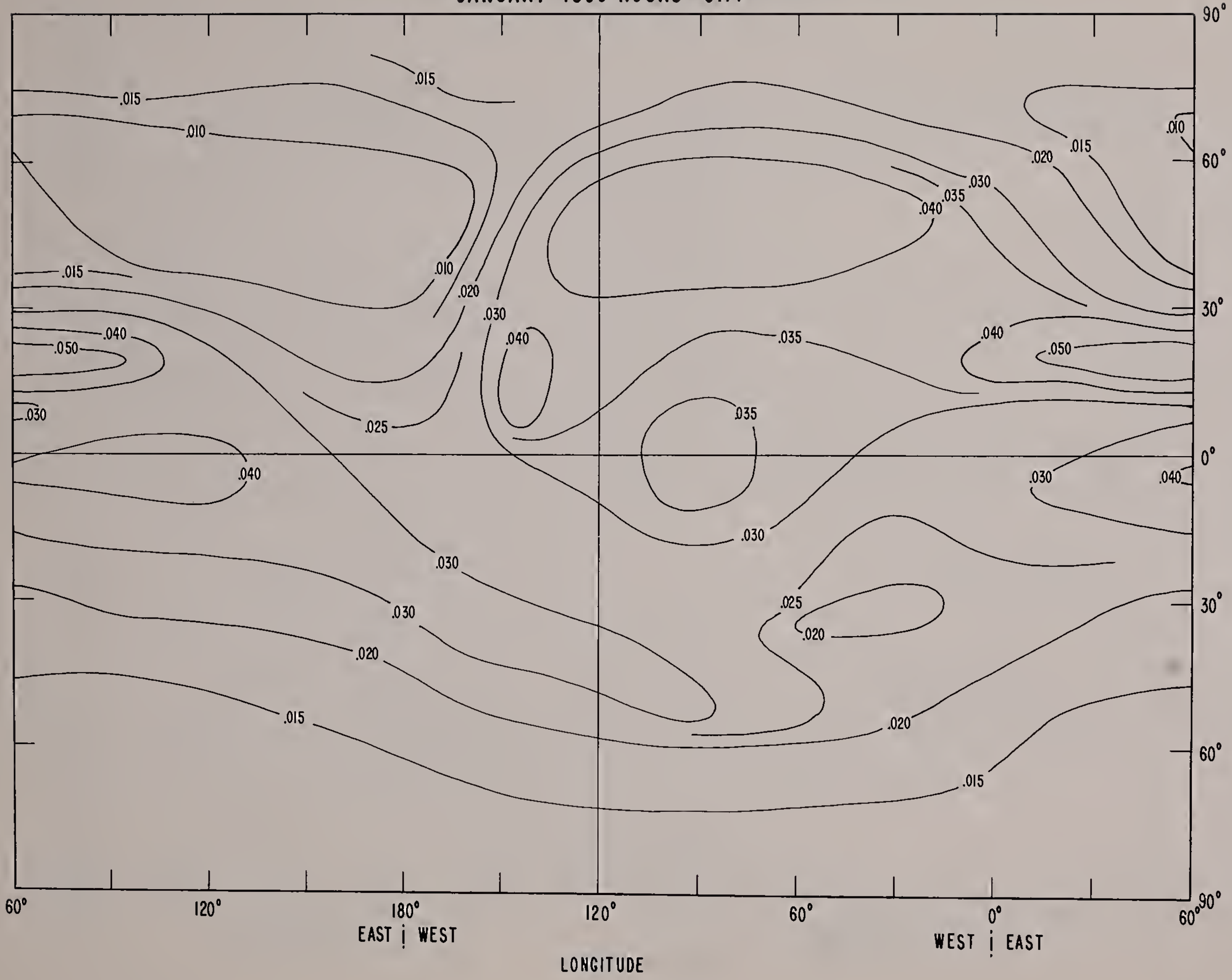
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 1400 HOURS GMT



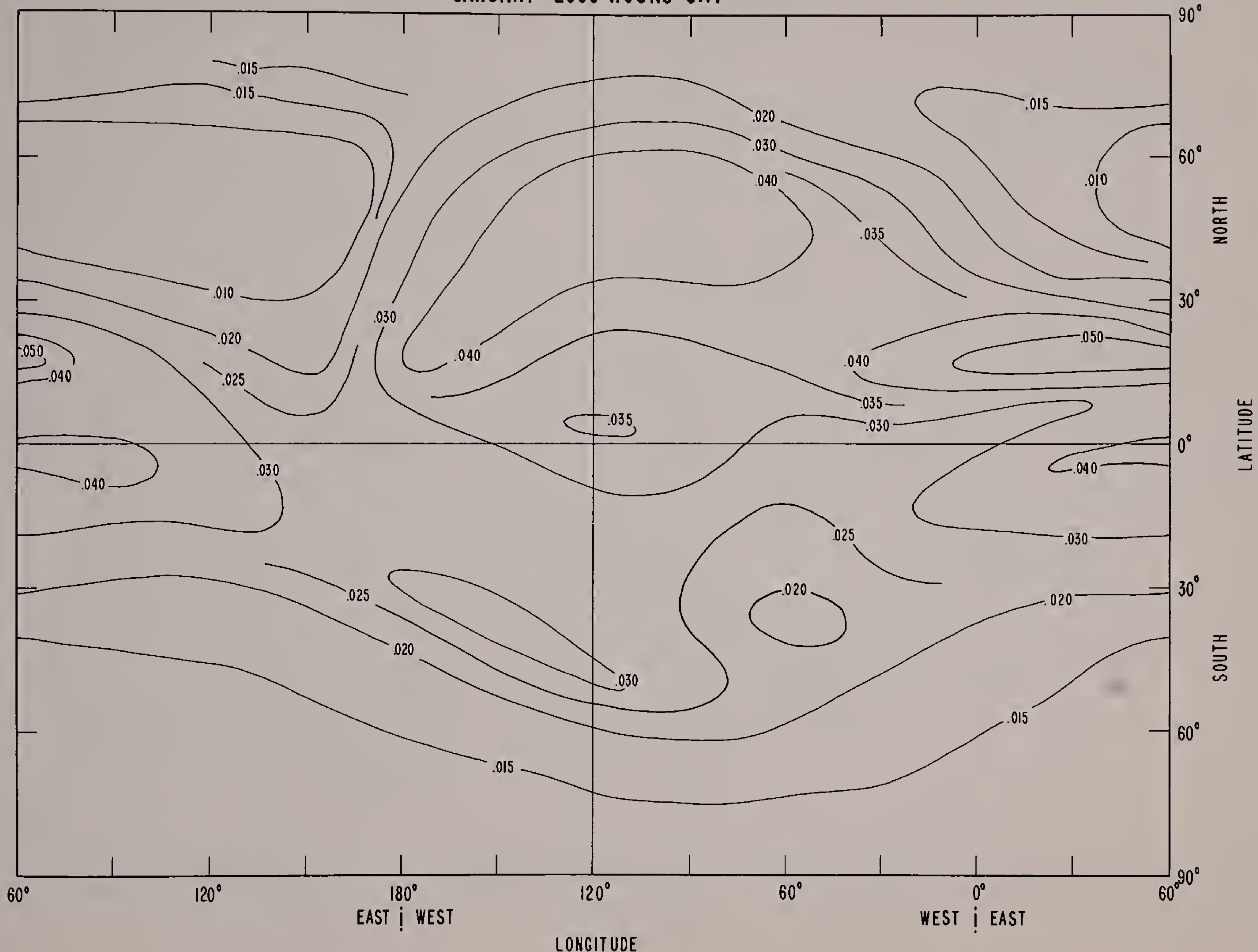
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 1600 HOURS GMT



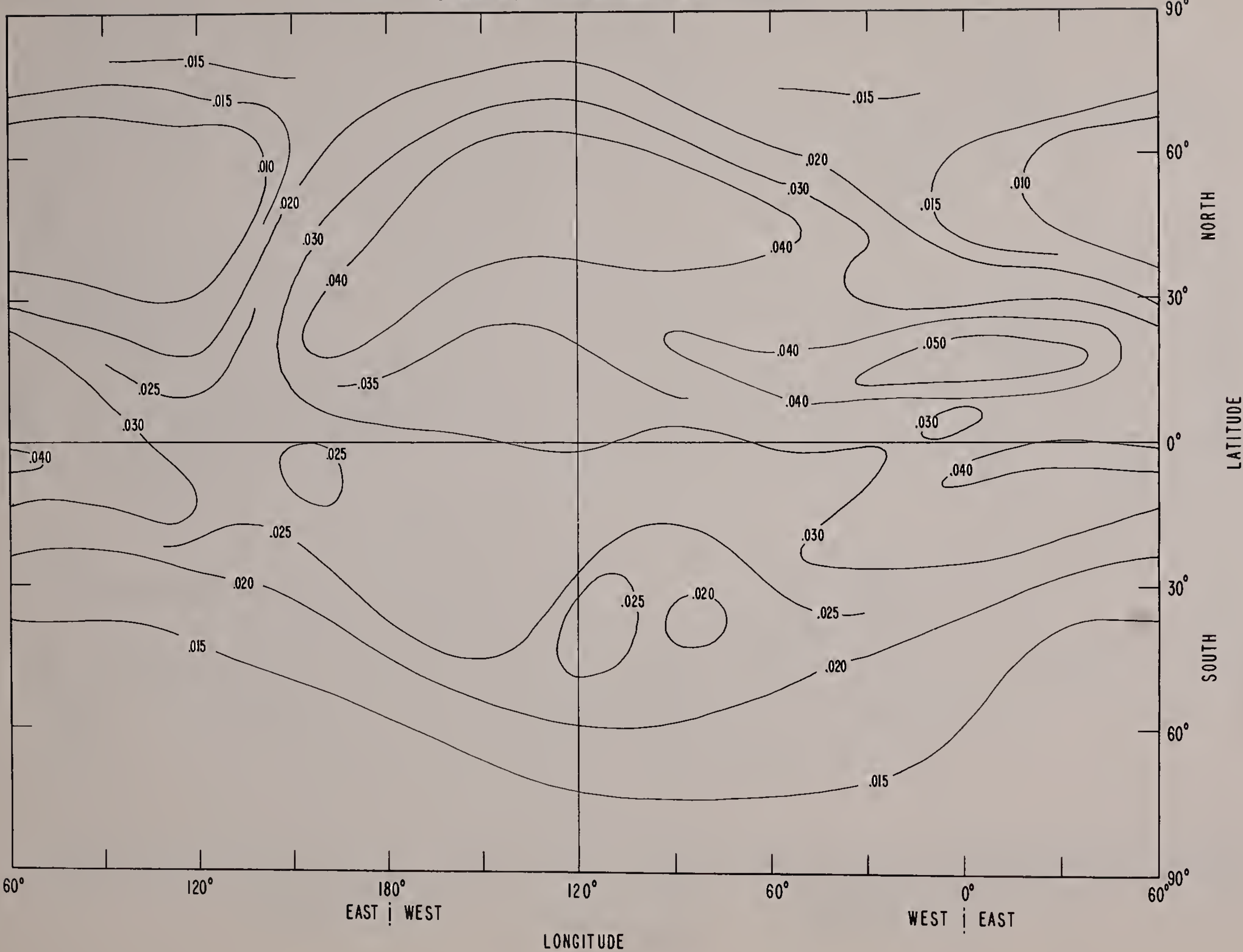
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 1800 HOURS GMT



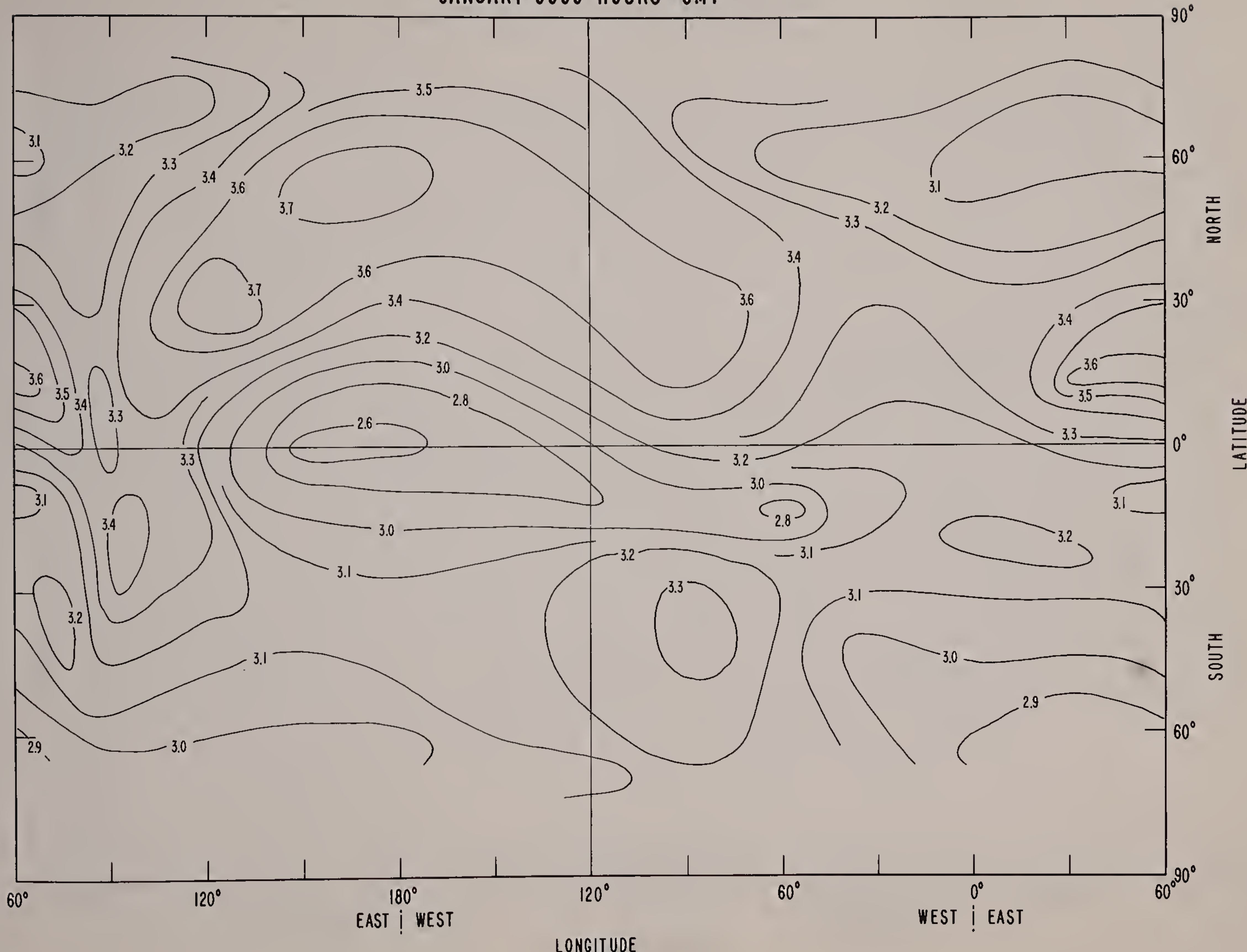
SLOPE OF REGRESSION LINE OF foF2 AT RASSN
JANUARY 2000 HOURS GMT



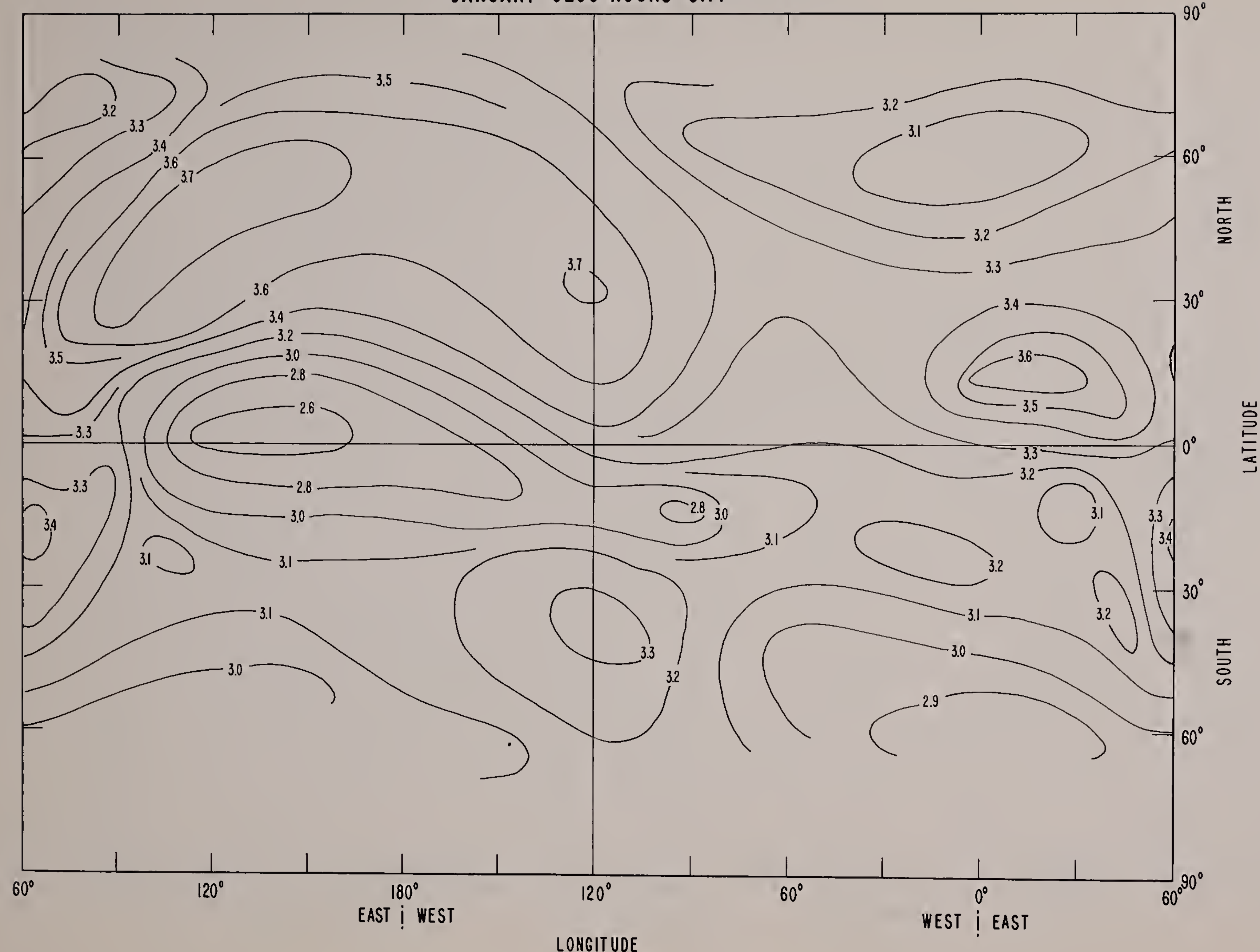
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JANUARY 2200 HOURS GMT



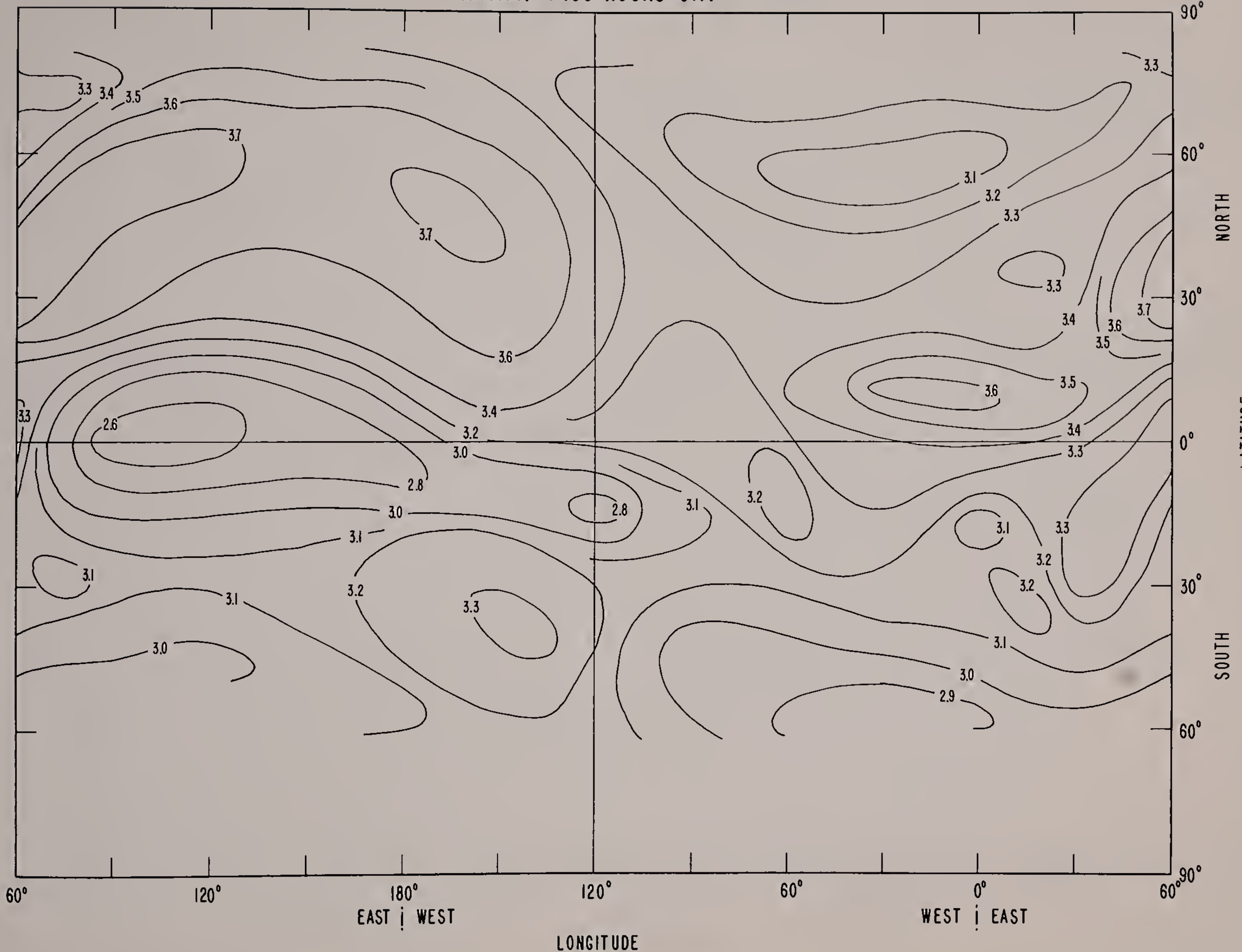
M-4000 FACTOR AT RASSN 50
JANUARY 0000 HOURS GMT



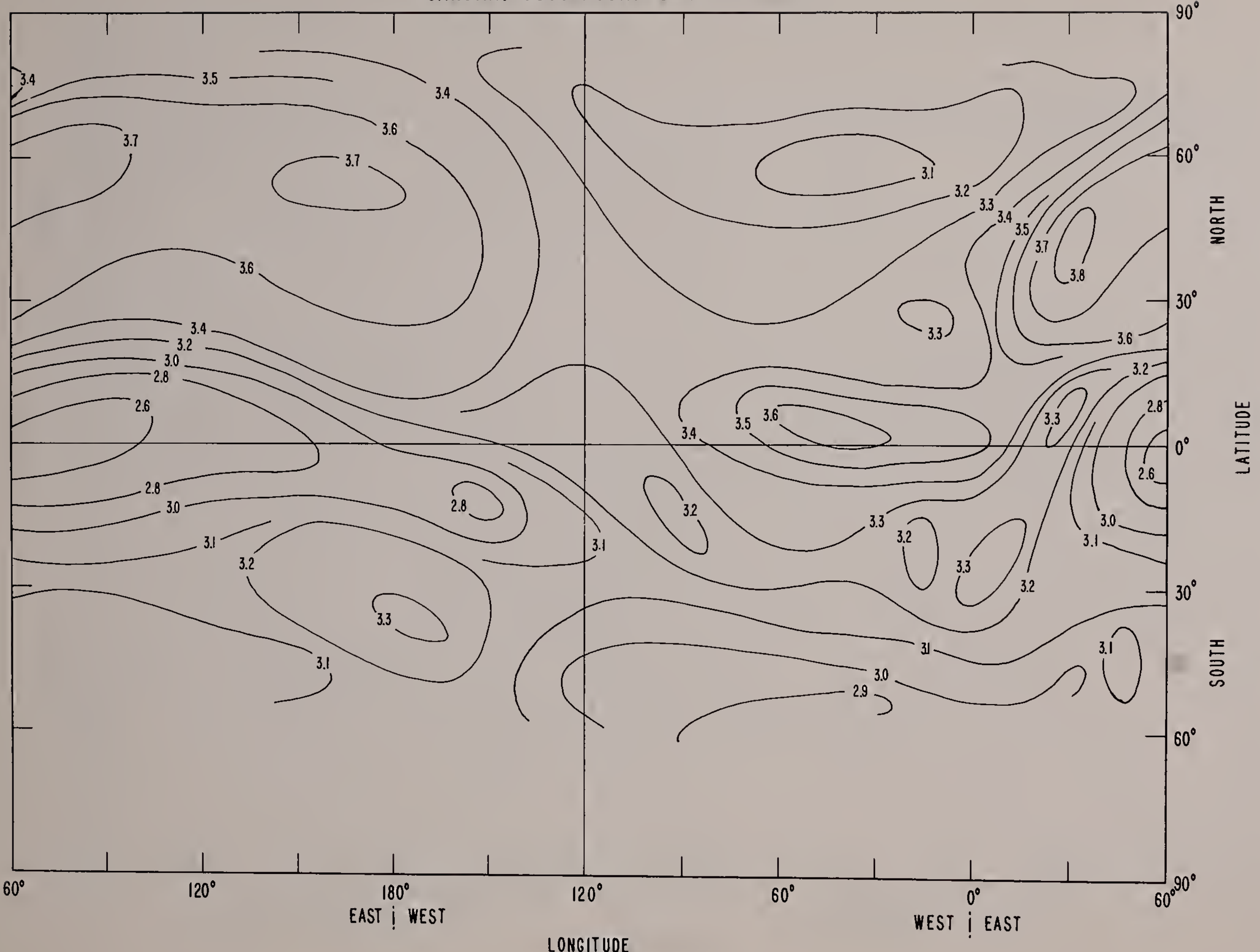
M-4000 FACTOR AT RASSN 50
JANUARY 0200 HOURS GMT



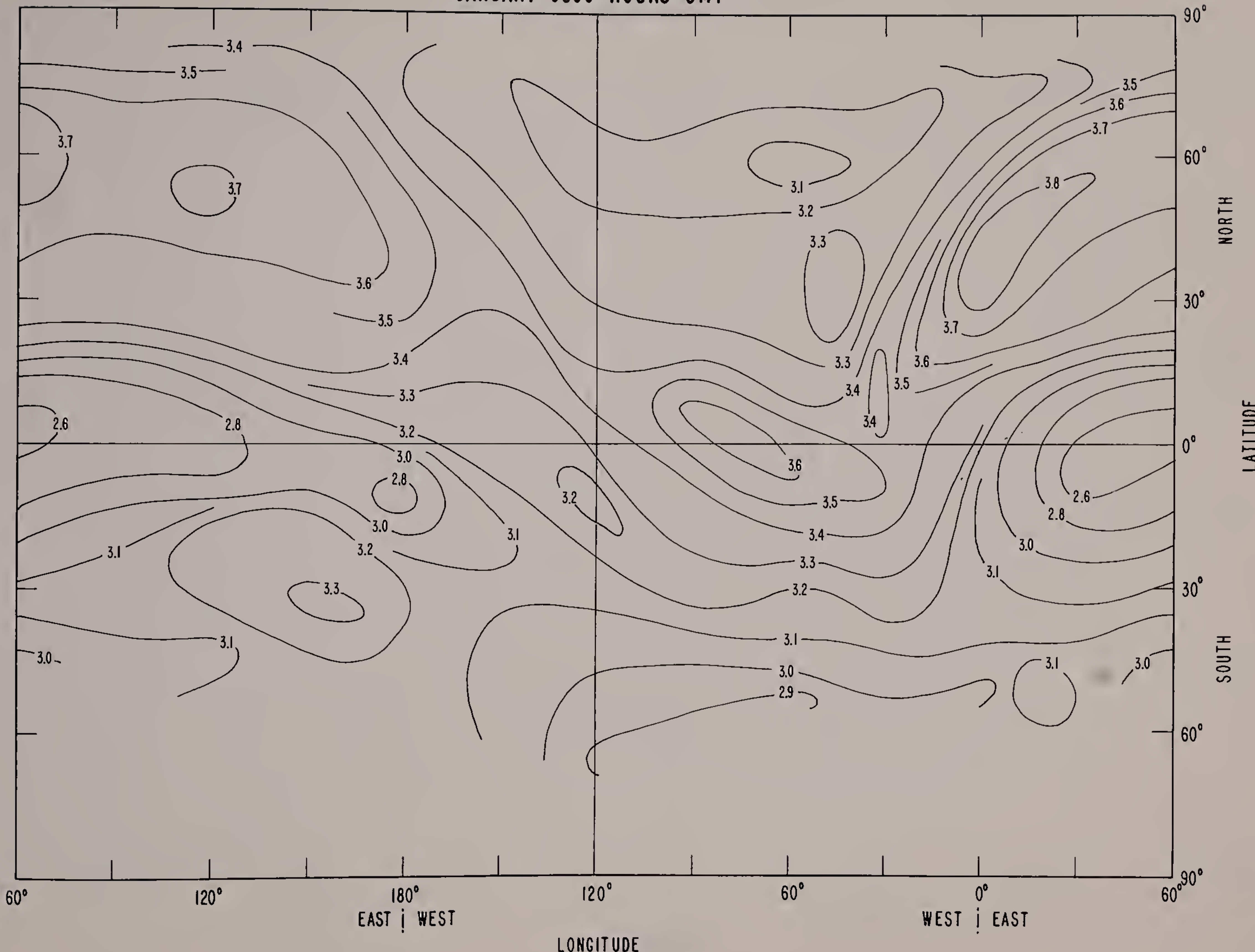
M-4000 FACTOR AT RASSN 50
JANUARY 0400 HOURS GMT



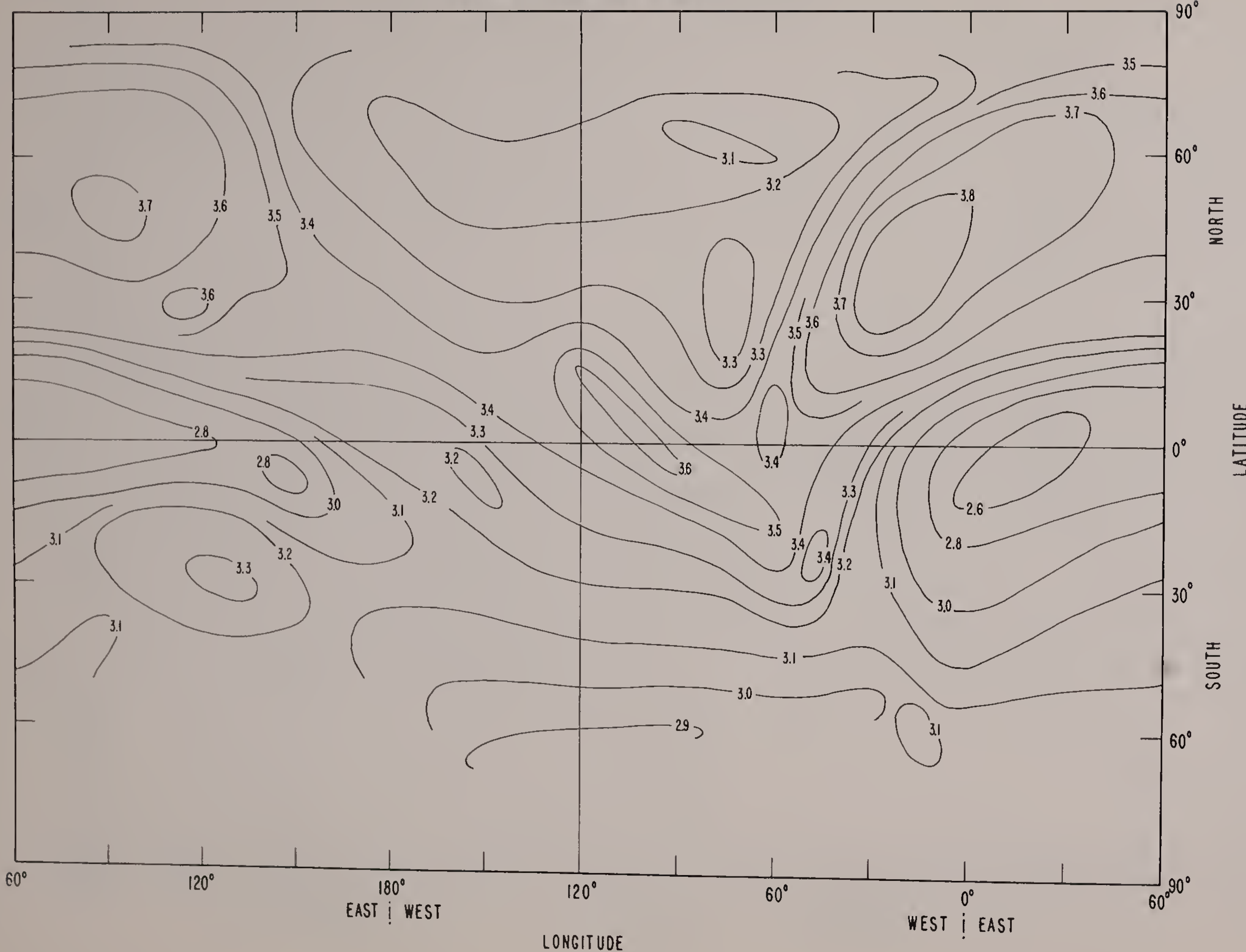
M-4000 FACTOR AT RASSN 50
JANUARY 0600 HOURS GMT



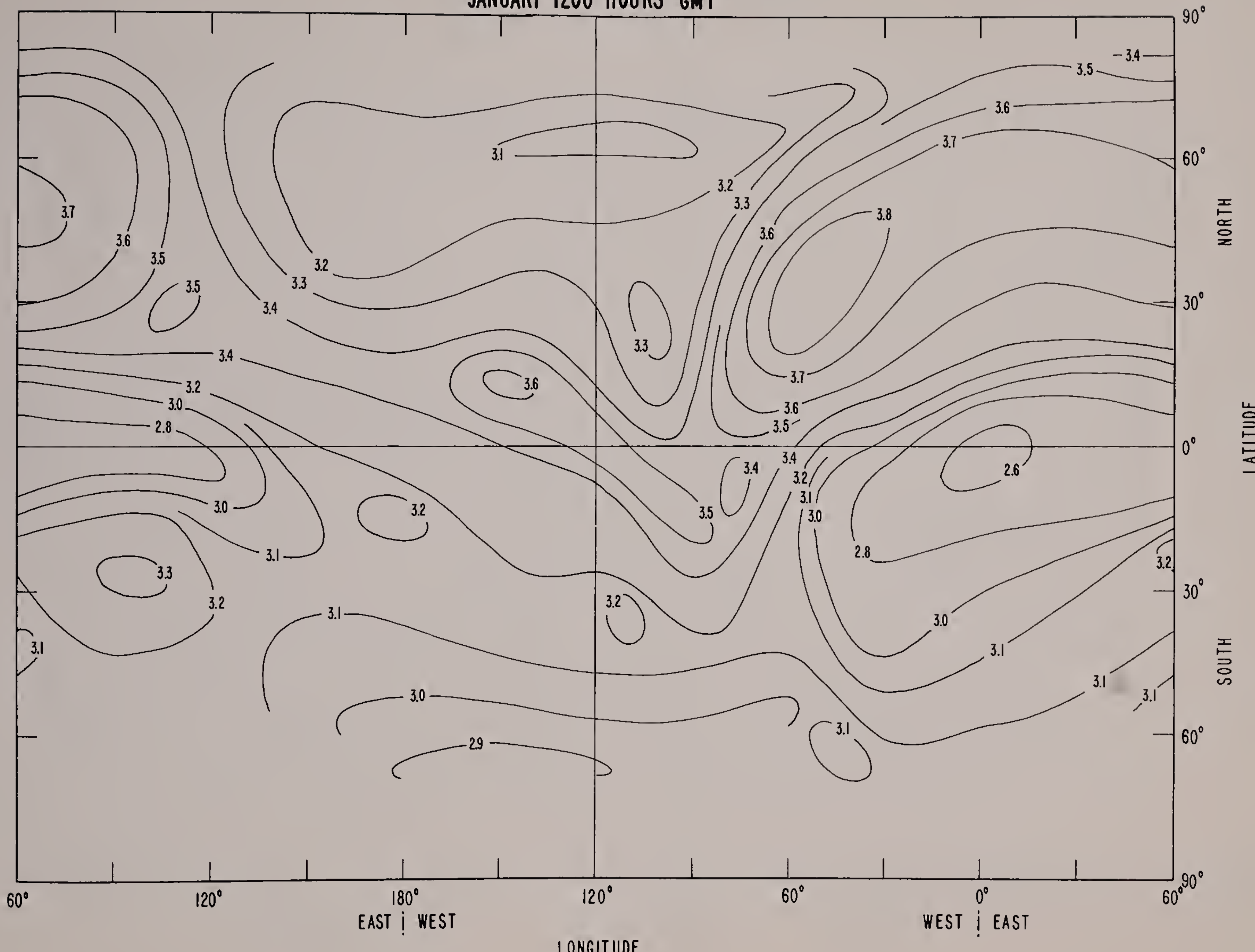
M-4000 FACTOR AT RASSN 50
JANUARY 0800 HOURS GMT



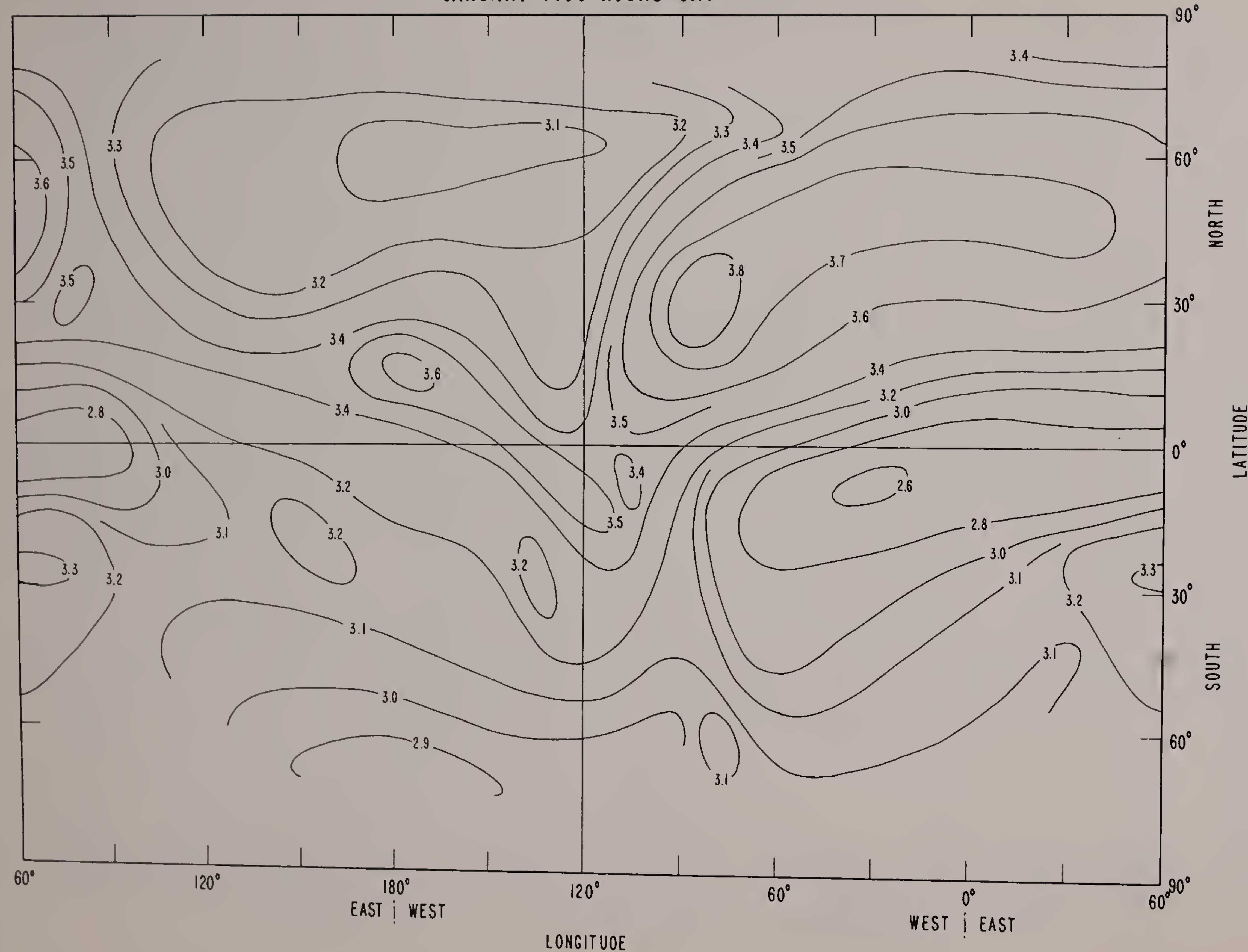
M-4000 FACTOR AT RASSN 50
JANUARY 1000 HOURS GMT



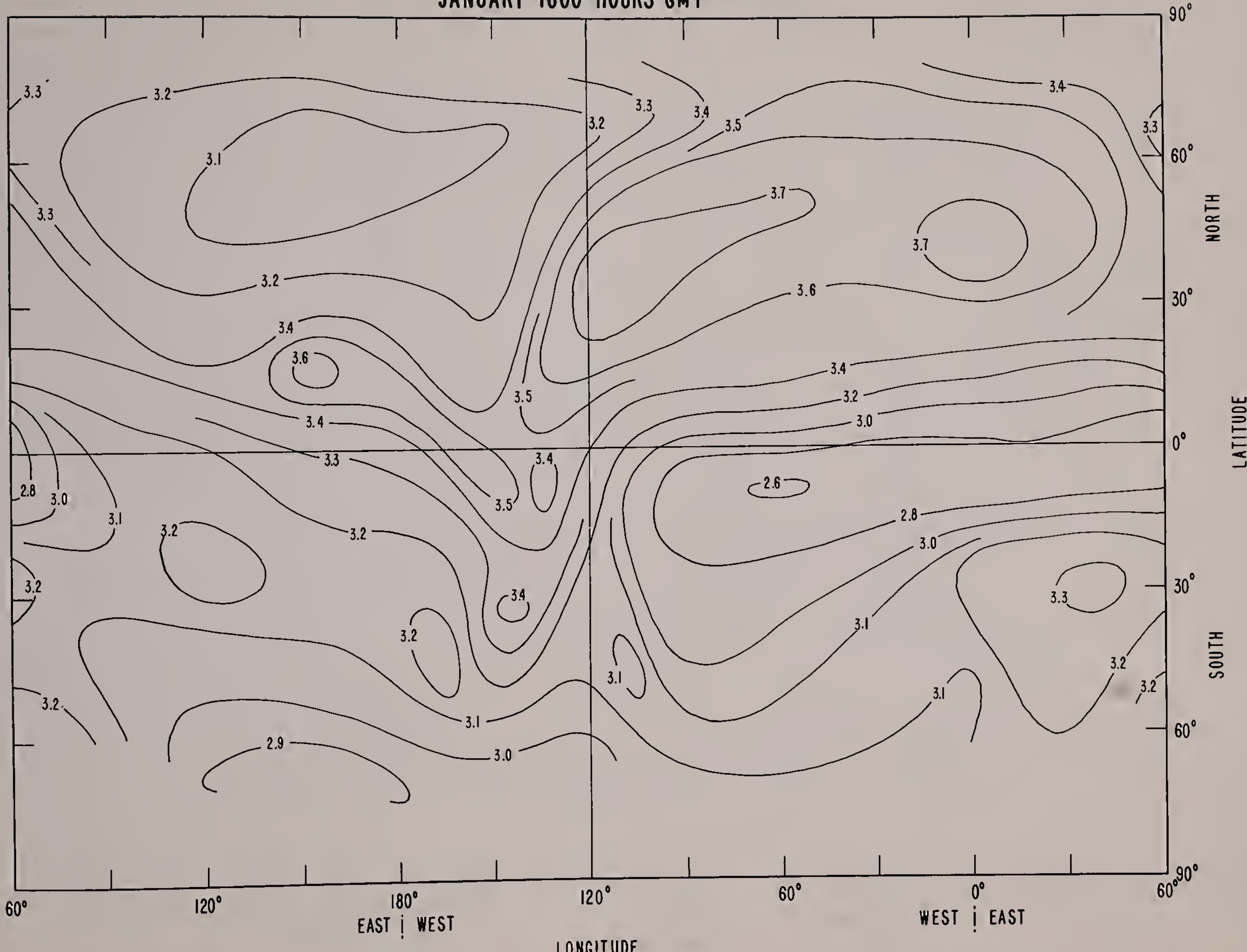
M-4000 FACTOR AT RASSN 50
JANUARY 1200 HOURS GMT



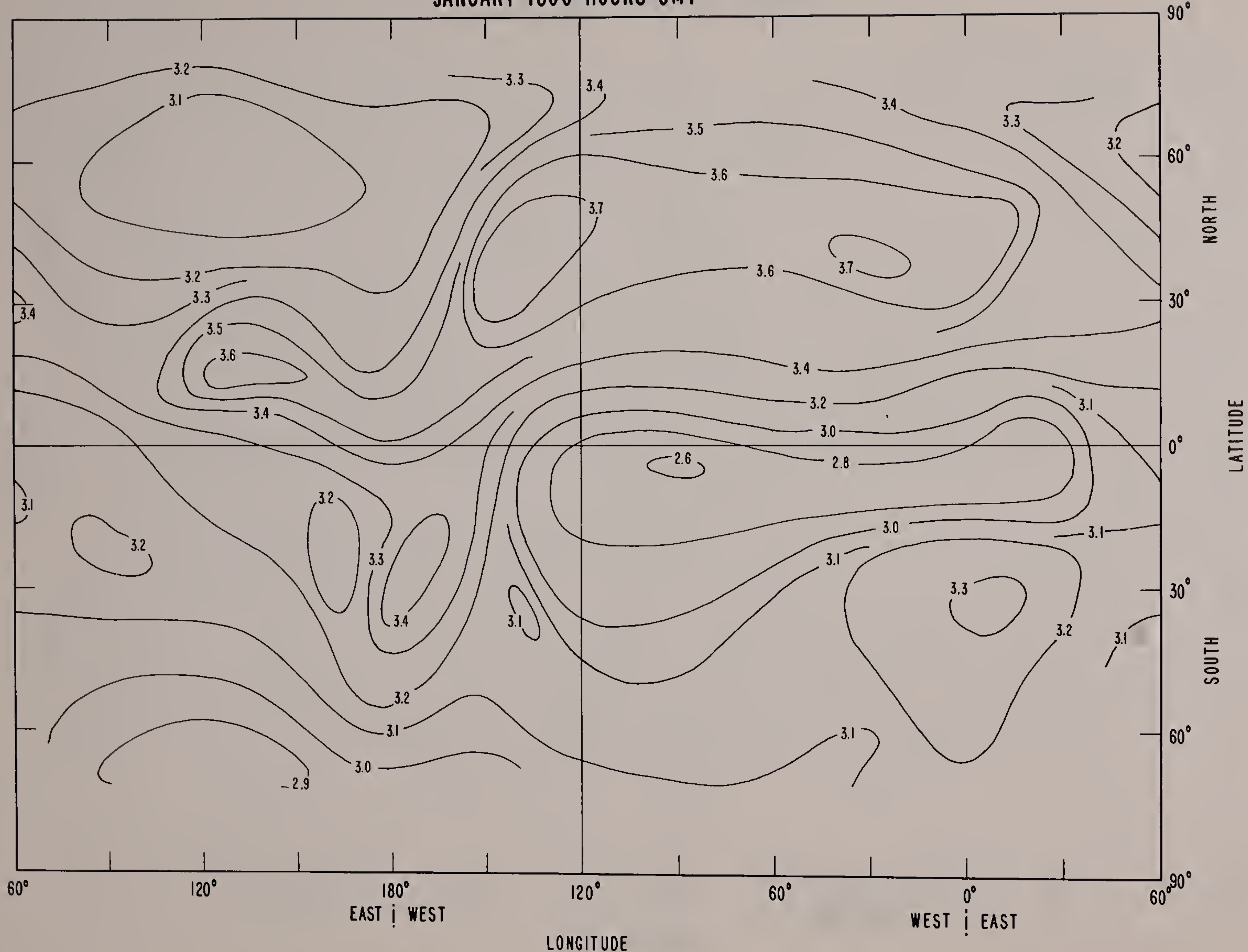
M-4000 FACTOR AT RASSN 50
JANUARY 1400 HOURS GMT



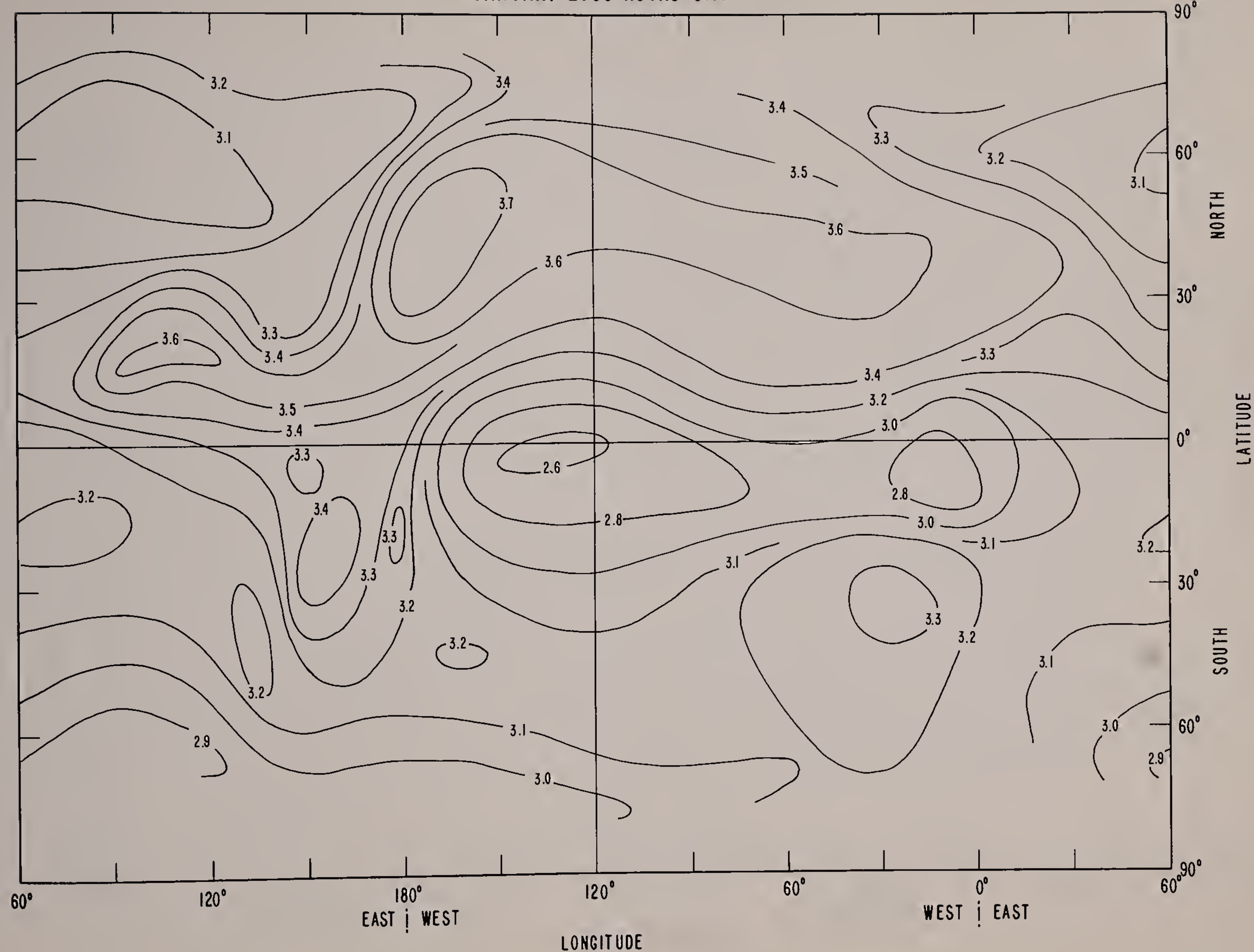
M-4000 FACTOR AT RASSN 50
JANUARY 1600 HOURS GMT



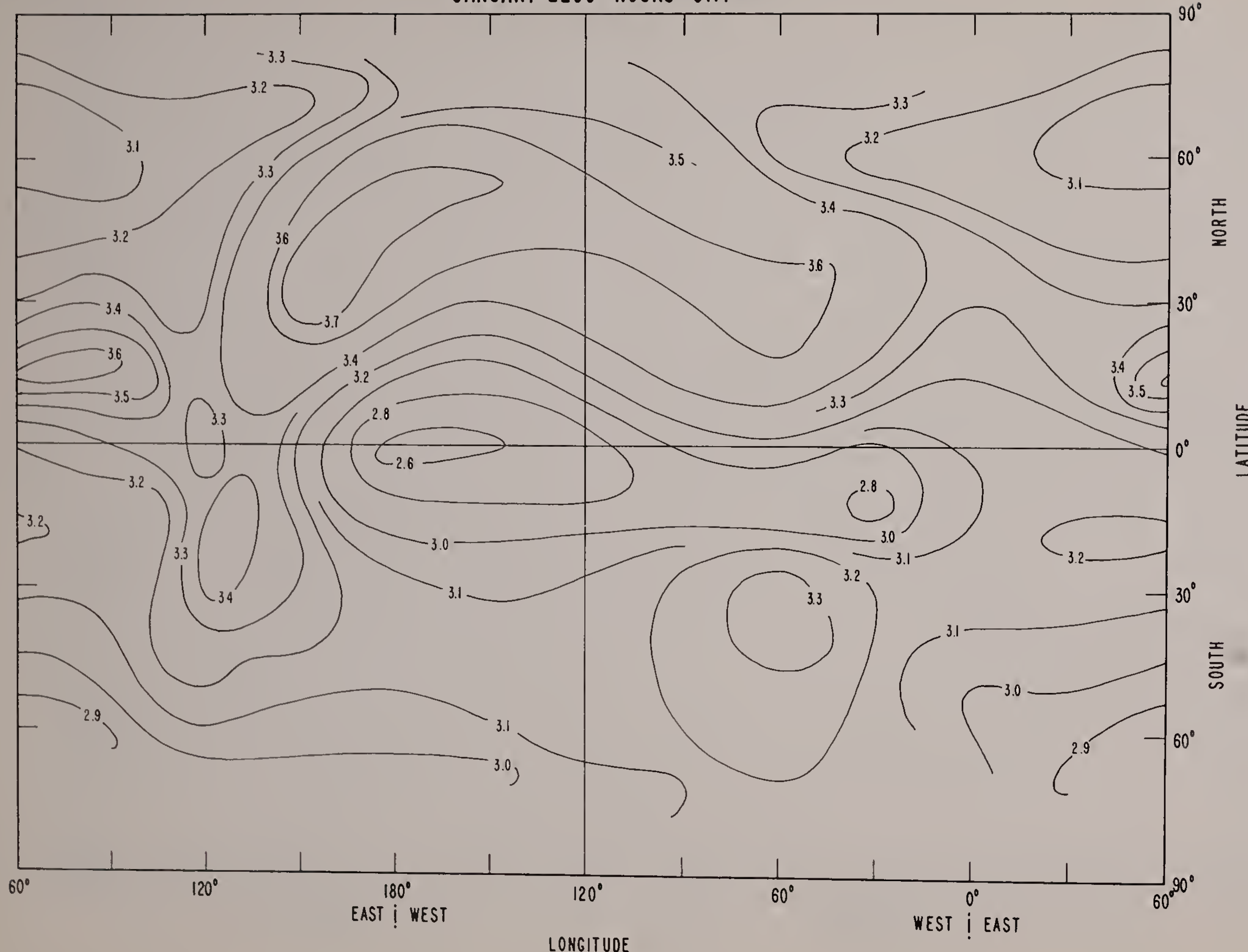
M-4000 FACTOR AT RASSN 50
JANUARY 1800 HOURS GMT



M-4000 FACTOR AT RASSN 50
JANUARY 2000 HOURS GMT

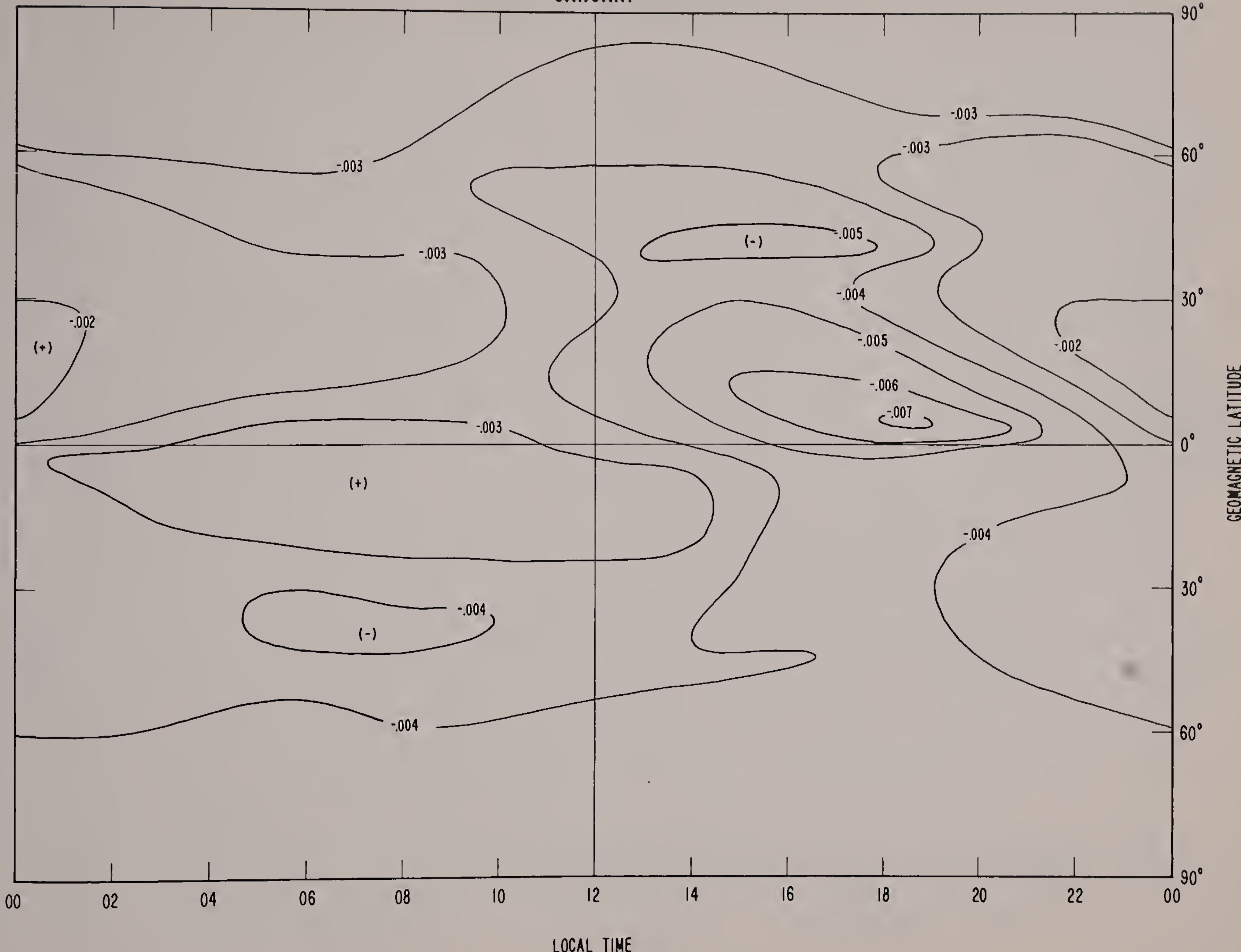


M-4000 FACTOR AT RASSN 50
JANUARY 2200 HOURS GMT

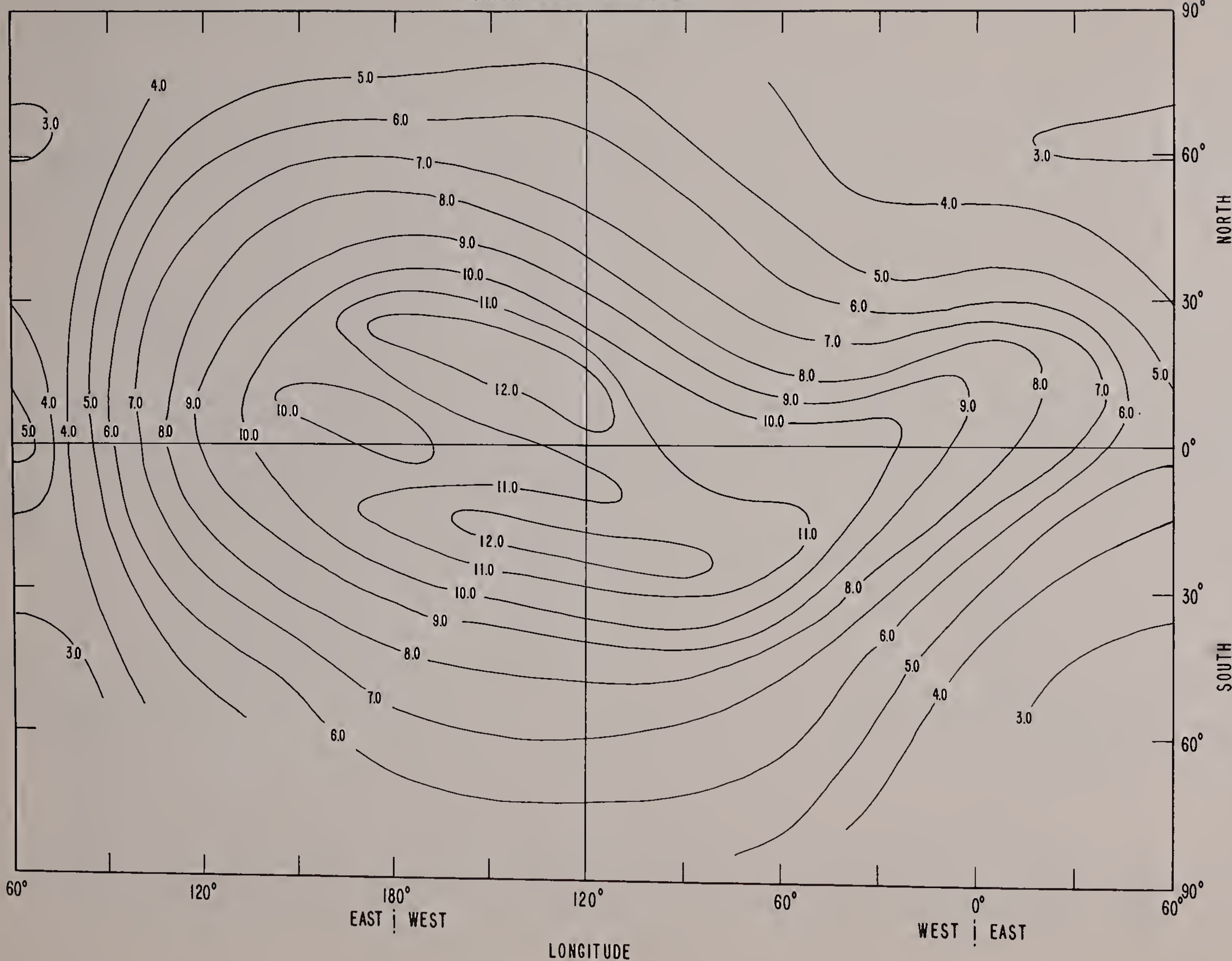


SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN

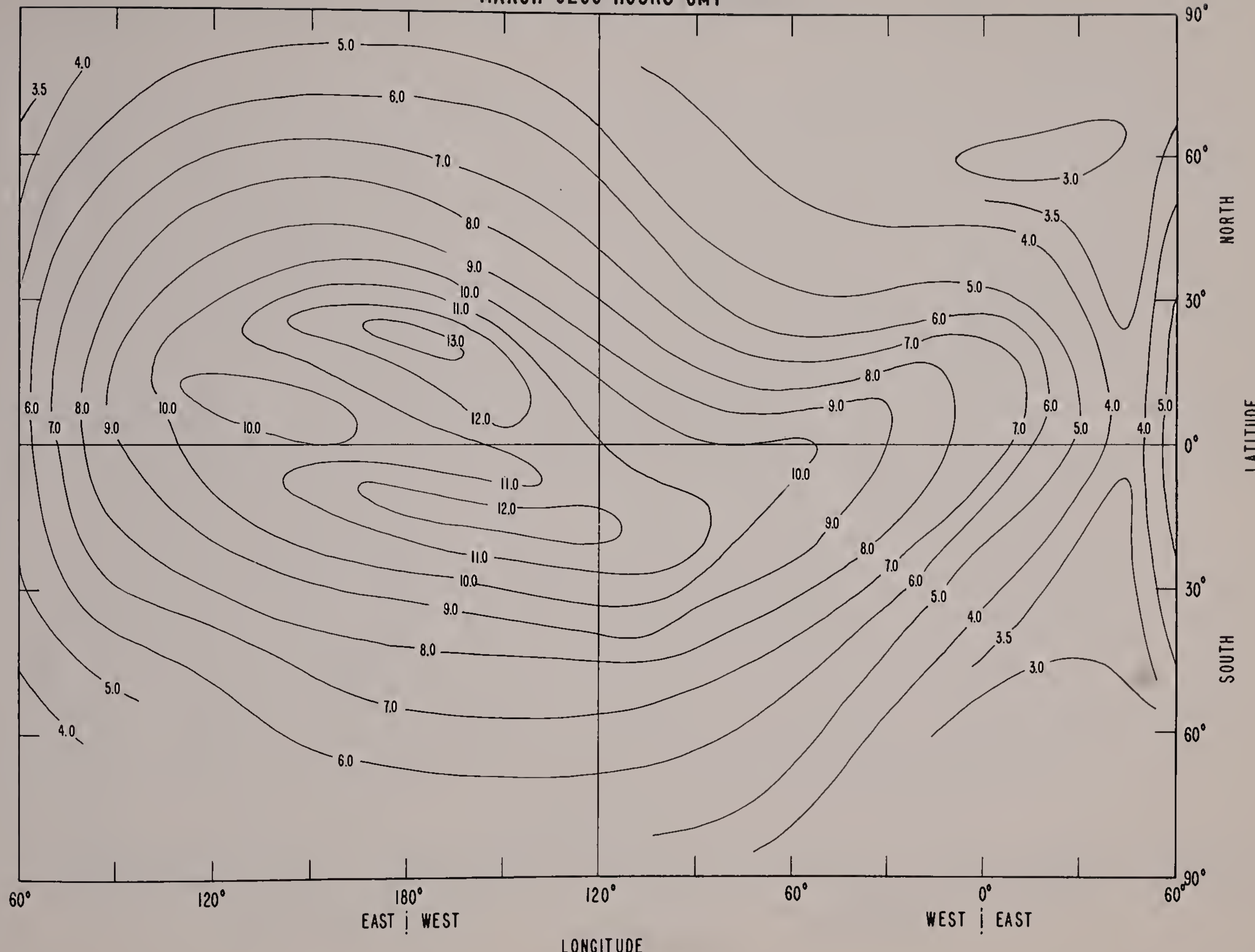
JANUARY



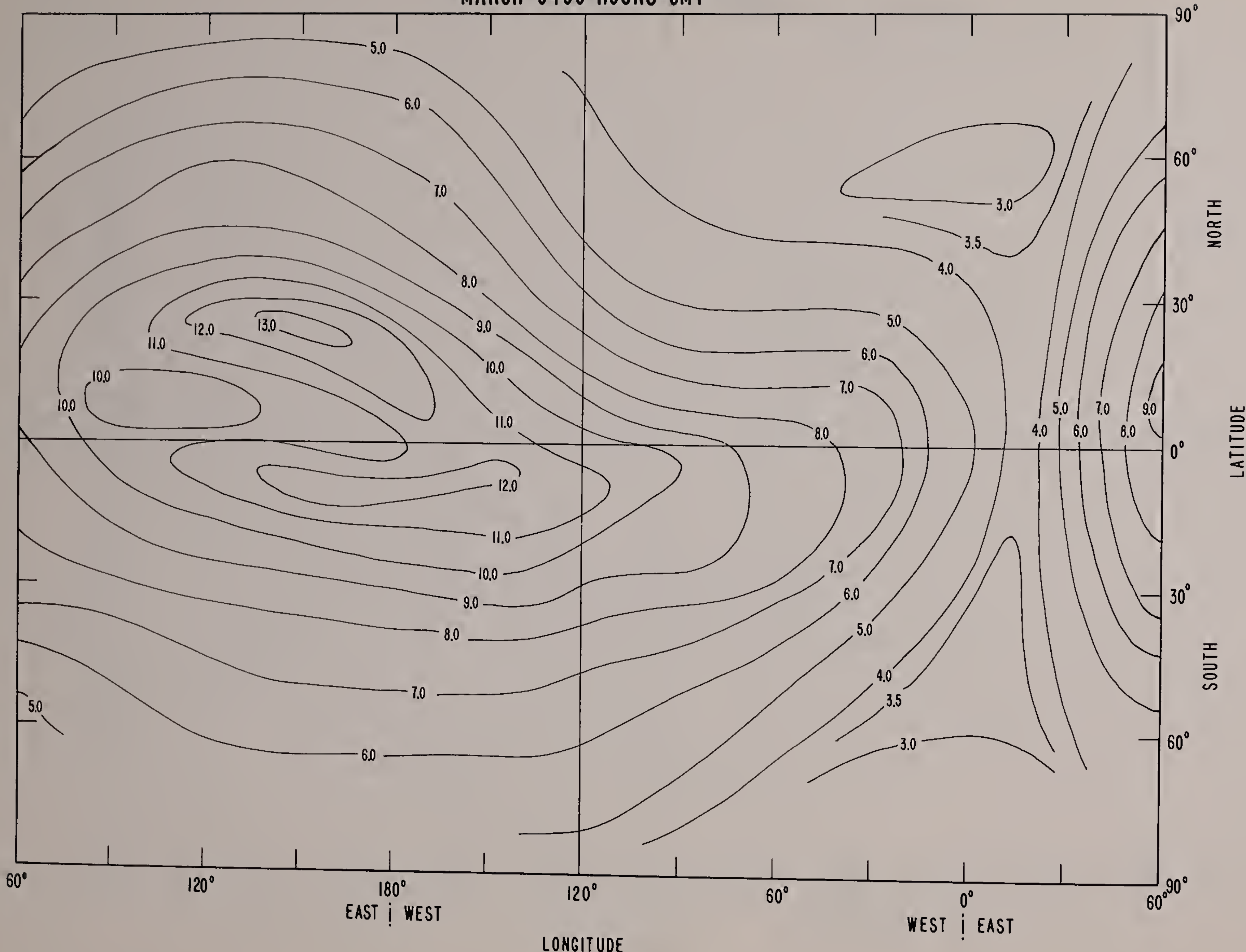
foF2 AT RASSN 50
MARCH 0000 HOURS GMT



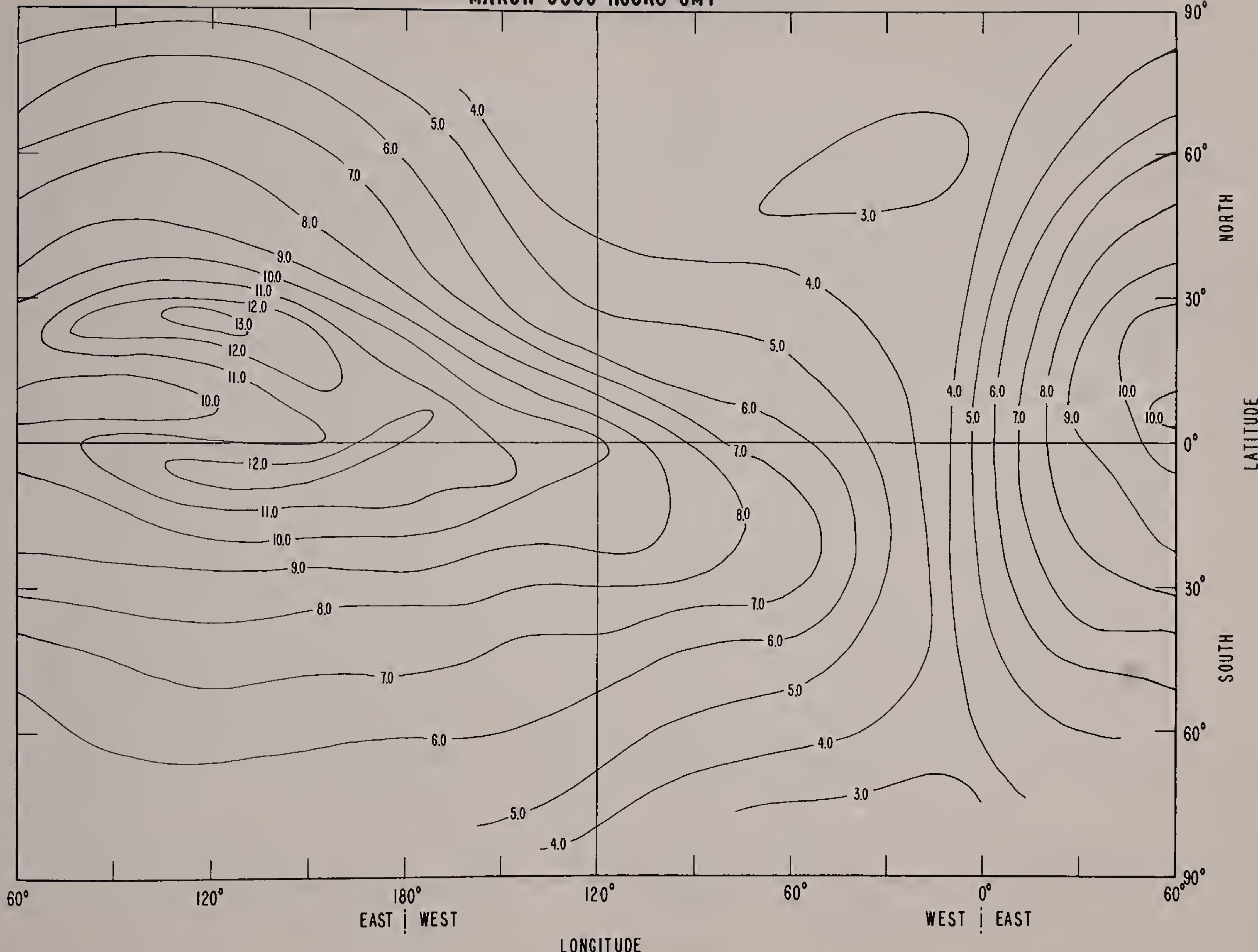
foF2 AT RASSN 50
MARCH 0200 HOURS GMT



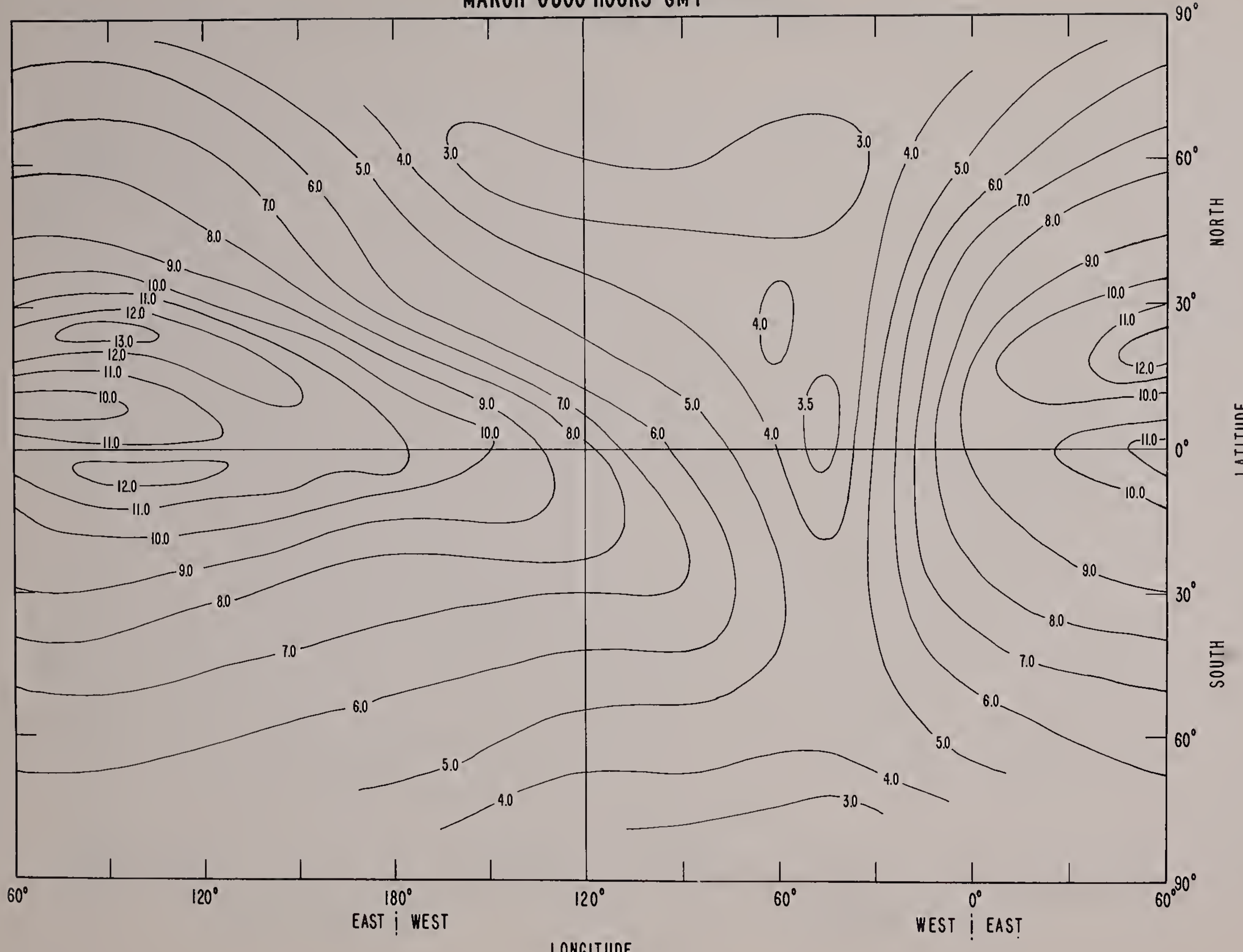
f_oF2 AT RASSN 50
MARCH 0400 HOURS GMT



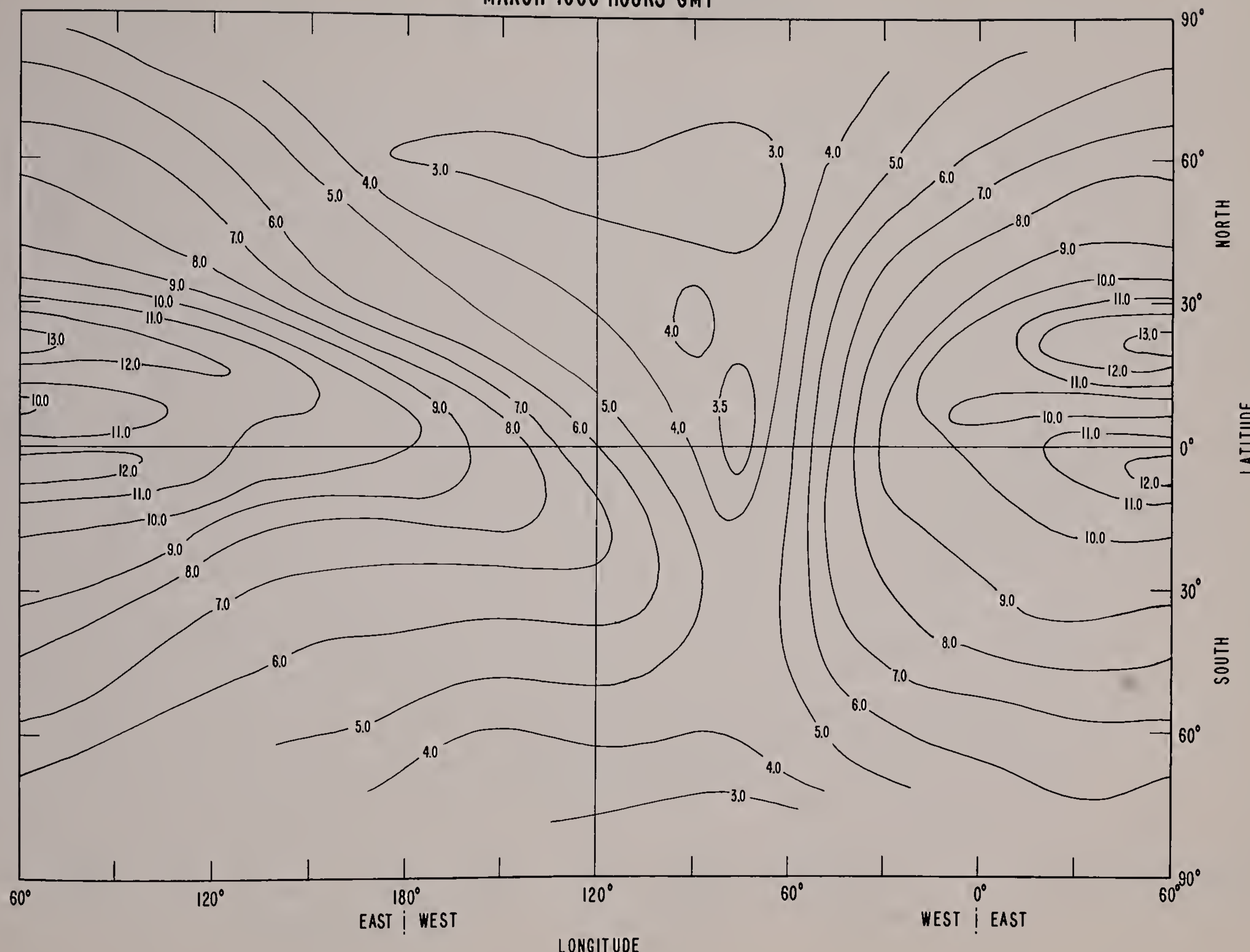
foF2 AT RASSN 50
MARCH 0600 HOURS GMT



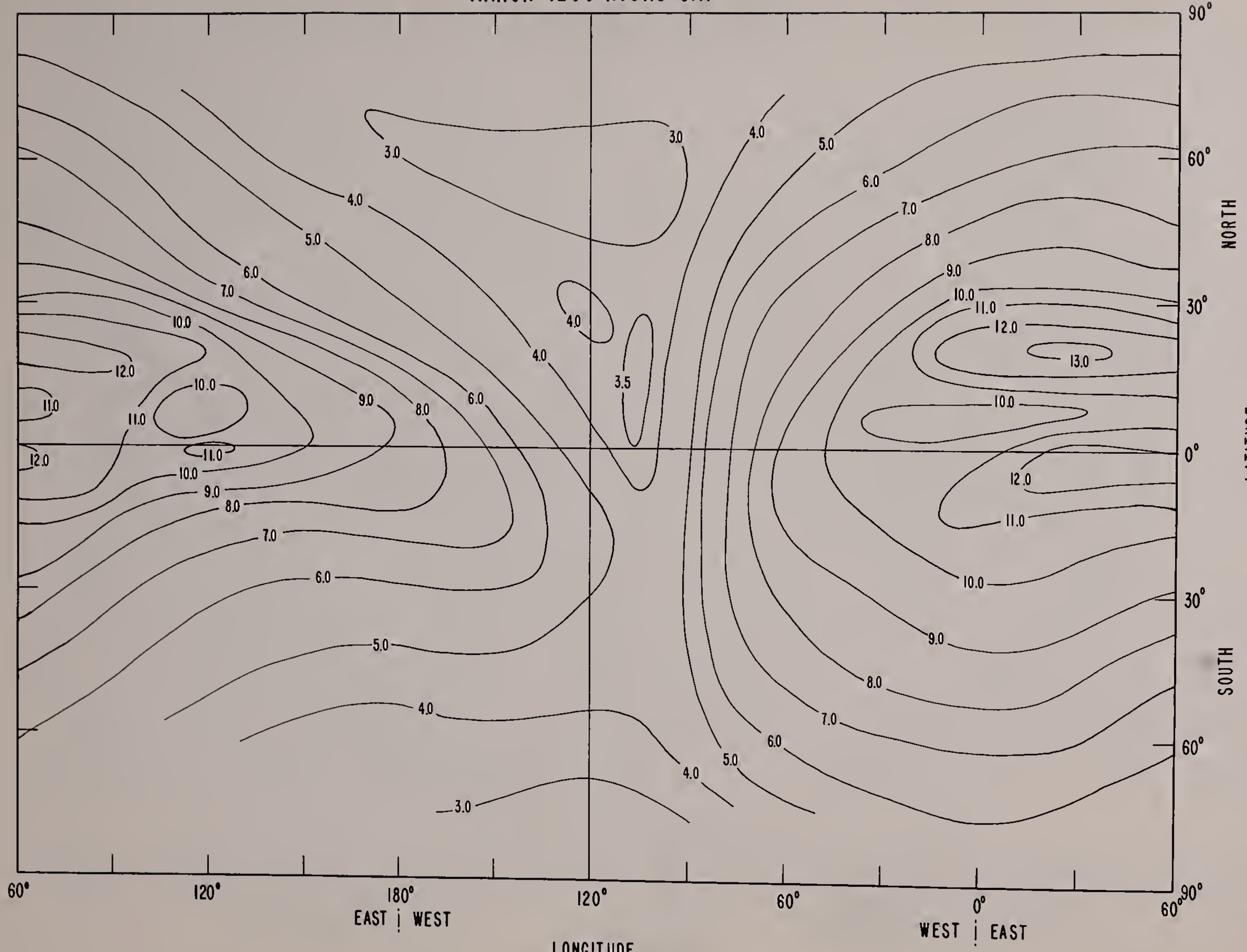
foF2 AT RASSN 50
MARCH 0800 HOURS GMT



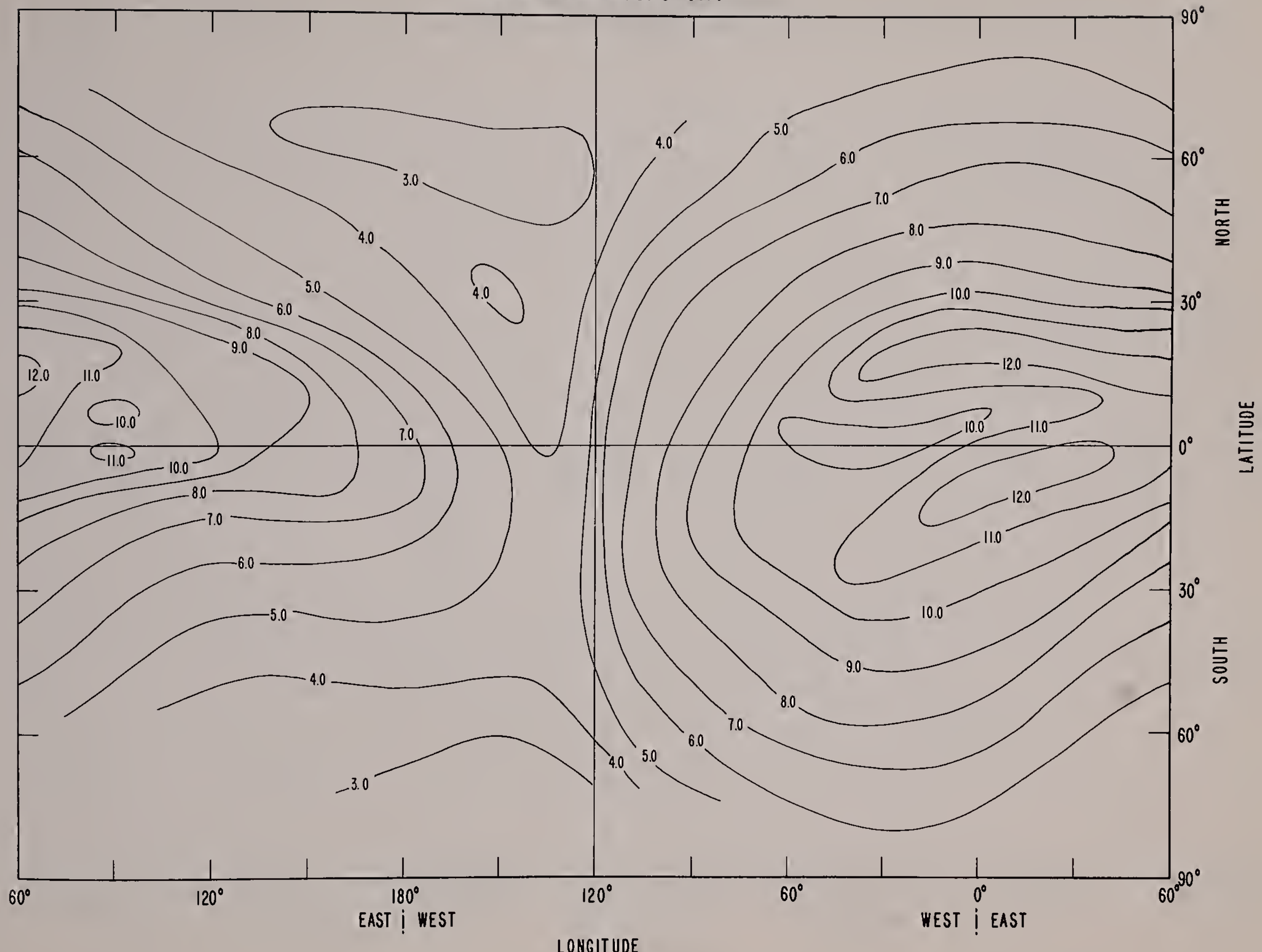
foF2 AT RASSN 50
MARCH 1000 HOURS GMT



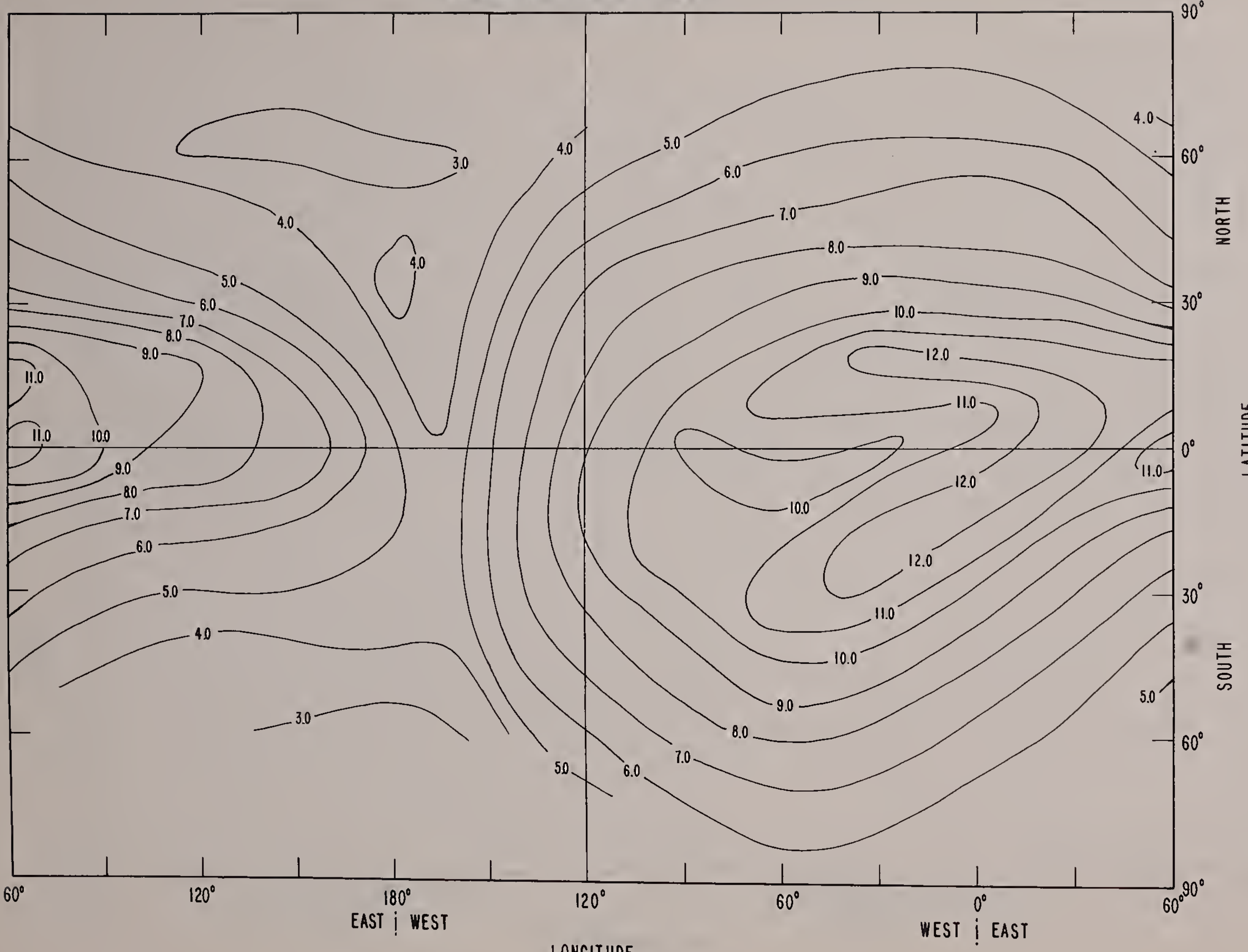
foF2 AT RASSN 50
MARCH 1200 HOURS GMT



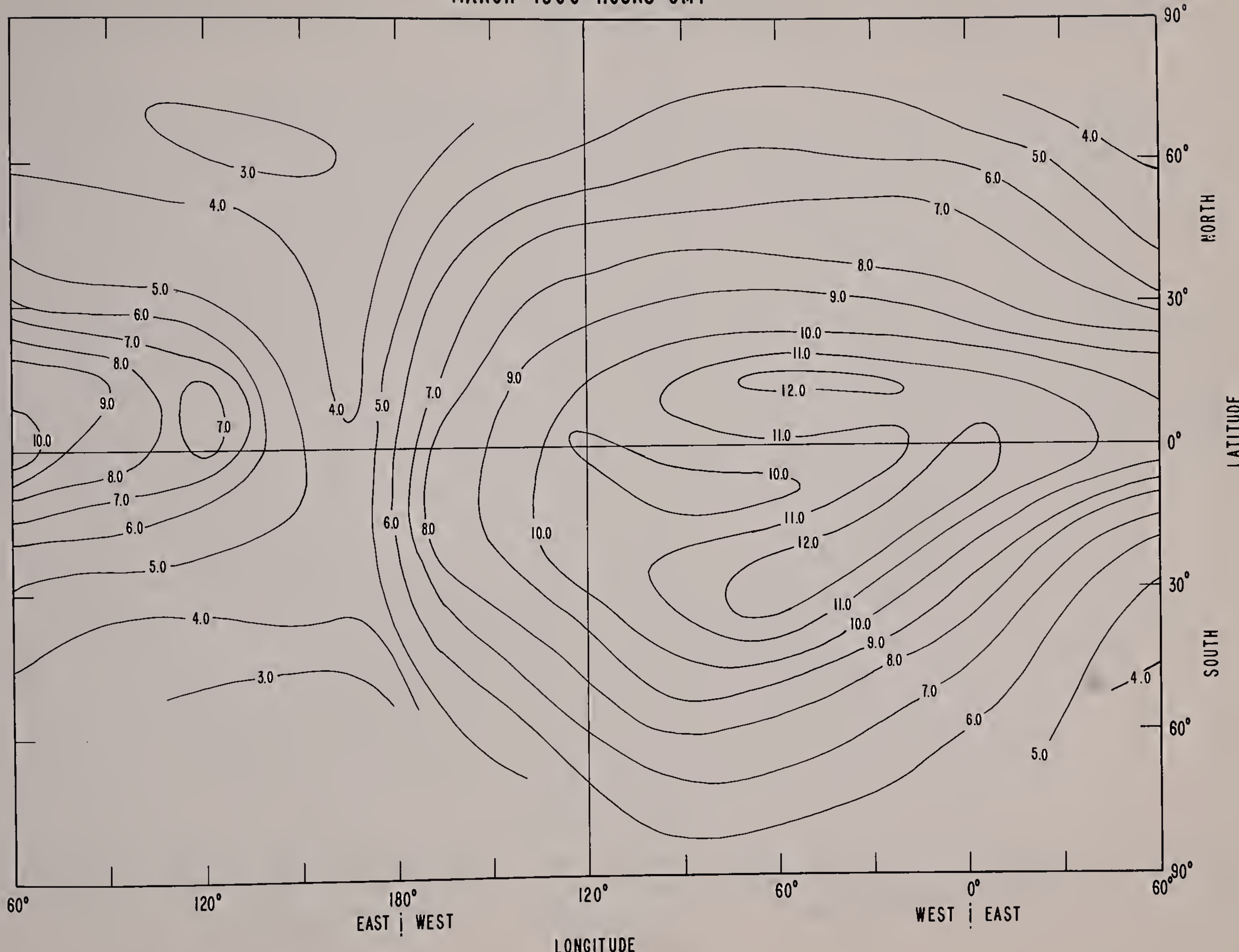
foF2 AT RASSN 50
MARCH 1400 HOURS GMT



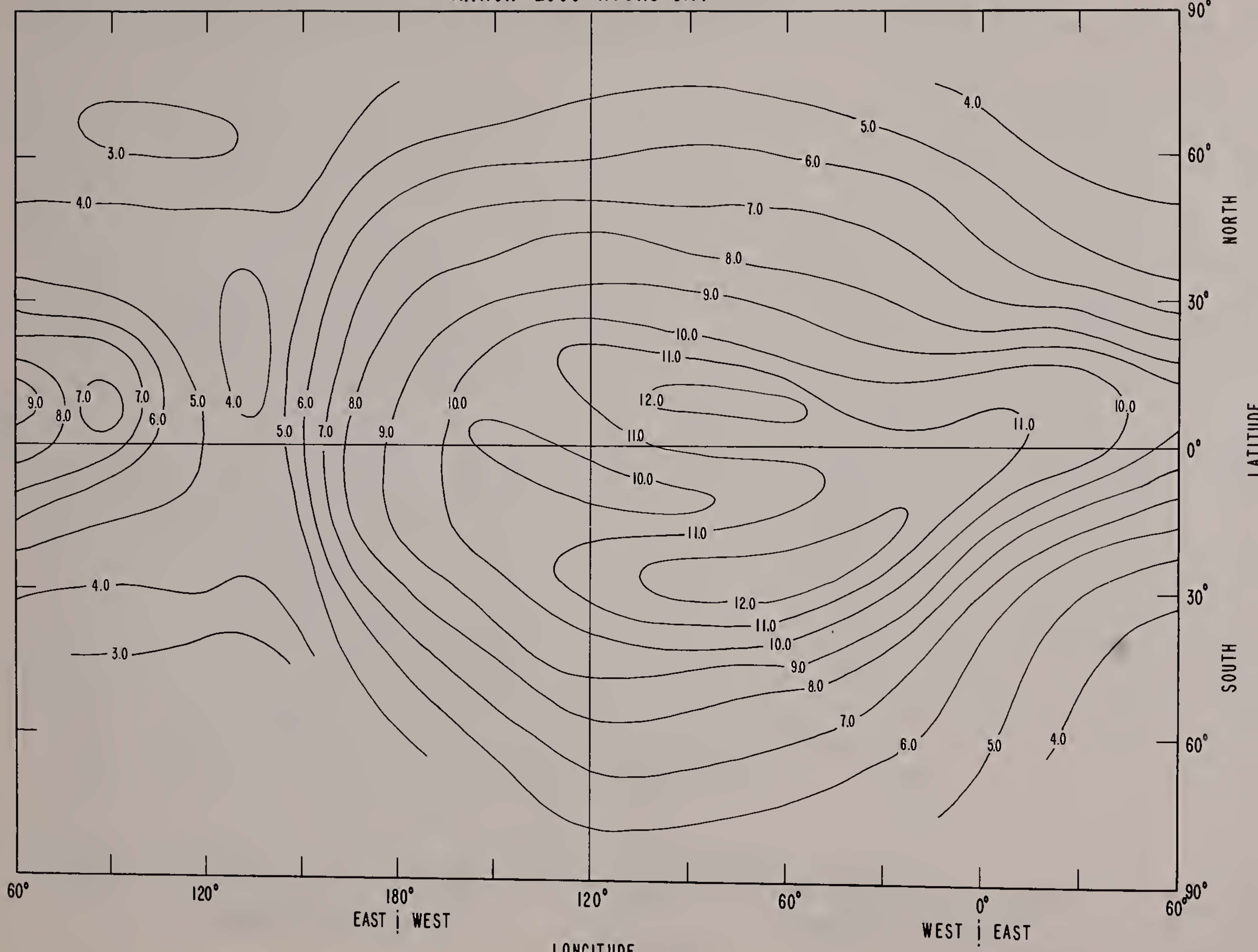
foF2 AT RASSN 50
MARCH 1600 HOURS GMT



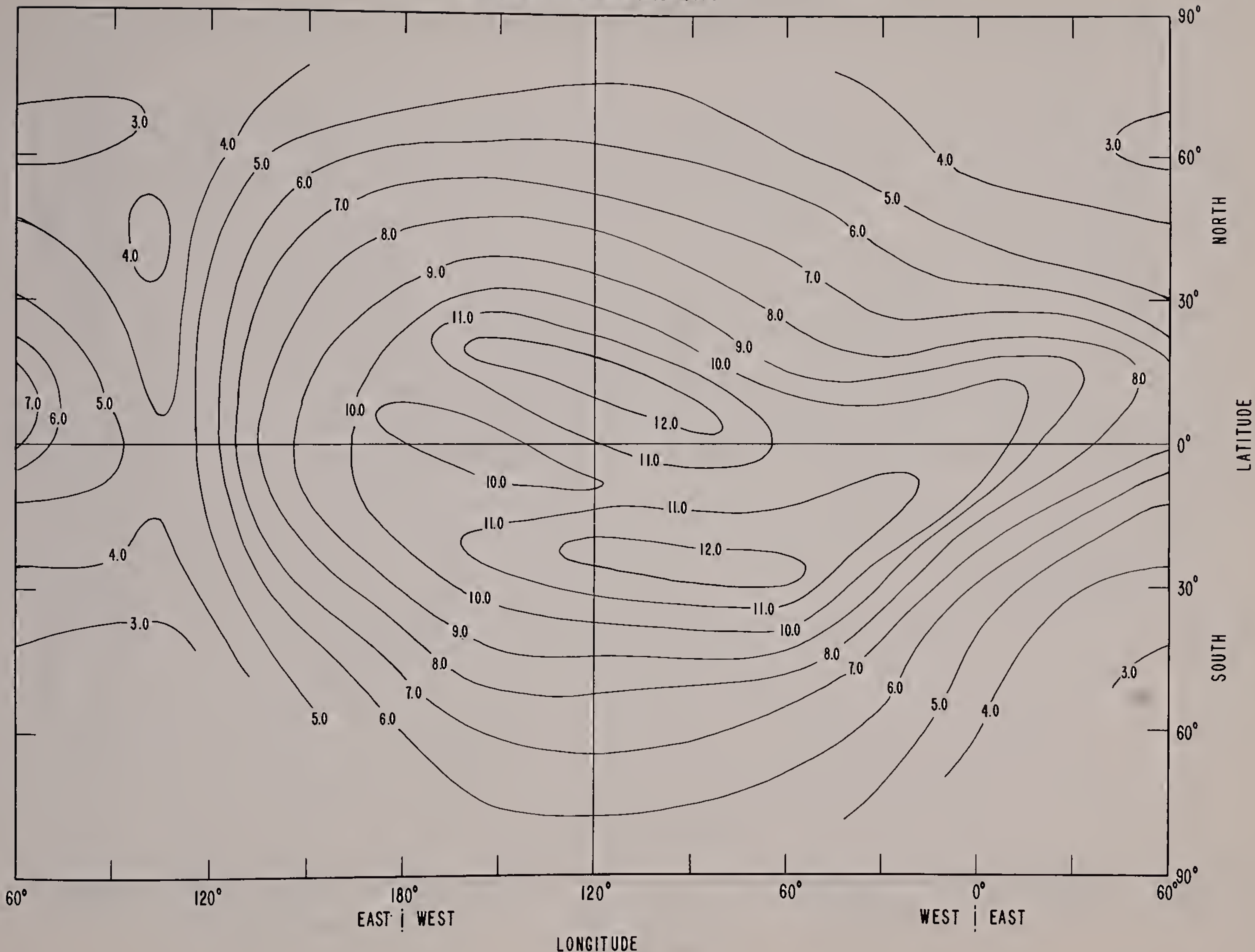
foF2 AT RASSN 50
MARCH 1800 HOURS GMT



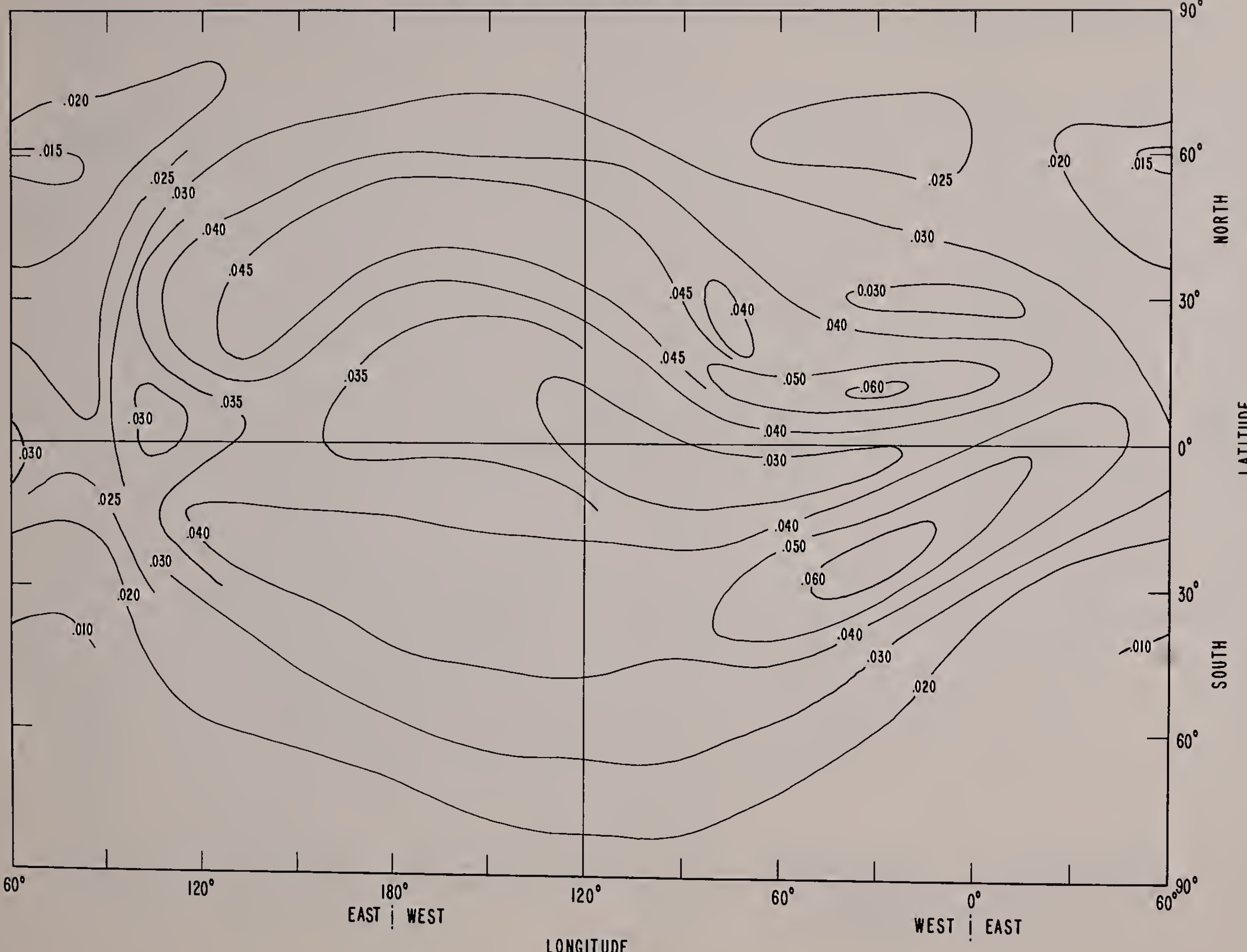
foF2 AT RASSN 50
MARCH 2000 HOURS GMT



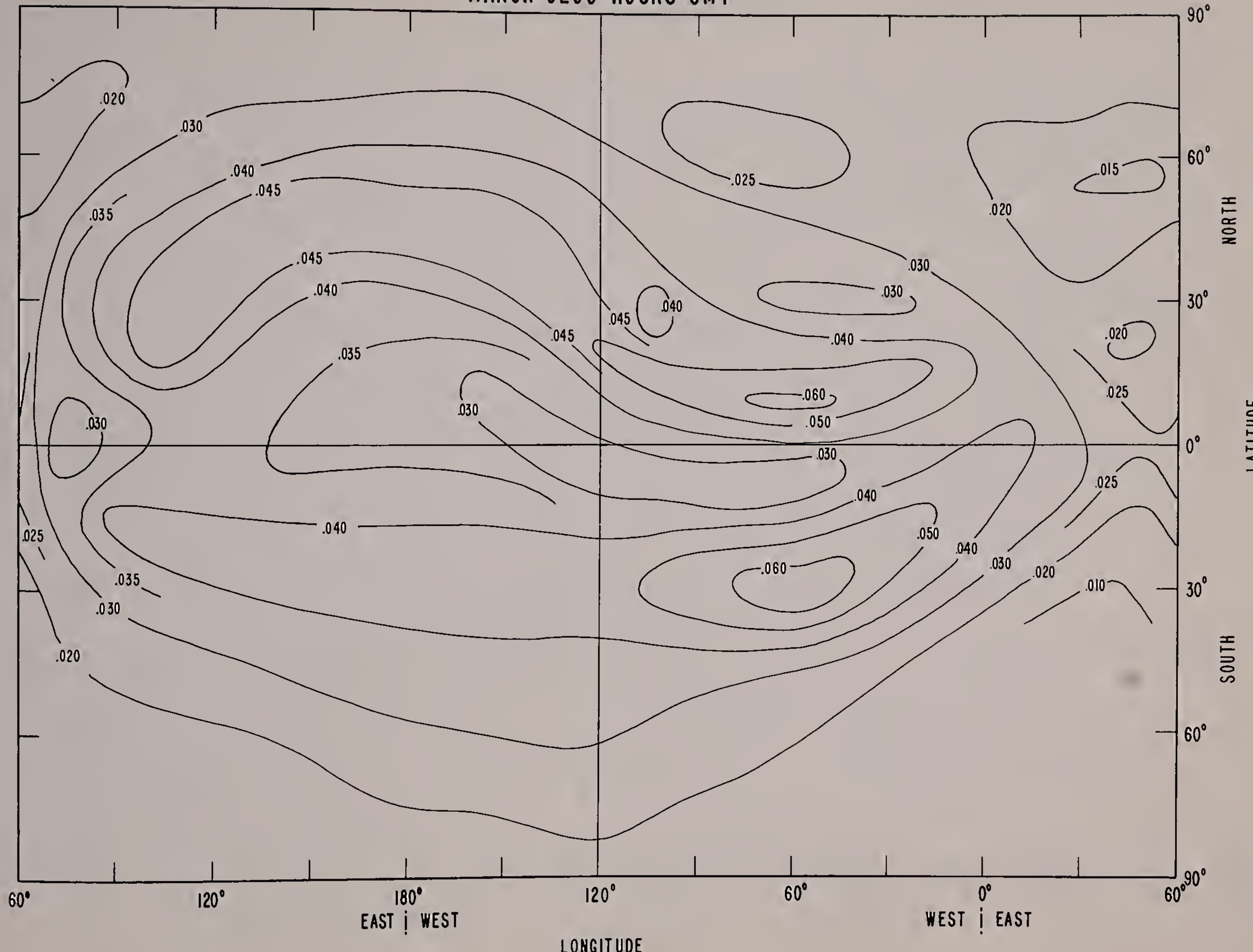
fOF2 AT RASSN 50
MARCH 2200 HOURS GMT



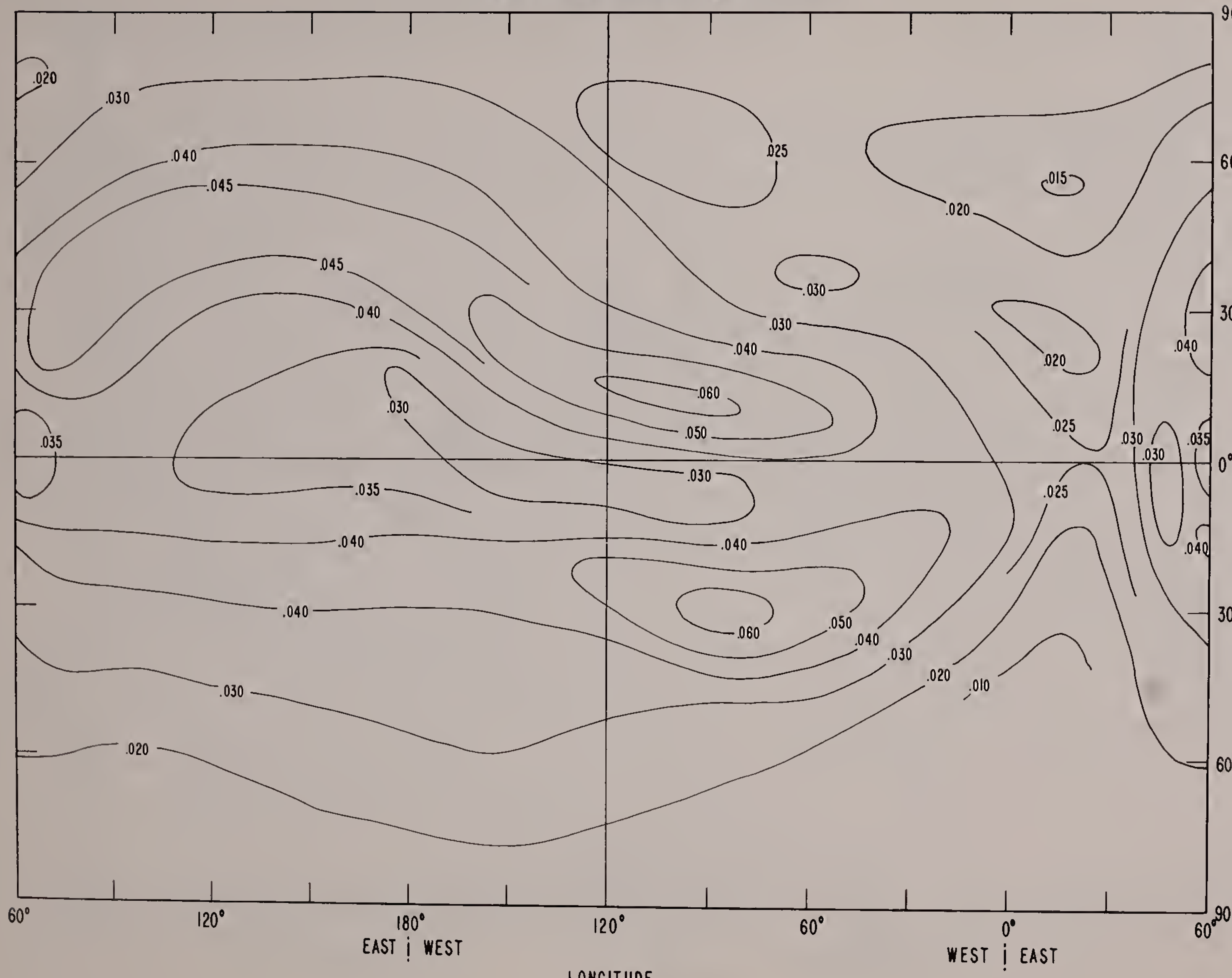
SLOPE OF REGRESSION LINE OF f_oF_2 ON RASSN
MARCH 0000 HOURS GMT



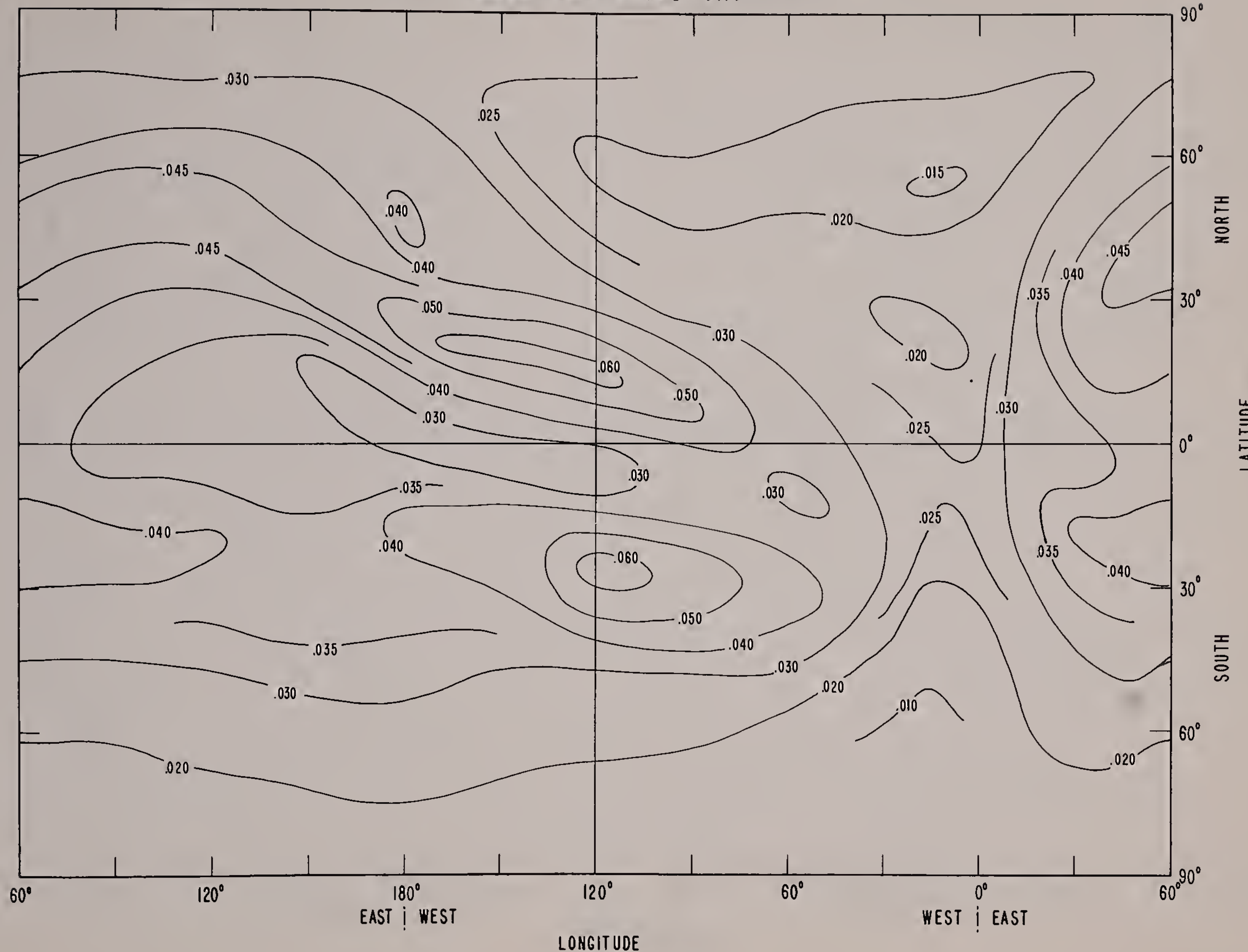
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
MARCH 0200 HOURS GMT



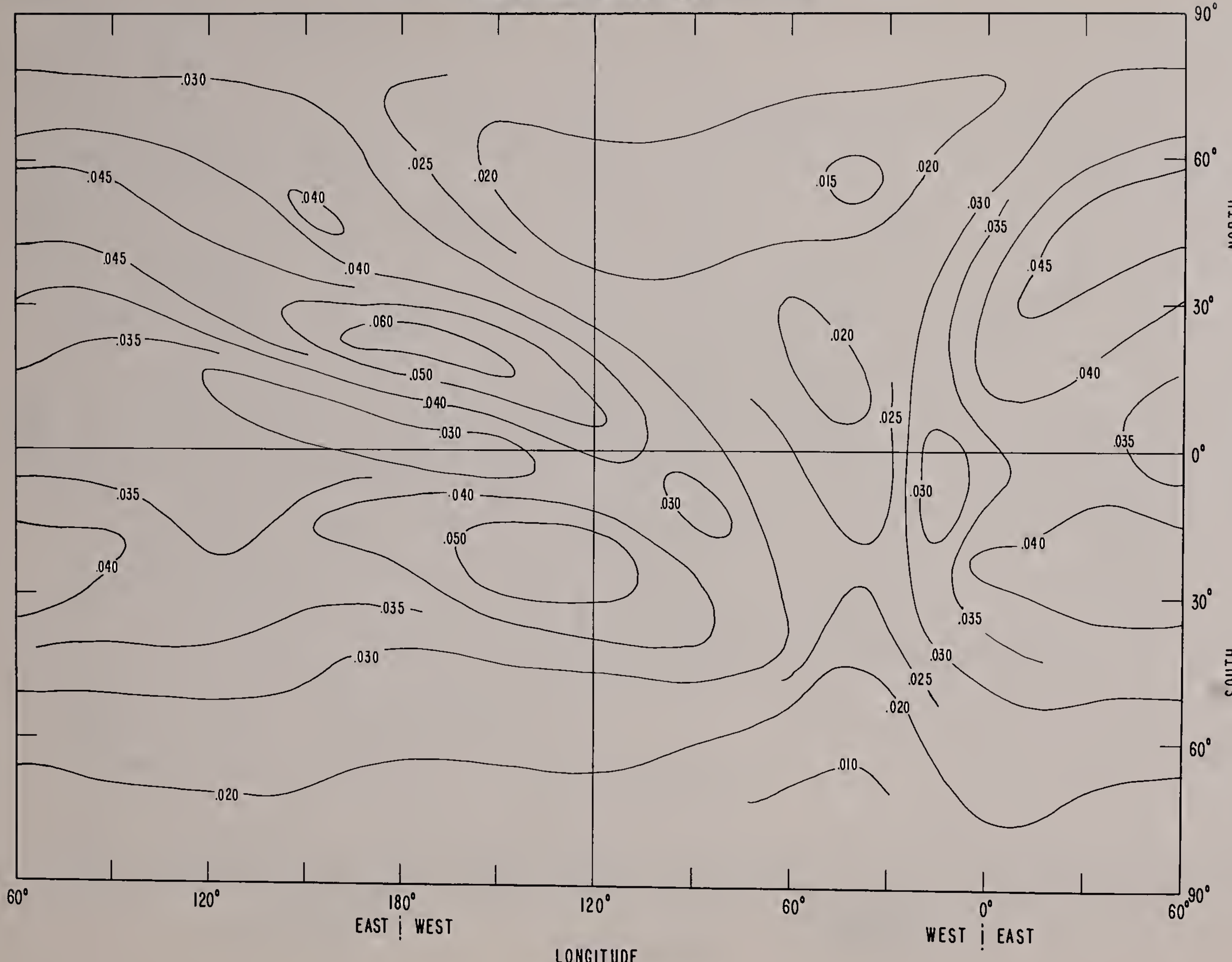
SLOPE OF REGRESSION LINE OF f_oF_2 ON RASSN
MARCH 0400 HOURS GMT



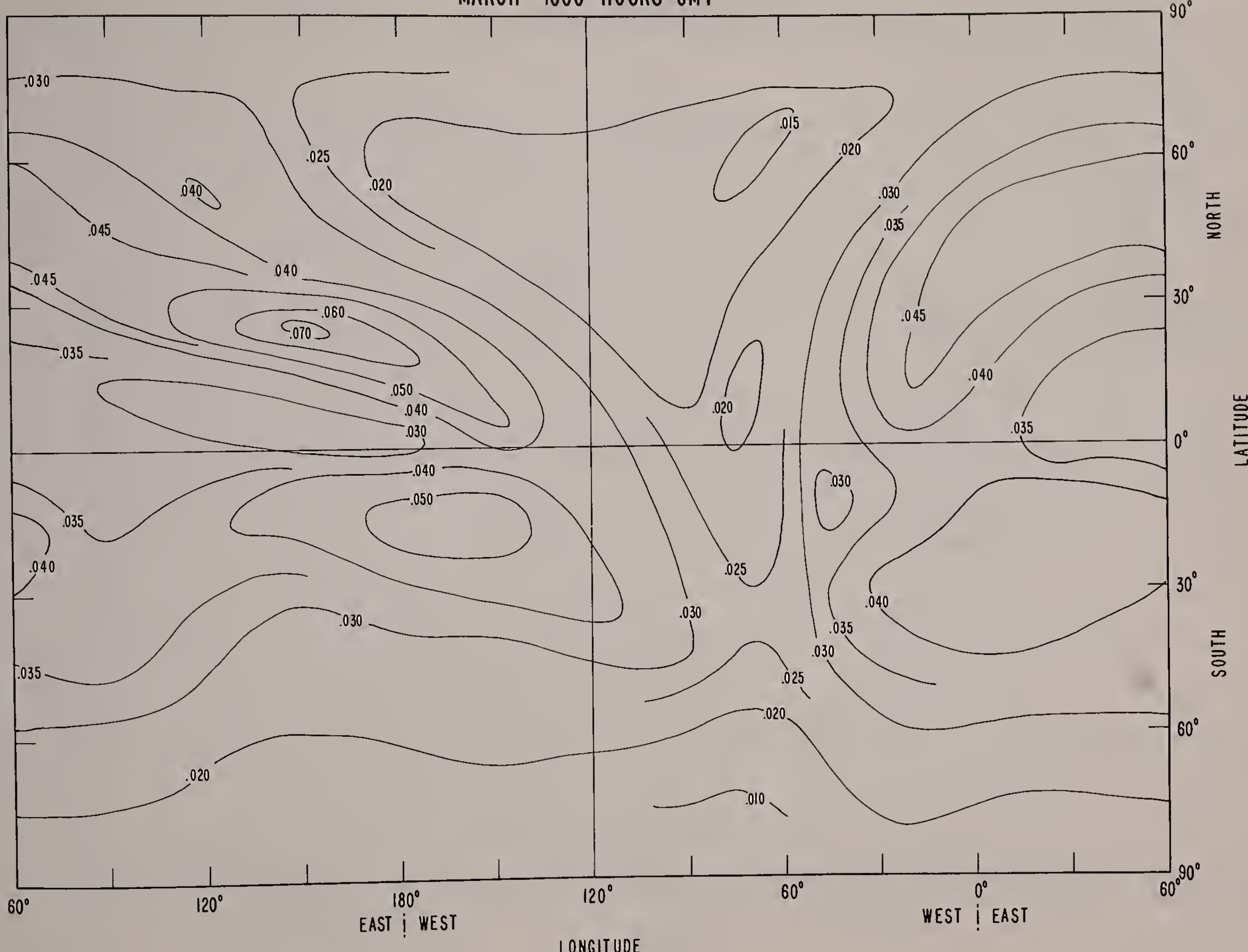
SLOPE OF REGRESSION LINE OF f_0F_2 ON RASSN
MARCH 0600 HOURS GMT



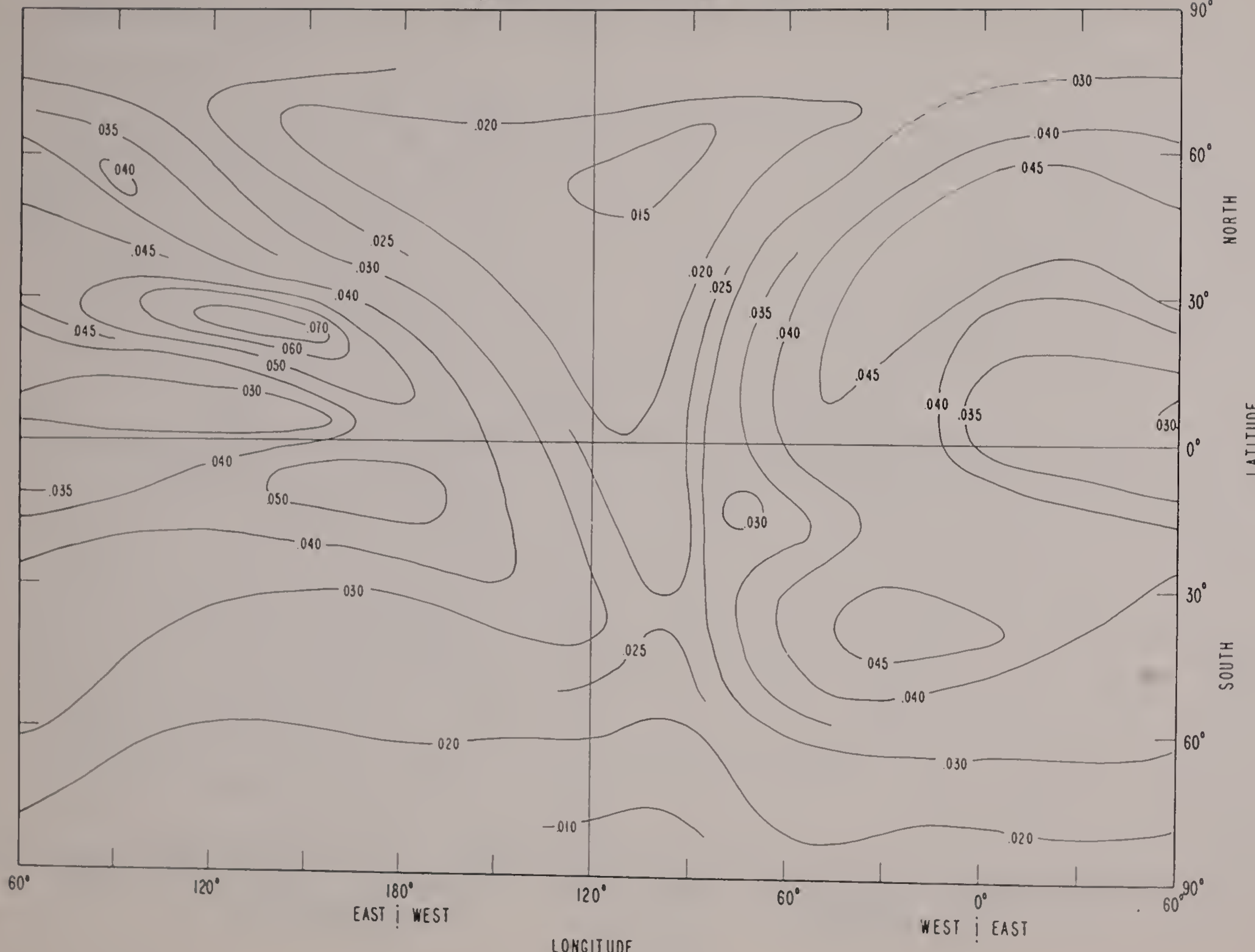
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
MARCH 0800 HOURS GMT



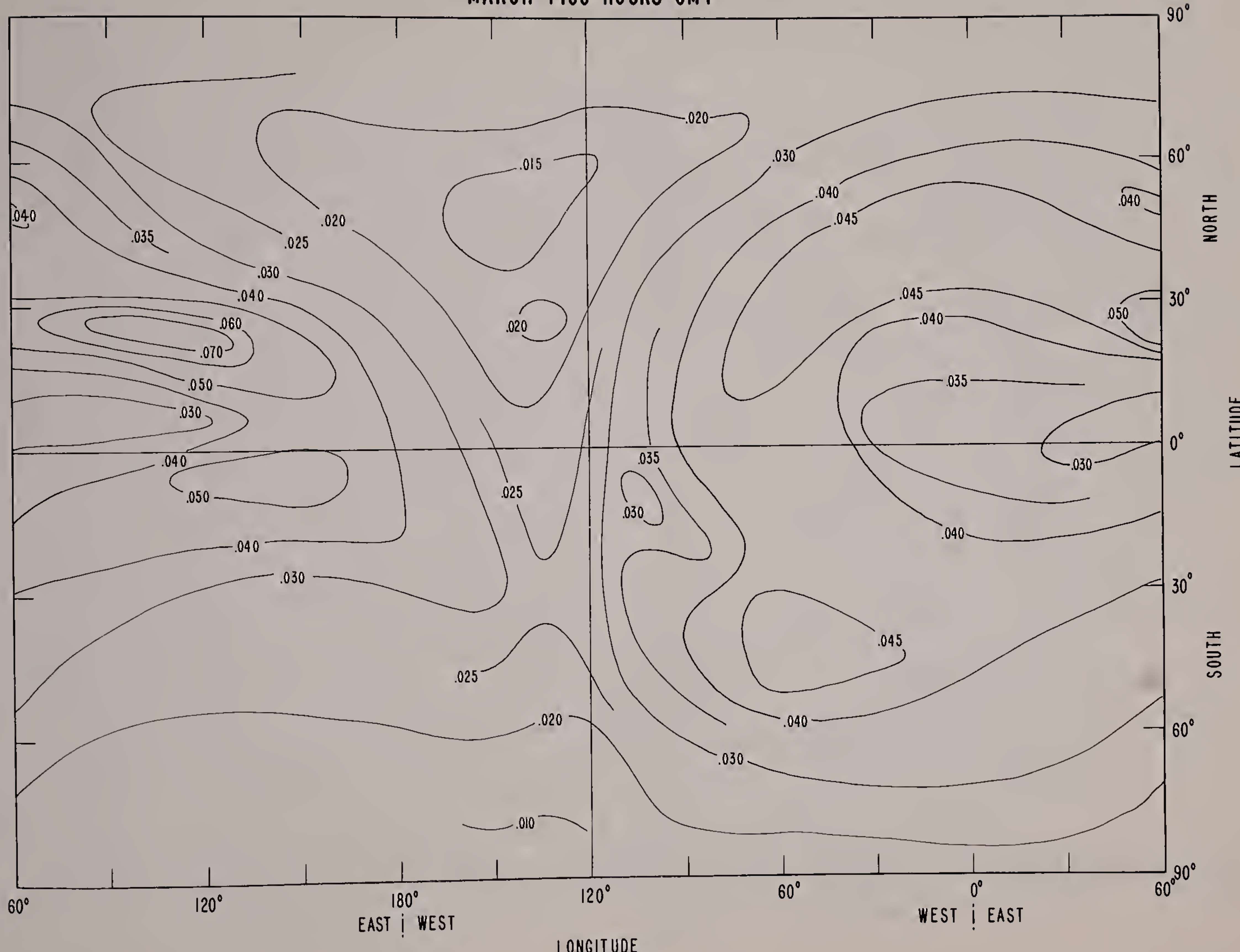
SLOPE OF REGRESSION LINE OF f_oF_2 ON RASSN
MARCH 1000 HOURS GMT



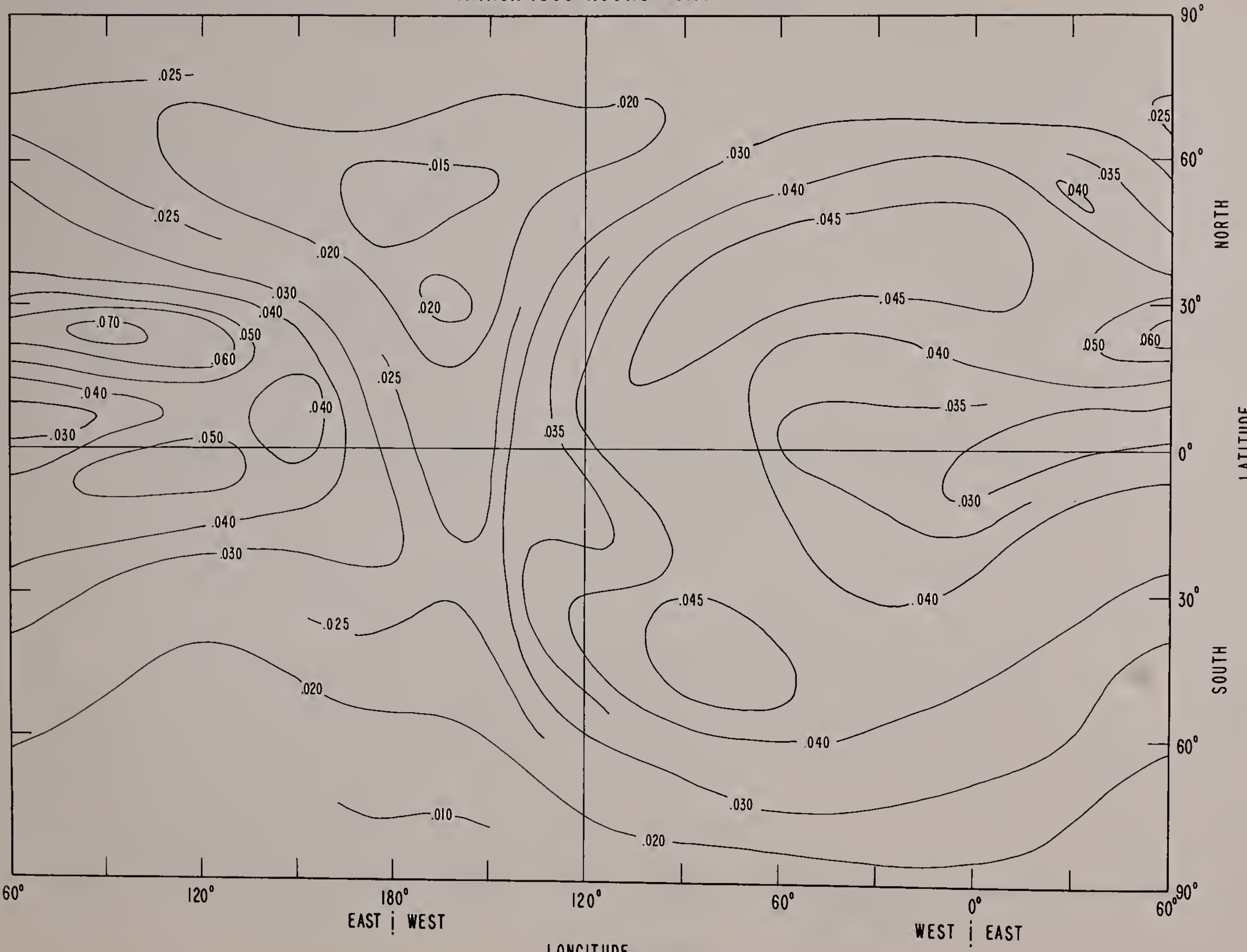
SLOPE OF REGRESSION LINE OF f_oF_2 ON RASSN
MARCH 1200 HOURS GMT



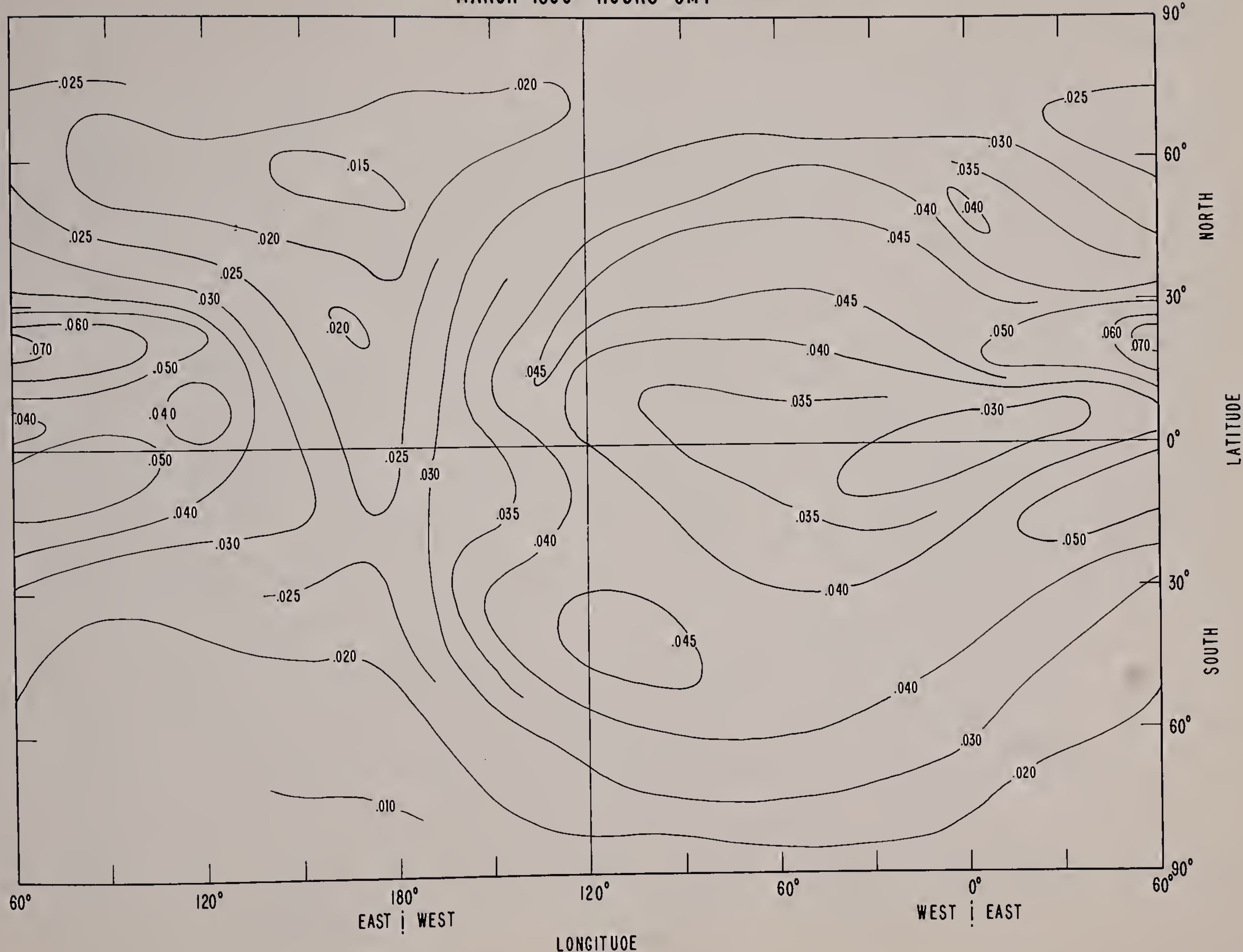
SLOPE OF REGRESSION LINE OF f_oF_2 ON RASSN
MARCH 1400 HOURS GMT



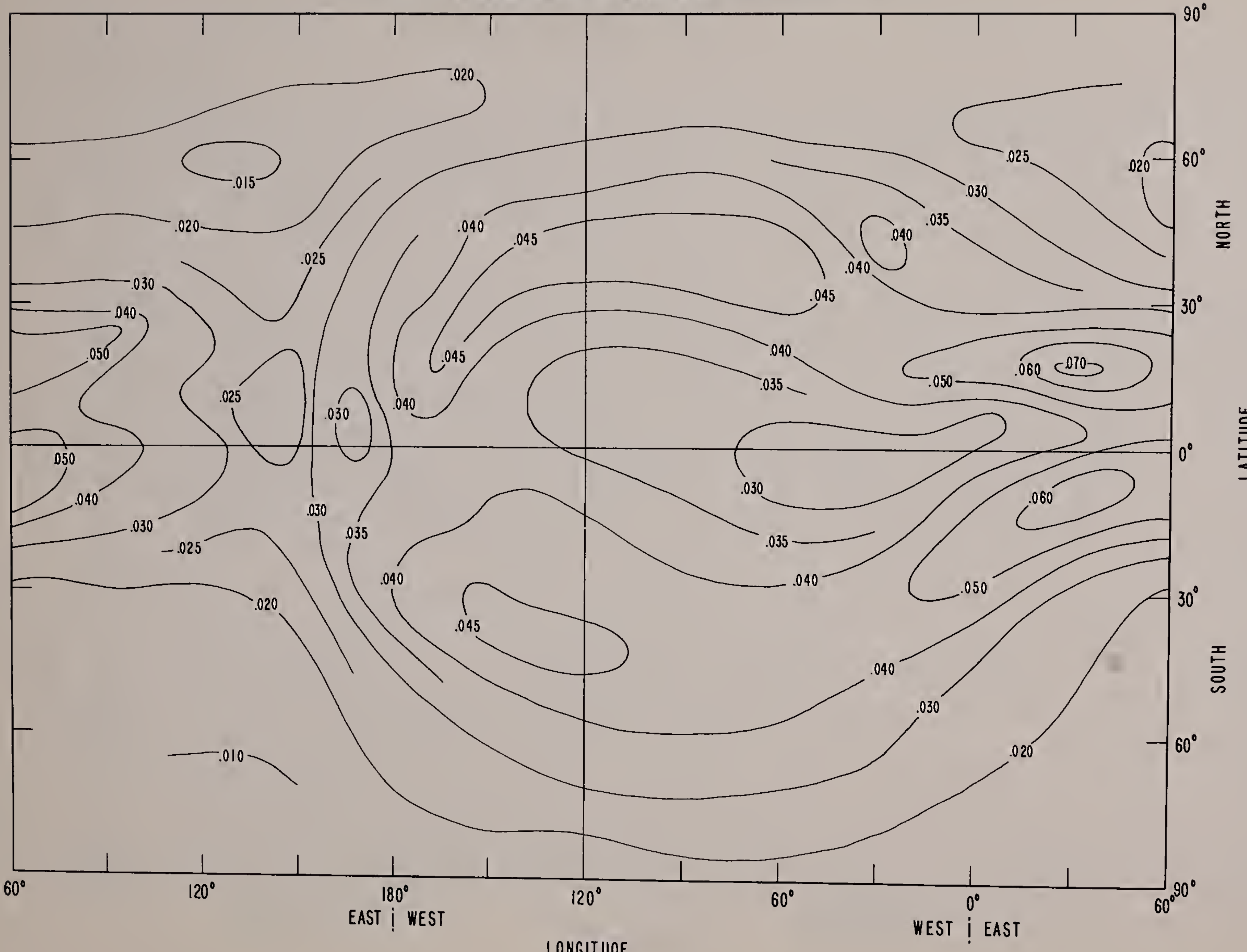
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
MARCH 1600 HOURS GMT



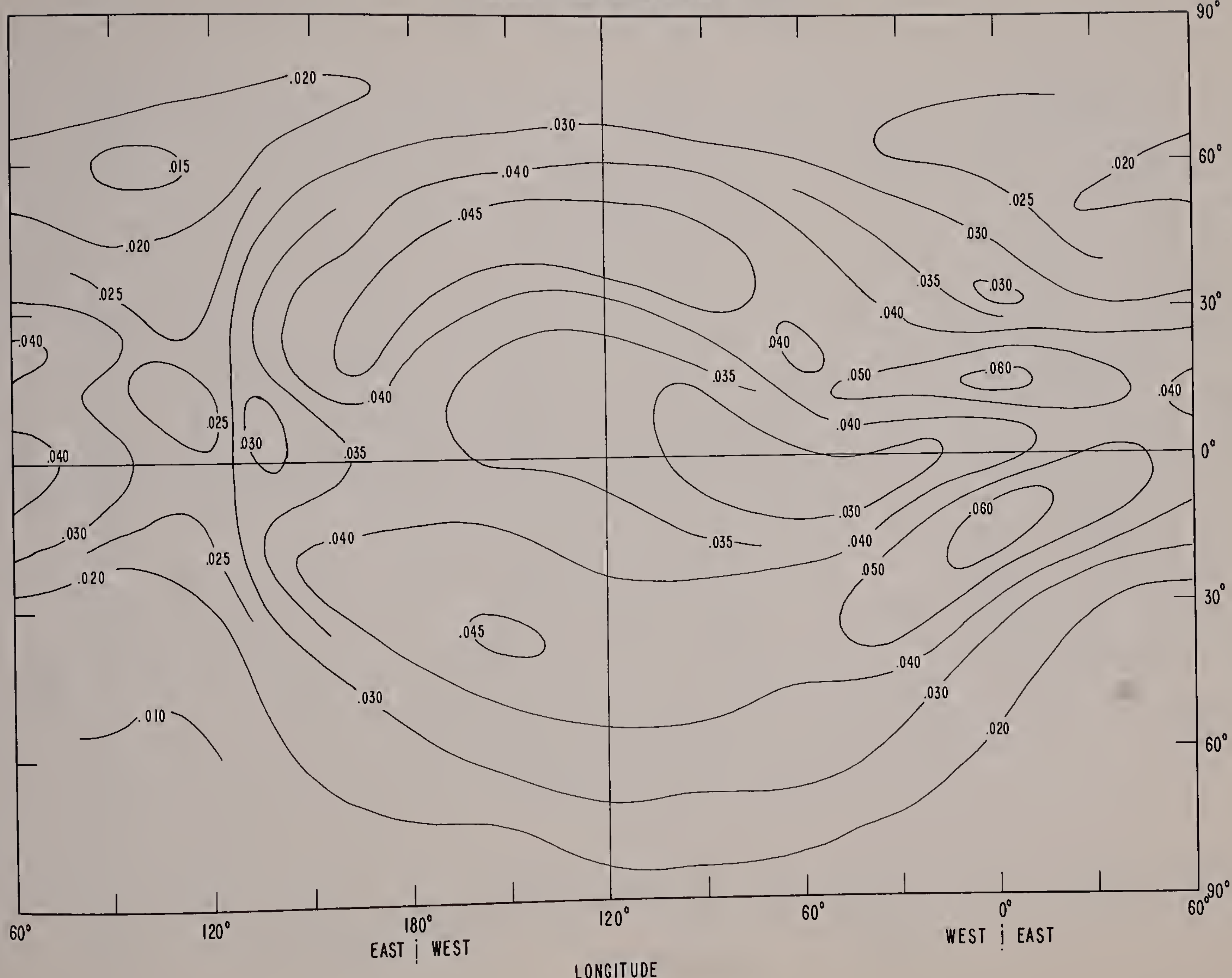
SLOPE OF REGRESSION LINE OF f_oF_2 ON RASSN
MARCH 1800 HOURS GMT



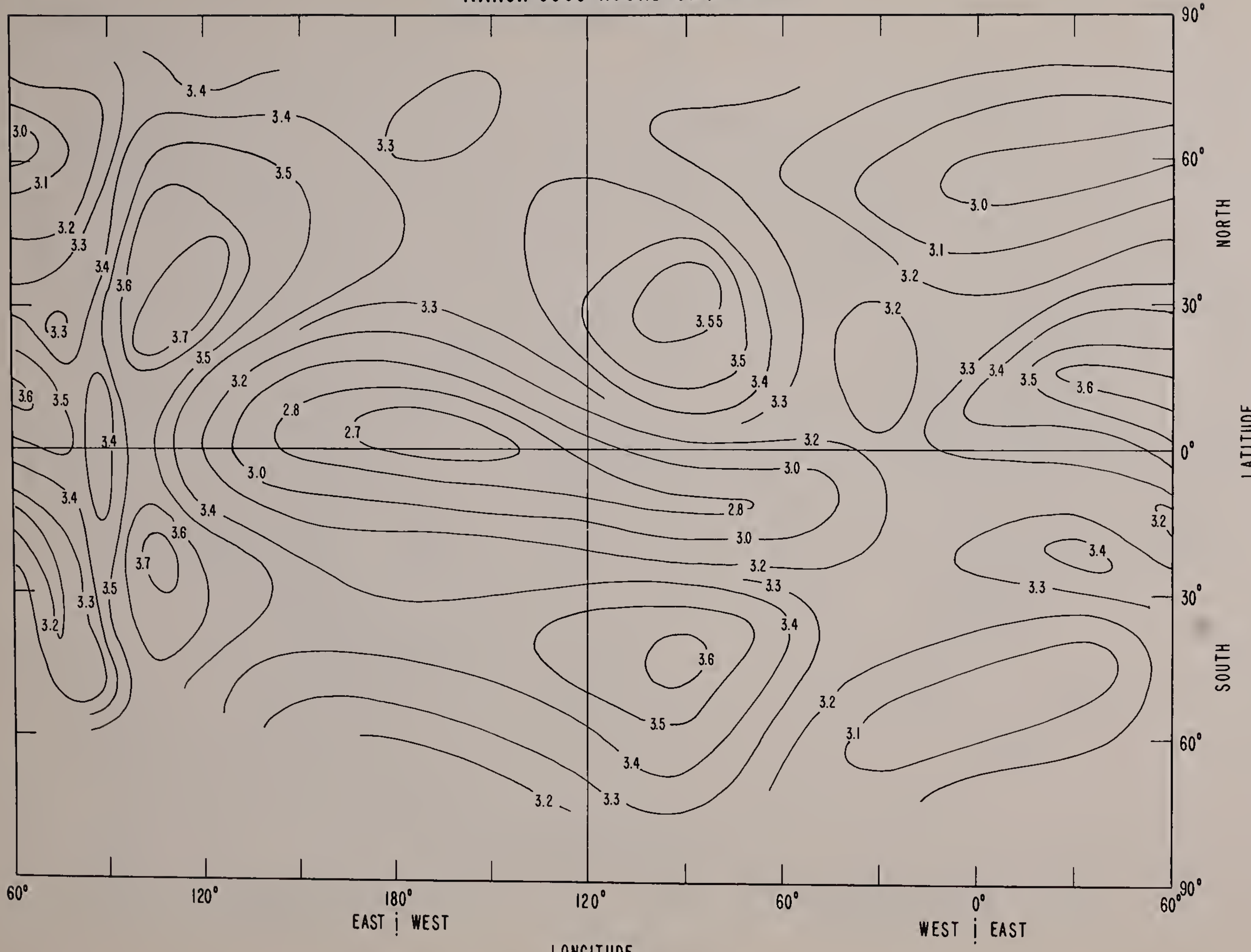
SLOPE OF REGRESSION LINE OF f_oF_2 ON RASSN
MARCH 2000 HOURS GMT



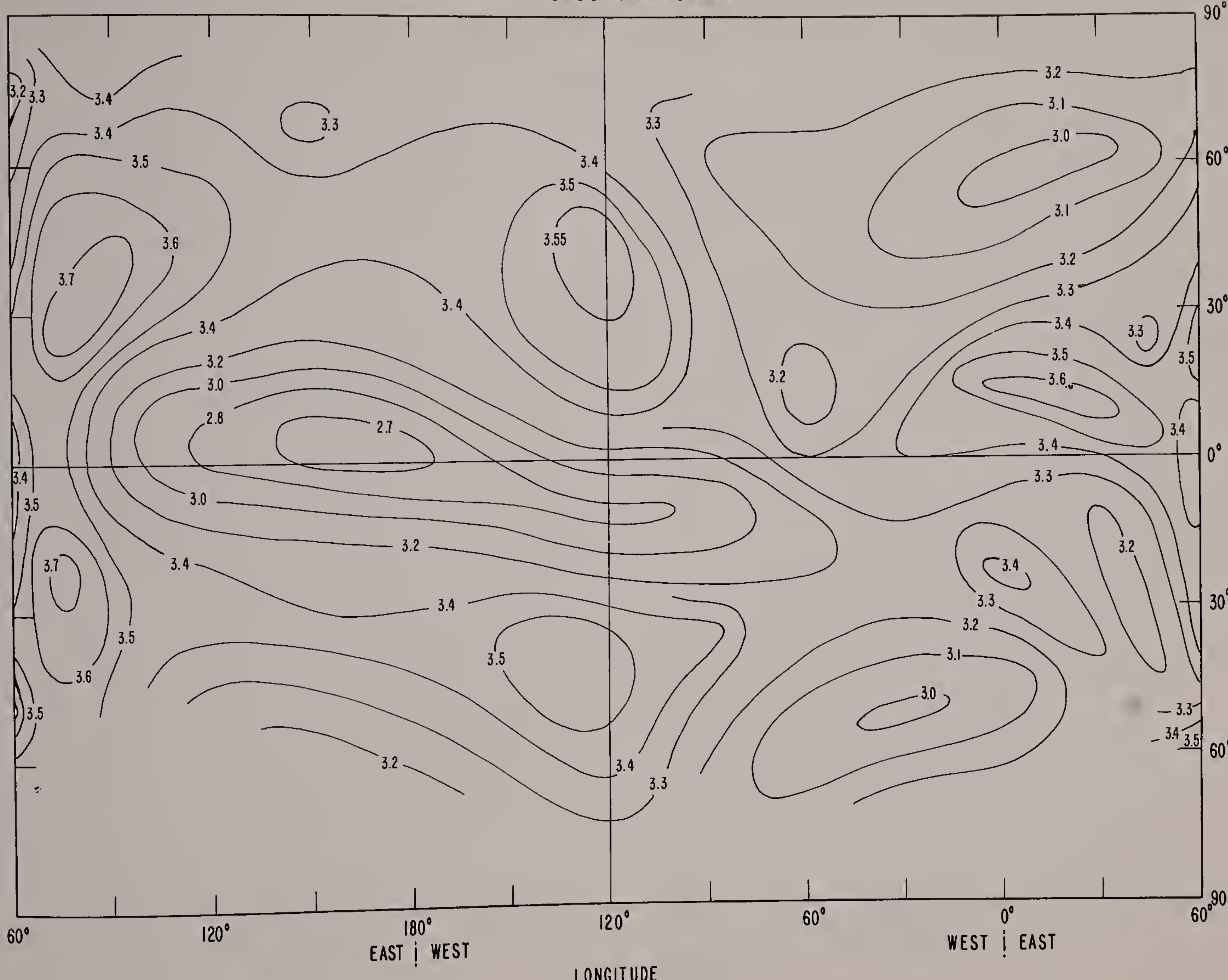
SLOPE OF REGRESSION LINE OF f_oF_2 ON RASSN
MARCH 2200 HOURS GMT



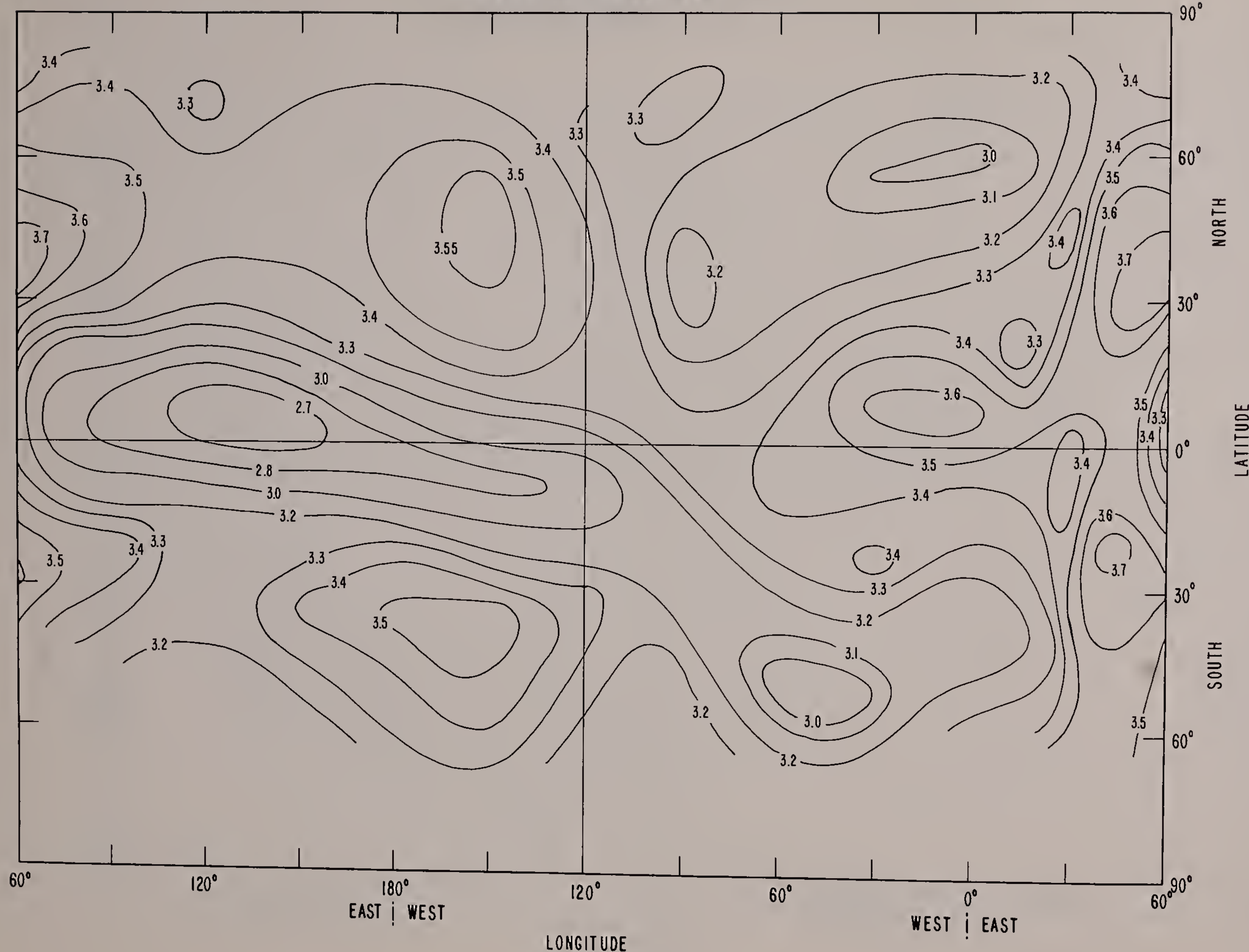
M-4000 FACTOR AT RASSN 50
MARCH 0000 HOURS GMT



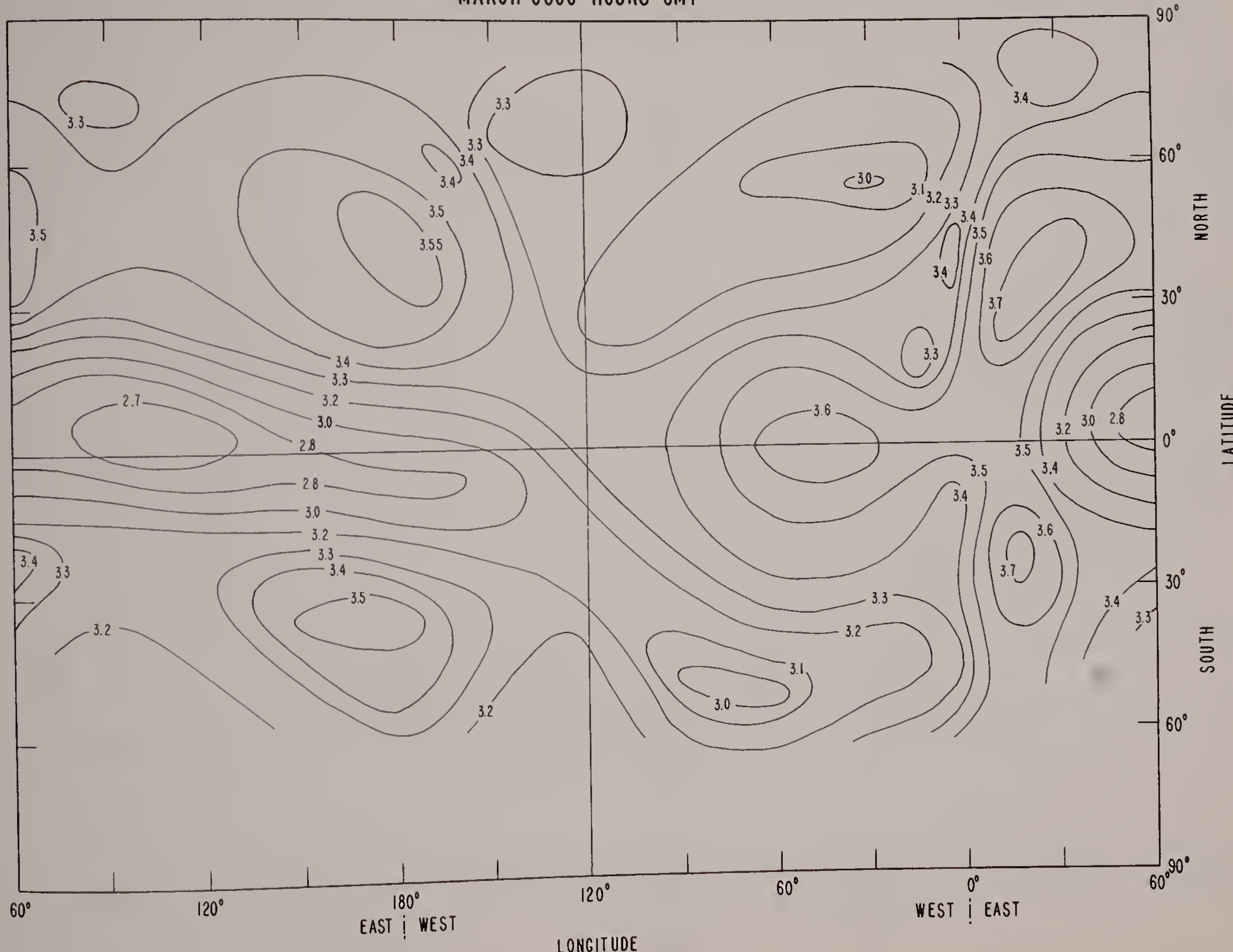
M-4000 FACTOR AT RASSN 50
MARCH 0200 HOURS GMT



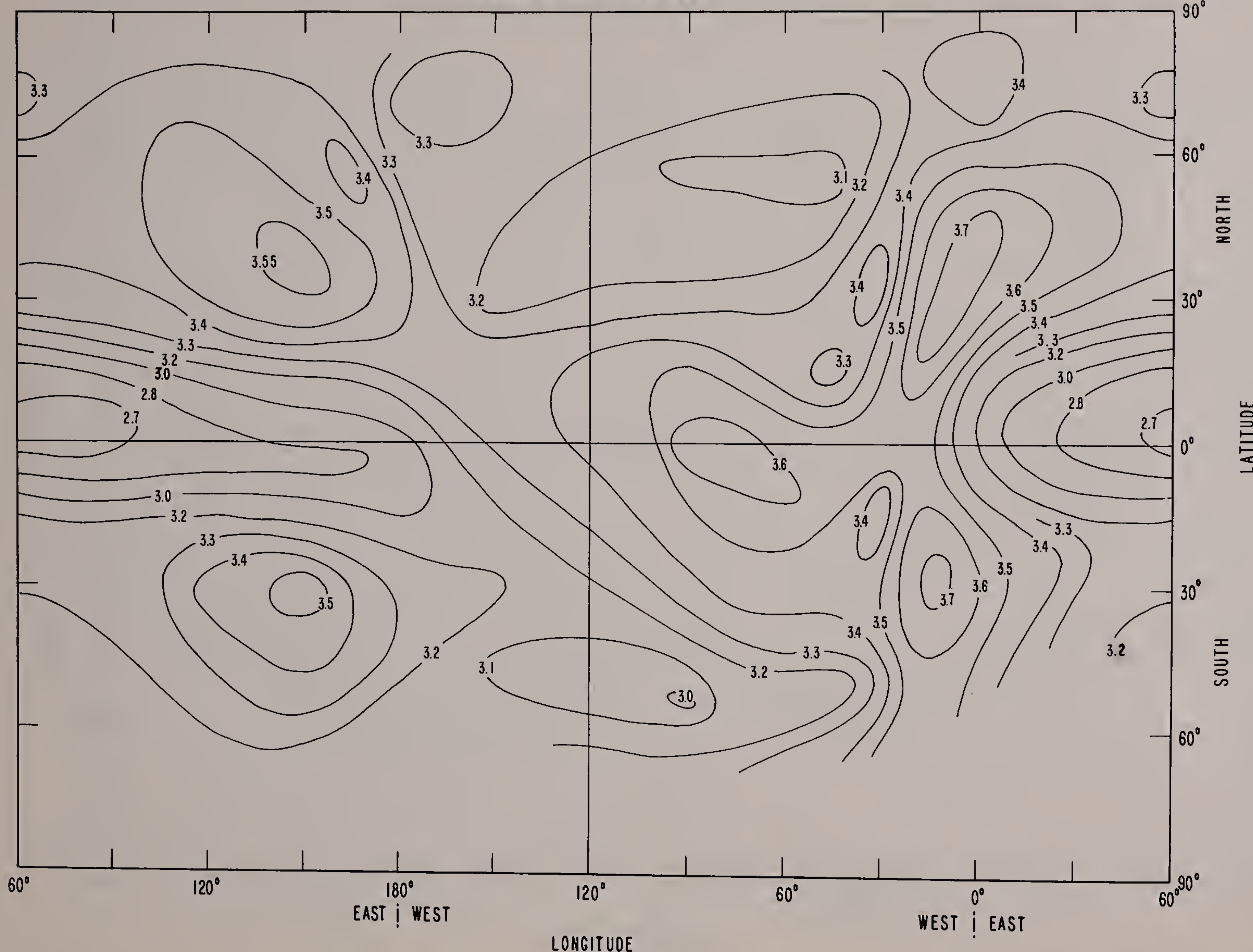
M-4000 FACTOR AT RASSN 50
MARCH 0400 HOURS GMT



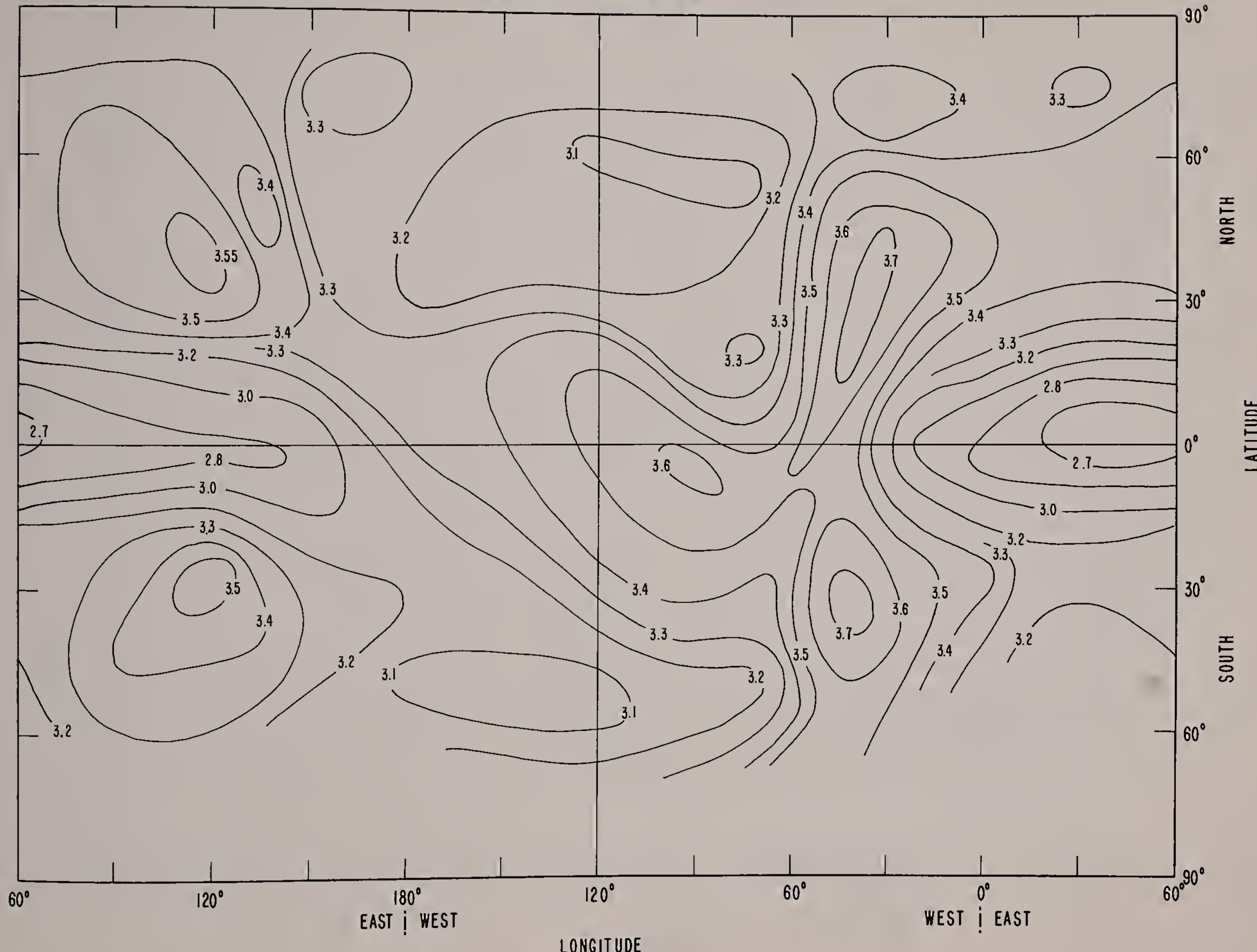
M-4000 FACTOR AT RASSN 50
MARCH 0600 HOURS GMT



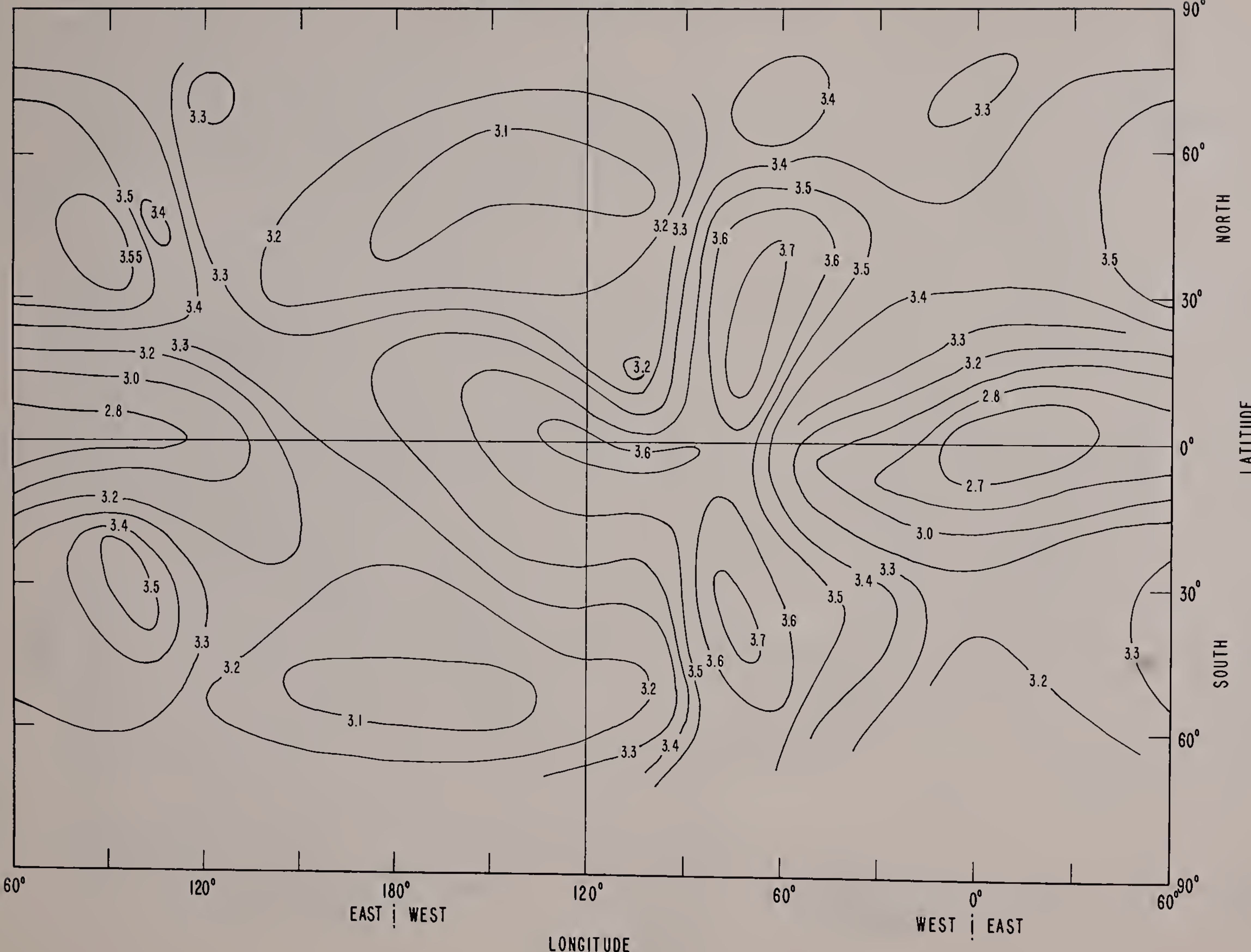
M-4000 FACTOR AT RASSN 50
MARCH 0800 HOURS GMT



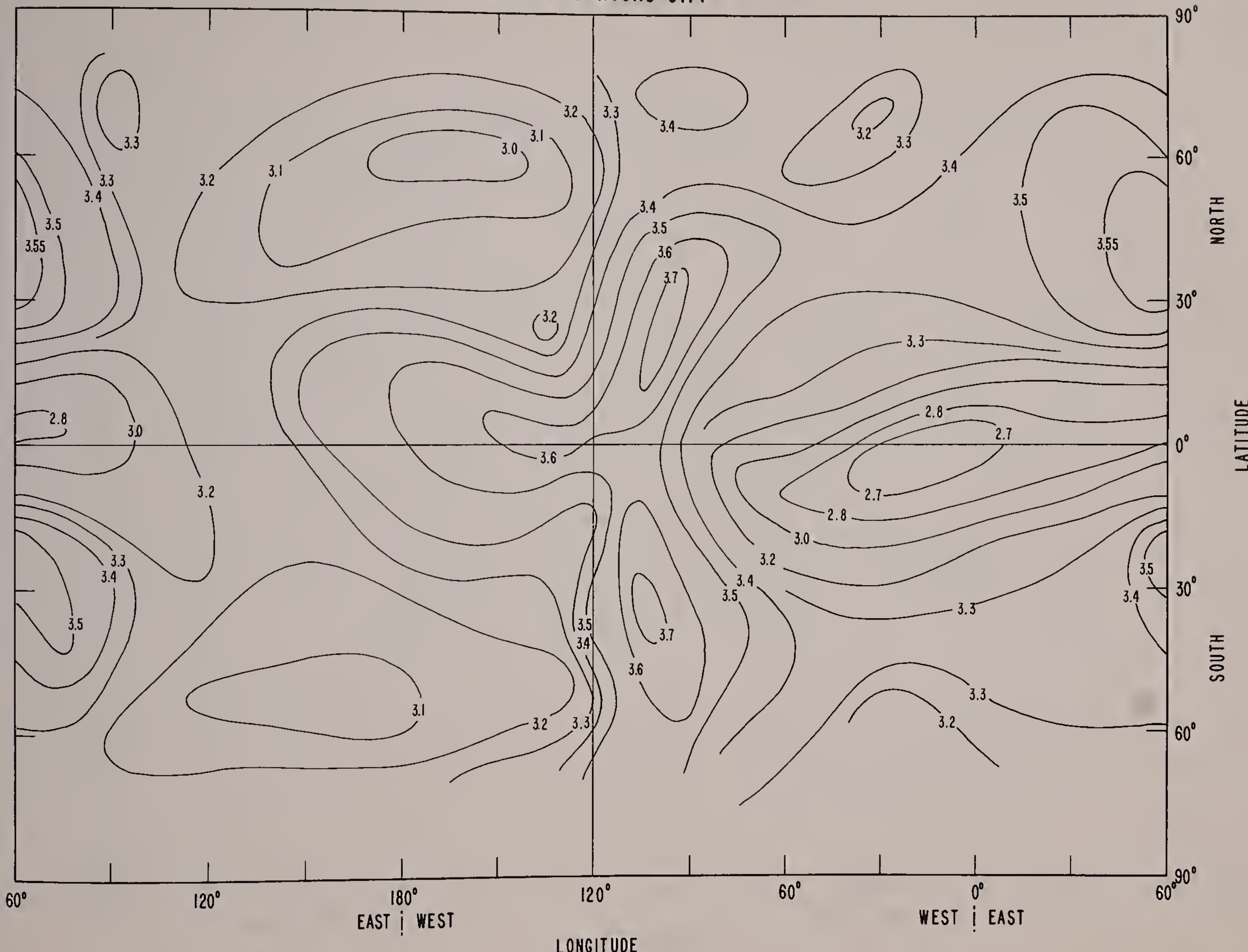
M-4000 FACTOR AT RASSN 50
MARCH 1000 HOURS GMT



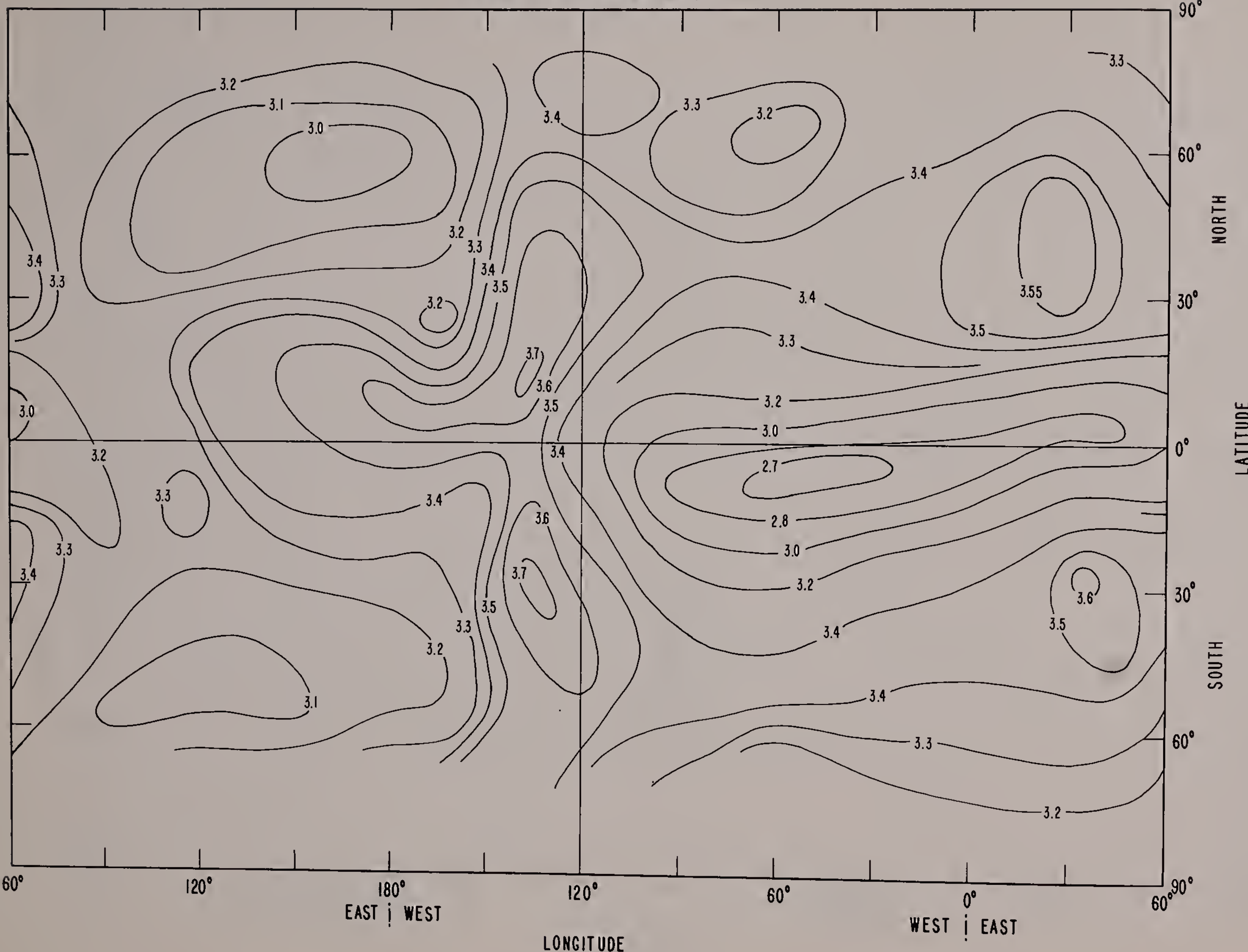
M-4000 FACTOR AT RASSN 50
MARCH 1200 HOURS GMT



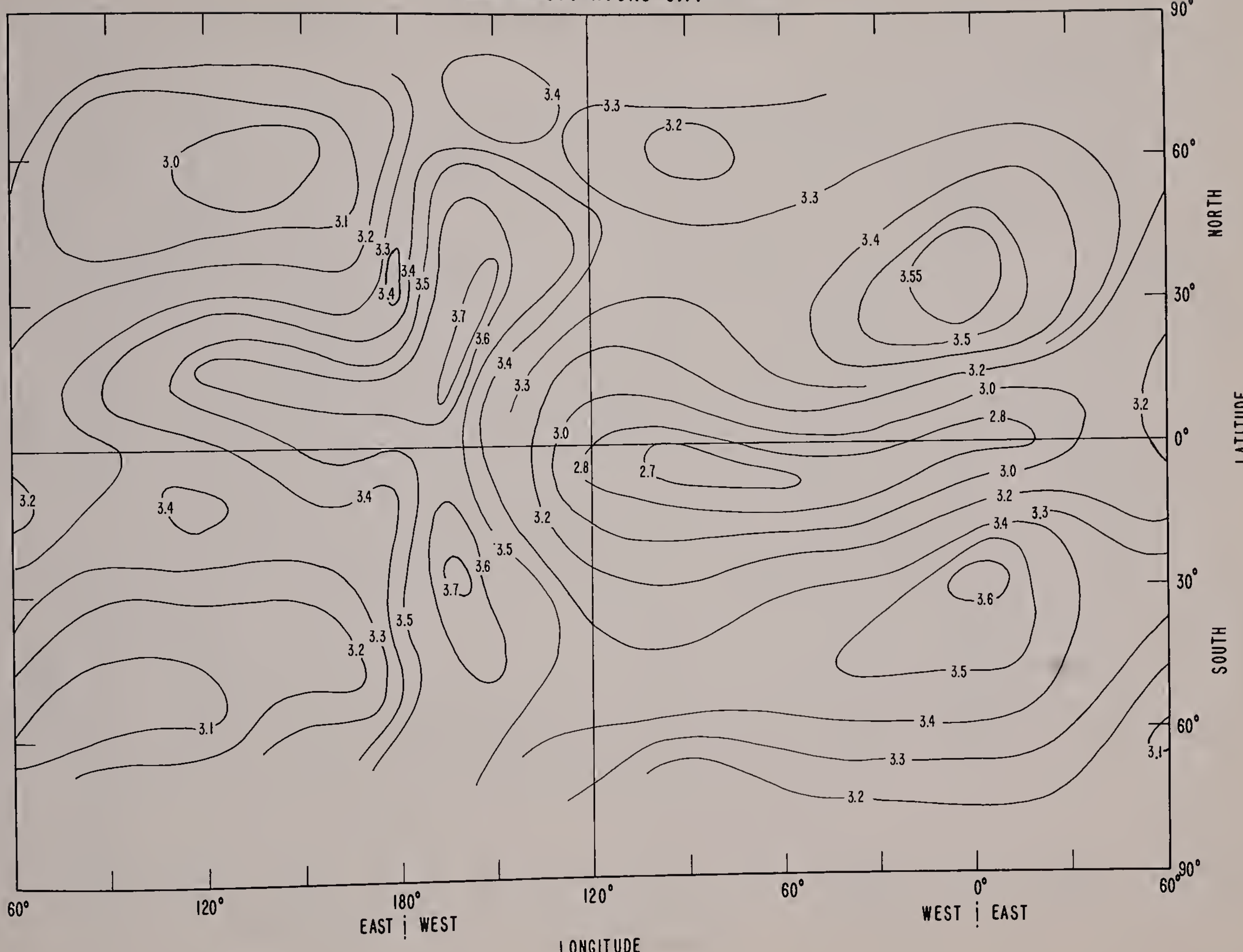
M-4000 FACTOR AT RASSN 50
MARCH 1400 HOURS GMT



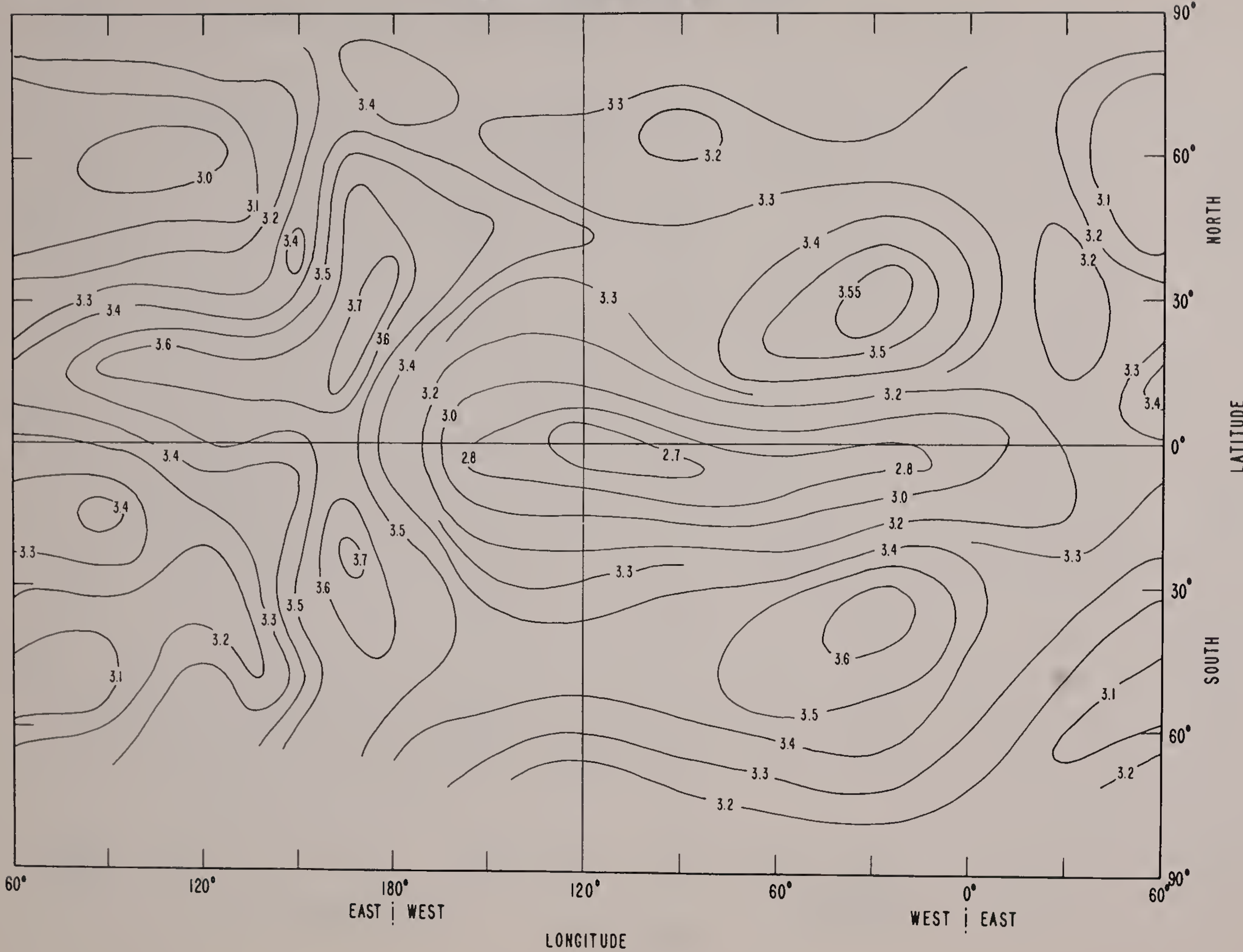
M-4000 FACTOR AT RASSN 50
MARCH 1600 HOURS GMT



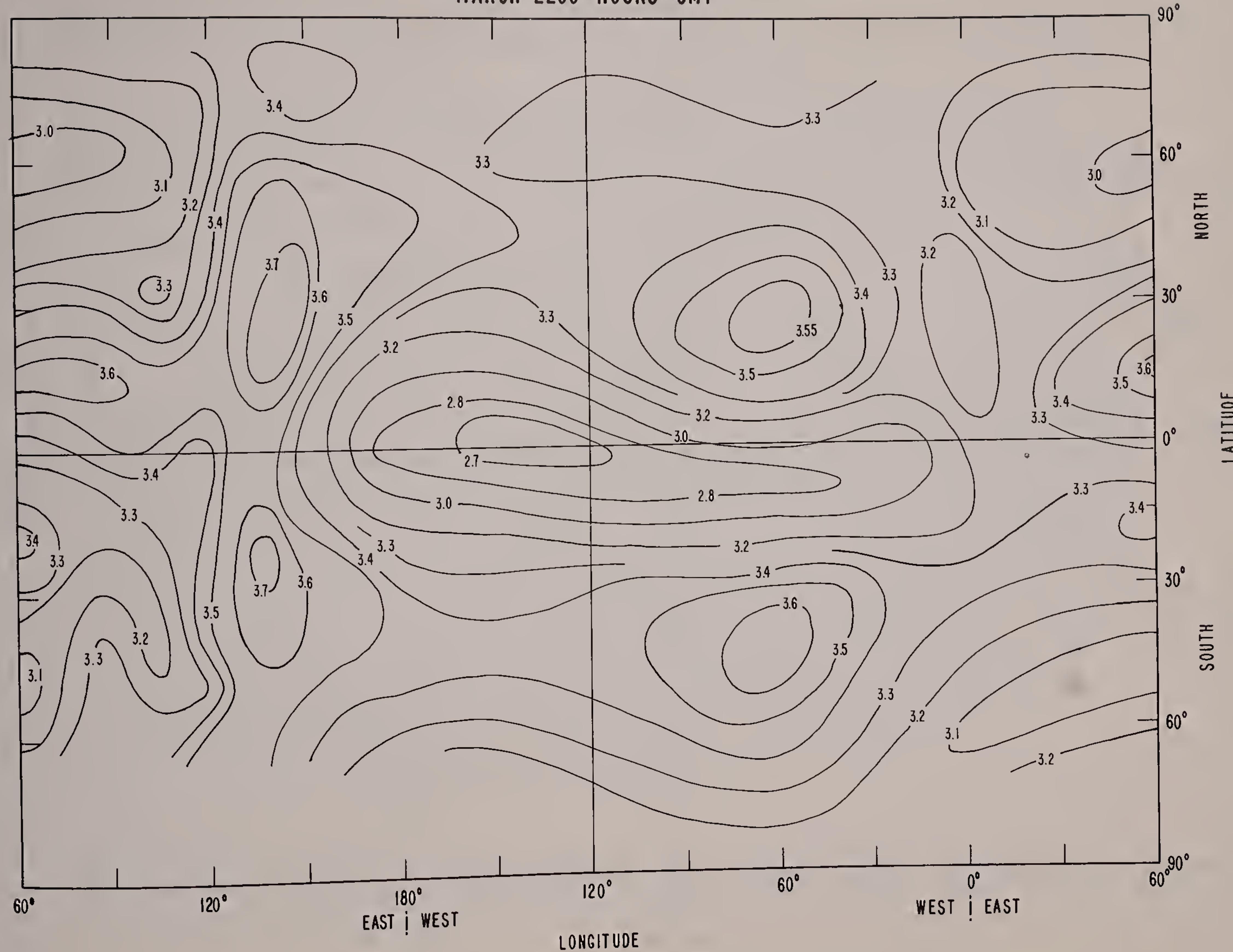
M-4000 FACTOR AT RASSN 50
MARCH 1800 HOURS GMT



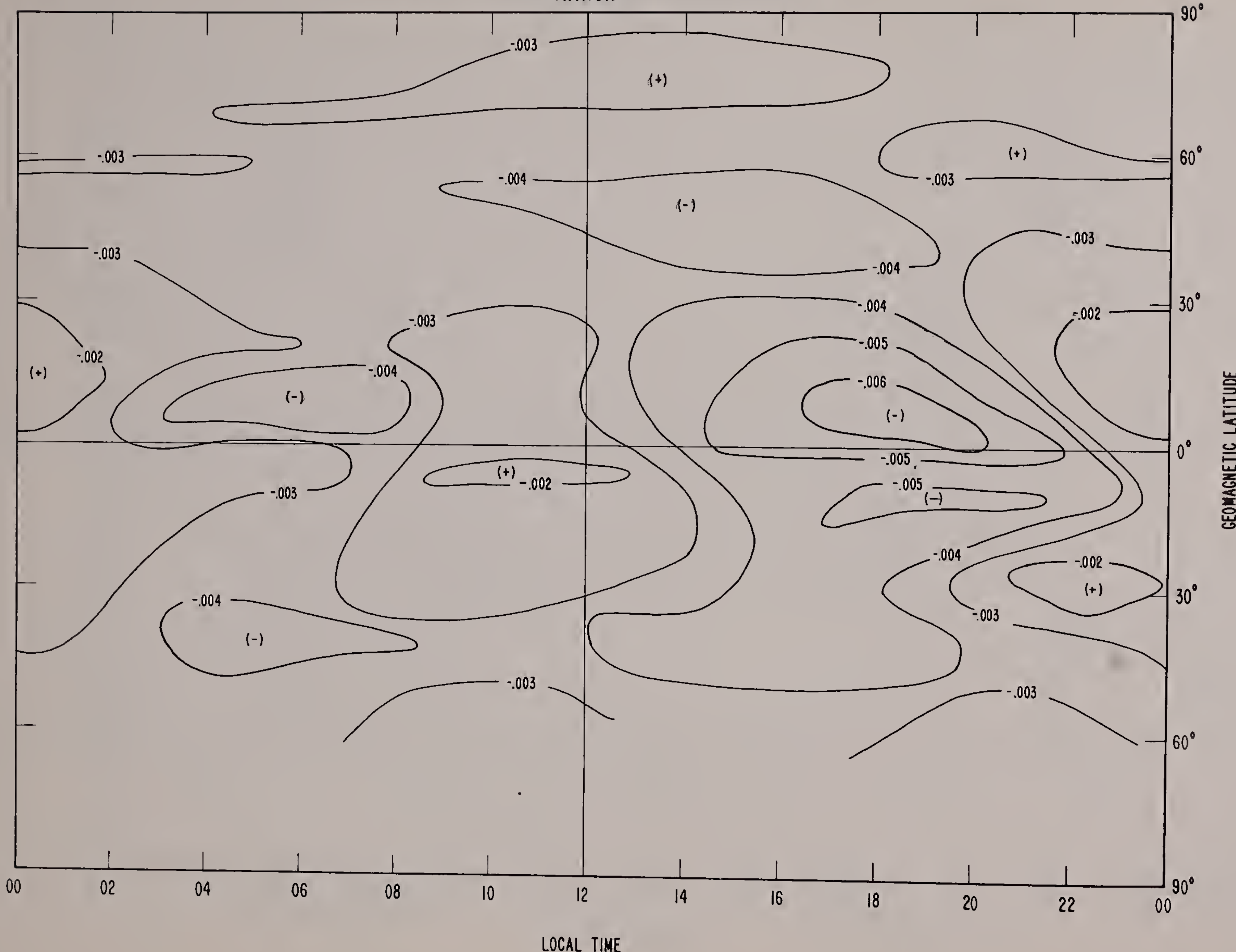
M-4000 FACTOR AT RASSN 50
MARCH 2000 HOURS GMT



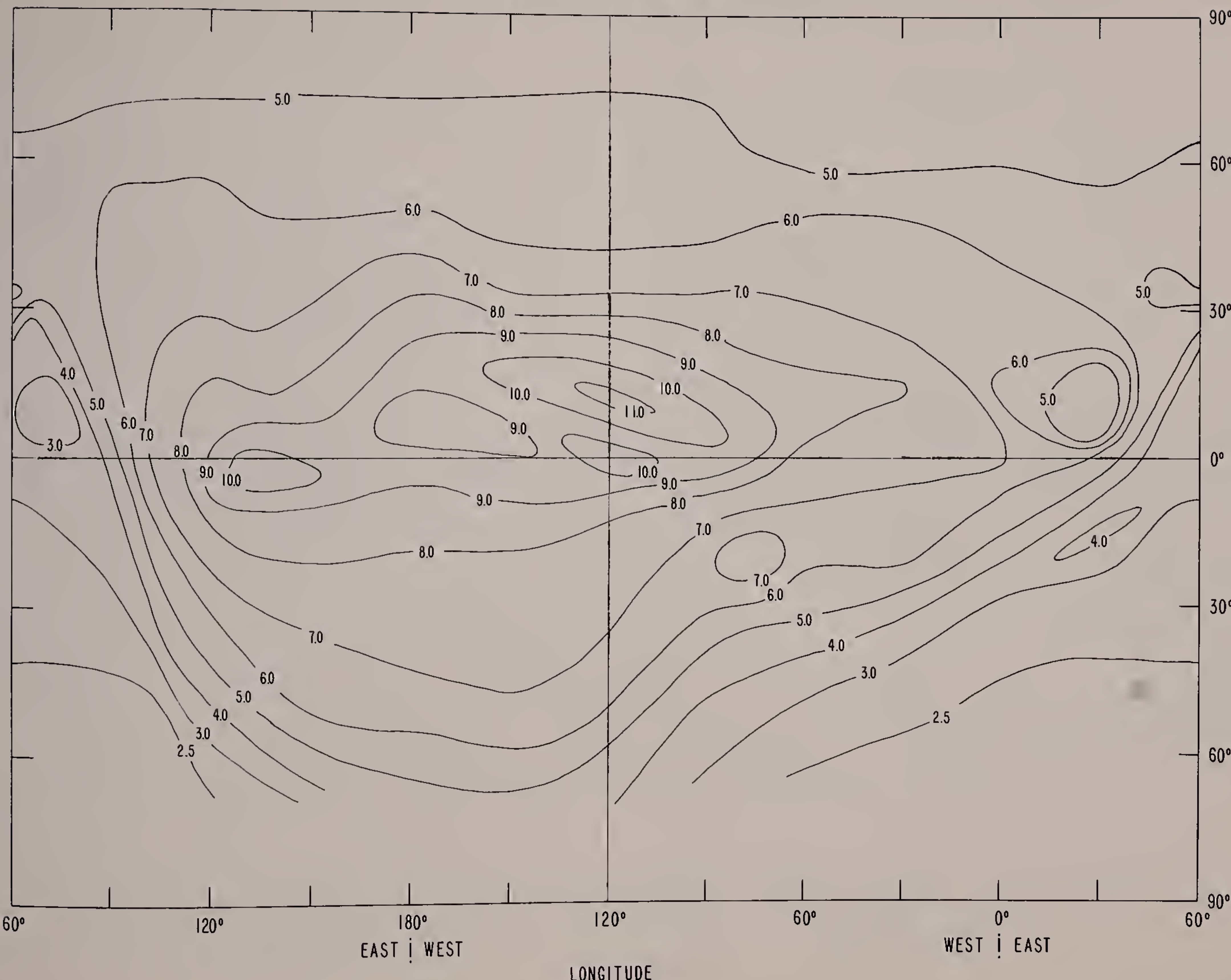
M-4000 FACTOR AT RASSN 50
MARCH 2200 HOURS GMT



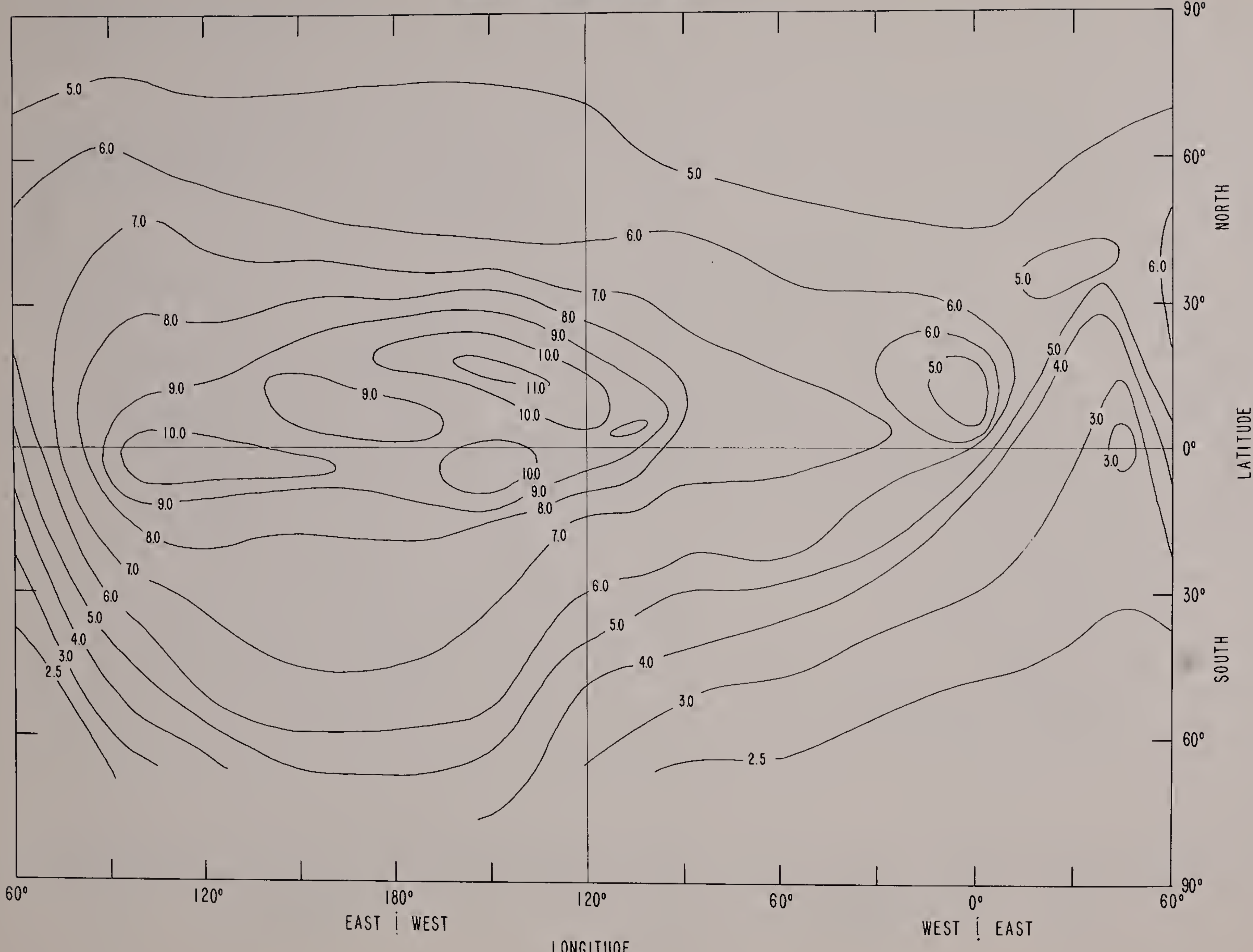
SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN
MARCH



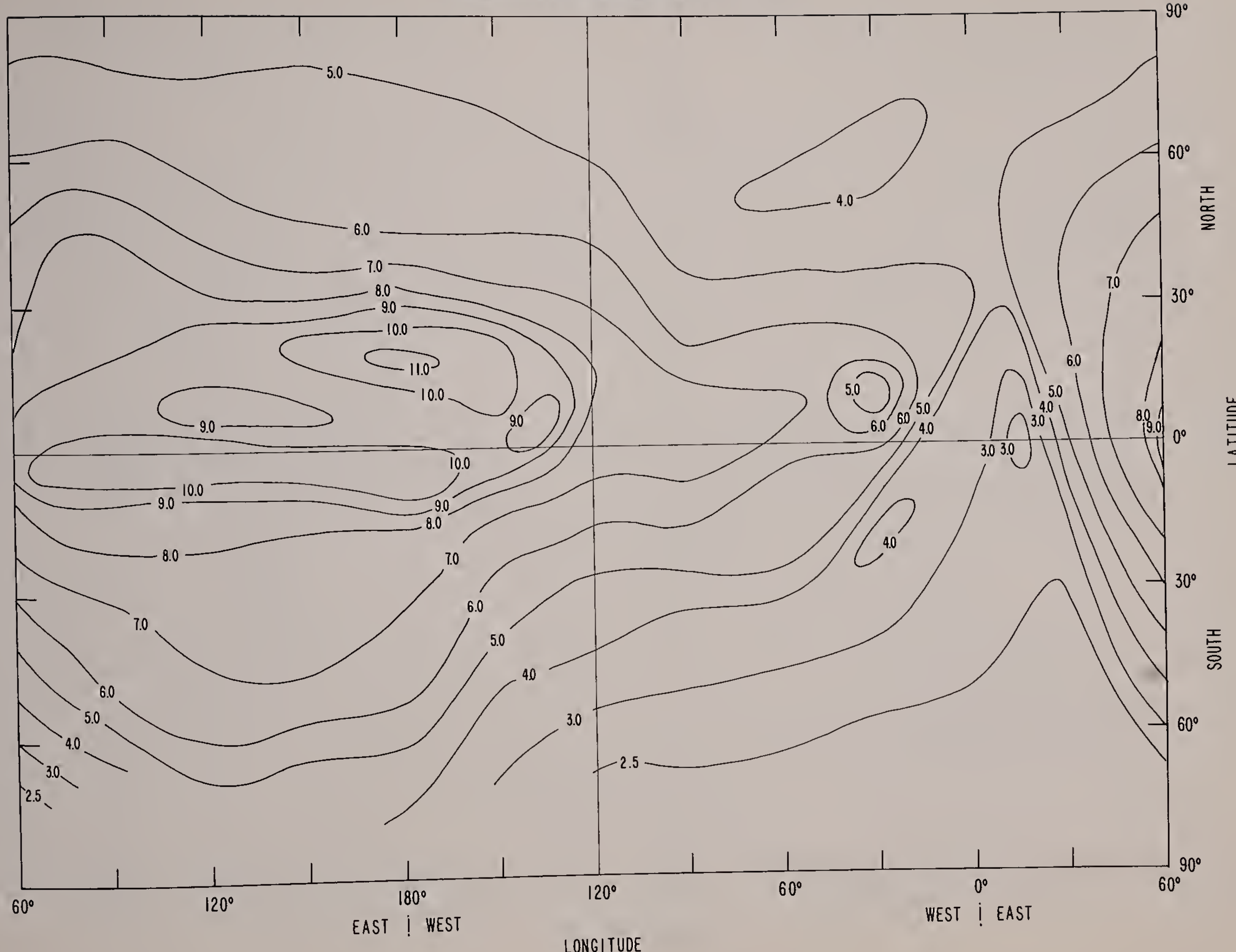
f_oF2 AT RASSN 50
JUNE 0000 HOURS GMT



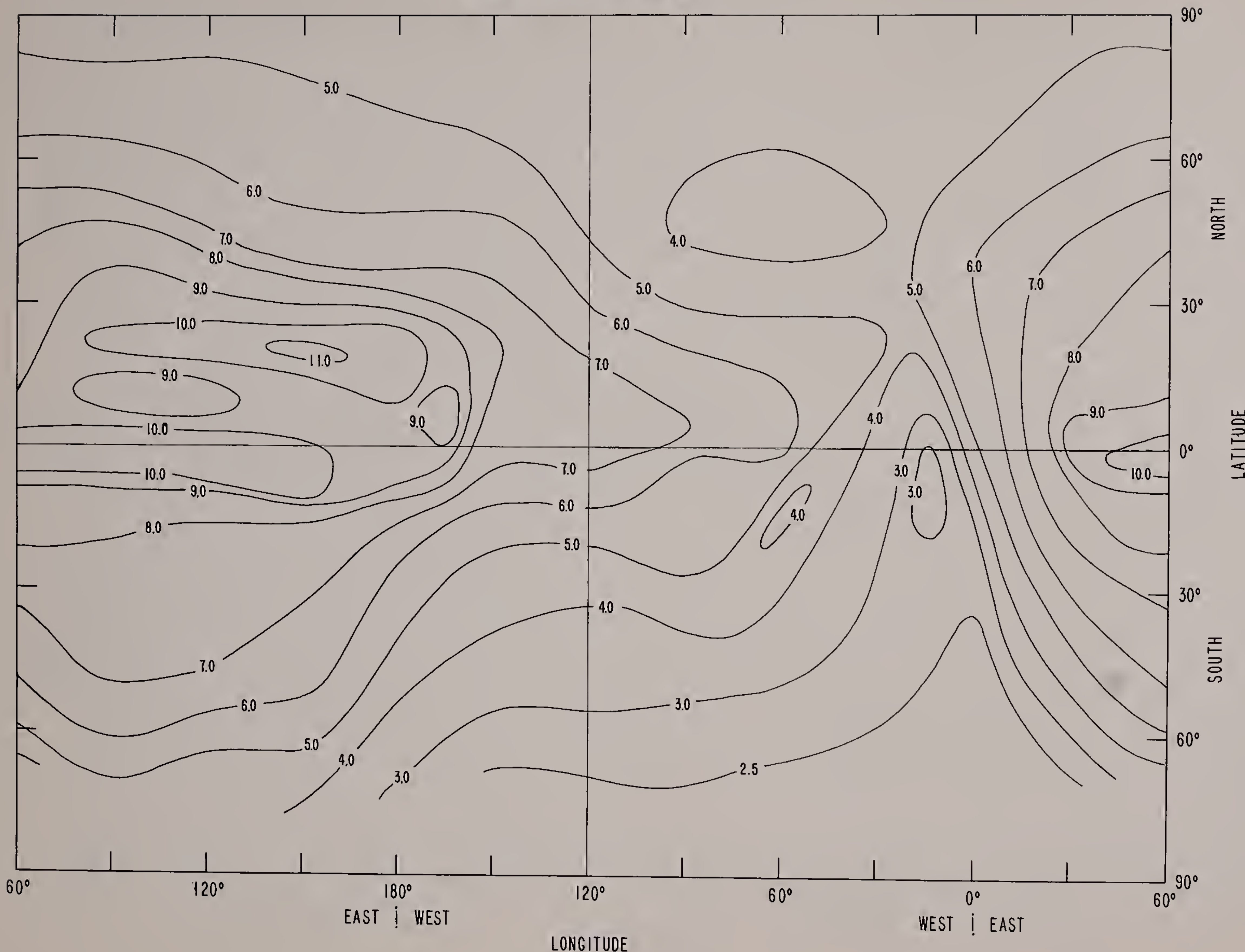
f_oF2 AT RASSN 50
JUNE 0200 HOURS GMT



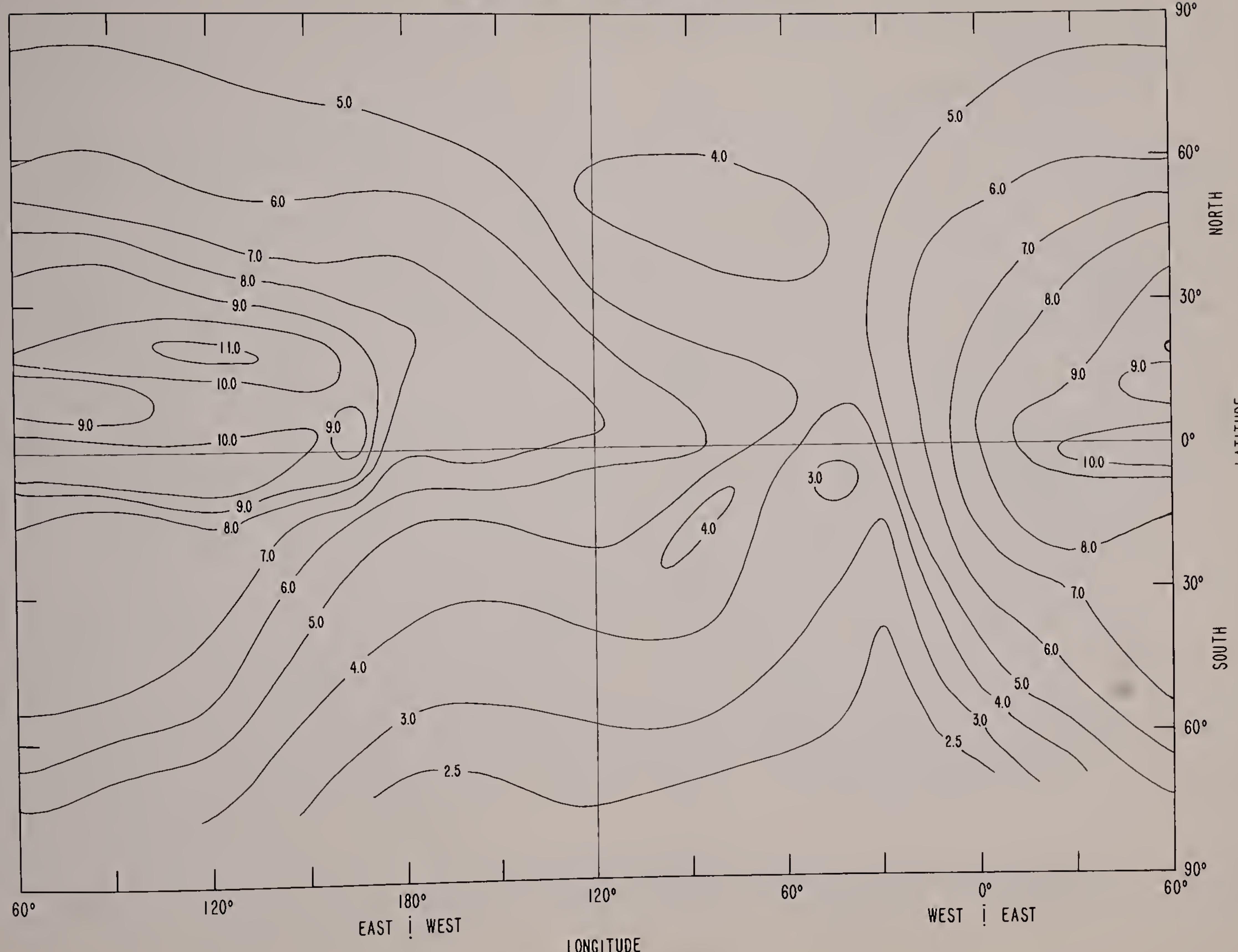
f_oF2 AT RASSN 50
JUNE 0400 HOURS GMT



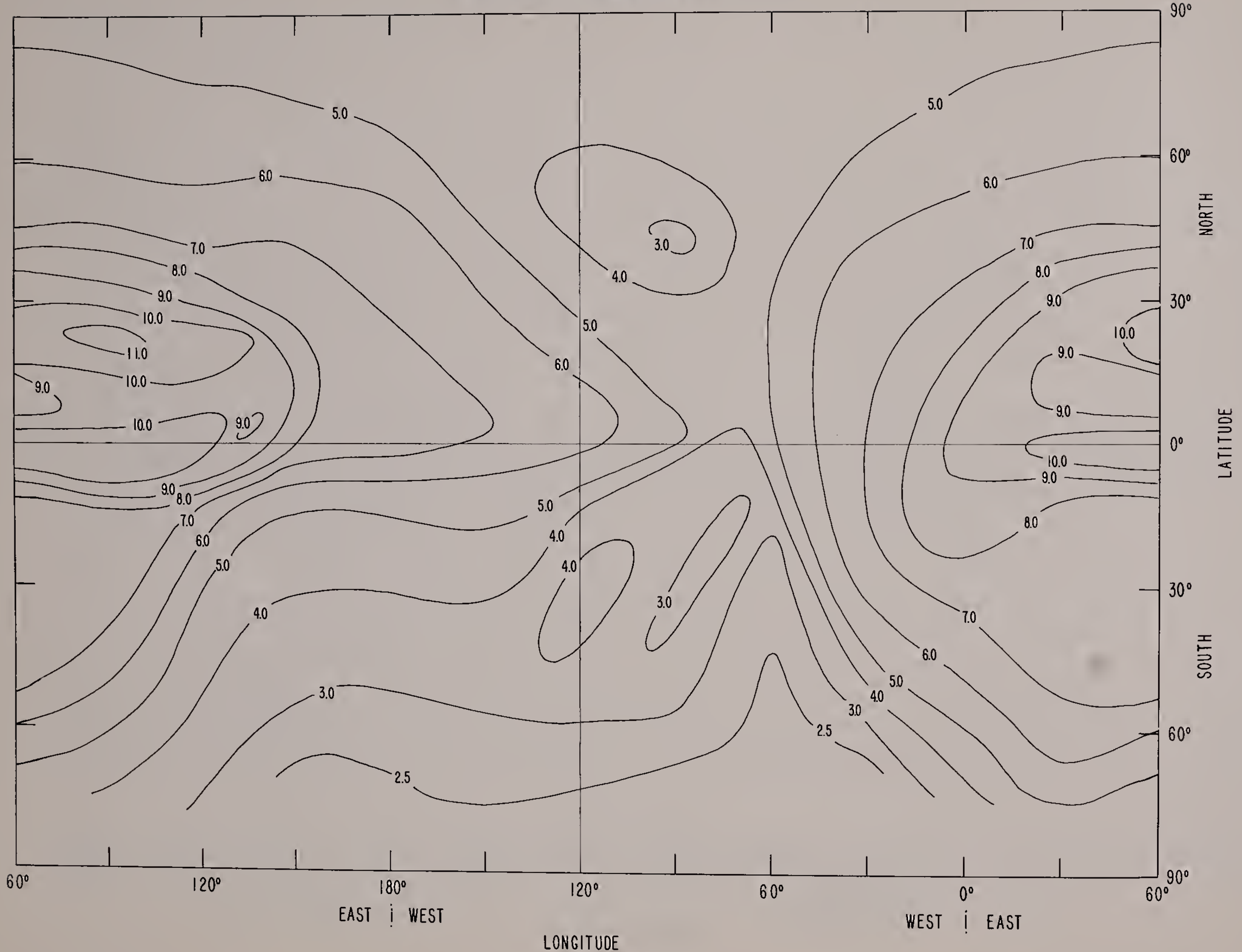
f_oF2 AT RASSN 50
JUNE 0600 HOURS GMT



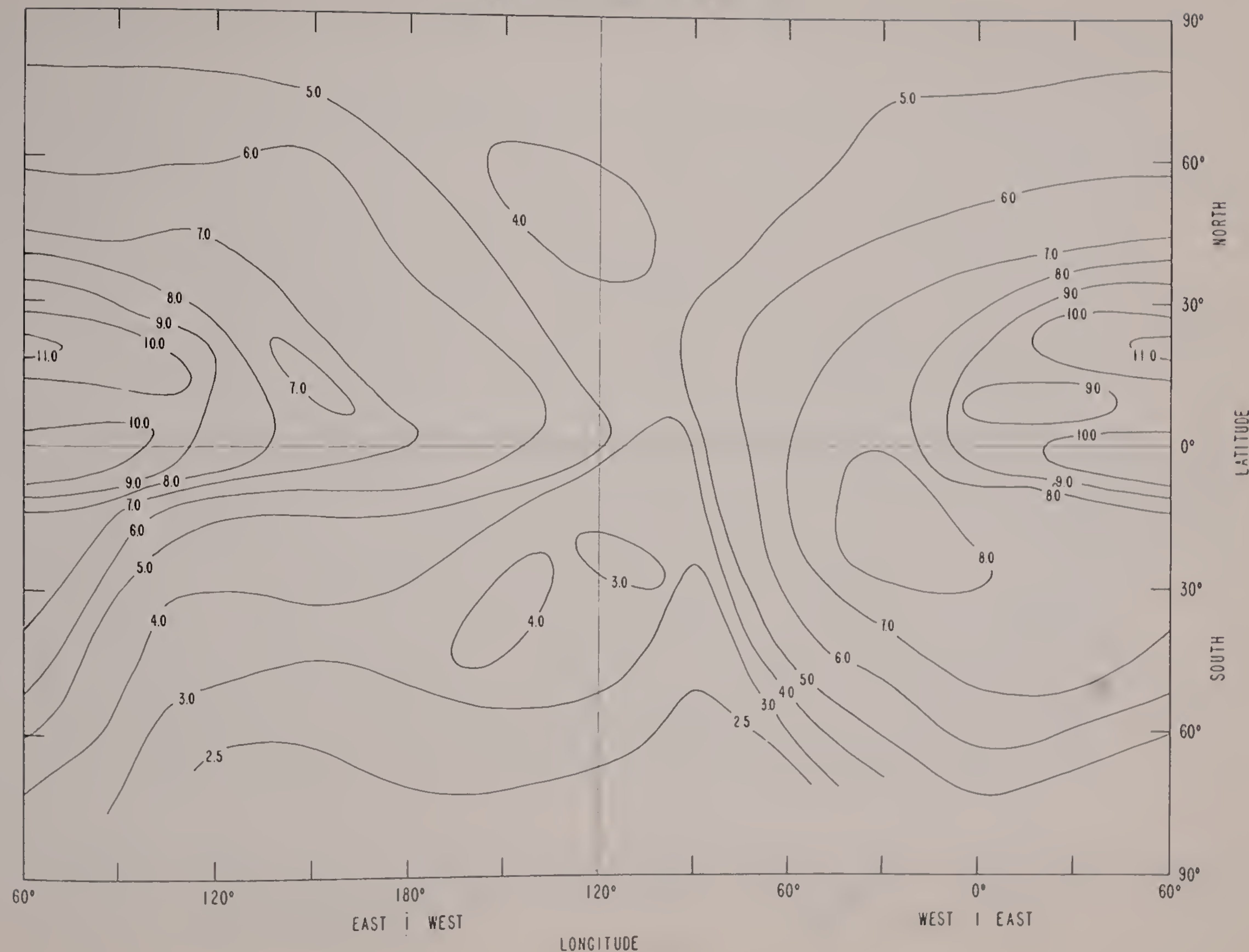
f_oF2 AT RASSN 50
JUNE 0800 HOURS GMT



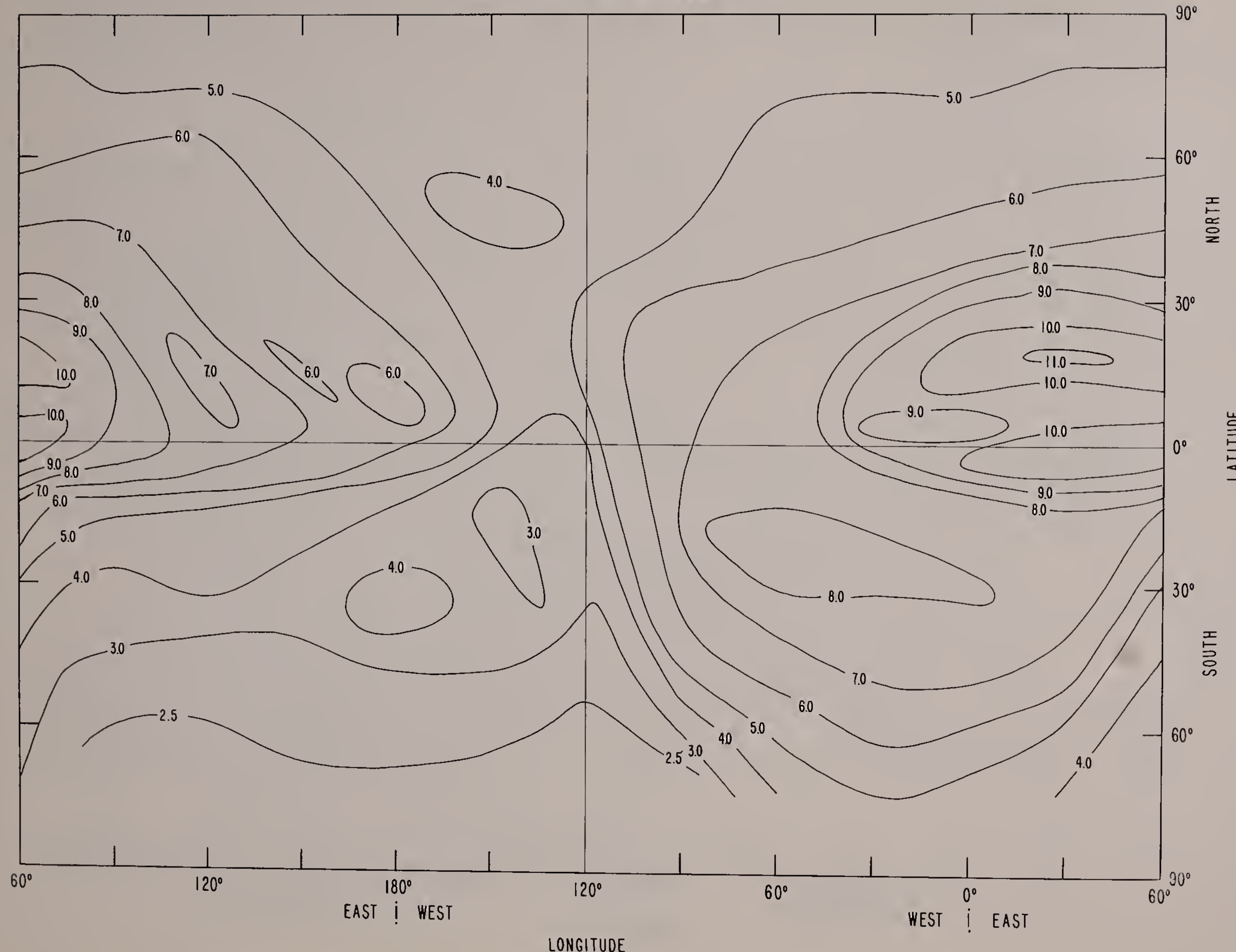
f_oF2 AT RASSN 50
JUNE 1000 HOURS GMT



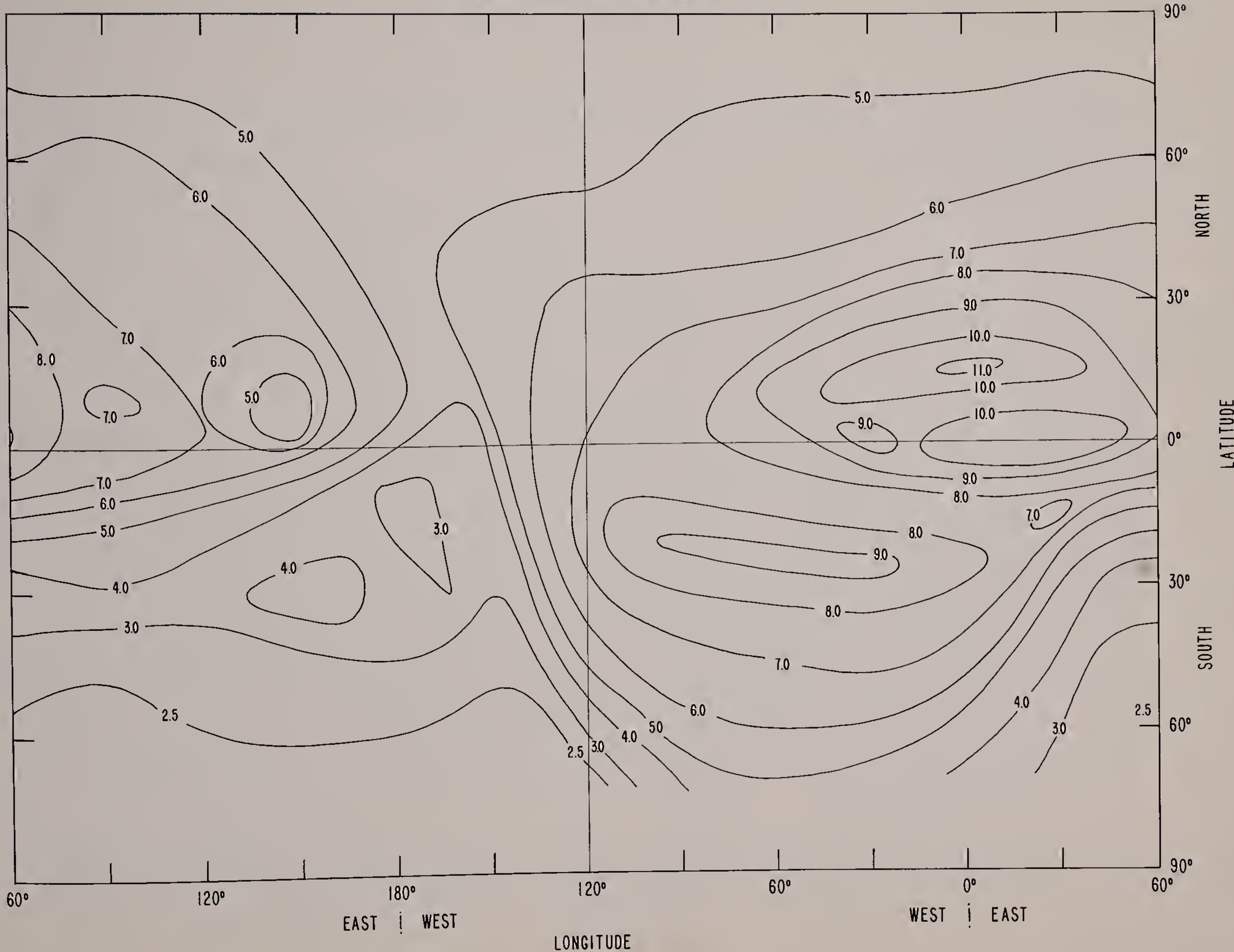
f_oF2 AT RASSN 50
JUNE 1200 HOURS GMT



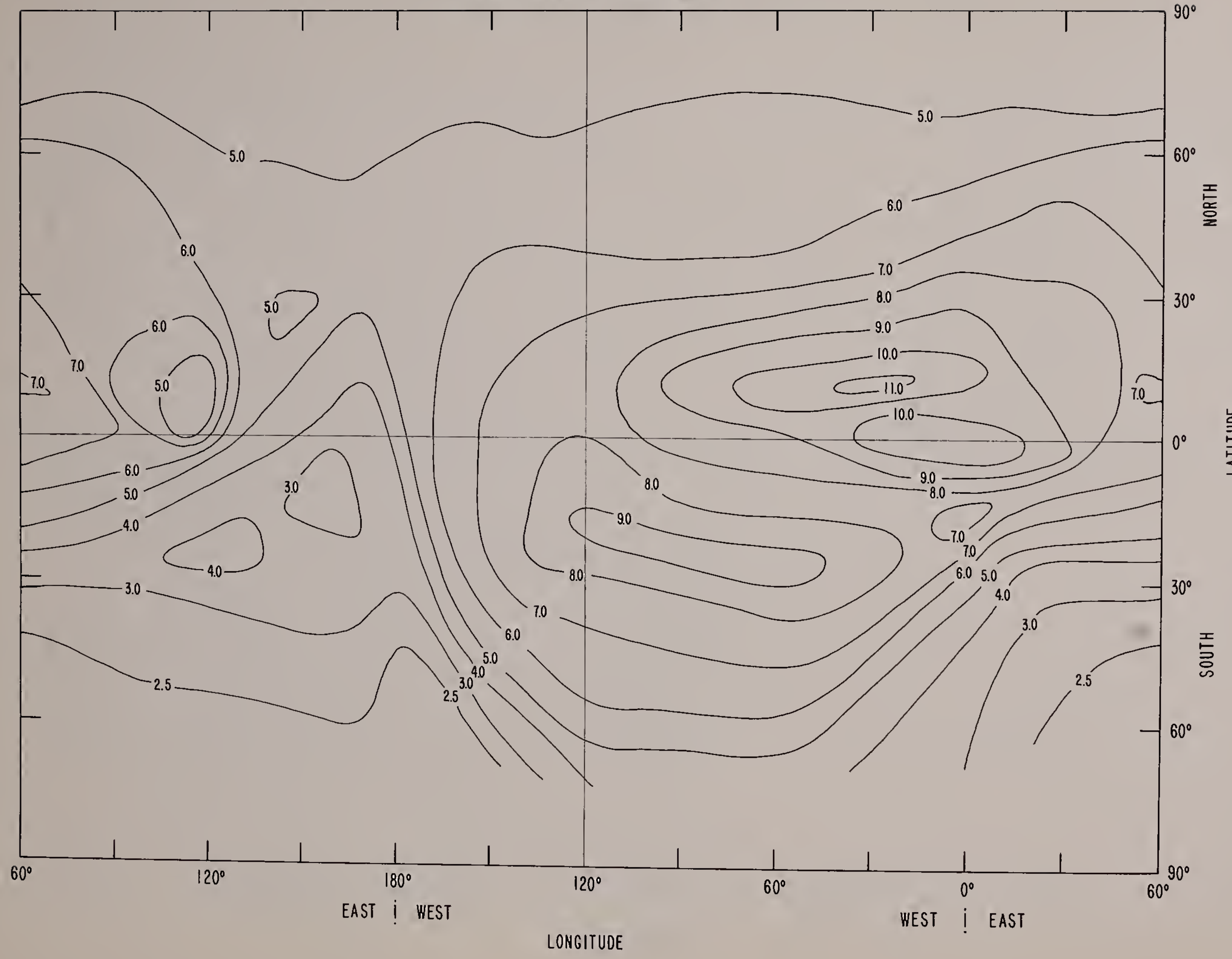
f_oF2 AT RASSN 50
JUNE 1400 HOURS GMT



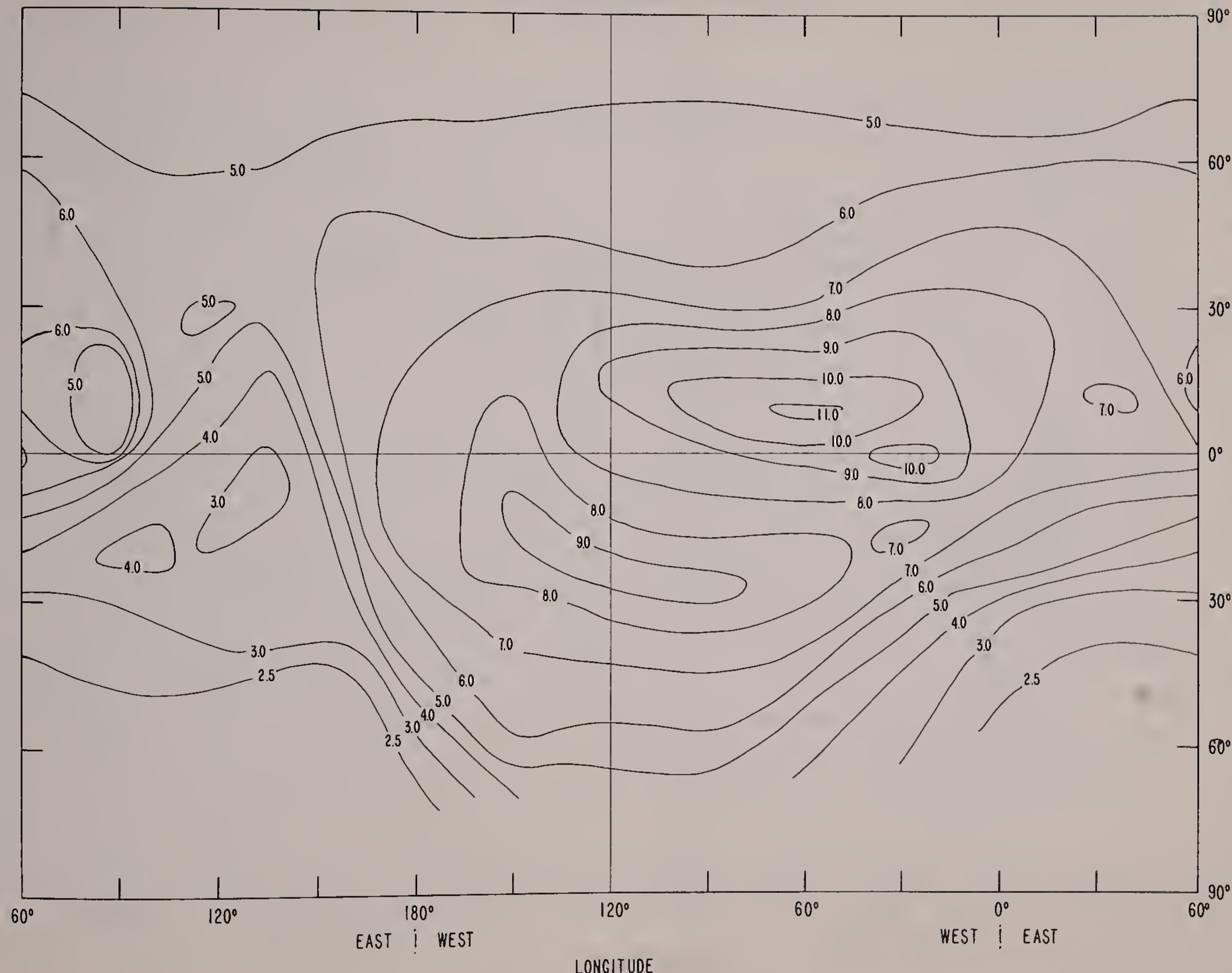
f_oF2 AT RASSN 50
JUNE 1600 HOURS GMT



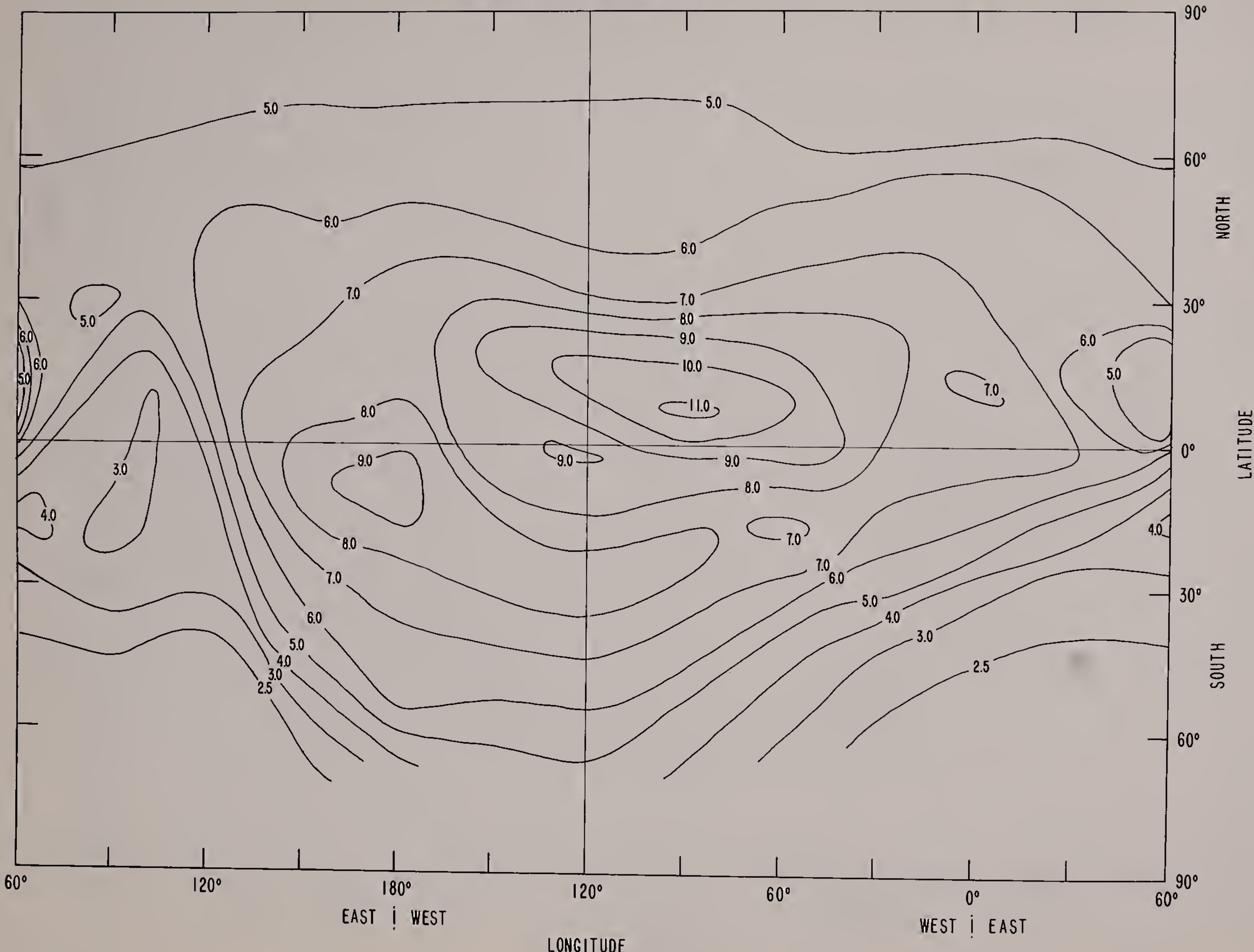
f₀F2 AT RASSN 50
JUNE 1800 HOURS GMT



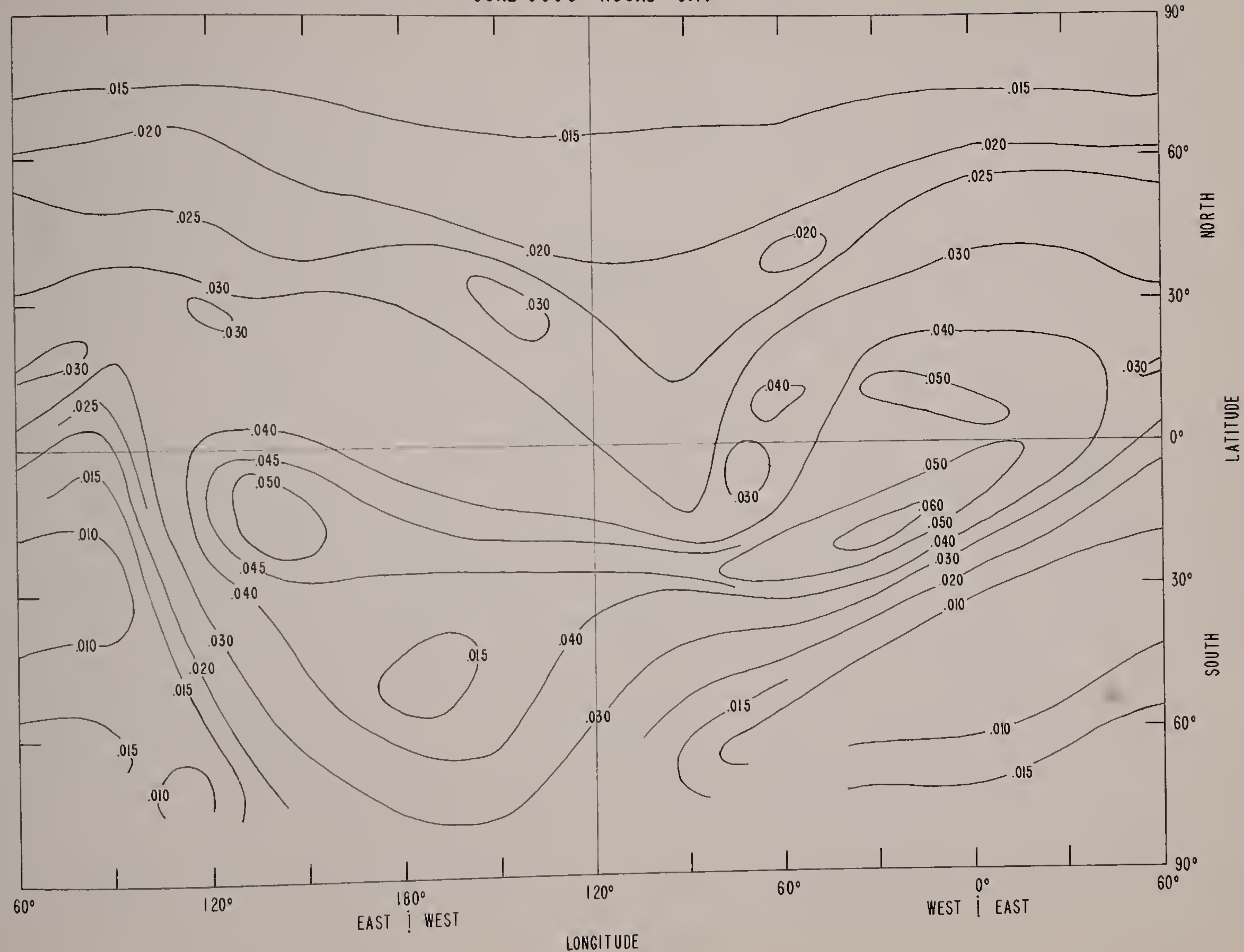
f₀F2 AT RASSN 50
JUNE 2000 HOURS GMT



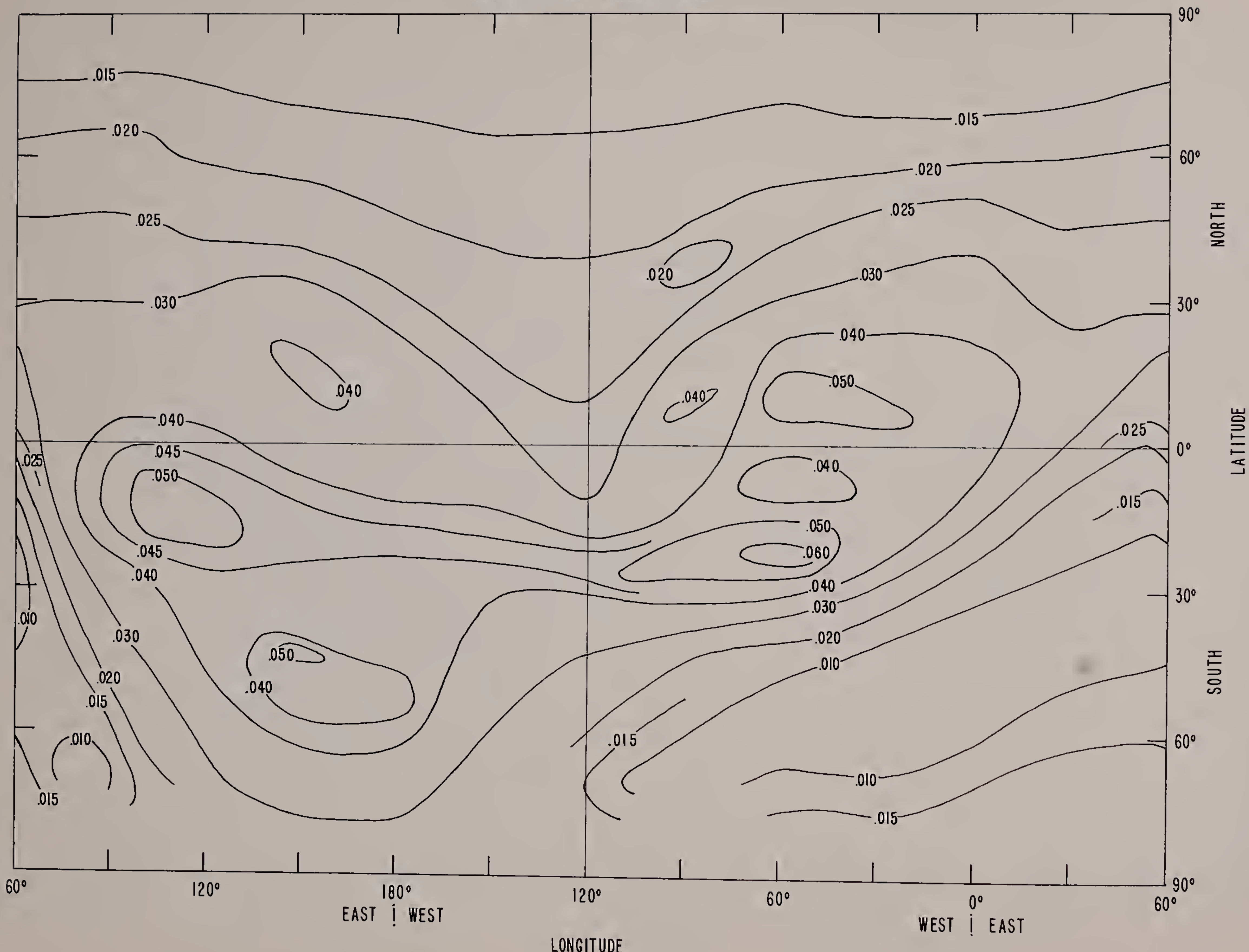
f_oF2 AT RASSN 50
JUNE 2200 HOURS GMT



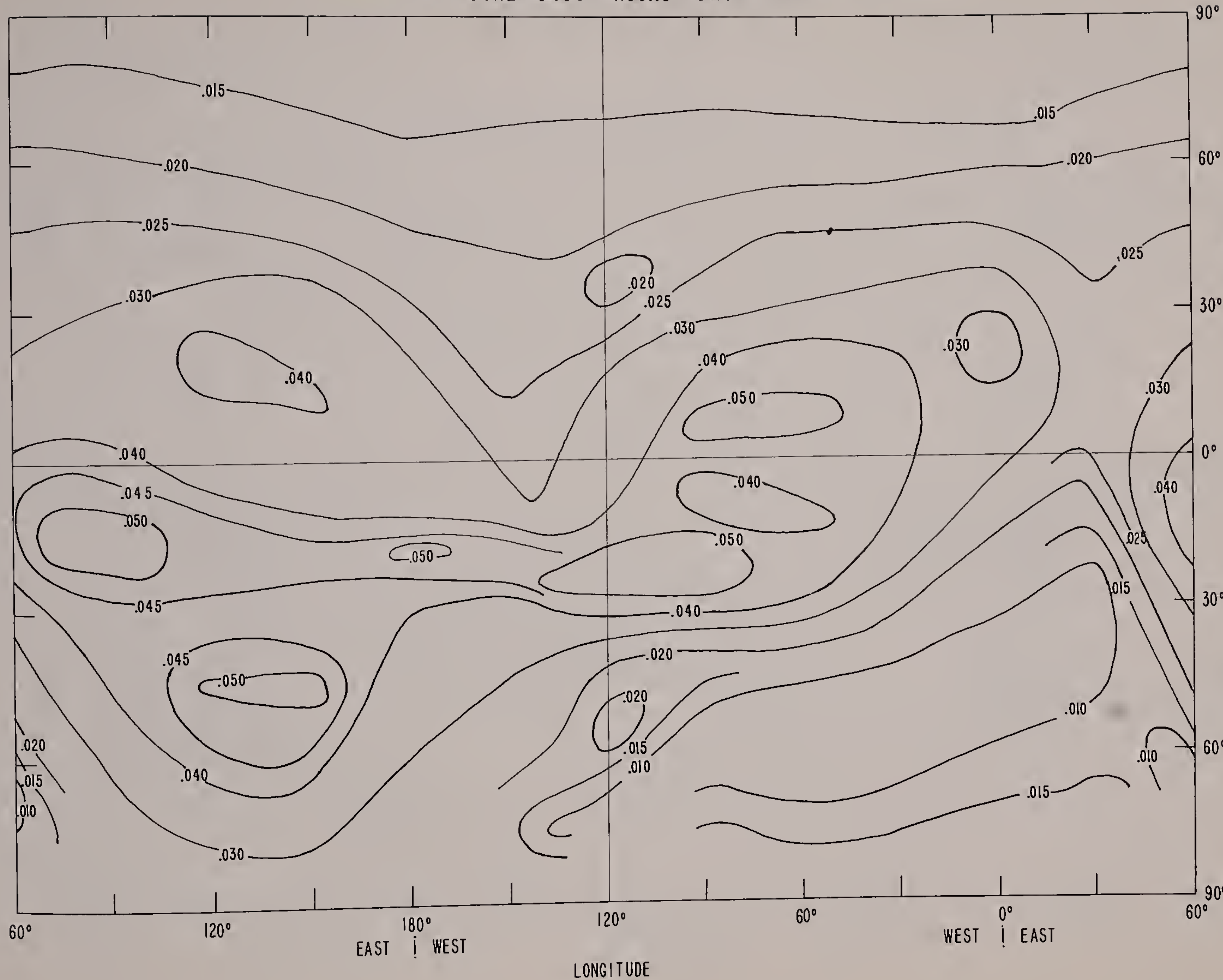
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 0000 HOURS GMT



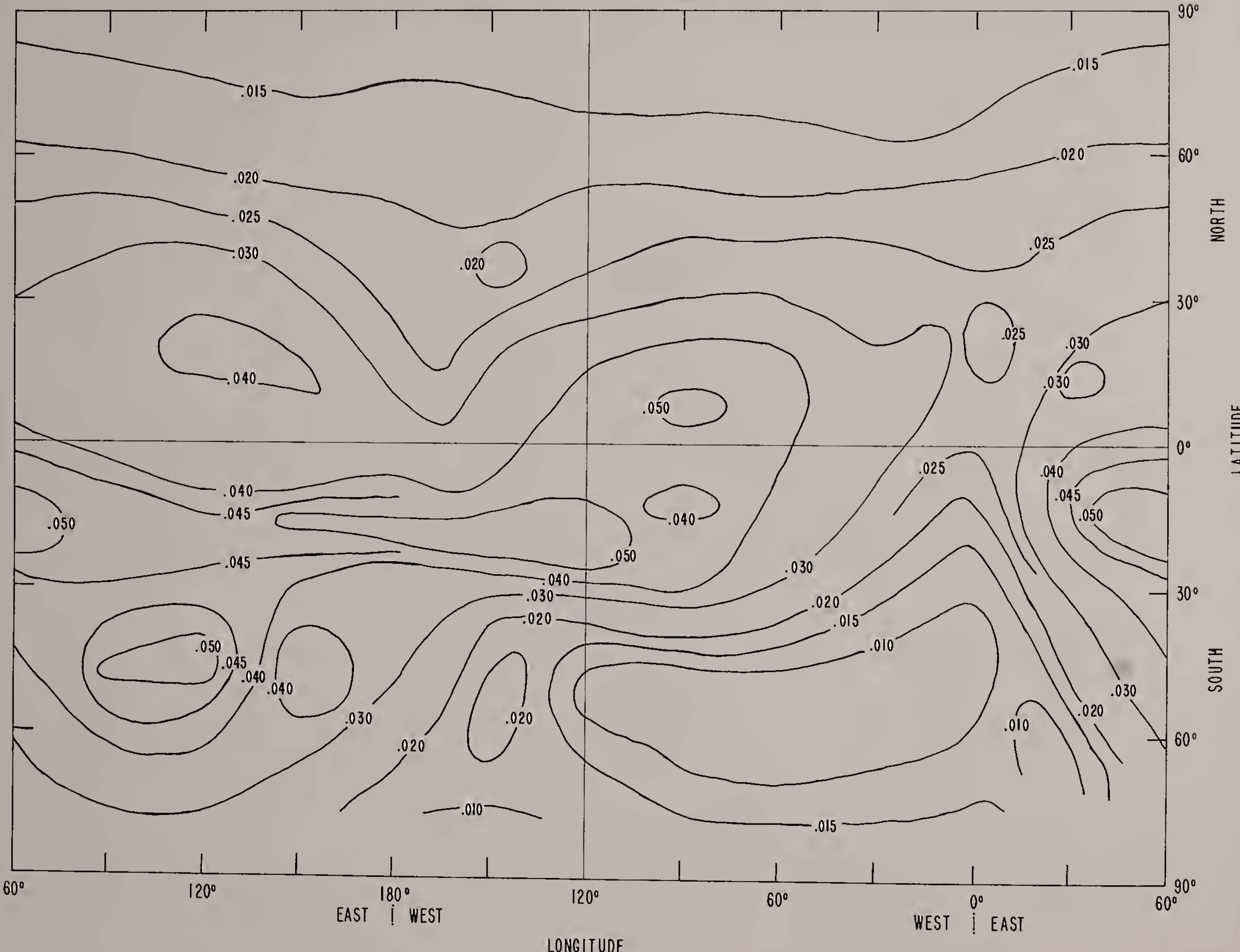
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 0200 HOURS GMT



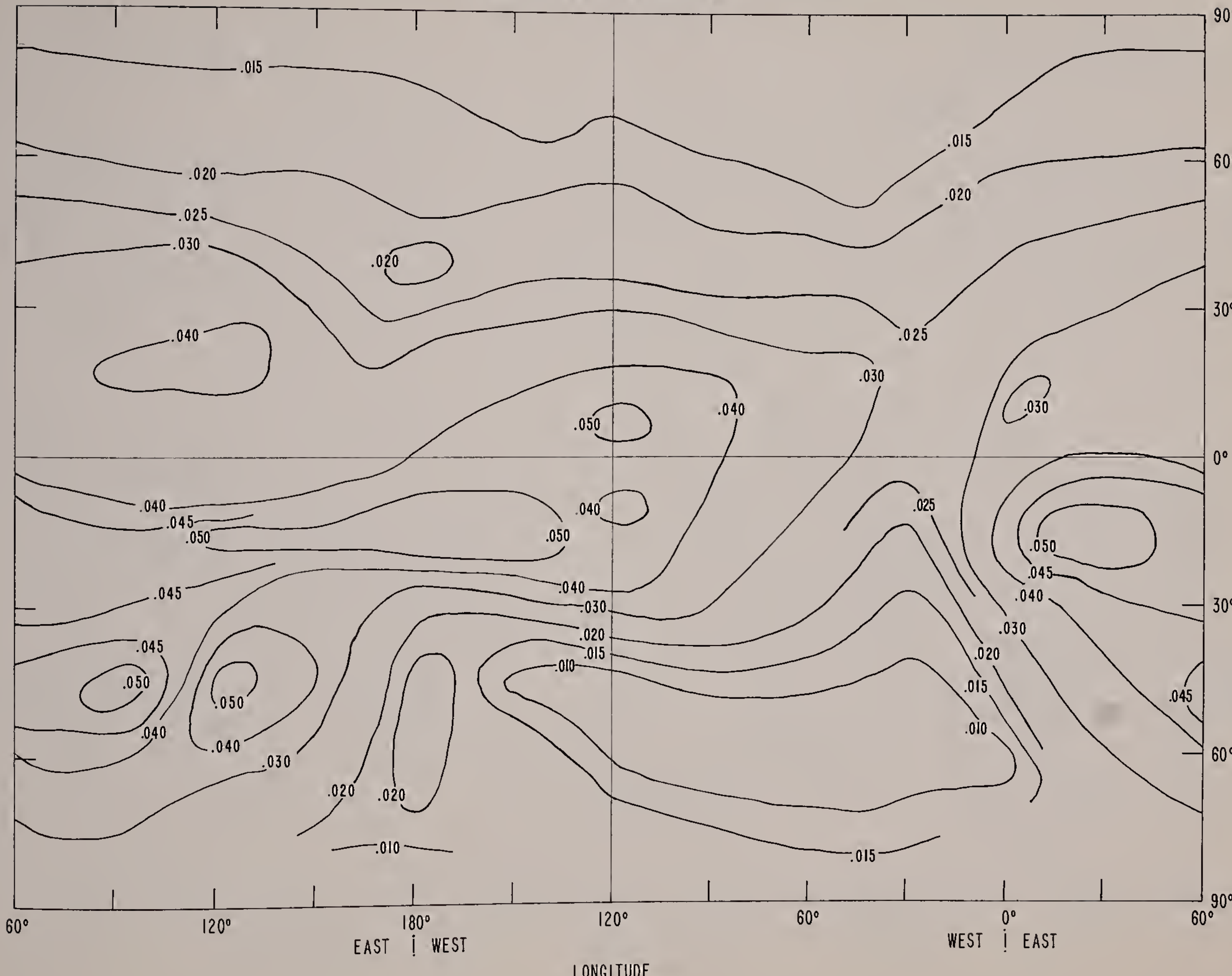
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 0400 HOURS GMT



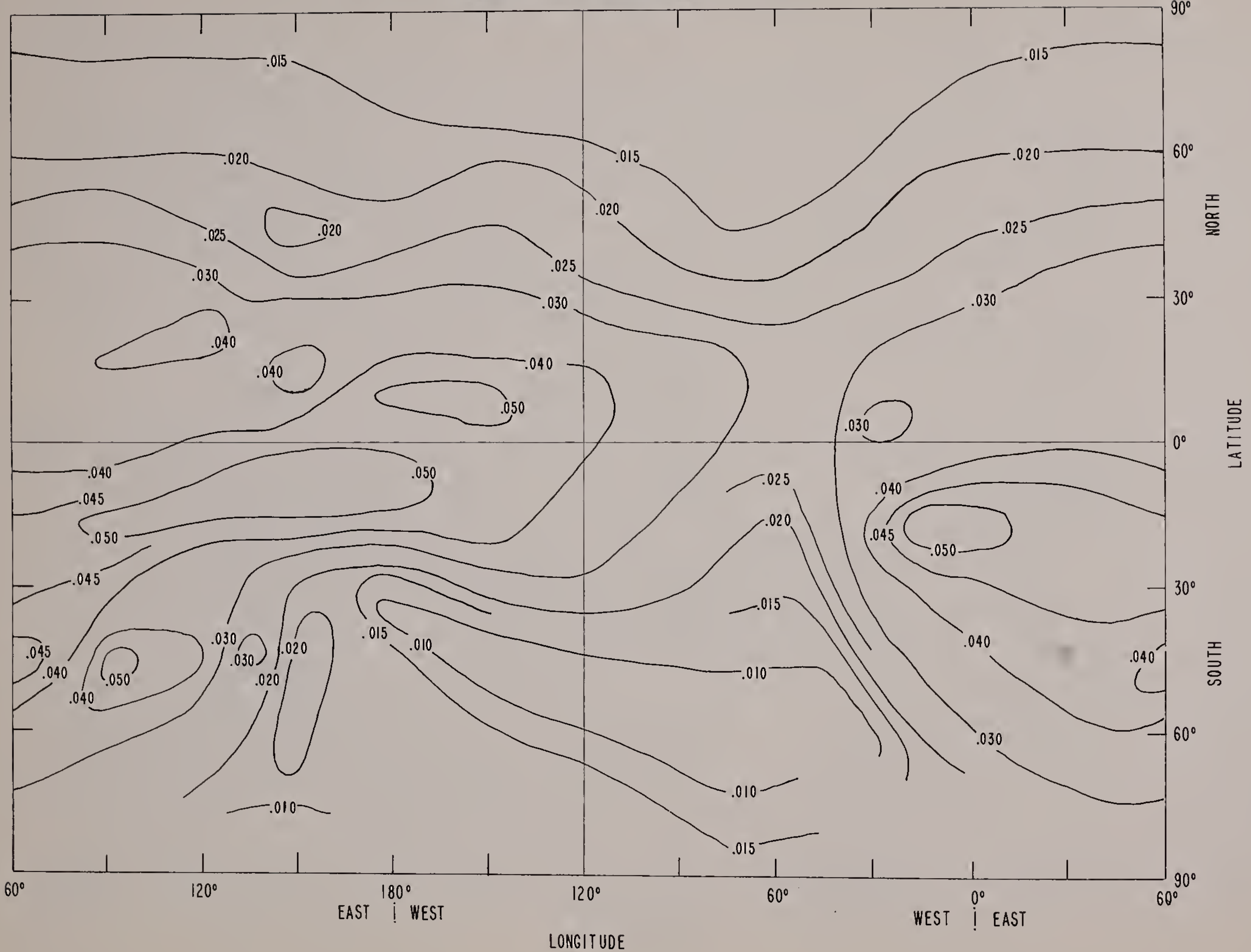
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 0600 HOURS GMT



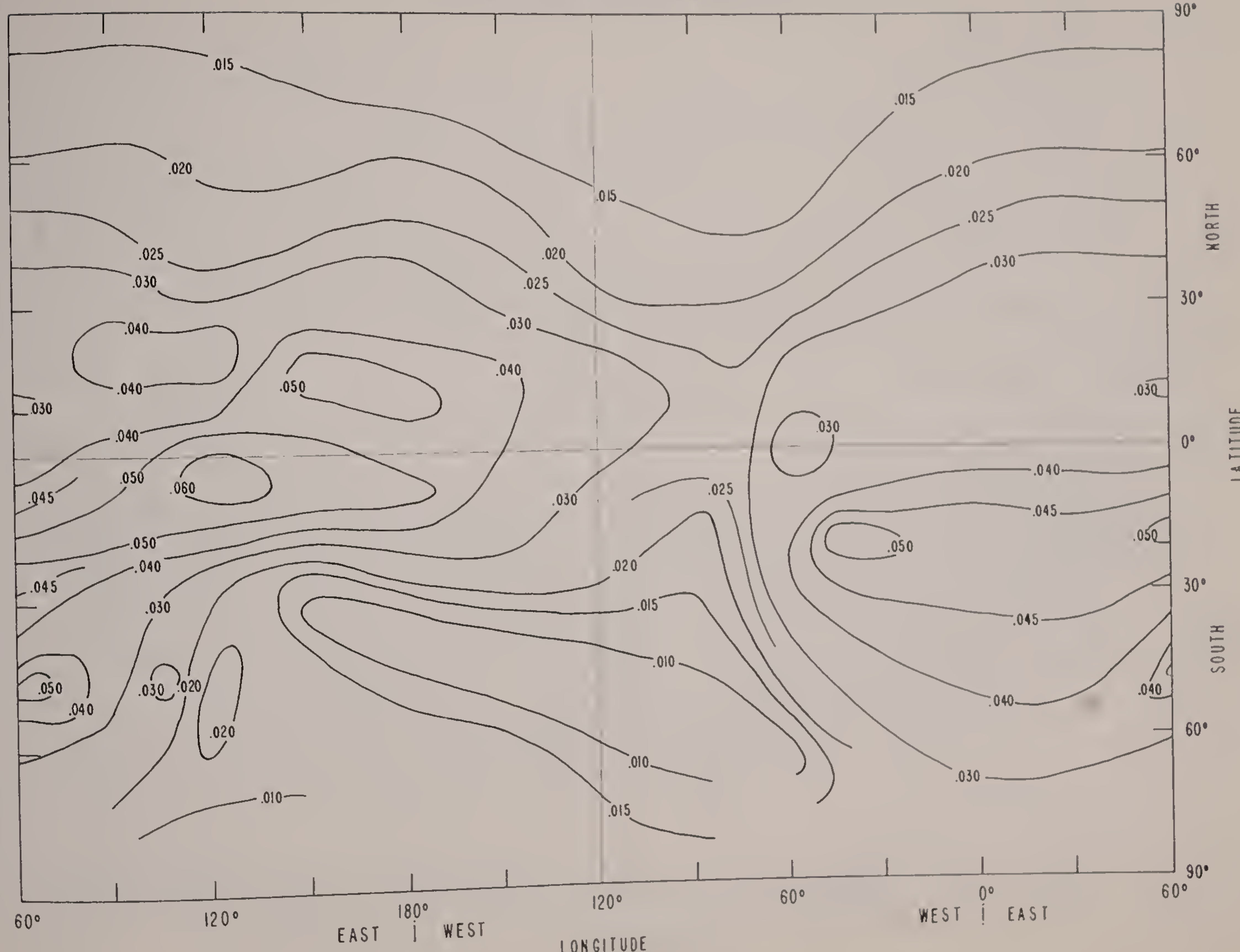
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 0800 HOURS GMT



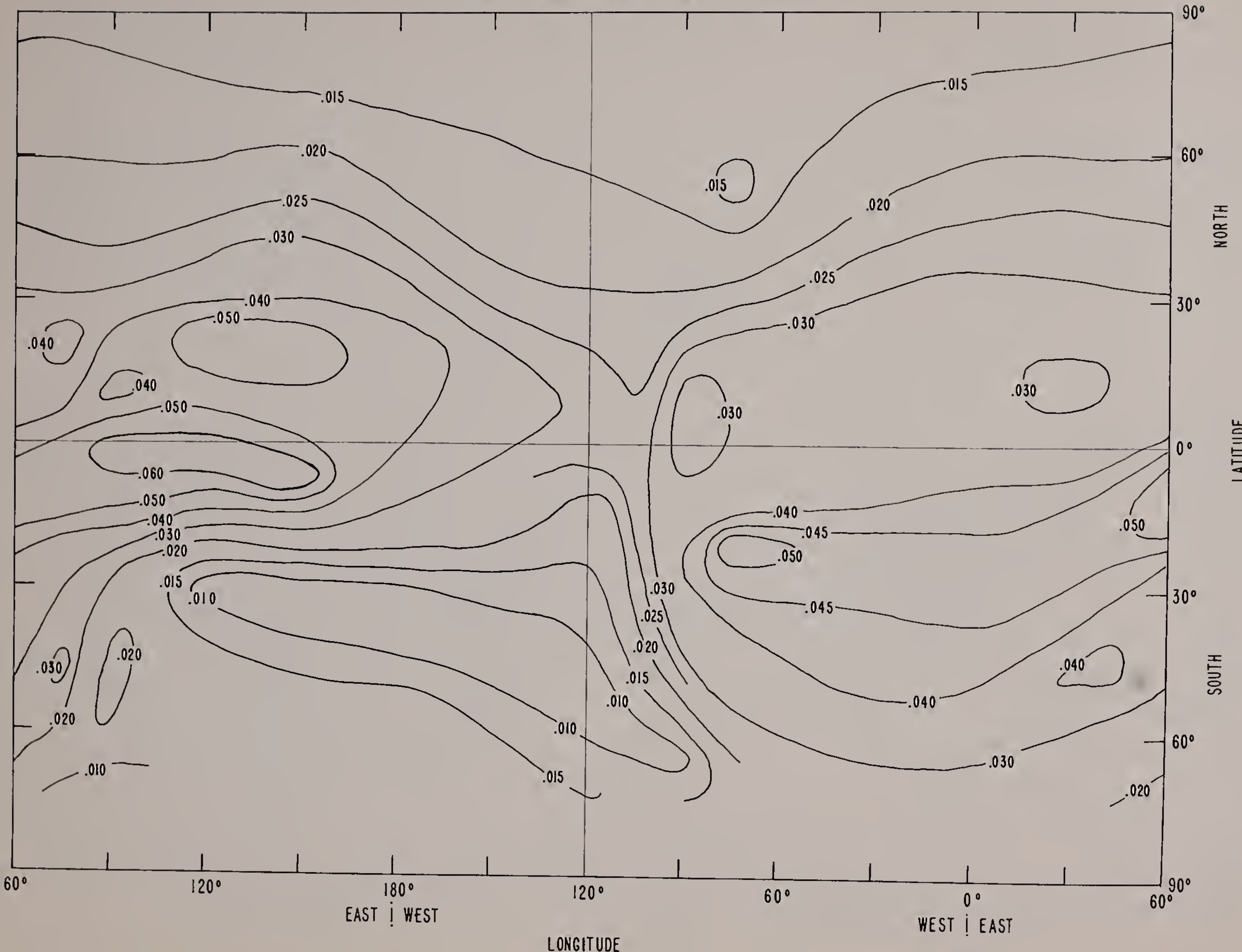
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 1000 HOURS GMT



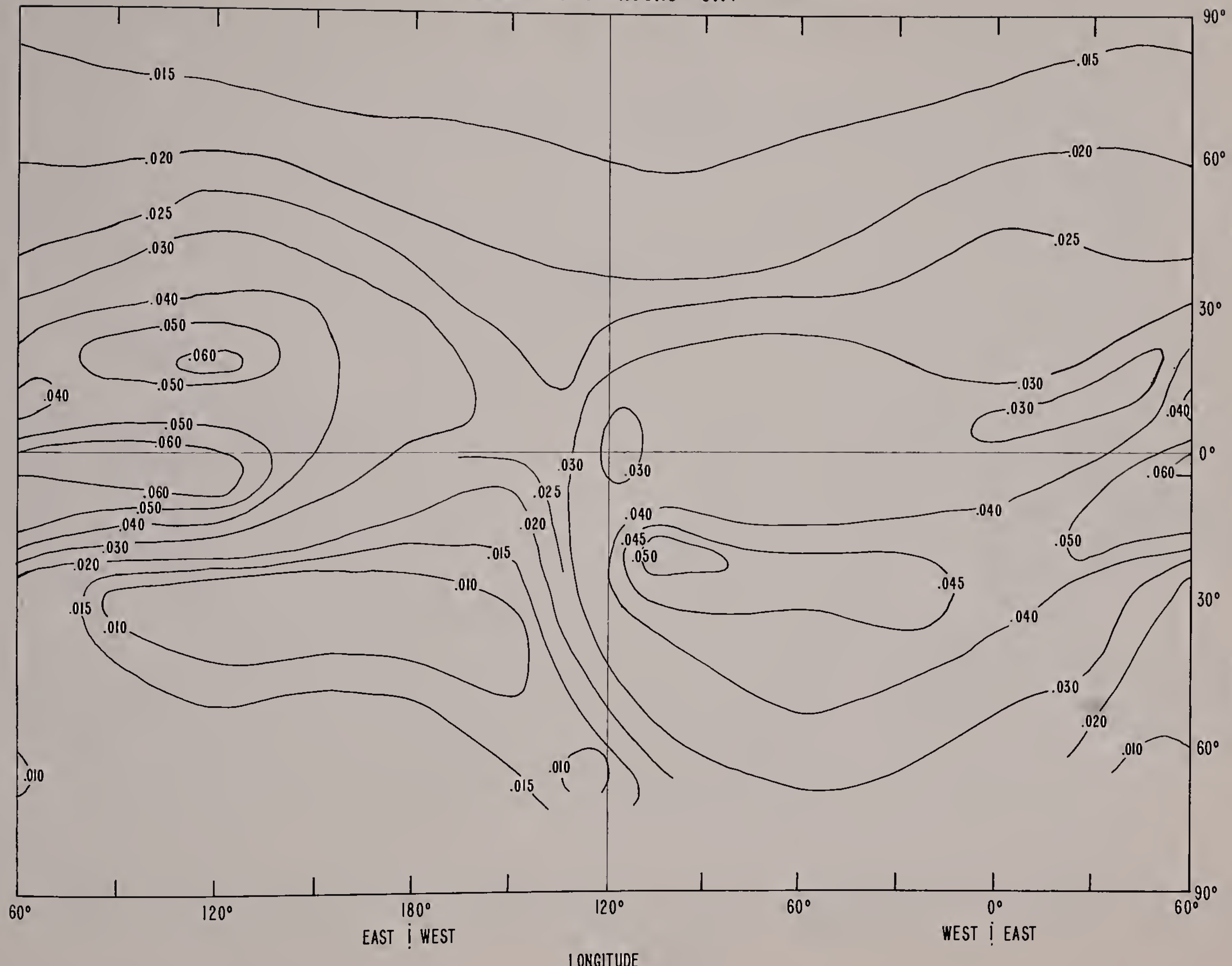
SLOPE OF REGRESSION LINE OF f_oF2 RASSN
JUNE 1200 HOURS GMT



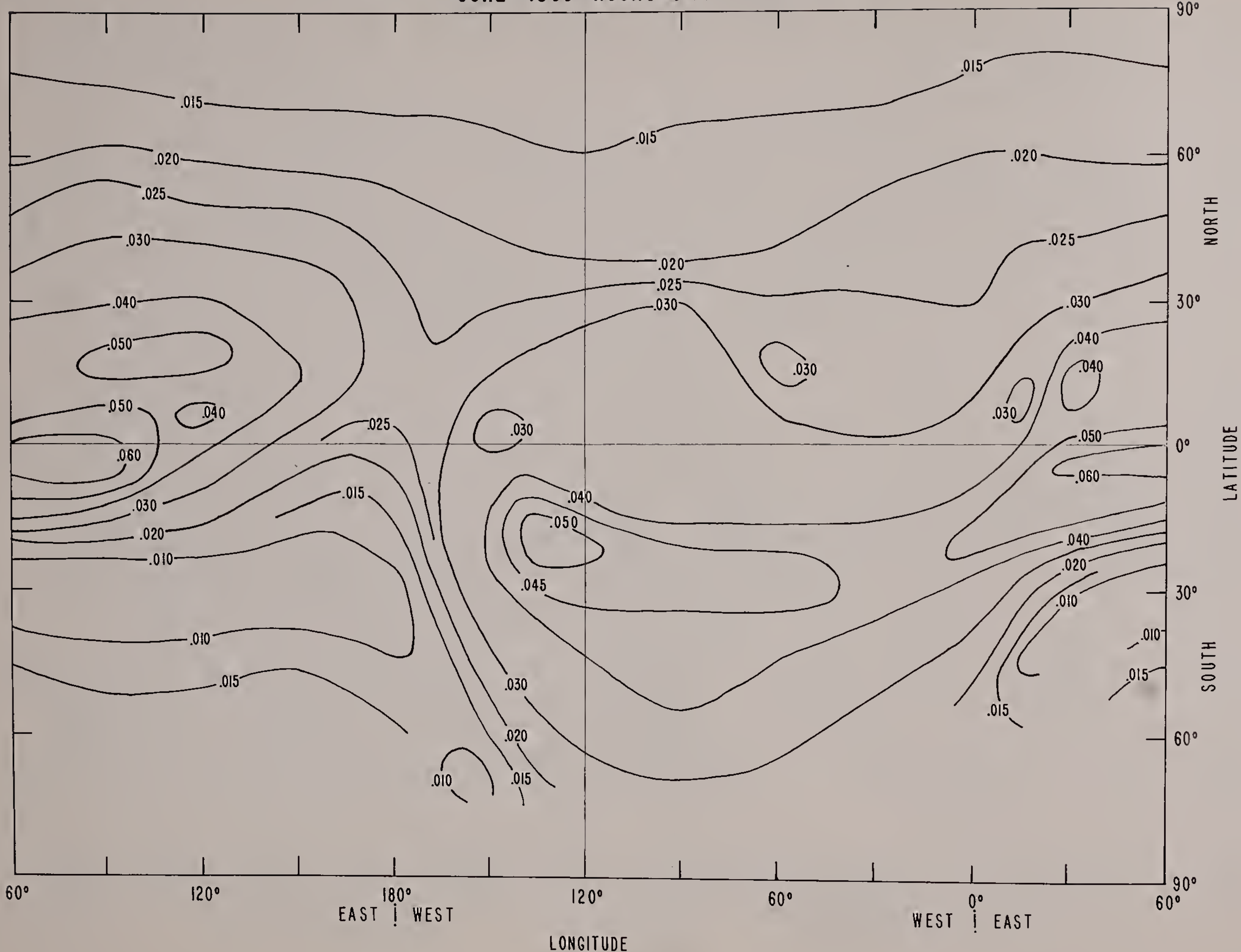
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 1400 HOURS GMT



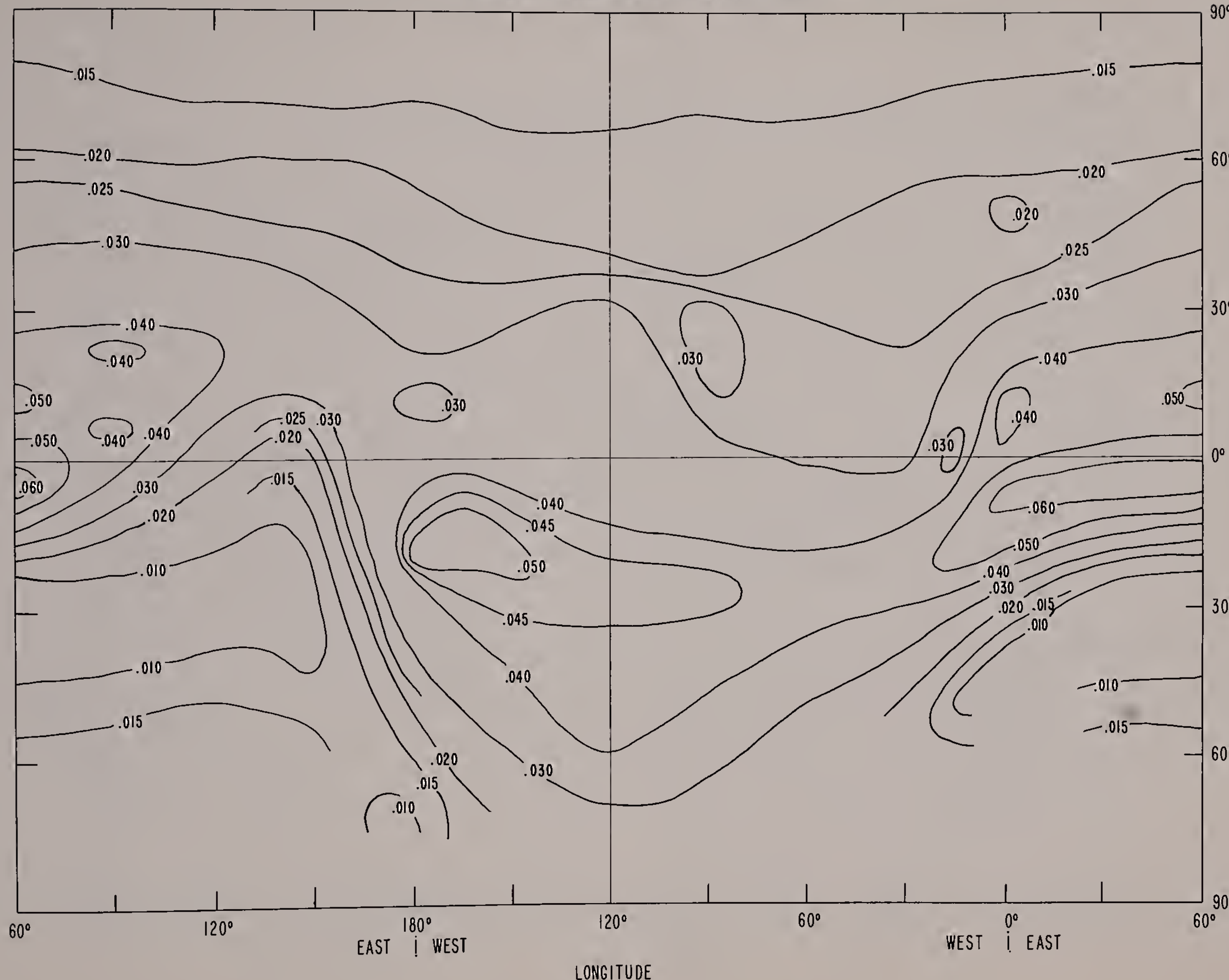
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JUNE 1600 HOURS GMT



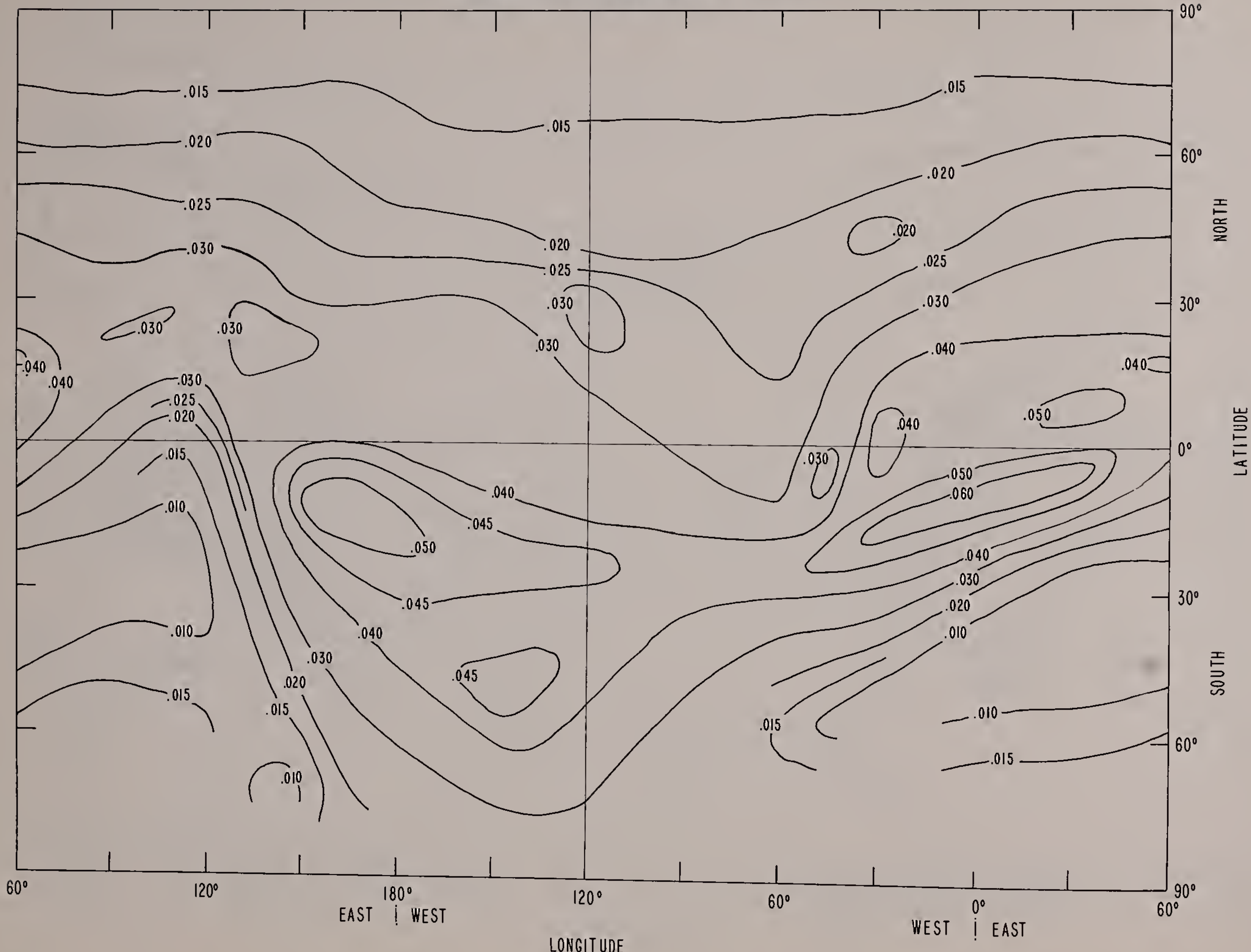
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JUNE 1800 HOURS GMT



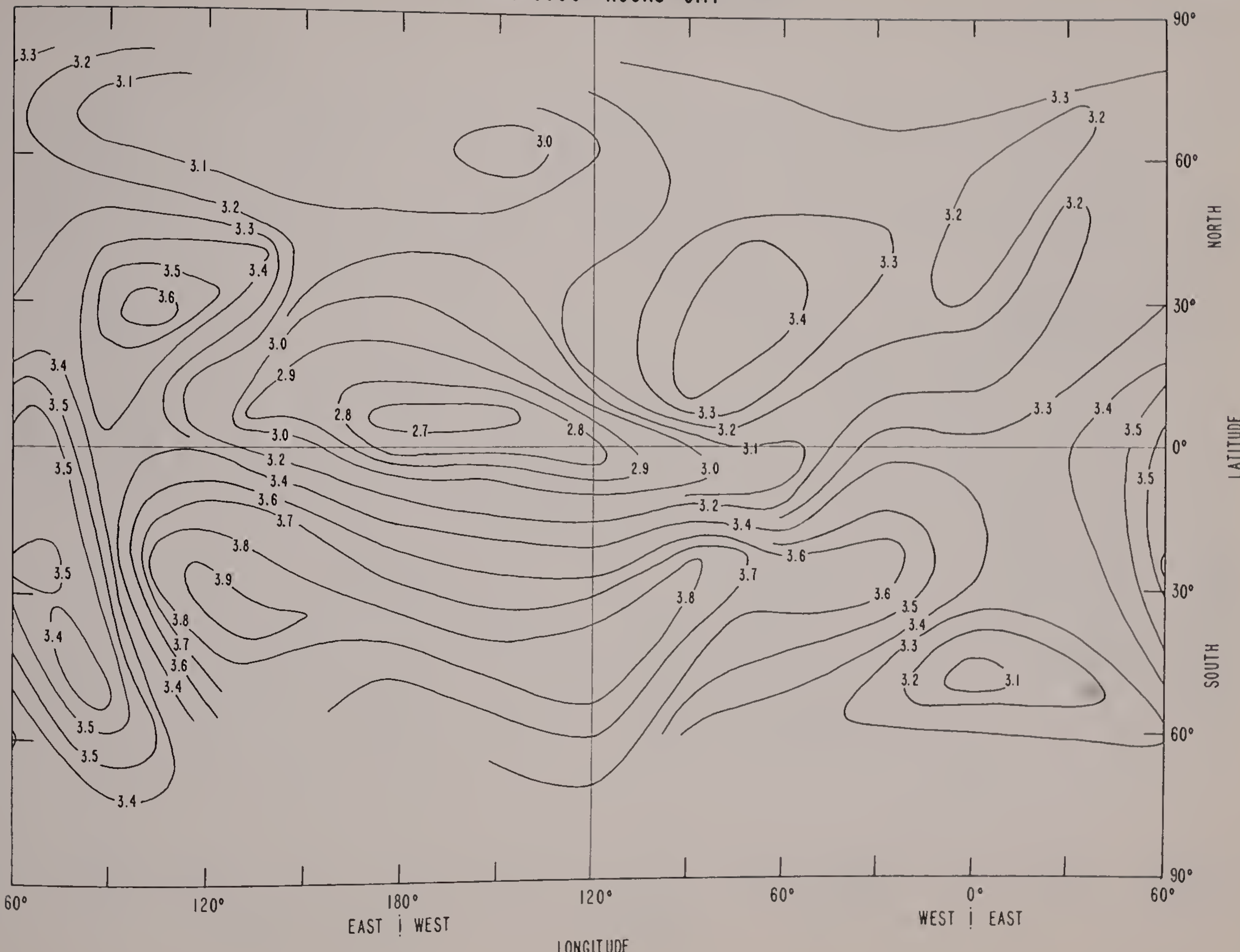
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 2000 HOURS GMT



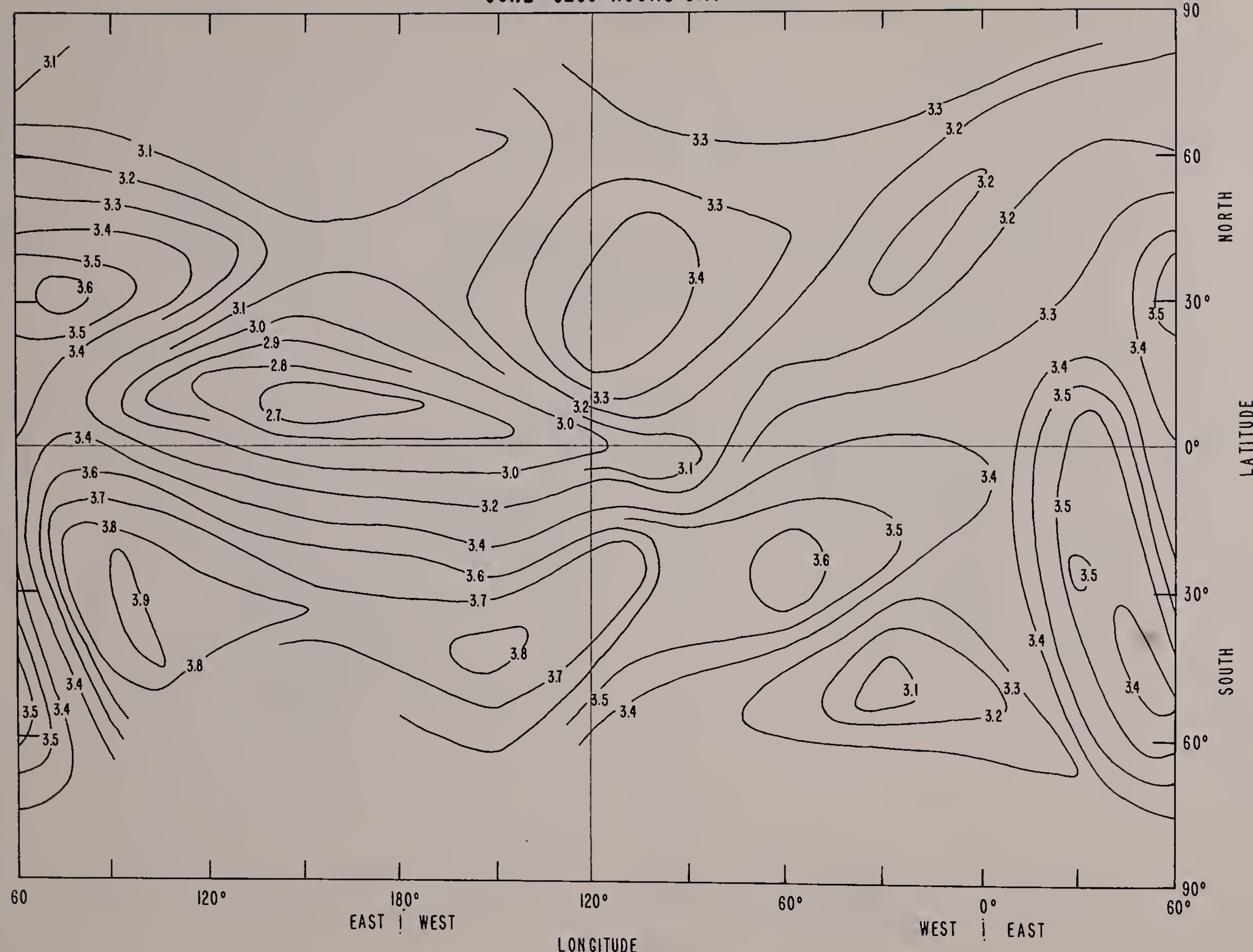
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JUNE 2200 HOURS GMT



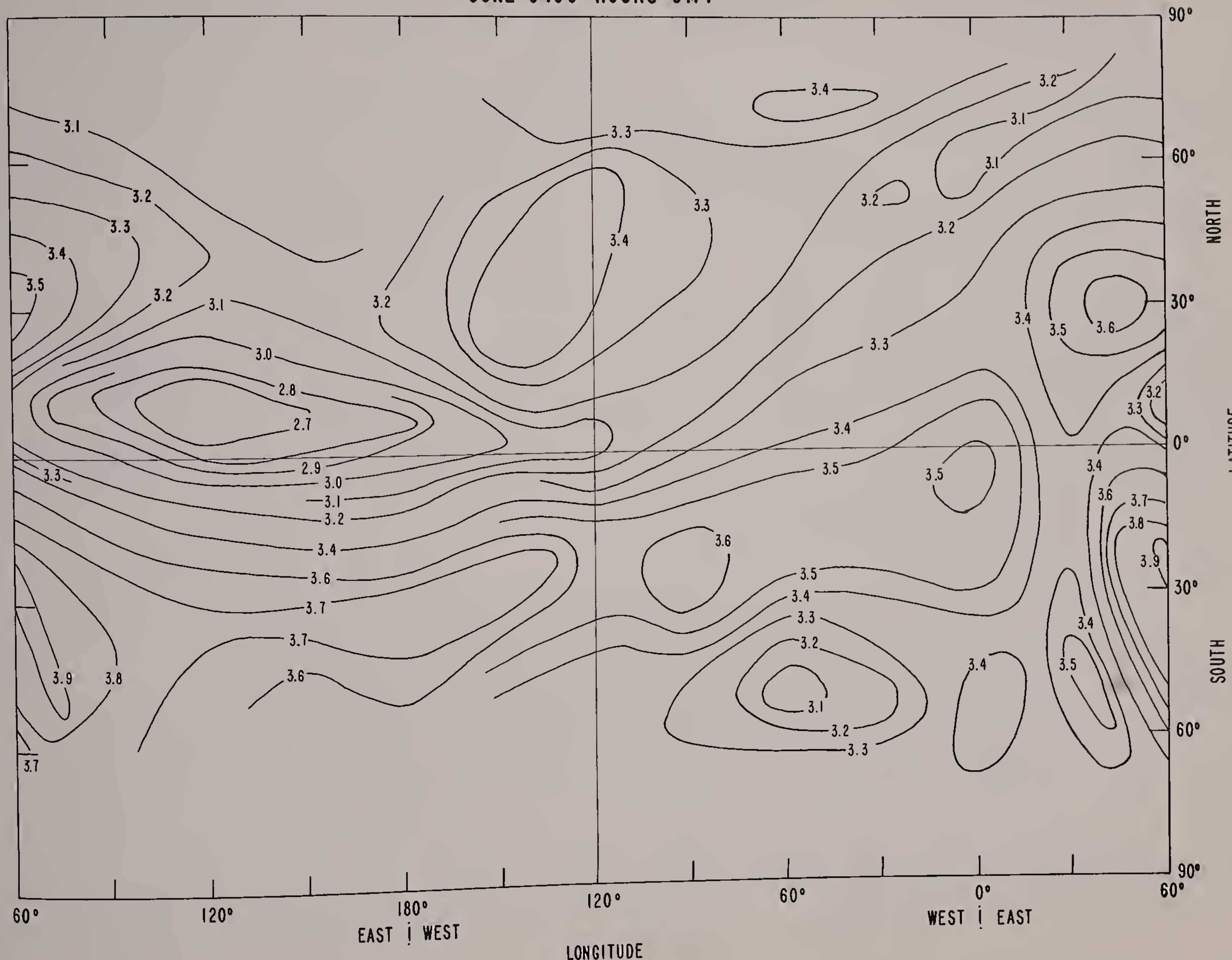
M-4000 FACTOR AT RASSN 50
JUNE 0000 HOURS GMT



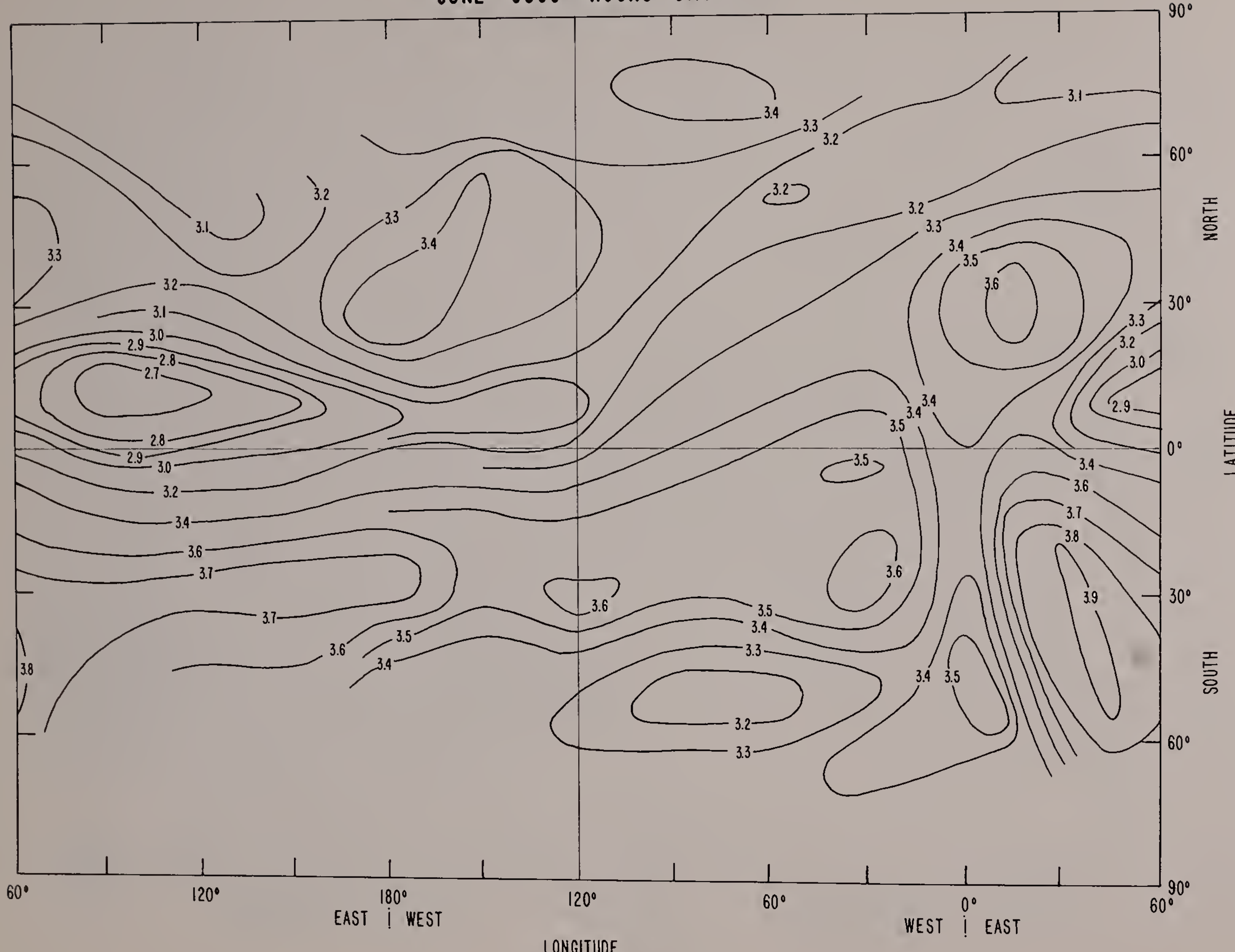
M-4000 FACTOR AT RASSN 50
JUNE 0200 HOURS GMT



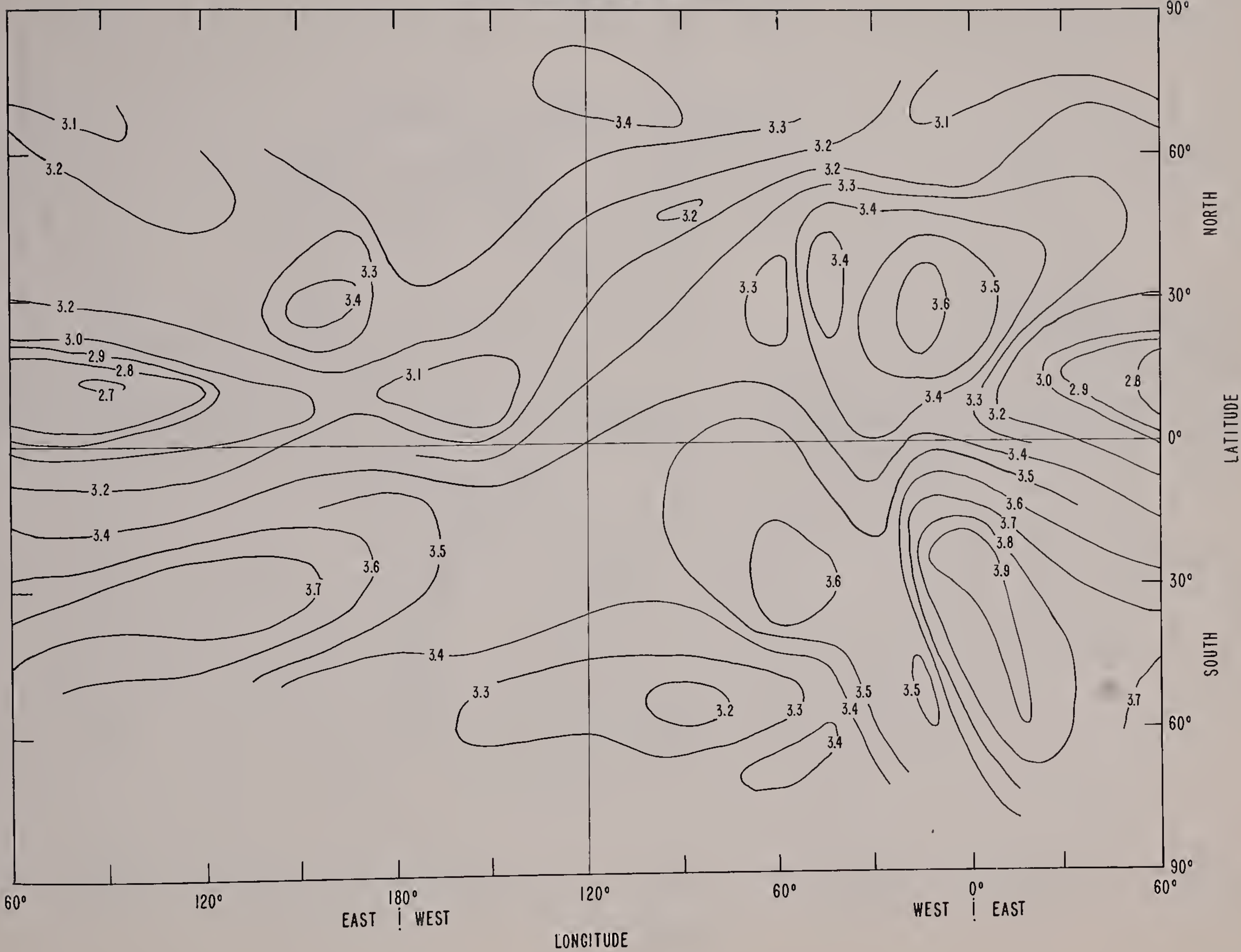
M-4000 FACTOR AT RASSN 50
JUNE 0400 HOURS GMT



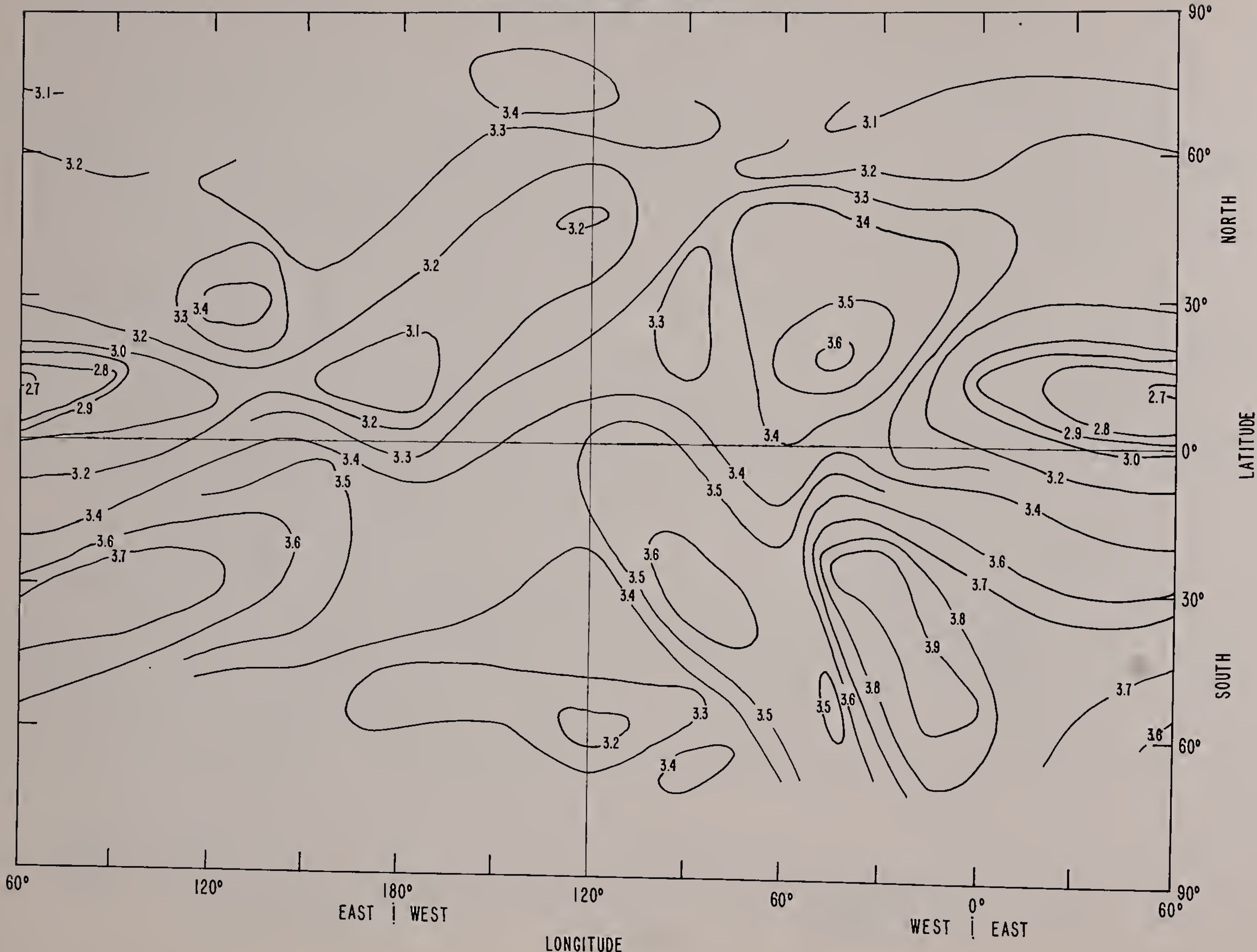
M-4000 FACTOR AT RASSN 50
JUNE 0600 HOURS GMT



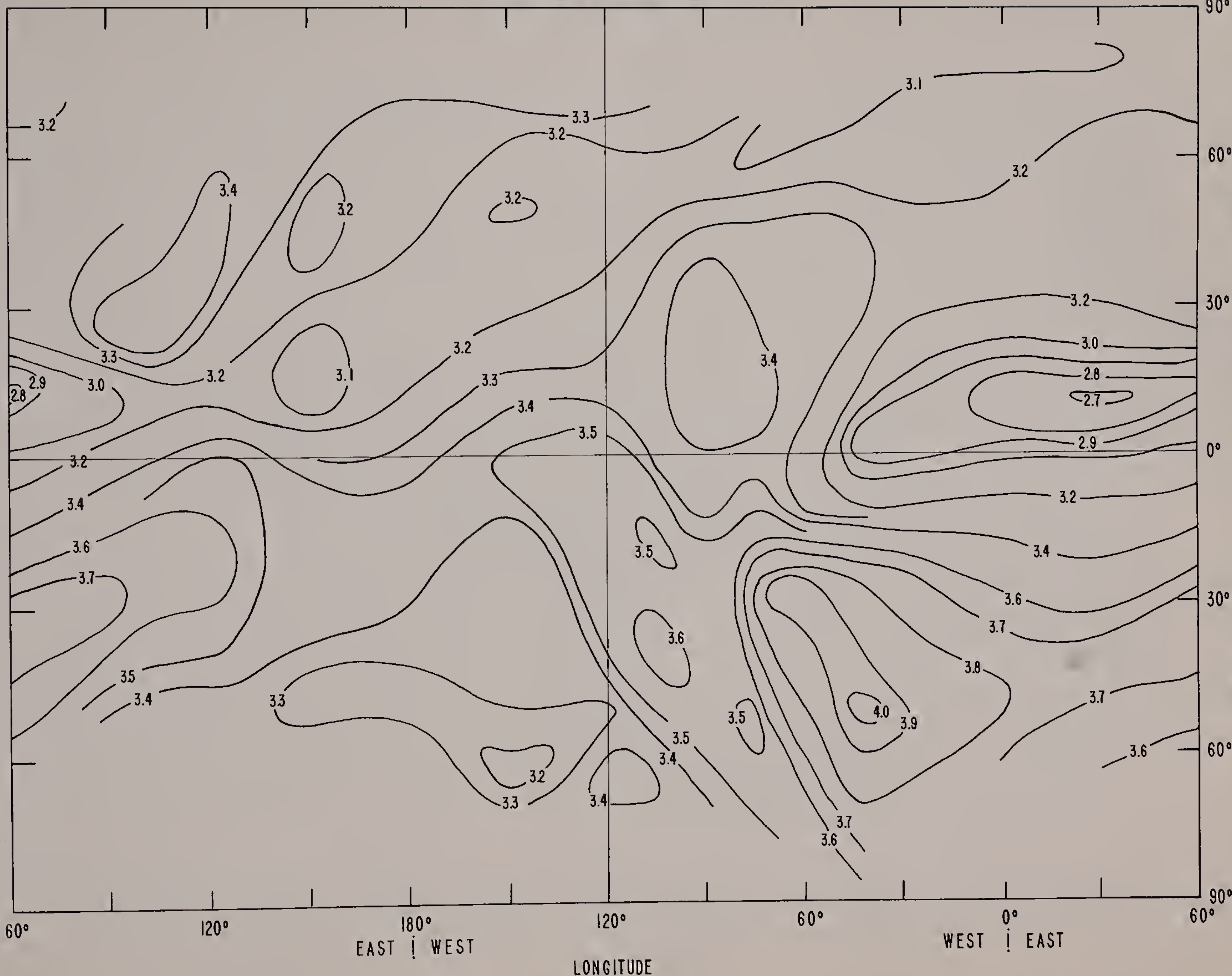
M-4000 FACTOR AT RASSN 50
JUNE 0800 HOURS GMT



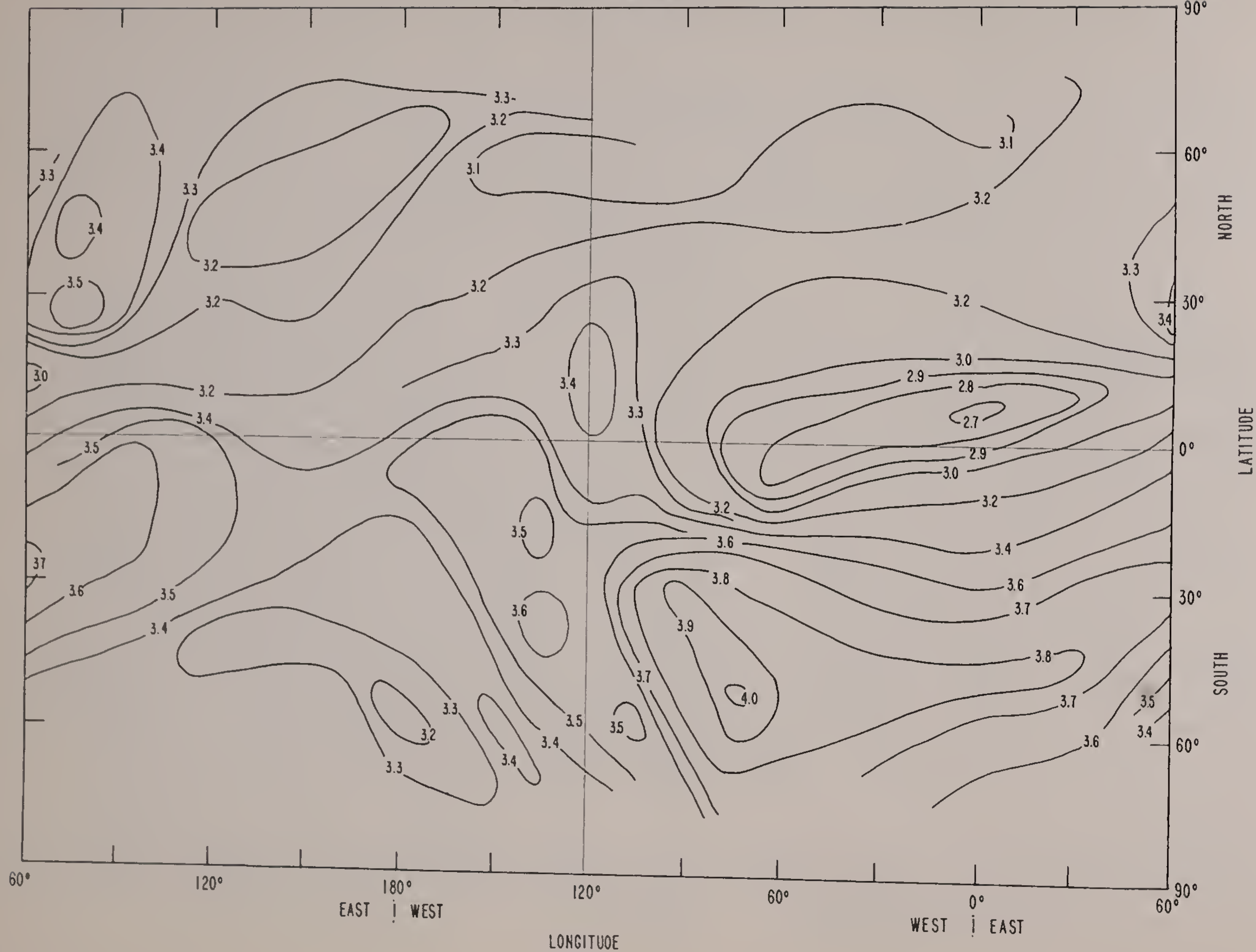
M-4000 FACTOR AT RASSN 50
JUNE 1000 HOURS GMT



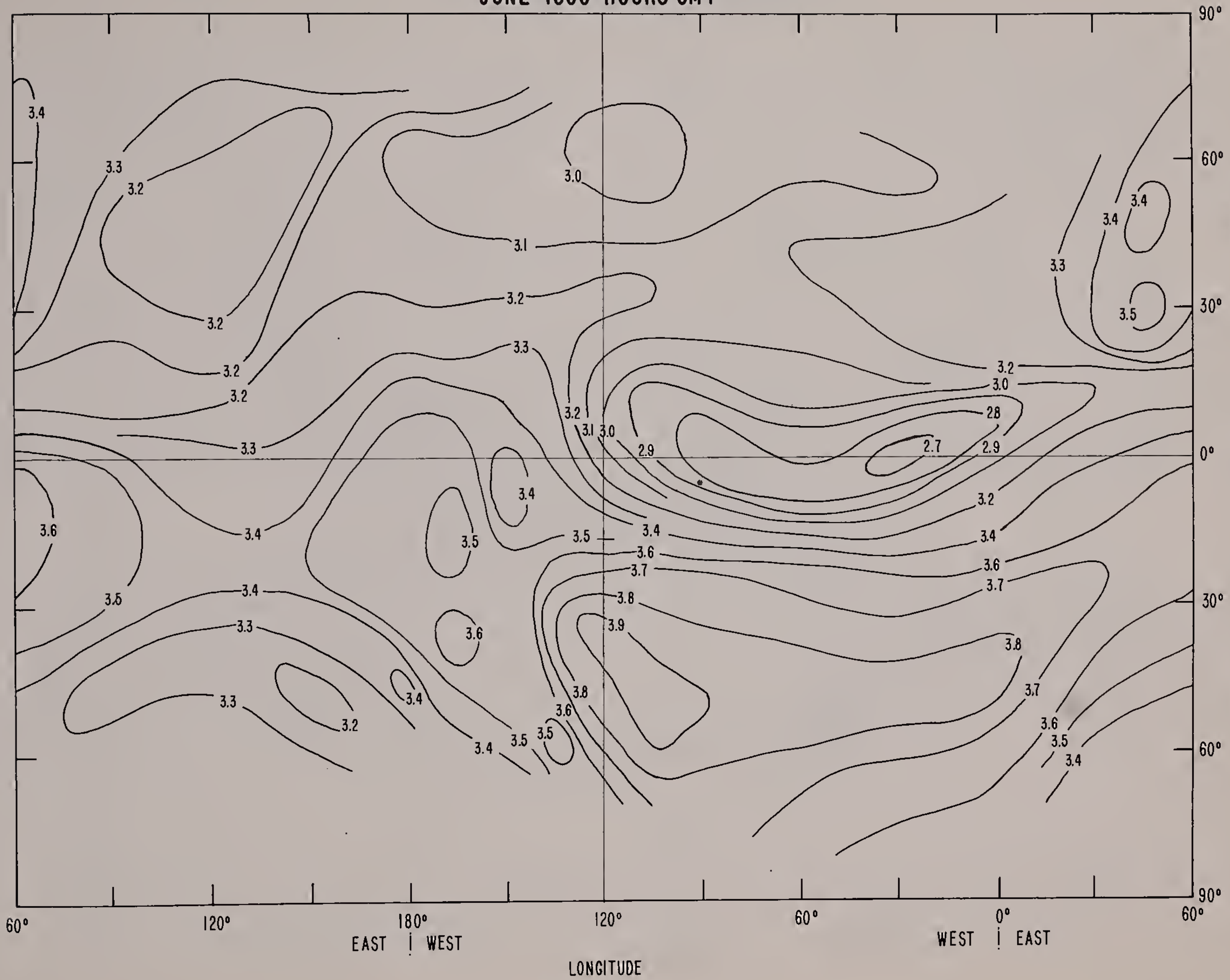
M-4000 FACTOR AT RASSN 50
JUNE 1200 HOURS GMT



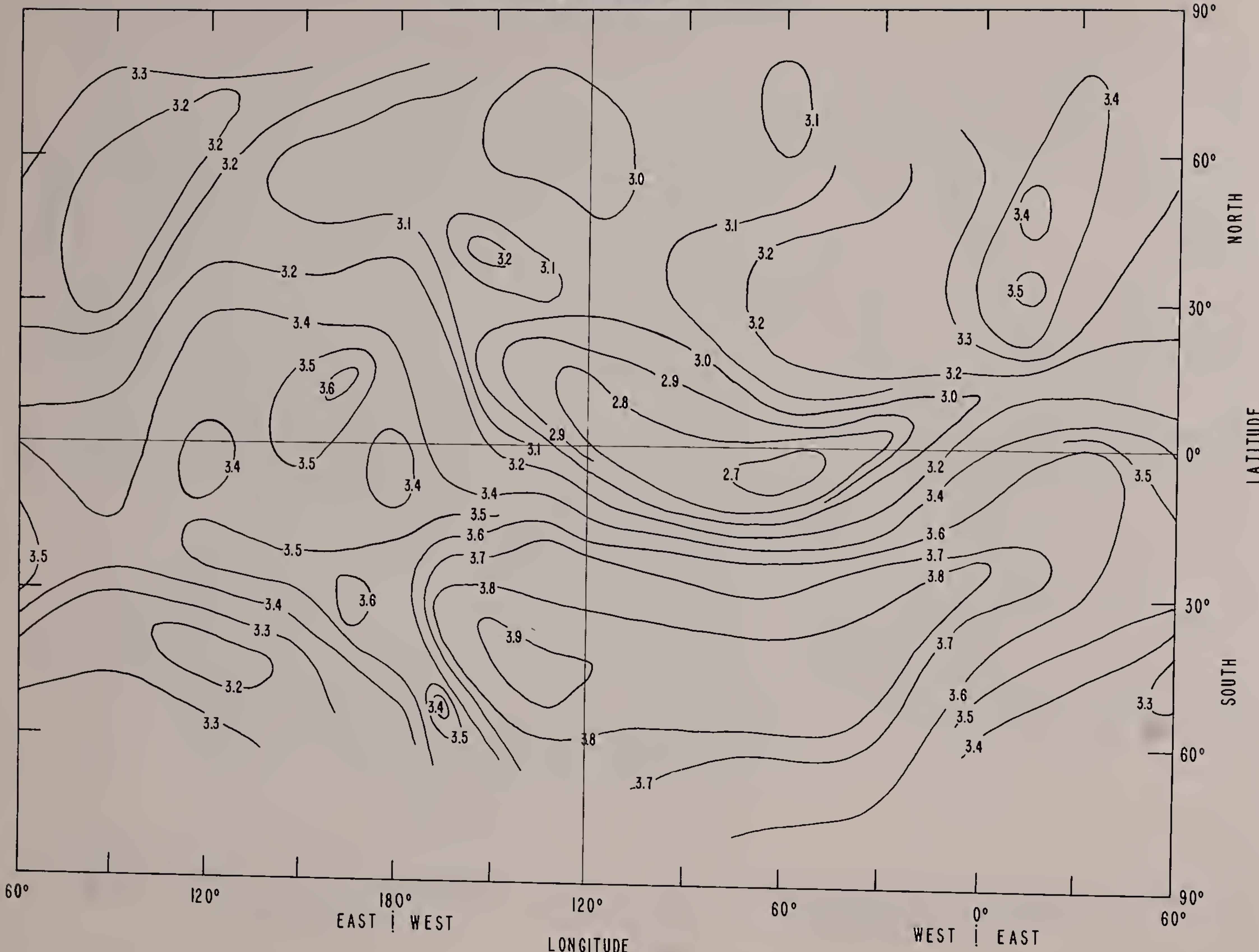
M-4000 FACTOR AT RASSN 50
JUNE 1400 HOURS GMT



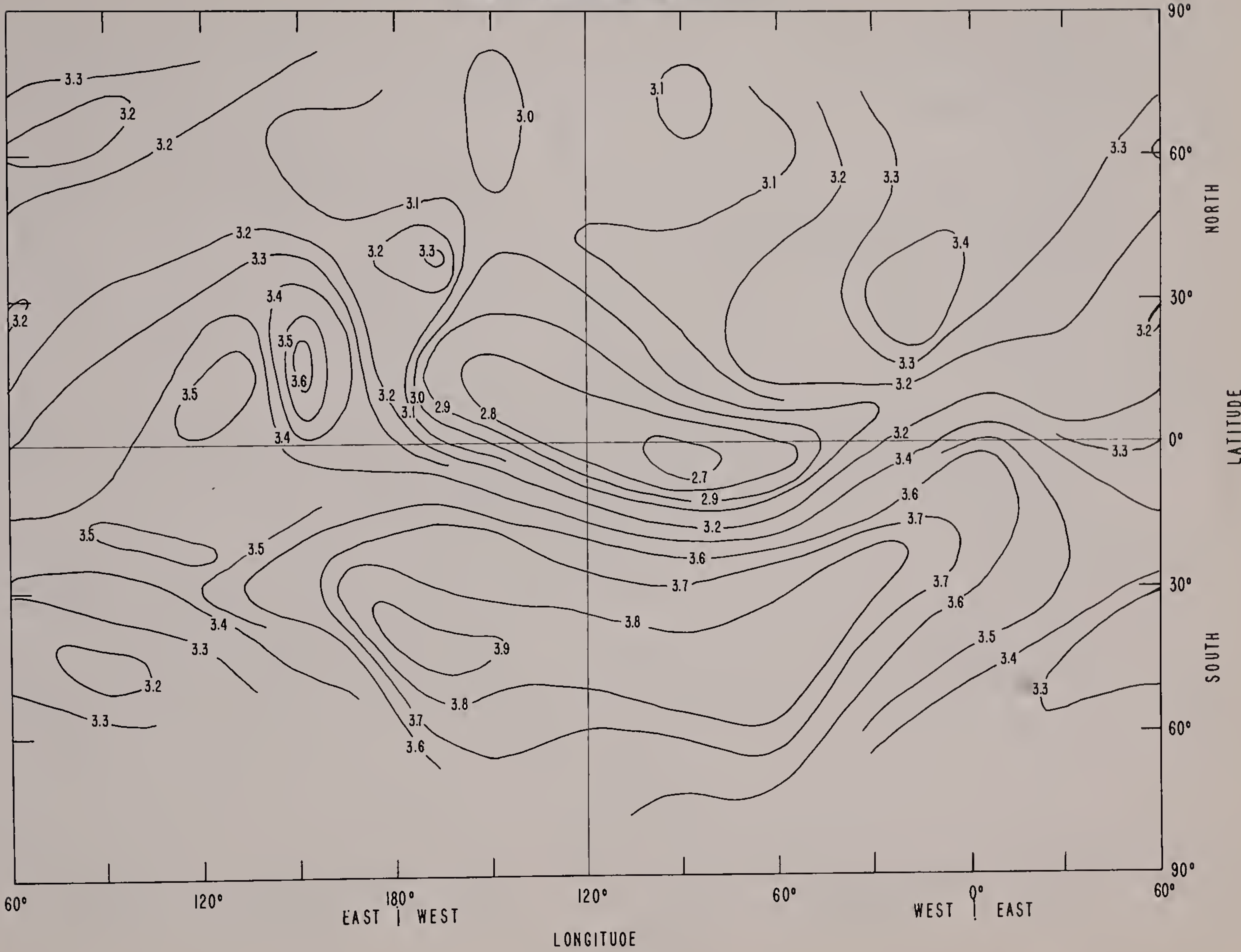
M-4000 FACTOR AT RASSN 50
JUNE 1600 HOURS GMT



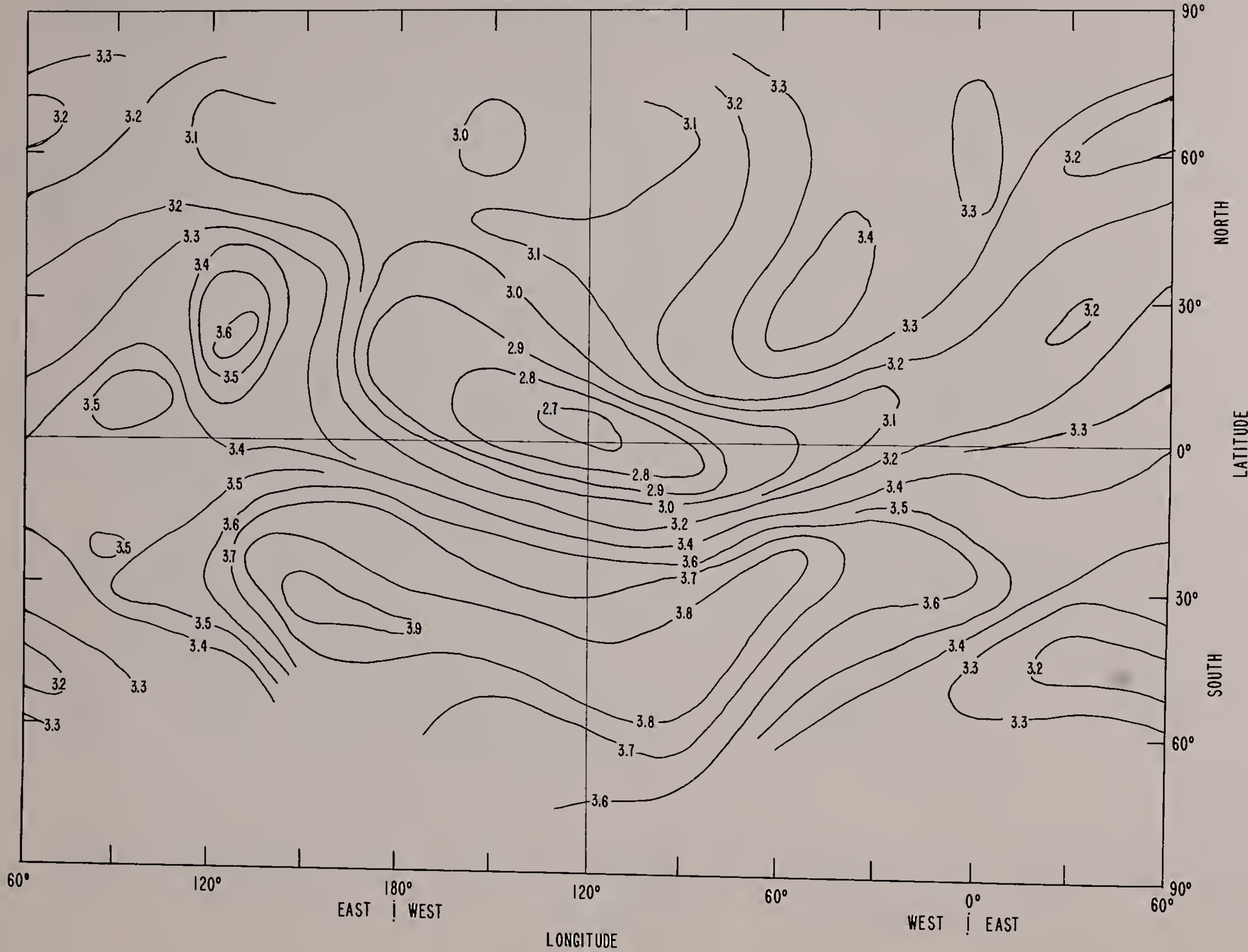
M-4000 FACTOR AT RASSN 50
JUNE 1800 HOURS GMT



M-4000 FACTOR AT RASSN 50
JUNE 2000 HOURS GMT

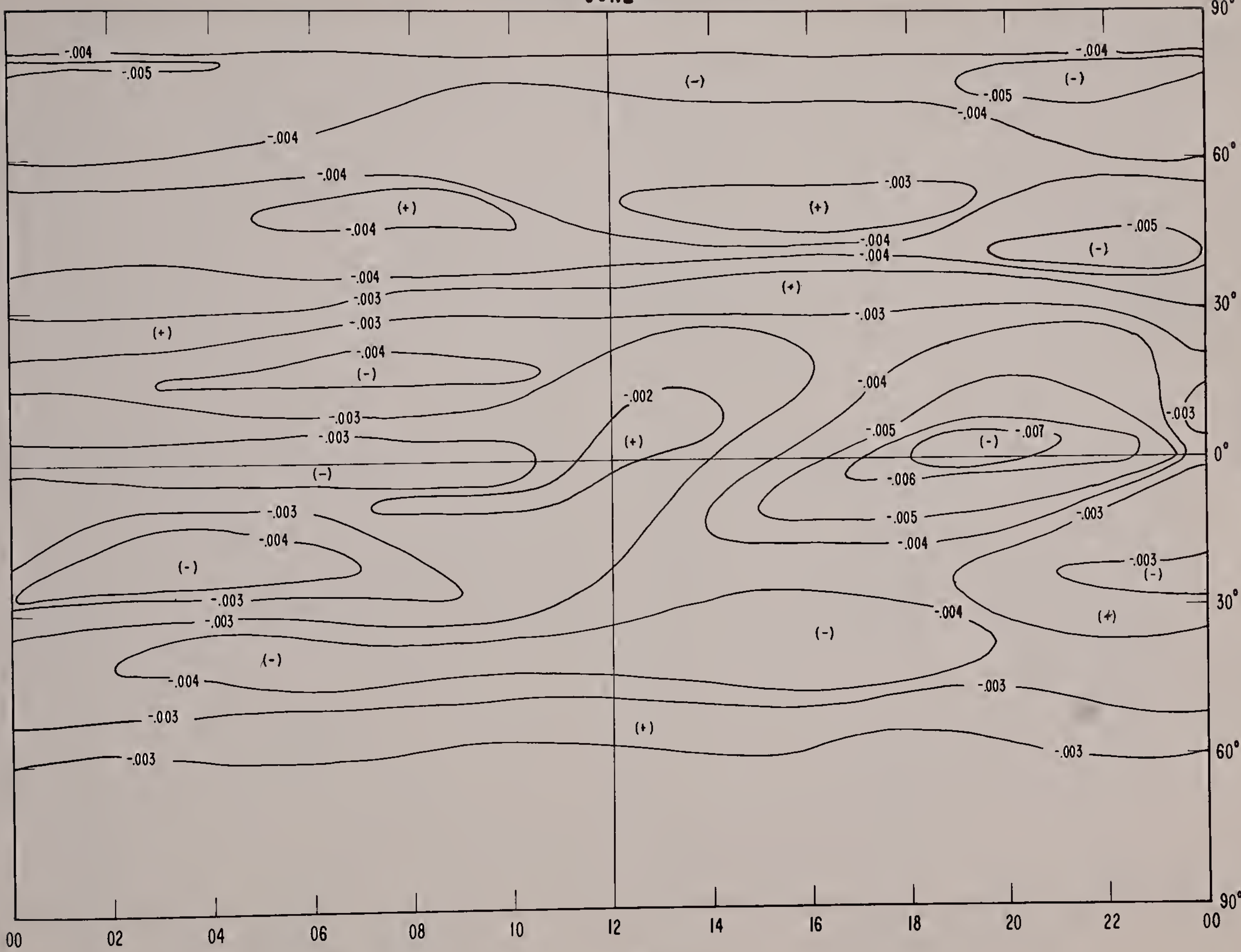


M-4000 FACTOR AT RASSN 50
JUNE 2200 HOURS GMT

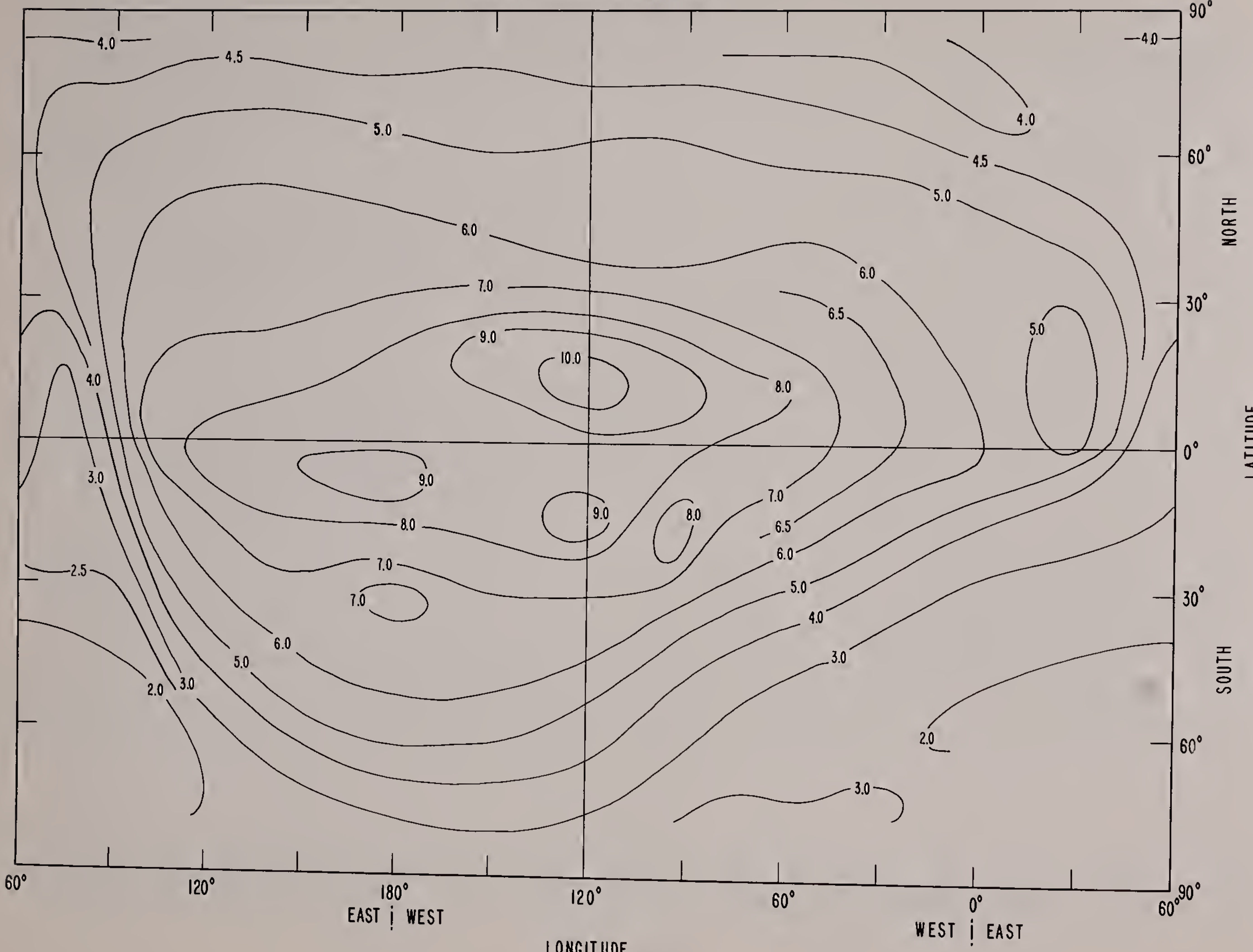


SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN

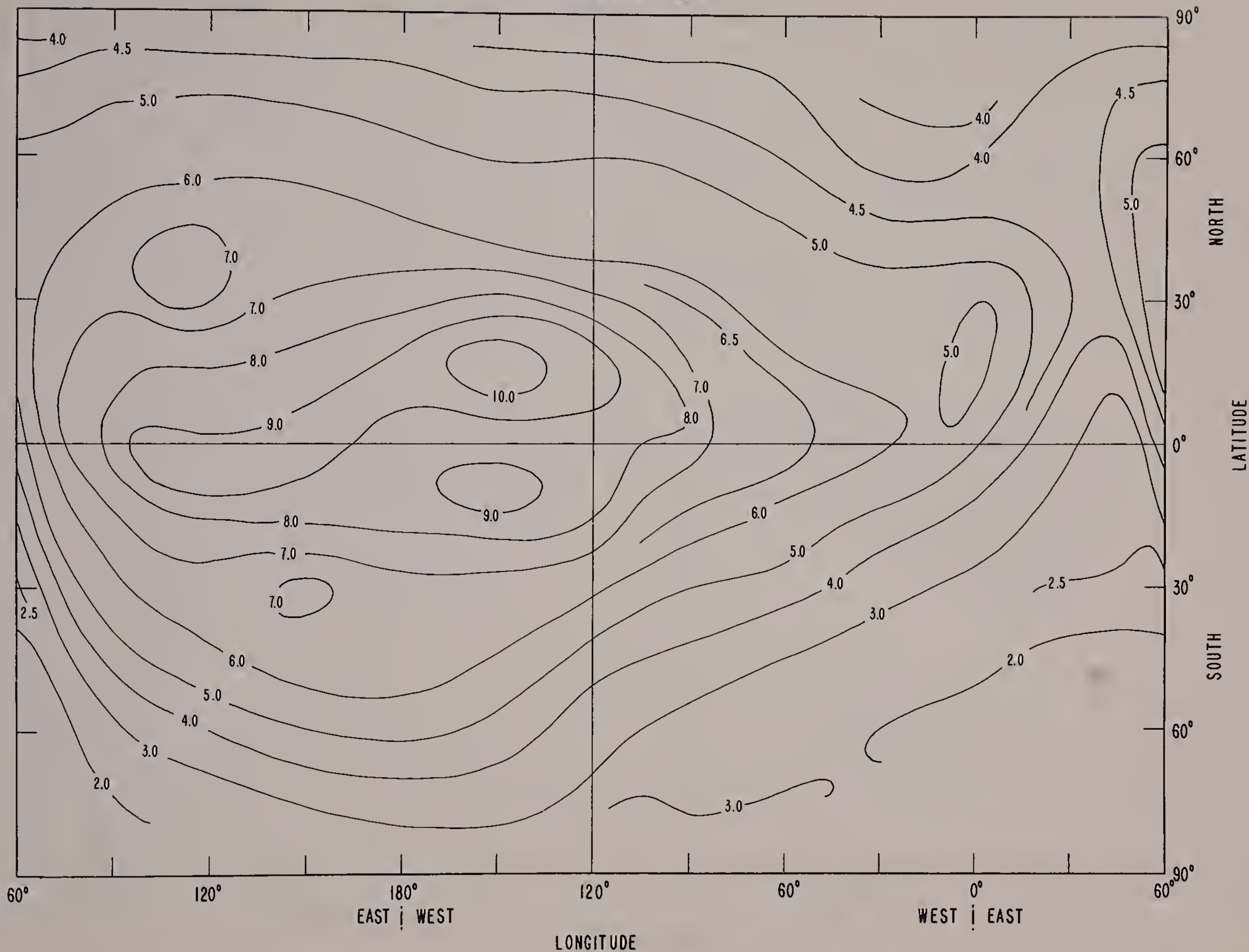
JUNE



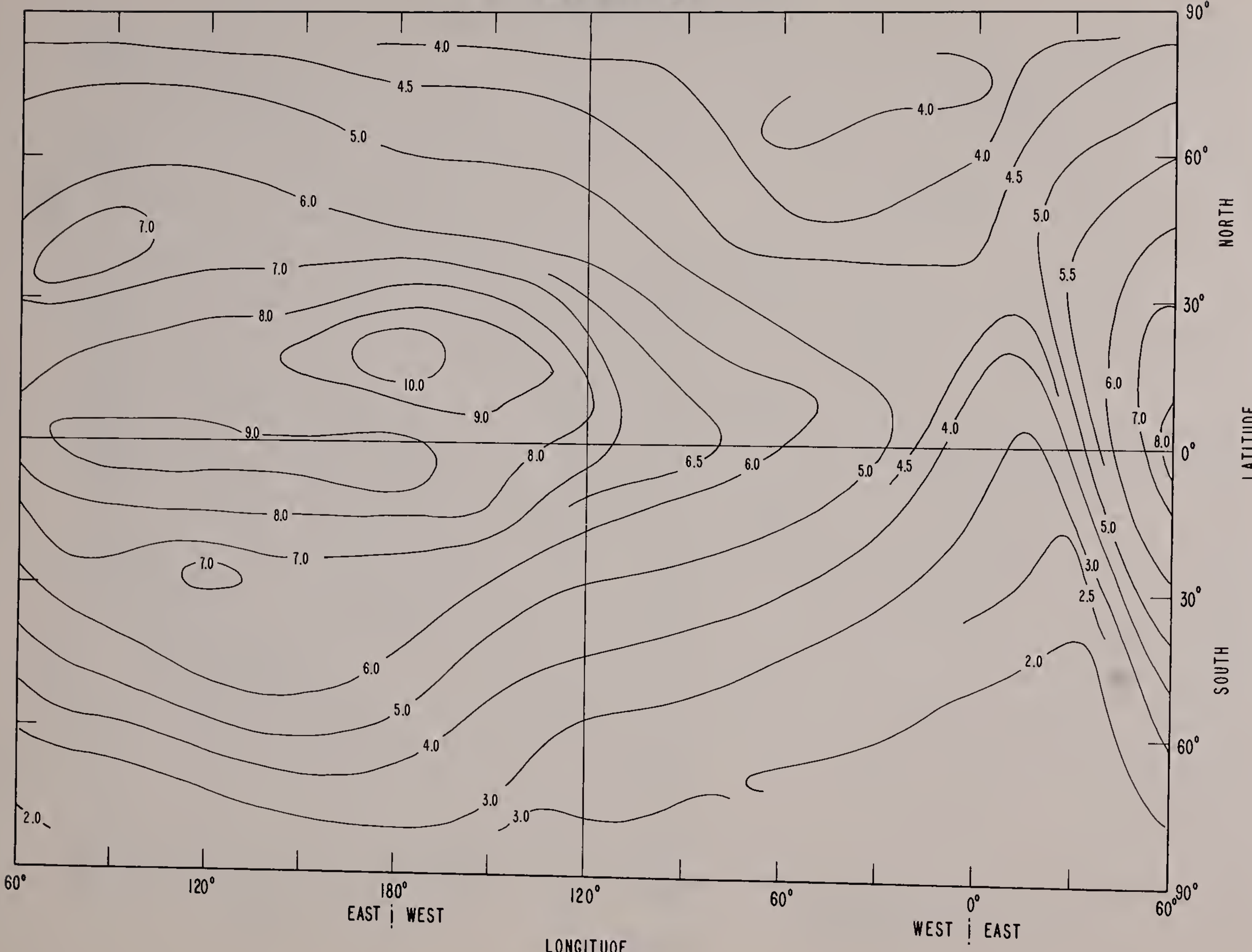
foF2 AT RASSN 50
JULY 0000 HOURS GMT



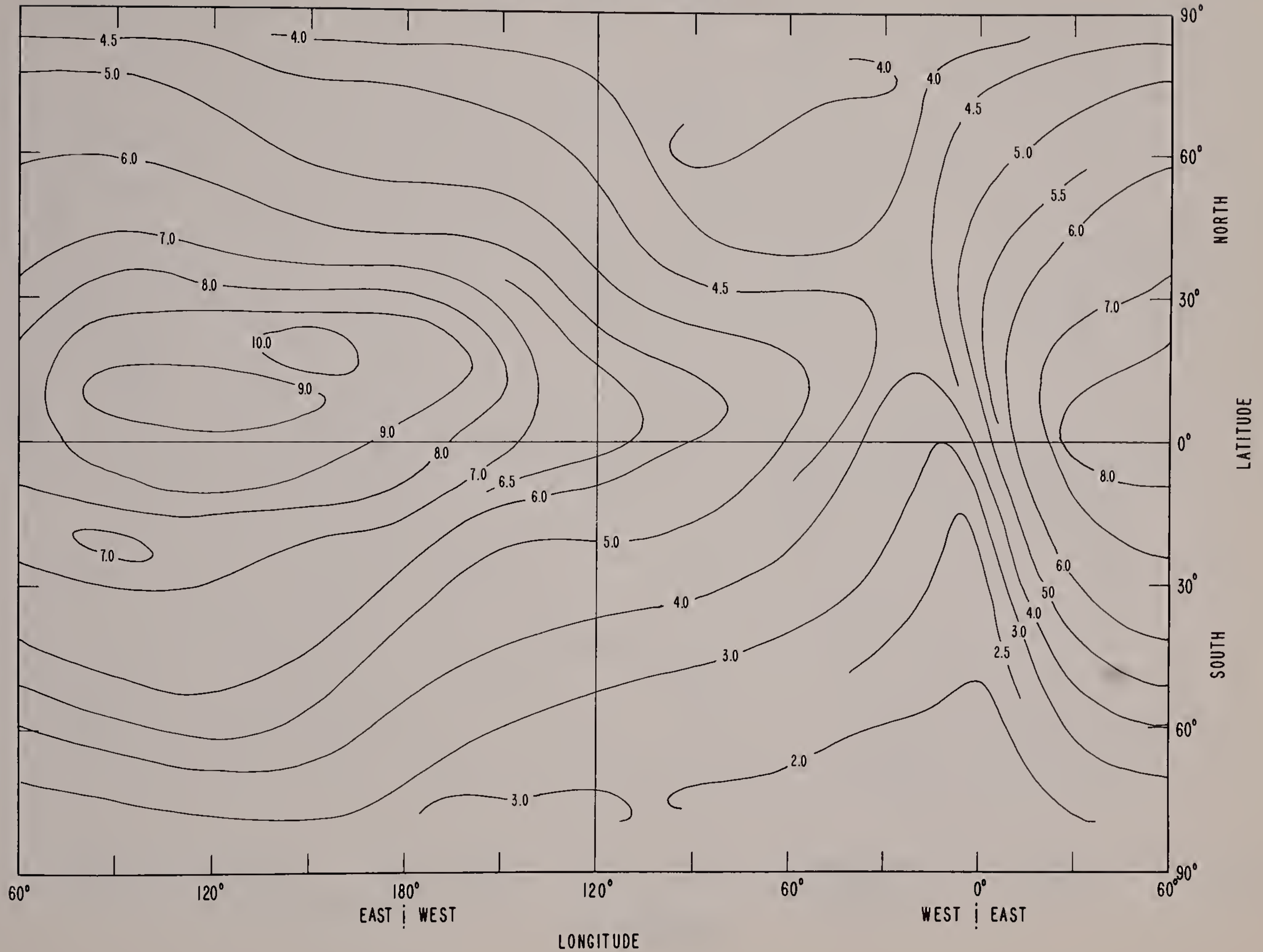
foF2 AT RASSN 50
JULY 0200 HOURS GMT



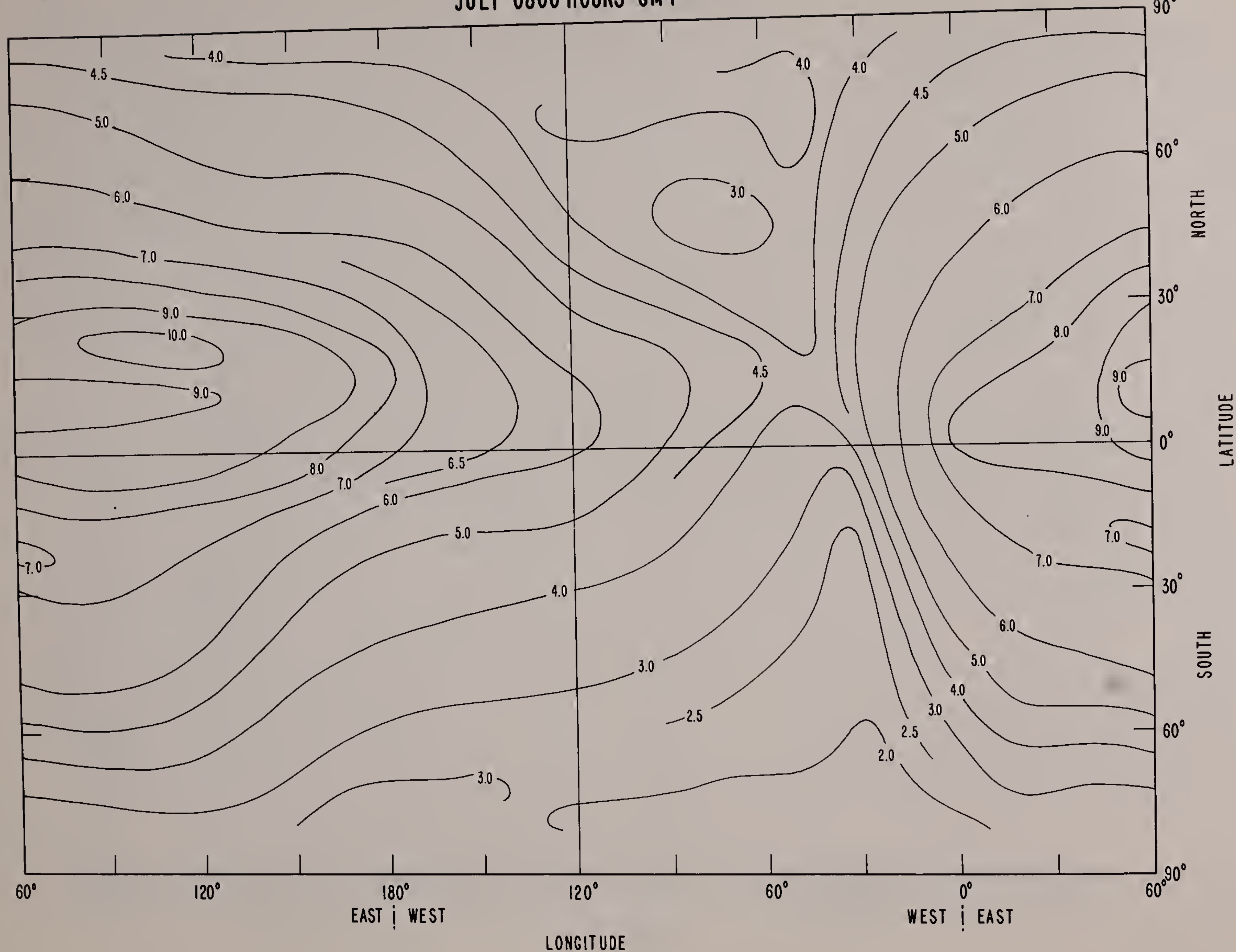
foF2 AT RASSN 50
JULY 0400 HOURS GMT



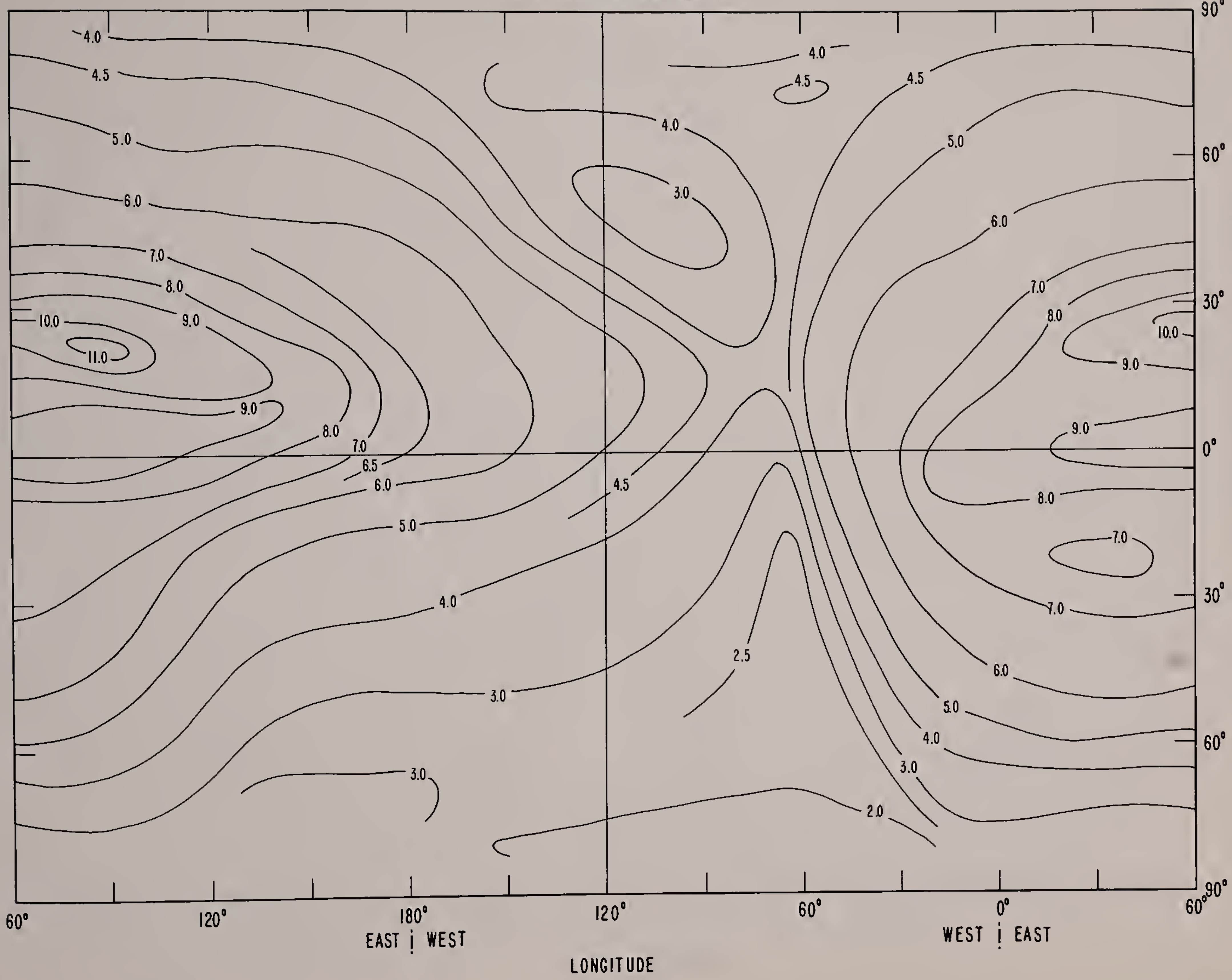
foF2 AT RASSN 50
JULY 0600 HOURS GMT

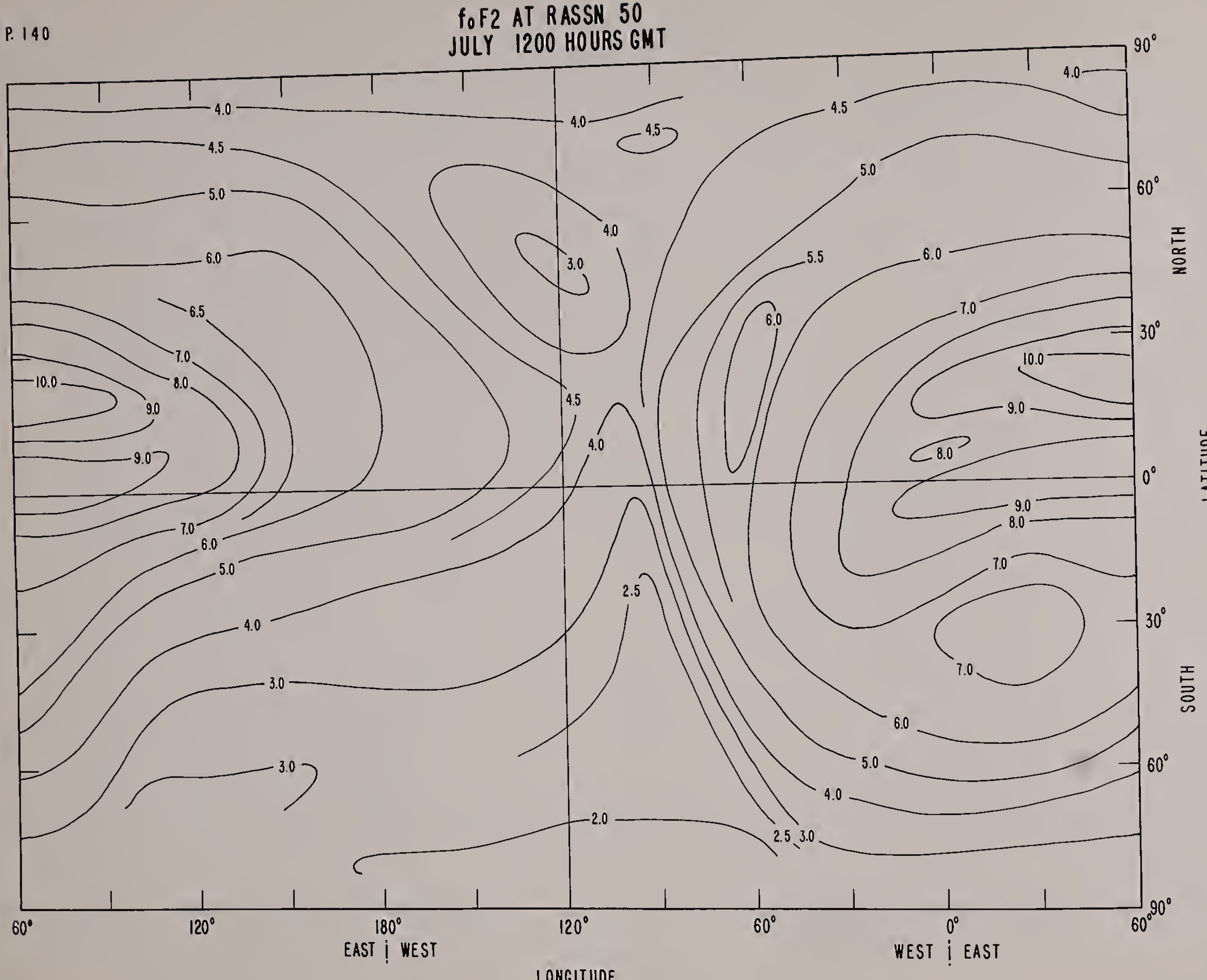


foF2 AT RASSN 50
JULY 0800 HOURS GMT



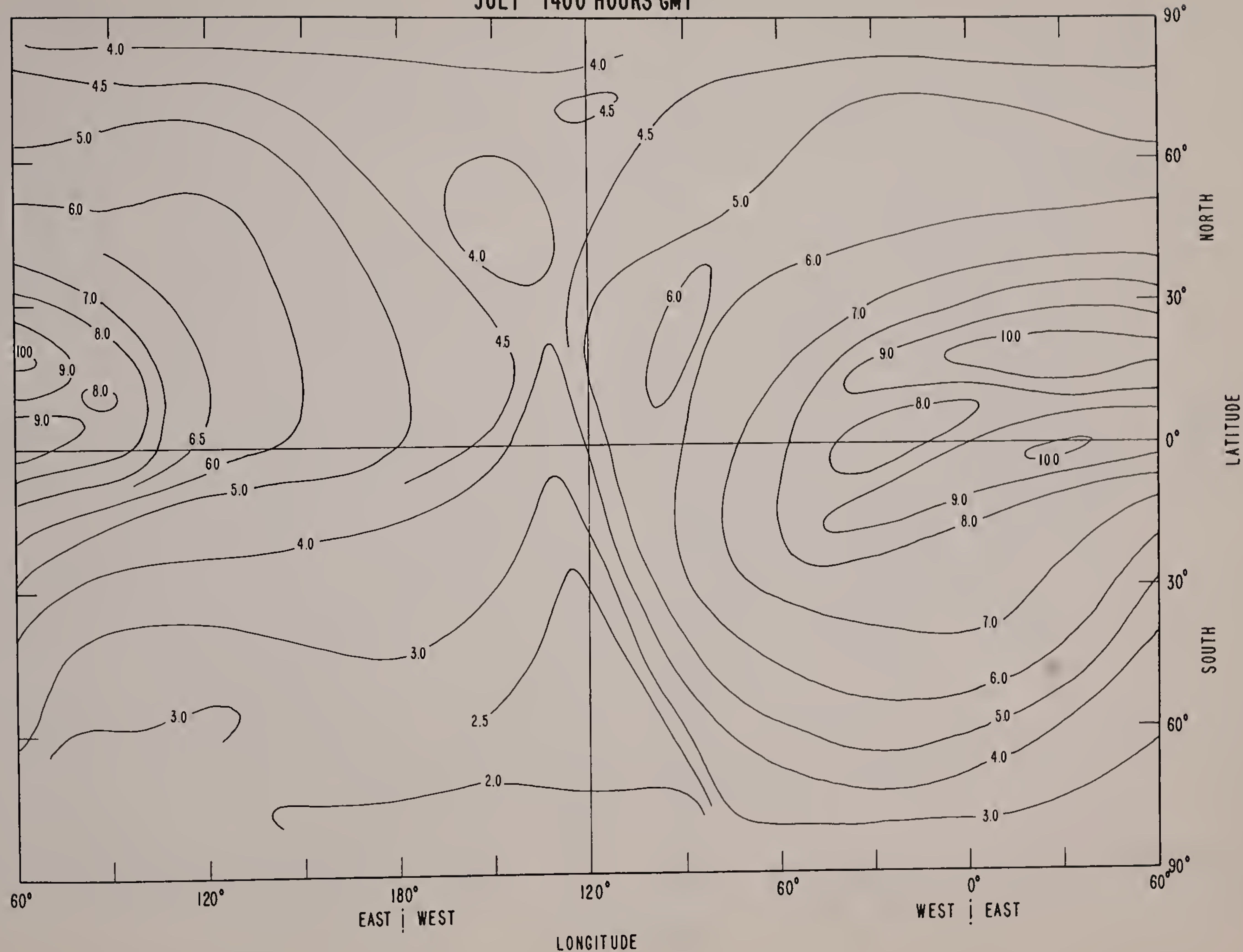
foF2 AT RASSN 50
JULY 1000 HOURS GMT



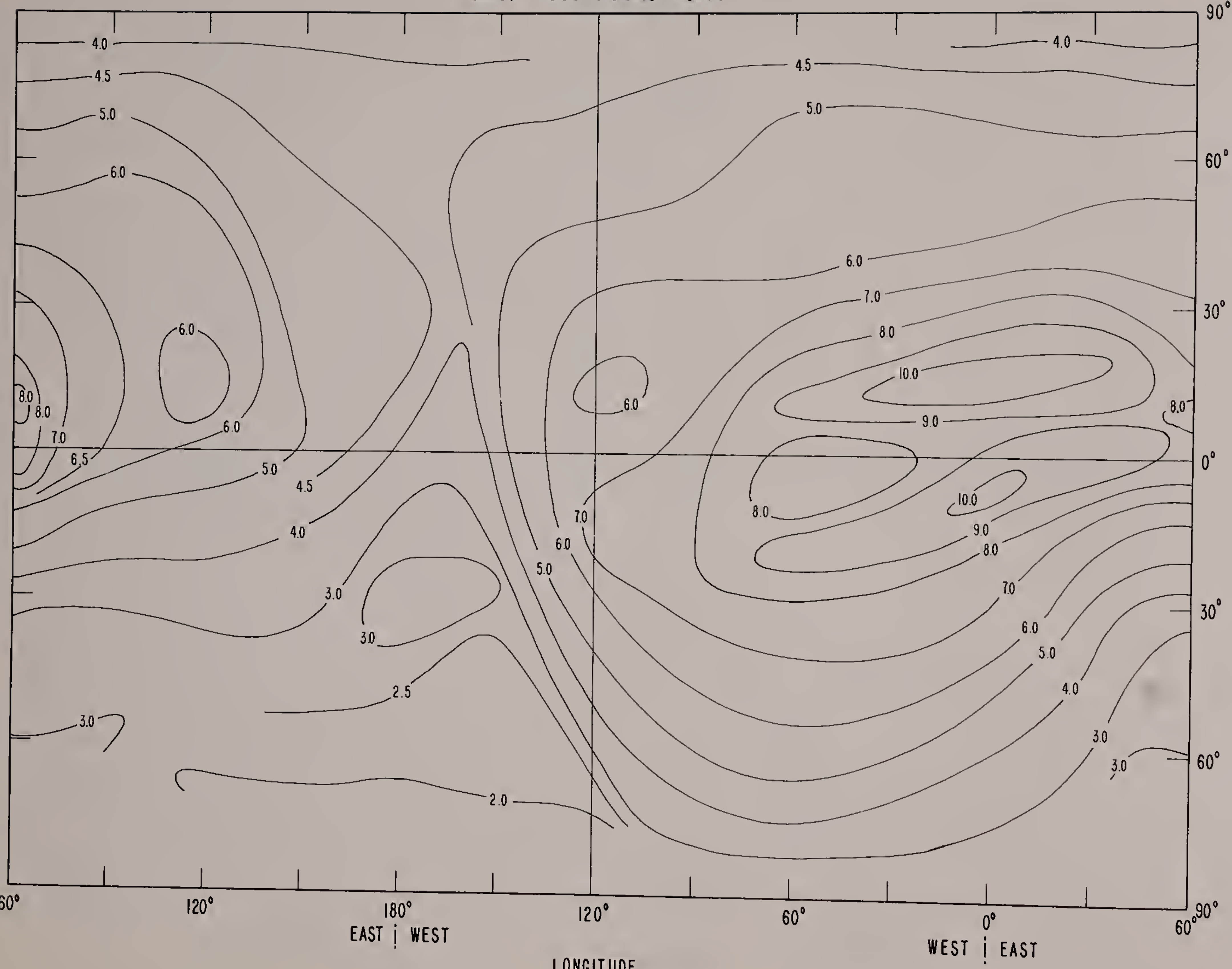


foF2 AT RASSN 50
JULY 1200 HOURS GMT
4.0
4.5
5.0
5.5
6.0
6.5
7.0
8.0
9.0
10.0
3.0
2.5
2.0
90°
60°
30°
0°
30°
60°
90°
NORTH
LATITUDE
SOUTH
60°
120°
180°
120°
60°
0°
60°
EAST | WEST
WEST | EAST
LONGITUDE

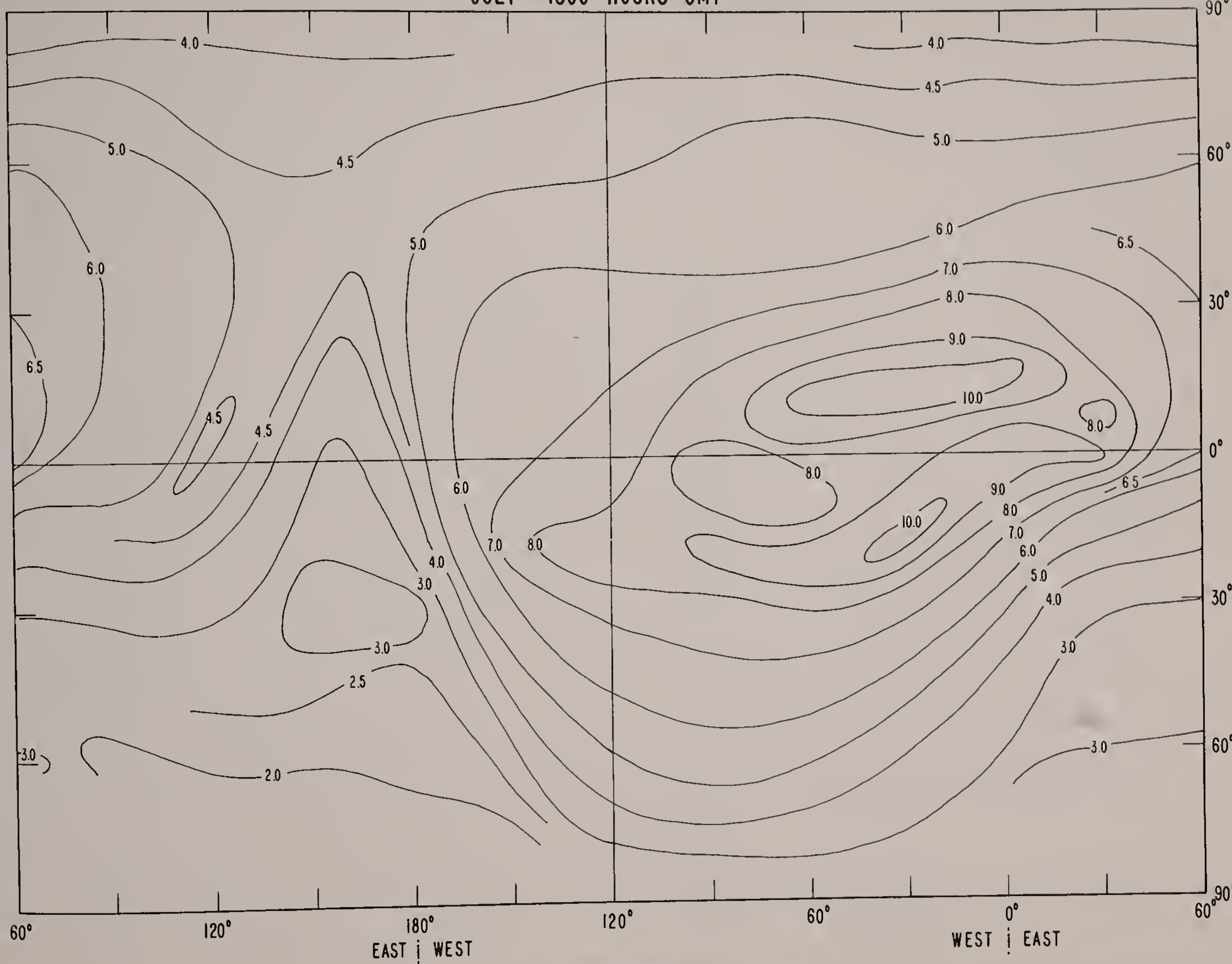
foF2 AT RASSN 50
JULY 1400 HOURS GMT

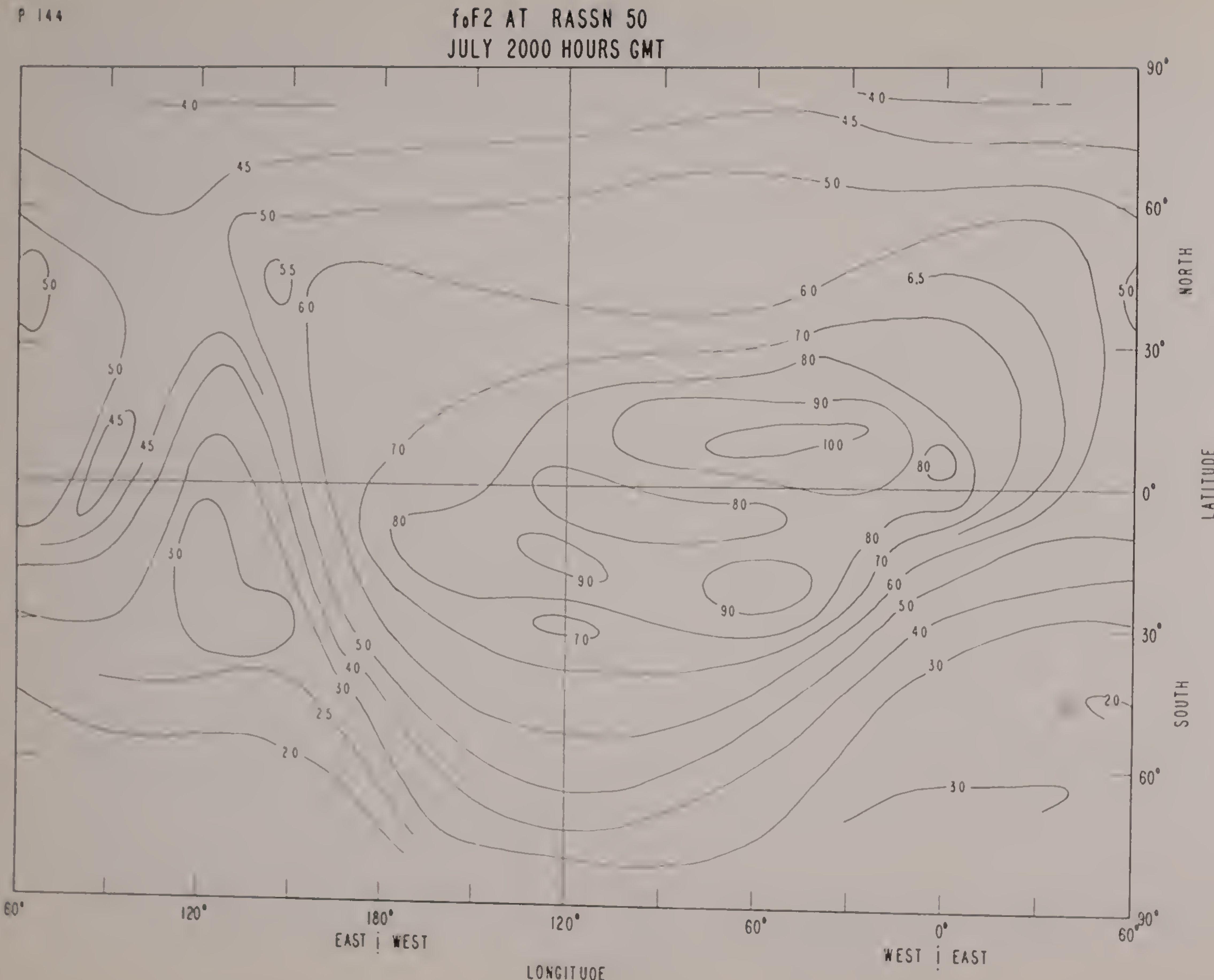


foF2 AT RASSN 50
JULY 1600 HOURS GMT

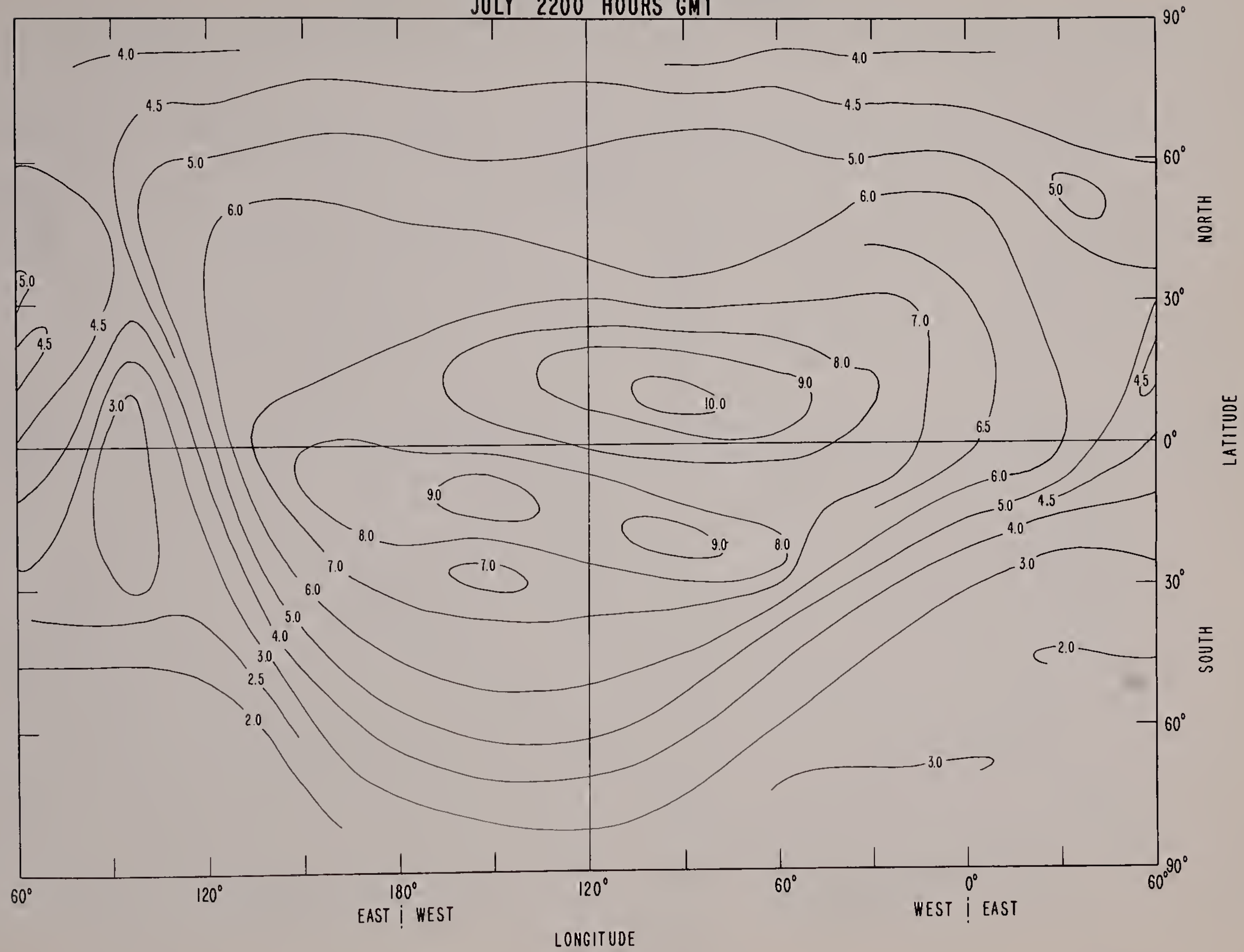


foF2 AT RASSN 50
JULY 1800 HOURS GMT

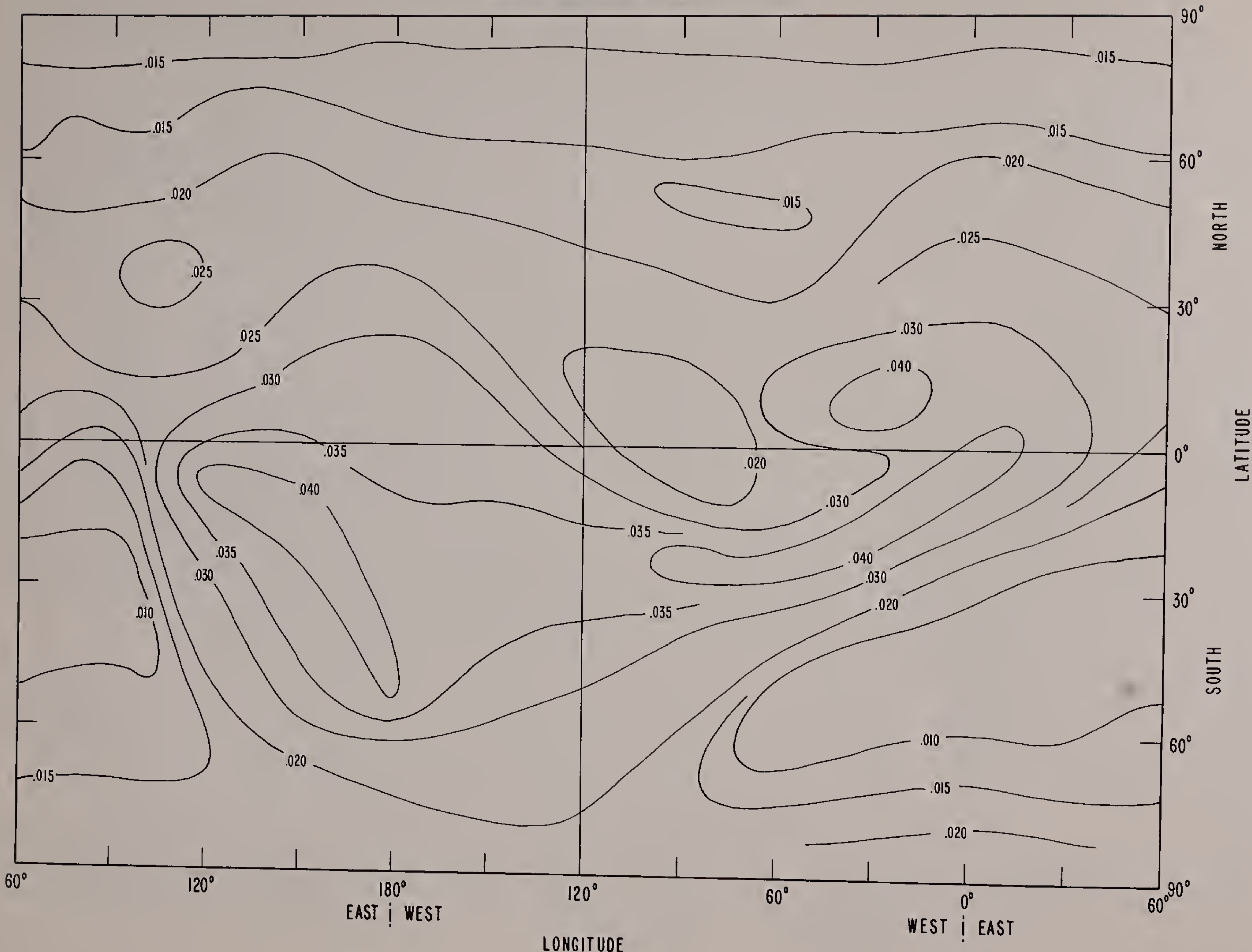



foF2 AT RASSN 50
JULY 2000 HOURS GMT
90°
60°
30°
0°
30°
60°
90°
NORTH
LATITUDE
SOUTH
60°
120°
180°
EAST | WEST
120°
60°
0°
WEST | EAST
60°
LONGITUDE
40
45
50
55
60
6.5
70
80
90
100
30
25
20

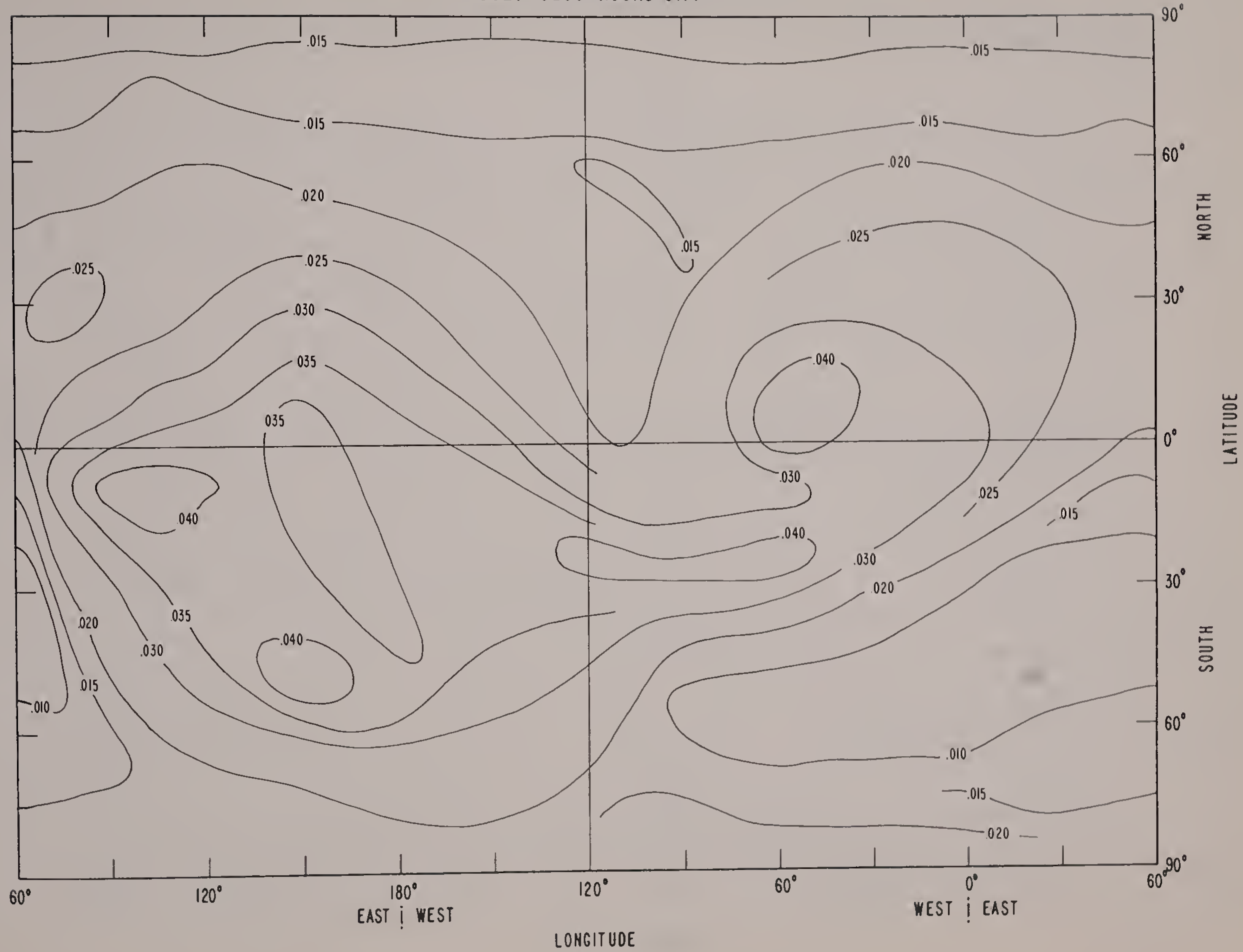
f_oF2 AT RASSN 50
JULY 2200 HOURS GMT



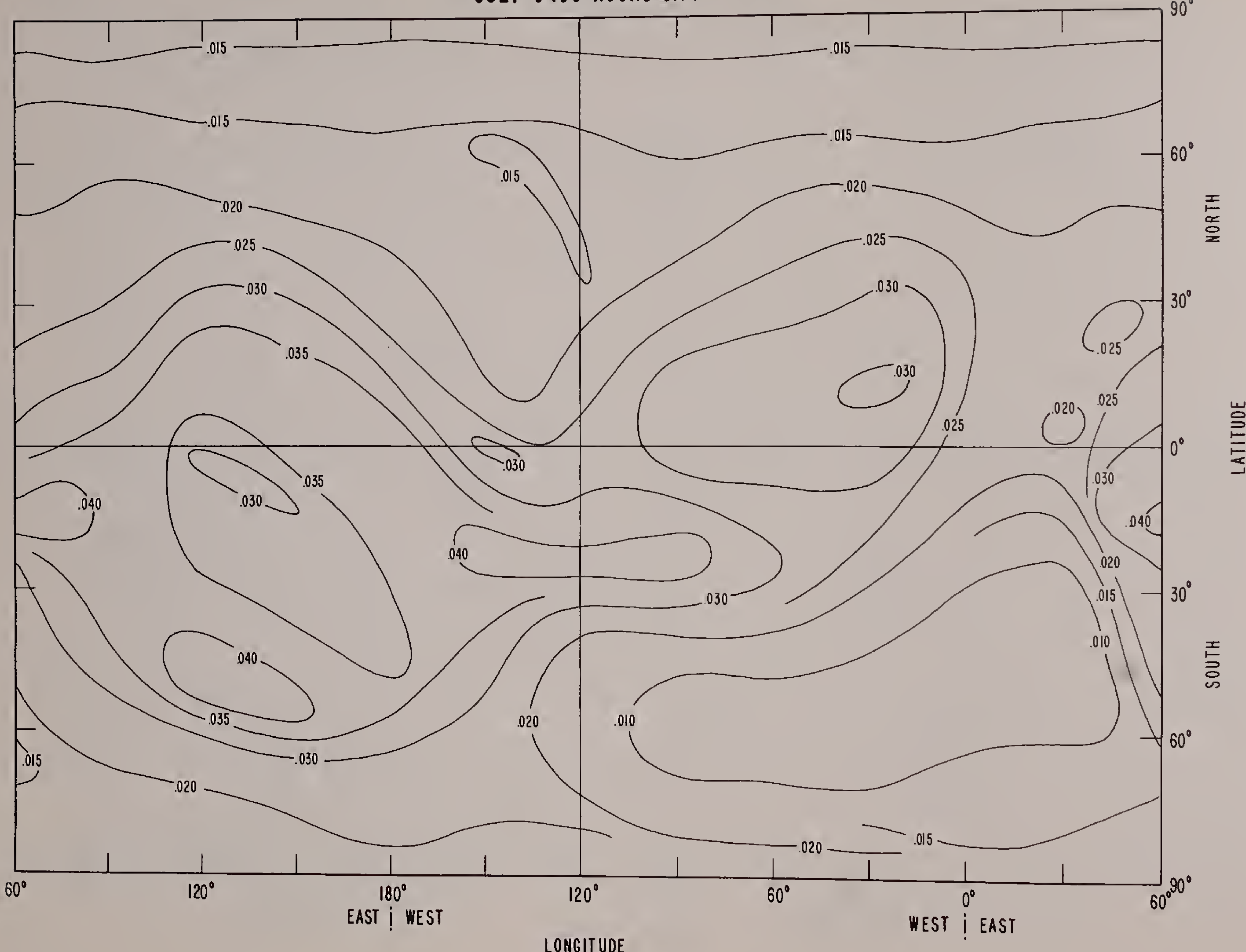
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 0000 HOURS GMT



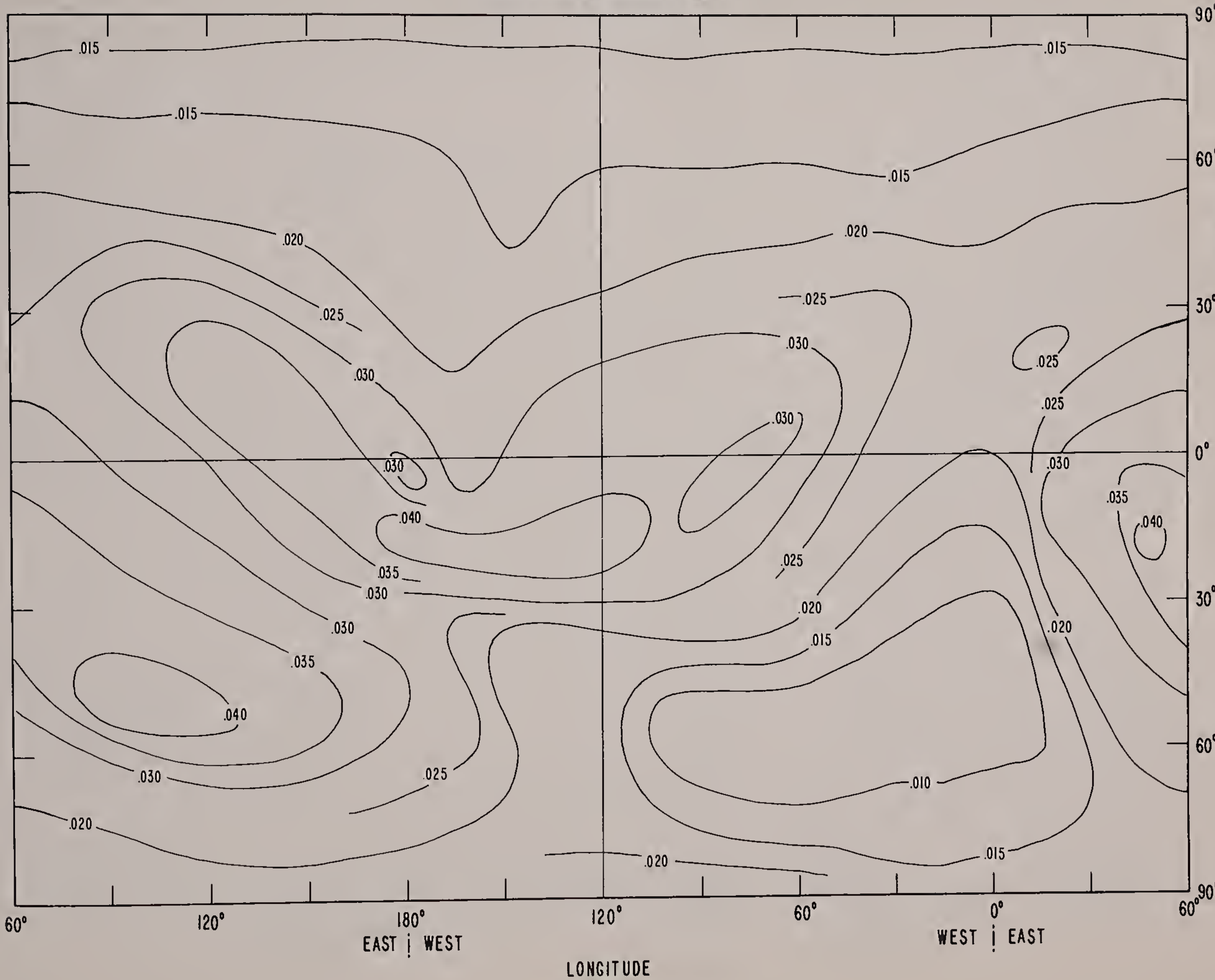
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 0200 HOURS GMT



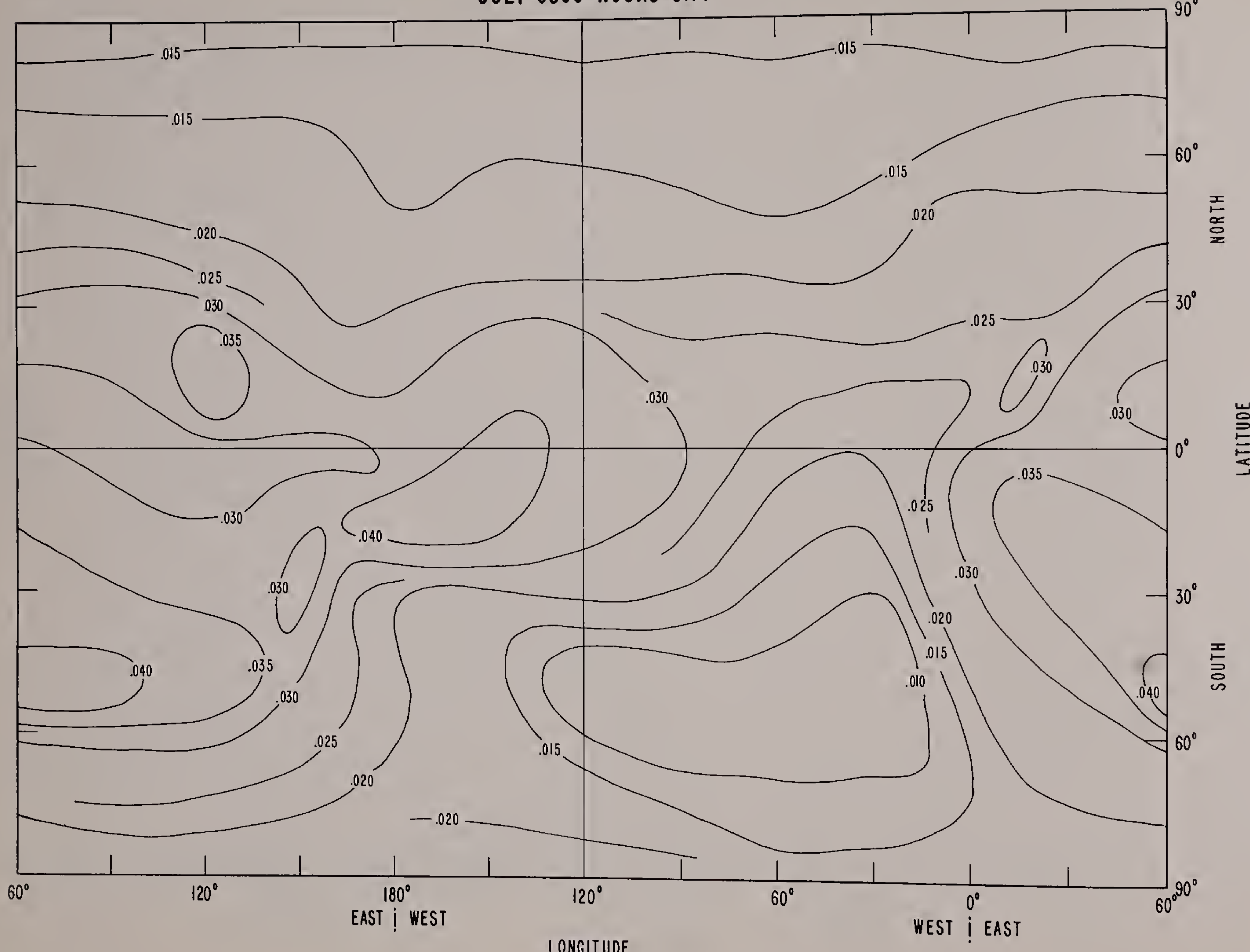
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 0400 HOURS GMT



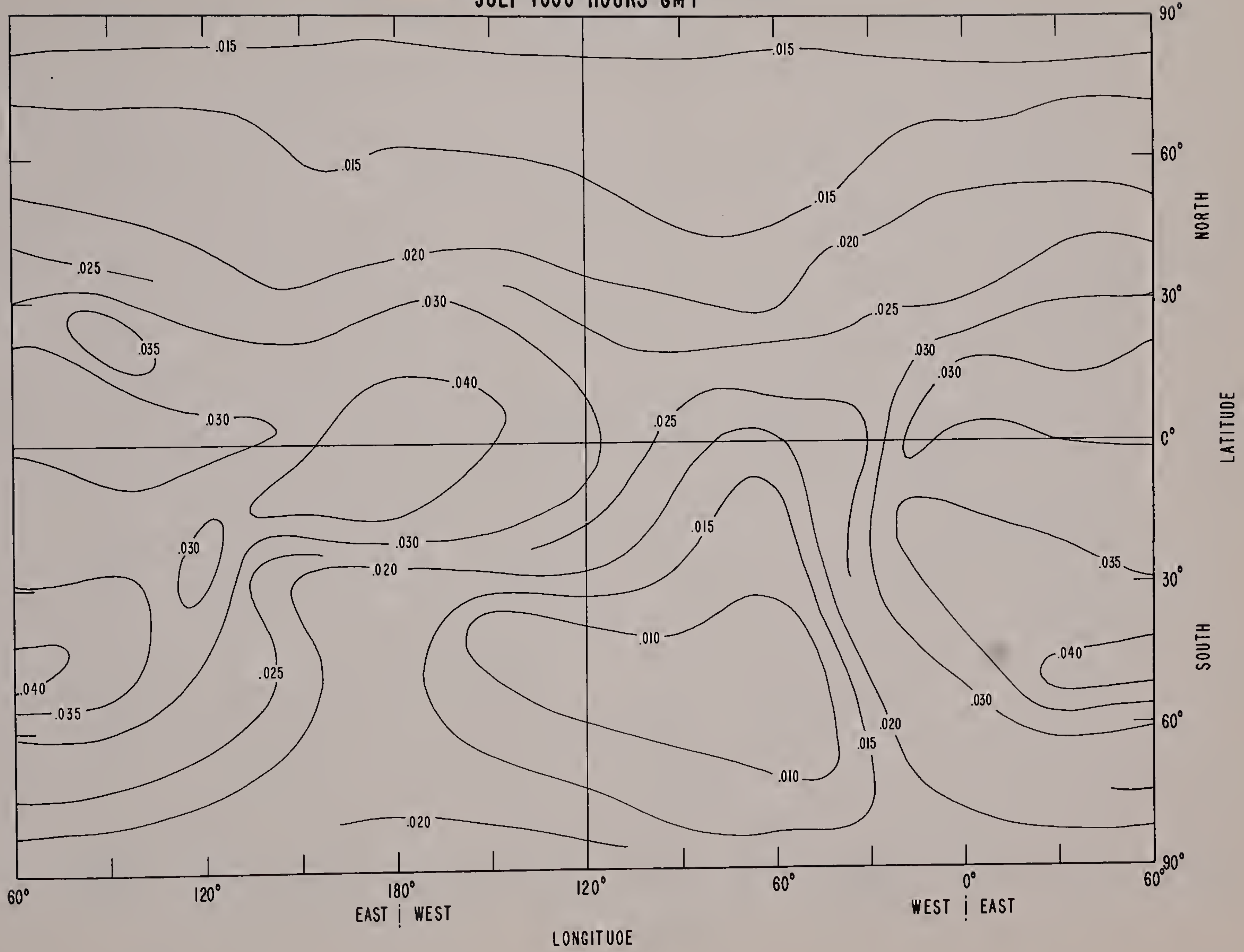
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
JULY 0600 HOURS GMT



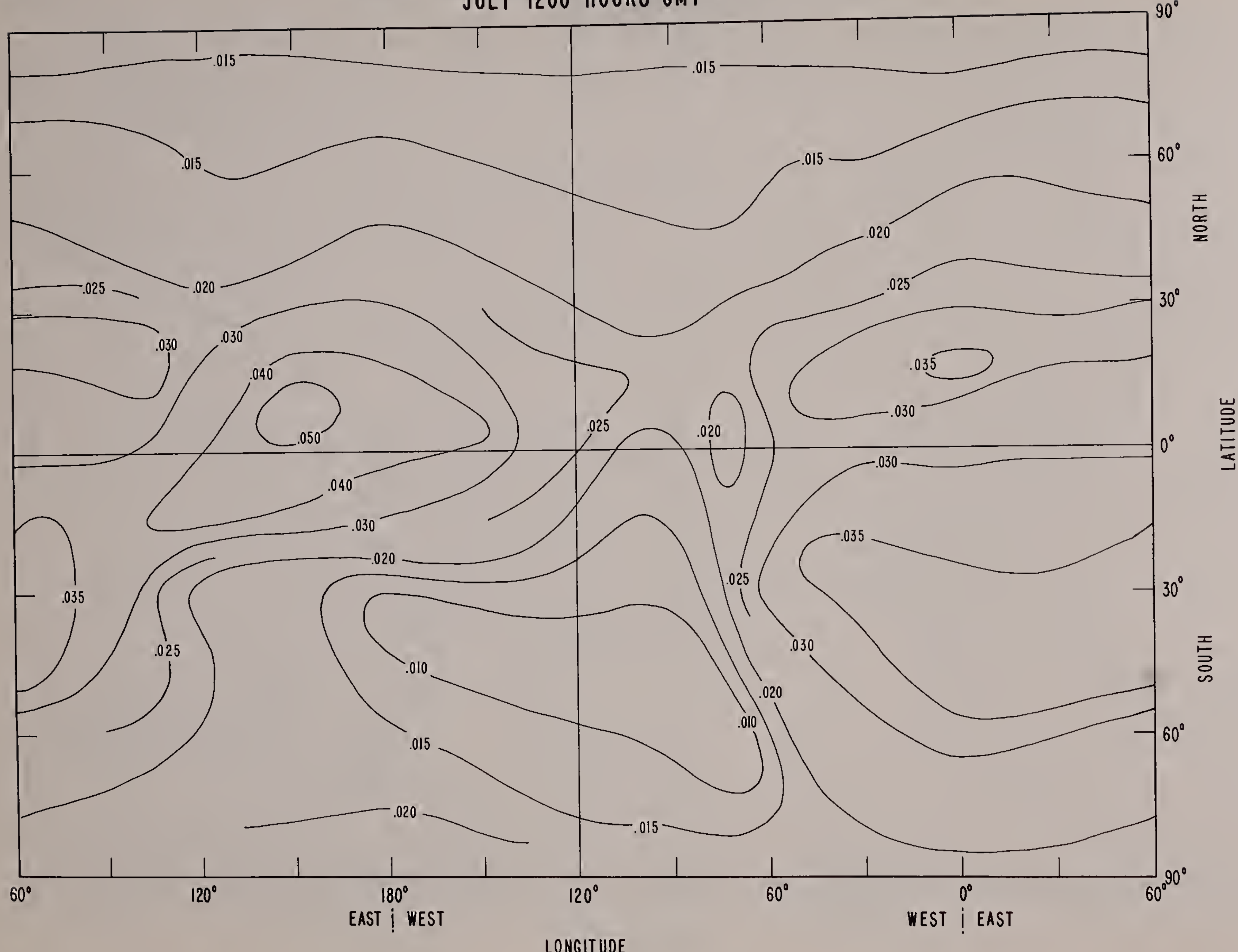
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 0800 HOURS GMT



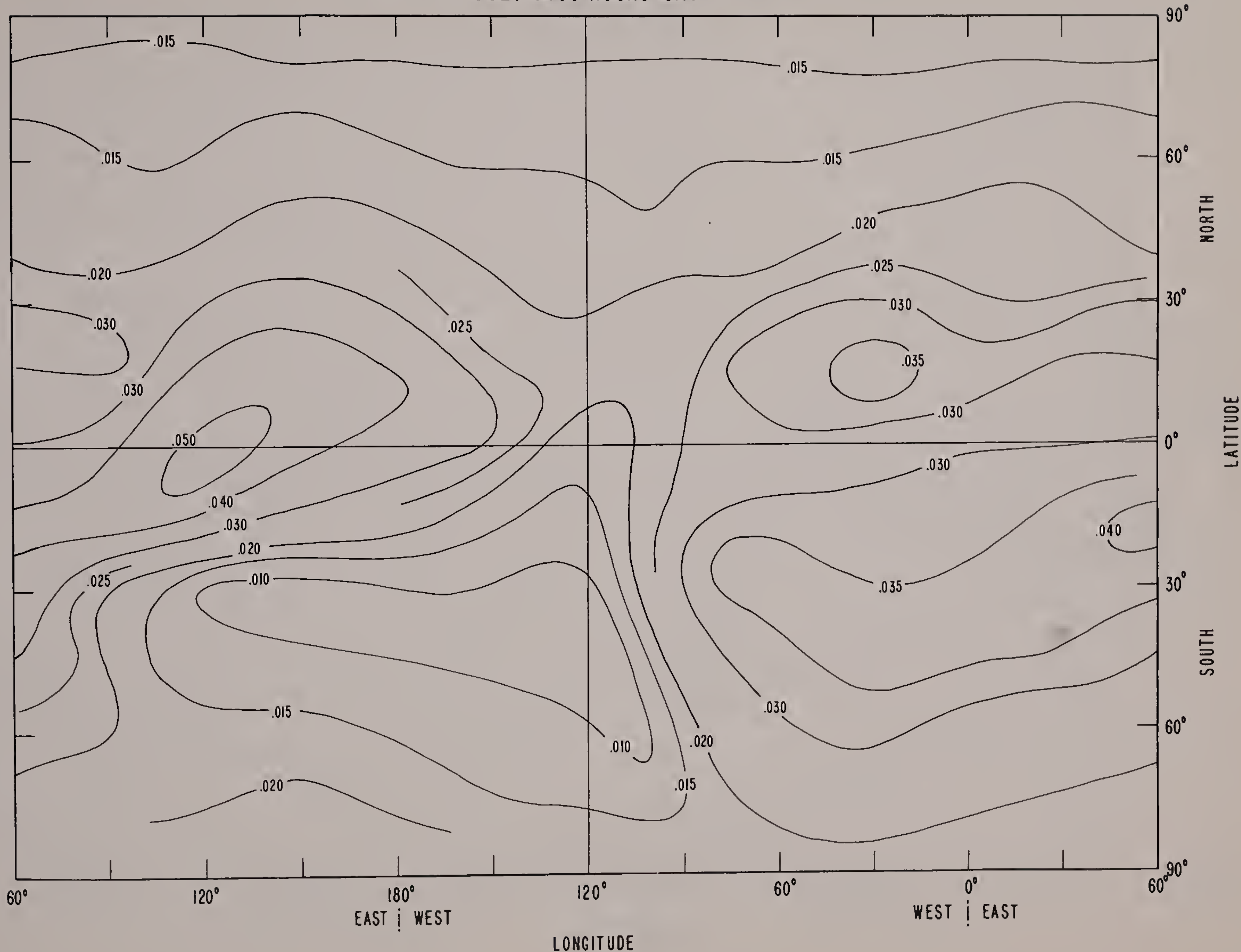
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 1000 HOURS GMT



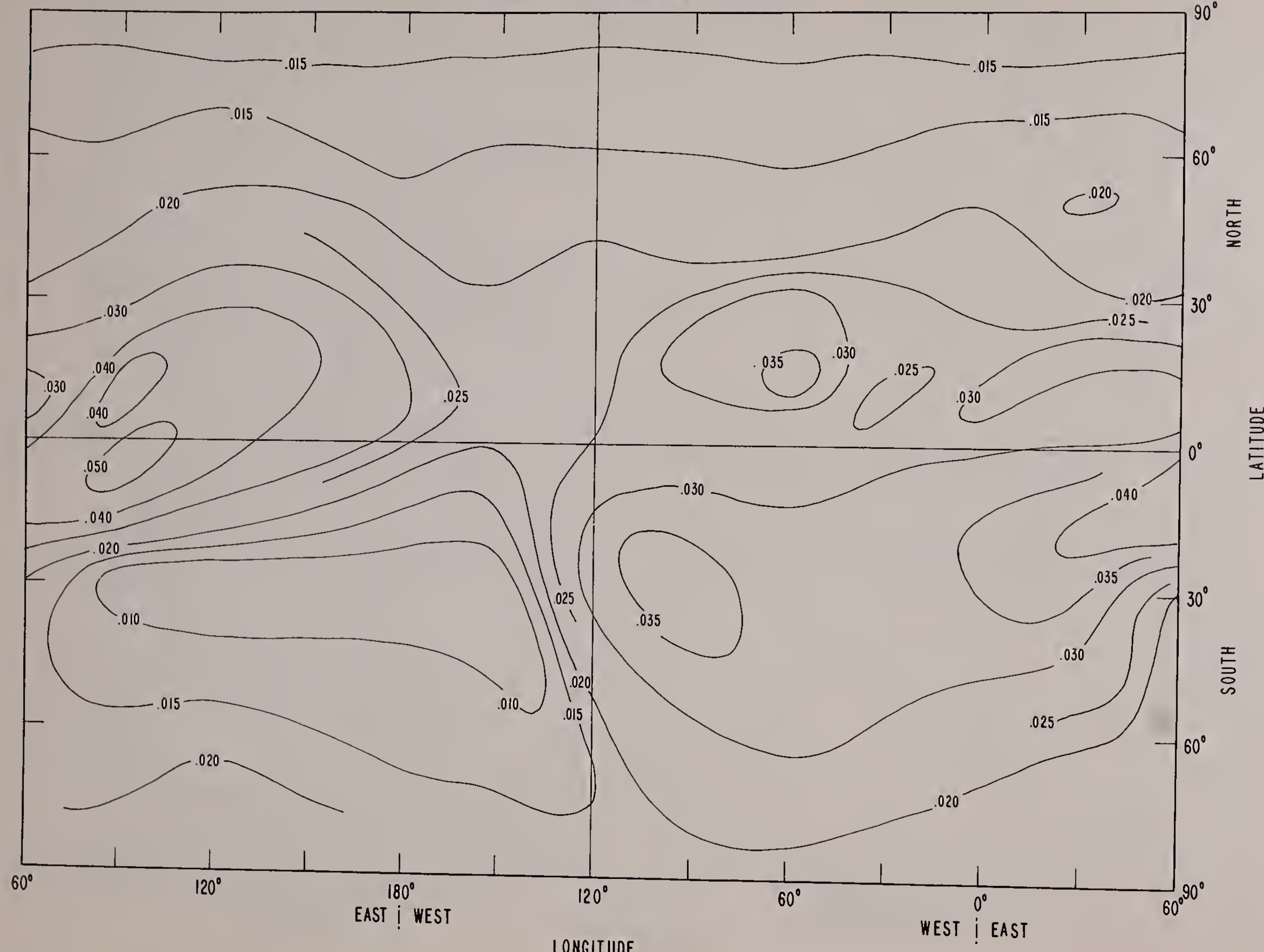
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 1200 HOURS GMT



SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 1400 HOURS GMT

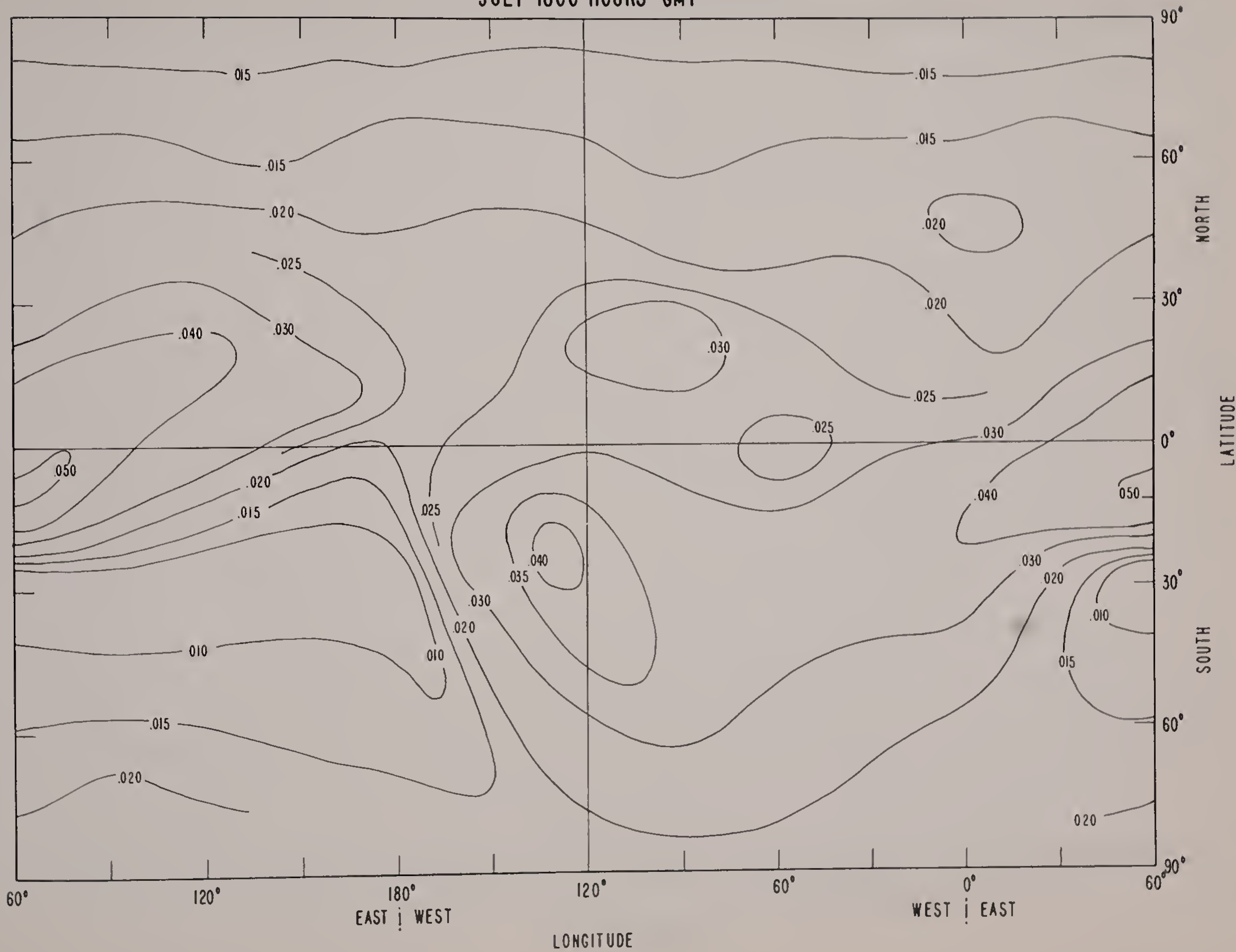


SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 1600 HOURS GMT

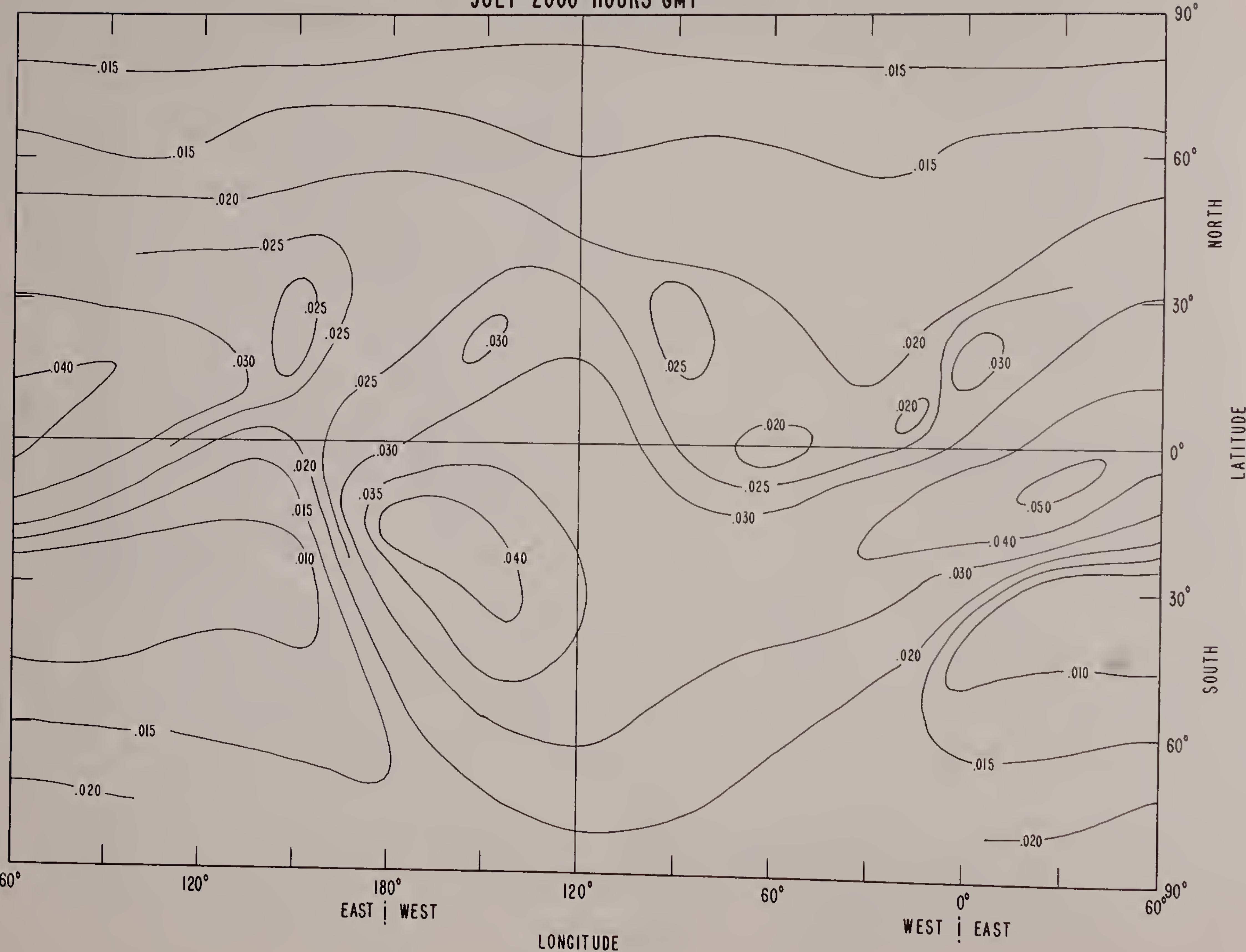


SLOPE OF REGRESSION LINE OF foF2 ON RASSN

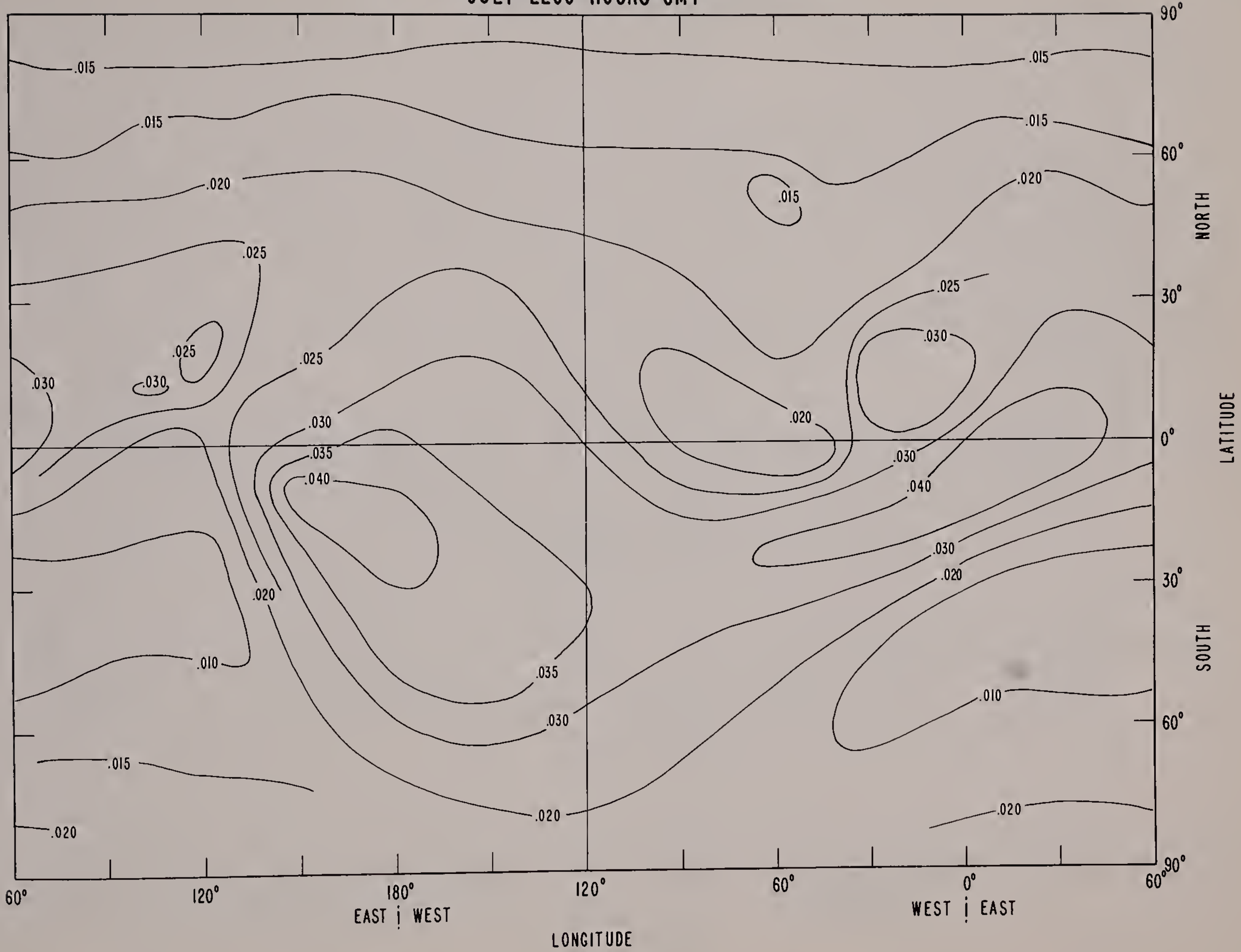
JULY 1800 HOURS GMT



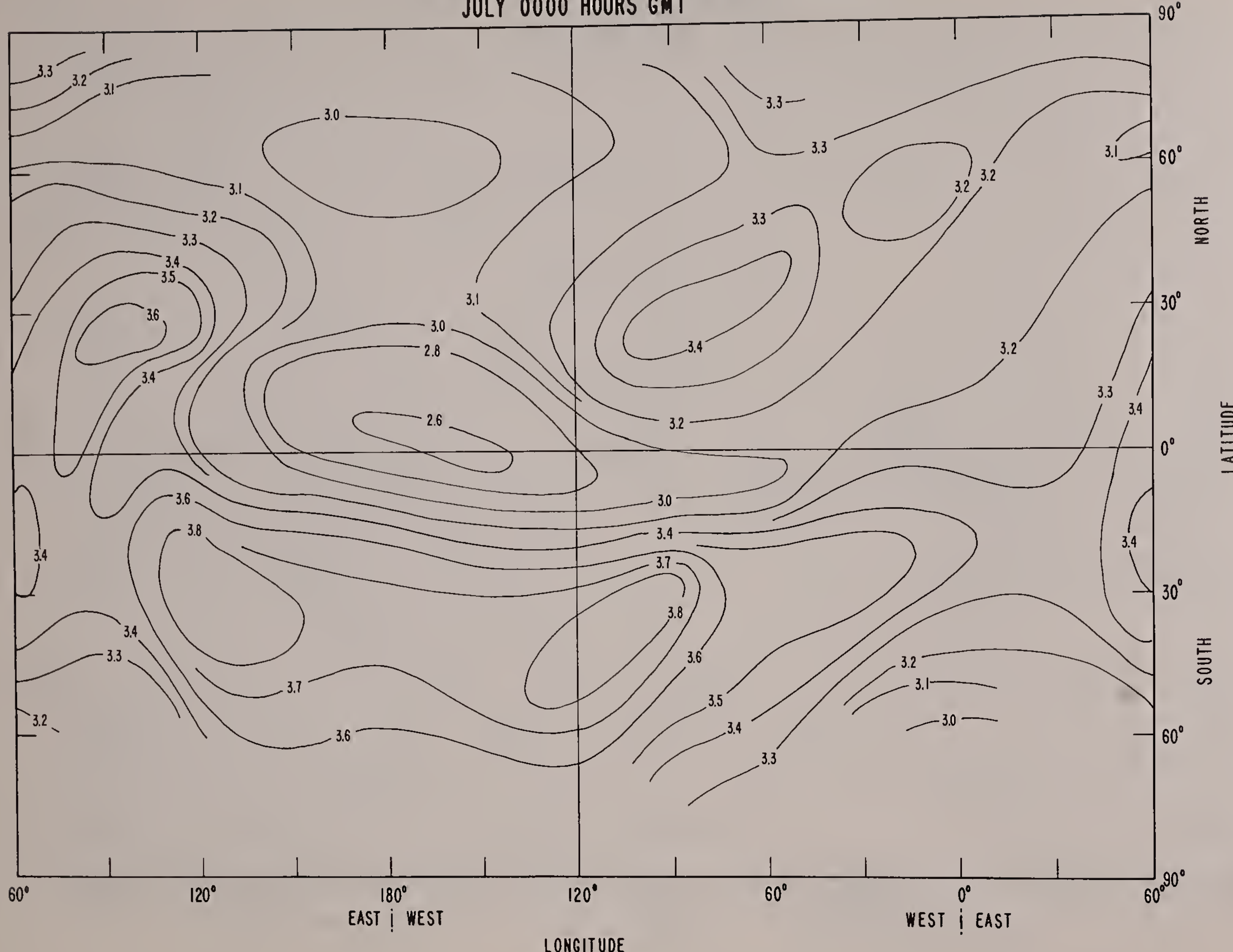
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 2000 HOURS GMT



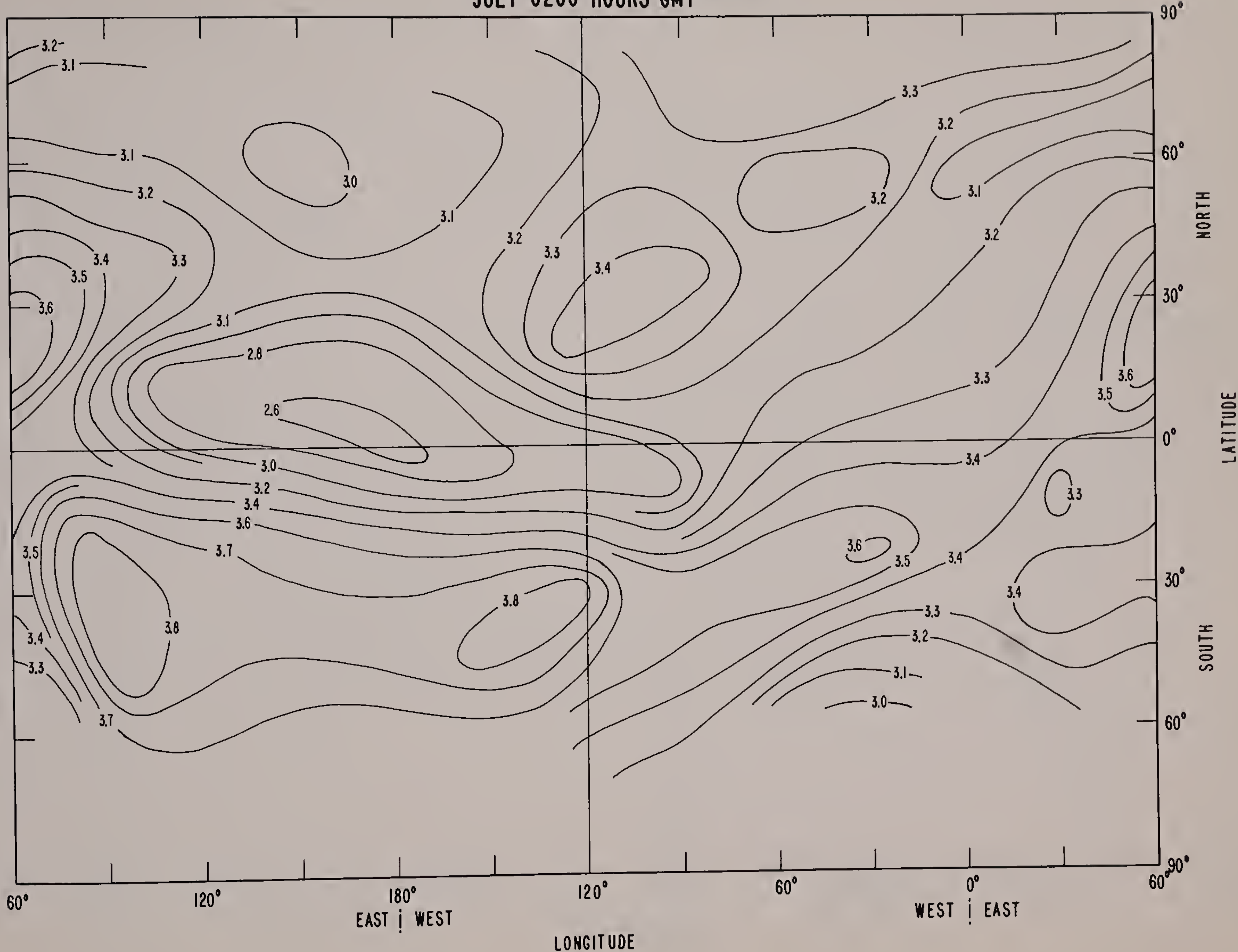
SLOPE OF REGRESSION LINE OF foF2 ON RASSN
JULY 2200 HOURS GMT



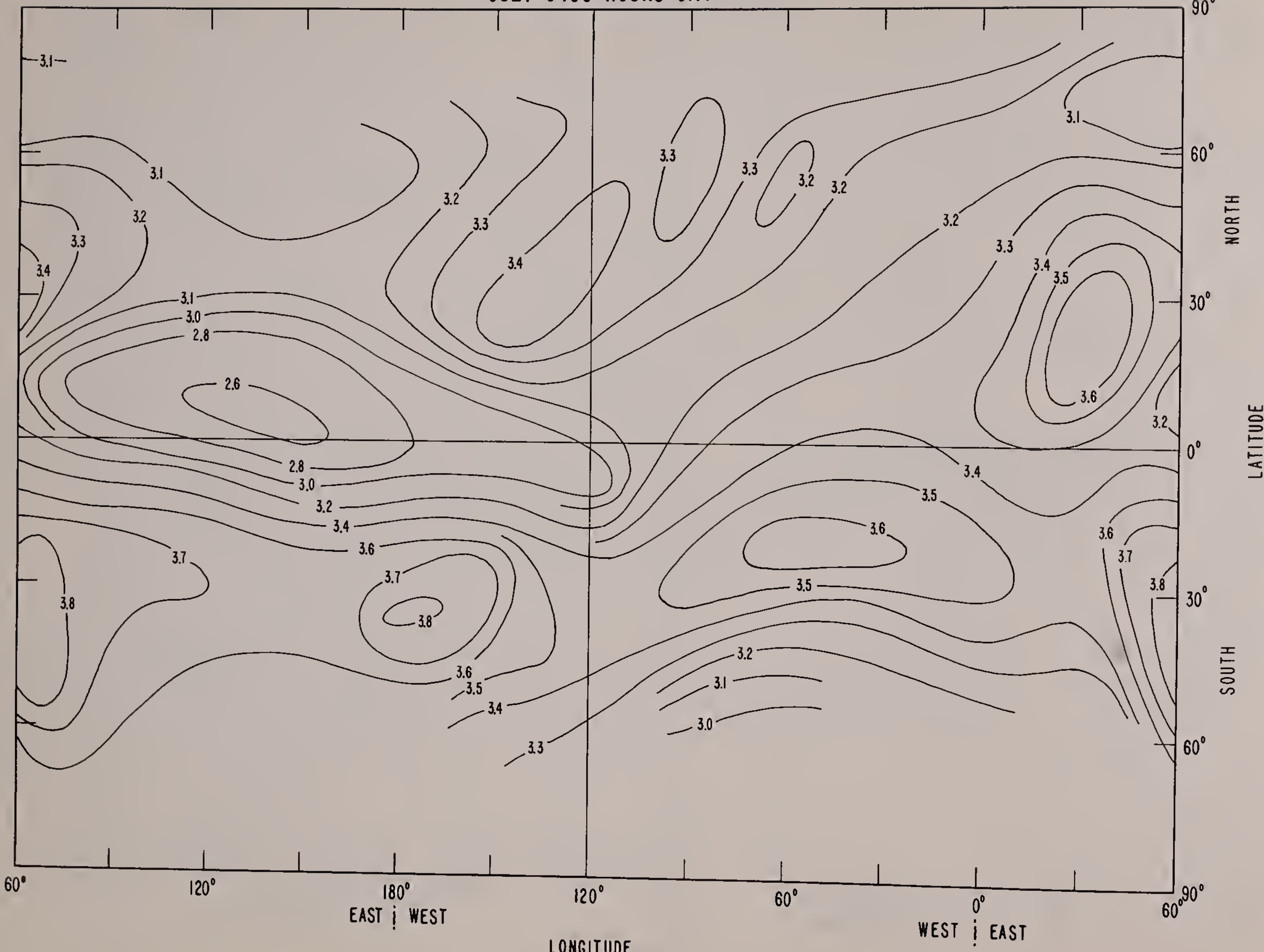
M-4000 FACTOR AT RASSN 50
JULY 0000 HOURS GMT



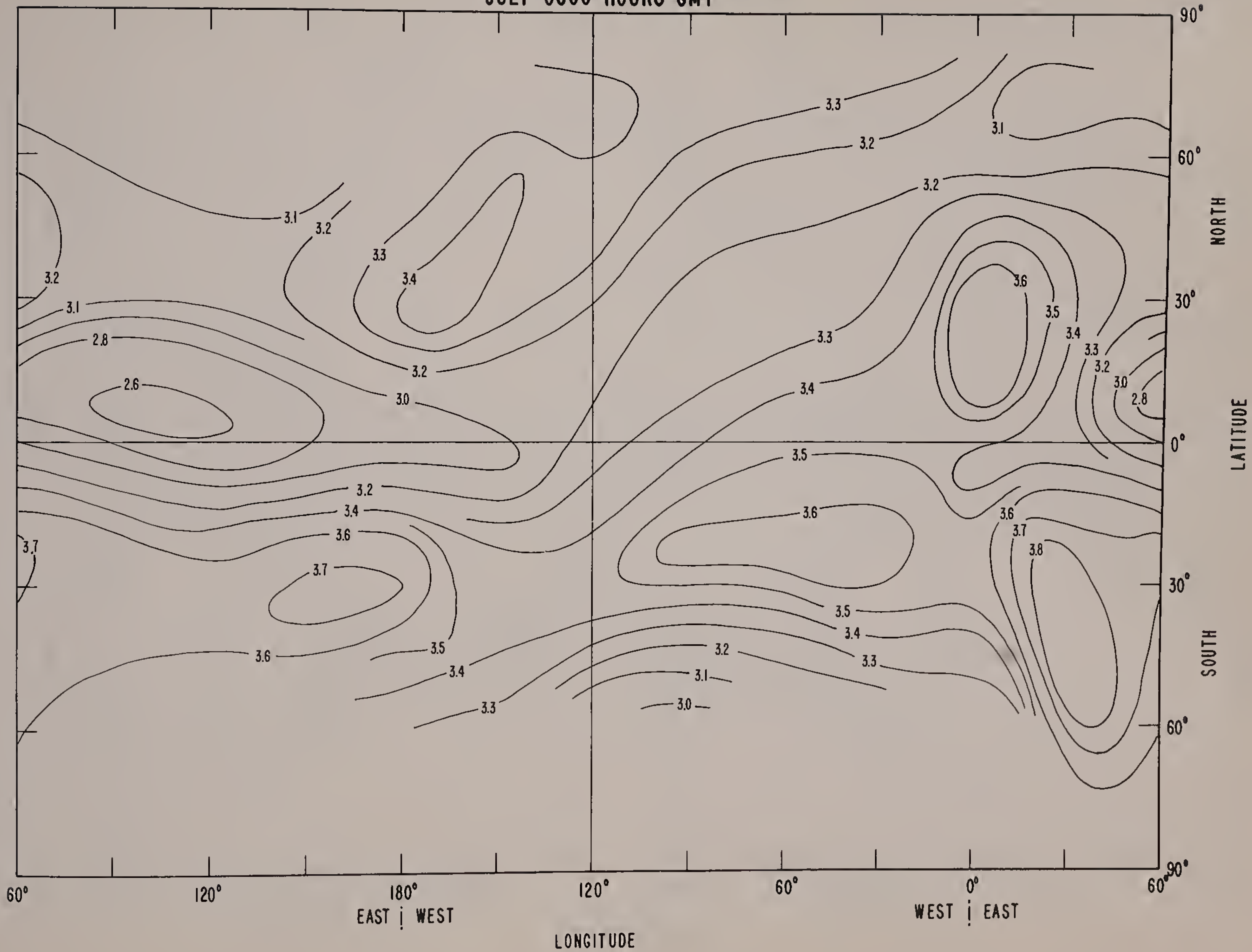
M-4000 FACTOR AT RASSN 50
JULY 0200 HOURS GMT



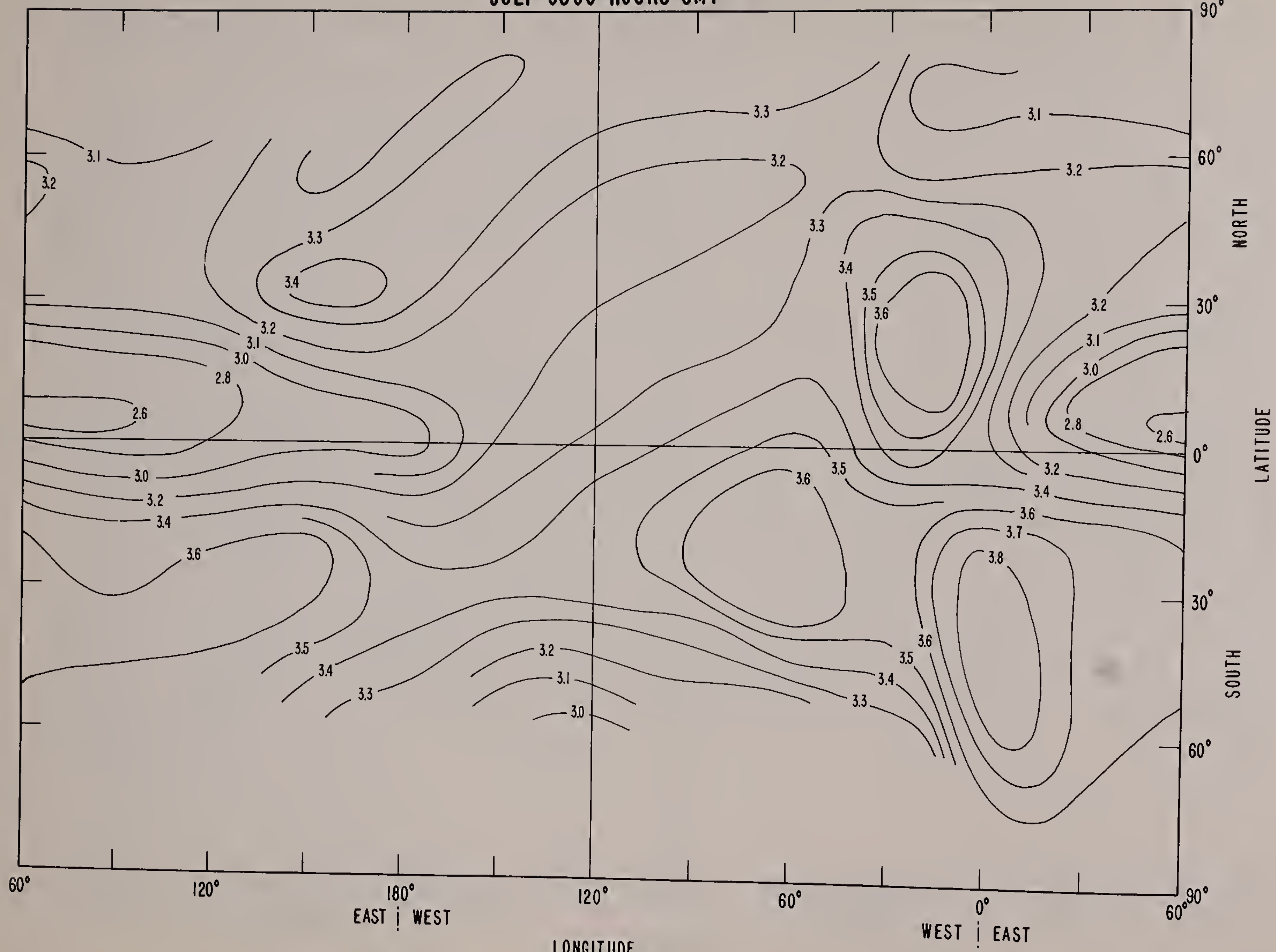
M-4000 FACTOR AT RASSN 50
JULY 0400 HOURS GMT



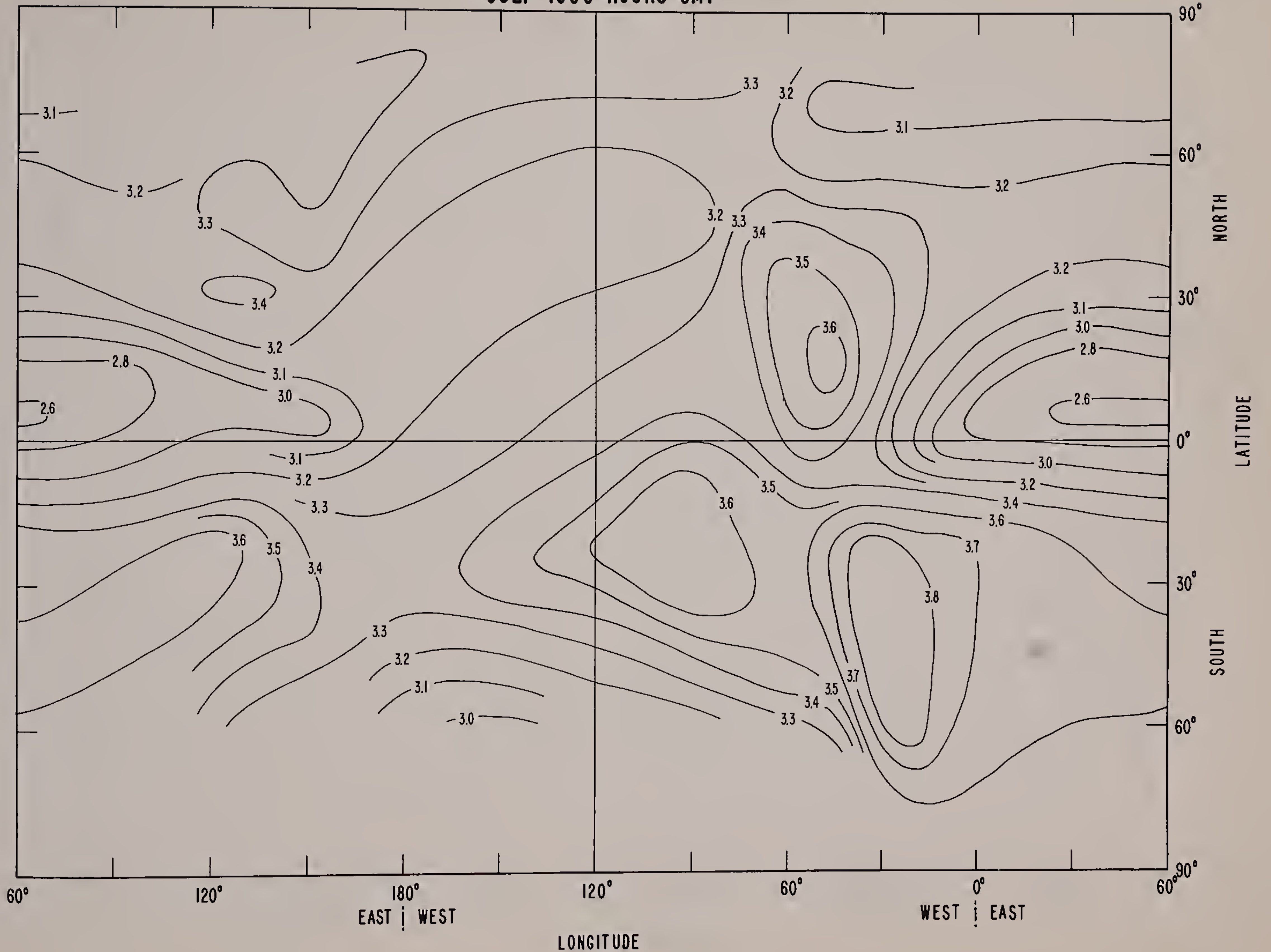
M-4000 FACTOR AT RASSN 50
JULY 0600 HOURS GMT



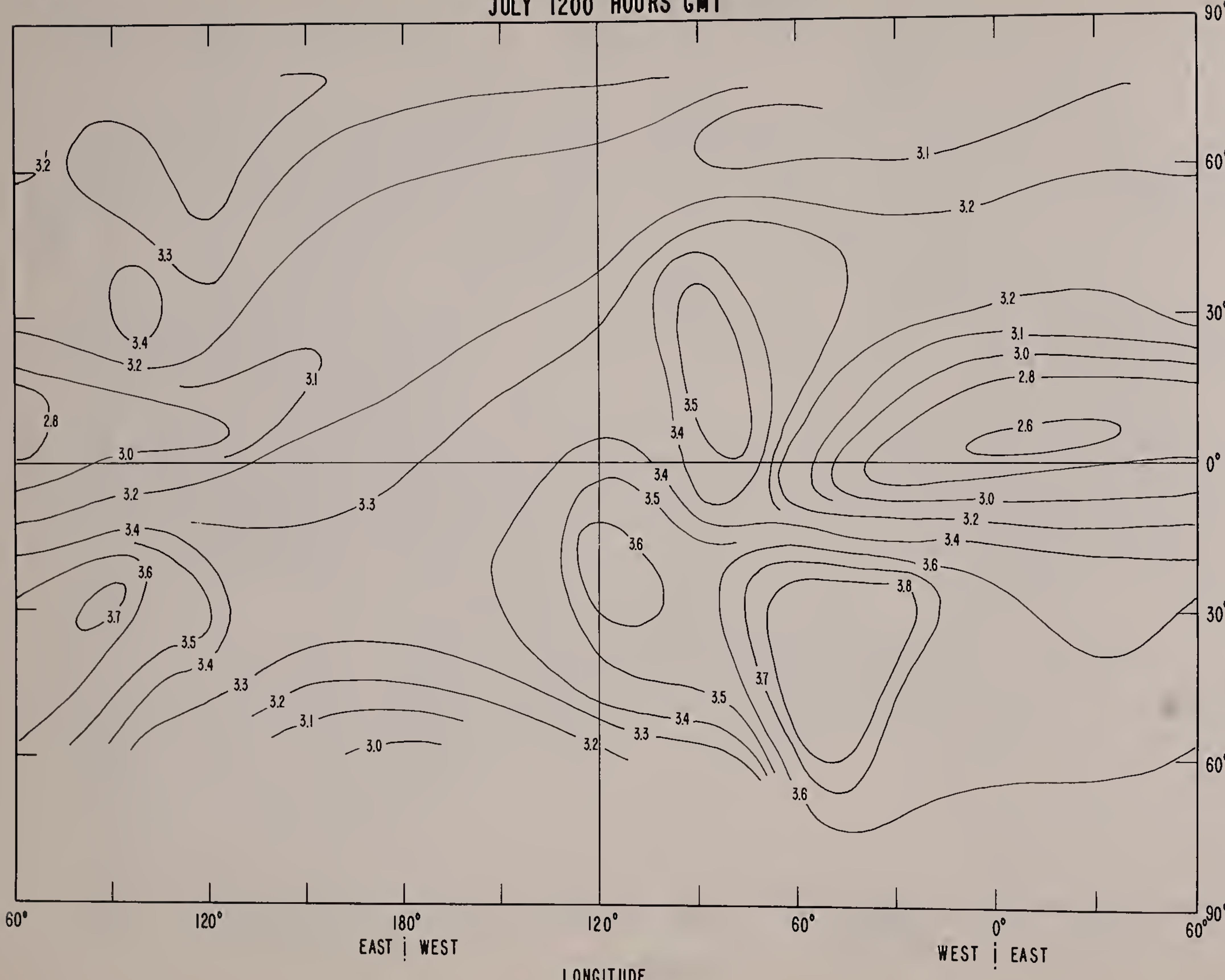
M-4000 FACTOR AT RASSN 50
JULY 0800 HOURS GMT



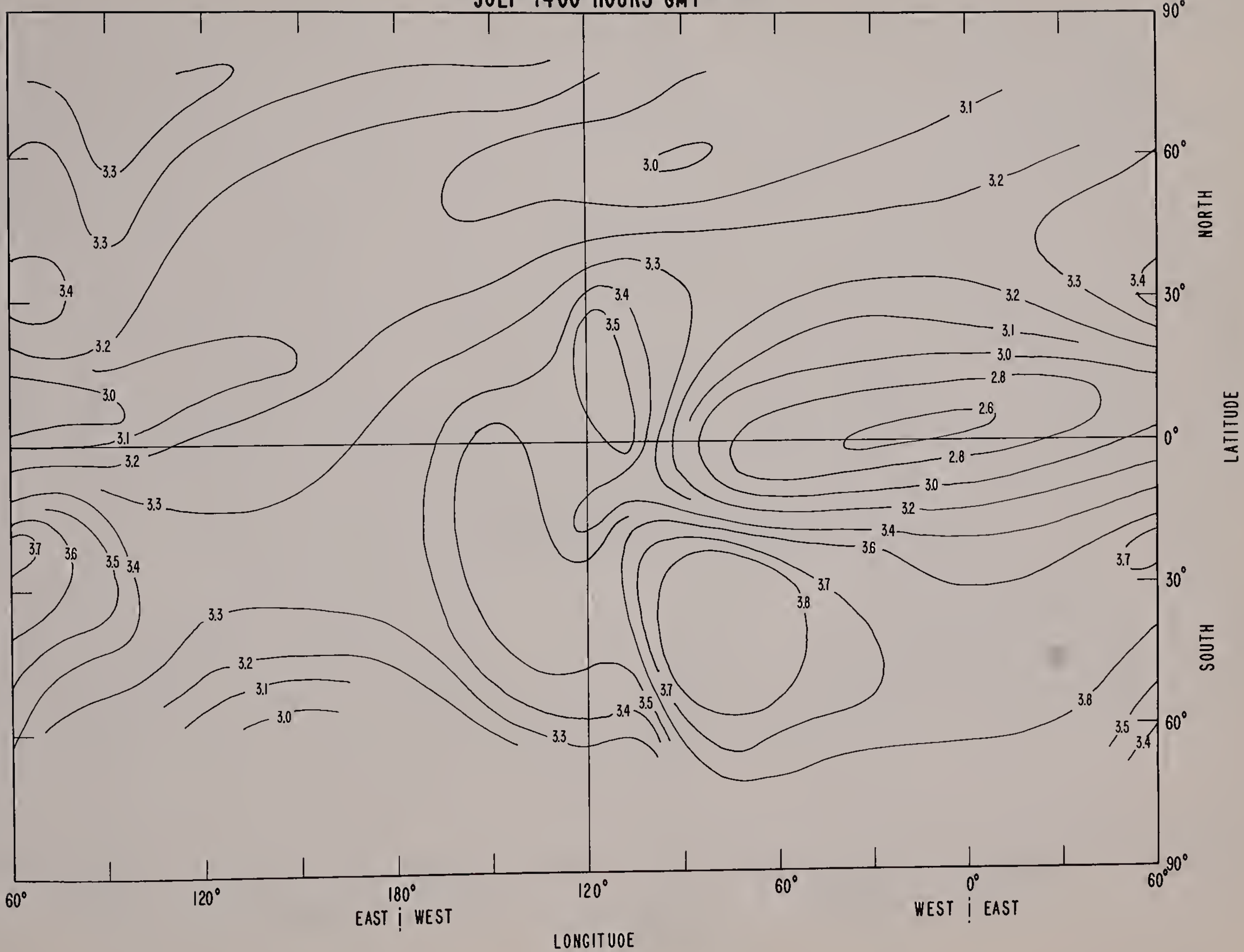
M-4000 FACTOR AT RASSN 50
JULY 1000 HOURS GMT



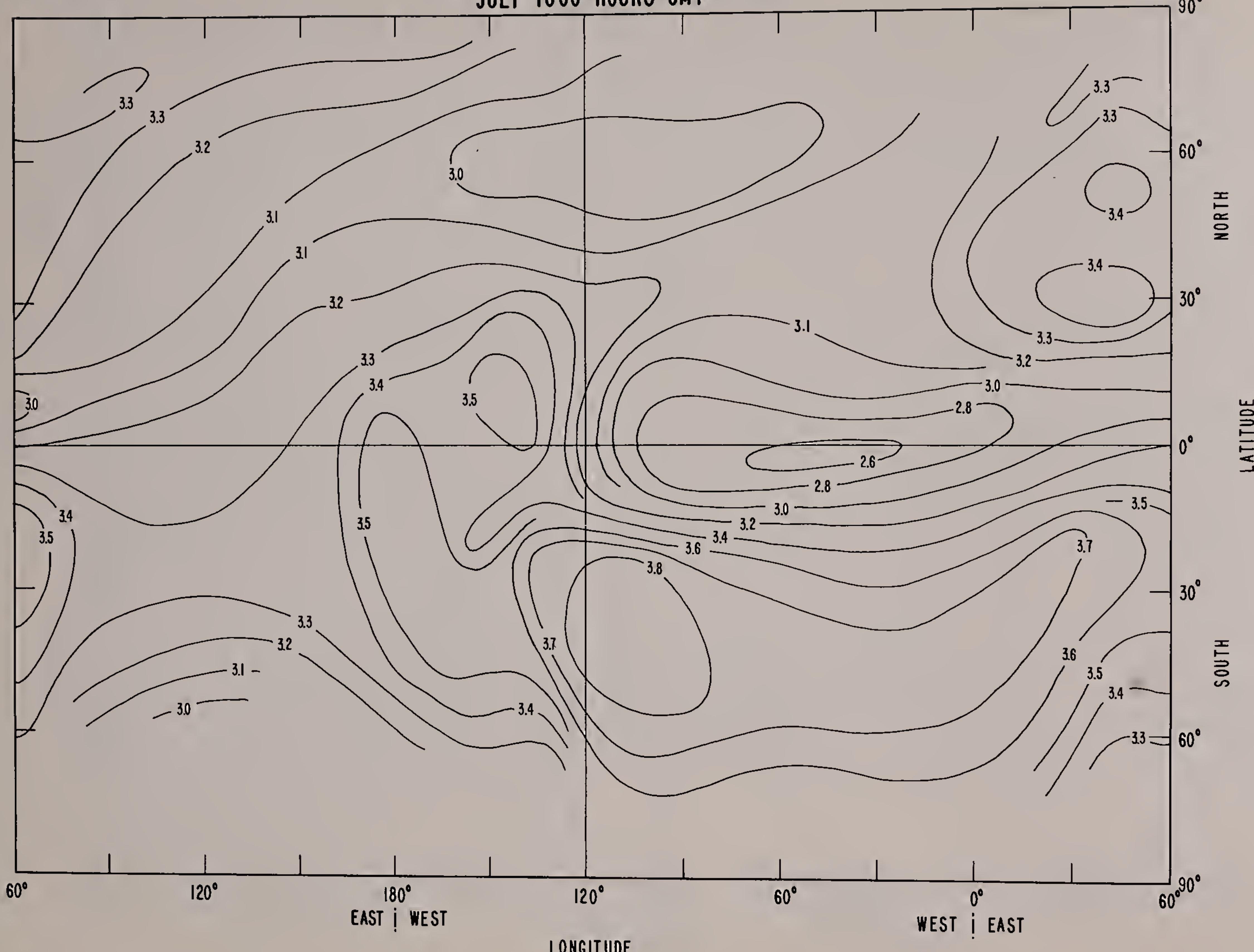
M-4000 FACTOR AT RASSN 50
JULY 1200 HOURS GMT



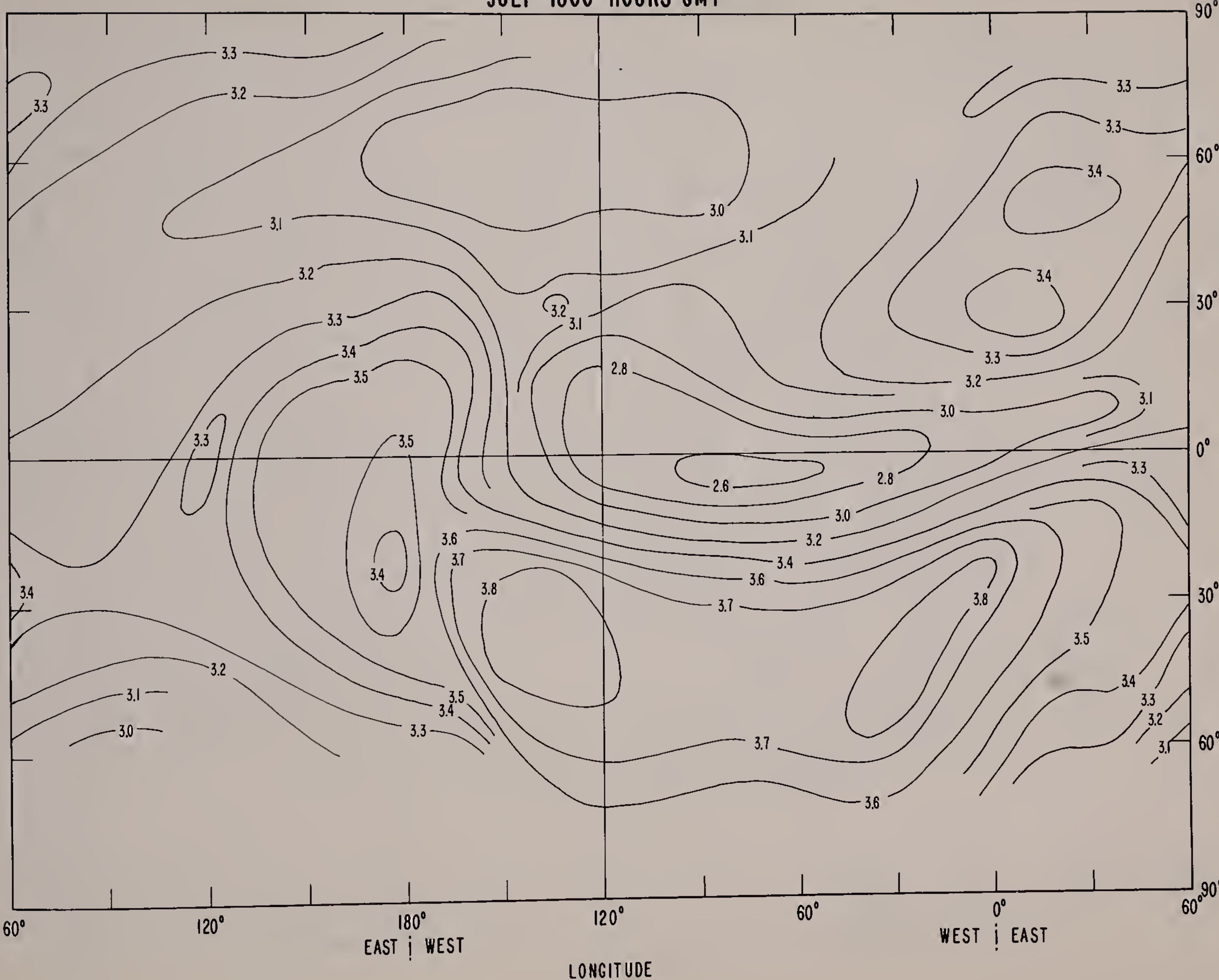
M-4000 FACTOR AT RASSN 50
JULY 1400 HOURS GMT



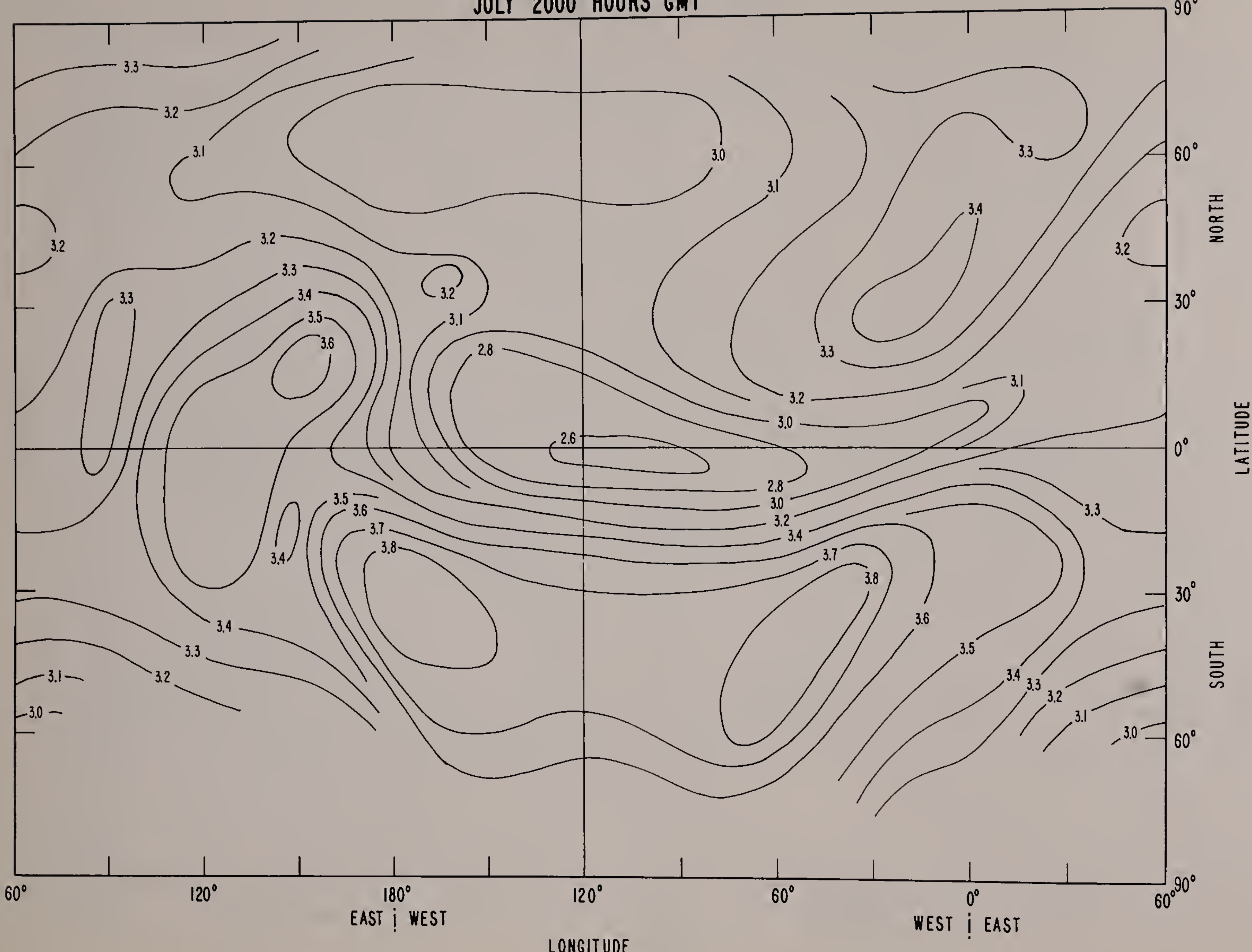
M-4000 FACTOR AT RASSN 50
JULY 1600 HOURS GMT



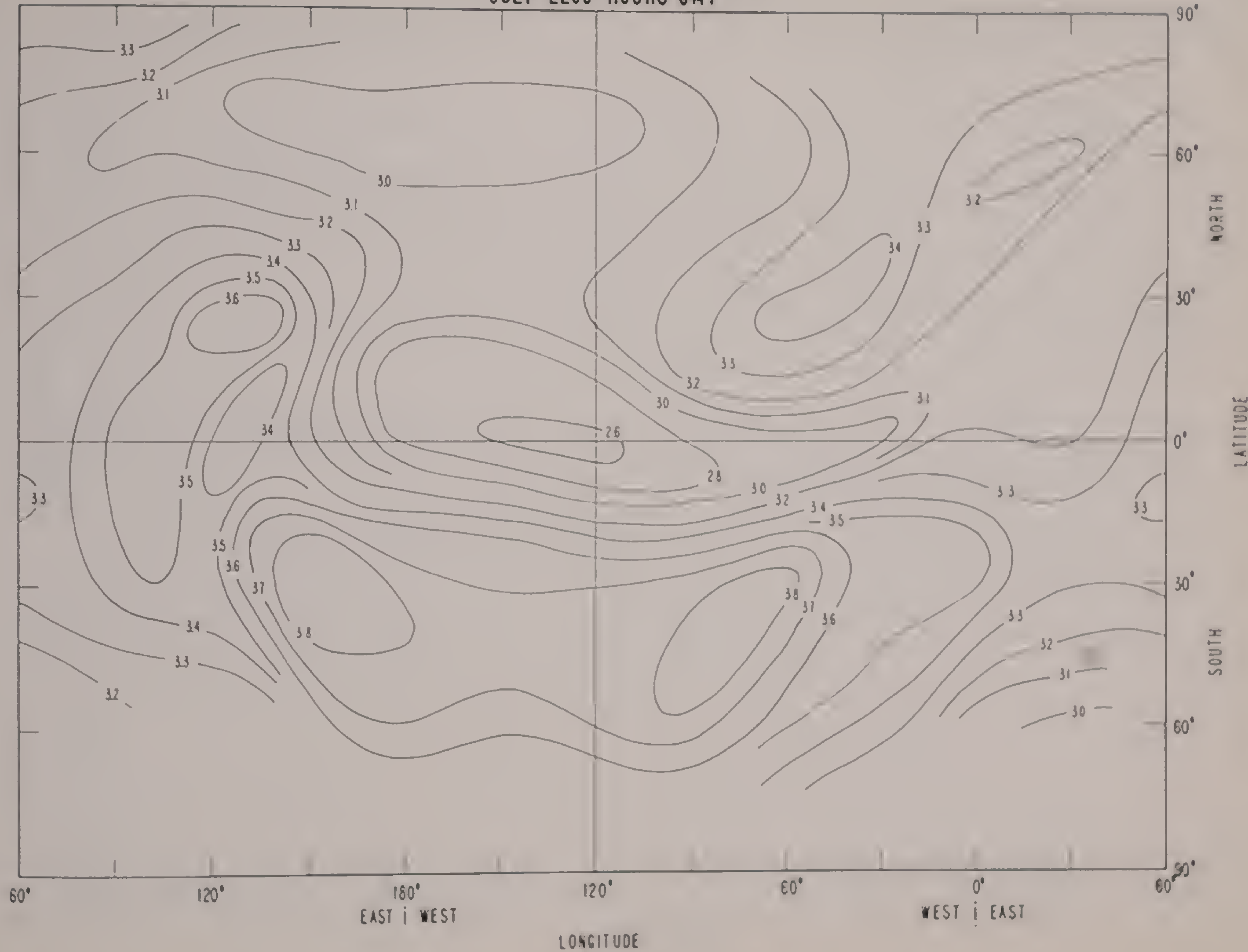
M-4000 FACTOR AT RASSN 50
JULY 1800 HOURS GMT



M-4000 FACTOR AT RASSN 50
JULY 2000 HOURS GMT

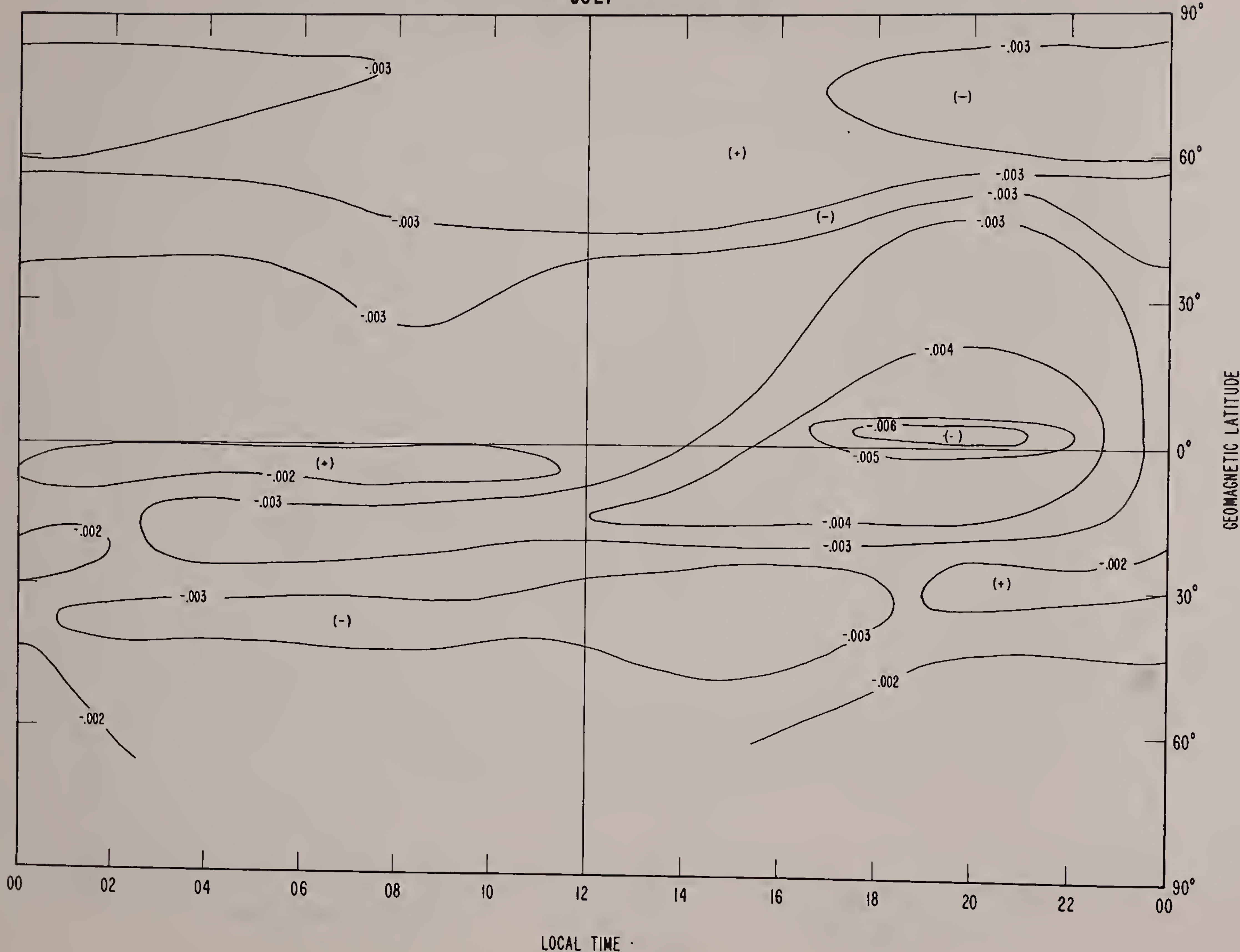


M-4000 FACTOR AT RASSN 50
JULY 2200 HOURS GMT

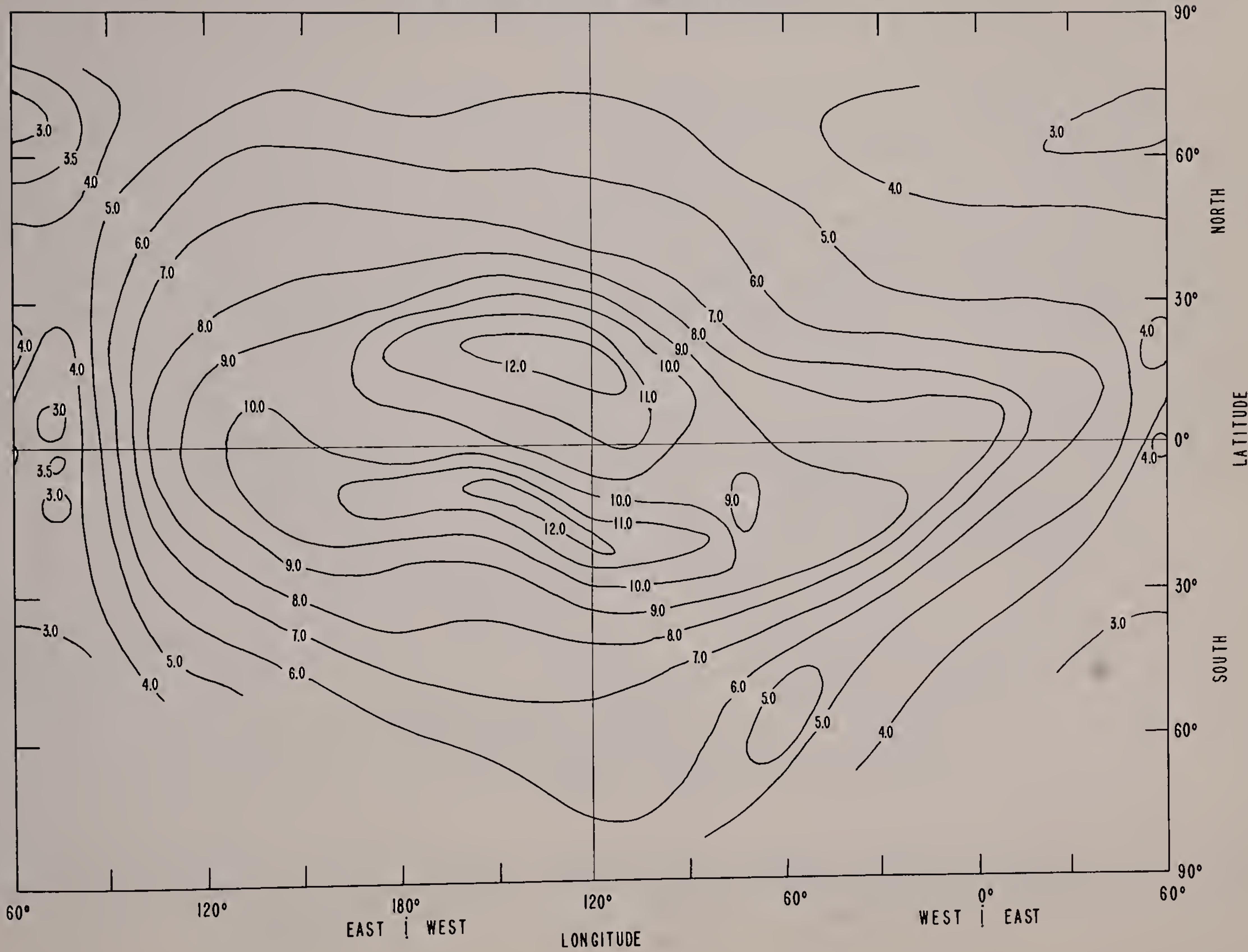


SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN

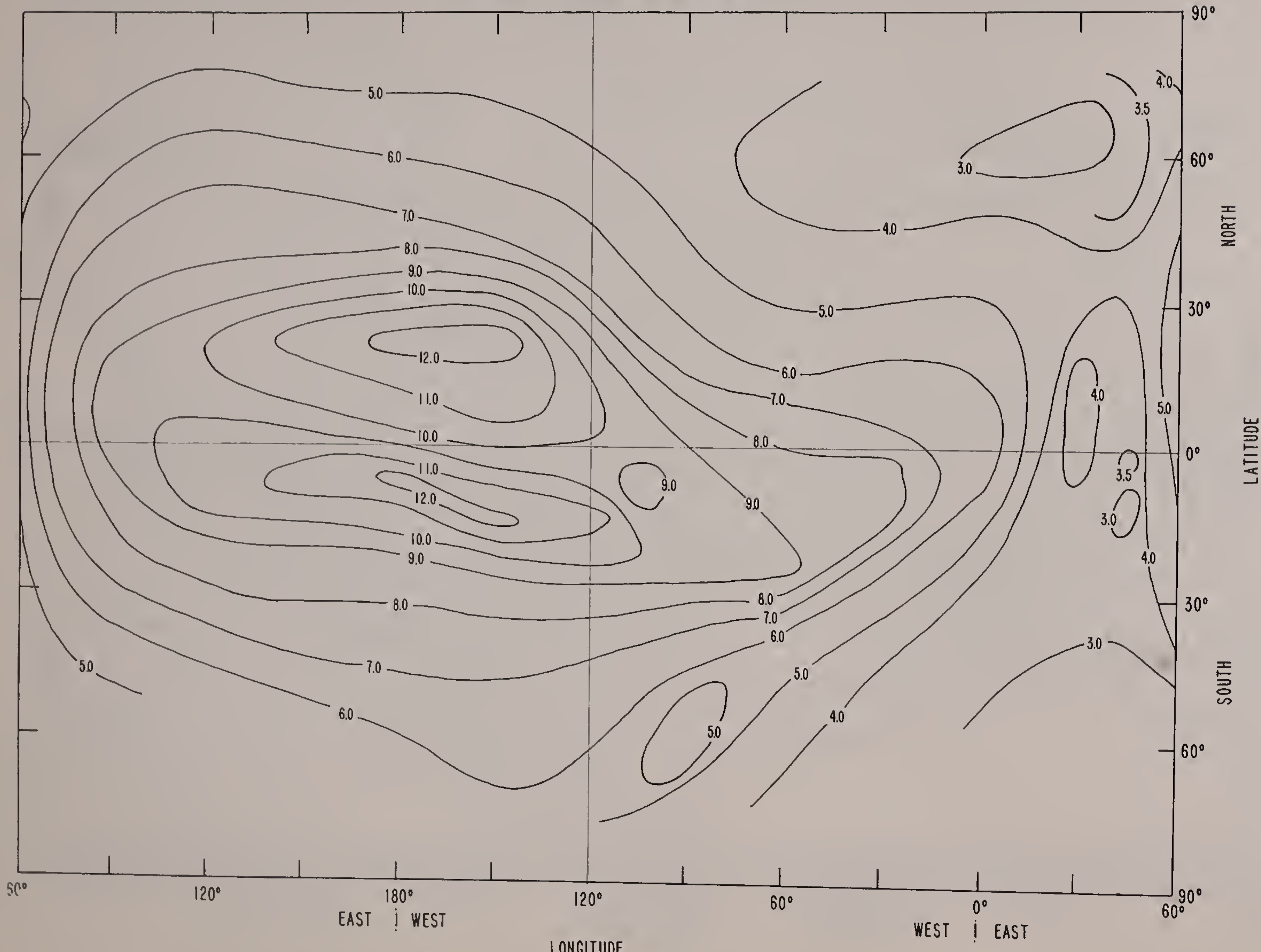
JULY



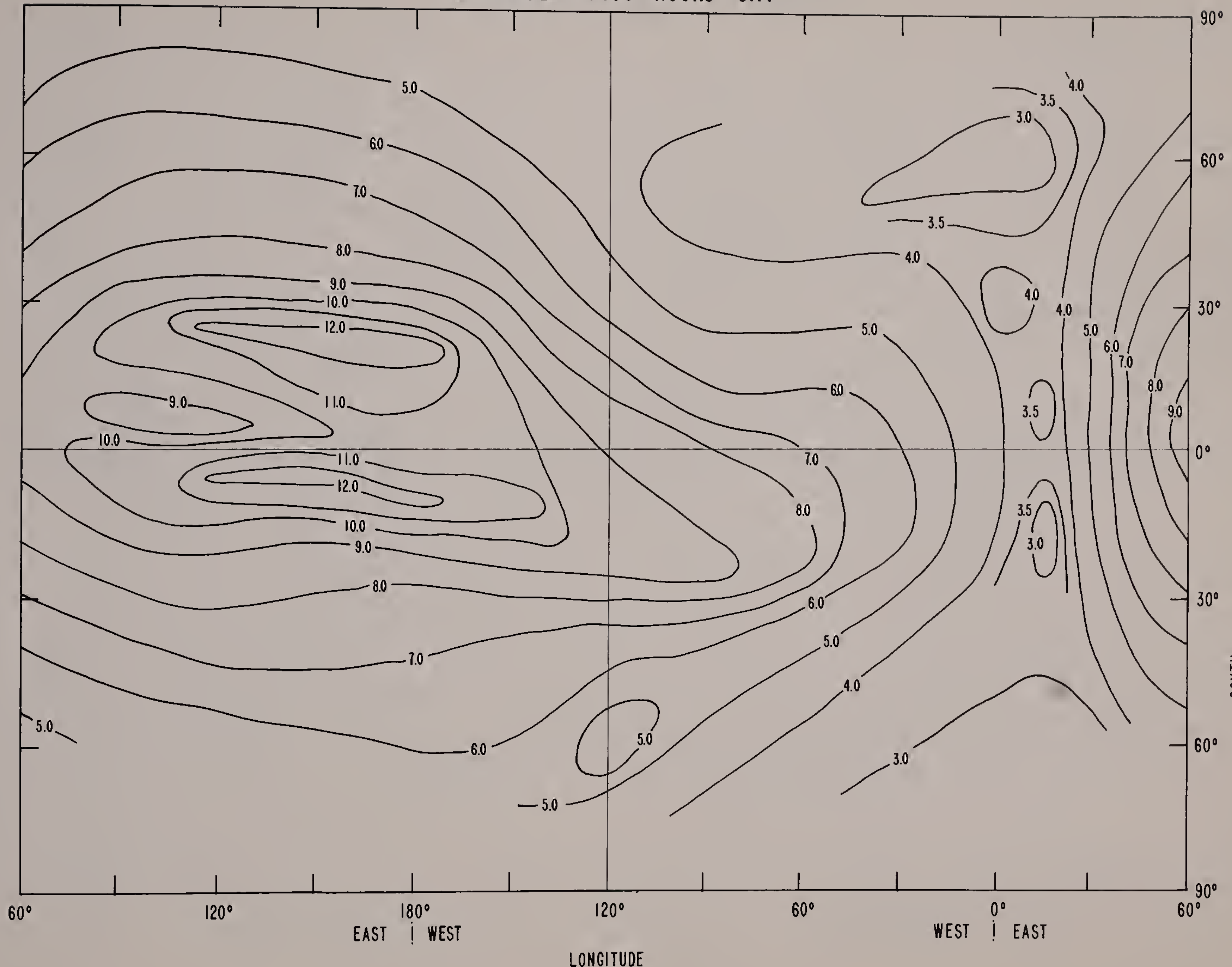
f_oF2 AT RASSN 50
SEPTEMBER 0000 HOURS GMT



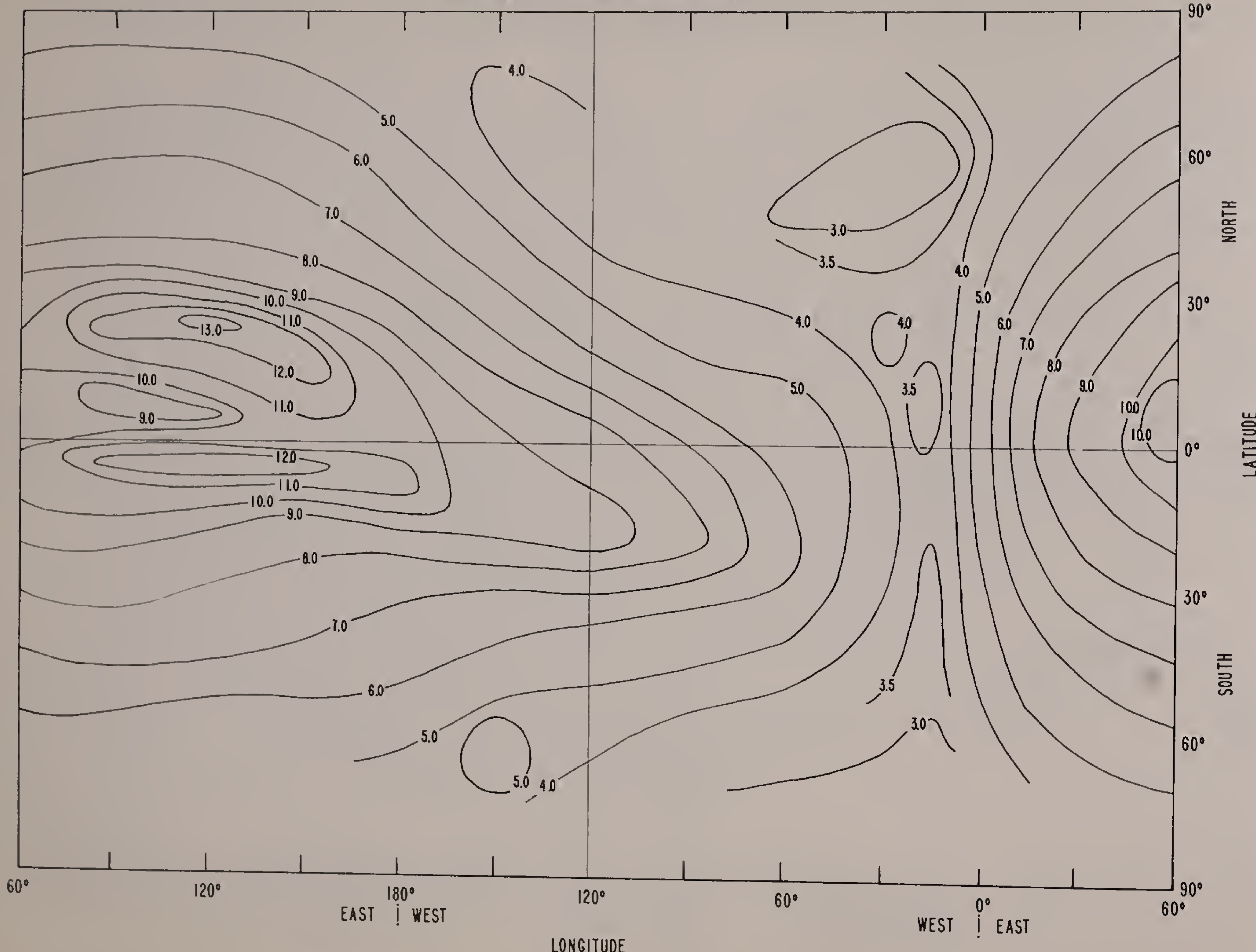
f_oF2 AT RASSN 50
SEPTEMBER 0200 HOURS GMT



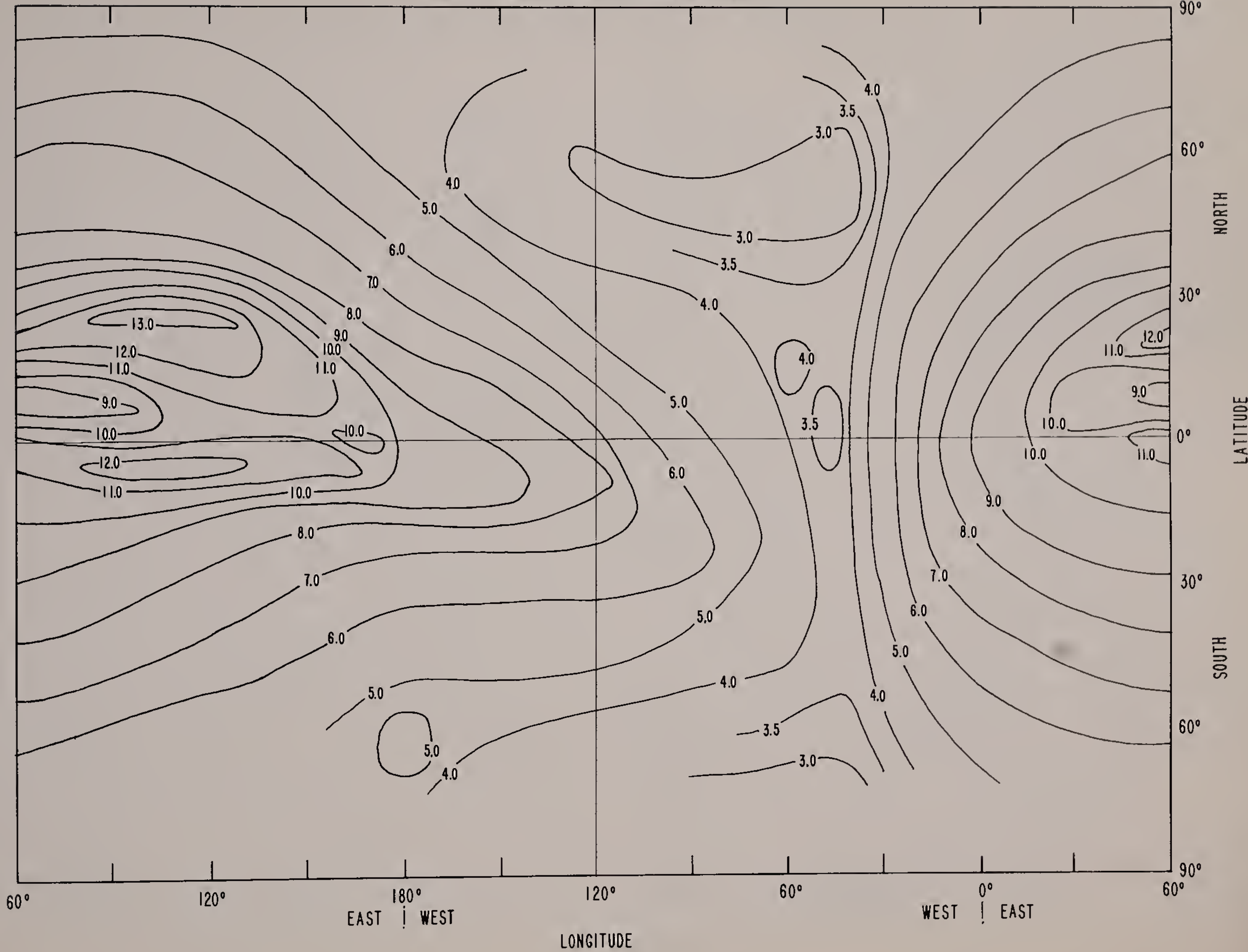
f₀F2 AT RASSN 50
SEPTEMBER 0400 HOURS GMT



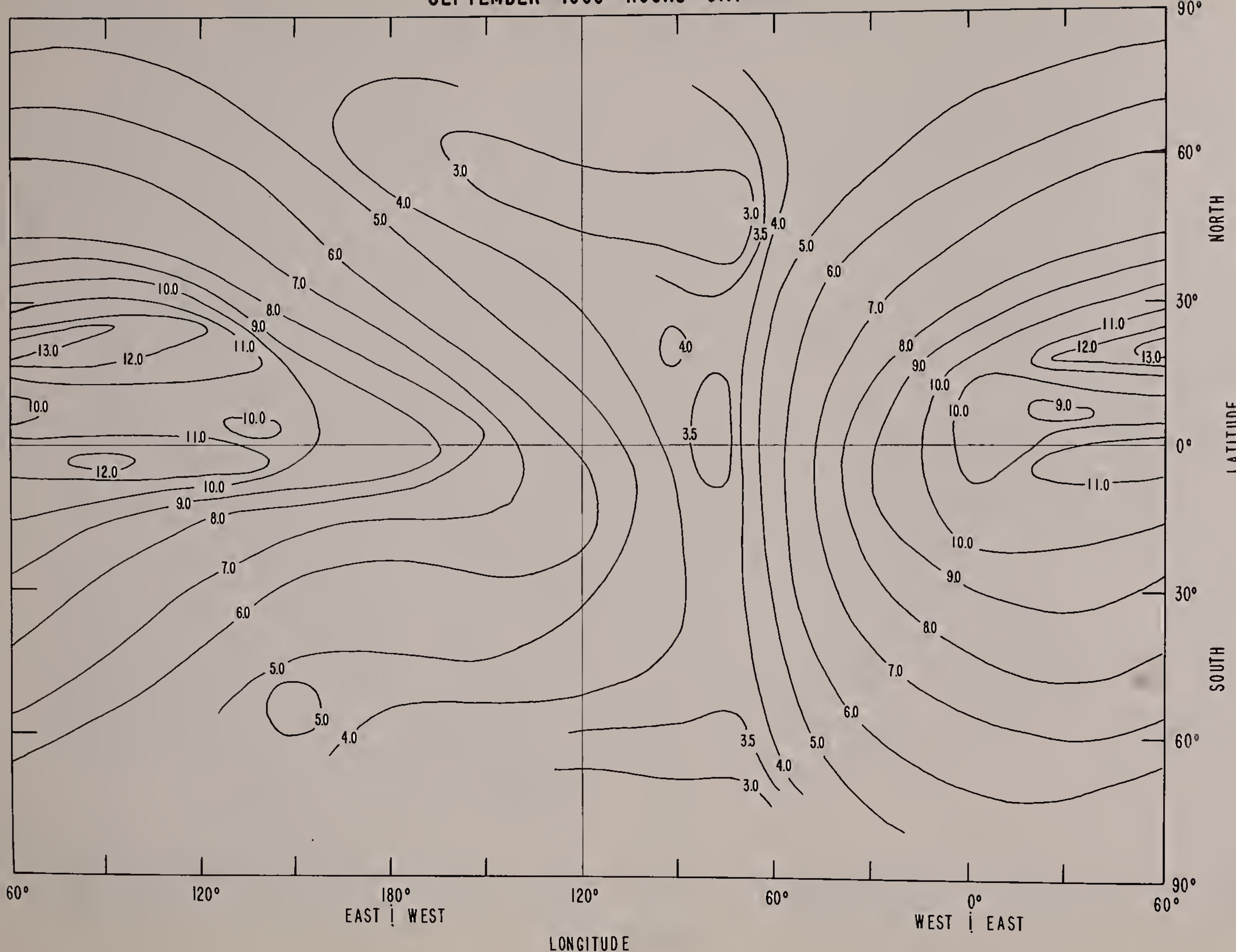
f_oF2 AT RASSN 50
SEPTEMBER 0600 HOURS GMT



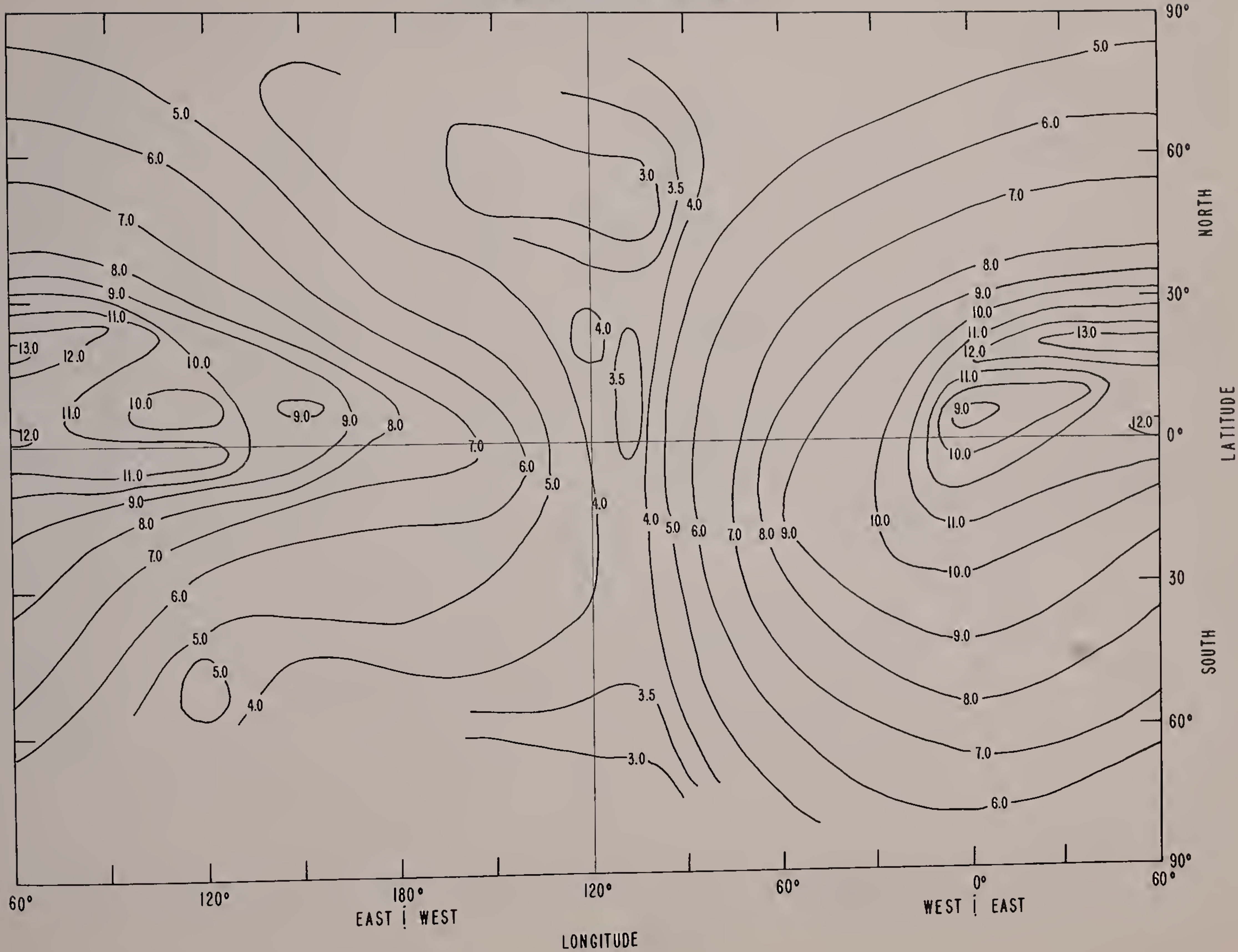
f_oF2 AT RASSN 50
SEPTEMBER 0800 HOURS GMT



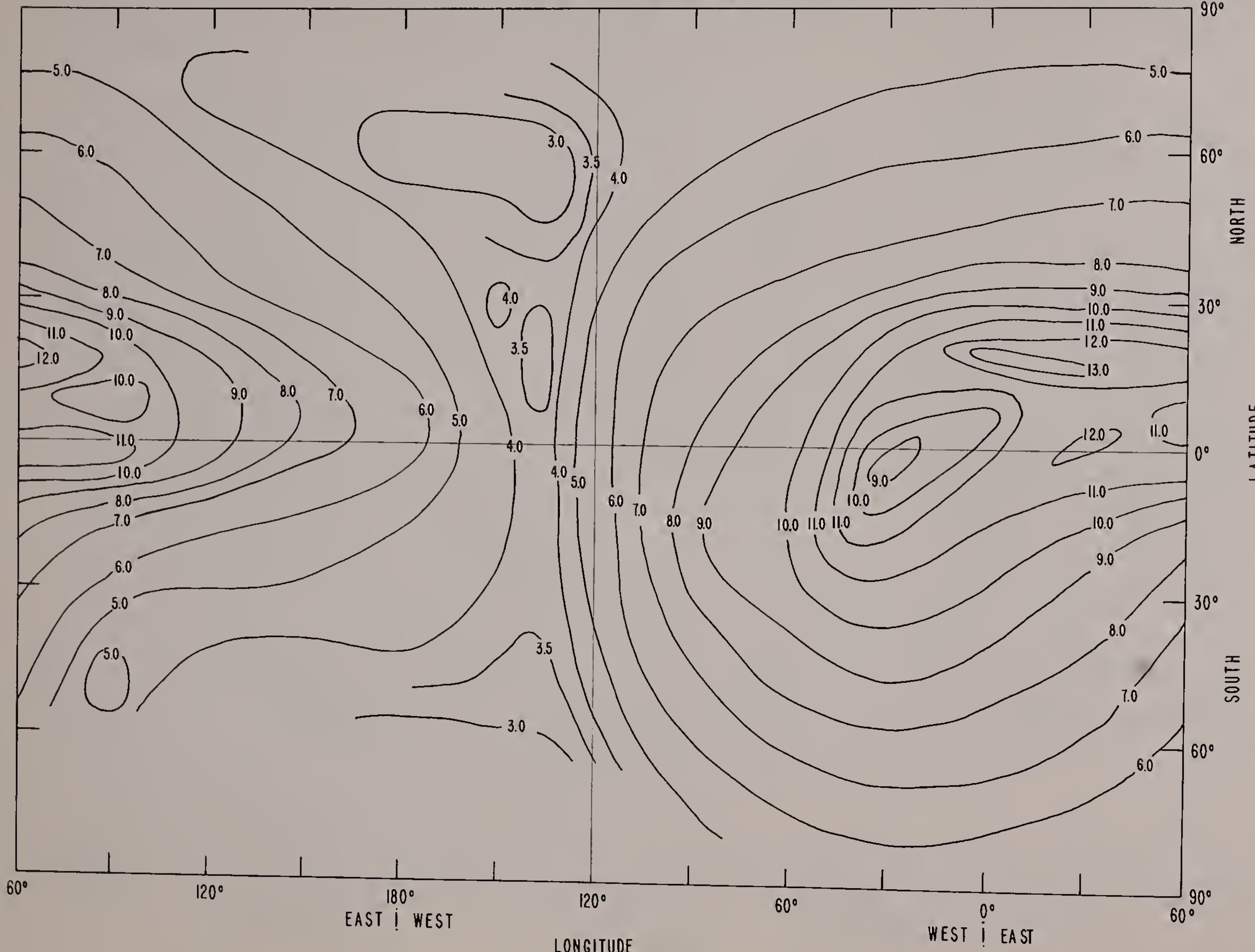
f_oF2 AT RASSN 50
SEPTEMBER 1000 HOURS GMT



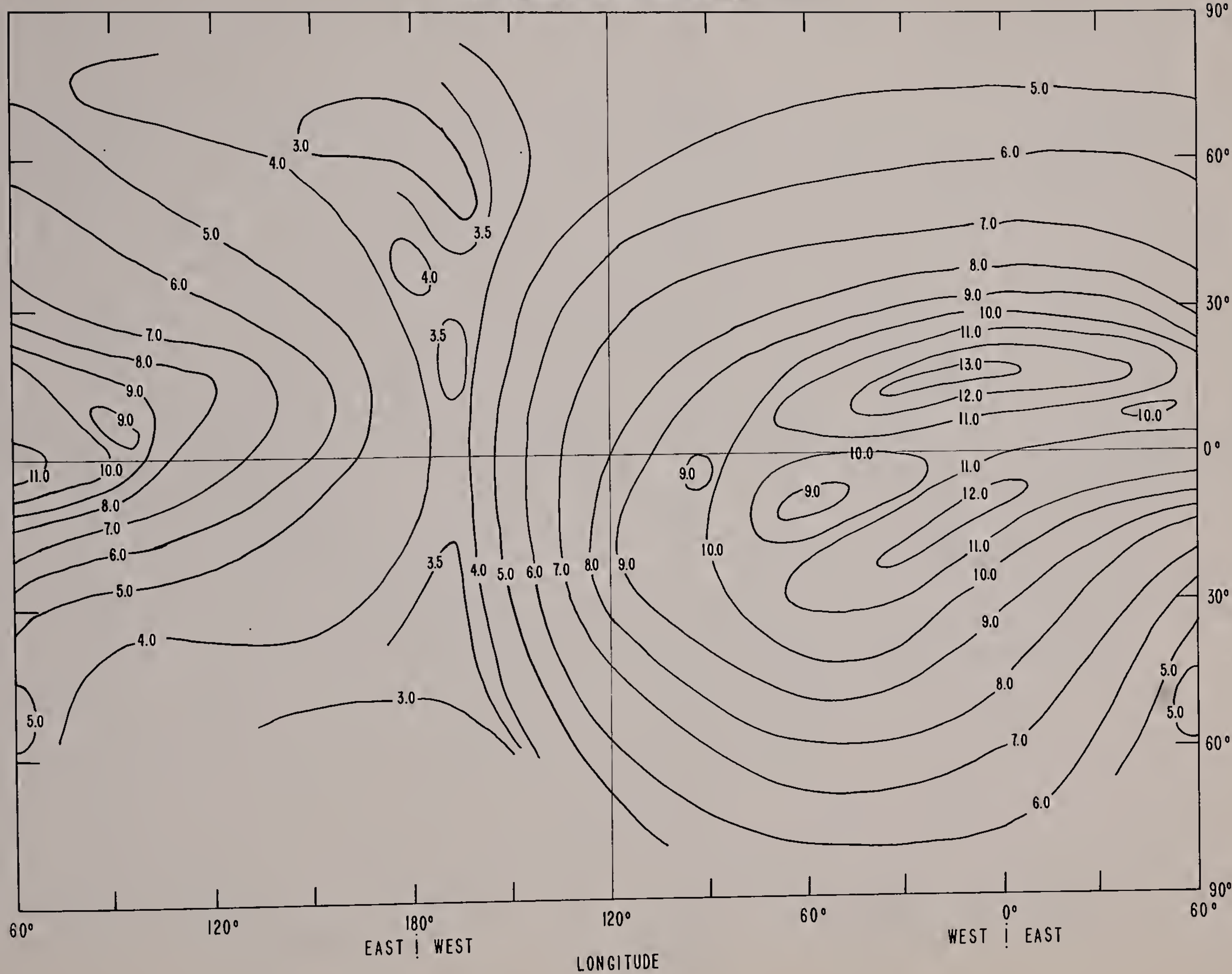
foF2 AT RASSN 50
SEPTEMBER 1200 HOURS GMT



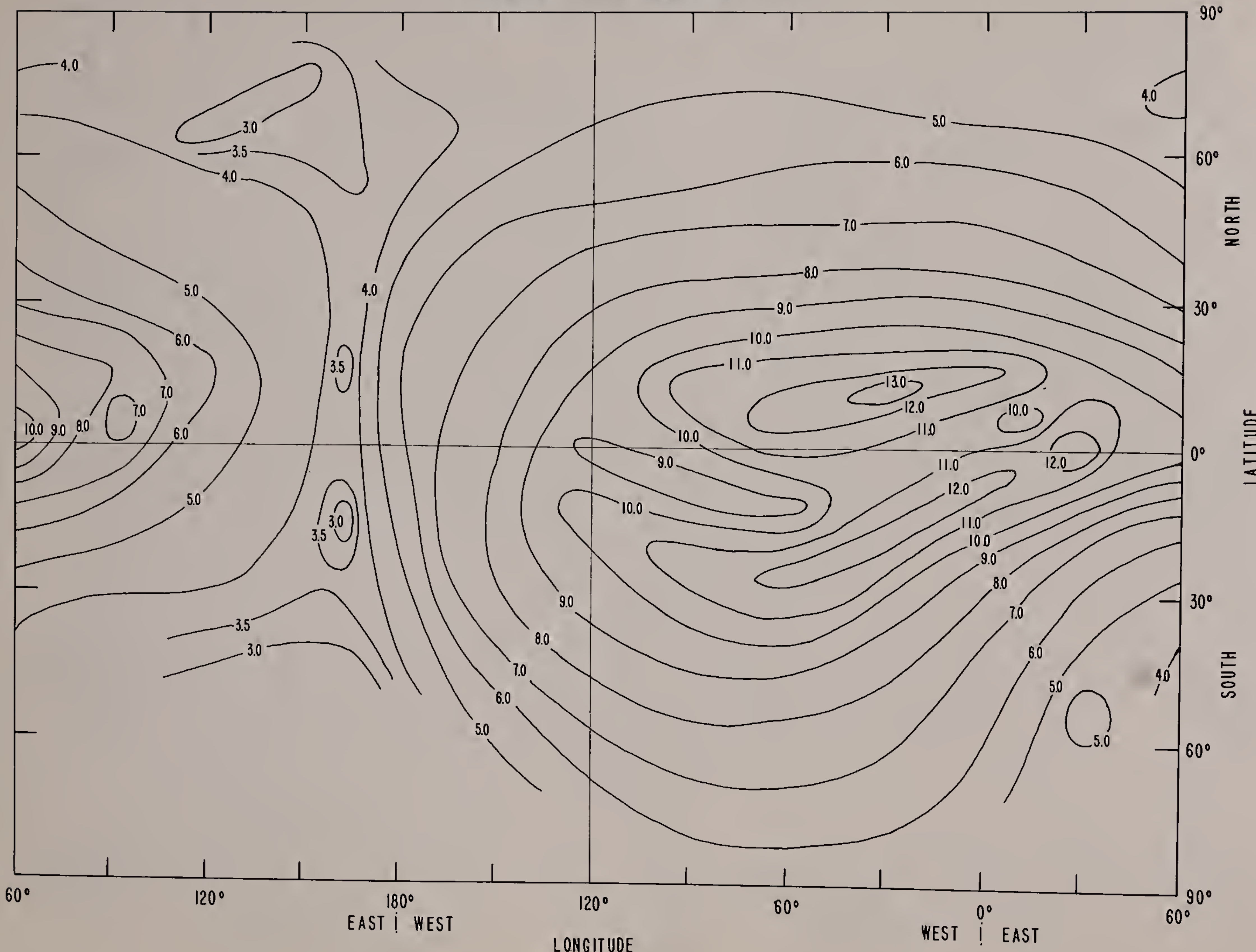
f₀F2 AT RASSN 50
SEPTEMBER 1400 HOURS GMT



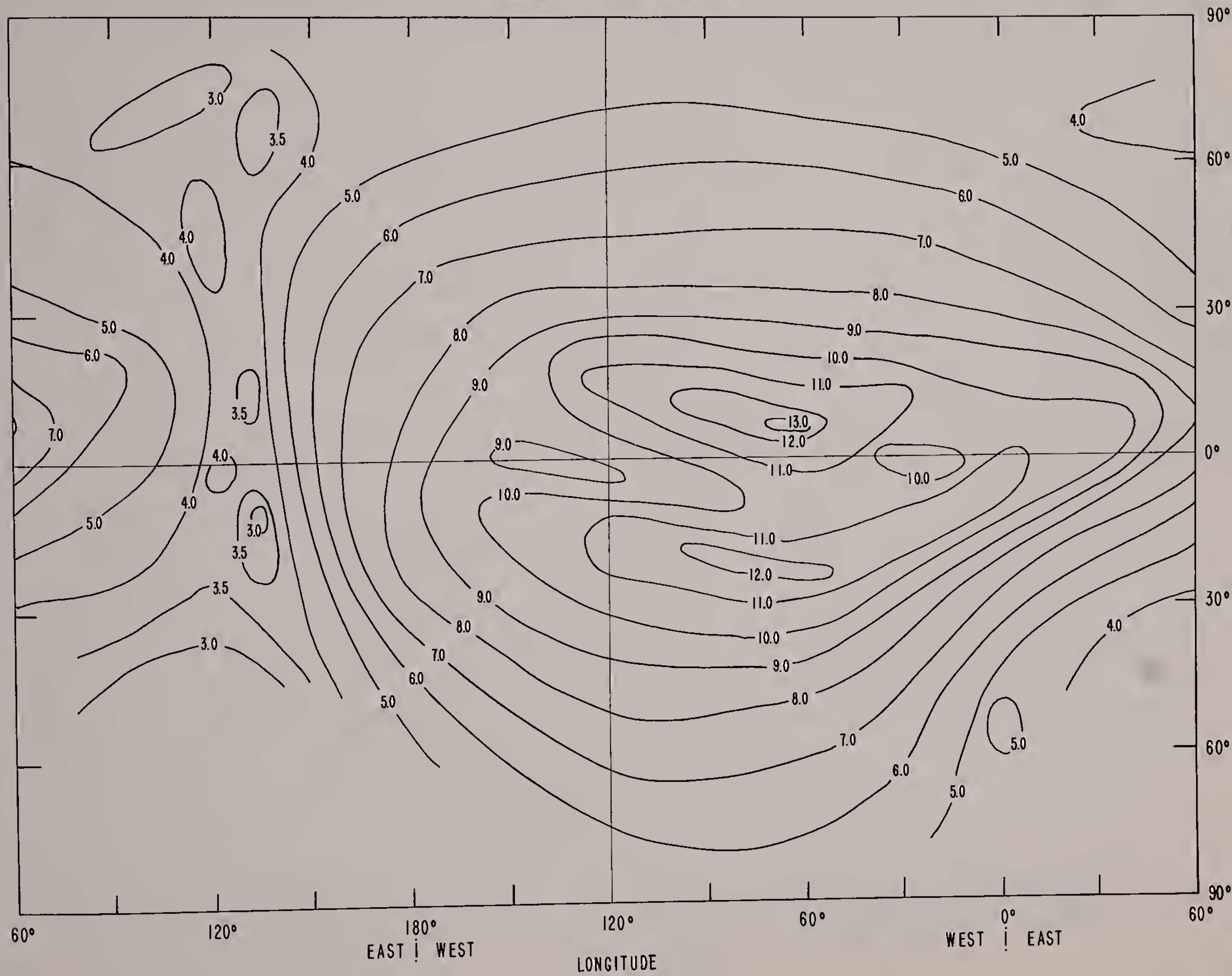
foF2 AT RASSN 50
SEPTEMBER 1600 HOURS GMT



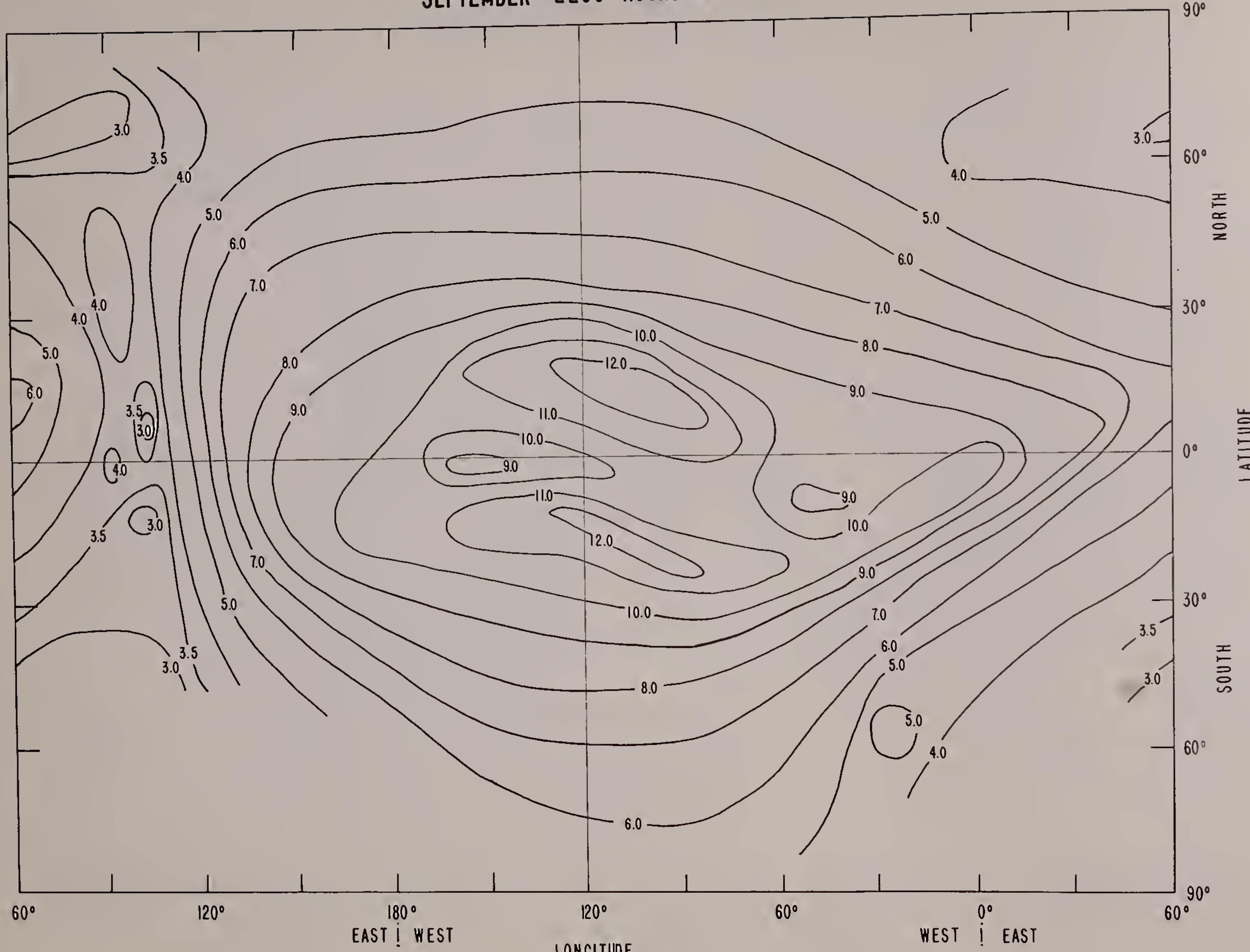
f_oF2 AT RASSN 50
SEPTEMBER 1800 HOURS GMT



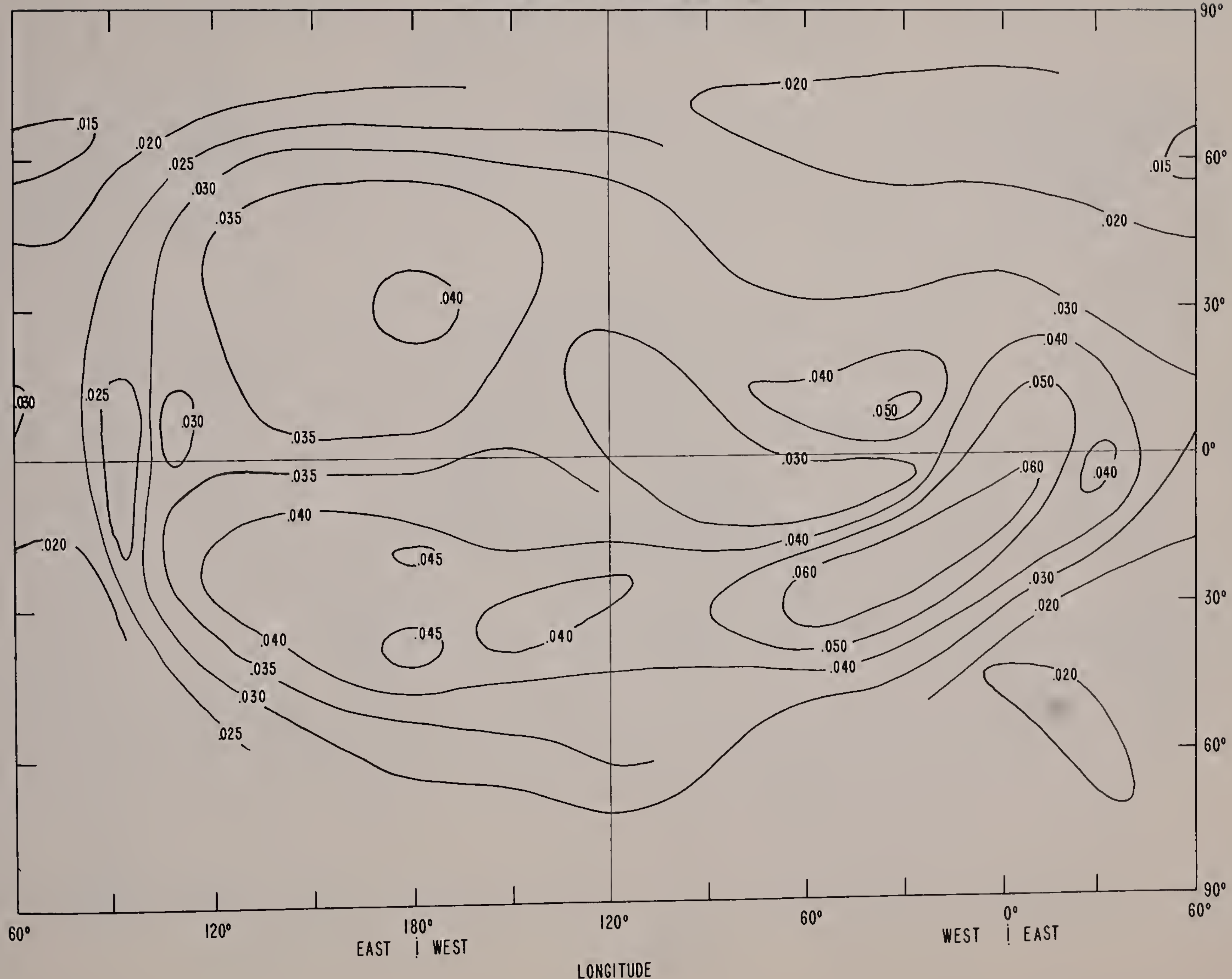
f_oF2 AT RASSN 50
SEPTEMBER 2000 HOURS GMT



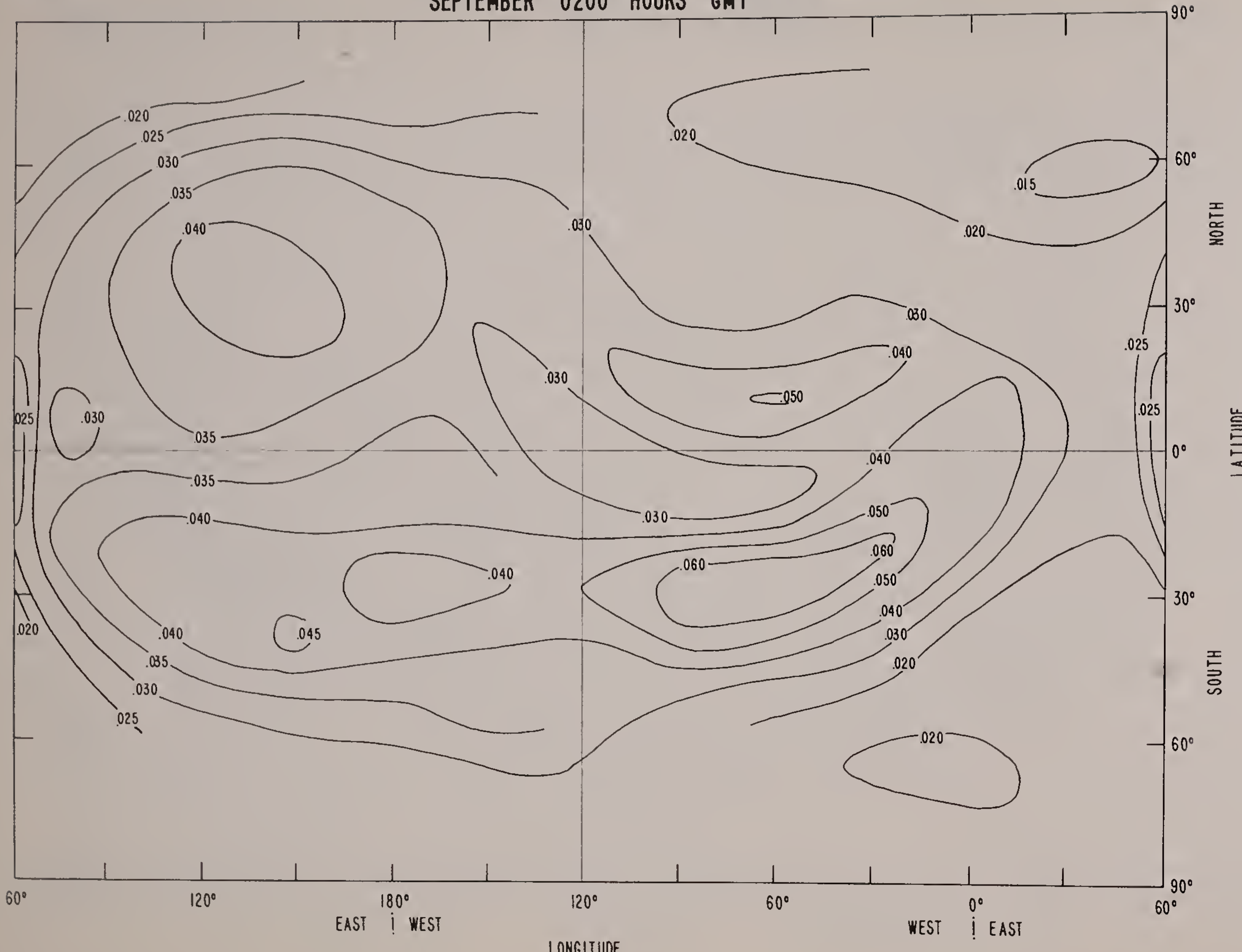
foF2 AT RASSN 50
SEPTEMBER 2200 HOURS GMT



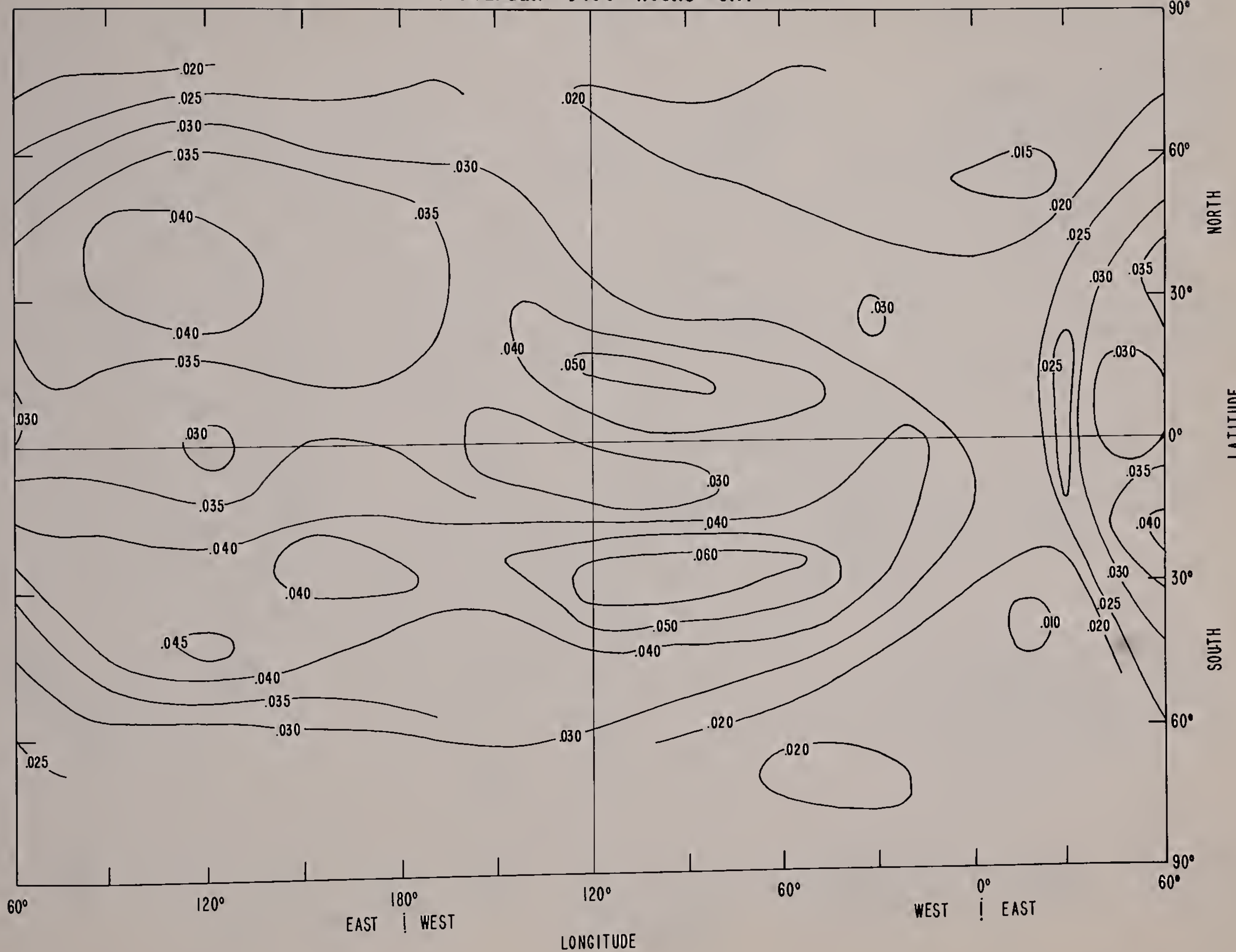
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 0000 HOURS GMT



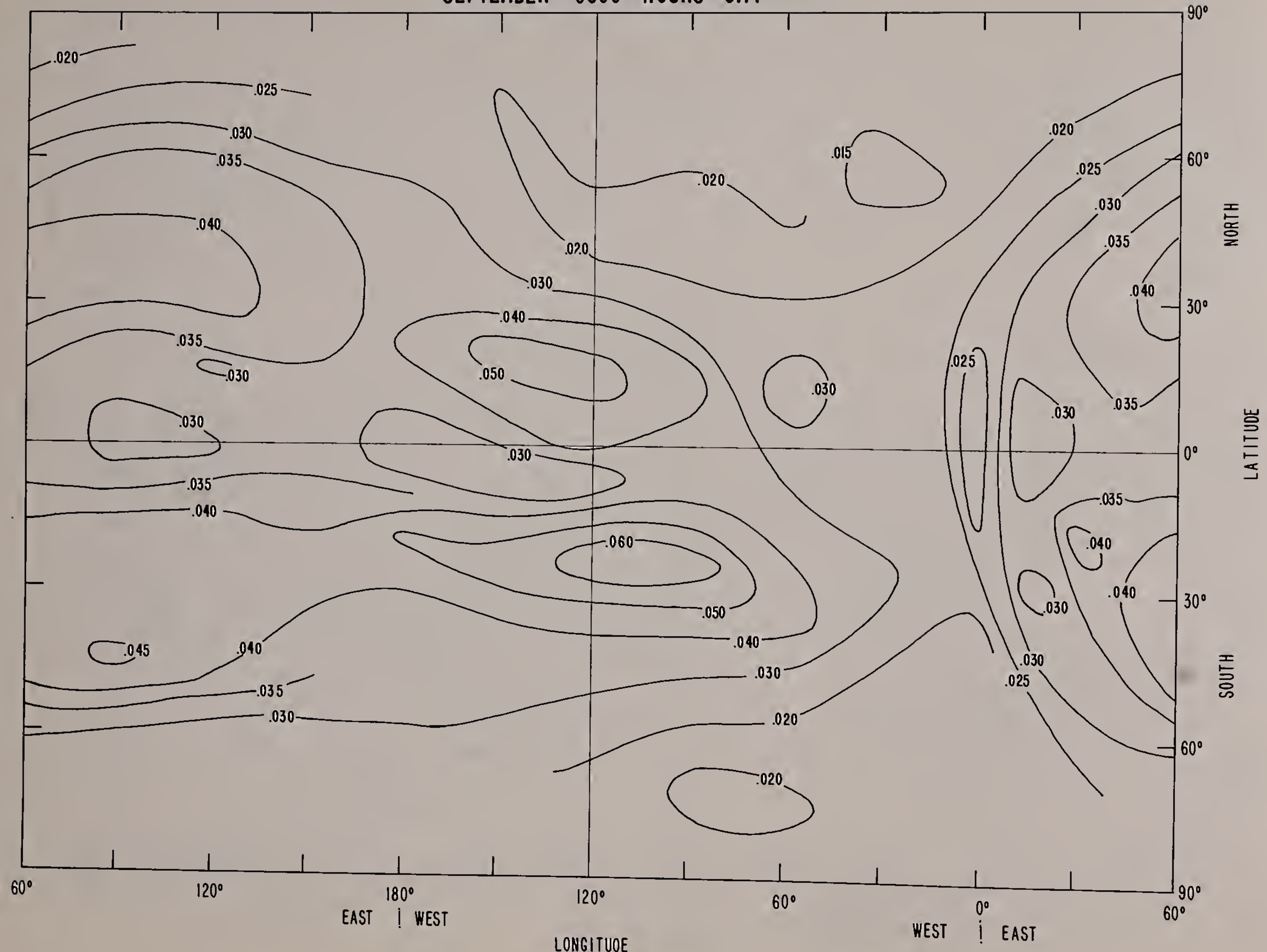
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 0200 HOURS GMT



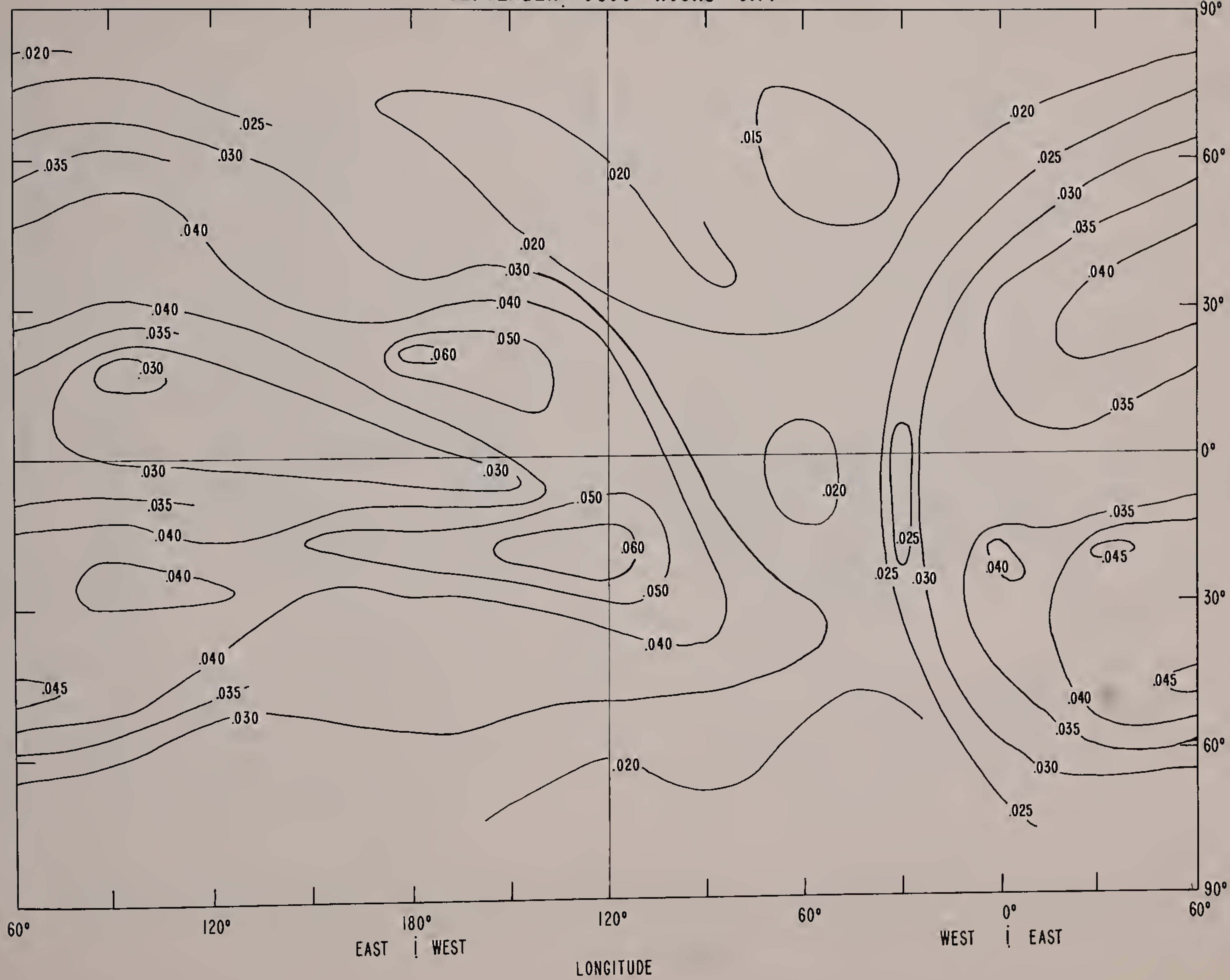
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 0400 HOURS GMT



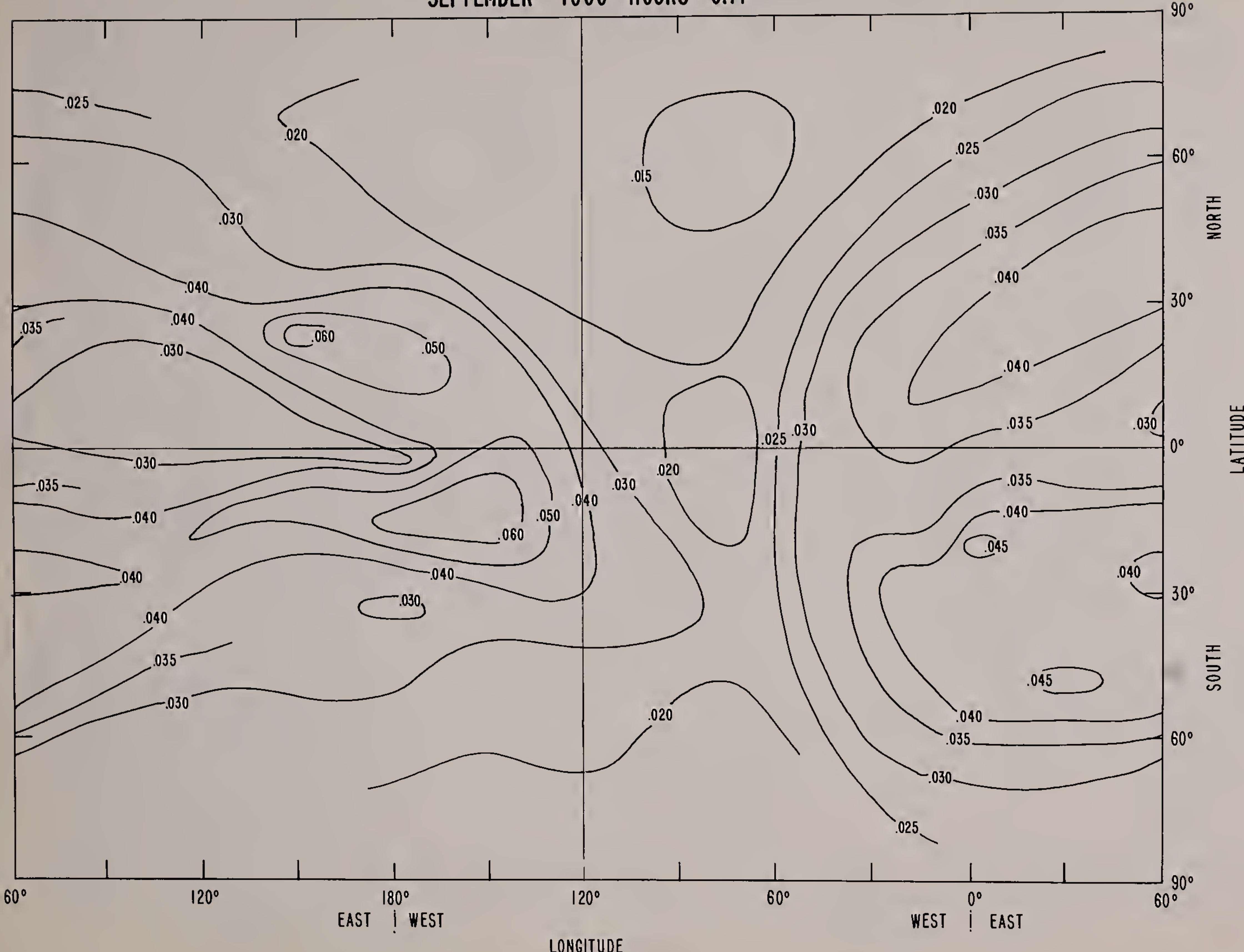
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 0600 HOURS GMT



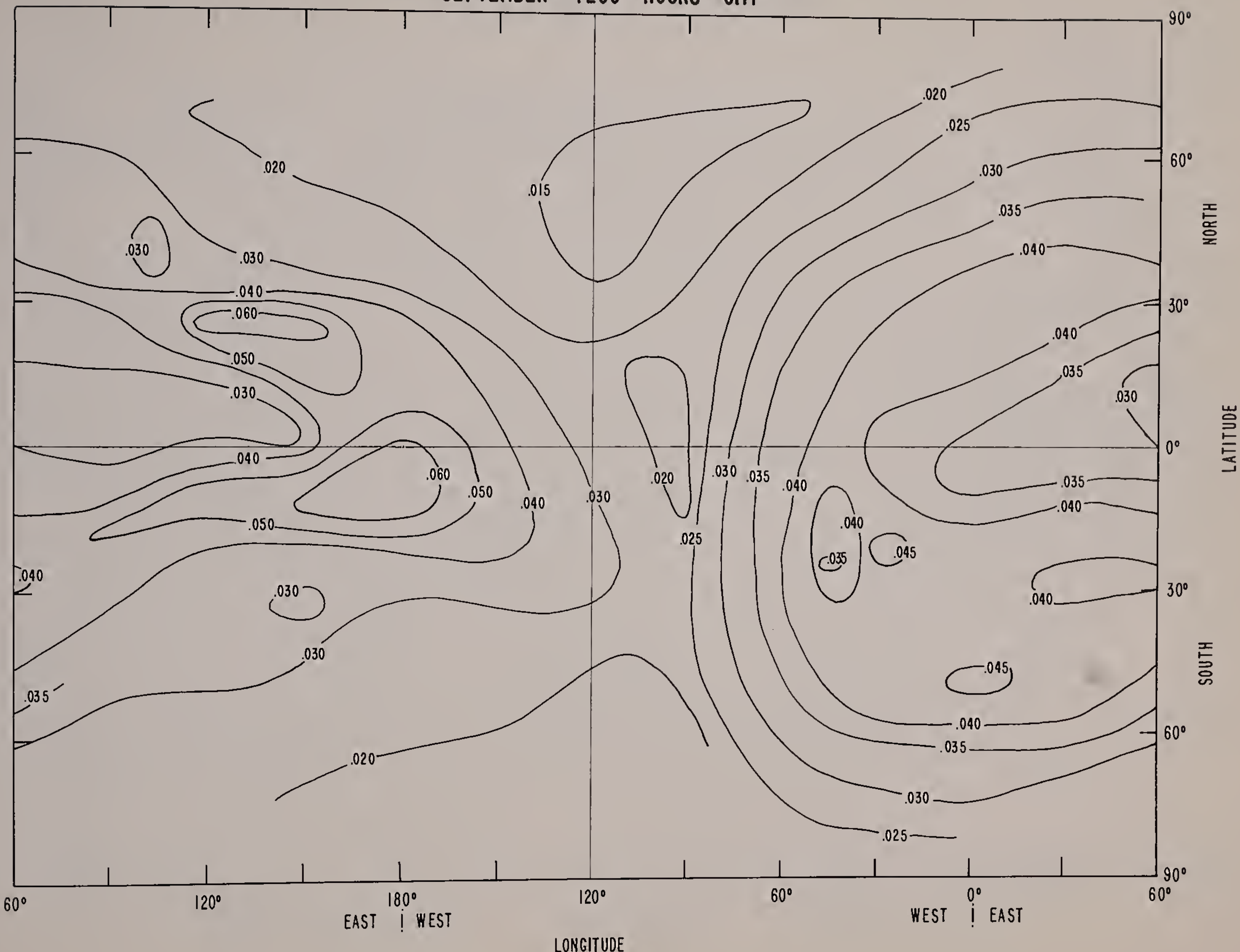
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 0800 HOURS GMT



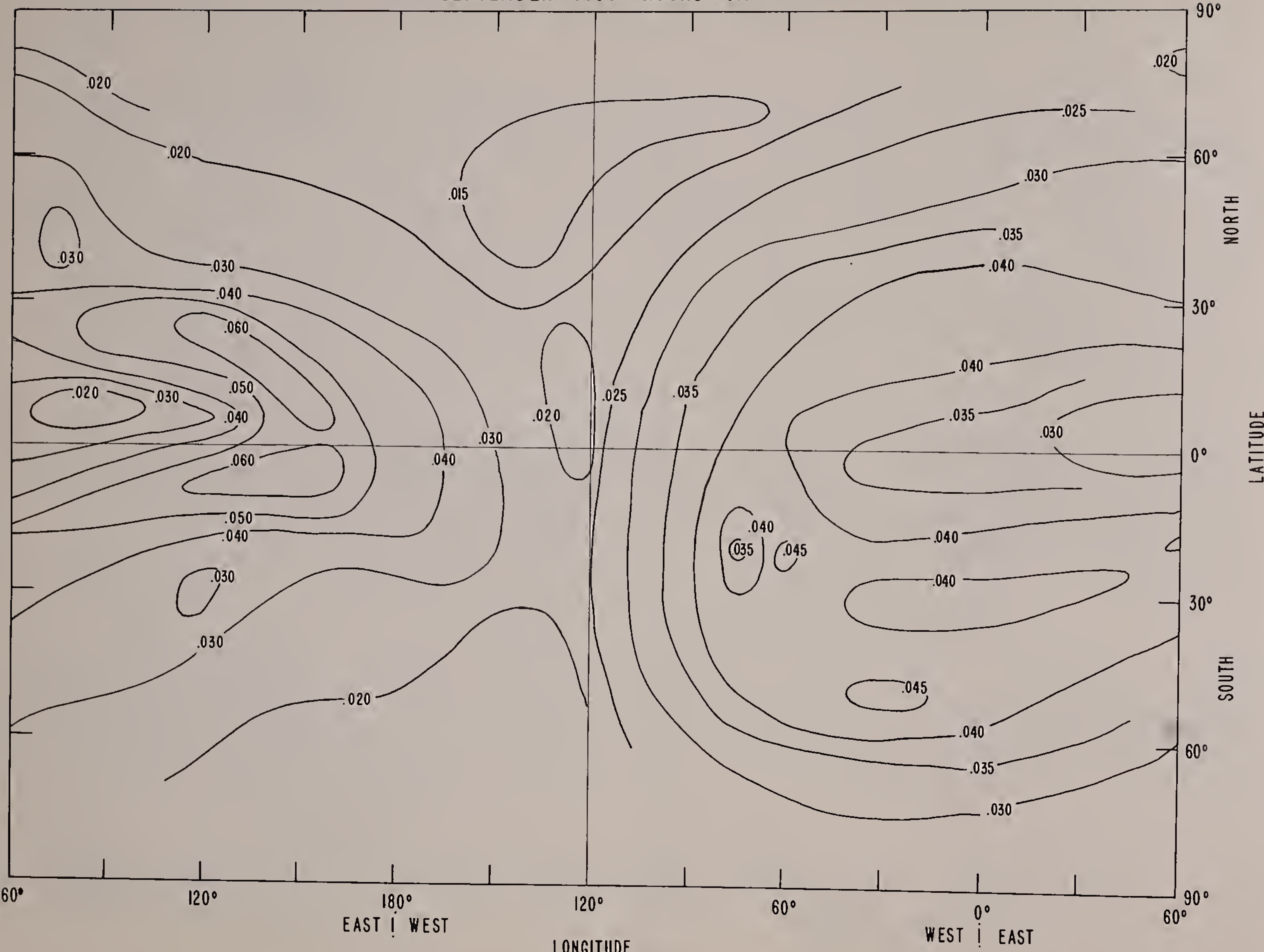
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 1000 HOURS GMT



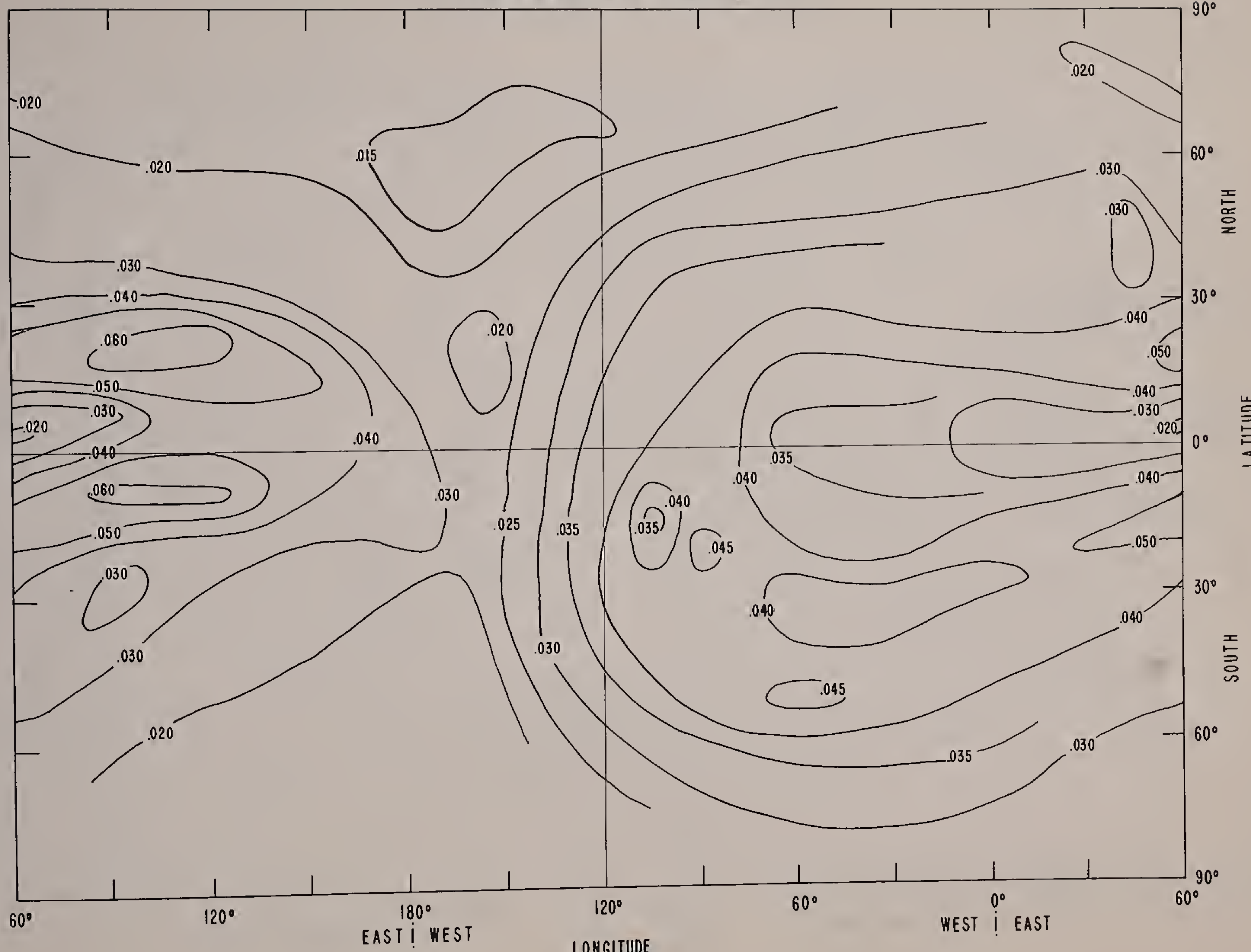
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 1200 HOURS GMT



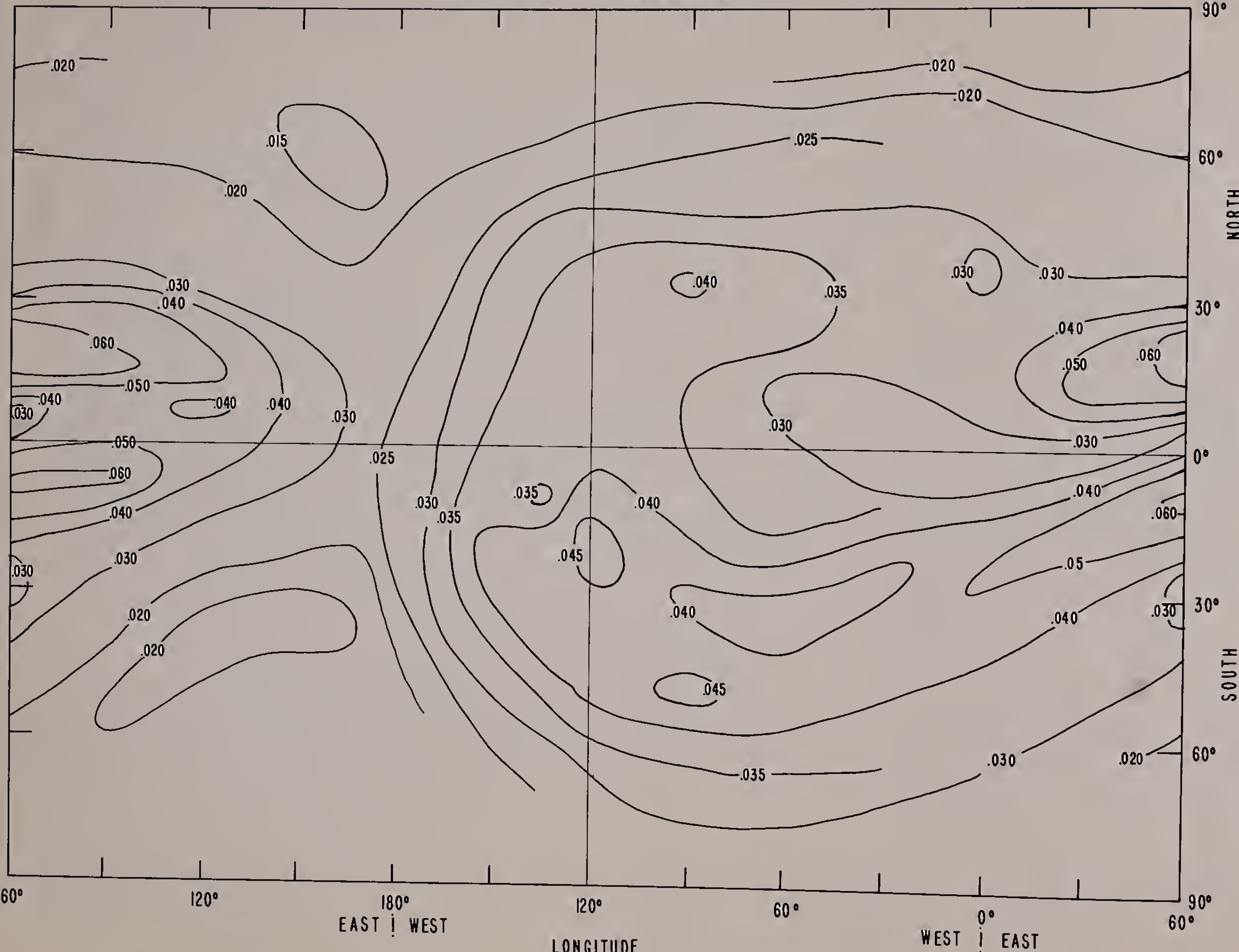
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 1400 HOURS GMT



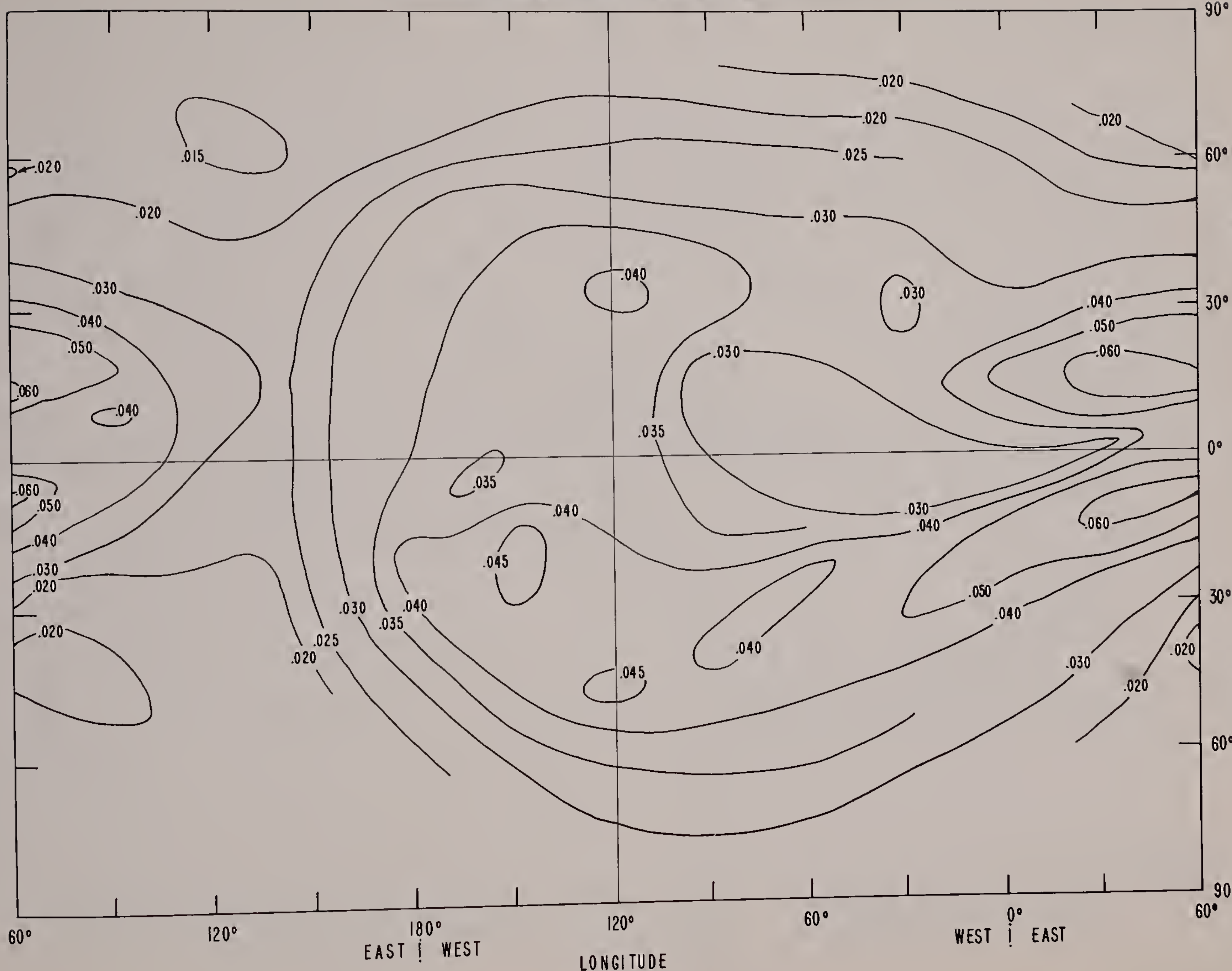
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 1600 HOURS GMT



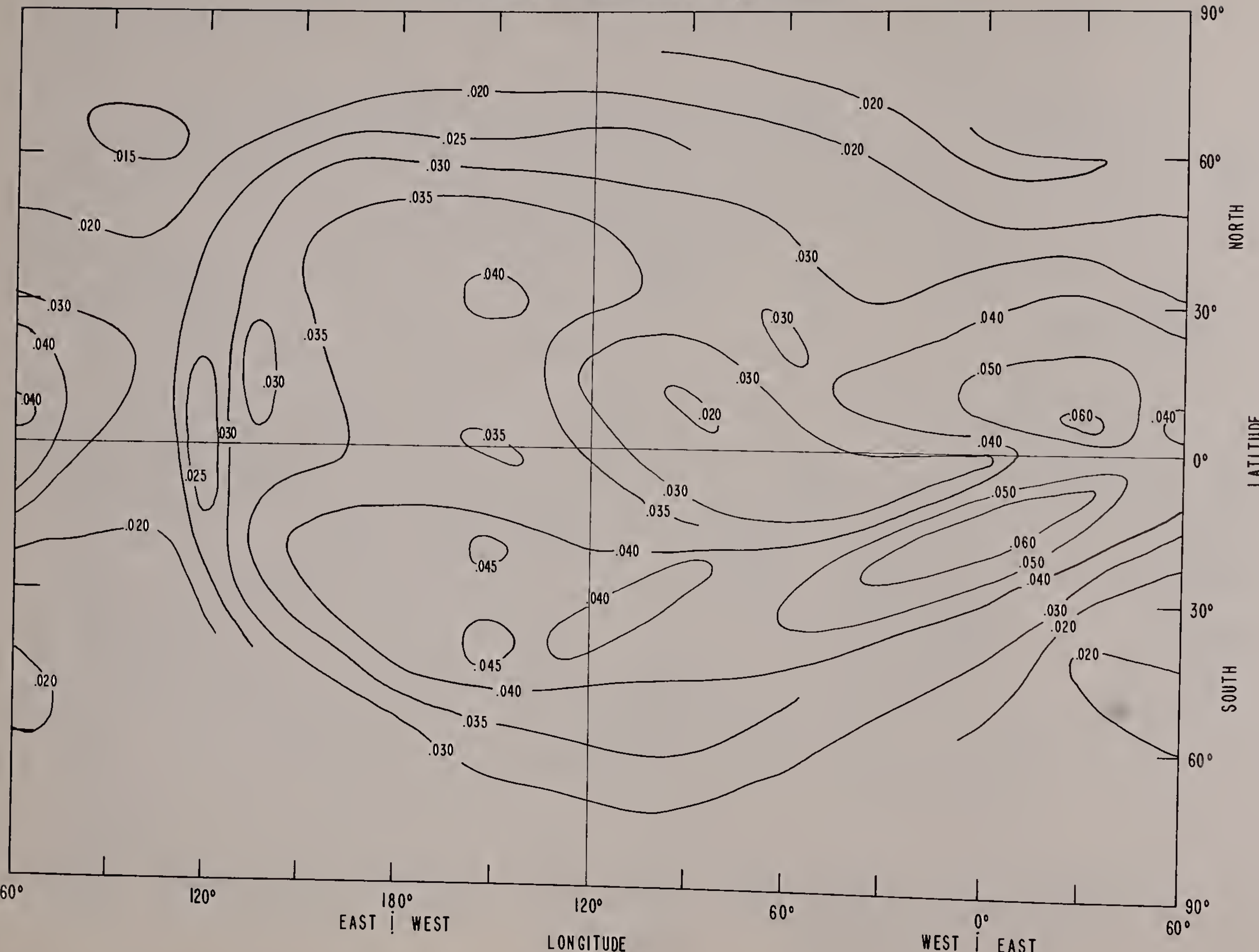
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 1800 HOURS GMT



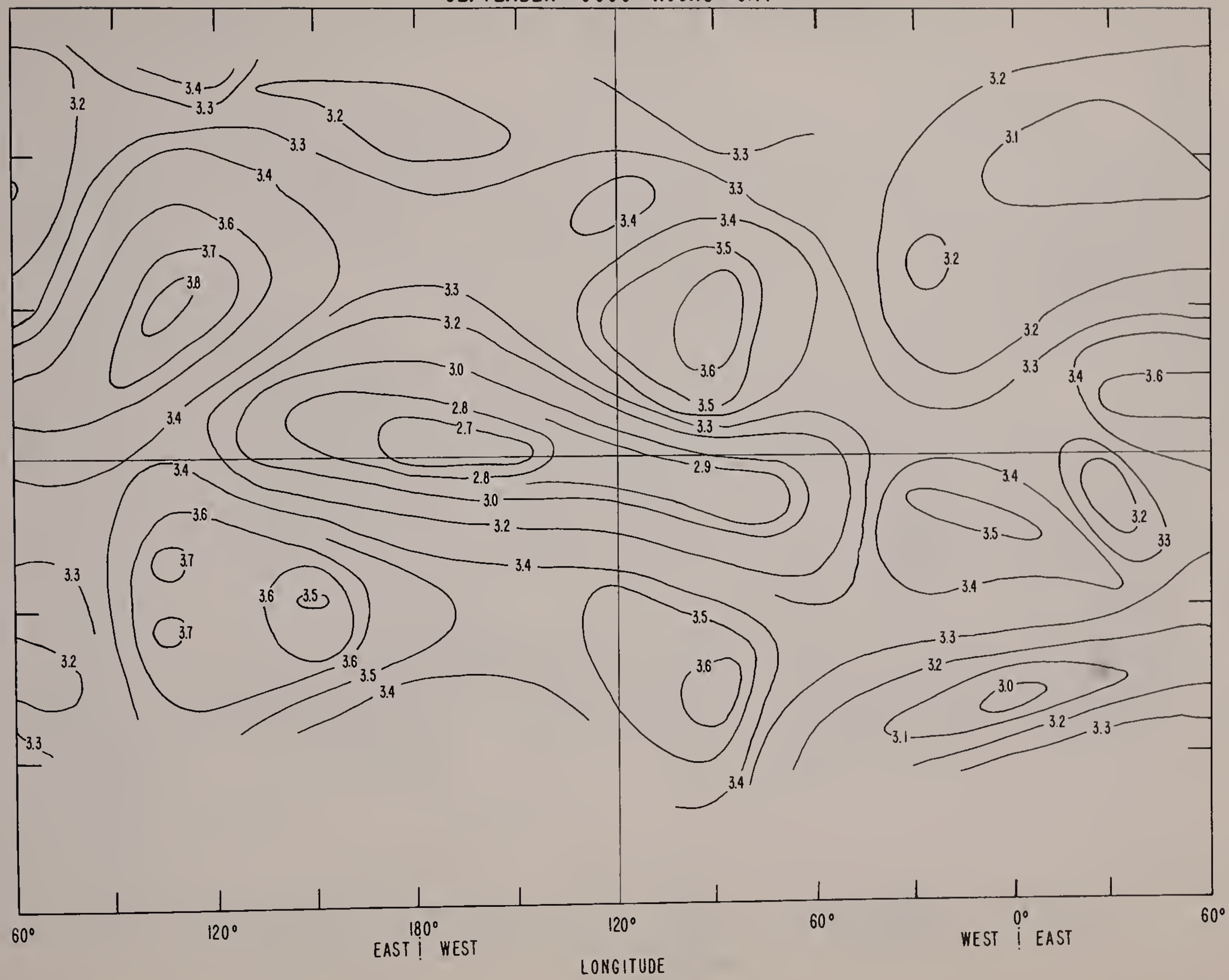
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 2000 HOURS GMT

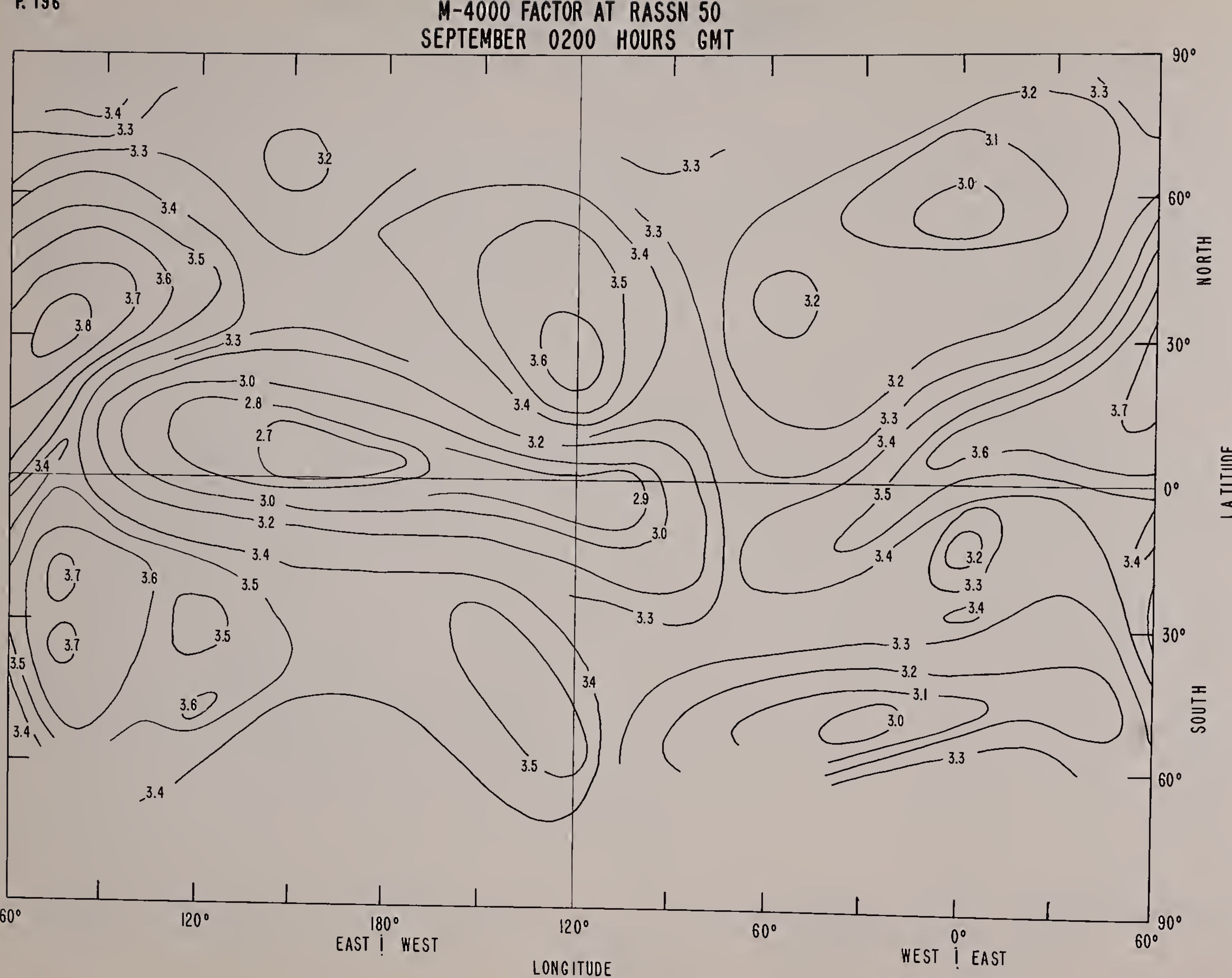


SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
SEPTEMBER 2200 HOURS GMT

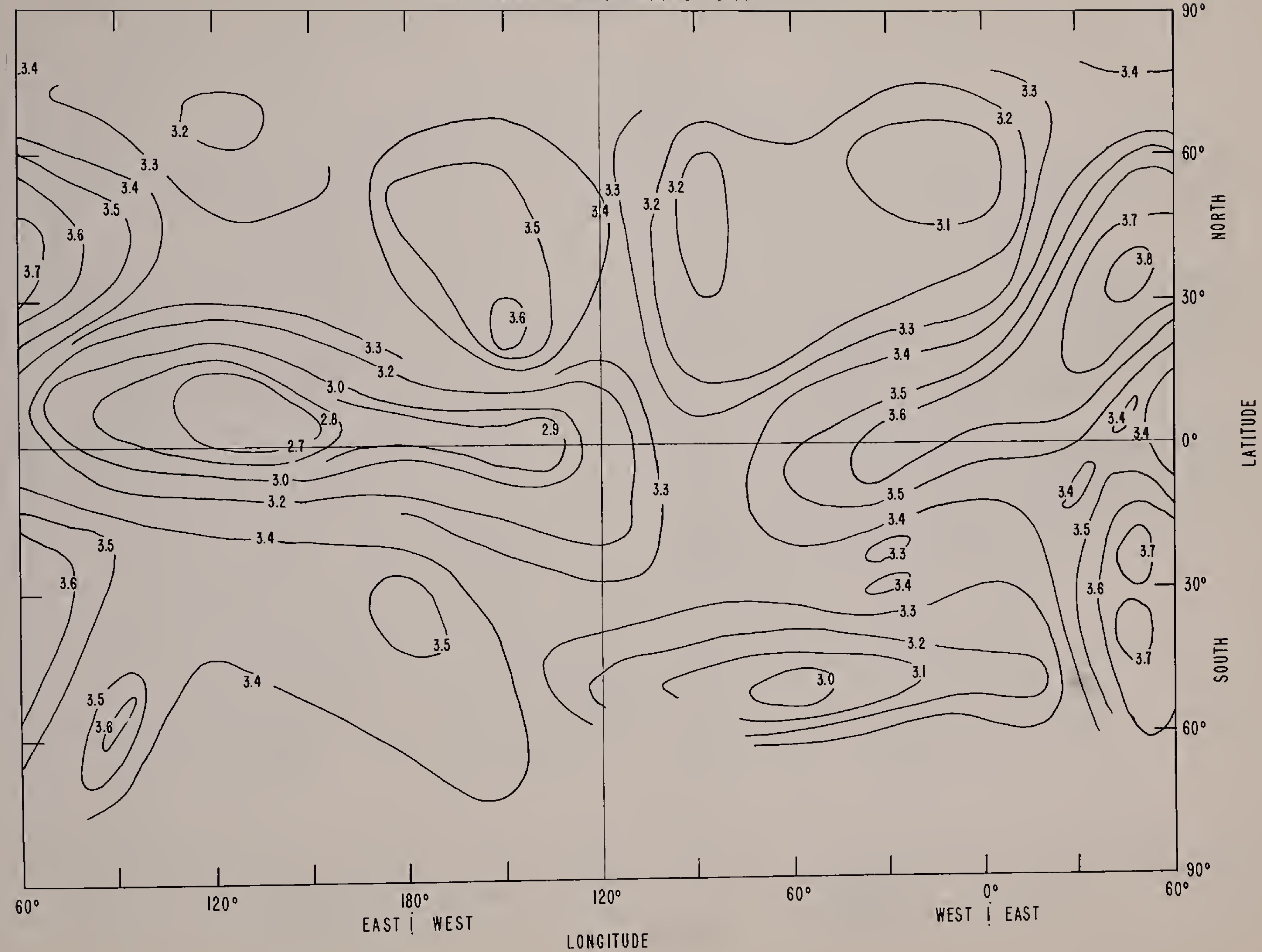


M-4000 FACTOR AT RASSN 50
SEPTEMBER 0000 HOURS GMT

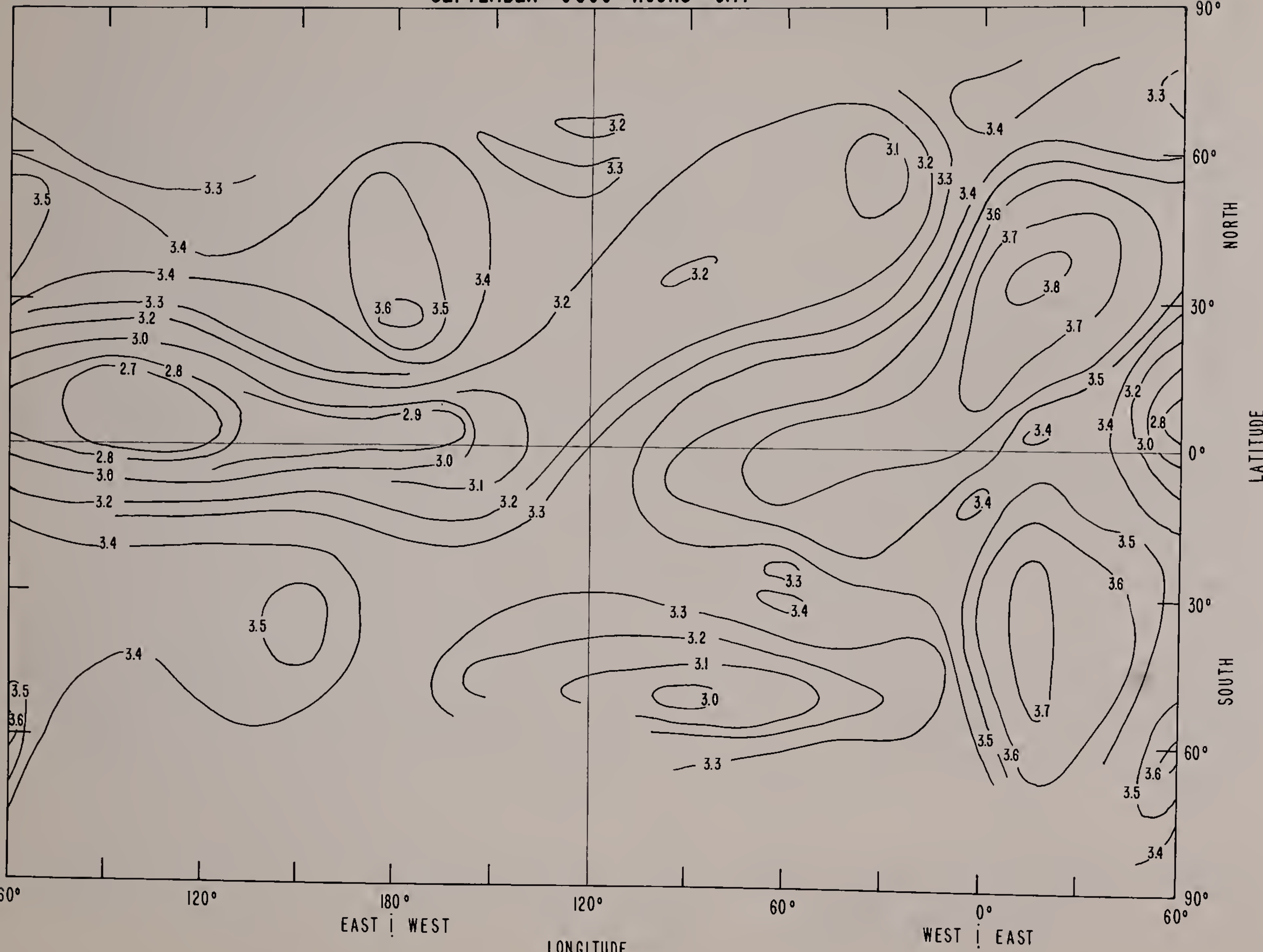



M-4000 FACTOR AT RASSN 50
SEPTEMBER 0200 HOURS GMT
90°
60°
30°
0°
30°
60°
90°
NORTH
LATITUDE
SOUTH
60°
120°
180°
EAST | WEST
120°
60°
0°
WEST | EAST
60°
LONGITUDE
3.4
3.3
3.2
3.5
3.6
3.7
3.8
3.0
2.8
2.7
2.9
3.1

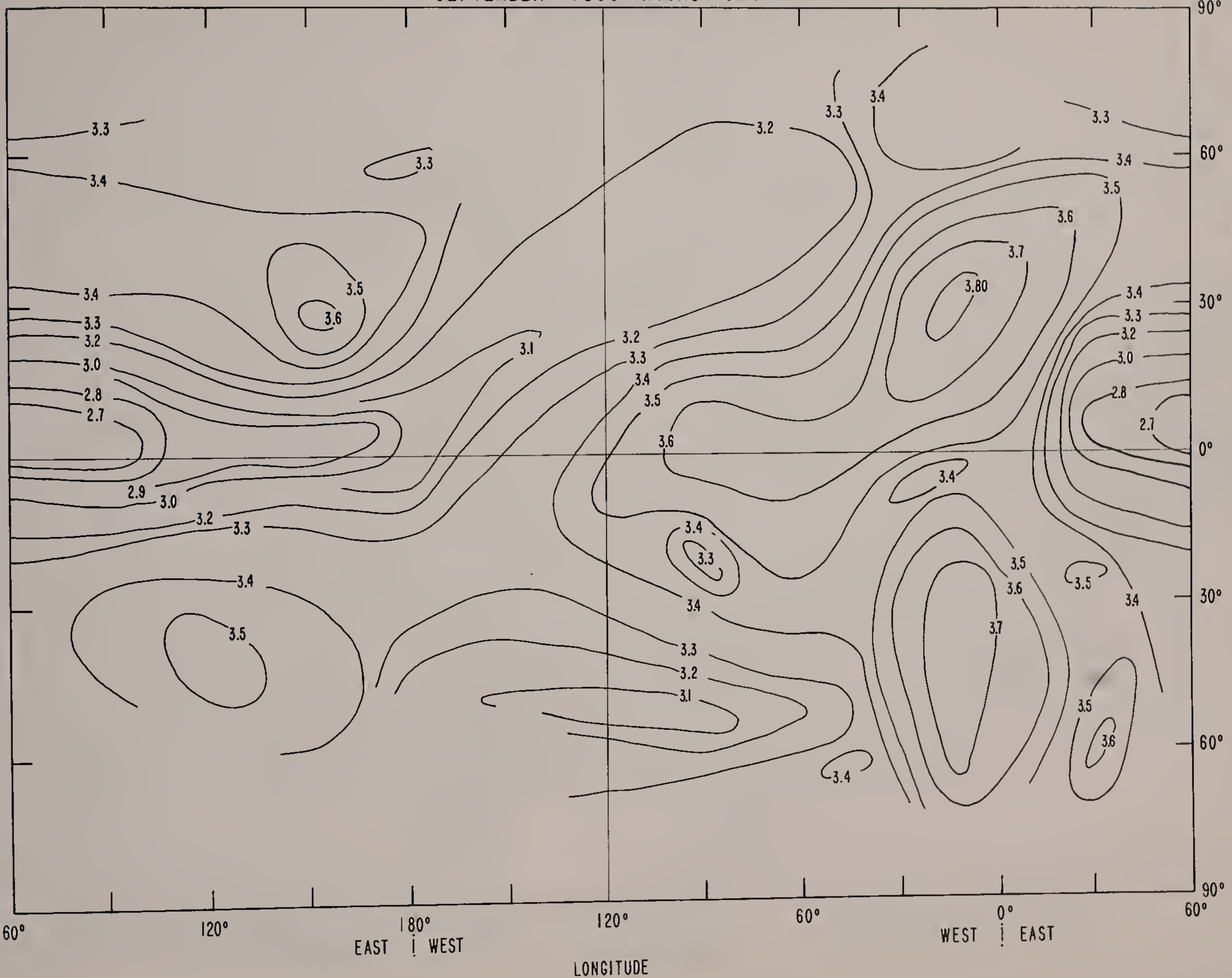
M-4000 FACTOR AT RASSN 50
SEPTEMBER 0400 HOURS GMT



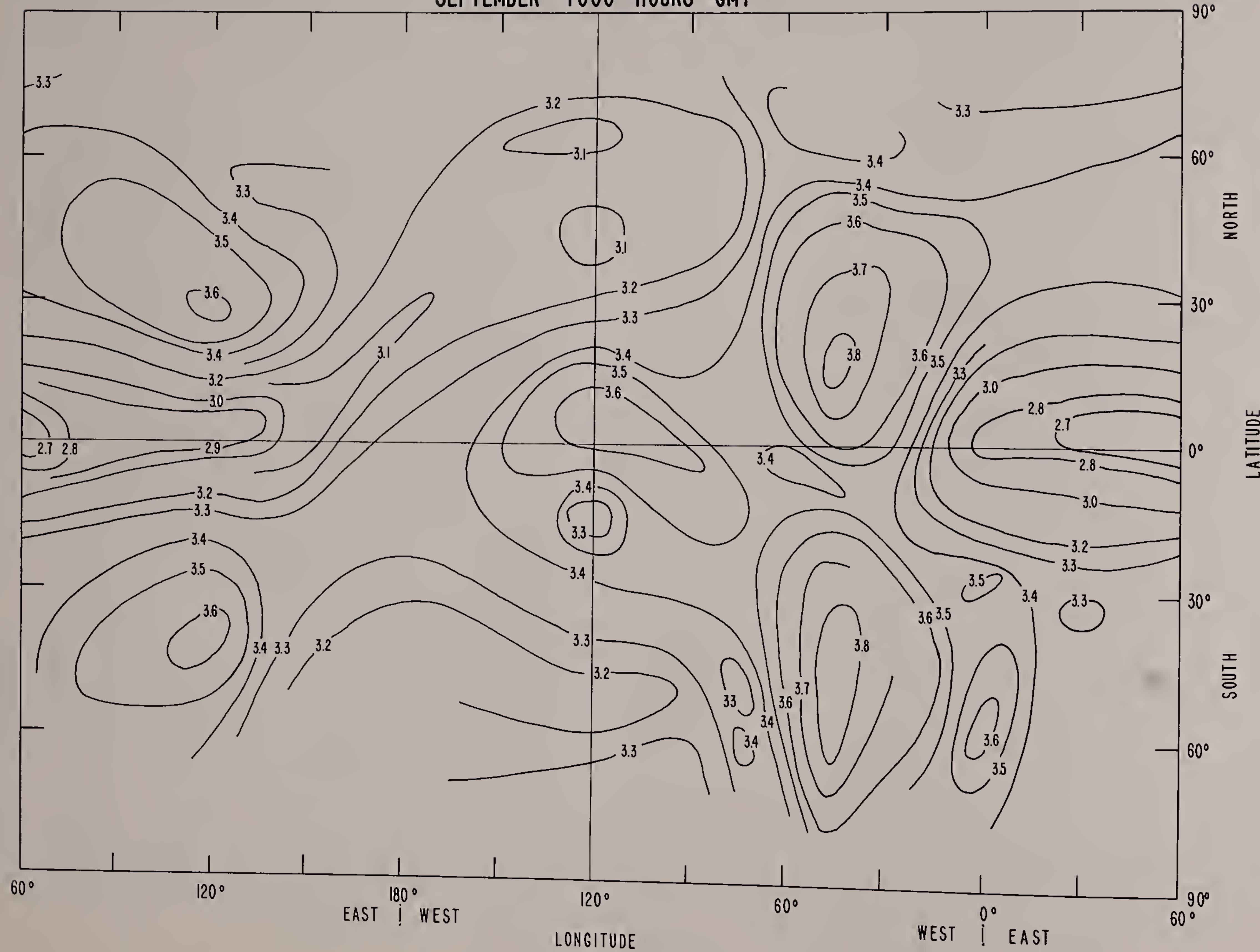
M-4000 FACTOR AT RASSN 50
SEPTEMBER 0600 HOURS GMT



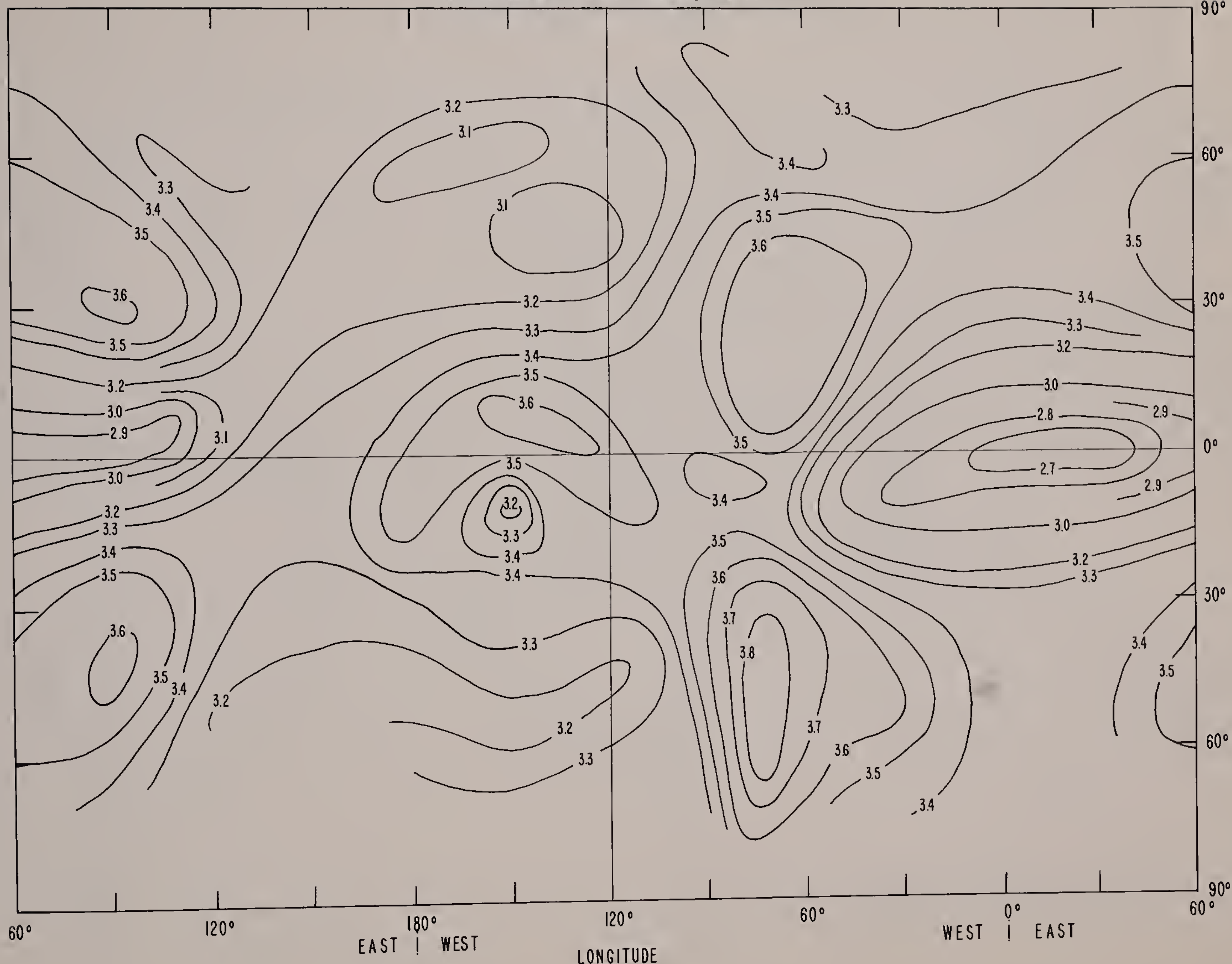
M-4000 FACTOR AT RASSN 50
SEPTEMBER 0800 HOURS GMT



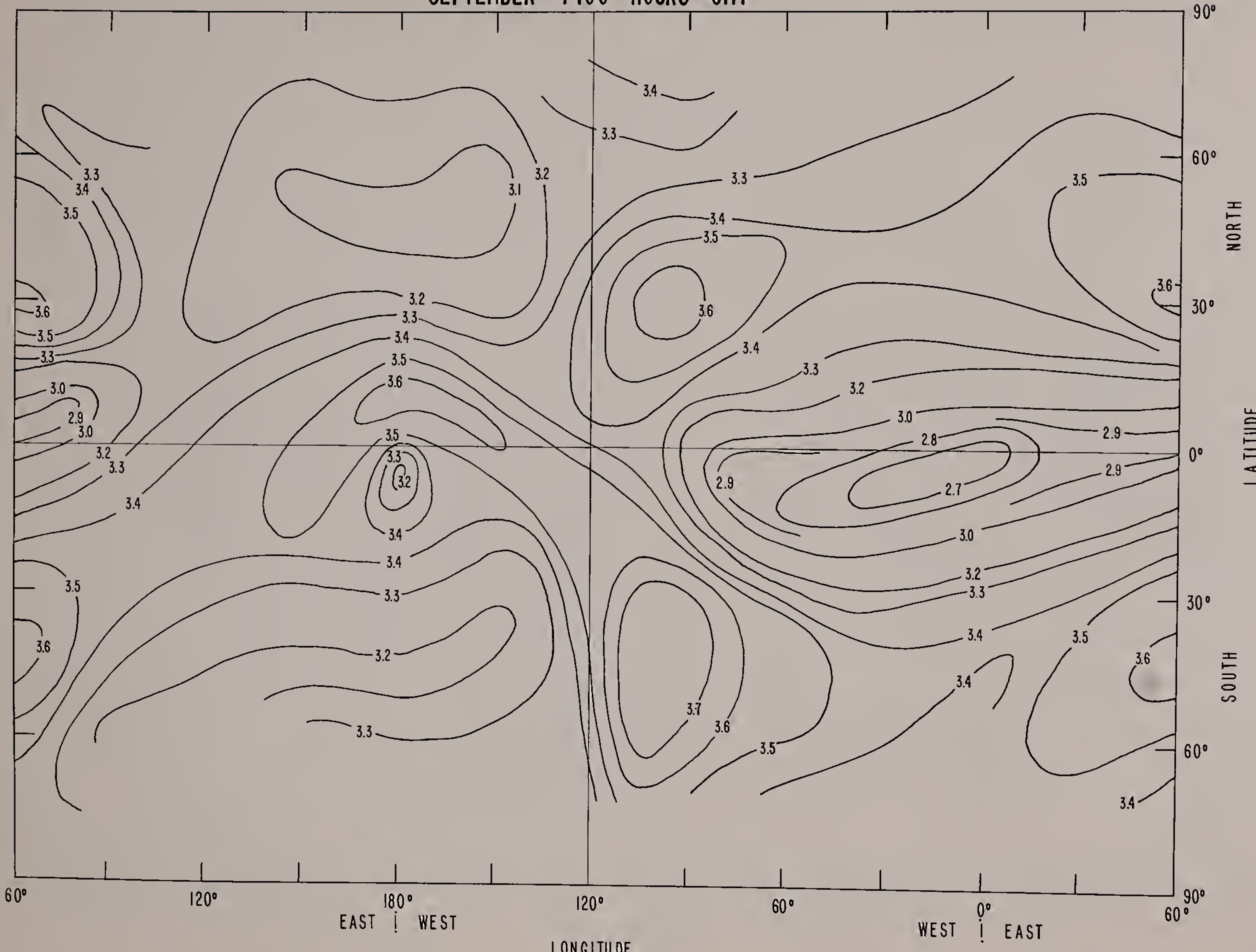
M-4000 FACTOR AT RASSN 50
SEPTEMBER 1000 HOURS GMT



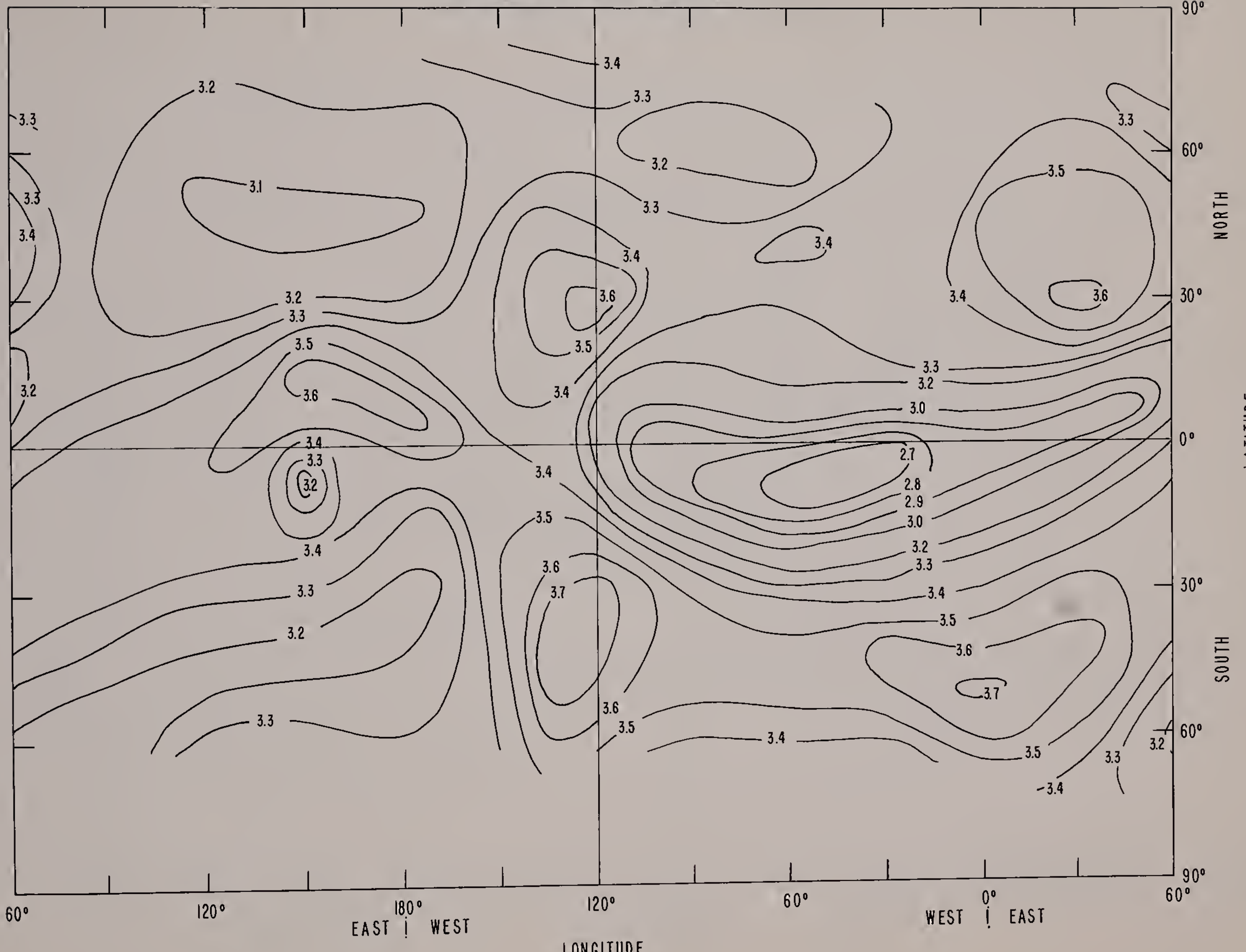
M-4000 FACTOR AT RASSN 50
SEPTEMBER 1200 HOURS GMT



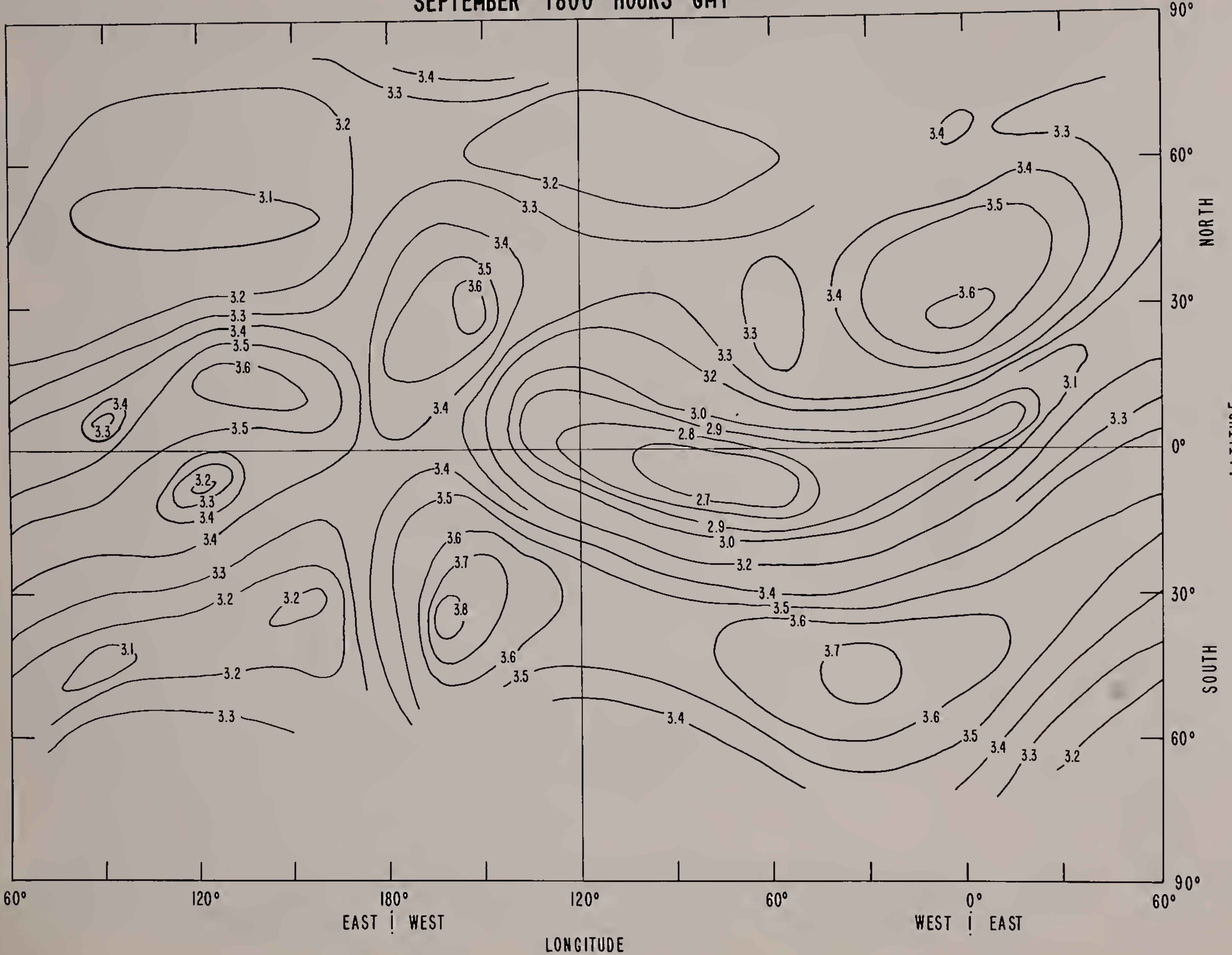
M-4000 FACTOR AT RASSN 50
SEPTEMBER 1400 HOURS GMT



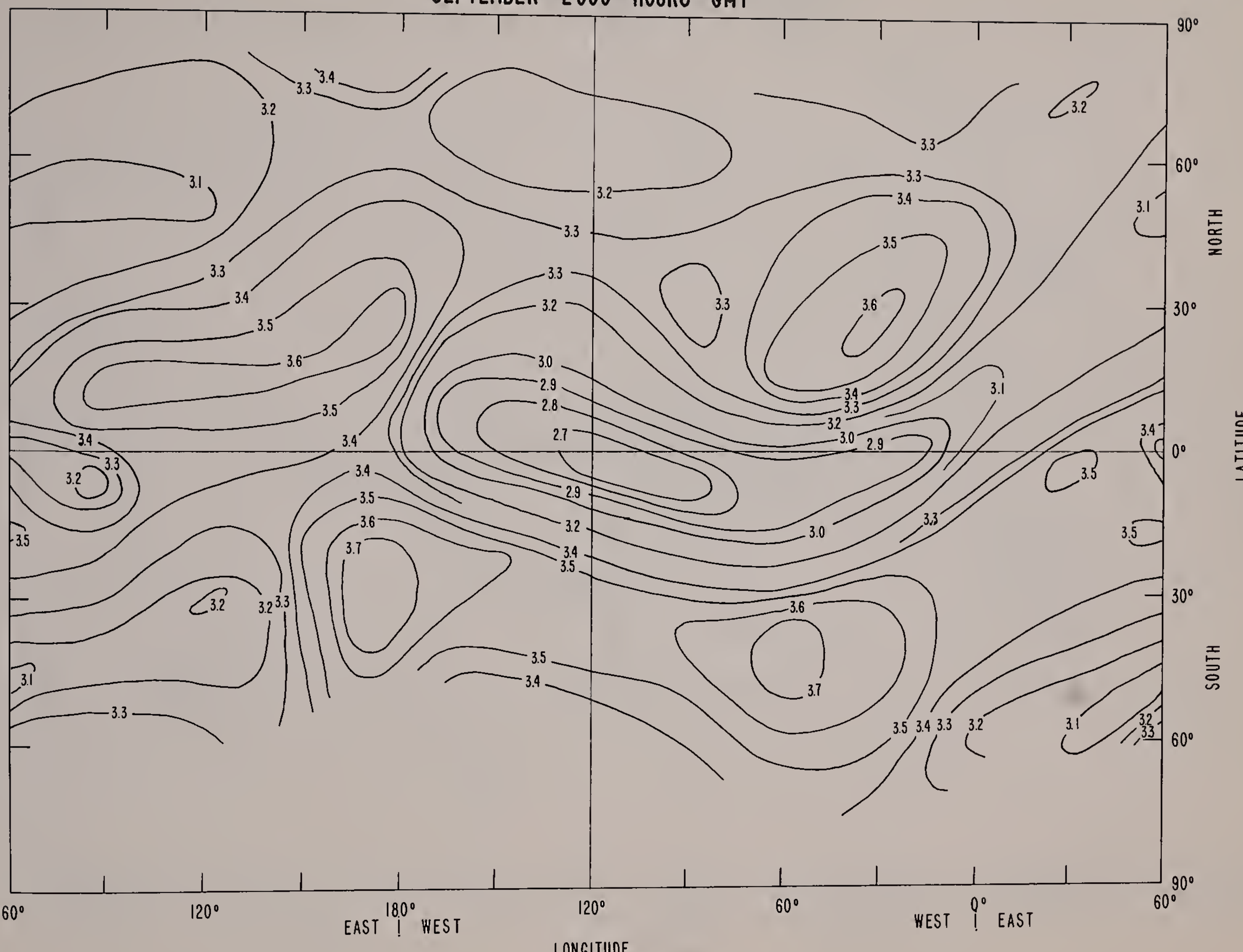
M-4000 FACTOR AT RASSN 50
SEPTEMBER 1600 HOURS GMT



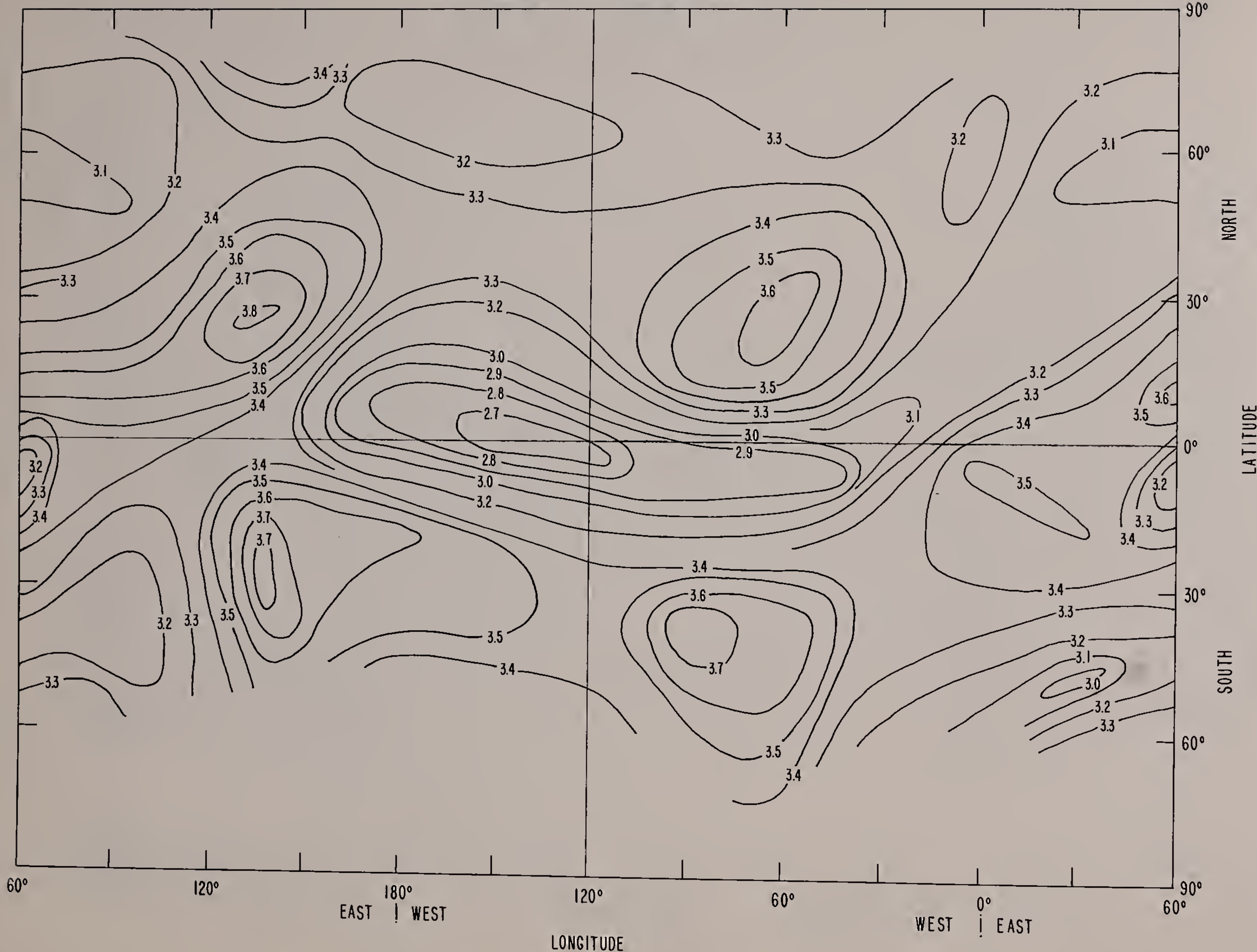
M-4000 FACTOR AT RASSN 50
SEPTEMBER 1800 HOURS GMT



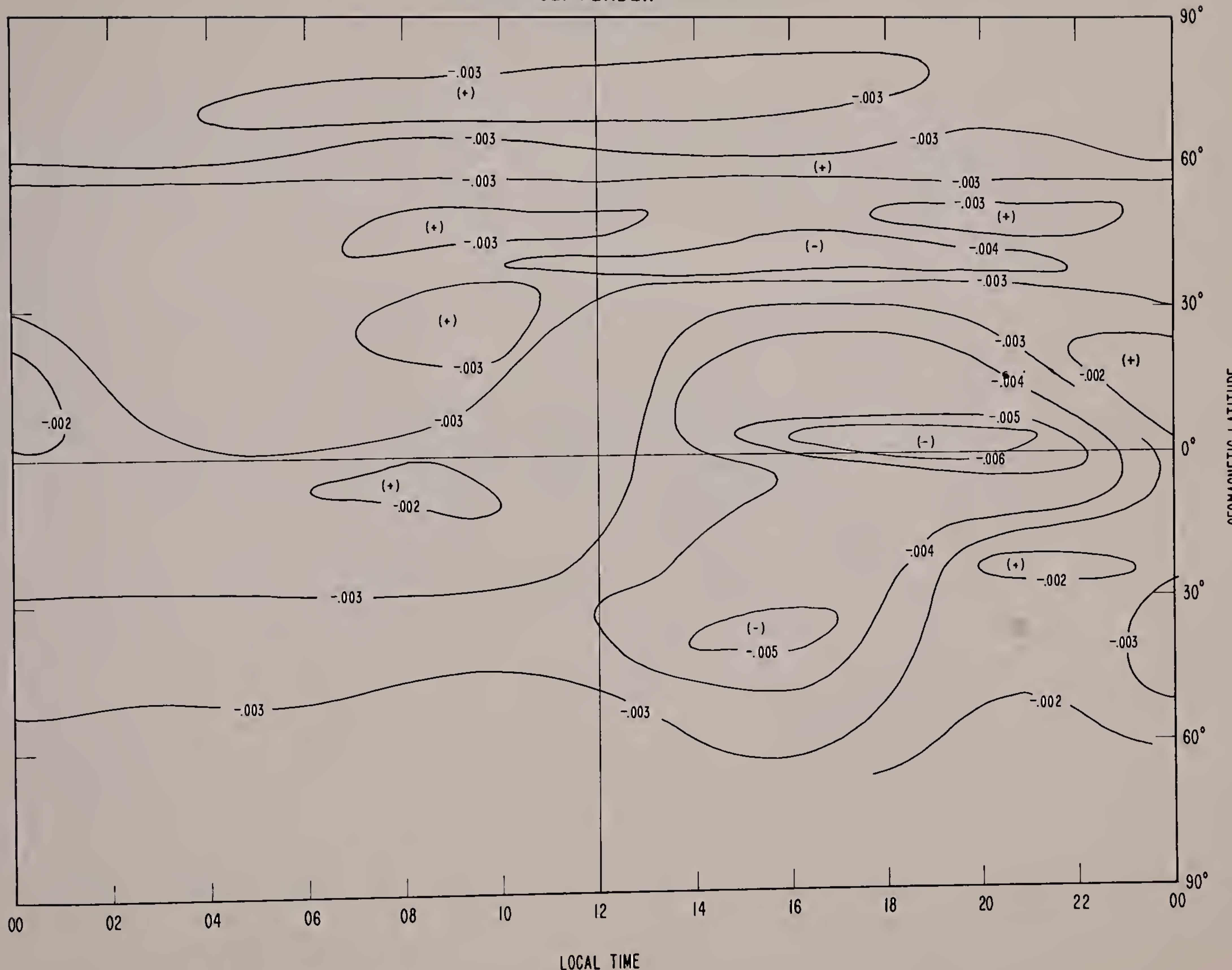
M-4000 FACTOR AT RASSN 50
SEPTEMBER 2000 HOURS GMT



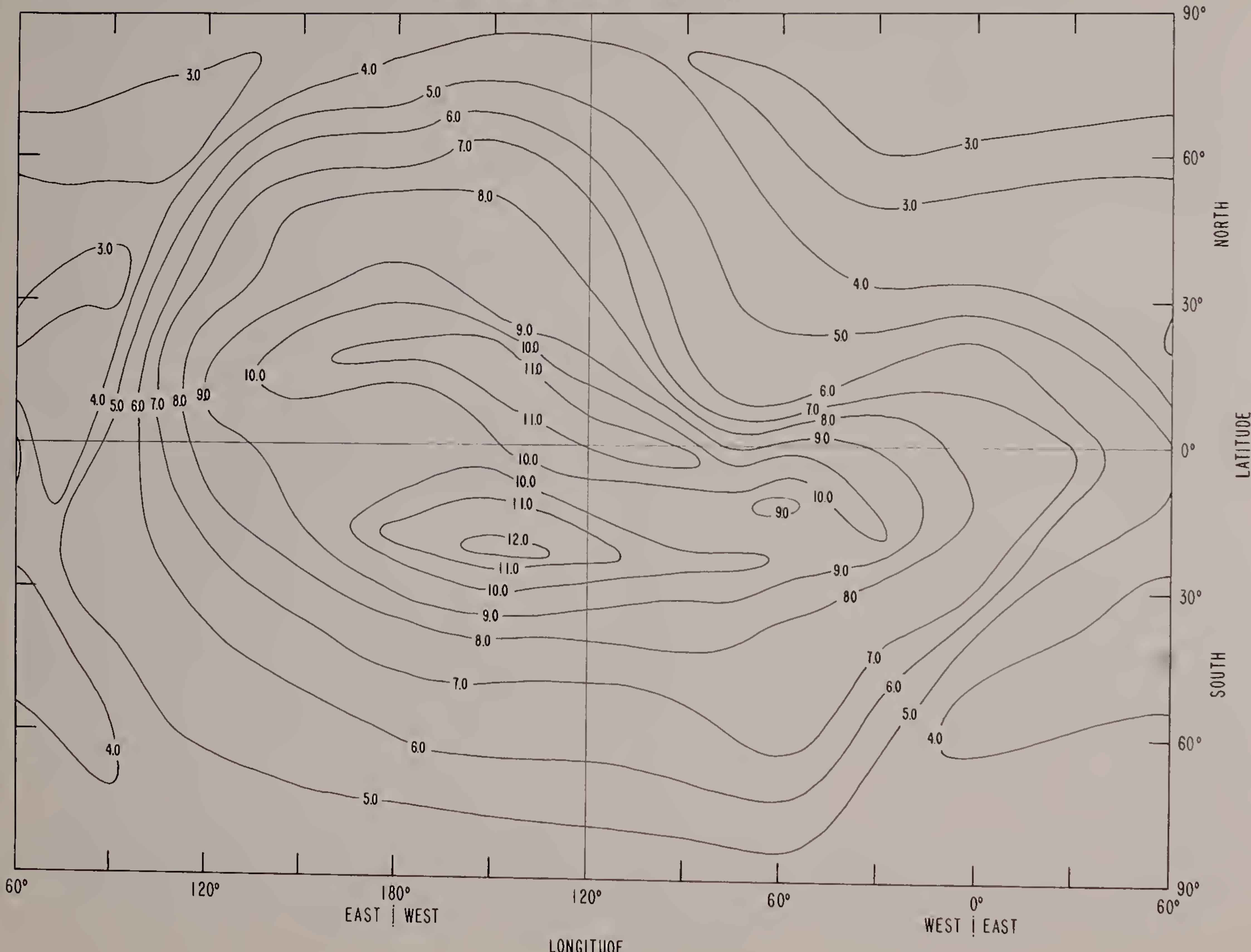
M-4000 FACTOR AT RASSN 50
SEPTEMBER 2200 HOURS GMT



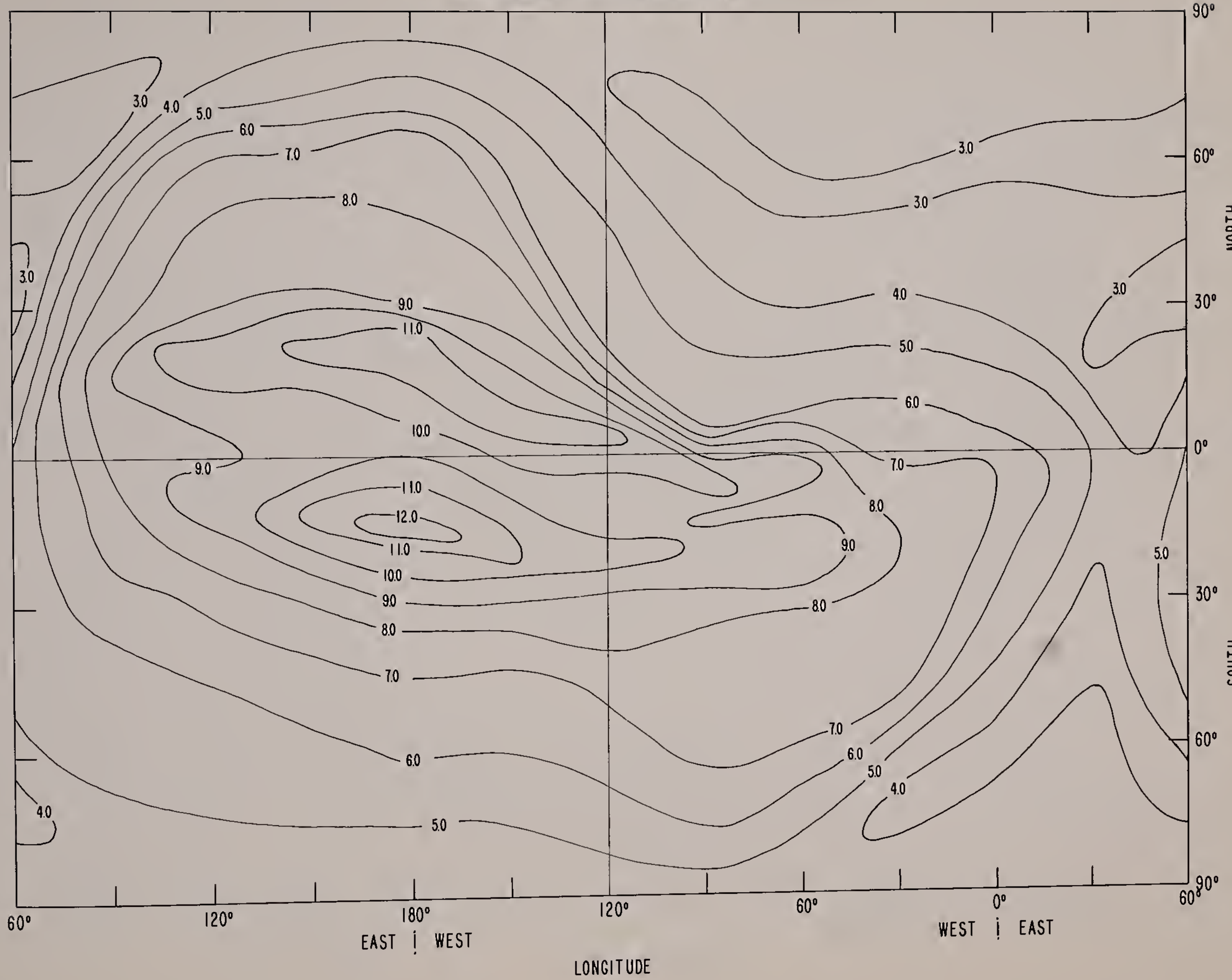
SLOPE OF REGRESSION LINE OF M-4000 FACTOR ON RASSN
SEPTEMBER

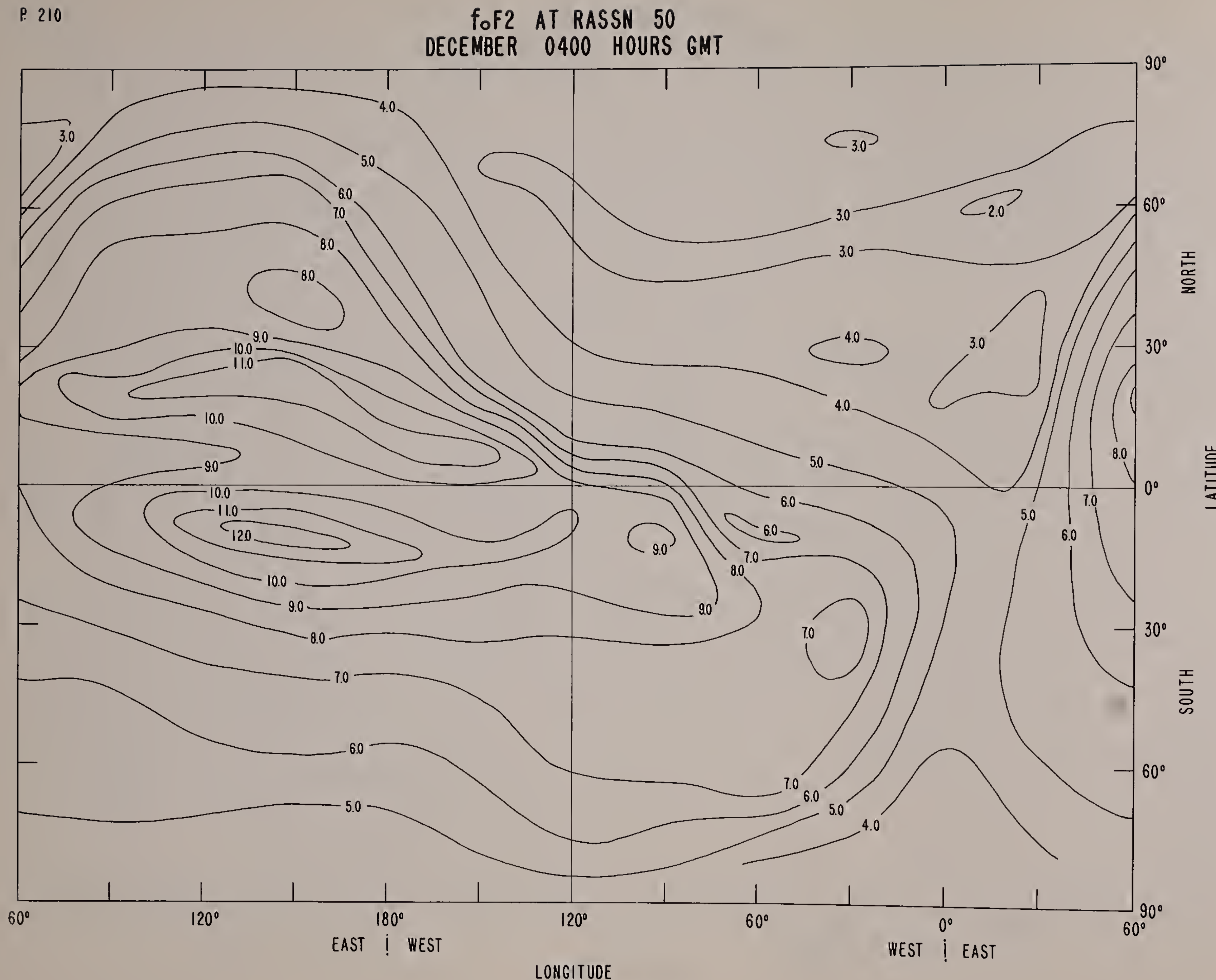


f_oF2 AT RASSN 50
DECEMBER 0000 HOURS GMT

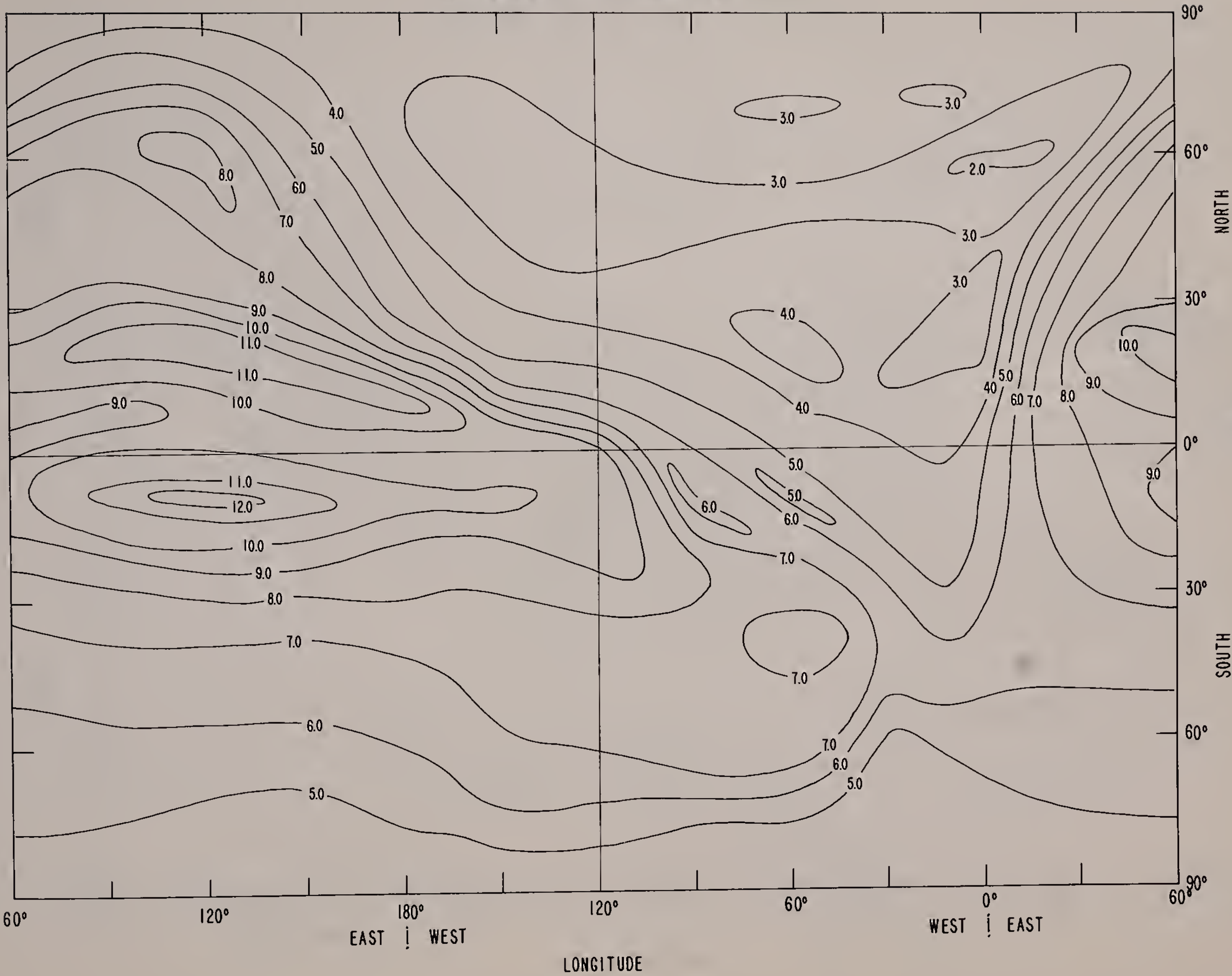


f_oF2 AT RASSN 50
DECEMBER 0200 HOURS GMT

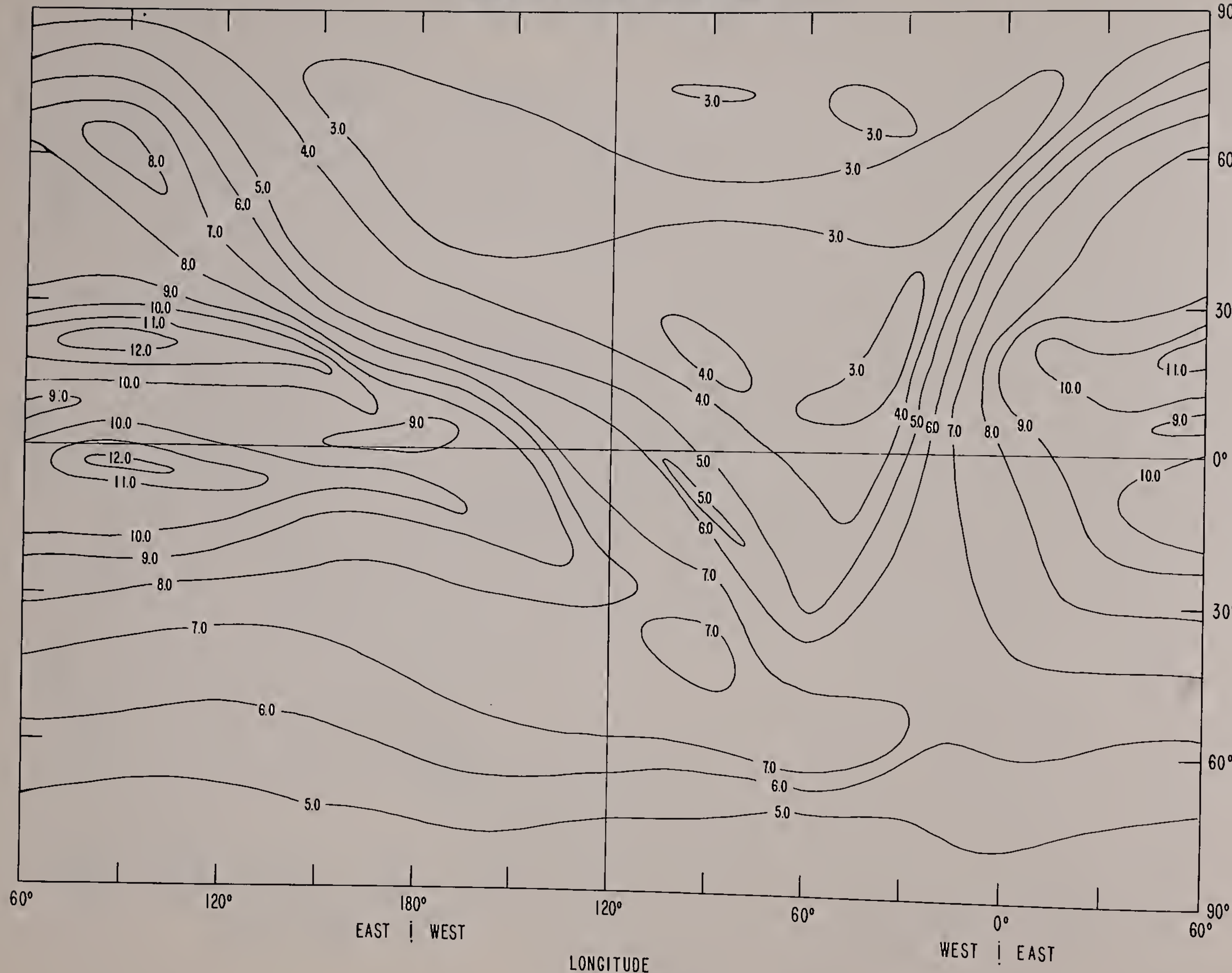



f₀F2 AT RASSN 50
DECEMBER 0400 HOURS GMT
4.0
3.0
5.0
6.0
7.0
8.0
8.0
9.0
10.0
11.0
10.0
9.0
10.0
11.0
12.0
10.0
9.0
8.0
7.0
6.0
5.0
3.0
2.0
3.0
3.0
4.0
3.0
4.0
5.0
8.0
6.0
6.0
7.0
8.0
9.0
9.0
7.0
5.0
6.0
7.0
7.0
6.0
5.0
4.0
90°
60°
30°
0°
30°
60°
90°
NORTH
LATITUDE
SOUTH
60°
120°
180°
120°
60°
0°
60°
EAST | WEST
WEST | EAST
LONGITUDE

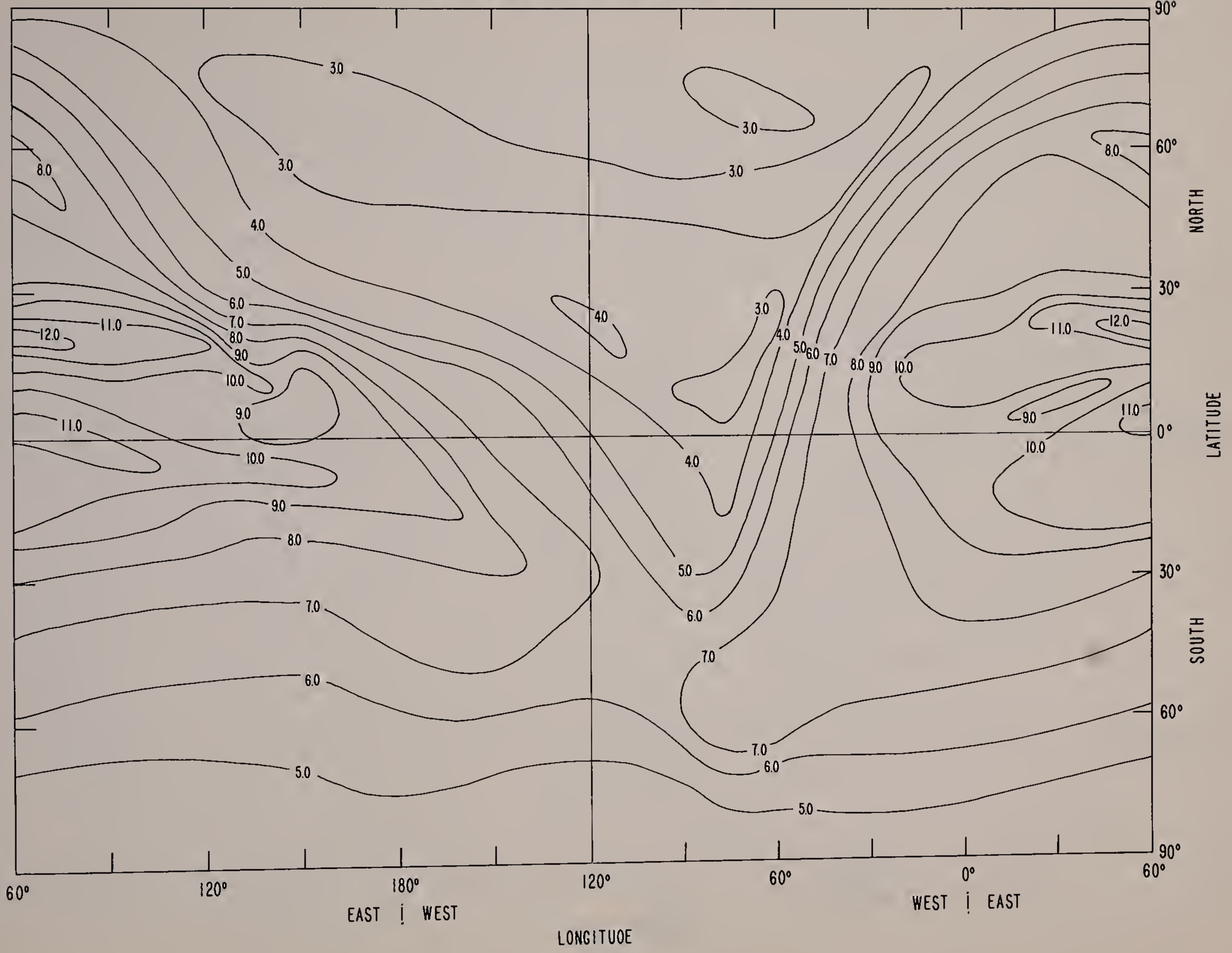
f_oF2 AT RASSN 50
DECEMBER 0600 HOURS GMT



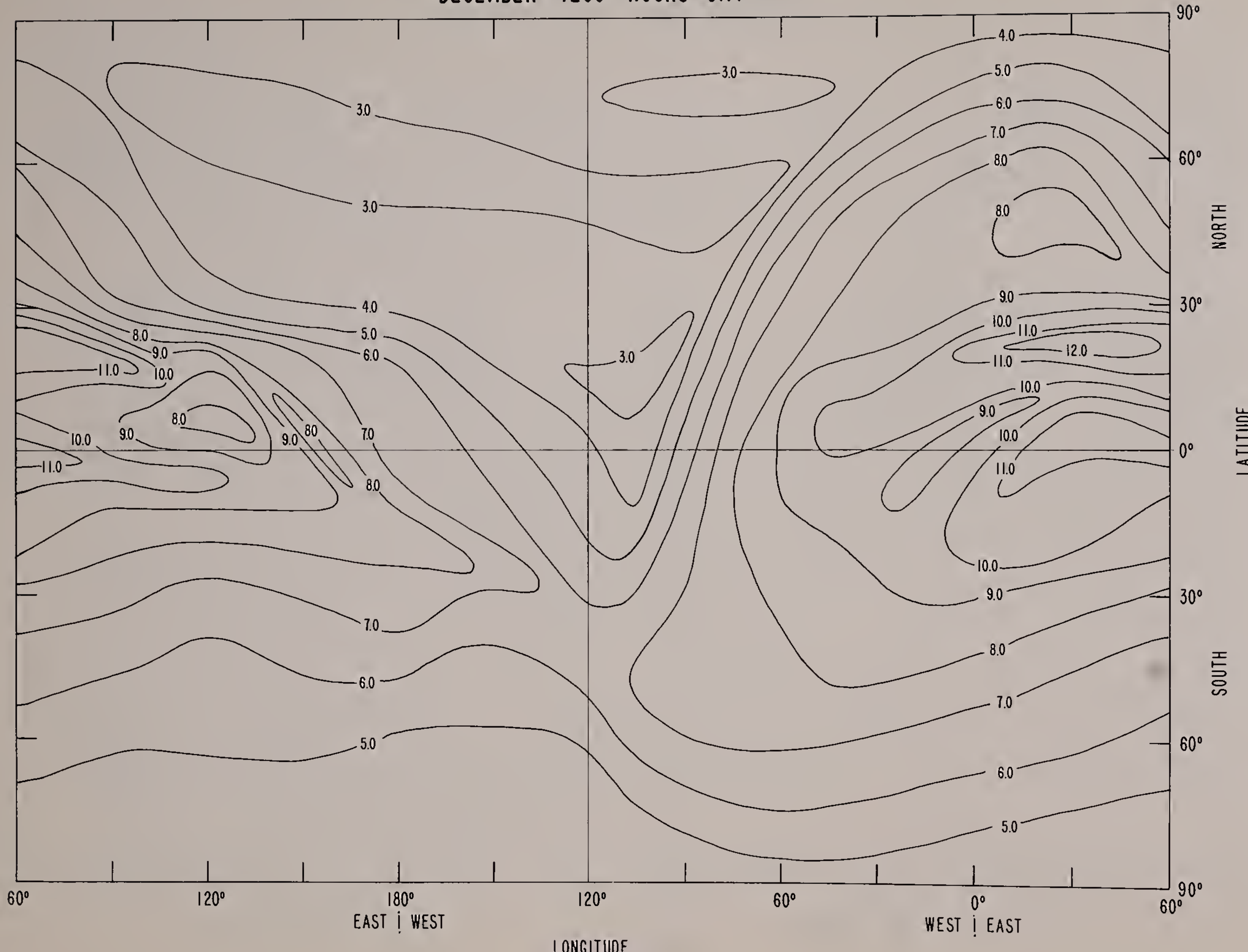
f_oF2 AT RASSN 50
DECEMBER 0800 HOURS GMT



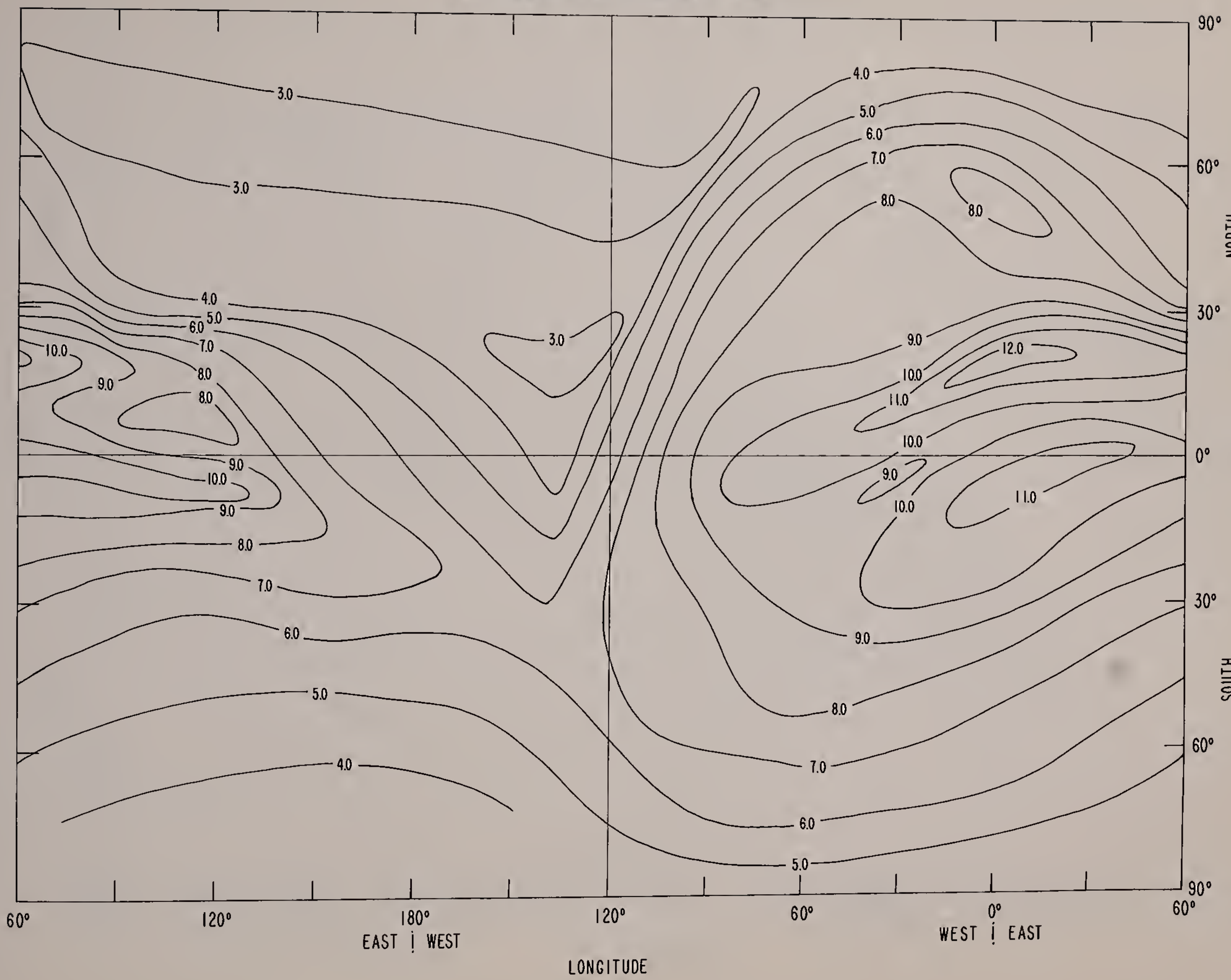
f_oF2 AT RASSN 50
DECEMBER 1000 HOURS GMT



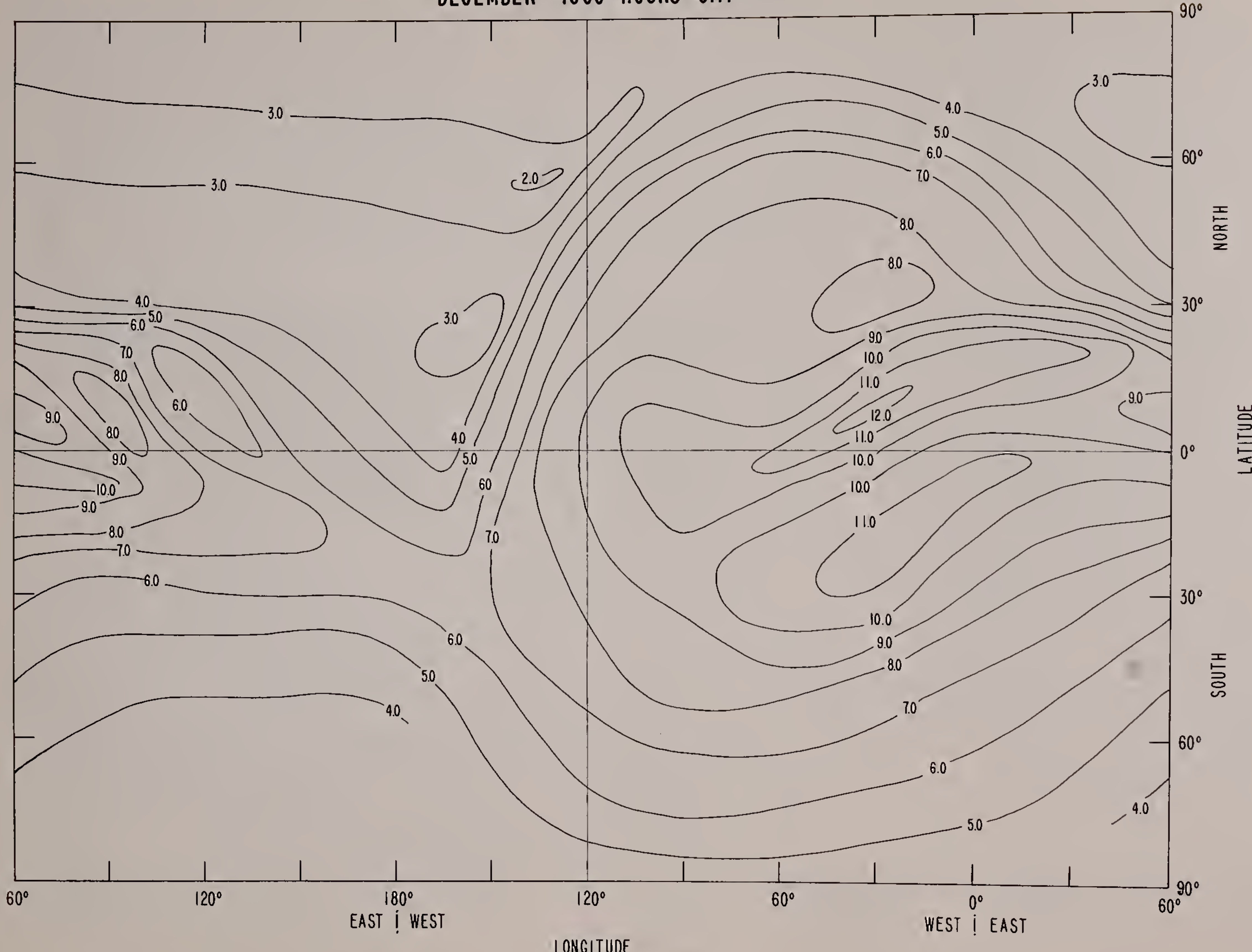
f_oF2 AT RASSN 50
DECEMBER 1200 HOURS GMT



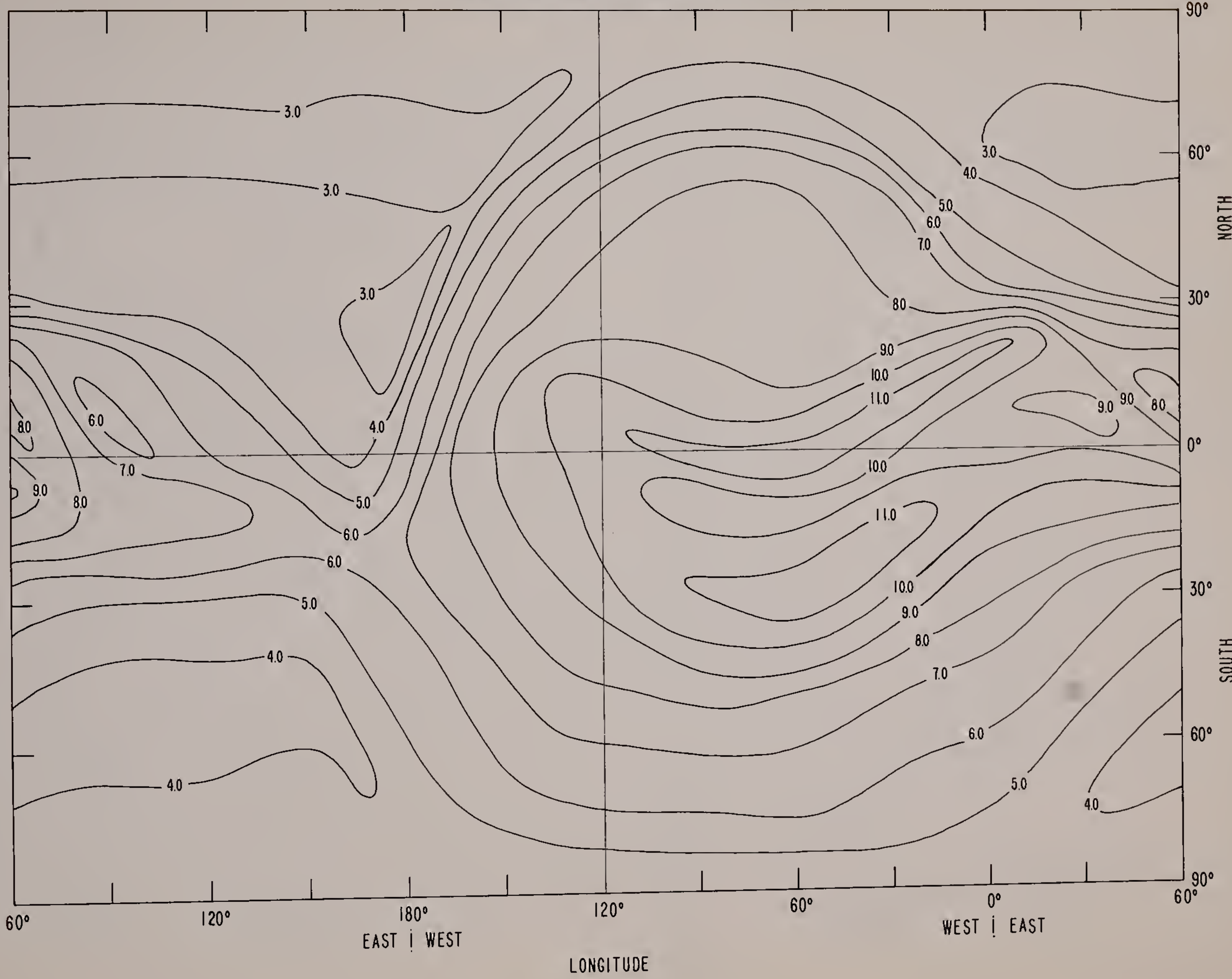
f_oF2 AT RASSN 50
DECEMBER 1400 HOURS GMT



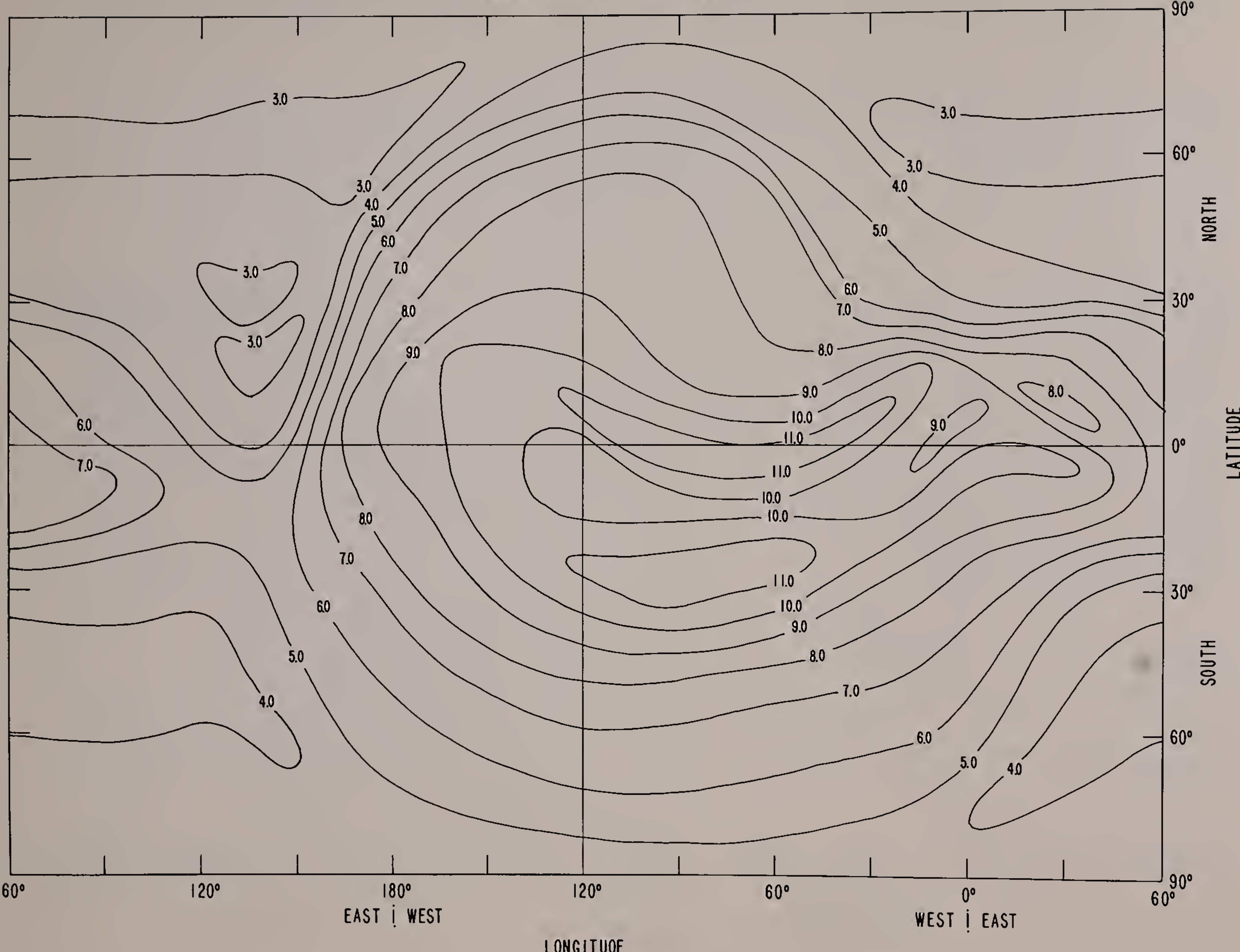
f_oF2 AT RASSN 50
DECEMBER 1600 HOURS GMT



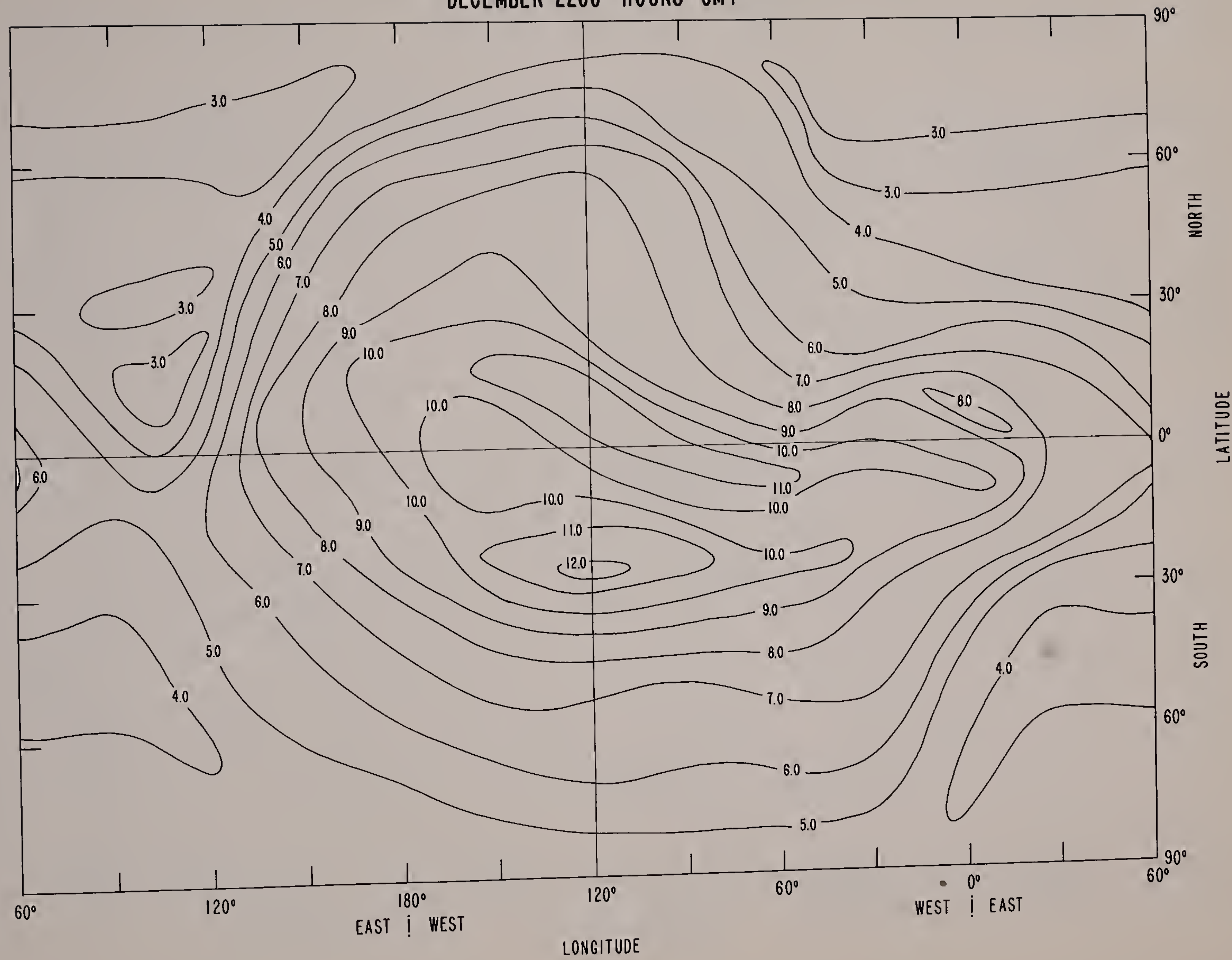
f_oF2 AT RASSN 50
DECEMBER 1800 HOURS GMT



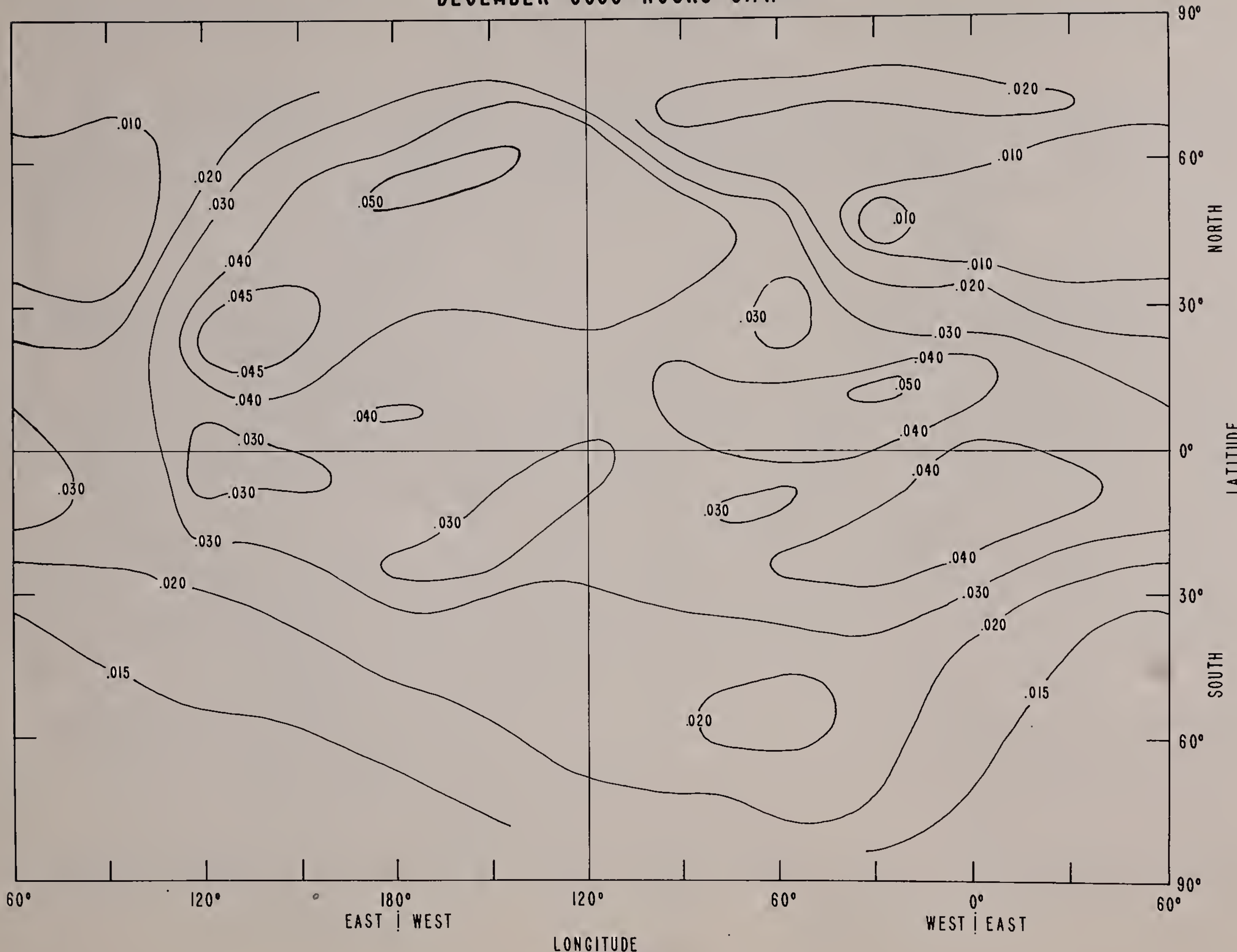
f_oF2 AT RASSN 50
DECEMBER 2000 HOURS GMT



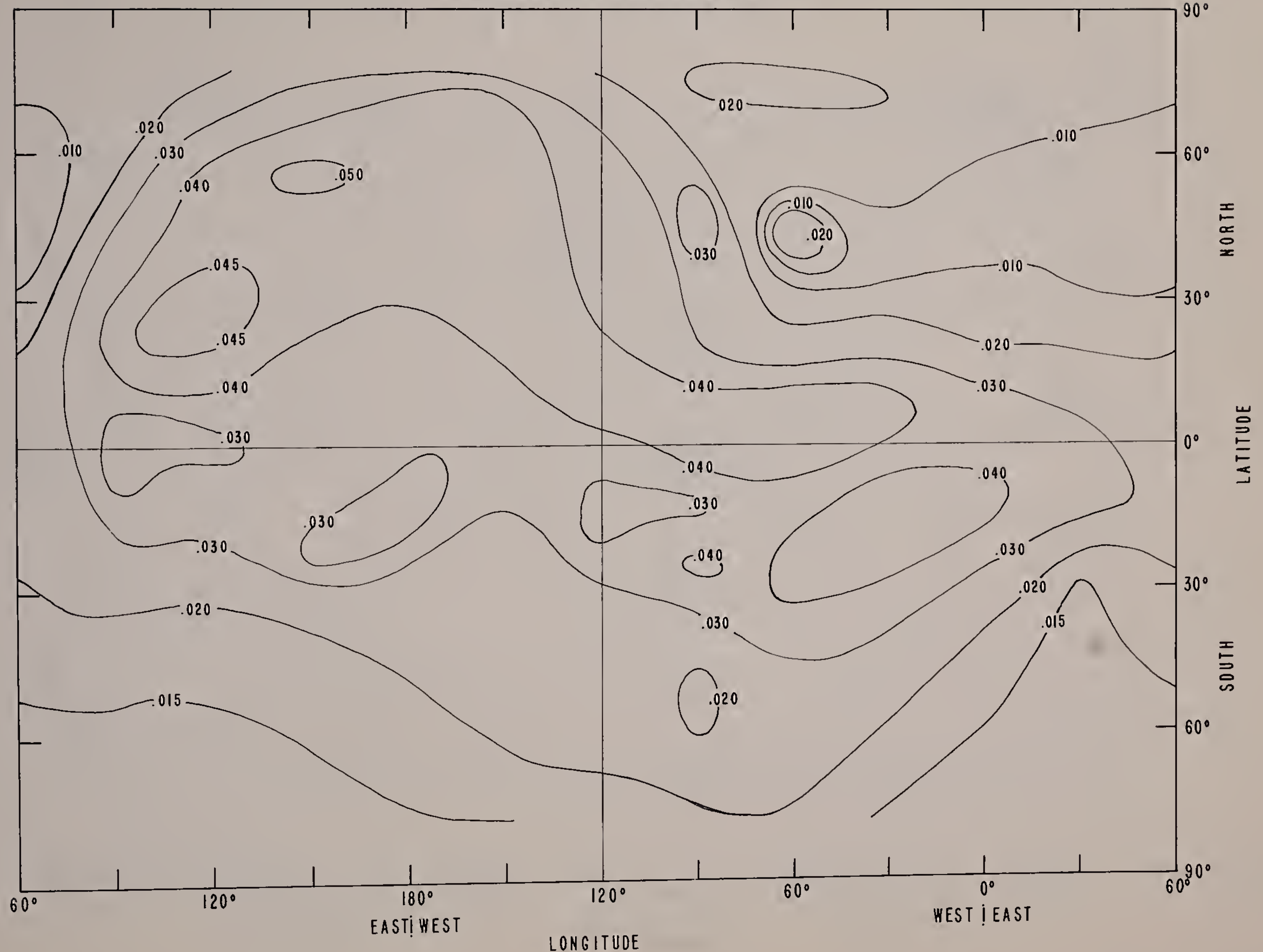
f_oF2 AT RASSN 50
DECEMBER 2200 HOURS GMT



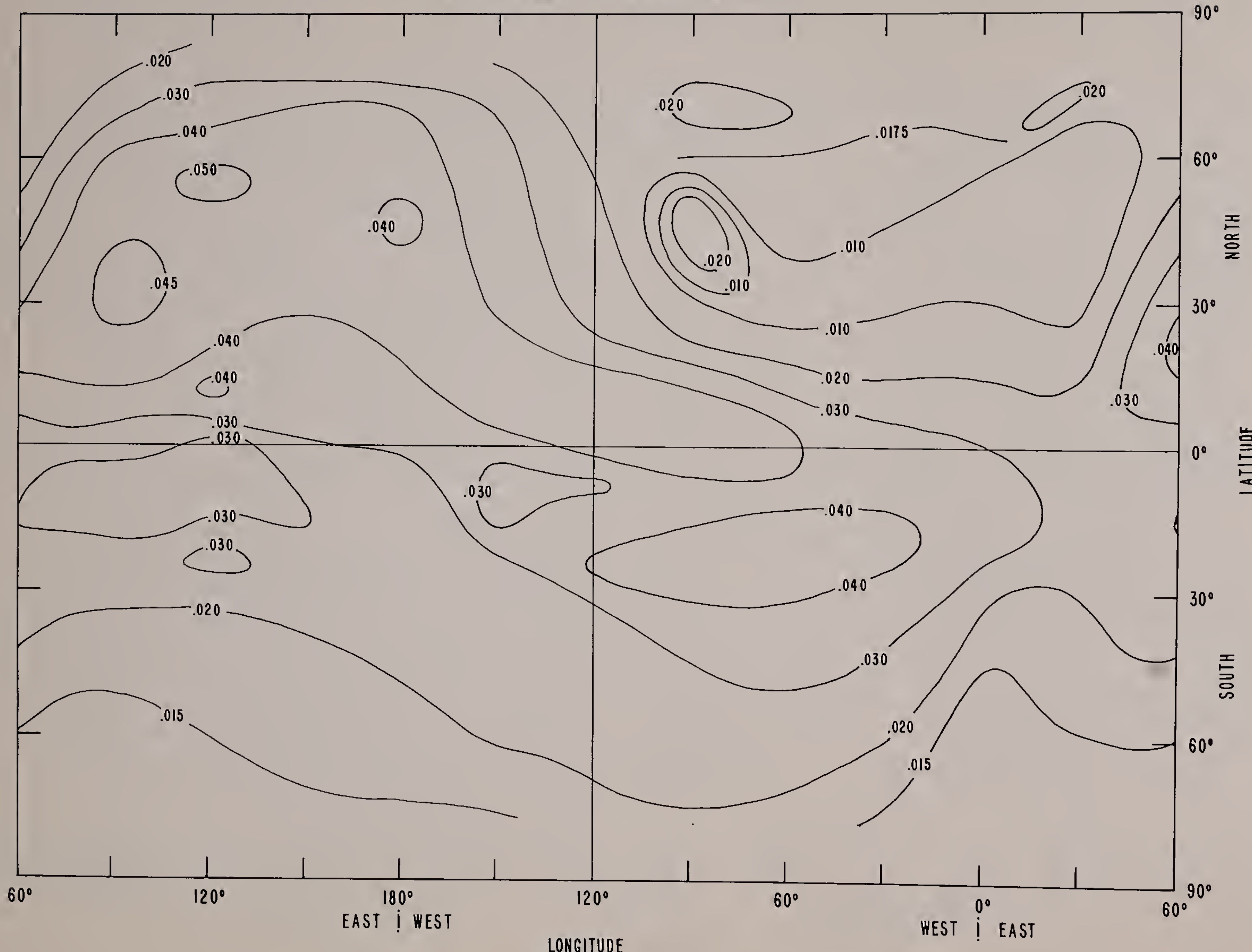
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 0000 HOURS GMT.



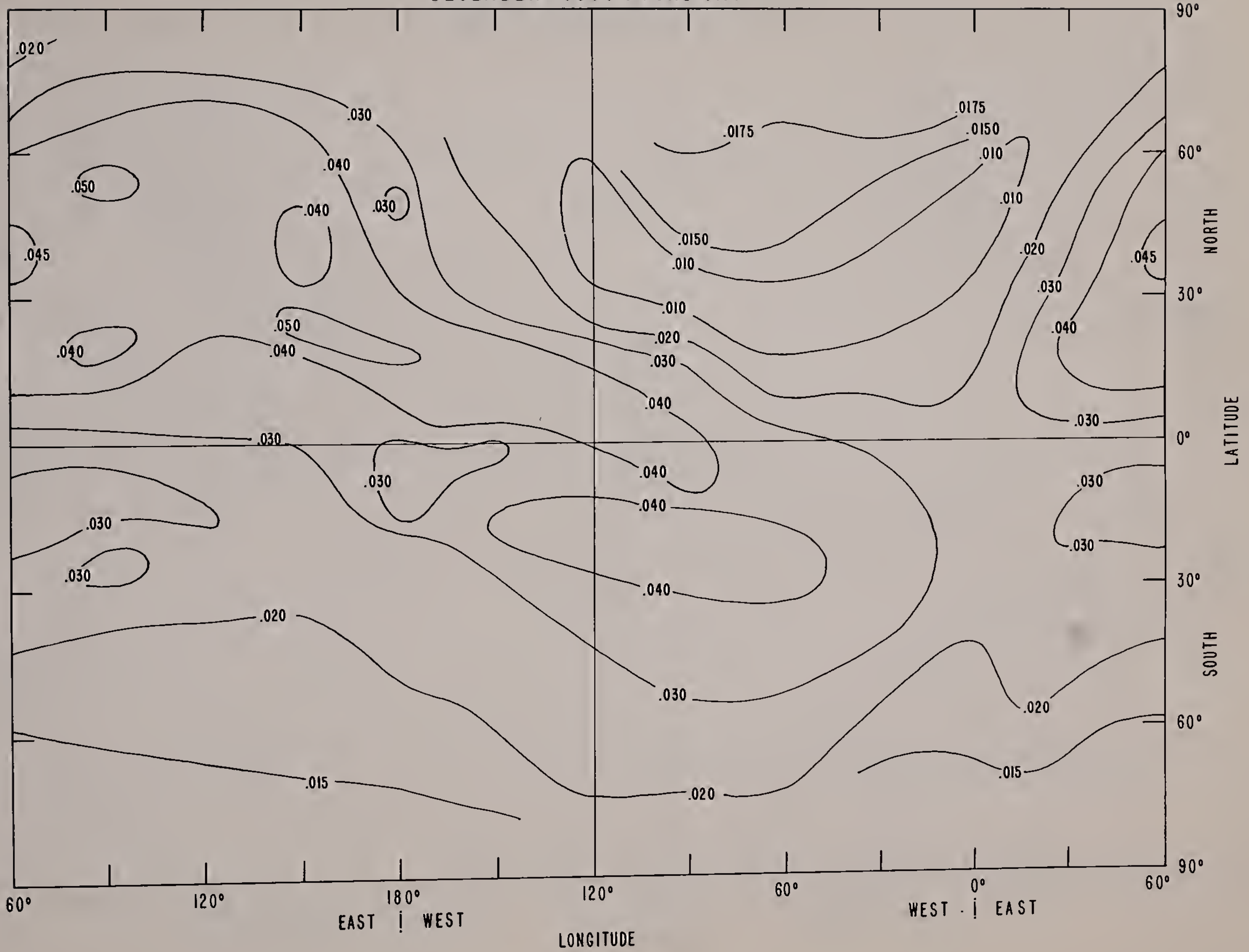
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 0200 HOURS GMT



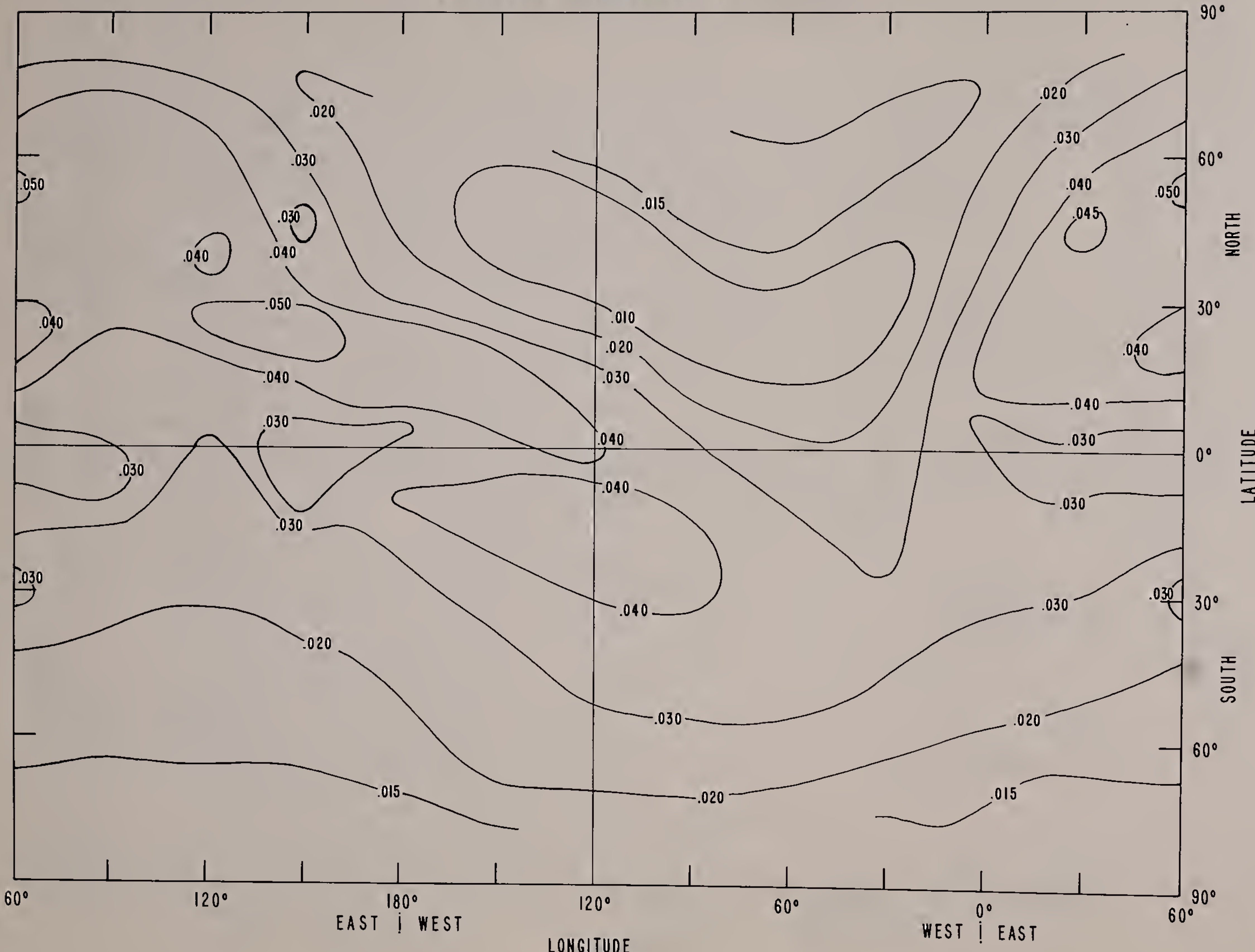
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 0400 HOURS GMT



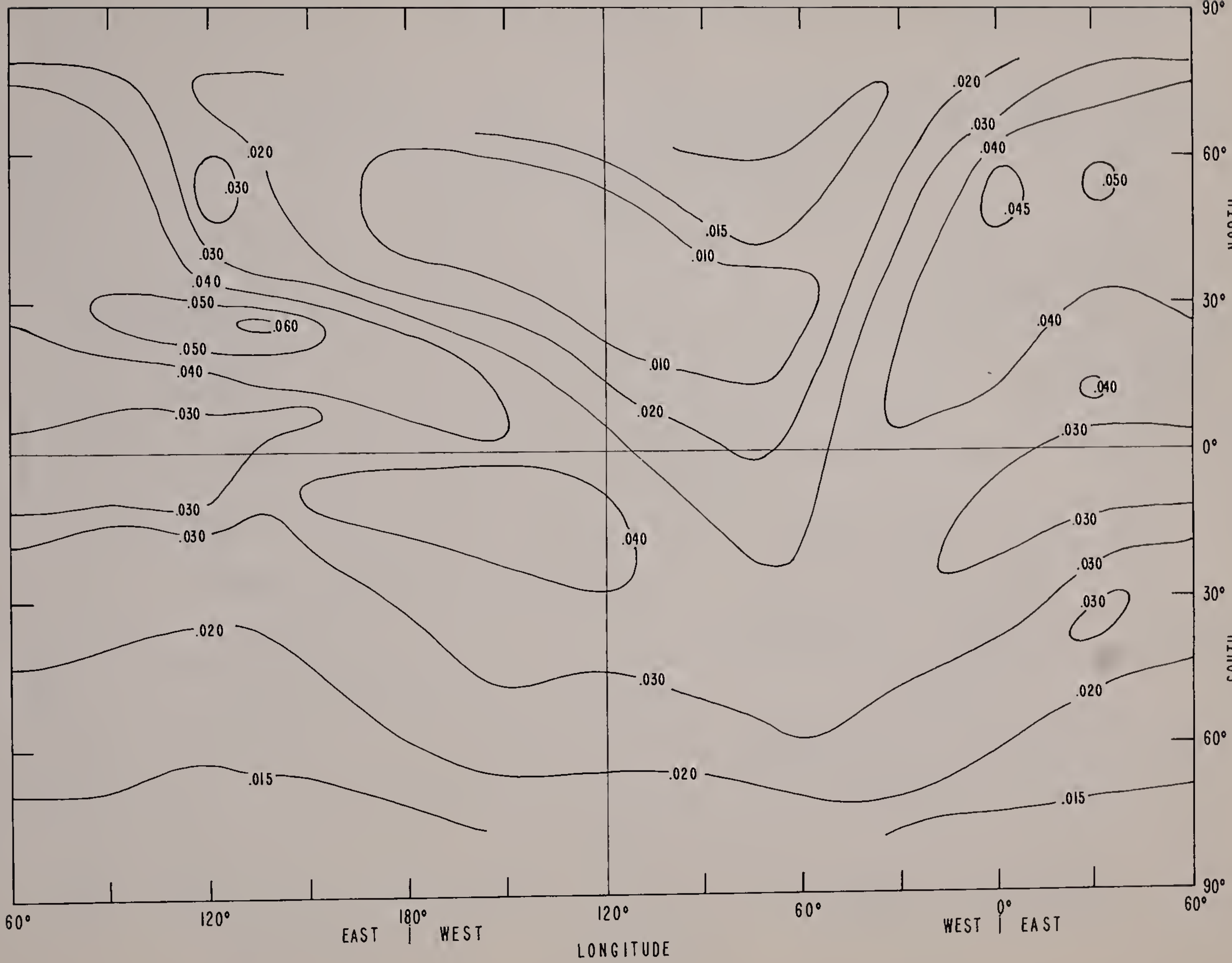
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 0600 HOURS GMT



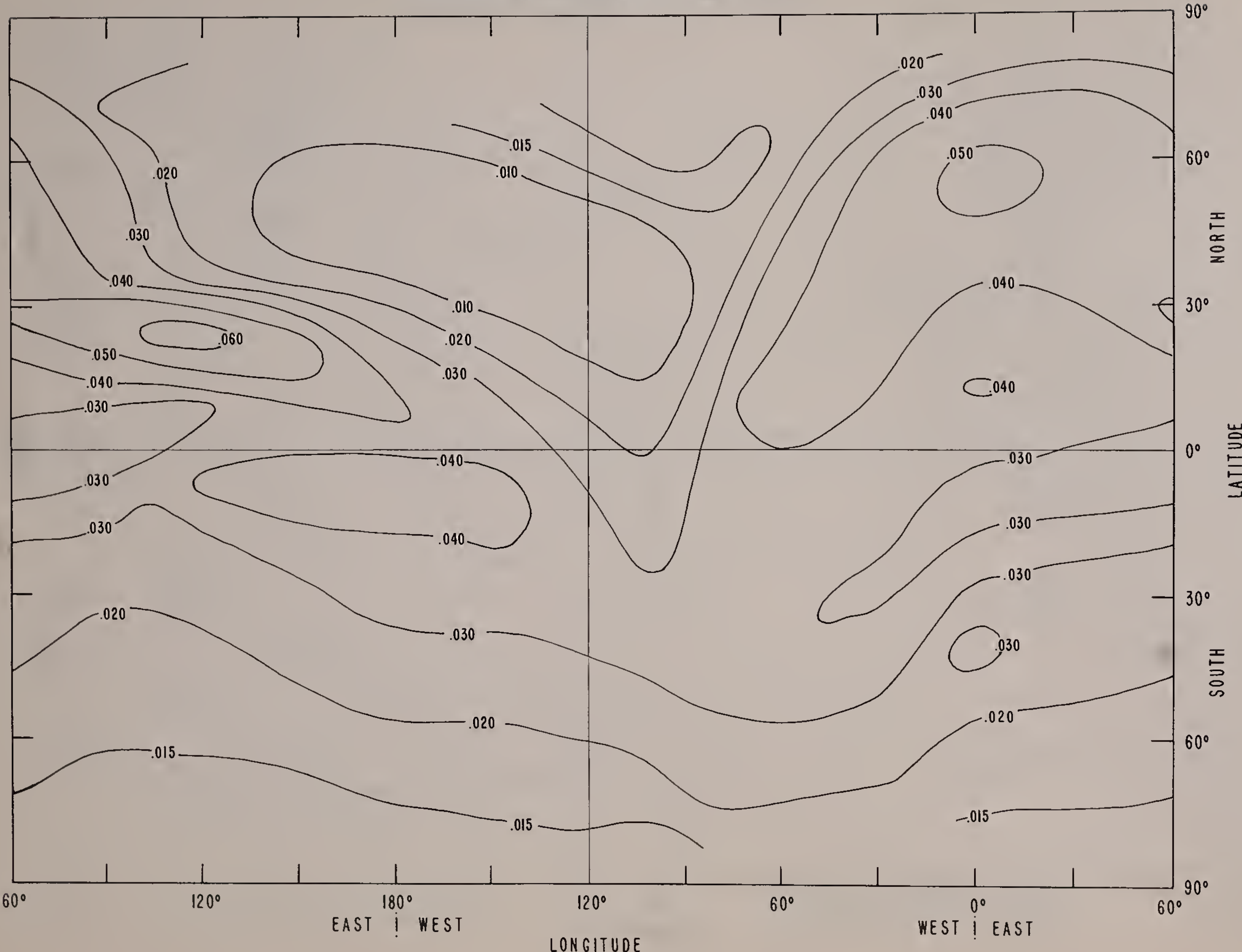
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 0800 HOURS GMT



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

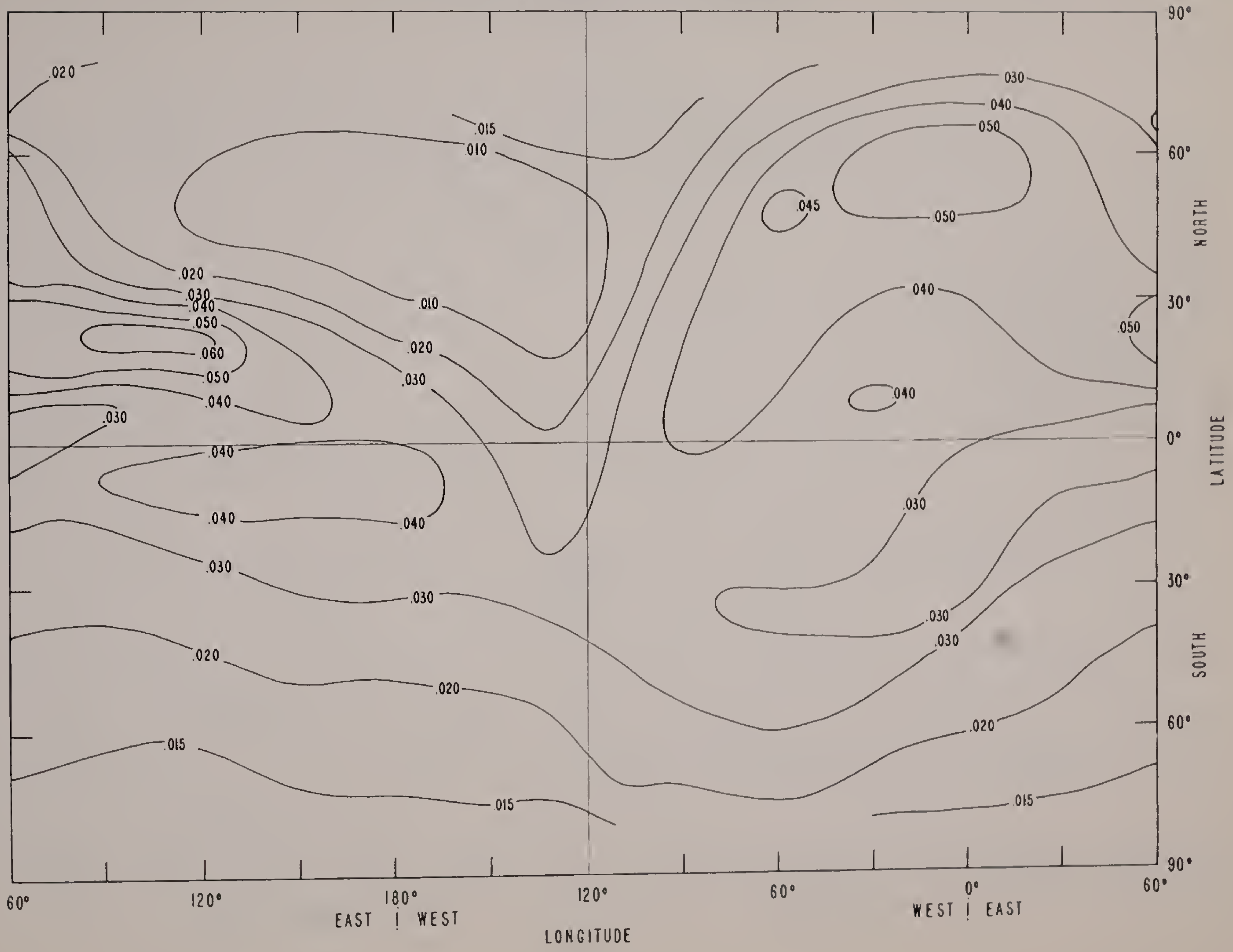


SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 1200 HOURS GMT

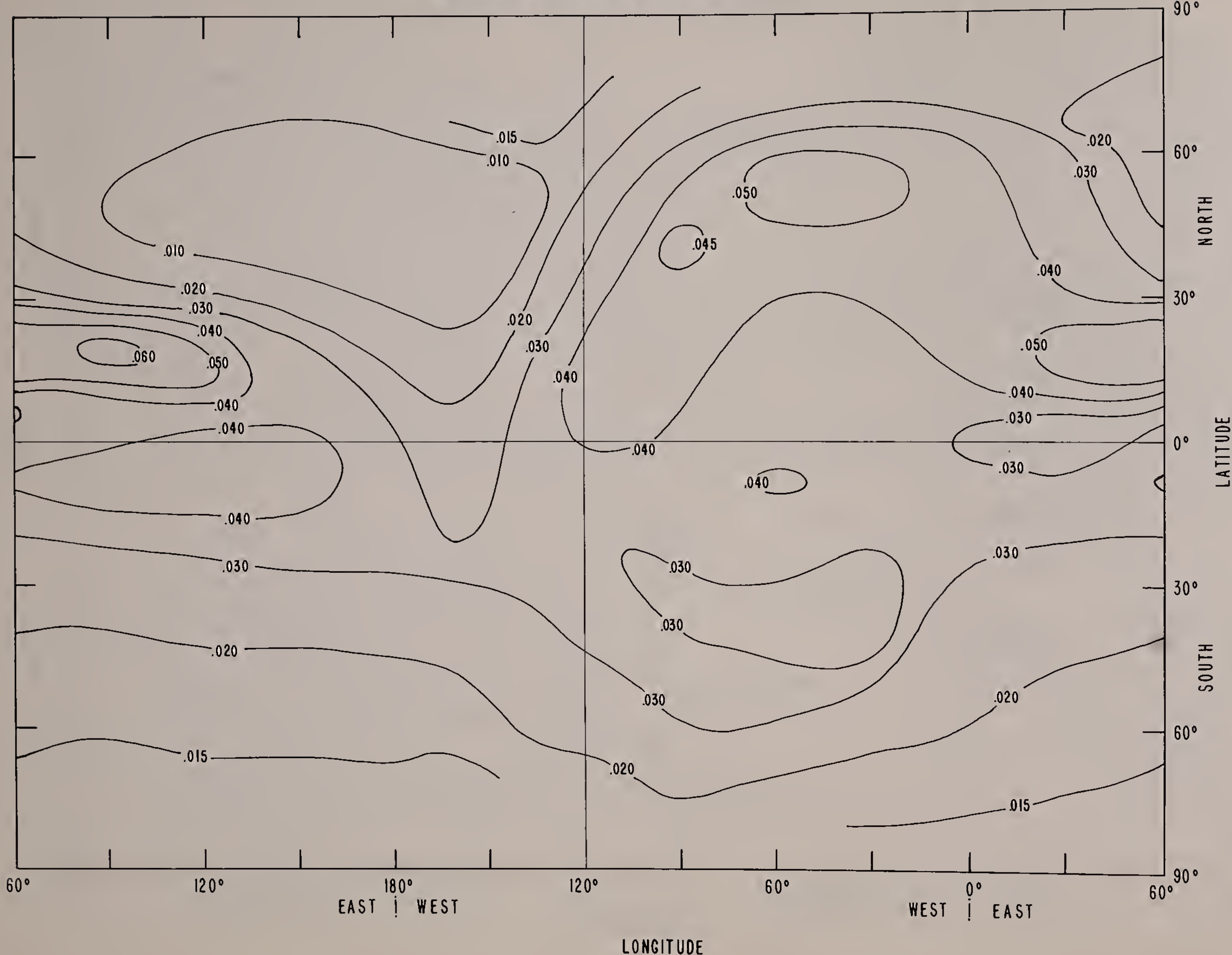


SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN

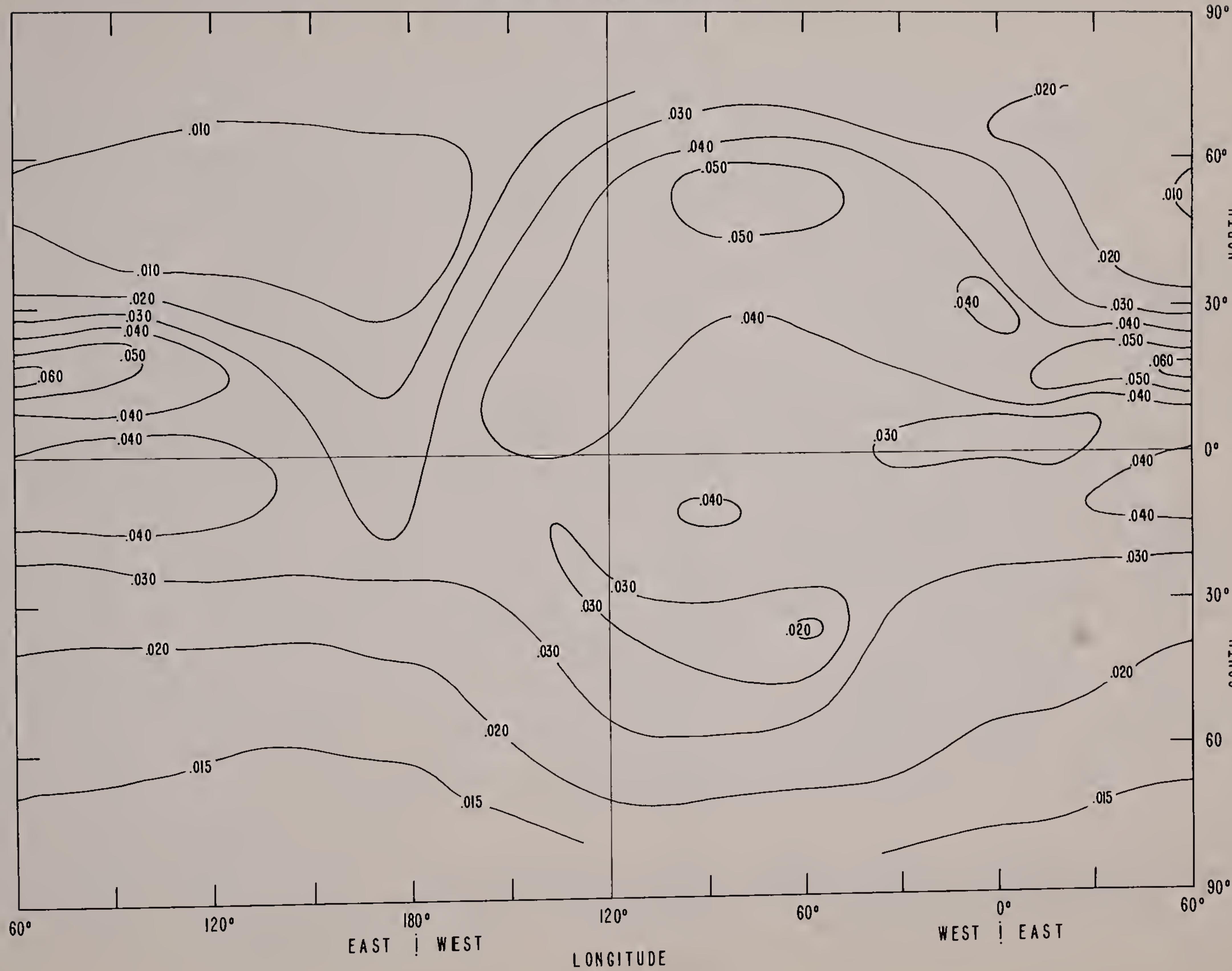
DECEMBER - 1400 HOURS GMT



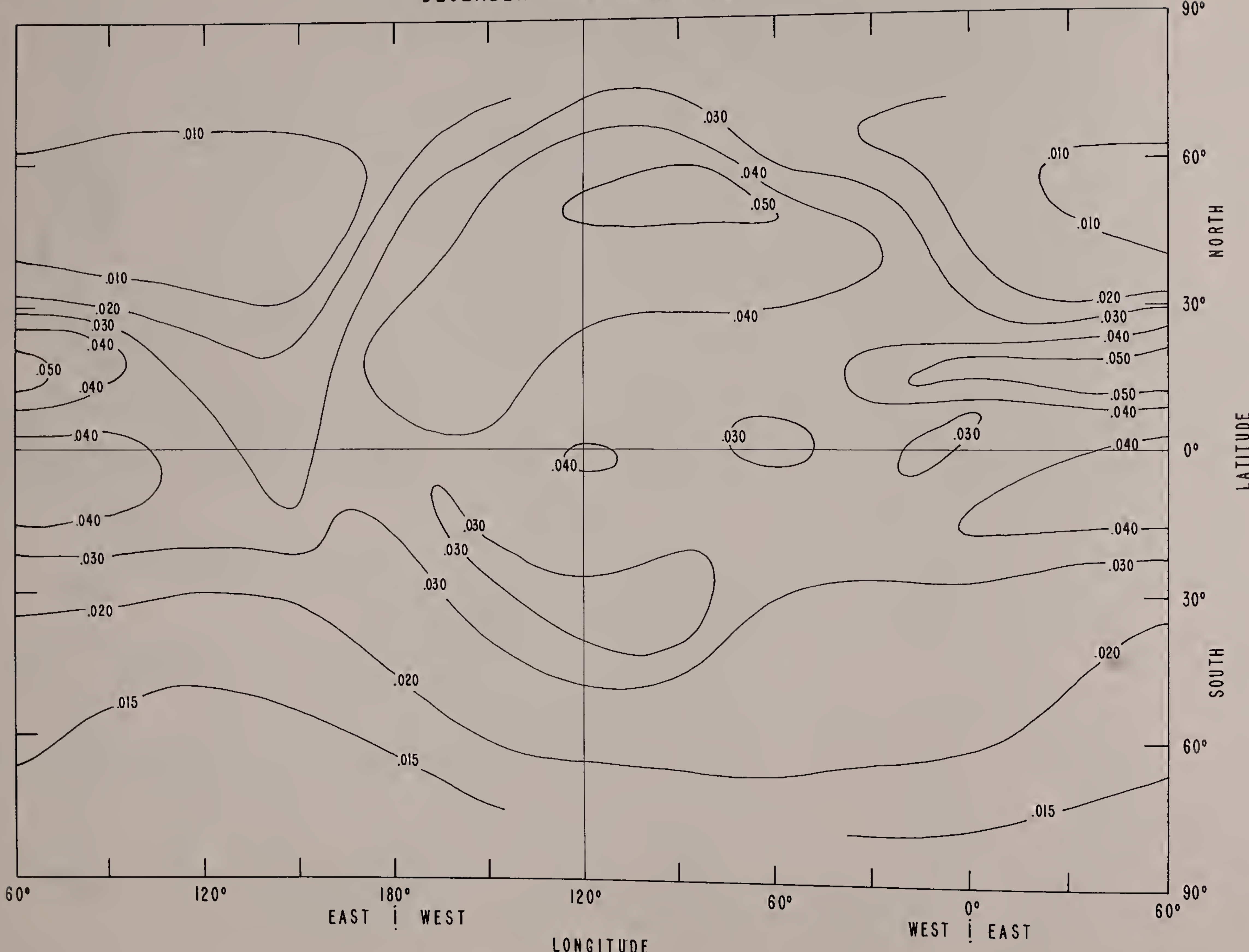
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 1600 HOURS GMT



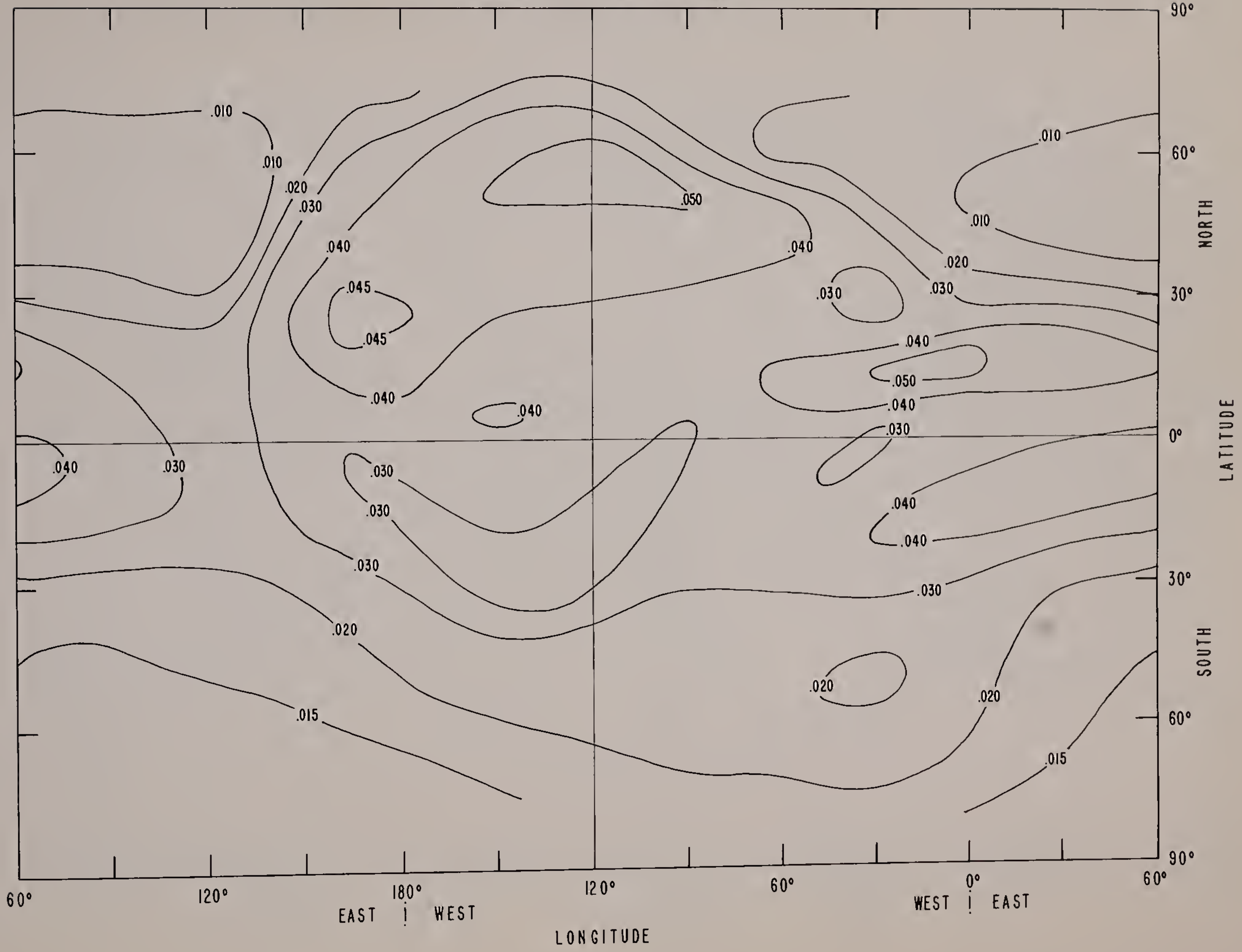
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 1800 HOURS GMT



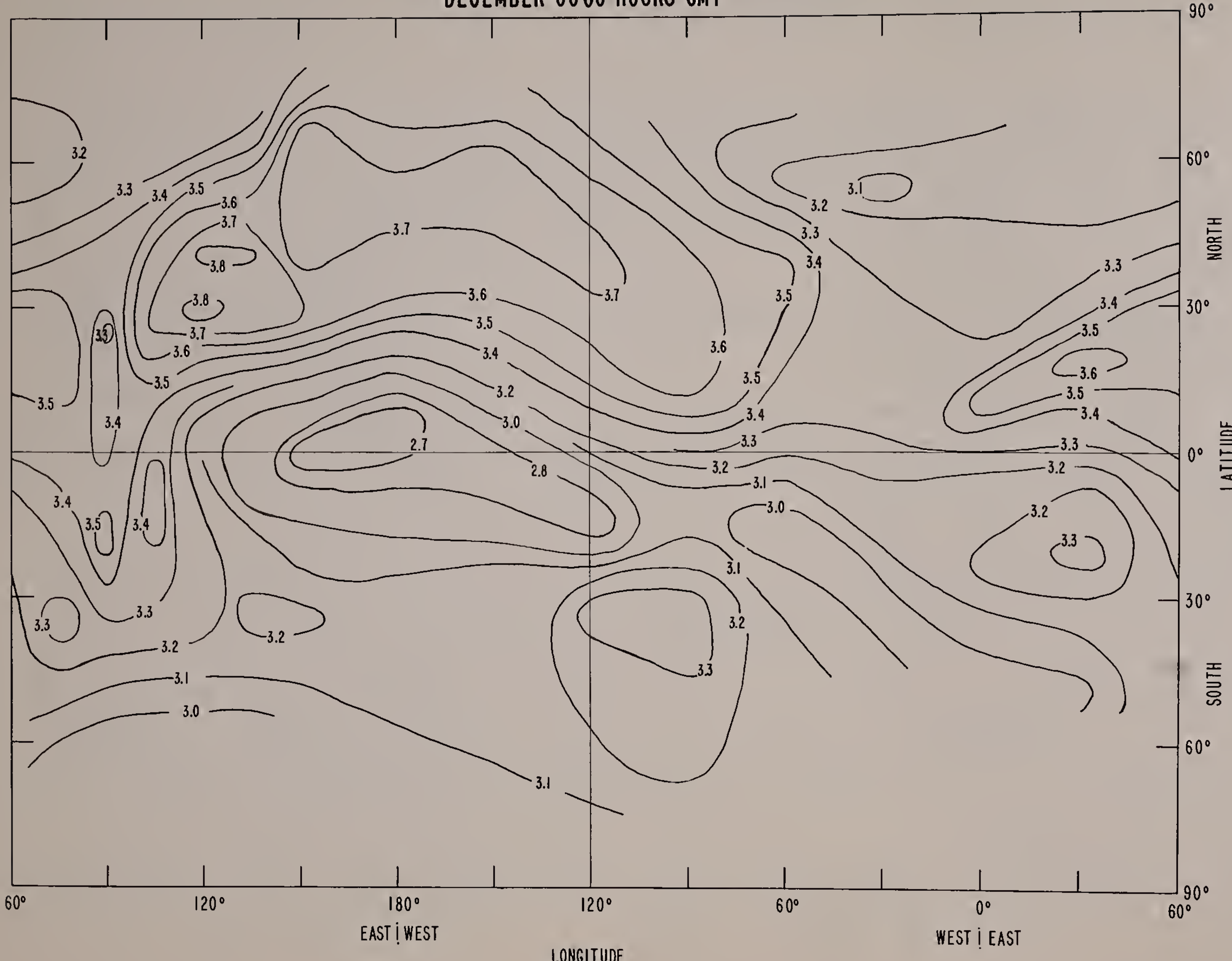
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 2000 HOURS GMT



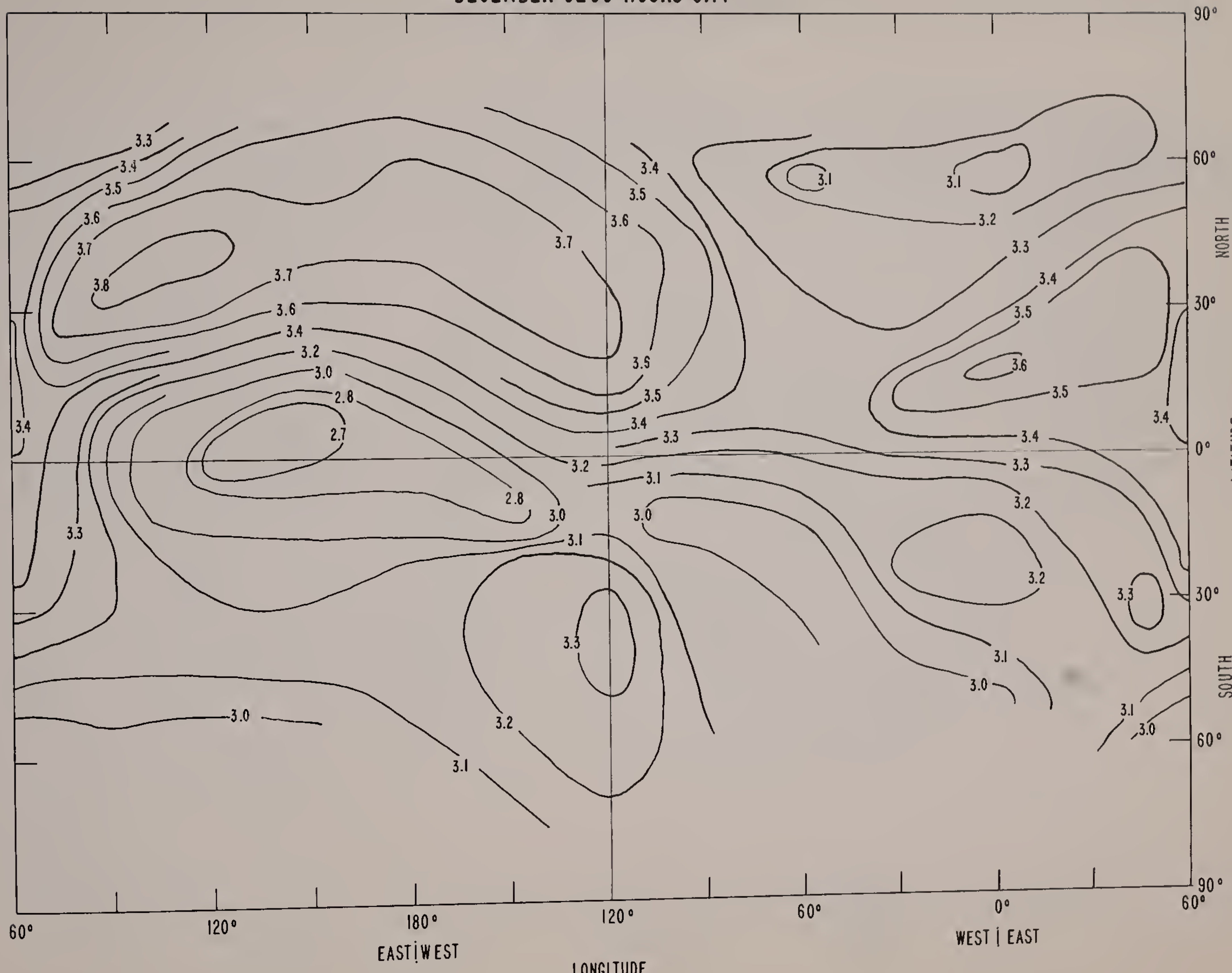
SLOPE OF REGRESSION LINE OF f_oF2 ON RASSN
DECEMBER 2200 HOURS GMT



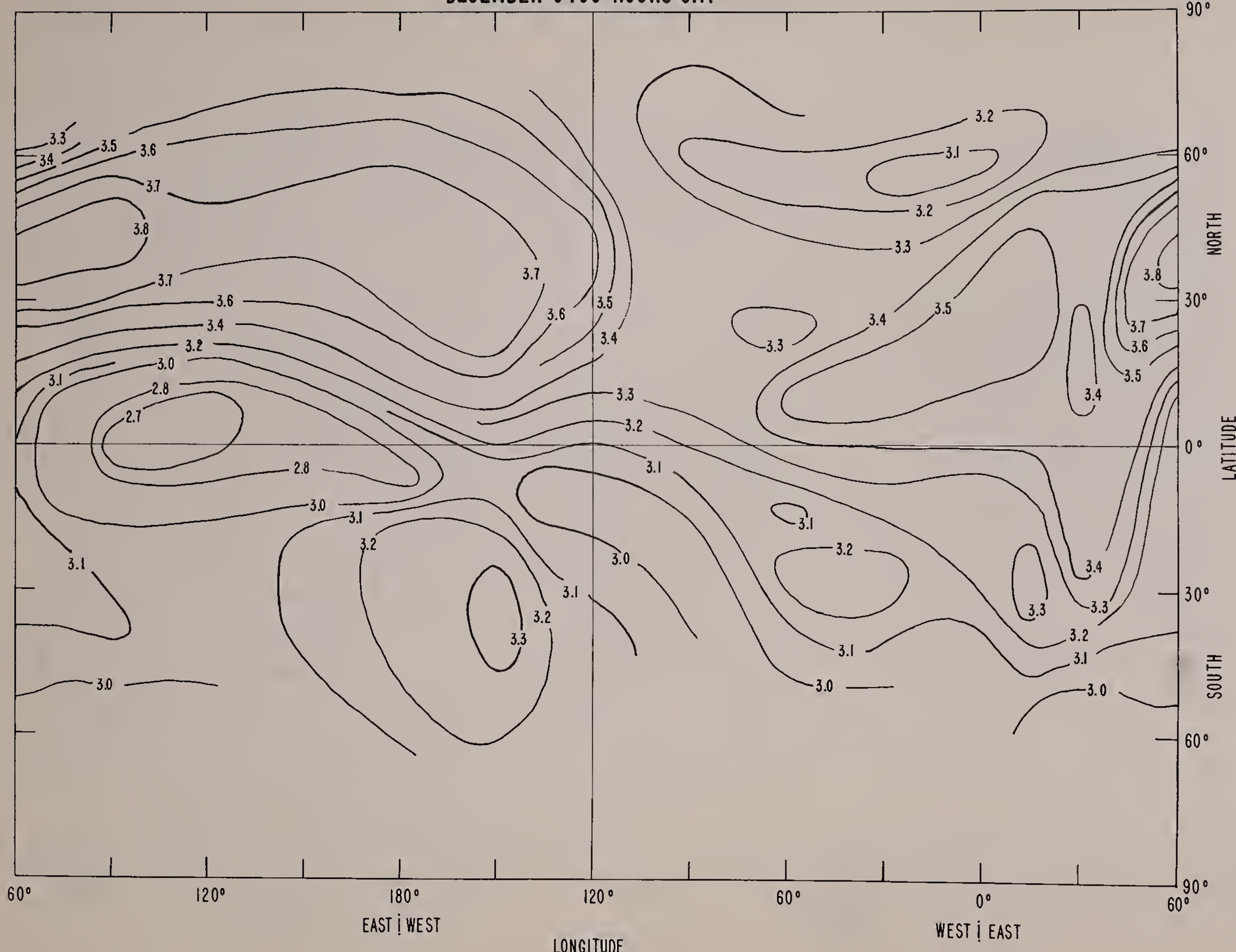
M-4000 FACTOR AT RASSN 50
DECEMBER 0000 HOURS GMT



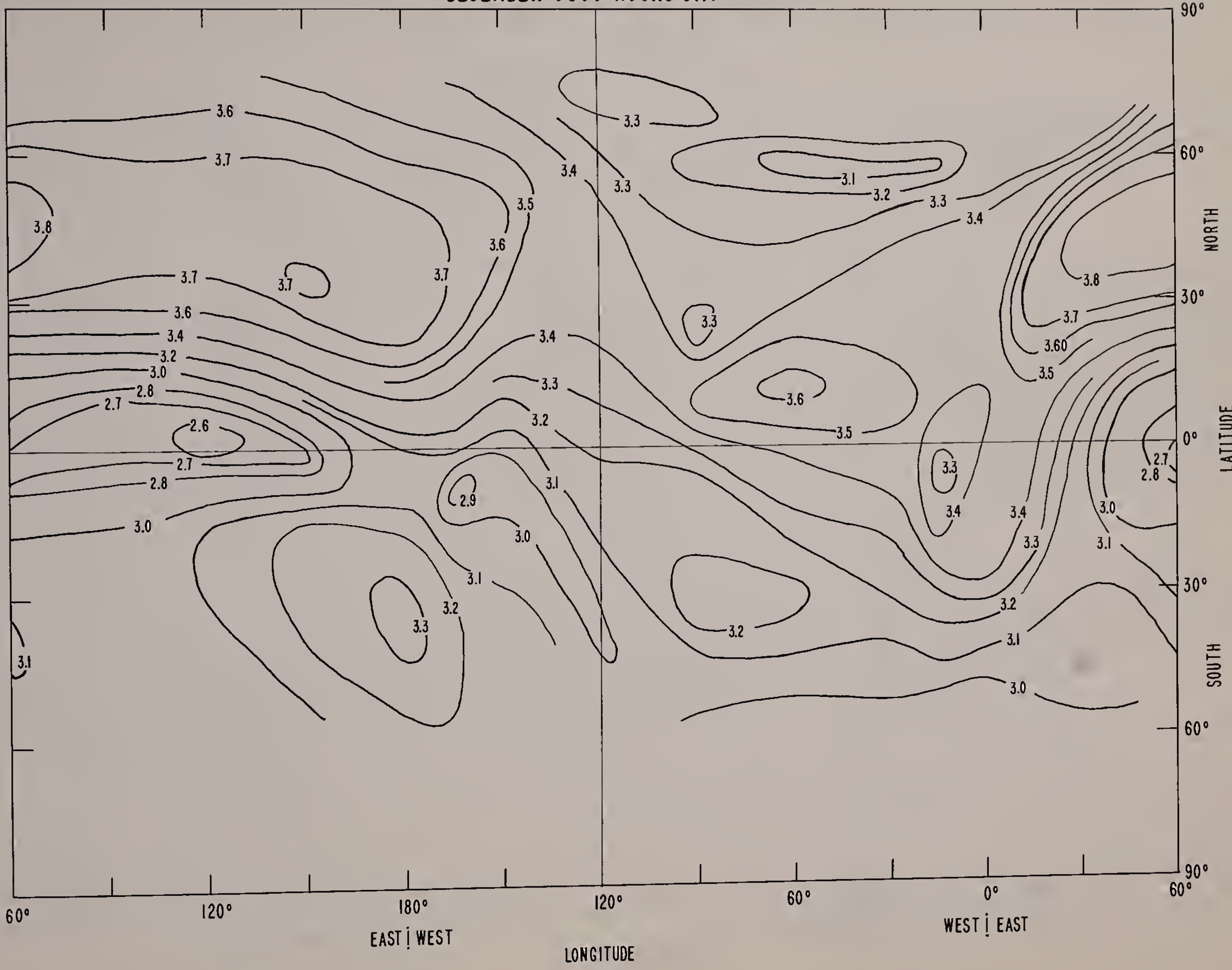
M-4000 FACTOR AT RASSN 50
DECEMBER 0200 HOURS GMT



M-4000 FACTOR AT RASSN 50
DECEMBER 0400 HOURS GMT



M-4000 FACTOR AT RASSN 50
DECEMBER 0600 HOURS GMT



M–4000 FACTOR AT RASSN 50
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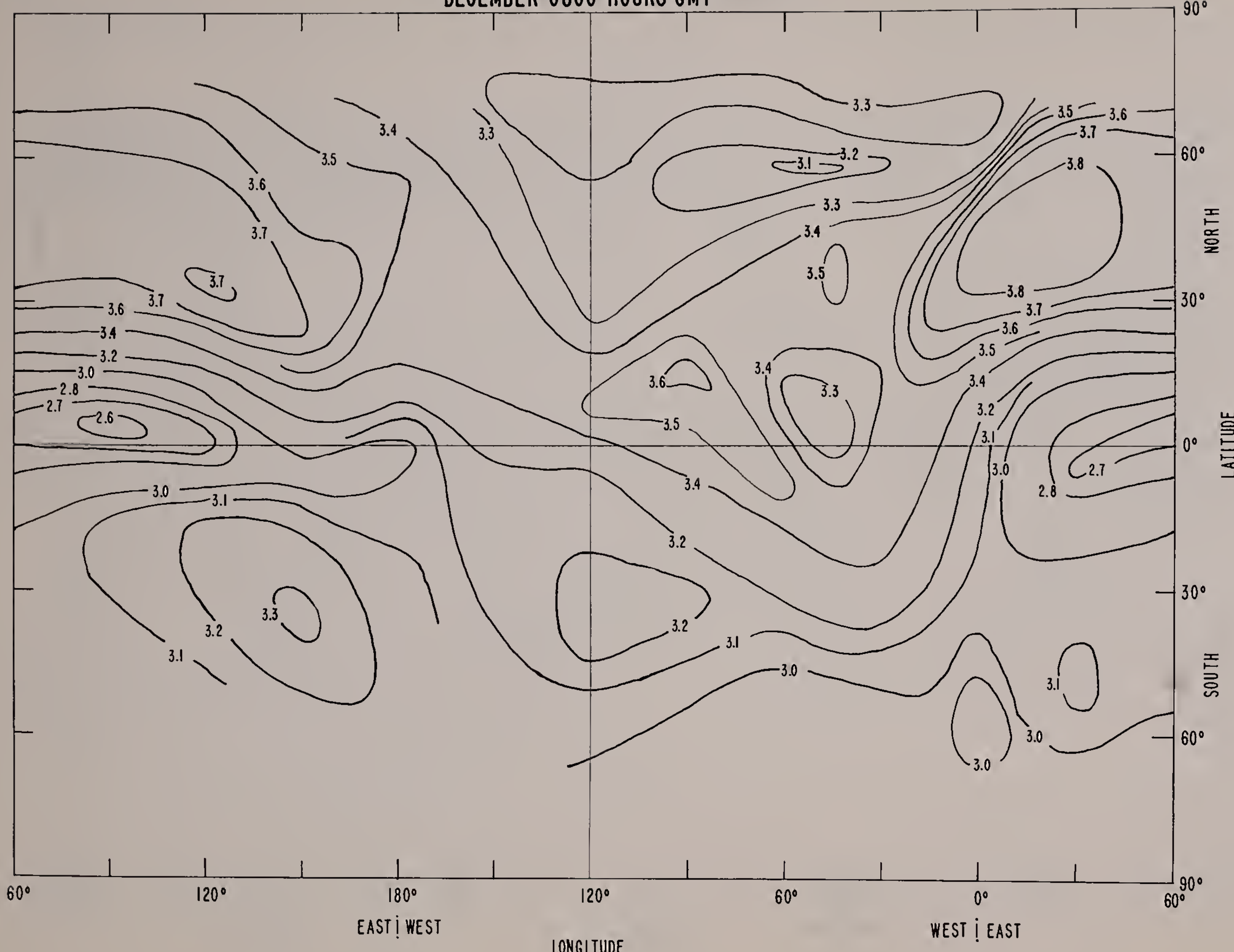
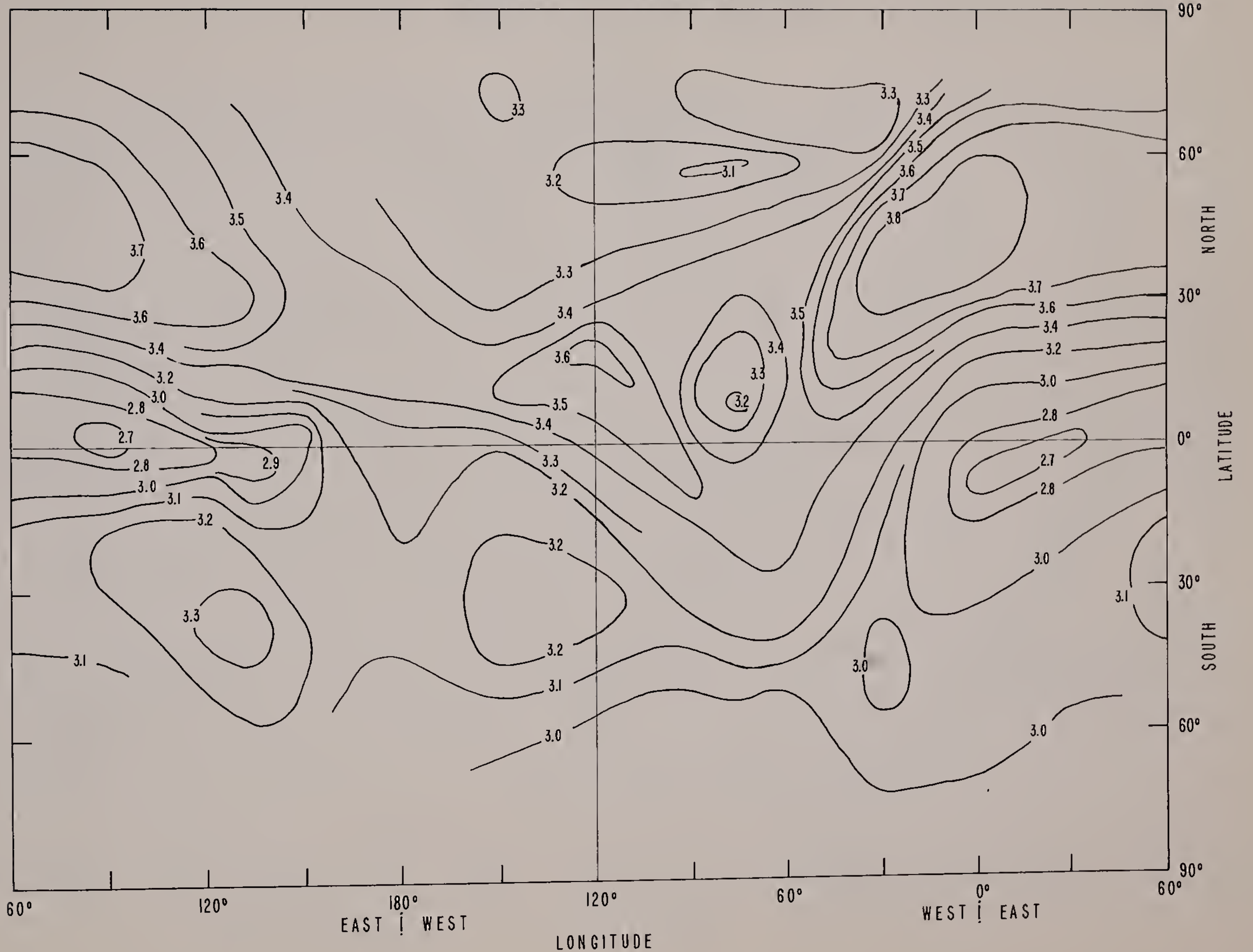
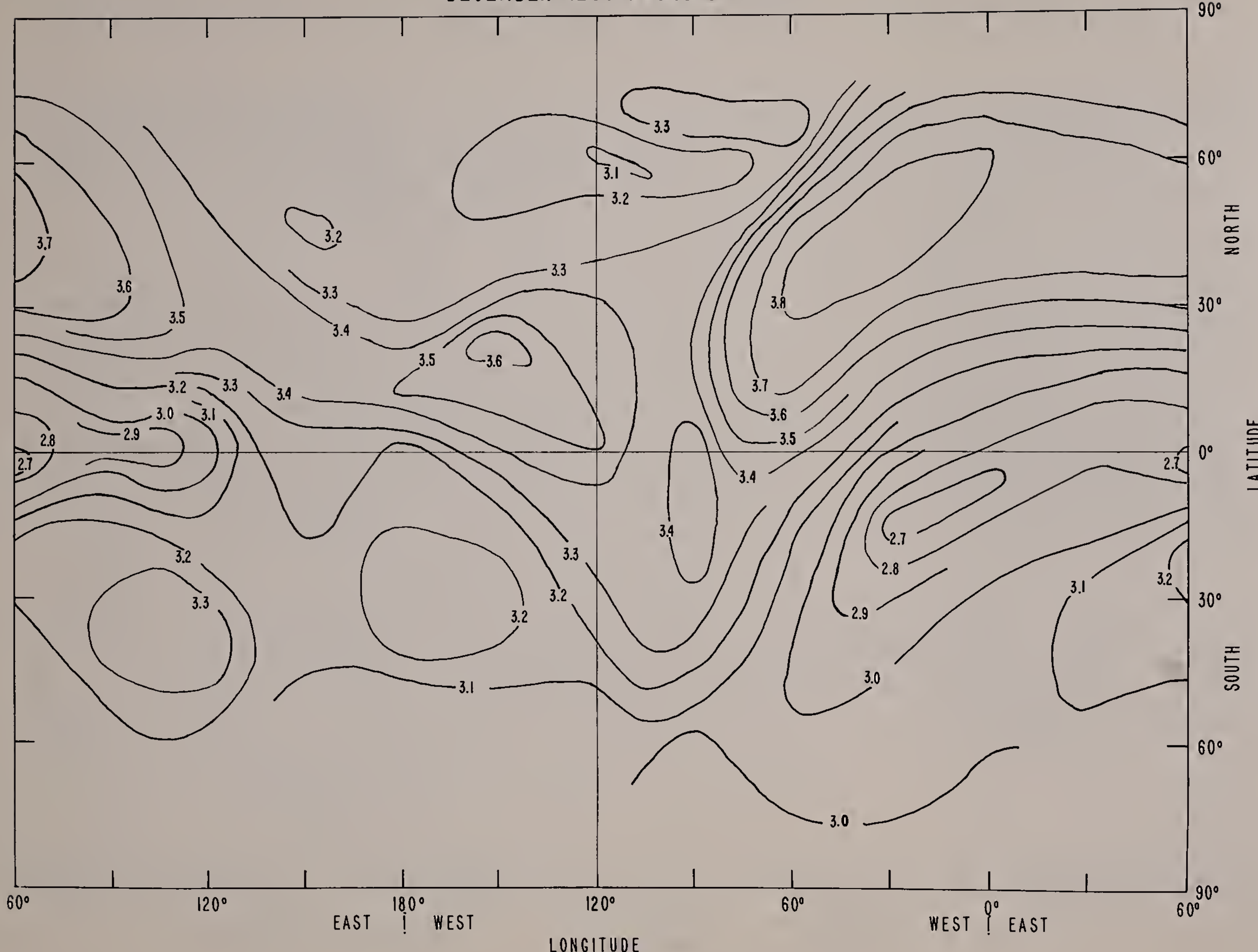


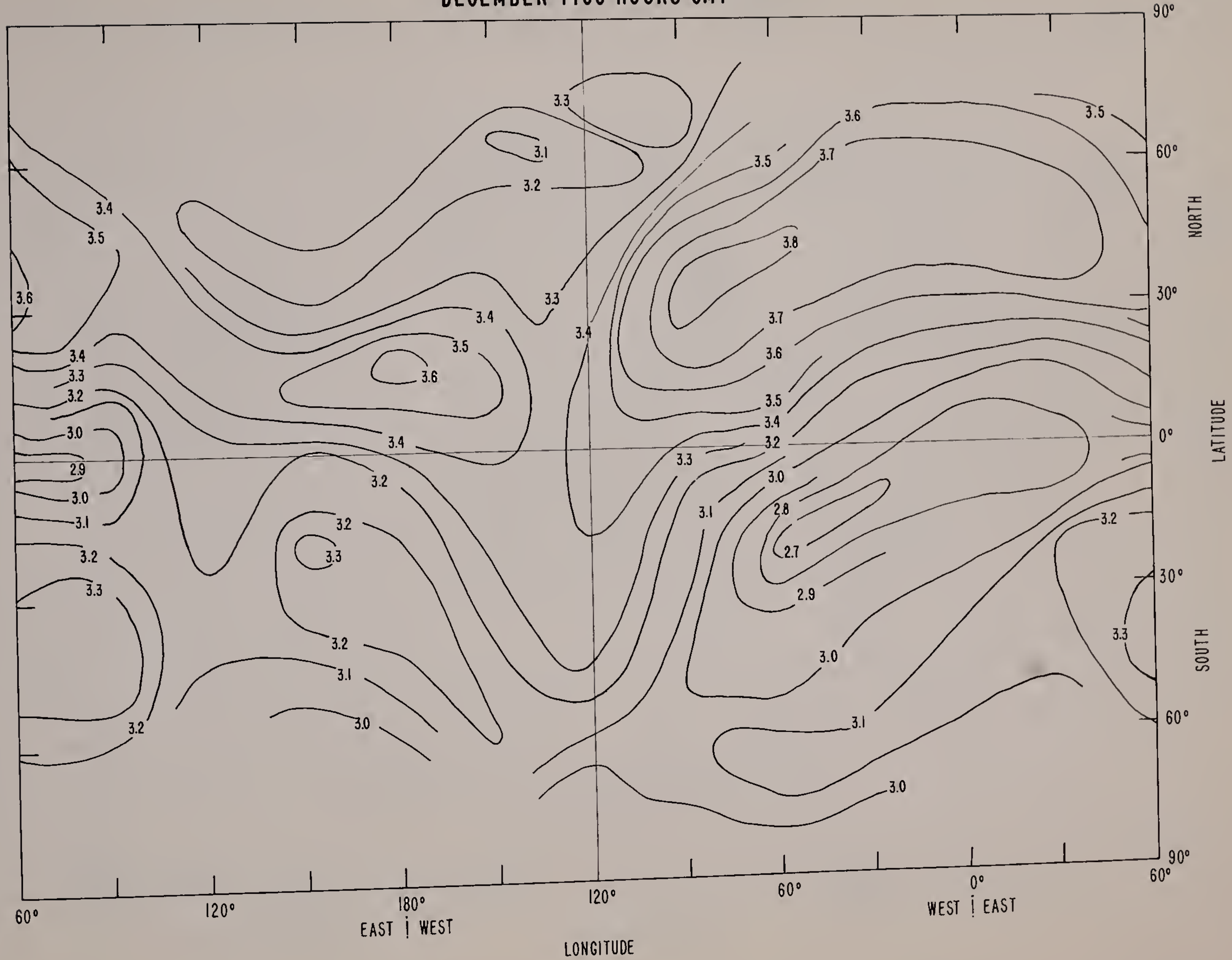
M—4000 FACTOR AT RASSN 50
DECEMBER 1000 HOURS GMT



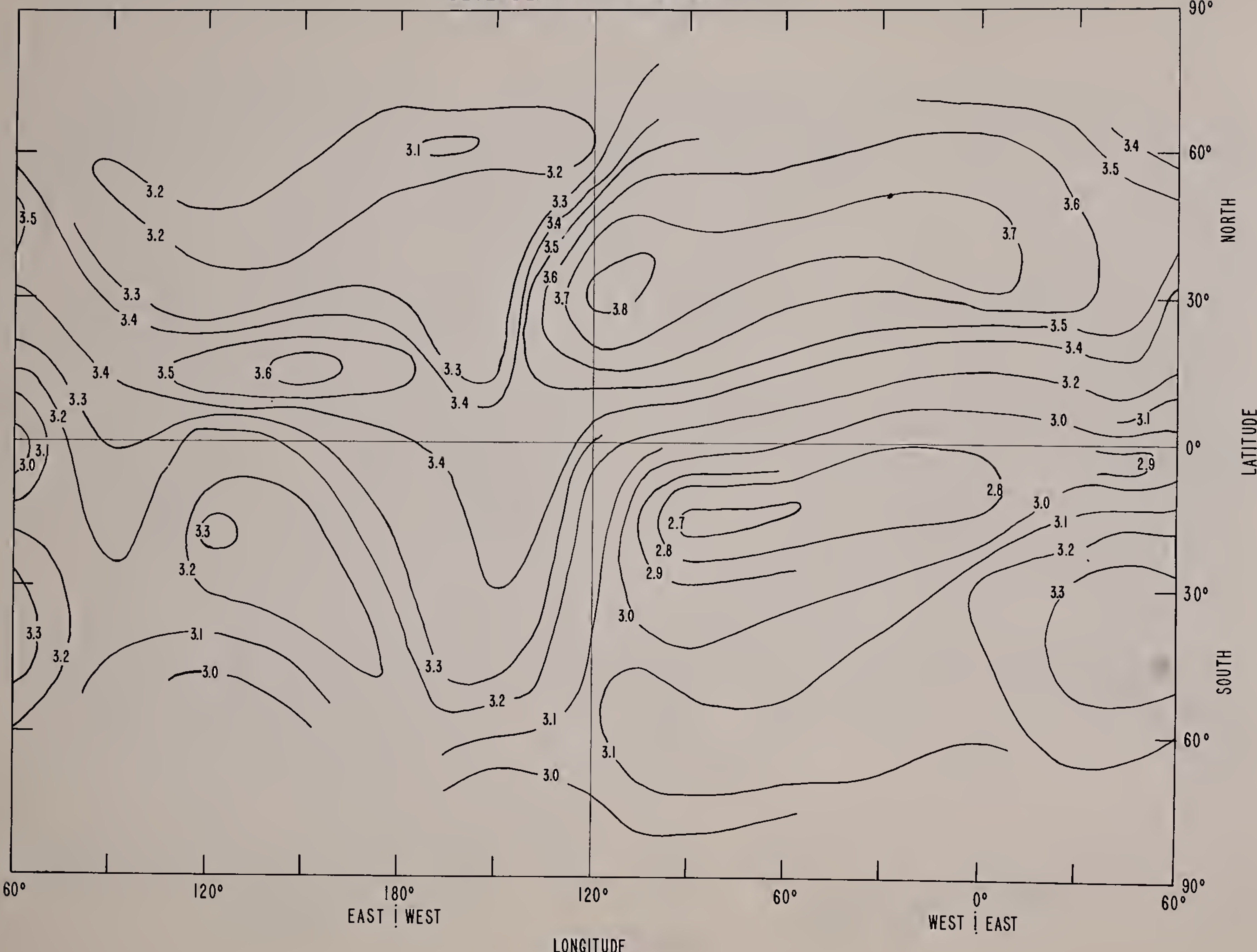
M-4000 FACTOR AT RASSN 50
DECEMBER 1200 HOURS GMT



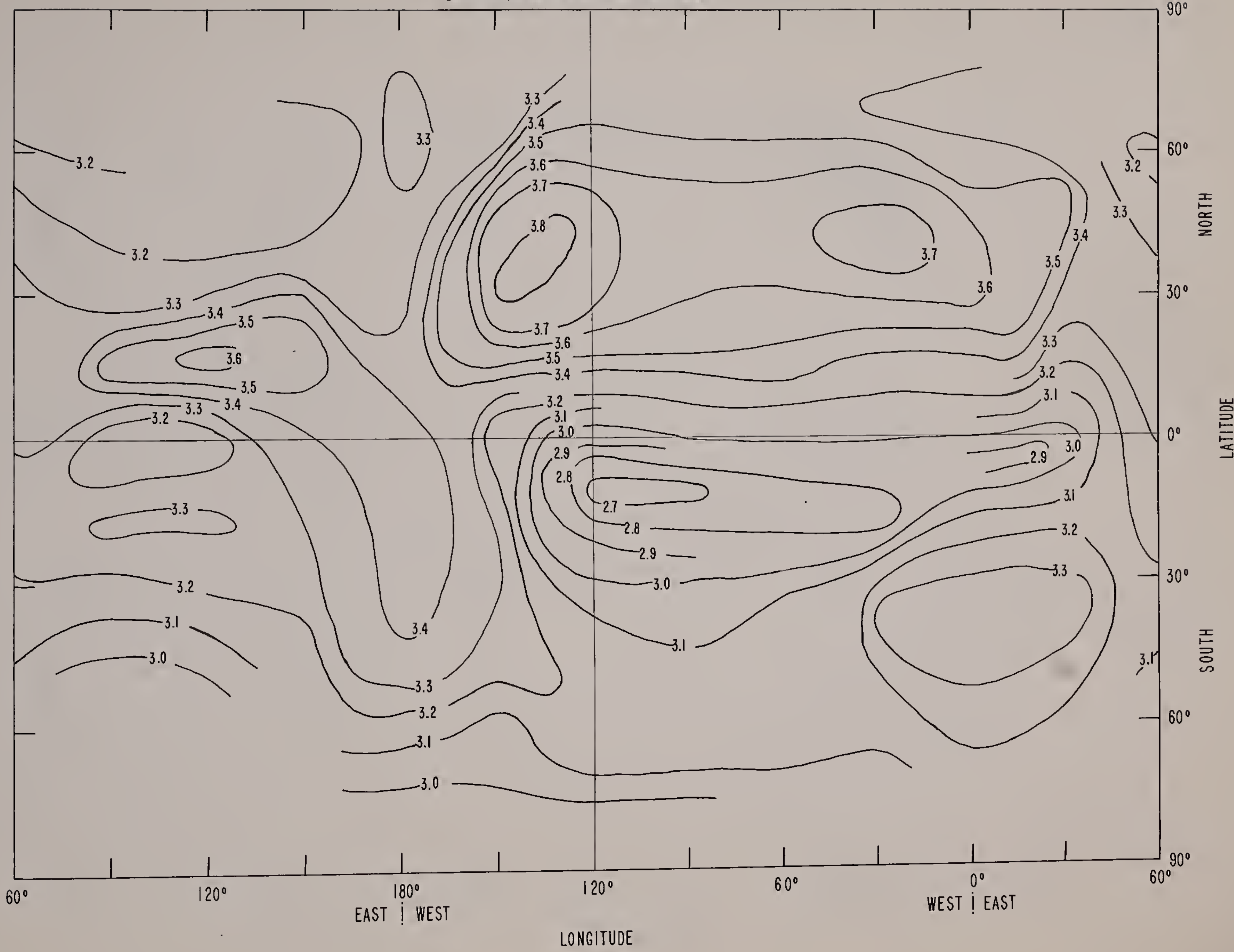
M-4000 FACTOR AT RASSN 50
DECEMBER 1400 HOURS GMT



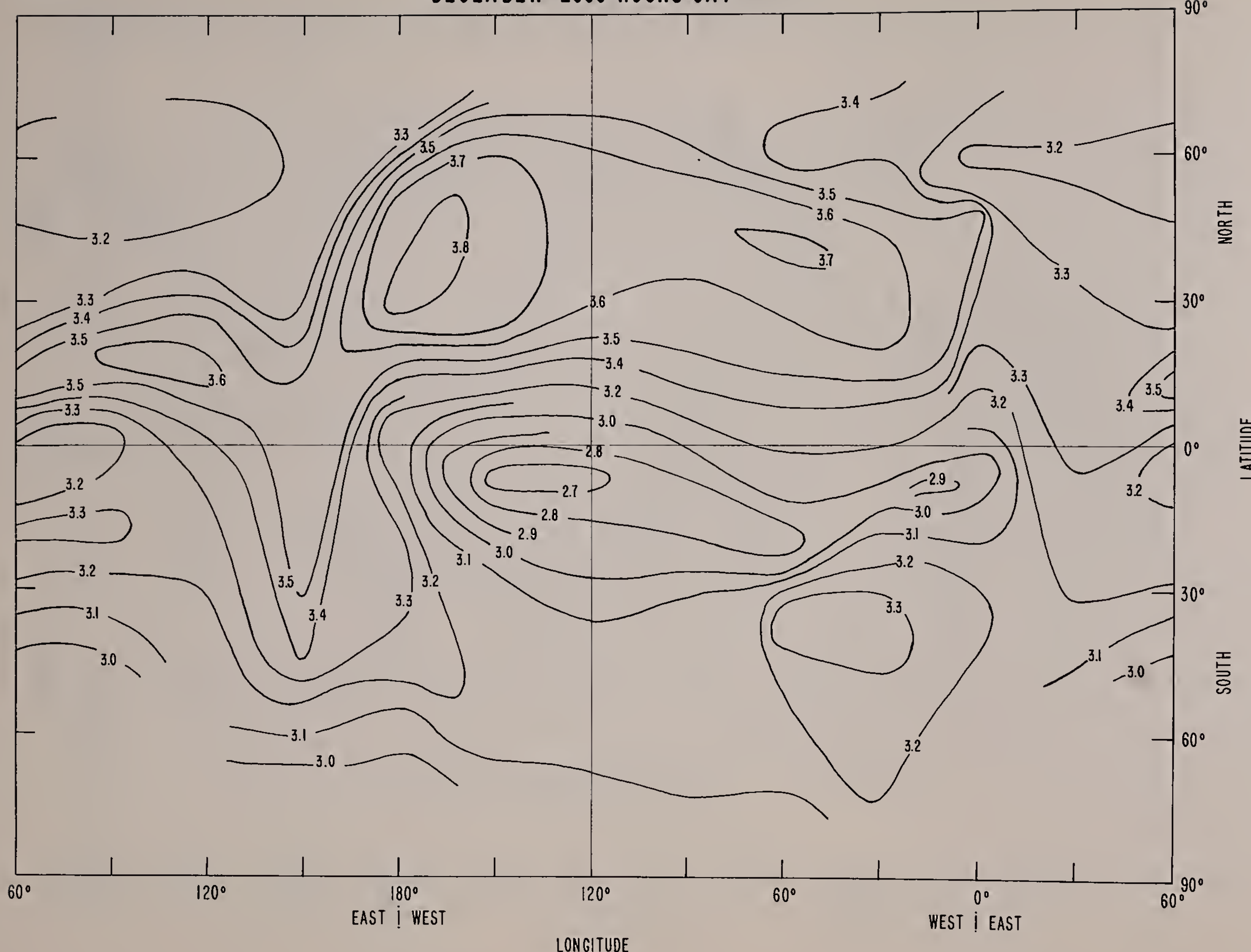
M-4000 FACTOR AT RASSN 50
DECEMBER 1600 HOURS GMT



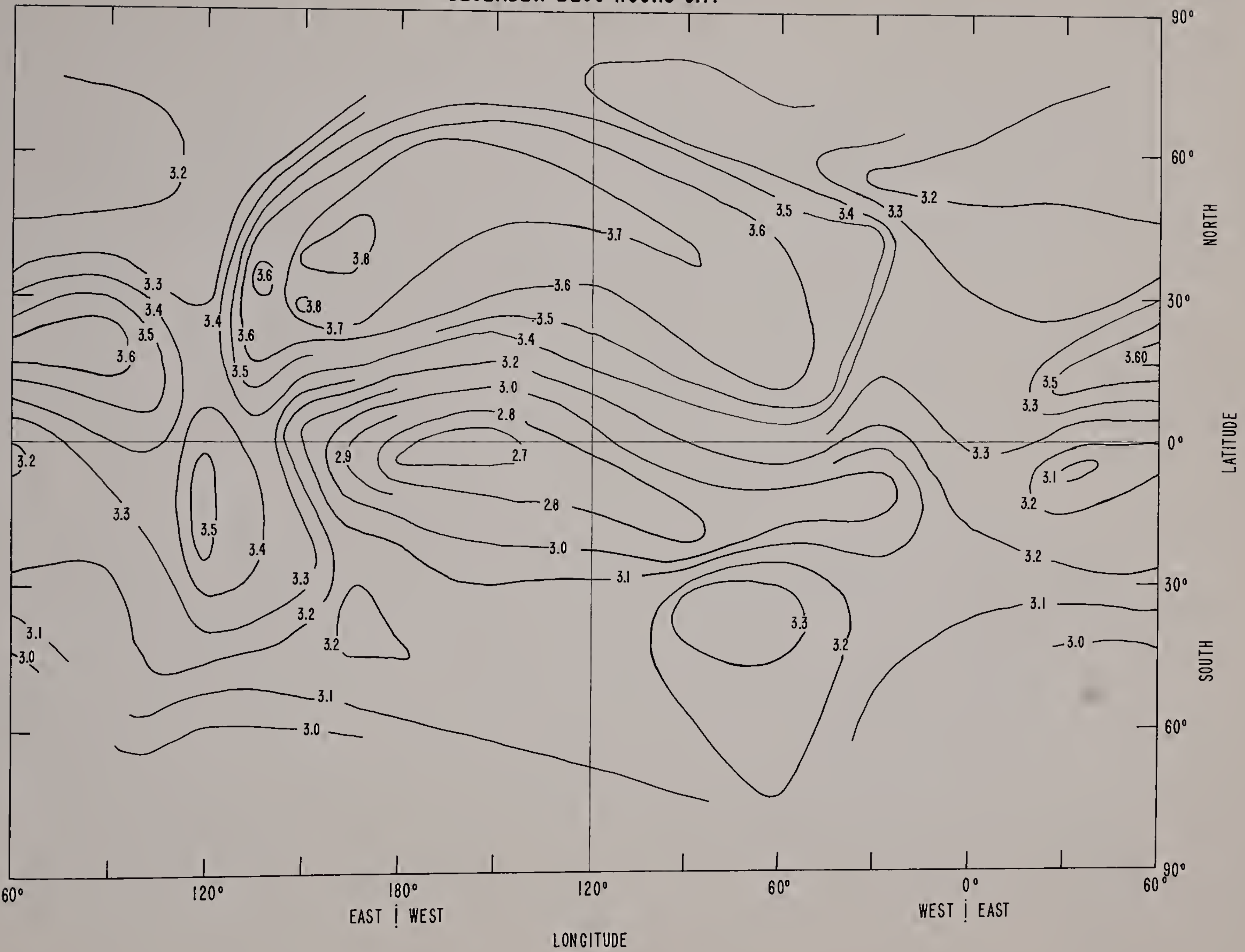
M-4000 FACTOR AT RASSN 50
DECEMBER 1800 HOURS GMT



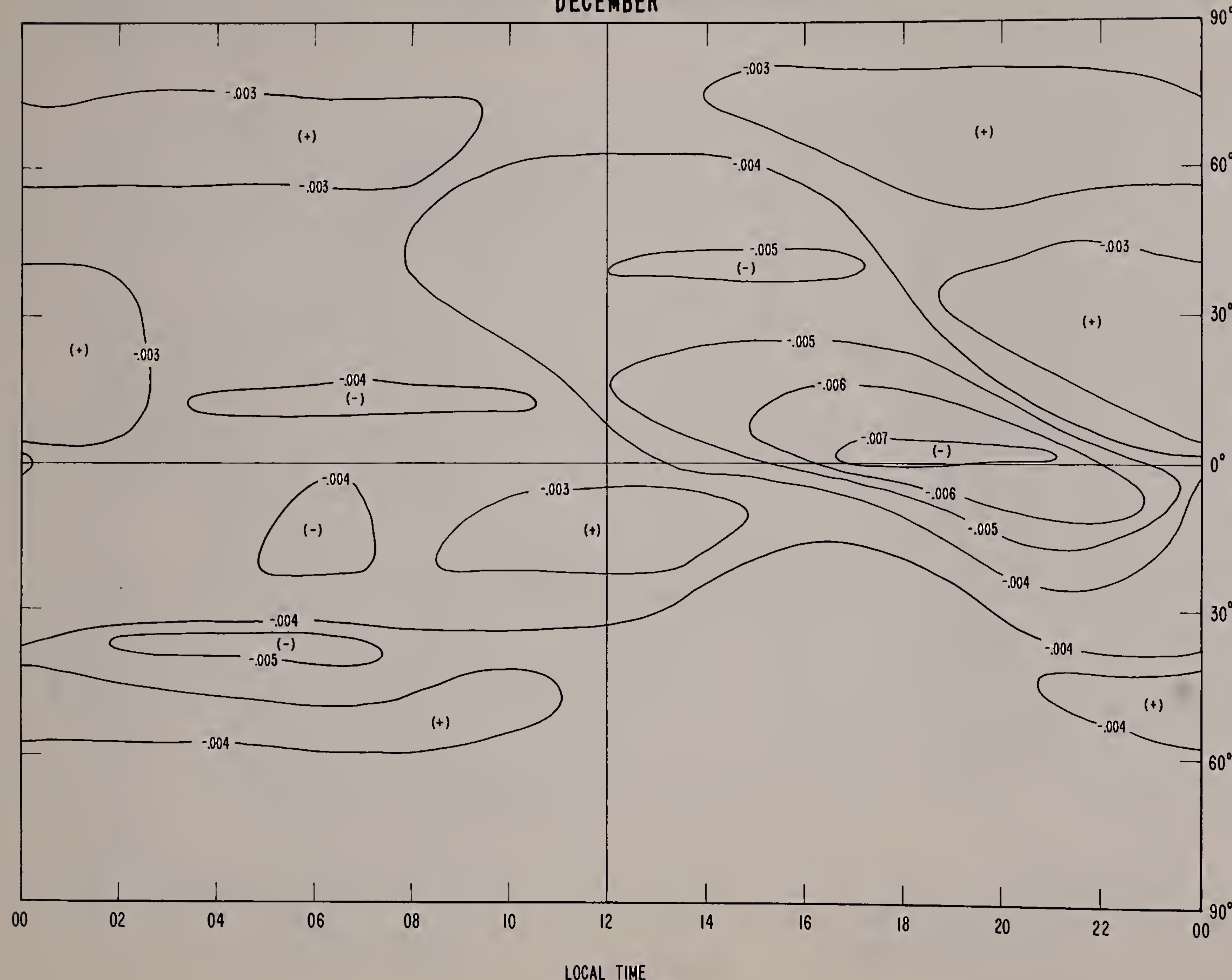
M-4000 FACTOR AT RASSN 50
DECEMBER 2000 HOURS GMT



M-4000 FACTOR AT RASSN 50
DECEMBER 2200 HOURS GMT



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



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