CHAPTER VII

RESEARCH

A. GENERAL

Research related to tropical cyclones is limited due to lack of personnel and time. Once the typhoon season is over, usually in December, the "Annual Typhoon Report" is written and published. This is completed by 1 April, and parts of April, May, and June are devoted to research. Problems encountered during the typhoon season are always greater in number than those solved during the research period. Research may be divided into two types: that leading to simplification of the forecast problem, and that research designed to improve the forecast. Projects are listed and discussed in this chapter.

B. A TEST OF THE MILLER-MOORE METHOD OF FORECASTING HURRICANE MOVEMENT AS APPLIED TO PACIFIC TYPHOONS OF 1960

While it is generally agreed that the motion of a typhoon or hurricane is not determined by the characteristics of the circulation at any one level, a number of objective forecasting methods have used this approach for sake of simplicity and useability.

One of the more recent studies of this type was made by B.I. Miller and P.L. Moore of the U.S. Weather Bureau and published in the February 1960 issue of the "Bulletin of the American Meteorological Society".

Briefly, the method consisted of correlating the storm movement with a mean geostrophic wind and the past 12 hour storm movement. Somewhat surprisingly this method, based upon 18 hurricanes and 127 forecast cases, showed better results using 700 mb data than either 500 or 300 mb data.

The method involves separate determination of meridional and zonal forecasts of storm movement. The equations developed by Miller-Moore are:

Initial latitude equal to or less than 27.5°

$$\bar{V} = 0.23v_7 + 0.65Py + 2.3$$
$$\bar{U} = 0.42u_7 + 0.54Px - 2.4 \qquad (1)$$

Initial latitude more than 27.5°

$$\bar{V} = 0.71v_7 + 0.40Py + 3.0$$
$$\bar{U} = 0.61u_7 + 0.48Px - 3.8 \qquad (2)$$

$\bar{U}$ = forecast mean 24 hour zonal speed of center movement (kts)

$\bar{V}$ = forecast mean 24 hour meridional speed of center movement (kts)

v_7 = first approximation: mean 700 mb geostrophic wind between five pairs of points 7.5 degrees E and 7.5 degrees W of the storm center and extending from 5 degrees S to 5 degrees N of the center. If southward movement results - no further computation.

·second approximation: add points 7.5 degrees N of center to first calculation. If both of the first

two approximations are less than 6.5 kts, use the largest - no further computation.

third approximation: same as second but adding points 10 degrees N of center to second approximation. Use the largest of the three approximations.

u_7 = mean 700 mb geostrophic wind between seven pairs of points 5 degrees S of the initial position of the storm center and 5 degrees N of the latitude the $\overline{V}$ computation indicates the center will reach 12 hours after chart time.

Py = mean meridional speed of movement of center for the 12 hours prior to chart time (kts).

Px = mean zonal speed of movement of center for the 12 hours prior to chart time (kts).

u_7 and v_7 are computed from the latest 700 mb chart on the Miller-Moore Grid shown herein. Heights are tabulated for every 2½ degrees. In the case of the meridional component, the average height difference is computed between 5 degrees N and S of the center; however, depending upon the resulting northward speed of the storm, this grid may be extended to 7½ or 10 degrees N of the center in accordance with the specified criteria. In the case of the zonal component, the average height difference between the two horizontal rows is computed; the bottom row being 5 degrees S of the initial surface position of the storm and the top row being 5 degrees N of the 12 hour meridional forecast position of the center. The average meridional and zonal height differences are then reduced to meters per degree and converted to geostrophic wind for the central latitude using the graph shown herein. $\overline{U}$ and $\overline{V}$ are then solved for, using the equations (1) or (2).

The above method was tested at the conclusion of the 1960 Typhoon Season, and the 24 hour forecast errors are shown on two scatter diagrams in this Section. Forecasts were made on Typhoons OLIVE through PHYLLIS. There were 29 cases N of 27.5 degrees N and 173 cases at or S of 27.5 degrees N. The cases used were based on forecasts made whenever the circulation was of tropical storm or typhoon intensity. The best tracks (shown in Chapter V) were used to obtain the data for Px and Py. The meridional and zonal 24 hour forecasts were applied to the best track position, and the error thus obtained is the difference between the 24 hour forecast position and the corresponding best track position.

The scatter diagram for cases N of 27.5 degrees N has little significance because the errors appear to be fairly well distributed; probably due to the limited number of cases available. In the scatter diagram for cases at or S of 27.5 degrees N, the majority of the cases are in the northeast quadrant. This indicates that the Miller-Moore method can be corrected to better distribute the forecast error; however, this assumption is based on data for one year, which includes many unusual tracks. The Miller-Moore method will be further evaluated on the data available for 1959, which was a season with more normal typhoon tracks and on the data that becomes available during 1961.

Tables in this Section show the 24 hour Miller-Moore forecast errors for Typhoons OLIVE through PHYLLIS. The distance, and meridional and zonal forecast errors are in nautical miles. The distance error is the difference between the forecast position and the actual position of the circulation. The meridional and zonal forecast error is the distance the forecast position is N,E,S, or W of the actual position of the circulation. The average distance error of all forecasts was 138 mi.

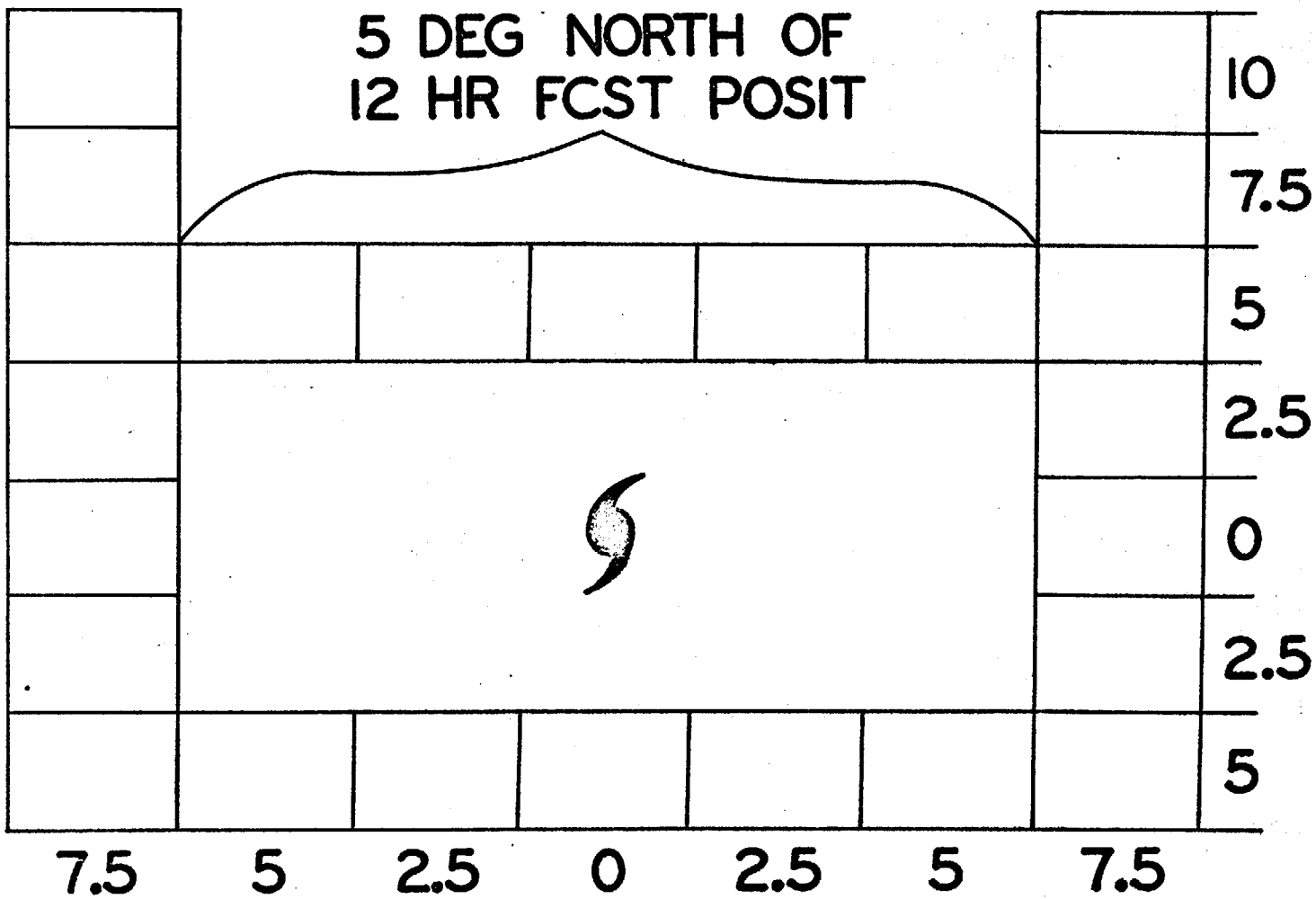
It should be emphasized that the Miller-Moore forecasts, as presented herein, cannot be compared with the operational forecasts made by the JTWC for the following reasons:

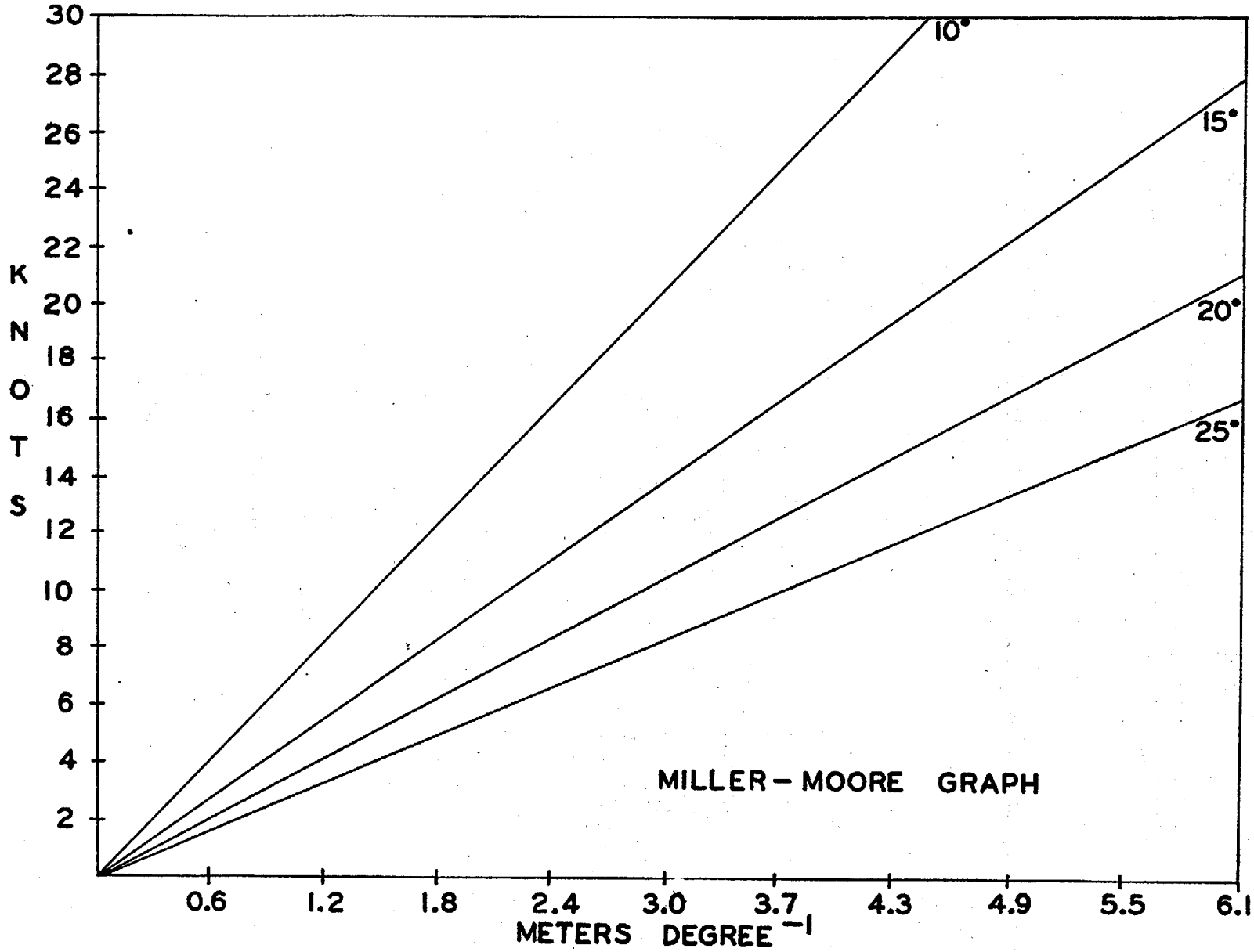
(1) JTWC forecasts are issued every 6 hours. Seven hundred millibar data, the bases for the Miller-Moore forecasts, are available in the Pacific only every 12 hours.

(2) The JTWC 24 hour forecasts are valid for a full 24 hours from the time they are transmitted. These forecasts are therefore often based on surface data as much as 6 hours old, and upper air data as much as 12 hours old. Due to the time required to process and analyze the 700 mb data, Miller-Moore forecasts are valid for a period of less than 20 hours from the time of preparation.

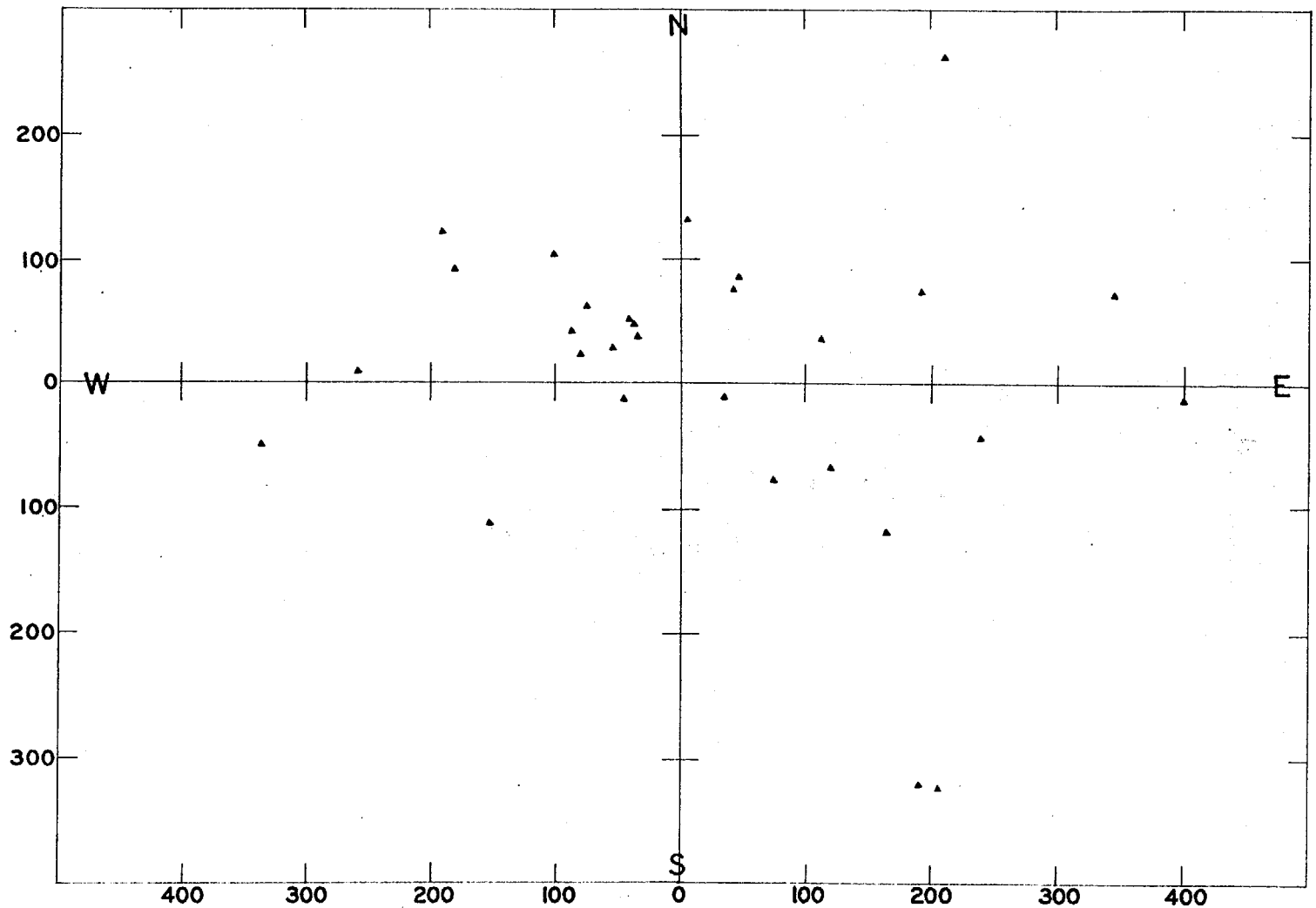
(3) In this evaluation the Miller-Moore Px and Py (past 12 hour movement factors) were obtained from best tracks. The JTWC forecasts were of course prepared from the best known positions of the typhoon or tropical storm at the time the forecasts (warnings) were prepared.

MILLER-MOORE GRID



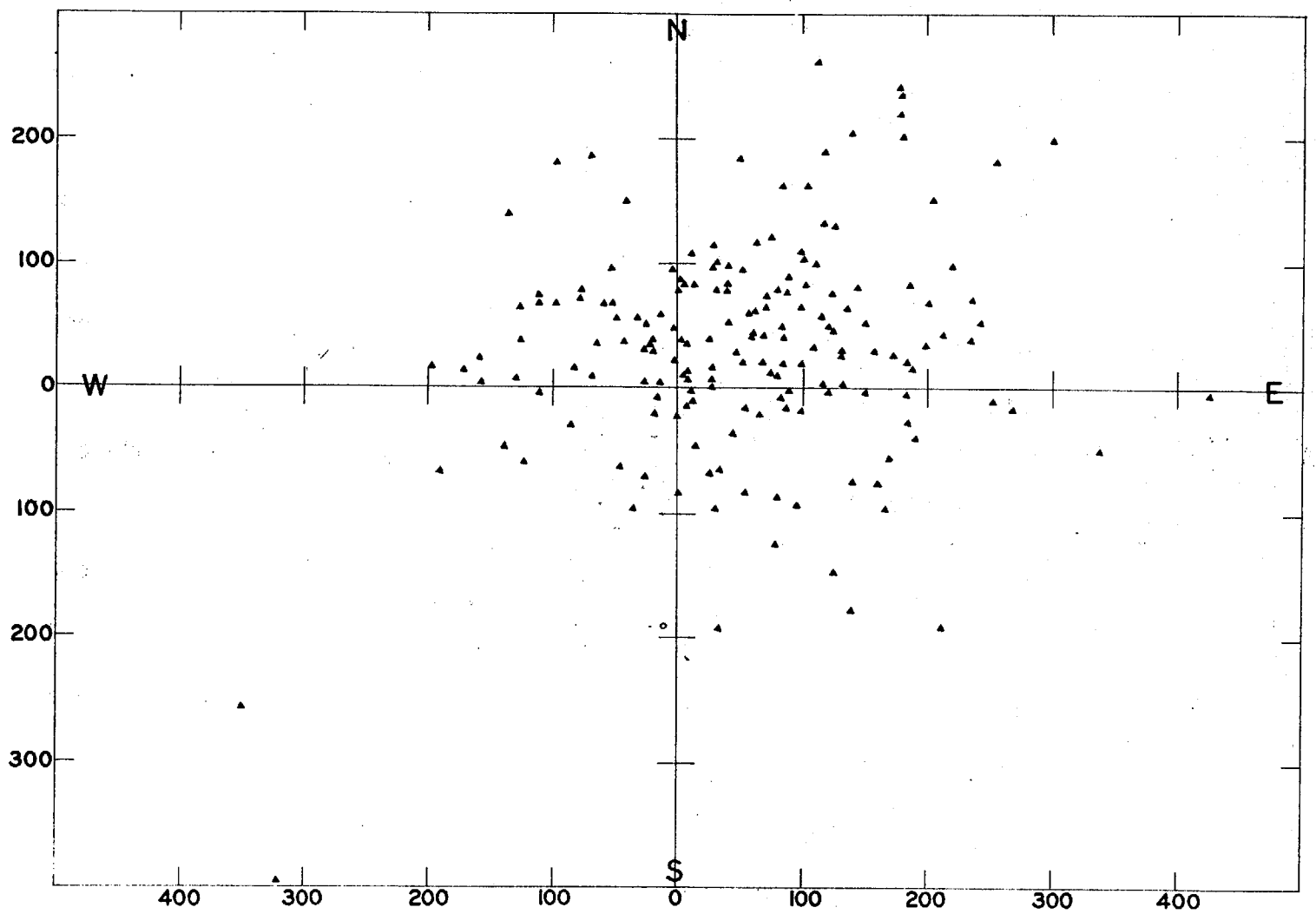

MILLER – MOORE GRAPH
KNOTS
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
10°
15°
20°
25°
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
METERS DEGREE^{-1}

MILLER-MOORE 24 HOUR FORECAST ERRORS
NORTH OF 27.5°N



MI N,E,S, OR W OF ACTUAL POSITION

MILLER-MOORE 24 HOUR FORECAST ERRORS
AT OR SOUTH OF 27.5° N



MI N,E,S, OR W OF ACTUAL POSITION

MILLER-MOORE 24 HOUR FORECAST ERRORS

OLIVE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2500Z	88	67	-	-	57
2512Z	103	50	-	85	-
2600Z	124	68	-	-	110
2612Z	48	39	-	26	-
2700Z	72	22	-	69	-
2712Z	75	45	-	62	-
2800Z	90	-	15	88	-
2812Z	82	10	-	80	-
2900Z	133	84	-	105	-
2912Z	146	100	-	113	-
3000Z	146	104	-	102	-
Average	101				

POLLY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1900Z	55	52	-	-	24
1912Z	40	36	-	-	22
2000Z	44	39	-	-	19
2012Z	49	49	-	-	1
2100Z	20	15	-	10	-
2112Z	85	-	6	84	-
2200Z	98	42	-	87	-
2212Z	89	79	-	41	-
2300Z	74	44	-	61	-
2312Z	85	79	-	32	-
2400Z	101	97	-	29	-
2412Z	12	-	2	11	-
2500Z	134	3	-	133	-
2512Z	100	21	-	99	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

POLLY (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2600Z	28	1	-	28	-
2612Z	15	5	-	-	14
2700Z	16	-	14	8	-
2712Z	71	-	19	66	-
2800Z	140	-	67	119	-
2812Z	111	-	76	74	-
2900Z	51	38	-	-	35
Average	68				

SHIRLEY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
3012Z	83	84	-	6	-
3100Z	36	17	-	29	-
3112Z	40	35	-	8	-
0100Z	126	90	-	90	-
0112Z	87	62	-	58	-
0200Z	149	-	46	-	139
0212Z	102	-	95	32	-
0512Z	373	-	320	192	-
0600Z	197	-	113	-	152
Average	133				

TRIX

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0512Z	74	36	-	-	63

MILLER-MOORE 24 HOUR FORECAST ERRORS

TRIX (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0600Z	26	-	20	-	17
0612Z	72	-	65	34	-
0700Z	122	-	2	122	-
0712Z	162	53	-	152	-
0800Z	192	185	-	52	-
0812Z	248	205	-	141	-
0900Z	192	140	-	-	134
0912Z	76	58	-	-	47
1000Z	188	-	25	187	-
Average	135				

VIRGINIA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0912Z	47	-	45	15	-
1000Z	251	-	192	217	-
1012Z	178	-	56	171	-
1100Z	103	86	-	46	-
1112Z	148	103	-	-	102
1200Z	255	-	43	240	-
Average	164				

WENDY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1200Z	200	-	97	168	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

WENDY (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1212Z	59	47	-	-	37
1300Z	133	37	-	112	-
Average	131				

BESS

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1800Z	162	30	-	159	-
1812Z	190	16	-	190	-
1900Z	91	68	-	-	51
1912Z	105	-	96	-	34
2000Z	60	51	-	-	40
2012Z	226	122	-	-	190
2100Z	264	59	-	-	258
2112Z	205	93	-	-	183
2300Z	90	62	-	-	76
2312Z	356	72	-	346	-
2400Z	401	-	12	400	-
2412Z	210	74	-	193	-
Average	197				

CARMEN

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1800Z	102	74	-	73	-
1812Z	108	99	-	47	-
1900Z	105	108	-	14	-
1912Z	65	58	-	-	30

MILLER-MOORE 24 HOUR FORECAST ERRORS

CARMEN (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2000Z	75	-	62	-	46
2012Z	88	20	-	86	-
2100Z	119	34	-	111	-
2112Z	201	35	-	200	-
2200Z	137	-	93	97	-
2212Z	192	-	149	126	-
2300Z	201	-	119	164	-
2312Z	330	-	323	207	-
Average	144				

DELLA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1900Z	240	98	-	222	-
2200Z	230	44	-	215	-
2212Z	60	22	-	54	-
2300Z	146	110	-	100	-
2312Z	191	163	-	106	-
2400Z	157	148	-	-	42
2412Z	11	11	-	6	-
2500Z	56	29	-	48	-
2512Z	136	47	-	125	-
2600Z	176	19	-	185	-
2612Z	184	27	-	175	-
2700Z	96	-	2	90	-
2712Z	57	-	15	55	-
2800Z	22	22	-	-	2
2812Z	133	131	-	5	-
2900Z	89	76	-	42	-
2912Z	47	-	12	-	45
Average	119				

MILLER-MOORE 24 HOUR FORECAST ERRORS

ELAINE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2112Z	138	27	-	132	-
2200Z	117	4	-	116	-
2212Z	137	30	-	133	-
2300Z	252	-	66	-	240
2312Z	421	199	-	302	-
2400Z	294	236	-	180	-
2412Z	75	-	67	28	-
2500Z	155	65	-	138	-
Average	199				

FAYE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2400Z	40	33	-	-	25
2412Z	197	83	-	183	-
2500Z	133	50	-	122	-
2512Z	180	133	-	118	-
2600Z	222	190	-	119	-
2612Z	310	183	-	256	-
2700Z	273	202	-	183	-
2712Z	258	153	-	206	-
2800Z	193	-	40	193	-
2812Z	100	-	17	98	-
2900Z	154	-	74	140	-
2912Z	97	-	82	56	-
3000Z	12	-	12	-	-
3012Z	70	-	70	-	25
3100Z	36	-	10	36	-
3112Z	90	41	-	-	87
Average	148				

MILLER-MOORE 24 HOUR FORECAST ERRORS

KIT

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0512Z	86	17	-	-	82
0600Z	38	38	-	3	-
0612Z	171	15	-	-	170
0700Z	68	10	-	-	67
0712Z	154	5	-	-	156
0800Z	110	-	4	-	110
0812Z	76	13	-	75	-
0900Z	176	-	76	161	-
0912Z	245	38	-	237	-
1000Z	120	115	-	30	-
1012Z	33	30	-	-	18
1100Z	94	65	-	72	-
1112Z	117	118	-	65	-
1200Z	150	122	-	76	-
1212Z	92	95	-	52	-
1300Z	109	80	-	81	-
Average	115				

LOLA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1000Z	197	186	-	-	68
1012Z	205	181	-	-	97
1100Z	180	163	-	85	-
1112Z	284	220	-	180	-
1200Z	114	77	-	88	-
1212Z	149	-	125	80	-
1300Z	270	-	15	270	-
1312Z	255	-	10	255	-
1400Z	183	82	-	145	-
1412Z	22	-	22	-	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

LOLA (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1500Z	252	54	-	245	-
1512Z	188	136	-	127	-
1600Z	12	7	-	9	-
1612Z	28	6	-	28	-
1700Z	131	58	-	117	-
Average	165				

MAMIE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1512Z	60	-	35	45	-
1600Z	17	-	7	-	15
1612Z	107	100	-	32	-
1700Z	84	62	-	62	-
1712Z	110	96	-	-	52
1800Z	112	79	-	-	76
1812Z	25	5	-	-	25
1900Z	83	-	83	-	-
1912Z	97	-	193	34	-
2000Z	221	-	178	140	-
2012Z	58	29	-	-	54
2100Z	89	23	-	-	80
Average	89				

NINA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2500Z	85	42	-	70	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

NINA (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2512Z	65	54	-	42	-
2600Z	90	84	-	41	-
2612Z	297	243	-	179	-
2700Z	282	263	-	113	-
2712Z	340	262	-	212	-
Average	193				

OPHELIA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2800Z	119	68	-	-	97
2812Z	114	65	-	100	-
2900Z	137	75	-	-	110
2912Z	343	-	50	341	-
3000Z	427	-	5	427	-
0100Z	118	-	87	81	-
0112Z	137	-	58	-	121
0200Z	89	-	29	-	85
0212Z	198	23	-	-	196
0300Z	107	78	-	-	76
0312Z	151	-	3	151	-
0400Z	184	-	5	184	-
0412Z	83	60	-	-	62
0500Z	422	-	256	-	349
0512Z	500	-	395	-	320
0600Z	340	-	50	-	335
Average	217				

MILLER-MOORE 24 HOUR FORECAST ERRORS

PHYLLIS

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1400Z	126	9	-	-	128
1412Z	131	40	-	-	123
1500Z	74	74	-	2	-
1512Z	88	87	-	2	-
1600Z	147	77	-	125	-
1612Z	216	70	-	203	-
1700Z	243	71	-	238	-
1712Z	15	-	10	13	-
1800Z	53	38	-	-	42
1900Z	65	65	-	-	125
1912Z	95	95	-	-	3
2000Z	83	83	-	15	-
Average	111				

AVERAGE 24 HOUR DISTANCE ERROR 138 MI (OLIVE-PHYLLIS)

C. WACHHOLZ GRAPHS

These graphs were compiled by Captain Edward R. Wachholz, USAF, in April and May of 1960 after a season of forecasting typhoons in 1959 at FWC/JTWC. The graphs are compiled from reconnaissance data for 1957, 1958, and 1959, and were tested on 1956 data. The three years used provided more complete information than any other period due to the availability of flight level winds determined by the APN-82, Doppler wind measuring equipment.

The first chart, called a coordination chart, is based on the theory that all typhoons develop in homogeneous air over areas of similar characteristics, and that typhoons are similar thermodynamically except for differences in intensity. These variations of intensity are due to seasonal heat differences, differences in spawning areas, and geography.

The graphs are as follows:

(1) The first graph (see this chapter) relates minimum 700 mb height (ft), maximum 700 mb temperature (°C), and minimum surface pressure (mb), as modified by latitude, to maximum 700 mb wind speed (kts) and maximum surface wind (kts). The graph is based on the following formulas:

$$\text{Sfc wind max} = \left[17 + \left(\frac{\theta - 15}{5}\right)\right]\sqrt{372 - \frac{7hm}{28}} \qquad (1)$$

$$\text{700 mb wind max} = 50 + \left(.5 + \frac{Sfcm}{500}\right)(Sfcm - 50) \qquad (2)$$

θ represents the latitude of the typhoon eye
7hm is the 700 mb minimum height of the eye in ft
Sfcm is the surface wind max around the eye in kts

The basis of these formulas is the original formula by Dr. Robert Fletcher who is presently Director of Scientific Services, Air Weather Service. This formula is shown below:

$$\text{Sfc wind max} = 16\sqrt{1010 - P_c} \qquad (3)$$

1010 represents the pressure in mb at the "bar" of the typhoon, and may be adjusted if the "bar" pressure differs.

P_c is the center pressure of the typhoon or hurricane in mb.

Note on the coordination chart that the 700 mb-surface wind relationship is direct (they are the same at 50 and 250 kts only), and that the surface pressure-700 mb height is also directly related. When the surface pressure is known, find it on the graph then follow horizontally to the correct latitude; from there extend vertically to the surface wind or to the 700 mb wind.

This chart was used through the 1960 season and found to be quite reliable. Information most frequently used to determine the surface wind was the 700 mb height and the 700 mb wind which are accurately measured by the aircraft. The surface pressure was most frequently obtained from dropsonde equipment and available as raw uncorrected data at time of chart use. Its value varied at times from the corrected pressure available later. The 700 mb temperature parameter was found to be least useful due to the fact that it is reported in whole degrees, and a small variation in temperature represents a large variation of other features in the graph. This graph works only for circulations thermodynamically classified as typhoons. The coordination graph is also used as an overlay for the climatological graphs discussed below.

(2) Three graphs of typhoon track climatology, using time and the 700 mb height as ordinates, are shown herein. The charts are for the periods June-15 August, 15 August-December, and November-May, for the western North Pacific and the South China Sea only. These graphs are scaled to the height values of the coordination graph. The time varies horizontally and the space between two vertical lines represents 6 hours. These graphs are "folded" at A and A'. There is an upper, lower and median line for each graph. Heavy hatching is placed between the upper and lower limits. Behavior of typhoons of various source regions is indicated on the graphs. The upper limit line on the June-15 August graph for the folded part beginning with A' starts 18-24 hours after A'. This is because those circulations that are weak (have height values that are near 10000 ft) usually do not re-intensify. For this reason, no upper limit is drawn in for the second intensification part of the graph.

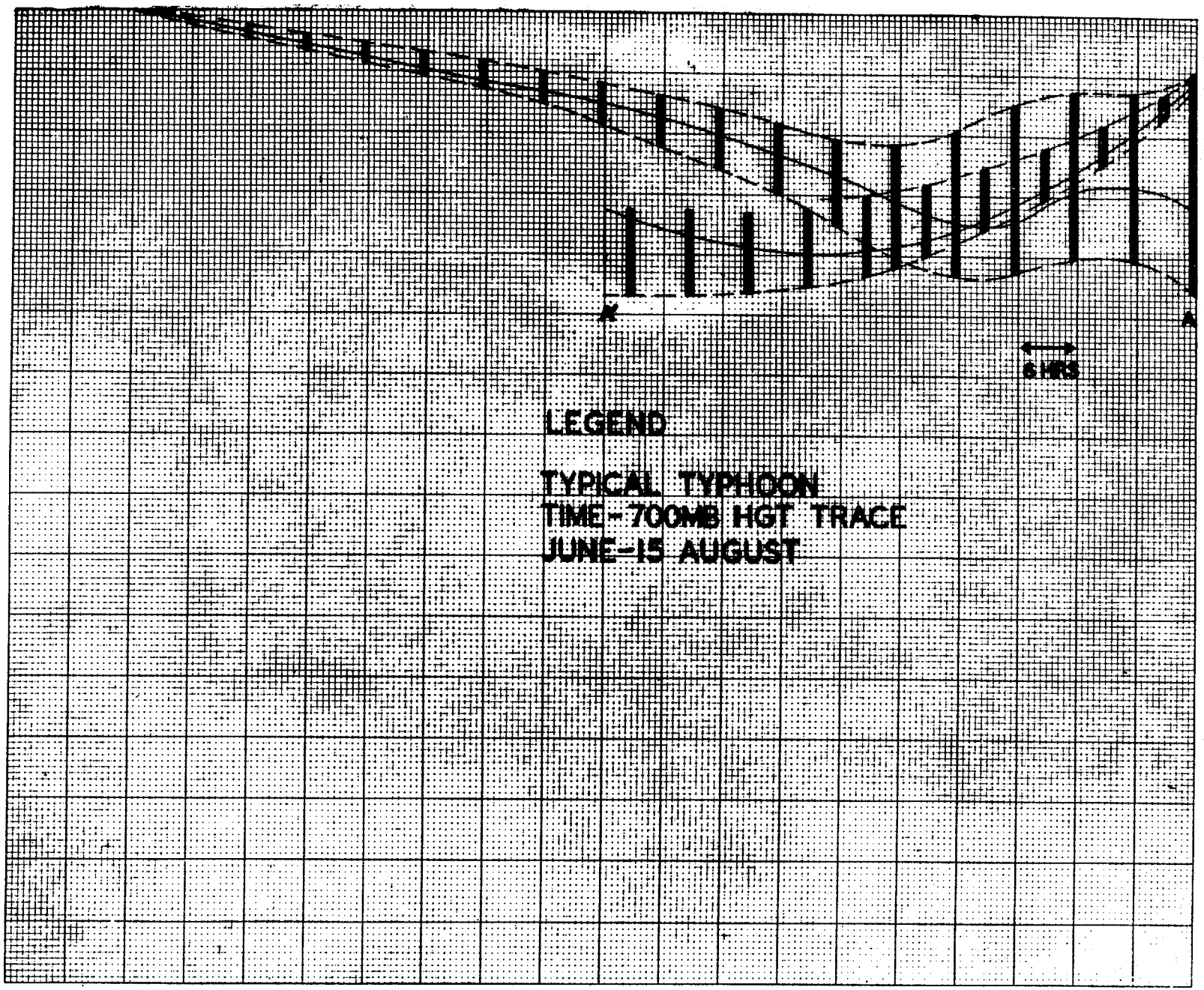
The June-15 August trace is 7 days in length and the other traces are 9½ to 10 days long. The double minimums on the June-15 August, November-May charts represent weakening, and re-intensification as a result of passage over land, or through the ridge line. The midseason 15

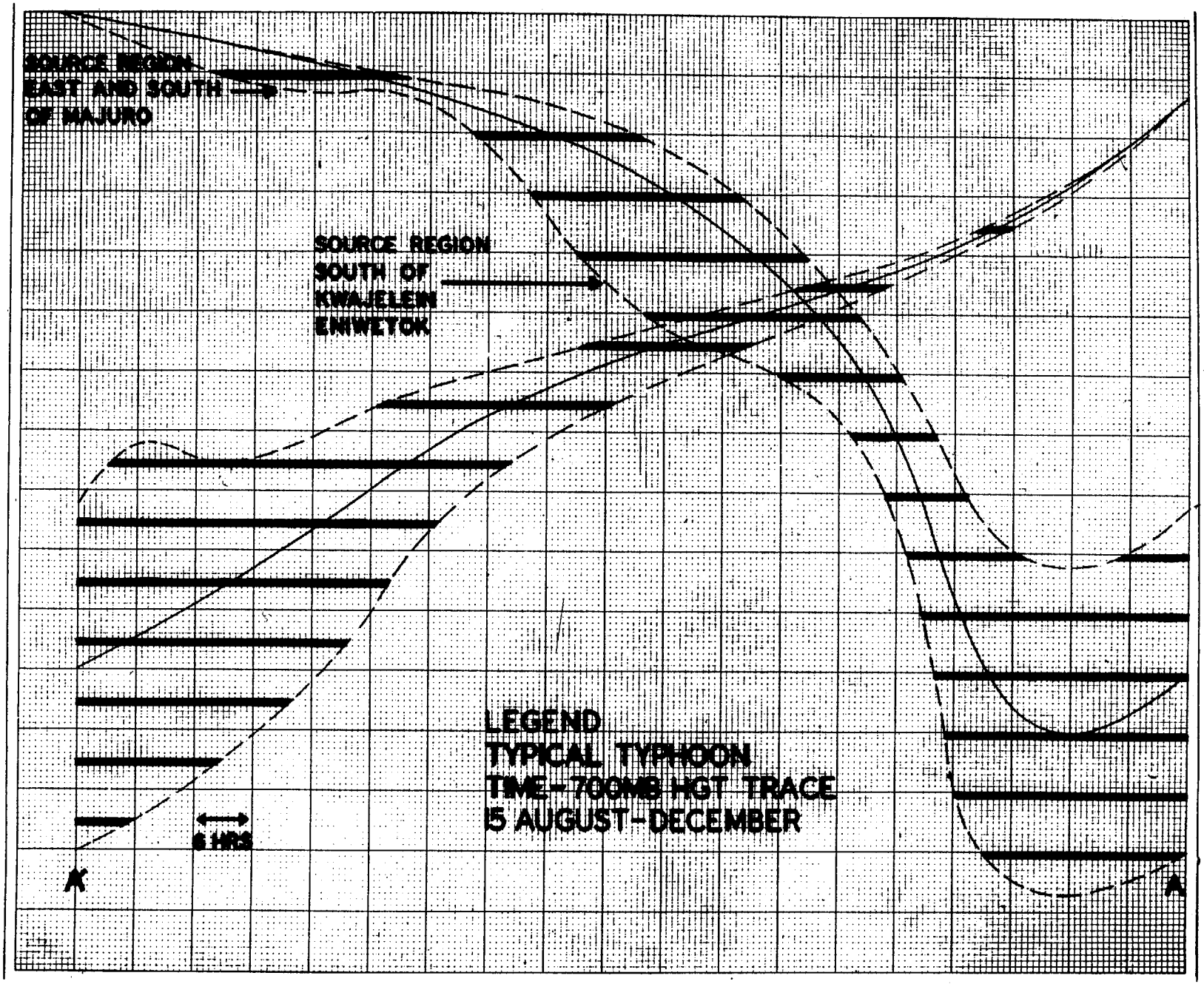
August-December trace reflects some of this variation between the 12-18 hour period after A'.

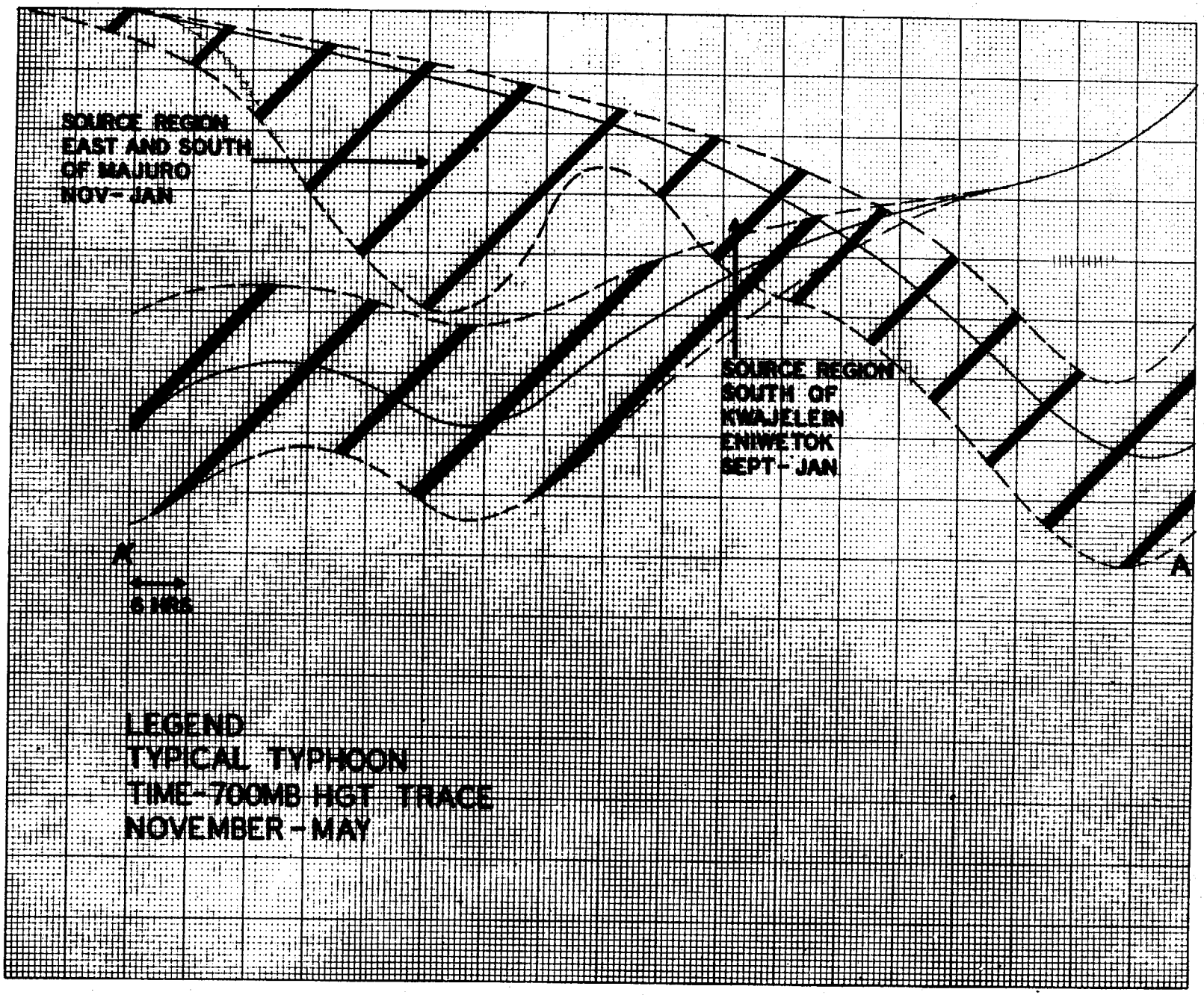
These charts are useful aids in forecasting typhoon intensity trends, but may not be used to forecast recurvature, minimum height/pressure, lifetime of the typhoon, or other implied features. To clarify the climatological aspect, the typhoons (including T.S. LUCILLE and NADINE) of this season averaged 7 days 17 hours, from first to last warning, comparing favorably with the climatology of the 3 charts. The life of two typhoons were 2½ and 15 3/4 days respectively; neither the 2½ day nor the 15 3/4 day typhoon would fit these charts due to the time difference, even though the curves would be similar; however, variation of intensity could be forecast reasonably for each.

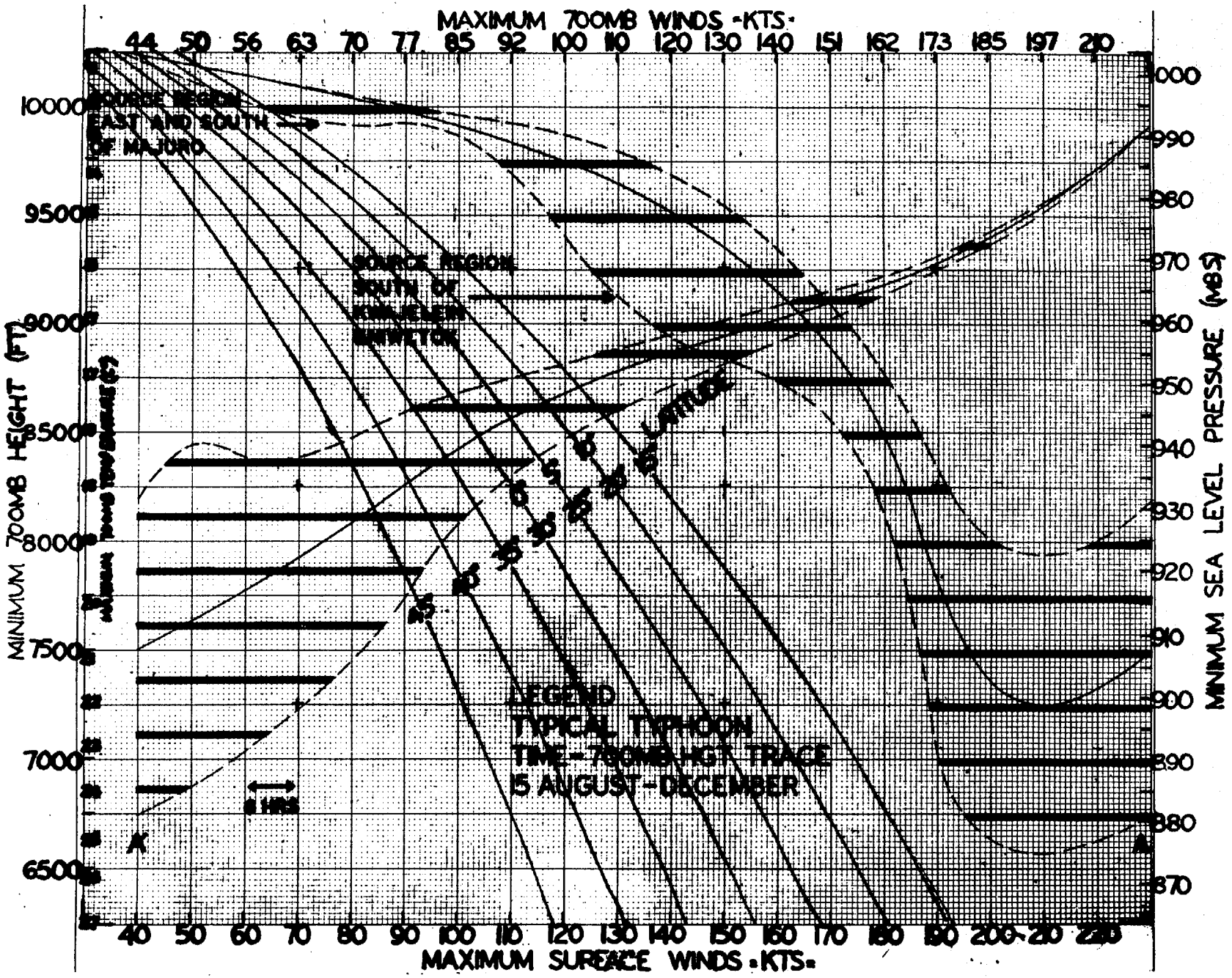
In summation, these graphs were used during the 1960 typhoon season and found to be very successful operational tools.

MAXIMUM 700MB WINDS -KTS-
MINIMUM 700MB HEIGHT [FT]
MINIMUM SEA LEVEL PRESSURE (MBS)
MAXIMUM SURFACE WINDS -KTS-
10000
9500
9000
8500
8000
7500
7000
6500
1000
990
980
970
960
950
940
930
920
910
900
890
880
870
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
44 48 52 56 60 64 68 72 76 80 84 88 92 96 100 104 108 112 116 120 124 128 132 136 140 144 148 152 156 160 164 168 172 176 180 184 188 192 196 200


A
6 HRS
LEGEND
TYPICAL TYPHOON
TIME-700MB HGT TRACE
JUNE-15 AUGUST


SOURCE REGION
EAST AND SOUTH
OF MAJURO
SOURCE REGION
SOUTH OF
KWAJELEIN
ENIWETOK
LEGEND
TYPICAL TYPHOON
TIME-700MB HGT TRACE
15 AUGUST-DECEMBER
6 HRS
K
A


SOURCE REGION
EAST AND SOUTH
OF MAJURO
NOV- JAN
SOURCE REGION
SOUTH OF
KWAJELEIN
ENIWETOK
SEPT- JAN
N
6 HRS
A
LEGEND
TYPICAL TYPHOON
TIME-700MB HGT TRACE
NOVEMBER-MAY


MAXIMUM 700MB WINDS -KTS-
44 50 56 63 70 77 85 92 100 110 120 130 140 151 162 173 185 197 210
MINIMUM 700MB HEIGHT (FT)
10000
9500
9000
8500
8000
7500
7000
6500
MINIMUM SEA LEVEL PRESSURE (MBS)
1000
990
980
970
960
950
940
930
920
910
900
890
880
870
SOURCE REGION EAST AND SOUTH OF MAJURO
SOURCE REGION SOUTH OF KWAJALEIN
LANDFALL
LEGEND
TYPICAL TYPHOON
TIME-700MB-HGT TRACE
15 AUGUST-DECEMBER
6 HRS
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
MAXIMUM SURFACE WINDS -KTS-