CHAPTER V - SUMMARY OF FORECAST VERIFICATION

1. ANNUAL FORECAST VERIFICATION

a. Western North Pacific Ocean

The positions given for warning times and those at the 24-, 48-, and 72-hour forecast times were verified against the final best track positions at the same valid times. The resultant vector and right angle (track) errors (illustrated in Figure 5-1) were then calculated for each tropical cyclone and are presented in Table 5-1. Figure 5-2 provides the frequency distributions of vector errors in 30 nm increments for 24-, 48-, and 72-hour forecasts of all 1985 tropical cyclones in the western North Pacific. A summation of the mean vector and right angle errors, as calculated for all tropical cyclones in each year, is shown in Table 5-2. A comparison of the annual mean vector errors for all tropical cyclones as compared to those tropical cyclones that reached typhoon intensity can be seen directly in Table 5-3. The annual mean vector errors for 1985 as compared to the ten previous years are graphed in Figure 5-3.

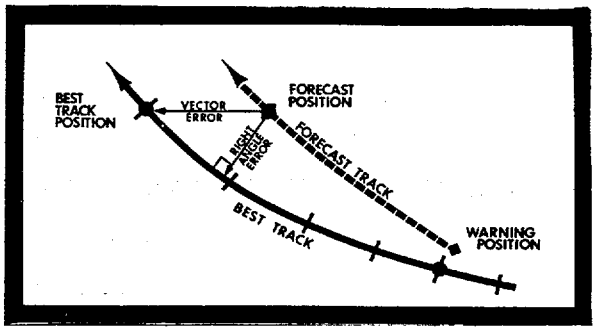

Figure 5-1. Illustration of the method to determine vector error and right angle error.

TABLE 5-1.

FORECAST ERROR SUMMARY FOR THE WESTERN NORTH PACIFIC SIGNIFICANT TROPICAL CYCLONES OF 1985. (ERRORS IN NM)

	WARNING			24-HOUR			48-HOUR			72-HOUR		
	VECTOR ERROR	RT ANGLE ERROR	NR OF WRNGS	VECTOR ERROR	RT ANGLE ERROR	NR OF WRNGS	VECTOR ERROR	RT ANGLE ERROR	NR OF WRNGS	VECTOR ERROR	RT ANGLE ERROR	NR OF WRNGS
01W. TS ELSIE	29	12	9	201	58	5	484	155	1	-	-	-
02W. TS FABIAN	35	7	16	87	30	12	158	51	8	191	25	4
03W. TY GAY	17	9	22	112	55	17	259	79	14	371	65	8
04W. TD 04W	48	27	10	177	110	6	213	-	2	-	-	-
05W. TY HAL	15	12	22	137	109	19	380	347	13	630	591	11
06W. TY IRWA	15	11	26	120	71	22	216	173	18	416	273	14
07W. TY JEFF	18	13	40	132	80	30	342	170	21	639	345	13
08W. TY KIT	14	9	33	113	56	28	305	156	22	523	259	15
09W. TS LEE	18	12	14	129	51	10	293	77	6	657	17	2
10W. TY MAMIE	26	14	17	120	70	13	229	147	9	266	122	4
11W. TY NELSON	10	9	26	64	47	22	132	88	17	182	148	14
12W. TY OLIVIA	15	8	37	146	66	33	238	111	26	272	128	21
13W. TY PAT	16	8	20	155	44	16	331	122	12	514	259	8
14W. TS RUBY	13	12	15	166	110	10	318	137	6	377	27	2
02C. TY SKIP	16	12	33	129	85	29	311	248	25	605	473	20
15W. TY TESS	19	15	22	122	70	18	97	56	14	141	115	10
16W. TS VAL	31	10	13	160	84	9	129	104	5	249	-	1
17W. TS WINONA	18	14	11	87	69	7	140	136	3	-	-	-
18W. TY ANDY	9	6	16	44	30	12	87	63	8	120	84	4
19W. TY BRENDA	17	12	23	93	43	19	245	106	15	436	230	11
20W. TY CECIL	14	11	16	104	93	13	179	159	9	196	139	2
21W. STY DOT	10	8	33	63	32	29	80	31	25	131	68	21
22W. TS ELLIS	16	10	17	149	117	13	363	311	9	583	430	5
23W. TY FAYE	15	7	38	104	58	34	242	136	30	414	231	26
24W. TS GORDON	37	16	23	114	51	17	159	58	11	238	80	6
25W. TY HOPE	19	15	26	123	83	22	201	124	18	159	102	14
26W. TS IRVING	35	18	14	132	73	12	163	41	9	170	51	5
ALL FORECASTS	18	11	592	117	66	477	231	134	356	367	214	241

TABLE 5-2

ANNUAL MEAN FORECAST ERRORS (NM) FOR THE WESTERN NORTH PACIFIC

	24-HOUR		48-HOUR		72-HOUR	
YEAR	VECTOR	RIGHT ANGLE	VECTOR	RIGHT ANGLE	VECTOR	RIGHT ANGLE
1971	111	64	212	118	317	117
1972	117	72	245	146	381	210
1973	108	74	197	134	253	162
1974	120	78	226	157	348	245
1975	138	84	288	181	450	290
1976	117	71	230	132	338	202
1977	148	83	283	157	407	228
1978	127	75	271	179	410	297
1979	124	77	226	151	316	223
1980	126	79	243	164	389	287
1981*	123	75	220	119	334	168
1982*	113	67	237	139	341	206
1983*	117	72	259	152	405	237
1984*	117	66	233	137	363	231
1985*	117	66	231	134	367	214

* The technique for calculating right angle error was revised in 1981; therefore, a direct correlation in right angle statistics cannot be made for the errors computed before 1981 and the errors computed since 1981.

TABLE 5-3. ANNUAL MEAN FORECAST ERRORS (NM) FOR WESTERN NORTH PACIFIC

	24-HOUR		48-HOUR		72-HOUR	
YEAR	ALL	TYPHOON*	ALL	TYPHOON*	ALL	TYPHOON*
1950-58		170				
1959		117**		267**		
1960		177**		354**		
1961		136		274		
1962		144		287		476
1963		127		246		374
1964		133		284		429
1965		151		303		418
1966		136		280		432
1967		125		276		414
1968		105		229		337
1969		111		237		349
1970	104	98	190	181	279	272
1971	111	99	212	203	317	308
1972	117	116	245	245	381	382
1973	108	102	197	193	253	245
1974	120	114	226	218	348	351
1975	138	129	288	279	450	442
1976	117	117	230	232	338	336
1977	148	140	283	266	407	390
1978	127	120	271	241	410	459
1979	124	113	226	219	316	319
1980	126	116	243	221	389	362
1981	123	117	220	215	334	342
1982	113	114	237	229	341	337
1983	117	110	259	247	405	384
1984	117	110	233	228	363	361
1985	117	112	231	228	367	355

* For Typhoons only while winds were over 35 kt (18 m/sec).

** Forecast positions north of 35 N were not verified.

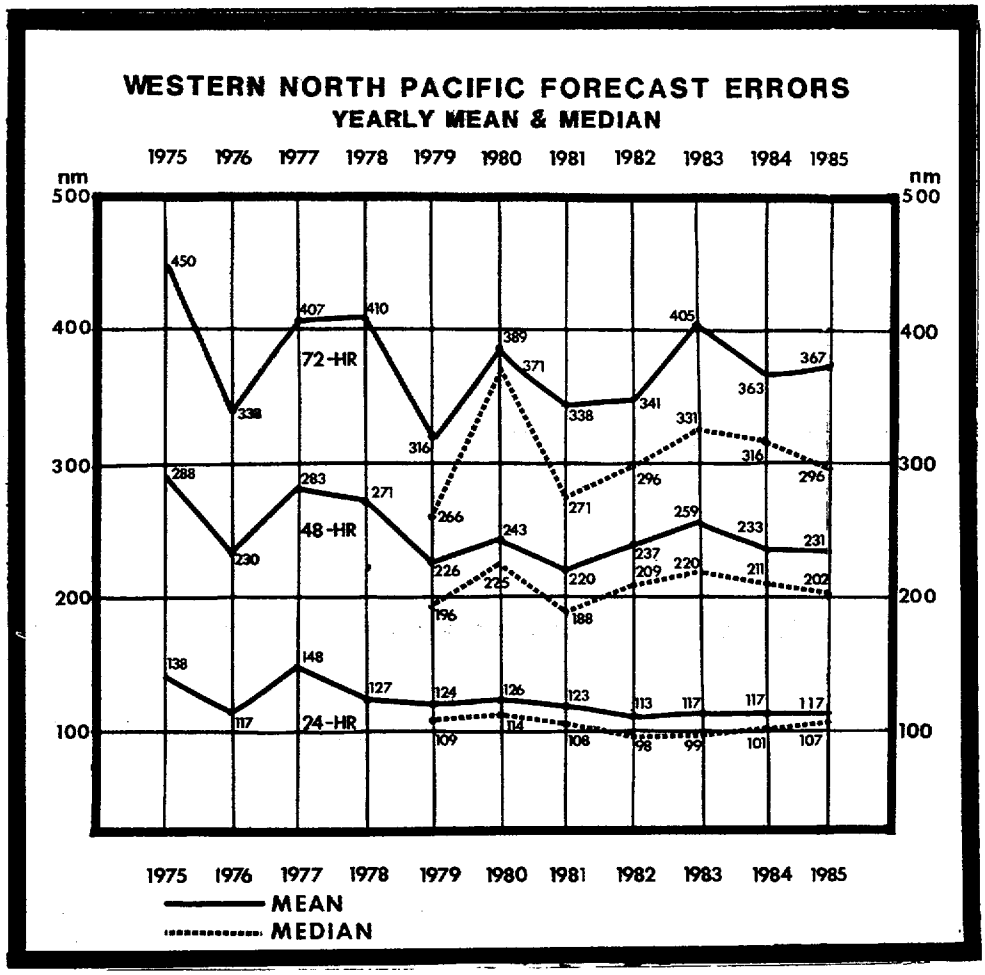

Figure 5-3. Annual mean and median vector errors (nm) for all tropical cyclones in the western North Pacific.

b. North Indian Ocean

The positions given for warning times and those at the 24-, 48-, and 72-hour valid times were verified for tropical cyclones in the North Indian Ocean by the same methods used for the western North Pacific. It should be noted that due to the low number of North Indian Ocean tropical cyclones, these error statistics should not be taken as representative of any trend.

Table 5-4 is the forecast error summary for the North Indian Ocean. Table 5-5 contains the annual average of forecast errors for each year through 1974. Vector errors are plotted in Figure 5-4 (Seventy-two hour forecast errors were evaluated for the first time in 1979). There were no verifying 72-hour forecasts in 1983 and 1985.

TABLE 5-4.

FORECAST ERROR SUMMARY FOT THE NORTH INDIAN OCEAN
SIGNIFICANT TROPICAL CYCLONES FOR 1985. (ERROR IN NM)

	WARNING			24-HOUR			48-HOUR			72-HOUR		
	POSIT ERROR	RT ANGLE ERROR	NR OF WRNGS	POSIT ERROR	RT ANGLE ERROR	NR OF WRNGS	POSIT ERROR	RT ANGLE ERROR	NR OF WRNGS	POSIT ERROR	RT ANGLE ERROR	NR OF WRNGS
1. TC 01B	33	14	8	134	29	4						
2. TC 02A	24	14	12	61	38	9	115	--	4			
3. TC 03B	26	20	7	141	42	3						
4. TC 04B	18	8	4									
5. TC 05B	47	16	12	188	71	8	369	109	4			
6. TC 06B	21	16	11	113	57	6						
ALL FORECAST:	24	14	12	61	38	9	115	--	4			

TABLE 5-5

ANNUAL MEAN FORECAST ERRORS FOR THE NORTH INDIAN OCEAN

	24-HOUR		48-HOUR		72-HOUR	
YEAR	VECTOR	RIGHT ANGLE	VECTOR	RIGHT ANGLE	VECTOR	RIGHT ANGLE
1971*	232	-	410	-	-	-
1972*	224	101	292	112	-	-
1973*	182	99	299	160	-	-
1974*	137	81	238	146	-	-
1975	145	99	228	144	-	-
1976	138	108	204	159	-	-
1977	122	94	292	214	-	-
1978	133	86	202	128	-	-
1979	151	99	270	202	437	371
1980	115	73	93	87	167	126
1981**	109	65	176	103	197	73
1982**	138	66	368	175	762	404
1983**	117	46	153	67	-	-
1984**	154	71	274	127	388	159
1985**	123	51	242	109	-	-

* The western Bay of Bengal and the Arabian Sea were not included in the JTWC area of responsibility until the 1975 tropical cyclone season.

** The technique for calculating right angle error was revised in 1981; therefore, a direct correlation in right angle statistics cannot be made for the errors computed before 1981 and the errors computed since 1981.

c. South Pacific and Indian Oceans

The positions given for warning times and those at the 24- and 48-hour valid times were verified for tropical cyclones in the South Pacific and South Indian Oceans by the same methods used for the western North Pacific.

Table 5-6 is the forecast error summary for the South Pacific and Indian Oceans and Table 5-7 contains the annual average of forecast errors for each year since 1981. Vector errors are plotted in Figures 5-5 (Seventy-two hours forecasts are not issued in the southern hemisphere).

TABLE 5-6

FORECAST ERROR SUMMARY FOR THE SOUTH PACIFIC AND SOUTH INDIAN OCEAN SIGNIFICANT TROPICAL CYCLONES FOR 1985. (ERRORS IN NM)

	WARNING			24-HOUR			48-HOUR		
	POSIT ERROR	RT ANGLE ERROR	NR OF WRNGS	POSIT ERROR	RT ANGLE ERROR	NR OF WRNGS	POSIT ERROR	RT ANGLE ERROR	NR OF WRNGS
TC 01S ----	53	18	8	105	38	6	180	78	5
TC 02S BOBALAHY	29	22	10	105	76	9	181	121	7
TC 03S EMMA	32	19	6	148	46	4	428	67	2
TC 04P ----	35	19	4	209	152	2	-	-	-
TC 05S FRANK	22	19	10	94	66	8	241	180	6
TC 06P ----	54	29	1	107	77	1	214	116	1
	45	26	5	135	90	3	235	206	1
TC 07P MONICA	43	22	5	176	48	5	259	57	1
TC 08P ----	21	21	1	91	55	1	-	-	-
	23	23	4	195	167	2	-	-	-
TC 09P DRENA	54	37	6	99	62	5	106	57	3
TC 10S CELESTINA	42	27	20	142	85	18	228	110	13
TC 11P ERIC	31	22	11	239	58	9	510	145	7
	67	67	1	221	216	1	400	396	1
TC 12S ----	50	47	4	138	33	3	165	22	1
TC 13P NIGEL	21	17	11	105	43	9	193	58	7
TC 14P ODDETTE	28	14	10	98	42	8	120	55	6
TC 15S DITRA	28	16	9	122	59	8	145	90	6
TC 16P FREDA	42	23	6	187	71	4	359	305	2
TC 17S GERTIE	18	19	4	152	104	2	-	-	-
TC 18P ----	50	32	9	146	124	7	219	142	4
TC 19S ESITERA	64	37	10	152	67	8	201	91	5
TC 20S HUBERT	24	17	11	142	89	10	375	229	9
TC 21S FELIKSA	37	5	1	135	105	1	-	-	-
	33	19	10	145	65	8	220	129	5
TC 22S ISOBEL	54	26	15	179	94	13	242	130	11
TC 23S GERIMENA	46	31	23	94	53	22	119	58	20
TC 24S ----	110	76	4	407	239	3	1124	613	1
TC 25S JACOB	20	14	15	80	66	13	152	113	11
TC 26P PIERRE	31	16	6	157	86	5	173	110	3
TC 27P GAVIN	62	56	8	203	131	6	182	159	2
TC 28S KIRSTY	27	16	16	101	68	14	232	161	12
TC 29S LINDSAY	39	23	5	218	99	3	565	235	1
TC 30P BINA	29	18	13	160	94	11	410	184	9
TC 31P SANDY	20	9	12	109	68	10	194	132	9
TC 32P TANYA	30	16	10	60	34	9	82	58	9
TC 33S HELISAONINA	32	21	11	192	110	10	403	243	9
TC 34S GRETEL	30	18	6	102	94	4	231	-	2
TC 35S MARGOT	28	21	11	178	119	10	404	237	8
ALL FORECASTS:	36	23	332	138	78	273	242	133	199

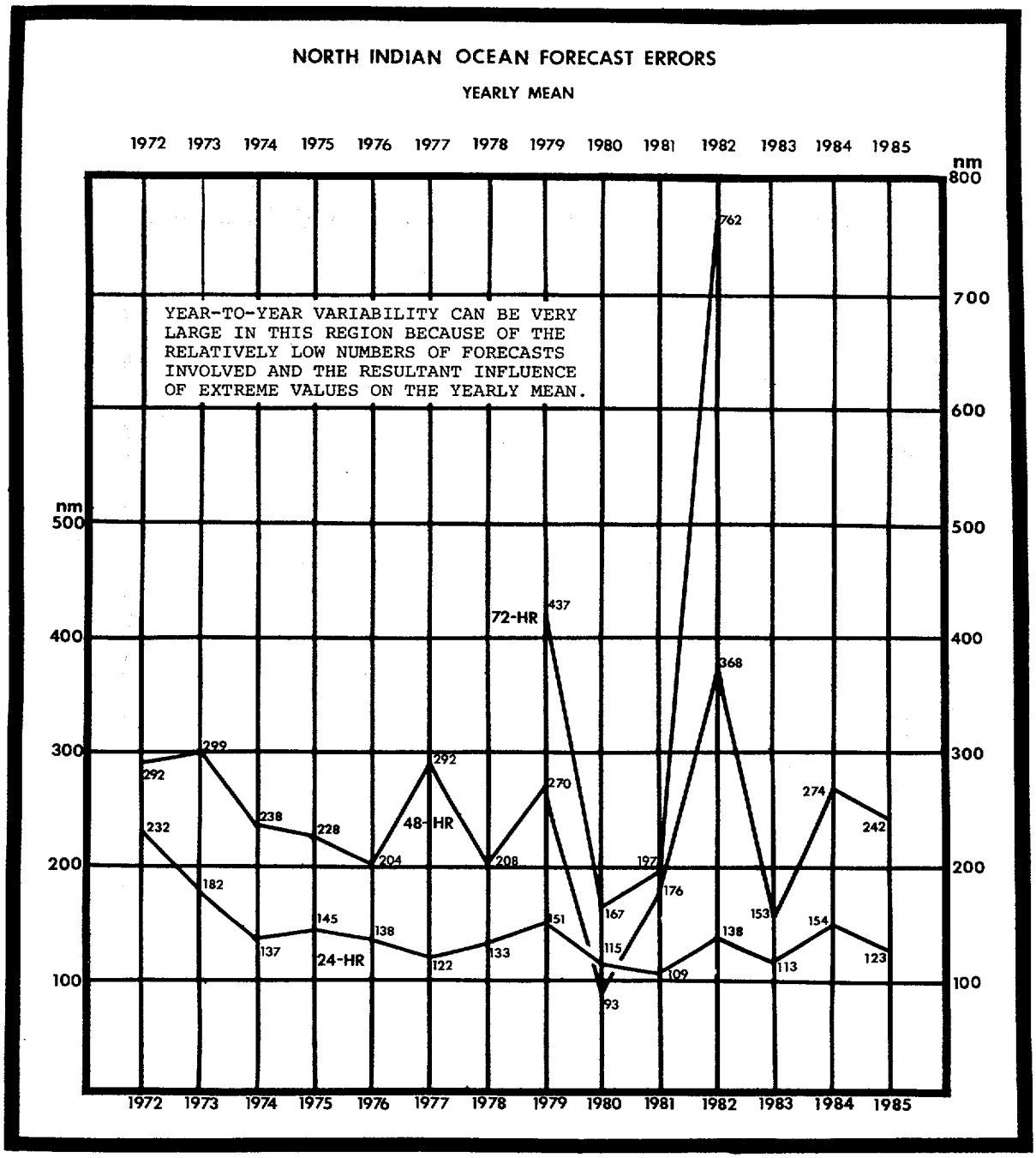

Figure 5-4. Annual mean vector errors (nm) for all tropical cyclones in the North Indian Ocean.

2. COMPARISON OF OBJECTIVE TECHNIQUES

a. General

Objective techniques used by JTWC are divided into five main categories:

(1) extrapolation;

(2) climatological and analog techniques;

(3) model output statistics;

(4) dynamic models; and

(5) empirical and analytical techniques;

In September 1981, JTWC began to initialize its array of objective forecast techniques (described below) on the six-hour-old preliminary best track position (an interpolative process) rather than the forecast (partially extrapolated) warning position, e.g. the 0600Z warning is now supported by objective techniques developed from the 0000Z preliminary best track position. This operational change has yielded several advantages:

*techniques can now be requested much earlier in the warning development time line, i.e. as soon as the track can be approximated by one or more fix positions after the valid time of the previous warning;

*receipt of these techniques is virtually assured prior to the development of the next warning; and

*improved (mean) forecast accuracy. This latter aspect arises because JTWC now has a more reliable approximation of the short-term tropical cyclone movement. Further, since most of the objective techniques are biased for persistence, this new procedure optimizes their performance and provides more consistent guidance on short-term movement, indirectly yielding a more accurate initial position estimate as well as lowering 24-hour forecast errors.

b. Description of Objective Techniques

(1) XTRP — Forecast positions for 24- and 48-hours are derived from the extension of a straight line which connects the most recent and 12-hour old preliminary best track positions.

(2) CLIM — A climatological aid providing 24-, 48-, and 72-hour tropical cyclone forecast positions (and intensity changes in the western North Pacific) based upon the position of the tropical cyclone. The output is based upon data records from 1945 to 1981 for the western North Pacific Ocean and 1900 to 1981 for the North Indian Ocean.

(3) TPAC — Forecast positions are generated from a blend of climatology and persistence. The 24- and 48-hour positions are equally weighted between climatology and persistence and the 72-hour position is one quarter persistence and three quarters climatology. Persistence is a straight line extension of a line connecting the current and 12-hour old positions. Climatology is based on data from 1945 to 1981 for the western North Pacfic Ocean and 1900 to 1981 for the North Indian Ocean.

(4) TYAN 78 — An updated analog program which combines the earlier versions TYFN 75 and INJAN 74. The program scans a 30-year climatology with a similar history (within a specified acceptance envelope) to the current tropical cyclone. For the western North Pacific Ocean, three forecasts of position and intensity are provided for 24-, 48-, and 72-hours: RECR - a weighted mean of all tropical cyclones which were categorized as "recurving" during their best track period; STRA - a weighted mean of all accepted tropical cyclones which were categorized as moving "straight" (westward) during their best track period; TOTL - a weighted mean of all accepted tropical cyclones, including those used in the RECR and STRA forecasts. For the North Indian Ocean, a single (total) forecast track is provided for the 12-hour intervals to 72 hours.

(5) COSMOS — A model output statistics (MOS) routine based on the geostrophic steering at the 850-, 700-, and 500-mb levels. The steering is derived from the HATTRACK point advection model run on Global prognostic fields from the FLENUMOCEANCEN NOGAPS prediction system. The MOS forecast is then blended with the 6-hour past movement to generate the forecast track.

(6) OTCM — (One-way Interactive Tropical Cyclone Model) A course-mesh, three-layer in the vertical, primative equation model with a 205 km grid spacing over a 6400 X 4700 km domain. The model's fields are computed around a bogused, digitized cyclone vortex using FLENUMOCEANCEN Numerical Variational Analysis (NVA) or NOGAPS prognostic fields for the specified valid time. The past motion of the tropical cyclone is compared to initial steering fields and a bias correction is computed and applied to the model. FLENUMOCEANCEN NOGAPS global prognostic fields are used at 12-hour intervals to update the model's boundaries. The resultant forecast positions are derived by locating the 850 mb vortex at six-hour intervals to 72-hours.

(7) NTCM — (Nested Tropical Cyclone Model) A primative equation model with properties similar to the OTCM. The NTCM differs by containing a finer scale "nested" grid, initializing on NVA analysis fields only, not containing a (persistence) bias correction, and being a channel model which runs independent of FLENUMOCEANCEN prognostic fields (not requiring updating of its boundaries). The "nested grid" covers a 1200 X 1200 km area with a 41 km grid spacing which moves within the course mesh domain to keep an 850 mb vortex at its center.

(8) TAPT — An empirical technique which utilizes upper-tropospheric wind fields to estimate acceleration associated with the tropical cyclones interaction with the mid-latitude westerlies. It includes guidelines for duration of acceleration, upper-limits, and probable path of the cyclone.

(9) CLIP — A statistical regression technique based on climatology, current intensity and position and past movement. This technique is used as a crude measure of real forecast skill when verifying forecast accuracy.

TABLE 5-7.

ANNUAL MEAN FORECAST ERRORS (NM) FOR SOUTH PACIFIC AND SOUTH INDIAN OCEANS

	24-HOUR		48-HOUR	
YEAR	VECTOR	RIGHT ANGLE	VECTOR	RIGHT ANGLE
1981	165	119	315	216
1982	144	91	274	174
1983	154	84	288	150
1984	133	73	231	124
1985	138	78	242	133

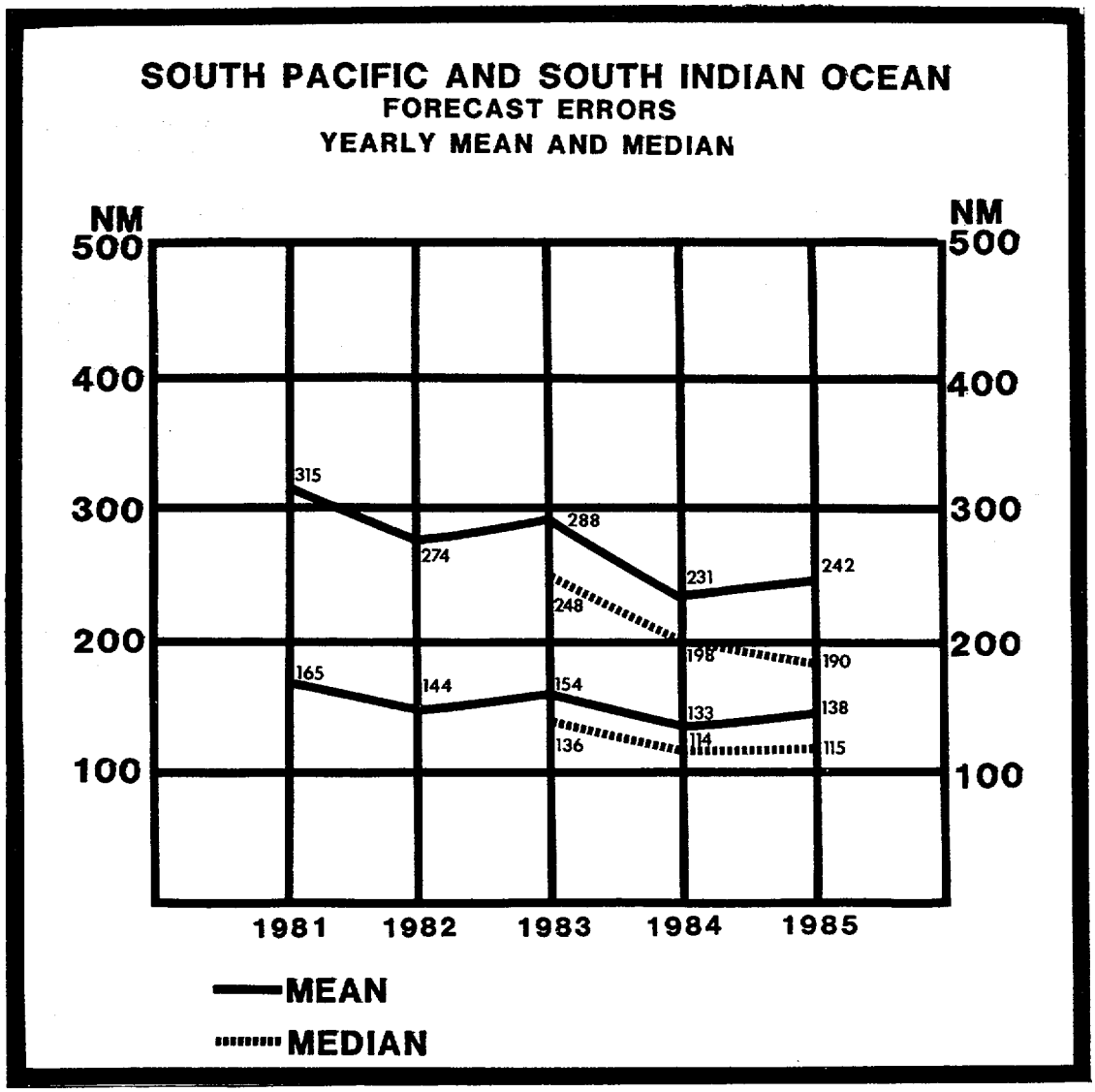

Figure 5-5. Annual mean and median vector errors (nm) for all tropical cyclones in the South Pacific and South Indian Oceans.

(10) THETA E — An empirically derived relationship between a tropical cyclone's minimum sea-level pressure (MSLP) and 700 mb equivalent potential temperature (Theta-E) was developed by Sikora (1976) and Dunnavan (1981). By monitoring MSLP and trends, the forecaster can evaluate the potential for sudden, rapid deepening of a tropical cyclone.

(11) WIND RADIUS — Following an analytic model of the radial profiles of sea-level pressures and winds in mature tropical cyclones (Holland, 1980), a set of radii for 30-, 50-, and 100-knot winds based on the tropical cyclone's maximum winds have been produced to aid the forecaster in determining forecast wind radii.

(12) DVORAK — An estimation of tropical cyclone's current and 24-hour forecast intensity is made from interpolation of satellite imagery (Dvorak, 1984) and provided to the forecaster. These intensity estimates are used in conjunction with other intensity-related data and trends to forecast tropical cyclone intensity.

JTWC currently uses TPAC, TAPT, TYAN78, COSMOS, OTCM and NTCM operationally to develop track forecasts.

c. Testing and Results

A comparison of selected techniques is included in Table 5-8 for all western North Pacific tropical cyclones, Table 5-9 for all North Indian Ocean tropical cyclones, and Table 5-10 for the South Pacific and South Indian Ocean tropical cyclones. In these tables, "X-axis" refers to techniques listed vertially. The example in the 449 cases available for a (homogeneous) comparison, the average vector error at 24 hours was 123 nm (228 km) for COSMOS and 117 nm (217 km) for OTCM. The difference of 5 nm (9 km) is shown in the lower right. (Differences are not always exact, due to computational round-off which occurs for each of the cases available for comparison).

TABLE 5-9. 1985 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES IN THE NORTH INDIAN OCEAN

24-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM		XTRP		HPAC	
JTWC	30	123																				
	123	0																				
TOTL	28	126	29	105																		
	107	-17	105	0																		
CLIP	0	0	0	0	0	0																
	0	0	0	0	0	0																
RECR	0	0	0	0	0	0	0	0														
	0	0	0	0	0	0	0	0														
COSM	0	0	0	0	0	0	0	0	0	0												
	0	0	0	0	0	0	0	0	0	0												
NTCM	20	120	21	104	0	0	0	0	0	0	21	105										
	103	-16	105	1	0	0	0	0	0	0	105	0										
OTCM	29	123	29	105	0	0	0	0	0	0	21	105	30	94								
	94	-28	92	-12	0	0	0	0	0	0	94	-10	94	0								
TPAC	29	123	29	105	0	0	0	0	0	0	21	105	30	94	30	101						
	102	-20	103	-1	0	0	0	0	0	0	103	-1	101	7	101	0						
CLIM	29	123	29	105	0	0	0	0	0	0	21	105	30	94	30	101	30	132				
	132	9	133	27	0	0	0	0	0	0	128	24	132	38	132	31	132	0				
XTRP	29	123	29	105	0	0	0	0	0	0	21	105	30	94	30	101	30	132	30	133		
	137	13	136	31	0	0	0	0	0	0	138	34	133	40	133	32	133	1	133	0		
HPAC	29	123	29	105	0	0	0	0	0	0	21	105	30	94	30	101	30	132	30	133	30	99
	100	-22	101	-3	0	0	0	0	0	0	100	-3	99	5	99	-1	99	-32	99	-33	99	0

NUMBER OF CASES	X-AXIS TECHNIQUE ERROR
Y-AXIS TECHNIQUE ERROR	ERROR DIFFERENCE Y - X

48-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM		XTRP		HPAC	
JTWC	8	242																				
	242	0																				
TOTL	8	242	12	181																		
	231	-10	181	0																		
CLIP	0	0	0	0	0	0																
	0	0	0	0	0	0																
RECR	0	0	0	0	0	0	0	0														
	0	0	0	0	0	0	0	0														
COSM	0	0	0	0	0	0	0	0	0	0												
	0	0	0	0	0	0	0	0	0	0												
NTCM	6	203	7	174	0	0	0	0	0	0	7	216										
	207	4	216	42	0	0	0	0	0	0	216	0										
OTCM	6	270	8	219	0	0	0	0	0	0	6	240	8	195								
	195	-74	195	-24	0	0	0	0	0	0	212	-27	195	0								
TPAC	8	242	12	181	0	0	0	0	0	0	7	216	8	195	12	189						
	258	16	189	8	0	0	0	0	0	0	208	-7	222	28	189	0						
CLIM	8	242	12	181	0	0	0	0	0	0	7	216	8	195	12	189	12	309				
	330	88	309	128	0	0	0	0	0	0	316	100	306	112	309	120	309	0				
XTRP	8	242	12	181	0	0	0	0	0	0	7	216	8	195	12	189	12	309	12	227		
	243	1	227	46	0	0	0	0	0	0	195	-20	280	85	227	38	227	-81	227	0		
HPAC	8	242	12	181	0	0	0	0	0	0	7	216	8	195	12	189	12	309	12	227	12	189
	257	15	189	8	0	0	0	0	0	0	208	-7	221	27	189	0	189	-119	189	-37	189	0

JTWC - OFFICIAL JTWC FORECAST
TOTL - ANALOG (TYAN 78)
NTCM - NESTED TROPICAL CYCLONE MODEL
OTCM - ONE-WAY TROPICAL CYCLONE MODEL
TPAC - CLIM AND PERSISTENCE BLEND
CLIM - CLIMATOLOGY
XTRP - 12-HOUR EXTRAPOLATION
HPAC - MEAN OF XTRP AND CLIM

72-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM	
JTWC	0	0																
	0	0																
TOTL	0	0	1	350														
	0	0	350	0														
CLIP	0	0	0	0	0	0												
	0	0	0	0	0	0												
RECR	0	0	0	0	0	0	0	0										
	0	0	0	0	0	0	0	0										
COSM	0	0	0	0	0	0	0	0	0	0								
	0	0	0	0	0	0	0	0	0	0								
NTCM	0	0	0	0	0	0	0	0	0	0	0	0						
	0	0	0	0	0	0	0	0	0	0	0	0						
OTCM	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
TPAC	0	0	1	350	0	0	0	0	0	0	0	0	0	0	1	489		
	0	0	489	138	0	0	0	0	0	0	0	0	0	0	489	0		
CLIM	0	0	1	350	0	0	0	0	0	0	0	0	0	0	1	489	1	639
	0	0	639	288	0	0	0	0	0	0	0	0	0	0	639	150	639	0

TABLE 5-8. 1985 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES IN THE WESTERN NORTH PACIFIC OCEAN

24-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM		XTRP		HPAC	
JTWC	477	117																				
	117	0																				
TOTL	455	117	463	120																		
	120	3	120	0																		
CLIP	333	116	329	121	338	122																
	122	6	121	0	122	0																
RECR	429	117	434	119	308	122	436	132														
	132	14	132	13	132	9	132	0														
COSM	449	118	442	120	323	121	421	132	457	124												
	123	6	124	4	125	4	124	-7	124	0												
NTCM	368	116	359	121	337	121	338	133	359	123	373	123										
	122	6	123	2	124	3	124	-8	123	1	123	0										
OTCM	460	116	450	118	327	120	426	130	449	123	363	121	467	116								
	115	0	116	-1	117	-2	117	-12	117	-5	115	-5	116	0								
TPAC	465	117	456	119	330	121	430	131	448	123	365	123	457	116	472	122						
	122	5	121	2	121	0	122	-8	122	-1	123	0	121	5	122	0						
CLIM	468	117	458	119	331	121	431	131	450	123	366	123	459	116	472	122	475	159				
	160	43	160	40	161	39	160	29	159	36	163	40	159	43	160	38	159	0				
XTRP	465	117	456	119	330	121	429	131	447	123	363	123	456	115	470	121	472	159	472	128		
	128	12	128	9	128	7	128	-1	129	6	127	4	127	12	129	8	128	-30	128	0		
HPAC	465	117	456	119	330	121	429	131	447	123	363	123	456	115	470	121	472	159	472	128	472	120
	120	3	120	1	121	0	121	-9	120	-2	121	-1	119	3	120	0	120	-38	120	-7	120	0

NUMBER OF CASES	X-AXIS TECHNIQUE ERROR
Y-AXIS TECHNIQUE ERROR	ERROR DIFFERENCE Y - X

48-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM		XTRP		HPAC	
JTWC	356	231																				
	231	0																				
TOTL	342	231	365	249																		
	249	18	249	0																		
CLIP	250	232	263	251	268	253																
	255	23	253	2	253	0																
RECR	319	231	339	247	243	255	339	268														
	265	34	268	20	271	16	268	0														
COSM	333	236	346	252	254	254	327	267	355	238												
	236	0	240	-11	247	-6	240	-25	238	0												
NTCM	276	234	286	252	267	253	266	275	281	239	294	231										
	231	-2	231	-20	231	-20	235	-39	233	-5	231	0										
OTCM	338	232	348	248	253	248	326	265	345	235	280	227	360	234								
	234	2	234	-12	228	-19	239	-25	236	1	227	0	234	0								
TPAC	348	231	359	248	262	252	334	267	348	237	288	231	352	234	370	235						
	235	4	236	-11	235	-16	238	-28	236	0	237	6	233	0	235	0						
CLIM	349	231	361	248	263	252	335	268	350	237	289	231	354	234	370	235	372	299				
	296	65	301	52	301	48	304	37	298	61	308	76	299	65	299	64	299	0				
XTRP	347	231	359	248	262	252	333	267	348	237	287	231	352	234	369	234	370	298	370	268		
	271	40	268	21	266	14	268	1	273	35	267	35	265	32	269	34	268	-29	268	0		
HPAC	347	231	359	248	262	252	333	267	348	237	287	231	352	234	369	234	370	298	370	268	370	233
	234	3	235	-12	235	-16	236	-29	234	-2	236	4	231	-2	233	0	233	-64	233	-34	233	0

JTWC - OFFICIAL JTWC FORECAST
TOTL - TOTAL (TYAN 78)
CLIP - CLIPPER
RECR - RECURVER (TYAN 78)
COSM - COSMOS (MOS)
NTCM - NESTED TROPICAL CYCLONE MODEL
OTCM - ONE-WAY TROPICAL CYCLONE MODEL
TPAC - CLIM AND PERSISTENCE BLEND
CLIM - CLIMATOLOGY
XTRP - 12-HOUR EXTRAPOLATION
HPAC - MEAN OF XTRP AND CLIM

72-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM	
JTWC	241	367																
	367	0																
TOTL	228	363	266	374														
	373	11	374	0														
CLIP	168	357	190	370	195	368												
	357	0	367	-2	368	0												
RECR	217	371	249	375	181	373	250	414										
	408	37	413	38	417	44	414	0										
COSM	226	373	253	377	186	370	242	412	263	380								
	367	-5	386	8	406	36	395	-16	380	0								
NTCM	186	367	208	374	194	370	196	412	207	387	216	352						
	345	-21	353	-21	348	-20	357	-55	353	-33	352	0						
OTCM	188	358	212	364	147	349	198	407	213	370	168	329	222	399				
	397	40	398	34	389	40	400	-6	403	33	393	64	399	0				
TPAC	232	369	258	376	188	371	245	413	256	382	208	351	214	400	268	373		
	374	5	378	1	369	-1	372	-41	375	-7	379	28	380	-20	373	0		
CLIM	234	367	261	375	190	369	246	413	258	381	210	352	216	399	268	373	271	422
	421	54	426	51	415	46	418	5	421	40	427	75	434	35	423	51	422	0

TABLE 5-10. 1985 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES IN THE SOUTH INDIAN AND SOUTH PACIFIC OCEANS

24-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM		XTRP		HPAC	
JTWC	273	138																				
	138	0																				
TOTL	196	128	198	112																		
	112	-15	112	0																		
CLIP	0	0	0	0	0	0																
	0	0	0	0	0	0																
RECR	0	0	0	0	0	0	0	0														
	0	0	0	0	0	0	0	0														
COSM	0	0	0	0	0	0	0	0	0	0												
	0	0	0	0	0	0	0	0	0	0												
NTCM	213	140	167	114	0	0	0	0	0	0	215	144										
	144	4	133	20	0	0	0	0	0	0	144	0										
OTCM	213	135	175	110	0	0	0	0	0	0	184	137	214	138								
	139	4	135	25	0	0	0	0	0	0	140	2	138	0								
TPAC	235	135	197	112	0	0	0	0	0	0	199	140	212	137	237	132						
	132	-1	125	13	0	0	0	0	0	0	133	-6	131	-5	132	0						
CLIM	236	134	198	112	0	0	0	0	0	0	200	140	213	138	237	132	238	183				
	184	50	172	60	0	0	0	0	0	0	186	45	184	46	183	51	183	0				
XTRP	236	134	197	112	0	0	0	0	0	0	200	140	214	138	236	132	237	184	238	116		
	116	-17	111	0	0	0	0	0	0	0	115	-24	113	-24	116	-15	116	-67	116	0		
HPAC	235	134	197	112	0	0	0	0	0	0	199	140	213	138	236	132	237	184	237	116	237	131
	131	-2	124	12	0	0	0	0	0	0	133	-6	130	-7	131	0	131	-52	131	15	131	0

NUMBER OF CASES	X-AXIS TECHNIQUE ERROR
Y-AXIS TECHNIQUE ERROR	ERROR DIFFERENCE Y - X

48-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM		XTRP		HPAC	
JTWC	199	242																				
	242	0																				
TOTL	148	225	160	242																		
	232	7	242	0																		
CLIP	0	0	0	0	0	0																
	0	0	0	0	0	0																
RECR	0	0	0	0	0	0	0	0														
	0	0	0	0	0	0	0	0														
COSM	0	0	0	0	0	0	0	0	0	0												
	0	0	0	0	0	0	0	0	0	0												
NTCM	163	252	136	249	0	0	0	0	0	0	174	274										
	269	18	256	7	0	0	0	0	0	0	274	0										
OTCM	158	243	137	243	0	0	0	0	0	0	147	266	169	295								
	292	50	288	45	0	0	0	0	0	0	297	31	295	0								
TPAC	177	244	159	243	0	0	0	0	0	0	159	270	163	292	189	268						
	267	23	258	15	0	0	0	0	0	0	271	1	268	-24	268	0						
CLIM	178	244	160	242	0	0	0	0	0	0	160	268	164	292	189	268	190	351				
	351	108	347	104	0	0	0	0	0	0	353	85	351	60	352	84	351	0				
XTRP	181	244	159	243	0	0	0	0	0	0	165	269	169	295	188	269	189	352	195	259		
	251	7	234	-8	0	0	0	0	0	0	258	-10	251	-43	258	-10	257	-94	259	0		
HPAC	177	243	159	243	0	0	0	0	0	0	159	269	164	292	188	269	189	352	189	257	189	267
	266	23	257	14	0	0	0	0	0	0	270	1	265	-25	268	0	267	-84	267	10	267	0

JTWC - OFFICIAL JTWC FORECAST
TOTL - ANALOG (TYAN 78)
CLIP - CLIPPER
RECR - RECURVER (TYAN 78)
COSM - COSMOS (MOS)
NTCM - NESTED TROPICAL CYCLONE MODEL
OTCM - ONE-WAY TROPICAL CYCLONE MODEL
TPAC - CLIM AND PERSISTENCE BLEND
CLIM - CLIMATOLOGY
XTRP - 12-HOUR EXTRAPOLATION
HPAC - MEAN OF XTRP AND CLIM

72-HOUR FORECAST ERRORS (NM)

	JTWC		TOTL		CLIP		RECR		COSM		NTCM		OTCM		TPAC		CLIM	
JTWC	0	0																
	0	0																
TOTL	0	0	122	351														
	0	0	351	0														
CLIP	0	0	0	0	0	0												
	0	0	0	0	0	0												
RECR	0	0	0	0	0	0	0	0										
	0	0	0	0	0	0	0	0										
COSM	0	0	0	0	0	0	0	0	0	0								
	0	0	0	0	0	0	0	0	0	0								
NTCM	0	0	104	357	0	0	0	0	0	0	128	415						
	0	0	394	37	0	0	0	0	0	0	415	0						
OTCM	0	0	101	340	0	0	0	0	0	0	107	405	124	472				
	0	0	456	116	0	0	0	0	0	0	456	51	472	0				
TPAC	0	0	122	351	0	0	0	0	0	0	124	410	121	462	146	433		
	0	0	424	73	0	0	0	0	0	0	432	21	427	-33	433	0		
CLIM	0	0	122	351	0	0	0	0	0	0	124	410	121	462	146	433	146	506
	0	0	503	152	0	0	0	0	0	0	505	95	497	35	506	73	506	0