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no.33

NOAA TECHNICAL MEMORANDUM NWSTM PR-33



1987 TROPICAL CYCLONES - CENTRAL NORTH PACIFIC

Honolulu, HI
April 1988

**U.S. DEPARTMENT OF
COMMERCE**

National Oceanic and
Atmospheric Administration

National Weather
Service

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National Weather Service, Pacific Region Subseries

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Wyman Au
Andrew Chun
Hans Rosendal

Honolulu, Hawaii
April 1988

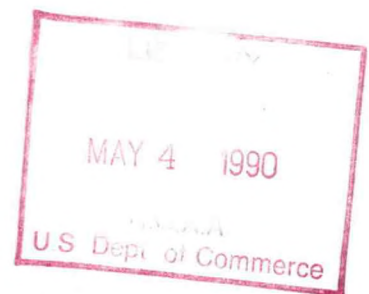


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CENTRAL NORTH PACIFIC TROPICAL CYCLONE DATA, 1987*

NAME	DATES	MAXIMUM CLASS	MAXIMUM SUSTAINED WINDS (KT)	LOWEST PRESSURE (MB)	TOTAL HOURS OBSERVED
FERNANDA	Jul 26-31	Tropical Storm	E55 (SFSS)	N/A**	60(TS), 72(TD)
JOVA	Aug 20-22	Tropical Storm	E45' (SFSS)	N/A	12(TS), 36(TD)
OKA	Aug 26-29	Tropical Storm	E50 (SFSS)	N/A	78(TS), 12(TD)
PEKE	Sep 21-27	Hurricane	E90 (SFSS)	N/A	96(H), 36(TS), 6(TD)

Key

H Hurricane

TS Tropical Storm

TD Tropical Depression

Example: 36(H), 84(TS), 12(TD)

Total hours per class: H 36 hrs
 TS 84 hrs
 TD 12 hrs

*Data pertains only to period tropical cyclone was in the central Pacific

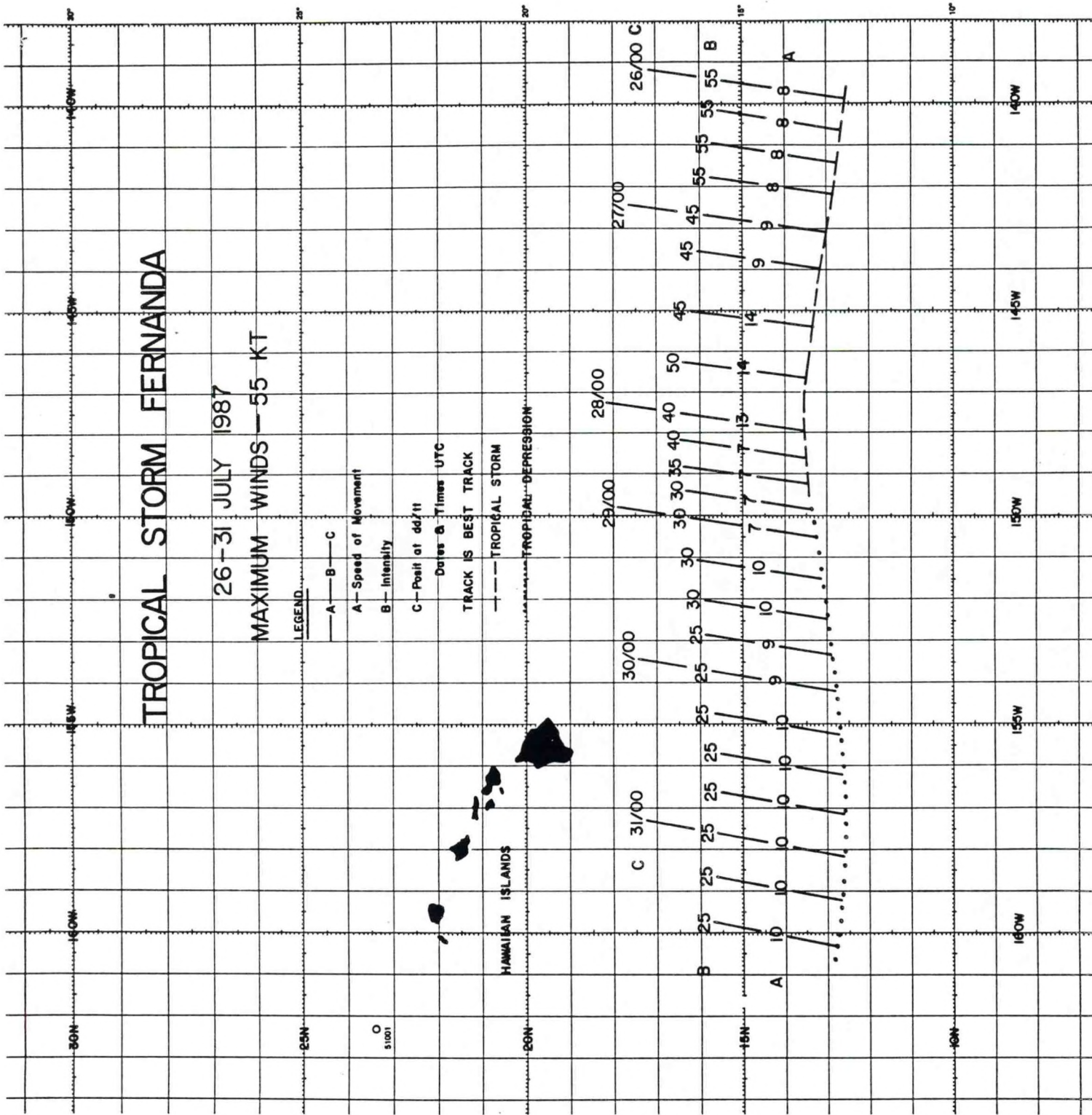
**RECECE flown after system reached peak and was in a weakening trend

TROPICAL STORM FERNANDA

July 26 - 31, 1987

Tropical Storm FERNANDA crossed 140W and into the Central Pacific Hurricane Center's area of responsibility on July 26 at 0000 UTC (Fig. 1). FERNANDA developed about 48 hours earlier near 11N 130W as Tropical Depression NINE-E and subsequently attained tropical storm strength 24 hours later near 11N 136W. This system developed farther west than usually is the case for eastern Pacific tropical cyclones. Assuming the normal cycle of development, FERNANDA appeared to be in a location favorable for further intensification and movement toward the Hawaiian Islands. This, however, was not to be. A trough in the upper level flow to the northwest of Hawaii was moving southeastward while FERNANDA was moving steadily west northwestward. The unfavorable environment created by the closing upper trough began to have its effects on FERNANDA by the 26th when it was near 13N 142W (Fig. 2). The storm failed to intensify and showed signs of becoming sheared and elongated in a northeast/southwest direction. Maximum intensity was estimated at 55 knots on July 26 when FERNANDA was about 900 miles to the east southeast of Hilo. Air Force reconnaissance into the storm on the 27th verified previous estimations of maximum winds using Dvorak classification techniques. FERNANDA continued to weaken and at 281800 UTC was downgraded to a tropical depression when it was near 13N 150W. The last advisory on FERNANDA was issued at 311800 UTC as the remnant circulation near 13N 160W moved westward.

(Fig. 1)



(Fig. 2)

2045 26JUL87 18H-2 04184 13872 AB13M1300-I



TROPICAL STORM FERNANDA
2045 UTC JUL. 26, 1987
MAX WINDS 55 KT

TROPICAL STORM FERNANDA - JULY 26-31, 1987

<u>DATE/TIME</u> <u>UTC</u>	<u>BEST TRACK</u>	<u>ACTUAL TRACK</u>	<u>DIST. ERROR (NM)</u>
260000	12.6N 139.9W	12.6N 139.9W	0
260600	12.7N 140.6W	12.7N 141.0W	24
261200	12.7N 141.4W	12.8N 142.2W	47
261800	12.8N 142.2W	12.9N 142.6W	24
270000	13.0N 143.1W	13.0N 143.3W	12
270600	13.2N 144.0W	13.1N 144.1W	8
271200	13.3N 145.4W	13.2N 144.9W	30
271800	13.5N 146.7W	13.7N 146.6W	14
280000	13.5N 148.0W	13.8N 148.0W	18
280600	13.4N 148.6W	14.2N 148.3W	51
281200	13.4N 149.3W	14.2N 149.4W	48
281800	13.3N 149.8W	13.4N 150.0W	14
290000	13.3N 150.6W	13.4N 150.3W	19
290600	13.2N 151.6W	13.3N 151.0W	36
291200	13.0N 151.5W	13.0N 152.5W	59
291800	12.9N 153.4W	12.9N 153.4W	0
300000	12.8N 154.2W	12.8N 154.2W	0
300600	12.7N 155.3W	12.8N 155.3W	6
301200	12.7N 156.3W	12.7N 156.5W	12
301800	12.6N 157.3W	12.6N 157.6W	18
310000	12.7N 158.3W	12.7N 158.7W	24
310600	12.8N 159.3W	12.8N 159.7W	24
311200	12.9N 160.3W	12.9N 160.5W	12

AVERAGE DISTANCE ERROR			22 NM

TROPICAL STORM FERNANDA - JULY 26 - 31, 1987

DTG	UTC	24 HOUR FORECAST POSITION				24 HOUR FORECAST ERROR																	
		CPHC	EP	EP	EP	EP	EP	EP	EP														
		SS87	AN85	CL84	CL81	SS87	AN85	CL84	CL81	SS87	AN85	CL84	CL81	SS87	AN85	CL84	CL81	SS87	AN85	CL84	CL81		
		N/W	N/W	N/W	N/W	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	
2700		13.2	13.0	13.1	13.1	12.6	13.3			71	82	76	76	63	50								
		144.5	144.7	144.6	144.6	144.3	144.1			101	100	94	94										
2706		145.8	145.8	145.7	145.7			13.4	13.1							18							
		145.8	145.8	145.7	145.7			144.1	145.9														
2712		13.2	13.3	13.3	13.3	13.3	14.2	13.3	13.2	117	117	117	117	105	101	47							
		146.9	146.9	146.9	146.9	146.7	146.3	145.7	147.3														
2718		13.6	13.6	13.7	13.6			13.6	13.4	6	8	0	8			47							
		146.6	146.7	146.6	146.5			145.8	147.5														
2800		13.6	13.8	13.7	13.6	13.5	14.1	13.4	13.4	88	88	82	88	61	67	74							
		146.5	146.5	146.6	146.5	147.0	149.1	146.8	147.7														
2806		13.8	14.1	13.8	13.7			14.3	13.4	63	53	63	66			64							
		147.3	147.4	147.3	147.3			147.2	148.2														
2812		14.1	14.3	13.9	13.8	13.7	15.1	13.6	13.0	47	53	50	58	55	71	105							
		148.6	148.5	148.6	148.5	148.6	148.6	147.7	148.5														
2818		14.8	15.1	15.0	15.0			14.6	13.5	91	108	109	102			73							
		150.6	150.6	150.9	150.6			149.8	149.9														
2900		15.3	15.3	15.6	15.4	14.5	14.3	14.5	13.8	163	185	219	184	155	93	67							
		152.3	152.8	153.3	152.7	152.7	151.6	150.5	151.7														
2906		15.0		15.5	15.3			13.2	14.2	102	149	149	133			584							
		151.0		152.2	152.0			161.0	151.3														
2912		15.2		14.9	14.6	14.7	15.2	14.1	14.5	133	121	121	99	104	135	67							
		152.8		153.2	152.9	152.8	153.0	152.3	152.4														
2918		13.2		13.2	13.2			12.8	13.1	39	50	50	34			8							
		154.0		154.2	153.9			153.3	153.6														
3000		13.3	14.5	13.5	13.5	13.7		12.8	12.9	104	146	108	141	93		53							
		152.5	152.4	152.5	151.9	152.9		153.3	152.8														
3006		13.2	14.2	13.3	13.2			13.6	13.6	97	117	93	114			110							
		153.7	153.9	153.8	153.4			163.6	153.7														
3012		12.9	13.7	12.8	12.8	13.3	14.2		13.1	13	61	14	14	36	93								
		156.5	156.7	156.7	156.3	156.5	156.1		156.6														
3018		12.9	13.0	12.1	12.2			12.7	13.1	45	48	38	69			88							
		156.9	156.9	157.2	156.5			156.1	157.9														
3100		12.9	13.2	12.8	12.6	13.0				22	61	42	65	39									
		158.4	157.8	158.0	157.6	158.1				24	38	12	45										
3106		12.9	13.2	12.8	12.5					24	38	12											
		159.3	159.2	159.5	159.0																		
3112		12.9	13.2	13.1	12.7	13.1		13.1	13.5	24	18	27	14	37		112							
		160.9	160.5	160.9	160.4	161.1		158.6	161.1														

----- AVERAGE DISTANCE ERRORS 71 80 77 80 75 87 101 64 -----

TROPICAL STORM FERNANDA - JULY 26 - 31, 1987

DTG	48 HOUR FORECAST POSITION				48 HOUR FORECAST ERROR					
	CPHC N/W	EP SS87 N/W	EP AN85 N/W	EP CL84 N/W	EP SS87 NM	EP AN85 NM	EP CL84 NM	EP CL81 NM	OTCM NM	TPAC NM
2800	13.9	13.8	13.6	13.9	24	53	48	27	67	
	148.4	148.9	148.8	148.9	87	94	103	101		118
2806	14.2	14.0	13.7	13.9						
	149.8	149.9	150.0	150.0	102	94	108	106	129	107
2812	13.8	14.0	13.8	13.9	85	72	57	67		
	151.1	151.0	151.2	151.2						
2818	14.7	14.5	14.3	14.5						
	150.6	150.5	150.3	150.2	78	86	57	76	252	109
2900	14.7	14.6	14.3	14.4	97	115	74	83		71
	150.4	149.5	150.0	149.5						
2906	14.9	15.1	14.5	14.5	138	150	91	104	144	101
	151.2	150.3	150.7	150.3	162	210	199	186		78
2912	15.3	15.3	14.5	14.5	199	235	349	211	222	135
	152.4	151.5	152.3	151.6						
2918	15.6	16.4	15.6	16.0	213	255	255	189	169	138
	153.5	153.5	155.4	153.6						
3000	16.1	16.6	17.4	16.2	233	193	193	153	230	174
	154.6	155.2	157.9	155.1						
3006	16.0	15.2	17.0	15.9	38	80	80	50	81	84
	143.7	156.0	154.7	154.7						
3012	16.5	15.8	15.2	15.2	132	305	157	324	200	170
	155.7	157.4	156.0	155.4						
3018	13.1	13.8	13.2	13.2	118	226	156	245	127	181
	158.0	158.2	157.0	157.0						
3100	13.2	16.0	14.2	14.3	32	108	43	59	137	59
	156.5	154.7	156.5	153.4						
3106	13.1	15.5	14.4	13.7						
	157.7	157.0	157.6	155.6						
3112	13.1	14.7	13.6	12.8	116	146	131	134	107	126
	160.0	160.4	160.6	159.5						
				157.9						
				13.6						
				161.2						
----- AVERAGE DISTANCE ERRORS -----										
					116	146	131	134	107	126
										115

TROPICAL STORM FERNANDA - JULY 26 - 31, 1987

DTG	UTC	72 HOUR FORECAST POSITION				72 HOUR FORECAST ERROR															
		CPHC N/W	EP AN85 N/W	EP CL84 N/W	EP CL81 N/W	SS87 NM	EP AN85 NM	EP CL84 NM	EP CL81 NM	OTCM N/W	TPAC N/W	CPHC NM	EP SS87 NM	EP AN85 NM	EP CL84 NM	EP CL81 NM	MFM NM	OTCM NM	TPAC NM		
2900		15.0	14.8	14.1	14.7	15.3	16.7					138	144	129	175	131	232				
2906		152.0	142.3	152.4	153.0	151.4	152.4					196	168	152	204			364		176	
2912		153.5	153.3	153.4	153.2	156.4	154.0					212	167	147	197	169	316			318	
2918		155.5	154.6	154.5	155.4	152.8	155.8					195	146	131	154			319			
3000		16.0	15.2	15.0	15.4	15.3						192	165	170	171	268	337			74	
3006		154.4	153.0	152.5	152.8	151.6	159.1					210	200	198	185			241		111	
3012		16.3	15.8	15.4	15.4	16.2	12.8					235	209	181	173	318	214			144	
3018		155.1	153.8	153.2	153.6	157.5	153.4					253	271	339	252			333		162	
3100		16.6	17.1	17.8	16.8	14.1	15.3					276	278	384	262	204	301			198	
3106		156.2	157.2	155.3	157.7	163.1	157.6					312		390	220			167		212	
3112		17.0	17.3	19.1	17.0	16.1	17.4					325		302	170	283	306			234	
		157.0	159.2	158.9	159.5	158.9	160.5														
		16.9		19.3	16.4	15.1	16.1														
		156.4		160.0	159.0	158.1	158.4														
		18.0		17.8	15.6	14.1	16.6														
		158.6		161.7	159.6	157.6	163.0														
										AVERAGE DISTANCE ERRORS											
										231	194	229	197	229	284	269	164				

TROPICAL STORM FERNANDA - JULY 26-31, 1987

CPHC MEAN ERROR FROM BEST TRACK.....22NM

MEAN FORECAST ERROR [ERROR (NM)/# OF CASES]

	24 HR FORECAST	48 HR FORECAST	72 HR FORECAST
CPHC	71/19	116/15	231/11
EPSS87	80/16	146/12	194/ 9
EPAN85	77/19	131/15	229/11
EFCL84	80/19	134/15	197/11
EPHC81	75/10	107/ 8	229/ 6
MFM	87/ 7	169/ 7	284/ 6
OTCM	101/15	126/13	269/10
TPAC	64/16	115/12	164/ 8

TROPICAL STORM JOVA

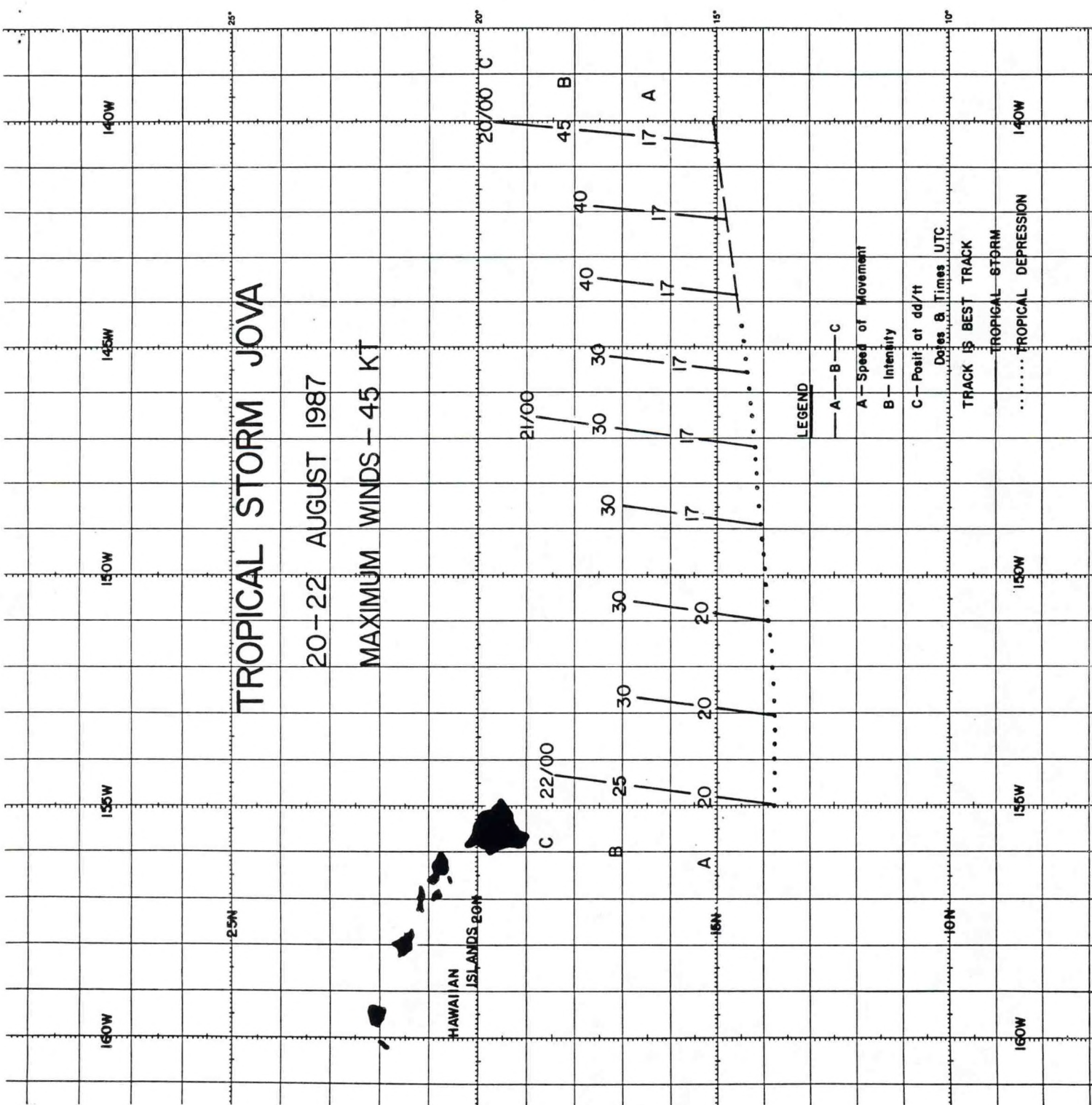
August 20 .- 22, 1987

Tropical Storm JOVA entered the Central Pacific Hurricane Center's (CPHC) area of responsibility on August 20th at 0000 UTC in a state of declining intensity (Fig. 3). JOVA was already a week old and had been a hurricane with maximum sustained winds estimated at 90 knots near 15N 133W. The weakening tropical storm crossed 140W with maximum sustained winds estimated at 45 knots and moved westward, roughly following latitude 15N with a rapid forward motion speed of 15 to 20 knots. JOVA continued to slowly weaken and was downgraded to a tropical depression at 201800 UTC when near 15N 145W (Fig. 4). The last advisory on JOVA was issued at 220000 UTC as the dissipating tropical depression passed about 300 miles south of South Point, Hawaii. The remnant circulation moved westward for several more days and was still discernible to the south of Johnston Island near 14N 170W on the 24th.

TROPICAL STORM JOVA

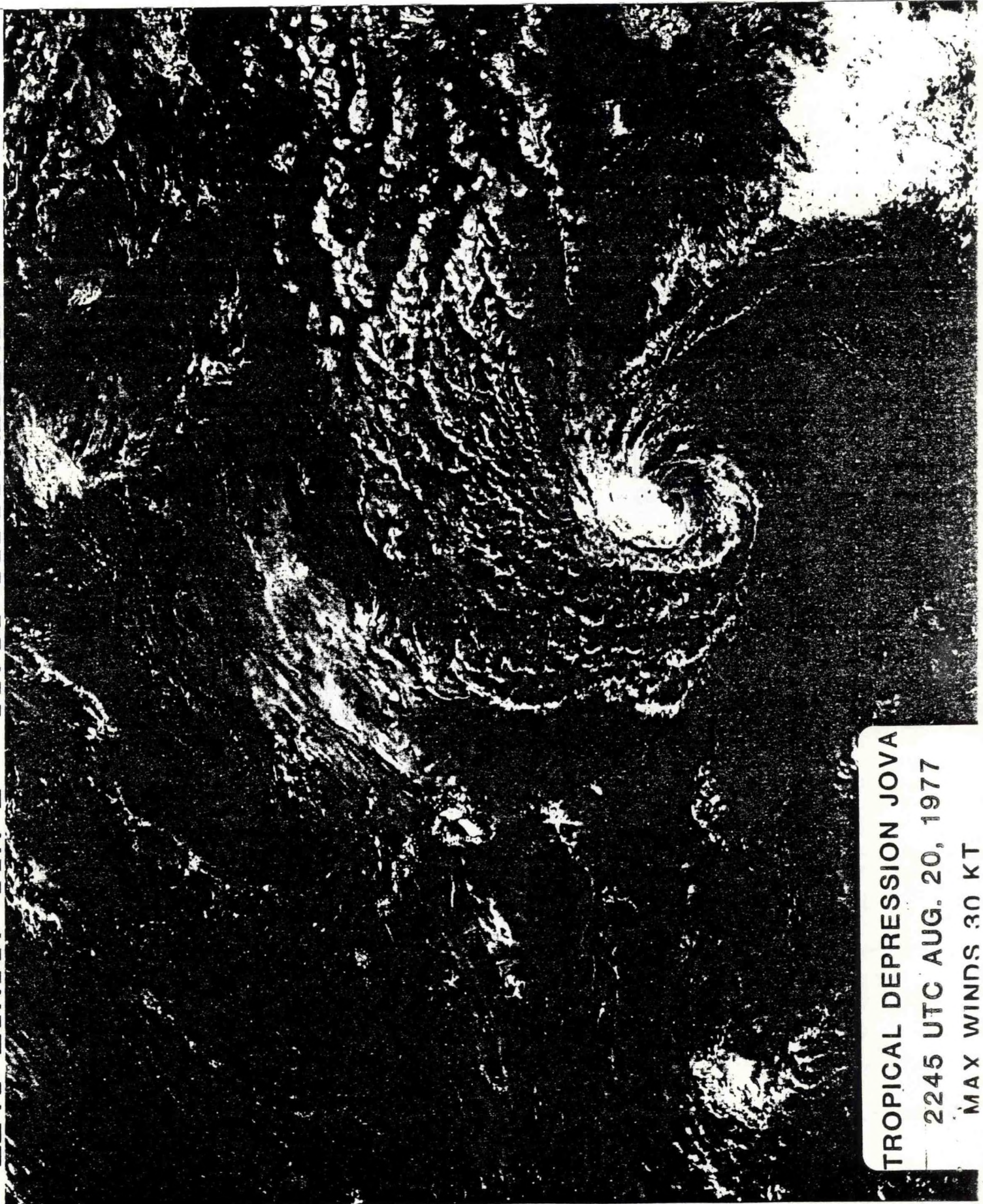
20-22 AUGUST 1987

MAXIMUM WINDS - 45 KT



(Fig. 3)

2245 20AU87 38A-2 03733 13951 HB18N150W-1



TROPICAL DEPRESSION JOVA

2245 UTC AUG. 20, 1977

MAX WINDS 30 KT

TROPICAL STORM JOVA - AUGUST 20-22, 1987

<u>DATE/TIME</u> <u>UTC</u>	<u>BEST TRACK</u>	<u>ACTUAL TRACK</u>	<u>DIST. ERROR (NM)</u>
200600	14.8N 142.2W	14.9N 141.7W	30
201200	14.6N 143.8W	14.9N 143.8W	18
201800	14.4N 145.5W	14.8N 145.4W	25
210000	14.2N 147.2W	14.2N 147.2W	0
210600	14.1N 148.9W	141.N 149.3W	23
211200	13.9N 151.0W	13.9N 151.0W	0
211800	13.8N 153.0W	13.8N 153.0W	0
220000	13.8N 153.0W	13.8N 155.0W	17

AVERAGE DISTANCE ERROR			14 NM

TROPICAL STORM JOVA - AUGUST 20 - 22, 1987

DTG	24 HOUR FORECAST POSITION				24 HOUR FORECAST ERROR									
	CPHC	EP	EP	OTCM	TPAC	CPHC	EP	EP	OTCM	TPAC				
UTC	N/W	SS87	N/W	EP	CL81	N/W	EP	EP	CL81	N/W				
2106	14.7	14.6	14.7	14.7	14.7	15.1	160	167	167	173				
	146.5	146.6	146.5	146.5	146.5	146.0	108	113	109	194				
2112	15.0	14.8	15.2	15.1	15.1	14.3	137	109	89	67				
	149.0	149.4	149.6	149.6	149.6	147.4	113	109	114	183				
2118	15.2	15.0	14.9	14.9	14.9	15.0	55	123	99	48				
	151.7	151.0	151.5	151.4	151.4	150.1	117	117	99	222				
2200	14.1	14.0	13.9	13.9	13.9	13.9	132	127	122	58				
	154.1	152.9	153.0	153.3	153.3	151.2	117	127	122	204				
										210				

	AVERAGE DISTANCE ERRORS													
							117	132	127	122	92	58	204	210

TROPICAL STORM JOVA - AUGUST 20-22, 1987

CPHC MEAN ERROR FROM BEST TRACK.....14NM

MEAN FORECAST ERROR [ERROR (NM)/# OF CASES]

	24 HR FORECAST	48 HR FORECAST	72 HR FORECAST
CPHC	117/ 4	N/A	N/A
EPSS87	132/ 4	N/A	N/A
EPAN85	127/ 4	N/A	N/A
EPCL84	122/ 4	N/A	N/A
EPHC81	92/ 2	N/A	N/A
MFM	58/ 2	N/A	N/A
OTCM	204/ 4	N/A3	N/A
TPAC	210/ 4	N/A	N/A

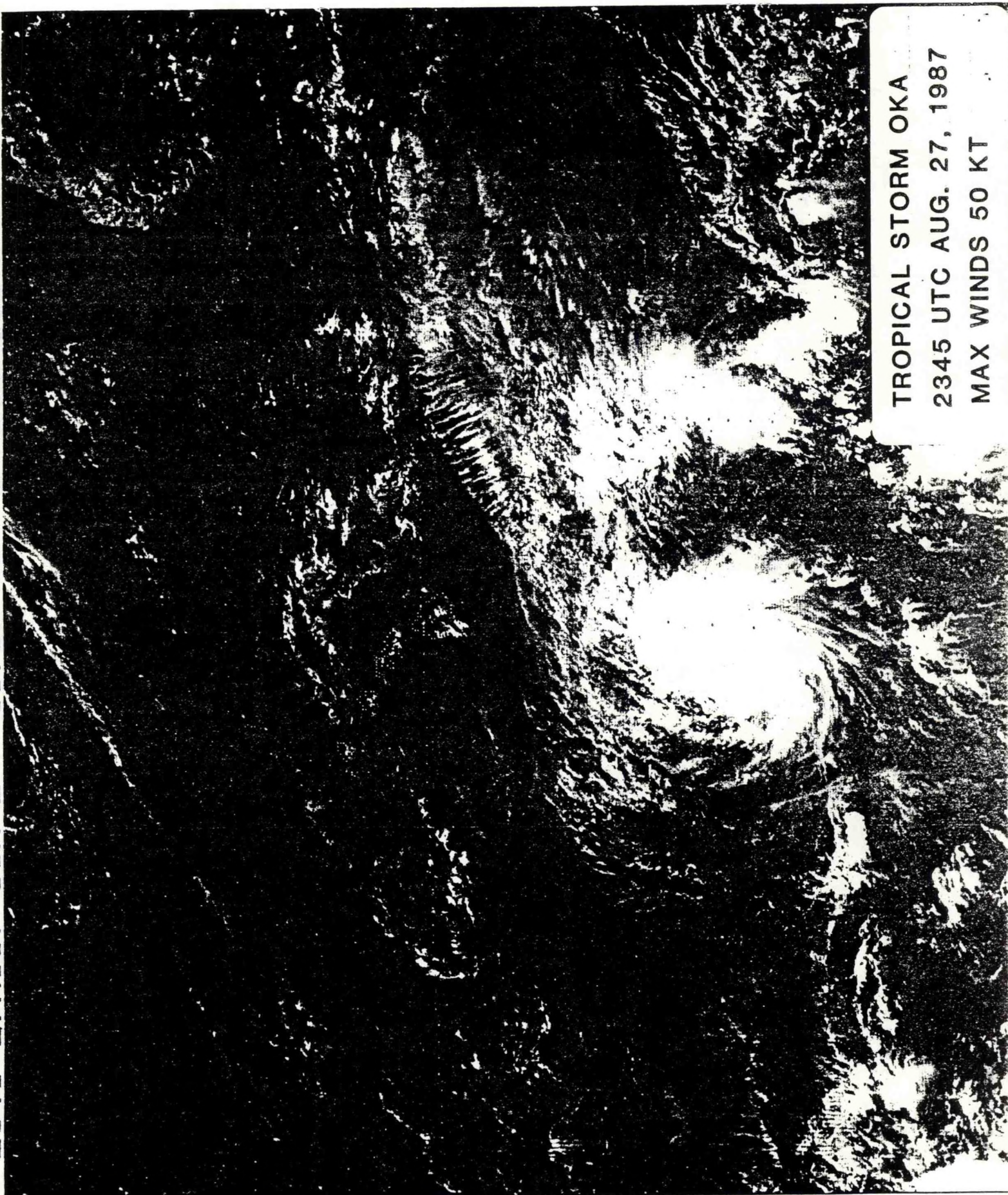
TROPICAL STORM OKA

August 26 - 29, 1987

Tropical Depression ONE-C was the first tropical cyclone to form in the central north Pacific during the 1987 season. It developed rather far to the south near 09N 147W out of a disturbed area along the ITCZ on August 25 with several ships in the vicinity reporting squally weather and southwesterly winds. The first advisory on Tropical Depression ONE-C was issued at 260000 UTC. Twelve hours later, the strengthening cyclone was upgraded to a tropical storm and named OKA (Hawaiian for Oscar) near 10N 150W (Fig. 5). OKA remained far to the south of the Hawaiian Islands near 10N as it moved slowly west northwestward and intensified with maximum sustained winds estimated at 50 knots on the 27th (Fig. 6). On the 28th, OKA was located southwest of the Hawaiian Islands and began to feel the effects of troughing in the upper flow to the northwest and started a rapid decline in intensity. At dawn on the 29th, the first visual satellite picture of the day indicated that OKA was dissipating rapidly. The moribund tropical storm was downgraded to a tropical depression and the last advisory was issued at 291800 UTC when it was near 13N 162W. By 300000 UTC, no trace of a remnant circulation could be seen in satellite imagery (Fig. 7).

(Fig. 6)

2345 2/AUG87 38H-2 0376Z 1239Z FB18N130W-1



TROPICAL STORM OKA
2345 UTC AUG. 27, 1987
MAX WINDS 50 KT

(Fig. 7)

2045 29AU87 38A-2 03754 12431 HB18N155W-1

TROPICAL DEPRESSION OKA
2045 UTC AUG. 29, 1987
MAX WINDS 25 KT

TROPICAL STORM OKA - AUGUST 26-29, 1987

<u>DATE/TIME</u> <u>UTC</u>	<u>BEST TRACK</u>	<u>ACTUAL TRACK</u>	<u>DIST. ERROR (NM)</u>
260000	9.5N 147.0W	9.5N 147.0W	0
260600	9.5N 148.3W	9.5N 148.3W	0
261200	9.5N 149.6W	9.5N 149.5W	7
261800	9.7N 150.9W	9.5N 150.6W	22
270000	9.9N 152.1W	10.0N 151.9W	14
270600	10.3N 153.4W	10.2N 153.3W	8
271200	10.9N 154.6W	10.3N 154.6W	36
271800	11.6N 155.7W	11.5N 155.6W	8
280000	12.3N 156.7W	12.0N 156.8W	19
280600	12.8N 157.9W	12.5N 157.8W	19
281200	13.0N 158.4W	12.8N 159.0W	37
281800	13.2N 158.9W	13.2N 158.8W	7
290000	13.4N 160.0W	13.3N 159.8W	14
290600	13.4N 161.1W	13.3N 161.0W	8
291200	13.4N 162.1W	13.3N 162.0W	8
291800	13.4N 162.1W	13.0N 162.0W	25

AVERAGE DISTANCE ERROR			15 NM

TROPICAL STORM OKA - AUGUST 26 -29, 1987

DTG	24 HOUR FORECAST POSITION				24 HOUR FORECAST ERROR						
	CPHC	EP SS87 N/W	EP AN85 N/W	EP CL84 N/W	EP SS87 NM	EP AN85 NM	EP CL84 NM	EP CL81 NM	OTCM	MFM	TPAC
2700	9.7	9.7	9.9	9.5	68	26	48	42	30	156	48
2706	153.0	152.7	152.4	152.3	42	27	45	43			76
2712	9.7	9.8	9.9	9.6	36	6	60	19	30	93	79
2718	153.8	153.5	154.0	153.7	96	89	103	111			51
2800	9.7	10.4	10.9	10.6	78	70	59	86	97	86	61
2806	154.6	154.6	155.4	154.7	99	85	72	96			68
2812	9.9	10.1	9.8	9.7	84	102	83	103	115	87	96
2818	155.6	155.1	155.4	155.2	82	37	63	35			53
2900	10.7	11.0	11.1	10.7	109	64	105	74	70	162	
2906	156.9	156.2	156.4	156.2	108	51	126	88			88
2912	10.9	11.1	11.3	10.9	131	75	147	106	72	166	70
2918	158.2	157.6	157.8	157.7	95	54	97	68			
	11.4	11.1	11.5	11.1							
	159.1	159.1	159.5	159.2							
	13.3	13.0	14.0	13.2							
	160.2	159.4	159.5	159.4							
	13.8	13.4	14.6	13.9							
	161.6	160.9	161.0	160.9							
	14.0	13.8	15.1	14.4							
	162.7	161.7	162.1	162.0							
	14.3	14.2	15.4	14.7							
	164.0	162.9	163.3	163.1							
	14.5	13.9	14.6	14.1							
	162.5	162.0	162.2	162.3							

AVERAGE DISTANCE ERRORS

86 57 84 73 69 125 68 75

TROPICAL STORM OKA - AUGUST 26 -29, 1987

DTG	UTC	48 HOUR FORECAST POSITION				48 HOUR FORECAST ERROR										
		CPHC N/W	EP SS87 N/W	EP AN85 N/W	EP CL84 N/W	EP CL81 N/W	EP CL84 NM	EP AN85 NM	EP SS87 NM	CPHC NM						
2800		9.9	10.7	10.9	9.9	10.7	13.2	12.2	12.2	145	80	106	127	101	223	60
2806		158.0	156.5	158.2	157.1	155.7	160.4	157.8	157.8	166	109	99	151		71	158
2812		159.0	157.5	158.7	158.1			12.4	12.4	193	114	146	165		251	189
2900		9.9	11.5	12.5	11.4	10.8	12.9	10.9	10.9	152	64	60	96	123	257	182
2906		159.7	158.0	160.8	158.3	157.5	162.9	159.5	158.8	141	54	69	89		178	105
2912		11.7	12.3	12.5	11.7	11.4	13.3	12.5	11.6	128	57	123	94	91	324	151
2918		161.8	159.4	160.4	159.9	159.0	164.2	162.8	160.9	197	93	213	106		151	
		12.0	12.4	12.7	11.9			12.8	12.5							
		163.0	161.0	162.0	161.5			164.0	162.6							
		12.7	12.4	13.1	12.0	11.8	14.1	12.7	11.9							
		164.1	162.3	164.1	162.9	161.8	167.5	164.5	163.7							
		14.5	14.5	16.5	14.7			14.9	14.9							
		165.0	162.4	162.6	162.5			163.7	163.7							
-----										AVERAGE DISTANCE ERRORS						
										163	84	115	115	116	258	144
																147

TROPICAL STORM OKA - AUGUST 26 -29, 1987

DTG	UTC	72 HOUR FORECAST POSITION				72 HOUR FORECAST ERROR											
		CPHC N/W	EP AN85 N/W	EP CL84 N/W	EP CL81 N/W	MFM N/W	OTCM N/W	TPAC N/W	CPHC NM	EP SS87 NM	EP AN85 NM	EP CL84 NM	EP CL81 NM	MFM NM	OTCM NM	TPAC NM	
2900		10.0	11.6	13.3	10.3	11.1	16.1	15.0									
		163.0	159.6	162.3	161.1	157.5	169.2	162.6									
2906		10.2	11.7	13.2	10.4			13.2									
		163.5	160.7	161.9	162.2			166.8									
2912		10.2	12.8	14.9	12.3	12.6	15.8	11.4									
		168.8	161.7	164.6	163.0	158.8	171.7	166.5									
2918		11.7	12.5	12.7	11.5			12.7									
		165.5	161.8	162.9	163.2			170.6									

AVERAGE DISTANCE ERRORS																	
293 67 109 146 191 577 330 171																	

TROPICAL STORM OKA - AUGUST 26-29, 1987

CPHC MEAN ERROR FROM BEST TRACK.....15NM

MEAN FORECAST ERROR [ERROR (NM)/# OF CASES]

	24 HR FORECAST	48 HR FORECAST	72 HR FORECAST
CPHC	86/12	163/ 8	293/ 4
EPSS87	57/12	84/ 8	67/ 4
EPAN85	84/12	115/ 8	109/ 4
EPCL84	73/12	115/ 8	146/ 4
EPHC81	69/ 6	116/ 4	191/ 2
MFM	125/ 6	258/ 4	577/ 2
OTCM	68/ 9	144/ 7	330/ 4
TPAC	75/ 9	147/ 7	171/ 3

HURRICANE/TYPHOON PEKE
September 21 - October 3, 1987

Hurricane PEKE was the second tropical cyclone of the 1987 season to form within the Central Pacific Hurricane Center's (CPHC) area of responsibility. Warmer than normal sea surface temperatures, associated with what has been referred to as the "El Nino", were present south of the Hawaiian Islands extending to the equator and beyond. Warmer than usual waters, together with the subtropical high pressure system being farther north and west than normal, helped induce an east/west trough which extended across near equatorial latitudes from the perpetually warm western Pacific. Light winds and high humidity thus prevailed over the region usually dominated by moderate trades. Cyclones within this portion of the north Pacific are far removed from areas farther east and west that normally possess conditions much more favorable for tropical cyclone genesis.

A cloud cluster was already evident on September 15 in the satellite pictures over the waters to the south of the Hawaiian Islands within the trough near 10N 155W. There were also frequent reports from ships, among them the vessel "PGDF", of westerly winds to the south of this active convection. This convective area drifted slowly westward over the next few days, and on the 21st near 10N 173W, satellite imagery clearly showed that a closed circulation had developed. The first advisory on Tropical Depression TWO-C was issued at 211800 UTC.

A few hours later at 220000 UTC near 11N 175W (Fig. 8), it was determined that the winds around the tropical depression had reached tropical storm strength and it was subsequently named PEKE, the Hawaiian name for Becky. As PEKE intensified, it moved along a more northwesterly and later northerly track (Fig. 9). At 231800 UTC, satellite pictures showed that an eye had formed near 15N 178W and the circulation had contracted and "spun up". Satellite intensity estimates at this time indicated maximum sustained winds at 75 knots or well above the hurricane threshold of 65 knots.

The numerical and climatological forecast guidance suggested that Hurricane PEKE would move in a northwesterly direction and quickly cross the International Dateline, thus become Typhoon PEKE, and move in the general direction of Wake Island. This, however, was not to be. It soon became apparent that PEKE was very reluctant to cross the Dateline and instead drifted slowly northward along the 178W meridian between 13N and 23N at about 5 to 10 knots with winds reaching a maximum for PEKE's lifetime of about 90 knots. During this period of northward movement from September 23 thru 26, PEKE remained over 28C (82F) or warmer waters with favorable conditions for latent and sensible heat transfer from the ocean to help maintain its hurricane intensity in spite of the now quite considerable northerly latitude. Finally on the 27th at about 2000 UTC, the center of PEKE appeared to cross the International Dateline near 24N moving on a northwesterly course with maximum sustained winds still near their peak and estimated at 85 knots. The CPHC passed the warning responsibility for PEKE to the Joint Typhoon Warning Center (JTWC) on Guam at this time (Fig. 10).

For several more days, Typhoon PEKE remained a large and vigorous storm just west of the Dateline at first moving northwestward for a while to near 32N 170E at 010000 UTC and then turning southeastward to a point west of Midway Island while weakening (Fig. 9). The JTWC issued its last advisory for Tropical Depression PEKE at 031500 UTC when the remains of the system was 400 miles west of Midway Island. A remnant circulation, within which ships now and then encountered near gale force winds, persisted for another 5 or 6 days near the Dateline before finally moving out of the tropics in a northeasterly direction across the Midway area on October 8. There were no known ship casualties associated with PEKE. The islands of Wake and Midway only received fringe effects such as high surf on Wake and some gusty winds and heavy rain squalls on Midway and the other atolls and islets on the western end of the Hawaiian Island chain.

One aspect peculiar to many of the western Pacific typhoons during the 1987 season, and shared by PEKE to some extent, was the slow northward drift with frequent stalls of well-developed cyclones approaching the area just south of strong high pressure cells centered over the middle latitudes near 40N. These highs repeatedly formed near Japan and moved eastward to just across the Dateline. We were thus not dealing with the typical subtropical high with its usual east/west ridge of high pressure roughly along 30N, but rather with high pressure systems of the "blocking high" variety. This area from Japan eastward to 170W or so has been dominated by blocking highs during much of the past year, in some way, perhaps tied to the earlier mentioned "El Nino" phenomenon. Whenever such blocking highs are present, there is a tendency for cyclone motion within the basin to become very erratic and for the forecast guidance to become relatively poor. This also holds true in no small measure for the Atlantic. It may thus be useful here to see why this may be so.

The subtropical high differs in several ways from the type of high pressure system we refer to as the blocking high. The subtropical high is of a larger scale than the blocking high and is centered near 30N rather than over the middle or high latitudes where we usually find the blocking highs. Both types are warm highs, as are nearly all strong highs found over the oceans. By warm highs, we mean that temperatures aloft within the highs are warmer than over surrounding areas. These warmer temperatures are the result of the slow subsidence and compressional heating of the air. High pressure thus is caused by the fact that air is flowing into this high at a rate faster than it can exit. In contrast, the cold high pressure system is of the type where the origin of high pressure is the cold, dense air caused by radiational heat loss and contact cooling over wintertime continental surfaces.

Returning to the blocking high, we may liken it to a large mound of air located in the middle of the jetstream dividing it into two branches with one branch flowing south of the high while the other moves north of it. The subtropical high does not act in this fashion. Usually it separates westerlies at all levels to the north

from easterlies on the equatorward side. The upper westerlies, however, may at times extend across the high or even south of it. We refer to this southern branch as the subtropical jet. In the case of a blocking high, a distinct bifurcation of the flow occurs. Downstream of this split in the jet is where the strong blocking develops and often times, an associated cutoff low 15 degrees south of the high center. We use the term "cutoff" to denote that this low is cut off from the main upper jet which now is flowing well north of the blocking high. However, at very high levels in the atmosphere we may still see a considerable stream of air encircling the south side of the low.

It is the tropical cyclone's interaction with the flow around this cutoff low that seems to cause many of the forecast difficulties for man and computer alike. As the tropical cyclone moves westward or northwestward and approaches the upper trough or low pressure system south of the high, the southwesterlies aloft descend lower and lower in the atmosphere, and the tropical cyclone comes under increasing shearing stress. Like in a thunderstorm a certain amount of vertical shear may be favorable but taken to the extreme, it can be fatal for the tropical cyclone. This particularly is so when static stability is high which is somewhat a function of seas surface temperatures. This shearing phenomenon is particularly common near the Hawaiian Islands where waters are only marginally warm. A 28C (82F) SST with an associated dewpoint temperature of 25C (76F) and a nearly saturated lapse rate along a moist adiabat throughout a fairly deep layer appear to be enough to overcome this tendency for shearing while supplying sufficient latent and sensible heat to overcome the expansionary cooling during ascent and thus maintain the warm core. This rich moisture supply, associated with warm waters, also helps to minimize the drying effect due to entrainment in the strongly sheared environment near the trough.

As the tropical cyclone itself becomes involved with the flow within the central core of the cutoff low, which is a cold core system, the above mentioned latent and sensible heat exchange may help transform the tropical cyclone into a hybrid system of the type sometimes referred to as a subtropical cyclone. This type of transformation occurs most frequently and successfully over the warm western regions of the tropical cyclone basins, such as over the waters south of Japan or south of Cape Hatteras. As in these cases, the blocking high to the north is also favorably located over the cool continental shelf waters and the adjacent cool continents during late season storms.

In summary, tropical cyclone motion, and likely also intensity, is strongly influenced by the type of high pressure cell located to the north. As long as the cyclone is embedded in the low latitude flow south of the subtropical high, it will likely move along westward steadily with some small northward component as it seeks to move toward higher latitudes with higher planetary vorticity values. The subtropical high pressure cell typically is centered near 30N and has a large east/west extent. However, if the high to the north or northwest of the tropical cyclone is located farther north and has the appearance of a blocking high, the cyclone motion is then apt to

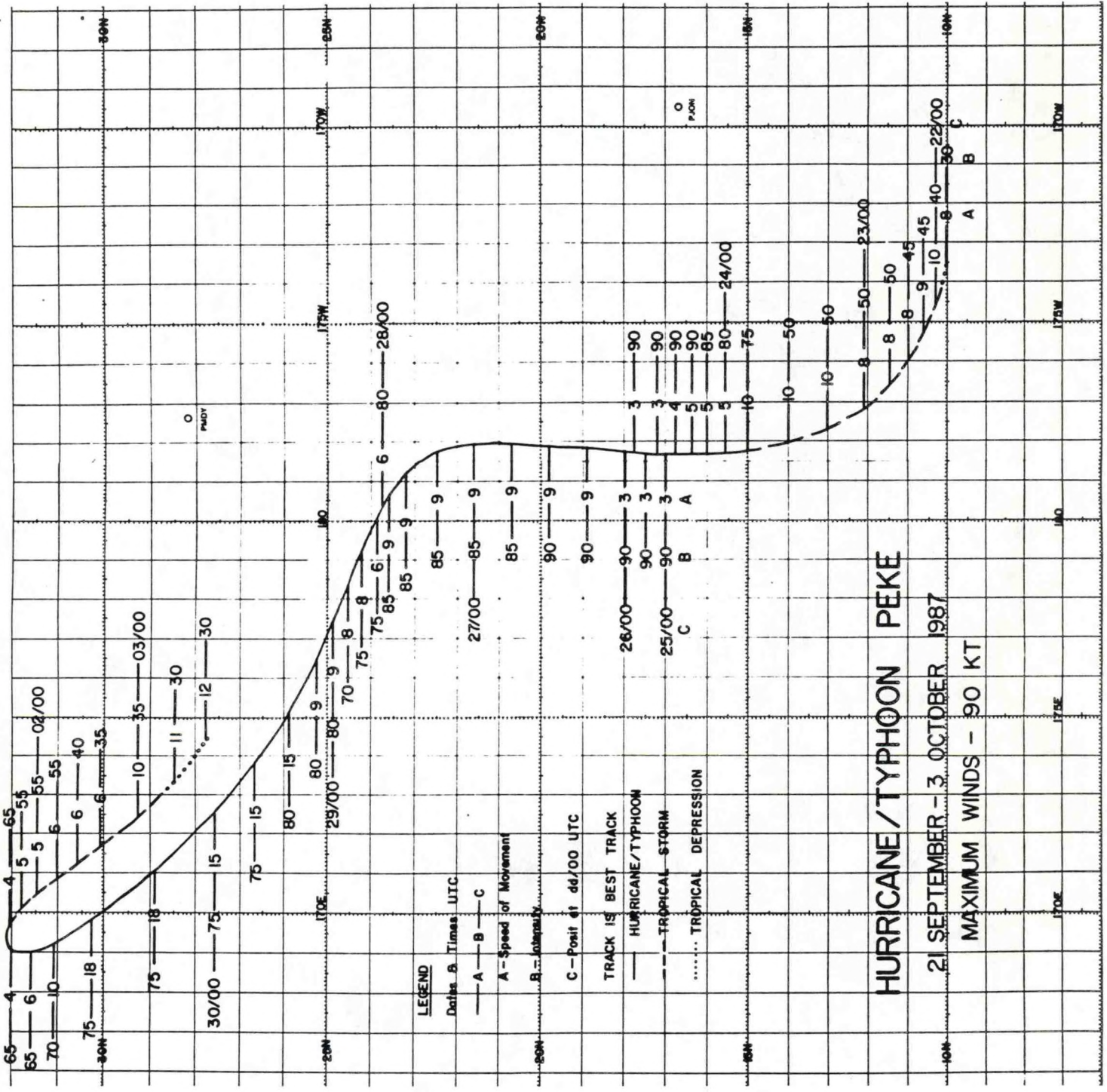
be erratic and slow with a tendency for slow northerly drift into the region along the south flank of the high. The tendency for these blocking high pressure systems to appear and reappear in a given area during a particular season is very pronounced and well recognized by forecasters. Being able to spot these situations of strong blocking highs near the path of tropical cyclones and relating the motion peculiarities of the cyclones, may thus prove useful.

(Fig. 8)

0015 22SE87 28A-4 01052 14341 HC24N150W-1

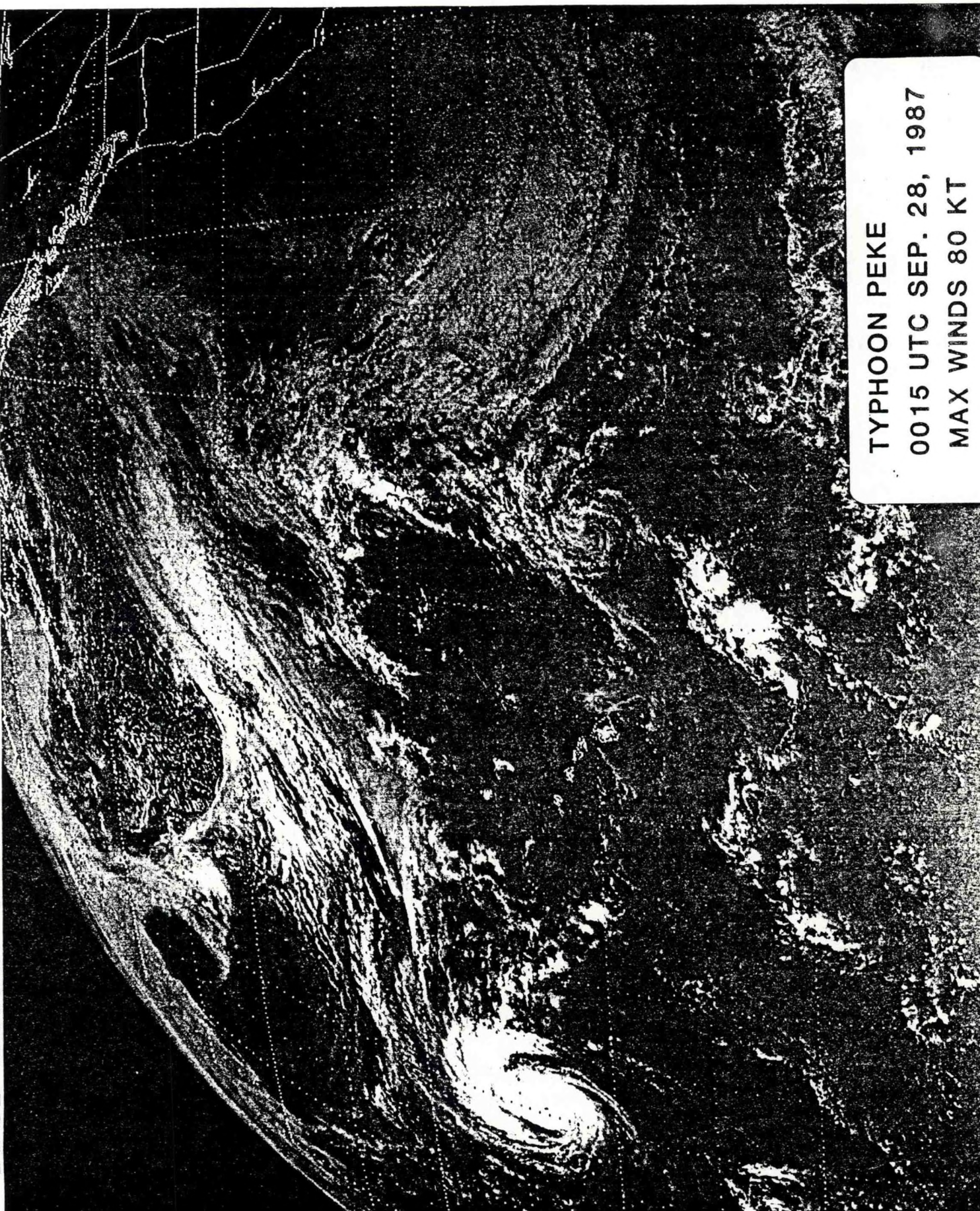
TROPICAL STORM PEKE
0015 UTC SEP. 22, 1987
MAX WINDS 40 KTS

(Fig. 9)



(Fig. 10)

0015 28SE87 28A-4 01061 14321 HC24N150W-1



TYPHOON PEKE
0015 UTC SEP. 28, 1987
MAX WINDS 80 KT

HURRICANE PEKE - SEPTEMBER 21-27, 1987

<u>DATE/TIME</u> <u>UTC</u>	<u>BEST TRACK</u>	<u>ACTUAL TRACK</u>	<u>DIST. ERROR (NM)</u>
211800	10.1N 173.5W	11.0N 173.5W	54
220000	10.3N 174.6W	10.5N 173.5W	14
220600	10.6N 175.4W	10.5N 175.4W	7
221200	11.0N 176.0W	10.6N 176.3W	30
221800	11.4N 176.7W	11.3N 176.6W	8
230000	12.1N 177.3W	12.2N 177.0W	19
230600	13.0N 177.8W	13.0N 177.8W	0
231200	14.0N 178.1W	13.8N 177.9W	17
231800	15.0N 178.3W	15.2N 177.4W	54
240000	15.5N 178.3W	16.0N 177.8W	42
240600	16.0N 178.4W	16.3N 177.8W	39
241200	16.4N 178.4W	16.7N 178.2W	22
241800	16.7N 178.4W	16.9N 178.2W	17
250000	17.0N 178.4W	17.0N 178.2W	12
250600	17.2N 178.4W	17.3N 178.3W	8
251200	17.5N 178.4W	17.4N 178.5W	8
251800	17.8N 178.4W	17.5N 178.2W	22
260000	18.0N 178.3W	18.0N 178.1W	12
260600	18.9N 178.2W	18.6N 178.1W	19
261200	19.8N 178.1W	19.8N 178.3W	12
261800	20.7N 178.1W	20.6N 178.3W	13
270000	21.6N 178.1W	21.4N 178.3W	17
270600	22.5N 178.3W	22.4N 178.3W	7
271200	23.2N 178.8W	23.3N 178.9W	8
271800	23.6N 179.5W	23.6N 179.8W	16

AVERAGE DISTANCE ERROR			19 NM
*280000	23.8N 179.7W	23.6N 179.5W	17
*280600	23.9N 180.0W	23.8N 180.0W	7
*281200	24.3N 179.2E	24.6N 179.6E	28
*281800	24.6N 178.3E	24.8N 178.4E	14
*290000	24.9N 177.4E	25.2N 177.4E	18
*290600	25.2N 176.5E	25.5N 176.0E	33
*291200	25.9N 175.1E	26.3N 174.4E	45
*291800	26.7N 173.7E	27.3N 173.0E	52
*300000	27.6N 172.4E	27.3N 173.0E	37
*300600	28.9N 171.1E	29.4N 170.8E	34
*301200	30.3N 169.8E	30.2N 169.5E	17
*301800	31.1N 169.2E	31.1N 169.3E	7

* Data for verification purposes. Actual track posits from JTWC bulletins. Smoothed best track by CPHC.

HURRICANE PEKE - SEPTEMBER 21 - 27, 1987

DTG	UTC	24 HOUR FORECAST POSITION				24 HOUR FORECAST ERROR				TPAC	OTCM	MFM	OTCM	TPAC
		EP SS87 N/W	EP CL84 N/W	EP CL81 N/W	MFM N/W	OTCM N/W	TPAC N/W	EP SS87 NM	EP CL84 NM					
2218		11.2	11.2	11.2	11.2	11.9				59	14	30		43
		177.6	177.1	177.1	177.0	177.0								
2300		10.7	10.8	10.8	12.6	12.0				102	86	89	44	14
		177.8	177.3	177.5	177.5	177.1								
2306		10.9	10.9	10.9						144	129	137		
		179.0	178.6	178.7										
2312		11.3	11.0	11.5	13.0	13.0				190	201	198	155	51
		179.9	179.6	179.7	179.1	178.2								
2318		11.8	12.1	12.5						216	197	174		175
		178.6	178.5	178.7										
2400		14.4	13.9	14.2	15.2	14.4				160	139	120	51	150
		180.0	178.8	178.7	178.1	179.8								
2406		14.8	14.8	15.4						180	170	149		204
		179.5E	179.7E	179.8E										
2412		14.9	15.2	15.4	16.5	16.8				138	97	81	53	146
		179.7	178.8	178.6	179.1	178.8								
2418		18.2	17.8	18.6						83	64	103		155
		178.7	178.8	177.9										
2500		17.9	18.5	19.2	18.6	17.6				164	141	174	96	192
		179.1E	179.9E	179.8E	178.1	178.6E								
2506		17.4	18.0	18.3						58	76	79		214
		179.3	179.4	179.2										
2512		18.1	18.5	19.1	18.5	19.3				51	108	130	108	169
		178.0	180.0	179.9	177.0	179.3								
2518		17.9	18.7	18.7						78	103	96		167
		179.5	179.5	179.3										
2600		18.0	19.0	18.8	18.8	19.0				40	75	59	93	224
		178.8	178.9	178.7	179.5	178.1E								
2606		18.2	19.3	19.1						57	62	54		141
		179.0	178.9	178.7	18.3	17.6								
2612		18.2	19.4	19.0	19.4	19.4				104	83	88	72	188
		179.0	179.5	179.6	179.5	178.4E								
2618		19.0	19.1	18.3						96	92	190		197
		178.2	178.6	179.0	179.5	178.4E								
2700		20.0	20.3	19.8	20.3	17.5				84	67	97	90	204
		178.2	178.5	178.1	179.4	179.1E								
2706		21.1	21.7	21.7						79	45	48		188
		178.5	178.6	177.9	22.3	21.9								
2712		22.0	23.2	23.7	23.8	23.0				80	88	60	90	222
		179.2	179.5E	179.9	179.7	177.9								
2718		23.2	23.6	23.7						24	44	8		114
		179.8	179.4E	179.9	179.9E	179.6								
2800		24.4	24.6	24.8	23.8	23.0				51	64	97	17	148
		179.2	179.1	178.3	179.7	177.9								
2806		25.6	25.9	26.5						111	156	192		90
		179.5E	178.3	178.1	25.8	25.7								
2812		25.7	25.3	25.9						132	132	143	139	127
		177.5E	177.3E	177.4E	177.4E	177.6E								
2818		26.1	24.6	24.5						147	148	159		177
		176.1E	175.7E	175.5E	23.7	26.9								

AVERAGE DISTANCE ERROR

105 103 135 108 87 131 150 166

HURRICANE PEKE - SEPTEMBER 21 - 27, 1987

DTG	UTC	48 HOUR FORECAST POSITION				48 HOUR FORECAST ERROR												
		CPHC N/W	EP AN85 N/W	EP CL84 N/W	EP CL81 N/W	CPHC NM	EP AN85 NM	EP CL84 NM	EP CL81 NM	SS87 NM	EP AN85 NM	EP CL84 NM	EP CL81 NM	OTCM N/W	OTCM N/W	OTCM NM	TPAC N/W	TPAC NM
2318		11.6	12.3	12.3		13.7				322	200	216				282		
		178.5E	179.1	179.6		178.0E												
2400		11.1	12.1	12.4	13.7	14.6	14.2			339	261	254	138	225	205			
		179.3E	179.8	179.9E	177.9	178.6E	179.2E											
2406		11.5	12.6	12.4						401	301	314						
		177.4E	178.7E	178.6E														
2412		12.3	12.6	12.7	13.6	15.8				384	350	350	203	198	365			
		177.0E	177.5E	177.4E	179.6	178.5E												
2418		13.0	13.9	14.6			13.6			285	214	182			365			
		179.0E	179.8E	179.6			176.5E											
2500		16.2	16.0	16.7		15.9	15.4			280	145	99		239	375			
		177.0E	179.5E	179.9		177.8	175.5E											
2506		16.4	16.8	19.3			15.5			287	243	538		490				
		176.8E	177.5E	172.5E			173.4E											
2512		16.0	17.2	17.8	20.3	17.6	15.7			245	218	185	177	235	454			
		177.5E	177.7E	178.3E	177.9	177.4E	173.8E											
2518		18.8	20.2	21.8			19.3			279	235	284		485	269			
		177.1E	178.8E	179.7E			173.5E	177.8E										
2600		18.6	20.7	22.1	22.4	18.7	20.5	20.7		395	376	400	277	356	553	331		
		175.0E	175.9E	176.3E	176.6E	175.7E	172.5E	176.8E										
2606		18.0	19.8	20.6			17.5	18.8		164	370	381		512	347			
		179.1E	175.5E	175.5E			173.0E	175.8E										
2612		18.8	20.4	21.6	20.1	22.3	18.5			440	334	343	29	333	441	365		
		174.0E	175.8E	175.9	177.9	176.4E	174.0E	175.4E										
2618		18.3	21.0	20.8			18.4	18.5		280	209	191		444	378			
		177.4E	178.0E	178.3E			174.2	175.4E										
2700		18.6	21.3	21.1	21.7	21.1	18.8	18.0		219	123	91	59	358	393	372		
		179.2E	179.5E	179.9	179.3	175.3	175.3E	176.2E										
2706		18.7	21.6	21.4			19.1	18.6		272	126	103		400	393			
		178.9E	179.6E	179.8E			175.5E	176.0E										
2712		19.2	21.6	20.9	22.0	21.5	18.8	18.7		264	200	212	85	252	414	422		
		179.4E	178.0E	178.3E	179.5	177.0E	175.5E	165.4E										
2718		21.0	21.3	19.8			18.1	18.4		172	143	228		415	375			
		178.5	179.5	179.7			175.7E	176.5E										
2800		22.0	22.9	22.0	22.4		18.6	19.7		97	53	108	72	414	294			
		179.2	179.9E	178.6	179.4		175.4E	177.3E										
2806		23.0	24.7	24.9			20.6	21.5		48	54	152		361	220			
		180.0	179.9E	177.5			174.5E	176.9E										
2812		24.5	26.2	27.2	26.4	23.3	21.6	23.0		61	149	156	182	349	382	220		
		178.5E	177.5E	179.8E	176.9E	173.4E	173.5E	176.0E										
2818		25.6	25.9	25.9			22.6	24.2		114	151	89		335	85			
		176.5E	175.9E	177.3E			172.8E	177.0E										
2900		26.5	27.0	27.3	26.5	24.8	22.2	24.1		78	116	188	81	251	342	67		
		177.5E	178.2E	180.0	177.0E	172.8E	172.1E	177.6E										
2906		27.0	28.8	29.5			24.0	25.4		94	265	350		206	103			
		175.5E	179.3E	179.2			172.6E	177.9E										
2912		26.8	26.9	26.8	27.0	27.7	25.1	28.6		81	83	132	166	240	243	199		
		173.0E	173.0E	172.0E	171.4E	170.2E	170.1E	177.1E										
2918		26.9	25.5	23.8			25.4	32.2		36	203	364		234	335			
		172.5E	169.8E	167.5E			169.2E	176.1E										

AVERAGE DISTANCE ERRORS

225	205	182	237	134	276	380	281
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HURRICANE PEKE - SEPTEMBER 21 - 27, 1987

DTG	72 HOUR FORECAST POSITION				72 HOUR FORECAST ERROR				
	UTC	CPHC	EP	EP	EP	EP	EP	EP	EP
	N/W	N/W	CL84	CL81	N/W	MFM	OTCM	TPAC	
			N/W	N/W	N/W	N/W	N/W	N/W	
2418	12.1	13.6	13.2				14.8		
	174.4E	178.0E	176.7E				173.8E		
2500	11.8	13.7	13.8	14.2	17.1		15.4		
	175.7E	177.4E	176.5E	179.1	176.1E		175.2E		
2506	12.2	14.1	13.7						
	173.9E	175.7E	174.6E						
2512	13.4	14.3	14.3	15.9	18.3				
	174.0E	174.6E	173.8E	179.7E	171.5E				
2518	15.0	15.9	16.5				12.9		
	175.3E	176.3E	174.9E				169.8E		
2600	18.0	18.2	19.0		16.8				
	174.0E	174.9E	174.6E		173.7E				
2606	18.2	19.3	20.4						
	174.3E	172.5E	171.9E				14.7		
2612	18.3	19.7	20.3	19.5	17.4		165.9		
	174.0E	175.2E	175.7E	178.9	172.9E		15.4		
2618	19.0	23.4	25.4				167.1		
	173.0E	174.3E	174.4E				20.6		
2700	19.3	23.7	25.2	22.0	21.4		167.1E		
	170.9E	172.1E	171.3E	178.3	171.8E		166.3E	23.5	
2706	18.4	23.1	24.3				18.6	20.5	
	176.5E	175.4E	175.9E				166.2E	172.3E	
2712	19.5	23.0	24.2	27.1	27.0		21.1	19.8	
	170.0E	173.6E	173.4E	178.5E	171.4E		167.5E	172.0E	
2718	18.9	23.1	23.0				19.7	19.8	
	173.3E	176.3E	176.2E				168.4E	172.0E	
2800	18.8	23.3	23.0	26.5	24.2		20.1	19.0	
	176.0E	177.6E	178.1E	176.6E	171.4E		169.7E	173.2E	
2806	19.0	23.8	23.2				19.3	18.6	
	175.7E	178.0E	178.2E				170.0E	173.0E	
2812	20.2	23.8	22.7	25.2	22.7		19.2	19.8	
	176.4E	176.8E	177.2E	177.5E	173.9E		169.6E	172.2E	
2818	23.4	23.4	21.6				17.8	19.2	
	179.6E	179.6E	178.4				169.9E	173.7E	
2900	24.2	24.7	23.8	24.9			18.7	21.0	
	178.8E	177.4E	179.7E	174.8E			169.1E	174.9E	
2906	24.8	26.7	26.8				22.3	23.6	
	178.1E	175.3E	178.2E				168.6E	174.2E	
2912	27.0	28.3	29.1	21.7	25.7		24.1	26.0	
	175.0E	171.4E	173.1E	175.3E	166.5E		167.3E	173.0E	
2918	26.9	28.4	27.7				24.5	27.2	
	172.6E	172.5E	173.3E				165.2E	174.0E	
3000	27.5	29.6	29.4	23.7	27.6		24.9	26.6	
	173.5E	175.2E	176.6E	174.0E	168.3E		165.2E	174.7E	
3006	28.0	31.5	31.9				26.5	27.7	
	171.4E	175.8E	176.2E				165.5E	174.9E	
3012	27.8	29.0	27.6	30.1	30.6		29.4	28.6	
	168.0E	171.3E	168.1E	171.1E	166.3E		163.6E	172.0E	
3018	28.5	27.6	24.2				30.3	27.3	
	169.7E	171.3E	166.7E				164.2E	168.6E	

AVERAGE DISTANCE ERROR

333 266 314 161 427 604 328

HURRICANE PEKE - SEPTEMBER 21-27, 1987

CPHC MEAN ERROR FROM BEST TRACK.....19NM

MEAN FORECAST ERROR [ERROR (NM)/# OF CASES]

	24 HR FORECAST	48 HR FORECAST	72 HR FORECAST
CPHC	105/25	225/25	333/25
EPSS87	103/25	205/25	266/25
EPAN85	135/ 4	182/ 1	N/A
EPCL84	108/25	237/25	314/25
EPHC81	87/11	134/11	161/11
MFM	131/11	276/11	427/11
OTCM	150/23	380/23	604/22
TPAC	166/17	281/17	328/16

1987 FORECAST VERIFICATION

Forecast Periods
 (Average error in nautical miles (NM)/
 number of forecasts.)

<u>FORECASTER/MODEL</u>	<u>24-HOUR</u>	<u>48-HOUR</u>	<u>72-HOUR</u>
CPHC Forecaster	92/60	181/48	301/40
EPSS87	89/57	168/45	228/38
EPAN85	90/39	128/24	197/15
EPCL84	93/60	184/48	265/40
EPHC81	79/29	121/23	186/19
MFM	112/26	239/22	398/19
OTCM	125/51	264/43	480/36
TPAC	117/46	200/36	261/27

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