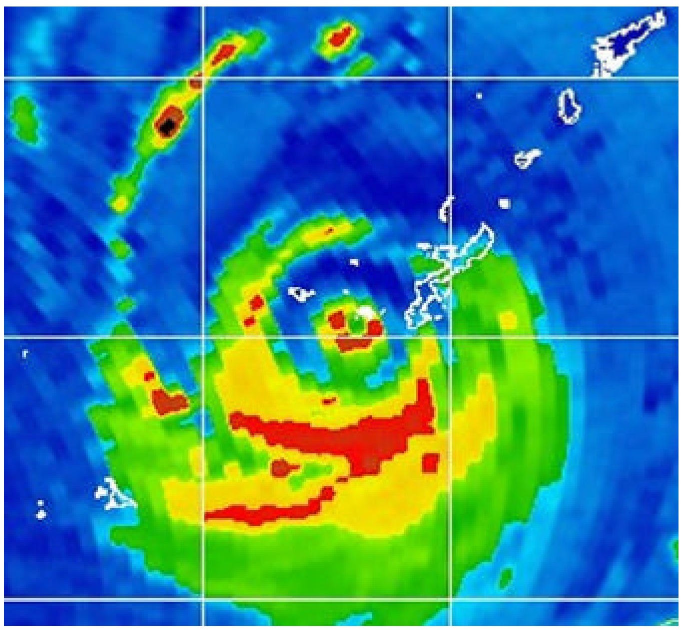
1999
Annual Tropical Cyclone Report

U.S. Naval Pacific Meteorology and Oceanography Center/ Joint Typhoon Warning Center
Pearl Harbor, Hawaii



Tropical Rainfall Measuring Mission (TRMM) microwave imagery of Super Typhoon Bart (24W) as the system passed Okinawa. Imagery is from 0917Z on September 22, 1999. Maximum intensity of the system was estimated at 140 knots .

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14. ABSTRACT
The mission of the Joint Typhoon Warning Center is multi-faceted and includes: Continuous monitoring of all tropical weather activity in the Northern and Southern Hemispheres, from 180 degrees longitude westward to the east coast of Africa, and the prompt issuance of appropriate advisories and alerts when tropical cyclone development is anticipated.

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Contents

1. SUMMARY OF NORTH WEST PACIFIC AND NORTHERN INDIAN OCEAN TROPICAL CYCLONES

1.1 NORTH WEST PACIFIC OCEAN TROPICAL CYCLONES

Tropical cyclone genesis regions compared to the 15-year average are shown in Figure 1-1. This year's tropical cyclones are listed in Table 1-1. Table 1-2 shows the monthly distribution of tropical cyclones for each year since 1959 and Table 1-3 shows the monthly average occurrence of tropical storms separated into: (1) typhoons only; and (2) tropical storms and typhoons. A summary of this year's Tropical Cyclone Formation Alerts is shown in Table 1-4. The annual number of tropical cyclones of tropical storm strength and higher appear in Figure 1-2, while the number of super typhoons are shown in Figure 1-3. Composites of the tropical cyclone best tracks for the North West Pacific appear in Figures 1-4a, 1-4b, 1-4c, 1-4d, and 1-4e.

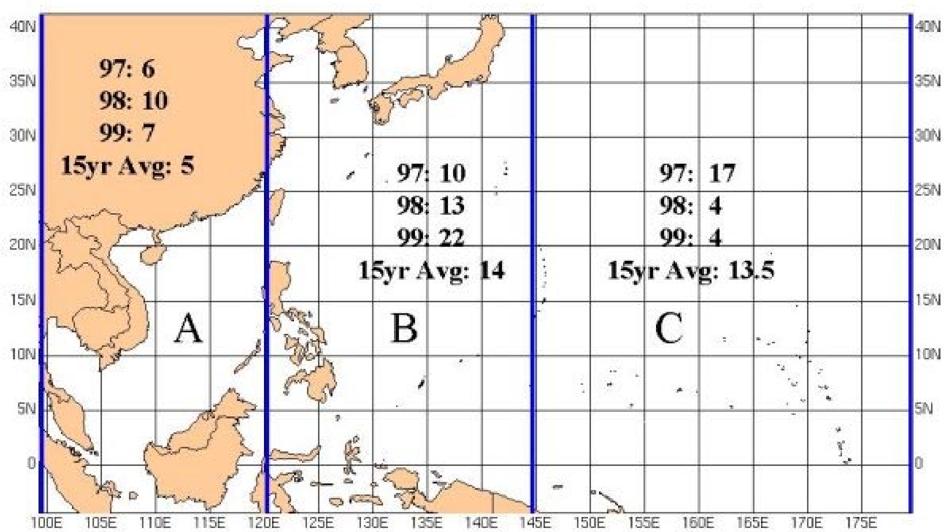


Figure 1-1. Comparison of the number of tropical cyclones that developed within 3 designated areas for 1997, 1998, 1999 and the 15-year average.

Table 1-1 WESTERN NORTH PACIFIC SIGNIFICANT TROPICAL CYCLONES FOR 1999 (01 JAN 1999 - 31 DEC 1999)

TC	NAME	PERIOD	NUMBER ISSUED	EST MAX SFC WINDS KTS (M/SEC)	MSLP (MB)
01W	TS HILDA	04 Jan 07 Jan	12	35 (18)	997
02W	TS IRIS	16 Feb 19 Feb	13	35 (18)	997
03W	TS JACOB	06 Apr 10 Apr	16	35 (18)	997
04W	TY KATE	22 Apr 28 Apr	27	75 (39)	967
05W	TY LEO	27 Apr 02 May	24	110 (57)	933
06W	TY MAGGIE	01 Jun 07 Jun	24	105 (54)	938
07W	-	15 Jul 18 Jul	14	30 (15)	1000
08W	-	21 Jul 22 Jul	6	30 (15)	1000
09W	TS NEIL	25 Jul 28 Jul	13	40 (21)	994
10W	-	28 Jul 27 Jul	3	25 (13)	1002
11W	TY OLGA	29 Aug 03 Aug	24	80 (41)	963
12W	TS PAUL	03 Aug 08 Aug	19	50 (26)	987
13W	TS RACHEL	06 Aug 09 Aug	14	35 (18)	997
14W	-	08 Aug 10 Aug	8	30 (15)	1000
*07E	TY DORA	05 Aug 23 Aug	(56)14	120 (62)	922
15W	-	16 Aug 18 Aug	9	25 (13)	1002
16W	TY SAM	18 Aug 23 Aug	20	75 (39)	967
17W	TY TANYA	19 Aug 24 Aug	18	70 (36)	972
18W	-	21 Aug 24 Aug	10	30 (15)	1000
19W	TY VIRGIL	24 Aug 29 Aug	21	70 (36)	972
20W	TS WENDY	01 Sep 04 Sep	13	40 (21)	994
21W	TY YORK	11 Sep 17 Sep	22	70 (36)	972
22W	TS ZIA	13 Sep 15 Sep	7	35 (18)	997
23W	TS ANN	15 Sep 20 Sep	18	45 (23)	991
24W	STY BART	17 Sep 24 Sep	29	140 (72)	898
25W	TS CAM	23 Sep 25 Sep	11	45 (23)	991
26W	TY DAN	02 Oct 11 Oct	35	110 (57)	933
27W	TS EVE	15 Oct 19 Oct	18	35 (18)	997
28W	-	05 Nov 06 NOV	4	30 (15)	1000
29W	TS FRANKIE	06 Nov 10 NOV	16	35 (18)	997
30W	TY GLORIA	13 Nov 16 NOV	13	65 (33)	976
31W	-	01 Dec 04 Dec	13	30 (15)	1000
32W	-	09 Dec 11 Dec	6	30 (15)	1000
33W	-	14 Dec16 Dec	7	30 (15)	1000
		JTWC TOTAL	521		
		( )NPMOC TOTAL	56		
		GRAND TOTAL	577		

*WARNINGS ISSUED BY NPMOC

Table 1-2 DISTRIBUTION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959 - 1999

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS

Table 1-2 DISTRIBUTION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959 - 1999

1959	0	1	1	1	0	1	3	8	9	3	2	2	31
	000	010	010	100	000	001	111	512	423	210	200	200	17 7 7
1960	1	0	1	1	1	3	3	9	5	4	1	1	30
	001	000	001	100	010	210	210	810	41	400	100	100	19 8 3
1961	1	1	1	1	4	6	5	7	6	7	2	1	42
	010	010	100	010	211	114	320	313	510	322	101	100	20 11 11
1962	0	1	0	1	3	0	8	8	7	5	4	2	39
	000	010	000	100	201	000	512	701	313	311	301	020	24 6 9
1963	0	0	1	1	0	4	5	4	4	6	0	3	28
	000	000	001	100	000	310	311	301	220	510	000	210	19 6 3
1964	0	0	0	0	3	2	8	8	8	7	6	2	44
	000	000	000	000	201	200	611	350	521	331	420	101	26 13 5
1965	2	2	1	1	2	4	6	7	9	3	2	1	40
	110	020	010	100	101	310	411	322	531	201	110	010	21 13 6
1966	0	0	0	1	2	1	4	9	10	4	5	2	38
	000	000	000	100	200	100	310	531	532	112	122	101	20 10 8
1967	1	0	2	1	1	1	8	10	8	4	4	1	41
	010	000	110	100	010	100	332	343	530	211	400	010	20 15 6
1968	0	1	0	1	0	4	3	8	4	6	4	0	31
	000	001	000	100	000	202	120	341	400	510	400	000	20 7 4
1969	1	0	1	1	0	0	3	3	6	5	2	1	23
	100	000	010	100	000	000	210	210	204	410	110	010	13 6 4
1970	0	1	0	0	0	2	3	7	4	6	4	0	27
	000	100	000	000	000	110	021	421	220	321	130	000	12 12 3
1971	1	0	1	2	5	2	8	5	7	4	2	0	37
	010	000	010	200	230	200	620	311	511	310	110	000	24 11 2
1972	1	0	1	0	0	4	5	5	6	5	2	3	32
	100	000	001	000	000	220	410	320	411	410	200	210	22 8 2
1973	0	0	0	0	0	0	7	6	3	4	3	0	23
	000	000	000	000	000	000	430	231	201	400	030	000	12 9 2
1974	1	0	1	1	1	4	5	7	5	4	4	2	35
	010	000	010	010	100	121	230	232	320	400	220	020	15 17 3
1975	1	0	0	1	0	0	1	6	5	6	3	2	25
	100	000	000	001	000	000	010	411	410	321	210	002	14 6 5
1976	1	1	0	2	2	2	4	4	5	0	2	2	25
	100	010	000	110	200	200	220	130	410	000	110	020	14 11 0
1977	0	0	1	0	1	1	4	2	5	4	2	1	21
	000	000	010	000	001	010	301	020	230	310	200	100	11 8 2
1978	1	0	0	1	0	3	4	8	4	7	4	0	32
	010	000	000	100	000	030	310	341	310	412	121	000	15 13 4
1979	1	0	1	1	2	0	5	4	6	3	2	3	28
	100	000	100	100	011	000	221	202	330	210	110	111	14 9 5
1980	0	0	1	1	4	1	5	3	7	4	1	1	28
	000	000	001	010	220	010	311	201	511	220	100	010	15 9 4
1981	0	0	1	1	1	2	5	8	4	2	3	2	29
	000	000	100	010	010	200	230	251	400	110	210	200	16 12 1
1982	0	0	3	0	1	3	4	5	6	4	1	1	28

Table 1-2 DISTRIBUTION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959 - 1999

	000	000	210	000	100	120	220	500	321	301	100	100	19 7 2
1983	0	0	0	0	0	1	3	6	3	5	5	2	25
	000	000	000	000	000	010	300	231	111	320	320	020	12 11 2
1984	0	0	0	0	0	2	5	7	4	8	3	1	30
	000	000	000	000	000	020	410	232	130	521	300	100	16 11 3
1985	2	0	0	0	1	3	1	7	5	5	1	2	27
	020	000	000	000	100	201	100	520	320	410	010	110	17 9 1
1986	0	1	0	1	2	2	2	5	2	5	4	3	27
	000	100	000	100	110	110	200	410	200	320	220	210	19 8 0
1987	1	0	0	1	0	2	4	4	7	2	3	1	25
	100	000	000	010	000	110	400	310	511	200	120	100	18 6 1
1988	1	0	0	0	1	3	2	5	8	4	2	1	27
	100	000	000	000	100	111	110	230	260	400	200	010	14 12 1
1989	1	0	0	1	2	2	6	8	4	6	3	2	35
	010	000	000	100	200	110	231	332	220	600	300	101	21 10 4
1990	1	0	0	1	2	4	4	5	5	5	4	1	31
	100	000	000	010	110	211	220	500	410	230	310	100	21 9 1
1991	0	0	2	1	1	1	4	8	6	3	6	0	32
	000	000	110	010	100	100	400	332	420	300	330	000	20 10 2
1992	1	1	0	0	0	3	4	8	5	6	5	0	33
	100	010	000	000	000	210	220	440	410	510	311	000	21 11 1
1993	0	0	2	2	1	2	5	8	5	6	4	3	38
	000	000	011	002	010	101	320	611	410	321	112	300	21 9 8
1994	1	0	1	0	2	2	9	9	8	7	0	2	41
	001	000	100	000	101	020	342	630	440	511	000	110	21 15 5
1995	1	0	0	0	1	2	3	7	7	8	2	3	34
	001	000	000	000	010	020	210	421	412	512	020	012	15 11 8
1996	0	1	0	2	2	0	7	10	7	5	6	3	43
	000	001	000	011	110	000	610	433	610	212	132	111	21 12 10
1997	1	0	0	2	3	3	4	8	4	6	1	1	33
	010	000	000	110	120	300	310	611	310	411	100	100	23 8 2
1998	0	0	0	0	0	0	3	3	8	6	3	4	27
	000	000	000	000	000	000	012	210	413	213	030	112	9 9 9
1999	1	1	0	3	0	1	5	9	6	2	3	3	34
	010	010	000	210	000	100	113	423	240	110	111	003	12 12 8
(1959-1999)													
MEAN	0.6	0.3	0.6	0.8	1.2	2.0	4.5	6.3	5.7	4.6	2.9	1.5	30.9
CASES	23	14	23	31	48	80	183	260	233	190	119	63	1267

The criteria used in TABLE 1-2 are as follows:

1) If a tropical cyclone was first warned on during the last two days of a particular month and continued into the next month for longer than two days, then that system was attributed to the second month.

2) If a tropical cyclone was warned on prior to the last two days of a month, it was attributed to the first month, regardless of how long the system lasted.

3) If a tropical cyclone began on the last day of the month and ended on the first day of the next month, that system was attributed to the first month. However, if a tropical cyclone began on the last day of the month and continued into the next month for only two days, then it was attributed to the second month.

TABLE 1-3 NORTH WEST PACIFIC TROPICAL CYCLONES

TYPHOONS (1945-1959)

TABLE 1-3 NORTH WEST PACIFIC TROPICAL CYCLONES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
MEAN	0.3	0.1	0.3	0.4	0.7	1	2.9	3.1	3.3	2.4	2	0.9	16.4
CASES	5	1	4	6	10	15	29	46	49	36	30	14	245

TYPHOONS (1960-1999)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
MEAN	0.3	0.1	0.2	0.5	0.7	1.1	2.7	3.5	3.4	3.2	1.6	0.7	17.7
CASES	10	2	8	18	27	42	108	138	135	127	64	27	706

TROPICAL STORMS AND TYPHOONS (1945-1959)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
MEAN	0.4	0.1	0.5	0.5	0.8	1.6	2.9	4	4.2	3.3	2.7	1.2	22.2
CASES	6	2	7	8	11	22	44	60	64	49	41	18	332

TROPICAL STORMS AND TYPHOONS (1960-1999)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
MEAN	0.5	0.2	0.4	0.7	1.2	1.8	4.3	5.7	5.2	4.4	2.7	1.3	27.7
CASES	21	10	17	28	44	71	167	224	204	168	106	49	1109

TABLE 1-4 TROPICAL CYCLONE FORMATION ALERTS FOR THE NORTH WEST PACIFIC OCEAN FOR 1976-1999

YEAR	INITIAL TCFAS	TROPICAL CYCLONES WITH TCFAS	TOTAL TROPICAL CYCLONES	PROBABILITY OF TCFA WITHOUT WARNING*	PROBABILITY OF TCFA BEFORE WARNING
1976	34	25	25	26%	100%
1977	26	20	21	23%	95%
1978	32	27	32	16%	84%
1979	27	23	28	15%	82%
1980	37	28	28	24%	100%
1981	29	28	29	3%	96%
1982	36	26	28	28%	93%
1983	31	25	25	19%	100%
1984	37	30	30	19%	100%
1985	39	26	27	33%	96%
1986	38	27	27	29%	100%
1987	31	24	25	23%	96%
1988	33	26	27	21%	96%
1989	51	32	35	37%	91%
1990	33	30	31	9%	97%
1991	37	29	31	22%	94%
1992	36	32	32	20%	100%
1993	50	35	38	30%	92%
1994	50	40	40	20%	100%
1995	54	33	35	39%	94%
1996	41	39	43	,5%	91%
1997	36	30	33	17%	91%

TABLE 1-4 TROPICAL CYCLONE FORMATION ALERTS FOR THE NORTH WEST PACIFIC OCEAN FOR 1976-1999

1998	38	18	27	53%	67%
1999	39	29	33	26%	88%
(1976-1999)					
MEAN:	37	26	30	30%	87%
TOTALS:	893	682	730		

* Percentage of initial TCFA's not followed by warnings.

1.2 NORTH INDIAN OCEAN TROPICAL CYCLONES

This year's North Indian Ocean tropical cyclones are listed in Table 1-5. The monthly distribution of tropical cyclones for each year since 1975 is shown in Table 1-6. Composites of the tropical cyclone best tracks for the Northern Indian Ocean appear in Figure 1-5.

Table 1-5 NORTH INDIAN OCEAN SIGNIFICANT TROPICAL CYCLONES FOR 1999 (01 JAN 1999 - 31 DEC 1999)

TC	NAME	PERIOD	NUMBER ISSUED	EST MAX SFC WINDS KTS (M/SEC)	MSLP (MB)
01B	-	02 Feb - 04 Feb	6	40 (21)	994
02A	-	16 May - 21 May	21	110 (57)	933
03B	-	10 Jun - 11 Jun	2	35 (18)	997
04B	-	15 Oct - 18 Oct	7	120 (62)	922
05B	-	26 Oct - 01 Nov	13	140 (72)	898

*WARNINGS ISSUED BY NPMOC

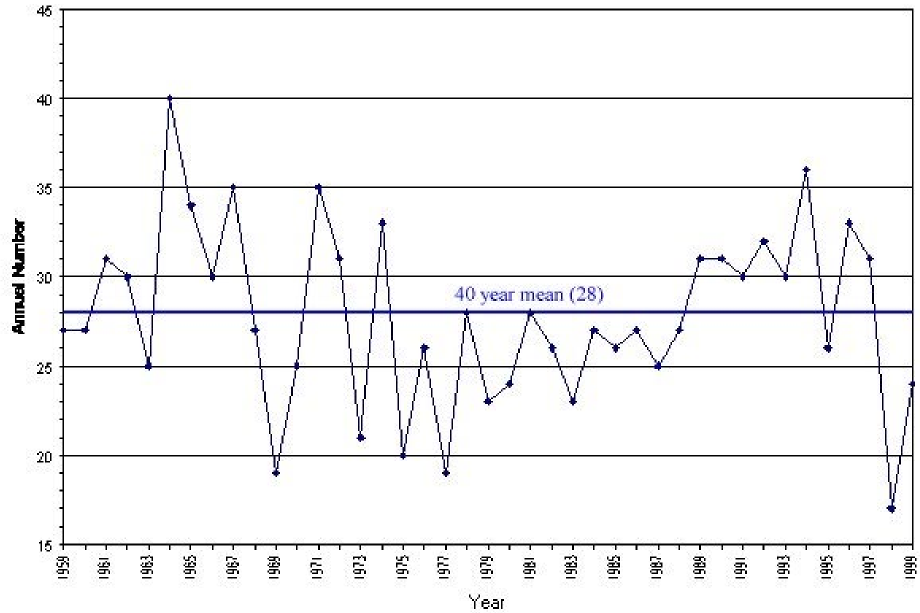


Figure 1-2. Tropical Cyclones of Tropical Storm or greater intensity in the North West Pacific (1959-1999).

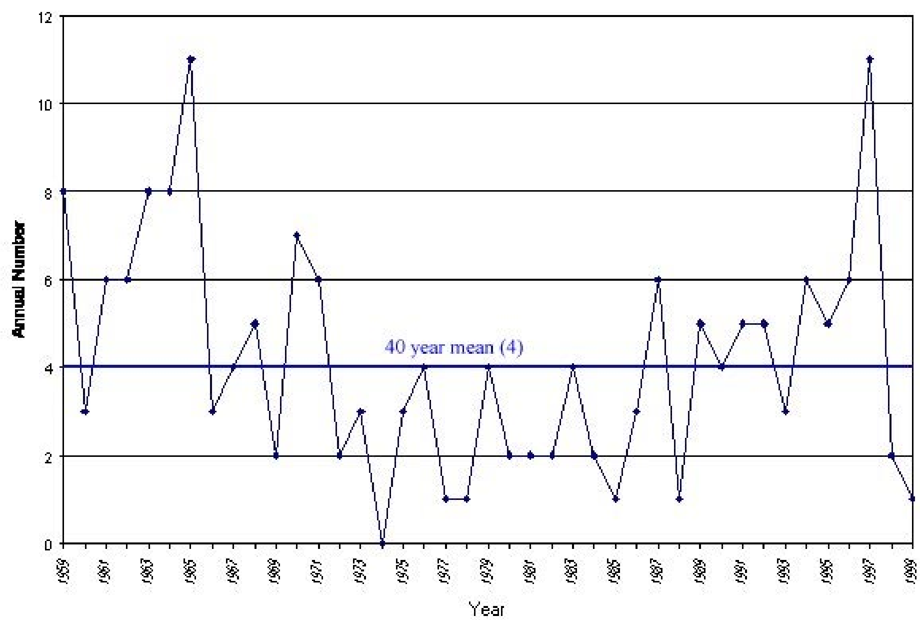
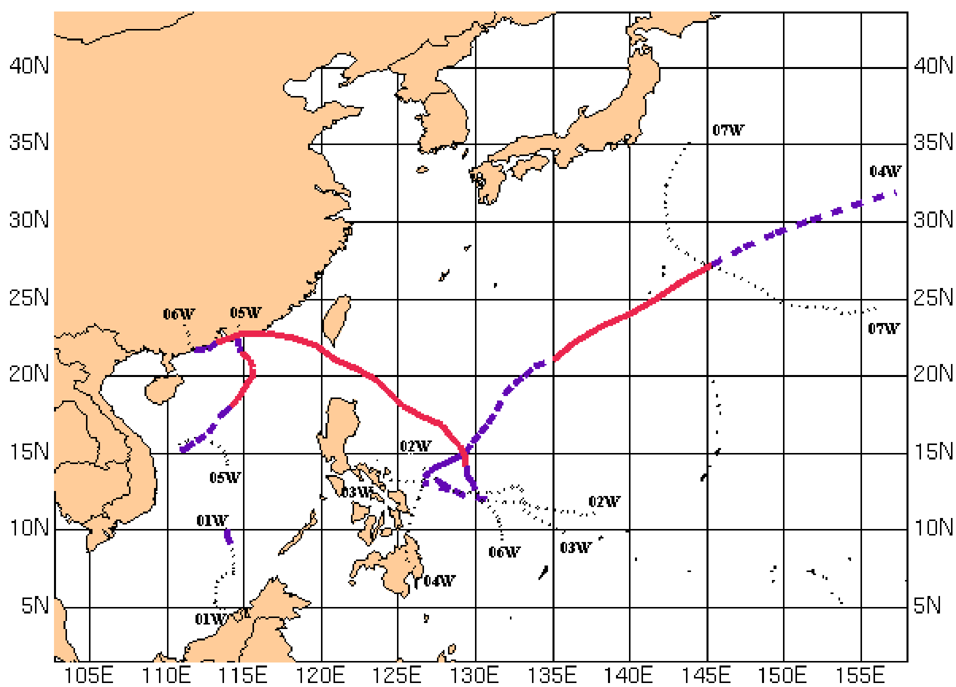


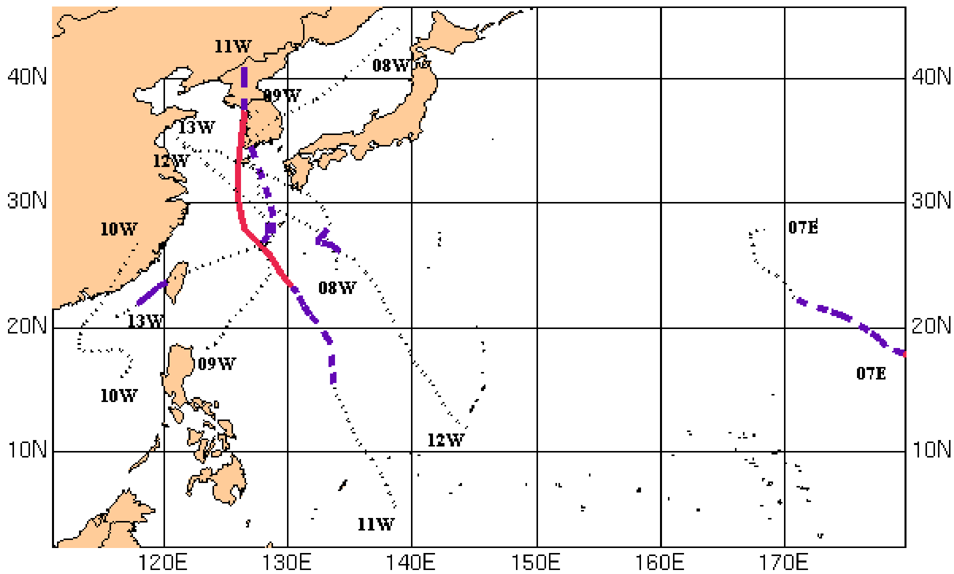
Figure 1-3. Number of North West Pacific Super Typhoons (1959-1999).



NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
04 JAN 99 - 18 JUL 99

01W TS HILDA	04 JAN - 07 JAN
02W TS IRIS	16 FEB - 19 FEB
03W TS JACOB	06 APR - 10 APR
04W TY KATE	22 APR - 28 APR
05W TY LEO	27 APR - 02 MAY
06W TY MAGGIE	01 JUN - 07 JUN
07W TD	15 JUL - 18 JUL

MAXIMUM SUSTAINED SURFACE WIND
64KT (33M/SEC) OR GREATER
34 TO 63KT (18 TO 32M/SEC)
33KT (17M/SEC) OR LESS



NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
21 JUL 99 - 23 AUG 99

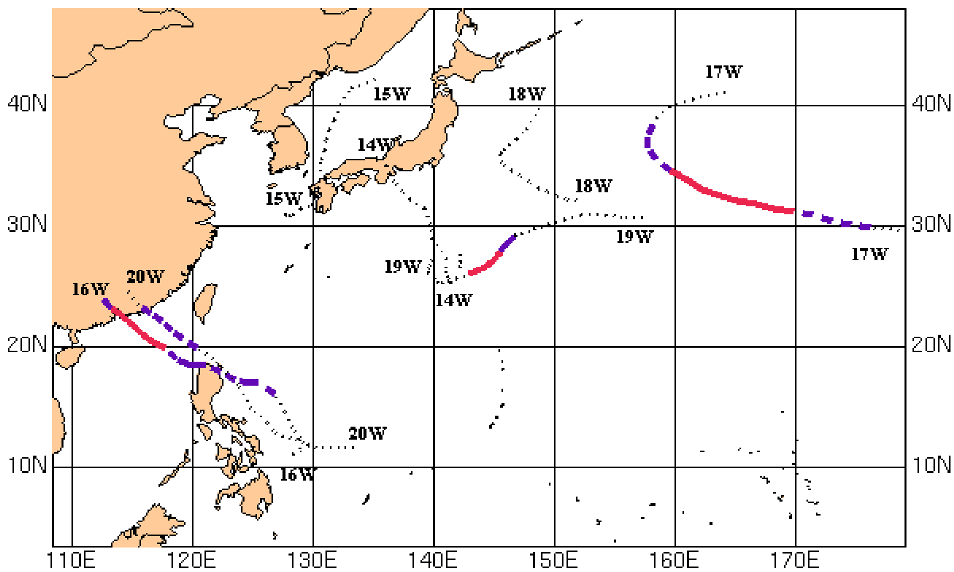
08W	TD	21 JUL - 22 JUL
09W	TS NEIL	25 JUL - 28 JUL
10W	TD	26 JUL - 27 JUL
11W	TY OLGA	29 JUL - 03 AUG
12W	TS PAUL	03 AUG - 08 AUG
13W	TS RACHEL	06 AUG - 09 AUG
07E	TY DORA	06 AUG - 23 AUG

MAXIMUM SUSTAINED SURFACE WIND

64KT (33M/SEC) OR GREATER

34 TO 63KT (18 TO 32M/SEC)

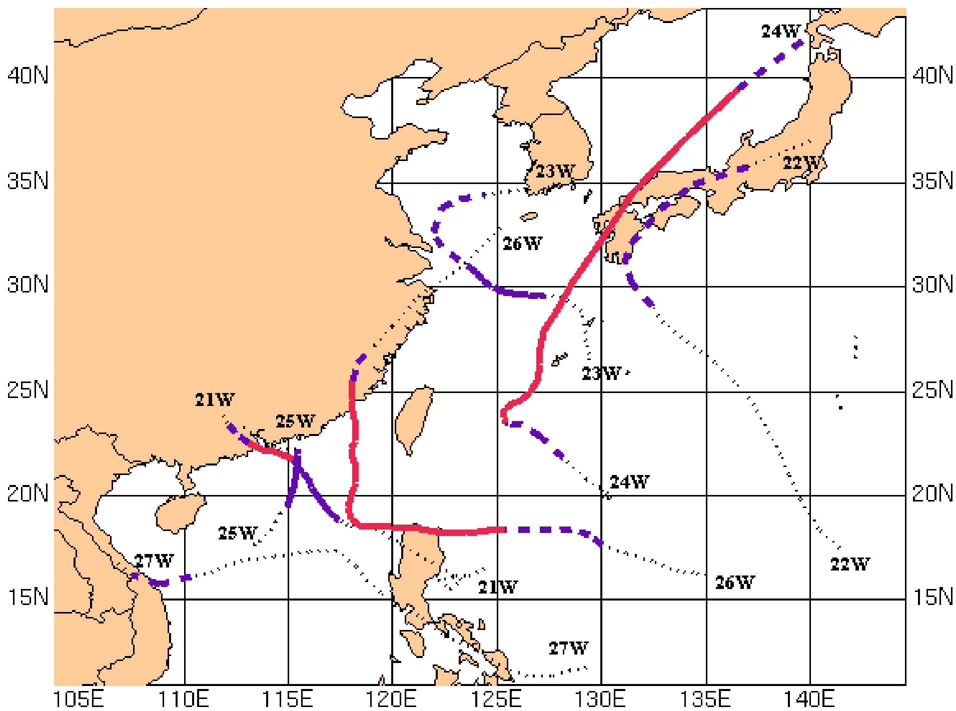
33KT (17M/SEC) OR LESS



NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
08 AUG 99 - 04 SEP 99

14W TD	08 AUG - 10 AUG
15W TD	16 AUG - 18 AUG
16W TY SAM	18 AUG - 23 AUG
17W TY TANYA	19 AUG - 24 AUG
18W TD	21 AUG - 24 AUG
19W TY VIRGIL	24 AUG - 29 AUG
20W TS WENDY	01 SEP - 04 SEP

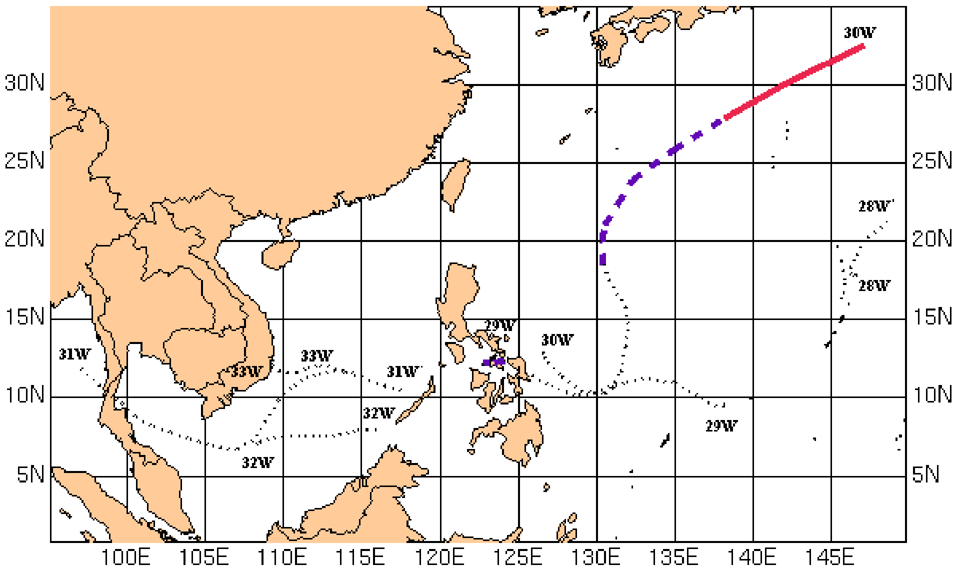
MAXIMUM SUSTAINED SURFACE WIND
64KT (33M/SEC) OR GREATER
34 TO 63KT (18 TO 32M/SEC)
33KT (17M/SEC) OR LESS



NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
11 SEP 99 - 19 OCT 99

21W TY YORK	11 SEP - 17 SEP
22W TS ZIA	13 SEP - 15 SEP
23W TS ANN	15 SEP - 20 SEP
24W STY BART	17 SEP - 24 SEP
25W TS CAM	23 SEP - 25 SEP
26W TY DAN	02 OCT - 11 OCT
27W TS EVE	15 OCT - 19 OCT

MAXIMUM SUSTAINED SURFACE WIND
- 64KT (33M/SEC) OR GREATER
- 34 TO 63KT (18 TO 32M/SEC)
- 33KT (17M/SEC) OR LESS



NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
05 NOV 99 - 16 DEC 99

28W TD	05 NOV - 06 NOV
29W TS FRANKIE	06 NOV - 10 NOV
30W TY GLORIA	13 NOV - 16 NOV
31W TD	01 DEC - 04 DEC
32W TD	09 DEC - 11 DEC
33W TD	14 DEC - 16 DEC

MAXIMUM SUSTAINED SURFACE WIND

64KT (33M/SEC) OR GREATER

34 TO 63KT (18 TO 32M/SEC)

33KT (17M/SEC) OR LESS

Table 1-6 DISTRIBUTION OF NORTHERN INDIAN OCEAN TROPICAL CYCLONES FOR 1975 - 1999

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS	
1975	1	0	0	0	2	0	0	0	0	1	2	0		6
	010	000	000	000	200	000	000	000	000	100	020	000	3 3 0	
1976	0	0	0	1	0	1	0	0	1	1	0	1		5
	000	000	000	010	000	010	000	000	010	010	000	010	0 5 0	
1977	0	0	0	0	1	1	0	0	0	1	0	2		5
	000	000	000	000	010	010	000	000	000	010	000	110	1 4 0	
1978	0	0	0	0	1	0	0	0	0	1	2	0		4
	000	000	000	000	010	000	000	000	000	010	200	000	2 2 0	
1979	0	0	0	0	1	1	0	0	2	1	2	0		7
	000	000	000	000	100	010	000	000	011	010	011	000	1 4 2	
1980	0	0	0	0	0	0	0	0	0	0	1	1		2
	000	000	000	000	000	000	000	000	000	000	010	010	0 2 0	
1981	0	0	0	0	0	0	0	0	1	0	1	1		3
	000	000	000	000	000	000	000	000	010	000	100	100	2 1 0	
1982	0	0	0	0	1	1	0	0	0	2	1	0		5
	000	000	000	000	100	010	000	000	000	020	100	000	2 3 0	
1983	0	0	0	0	0	0	0	1	0	1	1	0		3
	000	000	000	000	000	000	000	010	000	010	010	000	0 3 0	
1984	0	0	0	0	1	0	0	0	0	1	2	0		4
	000	000	000	000	010	000	000	000	000	010	200	000	2 2 0	
1985	0	0	0	0	2	0	0	0	0	2	1	1		6
	000	000	000	000	020	000	000	000	000	020	010	010	0 6 0	
1986	1	0	0	0	0	0	0	0	0	0	2	0		3
	010	000	000	000	000	000	000	000	000	000	020	000	0 3 0	
1987	0	1	0	0	0	2	0	0	0	2	1	2		8
	000	010	000	000	000	020	000	000	000	020	010	020	0 8 0	
1988	0	0	0	0	0	1	0	0	0	1	2	1		5
	000	000	000	000	000	010	000	000	000	010	110	010	1 4 0	
1989	0	0	0	0	1	1	0	0	0	0	1	0		3
	000	000	000	000	010	010	000	000	000	000	100	000	1 2 0	
1990	0	0	0	1	1	0	0	0	0	0	1	1		4
	000	000	000	001	100	000	000	000	000	000	001	010	1 1 2	
1991	1	0	0	1	0	1	0	0	0	0	1	0		4
	010	000	000	100	000	010	000	000	000	000	100	000	1 3 0	
1992	0	0	0	0	1	2	1	0	1	3	3	2		13
	000	000	000	000	100	020	010	000	001	021	210	020	3 8 2	
1993	0	0	0	0	0	0	0	0	0	0	2	0		2
	000	000	000	000	000	000	000	000	000	000	200	000	2 0 0	
1994	0	0	1	1	0	1	0	0	0	1	1	0		5
	000	000	010	100	000	010	000	000	000	010	010	000	1 4 0	
1995	0	0	0	0	0	0	0	0	1	1	2	0		4
	000	000	000	000	000	000	000	000	010	010	200	000	2 2 0	
1996	0	0	0	0	1	3	0	0	0	2	2	0		8
	000	000	000	000	010	120	000	000	000	110	200	000	4 4 0	

Table 1-6 DISTRIBUTION OF NORTHERN INDIAN OCEAN TROPICAL CYCLONES FOR 1975 - 1999

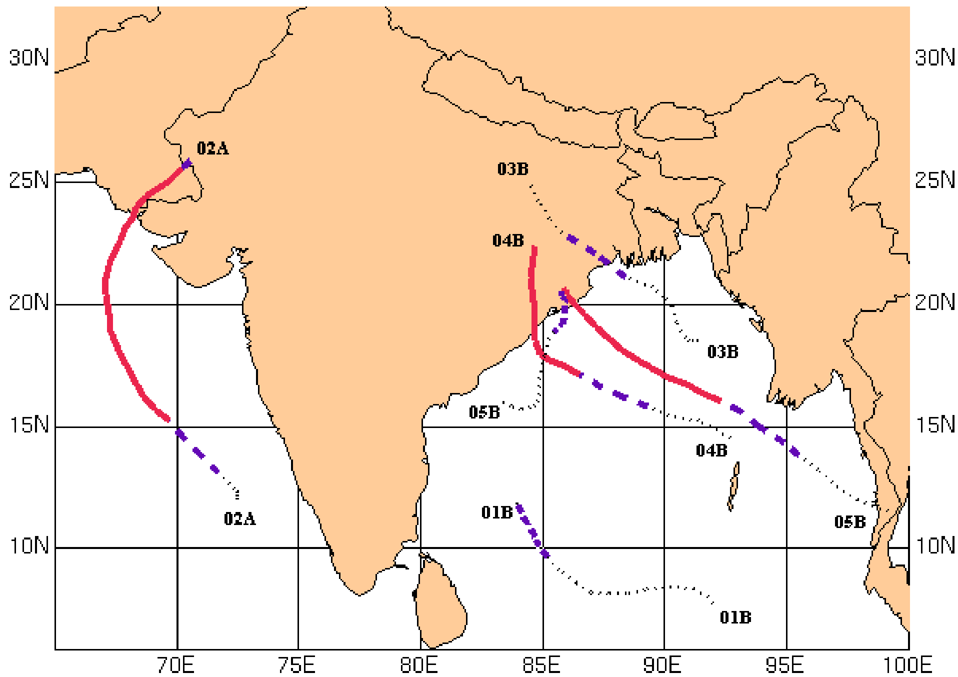
1997	0	0	0	0	1	0	0	0	1	1	1	0		4
	000	000	000	000	100	000	000	000	100	010	010	000	2 2 0	
1998	0	0	0	0	2	1	0	0	1	1	2	1		8
	000	000	000	000	110	100	000	000	010	010	200	100	5 3 0	
1999	0	1	0	0	1	1	0	0	0	2	0	0		5
	000	010	000	000	100	010	000	000	000	200	000	000	3 2 0	
(1975-1999)														
MEAN	0.1	0.1	0.1	0.2	0.6	0.6	0.1	0.1	0.3	1.0	1.3	0.5		5
													1.6 3.2 0.2	
CASES	3	2	1	4	15	14	1	1	8	26	32	13		126
													39 80 6	

The criteria used in TABLE 1-6 are as follows:

1) If a tropical cyclone was first warned on during the last two days of a particular month and continued into the next month for longer than two days, then that system was attributed to the second month.

2) If a tropical cyclone was warned on prior to the last two days of a month, it was attributed to the first month, regardless of how long the system lasted.

3) If a tropical cyclone began on the last day of the month and ended on the first day of the next month, that system was attributed to the first month. However, if a tropical cyclone began on the last day of the month and continued into the next month for only two days, then it was attributed to the second month.



ARABIAN SEA / BAY OF BENGAL
TROPICAL CYCLONES
02 FEB 99 - 01 NOV 99

TC 01	02 FEB - 04 FEB
TC 02	16 MAY - 21 MAY
TC 03	10 JUN - 11 JUN
TC 04	15 OCT - 18 OCT
TC 05	26 OCT - 01 NOV

MAXIMUM SUSTAINED SURFACE WIND

- 64KT (33M/SEC) OR GREATER
- 34 TO 63KT (18 TO 32M/SEC)
- 33KT (17M/SEC) OR LESS

Tropical Storm Hilda (01W)

Tropical Storm (TS) Hilda (01W) was the first tropical cyclone as well as the first named system in the 1999 season. This cyclone formed off the northwest coast of Borneo and reached a maximum intensity of 35 kt before dissipating over water in the South China Sea at 071200Z January. Six fatalities were attributed to the heavy rains of TS Hilda in Malaysia.

JTWC issued a Tropical Cyclone Formation Alert at 040230Z January on a broad circulation which extended off the northwest coast of Borneo into the South China Sea. The first warning was issued at 040900Z January as a 25 kt cyclone. Tropical Storm Hilda (01W) drifted slowly northward at 4 kt within the broad depression north of Borneo and reached tropical storm intensity at 061800Z January. Soon after reaching its maximum intensity of 35 knots, TS Hilda (01W) drifted into an area of increased vertical wind shear and dissipated over water. JTWC issued the 12th and final warning at 070300Z January.

The Country report of Malaysia from the 32nd Session ESCAP/WMO Typhoon Committee 1999 stated "..Hilda brought heavy rain to Sabah state causing severe flooding and landslide occurrences leading to six deaths."

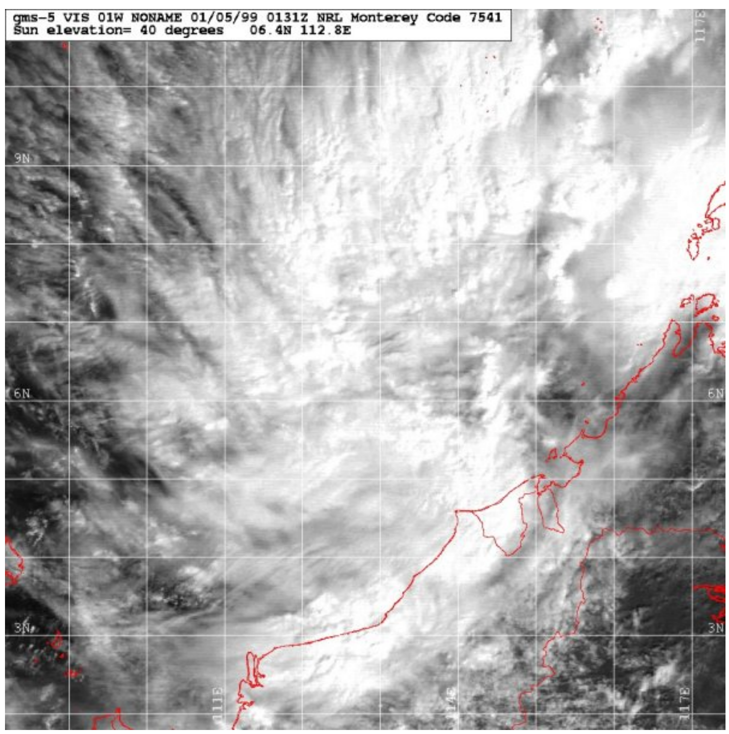
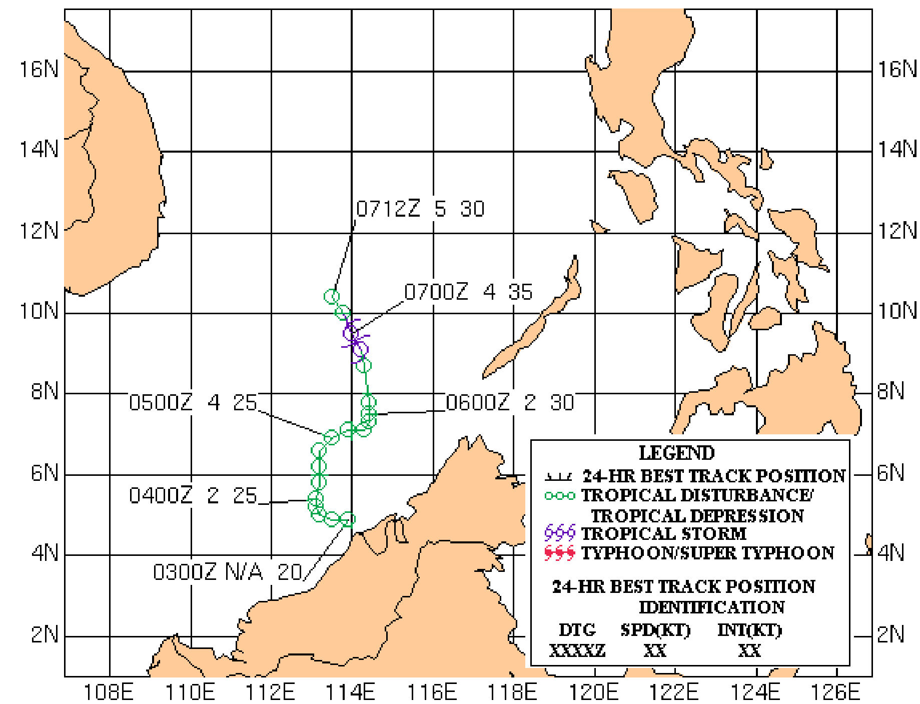


Figure 1-01-1. A visible satellite image showing TD 01W embedded in a large area of convection off the northwest coast of Borneo.

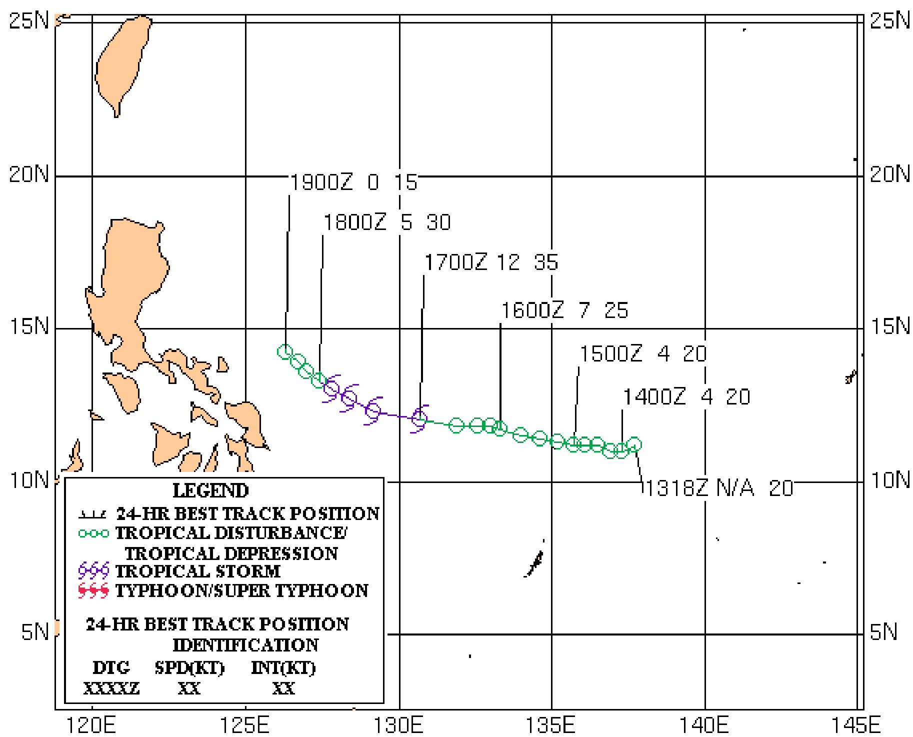


16N
14N
12N
10N
8N
6N
4N
2N
108E
110E
112E
114E
116E
118E
120E
122E
124E
126E
0712Z 5 30
0700Z 4 35
0600Z 2 30
0500Z 4 25
0400Z 2 25
0300Z N/A 20
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG
SPD(KT)
INT(KT)
XXXXZ
XX
XX

Tropical Storm Iris (02W)

Tropical Storm (TS) Iris (02W) formed in mid-February from a monsoon depression in the Philippine Sea. TS Iris reached a peak intensity of 35 kt as it tracked westward toward the Philippine Islands and dissipated after 6 days in the Philippine Sea.

A TCFA was issued on the monsoon depression approximately 400 nm west-southwest of Guam, at 132330Z February. The depression was slow to consolidate and JTWC issued two subsequent TCFA's (142330Z and 152330Z) before issuing the first tropical cyclone warning on TD 02W on 160000Z February. TD 02W tracked westward toward the Philippines until 170000Z February when it reached tropical storm strength. TS Iris then moved more northwestward in response to the subtropical ridge to the east. TS Iris attained a maximum intensity of 35 kt and then began to weaken over water, due to strong vertical wind shear. JTWC issued the 13th and final warning on TS Iris at 181800Z February as the cyclone dissipated 120 nm east of the Philippine Islands.



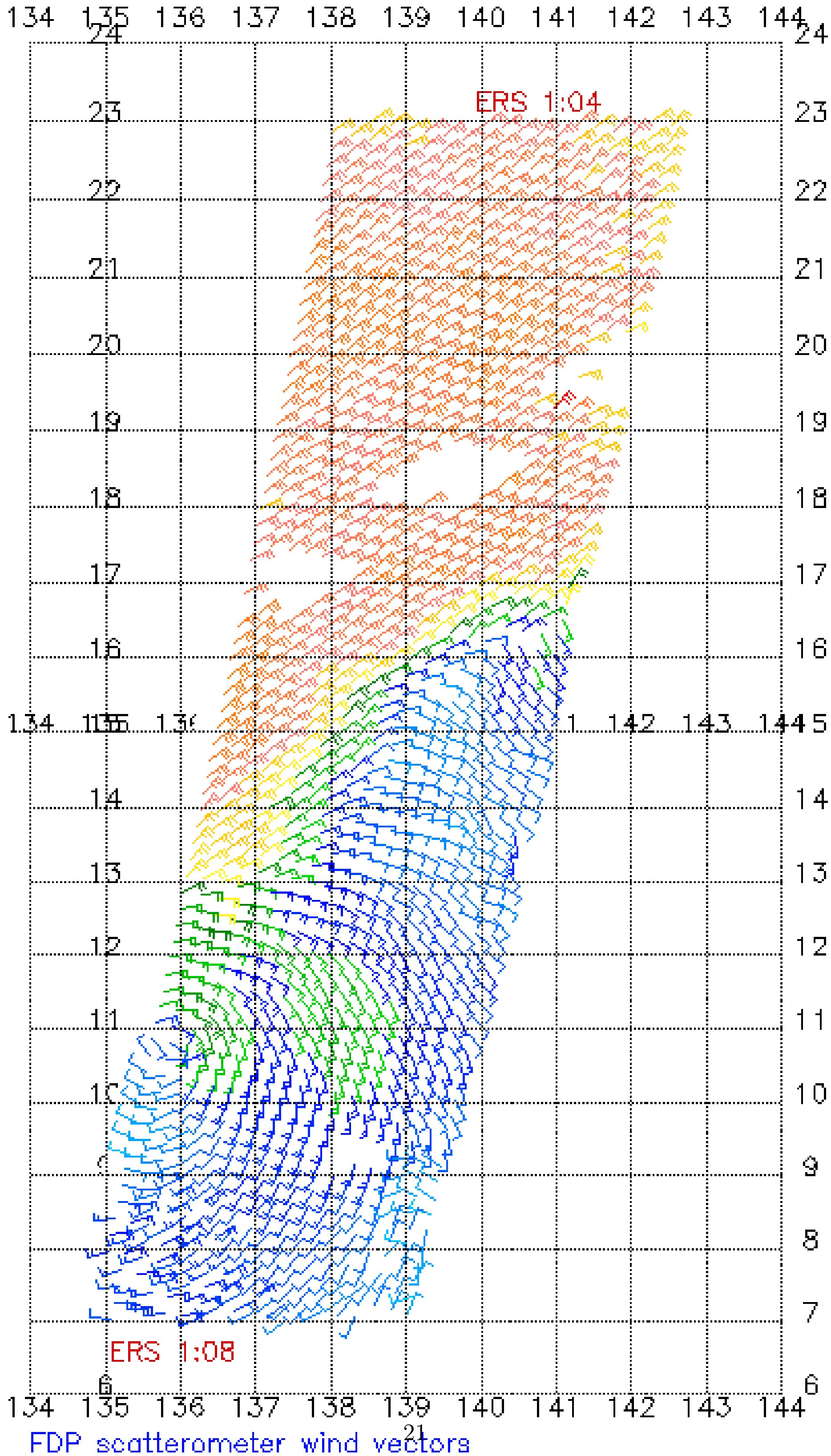


Figure 1-02-1. ERS-2 Scatterometer pass over Tropical Depression 02W which later developed into TS Iris. The low level circulation center seems to be enhanced due to horizontal wind shear from the strong northeasterly monsoon.

Tropical Storm Jacob (03W)

Tropical Storm (TS) Jacob (03W) was the third tropical cyclone as well as the third named storm of the 1999 season. This cyclone formed 120 nm west of Yap and reached a maximum intensity of 35 kt before making landfall on the southeast corner of Luzon, near Virac, Province of Cataduanes, at 091800Z April.

JTWC issued a Tropical Cyclone Formation Alert at 060330Z April on a low pressure area which displayed distinct cloud lines moving into a broad center (see Figure 1-03-1). The first warning for TD 03W was issued at 060900Z April as a 25 kt cyclone. Tropical Storm Jacob initially moved northward and then westward under the steering influence of a subtropical ridge located to its north.

As the cyclone slowly intensified to a 30 knot system, it began to accelerate as it reached its maximum intensity of 35 knots at 081800Z April. As TS Jacob reached its maximum intensity it began to enter a region of moderate to severe vertical wind shear. Subsequently, TS Jacob became a totally exposed low level circulation by 082330Z April (see Figure 1-03-2), and weakened before making landfall on the southeast coast of Luzon. JTWC issued the 16th and final warning at 100300Z April.

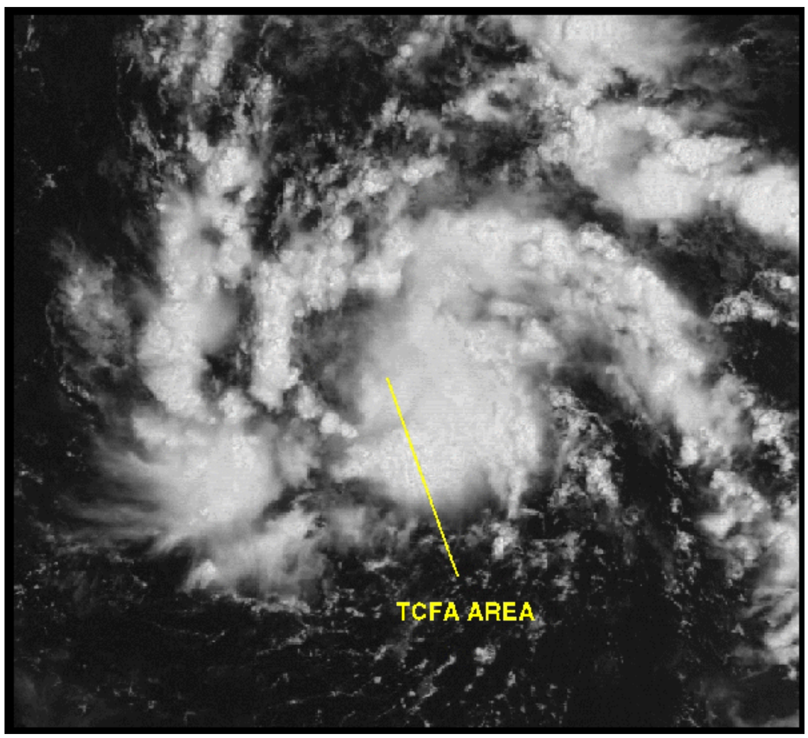


Figure 1-03-1. An infrared satellite image of the tropical disturbance which would become TS Jacob (03W).

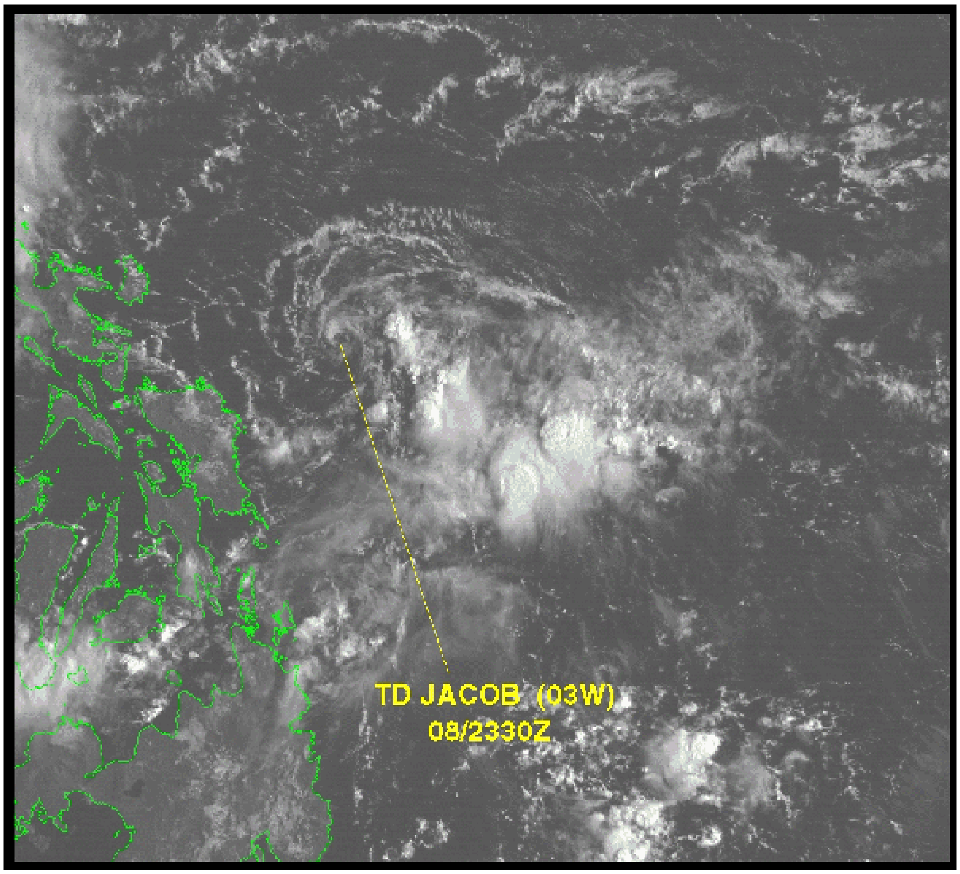
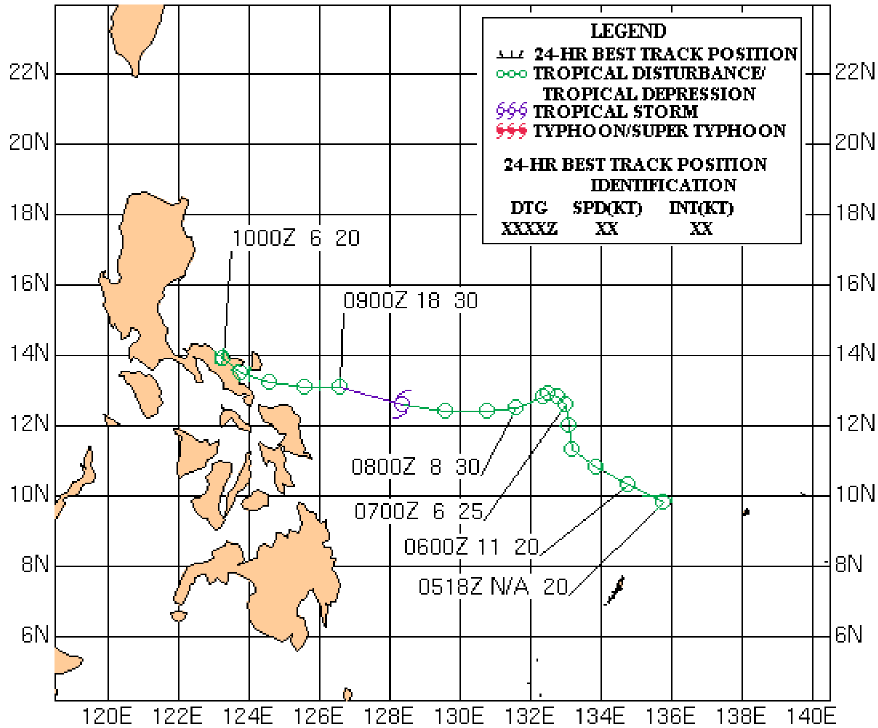


Figure 1-03-2. A visible satellite image of TD JACOB (03W) as it became a fully exposed low-level circulation just east of the Philippines.



LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
1000Z 6 20
0900Z 18 30
0800Z 8 30
0700Z 6 25
0600Z 11 20
0518Z N/A 20
22N
20N
18N
16N
14N
12N
10N
8N
6N
120E 122E 124E 126E 128E 130E 132E 134E 136E 138E 140E

Typhoon Kate (04W)

Typhoon Kate (04W) was the first 1999 cyclone to reach typhoon intensity. JTWC issued the first warning on this cyclone as a tropical depression while it was over Mindanao on 18 April. TY Kate initially moved northward then northeastward around the northern periphery of the subtropical ridge within the deep westerlies flow regime. TY Kate reached a max intensity of 75 kt and tracked 5 nm north of Iwo Jima, Japan. Observations from Iwo Jima included gusts to 68 kt. TY Kate later transitioned to an extratropical system well to the east of Honshu.

JTWC first mentioned the disturbance on the 180600Z April ABPW while it was in the Philippine Sea. As it drifted westward in the low-level flow it moved over Mindanao, Philippines on 20 April. Although it was over land, JTWC forecasters identified a slight intensification through synoptic data and satellite analysis. As such, JTWC issued a Tropical Cyclone Formation Alert at 210930Z April. The disturbance continued to slowly intensify and JTWC issued the first warning with a maximum intensity of 25 kt at 220300Z April, still over land.

During the first 24 hours, TD 04W tracked northward under the steering influence of the subtropical ridge to the east. On 230000Z April, the cyclone slowed and began to consolidate reaching tropical storm intensity. Initially the cyclone was forecast to intensify slightly and track north-northeastward and dissipate in a region of strong vertical windshear due to interaction with a mid-latitude frontal boundary. As it tracked further north and moved around the ridge axis it moved within the deep steering flow north of the ridge axis. As such, the vertical structure was all westerly flow and resultant windshear was minimal. The lack of windshear allowed TY Kate to continue to intensify as it remained embedded in the predominant westerly flow.

Visible imagery indicated TY Kate had developed an eye at 262330Z (Figure 1-04-1). Afterwards, a Tropical Rainfall Measurement Mission (TRMM) pass became available and indicated an eye was forming at 261800Z (Figure 1-04-2). A few hours later, a 262200Z Special Sensor Microwave/Imager (SSM/I) pass (Figure 1-04-3) indicated TY Kate had weakened, but still maintained a well defined eye. TY Kate tracked 5nm north of Iwo Jima, Japan on 271000Z Apr as a 70 kt system. Post analysis established peak intensity (75 kt) at 261800Z April as it continued to accelerate northeastward. TY Kate continued to accelerate east-northeastward and weaken (Figure 1-04-4) losing most of its convection by 271700Z (Figure 1-04-5/6). JTWC issued the 27th and final warning at 281500Z April as it become an extratropical system (Figure 1-04-7).

Observations from Iwo Jima included peak 10 minute sustained winds of 40 kt (50 kt 1 minute average) with 68 kt gusts. TY Kate was a 70 kt system as it tracked about 5 nm north of Iwo Jima. No damage reports were available.

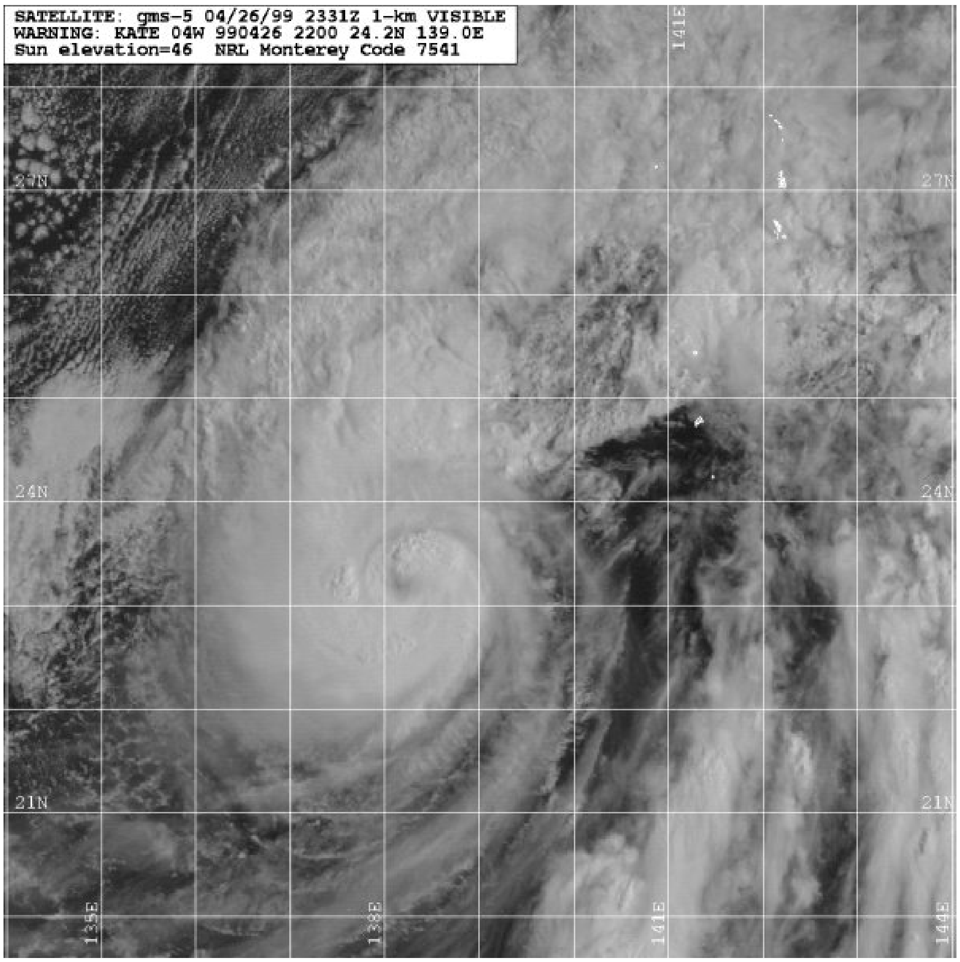


Figure 1-04-1. 262330Z April GMS-5 visible image of TY Kate. TY Kate was at it's max intensity (75 kt).

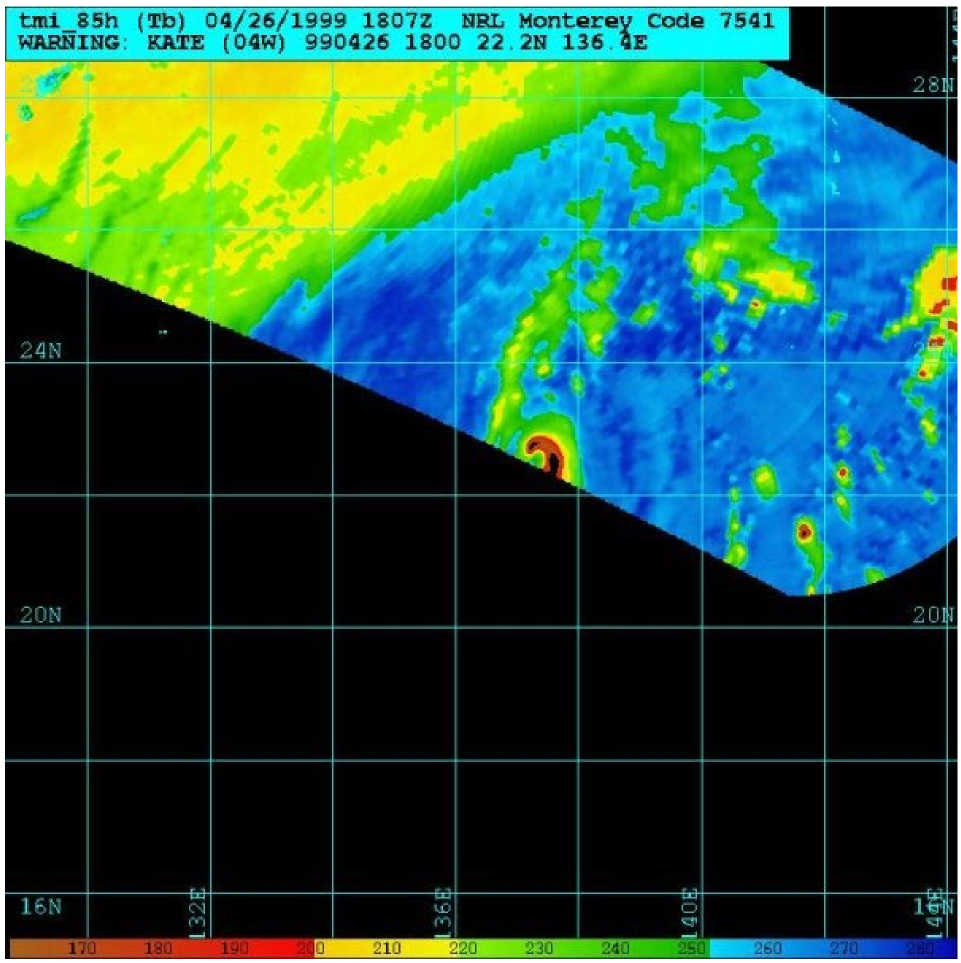


Figure 1-04-2. 261807Z April Tropical Rainfall Measurement Mission (TRMM) pass shows a very distinct spiral band and possible eyewall. TY Kate was at it's max intensity (75 kt).

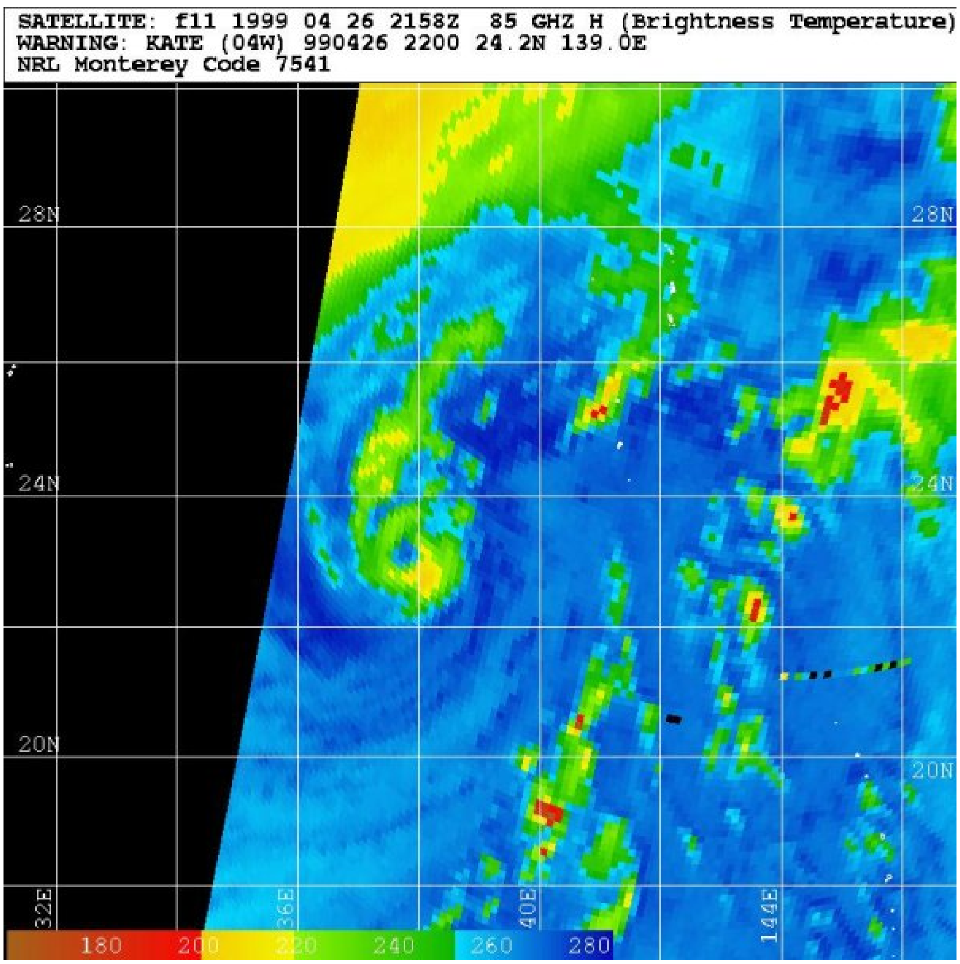


Figure 1-04-3. 262200Z April Special Sensor Microwave/Imager (SSM/I) pass reveals a distinct eye with max convection in the southeast quadrant.

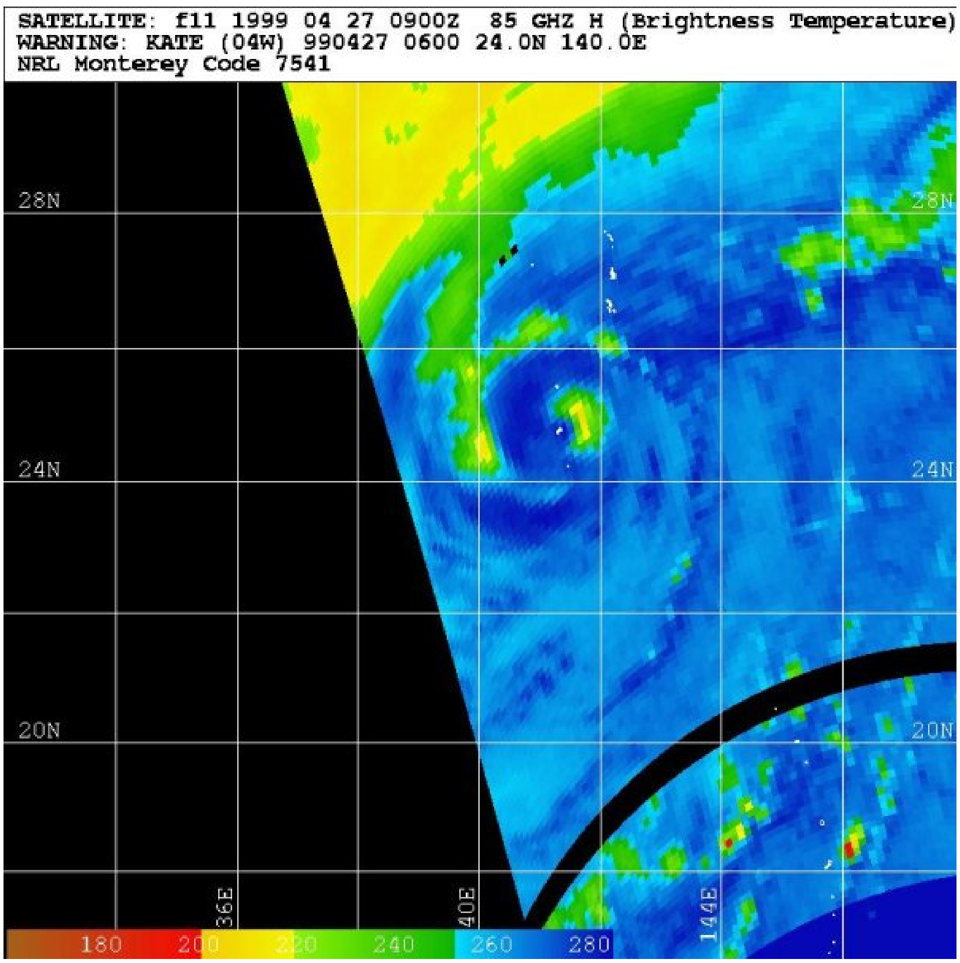


Figure 1-04-4. 270900Z April SSM/I pass shows convection now limited to the east side.

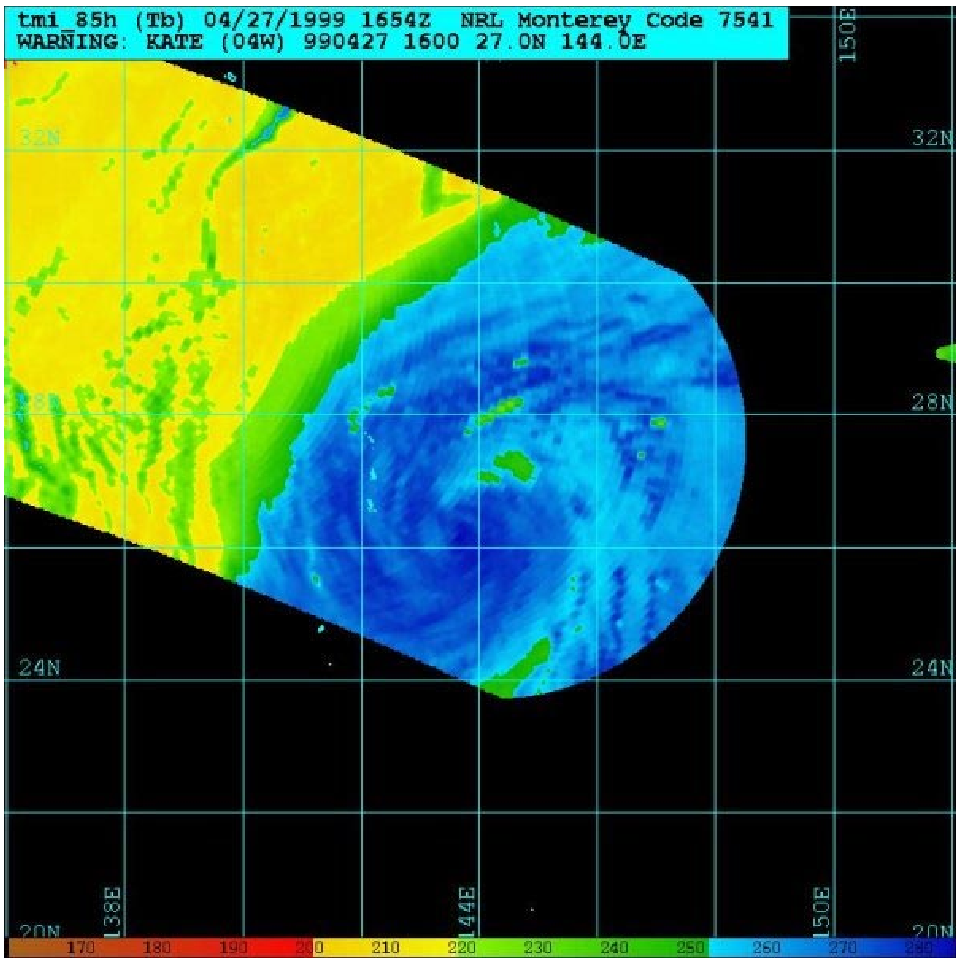


Figure 1-04-5. 271654Z April TRMM pass indicates deep convection has dissipated.

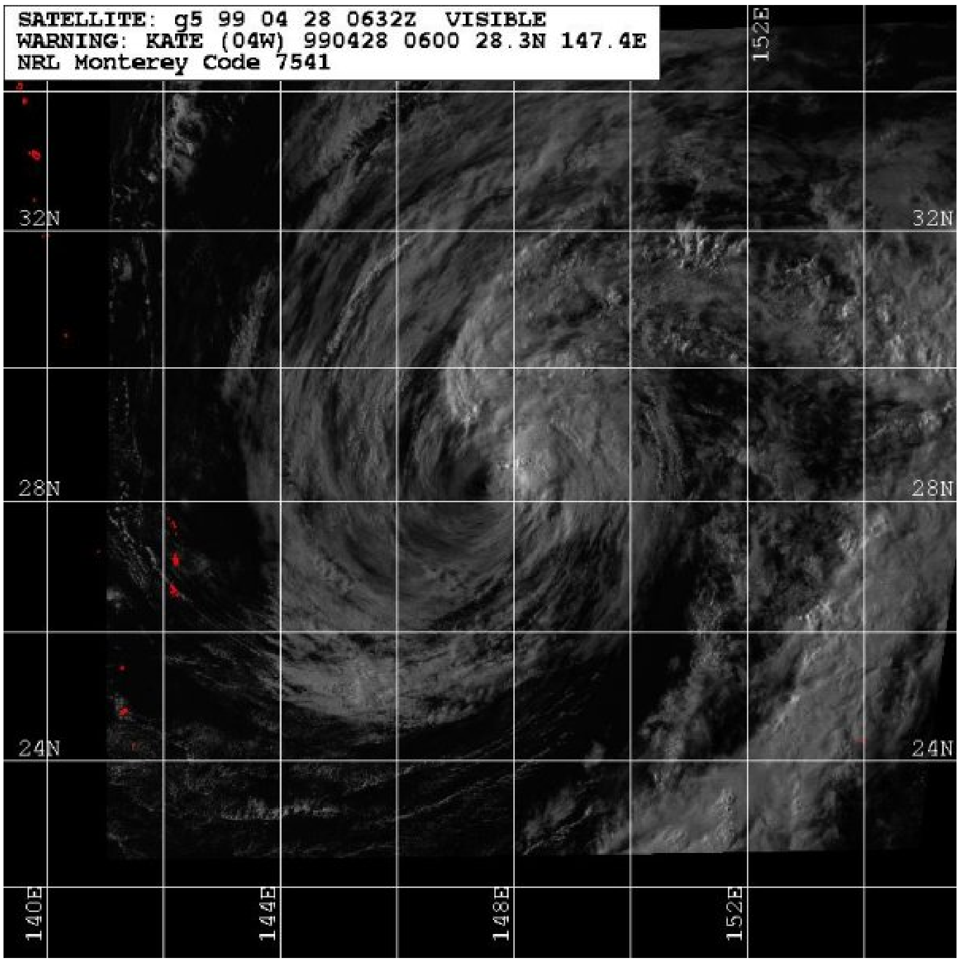


Figure 1-04-6. 280632Z April GMS-5 visible image indicates the system is elongating and transitioning to an extratropical system.

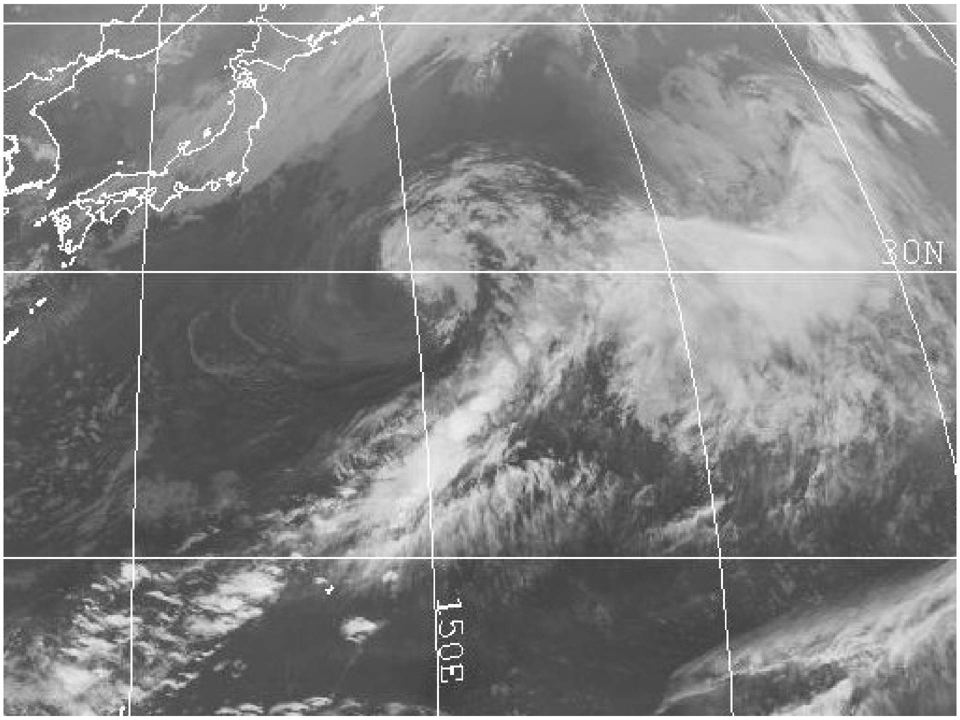
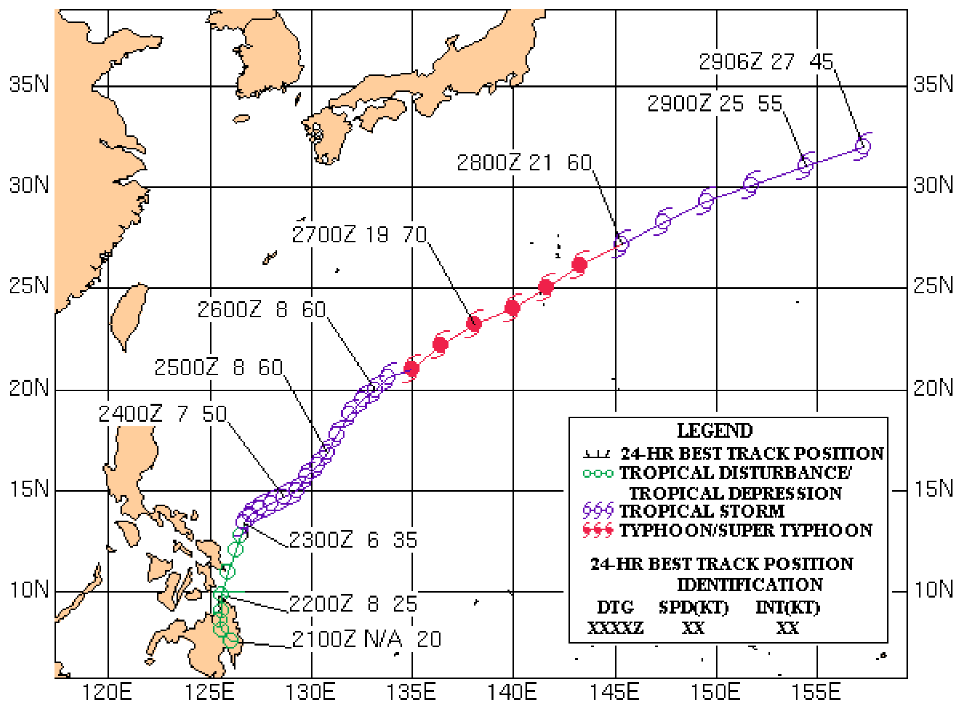


Figure 1-04-7. 281130Z April GMS-5 infrared image as TS Kate transitions to an extratropical system.


2906Z 27 45
2900Z 25 55
2800Z 21 60
2700Z 19 70
2600Z 8 60
2500Z 8 60
2400Z 7 50
2300Z 6 35
2200Z 8 25
2100Z N/A 20
35N
30N
25N
20N
15N
10N
120E
125E
130E
135E
140E
145E
150E
155E
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX

Typhoon Leo (05W)

Typhoon (TY) Leo (05W) developed off the coast of Vietnam and became the first tropical cyclone to threaten Hong Kong during the 1999 season. TY Leo (05W) peaked at 110 kt before weakening and making landfall with minimal effects on Hong Kong.

Typhoon Leo (05W) formed slowly in the South China Sea in late April. The cyclone formed within a broad monsoon depression off the coast of Vietnam partially due to enhanced southwesterly flow into the South China Sea caused by Typhoon Kate (04W) located in the Philippine Sea. Noting the increased winds and cyclonic shear in the area, JTWC added the disturbance which would become TY Leo to the Significant Tropical Weather Advisory (ABPW) at 251300Z April.

Within 24 hours, a broad circulation began to form and JTWC issued a Tropical Cyclone Formation Alert at 261030Z April. At 270300Z April, 25 kt winds were reported on the periphery of a very broad circulation and JTWC issued the first warning. As is the case with most monsoon depressions, the higher winds remained on the periphery of the broad circulation for several days. Since the winds near the center of the circulation were very light, locating the center was very difficult resulting in several relocations.

By 280600Z April, TD 05W intensified while moving westward and was upgraded to Tropical Storm Leo (05W). However, at 281800Z April, it became evident that the low-level circulation was moving in a cyclonic loop off the coast of Vietnam and the convection which was previously headed westward toward Vietnam was now moving northeast and consolidating. As the convection consolidated around a well-defined low-level circulation center, TS Leo began to rapidly intensify and attained typhoon intensity at 291800Z April.

Typhoon Leo (05W) formed directly below a relatively narrow 200 mb ridge. The ridge reduced the vertical wind shear affecting the cyclone, but the narrow nature of the ridge allowed for very good outflow north of the cyclone. Hence, TY Leo intensified quickly as it tracked northeastward at around 6 kt and reached a maximum intensity of 110 kt by 301800Z April. Although the thin ridge helped the rapid intensification, it also caused a rapid weakening of TY Leo. After TY Leo peaked, it moved north of the 200 mb ridge and quickly entered a high vertical shear environment. The low-level flow took TY Leo westward while the 500 mb and higher level flow pushed the cyclone to the northeast. Subsequently, the cyclone began to shear apart and weaken rapidly while moving to the north.

During the 36 hours prior to landfall, the low-level circulation became totally disconnected from the deep convection and tracked more northwestward and then north as it made landfall. TY Leo struck about 35 nm east of Hong Kong as a 30 kt system with minimal impact on the Hong Kong area. JTWC issued the 24th and final warning on 022100Z May.

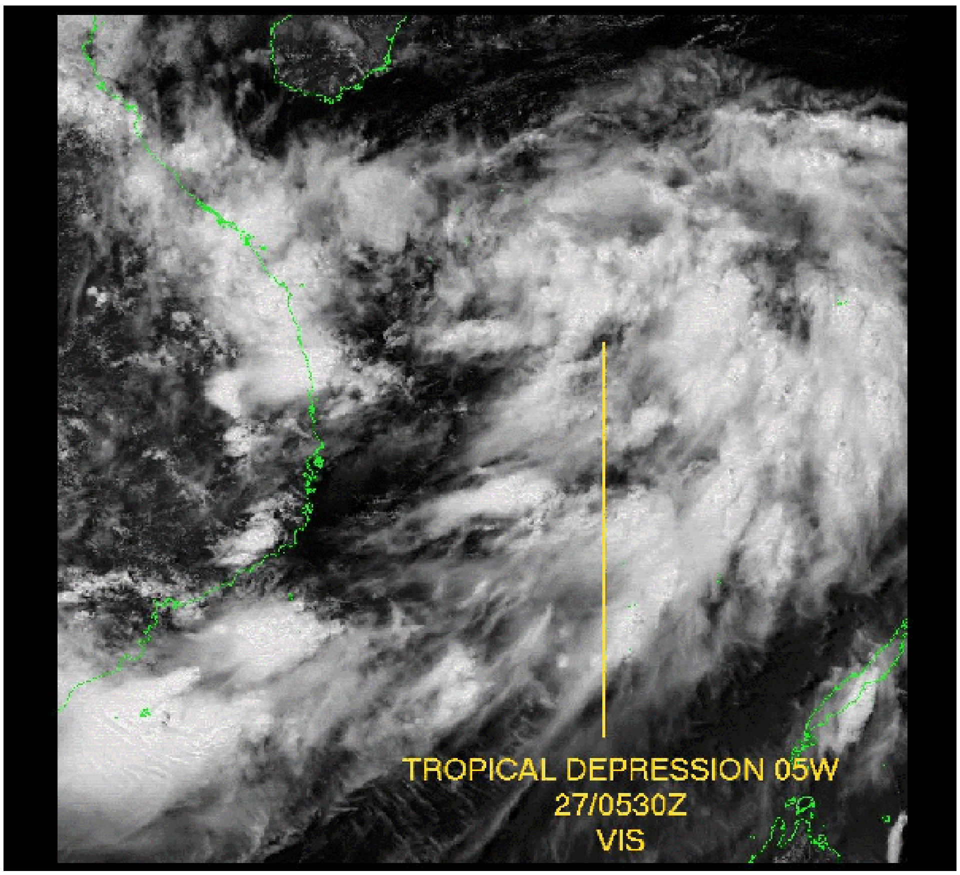


Figure 1-05-1. A visual image of TD 05W (25kt) at 270530Z April, off the east coast of Vietnam.

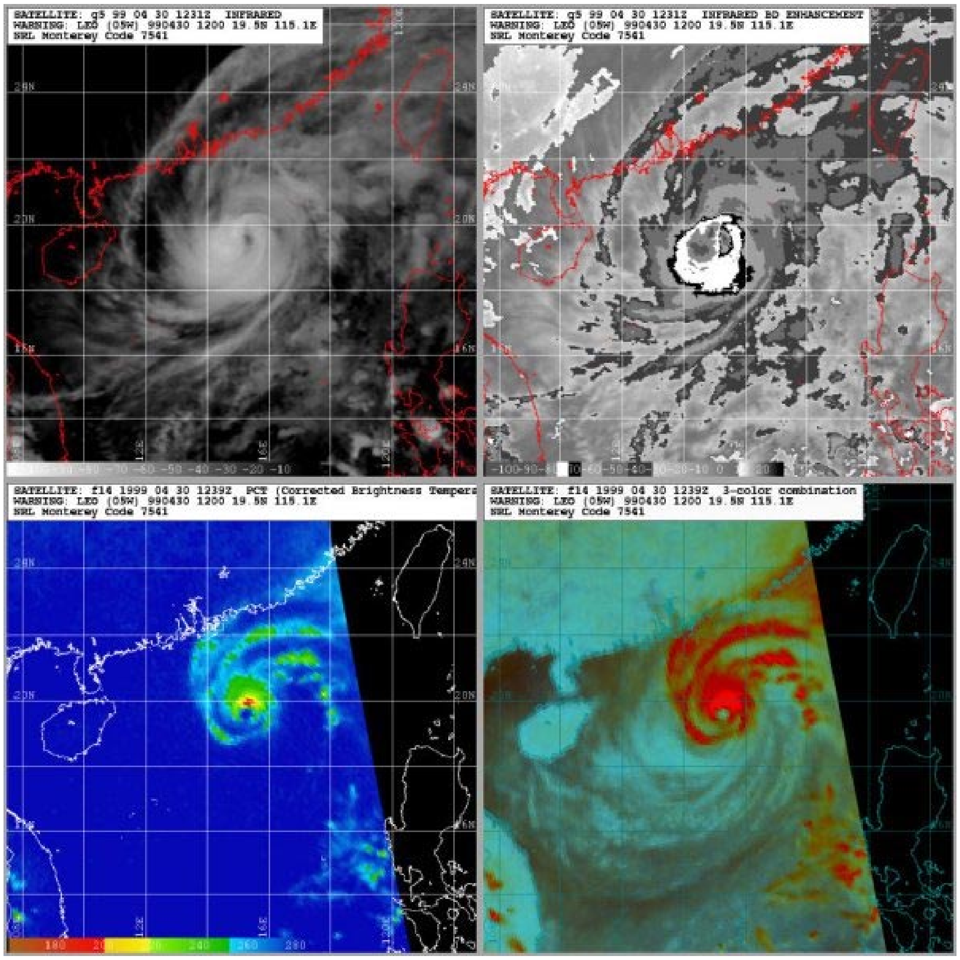
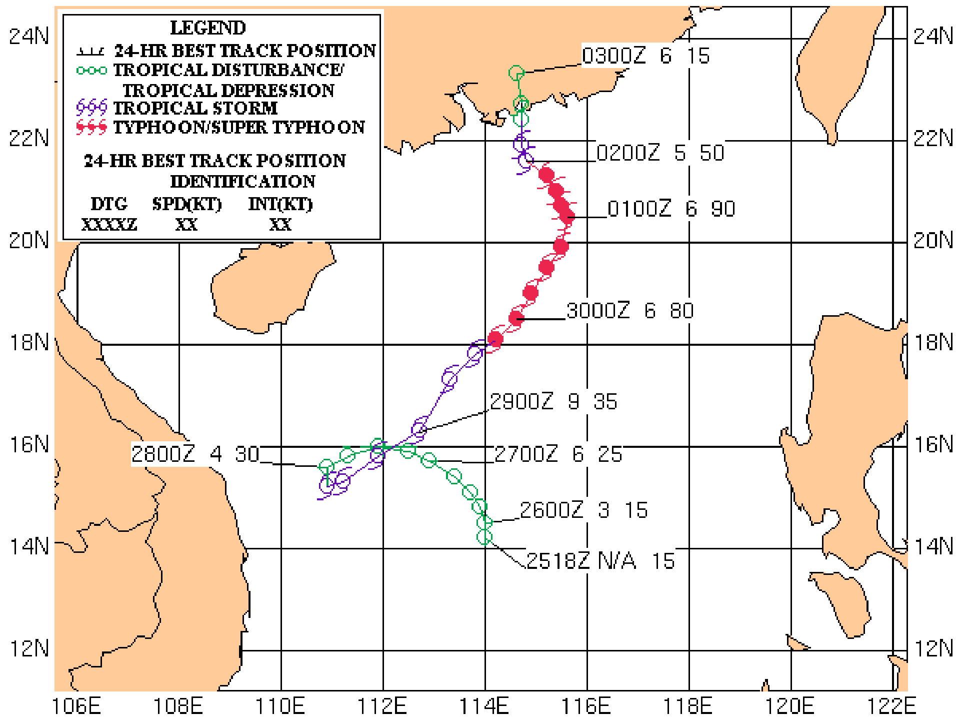


Figure 1-05-2. A 301239Z April multi-image mosaic from NRL including infrared imagery (top left and right) and Special Sensor Microwave Imagery (SSM/I) of Typhoon Leo (05W) at 105 kt intensity, 140 nm south of Hong Kong. TY Leo (05W) peaked six hours later at 110 kt.



LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
0300Z 6 15
0200Z 5 50
0100Z 6 90
3000Z 6 80
2900Z 9 35
2800Z 4 30
2700Z 6 25
2600Z 3 15
2518Z N/A 15
24N
22N
20N
18N
16N
14N
12N
106E
108E
110E
112E
114E
116E
118E
120E
122E

Typhoon Maggie (06W)

Typhoon (TY) Maggie (06W) formed east of the Philippines in the monsoon trough on the first day of June. Typhoon Maggie tracked toward the Philippines attaining a peak intensity of 105 kt east of Iligan Point, Luzon, Philippines. TY Maggie made landfall in southeastern China, approximately 55 nm east-northeast of Hong Kong and skirted along the coast before turning inland and dissipating on 08 June. TY Maggie (06W) left a trail of damage and fatalities from the Philippines to China.

TY Maggie (06W) developed in the monsoon trough extending from Southeast Asia into the Philippine Sea and genesis was aided by strong, moist cross-equatorial inflow. As satellite analysis indicated an increase in the organization of thunderstorms in the area, JTWC issued a TCFA at 010100Z June. As the cyclone continued moving slowly northward, JTWC issued the first tropical cyclone warning at 25 kt intensity eight hours later. This cyclone intensified at a faster-than-climatological rate, achieving tropical storm intensity at 020000Z and typhoon intensity later the same day at 021800Z. At 030032Z the first satellite position and intensity estimate report was received indicating a possible banding eye forming in the deep convection surrounding the system center.

As TY Maggie (06W) intensified, the subtropical ridge to the north became the dominant steering influence, adding a westward component to its previous northward track. TY Maggie peaked in intensity on 050000Z June at 105 knots before entering the Luzon Strait. From 051800Z through 060000Z TY Maggie tracked to the northwest, due to a combination of the increased steering provided by the subtropical ridge and the influence of Taiwan's terrain. Subsequently, the subtropical ridge steered TY Maggie westward toward the coast of southeastern China, approximately 55 nm east-northeast of Hong Kong, where it made landfall at 061200Z June as an 80 kt typhoon. TY Maggie spent its final 24 hours as a significant tropical cyclone moving along the coast of southern China and into the mouth of the Pearl River passing 5 km northwest of the Hong Kong Observatory at around 0400 local, producing winds near 50 kt at Hong Kong.

JTWC issued the 24th and final warning at 070300Z June as TY Maggie weakened and was forecast to turn inland and dissipate. Damage estimates from the system included 3 fatalities due to rain-induced landslides in the Philippines, 1 fatality and 5 missing in Taiwan, and $4.8 million dollars worth of agriculture damaged in southern China.

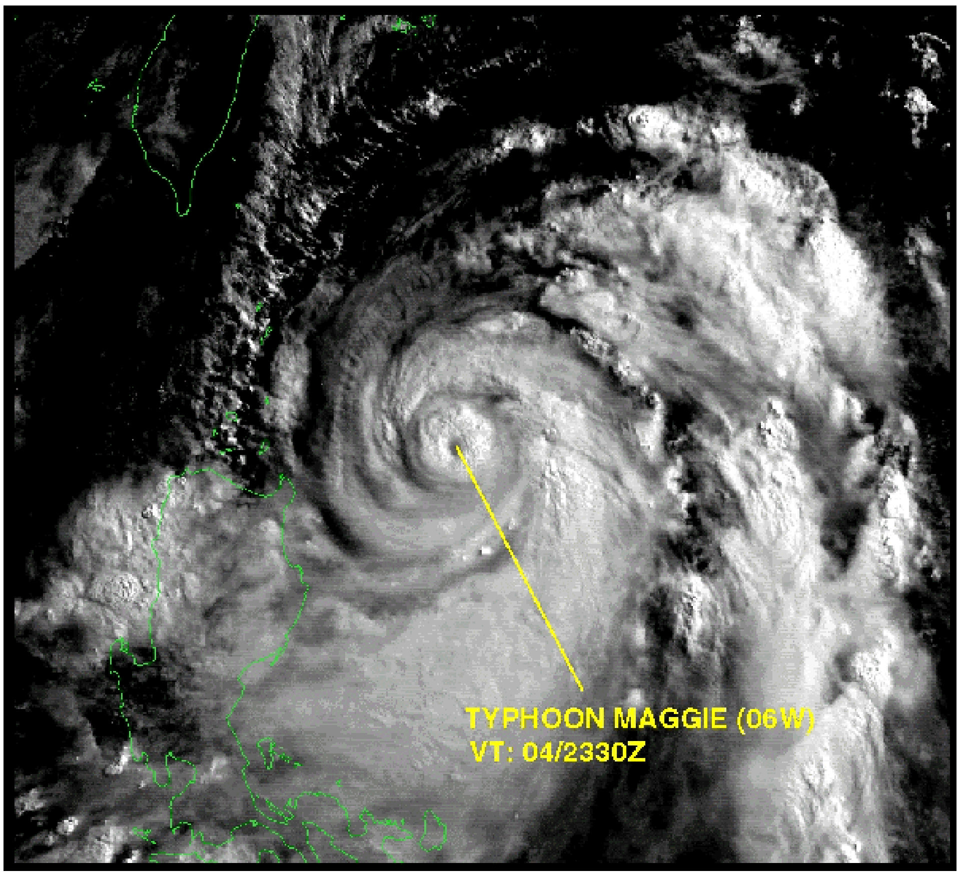


Figure 1-06-1. 042330Z June GMS-5 visible imagery of Typhoon Maggie (06W) prior to achieving its peak intensity (105 kt) northeast of Luzon; note the strong southeasterly cross-equatorial inflow.

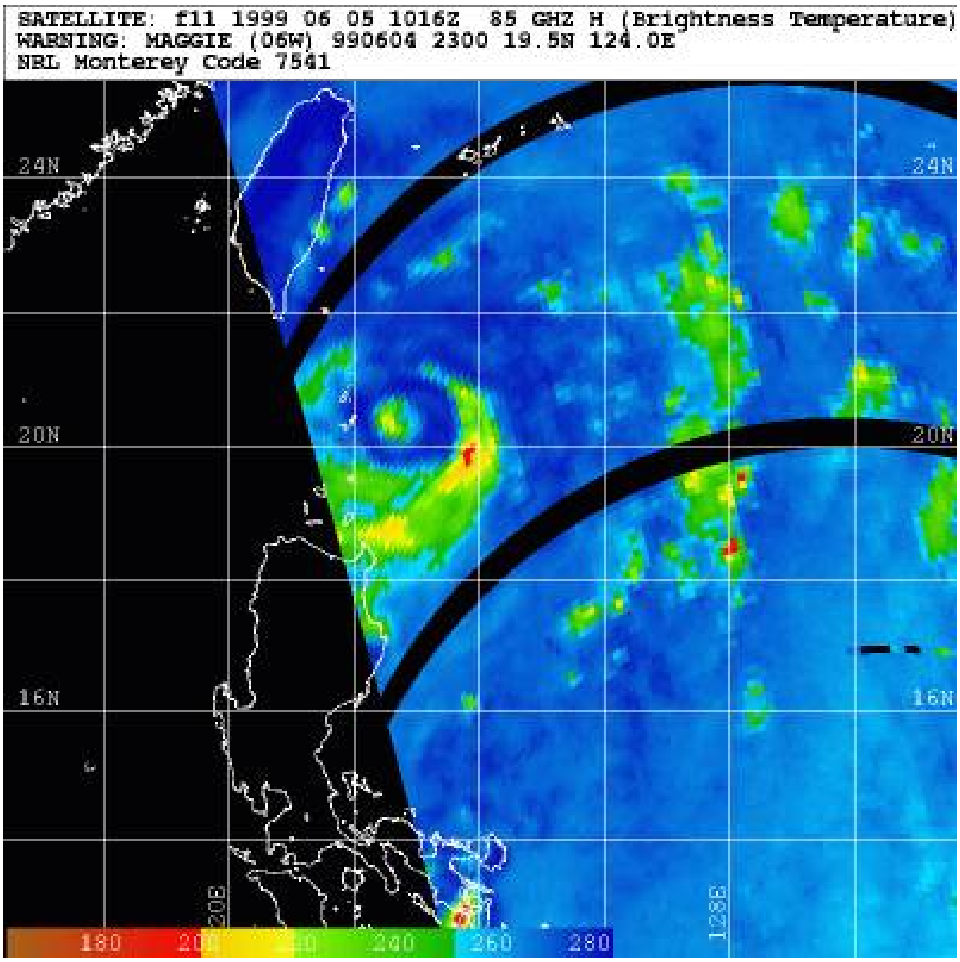
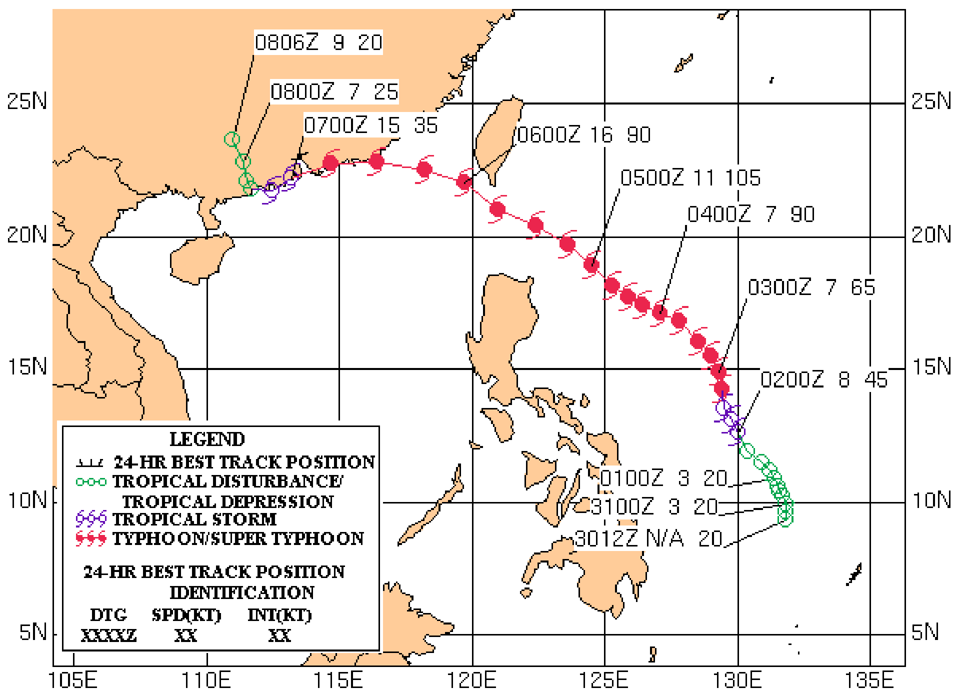


Figure 1-06-2. The convective structure of Typhoon Maggie (06W) is revealed in this 85Ghz Special Sensor Microwave/Imagery pass near its peak intensity (105 kts) on 051016Z June.


0806Z 9 20
0800Z 7 25
0700Z 15 35
0600Z 16 90
0500Z 11 105
0400Z 7 90
0300Z 7 65
0200Z 8 45
0100Z 3 20
3100Z 3 20
3012Z N/A 20
25N
20N
15N
10N
5N
105E
110E
115E
120E
125E
130E
135E
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX

Tropical Depression 07W

Tropical Depression (TD) 07W developed northeast of Guam in mid July. This weak tropical cyclone initially tracked southwestward before turning northwestward toward Japan. The cyclone reached a peak intensity of 30 kt before turning northward and dissipating over water southeast of Honshu.

JTWC first mentioned TD 07W as a suspect area on a 131600Z July Significant Tropical Weather Advisory (ABPW). At 142030Z July, a Tropical Cyclone Formation Alert was issued as the disturbance had gained some strength and organization. The first JTWC warning on TD 07W was issued at 150300Z July for a 25 kt system.

TD 07W formed within a moderate vertical wind shear environment with the subtropical ridge to the east, which would become the primary steering influence. TD 07W intensified to 30 kt 12 hours after the first warning and maintained that intensity for two days. Increased vertical windshear completely exposed the low-level circulation center by 152330Z July, and subsequently TD 07W began to weaken. JTWC issued the 14th and final warning at 180900Z July as the system dissipated southeast of Honshu.

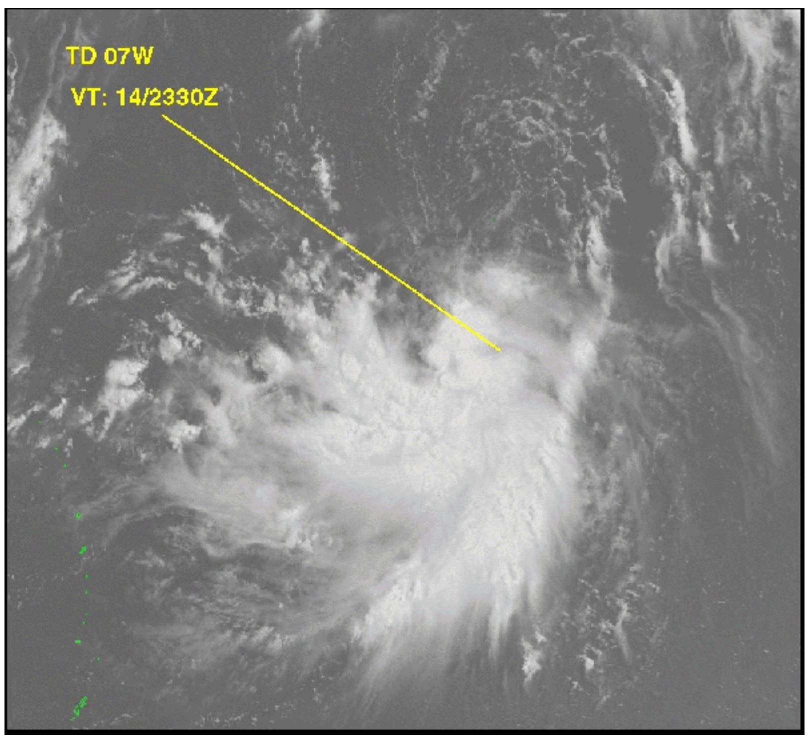


Figure 1-07-1. 142330Z July visible satellite image of TD 07W as it reached warning criteria of 25 kt.

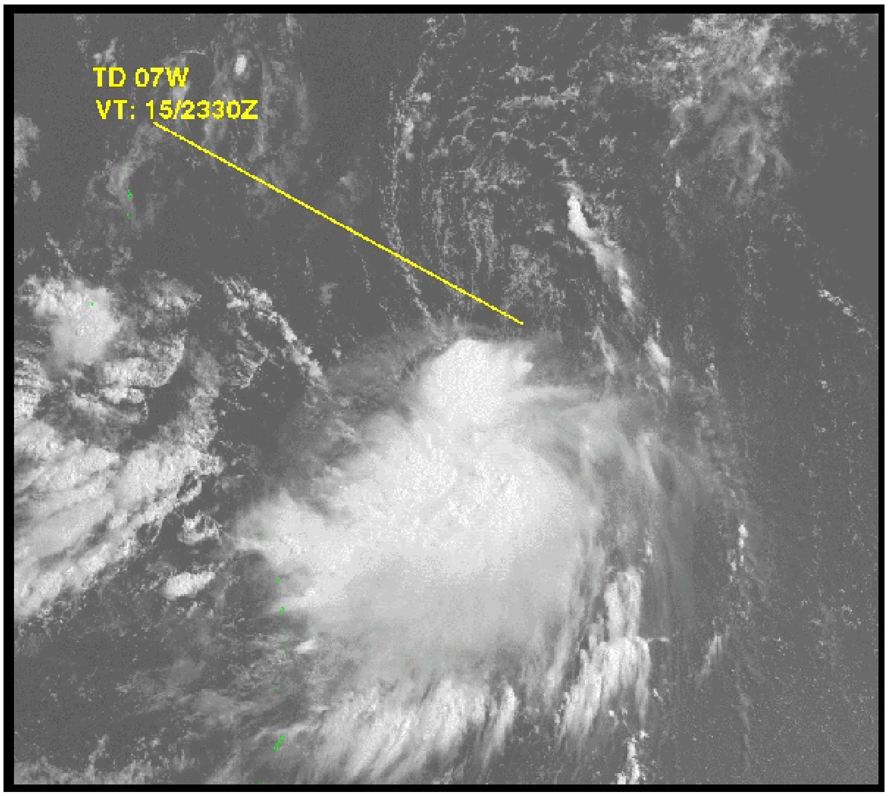
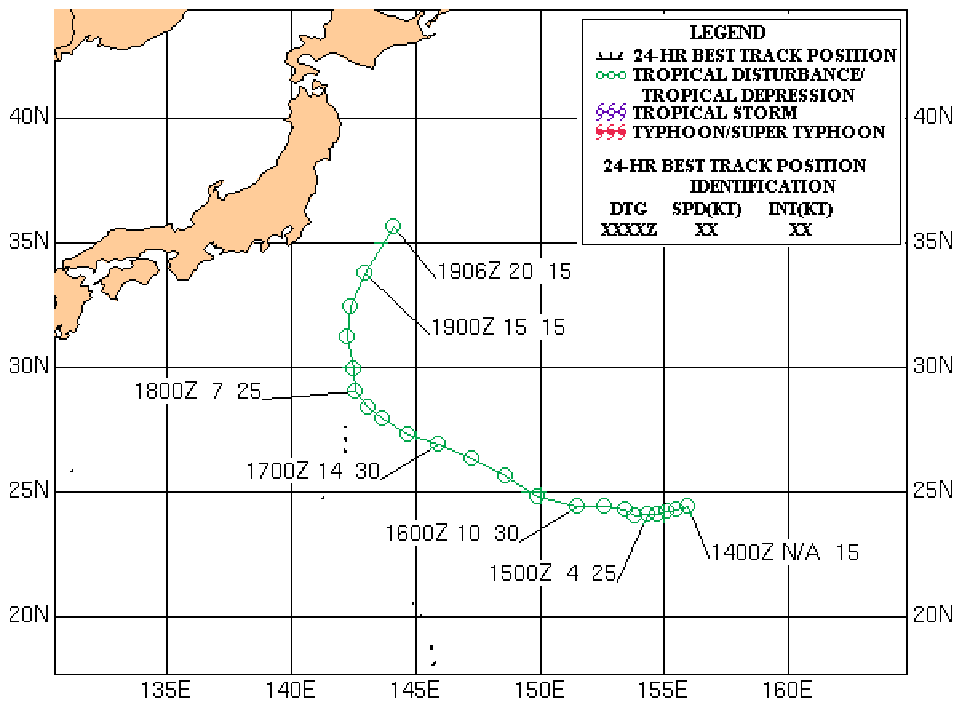


Figure 1-07-2. 152330Z July visible satellite image of TD 07W after vertical wind shear fully exposed the low-level circulation center. Current intensity was 25 kt.


LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
1906Z 20 15
1900Z 15 15
1800Z 7 25
1700Z 14 30
1600Z 10 30
1500Z 4 25
1400Z N/A 15
40N
35N
30N
25N
20N
135E
140E
145E
150E
155E
160E

Tropical Depression 08W

Tropical Depression (TD) 08W developed northeast of Okinawa in mid July and tracked northward into the East China Sea before turning northwestward toward Korea. The cyclone attained a peak intensity of 30 kt before making landfall near Changhung, South Korea at 220900Z July.

JTWC first mentioned TD 08W as a suspect area on the 170600Z July Significant Tropical Weather Advisory (ABPW). By 180730Z July, the suspect area had gained some strength and organization and a Tropical Cyclone Formation Alert (TCFA) was issued and then reissued 24 hours later. Decreased organization and weakening led to a TCFA cancellation by 191730Z July. However, by 210100Z July, the suspect area began reorganizing and a third TCFA was issued. JTWC commenced warning on TD 08W at 210900Z July.

TD 08W formed west of a low-level subtropical ridge, which steered the cyclone north into the East China Sea before recurving and moving northwestward toward the Korean Peninsula. TD 08W made landfall near Changhung, South Korea at 220900Z and began to weaken rapidly. TD 08W experienced extratropical transition within the mid-latitude westerlies over South Korea and subsequently moved into the Sea of Japan, where JTWC issued the sixth and final warning at 221500Z July.

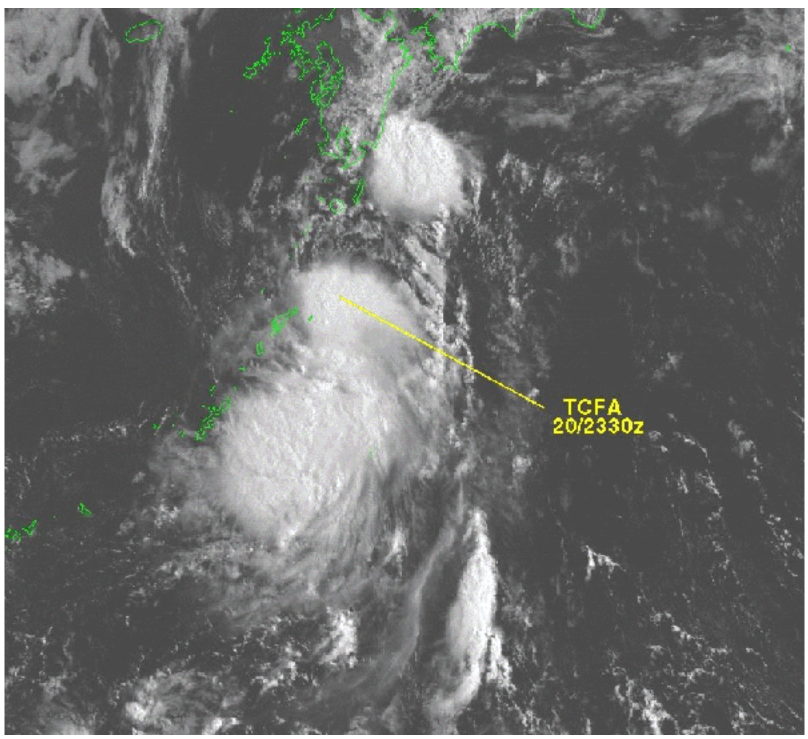


Figure 1-08-1. 202330Z July visible satellite image of the tropical disturbance that would become TD 08W.

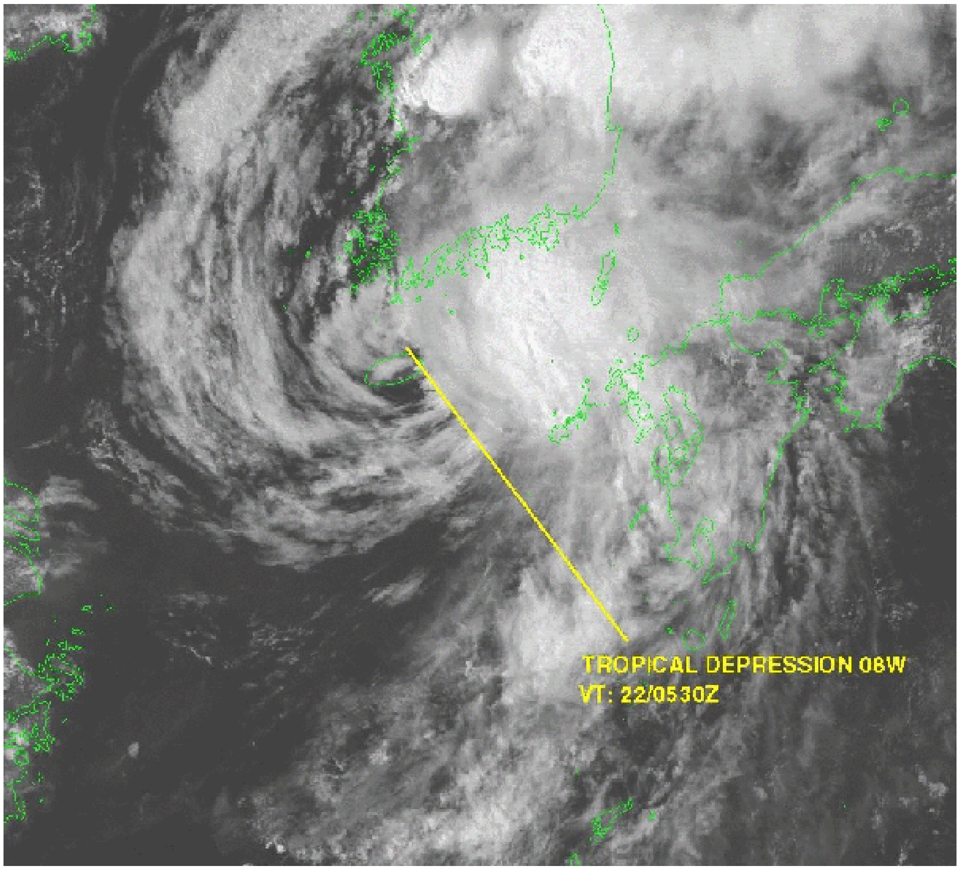
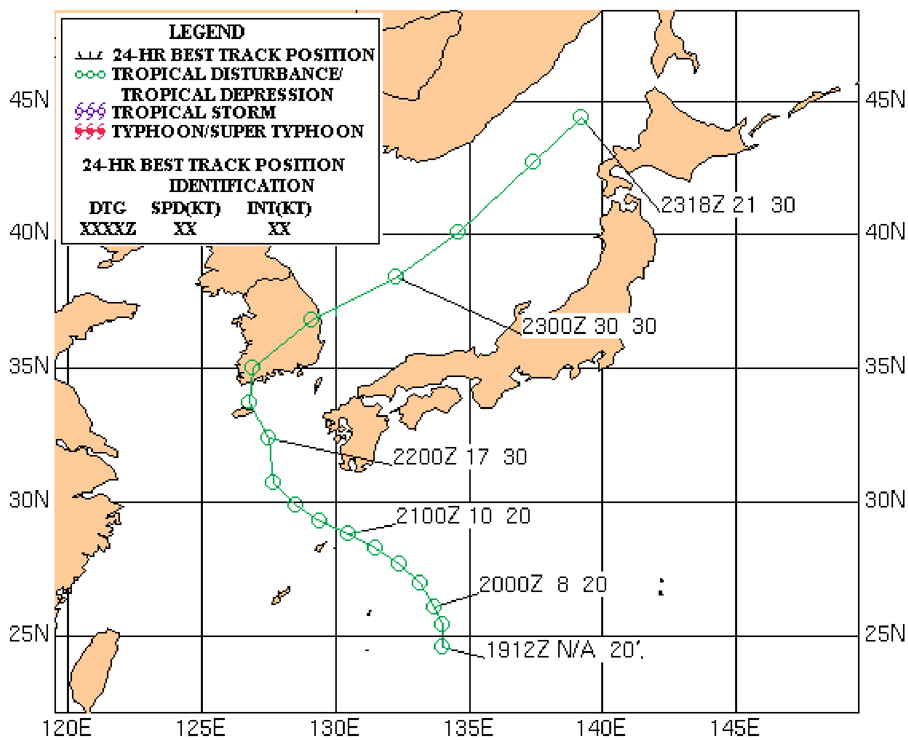


Figure 1-08-2. 220530Z July visible satellite image of TD 08W about 3 hours before making landfall near Changhung, South Korea. The image shows a partially exposed low-level circulation center with the deep convection sheared towards the east.



LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
2318Z 21 30
2300Z 30 30
2200Z 17 30
2100Z 10 20
2000Z 8 20
1912Z N/A 20
45N
40N
35N
30N
25N
120E
125E
130E
135E
140E
145E

Tropical Storm Neil (09W)

The disturbance that became Tropical Storm Neil (09W) began forming in the monsoon trough located in the Philippine Sea, just east of Luzon island, on 23 July. At the same time, within this very active monsoon trough, TD 10W was forming west of Luzon in the South China Sea. TS Neil tracked northeastward before turning more northward onto the Republic of Korea (ROK) on 27 July. TS Neil reached a peak intensity of 40 kt and made landfall in the ROK as a minimal tropical storm (35 kt). TS Neil was the second tropical cyclone to bring heavy rains to the ROK within a week. A Japanese news report stated a ferry was forced aground due to high winds, no injuries were reported.

JTWC first began tracking the tropical disturbance on 230000Z July and mentioned it on the 240600Z July ABPW. As the convection began consolidating, a TCFA was issued on 241730Z July and the first warning was issued on 250900Z July. For the first two days, TD 09W tracked northeastward within the monsoon trough. As it gained latitude and approached Okinawa, Japan, the cyclone turned more northward in response to the subtropical ridge to the east building westward. During the northward turn, TD 09W also intensified to tropical storm intensity.

TS Neil peaked at 40 kt on 26 July and as it approached the Japanese main islands, it took a slightly west of north path and moved inland over the southern Republic of Korea, 18 nm southwest of Suncheon at 270500Z as a minimum tropical storm (35 kt). TS Neil then continued to slowly weaken and move over the Yellow Sea before interacting with a mid-latitude trough. This interaction caused the cyclone to turn northeastward back over the northern portion of the ROK on 28 July, making landfall 20 nm southwest of Seoul at 280600Z as a 20 kt system.

JTWC issued the 13th and final warning at 280900Z July as TD 09W moved inland and dissipated over the Republic of Korea.

As TS Neil moved past the Japanese Island of Kyushu the Associated Press reported a ferry had run aground in Kannoura, Japan due to high winds from the storm. The US Forces Korea (USFK) Theater Forecast Unit received reports of gusts to 50 kt with 5 inches of rain on Cheju Island, ROK and southern areas of the ROK received 2-4 inches of rain with max gusts of 42 kt. The Korea Times, 28 July, reported 200mm of rainfall on Cheju Island on 27 July. They also reported a fishing boat capsized after colliding with another vessel in rough seas south of Wando Island. The crew of eight on the fishing boat perished. The JMA reported damage from floods and strong wind gusts.

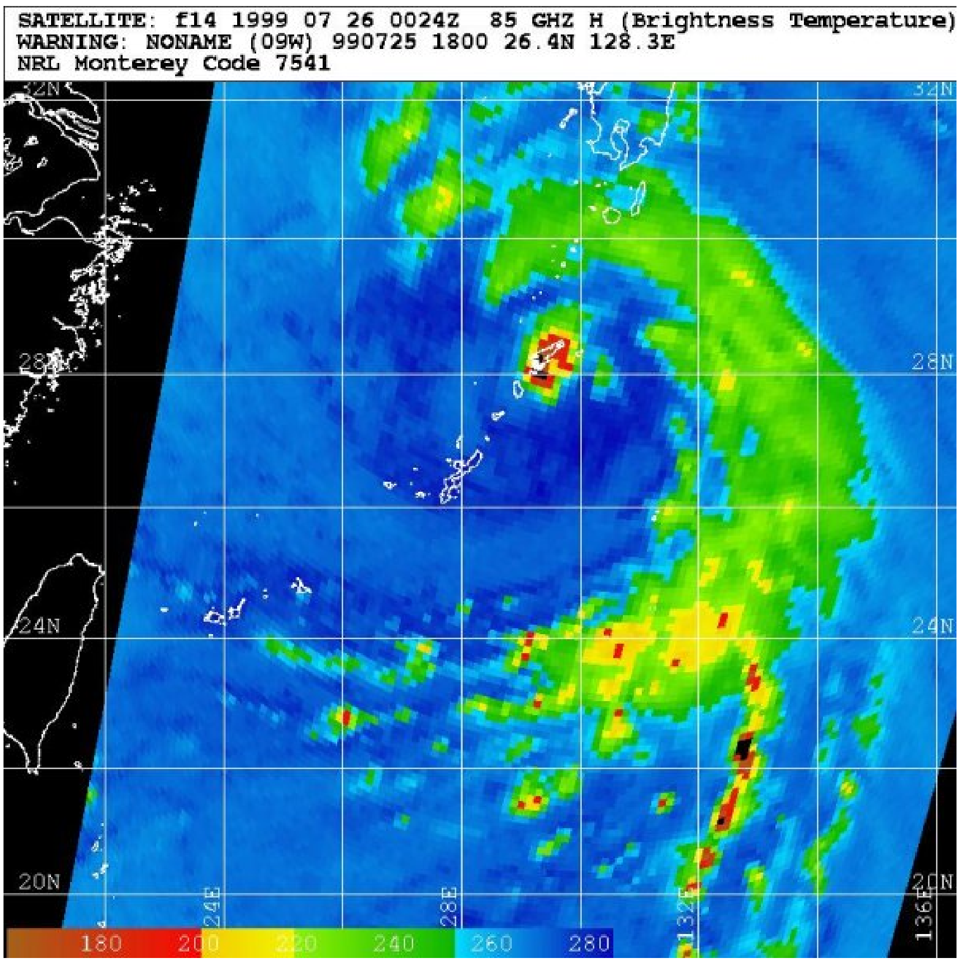


Figure 1-09-1. 260024Z July Special Sensor Microwave Imager (SSM/I) pass of TS Neil (09W). The center was located just west of Amamami O Shima, Japan. TS Neil was at 35 kt intensity and peaked at 40 kt six hours later.

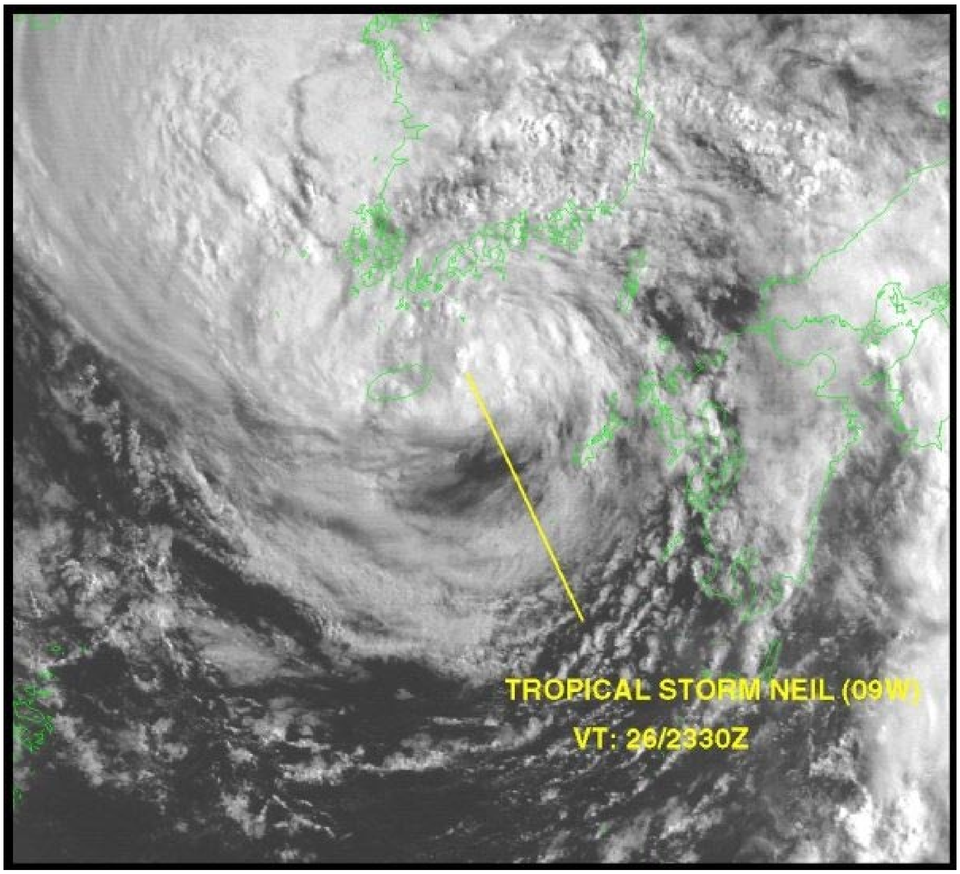


Figure 1-09-2. 262330ZZ July GMS-5 visible imagery of TS Neil (09W) as a 35 kt storm just east of Cheju Island, ROK. TS Neil made landfall six hours later 20 nm southwest of Sancheon, ROK.

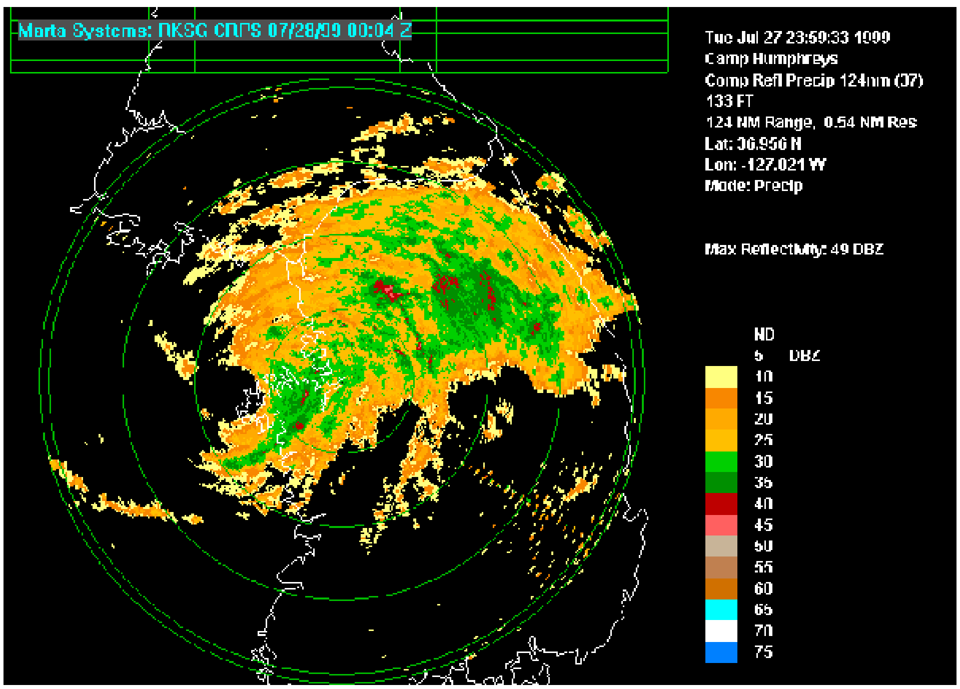
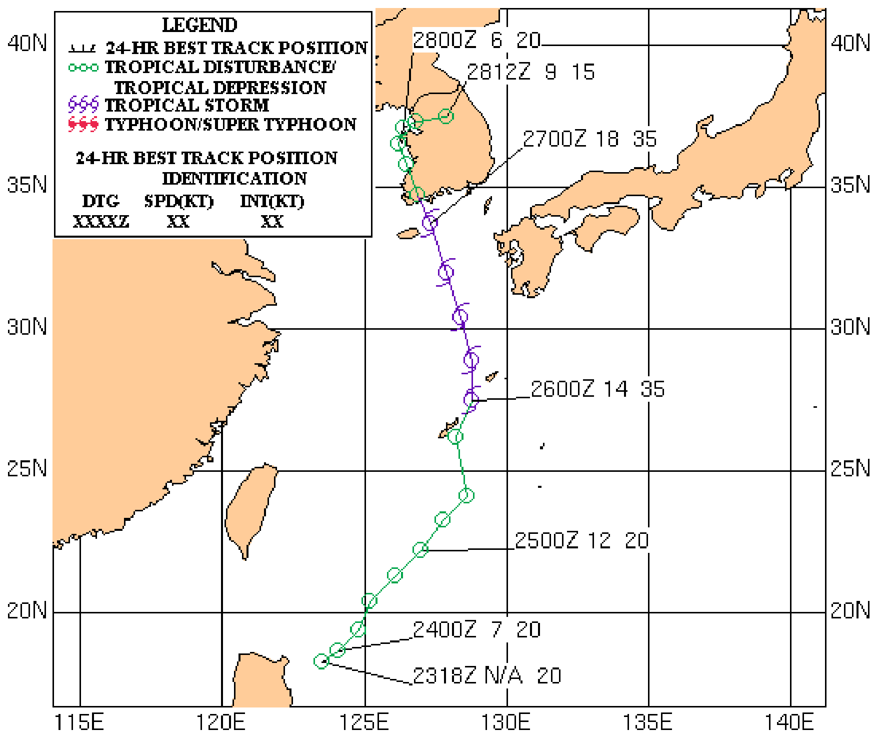


Figure 1-09-3. 272359Z July Camp Humphreys WSR-88D reflectivity image of TS Neil. TS Neil was downgraded to a 20 kt system shortly hereafter. The remnants of TS Neil made landfall 20 nm southwest of Seoul, ROK six hours later (280600Z).



LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
2800Z 6 20
2812Z 9 15
2700Z 18 35
2600Z 14 35
2500Z 12 20
2400Z 7 20
2318Z N/A 20
40N
35N
30N
25N
20N
115E
120E
125E
130E
135E
140E

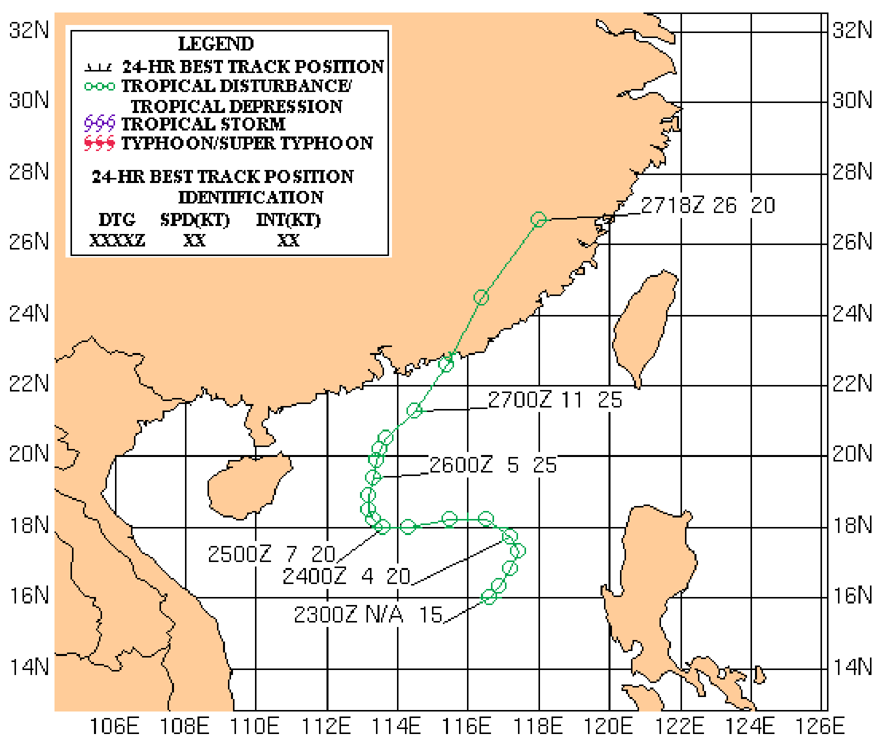
Tropical Depression 10W

Tropical Depression (TD) 10W began forming in the South China Sea, west of Luzon, Philippines on 23 July, reached tropical depression intensity on 251800Z July and remained a minimum TD as it meandered toward the Chinese coast. TD 10W made landfall near Shanwei, China on 270600Z July.

JTWC first began tracking the tropical disturbance on 230000Z July and mentioned it on the 230900Z July ABPW located west of Luzon in the South China Sea. TD 10W developed within a very active monsoon trough oriented from the South China Sea across Luzon to a disturbance that was to become TS Neil (09W), in the Philippine Sea. A TCFA was issued on 261800Z with the first warning issued immediately following it at 262100Z July.

The cyclone remained a very weak TD as it tracked north-northeastward under the steering flow of the subtropical ridge to the east. Synoptic data indicated a broad circulation, with a barely discernable low level circulation center on satellite imagery. TD 10W made landfall near Shanwei, China on 270600Z as a minimum TD.

JTWC issued the third and final warning at 270900Z July as TD 10W moved inland and dissipated. Post analysis indicated TD 10W actually reached 25 kt intensity on 251800Z, hence best track intensities were increased from 20 kt prior to the first warning.



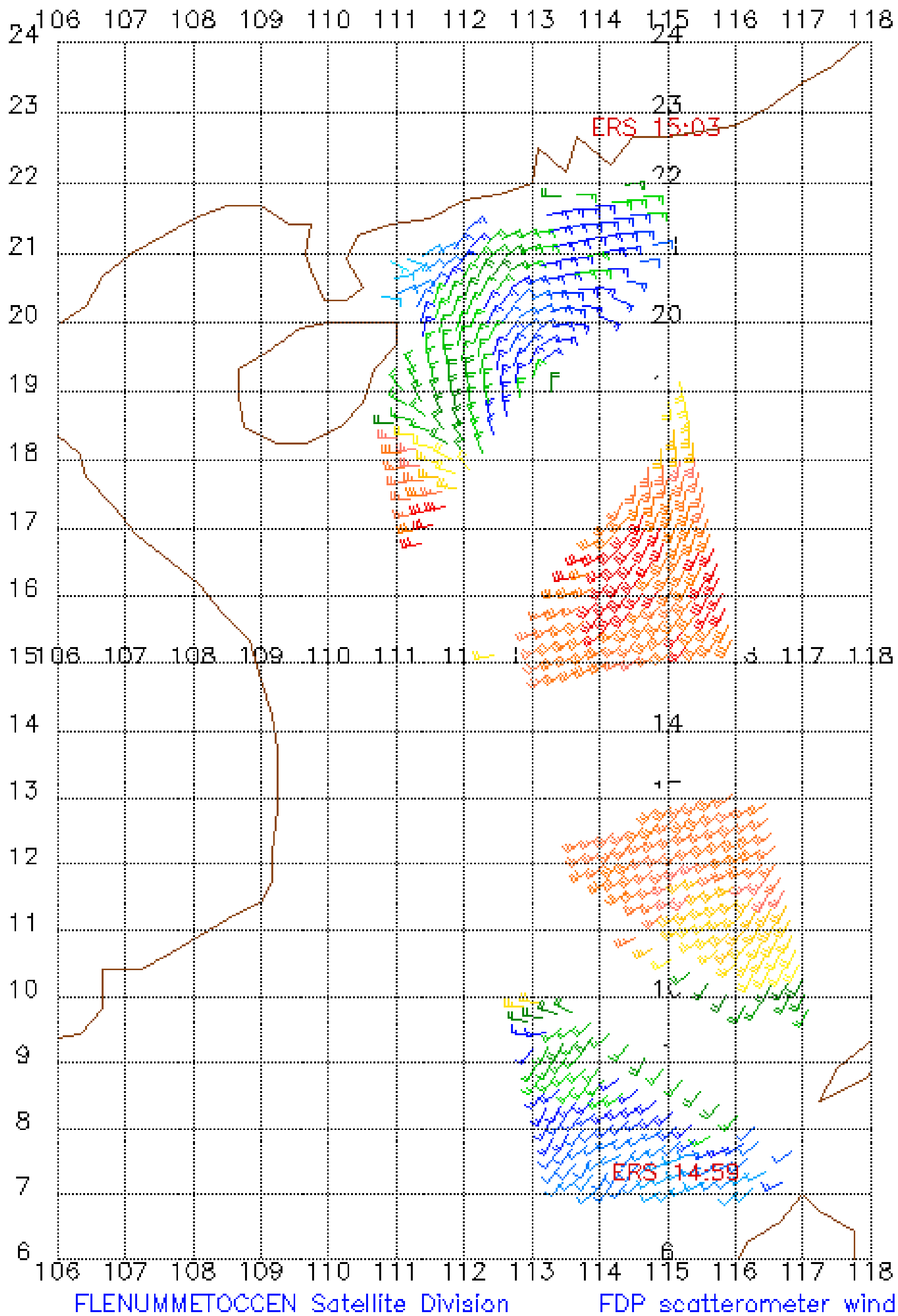


Figure 1-10-1. 251503Z July ERS-2 scatterometer pass. This pass indicated winds were greater than Dvorak analysis yielded. Hence, post analysis increased winds of the best track.

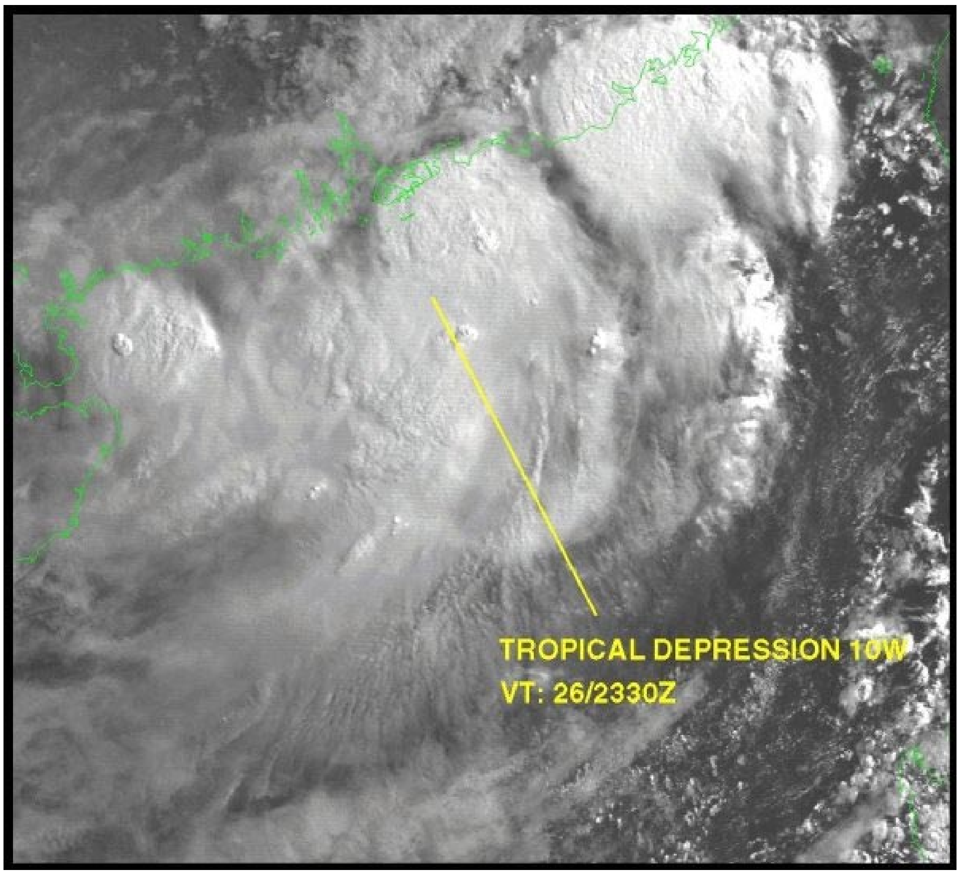


Figure 1-10-2. 262330Z July GMS-5 visible image. TD 10W was a 25 kt TD as it approached the Chinese coast. TD 10W made landfall about seven hours later.

Typhoon Olga (11W)

Typhoon (TY) Olga (11W) developed in the Philippine Sea, just west of Yap, in late July. TY Olga developed in the eastern end of a well-defined monsoon trough and tracked north-northwestward around a strong subtropical high to its northeast. TY Olga gradually intensified and peaked at 80 kt just northwest of Okinawa. TY Olga made landfall on Okinawa, the Republic of South Korea (ROK), and finally North Korea during its nine day lifecycle. Minimum damage was received on Okinawa, but torrential rains in South and North Korea led to landslides and fatalities. These heavy rains came only a few days after heavy rains associated with a frontal boundary moved through the area.

JTWC first began tracking the tropical disturbance on 261800Z July and included the disturbance on the 270600Z July ABPW. As the convection became better organized a TCFA was issued at 280230Z July. Over the next 24 hours, the convection continued to consolidate and JTWC issued the first warning at 290300Z July.

TY Olga (11W) slowly intensified and reached 75 kt intensity as it approached Okinawa, Japan. The ragged eye (Figure 1-11-1) began to weaken just prior to landfall over Ourawan Bay, Okinawa, about 10 nm east of Kadena Air Base. Figure 1-11-2 shows the deep convection was limited to the northeast quadrant as TY Olga made landfall at 011200Z August. The peak wind gust on Okinawa associated with landfall was at Kadena Air Base (011324Z August - 43 kt). As TY Olga moved off Okinawa, it continued to track north-northwestward and re-intensified to its peak of 80 kt. Additionally, a strong spiral band developed and moved over Okinawa and other southern islands (Figure 1-11-3 and 4). Okinoerabu (RJKB) reported 15038G53kt (10 minute mean) and Kumejima (ROKJ) reported 23028G38kt on 020600Z December associated with the spiral band passage.

As TY Olga (11W) gained latitude, a mid-latitude trough began digging into the Yellow Sea from China transitioning the steering flow to a more ”poleward” pattern. TY Olga began a more northward track and accelerated. TY Olga passed just west of Cheju Island, ROK and along the west coast of the ROK making landfall briefly over the T'aean Peninsula, about 40 nm southwest of Suweon, ROK, before making its final landfall in North Korea at 031400Z August as a strong tropical storm (55 kt). As TY Olga began interacting with the mid-latitude trough, it took on extratropical characteristics and began weakening.

JTWC issued the 24th and final warning on 032100Z August as the system weakened and became extratropical over North Korea.

Reuters reported torrential rains and landslides led to 64 fatalities in ROK and North Korea. US and ROK airbases in ROK also reported damage to buildings with only minor injuries as winds gusted to 52 kt at Seoul AB and 48 kt at Kunsan AB.

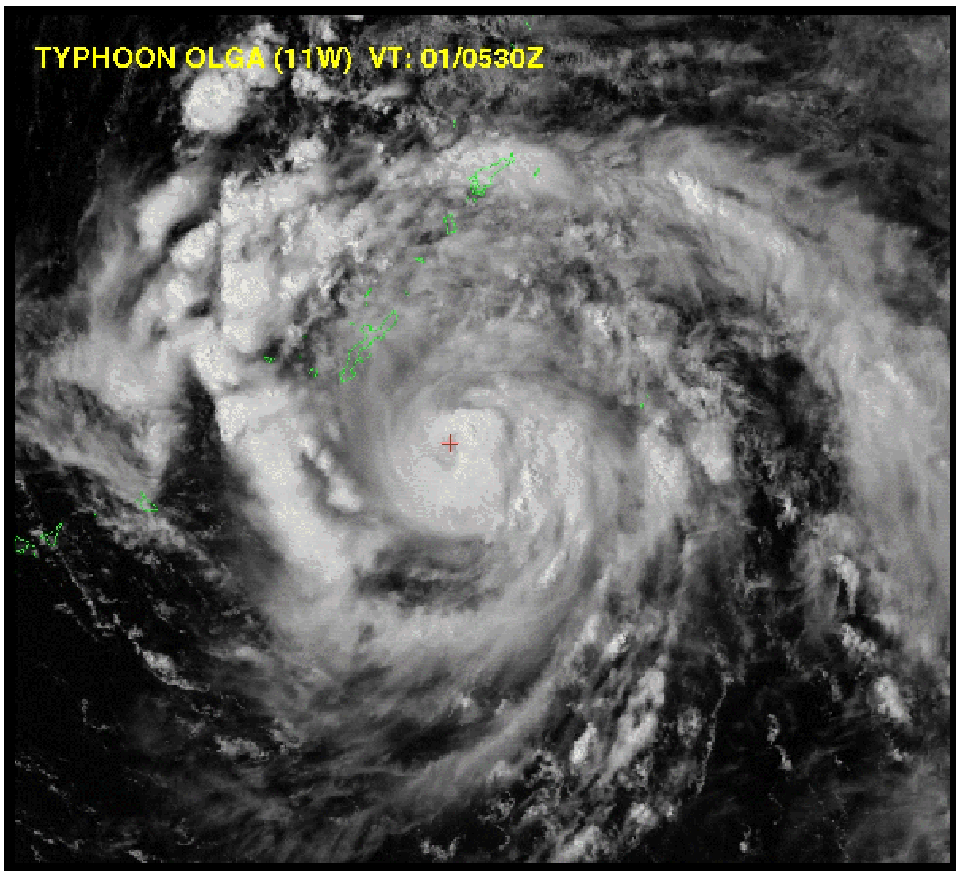


Figure 1-11-1. 010530Z August GMS-5 visible image of TY Olga (11W) approaching Okinawa, Japan. TY Olga (11W) was at 75 kt and beginning to show signs of weakening. As it moved over Okinawa, it was at minimum TY intensity (65 kt).

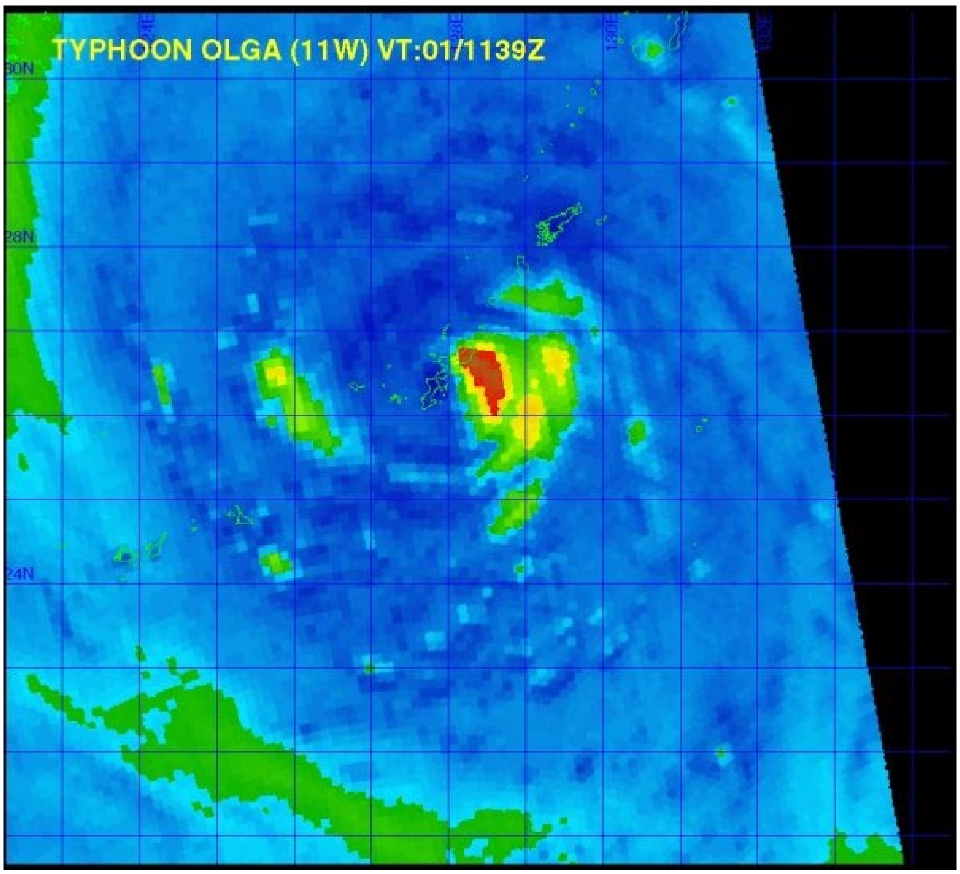


Figure 1-11-2. 011139ZZ August SSM/I pass of TY Olga (11W) as it moved over Okinawa, Japan. TY Olga (11W) was at 65 kt with deep convection limited to the northeastern quadrant.

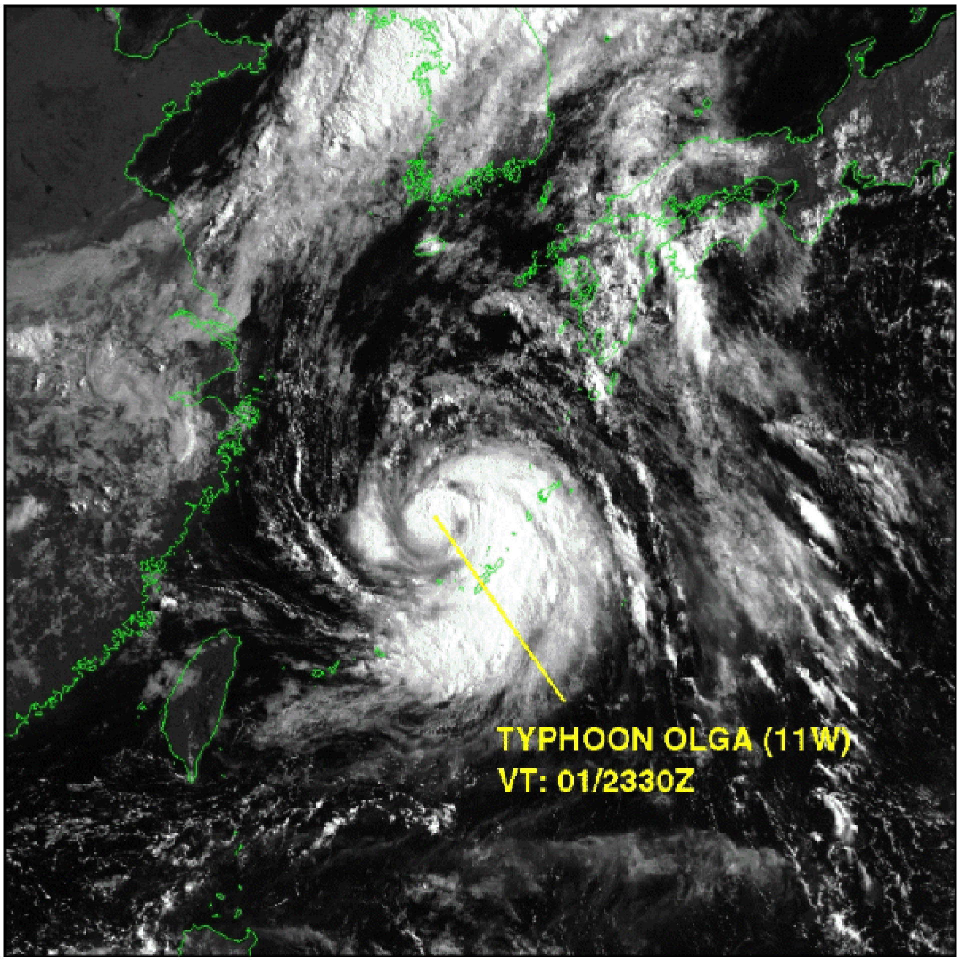


Figure 1-11-3. 012230Z August GMS-5 visible image of TY Olga (11W) northwest of Okinawa, Japan. TY Olga (11W) was at 75 kt with a strong spiral band on the eastern half. This band actually brought stronger wind gusts and heavier rains to the southern Japanese islands than the actual passage of the typhoon. TY Olga (11W) began intensifying and peaked at 80 kt 12 hours later.

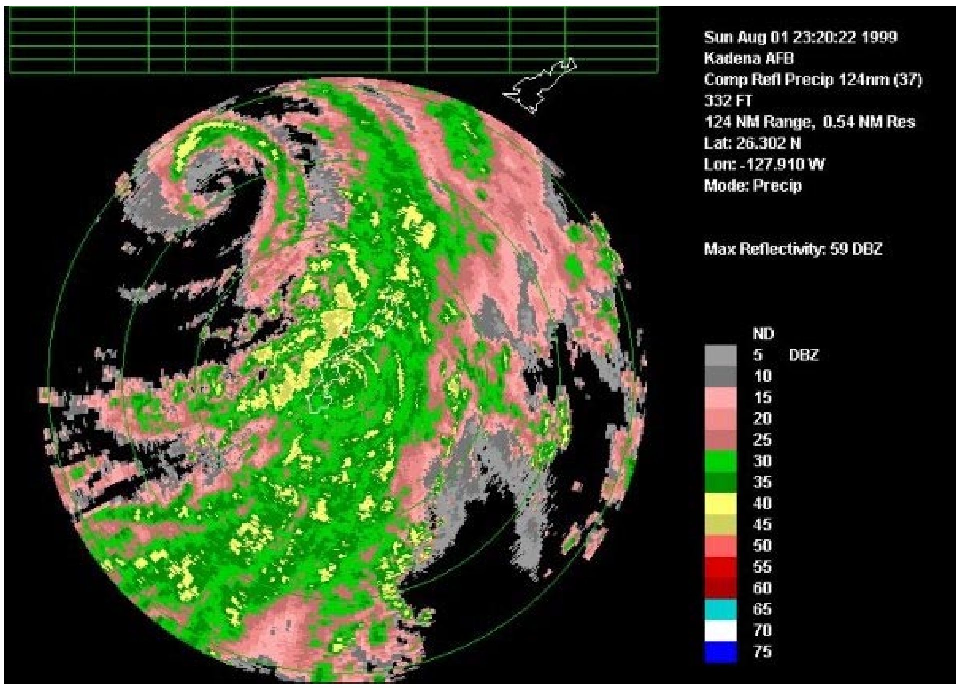


Figure 1-11-4. 012320Z August WSRD-88 NEXRAD radar image from Kadena AB, Japan. Image shows the band now moving offshore of Okinawa and a well-defined TY Olga (11W) to the northwest. TY Olga (11W) was at 70 kt intensity and continuing to intensify.

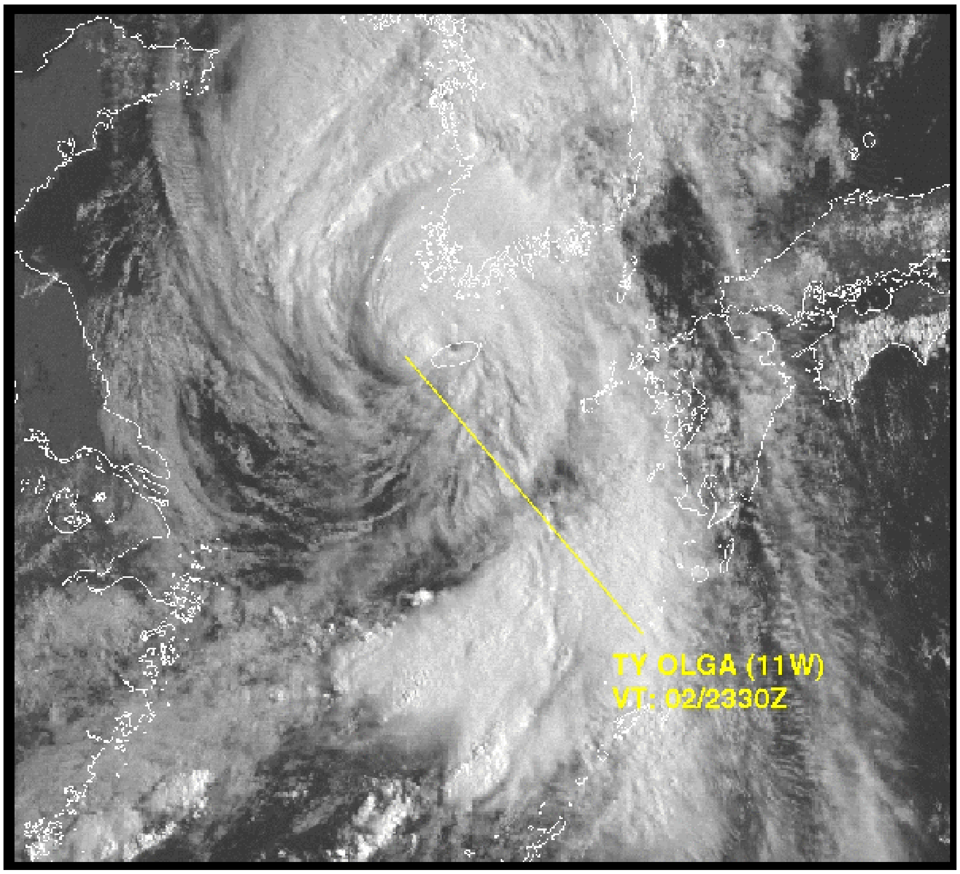
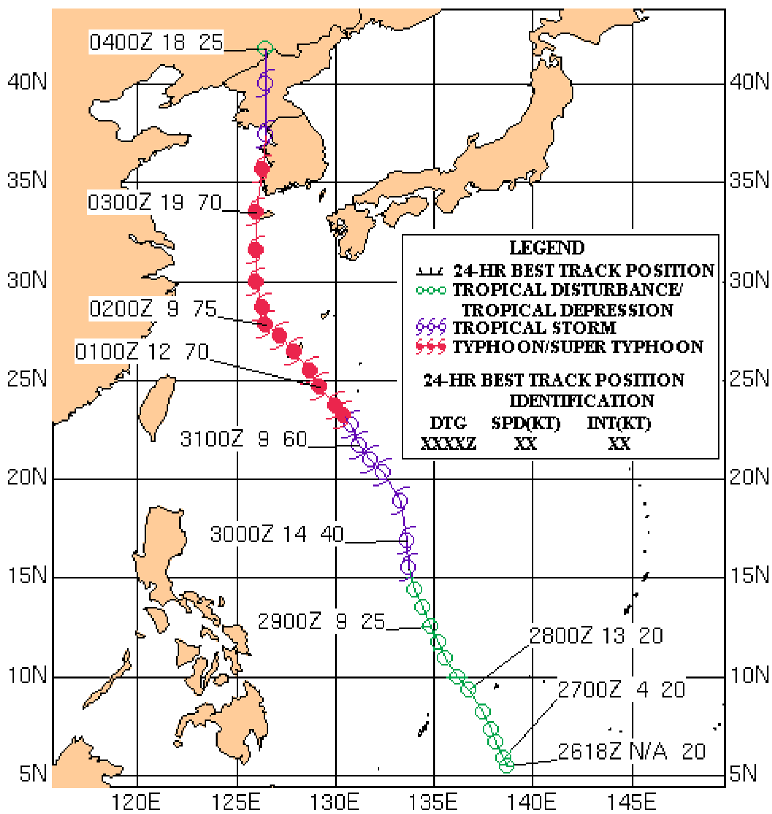


Figure 1-11-5. 022330Z August GMS-5 visible image of TY Olga (11W) just northwest of Cheju Island, ROK. TY Olga (11W) was at 75 kt intensity.


0400Z 18 25
0300Z 19 70
0200Z 9 75
0100Z 12 70
3100Z 9 60
3000Z 14 40
2900Z 9 25
2800Z 13 20
2700Z 4 20
2618Z N/A 20
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
40N
35N
30N
25N
20N
15N
10N
5N
120E 125E 130E 135E 140E 145E

Tropical Storm Paul (12W)

Tropical Storm Paul (12W) formed in early August in the southeast quadrant of a large monsoon gyre centered southeast of Okinawa and attained a maximum intensity of 50 kt on 050600Z August. This cyclone was unique in that it developed from a monsoon gyre and then merged into the gyre. During the merger period, TS Paul remained quasi-stationary for 12 hours and after the merger moved toward the Yellow Sea where it dissipated on 08 August.

JTWC issued a Tropical Cyclone Formation Alert on 020230Z August for a low-level circulation embedded in the deep convection associated with the monsoon gyre. As the circulation continued to intensify, JTWC issued the first warning on TD 12W at 031500Z August with maximum sustained winds of 25 kt.

TD 12W initially moved northwestward along the eastern periphery of the gyre (see Figure 1-12-1) and soon after reaching tropical storm intensity at 041800Z August turned westward as the cyclone merged with the monsoon gyre east of Okinawa (see Figure 1-12-2). It was during this merger period that TS Paul attained a maximum intensity of 50 kt at 050600Z August.

A review of past WESTPAC cyclones associated with monsoon gyres indicate that mergers rarely occur. The data indicates that it is much more common for a tropical cyclone to move either along the northern periphery of the gyre northeastward under the steering influence of a subtropical ridge located to the south-east, or continue westward north of the monsoon gyre. TS Paul took the least common scenario, merging with the gyre.

Another complexity noted with tropical cyclones that merge with monsoon gyres is that some of the tropical cyclones expand areally after merger and some do not. TS Paul (12W) did not expand in area after merger whereas a 1991 cyclone, TS Gladys (14W), merged with a monsoon gyre and evolved into a large tropical cyclone. The only differences noted in the synoptic and meteorological satellite data between TS Paul (1999, 12W) and TS Gladys (1991, 14W) was that TS Paul (12W) had much less associated deep convection than TS Gladys (14W). In the case of TS Gladys (14W), abundant deep convection was evident throughout the area and literally wrapped around the huge gyre. For TS Paul (12W), there was little associated convection and a large TUTT cell located over the cyclone. Thus, it appears that the TUTT may have influenced the TS Paul (12W)/monsoon gyre merger and the nonexpansion of the cyclone.

After the merger, TS Paul weakened to a tropical depression (see Figure 1-12-3) then initially moved northeastward. By 060600Z August, TS Paul had moved under the steering influence of the subtropical ridge to its north and began to track northwestward and then westward at 11 to 15 kt as a 25 kt system.

On 061800Z August TS Paul skimmed the southwest coast of Kyushu as a 25 kt system and the Japan Meteorological Agency reported that associated rainfall caused damage from landslides and floods in western Japan. TS Paul subsequently dissipated over water in the Yellow Sea and JTWC issued the 19th and final warning at 080300Z August.

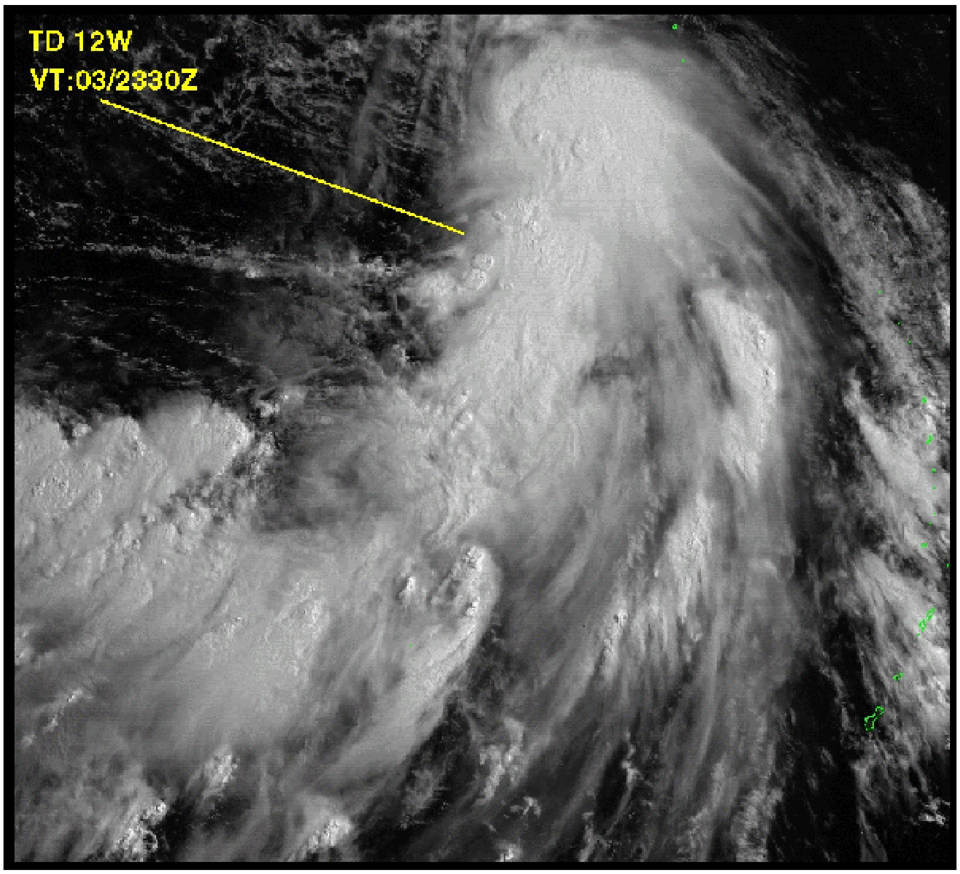


Figure 1-12-1. A visible satellite image showing TD 12W embedded within the southeast quadrant of a monsoon gyre centered southeast of Okinawa.

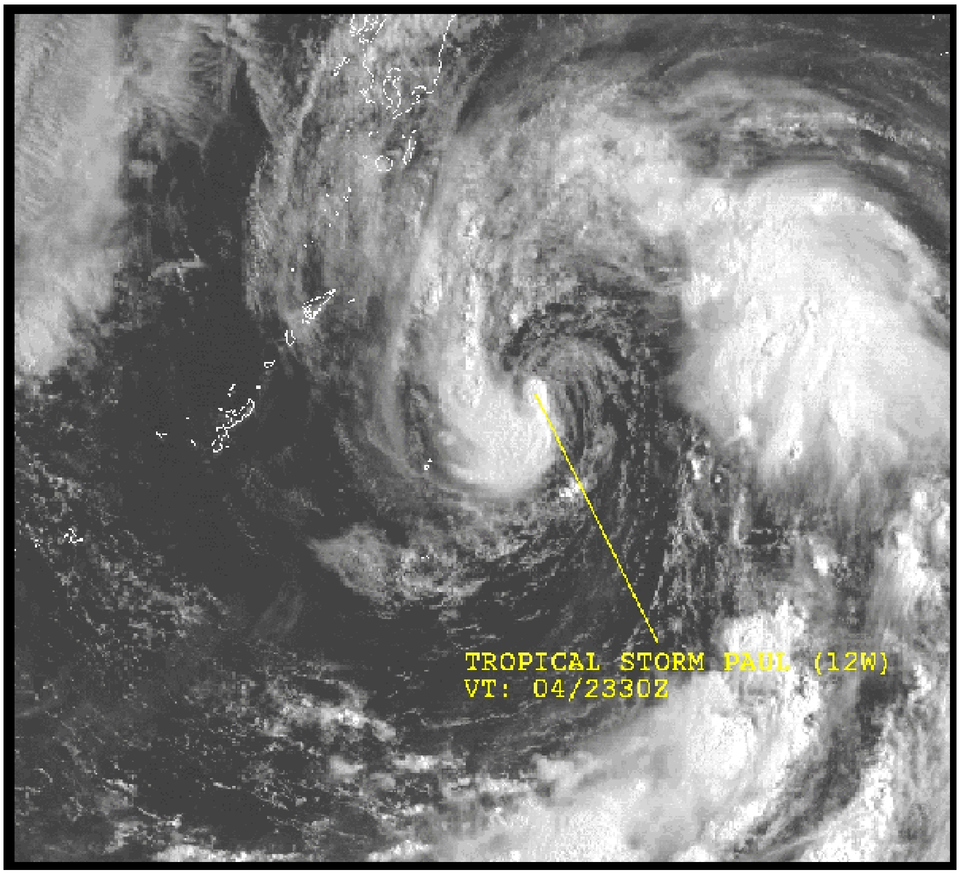


Figure 1-12-2. A visible satellite image of TS Paul (12W) just after it merged with the monsoon gyre east of Okinawa.

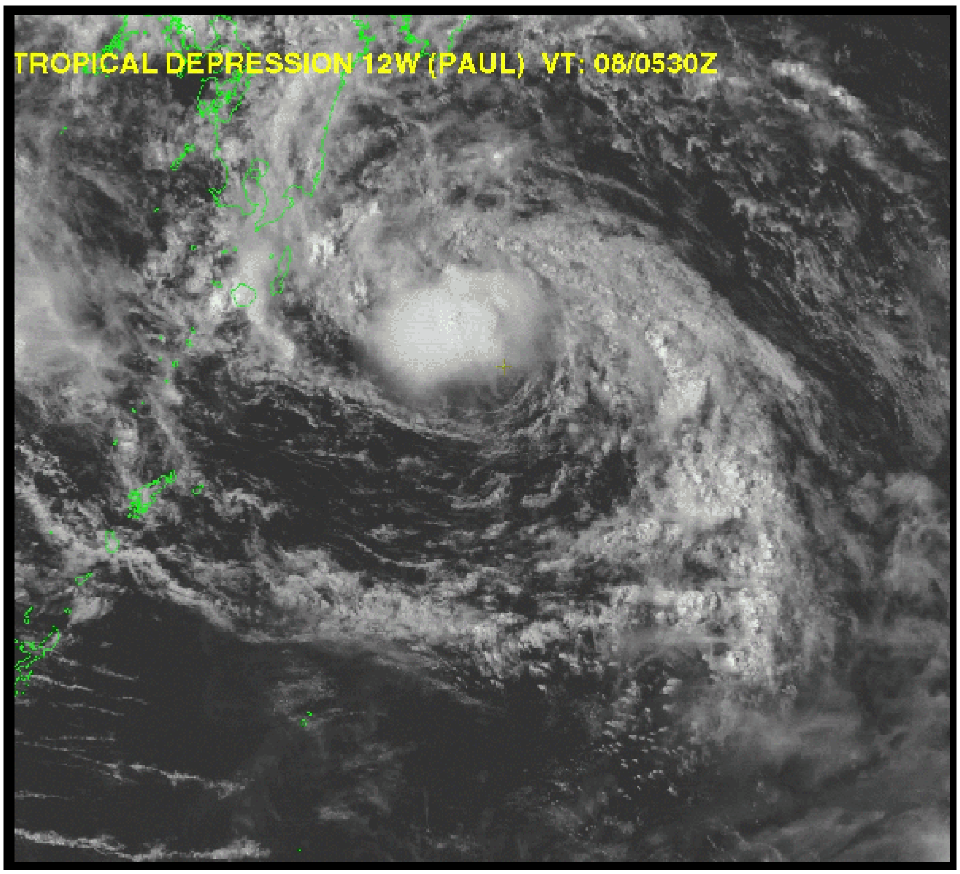
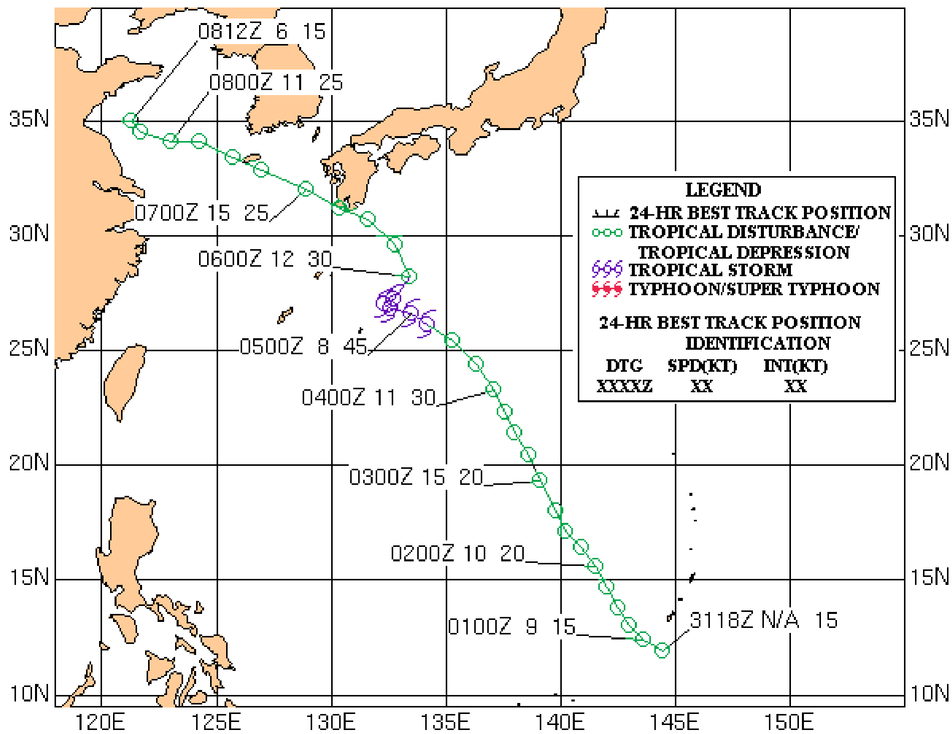


Figure 1-12-3. A visible satellite image of TD 12W (Paul) six hours after it merged with the monsoon gyre. The monsoon gyre itself collapsed around TD 12W (Paul) and together they became a large depression which moved off to the northwest.

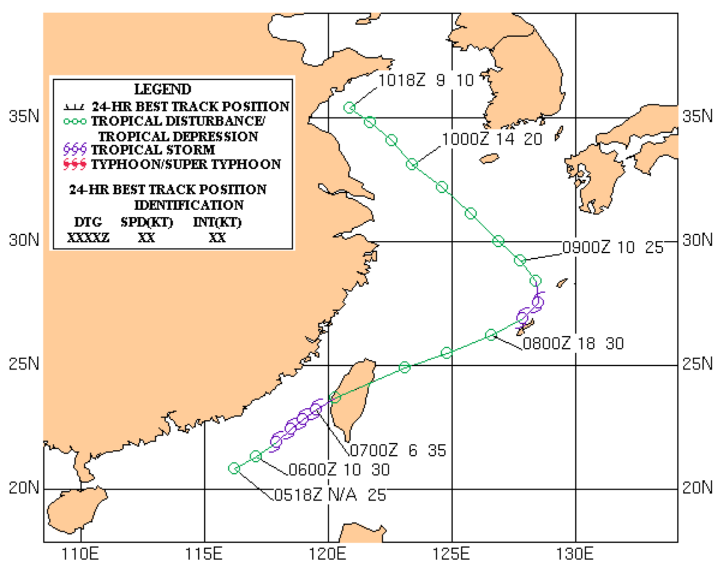

0812Z 6 15
0800Z 11 25
0700Z 15 25
0600Z 12 30
0500Z 8 45
0400Z 11 30
0300Z 15 20
0200Z 10 20
0100Z 9 15
3118Z N/A 15
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
35N
30N
25N
20N
15N
10N
120E
125E
130E
135E
140E
145E
150E

Tropical Storm Rachel (13W)

Tropical Storm (TS) Rachel (13W), the 13th 1999 Northwest Pacific Ocean tropical cyclone warned on by JTWC, developed in the South China Sea, intensified to a tropical storm, moved northeastward over Taiwan, and dissipated after only 36 hours later. This cyclone then regenerated as it moved into the East China Sea toward Okinawa and then turned northwestward, to dissipate over the Yellow Sea 5 days after initial development.

TS Rachel (13W) formed approximately 140 nm southeast of Hong Kong on 5 August. JTWC issued the first warning on TS Rachel at 060900Z August. By 061200Z August, the cyclone had reached a maximum intensity of 35 kt. The system weakened significantly as it moved over Taiwan, then re-intensified again to a maximum intensity of 35 kt by 080600Z August. Subsequently, cooler sea surface temperatures, and increasing vertical wind shear caused TS Rachel to dissipate over the Yellow Sea at 101800Z August.

TS Rachel (13W) developed in the monsoon trough just off the coast of China. The suspect area which eventually became TS Rachel was first mentioned on the 040600Z August Significant Tropical Weather Advisory (ABPW) with poor potential for development. After 2 days, a Tropical Cyclone Formation Alert (TCFA) was issued for the area. At 060900Z the first warning was issued, as scatterometry data indicated 30 kt winds associated with the tropical cyclone. TS Rachel tracked northeastward over Taiwan, where it dissipated over the Chungyang Mountain range. JTWC issued a final warning on the system at 070900Z August. JTWC subsequently regenerated the cyclone as it moved into the East China Sea and tracked toward Okinawa at 17 kt. TS Rachel (13W) re-intensified to 35 kt as it passed near Okinawa, and turned to the northwest. TS Rachel then moved into cooler waters and increasing vertical wind shear, causing the cyclone to rapidly weaken. JTWC issued the 14th and final warning at 092100Z August.



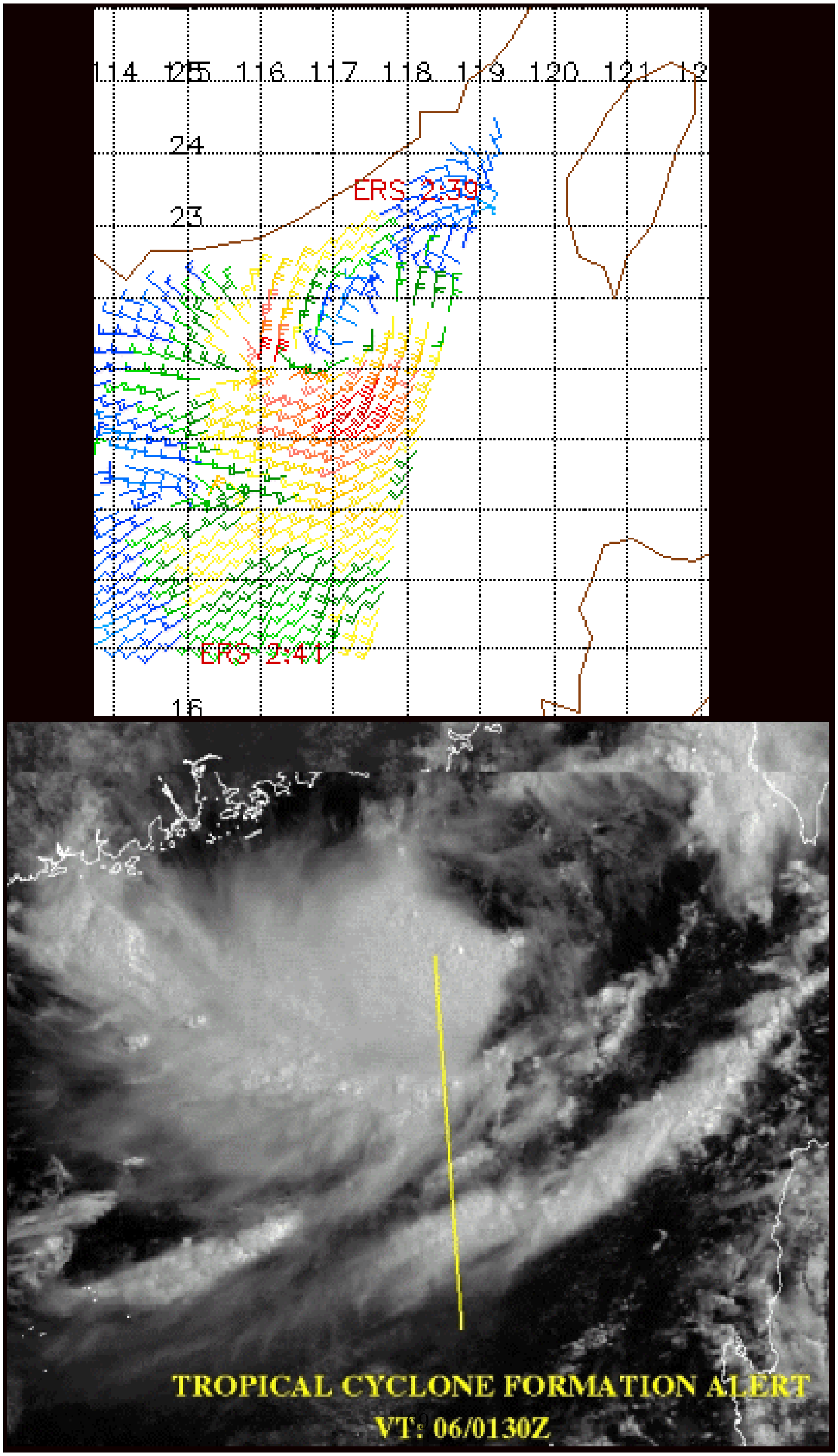
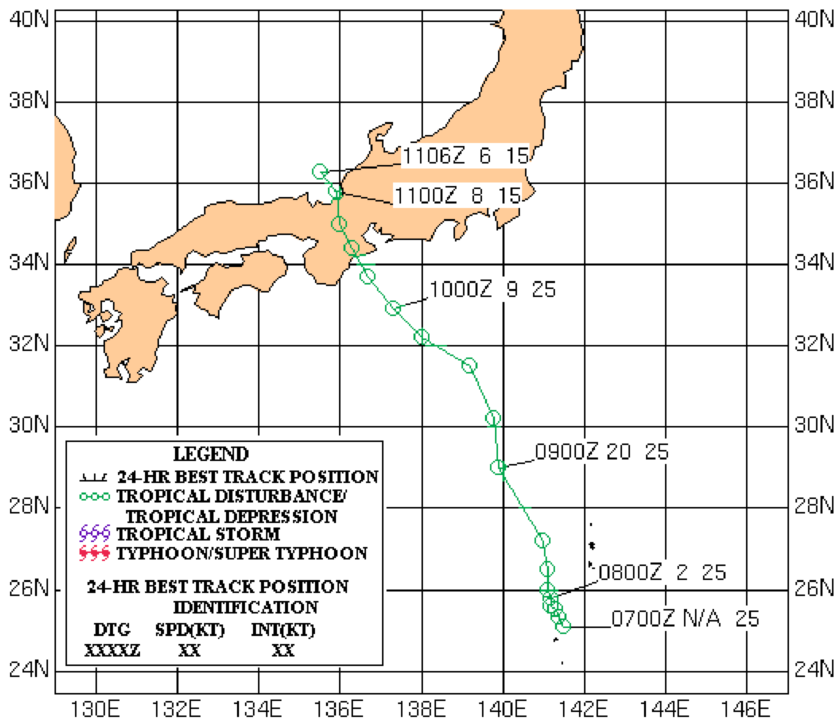


Figure 1-13-1. 060240Z August scatterometry pass, and 060130Z August visible imagery of Tropical Depression 13W which later developed into TS Rachel (13W). Satellite analysis indicated 20 to 25 kt (Dvorak T1.0) through 061025Z. The scatterometry pass however, indicates 30 to 35 kt winds already at 060240Z. The ERS-2 scatterometer has allowed for more accurate analysis of tropical cyclones. This capability will be further exploited as QuickScatt becomes operational.

Tropical Depression 14W

Tropical Depression (TD) 14W developed 65 nm north of Iwo Jima. It tracked northwest and made landfall near Owase, Japan around 101000Z August, while maintaining a 25 kt intensity.

JTWC issued a Tropical Cyclone Formation Alert at 070230Z August based on Special Sensor Microwave Imager (SSM/I) data which depicted an exposed low-level circulation center with associated convection displaced about 40 nm to the northeast (Figure 1-14-1). The first warning for TD 14W was issued at 082100Z August as a 25 kt cyclone. TD 14W initially moved northward at 5 to 7 kt under the steering influence of the subtropical ridge over northern Japan. TD 14W then turned northwestward around 091200Z August and increased in speed as the subtropical ridge began building over Honshu. TD 14W remained at 25 kt as it made landfall 25 nm northeast of Owase, Japan (Figure 1-14-2) at 101000Z August. TD 14W then began to weaken and moved northward dissipating just north of Honshu on 11 August. JTWC issued the eighth and final warning at 101500Z August.



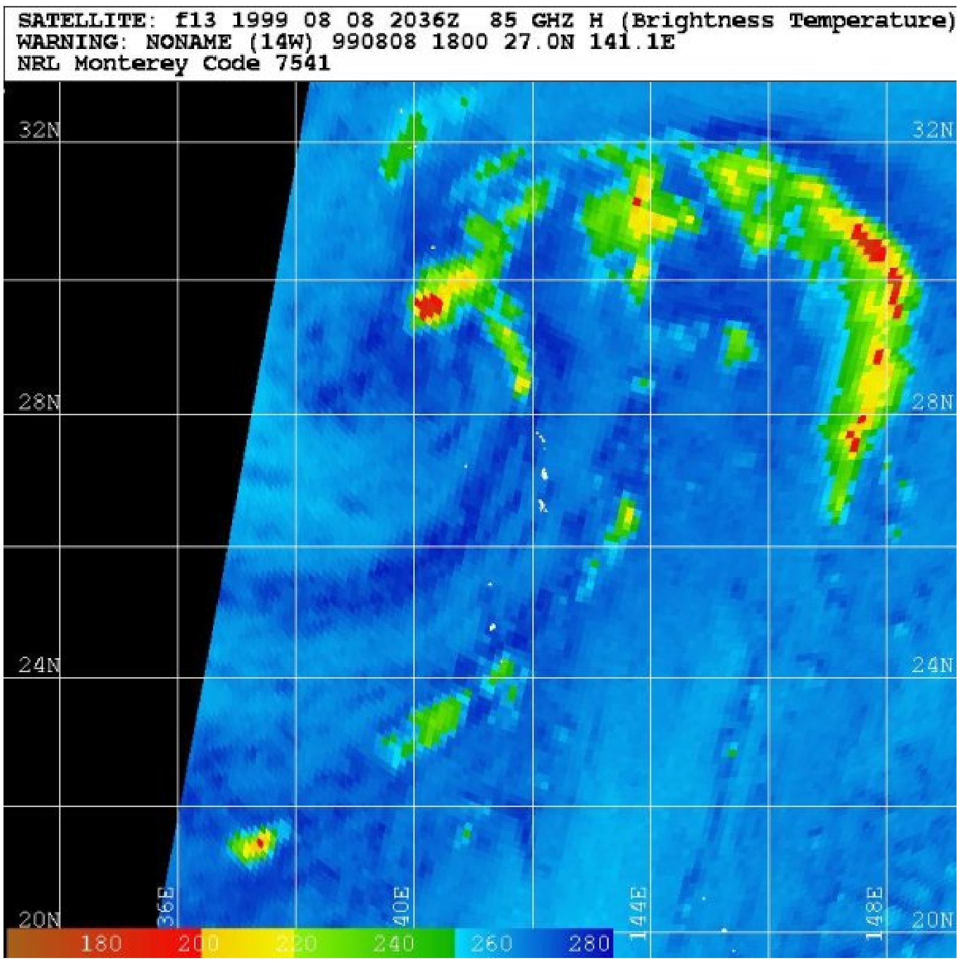


Figure 1-14-1. 082036Z August SSM/I pass reveals a fully exposed low-level circulation center positioned southwest of the associated convection. TD 14W was at 25 kt intensity.

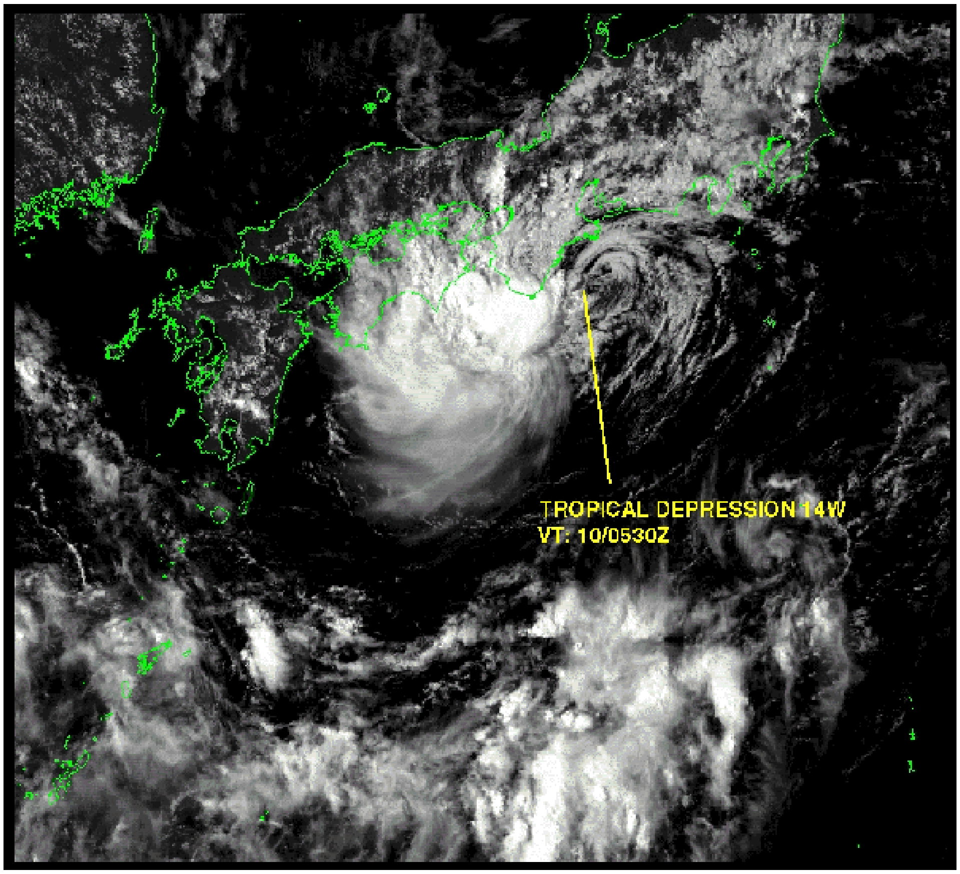


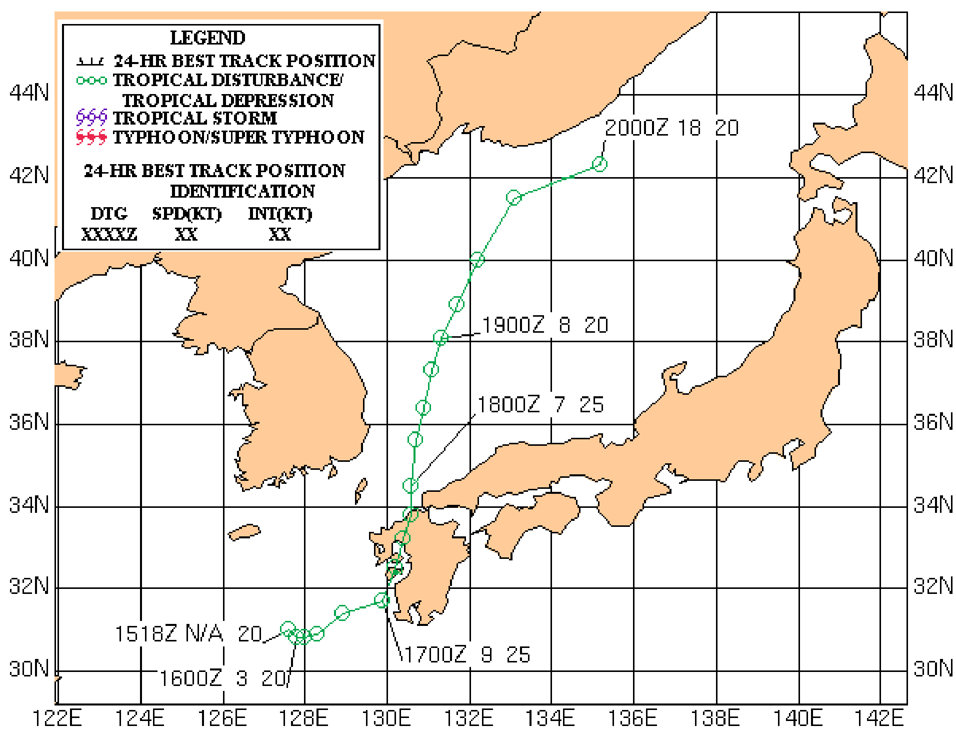
Figure 1-14-2. 100530Z August visible satellite imagery depicted a fully exposed low-level circulation center tracking over the coast of Honshu. TD 14W was at 25 kt intensity.

Tropical Depression 15W

Tropical Depression (TD) 15W developed in the East China Sea during mid August and initially drifted eastward toward Kyushu, then moved northeastward over Kyushu and into the Sea of Japan. The disturbance reached a peak intensity of 25 kt prior to and after landfall over Kyushu. TD 15W then dissipated over the Sea of Japan.

JTWC first mentioned TD 15W as a suspect area on the 150600Z August Significant Tropical Weather Advisory (ABPW). By 161400Z August, this suspect area had intensified and become better organized. The first warning was issued at 161500Z August. TD 15W was relocated further east on the fourth warning, positioning the disturbance approximately 24 nm from the coast of Kyushu.

TD 15W formed north of the subtropical ridge in the East China Sea with the mid-latitude westerlies as the dominant steering influence. TD 15W initially drifted east toward southwestern Kyushu, making landfall near Ushibuka at 170300Z August. TD 15W then moved northeastward over Kyushu and into the Sea of Japan. TD 15W weakened and dissipated over the Sea of Japan. JTWC issued the 9th and final warning at 180900Z August.



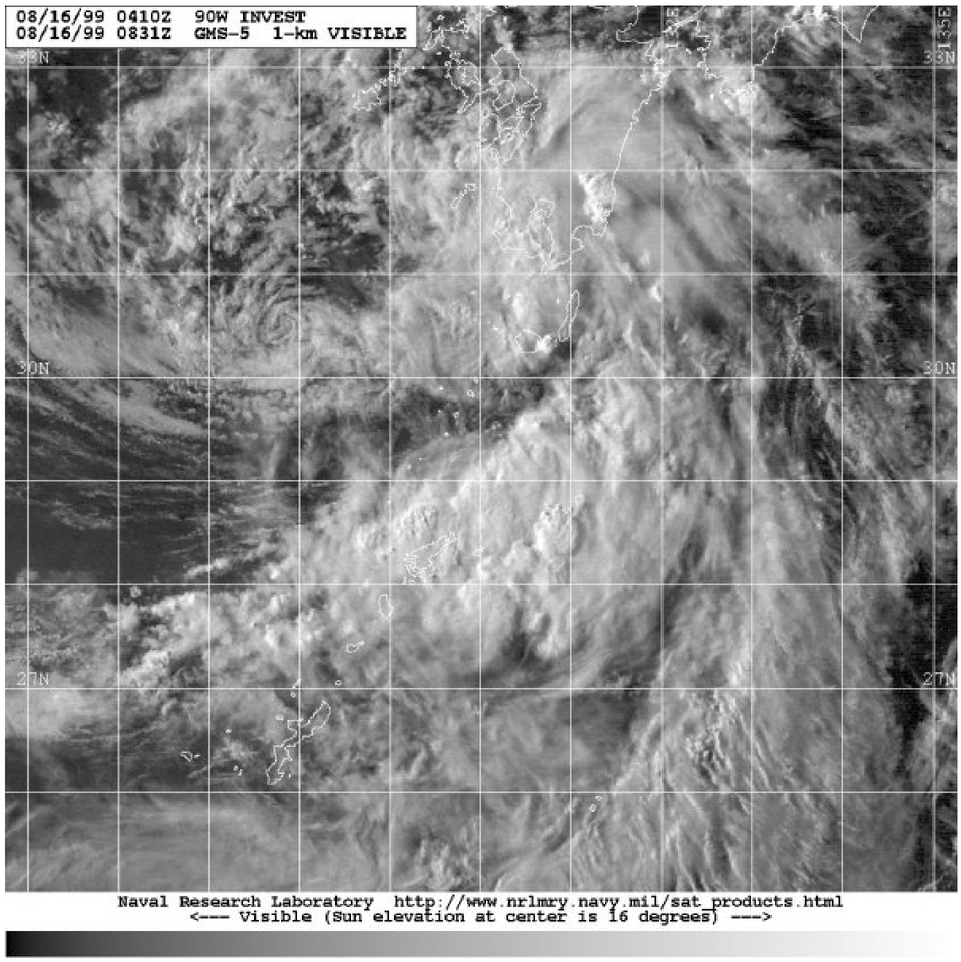


Figure 1-15-1. 160831Z August GMS-5 visible image of TD 15W shortly after the first warning. TD 15W was a small exposed low level circulation at 25 kt intensity.

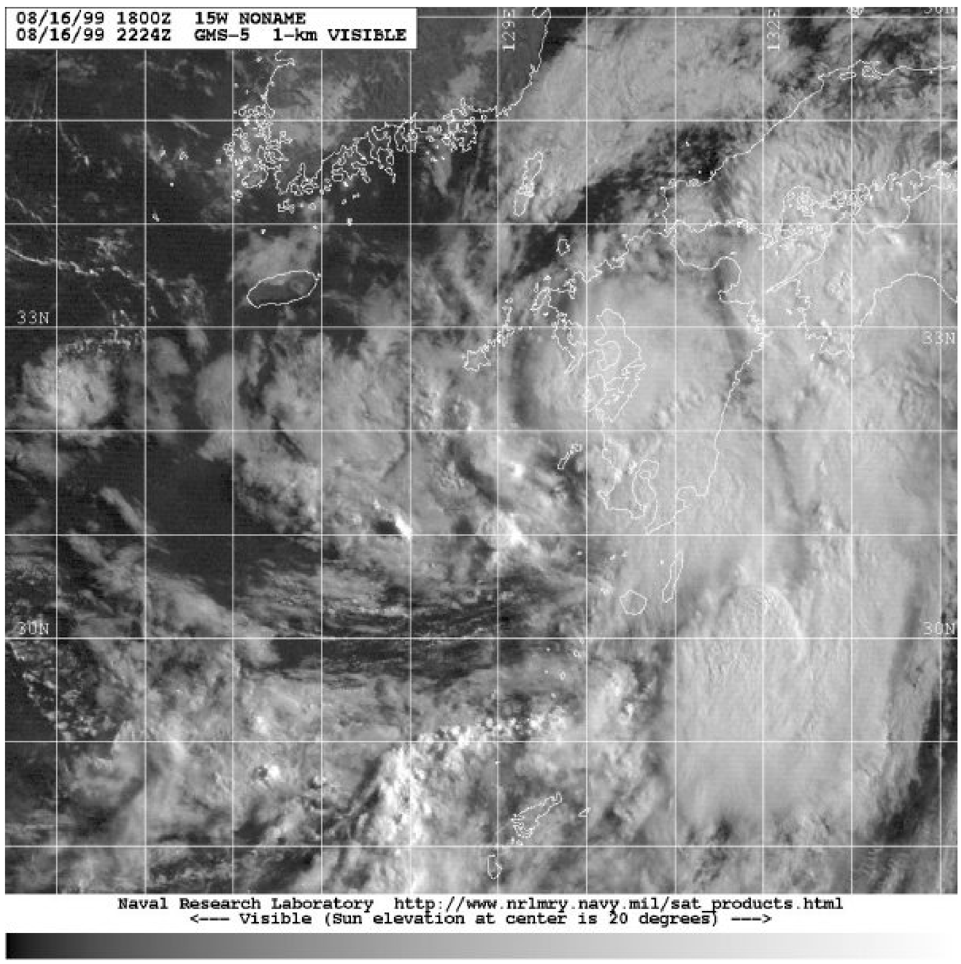


Figure 1-15-2. 162224Z August GMS-5 visible image. TD 15W was a 25 kt TD as it approached Kyushu, Japan. TD 15W made landfall 4 hours later over Kyusho.

Typhoon Sam (16W)

Typhoon (TY) Sam (16W) formed over the Philippine Sea in mid August and tracked northwestward across northern Luzon into the South China Sea then made landfall over Hong Kong before dissipating in Southern China. TY Sam reached a peak intensity of 75 kt just before making landfall near Hong Kong, China and caused significant damage in the Philippines and China.

TY Sam (16W) developed as a large circulation with monsoon depression characteristics and maximum winds on the periphery. JTWC issued a TCFA at 172330Z August as satellite analysis indicated an increase in the organization of convection in the area. JTWC issued the first tropical cyclone warning at 30 kt intensity nine hours later as the developing cyclone moved slowly northwestward. TY Sam achieved tropical storm strength at 190000Z and typhoon strength two days later at 210600Z.

As TY Sam (16W) intensified, the subtropical ridge to the north became more influential as a steering influence, adding a westward component to its previous northward track. TY Sam tracked across northern Luzon at tropical storm strength before entering the South China Sea and intensifying to typhoon strength. TY Sam made landfall about 10 nm northeast of Hong Kong with typhoon strength winds of 75 kt, then moved northwestward over southern China for 24 hours before dissipating. JTWC issued the 20th and final warning on 230300Z August.

Fatalities from the system included seven in the Philippines and 17 dead in China. CNN reported three fatalities and over 200 injured when a plane tried to land during storm passage and crashed at Hong Kong International Airport. The Hong Kong Observatory reported TY Sam was the wettest tropical cyclone to affect Hong Kong since 1926.

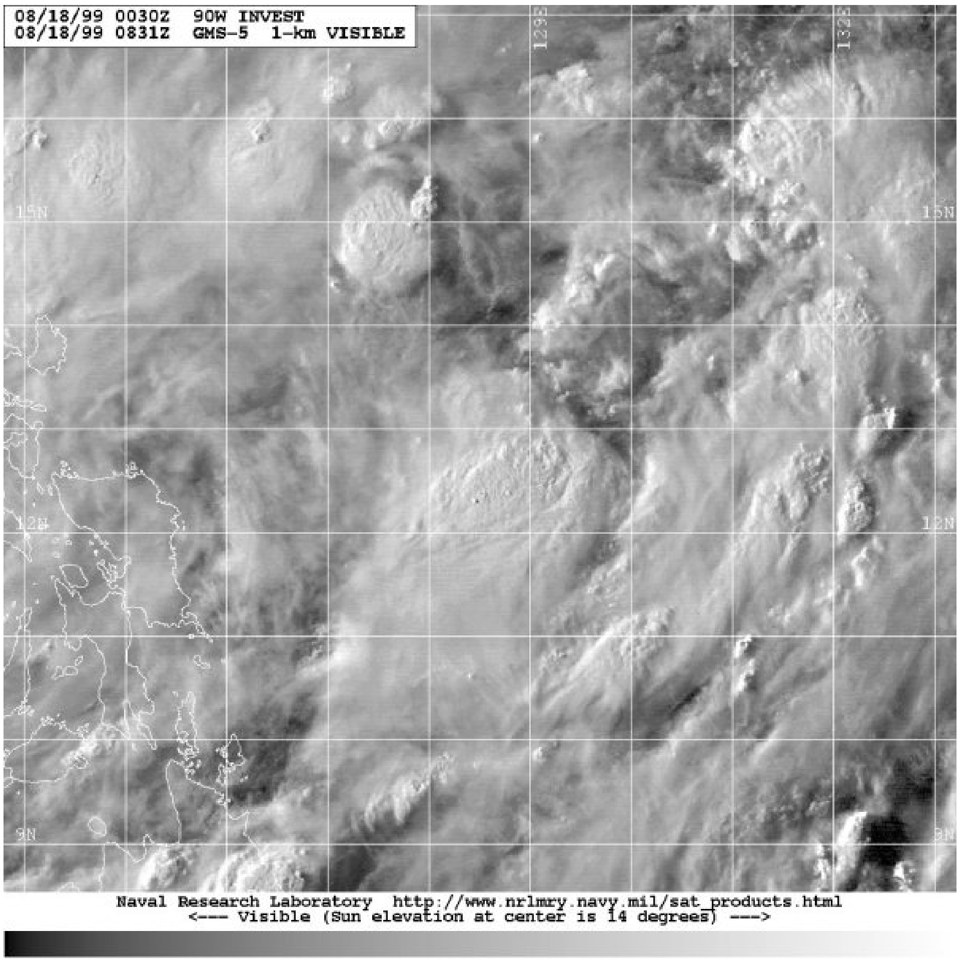


Figure 1-16-1. 180831Z August GMS-5 visible image of TY Sam (16W) shortly after the first warning. Notice the broad circulation and monsoon depression characteristics. TY Sam was at 30 kt intensity.

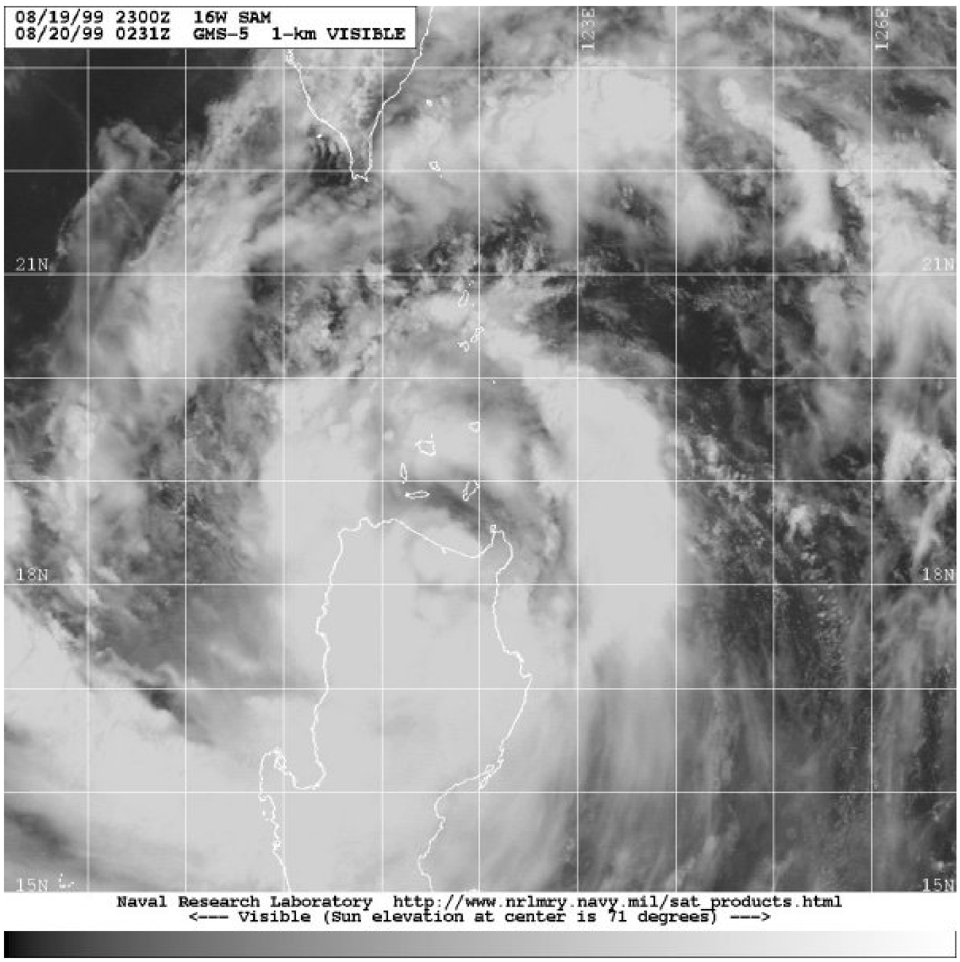


Figure 1-16-2. 200231Z August GMS-5 visible image of TY Sam (16W) as it tracked over northern Luzon. The large areal extent of the circulation is clearly visible. TY Sam was at 50 kt intensity.

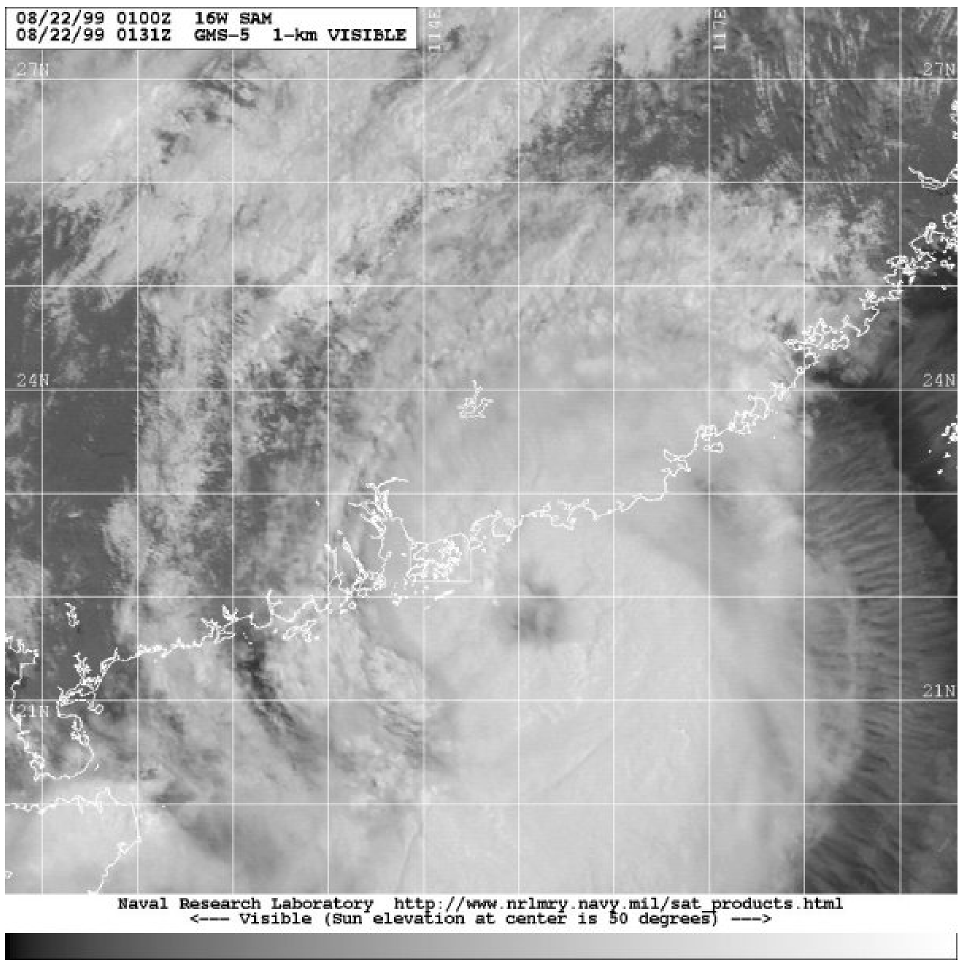
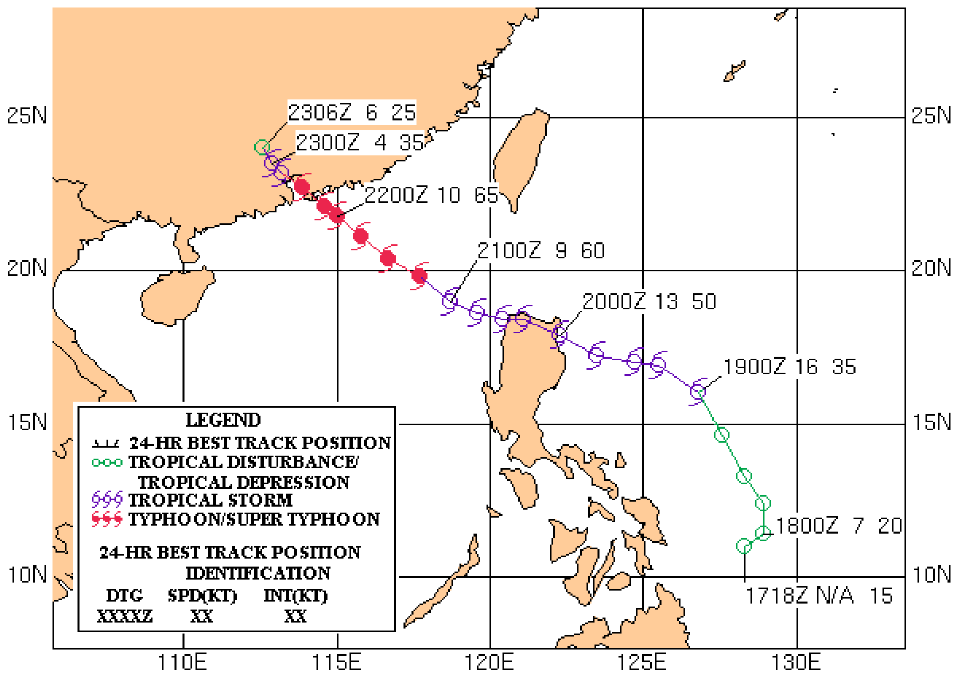


Figure 1-16-3. 220131Z August GMS-5 visible image of TY Sam (16W) at its peak intensity of 75 kt, just before making landfall northeast of Hong Kong.


2306Z 6 25
2300Z 4 35
2200Z 10 65
2100Z 9 60
2000Z 13 50
1900Z 16 35
1800Z 7 20
1718Z N/A 15
25N
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15N
10N
110E
115E
120E
125E
130E
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG
SPD(KT)
INT(KT)
XXXXZ
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XX

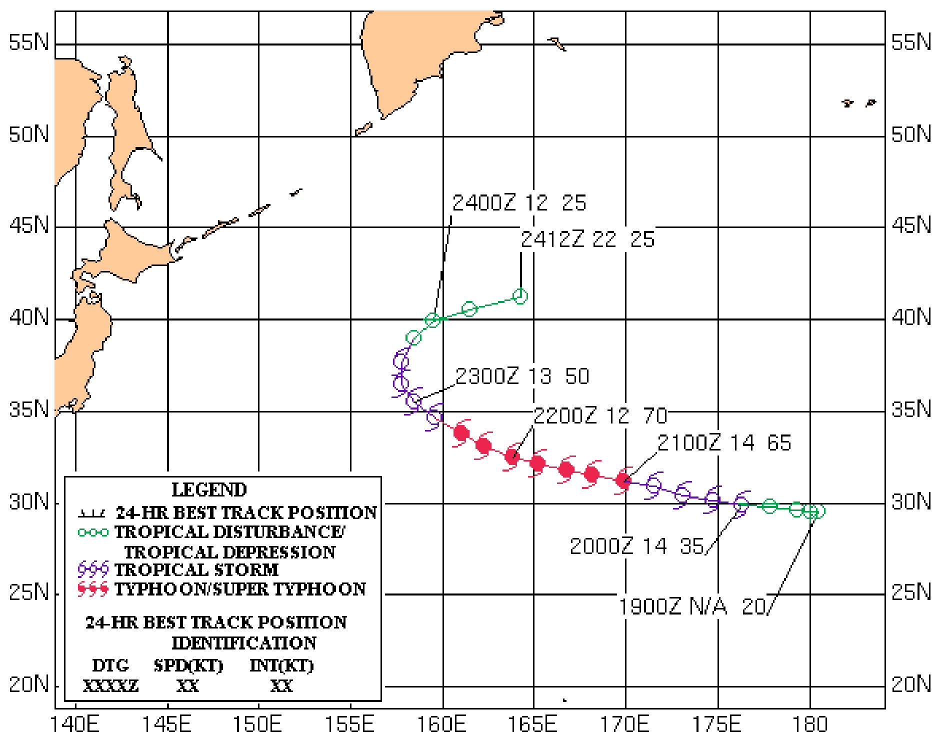
Typhoon Tanya (17W)

Typhoon (TY) Tanya (17W) was a small-sized tropical cyclone which formed just west of the dateline during mid August. It tracked west-northwestward before recurving toward the northeast and becoming extratropical. This cyclone reached a peak intensity of 70 kt just before recurving to the northeast and dissipating over water.

Based on meteorological satellite data, which indicated a tightly wrapped low level circulation, JTWC issued a TCFA at 191530Z August. As the convection became more organized, JTWC issued the first tropical cyclone warning for a 30 kt intensity at 192100Z August. Post analysis adjusted this to 40 kt.

Typhoon Tanya (17W) initially tracked westward under the steering influence of a subtropical ridge to its north. TY Tanya began recurvature through a weakness in the subtropical ridge at 230900Z August and began to experience increased vertical wind shear. As TY Tanya weakened and began extratropical transition, JTWC issued the 18th and final warning at 240300Z August.

Of special note was the fact that Typhoon Tanya (17W) developed at unusually high latitude as a very small (midget) tropical cyclone that reached typhoon intensity.



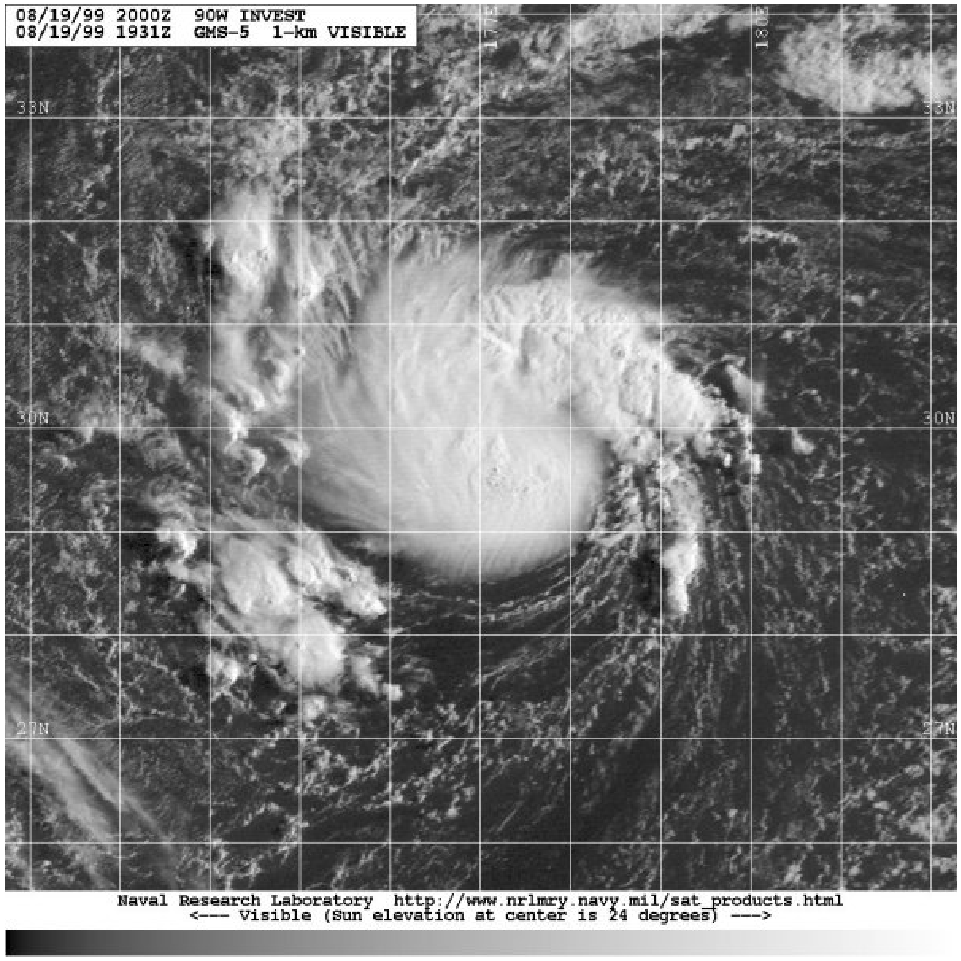


Figure 1-17-1. 191931Z August GMS-5 visible image of TS Tanya (17W) at an intensity of 40 kt. Image depicts the intense convection associated with the small, tightly wrapped low-level circulation.

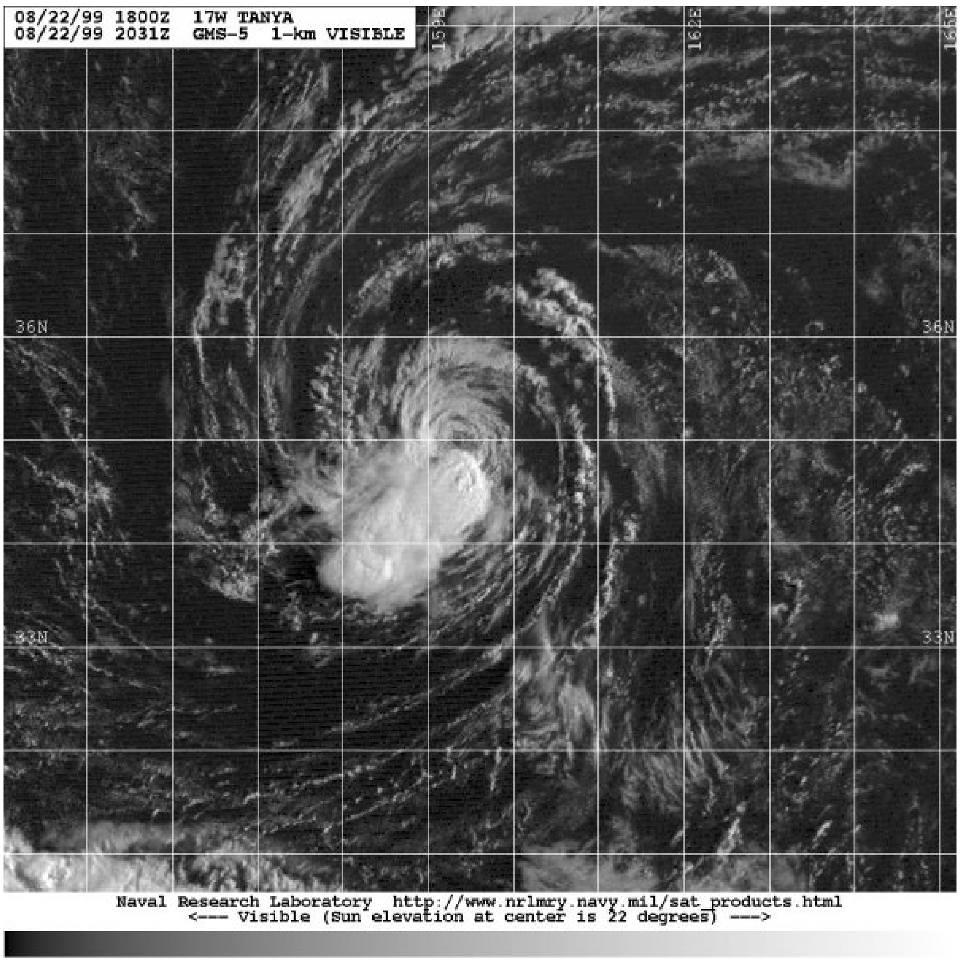


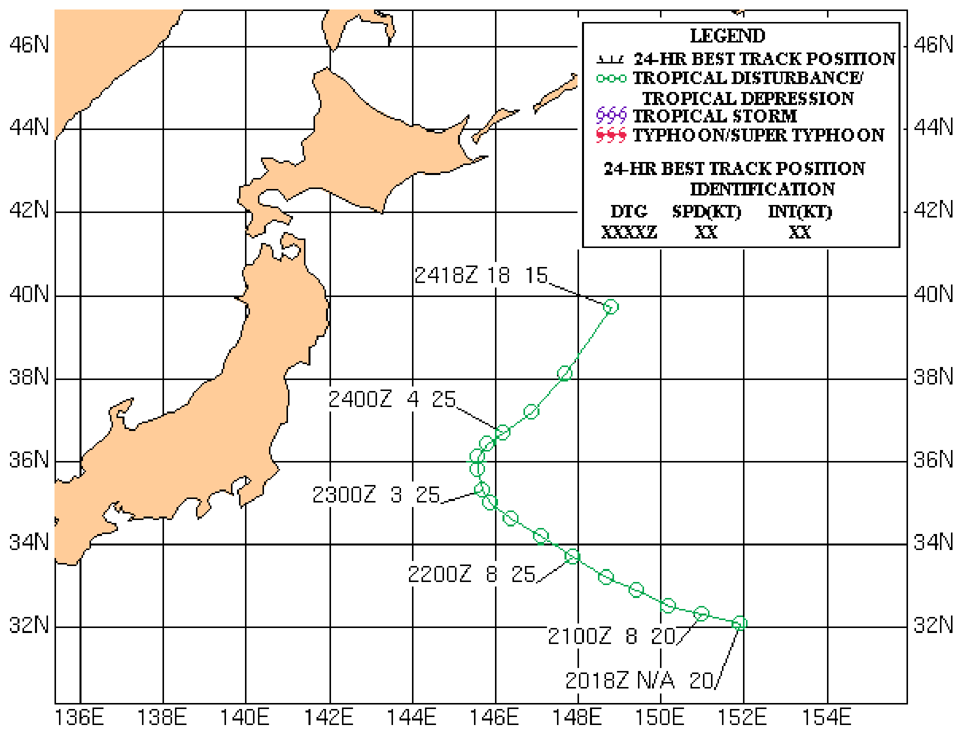
Figure 1-17-2. 222031Z August GMS-5 visible image of TY Tanya (17W). This image depicts the exposed low-level circulation center with deep convection being sheared to the south. Intensity at this time was 60 kt.

Tropical Depression 18W

Tropical Depression (TD) 18W was one of three very small (midget) tropical cyclones warned on by JTWC during the 1999 season. This cyclone developed at the tail end of a shearline then moved west and recurved, becoming an extratropical cyclone after 4 days.

TD 18W formed approximately 640 nm east of Tokyo, Japan and JTWC first mentioned the area on the 192251Z August re-issuance of the ABPW. The first warning on TD 18W was issued at 212100Z August and by 221200Z August, the cyclone had reached a maximum intensity of 30 kt. Vertical wind shear caused TD 18W to become an exposed low level cyclone after 090000Z August.

TD 18W moved at 8 kt for the initial 36 hours then began to slow as it recurved northeastward on 221200Z August. The system moved at 3-5 kt until 240000Z August then accelerated and moved into the same frontal boundary it developed from. JTWC issued the 10th and final warning at 240300Z August as TD 18W weakened and became extratropical.



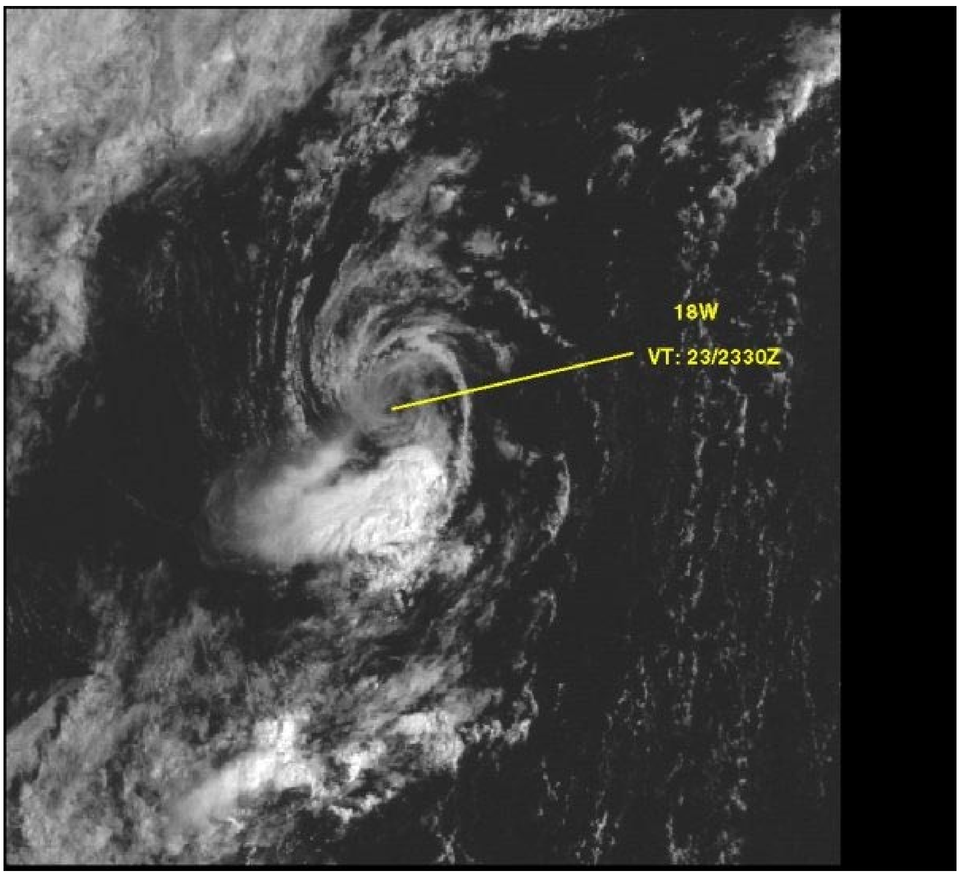


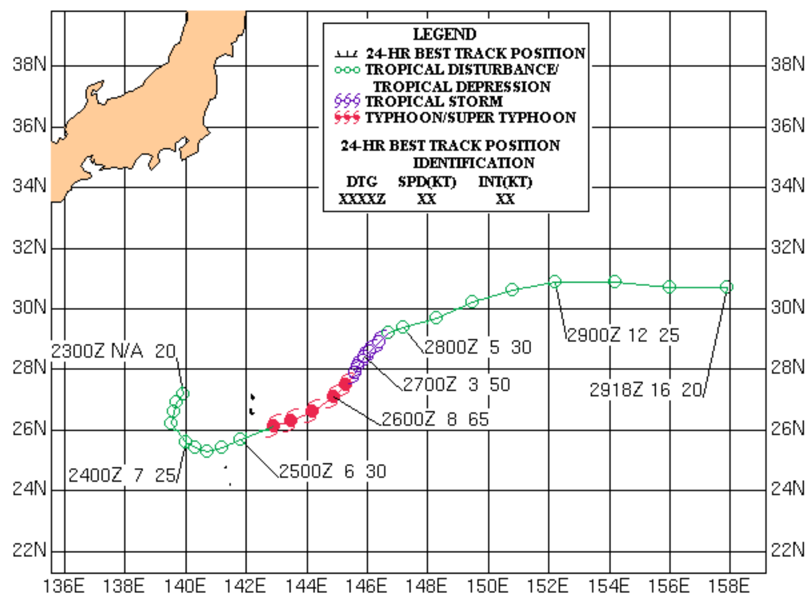
Figure 1-18-1. 232330Z visible image shows strong vertical windshear over TD 18W shearing the convection to the south of the exposed low-level circulation center (LLCC). Of note in this image is the tight wrap of the cloud lines into the LLCC. Current intensity was estimated at 25 kt.

Typhoon Virgil (19W)

Typhoon (TY) Virgil (19W) developed as a very small-sized (midget) tropical cyclone at the end of a quasi-stationary shear line north-northwest of Iwo Jima. After a short southward jog, TY Virgil moved east, intensified to a peak intensity of 70 kt, and then dissipated over water after 7 days. TY Virgil was one of three midget tropical cyclones JTWC warned on during the 1999 season. All three developed within the mid-latitude region of the Northwest Pacific.

JTWC identified the area which was to become TY Virgil (19W) on the 230600Z August ABPW and subsequently issued a TCFA at 230930Z August as a tropical upper-level trough (TUTT) moved to the east and vertical wind shear decreased. After a scatterometer pass indicated 25 kt winds, JTWC issued the first warning at 240300Z August. Between the 250300Z warning and 250600Z August, the cyclone rapidly intensified from 30 kt to 65 kt. Shortly after reaching typhoon intensity, TY Virgil reached a maximum intensity of 70 kt at around 251200Z August.

TY Virgil (19W) initially moved counter-clockwise while a tropical depression. As the cyclone began to develop further, it moved more rapidly, but then slowed as it again interacted with the TUTT. After the cyclone became vertically sheared, it accelerated rapidly in the low level steering flow, interacting with a passing mid-latitude front and continued to weaken as it became absorbed into the boundary. JTWC issued the 21st and final warning at 290300Z August as the cyclone dissipated over water.



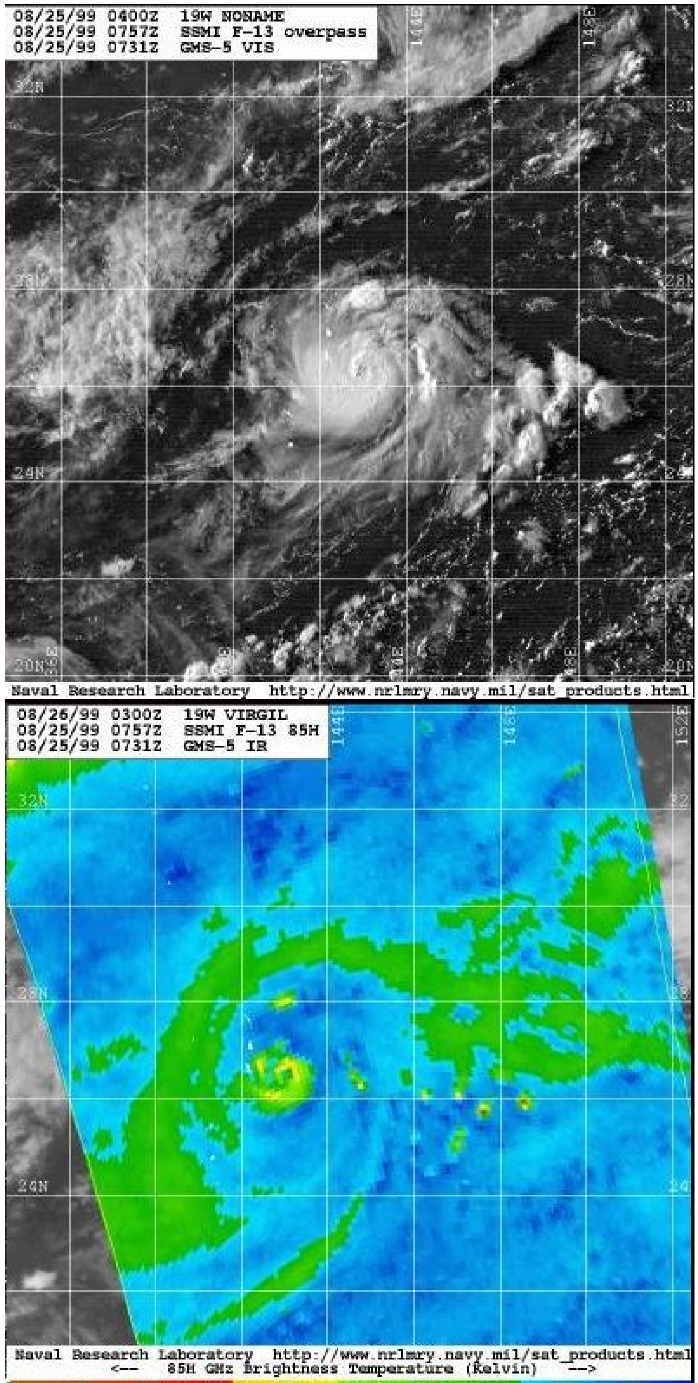


Figure 1-19-1. 250757Z microwave and 250731Z August visible imagery showing the low level circulation center of TY Virgil (19W) as it reached typhoon intensity (65 kt). Visible imagery indicates a possible eye, but the microwave image leaves little doubt.

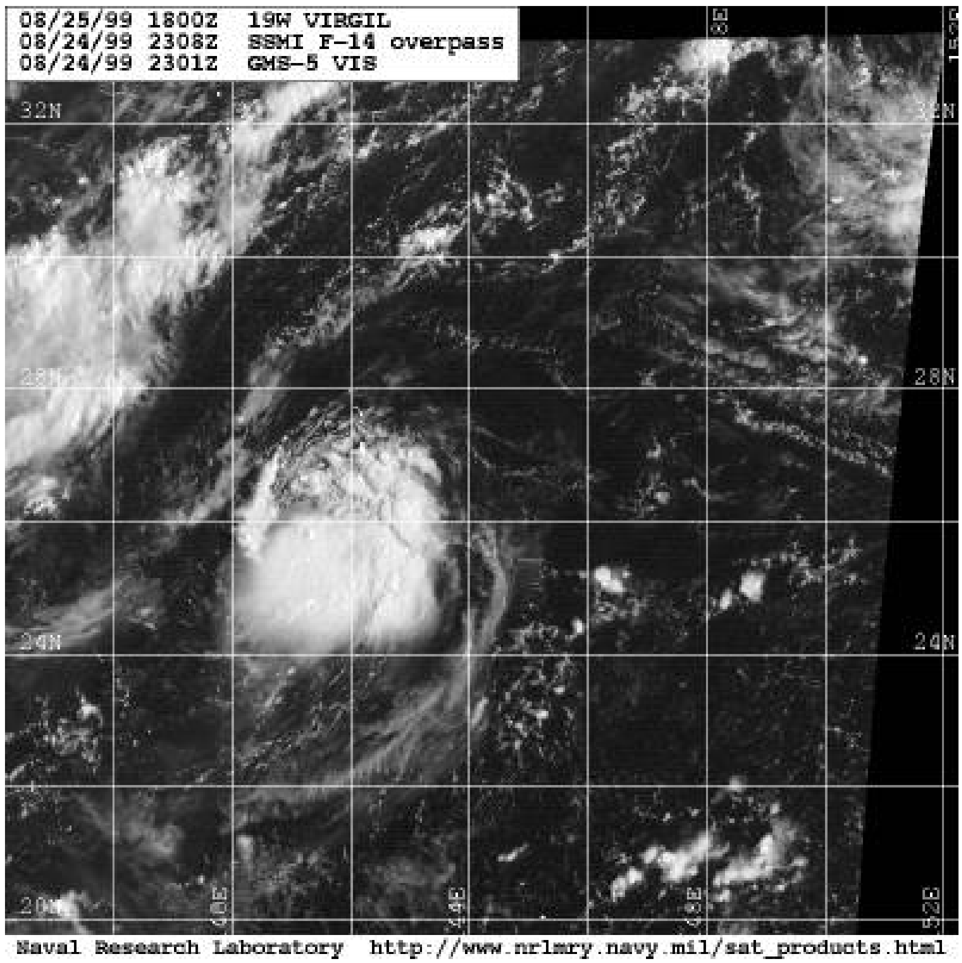


Figure 1-19-2. 242308Z visible image showing the tropical disturbance that 6 hours later developed into TY Virgil (19W) with an intensity of 65 kts. This explosive development was the result of the the upper-tropospheric low filling, and no longer restricting the outflow of the system.

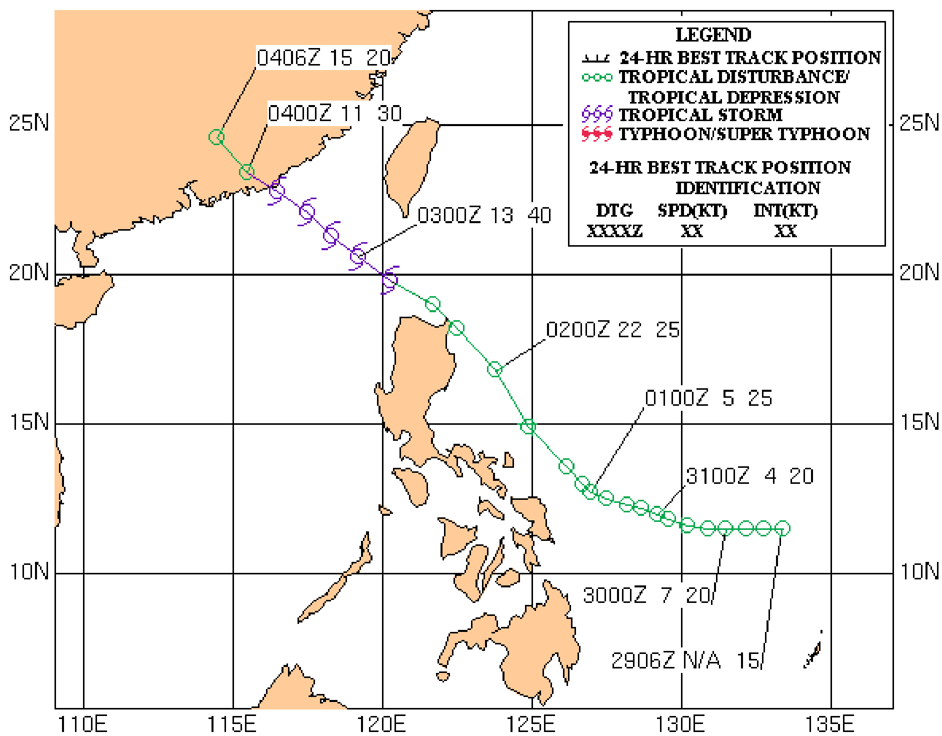
Tropical Storm Wendy (20W)

Tropical Storm (TS) Wendy (20W) formed over the Philippine Sea then tracked northwestward clipping northeastern Luzon, to make landfall in southeast China, east-northeast of Hong Kong about 5 days after initial detection. This cyclone attained a peak intensity of 40 kt while passing through the northern portion of the South China Sea.

A Tropical Cyclone Formation Alert was issued at 310230Z August as convection developed over a broad low-level circulation. This convection continued to slowly consolidate and the first warning was issued at 010300Z September for a 25 kt tropical depression.

This cyclone continued to track northwestward while accelerating and then slowed and turned more westward after skirting the northeastern coast of Luzon. TS Wendy (20W) reached a maximum intensity of 40 kt in the South China Sea at 030300Z September then made landfall approximately 120 nm east-northeast of Hong Kong at 031900Z September as a 40 kt tropical storm.

JTWC issued the 13th and final warning on 040300Z as TS Wendy moved inland and dissipated. The Hong Kong Observatory reported no significant damage.



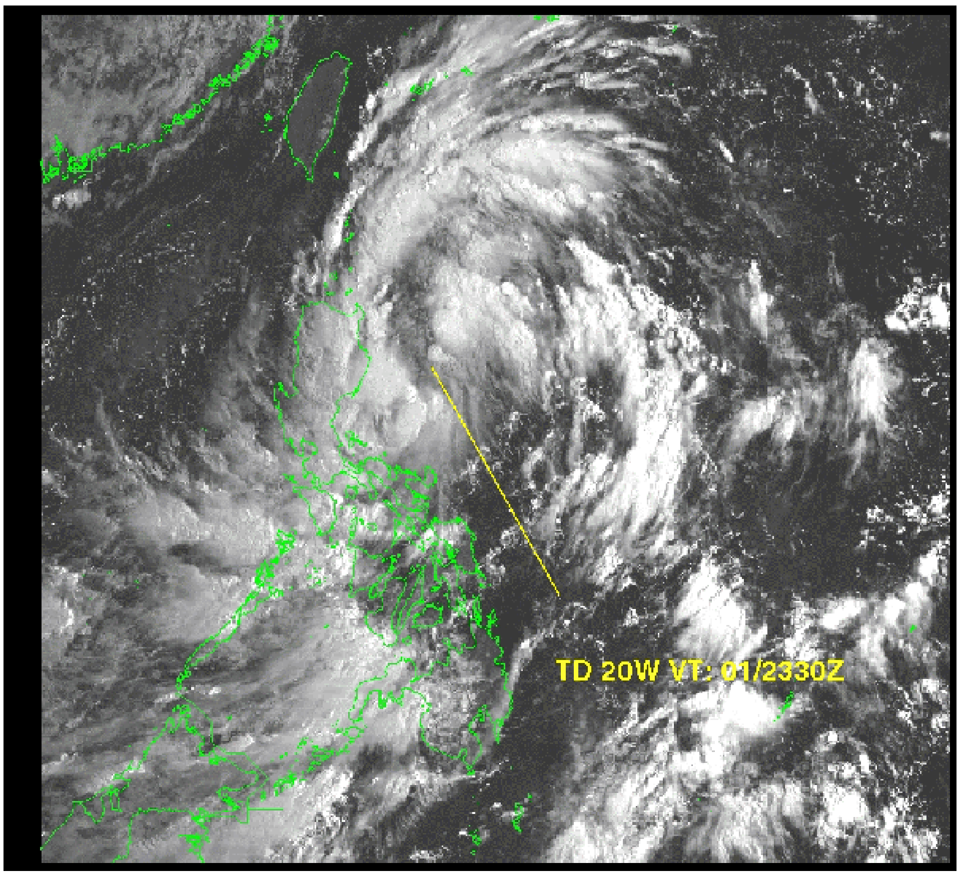


Figure 1-20-1. 012330Z September visible satellite image of a developing TS Wendy (20W) at 25 kt intensity, just east of Luzon.

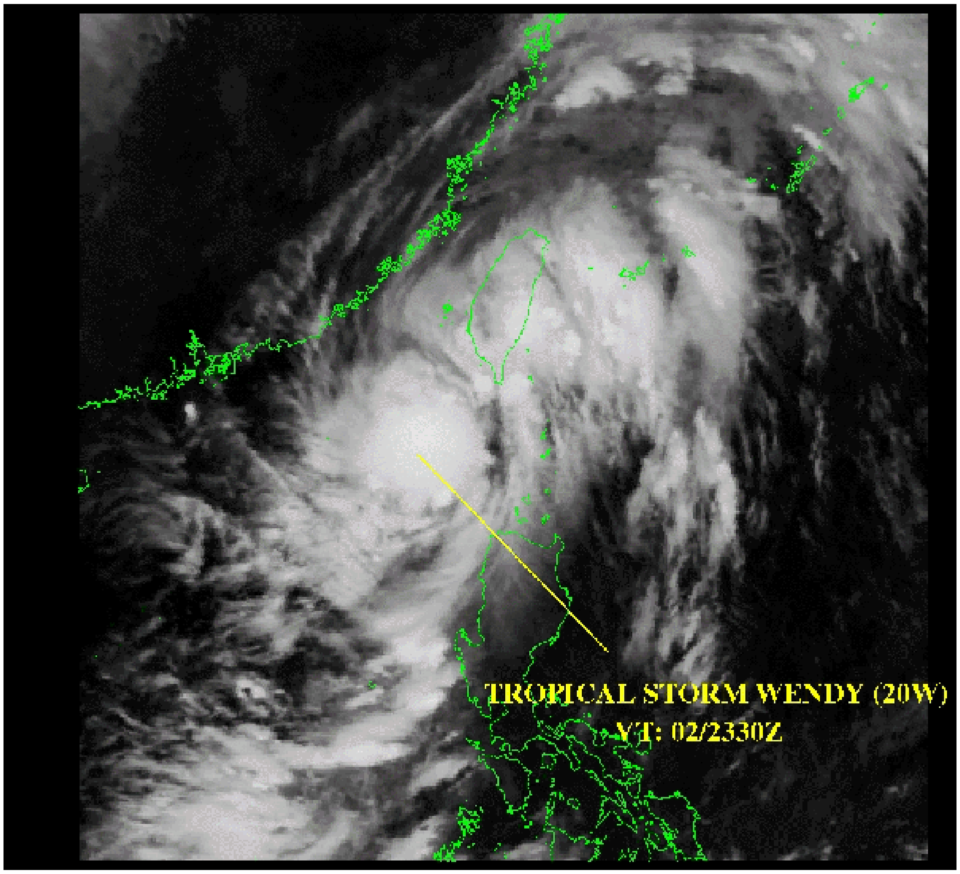


Fig 1-20-2. 022330Z September visible satellite image of Tropical Storm Wendy (20W) at its maximum intensity (40 kt), southwest of Taiwan.

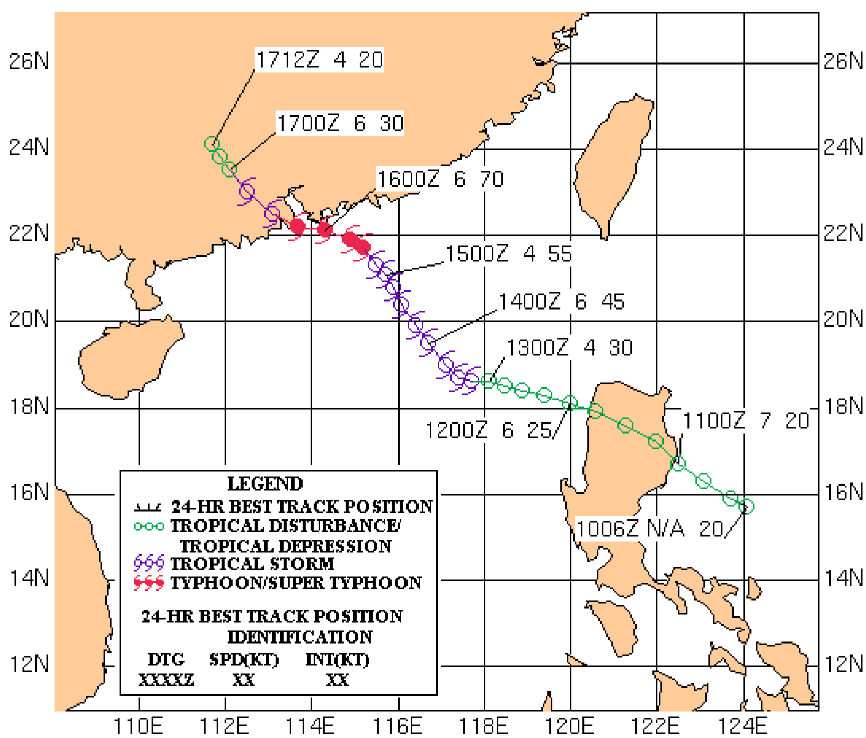
Typhoon York (21W)

Typhoon York (21W) initially formed in the Philippine Sea, slowly intensified in the South China Sea, and proceeded northwest into Hong Kong. News reports stated it was the worst tropical cyclone to hit Hong Kong in 16 years.

The disturbance that became Typhoon York developed in a broad region of cyclonic low level flow and scattered deep convection in the Philippine Sea. JTWC began tracking the disturbance on 061200Z September and issued a Tropical Cyclone Formation Alert (TCFA) at 100300Z September. The cloud system however, failed to develop as it began to interact with the terrain of Luzon. A second TCFA was issued 24 hours later as upper-level outflow became more favorable, and the mid-level vortex appeared to reconsolidate and organize in a region of deep convection.

The first warning was issued at 112100Z as a 25 kt tropical depression as the system began to slowly intensify and track northwestward, it subsequently attained tropical storm intensity over the South China Sea around 130900Z September (Figure 1-21-1). Typhoon York (21W) peaked at 70 kt on 151800Z as it moved toward Hong Kong and made landfall near 160900Z (Figure 1-21-2). JTWC issued the 22nd and final warning at 170300Z as the cyclone moved inland and dissipated.

The Hong Kong Observatory reported 2 fatalities with more than 500 people injured and direct economic losses, amounting to several billion Hong Kong dollars. The Hong Kong Observatory further reported that the last time typhoon force winds were measured in Hong Kong was in 1983.



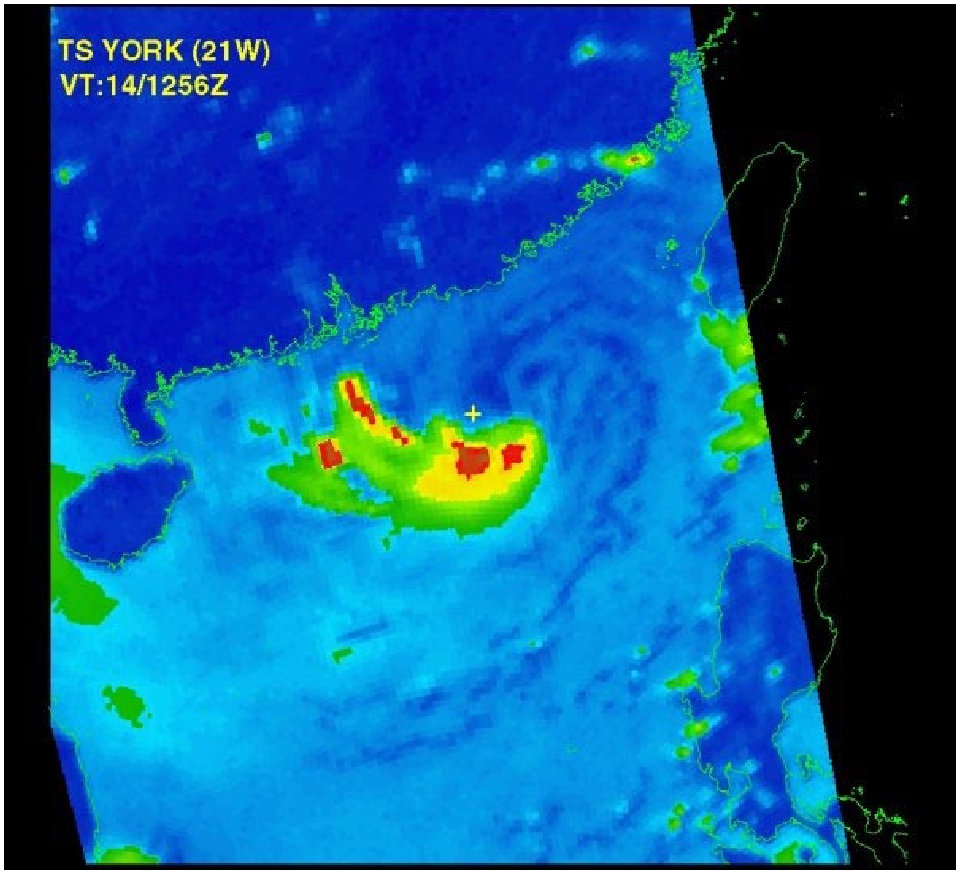


Figure 1-21-1. A special sensor microwave satellite image of developing Tropical Storm York (21W) at 141256Z September, in the South China Sea southeast of Hong Kong.

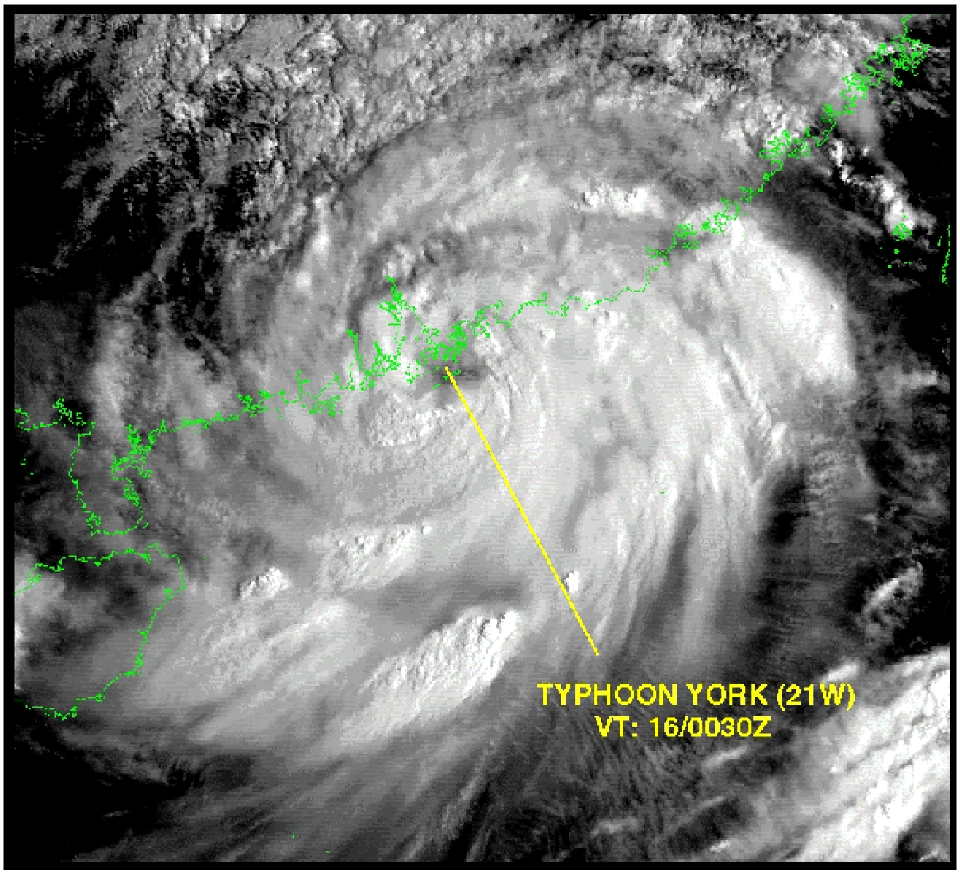


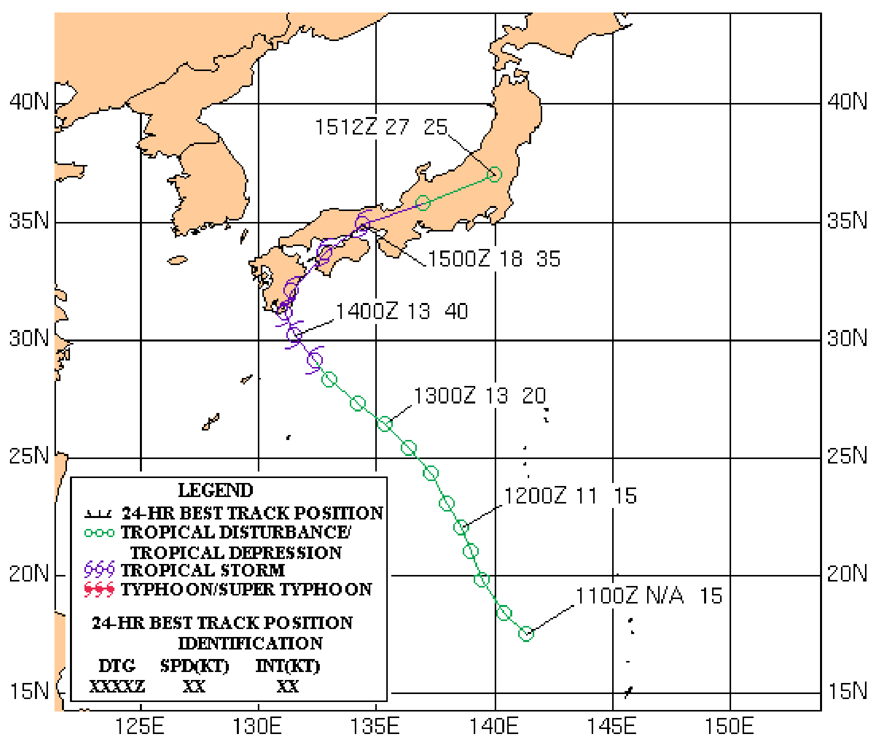
Figure 1-21-2. A visible geostationary satellite image of Typhoon York (21W) near peak intensity at 160030Z September, near Hong Kong.

Tropical Storm Zia (22W)

Tropical Storm (TS) Zia (22W) formed in the Philippine Sea and tracked northwestward making landfall approximately 50 nm south of Kushima, Kyushu with a maximum intensity of 45 kt. TS Zia then tracked over Honshu and dissipated.

TS Zia (22W) developed as a disturbance in the monsoon trough west of the Mariana Islands. JTWC began tracking the disturbance on 110000Z September and issued a Tropical Cyclone Formation Alert (TCFA) at 121000Z September. JTWC subsequently cancelled the TCFA as the convection associated with the low level circulation center (LLCC) was displaced well to the south. On 131730Z September, JTWC reissued a TCFA as convection began to rebuild over the exposed LLCC and outflow aloft dramatically improved due to the presence of a tropical upper-tropospheric low positioned to the northwest of the low level circulation center.

The first warning was issued at 132100Z September for a 35 kt tropical storm. TS Zia (22W) peaked at 45 kt on 140600Z as it moved toward the coast of Kyushu and made landfall at 140730Z. JTWC issued the 7th and final warning at 150900Z as the cyclone weakened to 20 kt and merged with a shear line near Fukushima, Honshu.



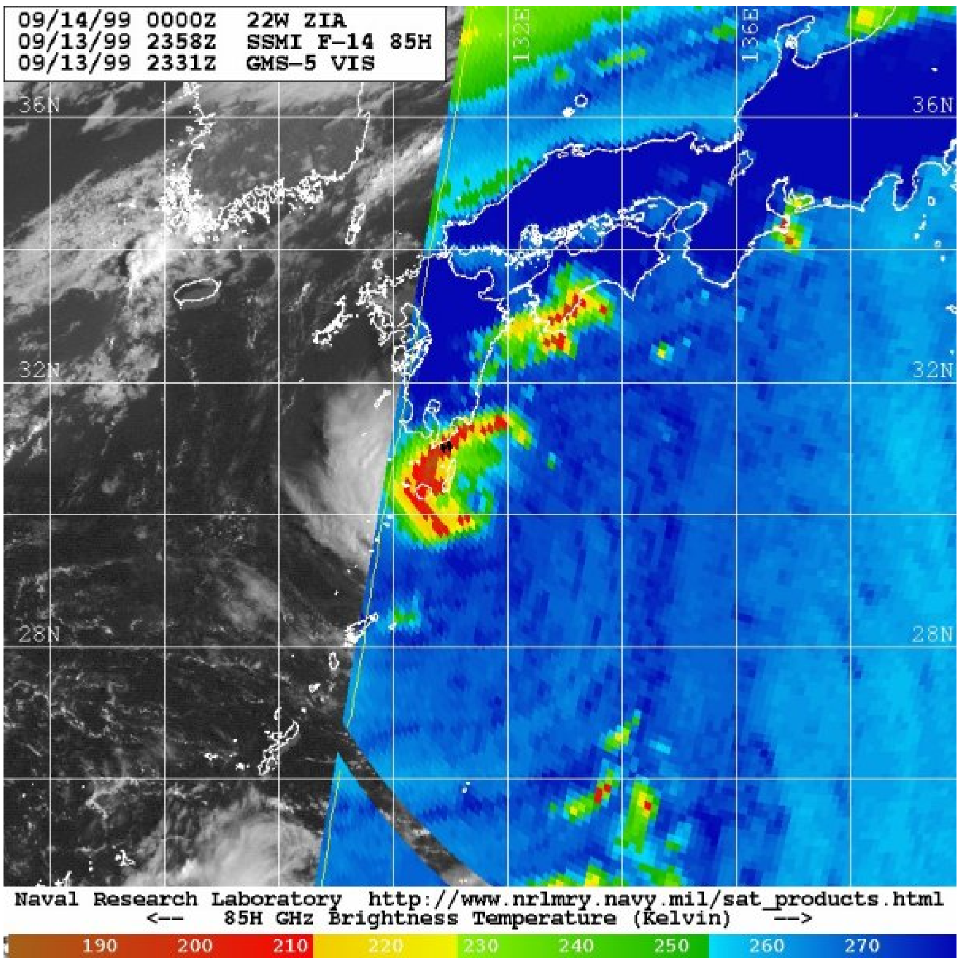


Figure 1-22-1. 132358Z September Special Sensor Microwave Imager pass depicting TS Zia (22W) just before it moved over the Kyushu coast as a 45 kt system.

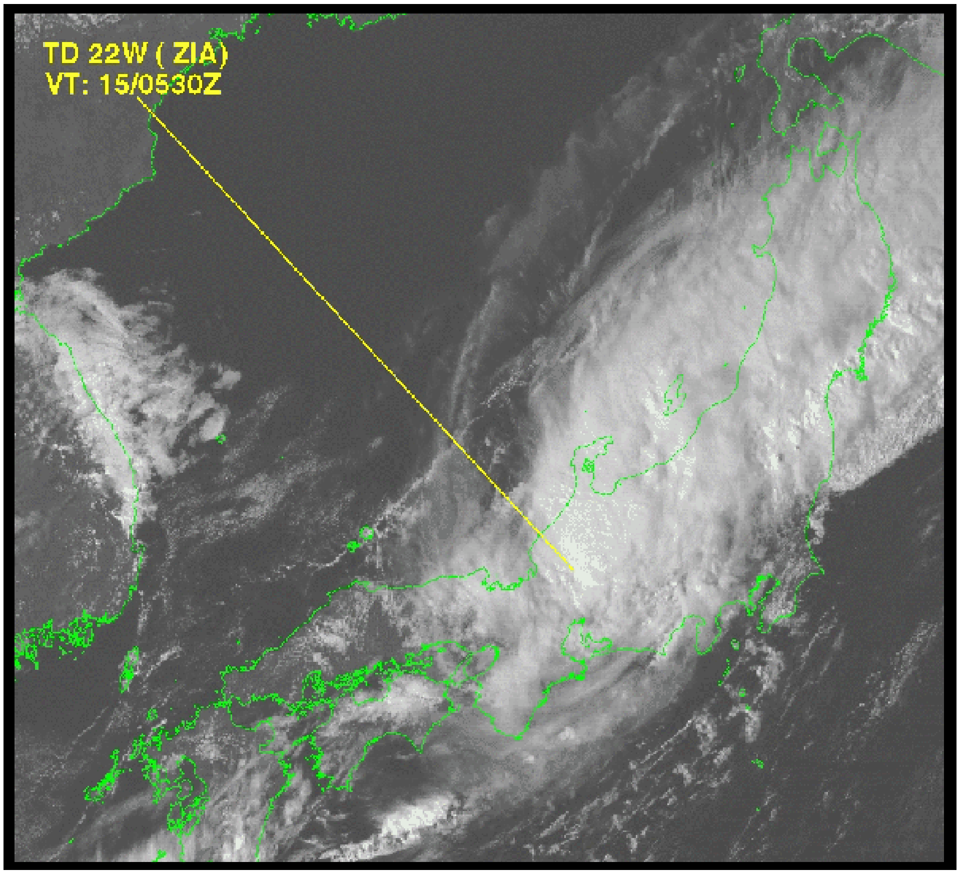


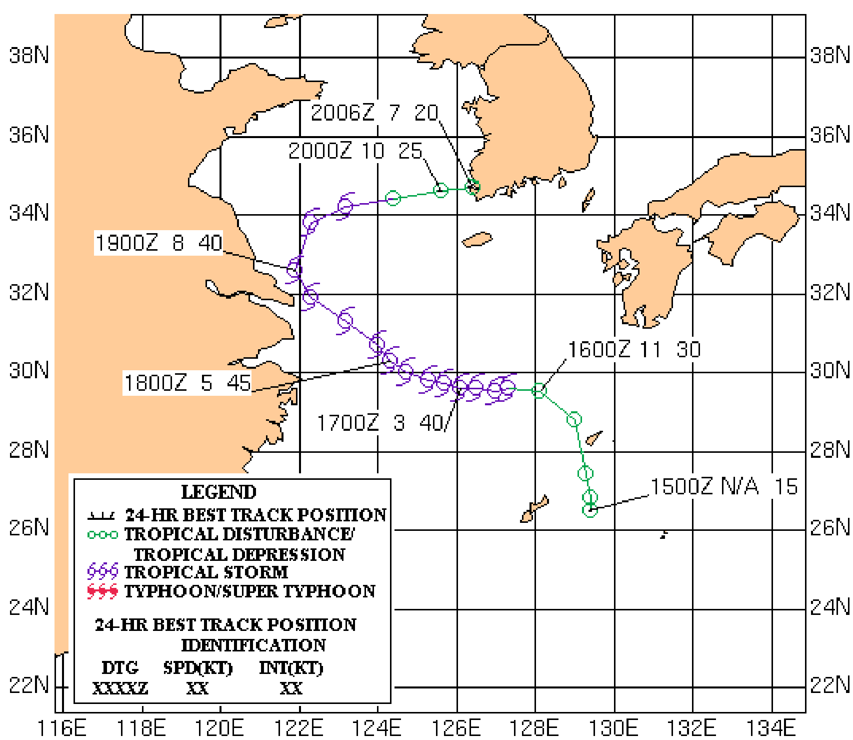
Figure 1-22-2. 150530Z September GMS-5 visible image shows TS Zia (22W) as an extratropical system along a shear line. Current intensity is 30 kt.

Tropical Storm Ann (23W)

Tropical Storm (TS) Ann (23W) formed about 90 nm east of Okinawa in mid September. This cyclone peaked at 45 kt over the southern portion of the Yellow Sea and then weakened as it moved under moderate to strong mid-latitude westerlies before dissipating on 20 September near the southwest coast of the Republic of Korea (ROK).

TS Ann (23W) initially tracked northward under the weak low/mid-level steering influence of the subtropical high over the northern Mariana Islands. JTWC issued the first warning on 152100Z September as a tropical depression. TS Ann then took a northwestward track, and reached a maximum intensity of 45 kt on 171200Z September.

TS Ann (23W) remained at 45 kt until 19 September. TS Ann then began to weaken under a moderate vertical wind shear environment generated by the mid-latitude westerlies. TS Ann then took a more northward track as the ridge over southern Japan began to weaken with the approach of a mid-latitude shortwave trough from the northwest. As the trough moved over the Yellow Sea, TS Ann tracked eastward dissipating near Makp'o ROK on 20 September. JTWC issued the 18th and final warning at 200300Z September.



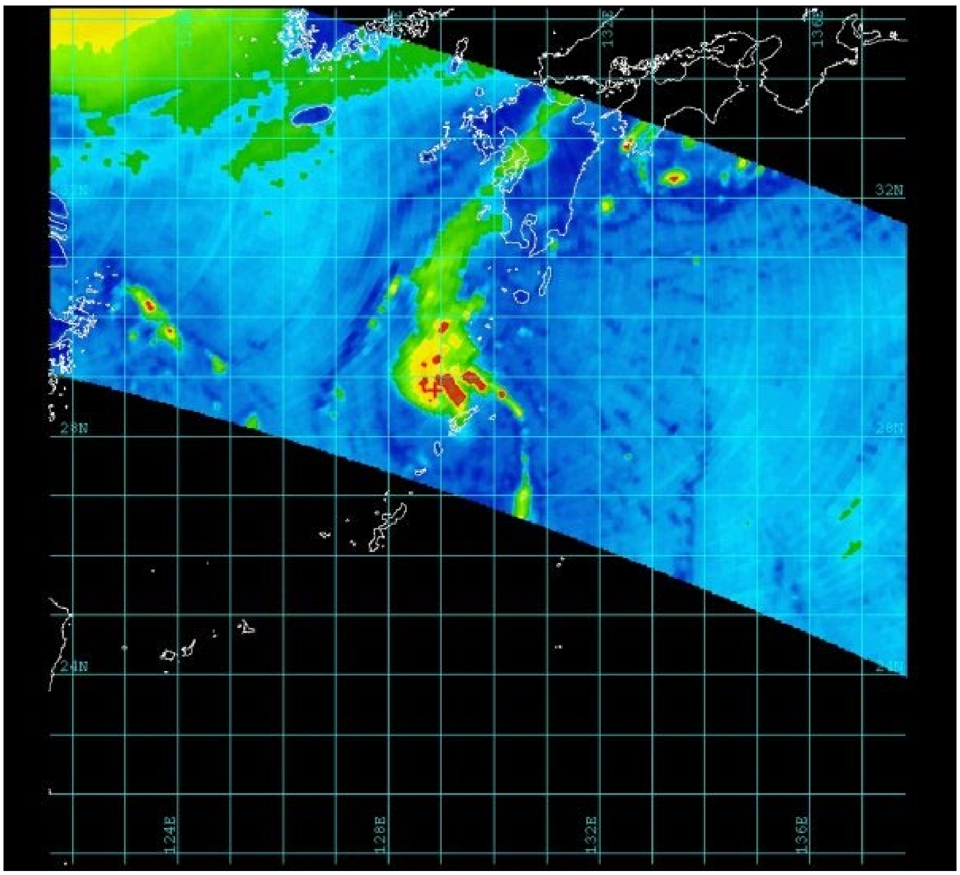


Figure 1-23-1. A Tropical Rainfall Measuring Mission (TRMM) pass of TS Ann (23W) at 30 kt at 151744Z September, off the west coast of Okinawa.

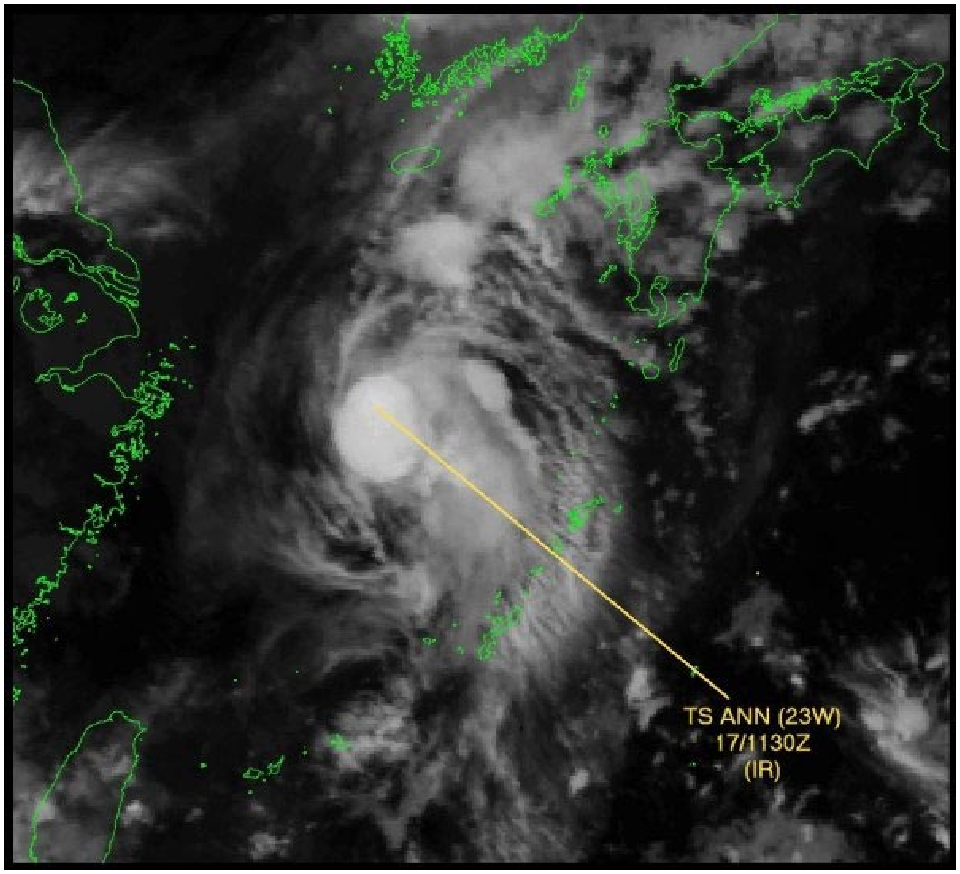


Figure 1-23-2. GMS-5 infrared image of TS Ann (23W) at 171130Z September over the Yellow Sea. Current intensity is 45 kt.

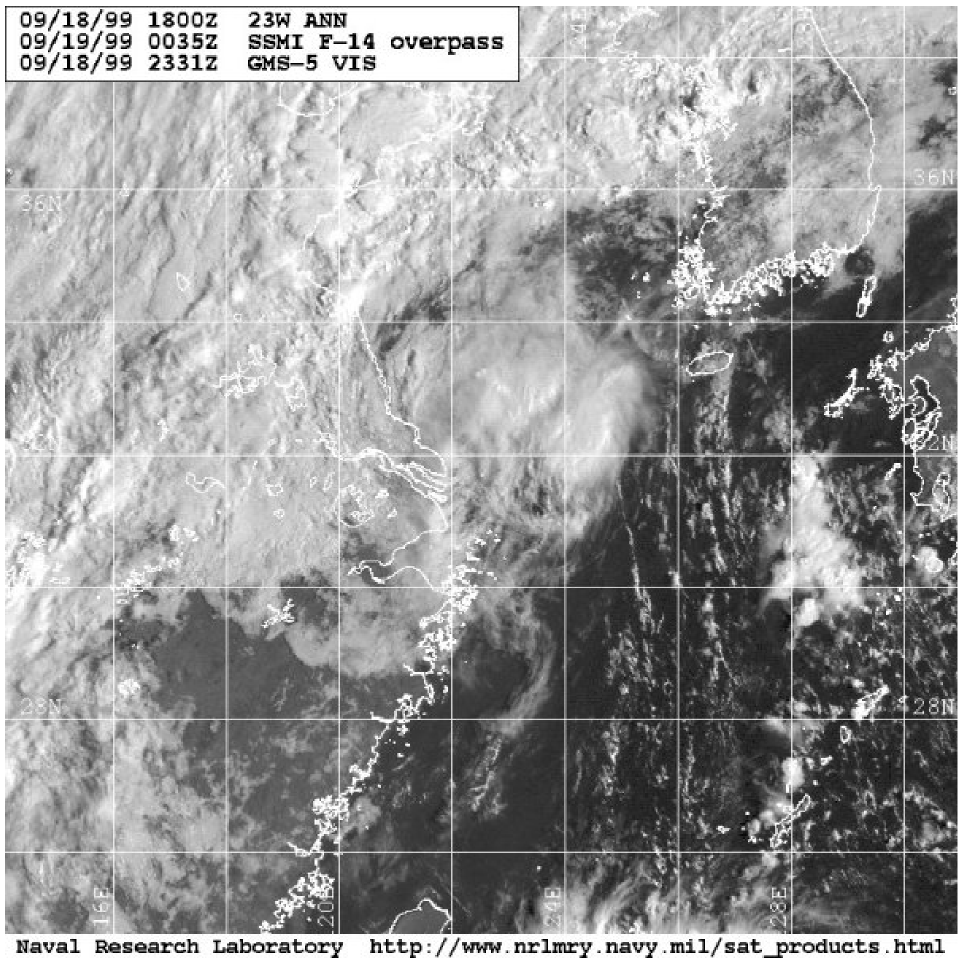


Figure 1-23-3. A GMS-5 visible image of TS Ann (23W) at 182331Z September. The image reveals the mid-latitude system to the northwest and a weakening, less organized, tropical cyclone. Current intensity is 40 kt.

Super Typhoon Bart (24W)

Super Typhoon (STY) Bart (24W), the only super typhoon of the season, developed in the Philippine Sea, south of a pronounced Tropical Upper Tropospheric Trough (TUTT) cell and gradually intensified into the most intense tropical cyclone of the 1999 Northwest Pacific season. STY Bart intensified at a climatological rate until reaching a maximum intensity of 140 kt. The system tracked generally northward and impacted Japan's southernmost islands then moved into the Sea of Japan where rapid northeastward acceleration and extratropical transition occurred.

STY Bart (24W) originated as a weak low level circulation south of a broad TUTT cell, just off the east coast of Taiwan. A Tropical Cyclone Formation Alert was issued at 170300Z September. Initially, poor outflow aloft suppressed development of the circulation and weak low level steering flow created a quasi-stationary environment. As the TUTT cell moved northwestward and began to fill, STY Bart slowly developed with improving outflow aloft. The first warning was issued at 171500Z September as a 25 kt system.

STY Bart (24W) initially tracked northwestward and continued to slowly intensify. Shortly after reaching typhoon intensity at 200000Z September, the cyclone slowed its northwestward track as it moved into a region of weak steering flow between the subtropical ridge cells to the east-northeast and west. STY Bart became nearly quasi-stationary with a slight northward drift. The system then drifted slowly northeastward as it continued to intensify at a climatological rate.

As STY Bart (24W) approached Okinawa, it reached Super Typhoon intensity at 211800Z September and began a slow acceleration northward, passing 40 nm west of Okinawa. STY Bart reached a maximum intensity of 140 kt at 220600Z September and remained very intense as it approached northwestern Kyushu, Japan. STY Bart then moved over the Sea of Japan and continued to accelerate toward the northeast. JTWC issued the 29th and final warning on STY Bart at 241500Z September, as the system became fully extratropical and moved over the northern Japanese island of Hokkaido, and continued to move back over the North Pacific.

STY Bart (24W) had a major impact on both military and civilian interests across the northern Philippine Sea and many parts of Japan. The Associated Press and the Japan Meteorological Agency reported 30 fatalities and 1314 injuries across Japan. Over 800,000 homes were left without power and 18,498 homes flooded due to very heavy rain and numerous landslides. Kadena Air Base on Okinawa reported over 28 inches of rain within a 48 hour period.

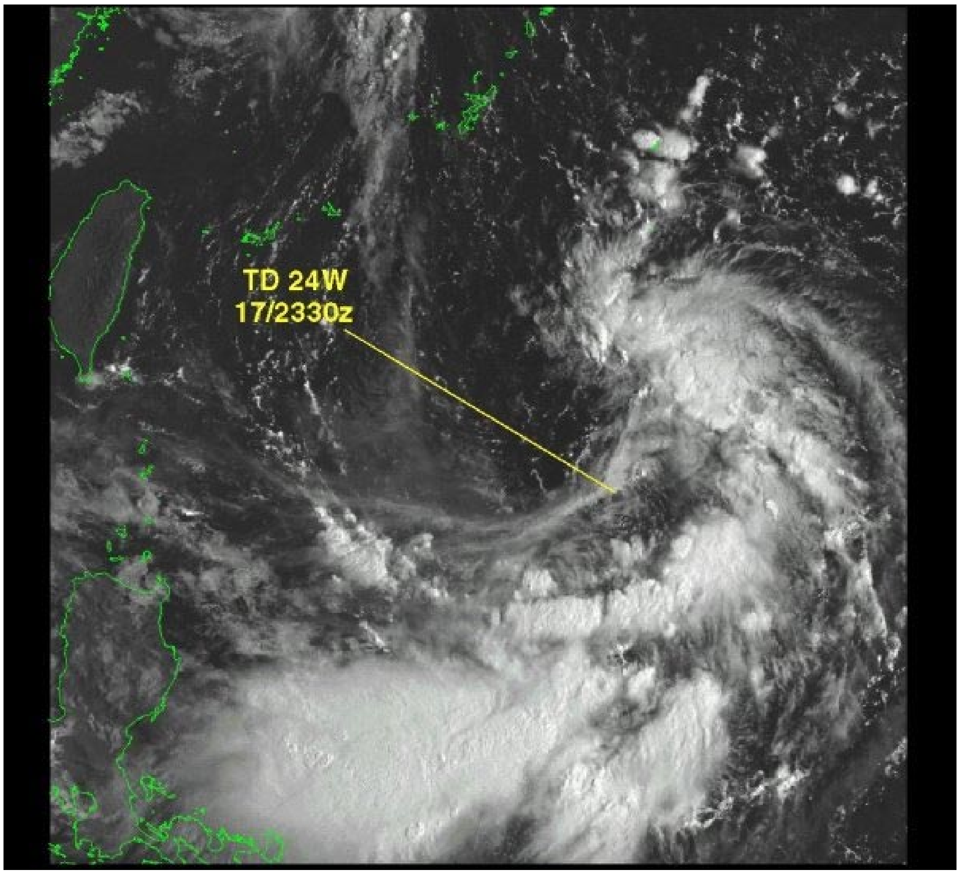


Figure 1-24-1. 172330Z September visible satellite image of STY Bart (24W) as a low-level circulation in the Philippine Sea, south of a TUTT cell (evident by the curved mid-level banding convection to the south and generally clear air to the northwest). This image was only 12 hours after the initial warning. TD 24W was at 25 kt intensity.

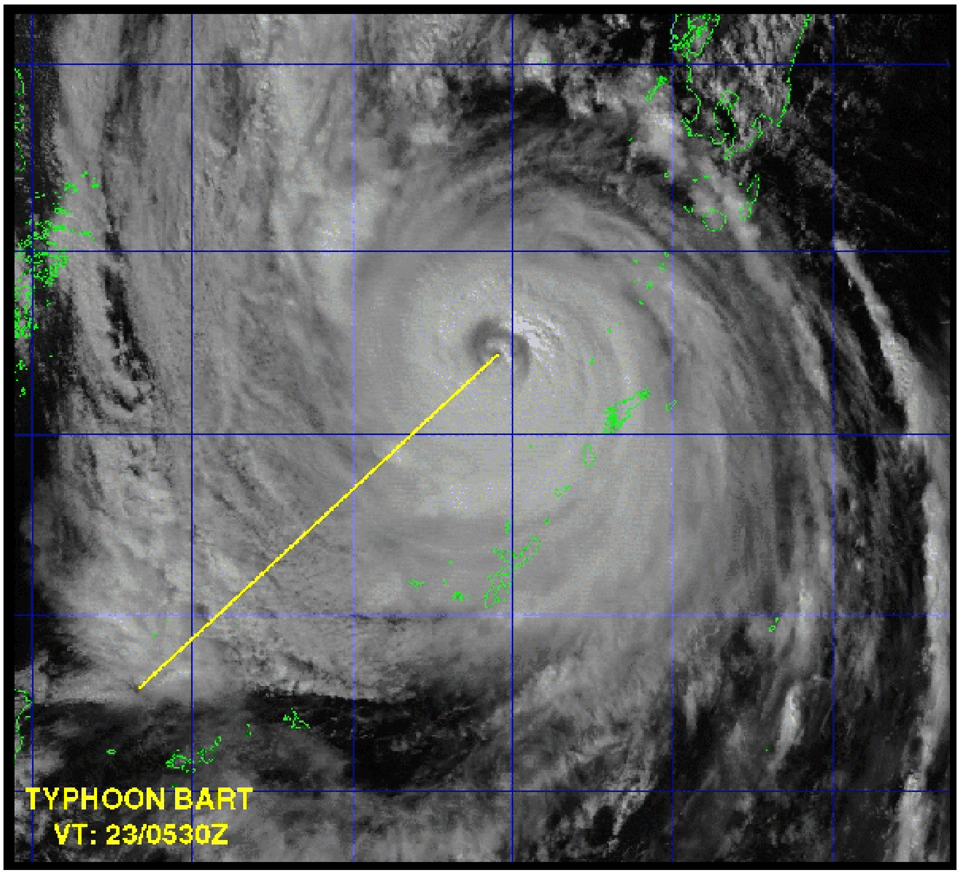


Figure 1-24-2. At 230530Z September, STY Bart (24W) was reaching maximum intensity of 140 kt just west of Japan's southern-most islands. This image reveals a double-eyewall structure.

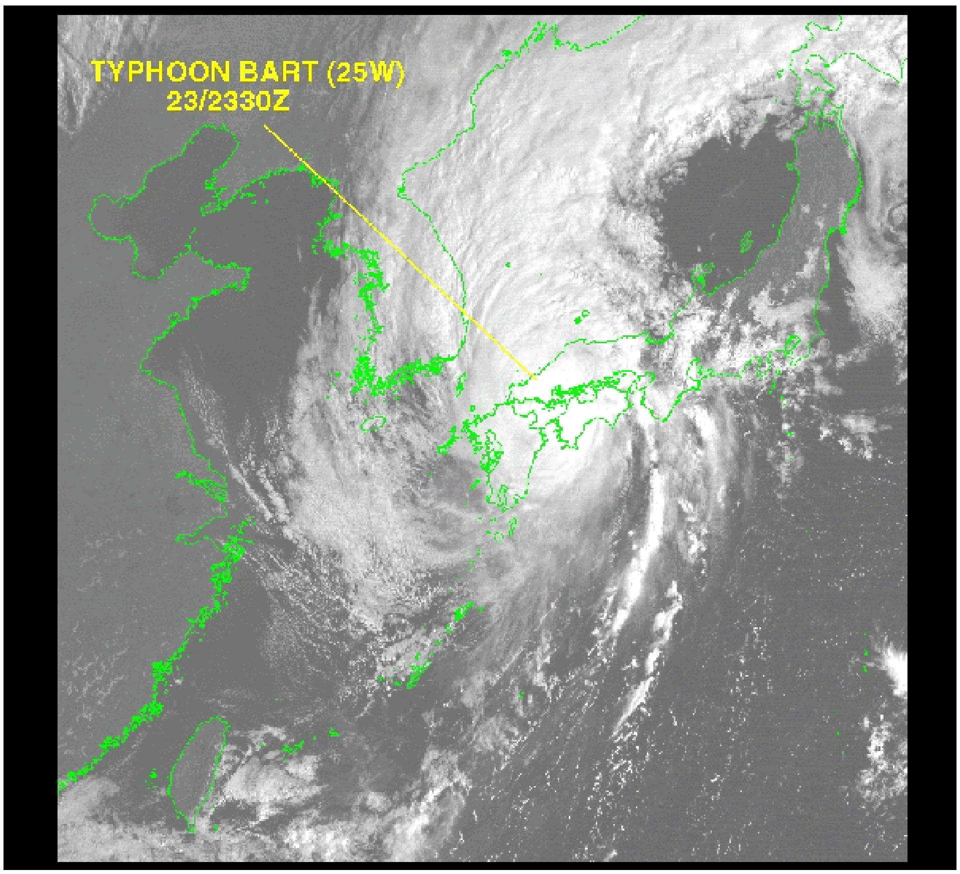
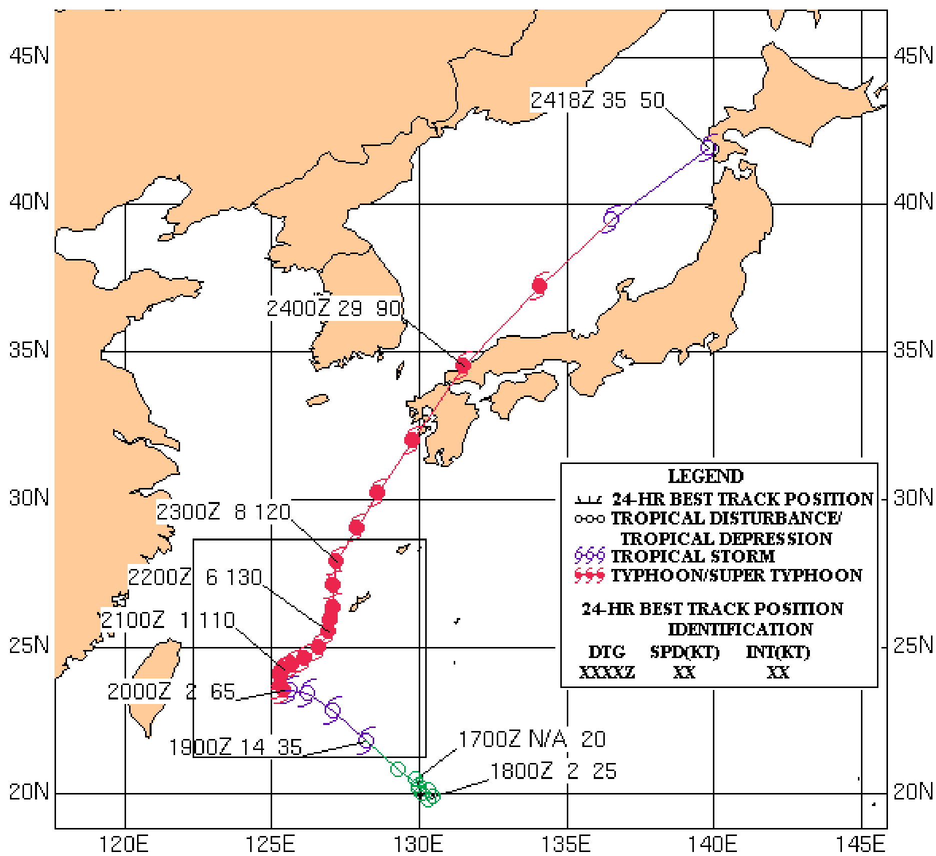


Figure 1-24-3. STY Bart (24W) had quickly passed over Kyushu and was moving into the Sea of Japan in this 232330Z September visible image. Even after significant interaction with land, the cyclone maintained an impressive structure as it moved back over water.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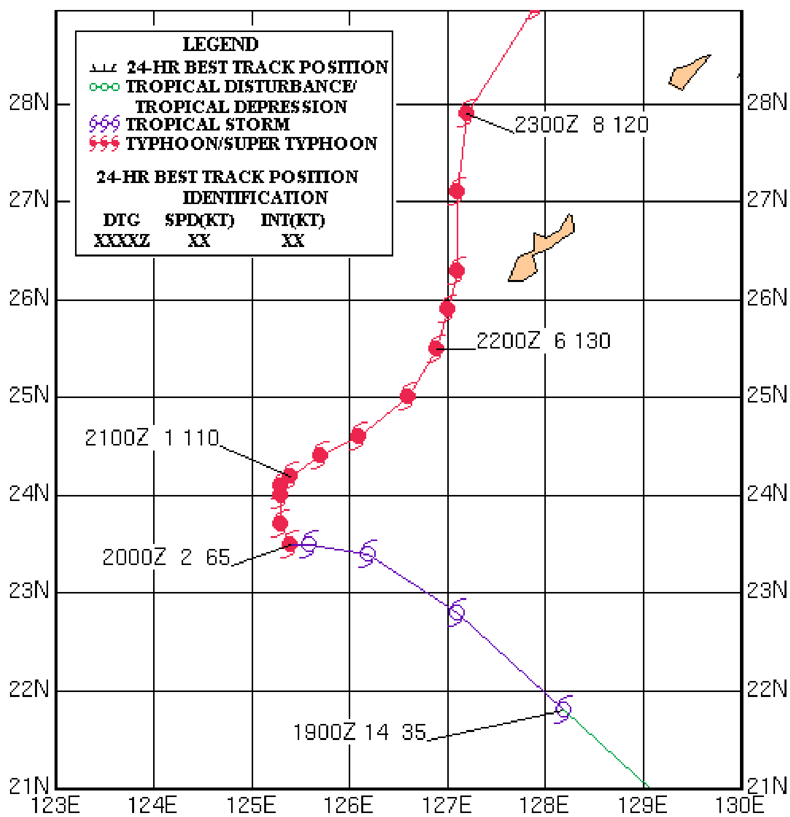
2400Z 29 90
2300Z 8 120
2200Z 6 130
2100Z 1 110
2000Z 2 65
1900Z 14 35
1700Z N/A 20
1800Z 2 25
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG
SPD(KT)
INT(KT)
XXXXZ
XX
XX



LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
2300Z 8 120
2200Z 6 130
2100Z 1 110
2000Z 2 65
1900Z 14 35
28N
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128E
129E
130E

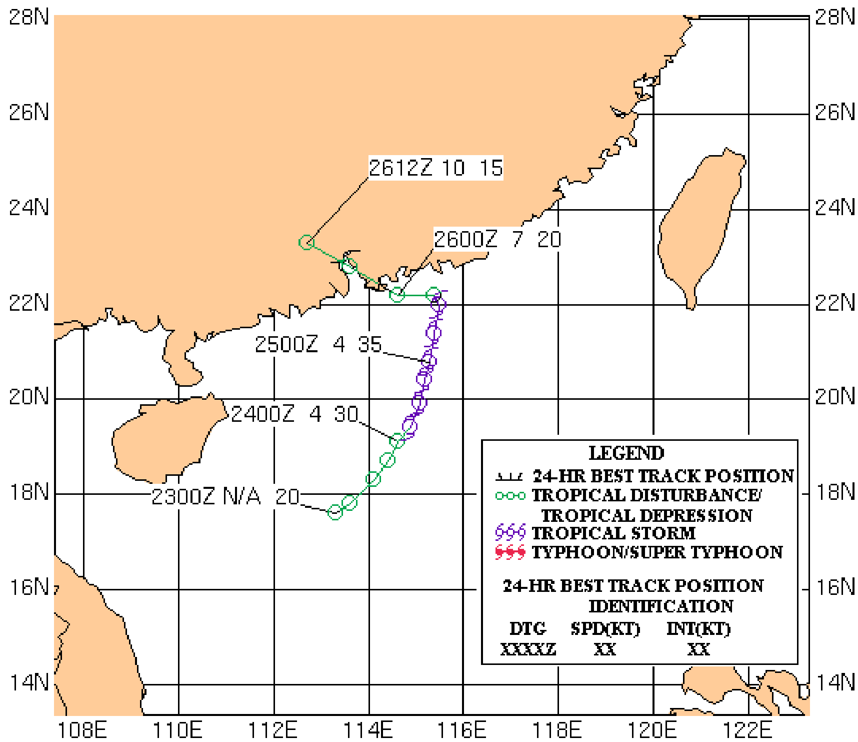
Tropical Storm Cam (25W)

Tropical Storm (TS) Cam (25W) developed in the central South China Sea and became one of four significant tropical cyclones to affect Hong Kong in 1999. After moving north-northeastward for 60 hours, the cyclone abruptly changed direction toward the west and made landfall over Hong Kong as a 20 kt system.

A Tropical Cyclone Formation Alert was issued at 230430Z September. The first warning was issued at 230900Z September for a 30 kt tropical depression. TS Cam (25W) began tracking northeastward under the steering flow of low to mid-level ridging to the east and slowly intensified attaining tropical storm intensity at 240600Z September and a maximum intensity of 40 knots at 241200Z September.

After TS Cam (25W) reached 22N, it abruptly turned west-northwestward in response to increased ridging to the north and consequently made landfall over Hong Kong at 260130Z as a 20 kt system. JTWC issued the 11th and final warning at 252100Z September as the system tracked inland and dissipated.

News reports indicated TS Cam (25W) was responsible for 15 injuries and the disruption of utilities and transportation services in and around Hong Kong.



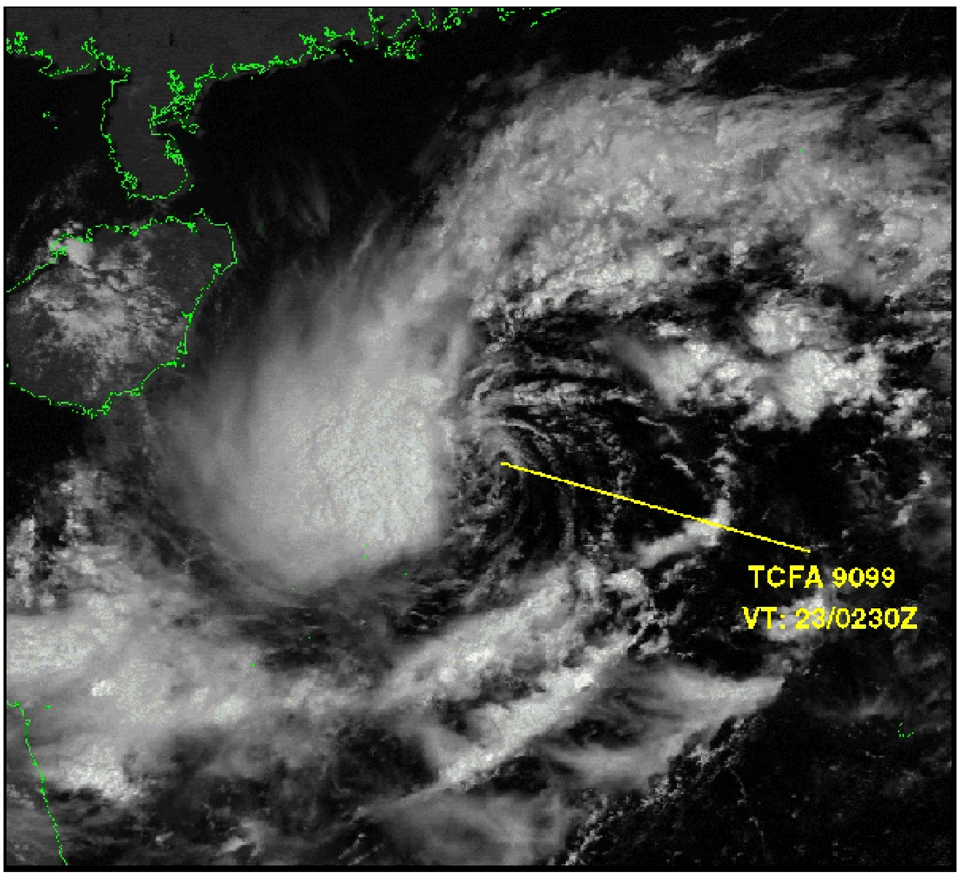


Figure 1-25-1. While a TCFA, this 230230Z September visible image reveals an exposed low level circulation center (LLCC) just east of convection. The convection built over the LLCC and the first warning on TS Cam (25W) was issued at 230900Z September.

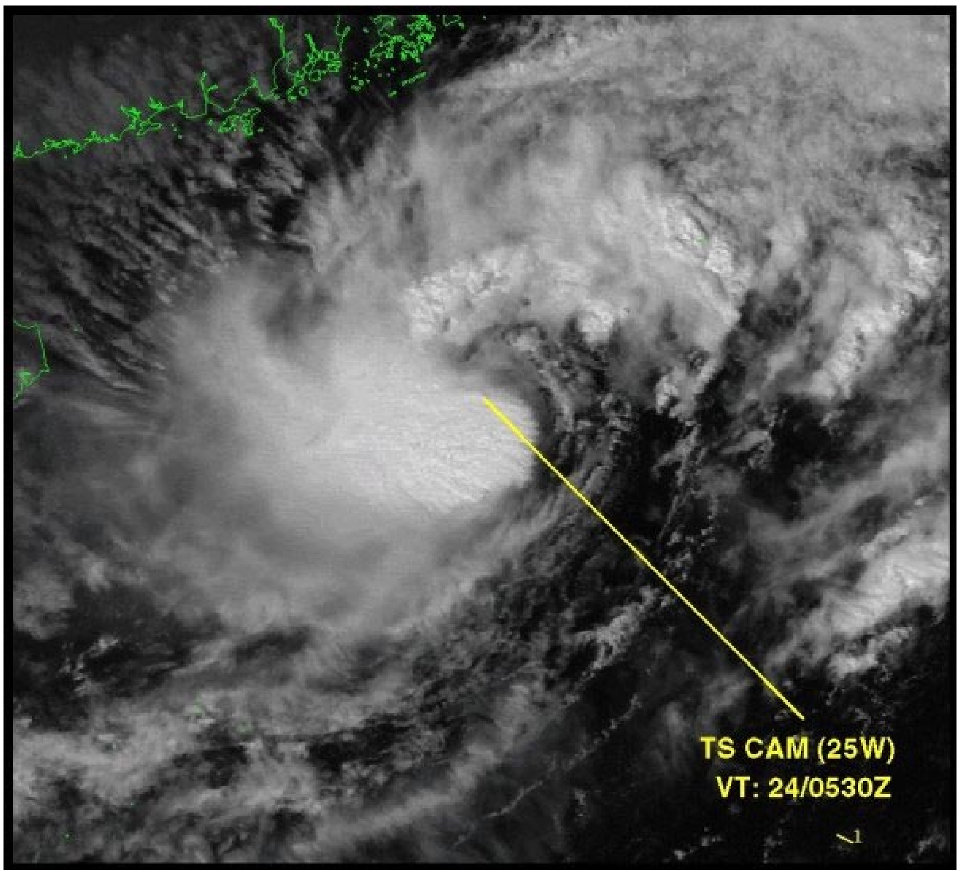


Figure 1-25-2. 240530Z September visible image of TS Cam (25W) at 35 kt intensity. This image reveals a partially exposed low level circulation center just north of the primary convection. Hong Kong lies just to the northwest.

Typhoon Dan (26W)

Typhoon (TY) Dan (26W) developed over the Philippine Sea about 400 nm east of Luzon and reached a peak intensity of 110 kt before brushing the Northern Luzon coast at 050000Z October. TY Dan then moved over the South China Sea and weakened to 80 kt as it entered an increased vertical wind shear environment, then slightly re-intensified, as it approached China making landfall at 090200Z October near Xiamen (Amoy), China. News reports stated TY Dan left a swath of damage and fatalities from Luzon to China.

JTWC issued a Tropical Cyclone Formation Alert at 020230Z October. A Special Sensor Microwave Imager (SSM/I) pass depicted deep convection building over the low-level circulation center (LLCC) from the south. The first warning for TY Dan was issued at 021500Z October as a 25 kt tropical depression. TY Dan initially moved west-northwestward at 8 to 12 kt under the steering influence of the subtropical ridge centered over Japan.

TY Dan (26W) intensified to 110 kt before moving over the northern tip of Luzon. TY Dan decreased to 80 kt as it tracked west into the South China Sea. TY Dan then turned northward as a major shortwave trough moved over the coast of China. The system slowed to 5 to 7 kt and re-intensified to 90 kt as it tracked northward into China. At 100600Z October TY Dan began to weaken and take on extra-tropical characteristics as it moved over the Fujian province. On 101800Z October, TY Dan decreased to 20 kt before becoming absorbed within a frontal system moving over the Yellow Sea. JTWC issued the 35th and final warning at 110300Z October as the cyclone dissipated over the Yellow Sea.

A 7 October AP news report stated TY Dan (26W) produced heavy rains, damaged hundreds of houses and killed at least one person on Luzon, Philippine Islands. According to USA Today, TY Dan killed 30 people and caused $240 million in damage as it battered China's Fujian province. Reports indicated that TY Dan was the worst tropical cyclone to hit the city of Xiamen in 46 years, killing five people and injuring more than 100 people. Collapsing buildings and walls killed seven people in Zhangzhou. Eighteen people were killed in the nearby city of Quanzhou.

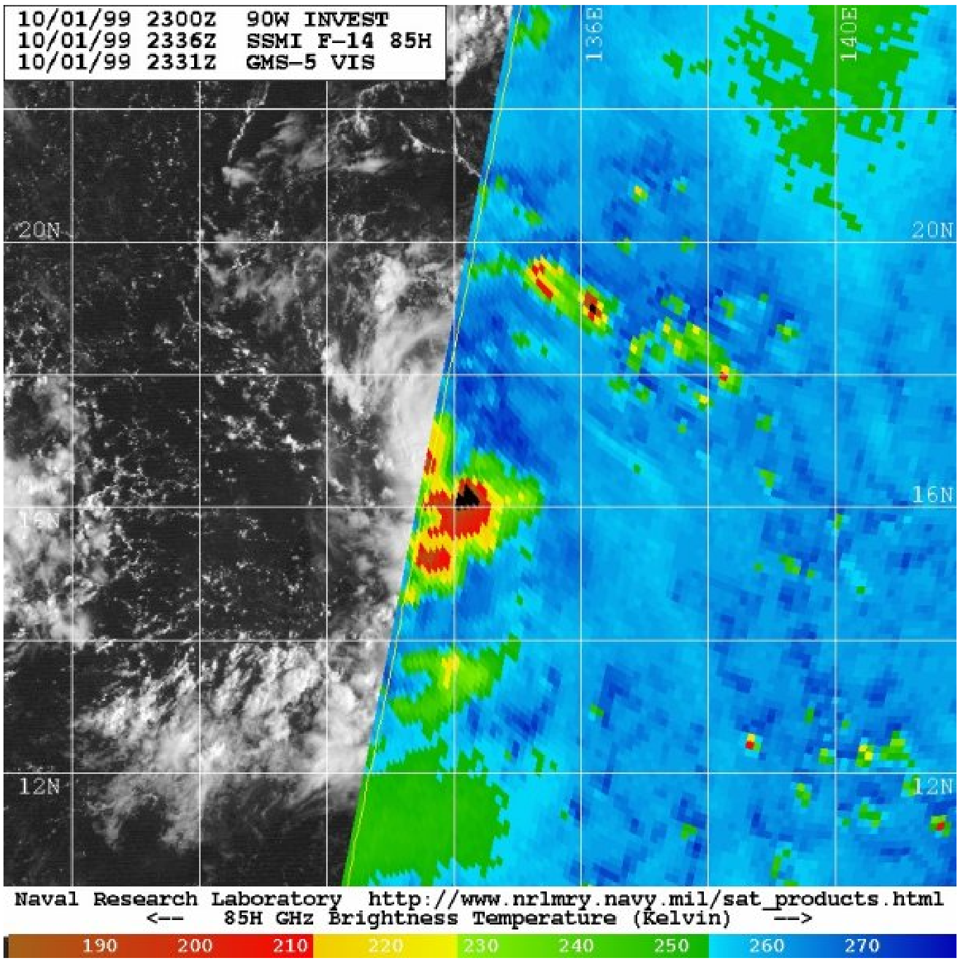


Figure 1-26-1. A 012336Z October Special Sensor Microwave Imager (SSM/I) pass combined with a 012331Z October GMS-5 visible image depicting deep convection building in over the low-level circulation center of TY Dan (26W) from the south. A TCFA was valid at the time and intensity is 20 kt.

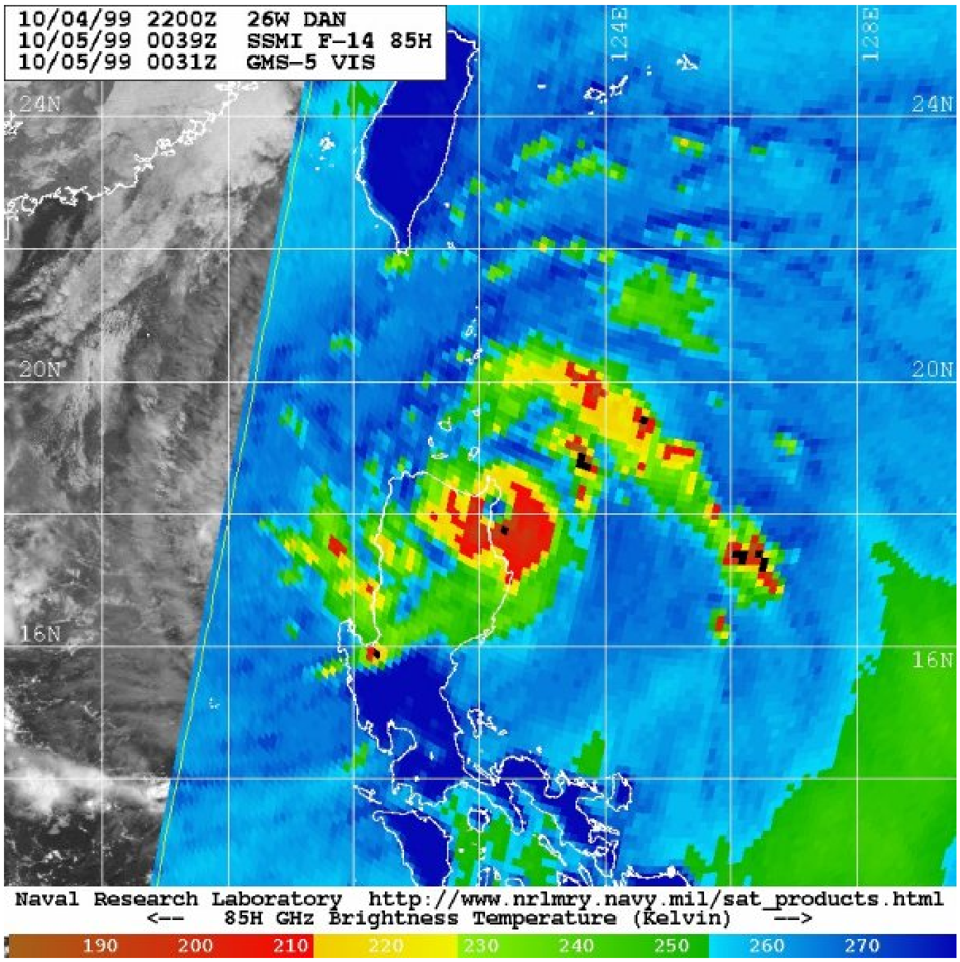


Figure 1-26-2. A 050039Z October Special Sensor Microwave Imager (SSM/I) pass depicting a 26 nm eye with a convective band situated to the northeast. TY Dan (26W) was at its maximum intensity of 110 kt.

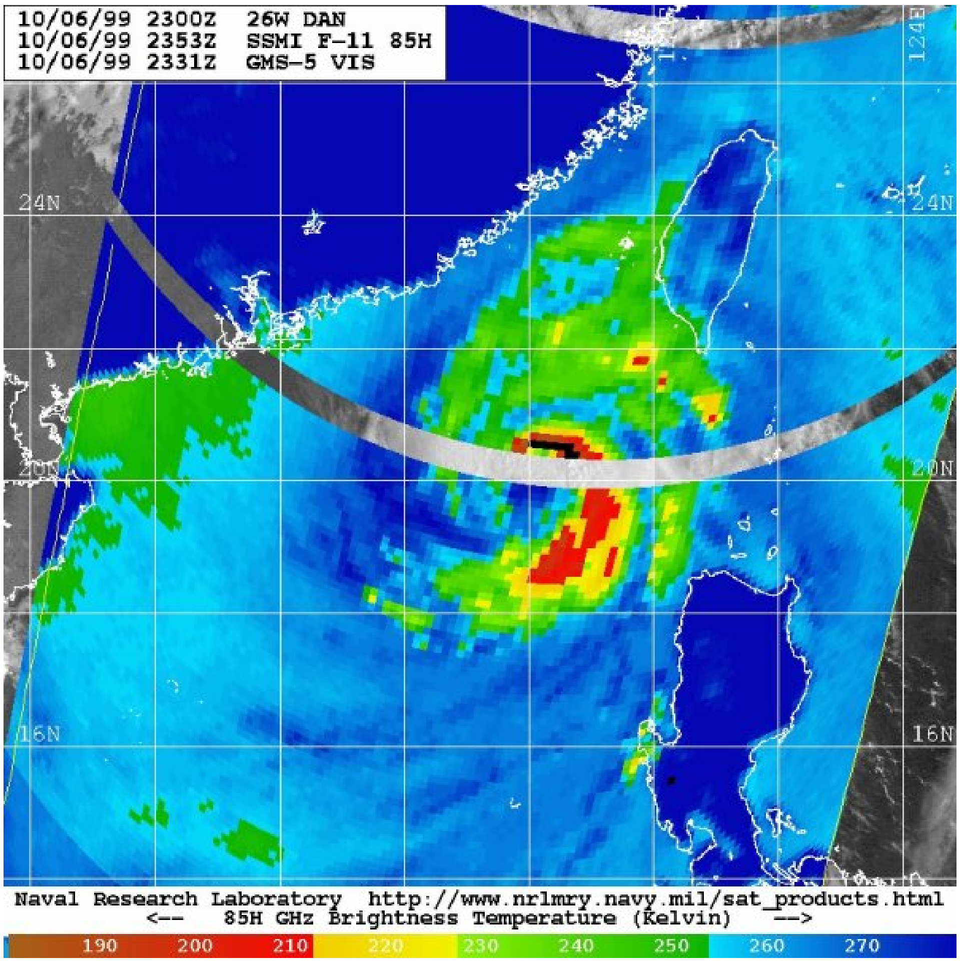


Figure 1-26-3. A 062352Z October Special Sensor Microwave Imager (SSM/I) pass depicting a significant banding feature of TY Dan (26W) extending south through north. Current intensity is 85 kt.

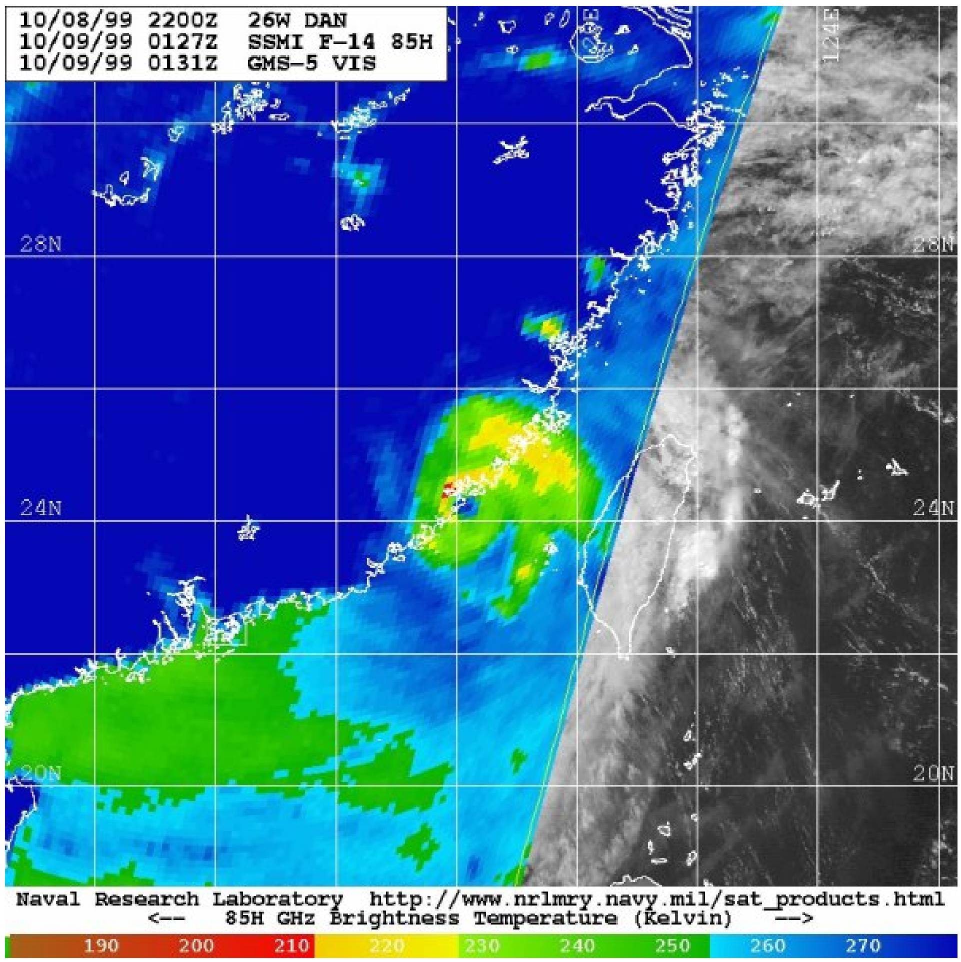


Figure 1-26-4. A 090127Z October Special Sensor Microwave Imager (SSM/I) pass depicting a 24 nm irregular eye and associated banding of TY Dan (26W) moving over the southeast coast of China. Current intensity is 90 kt.

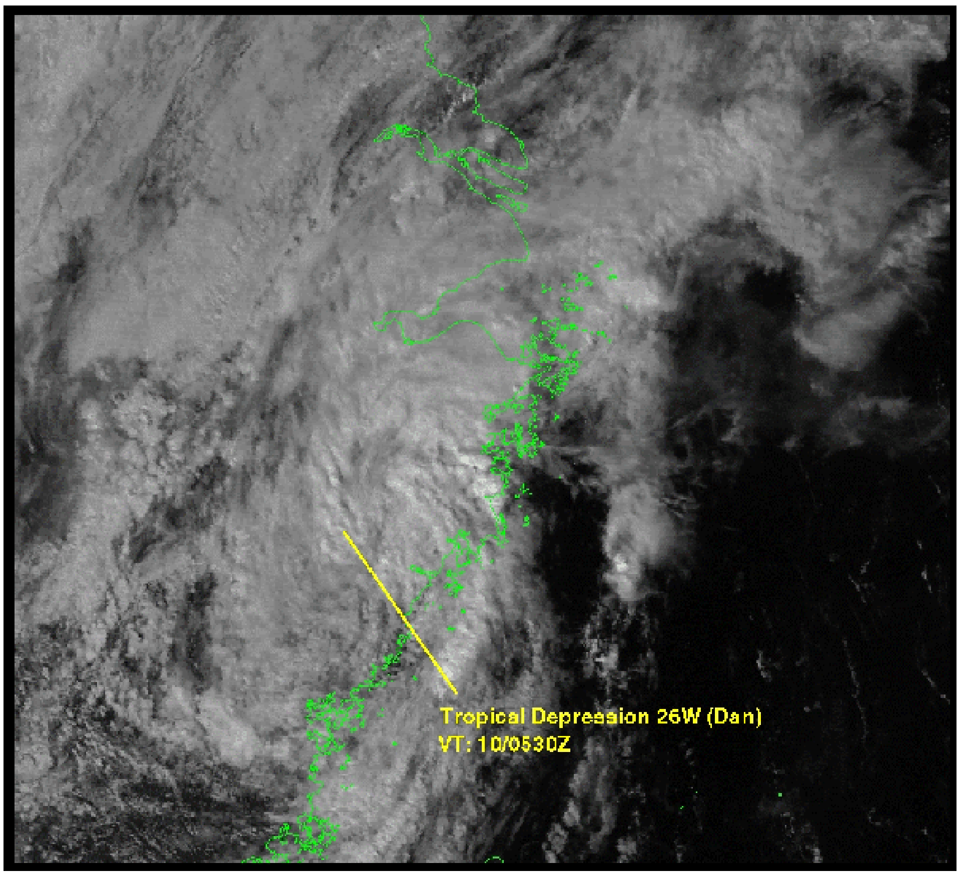


Figure 1-26-5. A 100530Z October GMS-5 visible satellite imagery shows TY Dan (26W) beginning to merge with a frontal system positioned just to the northwest. Current intensity is 25 kt.

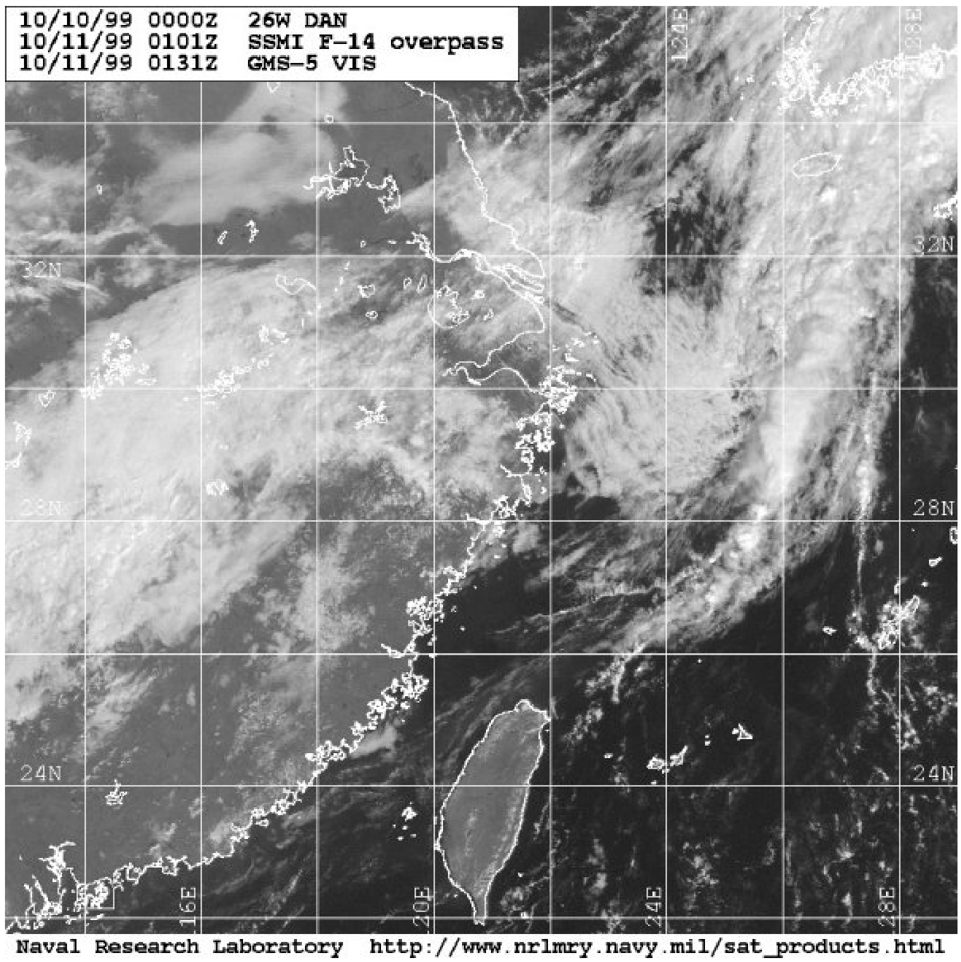
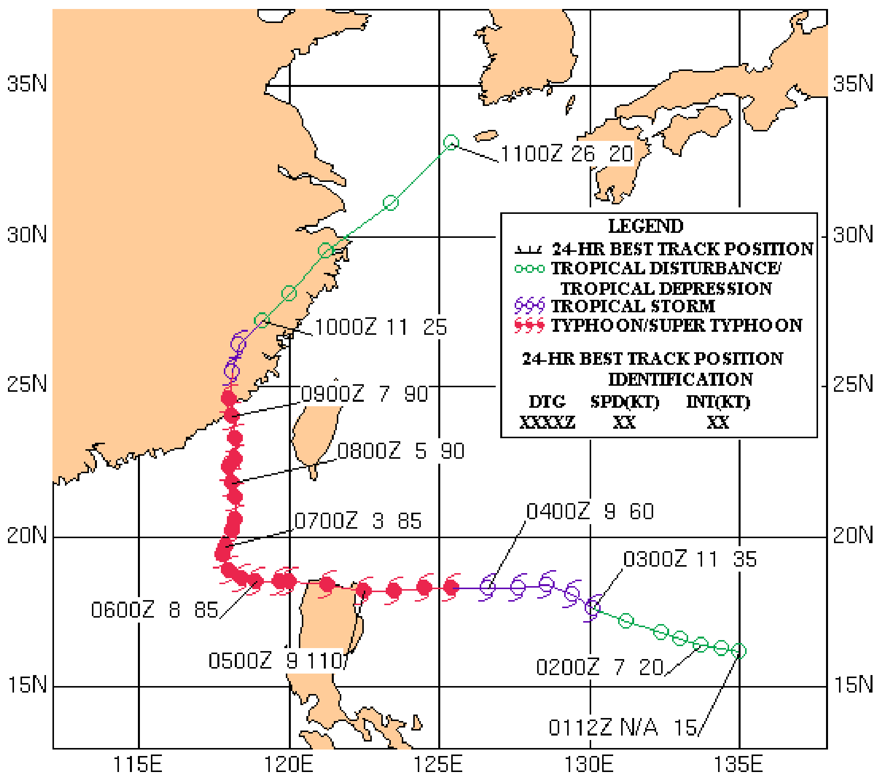


Figure 1-26-6. A 110131Z October GMS-5 visible satellite image shows TY Dan (26W) as an extratropical system now associated with a frontal boundary. Current intensity is 20 kt.


35N
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1000Z 11 25
0900Z 7 90
0800Z 5 90
0700Z 3 85
0600Z 8 85
0500Z 9 110
0400Z 9 60
0300Z 11 35
0200Z 7 20
0112Z N/A 15
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX

Tropical Storm Eve (27W)

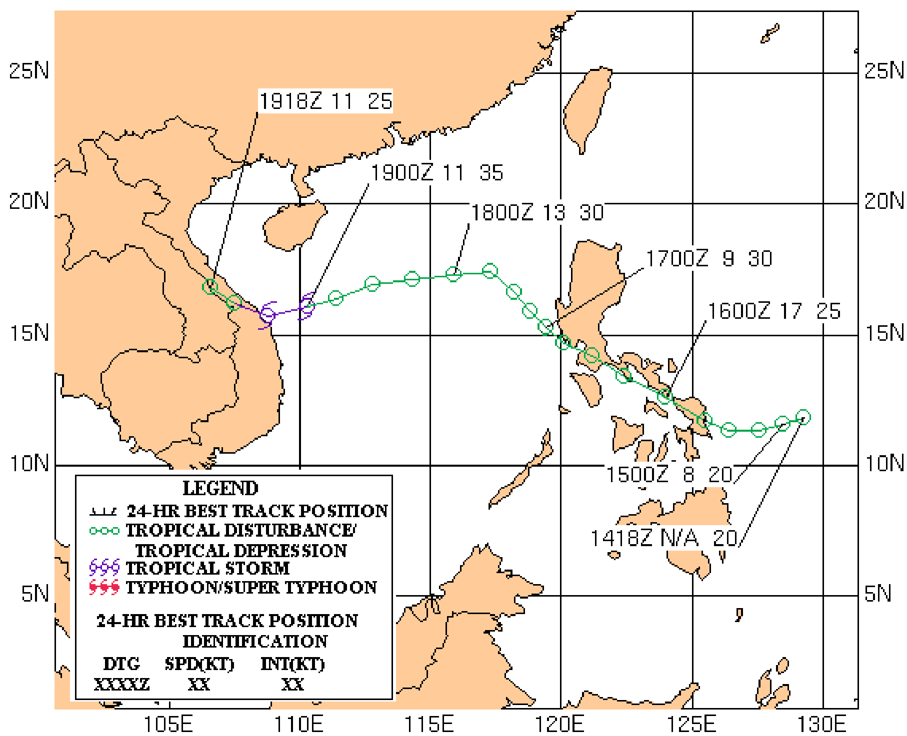
Tropical Storm (TS) Eve (27W) developed over the Philippine Sea and tracked northwestward over Samar and Luzon islands. The cyclone intensified, peaking at 35 kt, over the South China Sea and made landfall on 100600Z October southeast of Da Nang, Vietnam as a 35 kt tropical storm.

TS Eve (27W) was initially detected northeast of Mindanao as a poorly defined low level circulation center with disorganized convection. As organization increased, a TCFA was issued at 150230Z October followed by the first warning at 150900Z October with a 25 kt intensity.

TS Eve (27W) tracked northwestward across the Philippine Islands as a tropical depression. After the cyclone moved over the South China Sea, it turned toward the west, then west-southwest as low to mid-level ridging built north of the system from southeastern China. During this period, the cyclone also intensified into a minimal tropical storm reaching a maximum intensity of 35 kt at 190000Z October.

TS Eve (27W) made landfall at 190600Z October, 60 nm southeast of Da Nang, Vietnam, as a minimal tropical storm (35 kt) and the cyclone quickly dissipated over land. JTWC issued the 18th and final warning at 191500Z October as it moved inland and dissipated.

TS Eve's (27W) torrential rains were the first in a series of heavy rain events that lasted for 2-3 weeks and resulted in over 590 fatalities and $235M in flood damage across Vietnam (Dartmouth Flood Observatory 1999).



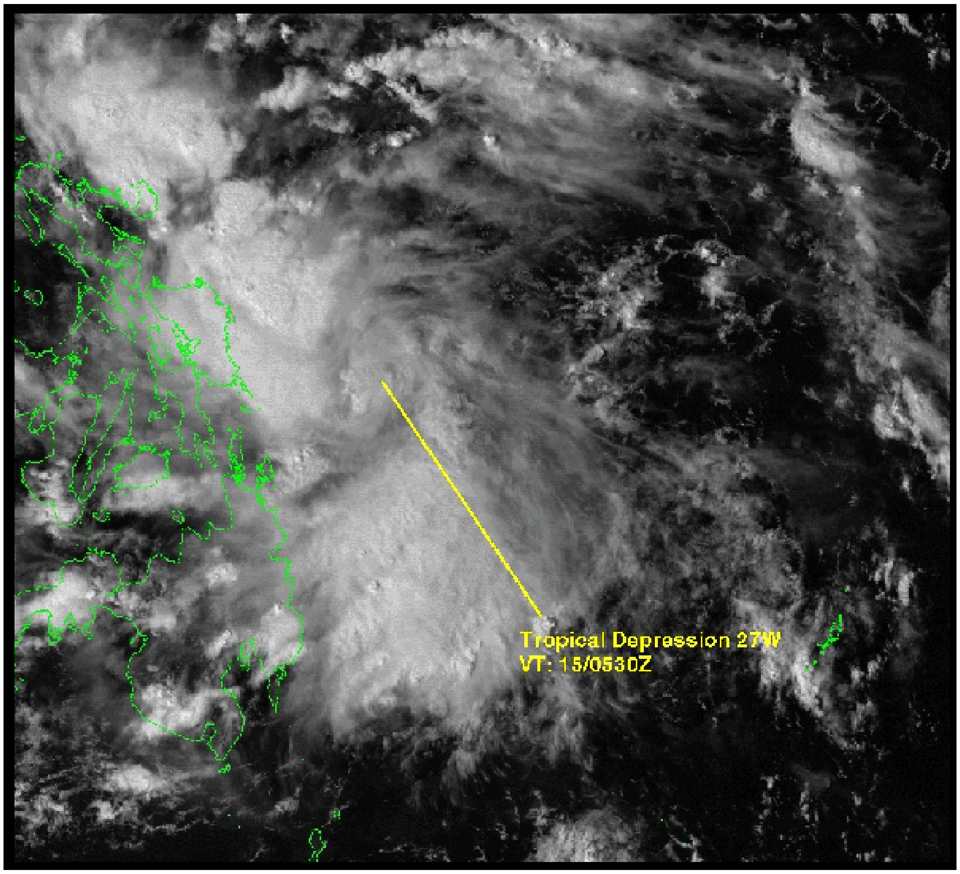


Figure 1-27-1. A visual image of TS Eve (27W), northeast of Mindanao, at 150530Z October. This image reveals the low level circulation center flanked to the northwest and southeast by clusters of convection as the system began to slowly organize. TS Eve is at 25 kt intensity.

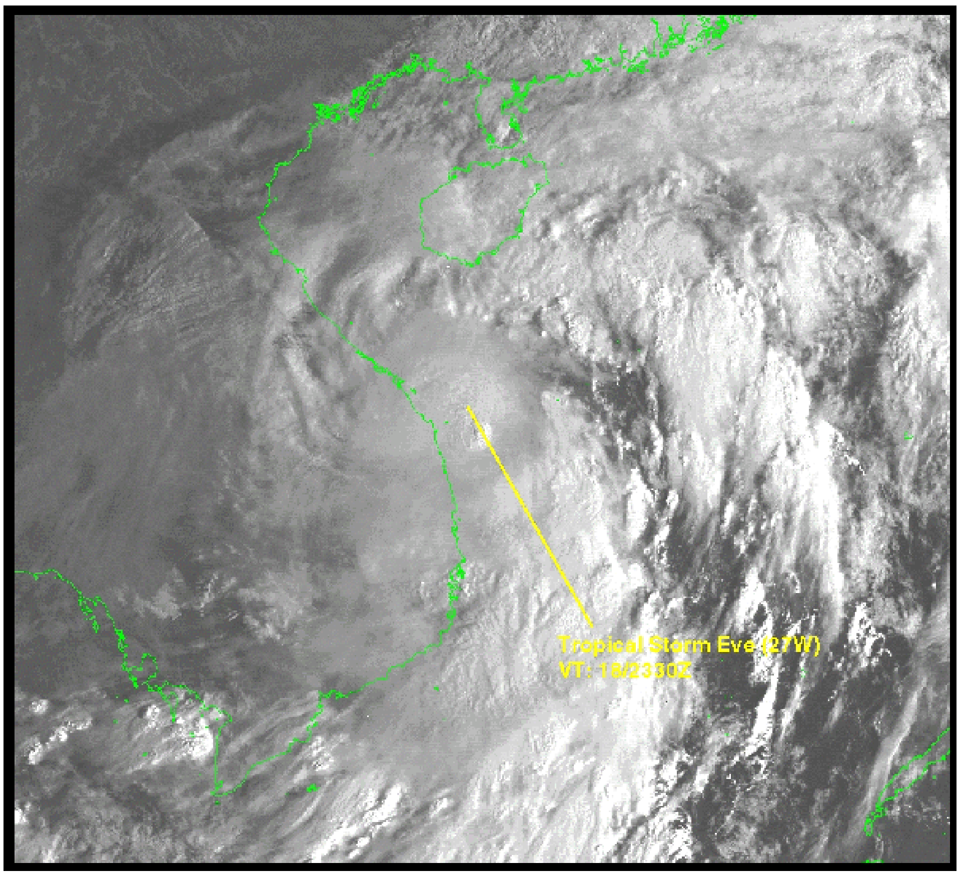


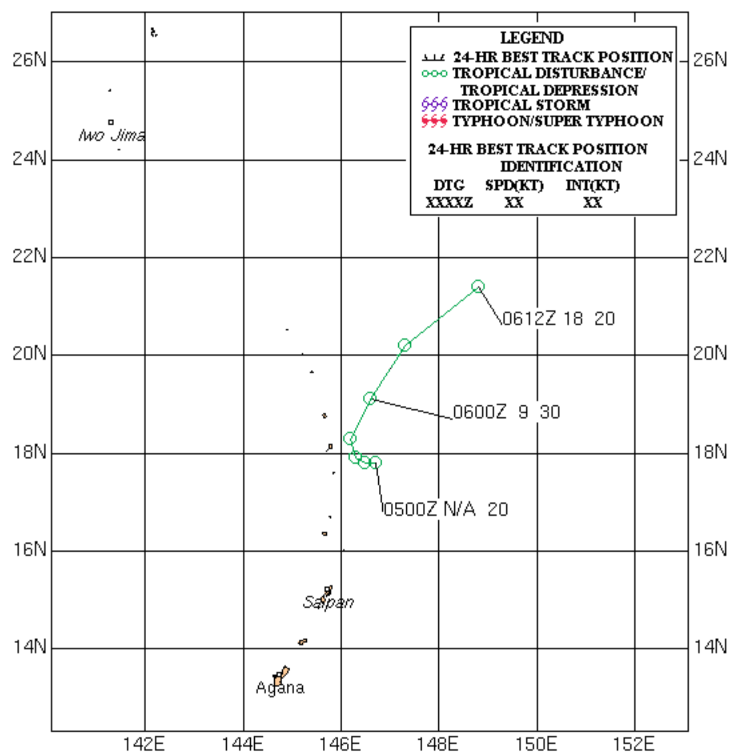
Figure 1-27-2. 182330Z October visible image of TS Eve (27W) six hours prior to landfall, just east of Vietnam. TS Eve had just reached tropical storm intensity and was tracking west-southwestward at 10-15 kt.

Tropical Depression 28W

Tropical Depression (TD) 28W developed northeast of the Mariana Islands, 25 nm southeast of Agrihan, in early November. TD 28W formed on the tail-end of a shearline in a weakness of the subtropical ridge. TD 28W was a weak, short-lived late season tropical depression. TD 28W peaked as a 30 kt tropical depression on 051800Z November and dropped to a 20 kt disturbance 18 hours later.

JTWC first began tracking the tropical disturbance on 040600Z November and mentioned the disturbance on the Significant Tropical Weather Advisory (ABPW). TD 28W developed on the end of a shearline that was connected to a frontal boundary off of Japan. TD 28W was very difficult to locate and satellite positions were relocated several times. Initial forecast tracks had relocated it southwestward, but post analysis of imagery indicates it was actually located northeast of the relocation. After the relocation, TD 28W tracked along the shearline and turned north of the ridge, accelerated, and weakened while transitioning to an extratropical low.

TD 28W was a short-lived tropical depression that reached a 30 kt maximum intensity. JTWC issued the fourth and final warning on 061500Z November as the depression weakened and began extratropical transition.



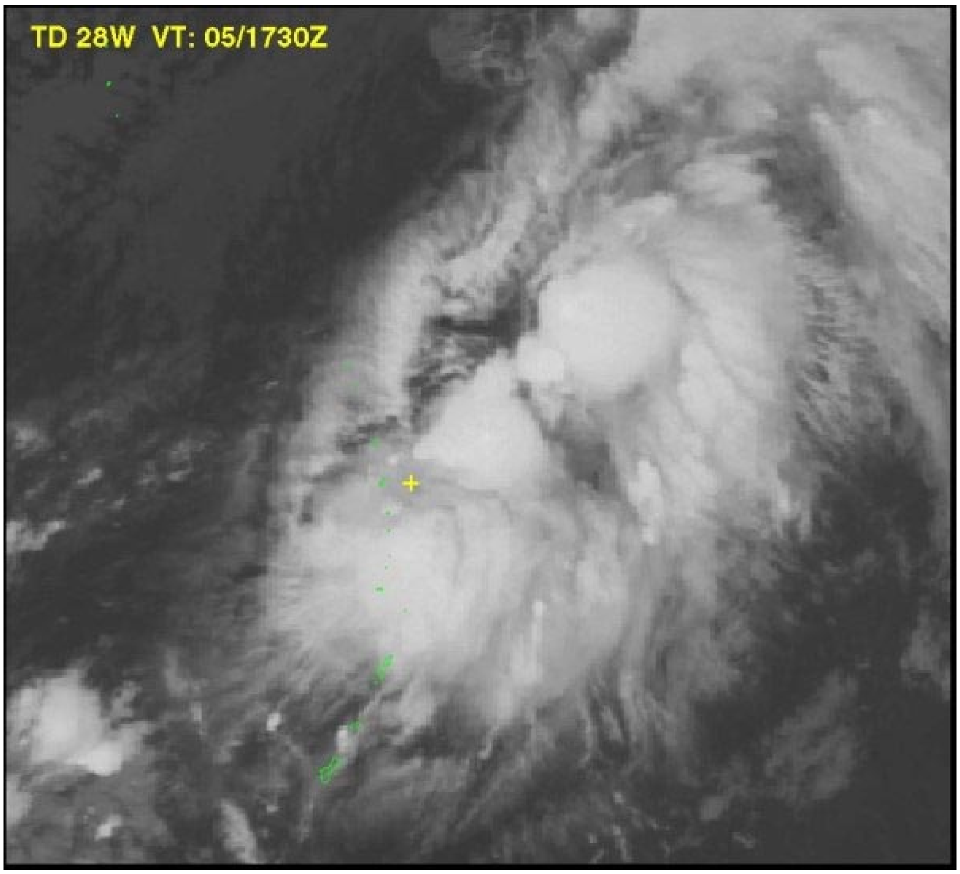


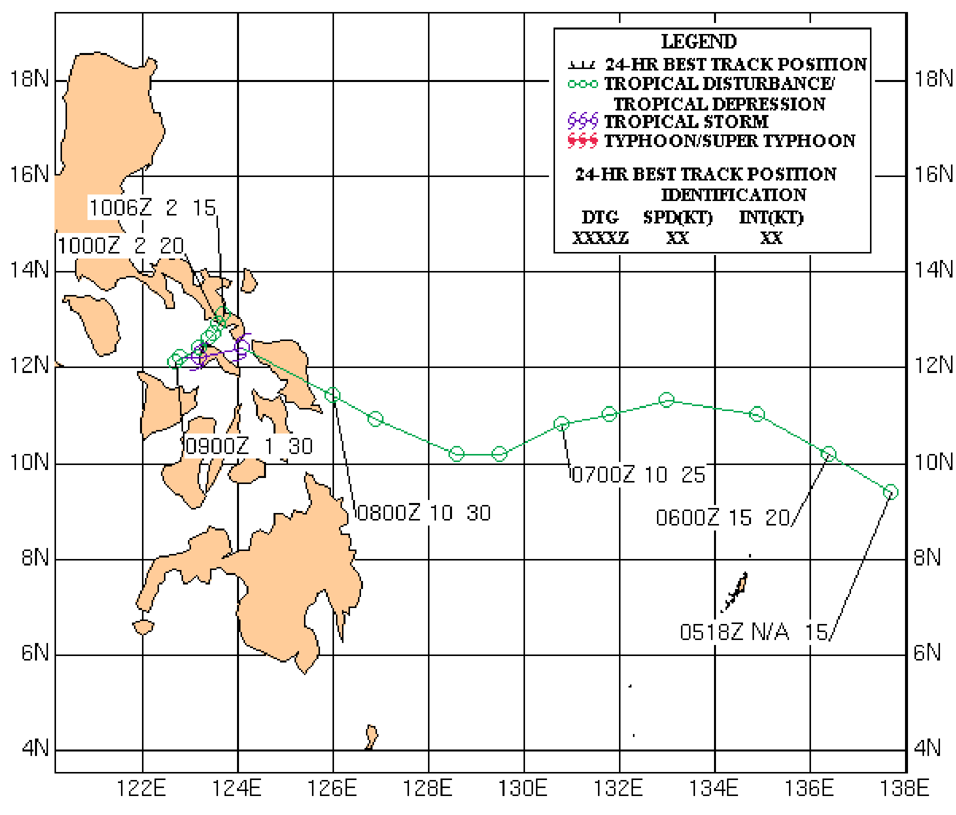
figure 1-28-1. 051730Z November GMS-5 infrared image of TD 28W at the initial warning. TD 28W was at its peak intensity of 30 kt.

Tropical Storm Frankie (29W)

Tropical Storm (TS) Frankie (29W) developed over the Philippine Sea, northeast of Koror and tracked westward under the steering influence of the subtropical ridge to the north. The cyclone peaked at minimal tropical storm intensity as it moved into the central Philippines. Once over the Philippines, TS Frankie became quasi-stationary and dissipated within 36 hours.

Initially detected as a disturbance on 3 November, a TCFA was issued at 06130Z November. JTWC issued the first warning at 060900Z November as a 25 kt tropical depression.

TS Frankie (29W) moved quickly toward the west at 10 to 19 knots, turning northwestward as it reached tropical storm intensity on 080600Z November and maintained a 35 kt intensity as it moved into the central Philippine Islands. Although the main steering influence was the subtropical ridge to the north, a secondary ridge formed southeast of the cyclone as it approached the Philippines. Hence, when TS Frankie made landfall, the steering influence from the ridge to the north was offset by the steering influence from the ridge to the southeast, and TS Frankie became quasi-stationary. The cyclone then weakened due to interaction with land and increasing vertical wind shear. JTWC issued the 16th and final warning at 100300Z November as TS Frankie dissipated over the central Philippine Islands.



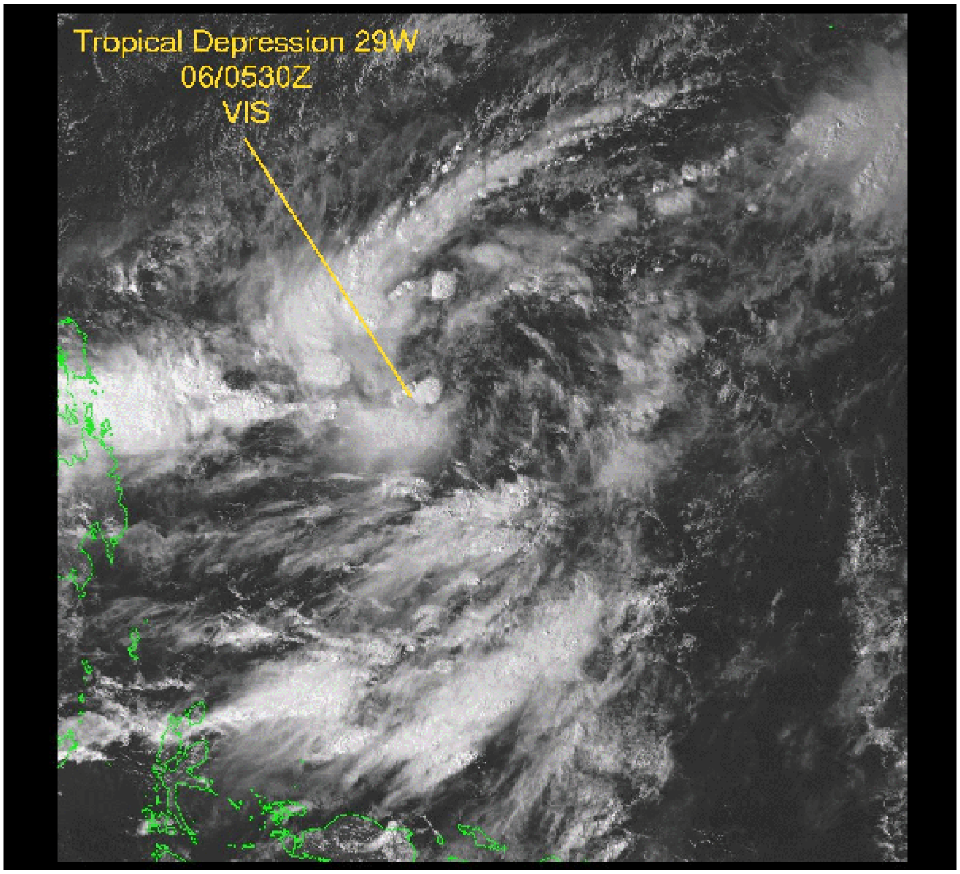


Figure 1-29-1. A visual image of TS Frankie (29W) at the initial warning at 060530Z November. This image reveals bands of deep convection beginning to develop and wrap toward the low level circulation center. Current intensity is 25kt.

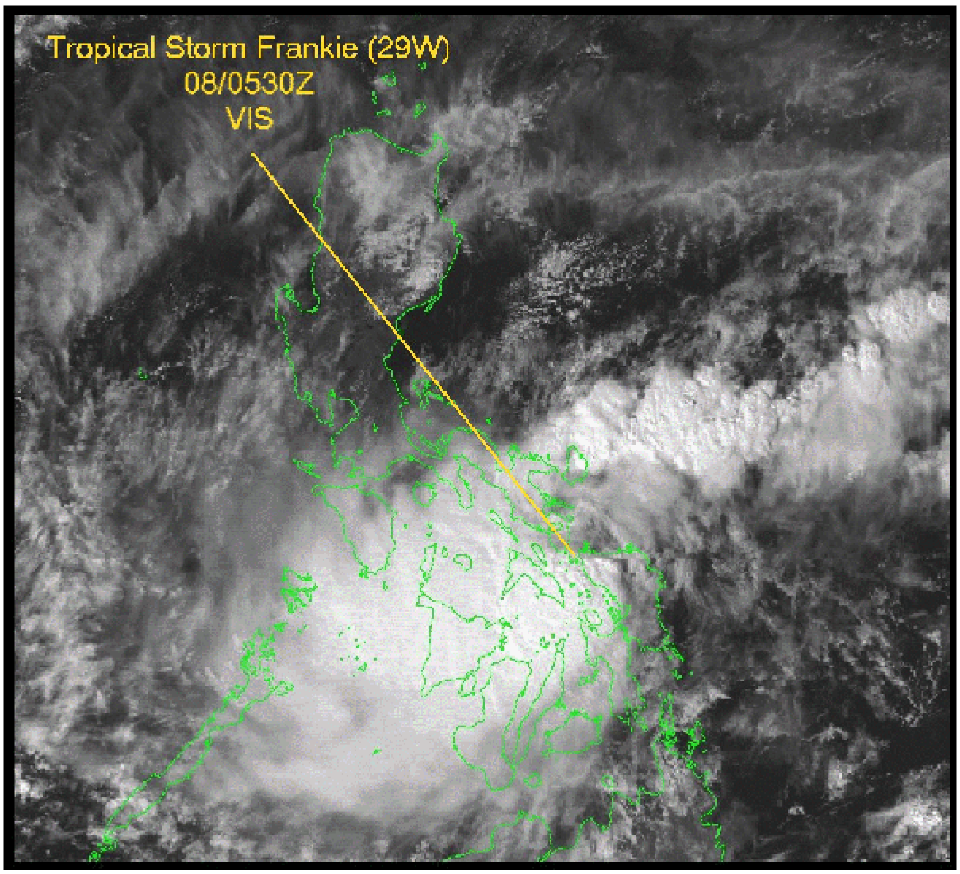


Figure 1-29-2. A visual image of TS Frankie (29W) at 080530Z November as the system began moving into the central Philippine Islands. The convection has been sheared to the west of the low level circulation center. The intensity was increased to 35 kt for the 080600Z November warning.

Typhoon Gloria (30W)

Typhoon Gloria (30W) developed in the Philippine Sea, east of Samar Island, and slowly intensified into a weak tropical storm while moving northward. Typhoon Gloria eventually turned northeastward and began to accelerate. It passed just north of Iwo Jima and then rapidly intensified and reached minimal typhoon intensity just prior to extratropical transition.

A Tropical Cyclone Formation Alert was issued at 120700Z November, as a persistent area of convection at the tail-end of a shear line. The first warning was issued at 130900Z November as a 25 kt cyclone, with stronger gradient winds to the north associated with the northeast monsoon. The developing tropical depression was difficult to locate, and as development continued, a more northerly track quickly became evident.

Typhoon Gloria (30W) reached tropical storm intensity at 140900Z November while moving on a north-northwestward track. Meanwhile, a pronounced band of mid-latitude westerlies continued to slowly press toward the south and was expected to increase and inhibit intensification to moderate tropical storm intensity and eventually cause dissipation over water. Instead, the westerly flow actually caused or influenced continued intensification, acceleration, northeastward movement, and eventual extratropical transition.

As Typhoon Gloria (30W) began to move and accelerate under the increasingly northeastward steering flow, the cyclone fluctuated in overall appearance but maintained its intensity. As acceleration continued, the westerly flow appeared to extend deep into the mid levels preventing a quick shearing of the circulation. The cyclone intensified to typhoon intensity at 152100Z November for a very short period and reached a forward speed of 48 kt. Typhoon Gloria became fully extratropical and JTWC issued the 13th and final warning on 160900Z November.

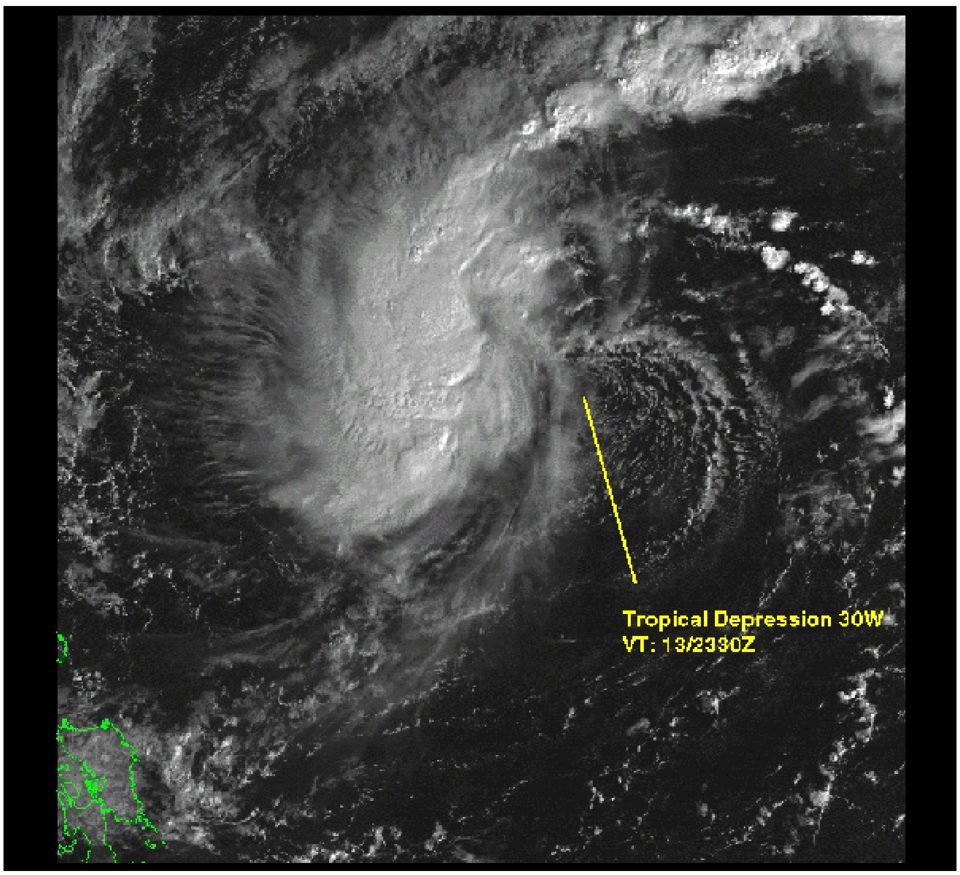


Figure 1-30-1. This visible image was taken 18 hours after the initial warning on TY Gloria (30W) at 132330Z November. A defined low-level circulation center (LLCC) remains completely exposed in the central Philippine Sea.

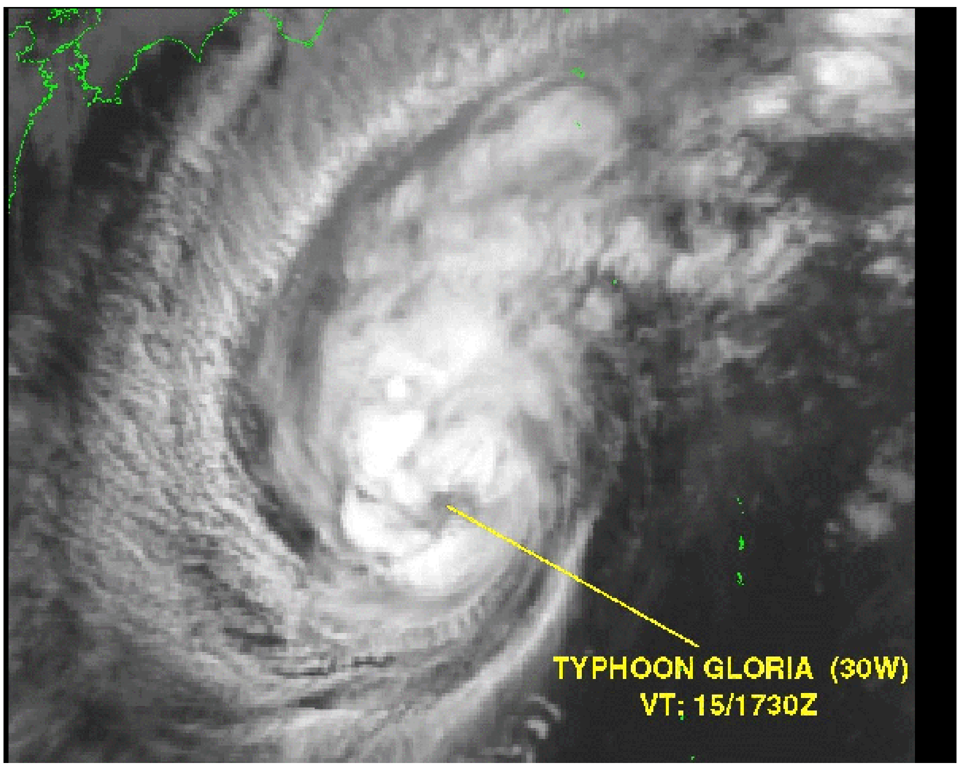
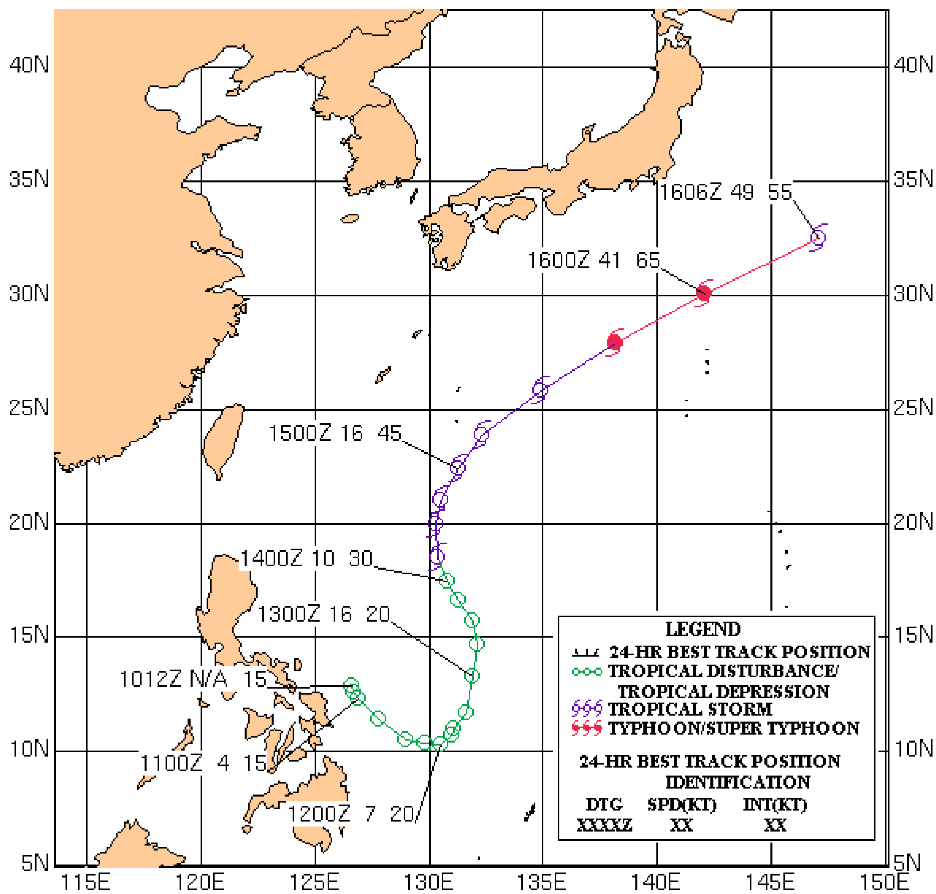


Figure 1-30-2. 151730Z November GMS-5 infrared image as Typhoon Gloria (30W) passed east of Iwo Jima. The short-term rapid intensification was just beginning as the system began extra-tropical transition and accelerated northeastward.



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1600Z 41 65
1500Z 16 45
1400Z 10 30
1300Z 16 20
1012Z N/A 15
1100Z 4 15
1200Z 7 20
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
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Tropical Depression 31W

Tropical Depression (TD) 31W developed in the South China Sea near Palawan Island at the end of November and remained a relatively weak tropical cyclone while moving to the west. The disturbance reached a peak intensity of 30 kt before dissipating over land, northeast of Phuket, Thailand some six days after initial detection.

JTWC first noted this disturbance on the 280600Z November Significant Tropical Weather Advisory (ABPW). By 302230Z November, the suspect area had intensified and organized, thus, a Tropical Cyclone Formation Alert was issued. The first warning on TD 31W was issued about four hours later on 010300Z December.

TD 31W formed within a moderate to high vertical wind shear environment in the South China Sea. The surface circulation formed within a region bounded by the northeasterly winds of the winter monsoon and cross-equatorial southwesterlies. A subtropical ridge to the north of the disturbance would remain the dominant steering influence. TD 31W was relocated on the sixth warning, positioning the disturbance approximately 200 nm southwest of the previous position. After the relocation, TD 31W tracked westward toward the Malay Peninsula. As the cyclone moved through the Gulf of Thailand, the Thai National Oil Company (PTTEP), Chevron, and Unocal provided additional weather observations. These observations were of significant assistance in determining the location, intensity, and movement of the cyclone during passage through this area.

JTWC issued the 13th and final warning at 040300Z December as TD 31W moved over the Malay Peninsula and weakened. Subsequently, JTWC continued to monitor the tropical cyclone remnants as it moved into the Andaman Sea for redevelopment, which did not occur.

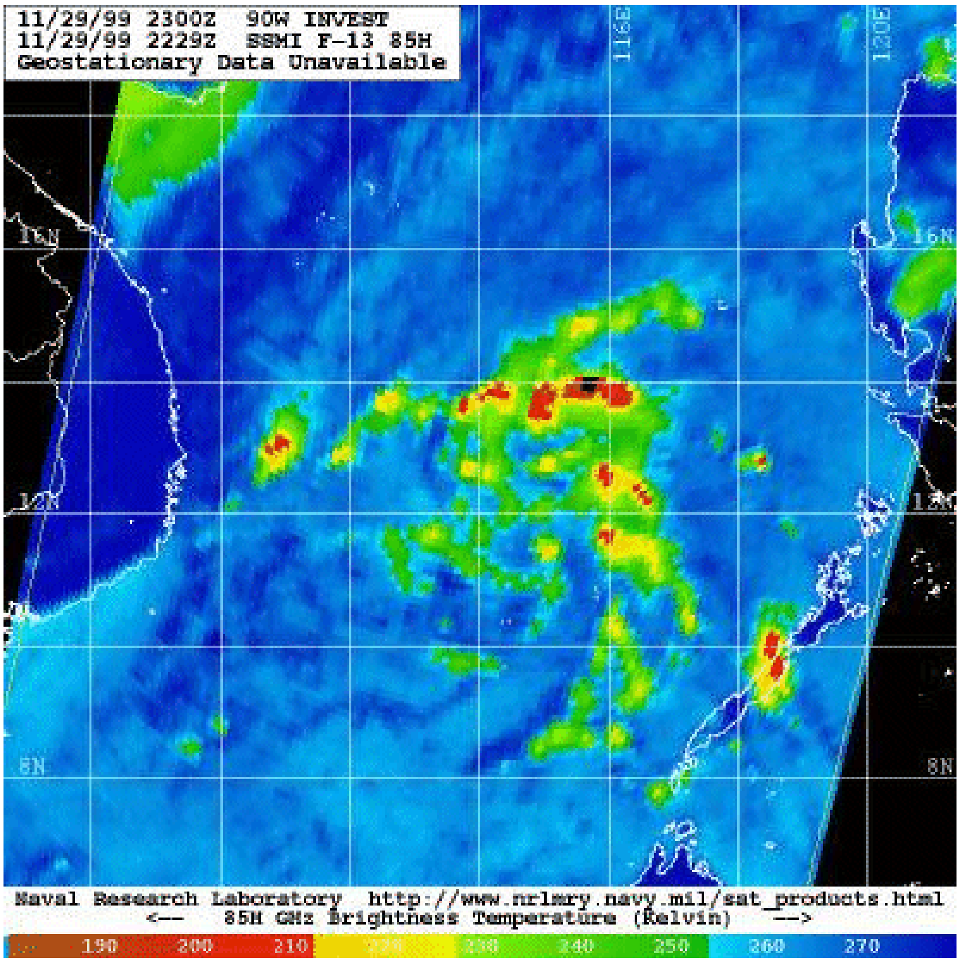


Figure 1-31-1. A Special Sensor Microwave Imager (SSM/I) image, taken at 292229Z November. A Tropical Cyclone Formation Alert was issued for this disturbance that would become Tropical Depression 31W. This image shows the increased organization and weak low-level circulation.

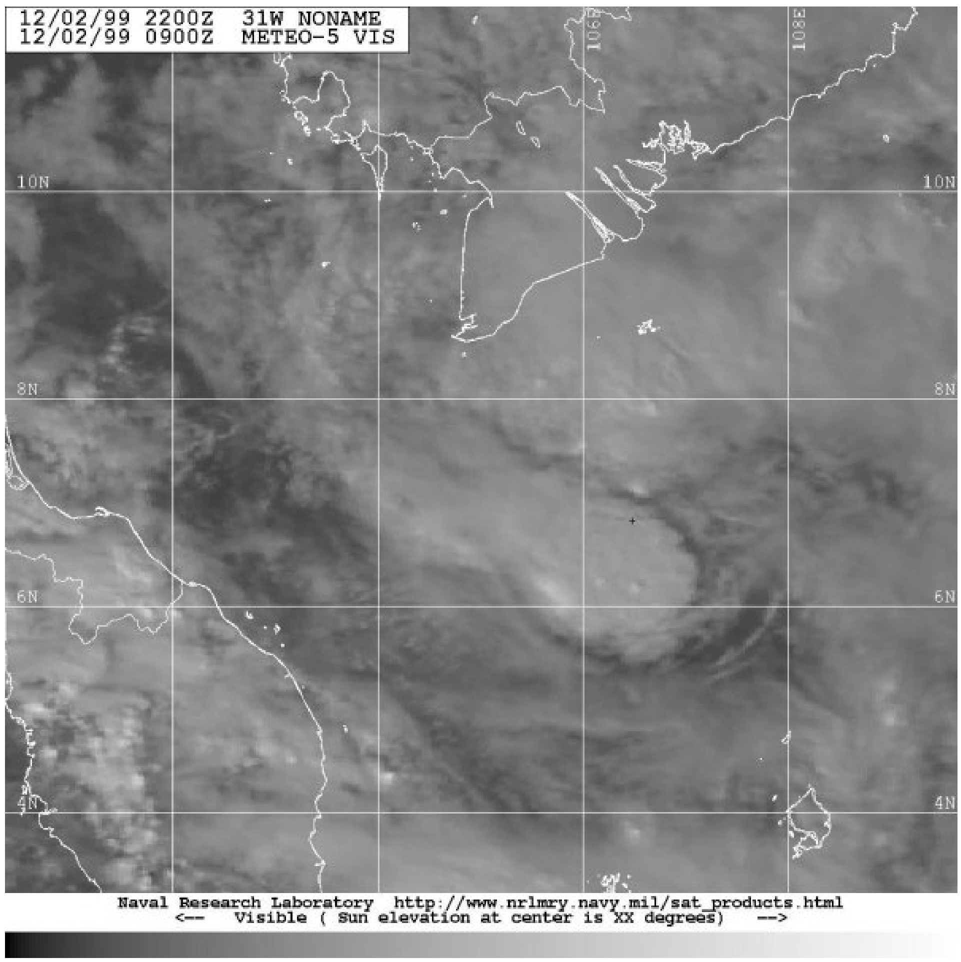
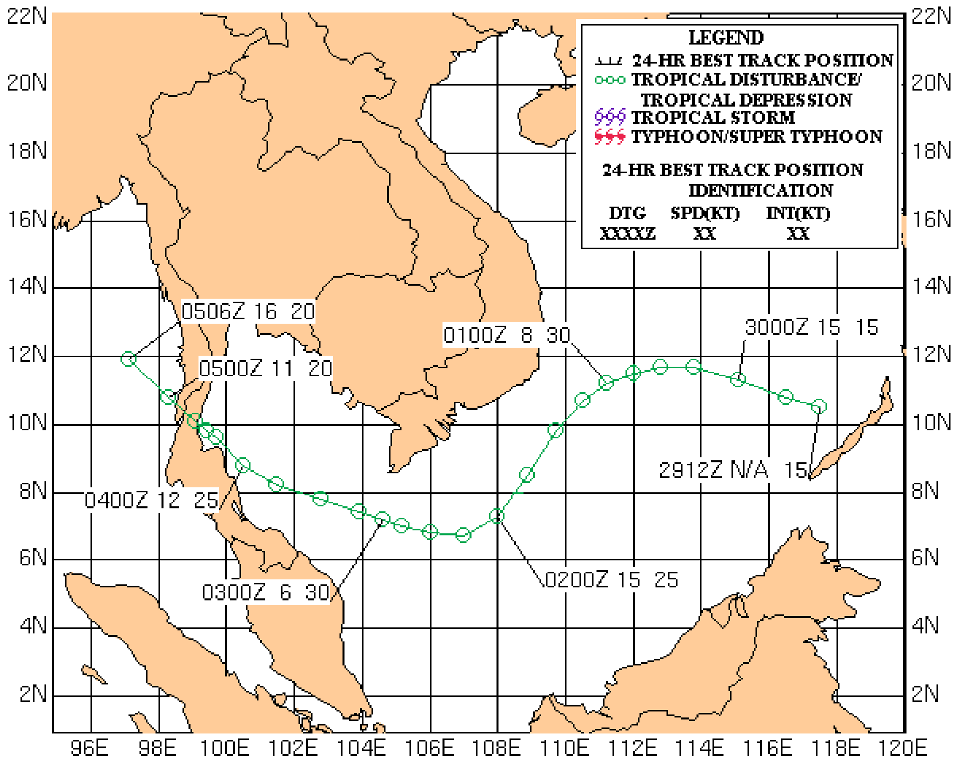


Figure 1-31-2. This visible Meteosat-5 image was taken at 020900Z December, shortly after Tropical Depression 31W was relocated 200 nm southwest. The weak low-level circulation is difficult to locate (near 6.8N 106.5E) and the moderate vertical wind shear environment is evident in the satellite imagery.


LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/ TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
0506Z 16 20
0500Z 11 20
0400Z 12 25
0300Z 6 30
0200Z 15 25
0100Z 8 30
3000Z 15 15
2912Z N/A 15
22N
20N
18N
16N
14N
12N
10N
8N
6N
4N
2N
96E
98E
100E
102E
104E
106E
108E
110E
112E
114E
116E
118E
120E

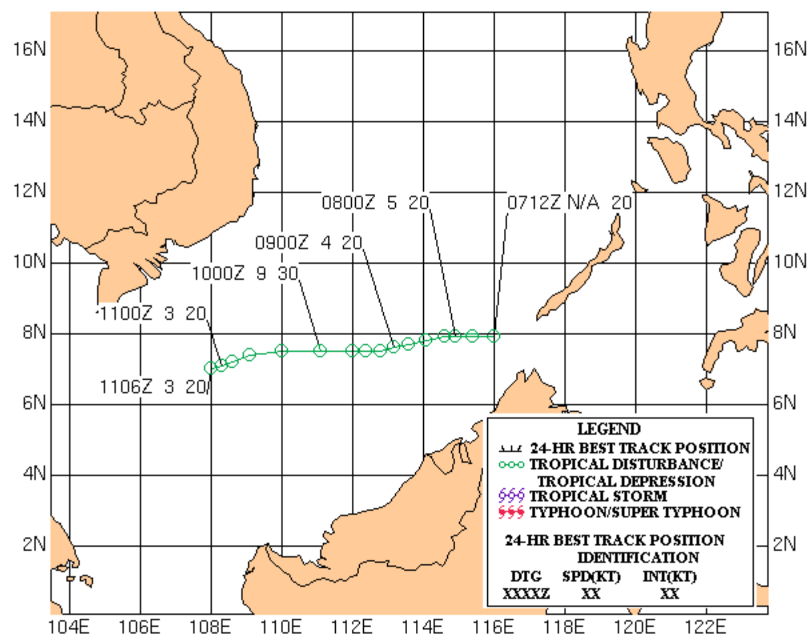
Tropical Depression 32W

The second South China Sea tropical cyclone of 1999 formed in part due to wind shear produced by northeast monsoon flow and cross-equatorial westerly flow. Tropical Depression (TD) 32W developed between Palawan and Borneo then intensified slowly, moved westward, and dissipated over water south of Vietnam after 3 days.

TD 32W formed approximately 460 nm east-southeast of Cam Ranh Bay, Vietnam. JTWC issued the first warning on TD 32W at 092100Z December. By 100000Z December, the cyclone had attained a maximum intensity of 30 kt. Subsequently, vertical wind shear resulted in TD 32W becoming an exposed low-level circulation after 110000Z December.

TD 32W moved very slowly through the initial 48 hours, then began to accelerate westward to about 11 kt, before becoming vertically sheared, off the southern tip of Vietnam around 110000Z December. JTWC issued the sixth and final warning at 110300Z December.

This was the second of three very weak tropical depressions to form in early to mid December. JTWC relied heavily on scatterometry data from both the ERS-2 and the NASA QuickScatt for detection and positioning. Although the wind speeds had not been calibrated, the QuickScatt data was useful in providing an additional remotely sensed data set. Scatterometry coupled with SSM/I imagery and the judicious use of QuickScatt, allowed JTWC to better position and determine intensity of the three disorganized and weak tropical depressions.



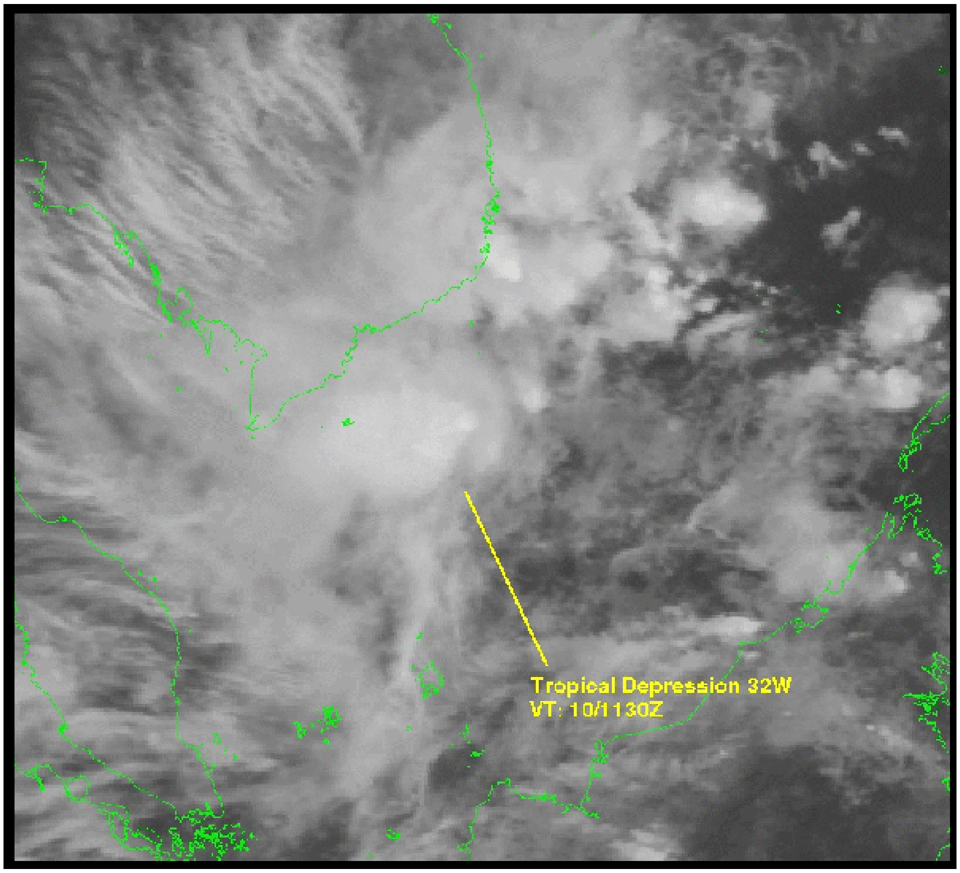


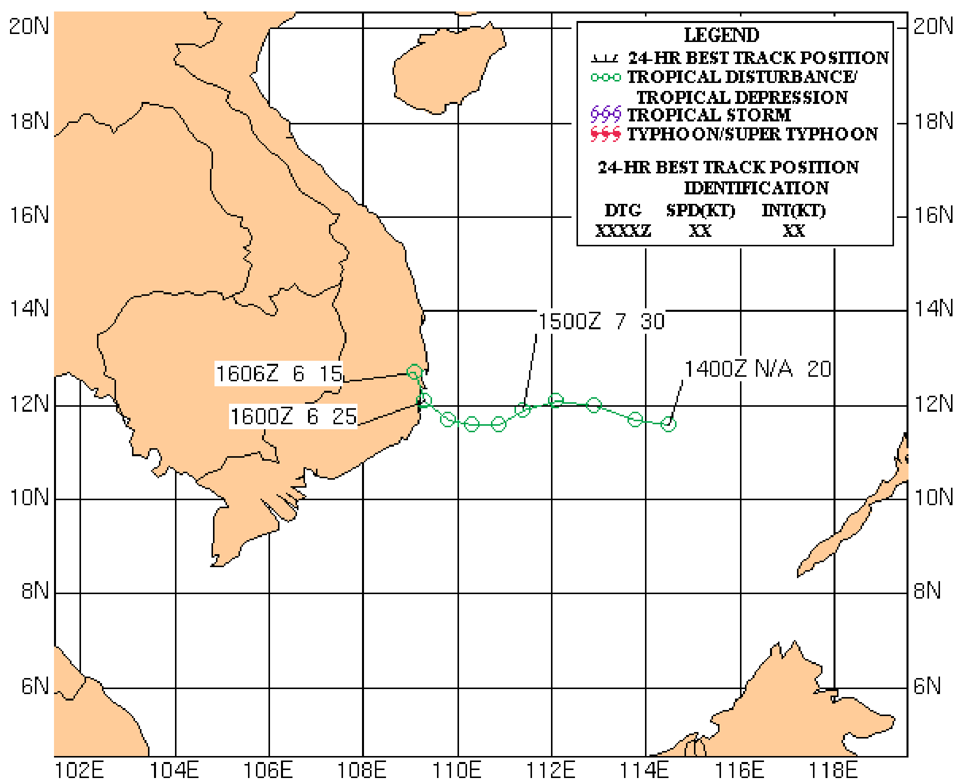
Figure 1-32-1. 101130Z December GMS-5 infrared satellite image of TD 32W at its peak intensity of 30 kt. The low-level circulation center (LLCC) is nearly indistinct in the image. This system once again showed the value of microwave satellites, passive and active, which can see through the upper-level clouds to pinpoint the LLCC.

Tropical Depression (TD) 33W

Tropical Depression (TD) 33W was the final 1999 Northwest Pacific tropical cyclone. It formed in mid December within a persistent trough located across the Southern Philippine islands into the South China Sea. TD 33W intensified very slowly and reached a peak intensity of 30 kt, then moved westward and dissipated over central Vietnam two days later.

Tropical Depression (TD) 33W formed approximately 230 nm east of Cam Ranh Bay, Vietnam. JTWC first carried it as a suspect area on the 110600Z December ABPW bulletin, and issued the first warning at 141500Z December. By 141800Z December, the cyclone had attained a maximum intensity of 30 kt, and maintained this intensity for the next 24 hours. Throughout its lifetime TD 33W remained under a high vertical wind shear environment which hindered development. After 160000Z December, TD 33W encountered increased vertical wind shear that resulted in the low-level circulation center becoming fully exposed with the deep convection shearing northward. This increased shear and interaction with land led to the dissipation of TD 33W as it moved over Vietnam.

TD 33W made landfall at 160300Z December near Nha Trang, Vietnam as a 25 kt tropical depression. JTWC issued the 7th and final warning at 160300Z December as TD 33W dissipated over land.



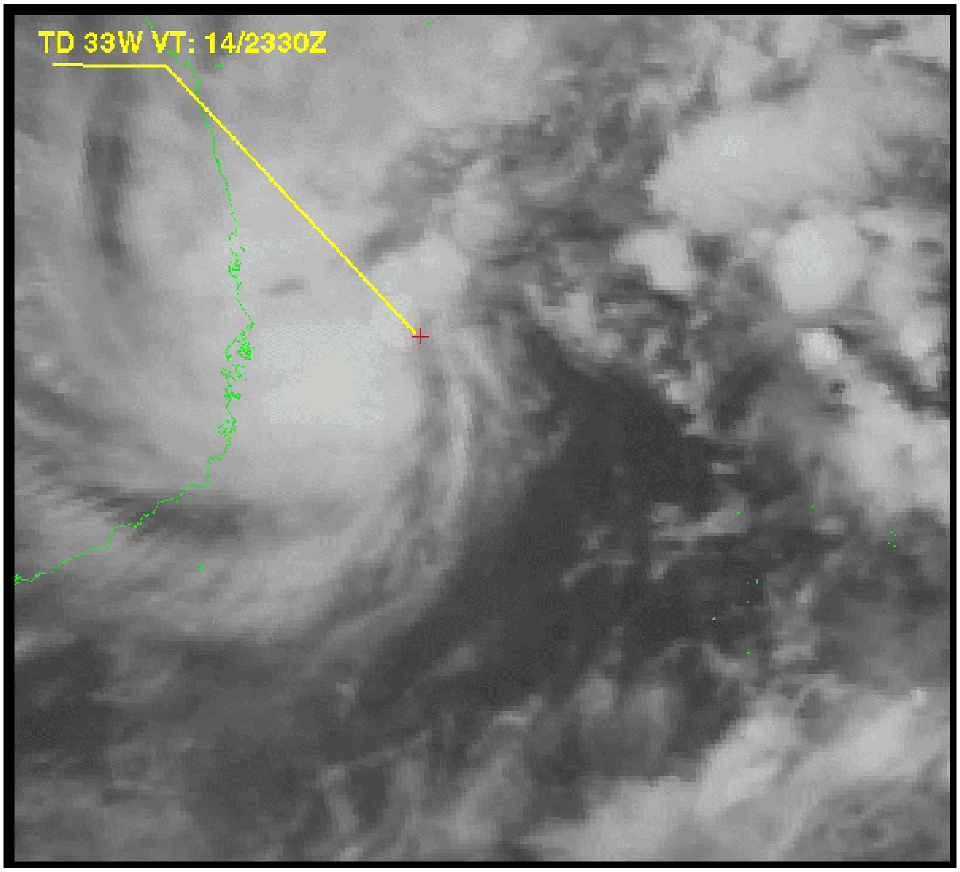


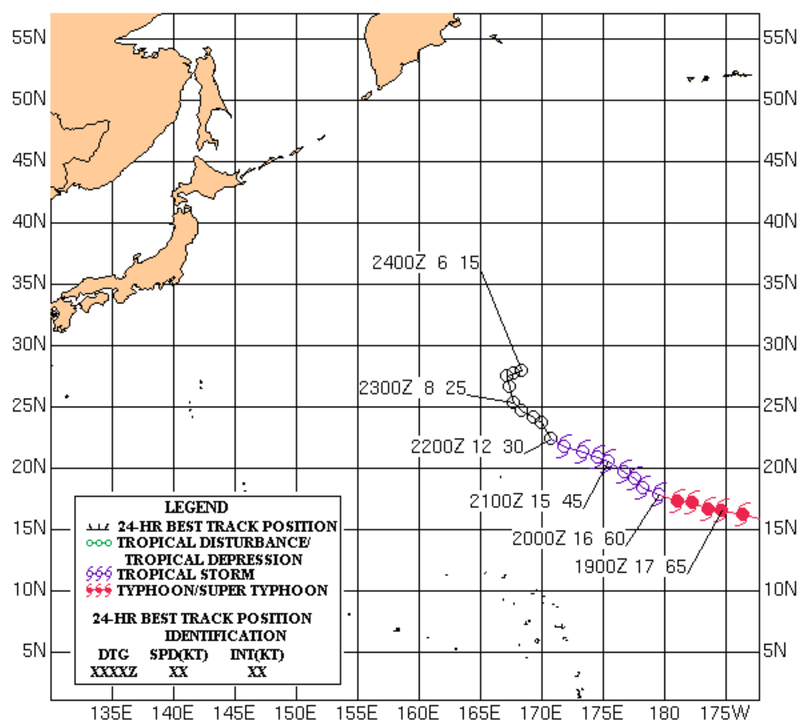
Figure 1-33-1. 142330Z December GMS-5 visible image of TD 33W as it approached the Vietnam coast. Current intensity is 30 kt.

Hurricane Dora (07E)

The disturbance that developed into Hurricane Dora (07E) formed in the eastern Pacific Ocean, west of Nicaragua, early in August 1999. The National Hurricane Center issued the first warning on Tropical Depression 07E at 060000Z after a ship report of 30 kt associated with the disturbance. Over a period of nearly three weeks this tropical cyclone would develop into an intense hurricane (120 kt) and travel more than five thousand miles across the Pacific Ocean before dissipating over open water.

After the first warning, this cyclone intensified for several days and developed a symmetric eye on 9 August. For over a week thereafter a strong mid-latitude anticyclone anchored over the central Pacific steered Hurricane Dora almost directly westward at an average speed of 14 knots. Hurricane Dora passed roughly 200 miles south of Hawaii island (Figure 1-07E-2). The forecast track and associated storm surge caused the evacuation of Johnston Atoll, however it passed 65 miles south of the atoll without causing significant damage.

Hurricane Dora crossed 180 degrees longitude and was downgraded to a tropical storm (50 kt) on Joint Typhoon Warning Center's first warning at 201500Z August. The system began gaining latitude and continued to weaken due to increasing vertical wind shear. JTWC issued the 70th and final warning at 230900Z August.



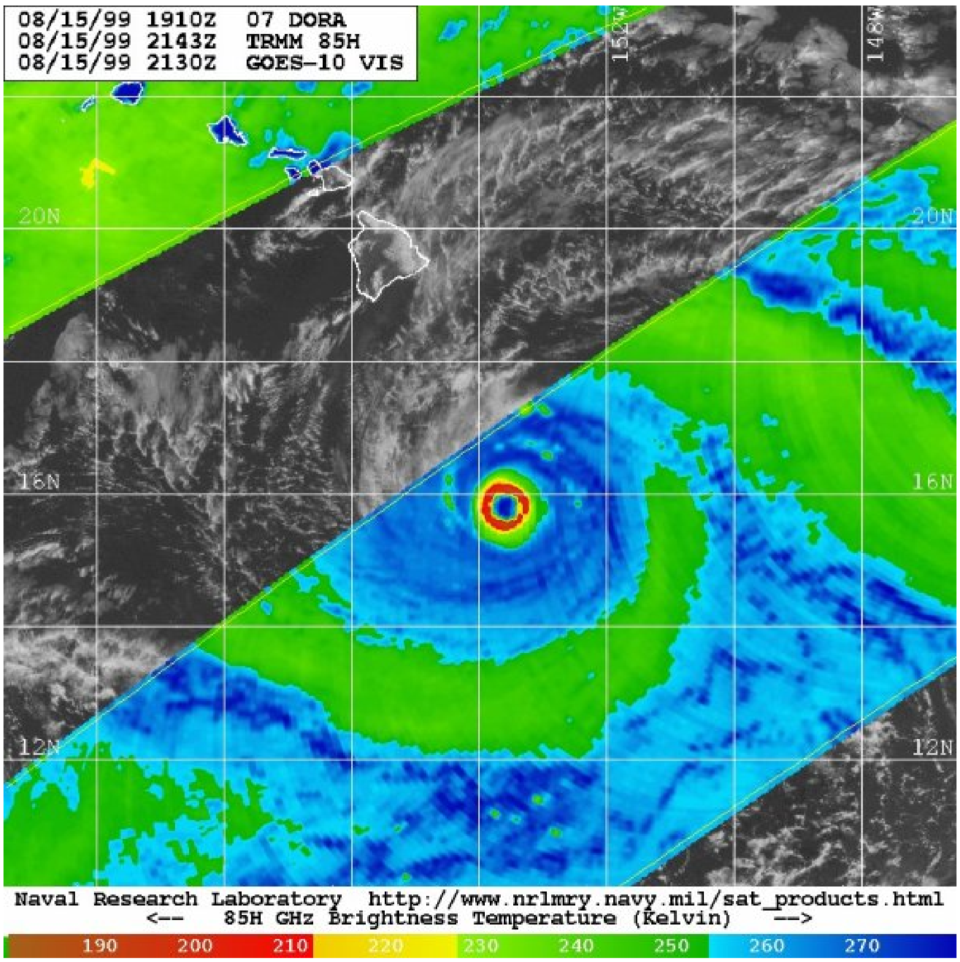


Figure 1-07E-1. 152143Z August Tropical Rainfall Measuring Mission (TRMM) microwave image overlaid on 152130Z August GOES- 10 visible satellite imagery created by the Naval Research Laboratory (NRL). Of note is the extremely intense eye-wall feature. Hurricane Dora passed south of the Island of Hawaii with a max intensity of 100 kt.

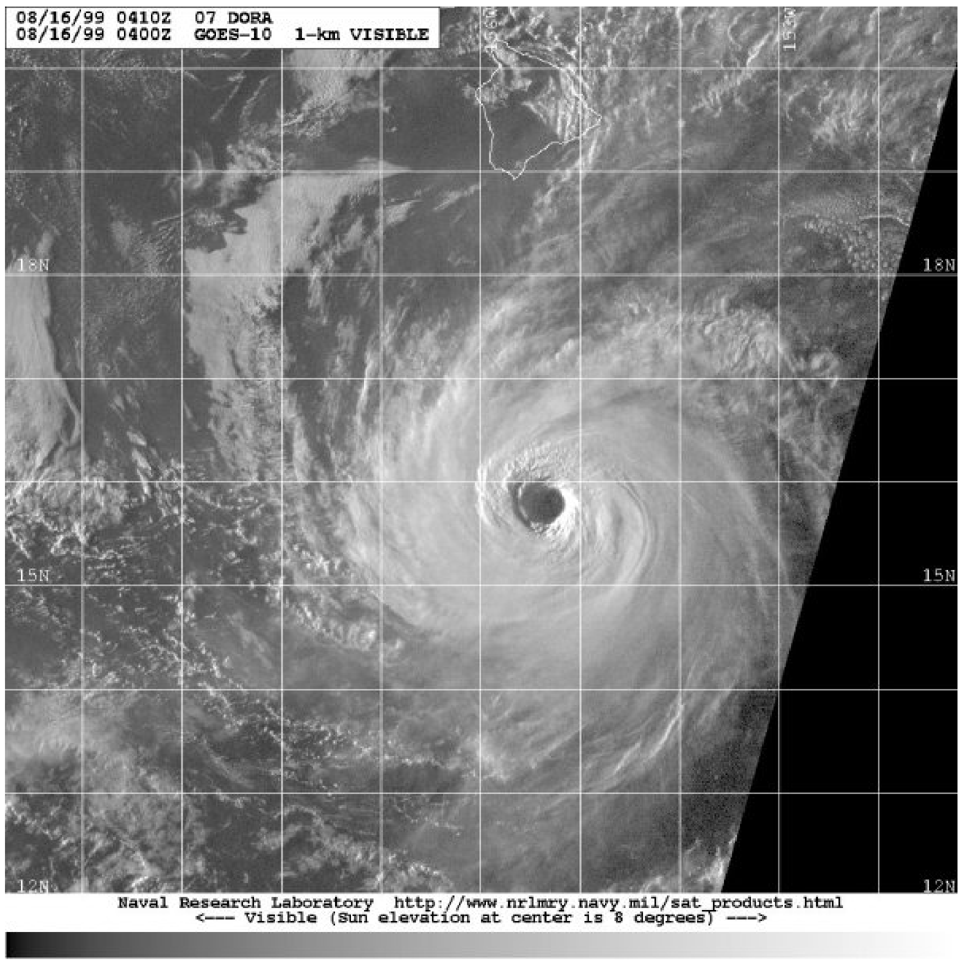


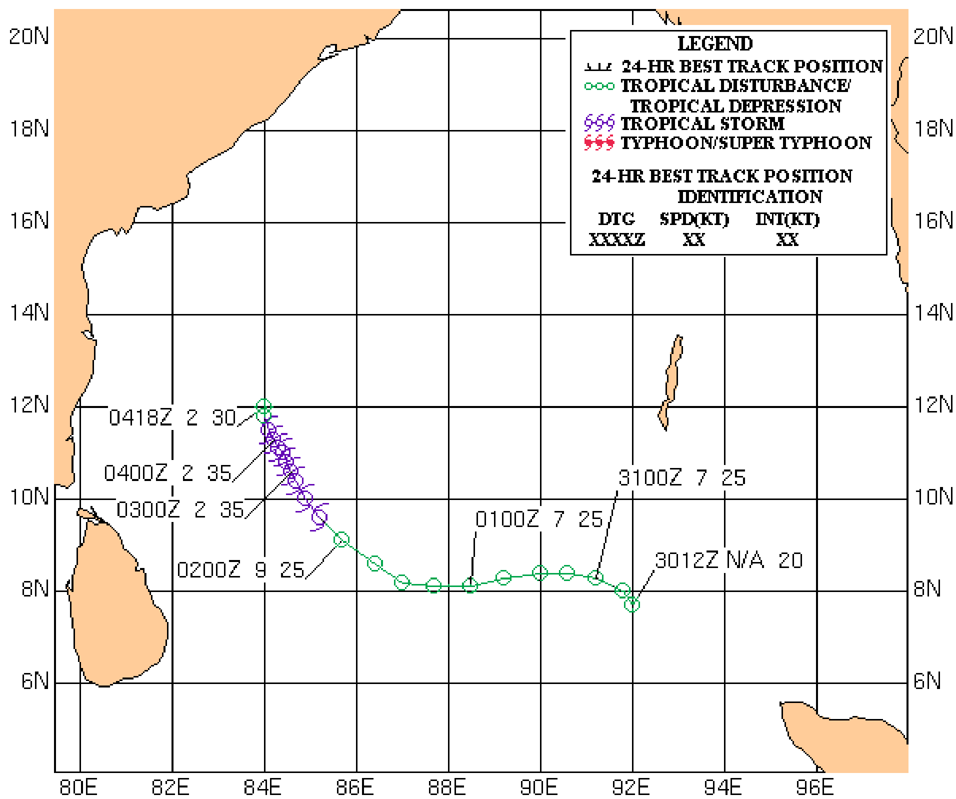
Figure 1-07E-2. 160400Z August GOES-10 visible satellite imagery showing the well-defined eye of Hurricane Dora as it passed south of the Island of Hawaii with an intensity of 100 kt. The system went on to pass 65 nm to the south of Johnston Atoll, but caused no significant damage.

Tropical Cyclone 01B

The first 1999 North Indian Ocean tropical cyclone warned on by JTWC developed in the southeastern Bay of Bengal. It intensified slowly (max 40 kt), moving westward, then northwestward, and dissipated over water after six days.

The disturbance that became TC 01B was very slow to develop and was first mentioned in the ABIO on 291800Z February. As the convection slowly consolidated, three Tropical Cyclone Formation Alerts were issued from 31 January to 02 February. Tropical Cyclone (TC) 01B formed approximately 370 nm west of Phuket, Thailand and JTWC issued the first warning at 020900Z February as satellite imagery indicated the disturbance had intensified. By 030600Z February, the cyclone had reached a maximum intensity of 40 kt. Subsequently, vertical wind shear caused TC 01B to weaken with an exposed low level circulation becoming apparent after 031800Z February.

JTWC issued the sixth and final warning at 042100Z February.



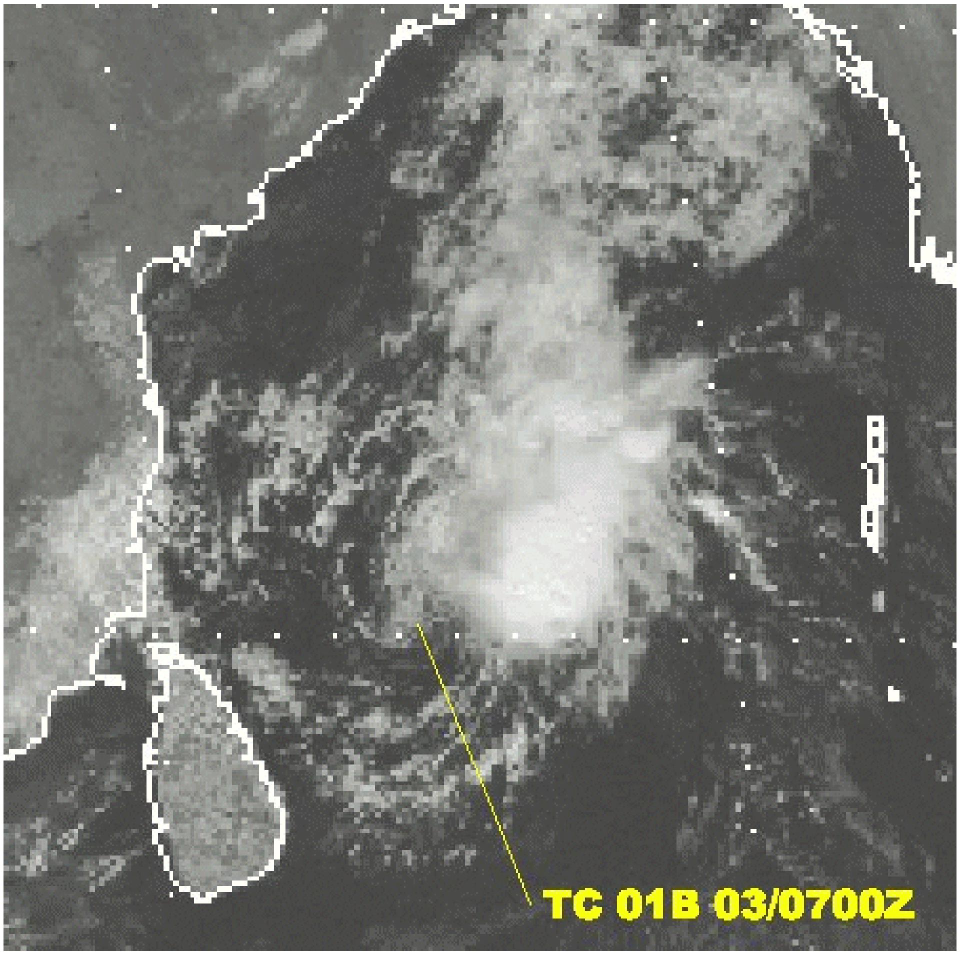


Figure 1-01B-1. This visible satellite imagery is indicative of the strong vertical wind shear environment in which TC 01B was situated as its maximum intensity. The Northeastern Monsoon coupled with strong southwesterly flow in the upper-levels is typical of this time of year, inhibiting tropical cyclone development. TC 01B was able to develop due to a weakness in the upper-level ridge.

Tropical Cyclone 02A

Tropical Cyclone (TC) 02A (02A) was the only 1999 cyclone warned on by JTWC in the Arabian Sea. This cyclone developed in the Laccadive Sea in mid-May and initially moved northwest before turning toward the northeast. TC 02A reached a maximum intensity of 110 kt while on a northeast heading, just before making landfall approximately 97 nm southeast of Karachi at 200600Z May.

Tropical Cyclone 02A developed in the southwest monsoonal flow during mid-May. The area of convection was discussed on the ABIO for 2 weeks before the cyclone developed. During that time, strong convection would develop just before sunrise, at the diurnal convective maximum, and subsequently dissipate around sunset. A TCFA was issued on the system on 16 May at 0100Z.

The first warning was issued at 160900Z May with northwestward movement. TC 02A subsequently reached typhoon intensity on 170600Z May, after which a mid-latitude trough passing through the Middle East significantly weakened the subtropical ridge, allowing the system to recurve into Pakistan. By 190000Z May, the cyclone reached its maximum intensity of 110 kt, which it maintained through 200600Z May. TC 02A made landfall near Karachi, Pakistan as a 110 kt tropical cyclone. JTWC issued the 21st and final warning on 210900Z May as the system moved into the Indus River valley.

TC 02A was one of the most intense cyclones on record to develop in the Arabian Sea. Reports by Agence France-Presse indicated that 700 people were reported missing and presumed dead, including 11 paramilitary soldiers who were lost during a rescue attempt at sea. Total damage was estimated at $6 million.

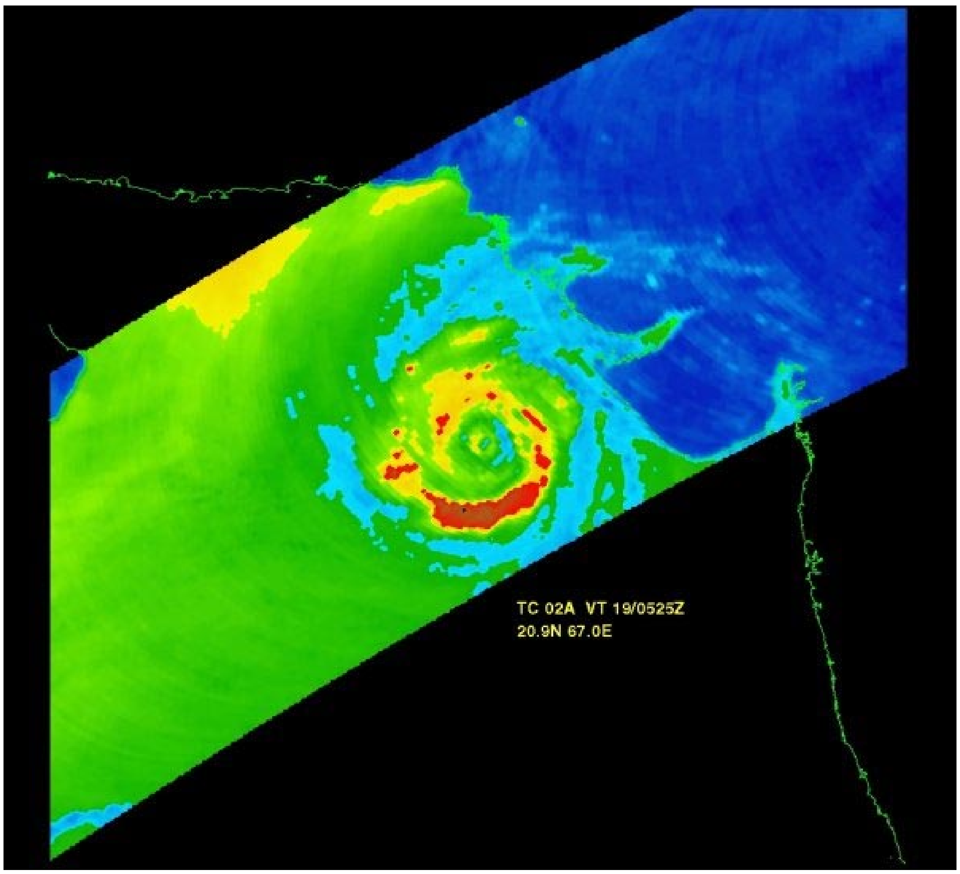
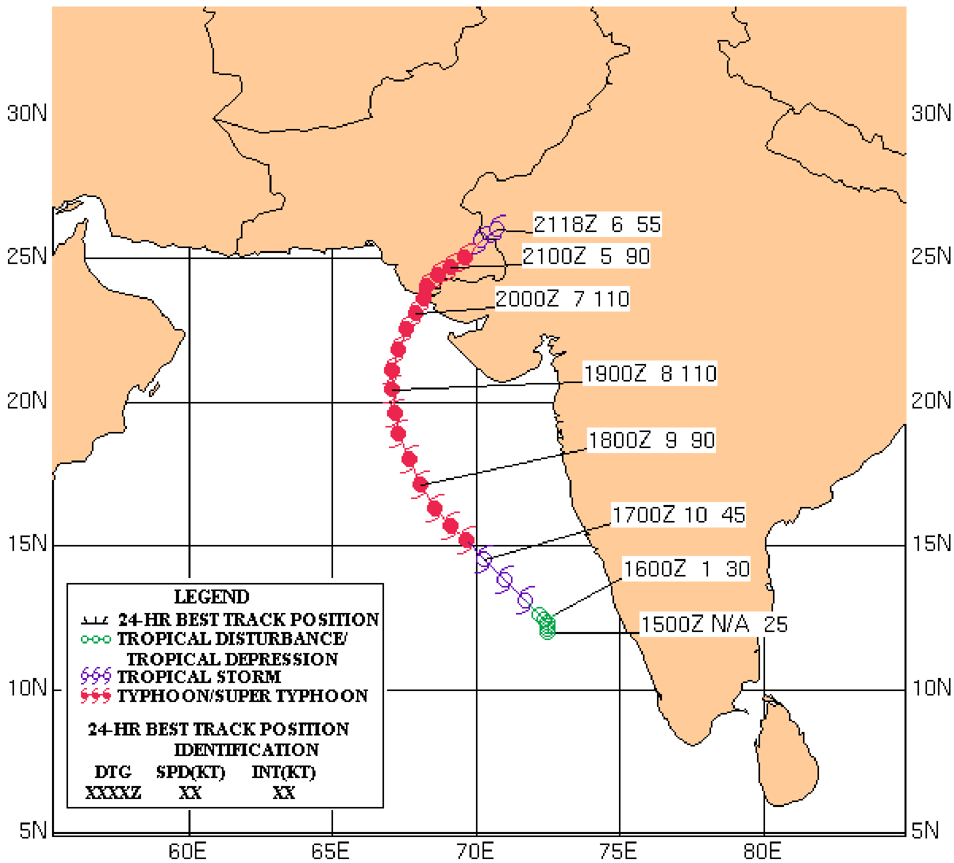


Figure 1-02A-1. 190525Z May SSM/I pass over TC 02A as it reached maximum intensity (110 kt) 235 nm south of Karachi. Of note in this image is the concentric eyewall. Continuing development served to weaken the inner eyewall, which was replaced by the outer, stronger feature.



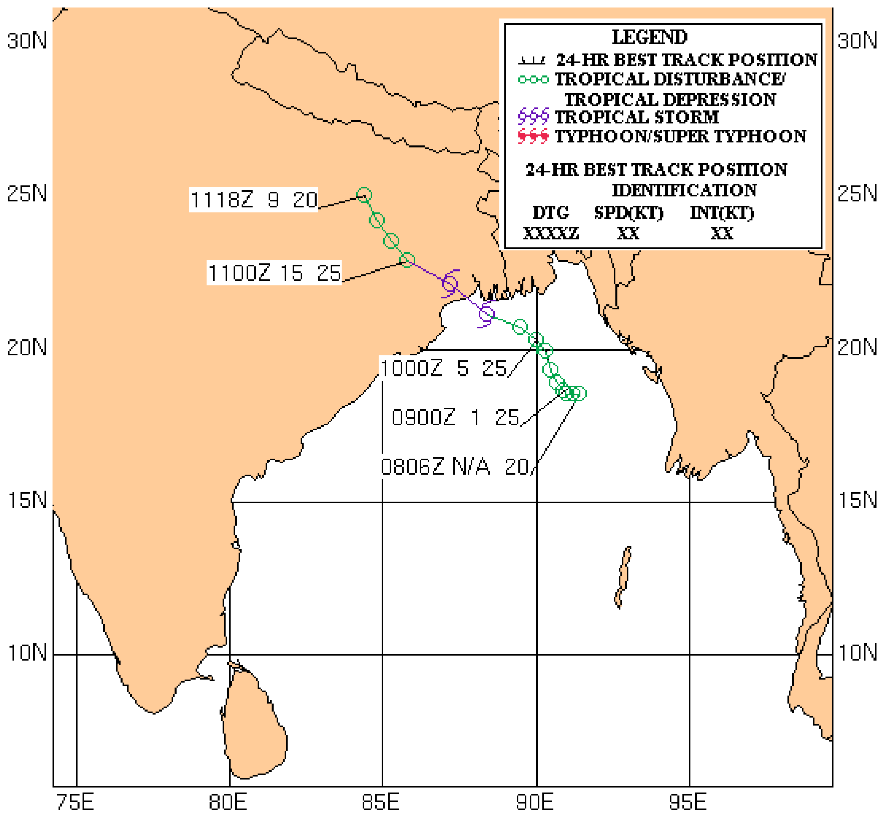
30N
25N
20N
15N
10N
5N
60E
65E
70E
75E
80E
2118Z 6 55
2100Z 5 90
2000Z 7 110
1900Z 8 110
1800Z 9 90
1700Z 10 45
1600Z 1 30
1500Z N/A 25
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX

Tropical Cyclone 03B

Tropical Cyclone (TC) 03B became the second 1999 Bay of Bengal tropical cyclone warned on by JTWC. TC 03B developed from a broad circulation over the northern Bay of Bengal, then tracked northwestward and peaked as a minimum tropical cyclone at 35 kt before dissipating over eastern India.

The area of convection that became Tropical Cyclone (TC) 03B formed approximately 235 nm south of Chittagong, Bangladesh. JTWC issued a Tropical Cyclone Formation Alert at 100830Z June, then issued the first warning on TC 03B at 101500Z June with a maximum intensity of 35 kt. The cyclone maintained its 35 kt intensity as it went ashore west of Calcutta, India. TC 03B then dissipated over land, due to frictional effects and vertical wind shear. JTWC issued the second and final warning at 110300Z June.

The primary significance of this system was it initially was associated with a mid-level circulation over land, which migrated over the Bay of Bengal, developed enough convection and intensity to become a 35 kt tropical cyclone and subsequently moved back over land.



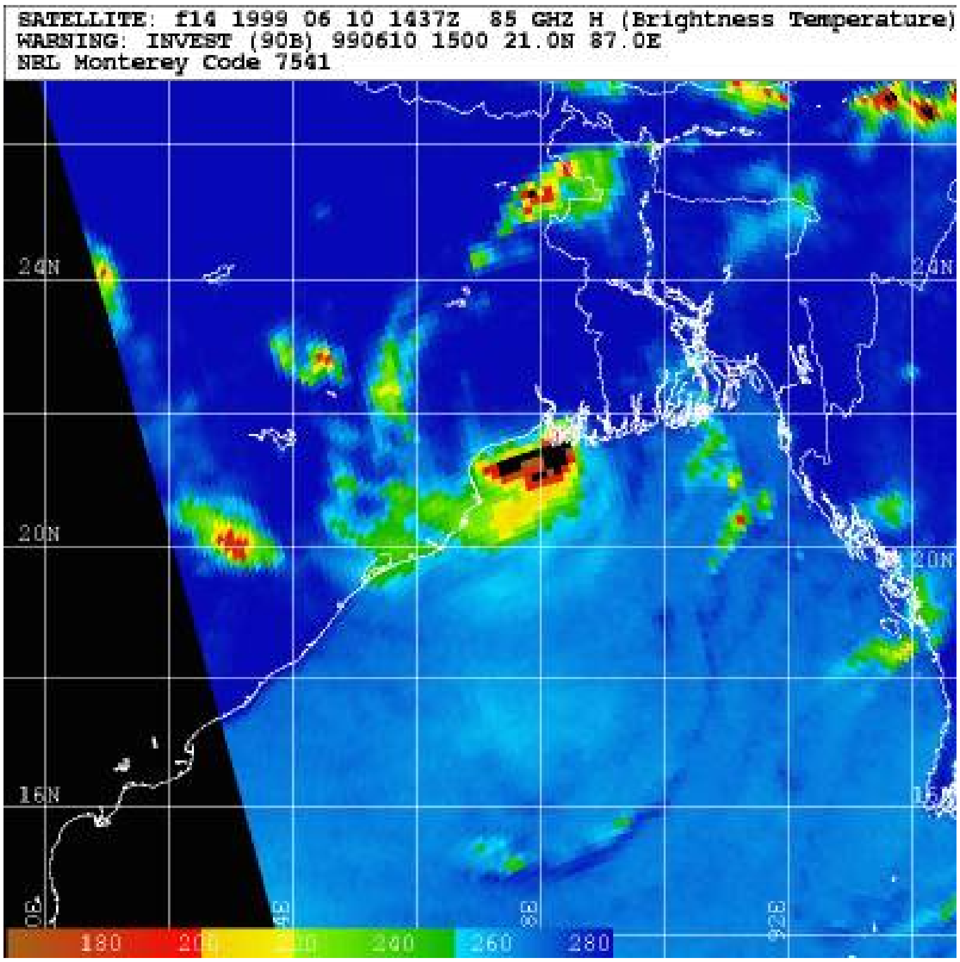
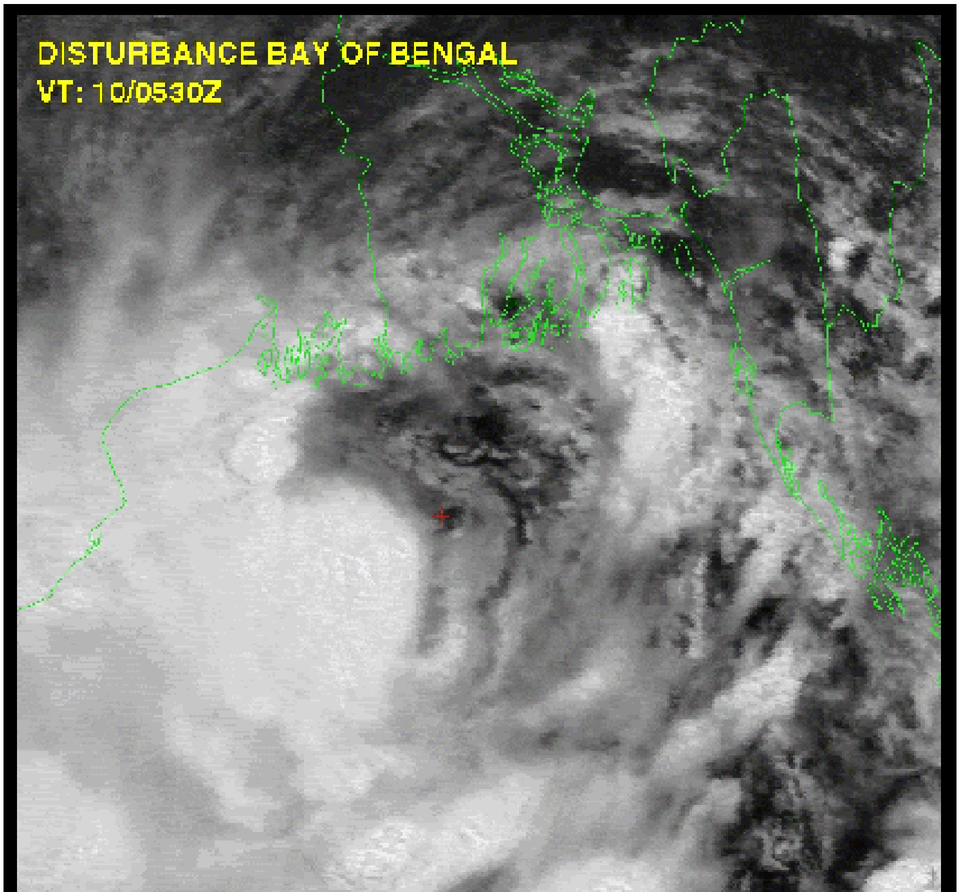
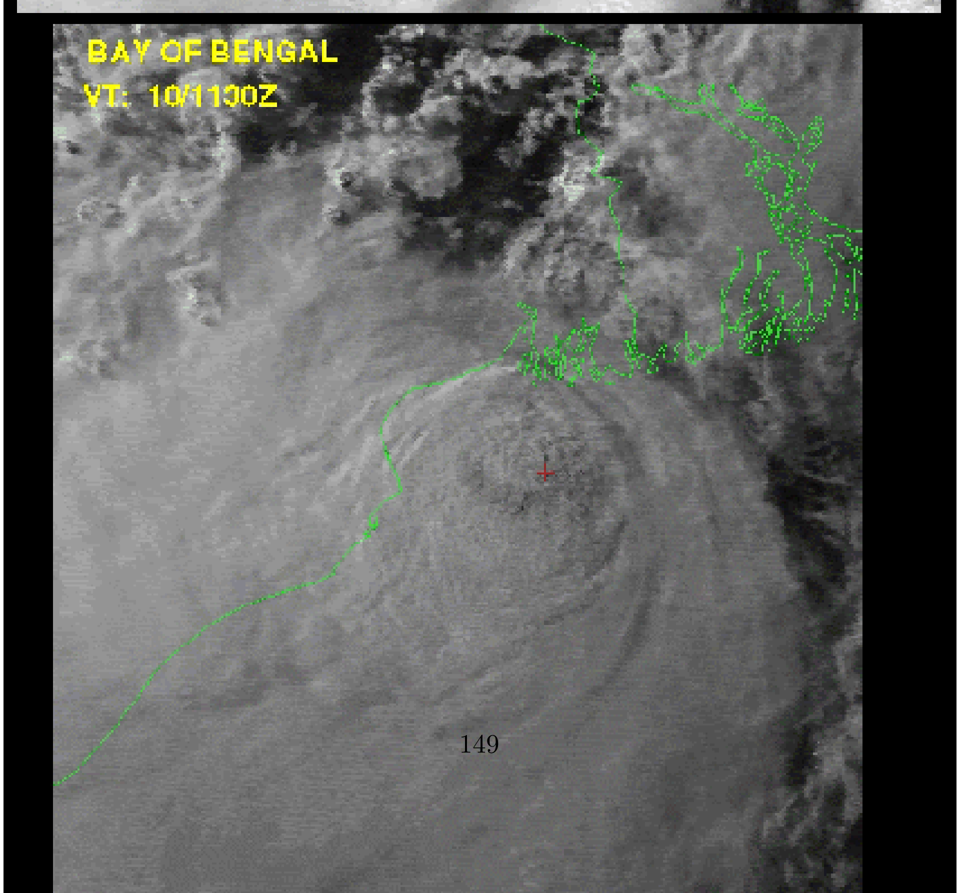


Figure 1-03B-1. 101437Z SSM/I pass over TC 03B as it makes landfall 90 nm southwest of Calcutta. Of note in this image is the strong convection to the south over the water. Interaction with land has served to weaken the system, over land, yet the low-level circulation continues to produce convection over the water.


DISTURBANCE BAY OF BENGAL
VT: 10/0530Z


BAY OF BENGAL
VT: 10/1130Z

Tropical Cyclone 04B

Tropical Cyclone (TC) 04B was the second tropical cyclone that developed over the Bay of Bengal during the 1999 season. This cyclone developed about 220 nm northwest of the Andaman Islands and reached a maximum intensity of 120 kt before making landfall over Gopalpur, India in the Ganjam district at 171730Z October.

JTWC issued a Tropical Cyclone Formation Alert at 151730Z October based on a Special Sensor Microwave/Imager (SSM/I) pass which depicted low level cloud lines over the northwest quadrant moving in toward the system center (Figure 1-04B-1). Subsequently, the first warning was issued at 152100Z October for a 45 kt cyclone.

Tropical Cyclone 04B initially moved west-northwestward at 8 to 12 knots under the influence of the subtropical ridge to the northwest. TC 04B then turned northward around 170600Z October, just before reaching the Orissa coastline. The cyclone slowed on 170000Z October and rapidly intensified to its maximum intensity of 120 kt. TC 04B remained at 120 kt while making landfall over the Orissa coast (Figure 1-04B-2). The cyclone then began to weaken moving northward and dissipating on the 19th of October near Aurangabad. JTWC issued the seventh and final warning at 180900Z October.

CNN and Reuters reported over 80 fatalities, severed communication lines, collapsed buildings and uprooted trees from the eastern Indian state of Orissa. The Ganjam district, specifically the port of Gopalpur, received the brunt of Tropical Cyclone 04B. Hundreds of houses and huts in the low-lying areas of Andhra Pradesh were also reported destroyed by flooding and three fatalities were reported to have occurred in that region.

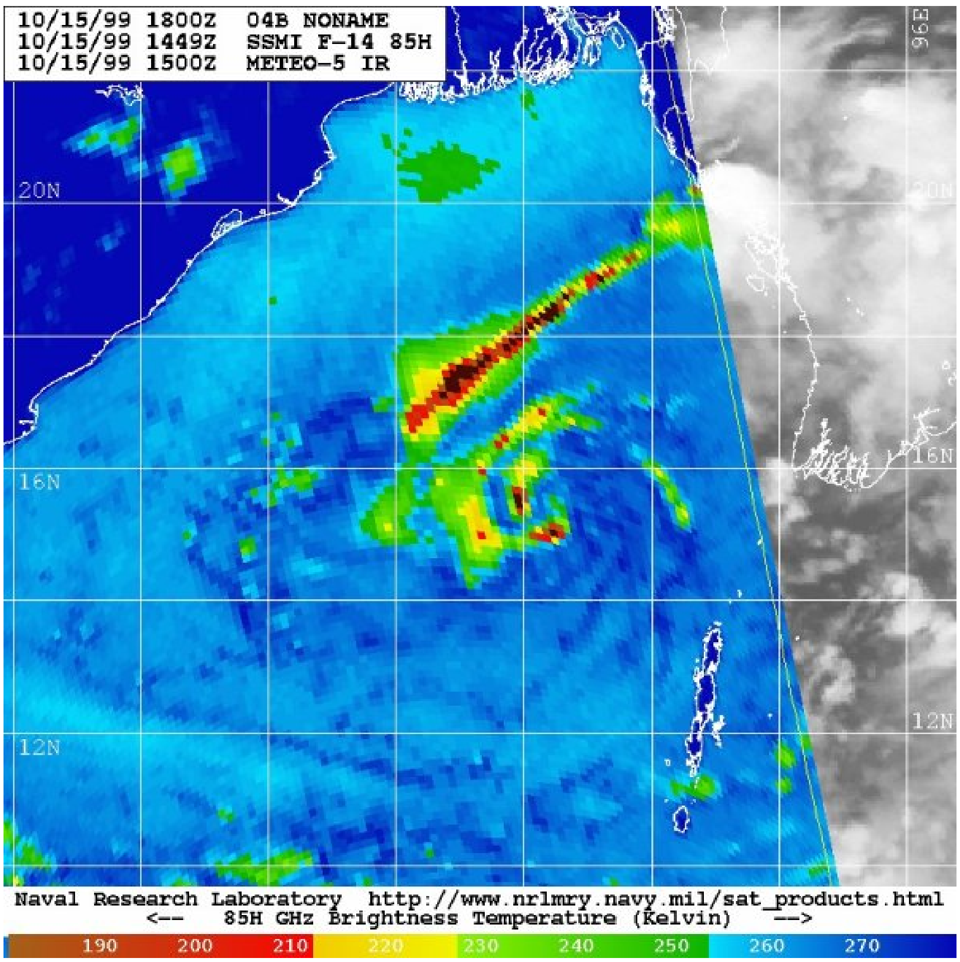


Figure 1-04B-1. 151449Z October combined SSM/I and infrared image from NRL reveals deep convection building in toward the low level circulation center from the northwest. Current intensity was 30 kt, but three hours later it was 45 kt.

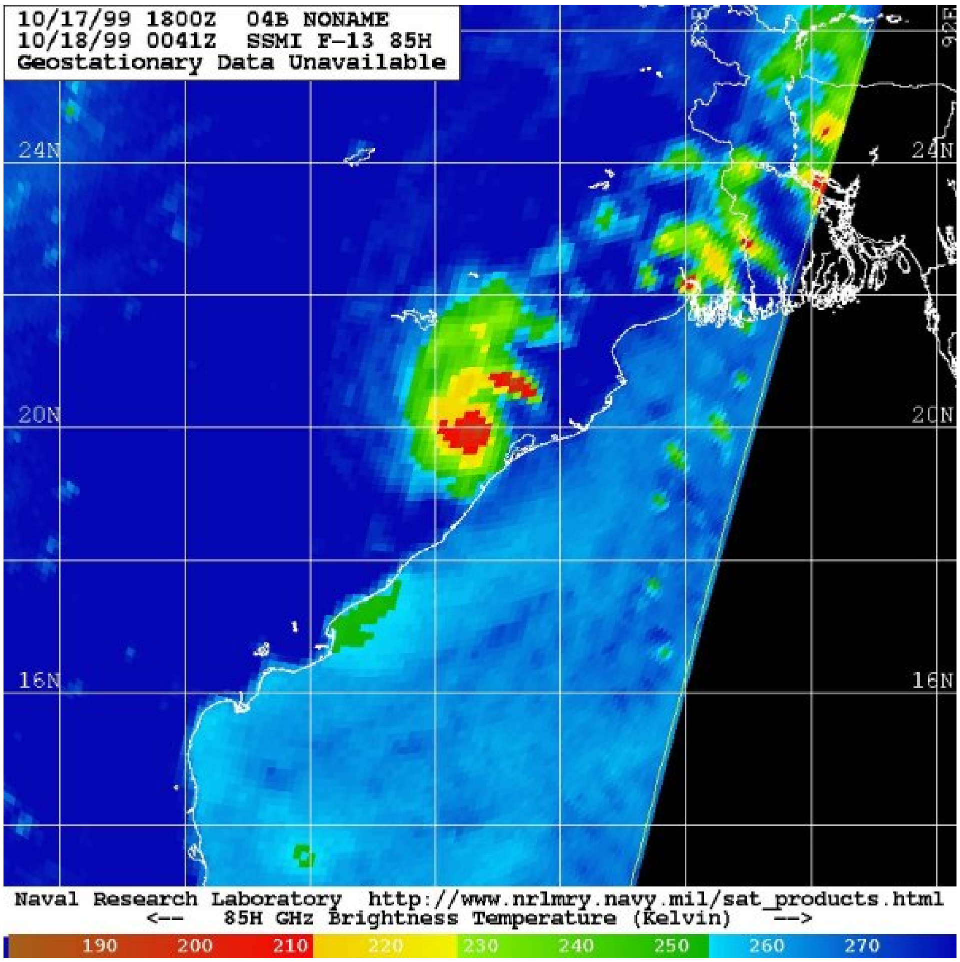
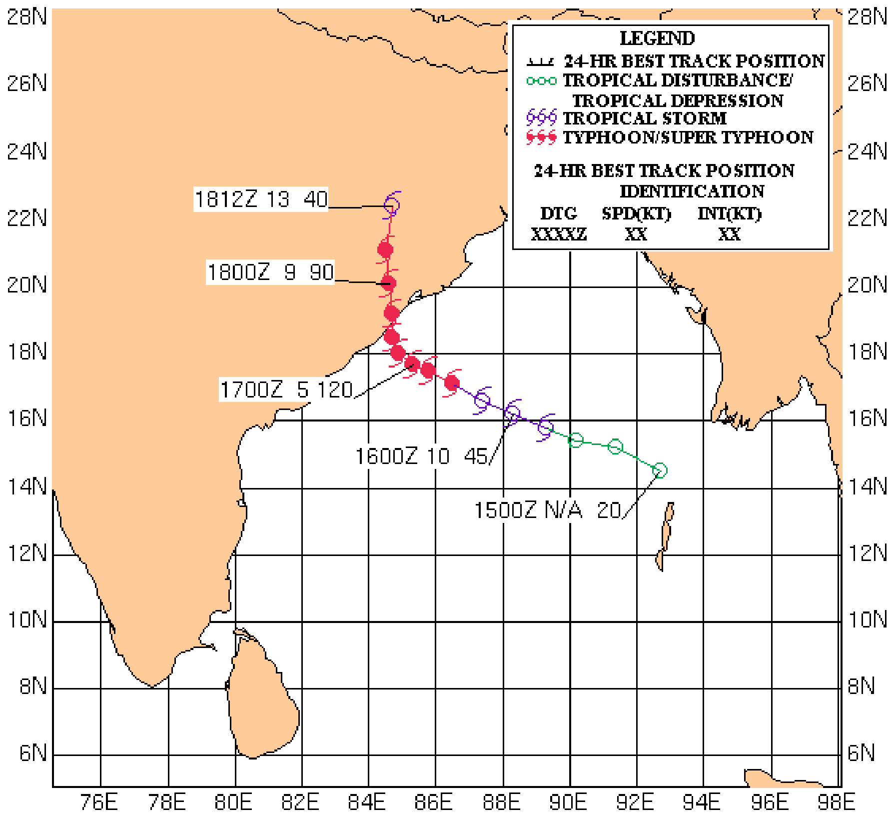


Figure 1-04B-2. 180041Z October SSM/I pass indicates little change in intensity and structure of the system after landfall. Current intensity was 90 kt.



LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/ TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
1812Z 13 40
1800Z 9 90
1700Z 5 120
1600Z 10 45
1500Z N/A 20
28N
26N
24N
22N
20N
18N
16N
14N
12N
10N
8N
6N
76E 78E 80E 82E 84E 86E 88E 90E 92E 94E 96E 98E

Tropical Cyclone 05B

Tropical Cyclone (TC) 05B was one of the most significant tropical cyclones on record to affect India, and the worst since 1971. News reports indicate approximately 10,000 fatalities and record flooding as TC 05B made landfall near Bhubaneswan, India around 290500Z October, with maximum winds of 135 kt. Of note, this same region was affected by TC 04B just two weeks earlier as a 120 kt tropical cyclone.

TC 05B developed from a disturbance that originated in the South China Sea and tracked through the Gulf of Thailand and across the Malay peninsula before developing in the Andaman Sea. JTWC issued a TCFA for this South China Sea disturbance on 230200Z October. The disturbance didn't develop and the TCFA was cancelled. Subsequently, JTWC monitored this weak disturbance as it moved into the Andaman Sea, where the convection began to consolidate. A TCFA was issued on 251930Z October and the first warning was issued at 260300Z October as the disturbance developed into a 35 kt cyclone.

TC 05B tracked northwestward and intensified across the Bay of Bengal under the steering influence of the subtropical ridge to the north. The intensification was at a greater than climatological rate, peaking at 281800Z October at 140 kt intensity. TC 05B made landfall 11 hours later as a 135 kt system about 35nm south-southeast of Cuttack and 30 nm southeast of Bhubaneswan, India. Subsequently, TC 05B maintained 100 kt intensity for 12 hours as it dumped torrential rains and battered the coastal areas, then slowly turned southward and moved back over the Bay of Bengal as a 40 kt tropical cyclone. TC 05B continued to drift southward and dissipate over water. JTWC issued the 13th and final warning at 2010300Z November.

News reports indicated this was the worst tropical cyclone to hit India since 1971. MSNBC reported Asim Kumar Vaishan, Chief Administrator of Baleshwar, stated "this is the worst flooding in 100 years. I would say it's the worst in India's history." The UN Office for the Coordination of Humanitarian Affairs (OCHA) Situation Report #11 for 26 November stated "... the death toll now stands at 9,803, with Jagatsinghpur district recording 8,119 victims. Forty persons are still missing and 3,312 have been injured. A total of 1.711 million hectares of crops have been affected. The number of livestock to have perished is 406,000."

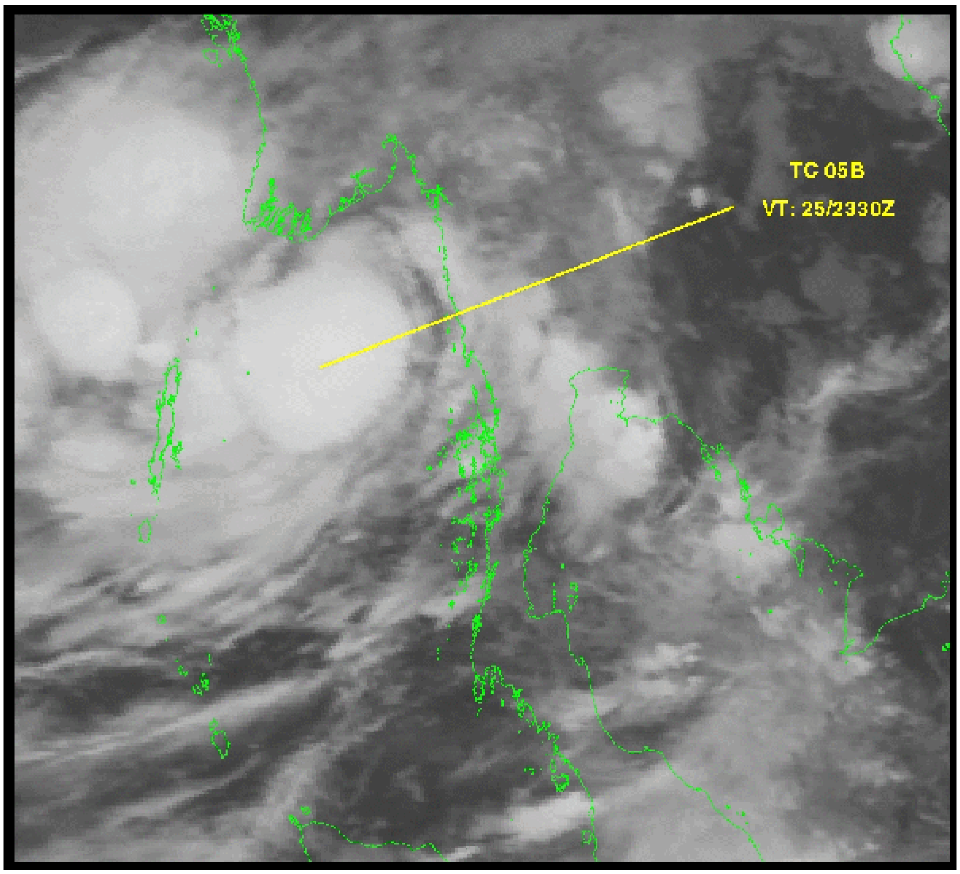


Figure 1-05B-1. 252330Z October GMS-5 infrared image of TC 05B at the initial warning. Intensity was 35 kt.

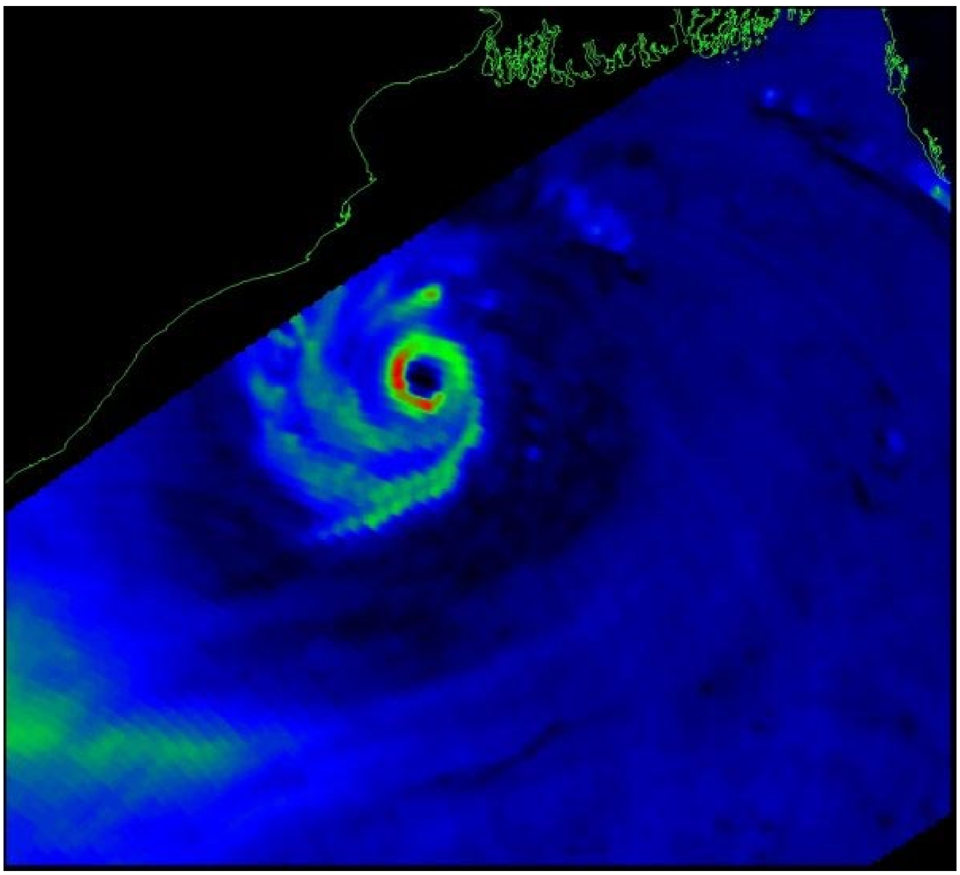


Figure 1-05B-2. 281543Z October Tropical Rainfall Measurement Mission pass of TC 05B. Intensity was 135 kt. TC 05B peaked three hours later at 140 kt.

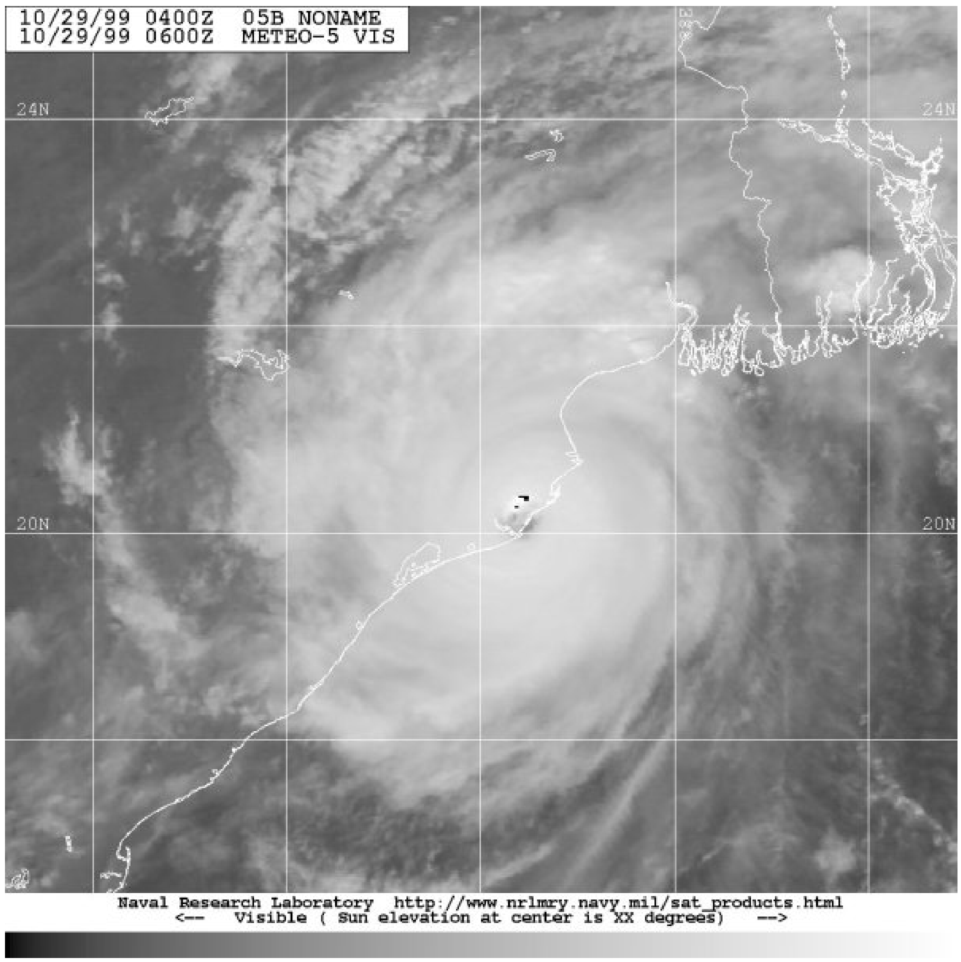
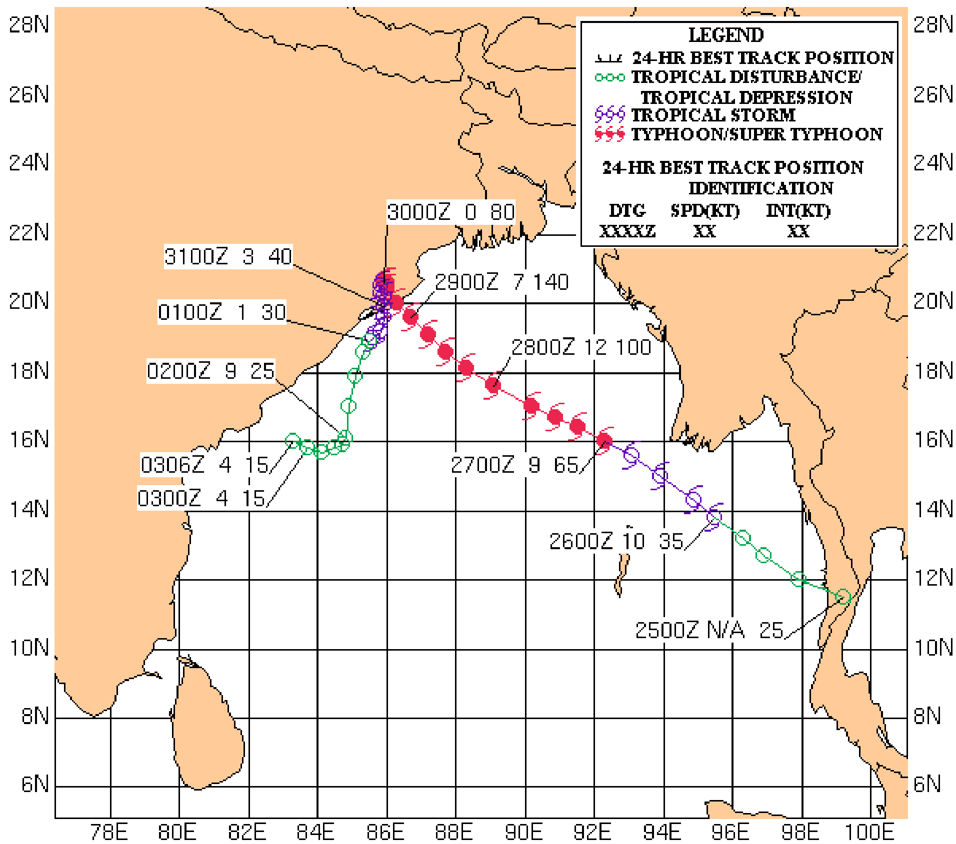


Figure 1-05B-3. 290600Z October METEOSAT-5 visible image of TC 05B. The center of TC 05B made landfall at 0500Z with an intensity of 135 kt.


LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
3000Z 0 80
3100Z 3 40
2900Z 7 140
0100Z 1 30
2800Z 12 100
0200Z 9 25
0306Z 4 15
0300Z 4 15
2700Z 9 65
2600Z 10 35
2500Z N/A 25
28N
26N
24N
22N
20N
18N
16N
14N
12N
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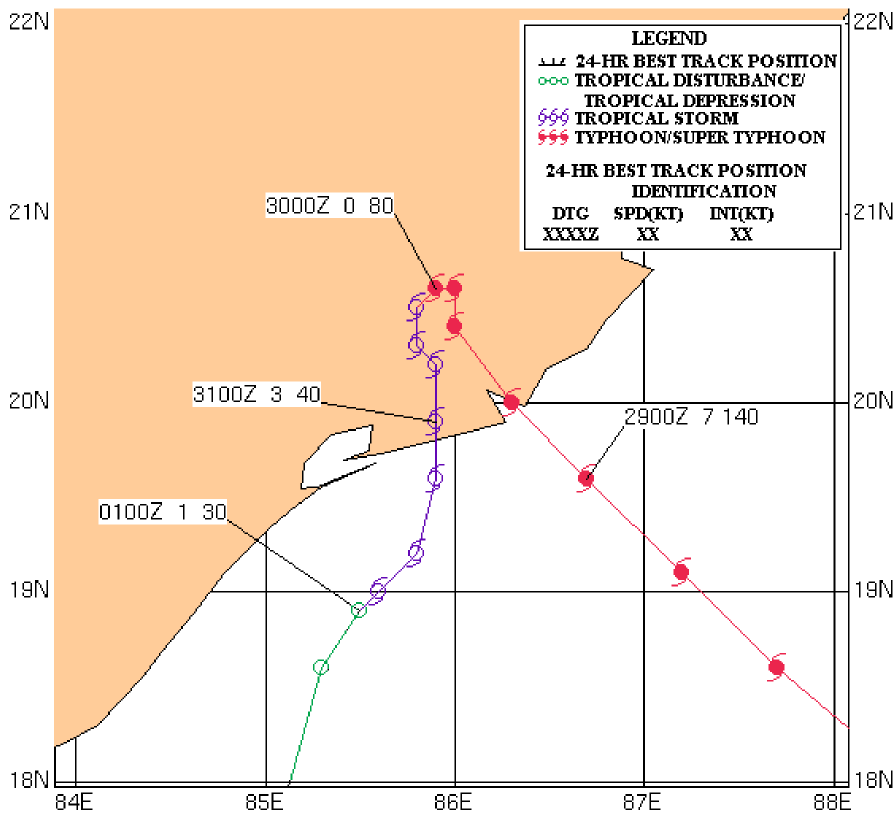
94E
96E
98E
100E


LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX
3000Z 0 80
3100Z 3 40
0100Z 1 30
2900Z 7 140
22N
21N
20N
19N
18N
84E
85E
86E
87E
88E

2. SOUTH PACIFIC AND SOUTH INDIAN OCEAN TROPICAL CYCLONES

2.1 GENERAL

In accordance with CINCPACINST 3140.1 (series), Southern Hemisphere tropical cyclones are numbered sequentially from 01 July through 30 June to reflect the Southern Hemisphere tropical season.

For warning message delineation, the Southern Hemisphere AOR is divided into two basins; the South Indian (west of 135 East longitude) and the South Pacific Ocean (east of 135 East longitude). The suffixes "S" (South Indian Ocean) and "P" (South Pacific Ocean) are appended to the tropical cyclone number to differentiate warnings for these basins.

2.2 SUMMARY

Table 2-1 lists the significant tropical cyclones during this season and can be compared to the climatological mean presented in Table 2-2. Table 2-3 compares this year's tropical cyclone activity in the Southern Hemisphere sub-basins to previous years and climatology. Composites of the tropical cyclone best tracks for the Southern Hemisphere appear in Figures 2-1a, 2-1b, 2-1c, 2-2a, 2-2b, and 2-3.

Table 2-1 SOUTHERN HEMISPHERE TROPICAL CYCLONES FOR 1999 (01 JULY 1998 - 30 JUNE 1999)

TC	NAME	PERIOD	NUMBER ISSUED	EST MAX SFC WINDS KTS (M/SEC)	MSLP (MB)
01S	–	23 JUL 25 JUL	6	40 (21)	994
02S	–	29 SEP 02 OCT	8	40 (21)	994
03S	Zelia	07 OCT 10 OCT	8	45 (23)	991
04S	Alison	08 NOV 13 NOV	11	70 (36)	972
05S	Billy	02 DEC 06 DEC	16	65 (33)	976
06S	–	05 DEC 15 DEC	21	135 (69)	904
07P	–	15 DEC 16 DEC	4	35 (18)	997
*08P	–	22 DEC 23 DEC	(3)	45 (23)	991
09P	Cora	23 DEC 27 DEC	8	90 (46)	954
10S	Cathy	25 DEC 28 DEC	7	40 (21)	994
11P	Dani	14 JAN 22 JAN	18	115 (59)	927
12S	Alda	16 JAN 17 JAN	5	55 (28)	984
13P	Olinda	20 JAN 25 JAN	11	55 (28)	984
14P	Pete	22 JAN 25 JAN	8	50 (26)	987
15S	Damien	22 JAN 30 JAN	23	80 (41)	963
16P	–	25 JAN 26 JAN	4	35 (18)	997

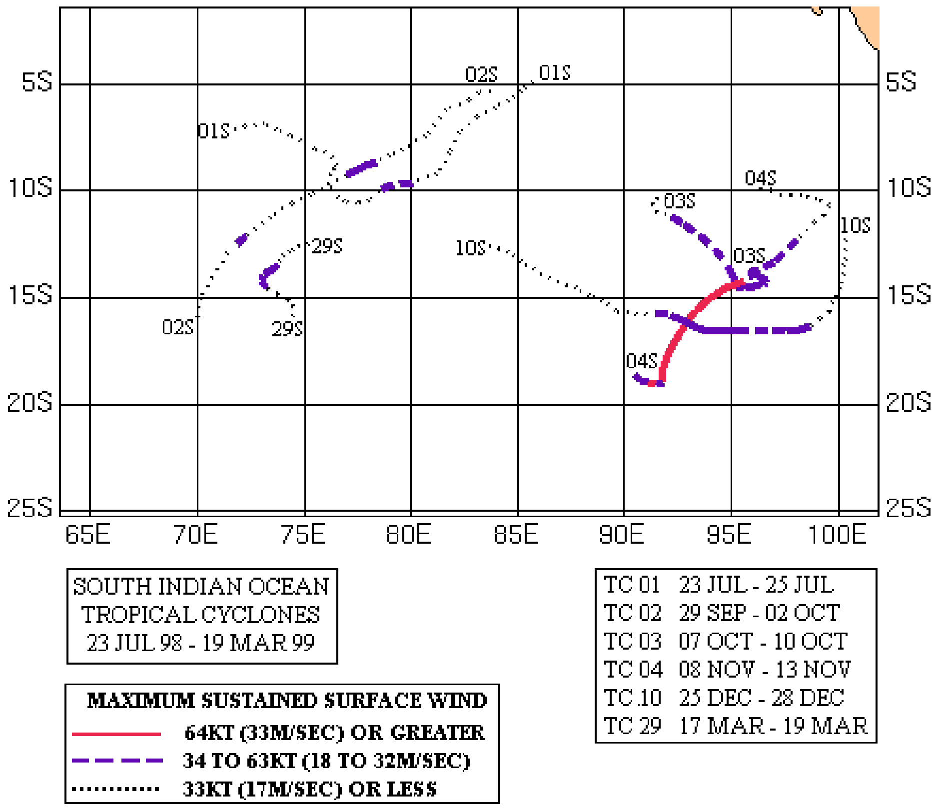
Table 2-1 SOUTHERN HEMISPHERE TROPICAL CYCLONES FOR 1999 (01 JULY 1998 - 30 JUNE 1999)					
17S	Chikita	30 JAN 04 FEB	11	40 (21)	994
18S	–	04 FEB 09 FEB	18	40 (21)	994
19P	Ella	10 FEB 13 FEB	11	45 (23)	991
20P	Rona	10 FEB 12 FEB	5	60 (31)	980
21S	–	13 FEB 15 FEB	8	45 (23)	991
22P	Frank	17 FEB 23 FEB	18	100 (51)	944
23S	–	27 FEB 01 MAR	5	30 (15)	1000
*24P	–	27 FEB 28 FEB	(2)	35 (18)	997
25S	Davina	01 FEB 14 MAR	29	105 (54)	938
26S	–	07 MAR 09 MAR	9	35 (18)	997
*27P	Hali	12 MAR 17 MAR	(11)	50 (26)	987
28S	Elaine	16 MAR 19 MAR	9	100 (51)	944
29S	–	17 MAR 19 MAR	8	35 (18)	997
30S	Vance	18 MAR 23 MAR	17	125 (64)	916
31S	Frederic	26 MAR 07 APR	28	140 (72)	898
32S	Gwenda	05 APR 07 APR	10	130 (67)	910
33S	Hamish	19 APR 24 APR	10	45 (23)	991
		JTWC TOTAL	354		
		( )NPMOC TOTAL	(16)		
		GRAND TOTAL	370		
*WARNINGS ISSUED BY NPMOC					

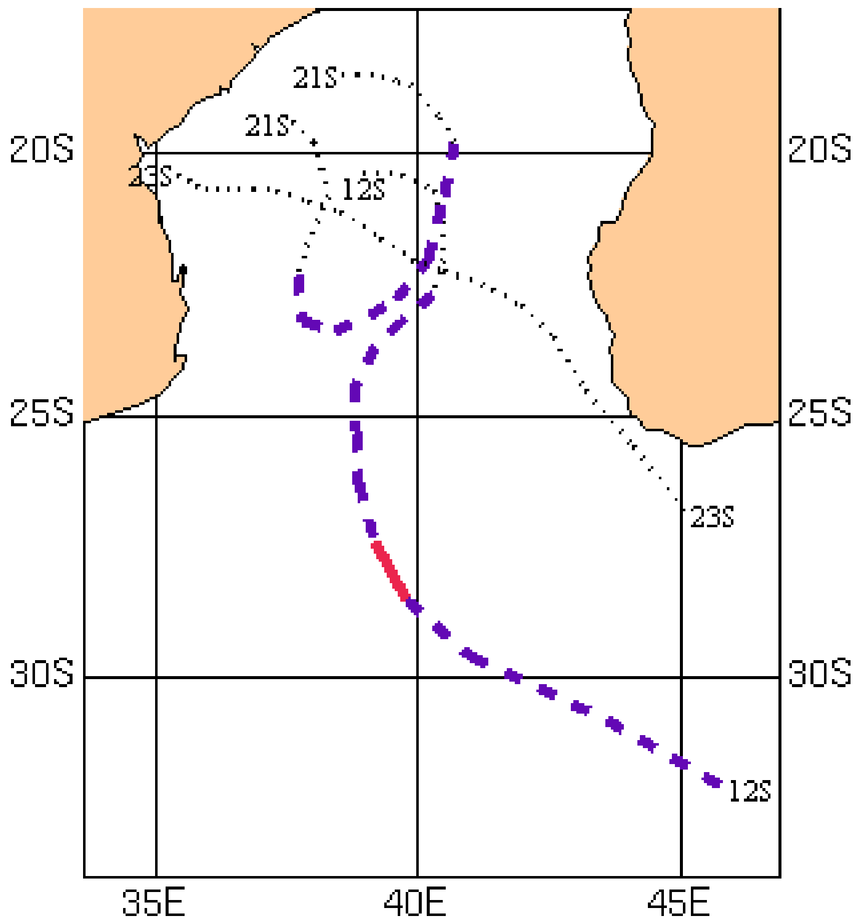
Table 2-2 MONTHLY DISTRIBUTION OF SOUTH PACIFIC AND SOUTH INDIAN OCEAN TROPICAL CYCLONES

YEAR	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
1958-1977 AVE*	-	-	-	0.4	1.5	3.6	6.1	5.8	4.7	2.1	0.5	-	24.7
1981	0	0	0	1	3	2	6	5	3	3	1	0	24
1982	1	0	0	1	1	3	9	4	2	3	1	0	25
1983	1	0	0	1	1	3	5	6	3	5	0	0	25
1984	1	0	0	1	2	5	5	10	4	2	0	0	30
1985	0	0	0	0	1	7	9	9	6	3	0	0	35
1986	0	0	1	0	1	1	9	9	6	4	2	0	33
1987	0	1	0	0	1	3	6	8	3	4	1	1	28
1988	0	0	0	0	2	3	5	5	3	1	2	0	21
1989	0	0	0	0	2	1	5	8	6	4	2	0	28
1990	2	0	1	1	2	2	4	4	10	2	1	0	29
1991	0	0	1	1	1	3	2	5	5	2	1	1	22
1992	0	0	1	1	2	5	4	11	3	2	1	0	30
1993	0	0	1	1	0	5	7	7	2	2	2	0	27
1994	0	0	0	0	2	4	8	4	9	3	0	0	30
1995	0	0	0	0	2	2	5	4	5	4	0	0	22
1996	0	0	0	0	1	3	7	6	6	4	1	0	28
1997	1	1	1	2	2	6	9	8	3	1	3	1	38
1998	1	0	0	3	2	3	7	9	6	6	0	0	37

Table 2-2 MONTHLY DISTRIBUTION OF SOUTH PACIFIC AND SOUTH INDIAN OCEAN TROPICAL CYCLONES													
1999	1	0	1	1	1	5	7	6	6	2	0	0	30
TOTAL	8	2	7	14	29	66	119	128	91	57	18	3	542
AVERAGE	0.4	0.1	0.4	0.7	1.5	3.5	6.2	6.7	4.8	3.0	0.9	0.2	28.5
(1981-1999)													
* (Gray, 1978)													

Table 2-3 ANNUAL VARIATION OF SOUTHERN HEMISPHERE TROPICAL CYCLONE BY OCEAN BASIN				
YEAR	SOUTH INDIAN	AUSTRALIAN	SOUTH PACIFIC	
	(WEST OF 105E)	(105E - 165E)	(EAST OF 165E)	TOTAL
1958-1977 AVERAGE*	8.4	10.3	5.9	24.6
1981	13	8	3	24
1982	12	11	2	25
1983	7	6	12	25
1984	14	14	2	30
1985	14	15	6	35
1986	14	16	3	33
1987	9	8	11	28
1988	14	2	5	21
1989	12	9	7	28
1990	18	8	3	29
1991	11	10	1	22
1992	11	6	13	30
1993	10	16	1	27
1994	16	10	4	30
1995	11	7	4	22
1996	13	11	4	28
1997	17	5	16	38
1998	12	10	15	37
1999	14	11	5	30
(1981-1999)				
TOTAL	242	183	107	542
AVERAGE	12.7	9.6	5.6	28.5
* (Gray,1978)				


5S
10S
15S
20S
25S
65E
70E
75E
80E
85E
90E
95E
100E
01S
02S
03S
04S
10S
29S
SOUTH INDIAN OCEAN
TROPICAL CYCLONES
23 JUL 98 - 19 MAR 99
MAXIMUM SUSTAINED SURFACE WIND
64KT (33M/SEC) OR GREATER
34 TO 63KT (18 TO 32M/SEC)
33KT (17M/SEC) OR LESS
TC 01 23 JUL - 25 JUL
TC 02 29 SEP - 02 OCT
TC 03 07 OCT - 10 OCT
TC 04 08 NOV - 13 NOV
TC 10 25 DEC - 28 DEC
TC 29 17 MAR - 19 MAR



SOUTH INDIAN OCEAN
TROPICAL CYCLONES
16 JAN 99 - 01 MAR 99

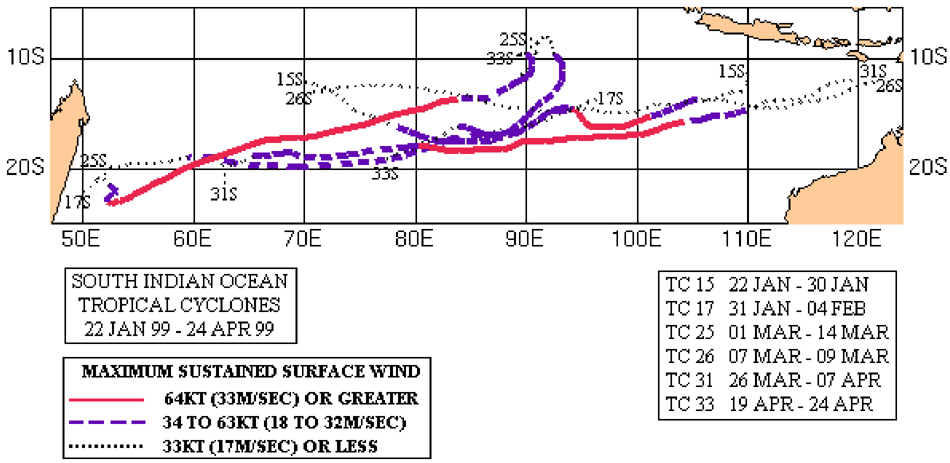
TC 12	16 JAN - 17 JAN
TC 21	13 FEB - 15 FEB
TC 23	27 FEB - 01 MAR

MAXIMUM SUSTAINED SURFACE WIND

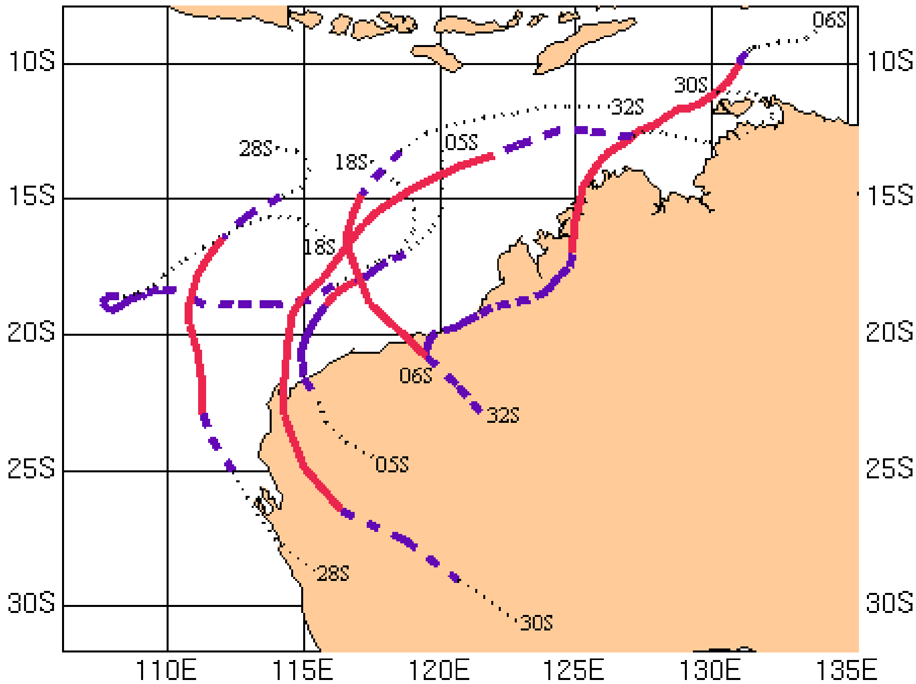
64KT (33M/SEC) OR GREATER

34 TO 63KT (18 TO 32M/SEC)

33KT (17M/SEC) OR LESS



10S
20S
50E
60E
70E
80E
90E
100E
110E
120E
15S
17S
25S
26S
31S
33S
SOUTH INDIAN OCEAN
TROPICAL CYCLONES
22 JAN 99 - 24 APR 99
MAXIMUM SUSTAINED SURFACE WIND
64KT (33M/SEC) OR GREATER
34 TO 63KT (18 TO 32M/SEC)
33KT (17M/SEC) OR LESS
TC 15 22 JAN - 30 JAN
TC 17 31 JAN - 04 FEB
TC 25 01 MAR - 14 MAR
TC 26 07 MAR - 09 MAR
TC 31 26 MAR - 07 APR
TC 33 19 APR - 24 APR



AUSTRALIA REGION
TROPICAL CYCLONES
02 DEC 98 - 07 APR 99

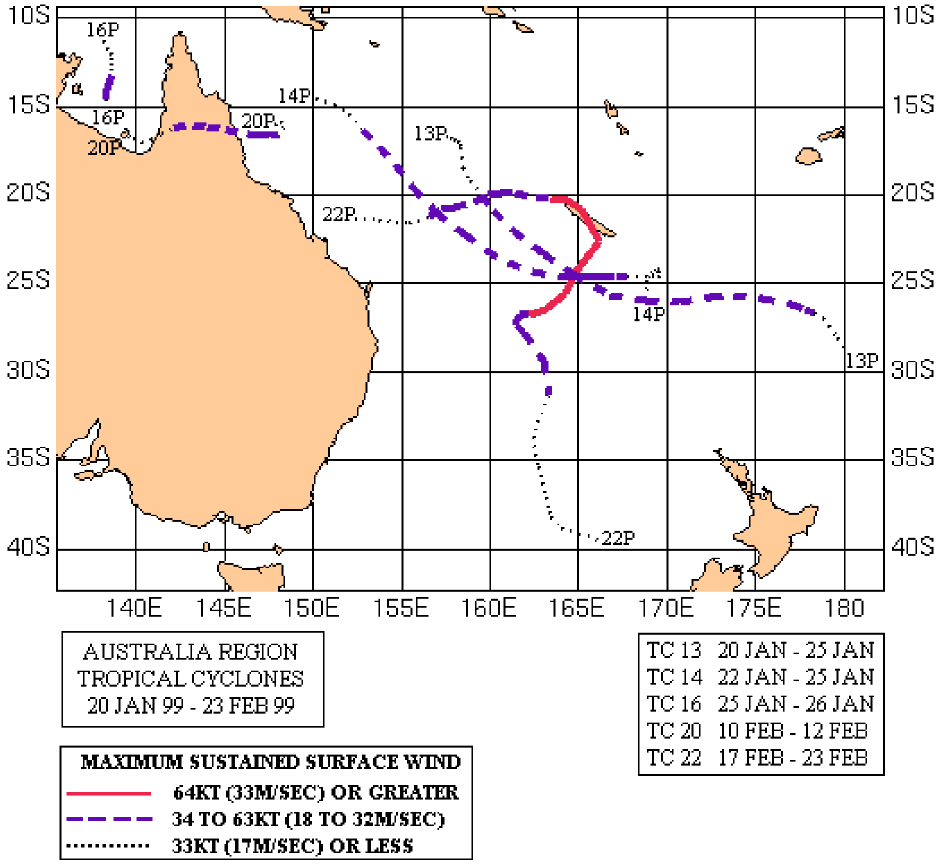
TC 05	02 DEC - 06 DEC
TC 06	05 DEC - 15 DEC
TC 18	04 FEB - 09 FEB
TC 28	16 MAR - 19 MAR
TC 30	18 MAR - 23 MAR
TC 32	05 APR - 07 APR

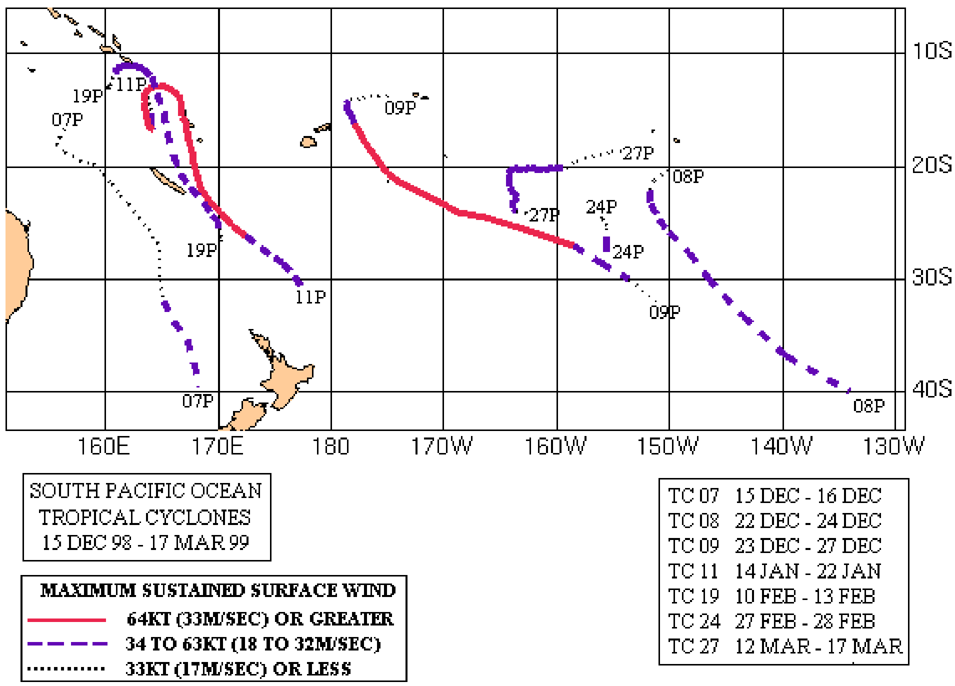
MAXIMUM SUSTAINED SURFACE WIND

64KT (33M/SEC) OR GREATER

34 TO 63KT (18 TO 32M/SEC)

33KT (17M/SEC) OR LESS


10S
15S
20S
25S
30S
35S
40S
140E
145E
150E
155E
160E
165E
170E
175E
180
16P
16P
20P
20P
14P
13P
22P
14P
13P
22P
AUSTRALIA REGION
TROPICAL CYCLONES
20 JAN 99 - 23 FEB 99
TC 13 20 JAN - 25 JAN
TC 14 22 JAN - 25 JAN
TC 16 25 JAN - 26 JAN
TC 20 10 FEB - 12 FEB
TC 22 17 FEB - 23 FEB
MAXIMUM SUSTAINED SURFACE WIND
64KT (33M/SEC) OR GREATER
34 TO 63KT (18 TO 32M/SEC)
33KT (17M/SEC) OR LESS


11P
19P
07P
09P
27P
08P
24P
27P
24P
19P
11P
09P
07P
08P
10S
20S
30S
40S
160E
170E
180
170W
160W
150W
140W
130W
SOUTH PACIFIC OCEAN
TROPICAL CYCLONES
15 DEC 98 - 17 MAR 99
MAXIMUM SUSTAINED SURFACE WIND
64KT (33M/SEC) OR GREATER
34 TO 63KT (18 TO 32M/SEC)
33KT (17M/SEC) OR LESS
TC 07 15 DEC - 16 DEC
TC 08 22 DEC - 24 DEC
TC 09 23 DEC - 27 DEC
TC 11 14 JAN - 22 JAN
TC 19 10 FEB - 13 FEB
TC 24 27 FEB - 28 FEB
TC 27 12 MAR - 17 MAR

3. SUMMARY OF FORECAST VERIFICATION

3.1 ANNUAL FORECAST VERIFICATION

Verification of warning positions and intensities at initial, 12-, 24-, 48-, and 72-hour forecast periods are made against the final best track. The (scalar) track forecast, along-track and cross-track errors (illustrated in Figure 3-1) were calculated for each verifying JTWC forecast. These data, in addition to a detailed summary for each tropical cyclone, are included as Chapter 4. This section summarizes verification data this year and contrasts it with annual verification statistics from previous years.

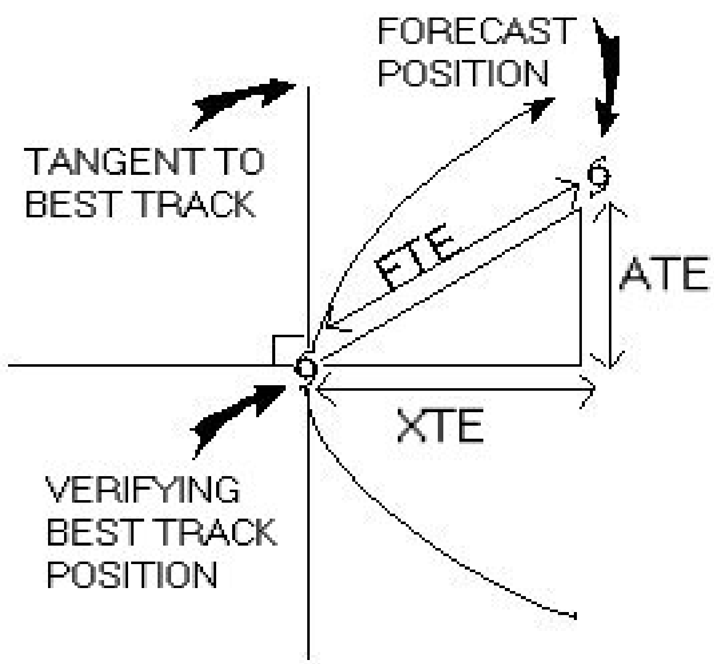


Figure 3-1. Definition of cross-track error (XTE), along-track error (ATE) and forecast track error (FTE). In this example, the forecast position is ahead of and to the right of the verifying best track position. Therefore, the XTE is positive (to the right of the best track) and the ATE is positive (ahead or faster than the best track). Adapted from Tsui and Miller, 1988.

3.1.1 NORTHWEST PACIFIC OCEAN

Table 3-1 includes mean track, along-track and cross-track errors for a 15-year period. Figure 3-2 shows mean track errors and a 5-year running mean of track errors at 24-, 48- and 72-hours since 1974. Table 3-2 lists annual mean track errors from 1959, when JTWC was founded, until the present.

Table 3-1 INITIAL POSITION AND FORECAST ERRORS (NM) FOR THE NORTH WEST PACIFIC 1985-1999

	Initial Position		24-Hour				48-Hour				72-Hour			
	Number	Error	Number	Track	Along	Cross	Number	Track	Along	Cross	Number	Track	Along	Cross
1985	592	18	477	117	80	68	336	231	153	138	241	367	230	227
1986	743	21	645	126	85	70	535	261	183	151	412	394	276	227
1987	657	18	563	107	71	64	465	204	134	127	389	303	198	186
1988	465	23	373	114	85	58	262	216	170	103	183	315	244	159
1989	710	20	625	120	83	69	481	231	162	127	363	350	265	177
1990	794	21	658	103	72	60	525	203	148	110	432	310	225	168
1991	835	22	733	96	69	53	599	185	137	97	484	287	229	146
1992	941	25	841	107	77	59	687	205	143	116	568	305	210	172
1993	853	26	725	112	79	63	570	212	151	117	437	321	226	173
1994	1058	24	932	98	85	62	753	176	158	105	608	242	218	144
1995	559	29	539	123	89	67	421	215	159	117	319	325	240	167
1996	922	25	880	105	76	56	711	178	134	89	607	272	203	137
1997	910	20	865	93	76	55	752	164	134	87	642	245	202	120
1998	450	22	375	124	98	58	273	239	178	127	202	370	274	201
1999	583	15	445	106	74	59	307	176	119	102	197	234	155	139
(1985-1999)														
Avg	738	22	645	110	80	62	512	206	151	114	406	309	227	170

Table 3-2 MEAN FORECAST TRACK ERRORS (NM) FOR WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959-1999

	24-HOUR				48-HOUR				72-HOUR			
YEAR (Notes)	TY (1)	TC (3)	CROSS TRACK (2)	ALONG TRACK (2)	TY (1)	TC (3)	CROSS TRACK (2)	ALONG TRACK (2)	TY (1)	TC (3)	CROSS TRACK (2)	ALONG TRACK (2)
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	98	104			181	190			272	279		
1971	99	111	64		203	212	118		308	317	177	

Table 3-2 MEAN FORECAST TRACK ERRORS (NM) FOR WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959-1999

1972	116	117	72		245	245	146		382	381	210	
1973	102	108	74		193	197	134		245	253	162	
1974	114	120	78		218	226	157		357	348	245	
1975	129	138	84		279	288	181		442	450	290	
1976	117	117	71		232	230	132		336	338	202	
1977	140	148	83		266	283	157		390	407	228	
1978	120	127	71	87	241	271	151	194	459	410	218	296
1979	113	124	76	81	219	226	138	146	319	316	182	214
1980	116	126	76	86	221	243	147	165	362	389	230	266
1981	117	124	77	80	215	221	131	146	342	334	219	206
1982	114	113	70	74	229	238	142	162	337	342	211	223
1983	110	117	73	76	247	260	164	169	384	407	263	259
1984	110	117	64	84	228	232	131	163	361	363	216	238
1985	112	117	68	80	228	231	138	153	355	367	227	230
1986	117	126	70	85	261	261	151	183	403	394	227	276
1987	101	107	64	71	211	204	127	134	318	303	186	198
1988	107	114	58	85	222	216	103	170	327	315	159	244
1989	107	120	69	83	214	231	127	162	325	350	177	265
1990	98	103	60	72	191	203	110	148	299	310	168	225
1991	93	96	53	69	187	185	97	137	298	287	146	229
1992	97	107	59	77	194	205	116	143	295	305	172	210
1993	102	112	63	79	205	212	117	151	320	321	173	226
1994**	96	105	56	76	172	186	105	131	244	258	152	176
1995	105	123	67	89	200	215	117	159	311	325	167	240
1996	85	105	56	76	157	178	89	134	252	272	137	203
1997	86	93	55	76	159	164	87	134	251	245	120	202
1998	127	124	58	98	263	239	127	178	392	370	201	274
1999	88	106	59	74	150	176	102	119	225	234	139	155
Averages	108	108	63	73	215	208	121	140	328	312	181	212

1. Forecasts were verified for typhoons when intensities were at least 35kt at warning times

2. Cross-track and along-track errors were adopted by the JTWC in 1986. Right angle errors (used prior to 1986) were recomputed as cross-track errors after-the fact to extend the data base. See Figure 3-1 for the definitions of cross-track and along-track.

3. Mean forecast errors for all warned systems in Northwest Pacific.

*Forecast positions north of 35 degrees North latitude were not verified.

**1994 statistics were recalculated to resolve earlier Along and Cross-Track discrepancies.

3.1.2 NORTH INDIAN OCEAN

Table 3-3 includes mean track, along-track and cross-track errors for a 15-year period. Figure 3-3 shows mean track errors and a 5-year running mean of track errors at 24-, 48- and 72-hours since 1981.

Table 3-3 JTWC INITIAL POSITION AND FORECAST ERRORS (NM) FOR THE NORTHERN INDIAN OCEAN 1985-1999

	Initial Position		24-Hour				48-Hour				72-Hour			
	Number	Error	Number	Track	Along	Cross	Number	Track	Along	Cross	Number	Track	Along	Cross
1985	53	31	30	122	102	53	8	242	119	194	0			

Table 3-3 JTWC INITIAL POSITION AND FORECAST ERRORS (NM) FOR THE NORTHERN INDIAN OCEAN 1985-1999

1986	28	52	16	134	118	53	7	168	131	80	5	269	189	180
1987	83	42	54	144	97	100	25	205	125	140	21	305	219	188
1988	44	34	30	120	89	63	18	219	112	176	12	409	227	303
1989	44	19	33	88	62	50	17	146	94	86	12	216	164	11
1990	46	31	36	101	85	43	24	146	117	67	17	185	130	104
1991	56	38	43	129	107	54	27	235	200	89	14	450	356	178
1992	191	35	149	128	73	86	100	244	141	166	62	398	276	218
1993	36	27	28	125	87	79	20	198	171	74	12	231	176	116
1994	60	25	44	97	80	44	28	153	124	63	13	213	177	92
1995	54	30	47	138	119	58	32	262	247	77	20	342	304	109
1996	135	33	123	134	94	80	85	238	181	127	58	311	172	237
1997	56	29	42	119	87	49	29	201	168	92	17	228	195	110
1998	80	20	55	106	84	51	34	198	135	106	17	262	188	144
1999	49	8	41	79	59	38	22	184	130	116	10	374	309	177
(1985-1999)														
Avg	68	30	50	120	92	60	31	207	151	112	20	280*	206*	145*

*14 year average (1985 not available)

3.1.3 SOUTH PACIFIC AND SOUTH INDIAN OCEANS

Table 3-4 includes mean track, along-track and cross-track errors for a 15-year period. Figure 3-4 shows mean track errors and a 5-year running mean of track errors at 24-, 48- and 72-hours since 1981.

Table 3-4 JTWC INITIAL POSITION AND FORECAST ERRORS (NM) FOR THE SOUTHERN HEMISPHERE 1985-1999

	Initial Position		24-Hour				48-Hour				72-Hour			
	Number	Error	Number	Track	Along	Cross	Number	Track	Along	Cross	Number	Track	Along	Cross
1985	306	36	257	134	92	79	193	236	169	132				
1986	279	40	227	129	86	77	171	262	169	164				
1987	189	46	138	145	94	90	101	280	153	138				
1988	204	34	99	146	98	83	48	290	246	144				
1989	287	31	242	124	84	73	186	240	166	136				
1990	272	27	228	143	105	74	177	263	178	152				
1991	264	24	231	115	75	69	185	220	152	129				
1992	267	28	230	124	91	64	208	240	177	129				
1993	257	21	225	102	74	57	176	199	142	114				
1994	386	28	345	115	77	68	282	224	147	134				
1995	245	24	222	108	82	55	175	198	144	108	53	291	169	190
1996	343	24	298	125	90	67	237	240	174	129	46	277	221	133
1997	561	24	499	109	82	72	442	210	163	135	150	288	248	175
1998	329	26	305	111	85	52	245	219	169	108	81	349	261	171
1999	348	17	322	113	80	64	245	226	159	132	59	286	198	164
(1985-1999)														
Avg	302	29	258	123	87	70	205	236	167	132	78*	298*	219*	167*

*5-year average

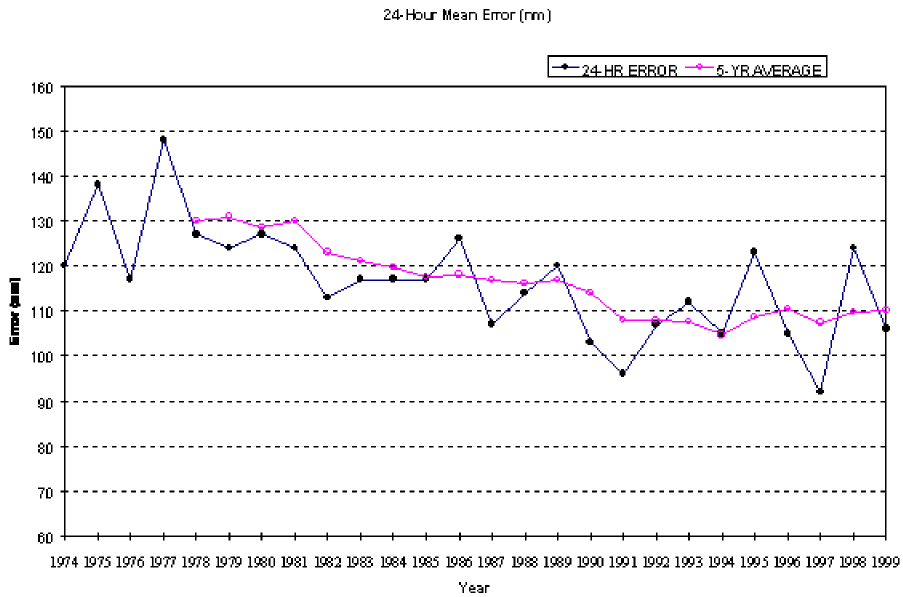


Figure 3-2a. Mean track forecast error (nm) and 5-year running mean for 24 hours for North West Pacific Ocean tropical cyclones from 1974-1999.

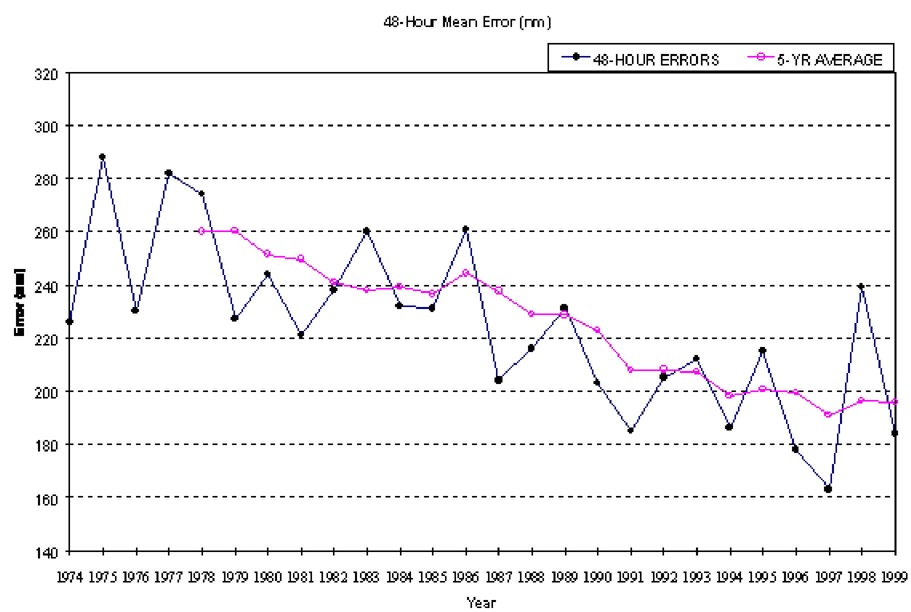


Figure 3-2b. Mean track forecast error (nm) and 5-year running mean for 48 hours for North West Pacific Ocean tropical cyclones from 1974-1999.

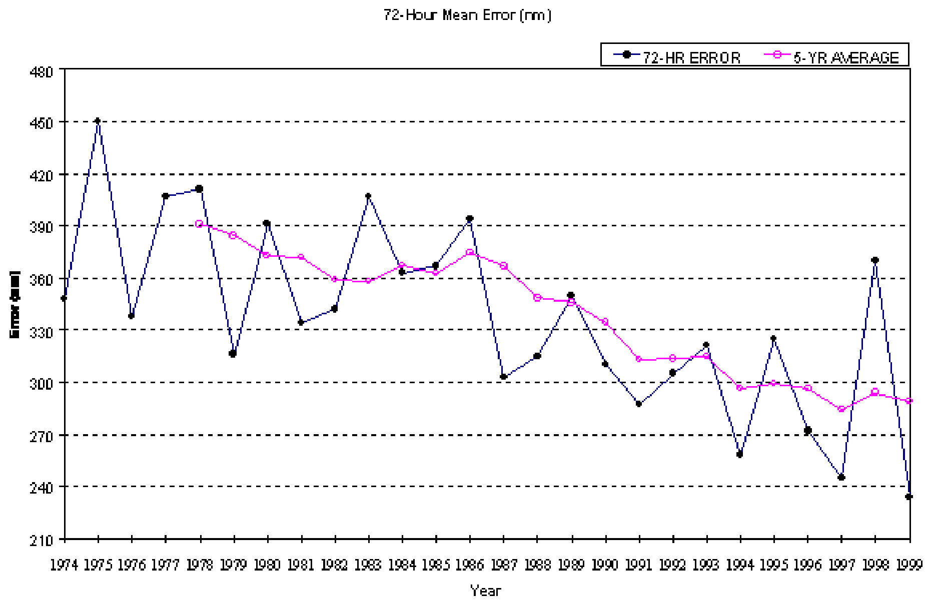


Figure 3-2c. Mean track forecast error (nm) and 5-year running mean for 72 hours for North West Pacific Ocean tropical cyclones from 1974-1999.

3.2 TESTING AND RESULTS

A comparison of selected techniques is included in Table 3-5 for all North West Pacific tropical cyclones, Table 3-6 for North Indian Ocean tropical cyclones and Table 3-7 for Southern Hemisphere tropical cyclones. For example, in Table 3-5 for the 12-hour mean forecast error, 212 cases were available for a homogeneous comparison. The average forecast error at 12 hours was 73 nm for NGPS and 61 nm for JTWC. The difference of 13 nm is shown in the lower right. Due to computational round-off, differences are not always exact.

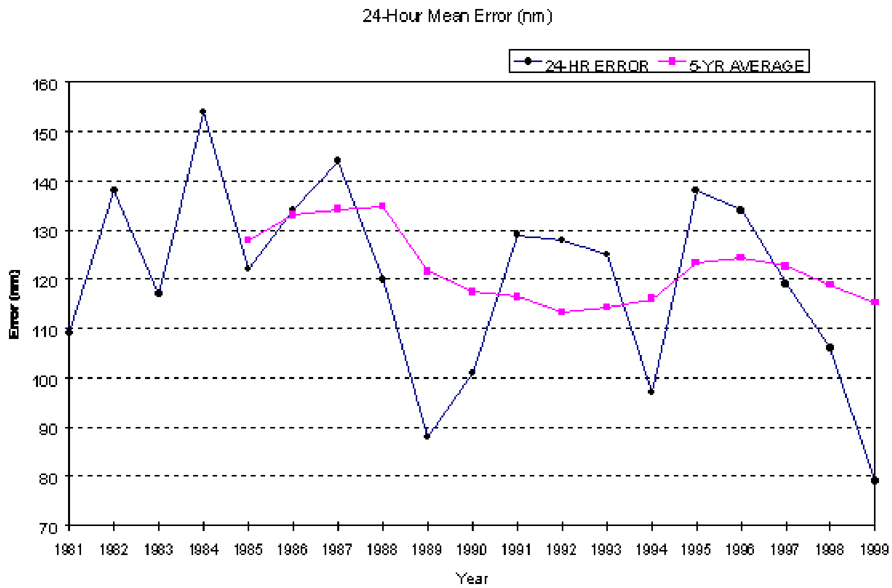


Figure 3-3a. Mean track forecast error (nm) and 5-year running mean for 24 hours for Northern Indian Ocean tropical cyclones from 1981-1999.

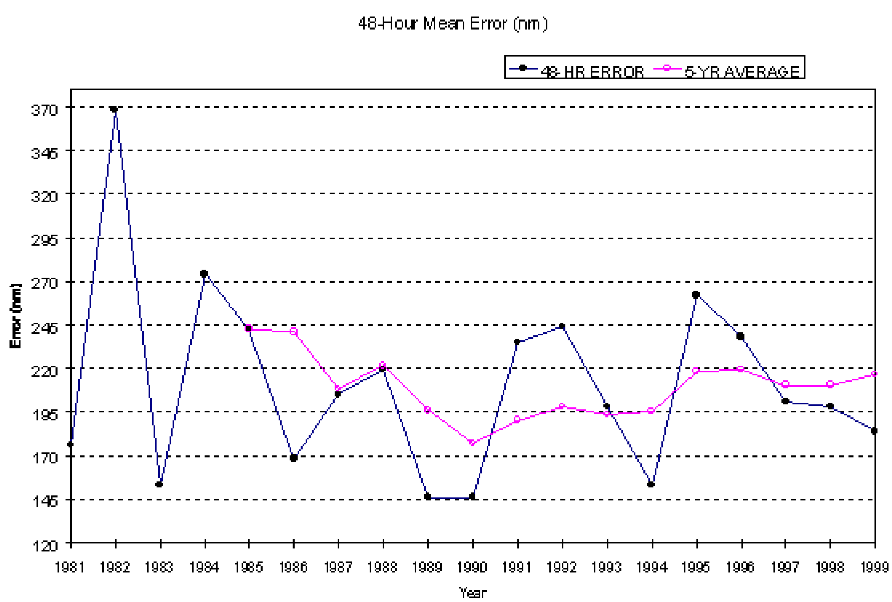


Figure 3-3b. Mean track forecast error (nm) and 5-year running mean for 48 hours, for Northern Indian Ocean tropical cyclones from 1981-1999.

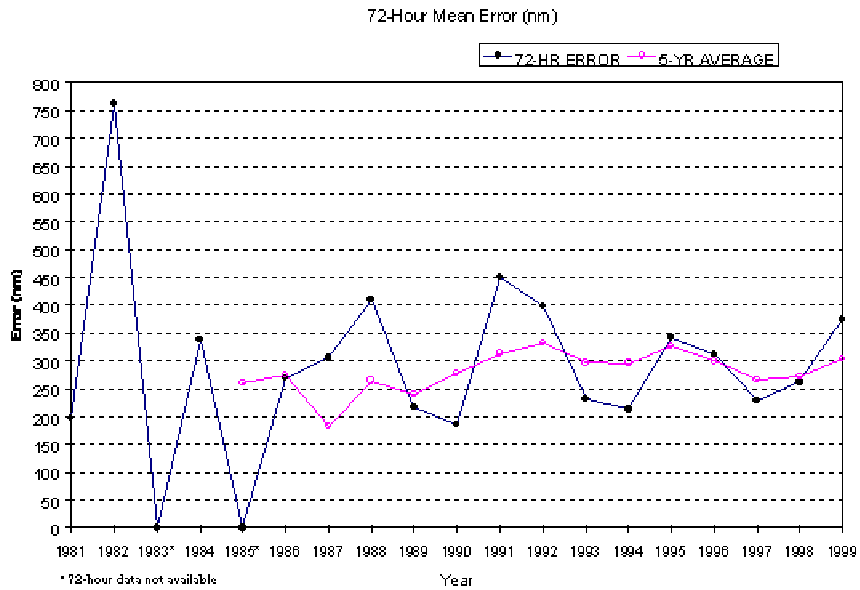


Figure 3-3c. Mean track forecast error (nm) and 5-year running mean for 72 hours for Northern Indian Ocean tropical cyclones from 1981-1999. The 1983 and 1985 zero values in the chart are due to no 72 hour forecasts during those years.

Table 3-5 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

12-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		CSUM		EGRR		GFDN		JGSM		JTYM		CLIP	
JTWC	498	61														
	61	0														
NGPS	212	61	238	70												
	73	12	70	0												
CSUM	460	61	202	72	520	67										
	65	4	64	-8	67	0										
EGRR	0	0	5	34	1	102	6	83								
	0	0	42	8	290	188	83	0								
GFDN	159	54	0	0	151	56	0	0	161	130						
	131	77	0	0	97	41	0	0	130	0						
JGSM	139	58	119	66	141	64	1	290	10	67	145	65				
	64	6	63	-3	65	1	70	-220	58	-9	65	0				
JTYM	146	55	9	62	142	60	0	0	100	54	14	70	147	59		
	59	4	81	19	59	-1	0	0	57	3	72	2	59	0		
CLIP	497	61	237	70	520	67	6	83	161	130	144	65	147	59	633	67
	66	5	64	-6	69	2	39	-44	58	-72	67	2	63	4	67	0

Table 3-5 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

24-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		CSUM		EGRR		GFDN		JGSM		JTYM		CLIP	
JTWC	445	106														
	106	0														
NGPS	191	104	218	115												
	120	16	115	0												
CSUM	414	106	185	118	473	126										
	124	18	119	1	126	0										
EGRR	172	104	156	114	181	122	214	105								
	96	-8	91	-23	104	-18	105	0								
GFDN	143	101	0	0	139	114	5	140	145	177						
	178	77	0	0	139	25	92	-48	177	0						
JGSM	128	97	111	109	131	116	103	92	9	116	136	92				
	88	-9	89	-20	91	-25	91	-1	75	-41	92	0				
JTYM	134	98	8	97	130	118	10	109	95	96	12	101	135	88		
	87	-11	116	19	88	-30	97	-12	87	-9	98	-3	88	0		
CLIP	445	106	217	116	473	126	196	104	145	177	134	91	135	88	580	123
	126	20	118	2	128	2	124	20	118	-59	127	36	125	37	123	0

36-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		CSUM		EGRR		GFDN		JGSM		JTYM		CLIP	
JTWC	375	145														
	145	0														
NGPS	154	141	183	157												
	160	19	157	0												
CSUM	346	144	152	157	413	177										
	176	32	170	13	177	0										
EGRR	0	0	5	105	0	0	5	116								
	0	0	116	11	0	0	116	0								
GFDN	119	140	0	0	119	160	0	0	125	173						
	175	35	0	0	122	-38	0	0	173	0						
JGSM	112	129	91	130	116	163	0	0	6	111	120	119				
	118	-11	114	-16	120	-43	0	0	105	-6	119	0				
JTYM	110	133	7	99	110	159	0	0	81	123	11	128	114	110		
	109	-24	140	41	111	-48	0	0	105	-18	119	-9	110	0		
CLIP	375	145	182	157	413	177	5	116	125	173	119	120	114	110	518	183
	186	41	173	16	188	11	95	-21	177	4	186	66	188	78	183	0

Table 3-5 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

48-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		CSUM		EGRR		GFDN		JGSM		JTYM		CLIP	
JTWC	307	176														
	176	0														
NGPS	120	169	146	186												
	182	13	186	0												
CSUM	281	175	119	185	351	220										
	217	42	212	27	220	0										
EGRR	114	159	93	154	124	209	155	150								
	136	-23	139	-15	146	-63	150	0								
GFDN	99	168	0	0	99	202	2	95	105	214						
	218	50	0	0	153	-49	134	39	214	0						
JGSM	101	155	77	151	103	197	80	138	6	120	108	155				
	152	-3	142	-9	154	-43	157	19	115	-5	155	0				
JTYM	96	166	5	98	95	202	7	123	70	156	9	127	98	138		
	138	-28	134	36	139	-63	177	54	136	-20	139	12	138	0		
CLIP	307	176	145	186	351	220	138	142	105	214	106	155	98	138	454	244
	249	73	232	46	249	29	237	95	244	30	243	88	254	116	244	0

72-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		CSUM		EGRR		GFDN		JGSM		JTYM		CLIP	
JTWC	197	234														
	234	0														
NGPS	70	234	92	271												
	250	16	271	0												
CSUM	176	236	70	244	237	301										
	293	57	281	37	301	0										
EGRR	74	228	57	214	80	290	103	196								
	187	-41	202	-12	202	-88	196	0								
GFDN	61	204	0	0	62	287	1	97	66	237						
	226	22	0	0	237	-50	23	-74	237	0						
JGSM	61	213	48	212	66	253	51	193	3	174	69	203				
	200	-13	199	-13	199	-54	199	6	182	8	203	0				
JTYM	59	205	2	247	62	275	3	122	43	235	5	152	63	187		
	183	-22	270	23	188	-87	293	171	185	-50	190	38	187	0		
CLIP	197	234	91	269	237	301	91	201	66	237	68	201	63	187	331	363
	358	124	352	83	353	52	321	120	357	120	320	119	323	136	363	0

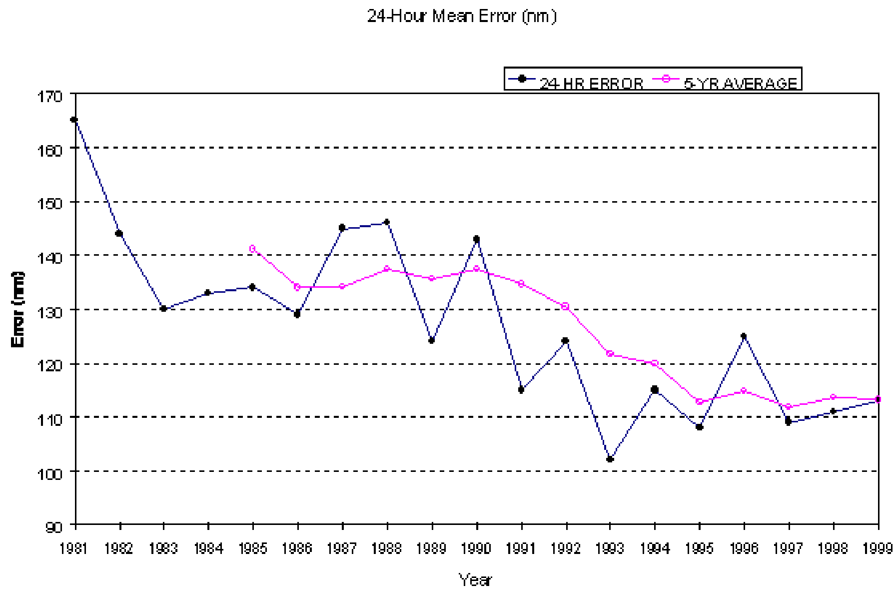


Figure 3-4a. Mean track forecast error (nm) and 5-year running mean for 24 hours for Southern Hemisphere (Africa to 180 degrees) tropical cyclones from 1981-1999.

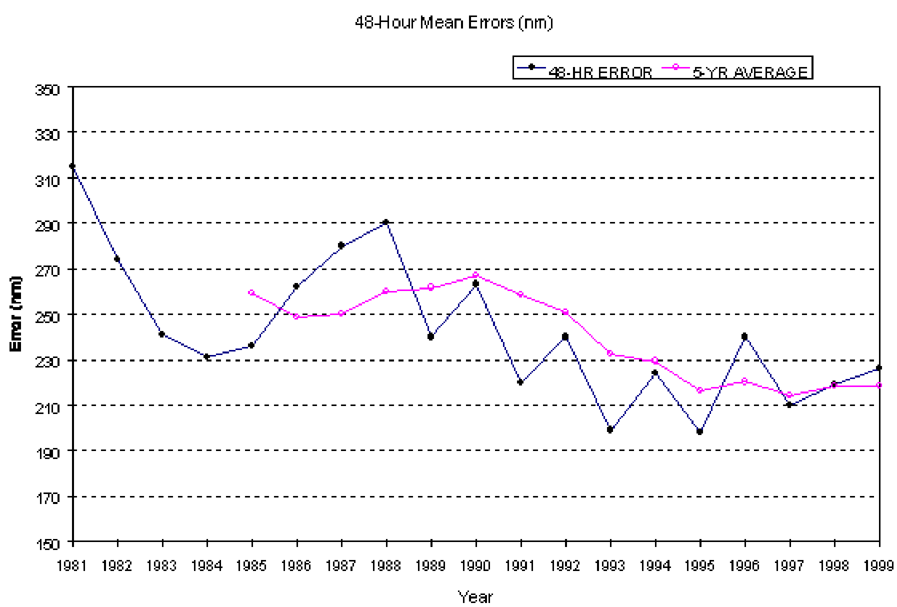


Figure 3-4b. Mean track forecast error (nm) and 5-year running mean for 48 hours for Southern Hemisphere (Africa to 180 degrees) tropical cyclones from 1981-1999.

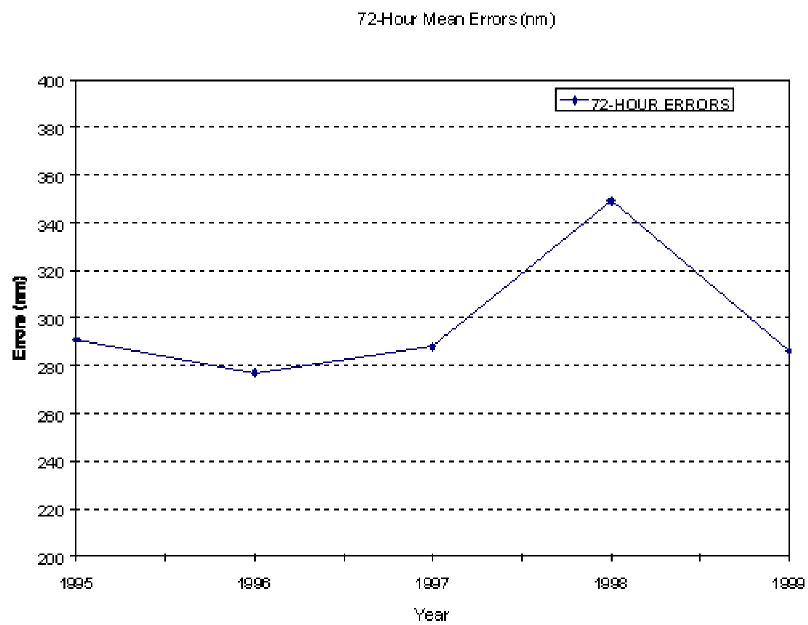


Figure 3-4c. Mean track forecast error (nm) at 72 hours for Southern Hemisphere (Africa to 180 degrees) tropical cyclones from 1995-1999.

Table 3-6 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

12-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		GFDN		CLIP	
JTWC	47	39						
	39	0						
NGPS	24	37	32	74				
	71	34	74	0				
GFDN	15	28	0	0	24	69		
	55	27	0	0	69	0		
CLIP	47	39	28	75	22	68	71	46
	36	-3	36	-39	32	-36	46	0

Table 3-6 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

24-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		EGRR		GFDN		CLIP	
JTWC	41	79								
	79	0								
NGPS	23	78	29	130						
	131	53	130	0						
EGRR	0	0	0	0	2	63				
	0	0	0	0	63	0				
GFDN	13	64	0	0	0	0	21	143		
	85	21	0	0	0	0	143	0		
CLIP	41	79	26	130	0	0	19	138	65	91
	75	-4	70	-60	0	0	68	-70	91	0

36-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		GFDN		CLIP	
JTWC	31	121						
	121	0						
NGPS	17	117	25	165				
	155	38	165	0				
GFDN	11	108	0	0	15	185		
	132	24	0	0	185	0		
CLIP	31	121	23	169	14	183	58	141
	117	-4	117	-52	101	-82	141	0

48-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		EGRR		GFDN		CLIP	
JTWC	22	184								
	184	0								
NGPS	12	176	21	205						
	164	-12	205	0						
EGRR	0	0	0	0	2	63				
	0	0	0	0	63	0				
GFDN	7	172	0	0	0	0	13	295		
	186	14	0	0	0	0	295	0		
CLIP	22	184	20	205	0	0	12	278	51	193
	176	-8	166	-39	0	0	148	-130	193	0

Table 3-6 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

72-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		EGRR		GFDN		CLIP	
JTWC	10	374								
	374	0								
NGPS	4	384	13	253						
	258	-126	253	0						
EGRR	0	0	0	0	2	87				
	0	0	0	0	87	0				
GFDN	5	342	0	0	0	0	8	408		
	269	-73	0	0	0	0	408	0		
CLIP	10	374	13	253	0	0	7	362	35	302
	342	-32	234	-19	0	0	292	-70	302	0

Table 3-7 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

12-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		EGRR		GFDN		CLIP		HPAC	
JTWC	343	61										
	61	0										
NGPS	104	61	181	74								
	79	18	74	0								
EGRR	3	27	1	50	4	110						
	128	101	143	93	110	0						
GFDN	101	55	4	84	0	0	161	69				
	54	-1	66	-18	0	0	69	0				
CLIP	340	61	134	76	3	128	131	62	495	127		
	79	18	103	27	24	-104	81	19	127	0		
HPAC	340	61	133	76	3	128	131	62	493	120	493	75
	72	11	73	-3	52	-76	64	2	75	-45	75	0

Table 3-7 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

24-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		EGRR		GFDN		CLIP		HPAC	
JTWC	322	113										
	113	0										
NGPS	100	115	172	119								
	126	11	119	0								
EGRR	63	107	49	115	114	110						
	106	-1	95	-20	110	0						
GFDN	98	107	4	120	5	109	154	109				
	99	-8	125	5	132	23	109	0				
CLIP	320	112	128	123	86	105	128	102	470	180		
	133	21	147	24	123	18	130	28	180	0		
HPAC	320	112	128	123	86	105	128	102	469	175	469	137
	134	22	136	13	133	28	124	22	137	-38	137	0

36-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		EGRR		GFDN		CLIP		HPAC	
JTWC	284	171										
	171	0										
NGPS	85	181	150	160								
	171	-10	160	0								
EGRR	3	117	1	72	4	170						
	179	62	200	128	170	0						
GFDN	93	168	4	183	0	0	145	161				
	152	-16	196	13	0	0	161	0				
CLIP	283	170	111	166	3	179	122	155	441	250		
	206	36	203	37	149	-30	204	49	250	0		
HPAC	280	166	110	165	3	179	122	155	438	248	438	205
	196	30	208	43	162	-17	192	37	205	-43	205	0

Table 3-7 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

48-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		EGRR		GFDN		CLIP		HPAC	
JTWC	245	226										
	226	0										
NGPS	61	248	124	198								
	204	-44	198	0								
EGRR	47	187	34	180	98	234						
	187	0	158	-22	234	0						
GFDN	78	220	3	167	4	192	134	211				
	209	-11	265	98	276	84	211	0				
CLIP	245	226	90	202	73	177	115	206	407	316		
	274	48	267	65	263	86	270	64	316	0		
HPAC	243	223	90	202	72	176	115	206	405	315	405	272
	264	41	283	81	256	80	264	58	272	-43	272	0

72-HOUR MEAN FORECAST ERROR (NM)

	JTWC		NGPS		EGRR		GFDN		CLIP		HPAC	
JTWC	59	286										
	286	0										
NGPS	15	333	88	248								
	272	-61	248	0								
EGRR	11	261	26	259	79	261						
	180	-81	278	19	261	0						
GFDN	13	304	2	76	1	73	96	303				
	240	-64	366	290	382	309	303	0				
CLIP	59	286	65	262	57	242	87	301	329	435		
	432	146	378	116	385	143	392	91	435	0		
HPAC	59	286	65	262	56	235	86	303	327	436	327	393
	385	99	390	128	355	120	379	76	393	-43	393	0

4. TROPICAL CYCLONE WARNING VERIFICATION STATISTICS

4.1 WARNING VERIFICATION STATISTICS

The verification data in this chapter includes best tracks (6-hourly positions and intensities), JTWC forecasts (12-, 24-, 36-, 48- and 72-hour position, intensity and wind radii), and fixes made from satellite, aircraft, radar, and synoptic data. These data are archived and available for download from the JTWC web page.

4.2 NORTH WEST PACIFIC AND NORTH INDIAN OCEAN VERIFICATION TABLES

This section includes this year's verification statistics for each North West Pacific and North Indian Ocean tropical cyclone warned on by JTWC.

Statistics for JTWC on TS 01W Hilda

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99010300		4.9N	113.9E	20												
99010306		4.9N	113.5E	20												
99010312		5.0N	113.2E	20												
99010318		5.2N	113.1E	20												
99010400		5.4N	113.1E	25												
99010406	1	5.8N	113.2E	25	21	46	120	206	277	430	0	5	10	10	15	25
99010412	2	6.2N	113.2E	25	24	32	126	193	277	415	0	5	10	10	15	25
99010418	3	6.6N	113.2E	25	26	111	194	264	341		0	5	10	15	15	
99010500	4	6.9N	113.5E	25	5	67	95	134	165		0	5	5	10	15	
99010506	5	7.1N	113.9E	25	24	83	120	179	229		5	5	10	10	20	
99010512	6	7.1N	114.3E	25	37	64	110	146	196		5	5	10	10	20	
99010518	7	7.3N	114.4E	30	34	47	100	135			0	0	0	10		
99010600	8	7.5N	114.4E	30	18	61	92	131			0	0	0	10		
99010606	9	7.8N	114.4E	30	26	90	133				5	5	10			
99010612	10	8.7N	114.3E	30	29	40	70				5	5	10			
99010618	11	9.1N	114.2E	35	29	48					0	10				
99010700	12	9.5N	114.0E	35	11	26					-5	-5				
99010706		10.0N	113.8E	30												
99010712		10.4N	113.5E	30												
			AVERAGE		24	60	116	173	247	422	2	5	8	11	17	25

Statistics for JTWC on TS 01W Hilda															
			BIAS							1	4	8	11	17	25
			# CASES	12	12	10	8	6	2	12	12	10	8	6	2

Statistics for JTWC on TS 02W Iris															
	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99021318		11.2N	137.7E 20												
99021400		11.0N	137.3E 20												
99021406		11.0N	136.9E 20												
99021412		11.2N	136.5E 20												
99021418		11.2N	136.1E 25												
99021500		11.2N	135.7E 20												
99021506		11.3N	135.2E 20												
99021512		11.4N	134.6E 20												
99021518		11.5N	134.0E 20												
99021600	1	11.7N	133.3E 25	18	56	30	30	19	47	0	0	0	0	0	10
99021606	2	11.8N	133.0E 25	18	46	111	118	85		0	0	0	0	0	
99021612	3	11.8N	132.6E 30	30	84	152	160	210		0	-5	-5	-5	-10	
99021618	4	11.8N	131.9E 30	21	129	155	122	82		0	-5	-5	-5	0	
99021700	5	12.0N	130.7E 35	31	93	74	30	38		0	5	15	20	30	
99021706	6	12.3N	129.2E 35	26	48	80	89			0	10	20	15		
99021712	7	12.7N	128.4E 35	13	70	123	173			0	10	10	15		
99021718	8	13.0N	127.8E 35	26	84	123				0	5	5			
99021800	9	13.3N	127.4E 30	26	58	115				0	0	10			
99021806	10	13.6N	127.0E 30	0	0					0	5				
99021812	11	13.9N	126.7E 30	0	17					0	10				
99021818	12	14.2N	126.3E 25	0						0					
99021900		14.2N	126.3E 15												
			AVERAGE	18	62	107	103	87	47	0	5	8	9	8	10
			BIAS							0	3	6	6	4	10
			# CASES	12	11	9	7	5	1	12	11	9	7	5	1

Statistics for JTWC on TS 03W Jacob															
	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99040518		9.8N	135.8E 20												
99040600		10.3N	134.8E 20												
99040606	1	10.8N	133.9E 25	41	130	246	352	407	391	0	10	10	15	15	-5
99040612	2	11.3N	133.2E 25	16	95	143	195	232	213	0	5	5	10	15	-5
99040618	3	12.0N	133.1E 25	33	66	94	93	64	83	0	0	5	10	5	20
99040700	4	12.6N	133.0E 25	29	93	173	201	174	144	0	0	5	10	10	25
99040706	5	12.8N	132.8E 30	24	76	127	151	180		0	0	5	5	10	
99040712	6	12.9N	132.5E 30	24	79	131	207	267		-5	0	5	0	-5	

Statistics for JTWC on TS 03W Jacob																
99040718	7	12.8N	132.4E	30	18	72	138	216	234		0	0	0	5	5	
99040800	8	12.5N	131.6E	30	42	103	205	257	252		0	5	5	0	10	
99040806	9	12.4N	130.8E	30	21	67	138	148			0	0	5	5		
99040812	10	12.4N	129.6E	30	23	104	111	94			0	5	5	10		
99040818	11	12.6N	128.4E	35	13	78	77				0	5	10			
99040900	12	13.1N	126.6E	30	11	64	117				0	0	5			
99040906	13	13.1N	125.6E	30	11	26					0	0				
99040918	14	13.5N	123.8E	25	26						0					
99041000		13.9N	123.3E	20												
			AVERAGE		24	81	142	191	226	208	0	2	5	7	9	14
			BIAS								0	2	5	7	8	9
			# CASES		14	13	12	10	8	4	14	13	12	10	8	4

Statistics for JTWC on TY 04W Kate																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99042100		7.6N	126.1E	20												
99042106		8.1N	125.6E	20												
99042112		8.6N	125.5E	20												
99042118		9.1N	125.6E	20												
99042200	1	9.9N	125.6E	25	13	95	120	143	211	371	0	-5	-5	-10	-20	-35
99042206	2	11.0N	125.9E	30	24	77	176	296	415	538	0	5	0	-10	-20	-35
99042212	3	12.1N	126.3E	30	39	118	229	357	430	470	0	0	-5	-15	-20	-35
99042218	4	12.8N	126.5E	30	29	63	129	204	224	207	0	0	-10	-20	-30	-40
99042300	5	13.4N	126.7E	35	37	84	134	170	189	174	0	-5	-15	-20	-35	-40
99042306	6	13.8N	127.0E	35	11	47	85	76	64	125	0	-5	-10	-20	-35	-40
99042312	7	14.1N	127.5E	40	11	26	21	25	46	127	0	-5	-10	-25	-35	-45
99042318	8	14.4N	128.0E	45	0	6	17	17	21	56	0	-5	-10	-20	-25	-45
99042400	9	14.7N	128.7E	50	0	8	18	17	6	129	0	5	0	5	10	-5
99042406	10	15.0N	129.3E	50	8	21	35	61	72	271	0	0	0	5	5	-10
99042412	11	15.7N	129.8E	50	8	19	64	59	78	254	0	-5	0	0	-10	-20
99042418	12	16.3N	130.3E	55	5	13	38	34	79	218	0	-5	0	0	-20	-15
99042500	13	16.9N	130.8E	60	8	45	37	63	128	192	0	5	5	-5	-20	-25
99042506	14	17.8N	131.3E	60	16	21	38	55	93	154	0	5	5	-15	-20	-20
99042512	15	18.8N	131.9E	60	0	69	150	142	168	148	0	0	-10	-20	-25	-20
99042518	16	19.5N	132.5E	60	13	24	58	86	82	99	0	-5	-20	-20	-20	-20
99042600	17	20.0N	133.2E	60	0	30	25	34	19	62	0	-10	-15	-20	-20	-25
99042606	18	20.6N	133.8E	60	0	53	84	97	105	195	-5	-25	-20	-20	-20	-20
99042612	19	21.0N	135.0E	65	0	69	70	91	106		-15	-20	-25	-20	-20	
99042618	20	22.2N	136.4E	75	0	20	30	49	85		-25	-20	-20	-15	-20	
99042700	21	23.2N	138.1E	70	8	19	38	60	137		-10	0	5	0	-5	
99042706	22	24.0N	140.0E	70	0	38	64	87	152		5	10	10	0	0	
99042712	23	25.0N	141.6E	70	21	66	69	70			0	-5	-5	-10		
99042718	24	26.1N	143.3E	65	8	29	91	179			0	5	-5	0		
99042800	25	27.2N	145.3E	60	16	63	127				0	0	-5			

Statistics for JTWC on TY 04W Kate															
99042806	26	28.3N	147.4E 55	0	84	149				0	-5	0			
99042812	27	29.3N	149.5E 55	10	81					-5	-5				
99042818		30.1N	151.7E 55												
99042900		31.0N	154.4E 55												
99042906		32.0N	157.3E 45												
			AVERAGE	11	48	81	103	132	210	2	6	8	12	20	28
			BIAS							-2	-4	-6	-11	-18	-28
			# CASES	27	27	26	24	22	18	27	27	26	24	22	18

Statistics for JTWC on TY 05W Leo															
	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99042518		14.2N	114.0E 15												
99042600		14.5N	114.0E 15												
99042606		14.8N	113.9E 15												
99042612		15.1N	113.7E 20												
99042618		15.4N	113.4E 20												
99042700	1	15.7N	112.9E 25 1	20	138	163	151	87	120	0	0	-5	-5	-5	-45
99042706	2	15.9N	112.5E 25 1	16	136	141	96	62	139	0	0	-10	-5	-15	-60
99042712	3	16.0N	111.9E 25 1	44	164	127	27	71	155	0	-5	-10	-5	-25	-65
99042718	4	15.8N	111.3E 25	57	101	66	97	162	252	0	-10	-10	-15	-35	-75
99042800	5	15.6N	110.9E 30	54	72	113	192	246	328	0	-5	0	-15	-35	-40
99042806	6	15.2N	110.9E 35	46	160	306	407	498		0	0	-15	-40	-80	
99042812	7	15.3N	111.2E 35	81	204	320	410	501		0	5	-15	-50	-85	
99042818	8	15.8N	111.9E 35	42	123	166	206	234	226	0	-10	-30	-60	-70	-20
99042900	9	16.3N	112.7E 35	13	63	79	114	141	127	0	-20	-45	-65	-50	-5
99042906	10	17.3N	113.3E 45	6	66	107	145	165	164	0	-15	-45	-55	-40	-20
99042912	11	17.8N	113.8E 55	12	54	87	115	117	111	0	-15	-35	-15	0	20
99042918	12	18.1N	114.2E 65	11	23	46	45	51	67	0	-30	-35	-20	-10	35
99043000	13	18.5N	114.6E 80	5	23	34	34	64	96	0	-15	-10	5	15	15
99043006	14	19.0N	114.9E 100	5	29	29	42	77		0	0	30	35	35	
99043012	15	19.5N	115.2E 105	5	23	32	58	85		0	20	40	40	45	
99043018	16	19.9N	115.5E 110	6	25	62	98	102		0	20	35	35	15	
99050100	17	20.5N	115.6E 90	5	45	90	98	105		0	-10	0	10	5	
99050106	18	20.7N	115.5E 85	5	25	62	73			0	-5	0	20		
99050112	19	21.0N	115.4E 70	11	39	51	58			0	5	15	15		
99050118	20	21.3N	115.2E 65	25	62	61				0	5	20			
99050200	21	21.6N	114.8E 50	0	53	94				0	10	20			
99050206	22	21.9N	114.7E 50	0	33					0	20				
99050212	23	22.4N	114.7E 30	6	13					0	10				
99050218	24	22.7N	114.7E 20	0						0					
99050300		23.3N	114.6E 15												
			AVERAGE	33	73	106	130	163	162	0	10	20	27	33	36
			BIAS							0	-2	-5	-10	-20	-24
			# CASES	24	23	21	19	17	11	24	23	21	19	17	11

Statistics for JTWC on TY 06W Maggie

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99053012		9.3N	131.8E	20												
99053018		9.6N	131.8E	20												
99053100		9.9N	131.8E	20												
99053106		10.2N	131.7E	20												
99053112		10.4N	131.6E	20												
99053118		10.6N	131.5E	20												
99060100		10.9N	131.4E	20												
99060106	1	11.2N	131.2E	25	21	72	130	172	227	376	0	0	-15	-30	-20	-35
99060112	2	11.5N	130.9E	25	21	64	92	113	149	249	0	-15	-20	-20	-20	-25
99060118	3	11.9N	130.4E	25	11	60	85	103	129	197	0	-15	-30	-20	-25	-25
99060200	4	12.6N	130.0E	45	0	40	59	78	135	301	0	-5	-10	-10	-15	-15
99060206	5	13.1N	129.8E	45	13	36	42	58	145	181	0	-15	-10	-15	-25	-10
99060212	6	13.5N	129.5E	55	0	33	6	60	124	206	0	0	0	0	0	5
99060218	7	14.2N	129.4E	65	0	21	86	150	174	238	0	10	10	0	15	20
99060300	8	14.9N	129.3E	65	0	39	104	151	171	251	0	0	0	0	10	30
99060306	9	15.5N	129.0E	65	0	29	66	88	82	218	0	-5	-10	0	15	35
99060312	10	16.0N	128.5E	75	13	21	26	23	70	255	0	-5	-5	0	15	45
99060318	11	16.8N	127.8E	80	5	38	54	23	87	259	-5	-15	-10	0	15	55
99060400	12	17.1N	127.1E	90	11	32	18	45	122	229	0	-5	-5	5	25	85
99060406	13	17.4N	126.4E	100	0	23	62	106	185	219	0	5	10	15	30	85
99060412	14	17.7N	125.9E	100	13	59	130	215	291	294	0	0	10	25	35	85
99060418	15	18.1N	125.3E	100	0	62	124	213	288	235	0	5	10	30	50	85
99060500	16	18.9N	124.5E	105	0	25	107	181	221	145	0	10	25	40	85	95
99060506	17	19.7N	123.6E	100	0	18	65	110	109	132	0	0	15	40	70	25
99060512	18	20.4N	122.4E	100	6	21	62	116	80		0	5	10	30	15	
99060518	19	21.0N	121.0E	100	0	53	94	98	50		0	10	25	30	15	
99060600	20	22.0N	119.7E	90	12	47	138	180	172		0	5	25	-5	5	
99060606	21	22.5N	118.2E	85	0	45	103				0	5	10			
99060612	22	22.8N	116.4E	80	0	85	104				0	15	-5			
99060618	23	22.7N	114.7E	65	0	58	73				0	10	-10			
99060700	24	22.2N	113.2E	35	12	67					-5	-10				
99060706		21.7N	112.5E	35												
99060712		21.8N	111.7E	30												
99060718		22.1N	111.5E	30												
99060800		22.8N	111.4E	25												
99060806		23.6N	111.0E	20												
			AVERAGE		6	44	80	114	151	234	0	7	12	16	25	45
			BIAS								0	0	1	6	15	32
			# CASES		24	24	23	20	20	17	24	24	23	20	20	17

Statistics for JTWC on TD 07W

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					

Statistics for JTWC on TD 07W

DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99071400		24.4N	155.9E	15												
99071406		24.3N	155.5E	25												
99071412		24.2N	155.1E	25												
99071418		24.1N	154.7E	25												
99071500	1	24.1N	154.3E	25 1	53	170	159	247	347	424	0	0	0	5	10	25
99071506	2	24.0N	153.8E	25	66	73	118	219	301	346	0	0	0	5	15	35
99071512	3	24.3N	153.4E	30	65	41	156	251	304	308	0	5	10	15	25	25
99071518	4	24.4N	152.6E	30	18	98	188	253	269	223	0	5	10	20	25	30
99071600	5	24.4N	151.5E	30	0	80	146	180	194	141	0	5	10	25	25	30
99071606	6	24.8N	149.9E	30	8	44	91	150	184	102	0	5	10	20	30	30
99071612	7	25.6N	148.6E	30	39	93	127	146	157		0	0	10	15	20	
99071618	8	26.3N	147.3E	30	5	24	68	120	128		0	0	10	20	25	
99071700	9	26.9N	145.9E	30	0	42	115	138	129		0	5	5	10	10	
99071706	10	27.3N	144.7E	30	0	12	42	62	145		0	5	10	15	10	
99071712	11	27.9N	143.7E	25	8	43	50	61			0	0	5	10		
99071718	12	28.4N	143.1E	25	18	30	31	138			0	5	10	5		
99071800	13	29.0N	142.6E	25	15	86	152				0	5	5			
99071806	14	29.9N	142.5E	20	13	85	213				0	5	0			
99071812		31.2N	142.3E	20												
99071818		32.4N	142.4E	15												
99071900		33.8N	143.0E	15												
99071906		35.6N	144.1E	15												
			AVERAGE		30	66	118	164	216	257	0	3	7	14	20	29
			BIAS								0	3	7	14	20	29
			# CASES		14	14	14	12	10	6	14	14	14	12	10	6

Statistics for JTWC on TD 08W

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99071912		24.6N	134.0E	20												
99071918		25.4N	134.0E	20												
99072000		26.1N	133.7E	20												
99072006		27.0N	133.2E	20												
99072012		27.7N	132.4E	20												
99072018		28.3N	131.5E	20												
99072100		28.8N	130.5E	20												
99072106	1	29.3N	129.4E	25	0	32	103	246	458		0	-5	0	5	-5	
99072112	2	29.9N	128.5E	25	0	75	139	407	614		0	-5	10	-5	-10	
99072118	3	30.7N	127.7E	30	0	78	198	364	500		-5	0	5	-10	-10	
99072200	4	32.4N	127.5E	30	0	27	149	234			0	5	-10	-10		
99072206	5	33.7N	126.8E	30	0	106	286	385			0	5	-10	-10		
99072212	6	35.0N	126.9E	20	0	200	306				5	-10	-10			
99072218		36.8N	129.1E	20												
99072300		38.4N	132.3E	30												

Statistics for JTWC on TD 08W													
99072306	40.1N	134.6E 30											
99072312	42.7N	137.4E 30											
99072318	44.4N	139.2E 30											
		AVERAGE	0	86	197	327	524		2	5	8	8	8
		BIAS							0	-2	-3	-6	-8
		# CASES	6	6	6	5	3		6	6	6	5	3

Statistics for JTWC on TS 09W Neil

DTG	WRN NO.	BEST TRACK LAT	LONG	wind	POSITION ERRORS 00	12	24	36	48	72	WIND ERRORS 00	12	24	36	48	72
99072318		18.3N	123.5E	20												
99072400		18.7N	124.1E	20												
99072406		19.4N	124.8E	20												
99072412		20.4N	125.2E	20												
99072418		21.3N	126.1E	20												
99072500		22.2N	127.0E	20												
99072506	1	23.3N	127.8E	25	28	62	79	118	165	235	0	5	0	5	10	15
99072512	2	24.1N	128.6E	30	20	87	117	168	185	294	0	5	5	10	15	10
99072518	3	26.2N	128.2E	30	13	90	123	173	221		0	-10	-10	-5	0	
99072600	4	27.5N	128.8E	35	13	30	97	118	157		0	0	5	10	10	
99072606	5	28.9N	128.8E	40	5	30	76	94	199		0	0	5	5	10	
99072612	6	30.4N	128.4E	40	18	90	96	116	233		0	5	10	10	10	
99072618	7	32.0N	127.9E	40	6	35	65	163			0	5	5	10		
99072700	8	33.7N	127.3E	35	6	32	94	229			0	5	5	5		
99072706	9	34.7N	126.9E	30	18	34	123				0	-5	0			
99072712	10	35.8N	126.5E	25	0	64	184				0	0	0			
99072718	11	36.5N	126.2E	25	0	60					0	5				
99072800	12	37.1N	126.4E	20	7	73					5	5				
99072806	13	37.3N	126.8E	15	7						0					
99072812		37.5N	127.9E	15												
			AVERAGE		11	57	105	148	193	264	0	4	5	8	9	13
			BIAS								0	2	3	6	9	13
			# CASES		13	12	10	8	6	2	13	12	10	8	6	2

Statistics for JTWC on TD 10W

DTG	WRN NO.	BEST TRACK LAT	LONG	wind	POSITION ERRORS 00	12	24	36	48	72	WIND ERRORS 00	12	24	36	48	72
99072300		16.0N	116.6E	15												
99072306		16.3N	116.9E	20												
99072312		16.8N	117.2E	20												
99072318		17.3N	117.4E	20												
99072400		17.7N	117.2E	20												
99072406		18.2N	116.5E	20												
99072412		18.2N	115.5E	20												
99072418		18.0N	114.3E	20												
99072500		18.0N	113.6E	20												
99072506		18.2N	113.3E	20												
99072512		18.5N	113.2E	20												
99072518		18.9N	113.2E	25												
99072600		19.4N	113.3E	25												
99072606		19.9N	113.4E	25												
99072612		20.2N	113.5E	25												

Statistics for JTWC on TD 10W

99072618	1	20.5N	113.7E	25	0	101	324				0	5	15			
99072700	2	21.3N	114.5E	25	0	175					0	10				
99072706	3	22.6N	115.4E	25	0	115					0	-5				
99072712		24.5N	116.4E	20												
99072718		26.7N	118.0E	20												
			AVERAGE		0	130	324				0	7	15			
			BIAS								0	3	15			
			# CASES		3	3	1				3	3	1			

Statistics for JTWC on TY 11W Olga

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99072618		5.5N	138.7E	20												
99072700		5.9N	138.5E	20												
99072706		6.7N	138.1E	20												
99072712		7.3N	137.9E	20												
99072718		8.2N	137.5E	20												
99072800		9.3N	136.8E	20												
99072806		10.0N	136.2E	20												
99072812		10.9N	135.6E	20												
99072818		11.7N	135.2E	20												
99072900	1	12.5N	134.8E	25	30	60	127	243	253	245	0	0	-5	0	-5	0
99072906	2	13.5N	134.4E	30	16	38	140	191	199	196	0	0	5	0	5	15
99072912	3	14.4N	134.0E	30	18	42	155	155	146	192	0	-5	0	-5	0	25
99072918	4	15.5N	133.7E	35	21	132	191	219	206	295	0	5	0	5	5	15
99073000	5	16.9N	133.6E	40	24	145	157	166	195	297	0	5	0	5	10	20
99073006	6	18.9N	133.3E	40	0	43	43	84	99	159	0	-5	0	0	5	20
99073012	7	20.3N	132.4E	45	0	34	63	78	105	201	0	-5	0	5	20	20
99073018	8	21.0N	131.8E	55	0	19	39	60	79	231	0	5	5	10	25	35
99073100	9	21.7N	131.2E	60	0	22	35	52	53	266	0	0	5	20	25	40
99073106	10	22.7N	130.8E	60	0	33	37	79	84	283	0	-5	0	10	25	30
99073112	11	23.2N	130.4E	65	0	17	36	54	105	365	0	5	25	25	25	45
99073118	12	23.7N	130.0E	70	6	60	94	97	179	436	0	0	5	10	15	45
99080100	13	24.7N	129.2E	70	0	21	39	67	118	287	0	10	0	-10	-10	25
99080106	14	25.5N	128.7E	75	8	24	0	62	83		0	10	25	5	-10	
99080112	15	26.4N	127.9E	65	16	37	12	58	109		5	5	10	10	5	
99080118	16	27.2N	127.2E	75	0	37	52	70	74		0	5	0	-15	0	
99080200	17	27.8N	126.5E	75	0	43	116	158	167		0	-5	0	0	10	
99080206	18	28.7N	126.3E	75	0	61	151	227			0	0	0	15		
99080212	19	30.0N	126.0E	80	0	68	115	128			0	-5	-5	5		
99080218	20	31.6N	126.0E	75	13	73	132				0	-10	10			
99080300	21	33.5N	126.0E	70	0	20	59				0	5	5			
99080306	22	35.7N	126.3E	70	5	84					0	0				
99080312	23	37.4N	126.5E	55	0	43					0	0				
99080318	24	40.0N	126.5E	35	27						0					

Statistics for JTWC on TY 11W Olga															
99080400		41.8N	126.5E 25												
			AVERAGE	8	50	85	118	133	266	0	4	5	8	12	26
			BIAS							0	1	4	5	9	26
			# CASES	24	23	21	19	17	13	24	23	21	19	17	13

Statistics for JTWC on TS 12W Paul															
	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99073118		11.9N	144.4E 15												
99080100		12.4N	143.6E 15												
99080106		13.0N	143.0E 15												
99080112		13.8N	142.5E 15												
99080118		14.7N	142.0E 20												
99080200		15.6N	141.5E 20												
99080206		16.4N	140.9E 20												
99080212		17.1N	140.2E 20												
99080218		18.0N	139.8E 20												
99080300		19.3N	139.1E 20												
99080306		20.4N	138.6E 20												
99080312	1	21.4N	138.0E 25	49	93	134	122	66	205	0	-5	0	-15	0	20
99080318	2	22.3N	137.6E 25	74	133	190	179	107	224	0	0	-5	-15	5	30
99080400	3	23.3N	137.1E 30 1	09	194	195	129	130	262	0	0	-10	5	20	35
99080406	4	24.4N	136.3E 30	0	8	77	234	389	348	0	-5	-15	5	25	20
99080412	5	25.4N	135.3E 30	0	32	112	275	325	339	0	-10	0	10	25	30
99080418	6	26.1N	134.2E 35	8	49	175	243	228	228	0	-10	10	20	20	15
99080506	7	26.8N	132.6E 50	16	95	142	102	108	136	0	15	25	25	20	20
99080512	8	27.0N	132.3E 35	12	108	205	293	429	606	0	-5	0	-5	-5	0
99080518	9	27.2N	132.7E 35	6	134	217	358	460		0	10	5	-5	-5	
99080600	10	28.2N	133.4E 30	12	115	180	259	288		0	5	5	5	0	
99080606	11	29.6N	132.8E 25	37	80	177	241	292		0	0	-10	-10	-5	
99080612	12	30.7N	131.6E 25	35	120	193				0	-10	-10			
99080618	13	31.2N	130.4E 25	0	28	35	103			0	0	0	0		
99080700	14	32.0N	128.9E 25	5	30	127	240			0	0	0	5		
99080706	15	32.8N	127.0E 25	13	54	166				0	0	0			
99080712	16	33.4N	125.7E 25	0	54	104				0	0	5			
99080718	17	34.1N	124.3E 25	18	122					0	5				
99080800	18	34.1N	123.0E 25	61	136					0	5				
99080806		34.5N	121.7E 20												
99080812		35.0N	121.3E 15												
			AVERAGE	25	88	152	214	256	294	0	5	6	10	12	21
			BIAS							0	0	0	2	9	21
			# CASES	18	18	16	13	11	8	18	18	16	13	11	8

Statistics for JTWC on TS 13W Rachel

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99080518		20.8N	116.2E	25												
99080600		21.3N	117.1E	30												
99080606	1	21.9N	117.9E	35	0	25	47	84	160	75	-5	5	0	5	5	20
99080612	2	22.4N	118.5E	35	16	58	82	193	203	17	0	0	0	-5	-10	0
99080618	3	22.8N	119.0E	35	24	43	192	295	259	161	0	0	-5	-5	0	10
99080700	4	23.2N	119.5E	35	36	182	294	320	262	239	0	10	-5	-5	5	15
99080706	5	23.7N	120.3E	30	35	278	375				5	-5	-15			
99080718	6	25.5N	124.8E	30	37	96	185	253	289	453	0	0	10	20	15	10
99080800	7	26.2N	126.6E	30	20	86	139	165	190		0	0	10	0	5	
99080806	8	26.9N	127.9E	35	0	28	62	76	127		0	5	5	5	10	
99080812	9	27.5N	128.5E	35	0	84	114	158	165		0	0	0	0	5	
99080818	10	28.4N	128.4E	30	0	148	197	213	201		0	0	5	10	10	
99080900	11	29.2N	127.8E	25	0	45	83	66			0	0	5	5		
99080906	12	30.0N	126.9E	25	0	43	53	54			0	5	5	10		
99080912	13	31.1N	125.8E	25	23	62	69				0	0	5			
99080918	14	32.2N	124.6E	20	15	73	136				0	0	0			
99081000		33.1N	123.4E	20												
99081006		34.1N	122.6E	15												
99081012		34.8N	121.7E	15												
99081018		35.4N	120.9E	10												
			AVERAGE		15	89	145	171	206	189	1	2	5	6	7	11
			BIAS								0	1	1	4	5	11
			# CASES		14	14	14	11	9	5	14	14	14	11	9	5

Statistics for JTWC on TD 14W

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99080700		25.1N	141.5E	25												
99080706		25.3N	141.4E	25												
99080712		25.5N	141.3E	25												
99080718		25.6N	141.2E	25												
99080800		25.8N	141.2E	25												
99080806		26.0N	141.1E	20												
99080812		26.5N	141.1E	25												
99080818		27.2N	141.0E	25												
99080900	1	29.0N	139.9E	25	24	36	33	48	76		0	5	15	15	15	
99080906	2	30.2N	139.8E	25	10	16	31	53	122		0	5	10	15	15	
99080912	3	31.5N	139.2E	25	0	37	43	96			5	10	10	15		
99080918	4	32.2N	138.0E	25	0	28	68	115			0	0	-5	0		
99081000	5	32.9N	137.3E	25	0	10	25				0	-5	0			
99081006	6	33.7N	136.7E	25	6	12	37				0	0	0			
99081012	7	34.4N	136.3E	25	17	54					-5	0				

Statistics for JTWC on TD 14W

99081018		35.0N	136.0E	20												
99081100		35.8N	135.9E	15												
99081106		36.3N	135.5E	15												
			AVERAGE		8	28	39	78	99		1	4	7	11	15	
			BIAS								0	2	5	11	15	
			# CASES		7	7	6	4	2		7	7	6	4	2	

Statistics for JTWC on TD 15W

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99081518		31.0N	127.6E	20												
99081600		30.8N	127.8E	20												
99081606	1	30.8N	128.0E	25	8	44	104	132	185	289	0	0	0	0	-5	-5
99081612	2	30.9N	128.3E	25	5	63	101	131	188	299	0	0	0	0	0	0
99081618	3	31.4N	128.9E	25	7	46	62	112			0	0	-5	-5		
99081700	4	31.7N	129.9E	25	5	78	134	218			0	0	-5	-5		
99081706	5	32.5N	130.2E	25	31	89	145	173			0	0	-5	0		
99081712	6	33.2N	130.4E	25	26	12	19	38			0	0	0	0		
99081718	7	33.8N	130.6E	25	0	44	49	24			0	0	0	-5		
99081800	8	34.5N	130.6E	25	16	24	30	48			0	0	-5	5		
99081806	9	35.6N	130.7E	25	24	30					0	0				
99081812		36.4N	130.9E	20												
99081818		37.3N	131.1E	20												
99081900		38.1N	131.3E	20												
99081906		38.9N	131.7E	20												
99081912		40.0N	132.2E	20												
99081918		41.5N	133.1E	20												
99082000		42.3N	135.2E	20												
			AVERAGE		14	48	80	110	187	294	0	0	3	3	3	3
			BIAS								0	0	-3	-1	-3	-3
			# CASES		9	9	8	8	2	2	9	9	8	8	2	2

Statistics for JTWC on TY 16W Sam

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99081718		11.0N	128.3E	15												
99081800		11.4N	128.9E	20												
99081806	1	12.4N	128.9E	30	18	31	76	93	139	217	0	0	0	0	0	0
99081812	2	13.3N	128.3E	30	0	78	75	116	147	237	0	-5	-5	-5	0	0
99081818	3	14.6N	127.6E	30	8	70	115	188	216	325	0	0	0	0	10	25
99081900	4	16.0N	126.8E	35	32	78	147	199	231	426	0	5	5	10	15	10
99081906	5	16.9N	125.5E	35	12	91	91	132	155	325	0	0	0	10	5	-35
99081912	6	17.0N	124.7E	40	0	63	97	99	131	275	0	-5	0	0	5	-15

Statistics for JTWC on TY 16W Sam															
99081918	7	17.2N	123.5E 45	8	51	74	100	175	311	0	-5	5	0	5	25
99082000	8	17.9N	122.3E 50	11	32	102	186	288	435	0	-5	0	0	-15	0
99082006	9	18.4N	121.1E 55	8	90	123	157	233		0	-5	-20	-30	-45	
99082012	10	18.4N	120.4E 55	11	27	41	62	119		0	0	-10	-20	-35	
99082018	11	18.6N	119.6E 55	29	26	8	32	66		0	-5	-10	-30	-10	
99082100	12	19.0N	118.7E 60	0	51	67	80	111		0	0	-5	-10	0	
99082106	13	19.8N	117.7E 65	8	46	66	111	125		0	-5	-25	-5	-5	
99082112	14	20.4N	116.7E 65	8	33	23	55			-5	-10	-25	-10		
99082118	15	21.1N	115.8E 65	11	56	41	61			-5	-15	-5	5		
99082200	16	21.8N	115.0E 65	0	16	6				0	-10	-5			
99082206	17	22.1N	114.6E 75	0	25	12				0	10	5			
99082212	18	22.7N	113.9E 65	5	29					0	5				
99082218	19	23.2N	113.2E 40	0	25					0	0				
99082300	20	23.5N	112.9E 35	12						0					
99082306		24.0N	112.6E 25												
			AVERAGE	9	48	68	111	164	319	1	5	7	9	12	14
			BIAS							-1	-3	-6	-6	-5	1
			# CASES	20	19	17	15	13	8	20	19	17	15	13	8

Statistics for JTWC on TY 17W Tanya															
	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99081900		29.5N	179.5W20												
99081906		29.5N	180.0W20												
99081912		29.6N	179.3E 25												
99081918	1	29.8N	177.9E 30	18	71	98	139	192	243	0	-20	-40	-50	-40	-35
99082000	2	29.9N	176.3E 35	5	17	21	70	86	46	0	-5	-20	-25	-35	-20
99082006	3	30.1N	174.7E 45	16	40	67	97	137	194	0	-5	-20	-25	-35	-10
99082012	4	30.4N	173.1E 50	6	16	30	47	40	96	0	-15	-20	-30	-30	-5
99082018	5	30.9N	171.5E 55	11	31	39	36	32	262	0	-10	-15	-25	-20	5
99082100	6	31.2N	169.9E 65	0	24	48	43	51	308	0	-5	-20	-25	-15	5
99082106	7	31.5N	168.2E 65	0	19	41	70	119	477	0	-5	-20	-20	-5	5
99082112	8	31.8N	166.8E 65	0	41	77	131	194	502	0	-10	-15	-10	0	5
99082118	9	32.1N	165.2E 65	0	6	12	53	131		0	-5	-15	0	5	
99082200	10	32.5N	163.8E 70	0	12	16	62	97		0	5	15	20	15	
99082206	11	33.1N	162.3E 70	0	12	27	89	157		0	10	25	25	15	
99082212	12	33.8N	161.1E 65	6	20	71	130	284		0	15	25	25	15	
99082218	13	34.6N	159.6E 60	0	19	76	150			0	20	25	20		
99082300	14	35.5N	158.5E 50	0	69	154	219			5	20	20	15		
99082306	15	36.5N	157.8E 40	0	63	106				10	10	5			
99082312	16	37.7N	157.8E 35	0	28	119				0	5	0			
99082318	17	39.0N	158.5E 30	11	73					0	0				
99082400	18	39.9N	159.5E 25	11	42					0	0				
99082406		40.5N	161.5E 25												
99082412		41.2N	164.3E 25												

Statistics for JTWC on TY 17W Tanya

			AVERAGE		5	33	63	95	127	266	1	9	19	23	19	11
			BIAS								1	0	-4	-8	-11	-6
			# CASES		18	18	16	14	12	8	18	18	16	14	12	8

Statistics for JTWC on TD 18W

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99082018		32.1N	151.9E	20												
99082100		32.3N	151.0E	20												
99082106		32.5N	150.2E	20												
99082112		32.9N	149.4E	20												
99082118	1	33.2N	148.7E	25	6	19	26	11			0	-5	-5	-5		
99082200	2	33.7N	147.9E	25	11	68	133				0	0	-5			
99082206	3	34.2N	147.1E	30	42	84	101	107			0	0	0	-5		
99082212	4	34.6N	146.4E	25	45	103	130				0	-5	-10			
99082218	5	35.0N	145.9E	25	43	68	105				0	-5	-10			
99082300	6	35.3N	145.7E	25	0	34	78				0	-5	-10			
99082306	7	35.8N	145.6E	25	7	38	61				0	0	0			
99082312	8	36.1N	145.6E	25	30	107	169				0	0	5			
99082318	9	36.4N	145.8E	25	11	43	13				0	5	5			
99082400	10	36.7N	146.2E	25	0	45					0	10				
99082406		37.2N	146.9E	20												
99082412		38.1N	147.7E	15												
99082418		39.7N	148.8E	15												
			AVERAGE		20	61	91	59			0	4	6	5		
			BIAS								0	-1	-3	-5		
			# CASES		10	10	9	2			10	10	9	2		

Statistics for JTWC on TY 19W Virgil

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99082300		27.2N	139.9E	20												
99082306		26.9N	139.7E	20												
99082312		26.6N	139.6E	20												
99082318		26.2N	139.5E	20												
99082400	1	25.6N	140.0E	25	10	16	72	153	226	281	0	5	0	-35	-30	-15
99082406	2	25.4N	140.3E	25	10	24	109	149	184	180	0	-5	-35	-40	-35	-10
99082412	3	25.3N	140.7E	25	26	55	134	195	223	235	0	0	-40	-30	-25	5
99082418	4	25.4N	141.2E	30	16	96	143	196	203	241	0	-35	-40	-30	-15	5
99082500	5	25.7N	141.8E	30	10	76	125	163	224	406	0	-35	-30	-25	-10	10
99082506	6	26.1N	142.9E	65	13	60	84	139	208	360	0	0	10	30	20	25
99082512	7	26.3N	143.5E	70	0	16	32	112	196	343	0	10	25	35	30	25
99082518	8	26.6N	144.2E	70	0	12	76	153	270	450	5	15	20	20	30	25

Statistics for JTWC on TY 19W Virgil																
99082600	9	27.1N	144.9E	65	6	32	71	128	202	427	0	5	5	10	5	0
99082606	10	27.5N	145.3E	65	16	99	195	293	393		0	5	0	5	0	
99082612	11	27.9N	145.6E	60	5	34	77	147	222	477	0	0	10	5	5	0
99082618	12	28.1N	145.7E	50	0	21	50	130	206		0	0	5	0	0	
99082700	13	28.4N	145.9E	50	12	37	78	182	290		0	10	5	5	0	
99082706	14	28.6N	146.1E	45	5	20	87	179	321		0	5	0	0	-5	
99082712	15	28.9N	146.4E	35	0	30	78	144			0	0	0	-5		
99082718	16	29.2N	146.7E	30	5	55	135	246			0	-5	0	-5		
99082800	17	29.4N	147.2E	30	8	83	180	331			0	0	0	-5		
99082806	18	29.7N	148.3E	30	8	45	160	279			0	0	0	0		
99082812	19	30.2N	149.5E	25	15	72	175				0	0	-5			
99082818	20	30.6N	150.8E	25	5	63	153				0	0	0			
99082900	21	30.9N	152.2E	25	5	91					0	-5				
99082906		30.9N	154.2E	25												
99082912		30.7N	156.0E	25												
99082918		30.7N	157.9E	20												
			AVERAGE		9	49	111	184	241	340	0	7	12	16	15	12
			BIAS								0	-1	-4	-4	-2	7
			# CASES		21	21	20	18	14	10	21	21	20	18	14	10

Statistics for JTWC on TS 20W Wendy																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99082906		11.5N	133.4E	15												
99082912		11.5N	132.8E	15												
99082918		11.5N	132.2E	15												
99083000		11.5N	131.5E	20												
99083006		11.5N	130.9E	20												
99083012		11.6N	130.2E	20												
99083018		11.8N	129.6E	20												
99083100		12.0N	129.2E	20												
99083106		12.2N	128.7E	20												
99083112		12.3N	128.2E	20												
99083118		12.5N	127.5E	20												
99090100	1	12.7N	127.0E	25	5	37	152	232	303	405	0	0	5	0	-15	0
99090106	2	13.0N	126.7E	25	6	107	279	344	398	519	0	0	5	-5	-10	10
99090112	3	13.6N	126.2E	25	32	224	334	406	444		0	0	0	-10	-10	
99090118	4	14.9N	124.9E	25	87	251	325	370	413		0	0	-10	-10	-10	
99090200	5	16.8N	123.8E	25	25	96	174	210	245		0	0	-5	-5	10	
99090206	6	18.2N	122.5E	25	8	23	61	101	173		0	-5	-5	5	15	
99090212	7	19.0N	121.7E	30	18	73	45	56			0	-10	0	15		
99090218	8	19.8N	120.3E	35	5	6	16	68			0	0	5	5		
99090300	9	20.6N	119.2E	40	16	57	83				0	5	15			
99090306	10	21.3N	118.3E	40	37	37	45				0	-5	5			
99090312	11	22.1N	117.5E	40	12	13					0	-5				

Statistics for JTWC on TS 20W Wendy

99090318	12	22.8N	116.5E 40	5	47					0	10				
99090400	13	23.4N	115.5E 30	0						0					
99090406		24.6N	114.5E 20												
			AVERAGE	20	81	151	224	329	462	0	3	6	7	12	5
			BIAS							0	-1	2	-1	-3	5
			# CASES	13	12	10	8	6	2	13	12	10	8	6	2

Statistics for JTWC on TY 21W York

	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99091000		16.5N	124.4E 25												
99091006		16.4N	124.1E 25												
99091012		16.1N	123.5E 25												
99091018		16.1N	122.9E 20												
99091100		16.0N	122.2E 20												
99091106		15.5N	122.7E 20												
99091112		16.0N	123.3E 20												
99091118	1	18.5N	119.0E 25 3	02	334	333	301	256	135	0	5	0	0	0	-10
99091200	2	18.5N	118.7E 25 3	26	324	311	250	170	127	0	5	0	-5	-5	-10
99091206	3	18.5N	118.4E 25 1	08	103	83	68	62	87	0	0	0	0	0	-5
99091212	4	18.5N	118.1E 25	39	80	124	153	166	229	5	5	0	0	0	-20
99091218	5	18.6N	117.8E 30	34	106	179	220	263	301	0	0	0	0	-5	-40
99091300	6	18.7N	117.6E 30	49	102	138	154	191	211	0	-5	-10	-10	-10	-45
99091306	7	18.8N	117.4E 35	5	46	80	116	159	184	0	0	0	-10	-10	-35
99091312	8	19.0N	117.2E 40	13	30	68	93	115	126	0	0	5	10	10	0
99091318	9	19.2N	117.0E 40	36	66	90	92	93	90	0	0	-5	0	-5	20
99091400	10	19.5N	116.7E 45	41	61	102	152	167	186	0	-5	-5	-5	-15	0
99091406	11	19.9N	116.4E 45	0	13	34	56	39	68	0	-10	-10	-15	-15	5
99091412	12	20.4N	116.1E 50	0	23	52	51	38	71	0	0	-5	-15	-15	5
99091418	13	20.8N	115.9E 55	0	16	33	77	73		0	0	-5	-15	-15	
99091500	14	21.1N	115.7E 55	5	29	62	103	96		0	-5	-5	0	-5	
99091506	15	21.3N	115.5E 60	0	0	33	35	8		0	0	-10	5	5	
99091512	16	21.7N	115.2E 65	13	23	50	60	29		0	5	5	15	10	
99091518	17	21.9N	114.9E 70	8	39	55	66			0	5	20	20		
99091600	18	22.1N	114.3E 70	20	37	55				0	-10	-5			
99091606	19	22.2N	113.7E 70	5	24	51				0	5	5			
99091612	20	22.5N	113.1E 55	0	53	80				0	5	5			
99091618	21	23.0N	112.5E 40	13	49					0	0				
99091700	22	23.5N	112.1E 30	0	62					0	0				
99091706		23.8N	111.9E 25												
99091712		24.1N	111.7E 20												
			AVERAGE	47	74	101	120	120	151	0	3	5	7	8	16
			BIAS							0	0	-1	-1	-5	-11
			# CASES	22	22	20	17	16	12	22	22	20	17	16	12

Statistics for JTWC on TS 22W Zia																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99091100		17.5N	141.4E	15												
99091106		18.4N	140.4E	15												
99091112		19.8N	139.5E	15												
99091118		21.0N	139.0E	15												
99091200		22.0N	138.6E	15												
99091206		23.0N	138.0E	20												
99091212		24.3N	137.3E	20												
99091218		25.4N	136.4E	20												
99091300		26.4N	135.4E	20												
99091306		27.3N	134.2E	20												
99091312		28.3N	133.0E	20												
99091318	1	29.1N	132.4E	35	0	24	148	354			0	-10	0	5		
99091400	2	30.2N	131.5E	40	15	57	219	451			-5	0	0	5		
99091406	3	31.1N	131.1E	45	0	81	209				-10	-5	-5			
99091412	4	32.1N	131.4E	35	5	101	245				0	-5	0			
99091418	5	33.7N	132.8E	35	38	120					0	0				
99091500	6	34.9N	134.4E	35	0	34					0	5				
99091506	7	35.8N	137.0E	30	5						0					
99091512		37.0N	140.0E	25												
			AVERAGE		9	69	205	403			2	4	1	5		
			BIAS								-2	-3	-1	5		
			# CASES		7	6	4	2			7	6	4	2		

Statistics for JTWC on TS 23W Ann																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99091500		26.5N	129.4E	15												
99091506		26.8N	129.4E	20												
99091512		27.4N	129.3E	20												
99091518	1	28.8N	129.0E	30	5	69	99	73	55	90	0	-5	-10	-15	-20	-25
99091600	2	29.5N	128.1E	30	12	75	131	195	255	310	0	0	-5	-15	-25	-20
99091606	3	29.6N	127.3E	40	20	91	181	259	329	289	0	10	20	20	10	10
99091612	4	29.5N	127.0E	40	27	59	114	173	222	273	0	5	5	5	-5	-5
99091618	5	29.6N	126.5E	40	21	37	48	59	115	230	-5	-10	-15	-20	-20	-5
99091700	6	29.6N	126.1E	40	31	42	34	78	121	367	-5	-15	-15	-20	-20	-10
99091706	7	29.7N	125.7E	40	19	26	34	73	155	352	0	-5	-10	-15	-10	0
99091712	8	29.8N	125.3E	45	24	29	50	97	177		0	0	-5	-5	-10	
99091718	9	30.0N	124.7E	45	19	50	122	192	247		0	0	-5	0	0	
99091800	10	30.3N	124.3E	45	0	41	96	145	201		0	0	0	0	5	
99091806	11	30.7N	124.0E	45	0	56	74	106	183		0	0	10	10	5	
99091812	12	31.3N	123.2E	45	11	28	55	147			0	5	5	5		
99091818	13	31.9N	122.3E	45	20	84	145	217			0	10	15	10		

Statistics for JTWC on TS 23W Ann															
99091900	14	32.6N	121.9E 40	0	70	166				0	0	0			
99091906	15	33.8N	122.3E 35	17	62	147				0	5	5			
99091912	16	34.2N	123.2E 35	13	106					0	5				
99092000	17	34.6N	125.6E 25	11						0					
99092006		34.7N	126.4E 20												
			AVERAGE	15	58	100	140	187	273	1	5	8	11	12	11
			BIAS							-1	0	0	-3	-8	-8
			# CASES	17	16	15	13	11	7	17	16	15	13	11	7

Statistics for JTWC on STY24W Bart															
	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99091700		20.5N	129.9E 20												
99091706		20.2N	130.0E 20												
99091712	1	20.0N	130.1E 25	20	25	84	211	327	344	0	0	5	-5	0	-45
99091718	2	19.8N	130.3E 25	23	36	84	213	277	272	0	0	0	-5	-10	-65
99091800	3	19.9N	130.5E 25	0	34	145	258	256	180	0	0	-5	-5	-30	-75
99091806	4	20.1N	130.3E 25	5	57	191	249	239	159	0	-5	-10	-15	-45	-75
99091812	5	20.3N	130.0E 25	12	128	251	262	247	142	0	-10	-10	-35	-50	-80
99091818	6	20.8N	129.3E 30	12	151	197	169	128	20	0	0	0	-25	-40	-65
99091900	7	21.8N	128.2E 35	17	65	74	77	105	162	0	10	-10	-15	-40	-55
99091906	8	22.8N	127.1E 35	0	63	128	177	221	282	0	-5	-30	-45	-45	-60
99091912	9	23.4N	126.2E 35	0	66	123	176	237	308	0	-20	-25	-45	-40	-60
99091918	10	23.5N	125.6E 45	5	69	124	184	238	272	0	-25	-45	-45	-55	-50
99092000	11	23.5N	125.4E 65	11	55	106	163	195	222	0	-10	-35	-35	-45	-30
99092006	12	23.7N	125.3E 75	5	24	67	104	126	140	0	-10	-10	-20	-25	-5
99092012	13	24.0N	125.3E 80	12	60	98	117	154	114	0	-20	-15	-20	-25	-5
99092018	14	24.1N	125.3E 100	8	40	63	72	96	98	0	0	-15	-25	-20	5
99092100	15	24.2N	125.4E 110	0	24	32	45	68	234	0	0	-15	-25	-10	15
99092106	16	24.4N	125.7E 110	0	23	37	26	36	406	0	-15	-25	-15	0	35
99092112	17	24.6N	126.1E 115	0	12	8	36	50	487	0	-15	-20	5	15	-5
99092118	18	25.0N	126.6E 130	8	11	49	52	25	393	0	-10	-10	0	0	25
99092200	19	25.5N	126.9E 130	0	36	72	36	50		0	-15	-5	-5	-10	
99092206	20	25.9N	127.0E 140	0	12	21	58	141		0	10	10	5	10	
99092212	21	26.3N	127.1E 140	0	30	57	120	183		0	0	-10	-5	10	
99092218	22	27.1N	127.1E 130	5	32	92	208	278		0	5	-5	10	15	
99092306	23	29.0N	127.9E 110	0	55	265	459			0	0	10	15		
99092312	24	30.2N	128.6E 110	0	128	317				0	5	15			
99092318	25	32.0N	129.8E 100	0	75	94				10	10	15			
99092400	26	34.5N	131.5E 90	11	15					0	10				
99092406	27	37.2N	134.1E 70	15	57					0	5				
99092412	28	39.5N	136.5E 60	62						0					
99092418		41.9N	139.8E 50												
			AVERAGE	9	51	111	151	167	235	0	8	14	18	25	42
			BIAS							0	-4	-10	-15	-20	-33

Statistics for JTWC on STY24W Bart																
			# CASES		28	27	25	23	22	18	28	27	25	23	22	18

Statistics for JTWC on TS 25W Cam																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99092300		17.6N	113.3E	20												
99092306	1	17.8N	113.6E	30	11	34	42	66	99	70	0	0	0	0	5	15
99092312	2	18.3N	114.1E	30	16	25	34	58	110	87	0	0	-5	5	5	20
99092318	3	18.7N	114.4E	30	6	6	33	68	107		0	-5	-5	-5	10	
99092400	4	19.1N	114.6E	30	17	38	61	100	99		0	-5	0	-5	10	
99092406	5	19.4N	114.9E	35	12	28	63	95	39		0	0	5	15	10	
99092412	6	19.9N	115.1E	40	0	6	54	53	66		0	10	15	25	20	
99092418	7	20.4N	115.2E	40	5	34	69	34			0	5	30	20		
99092500	8	20.8N	115.3E	35	0	33	13	69			0	-5	10	10		
99092506	9	21.4N	115.4E	40	5	28	29				0	15	15			
99092512	10	22.0N	115.5E	40	0	53	77				0	15	10			
99092518	11	22.2N	115.4E	25	0	89					0	0				
99092600		22.2N	114.6E	20												
99092606		22.8N	113.6E	20												
99092612		23.3N	112.7E	15												
			AVERAGE		7	34	47	68	87	78	0	5	10	11	10	18
			BIAS								0	3	8	8	10	18
			# CASES		11	11	10	8	6	2	11	11	10	8	6	2

Statistics for JTWC on TY 26W Dan																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99100112		16.2N	135.0E	15												
99100118		16.3N	134.4E	15												
99100200		16.4N	133.7E	20												
99100206		16.6N	133.0E	20												
99100212	1	16.8N	132.4E	25	0	82	116	183	239	354	0	-5	-10	-15	-25	-30
99100218	2	17.2N	131.2E	30	20	46	65	114	151	186	0	0	-15	-20	-35	-30
99100300	3	17.6N	130.1E	35	0	24	25	48	78	107	0	-5	-10	-20	-45	-15
99100306	4	18.1N	129.4E	35	0	21	61	93	111	92	0	-15	-15	-30	-35	-10
99100312	5	18.4N	128.6E	45	6	30	62	100	100	101	0	-5	-15	-40	-15	0
99100318	6	18.3N	127.6E	55	12	50	78	116	123	58	0	0	-15	-20	-5	15
99100400	7	18.3N	126.6E	60	6	12	27	62	42	72	0	-10	-30	-10	0	5
99100406	8	18.3N	125.4E	65	0	13	18	21	25	85	0	-15	-25	-10	5	0
99100412	9	18.3N	124.5E	80	6	34	97	69	45	52	0	-20	5	10	20	10
99100418	10	18.2N	123.5E	90	0	24	42	70	59	51	0	-5	5	15	20	10
99100500	11	18.2N	122.5E	110	0	57	54	70	73	46	0	-5	0	10	10	-5
99100506	12	18.4N	121.3E	100	0	21	60	73	91	87	0	0	10	15	5	-5

Statistics for JTWC on TY 26W Dan

99100512	13	18.5N	120.0E	90	0	58	75	107	143	164	0	10	15	15	10	-5
99100518	14	18.5N	119.7E	90	0	29	8	72	110	183	0	15	15	-5	-10	-20
99100600	15	18.5N	118.9E	85	0	12	58	121	168	254	0	15	10	0	-10	-20
99100606	16	18.6N	118.4E	80	0	41	105	162	194	280	0	10	5	0	-10	-5
99100612	17	18.9N	118.0E	80	18	79	141	176	212	273	0	5	0	-10	-20	0
99100618	18	19.4N	117.8E	80	8	63	118	152	197	267	0	0	0	-15	-25	-10
99100700	19	19.7N	117.9E	85	28	75	118	166	200	339	0	0	0	-15	-45	-5
99100706	20	20.2N	118.1E	90	5	28	50	110	147	279	0	0	0	-15	-35	-5
99100712	21	20.6N	118.2E	90	8	6	57	100	149	293	0	0	0	-15	-15	-5
99100718	22	21.3N	118.2E	90	5	21	41	71	138		0	-15	-30	-40	-15	
99100800	23	21.8N	118.1E	90	0	26	38	89	202		0	-10	-30	-20	-5	
99100806	24	22.3N	118.0E	90	0	34	63	134	218		0	0	-10	0	-5	
99100812	25	22.6N	118.2E	90	0	12	20	77	165		0	0	5	10	-5	
99100818	26	23.3N	118.2E	90	0	21	72	92	244		0	10	30	20	0	
99100900	27	24.0N	118.1E	90	5	11	8	37	106		-5	10	20	0	0	
99100906	28	24.6N	118.0E	75	6	20	74	166			0	20	10	5		
99100912	29	25.5N	118.1E	55	18	49	57	70			0	10	0	0		
99100918	30	26.4N	118.3E	35	6	32	114				0	0	0			
99101000	31	27.2N	119.1E	25	0	8	119				0	-5	0			
99101006	32	28.1N	120.0E	25	16	29					0	0				
99101012	33	29.5N	121.2E	25	44	8					0	0				
99101018	34	31.1N	123.4E	20	0						0					
99101100	35	33.1N	125.4E	20	0						0					
			AVERAGE		6	33	66	101	138	173	0	7	11	14	16	10
			BIAS								0	0	-2	-7	-11	-6
			# CASES		35	33	31	29	27	21	35	33	31	29	27	21

Statistics for JTWC on TS 27W Eve

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99101418		11.8N	129.3E	20												
99101500		11.6N	128.5E	20												
99101506	1	11.3N	127.6E	25	8	58	196	275	301	365	0	0	0	0	0	0
99101512	2	11.3N	126.4E	25	0	61	149	182	208	224	0	0	0	-5	0	0
99101518	3	11.7N	125.5E	25	0	40	49	84	151	81	0	0	0	-5	0	0
99101600	4	12.6N	124.0E	25	18	43	44	94	101	122	0	0	-5	0	0	-5
99101606	5	13.4N	122.4E	25	0	13	68	141	76	97	0	0	-5	0	0	-5
99101612	6	14.2N	121.2E	25	0	52	120	112	32	110	0	-5	0	0	0	0
99101618	7	14.7N	120.1E	25	13	54	121	51	39	94	0	-5	0	0	0	5
99101700	8	15.3N	119.4E	30	25	83	84	26	59		0	0	0	-5	-10	
99101706	9	15.9N	118.8E	30	30	79	32	42	80		0	0	0	-5	-10	
99101712	10	16.6N	118.2E	30	42	67	98	110	113		0	0	-5	-10	-5	
99101718	11	17.4N	117.3E	30	36	59	125	187	182		0	0	0	-10	0	
99101800	12	17.3N	115.9E	30	25	92	158	205			0	0	-5	-5		
99101806	13	17.1N	114.3E	30	11	24	23	79			0	-5	-10	-5		

Statistics for JTWC on TS 27W Eve

99101812	14	16.9N	112.8E 30	20	32	33				0	-10	-5			
99101818	15	16.4N	111.4E 30	12	36	42				5	-5	0			
99101900	16	16.1N	110.3E 35	50	66					10	0				
99101906	17	15.7N	108.8E 35	24	138					0	-5				
99101912	18	16.2N	107.5E 30	18						0					
99101918		16.8N	106.6E 25												
			AVERAGE	19	59	89	122	122	156	1	2	2	4	2	2
			BIAS							1	-2	-2	-4	-2	-1
			# CASES	18	17	15	13	11	7	18	17	15	13	11	7

Statistics for JTWC on TD 28W

	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99110500		17.8N	146.7E 20												
99110506		17.8N	146.5E 20												
99110512		17.9N	146.3E 25												
99110518	1	18.3N	146.2E 30	11	131					0	5				
99110600	2	19.1N	146.6E 30	61	238					0	15				
99110606	3	20.2N	147.3E 30 1	78						0					
99110612	4	21.4N	148.8E 20 3	44						5					
			AVERAGE 1	49	185					1	10				
			BIAS							1	10				
			# CASES	4	2					4	2				

Statistics for JTWC on TS 29W Frankie

	WRN	BEST TRACK		POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG wind	00	12	24	36	48	72	00	12	24	36	48	72
99110518		9.4N	137.7E 15												
99110600		10.2N	136.4E 20												
99110606	1	11.0N	134.9E 25	0	144	245	300	375	282	0	5	5	10	0	10
99110612	2	11.3N	133.0E 25	18	90	132	81	108	47	5	5	10	5	5	15
99110618	3	11.0N	131.8E 25	8	17	43	179	209	141	0	0	0	-10	0	10
99110700	4	10.8N	130.8E 25	0	21	94	173	147	70	0	0	-5	-5	-5	10
99110706	5	10.2N	129.5E 25	0	73	202	189	136	78	0	0	-10	0	0	15
99110712	6	10.2N	128.6E 25	0	118	227	195	152		0	-5	-10	0	5	
99110718	7	10.9N	126.9E 25	0	109	127	68	70		0	-10	-5	-5	0	
99110800	8	11.4N	126.0E 30	0	115	70	39	119		0	-10	-10	-5	5	
99110806	9	12.4N	124.1E 35	24	64	174	268	356		0	5	5	15	25	
99110812	10	12.2N	123.2E 35	44	195	359	491			0	0	10	20		
99110818	11	12.2N	122.8E 30	13	94	199	287			0	0	10	25		
99110900	12	12.1N	122.7E 30	0	71	123				0	5	10			
99110906	13	12.4N	123.2E 30	8	18	65				0	0	10			

Statistics for JTWC on TS 29W Frankie

99110912	14	12.6N	123.4E	25	0	17					0	5				
99110918	15	12.7N	123.5E	25	0	6					0	5				
99111000	16	12.9N	123.6E	20	5						0					
99111006		13.1N	123.7E	15												
			AVERAGE		8	77	158	206	186	124	0	4	8	9	5	12
			BIAS								0	0	2	5	4	12
			# CASES		16	15	13	11	9	5	16	15	13	11	9	5

Statistics for JTWC on TY 30W Gloria

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99111012		12.9N	126.6E	15												
99111018		12.6N	126.7E	15												
99111100		12.3N	126.9E	15												
99111106		11.4N	127.8E	15												
99111112		10.5N	129.0E	15												
99111118		10.4N	129.8E	20												
99111200		10.3N	130.5E	20												
99111206		10.7N	131.0E	20												
99111212		11.0N	131.1E	20												
99111218		11.7N	131.6E	20												
99111300		13.3N	131.9E	20												
99111306	1	14.7N	132.1E	25	52	76	133	267	467	1431	0	0	-5	0	5	-5
99111312	2	15.7N	131.9E	30	26	19	93	197	405		0	5	0	10	-10	
99111318	3	16.6N	131.3E	30	33	60	80	142	434		0	-5	-5	0	-25	
99111400	4	17.5N	130.8E	30	54	63	61	243	278		0	-10	-5	-15	-25	
99111406	5	18.5N	130.4E	40	0	54	195	513	900		0	0	-10	-40	-30	
99111412	6	20.0N	130.3E	45	0	73	275	627			0	0	-25	-35		
99111418	7	21.0N	130.5E	45	0	51	252	339			0	-10	-35	-35		
99111500	8	22.4N	131.3E	45	6	81	295				0	-25	-35			
99111506	9	23.9N	132.3E	45	17	186	418				0	-25	-20			
99111512	10	25.8N	134.9E	60	43	226					-20	-30				
99111518	11	27.9N	138.2E	65	36	156					0	-5				
99111600	12	30.1N	142.1E	65	38						0					
99111606	13	32.5N	147.1E	55	52						0					
			AVERAGE		28	95	200	332	497	1431	2	10	16	19	19	5
			BIAS								-2	-10	-16	-16	-17	-5
			# CASES		13	11	9	7	5	1	13	11	9	7	5	1

Statistics for JTWC on TD 31W

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99112912		10.5N	117.5E	15												

Statistics for JTWC on TD 31W

99112918		10.8N	116.5E	15												
99113000		11.3N	115.1E	15												
99113006		11.7N	113.8E	20												
99113012		11.7N	112.8E	20												
99113018		11.5N	112.0E	20												
99120100	1	11.2N	111.2E	30	13	56	199	245	232	342	0	0	5	0	-5	-10
99120106	2	10.7N	110.5E	30	21	138	247	249	232	309	0	5	5	0	-10	-10
99120112	3	9.8N	109.7E	30	61	203	246	234	233		0	0	0	-10	-10	
99120118	4	8.5N	108.9E	25 1	36	236	227	219	268		5	0	0	-10	-10	
99120200	5	7.3N	108.0E	25 1	93	224	207	221	295		0	0	-10	-5	-5	
99120206	6	6.7N	107.0E	25	5	36	54	87	119		0	0	-10	-5	-10	
99120212	7	6.8N	106.0E	25	12	43	42	67	90		0	-5	0	-5	-10	
99120218	8	7.0N	105.2E	25	29	49	105	186			0	-5	-5	-10		
99120300	9	7.2N	104.6E	30	18	37	100	137			0	0	-5	-10		
99120306	10	7.4N	103.9E	30	0	61	98	51	96		0	5	5	0	0	
99120312	11	7.8N	102.8E	25	11	45	48	89			5	0	-5	0		
99120318	12	8.2N	101.5E	25	5	66	148				0	-5	-10			
99120400	13	8.8N	100.5E	25	30	80					-5	-10				
99120406		9.6N	99.7E	25												
99120412		9.8N	99.4E	25												
99120418		10.1N	99.1E	25												
99120500		10.8N	98.3E	20												
99120506		11.9N	97.1E	20												
			AVERAGE		42	98	143	162	196	326	1	3	5	5	8	10
			BIAS								0	-1	-3	-5	-8	-10
			# CASES		13	13	12	11	8	2	13	13	12	11	8	2

Statistics for JTWC on TD 32W

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99120712		7.9N	116.0E	20												
99120718		7.9N	115.4E	20												
99120800		7.9N	114.9E	20												
99120806		7.9N	114.6E	20												
99120812		7.8N	114.1E	20												
99120818		7.7N	113.6E	20												
99120900		7.6N	113.2E	20												
99120906		7.5N	112.8E	20												
99120912		7.5N	112.4E	20												
99120918	1	7.5N	112.0E	25	13	51	46	76			0	0	0	10		
99121000	2	7.5N	111.1E	30	21	51	51				0	0	10			
99121006	3	7.5N	110.0E	30	16	48	120				0	0	10			
99121012	4	7.4N	109.1E	30	18	78					0	10				
99121018	5	7.2N	108.6E	30	8	74					0	10				
99121100	6	7.1N	108.3E	20	32						0					

Statistics for JTWC on TD 32W

99121106		7.0N	108.0E	20												
			AVERAGE		19	60	72	76			0	4	7	10		
			BIAS								0	4	7	10		
			# CASES		6	5	3	1			6	5	3	1		

Statistics for JTWC on TD 33W

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99121400		11.6N	114.5E	20												
99121406		11.7N	113.8E	20												
99121412	1	12.0N	112.9E	25	17	55	155	212			0	0	-5	-10		
99121418	2	12.1N	112.1E	30	30	110	158	184			0	0	-5	0		
99121500	3	11.9N	111.4E	30	53	127	164				0	-5	-10			
99121506	4	11.6N	110.9E	30	17	65	149				0	-5	0			
99121512	5	11.6N	110.3E	30	11	30					0	0				
99121518	6	11.7N	109.8E	30	0	59					0	10				
99121600	7	12.1N	109.3E	25	16						0					
99121606		12.7N	109.1E	15												
			AVERAGE		21	74	156	198			0	3	5	5		
			BIAS								0	0	-5	-5		
			# CASES		7	6	4	2			7	6	4	2		

Statistics for JTWC on HUR07E Dora

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99080500		10.8N	95.5W	25												
99080506		10.8N	96.7W	25												
99080512		11.4N	97.9W	25												
99080518		11.8N	99.2W	30												
99080600	1	12.2N	100.7W	30	0						0					
99080606	2	12.3N	102.2W	30	5						0					
99080612	3	12.6N	103.6W	30	18						0					
99080618	4	13.1N	105.0W	35	5						0					
99080700	5	13.6N	106.4W	35	5						10					
99080706	6	14.1N	107.6W	40	16						5					
99080712	7	14.5N	108.4W	45	8						0					
99080718	8	14.9N	108.9W	50	29						0					
99080800	9	15.2N	109.8W	55	13						5					
99080806	10	15.2N	111.0W	60	21						5					
99080812	11	15.1N	112.2W	65	29						0					
99080818	12	15.0N	113.2W	75	11						0					
99080900	13	14.9N	114.1W	85	6						5					
99080906	14	14.8N	115.2W	90	0						0					

Statistics for JTWC on HUR07E Dora

99080912	15	14.6N	115.9W90	0						0					
99080918	16	14.5N	116.8W90	0						5					
99081000	17	14.4N	117.6W100	8						0					
99081006	18	14.4N	118.5W105	0						0					
99081012	19	14.3N	119.4W110	0						0					
99081018	20	14.4N	120.4W115	0						0					
99081100	21	14.5N	121.5W115	0						0					
99081106	22	14.6N	122.6W115	0						0					
99081112	23	14.6N	123.8W115	0						0					
99081118	24	14.8N	125.0W115	0						0					
99081200	25	14.9N	126.4W120	0						0					
99081206	26	15.0N	127.7W115	0						0					
99081212	27	15.2N	129.1W115	0						0					
99081218	28	15.5N	130.5W120	0						0					
99081300	29	15.5N	132.2W115	0						5					
99081306	30	15.5N	133.9W120	0						0					
99081312	31	15.5N	135.7W115	0						0					
99081318	32	15.5N	137.6W110	0						0					
99081400	33	15.6N	139.7W100	0						0					
99081406	34	15.5N	141.8W85	5						0					
99081412	35	15.5N	143.3W70	0						0					
99081418	36	15.2N	145.4W70	0						0					
99081500	37	15.2N	147.2W70	0						0					
99081506	38	15.5N	149.0W90	0						0					
99081512	39	15.6N	150.8W95	6						0					
99081518	40	15.6N	152.5W95	0						0					
99081600	41	15.8N	154.3W95	0						0					
99081606	42	15.9N	156.6W100	40						0					
99081612	43	15.7N	157.7W90	0						0					
99081618	44	15.5N	159.1W85	0						0					
99081700	45	15.5N	160.8W75	5						5					
99081706	46	15.6N	162.8W75	0						0					
99081712	47	15.5N	164.0W75	5						0					
99081718	48	15.5N	166.0W70	0						0					
99081800	49	15.6N	167.8W65	0						0					
99081806	50	15.6N	169.5W65	0						0					
99081812	51	15.7N	171.4W65	0						0					
99081818	52	16.2N	173.6W65	0						0					
99081900	53	16.5N	175.3W65	0						0					
99081906	54	16.6N	176.4W65	0						0					
99081912	55	17.2N	177.7W65	0						0					
99081918	56	17.3N	178.9W65	0						0					
99082000	57	17.9N	179.5E 60	18						0					
99082006	58	18.4N	178.2E 50	8	68	91	99	115	279	0	0	5	10	15	20
99082012	59	19.1N	177.6E 45	0	50	29	94	92	186	0	0	5	15	20	20
99082018	60	19.7N	176.7E 45	0	6	62	50	69	193	0	5	10	15	20	20
99082100	61	20.6N	175.4E 45	0	29	76	60	74	93	0	5	15	20	15	25

Statistics for JTWC on HUR07E Dora																
99082106	62	20.9N	174.6E	40	0	73	114	130	144		0	5	10	15	15	
99082112	63	21.3N	173.4E	40	0	33	8	30	40		0	10	15	15	10	
99082118	64	21.8N	171.8E	35	0	53	56	126	218		0	5	5	5	5	
99082200	65	22.4N	170.7E	30	0	57	76	149			0	0	0	-5		
99082206	66	23.7N	170.0E	30	0	48	76	185			0	0	0	0		
99082212	67	24.2N	169.3E	25	32	84	116	294			0	0	-5	0		
99082218	68	24.7N	168.3E	25	49	124	271				0	0	0			
99082300	69	25.3N	167.7E	25	0	64	204				0	0	5			
99082306	70	26.6N	167.4E	25	5	81					0	0				
99082312		27.5N	167.1E	25												
99082318		27.7N	167.7E	20												
99082400		28.0N	168.3E	15												
			AVERAGE		5	59	98	122	108	188	1	2	6	10	14	21
			BIAS								1	2	5	9	14	21
			# CASES		70	13	12	10	7	4	70	13	12	10	7	4

Statistics for JTWC on TC 01B																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99013012		7.7N	92.0E	20												
99013018		8.0N	91.8E	25												
99013100		8.3N	91.2E	25												
99013106		8.4N	90.6E	25												
99013112		8.4N	90.0E	25												
99013118		8.3N	89.2E	25												
99020100		8.1N	88.5E	25												
99020106		8.1N	87.7E	25												
99020112		8.2N	87.0E	25												
99020118		8.6N	86.4E	25												
99020200		9.1N	85.7E	25												
99020206	1	9.6N	85.2E	35	16	56	100	135	163		0	10	10	20	20	
99020218	2	10.4N	84.7E	35	18	48	104	152	198		0	0	10	10	15	
99020306	3	10.8N	84.5E	40	11	35	59	77			0	5	5	10		
99020318	4	11.1N	84.3E	35	21	43	58				0	0	0			
99020406	5	11.5N	84.1E	35	6	0					0					
99020418	6	12.0N	84.0E	30	0						0					
			AVERAGE		12	36	80	121	181		0	3	6	13	18	
			BIAS								0	3	6	13	18	
			# CASES		6	5	4	3	2		6	5	4	3	2	

Statistics for JTWC on TC 02A

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99051500		12.0N	72.5E	25												
99051506		12.1N	72.5E	25												
99051512		12.2N	72.5E	25												
99051518		12.3N	72.5E	25												
99051600		12.4N	72.4E	30												
99051606	1	12.6N	72.2E	30	42	126	218	280	365	497	0	0	-25	-45	-45	-55
99051612	2	13.1N	71.7E	35	25	100	163	232	322	443	0	-5	-25	-40	-45	-50
99051618	3	13.8N	71.0E	35	6	31	67	146	225	419	0	-20	-35	-35	-40	-45
99051700	4	14.5N	70.3E	45	16	38	67	138	213		0	-15	-25	-30	-40	
99051706	5	15.2N	69.7E	65	0	23	75	149	239	453	0	-15	-15	-20	-20	-15
99051712	6	15.7N	69.1E	70	0	33	92	173	263	448	0	-15	-20	-25	-20	-5
99051718	7	16.3N	68.6E	90	0	42	87	153	253	427	0	5	5	5	-10	-15
99051800	8	17.1N	68.1E	90	6	54	100	156	227	350	0	0	0	0	-15	-15
99051806	9	18.0N	67.7E	95	0	29	66	123	173	259	0	-5	-5	-5	-15	10
99051812	10	18.9N	67.3E	100	5	47	86	143	177	293	0	-10	-5	-10	-5	20
99051818	11	19.6N	67.2E	105	8	33	82	108	115	152	0	0	0	5	15	20
99051900	12	20.4N	67.1E	110	6	28	77	101	131		0	0	5	10	15	
99051906	13	21.1N	67.1E	110	11	50	93	118	143		0	0	0	10	-10	
99051912	14	21.8N	67.3E	110	5	13	24	48			0	0	-30	-50		
99051918	15	22.5N	67.6E	110	8	21	73	149			-5	-20	-50	-35		
99052000	16	23.1N	67.9E	110	8	21	63	133			0	0	-35	-25		
99052006	17	23.6N	68.2E	110	0	8	29	38			-5	-30	-20	-25		
99052012	18	24.0N	68.3E	100	0	33	77				0	-20	-10			
99052018	19	24.4N	68.7E	100	11	37	60				0	20	-10			
99052100	20	24.7N	69.1E	90	0	24					0	10				
99052106	21	25.0N	69.6E	65	0	39					0	-10				
99052112		25.6N	70.2E	55												
99052118		26.0N	70.7E	55												
			AVERAGE		8	40	84	141	219	374	0	10	17	22	23	25
			BIAS								0	-6	-16	-19	-18	-15
			# CASES		21	21	19	17	13	10	21	21	19	17	13	10

Statistics for JTWC on TC 03B

	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99060806		18.5N	91.4E	20												
99060812		18.5N	91.2E	25												
99060818		18.5N	91.0E	25												
99060900		18.6N	90.9E	25												
99060906		18.9N	90.7E	25												
99060912		19.3N	90.5E	25												
99060918		19.9N	90.3E	25												

Statistics for JTWC on TC 03B																
99061000		20.3N	90.0E	25												
99061006		20.7N	89.5E	25												
99061012	1	21.1N	88.4E	35	12	99	98				0	20	5			
99061100	2	22.9N	85.8E	25	0	108					0	0				
99061106		23.5N	85.3E	20												
99061112		24.2N	84.8E	20												
99061118		25.0N	84.4E	20												
			AVERAGE		6	103	98				0	10	5			
			BIAS								0	10	5			
			# CASES		2	2	1				2	2	1			

Statistics for JTWC on TC 04B																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99101500		14.5N	92.7E	20												
99101506		15.2N	91.4E	25												
99101512		15.4N	90.2E	30												
99101518	1	15.8N	89.3E	45	0	13	26	45	54		-10	-10	-25	-70	-50	
99101606	2	16.6N	87.4E	55	0	17	55	80			0	-15	-50	-60		
99101618	3	17.5N	85.8E	80	5	55	79				-15	-55	-60			
99101700	4	17.7N	85.3E	120	0	35	75	148			-5	-30	-40	-10		
99101706	5	18.0N	84.9E	120	0	58	130				0	0	-15			
99101718	6	19.2N	84.7E	90	0	38					10	-10				
99101806	7	21.1N	84.5E	65	5						0					
99101812		22.4N	84.7E	40												
			AVERAGE		2	36	73	91	54		6	20	38	47	50	
			BIAS								-3	-20	-38	-47	-50	
			# CASES		7	6	5	3	1		7	6	5	3	1	

Statistics for JTWC on TC 05B																
	WRN	BEST TRACK			POSITION ERRORS						WIND ERRORS					
DTG	NO.	LAT	LONG	wind	00	12	24	36	48	72	00	12	24	36	48	72
99102500		11.5N	99.2E	25												
99102506		12.0N	97.9E	25												
99102512		12.7N	96.9E	25												
99102518		13.2N	96.3E	25												
99102600	1	13.8N	95.5E	35	0	0	0	18	13		0	0	-10	-25	-25	
99102612	2	15.0N	93.9E	45	0	12	32	32	48		0	-10	-25	-25	-45	
99102700	3	16.0N	92.3E	65	26	62	40	0	64		-5	-20	-20	-45	-45	
99102712	4	16.7N	90.9E	90	0	41	59	41	69		0	0	-25	-25	0	
99102800	5	17.6N	89.1E	100	0	6	33	113	246		0	-30	-40	-20	-5	
99102812	6	18.6N	87.7E	135	0	6	61	198			0	0	-15	-20		
99102900	7	19.6N	86.7E	140	8	34	109	222	340		0	0	5	15	5	

Statistics for JTWC on TC 05B

99102912	8	20.4N	86.0E	115	18	72	212			0	-10	-10		
99103000	9	20.6N	85.9E	80	16	70	167			0	0	-15		
99103012	10	20.3N	85.8E	45	0	13	48			0	-5	-10		
99103100	11	19.9N	85.9E	40	6	24	29	91		0	10	15	5	
99103112	12	19.2N	85.8E	35	20	12	72			0	0	0		
99110100	13	18.9N	85.5E	30	8	45				0	0			
99110106		18.6N	85.3E	25										
99110112		17.9N	85.1E	25										
99110118		17.0N	84.9E	25										
99110200		16.1N	84.8E	25										
99110206		15.9N	84.7E	20										
99110212		15.8N	84.5E	15										
99110218		15.7N	84.1E	15										
99110300		15.8N	83.7E	15										
99110306		16.0N	83.3E	15										
			AVERAGE		8	31	72	89	130	0	7	16	23	21
			BIAS							0	-5	-13	-18	-19
			# CASES		13	13	12	8	6	13	13	12	8	6