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.

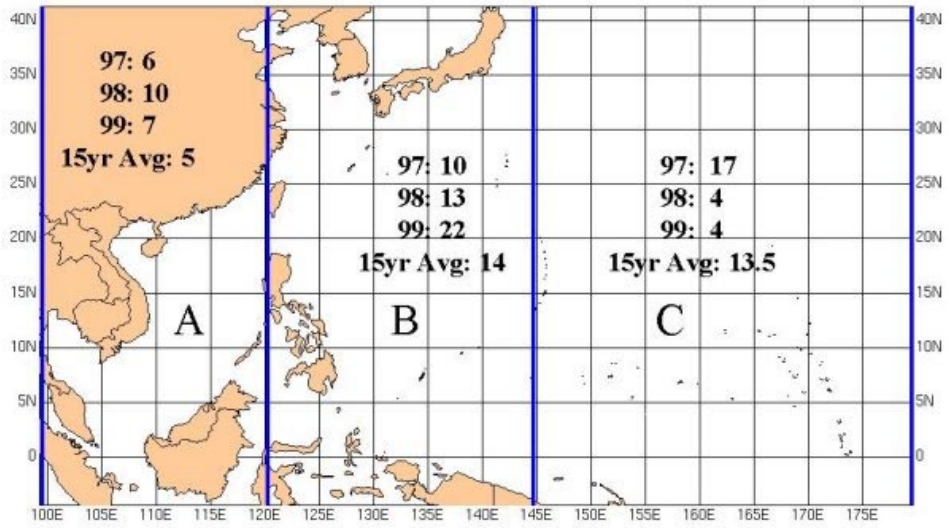


Figure 1-1. Comparison of the number of tropical cyclones that developed within 3 designated areas for 1997, 1998, 1999 and the 15-year average.

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

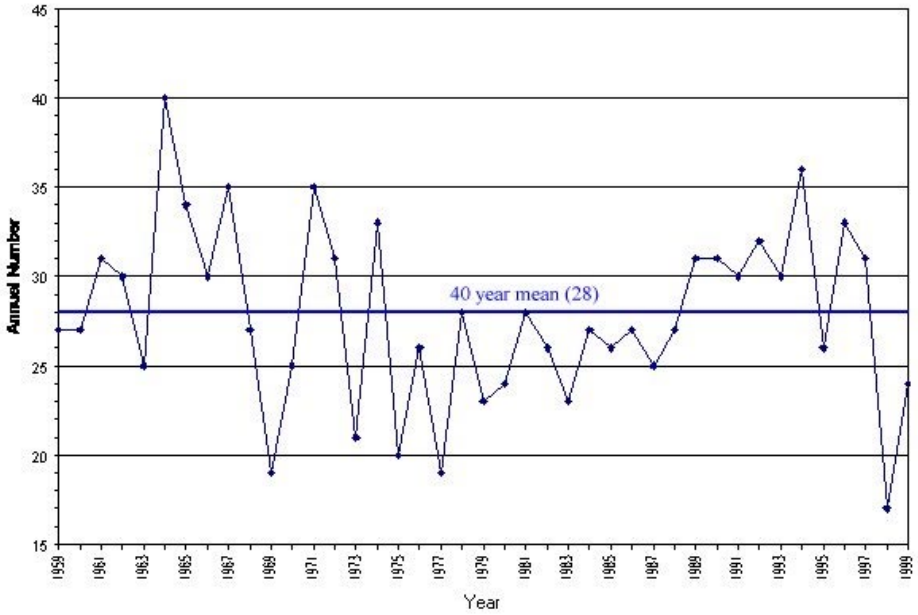


Figure 1-2. Tropical Cyclones of Tropical Storm or greater intensity in the North West Pacific (1959-1999).

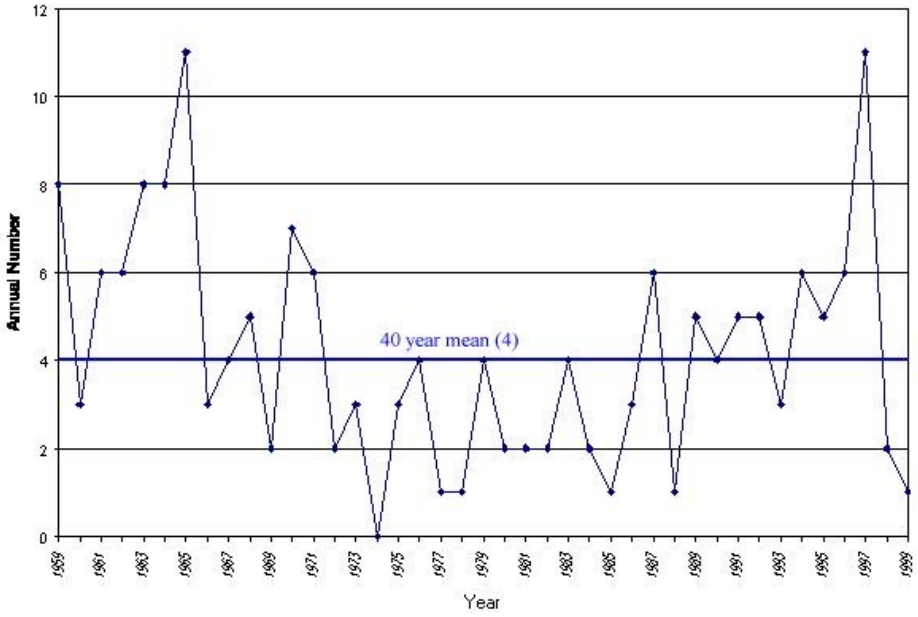
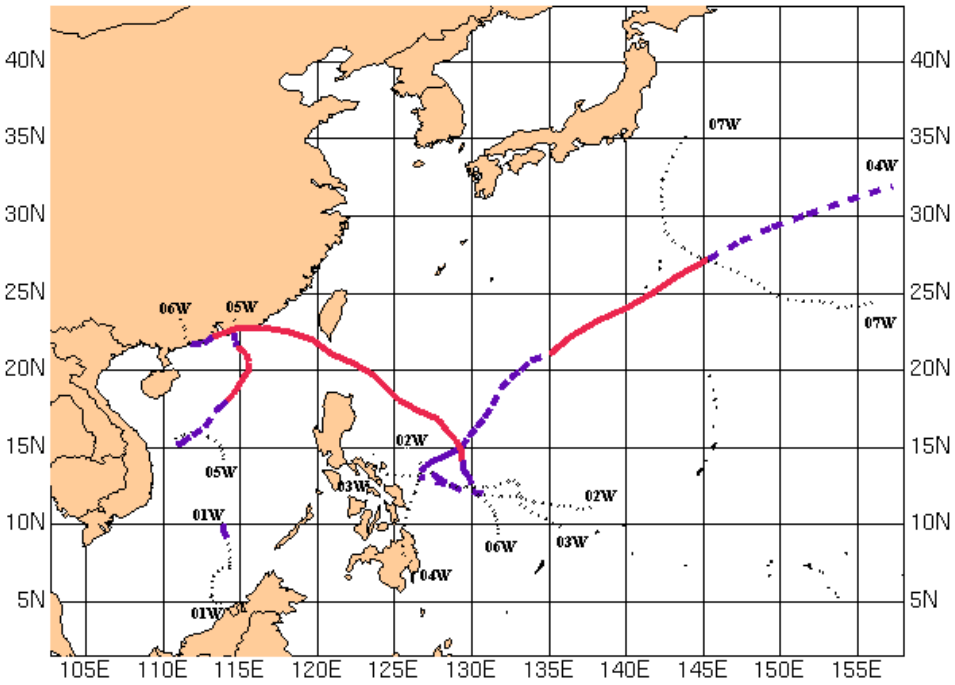


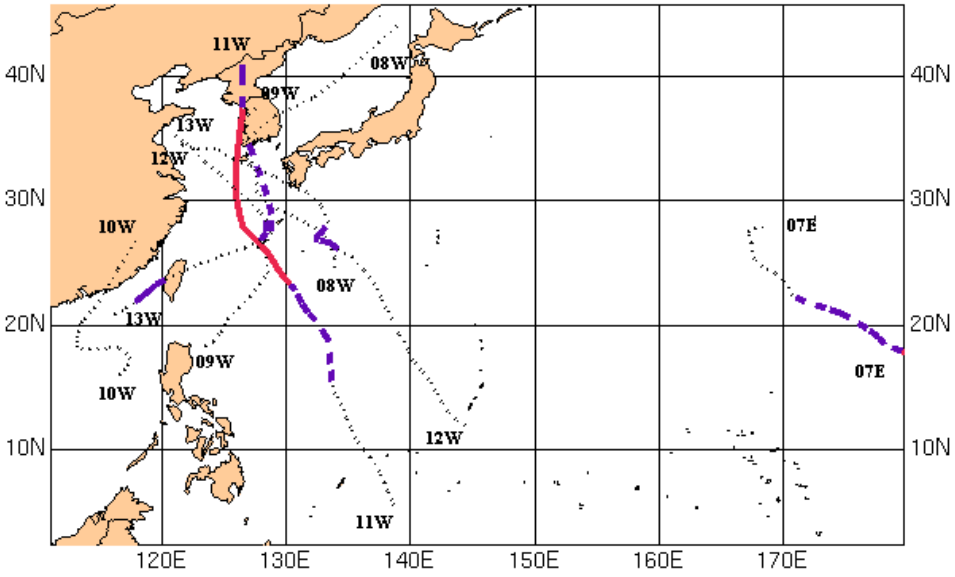
Figure 1-3. Number of North West Pacific Super Typhoons (1959-1999).



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

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

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

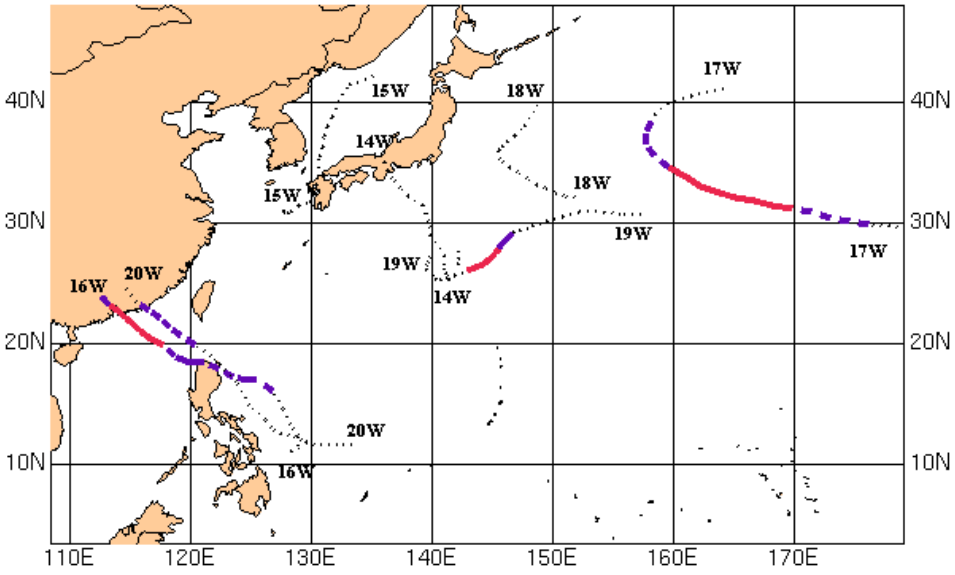


NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
21 JUL 99 - 23 AUG 99

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

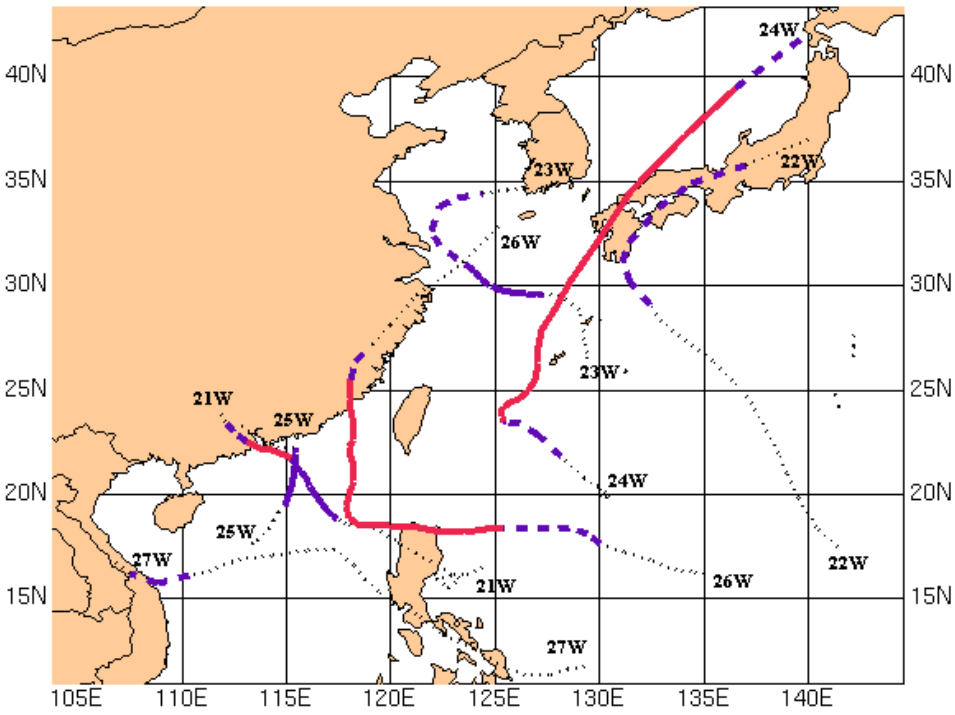


NORTHWEST PACIFIC OCEAN
TROPICAL CYCLONES
08 AUG 99 - 04 SEP 99

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

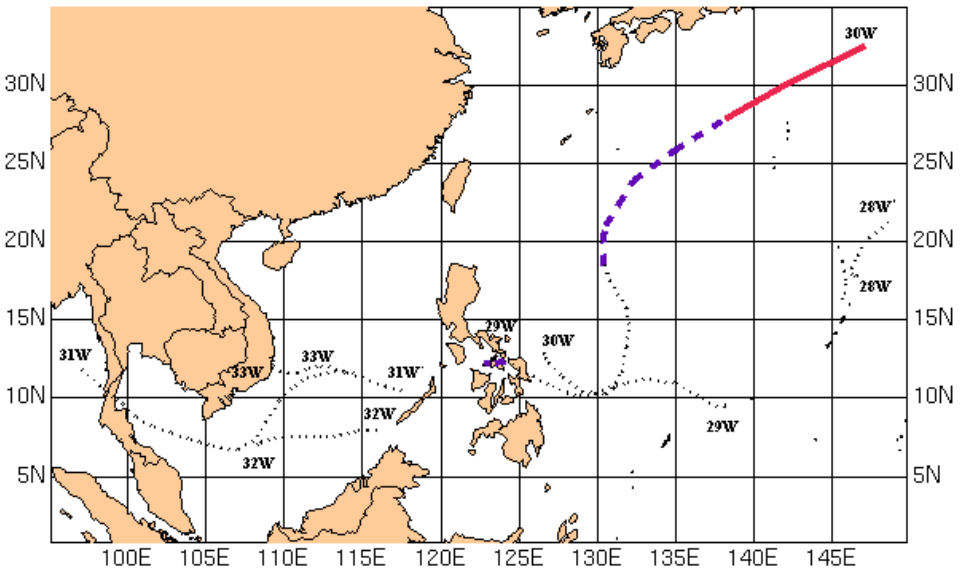
MAXIMUM SUSTAINED SURFACE WIND

64KT (33M/SEC) OR GREATER

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

33KT (17M/SEC) OR LESS

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



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

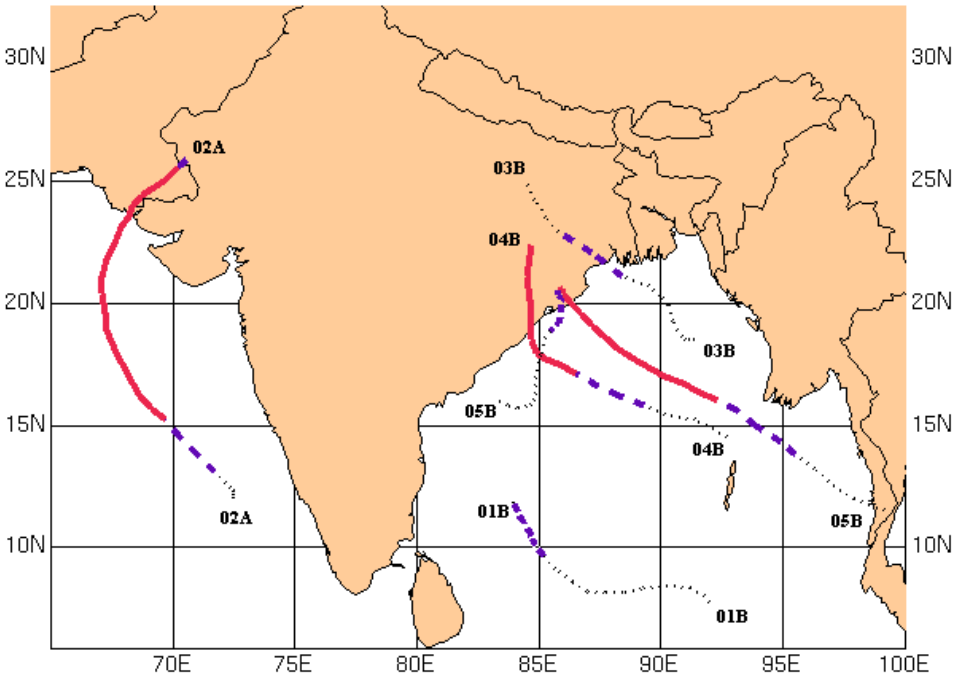
1997	0	0	0	0	1	0	0	0	1	1	1	0		4
	000	000	000	000	100	000	000	000	100	010	010	000	2 2 0	
1998	0	0	0	0	2	1	0	0	1	1	2	1		8
	000	000	000	000	110	100	000	000	010	010	200	100	5 3 0	
1999	0	1	0	0	1	1	0	0	0	2	0	0		5
	000	010	000	000	100	010	000	000	000	200	000	000	3 2 0	
(1975-1999)														
MEAN	0.1	0.1	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."

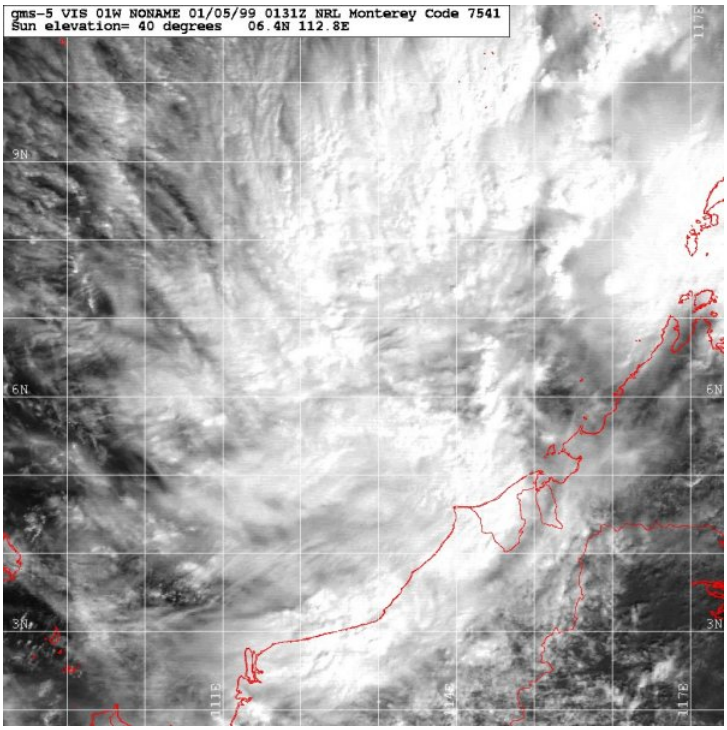
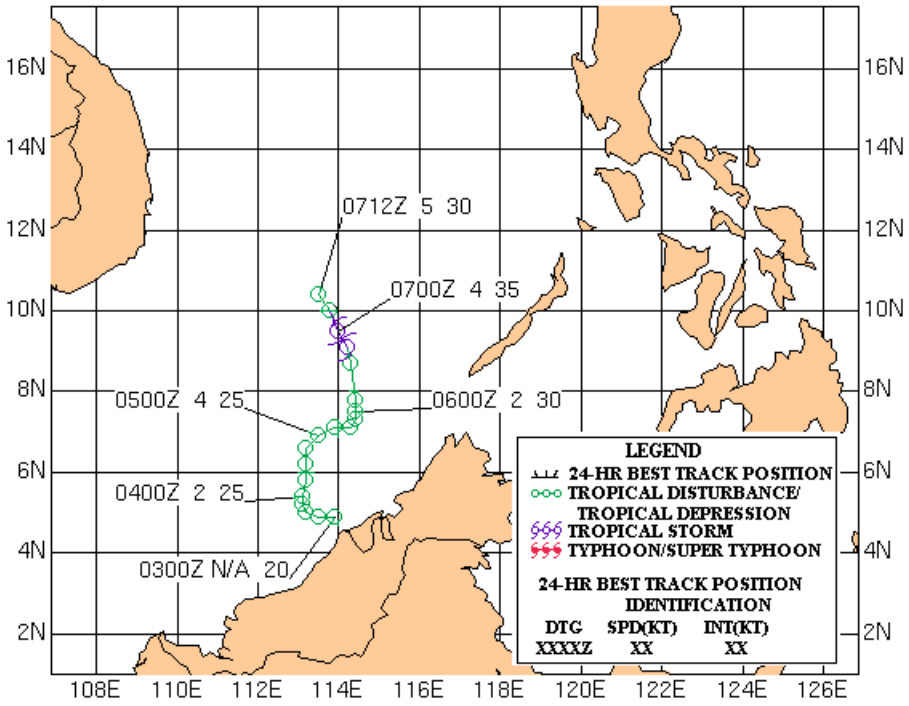


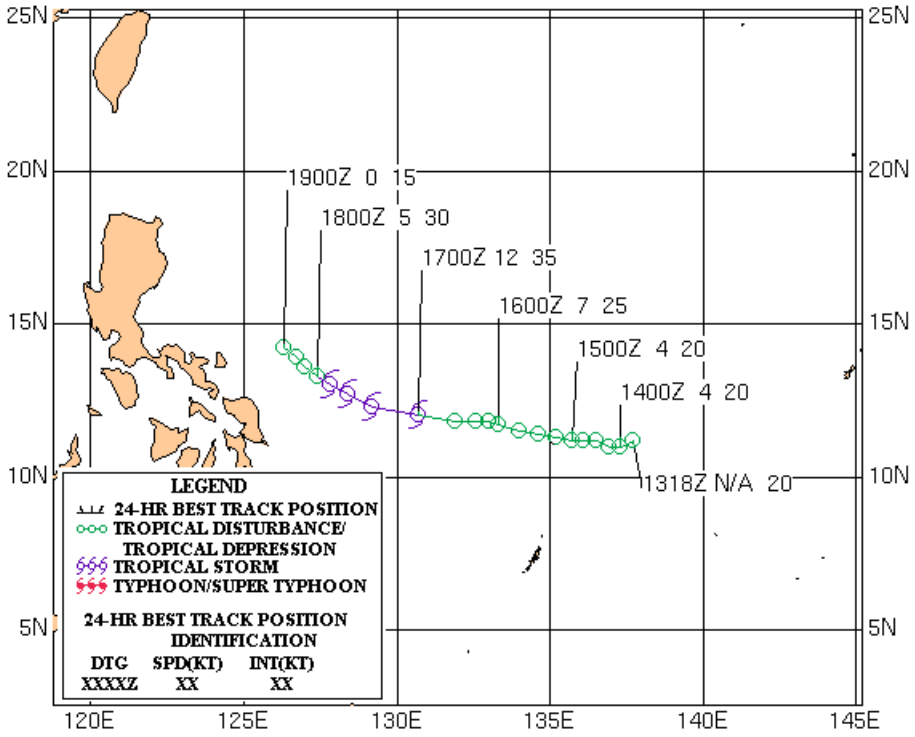
Figure 1-01-1. A visible satellite image showing TD 01W embedded in a large area of convection off the northwest coast of Borneo.


16N
14N
12N
10N
8N
6N
4N
2N
108E
110E
112E
114E
116E
118E
120E
122E
124E
126E
0712Z 5 30
0700Z 4 35
0500Z 4 25
0600Z 2 30
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.



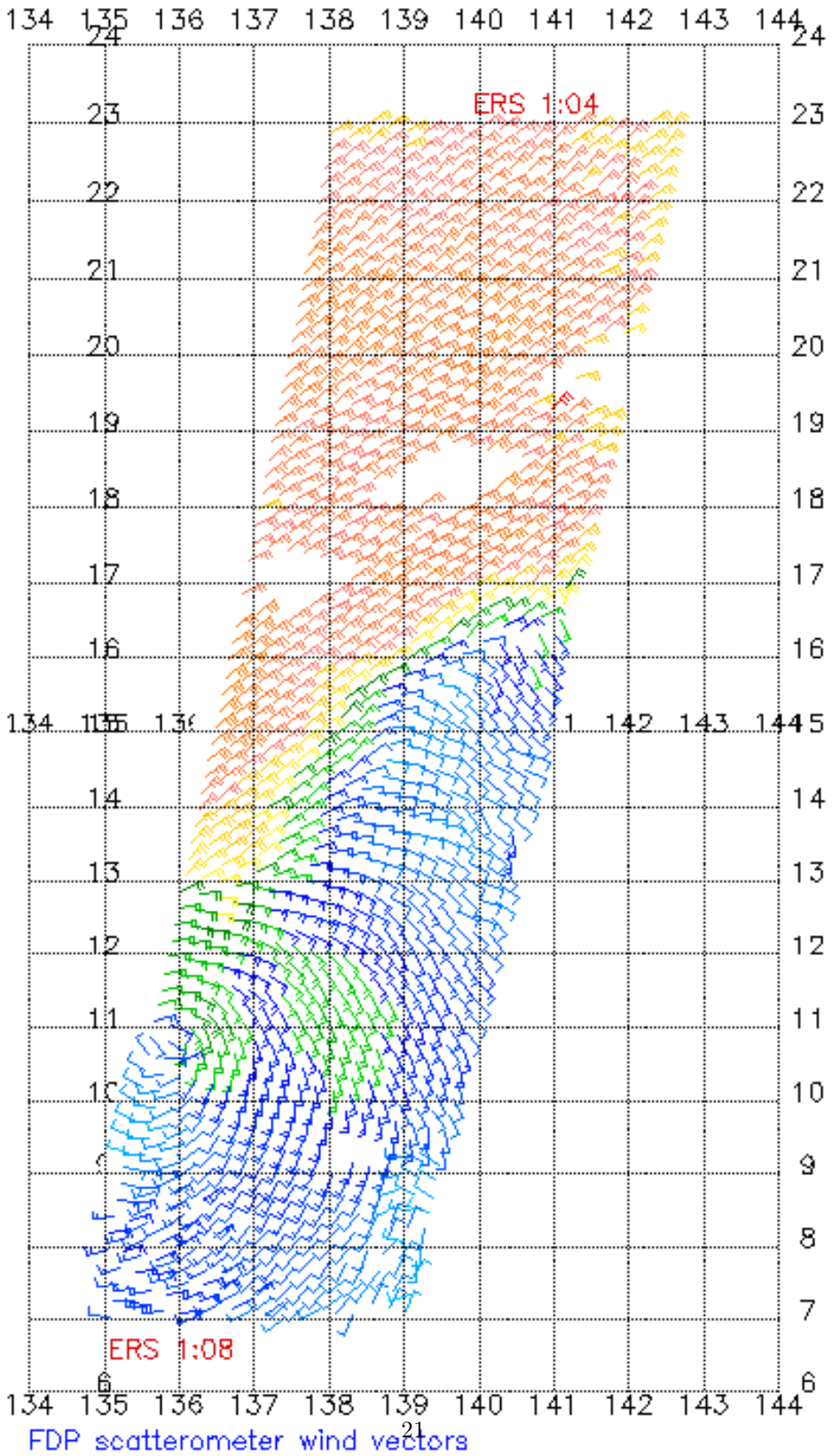


Figure 1-02-1. ERS-2 Scatterometer pass over Tropical Depression 02W which later developed into TS Iris. The low level circulation center seems to be enhanced due to horizontal wind shear from the strong northeasterly monsoon.

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.

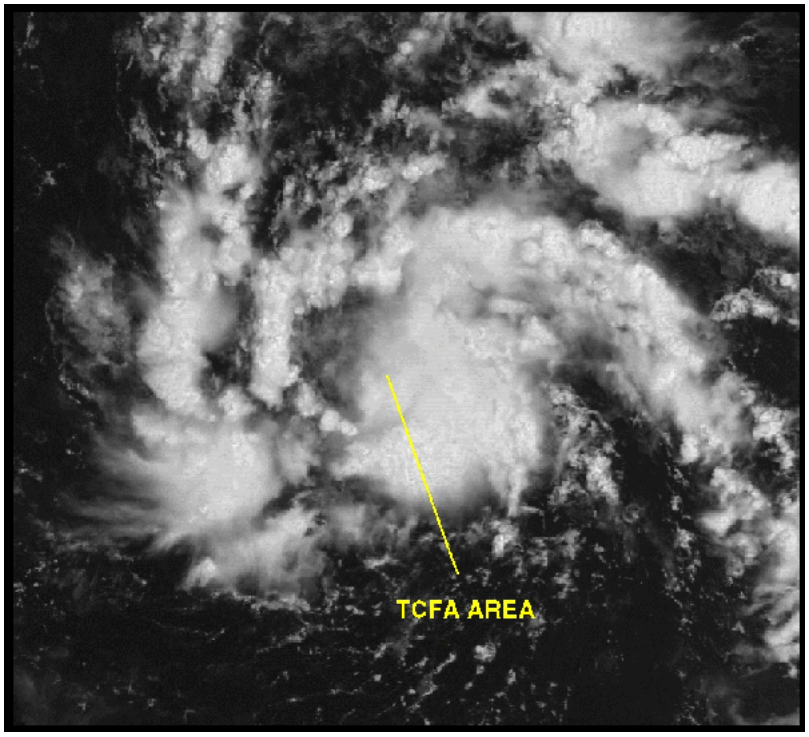


Figure 1-03-1. An infrared satellite image of the tropical disturbance which would become TS Jacob (03W).

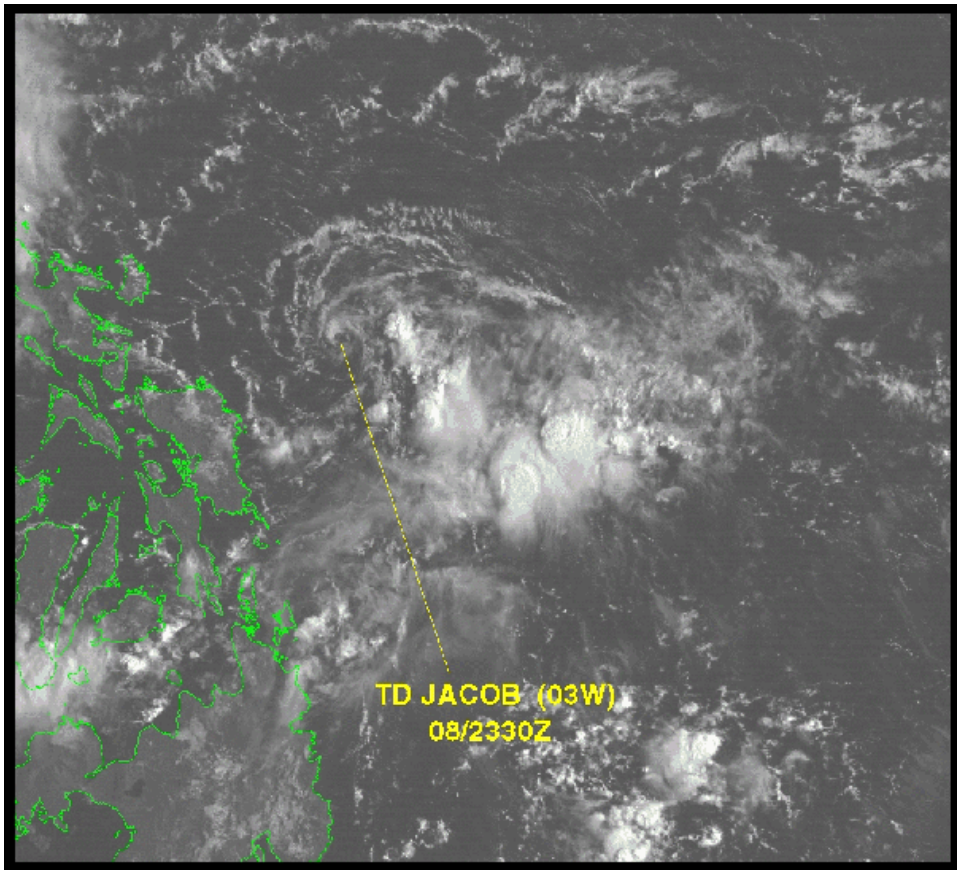
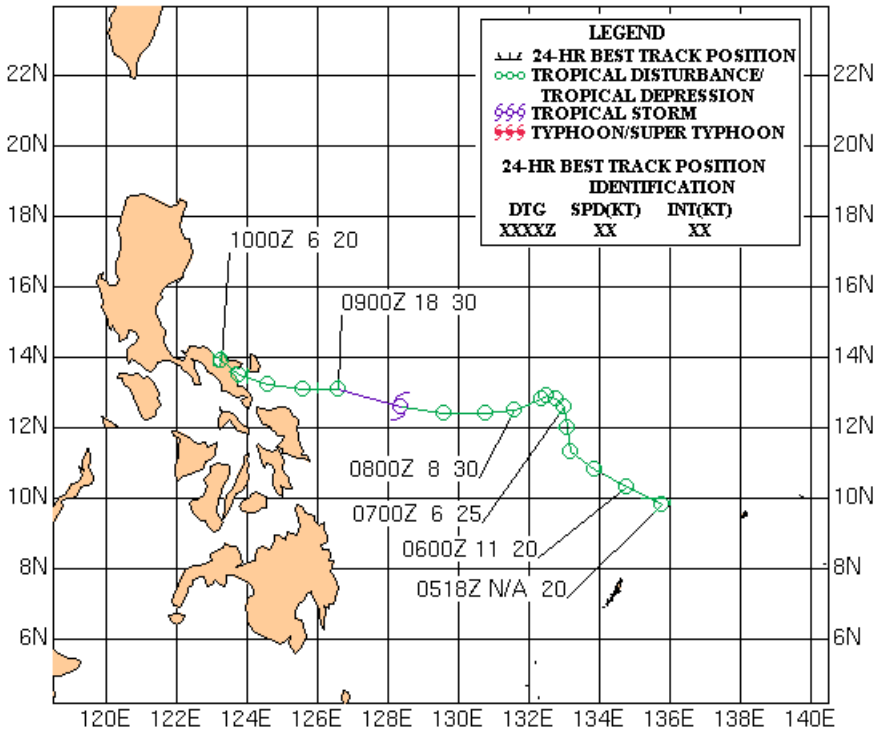


Figure 1-03-2. A visible satellite image of TD JACOB (03W) as it became a fully exposed low-level circulation just east of the Philippines.


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.

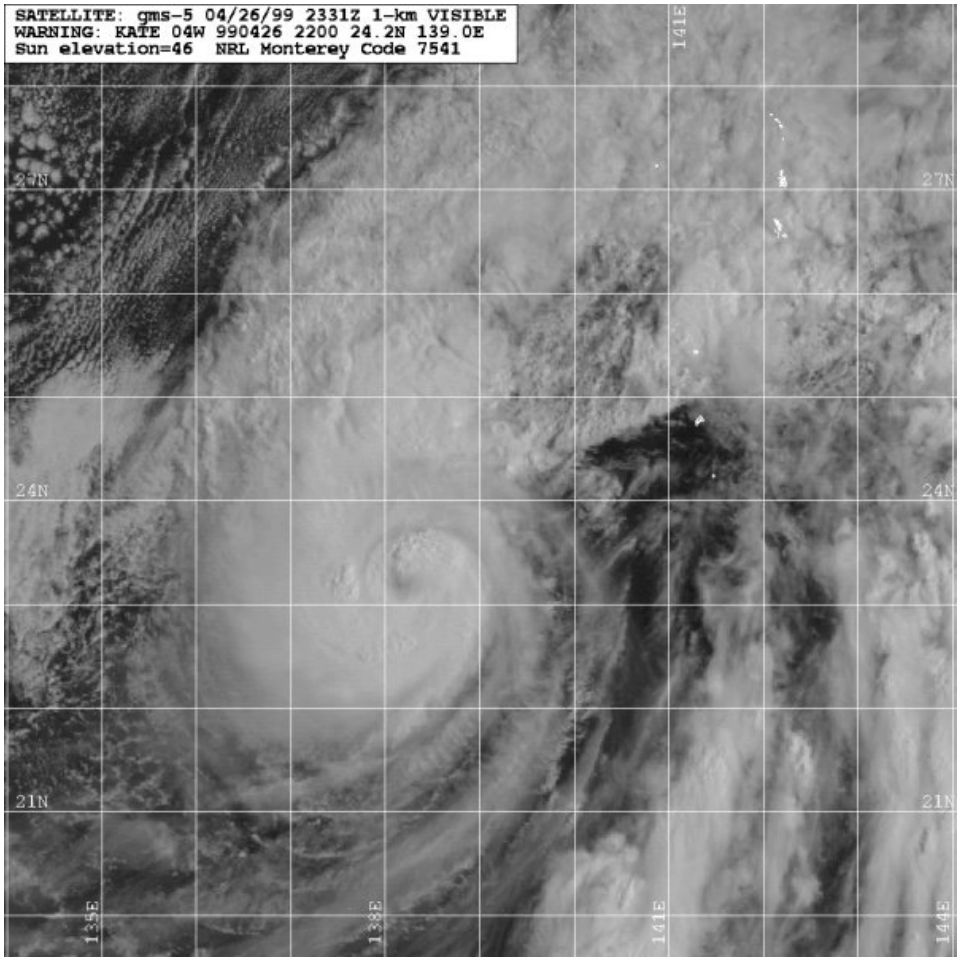


Figure 1-04-1. 262330Z April GMS-5 visible image of TY Kate. TY Kate was at it's max intensity (75 kt).

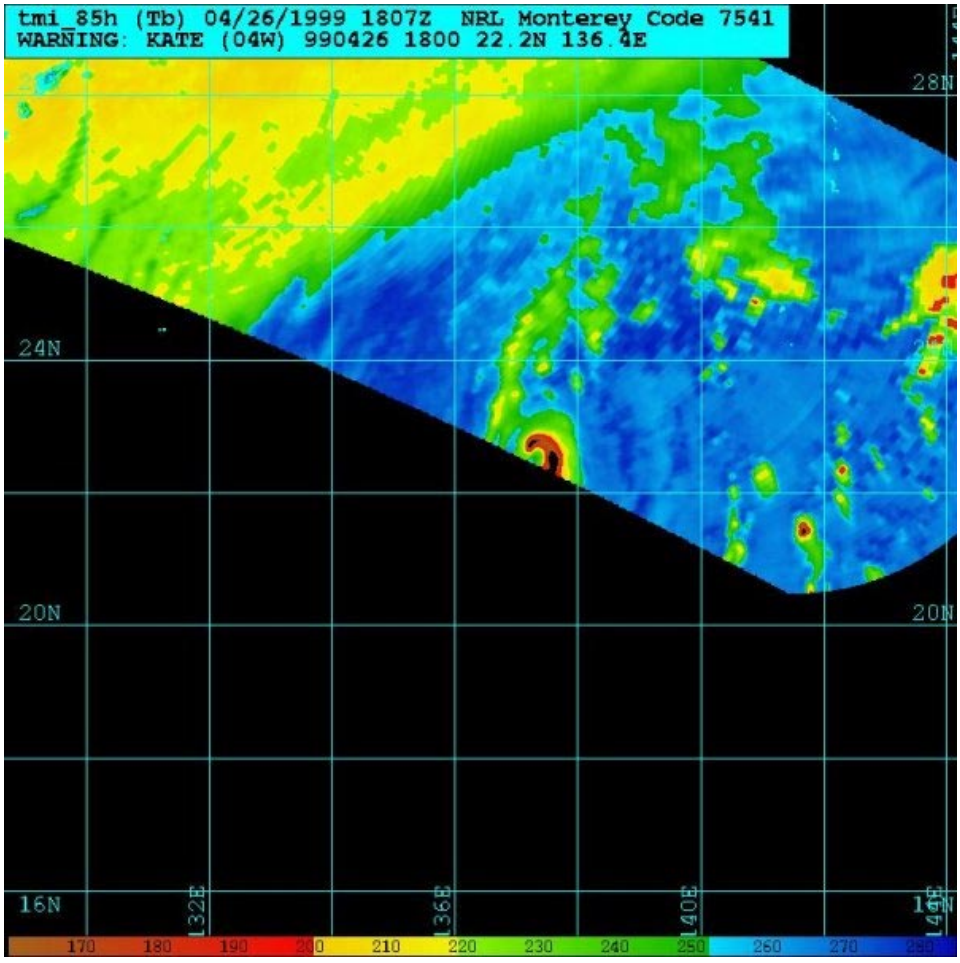


Figure 1-04-2. 261807Z April Tropical Rainfall Measurement Mission (TRMM) pass shows a very distinct spiral band and possible eyewall. TY Kate was at it's max intensity (75 kt).

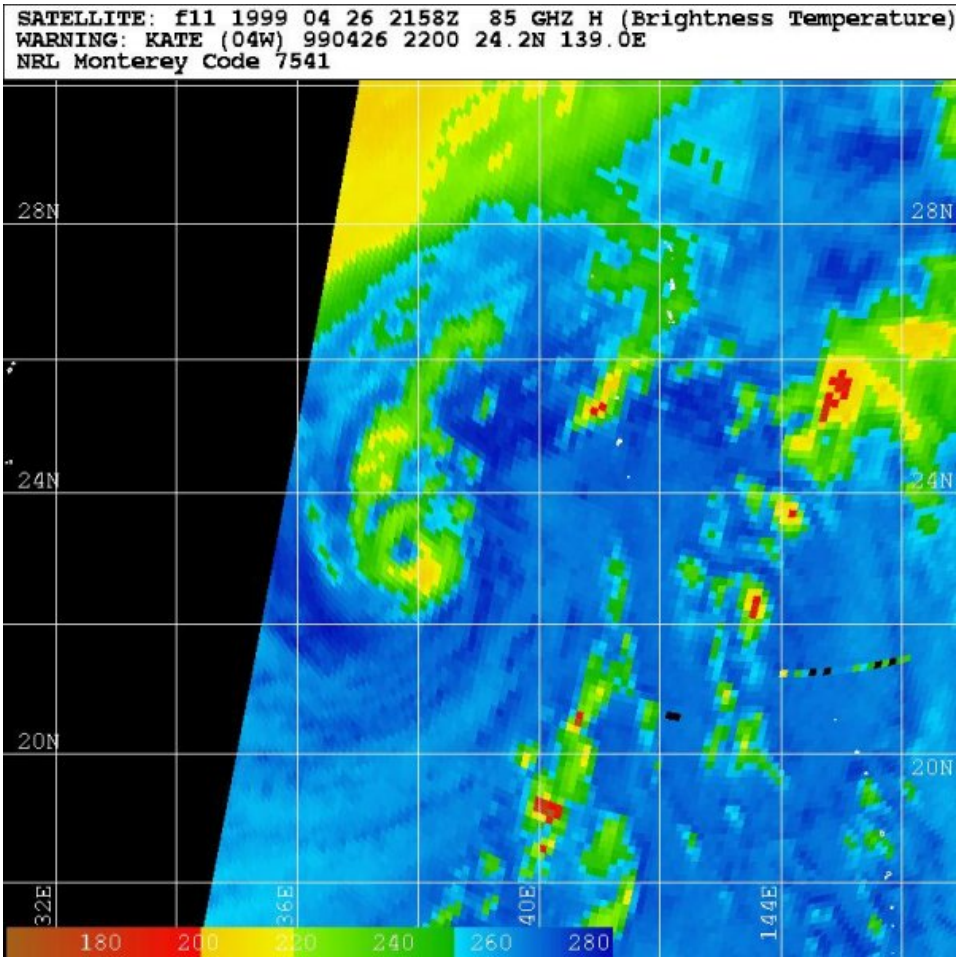


Figure 1-04-3. 262200Z April Special Sensor Microwave/Imager (SSM/I) pass reveals a distinct eye with max convection in the southeast quadrant.

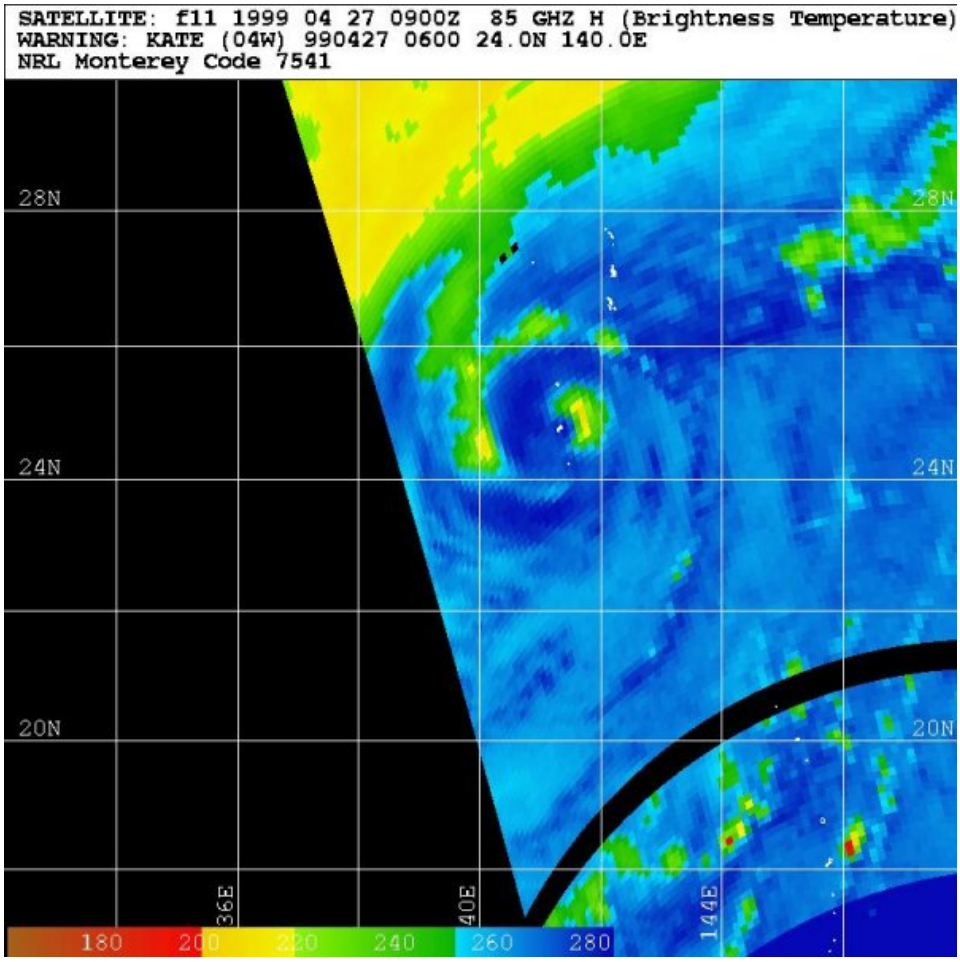


Figure 1-04-4. 270900Z April SSM/I pass shows convection now limited to the east side.

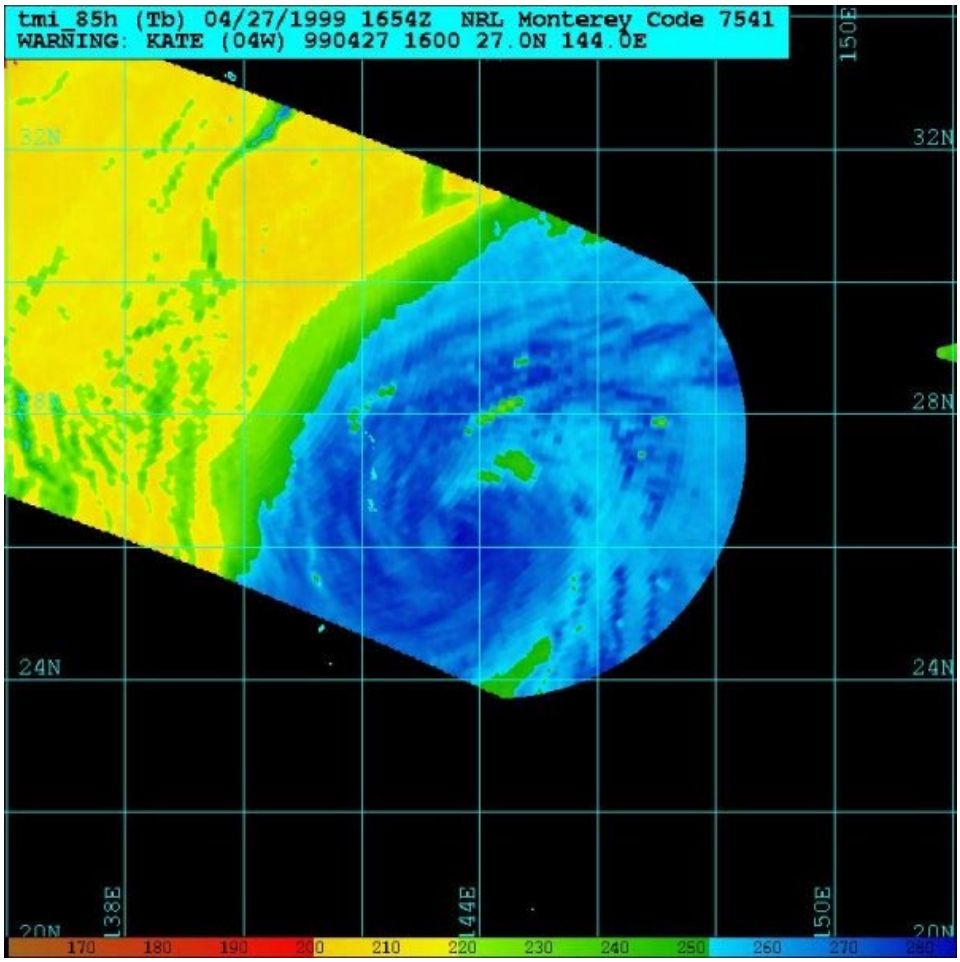


Figure 1-04-5. 271654Z April TRMM pass indicates deep convection has dissipated.

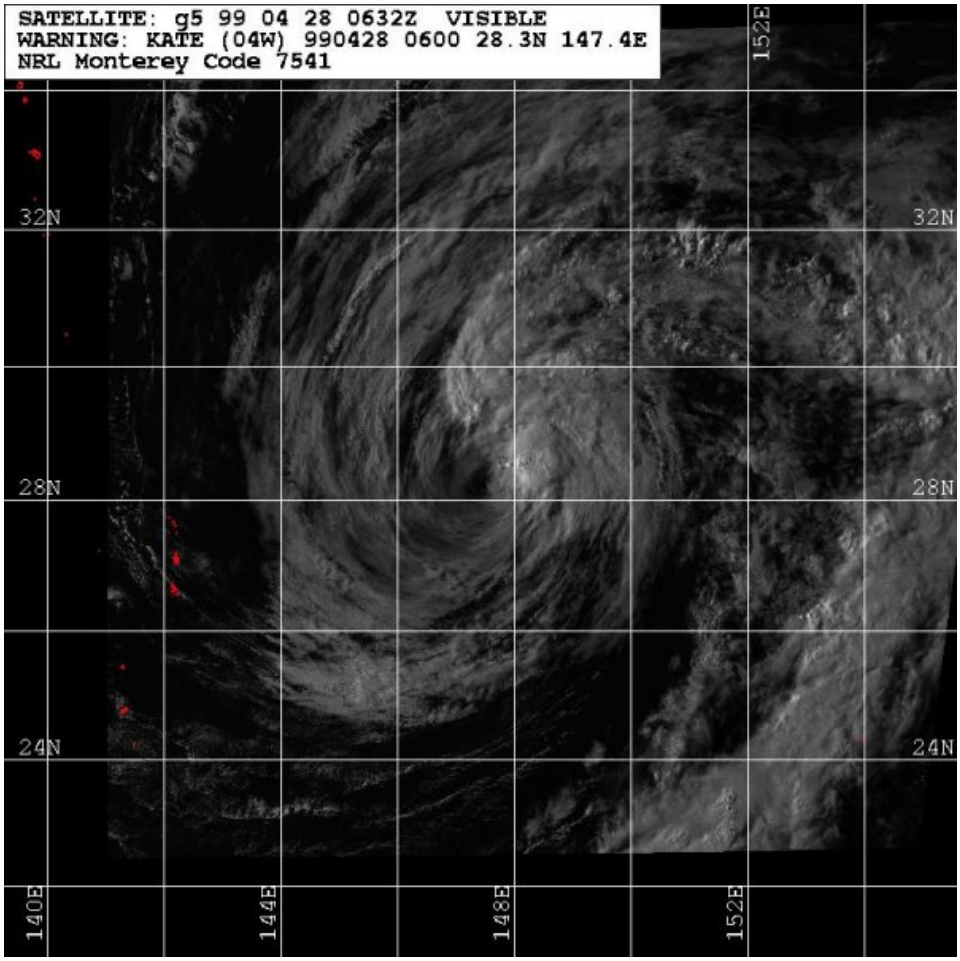


Figure 1-04-6. 280632Z April GMS-5 visible image indicates the system is elongating and transitioning to an extratropical system.

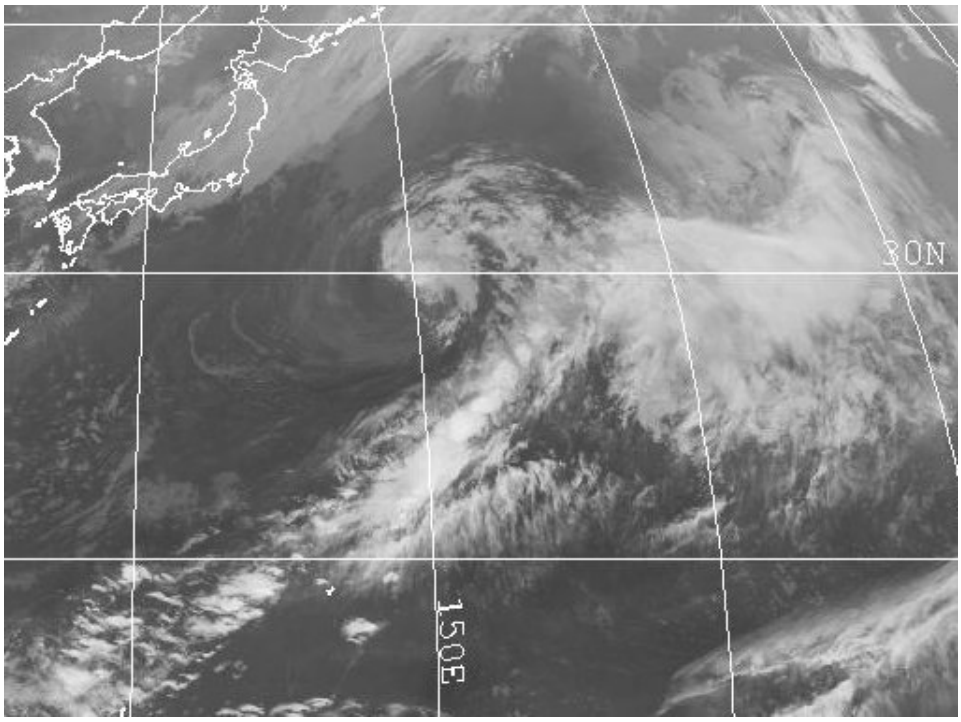
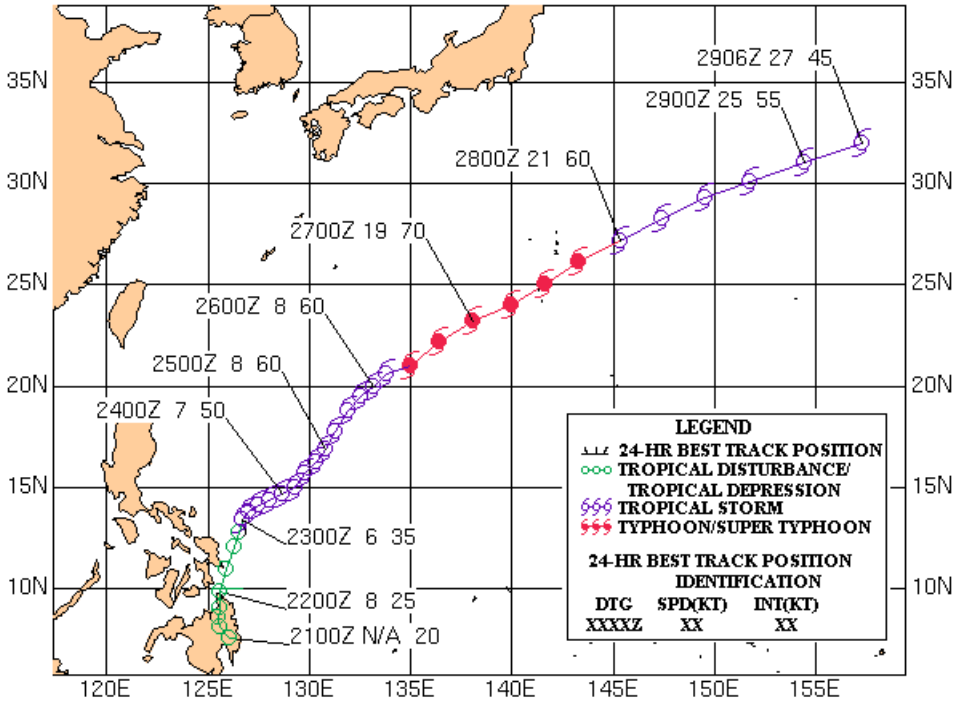


Figure 1-04-7. 281130Z April GMS-5 infrared image as TS Kate transitions to an extratropical system.


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.

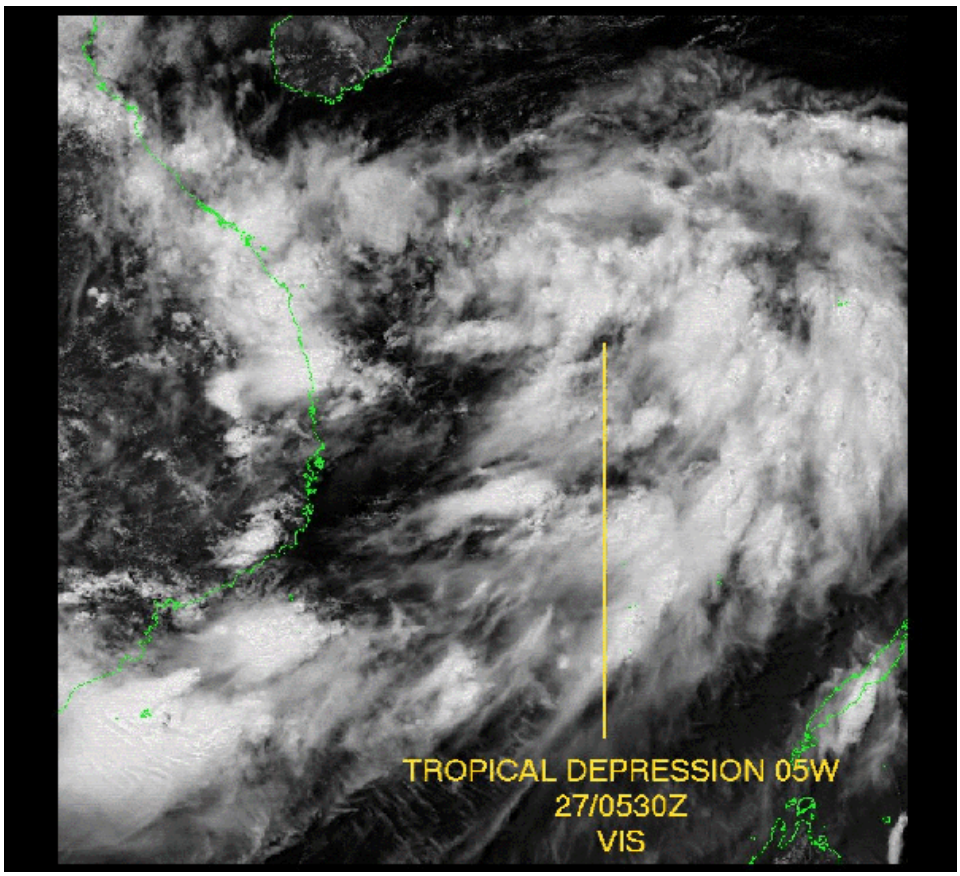


Figure 1-05-1. A visual image of TD 05W (25kt) at 270530Z April, off the east coast of Vietnam.

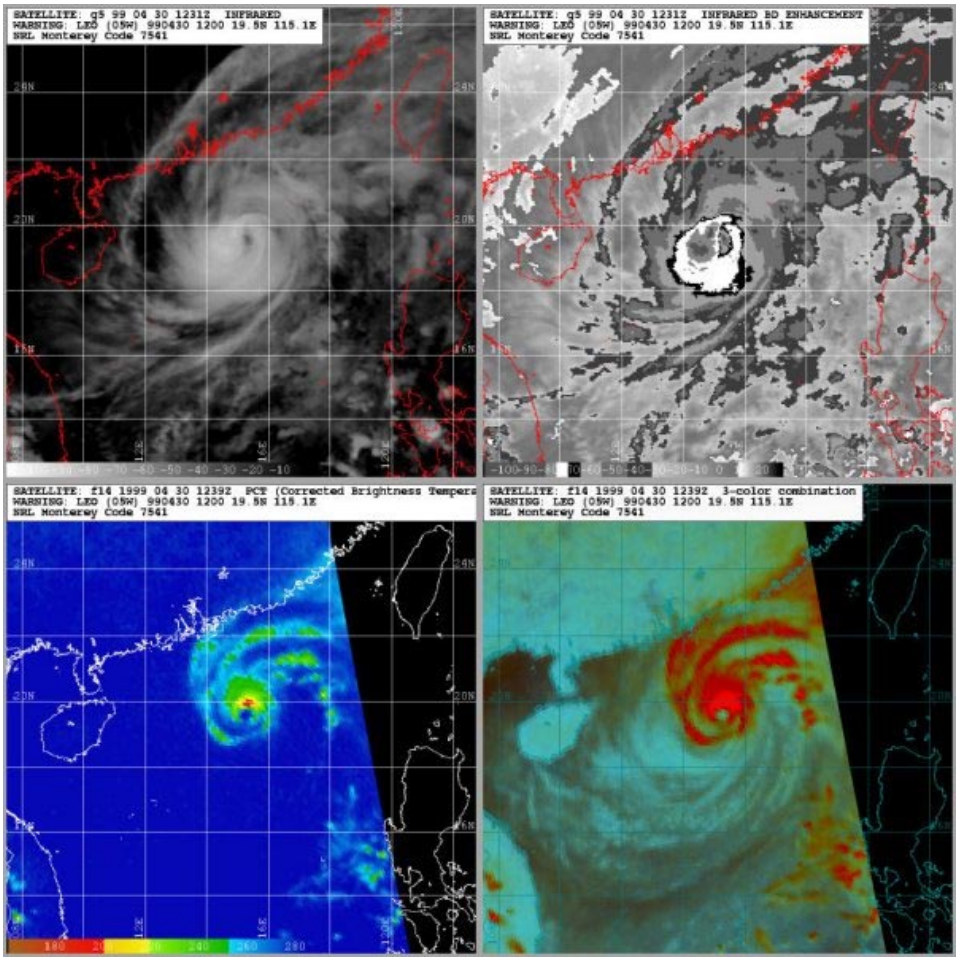
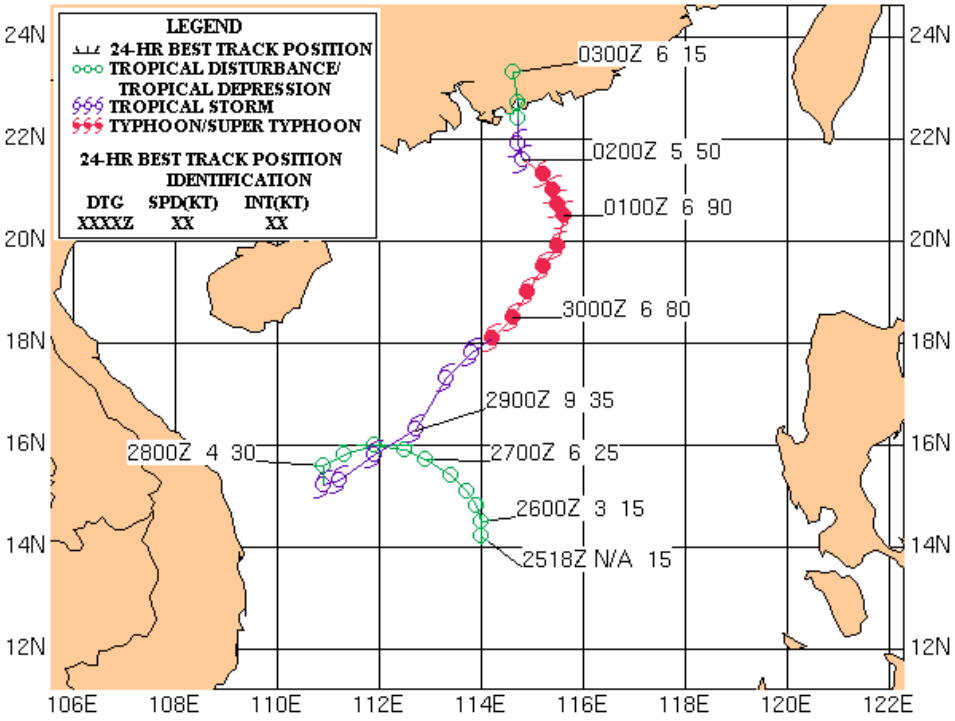


Figure 1-05-2. A 301239Z April multi-image mosaic from NRL including infrared imagery (top left and right) and Special Sensor Microwave Imagery (SSM/I) of Typhoon Leo (05W) at 105 kt intensity, 140 nm south of Hong Kong. TY Leo (05W) peaked six hours later at 110 kt.


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.

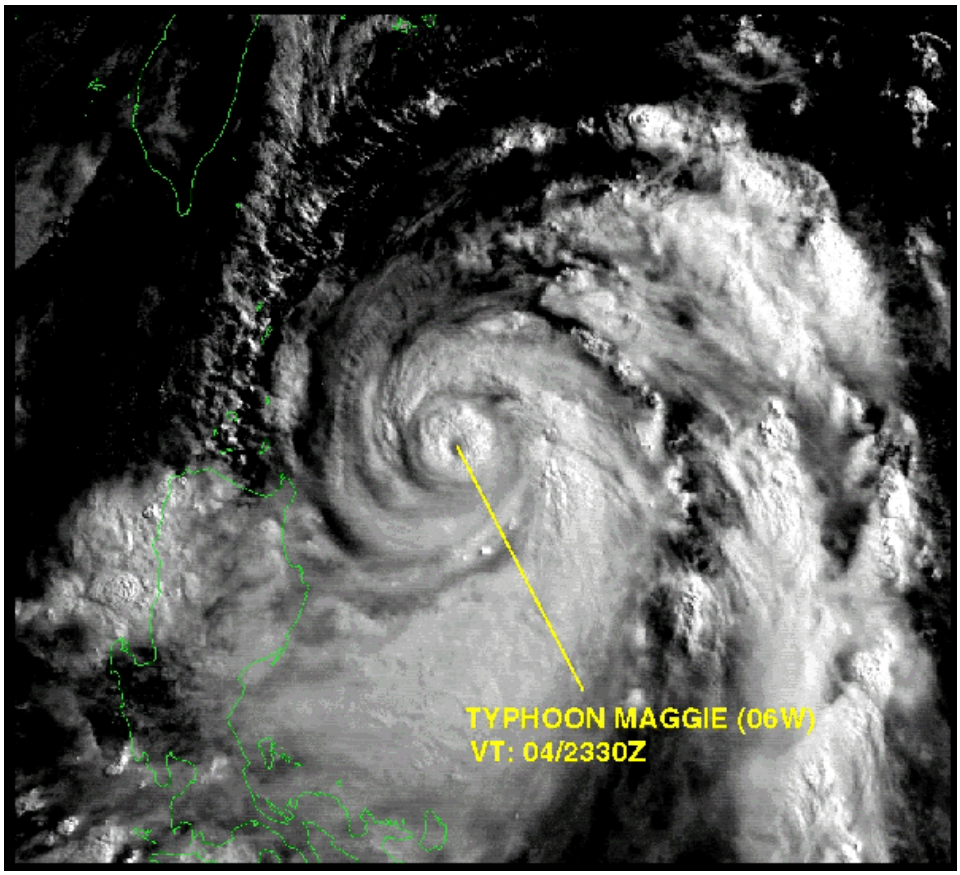


Figure 1-06-1. 042330Z June GMS-5 visible imagery of Typhoon Maggie (06W) prior to achieving its peak intensity (105 kt) northeast of Luzon; note the strong southeasterly cross-equatorial inflow.

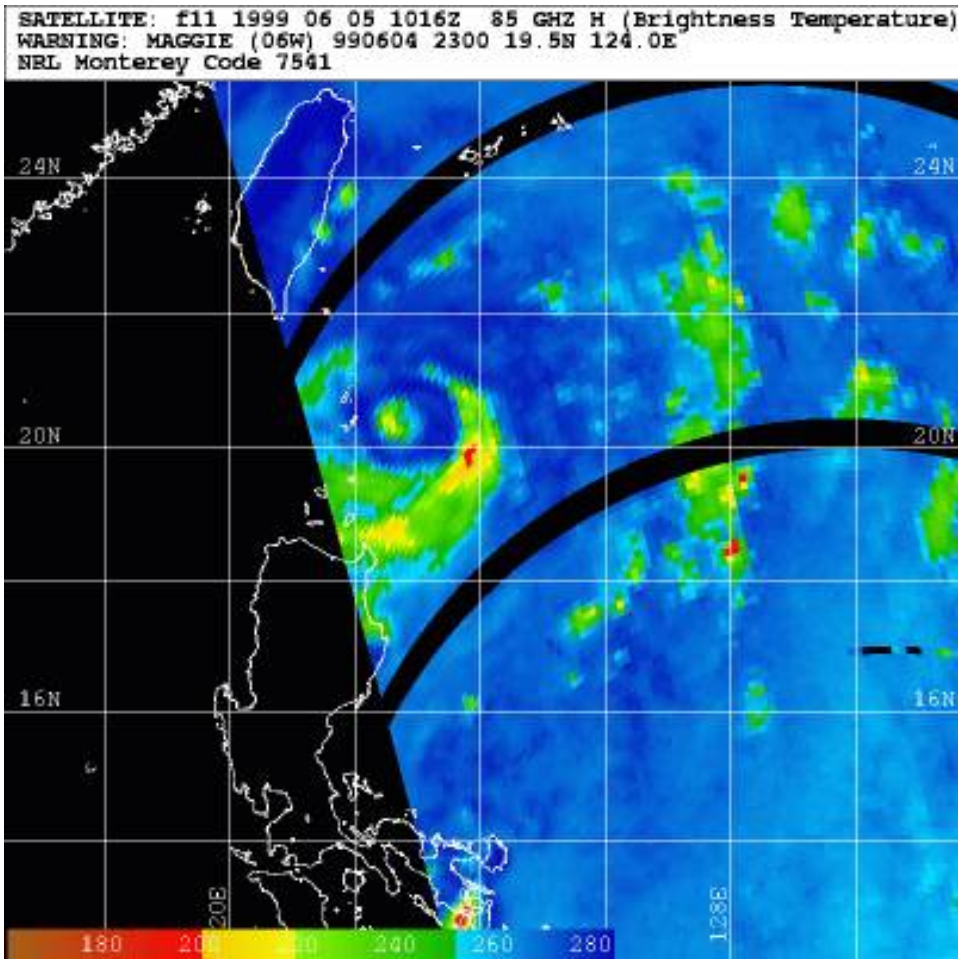
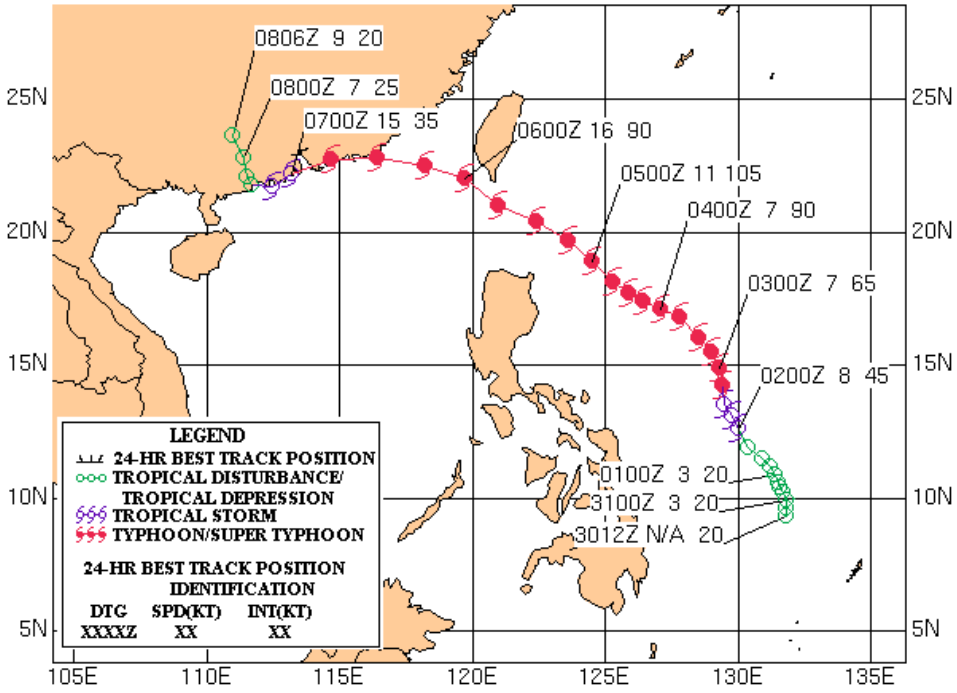


Figure 1-06-2. The convective structure of Typhoon Maggie (06W) is revealed in this 85Ghz Special Sensor Microwave/Imagery pass near its peak intensity (105 kts) on 051016Z June.


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.

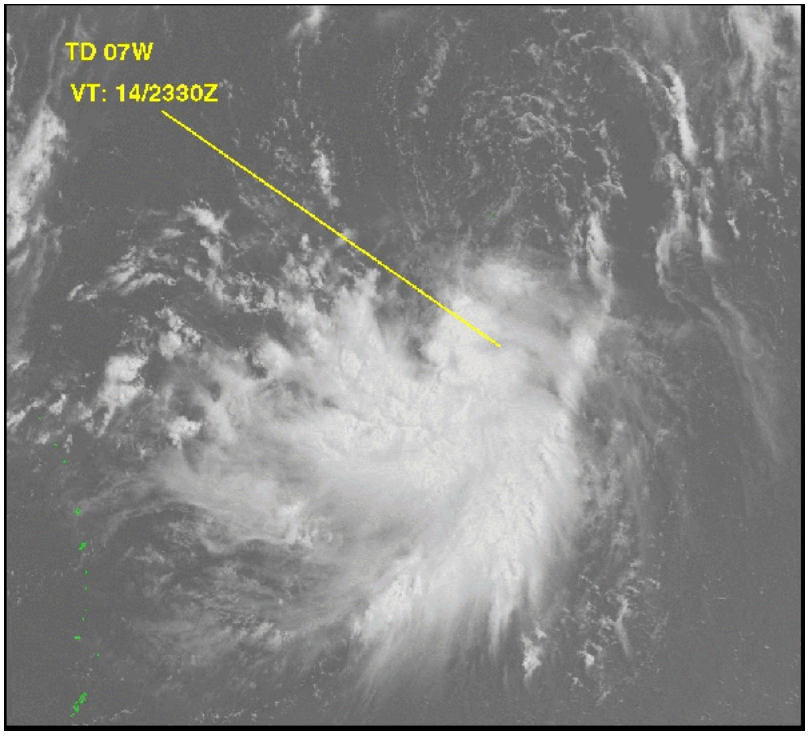


Figure 1-07-1. 142330Z July visible satellite image of TD 07W as it reached warning criteria of 25 kt.

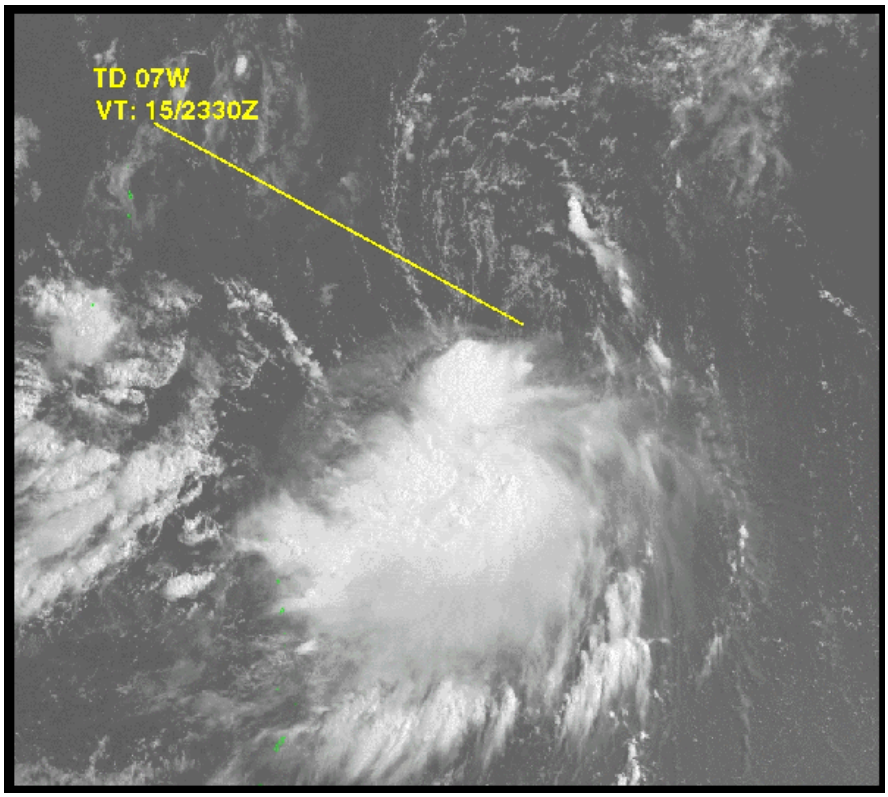
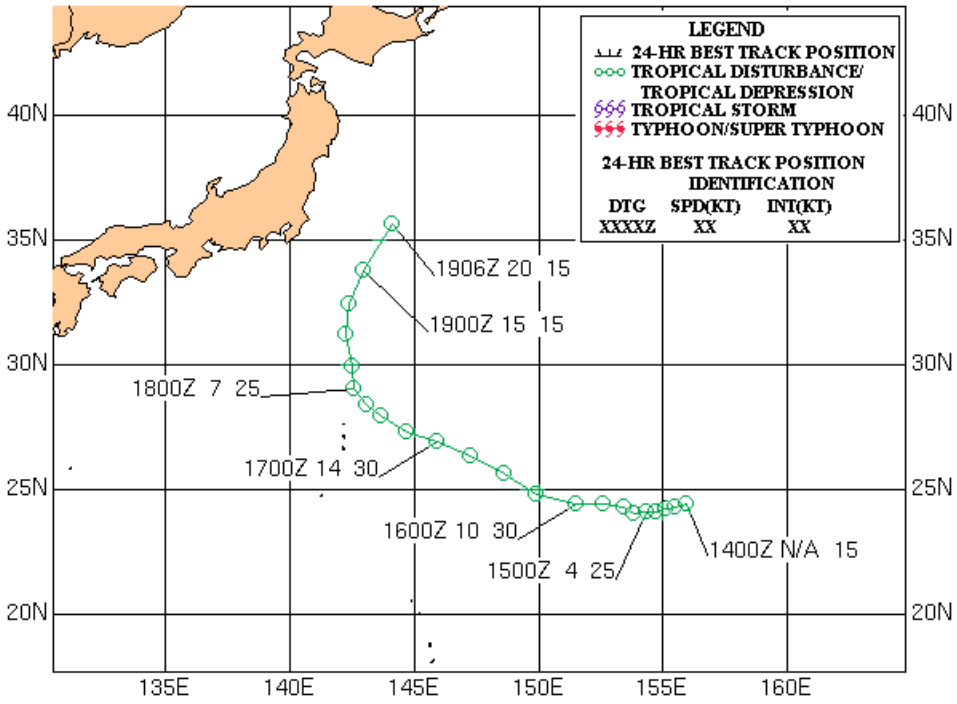


Figure 1-07-2. 152330Z July visible satellite image of TD 07W after vertical wind shear fully exposed the low-level circulation center. Current intensity was 25 kt.


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.

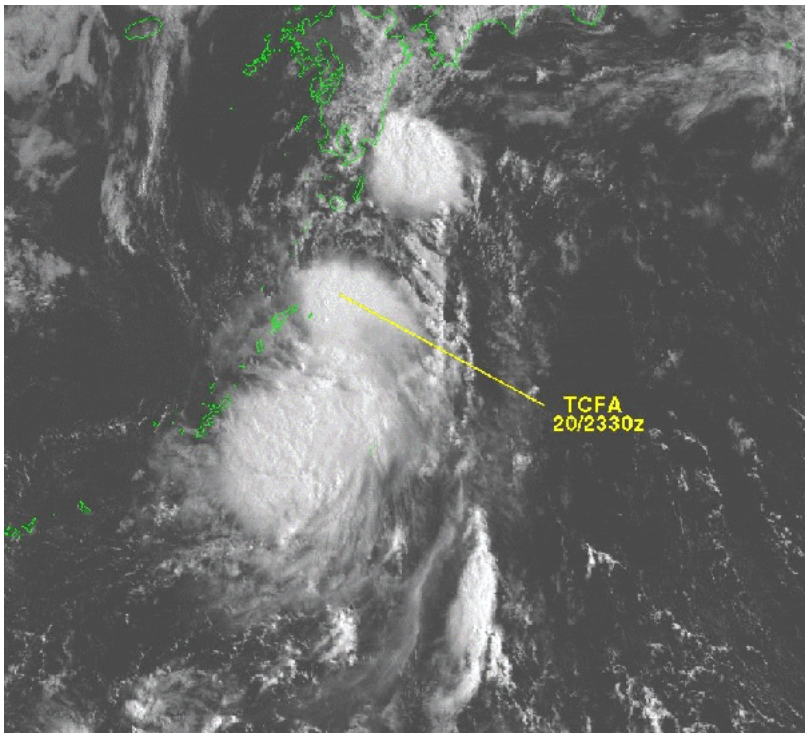


Figure 1-08-1. 202330Z July visible satellite image of the tropical disturbance that would become TD 08W.

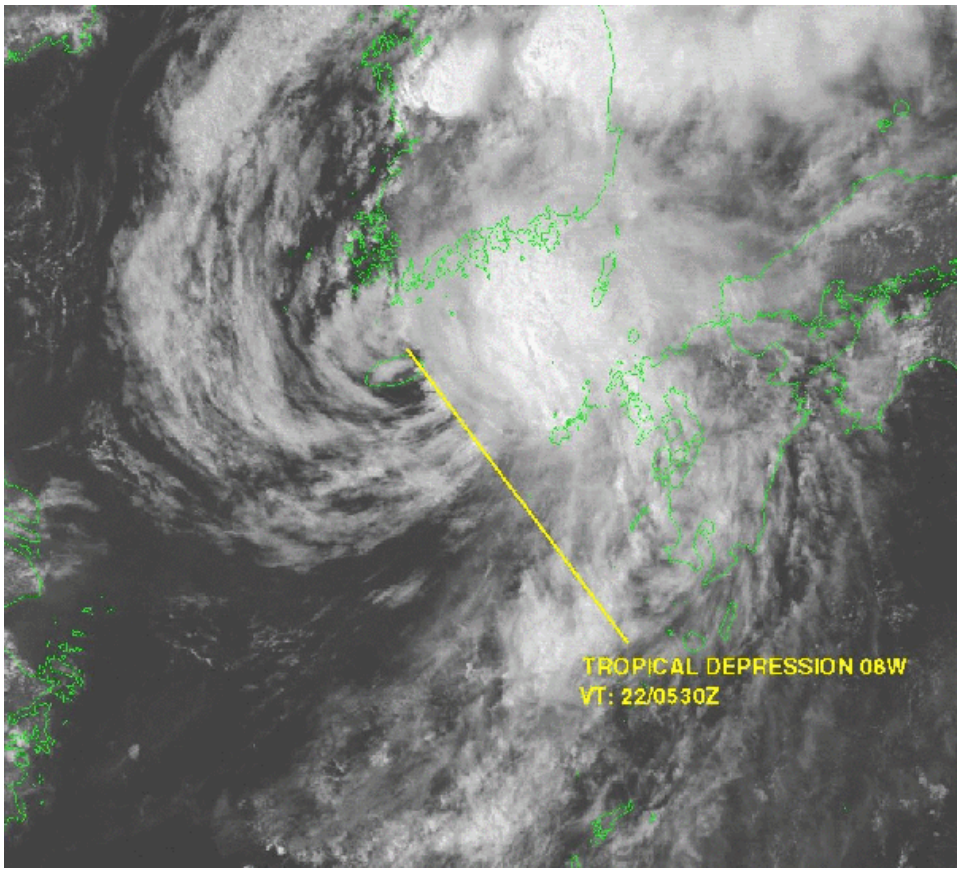
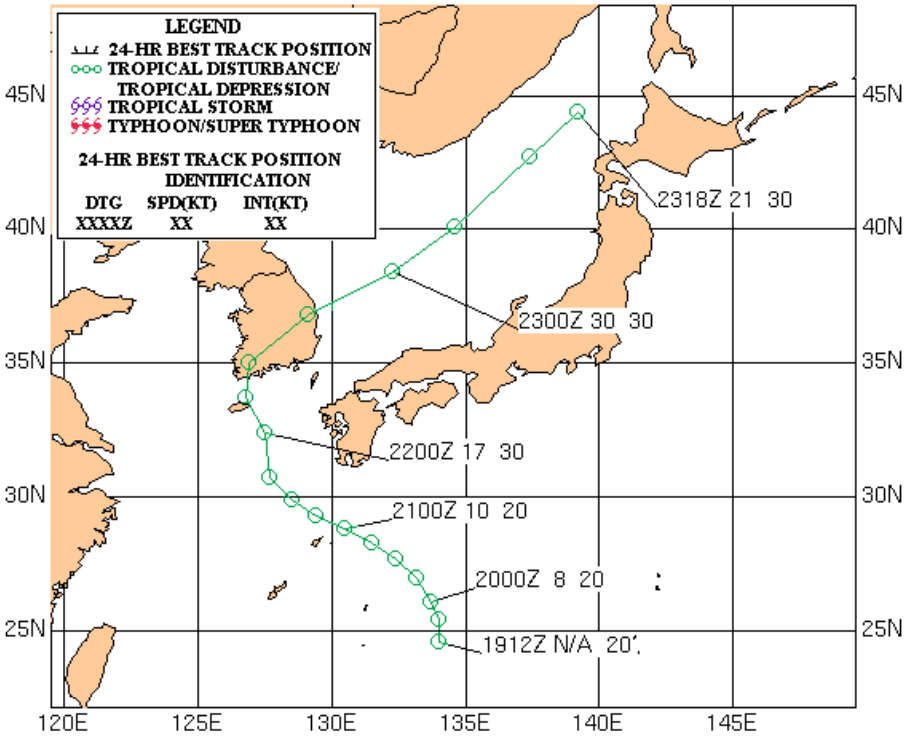


Figure 1-08-2. 220530Z July visible satellite image of TD 08W about 3 hours before making landfall near Changhung, South Korea. The image shows a partially exposed low-level circulation center with the deep convection sheared towards the east.


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
45N
40N
35N
30N
25N
120E
125E
130E
135E
140E
145E
2318Z 21 30
2300Z 30 30
2200Z 17 30
2100Z 10 20
2000Z 8 20
1912Z N/A 20'

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.

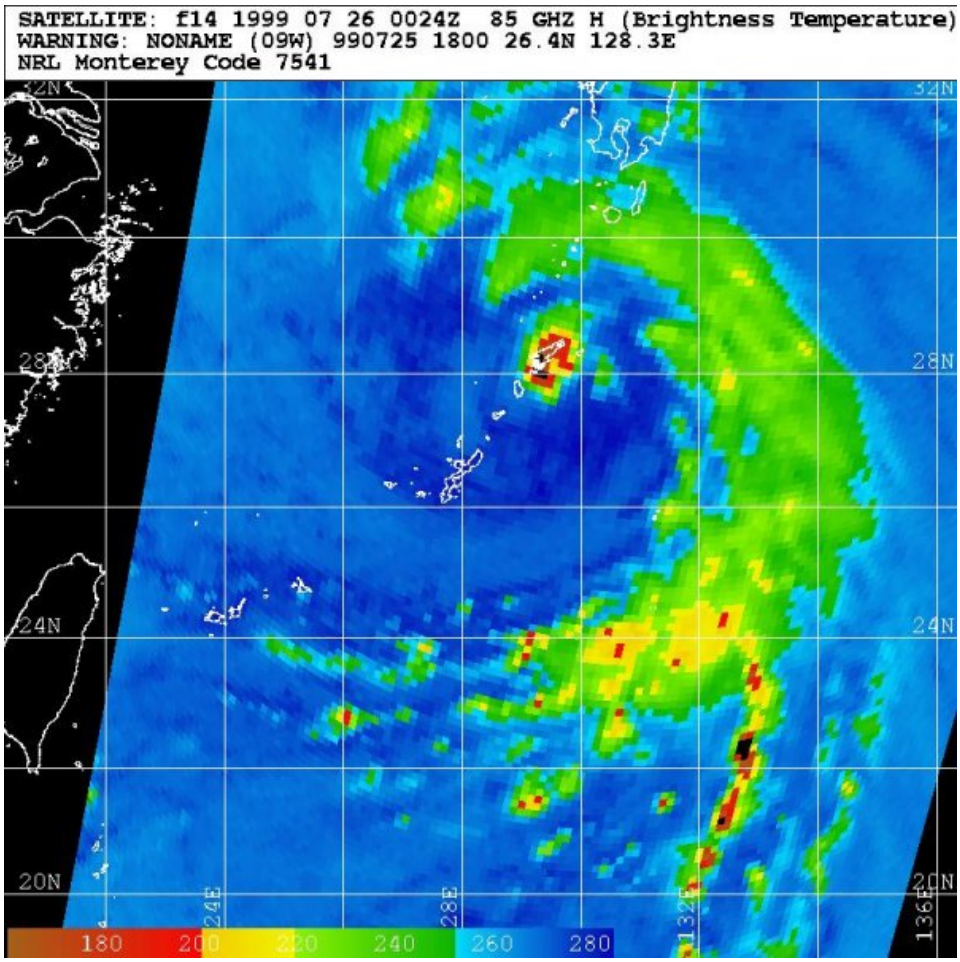


Figure 1-09-1. 260024Z July Special Sensor Microwave Imager (SSM/I) pass of TS Neil (09W). The center was located just west of Amamami O Shima, Japan. TS Neil was at 35 kt intensity and peaked at 40 kt six hours later.

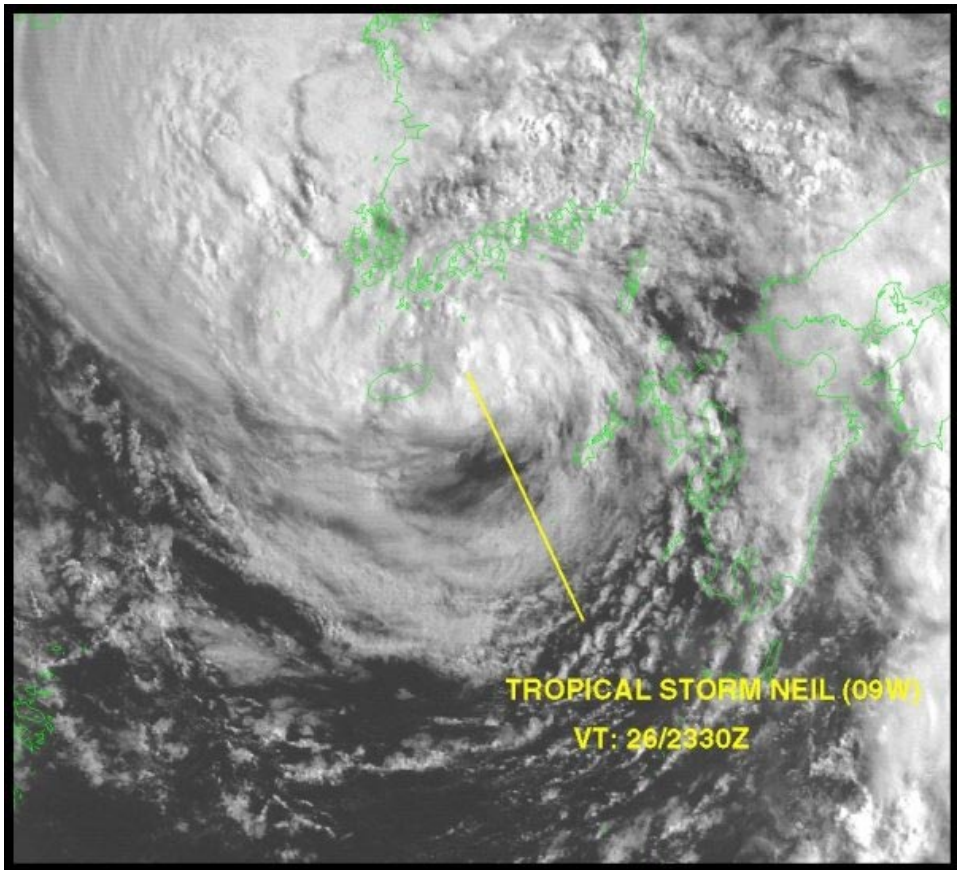


Figure 1-09-2. 262330ZZ July GMS-5 visible imagery of TS Neil (09W) as a 35 kt storm just east of Cheju Island, ROK. TS Neil made landfall six hours later 20 nm southwest of Sancheon, ROK.

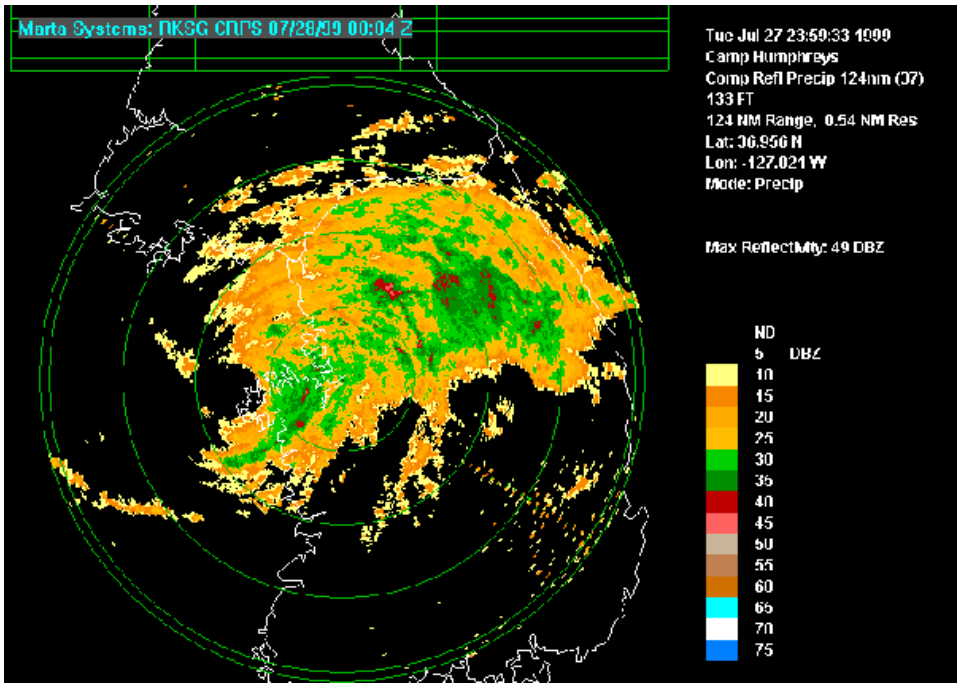
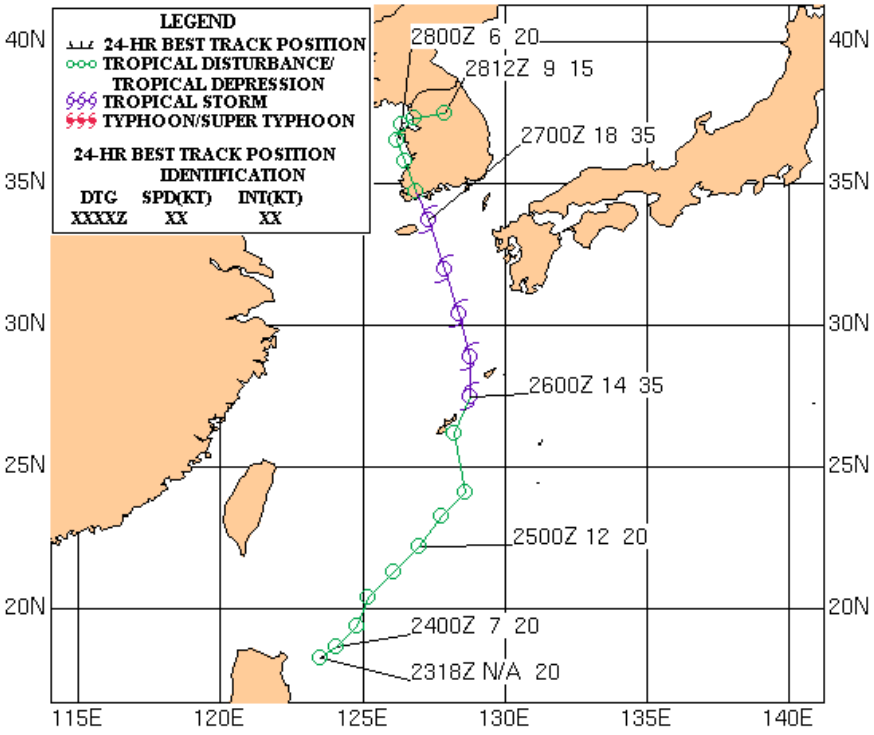


Figure 1-09-3. 272359Z July Camp Humphreys WSR-88D reflectivity image of TS Neil. TS Neil was downgraded to a 20 kt system shortly hereafter. The remnants of TS Neil made landfall 20 nm southwest of Seoul, ROK six hours later (280600Z).


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

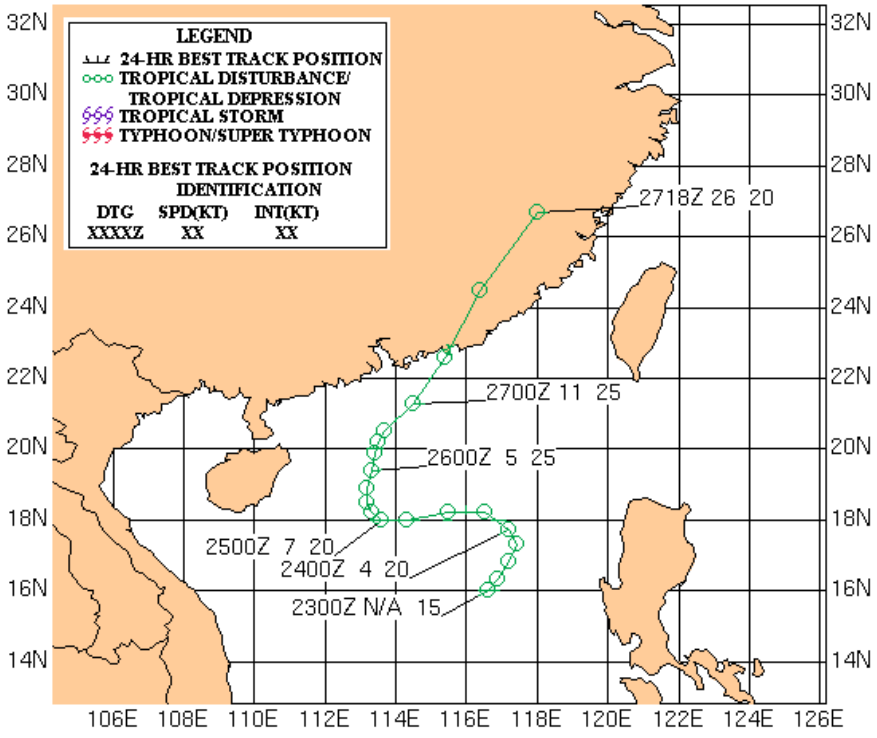
Tropical Depression 10W

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.



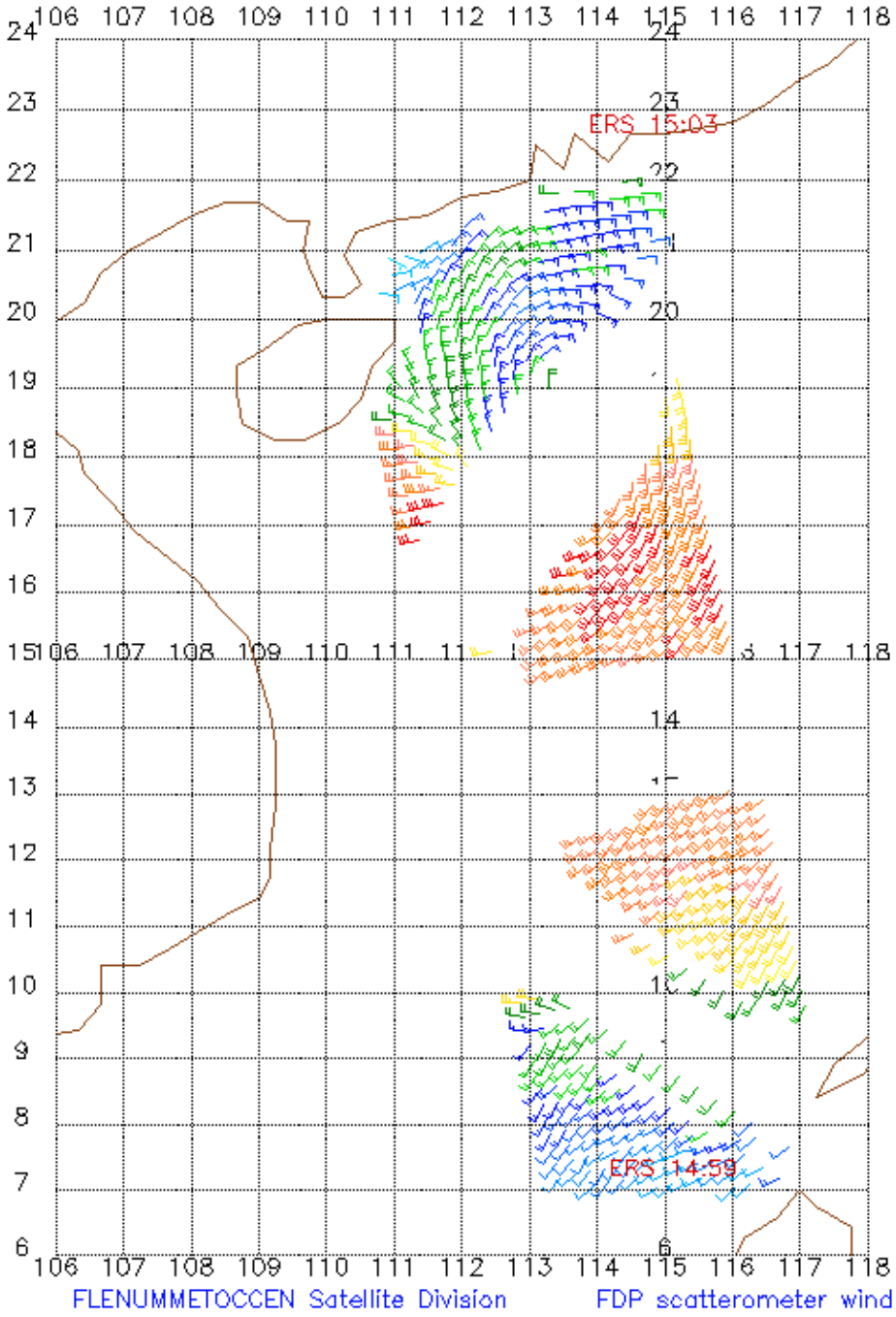


Figure 1-10-1. 251503Z July ERS-2 scatterometer pass. This pass indicated winds were greater than Dvorak analysis yielded. Hence, post analysis increased winds of the best track.

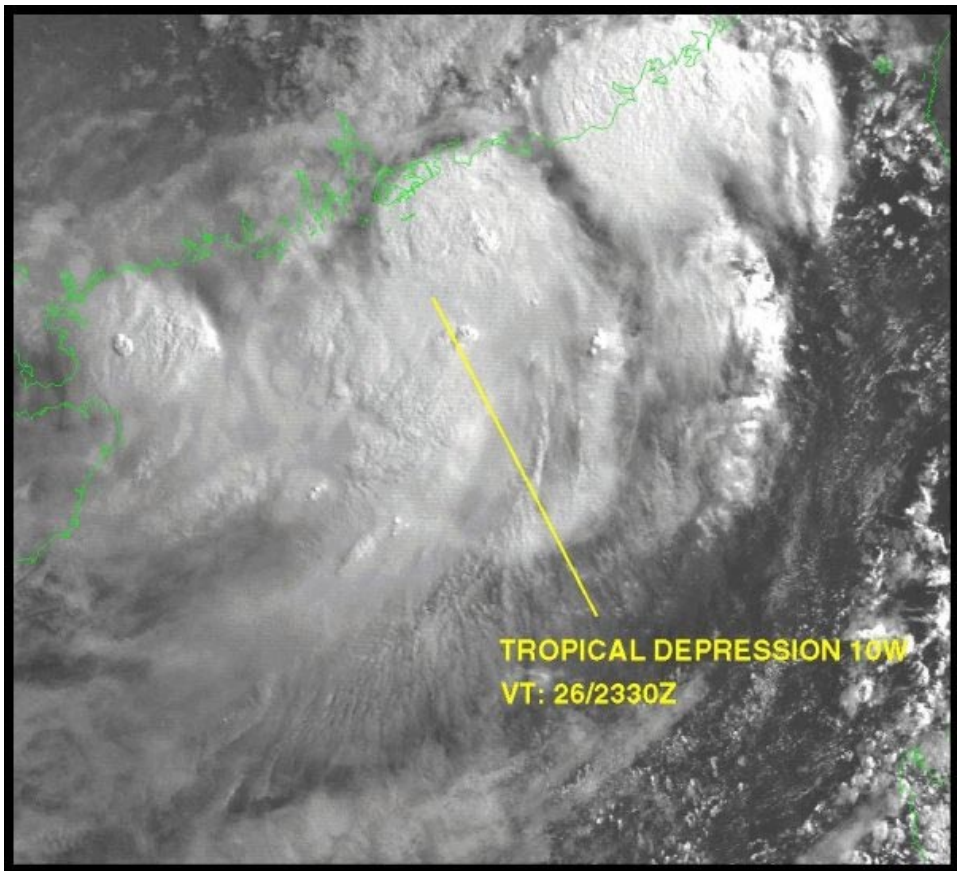


Figure 1-10-2. 262330Z July GMS-5 visible image. TD 10W was a 25 kt TD as it approached the Chinese coast. TD 10W made landfall about seven hours later.

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.

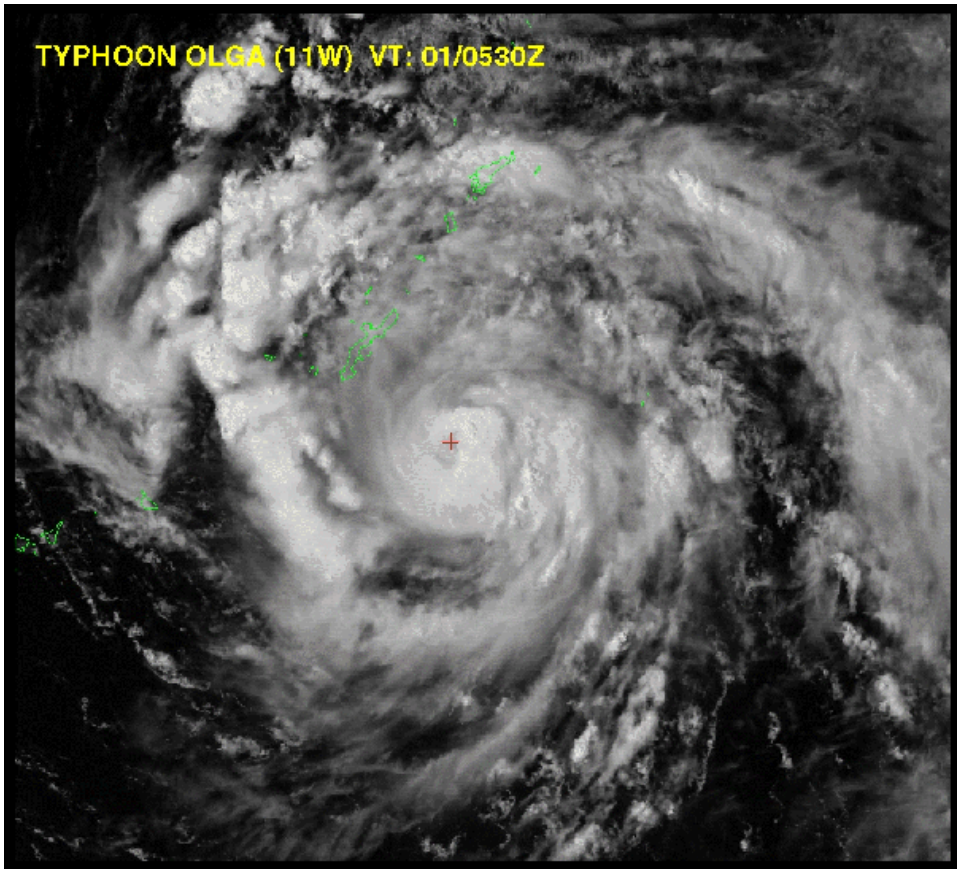


Figure 1-11-1. 010530Z August GMS-5 visible image of TY Olga (11W) approaching Okinawa, Japan. TY Olga (11W) was at 75 kt and beginning to show signs of weakening. As it moved over Okinawa, it was at minimum TY intensity (65 kt).

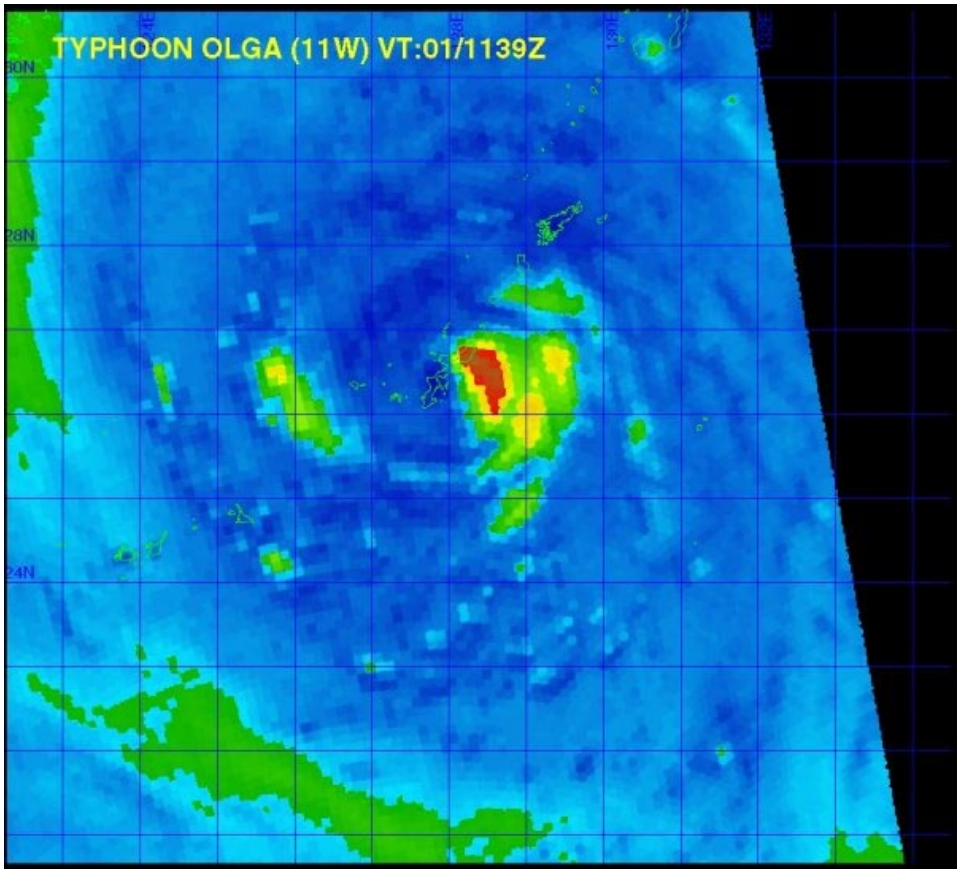


Figure 1-11-2. 011139ZZ August SSM/I pass of TY Olga (11W) as it moved over Okinawa, Japan. TY Olga (11W) was at 65 kt with deep convection limited to the northeastern quadrant.

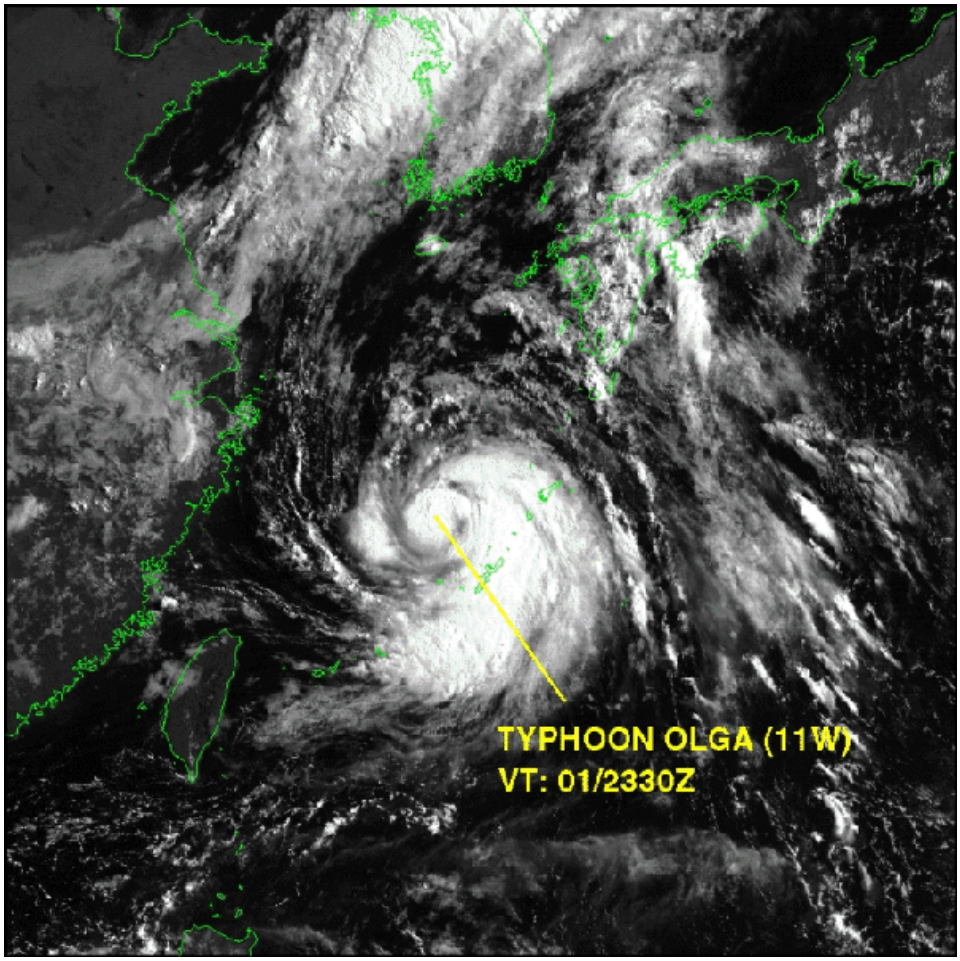


Figure 1-11-3. 012230Z August GMS-5 visible image of TY Olga (11W) northwest of Okinawa, Japan. TY Olga (11W) was at 75 kt with a strong spiral band on the eastern half. This band actually brought stronger wind gusts and heavier rains to the southern Japanese islands than the actual passage of the typhoon.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

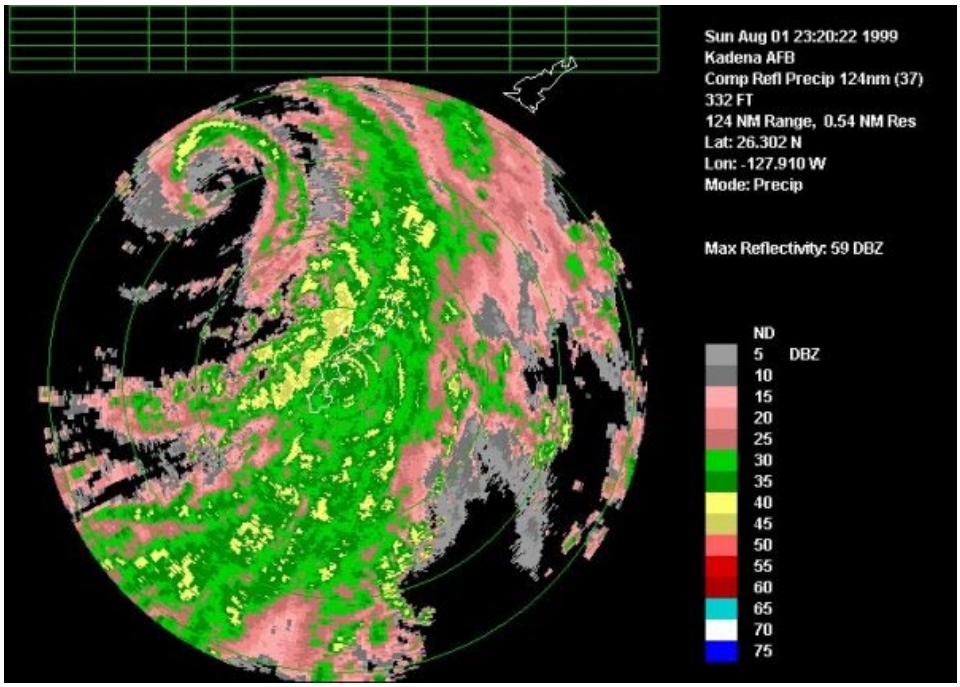


Figure 1-11-4. 012320Z August WSRD-88 NEXRAD radar image from Kadena AB, Japan. Image shows the band now moving offshore of Okinawa and a well-defined TY Olga (11W) to the northwest. TY Olga (11W) was at 70 kt intensity and continuing to intensify.

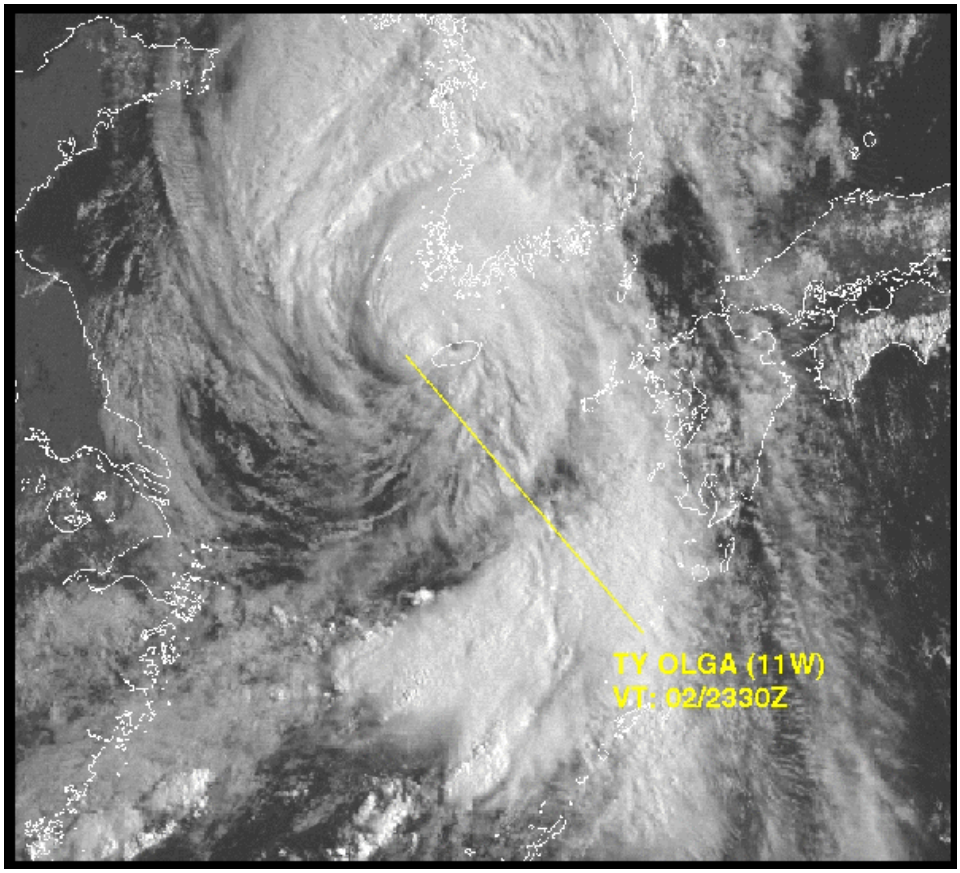
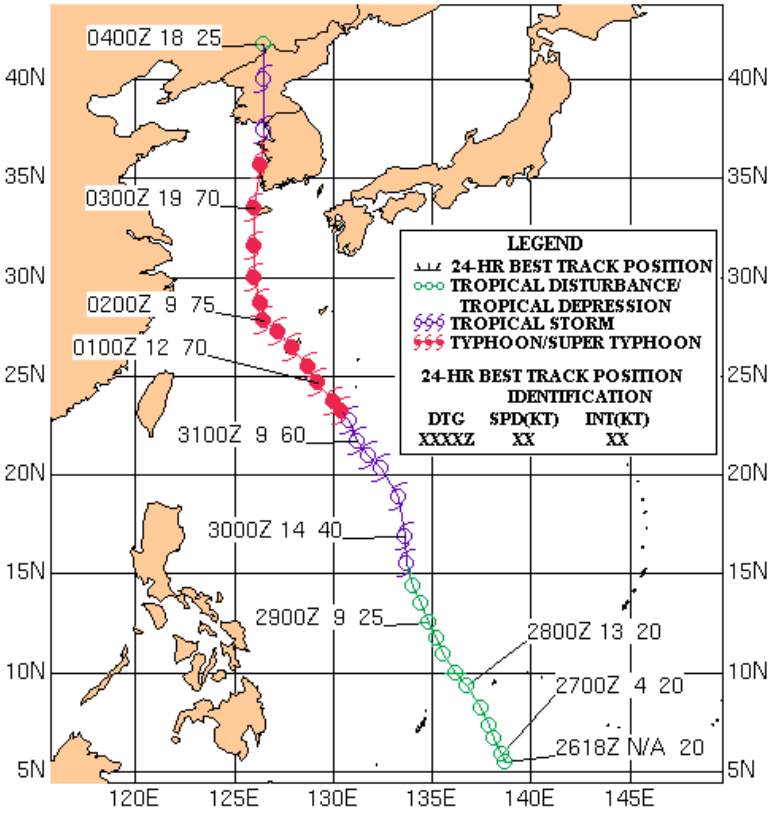


Figure 1-11-5. 022330Z August GMS-5 visible image of TY Olga (11W) just northwest of Cheju Island, ROK. TY Olga (11W) was at 75 kt intensity.


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 southeast, 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.

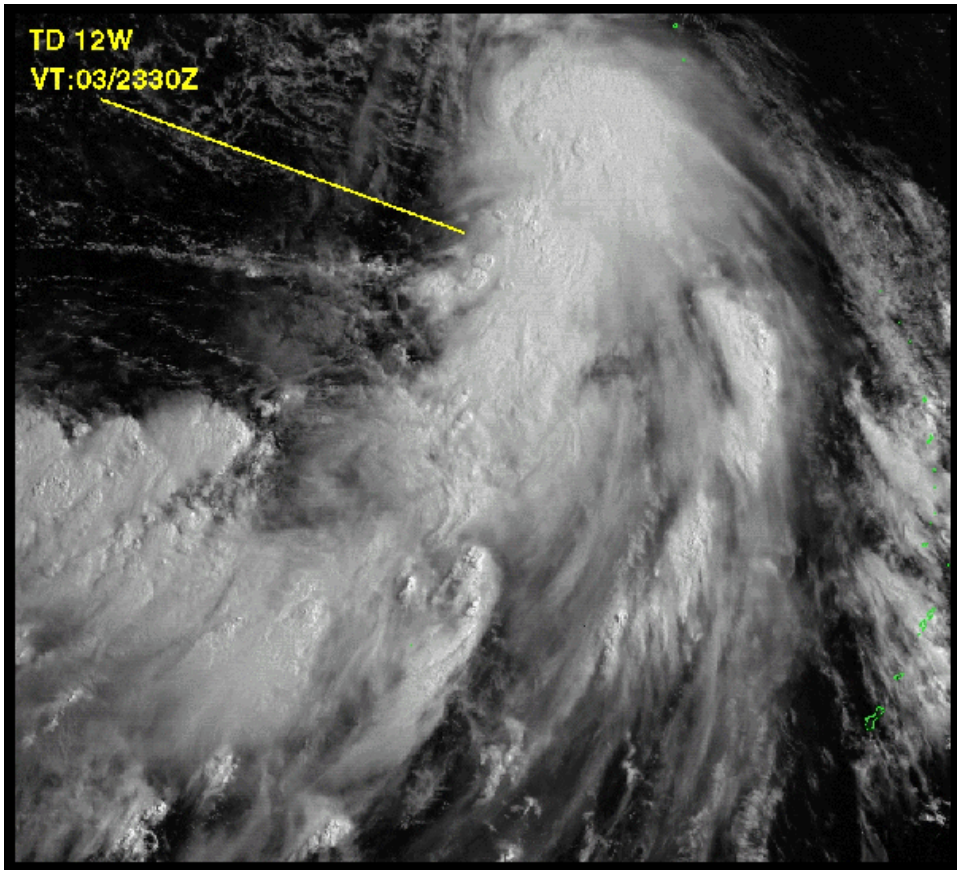


Figure 1-12-1. A visible satellite image showing TD 12W embedded within the southeast quadrant of a monsoon gyre centered southeast of Okinawa.

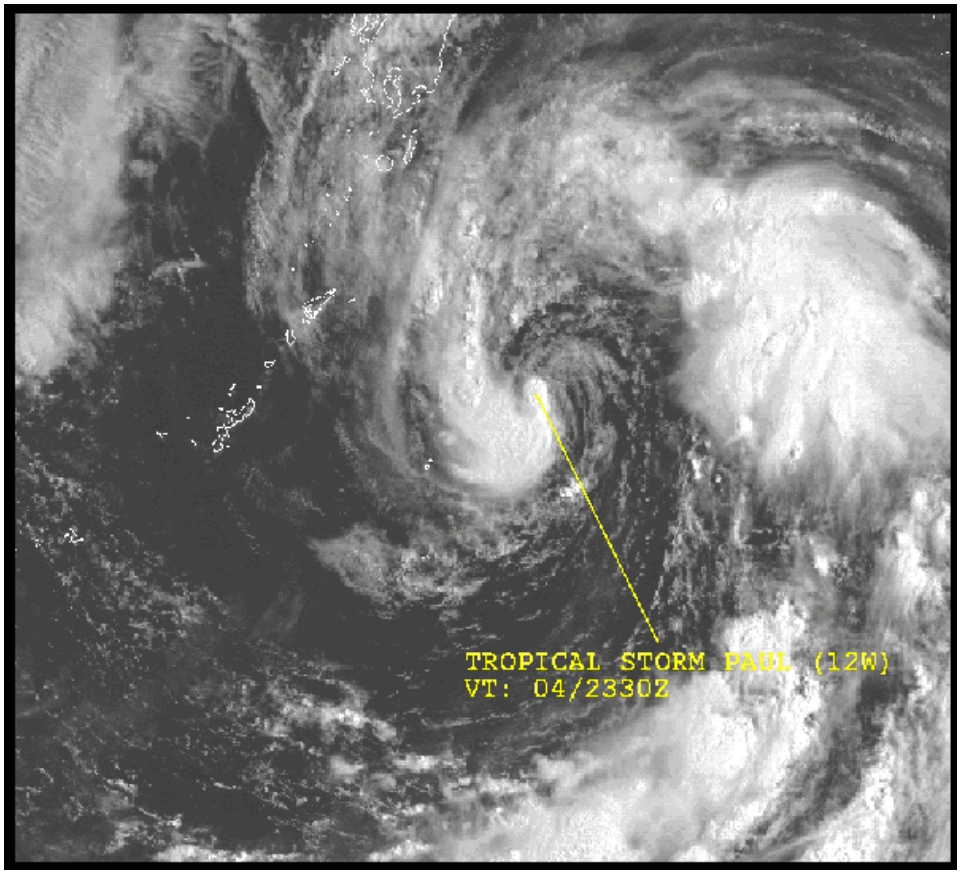


Figure 1-12-2. A visible satellite image of TS Paul (12W) just after it merged with the monsoon gyre east of Okinawa.

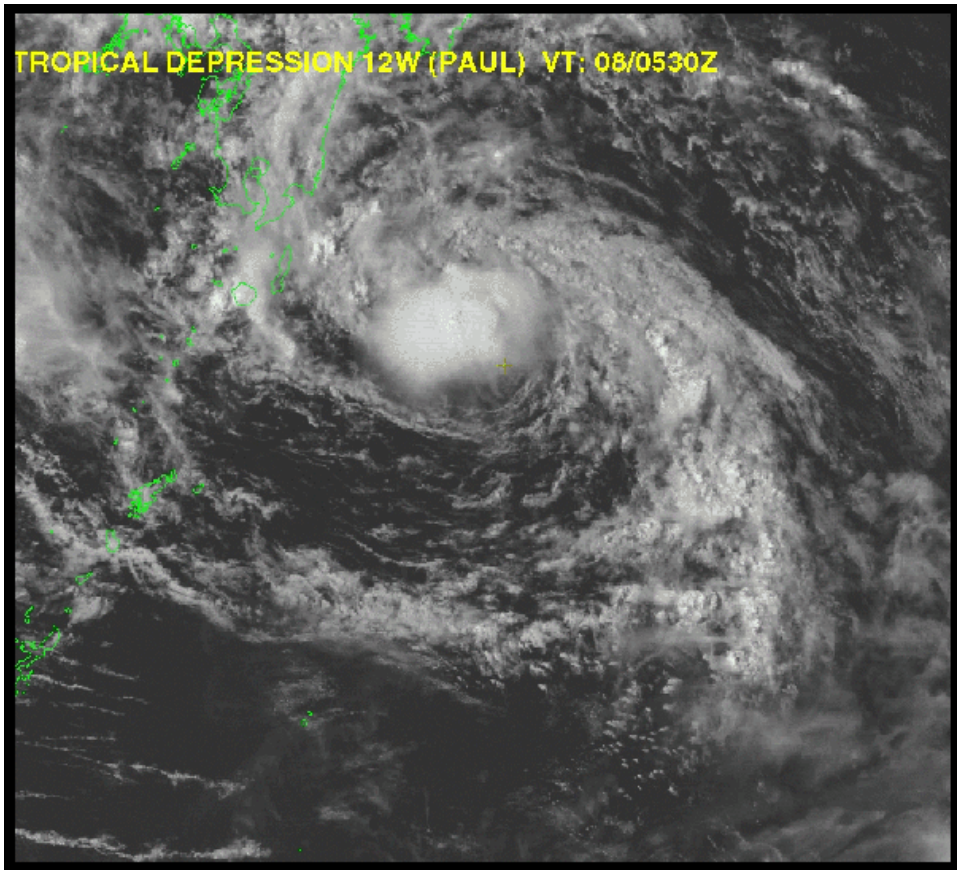
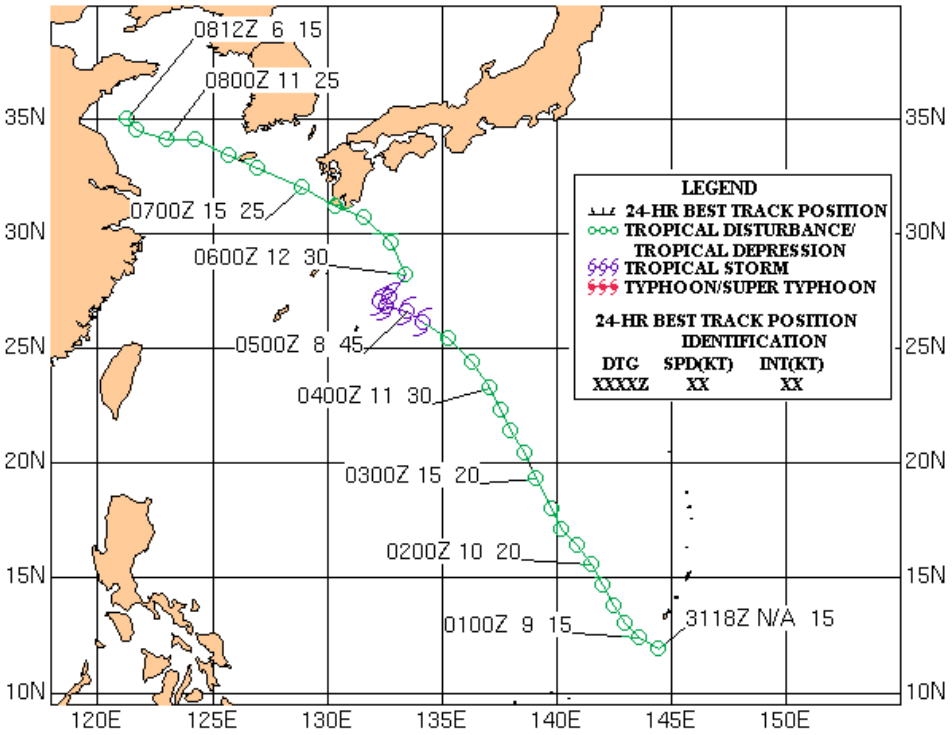


Figure 1-12-3. A visible satellite image of TD 12W (Paul) six hours after it merged with the monsoon gyre. The monsoon gyre itself collapsed around TD 12W (Paul) and together they became a large depression which moved off to the northwest.

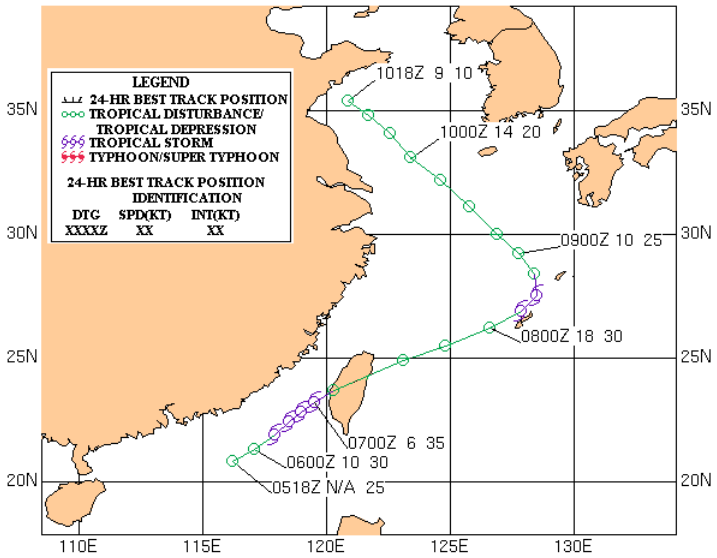

0812Z 6 15
0800Z 11 25
0700Z 15 25
0600Z 12 30
0500Z 8 45
0400Z 11 30
0300Z 15 20
0200Z 10 20
0100Z 9 15
3118Z N/A 15
35N
30N
25N
20N
15N
10N
120E
125E
130E
135E
140E
145E
150E
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/ TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK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

Tropical Storm 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.



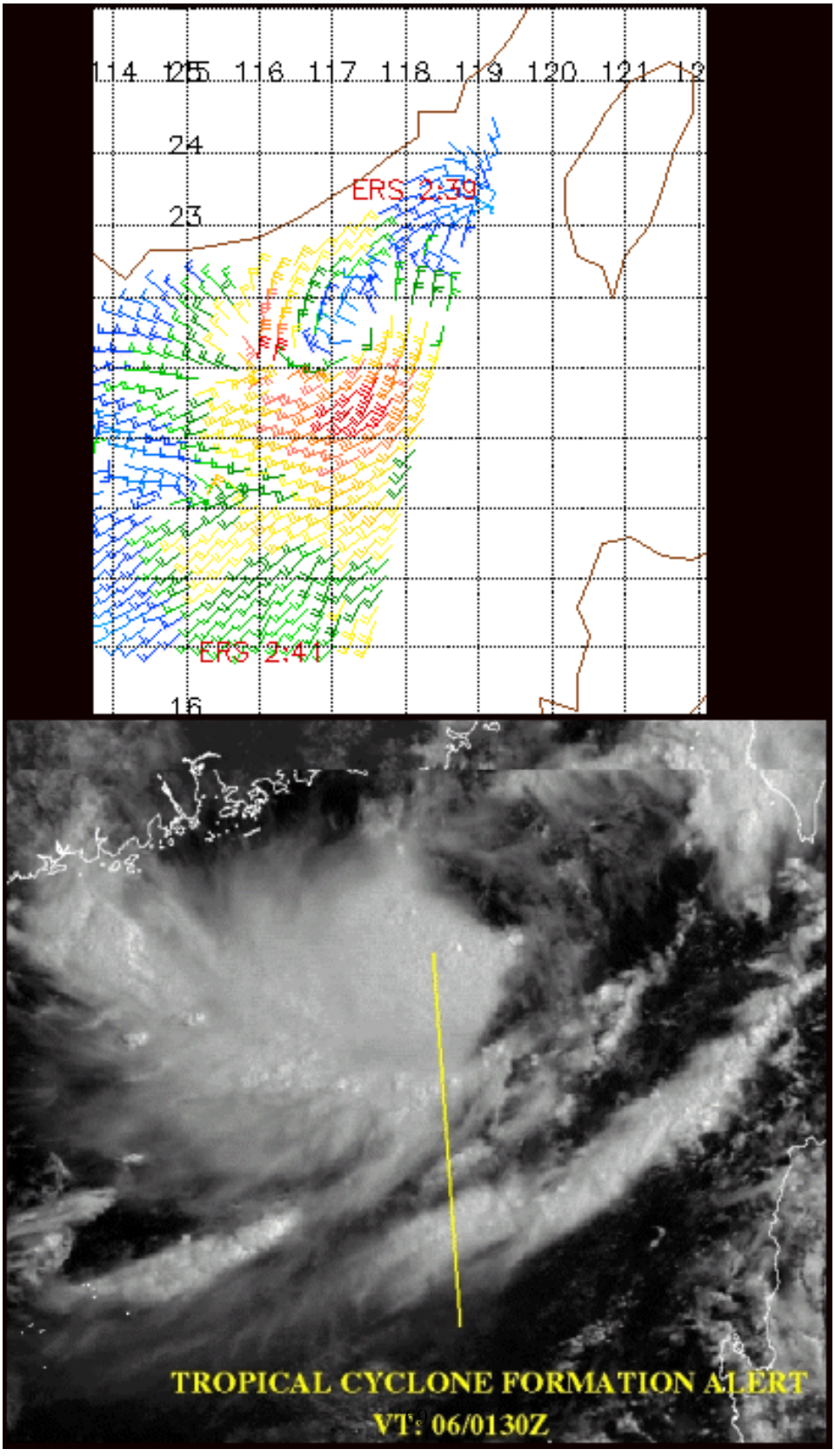
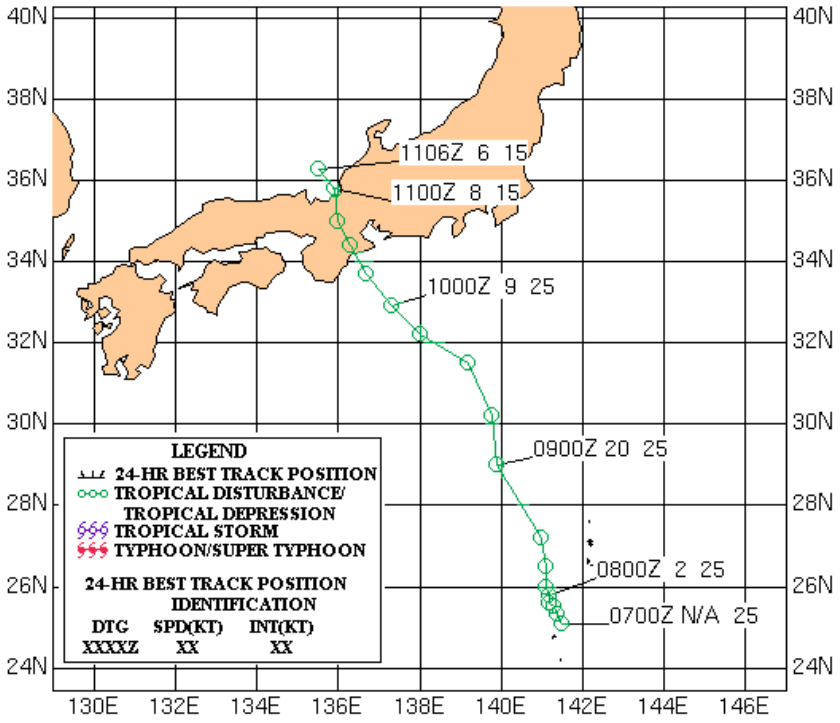


Figure 1-13-1. 060240Z August scatterometry pass, and 060130Z August visible imagery of Tropical Depression 13W which later developed into TS Rachel (13W). Satellite analysis indicated 20 to 25 kt (Dvorak T1.0) through 061025Z. The scatterometry pass however, indicates 30 to 35 kt winds already at 060240Z. 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.



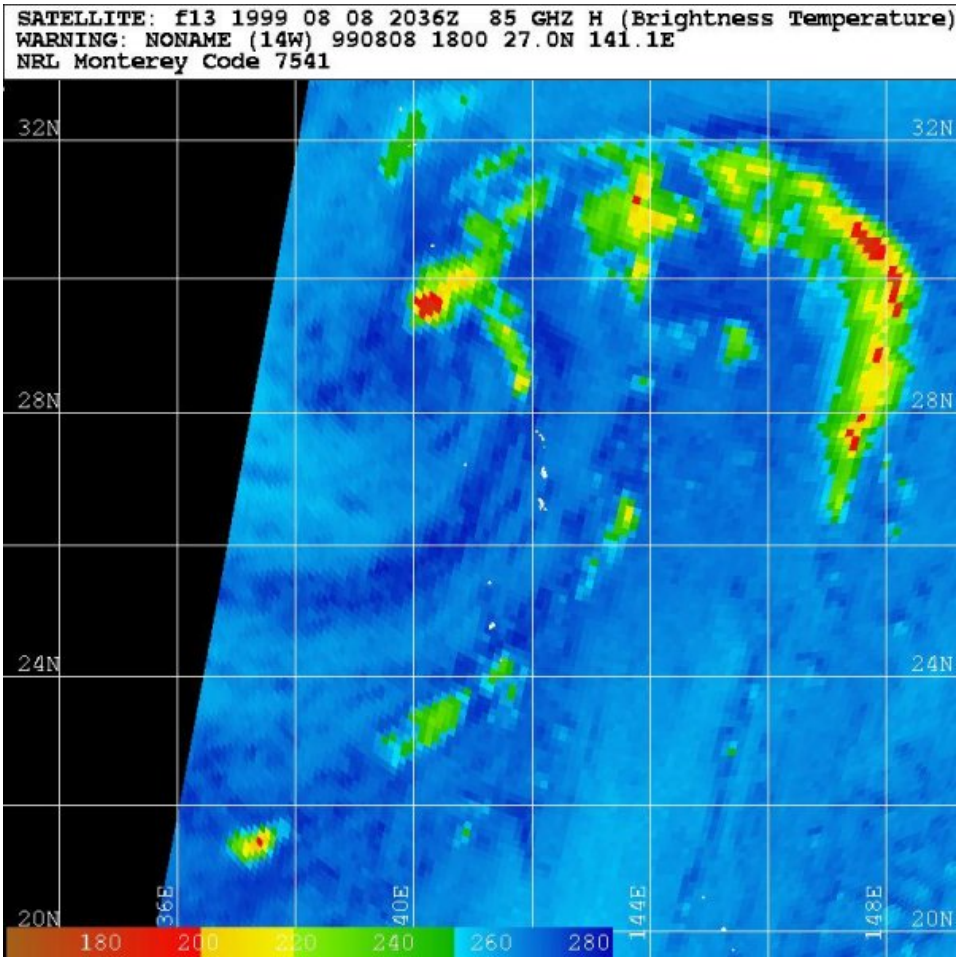


Figure 1-14-1. 082036Z August SSM/I pass reveals a fully exposed low-level circulation center positioned southwest of the associated convection. TD 14W was at 25 kt intensity.

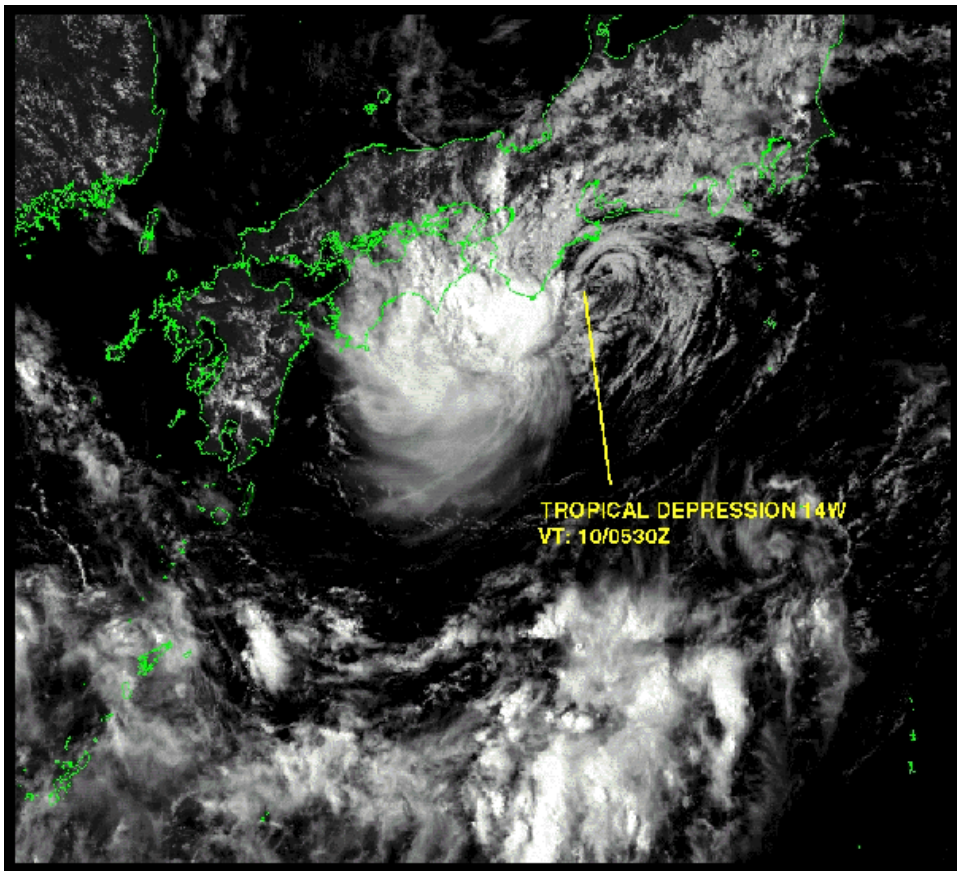


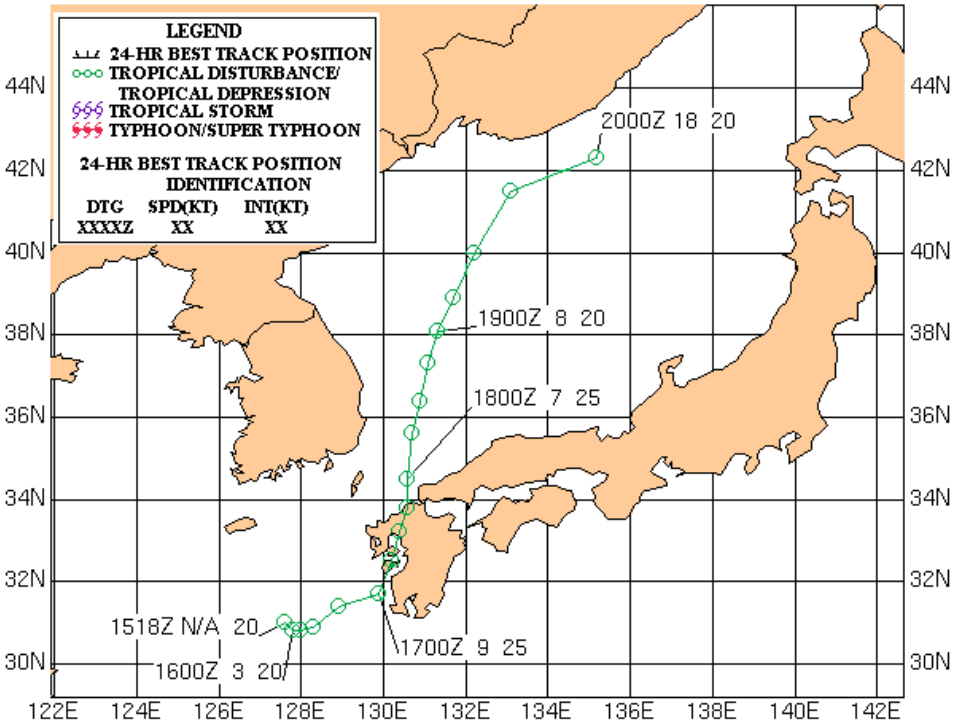
Figure 1-14-2. 100530Z August visible satellite imagery depicted a fully exposed low-level circulation center tracking over the coast of Honshu. TD 14W was at 25 kt intensity.

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.



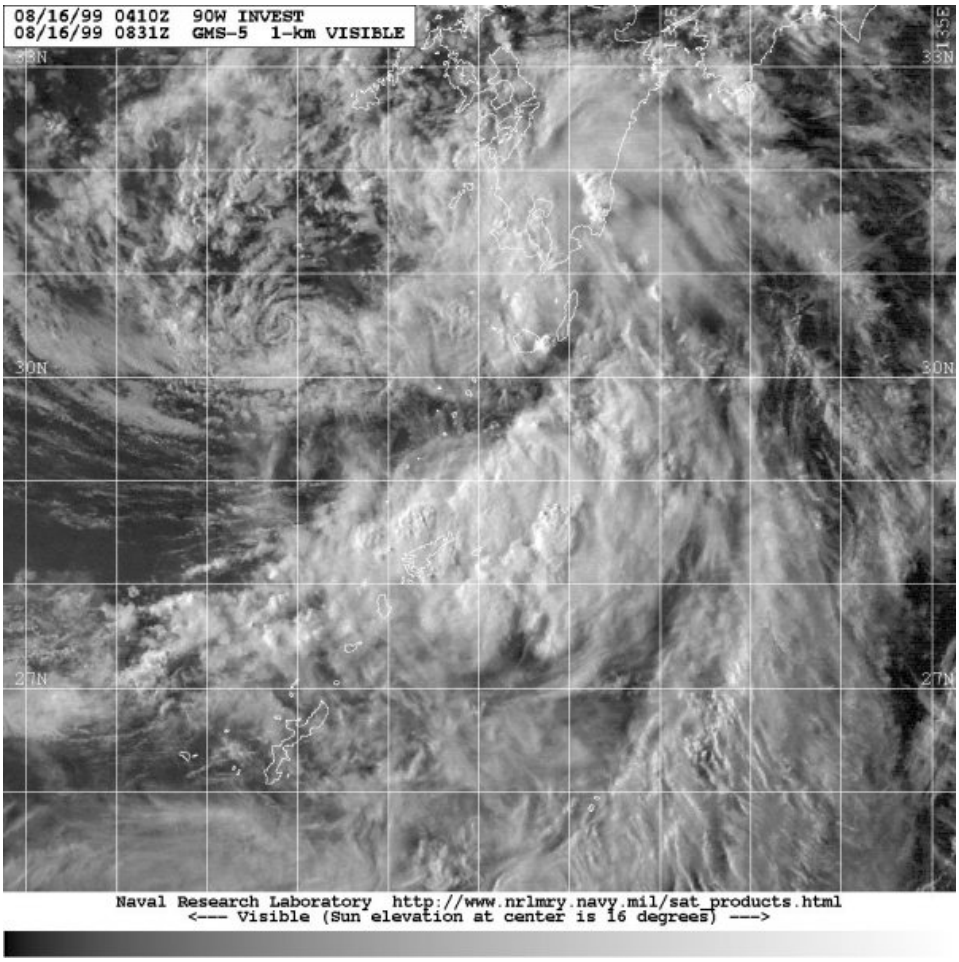


Figure 1-15-1. 160831Z August GMS-5 visible image of TD 15W shortly after the first warning. TD 15W was a small exposed low level circulation at 25 kt intensity.

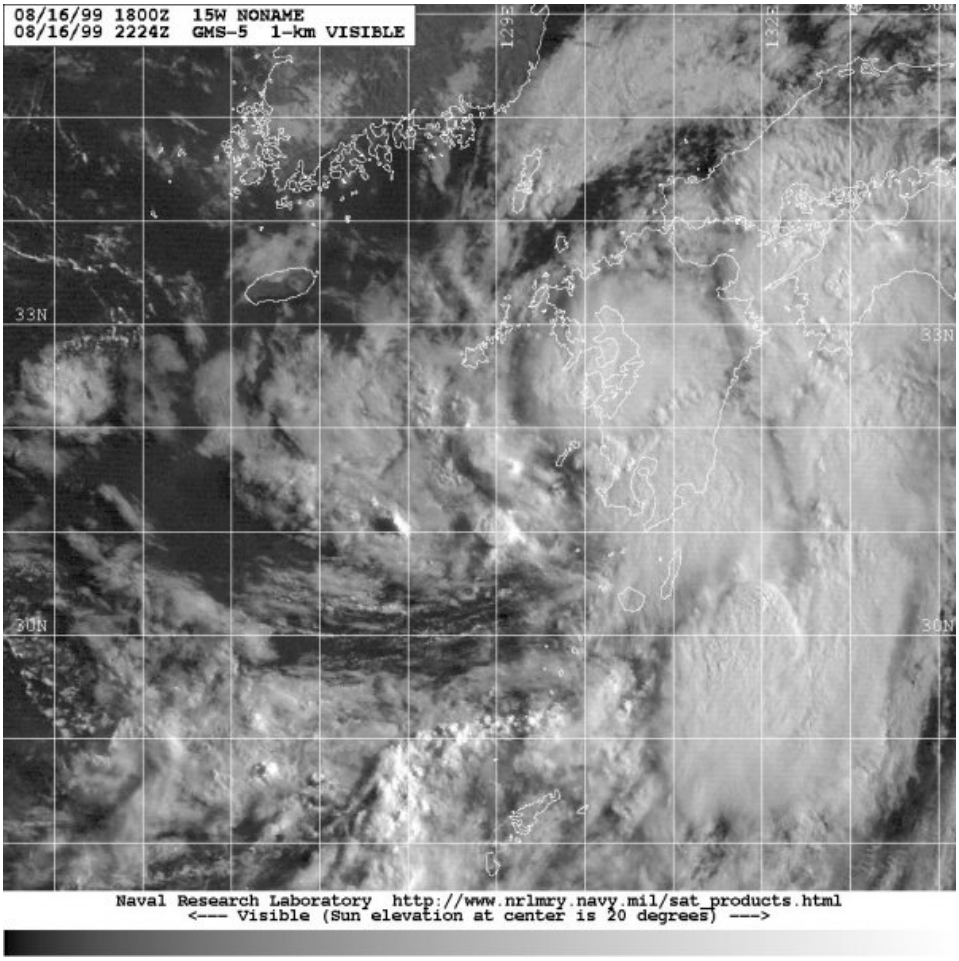


Figure 1-15-2. 162224Z August GMS-5 visible image. TD 15W was a 25 kt TD as it approached Kyushu, Japan. TD 15W made landfall 4 hours later over Kyusho.

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.

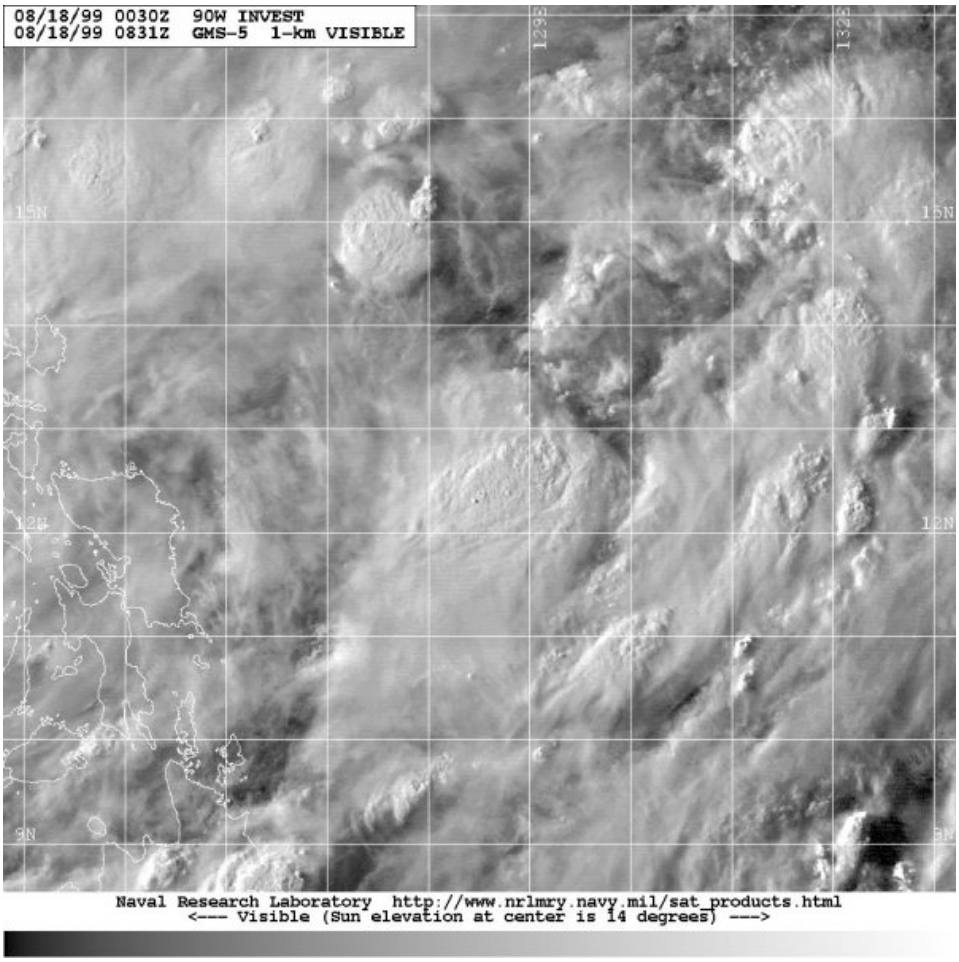


Figure 1-16-1. 180831Z August GMS-5 visible image of TY Sam (16W) shortly after the first warning. Notice the broad circulation and monsoon depression characteristics. TY Sam was at 30 kt intensity.

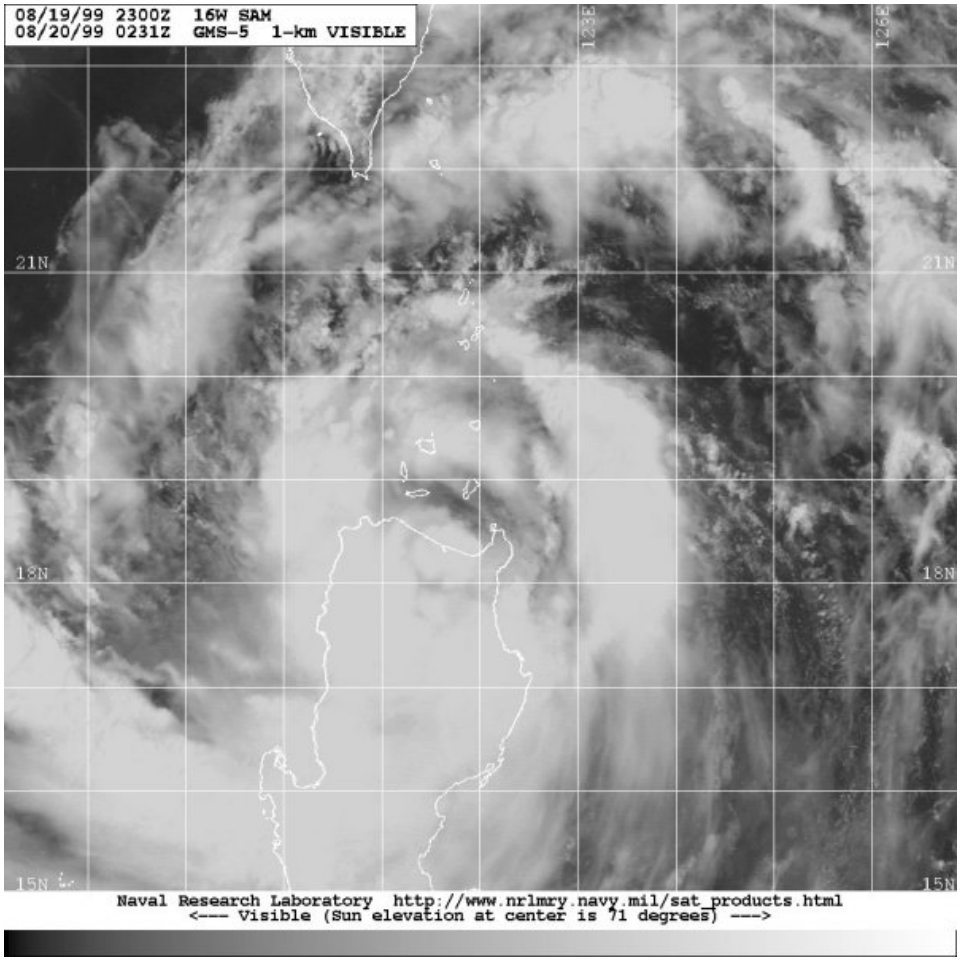


Figure 1-16-2. 200231Z August GMS-5 visible image of TY Sam (16W) as it tracked over northern Luzon. The large areal extent of the circulation is clearly visible. TY Sam was at 50 kt intensity.

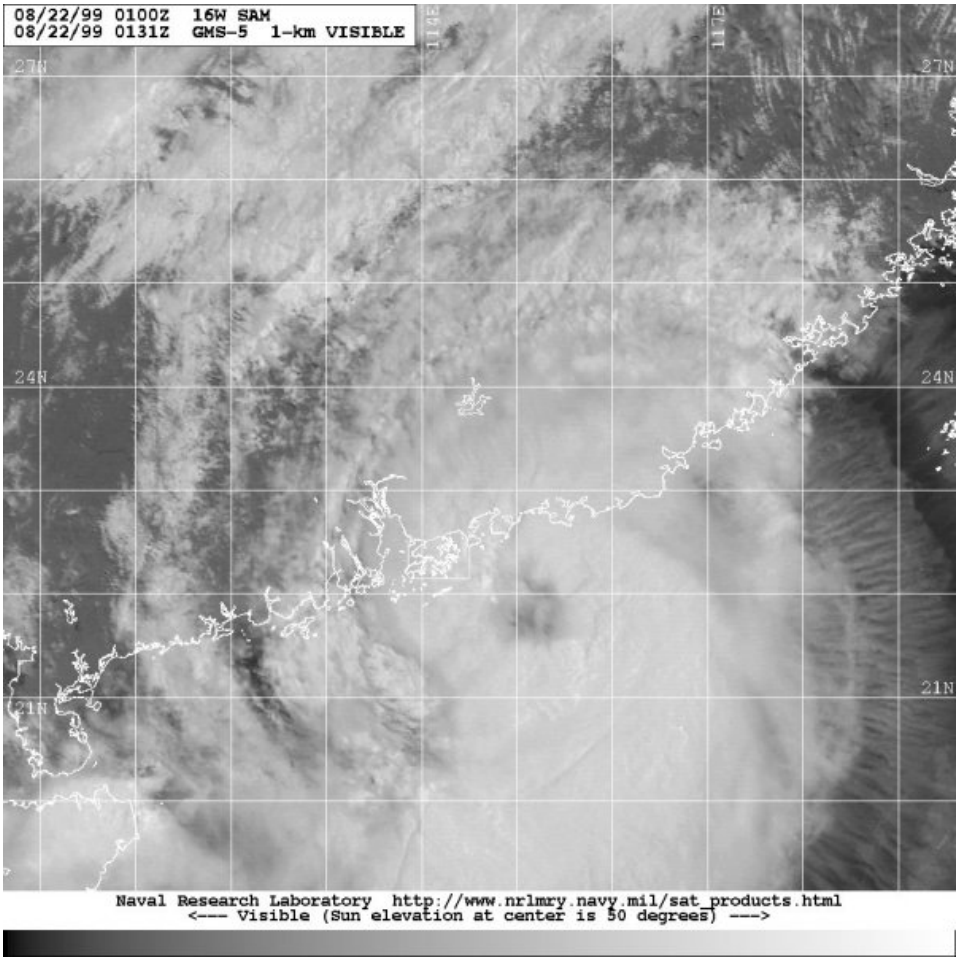
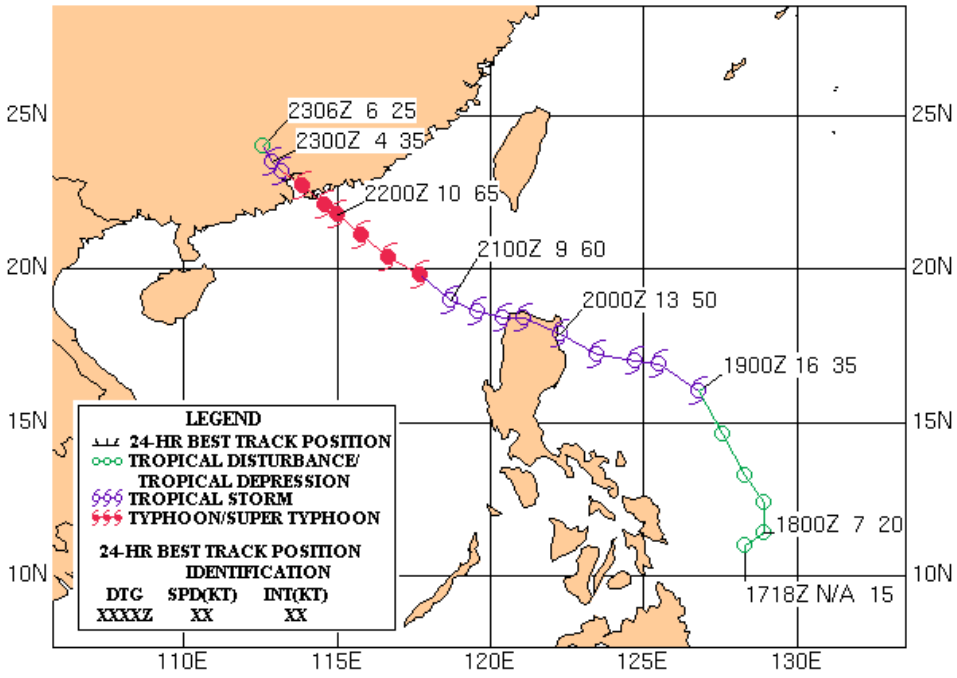


Figure 1-16-3. 220131Z August GMS-5 visible image of TY Sam (16W) at its peak intensity of 75 kt, just before making landfall northeast of Hong Kong.


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
20N
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 XX XX

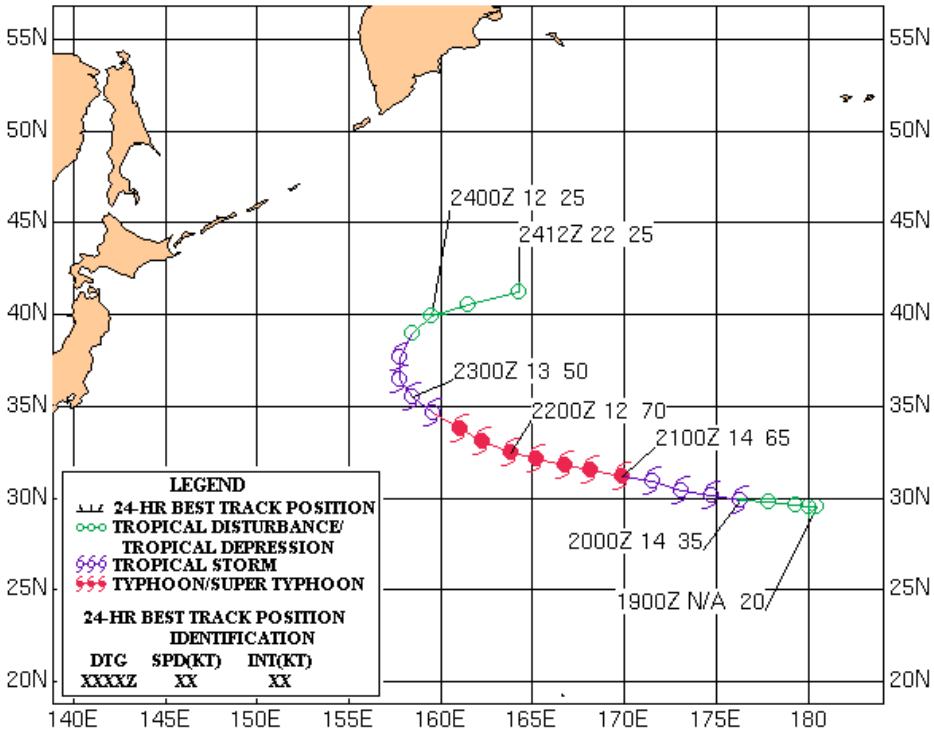
Typhoon Tanya (17W)

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.



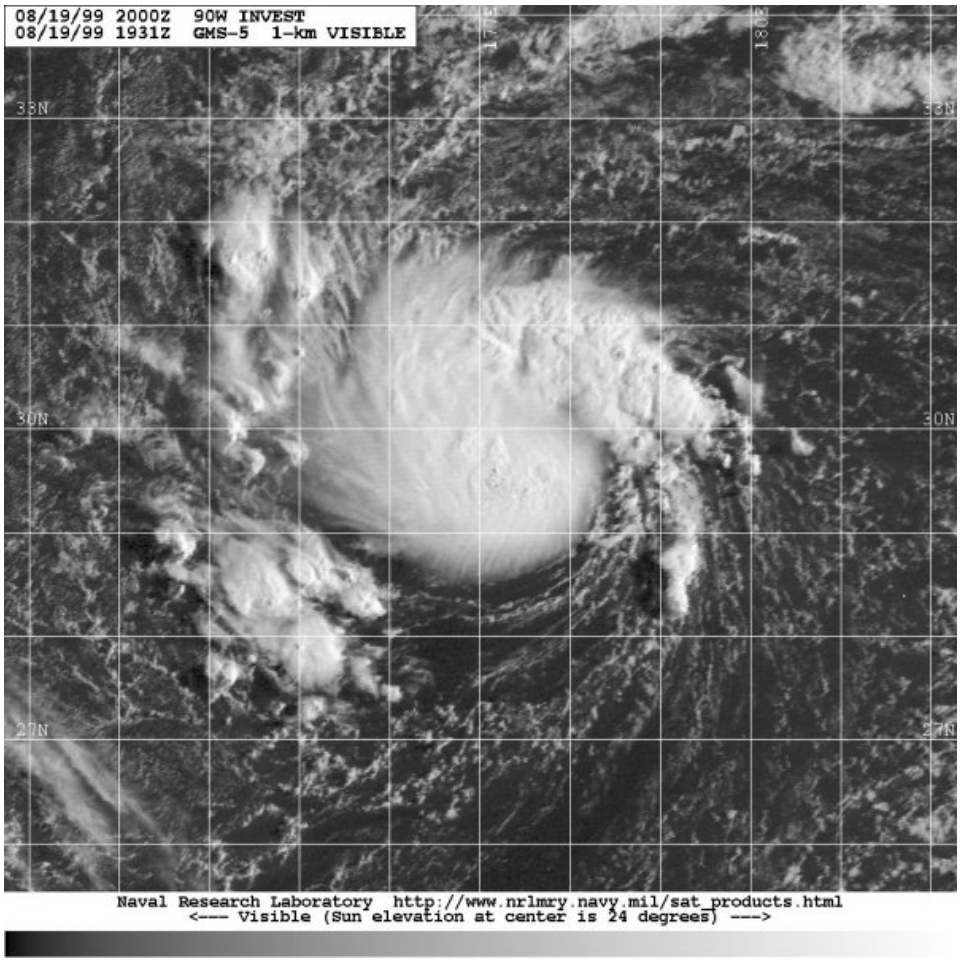


Figure 1-17-1. 191931Z August GMS-5 visible image of TS Tanya (17W) at an intensity of 40 kt. Image depicts the intense convection associated with the small, tightly wrapped low-level circulation.

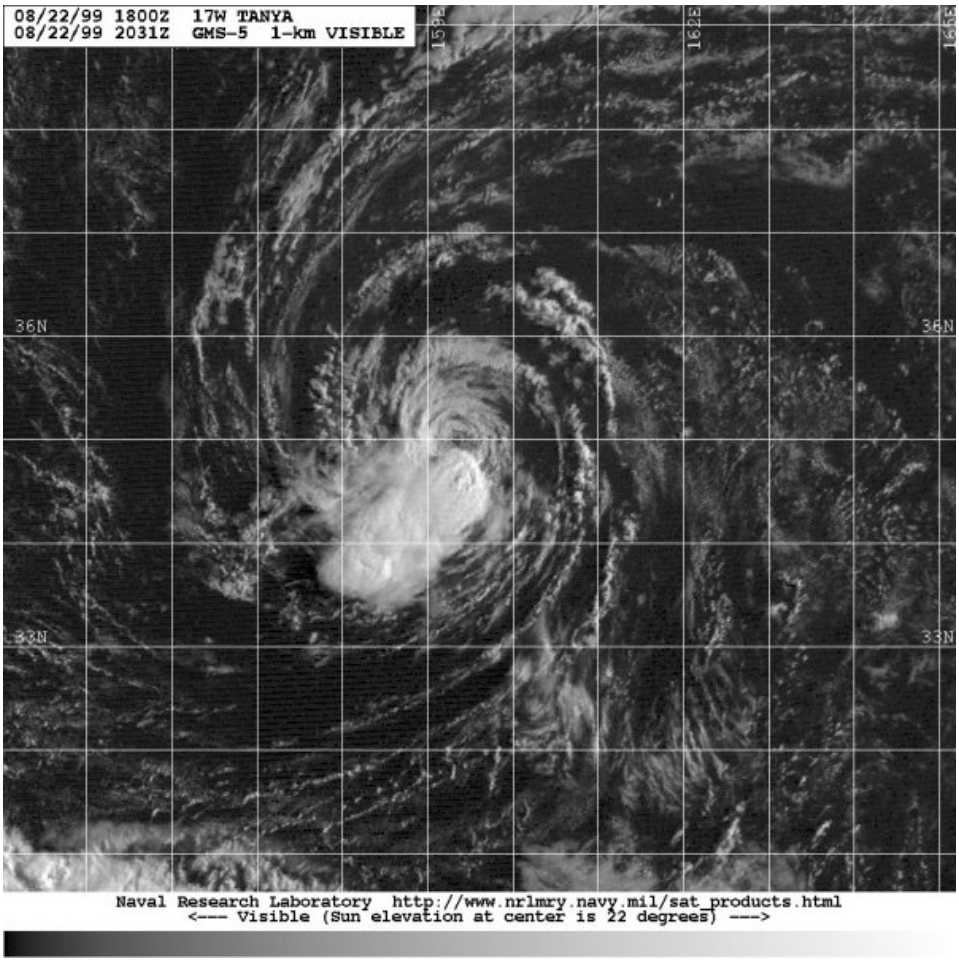


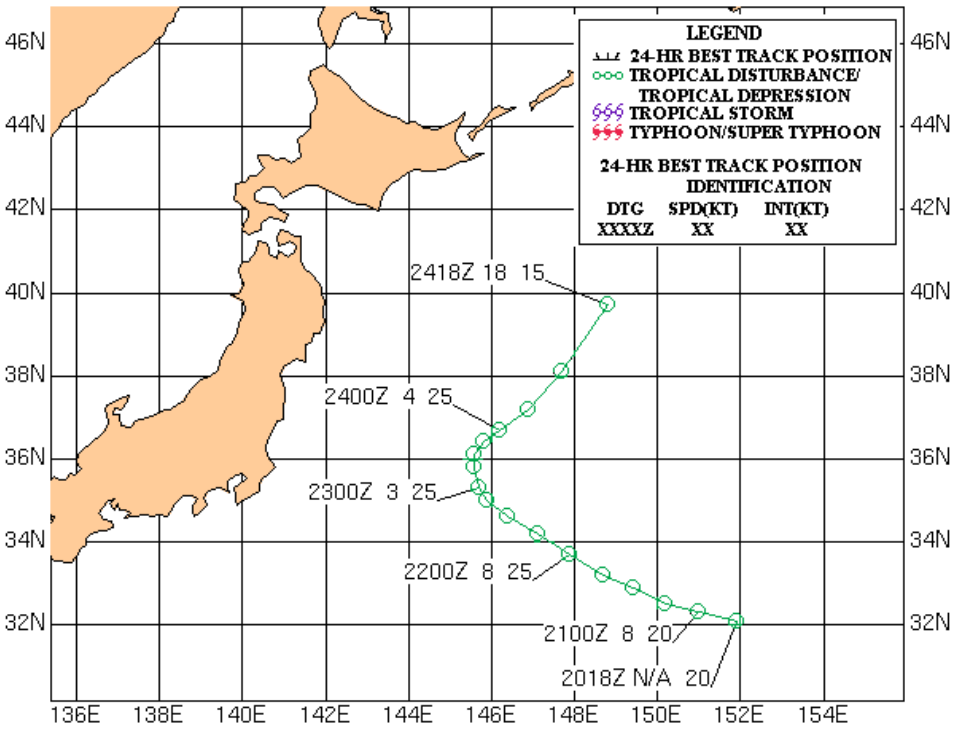
Figure 1-17-2. 222031Z August GMS-5 visible image of TY Tanya (17W). This image depicts the exposed low-level circulation center with deep convection being sheared to the south. Intensity at this time was 60 kt.

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.



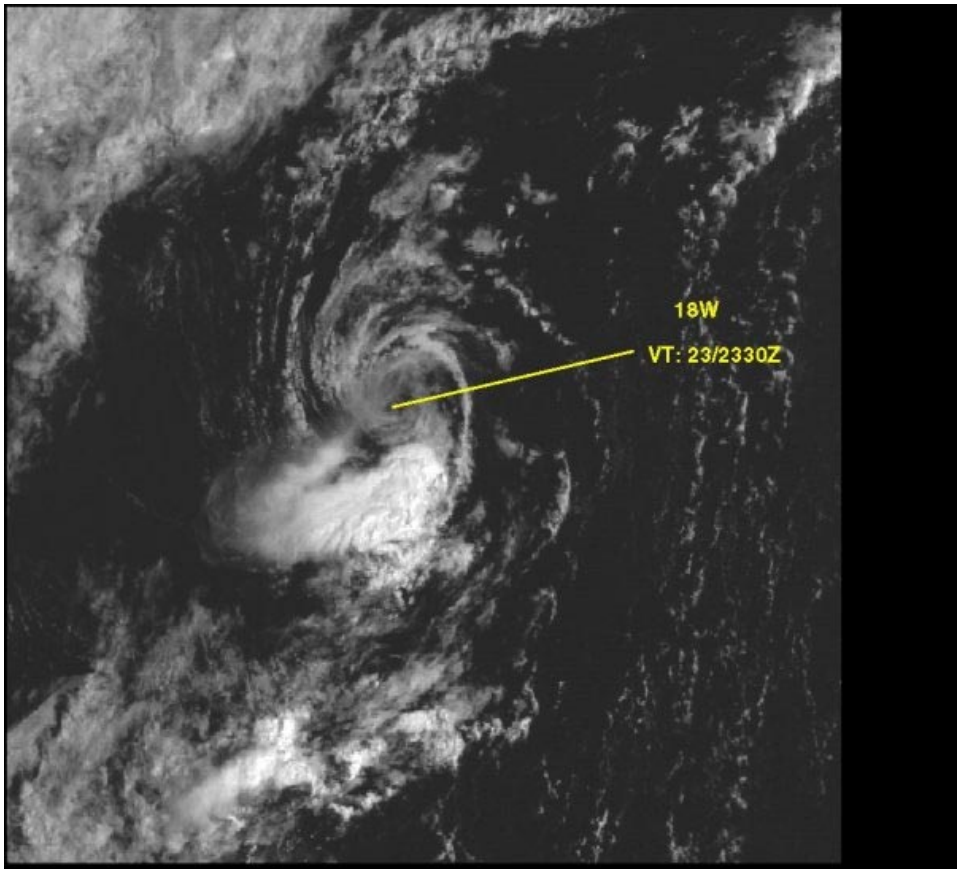


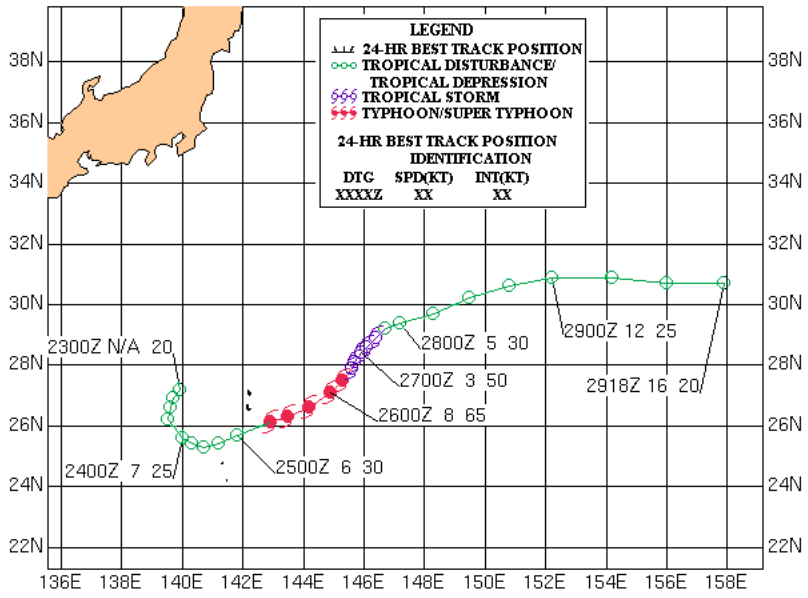
Figure 1-18-1. 232330Z visible image shows strong vertical windshear over TD 18W shearing the convection to the south of the exposed low-level circulation center (LLCC). Of note in this image is the tight wrap of the cloud lines into the LLCC. Current intensity was estimated at 25 kt.

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.



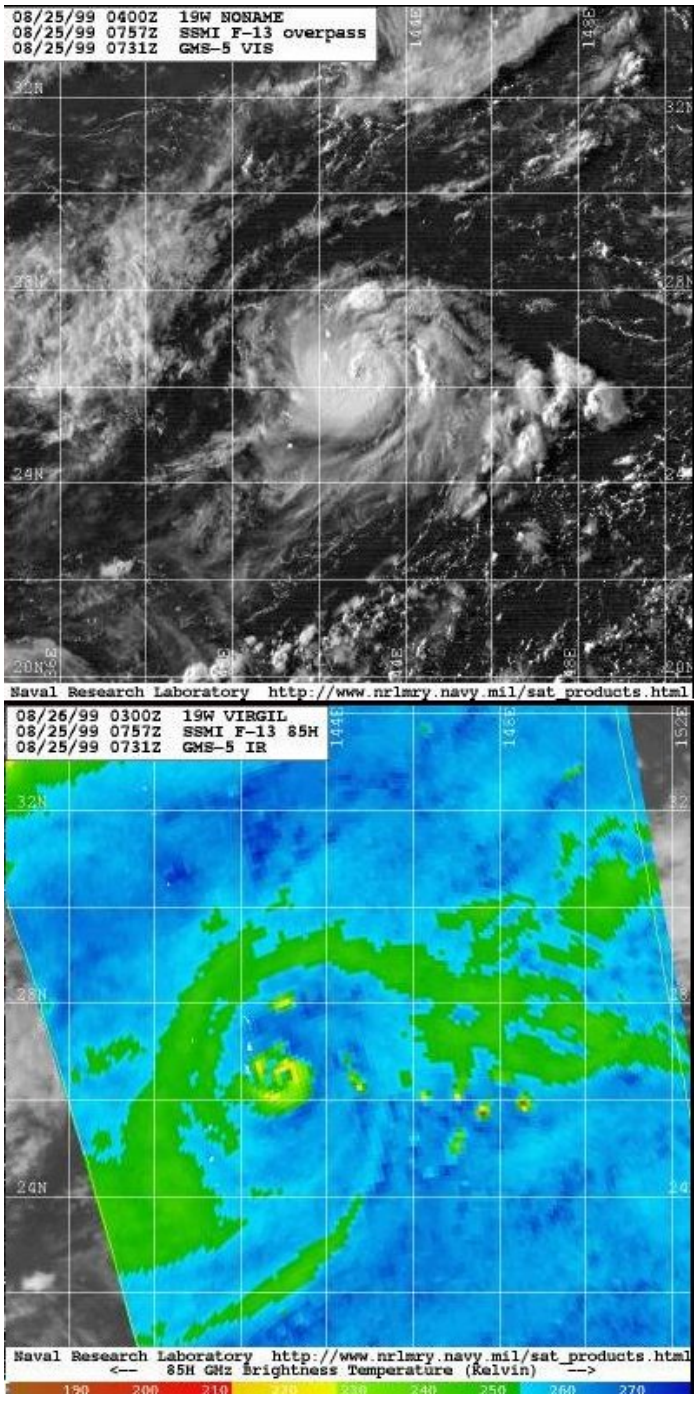


Figure 1-19-1. 250757Z microwave and 250731Z August visible imagery showing the low level circulation center of TY Virgil (19W) as it reached typhoon intensity (65 kt). Visible imagery indicates a possible eye, but the microwave image leaves little doubt.

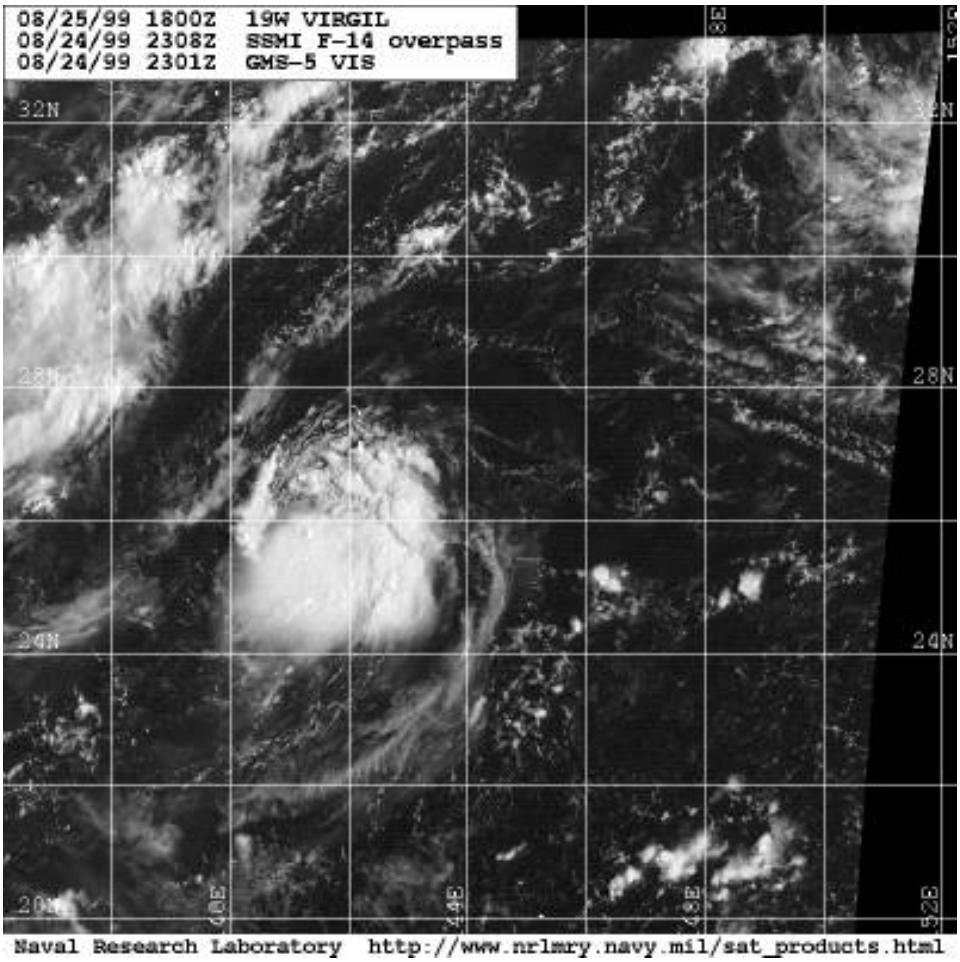


Figure 1-19-2. 242308Z visible image showing the tropical disturbance that 6 hours later developed into TY Virgil (19W) with an intensity of 65 kts. This explosive development was the result of the the upper-tropospheric low filling, and no longer restricting the outflow of the system.

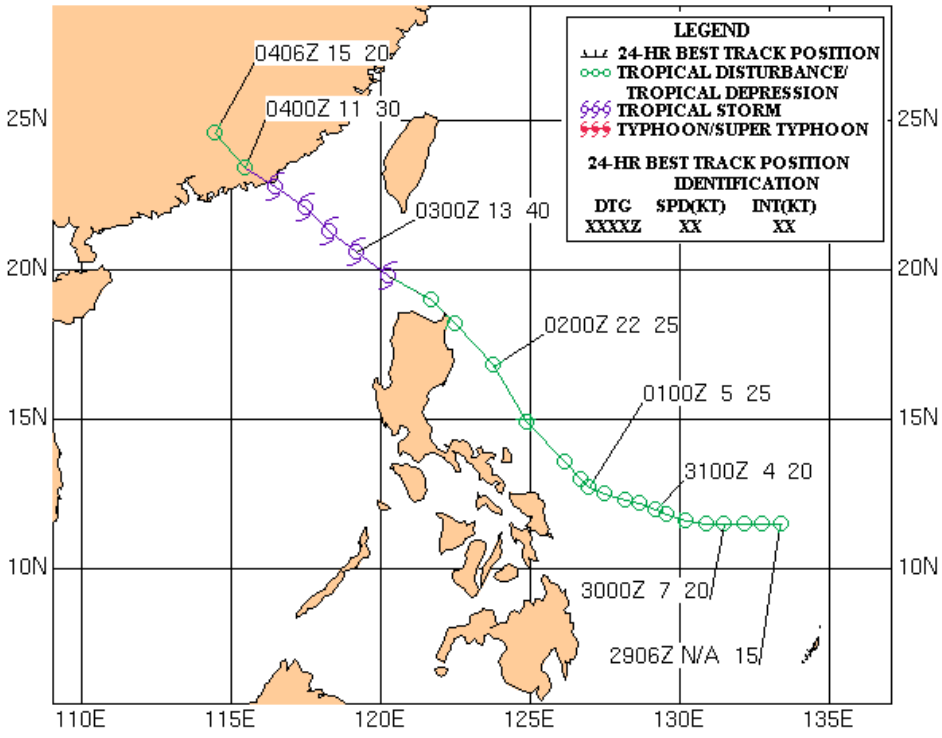
Tropical Storm Wendy (20W)

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.



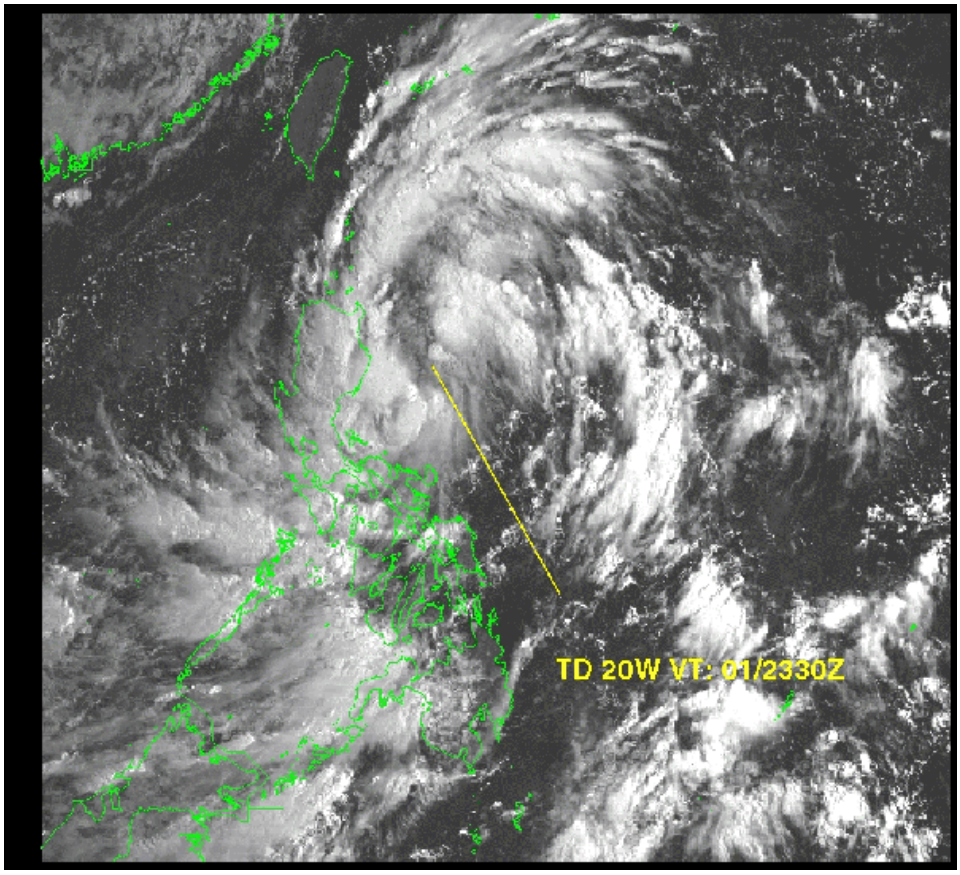


Figure 1-20-1. 012330Z September visible satellite image of a developing TS Wendy (20W) at 25 kt intensity, just east of Luzon.

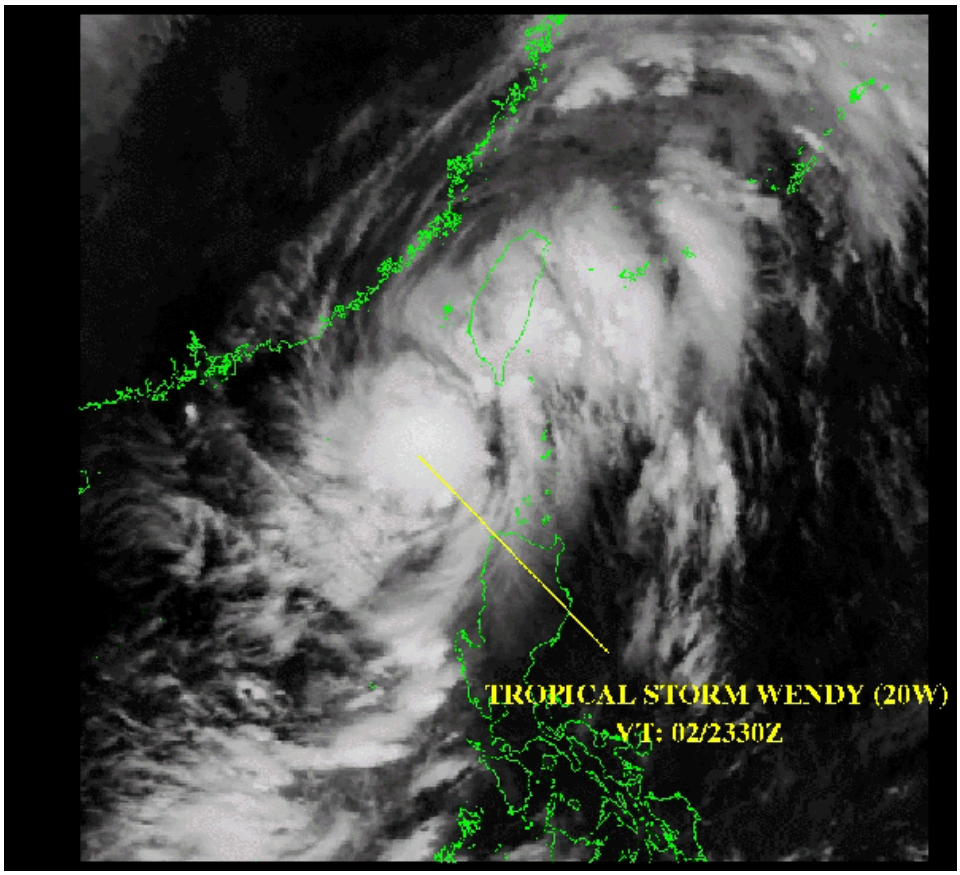


Fig 1-20-2. 022330Z September visible satellite image of Tropical Storm Wendy (20W) at its maximum intensity (40 kt), southwest of Taiwan.

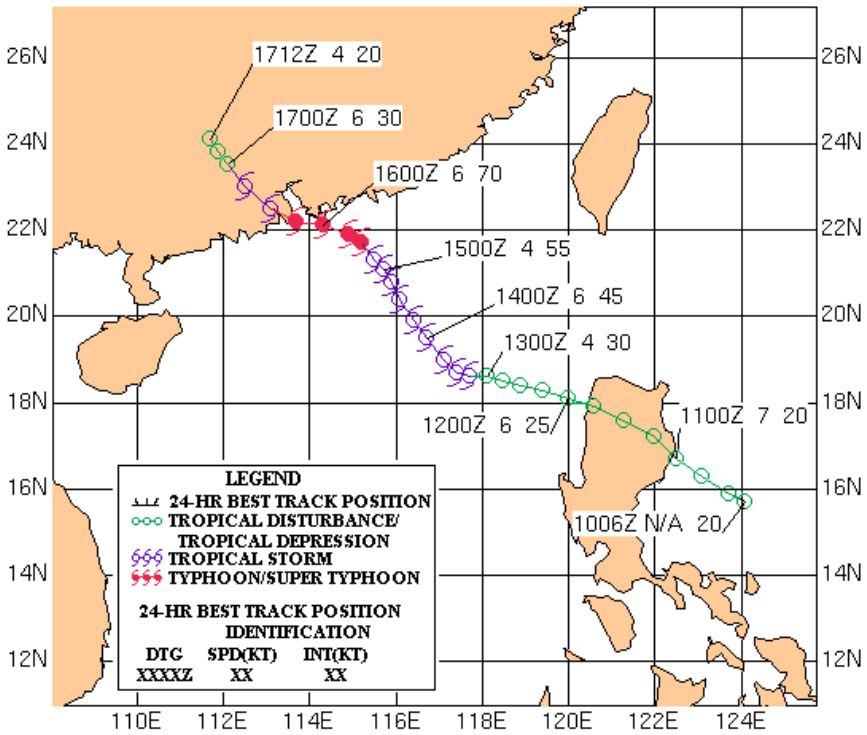
Typhoon York (21W)

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.



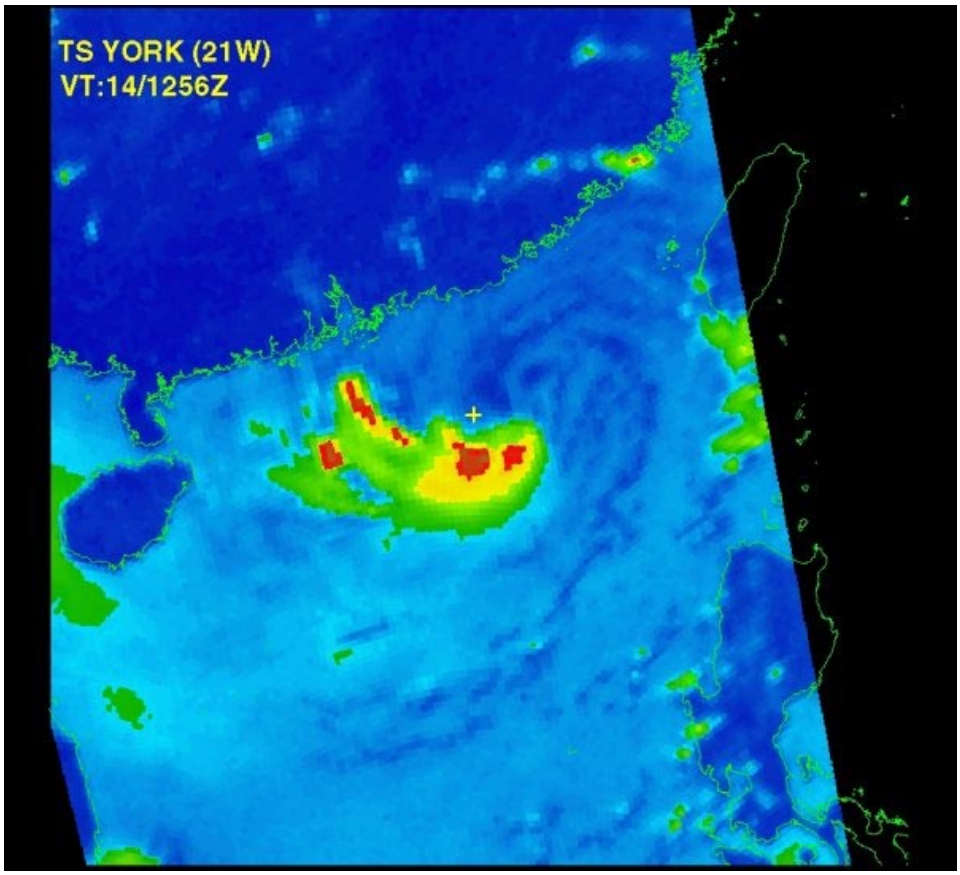


Figure 1-21-1. A special sensor microwave satellite image of developing Tropical Storm York (21W) at 141256Z September, in the South China Sea southeast of Hong Kong.

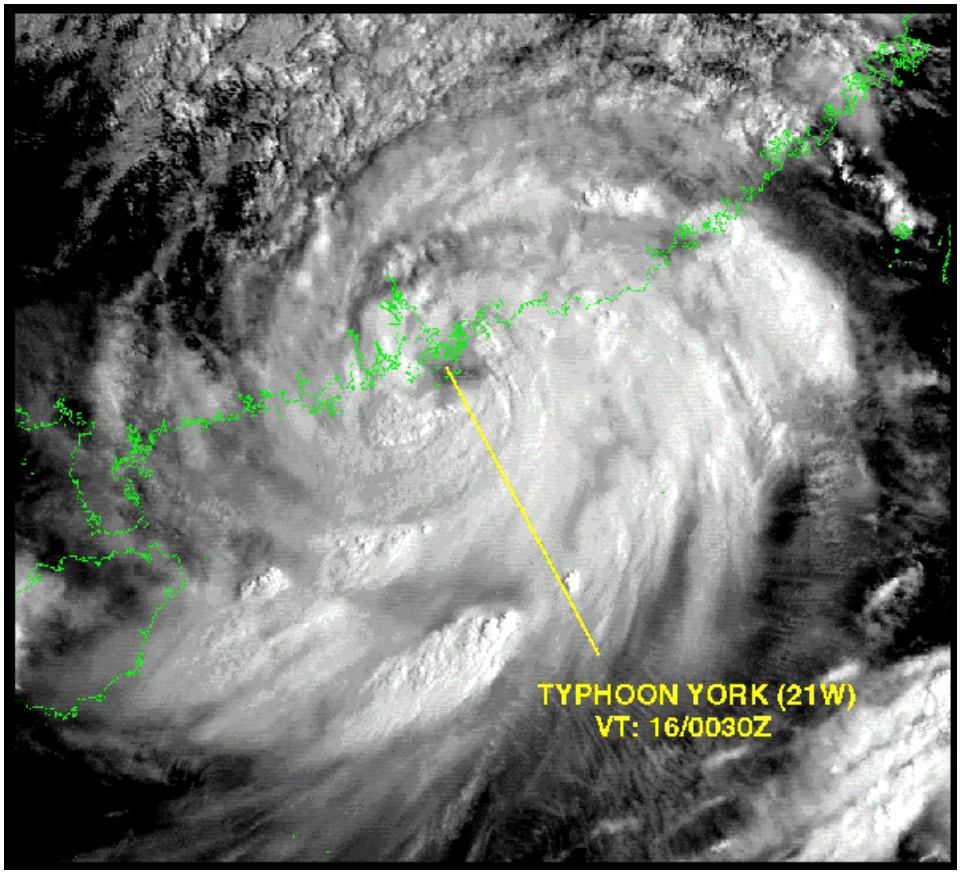


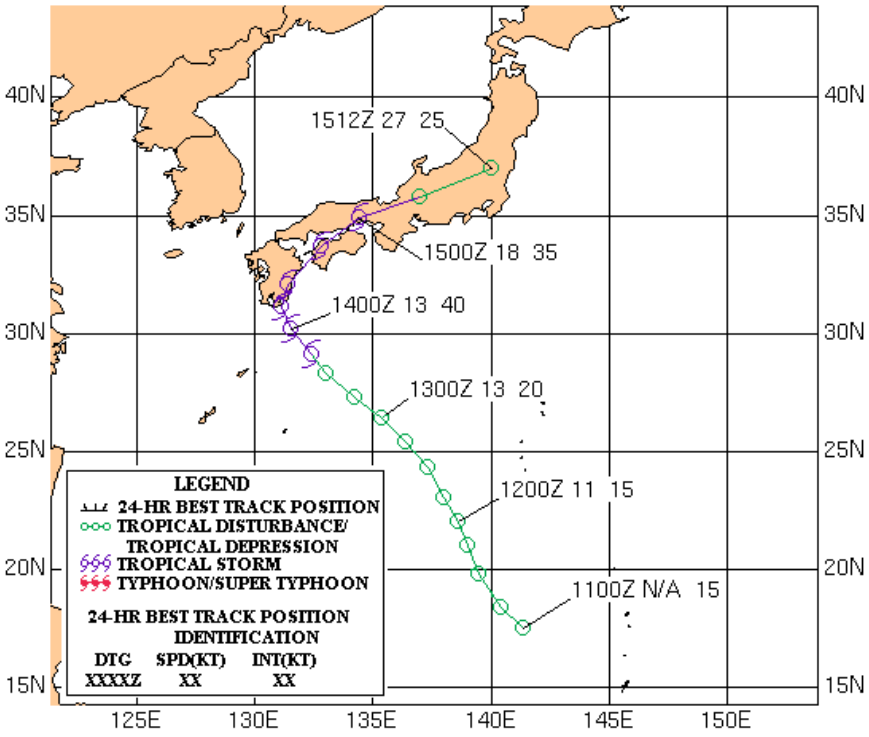
Figure 1-21-2. A visible geostationary satellite image of Typhoon York (21W) near peak intensity at 160030Z September, near Hong Kong.

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.



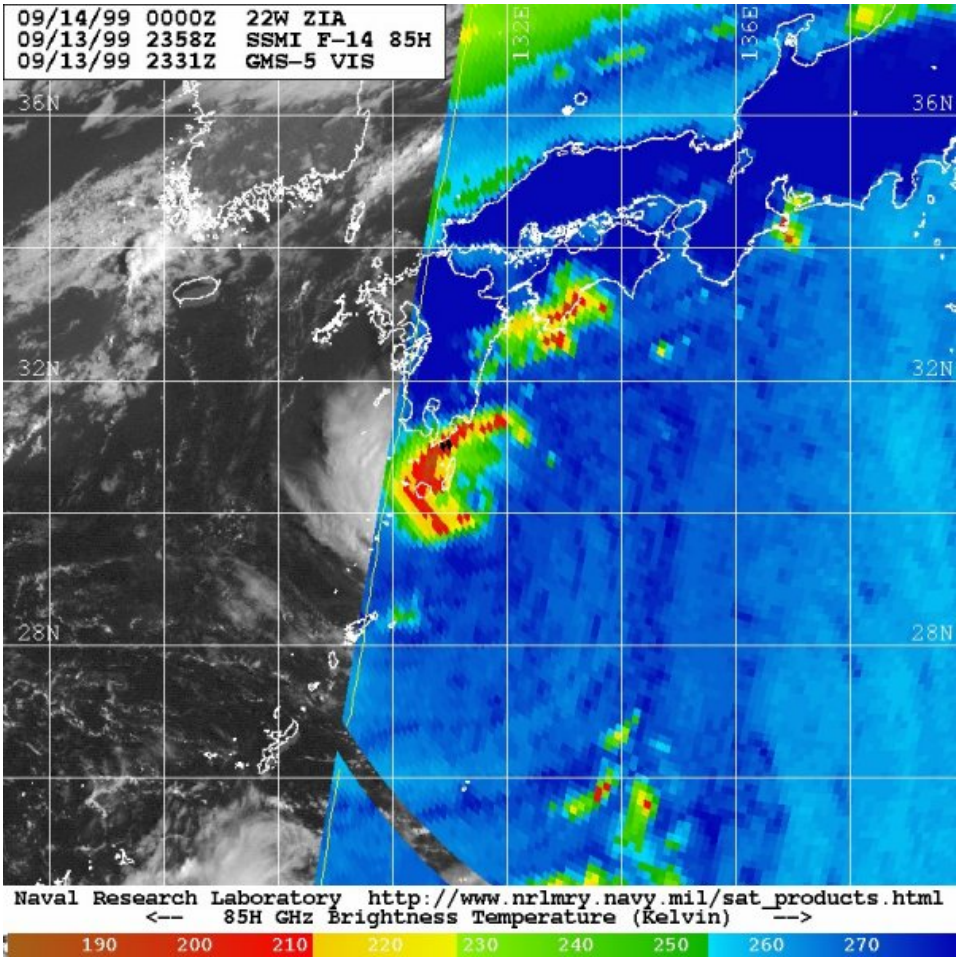


Figure 1-22-1. 132358Z September Special Sensor Microwave Imager pass depicting TS Zia (22W) just before it moved over the Kyushu coast as a 45 kt system.

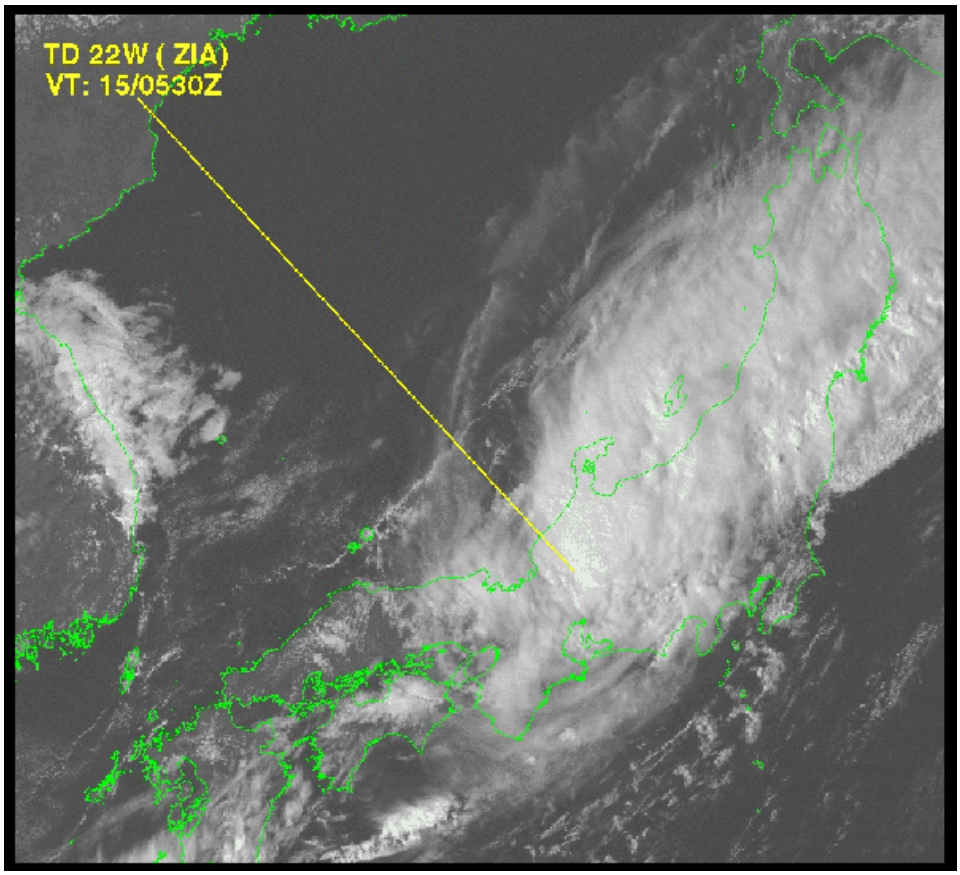


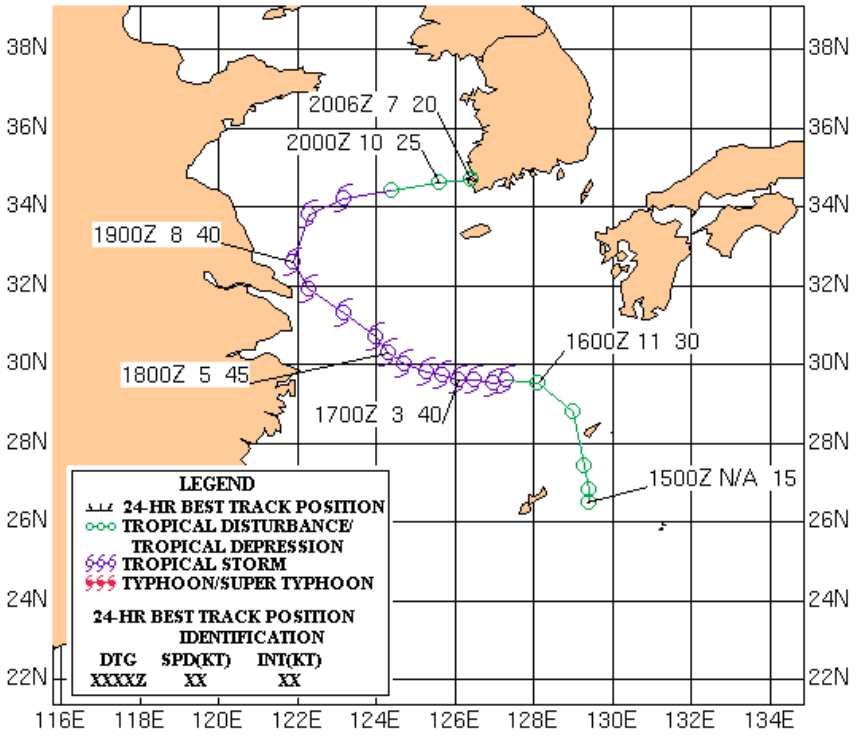
Figure 1-22-2. 150530Z September GMS-5 visible image shows TS Zia (22W) as an extratropical system along a shear line. Current intensity is 30 kt.

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.



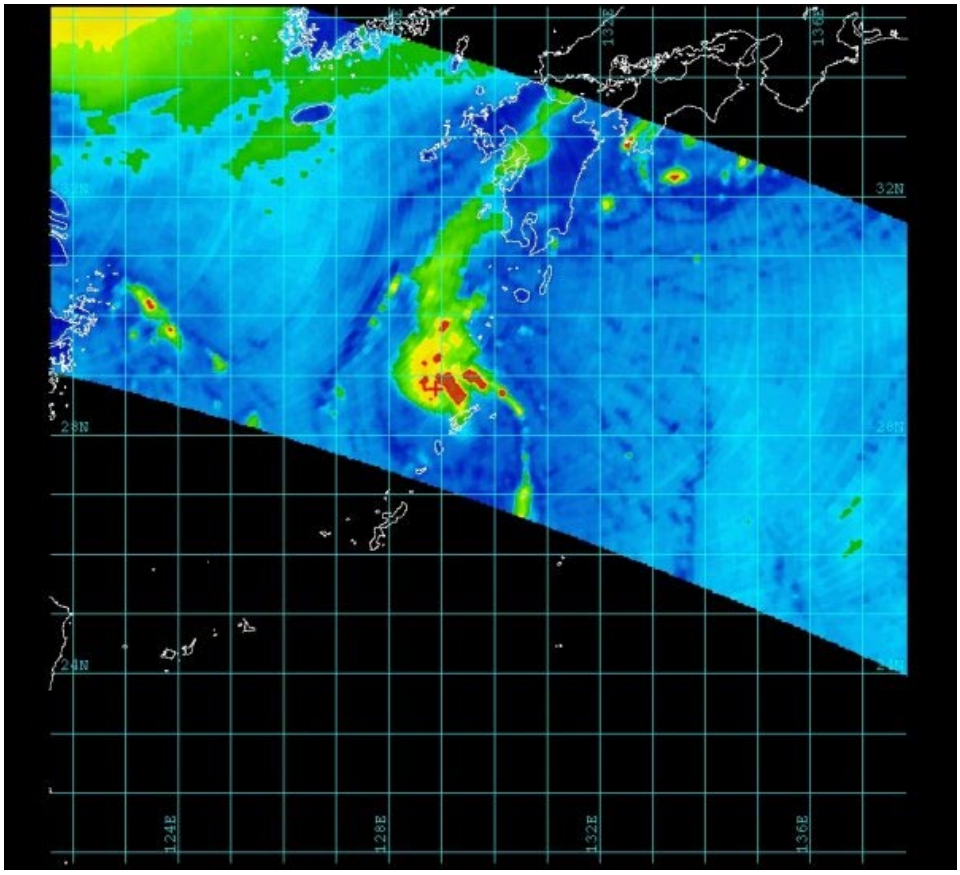


Figure 1-23-1. A Tropical Rainfall Measuring Mission (TRMM) pass of TS Ann (23W) at 30 kt at 151744Z September, off the west coast of Okinawa.

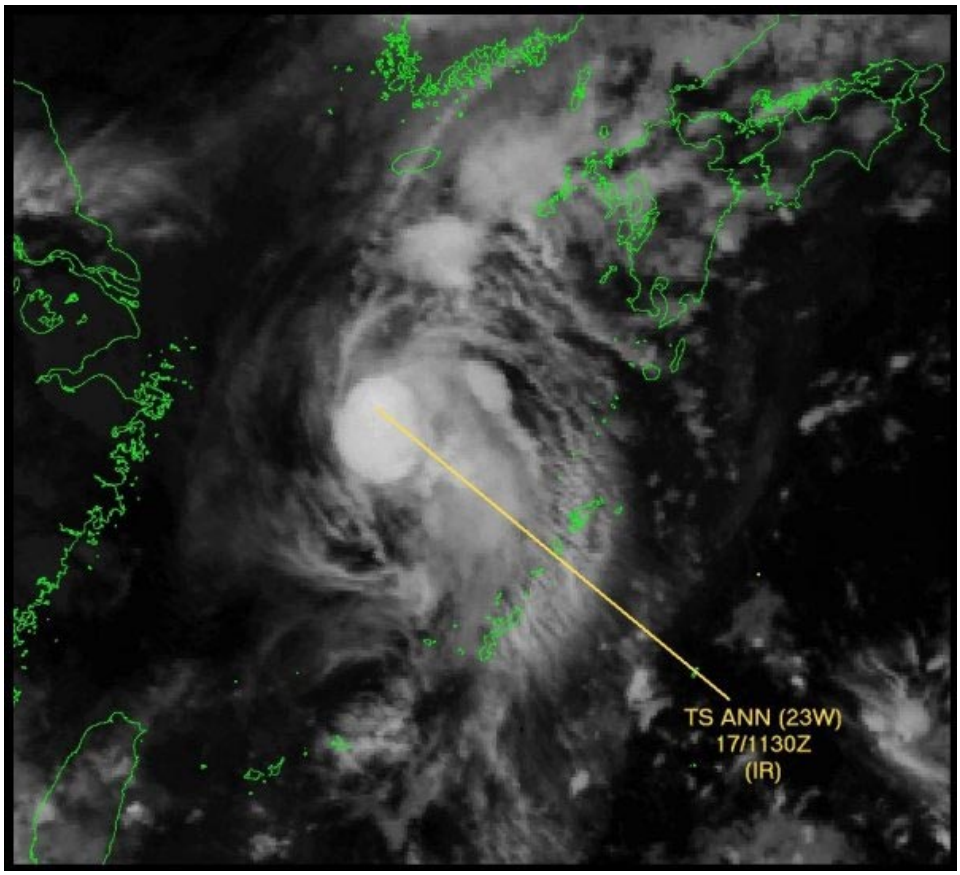


Figure 1-23-2. GMS-5 infrared image of TS Ann (23W) at 171130Z September over the Yellow Sea. Current intensity is 45 kt.

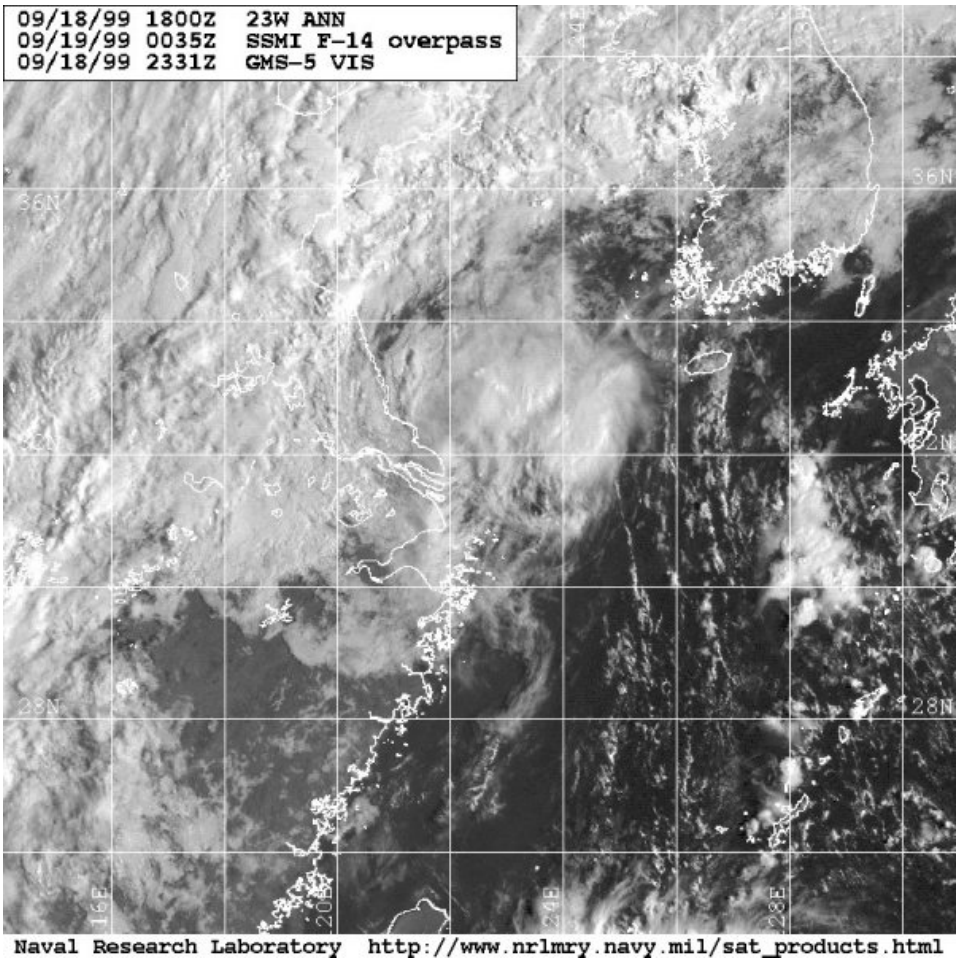


Figure 1-23-3. A GMS-5 visible image of TS Ann (23W) at 182331Z September. The image reveals the mid-latitude system to the northwest and a weakening, less organized, tropical cyclone. Current intensity is 40 kt.

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.

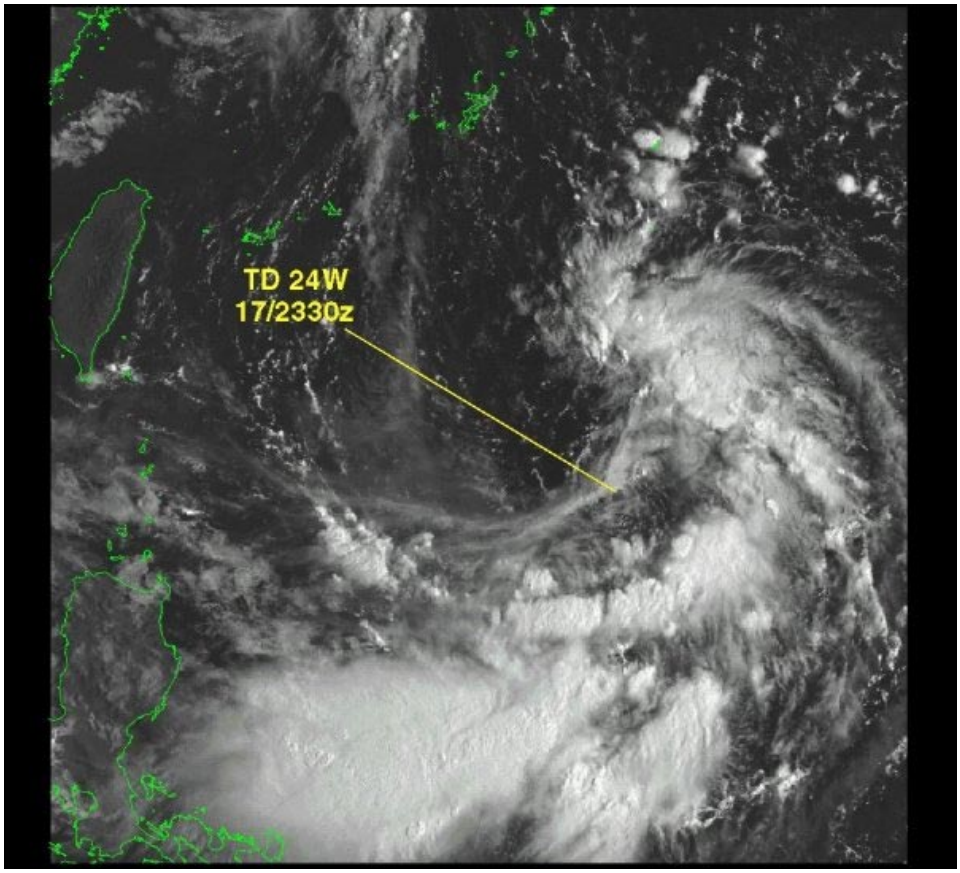


Figure 1-24-1. 172330Z September visible satellite image of STY Bart (24W) as a low-level circulation in the Philippine Sea, south of a TUTT cell (evident by the curved mid-level banding convection to the south and generally clear air to the northwest). This image was only 12 hours after the initial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

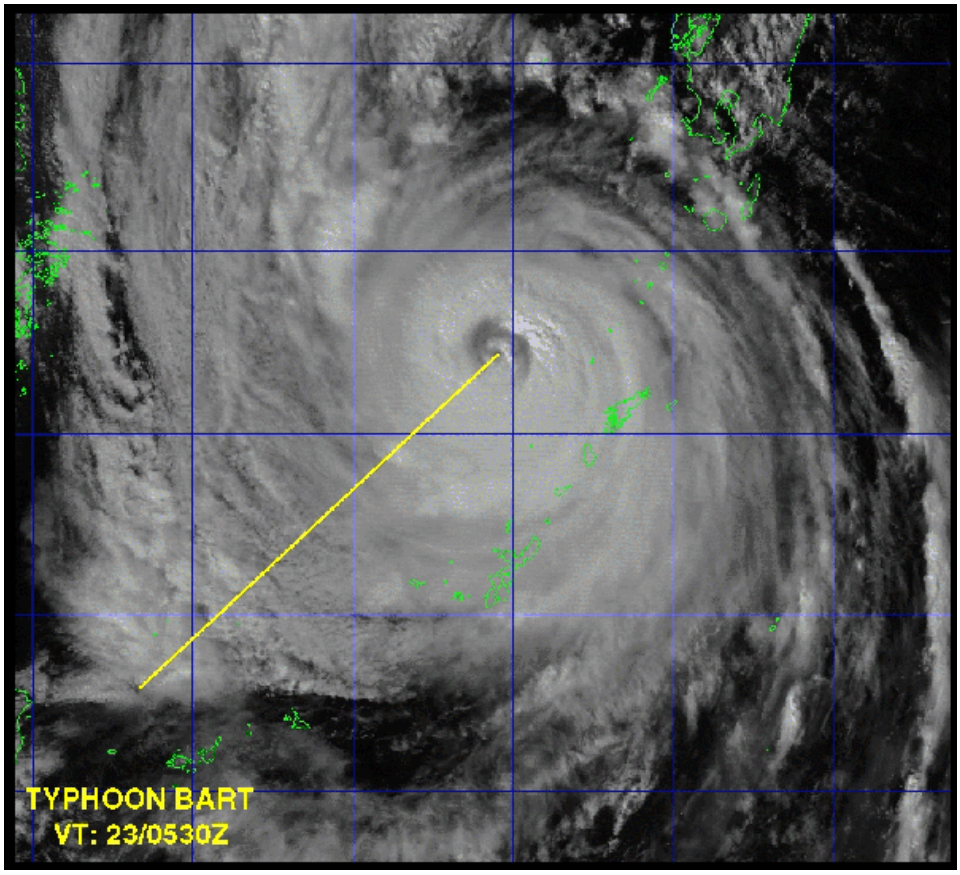


Figure 1-24-2. At 230530Z September, STY Bart (24W) was reaching maximum intensity of 140 kt just west of Japan's southern-most islands. This image reveals a double-eyewall structure.

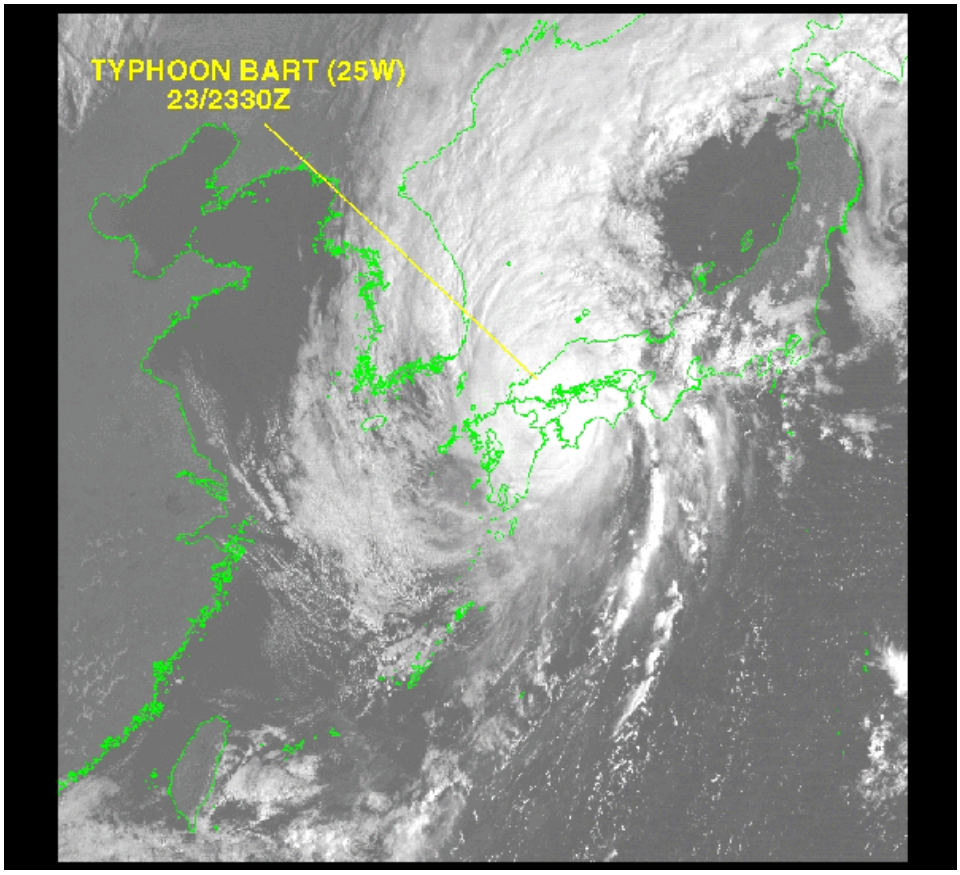
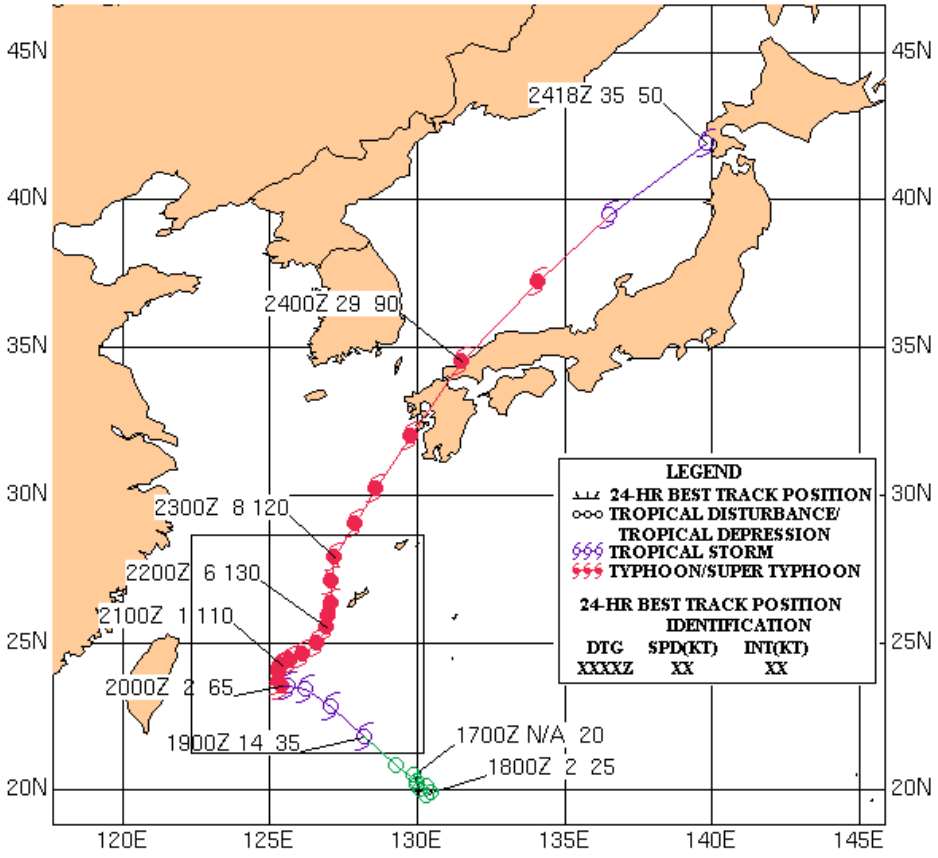


Figure 1-24-3. STY Bart (24W) had quickly passed over Kyushu and was moving into the Sea of Japan in this 232330Z September visible image. Even after significant interaction with land, the cyclone maintained an impressive structure as it moved back over water.


45N
40N
35N
30N
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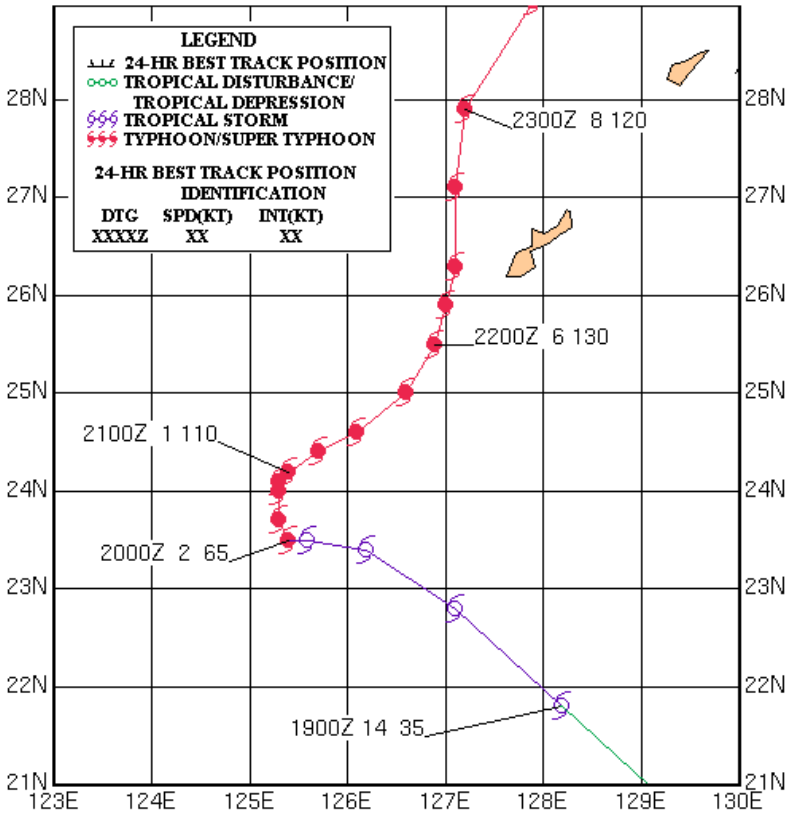
20N
120E
125E
130E
135E
140E
145E
2418Z 35 50
2400Z 29 90
2300Z 8 120
2200Z 6 130
2100Z 1 110
2000Z 2 65
1900Z 14 35
1700Z N/A 20
1800Z 2 25
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION
IDENTIFICATION
DTG SPD(KT) 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
27N
26N
25N
24N
23N
22N
21N
123E
124E
125E
126E
127E
128E
129E
130E

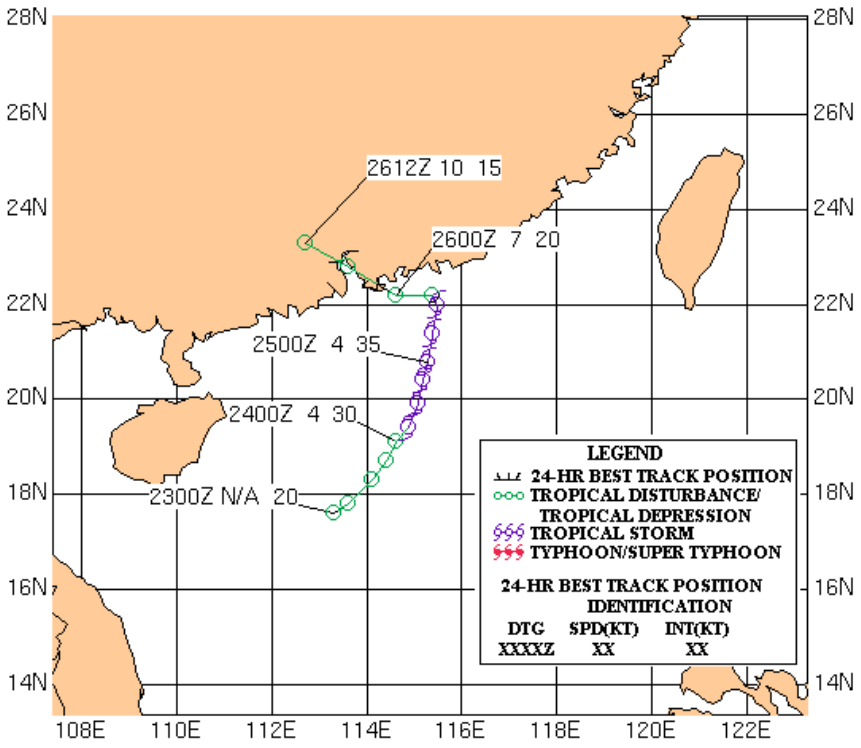
Tropical Storm Cam (25W)

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.



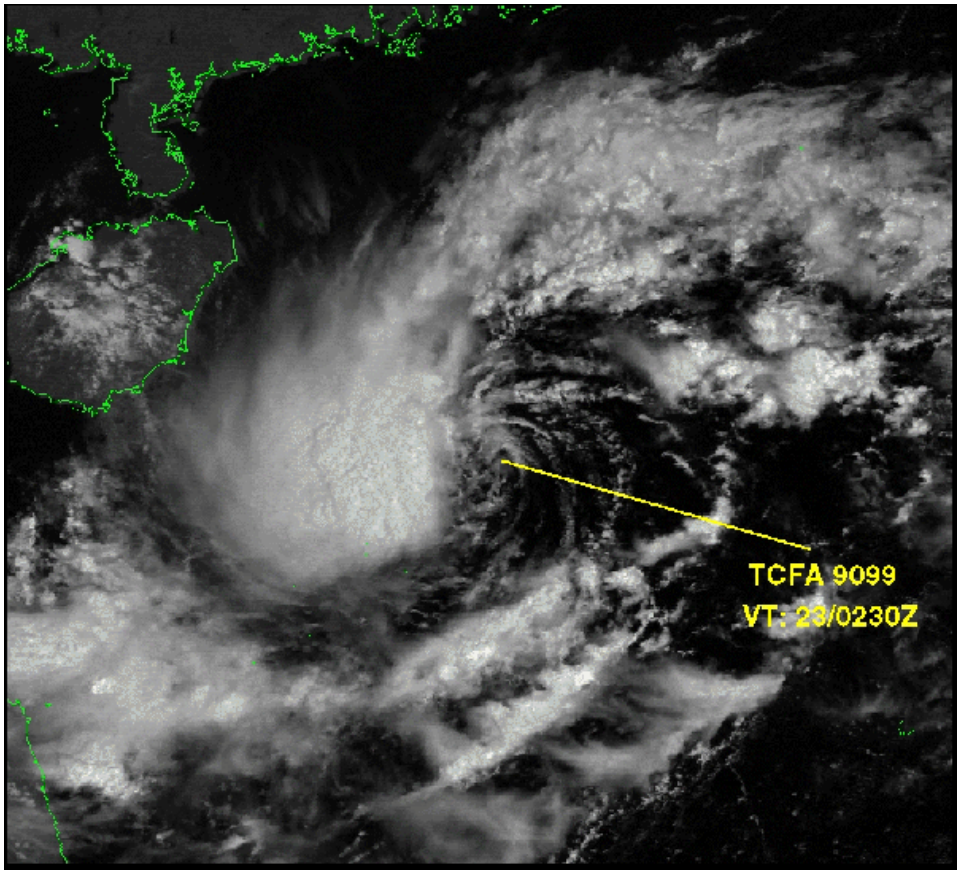


Figure 1-25-1. While a TCFA, this 230230Z September visible image reveals an exposed low level circulation center (LLCC) just east of convection. The convection built over the LLCC and the first warning on TS Cam (25W) was issued at 230900Z September.

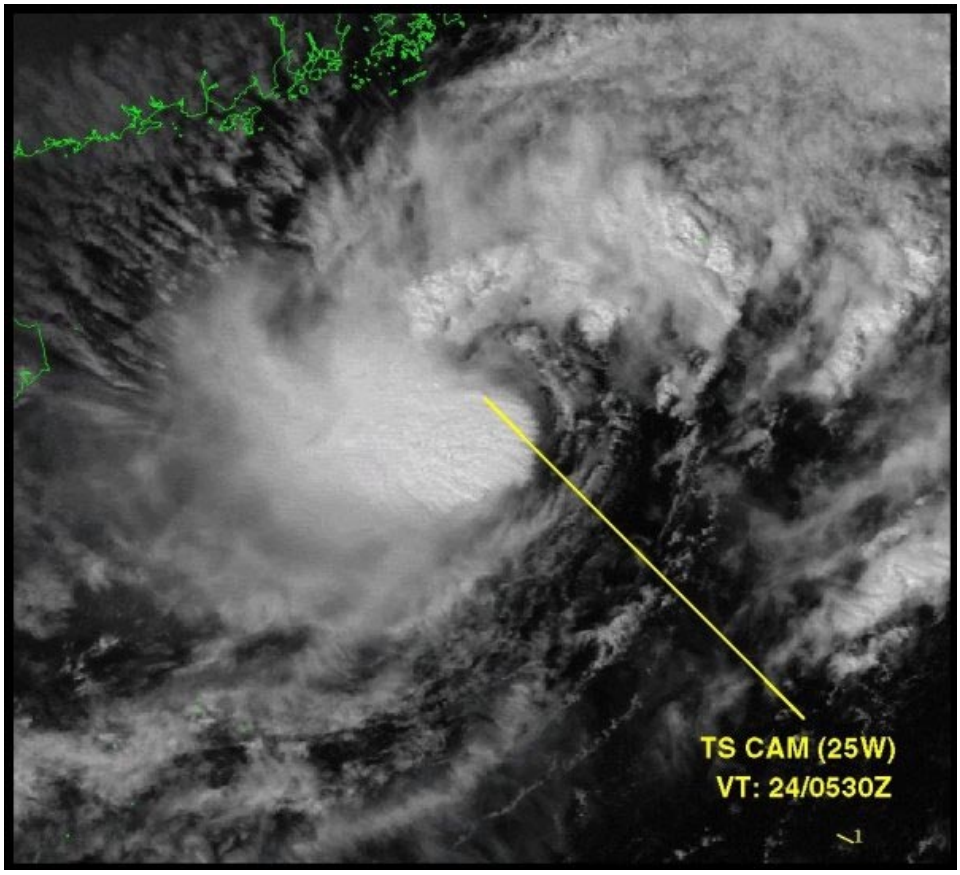


Figure 1-25-2. 240530Z September visible image of TS Cam (25W) at 35 kt intensity. This image reveals a partially exposed low level circulation center just north of the primary convection. Hong Kong lies just to the northwest.

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.

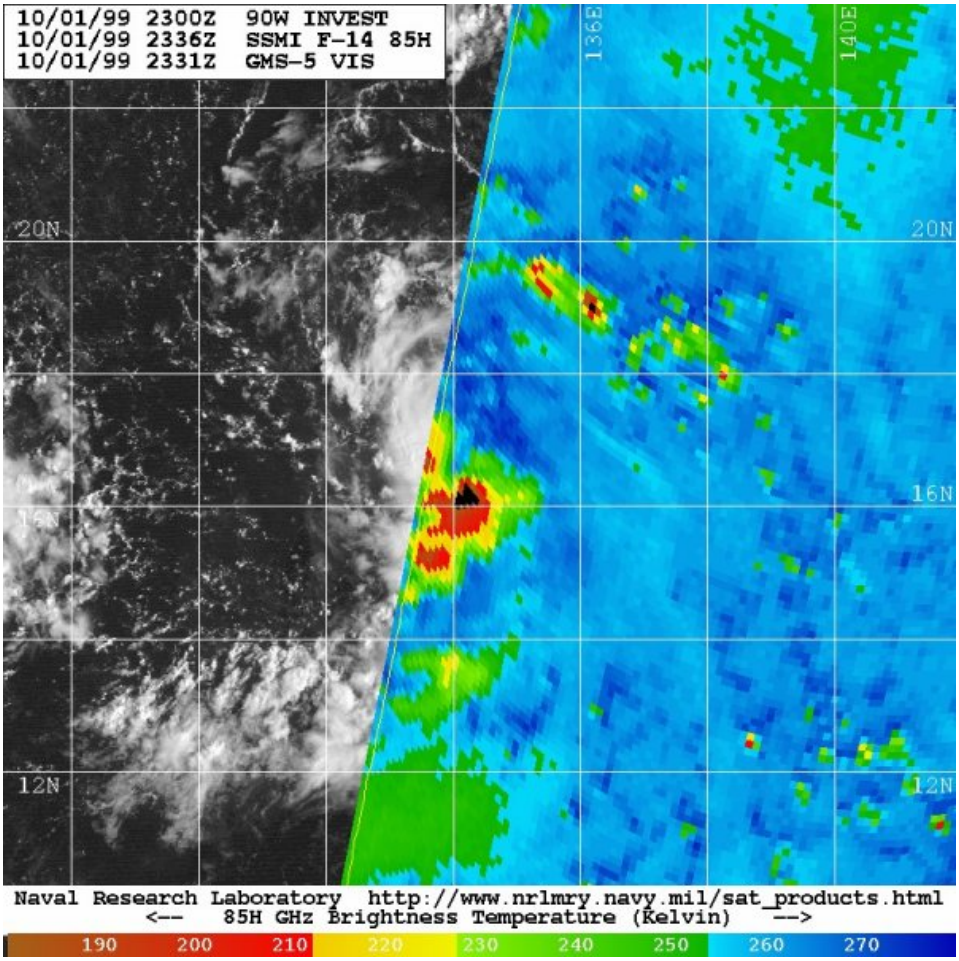


Figure 1-26-1. A 012336Z October Special Sensor Microwave Imager (SSM/I) pass combined with a 012331Z October GMS-5 visible image depicting deep convection building in over the low-level circulation center of TY Dan (26W) from the south. A TCFA was valid at the time and intensity is 20 kt.

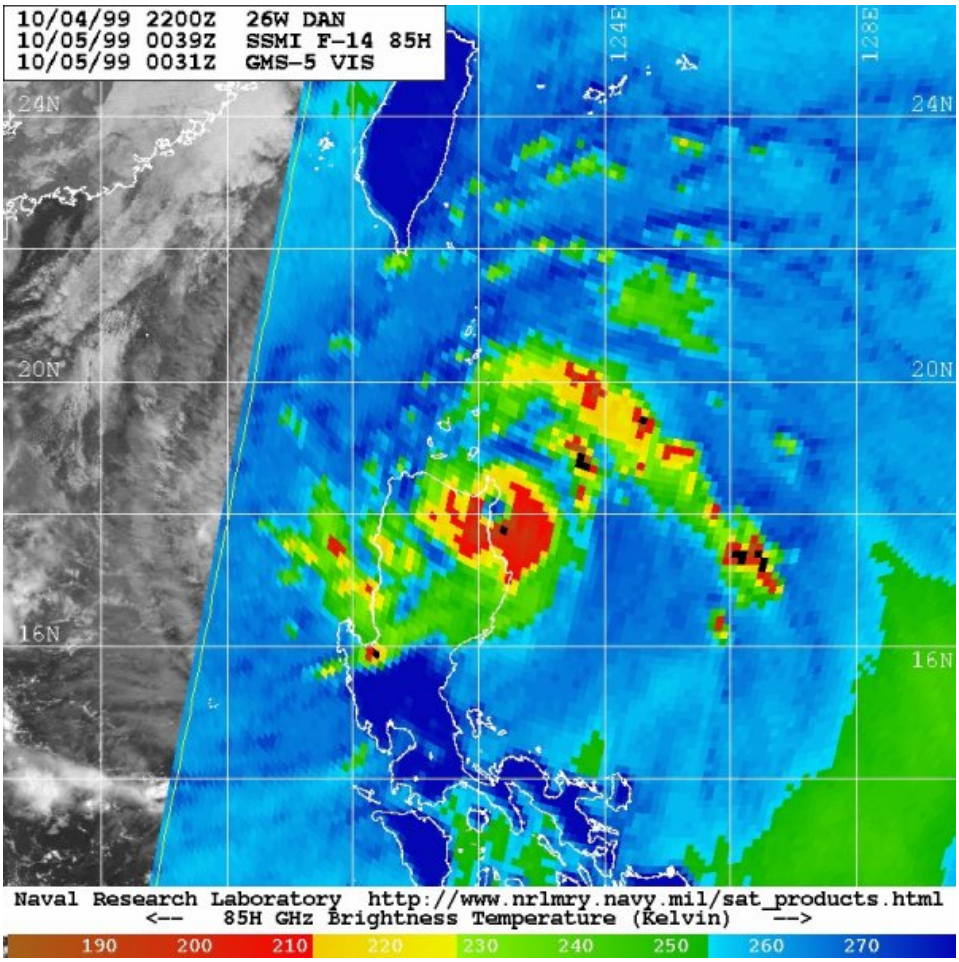


Figure 1-26-2. A 050039Z October Special Sensor Microwave Imager (SSM/I) pass depicting a 26 nm eye with a convective band situated to the northeast. TY Dan (26W) was at its maximum intensity of 110 kt.

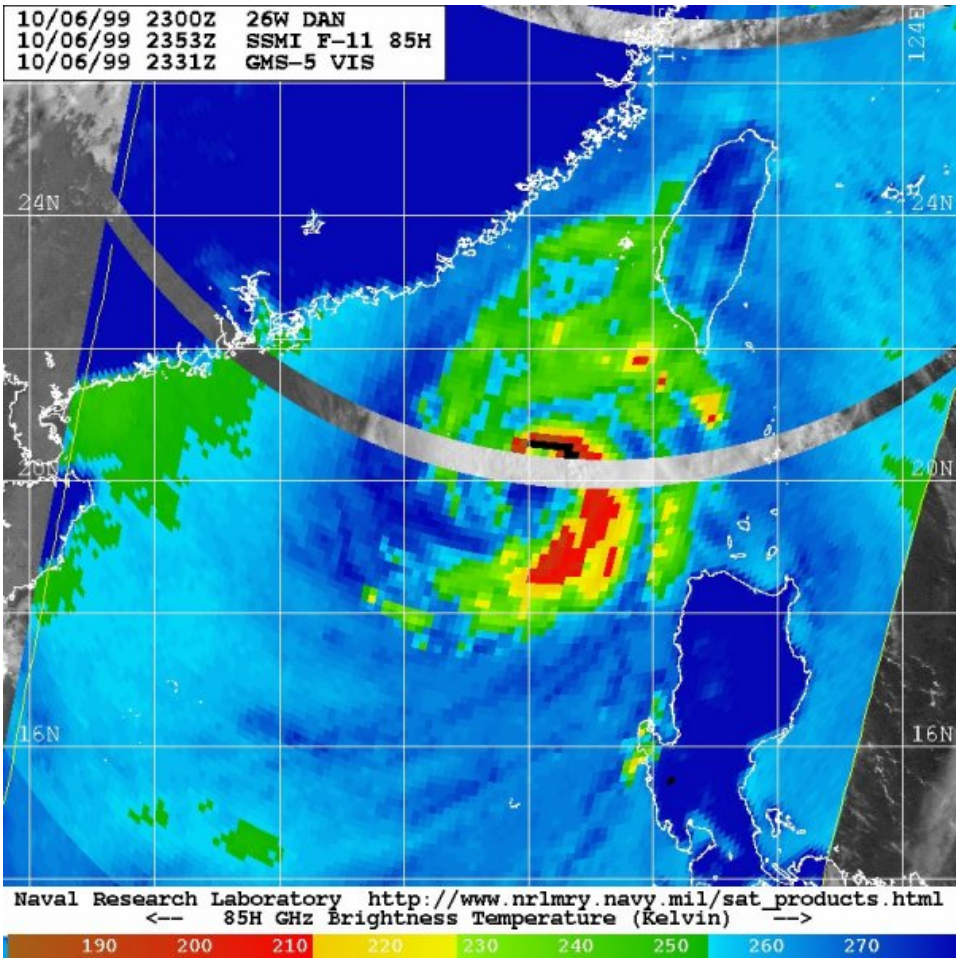


Figure 1-26-3. A 062352Z October Special Sensor Microwave Imager (SSM/I) pass depicting a significant banding feature of TY Dan (26W) extending south through north. Current intensity is 85 kt.

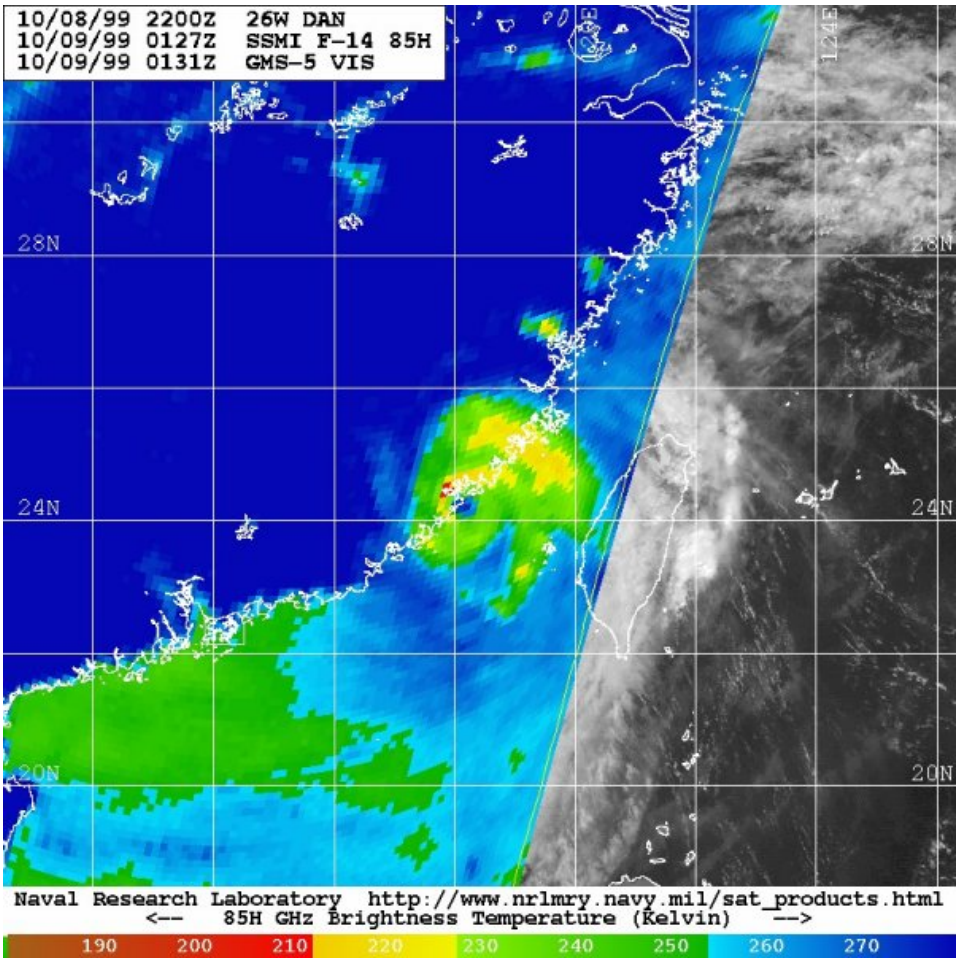


Figure 1-26-4. A 090127Z October Special Sensor Microwave Imager (SSM/I) pass depicting a 24 nm irregular eye and associated banding of TY Dan (26W) moving over the southeast coast of China. Current intensity is 90 kt.

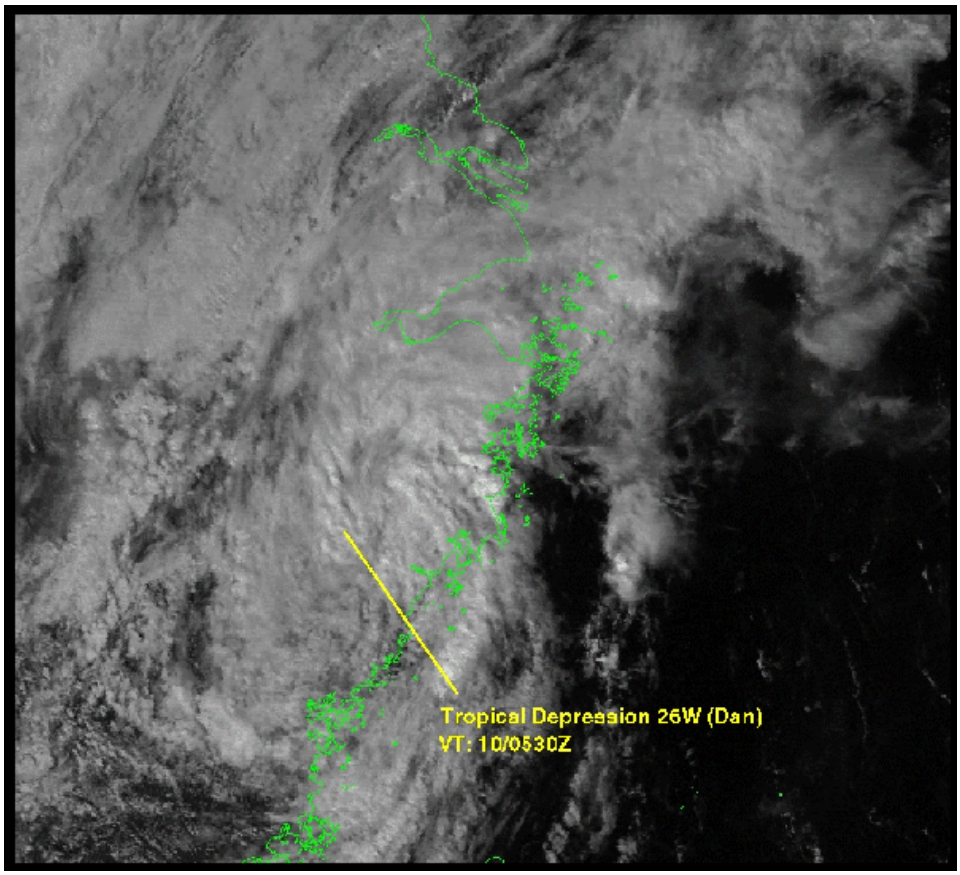


Figure 1-26-5. A 100530Z October GMS-5 visible satellite imagery shows TY Dan (26W) beginning to merge with a frontal system positioned just to the northwest. Current intensity is 25 kt.

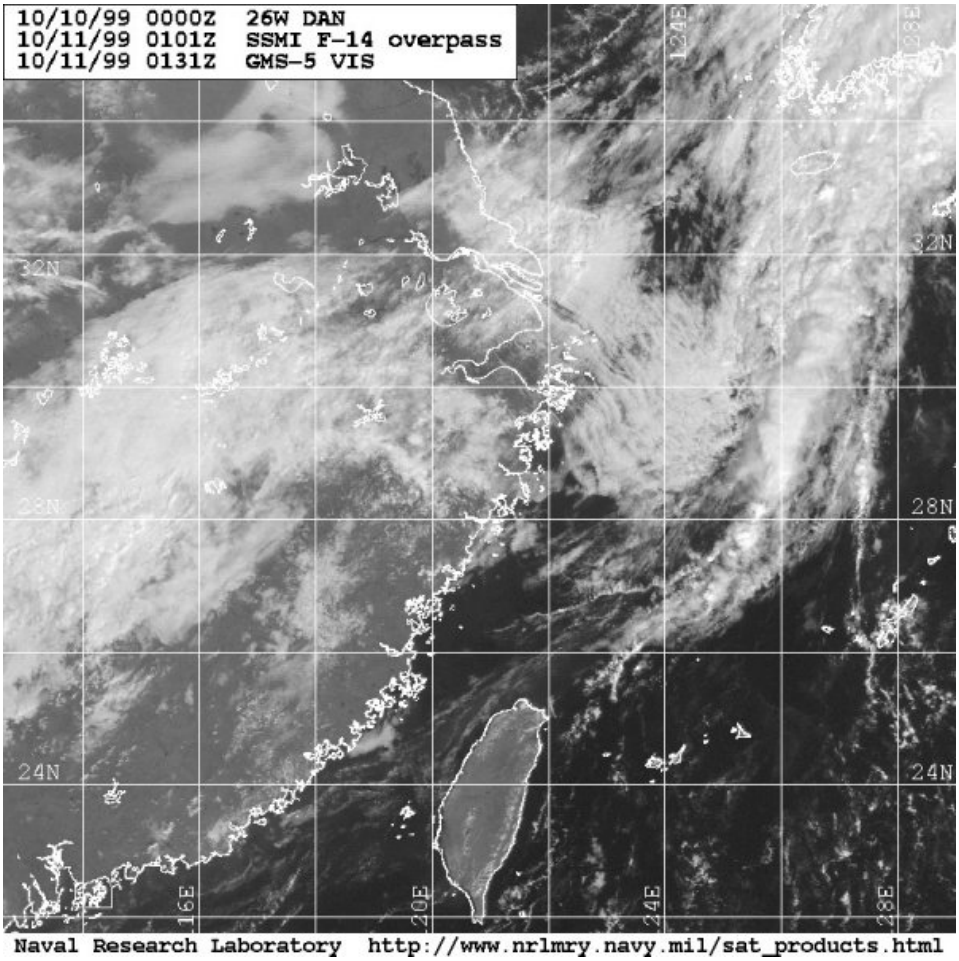
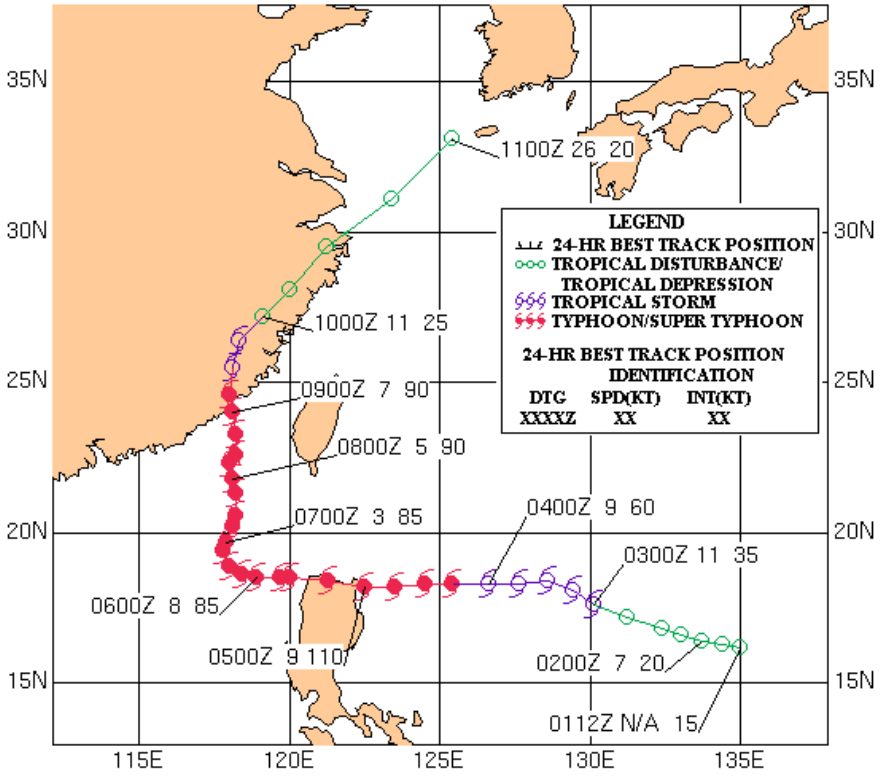


Figure 1-26-6. A 110131Z October GMS-5 visible satellite image shows TY Dan (26W) as an extratropical system now associated with a frontal boundary. Current intensity is 20 kt.


35N
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125E
130E
135E
1100Z 26 20
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)

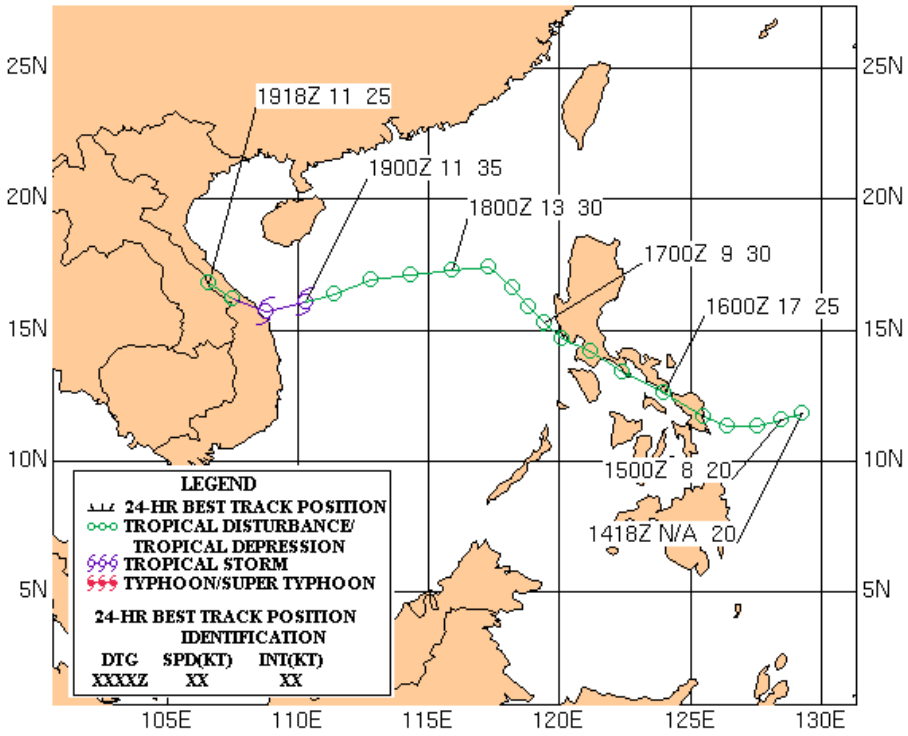
Tropical Storm (TS) Eve (27W) developed over the Philippine Sea and tracked northwestward over Samar and Luzon islands. The cyclone intensified, peaking at 35 kt, over the South China Sea and made landfall on 100600Z October southeast of Da Nang, Vietnam as a 35 kt tropical storm.

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).



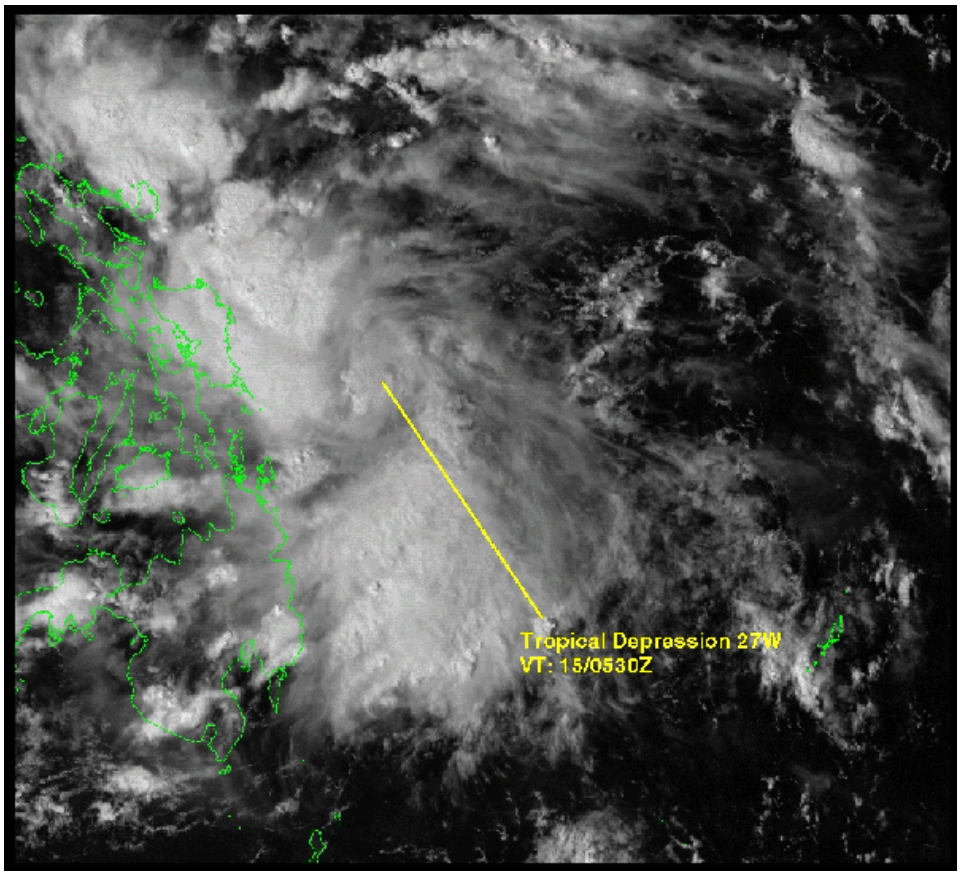


Figure 1-27-1. A visual image of TS Eve (27W), northeast of Mindanao, at 150530Z October. This image reveals the low level circulation center flanked to the northwest and southeast by clusters of convection as the system began to slowly organize. TS Eve is at 25 kt intensity.

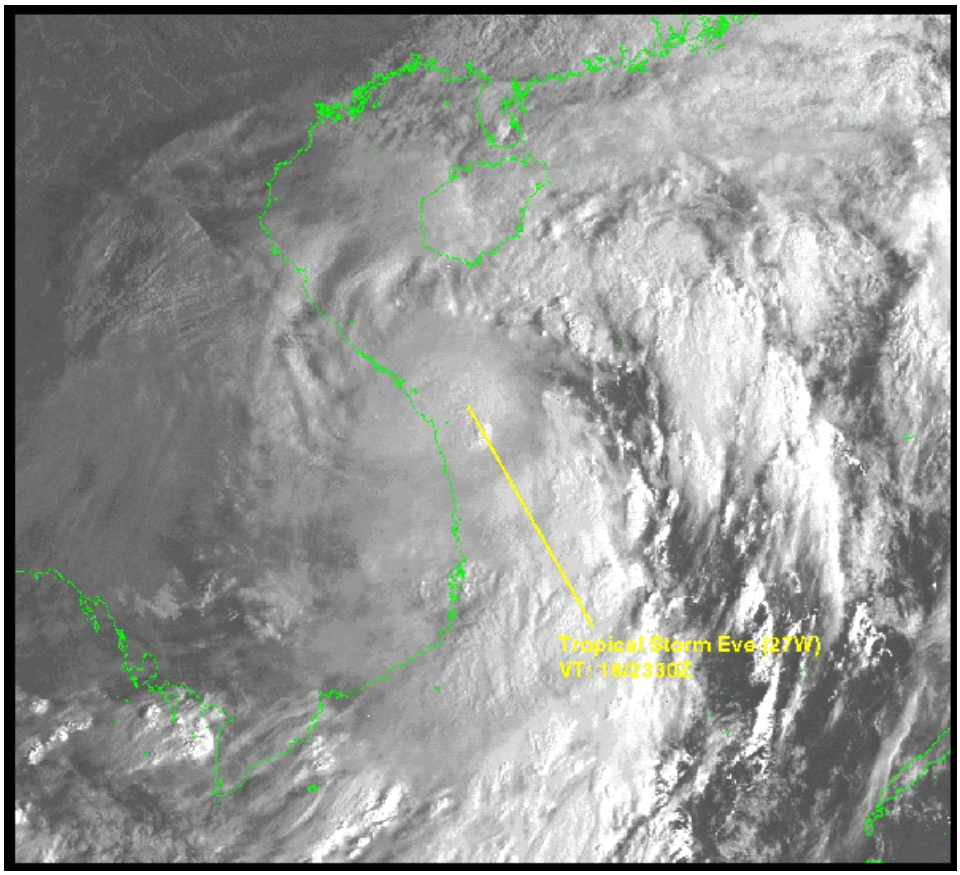


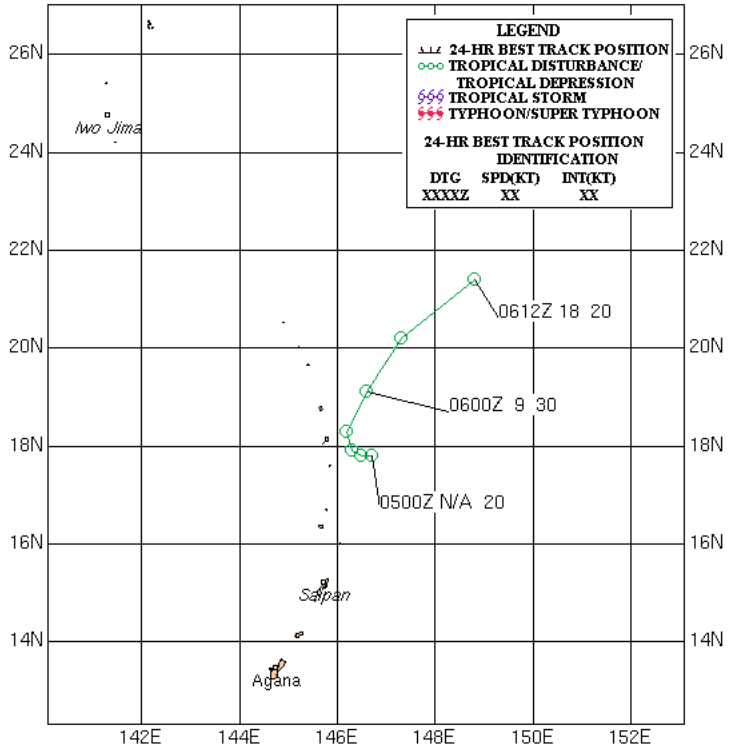
Figure 1-27-2. 182330Z October visible image of TS Eve (27W) six hours prior to landfall, just east of Vietnam. TS Eve had just reached tropical storm intensity and was tracking west-southwestward at 10-15 kt.

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.



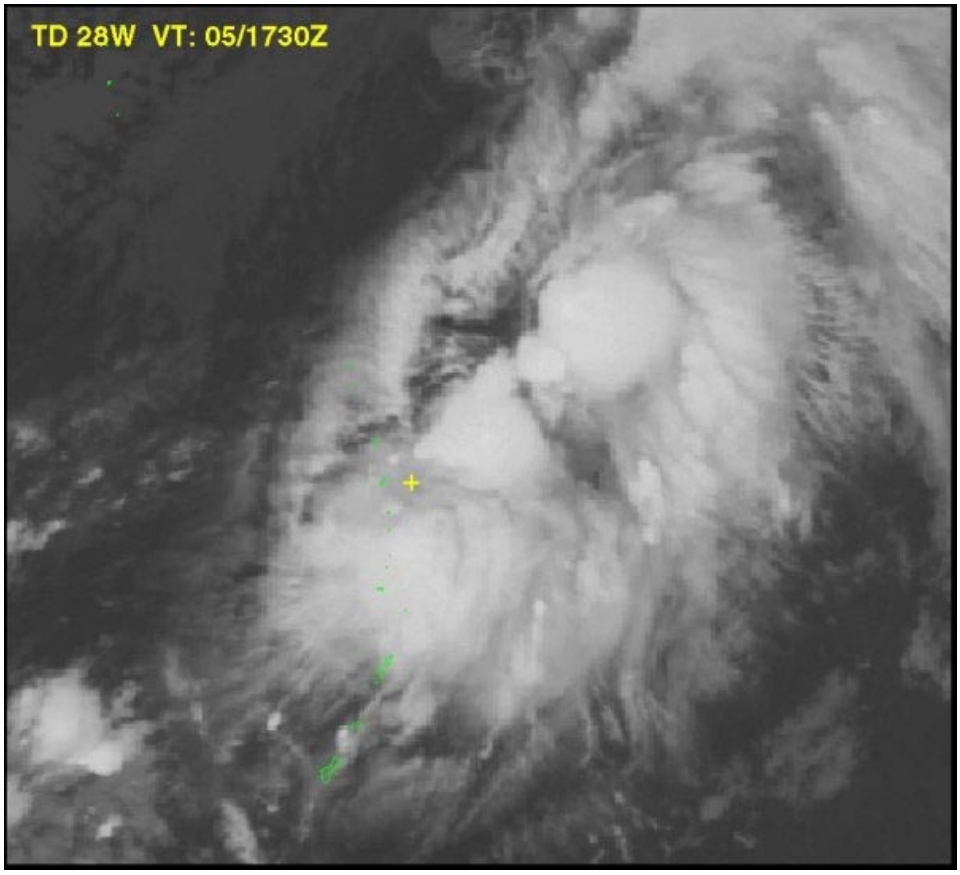


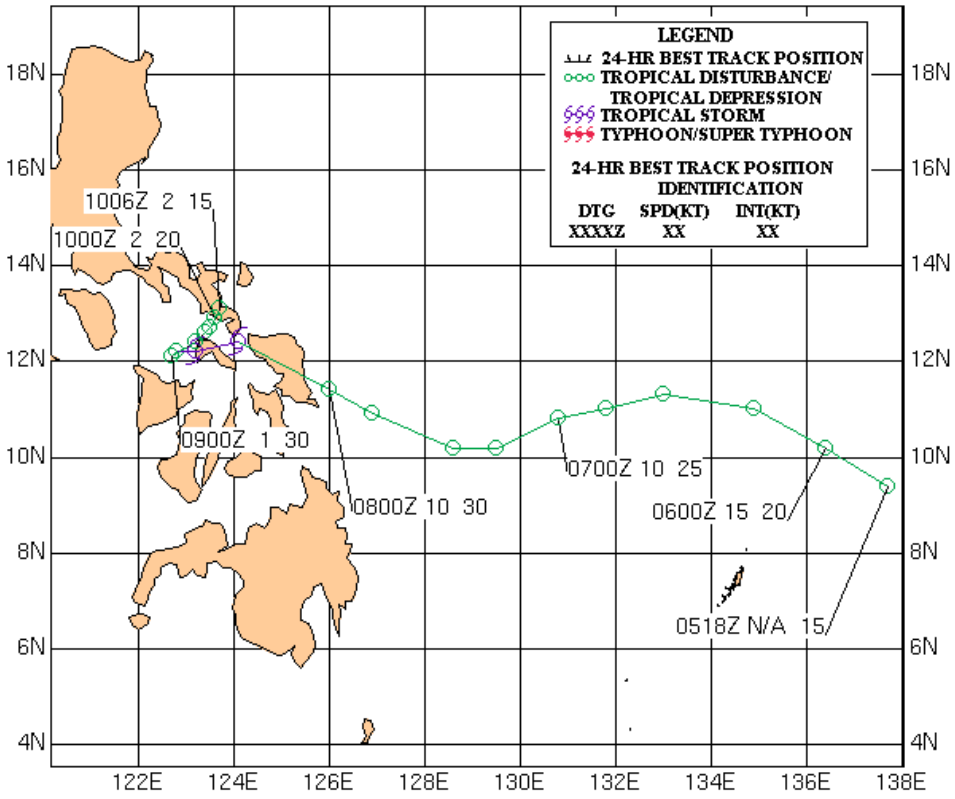
figure 1-28-1. 051730Z November GMS-5 infrared image of TD 28W at the initial warning. TD 28W was at its peak intensity of 30 kt.

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.



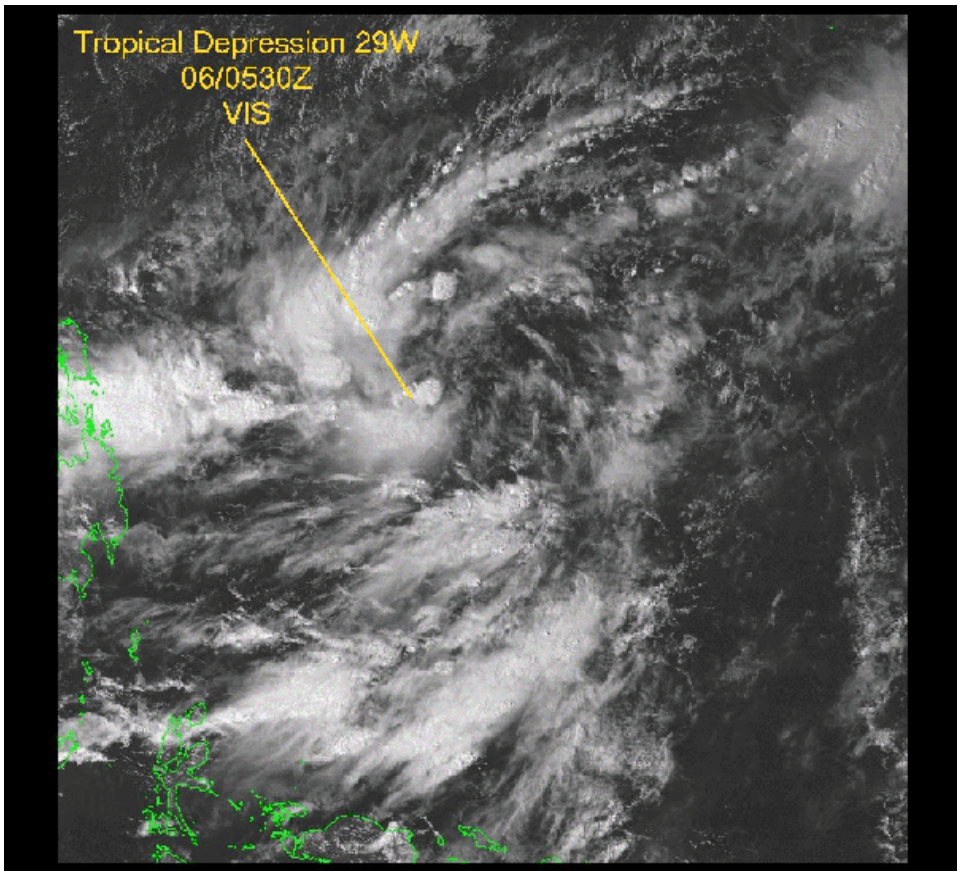


Figure 1-29-1. A visual image of TS Frankie (29W) at the initial warning at 060530Z November. This image reveals bands of deep convection beginning to develop and wrap toward the low level circulation center. Current intensity is 25kt.

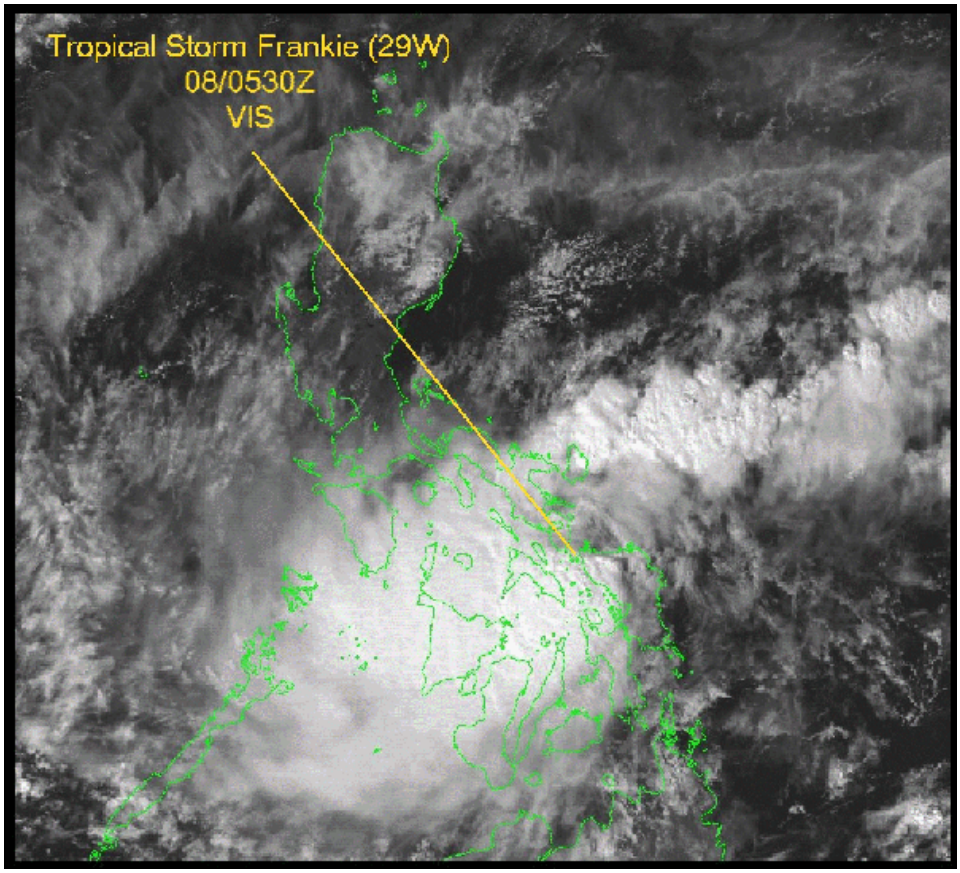


Figure 1-29-2. A visual image of TS Frankie (29W) at 080530Z November as the system began moving into the central Philippine Islands. The convection has been sheared to the west of the low level circulation center. The intensity was increased to 35 kt for the 080600Z November warning.

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.

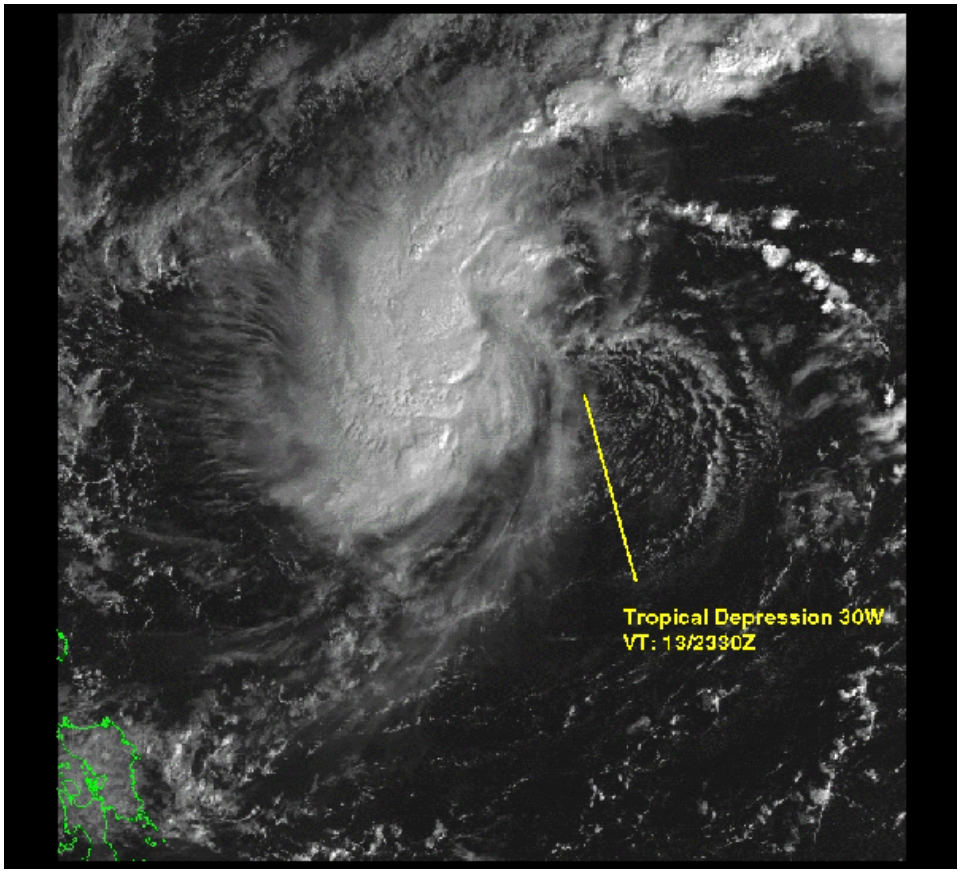


Figure 1-30-1. This visible image was taken 18 hours after the initial warning on TY Gloria (30W) at 132330Z November. A defined low-level circulation center (LLCC) remains completely exposed in the central Philippine Sea.

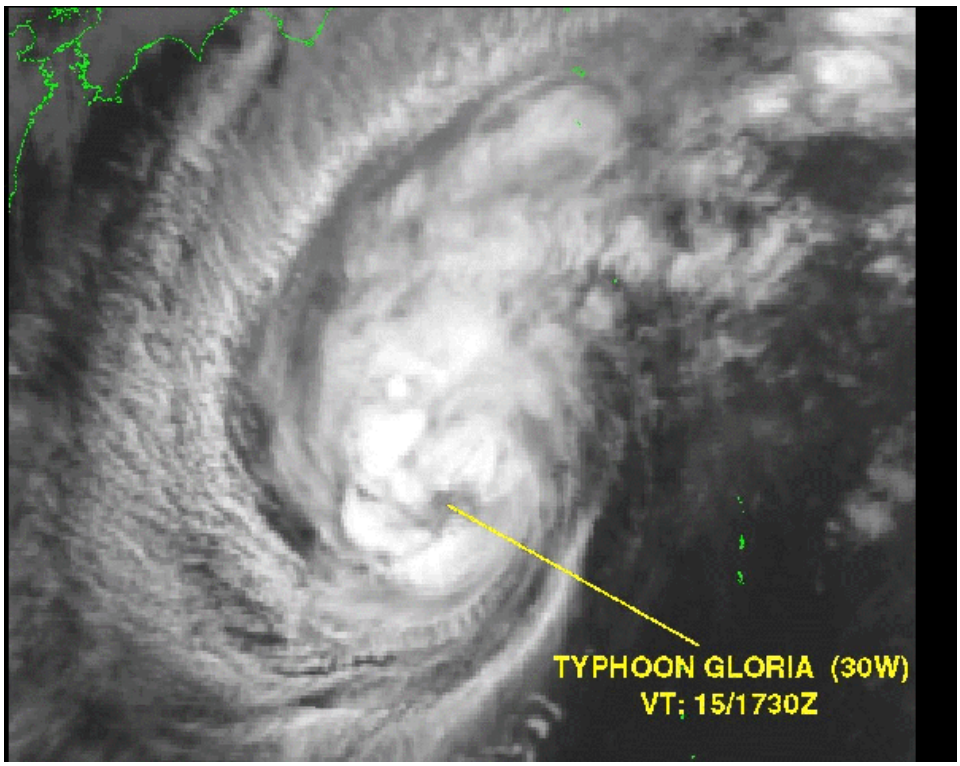
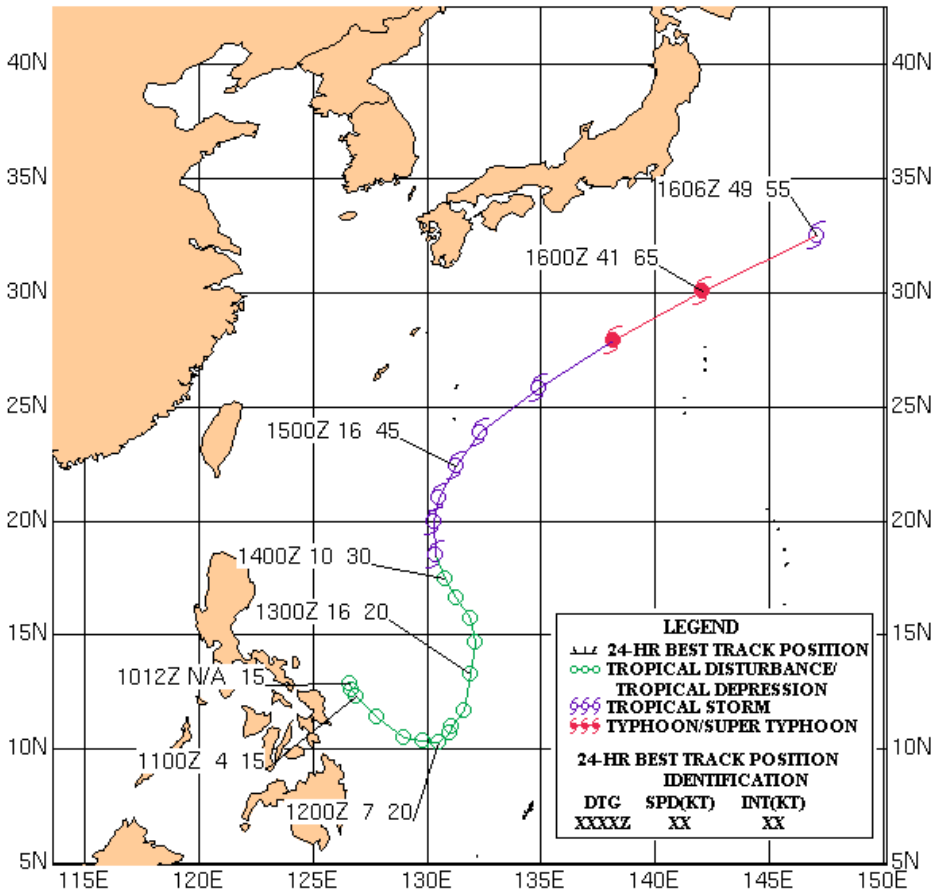


Figure 1-30-2. 151730Z November GMS-5 infrared image as Typhoon Gloria (30W) passed east of Iwo Jima. The short-term rapid intensification was just beginning as the system began extra-tropical transition and accelerated northeastward.


40N
35N
30N
25N
20N
15N
10N
5N
115E
120E
125E
130E
135E
140E
145E
150E
1606Z 49 55
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)
XXXXZ XX XX

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.

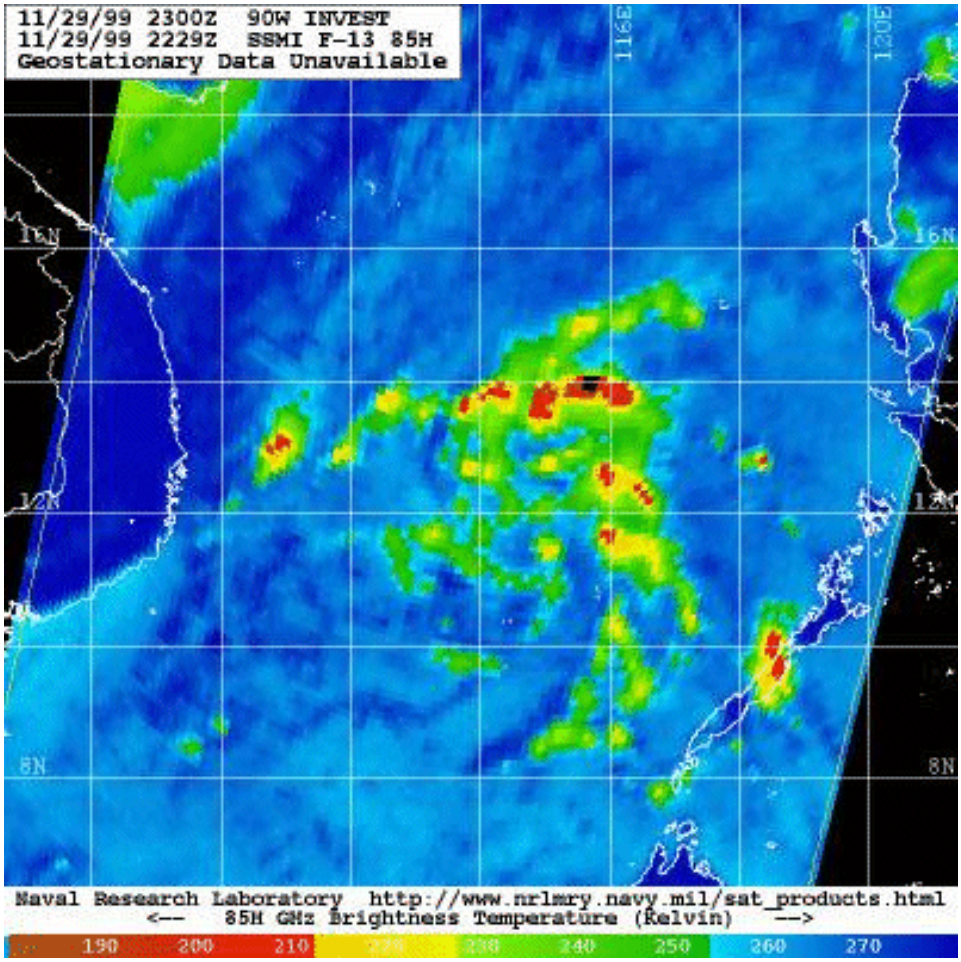


Figure 1-31-1. A Special Sensor Microwave Imager (SSM/I) image, taken at 292229Z November. A Tropical Cyclone Formation Alert was issued for this disturbance that would become Tropical Depression 31W. This image shows the increased organization and weak low-level circulation.

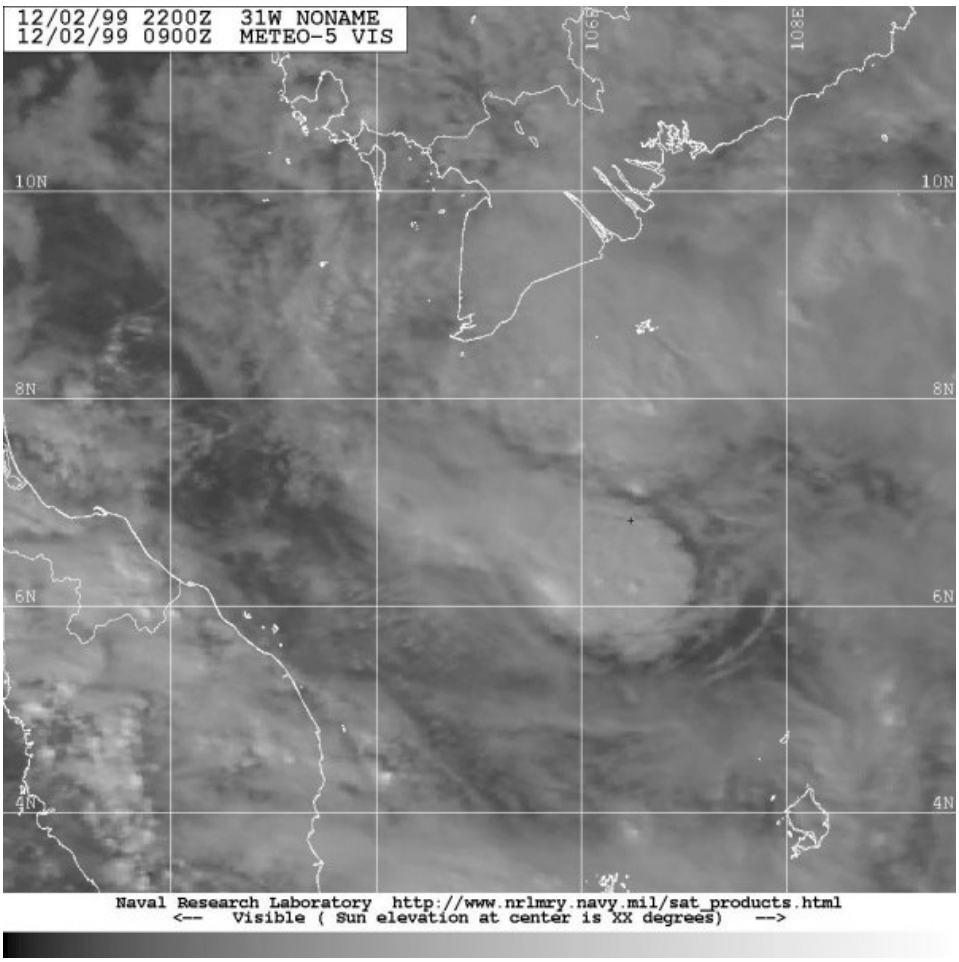
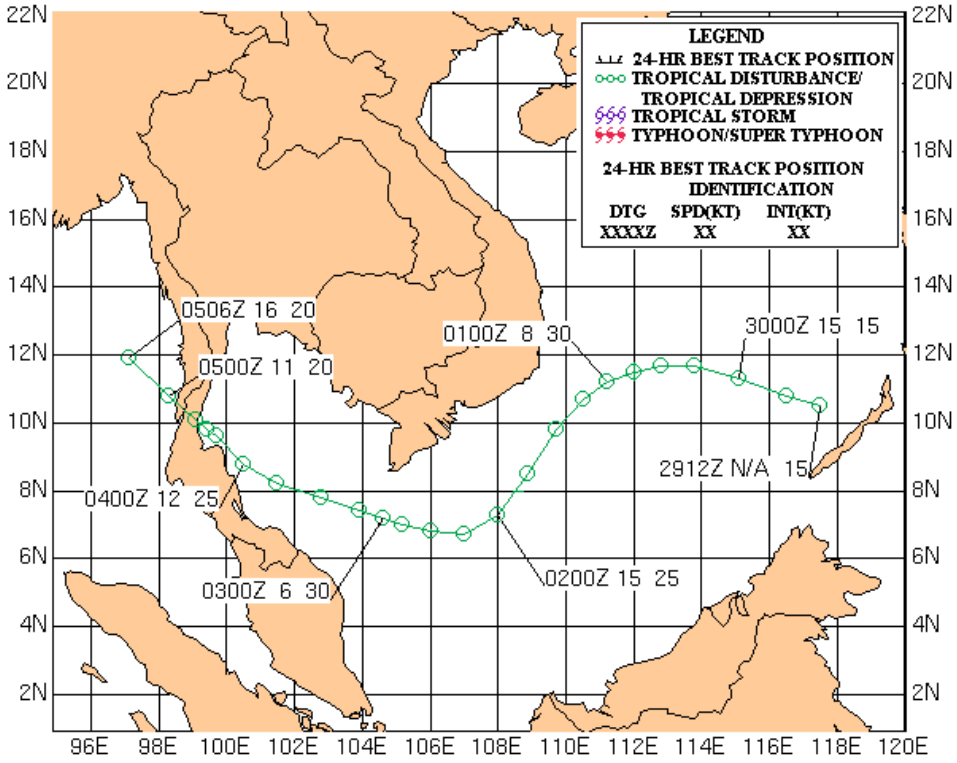


Figure 1-31-2. This visible Meteosat-5 image was taken at 020900Z December, shortly after Tropical Depression 31W was relocated 200 nm southwest. The weak low-level circulation is difficult to locate (near 6.8N 106.5E) and the moderate vertical wind shear environment is evident in the satellite imagery.


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
0100Z 8 30
3000Z 15 15
2912Z N/A 15
0400Z 12 25
0300Z 6 30
0200Z 15 25
22N
20N
18N
16N
14N
12N
10N
8N
6N
4N
2N
96E
98E
100E
102E
104E
106E
108E
110E
112E
114E
116E
118E
120E

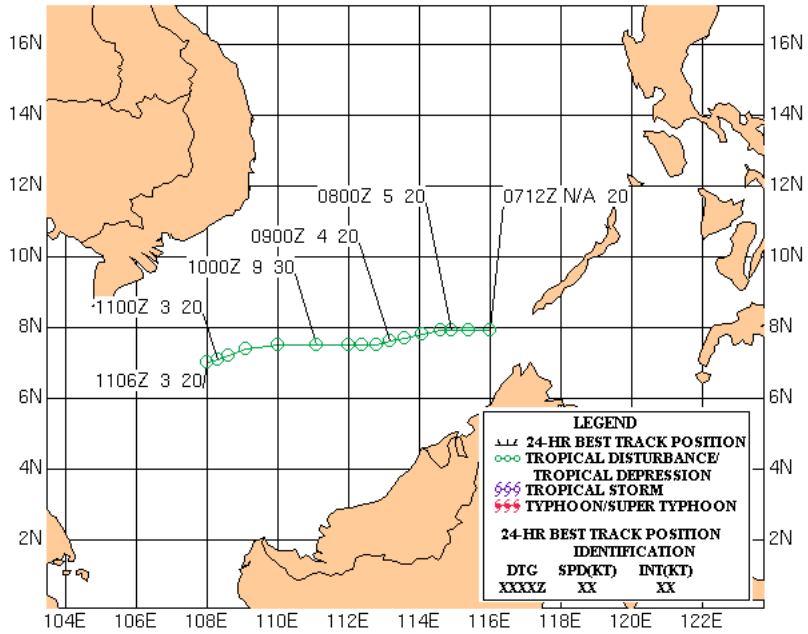
Tropical Depression 32W

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.



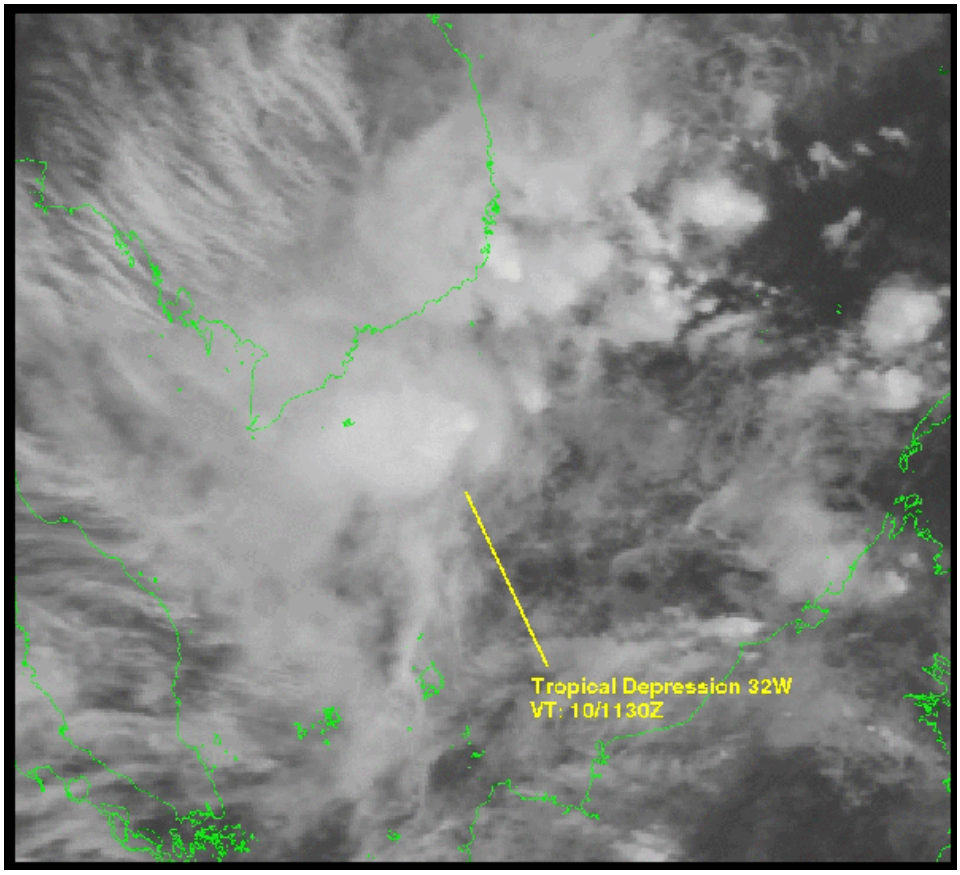


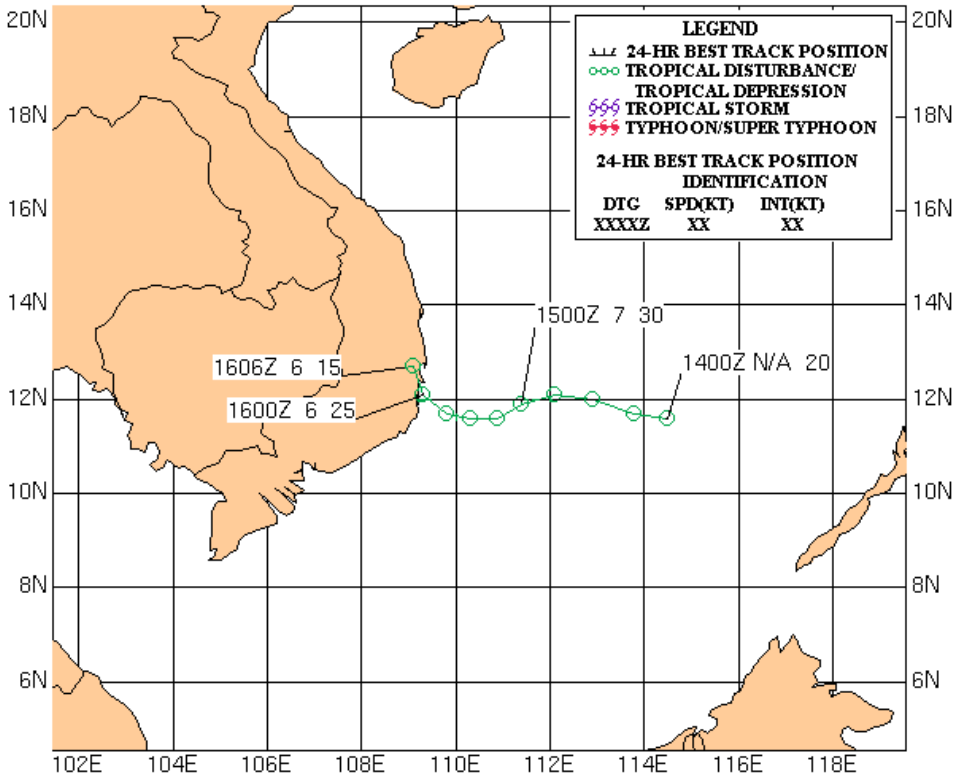
Figure 1-32-1. 101130Z December GMS-5 infrared satellite image of TD 32W at its peak intensity of 30 kt. The low-level circulation center (LLCC) is nearly indistinct in the image. This system once again showed the value of microwave satellites, passive and active, which can see through the upper-level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



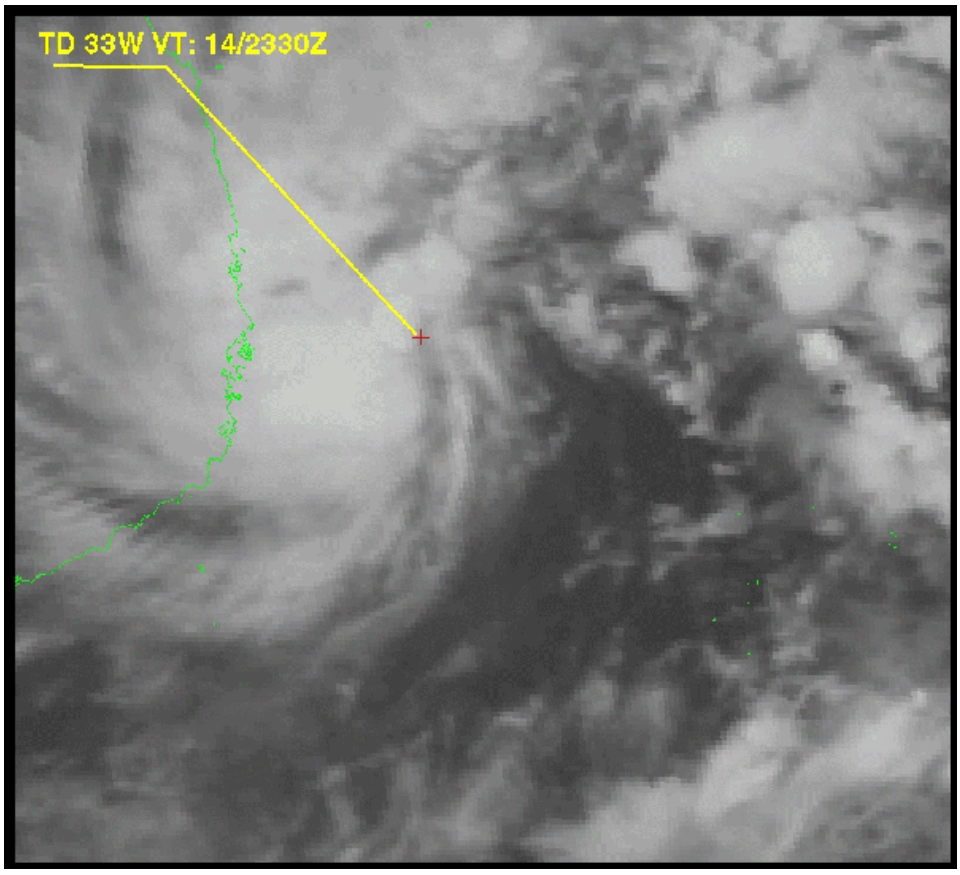


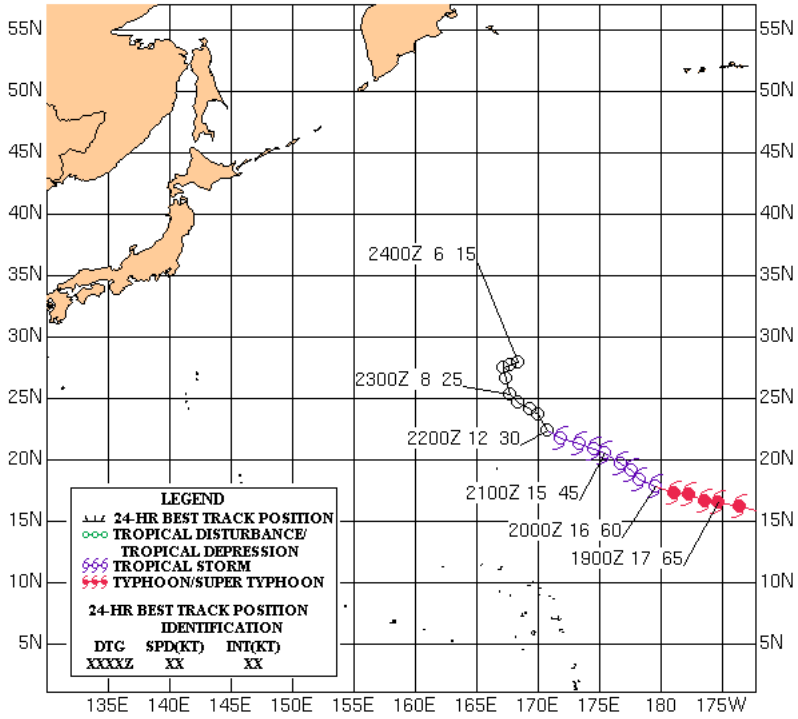
Figure 1-33-1. 142330Z December GMS-5 visible image of TD 33W as it approached the Vietnam coast. Current intensity is 30 kt.

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.



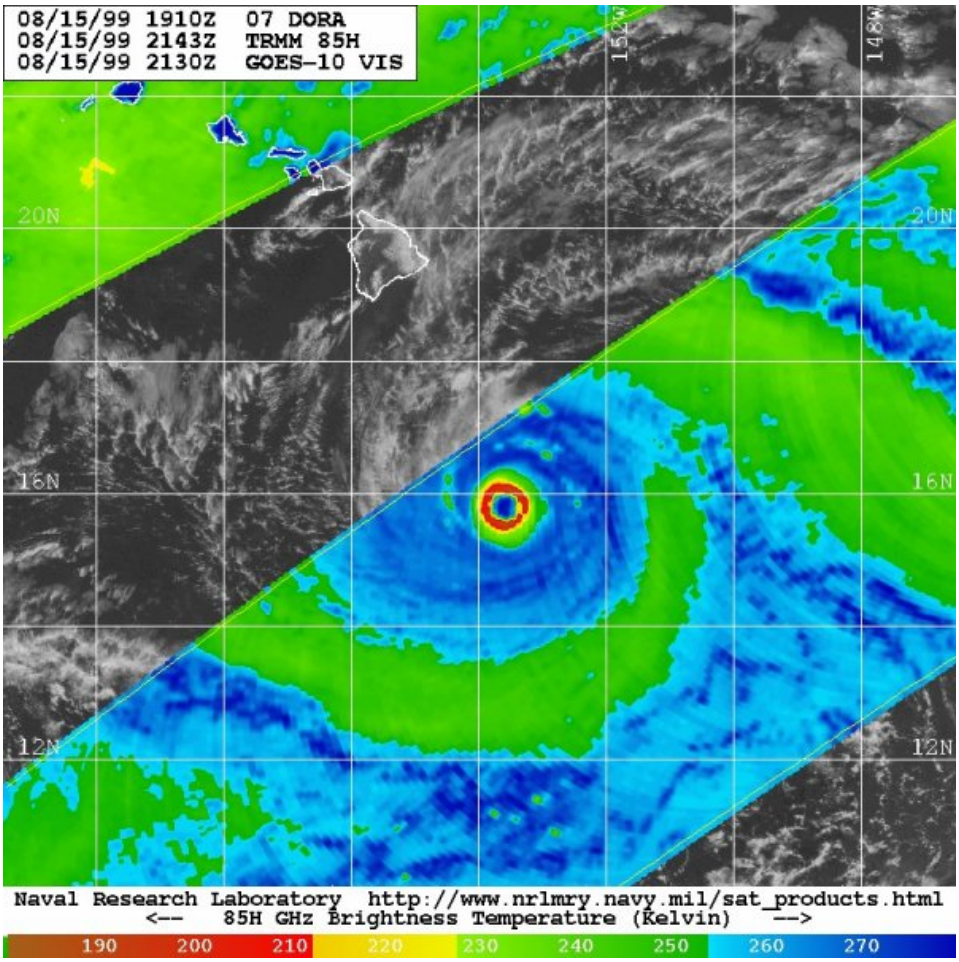


Figure 1-07E-1. 152143Z August Tropical Rainfall Measuring Mission (TRMM) microwave image overlaid on 152130Z August GOES- 10 visible satellite imagery created by the Naval Research Laboratory (NRL). Of note is the extremely intense eye-wall feature. Hurricane Dora passed south of the Island of Hawaii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

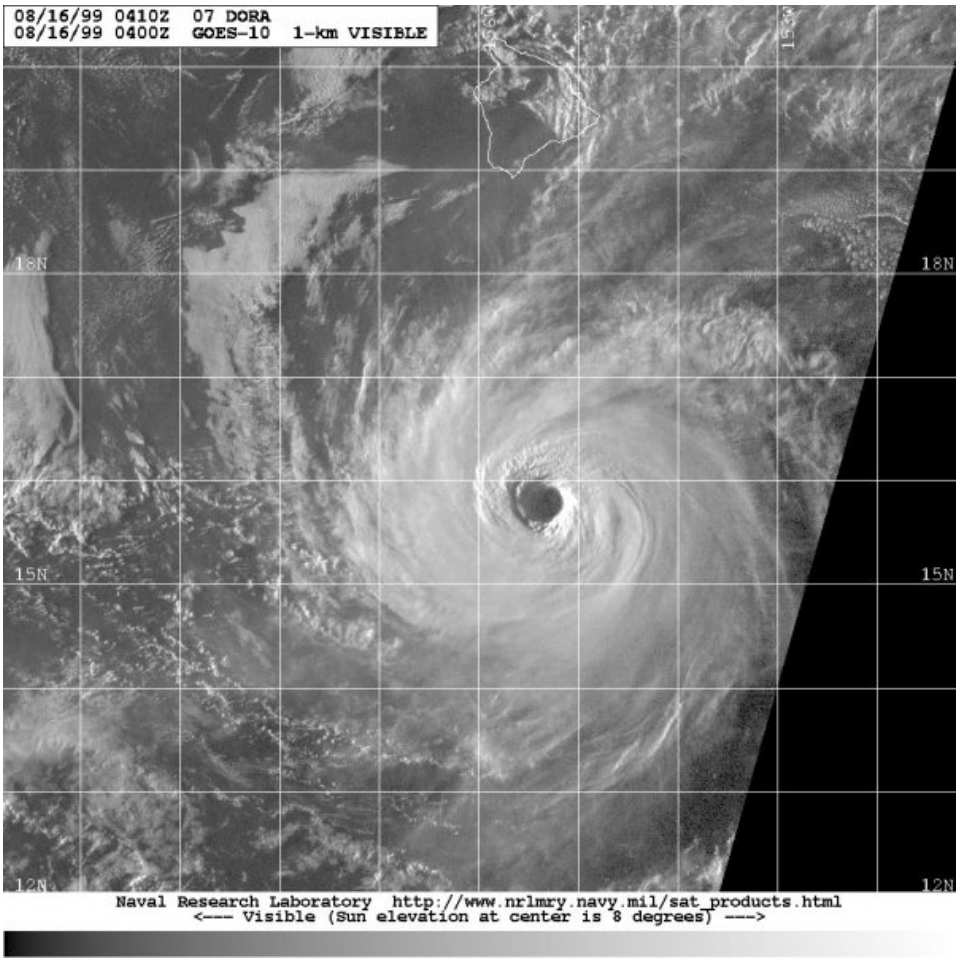


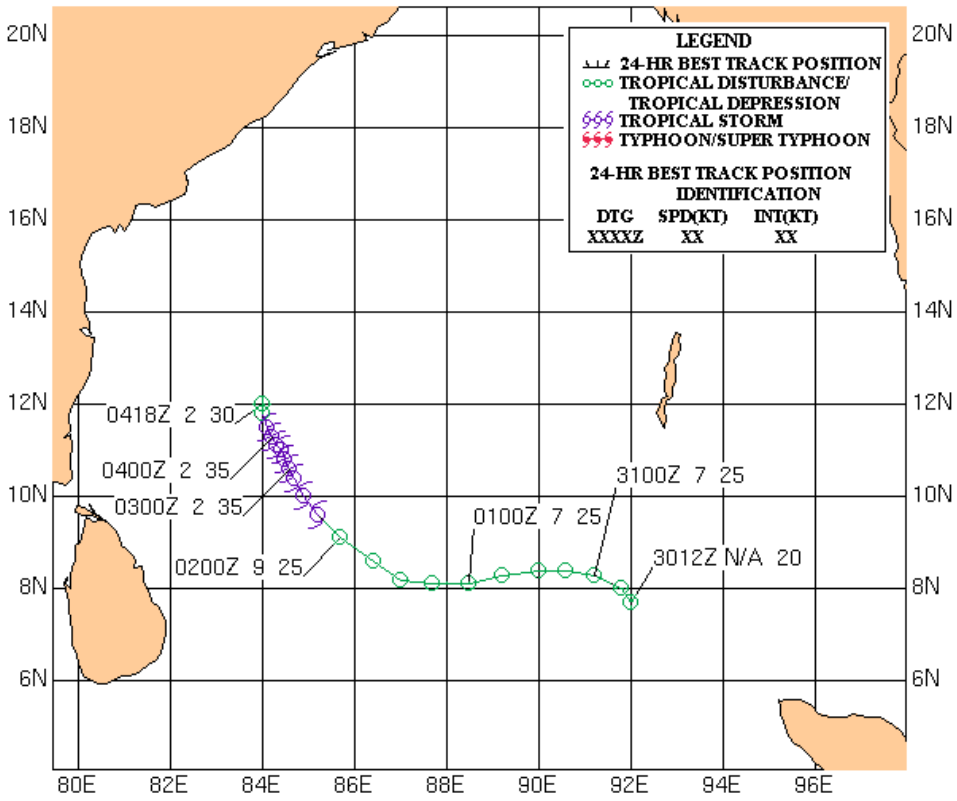
Figure 1-07E-2. 160400Z August GOES-10 visible satellite imagery showing the well-defined eye of Hurricane Dora as it passed south of the Island of Hawaii with an intensity of 100 kt. The system went on to pass 65 nm to the south of Johnston Atoll, but caused no significant damage.

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.



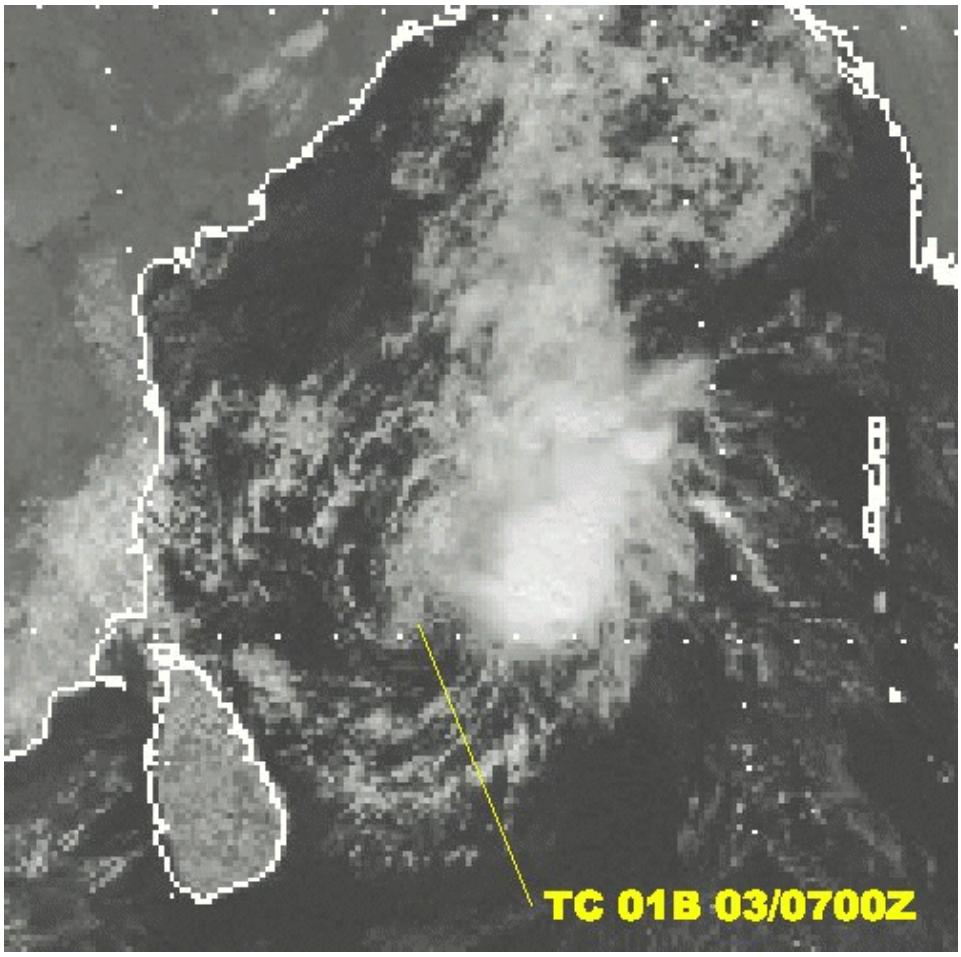


Figure 1-01B-1. This visible satellite imagery is indicative of the strong vertical wind shear environment in which TC 01B was situated as its maximum intensity. The Northeastern Monsoon coupled with strong southwesterly flow in the upper-levels is typical of this time of year, inhibiting tropical cyclone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

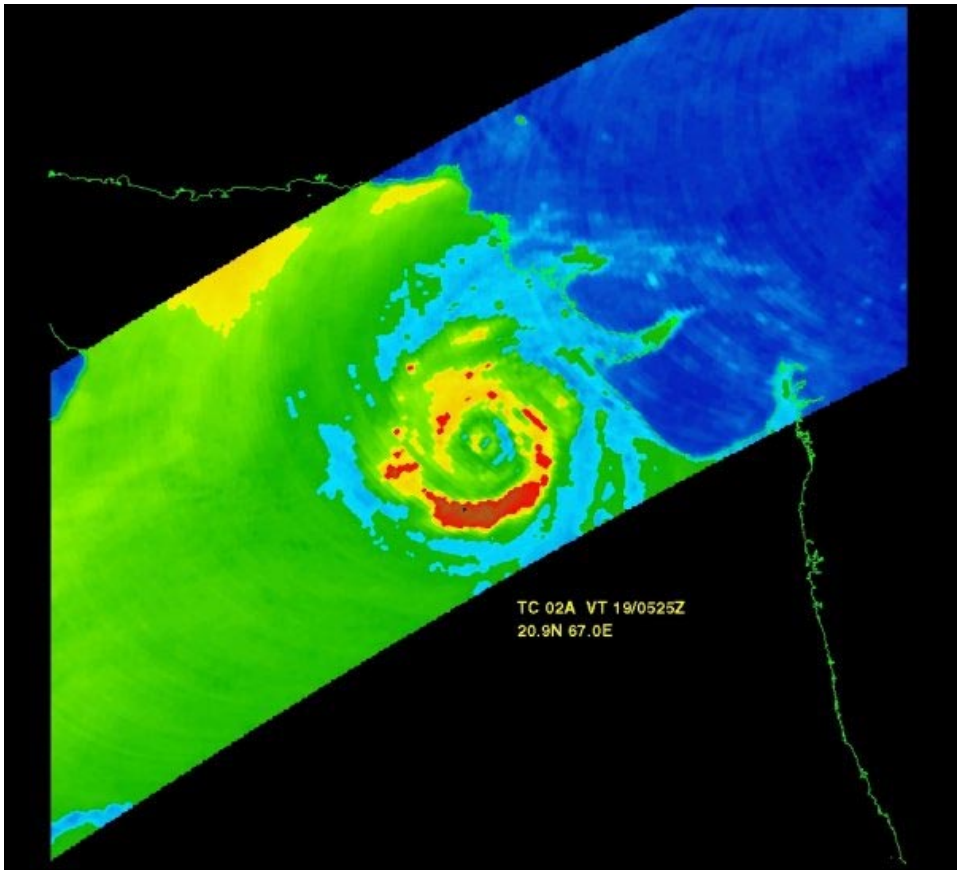
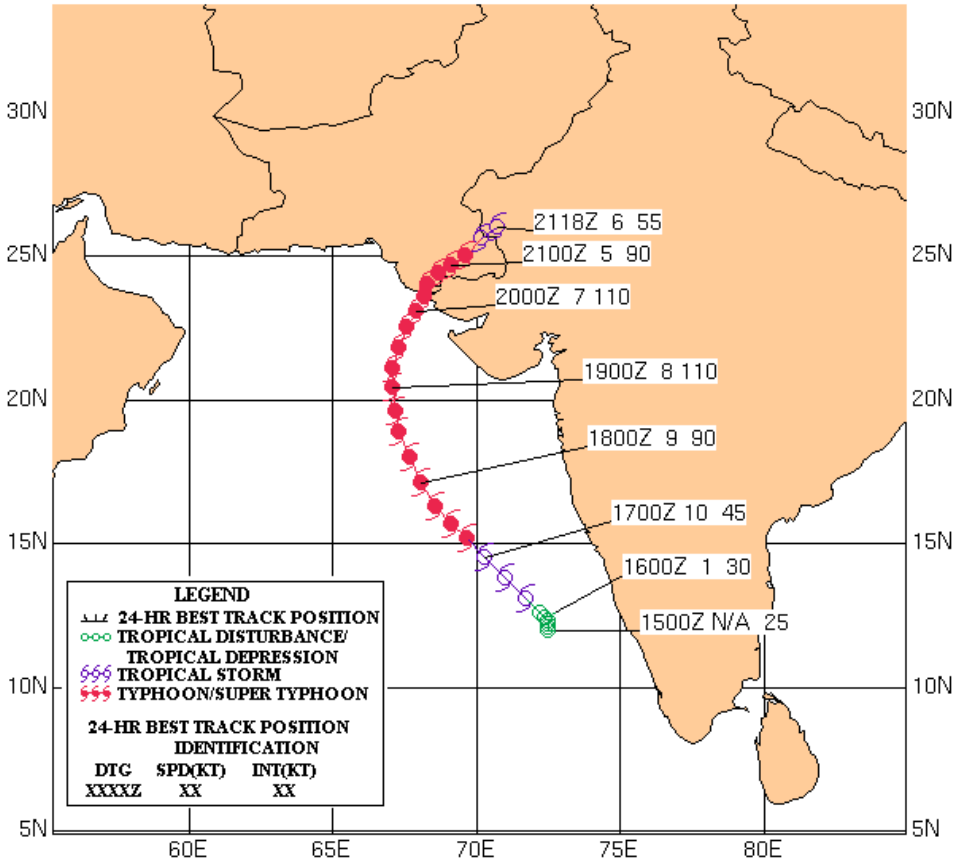


Figure 1-02A-1. 190525Z May SSM/I pass over TC 02A as it reached maximum intensity (110 kt) 235 nm south of Karachi. Of note in this image is the concentric eyewall. Continuing development served to weaken the inner eyewall, which was replaced by the outer, stronger feature.


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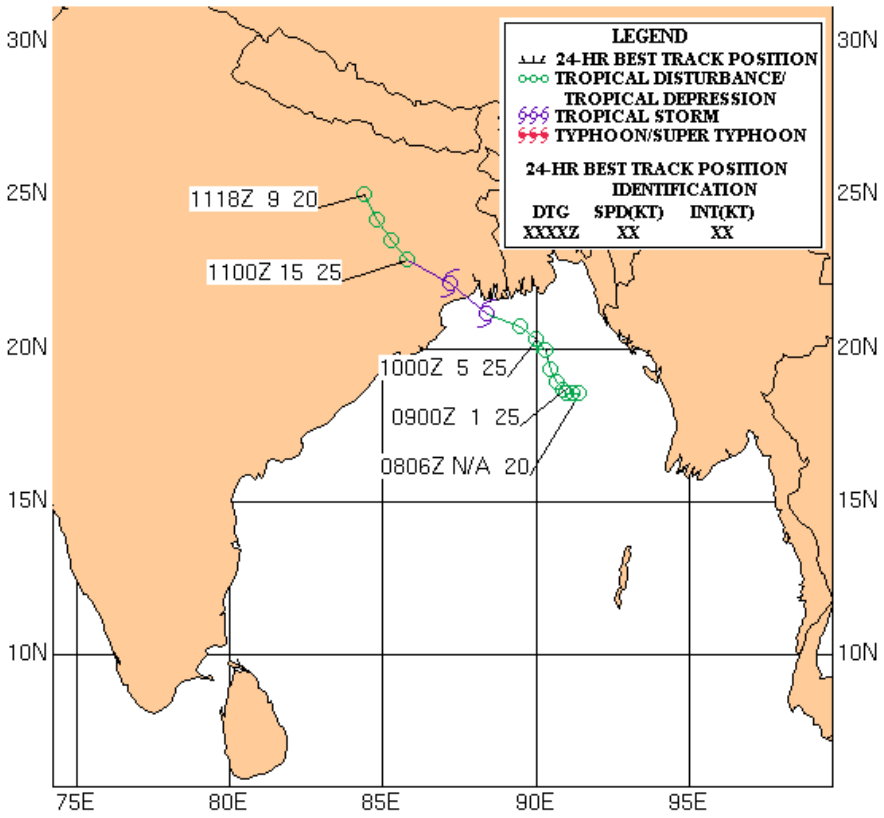
2118Z 6 55
2100Z 5 90
2000Z 7 110
1900Z 8 110
1800Z 9 90
1700Z 10 45
1600Z 1 30
1500Z N/A 25
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/ TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XX

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.



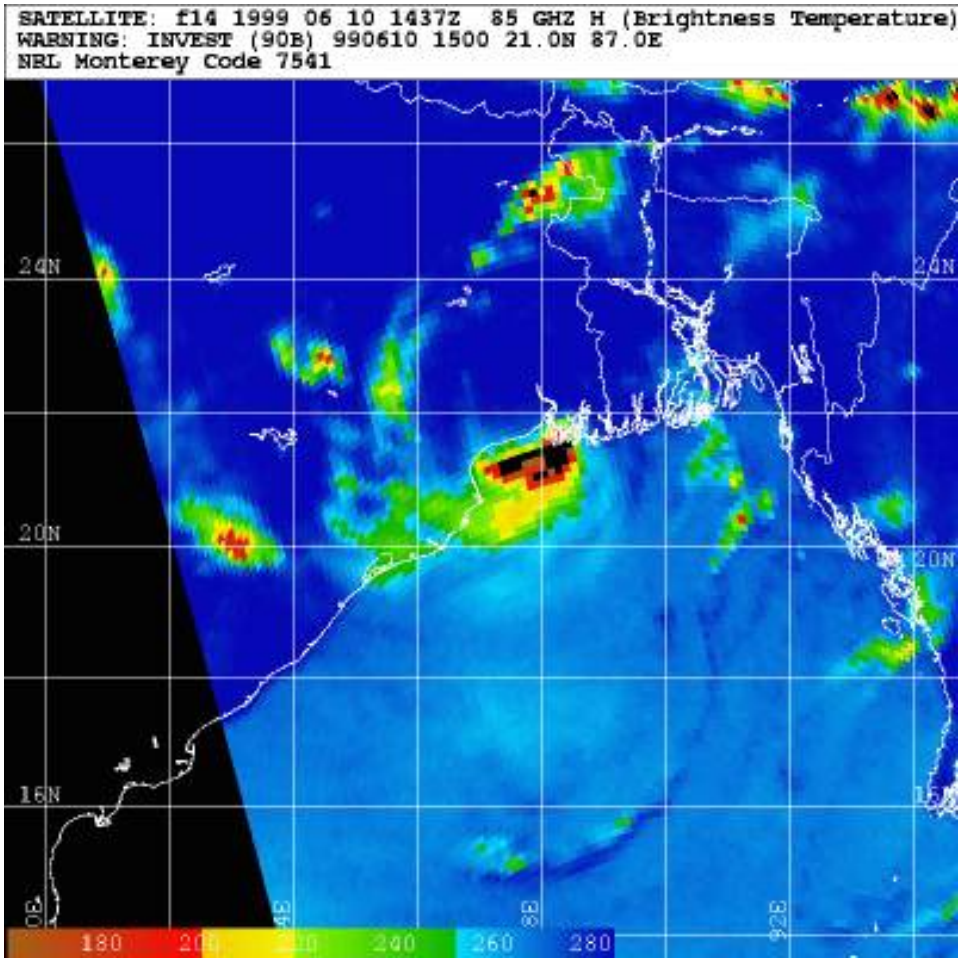
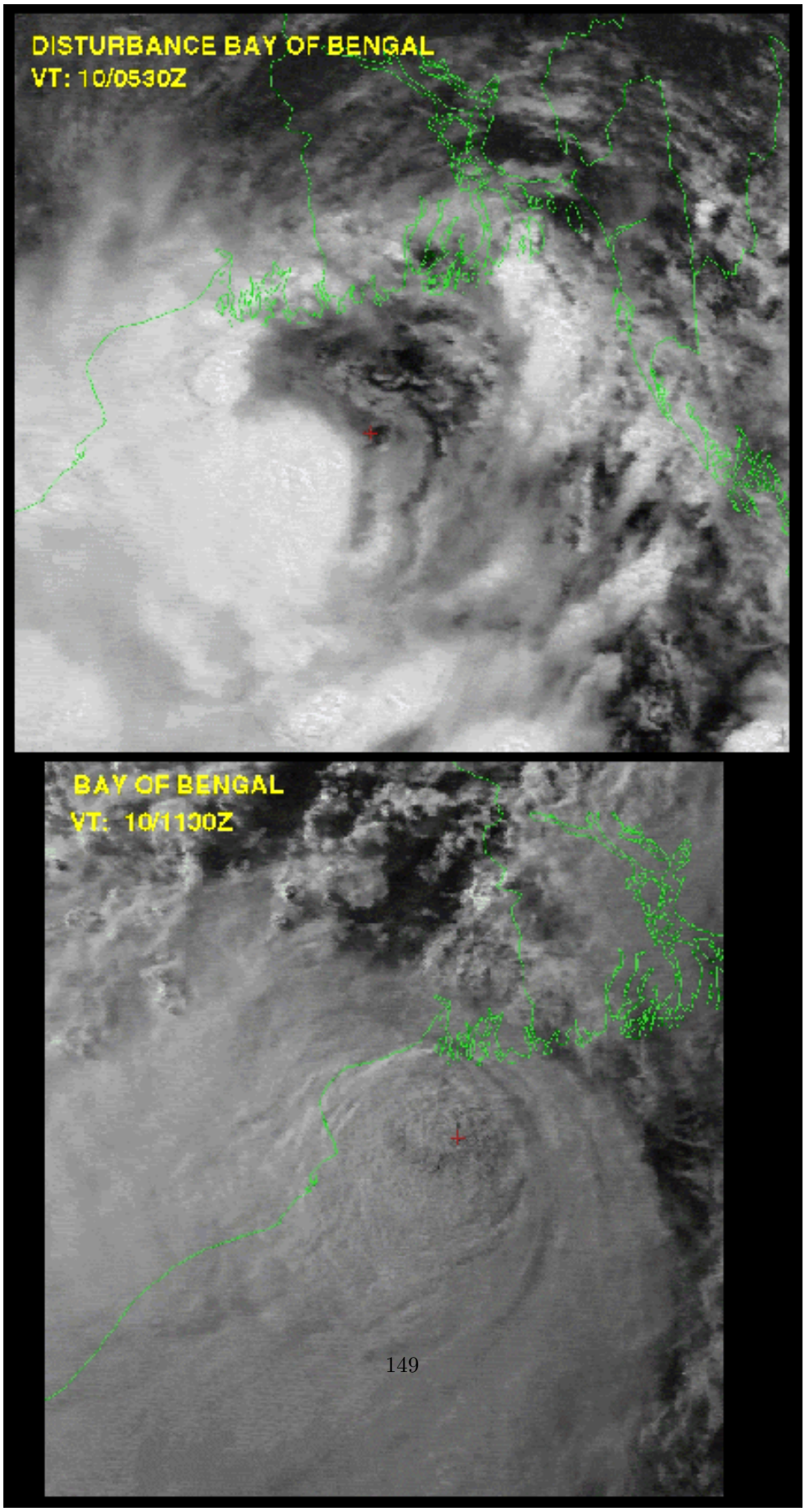


Figure 1-03B-1. 101437Z SSM/I pass over TC 03B as it makes landfall 90 nm southwest of Calcutta. Of note in this image is the strong convection to the south over the water. Interaction with land has served to weaken the system, over land, yet the low-level circulation continues to produce convection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

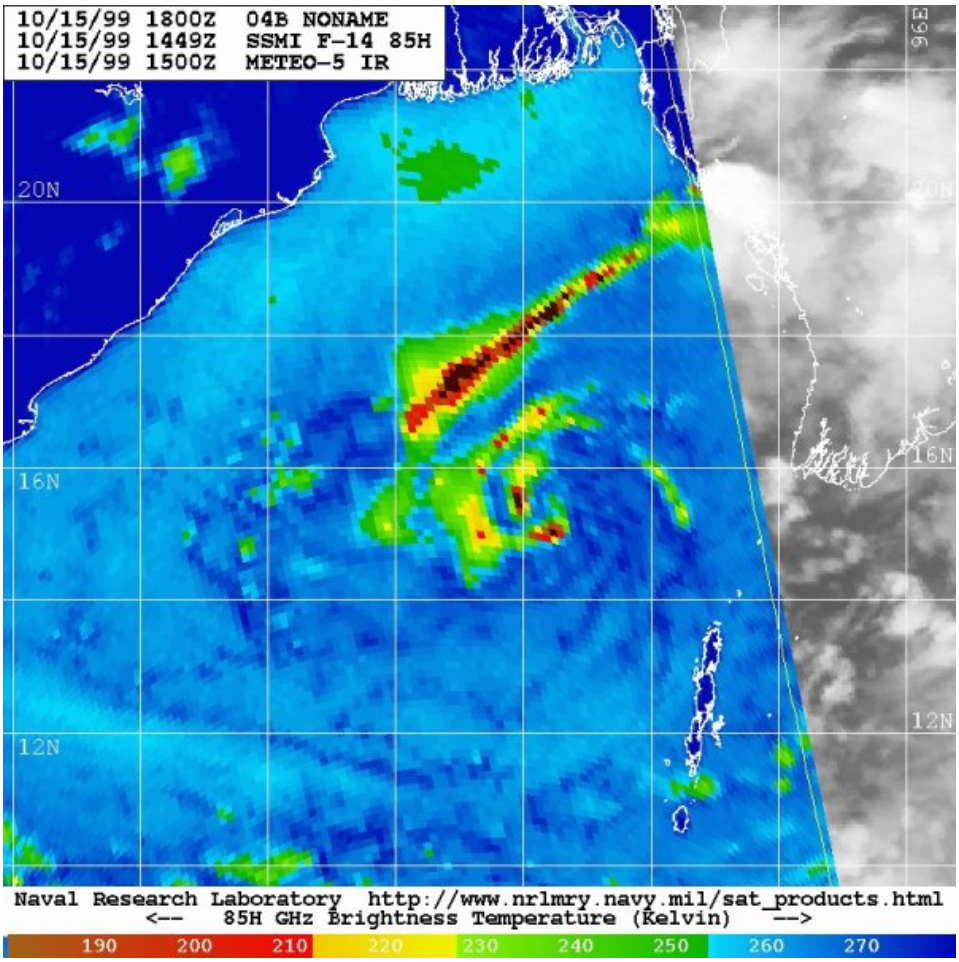


Figure 1-04B-1. 151449Z October combined SSM/I and infrared image from NRL reveals deep convection building in toward the low level circulation center from the northwest. Current intensity was 30 kt, but three hours later it was 45 kt.

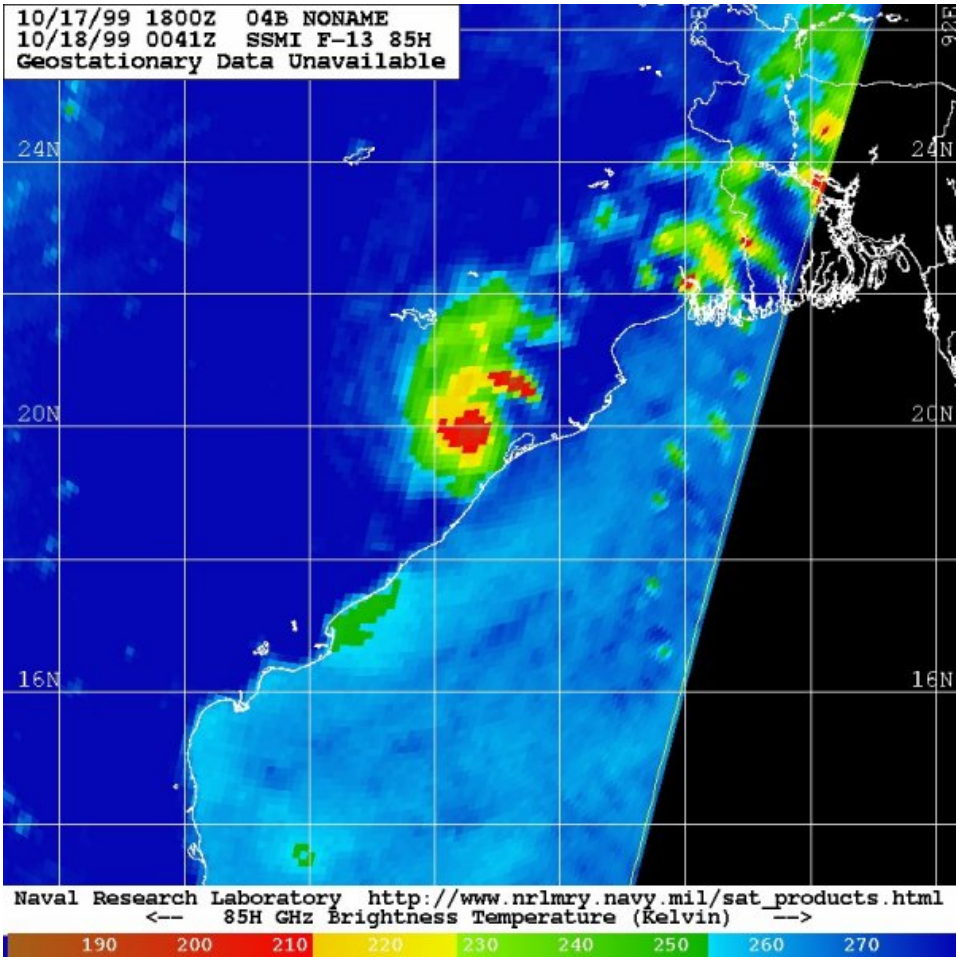
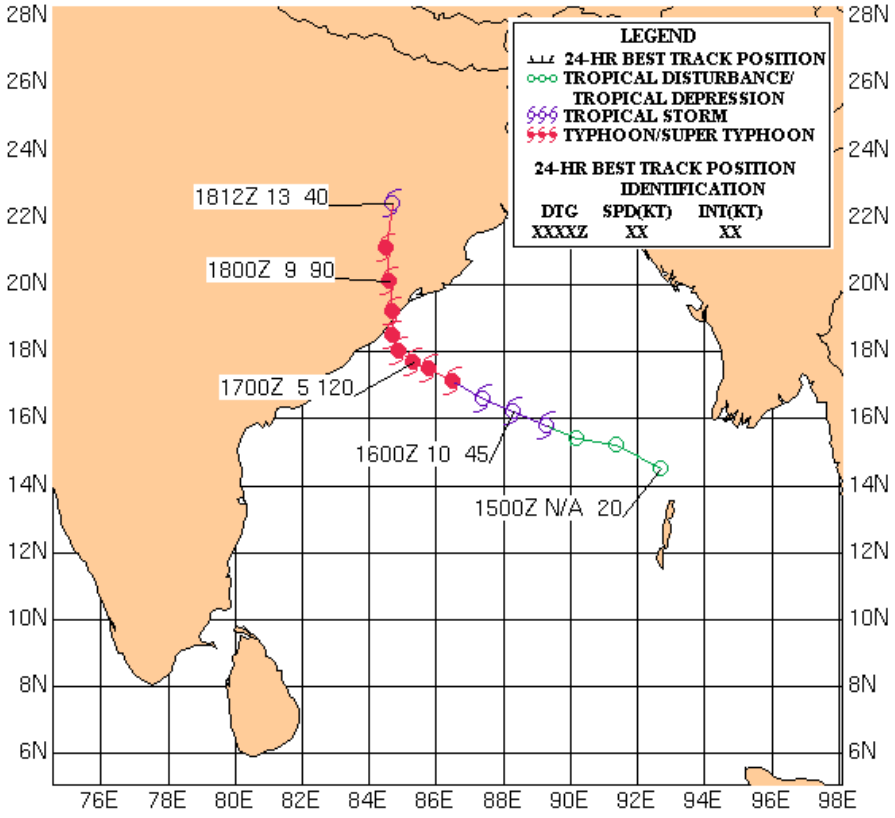


Figure 1-04B-2. 180041Z October SSM/I pass indicates little change in intensity and structure of the system after landfall. Current intensity was 90 kt.


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
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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."

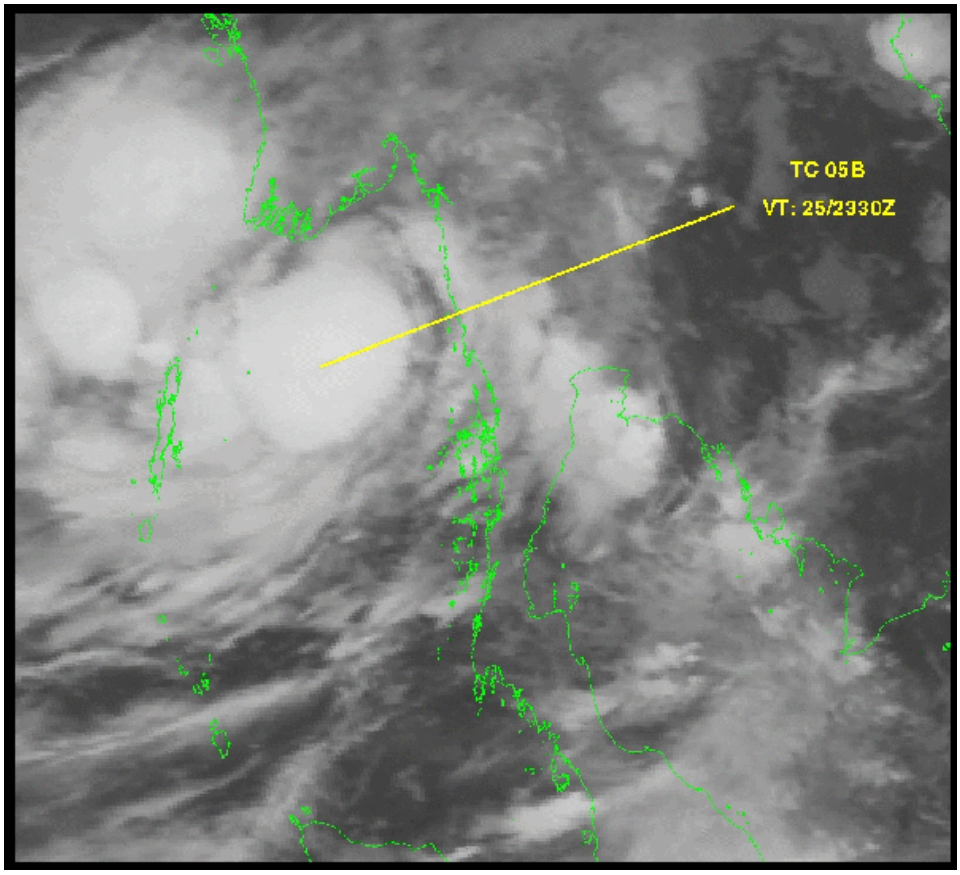


Figure 1-05B-1. 252330Z October GMS-5 infrared image of TC 05B at the initial warning. Intensity was 35 kt.

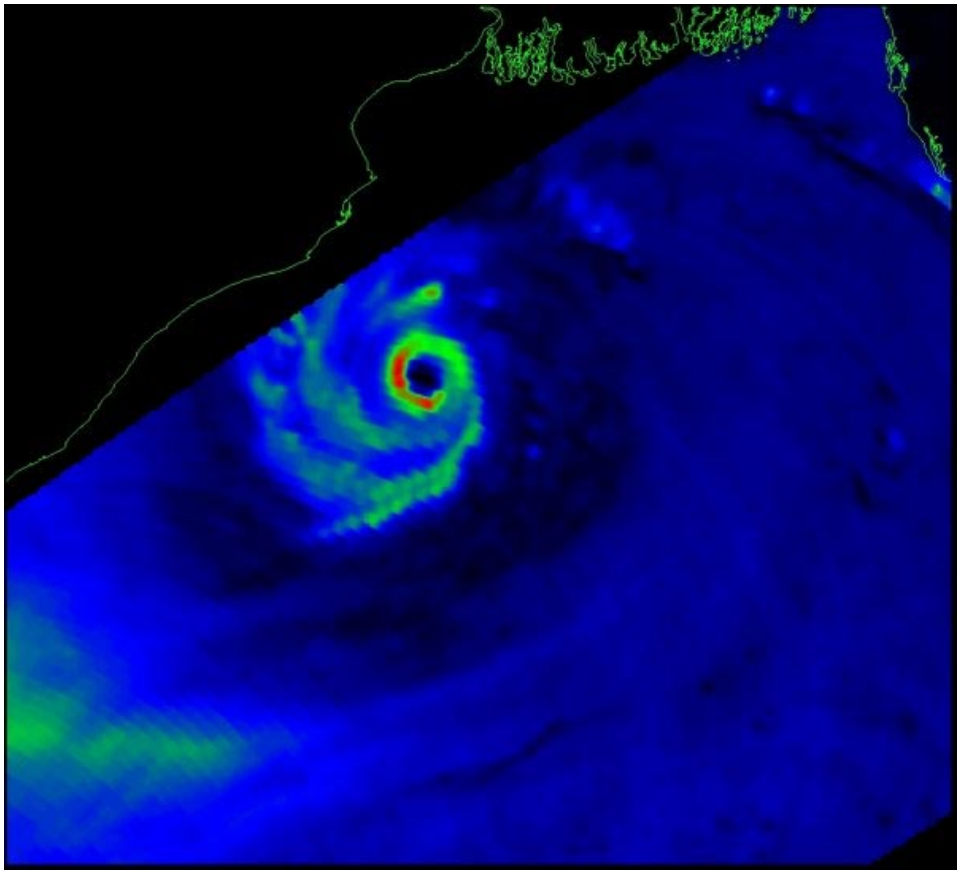


Figure 1-05B-2. 281543Z October Tropical Rainfall Measurement Mission pass of TC 05B. Intensity was 135 kt. TC 05B peaked three hours later at 140 kt.

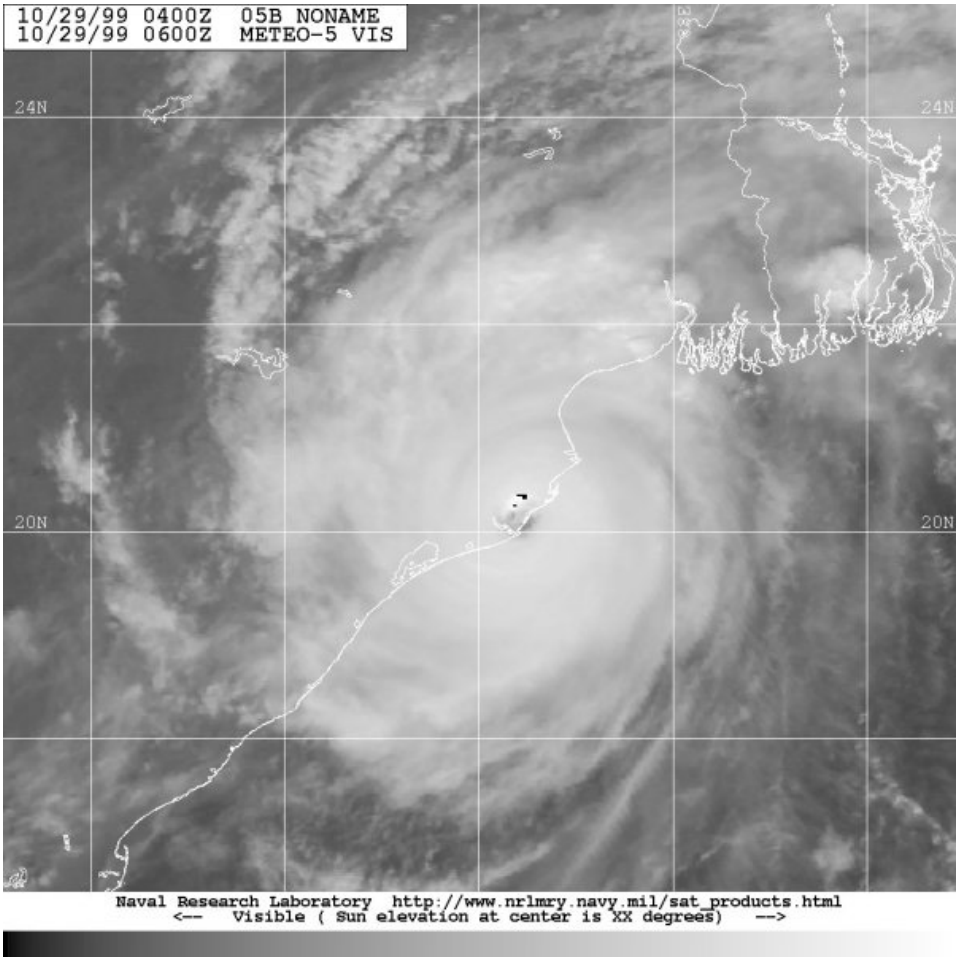
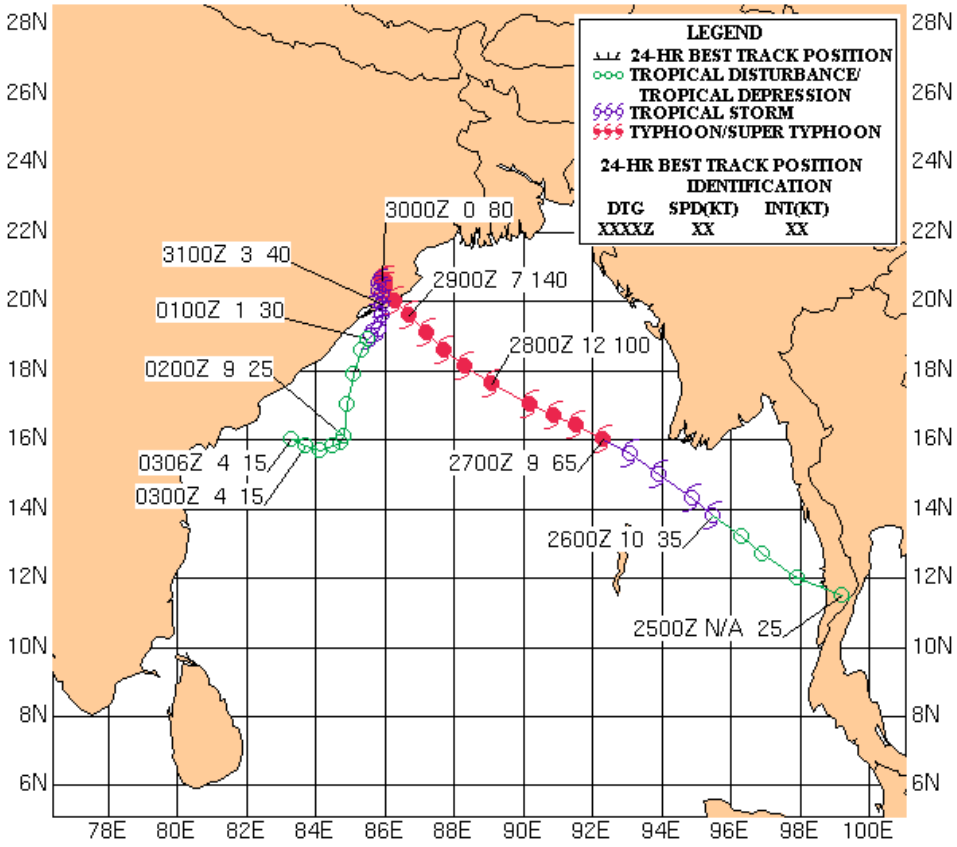
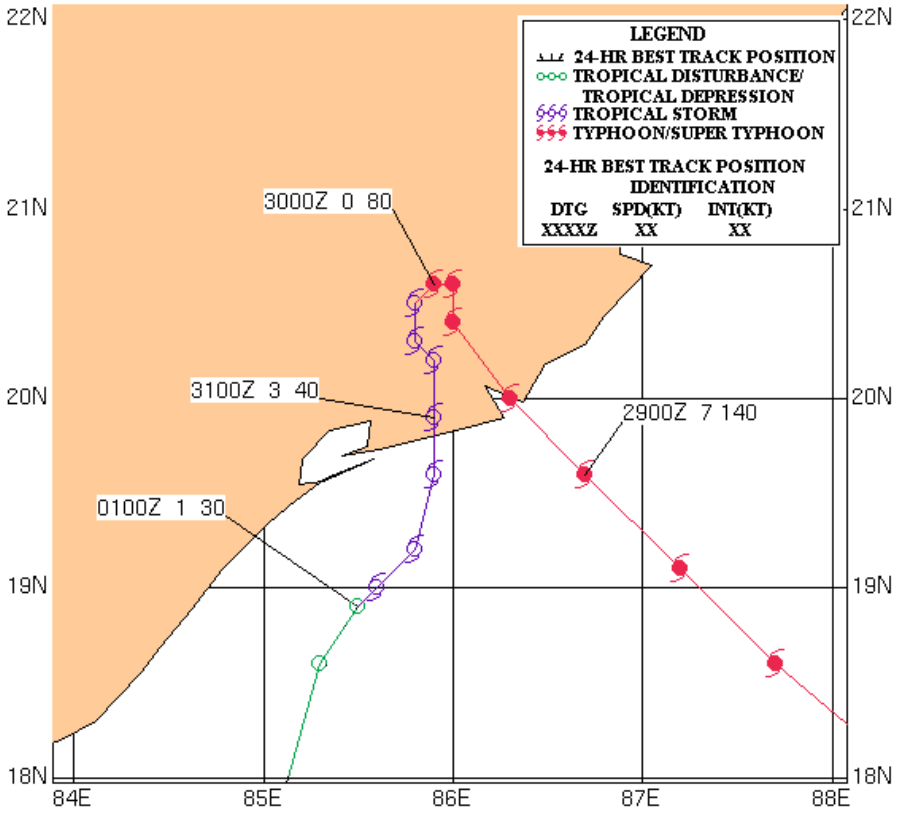


Figure 1-05B-3. 290600Z October METEOSAT-5 visible image of TC 05B. The center of TC 05B made landfall at 0500Z with an intensity of 135 kt.


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
10N
8N
6N
78E
80E
82E
84E
86E
88E
90E
92E
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
2900Z 7 140
0100Z 1 30
22N
21N
20N
19N
18N
84E
85E
86E
87E
88E