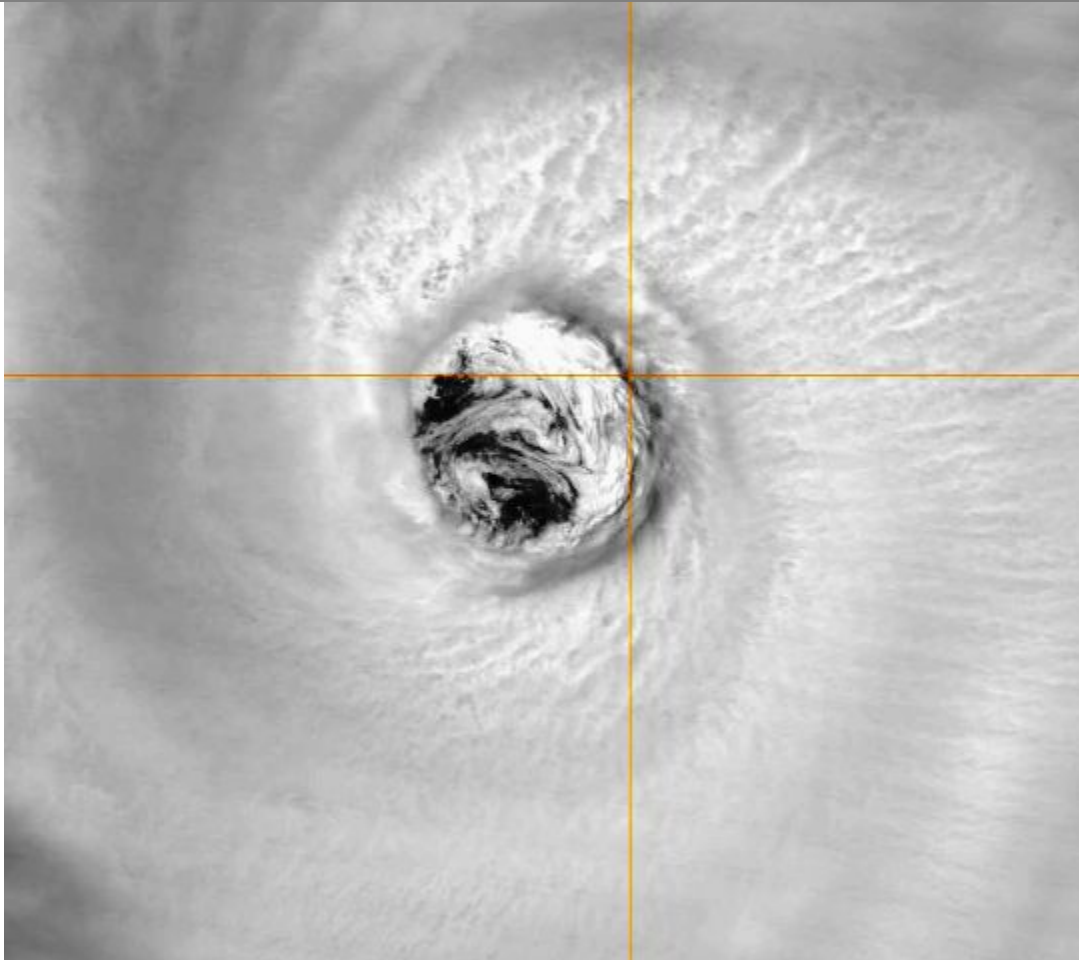


2008

Annual Tropical Cyclone Report

U.S. Naval Maritime Forecast Center/ Joint Typhoon Warning Center Pearl Harbor, Hawaii



MODIS visible image of Typhoon Rammasun (03W) in the eastern Philippine Sea showing multiple vortices in the well defined eye. Image courtesy of NASA Earth Observatory.

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Executive Summary

The Annual Tropical Cyclone Report is prepared by the staff of the Joint Typhoon Warning Center (JTWC), a combined Air Force/Navy organization operating under the command of the Commanding Officer, U.S. Naval Maritime Forecast Center/Joint Typhoon Warning Center (NMFC/JTWC), Pearl Harbor, Hawaii. JTWC was established in April 1959 when USCINCPAC directed USCINCPACFLT to provide a single tropical cyclone warning center for the western North Pacific region. The operations of JTWC are guided by USPACOM Instruction 0539.1. JTWC will celebrate its 50th Anniversary in a ceremony on Ford Island, Oahu, on 29 April 2009.

This edition continues our effort to provide standard tropical cyclone summaries by basin and detailed reviews of operationally or meteorologically significant tropical cyclones to document significant challenges and/or shortfalls in the tropical cyclone warning system to serve as a focal point for research and development efforts.

Year 2008 continued the below normal activity in the western North Pacific, with 27 tropical cyclones occurring compared to an average of 31. The South Indian Ocean and South Pacific activity was right on average with 29 cyclones. The North Indian Ocean was slightly above normal with 7 cyclones compared to an average of 5. Of significance in the North Indian Ocean was TC 01B, Nargis. Nargis formed in the central Bay of Bengal and tracked northwestward then turned east-northeastward, making landfall along the souther tip of Myanmar after reaching peak intensity of 115 knots. Other significant cyclones include Typhoon 07W, Fengshen, and Typhoon 15W, Sinlaku. Fengshen was significant because despite its continuous west-northwest track, all the numerical modes forecast it to turn north, some at right angles to the final track. Sinlaku was significant because it underwent two periods of rapid intensification, neither which was captured by the intensity guidance available to the JTWC forecasters.

Weather satellite data continued to be the mainstay for the tropical cyclone reconnaissance mission at JTWC, although limited aircraft reconnaissance was available for August and September. Satellite analysts exploited a wide variety of conventional and microwave satellite data to produce nearly 9,200 position and intensity estimates. A total of 4,639 fixes were done using microwave imagery, amounting to just over half of the total number of fixes. The USAF primary weather satellite direct readout system, Mark IVB, and the USN FMQ-17 continued to be invaluable tools in the tropical cyclone reconnaissance mission.

During August and September of 2008, the THORPEX Pacific Asian Regional Campaign (T-PARC) and Tropical Cyclone Structure 2008 (TCS-08) brought together an international group of researchers and operators to conduct an intense tropical cyclone data collection effort. This experiment enlisted a wide variety of data collection platforms including the USAFR WC-130J with its dropsondes and step frequency microwave radiometer (SMRF), the NRL P-3 with its ELDORA radar, the Taiwanese DOTSTAR with its dropsondes, and the German Falcon. Additionally, drifting bouys, and other insitu instruments were launched from various platforms including unmanned balloons launched from Hawaii.

Continuing dialogue and interaction with TC forecast support and research organizations such as the Fleet Numerical Meteorology and Oceanography Center, Naval Research Laboratory, Monterey, Naval Post Graduate School, and the Office of Naval Research for continued development of numerical TC models and forecast aids, including continued improvements to the Navy's version of the Geophysical Fluid Dynamics Lab (GFDL) mesoscale hurricane model (GFDN) occurred in 2008 and will continue into 2009. Additionally, a tropical cyclone version of COAMPS, designated COAMPS-TC was developed by NRL Monterey. COAMPS-TC was run experimentally during T-PARC and will be operationally tested by JTWC in 2009. Hurricane WRF (H-WRF) to support JTWC was also pursued, however, resource constraints will delay running this community model in the JTWC area of responsibility until at least 2010.

Behind all these efforts are the dedicated men and women of JTWC who continued their quest to remain the premier tropical cyclone reconnaissance and forecasting center in the Pacific and Indian Oceans. The civilianization of a large portion of the USAF members assigned to JTWC was completed in 2008, although the hiring process continued into 2009. Manning reductions as part of the larger DoD drawdown will result in the loss of 2 enlisted authorizations in 2009, bringing the USAF contribution to the JTWC mission to 14 personnel. The USN provided 3 Typhoon Duty Officers, the JTWC Operations Officer, and the JTWC Technical Advisor.

Thanks to the entire Naval Maritime Forecast Center/Joint Typhoon Warning Center N6 Department for their continued outstanding IT support with special thanks to Mr. Angelo Alvarez for his tireless efforts to keep the computers, communications and numerous websites working. Thanks also to the Navy and Air Force personnel across the Pacific who support our reconnaissance and forecasting functions, the researchers and programmers helping develop our knowledge base and tool kit to better forecast tropical cyclones. Without an integrated effort, the challenging task of locating and forecasting the movement and structure of tropical cyclones would be considerably more difficult. That entire TC community will continue to focus all available science and technology on providing the best possible support to you, our customers, who stand in harm's way.

As always, thanks to our supporting commands and organizations: Fleet Numerical Meteorology and Oceanography Center (FNMOC) for their operational support; the Naval Research Laboratory for its dedicated research; the Air Force Weather Agency (AFWA) and National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS) for satellite support; for their high quality support; all the men and women of the ships and facilities ashore throughout the JTWC area of responsibility (AOR); Dr. John Knaff, Dr. Jeff Hawkins, Dr Mark DeMaria, and Chris Veldon for their continuing efforts to exploit remote sensing technologies in new and innovative ways; Mr. Charles R. "Buck" Sampson and Ann J. Schrader for their support and continued development of the Automated Tropical Cyclone Forecasting (ATCF) system, which remains the backbone of production at JTWC.

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Chapter 1 Western North Pacific Ocean Tropical Cyclones

Section 1 Informational Tables

Table 1-1 is a summary of Tropical Cyclone activity in the western North Pacific Ocean (NWP) during the 2008 season. JTWC issued warnings on 27 cyclones. Table 1-2 shows the monthly distribution of Tropical Cyclone activity summarized for 1959 - 2007 and Table 1-3 shows the monthly average occurrence of tropical cyclones separated into: (1) typhoons and (2) tropical storms and typhoons. Table 1-4 summarizes Tropical Cyclone Formation Alerts issued. The annual number of tropical cyclones of tropical storm strength or higher appears in Figure 1-1, while the number of tropical cyclones of Super Typhoon intensity appears in Figure 1-2. Figure 1-3 illustrates a monthly average number of cyclones based on intensity categories. Graphics showing 2008 tropical cyclone best tracks appear following Figure 1-3.

Table 1-1					
WESTERN NORTH PACIFIC SIGNIFICANT TROPICAL CYCLONES FOR 2008					
(01 JAN 2008 - 31 DEC 2008)					
TC	NAME*	PERIOD**	WARNINGS ISSUED	EST MAX SFC WINDS KTS	MSLP (MB)***
TS 01W		13 - 16 JAN	13	40	992
TY 02W	Neoguri	14 - 20 APR	23	100	948
STY 03W	Rammasun	7 - 12 MAY	23	135	921
TS 04W	Matmo	14- 16 MAY	9	40	992
TY 05W	Halong	15 - 20 MAY	19	75	966
TY 06W	Nakri	27 MAY - 3 JUN	29	125	929
TY 07W	Fengshen	18 - 25 JUN	29	110	940
TY 08W	Kalmaegi	14 - 18 JUL	19	90	955
TY 09W	Fung-Wong	24 - 28 JUL	18	95	951
TS 10W	Kammuri	4 - 6 AUG	12	50	985
TS 11W		13 - 14 AUG	7	35	996
TS 12W	Vongfong	14 - 16 AUG	9	55	981
TY 13W	Nuri	17 - 22 AUG	24	100	948
TS 14W		26 - 28 AUG	7	35	996
TY 15W	Sinlaku	8 - 20 SEP	47	125	929
TS 16W		10 - 11 SEP	8	35	996
TS 17W		14-Sep	1	40	992
TY 18W	Hagupit	18 - 24 SEP	24	125	929
STY 19W	Jangmi	23 SEP - 1 OCT	29	145	914
TS 20W	Mekkhala	28 - 30 SEP	7	55	981
TS 21W	Higos	29 SEP - 4 OCT	21	45	988
TS 22W		14 - 15 OCT	6	35	996
TS 23W	Bavi	18 - 20 OCT	6	50	985
TS 24W	Maysak	7 - 10 NOV	14	55	981
TS 25W	Haishen	15 - 16 NOV	4	40	992
TS 26W	Noul	16 - 17 NOV	7	40	992
TY 27W	Dolphin	10 - 18 DEC	33	90	955
* As Designated by RSMC Tokyo					
** Dates are based on the issuance of JTWC warnings on system.					
***MSLP converted from estimated maximum surface winds using Knaff-Zehr wind-pressure relationship.					

Table 1-2
DISTRIBUTION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES
FOR 1959 - 2008

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
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	041	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	020	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
	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	541	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	32
	100	000	000	010	110	211	220	500	410	230	310	100	21 10 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	1	1	0	2	2	0	7	10	7	5	6	3	43
	001	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 8 10
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 10
2000	0	0	0	0	4	0	8	9	6	3	3	1	34
	000	000	000	000	112	000	233	432	411	210	111	100	15 10 9
2001	0	1	0	1	1	2	6	7	5	3	3	4	33
	000	001	000	001	010	200	411	331	500	300	120	220	20 9 4
2002	1	1	1	1	2	3	6	8	3	5	1	1	33
	010	100	001	001	101	300	321	431	120	302	100	100	18 8 7
2003	1	0	0	1	3	2	2	5	3	6	3	1	27
	010	000	000	100	111	110	200	410	300	213	300	010	17 6 4
2004	0	1	1	1	3	5	2	9	3	3	2	2	32
	000	010	010	100	210	500	110	621	111	300	200	020	21 9 2
2005	1	0	1	1	0	1	4	6	5	3	2	1	25
	100	000	100	100	000	100	130	600	410	201	110	010	18 6 1
2006	0	0	1	0	1	1	3	8	5	4	2	2	27
	000	000	010	000	100	010	210	341	302	211	200	101	14 8 5
2007	0	0	1	0	1	0	3	5	5	5	6	0	26
	000	000	100	000	100	000	210	321	221	320	312	000	15 8 4
2008	1	0	0	1	4	1	2	5	6	3	3	1	27
	010	000	000	100	310	100	200	140	330	030	030	100	12 15 0

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, the 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, it was attributed to the second month.

TABLE 1-2 Legend		
Total month/year		
GTE 64 knots (Typhoon)	34 - 63 knots (Tropical Storm)	LTE 33 knots (Tropical Depression)

TABLE 1-3 WESTERN NORTH PACIFIC TROPICAL CYCLONES

TYPHOONS (1945 - 1958)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
MEAN	0.4	0.1	0.3	0.4	0.7	1.1	2	2.9	3.2	2.4	2	0.9	24.4
CASES	5	1	4	5	10	15	28	41	45	34	28	12	228

TYPHOONS (1959 - 2008)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
MEAN	0.2	0.1	0.2	0.4	0.8	1.1	2.6	3.5	3.3	3.0	1.6	0.7	17.6
CASES	11	3	10	20	38	55	126	170	162	148	78	35	856

TROPICAL STORMS AND TYPHOONS (1945 - 1958)

	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 (1959 - 2008)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
MEAN	0.5	0.2	0.4	0.6	1.1	1.6	3.8	5.2	4.8	3.8	2.5	1.2	25.7
CASES	23	9	20	31	53	76	187	257	233	188	123	57	1257

**TABLE 1-4
TROPICAL CYCLONE FORMATION ALERTS FOR THE
WESTERN NORTH PACIFIC OCEAN 1976 - 2008**

YEAR	INITIAL TCFAS	TROPICAL CYCLONES WITH TCFAS	TOTAL TROPICAL CYCLONES	PROBABILITY OF TCFA WITHOUT WARNING*	PROBABILITY OF TCFA BEFORE WARNING
1976	34	25	25	36%	100%
1977	26	20	21	29%	95%
1978	32	27	32	16%	84%
1979	27	23	28	14%	82%
1980	37	28	28	32%	100%
1981	29	28	29	3%	97%
1982	36	26	28	36%	93%
1983	31	25	25	24%	100%
1984	37	30	30	23%	100%
1985	39	26	27	48%	96%
1986	38	27	27	41%	100%
1987	31	24	25	28%	96%
1988	33	26	27	26%	96%
1989	51	32	35	54%	91%
1990	33	30	31	10%	97%
1991	37	29	31	26%	94%
1992	36	32	32	13%	100%
1993	50	35	38	39%	92%
1994	50	40	40	25%	100%
1995	54	33	35	60%	94%
1996	41	39	43	5%	91%
1997	36	30	33	18%	91%
1998	38	18	27	74%	67%
1999	39	29	33	30%	88%
2000	40	31	34	26%	91%
2001	34	28	33	18%	82%
2002	39	31	33	24%	94%
2003	31	27	27	15%	100%
2004	35	32	32	9%	100%
2005	26	25	25	4%	100%
2006	23	22	26	4%	85%
2007	27	26	27	4%	96%
2008	23	23	27	0%	85%
MEAN	35.5	28.1	30.1	24.7%	93.2%
CASES	1173	927	994		

* Percentage of initial TCFAs not followed by warnings.

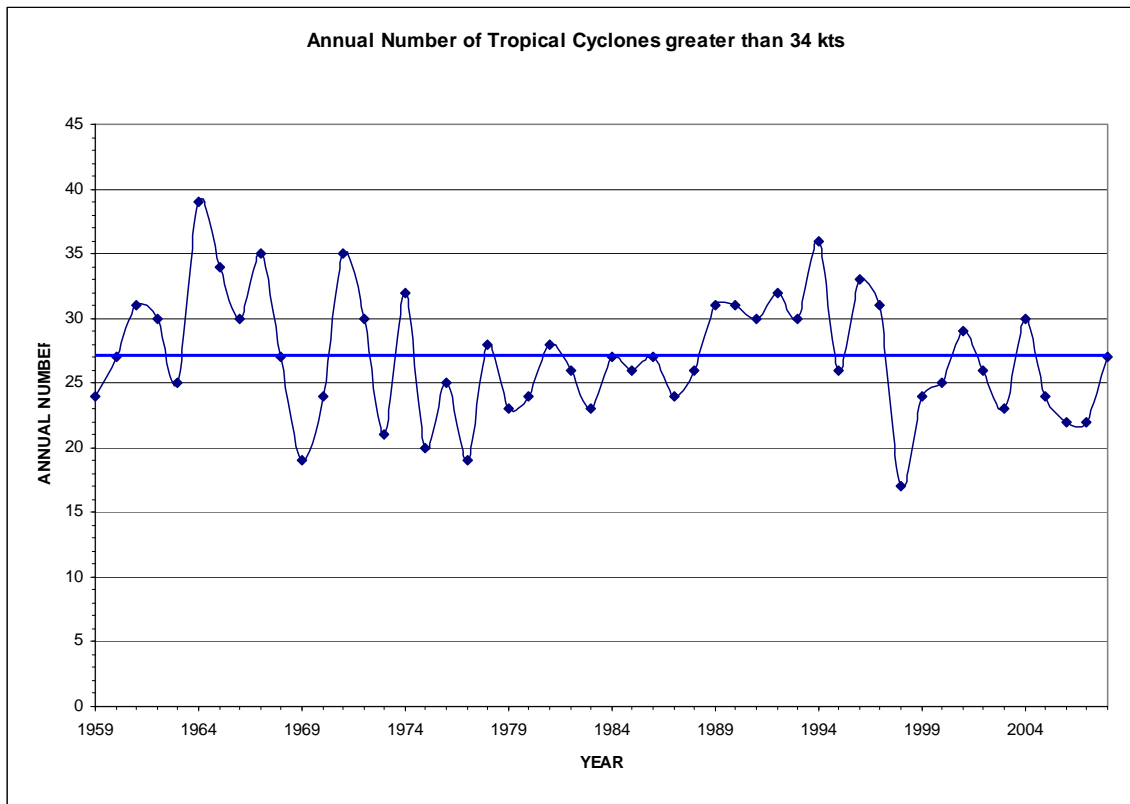


Figure 1-1. Annual number of Tropical Cyclones greater than 34 Kts intensity

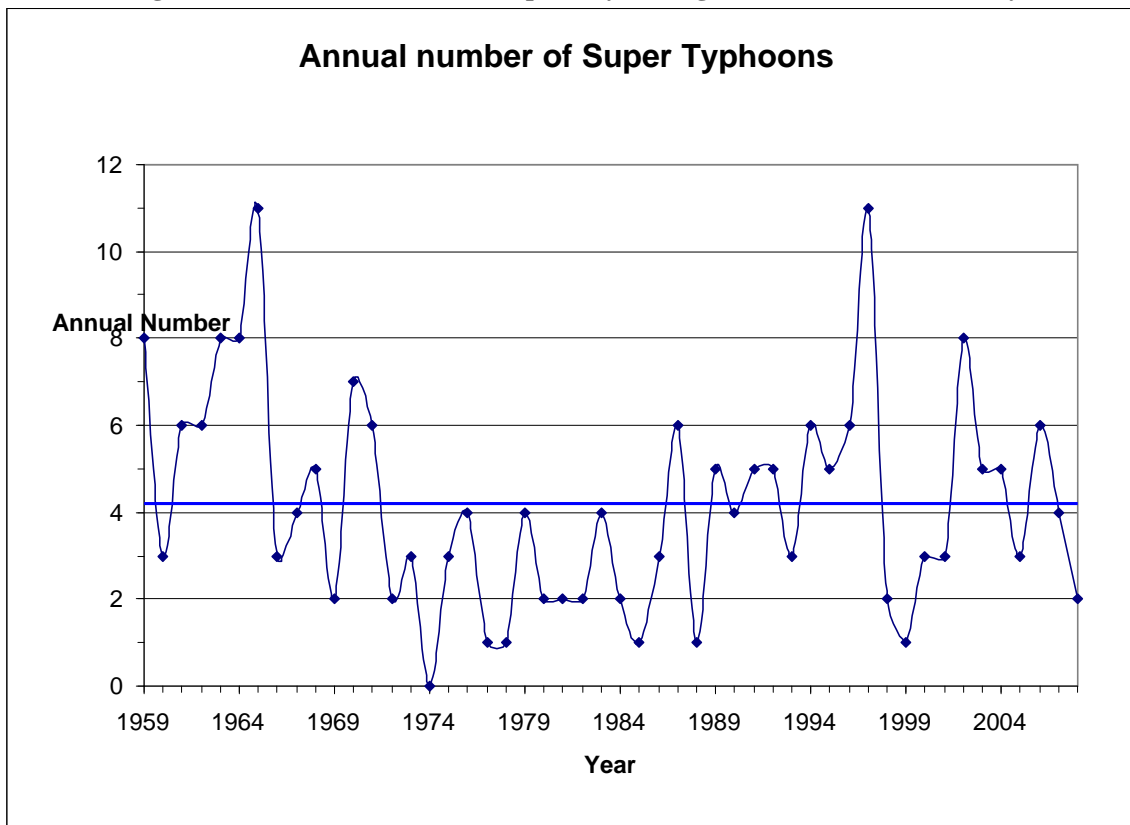


Figure1- 2. Annual number of Tropical Cyclones greater than 127 Kts intensity

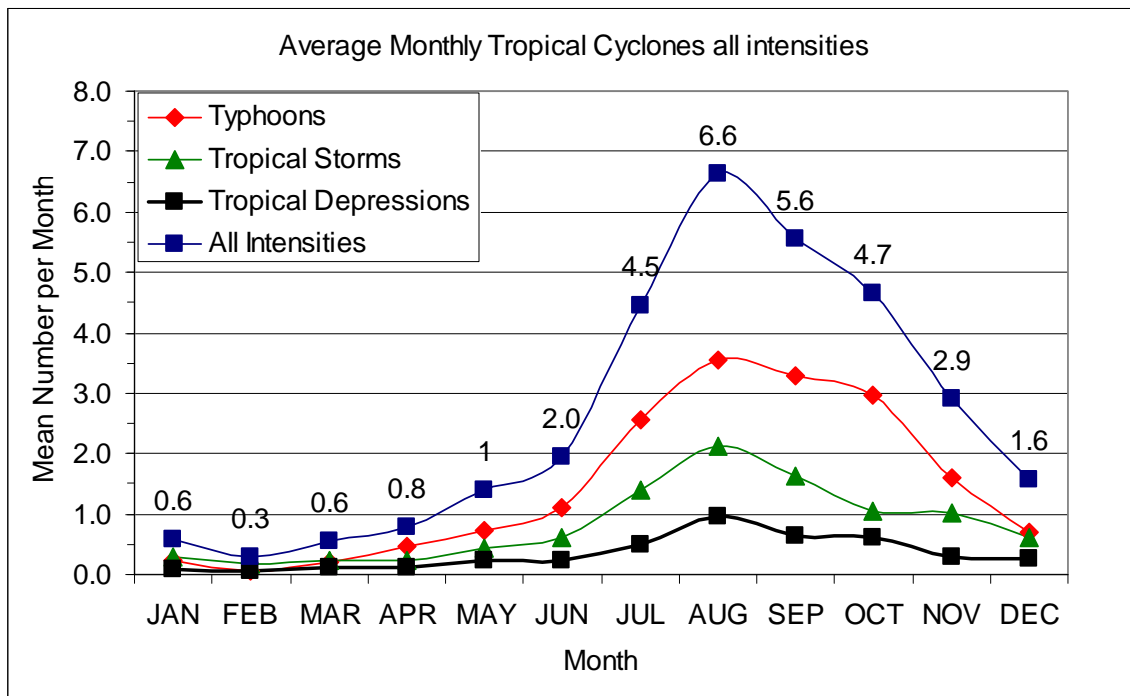
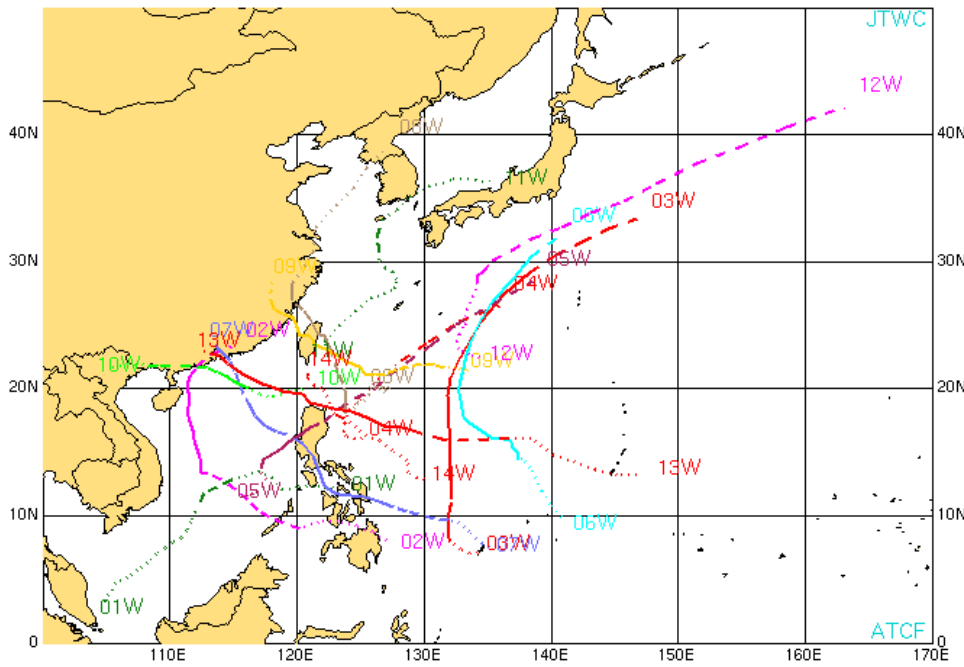


Figure 1-3. Average number of Tropical Cyclones of all intensities by month

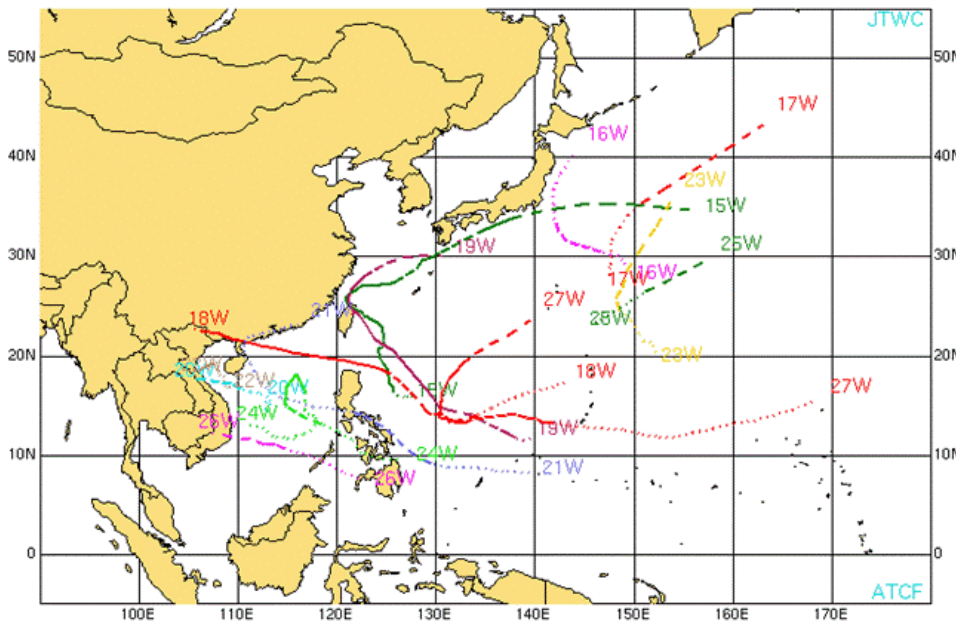


01W TS	09 JAN - 18 JAN
02W TY NEOGURI	12 APR - 19 APR
03W ST RAMMASUN	06 MAY - 13 MAY
04W TS MATMO	13 MAY - 16 MAY
05W TY HALONG	13 MAY - 20 MAY
06W TY NAKRI	25 MAY - 03 JUN
07W TY FENGSHEN	17 JUN - 26 JUN
08W TY KALMAEGI	11 JUL - 20 JUL
09W TY FUNG-WONG	23 JUL - 29 JUL
10W TS KAMMURI	02 AUG - 08 AUG
11W TS	10 AUG - 16 AUG
12W TS VONGFONG	12 AUG - 17 AUG
13W TY NURI	16 AUG - 23 AUG
14W TS FOURTEEN	24 AUG - 29 AUG

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



Figure 1-4. Western North Pacific Tropical Cyclones, January - August 2008



15W TS SINLUKU	07 SEP - 22 SEP
16W TS SIXTEEN	08 SEP - 12 SEP
17W TS SEVENTEEN	11 SEP - 15 SEP
18W TY HAGUPIT	14 SEP - 25 SEP
19W TS JANGMI	22 SEP - 01 OCT
20W TS MEKKHALA	25 SEP - 30 SEP
21W TD HIGGS	27 SEP - 06 OCT
22W TD TWENTYTWO	12 OCT - 15 OCT
23W TS BAVI	17 OCT - 20 OCT
24W TS MAYSACK	04 NOV - 14 NOV
25W TS HAISHEN	13 NOV - 17 NOV
26W TS NOUL	13 NOV - 19 NOV
27W TY DOLPHIN	08 DEC - 18 DEC

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



Figure 1-5. Western North Pacific Tropical Cyclones September - December 2008

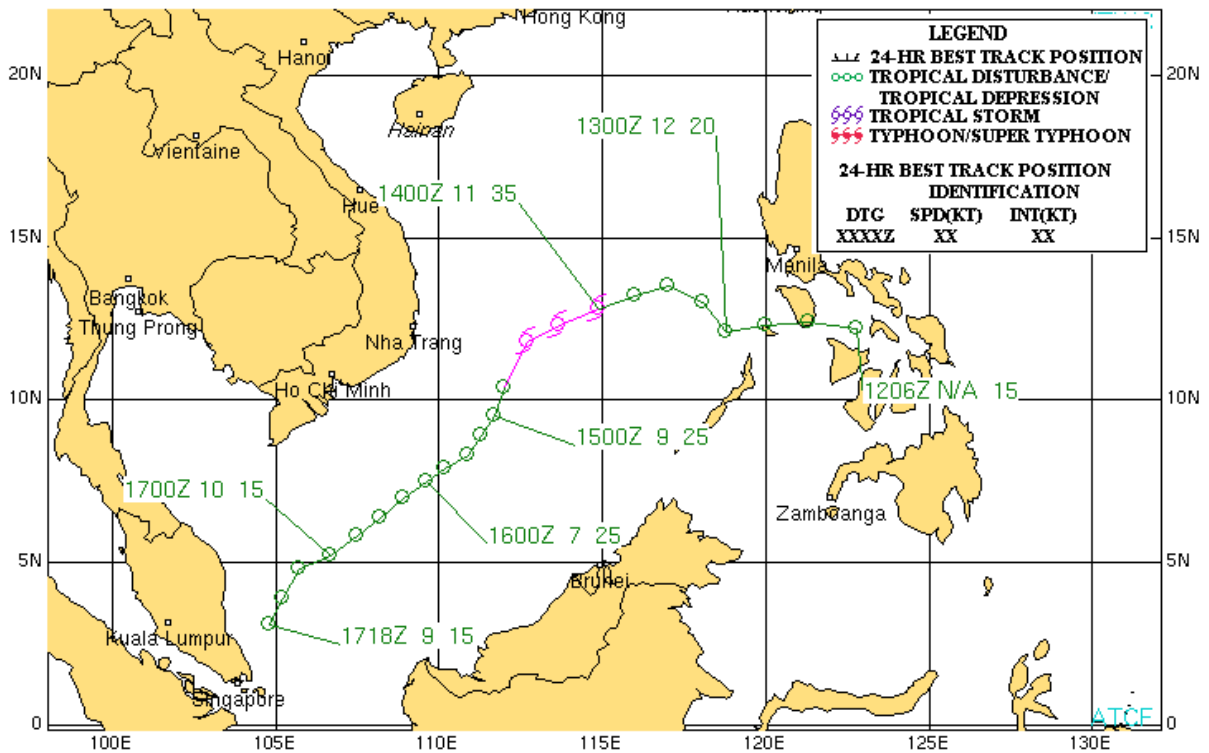
Section 2 Cyclone Summaries

This section presents a synopsis of each cyclone that occurred during 2008 in the western North Pacific Ocean. Each cyclone is presented, with the number and basin identifier used by JTWC, along with the RSMC Tokyo assigned name. Dates are also listed when JTWC first designated the various stages of development; as an area of interest (Poor classification), increased potential for development (Fair classification) and development occurring/TC expected (Good classification). Furthermore, first Tropical Cyclone Formation Alert (TCFA), and the initial and final warnings dates are also presented with the number of warnings issued by JTWC. Landfall over major landmasses with approximate locations is presented as well.

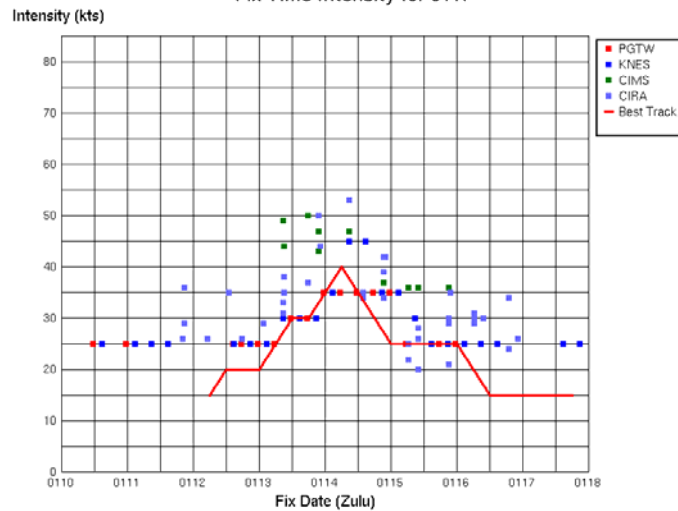
The JTWC post-event reanalysis best track is also provided for each cyclone. Data included on the best track are position and intensity noted with cyclone symbols and color coded track. Best track positions are marked by date at 0000 UTC, as well as the beginning and end points. Best track position labels include the date-time, track speed in knots, and maximum wind speed in knots. A graph of best track intensity and fix intensity versus time is presented. The fix plots on this graph are color coded by fixing agency.

TROPICAL STORM 01W

ISSUED POOR: 0600Z 11 Jan 2008
 ISSUED FAIR: 0600Z 12 Jan 2008
 FIRST TCFA: 1730Z 12 Jan 2008
 FIRST WARNING: 0600Z 13 Jan 2008
 LAST WARNING: 1200Z 16 Jan 2008
 LANDFALL: Near San Jose, Mindoro, Philippines
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 13

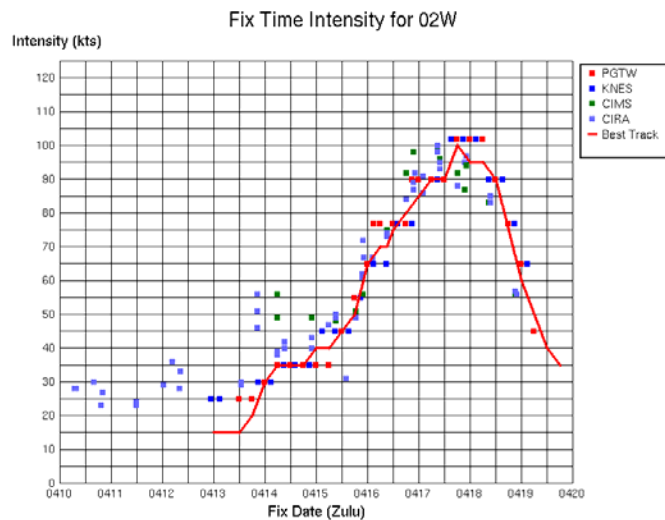
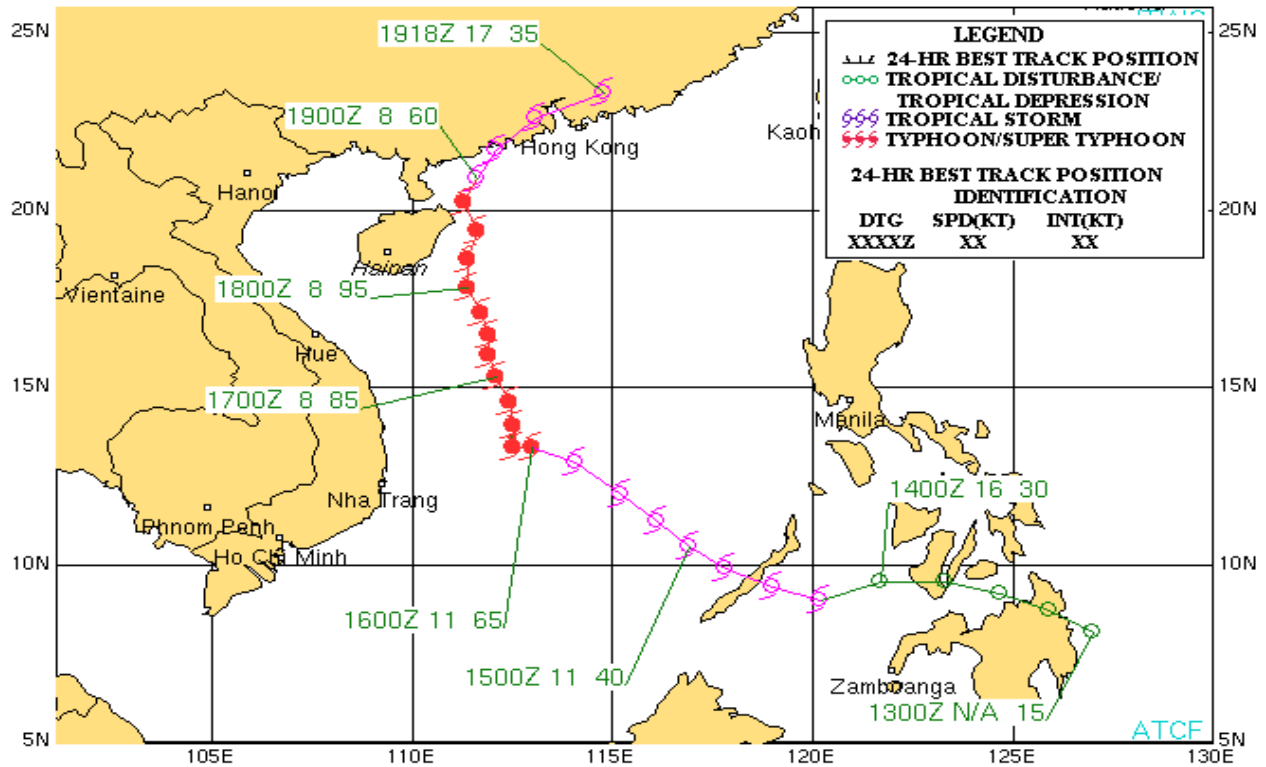


Fix Time Intensity for 01W



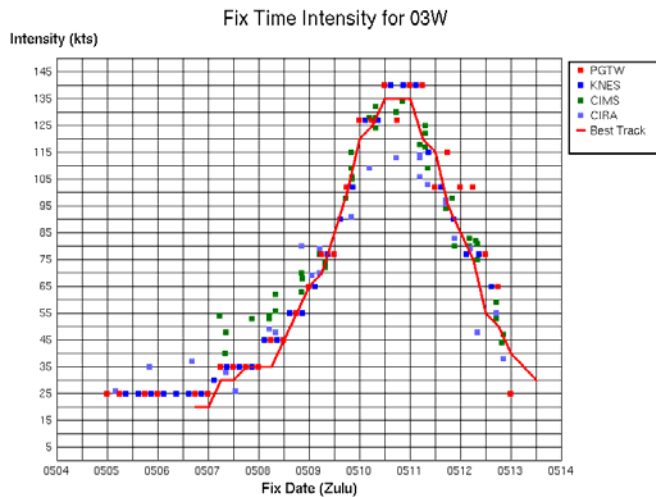
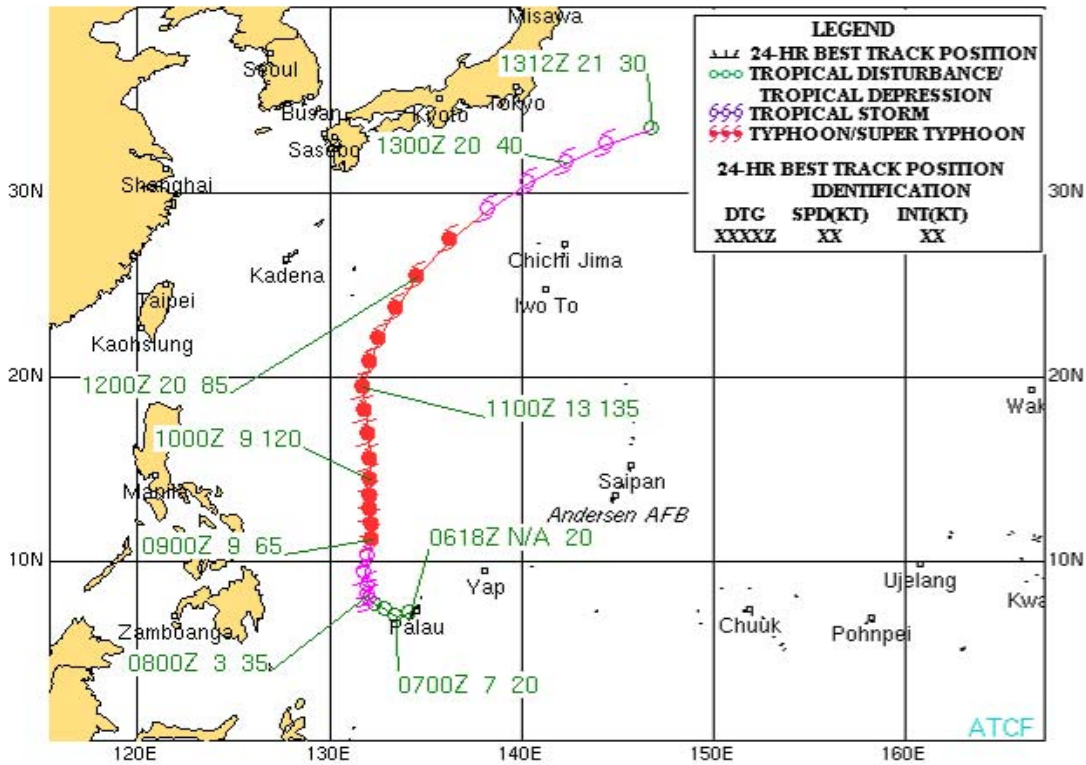
TYPHOON 02W (Neoguri)

ISSUED POOR: 2000Z 11 Apr 2008
 ISSUED FAIR: 0100Z 13 Apr 2008
 FIRST TCFA: 1930Z 13 Apr 2008
 FIRST WARNING: 0000Z 14 Apr 2008
 LAST WARNING: 1200Z 20 Apr 2008
 LANDFALL: Near Yangjiang, China
 MAX INTENSITY: 100 Kts
 NUMBER OF WARNINGS: 23



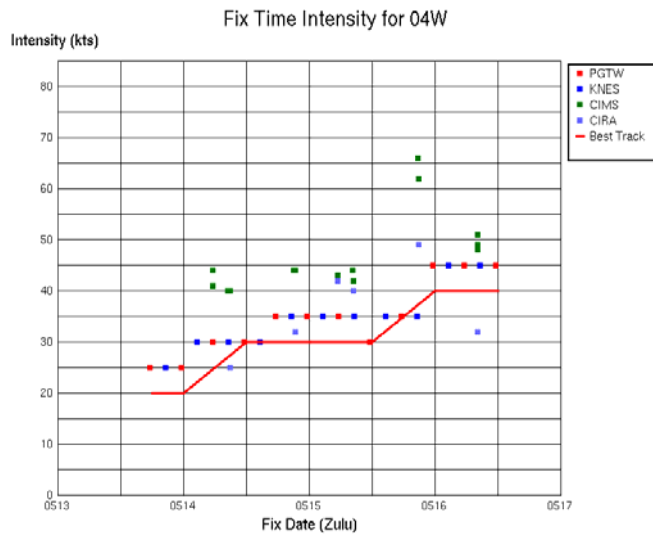
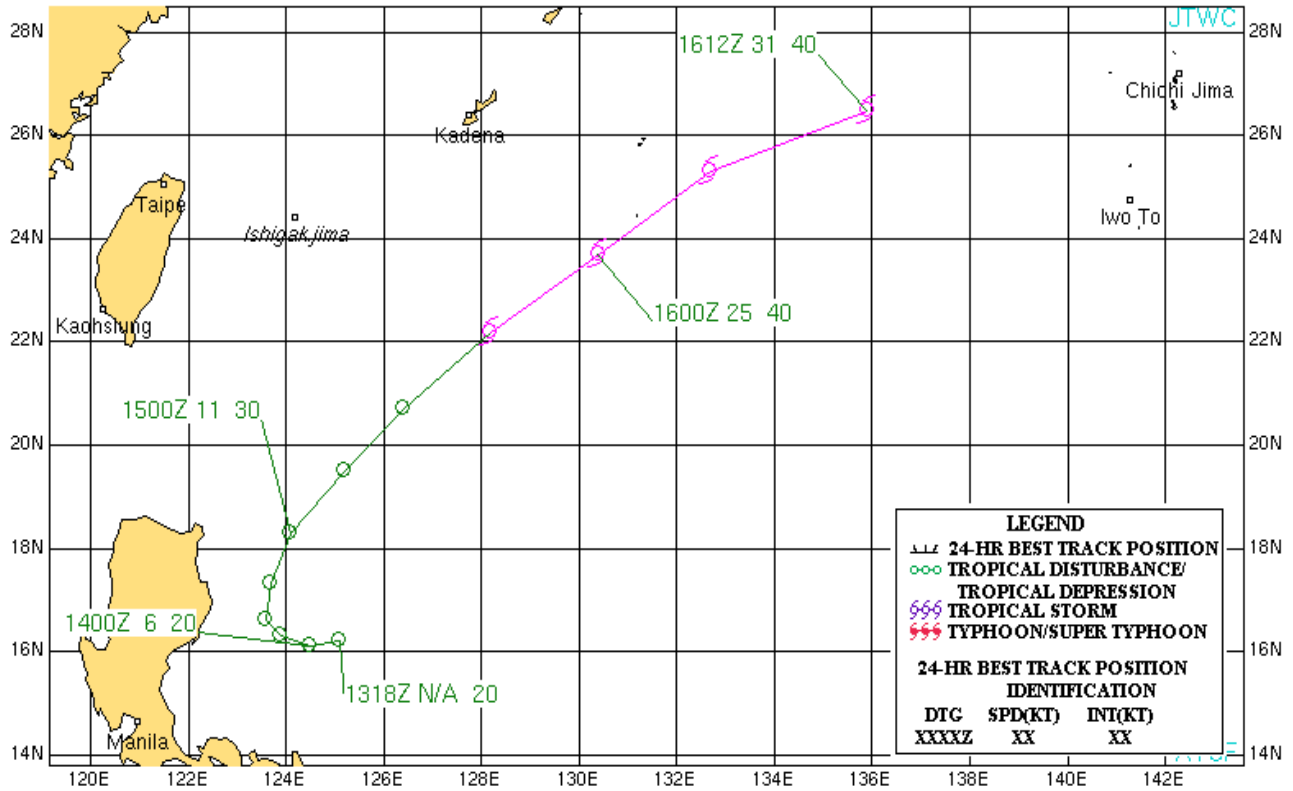
SUPER TYPHOON 03W (Rammasun)

ISSUED POOR: N/A
 ISSUED FAIR: 0030Z 06 May 2008
 FIRST TCFA: 2200Z 06 May 2008
 FIRST WARNING: 0600Z 07 May 2008
 LAST WARNING: 1800Z 12 May 2008
 LANDFALL: None
 MAX INTENSITY: 135 Kts
 NUMBER OF WARNINGS: 23



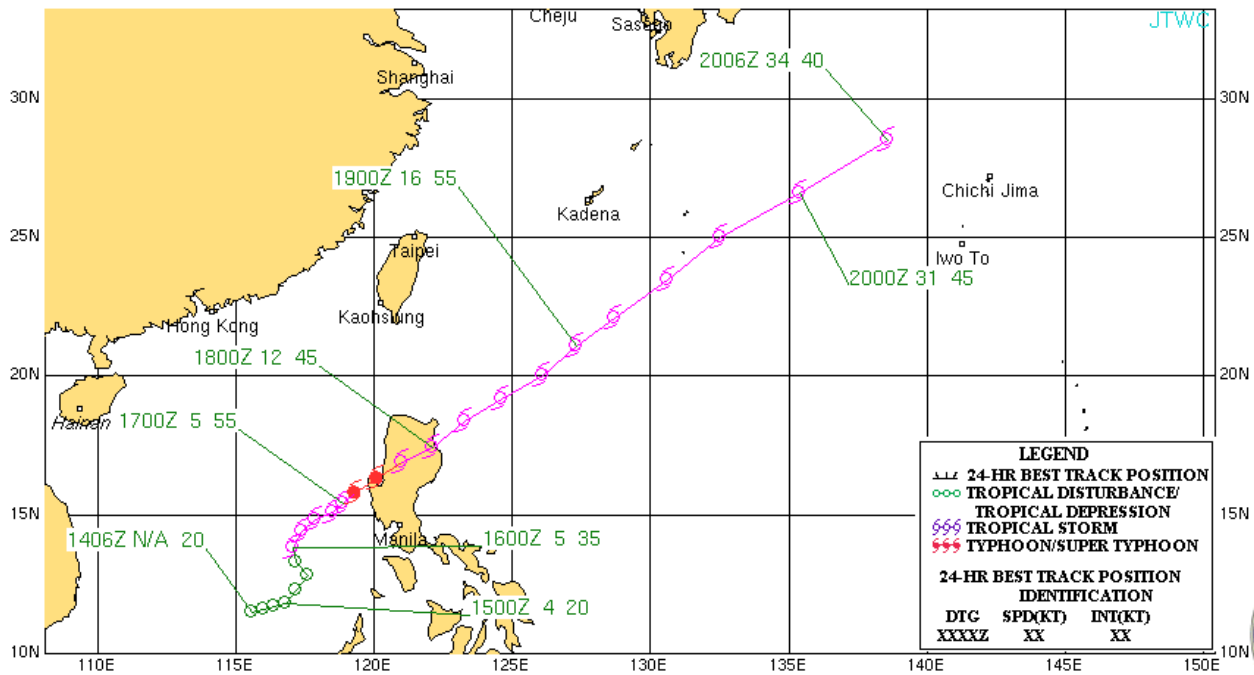
TROPICAL STORM 04W (Matmo)

ISSUED POOR: N/A
 ISSUED FAIR: 1730Z 13 May 2008
 FIRST TCFA: 0200Z 14 May 2008
 FIRST WARNING: 0600Z 14 May 2008
 LAST WARNING: 0600Z 16 May 2008
 LANDFALL: None
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 9

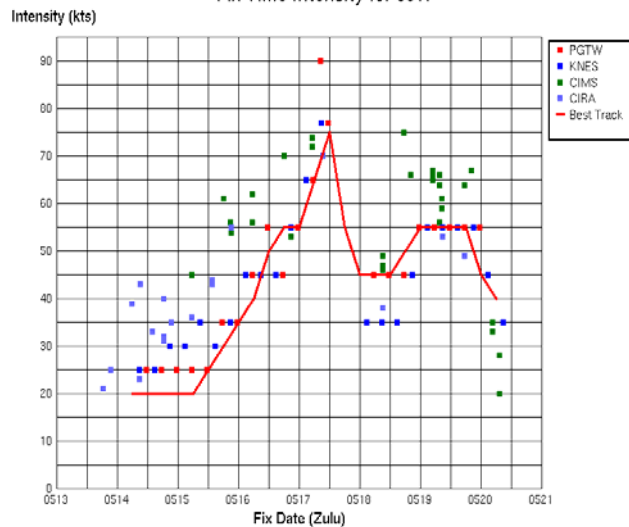


TYPHOON 05W (Halong)

ISSUED POOR: 0200Z 14 May 2008
 ISSUED FAIR: 0600Z 14 May 2008
 FIRST TCFA: 2000Z 14 May 2008
 FIRST WARNING: 1200Z 15 May 2008
 LAST WARNING: 0000Z 20 May 2008
 LANDFALL: Near San Carlos, Luzon, Philippines
 MAX INTENSITY: 75 Kts
 NUMBER OF WARNINGS: 19

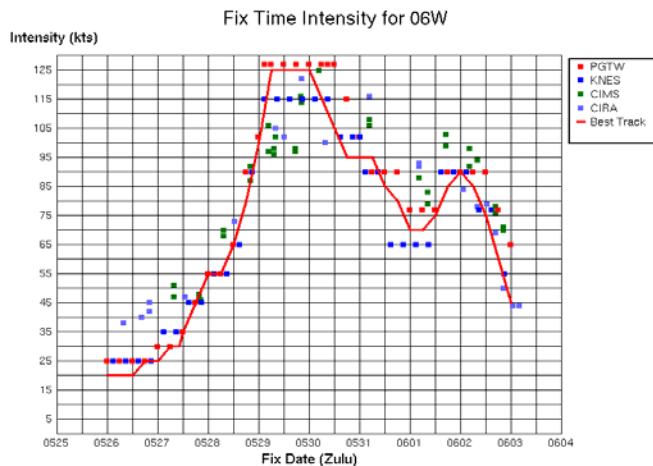
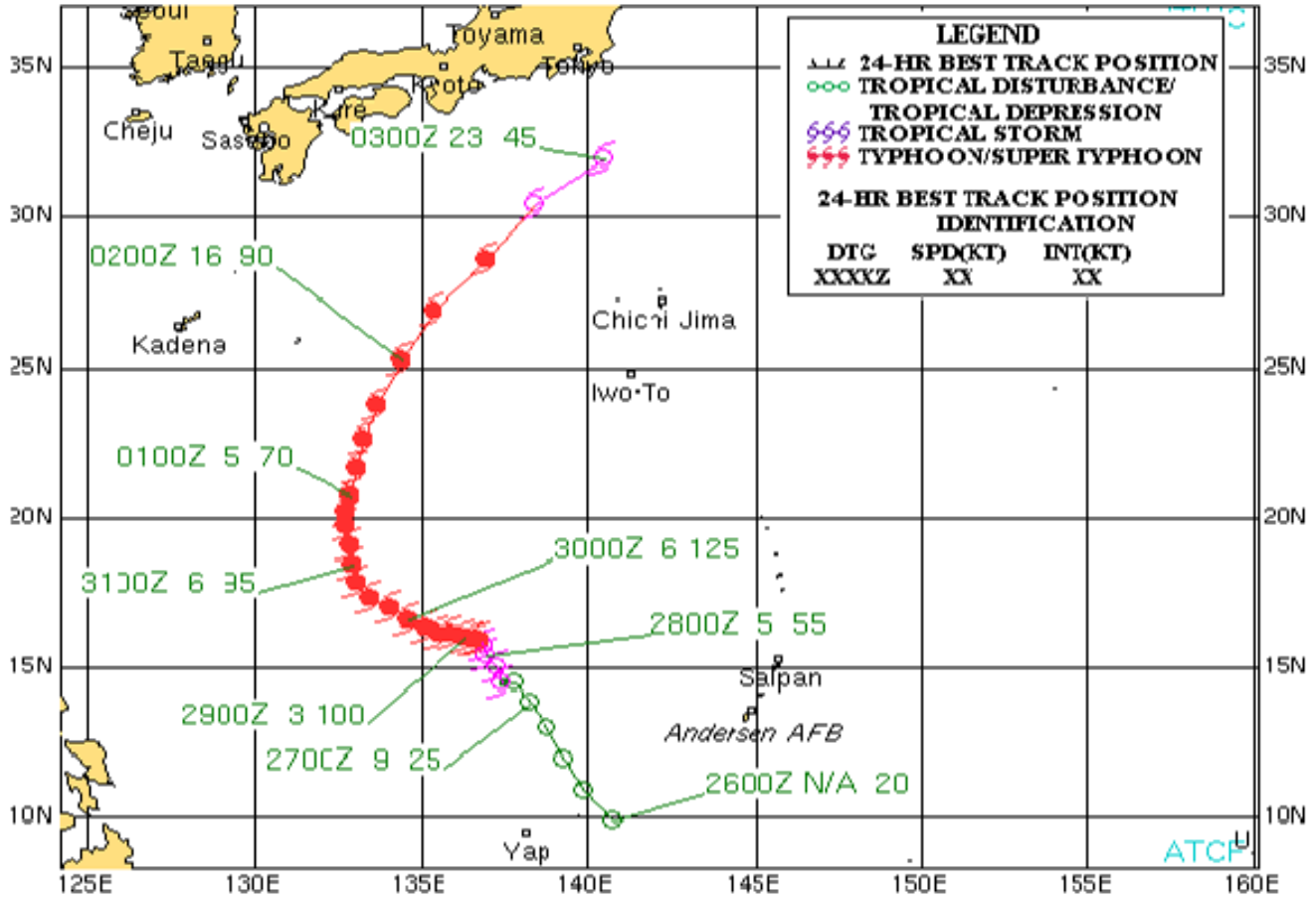


Fix Time Intensity for 05W



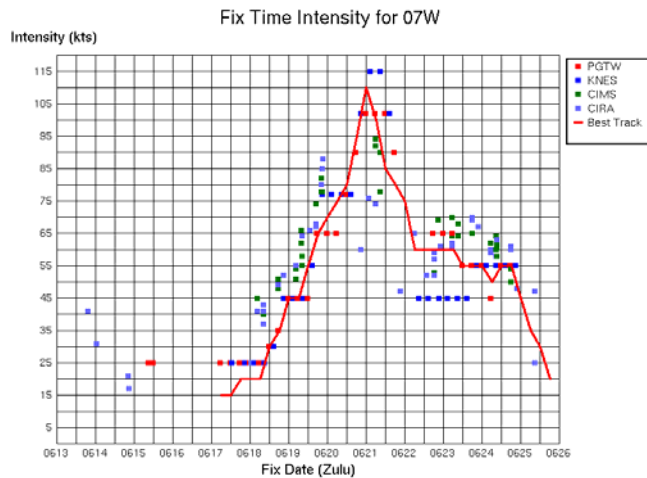
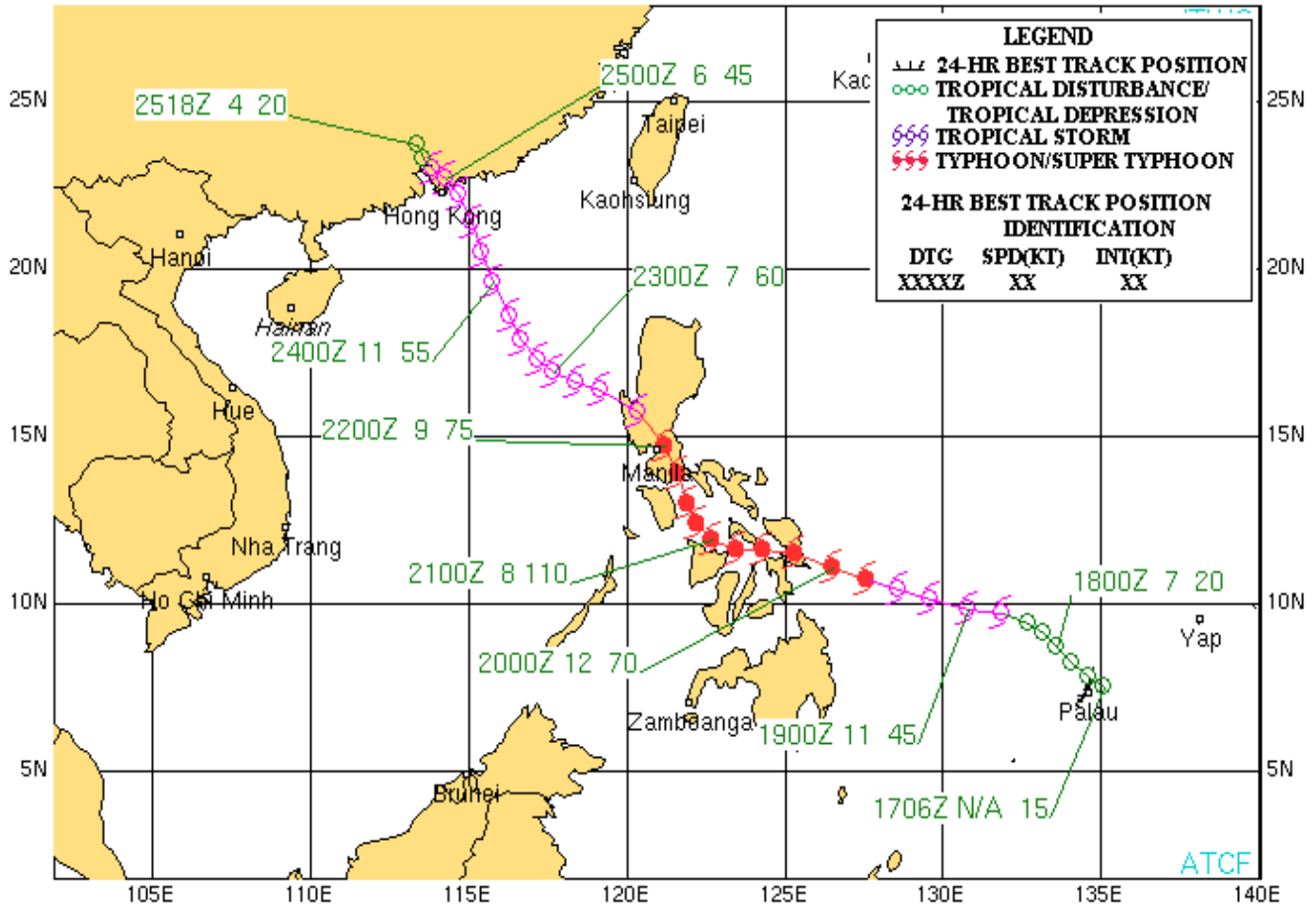
TYPHOON 06W (Nakri)

ISSUED POOR: 1300Z 25 May 2008
 ISSUED FAIR: 0030Z 26 May 2008
 FIRST TCFA: 2200Z 26 May 2008
 FIRST WARNING: 0000Z 27 May 2008
 LAST WARNING: 0000Z 03 Jun 2008
 LANDFALL: None
 MAX INTENSITY: 125 Kts
 NUMBER OF WARNINGS: 29



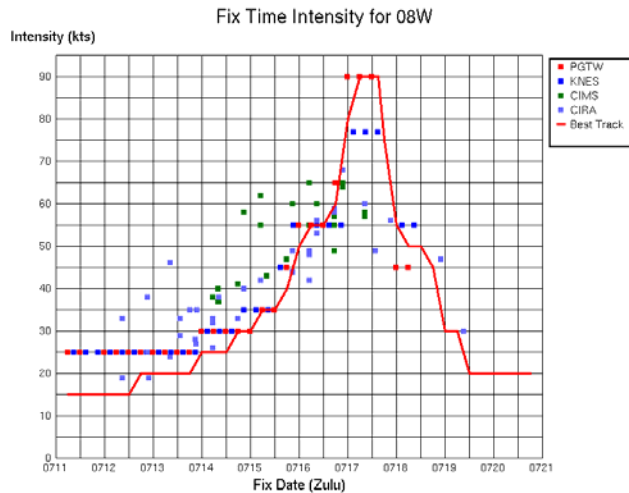
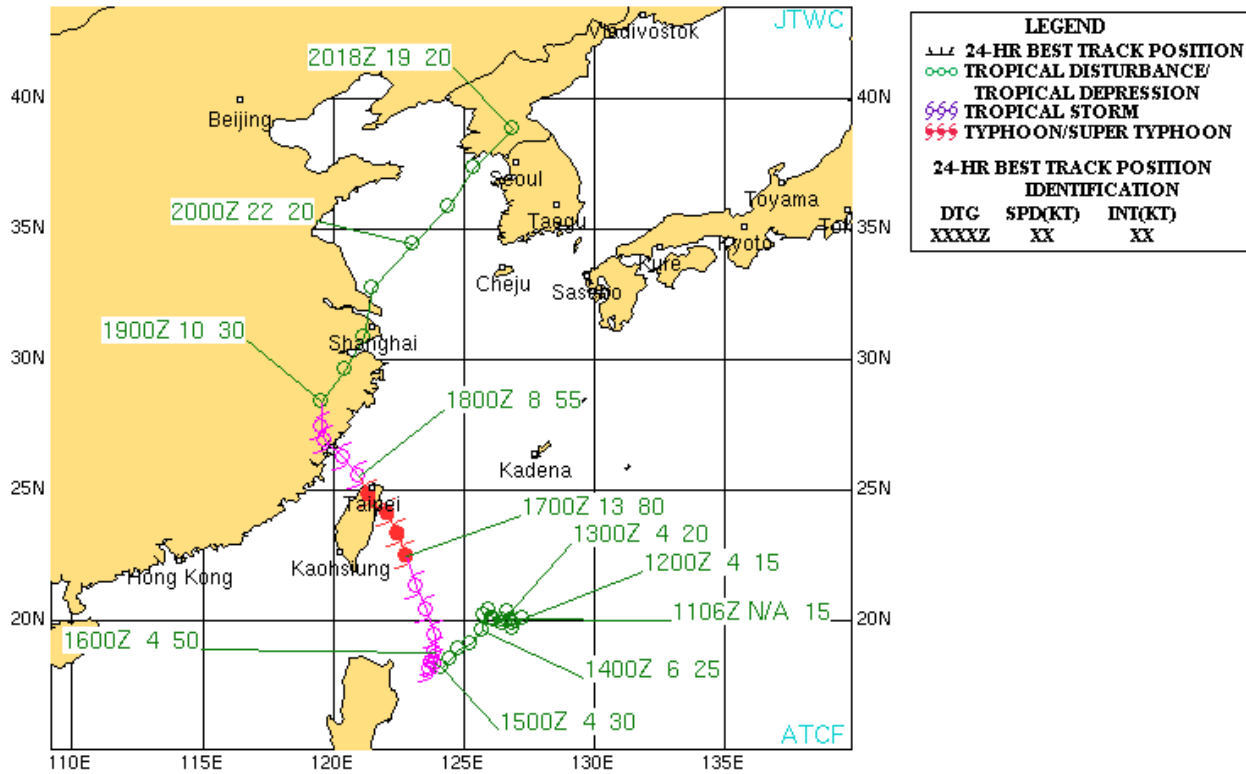
TYPHOON 07W (Fengshen)

ISSUED POOR: 1130Z 15 Jun 2008
 ISSUED FAIR: 1700Z 17 Jun 2008
 FIRST TCFA: 2300Z 17 Jun 2008
 FIRST WARNING: 1200Z 18 Jun 2008
 LAST WARNING: 1200Z 25 Jun 2008
 LANDFALL: Near Sulat, Samar, Philippines; Lucena, Luzon, Philippines; Hong Kong, China
 MAX INTENSITY: 110 Kts
 NUMBER OF WARNINGS: 29



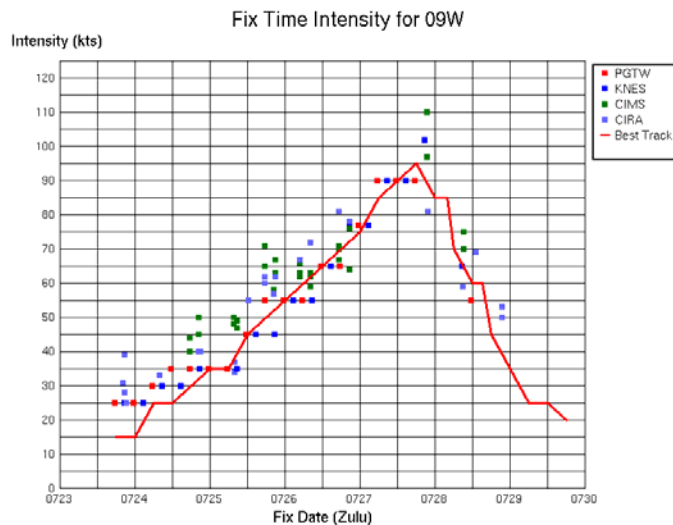
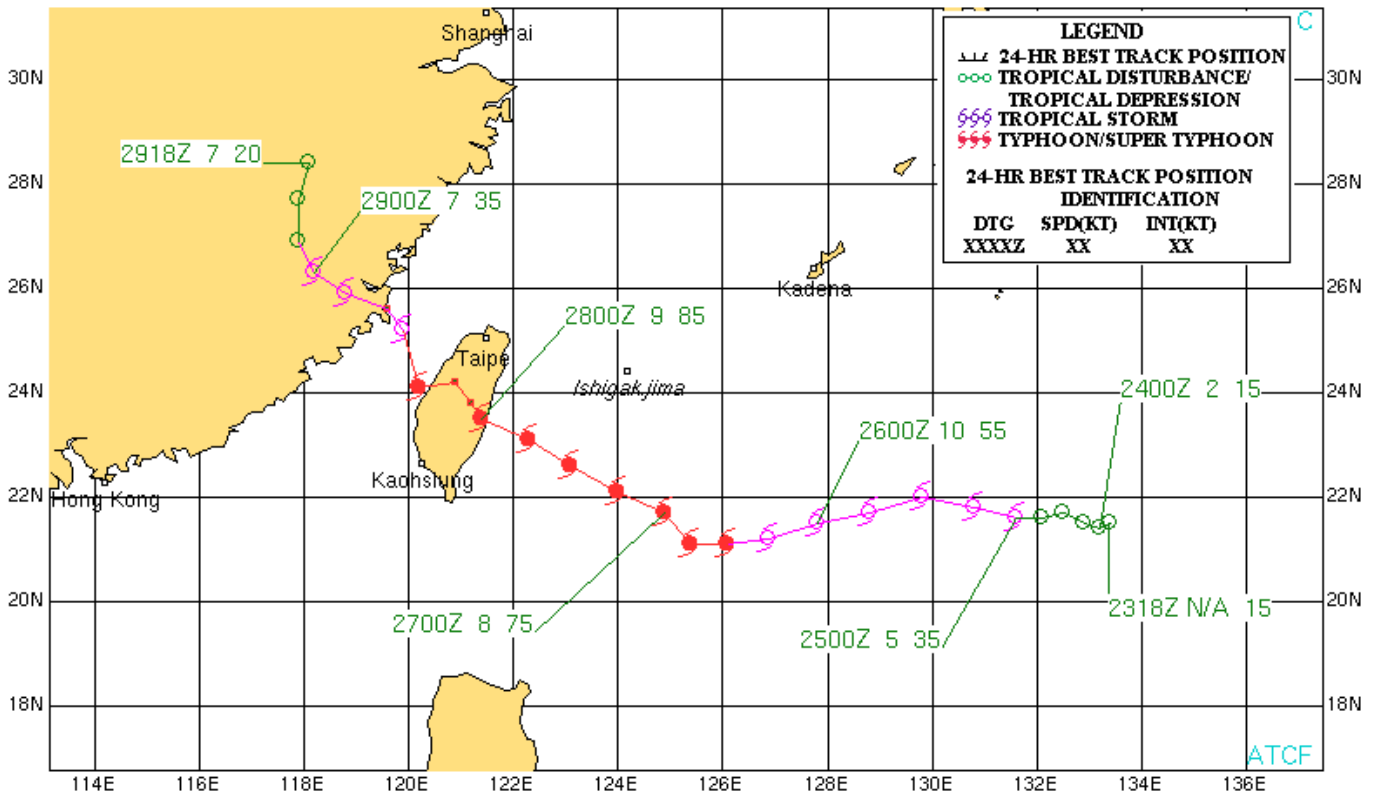
TYPHOON 08W (Kalmaegi)

ISSUED POOR: N/A
 ISSUED FAIR: 0600Z 11 Jul 2008
 FIRST TCFA: 0930Z 13 Jul 2008
 FIRST WARNING: 0600Z 14 Jul 2008
 LAST WARNING: 1800Z 18 Jul 2008
 LANDFALL: Near Ilan, Taiwan; Ningde, China
 MAX INTENSITY: 90 Kts
 NUMBER OF WARNINGS: 19



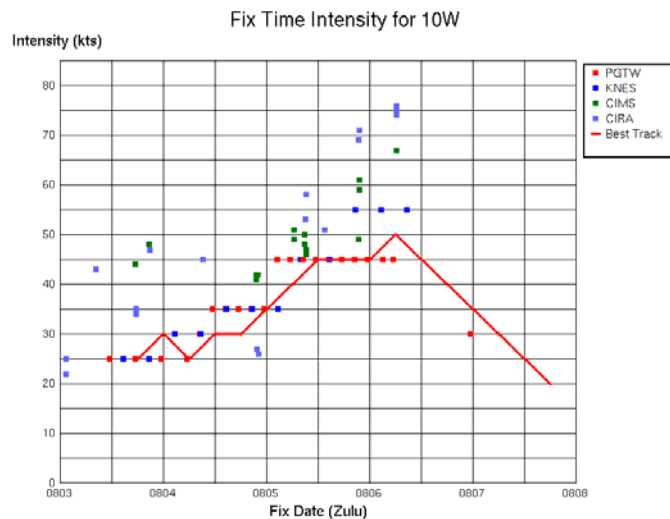
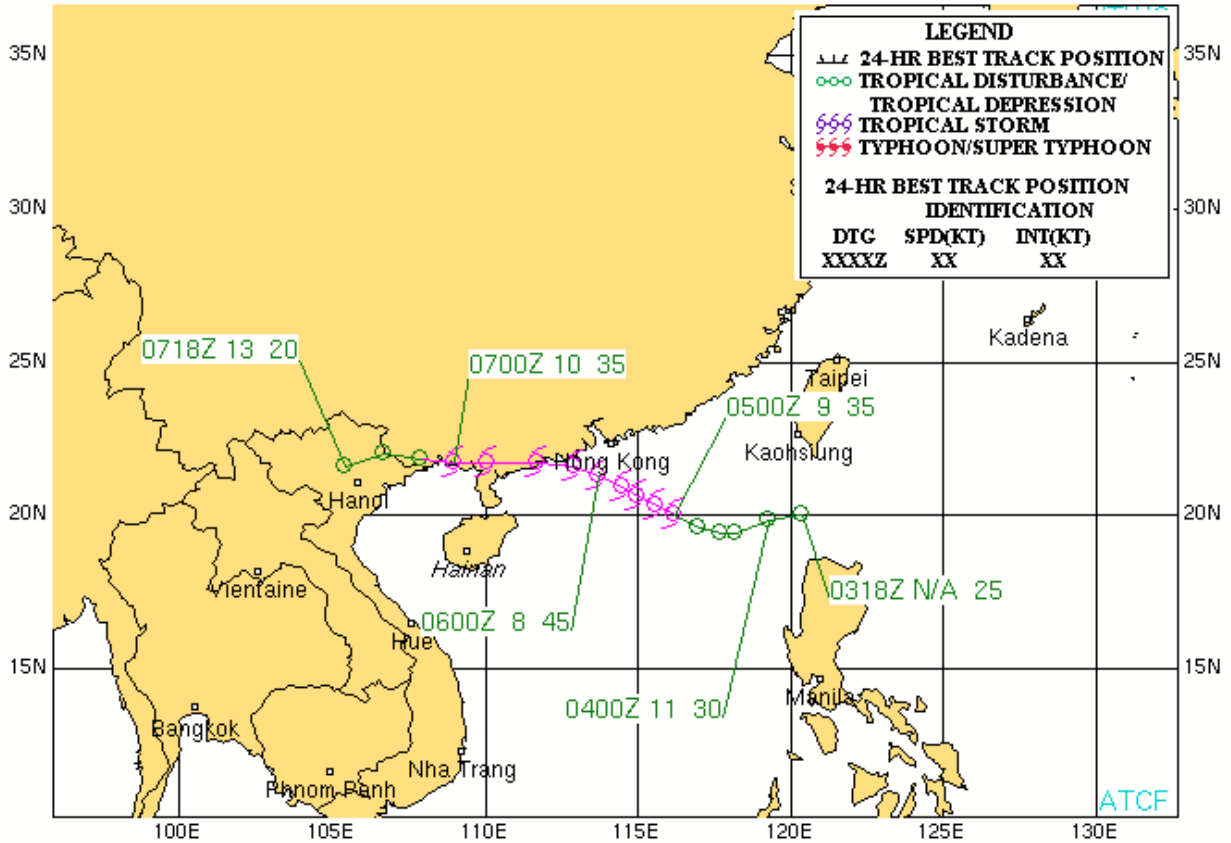
TYPHOON 09W (Fung-Wong)

ISSUED POOR: 2000Z 20 Jul 2008
 ISSUED FAIR: 2300Z 23 Jul 2008
 FIRST TCFA: 0600Z 24 Jul 2008
 FIRST WARNING: 1200Z 24 Jul 2008
 LAST WARNING: 1800Z 28 Jul 2008
 LANDFALL: Near Hualien, Taiwan; Putian, China
 MAX INTENSITY: 95 Kts
 NUMBER OF WARNINGS: 18



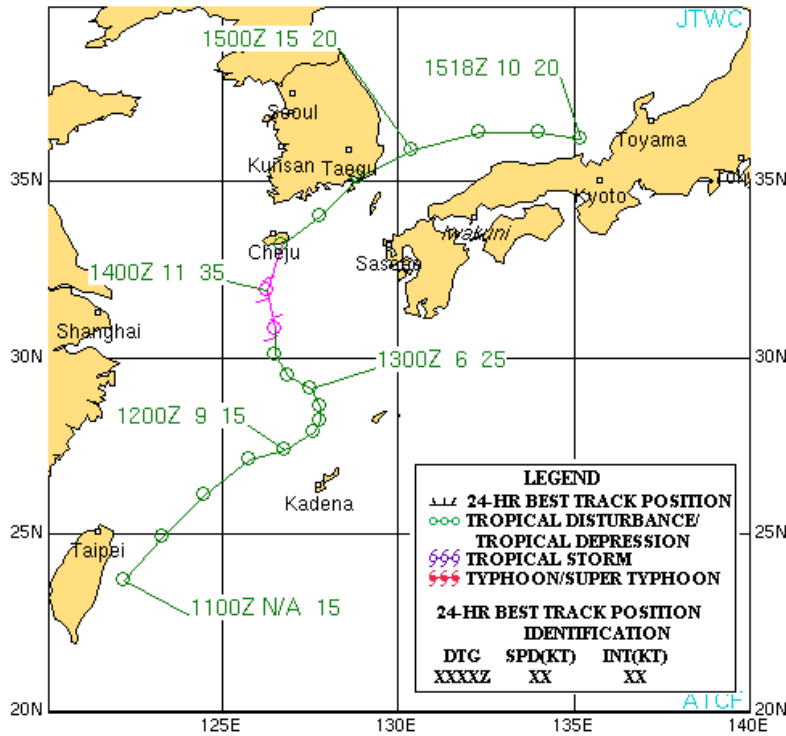
TROPICAL STORM 10W (Kammuri)

ISSUED POOR: N/A
 ISSUED FAIR: 2330Z 02 Aug 2008
 FIRST TCFA: 1930Z 03 Aug 2008
 FIRST WARNING: 0000Z 04 Aug 2008
 LAST WARNING: 1800Z 06 Aug 2008
 LANDFALL: Near Yangjiang, China
 MAX INTENSITY: 50 Kts
 NUMBER OF WARNINGS: 12

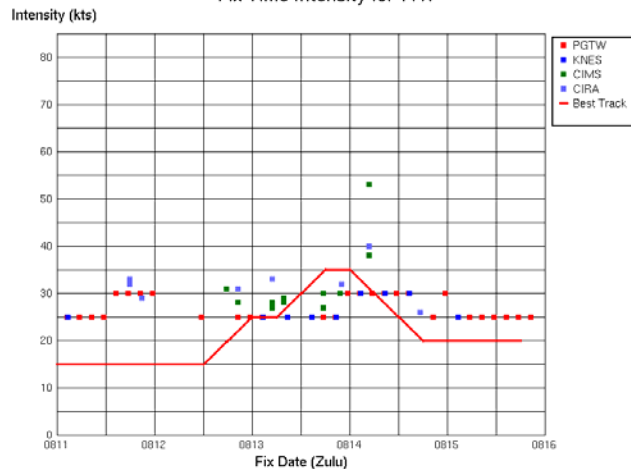


TROPICAL STORM 11W

ISSUED POOR: 0600Z 11 Aug 2008
 ISSUED FAIR: N/A
 FIRST TCFA: N/A
 FIRST WARNING: 0000Z 13 Aug 2008
 LAST WARNING: 1200Z 14 Aug 2008
 LANDFALL: Cheju Island, South Korea
 MAX INTENSITY: 35 Kts
 NUMBER OF WARNINGS: 7

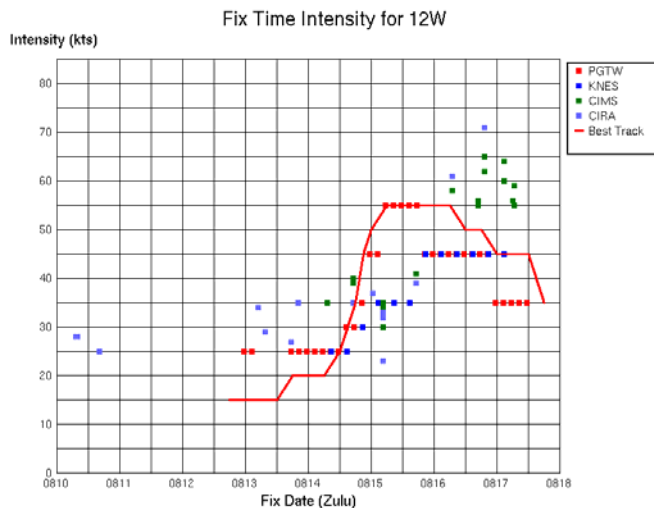
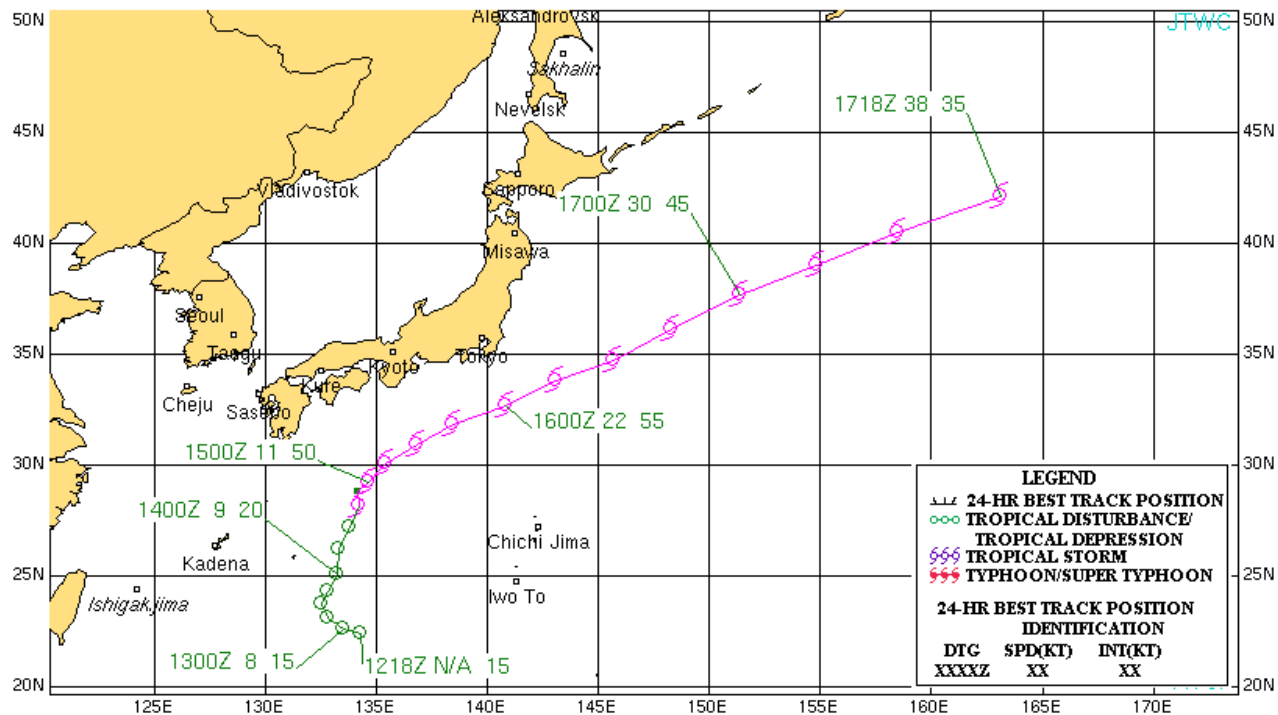


Fix Time Intensity for 11W



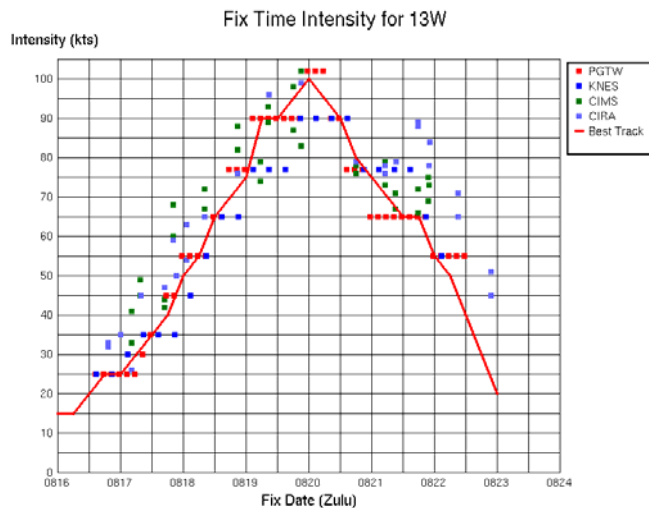
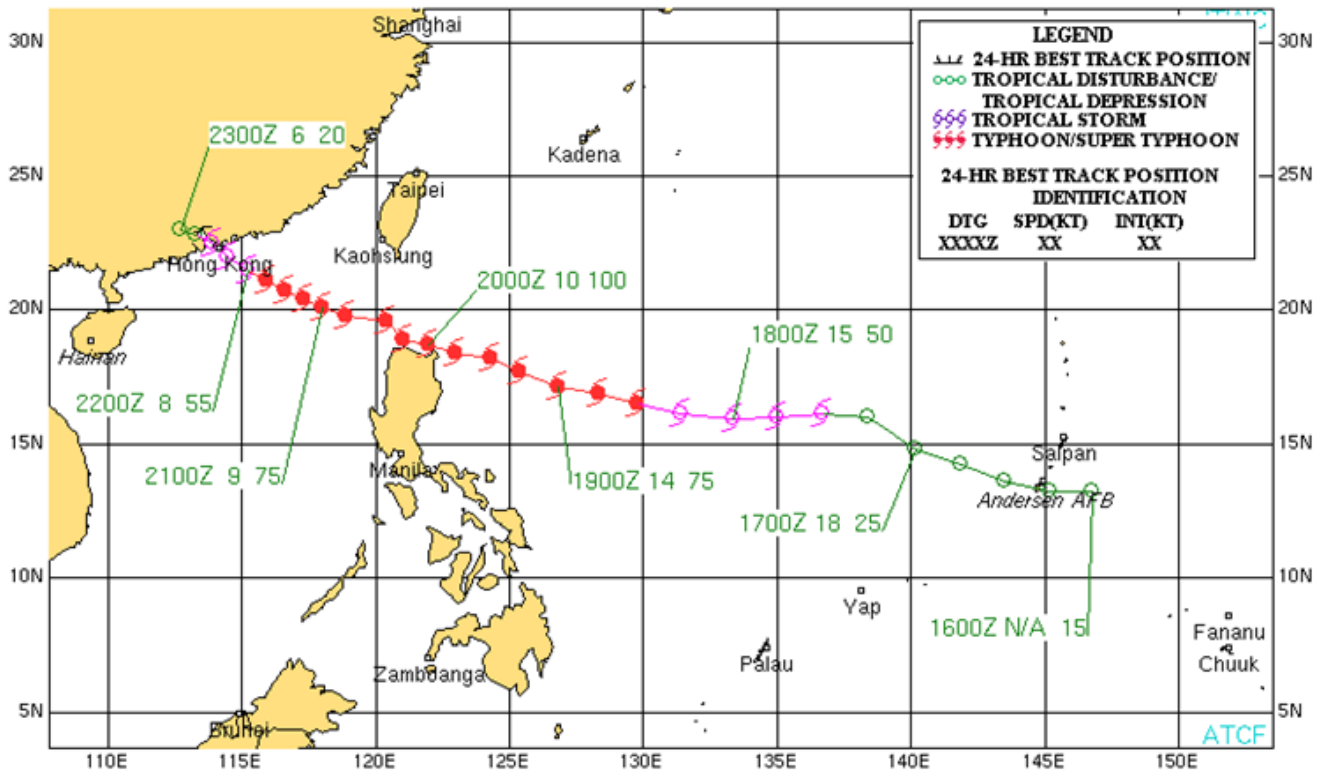
TROPICAL STORM 12W (Vongfong)

ISSUED POOR: N/A
 ISSUED FAIR: 0600Z 13 Aug 2008
 FIRST TCFA: 0030Z 14 Aug 2008
 FIRST WARNING: 1800Z 14 Aug 2008
 LAST WARNING: 1800Z 16 Aug 2008
 LANDFALL: None
 MAX INTENSITY: 55 Kts
 NUMBER OF WARNINGS: 9



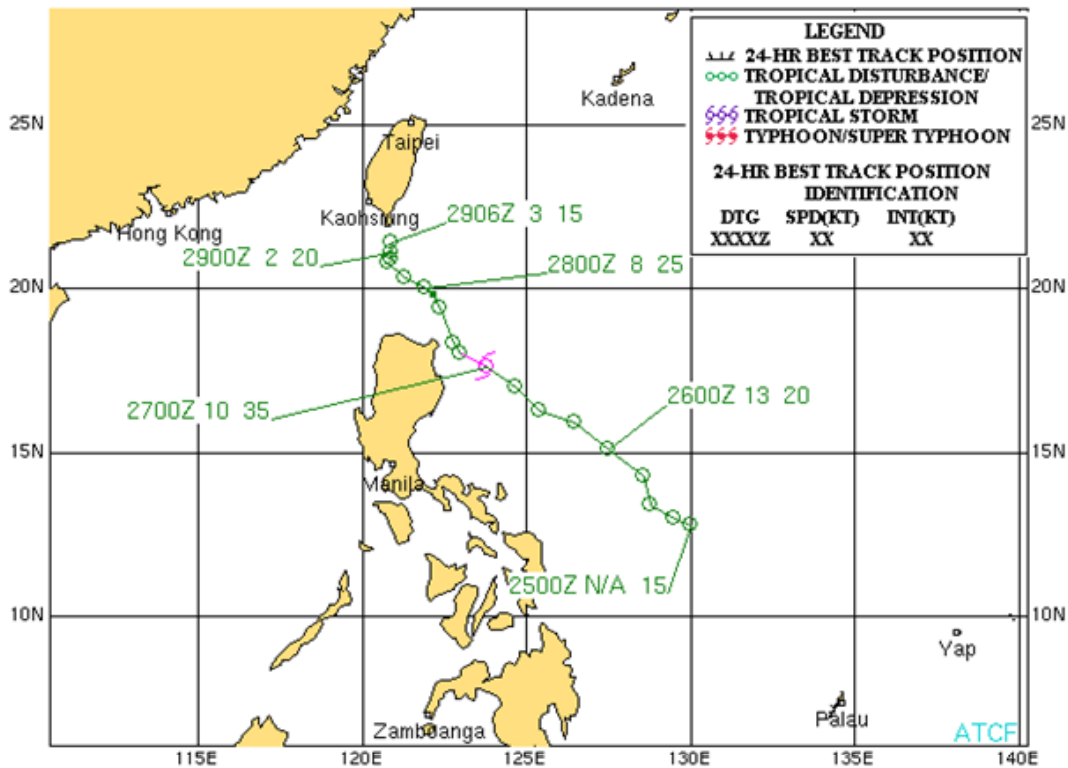
TYPHOON 13W (Nuri)

ISSUED POOR: 0600Z 16 Aug 2008
 ISSUED FAIR: 1730Z 16 Aug 2008
 FIRST TCFA: 2100Z 16 Aug 2008
 FIRST WARNING: 0000Z 17 Aug 2008
 LAST WARNING: 1800Z 22 Aug 2008
 LANDFALL: Near Hong Kong, China
 MAX INTENSITY: 100 Kts
 NUMBER OF WARNINGS: 24

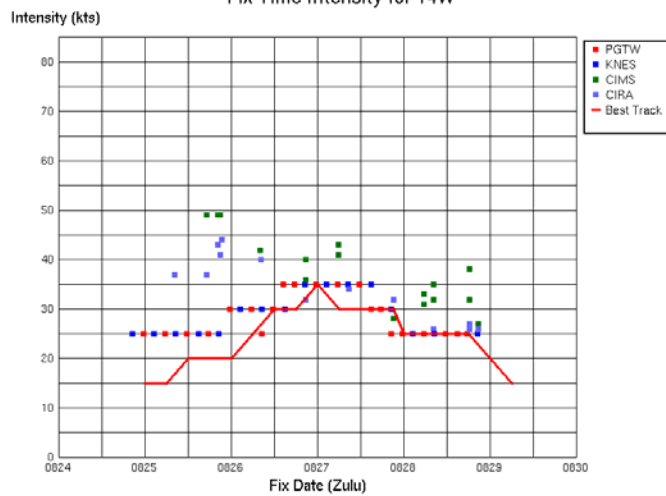


TROPICAL STORM 14W

ISSUED POOR: 0130Z 25 Aug 2008
 ISSUED FAIR: 0600Z 25 Aug 2008
 FIRST TCFA: 0100Z 26 Aug 2008
 FIRST WARNING: 1200Z 26 Aug 2008
 LAST WARNING: 0000Z 28 Aug 2008
 LANDFALL: None
 MAX INTENSITY: 35 Kts
 NUMBER OF WARNINGS: 7

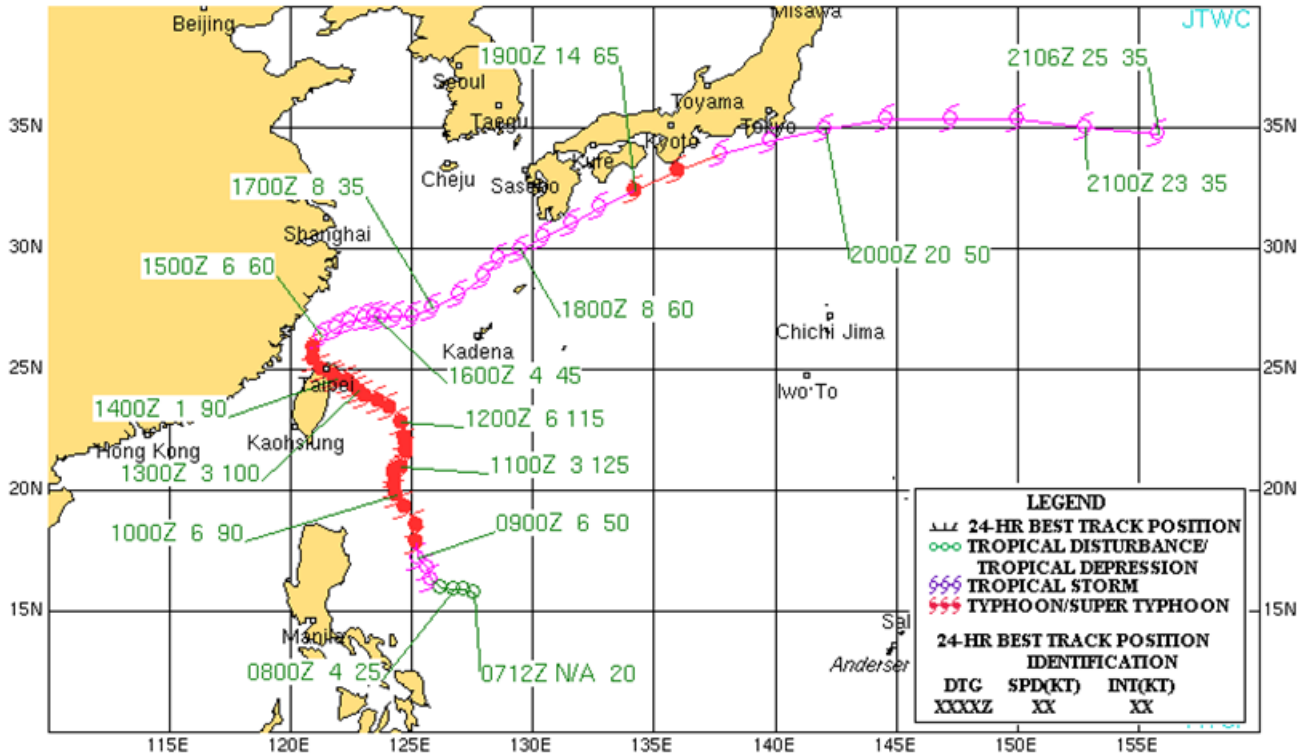


Fix Time Intensity for 14W

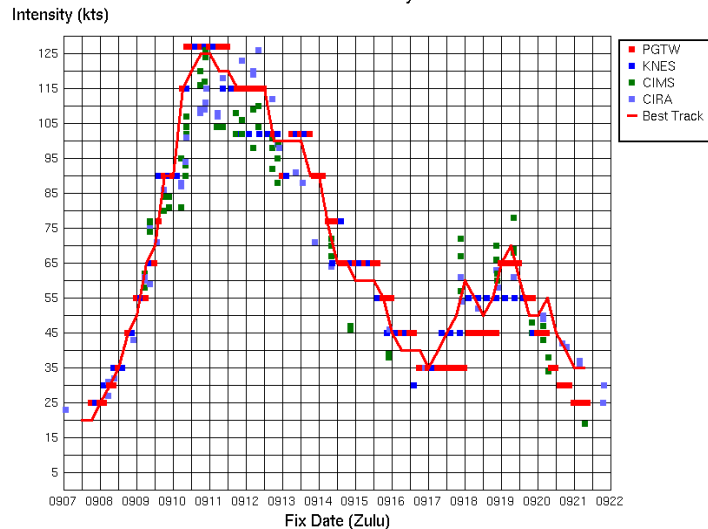


TYPHOON 15W (Sinlaku)

ISSUED POOR: 1430Z 07 Sep 2008
 ISSUED FAIR: 2200Z 07 Sep 2008
 FIRST TCFA: 0600Z 08 Sep 2008
 FIRST WARNING: 1200Z 08 Sep 2008
 LAST WARNING: 0000Z 20 Sep 2008
 LANDFALL: Near Taipei, Taiwan
 MAX INTENSITY: 125 Kts
 NUMBER OF WARNINGS: 47

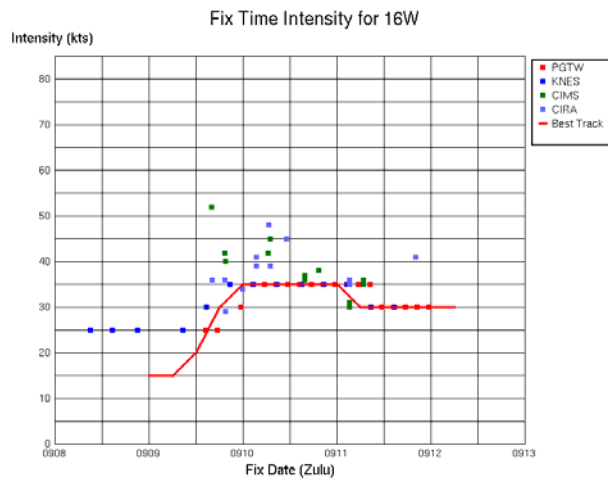
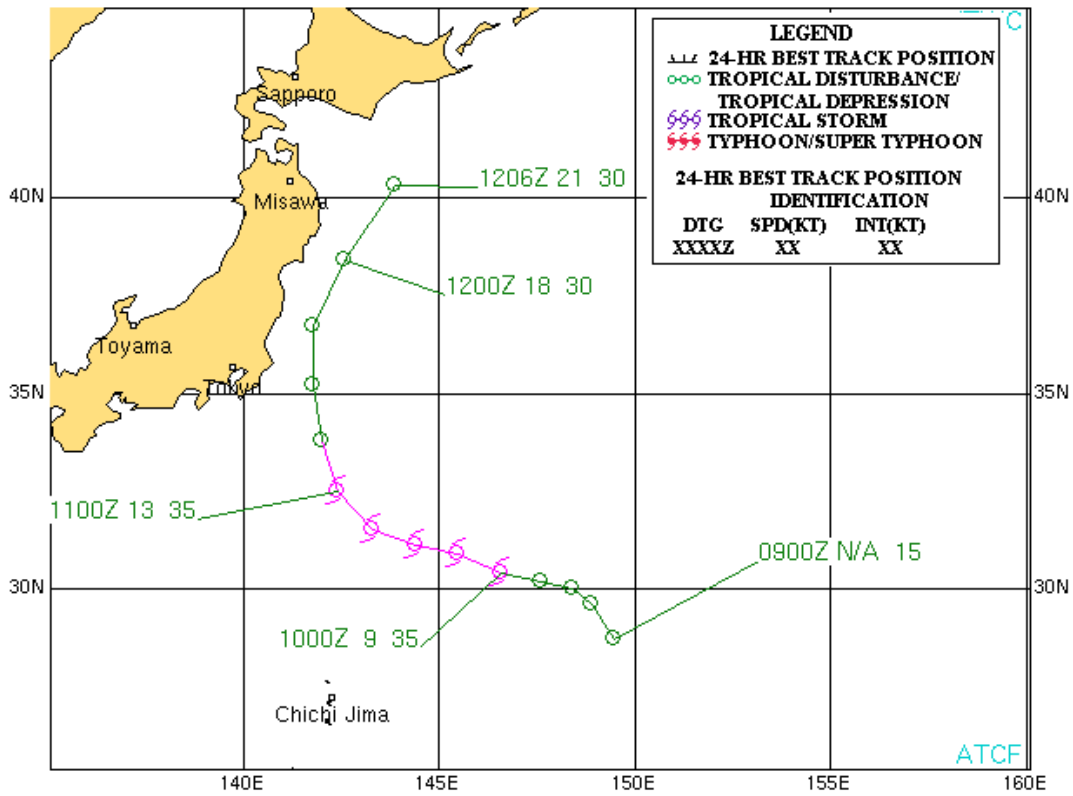


Fix Time Intensity for 15W



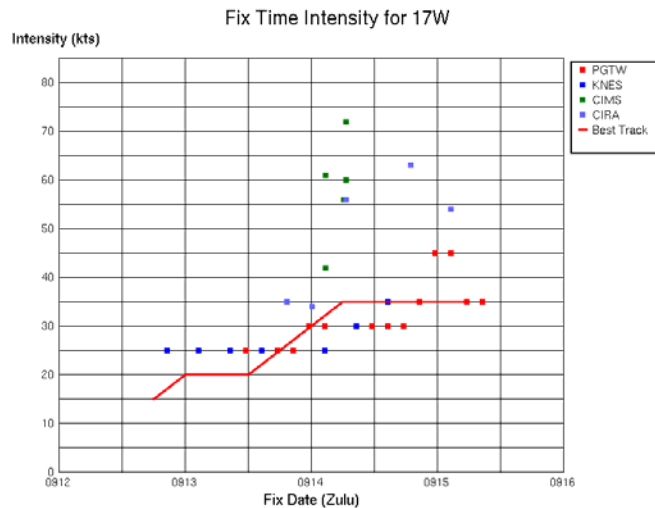
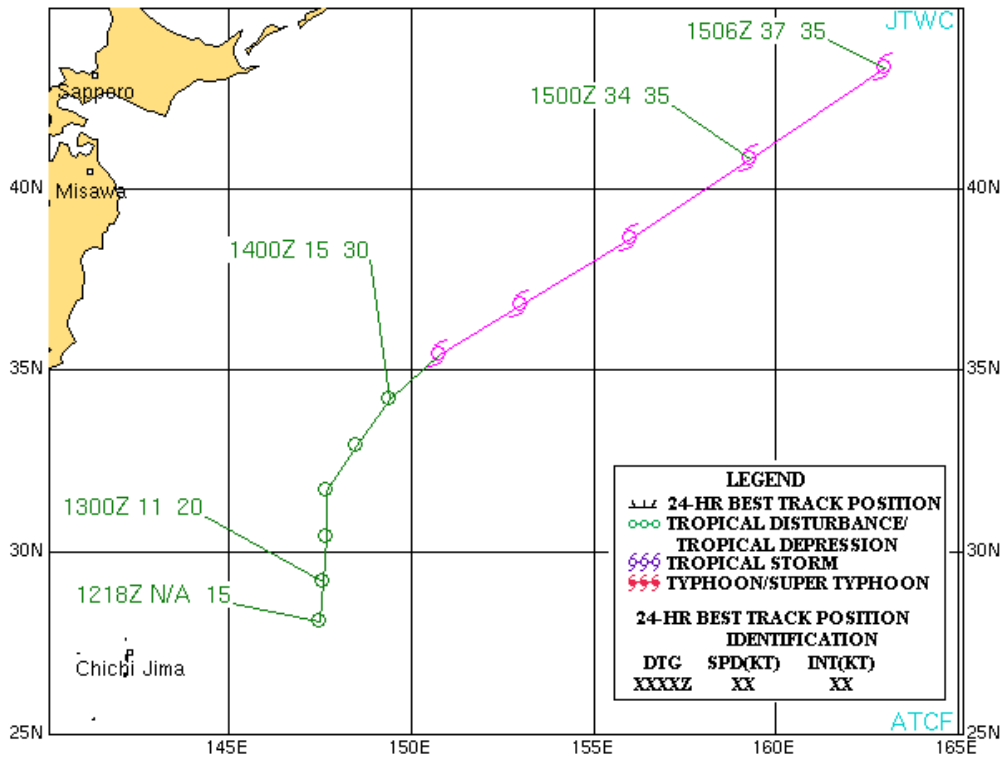
TROPICAL STORM 16W

ISSUED POOR: N/A
 ISSUED FAIR: 2330Z 09 Sep 2008
 FIRST TCFA: N/A
 FIRST WARNING: 0000Z 10 Sep 2008
 LAST WARNING: 1800Z 11 Sep 2008
 LANDFALL: None
 MAX INTENSITY: 35 Kts
 NUMBER OF WARNINGS: 8



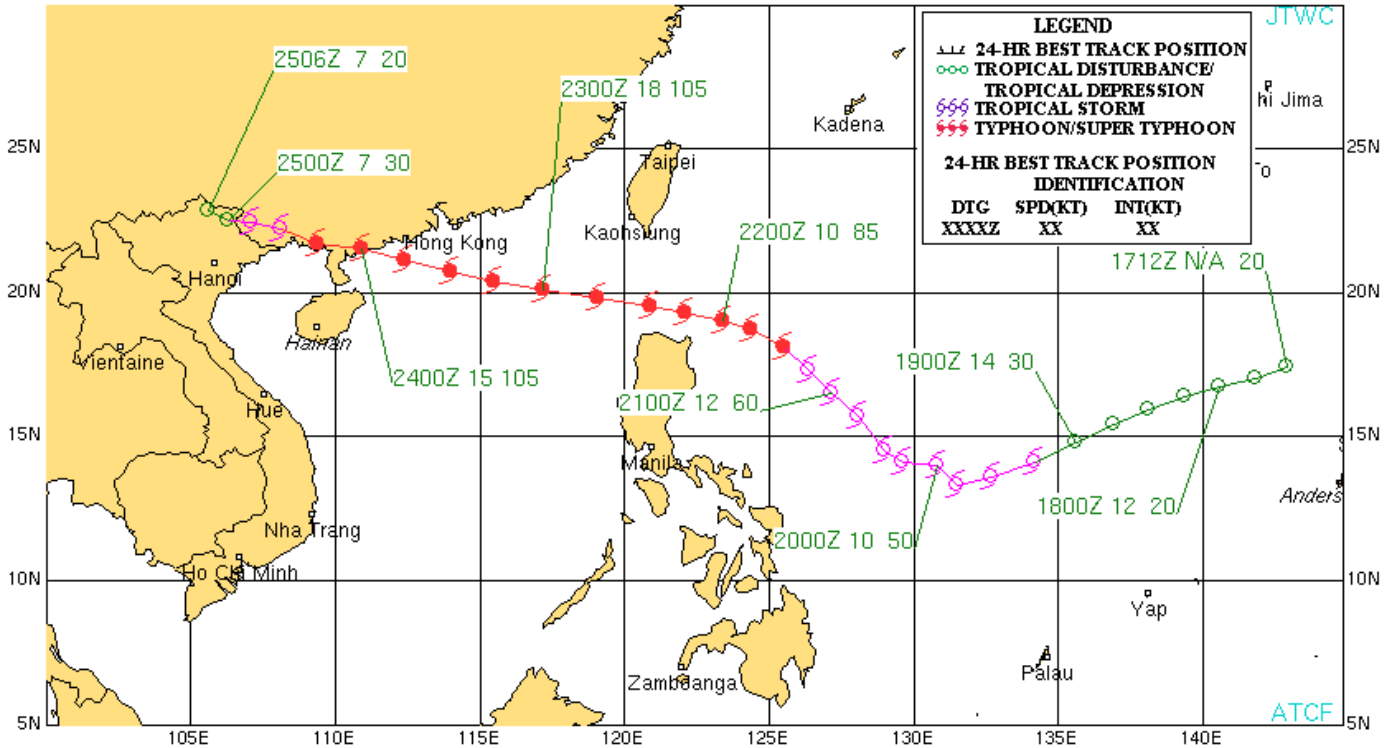
TROPICAL STORM 17W

ISSUED POOR: N/A
 ISSUED FAIR: N/A
 FIRST TCFA: N/A
 FIRST WARNING: 0000Z 14 Sep 2008
 LAST WARNING: 0000Z 14 Sep 2008
 LANDFALL: None
 MAX INTENSITY: 35 Kts
 NUMBER OF WARNINGS: 1

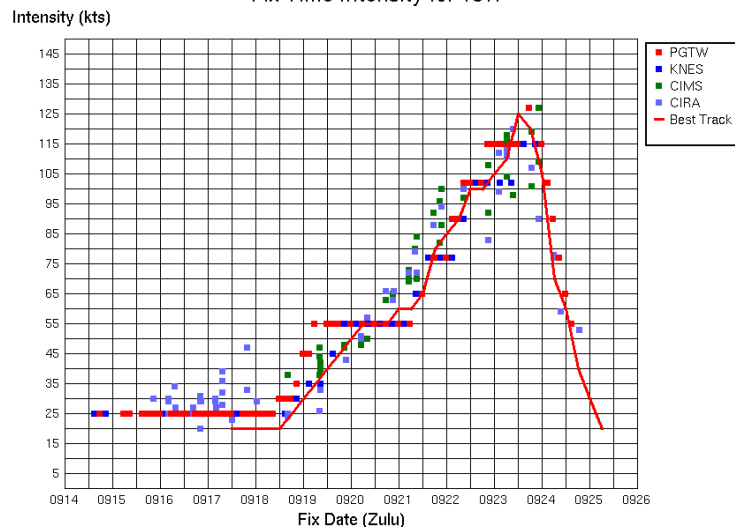


TYPHOON 18W (Hagupit)

ISSUED POOR: 0600Z 15 Sep 2008
 ISSUED FAIR: 0030Z 16 Sep 2008
 FIRST TCFA: 2330Z 17 Sep 2008
 FIRST WARNING: 1800Z 18 Sep 2008
 LAST WARNING: 1200Z 24 Sep 2008
 LANDFALL: Near Zhanjiang, China
 MAX INTENSITY: 125 Kts
 NUMBER OF WARNINGS: 24

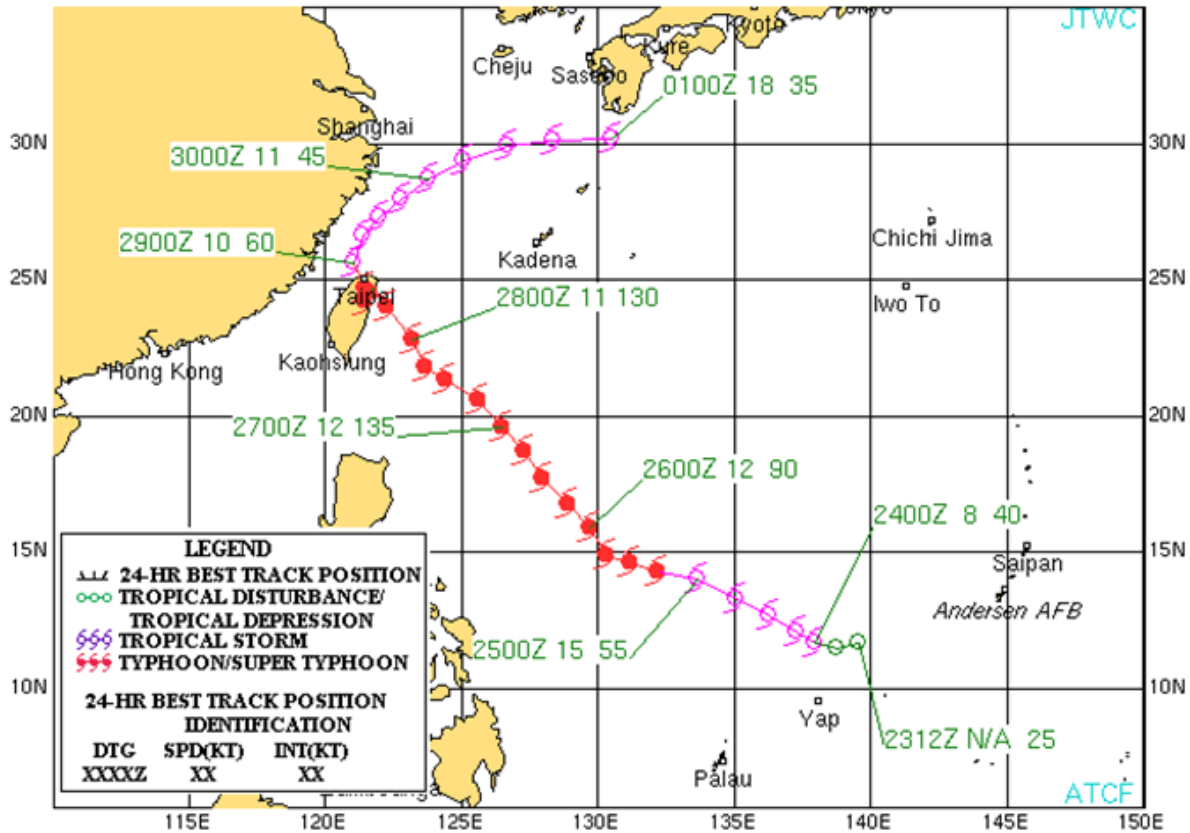


Fix Time Intensity for 18W

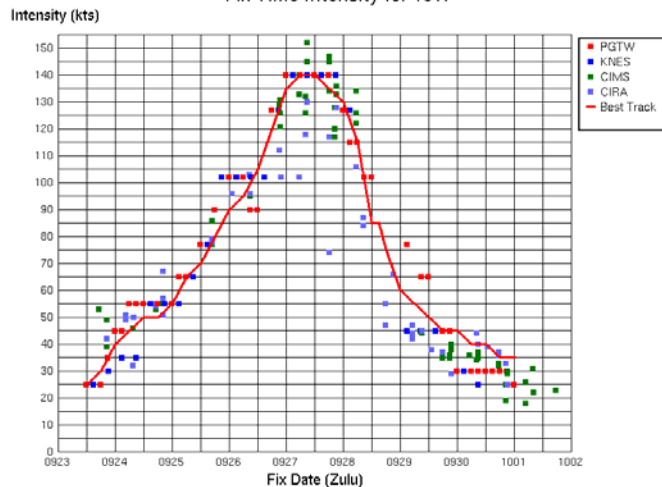


SUPER TYPHOON 19W (Jangmi)

ISSUED POOR: 0600Z 23 Sep 2008
 ISSUED FAIR: 1300Z 23 Sep 2008
 FIRST TCFA: 1930Z 23 Sep 2008
 FIRST WARNING: 1800Z 23 Sep 2008
 LAST WARNING: 1800Z 30 Sep 2008
 LANDFALL: Near Suao, Taiwan
 MAX INTENSITY: 140 Kts
 NUMBER OF WARNINGS: 29

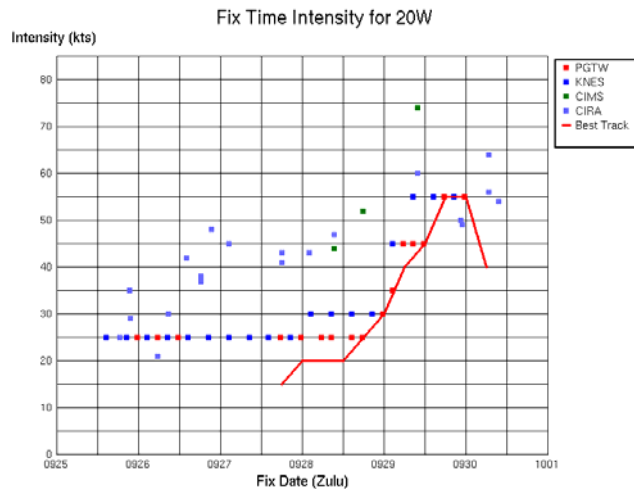
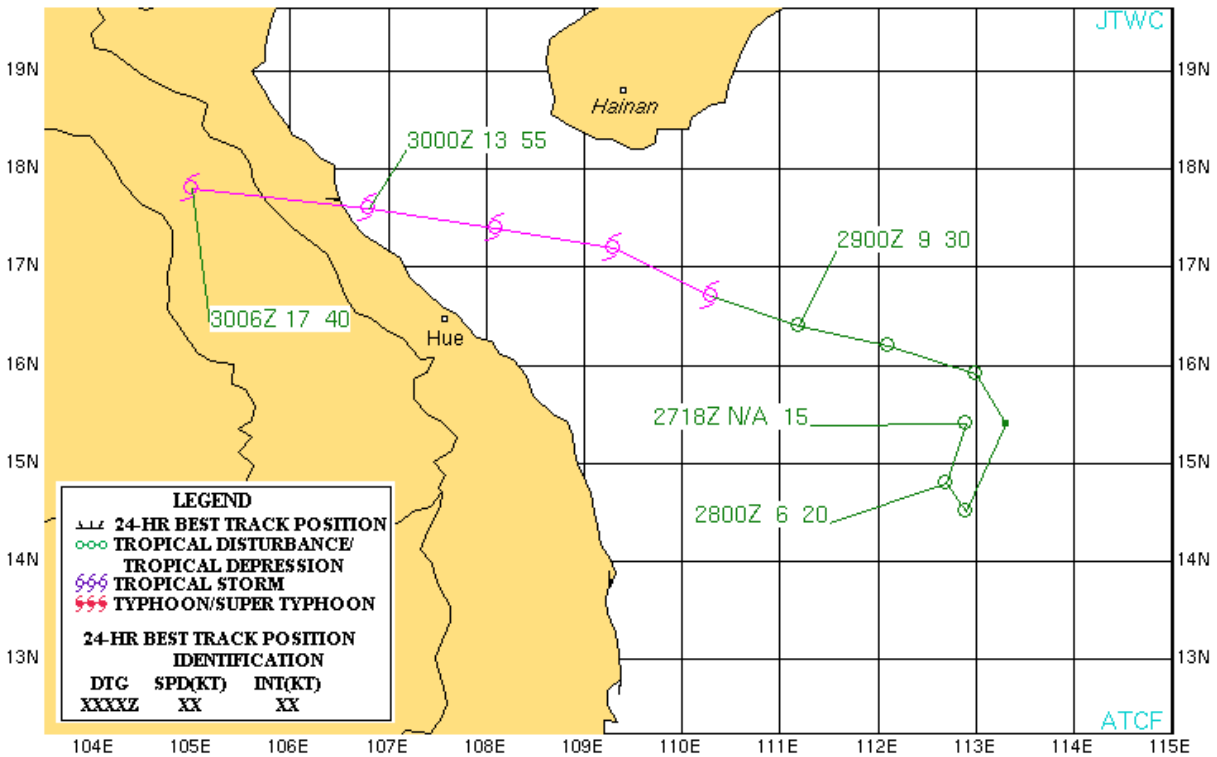


Fix Time Intensity for 19W



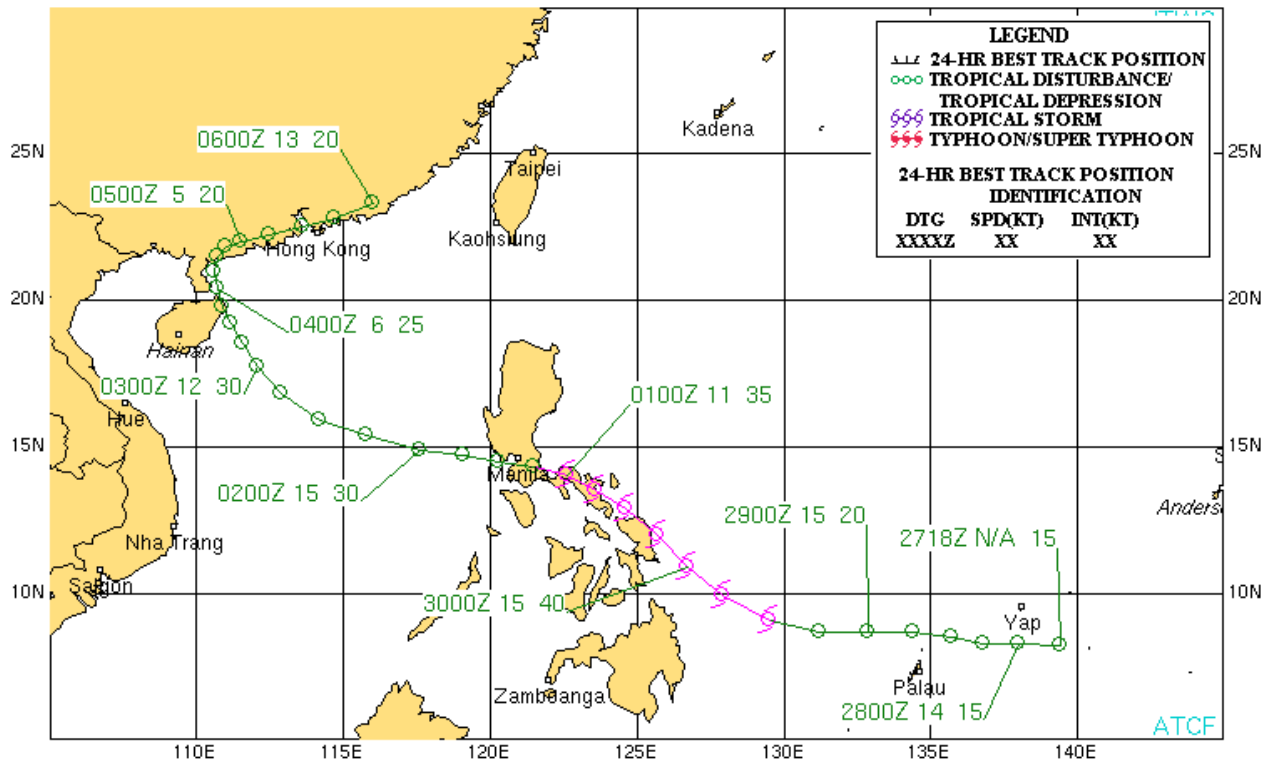
TROPICAL STORM 20W (Mekkhala)

ISSUED POOR: 0600Z 26 Sep 2008
 ISSUED FAIR: 0930Z 26 Sep 2008
 FIRST TCFA: 0630Z 28 Sep 2008
 FIRST WARNING: 1800Z 28 Sep 2008
 LAST WARNING: 0600Z 30 Sep 2008
 LANDFALL: Near Dong Hoi, Vietnam
 MAX INTENSITY: 55 Kts
 NUMBER OF WARNINGS: 7

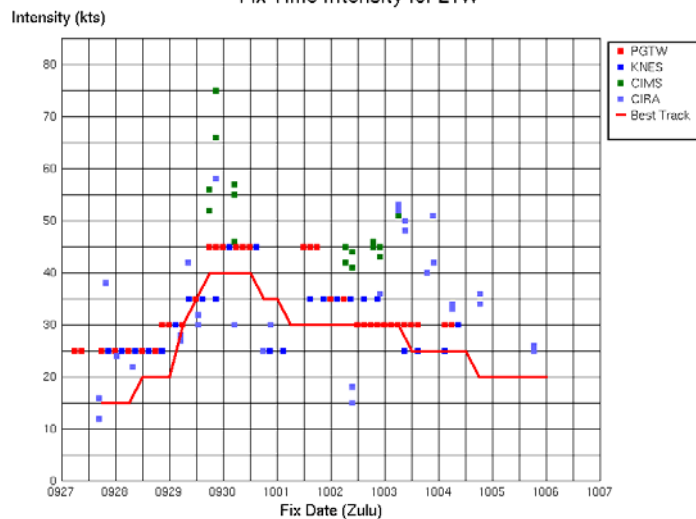


TROPICAL STORM 21W (Higos)

ISSUED POOR: 1300Z 27 Sep 2008
 ISSUED FAIR: 0600Z 28 Sep 2008
 FIRST TCFA: 2300Z 28 Sep 2008
 FIRST WARNING: 0600Z 29 Sep 2008
 LAST WARNING: 0600Z 04 Oct 2008
 LANDFALL: Near Legazpi, Luzon, Philippines; Haikou, China
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 21

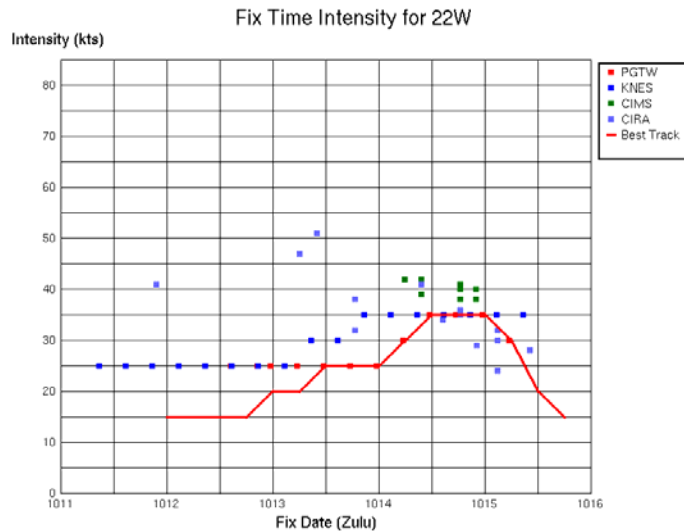
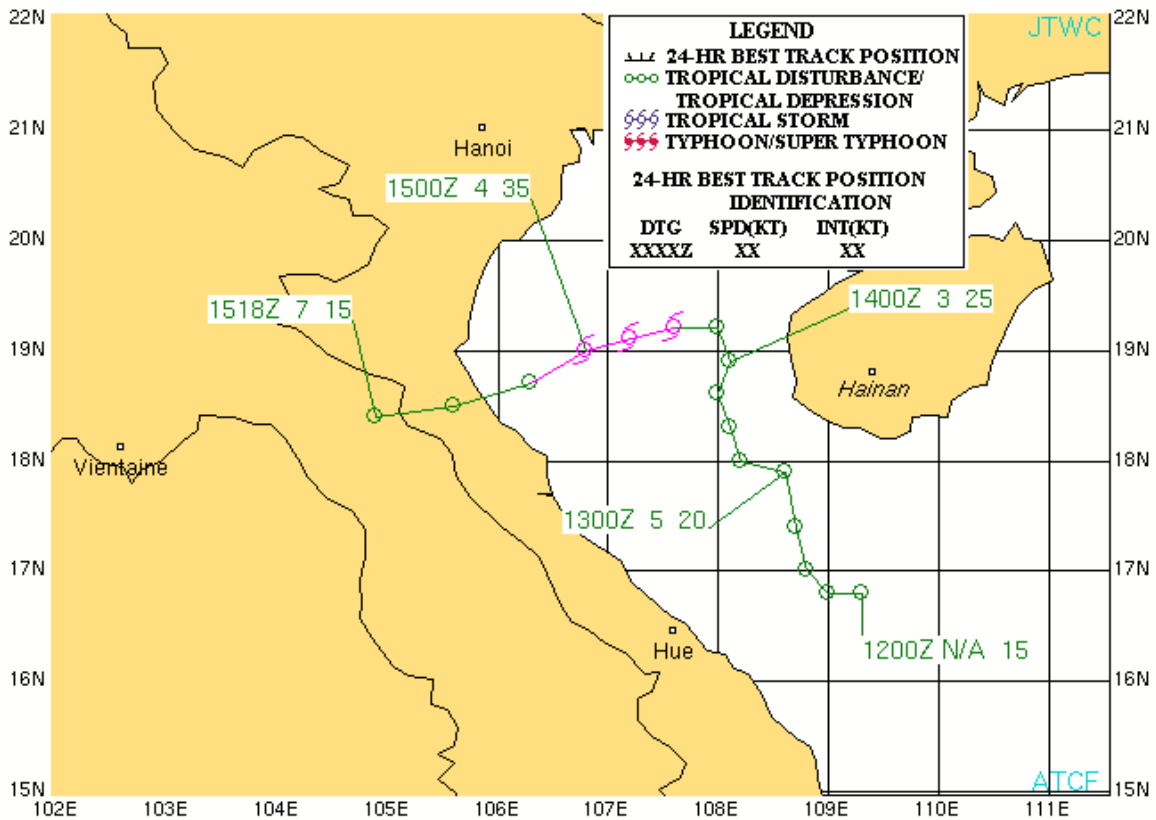


Fix Time Intensity for 21W



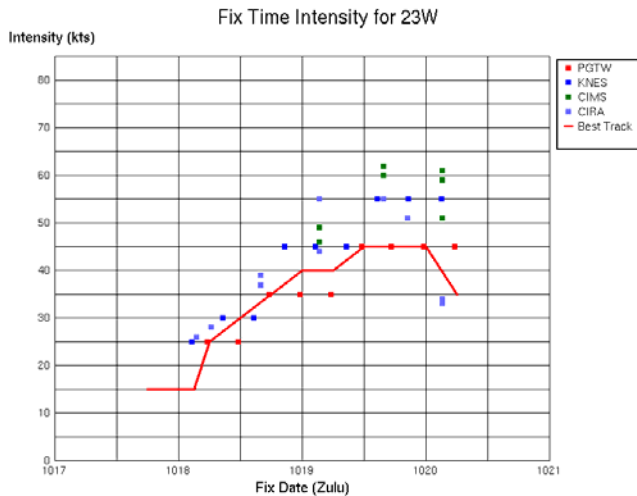
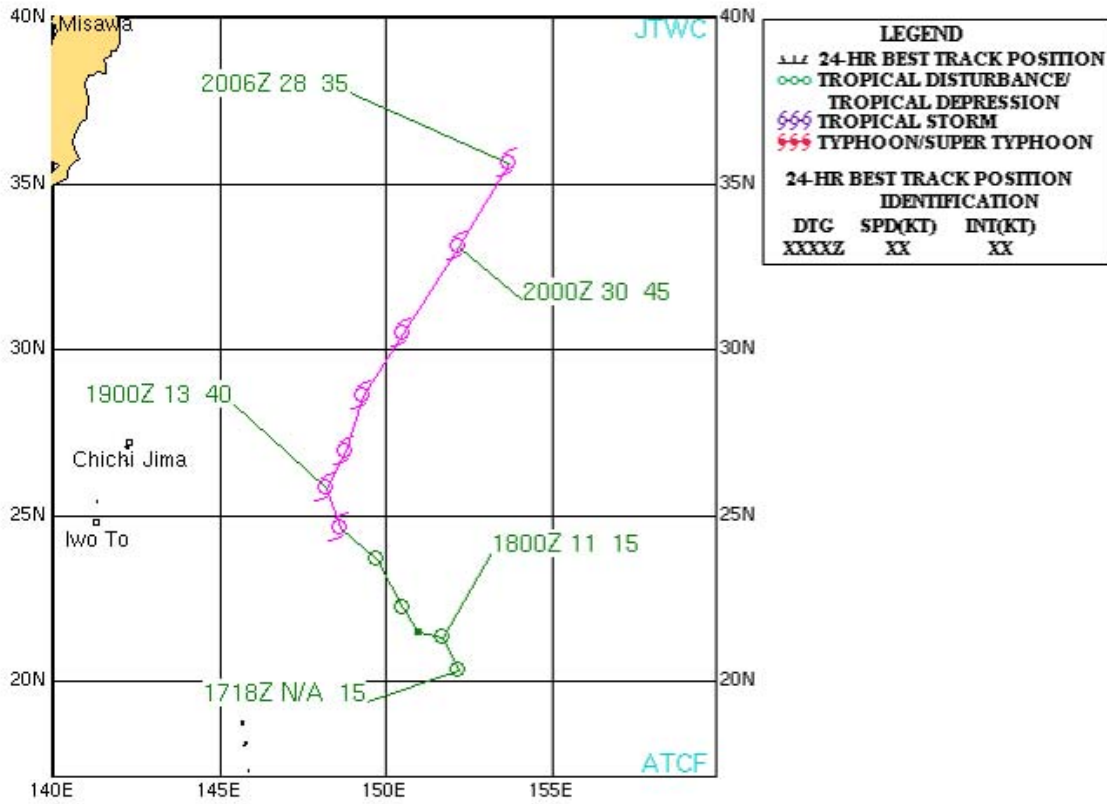
TROPICAL STORM 22W

ISSUED POOR: 1500Z 07 Oct 2008
 ISSUED FAIR: 2130Z 12 Oct 2008
 FIRST TCFA: 0600Z 14 Oct 2008
 FIRST WARNING: 0600Z 14 Oct 2008
 LAST WARNING: 1200Z 15 Oct 2008
 LANDFALL: 35 Kts
 MAX INTENSITY: Near Vinh, Vietnam
 NUMBER OF WARNINGS: 6



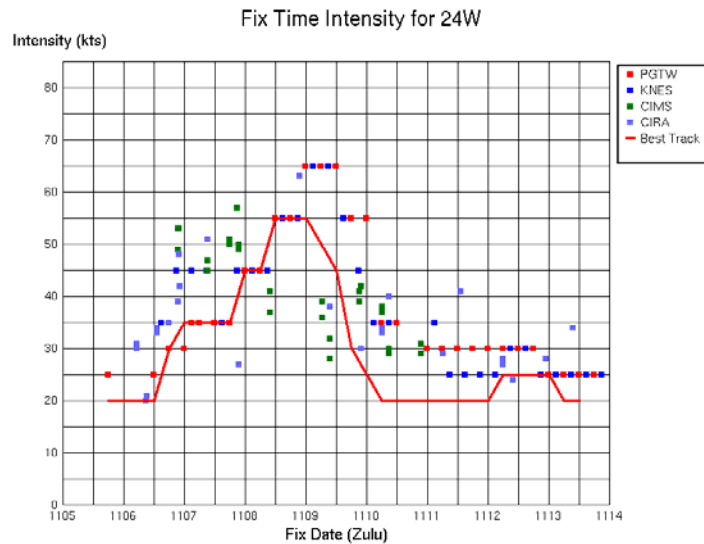
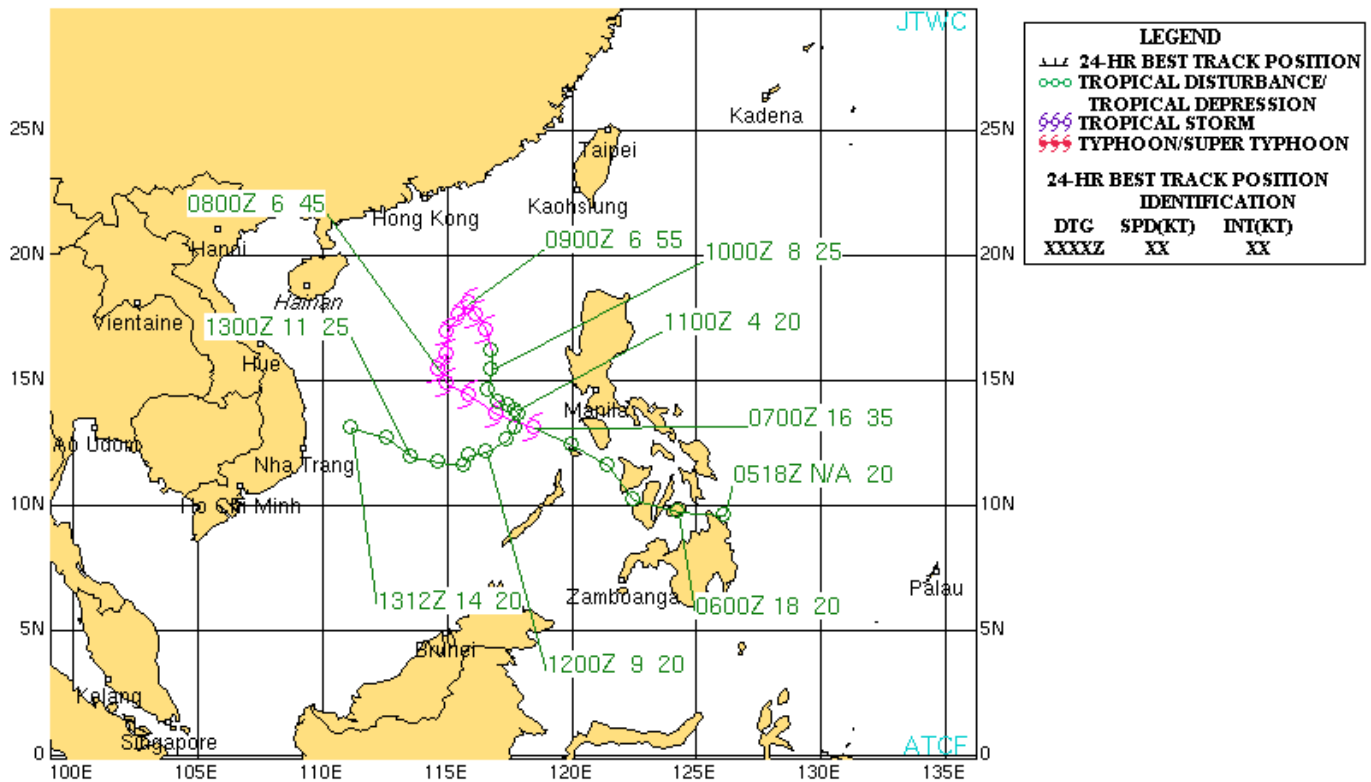
TROPICAL STORM 23W (Bavi)

ISSUED POOR: 0230Z 18 Oct 2008
 ISSUED FAIR: 0600Z 18 Oct 2008
 FIRST TCFA: 1100Z 18 Oct 2008
 FIRST WARNING: 1800Z 18 Oct 2008
 LAST WARNING: 0000Z 20 Oct 2008
 LANDFALL: None
 MAX INTENSITY: 45 Kts
 NUMBER OF WARNINGS: 6



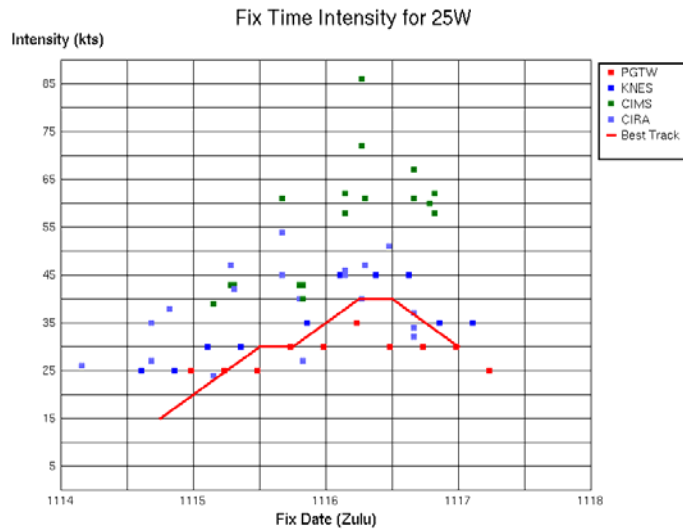
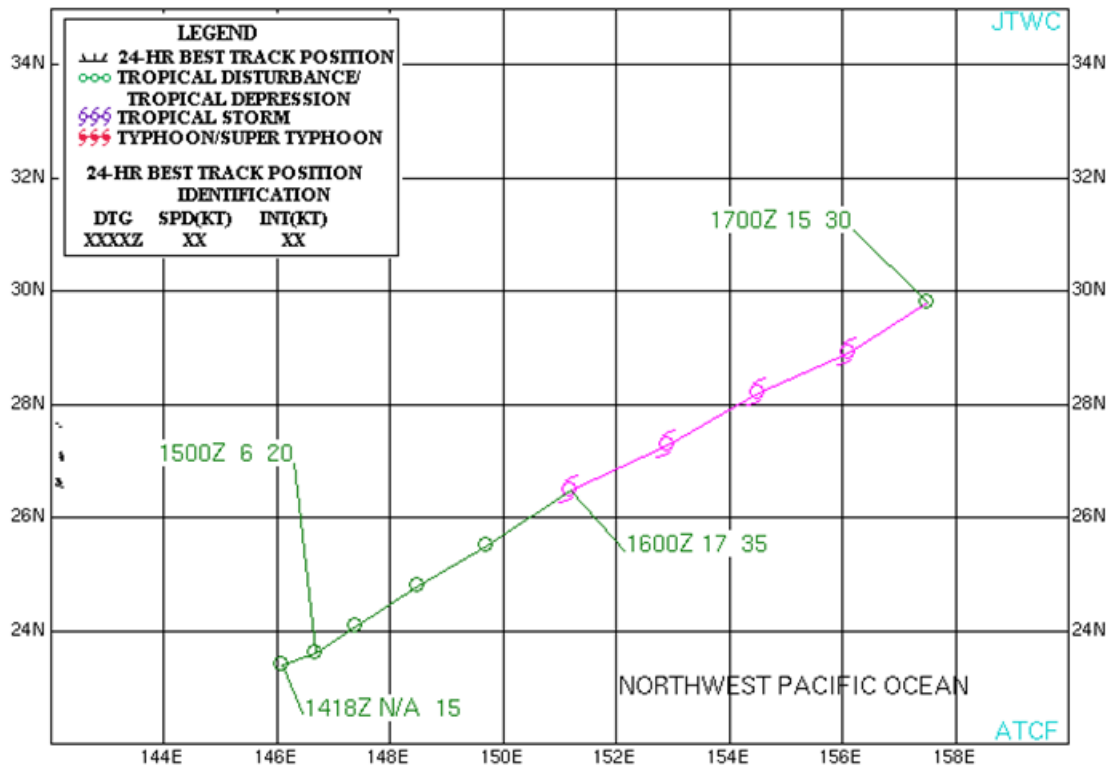
TROPICAL STORM 24W (Maysak)

ISSUED POOR: 1800Z 05 Nov 2008
 ISSUED FAIR: 0600Z 06 Nov 2008
 FIRST TCFA: 1500Z 06 Nov 2008
 FIRST WARNING: 0000Z 07 Nov 2008
 LAST WARNING: 0000Z 10 Nov 2008
 LANDFALL: Near Isabela, Negro, Philippines
 MAX INTENSITY: 55 Kts
 NUMBER OF WARNINGS: 14



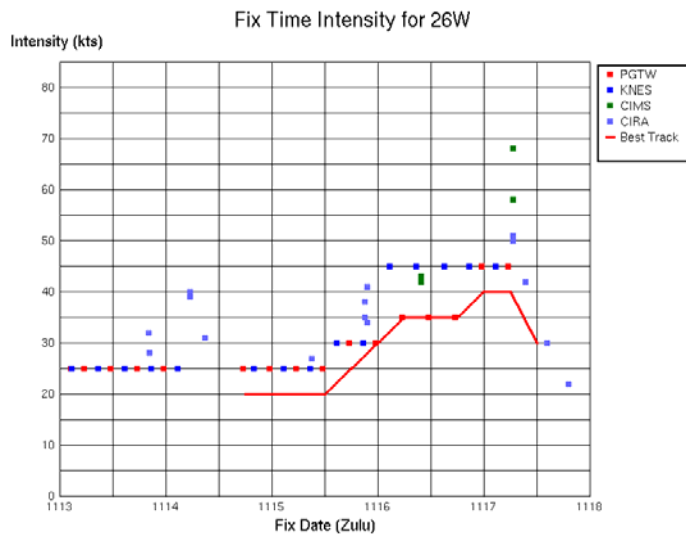
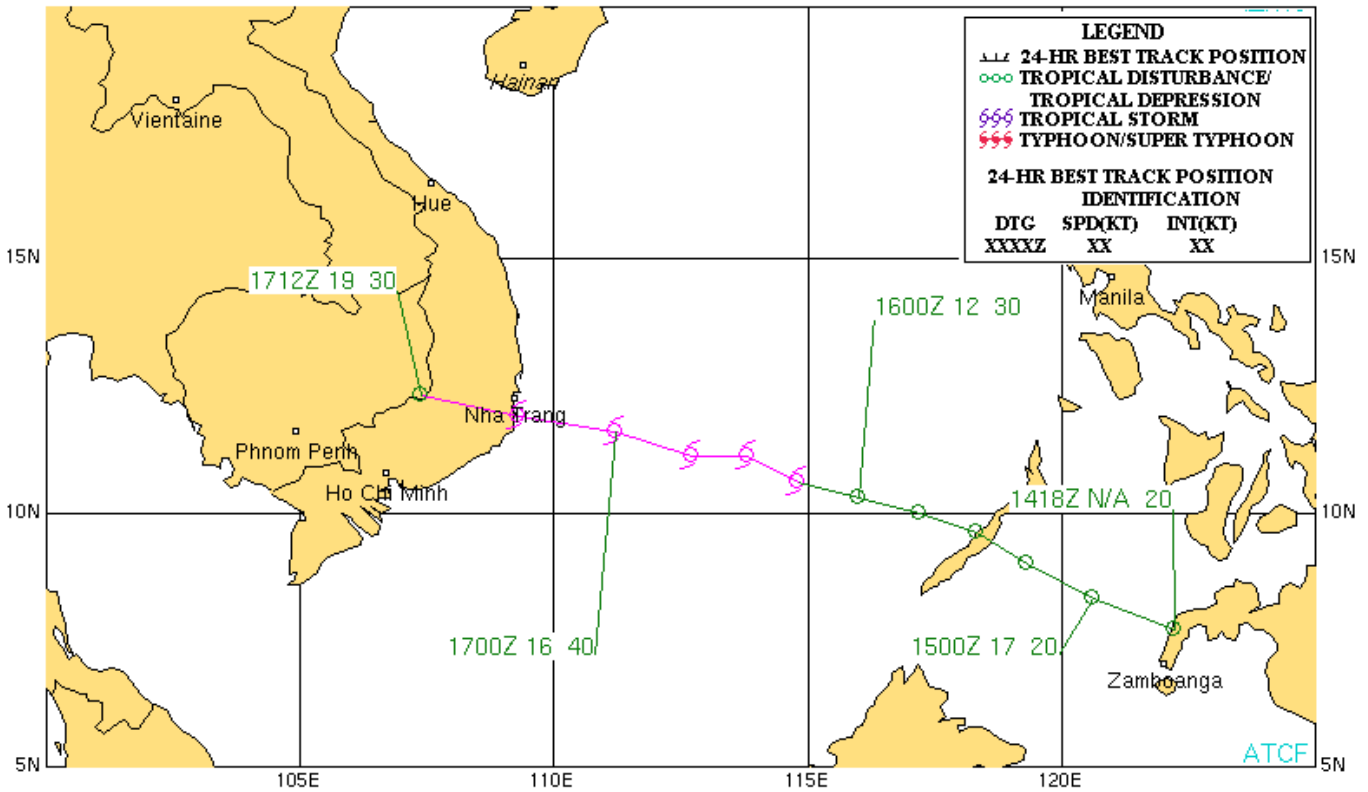
TROPICAL STORM 25W (Haishen)

ISSUED POOR: 0000Z 15 Nov 2008
 ISSUED FAIR: N/A
 FIRST TCFA: 1630Z 15 Nov 2008
 FIRST WARNING: 1800Z 15 Nov 2008
 LAST WARNING: 1200Z 16 Nov 2008
 LANDFALL: None
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 4



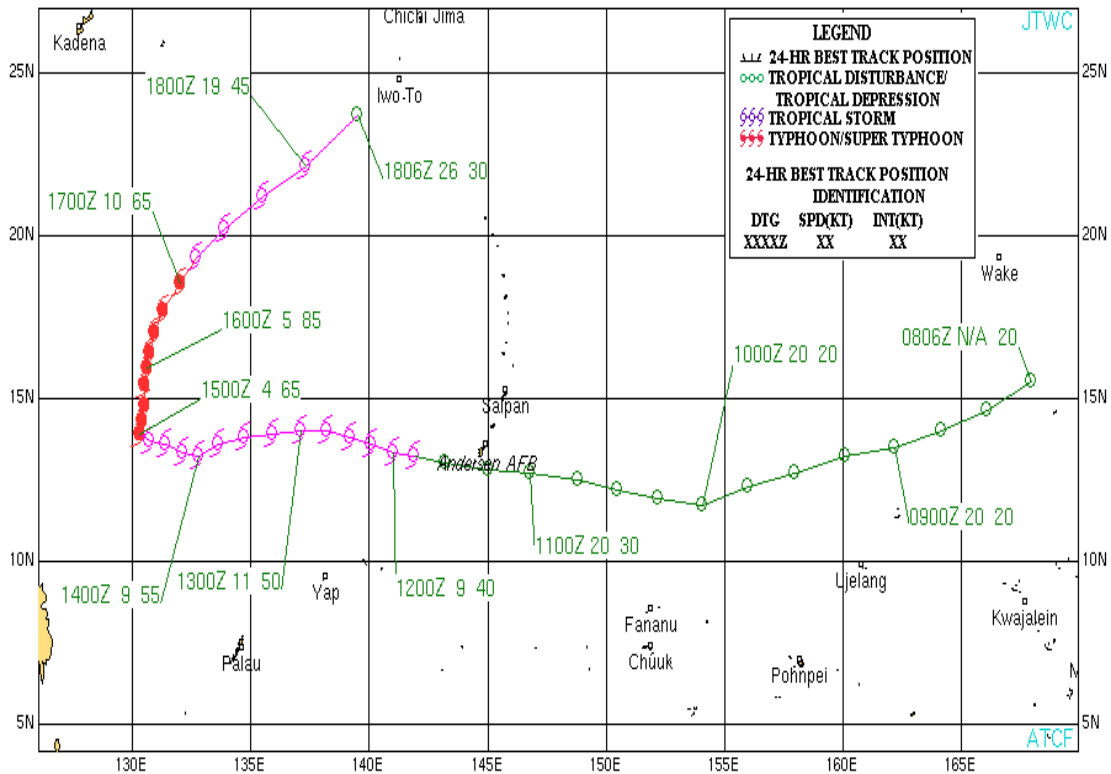
TROPICAL STORM 26W (Noul)

ISSUED POOR: 0600Z 13 Nov 2008
 ISSUED FAIR: 1400Z 13 Nov 2008
 FIRST TCFA: 2030Z 15 Nov 2008
 FIRST WARNING: 0000Z 16 Nov 2008
 LAST WARNING: 1200Z 17 Nov 2008
 LANDFALL: Near Puerto Princesa, Palawan; Nha Trang, Vietnam
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 7

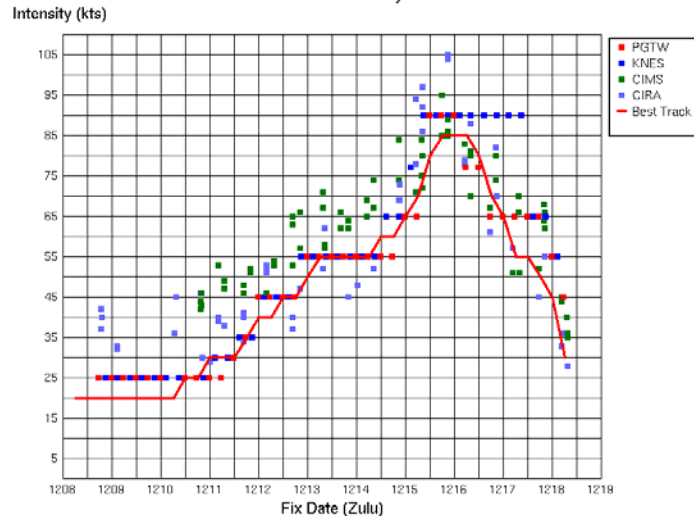


TYPHOON 27W (Dolphin)

ISSUED POOR: 0600Z 09 Dec 2008
 ISSUED FAIR: 2100Z 09 Dec 2008
 FIRST TCFA: N/A
 FIRST WARNING: 1200Z 10 Dec 2008
 LAST WARNING: 1200Z 18 Dec 2008
 LANDFALL: None
 MAX INTENSITY: 85 Kts
 NUMBER OF WARNINGS: 33



Fix Time Intensity for 27W



Two cyclones were deemed to be either meteorologically or operationally significant for 2008. Typhoon Fengshen experienced unusually poor model performance, resulting in large forecast errors. Typhoon Sinlaku experienced two distinct periods of rapid intensification and benefited from aerial reconnaissance as part of the T-PARC 2008 experiment.

Typhoon 07W (Fengshen)

Typhoon (TY) 07W (Fengshen) formed southeast of Yap in mid-June, tracked westward across the Philippines and made landfall north of Hong Kong around 25/00Z. TY 07W was noteworthy for persistently erroneous track forecasts from all of the numerical models used to produce the JTWC consensus (CONW) forecast aid shown in Figure 1-6. All the dynamic aids used in the CONW determination predicted northward movement within 12 to 24 hours of any given initial forecast position with several of the numerical forecast tracks predicting very sharp poleward turns and recurvature.

The erroneous poleward bias of the CONW and all of the dynamic aids that are used to compute the consensus, negatively affected the JTWC forecasts (Figure 1-7) issued for this cyclone,

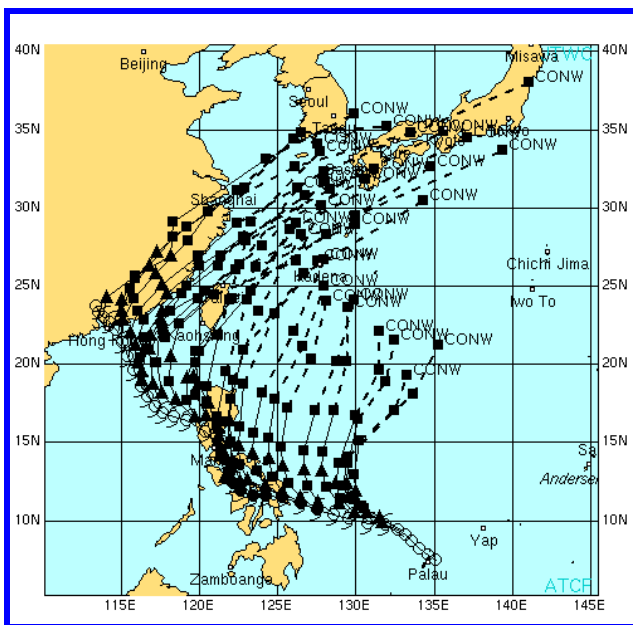


Figure 1-6. JTWC Model Consensus Forecasts

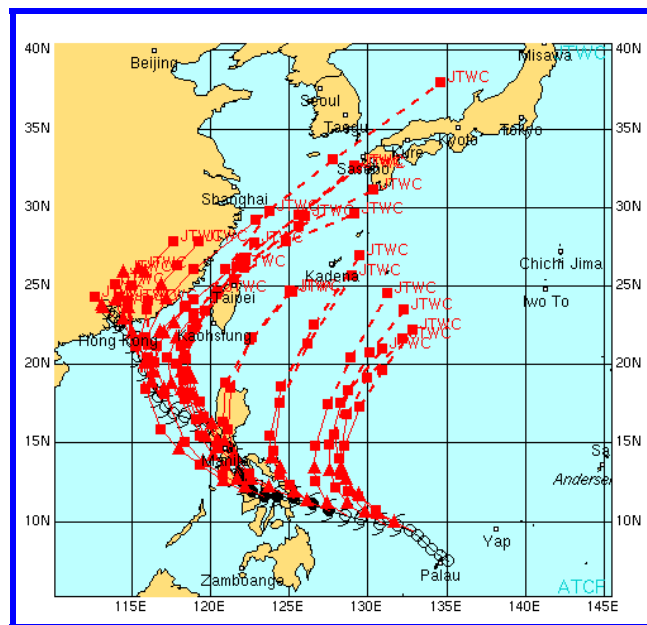


Figure 1-7. JTWC Official Forecasts

While TY 07W was developing in the Philippine Sea, the mid-tropospheric Subtropical Ridge (STR) extended from southeast China to central Japan with the anticyclone center located south of Kyushu. Contrary to model predictions, the STR persisted as the dominant steering mechanism as the cyclone moved through the South China Sea.

Overall, the average forecast track errors (FTE) were large at all taus (Table 1-5). The UK Met Office model (EGRI) outperformed the other dynamic models as well as JTWC and CONW, while NOGAPS (NGPI), GFS (AVNI) and GFDN (GFNI) models were the worst performing models.

	24	36	48	72	96	120
JTWC	108	169	206	308	658	874
CONW	115	192	262	430	703	838
AVNI	124	205	276	512	780	1005
EGRI	105	141	158	228	471	589
GFNI	165	259	354	534	791	848
NGPI	125	214	319	541	770	934
#CASES	14	14	12	11	6	6

Table 1-5: Average FTE (Homogeneous Comparison) Through Tau 120

Available real time reports and JTWC post analysis indicates that there were only minor impacts to DoD assets with 10 ships advised of the high winds and seas associated with Fengshen, but none were required to be diverted around the cyclone. It is highly unusual to have all forecast guidance be incorrect, so JTWC forecasters were reluctant to go against all the models, resulting in highly inaccurate official forecasts. Immediate evaluation by the modeling community is necessary to determine the root causes of the unreliability of the dynamic models in this case.

Typhoon 15W (Sinlaku)

Typhoon (TY) 15W (Sinlaku) formed in the Philippine Sea after tracking across much of the western North Pacific as a tropical wave. TY 15W was noteworthy in that it took a number of days to form, but then exhibited two distinct periods of rapid intensification (RI). During the first RI period, designated as R1 in Figure 1-8, TY 15W intensified at a rate of 45kts/24hrs for 2 consecutive days as it tracked northeastward toward Taiwan. The cyclone intensified from 35 knots at 12Z on 8 September to 120 knots at 12Z on 10 September. This 1st event occurred in a region with high ocean heat content and relatively low vertical wind shear. The second RI event, designated as R2 in Figure 3-3, occurred when TY 15W intensified 20 knots from 50 to 70 knots within an 18 hour period from 12Z on 18 September to 06Z on 19 September. Outflow enhancement by a midlatitude jet appears to have aided this rapid intensification.

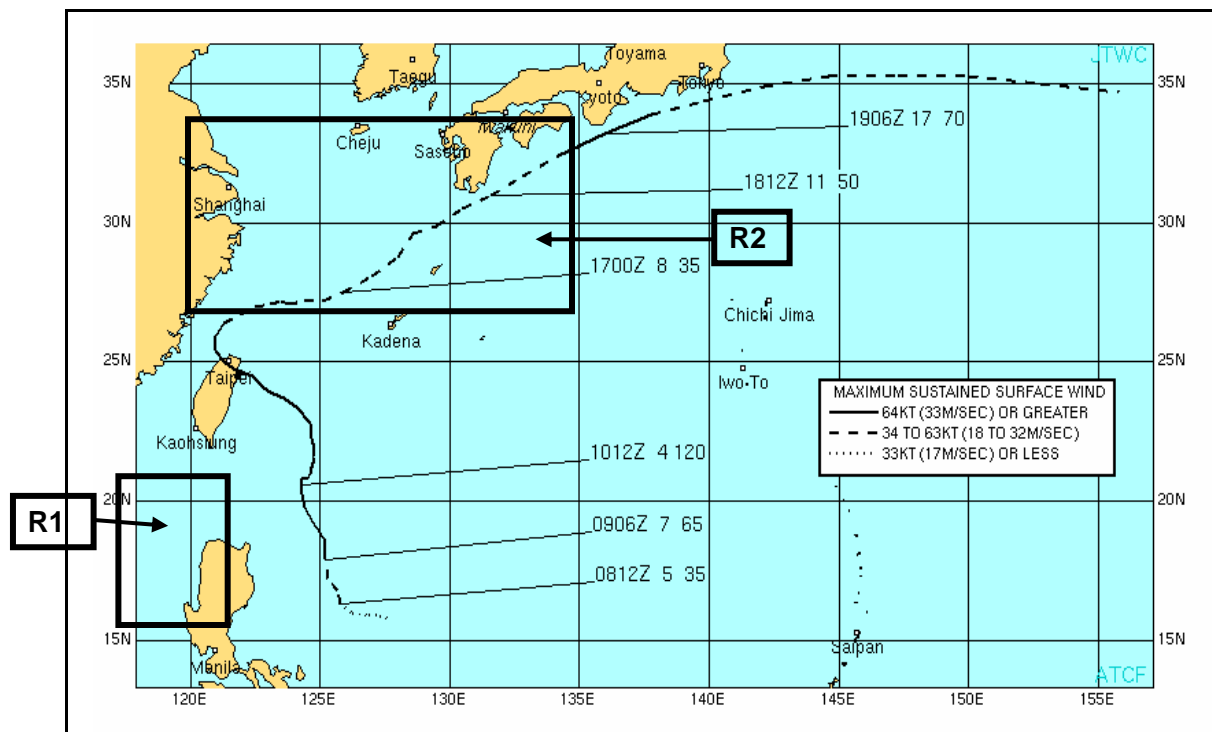


Figure 1-8. TY 15W (Sinlaku) Best Track

Figure 1-9 describes the noted RI events. During the first RI event, the subjective Dvorak intensity estimates matched the best track intensities well, but underestimated the best track intensity during the secondary RI period. Aircraft reconnaissance data was available during the secondary RI period, as part of the THORPEX Pacific Asian Regional Campaign (T-PARC), and allowed JTWC to determine that this occurred, even though meteorological satellite analysis was not as conclusive. The disparity between the aircraft and meteorological satellite data during the 2nd RI, illustrates one of the challenges faced when only satellite intensity estimates are available.

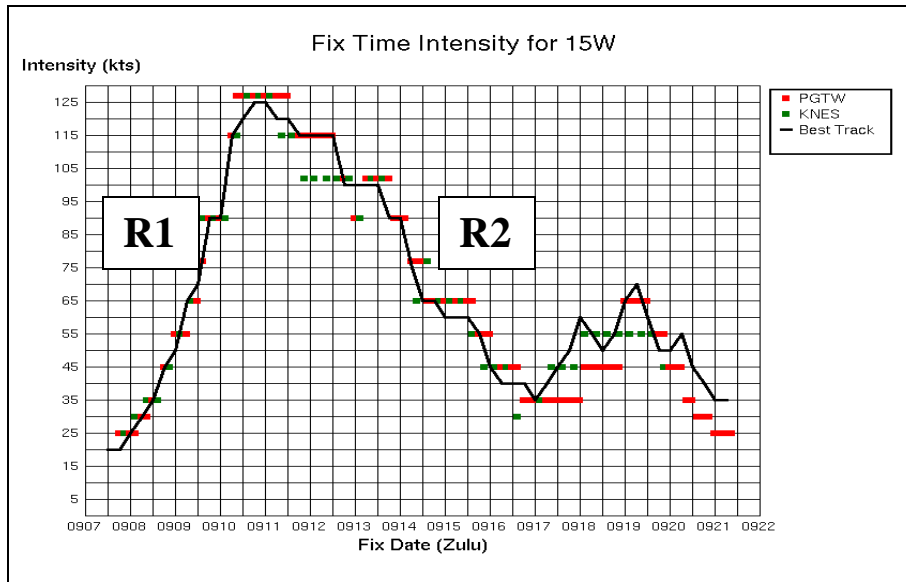


Figure 1-9. TY PGTW and KNES subjective Dvorak values versus Best Track Intensity for both R1 and R2 events

Figure 1-10 is provided to illustrate the inability of numerical and statistical forecast aids to capture the R1 rapid intensification event.

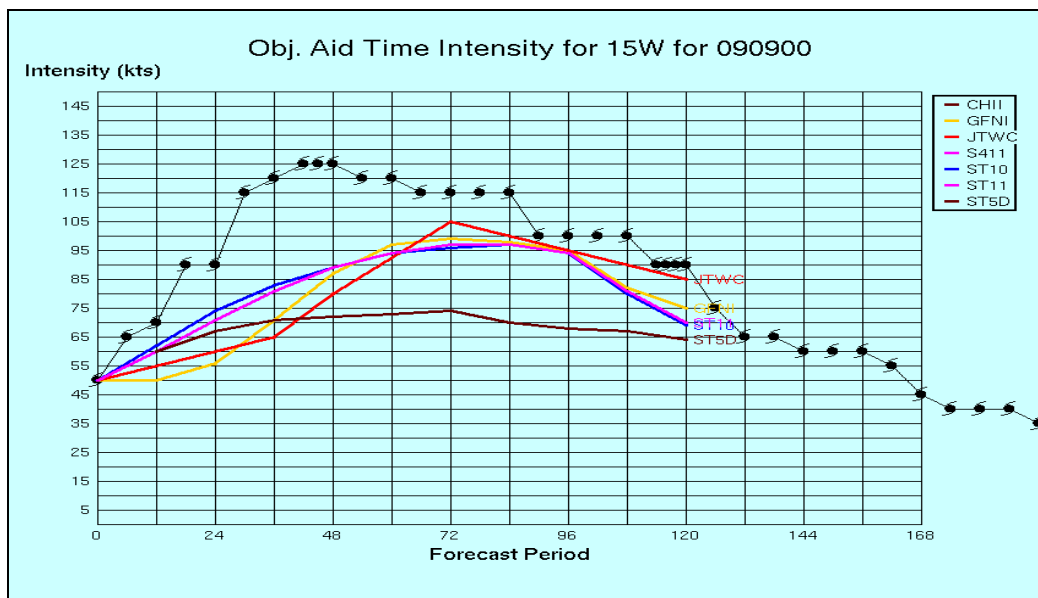


Figure 1-10. TY 15W Objective Aid Intensity Graph Showing Intensity Model Guidance (9 Sep, 00Z) versus final best track intensity for R1 event

While the RI of TY 15W in the early stages of the TC's lifecycle was noteworthy, the 2nd RI event presented challenges as well. The 2nd RI period occurred after the cyclone had weakened to 35 knots off the coast of Taiwan. This event was also not forecast well by the numerical guidance. Figure 1-11 is provided to illustrate the inability of the numerical forecast aids to capture the R2 rapid intensification event and the corresponding effect it had on the JTWC intensity forecast. Note that while cyclone intensities were increasing, the numerical guidance was showing a decrease in intensity.

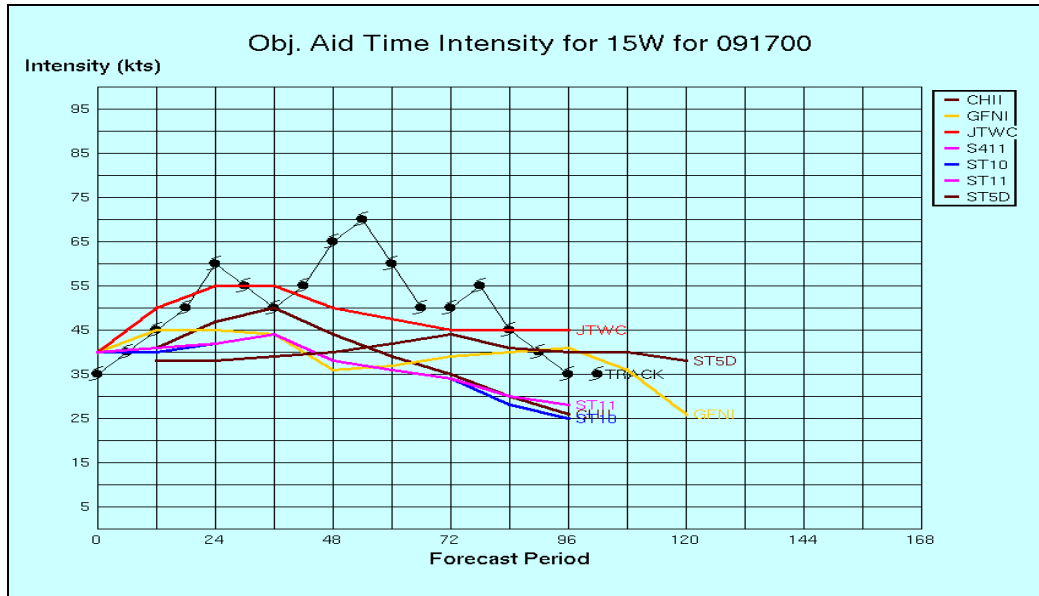


Figure 1-11. TY 15W Objective Aid Intensity Graph Showing Intensity Model Guidance (17 Sep, 00Z) versus final best track intensity for R2 event

Available real time reports and JTWC post analysis indicates that there were major impacts to DoD assets with 10 ships advised of the high winds and seas and 12 ships diverted around the cyclone. The poor performance of available intensity forecast tools and the JTWC intensity forecasts, highlight the need for improvements in forecasting TC intensity, especially in the area of RI. The extent of the 2nd RI event (R2) may have been missed had the aircraft reconnaissance not been in place for T-PARC. This had the potential, had the cyclone tracked slightly poleward of the actual track, to cause significant damage to U.S. assets in Japan.

Chapter 2 North Indian Ocean Tropical Cyclones

This chapter contains information on north Indian Ocean tropical cyclone activity during 2008 and the monthly distribution of Tropical Cyclone activity summarized for 1975 - 2008. North Indian Ocean tropical cyclone best tracks appear following Table 2-2.

Section 1 Informational Tables

Table 2-1 is a summary of Tropical Cyclone activity in the north Indian Ocean during the 2008 season. Seven cyclones occurred in 2008, with only one system reaching intensity greater than 64 knots (TC 01B Nargis). Table 2-2 shows the monthly distribution of Tropical Cyclone activity for 1975 - 2008.

Table 2-1					
NORTH INDIAN OCEAN SIGNIFICANT TROPICAL CYCLONES FOR 2008					
(01 JAN 2008 - 31 DEC 2008)					
TC	NAME*	PERIOD**	WARNINGS ISSUED	EST MAX SFC WINDS KTS	MSLP (MB)***
1B	Nargis	27 Apr - 3 May	25	115	
2B		16 Sep	2	45	
3A		20 - 23 Oct	11	30	
4B	Rashmi	26 - 27 Oct	5	45	
5B	Khai-Muk	14 - 16 Nov	9	45	
6B	Nisha	25 - 27 Nov	7	50	
7B		4 - 7 Dec	13	35	
* As Designated by RSMC New Delhi					
** Dates are based on Issuance of JTWC warnings on system.					
*** MSLP converted from estimated maximum surface winds using Knaff-Zehr wind-pressure relationship					

Table 2 - 2

**DISTRIBUTION OF NORTH INDIAN OCEAN TROPICAL CYCLONES
FOR 1975 - 2008**

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	330
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	050
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	140
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	220
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	142
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	020
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	210
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	230
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	030
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	220
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	060
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	030
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	080
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	140
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	120
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	112
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	220
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	382
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	200
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	140
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	220
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	440
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	220
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	530
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	320
2000	0	0	0	0	0	0	0	0	0	2	1	1	4
	000	000	000	000	000	000	000	000	000	020	100	010	130
2001	0	0	0	0	1	0	0	0	1	1	1	0	4
	000	000	000	000	100	000	000	000	010	010	001	000	121
2002	0	0	0	0	2	0	0	0	0	0	2	1	5
	000	000	000	000	020	000	000	000	000	000	020	010	050
2003	0	0	0	0	1	0	0	0	0	0	1	1	3
	000	000	000	000	100	000	000	000	000	000	100	010	210
2004	0	0	0	0	2	0	0	0	0	2	1	0	5
	000	000	000	000	020	000	000	000	000	020	100	000	140
2005	2	0	0	0	0	0	0	0	0	2	1	2	7
	011	000	000	000	000	000	000	000	000	020	010	020	061
2006	1	0	0	1	0	0	1	0	2	0	1	0	6
	010	000	000	100	000	000	010	000	020	000	010	000	150
2007	0	0	0	0	1	3	0	0	0	1	1	0	6
	000	000	000	000	100	120	000	000	000	010	100	000	330
2008	0	0	0	1	0	0	0	0	1	2	2	1	7
	000	000	000	100	000	000	000	000	010	011	020	010	151
(1975-2008)													
MEAN	0.2	0.1	0.0	0.2	0.7	0.6	0.1	0.0	0.3	1.0	1.3	0.5	5.0
CASES	6	2	1	5	24	20	2	1	11	33	43	18	166

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.

TABLE 2-2 Legend		
Total month/year		
GTE 64 knots (Typhoon)	34 to 63 knots (Tropical Storm)	LTE 33 knots (Tropical Depression)

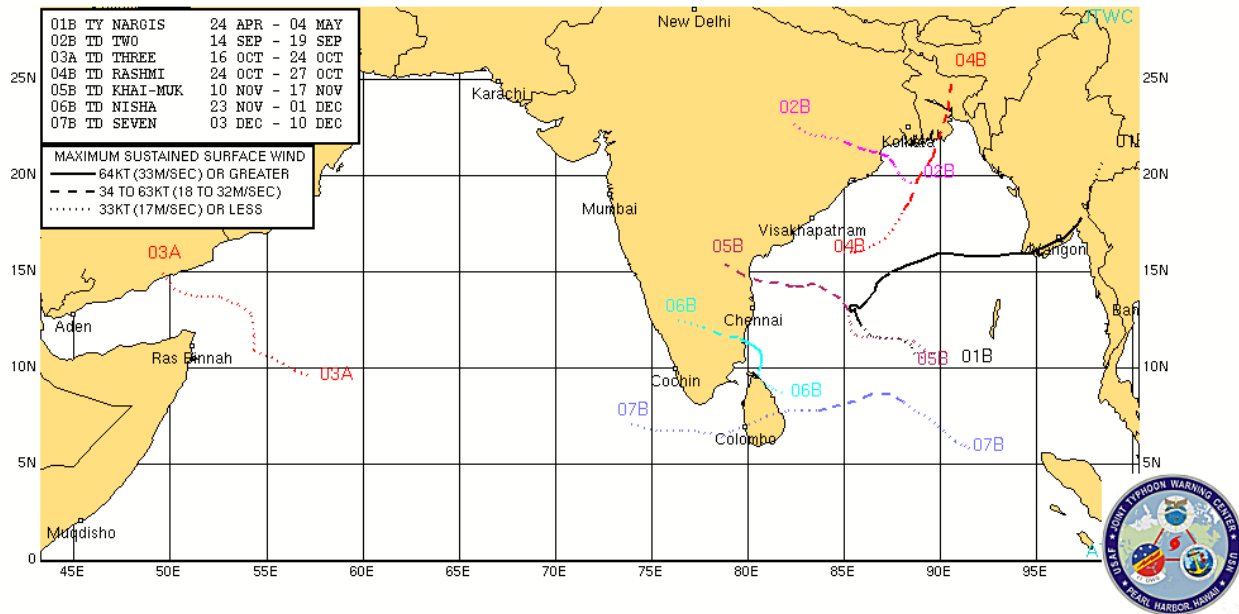


Figure 2-1. North Indian Ocean Tropical Cyclones Jan – Dec 2008.

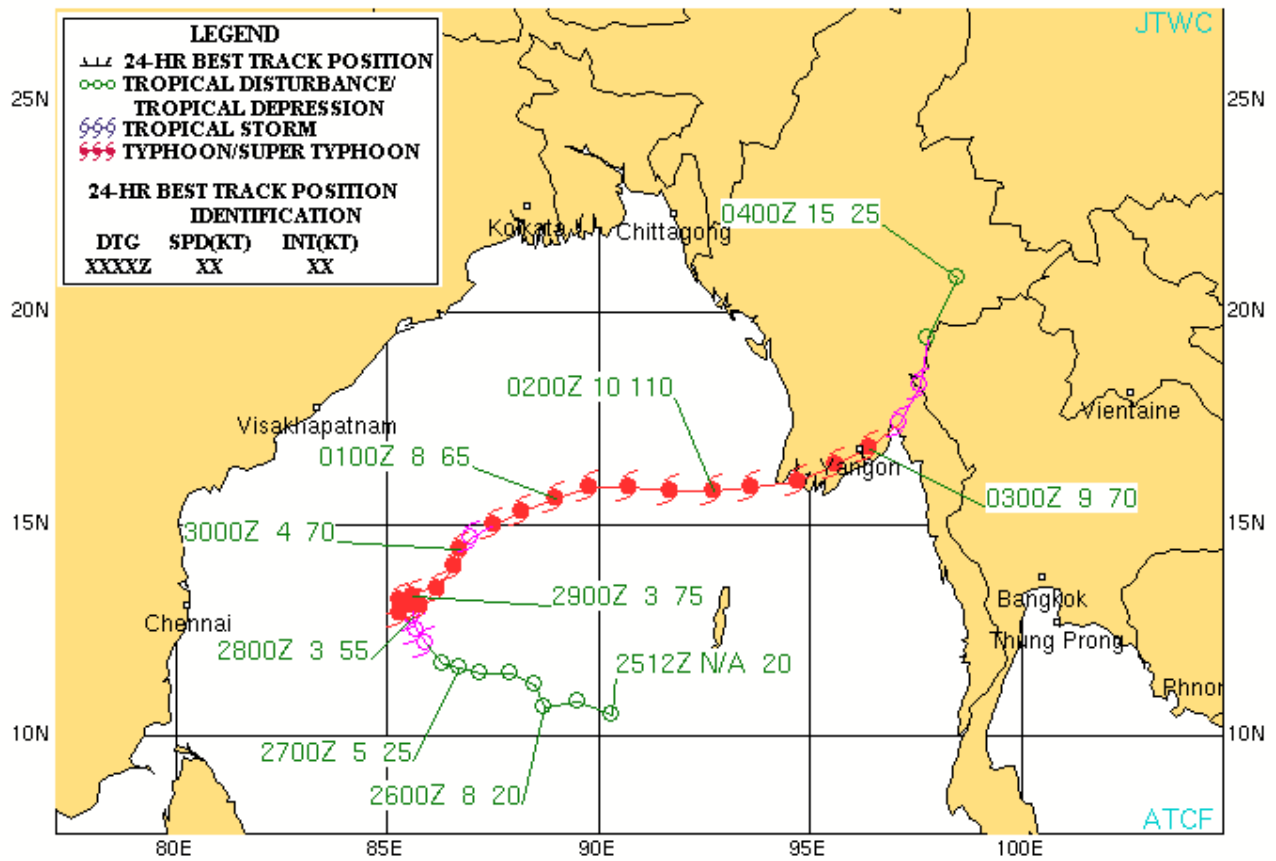
Section 2 Cyclone Summaries

Each cyclone is presented, with the number and basin identifier assigned by JTWC, along with the RSMC assigned cyclone name. Dates are also listed when JTWC first designated various stages of development; as an area of interest (Poor classification), increased potential for development (Fair classification) and development/TC expected (Good classification). Furthermore, the first Tropical Cyclone Formation Alert (TCFA), and the first and final warnings dates are also presented with the number of warnings issued by JTWC. Maximum intensity and the number of warnings issued by JTWC are included as well. Landfall over major landmasses and approximate locations are presented as well.

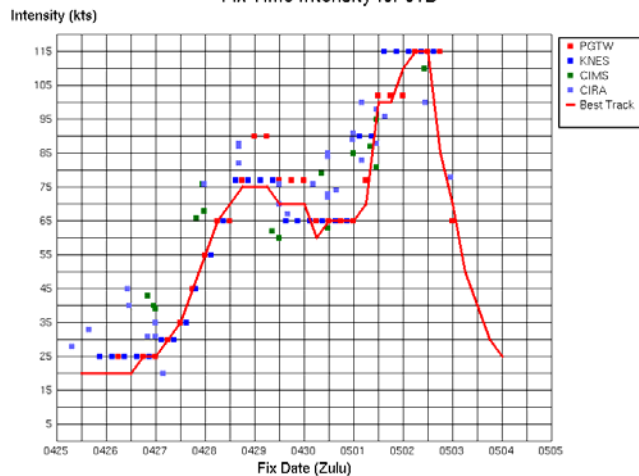
The JTWC post-event reanalysis best track is also provided for each cyclone. Data included on the best track are position and intensity noted with cyclone symbols and color coded track. Best track positions are marked by date at 0000 UTC, as well as the beginning and end points. Best track position labels include the date-time, track speed in knots, and maximum wind speed in knots. A graph of best track intensity versus time is presented. Fix plots on this graph are color coded by fixing agency

Tropical Cyclone 01B (Nargis)

ISSUED POOR: 1800Z 25 Apr 2008
 ISSUED FAIR: 1800Z 26 Apr 2008
 FIRST TCFA: 0600Z 27 Apr 2008
 FIRST WARNING: 1200Z 27 Apr 2008
 LAST WARNING: 1200Z 03 May 2008
 LANDFALL: Near Labutta, Myanmar
 MAX INTENSITY: 115 Kts
 NUMBER OF WARNINGS: 25

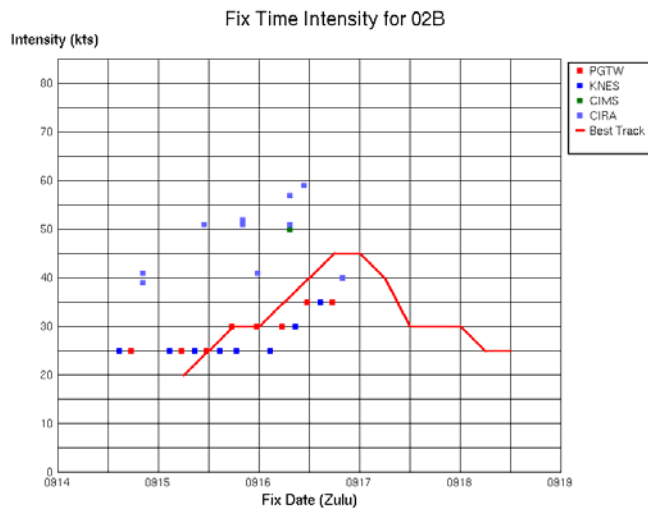
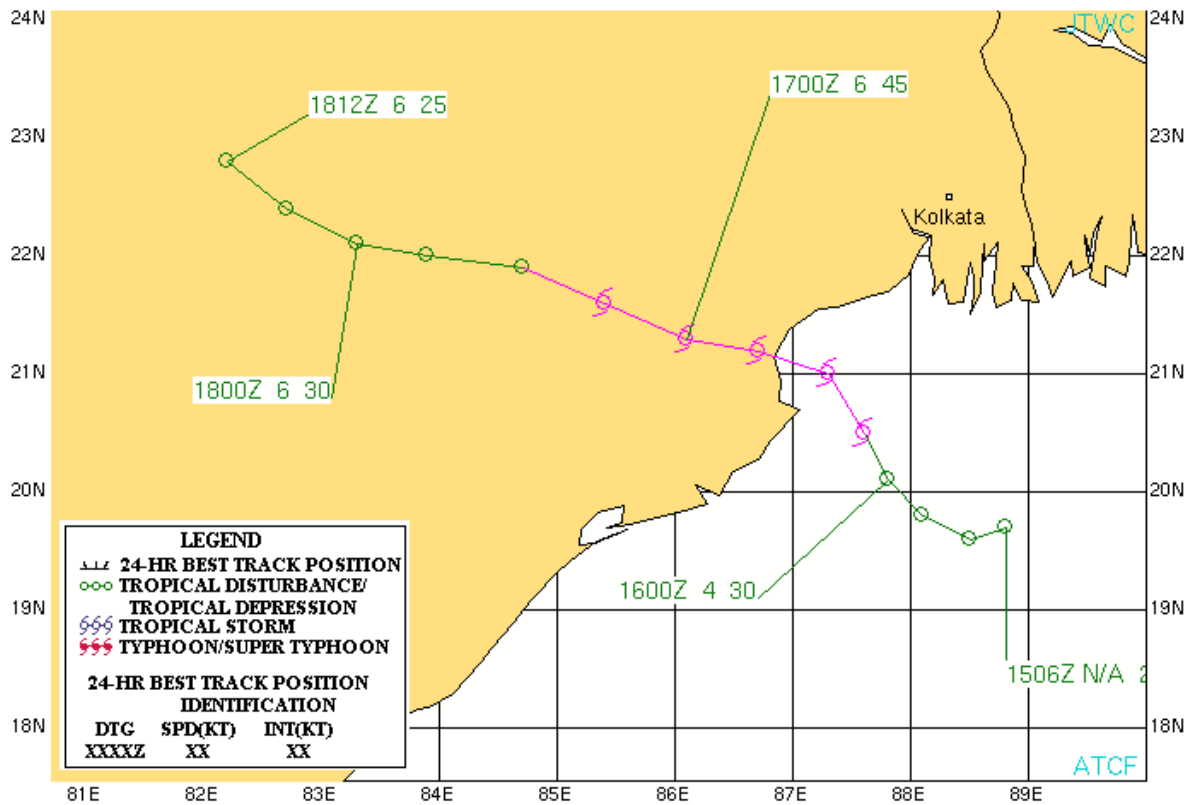


Fix Time Intensity for 01B



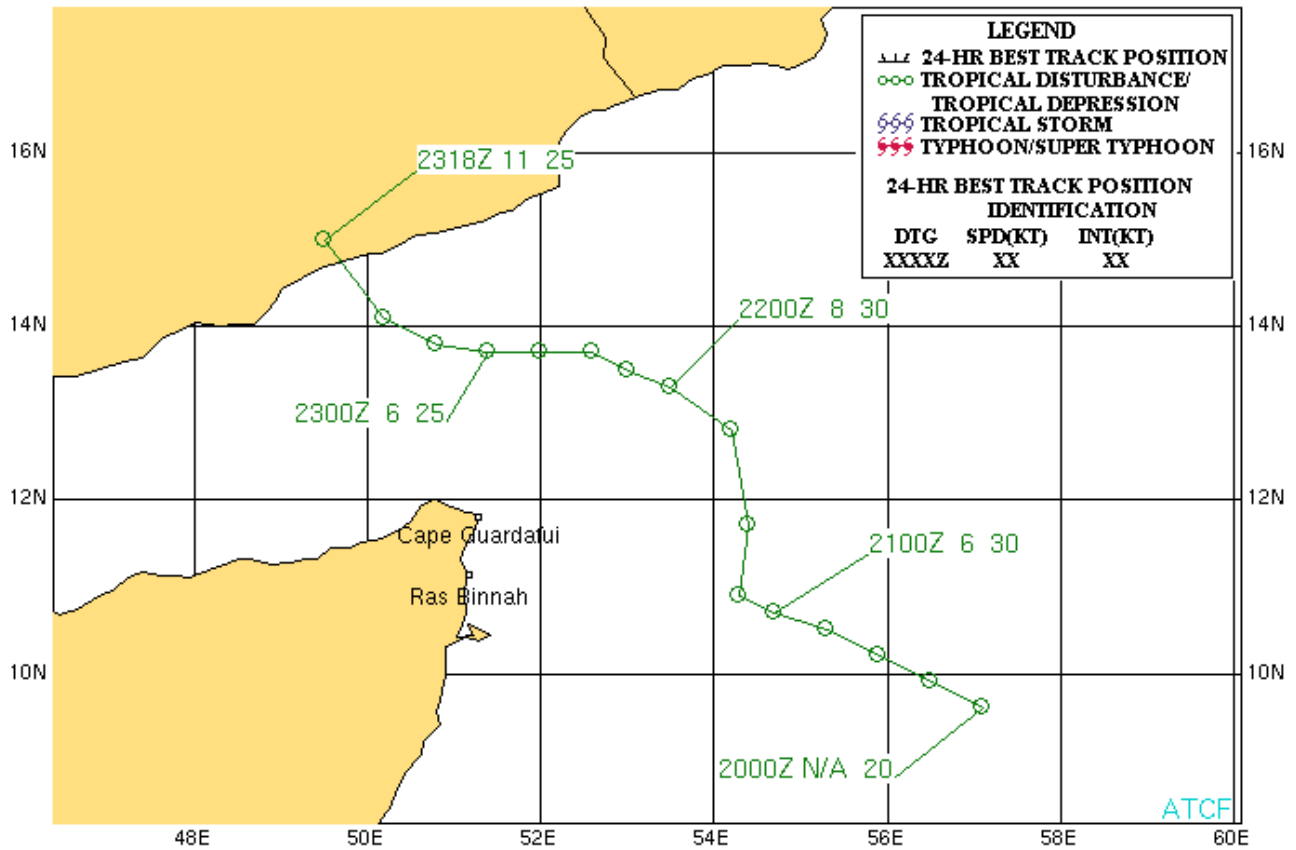
Tropical Cyclone 02B

ISSUED POOR: 1800Z 14 Sep 2008
 ISSUED FAIR: 1730Z 15 Sep 2008
 FIRST TCFA: 2230Z 15 Sep 2008
 FIRST WARNING: 1200Z 16 Sep 2008
 LAST WARNING: 1800Z 16 Sep 2008
 LANDFALL: Near Baleshwar, India
 MAX INTENSITY: 45 Kts
 NUMBER OF WARNINGS: 2

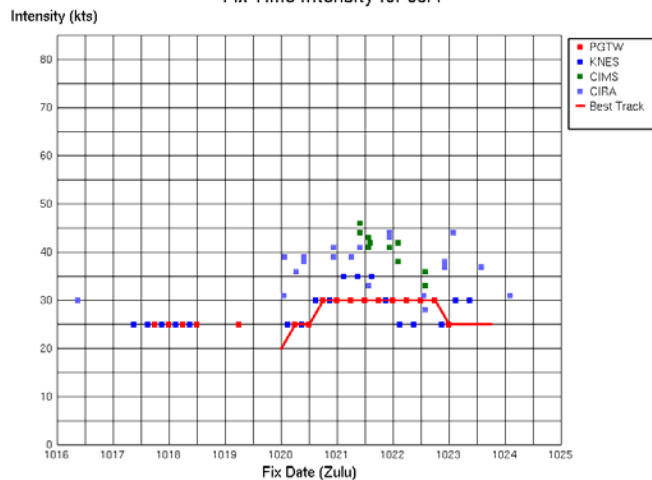


Tropical Cyclone 03A

ISSUED POOR: 0230Z 17 Oct 2008
 ISSUED FAIR: 0630Z 20 Oct 2008
 FIRST TCFA: 1430Z 20 Oct 2008
 FIRST WARNING: 1800Z 20 Oct 2008
 LAST WARNING: 0600Z 23 Oct 2008
 LANDFALL: Near Ash Shihr, Yemen
 MAX INTENSITY: 30 Kts
 NUMBER OF WARNINGS: 11

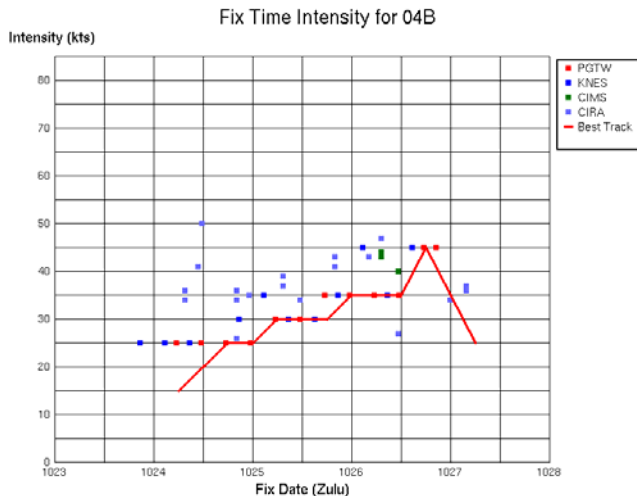
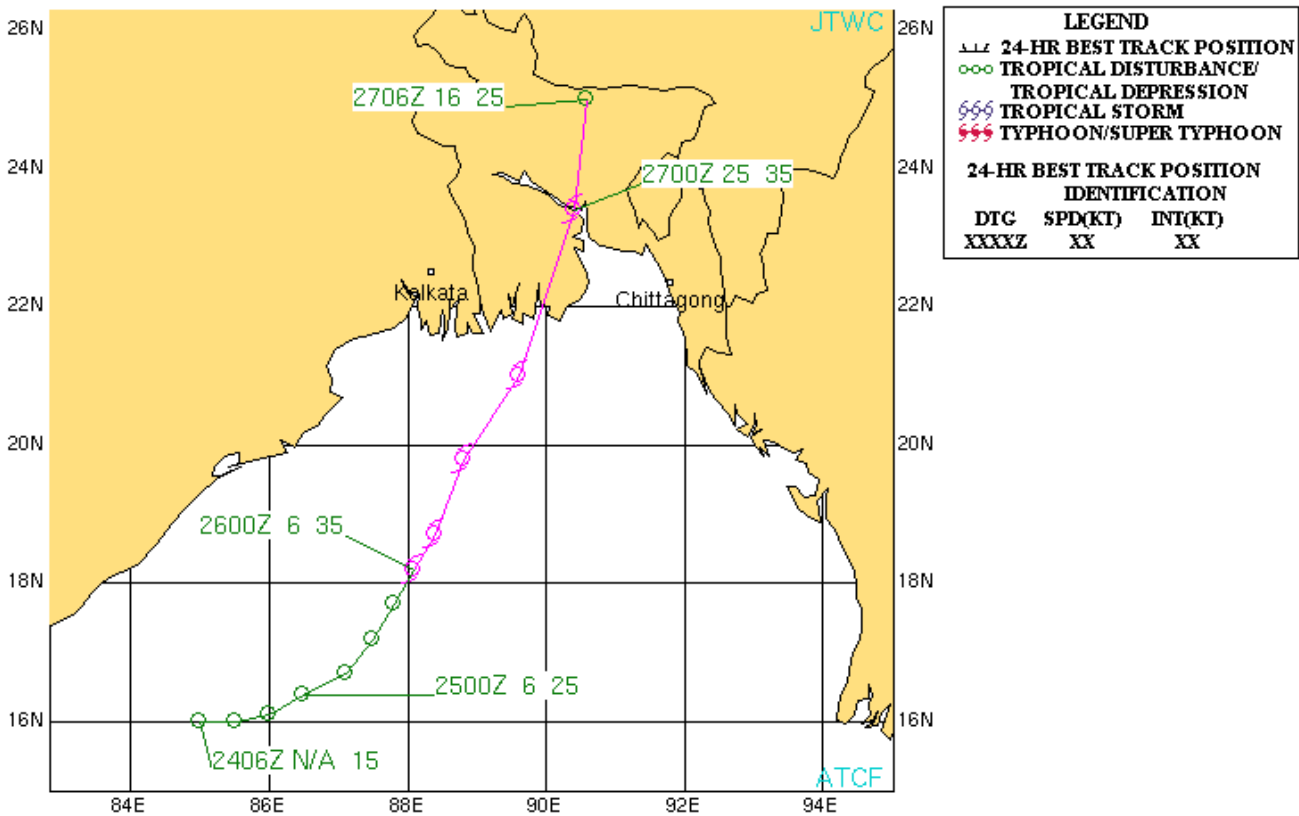


Fix Time Intensity for 03A



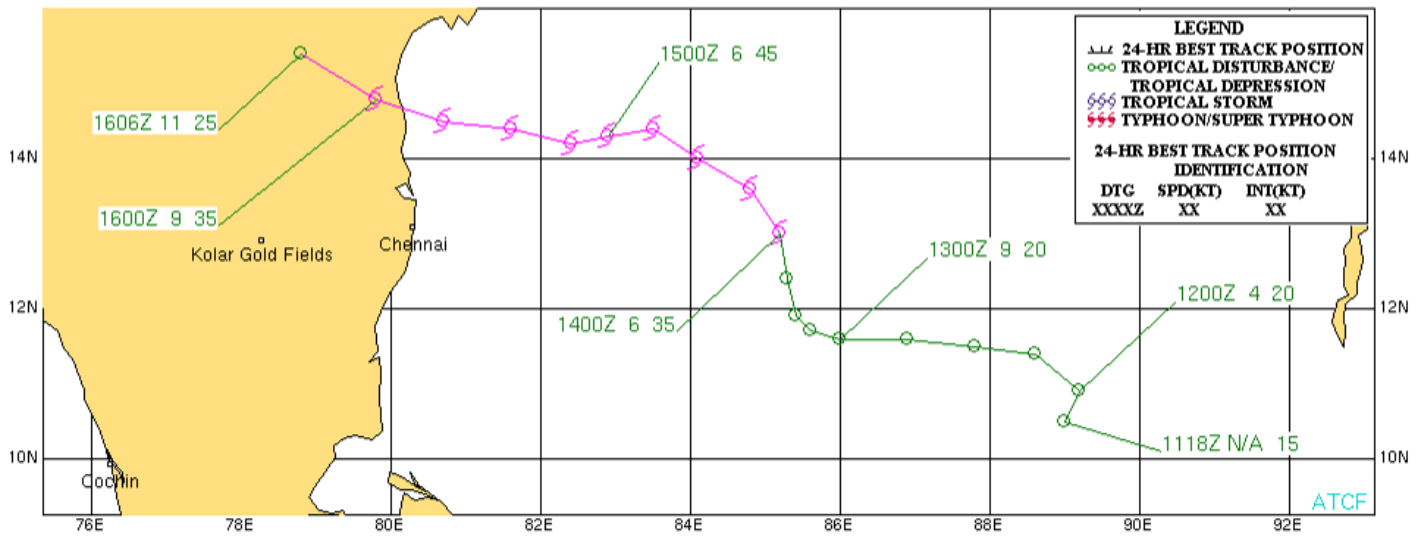
Tropical Cyclone 04B (Rashmi)

ISSUED POOR: N/A
 ISSUED FAIR: 1800Z 24 Oct 2008
 FIRST TCFA: 1500Z 24 Oct 2008
 FIRST WARNING: 0000Z 26 Oct 2008
 LAST WARNING: 0000Z 27 Oct 2008
 LANDFALL: Near Tetulbaria, Bangladesh
 MAX INTENSITY: 45 Kts
 NUMBER OF WARNINGS: 5

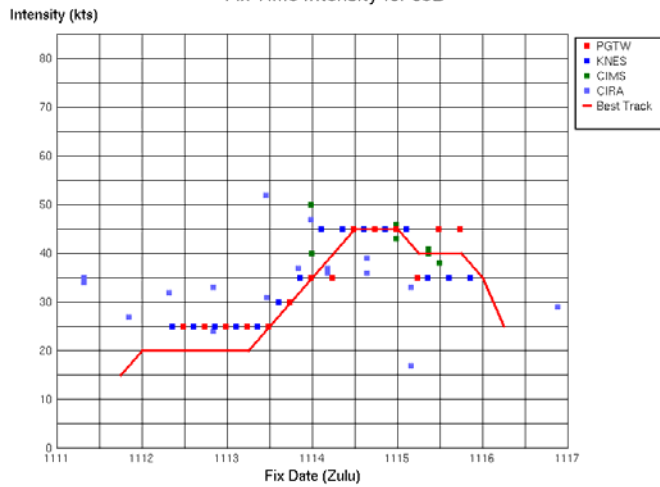


Tropical Cyclone 05B (Khai-Muk)

ISSUED POOR: 1800Z 09 Nov 2008
 ISSUED FAIR: 1800Z 12 Nov 2008
 FIRST TCFA: 1530Z 13 Nov 2008
 FIRST WARNING: 0000Z 14 Nov 2008
 LAST WARNING: 0000Z 16 Nov 2008
 LANDFALL: Near Nellore, India
 MAX INTENSITY: 45 Kts
 NUMBER OF WARNINGS: 9

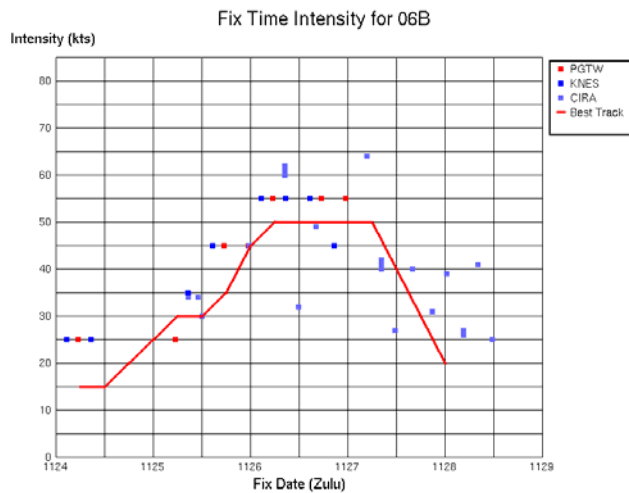
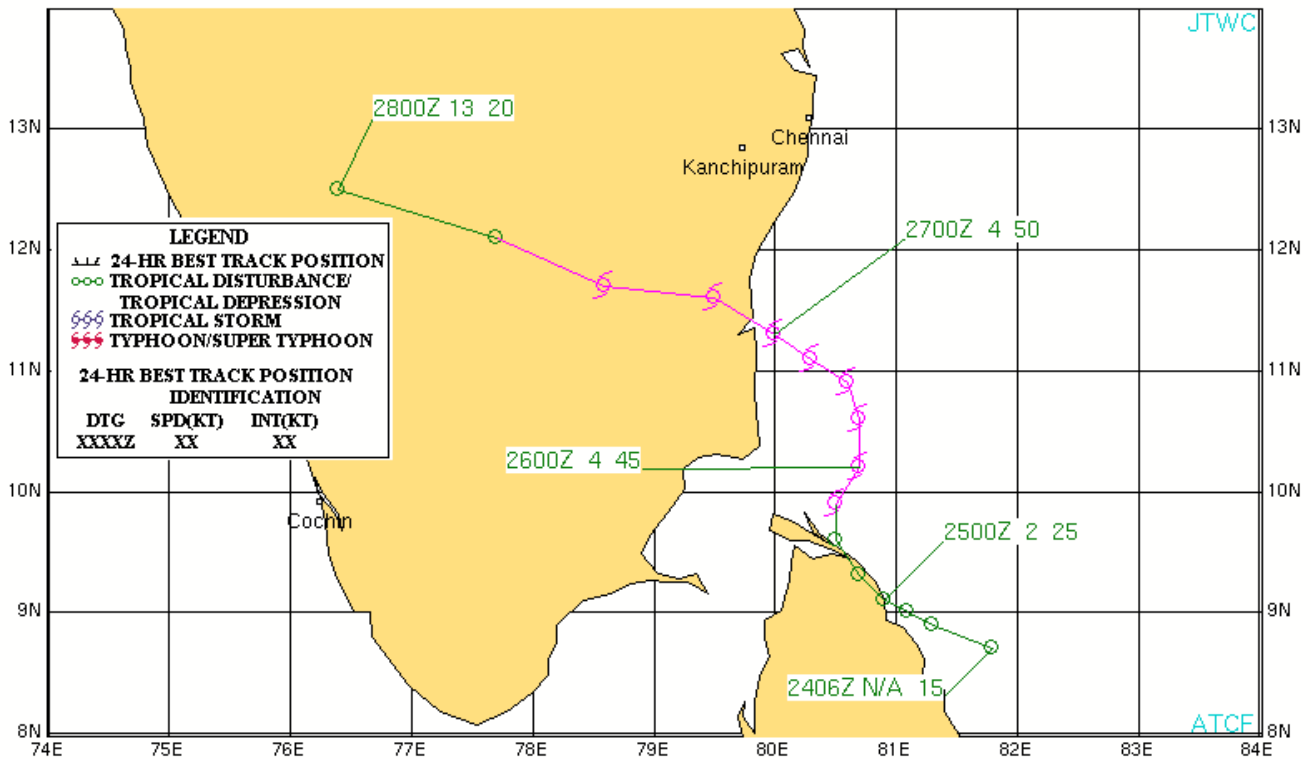


Fix Time Intensity for 05B



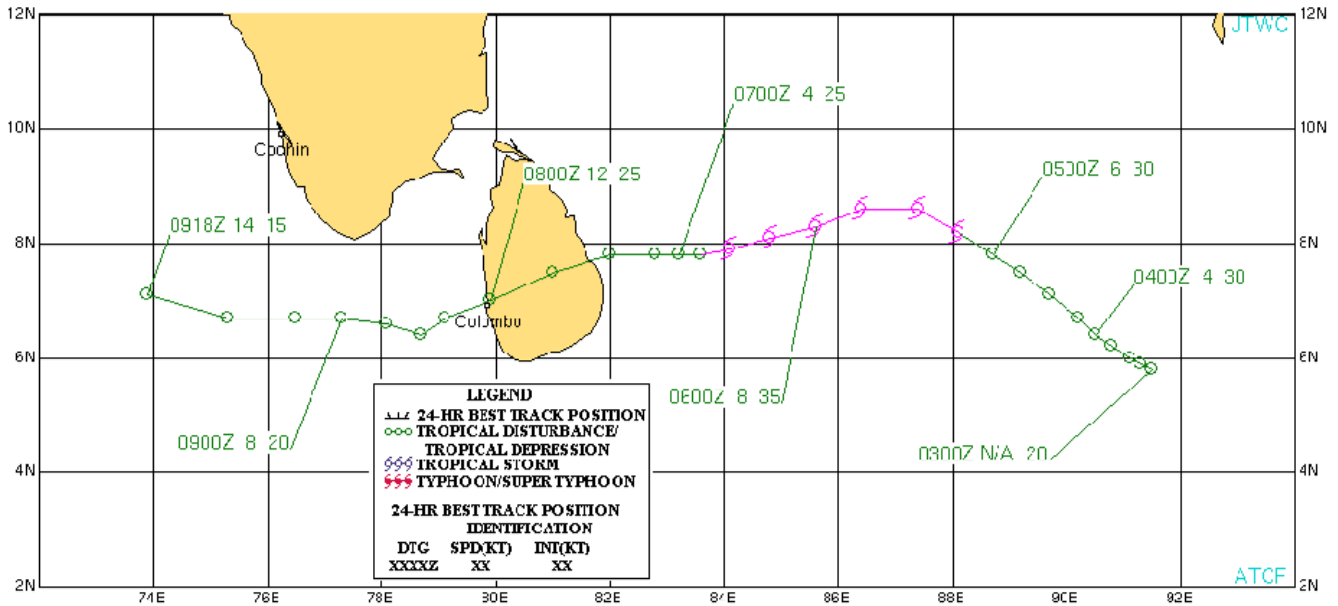
Tropical Cyclone 06B (Nisha)

ISSUED POOR: 1230Z 24 Oct 2008
 ISSUED FAIR: N/A
 FIRST TCFA: 0730Z 25 Nov 2008
 FIRST WARNING: 1800Z 25 Nov 2008
 LAST WARNING: 0600Z 27 Nov 2008
 LANDFALL: Near Puduchcheri, India
 MAX INTENSITY: 50 Kts
 NUMBER OF WARNINGS: 7

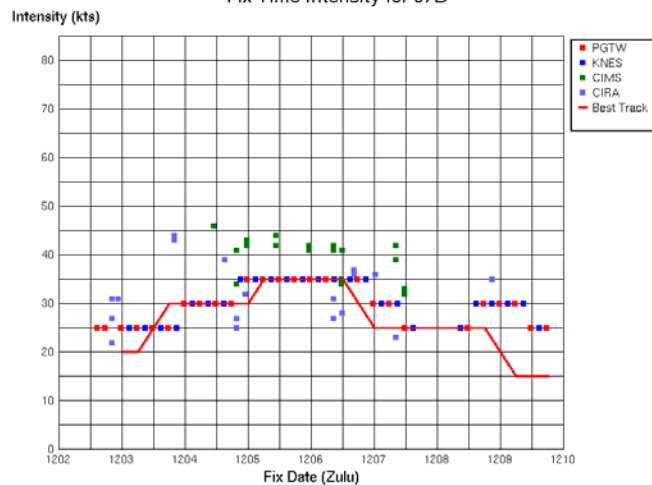


Tropical Cyclone 07B

ISSUED POOR: 0300Z 01 Dec 2008
 ISSUED FAIR: 1500Z 02 Dec 2008
 FIRST TCFA: 2230Z 03 Dec 2008
 FIRST WARNING: 0000Z 04 Dec 2008
 LAST WARNING: 0000Z 07 Dec 2008
 LANDFALL: Near Batticaloa, Sri Lanka
 MAX INTENSITY: 35 Kts
 NUMBER OF WARNINGS: 13



Fix Time Intensity for 07B



Chapter 3 South Pacific and South Indian Ocean Tropical Cyclones

This chapter contains information on south Pacific and south Indian Ocean tropical cyclone activity that occurred during 2008 tropical cyclone season (1 July 2007 – 30 June 2008) and the monthly distribution of Tropical Cyclone activity summarized for 1975 - 2008. 2008 tropical cyclone best tracks for this region appear following Table 3-3.

Section 1 Informational Tables

Table 3-1 is a summary of Tropical Cyclone activity in the Southern Hemisphere during the 2008 season. Table 3-2 provides the monthly distribution of Tropical Cyclone activity summarized for 1975 - 2008. Table 3-3 depicts the annual variation of Tropical Cyclone activity by basin.

Table 3-1 SOUTHERN HEMISPHERE TROPICAL CYCLONES FOR 2008 (01 JULY 2007 - 30 JUNE 2008)					
TC	NAME	PERIOD	WARNINGS ISSUED	EST MAX SFC WINDS KTS	MSLP (MB)**
01S		29 JUL - 30 JUL	2	40	
02P	Guba	13 NOV - 19 NOV	12	75	
03S	Lee-Ariel	14 NOV - 18 NOV	9	60	
04S	Bongwe	18 NOV - 23 NOV	12	65	
05P	Daman	5 DEC - 9 DEC	10	110	
06S	Celina	13 DEC - 18 DEC	11	40	
07S	Dama	18 DEC - 21 DEC	7	50	
08S	Melanie	28 DEC - 1 JAN	13	60	
09S	Elnus	31 DEC - 4 JAN	8	40	
10S	Helen	3 JAN - 6 JAN	6	50	
11P	Elisa	10 JAN - 11 JAN	4	50	
12P	Funa	16 JAN - 20 JAN	9	105	
13S	Fame	25 JAN - 1 FEB	13	85	
14S	Gula	27 JAN - 2 FEB	13	90	
15P	Gene	27 JAN - 6 FEB	20	100	
16S	Hondo	4 FEB - 24 FEB	20	130	
17S		7 FEB - 10 FEB	7	40	
18S	Ivan	7 FEB - 18 FEB	30	125	
19S	Nicholas	12 FEB - 20 FEB	26	80	
20P		29 FEB - 1 MAR	2	35	
21S	Ophelia	1 MAR - 6 MAR	19	65	
22S	Jokwe	5 MAR - 14 MAR	21	110	
23S	Kamba	7 MAR - 12 MAR	10	115	
24P		20 MAR - 21 MAR	3	35	
25S	Lola	21 MAR - 24 MAR	6	35	
26S	Pancho	24 MAR - 28 MAR	11	100	
27P	Noname	18 APR - 19 APR	3	30	
28S	Rosie	21 APR - 24 APR	6	50	
29S	Durga	22 APR - 24 APR	5	40	

**MSLP converted from estimated maximum winds using Knaff-Zehr wind pressure relationship. Number of warnings includes amended warnings.

Table 3-2
DISTRIBUTION OF SOUTH PACIFIC AND SOUTH INDIAN OCEAN TROPICAL CYCLONES
FOR 1958 - 2008

YEAR	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTALS
1958 - 1977 AVERAGE*													
-	-	-	-	0.4	1.5	3.6	6.1	5.8	4.7	2.1	0.5	-	24.7
1981 - 2007													
1981	0	0	0	1	3	2	6	5	3	3	1	0	24
1982	1	0	0	1	1	3	9	4	2	3	1	0	25
1983	1	0	0	1	1	3	5	6	3	5	0	0	25
1984	1	0	0	1	2	5	5	10	4	2	0	0	30
1985	0	0	0	0	1	7	9	9	6	3	0	0	35
1986	0	0	1	0	1	1	9	9	6	4	2	0	33
1987	0	1	0	0	1	3	6	8	3	4	1	1	28
1988	0	0	0	0	2	3	5	5	3	1	2	0	21
1989	0	0	0	0	2	1	5	8	6	4	2	0	28
1990	2	0	1	1	2	2	4	4	10	2	1	0	29
1991	0	0	1	1	1	3	2	5	5	2	1	1	22
1992	0	0	1	1	2	5	4	11	3	2	1	0	30
1993	0	0	1	1	0	5	7	7	2	2	2	0	27
1994	0	0	0	0	2	4	8	4	9	3	0	0	30
1995	0	0	0	0	2	2	5	4	5	4	0	0	22
1996	0	0	0	0	1	3	7	6	6	4	1	0	28
1997	1	1	1	2	2	6	9	8	3	1	3	1	38
1998	1	0	0	3	2	3	7	9	6	6	0	0	37
1999	1	0	1	1	1	6	6	8	7	2	0	0	33
2000	0	0	0	0	0	3	6	5	7	6	0	0	27
2001	0	1	0	0	1	1	4	6	2	5	0	1	21
2002	0	0	0	2	4	1	4	5	4	2	3	0	25
2003	0	0	1	0	2	5	5	7	5	2	1	1	29
2004	0	0	0	1	1	3	6	3	7	1	1	0	23
2005	0	0	1	1	2	2	7	7	4	2	0	0	26
2006	6	5	5	3	0	0	0	0	0	1	2	1	23
2007	0	0	0	0	1	2	2	5	6	6	1	1	24
2008	1	0	0	0	3	4	7	5	6	3	0	0	29
(1981 - 2008)													
MEAN	0.5	0.3	0.5	0.8	1.5	3.1	5.7	6.2	4.8	3.0	0.9	0.3	27.6
CASES	15	8	14	21	43	88	159	173	133	85	26	7	772

* (GRAY, 1978)

The criteria used in TABLE 3-2 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.

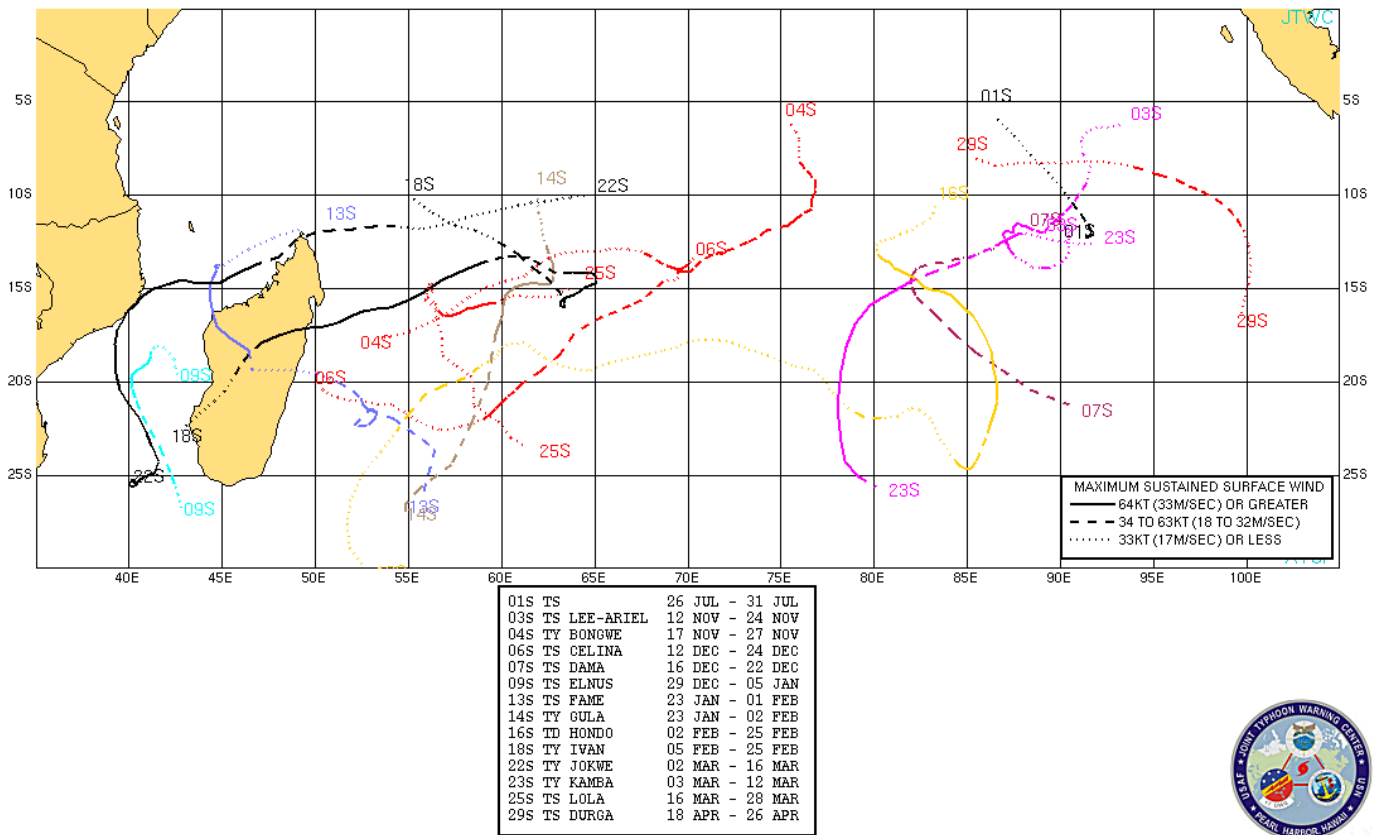


Figure 3-1. Southern Indian Ocean Tropical Cyclones 26 July 2007 – 26 April 2008.

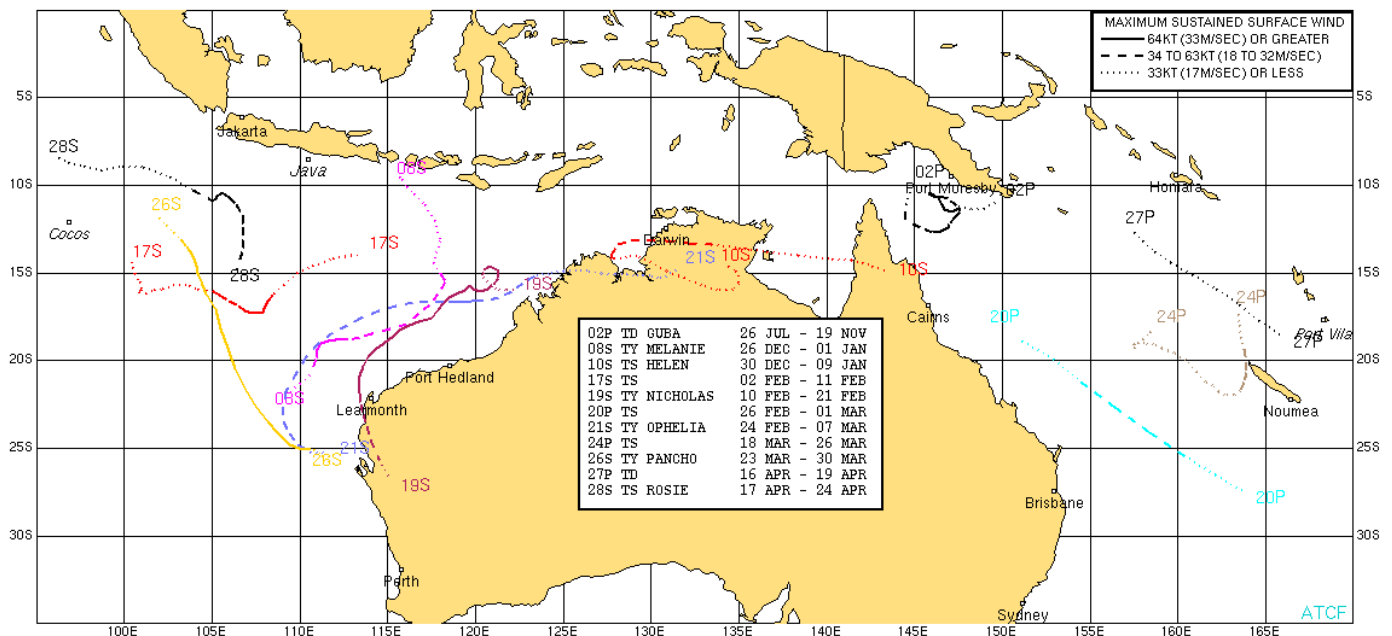


Figure 3-2. Australia Region Tropical Cyclones 26 July 2007 - 24 April 2008.

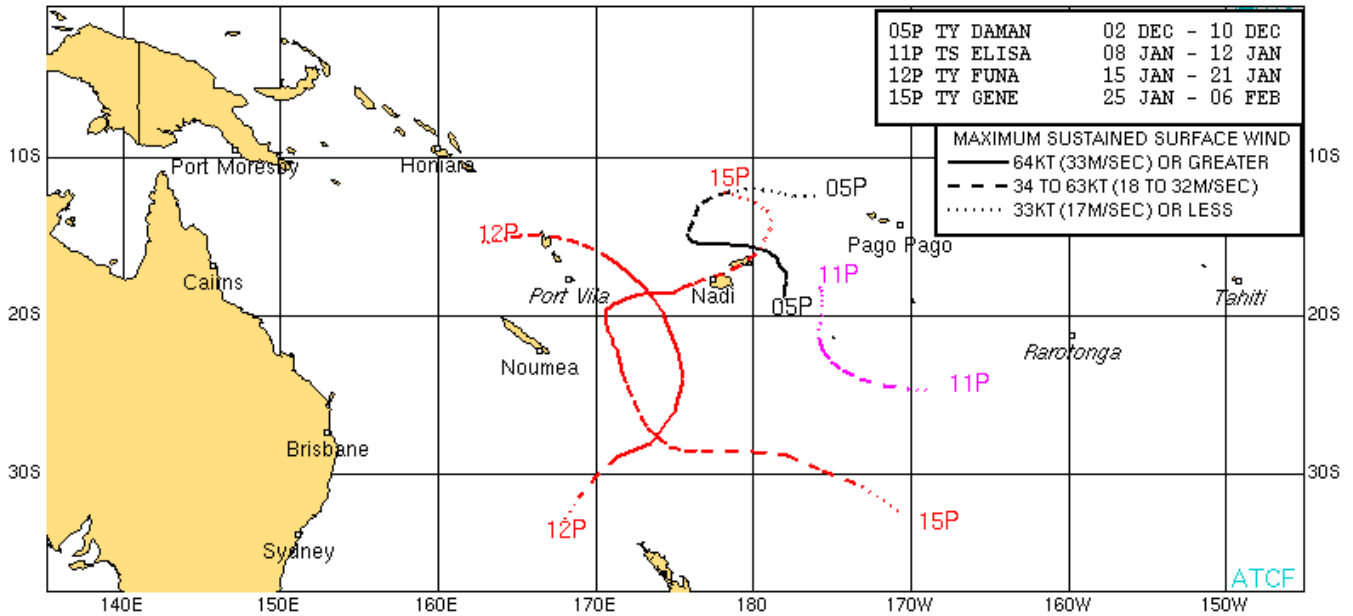


Figure 3-3. Southern Pacific Tropical Cyclones 02 December 2007 - 06 February 2008.

Section 2 Cyclone Summaries

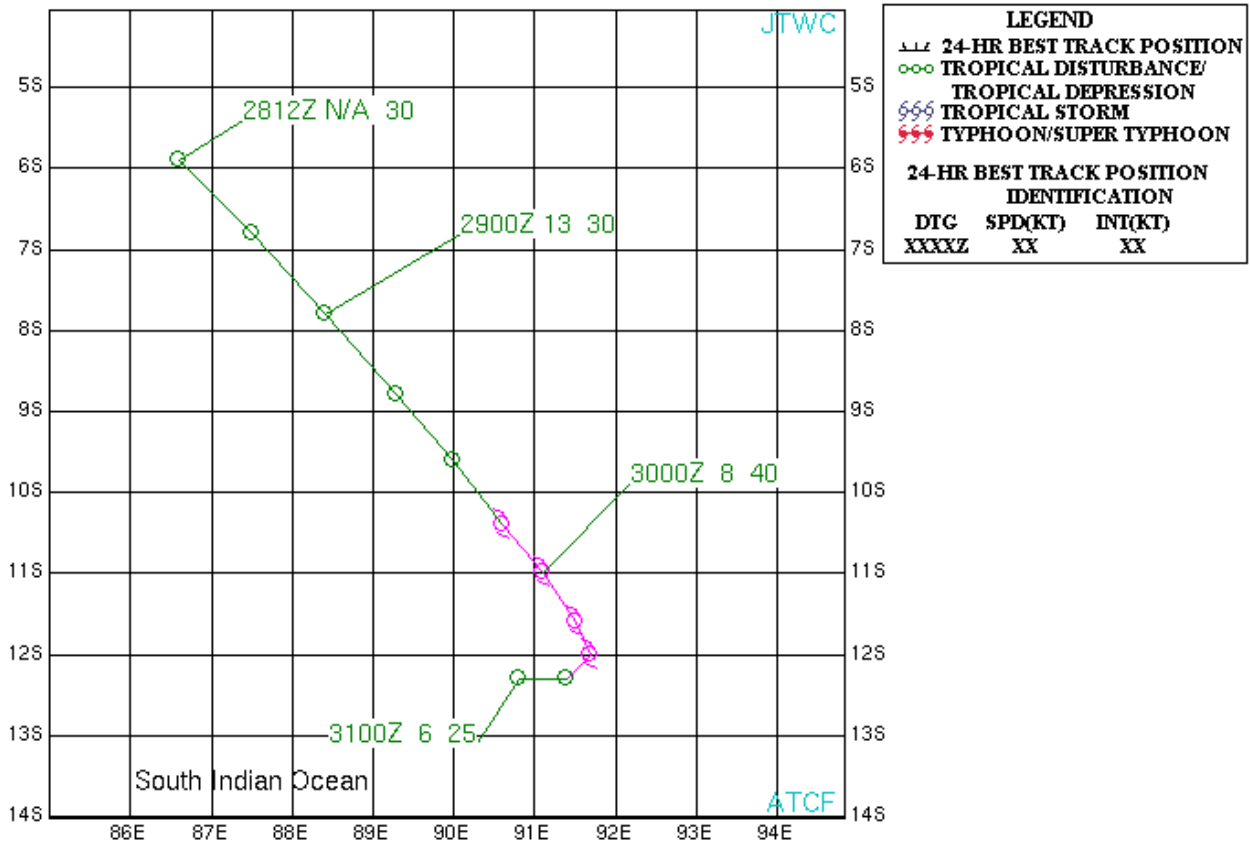
Each cyclone is presented, with the number and basin identifier assigned by JTWC, along with the RSMC assigned cyclone name. Dates are also listed when JTWC first designated various stages of development; as an area of interest (Poor classification), increased potential for development (Fair classification) and development/TC expected (Good classification). Furthermore, the first Tropical Cyclone Formation Alert (TCFA), and the first and final warnings dates are also presented with the number of warnings issued by JTWC. Maximum intensity and the number of warnings issued by JTWC are included as well. Landfall over major landmasses and approximate locations are presented as well.

The JTWC post-event reanalysis best track is also provided for each cyclone. Data included on the best track are position and intensity noted with cyclone symbols and color coded track. Best track positions are marked by date at 0000 UTC, as well as the beginning and end points. Best track position labels include the date-time, track speed in knots, and maximum wind speed in knots. A graph of best track intensity versus time is presented. Fix plots on this graph are color coded by fixing agency



Tropical Cyclone 01S

ISSUED POOR: N/A
 ISSUED FAIR: 0600Z 27 Jul 2007
 FIRST TCFA: 1330Z 27 Jul 2007
 FIRST WARNING: 1800Z 29 Jul 2007
 LAST WARNING: 0600Z 30 Jul 2007
 LANDFALL: None
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 2



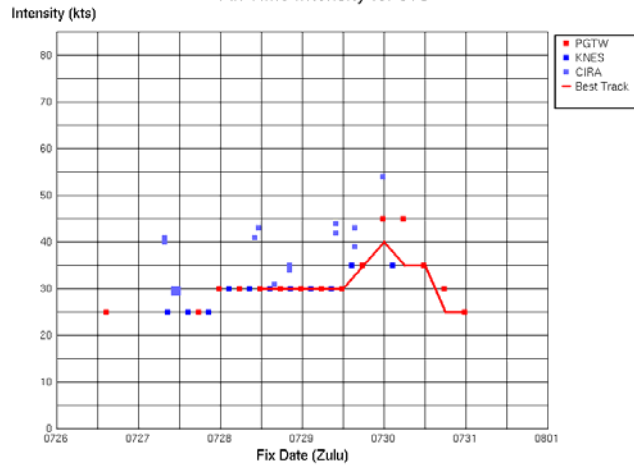
LEGEND

--- 24-HR BEST TRACK POSITION
 ○--- TROPICAL DISTURBANCE/
 TROPICAL DEPRESSION
 --- TROPICAL STORM
 --- TYPHOON/SUPER TYPHOON

24-HR BEST TRACK POSITION IDENTIFICATION

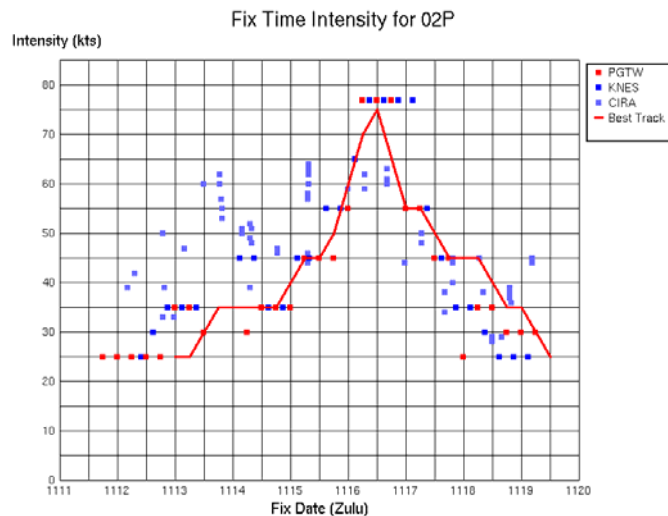
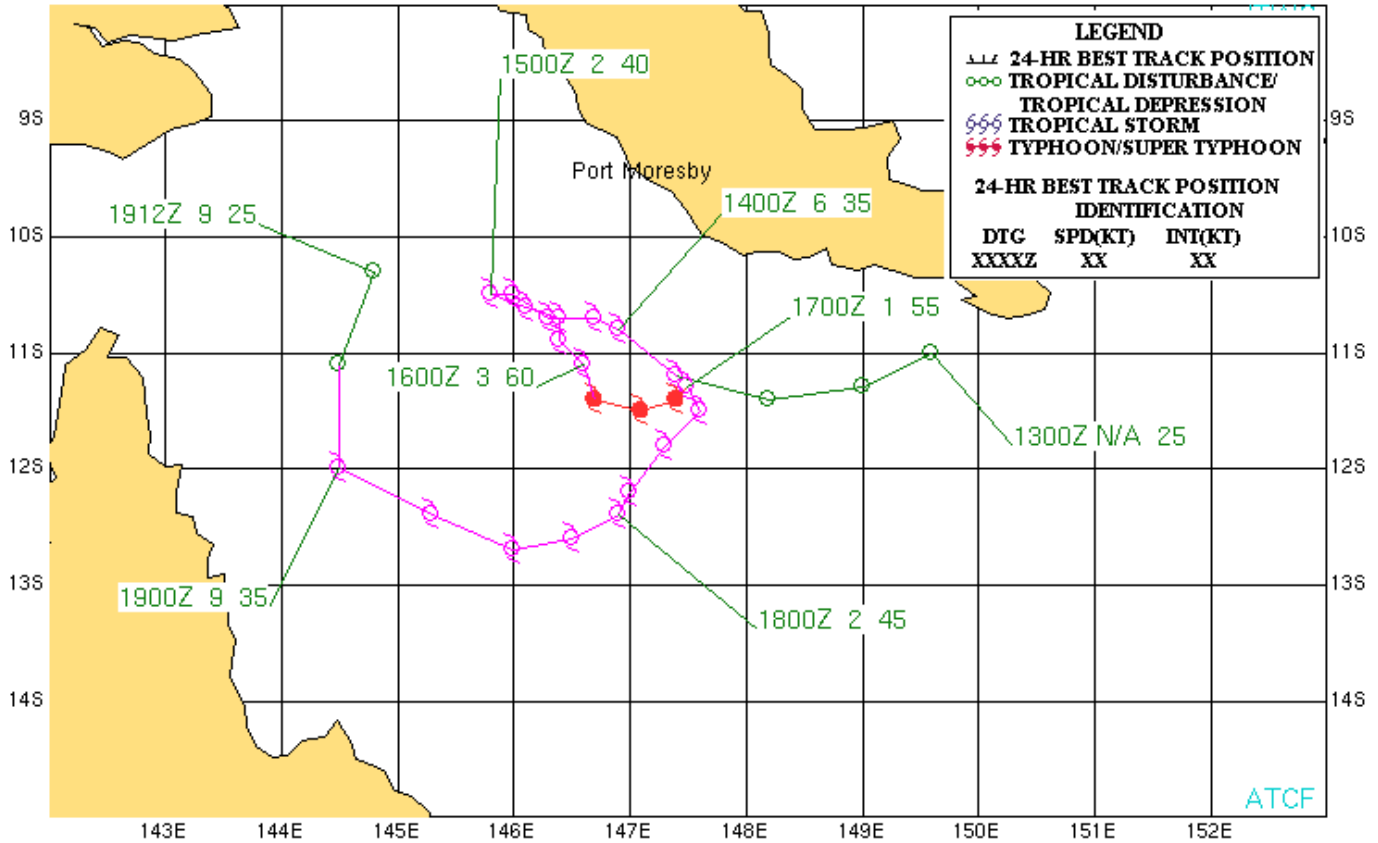
DTG	SPD(KT)	INT(KT)
XXXXZ	XX	XX

Fix Time Intensity for 01S



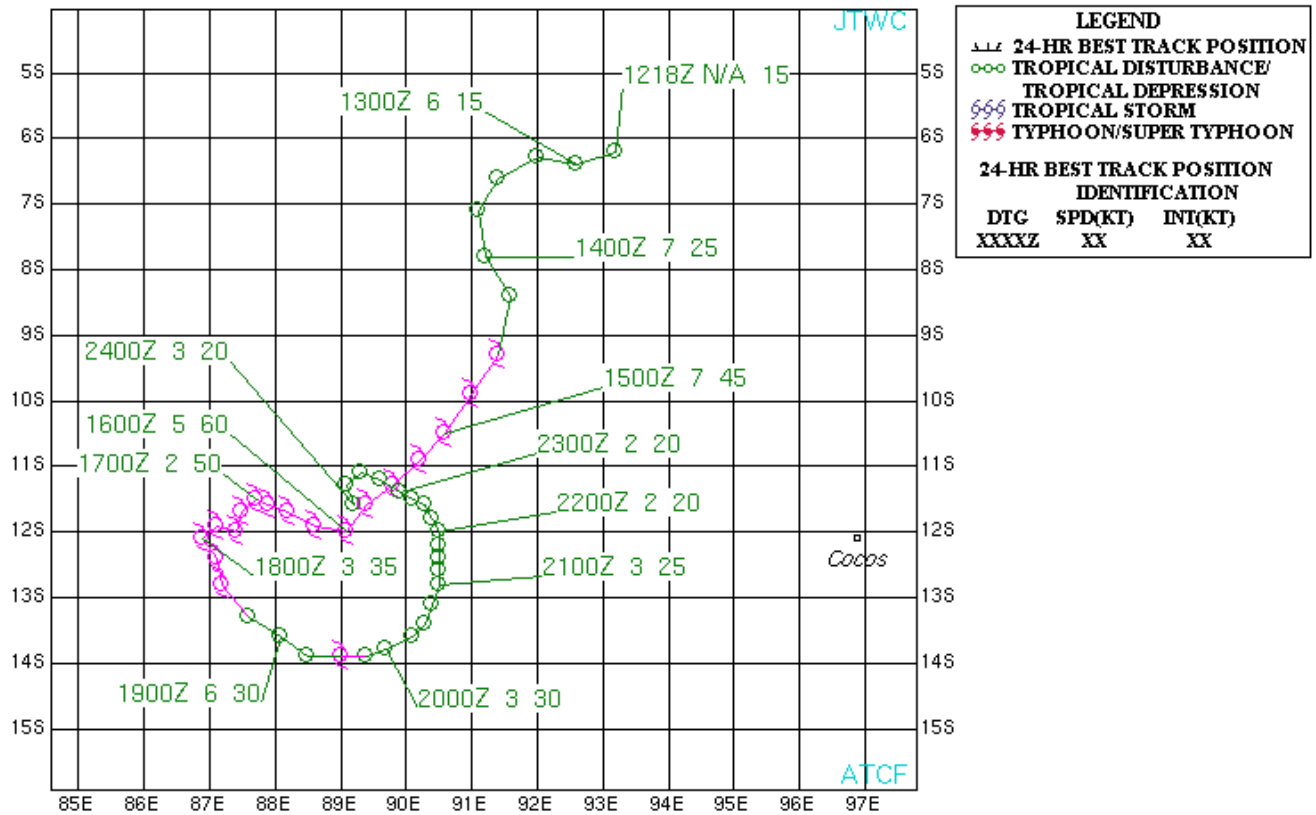
Tropical Cyclone 02P (Guba)

ISSUED POOR: 1730Z 11 Nov 2007
 ISSUED FAIR: 0600Z 12 Nov 2007
 FIRST TCFA: 0200Z 13 Nov 2007
 FIRST WARNING: 1200Z 13 Nov 2007
 LAST WARNING: 0000Z 19 Nov 2007
 LANDFALL: None
 MAX INTENSITY: 75 Kts
 NUMBER OF WARNINGS: 12



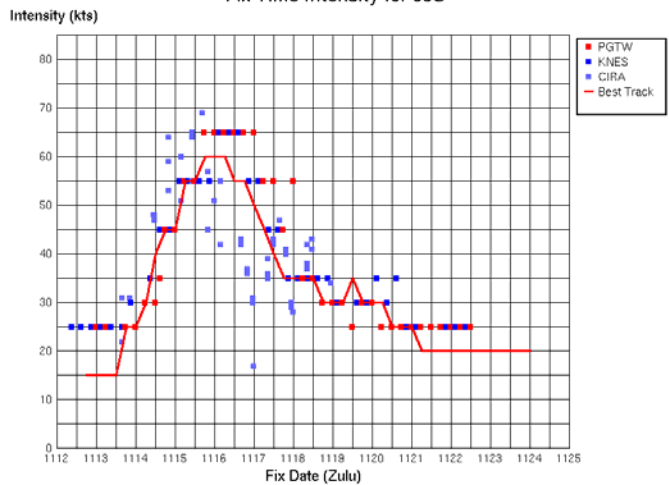
Tropical Cyclone 03S (Lee-Ariel)

ISSUED POOR: 1800Z 12 Nov 2007
 ISSUED FAIR: 1330Z 14 Nov 2007
 FIRST TCFA: 1630Z 14 Nov 2007
 FIRST WARNING: 1800Z 14 Nov 2007
 LAST WARNING: 1800Z 18 Nov 2007
 LANDFALL: None
 MAX INTENSITY: 60 Kts
 NUMBER OF WARNINGS: 9



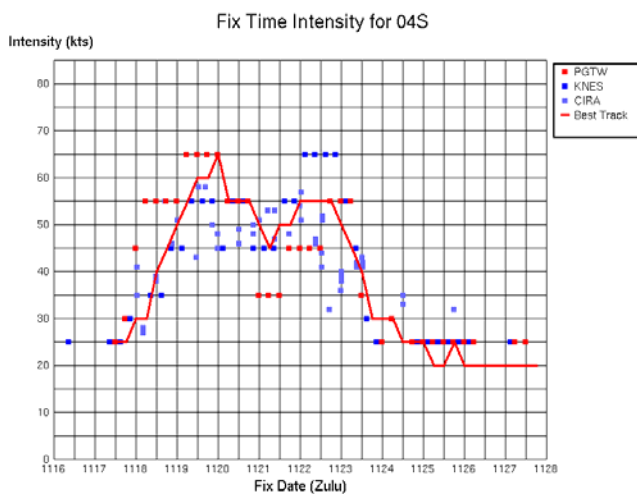
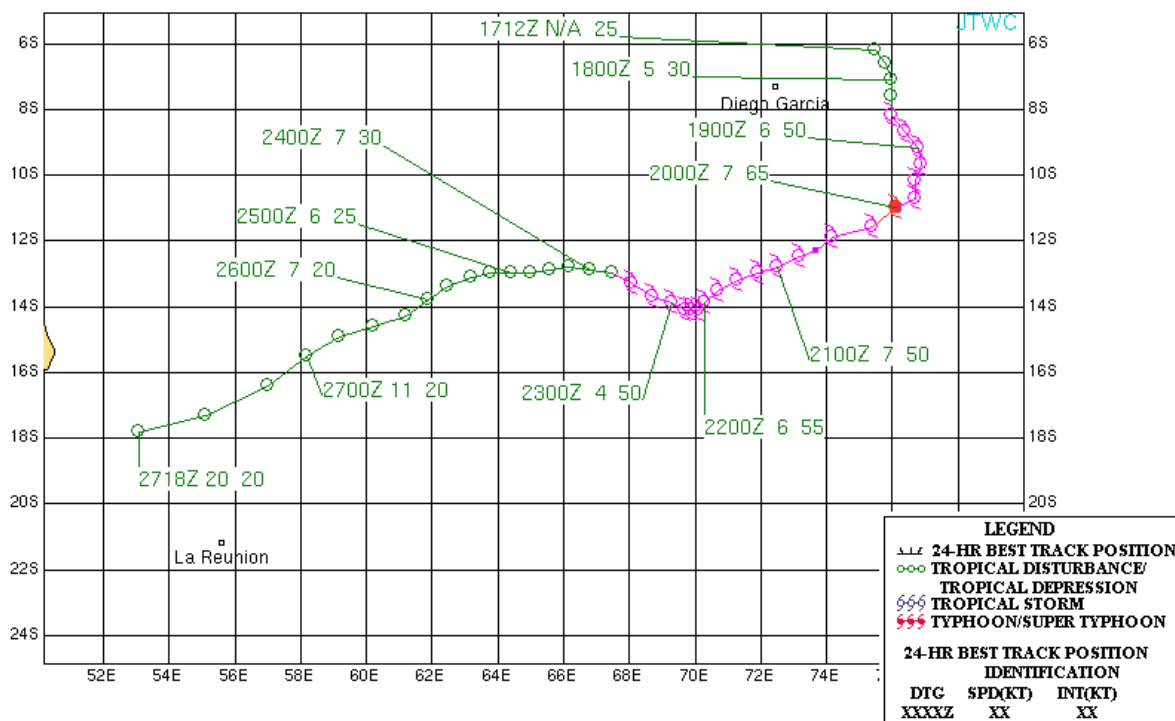
LEGEND		
---	24-HR BEST TRACK POSITION	
o-o-o	TROPICAL DISTURBANCE/ TROPICAL DEPRESSION	
---	TROPICAL STORM	
---	TYPHOON/SUPER TYPHOON	
24-HR BEST TRACK POSITION IDENTIFICATION		
DTG	SPD(KT)	INT(KT)
XXXXZ	XX	XX

Fix Time Intensity for 03S



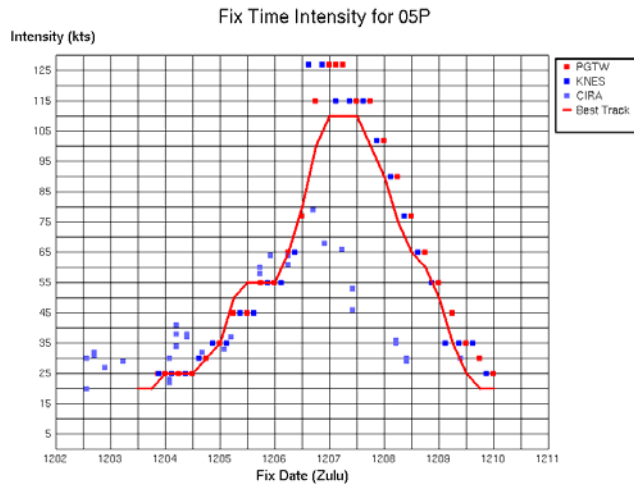
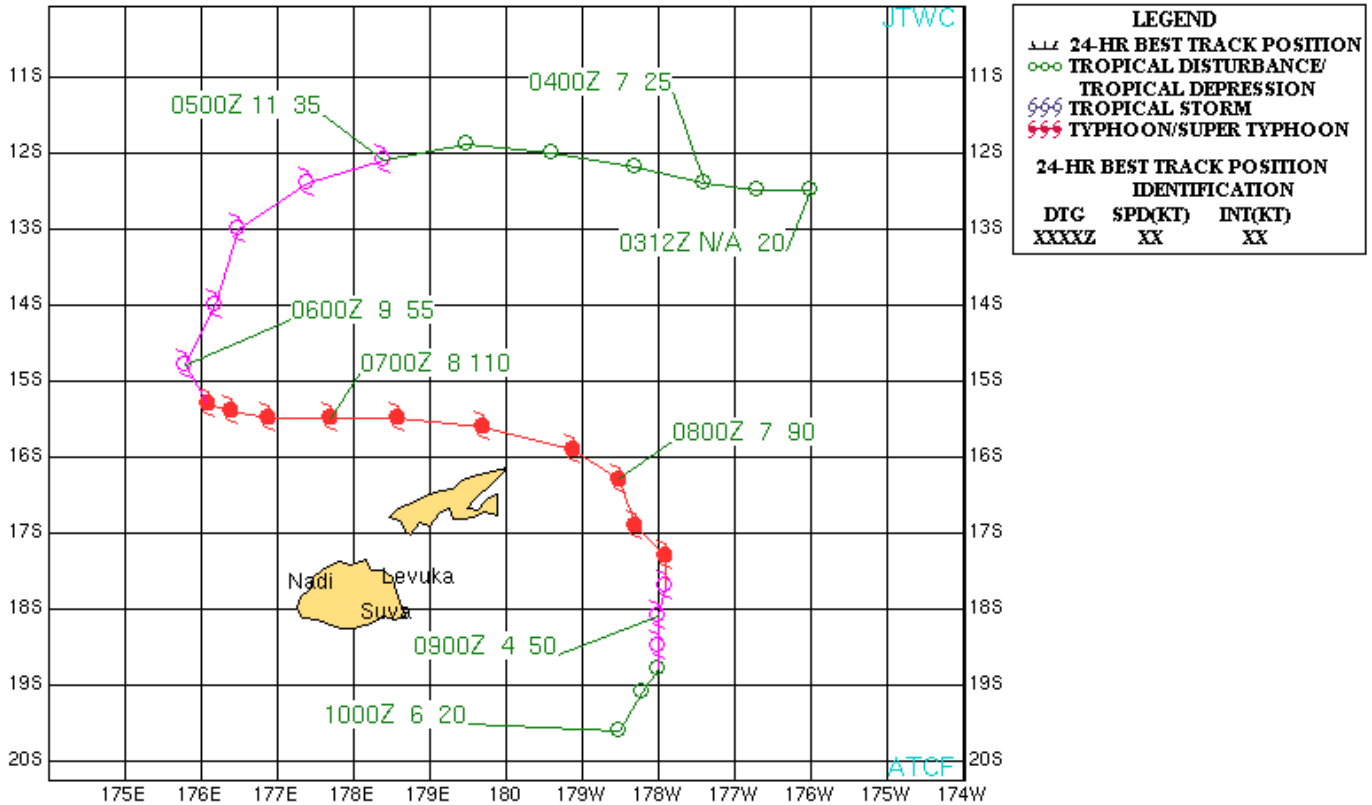
Tropical Cyclone 04S (Bongwe)

ISSUED POOR: 1000Z 17 Nov 2007
 ISSUED FAIR: 1800Z 17 Nov 2007
 FIRST TCFA: 2300Z 17 Nov 2007
 FIRST WARNING: 0600Z 18 Nov 2007
 LAST WARNING: 1800Z 23 Nov 2007
 LANDFALL: None
 MAX INTENSITY: 65 Kts
 NUMBER OF WARNINGS: 12



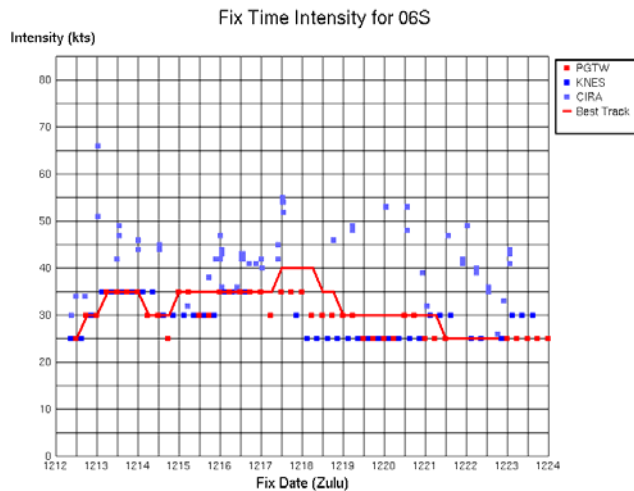
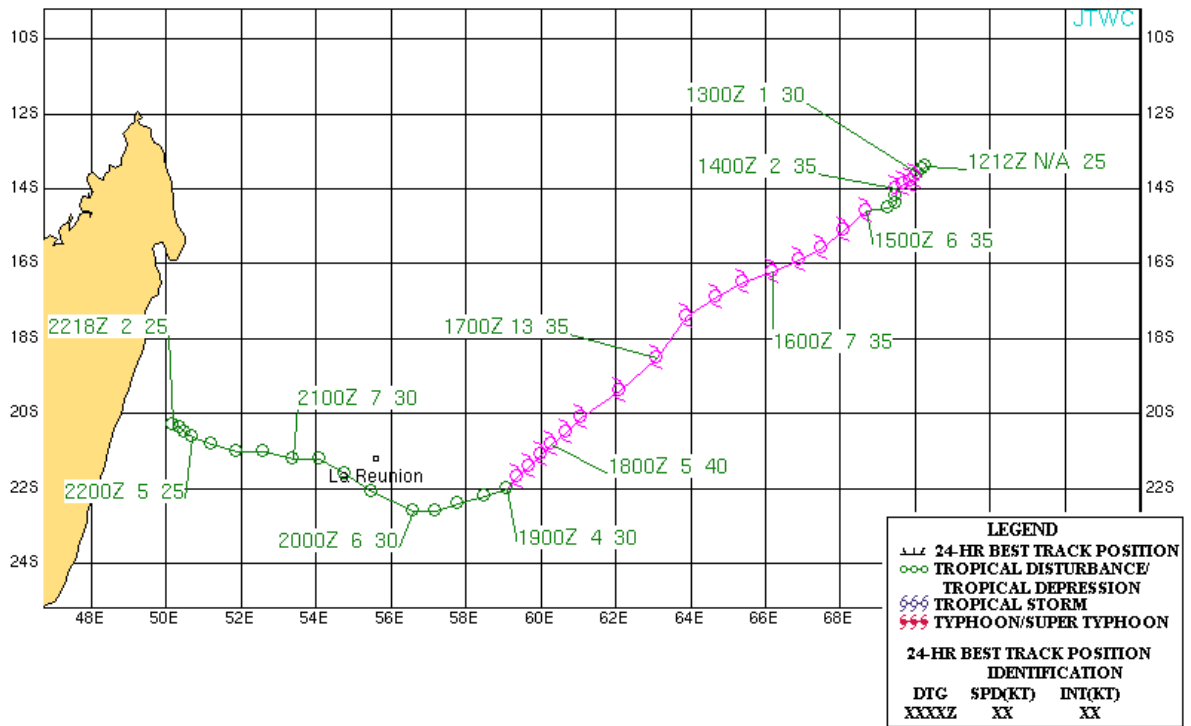
Tropical Cyclone 05P (Daman)

ISSUED POOR: 2130Z 02 Dec 2007
 ISSUED FAIR: 2330Z 03 Dec 2007
 FIRST TCFA: 0230Z 04 Dec 2007
 FIRST WARNING: 0000Z 05 Dec 2007
 LAST WARNING: 0600Z 09 Dec 2007
 LANDFALL: None
 MAX INTENSITY: 110 Kts
 NUMBER OF WARNINGS: 10



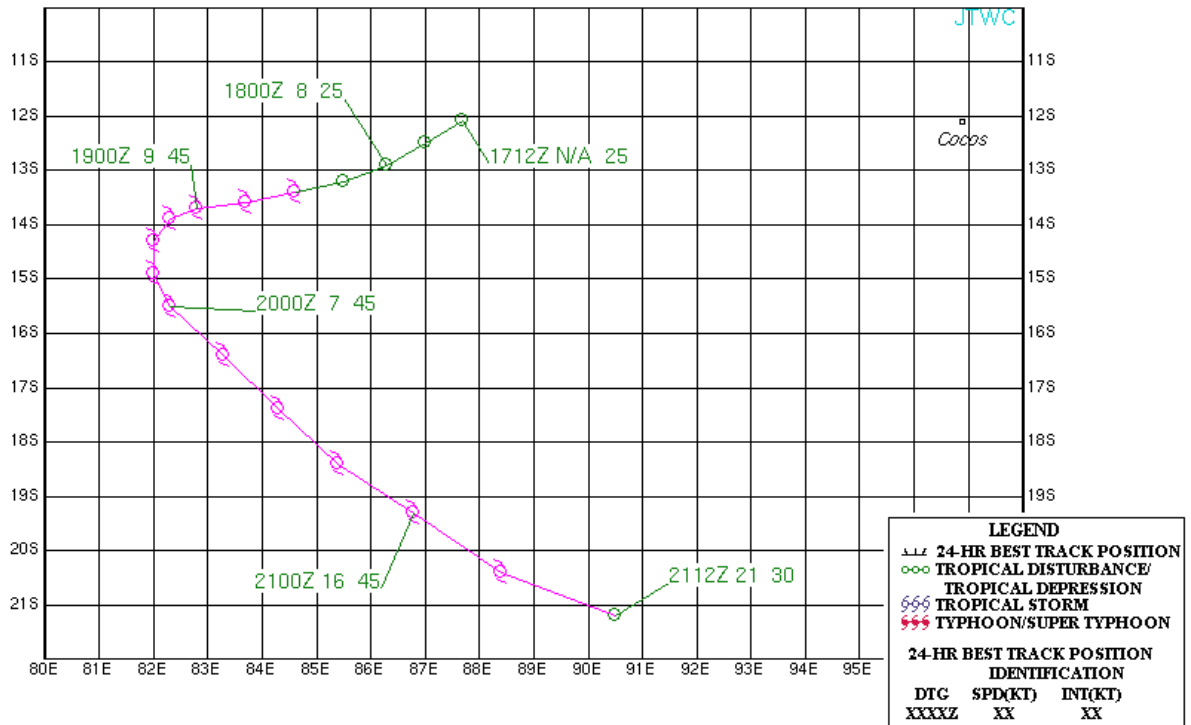
Tropical Cyclone 06S (Celina)

ISSUED POOR: 0830Z 12 Dec 2007
 ISSUED FAIR: 1800Z 12 Dec 2007
 FIRST TCFA: 2230Z 12 Dec 2007
 FIRST WARNING: 0900Z 13 Dec 2007
 LAST WARNING: 0000Z 18 Dec 2007
 LANDFALL: None
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 11

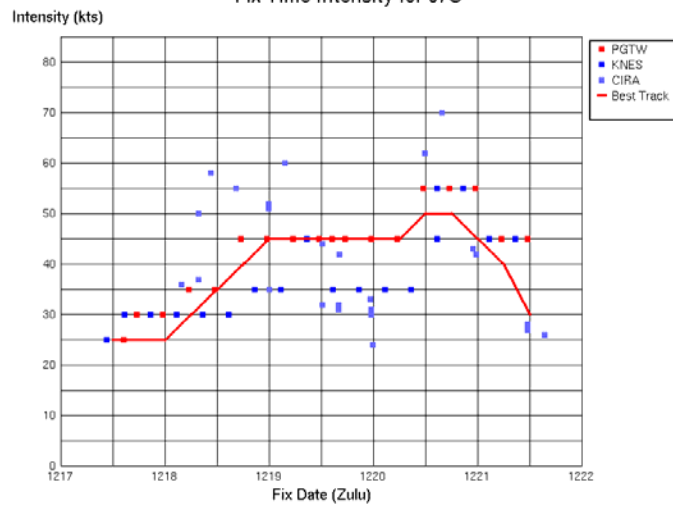


Tropical Cyclone 07S (Dama)

ISSUED POOR: 0900Z 17 Dec 2007
 ISSUED FAIR: 1530Z 17 Dec 2007
 FIRST TCFA: 2230Z 17 Dec 2007
 FIRST WARNING: 1200Z 18 Dec 2007
 LAST WARNING: 1200Z 21 Dec 2007
 LANDFALL: None
 MAX INTENSITY: 50 Kts
 NUMBER OF WARNINGS: 7

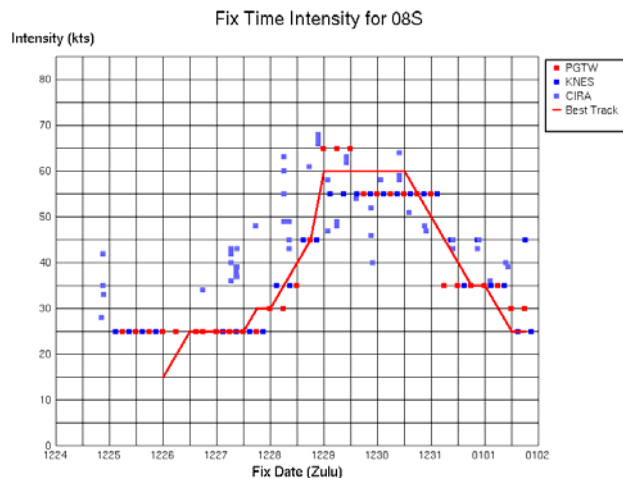
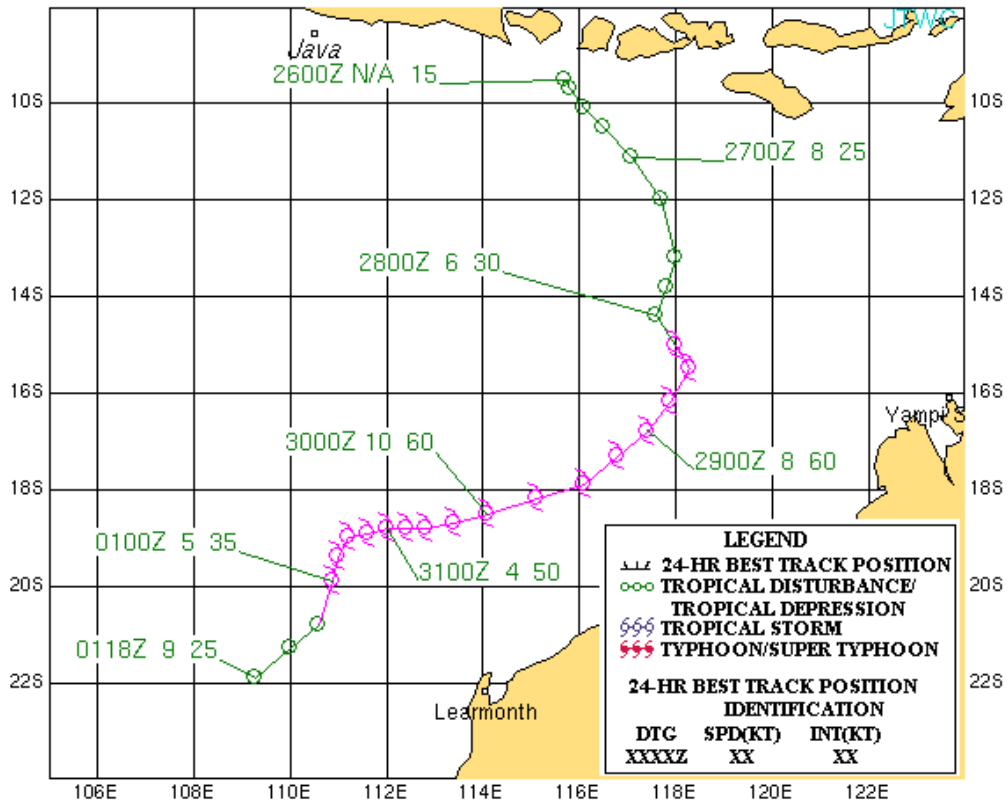


Fix Time Intensity for 07S



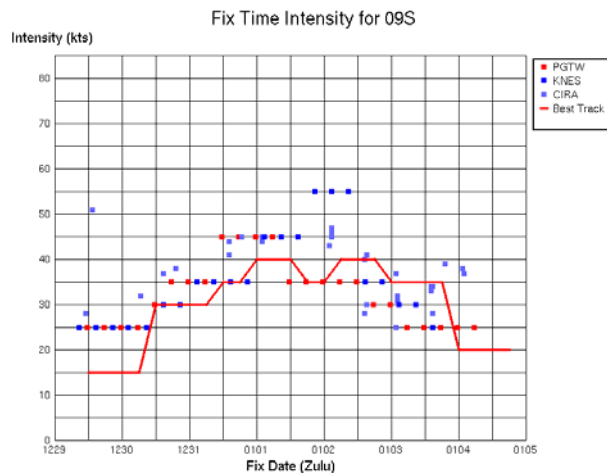
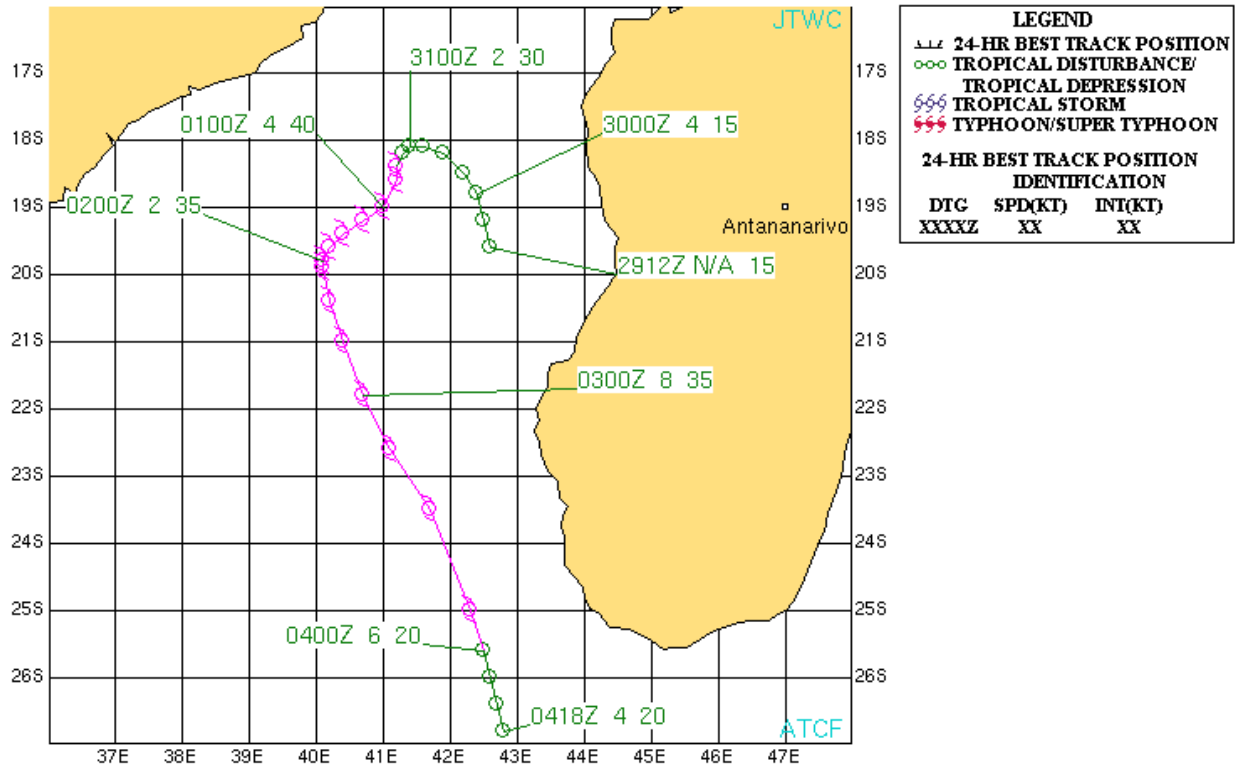
Tropical Cyclone 08S (Melanie)

ISSUED POOR: 0900Z 26 Dec 2007
 ISSUED FAIR: 1800Z 26 Dec 2007
 FIRST TCFA: 2130Z 27 Dec 2007
 FIRST WARNING: 0600Z 28 Dec 2007
 LAST WARNING: 0000Z 01 Jan 2008
 LANDFALL: None
 MAX INTENSITY: 60 Kts
 NUMBER OF WARNINGS: 13



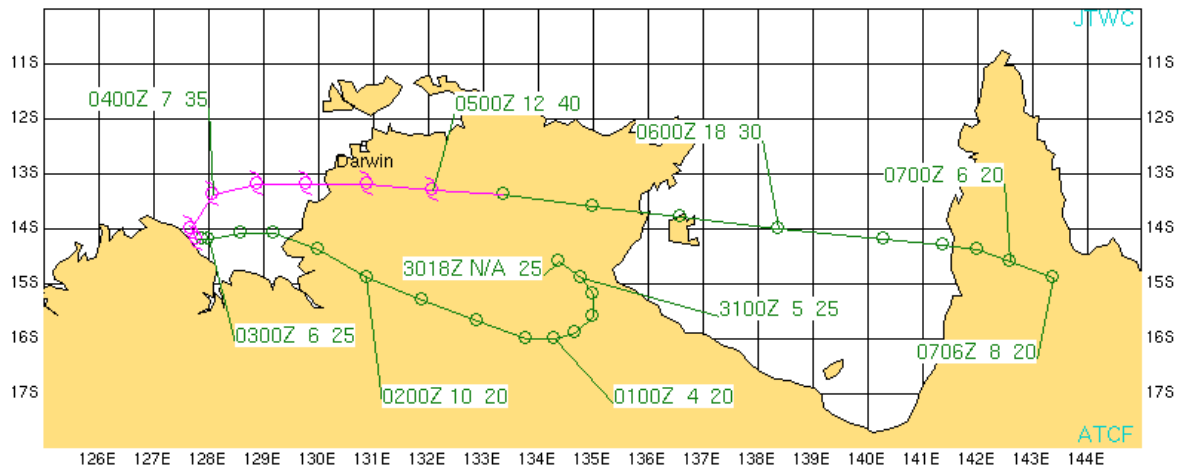
Tropical Cyclone 09S (Elnus)

ISSUED POOR: 1800Z 29 Dec 2007
 ISSUED FAIR: 1600Z 31 Dec 2007
 FIRST TCFA: 1730Z 30 Dec 2007
 FIRST WARNING: 1200Z 31 Dec 2007
 LAST WARNING: 0000Z 04 Jan 2008
 LANDFALL: None
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 8



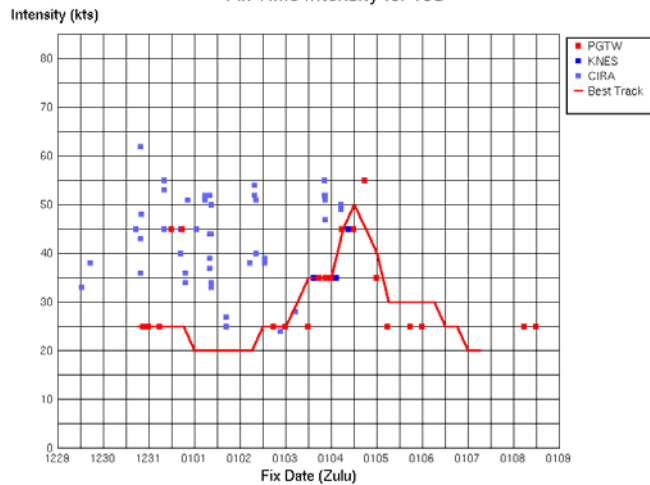
Tropical Cyclone 10S (Helen)

ISSUED POOR: 1900Z 29 Dec 2007
 ISSUED FAIR: 1300Z 03 Jan 2008
 FIRST TCFA: 1530Z 03 Jan 2008
 FIRST WARNING: 1800Z 03 Jan 2008
 LAST WARNING: 0600Z 06 Jan 2008
 LANDFALL: Near Anson Bay, Australia
 MAX INTENSITY: 50 Kts
 NUMBER OF WARNINGS: 6



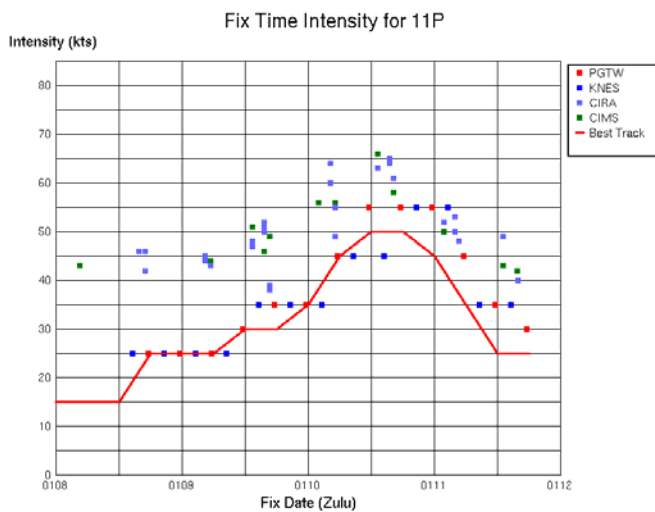
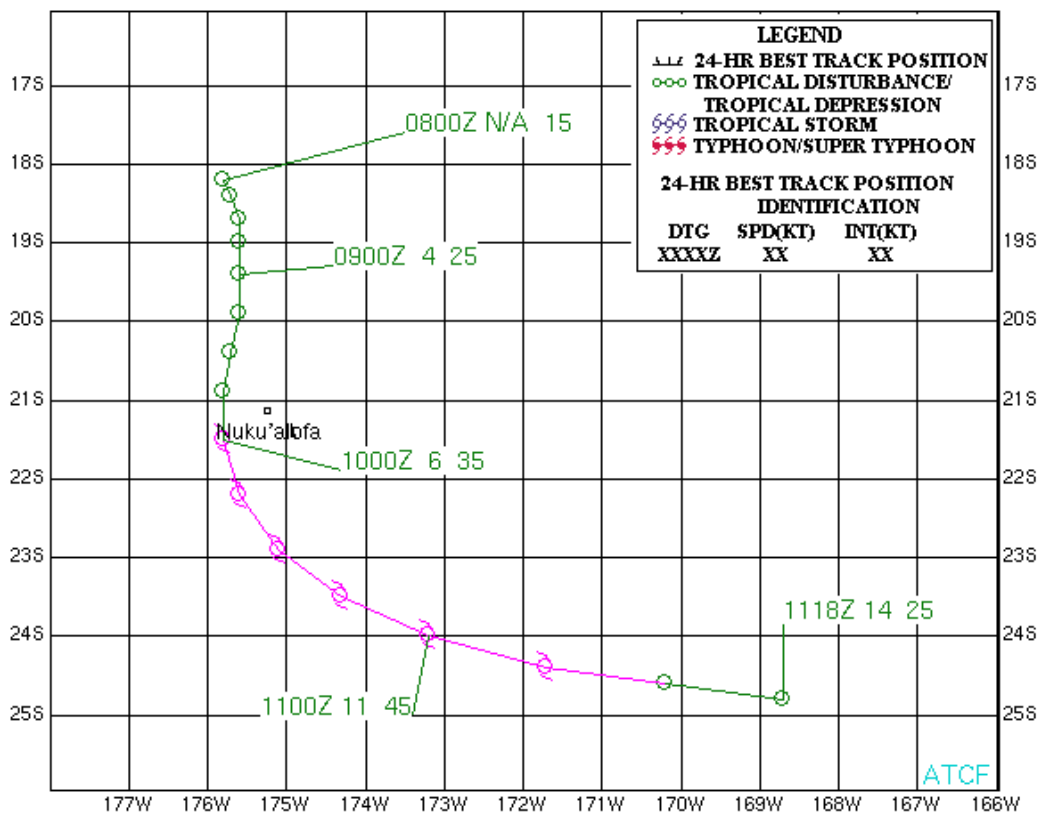
LEGEND		
---	24-HR BEST TRACK POSITION	
o-o-o	TROPICAL DISTURBANCE/ TROPICAL DEPRESSION	
6-6-6	TROPICAL STORM	
8-8-8	TYPHOON/SUPER TYPHOON	
24-HR BEST TRACK POSITION IDENTIFICATION		
DTC	SPD(KT)	INT(KT)
XXXXZ	XX	XX

Fix Time Intensity for 10S



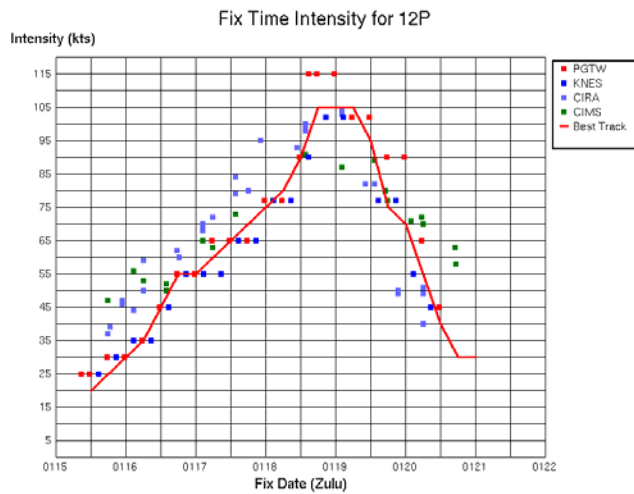
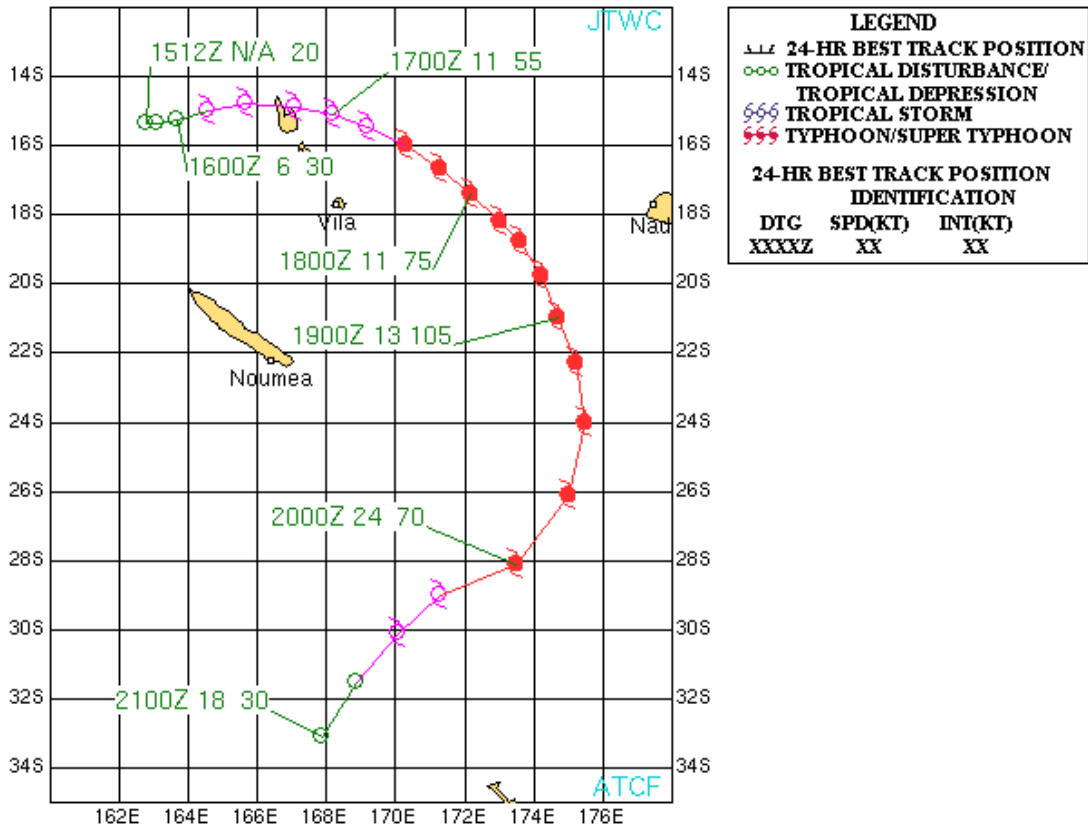
Tropical Cyclone 11P (Elisa)

ISSUED POOR: N/A
 ISSUED FAIR: 1430Z 08 Jan 2008
 FIRST TCFA: 1330Z 09 Jan 2008
 FIRST WARNING: 0000Z 10 Jan 2008
 LAST WARNING: 0600Z 11 Jan 2008
 LANDFALL: None
 MAX INTENSITY: 50 Kts
 NUMBER OF WARNINGS: 4



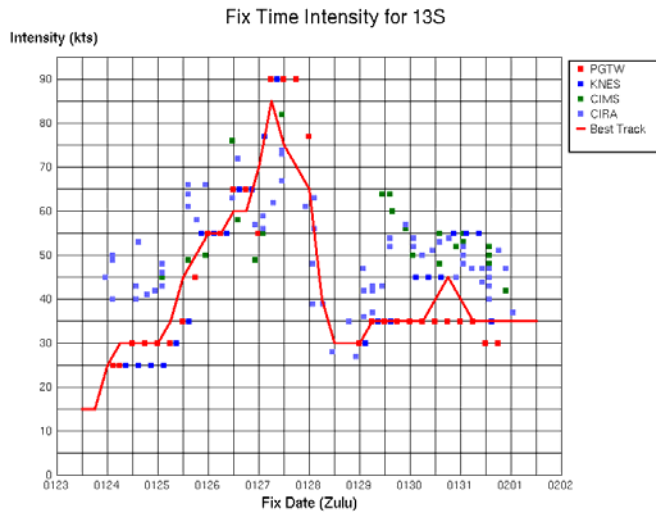
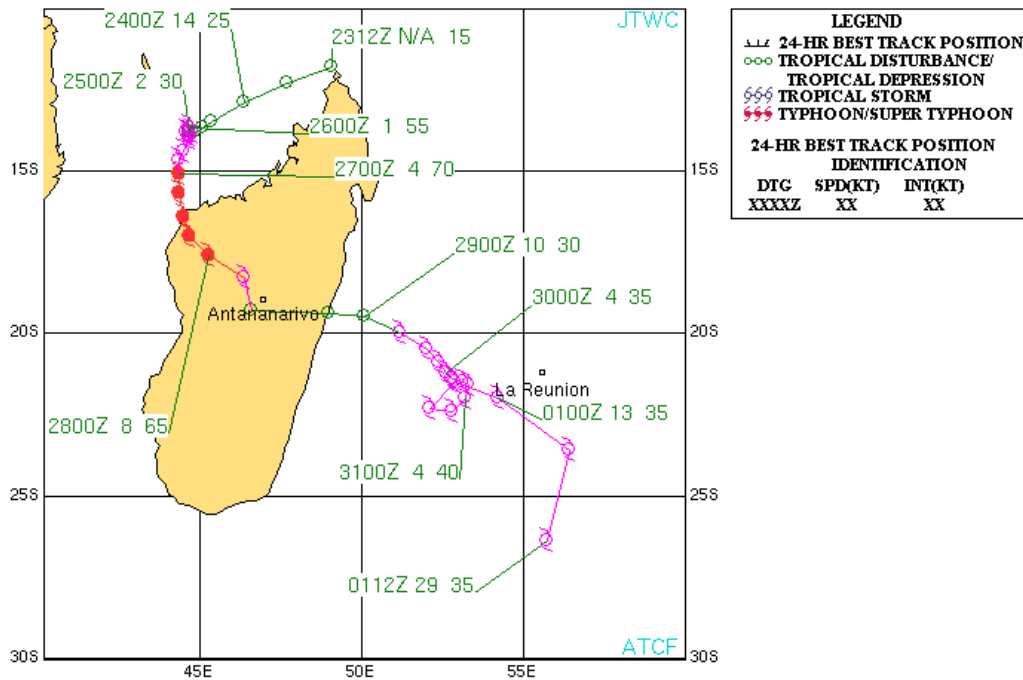
Tropical Cyclone 12P (Funa)

ISSUED POOR: 1330Z 15 Jan 2008
 ISSUED FAIR: 2300Z 15 Jan 2008
 FIRST TCFA: 0200Z 16 Jan 2008
 FIRST WARNING: 0600Z 16 Jan 2008
 LAST WARNING: 0600Z 20 Jan 2008
 LANDFALL: Near Nokuku, Espiritu Santo, Vanuatu
 MAX INTENSITY: 105 Kts
 NUMBER OF WARNINGS: 9



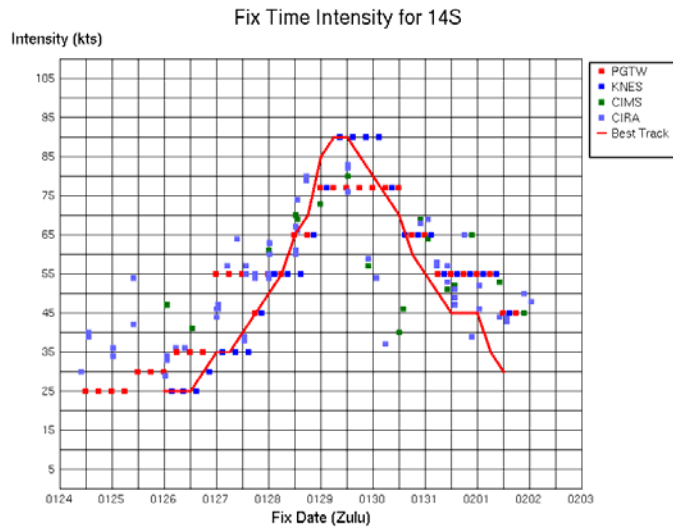
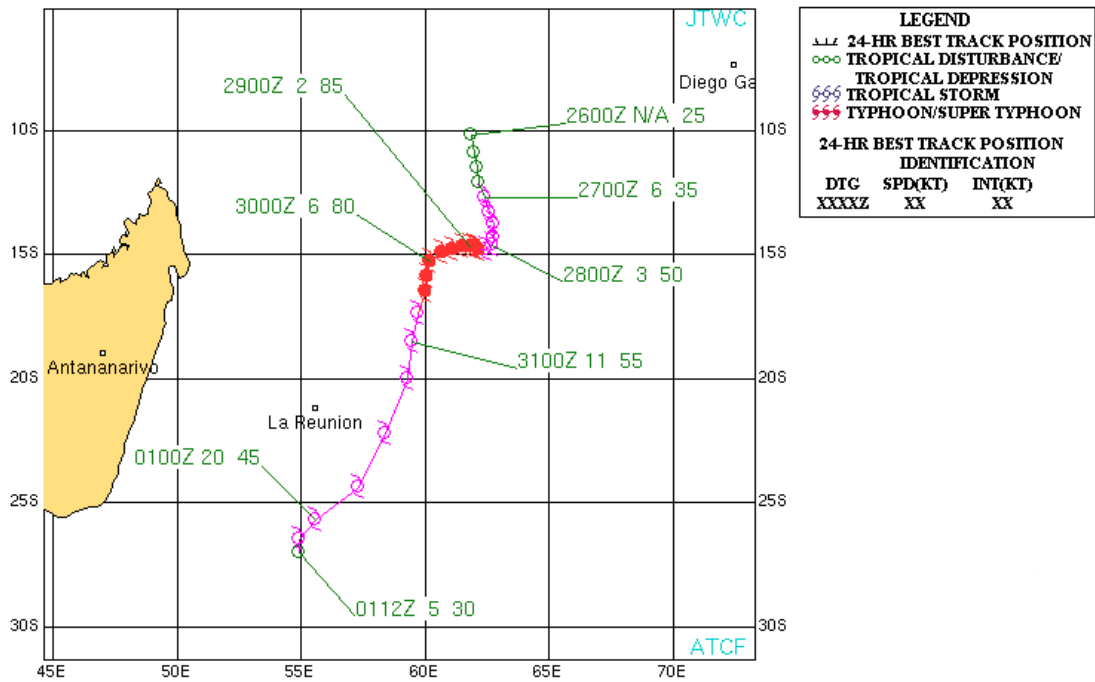
Tropical Cyclone 13S (Fame)

ISSUED POOR: 1800Z 23 Jan 2008
 ISSUED FAIR: 0800Z 24 Jan 2008
 FIRST TCFA: 1030Z 25 Jan 2008
 FIRST WARNING: 1800Z 25 Jan 2008
 LAST WARNING: 0600Z 01 Feb 2008
 LANDFALL: Near Soalala, Madagascar
 MAX INTENSITY: 85 Kts
 NUMBER OF WARNINGS: 13



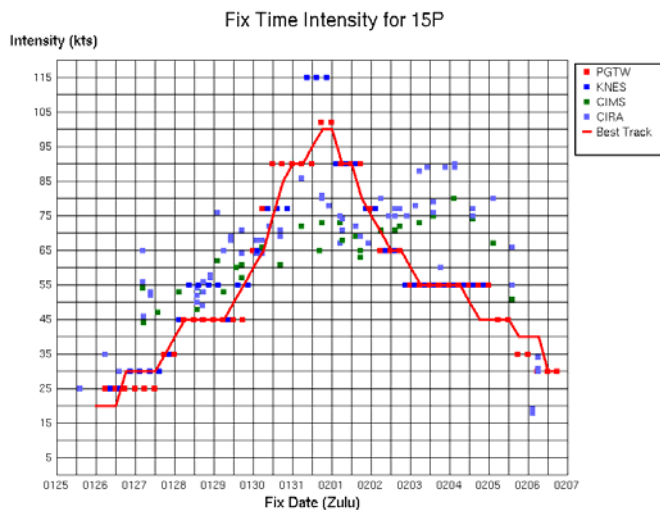
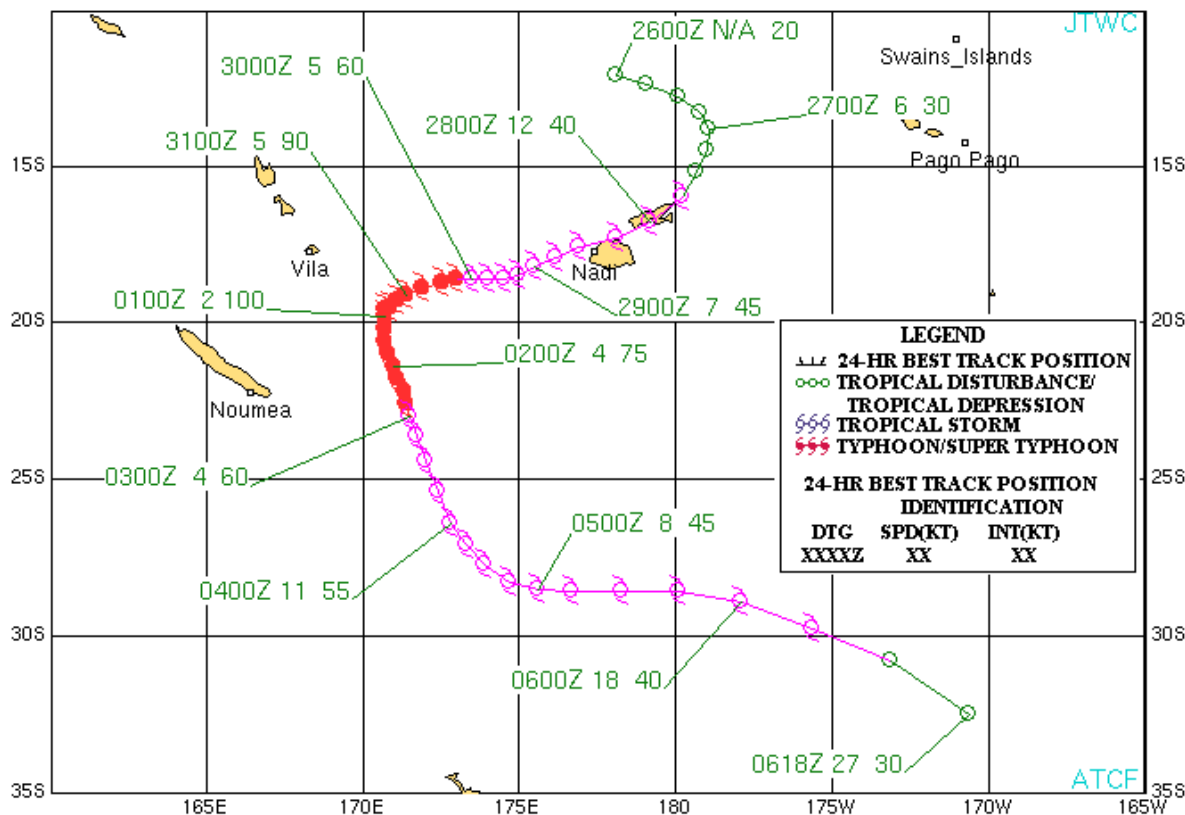
Tropical Cyclone 14S (Gula)

ISSUED POOR: 0230Z 24 Jan 2008
 ISSUED FAIR: 1400Z 25 Jan 2008
 FIRST TCFA: 2100Z 26 Jan 2008
 FIRST WARNING: 0000Z 27 Jan 2008
 LAST WARNING: 0000Z 02 Feb 2008
 LANDFALL: None
 MAX INTENSITY: 90 Kts
 NUMBER OF WARNINGS: 13



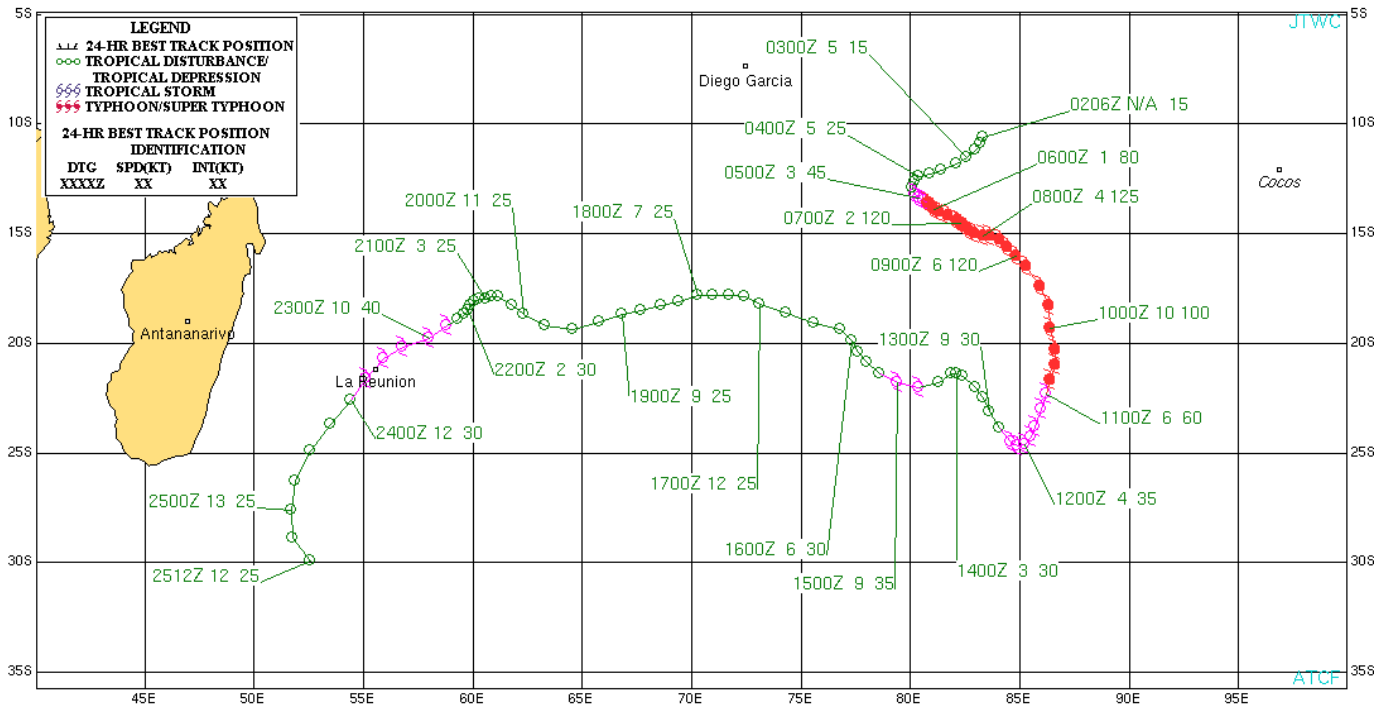
Tropical Cyclone 15P (Gene)

ISSUED POOR: 0600Z 26 Jan 2008
 ISSUED FAIR: 1630Z 26 Jan 2008
 FIRST TCFA: 2230Z 26 Jan 2008
 FIRST WARNING: 1800Z 27 Jan 2008
 LAST WARNING: 0600Z 06 Feb 2008
 LANDFALL: Near Lautoka, Viti Levu, Fiji
 MAX INTENSITY: 100 Kts
 NUMBER OF WARNINGS: 20

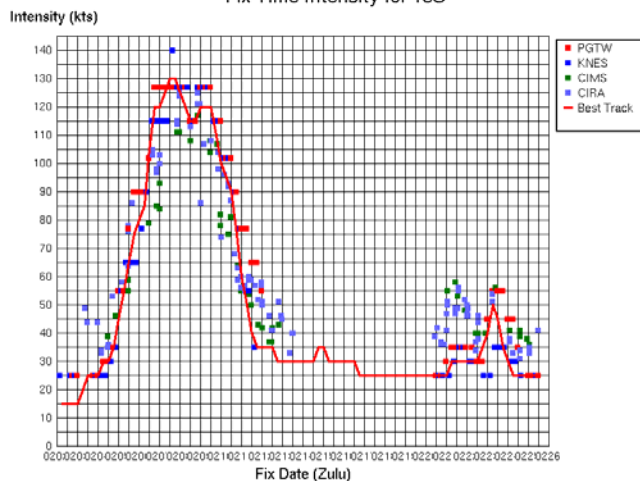


Tropical Cyclone 16S (Hondo)

ISSUED POOR: 1800Z 02 Feb 2008
 ISSUED FAIR: 0930Z 03 Feb 2008
 FIRST TCFA: 0300Z 04 Feb 2008
 FIRST WARNING: 1200Z 04 Feb 2008
 LAST WARNING: 0000Z 24 Feb 2008
 LANDFALL: La Reunion, France
 MAX INTENSITY: 130 Kts
 NUMBER OF WARNINGS: 20

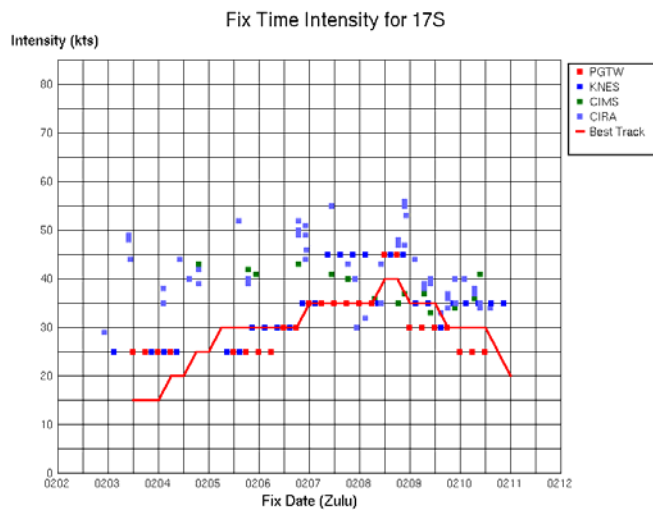
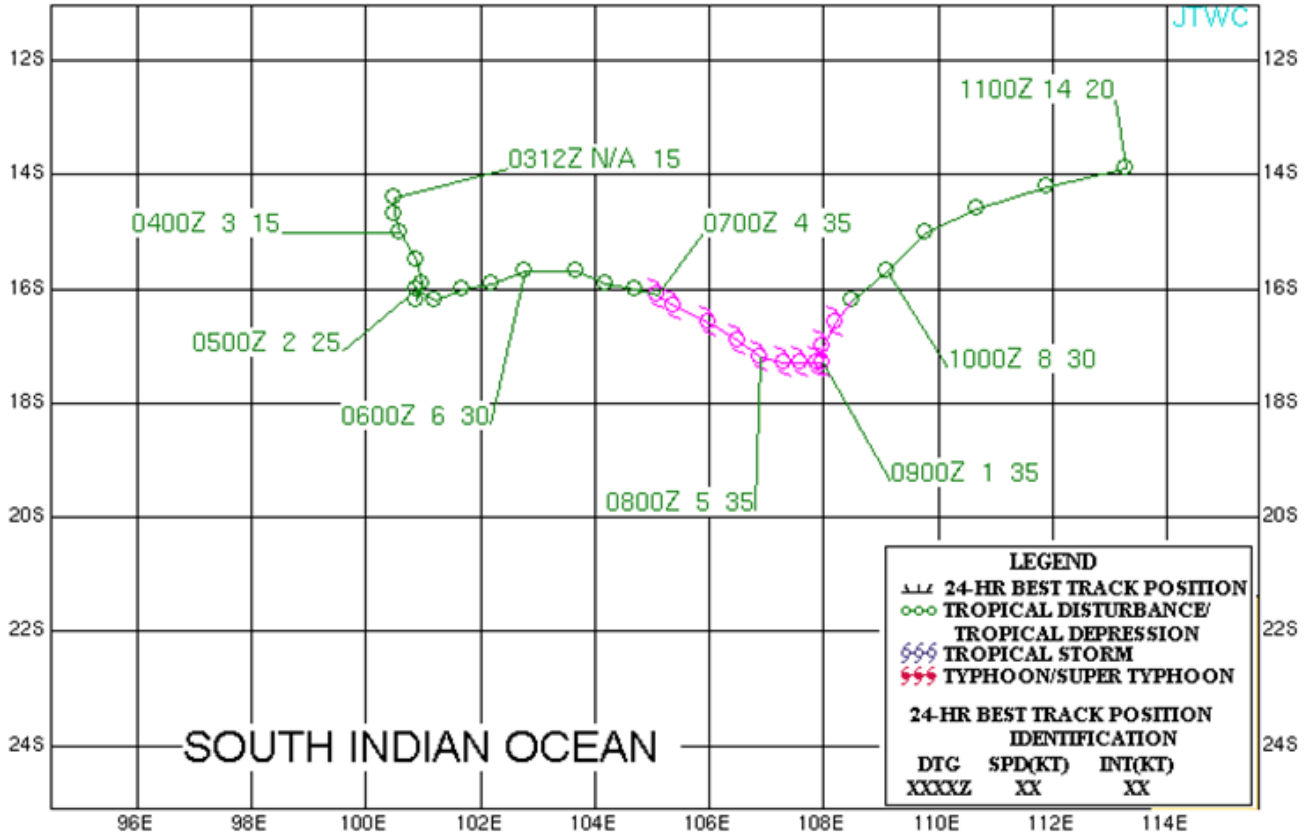


Fix Time Intensity for 16S



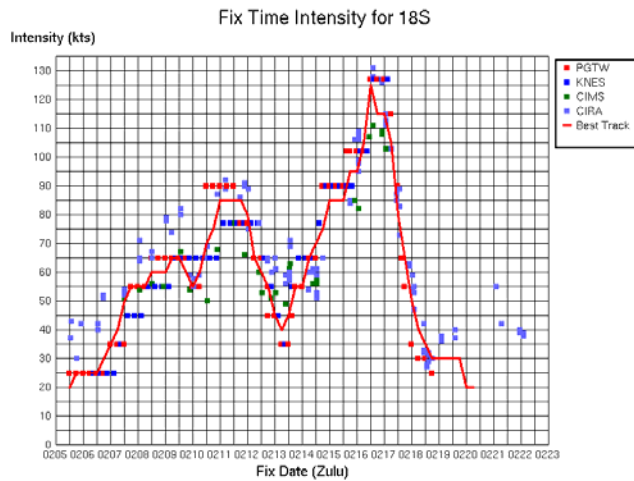
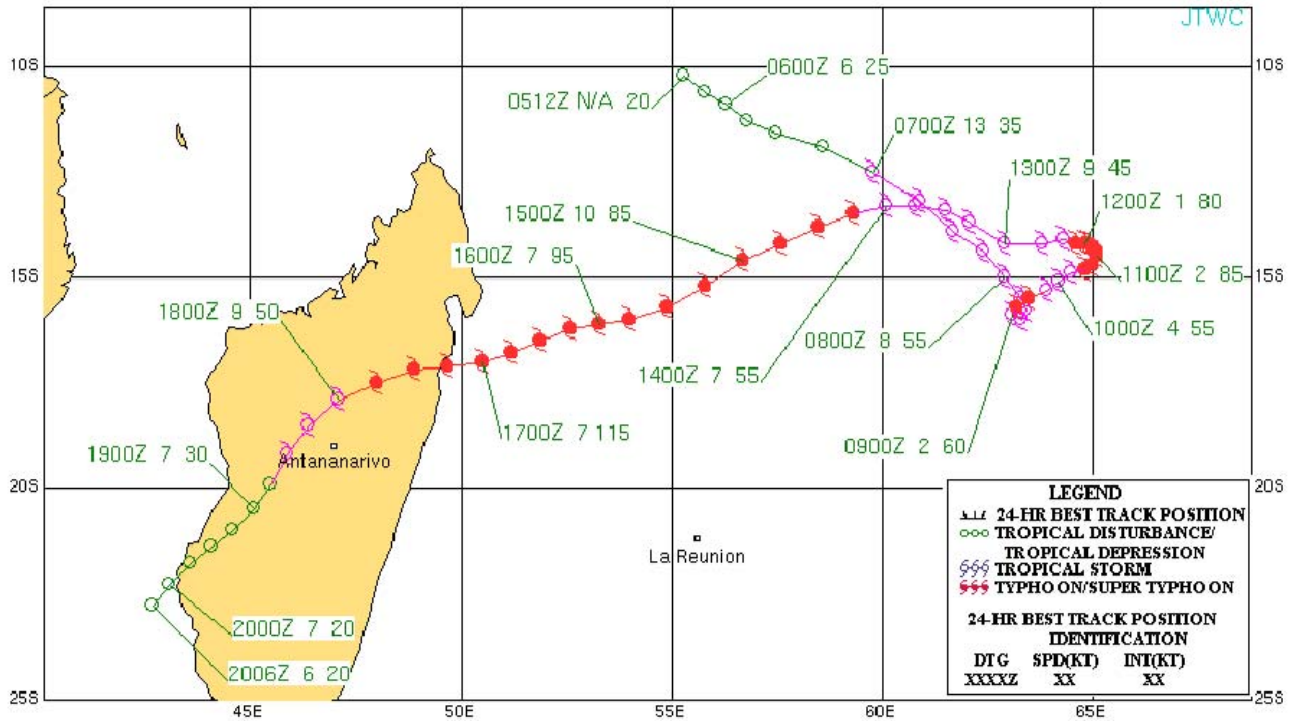
Tropical Cyclone 17S

ISSUED POOR: 0930Z 03 Feb 2008
 ISSUED FAIR: 0200Z 04 Feb 2008
 FIRST TCFA: 1930Z 06 Feb 2008
 FIRST WARNING: 0300Z 07 Feb 2008
 LAST WARNING: 0300Z 10 Feb 2008
 LANDFALL: None
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 7



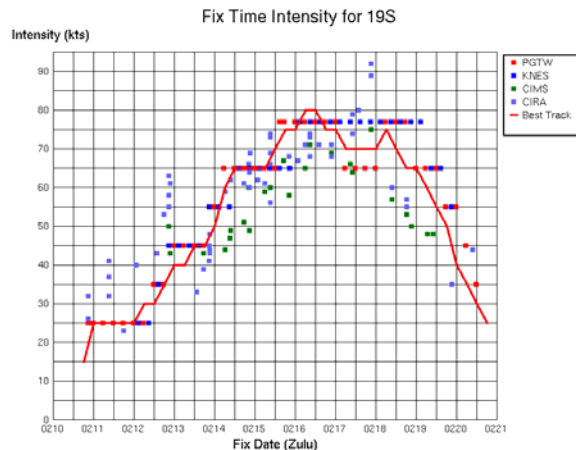
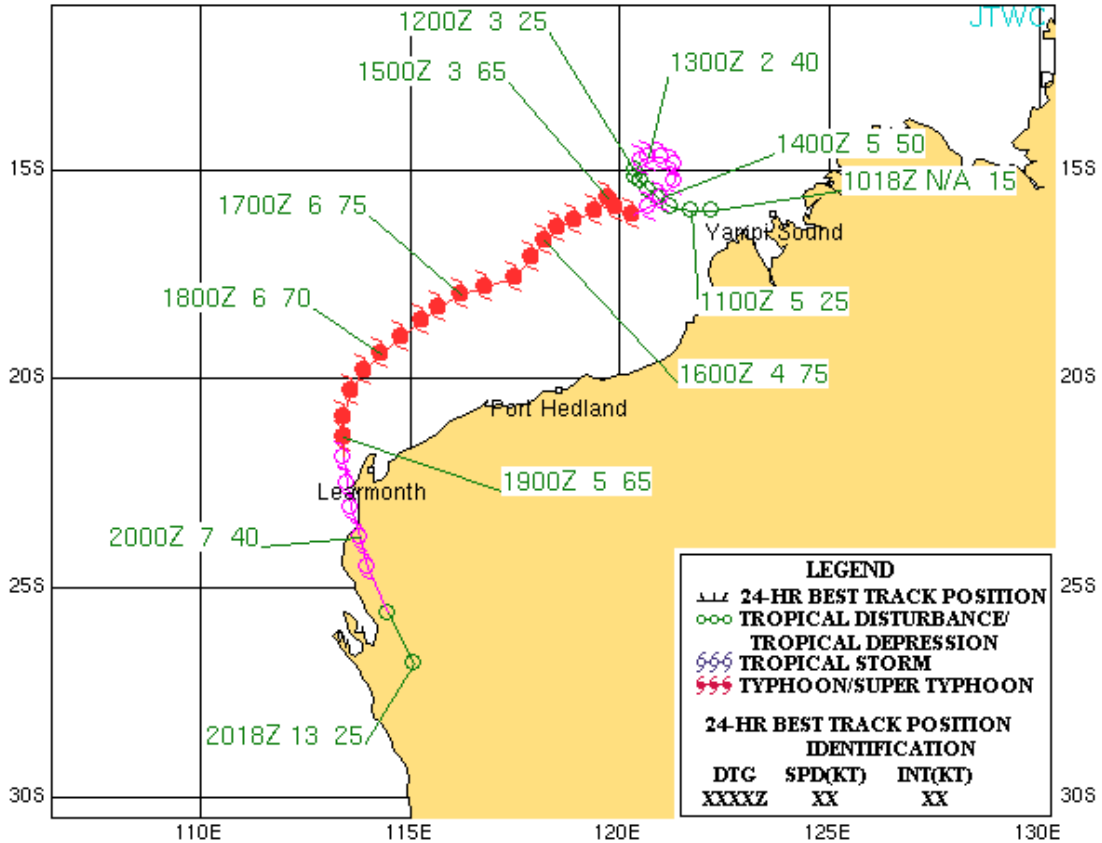
Tropical Cyclone 18S (Ivan)

ISSUED POOR: N/A
 ISSUED FAIR: 1800Z 05 Feb 2008
 FIRST TCFA: 0130Z 07 Feb 2008
 FIRST WARNING: 0600Z 07 Feb 2008
 LAST WARNING: 1800Z 18 Feb 2008
 LANDFALL: Near Ambodifotatra, Madagascar
 MAX INTENSITY: 125 Kts
 NUMBER OF WARNINGS: 30



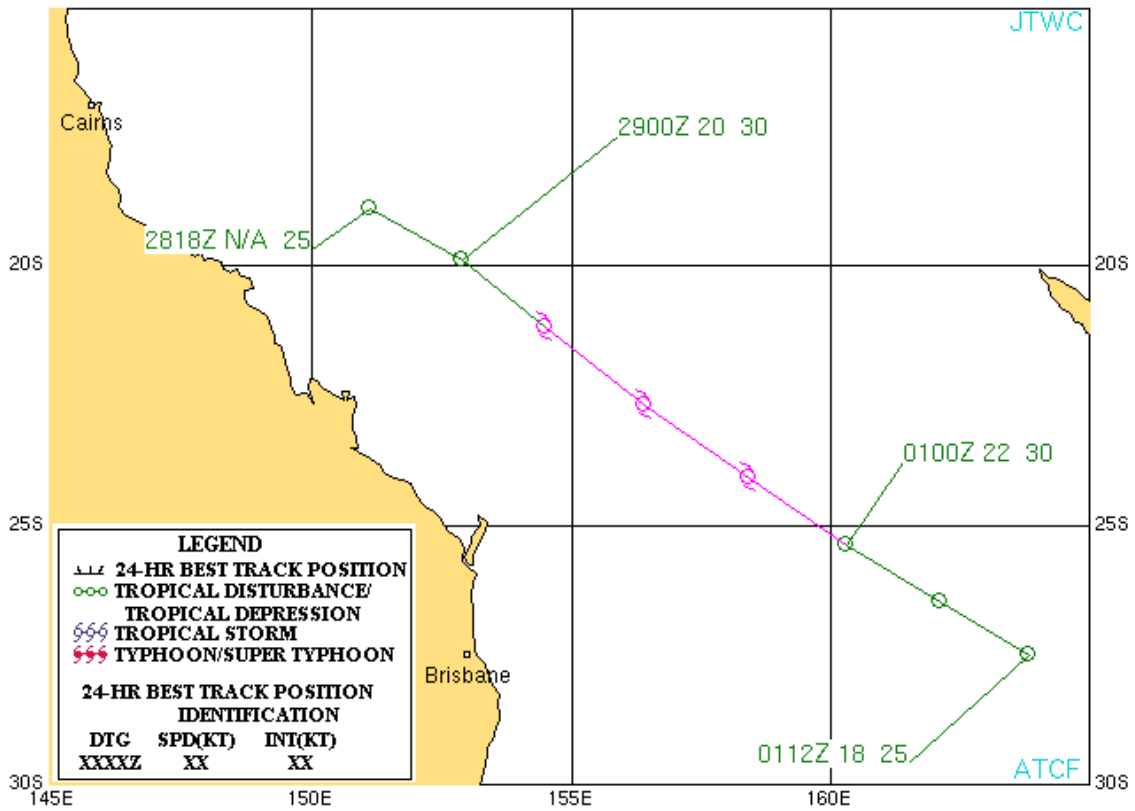
Tropical Cyclone 19S (Nicholas)

ISSUED POOR: N/A
 ISSUED FAIR: 2130Z 10 Feb 2008
 FIRST TCFA: 1100Z 12 Feb 2008
 FIRST WARNING: 1800Z 12 Feb 2008
 LAST WARNING: 1200Z 20 Feb 2008
 LANDFALL: Near Cardabia, Australia
 MAX INTENSITY: 80 Kts
 NUMBER OF WARNINGS: 26

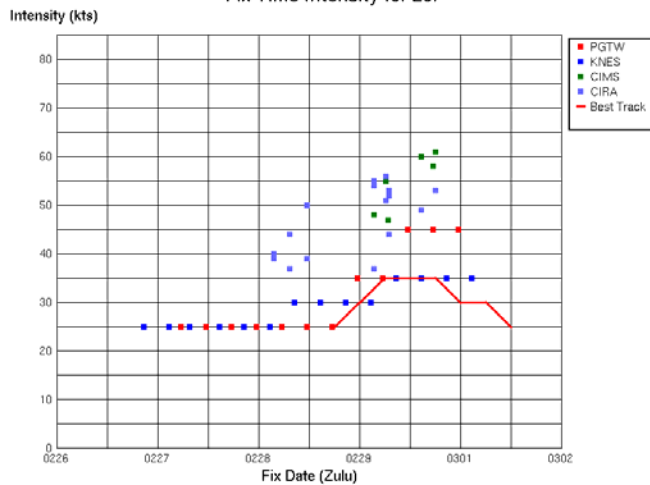


Tropical Cyclone 20P

ISSUED POOR: 1930Z 26 Feb 2008
 ISSUED FAIR: 0230Z 28 Feb 2008
 FIRST TCFA: 0200Z 29 Feb 2008
 FIRST WARNING: 0600Z 29 Feb 2008
 LAST WARNING: 1800Z 01 Mar 2008
 LANDFALL: None
 MAX INTENSITY: 35
 NUMBER OF WARNINGS: 2

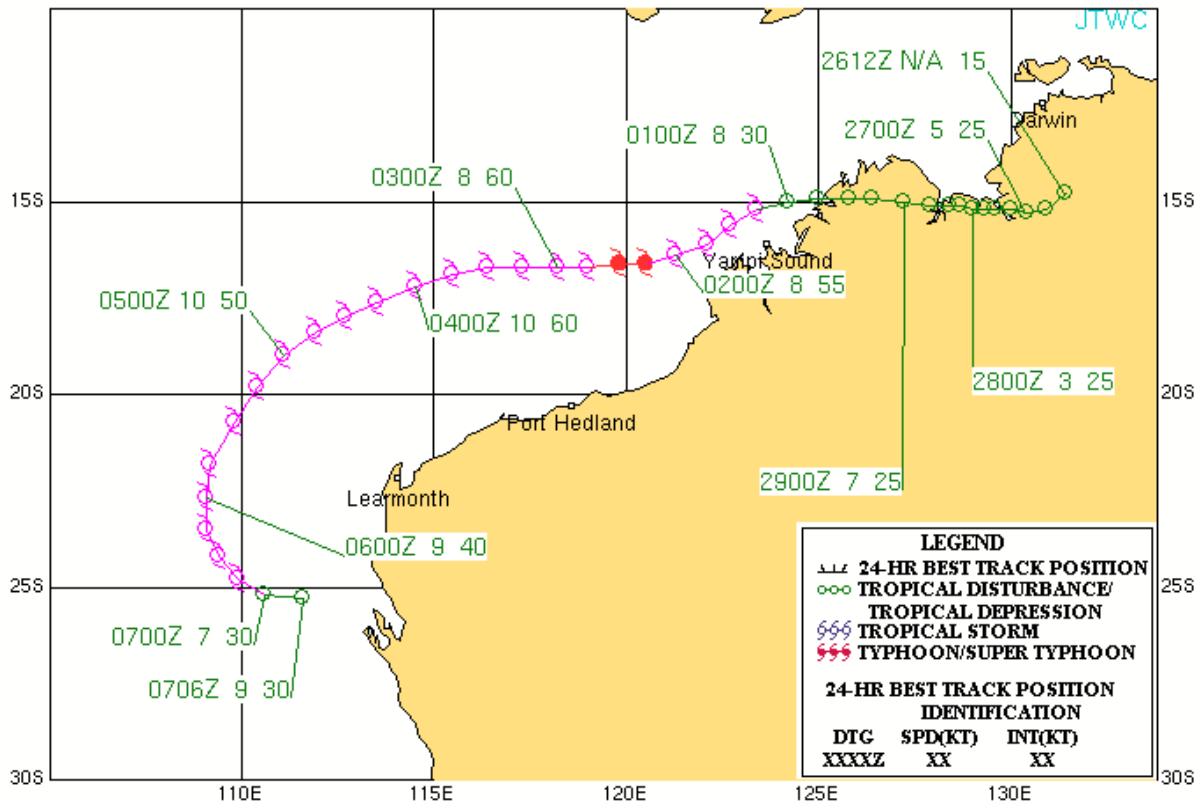


Fix Time Intensity for 20P

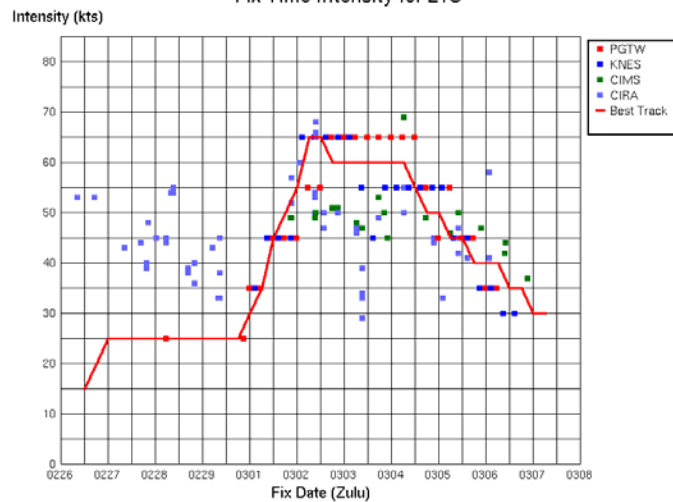


Tropical Cyclone 21S (Ophelia)

ISSUED POOR: 0200Z 27 Feb 2008
 ISSUED FAIR: 1430Z 27 Feb 2008
 FIRST TCFA: 2000Z 29 Feb 2008
 FIRST WARNING: 0600Z 01 Mar 2008
 LAST WARNING: 1800Z 06 Mar 2008
 LANDFALL: None
 MAX INTENSITY: 65 Kts
 NUMBER OF WARNINGS: 19

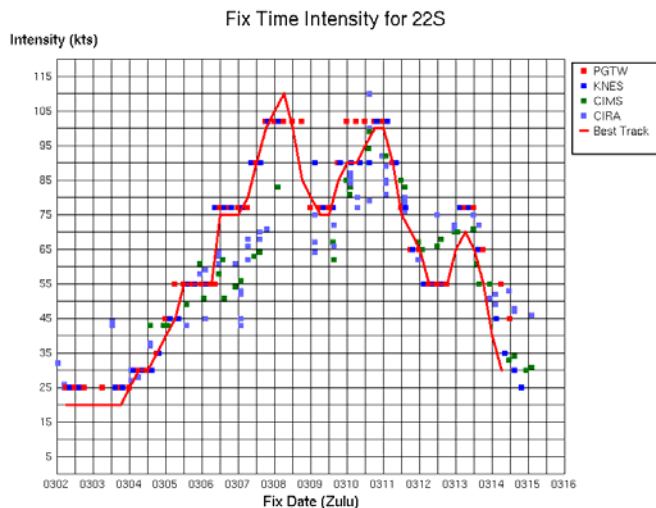
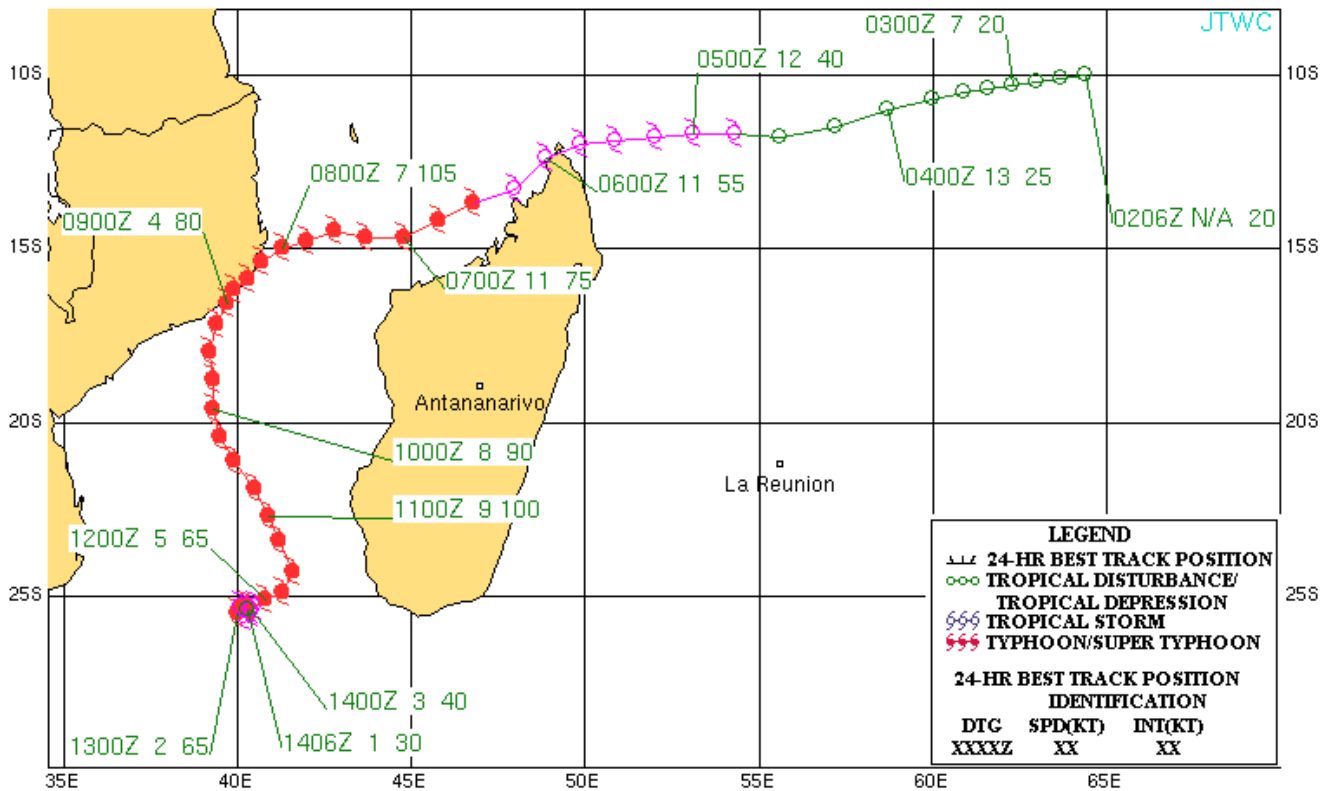


Fix Time Intensity for 21S



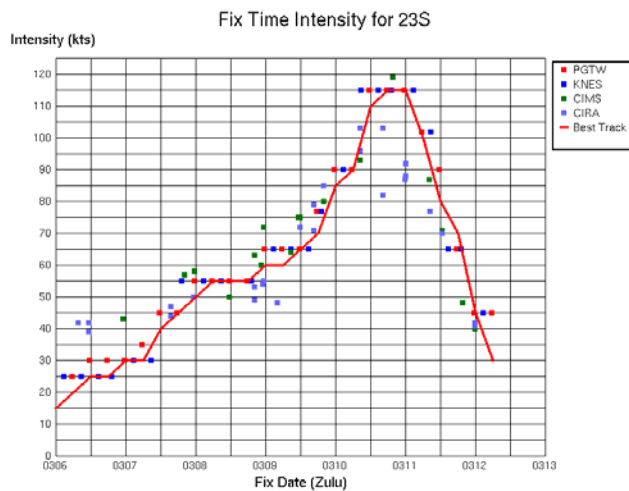
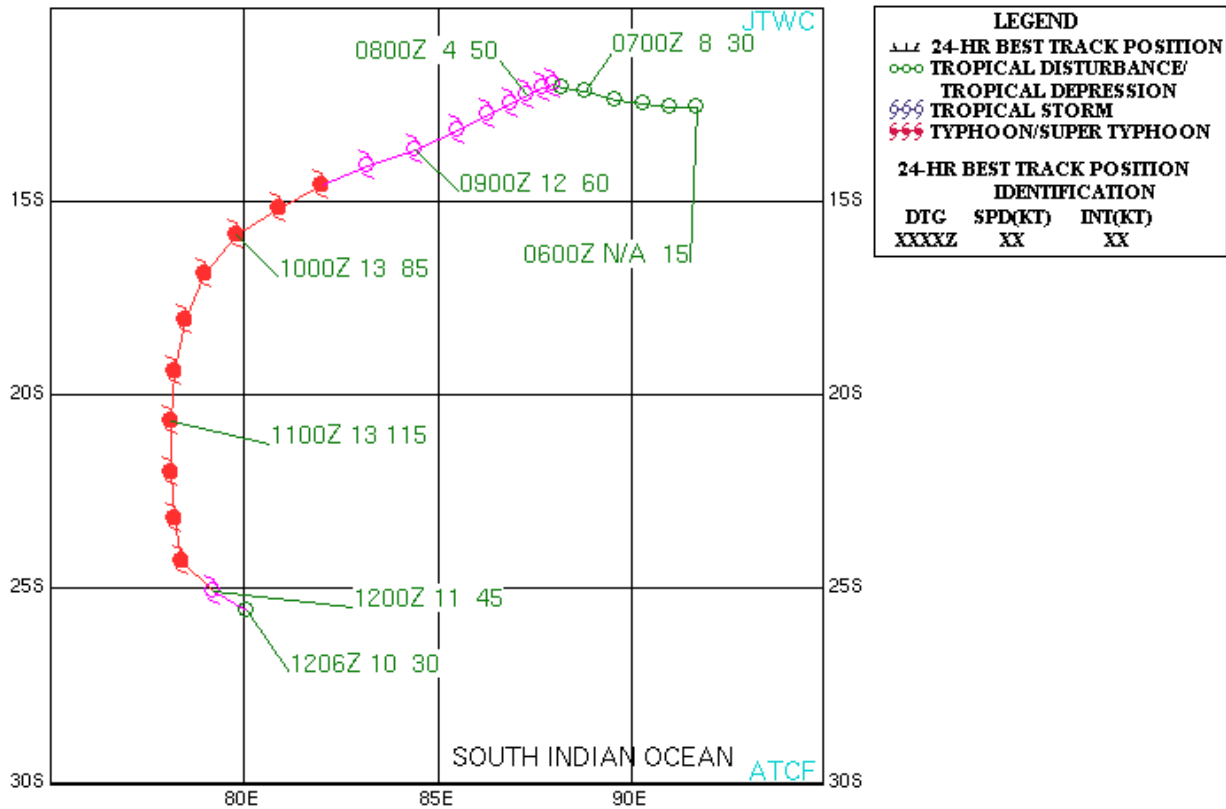
Tropical Cyclone 22S (Jokwe)

ISSUED POOR: 1030Z 01 Mar 2008
 ISSUED FAIR: 0300Z 04 Mar 2008
 FIRST TCFA: 1630Z 04 Mar 2008
 FIRST WARNING: 0300Z 05 Mar 2008
 LAST WARNING: 2100Z 14 Mar 2008
 LANDFALL: Near Antsiranana, Madagascar; Mocambique, Mozambique
 MAX INTENSITY: 110 Kts
 NUMBER OF WARNINGS: 21



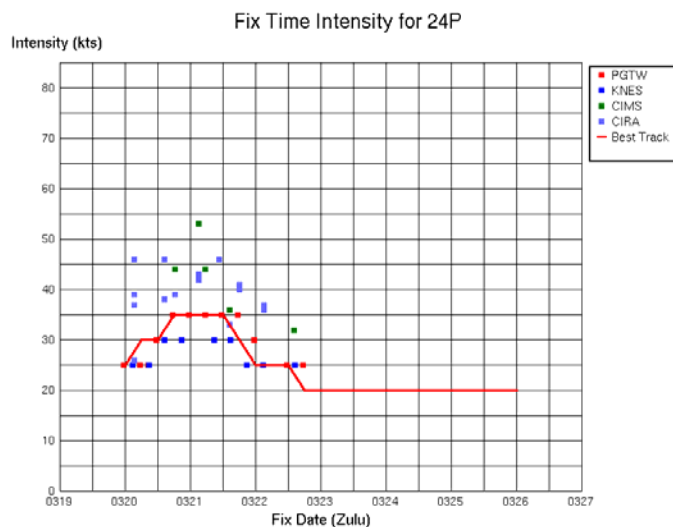
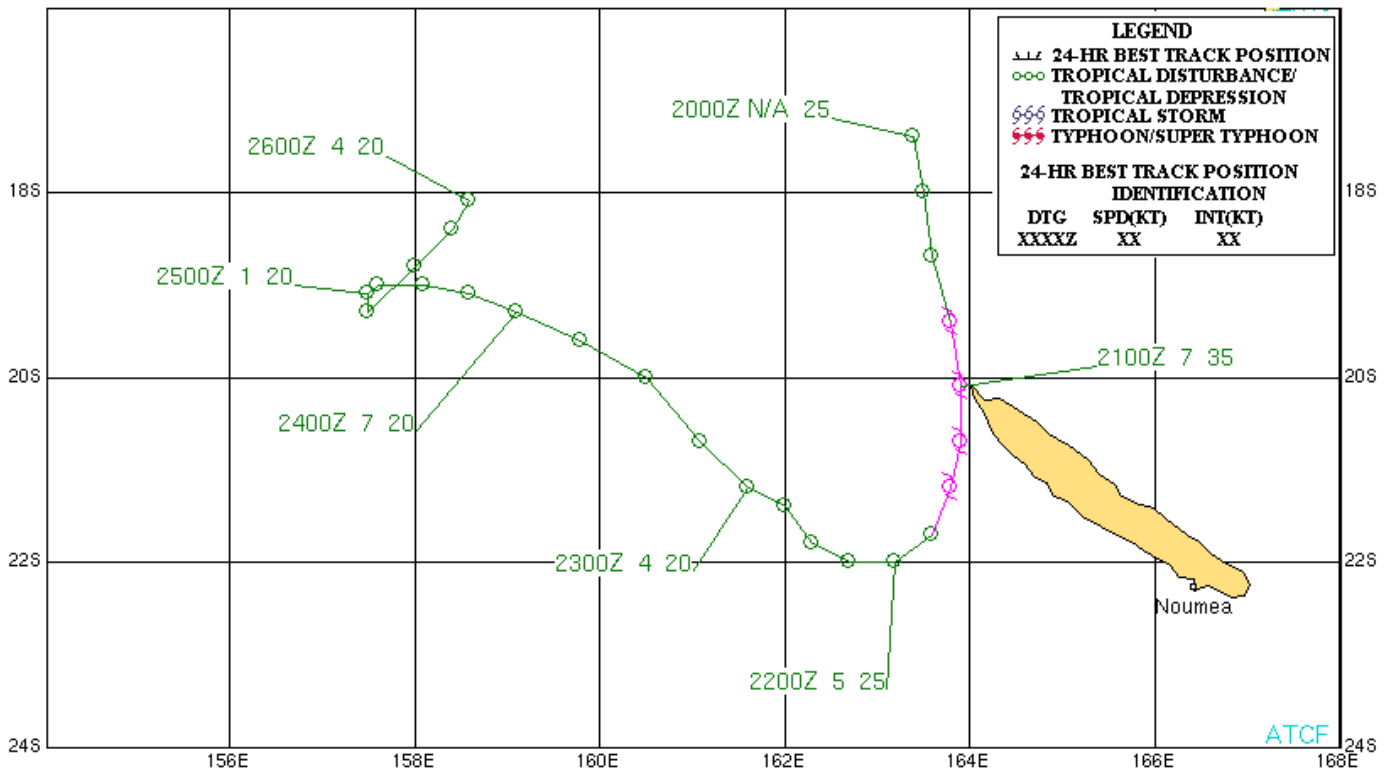
Tropical Cyclone 23S (Kamba)

ISSUED POOR: N/A
 ISSUED FAIR: 1800Z 06 Mar 2008
 FIRST TCFA: 0200Z 07 Mar 2008
 FIRST WARNING: 1200Z 07 Mar 2008
 LAST WARNING: 0000Z 12 Mar 2008
 LANDFALL: None
 MAX INTENSITY: 115 Kts
 NUMBER OF WARNINGS: 10



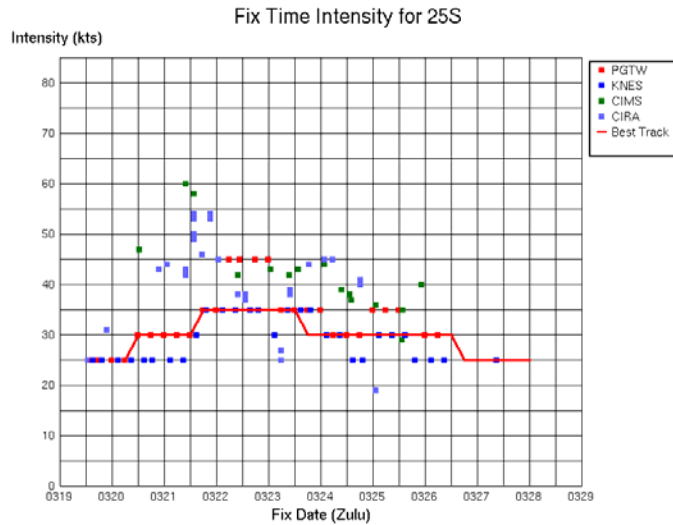
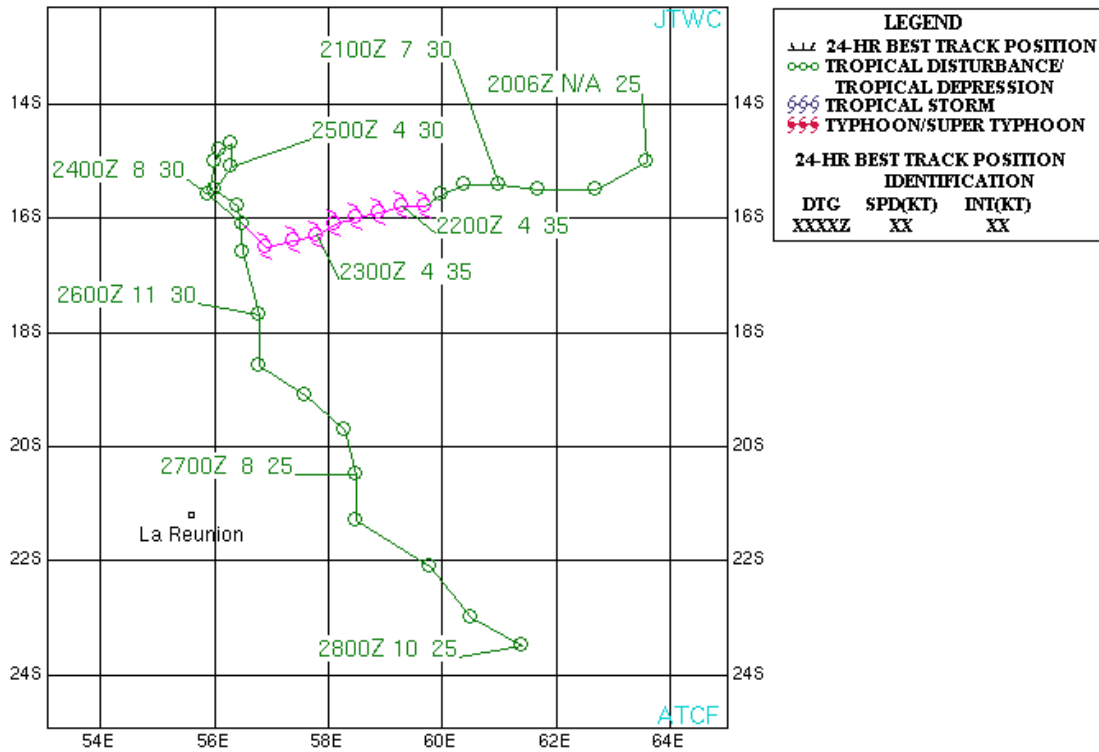
Tropical Cyclone 24P

ISSUED POOR: 0900Z 19 Mar 2008
 ISSUED FAIR: 2300Z 19 Mar 2008
 FIRST TCFA: 1200Z 20 Mar 2008
 FIRST WARNING: 2100Z 20 Mar 2008
 LAST WARNING: 2100Z 21 Mar 2008
 LANDFALL: None
 MAX INTENSITY: 35 Kts
 NUMBER OF WARNINGS: 3



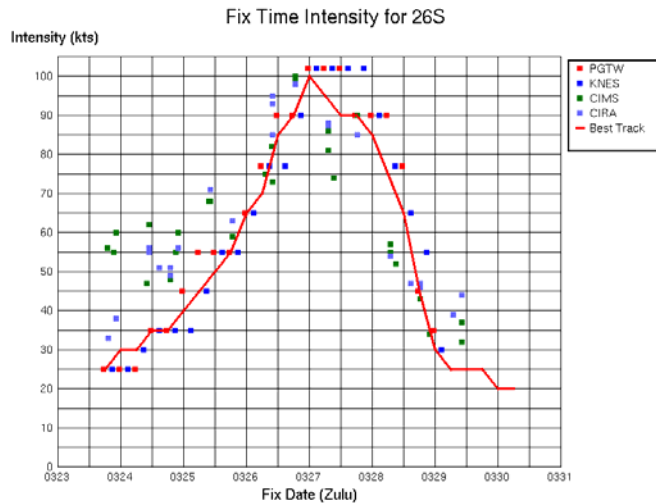
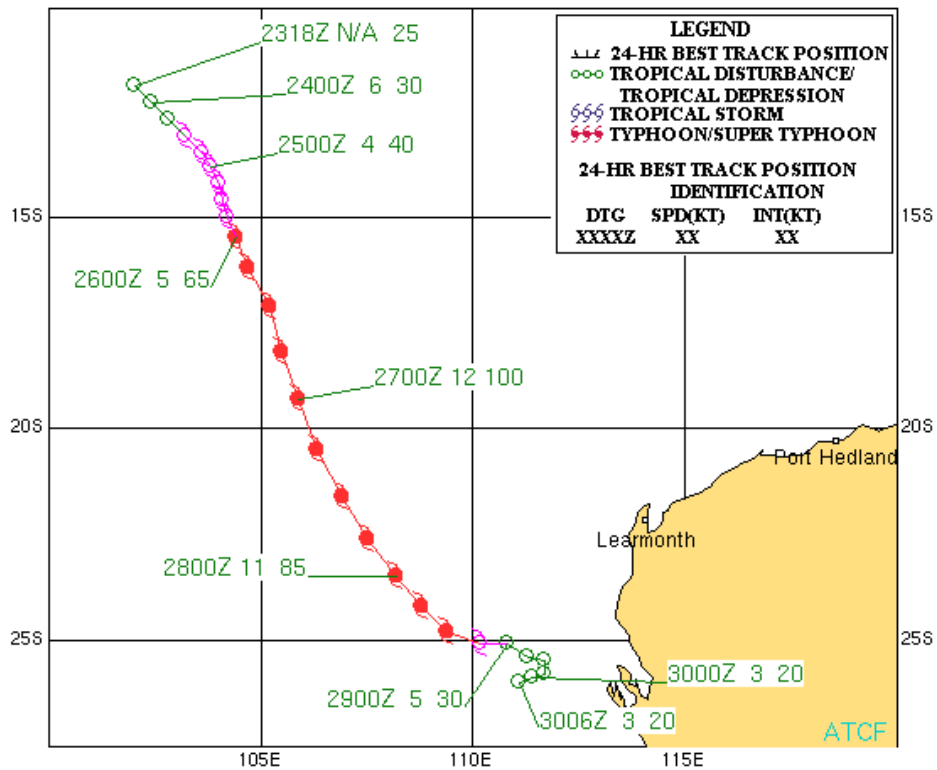
Tropical Cyclone 25S (Lola)

ISSUED POOR: 0900Z 17 Mar 2008
 ISSUED FAIR: 1800Z 19 Mar 2008
 FIRST TCFA: 1400Z 21 Mar 2008
 FIRST WARNING: 1800Z 21 Mar 2008
 LAST WARNING: 0600Z 24 Mar 2008
 LANDFALL: None
 MAX INTENSITY: 35 Kts
 NUMBER OF WARNINGS: 6



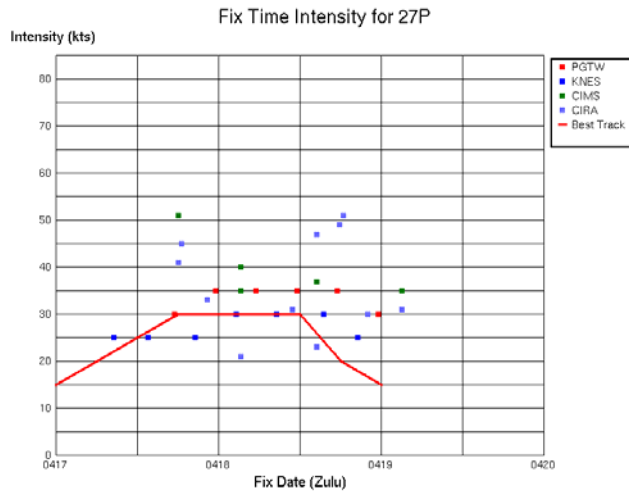
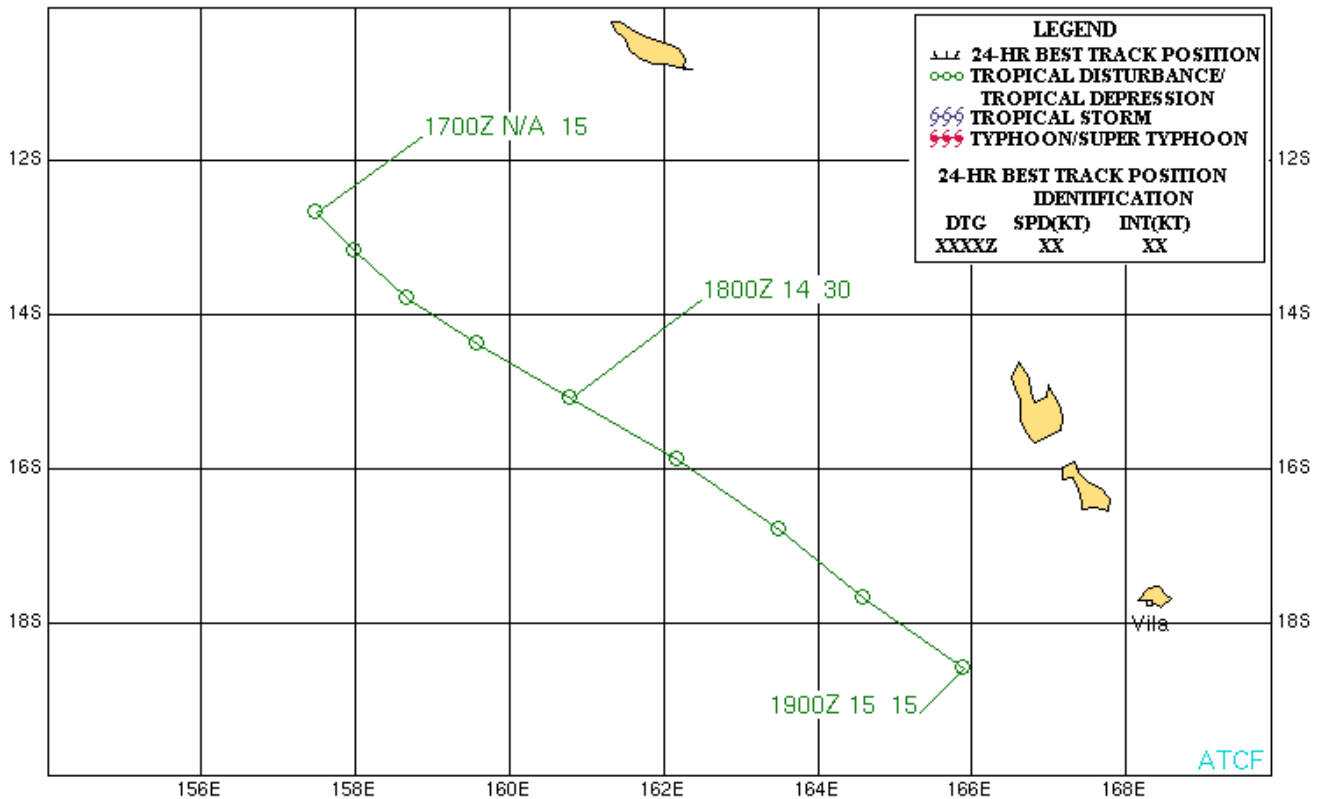
Tropical Cyclone 26S (Pancho)

ISSUED POOR: 1800Z 23 Mar 2008
 ISSUED FAIR: 2300Z 23 Mar 2008
 FIRST TCFA: 0530Z 24 Mar 2008
 FIRST WARNING: 1200Z 24 Mar 2008
 LAST WARNING: 1800Z 28 Mar 2008
 LANDFALL: None
 MAX INTENSITY: 100 Kts
 NUMBER OF WARNINGS: 11



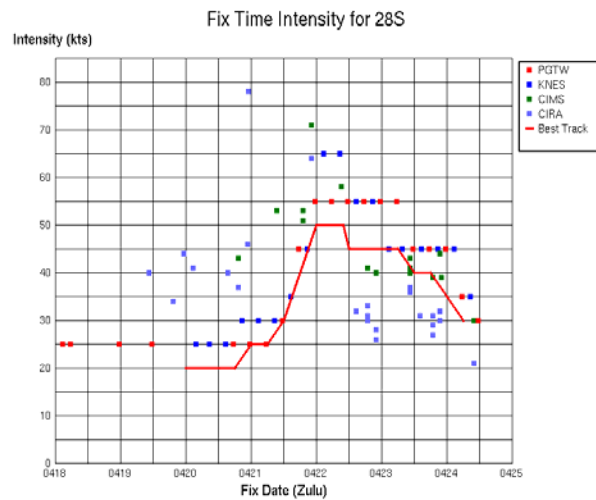
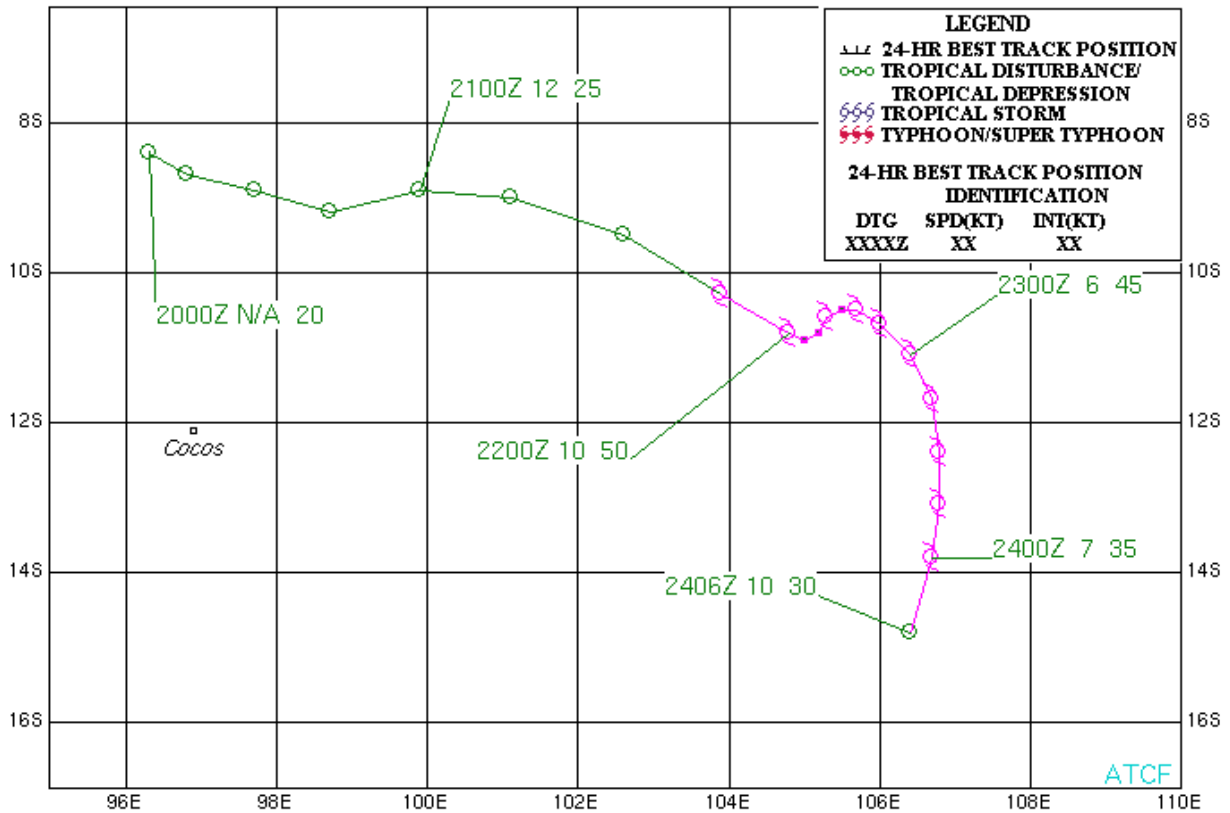
Tropical Cyclone 27P

ISSUED POOR: 1330Z 17 Apr 2008
 ISSUED FAIR: N/A
 FIRST TCFA: 1900Z 17 Apr 2008
 FIRST WARNING: 0000Z 18 Apr 2008
 LAST WARNING: 0000Z 19 Apr 2008
 LANDFALL: None
 MAX INTENSITY: 30 Kts
 NUMBER OF WARNINGS: 3



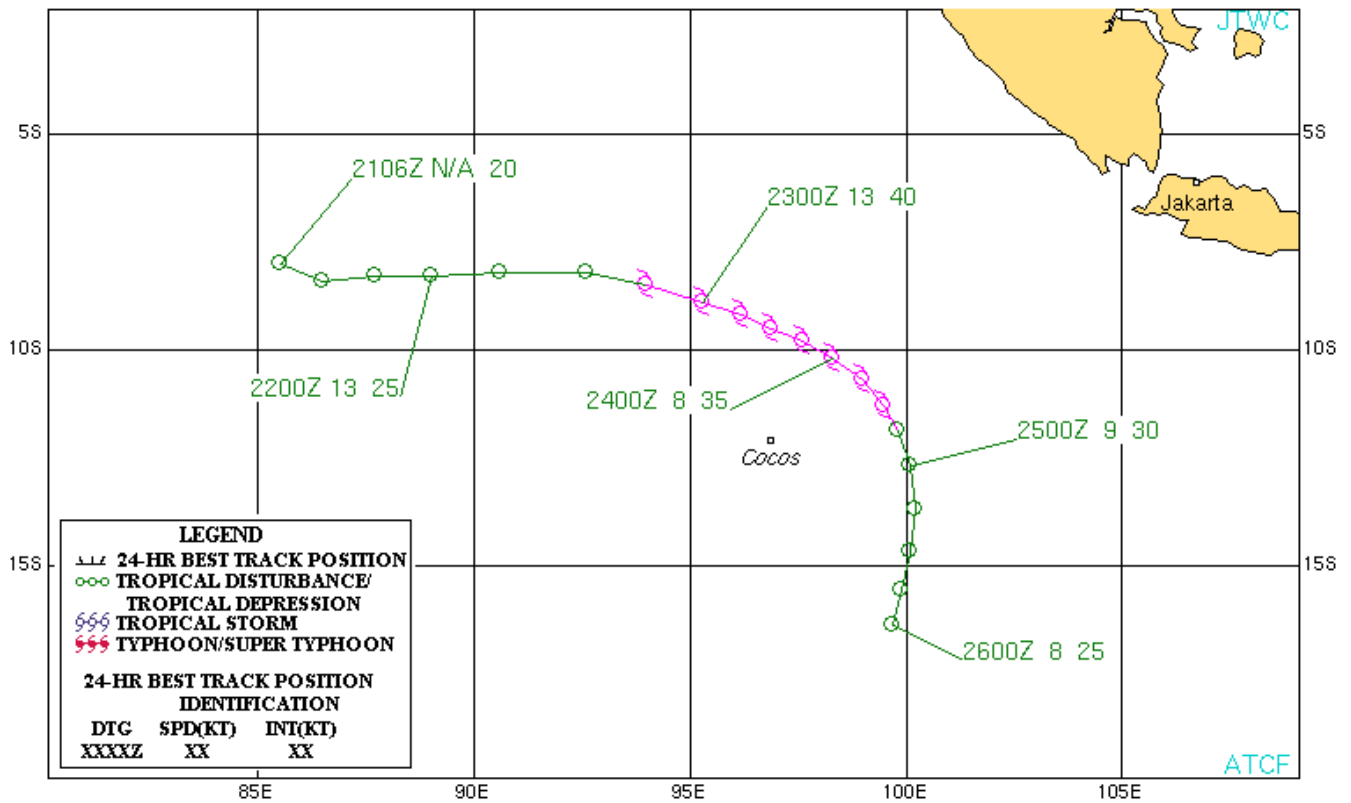
Tropical Cyclone 28S (Rosie)

ISSUED POOR: 1430Z 19 Apr 2008
 ISSUED FAIR: 2300Z 20 Apr 2008
 FIRST TCFA: 0530Z 21 Apr 2008
 FIRST WARNING: 1800Z 21 Apr 2008
 LAST WARNING: 0600Z 24 Apr 2008
 LANDFALL: None
 MAX INTENSITY: 50 Kts
 NUMBER OF WARNINGS: 6

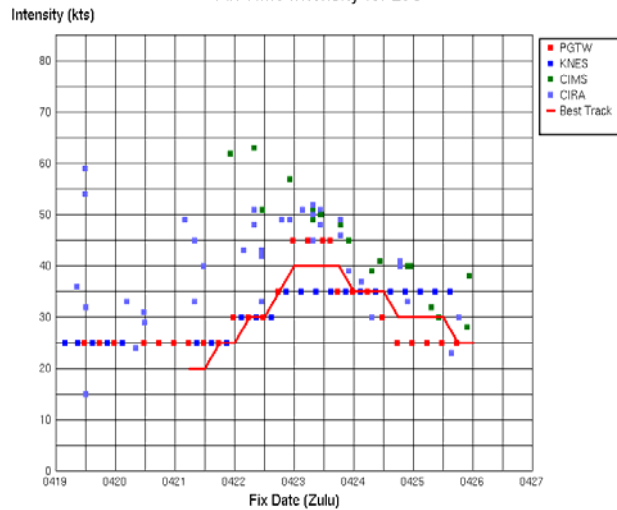


Tropical Cyclone 29S (Durga)

ISSUED POOR: 1430Z 19 Apr 2008
 ISSUED FAIR: 1800Z 21 Apr 2008
 FIRST TCFA: 2330Z 21 Apr 2008
 FIRST WARNING: 1800Z 22 Apr 2008
 LAST WARNING: 1800Z 24 Apr 2008
 LANDFALL: None
 MAX INTENSITY: 40 Kts
 NUMBER OF WARNINGS: 5



Fix Time Intensity for 29S



Section 3 Detailed Cyclone Reviews

Two cyclones were deemed to be either meteorologically or operationally significant for 2008. Tropical cyclones 13S and 14S experienced direct cyclone interaction during January – February 2008.

Tropical cyclones 13S and 14S-Direct Cyclone Interaction

Tropical Cyclones (TC) 13S and 14S were most notable for their direct cyclone interaction (also known as the Fujiwara effect.) The TCs moved within 500 nm of one another and began to rotate cyclonically around one another before TC 13S merge with TC 14S.

Tropical cyclone 13S (Fame) formed in the northern Mozambique Channel, made landfall and re-intensified to a 45-kt tropical cyclone after it re-emerged southeast of Madagascar. Tropical cyclone 14S (Gula) formed northeast of La Reunion near 15 degrees south latitude, and tracked initially westward before turning poleward along 60E as it rounded the subtropical ridge axis. As TC 14S turned poleward, it began to interact with TC 13S which was then located just south of La Reunion.

A 31 January 0216Z SSMI pass (Figure 3-4) shows a connection of low level cloud bands in between the two cyclones.

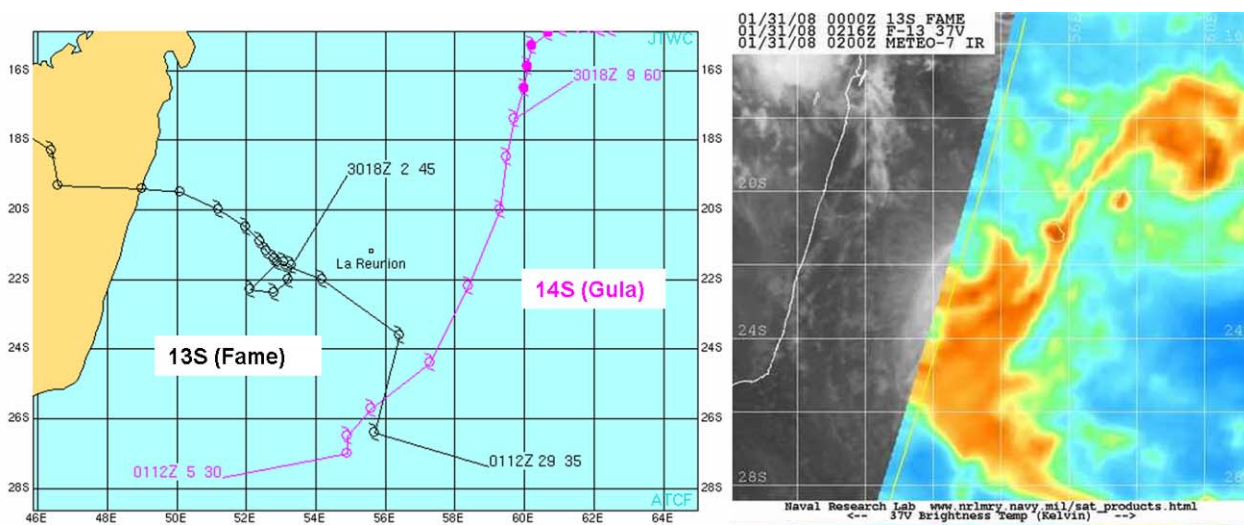


Figure 3-4 Left: Best tracks of TC 13S and TC 14S. Right: 0216Z SSMI pass showing the connection of low level cloud bands between the two systems.

On 30 January at 1800Z, the separation distance between TC 13S (45-kt intensity) and TC 14S (60-kt intensity) was 443 nm. The storms were roughly the same size. At this juncture, TC 13S, which had been tracking southeastward, departed from its track and began 24 hours of a looping motion, while TC 14S began to accelerate poleward. Over the next 36 hours, TC 13S and TC 14S rotated cyclonically about each other, with the separation distance between the two decreasing. The diagram in Figure 3-5 indicates how the separation distance decreased at each synoptic time, while the axis between the two rotated cyclonically. Finally, by 1 February at 1200Z, TC 13S merged into the outer circulation of TC 14S making it difficult to distinguish between the two TCs.

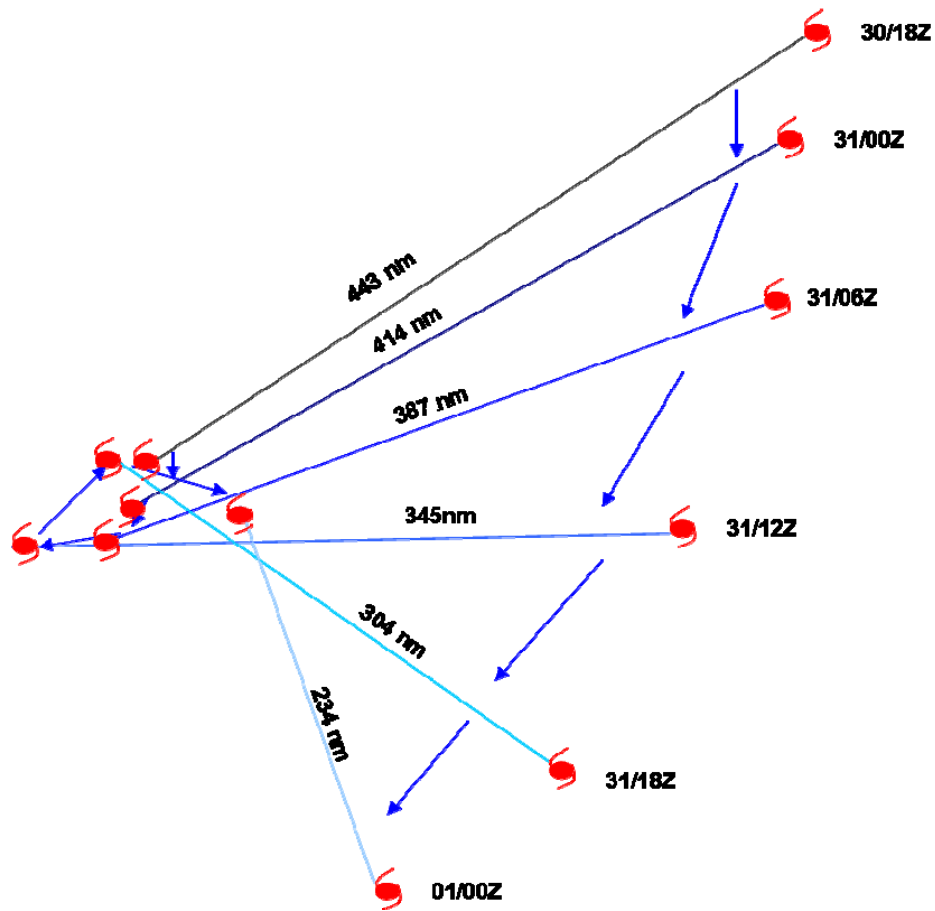


Figure 3-5: The axis between TC 13S (eastern TC) and TC 14S (western TC) rotated cyclonically (clockwise in the Southern Hemisphere) as the cyclones were drawn together. The separation distance between the TCs decreased from 443 nm on 30 January at 1800Z to 234 nm on 1 February at 0000Z (approximately 30 hours.)

Both storms weakened significantly during their direct cyclone interaction. As seen in Figure 3-6, TC 13S became partly exposed by 31 January at 0630Z. The central convection of TC 13S was sheared to the southeast due to outflow from the mesoscale anticyclone over TC 14S. TC 14S was initially the more intense circulation and maintained some convection over the low level circulation center. For this reason, TC 14S was the dominant circulation into which TC 13S was ultimately absorbed. The dynamic models were unable to resolve the interaction between the two cyclones, as they could not resolve which circulation would be dominant. The largest model and JTWC forecast errors occurred when the TCs were within 250 nm of one another, and TC 13S accelerated as it was “captured” into the outer circulation of TC 14S.

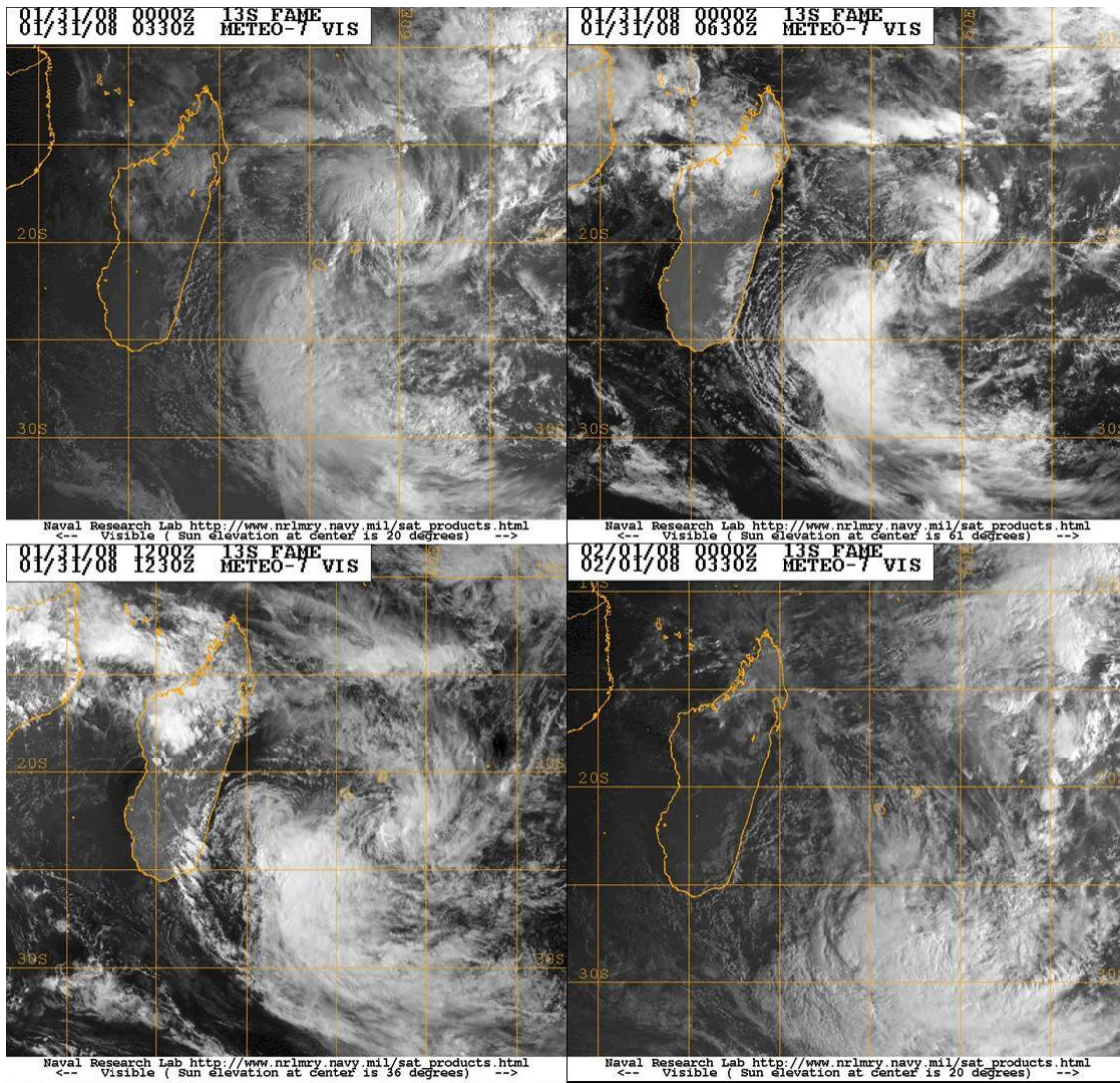


Figure 3-6: Visual satellite imagery showing the direct cyclone interaction of 13S and 14S. In the top two panels, the TCs began to rotate cyclonically around one another with 13S becoming partially exposed. In the bottom left panel (31 January 1230Z) some indications exist that the two cyclones may be beginning to merge. In the bottom right panel (1 February 0330Z), only one remnant cyclone is evident.

The inability of the dynamic models to accurately resolve the interaction between TC 13S and TC 14S illustrates the need for more research into this rare, but not uncommon occurrence.

Chapter 4 Tropical Cyclone Fix Data

TABLE 4-1					
SOUTH PACIFIC & SOUTH INDIAN OCEAN FIX SUMMARY FOR 2008					
Tropical Cyclone		Satellite	Radar	Synoptic	Total
TC 01S		100	0	0	100
TC 02P	Guba	172	0	0	172
TC 03S	Lee-Ariel	256	0	0	256
TC 04S	Bongwe	265	0	0	265
TC 05P	Daman	200	0	0	200
TC 06S	Celina	316	0	0	316
TC 07S	Dama	110	0	0	110
TC 08S	Melanie	204	0	0	204
TC 09S	Elnus	180	0	0	180
TC 10S	Helen	104	0	0	104
TC 11P	Elisa	140	0	0	140
TC 12P	Funa	216	0	0	216
TC 13S	Fame	228	0	0	228
TC 14S	Gula	225	0	0	225
TC 15P	Gene	366	0	0	366
TC 16S	Hondo	534	0	0	534
TC 17S		206	0	0	206
TC 18S	Ivan	427	0	0	427
TC 19S	Nicholas	286	0	0	286
TC 20P		96	0		96
TC 21S	Ophelia	225	0	0	225
TC 22S	Jokwe	382	0	0	382
TC 23S	Kamba	175	0	0	175
TC 24P		136	0	0	136
TC 25S	Lola	243	0	0	243
TC 26S	Pancho	196	0	0	196
TC 27P		55	0	0	55
TC 28S	Rosie	136	0	0	136
TC 29S	Durga	160	0	0	160
Totals		6339	0	0	6339
Percentage of Total		100.00%	0.00%	0.00%	100

TABLE 4-2

WESTERN NORTH PACIFIC OCEAN FIX SUMMARY FOR 2008

Tropical Cyclone		Satellite	Radar	Aircraft Recon	Dropsonde	Synoptic	Total
TS 01W	No Name	149	0	0	0	6	155
TY 02W	Neoguri	212	0	0	0	0	212
STY 03W	Rammasun	249	0	0	0	0	249
TS 04W	Matmo	94	0	0	0	0	94
TY 05W	Halong	183	0	0	0	0	183
TY 06W	Nakri	262	0	0	0	0	262
TY 07W	Fengshen	293	0	0	0	0	293
TY 08W	Kalmaegi	262	56	0	0	1	319
TY 09W	Fung-Wong	175	51	0	0	2	228
TS 10W	Kammuri	125	17	0	0	1	143
TS 11W		119	0	0	0	5	124
TS 12W	Vongfong	156	0	0	0	0	156
TY 13W	Nuri	228	55	3	5	0	291
TS 14W		111	0	0	0	0	111
TY 15W	Sinlaku	455	270	11	30	0	766
TS 16W		88	0	0	0	0	88
TS 17W		74	0	0	0	0	74
TY 18W	Hagupit	270	68	0	14	0	352
STY 19W	Jangmi	251	73	7	23	0	354
TS 20W	Mekkhala	111	0	0	0	0	111
TS 21W	Higos	217	0	0	0	0	217
TS 22W		85	0	0	0	0	85
TS 23W	Bavi	83	0	0	0	0	83
TS 24W	Maysak	227	0	0	0	1	228
TS 25W	Haishen	112	0	0	0	0	112
TS 26W	Noul	124	0	0	0	1	125
TY 27W	Dolphin	324	11	0	0	0	335
Total		5039	601	21	72	17	5750
Percentage of Total		87.63%	10.45%	0.37%	1.25%	0.30%	100

TABLE 4-3					
NORTHERN INDIAN OCEAN FIX SUMMARY FOR 2008					
Tropical Cyclone		Satellite	Radar	Synoptic	Total
TC 01B	Nargis	213	0	0	213
TC 02B		71	0	0	71
TC 03A		157	0	1	158
TC 04B	Rashmi	85	0	1	86
TC 05B	Khai-Muk	123	0	0	123
TC 06B	Nisha	121	0	0	121
TC 07B		171	0	2	173
Totals		941	0	4	945
Percentage of Total		99.58%	0.00%	0.42%	100

FIXES BY OCEANIC BASIN FOR 2008	
Oceanic Basin	Total Fixes
Northwest Pacific	5750
Southern Hemisphere	6339
Northern Indian Ocean	945
Total	13034

Chapter 5 Summary of Forecast Verification

Verification of warning position and intensities at initial, 12-, 24-, 48-, and 72-hour forecast periods are made against the final best track. The (scalar) track forecast, along-track and cross track errors (illustrated in Figure 5-1) were calculated for each verifying JTWC forecast. These data are included in this chapter. This section summarizes verification data for the 2008 season, and contrasts it with annual verification statistics from previous years.

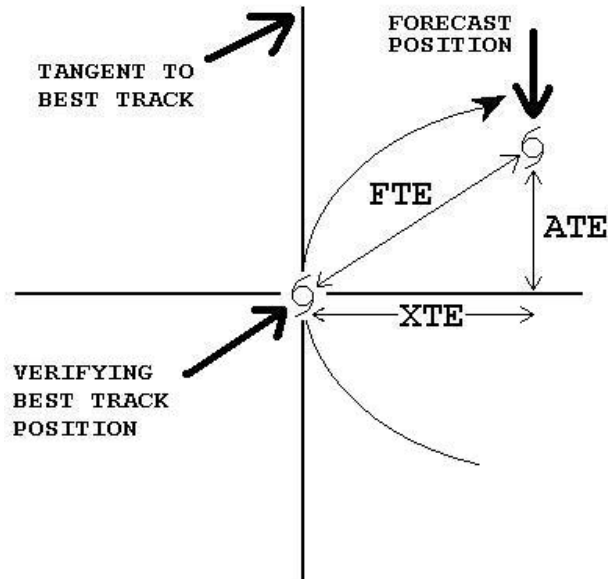


Figure 5-1. Definition of cross-track error (XTE), along track error (ATE), and forecast track error (FTE). In this example, the forecast position is ahead of and to the right of the verifying best track position. Therefore, the XTE is positive (to the right of track) and the ATE is positive (ahead of the best track). Adapted from Tsui and Miller, 1988.

Section 1. Annual Forecast Verification

**TABLE 5-1
MEAN FORECAST ERRORS (NM) FOR WESTERN NORTH PACIFIC
TROPICAL CYCLONES FROM 1959 - 2008**

Year (Notes)	24-Hour					48-Hour					72-Hour				
	Cases (1)	TY (2)	TC (4)	Cross Track (3)	Along Track (3)	Cases (1)	TY (2)	TC (4)	Cross Track (3)	Along Track (3)	Cases (1)	TY (2)	TC (4)	Cross Track (3)	Along Track (3)
1959		117					267								
1960		177					354								
1961		136					274								
1962		144					287					476			
1963		127					246					374			
1964		133					284					429			
1965		151					303					418			
1966		136					280					432			
1967		125					276					414			
1968		105					229					337			
1969		111					237					349			
1970		98	104				181	190				272	279		
1971		99	111	64			203	212	118			308	317	177	
1972		116	117	72			245	245	146			382	381	210	
1973		102	108	74			193	197	134			245	253	162	
1974		114	120	78			218	226	157			256	348	245	
1975		129	138	84			279	288	181			442	450	290	
1976		117	117	71			232	230	132			336	338	202	
1977		140	148	83			266	283	157			290	407	228	
1978		120	127	71	87		241	271	151	194		459	410	218	296
1979		113	124	76	81		219	226	138	146		319	316	182	214
1980		116	126	76	86		221	243	147	165		362	389	230	266
1981		117	124	77	80		215	221	131	146		342	334	219	206
1982		114	113	70	74		229	238	142	162		337	342	211	223
1983		110	117	73	76		247	260	164	169		384	407	263	259
1984		110	117	64	84		228	232	131	163		361	363	216	238
1985		112	117	68	80		228	231	138	153		355	367	227	230
1986		117	126	70	85		261	261	151	183		403	394	227	276
1987		101	107	64	71		211	204	127	134		318	303	186	198
1988	353	107	114	58	85	255	222	216	103	170	183	327	315	159	244
1989	585	107	120	69	83	458	214	231	127	162	343	325	350	177	265
1990	551	98	103	60	72	453	191	203	110	148	334	299	310	168	225
1991	673	93	96	53	69	570	187	185	97	137	467	298	287	146	229
1992	890	97	107	59	77	739	194	205	116	143	610	295	305	172	210
1993	744	102	112	63	79	596	205	212	117	151	469	320	321	173	226
1994	920	96	105	56	76	762	172	186	105	131	623	244	258	152	176
1995	521	105	123	67	89	409	200	215	117	159	315	311	325	167	240
1996	868	85	105	56	76	707	157	178	89	134	604	252	272	137	203
1997	905	86	93	55	76	783	159	164	87	134	665	251	245	120	202
1998	354	127	124	58	98	257	263	239	127	178	189	392	370	201	274
1999	433	88	106	59	74	300	150	176	102	119	191	225	234	139	155
2000	605	75	81	45	57	467	136	142	80	98	363	205	209	118	144
2001	627	66	73	42	49	512	114	122	75	78	395	169	180	110	120
2002	657	50	66	37	47	535	94	116	67	79	421	144	166	88	120
2003	602	59	73	41	52	495	119	128	68	94	397	186	186	89	147
2004	766	52	70	41	48	646	94	122	69	84	537	180	173	95	121
2005	507	41	61	38	38	407	81	102	59	72	316	138	156	76	120
2006	512	47	62	39	40	405	85	104	61	73	327	133	151	77	112
2007	343	45	61	24	42	260	72	100	58	69	189	89	148	83	102

2008	354	45	66	38	46	261	104	120	75	78	192	201	198	110	140
Averages (1978- 2008)	608	90	101	57	70	489	255	189	107	132	387	278	283	159	199

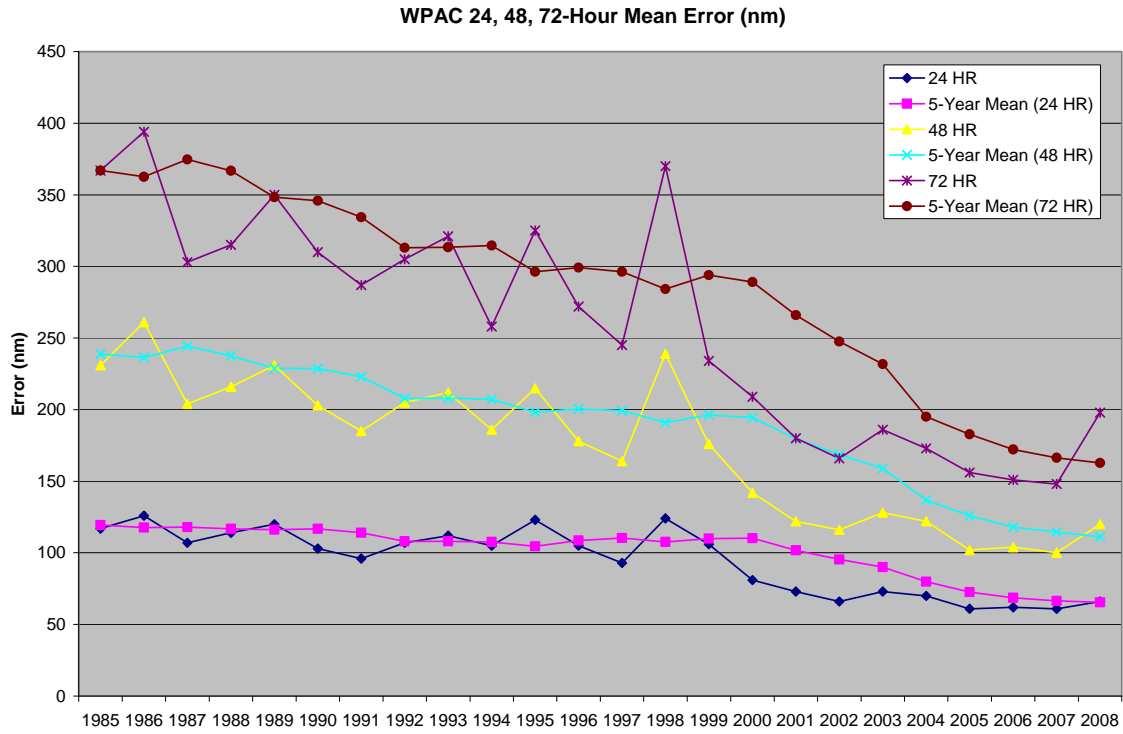


Figure 5-2. Graph of JTWC forecast errors and five year running mean errors for the Western North Pacific at 24, 48, and 72 hours.



Figure 5-3. Graph of JTWC forecast errors and five year running mean errors for the Western North Pacific at 96 and 120 hours.

Table 5-2
MEAN FORECAST TRACK ERRORS (NM) FOR NORTH INDIAN OCEAN
(TROPICAL CYCLONES FROM 1985-2008)

YEAR (Notes)	24-HOUR				48-HOUR				72-HOUR			
	Cases	Track	CROSS TRACK	ALONG TRACK	Cases	Track	CROSS TRACK	ALONG TRACK	Cases	Track	CROSS TRACK	ALONG TRACK
1985	30	122	102	53	8	242	119	194	0			
1986	16	134	118	53	7	168	131	80	5	269	189	180
1987	54	144	97	100	25	205	125	140	21	305	219	188
1988	30	120	89	63	18	219	112	176	12	409	227	303
1989	33	88	62	50	17	146	94	86	12	216	164	11
1990	36	101	85	43	24	146	117	67	17	185	130	104
1991	43	129	107	54	27	235	200	89	14	450	356	178
1992	149	128	73	86	100	244	141	166	62	398	276	218
1993	28	125	87	79	20	198	171	74	12	231	176	116
1994	44	97	80	44	28	153	124	63	13	213	177	92
1995	47	138	119	58	32	262	247	77	20	342	304	109
1996	123	134	94	80	85	238	181	127	58	311	172	237
1997	42	119	87	49	29	201	168	92	17	228	195	110
1998	55	106	84	51	34	198	135	106	17	262	188	144
1999	41	79	59	38	22	184	130	116	10	374	309	177
2000	24	61	47	26	16	85	69	37	1	401	399	38
2001	41	61	40	37	31	115	71	71	22	166	44	154
2002	30	84	41	63	18	137	92	83	10	185	92	133
2003	37	108	66	69	31	196	115	132	7	354	210	252
2004	46	81	53	52	36	140	95	85	9	173	144	86
2005	67	62	41	40	49	116	71	73	18	118	35	109
2006	19	64	37	44	13	92	58	60	0	-	-	-
2007	38	61	38	36	23	94	56	65	10	140	92	93
2008	59	70	46	44	38	99	71	55	24	127	94	127
Averages (1985-2008)	47	101	73	55	30	171	121	96	16	266	191	144

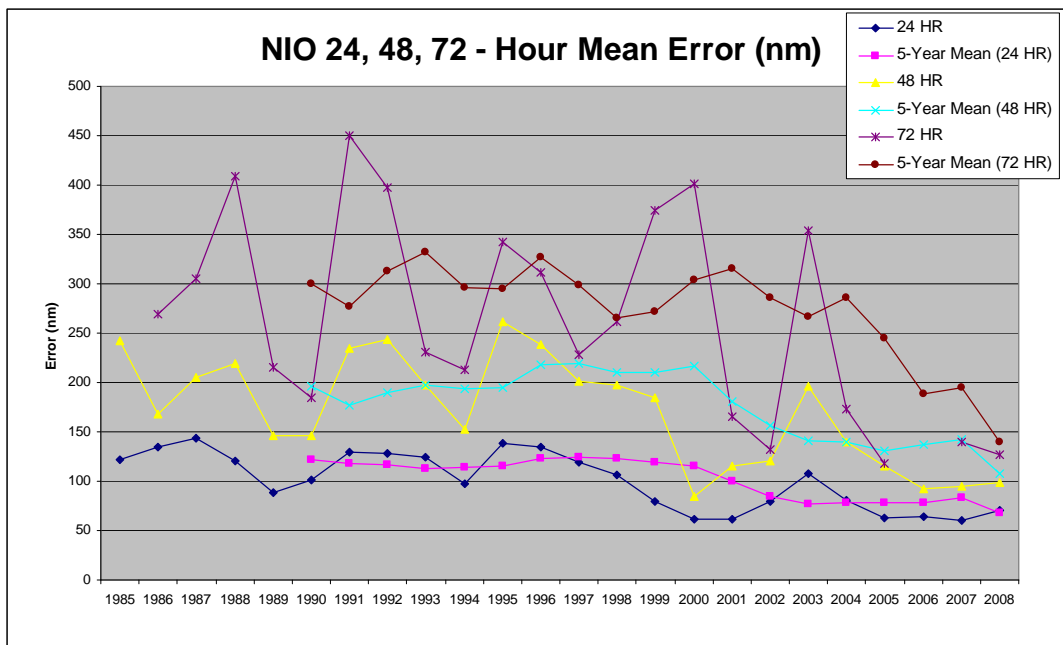


Figure 5-2. Graph of JTWC forecast errors and five year running mean errors for the North Indian Ocean at 24, 48, and 72 hours.

**TABLE 5-3
MEAN FORECAST ERRORS (NM) FOR SOUTHERN HEMISPHERE
TROPICAL CYCLONES 1985 - 2008**

Year (Notes)	24-Hour				48-Hour				72-Hour			
	Cases	Track	Cross	Along	Cases	Track	Cross	Along	Cases	Track	Cross	Along
1985	257	134	79	92	193	236	132	169				
1986	227	129	77	86	171	262	164	169				
1987	138	145	90	94	101	280	138	153				
1988	99	146	83	98	48	290	144	246				
1989	242	124	73	84	186	240	136	166				
1990	228	143	74	105	177	263	152	178				
1991	231	115	69	75	185	220	129	152				
1992	230	124	64	91	208	240	129	177				
1993	225	102	57	74	176	199	114	142				
1994	345	115	68	77	282	224	134	147				
1995	222	108	55	82	175	198	108	144	53	291	190	169
1996	298	125	67	90	237	240	129	174	46	277	133	221
1997	499	109	72	82	442	210	135	163	150	288	175	248
1998	305	111	52	85	245	219	108	169	81	349	171	261
1999	322	113	64	80	245	226	132	159	59	286	164	198
2000	313	72	45	47	245	135	86	84	58	180	139	94
2001	147	84	44	61	113	148	86	105	11	248	197	133
2002	200	82	43	60	146	133	75	93	5	102	41	91
2003	279	74	37	57	221	127	68	90	37	123	54	99
2004	277	77	45	52	233	142	89	92	47	210	102	162
2005	214	70	44	44	170	116	77	72	41	199	117	136
2006	191	65	37	46	140	116	69	79	32	201	101	151
2007	186	74.9	41	52	131	147.2	80	105	3	173.1	146	73
2008	269	61	38	40	211	106	64	72	27	97	53	65
Averages (1985-2008)	248	104	59	73	195	197	112	138	46	216	127	150

SHEM 24, 48, 72-Hour Mean Error (nm)

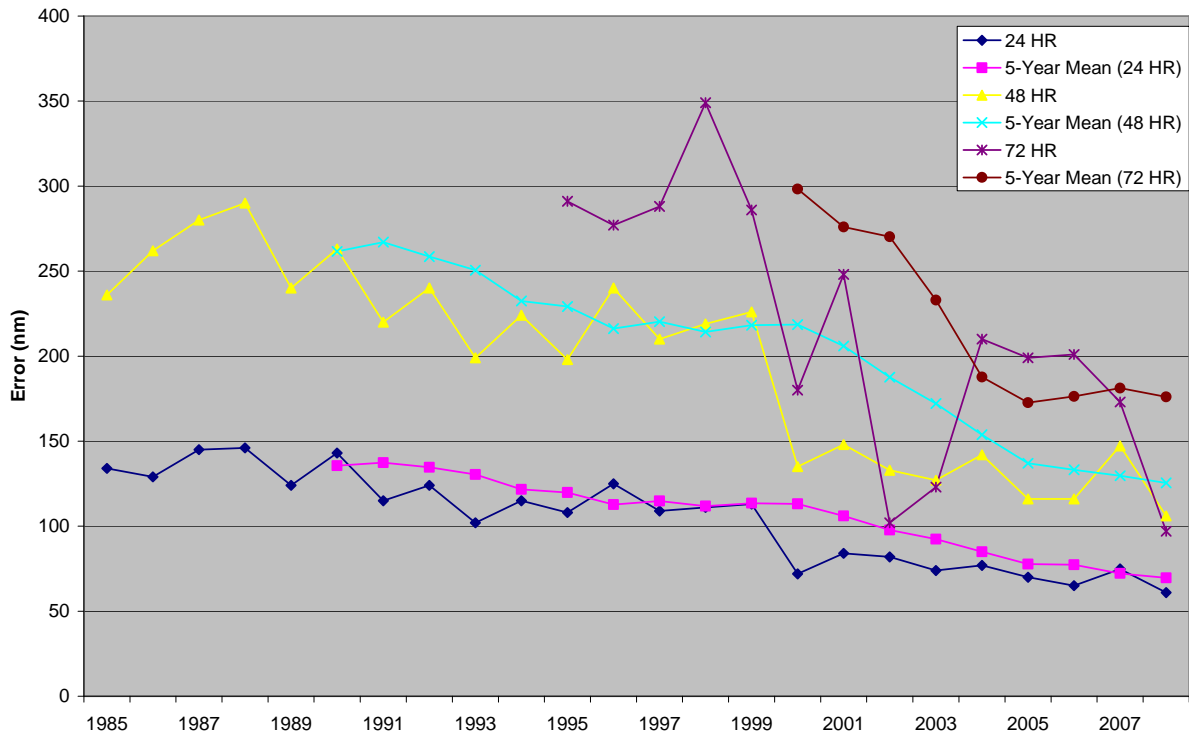


Figure 5-2. Graph of JTWC forecast errors and five year running mean errors for the Sothern Hemisphere at 24, 48, and 72 hours.

Section 2. Objective Aid Comparison

A comparison of the JTWC forecast, the multi-model consensus forecast (CONW) and the members of the CONW are provided in Table 5-4 for all western North Pacific tropical cyclones, Table 5-5 for north Indian Ocean tropical cyclones, and Table 5-6 for Southern Hemisphere tropical cyclones. For example, in Table 5-4 for the homogeneous comparison of the 12-hour mean forecast error between JTWC and CONW, 386 cases were available. The average forecast error at 12 hours was 39 nm for CONW and 40 nm for JTWC. The difference of 1 nm is shown in the lower right. Due to computational round-off, differences are not always exact.

TABLE 5-4 SELECTED OBJECTIVE TECHNIQUES WESTERN NORTH PACIFIC OCEAN

12-HOUR MEAN FORECAST ERROR (NM)

	JTWC	CONW	AVNI	EGRI	ECMI	ECM2	ECM3	ECM4	GFNI	JGSI	NGPI	TCLI	WBAI													
JTWC	402	39																								
	39	0																								
CONW	398	39	417	39																						
	38	-1	39	0																						
AVNI	318	37	331	36	331	39																				
	38	1	39	3	39	0																				
EGRI	177	38	179	37	147	38	179	41																		
	41	3	41	4	40	2	41	0																		
ECMI	8	34	9	47	6	24	9	36	9	112																
	30	-4	112	65	149	125	112	76	112	0																
ECM2	135	33	136	32	118	37	0	0	0	0	136	29														
	29	-4	29	-3	28	-9	0	0	0	0	29	0														
ECM3	69	33	70	35	62	33	67	40	3	279	0	0	70	44												
	42	9	44	9	42	9	44	4	88	-191	0	0	44	0												
ECM4	65	31	65	30	60	33	0	0	0	0	58	27	0	0	65	42										
	42	11	42	12	43	10	0	0	0	0	37	10	0	0	42	0										
GFNI	307	37	310	35	275	38	138	40	7	30	116	28	60	44	59	35	310	52								
	52	15	52	17	50	12	51	11	66	36	47	19	50	6	46	11	52	0								
JGSI	282	36	283	34	240	36	144	40	8	30	110	28	62	37	58	35	244	51	283	37						
	37	1	37	3	34	-2	38	-2	34	4	33	5	35	-2	31	-4	36	-15	37	0						
NGPI	347	38	357	37	313	38	161	41	8	122	123	30	66	44	59	36	302	52	260	36	357	44				
	44	6	44	7	43	5	42	1	36	-86	40	10	39	-5	38	2	43	-9	42	6	44	0				
TCLI	104	37	104	35	90	35	99	41	6	29	1	38	39	37	1	38	90	47	98	37	99	39	104	58		
	58	21	58	23	55	20	57	16	70	41	38	0	51	14	38	0	59	12	58	21	58	19	58	0		
WBAI	340	39	354	38	289	39	155	40	8	122	113	29	62	45	56	37	273	52	241	37	314	44	96	58	355	51
	50	11	50	12	48	9	50	10	47	-75	42	13	44	-1	40	3	48	-4	46	9	50	6	48	-10	51	0

	100	-2	100	0	96	-6	100	-9	59	-4	0	0	100	0												
ECM4	47	104	47	103	43	107	0	0	0	0	42	91	0	0	47	113										
	113	9	113	10	108	1	0	0	0	0	114	23	0	0	113	0										
GFNI	182	122	183	112	156	121	83	111	4	64	77	89	41	104	43	115	183	185								
	185	63	185	73	161	40	178	67	233	169	171	82	178	74	185	70	185	0								
JGSI	184	113	186	107	153	114	94	108	5	64	79	86	45	94	44	108	151	185	186	107						
	107	-6	107	0	98	-16	103	-5	74	10	99	13	94	0	94	-14	109	-76	107	0						
NGPI	219	120	225	115	189	122	102	111	4	64	86	89	45	100	43	115	176	179	166	105	225	157				
	157	37	157	42	138	16	154	43	189	125	146	57	140	40	137	22	150	-29	149	44	157	0				
TCLI	71	112	71	110	61	115	67	109	4	60	1	107	34	94	1	132	58	168	66	105	67	134	71	196		
	196	84	196	86	172	57	199	90	215	155	74	-33	184	90	74	-58	195	27	191	86	192	58	196	0		
WBAI	219	123	227	115	173	119	101	111	4	64	78	83	44	101	41	116	159	188	156	108	196	155	65	196	228	157
	158	35	157	42	150	31	152	41	205	141	147	64	152	51	155	39	158	-30	147	39	155	0	146	-50	157	0

72-HOUR MEAN FORECAST ERROR (NM)

	JTWC	CONW	AVNI	EGRI	ECMI	ECM2	ECM3	ECM4	GFNI	JGSI	NGPI	TCLI	WBAI												
JTWC	192	198																							
	198	0																							
CONW	189	196	199	196																					
	199	3	196	0																					
AVNI	135	187	139	184	139	219																			
	220	33	219	35	219	0																			
EGRI	83	192	84	193	61	207	85	182																	
	181	-11	181	-12	184	-23	182	0																	
ECMI	3	266	3	175	1	124	3	193	3	172															
	172	-94	172	-3	46	-78	172	-21	172	0															
ECM2	70	178	71	176	59	206	0	0	0	0	71	139													
	140	-38	139	-37	128	-78	0	0	0	0	139	0													
ECM3	39	192	39	175	34	185	38	194	1	46	0	0	39	166											
	166	-26	166	-9	155	-30	166	-28	33	-13	0	0	166	0											
ECM4	36	181	36	165	33	197	0	0	0	0	33	137	0	0	36	173									
	173	-8	173	8	174	-23	0	0	0	0	176	39	0	0	173	0									
GFNI	122	210	123	206	101	219	55	204	2	235	52	147	32	168	32	167	123	315							
	315	105	315	109	272	53	305	101	673	438	291	144	298	130	284	117	315	0							
JGSI	132	192	134	188	105	198	66	182	3	172	56	140	36	164	33	171	101	317	134	185					
	185	-7	185	-3	166	-32	185	3	212	40	161	21	177	13	149	-22	193	-124	185	0					
NGPI	155	204	163	203	134	221	71	184	2	235	61	147	35	156	33	181	120	309	117	184	163	265			
	268	64	265	62	234	13	251	67	564	329	239	92	209	53	206	25	262	-47	248	64	265	0			

TABLE 5-5 ERROR STATISTICS FOR SELCTED OBJECTIVE TECHNIQUES NORTHERN INDIAN OCEAN

12-HOUR MEAN FORECAST ERROR (NM)

	JTWC		CONW		AVNI		EGRI		ECM2		GFNI		NGPI		TCLI		WBAI	
JTWC	70	44																
	44	0																
CONW	68	44	83	46														
	44	0	46	0														
AVNI	61	44	73	45	73	49												
	49	5	49	4	49	0												
EGRI	18	35	18	35	17	44	19	41										
	41	6	41	6	42	-2	41	0										
ECM2	10	23	10	21	9	32	0	0	10	31								
	31	8	31	10	33	1	0	0	31	0								
GFNI	60	42	68	44	64	49	17	44	10	31	68	55						
	53	11	55	11	57	8	46	2	27	-4	55	0						
NGPI	58	44	68	44	64	48	18	41	10	31	59	52	68	48				
	47	3	48	4	47	-1	38	-3	24	-7	45	-7	48	0				
TCLI	12	27	12	25	11	29	11	28	0	0	11	34	12	27	12	36		
	36	9	36	11	38	9	33	5	0	0	35	1	36	9	36	0		
WBAI	55	46	65	47	59	50	13	42	5	29	54	59	53	51	8	42	69	62
	62	16	63	16	61	11	50	8	33	4	62	3	62	11	46	4	62	0

24-HOUR MEAN FORECAST ERROR (NM)

	JTWC		CONW		AVNI		EGRI		ECM2		GFNI		NGPI		TCLI		WBAI	
JTWC	59	70																
	70	0																
CONW	57	70	73	72														
	69	-1	72	0														
AVNI	47	68	58	70	58	77												
	77	9	77	7	77	0												
EGRI	16	54	16	51	14	50	17	70										
	72	18	72	21	78	28	70	0										
ECM2	10	41	10	35	7	56	0	0	10	56								
	56	15	56	21	70	14	0	0	56	0								
GFNI	52	68	60	70	52	79	15	74	10	56	60	91						

ECM2	83	83	190	81	161	94	0	0	0	0	190	68										
	67	-16	68	-13	66	-28	0	0	0	0	68	0										
GFNI	210	84	436	90	360	100	164	113	2	51	166	67	436	119								
	116	32	119	29	114	14	116	3	101	50	112	45	119	0								
JGSI	27	98	31	93	28	113	27	104	0	0	0	0	29	142	31	116						
	121	23	116	23	97	-16	110	6	0	0	0	0	116	-26	116	0						
NGPI	228	85	471	89	388	99	178	114	2	51	181	69	411	117	31	116	471	113				
	109	24	113	24	106	7	110	-4	107	56	103	34	113	-4	124	8	113	0				
TCLI	68	82	82	83	76	108	70	110	0	0	0	0	74	116	26	119	82	98	82	128		
	128	46	128	45	126	18	125	15	0	0	0	0	130	14	113	-6	128	30	128	0		
WBAI	230	86	498	90	384	99	181	112	2	51	183	69	421	119	30	114	451	114	77	128	501	136
	131	45	136	46	137	38	129	17	113	62	136	67	136	17	136	22	136	22	139	11	136	0

48-HOUR MEAN FORECAST ERROR (NM)

	JTWC	CONW	AVNI	EGRI	ECMI	ECM2	GFNI	JGSI	NGPI	TCLI	WBAI											
JTWC	211	106																				
	106	0																				
CONW	211	106	487	112																		
	105	-1	112	0																		
AVNI	169	103	358	106	358	129																
	125	22	129	23	129	0																
EGRI	105	104	175	108	136	121	175	145														
	155	51	145	37	146	25	145	0														
ECMI	0	0	3	59	2	126	2	105	3	74												
	0	0	74	15	74	-52	76	-29	74	0												
ECM2	72	99	173	101	141	118	0	0	0	0	173	86										
	85	-14	86	-15	83	-35	0	0	0	0	86	0										
GFNI	180	105	388	111	316	132	145	148	2	74	151	85	388	145								
	141	36	145	34	141	9	140	-8	114	40	144	59	145	0								
JGSI	23	120	25	121	22	139	21	139	0	0	0	0	24	179	25	164						
	164	44	164	43	136	-3	148	9	0	0	0	0	159	-20	164	0						
NGPI	198	106	426	111	346	128	159	148	2	74	163	86	365	144	25	164	426	140				
	137	31	140	29	134	6	141	-7	111	37	127	41	140	-4	158	-6	140	0				
TCLI	58	106	72	109	66	142	60	148	0	0	0	0	65	140	21	165	72	125	72	175		
	170	64	175	66	172	30	174	26	0	0	0	0	177	37	153	-12	175	50	175	0		
WBAI	200	105	453	111	342	128	162	145	2	74	167	87	374	146	24	157	407	140	67	176	456	175
	163	58	175	64	175	47	165	20	146	72	176	89	171	25	178	21	175	35	180	4	175	0

72-HOUR MEAN FORECAST ERROR (NM)

	JTWC	CONW	AVNI	EGRI	ECMI	ECM2	GFNI	JGSI	NGPI	TCLI	WBAI											
JTWC	27	97																				
	97	0																				
CONW	27	97	392	160																		
	99	2	160	0																		
AVNI	25	95	264	154	264	199																
	187	92	199	45	199	0																
EGRI	12	112	139	164	97	198	140	217														
	143	31	217	53	223	25	217	0														
ECMI	0	0	3	138	1	92	2	225	3	106												
	0	0	106	-32	116	24	101	-124	106	0												
ECM2	13	90	136	145	107	184	0	0	0	136	129											
	109	19	129	-16	120	-64	0	0	0	129	0											
GFNI	26	96	294	159	220	206	110	225	2	120	114	131	294	201								
	206	110	201	42	199	-7	200	-25	177	57	196	65	201	0								
JGSI	9	103	15	159	12	213	12	201	0	0	0	0	14	247	15	207						
	163	60	207	48	208	-5	198	-3	0	0	0	0	201	-46	207	0						
NGPI	26	94	338	159	254	200	124	224	2	120	128	130	271	201	15	207	338	203				
	148	54	203	44	196	-4	209	-15	139	19	186	56	198	-3	211	4	203	0				
TCLI	9	89	50	167	45	243	39	237	0	0	0	0	44	202	11	187	50	186	50	267		
	202	113	267	100	252	9	260	23	0	0	0	0	272	70	257	70	267	81	267	0		
WBAI	27	97	368	157	254	196	130	213	2	120	133	130	284	200	14	177	324	199	47	264	371	262
	260	163	262	105	263	67	255	42	248	128	261	131	258	58	303	126	266	67	263	-1	262	0

96-HOUR MEAN FORECAST ERROR (NM)

	CONW	AVNI	EGRI	ECMI	ECM2	GFNI	NGPI	TCLI
CONW	298	223						
	223	0						
AVNI	175	203	175	280				
	280	77	280	0				
EGRI	97	233	60	273	98	286		
	284	51	271	-2	286	0		
ECMI	2	159	1	114	0	0	2	111
	111	-48	76	-38	0	0	111	0
ECM2	102	195	69	268	0	0	0	0
	158	-37	151	-117	0	0	0	0

GFNI	208	229	140	288	67	288	1	145	77	155	210	287									
	287	58	287	-1	277	-11	125	-20	288	133	287	0									
NGPI	252	220	167	280	87	284	2	111	92	157	190	283	254	280							
	280	60	267	-13	286	2	205	94	263	106	281	-2	280	0							
TCLI	3	220	3	248	2	169	0	0	0	0	3	202	3	347	3	306					
	306	86	306	58	281	112	0	0	0	0	306	104	306	-41	306	0					

120-HOUR MEAN FORECAST ERROR (NM)

	CONW		AVNI		EGRI		ECMI		ECM2		GFNI		NGPI		TCLI						
CONW	225	307																			
	307	0																			
AVNI	120	292	120	351																	
	351	59	351	0																	
EGRI	76	322	40	377	77	356															
	354	32	319	-58	356	0															
ECMI	2	185	1	99	0	0	2	185													
	185	0	104	5	0	0	185	0													
ECM2	75	254	47	306	0	0	0	0	75	233											
	233	-21	225	-81	0	0	0	0	233	0											
GFNI	150	317	97	377	48	324	1	266	53	217	152	415									
	415	98	448	71	397	73	210	-56	428	211	415	0									
NGPI	178	289	112	350	66	340	2	185	62	222	129	398	179	355							
	356	67	349	-1	380	40	284	99	325	103	356	-42	355	0							
TCLI	3	239	2	280	2	222	0	0	0	0	3	280	3	491	3	352					
	352	113	399	119	302	80	0	0	0	0	352	72	352	-139	352	0					

POSITION ERROR (NM)

	CARQ					WRNG				
	0 HR	-6 HR	-12 HR	-18 HR	-24 HR	0 HR	-6 HR	-12 HR	-18 HR	-24 HR
MEAN	18	12	11	11	11	14	10	10	10	10
STD. DEV.	18	11	10	11	10	13	8	8	8	9
CASES	751	732	716	696	670	316	316	316	314	309