CHAPTER II - RECONNAISSANCE AND FIXES

1. GENERAL

The Joint Typhoon Warning Center depends on reconnaissance to provide necessary, accurate, and timely meteorological information in support of each warning. JTWC relies primarily on three reconnaissance platforms: aircraft, satellite, and radar. In data rich areas, synoptic data are also used to supplement the above. Optimum utilization of all available reconnaissance resources is obtained through the Selective Reconnaissance Program (SRP); various factors are considered in selecting a specific reconnaissance platform including capabilities and limitations, and the tropical cyclone's threat to life and property both afloat and ashore. A summary of reconnaissance fixes received during 1985 is included in Section 6 of this chapter.

2. RECONNAISSANCE AVAILABILITY

a. Aircraft

Aircraft weather reconnaissance for the JTWC is performed by the 54th Weather Reconnaissance Squadron (54th WRS) located at Andersen Air Force Base, Guam. The 54th WRS only averaged three to four storm-capable aircraft (six assigned) throughout the entire year. On April 8th, five of the 54th WRS's six WC-130 aircraft were grounded for cracked wings (the sixth was previously grounded for major maintenance repairs). This left the unit with no storm-capable aircraft for a short period of time until replacements began arriving from the 53rd WRS, Keesler Air Force Base, Mississippi. During the period 1 August - 5 October, two 53rd WRS WC-130 aircraft and crews were in place to augment 54th WRS resources. But during this period, Joint Chiefs of Staff tasking took away two WC-130 aircraft from the 54th WRS, resulting in no net aircraft augmentation for the season. The JTWC aircraft reconnaissance requirements are provided daily to the Reconnaissance Coordinator (TCARC). The TCARC then marries the tasking from JTWC with the available airframes from the 54th WRS.

As in previous years, aircraft reconnaissance provides direct measurements of standard pressure-level height, temperature, flight-level winds, sea-level pressure, estimated surface winds (when observable), and numerous additional parameters. The meteorological data are gathered by the Aerial Reconnaissance Weather Officer (ARWO) and dropsonde operators of Detachment 3, 1st Weather Wing who fly with the 54th WRS. These data provide the Typhoon Duty Officer (TDO) with indications of tropical cyclone position and intensity. Another important aspect is the availability of the data for technique development and tropical cyclone research.

b. Satellite

Satellite fixes from USAF/USN ground sites and USN ships provide day and night coverage in JTWC's area of responsibility. Interpretation of this satellite imagery provides tropical cyclone positions and estimates of current and forecast intensities through the Dvorak technique.

c. Radar

Land-based radar provides positioning data on well-developed tropical cyclones when in the proximity (usually within 175 nm (324 km)) of the radar sites in the Philippines, Taiwan, Hong Kong, Japan, South Korea, Kwajalein, and Guam.

d. Synoptic

JTWC also determines tropical cyclone positions based on the analysis of the surface/gradient-level synoptic data. These positions were helpful in situations where the vertical structure of the tropical cyclone was weak or accurate surface positions from aircraft or satellite were not available.

3. AIRCRAFT RECONNAISSANCE SUMMARY

During 1986, JTWC levied requirements for 250 vortex fixes and 73 investigative missions of which 9 were flown into disturbances that did not develop. In addition to the levied fixes, 206 intermediate fixes were also obtained. Thirty-six synoptic missions were requested and flown to provide mid-level steering information. The average distance error for all aircraft fixes received at JTWC during 1986 was 13 nm (24 km).

Aircraft reconnaissance effectiveness is summarized in Table 2-1. The manner in which the aerial reconnaissance mission is graded changed during 1986. A new Mission Effectiveness Grading (MEG) system was tested operationally. No longer is the early, late or on-time criteria being used. The new system graded the performance of the mission as satisfactory, degraded but satisfactory, unsatisfactory or missed. A mission could be degraded if certain critical weather parameters were not obtained such as temperature, dew point, minimum sea-level pressure, flight-level height in meters, etc. Also if too much time or too little time elapsed between the primary and intermediate fixes, the mission could be degraded and yet be satisfactory.

TABLE 2-1. AIRCRAFT RECONNAISSANCE EFFECTIVENESS

MISSIONS	TASKED	COMPLETED	MISSED	PERCENT
FIXES	250	240	10	96.0%
INVESTS	73	70	3	95.9%
SYNOPTIC TRACKS	36	30	6	83.3%

MISSION EFFECTIVENESS GRADING

	TOTAL	PERCENT
FIX MISSIONS TASKED	250	——
SATISFACTORY	210	84.0%
DEGRADED (BUT SATISFACTORY)	57	22.8%
UNSATISFACTORY	40	16.0%

LEVIED VS. MISSED FIXES

	LEVIED	MISSED	PERCENT
AVERAGE 1965-1970	507	10	2.0%
1971	802	61	2.0%
1972	624	126	20.2%
1973	227	13	5.7%
1974	358	30	8.4%
1975	217	7	3.2%
1976	317	11	3.5%
1977	203	3	1.5%
1978	290	2	0.7%
1979	289	14	4.8%
1980	213	4	1.9%
1981	201	3	1.5%
1982	276	17	6.2%
1983	157	3	1.9%
1984	210	2	1.0%
* 1985	210	14	6.7%
1986	250	10	4.0%

* CORRECTED DATA FOR 1985.

4. SATELLITE RECONNAISSANCE SUMMARY

The Air Force provides satellite reconnaissance support to JTWC through a tropical cyclone satellite surveillance network consisting of both tactical and centralized facilities. Tactical DMSP sites monitoring DMSP, NOAA and geostationary satellite data are located at Nimitz Hill, Guam; Clark AB, Republic of the Philippines; Kadena AB, Okinawa, Japan; Osan AB, Republic of Korea; and Hickam AFB, Hawaii. These sites provide a combined coverage that includes most of JTWC's area of responsibility in the western North Pacific from near the dateline westward to the Malay Peninsula. For the remainder of its AOR, JTWC relies on the Air Force Global Weather Central (AFGWC) to provide coverage using stored satellite data. The Naval Oceanography Command Detachment, Diego Garcia, provides NOAA polar orbiting coverage in the central Indian Ocean as a supplement to this support. U.S. Navy ships equipped for direct readout also provide supplementary support.

AFGWC, located at Offutt AFB, Nebraska, is the centralized member of the tropical cyclone satellite surveillance network. In support of JTWC, AFGWC processes stored imagery from DMSP and NOAA spacecraft. Imagery recorded onboard the spacecraft as they pass over the earth is later downlinked to AFGWC via a network of command readout sites and communication satellites. This enables AFGWC to obtain the coverage necessary to fix all tropical systems of interest to JTWC. AFGWC has the primary responsibility to provide tropical cyclone surveillance over the entire Indian Ocean, southwest Pacific, and the area near the dateline. Additionally, AFGWC can be tasked to provide tropical cyclone positions in the entire western North Pacific as backup to coverage routinely available in that region.

The hub of the network is Detachment 1, First Weather Wing (Det 1, 1WW), colocated with JTWC on Nimitz Hill, Guam. Based on available satellite coverage, Det 1, 1WW is responsible for coordinating satellite reconnaissance requirements with JTWC and tasking the individual network sites for the necessary tropical cyclone fixes and intensity estimates. When a particular fix is important to the development of JTWC's next tropical cyclone warning, two sites are tasked to fix the tropical cyclone from the same satellite pass. This "dual-site" concept provides the necessary redundancy to virtually guarantee JTWC an accurate satellite fix on the tropical cyclone.

The network provides JTWC with several products and services. The main service is one of monitoring its AOR for indications of tropical cyclone development. If an area exhibits the potential for development, JTWC is notified. Once JTWC issues either a Tropical Cyclone Formation Alert or warning, the network is tasked to provide three products: tropical cyclone positions, intensity estimates and forecast intensities. Each satellite tropical cyclone position is assigned a Position Code Number (PCN) to indicate the accuracy of the fix position. This is determined by the availability of visible landmarks in the image for precise gridding, and the degree of organization of the tropical cyclone's cloud system (Table 2-2).

TABLE 2-2. POSITION CODE NUMBERS

PCN	METHOD OF CENTER DETERMINATION/GRIDDING
1	EYE/GEOGRAPHY
2	EYE/EPHEMERIS
3	WELL-DEFINED CIRCULATION CENTER/GEOGRAPHY
4	WELL-DEFINED CIRCULATION CENTER/EPHEMERIS
5	POORLY DEFINED CIRCULATION CENTER/GEOGRAPHY
6	POORLY DEFINED CIRCULATION CENTER/EPHEMERIS

During 1986, the network provided JTWC with a total of 2693 satellite fixes on tropical systems in the western North Pacific. This is a record number of fixes for the year. Another 57 fixes were made for tropical systems in the North Indian Ocean. A comparison of those fixes of numbered tropical cyclones in the western North Pacific with their corresponding JTWC best track positions is shown in Table 2-3a (Comparison of fixes with the corresponding best track for the South Pacific and Indian Oceans are presented in Table 2-3b).

TABLE 2-3A. MEAN DEVIATION (NM) OF ALL SATELLITE DERIVED TROPICAL CYCLONE POSITIONS FROM THE JTWC BEST TRACK POSITIONS IN THE WESTERN NORTH PACIFIC AND NORTH INDIAN OCEANS. NUMBER OF CASES IN PARENTHESES.

	WESTERN NORTH PACIFIC OCEAN				NORTH INDIAN OCEAN			
	1976-1985 AVERAGE		1986		1980-1985 AVERAGE		1986	
PCN	(ALL SITES)		(ALL SITES)		(ALL SITES)		(ALL SITES)	
1	13.6	(1632)	17.7	(188)	16.7	(40)	------	(0)
2	16.6	(1792)	16.0	(450)	18.9	(7)	------	(0)
3	20.9	(2367)	26.6	(204)	17.6	(21)	161.6	(1)
4	22.9	(1300)	29.4	(398)	58.3	(10)	------	(0)
5	37.4	(4381)	45.1	(322)	33.5	(220)	87.4	(12)
6	39.5	(3250)	40.8	(1125)	37.5	(203)	106.1	(22)
1&2	15.2	(3424)	16.5	(638)	17.2	(47)	------	(0)
3&4	21.6	(3667)	28.5	(602)	33.0	(31)	161.6	(1)
5&6	38.3	(7631)	41.8	(1447)	34.7	(423)	99.5	(34)
TOTALS		(14722)		(2687)		(501)		(35)

TABLE 2-3B. MEAN DEVIATION (NM) OF ALL SATELLITE DERIVED TROPICAL CYCLONE POSITIONS IN THE SOUTH PACIFIC AND SOUTH INDIAN OCEANS. NUMBER OF CASES IN PARENTHESES.

PCN	1986 (ALL SITES)	
1	18.3	(48)
2	15.6	(144)
3	39.5	(55)
4	23.9	(111)
5	46.7	(158)
6	36.1	(1012)
1&2	16.3	(192)
3&4	29.1	(166)
5&6	37.5	(1170)
TOTALS		(1528)

Estimates of the tropical cyclone's current intensity and 24-hour intensity forecast are made every 12 hours by applying the Dvorak technique (NOAA Technical Report NESDIS 11) to visual and enhanced infrared imagery (Figure 2-1 and Table 2-4).

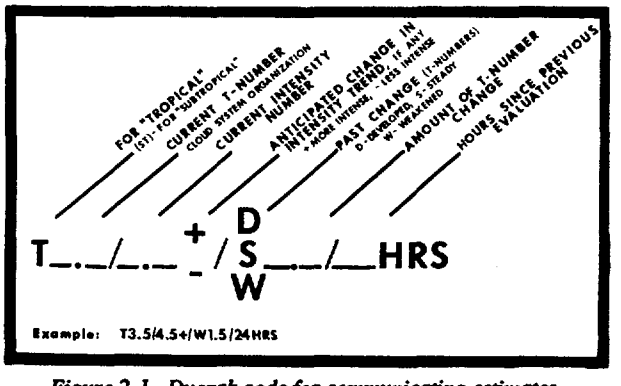
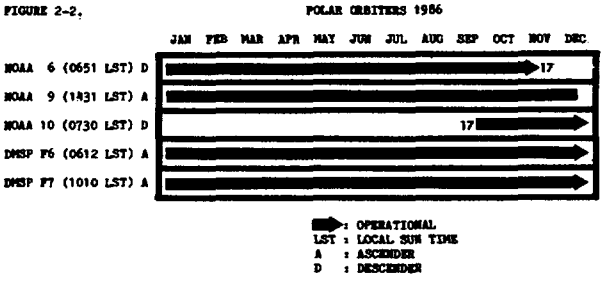


Figure 2-1. Dvorak code for communicating estimates of current and forecast intensity derived from satellite data. In the example, the current T-number is 3.5, but the current intensity estimate is 4.5 (equivalent to 77 kt (40 m/sec)). The cloud system has weakened by 1.5 T-numbers since the previous evaluation conducted 24 hours earlier. The plus (+) symbol indicates an expected reversal of the weakening trend or very little further weakening of the tropical cyclone during the next 24-hour period.

Figure 2-2 shows the status of operational polar orbiting spacecraft. Four were available, on the average, throughout the year. The two DMSP satellites, 17540 (F6) and 18541 (F7), operated reliably through the year with only occasional minor imagery loss due to seasonal repositioning of a glare obstructor (GLOB) on the F6 spacecraft. NOAA spacecraft did not fare as well. On January 1st,

FIGURE 2-2. POLAR ORBITERS 1986



NOAA 6 was returned to service from standby mode to replace an ailing NOAA 8. Only partially operational, NOAA 6 served as the primary morning spacecraft for most of 1986. Its most serious limitation (for Det 1, 1WW's operations) was the appearance of "railroad track-like" lines through the center of its High Resolution Picture Transmissions (HRPT) imagery. But by 17 November, it had again been placed on standby (with HRPT and Automatic Picture Transmission (APT) turned off), and was replaced by the newly-launched NOAA 10. NOAA 10 and NOAA 9 have had no major problems providing high-quality imagery through the remainder of the year.

5. RADAR RECONNAISSANCE SUMMARY

Eighteen of the 27 significant tropical cyclones in the western North Pacific during 1986 passed within range of land-based radar with sufficient cloud pattern organization to be fixed. The land-based radar fixes that were obtained and transmitted to JTWC totaled 899. Only one radar fix was obtained by reconnaissance aircraft.

The WMO radar code defines three categories of accuracy: good (within 10 km (5 nm)), fair (within 10-30 km (5-16 nm)), and poor (within 30-50 km (16-27 nm)). Of the 900 radar fixes coded in this manner; 243 were good, 257 were fair, and 400 were poor. Compared to JTWC's best track, the mean vector deviation for land-based radar sites was 16 nm (29 km). Excellent support through timely and accurate radar fix positioning allowed JTWC to track and forecast tropical cyclone movement through even the most difficult erratic tracks.

As in previous years, no radar reports were received on North Indian Ocean tropical cyclones.

6. TROPICAL CYCLONE FIX DATA

A total of 3868 fixes on 27 western North Pacific tropical cyclones and 59 fixes on 3 North Indian Ocean tropical cyclones were received at JTWC. Table 2-5A, Fix Platform Summary, delineates the number of fixes per platform for each individual tropical cyclone. Season totals and percentages are also indicated. (Table 2-5B provides the same information for the South Pacific and South Indian Oceans.)

TABLE 2-4. MAXIMUM SUSTAINED WIND SPEED (KT) AS A FUNCTION OF DVORAK CI & FI (CURRENT AND FORECAST INTENSITY) NUMBER AND MINIMUM SEA-LEVEL PRESSURE (MSLP)

TROPICAL CYCLONE INTENSITY NUMBER	WIND SPEED	MSLP (NW PACIFIC)
0.0	<25	----
0.5	25	----
1.0	25	----
1.5	25	----
2.0	30	1000
2.5	35	997
3.0	45	991
3.5	55	984
4.0	65	976
4.5	77	966
5.0	90	953
5.5	102	941
6.0	115	927
6.5	127	914
7.0	140	898
7.5	155	879
8.0	170	858

TABLE 2-5A. FIX PLATFORM SUMMARY FOR 1986

WESTERN NORTH PACIFIC		AIRCRAFT	SATELLITE	RADAR	SYNOPTIC	TOTAL
TY JUDY	(01W)	9	84	0	0	93
TY KEN	(02W)	8	97	0	0	105
STY LOLA	(03W)	10	92	0	0	102
TS MAC	(04W)	4	104	27	0	135
TY NANCY	(05W)	4	60	26	0	90
TS OWEN	(06W)	8	49	0	0	57
STY PEGGY	(07W)	16	179	40	0	235
TY ROGER	(08W)	10	98	82	0	190
TS SARAH	(09W)	8	112	2	0	122
TY GEORGETTE	(11E)	9	93	0	0	102
TY TIP	(10W)	10	91	0	0	101
TY VERA	(11W)	20	190	70	0	280
TY WAYNE	(12W)	18	257	374	3	652
TY ABBY	(13W)	10	93	79	1	183
TY BEN	(14W)	21	147	0	0	168
TY CARMEN	(15W)	11	99	7	0	117
TS DOM	(16W)	1	56	13	0	70
TY ELLEN	(17W)	8	174	74	0	256
TY FORREST	(18W)	8	91	0	0	99
TS GEORGIA	(19W)	4	76	5	0	85
TS HERBERT	(20W)	4	90	1	0	95
TS IDA	(21W)	6	90	10	1	107
TY JOE	(22W)	13	153	64	0	230
STY KIM	(23W)	23	263	21	0	307
TS LEX	(24W)	2	48	0	0	50
TY MARGE	(25W)	9	144	6	0	159
TY MORRIS	(26W)	16	149	29	0	194
TOTALS		270	3179	930	5	4384
% OF TOTAL NR OF FIXES		6.2%	72.5%	21.2%	0.1%	100.0%

NORTH INDIAN OCEAN	SATELLITE	SYNOPTIC	TOTAL
TC 01B	25	2	27
TC 02B	15	0	15
TC 03A	17	0	17
TOTALS	57	2	59
% OF TOTAL NR OF FIXES	96.6%	3.4%	100.0%

TABLE 2-5B. FIX PLATFORM SUMMARY FOR 1986

THE SOUTH PACIFIC AND SOUTH INDIAN OCEANS	SATELLITE	RADAR	SYNOPTIC	TOTAL
TC 01S ----------	54	0	0	54
TC 02S NICHOLAS	156	0	0	156
TC 03P ----------	48	0	0	48
TC 04S DELIFININA	58	0	1	59
TC 05S COSTA	57	0	5	62
TC 06S ----------	16	0	0	16
TC 07S OPHELIA	46	0	0	46
TC 08S ----------	36	0	0	36
TC 09S HECTOR	60	0	2	62
TC 10S PANCHO	21	0	0	21
TC 11P VERNON	42	0	0	42
TC 12P WINIFRED	58	0	0	58
TC 13S ERINESTA	74	0	0	74
TC 14S FILOMENA	40	0	0	40
TC 15P IMA	14	0	0	14
TC 16P JUNE	8	0	0	8
TC 17P KELI	48	0	0	48
TC 18S RHONDA	17	0	0	17
TC 19S GISTA	42	0	0	42
TC 20S SELWYN	43	0	0	43
TC 21S TIFFANY	32	0	0	32
TC 22S VICTOR	90	3	0	93
TC 23P LUSI	81	0	3	84
TC 24P ALFRED	54	0	0	54
TC 25S HONORININA	75	0	0	75
TC 26S IARIMA	19	0	0	19
TC 27S JEFOTRA	56	0	0	56
TC 28S KRISOSTOMA^	73	0	1	74
TC 29P MARTIN	43	0	0	43
TC 30P ----------	33	0	0	33
TC 31P MANU	52	0	0	52
TC 32S BILLY#	91	0	0	91
TC 33P NAMU	82	0	0	82
TOTALS	1719	3	12	1734
% OF TOTAL NR OF FIXES	99.1%	0.2%	0.7%	100.0%

^ TC 28S (KRISOSTOMA) WAS ALSO NAMED ALISON.
# TC 32S (BILLY) WAS ALSO NAMED LILA.