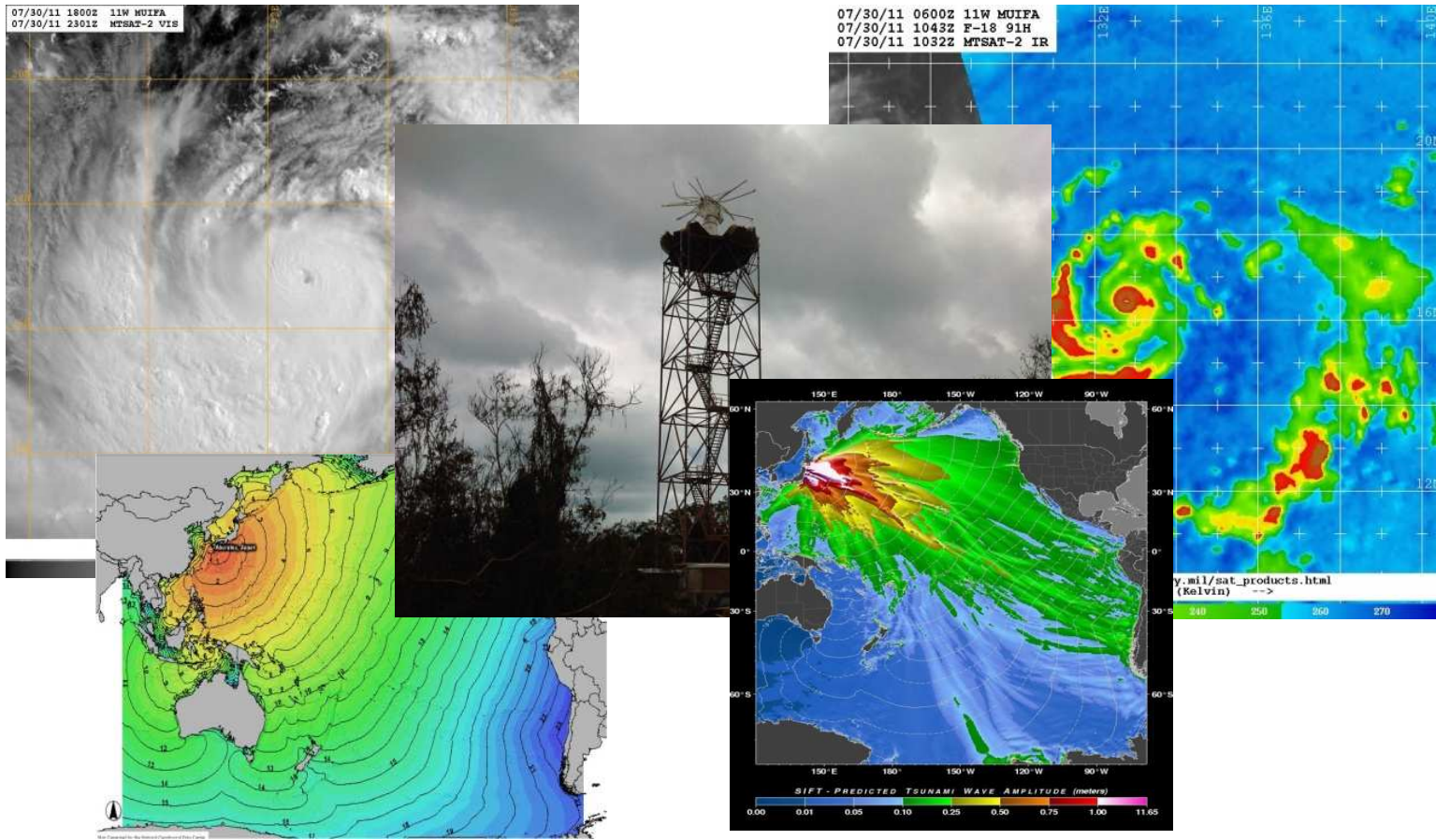




# Joint Typhoon Warning Center Overview

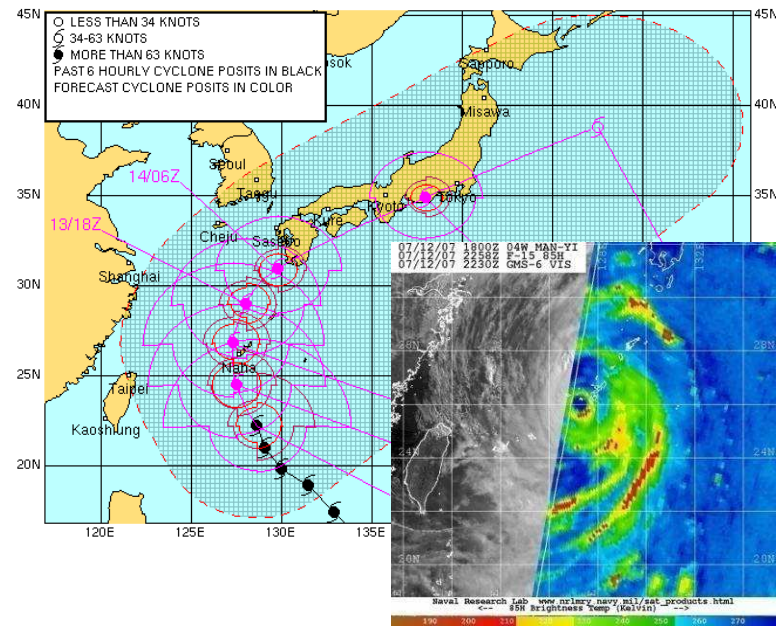


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# Missions

- Provide tropical cyclone reconnaissance, forecast, and warning support for the Department of Defense and other U.S. Government agencies in the Pacific and Indian Oceans as established by Commander, United States Pacific Command
- Provide tropical cyclone and tsunami decision support to U.S. Navy shore installations and fleet assets as directed by Commander, Fleet Forces Command.



**Airmen from the 18th Aircraft Maintenance Squadron tow an F-15 Eagle into a protective aircraft shelter in preparation for Typhoon Man-Yi 12 Jul 07 at Kadena Air Base, Japan. (Source: U.S. Air Force/A1C Kasey Zickmund)**

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# Command History/Background



- 1959:** CINCPAC directs CINCPACFLT & PACAF to establish a joint Pacific Fleet – Pacific Air Forces typhoon warning center integral to Fleet Weather Central (FWC), Guam. 50<sup>th</sup> Anniversary 2009
- Senior USAF officer assigned shall be the Director, JTWC and should be junior to the CO, FWC/JTWC, Guam.
- 1967:** FWC, Guam re-aligned under the newly formed Naval Weather Service (direct report to CNO). BUPERS Ltr of 27 Nov 1967 directed incumbent CO, FWC Guam to report to CINCPACFLT for additional duty.
- 1999:** BRAC (Guam) forced relocation of JTWC to Pearl Harbor, co-locating it with Naval Maritime Forecast Center (NMFC).
- 2011:** JTWC becomes stand-alone Navy command after NMFC is moved to San Diego. Tsunami support mission added.
- 2015:** JTWC realigned under Fleet Weather Center San Diego

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# Command Relationships



- **CDRUSPACOM: Policy Oversight**
- **COMPACFLT: Supported Component Commander for overall JTWC mission.**
- **ACC Command**
  - Supporting Component Commander for overall JTWC mission.
  - Supported Component Commander for tropical cyclone reconnaissance.
- **Echelon: Chief of Naval Operations  
COMFLTFORCOM  
COMNAVMETOCOM  
Commanding Officer, FWC San Diego  
Commanding Officer, JTWC**

\* Per USPACOMINST 0539.1 dtd 25 March 2014.

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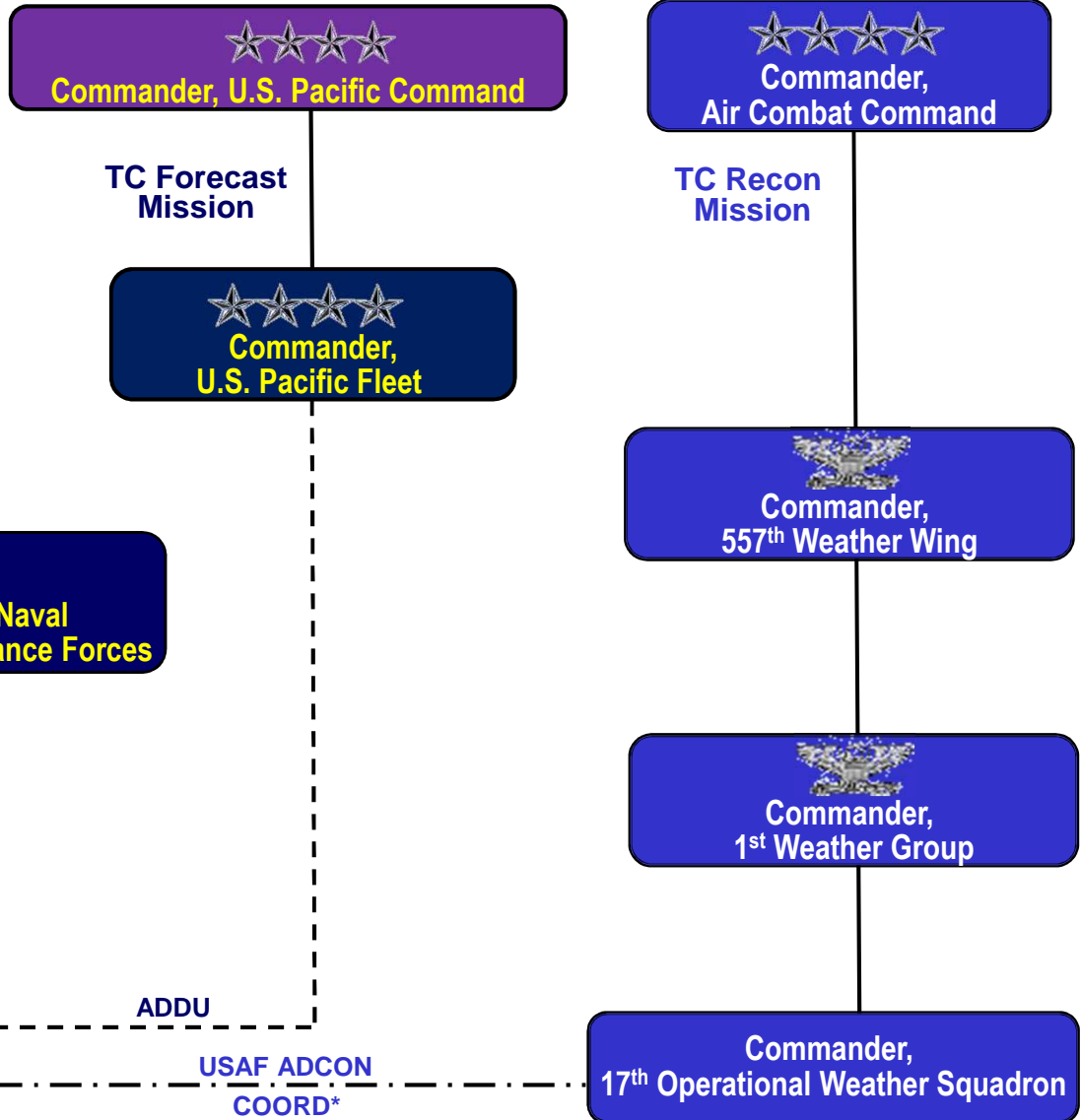


# Joint Typhoon Warning Center

## Command & Control



- CINCPAC directed PACFLT & PACAF to establish JTWC in ADMINO message DTG 230233Z APR 59.
- Current C2 structure IAW USPACOMINST 0539.1/S3020.2L.
- ADDU relationship with COMPACFLT retained since COMPACFLT is tasked with overall tropical cyclone (TC) forecast mission.
- ACC assumed TC recon responsibility under AFW re-org





# Infrastructure & Manning Responsibilities



- Infrastructure & Manning Responsibilities
- No Joint billets, but manned by Navy and Air Force personnel.
- Navy provides facility, equipment, & manning (TC Forecasters, Geophysical Technicians, and other support personnel (N1, N4, N6)).
- Air Force provides the Director, TC reconnaissance, TC Forecasters and techniques development personnel.

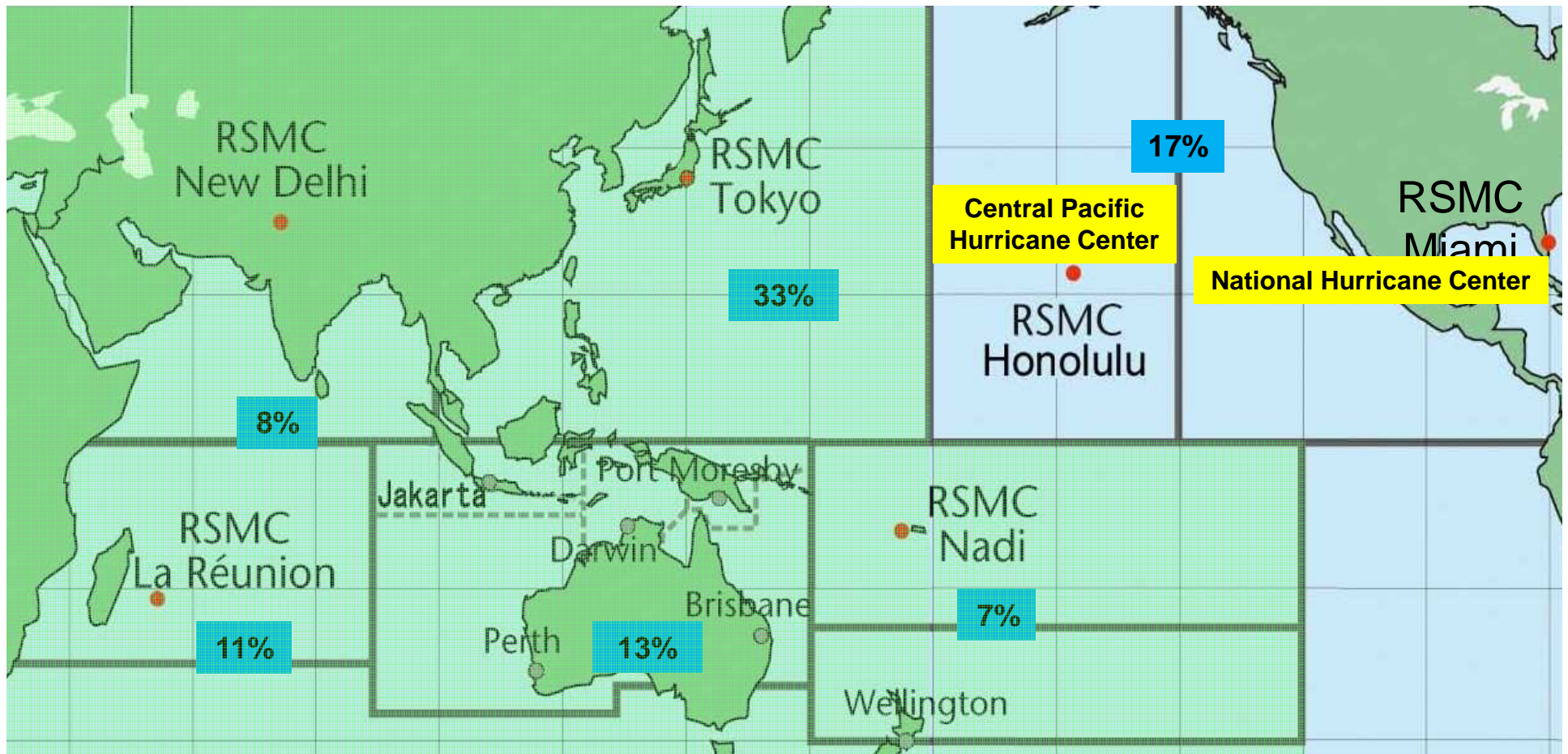
## Personnel Breakdown (50 total)

- Military Officer: 11 USN & 1 USAF
- Military Enlisted: 18 USN & 5 USAF
- Civilian: 8 USN & 7 USAF
- Total 37 USN & 13 USAF

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# JTWC Tropical Cyclone Forecasting Area of Responsibility



- Includes WMO-sponsored Regional Specialized Meteorology Centers (RSMC) and percent of tropical cyclones by region.
- JTWC issues forecasts & warnings for green shaded area for use by DoD and other U.S. Government agencies.
- JTWC coordinates with CPHC & NHC regarding tropical cyclone forecasts in the eastern & central Pacific to ensure safety of DoD assets.

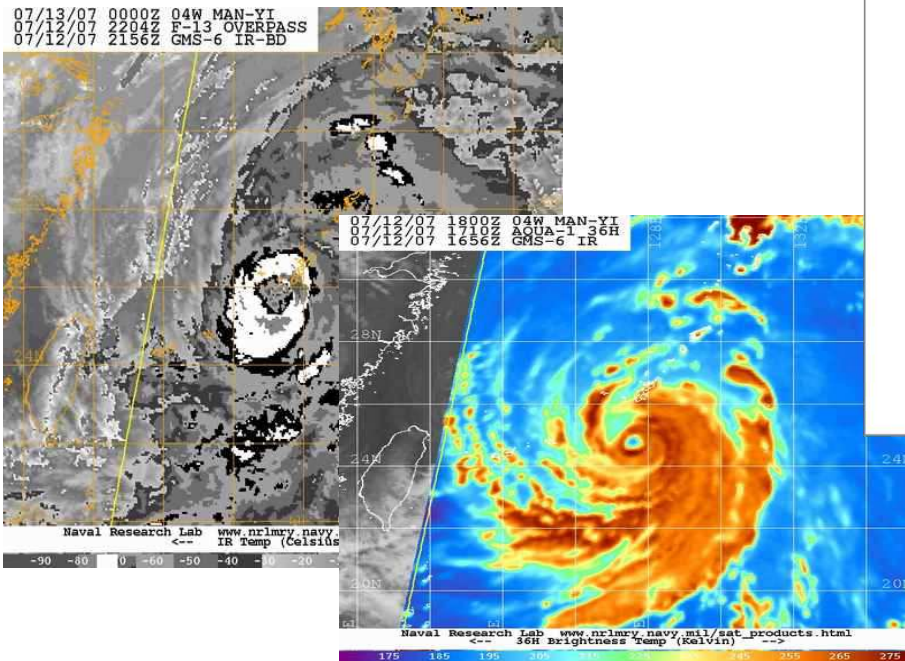


# Satellite Reconnaissance



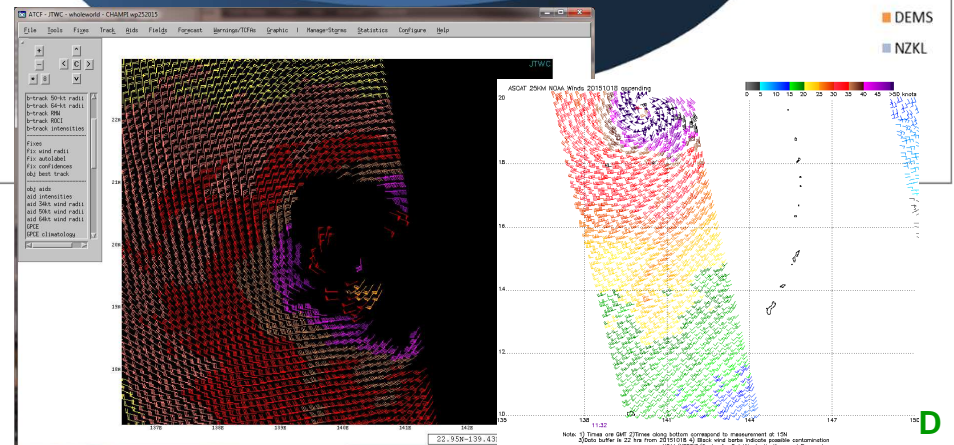
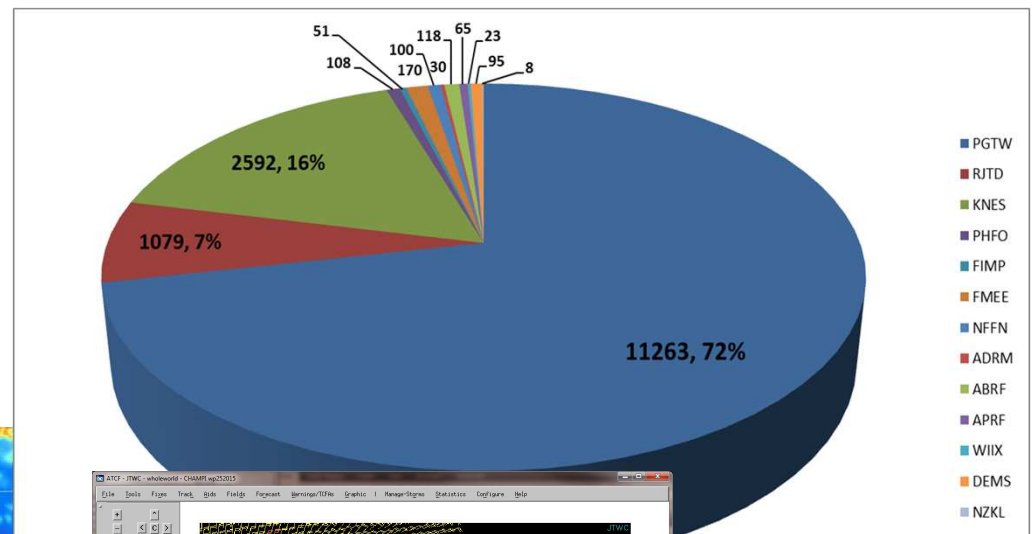
## Position/Intensity Fixes

- Exclusively remotely sensed data – satellite/radar
  - USAF aircraft recon ended in 1987
- Infrared/Visible imagery fixes every 3 hours
- Microwave Imagery fixes as imagery is available
- Scatterometry fixes including position, maximum wind and 35/50 knot wind radii
- Weather radar fixes from Guam and Hawaii



## Satellite Fixes by Agency

- 2014 Total 15,702 – 11,263 completed at JTWC
- Second (& third) set of eyes aids TC position & intensity estimation





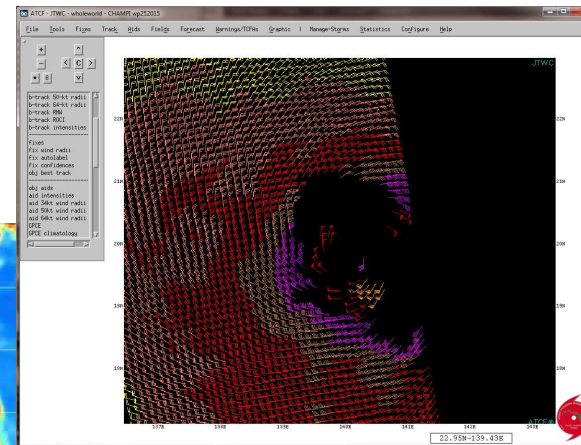
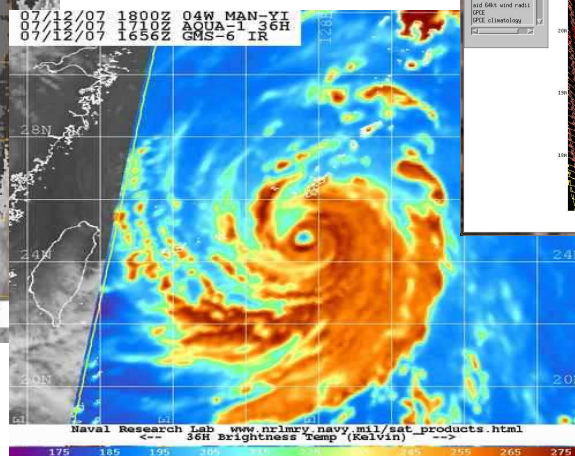
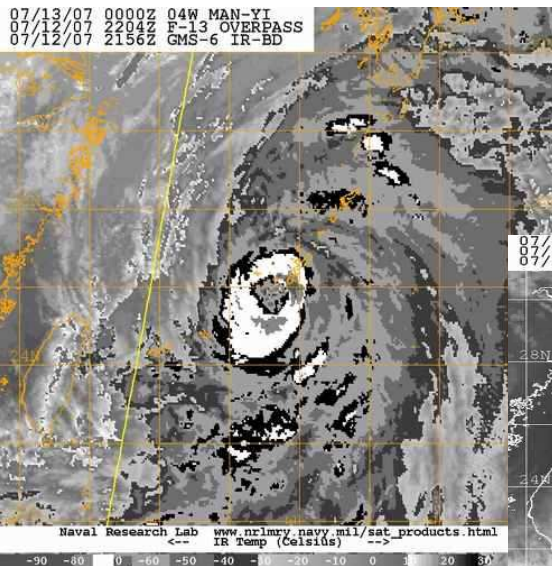
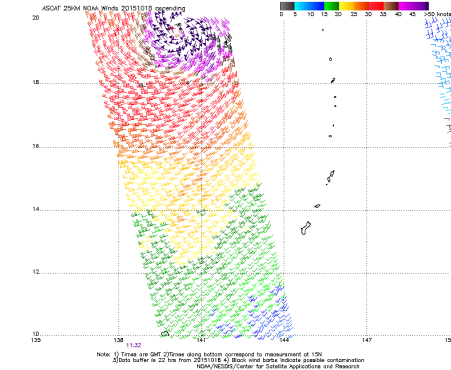


# Satellite Reconnaissance



## Position/Intensity Fixes

- Exclusively remotely sensed data – satellite/radar
  - USAF aircraft recon ended in 1987
- Infrared/Visible imagery fixes every 3 hours
- Microwave Imagery fixes as imagery is available
- Scatterometry fixes including position, maximum wind and 35/50 knot wind radii
- Weather radar fixes from Guam and Hawaii



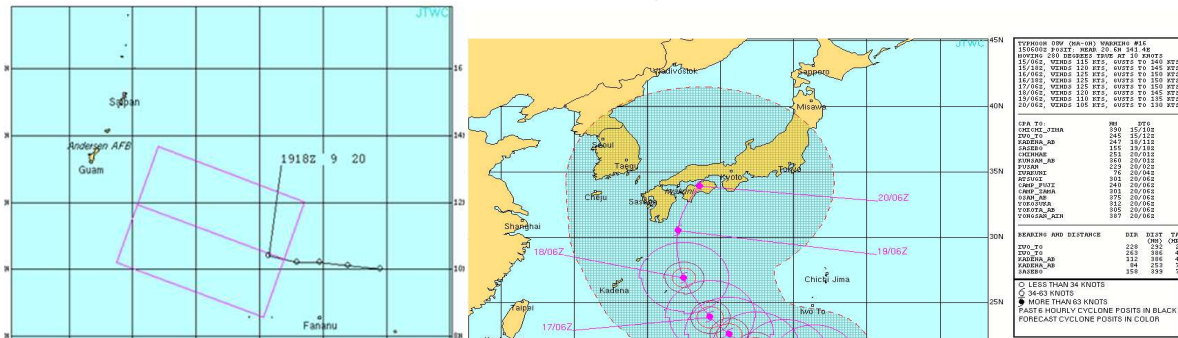
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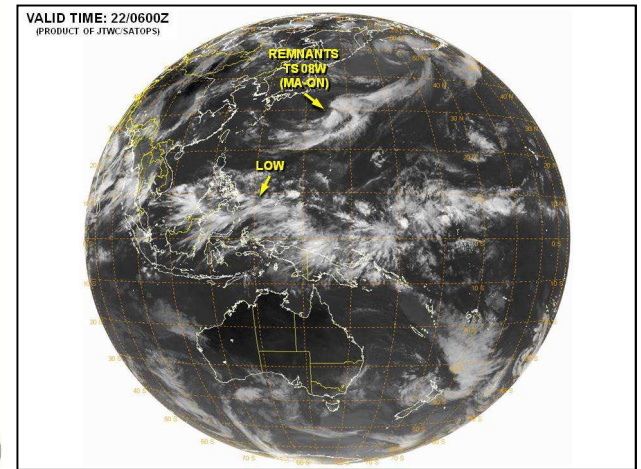
# Tropical Cyclone Forecasting



Enable effective Fleet and Joint Force operations and planning through tropical cyclone reconnaissance, forecast, warning, and decision support to U.S. assets in the Pacific and Indian Oceans as established by Commander, U.S. Pacific Command.

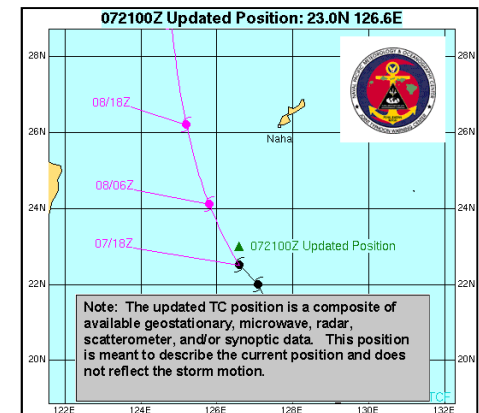


ABPW10 FGTW 220600  
 MSGID/GENADMIN/NAVMAFSTCEN PEARL HARBOR HI/JTWC//  
 SUBJ/SIGNIFICANT TROPICAL WEATHER ADVISORY FOR THE WESTERN AND  
 /SOUTH PACIFIC OCEANS/220600Z-230600ZJUL2011//  
 REF/A/MSG/NAVMAFSTCEN PEARL HARBOR HI/220151ZJUL2011//  
 RMPN/REF A IS A TROPICAL CYCLONE WARNING.//  
 RMRK/  
 1. WESTERN NORTH PACIFIC AREA (180 TO MALAY PENINSULA):  
 A. TROPICAL CYCLONE SUMMARY:  
 (1) AT 220000Z, TROPICAL DEPRESSION 08W (MA-ON) WAS LOCATED NEAR 28.9N 142.7E, APPROXIMATELY 435 NM SOUTH-SOUTHEAST OF TOKYO, JAPAN, AND HAD TRACKED SOUTHEASTWARD AT 11 KNOTS DURING THE PAST SIX HOURS. MAXIMUM SUSTAINED SURFACE WINDS WERE ESTIMATED AT 20 KNOTS GUSTING TO 30 KNOTS. SEE REF A (WTPN31 FGTW 220300) FOR THE FINAL WARNING ON THIS SYSTEM.  
 (2) NO OTHER TROPICAL CYCLONES.  
 B. TROPICAL DISTURBANCE SUMMARY:  
 (1) AN AREA OF CONVECTION HAS DEVELOPED NEAR 10.3N 128.5E, APPROXIMATELY 265 NM EAST OF CEBU, PHILIPPINES, AND IS SHOWING POTENTIAL FOR DEVELOPMENT OVER THE LONG TERM. THE LOW LEVEL CIRCULATION CENTER (LLCC) IS CURRENTLY POORLY DEFINED ON ANIMATED SATELLITE IMAGERY, BUT THE 220000Z PGTW STREAMLINE ANALYSIS REVEALS A CLOSED CIRCULATION. THE LLCC EXISTS WITHIN THE MONSOON TROUGH UNDERNEATH APPROXIMATELY 15 KNOTS OF EASTERLY VERTICAL WIND SHEAR. THE MONSOON TROUGH IS RAPIDLY BECOMING RE-ESTABLISHED OVER THE PHILIPPINE SEA IN THE WAKE OF 08W. STEADY SOUTHWESTERLIES HAVE SET IN ON PALAU AND ANIMATED MULTISPECTRAL IMAGERY SHOWS INCREASING CONVECTION ON THE SOUTH SIDE OF THE TROUGH. A 2123Z7Z SSMIS IMAGE SHOWS BROAD, MODERATE CURVATURE ON THE POLEWARD SIDE OF THE TROUGH AND DEEPENING CONVECTION ON THE SOUTHERN SIDE. MAXIMUM SUSTAINED SURFACE WINDS ARE ESTIMATED AT 10 TO 15 KNOTS. MINIMUM SEA LEVEL PRESSURE IS ESTIMATED TO BE NEAR 1008 MB. THE POTENTIAL FOR THE DEVELOPMENT OF A SIGNIFICANT TROPICAL CYCLONE WITHIN THE NEXT 24 HOURS IS LOW.  
 (2) NO OTHER SUSPECT AREAS.  
 2. SOUTH PACIFIC AREA (WEST COAST OF SOUTH AMERICA TO 135 EAST):  
 A. TROPICAL CYCLONE SUMMARY: NONE.  
 B. TROPICAL DISTURBANCE SUMMARY: NONE.//  
 NNNN



## TC Forecast Products

- Daily Significant Tropical Weather Advisories
- Tropical Cyclone Formation Alerts (TCFA)
- TC Warning Packages
  - Warning message/graphics
  - Prognostic reasoning message



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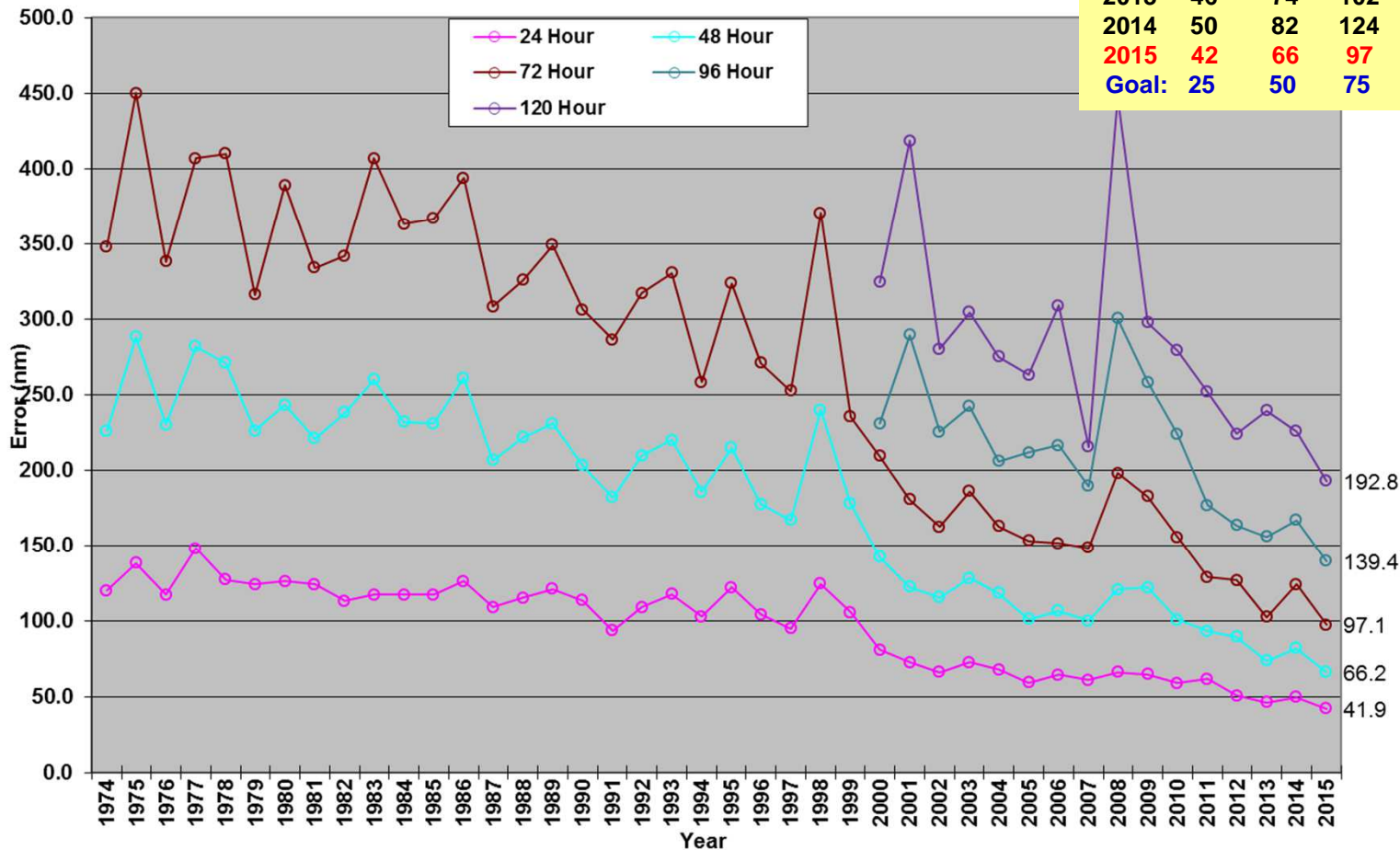


# JTWC Track Forecast Performance

## WESTPAC (2015 Preliminary)



	24 Hr	48 Hr	72 Hr	96 Hr	120 Hr
2011	62	93	129	177	252
2012	51	90	128	166	226
2013	46	74	102	156	240
2014	50	82	124	167	226
2015	42	66	97	139	193
Goal:	25	50	75	100	150

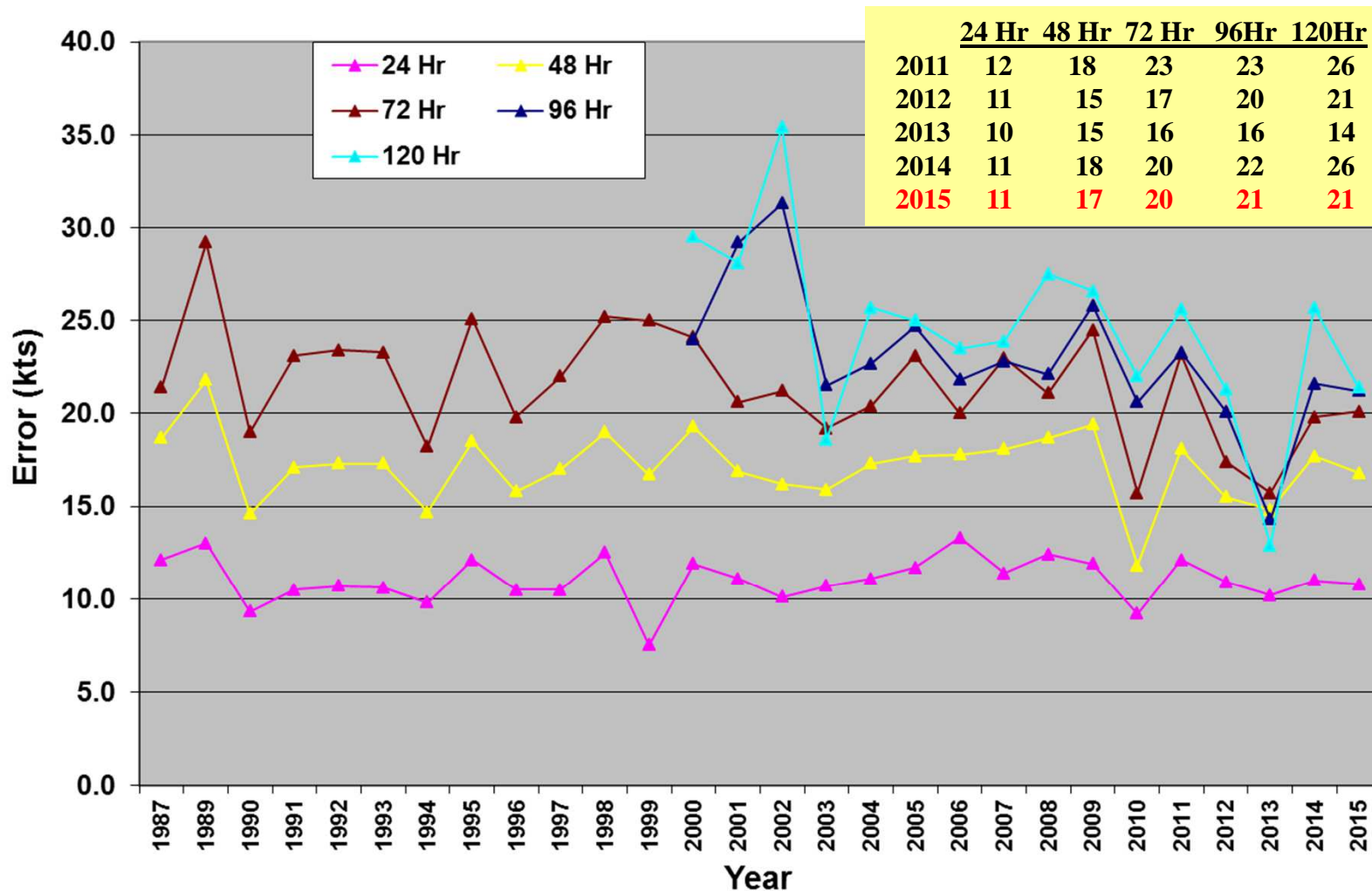


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# JTWC Intensity Forecast Performance

## WESTPAC (2015 Preliminary)



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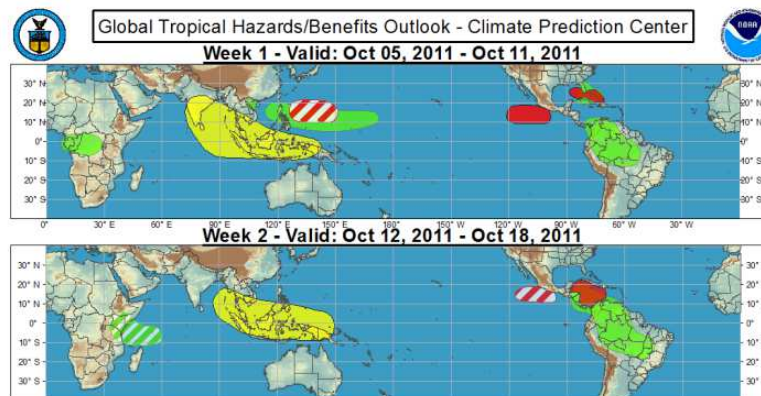
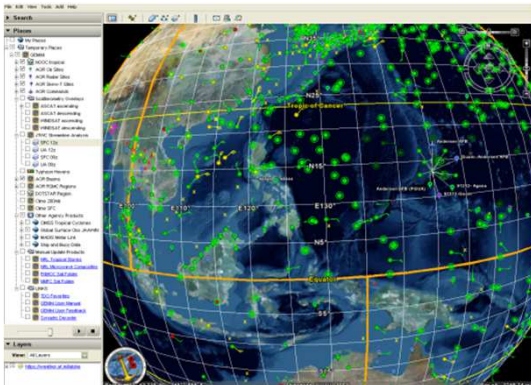


# Techniques Development



The Techniques Development team facilitates JTWC operations and improves TC reconnaissance and forecasts through effective transition of mature research into operations via scientific study, techniques development, IT exploitation, data evaluation, and process improvement.

- Improve processes: Introduce new tools
- Lead cooperative efforts with external R&D agencies and Universities
- Evaluate numerical model and subjective forecast performance
- Study new satellite data sources and transition to forecast operations
- Evaluate use of non-traditional data sources (UAS (GH, BAMS), GPS occultation, etc.)
- Publish Annual Tropical Cyclone Report
- **Develop and implement GIS and KML products for TC analysis and forecasting**
- **Global Tropics Hazards**
- **Low-Medium-High probability of TC formation worksheet**



Low/Medium/High Worksheet	
Invest number:	XXW
Date:	10/11/11
Time:	Select time
Best Track Coordinates:	
<b>A. LOW LEVEL STRUCTURE 3 CRITERIA</b>	
Symmetry (long/short axis diameter)	
GMSS 850 mb vorticity value	
If no circ, w/lies equward of disturbance?	
<b>B. DVORAK FIX VALUES</b>	
Most recent PGTW final T number	From fdeck.txt
Most recent KNES final T number	
<b>D. MJO DEVELOPMENT</b>	
	WxMap
	WxMap II
<i>Development within 48 hours</i>	
NOGAPS	
GFS	
JGSM	
UKMET	
ECMWF	
<i>Development within 24 hours</i>	
NOGAPS	
GFS	
JGSM	
UKMET	
ECMWF	
<b>E. MJO STATUS</b>	
OLR anomaly	
<b>F. VERTICAL WIND SHEAR</b>	
Vertical wind shear value	
<b>G. UPPER LEVEL OUTFLOW</b>	
Upper level outflow pattern	
Current recommendation:	
Legend:	
	INVEST ONLY
	LOW
	MEDIUM
	HIGH
Need help with this worksheet? <a href="#">CLICK HERE</a>	

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NORTH INDIAN OCEAN FIX SUMMARY FOR 2011				
Tropical Cyclone		Visible/Infrared	Microwave/Scatterometry	Total
01A		47	33	80
02B		20	16	36
03A	Keila	61	46	107
04A		62	69	131
05A		66	96	162
06B	Thane	67	50	117
DND		111	34	145
Totals		434	344	778
Percentage of Total		55.78%	44.22%	

WESTERN NORTH PACIFIC OCEAN FIX SUMMARY FOR 2011				
Tropical Cyclone		Visible/Infrared	Microwave/Scatterometry	Total
01W	N/A	20	29	49
02W	N/A	22	17	39
03W	Aere	61	84	145
04W	Songda	93	138	231
05W	Sarika	23	28	51
06W	Haima	76	60	136
07W	Meari	77	57	134
08W	Ma-On	110	246	356
09W	Tokage	38	25	63
10W	Nock-Ten	53	100	153
11W	Muifa	123	233	356
12W	Merbok	66	137	203
13W	N/A	52	113	165
14W	Nanmadol	85	127	212
15W	Talas	104	180	284
16W	Noru	60	54	114
17W	Kulap	48	34	82
18W	Roke	108	215	323
19W	Sonca	52	103	155
20W	Nesat	69	80	149
21W	Haitang	28	52	80
22W	Nalgae	67	131	198
23W	Banyan	65	51	116
24W	N/A	33	37	70
25W	N/A	10	10	20
26W	N/A	42	57	99
27W	Washi	57	91	148
DND		601	388	989
Totals		2243	2877	5120
Percentage of Total		43.81%	56.19%	

SOUTH PACIFIC & SOUTH INDIAN OCEAN FIX SUMMARY FOR 2011				
Tropical Cyclone		Visible/Infrared	Microwave/Scatterometry	Total
01S		48	58	106
02S	Anggrek	64	86	150
03S	Abele	72	91	163
04P	Tasha	14	5	19
05P	Vania	57	55	112
06S	Vince	50	71	121
07P	Zelia	36	49	85
08P	Wilma	69	102	171
09P	Anthony	65	67	132
10S	Bianca	41	58	99
11P	Yasi	68	60	128
12P	Zaka	32	54	86
13S	Bingiza	75	78	153
14S		33	45	78
15S	Carlos	94	80	174
16S	Diane	65	104	169
17P	Atu	62	125	187
18S	Cherono	71	119	190
19P	Bune	61	120	181
20S		35	10	45
21S	Errol	55	41	96
DND		1296	1500	2796
Totals		2463	2978	5441
Percentage of Total		45.27%	54.73%	

Satellite analysts exploited a wide variety of conventional and microwave satellite data to produce **11,339** position and intensity estimates.

A total of **6,199** fixes were made using microwave imagery, over half of the total number of fixes, ratio of microwave imagery used dropped significantly this year due to the loss NASA's AMSR-E and degradation and eventual loss of NOAA-16 AMSU.

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# 2012 Satellite Fixes

SOUTH PACIFIC & SOUTH INDIAN OCEAN FIX SUMMARY FOR 2012				
Tropical Cyclone		Visible/ Infrared	Microwave/ Scatterometry	Total
01S	Alenga	63	89	152
02S		70	106	176
03S	Grant	43	17	60
04S	Benilde	62	82	144
05S	Chanda	39	10	49
06S	Heidi	31	39	70
07S	Ethel	44	80	124
08S	Funso	100	149	249
09S	Iggy	85	139	224
10P	Jasmine	126	125	251
11P	Cyril	21	43	64
12S	Giovanna	109	189	298
13S	Hilwa	90	154	244
14S	Irina	116	188	304
15S		40	49	89
16S	Koji	51	92	143
17S	Lua	44	64	108
18P	Daphne	20	0	20
19P		52	70	122
20S	Kuena	51	63	114
21P		31	32	63
DND		417	298	715
Totals		1705	2078	3783
Percentage of Total		45.07%	54.93%	100

NORTH INDIAN OCEAN (BAY OF BENGAL/ARABIAN SEA) FIX SUMMARY FOR 2012				
Tropical Cyclone		Visible/ Infrared	Microwave/ Scatterometry	Total
01A	Murjan	33	48	81
02B	Nilam	46	52	98
03B		54	59	113
04A		28	36	64
DND		38	28	66
Totals		199	223	422
Percentage of Total		47.16%	52.84%	100

WESTERN NORTH PACIFIC OCEAN FIX SUMMARY FOR 2012				
Tropical Cyclone		Visible/ Infrared	Microwave/ Scatterometry	Total
01W		33	29	62
02W	Pakhar	61	49	110
03W	Sanvu	69	107	176
04W	Mawar	56	82	138
05W	Guchol	88	148	236
06W	Talim	33	34	67
07W	Doksuri	37	44	81
08W	Khanun	40	51	91
09W	Vicente	43	52	95
10W	Saola	73	81	154
11W	Damrey	58	85	143
12W	Haikui	71	91	162
13W	Kirogi	61	84	145
14W	Kai-Tak	49	68	117
15W	Tembin	100	165	265
16W	Bolaven	80	153	233
17W	Sanba	65	102	167
18W	Jelawat	90	131	221
19W	Ewiniar	55	107	162
20W	Maliksi	39	49	88
21W	Gaemi	58	77	135
22W	Prapiroon	113	176	289
23W	Maria	56	90	146
24W	Son-Tinh	64	59	123
25W		21	13	34
26W	Bopha	111	161	272
27W	Wukong	43	43	86
DND		204	119	323
Totals		1871	2450	4321
Percentage of Total		43.30%	56.70%	100

Satellite analysts exploited a wide variety of conventional and microwave satellite data to produce **8,526** position and intensity estimates. A total of **4,751** fixes were made using microwave imagery, amounting to over half of the total number of fixes.

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# 2013 Satellite Fixes

**NORTH INDIAN OCEAN (BAY OF BENGAL/ARABIAN SEA)  
FIX SUMMARY FOR 2013**

Tropical Cyclone	Visible/Infrared	Microwave/Scatterometry	Total
01A Mahasen	64	90	154
02B Phailin	46	95	141
03B	49	50	99
04A Helen	40	61	101
05B Lehar	55	87	142
06B Madi	69	109	178
DND	89	34	123
<b>Totals</b>	<b>412</b>	<b>526</b>	<b>938</b>
Percentage of Total	43.92%	56.08%	100

**SOUTH PACIFIC & SOUTH INDIAN OCEAN  
FIX SUMMARY FOR 2013**

Tropical Cyclone	Visible/Infrared	Microwave/Scatterometry	Total
01S Anais	60	73	133
02S Boldwin	34	62	96
03S Claudia	77	131	208
04P Evan	75	109	184
05P Freda	42	66	108
06S Mitchell	37	84	121
07S Dumile	36	53	89
08S Narelle	70	94	164
09S Emang	110	144	254
10P Garry	75	106	181
11P Oswald	50	20	70
12S Peta	45	77	122
13S Felleng	85	143	228
14P Haley	45	54	99
15S Gino	60	65	125
16S Haruna	115	181	296
17S Rusty	50	55	105
18S	92	164	256
19P Sandra	159	264	423
20P Tim	104	179	283
21S Imelda	157	287	444
22S Victoria	88	174	262
23P Zane	114	203	317
24S Jamala	123	182	305
DND	472	429	901
<b>Totals</b>	<b>2375</b>	<b>3399</b>	<b>5774</b>
Percentage of Total	41.13%	58.87%	100

**WESTERN NORTH PACIFIC OCEAN FIX SUMMARY FOR 2013**

Tropical Cyclone	Visible/Infrared	Microwave/Scatterometry	Total
01W Sonamu	56	111	167
02W Shanshan	39	98	137
03W Yagi	58	130	188
04W Leepi	36	44	80
05W Bebinca	36	50	86
06W Rumbia	41	56	97
07W Soulik	62	79	131
08W Cimaron	33	33	66
09W Jebi	35	44	79
10W Mangkhut	26	30	56
11W Utor	71	132	203
12W Trami	55	68	123
13W	22	33	55
14W Kong-Rey	48	97	145
15W Toraj	26	48	74
16W Man-Yi	43	81	124
17W Usagi	56	128	184
18W	21	24	45
19W Pabuk	63	109	172
20W Wutip	41	82	123
21W Sepat	27	57	84
22W Fitow	56	124	180
23W Danas	56	135	191
24W Nari	57	118	175
25W Wipha	47	101	148
26W Francisco	84	192	276
27W	31	80	111
28W Lekima	58	121	179
29W Krosa	67	116	183
30W	141	188	329
31W Haiyan	69	135	204
32W Podul	25	38	63
33W	16	27	43
DND	113	79	192
<b>Totals</b>	<b>1705</b>	<b>2988</b>	<b>4693</b>
Percentage of Total	36.33%	63.67%	100

Weather satellite data continued to be the mainstay for the TC reconnaissance mission at JTWC.

JTWC satellite analysts produced **11,405** position and intensity estimates.

A total of **6,913** were made using microwave imagery, amounting to over 60 percent of the total number of fixes. **UNCLASSIFIED**





# 2014 Satellite Fixes

NORTH INDIAN OCEAN (BAY OF BENGAL/ARABIAN SEA) FIX SUMMARY FOR 2014				
Tropical Cyclone	Name	Visible/Infrared	Microwave/Scatterometry	Total
01B	N/A	47	63	110
02A	Nanauk	50	98	148
03B	Hudhud	62	138	200
04A	Nilofar	78	174	252
05B	N/A	36	77	113
<b>DND</b>		<b>191</b>	<b>276</b>	<b>467</b>
<b>Totals</b>		<b>464</b>	<b>826</b>	<b>1290</b>
<b>Percentage of Total</b>		<b>35.97%</b>	<b>64.03%</b>	<b>100</b>

SOUTH PACIFIC & SOUTH INDIAN OCEAN FIX SUMMARY FOR 2014				
Tropical Cyclone	Name	Visible/Infrared	Microwave/Scatterometry	Total
01S	N/A	66	67	133
02S	Alessia	63	74	137
03S	Amara	76	227	303
04S	Bruce	80	182	262
05S	Christine	45	101	146
06S	Hejisa	81	207	288
07P	Ian	79	184	263
08S	Colin	76	181	257
09S	Delwe	56	126	182
10P	June	21	46	67
11P	Dylan	33	81	114
12P	Edna	35	87	122
13S	Edison	40	101	141
14S	Fobane	90	231	321
15S	Guito	43	106	149
16P	Kofi	47	82	129
17P	Gillian	157	332	489
18P	Lusi	45	84	129
19P	Hadi	45	137	182
20P	Mike	19	51	70
21S	Hellen	78	92	170
22S	Ivanoe	21	65	86
23P	Ita	108	175	283
24S	Jack	42	101	143
<b>DND</b>		<b>578</b>	<b>550</b>	<b>1128</b>
<b>Totals</b>		<b>2024</b>	<b>3670</b>	<b>5694</b>
<b>Percentage of Total</b>		<b>35.55%</b>	<b>64.45%</b>	<b>100</b>

WESTERN NORTH PACIFIC OCEAN FIX SUMMARY FOR 2014				
Tropical Cyclone	Name	Visible/Infrared	Microwave/Scatterometry	Total
01W	Lingling	36	142	178
02W	Kajiki	32	66	98
03W	Faxai	73	156	229
04W	N/A	64	97	161
05W	Peipah	97	179	276
06W	Tapah	67	115	182
07W	Hagibis	39	71	110
08W	Neoguri	74	162	236
09W	Rammasun	81	149	230
10W	Matmo	74	133	207
11W	Halong	112	253	365
12W	Nakri	100	210	310
07E	Genevieve	49	129	178
13W	Fangshen	49	114	163
14W	N/A	39	62	101
15W	Kalmaegi	61	107	168
16W	Fung-wong	57	149	206
17W	Kammuri	60	163	223
18W	Phanfone	81	202	283
19W	Vongfong	101	272	373
20W	Nuri	65	177	242
21W	Sinlaku	47	98	145
22W	Hagupit	103	226	329
23W	Jangmi	38	89	127
<b>DND</b>		<b>184</b>	<b>273</b>	<b>457</b>
<b>Totals</b>		<b>1783</b>	<b>3794</b>	<b>5577</b>
<b>Percentage of Total</b>		<b>31.97%</b>	<b>68.03%</b>	<b>100</b>

JTWC satellite analysts produced **12,561** position and intensity estimates. A total of **8260** of those 12,561 fixes were made using microwave imagery, amounting to well over 65 percent of the total number of fixes.

Began 3hr Intensity fixes (versus position only every 6hrs)

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# 2015 Satellite Fixes



- Began use of Mark IV-B for primary satellite fix platform vs FMQ-17 due to Himawari availability
- Contemplating fix frequency/ time adjustments

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## *Questions*



**This Brief is Unclassified**

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