



2017 Year in review: JTWC TC Activity, Forecast Challenges, and Developmental Priorities



Mean Annual TC Activity



Hurricane Forecast Improvement Program Annual Review

8-9 NOV 2017

Brian Strahl, Joint Typhoon Warning Center

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2017 JTWC Warned Tropical Cyclones (As of 31OCT17)



Peak Tropical Cyclone Intensity

< 35 knots
≥ 35 knots to < 65 knots
≥ 65 knots to < 130 knots
≥ 130 knots

2017 Super Typhoons *

- WP07 – Noru
- WP25 – Lan
- SH09 – Enawo
- SH15 – Ernie

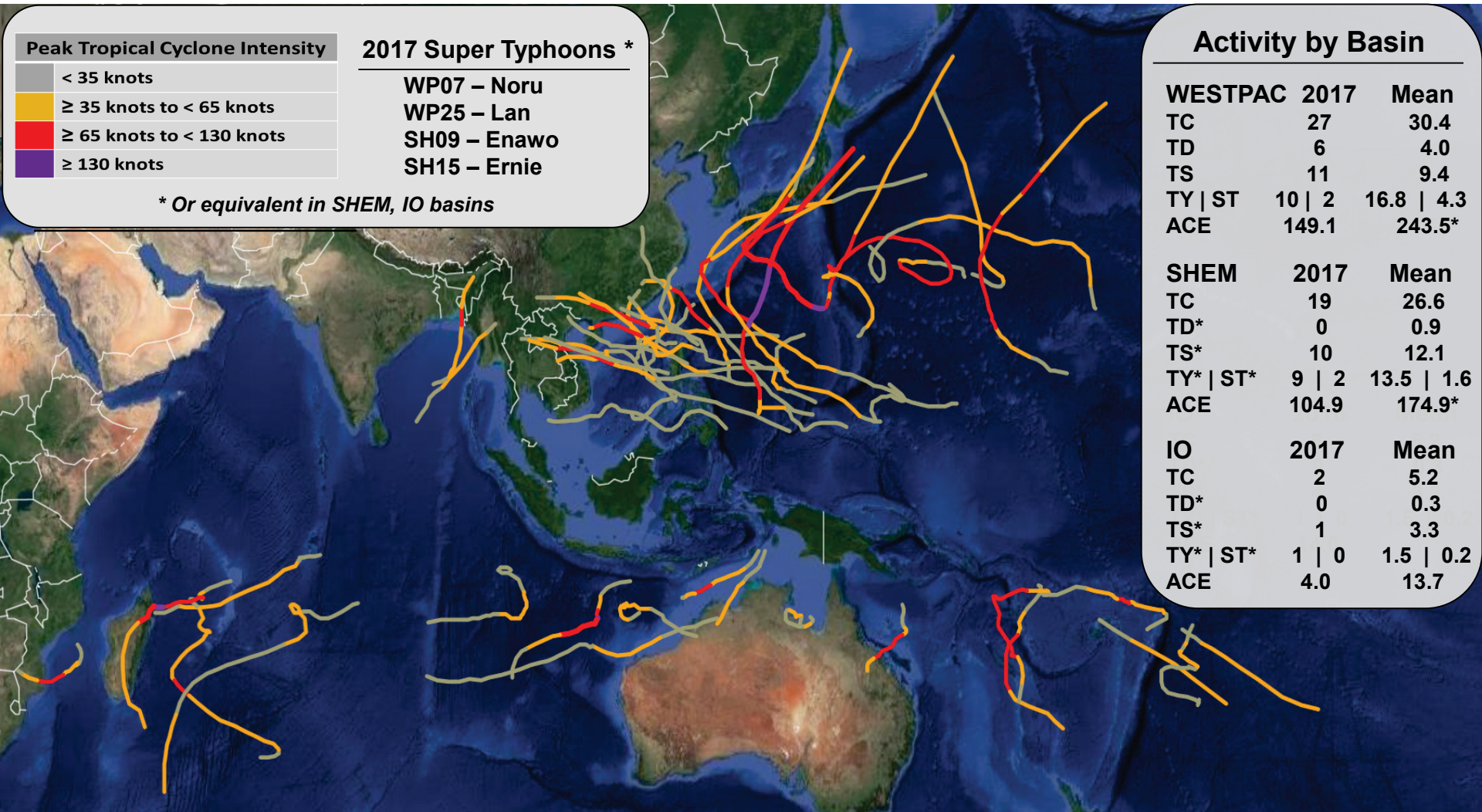
* Or equivalent in SHEM, IO basins

Activity by Basin

WESTPAC	2017	Mean
TC	27	30.4
TD	6	4.0
TS	11	9.4
TY ST	10 2	16.8 4.3
ACE	149.1	243.5*

SHEM	2017	Mean
TC	19	26.6
TD*	0	0.9
TS*	10	12.1
TY* ST*	9 2	13.5 1.6
ACE	104.9	174.9*

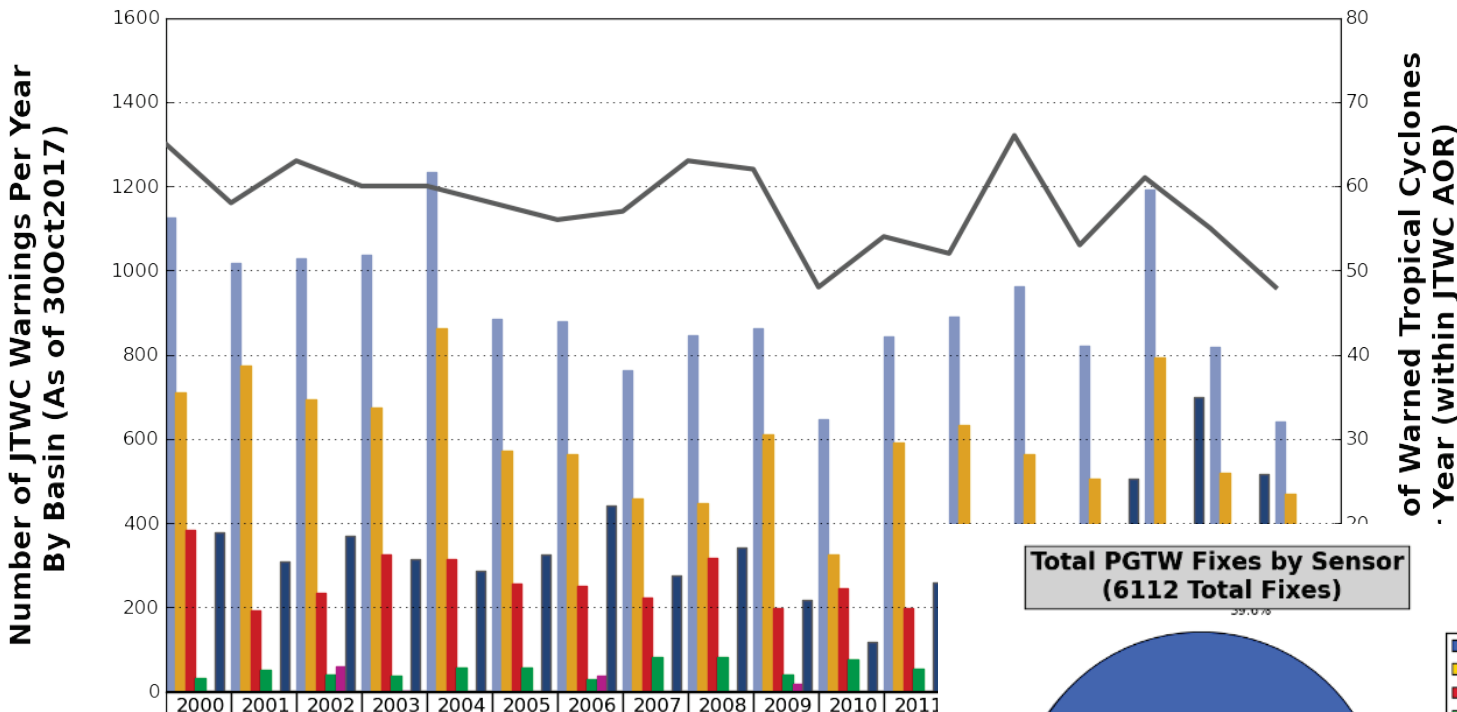
IO	2017	Mean
TC	2	5.2
TD*	0	0.3
TS*	1	3.3
TY* ST*	1 0	1.5 0.2
ACE	4.0	13.7



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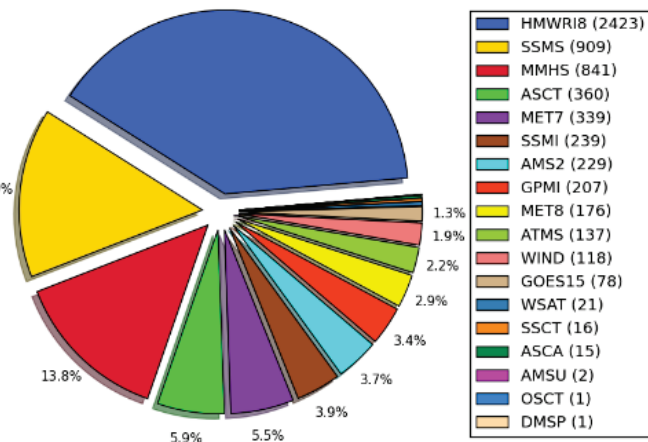
JTWC Warnings (* Preliminary)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total # Warnings	1125	1016	1027	1038	1233	884	879	762	846	862	646	842
Western Pacific	709	773	693	675	862	572	562	458	446	609	324	591
S. Hemisphere	384	193	234	324	313	256	251	223	318	197	246	197
Indian Ocean	32	50	40	37	58	56	29	81	82	39	76	54
CP/EP Crossover*	0	0	60	2	0	0	37	0	0	17	0	0
CP/EP Repackages**	379	310	370	314	286	324	442	276	342	216	118	258
# of TCs	65	58	63	60	60	58	56	57	63	62	48	54

* Denotes tropical cyclones that formed in the Central or Eastern Pacific and the Indian Ocean.
 ** Denotes NHC/CPHC advisories re-issued by JTWC for the Department of Defense.

Total PGTW Fixes by Sensor (6112 Total Fixes)



- Lowest # of total warnings since at least 2000
- Minimum in SHEM/IO
- Over 6,000 PGTW satellite fixes

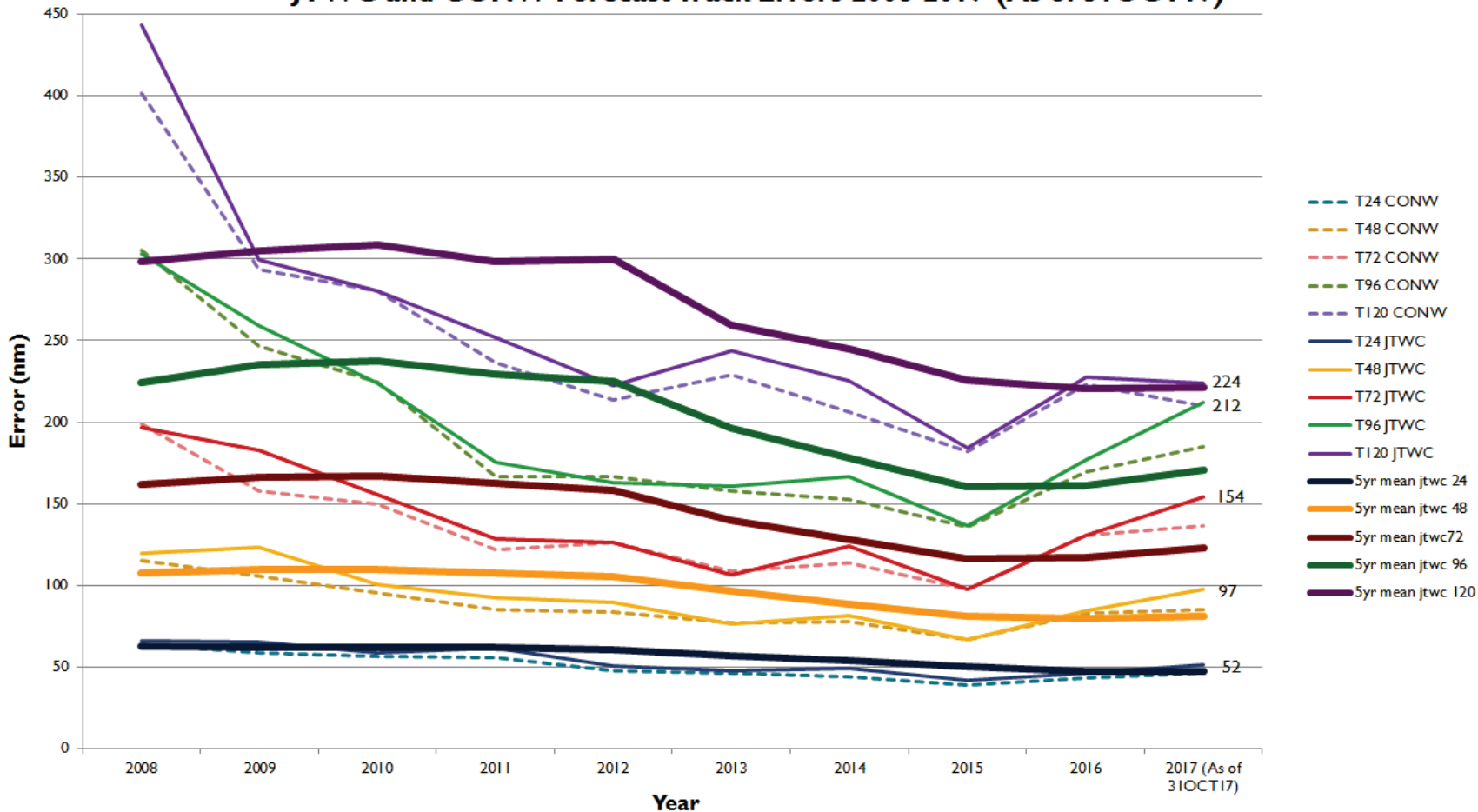
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JTWC and CONW Forecast Track WESTPAC Errors (*Preliminary)



JTWC and CONW Forecast Track Errors 2008-2017 (As of 31OCT17)



- Day 2,3,4 mean errors well above 5-year running mean
- Increased errors at these lead times largely due to 1-2 TCs

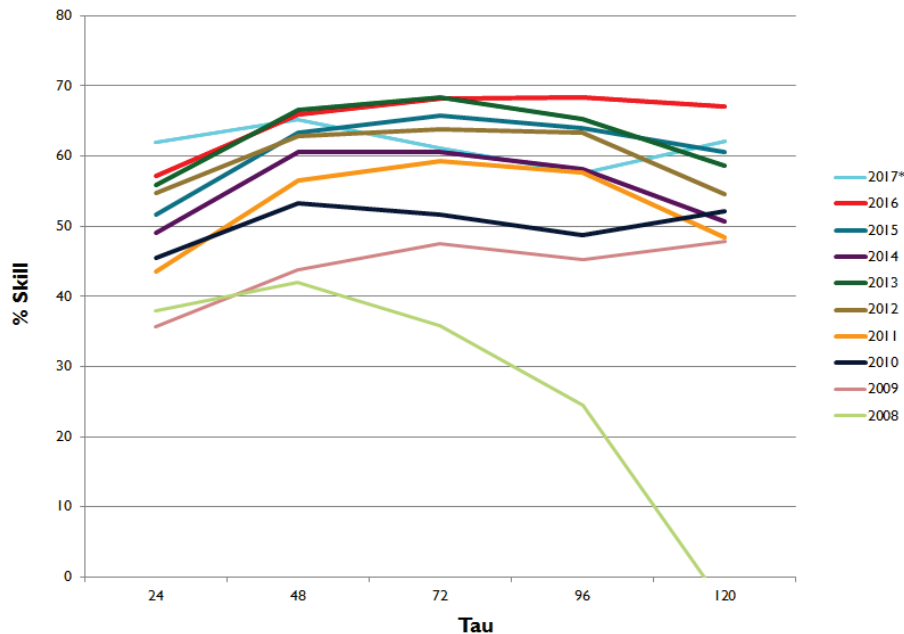
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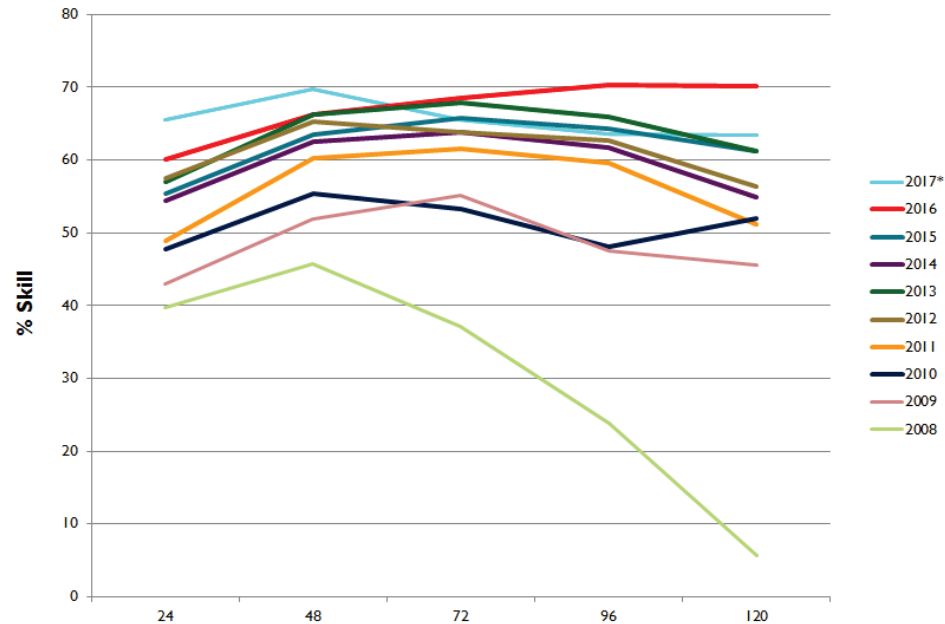
2017 JTWC and CONW Forecast Track Errors (*Preliminary), Cont'd



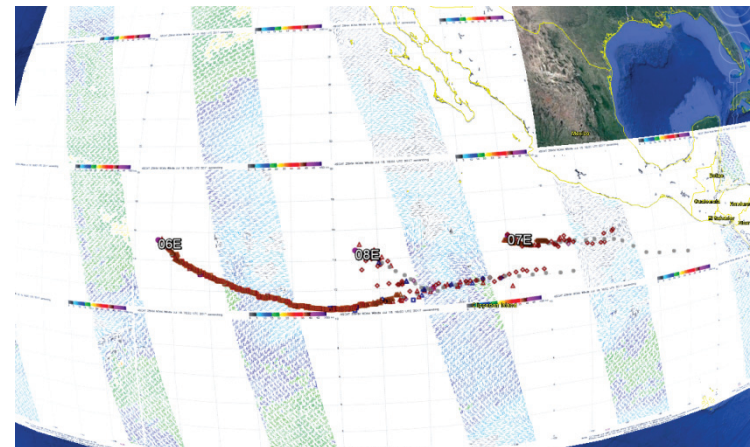
2008-2017 JTWC WPAC Forecast Skill (As of 31OCT17)



2008-2017 CONW WPAC Forecast Skill (As of 31OCT17)

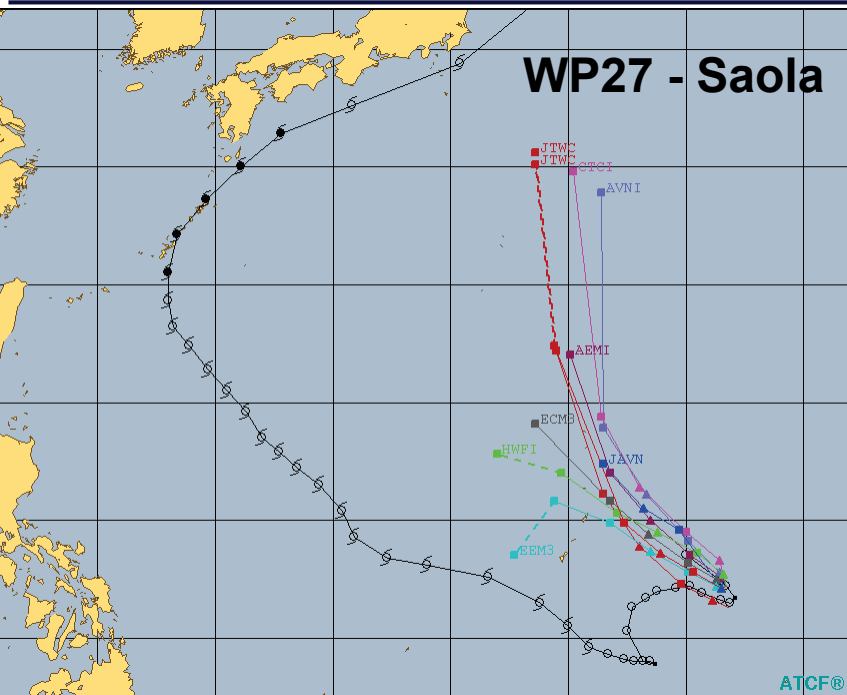


- Improved Day 1 skill - surprising given high number of TDs and degraded sat recon, but reflects increased analysis emphasis
- Day 5 skill just below 2016
- 3-σ errors at Days 3/4 had a large negative impact





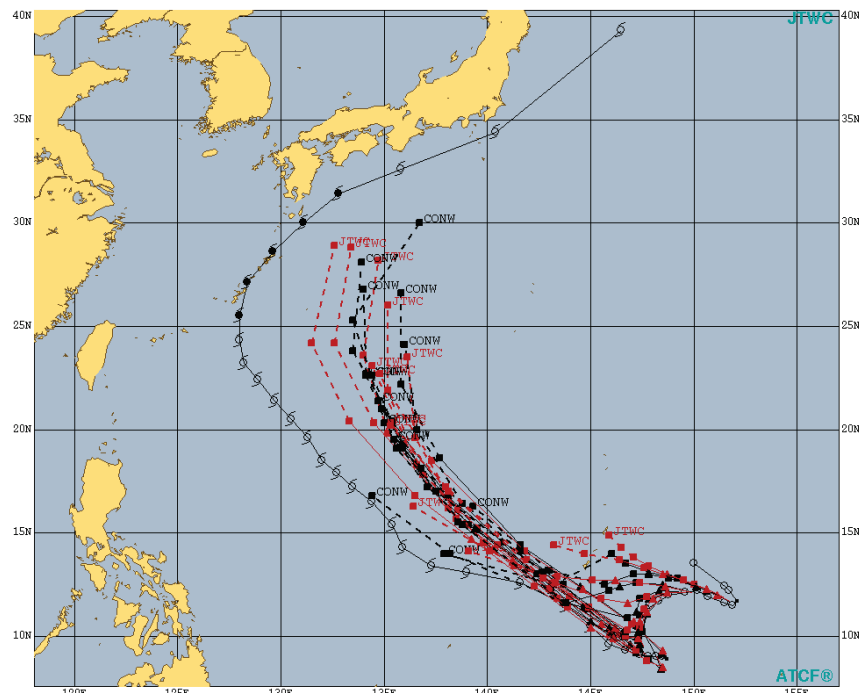
2017 Largest Forecast Errors



- First two warnings of WP27
- Limited available guidance largely NNW

average track errors (NM) FOR HOMOGENEOUS SAMPLE

	00	12	24	36	48	72	96	120
JTWC	12.8	56.1	70.5	94.1	139.4	244.7	310.4	295.5
#CASES	40	39	37	35	33	29	25	19

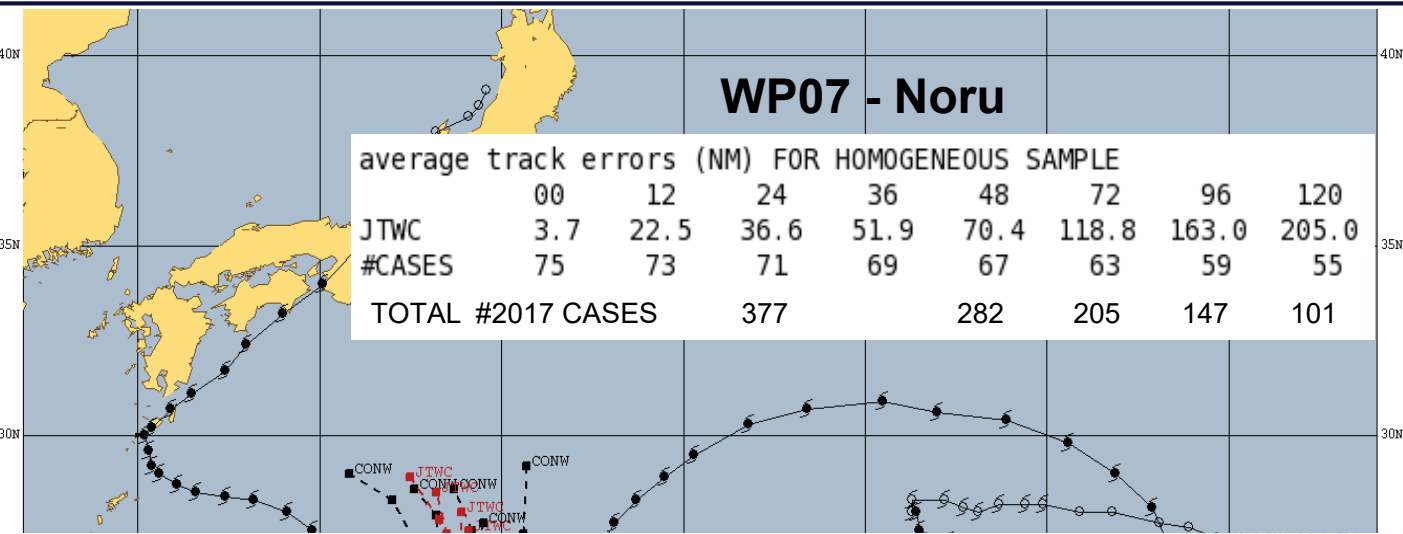


- A-climatological SW'ly track phase
- Best-tracked at 30 kts during this phase
- Models eventually indicated resumption of NW motion, but re-curved too soon

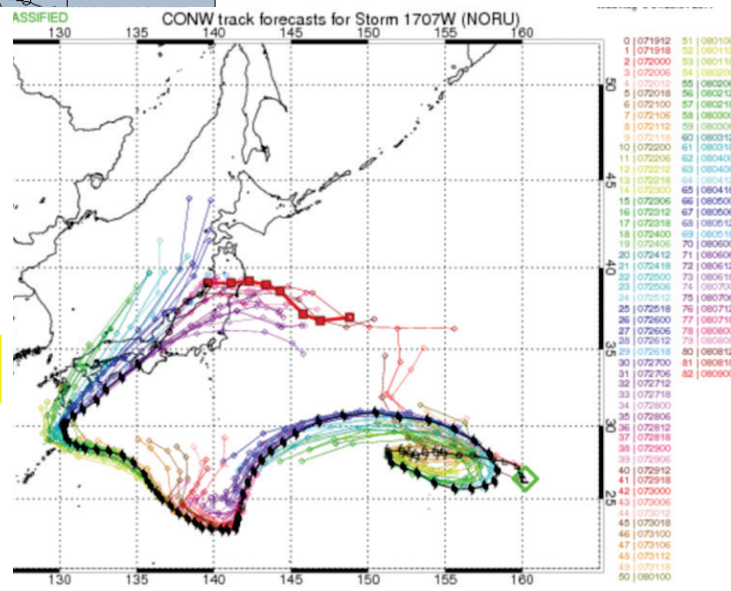
Highlights need for early guidance, and improvements for weak TCs/initialization



2017 Largest Forecast Errors, Cont'd



average track errors (NM) FOR HOMOGENEOUS SAMPLE								
	00	12	24	36	48	72	96	120
JTWC	4.2	21.7	35.7	50.5	71.4	114.6	155.3	194.8
CONW	4.8	18.9	32.2	44.1	61.0	96.3	131.5	187.3
AEMI	4.8	20.1	34.6	47.4	63.5	101.6	150.8	219.7
AVNI	4.8	20.0	34.2	47.5	61.1	96.3	132.1	189.9
COTI	4.8	28.3	50.6	73.2	95.4	156.0	243.9	360.9
ECM2	4.8	17.5	32.9	47.0	68.5	112.6	146.5	179.9
EEM2	4.8	17.0	31.4	46.1	66.9	104.3	132.3	184.5
EGRI	4.8	20.5	37.2	54.0	71.9	98.1	146.7	182.4
HWFI	4.8	22.0	39.4	52.4	68.5	120.9	174.8	221.0
NVGI	4.8	23.9	40.5	57.6	81.4	126.6	152.0	218.8
CTCI	4.8	22.3	38.2	52.0	75.9	132.2	220.2	345.4
#CASES	26	25	25	25	25	25	23	21



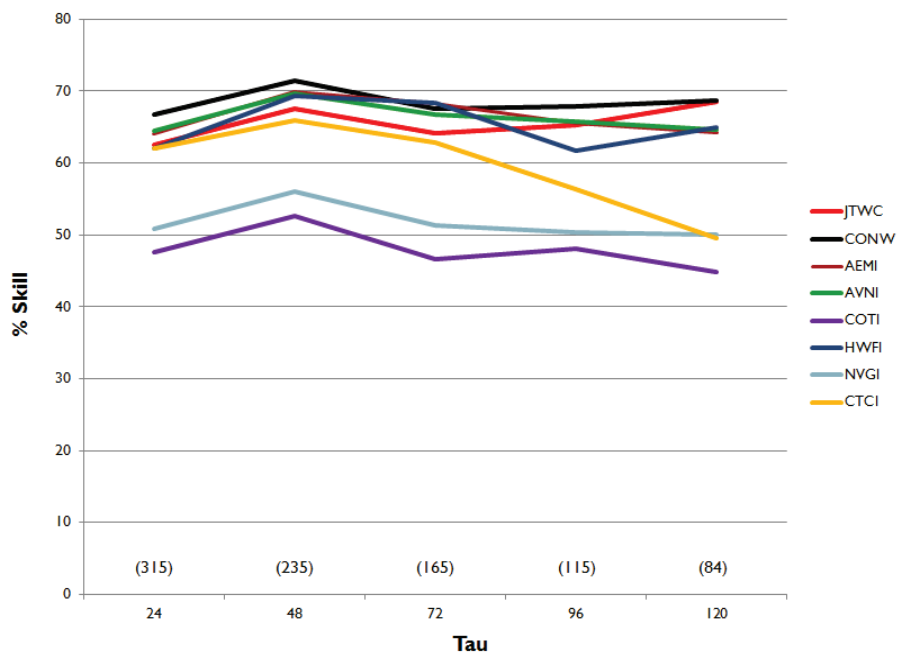
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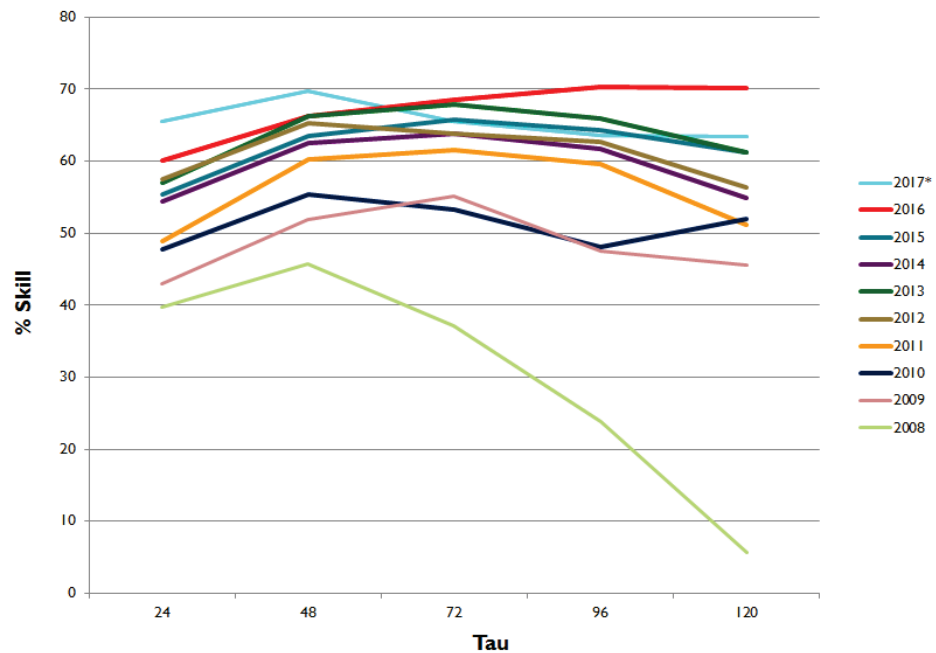
2017 Model Track Forecast Skill (* Preliminary)



2017 Model Forecast Track Skill (WPAC - Preliminary)



2008-2017 CONW WPAC Forecast Skill (As of 31 OCT 17)



- GFS, AEMN on top of one another, as well as HWRF at all but day 4
- CTCI skill competitive through day 3

- Significant increase in CONW skill at days 1-2, but down from 2016 peak for days 3-5

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2017 Model Track Forecast Skill Cont'd (* Preliminary)



average track errors (NM) FOR HOMOGENEOUS SAMPLE

	12	24	36	48	72	96	120
JTWC	32.1	48.1	66.0	91.3	146.2	175.7	206.3
CONW	28.0	43.1	58.2	77.0	127.6	164.0	203.9
AEMI	30.0	47.2	64.3	82.2	125.9	175.8	251.4
AVNI	30.4	47.1	65.6	84.7	134.4	173.8	218.9
COTI	42.8	68.2	94.8	127.1	209.5	278.1	360.7
ECM2	29.3	45.3	63.5	89.6	152.7	192.5	200.3
EEM2	29.0	44.9	63.4	85.8	144.5	171.8	230.9
EGRI	31.6	48.1	61.1	79.0	126.5	195.2	237.3
HWFI	30.3	48.0	64.9	85.7	127.5	198.5	239.5
HVGI	38.6	65.7	92.2	124.2	188.3	233.9	253.1
CTCI	31.4	50.4	68.4	93.7	144.5	243.9	347.3
#CASES	135	121	107	93	64	44	29

Aid error ≤ CONW

Small sample size

average track errors (NM) FOR HOMOGENEOUS SAMPLE

	12	24	36	48	72	96	120
AEMI	29.7	45.7	63.0	84.0	130.6	193.0	268.4
AVNI	30.3	45.9	63.8	85.9	138.7	192.0	242.4
ECMI	29.1	44.2	62.8	89.0	152.9	205.5	224.0
EEM2	28.5	44.0	62.6	86.3	148.6	187.6	242.5
EGRI	30.9	47.4	60.6	81.3	127.8	205.5	231.6
UEMI	28.9	45.5	63.1	83.6	137.2	192.3	208.3
#CASES	149	133	117	104	74	51	35

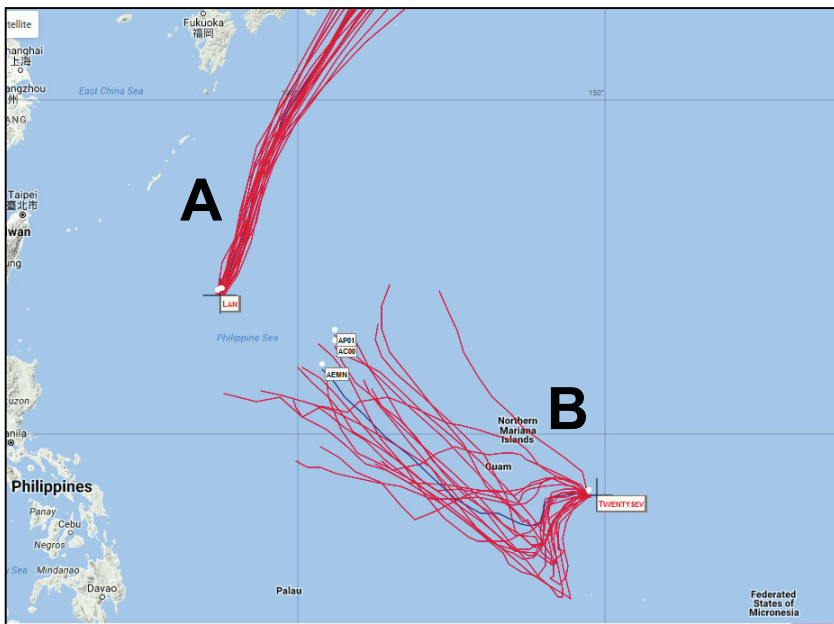
Ensemble mean error ≤ deterministic

- AEMN and EEMN ensemble means adding value to JTWC CONW, and not just at long lead times
- MOGREPS ensemble being evaluated for addition to CONW. USAF version of the deterministic Unified model added for 2017.

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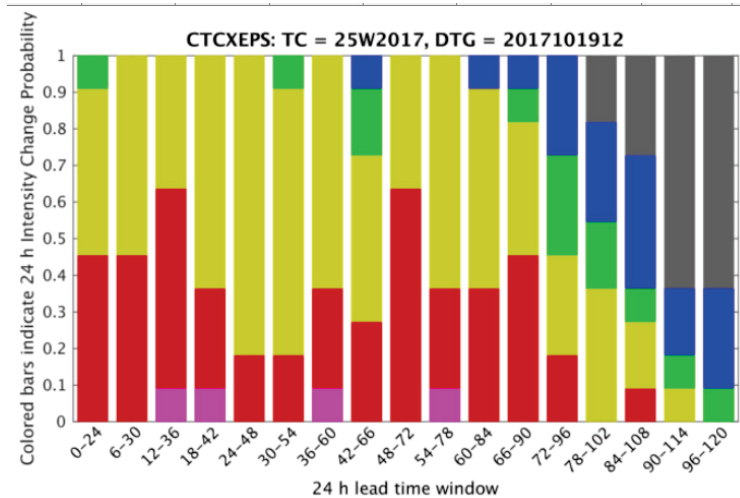


Ensembles



- Effective forecaster use of ensemble information, particularly case B-type, remains challenging except to say there is significant uncertainty, manual inspection of the strike-P, and ultimately the ensemble mean
- TDOs have track ‘ensemble fatigue’ with 2/3/4/5 EMNs, NEUs, FEMNs, etc., etc. Automated track clustering may be useful

- Skillful intensity ensembles, on the other hand, are sparse in JTWC AOR. HWRF/HMON would be a welcome addition for evaluation!
- TDOs like COAMPS-TC intensification depiction, but more members needed.
- Extra-tropical transition timing would be useful
- Assessing potential for ensemble-based storm size is another area for study



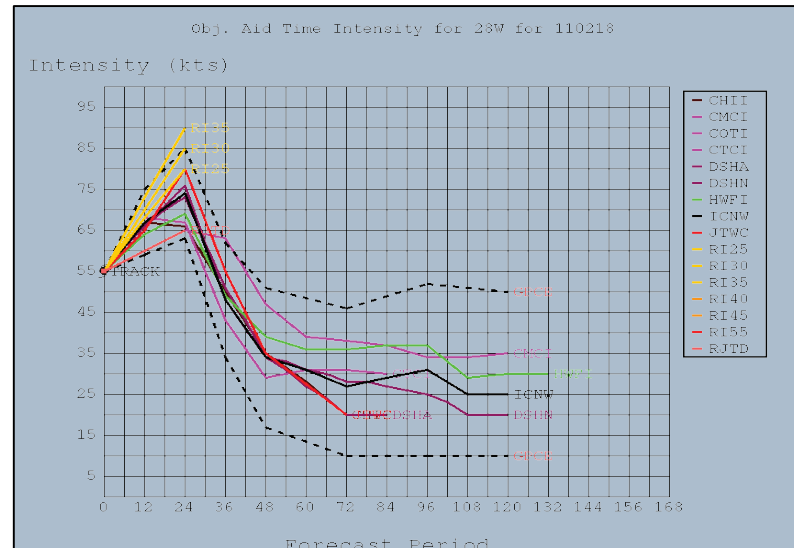
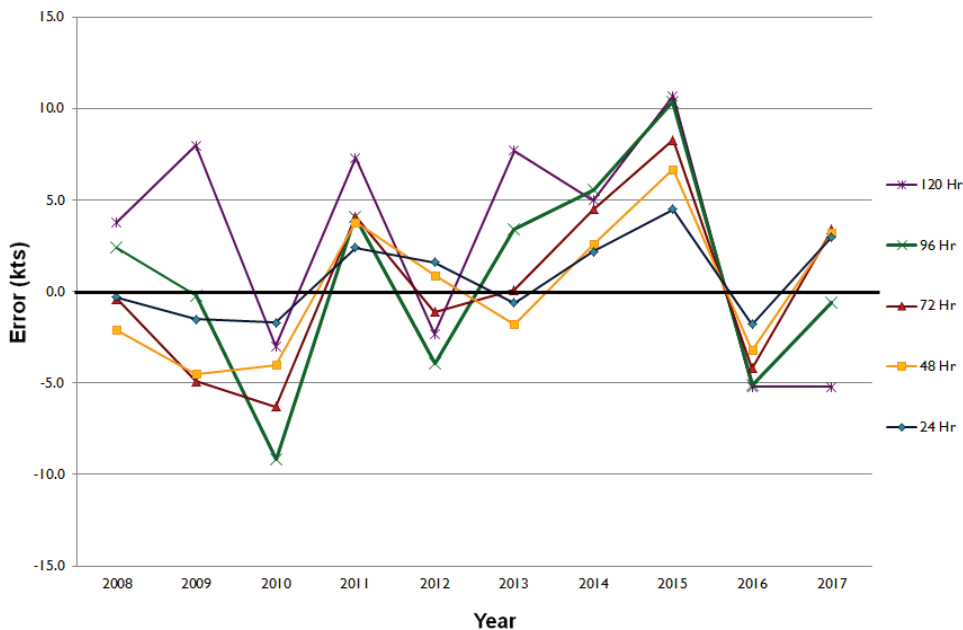
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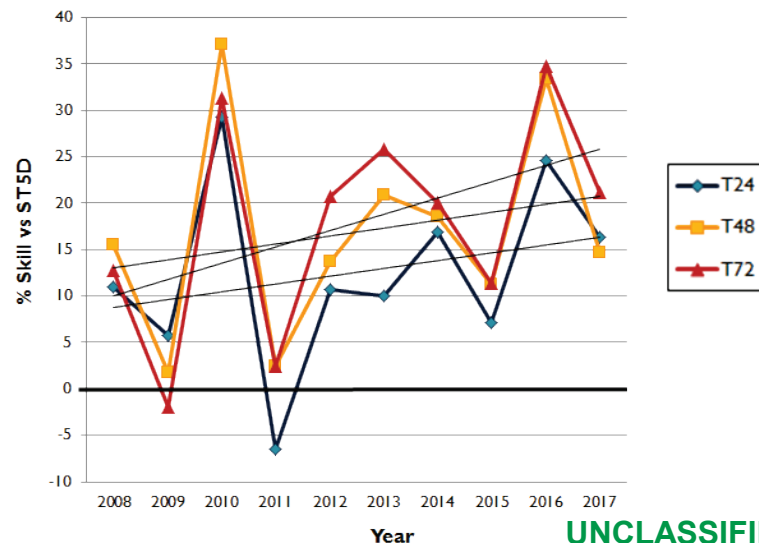
2017 JTWC WESTPAC Forecast Intensity Error (* Preliminary)



JTWC WESTPAC Average Intensity Biases 2008-2017* (* As of 31OCT17)



- **New RI guidance in ATCF installed in Sept**
- **JHT project to evaluate MI cyan ring as an RI predictor in WPAC/SHEM – not enough data to evaluate**



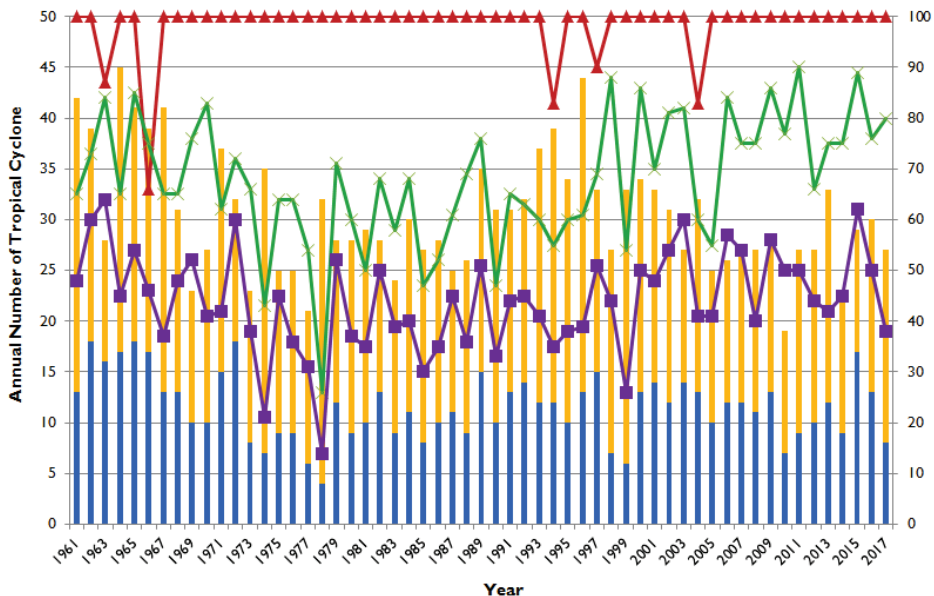
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Forecast Challenges – Rapid Intensification



**% of Tropical Cyclones with Rapid Intensification*
WESTPAC**



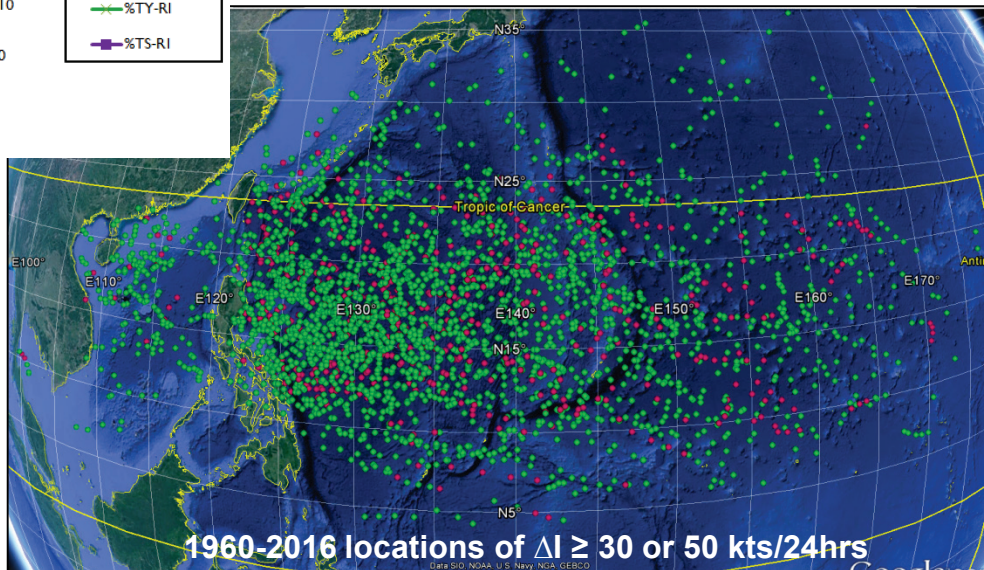
* RI defined as the an increase of 30 kts or more per 24 hours. Only the first occurrence of RI per TC is counted.

2017 TCs with RI/ERI*

- WP07 Noru - ERI
- WP14 Banyan- RI
- WP15 Hato- RI
- WP17 Sanvu - RI
- WP20 Talim - RI
- WP21 Doksuri - RI
- WP24 Khanun - RI
- WP25 Lan - ERI

*** 95% percentile of intensifying TCs in WESTPAC actually corresponds to ≥ 40 kts/24 hours**

- Below average year for RI, only 38% of TS or higher had ≥ 30 kts/24 hours
- RI frequency and spatial distribution contribute to the forecast challenge



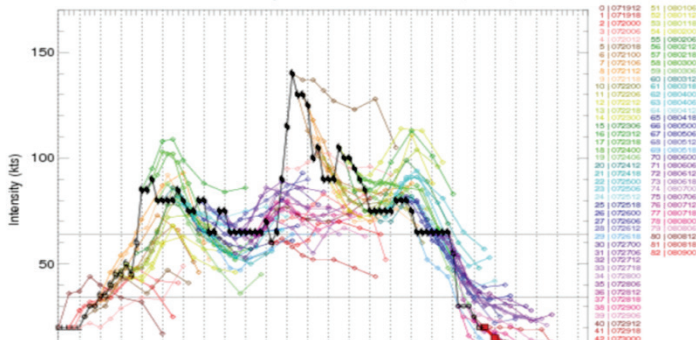
1960-2016 locations of $\Delta I \geq 30$ or 50 kts/24hrs



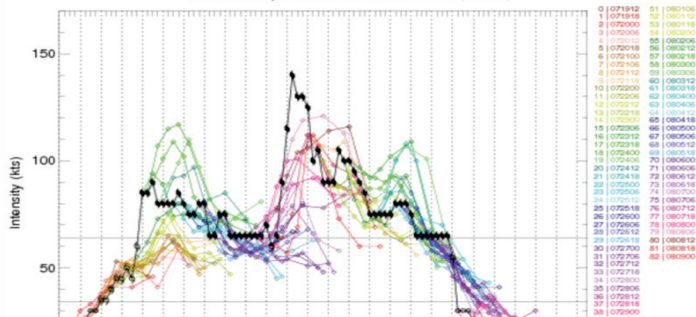
Rapid Intensification, cont'd



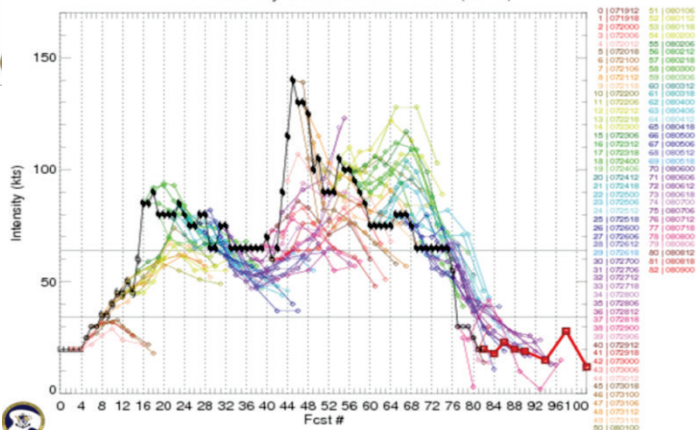
UNCLASSIFIED HWFI intensity forecasts for Storm 1707W (NORU)



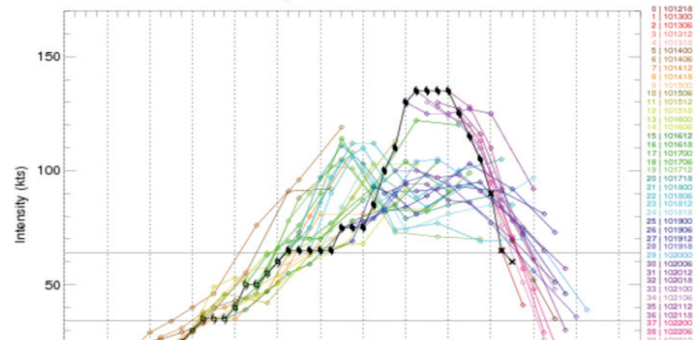
UNCLASSIFIED CTCI intensity forecasts for Storm 1707W (NORU)



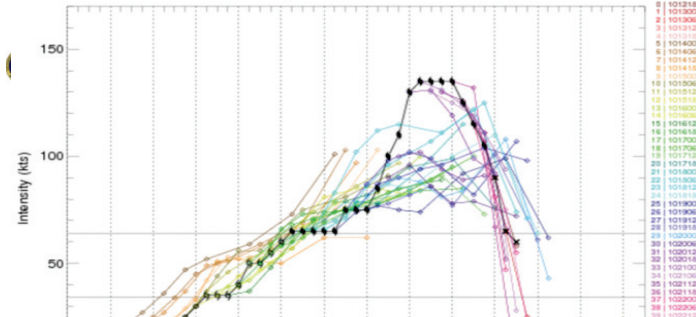
UNCLASSIFIED COTI intensity forecasts for Storm 1707W (NORU)



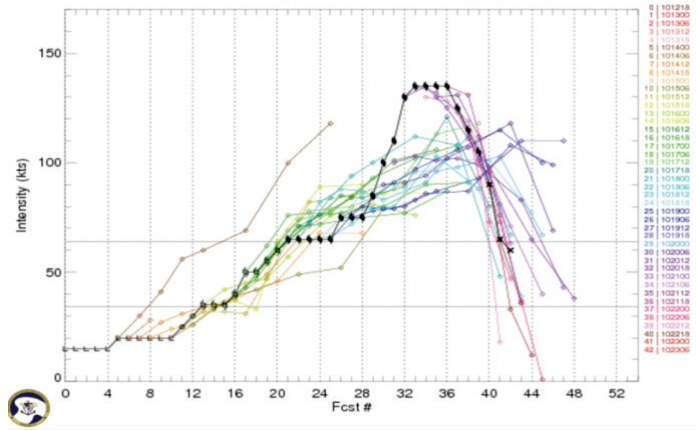
UNCLASSIFIED HWFI intensity forecasts for Storm 1725W (LAN)



UNCLASSIFIED CTCI intensity forecasts for Storm 1725W (LAN)



UNCLASSIFIED COTI intensity forecasts for Storm 1725W (LAN)

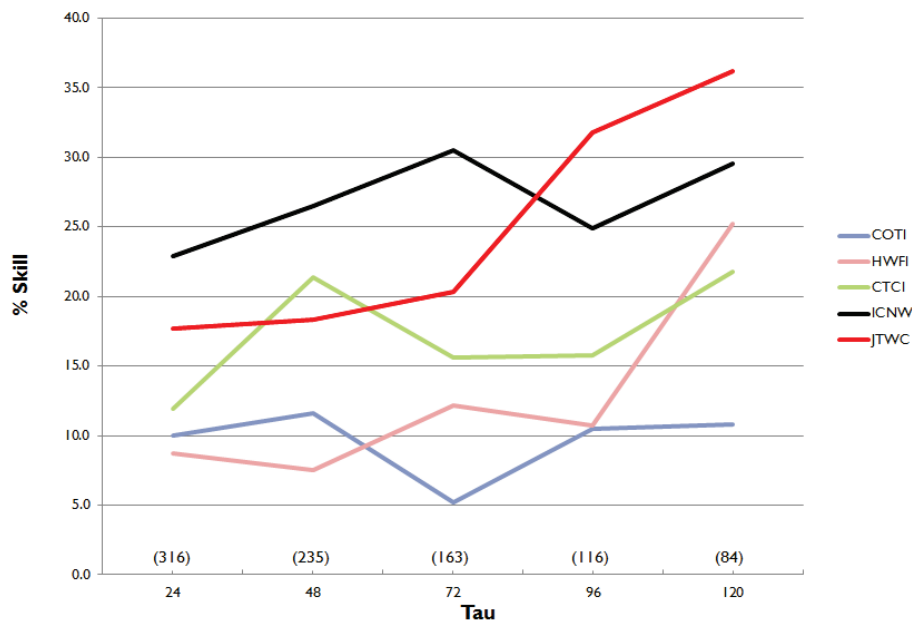




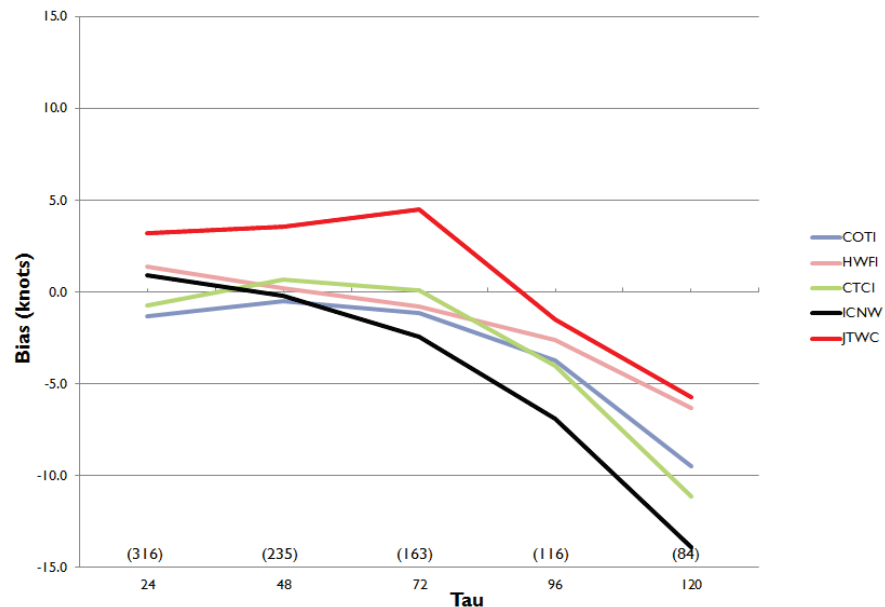
Model Forecast Intensity



2017 Model Forecast Intensity Skill (WPAC - Preliminary)



2017 Model Forecast Intensity Bias (WPAC - Preliminary)

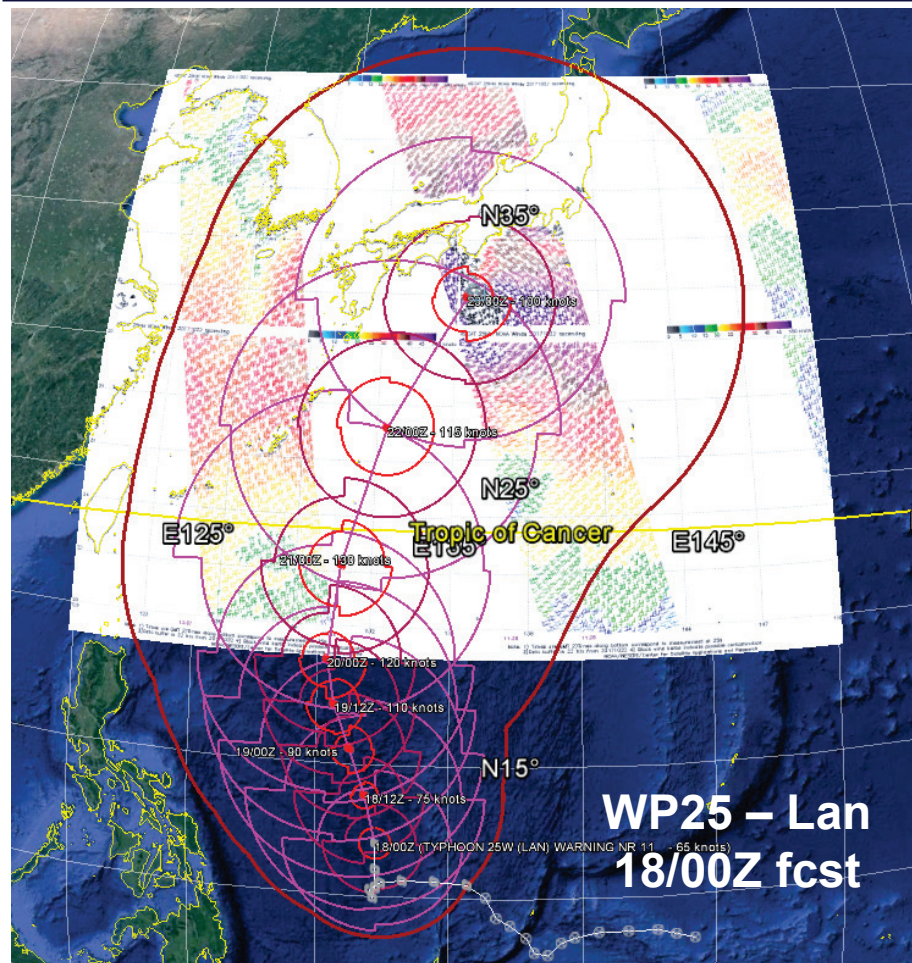


- JTWC beat ICNW at Days 4/5
- Large negative bias at Day 5 largely attributed to 07W (Noru)
- JTWC very interested in 1st year HMON results, potential for HMON evaluation in JTWC basins for 2018 – even if experimental

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Wind Radii



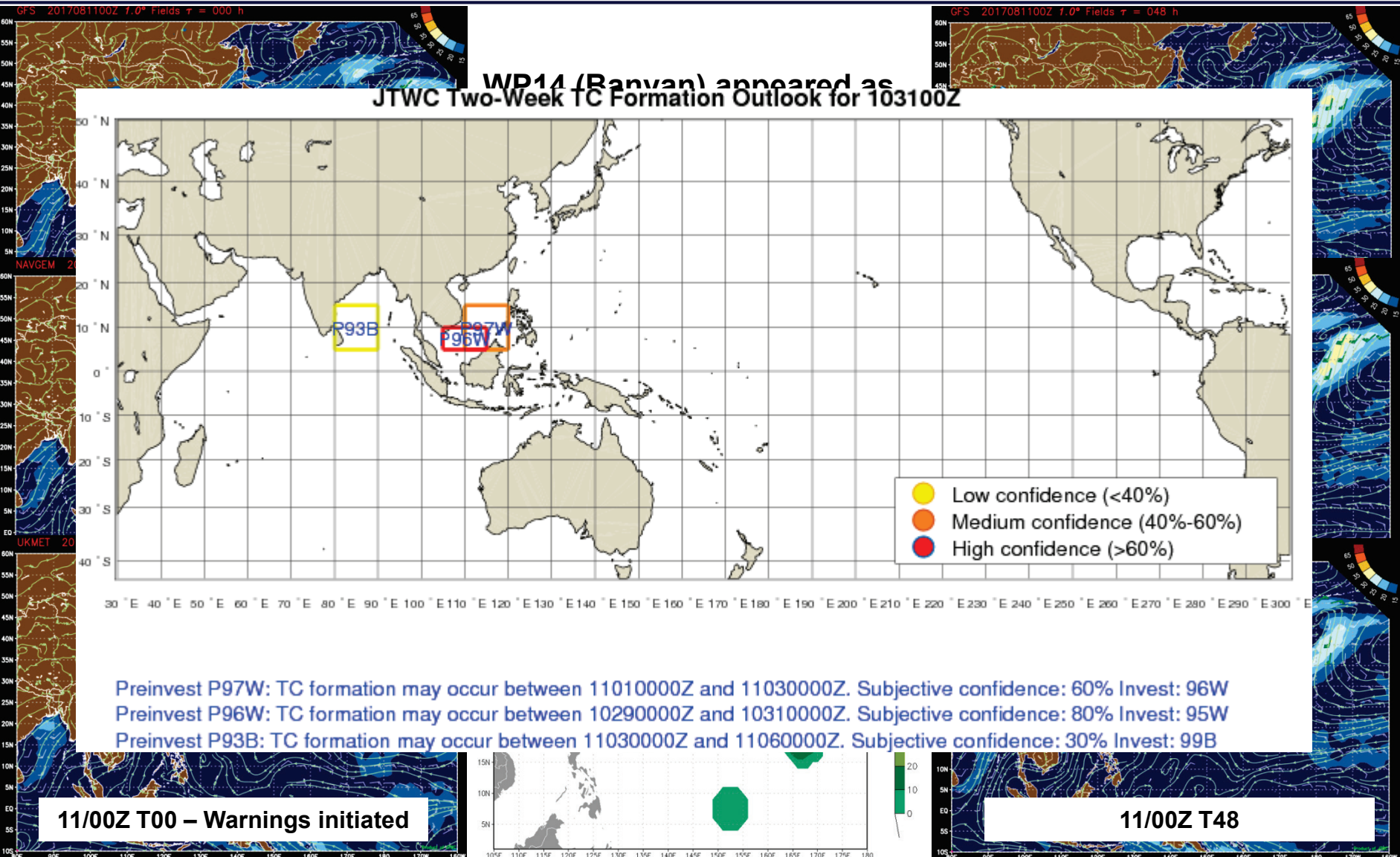
- 2017 first year for 5-day radii forecasts - Analysis/results to be presented at AMS
- RVCN significantly reduced small bias of DRCL (re-derived for 2017)
- RVCN degraded by loss of GFDL
- Much more accurate 34-knot swath depiction at days 4/5
- Noted several instances of “large” hurricanes in Atlantic with tremendous impacts – NWP storm size is an area for future HFIP work, though TC size not specifically noted in Weather Act



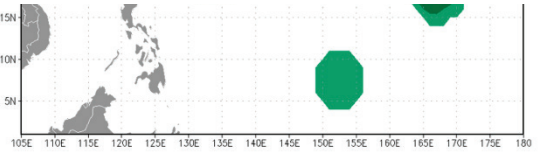
- Dynamic, probability-based swath remains the goal



Genesis



11/00Z T00 – Warnings initiated



11/00Z T48



Strategic Development Priorities



- **ATCF Development**

Chapter 5 Technical Development Summary

Section 1: Operational Priorities

The top operational priority of the Joint Typhoon Warning Center remains the sustained development and support of The Automated Tropical Cyclone Forecast System (ATCF). ATCF is the DOD's primary toolkit for analyzing and forecasting tropical cyclones (TCs), and is the principal software platform through which emerging research transitions into JTWC operations. Without ATCF, JTWC could not generate TC formation alerts or warnings. The systems tracks all TC activity and invest areas, automatically processes objective forecasting aids, produces TC formation alert, warning text and graphical products, and provides core capabilities for analyzing TCs and their environment. Additionally, ATCF provides JTWC Contingency of Operations Plan (COOP) backup capabilities to Fleet Weather Center (FWC)-Norfolk and analytic support to FWC-San Diego for tasks such as setting TCCOR, forecasting on-station wind speed, designating Optimum Track Ship Routing (OTSR) "MODSTORM" locations, and preparing diverts and advisories. JTWC upgraded to the latest

- **AWIPS-II at JTWC, installation scheduled March FY18**

JTWC is interested in seeing more HFIP products developed for these systems vice websites, where feasible

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Other Development Priorities



Further improvements/refinements to wind structure analysis and forecasts

- JTWC released 2016 best-tracked radii. 2013-2015 will be released.
- Planning to continue radii best-tracking, pending funding

Storm surge in JTWC AOR

Basin-scale HWRF, COAMPS-TC

- Concurrent TCs in WPAC, monsoon depressions and gyres

Operational COAMPS-TC ensembles

- Including addition of NAVGEM, GFS, UKMet, etc as parent model

NWP initialization of monsoon depressions

7-day forecasting

- In-house evaluation of 7-day skill and resource impacts pushed to 2018

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Thank You!



The collaborative efforts of the many agencies, labs, and academia through HFIP are making a difference.

Questions?

References:

Sampson, C. R., et. al. (2017). Tropical cyclone gale wind radii estimates, forecasts and error forecast for the western North Pacific. Manuscript submitted for publication.

Sampson C. R, and J. A. Knaff, 2015: A consensus forecast for tropical cyclone gale wind radii. *Wea. Forecasting*, 30, 1397-1403.

Knaff, J.A., C.J. Slocum, K.D. Musgrave, C.R. Sampson, and B.R. Strahl, 2016: Using Routinely Available Information to Estimate Tropical Cyclone Wind Structure. *Mon. Wea. Rev.*, 144, 1233–1247

Sampson C. R., E. M. Fukada, J. A. Knaff, B. R. Strahl, M. J. Brennan, and T. Marchok, 2017: Tropical cyclone gale wind radii estimates for the western North Pacific. *Wea. Forecasting*, 32, 1029-1040.

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