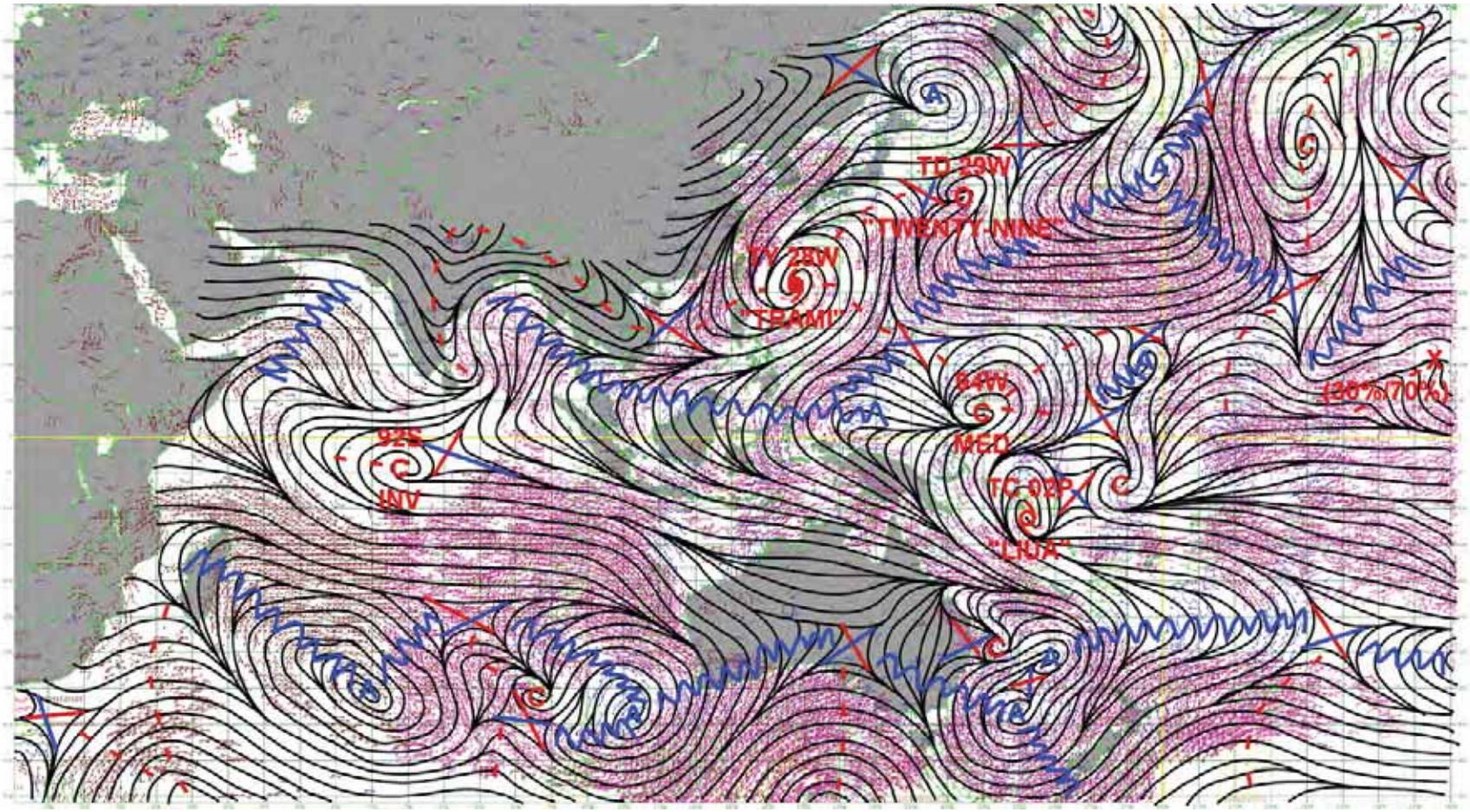
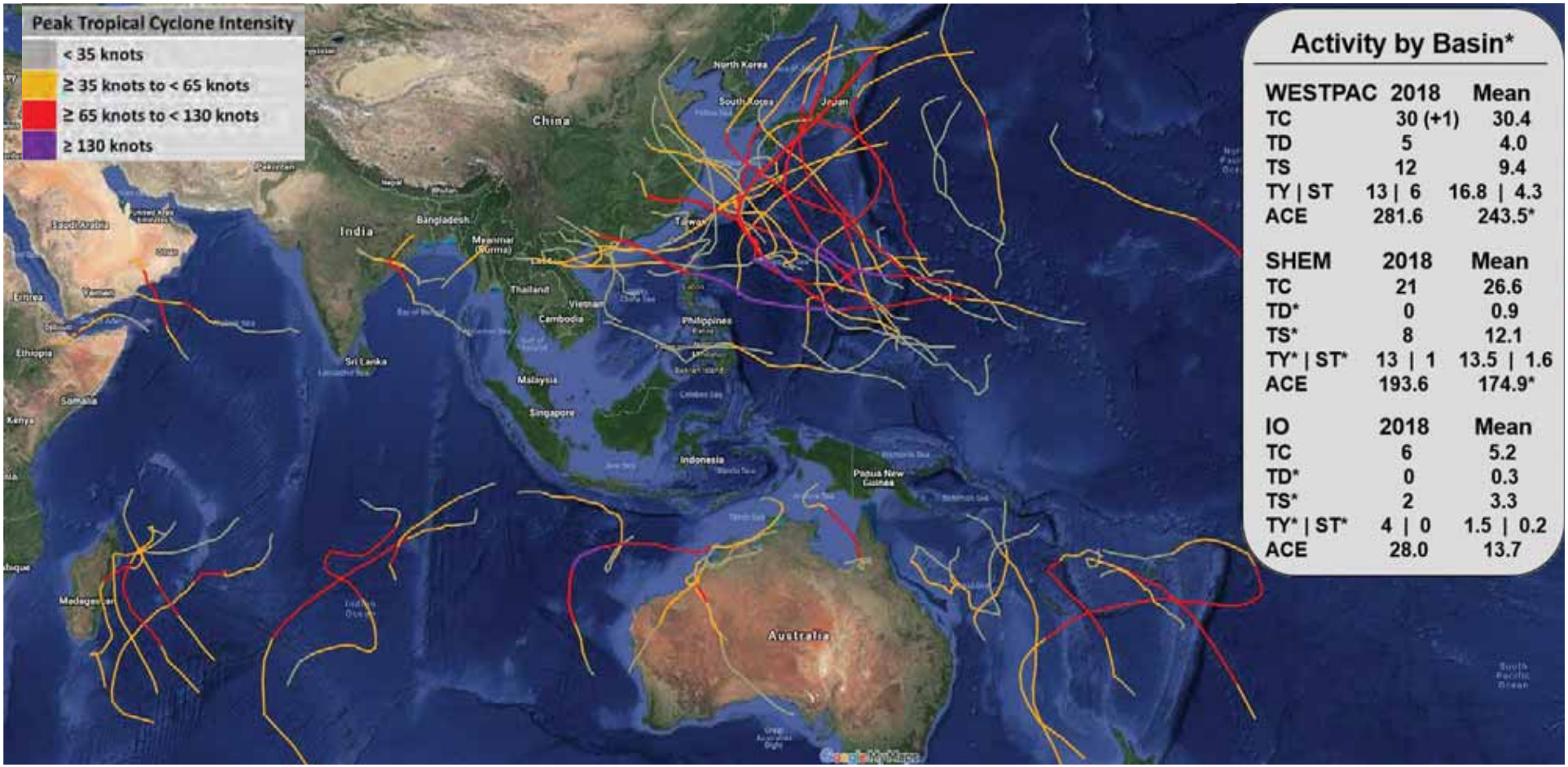
2018 Year in Review: Joint Typhoon Warning Center TC Activity, Forecast Challenges, and Priorities



OWEN SHIEH
Training Department Head
Joint Typhoon Warning Center
Pearl Harbor, Hawaii

UNCLASSIFIED

2018 JTWC Warned Tropical Cyclones
(*As of 18OCT18)



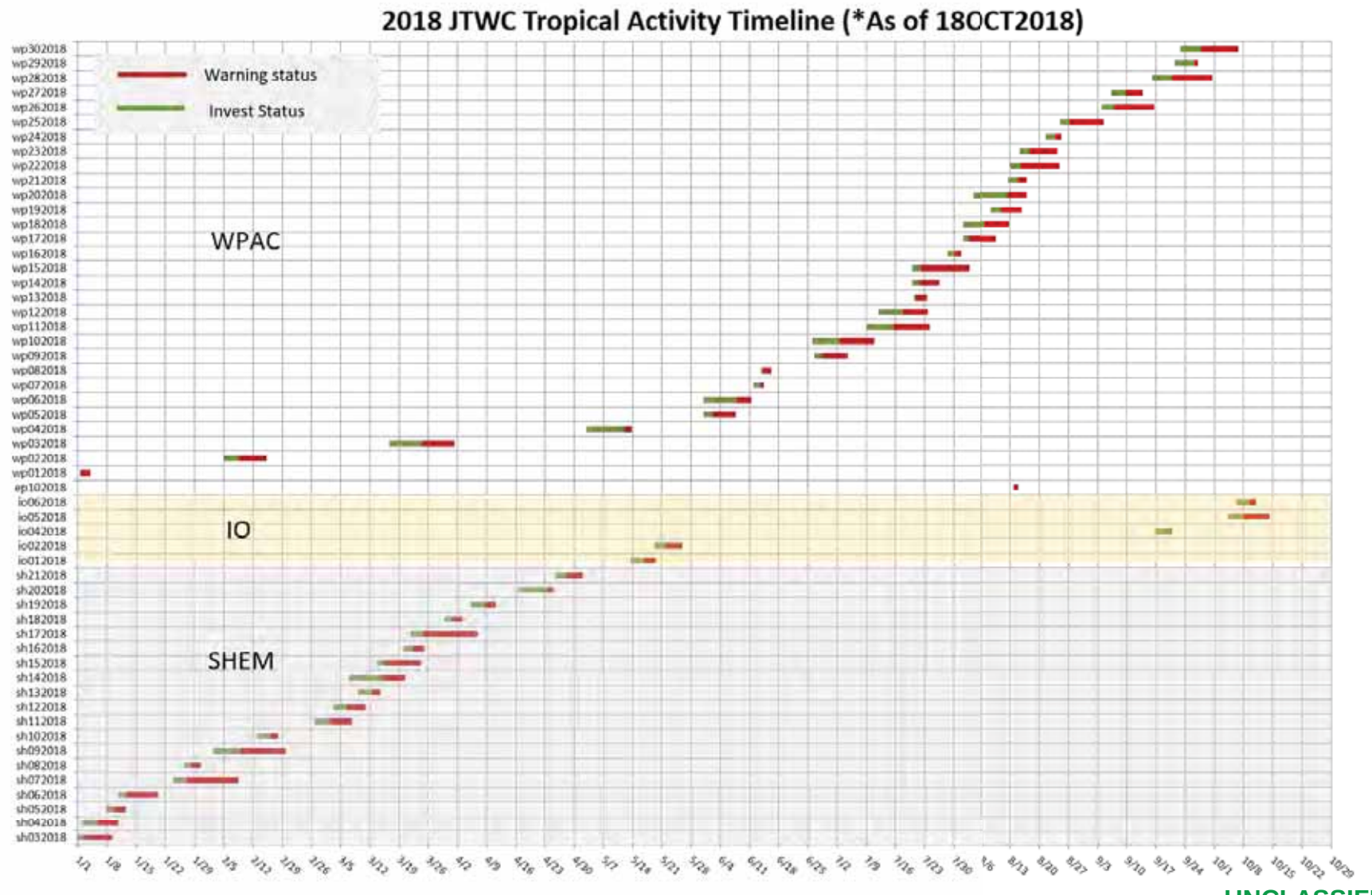
Activity by Basin*

WESTPAC	2018	Mean
TC	30 (+1)	30.4
TD	5	4.0
TS	12	9.4
TY | ST	13 | 6	16.8 | 4.3
ACE	281.6	243.5*

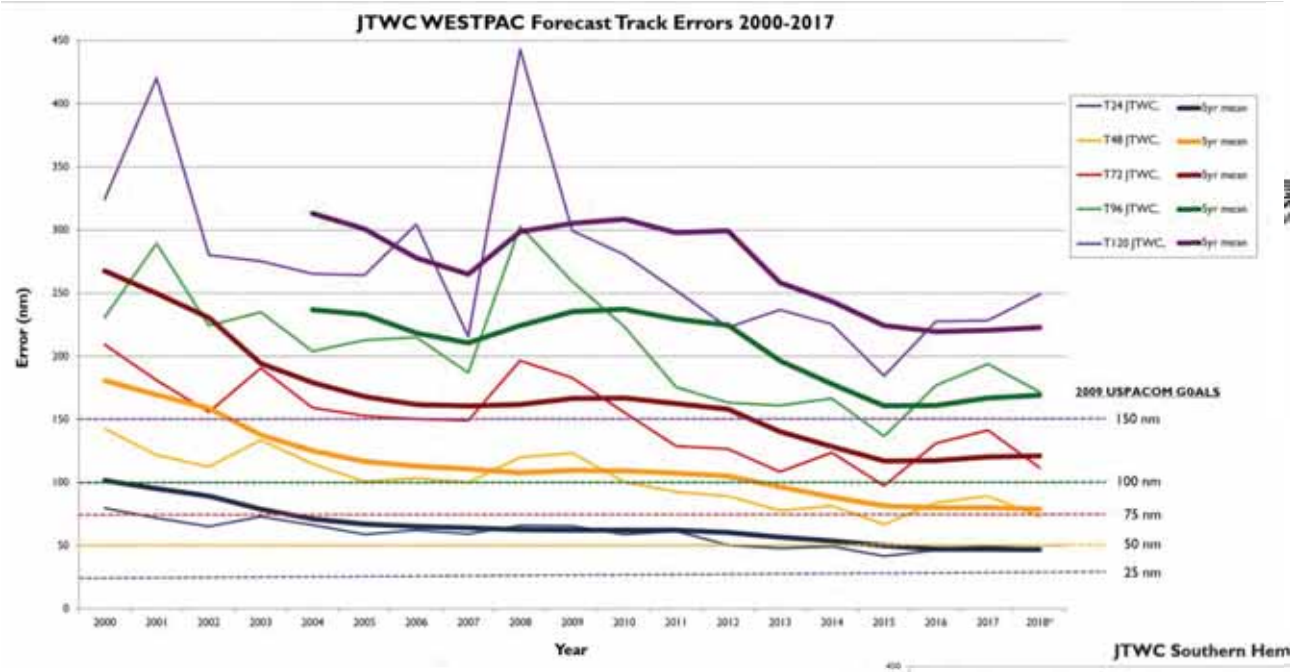
SHEM	2018	Mean
TC	21	26.6
TD*	0	0.9
TS*	8	12.1
TY* | ST*	13 | 1	13.5 | 1.6
ACE	193.6	174.9*

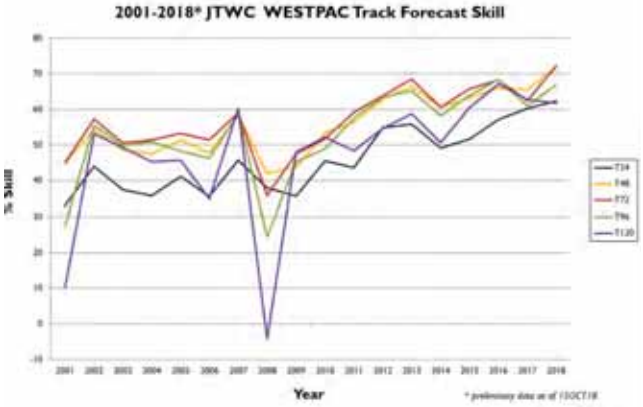
IO	2018	Mean
TC	6	5.2
TD*	0	0.3
TS*	2	3.3
TY* | ST*	4 | 0	1.5 | 0.2
ACE	28.0	13.7

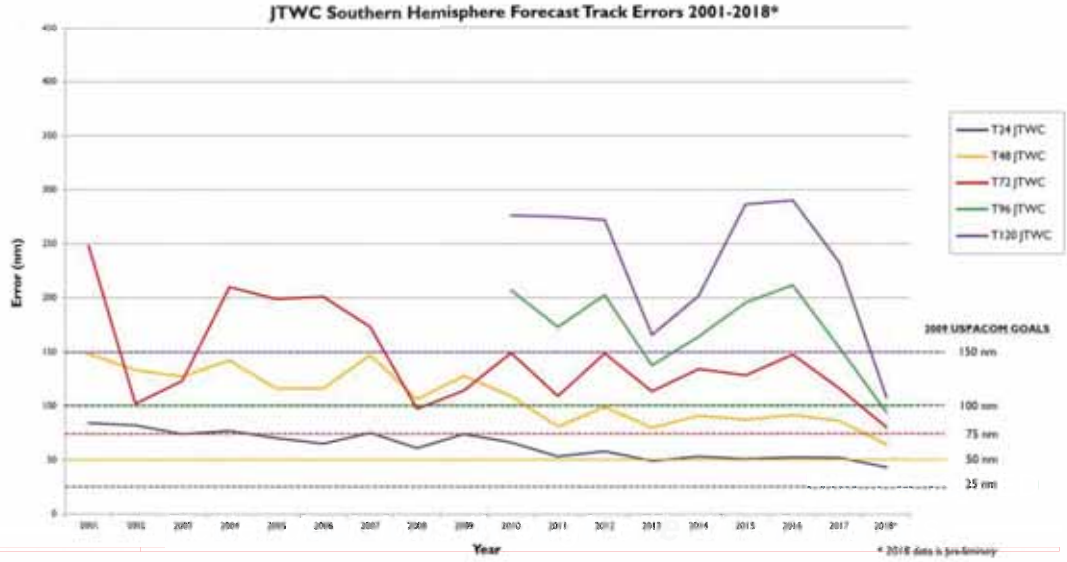
2018 JTWC Tropical Cyclone Timeline



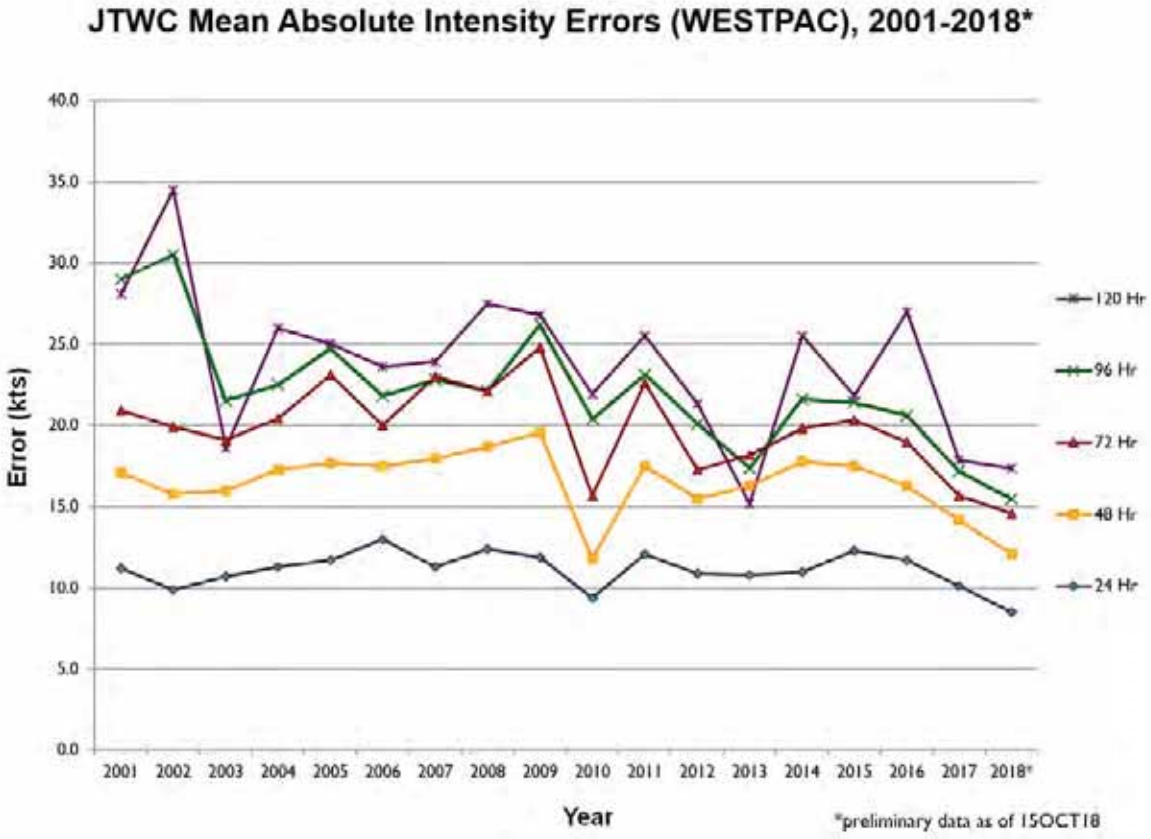
2018 JTWC Track Forecasts

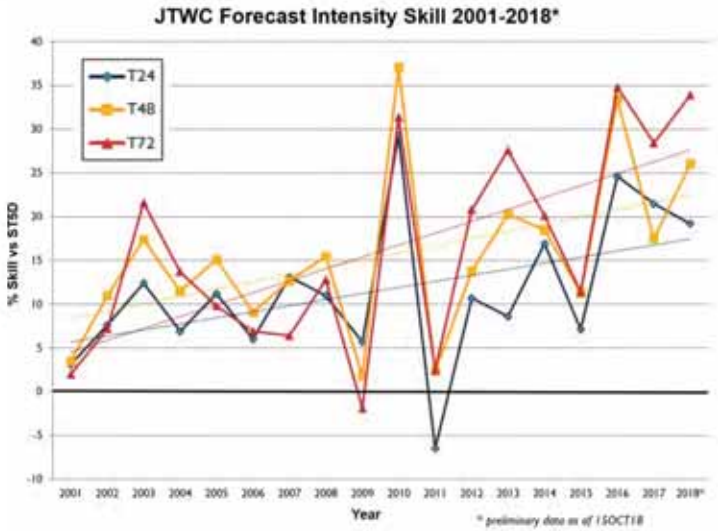


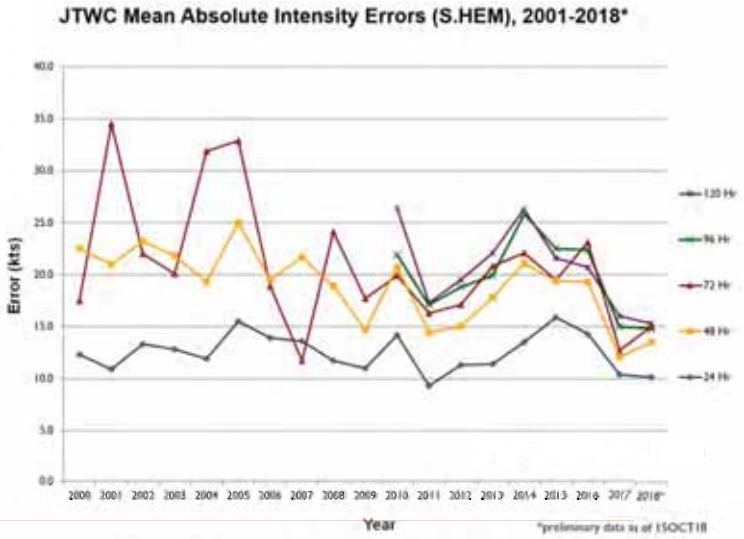




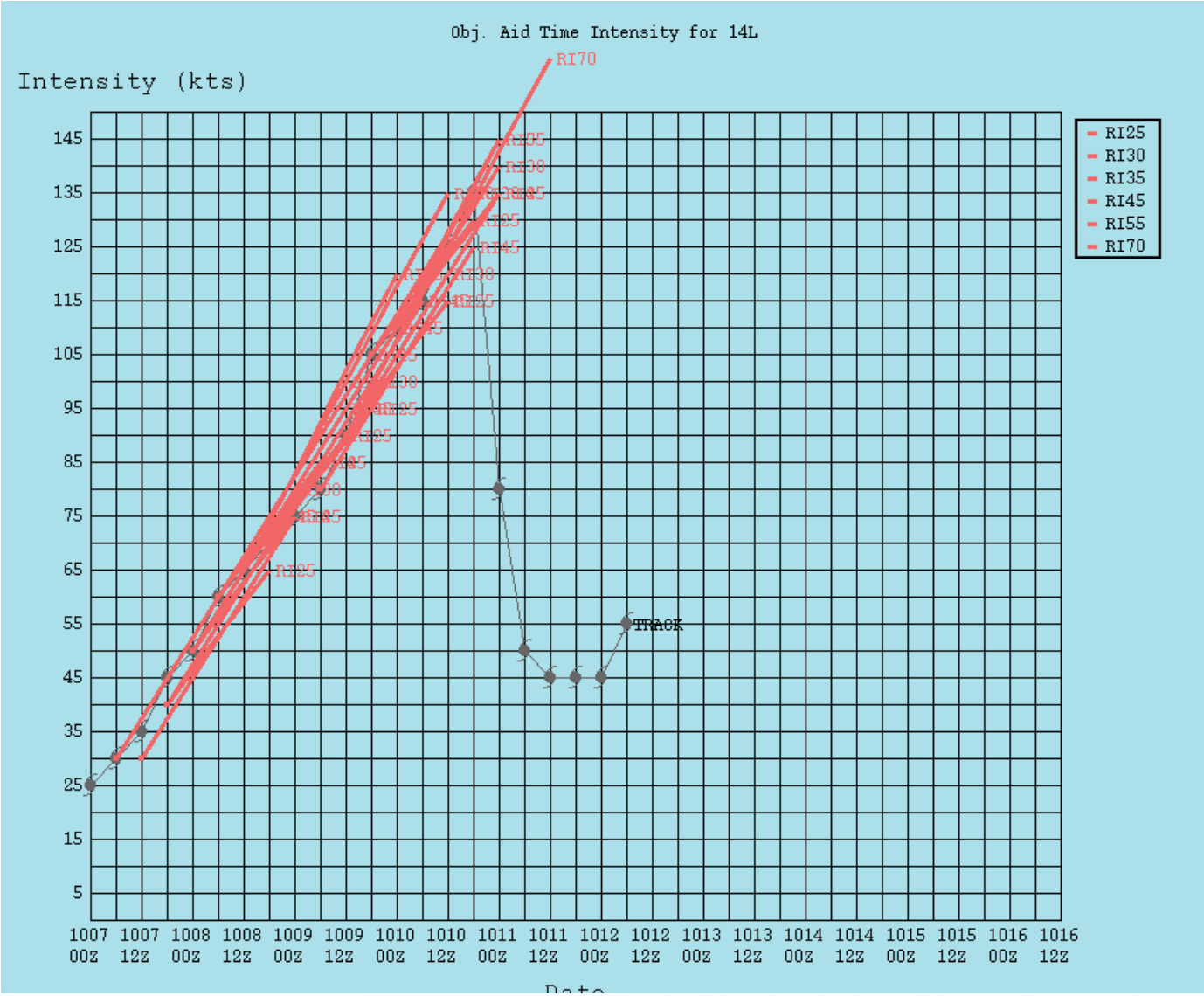
2018 JTWC Intensity Forecasts



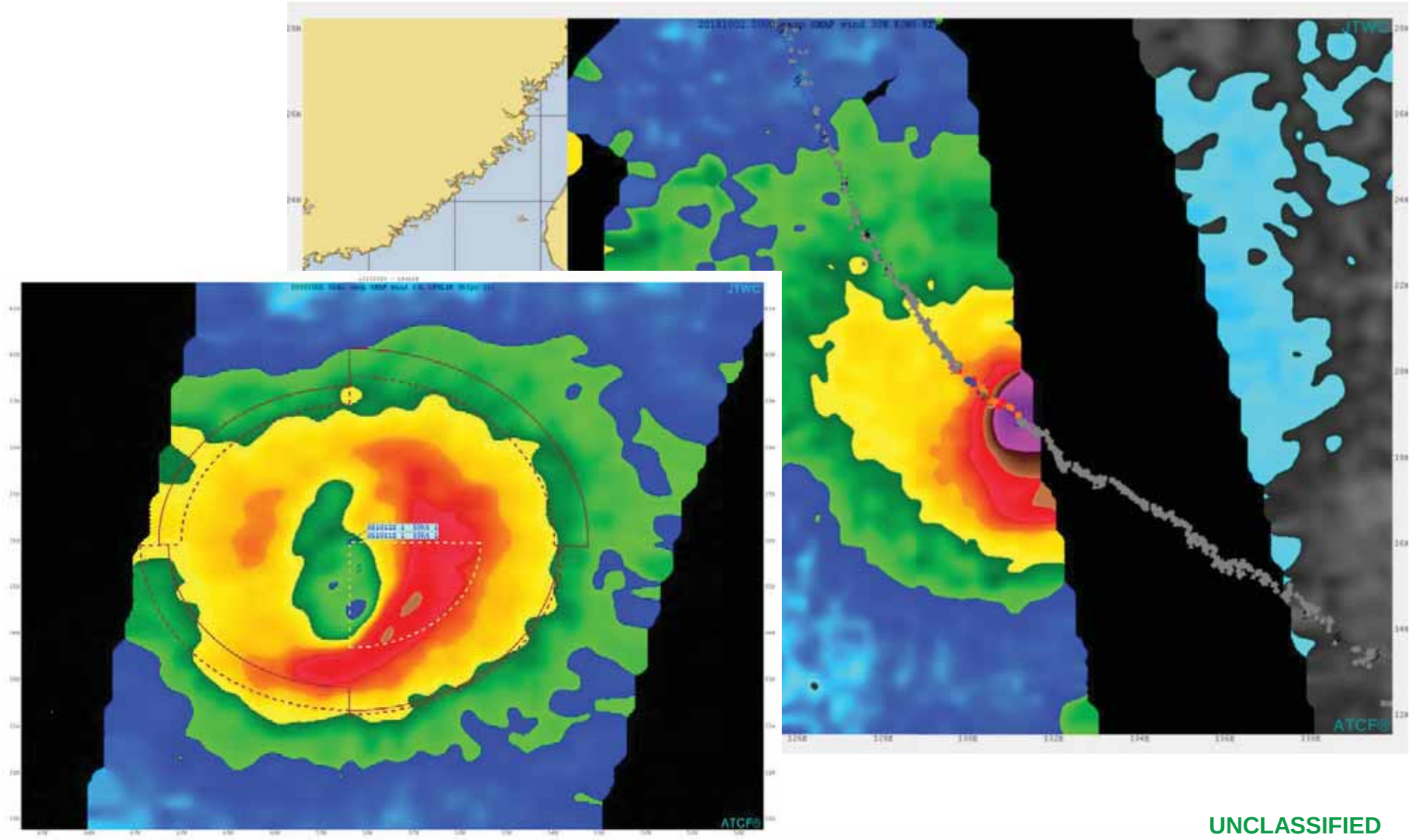




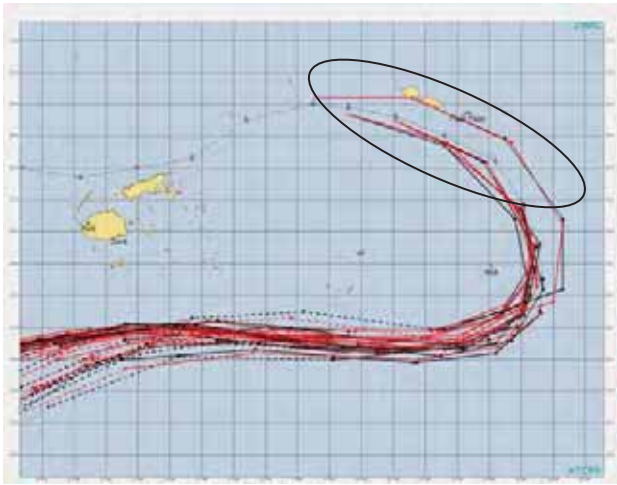
Operational Implementation: RIPA

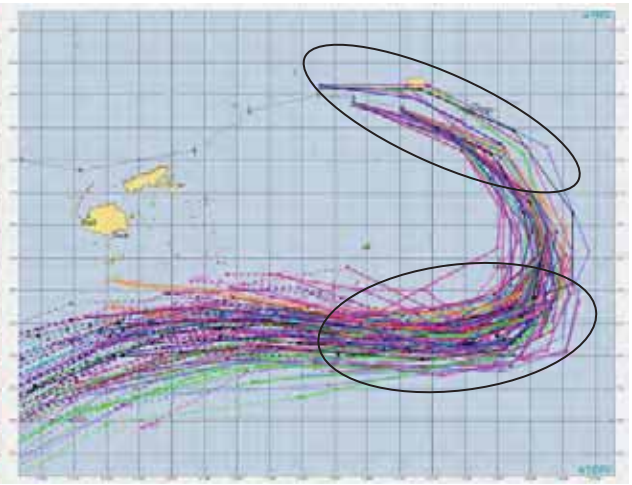


Operational Implementation: SMAP



TC 09P (GITA) Track

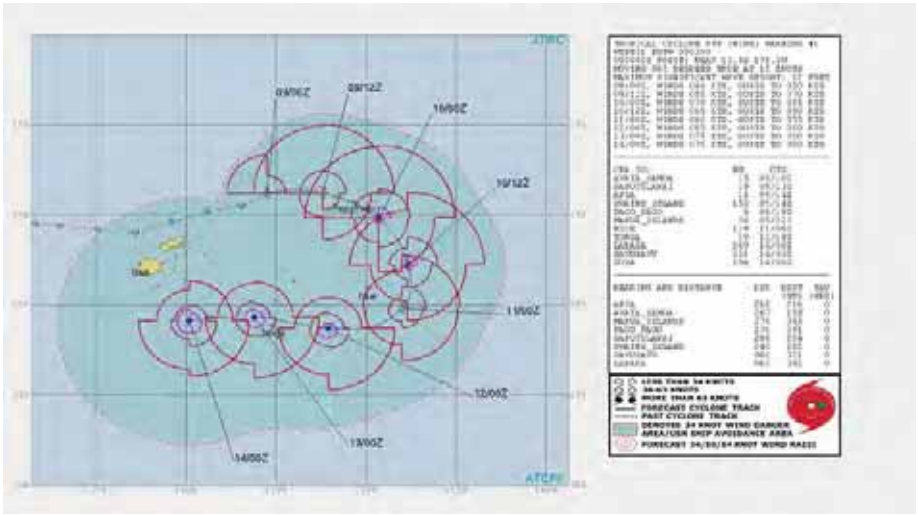




average track errors (NM) FOR HOMOGENEOUS SAMPLE

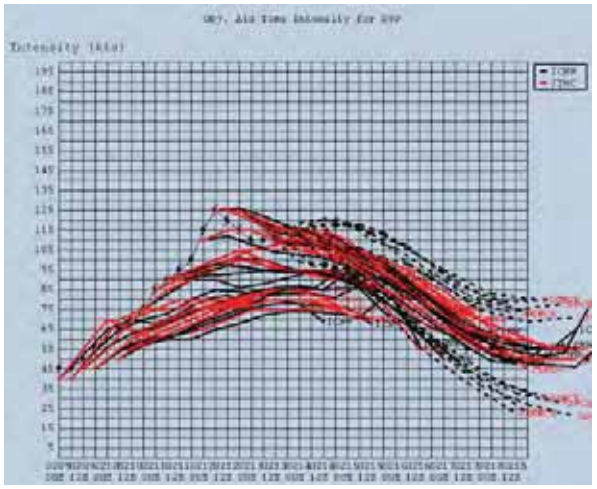
	00	12	24	36	48	72	96	120
JTWC	11.4	17.5	22.4	34.6	46.4	79.9	0.0	0.0
CONW	11.4	15.6	21.9	30.8	39.6	67.6	0.0	0.0
AVHI	11.7	16.8	24.6	33.7	43.7	72.5	0.0	0.0
ECMI	11.7	19.1	25.7	31.7	33.6	50.7	0.0	0.0
JGSI	11.7	18.0	31.0	41.3	53.9	79.4	0.0	0.0
AFUI	11.7	21.5	32.8	48.6	67.2	116.8	0.0	0.0
NVGI	11.7	20.8	33.1	48.3	68.7	115.2	0.0	0.0
#CASES	33	32	31	30	29	26	0	0

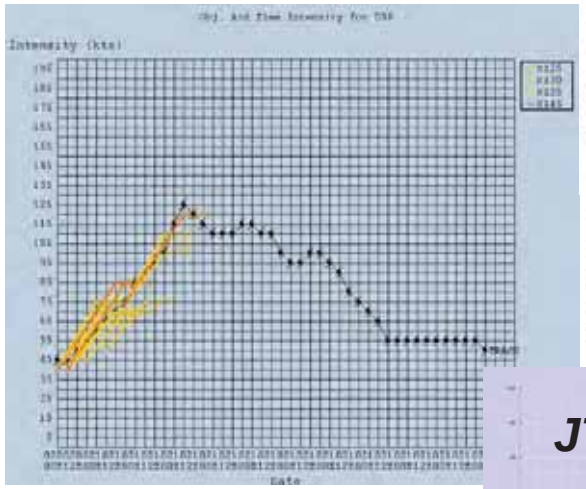
- **Difficulty with the initial position led to increased errors in the long term**
- **CONW and ECMWF had lowest errors**
- **AFUM and NAVGEM had significant errors at tau 72**
- **Combination of the error in the initial position, a wide spread in model guidance and sharply curved track made for a challenging forecast**



UNCLASSIFIED

TC 09P (GITA) Intensity



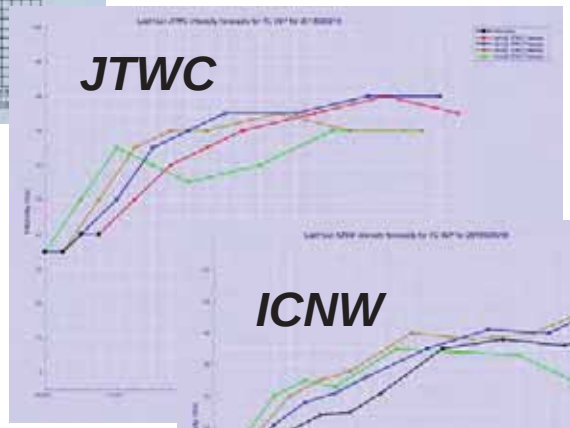


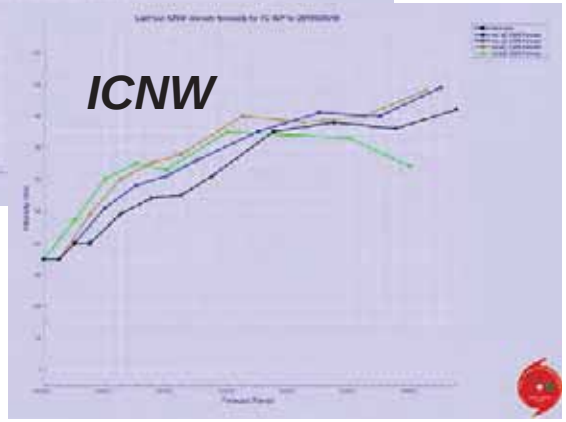
AVERAGE INTENSITY ERRORS (KT) FOR HOMOGENEOUS SAMPLE

	00	12	24	36	48	72	96	120
JTWC	4.4	6.3	7.5	8.3	10.6	13.5	13.1	15.0
CONW	4.4	8.8	14.2	19.4	23.9	30.1	29.5	31.0
COTI	4.4	8.3	14.6	18.6	15.6	14.1	12.8	16.5
HMPI	4.4	5.6	8.7	11.8	14.5	15.6	17.3	24.1
CTCI	4.4	8.5	12.7	14.0	16.1	13.2	10.3	10.0
#CASES	42	40	38	36	34	30	26	22

FREQUENCY OF SUPERIOR PERFORMANCE (%)

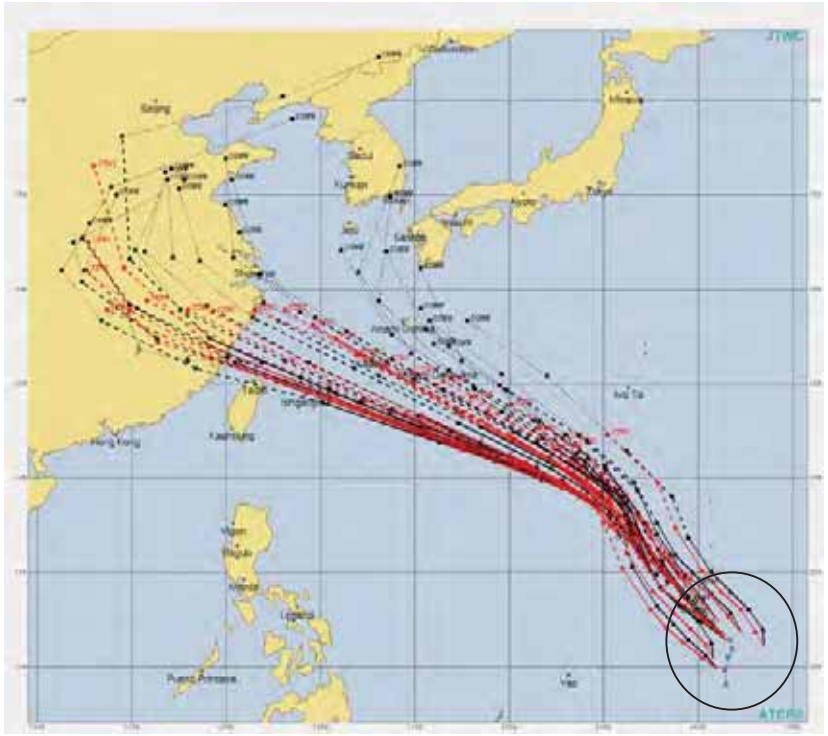
	00	12	24	36	48	72	96	120
JTWC	20.0	26.1	40.4	40.5	34.2	34.3	25.0	22.7
CONW	20.0	13.0	8.5	0.0	2.6	0.0	7.1	9.1
COTI	20.0	17.4	14.9	16.7	23.7	20.0	35.7	22.7
HMPI	20.0	32.6	25.5	21.4	18.4	11.4	10.7	0.0
CTCI	20.0	10.9	10.6	21.4	21.1	34.3	21.4	45.5

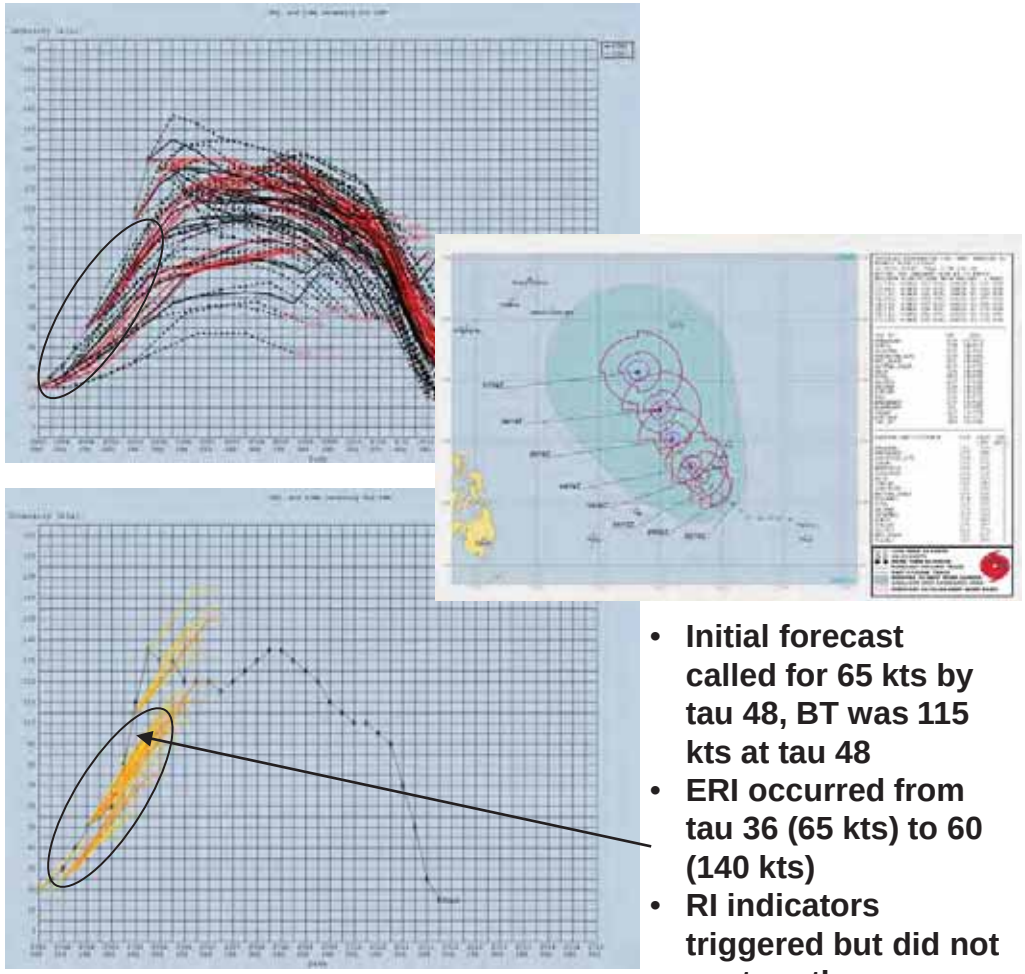




- JTWC intensity generally too low
- JTWC had highest frequency of superior performance at all taus except 120
- RI indicators triggered and were fairly accurate, still a relatively new feature for JTWC at this time (February 2018)
- Inconsistent intensity forecasts early in the life of the storm

STY 10W (MARIA) Track & ERI

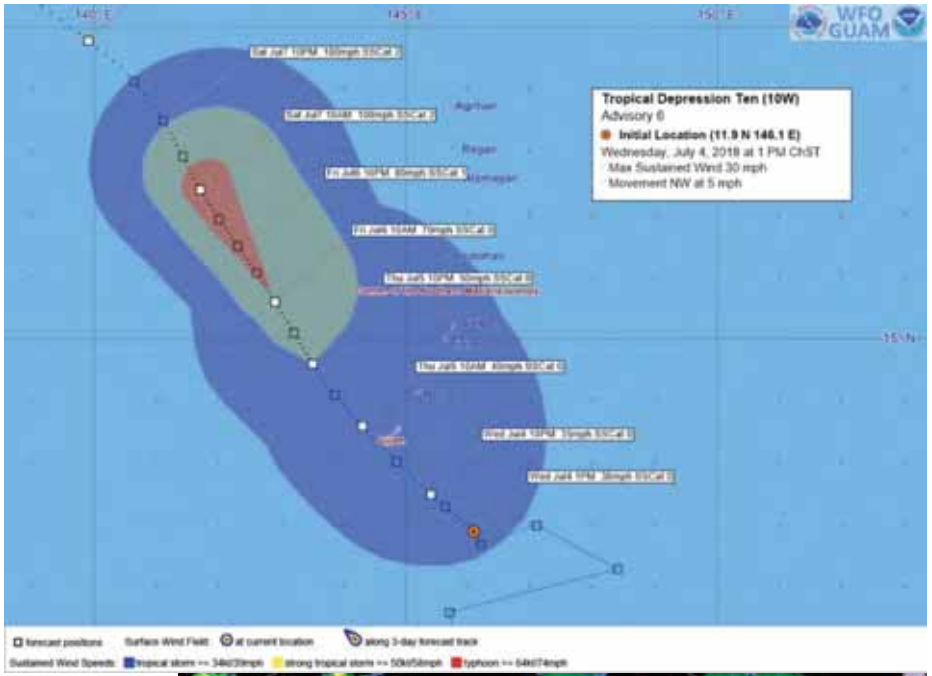


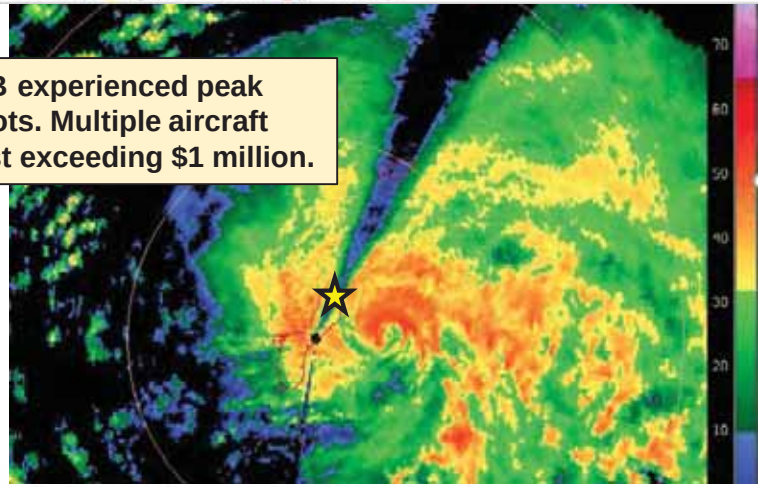


- LLCC difficult to locate early in life of system, resulting in large track errors
- intensified from 25 kt TD to 130 kt STY in 54 hours
- JTWC & ICNW lagged in behind in intensity
- RI indicators triggered but were still generally too weak

- Initial forecast called for 65 kts by tau 48, BT was 115 kts at tau 48
- ERI occurred from tau 36 (65 kts) to 60 (140 kts)
- RI indicators triggered but did not capture the magnitude of the RI

STY 10W (MARIA): Mesoscale Mystery





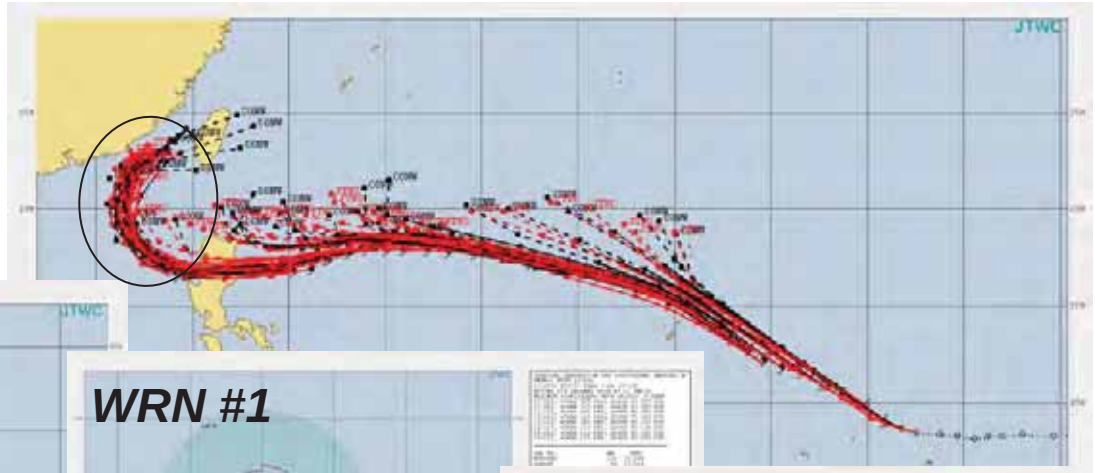
Andersen AFB experienced peak wind of 83 knots. Multiple aircraft damaged; cost exceeding $1 million.

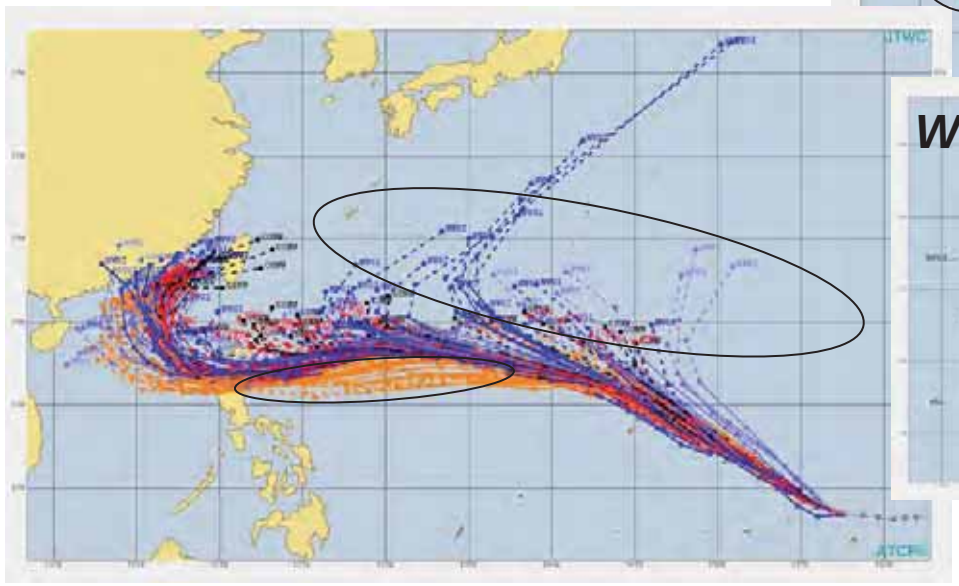
Courtesy of Chip Guard, NWS Guam

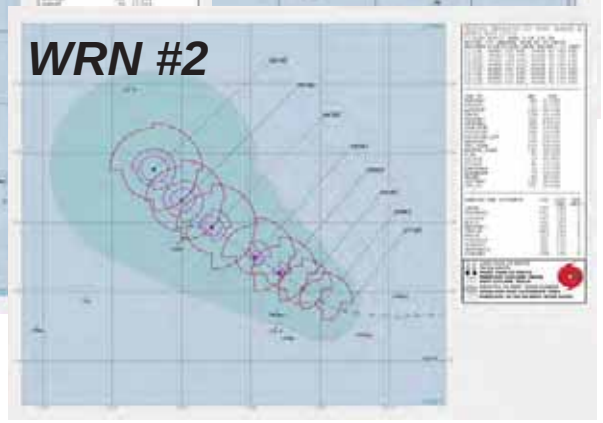
STY 31W (YUTU) Track

average track errors (NM) POR HOMOGENEOUS SAMPLE

	00	12	24	36	48	72	96	120
JTWC	3.0	22.6	28.9	38.9	51.1	101.9	195.3	314.0
CONW	3.7	18.8	24.8	35.0	48.1	97.4	190.9	353.2
AVNI	3.7	22.1	34.6	47.5	67.4	118.0	201.3	340.1
ECMI	3.7	19.8	25.5	36.4	47.1	74.1	118.9	177.1
JGSI	3.7	19.5	33.7	45.4	57.6	89.1	121.2	136.7
AFUI	3.7	19.8	33.5	41.8	47.6	74.7	116.9	155.5
NVGI	3.7	22.9	36.7	48.9	70.1	157.4	359.0	730.8
#CASES	37	36	34	32	30	26	23	20



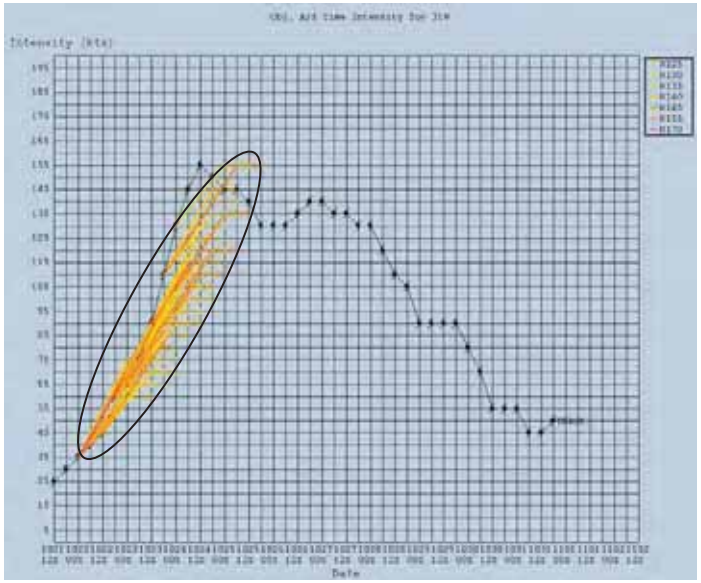




- NAVGEM and GFS: northward track and recurve scenario early in the life of the storm
- ECMWF, JGSM, and AFUM: more westward track

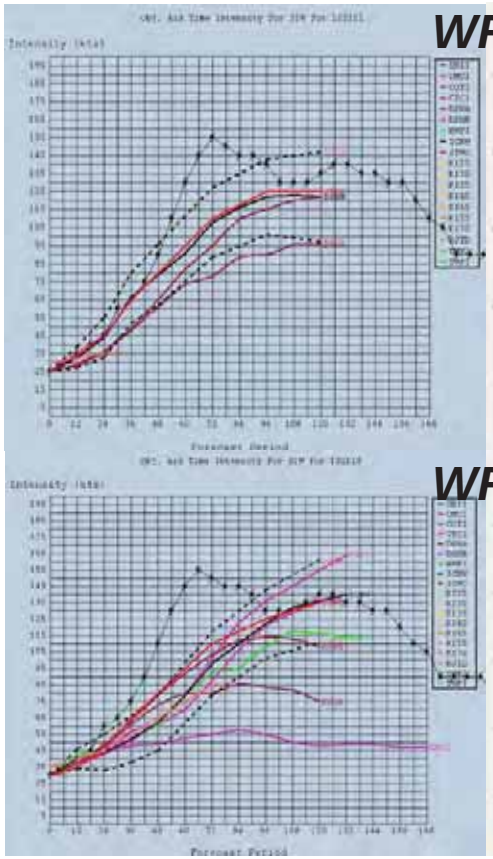
- LLCC was fairly easy to locate
- Initial forecasts placed W of CONW
- Better model agreement west of 130E

STY 31W (YUTU) Intensity

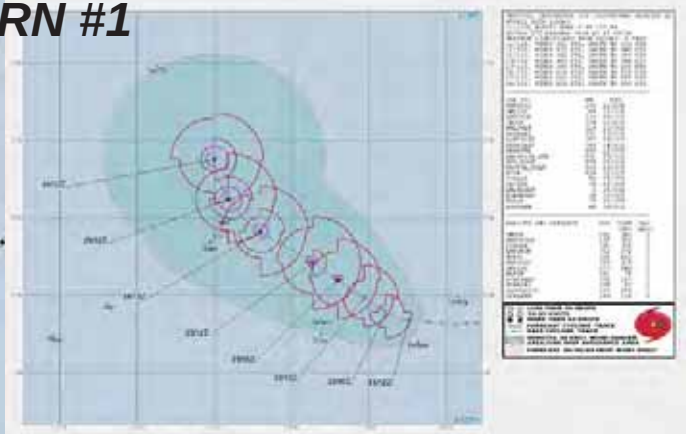


AVERAGE INTENSITY ERRORS (KT) FOR HOMOGENEOUS SAMPLE								
	00	12	24	36	48	72	96	120
JTWC	0.6	8.3	14.7	19.3	21.6	20.5	22.5	26.4
CONW	0.6	10.4	18.7	24.9	30.9	38.0	43.4	46.6
COTI	0.6	10.9	18.8	23.0	24.8	21.9	24.3	38.6
HWFI	0.6	8.3	13.9	15.3	19.2	20.9	20.3	27.2
CTCI	0.6	10.3	17.6	21.0	23.3	21.0	28.8	36.6
#CASES	42	40	38	36	34	30	26	21

- RI indicators early on
- HWFI at the lowest error at all taus except 72 (JTWC)
- JTWC relied on RI indicators and generally did better than the other guidance



WRN #1

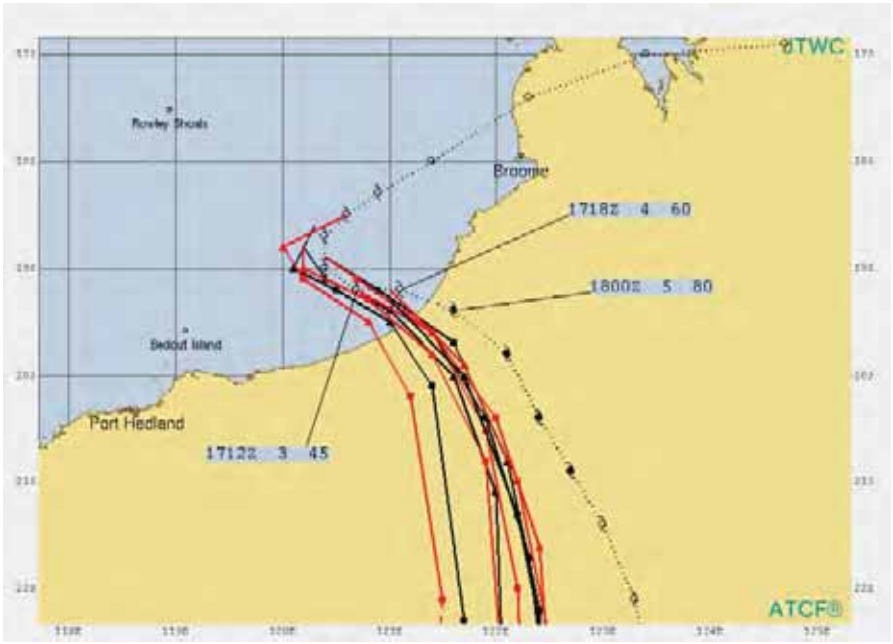


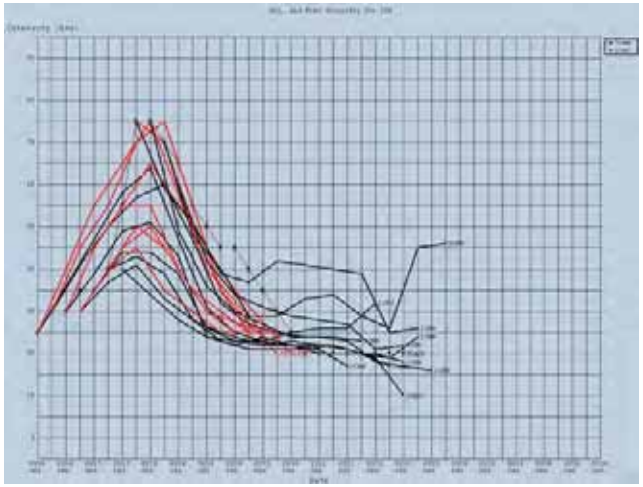
WRN #2

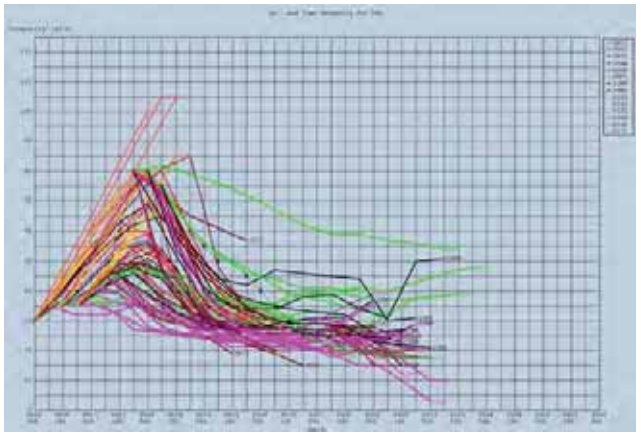
- Initial forecast: 25 kt TD to be 125 kt TY by tau 120, peak BT was 155 kts at tau 72
- Second forecast: 30 kt TD to be 130 kt STY by tau 120, peak BT was 155 kt at tau 66

UNCLASSIFIED

TC 10S (KELVIN) RI @ Landfall



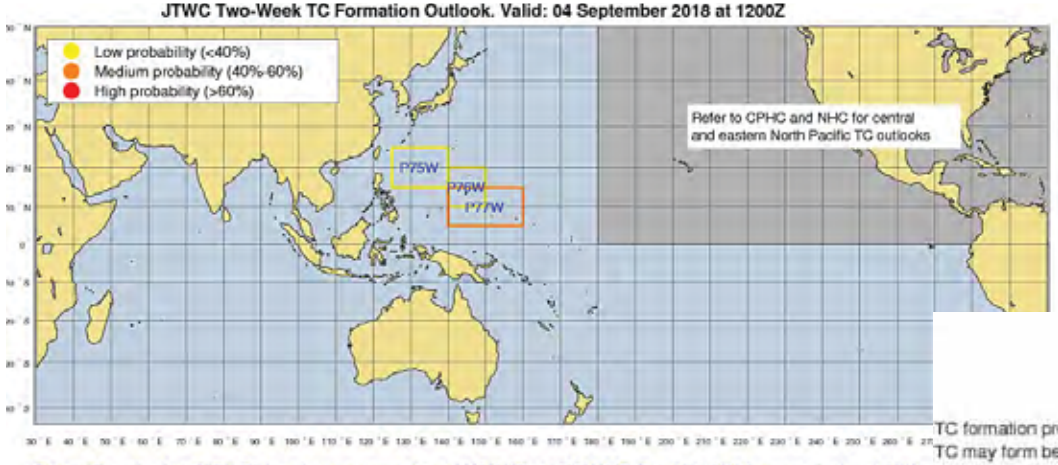




- **RI 70 triggered before warning status**
- **RI indicators continued but RI did not occur until 10S was beginning to track over land**
- **JTWC and CONW in fairly good agreement for track before RI**
- **After RI the storm tracked to the east of JTWC and CONW earlier forecasts**

Two-Week Outlooks

- **Two-week outlooks prepared at least twice daily by JTWC forecasters**
  - **Designed to provide advanced situational awareness to DoD customers and improve TC formation forecast lead times and first forecast accuracy**
- **Process development influenced by collaboration with outside agencies and researchers, e.g., Climate Prediction Center (Global Tropics Hazards/Benefits Outlook), Elsberry/Tsai/Jordan ensemble forecast data evaluation technique, etc.**

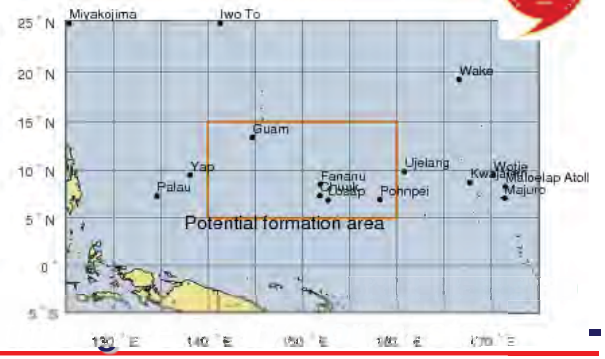


Potential Formation Area P77W status
Based on 090412Z forecast
Updated 9/4/2018 at 11:41Z

TC formation probability: 40%
TC may form between 10/00Z and 11/00Z
Est. time to formation: 6.0 days (~10/12Z)

Projected classification timeline:
Invest: 05/12Z
Low: 07/12Z
Medium: 08/12Z
High: 09/12Z
First warning: 10/12Z

Corresponding invest designator: 99W



Genesis Prediction: LMH Worksheet

- **Goals**:

  1) Establish realistic, quantitative framework to define low, medium, and high TC development (formation) potential

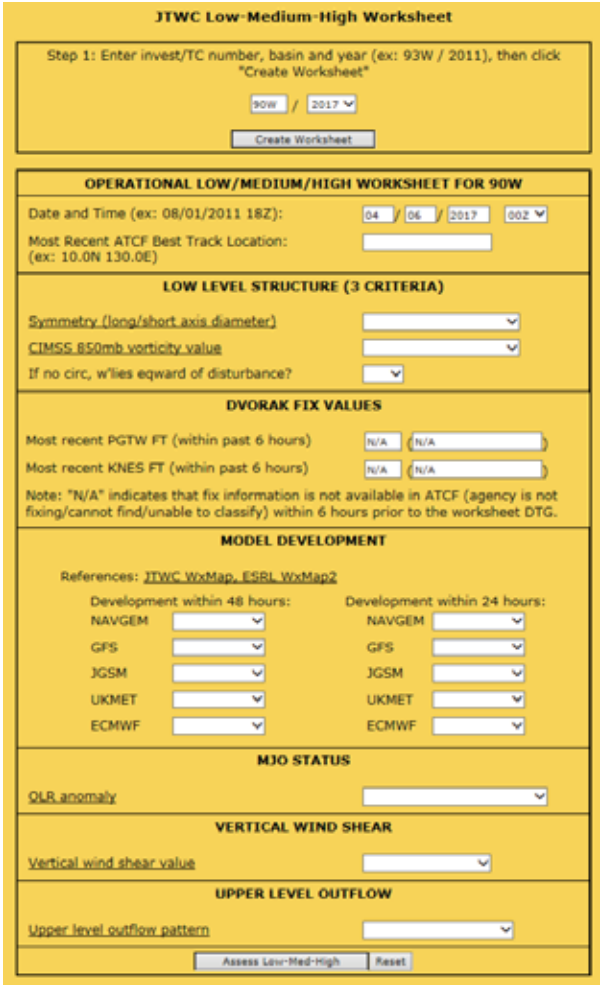
  2) Standardize process to determine low, medium, and high development potential from available data

- **Developed list of data / observable phenomena that influenced subjective genesis forecasts**

- **Recorded values (binned) for eight "development factors" – 48 hour period prior to first warning for 17 developers and prior to invest closure for 17 non-developers**

- **Identified logical relationships between development factors to determine low, medium, and high classification recommendations**

- **Implemented web-based worksheet to guide real-time assessments**



JTWC Low-Medium-High Worksheet

Step 1: Enter invest/TC number, basin and year (ex: 93W / 2011), then click "Create Worksheet"

90W / 2017

Create Worksheet

OPERATIONAL LOW/MEDIUM/HIGH WORKSHEET FOR 90W

Date and Time (ex: 08/01/2011 18Z): 04 / 06 / 2017 00Z

Most Recent ATCF Best Track Location: (ex: 10.0N 130.0E)

LOW LEVEL STRUCTURE (3 CRITERIA)

Symmetry (long/short axis diameter)

CIMSS 850mb vorticity value

If no circ, w'lies eqward of disturbance?

DVORAK FIX VALUES

Most recent PGTW FT (within past 6 hours) N/A (N/A)

Most recent KNES FT (within past 6 hours) N/A (N/A)

Note: "N/A" indicates that fix information is not available in ATCF (agency is not fixing/cannot find/unable to classify) within 6 hours prior to the worksheet DTG.

MODEL DEVELOPMENT

References: JTWC WxMap, ESRL WxMap2

	Development within 48 hours:	Development within 24 hours:
NAVGEM		
GFS		
JGSM		
UKMET		
ECMWF		

MJO STATUS

OLR anomaly

VERTICAL WIND SHEAR

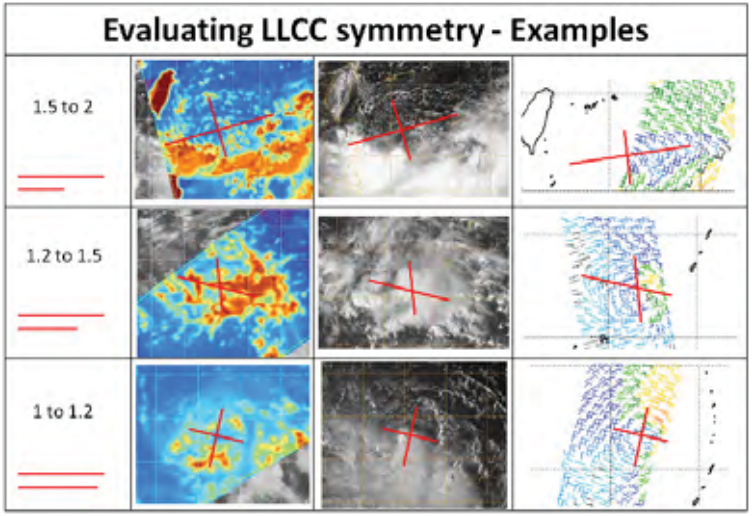
Vertical wind shear value

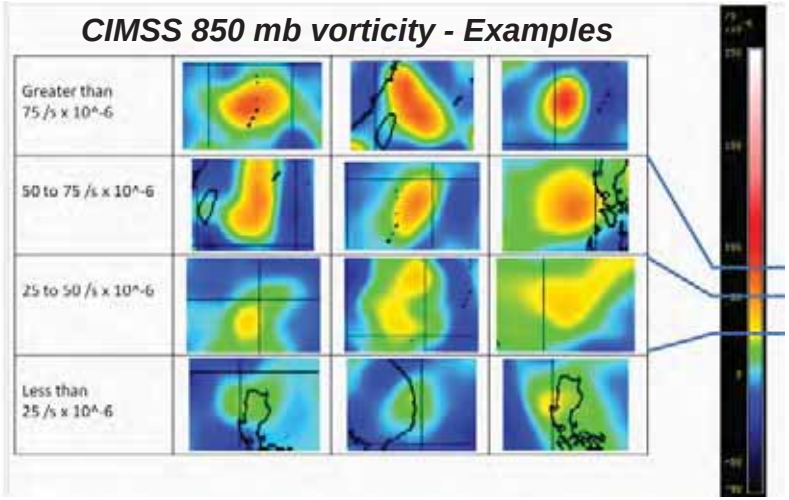
UPPER LEVEL OUTFLOW

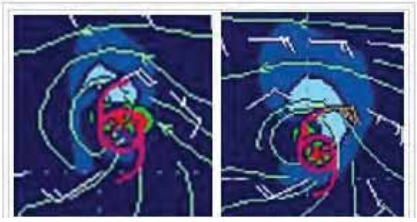
Upper level outflow pattern

Assess Low-Med-High Reset

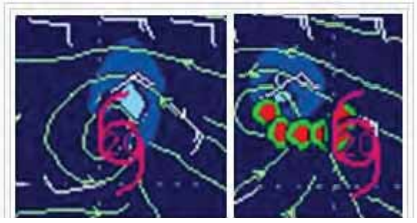
LMH Worksheet: Reference Imagery



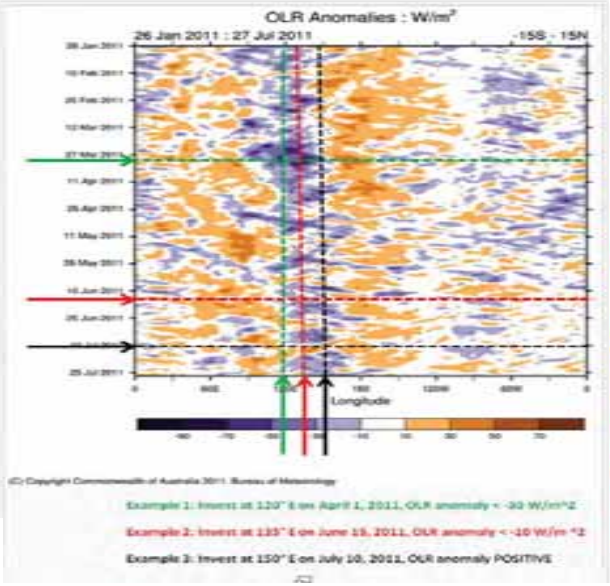


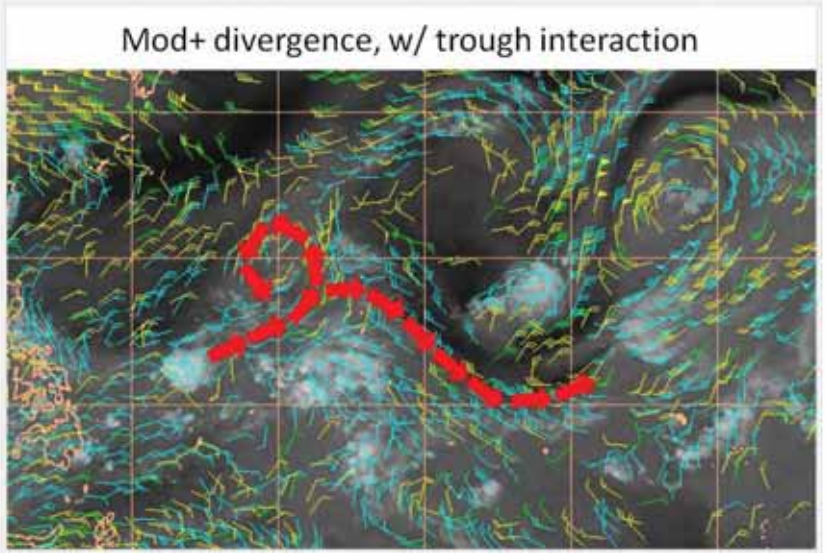


Example "developed" cyclones



Example "non-developed" cyclones

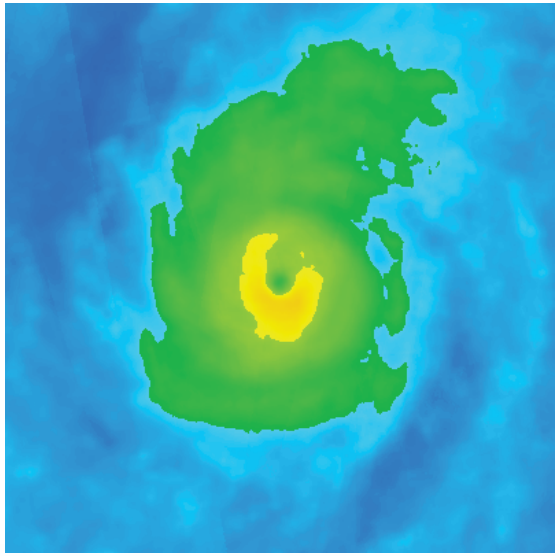




UNCLASSIFIED

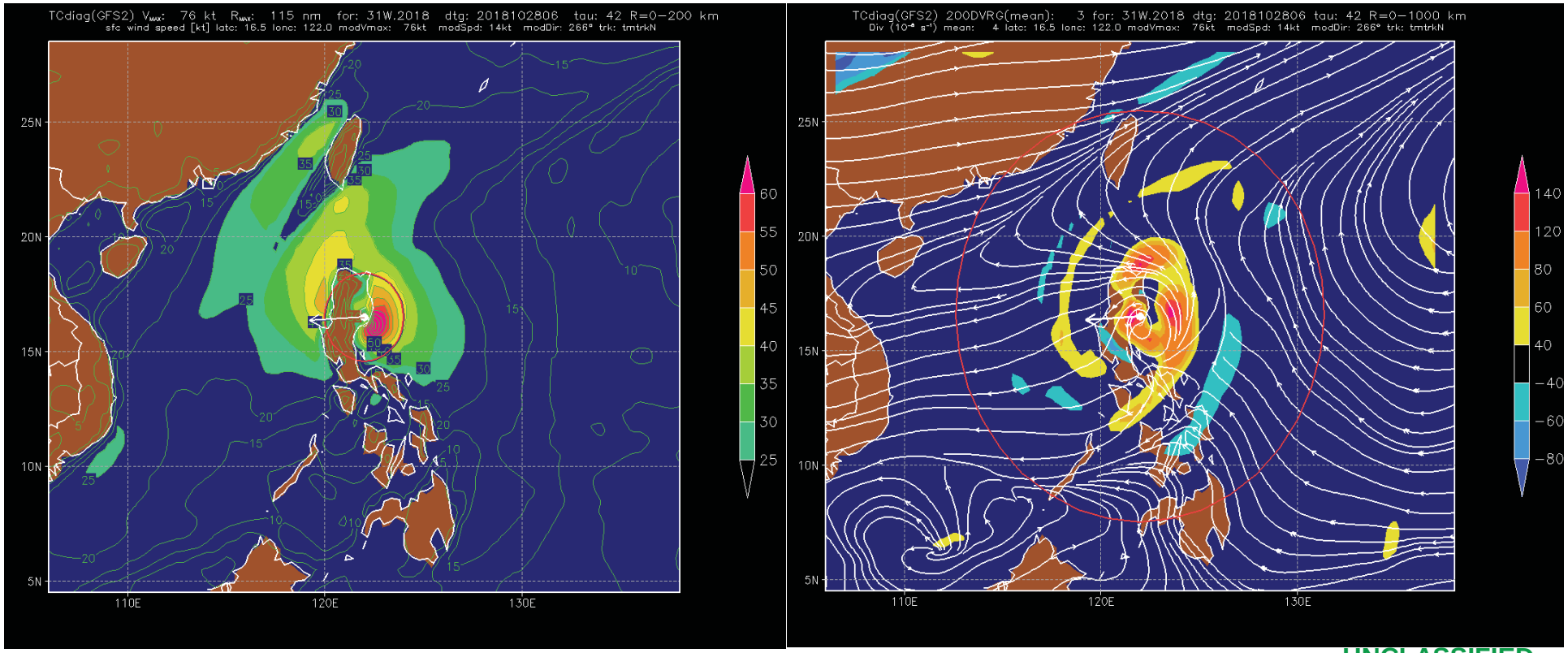
AFIT Microwave Intensity Studies

- Determining viability of subjective TC intensity estimation using microwave satellite imagery
  - 2 Air Force Institute of Technology Masters students – 1 past, 1 current
- Identifying patterns associated with tropical cyclones at different intensity thresholds
- Compositing imagery associated with identified patterns – goal to produce a visual tool for satellite analysts to compare real-time imagery and estimate intensity
  - Similar to subjective Dvorak pattern-T



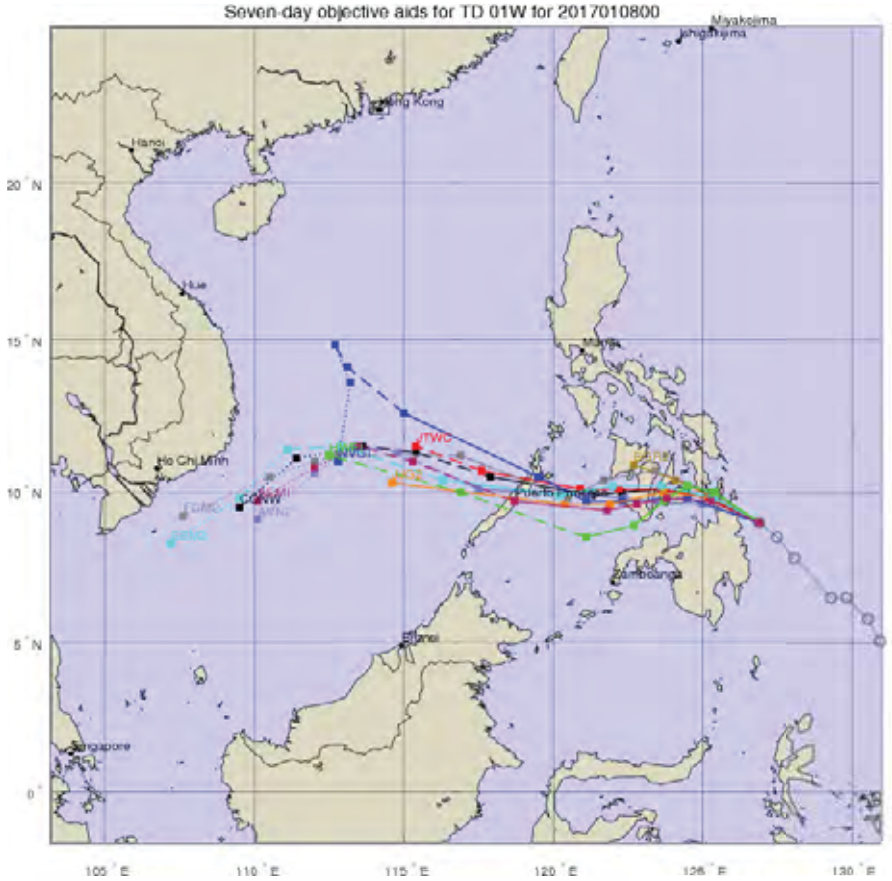
JTWC TC Diagnotics ("JTdiag") Tool

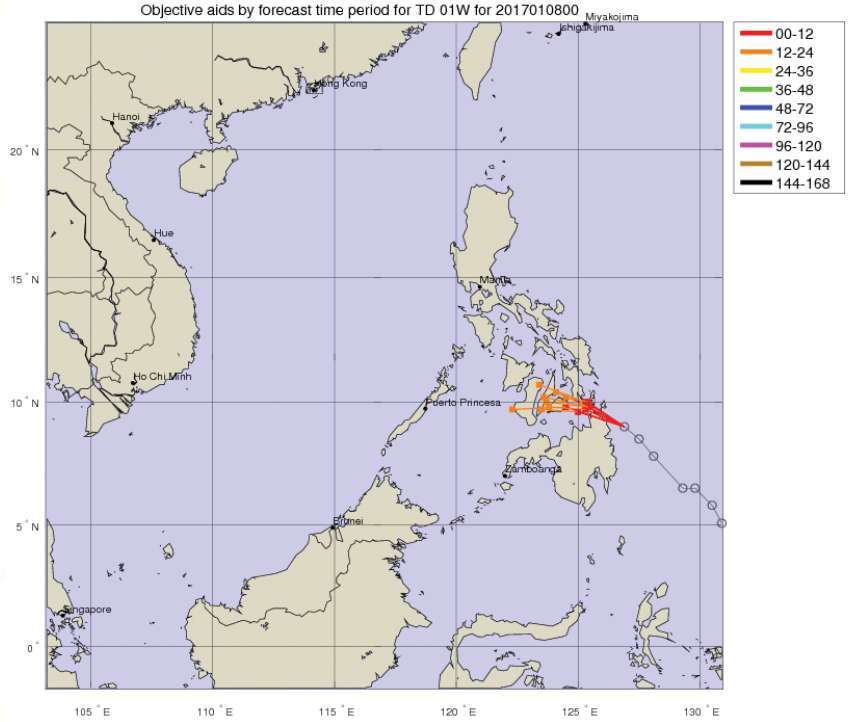
- **Tailored interface designed by Dr. Mike Fiorino (NOAA / Univ. Colorado)**
  - **User-friendly site analogous to ESRL TCdiag page, tailored for JTWC operations**
  - **Storm-centered, high-resolution model diagnostic and forecast fields**
  - **Collaborative development ongoing**



Decision Support Aids

- Multiple graphics depict data used to analyze and forecast TC position, intensity, etc.
- Automated production
- Provided to US Govt / DoD customers and research partners through decision support and collaboration websites





Summary & Priorities

- Large WPAC track errors (especially Day 5) due to monsoon gyre, with longer tracks east of the Marianas due to ENSO transition
- Record-breaking improvement in intensity forecasts attributable to the implementation of RIPA guidance
- Record-shattering track forecasts in SHEM and met INDOPACOM goals for Days 4, 5 (also quieter season)
- SMAP/SMOS integration into ATCF shows promise for diagnosing TC intensity and wind radii
- Redesign of JTWC watch floor to include AWIPS-II
  - Currently in testing, awaiting operational implementation
  - ATCF capability integration and/or TC-scale diagnostics
- “Spatial” priorities: monsoon depressions/gyres/TC interactions
- “Temporal” priority: 1-2 week genesis period (DoD decision support)

Thank You!

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

Questions?

Brian Strahl: brian.r.strahl@navy.mil
Owen Shieh: owen.shieh@navy.mil