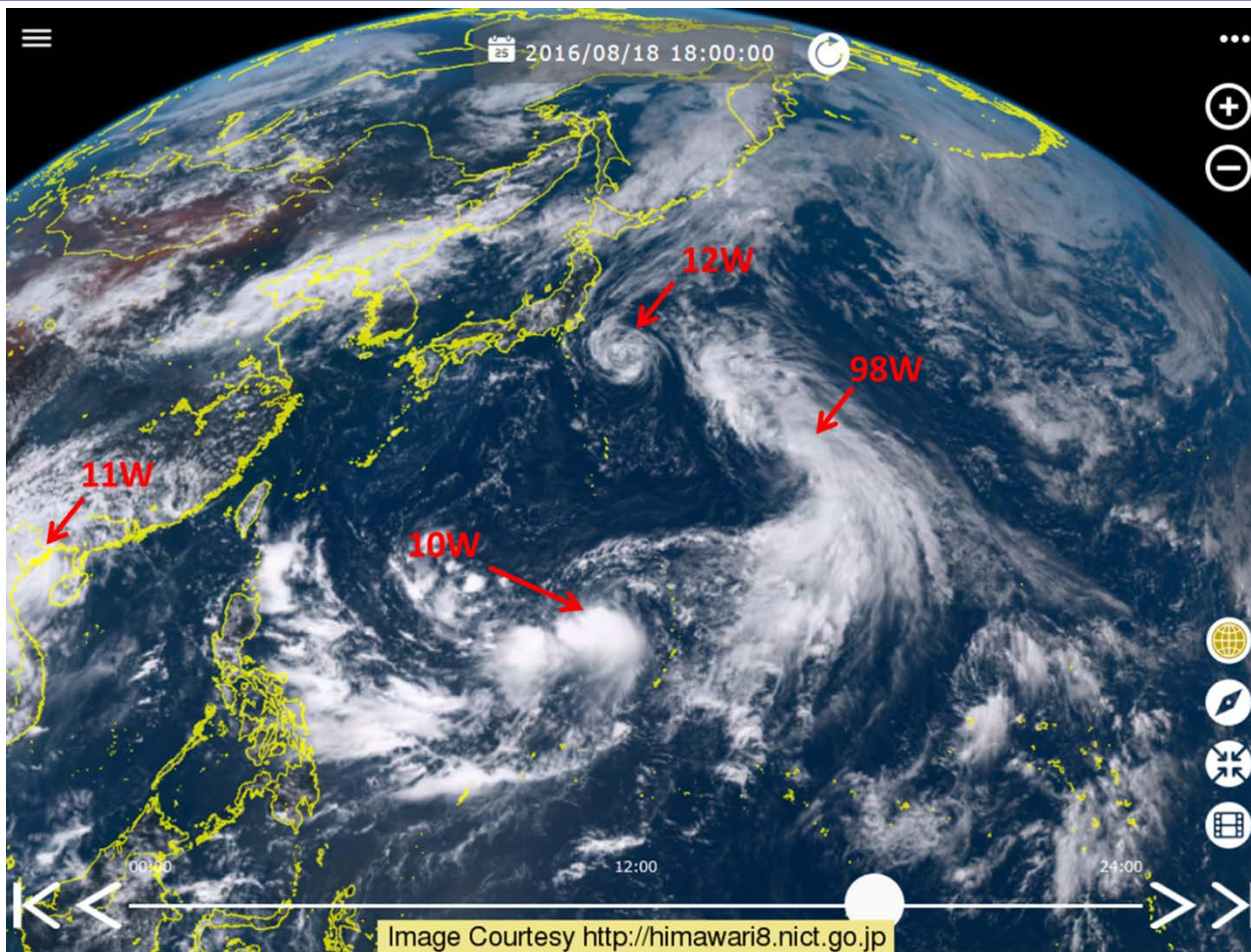




# 2016 Year in review: JTWC TC Activity, Forecast Challenges, and Developmental Priorities



**Hurricane Forecast Improvement Program Annual Review**

**11-12 JAN 2017**

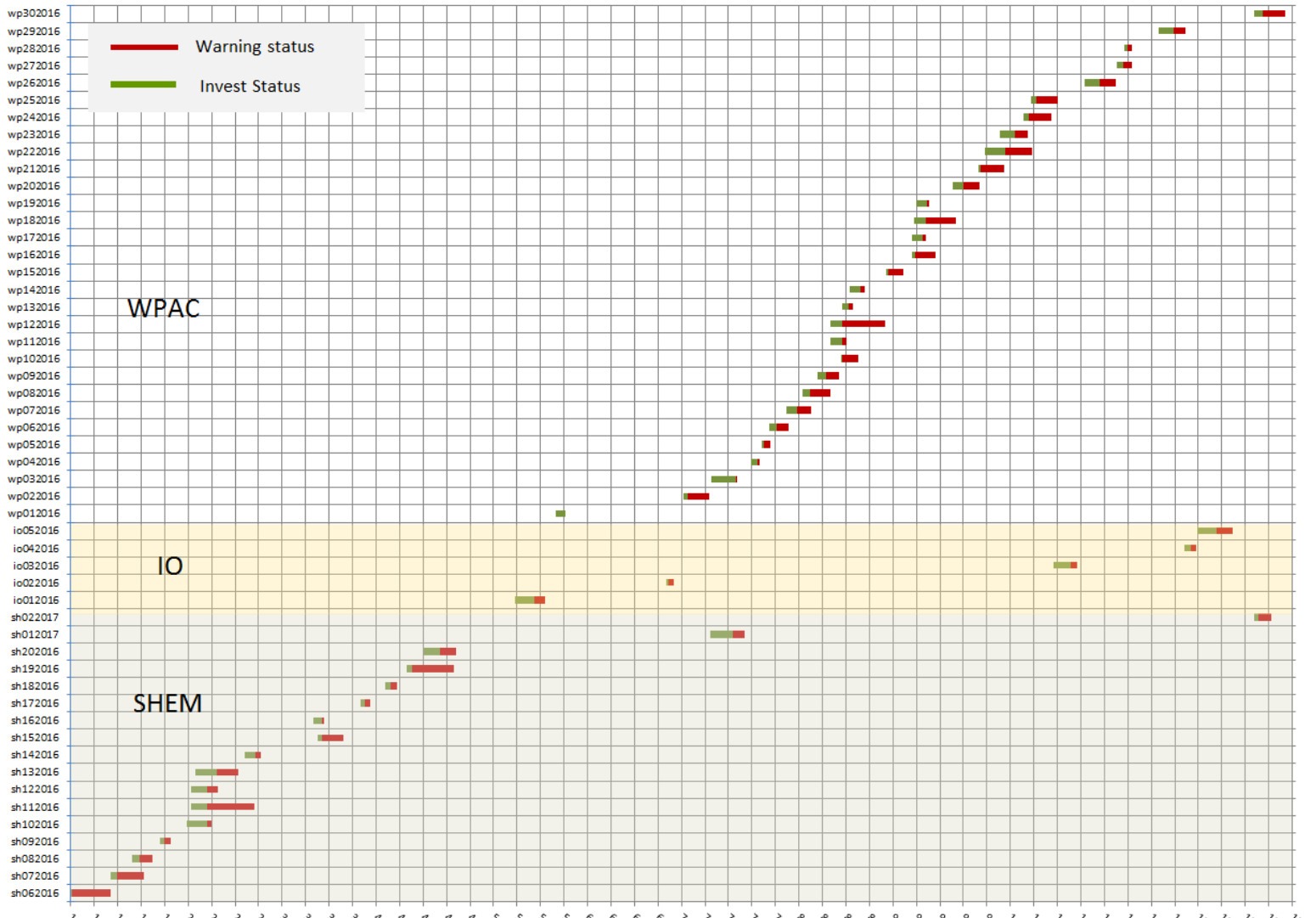
**Brian Strahl, Joint Typhoon Warning Center**

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# 2016 JTWC Tropical Cyclone Timeline

2016 JTWC Tropical Activity Timeline

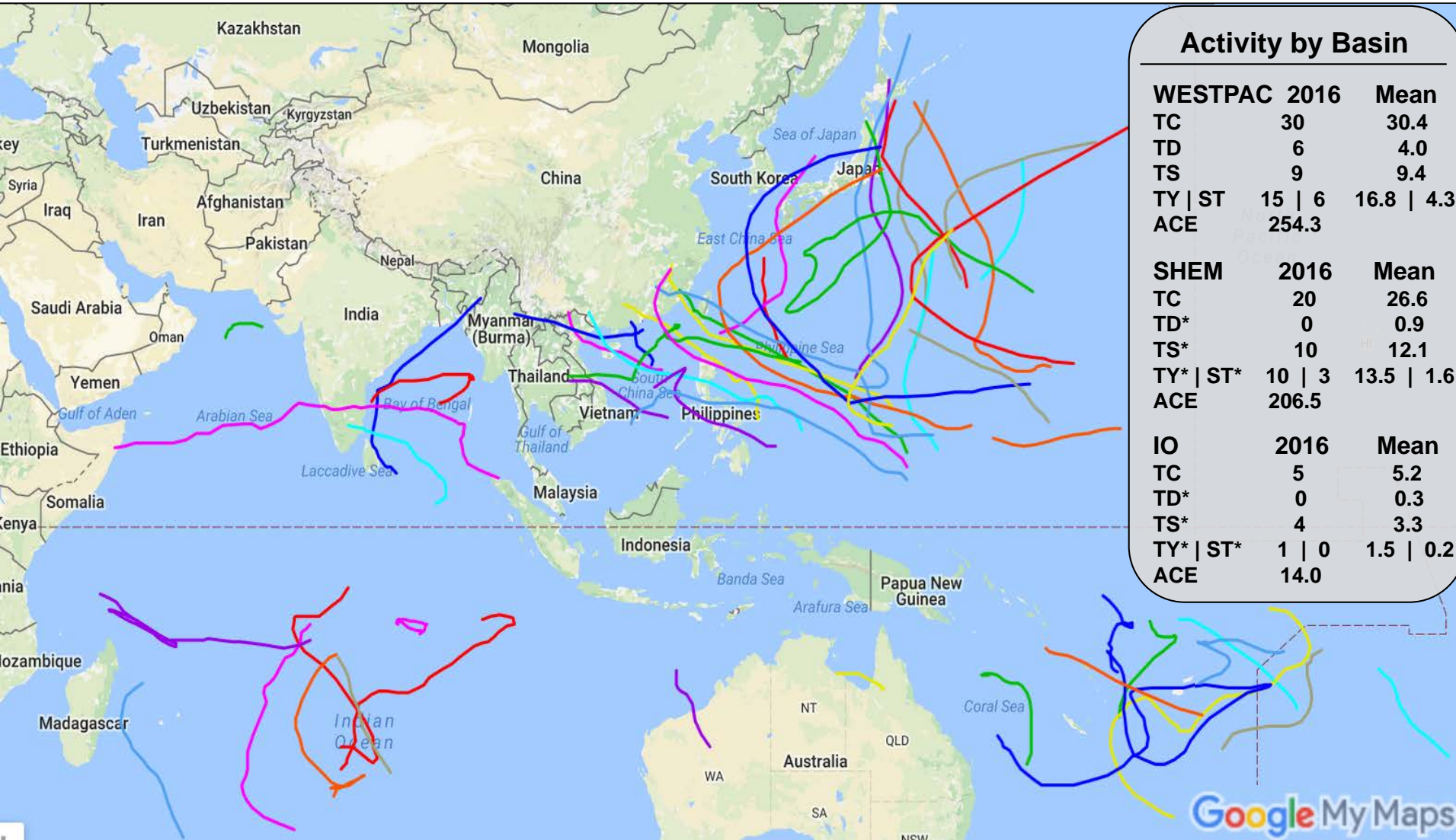


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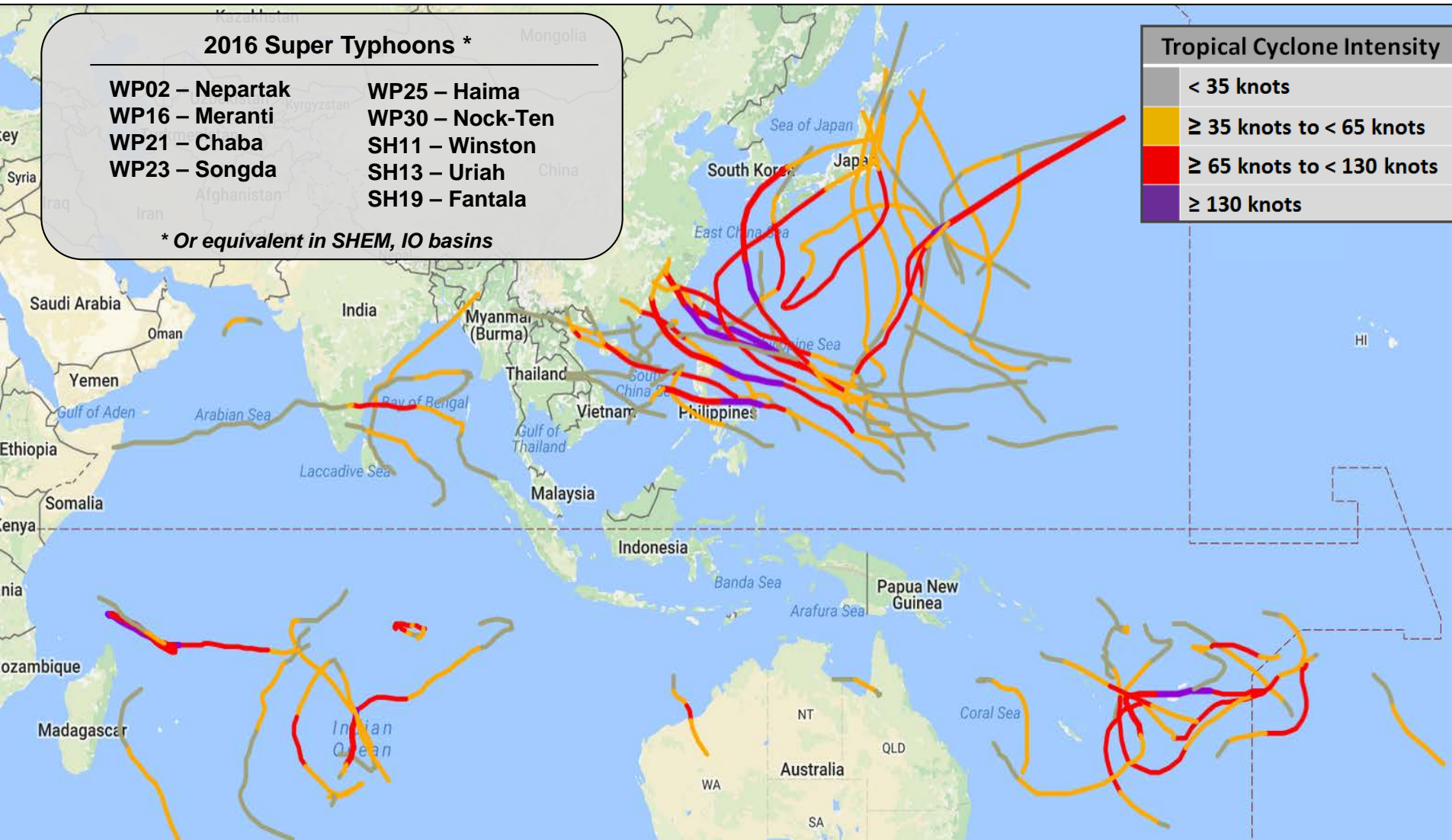
# 2016 JTWC Warned Tropical Cyclones



Google My Maps

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# 2016 Tropical Cyclone Activity by Intensity

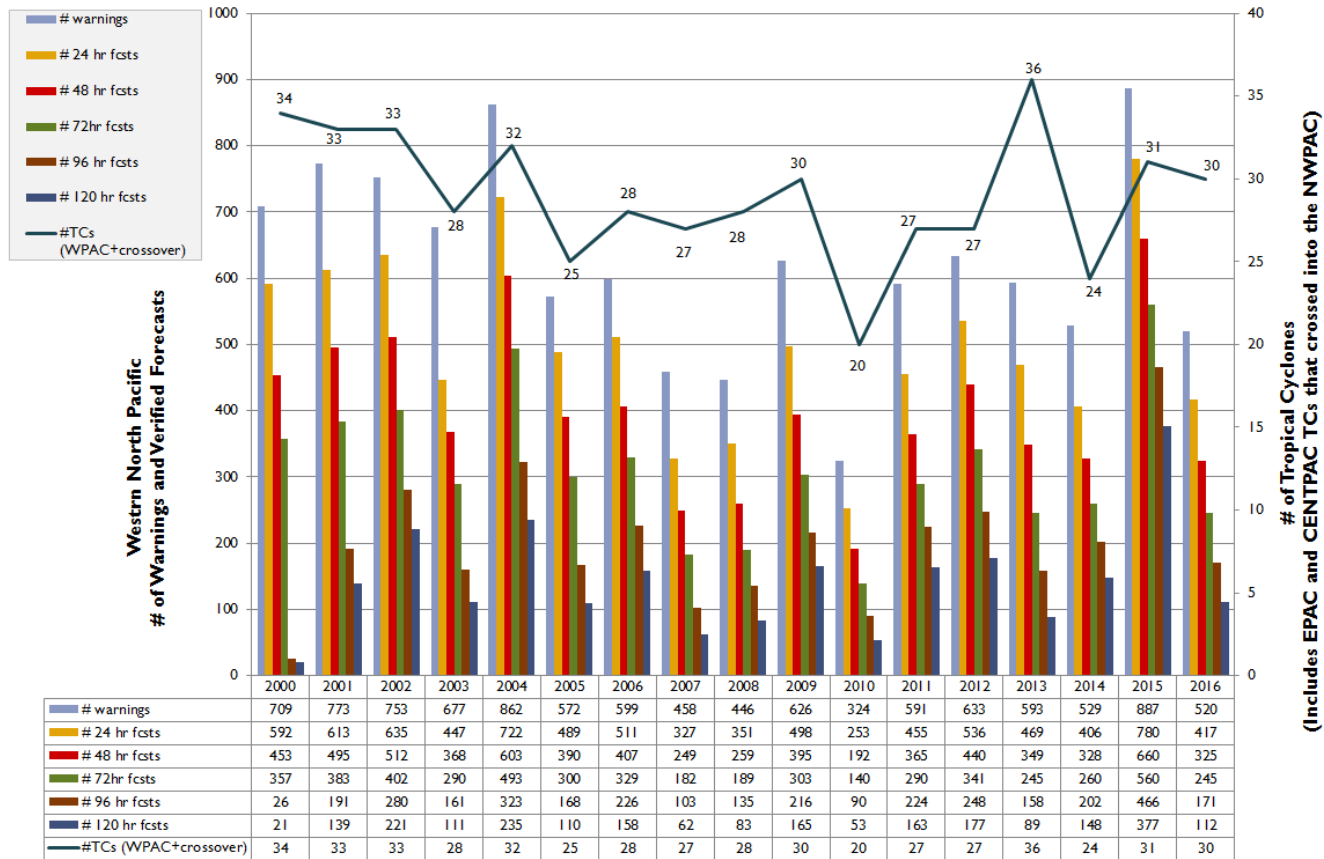


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# JTWC Warnings



- WPAC returned to “normal” activity with return to ENSO neutral conditions
- Total # of warnings in all JTWC basins was 819, compared to 1,181 in 2015
- Over 7,000 PGTW satellite fixes

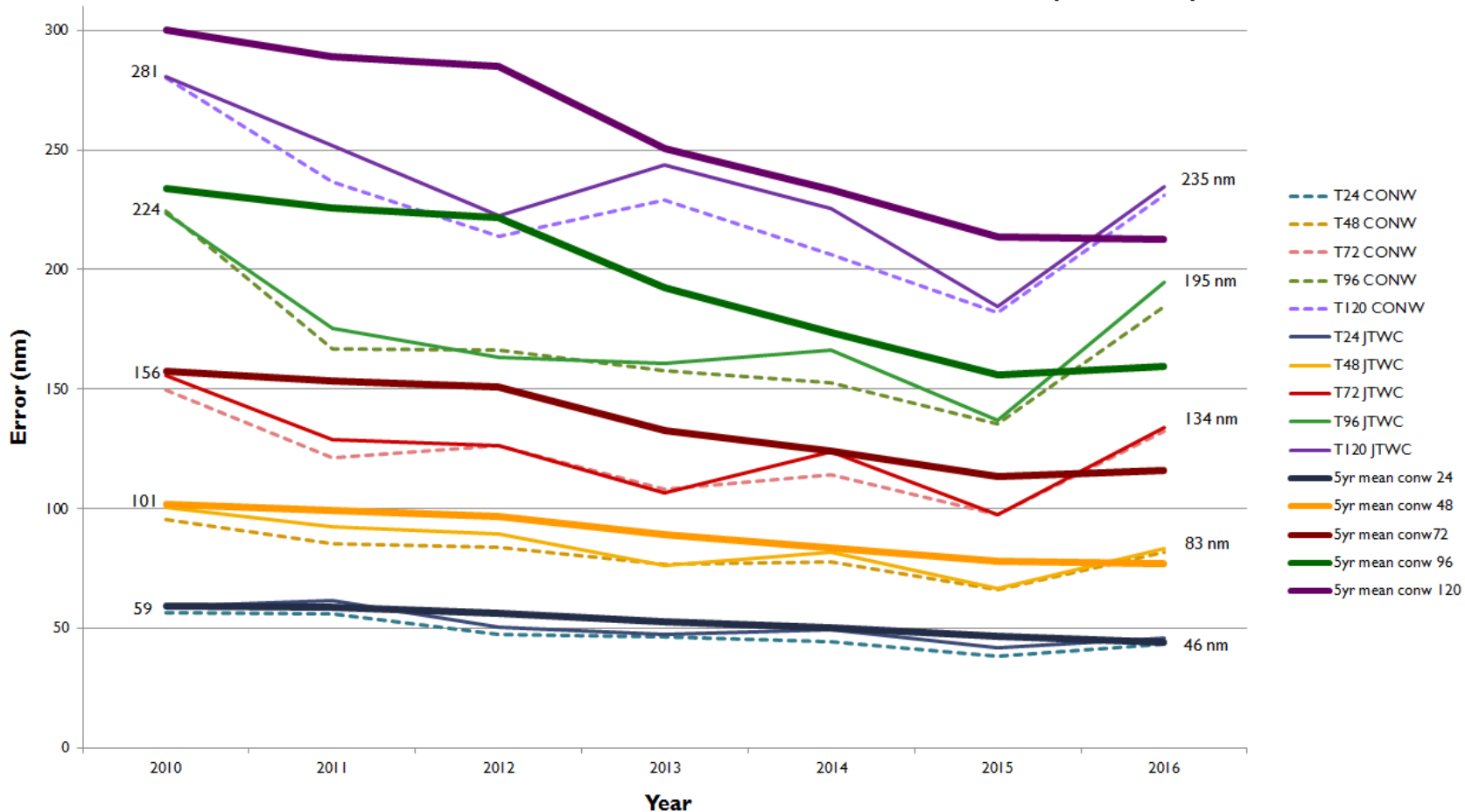
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# 2016 JTWC and CONW Forecast Track Errors (\*Preliminary)



### JTWC and CONW Forecast Track Errors for WESTPAC (2010-2016)



2016 Mean errors well above record 2015, but...

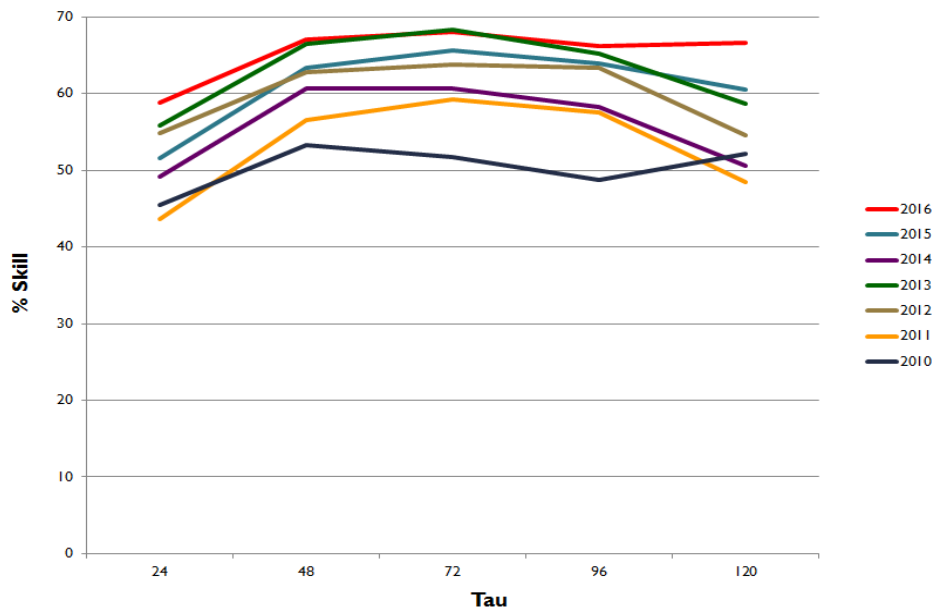
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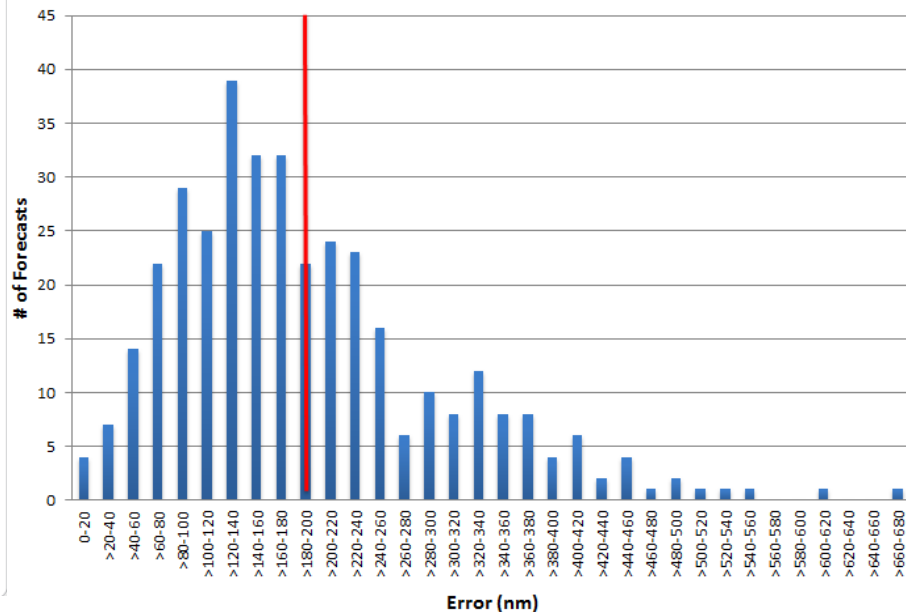
# 2016 JTWC and CONW Forecast Track Errors (\*Preliminary), Cont'd



### JTWC Forecast Skill (WPAC - Preliminary)



### 2015 Day 5 Forecast Error Histogram

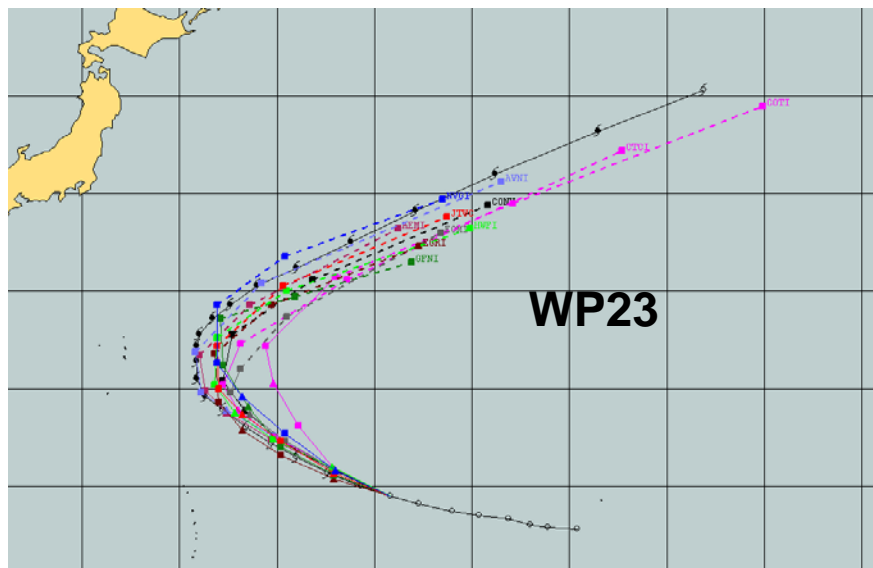


- CLIPR error indicates significantly more difficult storms to forecast
- 5-day CLIPR error increased 51% over 2015, JTWC error increased 27%
- Error distribution was flat (fewer big busts)
- Analysis capabilities negatively impacted by loss of RSCAT and F19

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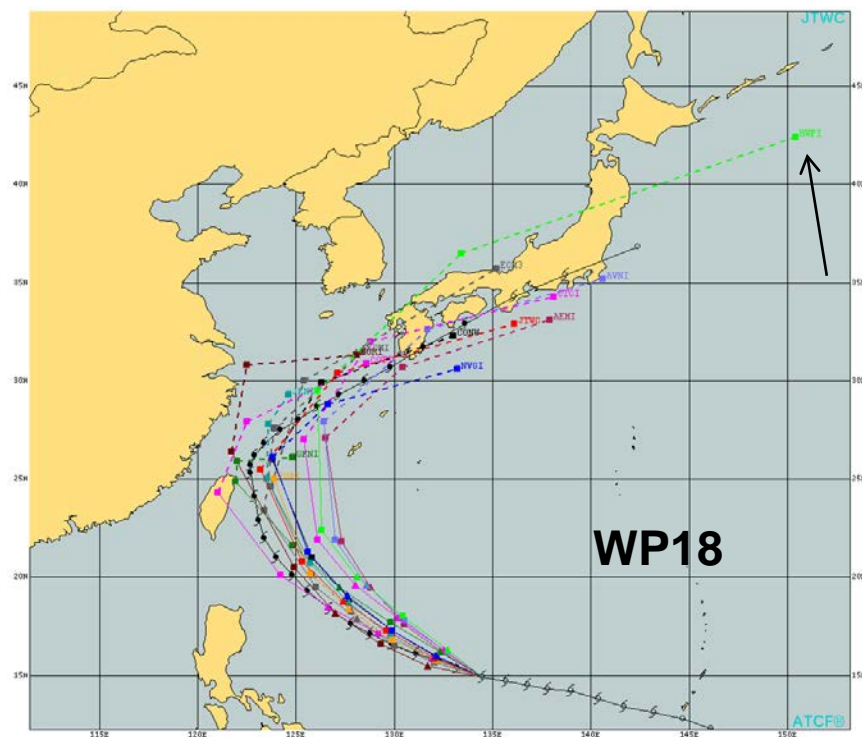


# 2016 Largest Forecast Errors



- First warning of WP23
- Good aid agreement – 740nm error was along track
- COAMPS showed faster motion, but higher cross-track error

- Four early warnings for WP18
- Again, error mostly along-track
- HWRF was particularly fast

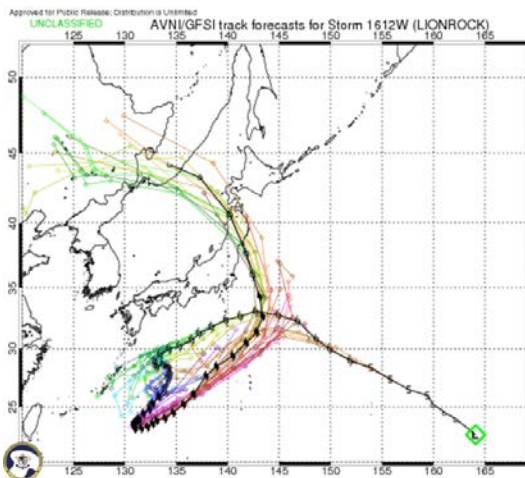


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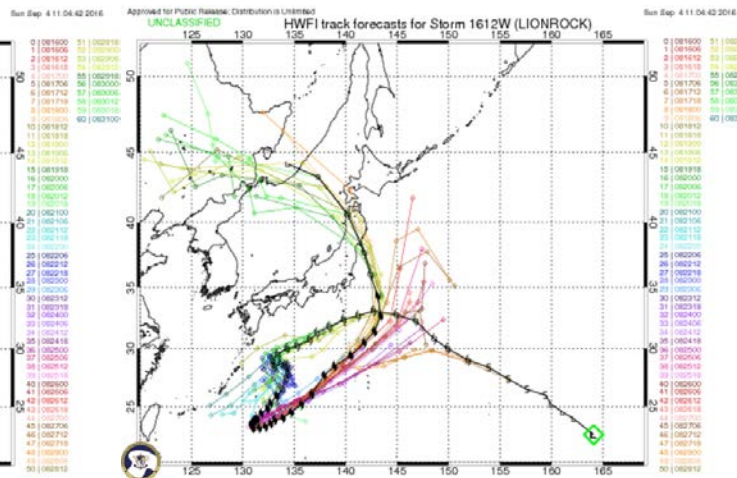




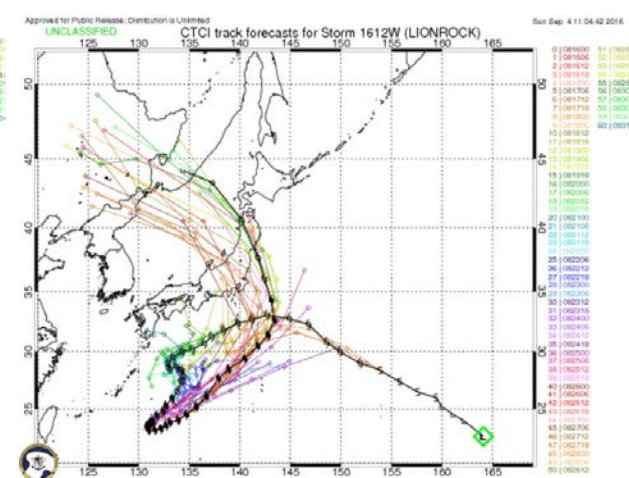
# WP 12 - Lionrock



**GFS**



**HWRF**



**CTCI**

- Despite a very complex track, model guidance was generally very good, particularly after the intensification phase
- Five-day mean track errors were only 153nm (CONW) and 192nm (JTWC)

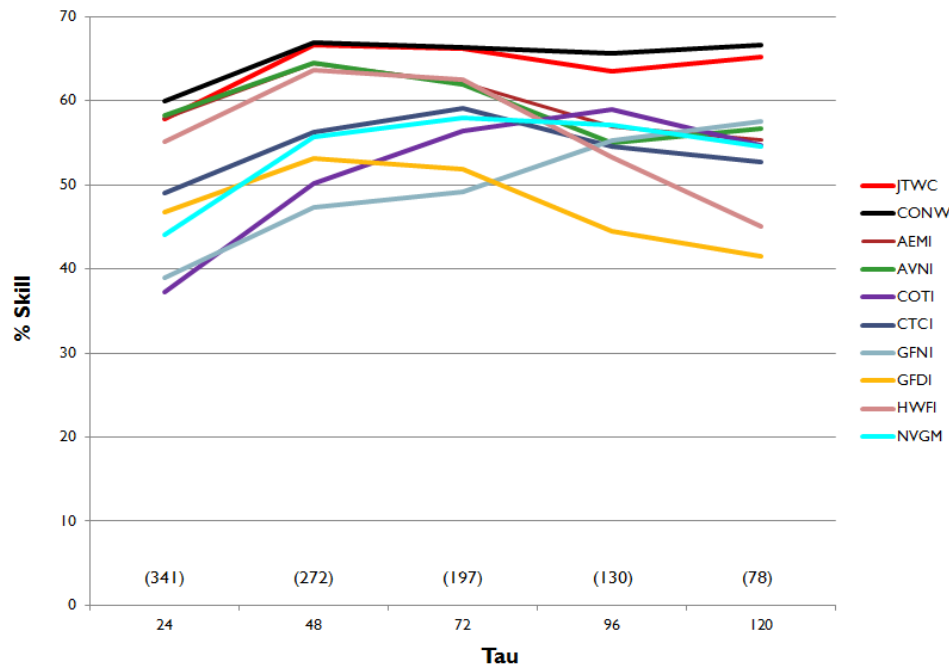
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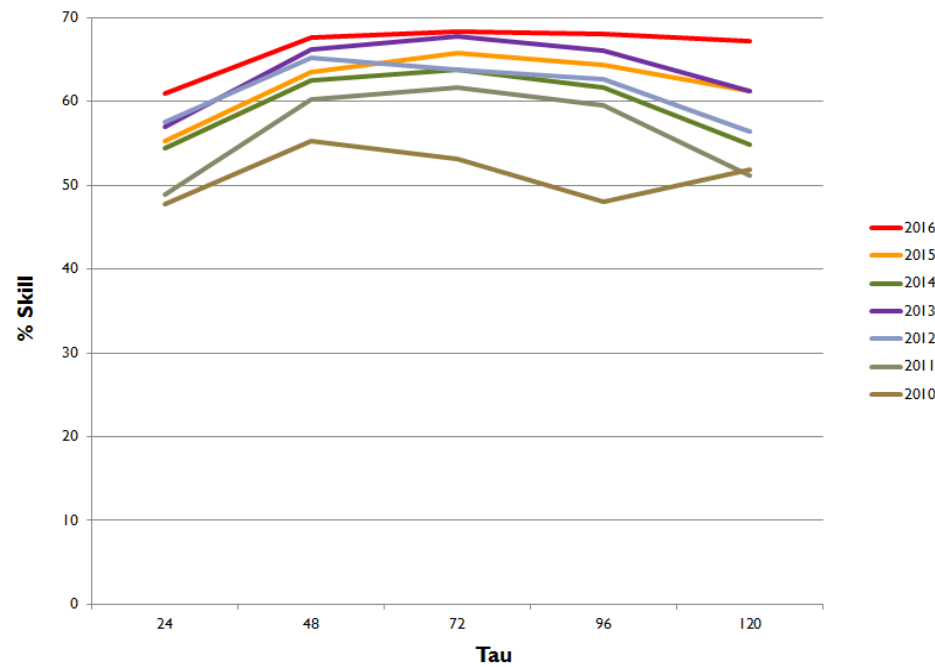
# 2016 Model Track Forecast Skill



### 2016 Model Forecast Track Skill (WPAC - Preliminary)



### CONW WPAC Forecast Skill



- Somewhat of a mixed bag. CONW still beat all members
- ECMWF and UKMET (not shown) on par with GFS through day-3, best members at days 4 & 5
- NVGM-driven COTI and GFDN outperformed GFS counterpart at days 4-5

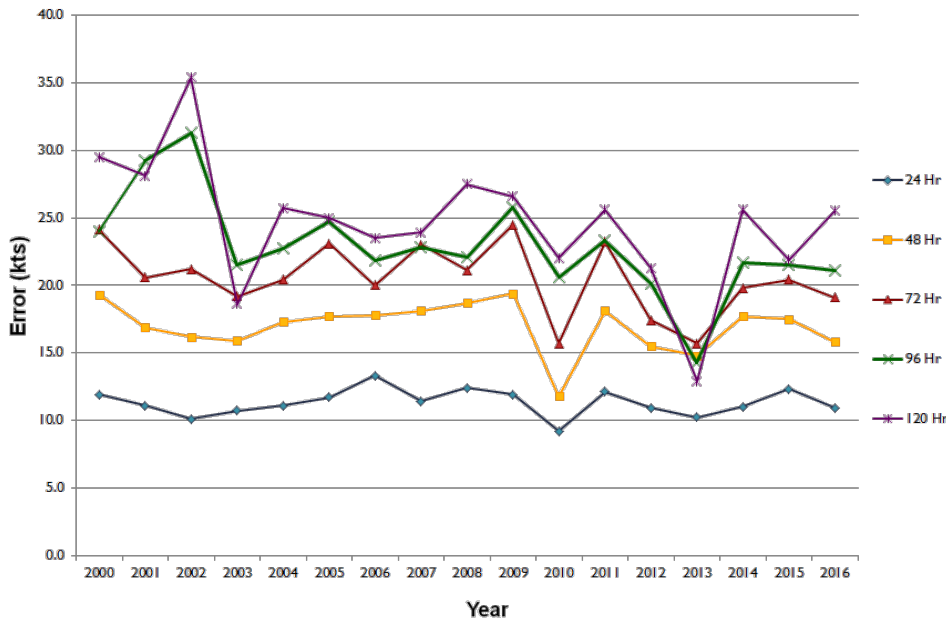
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# 2016 JTWC Forecast Intensity Error (\* Preliminary)



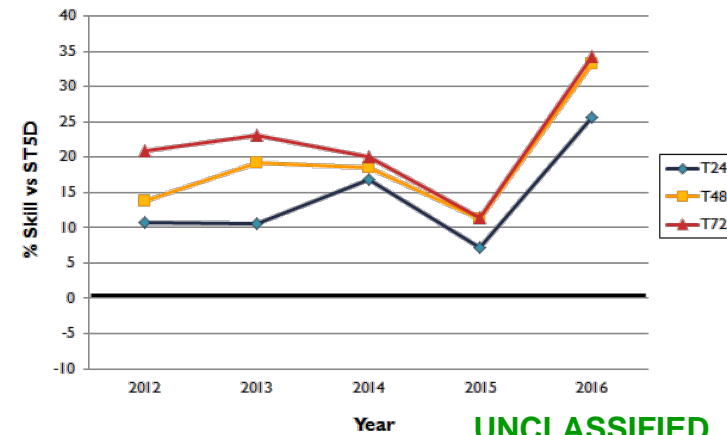
### JTWC Average Intensity Errors



- Mean errors improved over 2015 except day-5
- Despite small mean error improvement, skill was significantly improved over previous 5 years

- TC intensity change, particularly onset and duration of RI still #1 forecast improvement priority
- JHT project to evaluate MI cyan ring as an RI predictor in WPAC in process

### JTWC Forecast Intensity Skill



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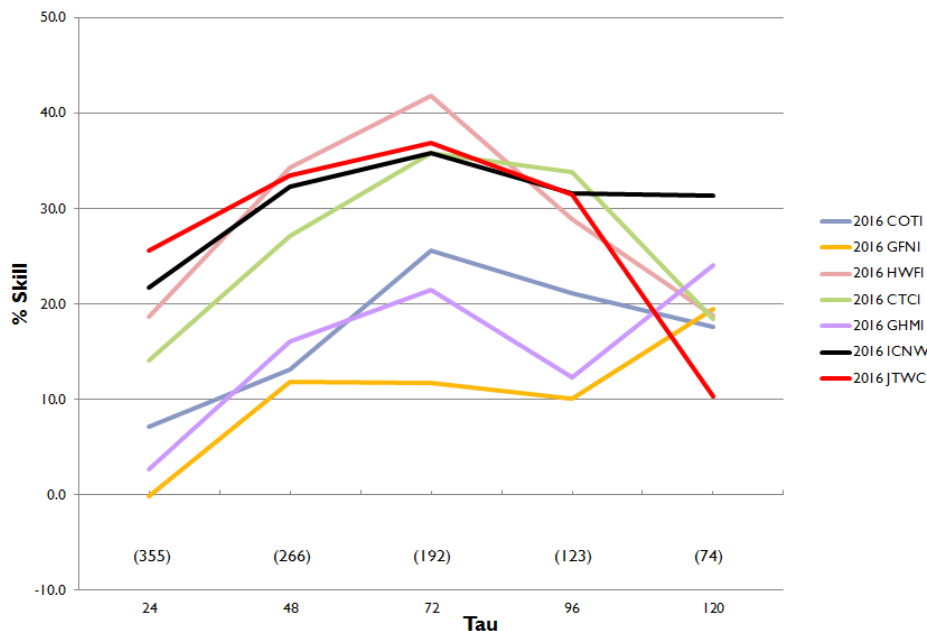




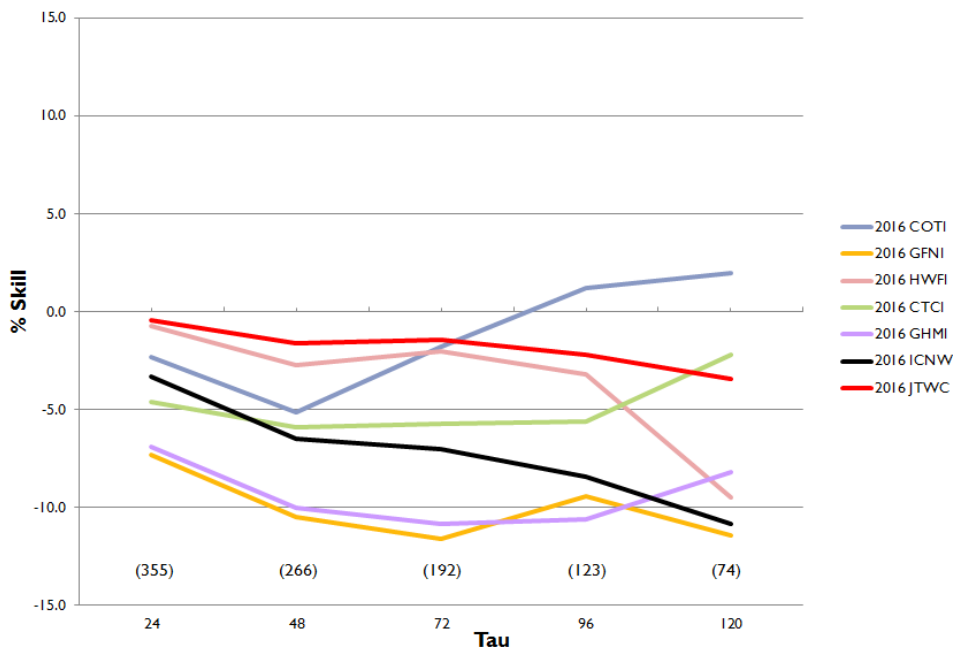
# Model Forecast Intensity



2016 Model Forecast Intensity Skill (WPAC - Preliminary)



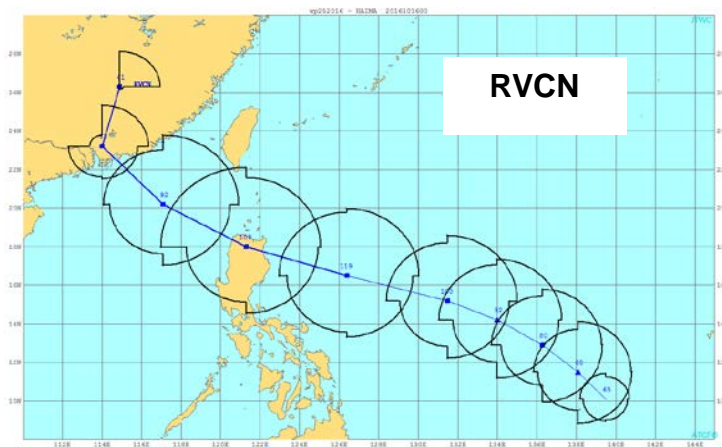
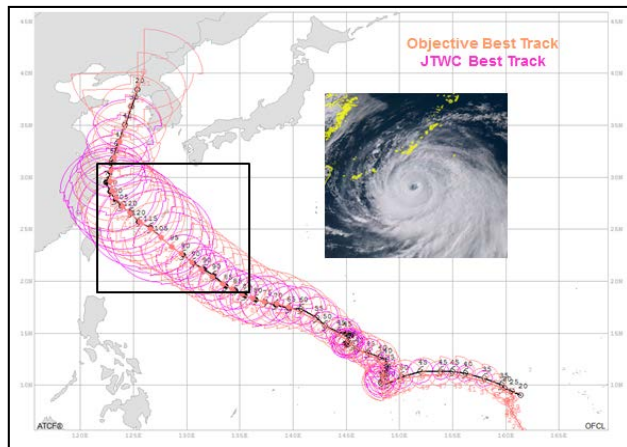
2016 Model Forecast Intensity Bias (WPAC - Preliminary)



- HWRf outperformed consensus/JTWC days 2-3, then dropped sharply with higher negative bias
  - Likely linked to high track errors
- Skill suggests JTWC closely followed HWRf/CTCI – but weakened even more
- GHMI/GFDN lowest skill, most negative bias
- Note, intensity consensus ID name changed to ICNW

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PACOM TC Forecast goals include “Predict the radius of 35- and 50-knot winds within 20% (by quadrant)...”



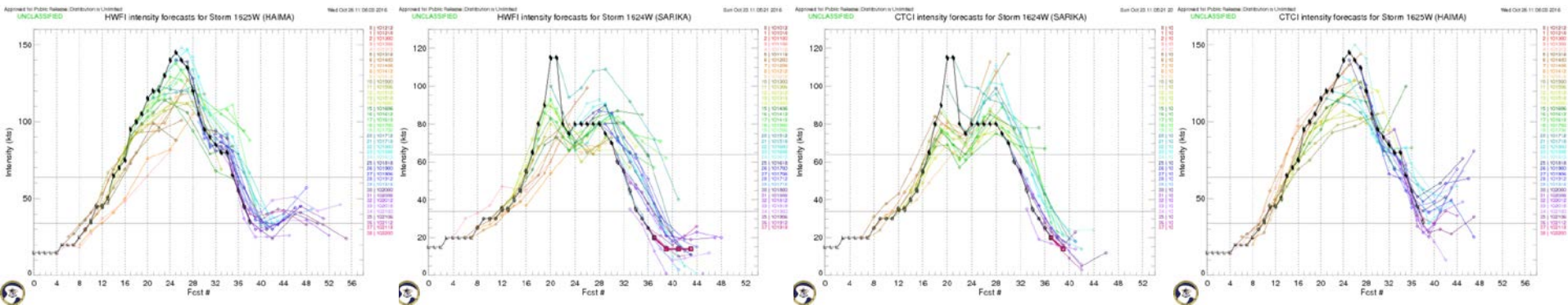
- ATCF v5.8 included objective wind radii analysis and forecast consensus utilizing NWP wind radii from HWRF, COAMPS-TC, GFDL, GFS, and ECMWF
  - Efficient TDO application allowed expansion to 5-day wind radii forecasts (resource neutral)
  - More inspection required in early/late stages (fewer members), interaction with gradient wind events such as a cold surge
  - More stable growth curve, reduced small bias, more accurate ET size, better vitals inputs

(More details in Sampson and Knaff 2015, and Sampson et al. 2017, submitted)

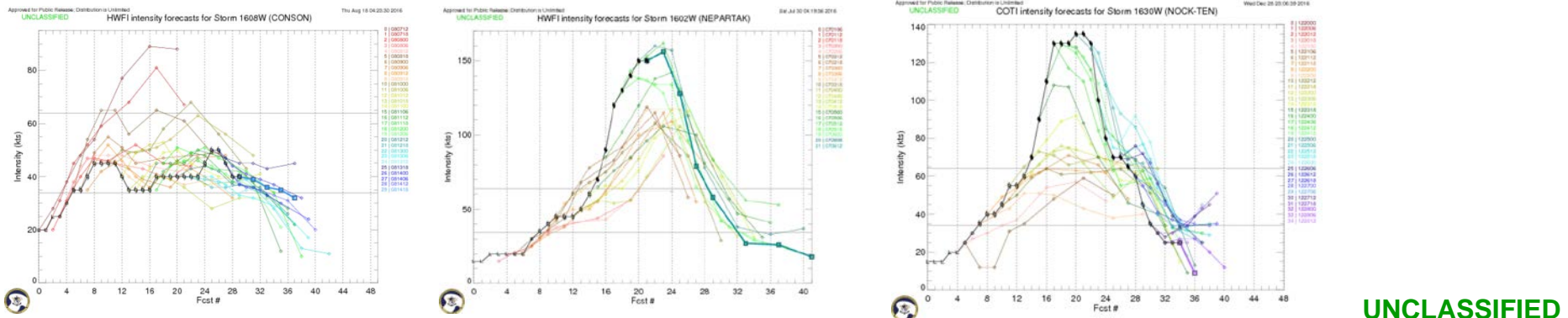
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# Forecast Challenges – Rapid Intensification



- Some NWP success stories with RI (above examples)
  - Peak forecast winds usually too low, but timing is improved
  - Trends remain the key indicator vs individual model values
  - Tendency to maintain strong vortex after peak is MUCH improved
- Despite successes, still too many misses and false alarms (below examples)



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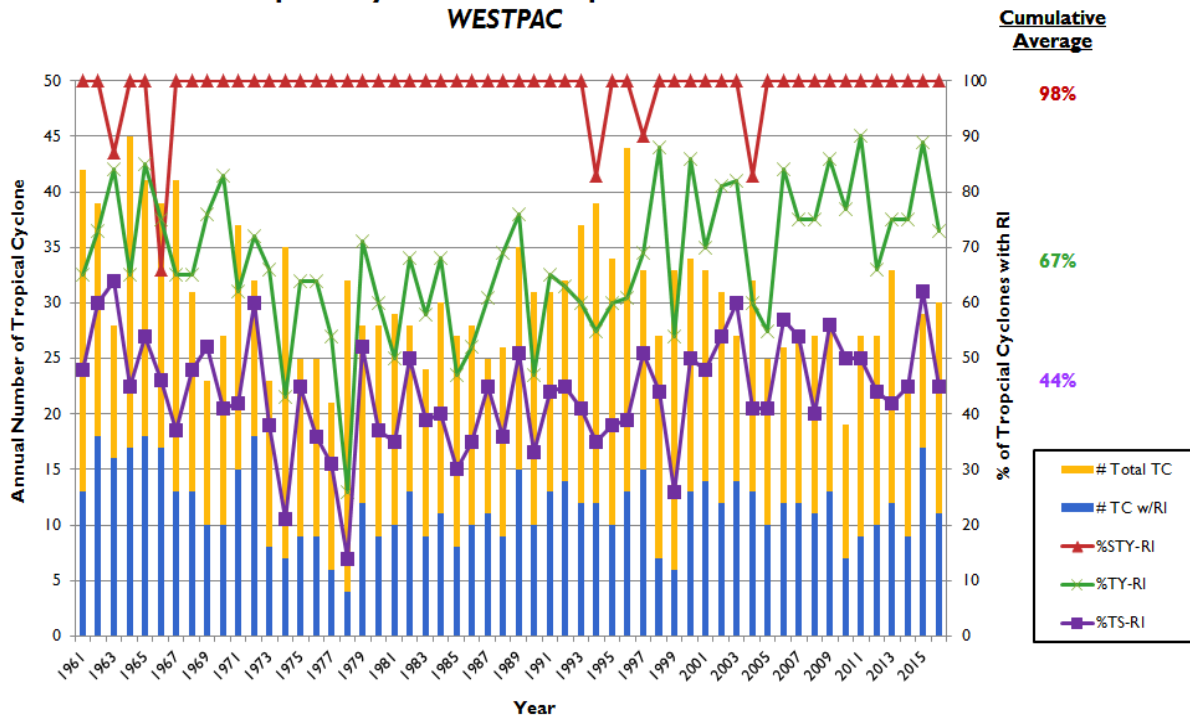




# Forecast Challenges – Rapid Intensification



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



- 2016 TCs with RI/ERI**
- WP02 Nepartak - ERI
  - WP12 Lionrock - RI
  - WP15 Namtheun - RI
  - WP16 Meranti - ERI
  - WP20 Megi - ERI
  - WP21 Chaba - ERI
  - WP23 Songda - ERI
  - WP24 Sarika - ERI
  - WP25 Haima - RI
  - WP26 Meari - RI
  - WP30 Nock-Ten - ERI

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

- Average year for rapid intensification, but above average ERI
- Nearly half of WPAC TCs reaching TS strength or greater will have RI

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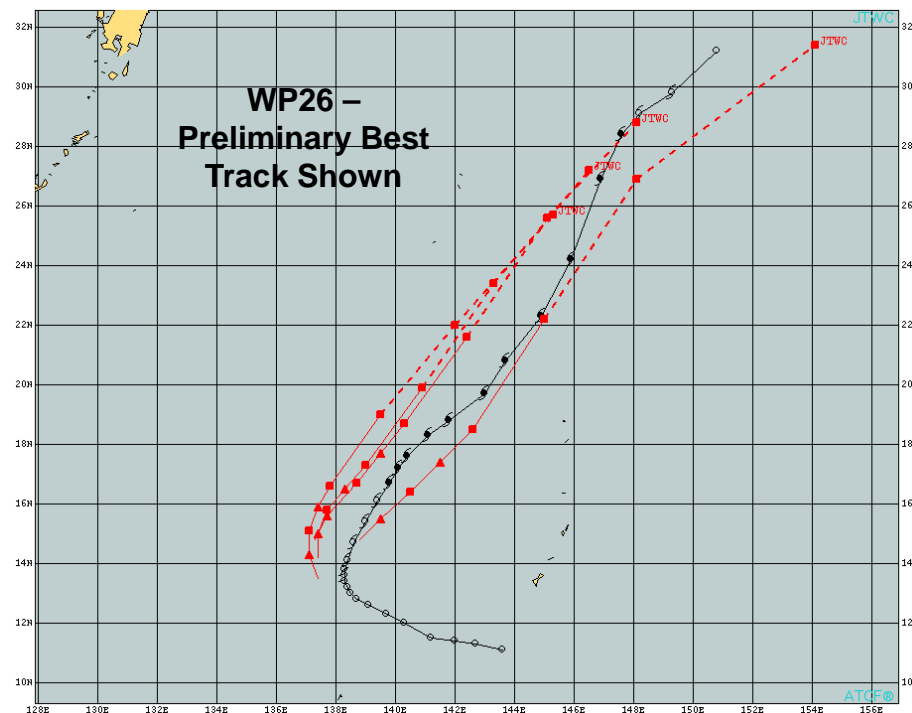


# Forecast Challenges



## Analysis

- Particularly critical for disturbances – where is the center? Has it reached JTWC warning criteria?
- Microwave imagery and scatterometry will routinely cover super-typhoons with well-defined eyes, but miss the formation stage
- Noted earlier, loss of F19 and RSCAT with little remaining life in DMSP
- WSF planned passive scatterometer



Analysis impacts entire forecast

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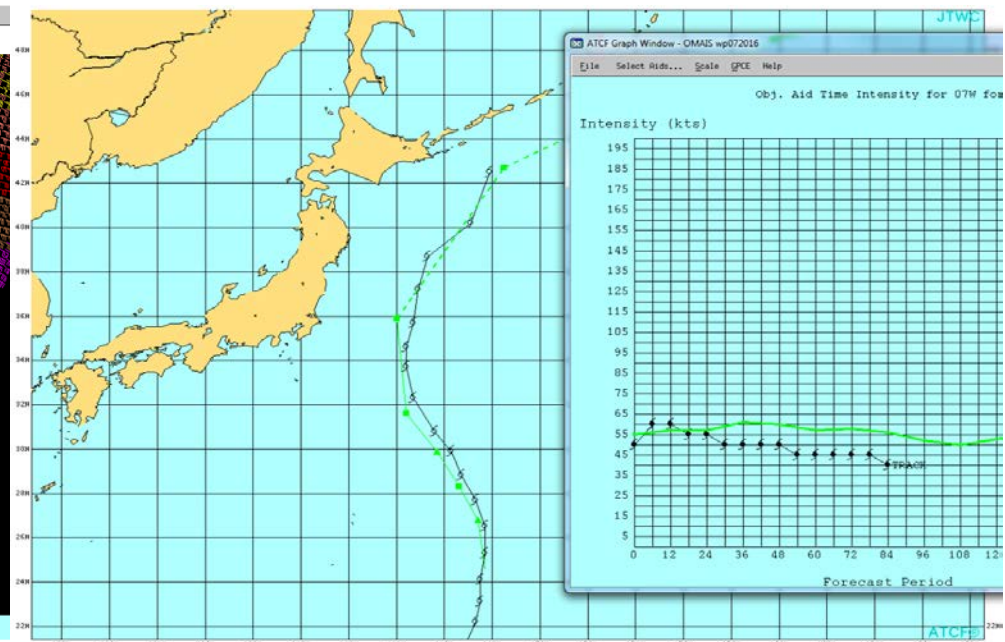
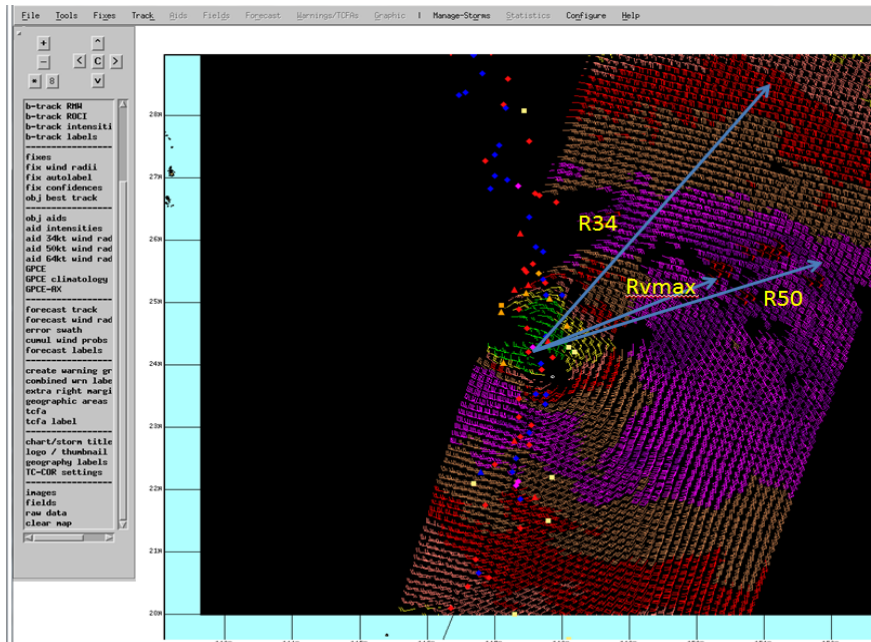


# Forecast Challenges



## TC Genesis

- Notable improvement in NWP TC Genesis since HFIP began
- Non-classical development/transition is one area for R&D
  - Monsoon Depression/Gyre



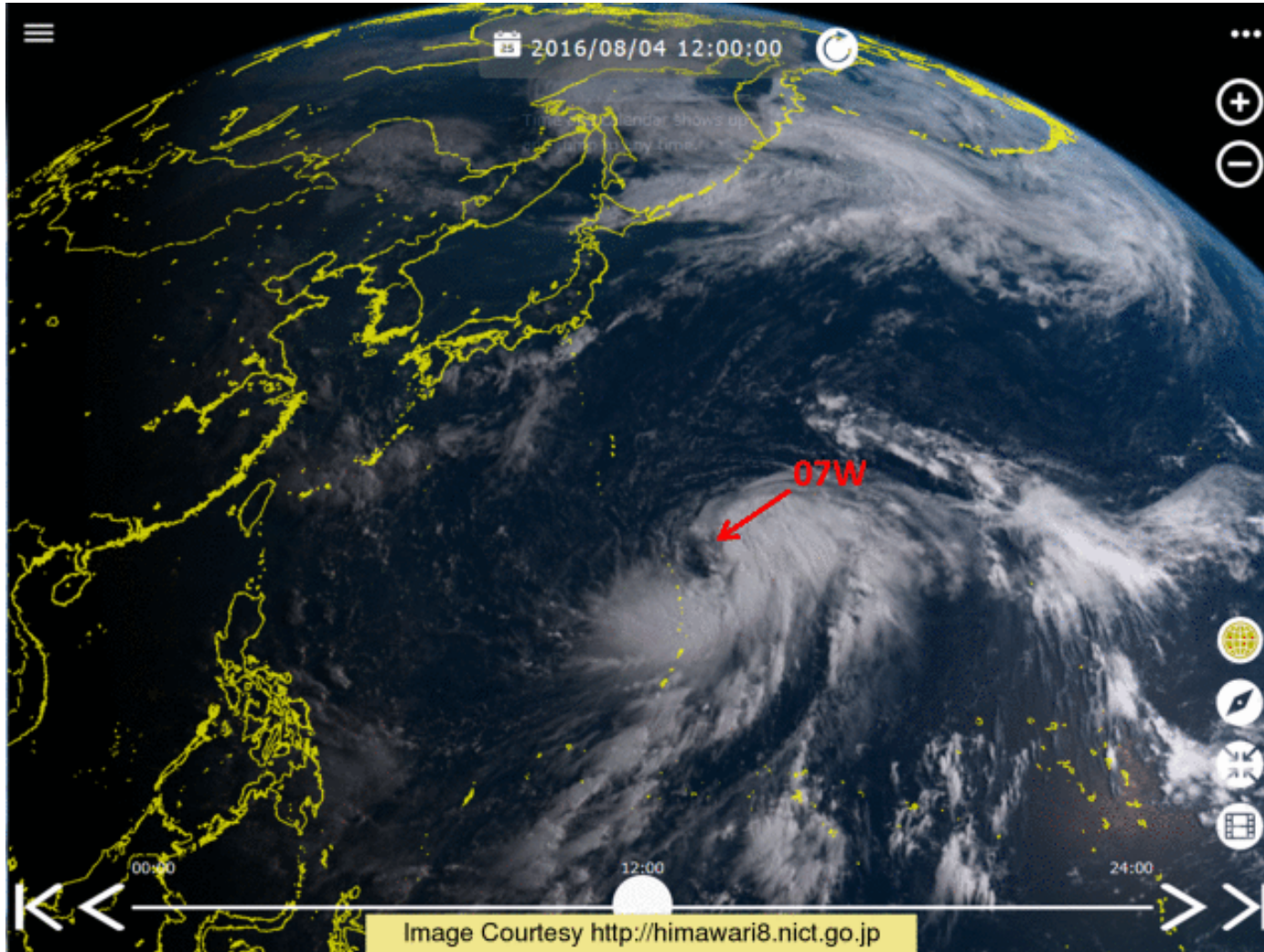
07W2016 (OMAIS) 080600Z  
 Vmax=50kts R34 (NE quad)=325nm!  
 Rvmax=160nm R50 (NE quad)=230nm!

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# August Monsoon Gyre



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# 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 system 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

## ■ **Addition of AWIPS-II to watchfloor**

- **Late-2017**
- **JTWC participating in monthly updates on ATCF capability migration**
  - **Developing an unfunded requirement package to request funds to assist effort, particularly areas where DoD ATCF use differs from NHC/CPHC**

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# *Other Development Priorities*



## **Further improvements/refinements to wind structure analysis and forecasts**

- **NRL is expanding R34 dataset**
- **NRL-CIRA collaboration is ongoing**
- **Desire to routinely best-track storm structure**

## **JTWC requests HNMMB model runs using HFIP resources, similar to previous HWRF experimental support**

- **In addition to track/intensity HNMMB can be evaluated for wind radii consensus**
- **Also interested in future experimental basin-scale HWRF**
  - **Concurrent TCs in WPAC, monsoon depressions and gyres**

## **JTWC desires operational COAMPS-TC ensembles**

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

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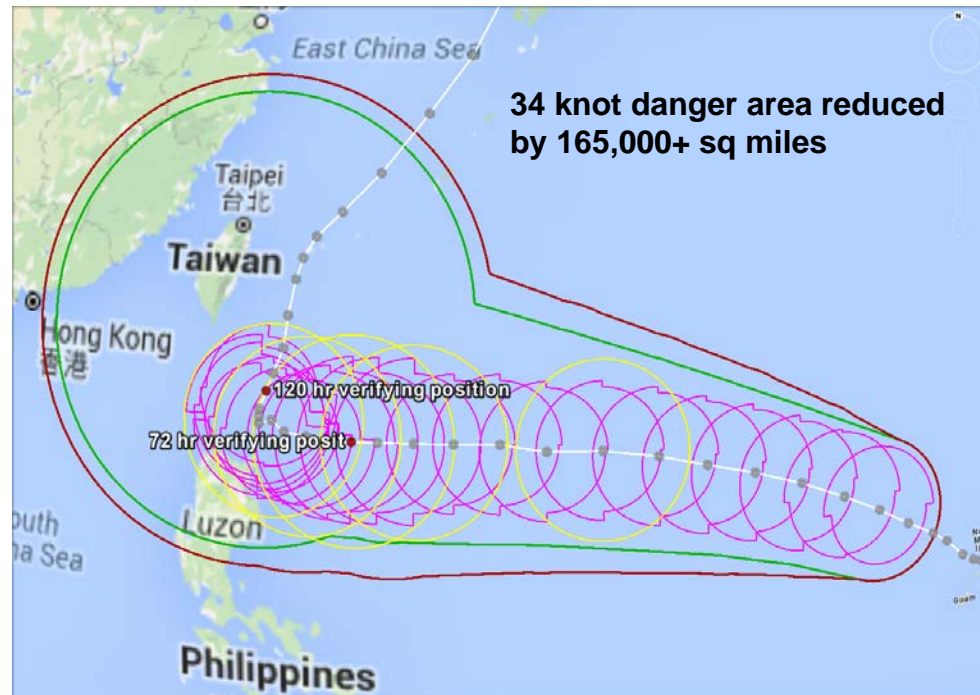


# Other Development Priorities



## Dynamic Swath

- JTWC evaluated a GPCE based dynamic 34-knot danger swath in 2015
  - Work funded to update GPCE-AX to further refine/improve this technique



## 7-day forecasting

- PACOM goals call for 7-day forecasts
- In-house evaluation of 7-day skill and resource impacts likely to begin in 2017

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

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. Submitted *Wea. Forecasting*.

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