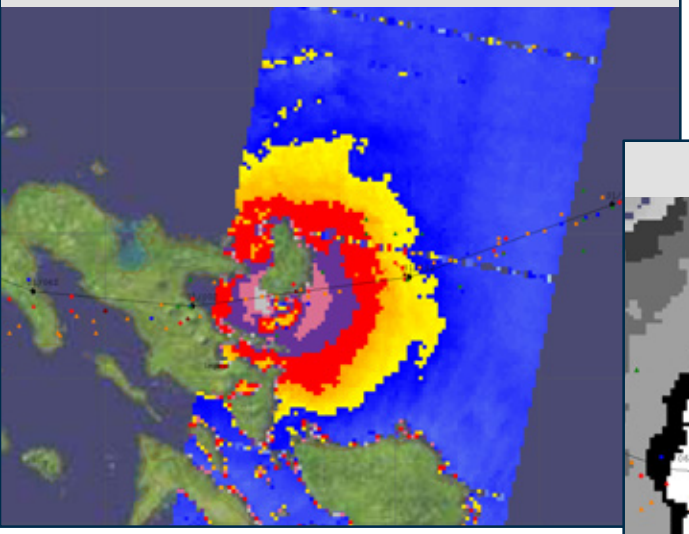
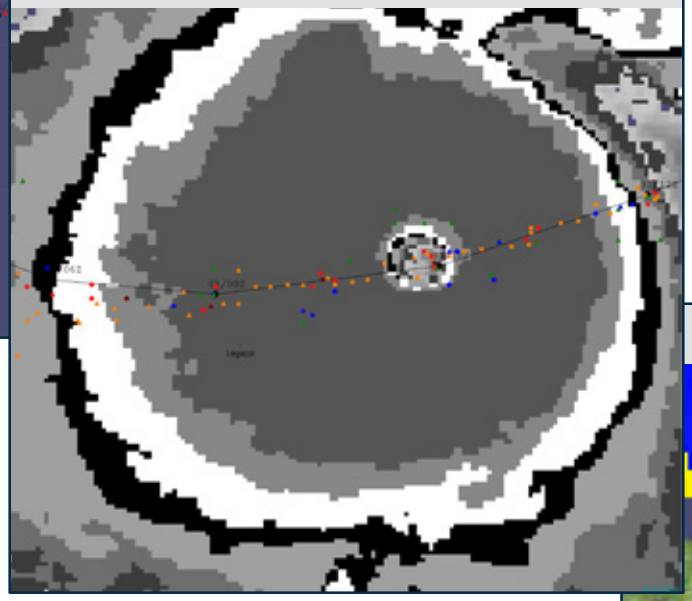
JTWC 2020 Operational Highlights, Challenges, and Future Changes

31 OCT 20 2130UTC Sentinel1-B SAR

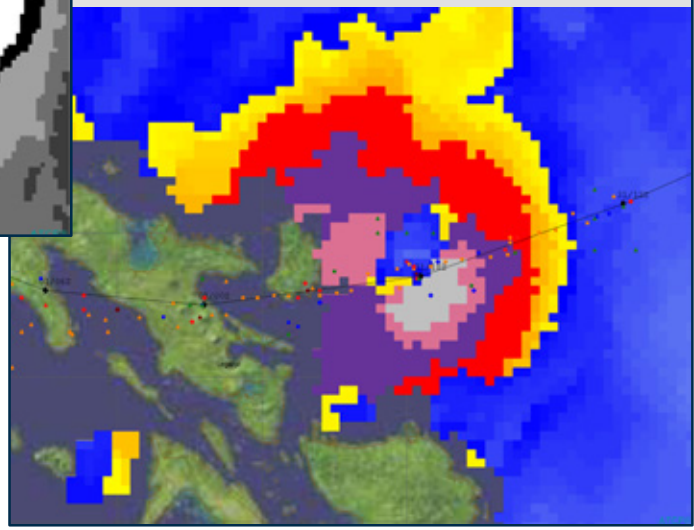


Super Typhoon 22W (Goni)

31 Oct 20 1800UTC Himawari-8 IRBD



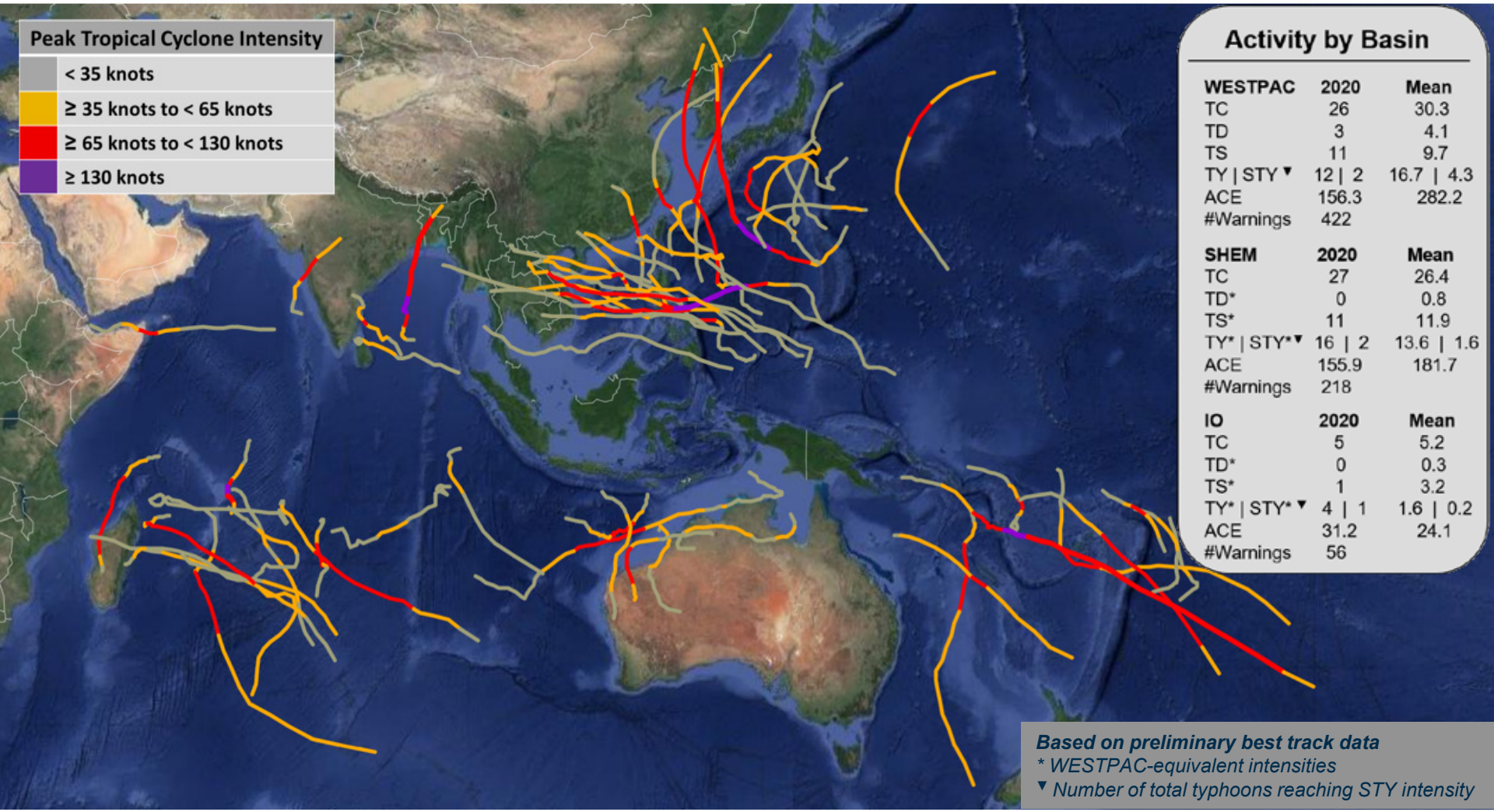
31 Oct 20 1733UTC AMSR2 Winds



TCORF/71st IHC
March 3, 2021

CDR Angela Francis, Commanding Officer
Mr. Brian Strahl, Director
Joint Typhoon Warning Center

2020 - Warned Tropical Cyclones



Activity by Basin

WESTPAC	2020	Mean
TC	26	30.3
TD	3	4.1
TS	11	9.7
TY | STY ▼	12 | 2	16.7 | 4.3
ACE	156.3	282.2
#Warnings	422	

SHEM	2020	Mean
TC	27	26.4
TD*	0	0.8
TS*	11	11.9
TY* | STY* ▼	16 | 2	13.6 | 1.6
ACE	155.9	181.7
#Warnings	218	

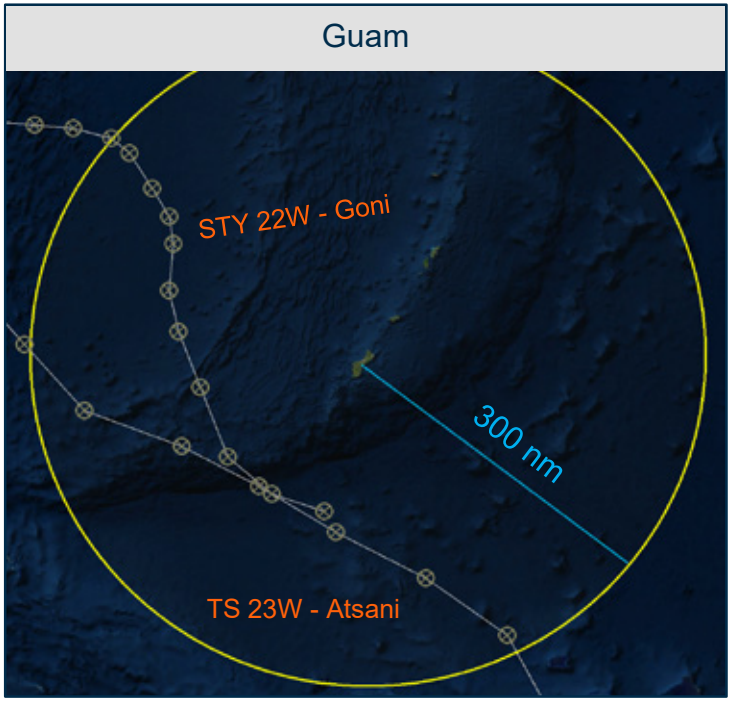
IO	2020	Mean
TC	5	5.2
TD*	0	0.3
TS*	1	3.2
TY* | STY* ▼	4 | 1	1.6 | 0.2
ACE	31.2	24.1
#Warnings	56	

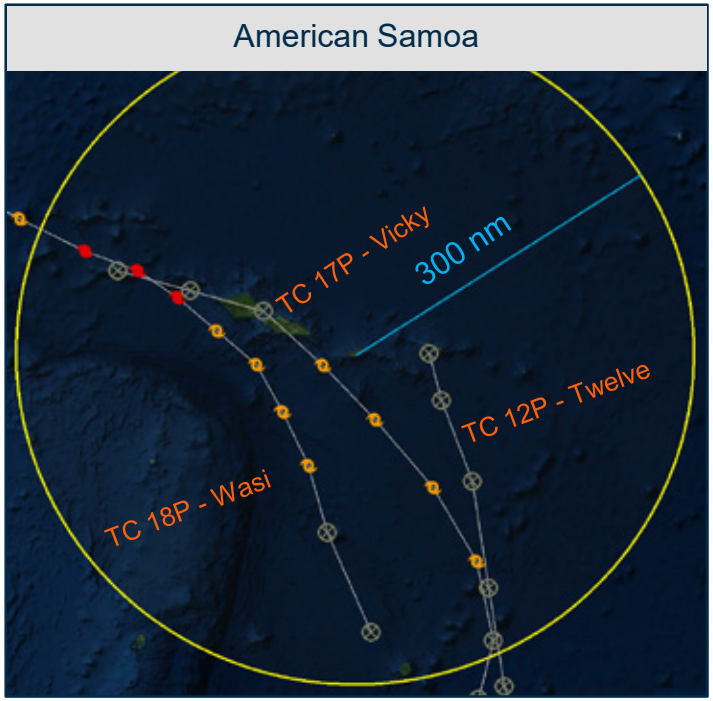
Based on preliminary best track data
** WESTPAC-equivalent intensities*
▼ Number of total typhoons reaching STY intensity

2020 -Tropical Cyclone Activity Timeline

* Based on preliminary best track data, as of 03 FEB 2021

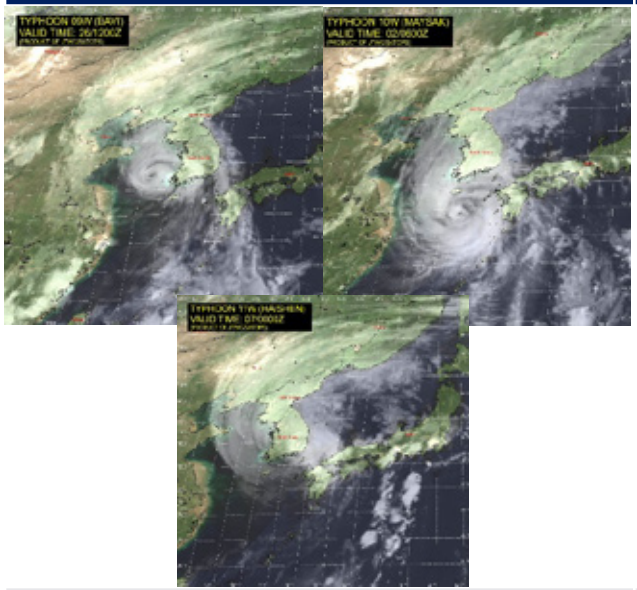
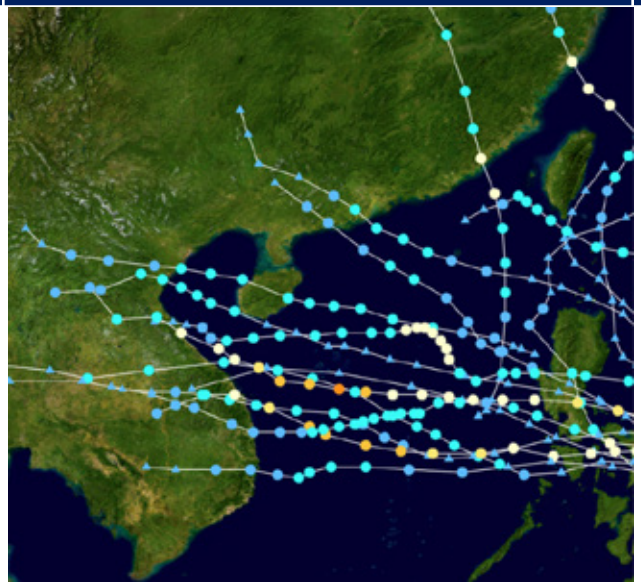
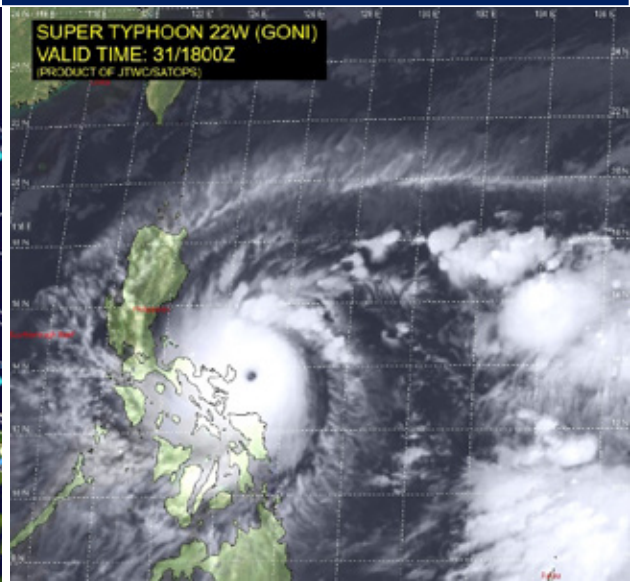
JTWC-NOAA Support/Coordination



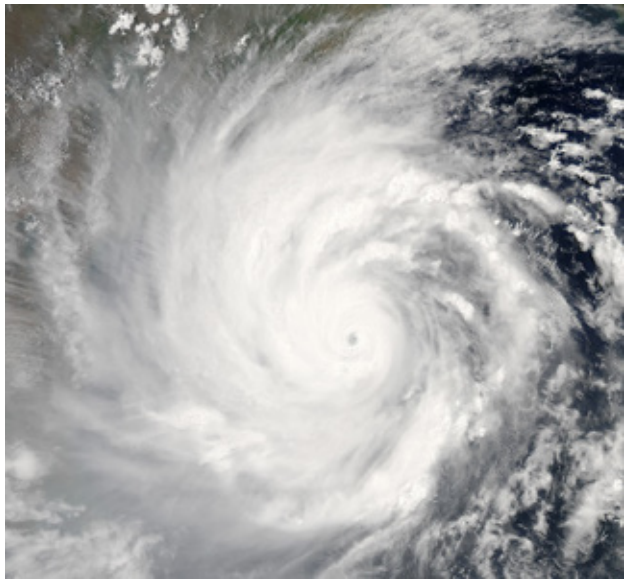
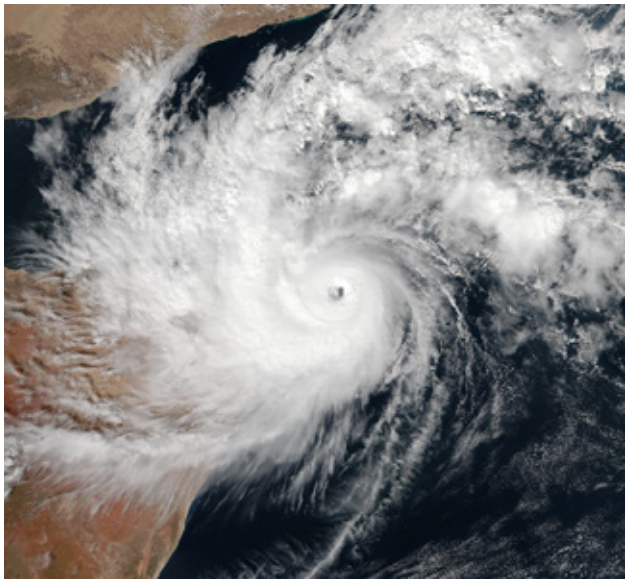


- 168 PGTW fixes in Central Pacific
- 64 PHFO fixes in South Pacific
- 1,073 KNES fixes in JTWC AOR
- 316 NHC EPAC advisories for 21 tropical cyclones repackaged for DoD by JTWC
- 1 Remnant low (Douglas) transitioned from CENTPAC to WESTPAC
- Utilized MS Teams channels for JTWC/WFO Guam/WSO Pago Pago/ROC communications

Major Pacific Impacts

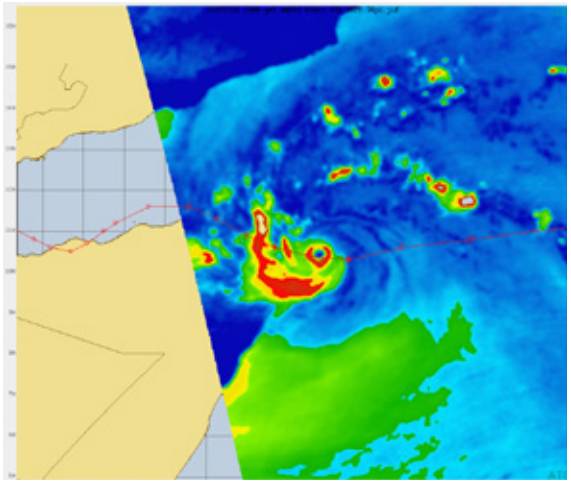
Typhoons Bavi (9W), Maysak (10W), Haishen (11W) 21 August – 07 September 2020	Central Vietnam Flooding from Multiple Tropical Cyclones October – November 2020	Super Typhoon Goni (22W) 28 October – 05 November 2020
		
Primary Impact Region: North Korea, South Korea, and Japan	**Primary Impact Region:** Vietnam and Cambodia	**Primary Impact Region:** Philippines and Vietnam
Fatalities: 51+ **Damage:** $211.7 million USD	**Fatalities:** 233+ **Damage:** $1.52 billion USD	**Fatalities:** 32 **Damage:** $1.02 billion USD
• Rare 3 typhoon impacts to Korean Peninsula within 2 weeks. • Panamanian *Gulf Livestock 1* cargo ship lost at sea with 43 crew.	• Hyperactive TC and monsoon activity in South China Sea due to La Niña. • 127.75” accumulation in Hướng Linh during 13-day period.	• Most intense TC of the season. • Most intense landfalling TC on record (170 knots), matching STY Haiyan (2013) and STY Meranti (2016).

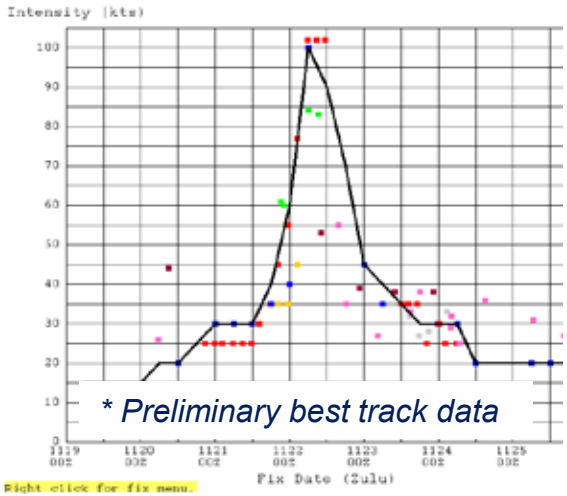
Major Indian Ocean Impacts

Tropical Cyclone Belna (02S) 04 – 11 December 2019	Tropical Cyclone Amphan (01B) 16 May – 20 May 2020	Tropical Cyclone Gati (03A) 21 – 23 November 2020
		
Primary Impact Region: Madagascar	**Primary Impact Region:** Eastern India and Bangladesh	**Primary Impact Region:** Somalia and Socotra
Fatalities: 9 **Damage:** $25 million USD	**Fatalities:** 128 **Damage:** $13.7 billion USD	**Fatalities:** 9+ with 30 missing **Damage:** several million USD
• Widespread heavy rain and flooding. • 80% of residences in town of Soalala suffered wind damage.	• Costliest cyclone on record in the North Indian Ocean. • Most intense TC in the Bay of Bengal since the Odisha cyclone of 1999.	• Most intense TC on record to make landfall in Somalia. • Over a year's worth of rainfall fell within 24 hours.

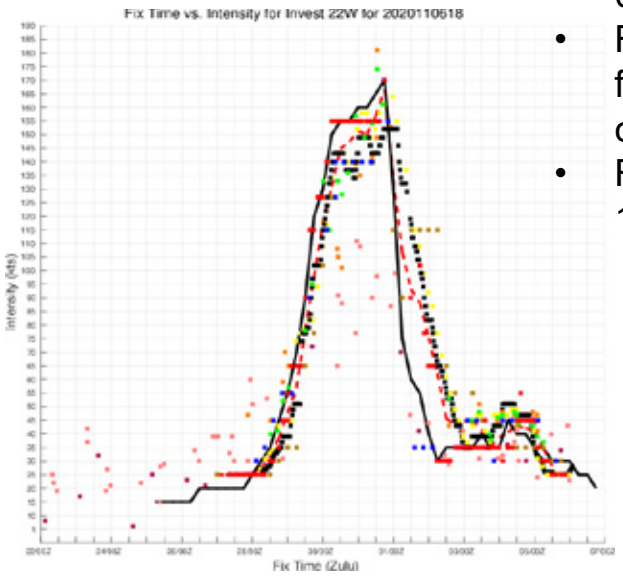
Primary Forecast Challenges

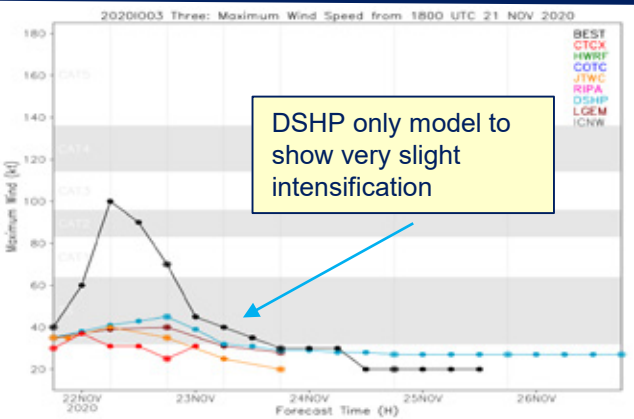
Tropical Cyclone Gati (03A) Rapid Intensification



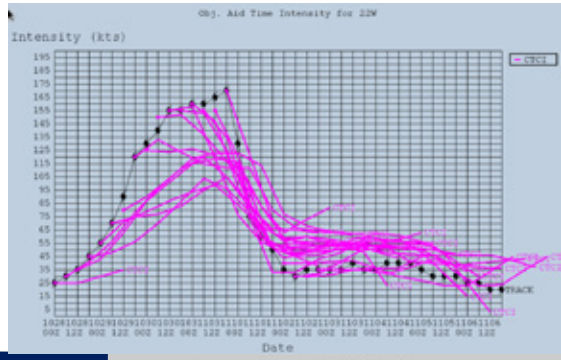


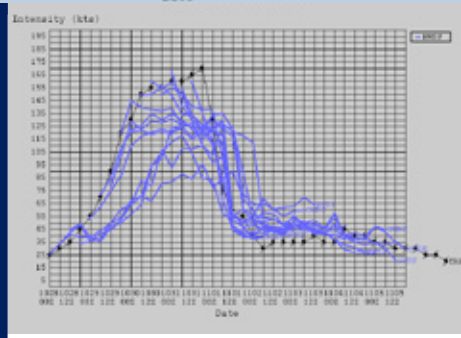
Super Typhoon Goni (22W) Rapid Intensification



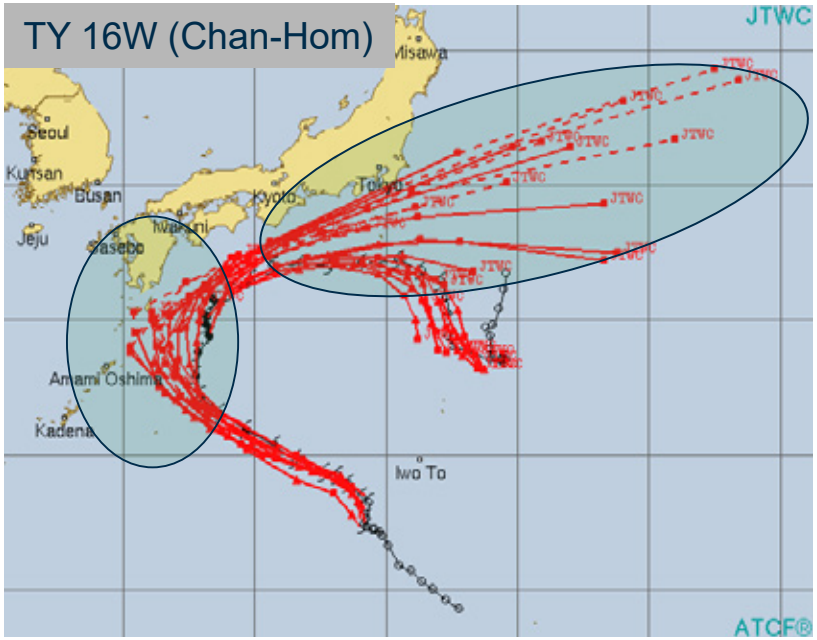


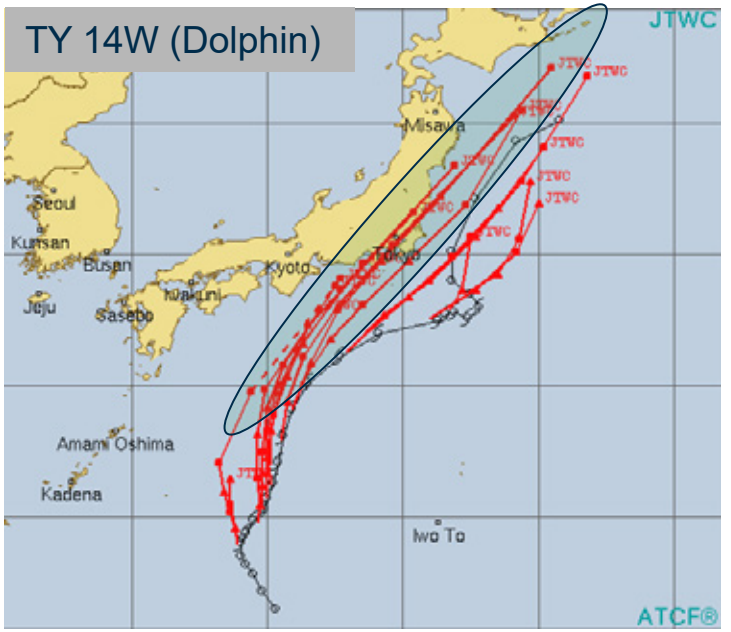
- Best track data are **preliminary**
- 80 kt increase 10/29 06Z to 10/30 06Z (70-150 kts)
- RI and rapid weakening under-forecast (HRWF predicted rate of change and weakening fairly well)
- RIPA (up to 55 kt in 36 hr) from 10/28 12Z to 10/29 12Z





Track Forecasting Challenge: Mid-latitude Flow Interactions





- Early deterministic guidance indicated "wider turn," ET transition / acceleration
- System followed flow around steering ridge
- Rapidly dissipated - no ET transition

Mean track errors (NM) FOR HOMOGENEOUS SAMPLE*

	00	12	24	36	48	72	96	120
JTWC	8.2	25.0	36.7	51.9	78.6	202.3	299.1	277.7
CONW	8.2	22.5	33.2	50.3	71.8	179.6	308.1	325.0
#CASES	31	29	27	25	23	19	15	11

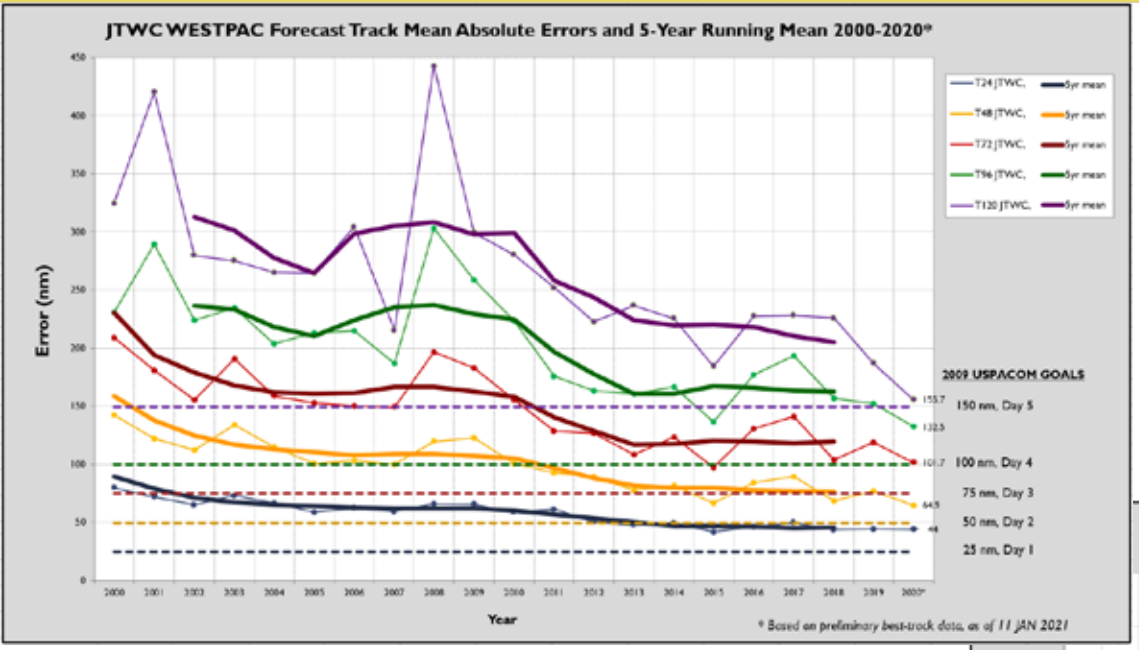
- Weak system detached from mid-lat flow longer than anticipated - ETT delayed
- Most model guidance too far west

Mean track errors (NM) FOR HOMOGENEOUS SAMPLE*

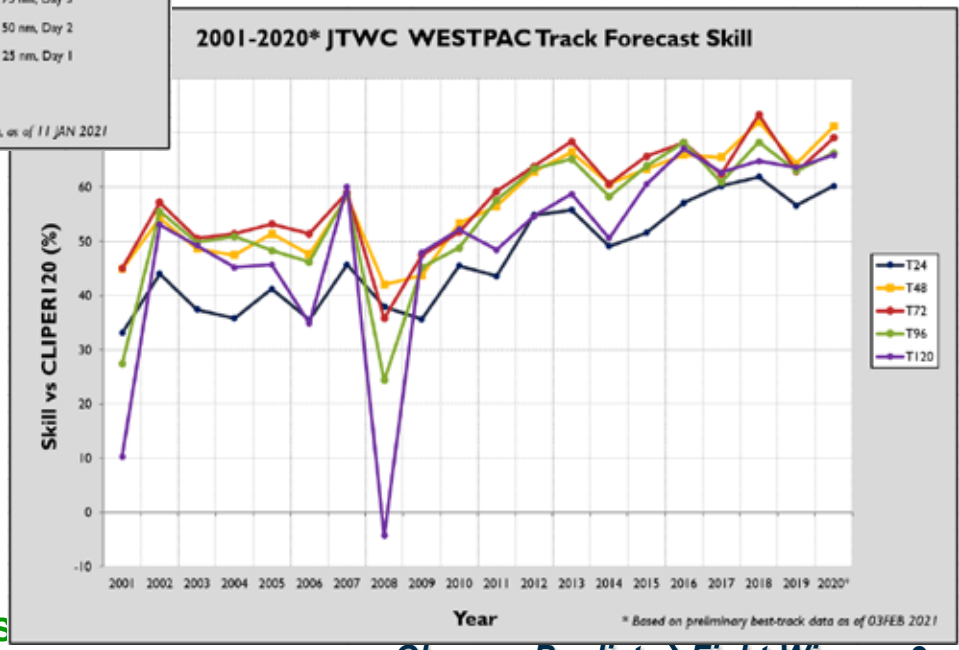
	00	12	24	36	48	72
JTWC	15.8	63.4	109.6	161.2	215.6	299.3
CONW	15.8	62.6	107.4	159.1	219.1	301.9
#CASES	15	14	12	10	7	3

** Based on preliminary best track data*

2020 WESTPAC Forecast Track Errors (Preliminary)



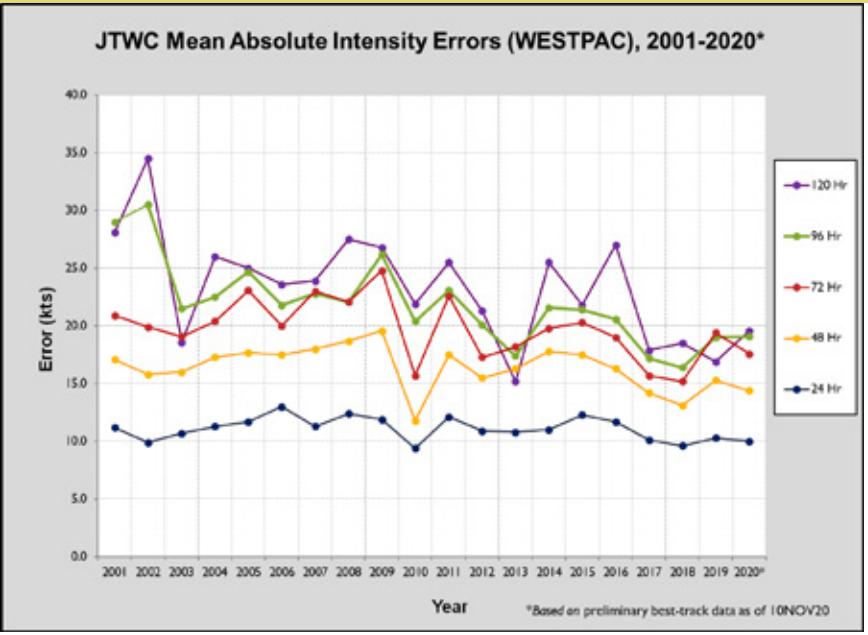
- Record low mean absolute error at days 2, 4, and 5

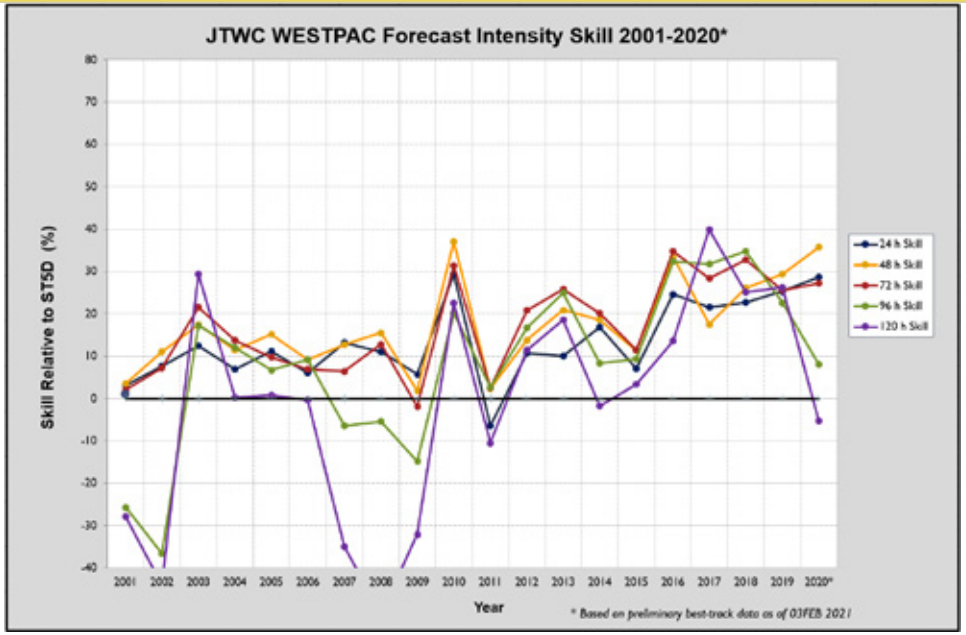


- Number of cases in sample:

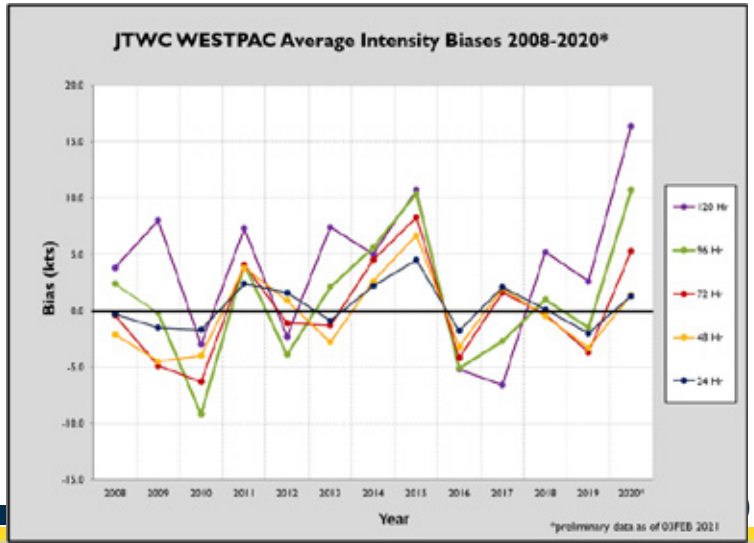
24: 340
48: 246
72: 174
96: 120
120: 81

2020 WESTPAC Forecast Intensity Errors (Preliminary)





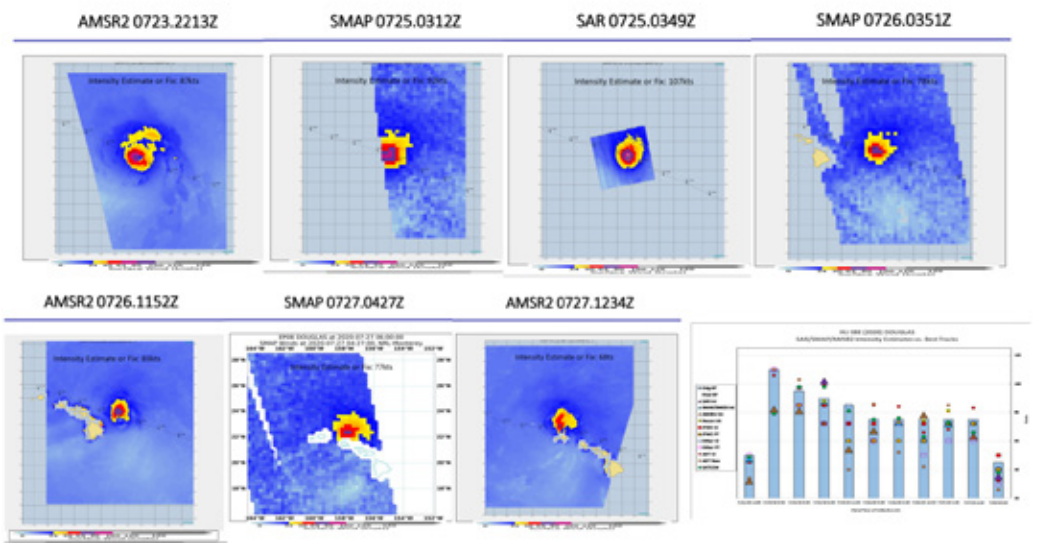
- Intensity MAE relatively steady last four years
- Days 1, 2 skill climbed
  - RIPA was a positive contributor
  - Intensity consensus (ICNW) remains best performer
- Days 4,5 skill dropped sharply
  - Significant high biases
  - Partially consistent with weaker TCs due to La Nina
  - Noted high bias in HWRF



Reconnaissance

The Good News:

- JTWC expanded use of SMAP/SMOS winds and added AMSR-2 and SAR
  - Capable of measuring high winds above scatterometer sensitivity thresholds
  - NESDIS SAR Demonstrator continues to expand collections and reduce latency
  - ESA transitioned SHOC to Cyclone Monitoring System (CYMS)
  - New imagery visualization, interrogation, automated fix integration into ATCF
- Addition of ASCAT-C
- Addition of CIMSS Archer in ATCF
- New NRL product development
  - GeoIPS
- Expanding use of MS Teams to collaborate more directly with NRL, CIRA, CIMSS, etc.
- New R&D satellites on the way
  - COWVR
  - Cubesats

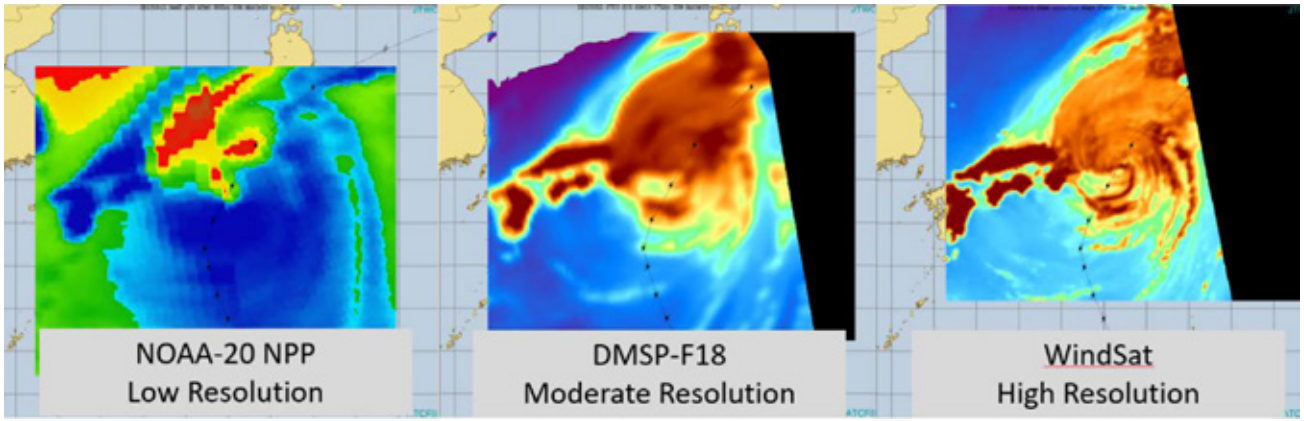


Sample of AMSR2, SMAP, SMOS, and SAR passes during Hurricane Douglas

Reconnaissance

The Bad News:

- Navy did not prioritize funding to continue WindSat operations, ended Nov 2020
  - Leaves only two critical high resolution 37GHz microwave imagers currently
  - Loss of additional OSVW source
  - Overall mean microwave imagery refresh rate degraded



Comparison of satellite resolutions for Typhoon Hagibis, 2019

- No plans for routine aerial recon outside of CONUS
  - Field campaign needed to validate new sat-based wind estimates in JTWC AOR
- DMSP beyond end-of-life, 1 WSF-M launch planned in 2023

Upcoming Changes

- Transition to bulletized prognostic reasoning message format (next slide)
  - Will include ***all*** current information
  - Adds wind radii analysis and assessed confidence, more explicit 0-72/72-120 hour track and intensity forecast confidence description
  - Allows partial automation of message generation
  - Customer roadshow surveys indicates bulletized format easier to read and find information
  - Will provide public announcement, feedback period, and coordination ahead of change
- Tentatively plan to expand prognostic reasoning messages to include Indian Ocean and Southern Hemisphere tropical cyclones
- Expanding available WMO bulletin headers (NHOP, Appendix C)
  - Additional bulletins in case of more than 5 concurrent TCs
  - Preparation for future TC products/service
  - Will utilize existing 5 bins/headers during 2021

Prototype Prognostic Reasoning Message (Bullet Format)

*** Prototype sample shown below. Final production format may be different**

WDPN31 PGTW 112200
MSGID/GENADMIN/JOINT TYPHOON WRNCEN PEARL HARBOR HI//
SUBJ/PROGNOSTIC REASONING FOR TROPICAL STORM 01W (VONGFONG) WARNING
NR 001//
RMKS/
1. FOR METEOROLOGISTS.
2. 6(12) HOUR SUMMARY AND ANALYSIS

APPROXIMATE LOCATION: 547 NM ESE OF MANILA, PHILIPPINES
MOVEMENT PAST 6 (12) HOURS: NNW AT 04 KTS

SATELLITE DISCUSSION. ANIMATED ENHANCED INFRARED SATELLITE IMAGERY SHOWS FLARING CONVECTION OFFSET SOUTHEAST OF THE LOW LEVEL CIRCULATION (LLC), WITH SOME WEAKER FLARING CONVECTION NEAR THE ASSESSED CENTER POSITION. A 111237Z ASCAT-B PASS AND ACCOMPANYING AMSU 89 GHZ MICROWAVE IMAGE DEPICT LOW LEVEL CLOUD BANDS WHICH CAN BE SEEN WRAPPING INTO THE OBSCURED CENTER.

CONFIDENCE IN INITIAL POSITION: LOW, BASED ON AGENCY FIXES AND ILL-DEFINED CENTER IN NOTED AMSU 89 GHZ IMAGE

AGENCY DVORAK AND AUTOMATED FIXES:
  PGTW T1.5 (25 KTS)
  RJTD T1.5 (25 KTS)
  SATCON: NA
  ADT: NA
  OTHER OBSERVATIONS: SHIP 50 NM SE OF CENTER OBSERVED 28 KTS
CONFIDENCE IN INITIAL INTENSITY: HIGH

WIND RADII BASED ON: ADJUSTED FROM A 111145Z ASCAT-C PASS
CONFIDENCE IN WIND RADII: FAIR

ENVIRONMENT: SUPPORTS INTENSIFICATION
  VWS: LOW (10-15 KTS)
  SST: WARM (28-29 C)
  OUTFLOW: MODERATE RADIAL
  OTHER NOTABLE ENVIRONMENTAL FACTORS: NA

STEERING. TRACKING ALONG THE WESTERN PERIPHERY OF A DEEP-LAYERED SUBTROPICAL RIDGE (STR) CENTERED OVER THE NORTHERN MARIANAS ISLANDS WITH A NORTH-SOUTH ORIENTED AXIS ALONG ROUGHLY 145E LONGITUDE.

SIGNIFICANT WAVE HEIGHT: 13 FT

3. FORECAST REASONING

SIGNIFICANT FORECAST CHANGES: NONE, INITIAL WARNING.
FORECAST TRACK CONFIDENCE:
  0-72 HR: LOW
  72-120 HR: LOW
FORECAST INTENSITY CONFIDENCE:
  0-72 HR: MODERATE (WAS LOW PREVIOUS WARNING)
  72-120 HR: LOW

0-72 HR DISCUSSION. TD 01W WILL TRACK SLOWLY NORTH-NORTHWESTWARD OVER THE NEXT 24 HOURS AS THE DEEP-LAYERED STR REMAINS ENTRENCHED FAR TO THE EAST. BY TAU 36, THE STR REORIENTS EAST TO WEST, SHIFTING TD 01W ONTO A WEST-NORTHWESTWARD TRACK TOWARD THE CENTRAL PHILIPPINES. THE SYSTEM IS EXPECTED TO SKIRT THE NORTH SHORE OF SAMAR ISLAND BEFORE MAKING LANDFALL ON THE SOUTHEASTERN PORTION OF LUZON AROUND TAU 72. THE FAVORABLE ENVIRONMENT IS EXPECTED TO SUPPORT STEADY INTENSIFICATION THROUGH TAU 72.

72-120 HR DISCUSSION. THE NORTHWESTWARD TRACK WILL SHIFT MORE NORTHWARD AS IT BEGINS ROUNDING THE WESTERN PERIPHERY OF THE STR AND DRAGS ACROSS THE LENGTH OF LUZON BEFORE REEMERGING OVER WATER IN THE BABUYUAN CHANNEL BY TAU 120. THE INTENSITY WILL STEADILY WEAKEN AS IT TRANSITS OVER THE ROUGH TERRAIN, HOWEVER, ROBUST POLEWARD OUTFLOW WILL LIMIT THE AMOUNT OF WEAKENING AND ALLOW THE SYSTEM TO REEMERGE OVER WATER AS A WEAK TROPICAL STORM.

MODEL DISCUSSION: ALTHOUGH EVERY MEMBER OF THE CONSENSUS DEPICTS A STAIR STEP TRACK SCENARIO, THEY DIFFER CONSIDERABLY ON THE EXACT TRACK AND CROSS-TRACK SPREAD IS OVER 250 NM AT TAU 72. BY TAU 120, ALONG-TRACK SPREAD BECOMES SIGNIFICANT AS WELL AND TOTAL SPREAD IS OVER 300 NM BY TAU 120. THE JTWC TRACK FORECAST LIES JUST WEST OF THE MULTI-MODEL CONSENSUS TRACK THROUGH TAU 24. IT LIES NORTH AND EAST OF THE CONSENSUS THROUGH THE REMAINDER OF THE FORECAST PERIOD. CLOSER TO THE ECMWF SOLUTION.//NNNN

JTWC R&D Priorities

Priority	Need
1 TC Intensity Change	*Basin-specific* (WESTPAC, SHEM, NIO, SIO, and SWPAC) probabilistic and deterministic *forecast guidance for TC intensity change*, *particularly* the onset, duration, and magnitude of *rapid intensity change* events (including ERC, over-water weakening, etc.) at 2-3 day lead times.
2 Data Exploitation	Techniques, products, or sources that *improve* the utility and *exploitation of microwave satellite, ocean surface wind vectors, and radar data* for fixing (center, intensity, radii) TCs, or for diagnosing RI, ETT, ERC, *etc.* (*e.g.*, develop a "Dvorak-like" technique using microwave imagery). Leverage machine learning methods to maximize automation, and ensure rapid integration into visualization system.
3 TC Structure Specification	*Basin-specific* (WESTPAC, SHEM, NIO, SIO, and SWPAC) probabilistic and deterministic guidance for the *specification* (analysis and forecast) *of key TC structure variables*, *including* the production of 34-, 50- and 64- knot wind radii and a *dynamic* (situational) confidence-based *swath* of potential 34-kt wind impacts
4 TC Track Improvement	Model and DA enhancements or guidance to *improve TC track forecast skill and* the *conveyance of probabilistic track uncertainty*. Includes development of guidance-on-guidance to identify and reduce forecast error outliers resulting from large speed (e.g., accelerating recurvers) and directional (e.g., loops) errors, or from specific forecast problems such as upper-level trough interaction, near/over-land, elevated terrain, and extratropical transition.
5 TC Genesis Timing and Forecast	Guidance to *improve* the *forecasting of TC genesis timing* and the subsequent track, intensity and structure of pre-genesis tropical disturbances out to two week lead-times, that exhibits a high probability of detection and a low false alarm rate. Techniques to diagnose and predict the formation of TCs via transition of non-classical disturbances (e.g. monsoon depressions, sub-tropical, hybrids, etc).

Questions?

THANK YOU!