

# **Welcome to the 2023 RA-IV Workshop on Hurricane Forecasting and Warning**

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WMO Tropical Cyclone Program**

**February 27, 2023**





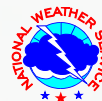
# Workshop Introduction Outline

- **ORIENTATION**
  - Laptops
  - NHC Facility
  - Campus Map
  - Overview of Workshop
- **INTRODUCTION OF PARTICIPANTS**
- **OVERVIEW OF NHC ORGANIZATION**
- **PRODUCT ENHANCEMENTS**
- **TOUR**





# Access to Course Material



- **Presentations available on Google Drive in the folder:**

## **2023 WMO Workshop Material**

- **That drive should have been shared with you or will be shortly. If you are signed into a different Google account then you may need to request access.**







# NHC Facility

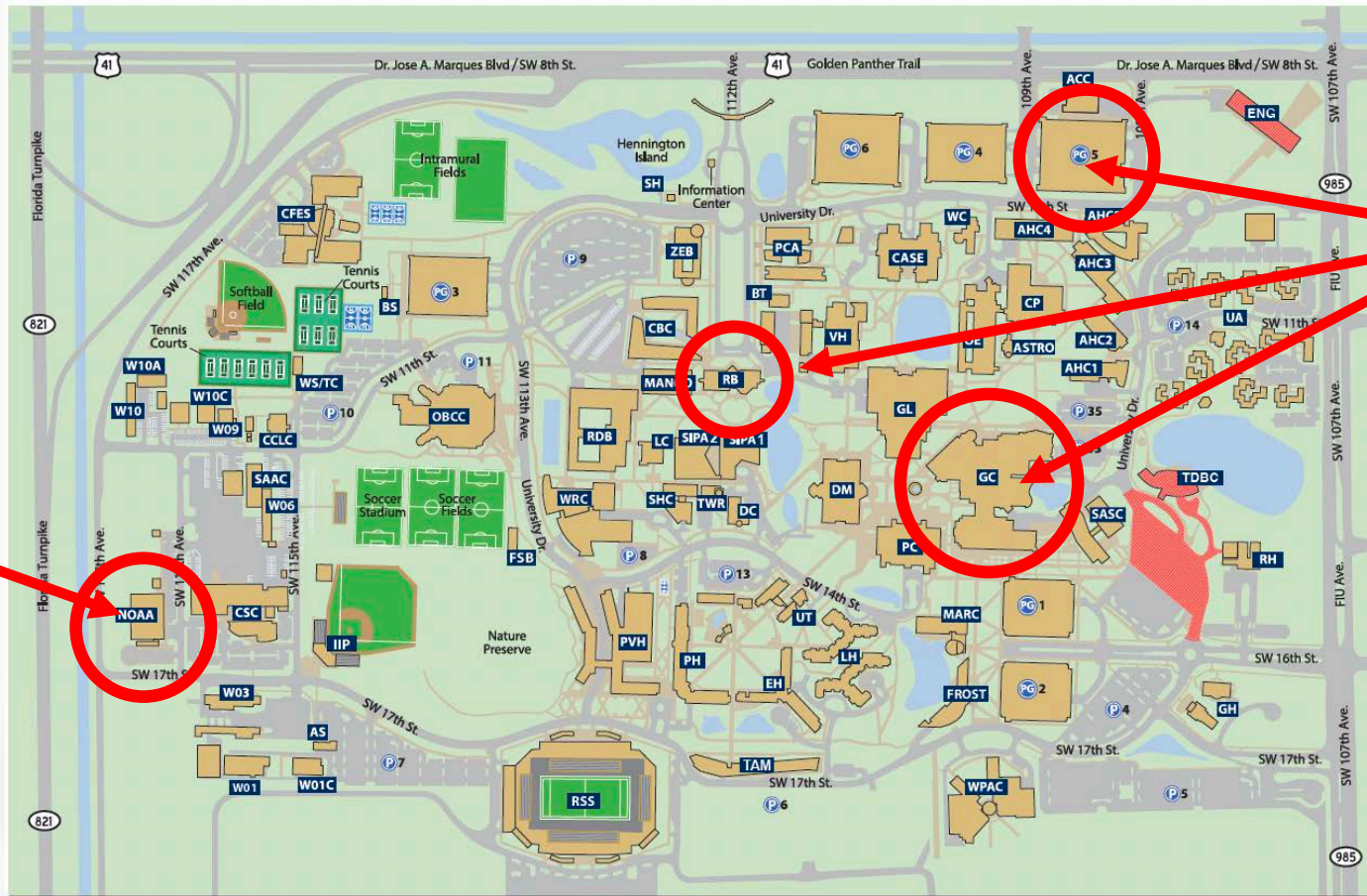


- **Sign in/Sign out**
- **Restrooms**
- **Breaks & Food**
- **Campus map**





# FIU Campus Map



NHC





# Introduction of Participants

**16 countries & WMO Represented**

- **NAME**
- **ORGANIZATION**
- **CITY, COUNTRY**
- **DUTIES**
- **WHAT WOULD YOU LIKE TO GET FROM THIS WORKSHOP?**

A red rectangular name tag with the word "HELLO" in large white capital letters and "my name is" in smaller white lowercase letters below it. The tag is positioned on a white background with a faint palm tree silhouette. Below the tag is a thick red horizontal line.



# Workshop Agenda – Week 1



## *2023 WMO RA-IV WORKSHOP ON HURRICANE FORECASTING AND WARNING*

*February 27 – March 10, 2023*

**NHC COURSE COORDINATOR: RICHARD J. PASCH**

### **Week 1 (Feb 27-Mar 3)**

	<b>Monday, Feb 27</b>	<b>Tuesday, Feb 28</b>	<b>Wednesday, March 1</b>	<b>Thursday, March 2</b>	<b>Friday, March 3</b>
<b>8:30-9:50 AM</b>	<b>RJP/JR/MJB: Welcome &amp; Introduction (15 min), Tour</b>	<b>JC: Tropical Waves</b>	<b>JS: TC Modeling &amp; Data Assimilation</b>	<b>JB: Introduction to Satellites Dvorak Technique</b>	<b>JB: Dvorak Technique (Cont.)</b>
<b>10:10-11:30 AM</b>	<b>FM: Hurricane Research</b>	<b>SD: TAFB Operations and Products</b>	<b>EB/DB: Ensemble Forecasting &amp; Probabilistic Guidance</b>	<b>BR: Interpretation of Microwave Imagery</b>	<b>JB: Dvorak Technique (Cont.)</b>
	Lunch	Lunch	Lunch	Lunch	Lunch
<b>1-1:30 PM</b>	Map Discussion	Map Discussion	Map Discussion	Map Discussion	Map Discussion
<b>1:30-2:50 PM</b>	<b>KE: Hurricane Science Tutorial (remote)</b>	<b>SM: Special Lecture</b>	<b>MC/JG: Rainfall Forecasting</b>	<b>JB: Dvorak Technique (Cont.)</b>	<b>JB: Dvorak Technique (Cont.)</b>
<b>3:10-4:30 PM</b>	<b>BK: Large-Scale Circulation</b>	<b>RR: Aircraft Observations in TCs (40 min)</b> <b>GF: Saildrone (40 mi)</b>	<b>WH: Doppler Radar</b>	<b>JB: Dvorak Technique (Cont.)</b>	<b>SG: Objective Satellite Intensity Estimates from CIMSS ect.</b>
<b>4:30 PM</b>	<b>End Session</b>	<b>End Session</b>	<b>End Session</b>	<b>End Session</b>	<b>End Session</b>





# Workshop Agenda – Week 2



Week 2 (March 6-10)

	Monday, March 6	Tuesday, March 7	Wednesday, March 8	Thursday, March 9	Friday, March 10
8:30-9:50 AM	PP/RJP: TC Genesis	LB: Reconnaissance Aircraft Data Analysis	RB/DB/PS: W/W Philosophy (Probabilities/Risk, W/W Recommendations, Coordination)	TC Operations and Research Forum (TCORF) (Model Center Updates)	CW/GE (40 min): Social Science Research  DS: Effective Messaging (40 min)
10:10-11:30 AM	MD: TC Intensity Forecasting	DZ/RP TC Track Forecasting	RJP/DZ/DB: Operational Forecasting and Advisory Preparation (Analysis Portion)	TCORF (JTTI)	AD: Briefing EMs (40 min) RM: Role of WCM (40 min)
	Lunch	Lunch	Lunch	Lunch	Lunch
1-1:30 PM	Map Discussion	Map Discussion	Map Discussion	Map Discussion	Map Discussion
1:30-2:50 PM	MO: Tropical Cyclone Structure	EB: Intraseasonal TC Variability/Seasonal Forecasting	RJP/DZ/DB: Operational Forecasting and Advisory Preparation (Track & Intensity Forecast)	DB/EB/RB: Messaging/Social RP: Media	MB: EM Perspective (60 min)  MG: Hurricane Liaison Team (20 min)
3:10-4:30 PM	RT: TC track ensemble sensitivity	HN: Storm Surge	RJP/DZ/DB: Operational Forecasting and Advisory Preparation (Products/Messaging)	MT: Media Training	Open Discussion, Course Evaluation
4:30 PM	End Session	End Session	End Session	End Session	End Session





# National Hurricane Center

## Organizational Structure



### Hurricane Specialist Unit

Develop, coordinate (domestically and abroad), and issue tropical cyclone warnings, forecasts, and outlooks in text and graphical formats (~700 full advisory packages/yr)

“Off-season” outreach and public awareness programs

Applied research

### Tropical Analysis and Forecast Branch

Marine/ocean and satellite analyses, forecasts and warnings in text and graphical formats, 24x7, (~100 products/day)

Conduct tropical cyclone (Dvorak) analyses for the hurricane specialists

Augments operational support staffing

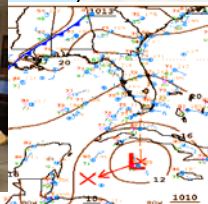
### Technology and Science Branch

Computer systems support 24x7

Applications development and technology infusion

Storm surge guidance (real time; community planning; preparedness)

Emergency operational support staffing





# Facts About the NHC Facility



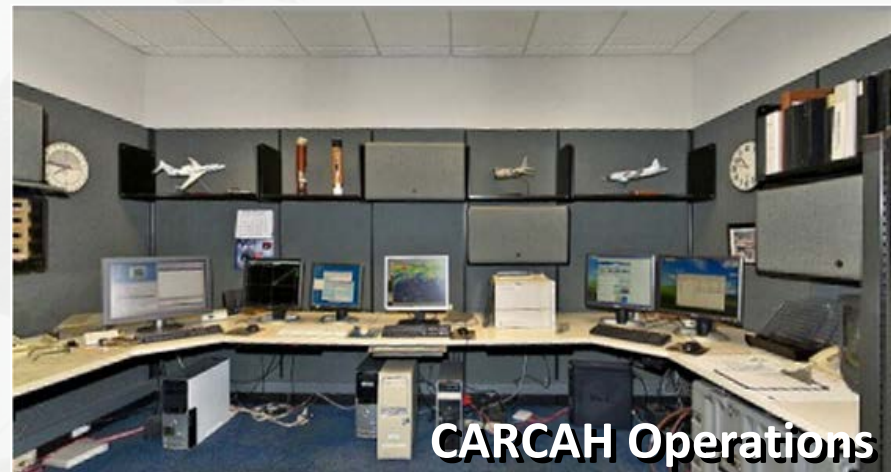
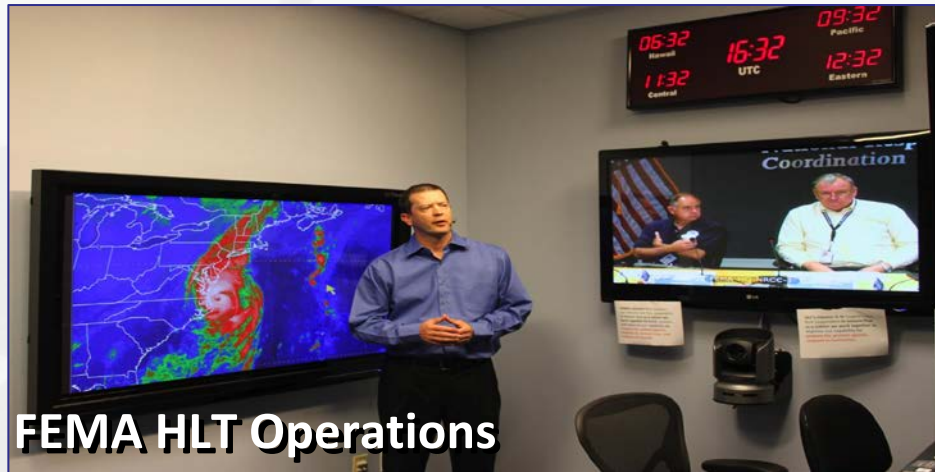
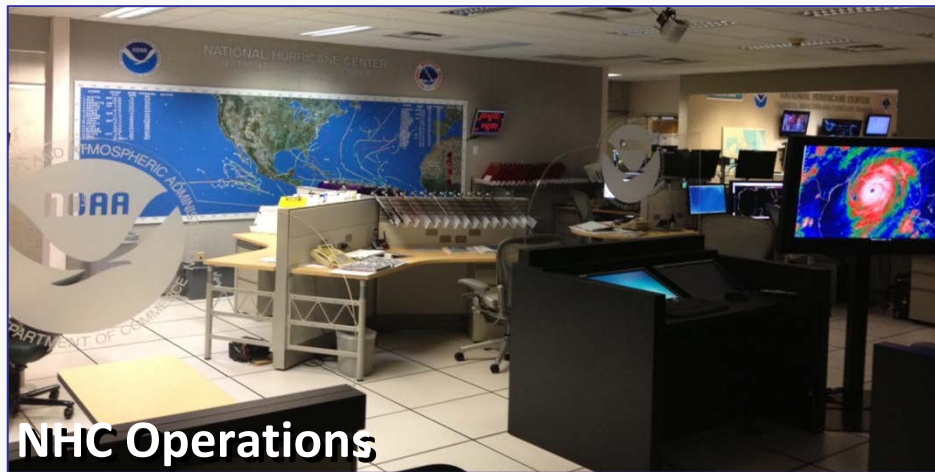
- Opened in 1995
- 25,000 square ft
- Design team included Herb Saffir
- Rest five feet above flood plain
- 10-inch thick walls made from 3000 cubic yards of concrete, reinforced with 45 miles of steel reinforcing rods
- More than 50 miles of electrical and communications wiring
- Also houses the NWS Miami Weather Forecast Office







# Tour of Primary Operations Areas





# World Meteorological Organization

## Regional Specialized Meteorological Centers (RSMC)



- **NHC is one of 7 RSMCs that produce and coordinate tropical cyclone forecasts for various ocean basins.**
- **NHC is responsible for both the Atlantic & eastern North Pacific Ocean basins.**





# International Collaboration Highlights



- Open exchange of meteorological data among countries
- NHC provides forecasts and guidance on watches and warnings to 28 WMO member nations
- NHC hosts and teaches two-week workshop on tropical cyclones for international government meteorologists
- NHC Director serves as Chairman of the WMO RA-IV Hurricane Committee. Annual meeting updates the Region's "Hurricane Operational Plan"
- U.S. conducts annual Caribbean Hurricane Awareness Tour
- Storm surge projects





# Hurricane Awareness Tour

- **2020 and 2021 – Canceled due to the pandemic; limited return in 2022 - U.S. Territories**
- **Full Return in 2023 – April 17-22 –  
(Merida and Chetumal, Mexico,  
Grand Cayman, Dominican Republic,  
Turks & Caicos, and Puerto Rico)**
- **Opportunity to increase hurricane awareness by meeting with emergency managers, media, and general public**
- **Tour of hurricane hunter aircraft**





# NHC's International Coordination



## World MET. ORGANIZATION - Regional Association IV Coordination



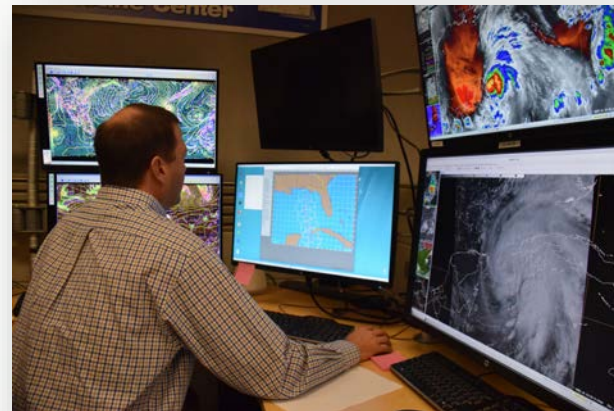
**RSMC= Regional Specialized Meteorological Center**

**RA-IV countries include Caribbean area, Central America, Mexico, Canada, and Bermuda.**



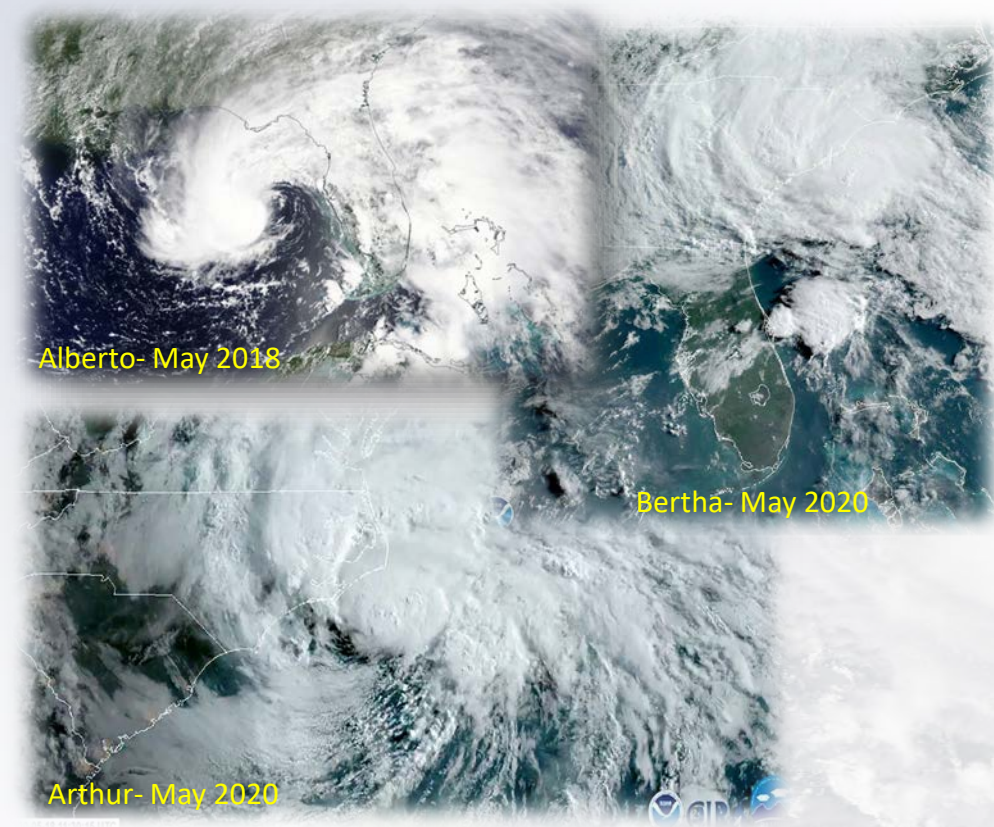
# Coordination of International Watches & Warnings

- Each country is responsible for issuing watches/warnings for their respective country or jurisdiction
  - NHC issues watches/warnings for Haiti
- NHC will recommend the placement of watches/warnings
- Coordinated with Met. Offices throughout the region
- Potential Tropical Cyclone advisories allow for the issuance of watches and warnings prior to the formation of a tropical depression





# Reminder: May 15 Start of NHC Atlantic Tropical Weather Outlooks



- In 2021, NHC began issuing Atlantic Tropical Weather Outlooks on May 15
  - No change to the official start of hurricane season
  - Provides information on possible development prior to June 1
- 7 straight years (2015-2021) with at least one named storm prior to June 1<sup>st</sup>
- 5 of the recent pre-season storms have impacted the United States
  - Arthur and Bertha ('20), Alberto ('18), Bonnie ('16), Ana ('15)



# World Meteorological Organization Tropical Cyclone Naming Update (2021)

Supplemental List of Atlantic Tropical Cyclone Season		
Adria	Heath	Orlanda
Braylen	Isla	Pax
Caridad	Jacobus	Ronin
Deshawn	Kenzie	Sophie
Emery	Lucio	Tayshaun
Foster	Makayla	Viviana
Gemma	Nolan	Will

- Overflow name list no longer includes the Greek Alphabet
- Supplemental name lists for Atlantic and Eastern Pacific basins

# Extension of the Tropical Weather Outlook to 7 Days - New for 2023

- The time period covered by the NHC Tropical Weather Outlook will be expanded to 7 days beginning in 2023
- The Outlook will provide 2- and 7-day probabilities of tropical cyclone formation
  - 7-day probabilities replace 5-day
- The 7-day genesis area will be depicted on the Graphical Tropical Weather Outlook

**NATIONAL HURRICANE CENTER**  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

TROPICAL WEATHER OUTLOOK  
NWS NATIONAL HURRICANE CENTER MIAMI FL  
800 PM EDT MON OCT 20 2023

For the North Atlantic...Caribbean Sea and the Gulf of Mexico:

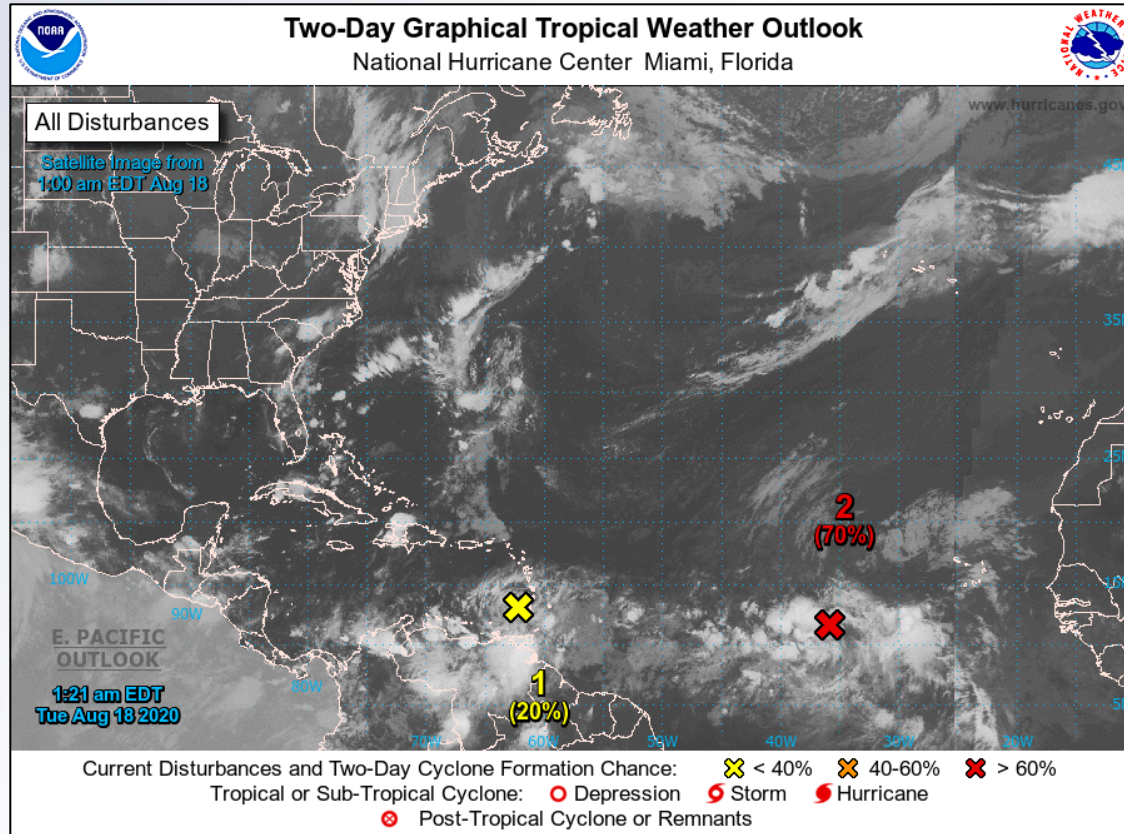
**Southwest Gulf of Mexico (AL92):**  
Showers and thunderstorms associated with an area of low pressure located over the southwestern Bay of Campeche have changed little in organization since this afternoon. This system has the potential to become a tropical cyclone during the next couple of days while it moves slowly eastward across the southern Bay of Campeche. Later in the week, the low is forecast to interact and possibly merge with a frontal system over the southeastern Gulf of Mexico or northwestern Caribbean Sea. An Air Force Reserve reconnaissance aircraft is scheduled to investigate the disturbance tomorrow afternoon, if necessary. Interests in the Yucatan Peninsula should monitor the progress of this system.

- \* Formation chance through 48 hours...medium...50 percent.
- Formation chance through 7 days...medium...60 percent.

Forecaster Brown



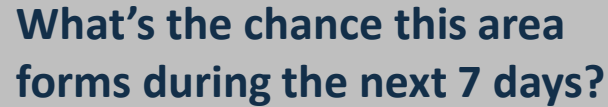
# 2-Day Graphical Tropical Weather Outlook Remains Unchanged



- Current location of disturbances
- Formation chance during the next 48 hours
- Categorical Probabilities (Low, Medium, and High)



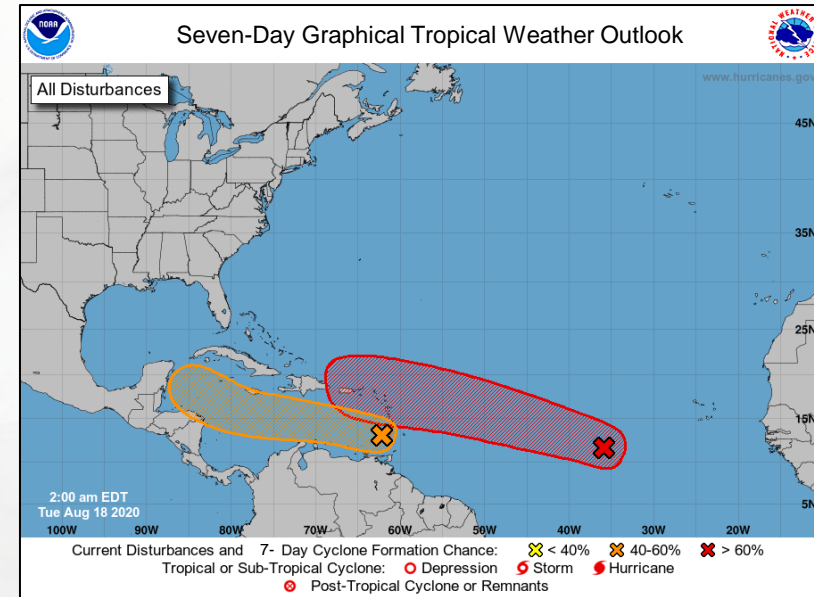
**NEW**  
**7days**



- Initial location of disturbance (x) indicated
  - Formation potential during the next 7 days
    - Shading represents formation area
- the chance this area  
during the next 7 days?
- Categorical Probabilities (Low, Medium, and High)

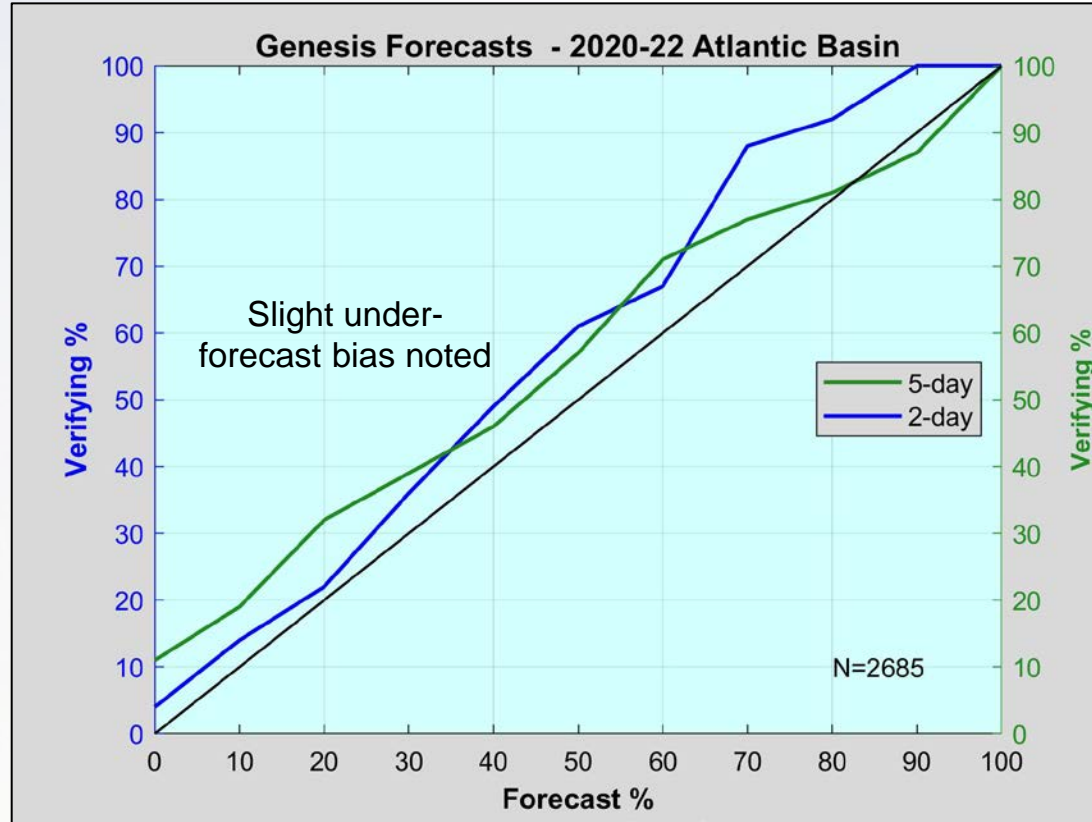
# 7-Day Graphical Tropical Weather Outlook

- What does a 7-day Tropical Weather Outlook mean for messaging pre-genesis disturbances?
  - Systems are likely to be introduced into the TWO sooner
  - Systems are likely to move into the medium and high categories earlier producing longer lead times
  - Genesis areas are likely to be larger, especially for systems with a fast forward speed



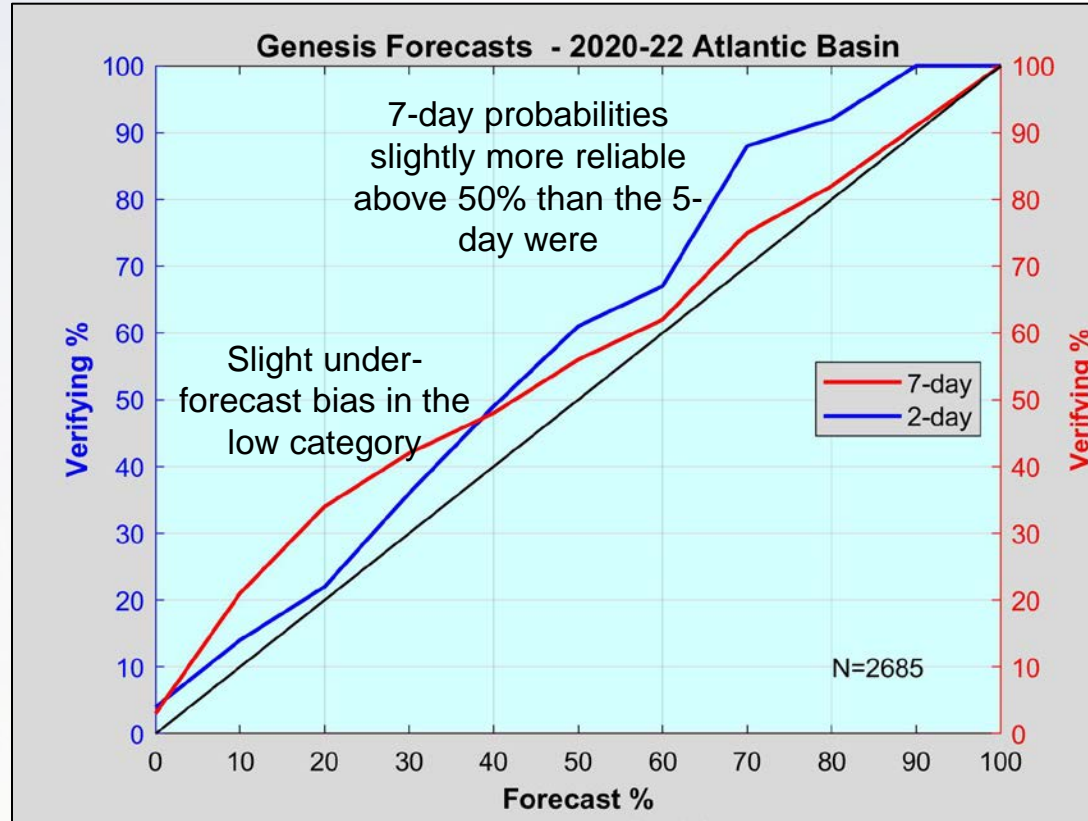
*Example of a Seven-Day Graphical Tropical Weather Outlook*

# How is the Extension to 7-Days Possible?



How reliable are these probabilistic forecasts?

# How is the Extension to 7-Days Possible?



**Three-year sample of 7-day in-house probabilities have proven to be quite reliable.**



# Outlook Now Includes Invest Numbers\* and Geographical Descriptors

Tropical Weather Outlook  
NWS National Hurricane Center Miami FL  
200 AM EDT Fri Sep 2 2022

For the North Atlantic...Caribbean Sea and the Gulf of Mexico:

**Active Systems:**

The National Hurricane Center is issuing advisories on Tropical Storm Danielle, located about 925 miles west of the Azores.

**East of the Leeward Islands (AL91):**

Satellite imagery indicates there has been little change in the organization of the area of low pressure located several hundred miles east of the Leeward Islands during the past several hours. Although environmental conditions remain only marginally conducive, any additional development of the system over the next few days would lead to the formation of a tropical depression. The disturbance is expected to move slowly west-northwestward, toward the adjacent waters of the northern Leeward Islands. Regardless of development, locally heavy rains may occur over portions of the Leeward Islands during the next couple of days, and interests in that area should monitor the progress of the system. An Air Force Reserve Hurricane Hunter aircraft is scheduled to investigate the system this afternoon, if necessary. Additional information on this system can be found in High Seas Forecasts issued by the National Weather Service.  
\* Formation chance through 48 hours...medium...50 percent.  
\* Formation chance through 7 days...high...70 percent.

**Eastern Tropical Atlantic:**

Shower activity associated with a broad area of low pressure located just northwest of the Cabo Verde Islands has increased some over the last several hours, but remains poorly organized. This system is moving into an area of less favorable environmental conditions, and significant development is not anticipated.  
\* Formation chance through 48 hours...low...10 percent.  
\* Formation chance through 7 days...low...10 percent.

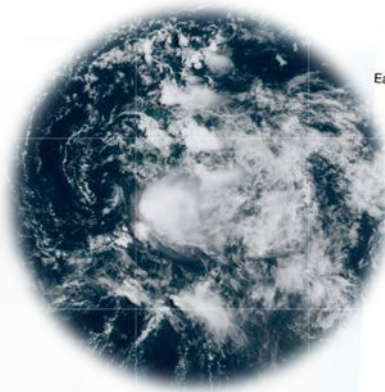
- In 2022, geographic headers were added for active systems and disturbances
- Beginning in 2023, invest numbers (AL90-99) will be included when available there is an active invest open in association with the disturbance
- These changes should:
  - Make the text product more readable and scannable
  - Minimizes confusion between multiple systems, especially when it's busy

Note: Headers will likely not be bold in the actual product

\*New for 2023 and when available

# Reminders about “Invests”

- Opening an “invest” allows:
  - NHC to monitor disturbances more carefully
  - Collection of microwave satellite data
  - Collect “fixes”
  - Ability to run model guidance
- Caveats for “invests”:
  - No standard for opening an invest – up to forecaster discretion
  - Invest information only has to be updated every 12 h
  - Guidance is typically run when a cloud system center is apparent
- More meteorological uncertainty associated with invests!
  - Extreme caution should be used when looking at model guidance for invests




# Removal of Watches & Warnings from the Forecast/Advisory

- In order to *expediate* the issuance of this product, *watch and warning information will be removed beginning in 2023*

- Watch and Warning information is available in the *Public Advisory*

- The Forecast/Advisory is a NHC text product that contains all the forecast information

- Generally used by parsing software to plot the forecast



**NATIONAL HURRICANE CENTER**  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

TROPICAL STORM MICHAEL FORECAST/ADVISORY NUMBER 7  
NWS NATIONAL HURRICANE CENTER MIAMI FL AL142018  
0900 UTC MON OCT 08 2018

TROPICAL STORM CENTER LOCATED NEAR 20.6N 85.5W AT 08/0900Z  
POSITION ACCURATE WITHIN 15 NM

PRESENT MOVEMENT TOWARD THE NORTH OR 360 DEGREES AT 6 KT

ESTIMATED MINIMUM CENTRAL PRESSURE 983 MB  
MAX SUSTAINED WINDS 60 KT WITH GUSTS TO 75 KT.  
50 KT..... 80NE 80SE 0SW 0NW.  
34 KT.....120NE 150SE 90SW 100NW.  
12 FT SEAS..135NE 120SE 30SW 60NW.  
WINDS AND SEAS VARY GREATLY IN EACH QUADRANT. RADII IN NAUTICAL  
MILES ARE THE LARGEST RADII EXPECTED ANYWHERE IN THAT QUADRANT.



REPEAT...CENTER LOCATED NEAR 20.6N 85.5W AT 08/0900Z  
AT 08/0600Z CENTER WAS LOCATED NEAR 20.2N 85.5W

FORECAST VALID 08/1800Z 21.7N 85.6W  
MAX WIND 70 KT...GUSTS 85 KT.  
64 KT... 30NE 30SE 0SW 0NW.  
50 KT... 90NE 90SE 30SW 30NW.  
34 KT...130NE 150SE 90SW 120NW.



# Removal of Watches & Warnings from the Forecast/Advisory

- Latest Watch and Warning information can always be found in the **NHC Public Advisory**, a text product issued every 3 hours whenever watches and warnings are in effect
- Tropical Storm and Hurricane Watches and Warnings are also displayed on the NHC Cone and Initial Wind Field graphics

**NATIONAL HURRICANE CENTER**  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Tropical Storm Michael Advisory Number 7  
NWS National Hurricane Center Miami FL AL142018  
400 AM CDT Mon Oct 08 2018

...MICHAEL ALMOST A HURRICANE...  
...HURRICANE WATCH ISSUED FOR THE FLORIDA PANHANDLE AND BIG BEND...

SUMMARY OF 400 AM CDT...0900 UTC...INFORMATION  
-----

LOCATION...20.6N 85.5W  
ABOUT 90 MI...145 KM E OF COZUMEL MEXICO  
ABOUT 100 MI...155 KM SSW OF THE WESTERN TIP OF CUBA  
MAXIMUM SUSTAINED WINDS...70 MPH...110 KM/H  
PRESENT MOVEMENT...N OR 360 DEGREES AT 7 MPH...11 KM/H  
MINIMUM CENTRAL PRESSURE...983 MB...29.03 INCHES

**WATCHES AND WARNINGS**  
-----

A Storm Surge Watch is in effect for...  
\* Navarre Florida to Anna Maria Island Florida, including Tampa Bay

A Hurricane Watch is in effect for...  
\* Alabama-Florida border to Suwanee River Florida

A Tropical Storm Watch is in effect for...  
\* Suwanee River to Anna Maria Island Florida, including Tampa Bay  
\* Alabama-Florida border to the Mississippi-Alabama border

***Questions?***





# Wifi



**NHC\_Guest\_Wifi\_New**

**Password: 20Cloud13**





# Polleverywhere



**Add QR Code**