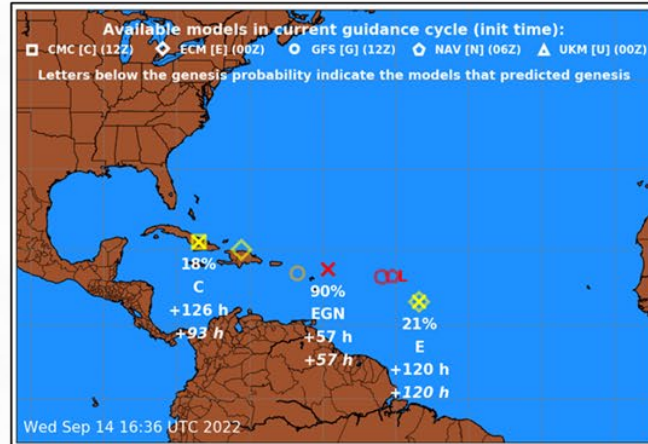
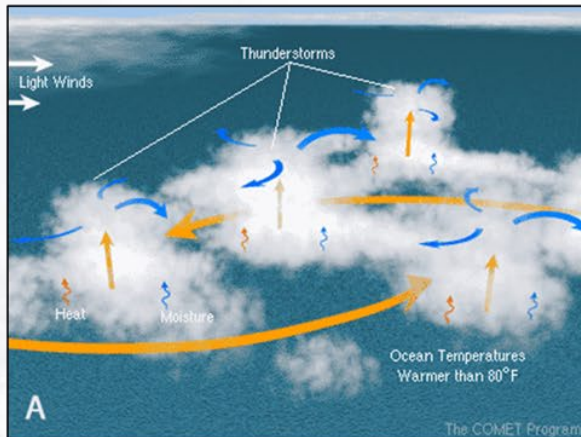
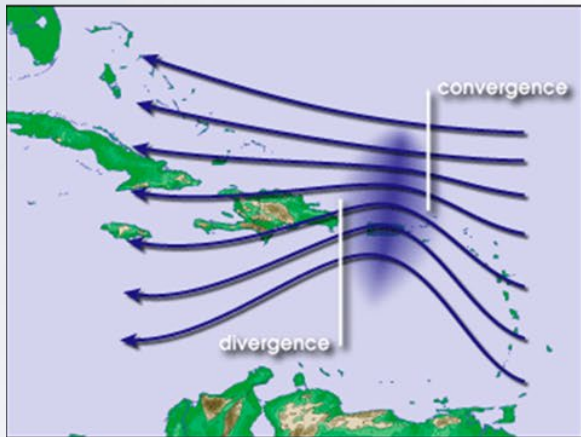


Tropical Cyclogenesis Forecasts

Tropical Weather Outlooks



Philippe P. Papin

National Hurricane Center

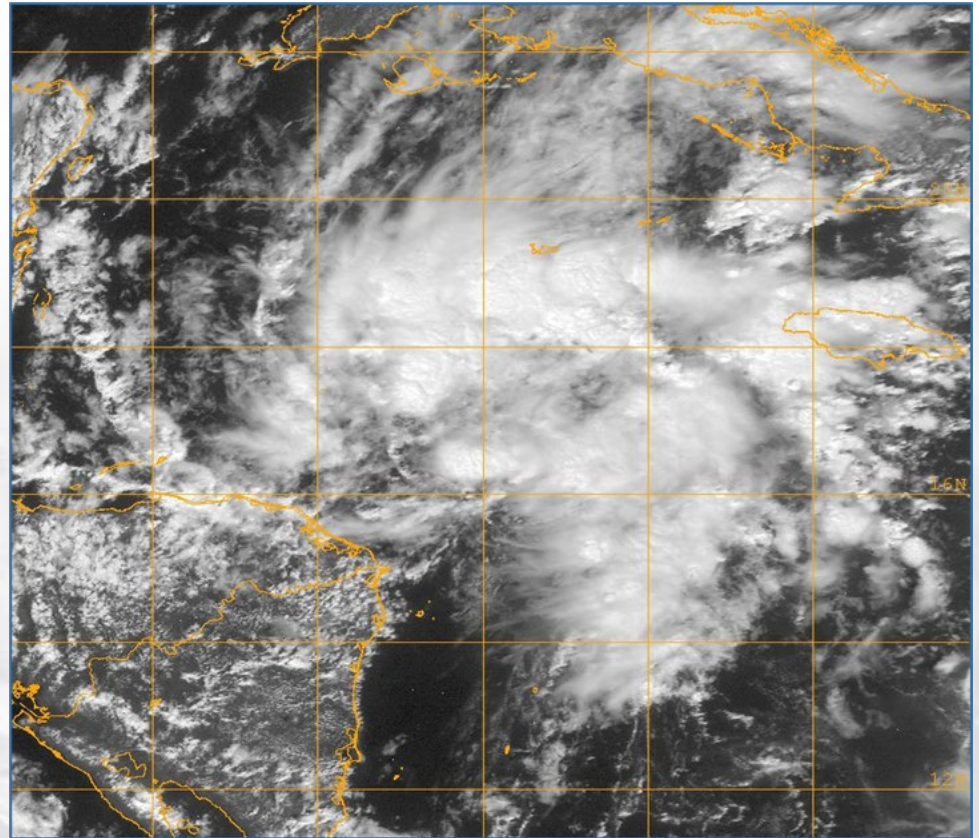
2024 WMO RA-IV Workshop on Hurricane Forecasting and Warning

TROPICAL CYCLOGENESIS

Definitions

WMO:

“A warm-core, non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and closed surface wind circulation about a well-defined center.”

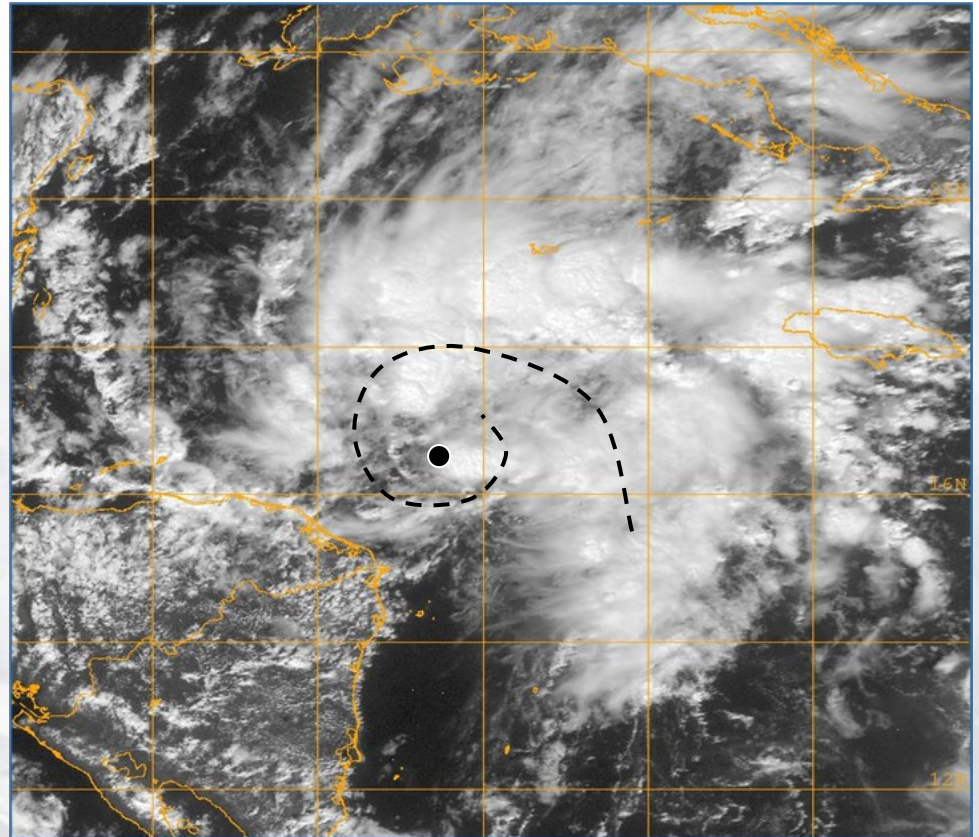


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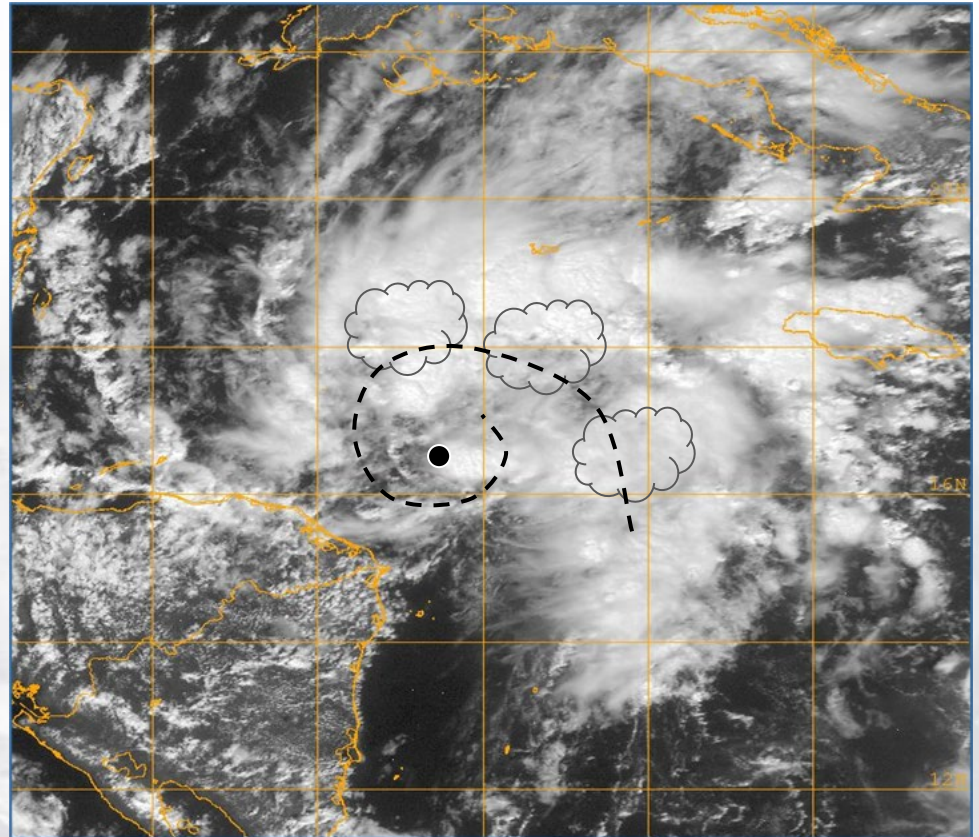


TROPICAL CYCLOGENESIS

Definitions

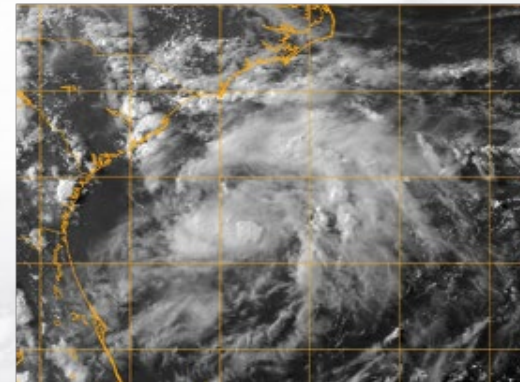
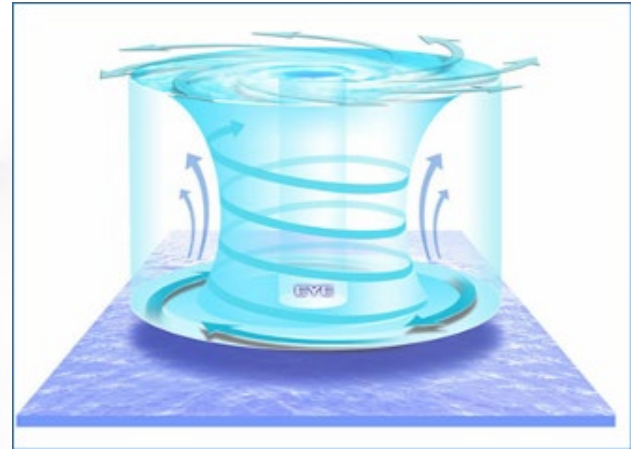
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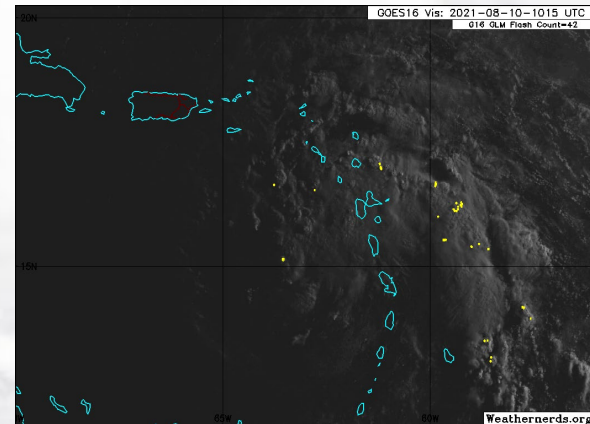
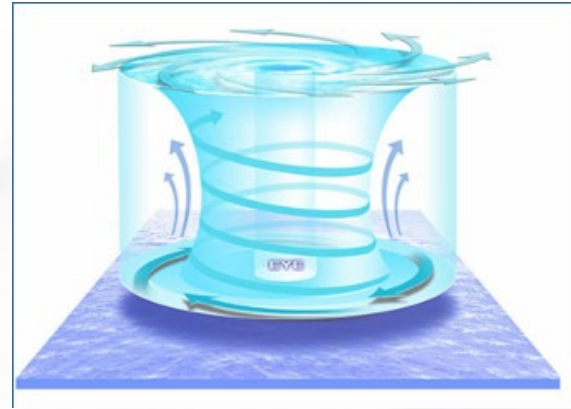
Large Scale Conditions Associated with TC Formation

- Upper-tropospheric anticyclonic outflow over the area
- Enhanced lower tropospheric relative vorticity
- Appearance of curved banding features in the deep convection
- Falling surface pressure: 24-hour pressure changes (falls) of usually 3 mb or more



Large Scale Conditions Associated with TC Formation

- A pre-existing disturbance containing abundant deep convection
- Poleward of of $\sim 5^\circ$
- Adequate ocean thermal energy
 - SST $> 26^\circ\text{C}$ extending to a depth of 60 m**
- A “sufficiently” unstable atmosphere & deep layer of moist air
- Small vertical shear of the horizontal wind



TROPICAL CYCLOGENESIS

Climatology/Factors

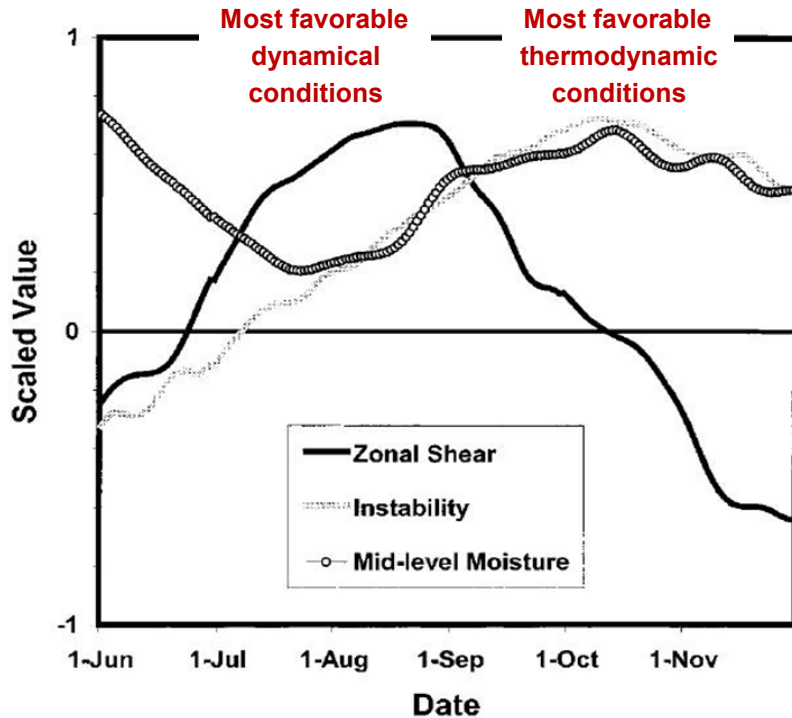
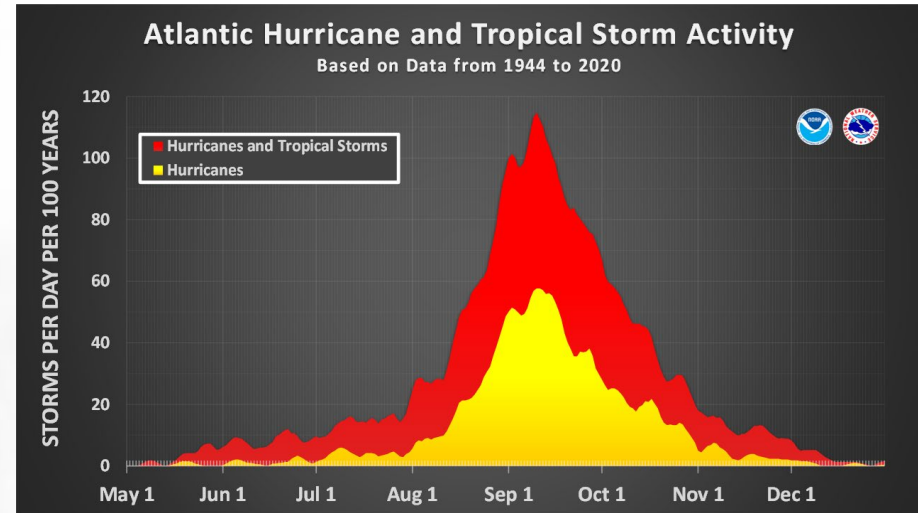


FIG. 7. Climatological time series of the scaled shear, instability, and moisture variables.



The atmosphere tends to be more unstable later in the season. The vertical shear tends to be weaker earlier in the season.

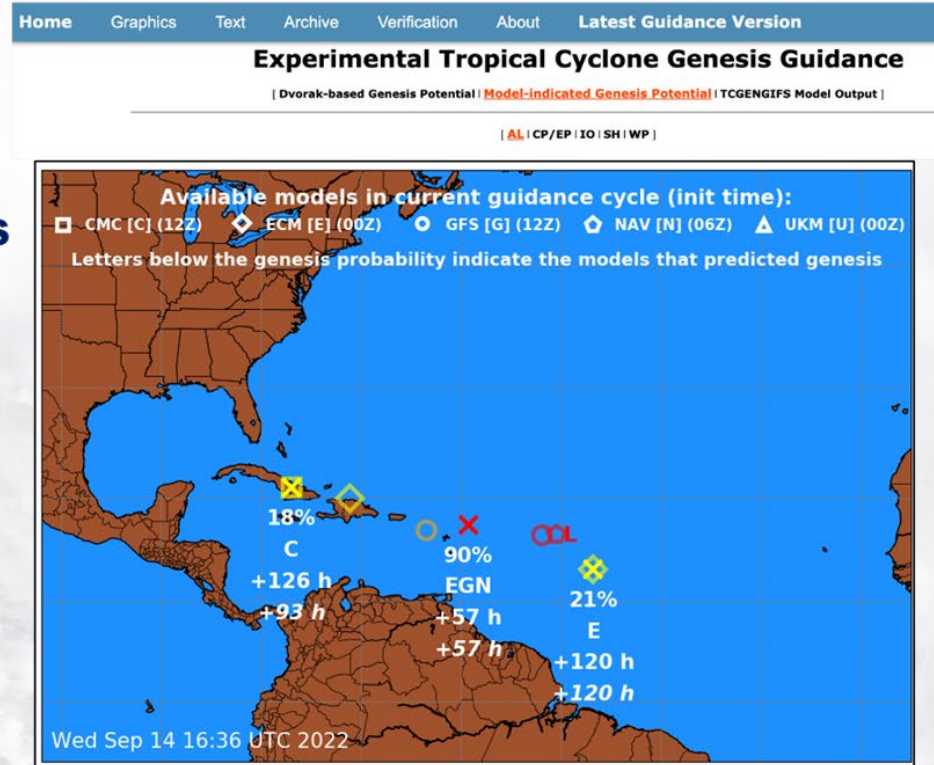
Peak of the season is September when there is the best balance of low shear and high instability/moisture

Tropical Cyclone Logistical Guidance for Genesis (TCLOGG)

Developed by Dan Halperin
and Bob Hart at FSU

- Provides TC genesis probabilities from deterministic models using regression equations of known atmospheric variables tied to genesis
- Ongoing Hurricane Forecast Improvement Project

URL: <http://moe.met.fsu.edu/modelgen/>



TROPICAL WEATHER OUTLOOK

Discussion: Assessment of Tropical Activity



NATIONAL HURRICANE CENTER

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



TROPICAL WEATHER OUTLOOK

NWS NATIONAL HURRICANE CENTER MIAMI FL

800 PM EDT MON OCT 20 2014

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

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 5 days...medium...60 percent.

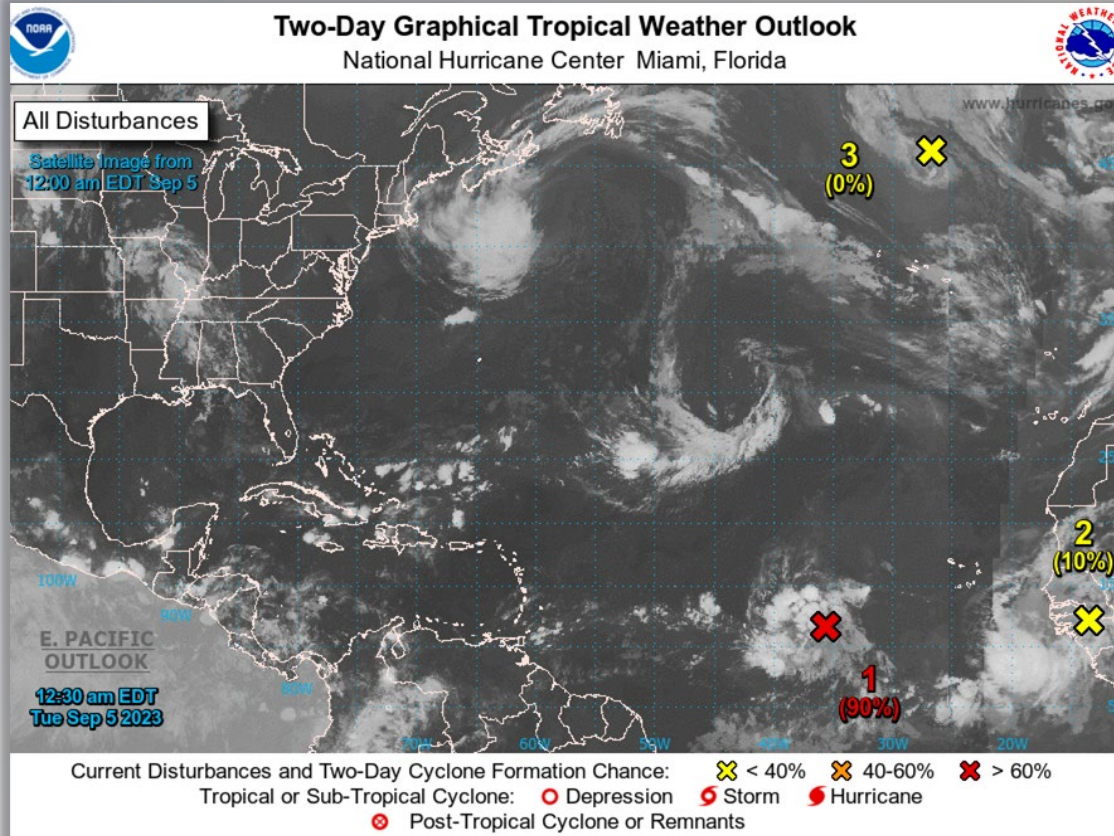
Forecaster Brown

Potential for development?
Headed where?

A large, grey, blocky arrow pointing from the right towards the text on the left. The arrow is semi-transparent and has a slight shadow.

TROPICAL WEATHER OUTLOOK

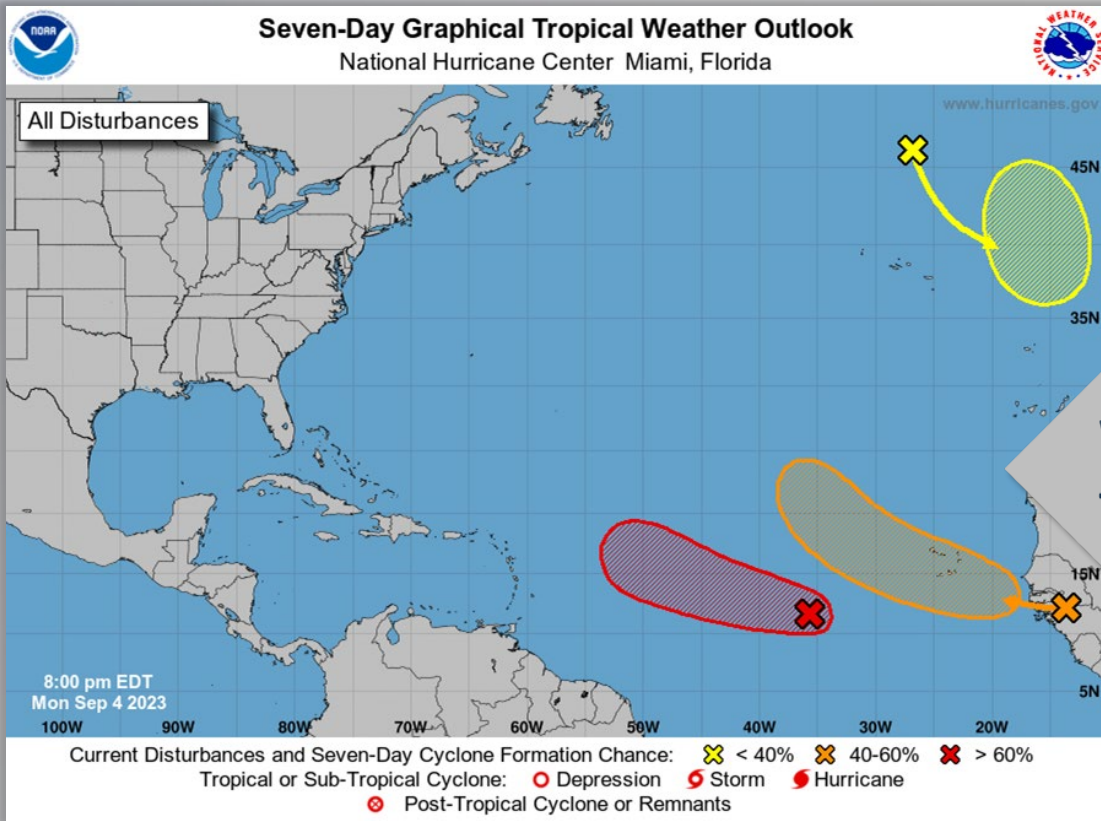
2-Day Formation Potential



- Current location of disturbance(s) (X)
- Formation chance during the next 48 hours
- Categorical probabilities (Low - yellow, medium - orange, red - high)

TROPICAL WEATHER OUTLOOK

7-Day Formation Potential



- Current location of disturbance(s) (X)
- Formation chance during the next 7 days
- Categorical probabilities (Low - yellow, medium - orange, red - high)

What's the chance this area forms during the next 7 days?

What data do the NHC take into account when generating this product? Check all that apply.



GFS forecast model only

0%

ECMWF forecast model only

0%

Multiple dynamical forecast models

0%

Observations

0%

Statistical forecasts

0%

Previous forecasts

0%

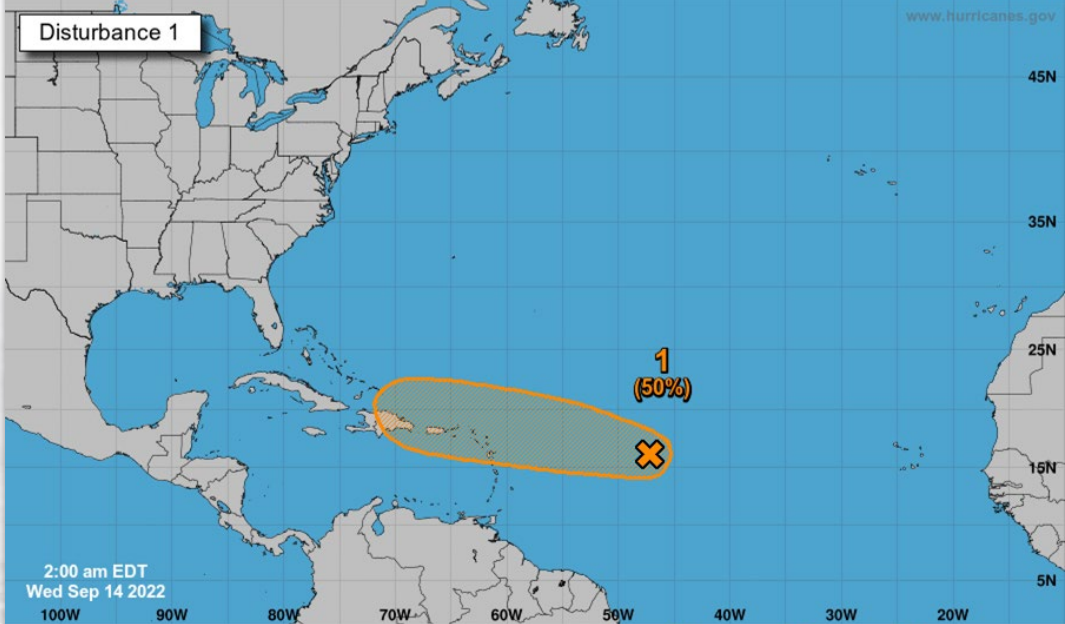
Climatology

0%



Seven-Day Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



Current Disturbances and Five-Day Cyclone Formation Chance: < 40% 40-60% > 60%

Tropical or Sub-Tropical Cyclone: Depression Storm Hurricane

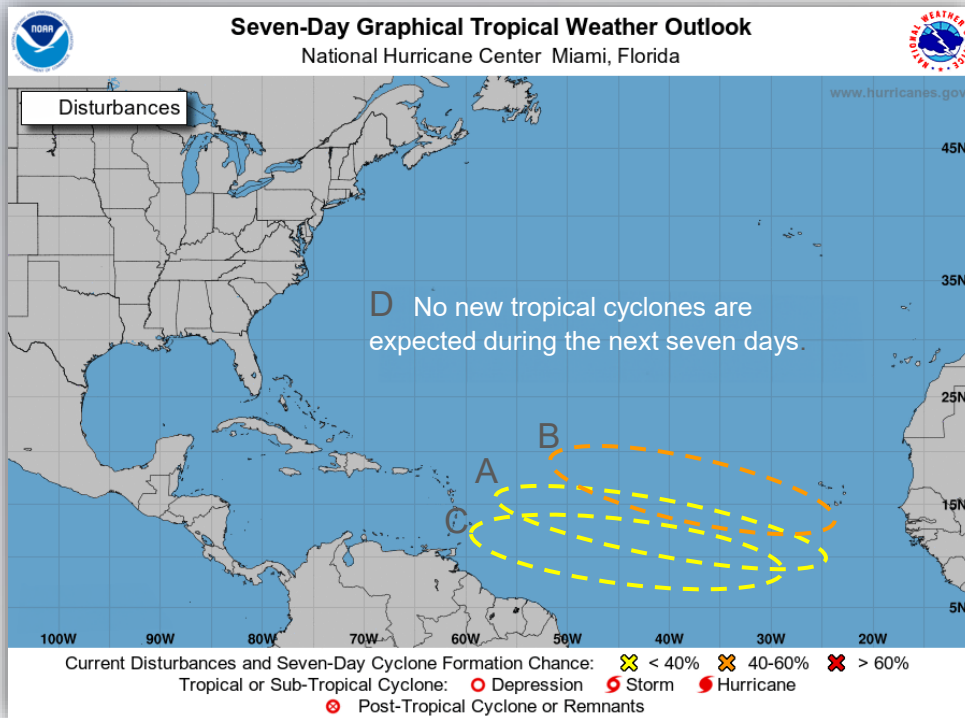
Post-Tropical Cyclone or Remnants



Scenario 1



Scenario 1: You are an NHC forecaster tasked with updating the tropical weather outlook. You have 5 minutes to review the data. Then you will update the outlook by answering poll questions (possible responses below).



*bold text indicates changes from the previous forecast

A. A tropical wave **emerging off the west coast of Africa is producing disorganized showers and thunderstorms**. Environmental conditions are expected to be conducive for gradual development of this system while it moves generally westward to west-northwestward at 15 to 20 mph across the eastern and central tropical Atlantic **during the next several days**.

- * Formation chance through 48 hours...low...near 0 percent.
- * Formation chance through 7 days...low...**30 percent**.

B. A tropical wave **emerging off the west coast of Africa is producing organized showers and thunderstorms**. Environmental conditions are expected to be conducive for **rapid** development of this system while it moves generally **northwestward** at 15 to 20 mph across the eastern and **northern** tropical Atlantic **during the next several days**.

- * Formation chance through 48 hours...low...near **10 percent**.
- * Formation chance through 7 days...low...**40 percent**.

C. A tropical wave **emerging off the west coast of Africa is producing disorganized showers and thunderstorms**. Environmental conditions are expected to be conducive for **slow** development of this system while it moves generally **westward** at 20 to 25 mph across the eastern and central tropical Atlantic **during the next several days**.

- * Formation chance through 48 hours...low...near 0 percent.
- * Formation chance through 7 days...low...20 percent.

D. Tropical cyclone formation is not expected during the next 7 days.

Select the paragraph you would use to update the outlook?



A
0%

B
0%

C
0%

D
0%

*bold text indicates changes from the previous forecast

A. tropical wave **emerging off the west coast of Africa is producing disorganized showers and thunderstorms.** Environmental conditions are expected to be conducive for gradual development of this system while it moves generally westward to west-northwestward at 15 to 20 mph across the eastern and central tropical Atlantic **during the next several days.**

- * Formation chance through 48 hours...low...near 0 percent.
- * Formation chance through 7 days...low...**30 percent.**

B. A tropical wave **emerging off the west coast of Africa is producing organized showers and thunderstorms.** Environmental conditions are expected to be conducive for **rapid** development of this system while it moves generally **northwestward** at 15 to 20 mph across the eastern and **northern** tropical Atlantic **during the next several days.**

- * Formation chance through 48 hours...low...near **10 percent.**
- * Formation chance through 7 days...low...**40 percent.**

C. A tropical wave **emerging off the west coast of Africa is producing disorganized showers and thunderstorms.** Environmental conditions are expected to be **conducive for slow development** of this system while it moves generally **westward at 20 to 25 mph** across the eastern and central tropical Atlantic **during the next several days.**

- * Formation chance through 48 hours...low...near 0 percent.
- * Formation chance through 7 days...low...**20 percent.**

D. Tropical cyclone formation is not expected during the next 7 days.

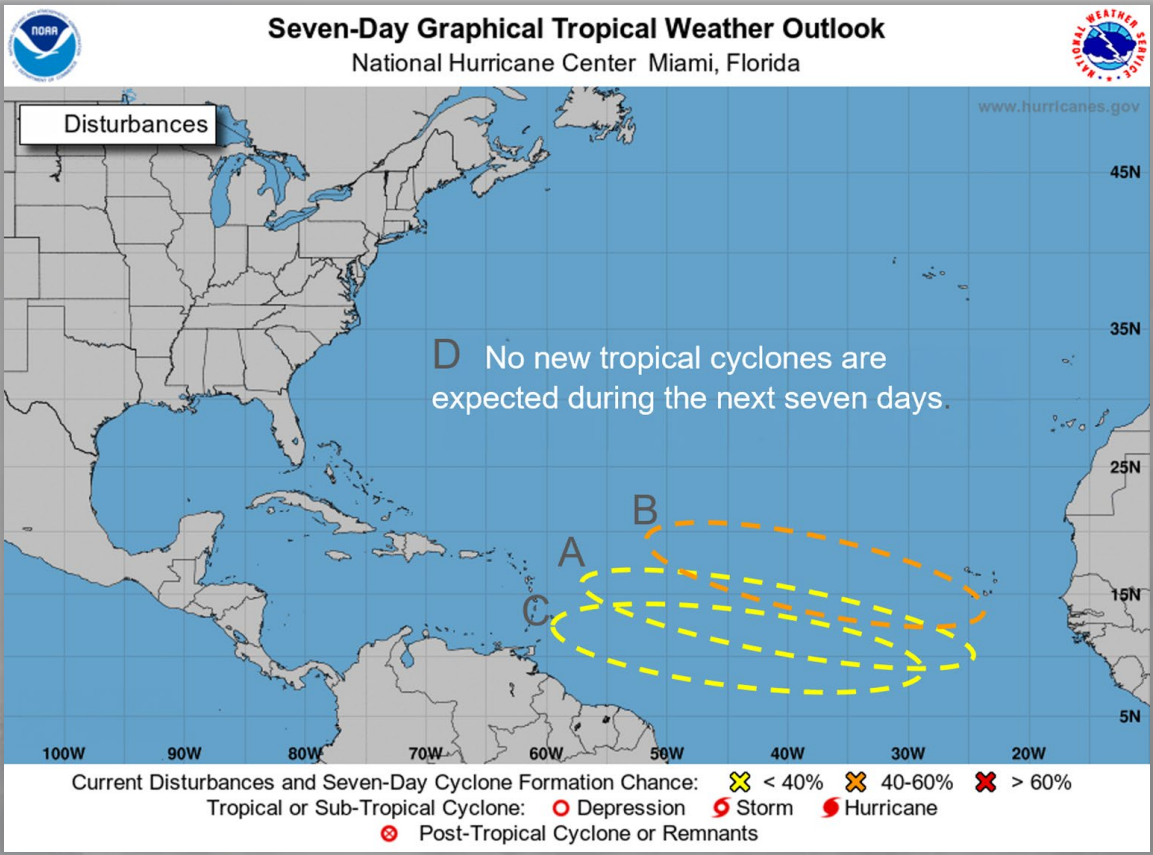
Which area would you pick to update the tropical weather outlook?



A
0%

B
0%

C
0%



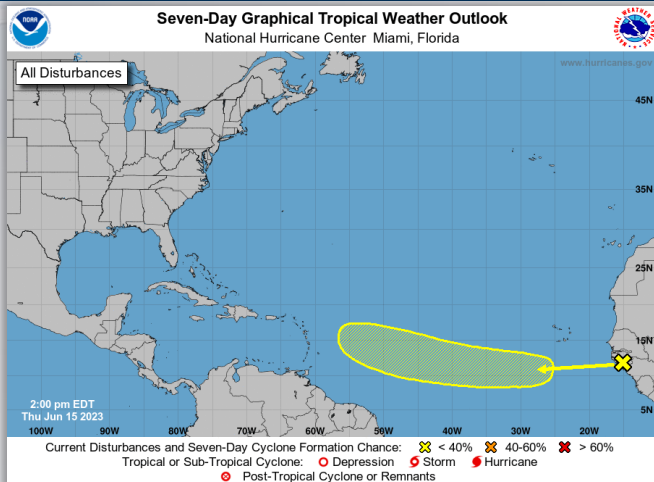


Scenario 1: Feedback



What happened?

Previous Outlook

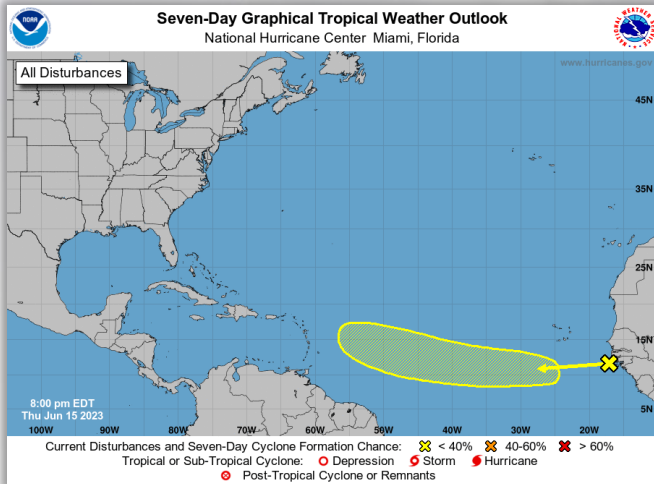


A tropical wave is **forecast to move** off the west coast of Africa **tonight and early Friday**. Environmental conditions are expected to be conducive for gradual development of this system while it moves generally westward to west-northwestward at 15 to 20 mph across the eastern and central tropical Atlantic during the **early to middle part of next week**.

* Formation chance through 48 hours...low...near 0 percent.

* Formation chance through 7 days...low...**20 percent**.

Current Outlook



A tropical wave **emerging** off the west coast of Africa **is producing disorganized showers and thunderstorms**. Environmental conditions are expected to be conducive for gradual development of this system while it moves generally westward to west-northwestward at 15 to 20 mph across the eastern and central tropical Atlantic during the **next several days**.

* Formation chance through 48 hours...low...near 0 percent.

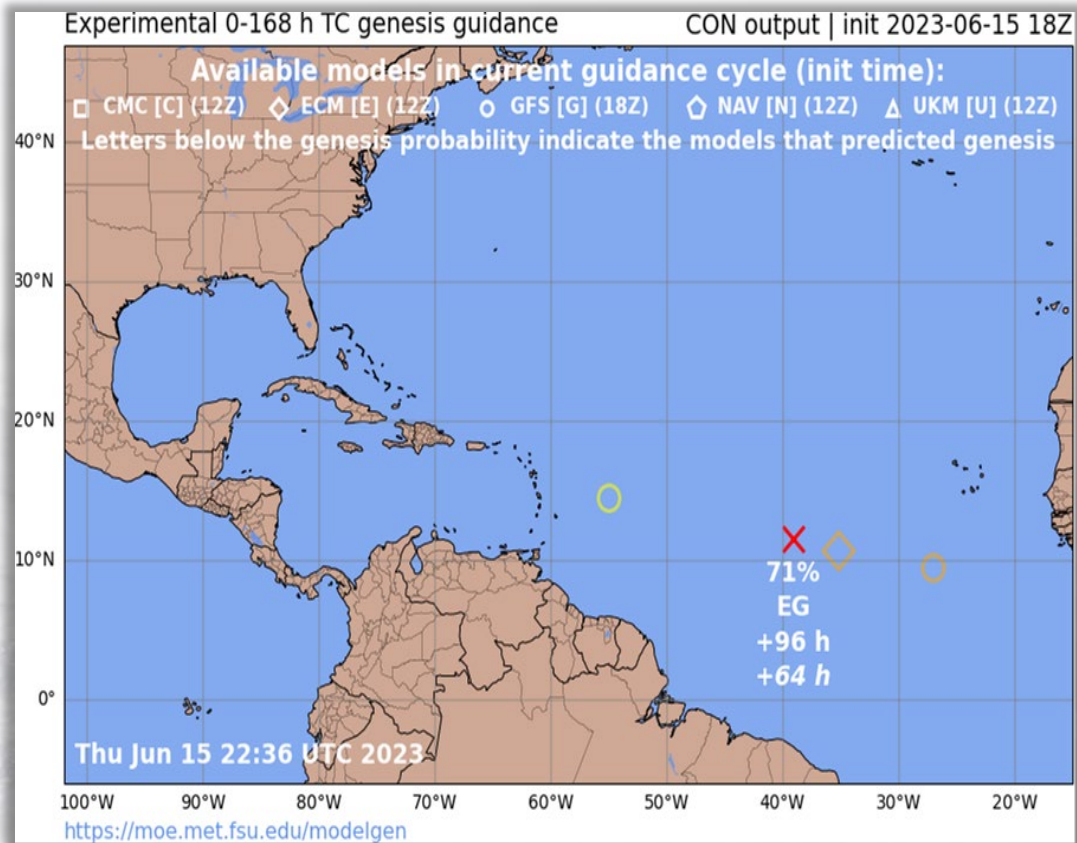
* Formation chance through 7 days...low...**30 percent**.

Walk Through NHC Forecasters Perspective

This was a Tropical Weather Outlook (TWO) outlook that became Bret in 2023.

Straightforward example of a single tropical wave that became a tropical cyclone a few days later.

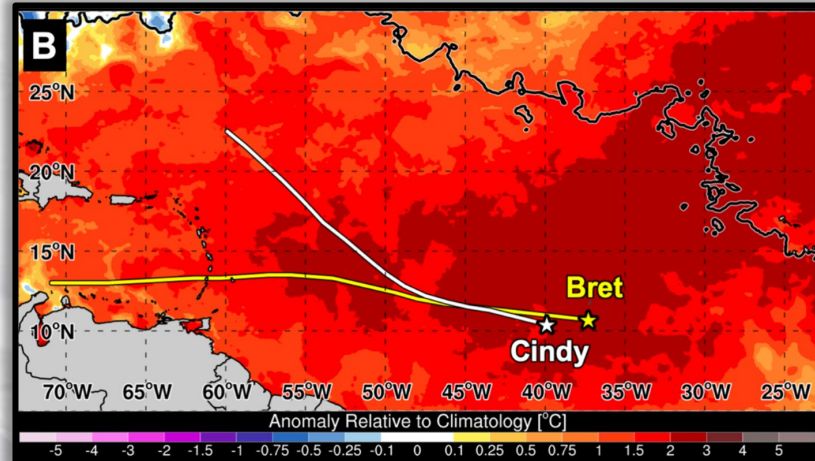
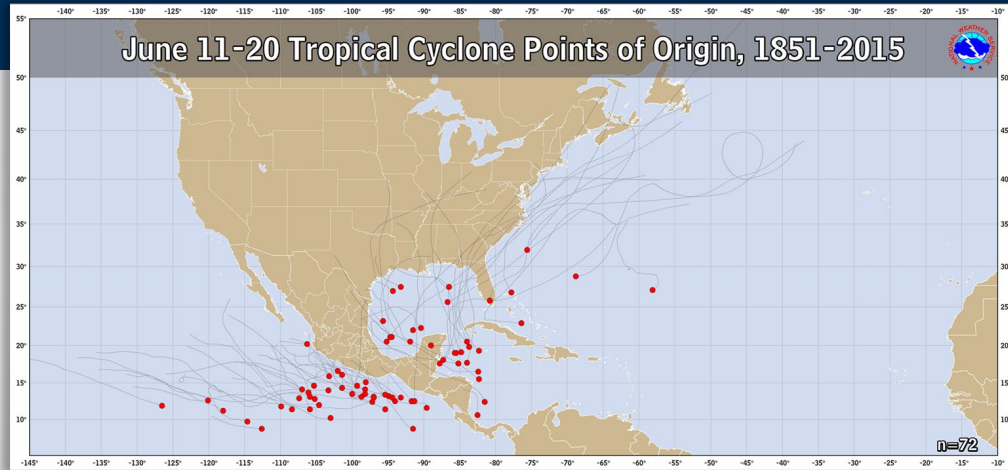
While it only had a low probability (30% of development in 7-days) it had been increased 10% from the previous outlook, and both the GFS and ECMWF models were very supportive of development.



Walk Through NHC Forecasters Perspective

Conflicting guidance

- Climatology suggests this is highly unlikely.
- SSTs are anomalously very high.
- Models are forecasting genesis
- Satellite shows an area of convection growing more organized.

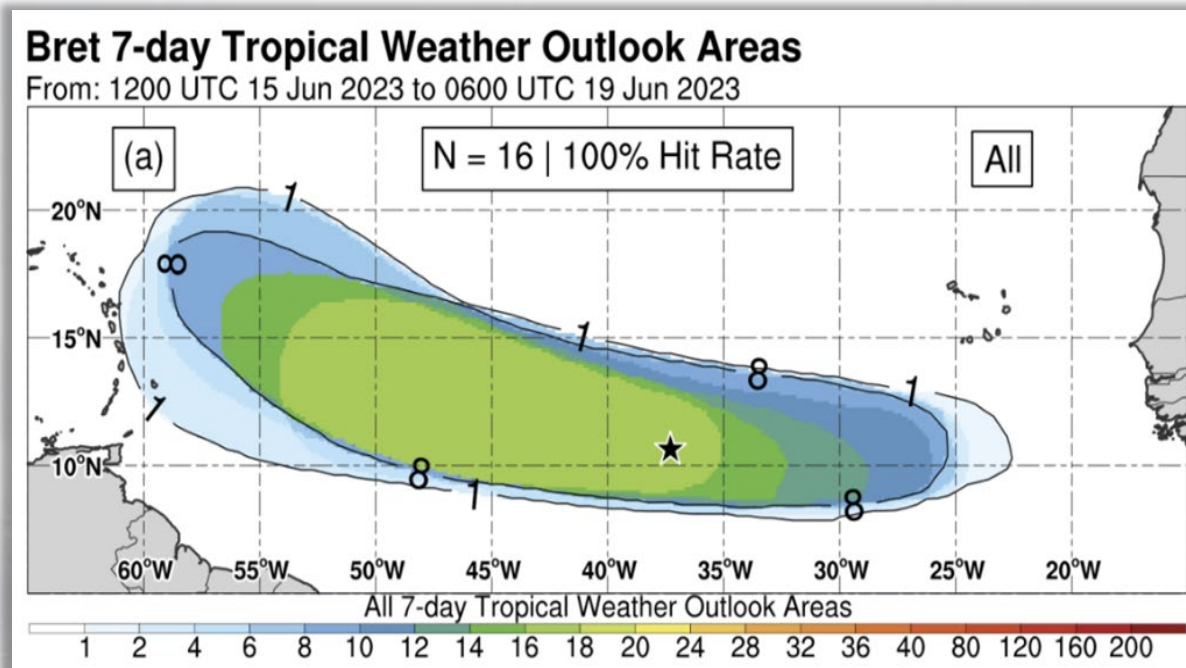


Key Theme: Consistency

Consistency across outlooks is important.

Remain consistent with the previous outlooks as we showed in the discussion.

All tropical weather outlook areas for Bret are shown as a density plot. All 16 had the eventual genesis point within their areas.

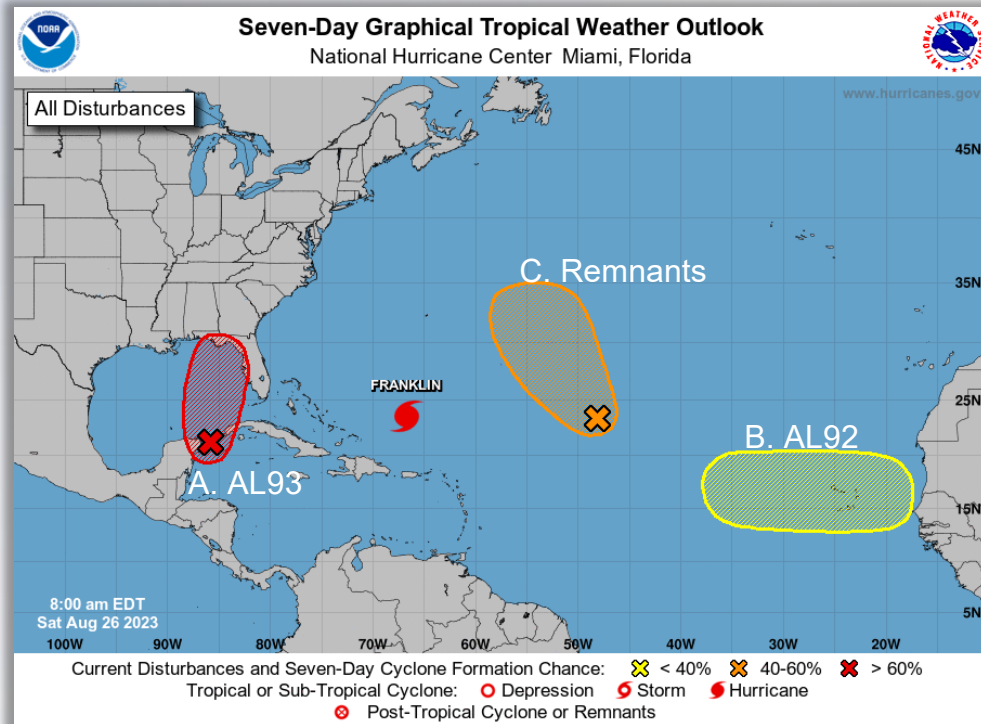




Scenario 2



Scenario 2: You are an NHC forecaster tasked with updating the tropical weather outlook. You have limited time to update the outlook due to a very active period in the Atlantic with an existing system and many areas of interest.



Q6: Which area will you focus the majority of your time on in the current outlook?

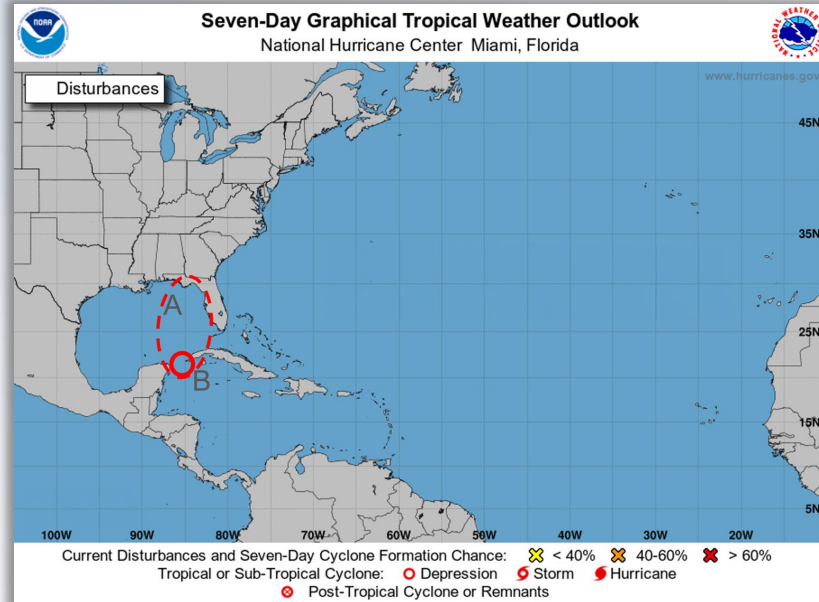
A 0%

B 0%

C 0%

Scenario 2: You have 5 minutes to review the data. Then you will update the outlook for AL93 by answering poll questions (possible responses below).

*bold text indicates changes from the previous forecast



A. Shower and thunderstorm activity continues to show signs of organization in association with an area of low pressure located near the Yucatan Channel. **However, environmental conditions appear to be less conducive for further development of this system, than at the previous outlook time.** A tropical depression **may still** form within the next day or two while it moves generally northward over the southeastern Gulf of Mexico. Interests in the Yucatan Peninsula of Mexico, western Cuba, and Florida should monitor the progress of this system.

- * Formation chance through 48 hours...high...**60** percent.
- * Formation chance through 7 days...high...**80** percent.

B. Shower and thunderstorm activity continues to show signs of organization in association with an area of low pressure located near the Yucatan Channel. Environmental conditions appear conducive for further development of this system, and a tropical depression is likely to form within the next day or two while it moves generally northward over the southeastern Gulf of Mexico. Interests in the Yucatan Peninsula of Mexico, western Cuba, and Florida should monitor the progress of this system.

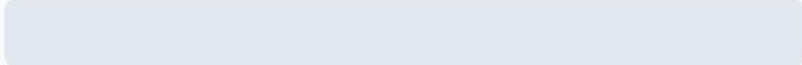
- * Formation chance through 48 hours...high...**70** percent.
- * Formation chance through 7 days...high...**90** percent.


C. Showers and thunderstorms associated with an area of low pressure located near the Yucatan Channel continue to gradually become better organized. **If this trend continues, advisories will be initiated on this system later today. The system is expected to move very slowly northward into the southeastern Gulf of Mexico during the next couple of days. Heavy rains are likely over portions of western Cuba and the Yucatan Peninsula of Mexico.** Interests in the Yucatan Peninsula of Mexico, western Cuba, and Florida should monitor the progress of this system.

- * Formation chance through 48 hours...high...**90** percent.
- * Formation chance through 7 days...high...**90** percent.

Select the paragraph you would use to update the outlook?



A  0%

B  0%

C  0%

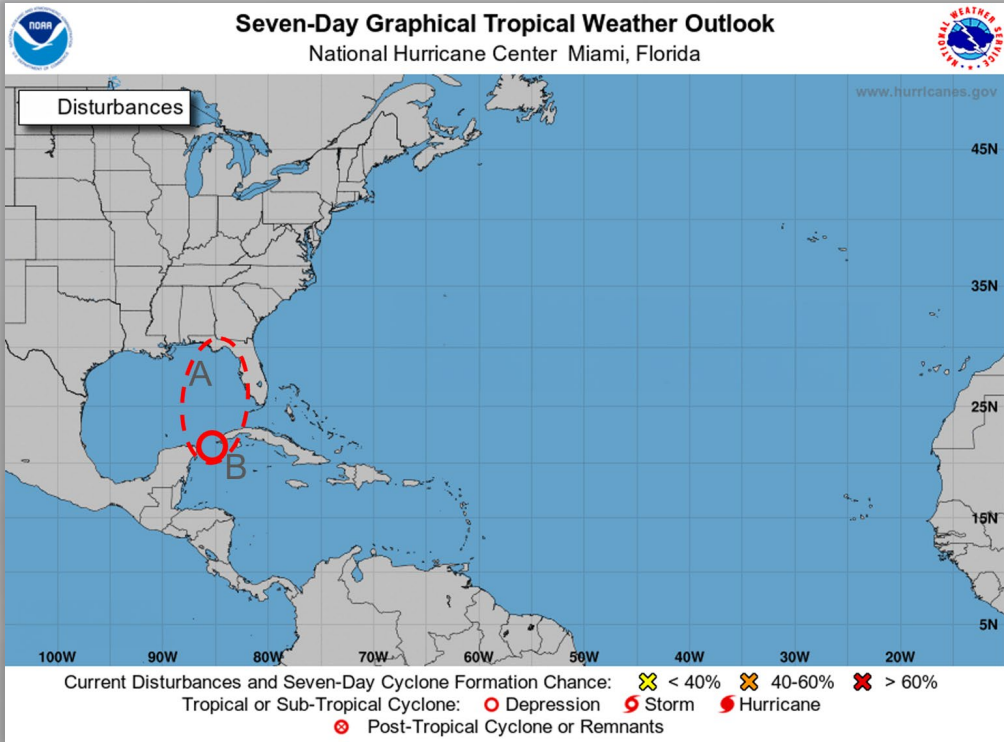
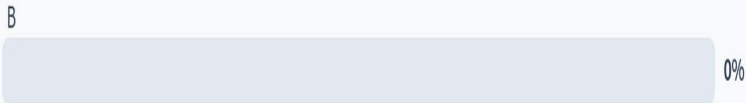
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B. Shower and thunderstorm activity continues to show signs of organization in association with an area of low pressure located near the Yucatan Channel. Environmental conditions appear conducive for further development of this system, and a tropical depression is likely to form within the next day or two while it moves generally northward over the southeastern Gulf of Mexico. Interests in the Yucatan Peninsula of Mexico, western Cuba, and Florida should monitor the progress of this system.
* Formation chance through 48 hours...high...70 percent.
* Formation chance through 7 days...high...90 percent.

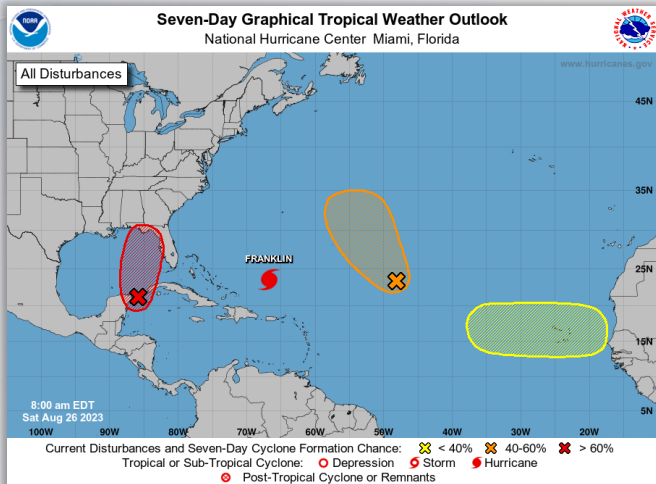
C. Showers and thunderstorms associated with an area of low pressure located near the Yucatan Channel continue to gradually become better organized. **If this trend continues, advisories will be initiated on this system later today. The system is expected to move very slowly northward into the southeastern Gulf of Mexico during the next couple of days. Heavy rains are likely over portions of western Cuba and the Yucatan Peninsula of Mexico.** Interests in the Yucatan Peninsula of Mexico, western Cuba, and Florida should monitor the progress of this system.
* Formation chance through 48 hours...high...90 percent.
* Formation chance through 7 days...high...90 percent.

Which area would you pick to update the tropical weather outlook?



What happened?

Previous Outlook

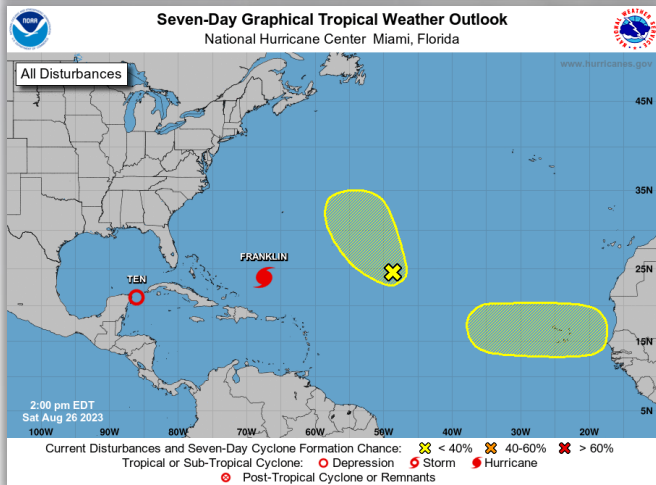


Shower and thunderstorm activity continues to show signs of organization in association with an area of low pressure located near the Yucatan Channel. Environmental conditions appear conducive for further development of this system, and a tropical depression is likely to form within the next day or two while it moves generally northward over the southeastern Gulf of Mexico. Interests in the Yucatan Peninsula of Mexico, western Cuba, and Florida should monitor the progress of this system.

* Formation chance through 48 hours...high...70 percent.

* Formation chance through 7 days...high...90 percent.

Current Outlook



Showers and thunderstorms associated with an area of low pressure located near the Yucatan Channel continue to gradually become better organized. **If this trend continues, advisories will be initiated on this system later today.** The system is expected to move very slowly northward into the southeastern Gulf of Mexico during the next couple of days. Heavy rains are likely over portions of western Cuba and the Yucatan Peninsula of Mexico. Interests in the Yucatan Peninsula of Mexico, western Cuba, and Florida should monitor the progress of this system.

* Formation chance through 48 hours...high...90 percent.

* Formation chance through 7 days...high...90 percent.

Walk Through NHC Forecasters Perspective

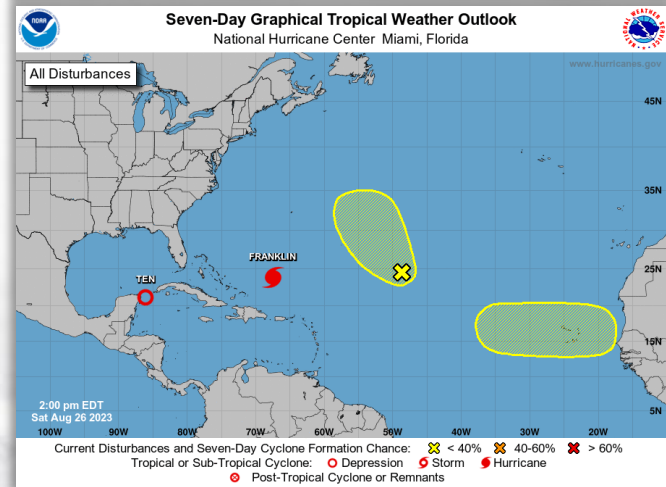
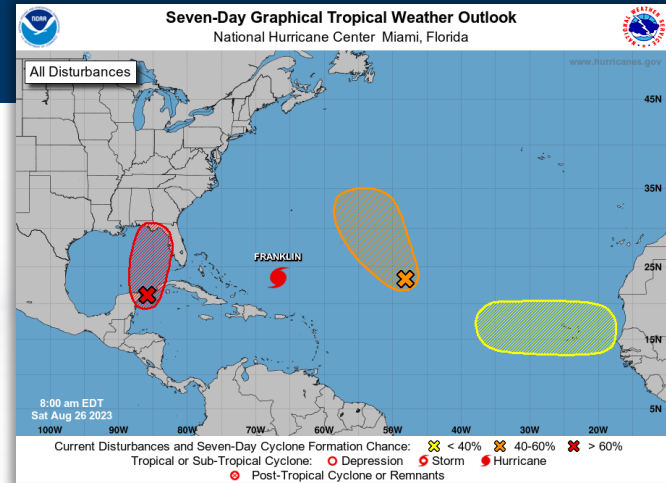
The case in the Yucatan Channel would go on to become Hurricane Idalia. By this time there was high confidence the system would develop in the model guidance.

The medium area (remnants) continued to struggle and it would be another 3–4 days before the system became a TC (Jose) In this period the NHC probabilities were actually lowered and zeroed for a period before it re-developed. At the time of this outlook, there was not much support for development in the model guidance, and a lot of the probabilities came from continuity with the prior outlook.

Finally the low area off the coast of Africa would ultimately become TC Katia, but not for another 5 days.

Also Hurricane Franklin was active during all this outlook action between Bermuda and the United States.

There was a lot to deal with!



Key Theme: Time-Management

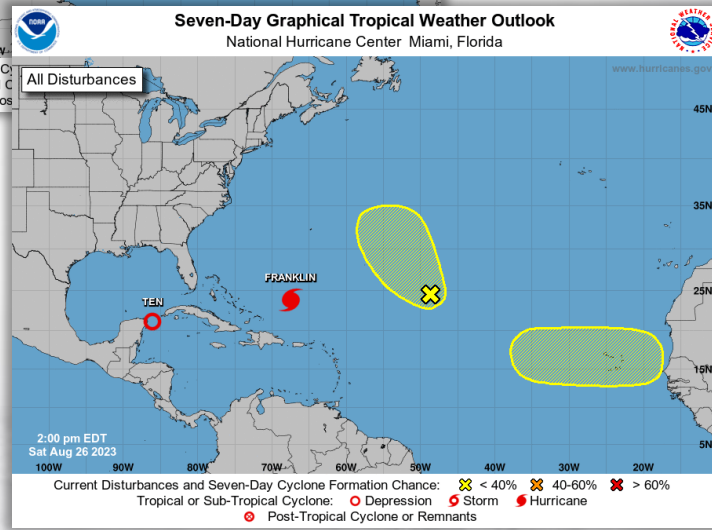
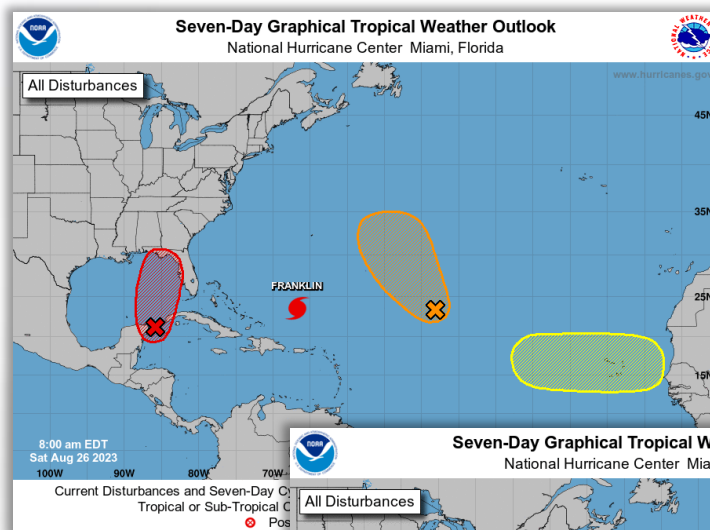
Time-management is important. NHC forecaster has many duties.

In this case:

- Advisories for active TC Franklin (highest priority).
- Tropical weather outlook with three separate areas of interest, each at a different stage of their lifecycle.

Prioritize the biggest threats to land and commit the most time to those.

1. In this case, Franklin was an active storm so that takes the most time.
2. AL93 (TD Ten and later Idalia) posed a threat to many locations. This is the top priority for the tropical weather outlook.
3. Still need some time to focus on the other two areas in the tropical Atlantic.

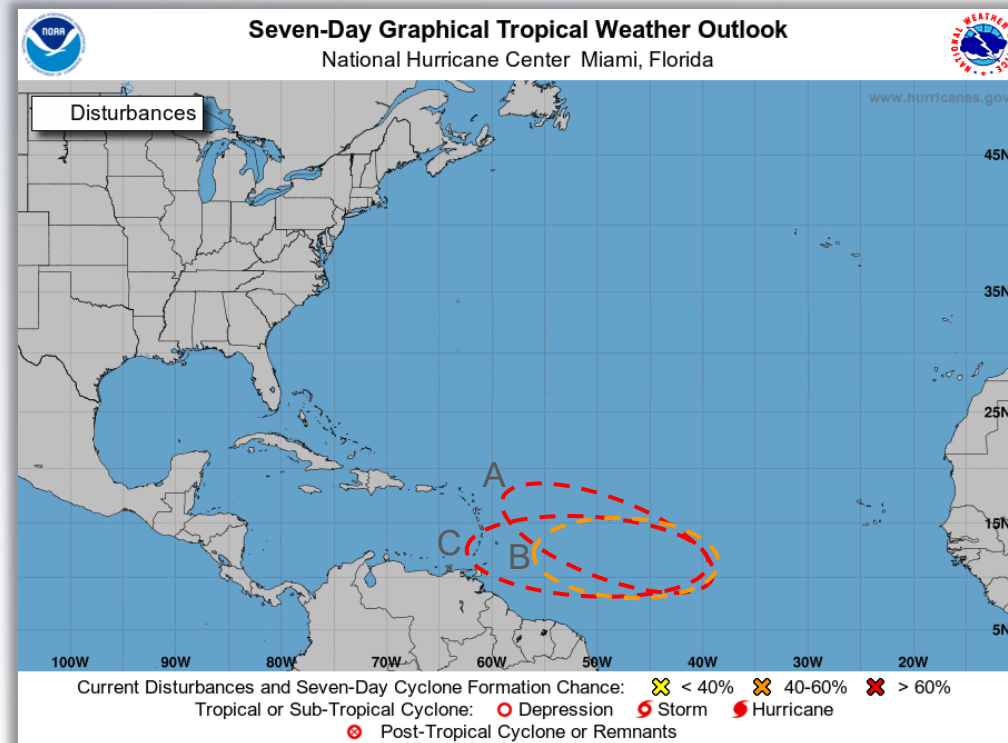




Scenario 3



Scenario 3: You are an NHC forecaster tasked with updating the tropical weather outlook. You have 5 minutes to review the data. Then you will update the outlook by answering poll questions (possible responses below).



A. **Shower activity associated with** a small area of low pressure located roughly midway between the Cabo Verde Islands and the Lesser Antilles **is showing signs of organization**. Environmental conditions are still conducive and therefore slow development is expected and this system will likely become a tropical depression by early next week while it moves **northwestward** across the tropical Atlantic. **Interests in the Lesser Antilles should monitor the progress of this system.**

- * Formation chance through 48 hours...medium...**60** percent.
- * Formation chance through 7 days...medium...**80** percent.

B. A small area of low pressure located roughly midway between the Cabo Verde Islands and the Lesser Antilles continues to produce disorganized showers and thunderstorms. **Environmental conditions do not look conducive for further development. However, there is the possibility that conditions will improve and the system could still become a tropical depression by early next week while it moves westward** across the tropical Atlantic.

- * Formation chance through 48 hours...medium...**40** percent.
- * Formation chance through 7 days...high...**60** percent.

C. **Shower activity associated with** a small area of low pressure located roughly midway between the Cabo Verde Islands and the Lesser Antilles **is showing signs of organization**. Although environmental conditions are only marginally conducive, slow development is expected and this system will likely become a tropical depression by early next week while it moves westward across the tropical Atlantic. **Interests in the Lesser Antilles should monitor the progress of this system.**

- Formation chance through 48 hours...medium...**50** percent.
- * Formation chance through 7 days...high...**70** percent.