

**COLORADO STATE UNIVERSITY FORECAST OF ATLANTIC HURRICANE
ACTIVITY FROM OCTOBER 1–14, 2024 AND OUTLOOK FOR OCTOBER-
NOVEMBER CARIBBEAN ACCUMULATED CYCLONE ENERGY**

We believe with virtual certainty that Atlantic hurricane activity in the next two weeks will be above normal (99% chance), with a nominal chance of near-normal activity (1%). We anticipate well above average October–November Caribbean Accumulated Cyclone Energy.

(as of 1 October 2024)

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In Memory of William M. Gray⁶

This discussion as well as past forecasts and verifications are available online at <http://tropical.colostate.edu>

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1 Introduction

This is the 16th year that we have issued shorter-term forecasts of tropical cyclone (TC) activity starting in early August. These two-week forecasts are based on a combination of observational and modeling tools. The primary tools that are used for this forecast are as follows: 1) current storm activity, 2) National Hurricane Center Tropical Weather Outlooks, 3) forecast output from global models and 4) the current and projected state of the Madden-Julian oscillation (MJO).

Our forecast definition of above-normal, normal, and below-normal Accumulated Cyclone Energy (ACE) periods is defined by ranking observed activity in the satellite era from 1966–2023 and defining above-normal, normal and below-normal two-week periods based on terciles. Since there are 58 years from 1966–2023, we include the 19 years with the most ACE from October 1–14 as the upper tercile, the 19 years with the least ACE as the bottom tercile, while the remaining 20 years are counted as the middle tercile.

Table 1: ACE forecast definition and probabilistic forecast for TC activity for October 1–14, 2024.

Parameter	Definition	Probability in Each Category
Above-Normal	Upper Tercile (>10 ACE)	99%
Normal	Middle Tercile (3–10 ACE)	1%
Below-Normal	Lower Tercile (<3 ACE)	~0%

2 Forecast

We are very confident that the next two weeks will be characterized by activity at above-normal levels (>10 ACE). Tropical Storm Kirk is extremely likely to generate >10 ACE during its lifetime in the eastern/central Atlantic. The National Hurricane Center is currently monitoring two additional areas for tropical cyclone formation in the next week. Invest 91L in the eastern Atlantic has a high chance (80%) of tropical cyclone formation in the next 48 hours, while an additional tropical cyclone may form in either the northwest Caribbean or Gulf of Mexico. This area is given a medium chance (40%) of formation in the next week. Signals for additional tropical cyclone formation beyond these areas are weak. The Madden-Julian Oscillation (MJO) is forecast to predominately be over the Indian Ocean and the western part of the Maritime Continent during the two-week period. These phases of the MJO are typically favorable for Atlantic hurricane formation.

Figure 1 displays the formation locations of tropical cyclones from October 1–14 for the years from 1966–2023, along with the maximum intensities that these storms reached. Figure 2 displays the October 1–14 forecast period with respect to climatology. The primary threat area for major hurricane formations shifts farther to the west, with formations picking up considerably in the western Caribbean.

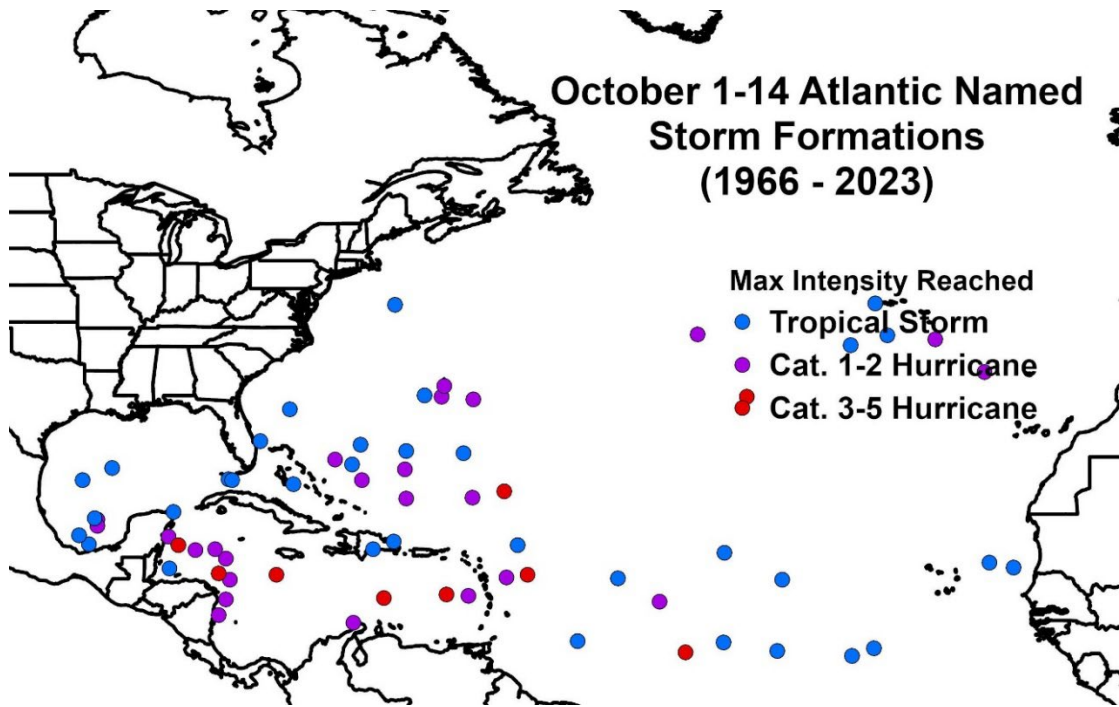


Figure 1: Atlantic named storm formations from October 1–14 from 1966–2023 and the maximum intensity that these named storms reached.

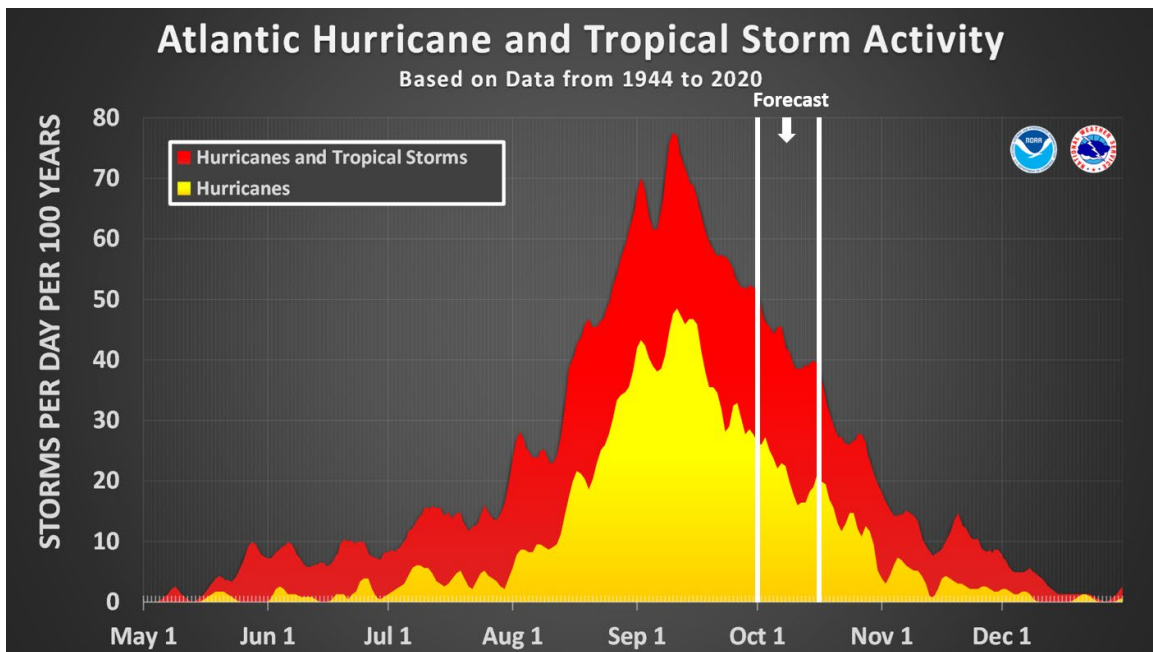


Figure 2: The current forecast period (October 1–14) with respect to climatology, delimited with white lines. Figure courtesy of NOAA.

We now examine how we believe each of the four factors discussed in the introduction will impact Atlantic TC activity for the period from October 1–14.

1) Current Storm Activity

Tropical Storm Kirk is forecast to track northwestward across the open Atlantic over the next few days, likely becoming a powerful major hurricane in the process (Figure 3). The system looks to generate an additional ~20 ACE before dissipation, effectively guaranteeing the above-normal category for the two-week period.

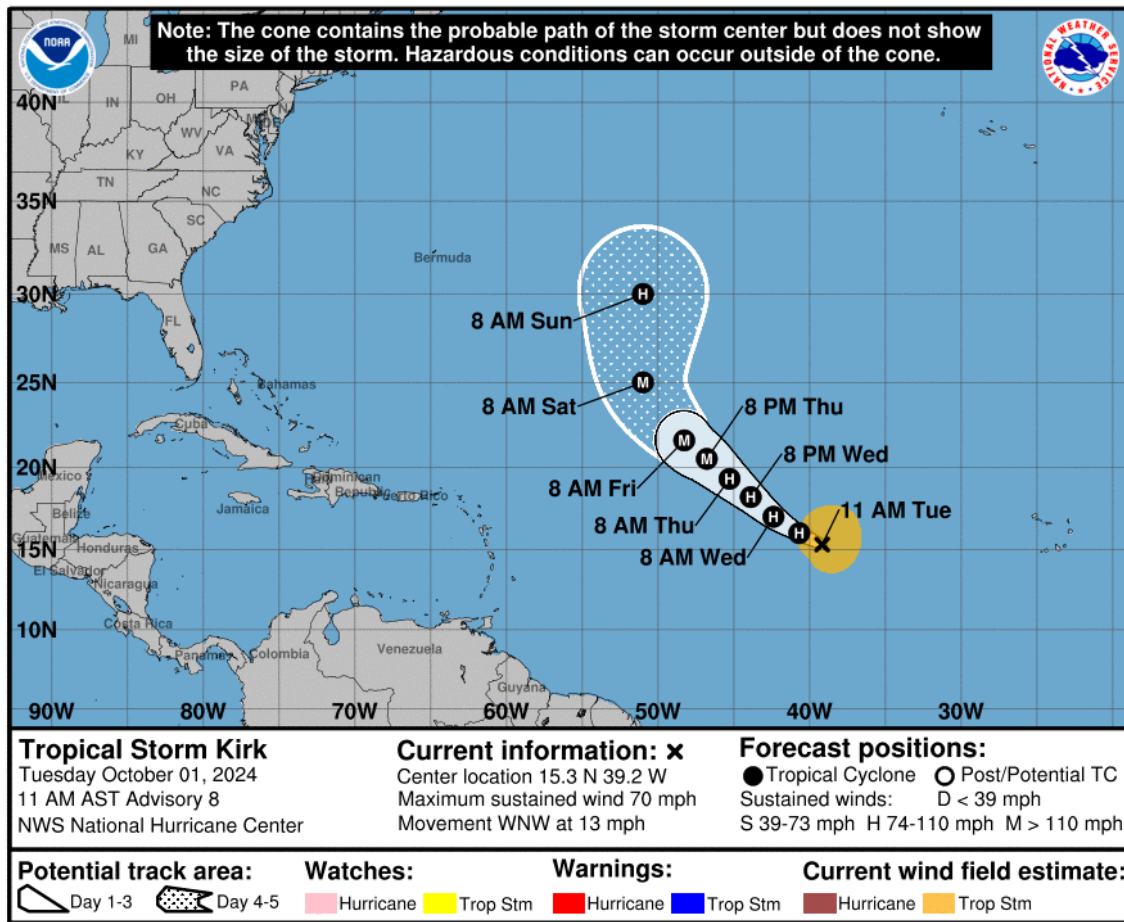


Figure 3: National Hurricane Center forecast for Tropical Storm Kirk.

2) National Hurricane Center Tropical Weather Outlook

The latest NHC Tropical Weather Outlook is monitoring two additional areas for tropical cyclone formation. Invest 91L in the eastern Atlantic has a high chance of tropical cyclone formation in the next 48 hours (80%) and looks poised to become a hurricane, likely generating considerable ACE in the process. An additional area is being monitored for potential formation in the northwest Caribbean/Gulf of Mexico with a medium chance

of tropical cyclone formation in the next week (40%). If it were to develop, it would have the potential to generate moderate ACE, although model consistency on this system is quite poor, making it very difficult to estimate potential ACE from this system (Figure 4). Of course, any development in the northwest Caribbean/Gulf needs to be closely monitored for threats to life and property.

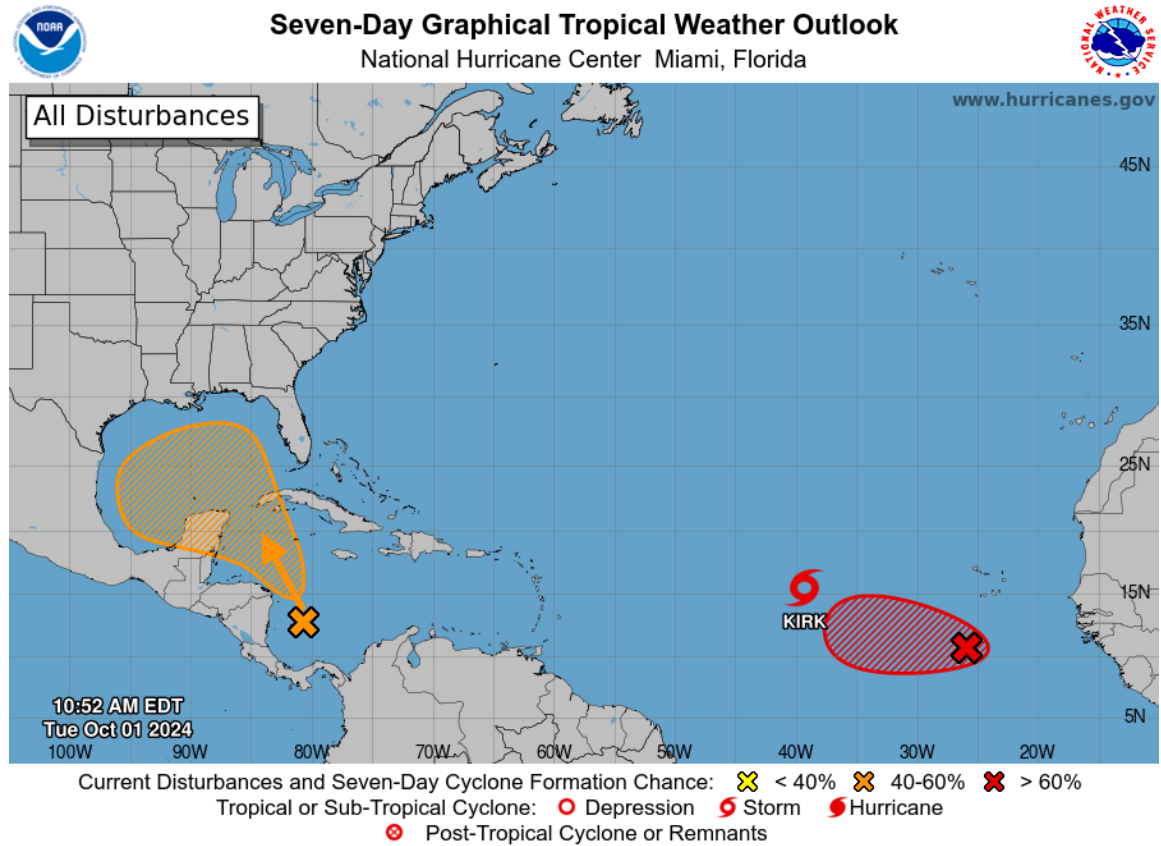


Figure 4: Current National Hurricane Center Atlantic Tropical Weather Outlook.

3) Global Model Analysis

The ECMWF EPS ensemble (Figure 5) and the GEFS ensemble (Figure 6) are highlighting Kirk as well as Invest 91L and the system in the Caribbean/Gulf of Mexico. There are some hints of additional potential formation in the eastern or central tropical Atlantic, although it is getting late in the year for tropical cyclone formation in this region.

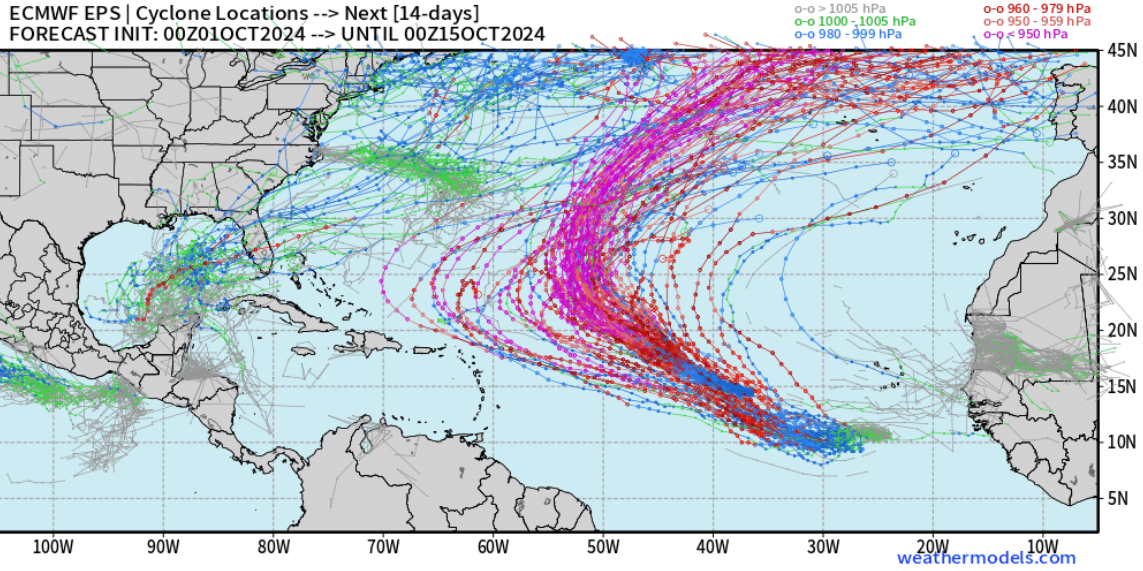


Figure 5: Cyclone locations from the ECMWF EPS ensemble for the next 14 days. Figure courtesy of weathermodels.com

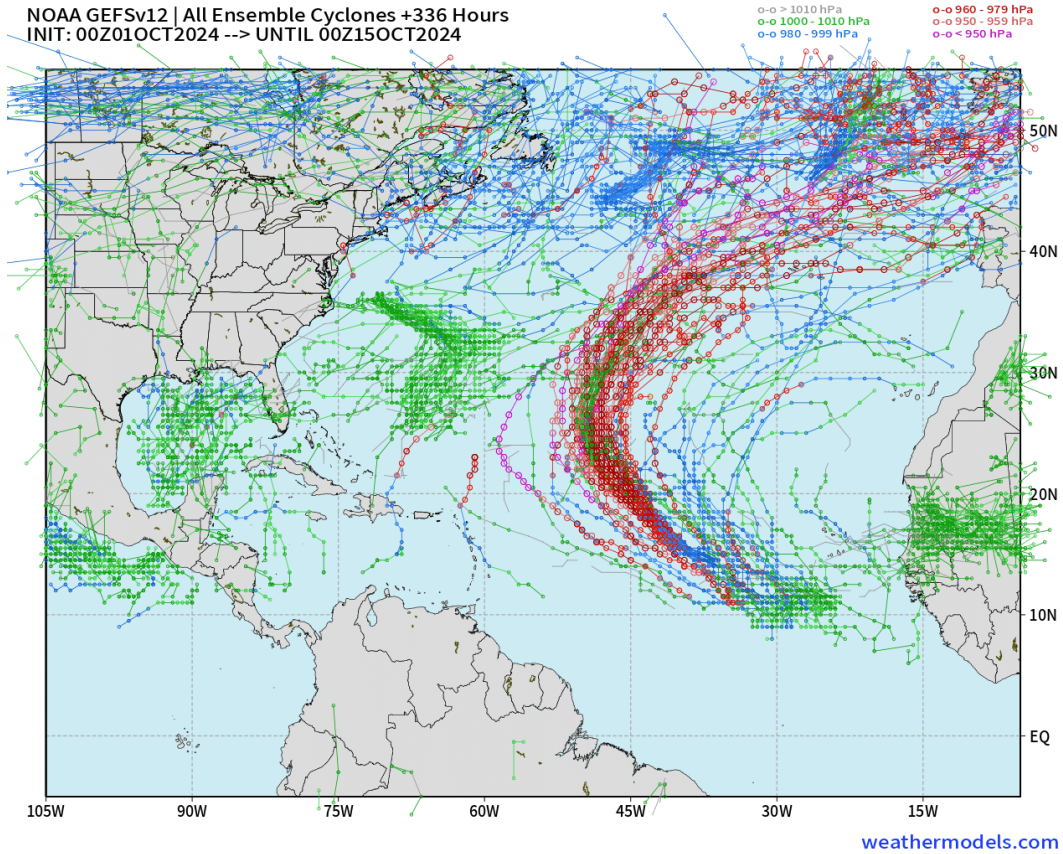


Figure 6: Cyclone locations from the GEFS ensemble for the next 14 days. Figure courtesy of weathermodels.com

4) Madden-Julian Oscillation

The MJO as measured by the Wheeler-Hendon index, is currently located over Africa. The MJO is forecast by the ECMWF to track eastward across the Indian Ocean and into the western part of the Maritime Continent during the two-week period (Figure 7). When the MJO index is located in these phases, Atlantic tropical cyclone activity is typically favored due to reductions in vertical wind shear and increased rising motion over Africa.

The EPS is predicting below-normal vertical wind shear across the tropical Atlantic and Caribbean over the next 20 days (Figure 8). This reduction in shear is likely to lead to an active period for Atlantic TCs over the next two weeks.

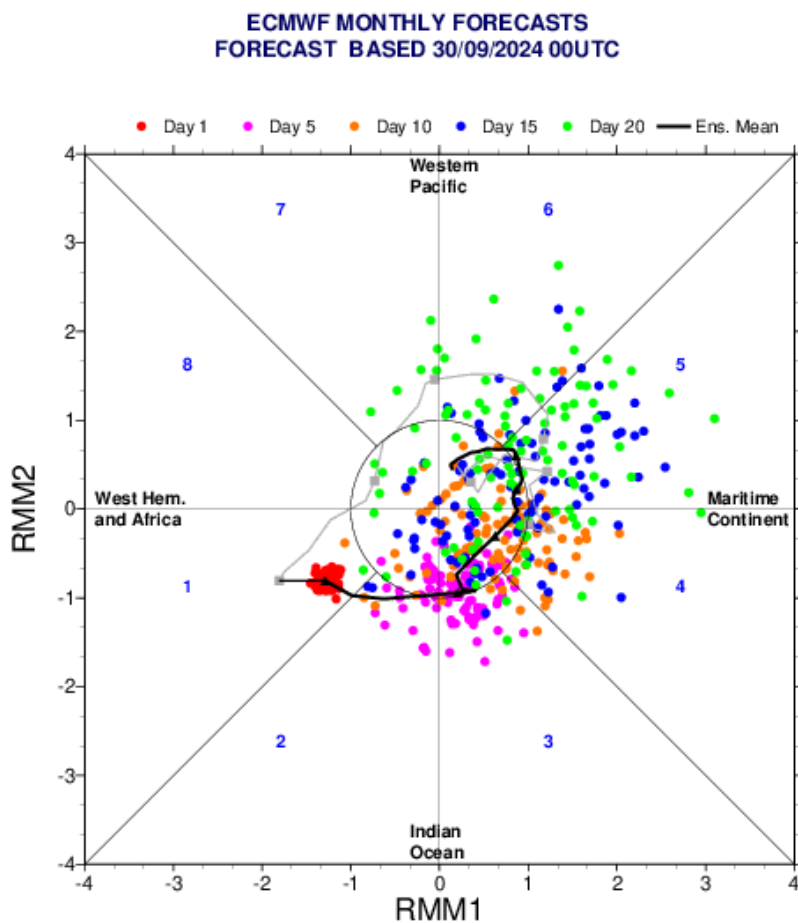


Figure 7: Predicted propagation of the MJO by the ECMWF Ensemble Prediction System. Figure courtesy of ECMWF.

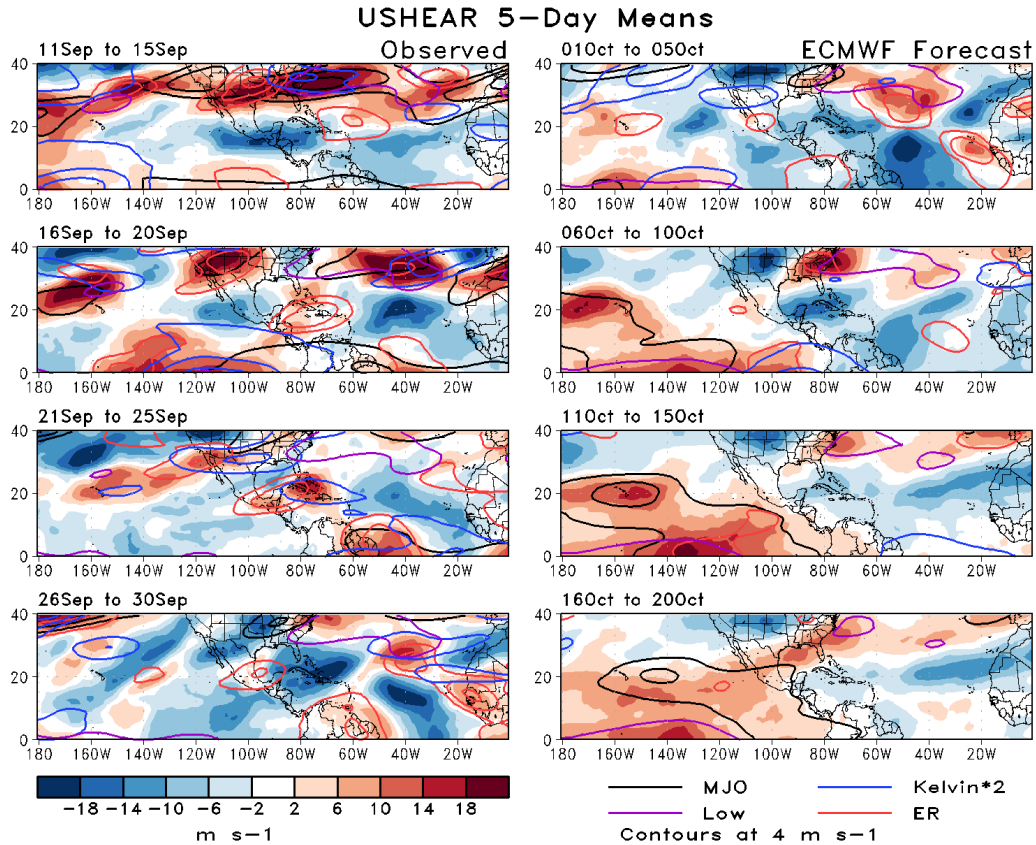


Figure 8: Observed and predicted zonal wind shear by the ECMWF ensemble for the next 20 days. Vertical wind shear is generally forecast to be below normal (e.g., easterly anomalies) across the tropical Atlantic and Caribbean for the next four weeks. Figure courtesy of Nick Novella (NOAA/CPC).

3 Upcoming Forecasts

A final two-week forecast will be issued on October 15 for the October 15–28 period.

VERIFICATION OF SEPTEMBER 17 – 30 FORECAST

17 ACE were generated during the two-week period, which places it in the normal category. Isaac generated the most ACE during the period (8 ACE), Helene generated 7 ACE, while Joyce and Kirk contributed the remainder. We had assigned a 50% probability of normal activity, with a 40% chance of below-normal and a 10% chance of above-normal activity during the two-week period.

Table 3 displays the percentage chance that we gave for each category being reached and observed ACE.

Table 3: ACE forecast for TC activity for September 17–30, the probability assigned for each category being reached and observed ACE.

ACE Category	Definition	Probability in each Category	Observed ACE
Above Normal	Upper Tercile (>27 ACE)	10%	17
Normal	Middle Tercile (10–27 ACE)	50%	
Below Normal	Lower Tercile (<10 ACE)	40%	

COLORADO STATE UNIVERSITY FORECAST OF OCTOBER–NOVEMBER CARIBBEAN ACE

In 2011, we published a paper detailing a model that forecast October–November Caribbean hurricane days (Klotzbach 2011) using the state of ENSO and sea surface temperatures in the western tropical Atlantic and Caribbean (e.g., the Atlantic Warm Pool). In an analysis of an article on the October–November portion of the 2020 Atlantic hurricane season (Klotzbach et al. 2022), we revised the model slightly to use the ENSO Longitude Index (Williams and Patricola 2018) to assess the state of ENSO and now use ACE as our primary forecast metric.

For this outlook, we use SSTs from the ERA5 reanalysis to estimate the strength of the Atlantic warm pool, while Christina Patricola has kindly provided an estimated value of the ENSO Longitude Index using daily NOAA OI SSTs. We find that using three-month averages optimizes the hindcast skill of this model over the period from 1979–2023. Table 3 displays the locations and time periods of the predictors, their standardized values relative to 1991–2020 and their effect on October–November Caribbean ACE, defined to span 10–20°N, 88–60°W.

For 2024, the ENSO Longitude Index is slightly negative, indicating cool neutral ENSO conditions. The Atlantic warm pool is record warm this year, slightly eclipsing the values from last year. These two predictors, in combination, favor a well above-average end to the Atlantic hurricane season in the Caribbean.

Table 3: Listing of predictors of October–November Caribbean ACE. A plus (+) means that positive deviations of the parameter indicate increased October–November Caribbean ACE this year, and a minus (-) means that positive deviations of the parameter indicate decreased October–November Caribbean ACE this year.

Predictor	Values for 2024 Forecast	Effect on Oct–Nov Caribbean ACE
1) July–September ENSO Longitude Index (-)	-0.6 SD	Enhance
2) July–September SST (10–20°N, 85–50°W) (+)	+2.8 SD	Strongly Enhance

These two predictors are then combined in a rank regression model to forecast October–November Caribbean ACE. The model shows a hindcast correlation skill of 0.77 over the period from 1979–2023 (Figure 8).

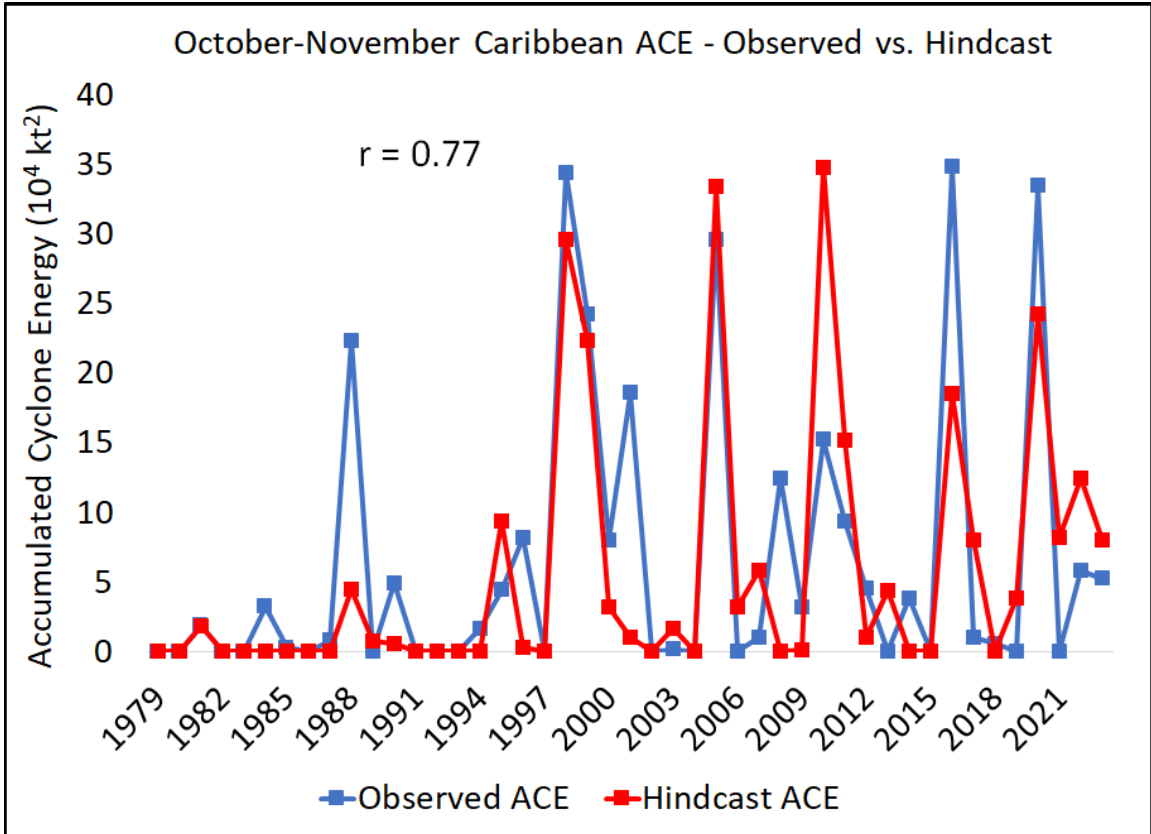


Figure 8: Observed vs. hindcast October–November Caribbean from 1979–2023.

As you can see from the above graph, Caribbean ACE is strongly positively skewed with several years having 0 ACE in the Caribbean during October–November, with other years (such as 2020) having over 30 ACE. The median 1991–2020 ACE is 2, while the mean 1991–2020 ACE is 8.

The forecast from the statistical model for October–November Caribbean ACE in 2024 is extremely aggressive, calling for an ACE of 34, which would be comparable to ACE generated in the Caribbean in other extremely busy Caribbean late seasons such as 1998, 2005, 2016 and 2020. However, given the lack of model support for Caribbean tropical cyclone formation in the next two weeks and the potential for less favorable MJO phases through the latter part of October, we have decreased the ACE forecast for October–November Caribbean ACE to 15, which is still well above the long-term average.