

**COLORADO STATE UNIVERSITY FORECAST OF ATLANTIC HURRICANE
ACTIVITY FROM SEPTEMBER 30 – OCTOBER 13, 2021 AND OUTLOOK FOR
OCTOBER-NOVEMBER CARIBBEAN ACCUMULATED CYCLONE ENERGY**

We believe (with extremely high confidence) that the next two weeks will be characterized by above-normal amounts of hurricane activity, due to current storm activity (e.g., Sam and to a much lesser extent Victor). We also anticipate well above-median October-November Caribbean Accumulated Cyclone Energy

(as of 30 September 2021)

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In Memory of William M. Gray³

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 13th year that we have issued shorter-term forecasts of tropical cyclone activity (TC) 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, 4) the current and projected state of the Madden-Julian Oscillation (MJO) and 5) the current seasonal forecast.

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 1966-2019 and defining above-normal, normal and below-normal two-week periods based on terciles. Since there are 54 years from 1966-2019, each tercile is composed of 18 years. The 18 years with the most active ACE periods from September 30 – October 13 are classified as the upper tercile, the 18 years with the least active ACE periods from September 30 – October 13 are classified as the lower tercile, while the remaining 18 years are classified as the middle tercile. We now also issue probabilities for ACE being in each category as defined in Table 1.

Table 1: ACE forecast definition for TC activity for September 30 – October 13, 2021 and forecast probabilities for each category for the next two weeks.

ACE Category	Definition	Probability in each Category
Above-Normal	Upper Tercile (>9 ACE)	>99%
Normal	Middle Tercile (4–9 ACE)	<1%
Below-Normal	Lower Tercile (<4 ACE)	<1%

2 Forecast

We believe with extremely high confidence (>99%) that the next two weeks will generate above-normal TC activity. This is due to Hurricane Sam which should generate >9 ACE in the next couple of days. Tropical Storm Victor will also likely contribute modest levels of ACE before encountering strong wind shear. The National Hurricane Center does not anticipate any other areas of TC development in the next five days. Both the GFS and ECMWF ensembles are indicating the possibility of TC development off of the US East Coast in 6-7 days. The ECMWF and GFS ensembles are also hinting at potential development in the western Caribbean in the 7-14-day timeframe, although the signal is still fairly weak. We do anticipate lack of TC development in the next week (in agreement with the National Hurricane Center) due to a convectively-suppressed phase of a convectively-coupled Kelvin wave transiting across the tropical Atlantic.

The Madden-Julian Oscillation (MJO) is currently located in phase 4 and is forecast to track into phase 5 over the next several days and is then likely to weaken over the Maritime Continent, possibly due to the background base state driven by a transition to La Niña conditions. The forecast large-scale circulation over the next couple of weeks

looks to be less favorable than occurred during most of August and September, with the general rising motion over Africa forecast to be replaced by sinking motion for at least the next 10 days. After that point, conditions tend to look more favorable for Atlantic hurricane activity, with sinking motion returning to the Pacific Ocean and rising motion returning to Africa and especially the Indian Ocean. These conditions are associated with reduced vertical wind shear in the tropical Atlantic.

Figure 1 displays the formation locations of TCs from September 30 – October 13 for the years from 1966 – 2019 (e.g., the satellite era), along with the maximum intensities that these storms reached. Figure 2 displays the September 30 – October 13 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.

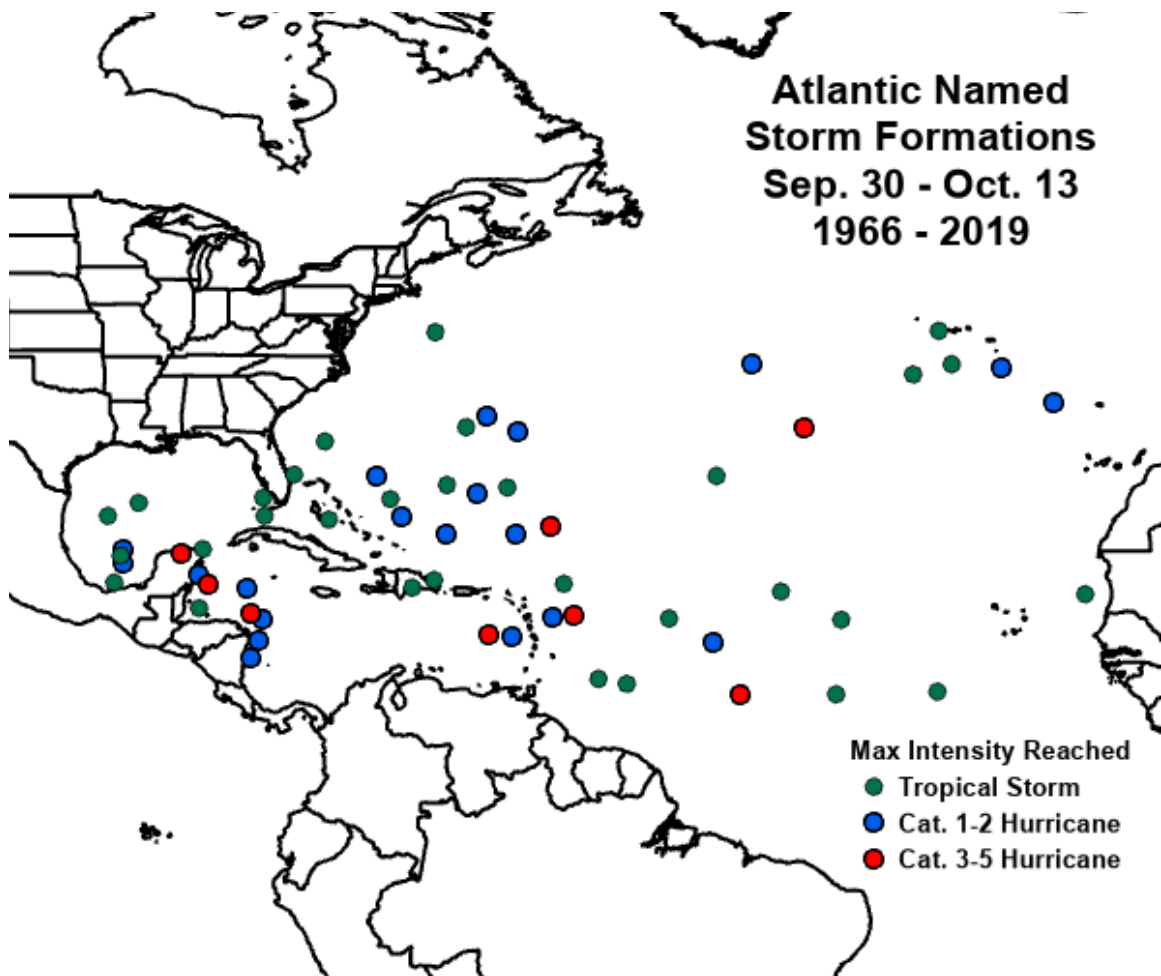


Figure 1: Atlantic named storm formations from September 30 – October 13 during the years from 1966 – 2019 and the maximum intensity that these named storms reached.

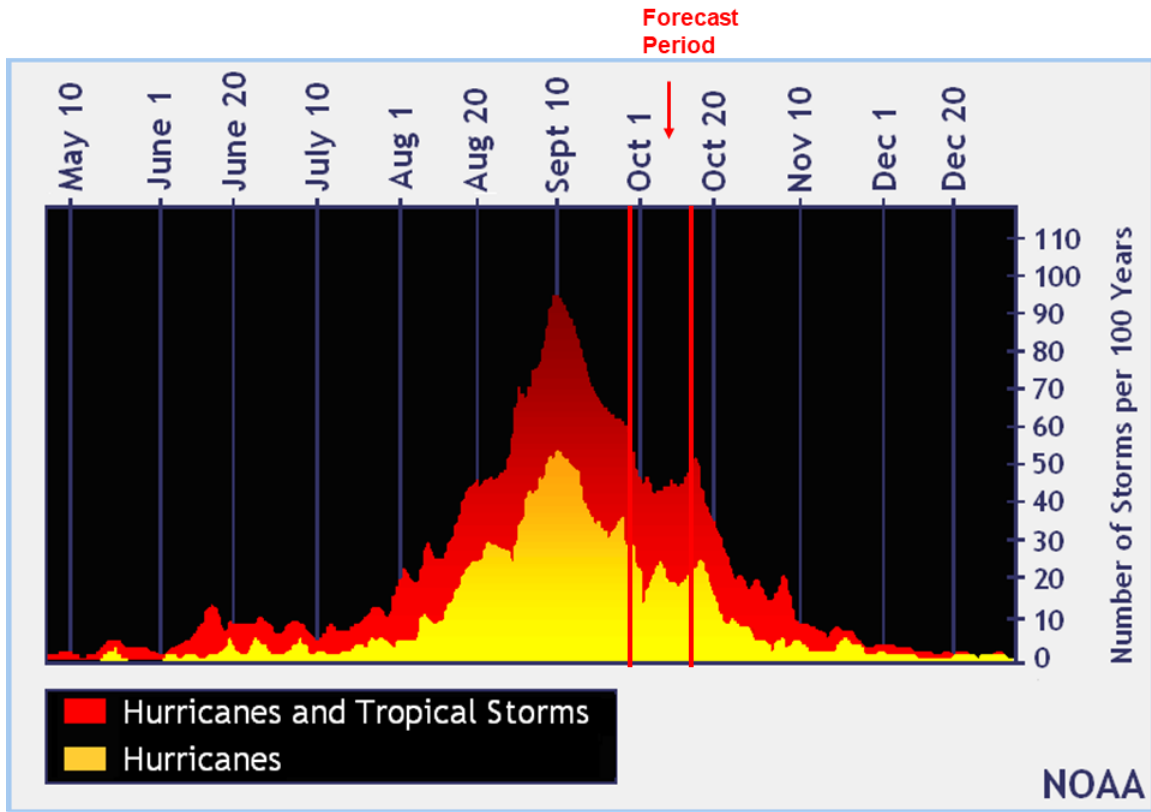


Figure 2: The current forecast period (September 30 – October 13) with respect to climatology. Figure courtesy of NOAA.

We now examine how we believe each of the five factors discussed in the introduction will impact Atlantic TC activity for the period from September 30 – October 13.

1) Current Storm Activity

Hurricane Sam remains a Category 4 hurricane this morning and is forecast to remain a major hurricane for the next couple of days before slowly weakening. Sam is estimated to generate ~15-20 additional ACE before dissipation. Tropical Storm Victor is also estimated to produce 3-5 ACE before weakening due to strong vertical wind shear from an upper-level trough.

2) National Hurricane Center Tropical Weather Outlook

The latest NHC Tropical Weather Outlook is not monitoring any areas for TC development in the next five days (Figure 3). The yellow “X” on the figure was an area that the National Hurricane Center had formerly been monitoring but now gives a ~0% chance of development in the next five days.

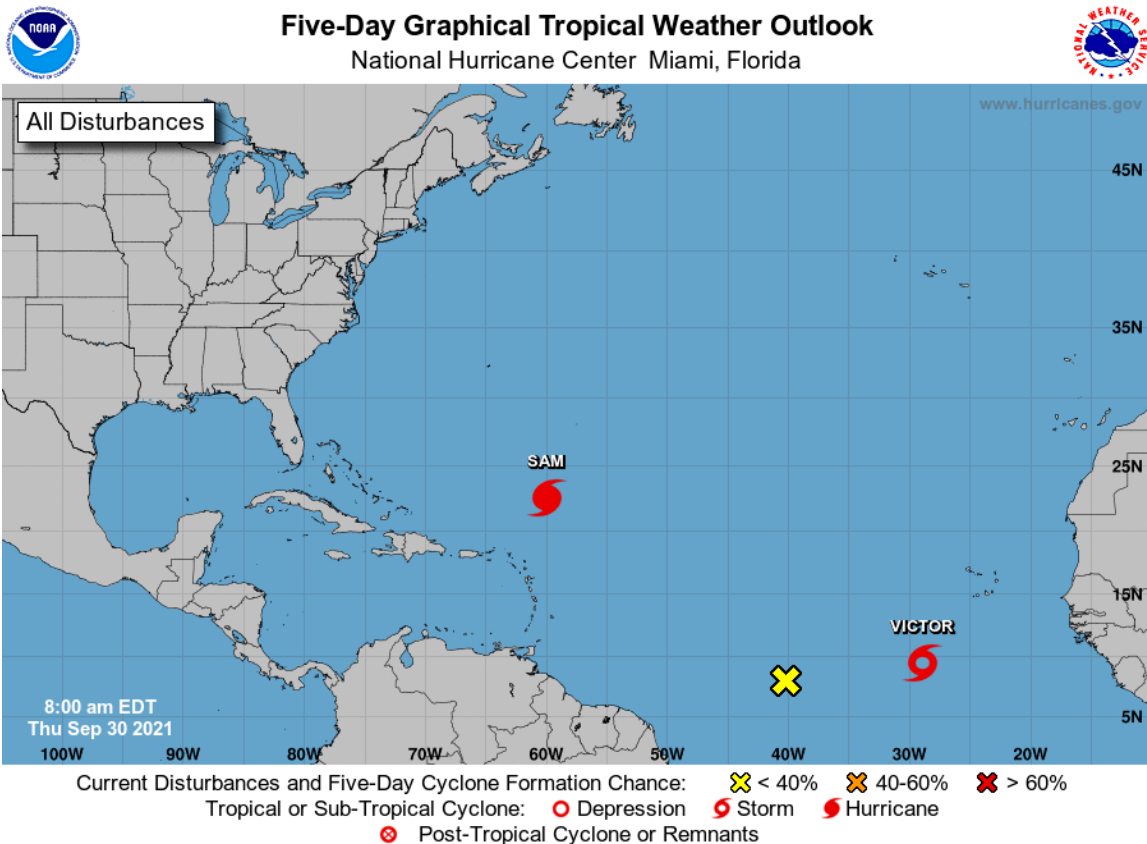


Figure 3: Recent five-day Tropical Weather Outlook from the National Hurricane Center.

3) Global Model Analysis

Both the GFS and ECMWF ensembles are hinting at development off of the US East Coast in about one week with potential development also possible in the western Caribbean in week two. The 6Z ECMWF ensemble highlighted some potential for US East Coast development in 5-6 days, while today's 0Z ECMWF ensemble 10-day forecast does have several members with developing TCs in the western Caribbean (Figure 4).

ECMWF ATLANTIC EPS Cyclone Locations --> Next [10-days]
INIT: 00Z30SEP2021 --> UNTIL 00Z10OCT2021

o-o ENSEMBLE MEAN
o-o 1000 - 1010 hPa
o-o 980 - 999 hPa
o-o 960 - 979 hPa
o-o 950 - 959 hPa
o-o < 950 hPa

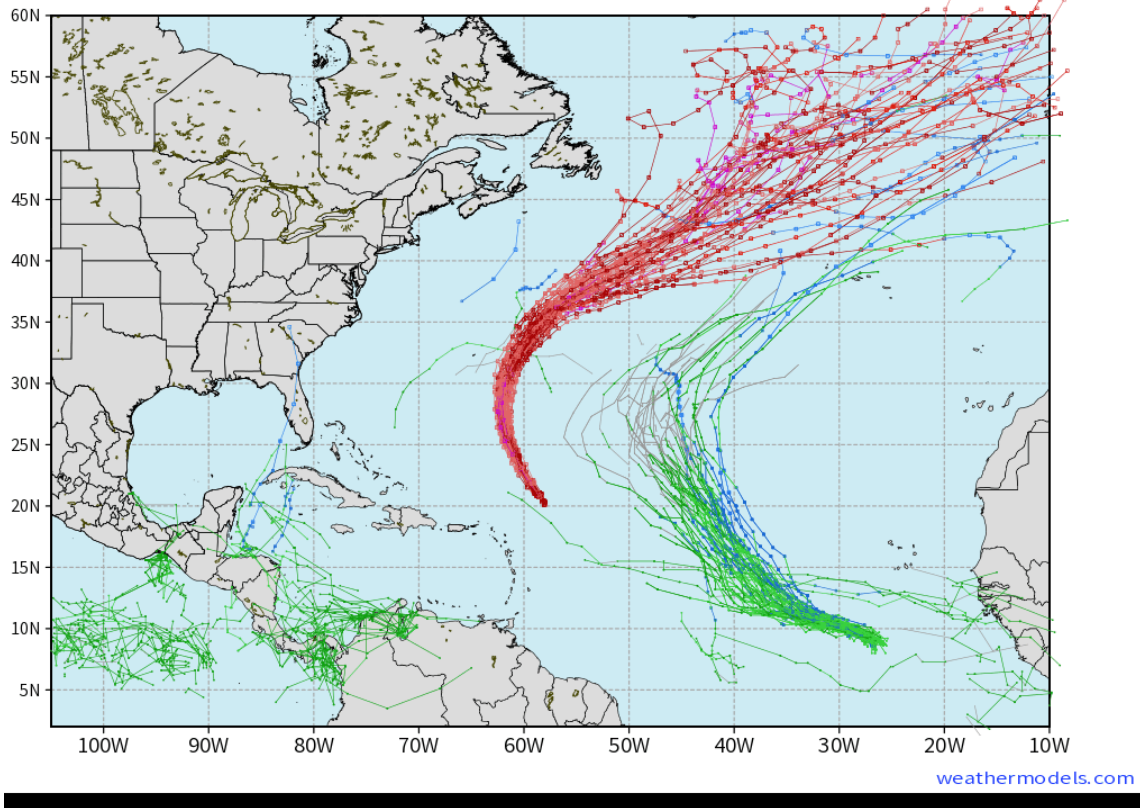


Figure 4: 0Z ECMWF ensemble for 30 September. The western Caribbean activity is generally shown in the 7-10-day timeframe.

4) Madden-Julian Oscillation

The Madden-Julian Oscillation (MJO), as measured by the Wheeler-Hendon index, is currently in phase 4 over the Maritime Continent and is forecast to propagate into Phase 5 in the next few days and then likely weaken (Figure 5). Table 2 summarizes the typical MJO impacts on Atlantic TC activity. The upper-level velocity potential field generally is not as favorable for the next week, with upward motion over Africa being replaced by downward motion. The fast moving sinking pattern seen transiting the Atlantic is likely due to a convectively-suppressed phase of a convectively-coupled Kelvin wave. However, around 10 October, conditions look to become more favorable for Atlantic hurricane activity, with upward motion again favored over the Indian Ocean and suppressed vertical motion over the tropical Pacific (Figure 6).

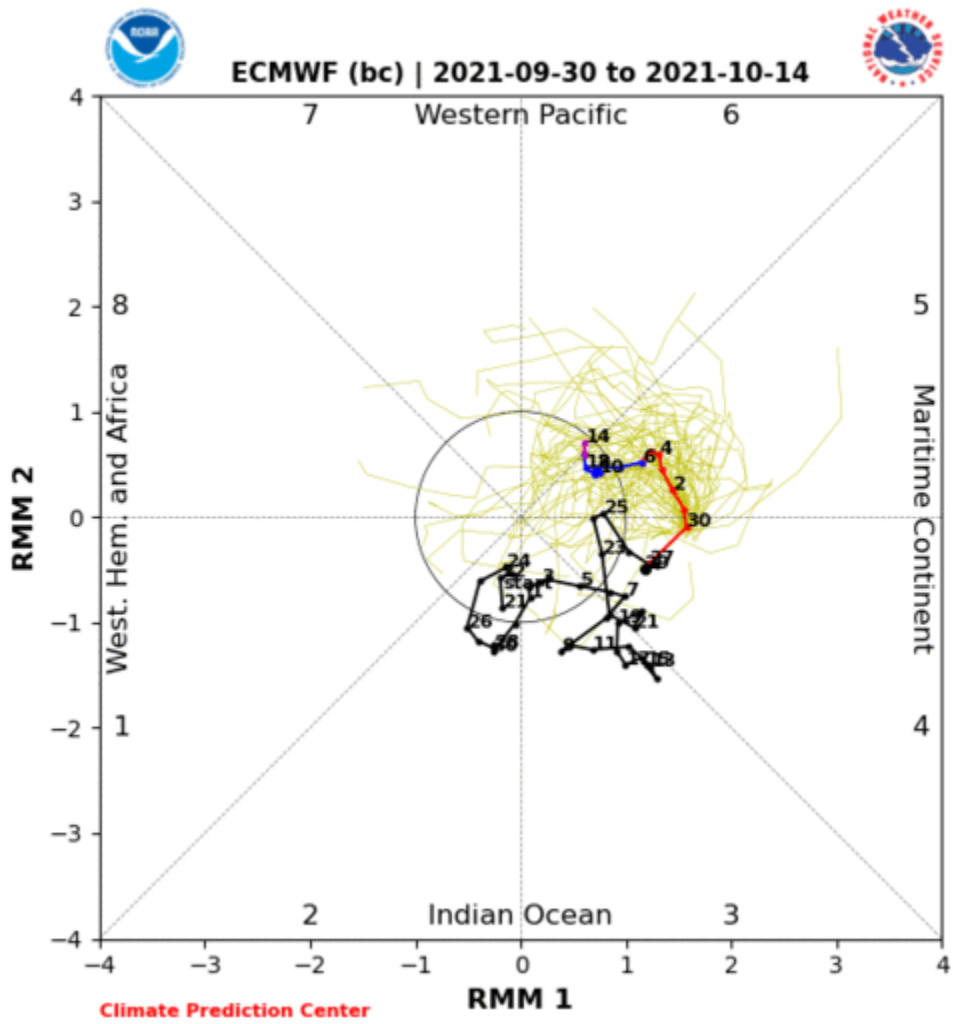


Figure 5: Predicted propagation of the MJO by the ECMWF model. Figure courtesy of NOAA.

Table 2: Normalized values of named storms (NS), named storm days (NSD), hurricanes (H), hurricane days (HD), major hurricanes (MH), major hurricane days (MHD) and Accumulated Cyclone Energy (ACE) generated by all tropical cyclones forming in each phase of the MJO over the period from 1974-2007. Normalized values are calculated by dividing storm activity by the number of days spent in each phase and then multiplying by 100. This basically provides the level of TC activity that would be expected for 100 days given a particular MJO phase.

MJO Phase	NS	NSD	H	HD	MH	MHD	ACE
Phase 1	6.4	35.9	3.7	17.9	1.8	5.3	76.2
Phase 2	7.5	43.0	5.0	18.4	2.1	4.6	76.7
Phase 3	6.3	30.8	3.0	14.7	1.4	2.8	56.0
Phase 4	5.1	25.5	3.5	12.3	1.0	2.8	49.4
Phase 5	5.1	22.6	2.9	9.5	1.2	2.1	40.0
Phase 6	5.3	24.4	3.2	7.8	0.8	1.1	35.7
Phase 7	3.6	18.1	1.8	7.2	1.1	2.0	33.2
Phase 8	6.2	27.0	3.3	10.4	0.9	2.6	46.8
Phase 1-2	7.0	39.4	4.3	18.1	1.9	4.9	76.5
Phase 6-7	4.5	21.5	2.5	7.5	1.0	1.5	34.6
Phase 1-2 / Phase 6-7	1.6	1.8	1.7	2.4	2.0	3.2	2.2

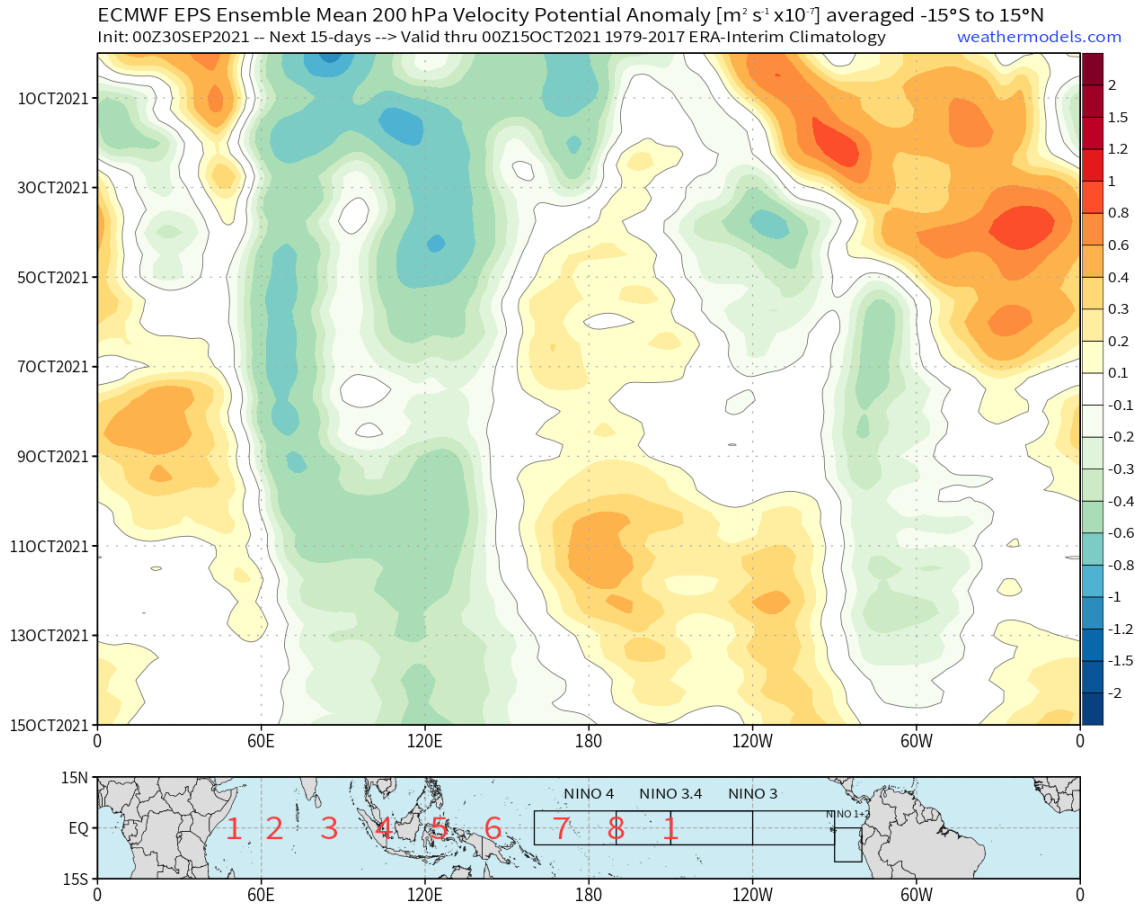


Figure 6: Ensemble mean forecast from the ECMWF model for 200 hPa velocity potential anomalies over the next 15 days.

5) Seasonal Forecast

The most recent seasonal forecast calls for an active season. We believe that the next two weeks should generate above-normal TC activity, due to Sam and to a lesser extent Victor.

3 Upcoming Two-Week Forecast

A final two-week forecast will be issued on October 14 for the period between October 14 – 27.

VERIFICATION OF SEPTEMBER 16 – SEPTEMBER 29, 2021 FORECAST

The two-week forecast of tropical cyclone activity from September 16 – 29, 2021 verified in the above-normal category (>23 ACE). A total of 33 ACE was observed during the two-week period. We assigned probabilities of 40% to above-normal, 50% to normal and 10% to below-normal. While models were hinting at Sam’s development, they were generally weaker with Sam than what was actually observed.

Sam was by far the largest producer of ACE during the two-week timeframe (28). Odette, Peter, Rosa, Teresa and Victor all contributed <2 ACE to the two-week ACE total. Table 4 displays the percentage chance that we gave for each category being reached and observed ACE:

Table 3: ACE forecast for TC activity for September 16 – September 29, 2021, the probability assigned for each category being reached and observed ACE.

ACE Category	Definition	Probability in each Category	Observed ACE
Above-Normal	Upper Tercile (>23 ACE)	40%	33
Normal	Middle Tercile (6–23 ACE)	50%	
Below-Normal	Lower Tercile (<6 ACE)	10%	

**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. In an analysis of a recently accepted article on the October-November portion of the 2021 Atlantic hurricane season, we revised the model slightly to use the ENSO Longitude Index (Williams and Patricola 2018) to assess the state of ENSO.

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 1979-2019. Table 4 displays the locations and time periods of the predictors, their standardized values relative to 1991-2020 and their effect on October-November Caribbean ACE.

Table 4: 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 2021 Forecast	Effect on Oct-Nov Caribbean ACE
1) July-September ENSO Longitude Index (-)	-0.7 SD	Enhance
2) July-September SST (10-20°N, 85-50°W) (+)	+0.2 SD	Slightly Enhance

These two predictors are then combined in a rank regression model to forecast October-November Caribbean ACE. The model shows hindcast correlation skill of 0.80 over the period from 1979-2020 (Figure 7).

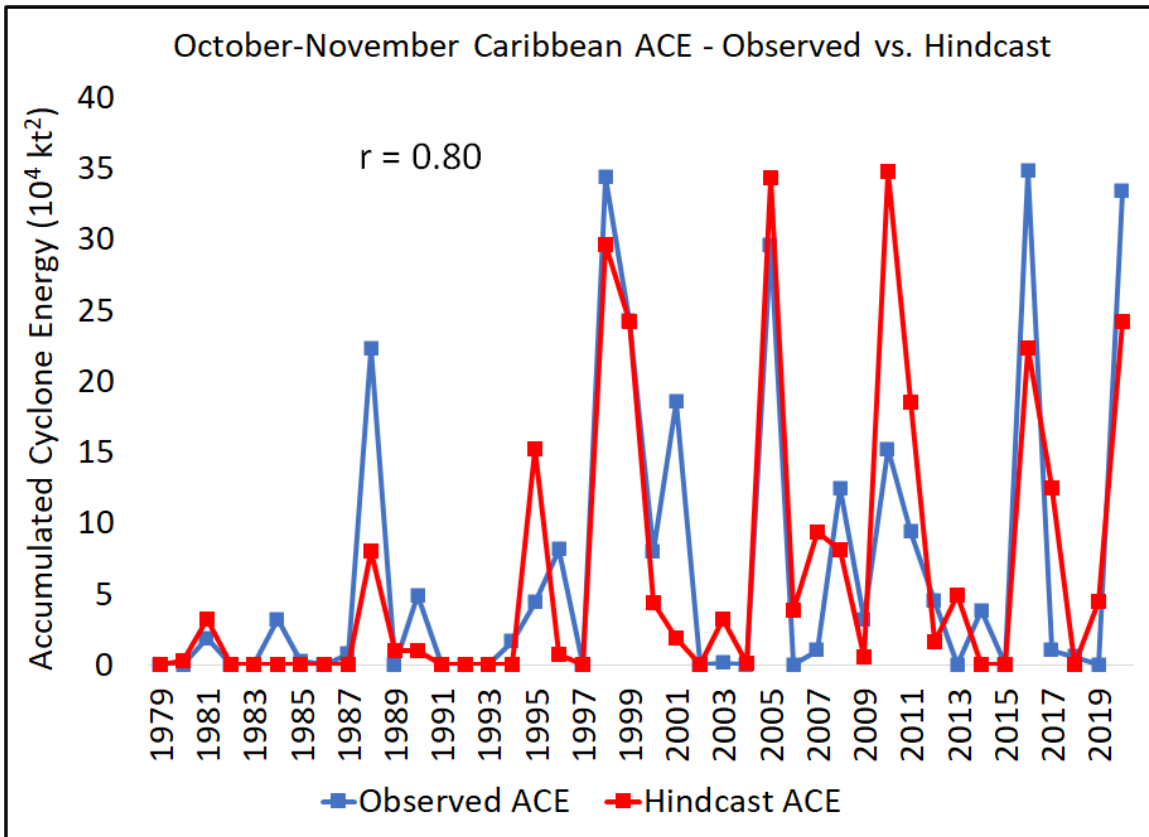


Figure 7: Observed vs. hindcast October-November Caribbean from 1979-2020.

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, while other years (such as last year) having over 30 ACE. The median 1991-2020 ACE is 2, while the mean 1991-2020 ACE is 8.

The final forecast for October-November Caribbean ACE in 2021 is 9, meaning a slightly above-average and well above-median October-November ACE is forecast this year.

References

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