FORECAST OF ATLANTIC SEASONAL HURRICANE ACTIVITY AND LANDFALL STRIKE PROBABILITY FOR 2022

We have decreased our forecast but continue to call for an above-average 2022 Atlantic hurricane season. Sea surface temperatures averaged across the tropical Atlantic are slightly warmer than normal, while subtropical Atlantic sea surface temperatures are cooler than normal. Vertical wind shear anomalies averaged over the past 30 days over the Caribbean and tropical Atlantic are slightly weaker than normal. Current La Niña conditions are likely to persist for the rest of the Atlantic hurricane season. We continue to anticipate an above-normal probability for major hurricanes making landfall along the continental United States coastline and in the Caribbean. As is the case with all hurricane seasons, coastal residents are reminded that it only takes one hurricane making landfall to make it an active season for them. They should prepare the same for every season, regardless of how much activity is predicted.

(as of 4 August 2022)

By Philip J. Klotzbach[1], Michael M. Bell[2] and Alexander J. DesRosiers[3]
In Memory of William M. Gray[4]

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

Anne Manning, Colorado State University media representative, is coordinating media inquiries into this verification. She can be reached at 970-491-7099 or
Anne.Manning@colostate.edu

Department of Atmospheric Science
Colorado State University
Fort Collins, CO 80523

Project Sponsors:

[1] Senior Research Scientist
[2] Professor
[3] Graduate Research Assistant
[4] Professor Emeritus

ATLANTIC BASIN SEASONAL HURRICANE FORECAST FOR 2022

Forecast Parameter and 1991-2020 Average (in parentheses)	Issue Date 7 April 2022	Issue Date 2 June 2022	Issue Date 7 July 2022	Issue Date 4 August 2022	Observed Thru 3 August 2022	Remainder of Season Forecast
Named Storms (NS) (14.4)	19	20	20	18*	3	15
Named Storm Days (NSD) (69.4)	90	95	95	85	3.25	81.75
Hurricanes (H) (7.2)	9	10	10	8	0	8
Hurricane Days (HD) (27.0)	35	40	40	30	0	30
Major Hurricanes (MH) (3.2)	4	5	5	4	0	4
Major Hurricane Days (MHD) (7.4)	9	11	11	8	0	8
Accumulated Cyclone Energy (ACE) (123)	160	180	180	150	3	147
Net Tropical Cyclone Activity (NTC) (135%)	170	195	195	160	6	154

*Total forecast includes Alex, Bonnie and Colin which have formed in the Atlantic as of August 3rd.

PROBABILITIES FOR AT LEAST ONE MAJOR (CATEGORY 3-4-5) HURRICANE LANDFALL ON EACH OF THE FOLLOWING COASTAL AREAS (AFTER 4 AUGUST):

1) Entire continental U.S. coastline - 68% (full-season average for last century is 52%)

2) U.S. East Coast Including Peninsula Florida - 43% (full-season average for last century is 31%)

3) Gulf Coast from the Florida Panhandle westward to Brownsville - 43% (full-season average for last century is 30%)

PROBABILITY FOR AT LEAST ONE MAJOR (CATEGORY 3-4-5) HURRICANE TRACKING INTO THE CARIBBEAN (10-20°N, 88-60°W) (AFTER 4 AUGUST):

1) 57% (full-season average for last century is 42%)

ABSTRACT

Information obtained through July 2022 indicates that the 2022 Atlantic hurricane season will have above-average activity, although less than forecast with our earlier 2022 seasonal hurricane outlooks. The Atlantic has had 3 named storms through August 3. We estimate that 2022 will have an additional 15 named storms (post-31 July average is 11.6), 8 hurricanes (post-31 July average is 6.5), and 4 major (Category 3-4-5) hurricanes (post-31 July average is 3.1). The probability of U.S. major hurricane landfall is estimated to be ~140% of the long-period full-season average. We predict Atlantic basin Accumulated Cyclone Energy (ACE) to be ~130% of its long term post-31 July average.

This forecast is based on an extended-range early August statistical prediction scheme that was developed using 40 years of past data and a new August statistical prediction model developed using 43 years of past data. We also include statistical/dynamical model forecasts from the European Centre for Medium-Range Weather Forecasts, the UK Met Office and the Japan Meteorological Agency. Analog predictors are also utilized.

Most of the tropical Atlantic and Caribbean is slightly warmer than normal, while vertical wind shear averaged across the tropical Atlantic and Caribbean over the past 30 days is slightly weaker than normal. Warmer than normal water across the tropical Atlantic provides more fuel for tropical cyclones. Vertical wind shear in July typically has strong persistence, that is, if vertical wind shear is high in July, it is likely to remain elevated for the rest of the season. All three climate models are predicting slightly weaker-than-normal vertical wind shear for August-September. Lower vertical wind shear allows hurricanes to better vertically align and inhibits entrainment of dry air into the circulation.

Sea surface temperatures averaged across the eastern and central tropical Pacific are cooler than normal, indicating continued persistence of La Niña conditions. Given observed and continued forecast strong trade winds and strong anomalous cooling in the subsurface tropical Pacific, we anticipate that La Niña is likely to persist through the remainder of the Atlantic hurricane season.

While these factors tend to point towards an above-normal season, the subtropical Atlantic has anomalously cooled. This anomalous cooling can increase the tropical/subtropical Atlantic sea surface temperature gradient, potentially favoring increased frontal intrusions into the tropics and increasing vertical wind shear.

The early August forecast has good long-term skill when evaluated in hindcast mode. The skill of CSU's forecast updates typically increases as the peak of the Atlantic hurricane season approaches.

Starting today and issued every two weeks following (e.g., August 4, August 18, September 1, etc.), we will issue two-week forecasts for Atlantic TC activity during the peak of the Atlantic hurricane season from August-October.

Why issue forecasts for seasonal hurricane activity?

We are frequently asked this question. Our answer is that it is possible to say something about the probability of the coming year's hurricane activity which is superior to climatology. The Atlantic basin has the largest year-to-year variability of any of the global tropical cyclone basins. People are curious to know how active the upcoming season is likely to be, particularly if you can show hindcast skill improvement over climatology for many past years.

Everyone should realize that it is impossible to precisely predict this season's hurricane activity in early August. There is, however, much curiosity as to how global ocean and atmosphere features are presently arranged as regards to the probability of an active or inactive hurricane season for the coming year. Our early August statistical and statistical/dynamical hybrid models show strong evidence on ~25-40 years of data that significant improvement over a climatological forecast can be attained. We would never issue a seasonal hurricane forecast unless we had models developed over a long hindcast period which showed skill. We also now include probabilities of exceedance to provide improved quantification of the uncertainty associated with these predictions.

We issue these forecasts to satisfy the curiosity of the general public and to bring attention to the hurricane problem. There is a general interest in knowing what the odds are for an active or inactive season. One must remember that our forecasts are based on the premise that those global oceanic and atmospheric conditions which preceded comparatively active or inactive hurricane seasons in the past provide meaningful information about similar trends in future seasons.

It is also important that the reader appreciate that these seasonal forecasts are based on statistical and dynamical models which will fail in some years. Moreover, these forecasts do not specifically predict where within the Atlantic basin these storms will strike. The probability of landfall for any one location along the coast is very low and reflects the fact that, in any one season, most U.S. coastal areas will not feel the effects of a hurricane no matter how active the individual season is. However, regardless of seasonal outlooks, it only takes one hurricane making landfall near you to make it an active season.

Acknowledgment

These seasonal forecasts were developed by the late Dr. William Gray, who was lead author on these predictions for over 20 years and continued as a co-author until his death in 2016. In addition to pioneering seasonal Atlantic hurricane prediction, he conducted groundbreaking research on a wide variety of other topics including hurricane genesis, hurricane structure and cumulus convection. His investments in both time and energy to these forecasts cannot be acknowledged enough.

We are grateful for support from Ironshore Insurance, the Insurance Information Institute, Weatherboy, First Onsite and IAA. We acknowledge a grant from the G. Unger Vetlesen Foundation for additional financial support.

Colorado State University's seasonal hurricane forecasts have benefited greatly from a number of individuals that were former graduate students of William Gray. Among these former project members are Chris Landsea, John Knaff and Eric Blake. We also would like to thank Jhordanne Jones, recent Ph.D. graduate in Michael Bell's research group, for model development and forecast assistance over the past several years.

We thank Louis-Philippe Caron and the data team at the Barcelona Supercomputing Centre for providing data and insight on the statistical/dynamical models. We have also benefited from meteorological discussions with Carl Schreck, Louis-Philippe Caron, Brian McNoldy, Paul Roundy, Jason Dunion, and Peng Xian over the past few years.

DEFINITIONS AND ACRONYMS

Accumulated Cyclone Energy (ACE) - A measure of a named storm's potential for wind and storm surge destruction defined as the sum of the square of a named storm's maximum wind speed (in 10^4 $knots^2$) for each 6-hour period of its existence. The 1991–2020 average value of this parameter is 123 for the Atlantic basin.

Atlantic Multi-Decadal Oscillation (AMO) – A mode of natural variability that occurs in the North Atlantic Ocean and evidencing itself in fluctuations in sea surface temperature and sea level pressure fields. The AMO is likely related to fluctuations in the strength of the oceanic thermohaline circulation. Although several definitions of the AMO are currently used in the literature, we define the AMO based on North Atlantic sea surface temperatures from 50–60°N, 50–10°W and sea level pressure from 0–50°N, 70–10°W.

Atlantic Basin – The area including the entire North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico.

El Niño – A 12-18 month period during which anomalously warm sea surface temperatures occur in the eastern half of the equatorial Pacific. Moderate or strong El Niño events occur irregularly, about once every 3–7 years on average.

ENSO Longitude Index – An index defining ENSO that estimates the average longitude of deep convection associated with the Walker Circulation.

Hurricane (H) - A tropical cyclone with sustained low-level winds of 74 miles per hour (33 ms^{-1} or 64 knots) or greater.

Hurricane Day (HD) - A measure of hurricane activity, one unit of which occurs as four 6-hour periods during which a tropical cyclone is observed or is estimated to have hurricane-force winds.

Indian Ocean Dipole (IOD) - An irregular oscillation of sea surface temperatures between the western and eastern tropical Indian Ocean. A positive phase of the IOD occurs when the western Indian Ocean is anomalously warm compared with the eastern Indian Ocean.

Madden Julian Oscillation (MJO) – A globally propagating mode of tropical atmospheric intra-seasonal variability. The wave tends to propagate eastward at approximately 5 ms^{-1}, circling the globe in roughly 30-60 days.

Main Development Region (MDR) – An area in the tropical Atlantic where a majority of major hurricanes form, which we define as 7.5-22.5°N, 75-20°W.

Major Hurricane (MH) - A hurricane which reaches a sustained low-level wind of at least 111 mph (96 knots or 50 ms^{-1}) at some point in its lifetime. This constitutes a category 3 or higher on the Saffir/Simpson scale.

Major Hurricane Day (MHD) - Four 6-hour periods during which a hurricane has an intensity of Saffir/Simpson category 3 or higher.

Named Storm (NS) - A hurricane, a tropical storm or a sub-tropical storm.

Named Storm Day (NSD) - As in HD but for four 6-hour periods during which a tropical or sub-tropical cyclone is observed (or is estimated) to have attained tropical storm-force winds.

Net Tropical Cyclone (NTC) Activity –Average seasonal percentage mean of NS, NSD, H, HD, MH, MHD. Gives overall indication of Atlantic basin seasonal hurricane activity. The 1950-2000 average value of this parameter is 100.

Saffir/Simpson Hurricane Wind Scale – A measurement scale ranging from 1 to 5 of hurricane wind intensity. One is a weak hurricane; whereas, five is the most intense hurricane.

Southern Oscillation Index (SOI) – A normalized measure of the surface pressure difference between Tahiti and Darwin. Low values typically indicate El Niño conditions.

Standard Deviation (SD) – A measure used to quantify the variation in a dataset.

Sea Surface Temperature Anomaly – SSTA

Thermohaline Circulation (THC) – A large-scale circulation in the Atlantic Ocean that is driven by fluctuations in salinity and temperature. When the THC is stronger than normal, the AMO tends to be in its warm (or positive) phase, and more Atlantic hurricanes typically form.

Tropical Cyclone (TC) - A large-scale circular flow occurring within the tropics and subtropics which has its strongest winds at low levels; including hurricanes, tropical storms and other weaker rotating vortices.

Tropical Storm (TS) - A tropical cyclone with maximum sustained winds between 39 mph (18 ms^{-1} or 34 knots) and 73 mph (32 ms^{-1} or 63 knots).

Vertical Wind Shear – The difference in horizontal wind between 200 hPa (approximately 40000 feet or 12 km) and 850 hPa (approximately 5000 feet or 1.6 km).

1 knot = 1.15 miles per hour = 0.515 meters per second

1 Introduction

This is the 39th year in which the CSU Tropical Meteorology Project has made forecasts of the upcoming season's Atlantic basin hurricane activity. Our research team has shown that a sizable portion of the year-to-year variability of Atlantic tropical cyclone (TC) activity can be hindcast with skill exceeding climatology. This year's August forecast is based on two statistical models as well as output from statistical/dynamical models based on the European Centre for Medium Range Weather Forecasts (ECMWF), the UK Met Office and the Japan Meteorological Agency (JMA) model output. These models show skill at predicting TC activity based on ~25–40 years of historical data. We also select analog seasons, based primarily on conditions we anticipate for the peak of the Atlantic hurricane season. Qualitative adjustments are added to accommodate additional processes which may not be explicitly represented by these analyses. These evolving forecast techniques are based on a variety of climate-related global and regional predictors previously shown to be related to the forthcoming seasonal Atlantic basin TC activity and landfall probability. We believe that seasonal forecasts must be based on methods that show significant hindcast skill in application to long periods of prior data. It is only through hindcast skill that one can demonstrate that seasonal forecast skill is possible. This is a valid methodology provided that the atmosphere continues to behave in the future as it has in the past.

The best predictors do not necessarily have the best individual correlations with hurricane activity. The best forecast parameters are those that explain the portion of the variance of seasonal hurricane activity that are not associated with the other forecast variables. It is possible for an important hurricane forecast parameter to show little direct relationship to a predictand by itself but to have an important influence when included with a set of 2-3 other predictors.

A direct correlation of a forecast parameter may not be the best measure of the importance of this predictor to the skill of a 3-4 parameter forecast model. This is the nature of the seasonal or climate forecast problem where one is dealing with a very complicated atmospheric-oceanic system that is highly non-linear. There are a maze of changing physical linkages between the many variables. These linkages can undergo unknown changes from weekly to decadal time scales. It is impossible to understand how all of these processes interact with each other. But, it is still possible to develop a reliable statistical forecast scheme which incorporates a number of the climate system's non-linear interactions. Any seasonal or climate forecast scheme should show significant hindcast skill before it is used in real-time forecasts.

2 August Forecast Methodology

2.1 August Statistical Forecast Scheme using July Data

We developed a 1 August statistical seasonal forecast scheme for the prediction of Accumulated Cyclone Energy (ACE) that has been utilized operationally since 2012.

This model was re-run in 2020 with the latest version of the European Centre for Medium Range Weather Forecasts (ECMWF) Reanalysis product – ERA5. We use the daily NOAA Optimum Interpolation SST version 2 product for the SST predictor. Since the NOAA daily SST product is available since September 1981, this model was developed on Atlantic hurricane seasons from 1982-2020.

The pool of three predictors for the early August statistical forecast scheme is given and defined in Table 1. The location of each of these predictors is shown in Figure 1. Skillful forecasts can be issued for post-31 July ACE based upon cross-validated hindcasts from 1982-2021. When these three predictors are combined, they correlate at 0.82 with observed ACE using cross-validated hindcasts from 1982-2021 (Figure 2). Predictor 1 (Caribbean trade wind strength) and Predictor 3 (tropical Africa upper-level winds) call for slightly above-average activity, while Predictor 2 (Subtropical northeastern Atlantic SST) calls for a below-average remainder of the 2022 Atlantic hurricane season.

Table 1: Listing of 1 August 2022 predictors for this year's hurricane activity. A plus (+) means that positive deviations of the parameter indicate increased hurricane activity this year, and a minus (-) means that positive deviations of the parameter indicate decreased hurricane activity this year.

Predictor	Values for 2022 Forecast	Effect on 2022 Hurricane Season
1) July 10 m U (10-17.5°N, 85-60°W) (+)	+0.2 SD	Slightly Enhance
2) July SST (20-40°N, 35-15°W) (+)	-0.7 SD	Suppress
3) July 200 hPa U (5-15°N, 0-40°E) (-)	-0.2 SD	Slightly Enhance

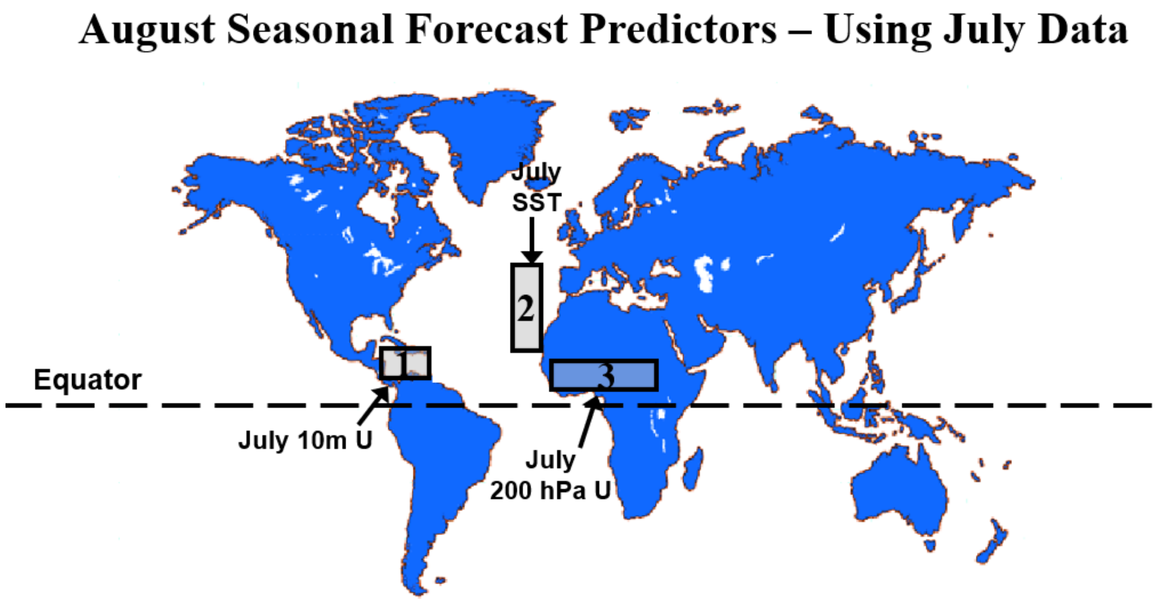

Figure 1: Location of predictors for the post-31 July forecast for the 2022 hurricane season from the July-averaged statistical model.

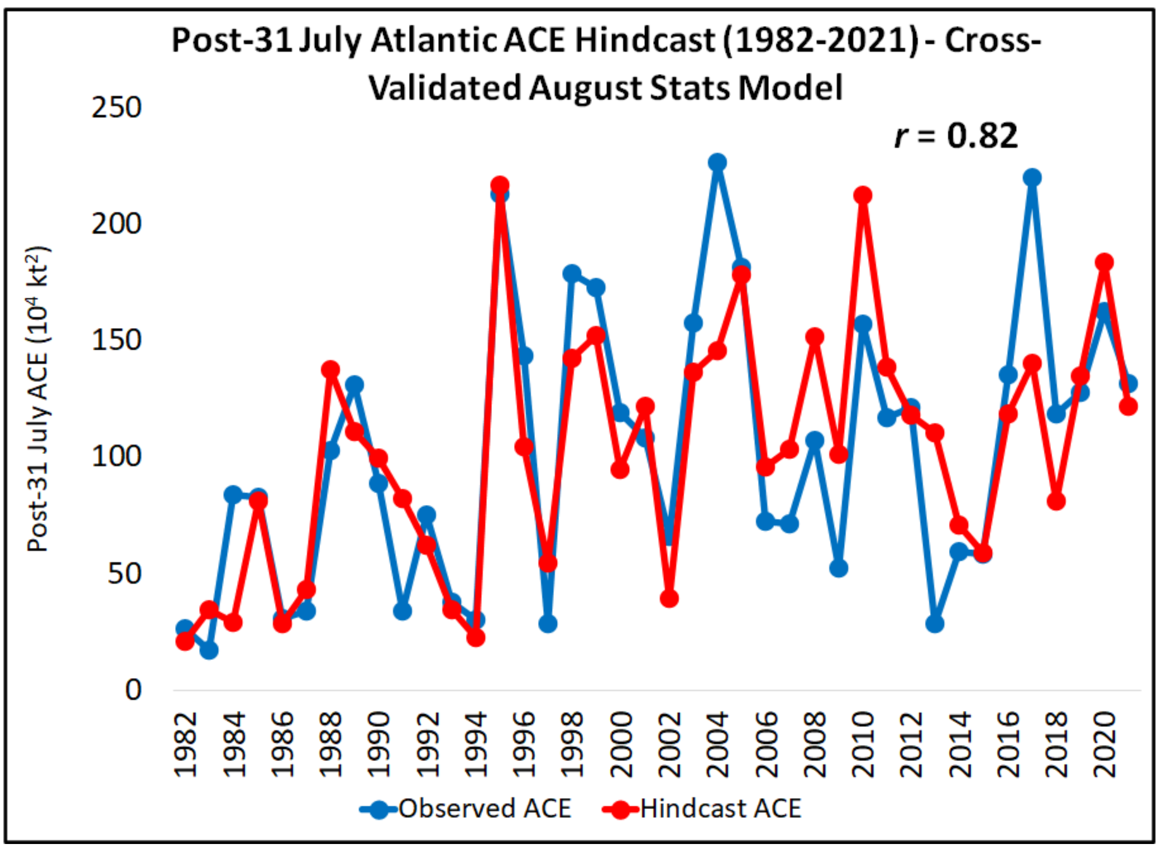

Figure 2: Observed versus hindcast values of post-31 July ACE for 1982-2021 using our statistical scheme that uses July averages.

Table 2 shows our forecast for the 2022 hurricane season from the statistical model using July averages and the comparison of this forecast with the 1991-2020 average. This statistical forecast is calling for a near-average remainder of the season.

Table 2: Post-31 July statistical forecast for 2022 from the July-averaged statistical model.

Predictands and Climatology (1991-2020 Post-31 July Average)	Post-31 July Statistical Forecast	Full Season Statistical Forecast (Activity Thru 3 August Added In)
Named Storms (NS) – 11.6	13.6	16.6
Named Storm Days (NSD) – 61.3	64.1	67.3
Hurricanes (H) – 6.5	6.6	6.6
Hurricane Days (HD) – 25.6	24.1	24.1
Major Hurricanes (MH) – 3.1	2.9	2.9
Major Hurricane Days (MHD) – 7.1	6.3	6.3
Accumulated Cyclone Energy (ACE) – 113	110	113
Net Tropical Cyclone Activity (NTC) – 123	122	128

2.1a Physical Associations among Predictors Listed in Table 2

The locations and brief descriptions of the three predictors for our current August statistical forecast are now discussed. It should be noted that all forecast parameters correlate significantly with physical features during August through October that are known to be favorable for elevated levels of TC activity. For each of these predictors, we display a four-panel figure showing rank correlations between values of each predictor and August-October values of SST, sea level pressure (SLP), 850 hPa (~1.5 km altitude) zonal wind (U), and 200 hPa (~12 km altitude) zonal wind (U), respectively.

Predictor 1. July 10 meter U in the Caribbean (+)

(10-17.5°N, 85-60°W)

Low-level trade wind flow has been utilized as a predictor in seasonal forecasting systems for the Atlantic basin (Saunders and Lea 2008). When the trades are weaker-than-normal, SSTs across the tropical Atlantic tend to be elevated, and consequently a larger-than-normal Atlantic Warm Pool (AWP) is typically observed (Wang and Lee 2007) (Figure 3). A larger AWP also correlates with reduced vertical shear across the tropical Atlantic. Weaker trade winds are typically associated with higher pressure in the tropical eastern Pacific (a La Niña signal) and lower pressure in the Caribbean and tropical Atlantic. Both of these conditions generally occur when active hurricane seasons are observed. Predictor 1 also has a strong negative correlation with August-October-averaged 200-850-hPa zonal shear.

Predictor 2. July SST in the Northeastern Subtropical Atlantic (+)

(20°-40°N, 35-15°W)

A similar predictor was utilized in earlier August seasonal forecast models (Klotzbach 2007, Klotzbach 2011). Anomalously warm SSTs in the subtropical North Atlantic are associated with a positive phase of the Atlantic Meridional Mode (AMM), a northward-shifted Intertropical Convergence Zone, and consequently, reduced trade wind strength (Kossin and Vimont 2007). Weaker trade winds are associated with less surface evaporative cooling and less mixing and upwelling. This results in warmer tropical Atlantic SSTs during the August-October period (Figure 4).

Predictor 3. July 200 hPa U over Northern Tropical Africa (-)

(5-15°N, 0-40°E)

Anomalous easterly flow at upper levels over northern tropical Africa provides an environment that is more favorable for easterly wave development into TCs. This anomalous easterly flow tends to persist through August-October, which reduces shear over the Main Development Region (MDR). This predictor also correlates with SLP and SST anomalies over the tropical eastern Pacific that are typically associated with cool ENSO conditions (Figure 5).

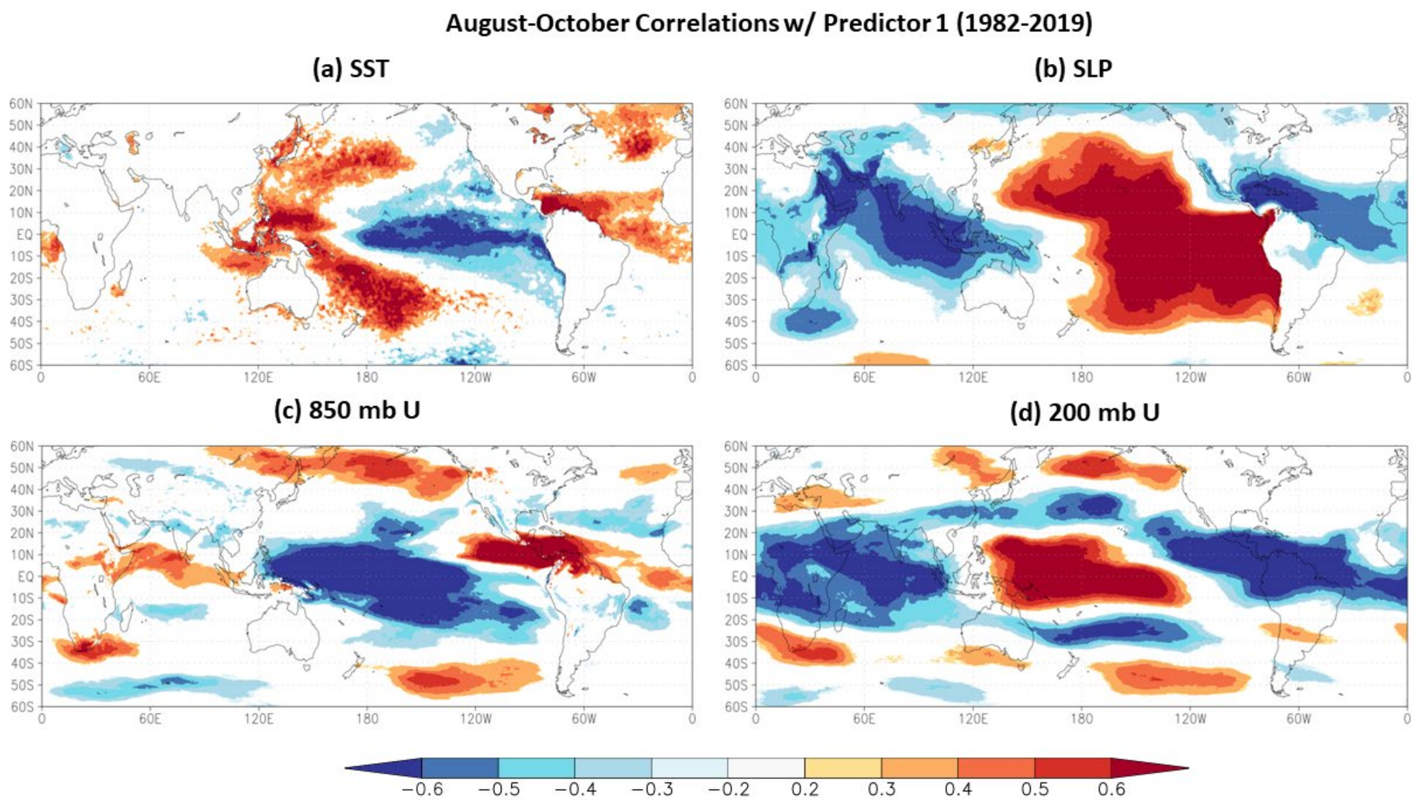

Figure 3: Rank correlations between July 10 meter U in the Caribbean (Predictor 1) and August-October sea surface temperature (panel a), August-October sea level pressure (panel b), August-October 850 hPa zonal wind (panel c) and August-October 200 hPa zonal wind (panel d) over the period from 1982-2019.

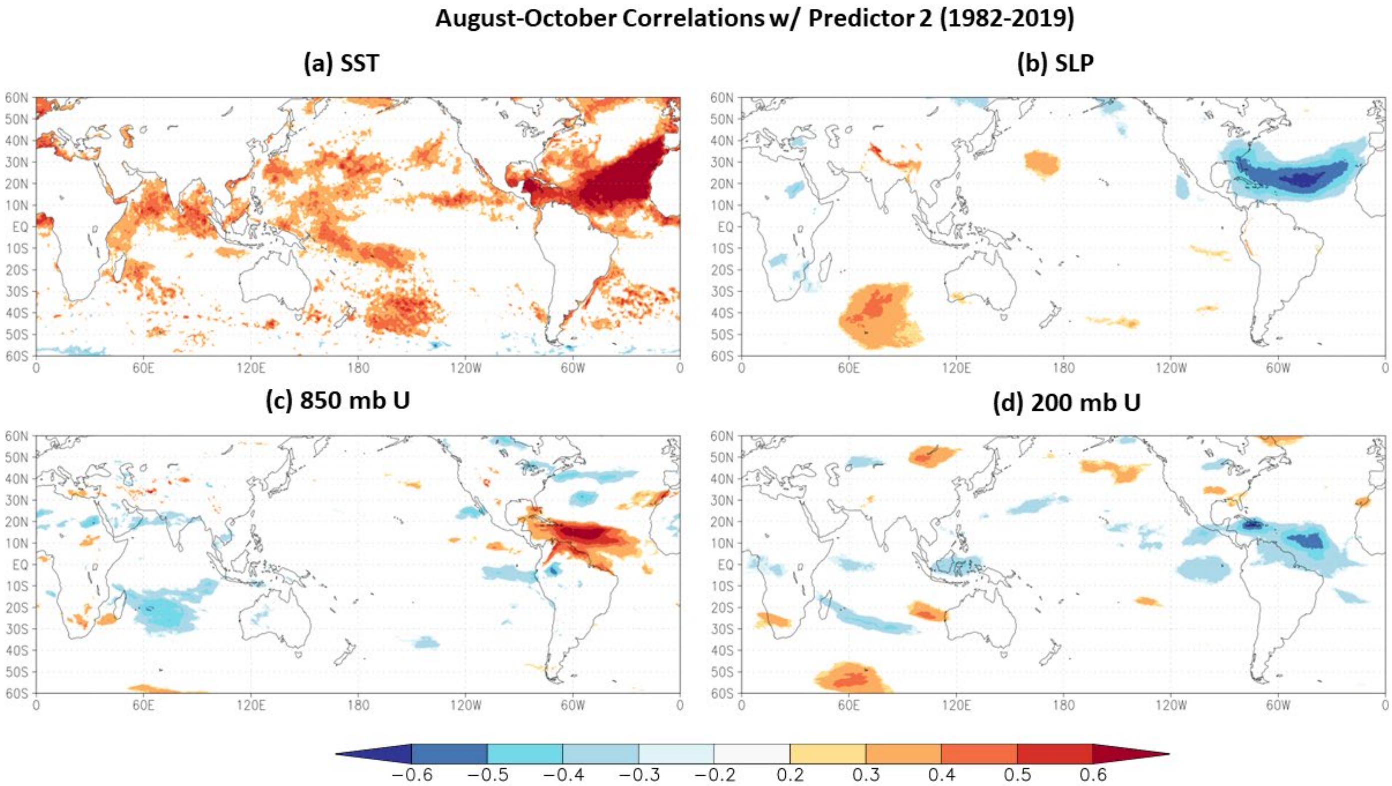

Figure 4: Rank correlations between July sea surface temperature in the subtropical northeastern Atlantic (Predictor 2) and August-October sea surface temperature (panel a), August-October sea level pressure (panel b), August-October 850 hPa zonal wind (panel c) and August-October 200 hPa zonal wind (panel d) over the period from 1982-2019.

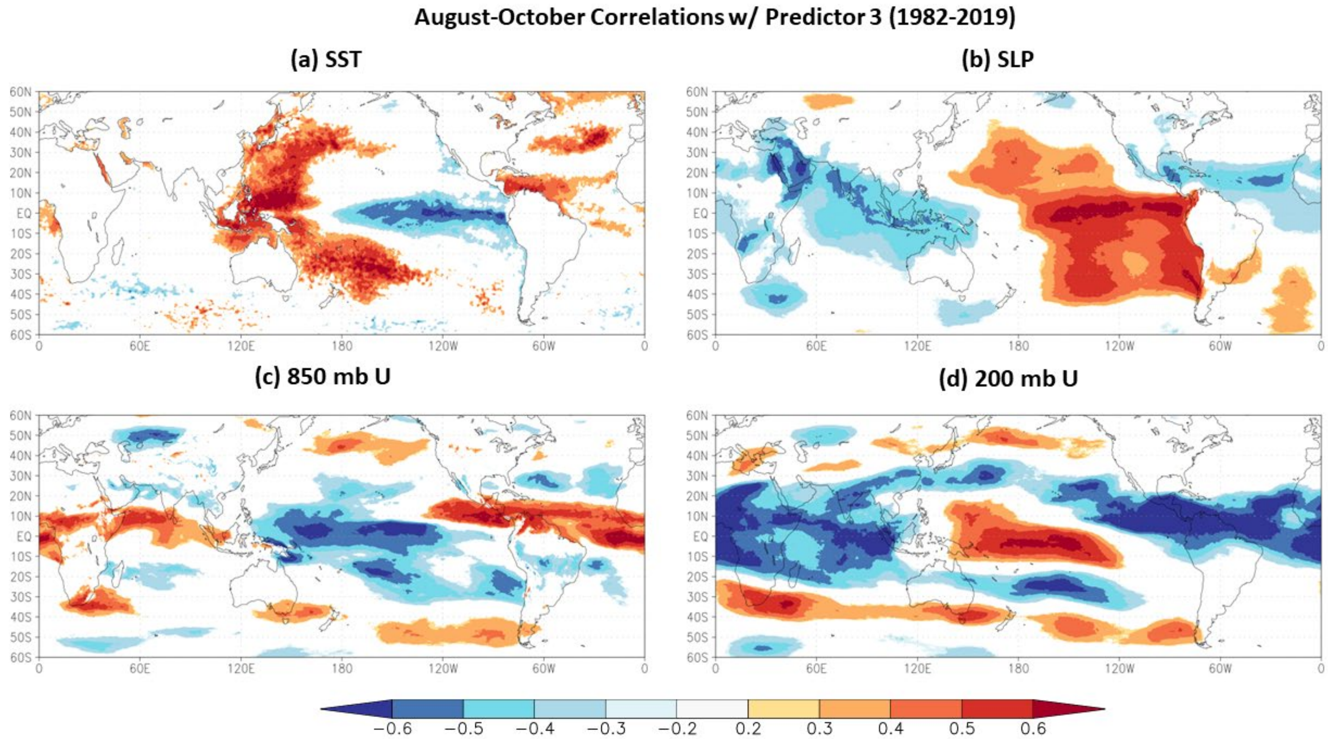

Figure 5: Rank correlations between July 200 hPa zonal wind over tropical north Africa (Predictor 3) and August-October sea surface temperature (panel a), August-October sea level pressure (panel b), August-October 925 hPa zonal wind (panel c) and August-October 200 hPa zonal wind (panel d) over the period from 1982-2019. Predictor values have been multiplied by -1 so that the signs of correlations match up with those in Figures 4 and 5.

2.2 August Statistical Forecast Scheme using 50-Day Averages

We have developed a new 1 August statistical seasonal forecast scheme that uses 50-day averages, as opposed to 31-day July monthly averages. The reason for using the longer averages is to reduce the impact of sub-seasonal variability, such as the Madden-Julian oscillation, which can impart atmospheric signals on shorter timescales that may not be representative of the longer-term signal, which is critical for seasonal forecasting. The new model uses very similar predictors to what is used with our model using July averages, with slight tweaks to the predictor boundaries to capture where these predictors showed higher skill in mid- to late June. Given that the boundaries and physical reasonings are similar between our 50-day-averaged and July-averaged statistical model, we do not include a separate discussion of the physical reasoning behind each of the three predictors selected for the 50-day-average model.

Our new statistical model uses ERA5 data for all predictors, including SST. The ERA5 dataset extends back to 1979, so the model was developed on data from 1979-2021.

The pool of three predictors for the 50-day-averaged early August statistical forecast scheme is given and defined in Table 3. The location of each of these predictors is shown in Figure 6. Skillful forecasts can be issued for post-31 July ACE based upon cross-validated hindcasts from 1979-2021. When these three predictors are combined, they correlate at 0.79 with observed ACE using cross-validated hindcasts from 1979-2021 (Figure 7). Predictor 1 (Caribbean trade wind strength) and Predictor 3 (tropical Africa upper-level winds) call for above-average activity, while Predictor 2 (Subtropical northeastern Atlantic SST) calls for a below-average remainder of the 2022 Atlantic hurricane season.

Table 3: Listing of 50-day-averaged statistical model values for the August 2022 hurricane forecast. A plus (+) means that positive deviations of the parameter indicate increased hurricane activity this year, and a minus (-) means that positive deviations of the parameter indicate decreased hurricane activity this year.

Predictor	Values for 2022 Forecast	Effect on 2022 Hurricane Season
1) June 12 – July 31 10 m U (5-20°N, 90-60°W) (+)	+0.5 SD	Enhance
2) June 12 – July 31 SST (25-50°N, 30-10°W) (+)	-0.9 SD	Suppress
3) June 12 – July 31 200 hPa U (15°S-15°N, 20°W-40°E) (-)	-1.2 SD	Enhance

August Seasonal Forecast Predictors – Using 50-Day Averages

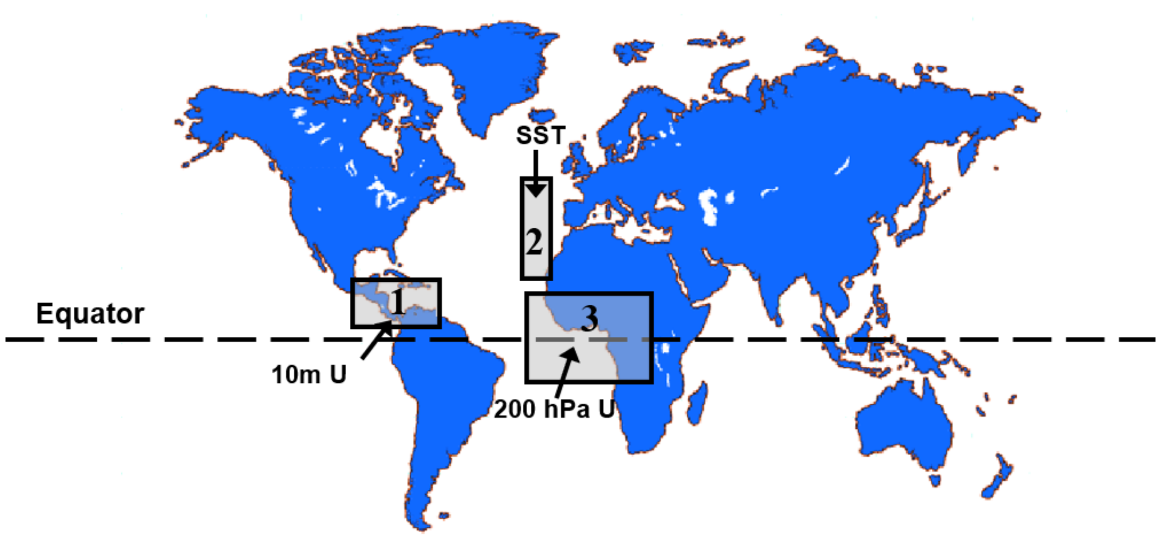

Figure 6: Location of predictors for the post-31 July forecast for the 2022 hurricane season from the 50-day-averaged (e.g., June 12 – July 31) statistical model.

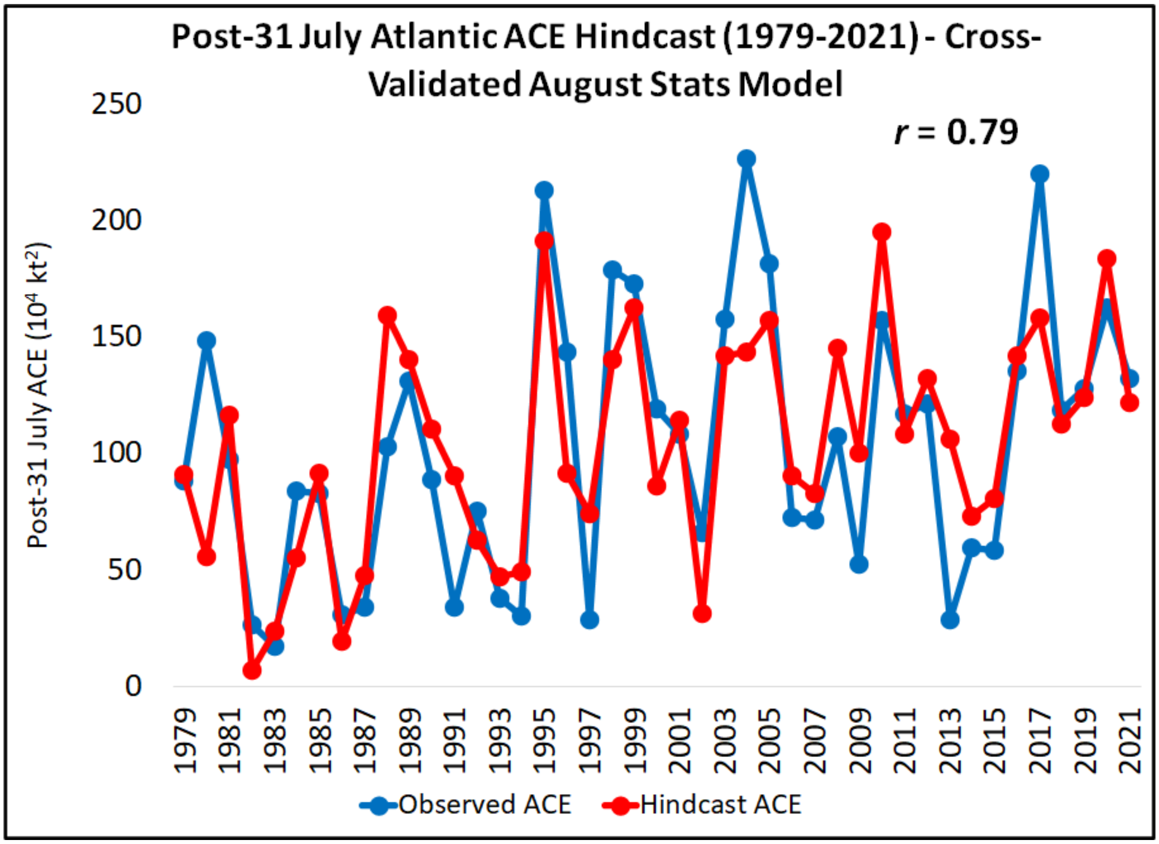

Figure 7: Observed versus hindcast values of post-31 July ACE for 1979-2021 using our statistical scheme that uses 50-day averages.

Table 4 shows our forecast for the 2022 hurricane season from the statistical model using 50-day averages and the comparison of this forecast with the 1991-2020 average. This statistical forecast is calling for a slightly above average remainder of the season.

Table 4: Post-31 July statistical forecast for 2022 from the 50-day averaged statistical model.

Predictands and Climatology (1991-2020 Post-31 July Average)	Post-31 July Statistical Forecast	Full Season Statistical Forecast (Activity Thru 3 August Added In)
Named Storms (NS) – 11.6	14.9	17.9
Named Storm Days (NSD) – 61.3	72.9	76.2
Hurricanes (H) – 6.5	7.5	7.5
Hurricane Days (HD) – 25.6	28.9	28.9
Major Hurricanes (MH) – 3.1	3.4	3.4
Major Hurricane Days (MHD) – 7.1	8.1	8.1
Accumulated Cyclone Energy (ACE) – 113	131	134
Net Tropical Cyclone Activity (NTC) – 123	143	149

2.3 August Statistical/Dynamical Forecast Schemes

We continue to use the statistical/dynamical forecast model scheme for the early August outlook that we developed for last year's outlook. This model, developed in partnership with Louis-Philippe Caron and the data team at the Barcelona Supercomputing Centre, uses output from the European Centre for Medium-Range Weather Forecasts (ECMWF), the UK Met Office and the Japan Meteorological Agency (JMA) to forecast August-September zonal wind shear and SSTs across the tropical Atlantic and Caribbean (10-20°N, 85-40°W). Lower-than-normal shear and above-normal SSTs in the tropical Atlantic and Caribbean both favor an active Atlantic hurricane season.

All three models are able to forecast August-September large-scale fields with considerable skill from an early July initialization. We then use the forecasts of the individual parameters to forecast ACE for the 2022 season. All of the other predictands (e.g., named storms, major hurricanes) are calculated based on their historical relationships with ACE. It typically takes about two weeks after the initialization date to obtain the output from the three models, so the results displayed here are from the model output from the 1 July forecast. We note that both the UK Met Office and JMA forecasts only have hindcasts for the 1993–2016 period on the Copernicus website (the website where we download our climate model forecasts), which is why the hindcast period is shorter than what we used for ECMWF.

a) ECMWF statistical/dynamical forecast scheme

Figure 8 displays the parameters used in our statistical/dynamical model scheme, while Table 5 displays ECMWF's forecasts of these parameters for 2022 from a 1 July initialization date. ECMWF is calling for slightly below-normal zonal vertical wind shear and near-average SSTs across the central tropical Atlantic and Caribbean for August-September. Figure 9 displays cross-validated hindcasts for ECMWF forecasts of ACE from 1981-2021, while Table 6 presents the forecast from ECMWF for the 2022 Atlantic hurricane season. ECMWF is calling for a slightly above-average rest of the hurricane season.

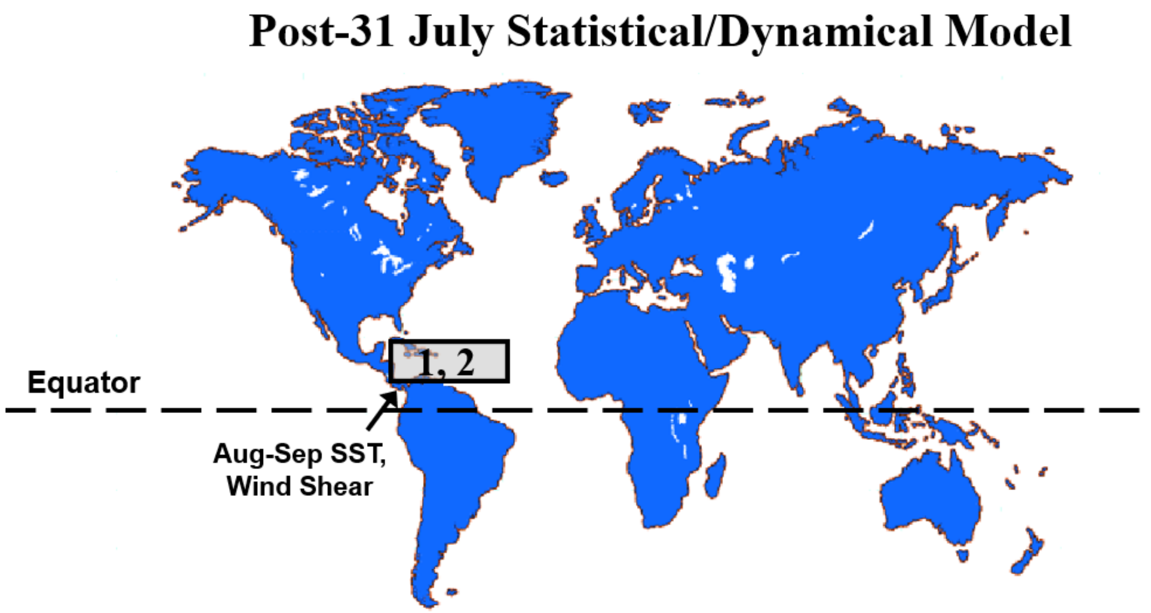

Figure 8: Location of predictors for our early August statistical/dynamical prediction for the 2022 hurricane season. This forecast uses the ECMWF model, the UK Met Office model or the JMA model to predict August-September SST and zonal wind shear in the box displayed and uses those predictors to forecast ACE.

Table 5: Listing of predictions of August-September large-scale conditions from ECMWF output, initialized on 1 July. A plus (+) means that positive deviations of the parameter are associated with increased hurricane activity, while a minus (-) means that negative deviations of the parameter are associated with increased hurricane activity.

Predictor	Values for 2022 Forecast	Effect on 2022 Hurricane Season
1) ECMWF Prediction of Aug-Sep Zonal Wind Shear (10-20°N, 85-40°W) (-)	-0.5 SD	Enhance
2) ECMWF Prediction of Aug-Sep SST (10-20°N, 85-40°W) (+)	+0.1 SD	Neutral

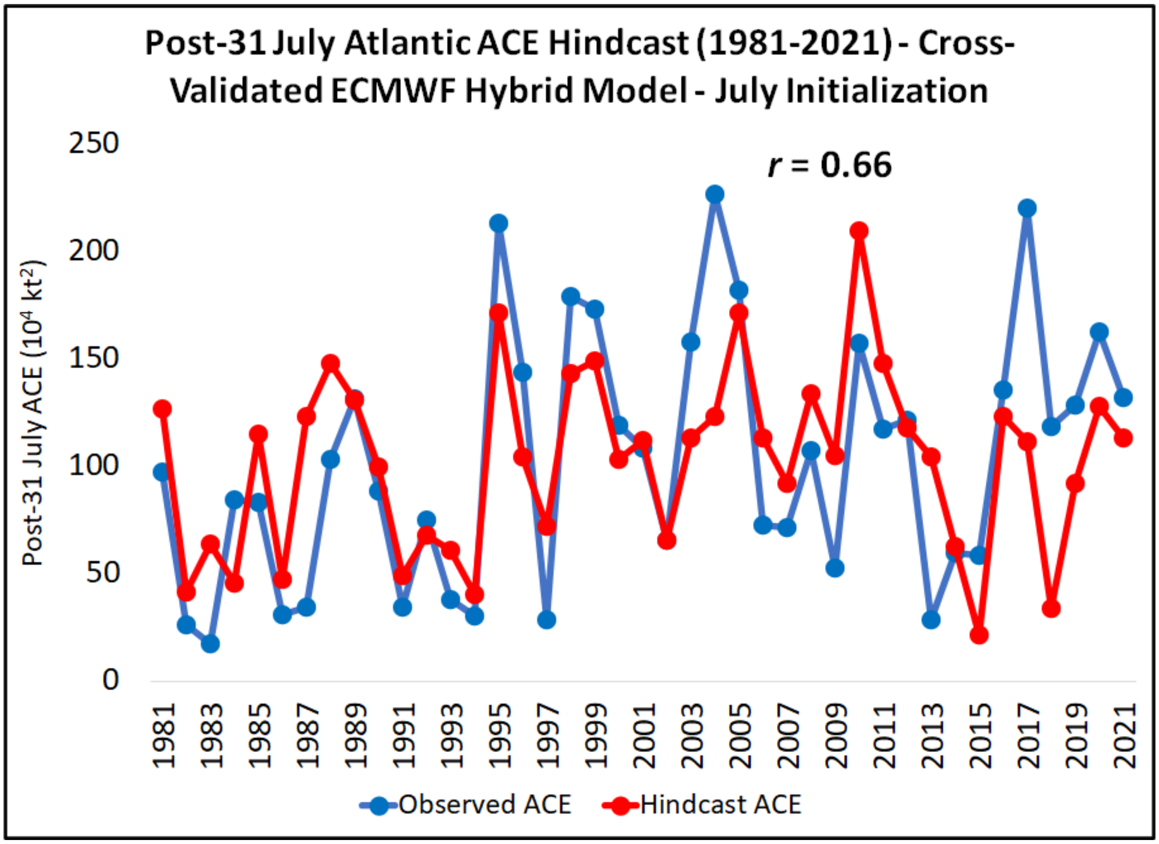

Figure 9: Observed versus cross-validated statistical/dynamical hindcast values of post-31 July Atlantic ACE for 1981-2021 from ECMWF.

Table 6: Statistical/dynamical model output from ECMWF for the 2022 Atlantic hurricane season and the final adjusted forecast.

Predictands and Climatology (1991-2020 Post-31 July Average)	Post-31 July Statistical/Dynamical Forecast	Full Season Statistical/Dynamical Forecast (Activity Thru 3 August Added In)
Named Storms (NS) – 11.6	14.9	17.9
Named Storm Days (NSD) – 61.3	72.9	76.2
Hurricanes (H) – 6.5	7.5	7.5
Hurricane Days (HD) – 25.6	28.9	28.9
Major Hurricanes (MH) – 3.1	3.4	3.4
Major Hurricane Days (MHD) – 7.1	8.1	8.1
Accumulated Cyclone Energy (ACE) – 113	131	134
Net Tropical Cyclone Activity (NTC) – 123	143	149

b) UK Met Office statistical/dynamical forecast scheme

As noted earlier, we have also developed a statistical/dynamical model forecasting the same large-scale fields and using the UK Met Office model. Figure 10 displays observed versus cross-validated hindcast ACE using the UK Met Office model.

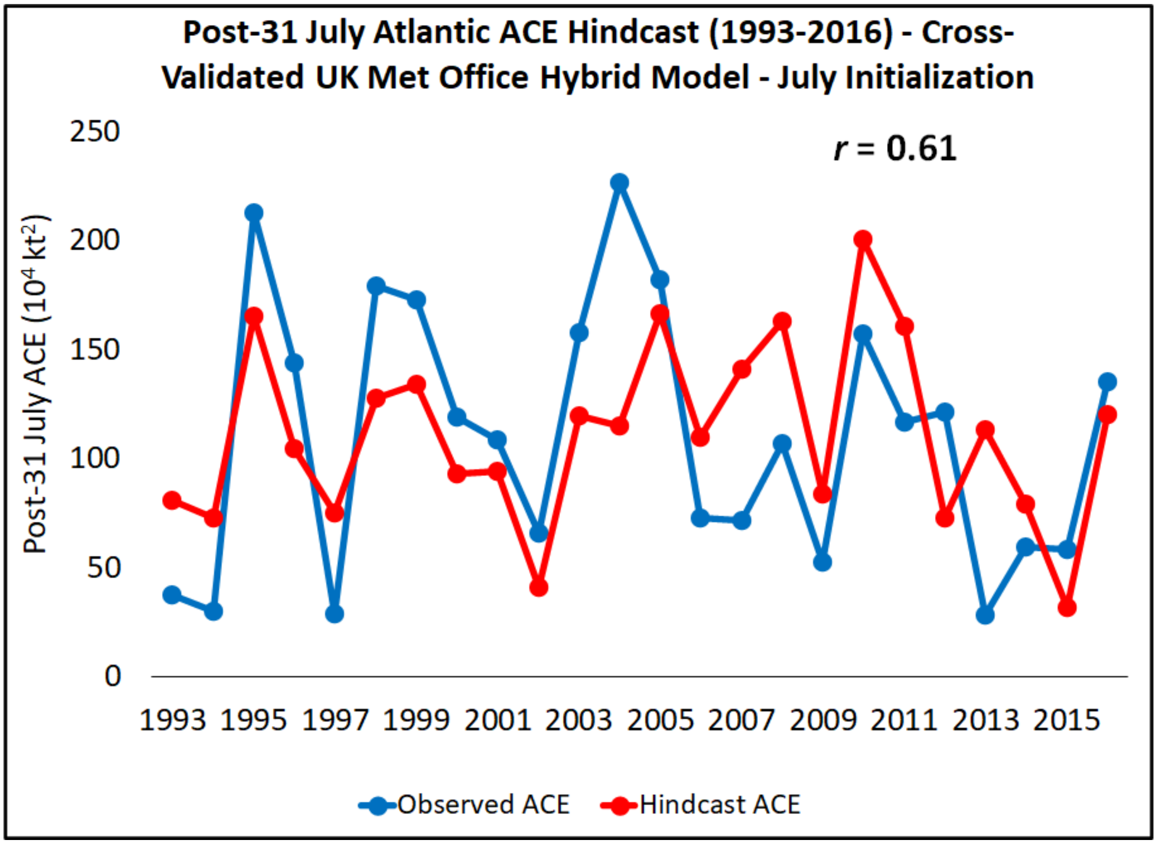

Figure 10: Observed versus cross-validated statistical/dynamical hindcast values of post-31 July Atlantic ACE for 1993-2016 from the UK Met Office.

The output from the UK Met Office model calls for an above-average remainder of the Atlantic hurricane season in 2022. UK Met Office is predicting below-average vertical wind shear and above-average tropical Atlantic SSTs. Table 7 displays the forecasts of the two individual parameters comprising the early August statistical/dynamical hybrid forecast, while Table 8 displays the final forecast from the UK Met Office model.

Table 7: Listing of predictions of August-September large-scale conditions from UK Met Office output, initialized on 1 July. A plus (+) means that positive deviations of the parameter are associated with increased hurricane activity, while a minus (-) means that negative deviations of the parameter are associated with increased hurricane activity.

Predictor	Values for 2022 Forecast	Effect on 2022 Hurricane Season
1) Met Office Prediction of Aug-Sep Zonal Wind Shear (10-20°N, 85-40°W) (-)	-1.0 SD	Enhance
2) Met Office Prediction of Aug-Sep SST (10-20°N, 85-40°W) (+)	+0.5 SD	Enhance

Table 8: Statistical/dynamical model output from the UK Met Office for the 2022 Atlantic hurricane season and the final adjusted forecast.

Predictands and Climatology (1991-2020 Post-31 July Average)	Post-31 July Statistical/Dynamical Forecast	Full Season Statistical/Dynamical Forecast (Activity Thru 3 August Added In)
Named Storms (NS) – 11.6	16.0	19.0
Named Storm Days (NSD) – 61.3	80.5	83.8
Hurricanes (H) – 6.5	8.3	8.3
Hurricane Days (HD) – 25.6	33.0	33.0
Major Hurricanes (MH) – 3.1	3.9	3.9
Major Hurricane Days (MHD) – 7.1	9.5	9.5
Accumulated Cyclone Energy (ACE) – 113	149	152
Net Tropical Cyclone Activity (NTC) – 123	161	167

c) JMA statistical/dynamical forecast scheme

As noted earlier, we have also developed a statistical/dynamical model forecasting the same large-scale fields and using the JMA model. Figure 11 displays observed versus cross-validated hindcast ACE using the JMA model.

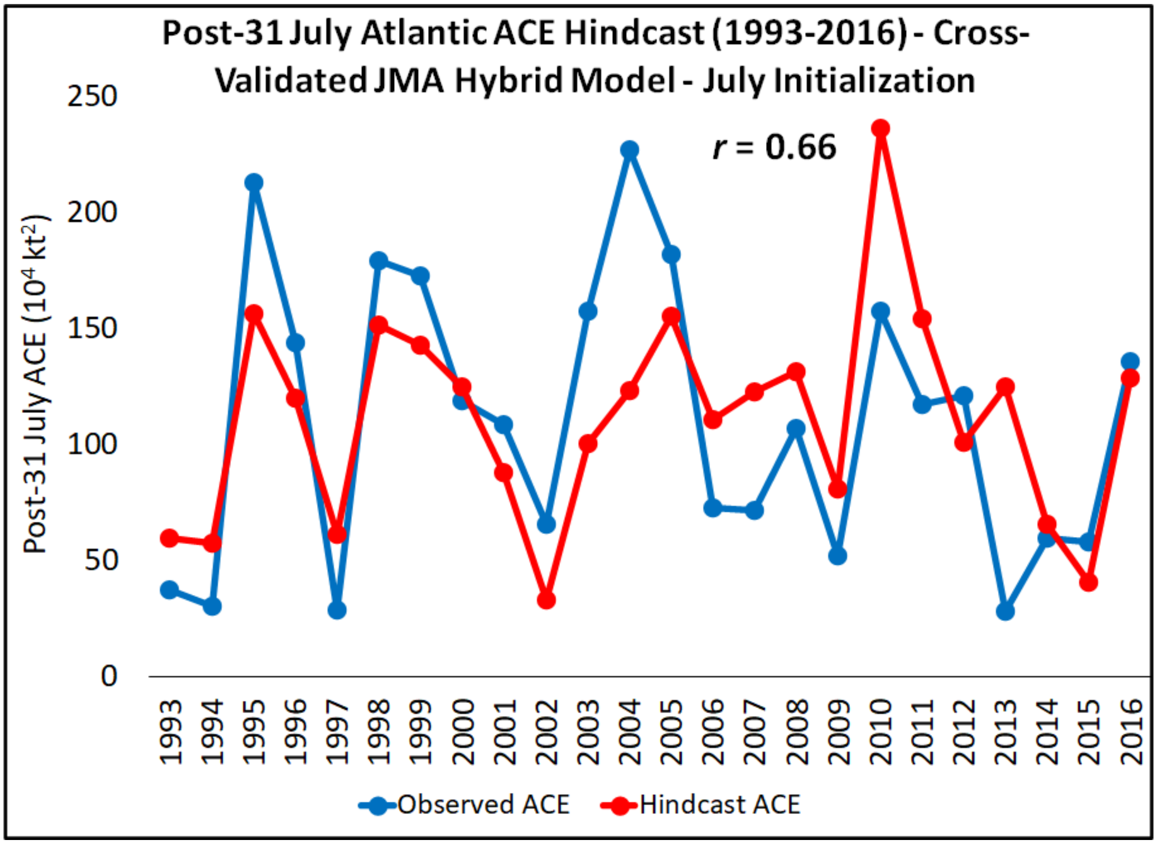

Figure 11: Observed versus cross-validated statistical/dynamical hindcast values of post-31 July Atlantic ACE for 1993-2016 from the JMA.

The output from the JMA model calls for an above-average remainder of the 2022 Atlantic hurricane season. The JMA is predicting below-average vertical wind shear and near-average tropical Atlantic SSTs. Table 9 displays the forecasts of the two individual parameters comprising the early August statistical/dynamical hybrid forecast, while Table 10 displays the final forecast from the JMA model.

Table 9: Listing of predictions of August-September large-scale conditions from JMA output, initialized on 1 July. A plus (+) means that positive deviations of the parameter are associated with increased hurricane activity, while a minus (-) means that negative deviations of the parameter are associated with increased hurricane activity.

Predictor	Values for 2022 Forecast	Effect on 2022 Hurricane Season
1) JMA Prediction of Aug-Sep Zonal Wind Shear (10-20°N, 85-40°W) (-)	-1.1 SD	Enhance
2) JMA Prediction of Aug-Sep SST (10-20°N, 85-40°W) (+)	+0.2 SD	Neutral

Table 10: Statistical/dynamical model output from the JMA for the 2022 Atlantic hurricane season and the final adjusted forecast.

Predictands and Climatology (1991-2020 Post-31 July Average)	Post-31 July Statistical/Dynamical Forecast	Full Season Statistical/Dynamical Forecast (Activity Thru 3 August Added In)
Named Storms (NS) – 11.6	16.1	19.1
Named Storm Days (NSD) – 61.3	80.9	84.2
Hurricanes (H) – 6.5	8.4	8.4
Hurricane Days (HD) – 25.6	33.3	33.3
Major Hurricanes (MH) – 3.1	3.9	3.9
Major Hurricane Days (MHD) – 7.1	9.6	9.6
Accumulated Cyclone Energy (ACE) – 113	150	153
Net Tropical Cyclone Activity (NTC) – 123	162	168

2.4 August Analog Forecast Scheme

Certain years in the historical record have global oceanic and atmospheric trends which are similar to 2022. These years also provide useful clues as to likely levels of activity that the forthcoming 2022 hurricane season may bring. For this early August forecast, we determine which of the prior years in our database have distinct trends in key environmental conditions which are similar to current July 2022 conditions and, more importantly, projected August-October 2022 conditions. Table 11 lists our analog selections.

We searched for years that were generally characterized by La Niña conditions during August-October. These seasons also had slightly below-average to slightly above-average SSTs in the tropical Atlantic, with the average of all four years being slightly below average (Figure 12). We anticipate that the 2022 hurricane season will have activity near the average of our four analog years.

Table 11: Analog years for 2022 with the associated hurricane activity listed for each year.

Year	NS	NSD	H	HD	MH	MHD	ACE	NTC
1999	12	78.50	8	41.00	5	14.25	177	182
2000	15	71.50	8	32.75	3	5.00	119	134
2011	19	89.75	7	26.00	4	4.50	126	145
2021	21	79.75	7	27.75	4	12.75	146	174
Average	16.8	79.9	7.5	31.9	4.0	9.1	142	159
2022 Forecast	**18**	**85**	**8**	**30**	**4**	**8**	**150**	**160**

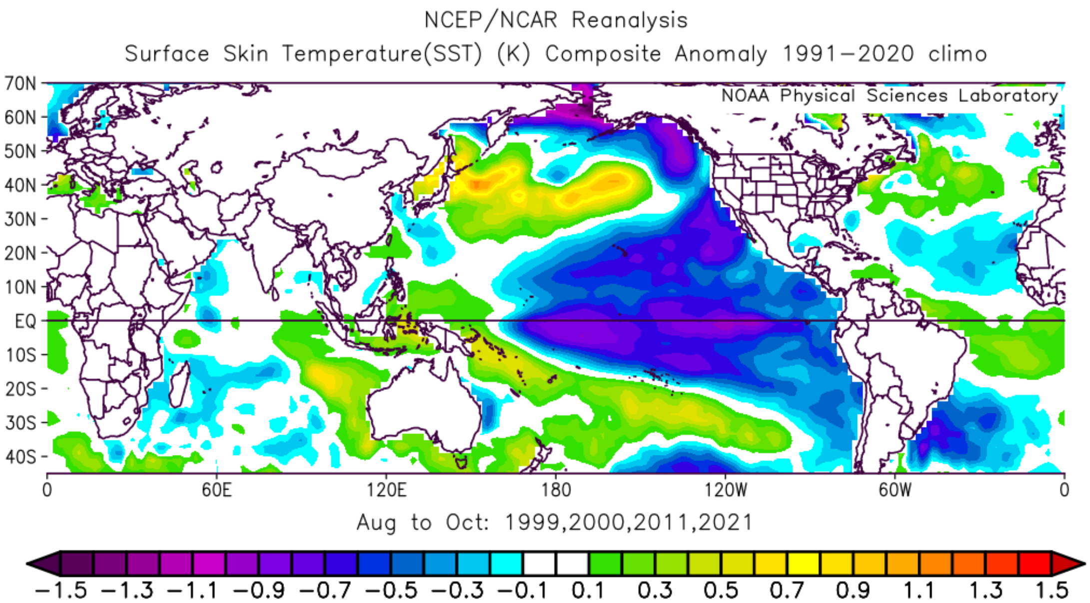

Figure 12: Average August–October SST anomalies in our four analog years.

2.4 August Forecast Summary and Final Adjusted Forecast

Table 12 shows our final adjusted early August forecast for the 2022 season which is a combination of our two statistical schemes, our three statistical/dynamical model schemes, our analog scheme and qualitative adjustments for other factors not explicitly contained in any of these schemes. Most of our model guidance is calling for a slightly above-average remainder of the Atlantic hurricane season. Our forecast is slightly higher than the average of the six-forecast average in deference to our earlier statistical model guidance which called for a more active season.

Table 12: Summary of our two early August statistical forecasts, our three statistical/dynamical model forecasts, our analog forecast, the average of these schemes and our adjusted final forecast for the 2022 hurricane season. All schemes have TC activity that was observed prior to 4 August included.

Forecast Parameter (1991-2020 Average)	July Statistical Scheme	50-Day Statistical Scheme	ECMWF Scheme	UK Met Office Scheme	JMA Scheme	Analog Scheme	Average	Adjusted Final Forecast
Named Storms (14.4)	16.6	17.9	17.9	19.0	19.1	16.8	17.9	18
Named Storm Days (69.4)	67.3	76.2	76.2	83.8	84.2	79.9	77.9	85
Hurricanes (7.2)	6.6	7.5	7.5	8.3	8.4	7.5	7.6	8
Hurricane Days (27.0)	24.1	28.9	28.9	33.0	33.3	31.9	30.0	30
Major Hurricanes (3.2)	2.9	3.4	3.4	3.9	3.9	4.0	3.6	4
Major Hurricane Days (7.4)	6.3	8.1	8.1	9.5	9.6	9.1	8.5	8
ACE Index (123)	113	134	134	152	153	142	138	150
NTC Activity (135%)	128	149	149	167	168	159	153	160

3 Forecast Uncertainty

This season we continue to use probability of exceedance curves as discussed in Saunders et al. (2020) to better quantify forecast uncertainty. In that paper, we outlined an approach that uses statistical modeling and historical skill of various forecast models to arrive at a probability that particular values for hurricane numbers and ACE would be exceeded. Here we display probability of exceedance curves for hurricanes and ACE (Figures 13 and 14), using the error distributions calculated from both normalized cross-validated statistical as well as the cross-validated statistical/dynamical hindcasts from ECMWF. Hurricane numbers are fit to a Poisson distribution, while ACE is fit to a Weibull distribution. Table 13 displays one standard deviation uncertainty ranges (~68% of all forecasts within this range). This uncertainty estimate is also very similar to the 70% uncertainty range that NOAA provides with its forecasts. We use Poisson distributions for all storm parameters (e.g., named storms, hurricanes and major hurricanes) while we use a Weibull distribution for all integrated parameters (e.g., named storm days, ACE, etc.) except for major hurricane days. We use a Laplace distribution for major hurricane days.

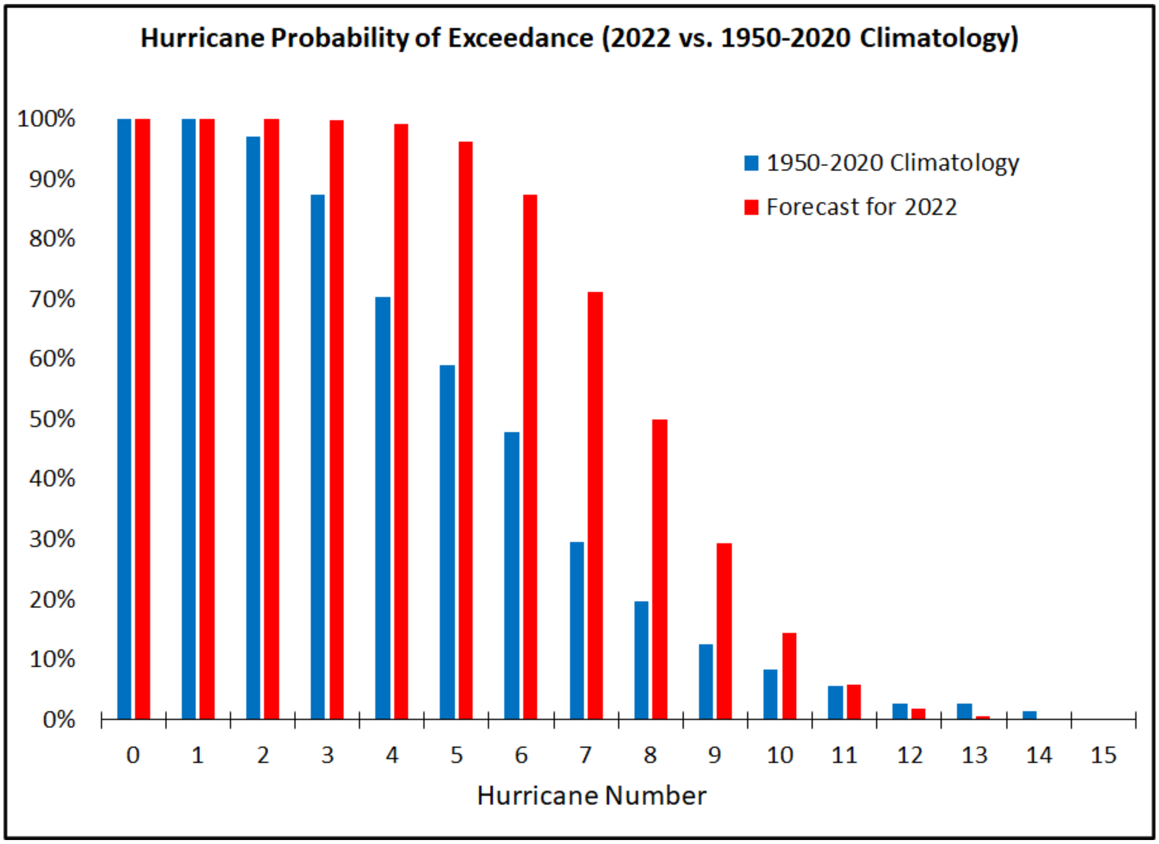

Figure 13: Probability of exceedance plot for hurricane numbers for the 2022 Atlantic hurricane season. The values on the x-axis indicate that the number of hurricanes exceeds that specific number. For example, 97% of Atlantic hurricane seasons from 1950-2020 have had more than two hurricanes.

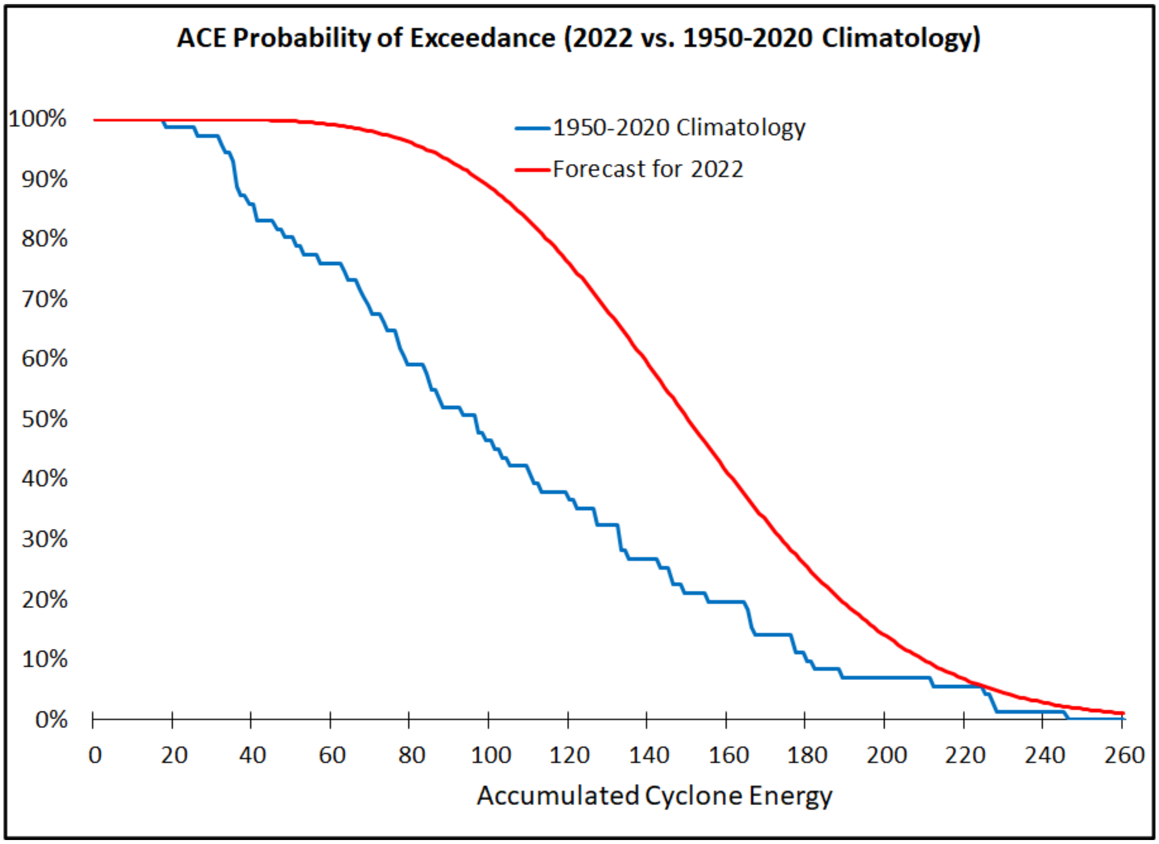

Figure 14: As in Figure 13 but for ACE.

Table 13: Forecast ranges for each parameter. Note that the forecast spread may not be symmetric around the mean value, given the historical distribution of tropical cyclone activity.

Parameter	2022 Forecast	Uncertainty Range (68% of Forecasts Likely to Fall in This Range)
Named Storms (NS)	18	15 – 21
Named Storm Days (NSD)	85	66 – 104
Hurricanes (H)	8	6 – 10
Hurricane Days (HD)	30	20 – 42
Major Hurricanes (MH)	4	3 – 5
Major Hurricane Days (MHD)	8	5 – 12
Accumulated Cyclone Energy (ACE)	150	107 – 198
Net Tropical Cyclone (NTC) Activity	160	118 – 205

4 ENSO

The tropical Pacific continues to be characterized by La Niña conditions, with below-average SSTs across most of the central and eastern tropical Pacific (Figure 15). ENSO events are partially defined by NOAA based on SST anomalies in the Nino 3.4 region, which is defined as 5°S-5°N, 170-120°W. SST anomalies in the Nino 3.4 region that are <= -0.5°C are generally classified as La Niña. SST anomalies have trended downward in the Nino 3.4 region over the past few weeks (Figure 16), due in part to anomalously strong trade winds across the central tropical Pacific for the past several weeks (Figure 17). These strong low-level easterly winds are forecast to persist by the Climate Forecast System. These trade winds have also kicked off a robust upwelling (cooling) Kelvin wave (Figure 18), which will likely lead to additional anomalous cooling in the eastern tropical Pacific over the next few weeks.

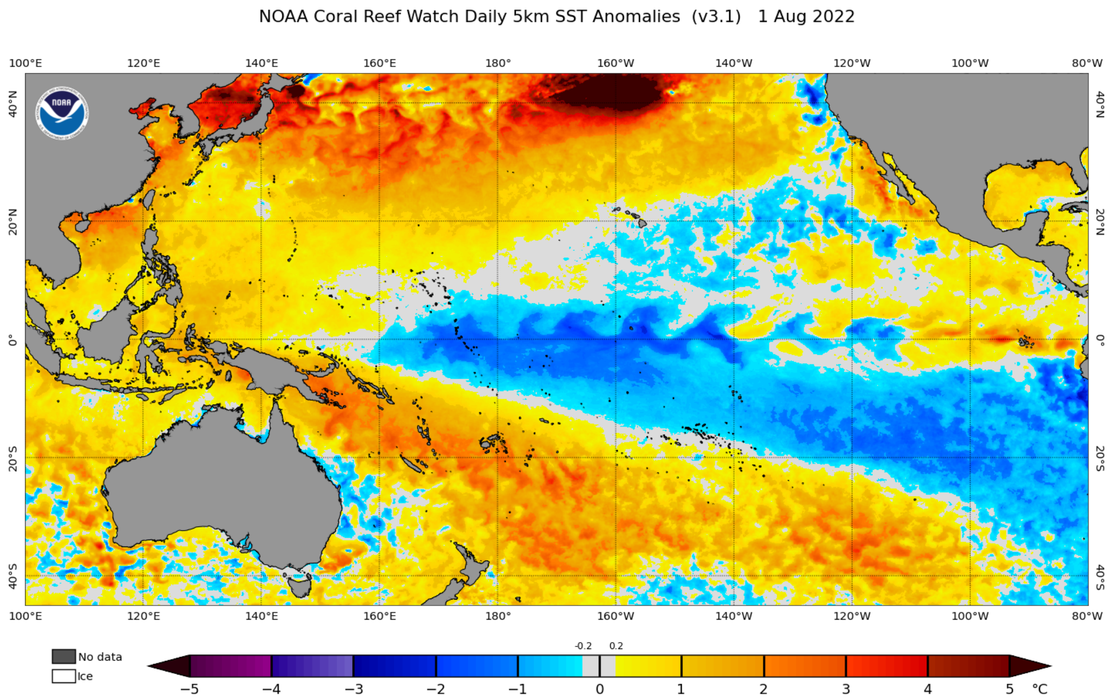

Figure 15: Current SST anomalies across the tropical and subtropical Pacific.

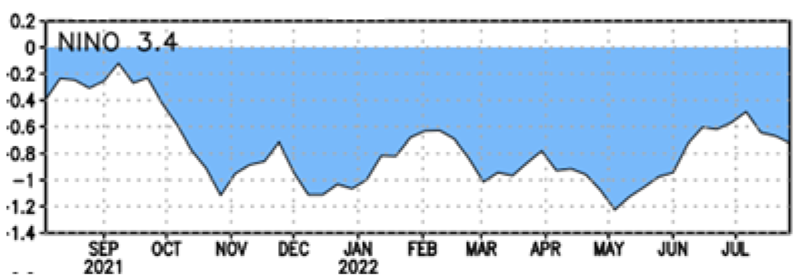

Figure 16: Nino 3.4 SST anomalies from August 2021 through July 2022. Figure courtesy of the Climate Prediction Center.

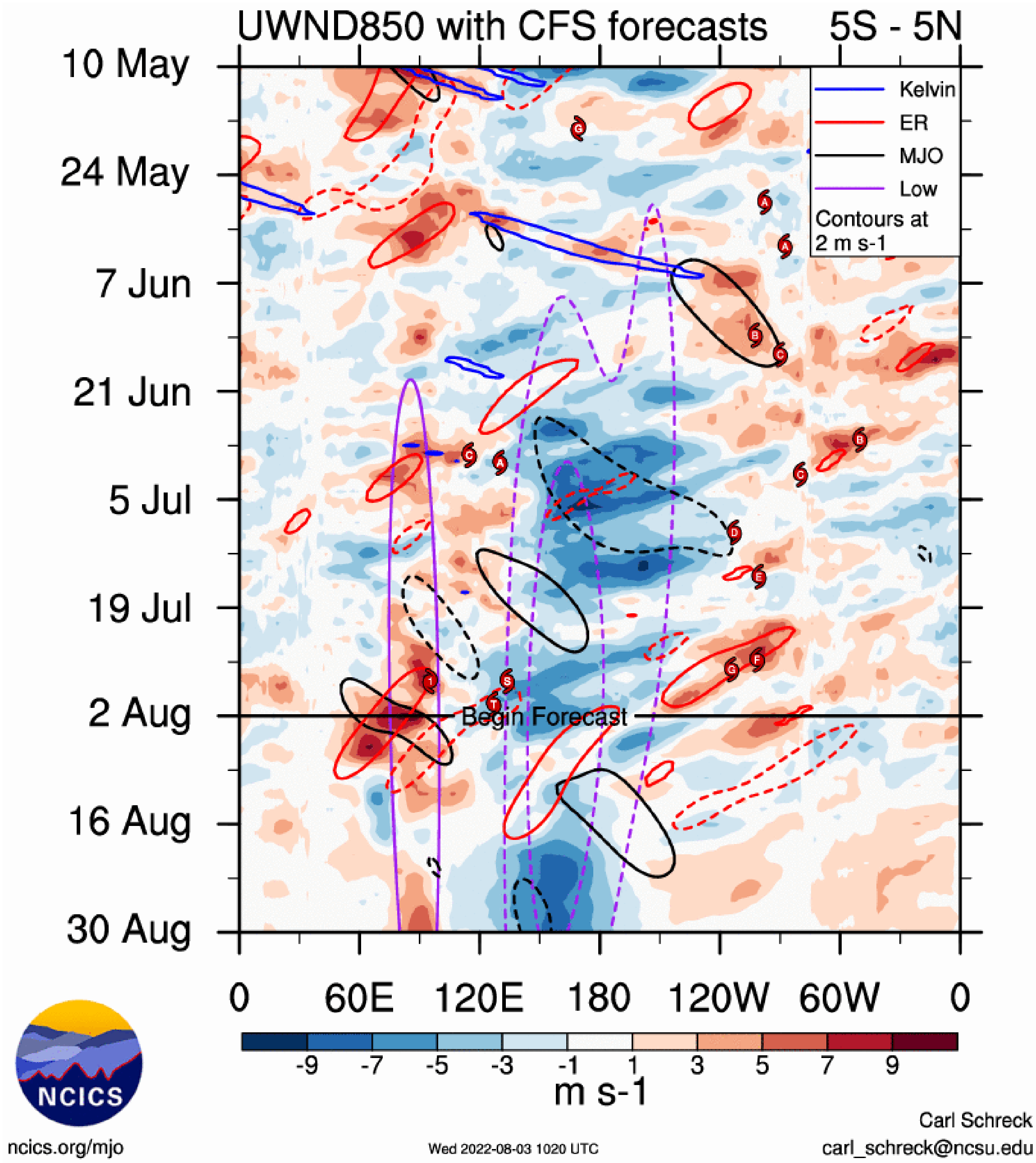

Figure 17: Observed low-level winds across the equatorial region as well as predictions for the next four weeks by the Climate Forecast System. The small TC symbols on the figure indicate TC formations, with the letter denoting the first letter of the storm that formed. Figure courtesy of Carl Schreck.

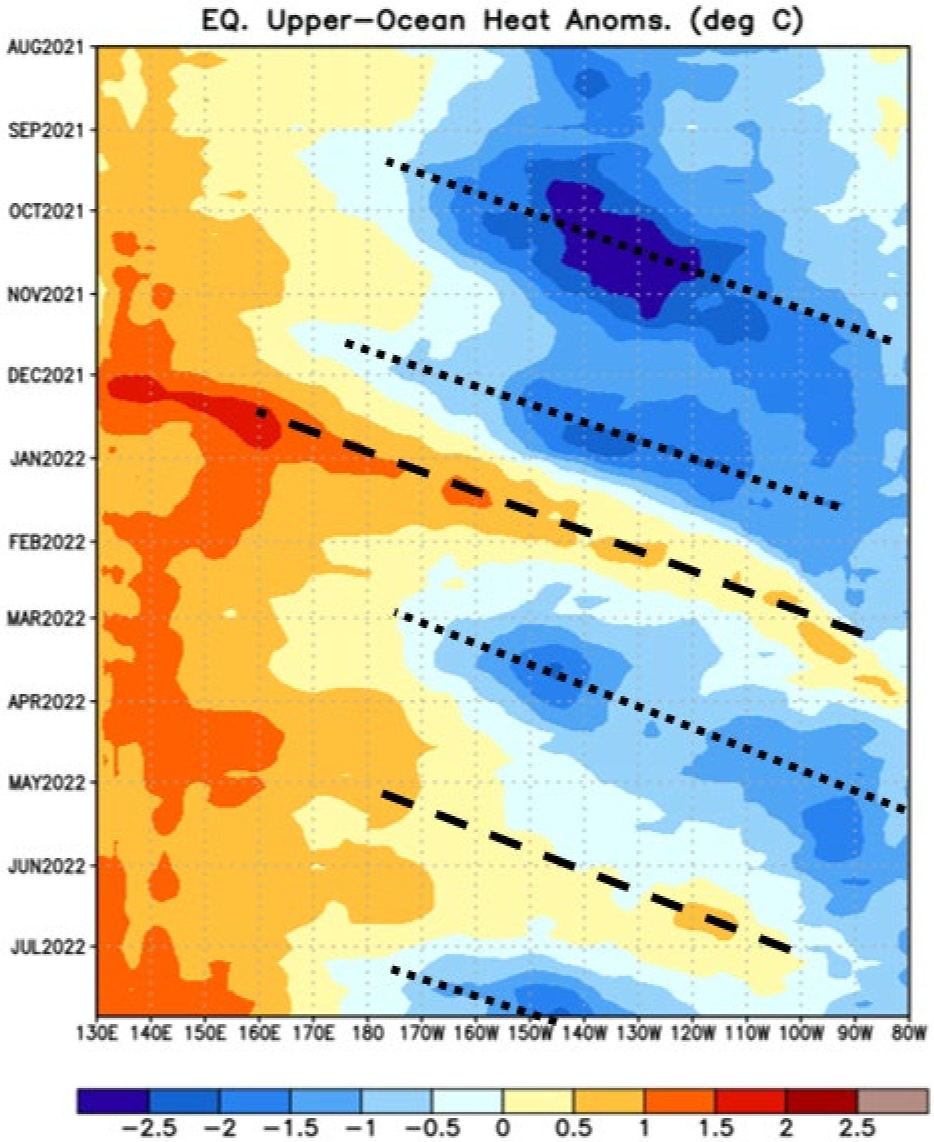

Figure 18: Upper-ocean heat content anomalies in the tropical Pacific since August 2021. Dashed lines indicate downwelling Kelvin waves, while dotted lines indicate upwelling Kelvin waves. Downwelling Kelvin waves result in upper-ocean heat content increases, while upwelling Kelvin waves result in upper-ocean heat content decreases.

Upper-ocean heat content anomalies in the eastern and central tropical Pacific reached their coldest during the middle part of October and then increased rapidly through early February (Figure 19). The heat content anomalies decreased through the middle of March, increased through early July and have rapidly decreased since that time. As noted earlier, these decreases in upper ocean heat content over the past few weeks are likely due to the anomalously strong trade winds which have prevailed across the central tropical Pacific during this time and the associated upwelling Kelvin wave which has developed in response.

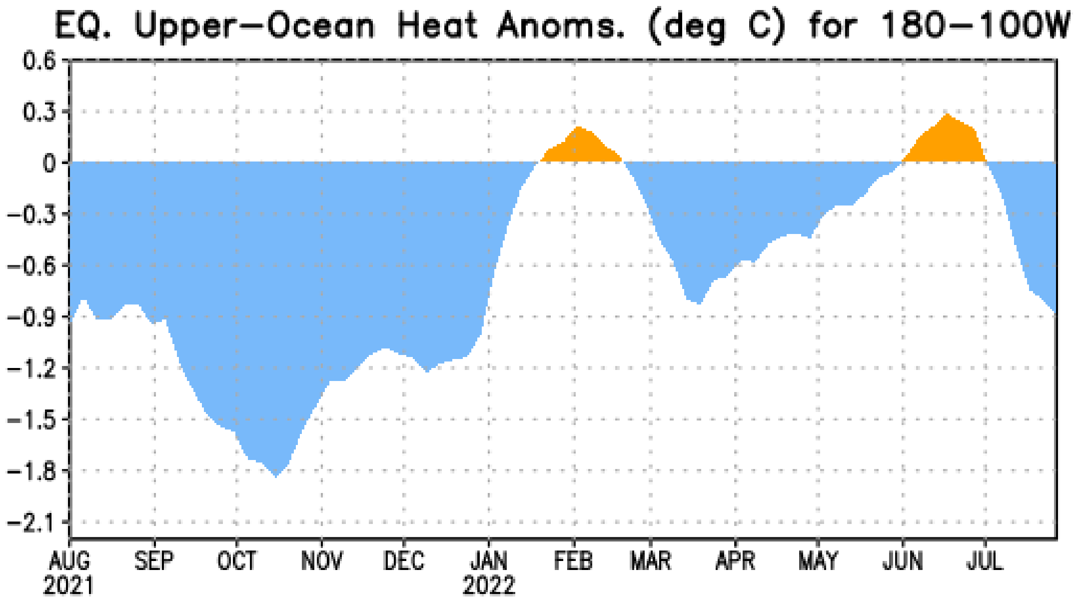

Figure 19: Central and eastern equatorial Pacific upper ocean (0-300 meters) heat content anomalies over the past year.

Table 14 displays June and July SST anomalies for several Nino regions. Anomalies have trended downward in the central tropical Pacific and upward in the eastern tropical Pacific. We do anticipate that there will be considerable anomalous cooling in the eastern tropical Pacific coming up given the upwelling Kelvin wave discussed previously.

Table 14: June and July SST anomalies for Nino 1+2, Nino 3, Nino 3.4, and Nino 4, respectively. July minus June SST anomaly differences are also provided.

Region	June SST Anomaly (°C)	July SST Anomaly (°C)	July – June SST Anomaly (°C)
Nino 1+2	-1.4	-1.1	+0.3
Nino 3	-0.6	-0.4	+0.2
Nino 3.4	-0.6	-0.7	-0.1
Nino 4	-0.7	-0.9	-0.2

There is still some uncertainty as to what the exact state of ENSO will be for the peak of the Atlantic hurricane season. The latest plume of ENSO predictions from several statistical and dynamical models shows a continued spread for August-October (Figure 20). We favor the cooler model solutions given the current upwelling Kelvin wave and the forecast anomalously strong trade winds.

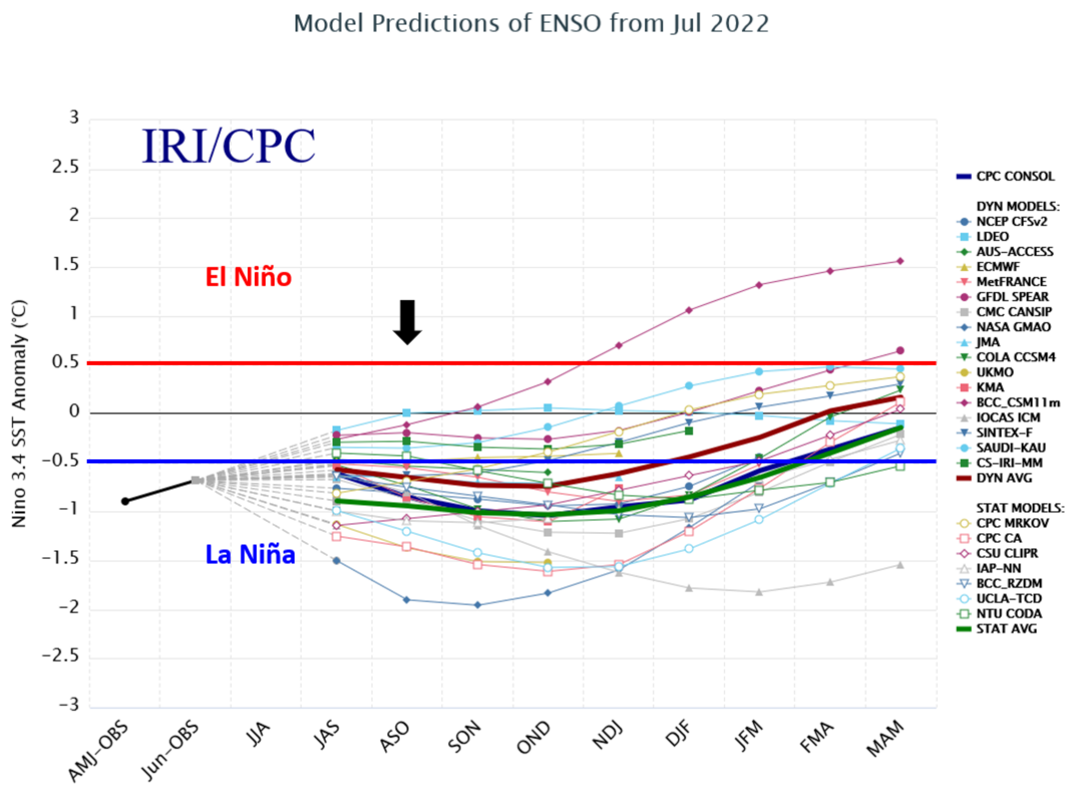

Figure 20: ENSO forecasts from various statistical and dynamical models for the Nino 3.4 SST anomaly based on late June to early July initial conditions. Figure courtesy of the International Research Institute (IRI). The black arrow denotes the peak of the Atlantic hurricane season (August-October).

The latest official forecast from NOAA indicates that the chances of El Niño are quite low for August-October. NOAA is currently predicting a 2% chance of El Niño, a 36% chance of ENSO neutral conditions and a 62% chance of La Niña for the peak of the Atlantic hurricane season (Figure 21).

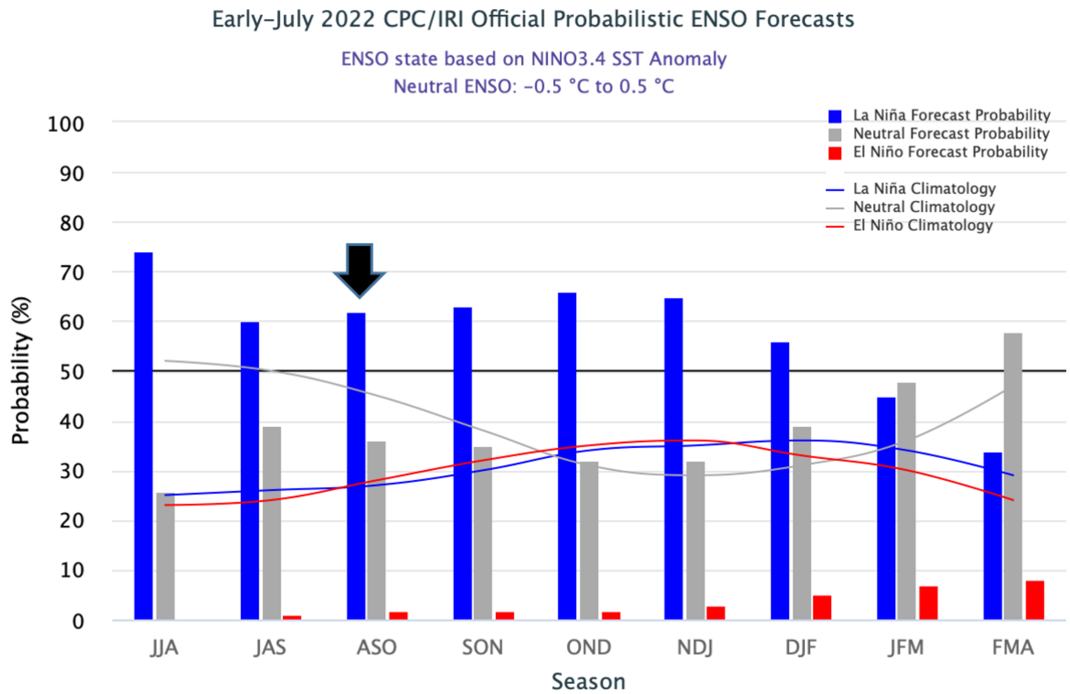

Figure 21: Official NOAA probabilistic forecast for ENSO.

5 Current Atlantic Basin Conditions

The tropical and subtropical eastern Atlantic have undergone a bit of anomalous cooling over the past few weeks, but the tropical Atlantic (10-20°N, 60-20°W) remains slightly warmer than normal (Figure 22). One of the reasons for the reduction in our forecast was due to anomalous cooling in the subtropical eastern and central Atlantic. Cooler-than-normal SSTs in this region have been associated with enhanced wavebreaking into the tropics, which could potentially somewhat counteract the anticipated reduction in wind shear associated with La Niña.

Following enhanced trade winds over the next few days, we anticipate weaker-than-normal trade winds for the next couple of weeks, likely leading to some anomalous warming in the tropical Atlantic. Current 30-day-averaged SST anomalies in the tropical Atlantic are at their 8th highest levels on record (since 1982) through July 31, trailing (in descending order from warmest SSTs): 2010, 2005, 2017, 2020, 2016, 2011 and 2008. All of those hurricane seasons had more ACE than the average 1991-2020 season, and four of those seven seasons were characterized as hyperactive by NOAA (e.g., seasonal ACE >= 160). The current SST anomaly pattern is relatively similar to the historical SST pattern in August that has correlated with active Atlantic hurricane seasons (Figure 23). The current SST pattern is tracking between SSTs typically experienced in above-average Atlantic hurricane seasons and hyperactive seasons of the past 40 years (Figure 24).

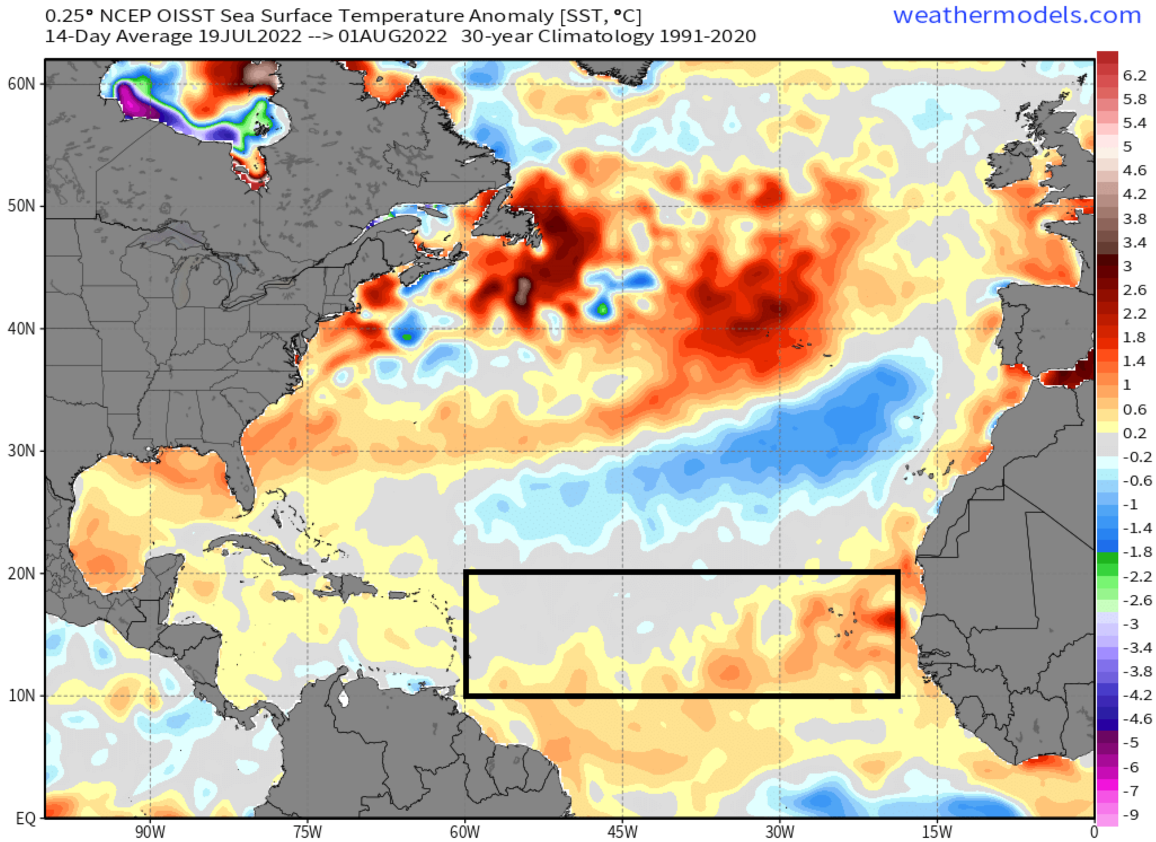

Figure 22: Late July/early August SST anomaly pattern across the North Atlantic Ocean. The black rectangle highlights the tropical Atlantic region that we assess in Figure 24.

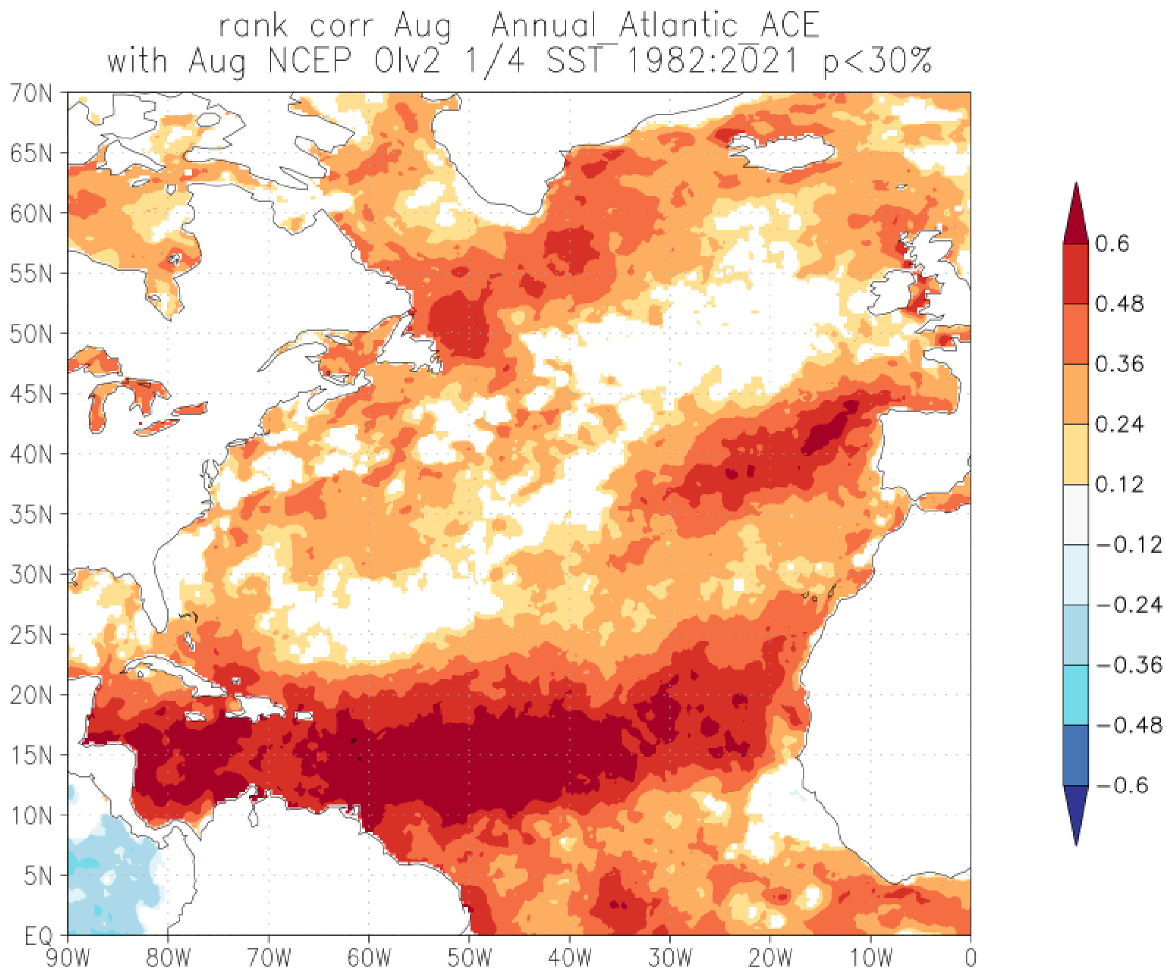

Figure 23: Correlation between August North Atlantic SSTs and seasonal Atlantic ACE from 1982-2021.

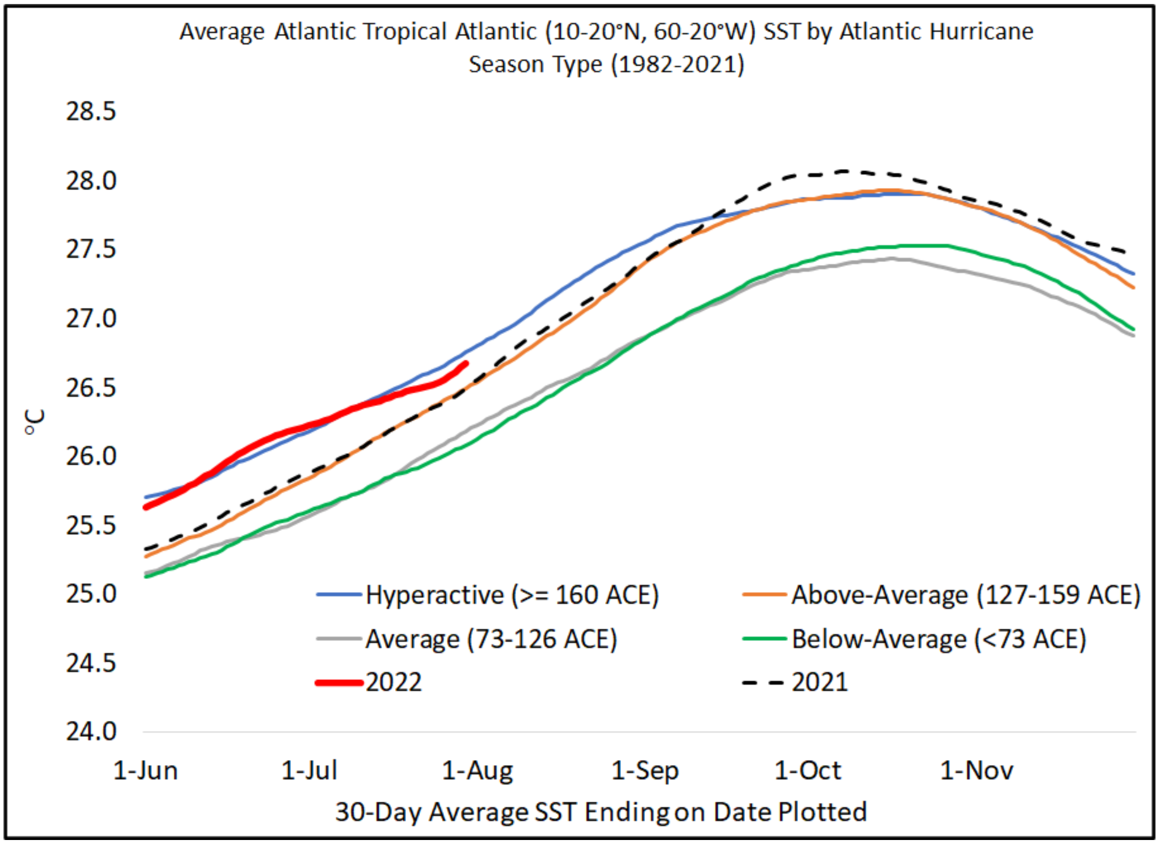

Figure 24: 30-day average SSTs for various Atlantic hurricane season types from 1982-2021 based on the NOAA definition. Also plotted are SSTs for 2022 and 2021 (for comparison). Sea surface temperature anomalies in the tropical Atlantic in 2022 are currently tracking between above-average and hyperactive Atlantic hurricane seasons.

Vertical wind shear was below-normal for most of June, was well above-average for the first two weeks in July and has since been mostly below average. Vertical wind shear averaged over the past 30 days has generally been slightly below normal across the central tropical Atlantic and Caribbean (Figure 25). Current 30-day-averaged zonal wind shear across the central tropical Atlantic and Caribbean (10-20°N, 90-40°W) is tracking between a typical above-normal and hyperactive Atlantic hurricane season, indicating ACE activity at levels similar to what we are currently forecasting (e.g., 150 ACE) (Figure 26).

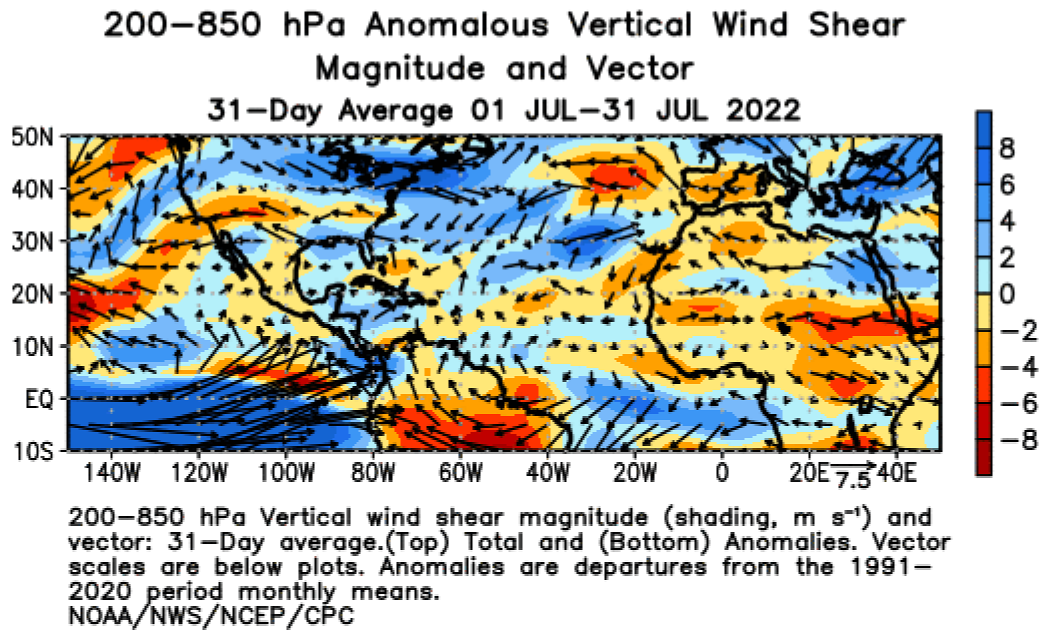

Figure 25: July-averaged vertical wind shear across the tropical and subtropical Atlantic differenced from the 1991-2020 climatology.

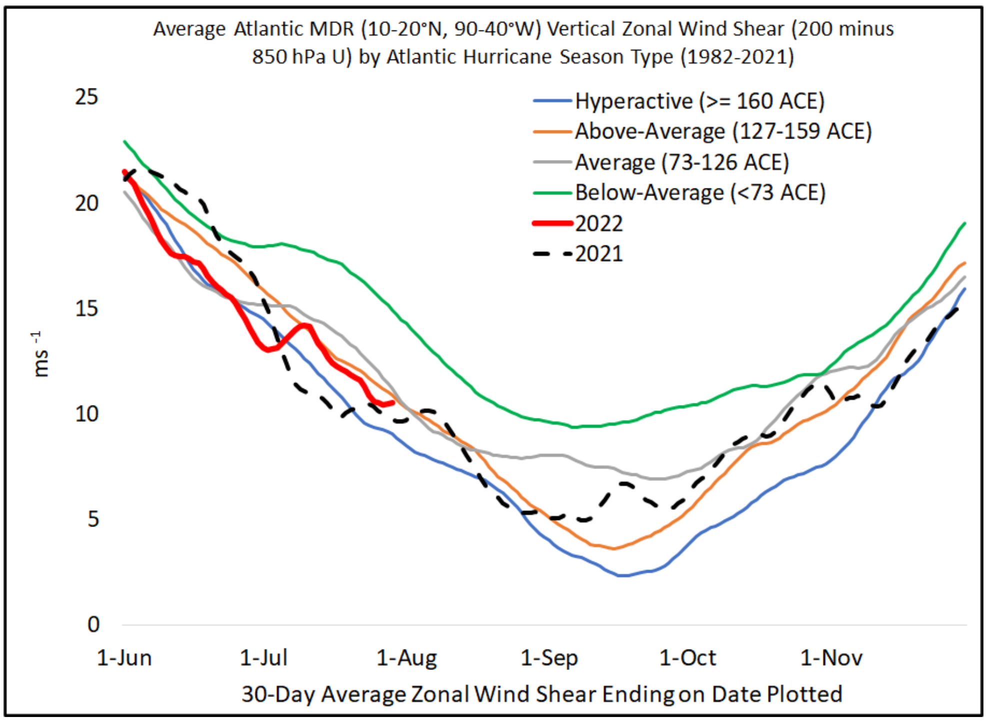

Figure 26: 30-day average zonal wind shear for various Atlantic hurricane season types from 1982-2021 based on the NOAA definition. Also plotted is zonal wind shear for 2022 and for 2021 (for comparison). Zonal wind shear in the central tropical Atlantic and Caribbean in 2022 is currently tracking between above-average and hyperactive Atlantic hurricane season types.

Sea level pressure anomalies across the tropical Atlantic (10-20°N, 60-20°W) in July 2022 were generally below normal (Figure 27). Generally, when July sea level pressure anomalies are low, more active Atlantic hurricane seasons are experienced. Lower pressure is typically associated with increased instability, increased mid-level moisture and decreased vertical wind shear.

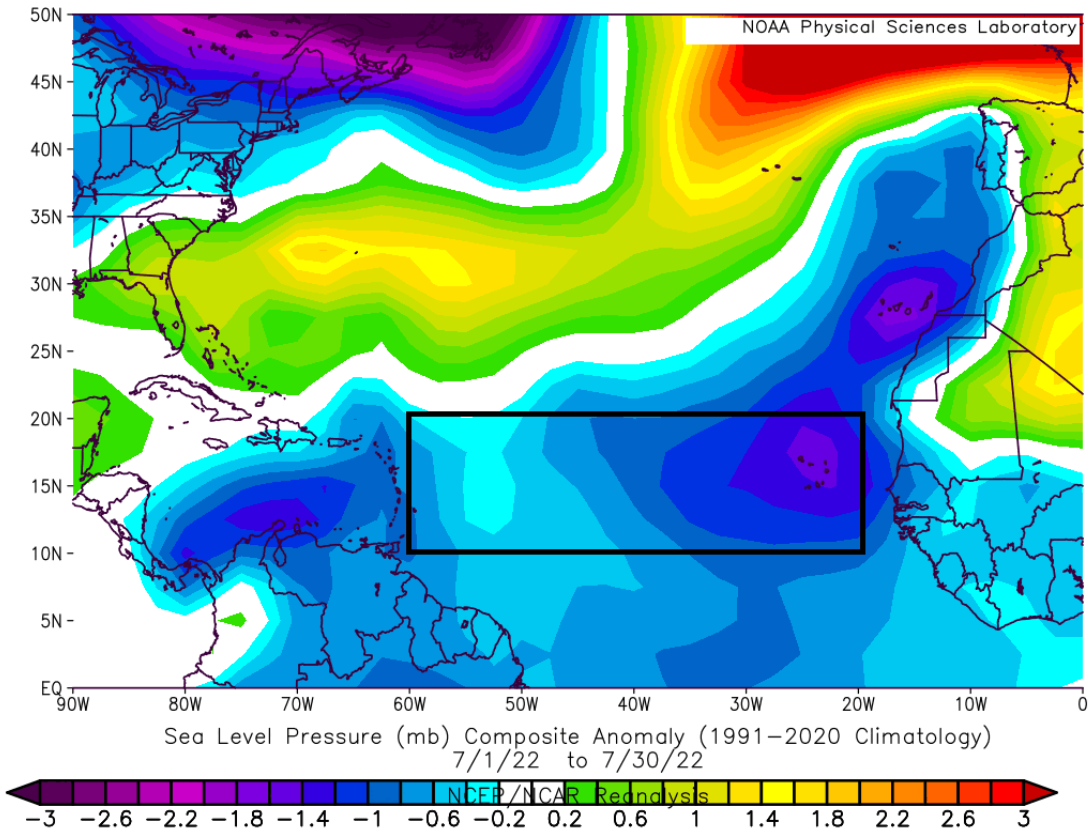

Figure 27: July 1–30-averaged sea level pressure anomalies across the tropical and subtropical North Atlantic. The black rectangle highlights the definition of the tropical Atlantic used in the above paragraph.

6 West Africa Conditions

During July, the West African monsoon has generally been relatively active, with enhanced vertical motion over West Africa (Figure 28). We anticipate short-term suppression of the monsoon in the next ten days, however, after that time, the monsoon does look like to become reinvigorated, likely leading to a heightened period of Atlantic hurricane activity (Figure 29). We will have more to say about the West African monsoon and shorter-term Atlantic hurricane chances with our first two-week Atlantic hurricane forecast, which will be released later today.

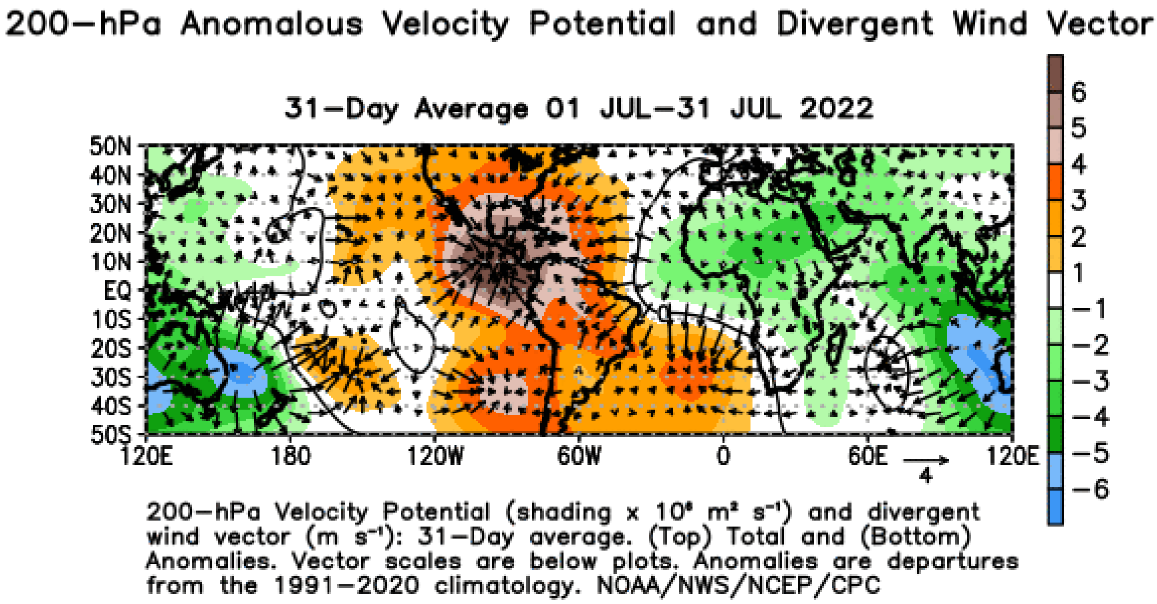

Figure 28: July-averaged 200 hPa velocity potential anomalies from 50°S – 50°N. Negative velocity potential favors upward vertical motion.

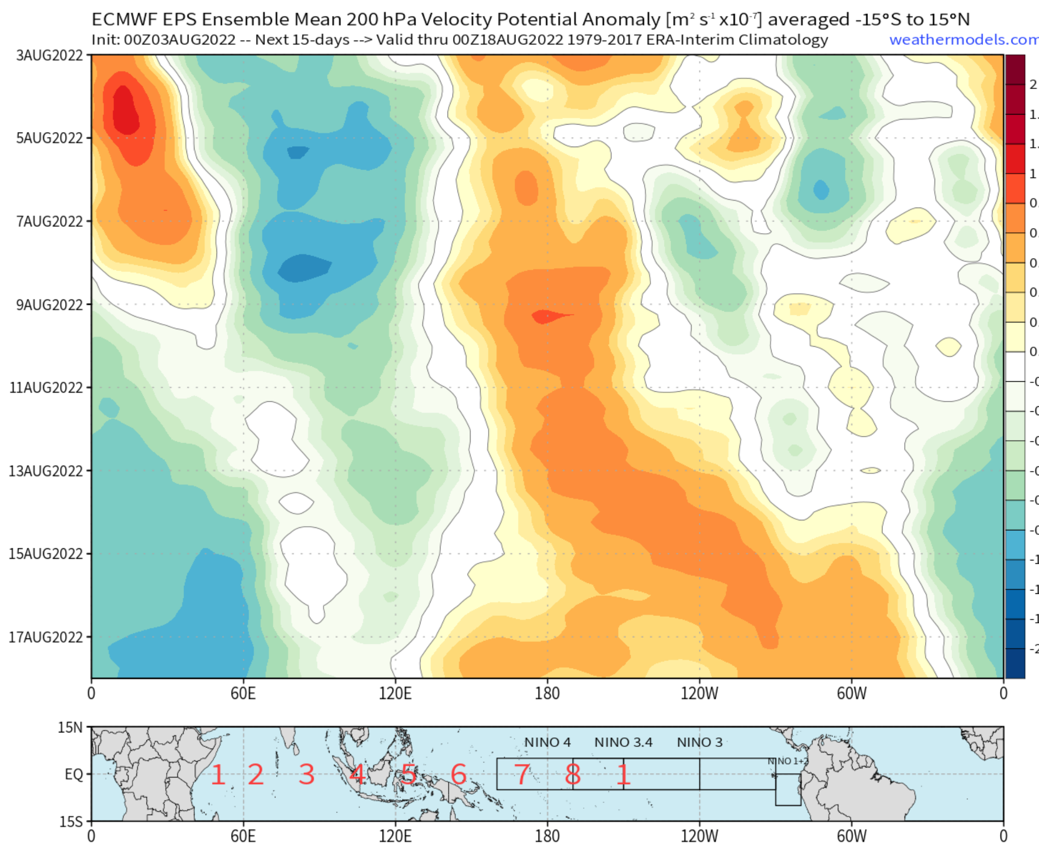

Figure 29: Forecast 200 hPa velocity potential anomalies from ECMWF averaged over the latitude band from 15°S-15°N for the next 15 days.

7 Tropical Cyclone Impact Probabilities for 2022

This year, we continue to calculate the impacts of tropical cyclones for each state and county/parish along the Gulf and East Coasts, tropical cyclone-prone provinces of Canada and states in Mexico, islands in the Caribbean and countries in Central America. We have used NOAA's Historical Hurricane Tracks website and selected all named storms, hurricanes and major hurricanes that have tracked within 50 miles of each landmass from 1880-2020. This approach allows for tropical cyclones that may have made landfall in an immediately adjacent region to be counted for all regions that were in close proximity to the landfall location of the storm. We then fit the observed frequency of storms within 50 miles of each landmass using a Poisson distribution to calculate the climatological odds of one or more events within 50 miles.

Net landfall probability is shown to be linked to the overall Atlantic basin Net Tropical Cyclone activity (NTC; see Table 15). NTC is a combined measure of the year-to-year mean of six indices of hurricane activity, each expressed as a percentage difference from the 1950-2000 climatological average. Long-term statistics show that, on average, the more active the overall Atlantic basin hurricane season is, the greater the probability of U.S. hurricane landfall.

Table 15: NTC activity in any year consists of the seasonal total of the following six parameters expressed in terms of their long-term averages. A season with 10 NS, 50 NSD, 6 H, 25 HD, 3 MH, and 5 MHD would then be the sum of the following ratios: 10/9.6 = 104, 50/49.1 = 102, 6/5.9 = 102, 25/24.5 = 102, 3/2.3 = 130, 5/5.0 = 100, divided by six, yielding an NTC of 107.

	1950-2000 Average	
1)	Named Storms (NS)	9.6
2)	Named Storm Days (NSD)	49.1
3)	Hurricanes (H)	5.9
4)	Hurricane Days (HD)	24.5
5)	Major Hurricanes (MH)	2.3
6)	Major Hurricane Days (MHD)	5.0

Table 16 displays the climatological odds of storms tracking within 50 miles of each state along the Gulf and East Coasts along with the odds for the remainder of 2022. Given that the seasonal forecast is for above-average hurricane activity, the odds of tropical cyclone impacts are also elevated. Probabilities for other Atlantic basin landmasses are available on our website.

Table 16: Probability of >=1 named storm, hurricane and major hurricane tracking within 50 miles of each Atlantic and Gulf coastal state for the remainder of 2022. Probabilities are provided for both the 1880–2020 climatological average as well as the probability for the remainder of 2022, based on the latest CSU seasonal hurricane forecast.

		2022 Probability			Climatological	
	Probability >=1	**event within**	**50 miles**	**Probability >=1**	**event within**	**50 miles**
State	Named Storm	Hurricane	Major Hurricane	Named Storm	Hurricane	Major Hurricane
Alabama	74%	39%	12%	58%	28%	8%
Connecticut	32%	11%	2%	22%	8%	1%
Delaware	33%	9%	1%	23%	6%	1%
Florida	95%	72%	41%	86%	56%	29%
Georgia	78%	43%	9%	63%	30%	6%
Louisiana	81%	52%	21%	66%	38%	14%
Maine	31%	10%	2%	21%	7%	1%
Maryland	43%	16%	1%	31%	11%	1%
Massachusetts	46%	21%	4%	33%	14%	3%
Mississippi	69%	40%	11%	53%	28%	8%
New Hampshire	26%	8%	2%	18%	6%	1%
New Jersey	33%	10%	1%	23%	7%	1%
New York	37%	14%	3%	26%	9%	2%
North Carolina	82%	52%	11%	68%	38%	8%
Rhode Island	29%	11%	2%	20%	8%	1%
South Carolina	72%	41%	12%	57%	29%	8%
Texas	77%	50%	23%	61%	36%	16%
Virginia	61%	29%	2%	46%	20%	1%

8 Summary

An analysis of a variety of different atmosphere and ocean measurements (through July) which are known to have long-period statistical relationships with the upcoming season's Atlantic tropical cyclone activity indicate that the remainder of the 2022 Atlantic hurricane season should be above average. We anticipate La Niña conditions to persist for the remainder of the hurricane season. Tropical Atlantic sea surface temperatures are slightly warmer than normal, while vertical wind shear is slightly lower than normal. We believe that the combination of a relatively warm tropical Atlantic and a cool eastern and central tropical Pacific favor an above-average remainder of the Atlantic hurricane season. Our forecast numbers were lowered from earlier outlooks due to anomalous cooling of the subtropical eastern and central Atlantic and lower output from our statistical and statistical/dynamical model guidance.

9 Forthcoming Updated Forecasts of 2022 Hurricane Activity

We will be issuing two-week forecasts for Atlantic TC activity during the climatological peak of the season from August-October, beginning today, Thursday, August 4 and continuing every other Thursday (e.g., August 18, September 1, etc.). A verification and discussion of all 2022 forecasts will be issued in late November 2022. All of these forecasts will be available online.