FORECAST OF ATLANTIC SEASONAL HURRICANE ACTIVITY AND LANDFALL STRIKE PROBABILITY FOR 2017

We have maintained our forecast for above-average Atlantic hurricane activity. ENSO-neutral conditions appear likely to persist, and most of the tropical and subtropical Atlantic is anomalously warm and is likely to remain so. The probability for major hurricanes making landfall along the United States coastline and in the Caribbean is above-normal due to the forecast for an above-average season. 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 2017)

By Philip J. Klotzbach[1] and Michael M. Bell[2]

In Memory of William M. Gray[3]

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

Jennifer Dimas, Colorado State University media representative, is coordinating media inquiries into this forecast. She can be reached at 970-491-1543 or Jennifer.Dimas@colostate.edu.

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ATLANTIC BASIN SEASONAL HURRICANE FORECAST FOR 2017

Forecast Parameter and 1981-2010 Median (in parentheses)	Issue Date 6 April 2017	Issue Date 1 June 2017	Issue Date 5 July 2017	Observed Activity Thru July 2017	Forecast Activity After 31 July	**Total Seasonal Forecast**
Named Storms (NS) (12.0)	11	14	15	5	11	**16**
Named Storm Days (NSD) (60.1)	50	60	70	6	64	**70**
Hurricanes (H) (6.5)	4	6	8	0	8	**8**
Hurricane Days (HD) (21.3)	16	25	35	0	35	**35**
Major Hurricanes (MH) (2.0)	2	2	3	0	3	**3**
Major Hurricane Days (MHD) (3.9)	4	5	7	0	7	**7**
Accumulated Cyclone Energy (ACE) (92)	75	100	135	4	131	**135**
Net Tropical Cyclone Activity (NTC) (103%)	85	110	140	11	129	**140**

POST-31 JULY PROBABILITIES FOR AT LEAST ONE MAJOR (CATEGORY 3-4-5) HURRICANE LANDFALL ON EACH OF THE FOLLOWING UNITED STATES COASTAL AREAS:

1) Entire U.S. coastline - 62% (full-season average for last century is 52%)

2) U.S. East Coast Including Peninsula Florida - 38% (full-season average for last century is 31%)

3) Gulf Coast from the Florida Panhandle westward to Brownsville - 38% (full-season average for last century is 30%)

POST-31 JULY PROBABILITIES FOR AT LEAST ONE MAJOR (CATEGORY 3-4-5) HURRICANE TRACKING INTO THE CARIBBEAN (10-20°N, 60-88°W)

1) 51% (full-season average for last century is 42%)

POST-31 JULY HURRICANE IMPACT PROBABILITIES FOR 2017 (NUMBERS IN PARENTHESES ARE LONG-PERIOD FULL SEASON AVERAGES)

State	Hurricane	Major Hurricane
Texas	41% (33%)	15% (12%)
Louisiana	38% (30%)	15% (12%)
Mississippi	14% (11%)	6% (4%)
Alabama	20% (16%)	3% (3%)
Florida	61% (51%)	27% (21%)
Georgia	14% (11%)	2% (1%)
South Carolina	22% (17%)	5% (4%)
North Carolina	35% (28%)	10% (8%)
Virginia	8% (6%)	1% (1%)
Maryland	2% (1%)	<1% (<1%)
Delaware	2% (1%)	<1% (<1%)
New Jersey	2% (1%)	<1% (<1%)
New York	10% (8%)	4% (3%)
Connecticut	9% (7%)	3% (2%)
Rhode Island	7% (6%)	3% (3%)
Massachusetts	9% (7%)	3% (2%)
New Hampshire	2% (1%)	<1% (<1%)
Maine	5% (4%)	<1% (<1%)

POST-31 JULY PROBABILITIES OF HURRICANES AND MAJOR HURRICANES TRACKING WITHIN 100 MILES OF EACH ISLAND OR LANDMASS FOR 2017 (NUMBERS IN PARENTHESES ARE LONG-PERIOD FULL SEASON AVERAGES)

Island/Landmass	Hurricane within 100 Miles	Major Hurricane within 100 Miles
The Bahamas	61% (51%)	37% (30%)
Cuba	62% (52%)	35% (28%)
Haiti	34% (27%)	17% (13%)
Jamaica	31% (25%)	14% (11%)
Mexico (East Coast)	67% (57%)	29% (23%)
Puerto Rico	36% (29%)	17% (13%)
Turks and Caicos	30% (24%)	12% (9%)
US Virgin Islands	37% (30%)	16% (12%)

Please also visit the Landfalling Probability Webpage for landfall probabilities for 11 U.S. coastal regions and 205 coastal and near-coastal counties from Brownsville, Texas to Eastport, Maine as well as probabilities for every island in the Caribbean.

ABSTRACT

Information obtained through July 2017 indicates that the 2017 Atlantic hurricane season will have activity above the median 1981-2010 season. There remains uncertainty with this forecast which we outline in the following paragraphs.

We estimate that the remainder of 2017 will have about 8 hurricanes (average is 5.5), 11 named storms (average is 10.5), 64 named storm days (average is 58), 35 hurricane days (average is 21.3), 3 major (Category 3-4-5) hurricanes (average is 2.0) and 7 major hurricane days (average is 3.9). The probability of U.S. major hurricane landfall is estimated to be above the long-period average. We expect Atlantic basin Accumulated Cyclone Energy (ACE) and Net Tropical Cyclone (NTC) activity in 2017 to be above their long-term averages for the remainder of the season. Our seasonal forecast is very close to the forecast that we issued on July 5.

There remains considerable uncertainty surrounding this outlook. Hurricane-enhancing conditions include a warmer-than-normal tropical and subtropical Atlantic, anomalously low vertical wind shear across the Main Development Region in July and neutral ENSO conditions. However, the far North Atlantic remains cooler than normal, and the Caribbean has had anomalously strong shear over the past few weeks. Typically, a cold far North Atlantic favors higher pressure in the Main Development Region, generating a more stable atmosphere and suppressing tropical cyclone activity. In general, anomalously strong shear in the Caribbean is associated with suppressed hurricane activity. However, we believe that the hurricane-enhancing conditions are likely to dominate this season, leading us to call for an active season.

This forecast is based on an extended-range early August statistical prediction scheme developed on data from 1979-2011 and issued operationally since 2012. Analog predictors were also considered.

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.

Coastal residents are reminded that it only takes one hurricane making landfall to make it an active season for them, and they need to prepare the same for every season, regardless of how much activity is predicted.

Why issue extended-range 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 forecast methodology shows strong evidence over 38 past years that significant improvement over climatology can be attained. We would never issue a seasonal hurricane forecast unless we had a statistical model developed over a long hindcast period which showed significant skill over climatology.

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 schemes which, owing to their intrinsically probabilistic nature, 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.

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 last year. In addition to pioneering seasonal Atlantic hurricane prediction, he conducted groundbreaking research in 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 Interstate Restoration, the Insurance Information Institute and Ironshore Insurance that partially support the release of these predictions. We acknowledge a grant from the G. Unger Vetlesen Foundation for additional financial support. We thank the GeoGraphics Laboratory at Bridgewater State University (MA) for their assistance in developing the United States Landfalling Hurricane Probability Webpage.

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 have also benefited from meteorological discussions with Carl Schreck, Brian McNoldy, Paul Roundy, Jason Dunion, Mike Ventrice, Peng Xian and Amato Evan 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 1950-2000 average value of this parameter is 96 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.

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.

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 tropical cyclones that become major hurricanes form, which we define as 10-20°N, 20-60°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.

Multivariate ENSO Index (MEI) – An index defining ENSO that takes into account tropical Pacific sea surface temperatures, sea level pressures, zonal and meridional winds and cloudiness.

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.

Sea Surface Temperature – SST

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 North Atlantic (TNA) index – A measure of sea surface temperatures in the area from 5.5-23.5°N, 15-57.5°W.

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 mb (approximately 40000 feet or 12 km) and 850 mb (approximately 5000 feet or 1.6 km).

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

1 Introduction

This is the 34th 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 a statistical methodology developed on Atlantic hurricane seasons from 1979-2011 and has been utilized operationally since 2012. Qualitative adjustments are added to accommodate additional processes which may not be explicitly represented by our statistical 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 is 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 is 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 these processes interact with each other. No one can completely understand the full complexity of the atmosphere-ocean system. 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.

1.1 2017 Atlantic Basin Activity through July

The 2017 Atlantic basin hurricane season has had an above-average number named storms but below-average ACE through the end of July. However, over 90% of all ACE is generated after 1 August. Real-time global TC statistics are available.

Table 1 records observed Atlantic basin TC activity through 31 July, while tracks through 31 July are displayed in Figure 1. All TC activity calculations are based upon data available in the National Hurricane Center's b-decks.

Table 1: Observed 2017 Atlantic basin tropical cyclone activity through July 31. Dates listed are those where TCs had maximum sustained winds of at least 35 knots and are given in UTC time.

Highest Category	Name	Dates	Peak Sustained Winds (kts)/lowest SLP (mb)	NSD	HD	MHD	ACE
TS	Arlene	April 20 – 21	45 kt/993 mb	0.75			0.6
TS	Bret	June 19 – 20	40 kt/1007 mb	1.25			0.7
TS	Cindy	June 20 – 22	50 kt/992 mb	2.00			1.6
TS	Don	July 17 – 18	40 kt/1009 mb	1.25			0.7
TS	Emily	July 31 -	45 kt/1002 mb	0.75			0.4
Totals	5			6			3.9

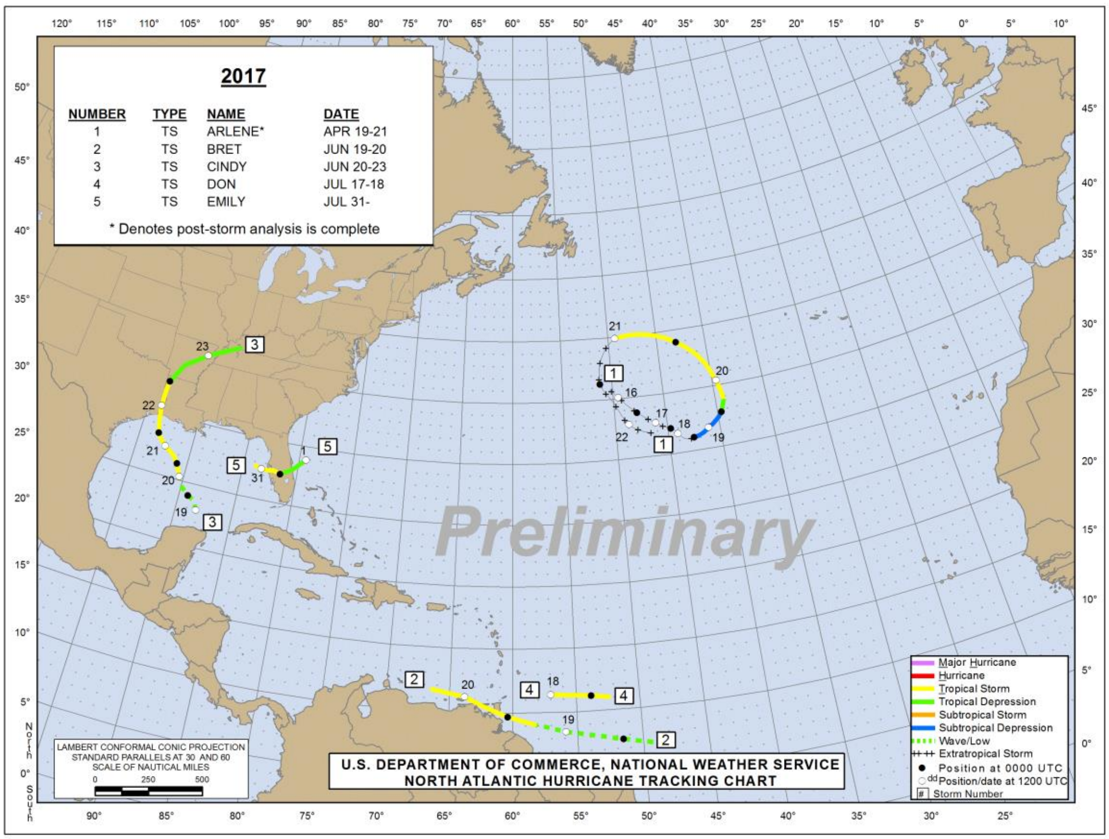

Figure 1: 2017 Atlantic basin hurricane tracks through July. Figure courtesy of the National Hurricane Center.

2 1 August Statistical Forecast Scheme

We developed a 1 August statistical seasonal forecast scheme for the prediction of Accumulated Cyclone Energy (ACE) that was developed over the period from 1979-2011 and has been issued operationally since 2012. This model uses three predictors, all of which are selected from the ERA-Interim Reanalysis dataset, which is available from 1979 to near-present. Real-time predictor estimates are done from the NCEP/NCAR Reanalysis, as ERA-Interim Reanalysis products are not available in real time. The major components of the forecast scheme are discussed in the next few paragraphs.

The pool of three predictors for the early August statistical forecast scheme is given and defined in Table 2. The location of each of these predictors is shown in Figure 2. Skillful forecasts can be issued for post-31 July ACE based upon hindcast results over the period from 1979-2011 as well as real-time forecasts in 2012, and 2014-2016. Like all of our other forecasts, the model did not anticipate the below-average 2013 Atlantic hurricane season. When these three predictors are combined, they correlate at 0.87 with observed ACE using hindcasts/forecasts over the period from 1979-2016 (Figure 3).

Table 2: Listing of 1 August 2017 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 2017 Forecast	Effect on 2017 Hurricane Season
1) July Surface U (10-17.5°N, 60-85°W) (+)	-0.4 SD	Slightly Suppress
2) July Surface Temperature (20-40°N, 15-35°W) (+)	+0.5 SD	Slightly Enhance
3) July 200 mb U (5-15°N, 0-40°E) (-)	-1.7 SD	Strongly Enhance

Post-31 July Seasonal Forecast Predictors

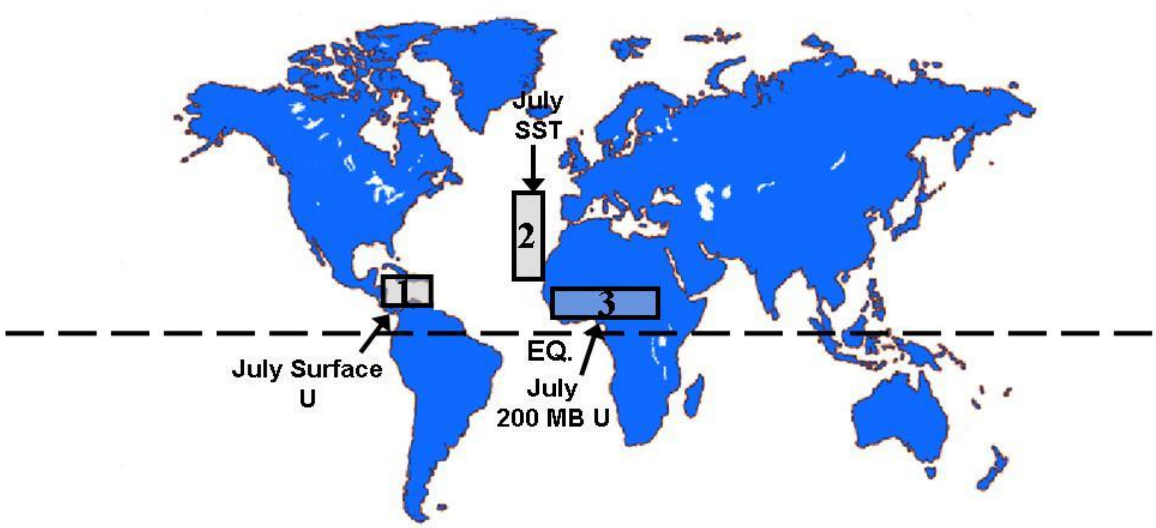

Figure 2: Location of predictors for the post-31 July forecast for the 2017 hurricane season from the statistical model.

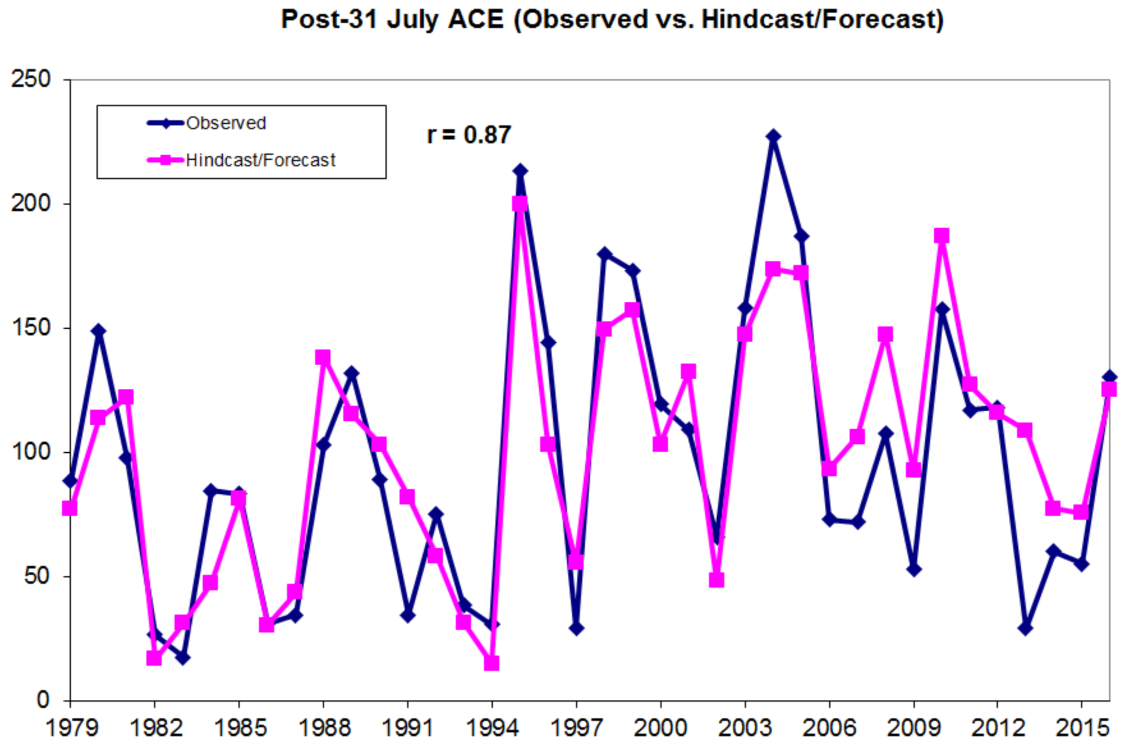

Figure 3: Observed versus hindcast values of post-31 July ACE for 1979-2016 using our current statistical scheme.

Table 3 shows our statistical forecast for the 2017 hurricane season from the new statistical model and the comparison of this forecast with the 1981-2010 median. Our statistical forecast is calling for an above-average hurricane season.

Table 3: Post-31 July statistical forecast for 2017 from the statistical model.

Predictands and Climatology (1981-2010 Post-31 July Median)	Statistical Forecast
Named Storms (NS) – 10.5	12.1
Named Storm Days (NSD) – 58.0	63.1
Hurricanes (H) – 5.5	7.1
Hurricane Days (HD) – 21.3	29.8
Major Hurricanes (MH) – 2.0	3.4
Major Hurricane Days (MHD) – 3.8	8.3
Accumulated Cyclone Energy Index (ACE) – 86	124
Net Tropical Cyclone Activity (NTC) – 95	134

2.2 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 linear correlations between values of each predictor and August-October values of SST, sea level pressure (SLP), 850 mb (~1.5 km altitude) zonal wind (U), and 200 mb (~12 km altitude) zonal wind (U), respectively.

Predictor 1. July Surface U in the Caribbean (+)

(10-17.5°N, 60-85°W)

Low-level trade wind flow has been utilized as a predictor in seasonal forecasting systems for the Atlantic basin (Lea and Saunders 2004). 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 4). 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-mb zonal shear.

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

(20°-40°N, 15-35°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 5).

Predictor 3. July 200 mb 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 6).

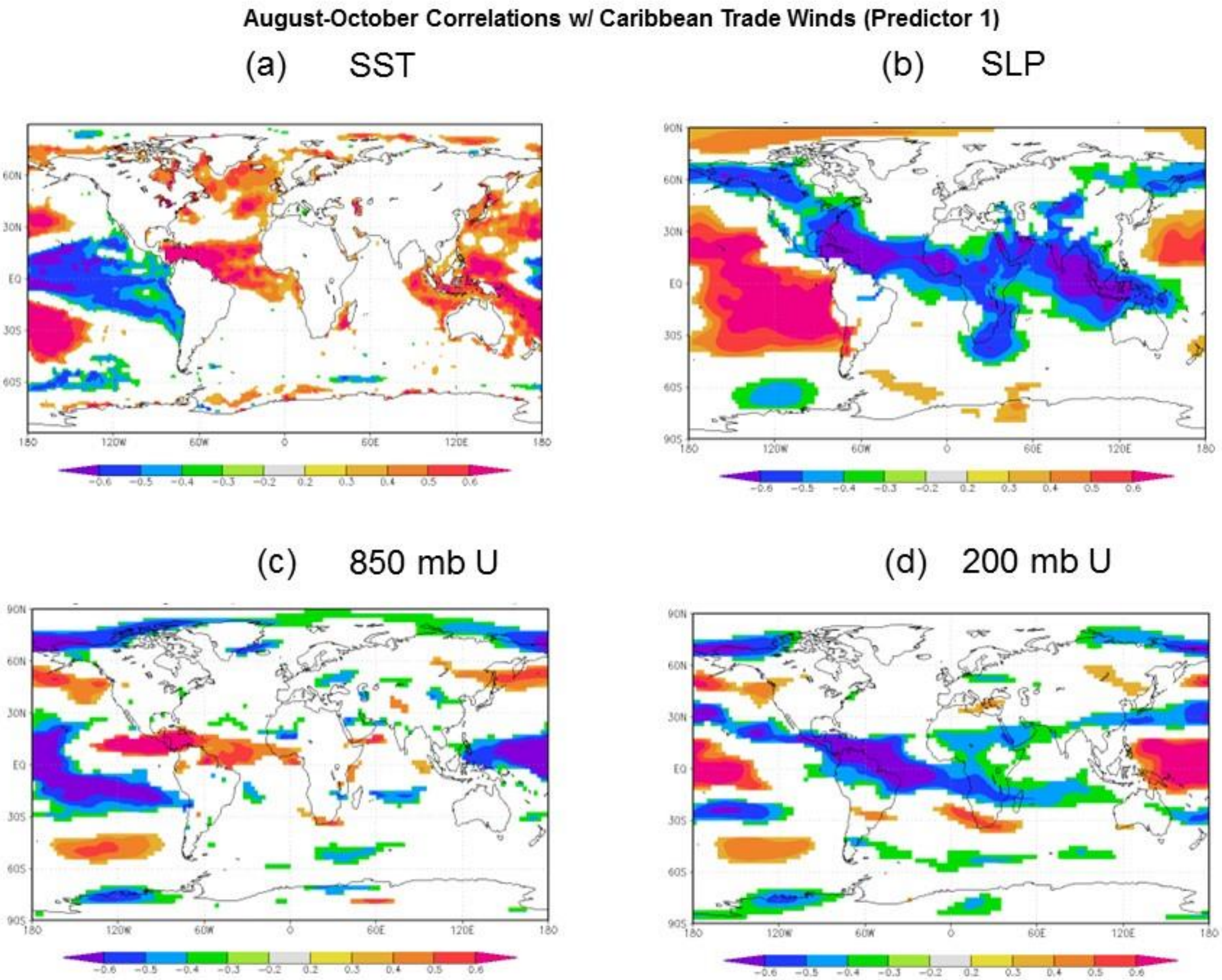

Figure 4: Linear correlations between July Surface U in the Caribbean (Predictor 1) and August-October sea surface temperature (panel a), August-October sea level pressure (panel b), August-October 850 mb zonal wind (panel c) and August-October 200 mb zonal wind (panel d) over the period from 1979-2011.

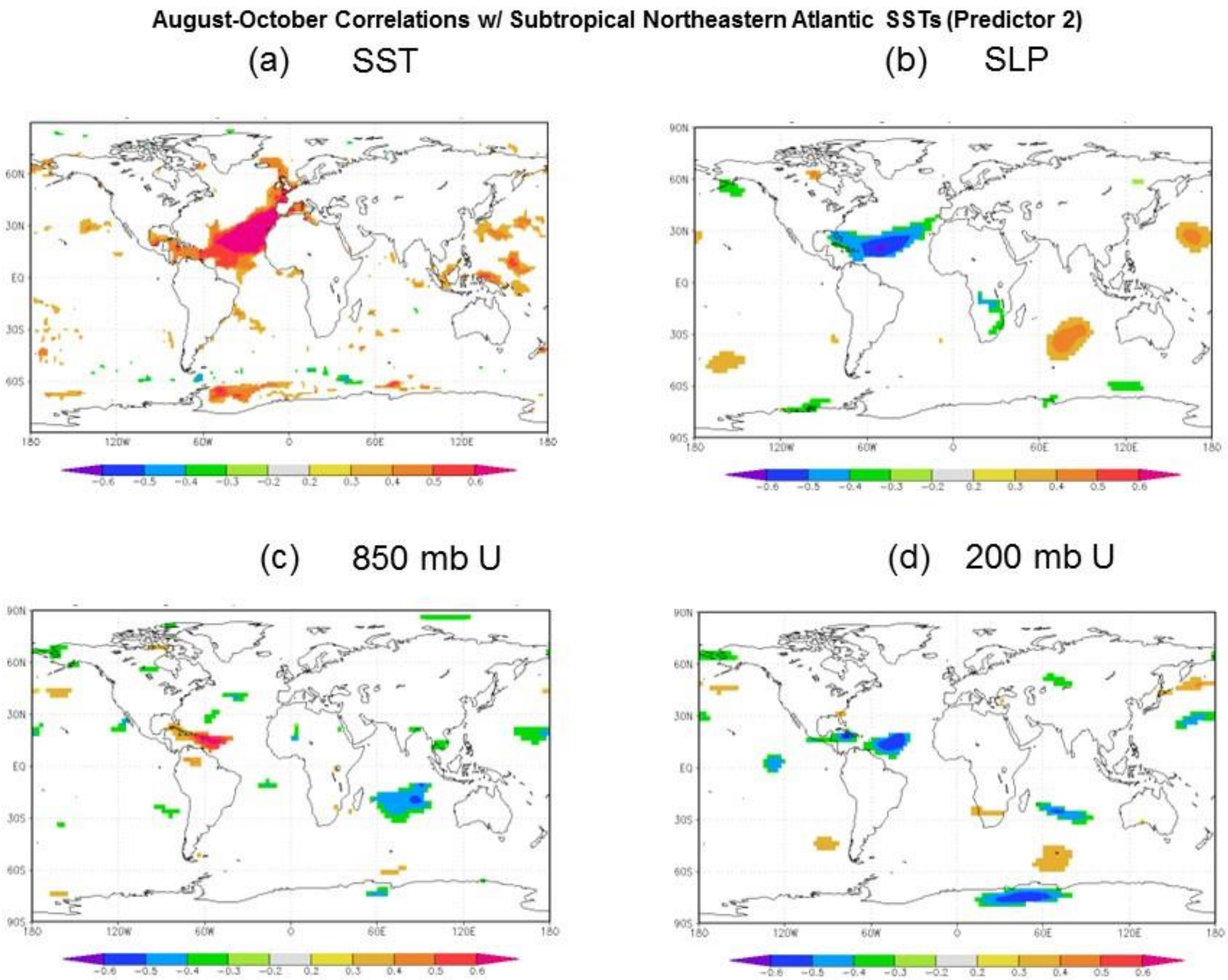

Figure 5: Linear correlations between July Surface Temperature in the Subtropical Northeastern Atlantic (Predictor 2) and August-October sea surface temperature (panel a), August-October sea level pressure (panel b), August-October 850 mb zonal wind (panel c) and August-October 200 mb zonal wind (panel d) over the period from 1979-2011.

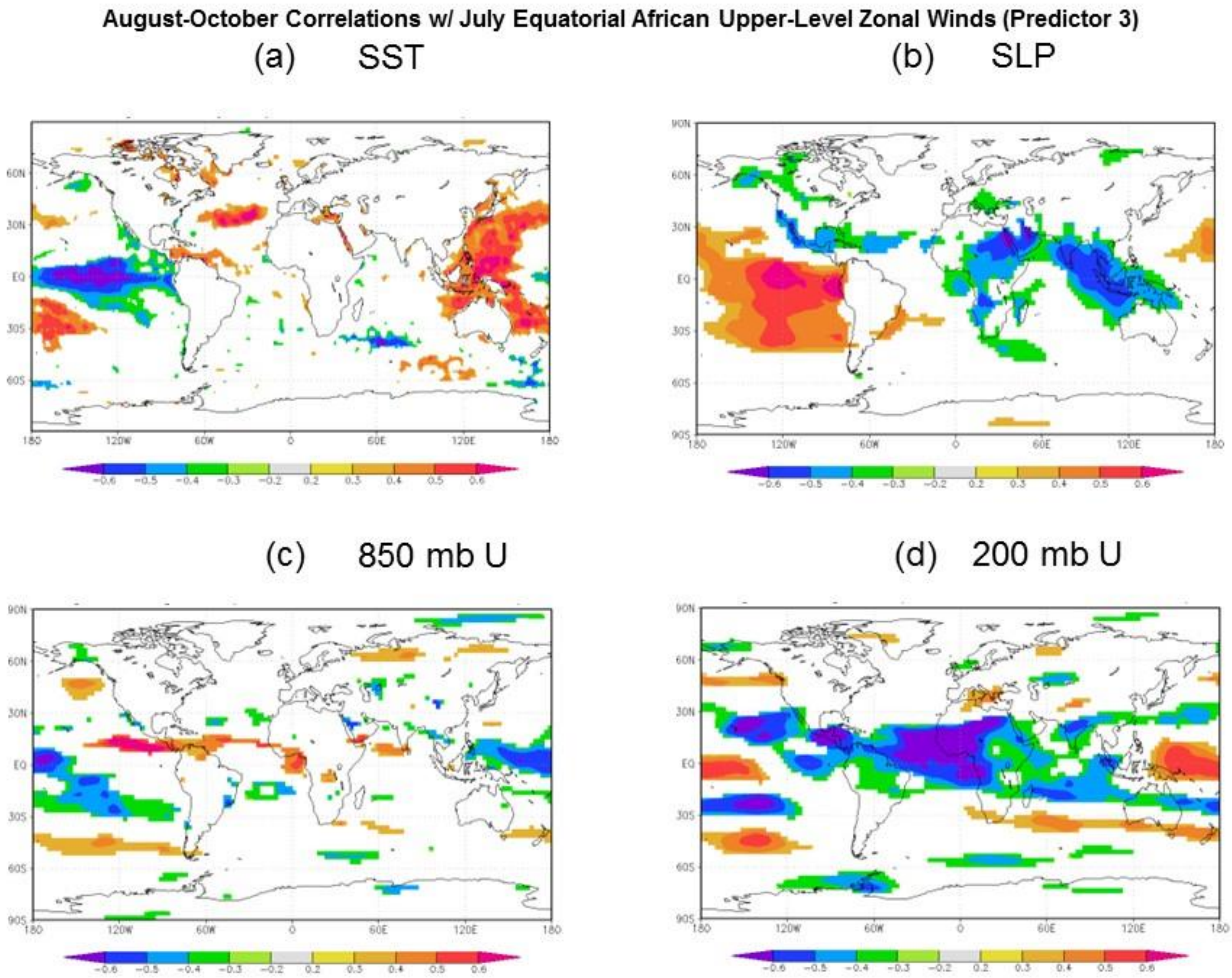

Figure 6: Linear correlations between July 200 MB Zonal Wind over tropical north Africa (Predictor 3) and August-October sea surface temperature (panel a), August-October sea level pressure (panel b), August-October 925 mb zonal wind (panel c) and August-October 200 mb zonal wind (panel d) over the period from 1979-2011. The color scale has been reversed so that the correlations match up with those in Figures 4 and 5.

3 Forecast Uncertainty

One of the questions that we are asked regarding our seasonal hurricane predictions is the degree of uncertainty that is involved. Obviously, our predictions are our best estimate, but there is with all forecasts an uncertainty as to how well they will verify.

Table 4 provides our post-31 July forecast, with error bars (based on one standard deviation of absolute errors) as calculated from hindcasts/forecasts of the Klotzbach (2007) scheme over the 1990-2009 period, using equations developed over the 1950-1989 period. We typically expect to see 2/3 of our forecasts verify within one standard deviation of observed values, with 95% of forecasts verifying within two standard deviations of observed values.

Table 4: Model hindcast error and our post-31 July 2017 hurricane forecast. Uncertainty ranges are given in one standard deviation (SD) increments.

Parameter	Hindcast Error (SD)	Post-31 July 2017 Forecast	Uncertainty Range – 1 SD (67% of Forecasts Likely in this Range)
Named Storms (NS)	2	11	9 – 13
Named Storm Days (NSD)	17	64	47 - 81
Hurricanes (H)	2	8	6 – 10
Hurricane Days (HD)	9	35	26 – 44
Major Hurricanes (MH)	1	3	2 – 4
Major Hurricane Days (MHD)	4	7	3 – 11
Accumulated Cyclone Energy (ACE)	36	131	95 – 167
Net Tropical Cyclone (NTC) Activity	34	129	95 - 163

4 Analog-Based Predictors for 2017 Hurricane Activity

Certain years in the historical record have global oceanic and atmospheric trends which are substantially similar to 2017. These years also provide useful clues as to likely trends in activity that the 2017 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 June-July 2017 conditions as well as conditions that we anticipate to be present during the peak months of the Atlantic hurricane season from August-October. Table 5 lists the best analog selections from our historical database.

We select prior hurricane seasons since 1950 which have similar atmospheric-oceanic conditions to those currently being experienced. We searched for years that had generally ENSO neutral conditions along with warm Atlantic MDR SST configurations.

There were five hurricane seasons with characteristics most similar to what we observed in June-July 2017. The best analog years that we could find for the 2017 hurricane season were 1953, 1969, 1979, 2001, and 2004. We anticipate that 2017 seasonal hurricane activity will have activity close to the average of these five analog years. We believe that the remainder of 2017 will have above-average activity in the Atlantic basin.

Table 5: Best analog years for 2017 with the associated hurricane activity listed for each year.

Year	NS	NSD	H	HD	MH	MHD	ACE	NTC
1953	14	61.75	7	19.00	3	5.00	99	116
1969	18	92.25	12	40.25	5	6.50	166	182
1979	9	45.75	6	21.75	2	5.75	93	97
2001	15	68.75	9	25.50	4	4.25	110	135
2004	15	93.00	9	45.50	6	22.25	227	232
Mean (Full Season)	**14.2**	**72.3**	**8.6**	**30.4**	**4.0**	**8.8**	**139**	**152**
2017 Forecast (Full Season)	**16**	**70**	**8**	**35**	**3**	**7**	**135**	**140**
1981-2010 Median (Full Season)	**12.0**	**60.1**	**6.5**	**21.3**	**2.0**	**3.9**	**92**	**103**

5 ENSO

Warm neutral ENSO conditions currently exist across the tropical Pacific. Table 6 displays July and May SST anomalies for several Nino regions. The eastern and central tropical Pacific has cooled somewhat over the past two months, while the central tropical Pacific has warmed slightly.

Table 6: May and July 2017 SST anomalies for Nino 1+2, Nino 3, Nino 3.4, and Nino 4, respectively. July-May SST anomaly differences are also provided.

Region	May SST Anomaly (°C)	July SST Anomaly (°C)	July minus May SST Change (°C)
Nino 1+2	+0.8	-0.1	-0.7
Nino 3	+0.5	+0.3	-0.2
Nino 3.4	+0.5	+0.4	-0.1
Nino 4	+0.3	+0.4	+0.1

While there is still some uncertainty as to ENSO conditions during the peak of the Atlantic hurricane season from August-October, the odds of a significant El Niño have diminished markedly. With our early outlook issued in April, we anticipated the chance of a moderate El Niño event and associated increased vertical wind shear across the Caribbean and tropical Atlantic. However, the most likely scenario for the tropical Pacific now appears to be neutral ENSO conditions for the next several months. Upper ocean heat content anomalies across the eastern and central tropical Pacific have been slightly above-average over the past couple of months, but they have diminished in recent weeks (Figure 7).

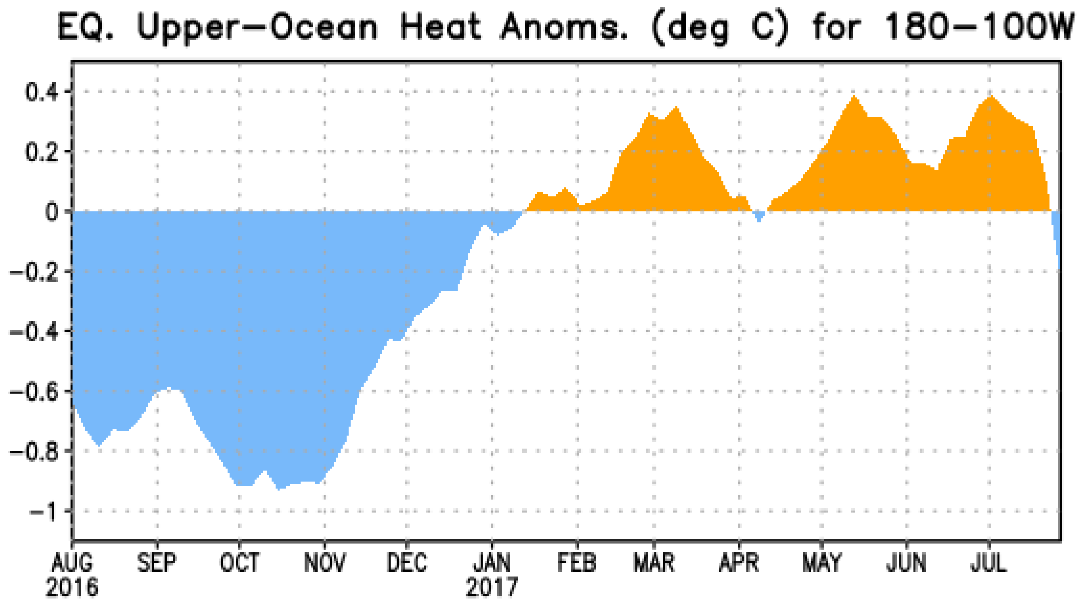

Figure 7: Upper-ocean (0-300 meters depth) heat content anomalies in the eastern and central Pacific since August 2016. Upper ocean heat content increased from November through February and have experienced some variability since but remain at levels typically observed in neutral ENSO conditions.

One of the reasons why El Niño conditions likely did not develop this season has been the lack of westerly wind anomalies in the central tropical Pacific. Weaker-than-normal trade winds favor downwelling and warming in the eastern and central equatorial Pacific. As Figure 8 shows, low-level wind flow has been anomalously easterly in the central tropical Pacific over the past few months, while anomalous westerly flow has persisted in the far eastern tropical Pacific.

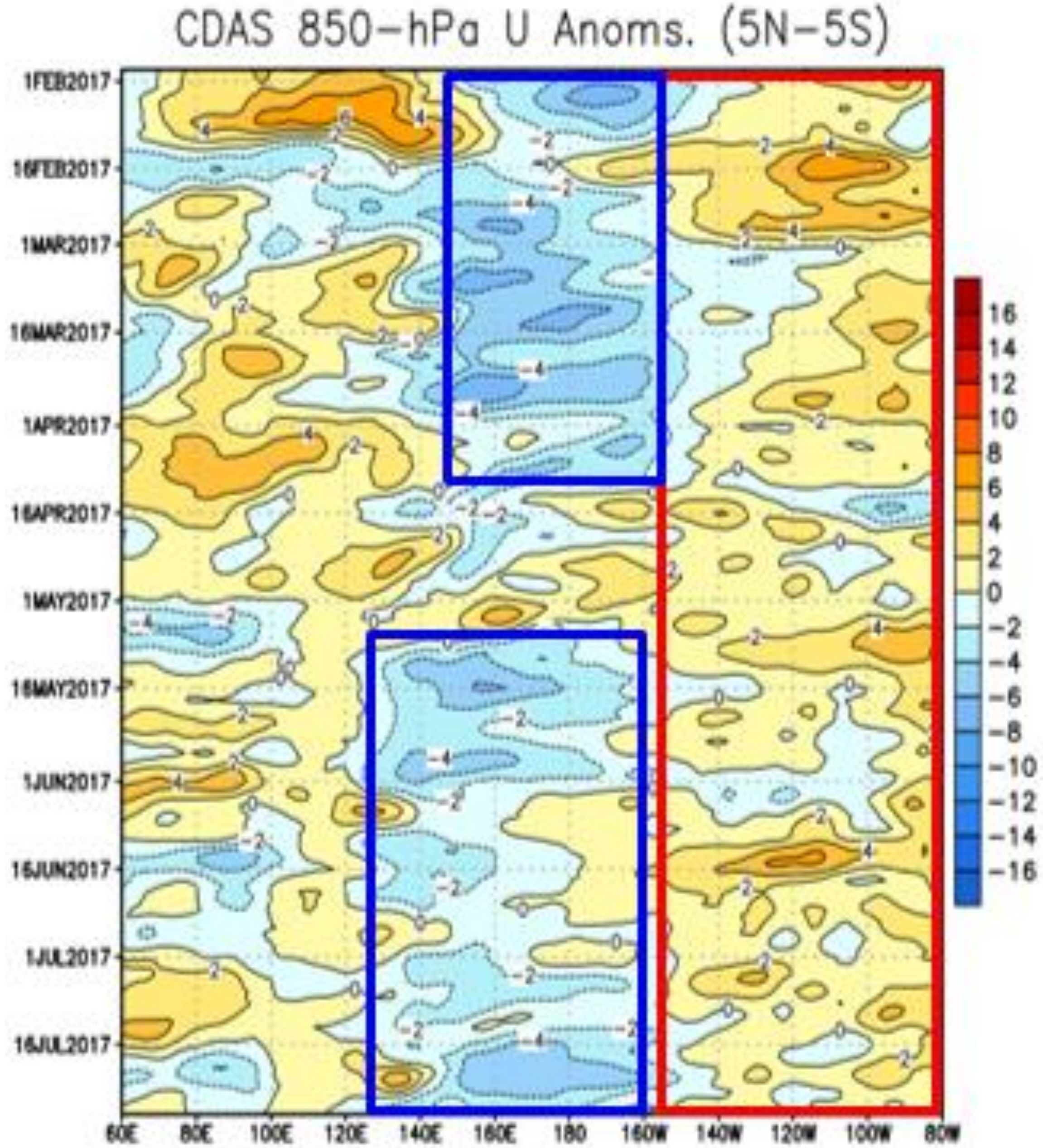

Figure 8: Anomalous 850-mb winds across the tropical Indian and Pacific Oceans from 60°E-80°W. Trade winds have generally been stronger than normal across the central tropical Pacific over the past several months.

There has also been a lack of significant oceanic Kelvin wave activity over the past couple of months (Figure 9). Downwelling (warming) Kelvin waves are essential for the development and sustenance of El Niño conditions. The lack of anomalously low-level westerly wind flow is the primary reason why we have not seen the downwelling Kelvin waves necessary for El Niño formation.

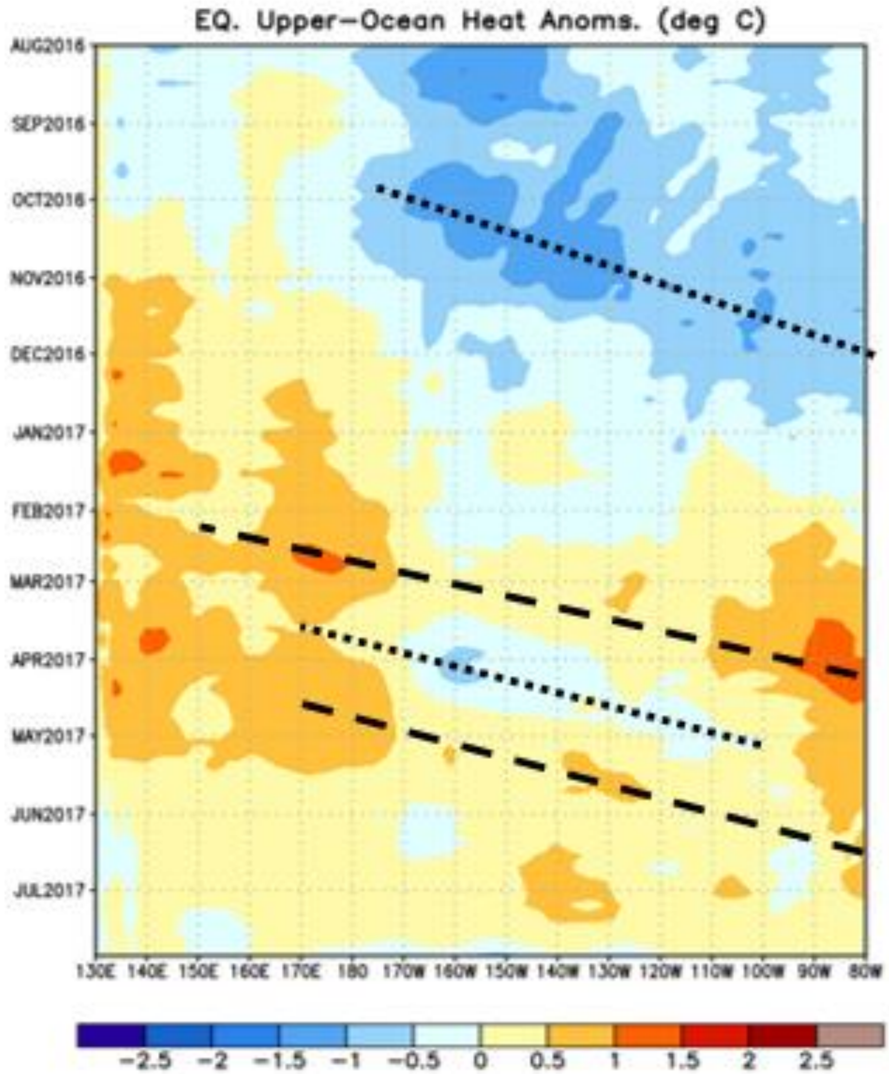

Figure 9: Upper-ocean heat content anomalies across the tropical Pacific. Dashed lines indicate downwelling (warming) Kelvin waves, while dotted lines indicate upwelling (cooling) Kelvin waves. Oceanic Kelvin wave activity appears to have been fairly limited over the past few months.

The official forecast from the Climate Prediction Center indicates that ENSO neutral conditions are the most likely scenario for the peak of the Atlantic hurricane season from August through October (Figure 10). Based on our assessment of both current conditions as well as forecast model output, we are now quite confident that El Niño will not play a significant role in the 2017 Atlantic hurricane season.

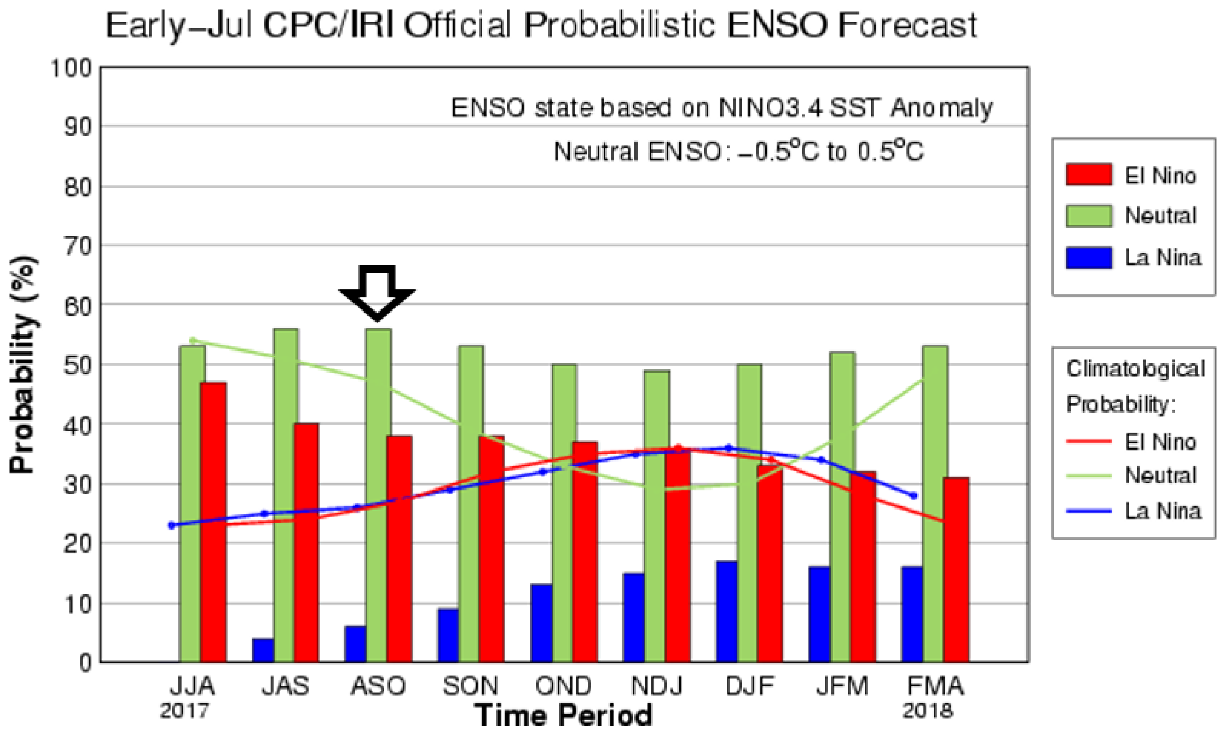

Figure 10: Official ENSO forecast from the Climate Prediction Center.

6 Current Atlantic Basin Conditions

The most challenging aspect of this year's Atlantic basin seasonal hurricane forecast remain the current configuration of atmospheric and oceanic patterns across the Atlantic basin. Figure 11 displays SST anomalies observed across the North Atlantic in July. The western Atlantic is very warm right now, as is all of the tropical Atlantic. However, the far North Atlantic is much colder than normal. The current SST anomaly pattern does not strongly resemble a canonical positive or negative phase of the Atlantic Multi-Decadal Oscillation (AMO). Typically when the far North Atlantic is cold, as it is now, the tropical Atlantic also tends to be cooler than normal. The July 2017 SST pattern generally resembles the July SST pattern associated with active Atlantic hurricane seasons (Figure 12).

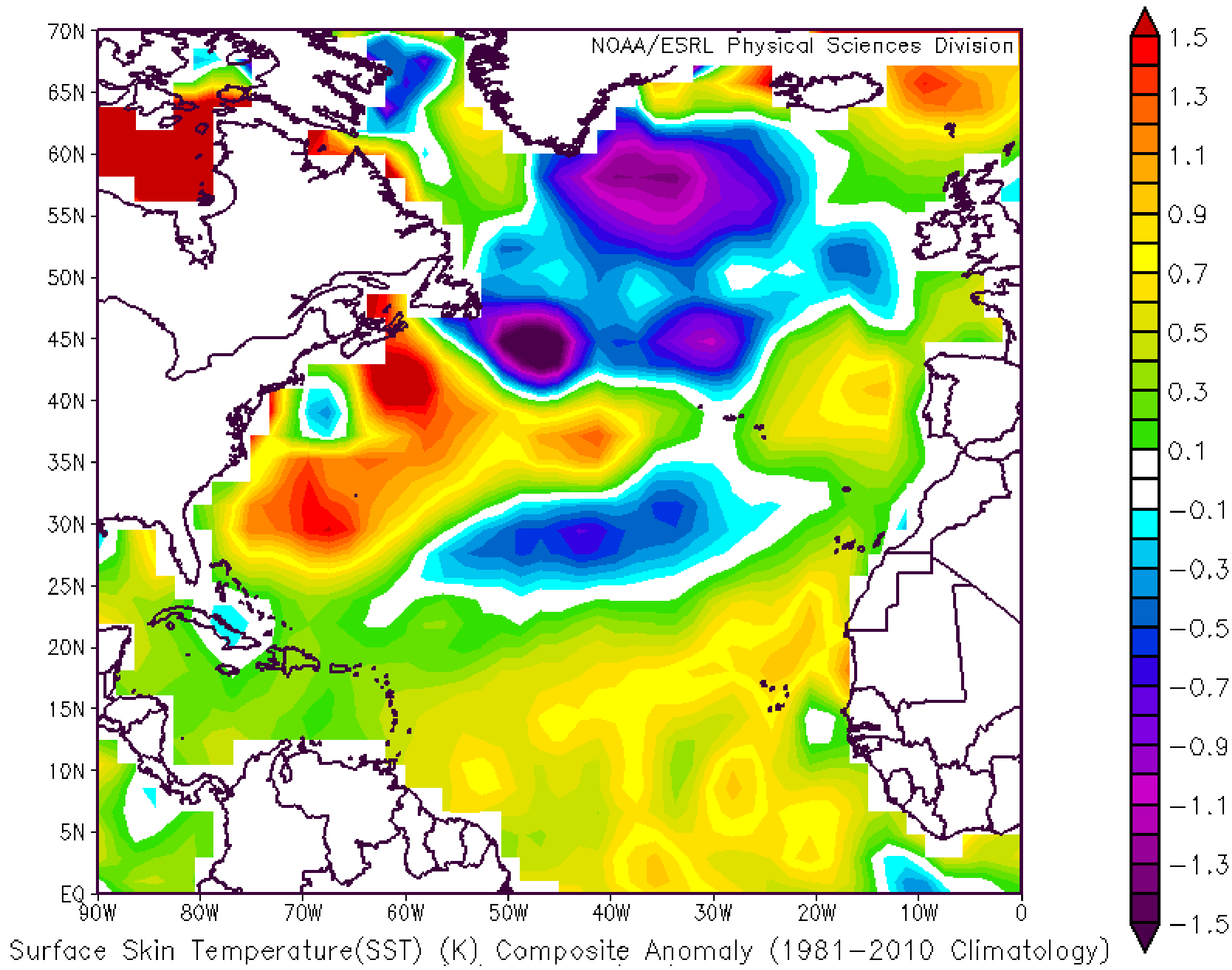

Figure 11: July 2017 SST anomalies.

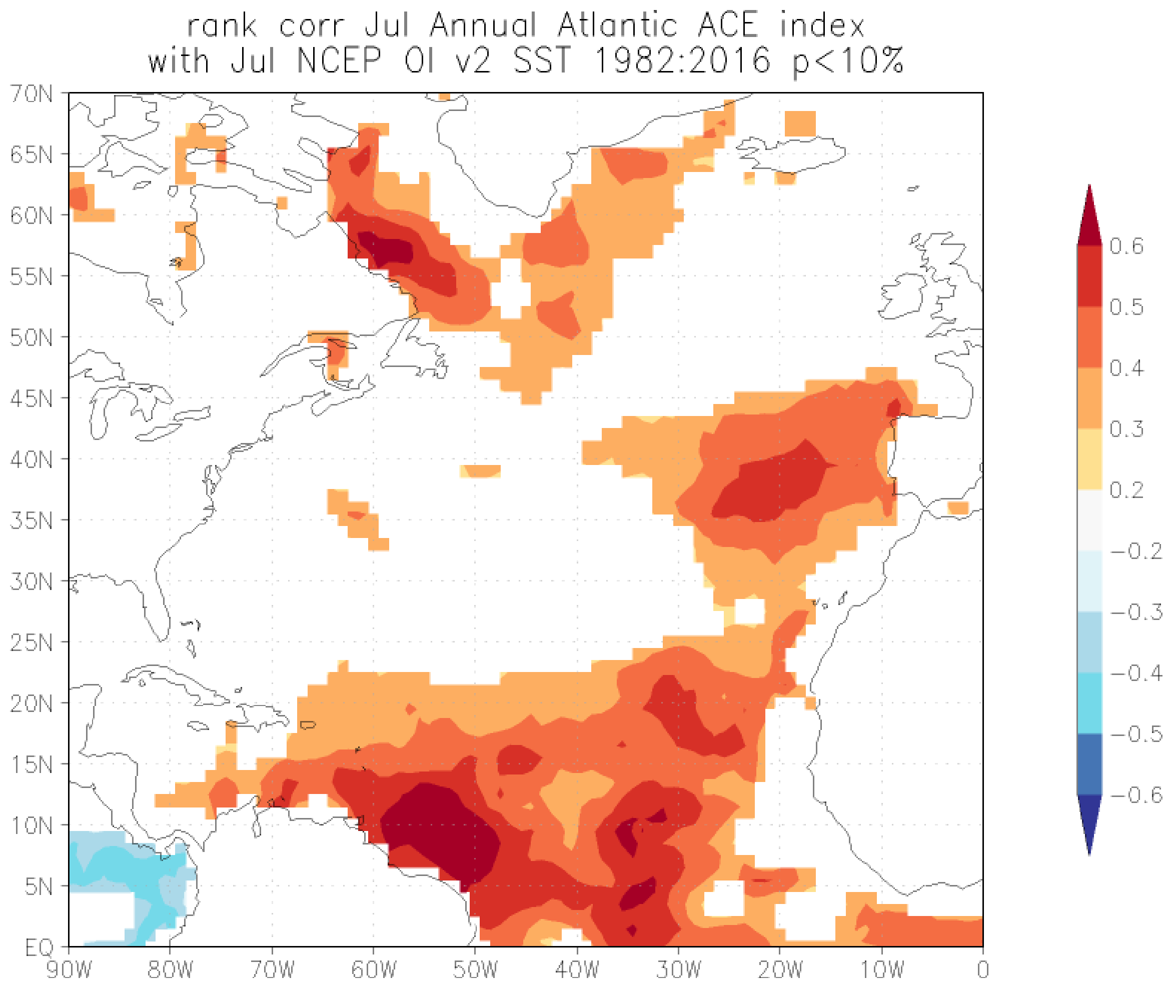

Figure 12: Correlation map between July SSTs and seasonal Atlantic ACE based on data over the period from 1982-2016.

Sea level pressure anomalies over the past month have been lower than normal in the western tropical Atlantic and higher than normal in the eastern tropical Atlantic. Above-normal sea level pressure anomalies in the tropical Atlantic imply a stronger than normal Tropical Upper Tropospheric Trough (TUTT) (Figure 13). A strong TUTT typically relates to increased vertical wind shear across the tropical Atlantic and Caribbean (Knaff 1997).

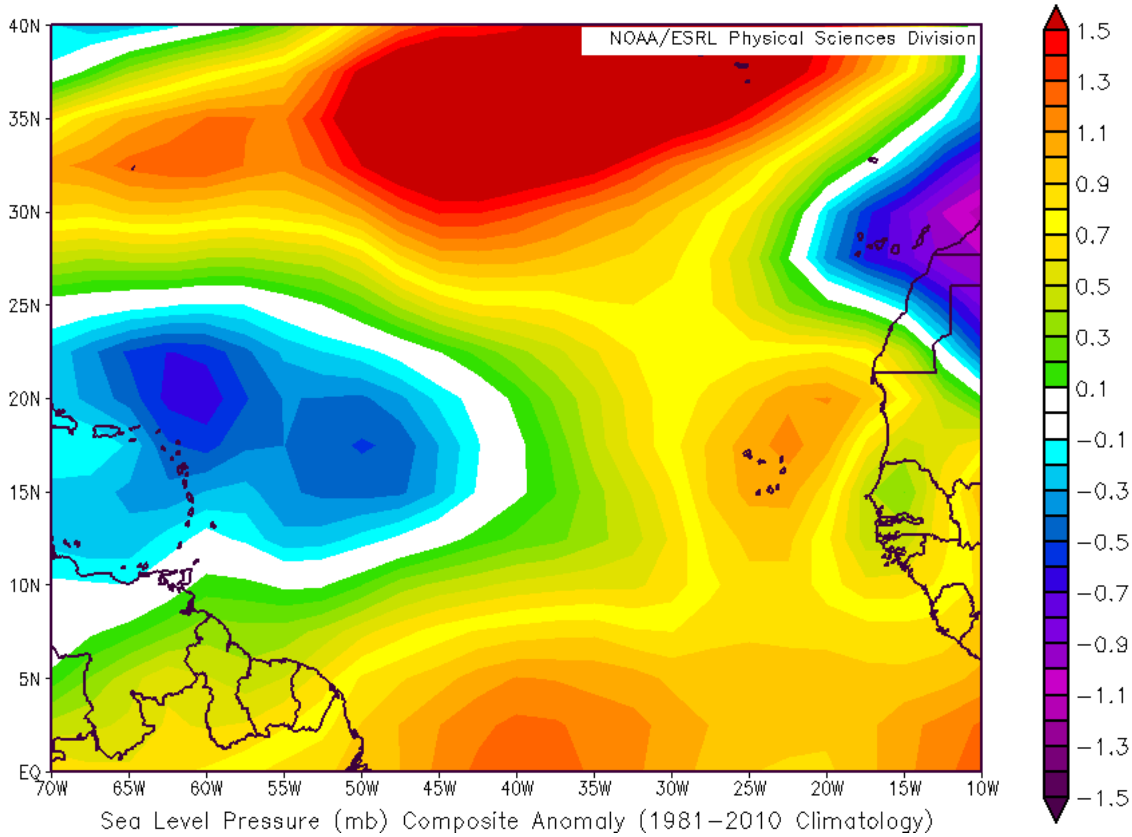

Figure 13: July 2017 Atlantic SLP anomaly. Sea level pressure anomalies were generally below normal in the western tropical Atlantic and above normal in the eastern tropical Atlantic.

Vertical wind shear has been generally below normal across most of the tropical Atlantic and above-normal across the Caribbean over the past few weeks (Figure 14). While the July correlation between wind shear and seasonal Atlantic Accumulated Cyclone Energy is significant in both the tropical Atlantic and in the Caribbean, the correlation is slightly stronger in the Caribbean. Some of this anomalously strong shear across the Caribbean over the past few weeks is likely due to intra-seasonal variability (e.g., the Madden-Julian Oscillation), and consequently, we do not expect these hurricane-unfavorable winds over the Caribbean to persist over the next few months.

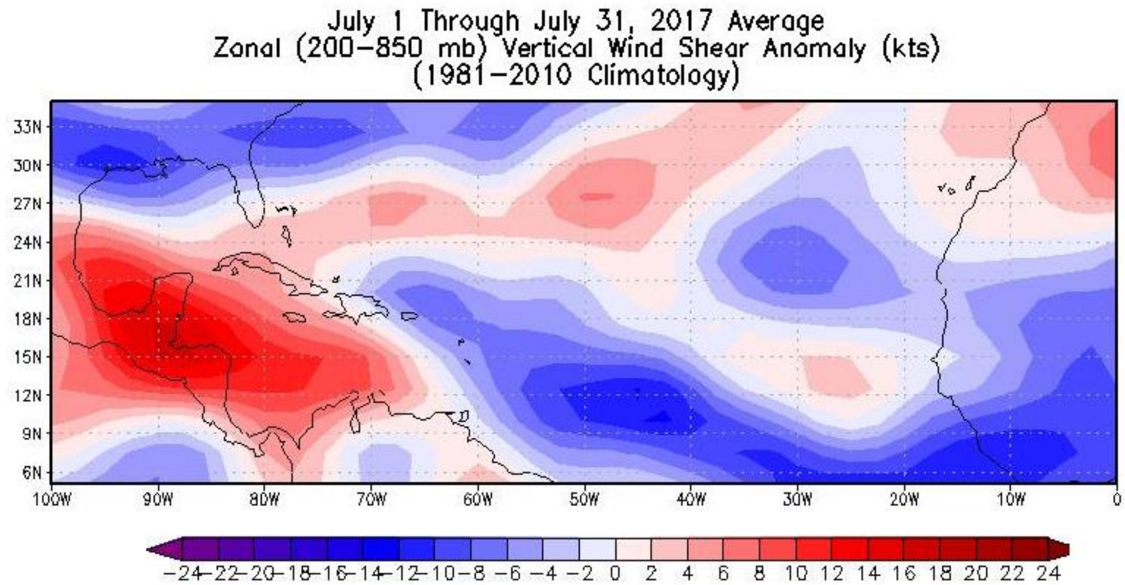

Figure 14: July 2017 averaged 200-850-mb zonal wind anomalies across the tropical Atlantic

As has been the case the past few years, the tropical Atlantic was drier than normal this July (Figure 15). However, the dryness in the tropical Atlantic has not been as pronounced this July as it has been over the past few years.

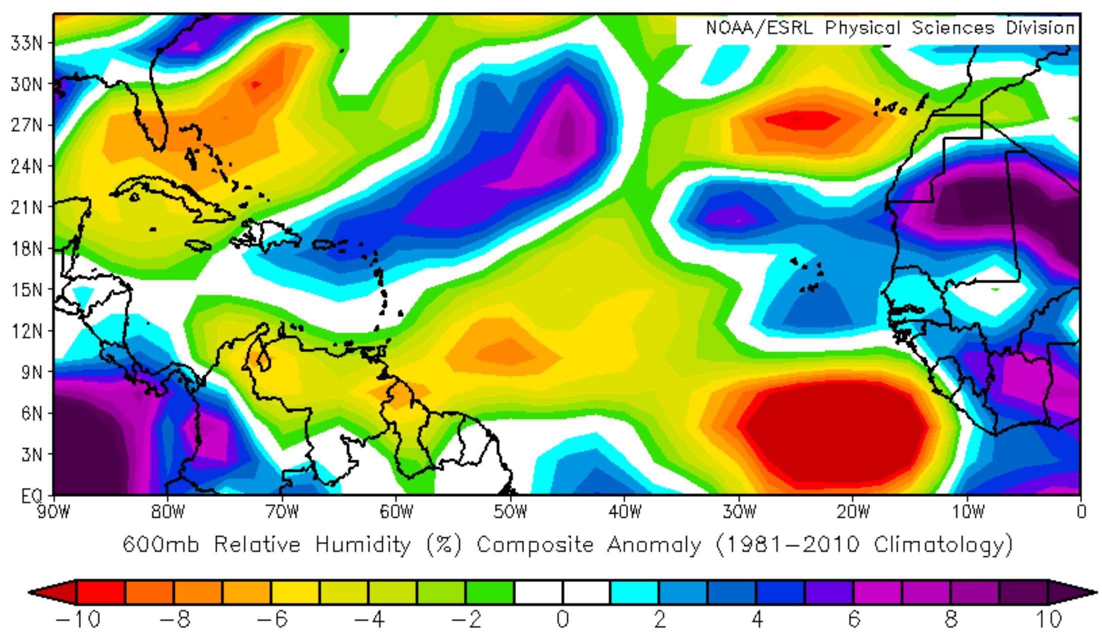

Figure 15: July 2017 600-mb relative humidity anomalies across the tropical Atlantic.

The Cooperative Research Institute for the Atmosphere (CIRA) monitors real-time conditions for genesis in the tropical Atlantic, and according to their analysis, vertical instability has been below normal over the past few weeks (Figure 16). Positive deviations from the curve displayed below indicate a more unstable atmosphere than normal. In general, the atmosphere has been more stable than normal over the past few weeks.

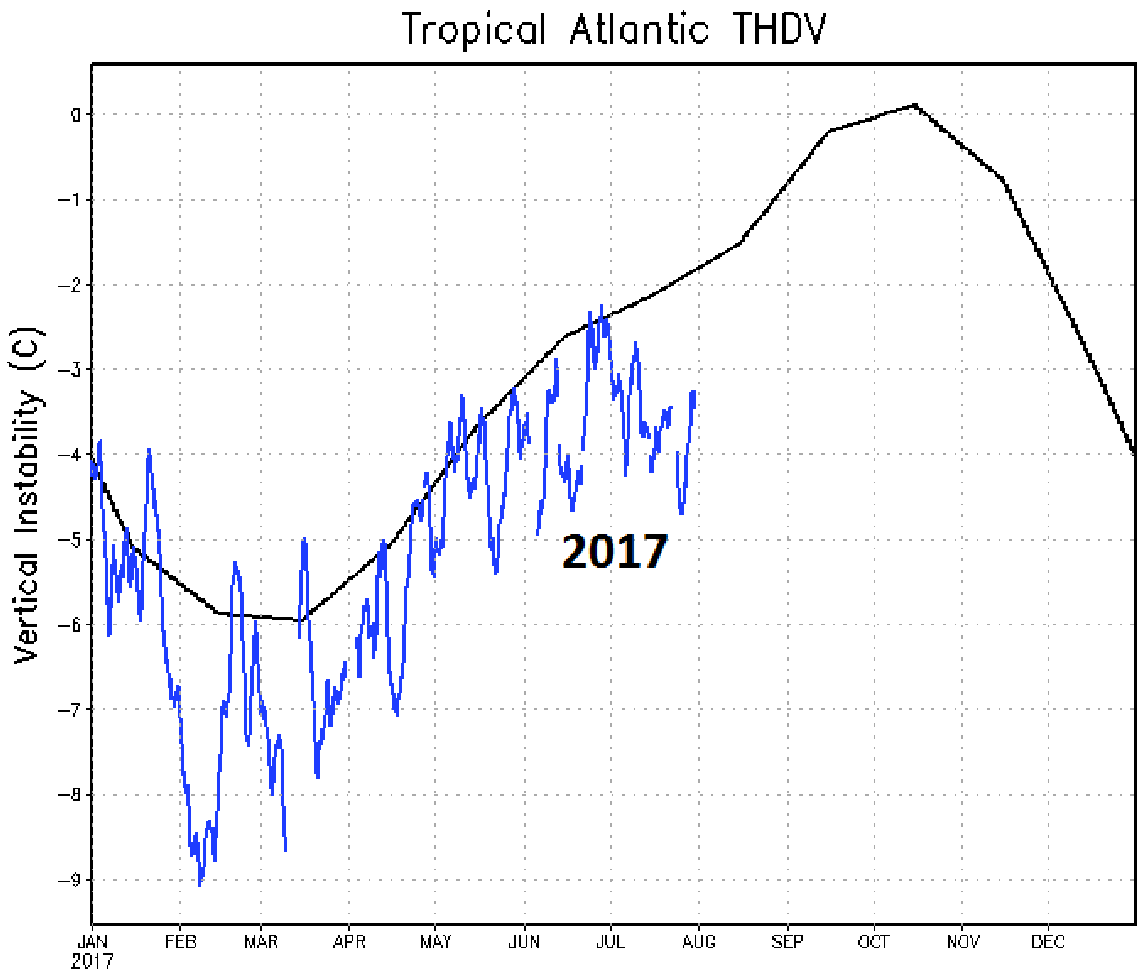

Figure 16: Vertical instability across the tropical Atlantic since January 2017 (blue line). The average season is represented by the black line.

7 West Africa Conditions

Enhanced rainfall in the Sahel region of West Africa during July has been associated with active hurricane seasons (Landsea and Gray 1992). Figure 17 displays rainfall estimates over Africa over the past few weeks. In general, rainfall in the western Sahel has been somewhat greater than normal, which would tend to favor a more active season. Upper-level winds over Africa have also been anomalously out of the east over the past several weeks, which is typically correlated with active Atlantic hurricane seasons (Figure 18). African dust outbreaks over the tropical Atlantic have also been somewhat lower than normal in June-July, indicative of an anomalously moist Sahel (Peng Xian, personal communication).

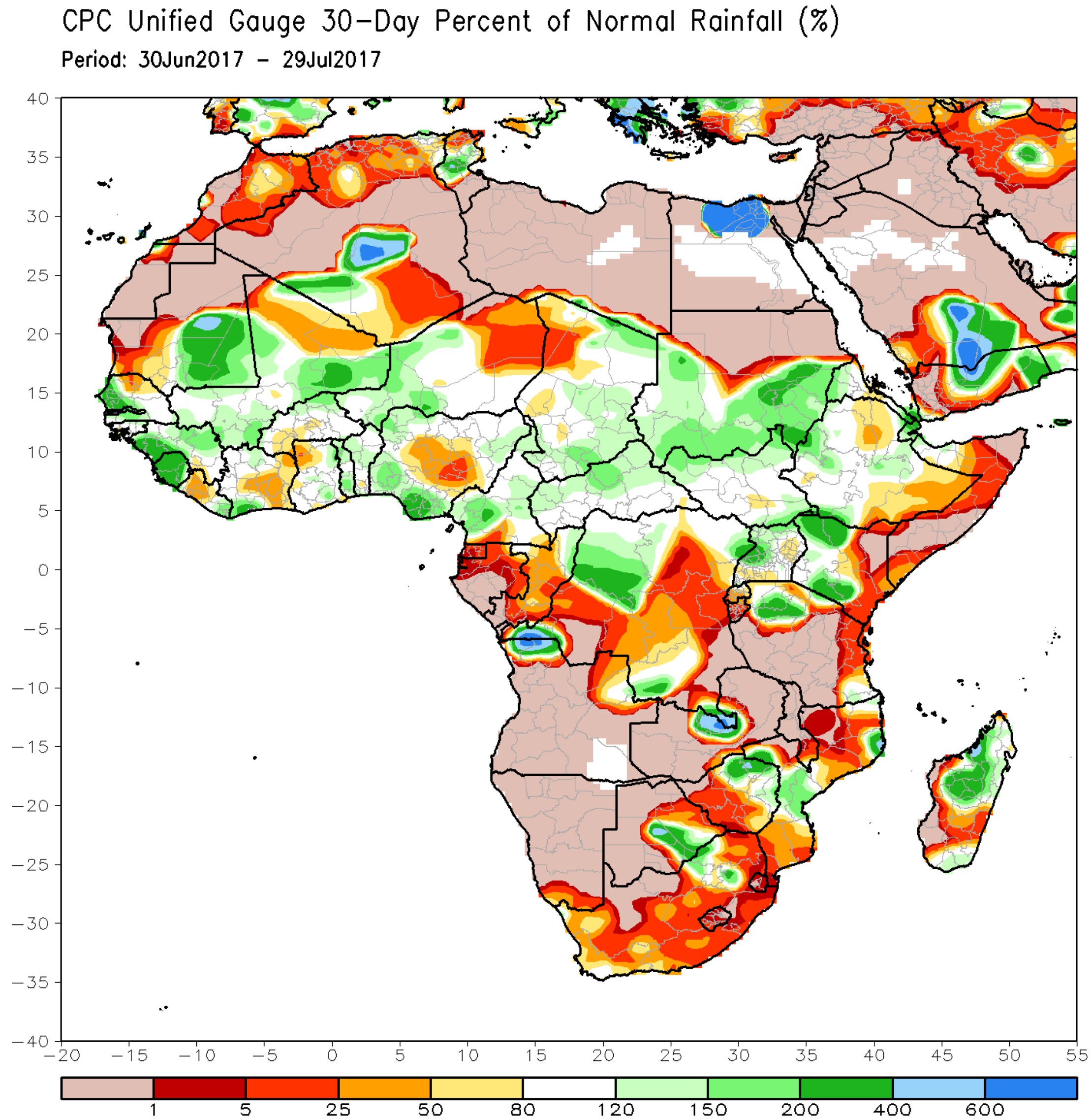

Figure 17: Climate Prediction Center Unified Gauge estimate of percent of normal rainfall from June 30 – July 29, 2017.

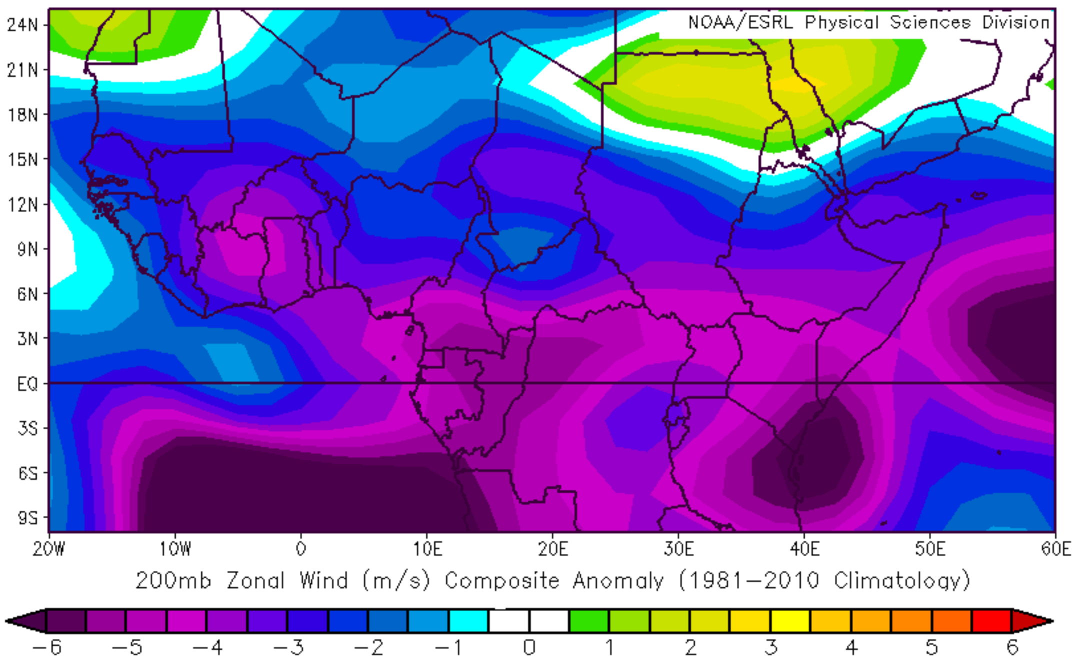

Figure 18: Upper-level wind anomalies over Africa during July. Anomalous upper-level easterlies are typically associated with more active Atlantic hurricane seasons, due to stronger-than-normal easterly waves.

8 Atlantic Multi-Decadal Oscillation (AMO)/Thermohaline Circulation (THC) Conditions

One of the big questions that has been asked over the past couple of years is whether we have moved out of the active Atlantic hurricane era. We currently monitor the strength of the Atlantic Multidecadal Oscillation (AMO) and Atlantic thermohaline circulation (THC) using a combined proxy measure of SST in the region from 50-60°N, 50-10°W and SLP in the region from 0-50°N, 70-10°W (Figure 19). This index was discussed in detail in Klotzbach and Gray (2008).

We currently weigh standardized values of the index by using the following formula: 0.6*SST – 0.4*SLP. The AMO was quite negative in July 2017, due to both cold far North Atlantic SSTs and anomalously high SLPAs when averaged over the North Atlantic. The July 2017 AMO value was approximately 1 standard deviation less than the 1981-2010 average (Figure 20).

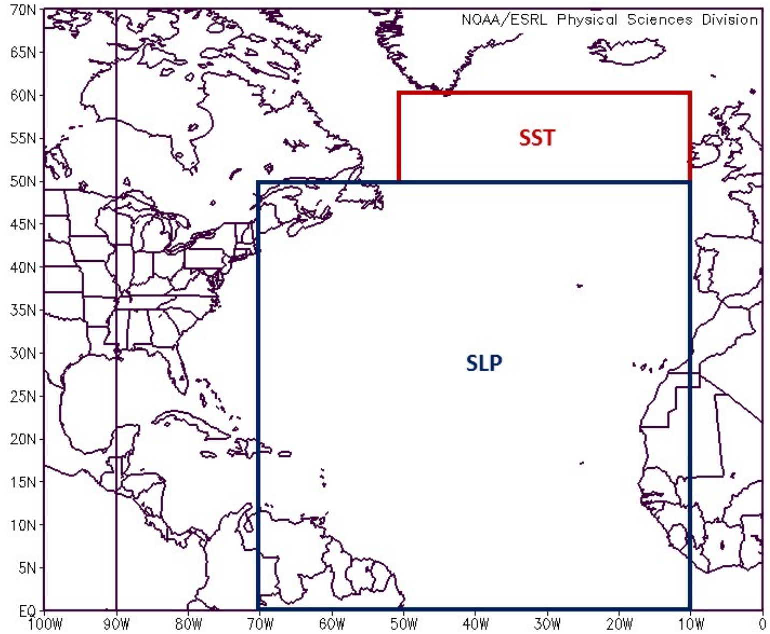

Figure 19: Regions which are utilized for the calculation of our THC/AMO index.

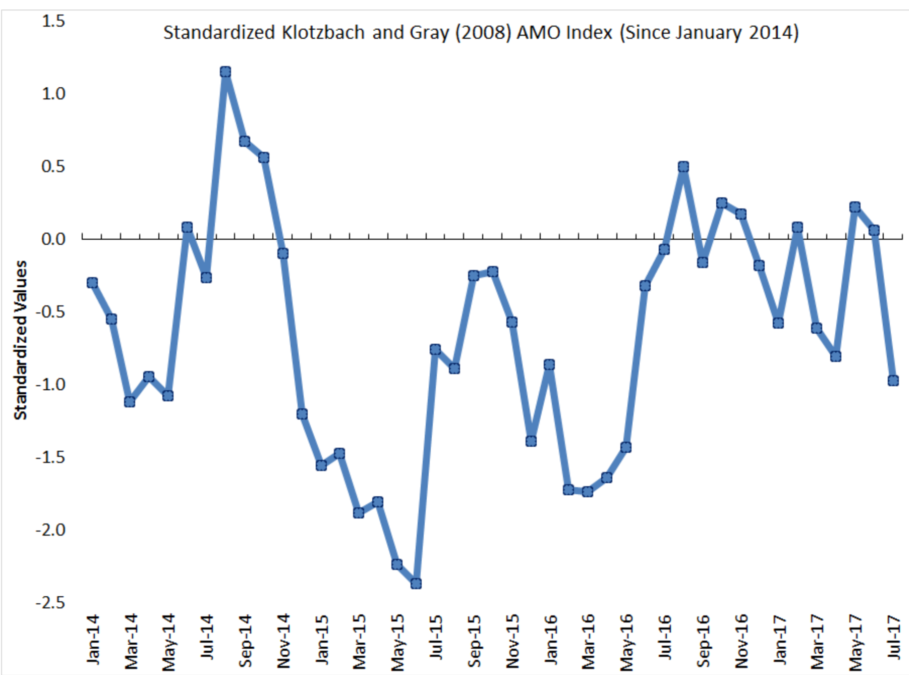

Figure 20: Monthly values of the Klotzbach and Gray (2008) AMO index since January 2014.

9 Adjusted 2017 Forecast

Table 7 shows our final adjusted early August forecast for the 2017 season which is a combination of our statistical scheme (with June-July activity added in), our analog forecast and qualitative adjustments for other factors not explicitly contained in any of these schemes. Our statistical forecast, analog forecast and final qualitative outlook are in good agreement that the remainder of the 2017 Atlantic hurricane season should have above-average TC activity.

Table 7: June-July 2017 observed activity, our August full season statistical forecast (with June-July 2017 activity added in), our analog forecast and our adjusted final forecast for the 2017 hurricane season.

Forecast Parameter and 1981-2010 Median (in parentheses)	June-July 2017 Observed Activity	Statistical Scheme	Analog Scheme	Adjusted Final Forecast (Whole Season)
Named Storms (12.0)	5	16.1	14.2	**16**
Named Storm Days (60.1)	6	68.4	72.3	**70**
Hurricanes (6.5)	0	7.1	8.6	**8**
Hurricane Days (21.3)	0	29.8	30.4	**35**
Major Hurricanes (2.0)	0	3.4	4.0	**3**
Major Hurricane Days (3.9)	0	8.3	8.8	**7**
Accumulated Cyclone Energy Index (92)	4	128	139	**135**
Net Tropical Cyclone Activity (103%)	11	143	152	**140**

10 Landfall Probabilities for 2017

A significant focus of our recent research involves efforts to develop forecasts of the probability of hurricane landfall along the U.S. coastline and in the Caribbean. Whereas individual hurricane landfall events cannot be forecast months in advance, the total seasonal probability of landfall can be forecast with statistical skill. With the observation that landfall is a function of varying climate conditions, a probability specification has been developed through statistical analyses of all U.S. hurricane and named storm landfall events during the 20th century (1900-1999). Specific landfall probabilities can be given for all tropical cyclone intensity classes for a set of distinct U.S. coastal regions.

Net landfall probability is shown linked to the overall Atlantic basin Net Tropical Cyclone activity (NTC; see Table 8). 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 long-term 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 8: 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 9 lists strike probabilities for the 2017 hurricane season for different TC categories for the entire U.S. coastline, the Gulf Coast and the East Coast including the Florida peninsula. We also issue probabilities for various islands and landmasses in the Caribbean and in Central America. Note that Atlantic basin post-31 July NTC activity in 2017 is expected to be above its long-term average, and therefore, landfall probabilities are above their long-term average.

Table 9: Estimated probability (expressed in percent) of one or more landfalling tropical storms (TS), category 1-2 hurricanes (HUR), category 3-4-5 hurricanes, total hurricanes and named storms along the entire U.S. coastline, along the Gulf Coast (Regions 1-4), and along the Florida Peninsula and the East Coast (Regions 5-11) for the remainder of the 2017 Atlantic hurricane season. Probabilities of a tropical storm, hurricane and major hurricane tracking into the Caribbean are also provided. The long-term mean annual probability of one or more landfalling systems during the 20th century is given in parentheses.

Region	TS	Category 1-2 HUR	Category 3-4-5 HUR	All HUR	Named Storms
Entire U.S. (Regions 1-11)	87% (79%)	77% (68%)	62% (52%)	91% (84%)	99% (97%)
Gulf Coast (Regions 1-4)	68% (59%)	51% (42%)	38% (30%)	70% (60%)	90% (83%)
Florida plus East Coast (Regions 5-11)	60% (50%)	53% (44%)	38% (31%)	71% (61%)	88% (81%)
Caribbean (10-20°N, 60-88°W)	90% (82%)	67% (57%)	51% (42%)	84% (75%)	98% (96%)

Please also visit the Landfalling Probability Webpage for landfall probabilities for 11 U.S. coastal regions and 205 coastal and near-coastal counties from Brownsville, Texas to Eastport, Maine as well as probabilities for every island in the Caribbean.

11 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 2017 should have above-average hurricane activity. Neutral ENSO conditions and a warmer-than-normal

Main Development Region should help generate anomalously favorable conditions for hurricane formation conditions over the peak months of this year's hurricane season.

12 Forthcoming Updated Forecasts of 2017 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, Friday, August 4 and continuing every other Friday (August 18, September 1, etc.). A verification and discussion of all 2017 forecasts will be issued in late November 2017. All of these forecasts will be available online.

13 Citations and Additional Reading

Alexander, M. A., I. Blade, M. Newman, J. R. Lanzante, N.-C. Lau, and J. D. Scott, 2002: The atmospheric bridge: The influence of ENSO teleconnections on air-sea interaction over the global oceans. *J. Climate,* 15, 2205-2231.

Blake, E. S., 2002: Prediction of August Atlantic basin hurricane activity. Dept. of Atmos. Sci. Paper No. 719, Colo. State Univ., Ft. Collins, CO, 80 pp.

Blake, E. S. and W. M. Gray, 2004: Prediction of August Atlantic basin hurricane activity. *Wea. Forecasting,* 19, 1044-1060.

Chiang, J. C. H. and D. J. Vimont, 2004: Analogous Pacific and Atlantic meridional modes of tropical atmosphere-ocean variability. *J. Climate,* 17, 4143-4158.

DeMaria, M., J. A. Knaff and B. H. Connell, 2001: A tropical cyclone genesis parameter for the tropical Atlantic. *Wea. Forecasting,* 16, 219-233.

Elsner, J. B., G. S. Lehmiller, and T. B. Kimberlain, 1996: Objective classification of Atlantic hurricanes. *J. Climate*, 9, 2880-2889.

Evan, A. T., J. Dunion, J. A. Foley, A. K. Heidinger, and C. S. Velden, 2006: New evidence for a relationship between Atlantic tropical cyclone activity and African dust outbreaks, *Geophys. Res. Lett,* 33, doi:10.1029/2006GL026408.

Goldenberg, S. B., C. W. Landsea, A. M. Mestas-Nunez, and W. M. Gray, 2001: The recent increase in Atlantic hurricane activity: Causes and Implications. *Science,* 293, 474-479.

Goldenberg, S. B. and L. J. Shapiro, 1996: Physical mechanisms for the association of El Niño and West African rainfall with Atlantic major hurricane activity. *J. Climate,* 1169-1187.

Gray, W. M., 1984a: Atlantic seasonal hurricane frequency: Part I: El Niño and 30 mb quasi-biennial oscillation influences. *Mon. Wea. Rev.,* 112, 1649-1668.

Gray, W. M., 1984b: Atlantic seasonal hurricane frequency: Part II: Forecasting its variability. *Mon. Wea. Rev.,* 112, 1669-1683.

Gray, W. M., 1990: Strong association between West African rainfall and US landfall of intense hurricanes. *Science,* 249, 1251-1256.

Gray, W. M., and P. J. Klotzbach, 2011: Have increases in CO_2 contributed to the recent large upswing in Atlantic basin major hurricanes since 1995? Chapter 9 in "Evidence-Based Climate Science", D. Easterbrook, Ed., Elsevier Press, 27 pp.

Gray, W. M., C. W. Landsea, P. W. Mielke, Jr., and K. J. Berry, 1992: Predicting Atlantic seasonal hurricane activity 6-11 months in advance. *Wea. Forecasting,* 7, 440-455.

Gray, W. M., C. W. Landsea, P. W. Mielke, Jr., and K. J. Berry, 1993: Predicting Atlantic basin seasonal tropical cyclone activity by 1 August. *Wea. Forecasting,* 8, 73-86.

Gray, W. M., C. W. Landsea, P. W. Mielke, Jr., and K. J. Berry, 1994a: Predicting Atlantic basin seasonal tropical cyclone activity by 1 June. *Wea. Forecasting,* 9, 103-115.

Gray, W. M., J. D. Sheaffer and C. W. Landsea, 1996: Climate trends associated with multi-decadal variability of intense Atlantic hurricane activity. Chapter 2 in "Hurricanes, Climatic Change and

Socioeconomic Impacts: A Current Perspective", H. F. Diaz and R. S. Pulwarty, Eds., Westview Press, 49 pp.

Gray, W. M., 1998: Atlantic ocean influences on multi-decadal variations in El Niño frequency and intensity. Ninth Conference on Interaction of the Sea and Atmosphere, 78th AMS Annual Meeting, 11-16 January, Phoenix, AZ, 5 pp.

Grossmann, I. and P. J. Klotzbach, 2009: A review of North Atlantic modes of natural variability and their driving mechanisms. *J. Geophys. Res.*, 114, D24107, doi:10.1029/2009JD012728.

Henderson-Sellers, A., H. Zhang, G. Berz, K. Emanuel, W. Gray, C. Landsea, G. Holland, J. Lighthill, S-L. Shieh, P. Webster, and K. McGuffie, 1998: Tropical cyclones and global climate change: A post-IPCC assessment. *Bull. Amer. Meteor. Soc.*, 79, 19-38.

Klotzbach, P. J., 2002: Forecasting September Atlantic basin tropical cyclone activity at zero and one-month lead times. Dept. of Atmos. Sci. Paper No. 723, Colo. State Univ., Ft. Collins, CO, 91 pp.

Klotzbach, P. J., 2006: Trends in global tropical cyclone activity over the past twenty years (1986-2005). *Geophys. Res. Lett.*, 33, doi:10.1029/2006GL025881.

Klotzbach, P. J., 2007: Revised prediction of seasonal Atlantic basin tropical cyclone activity from 1 August. *Wea. and Forecasting*, 22, 937-949.

Klotzbach, P. J. and W. M. Gray, 2003: Forecasting September Atlantic basin tropical cyclone activity. *Wea. and Forecasting*, 18, 1109-1128.

Klotzbach, P. J. and W. M. Gray, 2004: Updated 6-11 month prediction of Atlantic basin seasonal hurricane activity. *Wea. and Forecasting*, 19, 917-934.

Klotzbach, P. J. and W. M. Gray, 2006: Causes of the unusually destructive 2004 Atlantic basin hurricane season. *Bull. Amer. Meteor. Soc.*, 87, 1325-1333.

Knaff, J. A., 1997: Implications of summertime sea level pressure anomalies. *J. Climate*, 10, 789-804.

Knaff, J. A., 1998: Predicting summertime Caribbean sea level pressure. *Wea. and Forecasting*, 13, 740-752.

Kossin, J. P., and D. J. Vimont, 2007: A more general framework for understanding Atlantic hurricane variability and trends. *Bull. Amer. Meteor. Soc.*, 88, 1767-1781.

Landsea, C. W., 1991: West African monsoonal rainfall and intense hurricane associations. Dept. of Atmos. Sci. Paper, Colo. State Univ., Ft. Collins, CO, 272 pp.

Landsea, C. W., 1993: A climatology of intense (or major) Atlantic hurricanes. *Mon. Wea. Rev.*, 121, 1703-1713.

Landsea, C. W., 2007: Counting Atlantic tropical cyclones back to 1900. *EOS*, 88, 197, 202.

Landsea, C. W. and W. M. Gray, 1992: The strong association between Western Sahel monsoon rainfall and intense Atlantic hurricanes. *J. Climate*, 5, 435-453.

Landsea, C. W., W. M. Gray, P. W. Mielke, Jr., and K. J. Berry, 1992: Long-term variations of Western Sahelian monsoon rainfall and intense U.S. landfalling hurricanes. *J. Climate*, 5, 1528-1534.

Landsea, C. W., W. M. Gray, K. J. Berry and P. W. Mielke, Jr., 1996: June to September rainfall in the African Sahel: A seasonal forecast for 1996. 4 pp.

Landsea, C. W., N. Nicholls, W.M. Gray, and L.A. Avila, 1996: Downward trends in the frequency of intense Atlantic hurricanes during the past five decades. *Geo. Res. Letters*, 23, 1697-1700.

Landsea, C. W., R. A. Pielke, Jr., A. M. Mestas-Nunez, and J. A. Knaff, 1999: Atlantic basin hurricanes: Indices of climatic changes. *Climatic Changes*, 42, 89-129.

Landsea, C.W. et al., 2005: Atlantic hurricane database re-analysis project. Available online at http://www.aoml.noaa.gov/hrd/data_sub/re_anal.html

Mielke, P. W., K. J. Berry, C. W. Landsea and W. M. Gray, 1996: Artificial skill and validation in meteorological forecasting. *Wea. Forecasting*, 11, 153-169.

Mielke, P. W., K. J. Berry, C. W. Landsea and W. M. Gray, 1997: A single sample estimate of shrinkage in meteorological forecasting. *Wea. Forecasting*, 12, 847-858.

Pielke, Jr. R. A., and C. W. Landsea, 1998: Normalized Atlantic hurricane damage, 1925-1995. *Wea. Forecasting*, 13, 621-631.

Pielke, Jr. R. A., and J. Gratz, C. W. Landsea, D. Collins, and R. Masulin, 2008: Normalized hurricane damage in the United States: 1900-2005. *Nat. Haz. Rev.*, 9, 29-42, doi:10.1061/(ASCE)1527-6988(2008)9:1(29).

Rasmusson, E. M. and T. H. Carpenter, 1982: Variations in tropical sea-surface temperature and surface wind fields associated with the Southern Oscillation/El Niño. *Mon. Wea. Rev.*, 110, 354-384.

Seseske, S. A., 2004: Forecasting summer/fall El Niño-Southern Oscillation events at 6-11 month lead times. Dept. of Atmos. Sci. Paper No. 749, Colo. State Univ., Ft. Collins, CO, 104 pp.

Vimont, D. J., and J. P. Kossin, 2007: The Atlantic meridional mode and hurricane activity. *Geophys. Res. Lett.*, 34, L07709, doi:10.1029/2007GL029683.

Wheeler, M. C., and H. H. Hendon, 2004: An all-season real-time multivariate MJO index: Development of an index for monitoring and prediction. *Mon. Wea. Rev.*, 132, 1917-1932.

14 Verification of Previous Forecasts

Table 10: Summary verification of the authors' five previous years of seasonal forecasts for Atlantic TC activity from 2012-2016.

2012	4 April	Update 1 June	Update 3 August	Obs.
Hurricanes	4	5	6	10
Named Storms	10	13	14	19
Hurricane Days	16	18	20	26
Named Storm Days	40	50	52	99.50
Major Hurricanes	2	2	2	1
Major Hurricane Days	3	4	5	0.25
Net Tropical Cyclone Activity	75	90	105	121

2013	10 April	Update 3 June	Update 2 August	Obs.
Hurricanes	9	9	8	2
Named Storms	18	18	18	13
Hurricane Days	40	40	35	3.75
Named Storm Days	95	95	84.25	38.50
Major Hurricanes	4	4	3	0
Major Hurricane Days	9	9	7	0
Accumulated Cyclone Energy	165	165	142	33
Net Tropical Cyclone Activity	175	175	150	44

2014	10 April	Update 2 June	Update 1 July	Update 31 July	Obs.
Hurricanes	3	4	4	4	6
Named Storms	9	10	10	10	8
Hurricane Days	12	15	15	15	17.75
Named Storm Days	35	40	40	40	35
Major Hurricanes	1	1	1	1	2
Major Hurricane Days	2	3	3	3	3.75
Accumulated Cyclone Energy	55	65	65	65	67
Net Tropical Cyclone Activity	60	70	70	70	82

2015	9 April	Update 1 June	Update 1 July	Update 4 August	Obs.
Hurricanes	3	3	3	2	4
Named Storms	7	8	8	8	11
Hurricane Days	10	10	10	8	11.50
Named Storm Days	30	30	30	25	43.75
Major Hurricanes	1	1	1	1	2
Major Hurricane Days	0.5	0.5	0.5	0.5	4
Accumulated Cyclone Energy	40	40	40	35	60
Net Tropical Cyclone Activity	45	45	45	40	81

2016	9 April	Update 1 June	Update 1 July	Update 4 August	Obs.
Hurricanes	6	6	6	6	7
Named Storms	13	14	15	15	15
Hurricane Days	21	21	21	22	27.75
Named Storm Days	52	53	55	55	81.00
Major Hurricanes	2	2	2	2	4
Major Hurricane Days	4	4	4	5	10.25
Accumulated Cyclone Energy	93	94	95	100	141
Net Tropical Cyclone Activity	101	103	105	110	155