# FORECAST OF ATLANTIC HURRICANE ACTIVITY FOR OCTOBER 2008 AND SEASONAL UPDATE THROUGH SEPTEMBER

Well above-average activity has occurred so far during the 2008 hurricane season. We expect an active October.

(as of 1 October 2008)

By Philip J. Klotzbach[1] and William M. Gray[2]

This forecast as well as past forecasts and verifications are available via the World Wide Web at http://hurricane.atmos.colostate.edu/Forecasts

Emily Wilmsen, Colorado State University Media Representative, (970-491-6432) is available to answer various questions about this forecast

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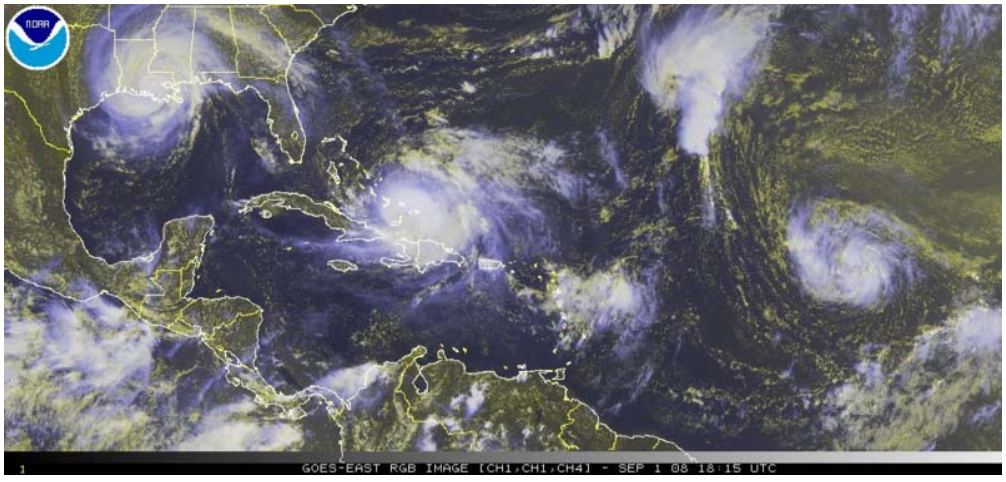


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ATLANTIC BASIN SEASONAL HURRICANE FORECAST FOR 2008

| Forecast Parameter and 1950-2000 Climatology (in parentheses) | Full Season Forecast 3 June 2008 | Full Season Forecast 5 August 2008 | Observed Activity Through September | Percentage of Climatological Average Through September | October Monthly Forecast |
|---|---|---|---|---|---|
| Named Storms (NS) (9.6) | 15 | 17 | 12 | 155% | 3 |
| Named Storm Days (NSD) (49.1) | 80 | 90 | 74.50 | 196% | 15 |
| Hurricanes (H) (5.9) | 8 | 9 | 6 | 134% | 2 |
| Hurricane Days (HD) (24.5) | 40 | 45 | 24.75 | 132% | 7 |
| Intense Hurricanes (IH) (2.3) | 4 | 5 | 3 | 150% | 1 |
| Intense Hurricane Days (IHD) (5.0) | 9 | 11 | 6.75 | 147% | 2 |
| Accumulated Cyclone Energy (ACE) (96) | 150 | 175 | 122 | 164% | 30 |
| Net Tropical Cyclone Activity (NTC) (100%) | 160 | 190 | 124 | 153% | 35 |

## Notice of Author Changes

**By William Gray**

The order of the authorship of these forecasts was reversed in 2006 from Gray and Klotzbach to Klotzbach and Gray. After 22 years (1984-2005) of making these forecasts, it was appropriate that I step back and have Phil Klotzbach assume the primary responsibility for our project's seasonal, monthly and landfall probability forecasts. Phil has been a member of my research project for the last eight years and was second author on these forecasts from 2001-2005. I have greatly profited and enjoyed our close personal and working relationships.

Phil is now devoting much more time to the improvement of these forecasts than I am. I am now giving more of my efforts to the global warming issue and in synthesizing my projects' many years of hurricane and typhoon studies.

Phil Klotzbach is an outstanding young scientist with a superb academic record. I have been amazed at how far he has come in his knowledge of hurricane prediction since joining my project in 2000. I foresee an outstanding future for him in the hurricane field. I expect he will make many new seasonal and monthly forecast innovations and skill improvements in the coming years. He was awarded his Ph.D. degree in 2007. Klotzbach is currently spending most of his time working towards the improvement of these Atlantic basin seasonal hurricane forecasts.

## ABSTRACT

Information obtained through 30 September 2008 shows that we have so far experienced 124 percent of the average of a full season's Net Tropical Cyclone (NTC) activity and about 155 percent of the long-period average season through September. We correctly predicted above-average September NTC, although we predicted more activity than was observed.

Our October-only forecast calls for 3 named storms, 2 hurricanes, 1 major hurricane and NTC activity of 35 which is well above the October-only average value of 18. This is due to Atlantic basin sea surface temperatures remaining at above-average values and ENSO conditions remaining at neutral levels. Tropical Atlantic sea level pressure values have also remained at below-average levels. We think that the first half of October will be in the active phase of the Madden-Julian Oscillation (MJO) which appears to have been a major player in this season's Atlantic basin TC activity.

## SEPTEMBER FORECAST VERIFICATION

Our September 2008 forecast called for well above-average NTC activity. September 2008 did have above-average activity but not to the level that we predicted. We have now correctly predicted above- or below-average September NTC in six out of the last seven years. Forecast error standard deviations are provided based upon hindcast errors over the 1948-2007 period. Assuming a normalized error distribution, we expect that 2/3 of our forecasts will fall within one standard deviation of actual activity, with 95% of our forecasts falling within two standard deviations of actual activity.

We prefer to verify our forecasts based upon aggregate measures such as ACE and NTC. Although not our most accurate forecast, both ACE and NTC were at above-average levels in September 2008. A more in-depth analysis of the atmospheric and oceanic conditions that were present during September 2008 follows in our discussion (Section 3).

CSU forecast and verification of September-only hurricane activity made in early September. Error bars are provided (in parentheses) based upon one standard deviation of forecast errors over the 1948-2007 hindcast periods.

| Tropical Cyclone Parameters and 1950-2000 September Average (in parentheses) | September 2008 Forecast | September 2008 Verification |
|---|---|---|
| Named Storms (NS) (3.4) | 5 (±1.3) | 4 |
| Named Storm Days (NSD) (21.7) | 35 (±8.5) | 29.00 |
| Hurricanes (H) (2.4) | 4 (±1.0) | 3 |
| Hurricane Days (HD) (12.3) | 20 (±5.1) | 13.00 |
| Intense Hurricanes (IH) (1.3) | 2 (±0.6) | 1 |
| Intense Hurricane Days (IHD) (3.0) | 8 (±2.7) | 4.50 |
| Accumulated Cyclone Energy (ACE) (48) | 85 (±20) | 59 |
| Net Tropical Cyclone Activity (NTC) (48) | 90 (±16) | 56 |

# 1 Introduction

Our Colorado State University research project has shown that a sizable portion of the year-to-year variability of Atlantic tropical cyclone (TC) activity can be hindcast with skill significantly exceeding climatology. These forecasts are based on a statistical methodology derived from 60 years of past global reanalysis data and a separate study of prior analog years which have had similar global atmospheric and oceanic precursor circulation features. Qualitative adjustments are added to accommodate additional processes which may not be explicitly represented by our statistical analyses. We believe that seasonal forecasts must be based on methods showing significant hindcast skill in application to long periods of prior seasonal and monthly data.

# 2 Seasonal Update through September 2008

Through September, the 2008 hurricane season has had 124 percent of the NTC activity of the average full hurricane season. June-July 2008 had near-record activity, while August and September had slightly above-average activity. As of 1 October, 12 named storms, 6 hurricanes and 3 major (Cat. 3-4-5) hurricanes have developed. Through September, the climatological (1950-2000) average number of named storms, hurricanes and major hurricanes is 7.8, 4.5, and 2.0, respectively. The Atlantic basin has witnessed 155, 134 and 150 percent of average named storm, hurricane, and major hurricane activity, through September respectively. Overall, based on NTC, we have experienced 153 percent of the average tropical cyclone season through September 30. Table 1 and Figure 1 display Atlantic tropical cyclone statistics and tracks of tropical cyclones through September 30, respectively.

Table 1: Observed 2008 Atlantic basin tropical cyclone activity through September 30

| Highest Category | Name | Dates | Peak Sustained Winds (kts)/lowest SLP (mb) | NSD | HD | IHD | ACE | NTC |
|---|---|---|---|---|---|---|---|---|
| TS | Arthur | May 31 – June 1 | 35 kt/1005 mb | 0.75 | | | 0.4 | 2.0 |
| IH-3 | Bertha | July 3 – 20 | 105 kt/948 mb | 17.25 | 7.50 | 0.75 | 28.4 | 25.3 |
| TS | Cristobal | July 19 – 23 | 55 kt/1000 mb | 3.75 | | | 3.2 | 3.0 |
| H-2 | Dolly | July 20 – 24 | 85 kt/964 mb | 4.00 | 1.25 | | 5.3 | 6.8 |
| TS | Edouard | August 3 – 5 | 55 kt/997 mb | 1.75 | | | 1.5 | 2.3 |
| TS | Fay | August 15 – 24 | 55 kt/986 mb | 8.25 | | | 6.7 | 4.5 |
| IH-4 | Gustav | August 25 – September 2 | 130 kt/941 mb | 7.50 | 4.00 | 2.00 | 18.5 | 23.7 |
| H-1 | Hanna | August 28 – September 7 | 70 kt/978 mb | 10.00 | 0.75 | | 10.5 | 8.5 |
| IH-4 | Ike | September 1 – 14 | 125 kt/935 mb | 12.50 | 10.00 | 4.00 | 38.3 | 36.2 |
| TS | Josephine | September 2 – 5 | 55 kt/994 mb | 3.50 | | | 2.8 | 2.9 |
| H-1 | Kyle | September 25 – 29 | 70 kt/984 mb | 3.50 | 1.25 | | 4.7 | 6.6 |
| TS | Laura | September 29 – Present | 50 kt/993 mb | 1.50 | | | 1.5 | 2.2 |
| | | | | | | | | |
| Totals | 12 | | | 74.50 | 24.75 | 6.75 | 122.0 | 124.2 |

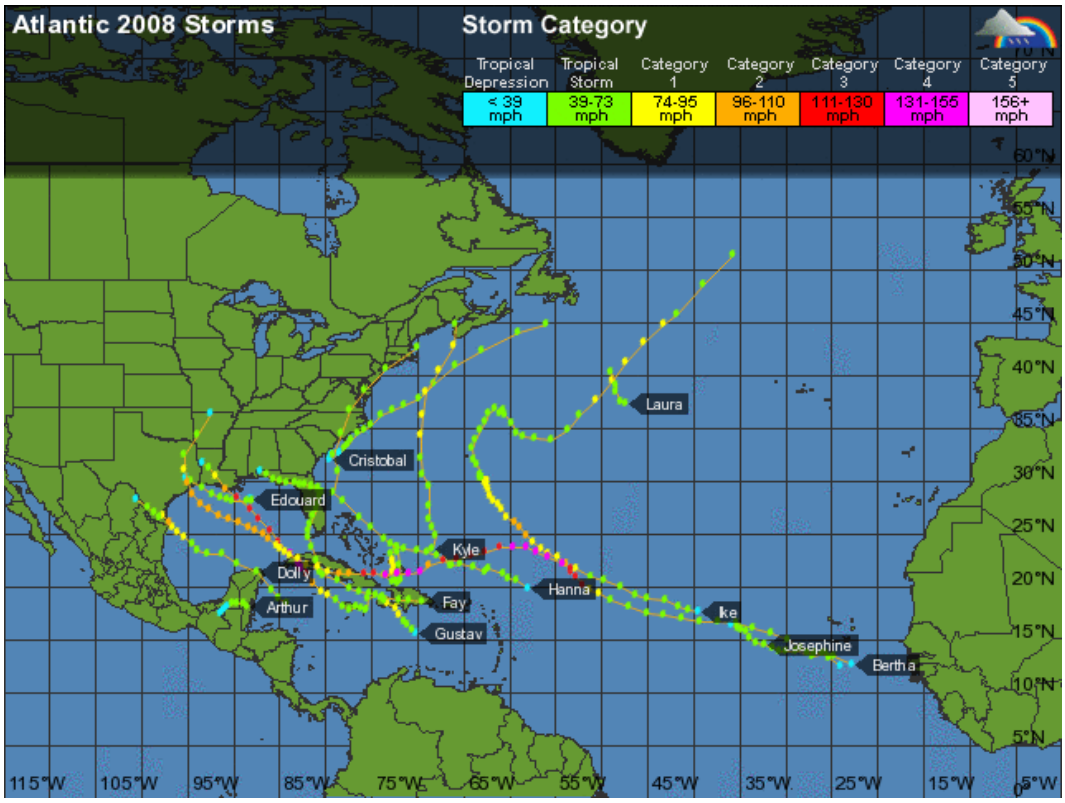


Figure 1: Tracks of 2008 Atlantic Basin tropical cyclones through September 30. Figure courtesy of Weather Underground (http://www.weatherunderground.com).

# 3 October Monthly Forecast

We have extensively revised our monthly forecasts this year. We are now issuing individual monthly predictions for the months of August, September and October during the early part of the month being predicted. Our statistical model for October monthly activity utilizes a smaller predictor pool than was used in the original forecast scheme, and, as is done with our seasonal predictions, we only attempt to hindcast NTC. The new model utilizes two predictors that evaluate upper- and lower-level winds in the east Atlantic and over Africa, as well as a predictor that evaluates early season tropical cyclone activity in the tropical Atlantic. Table 2 and Figure 2 discuss and display the predictors utilized in this year's October monthly forecast.

Table 2: Listing of predictors for October's hurricane activity. A plus (+) means that positive deviations of the parameter indicate increased hurricane activity for October, and a minus (-) means that positive deviations of the parameter indicate decreased hurricane activity for October.

| Predictor | Values for 2008 Forecast | Effect on 2008 Hurricane Season |
|---|---|---|
| 1) July-September 925 MB U (5-15°N, 35-65°W) (+) | +1.9 SD | **Enhance** |
| 2) September 200 MB U (10-25°N, 20°W-30°E) (-) | +0.2 SD | **Suppress** |
| 3) Prior to 1 Aug. – Named Storm Days in the Main Development Region (+) | 5.75 NSD | **Enhance** |

## October Monthly Forecast Predictors

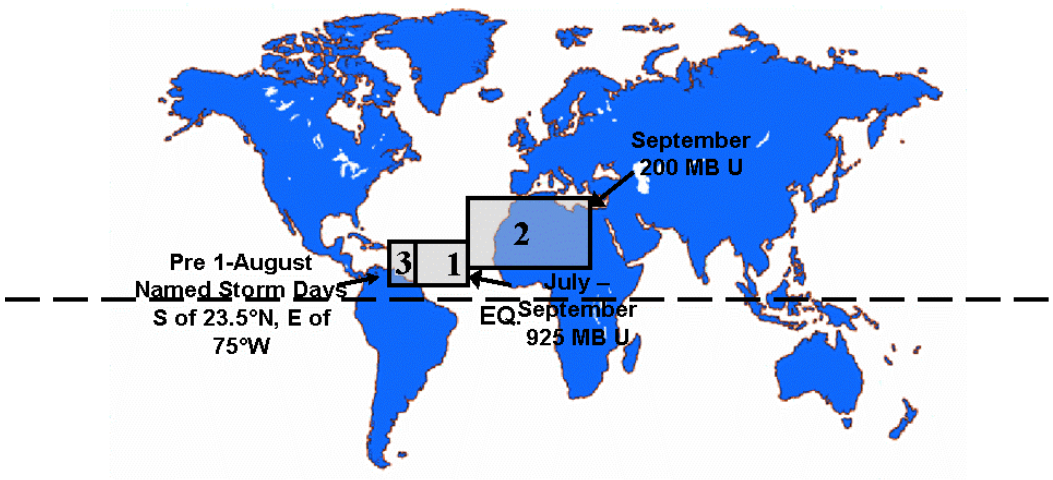


Figure 2: Global map showing locations of October-only TC predictors. Table 2 provides a listing and description of these predictors. The numbers in the boxes are keyed to the descriptions given in Table 2.

This new October statistical forecast model has shown considerable skill at hindcasting NTC over the period from 1948-2007. Using a linear regression model and the same ranking technique that was used in our seasonal forecast schemes from December, April, and June, we were able to hindcast 57 percent of the variance from 1948-2007. Each predictor had to explain additional variance over each of the periods from 1948-1987, 1988-2007, and over the full 1948-2007 period to be included the model. Figure 3 shows hindcasts of October NTC along with observations over the past sixty years. Table 3 displays our October monthly forecast for this year. All other parameters are calculated from the statistical model's NTC prediction using a similar methodology to what was used for the seasonal forecast calculations. Final October equations are shown below. For an October NTC prediction of 35, our statistical forecast for the number of named storms would thus be 0.8 + (0.05 * 35) = 2.6.

Named Storms = 0.8 + (0.05 * NTC)
Named Storm Days = 2.3 + (0.40 * NTC)
Hurricanes = 0.3 + (0.04 * NTC)
Hurricane Days = -0.1 + (0.24 * NTC)
Intense Hurricanes = -0.2 + (0.03 * NTC)
Intense Hurricane Days = -0.6 + (0.08 * NTC)

Accumulated Cyclone Energy = -0.44 + (0.96 * NTC)

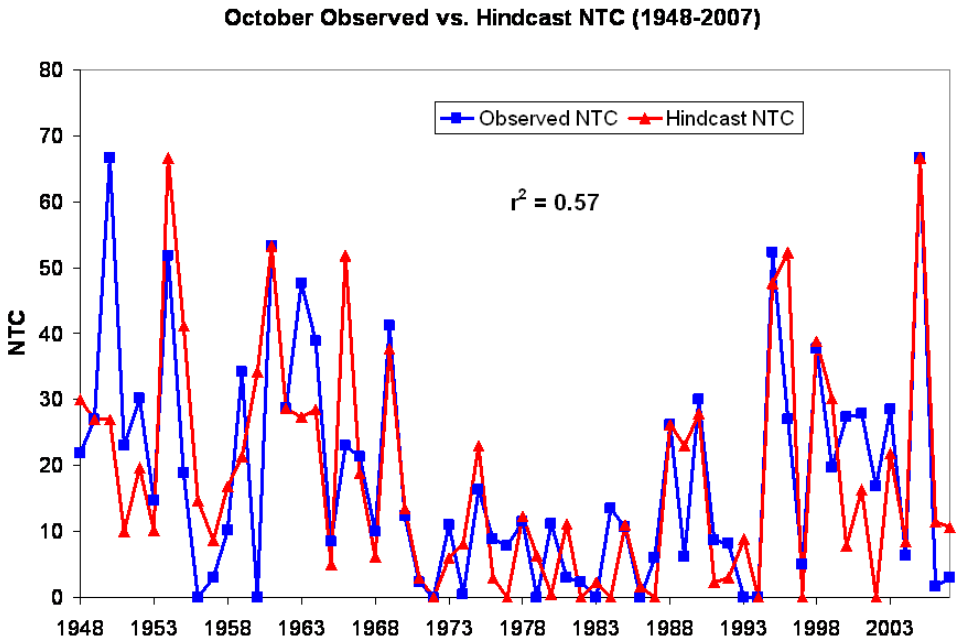


Figure 3: Observed versus hindcast October NTC over the period from 1948-2007.

Table 3: Independent **October-only** prediction of 2008 hurricane activity. October climatology is shown in parentheses in the middle column. Our October forecast for 2008 and October standard deviation errors are provided based upon hindcast errors over the 1948-2007 period in the right-hand column. Assuming a normalized error distribution, we expect that 2/3 of our forecasts will fall within one standard deviation of actual October activity, with 95% of our forecasts falling within two standard deviations of actual October activity.

| Parameter | Statistical Model | Qualitative Adjustment |
|---|---|---|
| NS | 3.0 (1.7) | 3 (±1.1) |
| NSD | 20.0 (9.0) | 15 (±5.4) |
| H | 2.1 (1.1) | 2 (±0.7) |
| HD | 10.4 (4.4) | 7 (±2.6) |
| IH | 1.2 (0.3) | 1 (±0.4) |
| IHD | 3.0 (0.8) | 2 (±0.9) |
| ACE | 42 (17) | 30 (±9) |
| NTC | 44 (18) | 35 (±9) |

# 4 September Discussion

The early portion of September was very active, with Ike forming on the first of the month and Josephine on the second of the month. Gustav made landfall as a strong Category 2 storm in central Louisiana on September 1. Hanna intensified into a hurricane during the early part of September, bringing torrential rains and flooding to Hispaniola before making landfall near Myrtle Beach, SC as a strong tropical storm on September 6. Ike reached Category 4 status and brought devastation to both the Turks and Caicos Islands and Cuba as it tracked through the northern Caribbean. Ike also exacerbated already devastating flooding from Hanna in Hispaniola. Following weakening over Cuba, Ike re-strengthened to a Category 2 hurricane and became a very large tropical cyclone in the northern Gulf of Mexico. Ike made landfall near Galveston Island early on September 12, causing extensive damage and destruction in the eastern part of Texas. Despite the active season that has occurred so far, a significant lull in storm formations occurred during September. Between Josephine that formed on September 2 and Kyle which formed on September 25, no tropical cyclones developed. This is unusual, considering that the three-week period during the middle of September is typically the most active period for storm formations in the Atlantic. However, very active seasons in the past have had similar types of lulls. For example, only one storm (Hurricane Marilyn) formed between August 27 and September 26 in 1995, which had a total of nineteen named storms and eleven hurricanes. When investigating an aggregate measure such as ACE or NTC, September 2008 had slightly above-average activity.

One of the primary reasons why we believe there was such a pronounced lull in an otherwise active hurricane season was due to the convectively-capped phase of the Madden-Julian Oscillation (MJO) that dominated the Atlantic for most of the month of September. Evidence of the reduction in convection over the tropical Atlantic can be seen by examining a time series of cold pixel count (a measure of deep convection) from the Cooperative Institute for Research in the Atmosphere (Figure 4). Note that, in general, there was much-reduced convection over the tropical Atlantic during September of this year when compared with August of this year.

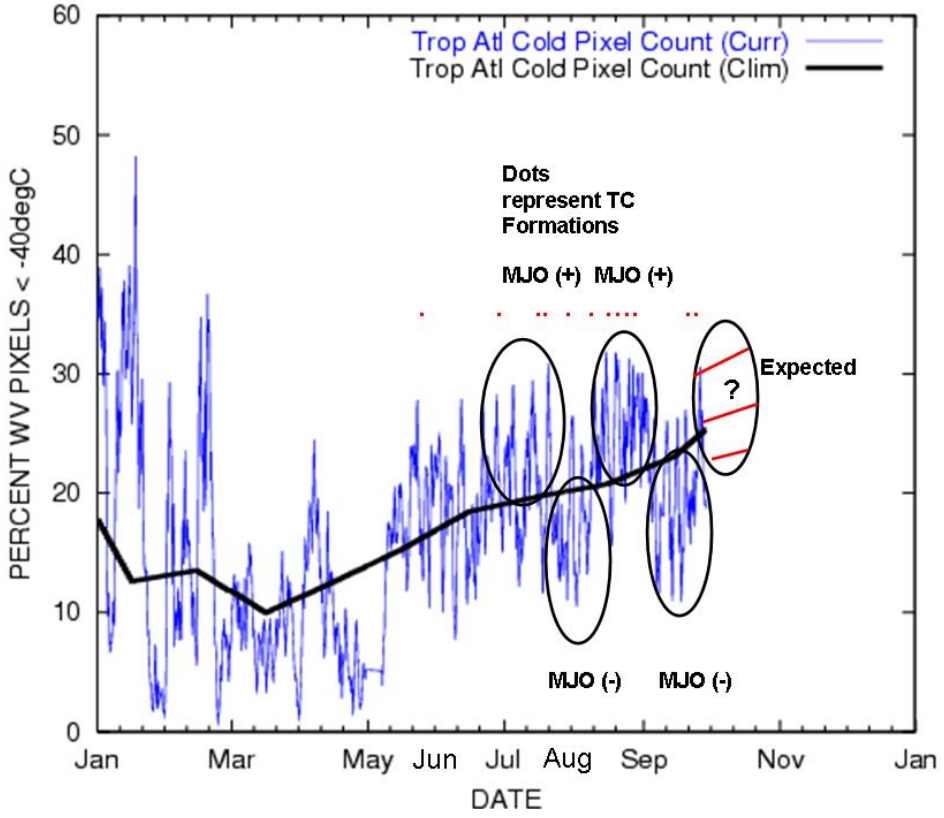


Figure 4: Tropical Atlantic cold pixel count. Figure adapted from an original provided by the Cooperative Institute for Research in the Atmosphere (CIRA).

From a large-scale perspective, other atmospheric and oceanic conditions were favorable for an active month. Sea level pressures remained at below average levels during September.

This was one of those years where the 40-50 day MJO appears to have had a prominent influence on Atlantic basin hurricane activity. The MJO modifies TC formation conditions through a general enhancement and suppression of tropical Atlantic subsidence as shown in Figure 4. More cold pixels imply weaker subsidence and more hurricane activity.

The apparent strong influence of the MJO observed in the difference in upper-level velocity potential anomalies between an inactive MJO phase (Figure 5) and an active MJO phase (Figure 6) appears to play an important role this year in explaining why we have seen such a strong time clustering of tropical cyclones this year. During the 18-day period from 3 July to 20 July, 3 named storms formed including major hurricane Bertha, the longest-lived tropical cyclone on record for the month of July. Over the 24-day period between 21 July and 14 August, only one short-lived tropical storm formed (Edouard). In the 22-day period between 3 September and 24 September, no named storms formed in the Atlantic (Figure 6), due largely to upper-level convergence dominating the tropical Atlantic. During a combined 46-day period in the middle of the

hurricane season, only one tropical storm formed in the Atlantic. By contrast, in the 17-day period from 3 to 20 July and the 18-day period from 15 August to 2 September, 8 named storms, 5 hurricanes and 3 major hurricanes formed. We have recently entered a convectively-enhanced portion of the MJO and expect enhanced conditions to persist during the first half of October. We consequently expect to have above-average hurricane activity during this period (Figure 7). Table 4 summarizes the strong time clustering of this year's hurricane season.

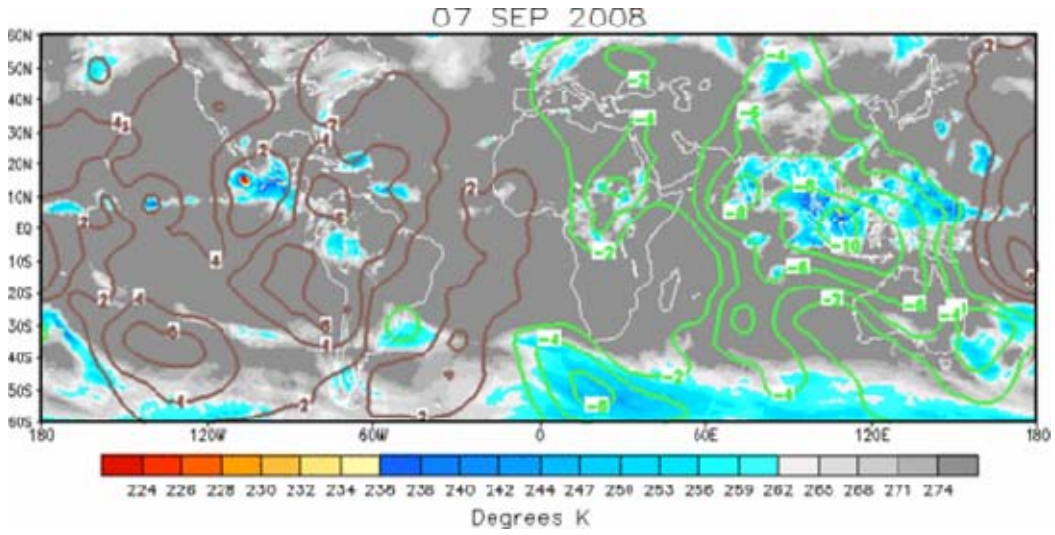


Figure 6: Upper-level velocity potential anomalies as observed on September 7, 2008. Note that anomalous upper-level convergence dominated the tropical Atlantic, as evidenced by the brown colors over the tropical Atlantic. This led to a three-week suppression of hurricane activity during the middle of September.

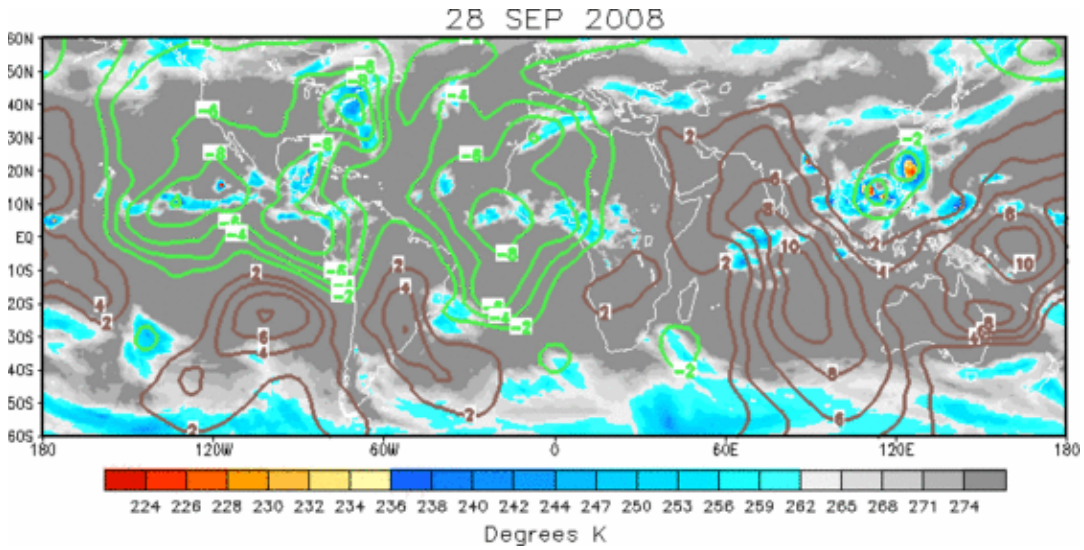


Figure 7: Current upper-level velocity potential anomalies. Green colors correspond to upper-level divergence which promotes convection and enhanced hurricane activity.

Table 4: Illustration of how Atlantic 2008 named storm formations during July-September have clustered into three distinct active periods of 42 days (10 formations occurred) and two distinct inactive periods of 47 days (1 formation occurred).

| Period | Named Storm Formations | MJO Phase |
|---|---|---|
| July 3 – 20 (18 Days) | 3 | **Positive** |
| July 21 – August 14 (25 Days) | 1 | Negative |
| August 15 – September 2 (18 Days) | 5 | **Positive** |
| September 3 – September 24 (22 Days) | 0 | Negative |
| September 25 – September 30 (6 Days) | 2 | **Positive** |
| October 1 – October 15 (16 Days) | ? | **Expected (Positive)** |

Sea surface temperatures remain in a favorable configuration for an active end to the season in the tropical Atlantic. Figure 8 displays September global sea surface temperature anomalies, while Figure 9 displays September tropical Atlantic sea level pressure anomalies. One interesting feature to observe is that there has been a considerable cooling in the eastern and central tropical Pacific from earlier in the summer. Earlier this year, we were concerned about the potential development of an El Niño during the latter portion of this summer and early this fall; however, this warm ENSO event failed to develop. We believe that the failure of the El Niño to develop was at least partially due to the pronounced anomalously strong trade winds which persisted throughout the summer in the central tropical Pacific. These strong trades helped reinforce cool sub-surface anomalies that were already present in the central Pacific. Figure 10 displays a time-longitude plot of low-level winds across the tropical Pacific. Table 5 displays the cooling that has occurred in all four Nino regions between August and September.

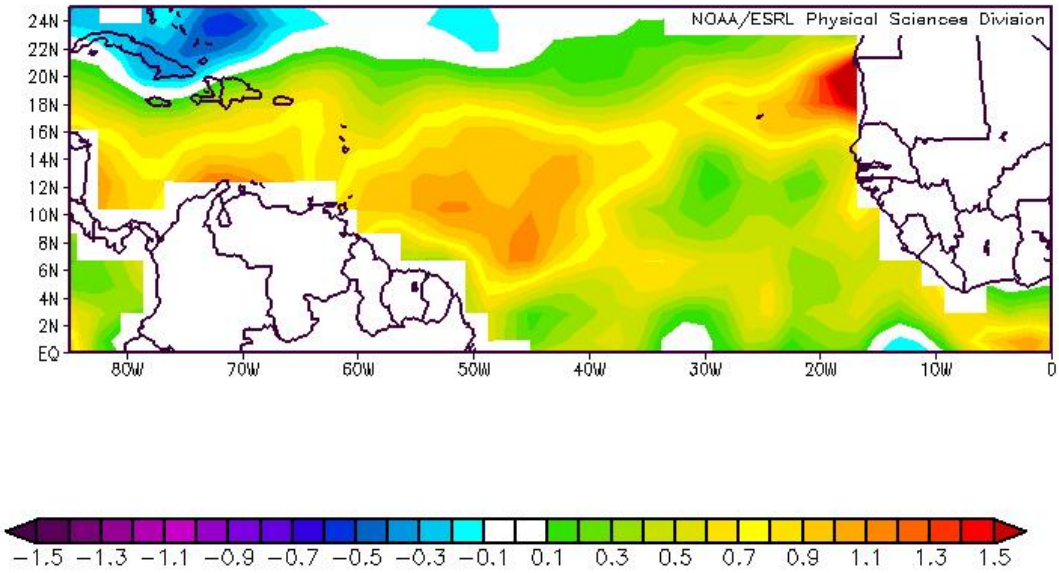


Figure 8: September SST anomalies over the tropical Atlantic.

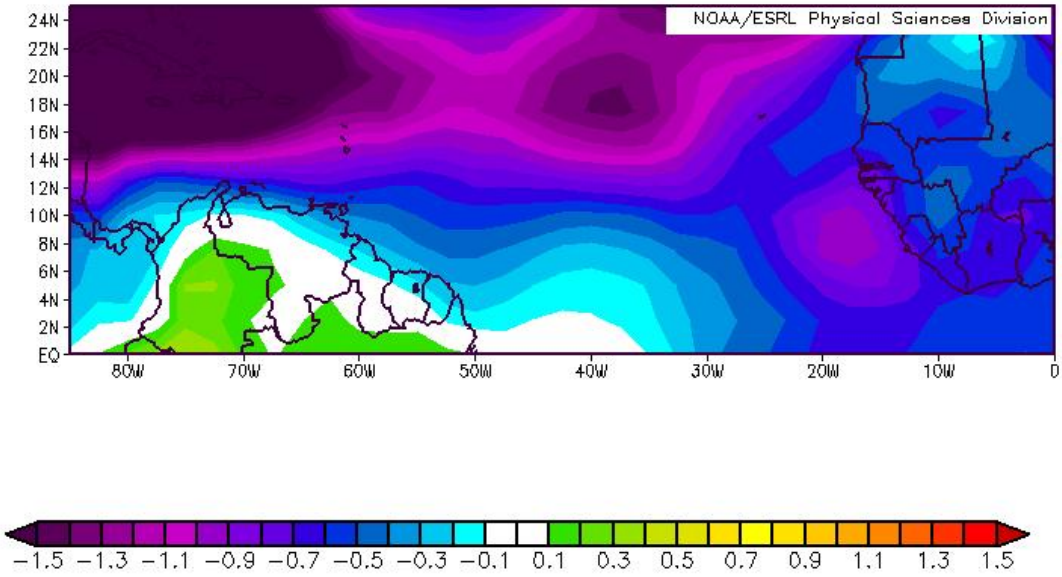


Figure 9: September SLP anomalies over the tropical Atlantic.

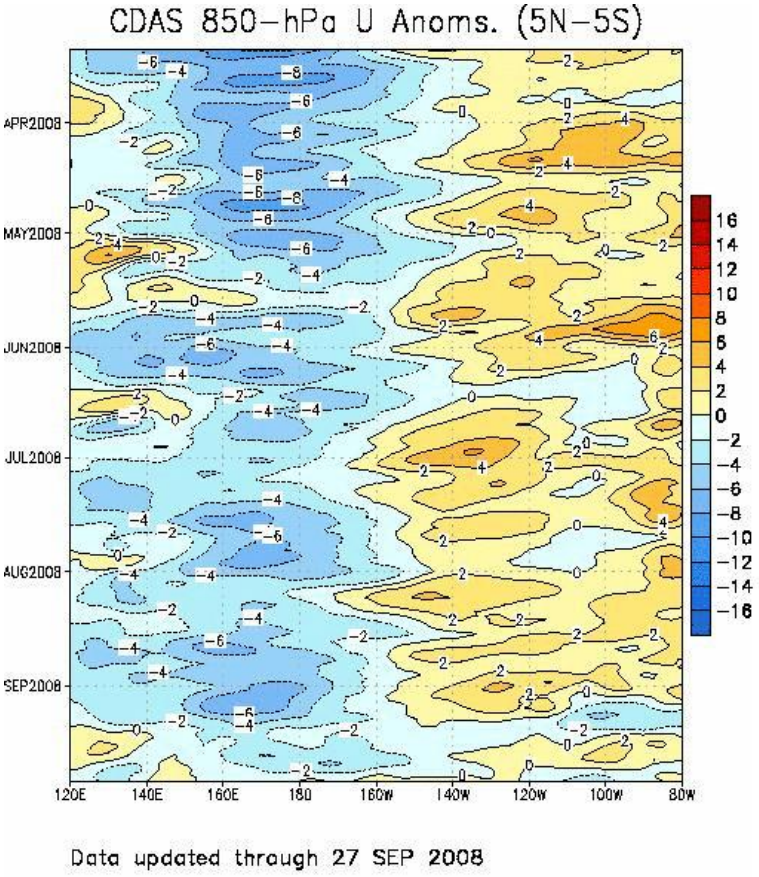


Figure 10: Time-longitude plot of 850-mb zonal wind anomalies across the tropical Pacific. Figure courtesy of the Climate Prediction Center. The continuous anomalously strong trade winds in the central Pacific helped prevent the formation of an El Niño event.

Table 5: August and September 2008 SST anomalies for Nino 1+2, Nino 3, Nino 3.4, and Nino 4, respectively. September-August SST anomaly differences are also provided.

| Region | August SST Anomaly (°C) | September SST Anomaly (°C) | September minus August SST Cooling (°C) |
|---|---|---|---|
| Nino 1+2 | 1.1 | 0.6 | -0.5 |
| Nino 3 | 0.7 | 0.2 | -0.5 |
| Nino 3.4 | 0.2 | -0.2 | -0.4 |
| Nino 4 | -0.3 | -0.4 | -0.1 |

## 5 Forecast Theory and Cautionary Note

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 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. However, it must also be emphasized that a low landfall probability does not insure that hurricanes will not come ashore. Regardless of how active the remainder of the 2008 hurricane season is, a finite probability always exists that one or more hurricanes may strike along the U.S. coastline or in the Caribbean Basin and do much damage.

# 6 Forthcoming 2008 Verification and Initial Forecast of 2009 Hurricane Activity

A 2008 seasonal forecast verification and detailed discussion of all aspects of this year's hurricane activity will be issued on **Wednesday, November 19, 2008**. We attempt to explain why seasonal activity occurred the way that it did and how this seasonal activity compared to other seasons in the past. Our first seasonal hurricane forecast for the 2009 hurricane season will be issued on **Tuesday, December 9, 2008.** All forecasts are available on the web at: http://hurricane.atmos.colostate.edu/.