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# 2015 ATLANTIC HURRICANE SEASON: TROPICAL STORMS ANA AND BILL RUSH IN ON EXPECTED QUIET SEASON

## The 1957 and 1965 seasons were both moderate El Niño seasons and saw major hurricane landfalls with Audrey (1957) and Betsy (1965).

As with any season, a landfalling hurricane can be a serious threat regardless of seasonal outlooks for the Atlantic Basin at large.

For the North Atlantic Basin, seasonal outlook providers are expecting tropical activity to fall below the long-term average of 1955-2014. Common factors include a continuing El Niño and cool sea-surface temperatures (SSTs) in the Atlantic Main Development Region (AMDR) (the area of the tropical Atlantic between Africa and the Gulf of Mexico, specifically 10°N-20°N and 20°W-85°W).

Historically, it is clear that the relationship between basin activity and landfalls is very volatile. Greater Atlantic activity does not necessarily equate to more tropical storm landfalls, just as a quiet season does not guarantee safety from a catastrophic hurricane landfall. Landfalls are determined by weather patterns during a hurricane's lifetime, not pre-season estimates of hurricane frequency. The recent landfall of Tropical Storms Ana and Bill stands as a reminder to this point.

Indeed, much of the Atlantic Main Development region currently carries cooler sea-surface temperatures, but the waters of the northern Caribbean and northern Gulf of Mexico are warmer than average. Tropical storm development close to the mainland carries a higher chance of landfall.

Also, it is accepted that El Niño conditions tend to suppress hurricane development in the Atlantic Basin, but scientific research reveals that this effect is strongest in the deep tropics, and generally south of 20°N. The 1957 and 1965 seasons were both moderate El Niño years, but witnessed the landfall of major hurricanes — Audrey (1957) and Betsy (1965). The 1957 season experienced only three hurricanes in the Atlantic Basin at large and Audrey was the only one of the three to make U.S. landfall. Audrey formed in the Gulf of Mexico and made landfall as a notorious Category 4 hurricane near the Texas-Louisiana border.

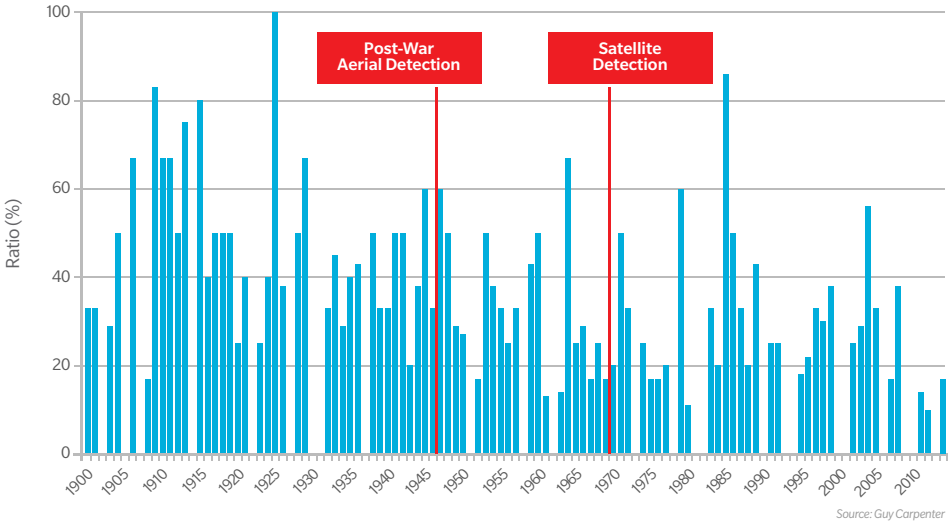
While we indeed may see a quiet season, warm waters in the northern Gulf of Mexico and northern Caribbean warrant a moment of pause. As with any season, landfall is a possibility and warrants review of hurricane plans and procedures by both property owners and the (re) insurance industry alike.

## 2015 SEASONAL OUTLOOKS SUGGEST REDUCED BASIN ACTIVITY

### Development Near United States Still Possible – U.S. Landfalls Uncertain

As illustrated in Figure 1 (right), the historical proportion between basin counts and landfalls has been very volatile on an annual basis. There is only a weak correlation between hurricane counts in the Atlantic Basin and the number of U.S. landfalls. The statistical significance is a subject of some debate in the scientific community (Coughlin et al., 2009; Dailey et al., 2009).

F-1 | U.S. LANDFALL TO BASIN RATIO – DETECTED HURRICANES (1900-2014)




Source: Guy Carpenter

Note declining trend over time with post-war overflight detection (late 1940s) and satellite detection (1970s).
Note variability from year to year and high ratio in 1985.

The year to year volatility warrants preparation for any season. The quiet 1992 season saw only four hurricanes with one making a very impactful and historic U.S. landfall. Meanwhile, the 2010 season saw 19 named storms and 12 hurricanes, without a single U.S. landfall. In 1985 there were seven hurricanes in the basin, and six of these made U.S. landfall (some of which were very impactful).

Seasonal activity predictions for the basin are valuable, but the impacts of even a single tropical storm or hurricane landfall (quiet season or not) can be quite severe. Historical experience warrants proper review and preparation of hurricane plans by all interests from individual homeowners to businesses to the (re)insurance industry at large.

In light of this reality, seasonal outlook providers expect 2015 basin counts to fall below the long-term mean of 1955-2014. The expected counts also fall clearly below the short-term 1995-2014 mean, reflecting the current warm phase of the Atlantic Multidecadal Oscillation.

Factors of greatest influence include:

1. A moderate El Niño expected through the 2015 hurricane season.
2. Cooler than normal SSTs in the AMDR.

The predictions of seasonal outlook providers, including the Colorado State University team of Professors William A. Gray and Phillip J. Klotzbach, are included in Table 1 below.

T-1 | SEASONAL OUTLOOKS FOR THE 2015 ATLANTIC HURRICANE SEASON

| Source | Named Storms[7] | Hurricanes[8] | Major Hurricanes[9] | A.C.E.[10] |
|---|---|---|---|---|
| WSI[1] (May 26) | 9 | 5 | 1 | - |
| CSU[3] (June 1) | 8 | 3 | 1 | 40 |
| UK Met[4] (May 21) | 8 | 5 | - | 74 |
| NOAA[5] (May 27) | 6-11 | 3-6 | 0-2 | 37-79 |
| NCSU[2] (April 16) | 4-6 | 1-3 | 1 | - |
| 1995-2014 Mean[6] | 14.8 | 7.6 | 3.5 | 131 |
| 1955-2014 Mean[6] | 11.2 | 6.1 | 2.5 | 100 |

1 Weather Services Incorporated/The Weather Channel
2 North Carolina State University. (Xie et. al.,2015)
3 Colorado State University (Klotzbach, Gray)
4 U.K. Met Office, 2015: North Atlantic tropical storm seasonal forecast 2015. http://www.metoffice.gov.uk/weather/tropicalcyclone/seasonal/northatlantic2015. Accessed May 2015.
5 Climate Prediction Center of the National Oceanic and Atmospheric Administration (NOAA)
6 Hurricane Research Division (NOAA)
7 Tropical cyclone with maximum sustained surface winds of at least 39 mph
8 Tropical cyclone with maximum sustained surface winds of at least 74 mph
9 Hurricane with maximum sustained surface winds of at least 111 mph (Category 3 or higher on the Saffir-Simpson scale)
10 Accumulated Cyclone Energy (or A.C.E.) is defined as the sum of squares of six-hourly maximum sustained wind speeds (in knots) for all tropical storms or hurricanes. Units are $x10^4$ $knots^2$. This index is a proxy for the energy expended by a tropical cyclone.

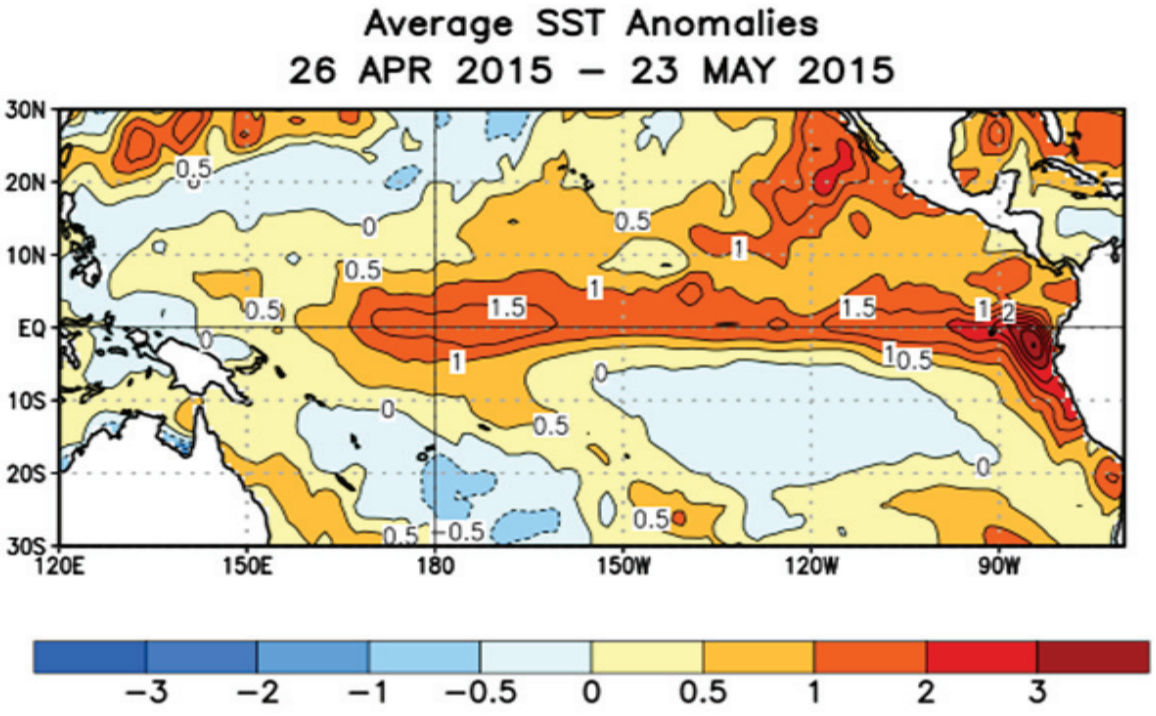
## EL NIÑO SOUTHERN OSCILLATION (ENSO)

The ENSO phenomenon is signaled by SSTs in the tropical East Pacific, with warm "El Niño" phases and cold "La Niña" phases. The large-scale circulations associated with El Niño enhance wind shear (changing wind speed with height) in the tropical Atlantic. The enhanced wind shear disrupts tropical cyclone development, generally resulting in fewer tropical cyclones in the Atlantic Basin. The suppressing effects of El Niño are found to be strongest in the deep tropics (Kossin et al., 2010) and for African "Cape Verde" type storms.

According to the NOAA Climate Prediction Center (CPC), El Niño conditions are in place and there is a 90 percent chance of ongoing El Niño conditions through the upcoming season. Expectations are for a moderate El Niño.

As always there are no absolutes to hurricane predictability. The 1957 hurricane season produced three hurricanes. One of those hurricanes, Audrey, made landfall on the northern Gulf of Mexico as an impactful Category 4 hurricane. The 1965 season produced four hurricanes, with Hurricane Betsy, a Category 4 storm, making U.S. landfall on the northern Gulf. Both the 1957 and 1965 seasons were moderate El Niño years.

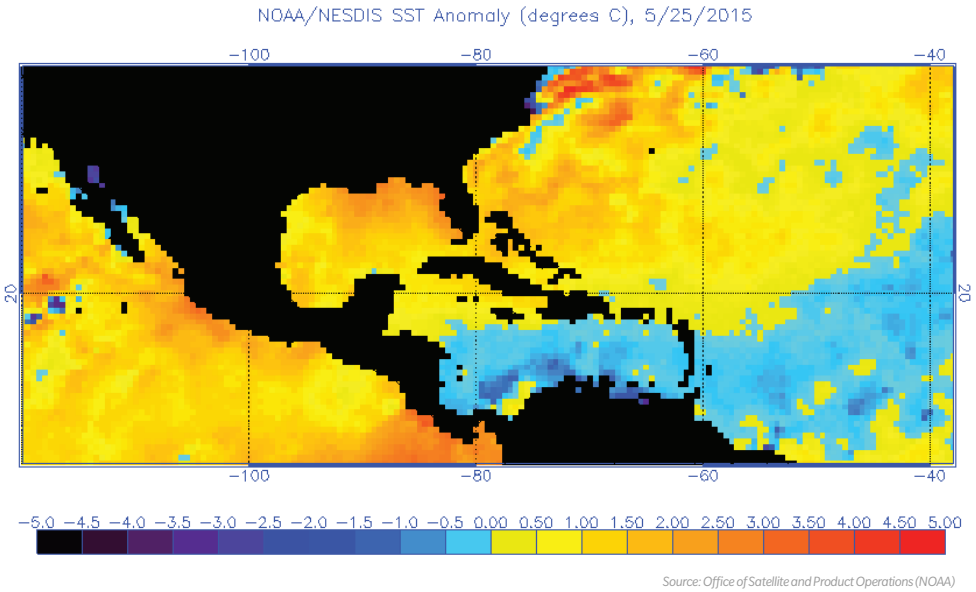
F-2 | AVERAGE SEA-SURFACE TEMPERATURE ANOMALIES FOR THE PACIFIC BASIN




*Source: Climate Prediction Center (NOAA)*

Note the warm pool near 0°N by 180°W and warmer waters centered along the equatorial regions of the East Pacific.

F-3 | SEA-SURFACE TEMPERATURE ANOMALIES AS OF MAY 25, 2015




*Source: Office of Satellite and Product Operations (NOAA)*

Note the patches below normal in the deep tropics.
Note the area above normal near the southeast U.S., northern Caribbean and Gulf of Mexico.

## TROPICAL ATLANTIC SEA-SURFACE TEMPERATURES (SSTs)

Seasonal outlook providers note the cooler than average SSTs in the tropical Atlantic as a key factor for a quiet season.

Indeed, a closer look reveals cooler SSTs in the AMDR. However, on closer inspection, above normal SSTs are found in an area adjacent to the U.S. Florida coast including the Bahamas and northern Caribbean. SSTs are also quite warm in the northern Gulf of Mexico (Figure 3).

- Disturbances adjacent to the U.S. mainland, northern Gulf of Mexico and northern Caribbean may find an environment that enables development. This applies both to disturbances that originate in the area and also for "Cape Verde" disturbances arriving from their Atlantic transit, even if they haven't had a chance to develop.

## IMPLICATIONS

In light of the expected El Niño and cooler than average SSTs over the AMDR, some subtle but important factors warrant consideration:

1. The suppressive effects of El Niño are found to be strongest over the deep tropics (Kossin et. al., 2010) and "Cape Verde" origin storms, and less pronounced for Gulf-origin storms or those of higher latitude.
2. With the moderate El Niño expected this year, tropical development may indeed be suppressed in the deep tropics and for African "Cape Verde" type storms.
3. SSTs are somewhat cooler than normal over the tropical East Atlantic, but not for the waters adjacent to Florida, the northern Caribbean or the northern Gulf of Mexico.
4. Disturbances adjacent to the U.S. mainland and northern Caribbean may find an environment that enables development. This applies both to disturbances that originate in the area, and also for "Cape Verde" disturbances that arrive from their Atlantic transit, even if they have not yet had a chance to develop.
5. Landfalls are influenced by large-scale weather patterns at the time of occurrence, which cannot be forecast beyond a 14-day time frame.

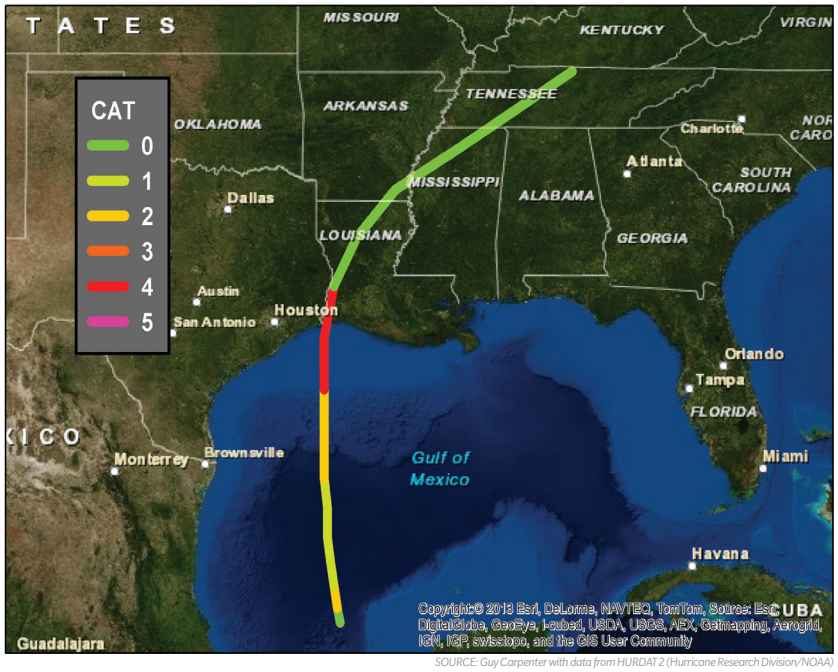
So while this indeed may be a quiet year, the northern Gulf of Mexico and northern Caribbean are areas still to watch closely. Hard experience has reminded us time and again that a single landfalling hurricane can be very impactful, with severe consequences both for those affected, and for the industry at large, regardless of basin activity.

## HISTORICAL IMPACTS – WHAT WE KNOW CAN HAPPEN

### Hurricane Audrey (1957)

- Hurricane Audrey made landfall as a Category 4 hurricane on the Saffir-Simpson Scale.
- Audrey originated from a tropical wave over the southwestern Gulf of Mexico.
- Just prior to landfall, Audrey experienced a period of rapid development, growing from a Category 2 to a Category 4 hurricane.
- Storm Surge: Estimated 8 to12 feet, with penetration as far as 25 miles inland.
- Audrey rendered significant damage under storm surge to the southwest coast of Louisiana, especially for the Cameron area. An estimated 60 to 80 percent of homes were floated off their foundations.
- Reliable wind observations are unavailable for a more precise estimate of sustained winds at landfall. (NHC, 2015)
- The landfall location was very close to that of Hurricane Ike (2008), a Category 2 hurricane at landfall.
- The 1957 tropical season was a moderate El Niño year that produced three hurricanes in the Atlantic Basin and one U.S. landfall.
- At least 390 fatalities were reported as a result of Audrey.

F-4 | HURRICANE AUDREY (1957)

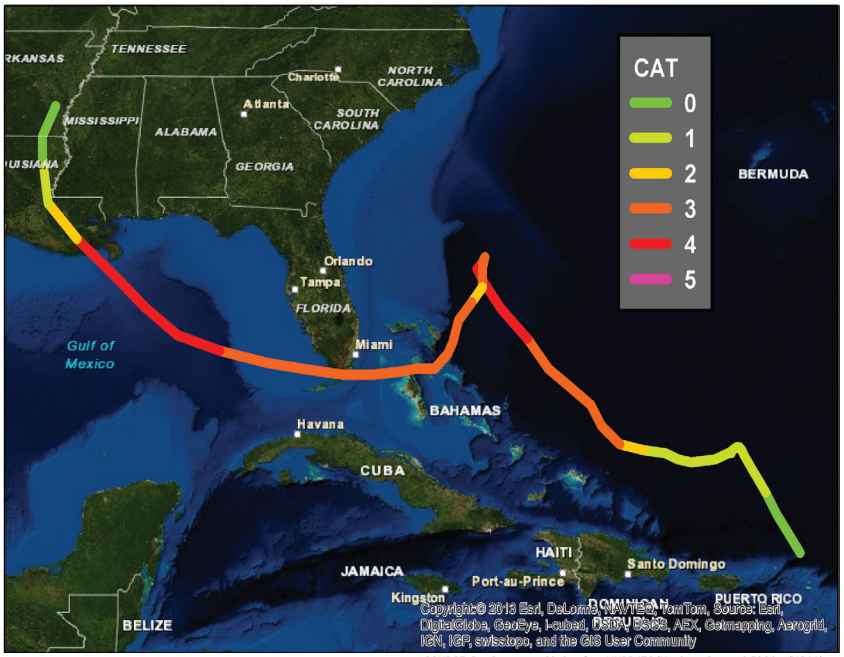



SOURCE: Guy Carpenter with data from HURDAT 2 (Hurricane Research Division/NOAA)

### Hurricane Betsy (1965)

- Betsy made landfall on Key Largo with estimated winds of 125 mph (Category 3 hurricane ) before entering the Gulf of Mexico.
- Betsy then made a second landfall near Grand Isle, Louisiana with estimated winds of 155 mph (Category 4).
- Storm surge of eight feet at Big Pine Key, also with severe beach erosion along southwest Florida.
- Storm surge of about 16 feet near Grand Isle, Louisiana.
- Estimated economic losses of USD18.7 billion in 2010 dollars, correcting for wealth and inflation (Blake et al., 2011).
- This was a very quiet season under a strong El Niño year, with only four hurricanes in the Atlantic Basin, one of which made U.S. landfall.

F-5 | HURRICANE BETSY (1965)




SOURCE: Guy Carpenter with data from HURDAT 2 (Hurricane Research Division/NOAA)

## WHAT ARE WE PREPARING FOR ANYWAY?

Any hurricane can produce wind, surge and inland flood impacts. The severity and scope of impacts is not always consistent with rating on the Saffir-Simpson scale, particularly for surge as we have seen with Katrina (2005) and Sandy (2012).

- **Wind:** For a typical wood frame structure, damage usually starts from the top of the structure and most often with the roof (trees notwithstanding). These effects can become noticeable with sustained wind speeds as low as 40 mph. For more severe wind events, wind damage will affect the walls, and in extreme cases such as Andrew (1992) or Charley (2004), many structures will be barely recognizable following the event. Downed trees and powerlines are commonly found with any tropical cyclone.
- **Storm surge:** Storm surge is related to many factors including wind speed over water, the area of water affected by wind, bathymetry and coastline shape. Water intrusion will ruin the interior of any coastal property. Water velocity and particularly wave activity can cause severe to complete structural damage, since water weighs about one ton per cubic yard. Water damage usually begins at the bottom of a structure and becomes more severe with increasing water levels and wave height. With excessive water velocity or wave activity, the foundation itself can be dislodged, resulting in structural failure. In extreme cases the property can be scoured from the foundation such as Katrina (2005) in the Mississippi Gulf coast area. Our most recent reminder of U.S. surge impacts is from Sandy (2012). While Sandy was a post-tropical cyclone at landfall, the size of the wind field and angle of landfall near Brigantine, New Jersey drove a historic surge event for the area as far north as Massachusetts. The severity of surge impacts was equivalent to a typical Category 3 hurricane, yet the wind speeds alone did not suggest the potential for such damage.
- **Freshwater flooding:** Freshwater flooding is affected by factors such as excessive rainfall, storm motion, the capacity of local storm-water management infrastructure and local geography. The freshwater impacts of Irene (2011) and Fay (2008) were quite severe in the New England and North Florida areas, respectively. Floodwaters can ruin any structure they affect, and can even cause structural damage if water velocity is sufficient. Flood damage starts at the bottom of the structure and increases in severity with increasing inundation height.

Preparation for each of these impacts and the resulting disruption to infrastructure is an ongoing and essential process for homeowners, businesses, government agencies including NOAA and FEMA, and of course the (re)insurance industry. The landfall of one or two hurricanes cannot be ruled out for any season.

## CLOSURE

Hurricane activity for the Atlantic Basin is projected by seasonal outlook providers to be below average for the 2015 season, but these providers all stress preparation for a landfalling hurricane, as with any season. Cool SSTs and a probable El Niño would indeed indicate reduced basin activity, although a closer look implies that these suppressing effects will be confined to the East Atlantic and deep tropics. Warm SSTs in the northern Caribbean and Gulf of Mexico warrant some caution. Hurricane landfall is a threat for any hurricane season, irrespective of basin activity, as history has shown more than once.

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## References


Blake, E.S., Landsea, C.W. and Gibney, E.J., 2011: The Deadliest, Costliest, and Most Intense United States Tropical Cyclones From 1851 to 2010. National Weather Service. NOAA Technical Memorandum NWS NHC-6.

Climate Prediction Center, 2015: Analysis Tools. National Oceanic and Atmospheric Administration. www.cpc.ncep.noaa.gov. Accessed May, 2015.

Coughlin, K., Bellone, E., Laepple, T., Jewson, S., Nzerem, K., 2009: A relationship between all Atlantic hurricanes and those that make landfall in the U.S.A. *Quarterly Journal of the Royal Meteorological Society*, 135, 371-379.

Dailey, P.S., Zuba, G., Ljung, G., Dima, I.M., Guin, J., 2009: On the Relationship between the North Atlantic Sea Surface Temperatures and U.S. Hurricane Landfall Risk. *Journal of Applied Meteorology and Climatology*, 48, 111-129.

Klotzbach, Philip J., and Gray, William M., 2015: Extended range forecast of Atlantic seasonal hurricane activity and landfall strike probability for 2015. http://hurricane.atmos.colostate.edu/Forecasts. Accessed June, 2015.

Kossin, J.P., Camargo, S.J. and Sitkowski, M., 2010: Climate Modulation of North Atlantic Hurricane Tracks. *Journal of Climate*, 23, 3057-3076.

National Hurricane Center, 2015: Tropical Cyclone Reports (Hurricane Andrew, Hurricane Betsy, Hurricane Audrey). National Oceanic and Atmospheric Administration. www.nhc.noaa.gov. Accessed May, 2015.

Office of Satellite and Product Operations, 2015: Sea Surface Temperature Contour Charts. National Oceanic and Atmospheric Administration. http://www.ospo.noaa.gov/Products/ocean/sst/contour/. Accessed May, 2015.

Pielke Jr., R.A., Gratz, J., Landsea, C.W., Collins, D., Saunders, M.A. and Musulin, R., 2008: Normalized Hurricane Damage in the United States: 1900-2005. *Natural Hazards Review*, 9, 29-42.

U.K. Met Office, 2015: North Atlantic tropical storm seasonal forecast 2015. http://www.metoffice.gov.uk/weather/tropicalcyclone/seasonal/northatlantic2015. Accessed May 2015.

Weather Services Incorporated, 2015: WSI: Lower-than-Normal Tropical Activity Levels Expected in 2015. Weather Services Incorporated. www.wsi.com. Accessed May, 2015.

Xie, L., Alfaro-Cordoba, M., Liu, B. and Fuentes, M., 2015: 2015 Atlantic Tropical Outlook. North Carolina State University.