



SHORELINES – January 2011

As presented to the *Island Review* magazine

The 2010 Hurricane Season - Revisited

November 30th signified the last day of the 2010 hurricane season which officially began on June 1st. Most of the headlines summarizing the season were marvelously consistent and read to the tune of; “Southeastern N.C. escapes very active hurricane season” (*Wilmington Star*), or “Extremely Active Atlantic Hurricane Season was a 'Gentle Giant' for U.S.” (*NOAA*), or my personal favorite, “Storms were numerous, but U.S. had ‘hurricane repellent,’ expert says.” (*National Geographic*).

Actually these snap-shot headlines appropriately summarize the 2010 hurricane season – 2010 had the 3rd highest number of cyclones (19) ever recorded for a season. Actually 2010 tied the years of 1995 and 1887, and only 2005 (28 named cyclones) and 1933 (21 named cyclones) were busier than 2010. However despite the high number of cyclones, only one weak tropical storm made a direct landfall on U.S. soil (tropical storm *Bonnie* in South Florida at 40 mph). That’s it. So let’s scratch beneath the surface and find out why. But first and foremost we need to be operating under the fundamental premise that the Atlantic Ocean basin continues to be in the middle of a heightened trend of tropical cyclone activity compliments of cyclical ocean-atmosphere interactions coupled with possible impacts from warming climate and seas (there’s still some debate on this).

Hot Water and La Niña (or ENSO cold phase)

The overall trend of increased cyclone activity this year has been mostly attributed to two factors; **(1)** record sea surface temperatures in the equatorial Atlantic, and **(2)** *La Niña* conditions that began to develop in June of 2010, which provides a favorable atmospheric environment for cyclone development and sustainability. Hence, there was plenty of “fuel” (warm water) to generate cyclones, and very little in the atmosphere to inhibit subsequent development.

Quickly, *El Niño* Southern Oscillation, or “ENSO” occurs in the Pacific Ocean basin - ENSO “warm phase” or *El Niño* occurs once every 2 to 7 years and generally produces atmospheric conditions (dry air and wind shear) that tend to suppress the formation of tropical cyclones in the Atlantic. The term *El Niño* means Little Boy or Christ Child, which was coined by South American fishermen noting the appearance of unusually warm water in the Pacific Ocean occurring near Christmas. As you may have guessed by now, “*La Niña*” (the girl child) is the “cold phase” of ENSO and as mentioned above, tends to produce atmospheric conditions more conducive for tropical cyclone development. Technically speaking we are currently experiencing *La Niña* conditions that are forecasted to peak during the winter of 2010-11, and gradually diminish in the spring and summer of 2011. If this prediction holds true, then enough time will have elapsed for this to become a full-fledged *La Niña* episode.

Hurricane Vocabulary

There are plenty of terms associated with the hurricane season, which are frequently mentioned in this summary as well - cyclones, tropical storms, subtropical storms, hurricanes, and more; and therefore it’s worth our effort to introduce some basic hurricane terminology below.

Tropical cyclone - warm-core, atmospheric closed circulation rotating counter-clockwise in the Northern Hemisphere (that's us) and clockwise in the Southern Hemisphere.

Tropical storm – a tropical cyclone with a maximum sustained surface wind speed ranging from 39 mph to 73 mph using the U.S. 1-minute average.

Hurricane - a tropical cyclone with a maximum sustained surface wind speed reaching 74 mph or more.

Saffir Simpson Scale – a scale including a 1 to 5 rating based upon wind speeds, again utilizing the U.S. 1-minute average. A category 1 hurricane has winds ranging from 74 to 95 miles per hour (mph), category 2 ranges from 96 to 100 mph, category 3 ranges from 111 to 130 mph, category 4 ranges from 131 to 155 mph, and a category 5 hurricane has sustained winds exceeding 155 mph.

Major Hurricane – a hurricane reaching category 3 or higher on the Saffir Simpson Scale. Interestingly, category 5 hurricanes very rarely make landfall while maintaining their category 5 intensity - only three have ever made landfall in the U.S. – the Labor Day hurricane (1935), *Camille* (1969), and *Andrew* (1992).

Now to account for some of the weather oddballs, we also need to include;

Extratropical Storm - a *cold-core* atmospheric cyclone deriving its energy when cold and warm air masses interact, not as part of the positive feedback loop identified with tropical storms as warm, moist air rises causing continual heat exchange. Unlike tropical storms, extratropical storms can have one or more fronts connected to them, and can occur over land or ocean. Extratropical cyclones can have winds ranging to levels associated with a tropical depression, or as strong as a hurricane and examples include blizzards and nor'easters, which often form in winter and fall months off the mid-Atlantic and drift slowly along the north Atlantic seaboard and eventually east. If it drifts back west towards land, it is called a retrograded nor'easter.

Subtropical Storm - occurs if waters under an extratropical cyclone are warm, followed by thunderstorms that gradually build inside the storm. The storm core may subsequently and gradually go from cold to warm, and the storm will be called subtropical.

Note: Both subtropical and extratropical cyclones have the highest winds and thunderstorms a good distance away from the center, and may have frontal boundaries associated with the systems. The two (extra- and subtropical) are usually broader systems than a tropical system, but the subtropical system will produce more rain compared to an extratropical one.

2010 Season Recap

Hurricane forecasters had an accurate year in 2010. How can we objectively make this assessment? If you're a frequent reader of the *Island Review*, then you will already know my personal preference is to review the predictions generated by groups that make not just their prediction public, but verify their prediction skill in the public arena as well. This really leaves us with; **(1)** the Tropical Meteorology Project at Colorado State University, **(2)** the University College London, U.K. for Tropical Storm Risk, and **(3)** our Federal voice for climatology/meteorology matters, the National Oceanic & Atmospheric Administration (NOAA). We then take these groups' last prediction just before or near the start of hurricane season on June 1st and compare the predictions to the actual results at the end of the season (November 30th). As the accompanying prediction summary chart indicates (Table 1), the average prediction included 18 total cyclones (the actual was 19), 10 of which were predicted to generate into hurricanes (the actual was 12), with 5 of these becoming major hurricanes (the actual was 5 – right on the money). This means 8 tropical storms were predicted and the actual number was very close – 7.

	NOAA (median)	Colorado State University, U.S.	University College London, U.K.	Average of Predictions	ACTUAL 2010	Average (1950-2000)
Total No. of Named Tropical Cyclones	19	18	18	18	19	10
Tropical Storms	8	8	8	8	7	4
Hurricanes / Major	11/5	10/5	10/4	10/5	12/5	6/2
Accumulated Cyclone Energy (ACE) Index	204	185	182	190	163	96

Table 1 - Summary comparing publicly available pre-season predictions for the 2010 Hurricane Season with actual results and average activity.

As can be quickly gleaned from this prediction chart, all the key elements for the 2010 hurricane season were significantly higher than the 1950-2000 average. However, one term we haven't discussed that appears on the prediction chart is the *Accumulated Cyclone Energy Index* (ACE Index), which is simply a measurement taking a storm's wind speed strength for each 6-hour period of its existence into account. The larger the ACE Index value, the more active the season. This is actually one of the more revealing parameters in my humble opinion (and others) and likely serves as a better barometer of whether or not a hurricane season is truly "active" or not. This past decade has some great examples to support this assertion.

For instance last year (2009) the ACE Index was a dramatically low 51 – the average ACE Index is 96 and since 1950, only 14 hurricane seasons had a lower ACE Index than the 2009 value. There were 12 cyclones in 2009 – most were relatively weak with the exception of three hurricanes, of which, two became major. There were no cyclones (tropical storms or hurricanes) that made landfall along the Atlantic U.S. seaboard, making 2009 the fourth consecutive year the Atlantic coast did not absorb a single hurricane strike (there have been tropical storm landfalls).

On the flip side, 2005 had an ACE Index of 248 – the highest on record and was punctuated by more tropical storms, total hurricanes, and category 5 hurricanes than in any season previously recorded for the Atlantic; and included *Ophelia* for North Carolina and the infamous major hurricanes of *Katrina*, *Wilma*, and *Rita* in the Gulf of Mexico. Table 2 includes the ACE Index for the past seven years and a few notes justifying the value.

YEAR	ACE Index	Notes
2010	163	Tied for third-most most cyclones for a season at 19, and tied for second-most hurricanes for a season at 12. <i>Igor</i> had an ACE Index of 42 alone - highest since <i>Ivan</i> (2004).
2009	51	<i>El Niño</i> year - 15th lowest ACE Index since 1950, 12 cyclones (most were short-lived), 3 hurricanes.
2008	145	<i>Ike</i> and <i>Gustav</i> were two major hurricanes that impacted Tx. and La., <i>Bertha</i> was an extremely long-lived cyclone, and collectively accounted for 60% of the total ACE Index for 2008.
2007	72	Five more tropical cyclones than average, but most were very short-lived or rather weak, with the exception of two category 5 hurricanes that impacted Central America (<i>Dean</i> and <i>Felix</i>).
2006	79	Ten cyclones total (lowest number since the 1997 season)
2005	248	Highest ACE Index on record and included the most cyclones (28), hurricanes (15), and category 5 hurricanes (4) in a single season, and the most intense hurricane on record (<i>Wilma</i>).
2004	225	4th highest ACE Index value on record, hurricane <i>Ivan</i> alone had an ACE Index of 70, 2004 had six major hurricanes.
2003	175	Hurricane <i>Isabel</i> will long be remembered in Carteret County for Down East flooding, and for the island breach near Hatteras Village in Dare County. <i>Isabel's</i> ACE Index alone was 63, one of the highest recorded for an individual cyclone.

Table 2 – ACE Index summary chart (2003 – 2010).

The ACE Index for 2010 was 163, the 12th highest on record since 1950. Hurricane *Igor* that recurved into the Atlantic and impacted Bermuda had an individual ACE Index of 42 compliments of its long duration and intensity. This was the highest value for an

individual cyclone since *Ivan* (2004). Also, the 12 hurricanes that formed in 2010 tied 1969 for second place for the most hurricanes in a season. And finally, the five major hurricanes that formed in 2010 places this year in a tie for ninth place in this category.

But It Only Takes One

Considering the very high ACE Index value, the total number of cyclones, total number of hurricanes, and other climatological parameters for 2010, the hurricane season was surprisingly a “yawner” for the U.S. as a whole and coastal North Carolina in particular. As mentioned earlier, only a very weak tropical storm *Bonnie* struck the U.S., and the nearest hurricane strike was from *Earl* that slid ~120 miles east/slightly southeast of our own Beaufort Inlet as a category 2 hurricane on September 2nd (see Figure 1), just after becoming the third strongest Atlantic hurricane on record so far north in U.S. coastal waters (Category 4, 140 mph near the latitude of the Georgia coast).

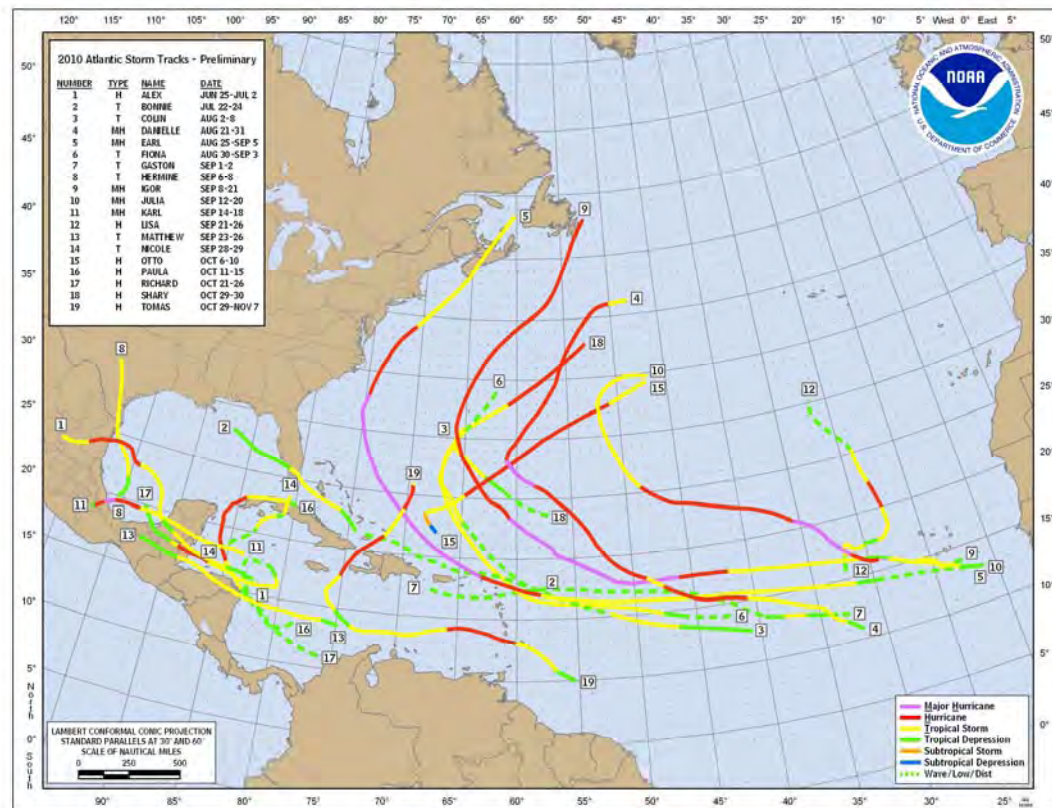


Figure 1 – Graphic prepared by NOAA depicting all cyclone positions (tracks) and intensities reported for the 2010 hurricane season.

What did we do to deserve such good fortune? Nothing really – just some short-term fortuitous metrological phenomena, which are very difficult to predict months ahead of any hurricane season. Hence why we only casually pay attention to hurricane strike probability assessments issued well before June 1st. It would take an inordinate amount of print space to detail all the metrological phenomena mentioned above, but for the sake of this article the two worth highlighting are; (1) the Azores/Bermuda high, which was positioned farther east in the Atlantic than usual, and (2) there were more strong troughs of low pressure over the U.S. East Coast than usual. These two factors in addition to the fact that so many cyclones formed in the extreme eastern Atlantic helped steer (recurve) just about everything north before arriving at the U.S. coast.

This all highlights the sometimes ironic nature of climatology – the 1992 hurricane season was a very quiet year (statistically-speaking) with only 7 named cyclones, 4 of which were hurricanes, with one of those classified as major, and an ACE index value of 75.

However that single major hurricane was *Andrew*, which struck Florida and was the costliest natural disaster in U.S. history until *Katrina* in 2005. The take home and concluding message is that it really only takes one cyclone to make or break a season, and perception is everything – i.e., the Caribbean Islands may have a very damaging year while the U.S. is unscathed. This is a good reminder as well to ensure we're all prepared for each and every hurricane season – regardless if it is "active" or not.