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SHORELINES – January 2010

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2009 Hurricane Season Recap

As customary, November 30th marked the last day of the 2009 hurricane season which officially started back on June 1st. Despite a very benign and below average season, most experts agree 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).

El Niño or ENSO warm phase

The overall trend of increased cyclone activity was kept in check this past year thanks to *El Niño* conditions that ushered a pattern of higher than average wind shear and dry air into the atmosphere. *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 that as mentioned above, tend to suppress the formation of tropical cyclones in the Atlantic. Interestingly, 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 tends to produce atmospheric conditions more conducive for tropical cyclone development.

Traditionally, ENSO cycles were determined empirically based upon the differences in surface air pressure between Tahiti and Darwin, Australia. Today, scientists use sea surface temperature measurements along the equatorial Pacific as an indicator of *El Niño* or *La Niña* (particularly in a region known as *Niño* 3.4). If the sea surface temperature variance is greater than or equal to +0.5° C in region *Niño* 3.4, then the conditions are classified as *El Niño* and vice-versa (i.e., if the temperature variance is lower than or equal to -0.5° C, then *La Niña* conditions are prevalent). And finally if the temperature variance is between +0.5° C and -0.5° C, then ENSO neutral phase is dominant (neither *El Niño* nor *La Niña*). This is probably a little bit too much information for this edition of *Shorelines*, but one of the take away messages is that a full-fledged *El Niño* or *La Niña* is only officially designated if the sea surface temperature thresholds are exceeded for a period of at least 5 consecutive overlapping 3-month seasons. Hence we may have *El Niño* or *La Niña* "conditions", but the history books may never reveal that an *El Niño* or *La Niña* episode ever occurred. At the time this edition of *Shorelines* is being prepared, we are very close to having a full-fledged *El Niño* officially classified, which is forecasted to persist through the entire winter of 2009-10.

Hurricane Vocabulary

It's also important to discuss some basic hurricane terminology so we can understand and finally dive into this season's review. A ***tropical cyclone*** is a warm-core, atmospheric closed circulation rotating counter-clockwise in the Northern Hemisphere (that's us) and clockwise in the Southern Hemisphere. A tropical cyclone becomes a ***tropical storm*** when the maximum sustained surface wind speed ranges from 39 mph to

73 mph using the U.S. 1-minute average, and is designated as a ***hurricane*** when the cyclone reaches a maximum sustained surface wind of 74 mph or more.

Hurricanes are further segregated utilizing the Saffir Simpson scale that includes 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. Category 3 or higher is classified as a major hurricane. 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).

The terms "extratropical" and "subtropical" are also mentioned sometimes during the hurricane season and deserve an explanation here as well. An ***extratropical storm*** is 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. An extratropical cyclone can have winds ranging to levels associated with a tropical depression, or as strong as a hurricane. Examples of extratropical cyclones 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.

A ***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. 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.

Season Recap (finally)

Hurricane forecasters had a slightly sub-par year in 2009. How can we objectively make this assessment? If you're a frequent reader of the *Island Review*, then you will already know that my personal preference is to review the predictions produced 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 two groups – the Tropical Meteorology Project at Colorado State University, and the University College London, U.K. for Tropical Storm Risk. We'll add the National Oceanic & Atmospheric Administration (NOAA) to the mix because this is our federal voice for climatology/meteorology matters. 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, the average prediction included 12 total cyclones (the actual was 9, or 75% of the cyclones predicted), 6 of which were predicted to generate into hurricanes (the actual was 3), with 2 of these becoming major hurricanes (the actual was 2 – right on the money). This means 6 tropical storms were predicted and the actual number was right on the money again – 6.

	NOAA (max.)	Colorado State University (US)	University College London (UK)	Average of Predictions	ACTUAL 2009	Average (1950-2000)
Total No. of Named Tropical Cyclones	14	11	11	12	9	10
Tropical Storms	7	6	6	6	6	4
Hurricanes / Major	7/3	5/2	5/2	6/2	3/2	6/2
Accumulated Cyclone Energy (ACE) Index	125	85	69	93	51	96

Table 1 - Summary comparing publicly available pre-season predictions for the 2009 Hurricane Season with actual results and average activity.

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 in 2007 we had 5 more tropical cyclones than average, but most of the cyclones were very short-lived or rather weak, with the exception of two category 5 hurricanes that impacted Central America. The mood for most of the Atlantic and Gulf States was that the hurricane season was very benign. The ACE Index for 2007 was 68 – the average is 96. The 2006, 2005, 2004, and 2003 Index figures were 79, 248 (highest on record), 225, and 175, respectively. These numbers are very consistent with the actual hurricane activity we had in these years. For 2008, the average predicted ACE Index was 147 – the actual was 141 (very close). Again, this makes a lot of sense – the 2008 season was not as active as the 2003, 2004, and 2005 seasons but definitely busier than the previous two years (2006 and 2007). For 2008, the intense hurricanes of *Gustav* and *Ike*, and the longevity associated with *Bertha* were the biggest factors contributing to the ACE Index.

The ACE Index for 2009 was a dramatically low 51 – since 1950, only 14 hurricane seasons had a lower ACE Index. The average predicted ACE Index for 2009 was 93, which is substantially far off the mark and hence why with other factors we can objectively claim a "slightly sub-par year" for the top hurricane forecasters. The shortcoming in the predictions appeared to be an underestimation of *El Niño.* The forecasters predicted an "average" or even "slightly below average" hurricane season for 2009, when in reality it was a very below average year.

What is there to expect for next year (2010)? *El Niño* episodes very rarely persist for two full hurricane seasons, hence we can likely expect *La Niña* or ENSO neutral conditions for all or part of the 2010 hurricane season, which should produce a more favorable environmental for tropical cyclone development than experienced in 2009. Again, this only refers to development, not landfall probability.

Otherwise and in closing, some of the more interesting aspects of the 2009 hurricane season included;

(a) Out of the 9 tropical cyclones that formed, 4 made landfall, 2 of which were in the U.S. (*Claudette* and *Ida* – both tropical storms at landfall along the Gulf of Mexico).

(b) *Ida* was the only hurricane to make landfall, attaining hurricane status just before reaching Nicaragua in November (see Figure 1).

(c) More on *Ida* - The remnants of *Ida* became extratropical (see definition above) as it crossed Alabama, merged with a frontal system and became the "Veteran's Day Nor'easter" as it developed off the coast of North Carolina and slowly drifted northeast. Beach erosion was extensive along the northern Outer Banks extending into New Jersey, and was punctuated by a series of record-breaking storm surges between southern Virginia and northern Delaware.

(d) No cyclones (tropical storms or hurricanes) made landfall along the Atlantic U.S. seaboard, making 2009 the fourth consecutive year the Atlantic coast has not absorbed a single hurricane strike (there have been tropical storm landfalls).

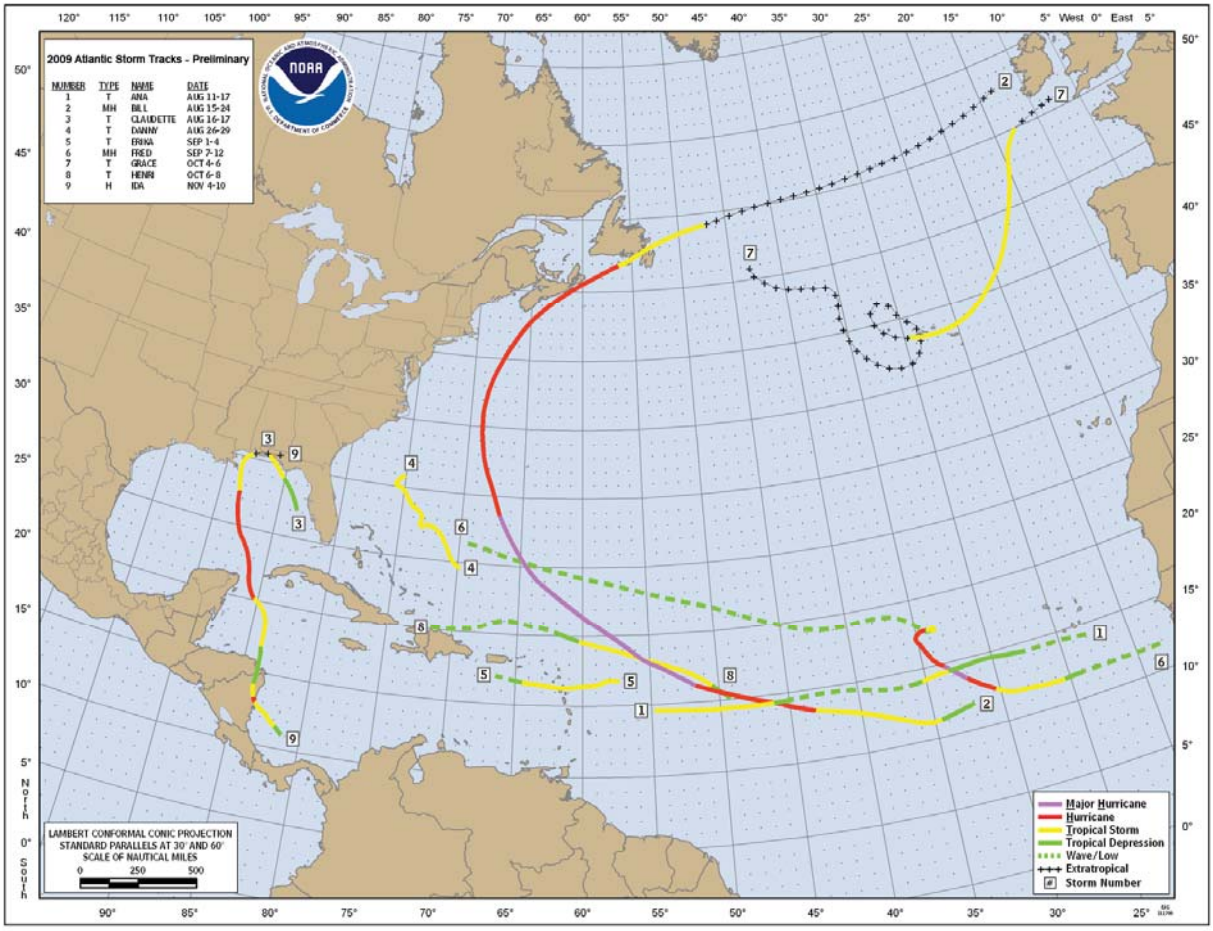

Figure 1 – Graphic prepared by NOAA depicting all tropical cyclone positions (tracks) and intensities reported for the 2009 hurricane season.