KAREN CLARK & COMPANY

Near Term Hurricane Models

Performance Update

January 2011

10 ST. JAMES AVENUE • BOSTON, MA 02116 • T: 617.423.2800 • F: 617.423.2808

Introduction

For the past two years, Karen Clark & Company has released reports titled "Near Term Hurricane Models – How Have They Performed?" [1] With 2010 marking the end of the first five year "near term" model projection period, we are once again providing a detailed analysis of the models' performance. The purpose of this report is to make more transparent to model users how actual results have compared to the model projections. In addition, we discuss the Hurricane Frequency Paradox and its relevance to the insurance industry, and review the U.S. hurricane experience for the first decade of the 21st century.

The 2010 Season

The 2010 Atlantic hurricane season was one of the busiest on record. It was the most active season since 2005, and with 19 named storms it ties as the third busiest season along with 1995 and 1887. Elevated sea surface temperatures and weak wind shear aided by La Nina conditions contributed to an environment highly favorable for hurricane development.

Of the 19 named storms, 12 became hurricanes, making 2010 a tie with 1969 for the second highest number of hurricanes on record. Five hurricanes reached major hurricane status—Category 3 or higher. Despite the highly active season, no hurricanes made landfall along the U.S. coastline. As a result, U.S. insured property losses associated with the hurricane season were minimal.

According to NOAA, the "…*extremely active Atlantic hurricane season was a 'Gentle Giant' for the U.S. …Short term weather patterns dictate where storms actually travel and in many cases this season, that was away from the United States. The jet stream's position contributed to warm and dry conditions in the eastern U.S. and acted as a barrier that kept many storms over open water. Also, because many storms formed in the extreme eastern Atlantic, they re-curved back out to sea without threatening land.*"[2]

The Track Record of the Near Term Models

Each of the three major modeling companies – AIR Worldwide (AIR), EQECAT, and Risk Management Solutions (RMS) – introduced near term hurricane models in 2006. The new models, based on short term assessments of the frequency of hurricanes, were intended to be reflective of expectations for the five year period 2006 - 2010. Each of the near term models initially projected Atlantic tropical cyclone loss levels at least 35% above the long term average for the five year period.

In 2007, AIR modified its near term model, reducing its increases in risk relative to the long term model to about 16%. In 2009, RMS introduced a modification to its near term model following its annual elicitation of expert opinions. While this resulted in a reduction in RMS' near term model loss estimates, the model still implied a level of loss activity 25% above the long term historical average. EQECAT has made relatively minor adjustments to its near term model estimates since its introduction in 2006.

---

[1] Karen Clark & Company, "Near Term Models – How Have They Performed," December 2008, January 2010 http://www.karenclarkandco.com/pdf/KCC_NearTermHurricanes.pdf
[2] *Extremely Active Atlantic Hurricane Season was a 'Gentle Giant' for U.S.* (2010, November 29). Retrieved January 7, 2011 from http://www.noaanews.noaa.gov/stories2010/20101129_hurricaneseason.html

The three tables below compare actual results to the implied projections from each of the three modeling companies since the introduction of the near term models. As shown in Table 1, the last five years of Atlantic hurricane frequency have been a mixed bag compared to the long term averages. In terms of storm frequency, 2007 can be characterized as an average year, 2008 and 2010 can be characterized as above average years, and 2009 as a below average year. For the five year period, the aggregate number of hurricanes was above the long term average, but below the elevated level of activity implied by the near term models.

Table 1: **Number of Atlantic Hurricanes**

			Near Term Predictions		
	Long-Term Average	Actual	AIR	EQECAT	RMS
2006	5.9	5	8.4	8.0	8.4
2007	5.9	6	6.8	8.0	8.4
2008	5.9	8	6.8	8.1	8.4
2009	5.9	3	6.8	8.1	7.6
2010	5.9	12	6.8	8.1	7.6
Total	29.5	34	35.6	40.3	40.4

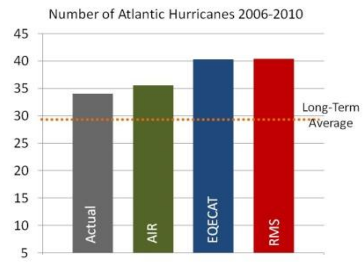


Table 2: **Number of U.S. Landfalling Hurricanes**

			Near Term Predictions		
	Long-Term Average	Actual	AIR	EQECAT	RMS
2006	1.7	0	2.4	2.3	2.4
2007	1.7	1	2.0	2.3	2.4
2008	1.7	3	2.0	2.3	2.4
2009	1.7	0	2.0	2.3	2.2
2010	1.7	0	2.0	2.3	2.2
Total	8.5	4	10.4	11.5	11.6

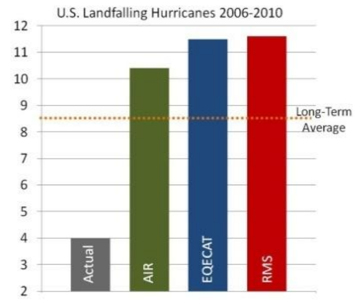
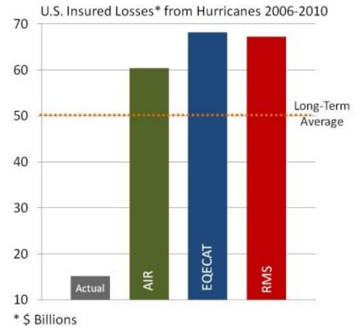


Table 3: **U.S. Insured Losses from Hurricanes ($ Billions)**

			Near Term Predictions		
	Long-Term Average	Actual	AIR	EQECAT	RMS
2006	10	0	14.0	13.6	14.0
2007	10	0	11.6	13.5	14.0
2008	10	15.2	11.6	13.7	14.0
2009	10	0	11.6	13.7	12.6
2010	10	0	11.6	13.7	12.6
Total	50	15.2	60.4	68.2	67.2



Tables 2 and 3 illustrate that, contrary to the near term model predictions, landfalling hurricanes and insured losses have been well below average. Insured losses in the United States from Atlantic tropical cyclones were negligible in 2010, for the fourth time in the last five years.

Why More Storms But Not More Landfalls?

In last year's report, we discussed the significant debate in the scientific community over whether Atlantic tropical cyclone frequency is trending upwards or if we are just detecting more storms over time.

Some scientists have suggested that we are experiencing an increase in Atlantic tropical cyclone activity, based on a trend in tropical cyclone counts from data going back to the late 19th century. See Figure 1.

Paradoxically, the apparent increase in Atlantic tropical cyclone activity has not resulted in an increase in hurricane landfalls in the United States, as shown in Figure 2. This is the Hurricane Frequency Paradox. If we are in fact experiencing more Atlantic storms, then over the past four decades the proportion of storms making landfall has declined to about 60%, compared to an average of about 75% prior to 1965. Why would this happen?

Figure 1: Trends in Atlantic Basin Tropical Cyclone Storm Counts[3]

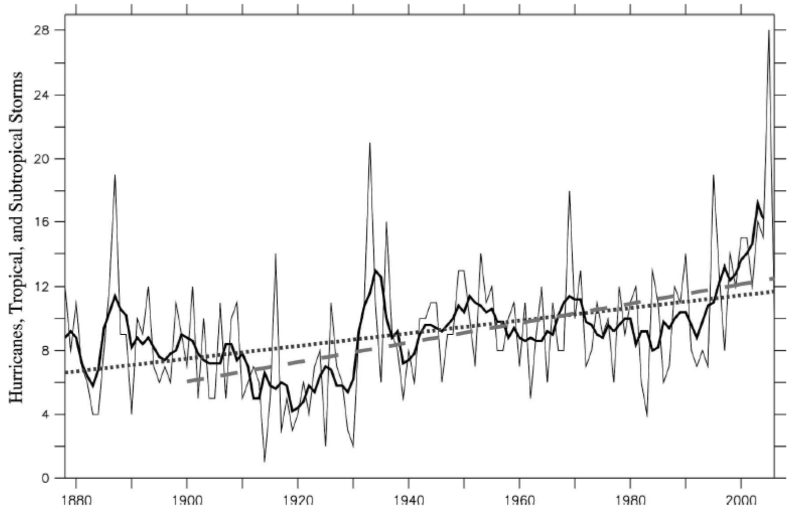
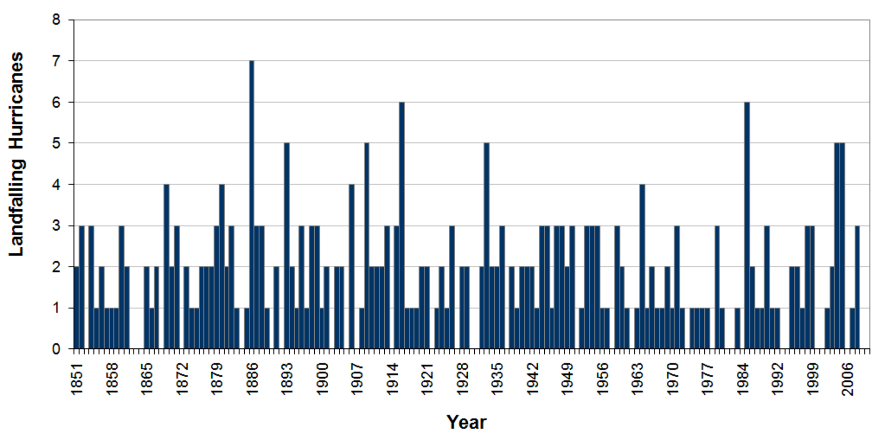


FIG. 1. Time series of unadjusted HURDAT Atlantic basin TC counts over the period 1878–2006. Black line shows the annual count of tropical and subtropical storms, and hurricanes in the HURDAT database. Dashed lines indicate the linear least squares trends computed over the periods 1878–2006 and 1900–2006.

Figure 2: United States Hurricane Landfalls by Year[4]



Scientists at NOAA have concluded that the increase in observed annual storm frequency is in large part attributable to improvements in observational technology leading to the increased detection of tropical storms. This is particularly true for short duration storms originating in the Eastern Atlantic, far removed from potential landfall. Prior to the introduction of satellite technology, such storms were dependent upon oceangoing ships for detection.

---

[3] Vecchi, Gabriel A. and Thomas R. Knutson, "On Estimates of Historical North Atlantic Tropical Cyclone Activity," *Journal of Climate*, 21, 3580 - 3600

[4] Blake, E.S., E.N. Rappaport, C.W. Landsea, "The Deadliest, Costliest and Most Intense United States Tropical Cyclones from 1851 to 2006 (and Other Frequently Requested Hurricane Facts)," NOAA, Technical Memorandum NWS-TPC-5, 43 pp, and National Hurricane Center Tropical Cyclone Reports. Updated to 2010 by Karen Clark & Company.

Figure 3 shows that observed short-lived storms (durations of two days or less) has been increasing dramatically over time. Figure 4 shows that for moderate to long-lived systems (durations in excess of two days), there has been minimal increase in observed frequency.

Figure 3: Short Duration Storm Frequency[5]

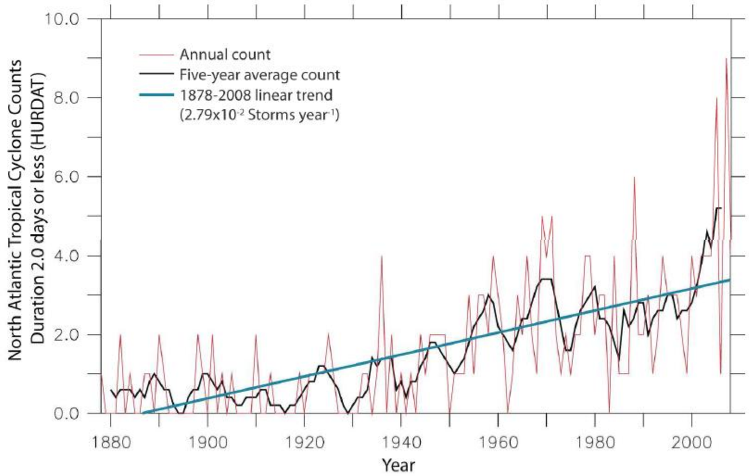
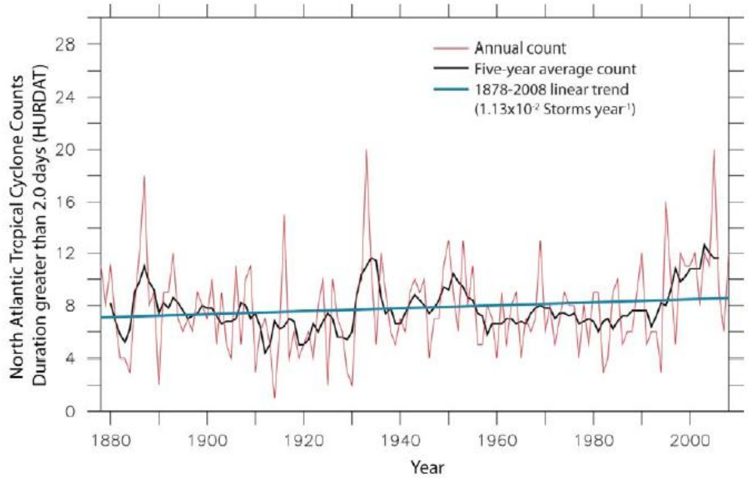


Figure 4: Moderate to Long-Lived Storm Frequency[6]



Because of improvements in storm detection technology, the increase in observed open ocean storms has not translated into more landfalling storms in the U.S. The 2010 season is a case in point. It was a highly active season in terms of storms in the Atlantic yet no hurricanes made landfall in the U.S. In the 2010 season, three tropical storms, Bonnie, Gaston, and Nicole, were short duration—two days or less—storms. Three storms, Lisa, Otto, and Shary were hurricanes for less than 24 hours. Gaston and Lisa formed and dissipated below tropical depression status approximately 2,500 miles from the U.S. coastline.

[5] Landsea, Christopher W., Gabriel A. Vecchi, Lennart Bengtsson, Thomas R. Knutson, "Impact of Duration Thresholds on Atlantic Tropical Cyclone Counts," *Journal of Climate, Vol. 23, No. 10: pp. 2508-2519* .
[6] Ibid.

Hurricane Landfalls by Decade

Apart from the catastrophe modelers, most scientists researching hurricane frequency focus on storms that form and develop in the Atlantic versus storms that make landfall along the U.S. coastline. However, insurance companies are most interested in landfalling storms that cause significant losses. Therefore, the Hurricane Frequency Paradox is an important issue for the insurance industry.

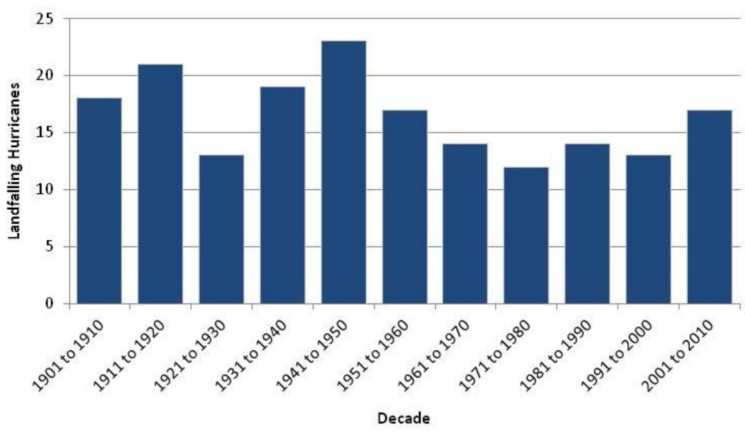
The catastrophe modelers have taken note of this issue. For example, a recent paper co-authored by RMS scientists[7] makes two interesting but conflicting conclusions:

- The proportion of hurricanes making landfall in the first half of the 20th century is different from the proportion in later periods.
- We cannot reject the hypothesis that the proportion of Atlantic hurricanes which make landfall in the U.S. is constant.

They reconcile these two conflicting conclusions by asserting "the resolution to this apparent contradiction is due to the sparsity of landfalling hurricanes." That is, because there may not be enough data to see the number of landfalling hurricanes increasing, they *could* be increasing even if it is not detectable in the data, and that is the paper's conclusion. Based on their statistical tests, the authors further conclude that the assumption of a constant proportion (which means increasing landfalls) leads to more accurate historical predictions of landfalling storms.

The models have not been accurate in predicting landfalling storms as earlier sections of this paper illustrated. Figure 5 clearly shows the lack of any evidence that the long term trend in landfalling storms is increasing. In fact, while landfall activity does fluctuate from year to year, and from decade to decade, the last 10 years have been average with respect to hurricane landfalls while the previous four decades have been below average. In fact, one has to go back to the 1940s for a decade of above average hurricane landfalling activity.

Figure 5: US Hurricane Landfalls by Decade[8]



[7] K. Coughlin, E. Bellone, T. Laepple, S. Jewson, K. Nzerem, "A Relationship Between All Atlantic Hurricanes and Those That Make Landfall in the U.S.," Quarterly Journal of the Royal Meteorological Society. 2008

[8] Blake, E.S., E.N. Rappaport, C.W. Landsea, 2007: The Deadliest, Costliest and Most Intense United States Tropical Cyclones from 1851 to 2006 (and Other Frequently Requested Hurricane Facts). NOAA, Technical Memorandum NWS-TPC-5, 43 pp, and National Hurricane Center Tropical Cyclone Reports. Updated to Nov. 2010 by Karen Clark & Company.

The standard hurricane models, based on nearly 100 years of data, were introduced in the 1980s, a period of below average hurricane activity by all counts. The results produced by the models were based on long term hurricane activity rates that were significantly above that experienced in the 1980s and the following decade. For the past decade U.S. hurricane landfalls and insured losses have been average.

The First Decade of the 21st Century

In the first decade of the 21st century, several records were set with respect to hurricane activity. In 2005 there were a record number of Atlantic hurricanes - 15. Hurricane Katrina caused the largest insured loss in current dollars of over $40 billion.

Despite these records, hurricane landfalls in the U.S. and insured losses were average for the period 2001 to 2010. Figure 6 shows the number of hurricane landfalls and the insured losses by year along with the long term averages.

Figure 6: US Hurricane Landfalls and Insured Losses in 21st Century[9]

Year	# Landfalls	Loss ($B)*
2001	0	-
2002	1	0.5
2003	2	2.0
2004	5	25.1
2005	5	61.9
2006	0	-
2007	1	-
2008	3	15.2
2009	0	-
2010	0	-
Decade Average	1.7	10.5
Long Term Average	1.7	10.0

***Years before 2008 have been adjusted to 2007 dollars. Long term average loss figure is derived from 2007 model estimates.**

All of the foregoing demonstrates that there is no clear basis for concluding that we are currently in a period where losses associated with hurricanes should be expected to be well above the long term average.

[9] ISO's Property Claim Services Unit loss estimates presented in Insurance Information Institute table *Catastrophic Hurricane Losses in the United States, 1998-2007*. Retrieved January 14, 2011 from http://old.iii.org/economics/disasters/hurricanes/.

Conclusions

We have now completed the first five-year near term hurricane model projected period, and actual insured loss experience has been well below the level of the model predictions. Four of the past five years have had minimal insured property loss from Atlantic tropical cyclones, well below both the long term average and the (much higher) near term projections. To date, the catastrophe models have not demonstrated any skill in projecting near term hurricane losses.

The first decade of the 21st century was equal to the long term average with respect to hurricane landfall frequency and loss experience. This average decade was preceded by several decades of below average activity. This means the even the long term standard hurricane model activity rates are higher than what has been experienced since the models were first introduced in the 1980's.

Catastrophe models are powerful, broad-based tools that are very good at:

- Providing a framework for tying together the principal components of catastrophe risk: hazard, engineering, and exposure
- Providing numerous scenarios that produce estimates of losses from different types of events
- Determining approximate estimates of losses associated with events of different magnitudes
- Providing a general indication of relative risk

However, catastrophe models are characterized by high uncertainty, and thus cannot:

- Produce accurate point estimates of infrequent events, such as the 1 in 100-year loss
- Produce credible, robust estimates of losses at specific locations
- Predict near term catastrophic losses

Hurricane activity is influenced by a number of climatological factors, many of which are known, but some unknown, by scientists. There are complicated feedback mechanisms in the atmosphere that cannot be quantified by even the most sophisticated and powerful climate models. Catastrophe models are relatively blunt tools with many simplifying assumptions based on limited scientific data. Despite the illusion of precision, the models cannot be expected to make projections or pinpoint specific numbers with accuracy.

Karen Clark & Company
10 St. James Avenue
Boston, MA 02116

T: 617.423.2800
F: 617.423.2808
E: info@karenclarkandco.com