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Near Term Hurricane Models

How Have They Performed?

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Introduction

Catastrophe models are valuable tools for estimating what *could* happen. But how good are they at predicting what *will* happen? More specifically, can catastrophe models be used to predict actual catastrophe experience over a brief one, two or five-year period?

Such “short term” or “near term” hurricane models were introduced to the insurance industry in 2006 and were designed to predict insured hurricane losses for the five-year period ending in 2010. Use of these near term models by insurance and reinsurance companies was a radical departure from the way in which catastrophe average annual losses (AALs) and probable maximum losses (PMLs) are typically derived from the catastrophe models. Use of the near term models also caused market disruptions in coastal areas because of the significant increases in hurricane losses the near term models predicted.

With the close of the 2008 hurricane season, we are three years into the five year prediction period. While no definitive conclusions can be reached until 2010, we are beyond the midway point and can review the performance to date of the near term hurricane models. This paper reviews the development of near term models, examines the 2006-2008 hurricane seasons and how accurately the models predicted real world results, and discusses possible implications for insurers, reinsurers, regulators and others.

The Black Box

With recent advances in computing power and the ability to quickly analyze large volumes of data, computer models have become ubiquitous in many industries, particularly financial services. While computer models are valuable decision-making tools, they can lead to bad business decisions when not used correctly. Model users frequently forget that all models are based on simplifying assumptions, and therefore *all models are wrong.* Models attempt to replicate reality, but they are not reality.

It’s easy to forget this fact when models produce detailed reports showing numbers with two decimal place precision. Many of the models used in the financial services industries are complex computer programs developed by Ph.D.-level scientists, engineers and statisticians. Because most non-technical people, in many cases the decision-makers, don’t understand what’s inside the “black box”, they don’t question what comes out. But precision does not equal accuracy.

Many models are inaccurate simply because they are constrained by a lack of data and scientific knowledge. This is certainly the case with the catastrophe models used extensively by the insurance industry. No matter how many Ph.D.s work on a catastrophe model, the fundamental uncertainties around the frequencies and intensities of large magnitude events cannot be removed.

This doesn’t mean the models are not valuable – the catastrophe models do provide a consistent framework for making risk management decisions. They are valuable tools for generating estimates of what could happen. They can also provide credible estimates of the probabilities of different size losses occurring.

The Near Term Models

Catastrophe models were first introduced to the insurance industry in the late 1980s. Because there had not been a multi-billion dollar loss from a catastrophe, insurance companies relying on short term experience were significantly underestimating their catastrophe loss potential. The catastrophe models, by utilizing many decades of historical data, gave insurance companies better estimates of what could happen and more specifically, the probabilities of losses of different sizes on specific portfolios of insured properties. In 1992, Hurricane Andrew confirmed for the industry that the models were much better risk assessment tools than short term experience, simple formulas or underwriting rules of thumb. Since that time, the uses of the models have expanded to include pricing, individual account underwriting and portfolio optimization.

The catastrophe models have been updated and refined over the past two decades. Every actual catastrophic event provides a learning experience and an opportunity to improve some of the model components – particularly the engineering components. Large events produce a lot of claims data that can be analyzed by the catastrophe modelers to fine-tune the model damage functions, for example.

The 2004 and 2005 hurricane seasons were particularly active and resulted in over $80 billion of insured hurricane losses. In 2006, the three major catastrophe modelers − AIR Worldwide (AIR), EQECAT and Risk Management Solutions (RMS) − introduced new hurricane models. These new models are based on short term assessments of the frequencies of hurricanes. Instead of basing hurricane frequency assumptions on long term experience, the new "near term" models predict hurricane frequency over a much shorter time horizon. This time horizon has been generally established as a five-year period.

AIR's near term model was designed to capture possible elevated hurricane activity and losses over the period 2006 – 2010. According to the company's white paper, "Understanding Climatological Influences on Hurricane Activity: The AIR Near-term Catalog", AIR's approach to estimating five year hurricane rates was based on statistical analysis relating sea surface temperature (SST) anomalies to regional risk from hurricanes. AIR's approach was developed in conjunction with Accurate Environmental Forecasting and Climatek. It was peer reviewed by Dr. Kerry Emanuel of MIT, and Dr. Jim Elsner of Florida State University.

Using a five year forecast of SST conditions, AIR's 2006 near term hurricane model projected significant increases in hurricane losses. While increases varied geographically, the overall annualized increase in hurricane losses in the AIR near term model was 40 percent. In 2007, AIR changed their methodology to eliminate the SST forecast element, and changed the name from a Near-Term Catalog to a Warm SST Conditioned Catalog, reflecting the fact that the revised view of risk is conditioned on a typical "warm ocean" season rather than a projected one. Consequently, increases in risk relative to the long term model for 2007 and 2008 fell to 16 percent countrywide. This latest research has been published in the peer-reviewed *Journal of Applied Meteorology and Climatology*.

To date, AIR has not recommended that insurers replace their standard hurricane model with their "climate conditioned" view because of the increased uncertainty in the smaller sample of historical data representative of a warm ocean condition. AIR advocates understanding both near term and long term views of risk.

After introducing its near term model, EQECAT updated it for the 2007 and 2008 hurricane seasons. EQECAT also predicted increases in hurricane activity and losses relative to their long term averages. Their annual increases have been relatively consistent and range between 35 and 37 percent for countrywide average annual losses.

RMS has been the strongest proponent of near term hurricane models and even submitted, in 2006, their near term model to the Florida Commission on Hurricane Loss Projection Methodology. The commission's approval is required for model use in the state of Florida. In a presentation at the Florida Commission on Hurricane Loss Projection Methodology Workshop in July 2006, RMS indicated they determined the appropriate risk horizon for catastrophe models is a five year period. In the workshop presentation, they explained their methodology, which uses a range of statistical analyses and an elicitation of leading experts in the field. The elicitation was organized to obtain a consensus of hurricane activity for the period 2006-2010.

Based on the results of the elicitation process, RMS announced that increases in hurricane landfall frequencies assumed in their model would increase annualized insurance losses by 40 percent on average for the Gulf Coast, Florida and the Southeast, and by 25 – 30 percent in the Mid-Atlantic and Northeast regions relative to those in their long term model. Furthermore, their five year model assumed a higher frequency of major hurricanes making landfall, which led to increases in modeled annualized losses closer to 50 percent in the Gulf, Florida and the Southeast, and 40 percent countrywide.

RMS recommended this model be used for all standard applications of the model by insurers, reinsurers, rating agencies and regulators. This recommendation notwithstanding, the RMS near term hurricane model was not approved by the Florida Commission on Hurricane Loss Projection Methodology. According to the Florida Commission, the short term models do not meet several of the model standards.

In October 2006, RMS held a second and expanded annual elicitation of expert opinions, and announced that the five year predictions would remain unchanged for the upcoming hurricane seasons. In December 2007, RMS again confirmed the elevated activity rates and increased overall losses of 40 percent for 2008 and beyond.

Hurricane Activity 2006-2008

We are now three years into the forecast period, so it's an appropriate time to evaluate how the near term models have performed for the period 2006 through 2008.

The 2006 hurricane season began with Tropical Storm Alberto, which developed in the northwestern Caribbean on June 10. No storm reached hurricane status until Ernesto on August 25, and this storm was only a minimal hurricane for a brief time. In September, Hurricane Florence reached Category 1 intensity briefly. Three more hurricanes formed in the season, and of these, two reached Category 3 strength and none made landfall in the U.S.

Overall, there were five hurricanes, two major hurricanes, no U.S. landfalls and no insured hurricane losses. The 2006 hurricane season was below average on all counts.

The first tropical storm of the 2007 season, Barry, formed on June 1, the official start of the hurricane season. The storm was very short-lived and dissipated by June 2. Dean became the first hurricane of the season on August 16. This storm intensified to a Category 5 hurricane. In early September, Felix became the second hurricane and the second Category 5 hurricane of the season.

Tropical Storm Humberto reached weak Category 1 hurricane status just before making landfall near Matagorda, Texas. This storm caused insignificant insured losses. Three more hurricanes formed in the season – Karen, Lorenzo, and Noel. All were minimal Category 1 hurricanes, and none made landfall in the U.S.

Overall, the 2007 hurricane season was average with respect to the number of hurricanes, but below average on all other counts – major hurricanes, landfalling hurricanes and insured hurricane losses in the U.S.

The 2008 hurricane season was more active than 2006 and 2007. Tropical Storm Arthur formed near the coast of Belize on May 30, before the official start of the hurricane season. The first hurricane, Bertha, developed on July 7. Bertha intensified rapidly to a major, Category 3 storm. Just as rapidly, the storm weakened back to a Category 1.

The second hurricane of the season, Dolly, also developed in July. Dolly reached Category 2 intensity just before making landfall on South Padre Island, Texas. Total insured losses are estimated at $525 million.

The third hurricane, Gustav, developed on August 26. Gustav became a strong Category 4 storm before making landfall in Cuba, but then weakened to a Category 2 hurricane just before it made landfall in Louisiana. Insured losses in the U.S. are estimated at just over $2 billion.

Five more hurricanes developed in the 2008 season, but only one of these, Ike, made a U.S. landfall. Ike came ashore on Galveston Island with strong Category 2 winds and a very large eyewall. Insured losses are currently estimated to be $10.6 billion.

Overall, the 2008 hurricane season was above average on all counts – the number of hurricanes, major hurricanes, landfalling hurricanes and insured hurricane losses in the U.S.

How the Models Performed

All three catastrophe modelers predicted above average hurricane activity and losses for the period 2006 through 2010. In order to evaluate the performance to date of the models, we applied the overall countrywide loss increase predicted by each model to the number of hurricanes, the number of U.S. landfalling hurricanes, and the long term average annual hurricane losses for each year. Note that because the modelers did not publicize the predicted number of hurricanes and landfalling hurricanes, the near term predictions in Tables 1 and 2 are derived numbers. While the modelers could argue that their predicted landfall frequencies are not as high as shown in the table below because they predicted some of the increased loss would come from hurricane intensity increases, the numbers below should be reasonable approximations.

The actual number of hurricanes for each year along with the long term average number of hurricanes and landfalling hurricanes are from NOAA data. More detailed NOAA data is included in the appendix. The tables below show how the predictions performed each year and for the cumulative three year period, 2006 through 2008.

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*
Total	*17.7*	*19*	*22.0*	*24.1*	*25.2*

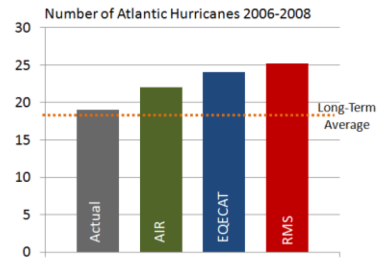
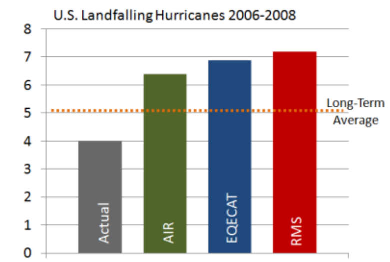


Table 2: **Number of U.S. Landfalling Hurricanes**

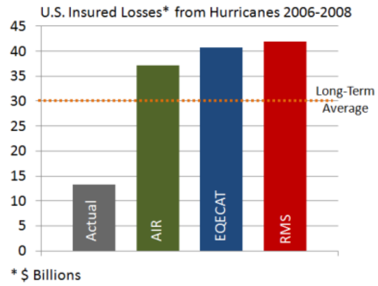
			Near Term Predictions		
	Long-Term Average	Actual	AIR	EQECAT	RMS
2006	*1.7*	*0*	*2.4*	*2.3*	*2.4*
2007	*1.7*	*1*	*2.0*	*2.3*	*2.4*
2008	*1.7*	*3*	*2.0*	*2.3*	*2.4*
Total	*5.1*	*4*	*6.4*	*6.9*	*7.2*



The long term average annual hurricane losses shown in Table 3 represent estimates from the long term hurricane models. Analyses of publicly available information resulted in about $10 billion for AIR and RMS modeled average annual hurricane losses. The near term predictions were calculated by applying the overall countrywide loss increase for each model to $10 billion. The actual U.S. insured losses are from Property Claim Services (PCS) data.

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*
2007	*10*	*0*	*11.6*	*13.5*	*14*
2008	*10*	*13.3*	*11.6*	*13.7*	*14*
Total	*30*	*13.3*	*37.2*	*40.8*	*42*



Three years into the five year prediction period, all of the near term models significantly over-predicted the number of hurricanes that would form in the Atlantic, the number of landfalling hurricanes, and the insured hurricane losses. While the number of hurricanes is running a bit above average for the cumulative period, 2006 through 2008, landfalling hurricanes are running about 22 percent below average, and insured losses are more than 50 percent below average.

Implications for Model Users

While it is too early to make definitive conclusions about the accuracy of the near term hurricane models, in order for the insured losses to reach 40 percent above average for the five year period, in line with the RMS predictions for example, the next two years will both have to be like 2004, or there will have to be another Katrina. For the cumulative period, 2006 through 2008, insured losses are significantly *below* average suggesting that there is too much uncertainty around year-to-year hurricane activity to make short term predictions. Hurricane activity is influenced by many climatological factors many of which are known but some unknown by scientists. There are complicated feedback mechanisms in the atmosphere that cannot be quantified precisely even by the most sophisticated and powerful climate models.

Insurers, reinsurers and regulators need to evaluate the efficacy of the near term hurricane models in light of this uncertainty. Even the standard, long term catastrophe models are characterized by a high degree of uncertainty. Short term assumptions on frequency and severity only magnify this uncertainty and the volatility in the loss estimates.

Given that in many coastal areas the catastrophe loss cost is the most significant component of the property premium, we need to ask if property owners should be subjected to this increased uncertainty and volatility in determining insurance rates. As stated earlier, an original objective of the catastrophe models was to bring more stability to insurance markets by providing a more credible view of risk than short term experience. Other business decisions relying too heavily on short term predictions can also be disruptive to effective business strategies.

Of course, if we knew there was a long term trend in either hurricane frequency and/or severity, and the trends could be credibly quantified, that information should be captured in premium calculations and other risk decisions taken by insurance companies. But hurricane activity can change markedly year to year, as the past several seasons illustrate. Two or three active seasons in a row, even those as extreme as 2004 and 2005, do not necessarily indicate a continuous trend, particularly for hurricane landfalls and insured losses.

Conclusions

Three years into the application of near term hurricane models, the model predictions have not performed well. While all three major catastrophe modeling companies predicted significantly elevated hurricane activity and losses for the period 2006 through 2010, two of the past three years have been below average. Catastrophe models are designed to simulate thousands of potential scenarios of what *could* happen to an insurance company – not what *will* happen in any given year or short time period. While catastrophe models, used appropriately, can provide credible estimates of a company's potential loss experience, the models are not able to predict where, when or how big actual events will be. While a definitive conclusion on the near term hurricane models cannot yet be made, early indications are that a five year period is too short for hurricane loss estimation.

Appendix

Table A-1: **2006 Atlantic Hurricanes**

Name	Dates	Wind Speed in Knots	Pressure in Millibars	Saffir-Simpson Category
Ernesto	8/24-9/1	*65*	*987*	*1*
Florence	9/3-9/12	*80*	*972*	*1*
Gordon	9/11-9/20	*105*	*955*	*3*
Helene	9/12-9/24	*105*	*954*	*3*
Isaac	9/27-10/2	*75*	*985*	*1*

Table A-2: **2007 Atlantic Hurricanes**

Name	Dates	Wind Speed in Knots	Pressure in Millibars	Saffir-Simpson Category
Dean	8/13-8/23	*145*	*918*	*5*
Felix	8/31-9/5	*145*	*929*	*5*
Humberto	9/12-9/14	*75*	*986*	*1*
Karen	9/25-9/29	*65*	*988*	*1*
Lorenzo	9/25-9/28	*70*	*990*	*1*
Noel	10/28-11/2	*70*	*980*	*1*

Table A-3: **2008 Atlantic Hurricanes**

Name	Dates	Wind Speed in Knots	Pressure in Millibars	Saffir-Simpson Category
Bertha	7/3-7/20	*105*	*948*	*3*
Dolly	7/20-7/25	*85*	*964*	*2*
Gustav	8/25-9/4	*130*	*941*	*4*
Hanna	8/28-9/7	*70*	*978*	*1*
Ike	9/1-9/14	*125*	*935*	*4*
Kyle	9/25-9/29	*70*	*984*	*1*
Omar	10/13-10/18	*110*	*959*	*3*
Paloma	11/5-11/10	*125*	*943*	*4*

Sources: NOAA (www.nhc.noaa.gov) and Unisys Corporation (weather.unisys.com)

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