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A Review of the Performance of Near Term Hurricane Models

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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 estimate 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 at this stage, we are beyond the midway point and can review the performance to date of the near-term hurricane models.

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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

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) anoma-

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lies 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 its 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 five-year projections of SST. 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.*

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 its long-term averages. Its annual increases have been relatively consistent and range between 35 and 37 percent for countrywide average annual losses.

RMS has been a strong proponent of near-term hurricane models and, in 2006, became the first modeling company to submit its near-term model to the Florida Commission on Hurricane Loss Projection Methodology. The commission reviews catastrophe models on an annual basis to determine their acceptability for personal residential rate filings in the state of Florida. In a presentation at the Florida Commission on Hurricane Loss Projection Methodology Workshop in July 2006, RMS indicated it 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. RMS ultimately withdrew their near-term model from Commission review, and currently the Florida Commission has not accepted a near-term model submission from any modeling company.

Based on the results of the elicitation process, RMS announced that increases in hurricane landfall frequencies assumed in its 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 its long-term model. Furthermore, its 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. 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.

HOW THE MODELS PERFORMED

All three catastrophe modelers predicted above-average hurricane activity and losses for the period 2006–2010. 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

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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.

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

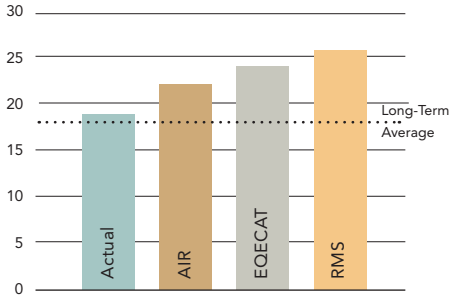


Table 2: Number of U.S. Landfalling Hurricanes

			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

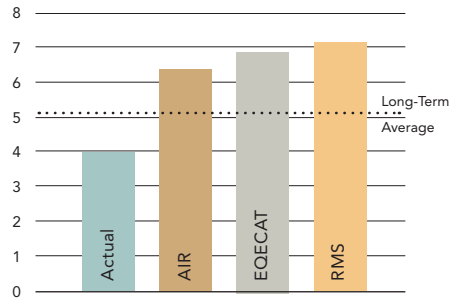
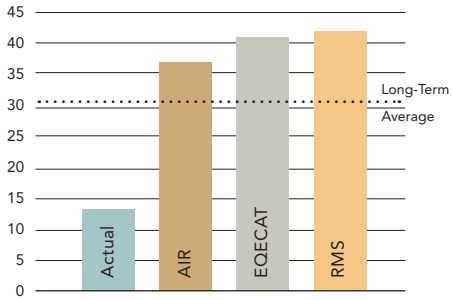


Table 3: U.S. Insured Losses from Hurricanes ($ Billions)

			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



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The actual number of hurricanes for each year along with the long-term average number of hurricanes and landfalling hurricanes are from NOAA data. The tables below show how the predictions performed each year and for the cumulative three-year period, 2006–2008.

The long-term average annual hurricane losses shown in Table 3 represent estimates of countrywide insured losses for onshore properties 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.

Three years into the five-year prediction period, all of the near-term models significantly overpredicted 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, 2006–2008, 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, for the cumulative period, 2006–2008, 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 within 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.

Of course, if we knew there was a long-term trend in either hurricane landfall 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 2006–2010, two of the past three years have been below average. Catastrophe models are capable of simulating thousands of potential scenarios of what *could* happen to an insurance company—but have yet to demonstrate significant skill in estimating 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 may be too short for hurricane loss estimation. ✦