# Using Recent Hurricane Data to Evaluate Prospective Risk Models

*Natural catastrophe models have evolved to support a dynamic international property insurance industry. These models reflect the latest understanding of science, engineering and finance to produce prospective risk evaluation tools designed to quantify the severity and volatility of natural-catastrophe linked instruments.*

A paper[1] published in December 2008 aims to demonstrate that hurricane risk models are "inadequate" at the task of forecasting insured tropical cyclone risk along the Atlantic and Gulf coasts because the insured losses in the years 2006 though 2008 were lower than average. That paper misrepresents the basis of natural catastrophe models for infrequent risks which undercuts its conclusion.

EQECAT provides multiple tools to help clients understand and quantify prospective risk. The core tool that EQECAT provides is USWIND™, a probabilistic risk tool for insurers to competently and consistently evaluate tropical-cyclone exposed risk in the North Atlantic basin, including the Gulf of Mexico. EQECAT also provides an alternative risk perspective based upon the status of the Atlantic Multi-decadal Oscillation (AMO). Independent academic studies and researches by EQECAT scientists have identified a strong confidence of correlation between the status of the AMO within a year and the severity of damages onshore. EQECAT continually strives to help insurers, reinsurers and governments answer the question: "How do we translate advances in long-term climate forecasting into quantifiable risk metrics?"

## *Understanding Hurricane Risk: A Historical Review*

The strongest way to assess what can happen is to review what has occurred in the past. The challenges in the collection of historic data include imperfect or incomplete historical data and the changing dynamics of population and wealth distributions. An understanding of the volatility surrounding property damage from tropical cyclones can be developed if we can "see" what has happened previously.

The United States National Hurricane Center maintains the HURDAT[2] data set which provides historical hurricane track information for the Atlantic and Gulf of Mexico regions. This catalog is a compilation of data about North Atlantic tropical cyclones from 1851. It includes hurricanes affecting both the Caribbean Sea and the U.S. mainland. The HURDAT catalog was first published in 1970 and is updated annually. For each recorded tropical cyclone, the catalog generally provides information such as the storm track, central pressure and wind speed at six-hour intervals along the track. This data set provides an important baseline in understanding hurricanes that have occurred in past.

[1] "Karen Clark & Company Report Analyzes Performance Of Near Term Hurricane Models",http://www.karenclarkandco.com/home/page/home.aspx#, December 2008

[2] Original HURDAT data format, http://www.aoml.noaa.gov/hrd/data_sub/hurdat.html. HURDAT re-analysis information, http://www.aoml.noaa.gov/hrd/hurdat/index.html.

Roger Pielke, et al[3] have developed a methodology to normalize to 2008 dollars the damages from historic hurricanes. This data set enables a statistical evaluation of the empirical hurricane set. The event losses from this paper can be accumulated to annual losses and plotted, as shown below.

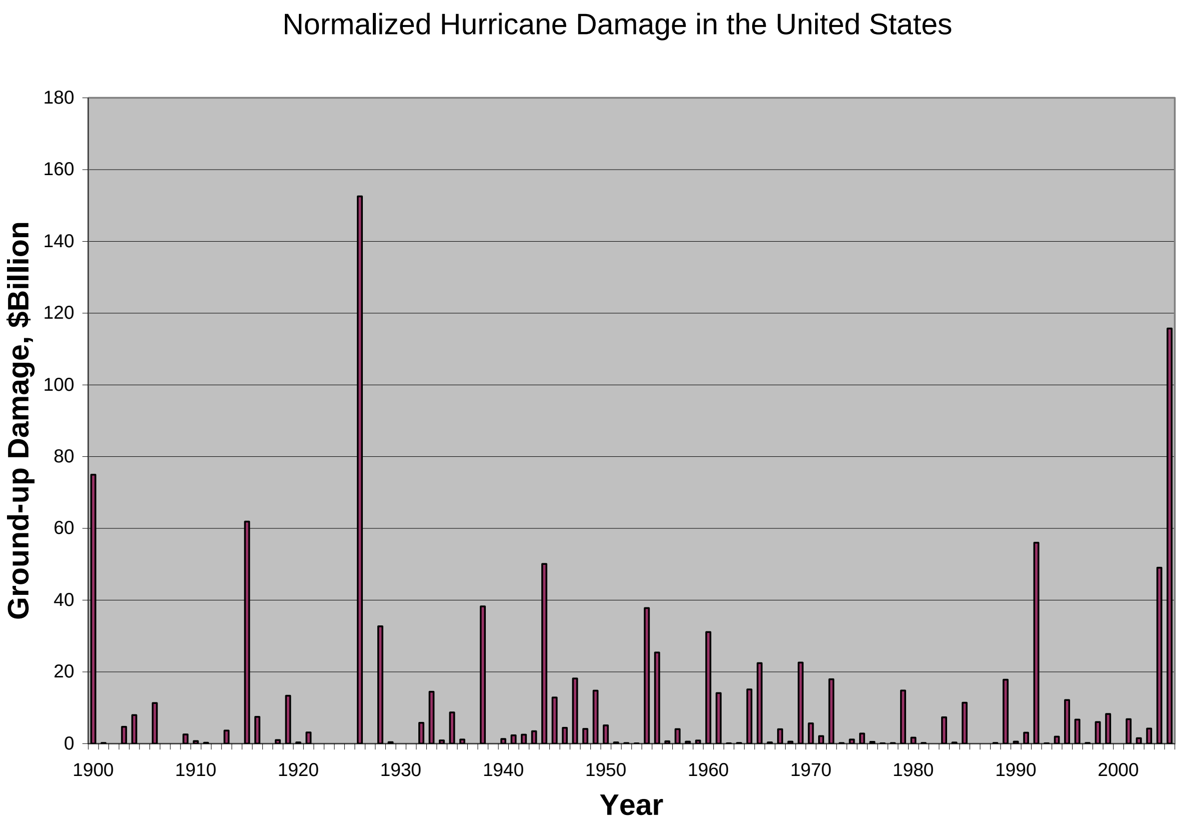


**Figure 1: Normalized Damages (average of PL05 and CL05, from Pielke et al)**

Useful statistics from this data set include these observations:

| | |
|---|---|
| Average Annual Damage | $10 Billion |
| Median Annual Damage | $2 Billion |
| Probability that Annual Damage is less than $1 Billion | 40% |
| Standard Deviation of the Annual Damage | $22 Billion |

The losses appear to be very volatile with few discernable/identifiable patterns or short-term patterns and 20 of the years show no losses. It is interesting to note that the worst 10 years (1900, 1915, 1926, 1928, 1938, 1944, 1954, 1992, 2004, and 2005), representing less than 10% of the 106 observed years, produced more than 60% of the normalized damages. Selecting only a small subset of these years to represent the entire spectrum of potential losses would be misleading.

[3] Roger A. Pielke Jr.; Joel Gratz; Christopher W. Landsea; Douglas Collins; Mark A. Saunders; and Rade Musulin, "Normalized Hurricane Damage in the United States: 1900–2005", Natural Hazards Review, Vol. 9, No. 1, February 1, 2008.

The Cumulative Distribution Function (CDF) of the annual damage tabulated in Figure 1 describes a very tail-weighted distribution.

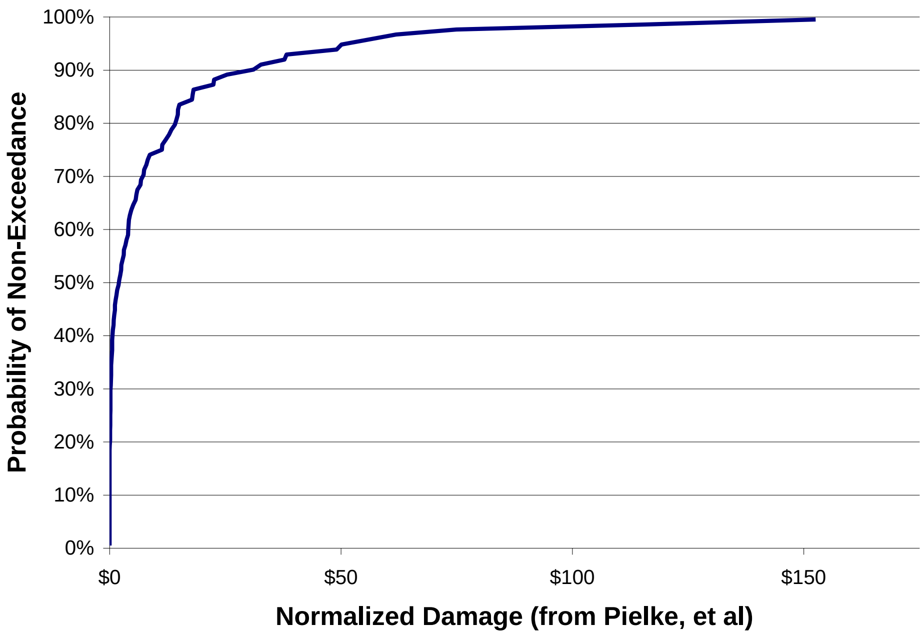


**Figure 2: CDF of Annual Normalized Damage (from Pielke, et al)**

The Karen Clark & Co. paper attempts to use the three most recently observed years (2006, 2007 and 2008) to evaluate the utility of catastrophe models. The data used for these years is zero insured losses in years 2006 and 2007, and $13.3 billion in losses in 2008. The cumulative insured loss for the three years, therefore, is $13.3 billion. The implications from the paper are that the average annual insured loss from three sequential years should equal the average annual loss from a model. This premise is not reflected in the observed data, as shown by the high volatility in the trailing three-year cumulative damages.

One method to evaluate the appropriateness of using a limited data set (in this case, three years of data) involves the calculation of a term the "Standard Error". The standard error can be calculated as being the standard deviation of the overall population divided by the square root of the observation set. In this case, the standard error of the annual mean calculated from a set of three years of data is $22 billion divided by the square root of 3, or almost $13 billion. Even if the annual damages from hurricanes were normally distributed, the simple three-year observation would not be sufficient to prove or disprove the appropriateness of "near-term" hurricane frequency-severity models.

EQECAT's near-term hurricane risk model is premised upon the status of the Atlantic Multi-decadal Oscillation (AMO) as being an indicator of the severity of damage upon the mainland U.S. EQECAT tested this premise in a multi-step process:

- First, an onshore "Damage Energy" Index was developed to enable a better comparison of the damage potential from different hurricanes, eliminating the bias of hitting an urban area (significant damage, even with moderate winds) or missing an urban area (the inverse, minimal damage even with catastrophic winds). EQECAT's damage index better mimics the needs of insurers and property owners to protect against loss-producing winds than other meteorological statistics that don't directly cause loss.

- The annual Damage Energy Index values were subset into a COOL AMO subset (years where the AMO signal was "cool") and a WARM AMO subset (the complement, years when the AMO signal was "warm") and the means were confidence tested to evaluate if the status of the AMO was a significant factor in the expected damage index for a given year. The result was a 98%+ statistical confidence that the AMO was a factor in the expected

Hurricane activity is not predictable, but EQECAT works continuously to develop tools to help its clients manage the extreme risk from natural catastrophes worldwide. The recent development of atmospheric models and the powerful computers to run them enable further research into the dynamics of risk estimation.

The concept of a "trailing" three-year cumulative damage statistic to evaluate natural catastrophe models can be pursued further. The hurricane damage data from Figure 1 can be used to plot the trailing three-year cumulative damage against the historic long-term damage (from the Pielke data set) and the bounds of EQECAT's Near-Term model (the Warm AMO, corresponding to the current status) and EQECAT's Cool AMO model, corresponding to a cool AMO status. This graph highlights the cyclical nature of catastrophic losses, and the volatility is easily seen by the relatively few data points beyond the long term average.

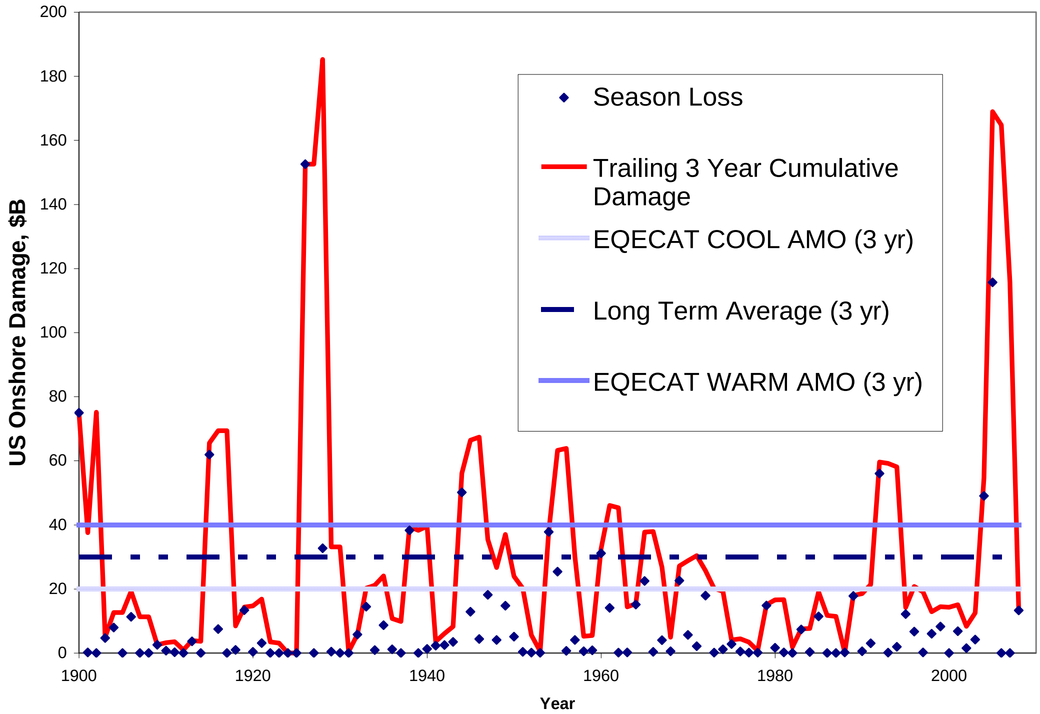


**Figure 3: Historic Damages, Trailing 3-year Cumulative Damage, Long-Term Average**