Hurricanes – "What's the frequency, Kenneth"?

By Bill Keogh and David F Smith

In 1994, the alternative rock group REM had a song on the charts called "What's the frequency, Kenneth?" – a reference to the brutal 1986 attack on former CBS anchor Dan Rather in New York City during which unknown assailants repeatedly asked him this question. Although the song was popular, the meaning of the question remains obscure. Likewise, when it comes to hurricanes, the question of frequency is little understood. However, all risk professionals deserve to have an answer to "What's the frequency?" because of its overall importance to modelling for hurricanes.

Basically, frequency assumptions drive modelled results. Robust catastrophic risk models, built by such highly-skilled professionals as engineers, meteorologists, mathematicians, actuaries and software designers, are the result of many components compiled into a single model, which is then validated and calibrated. One of the most important parameters influencing modelled results is the frequency assumption. Specifically, where and how often should we expect events to happen? How often will high consequence events occur that will cause significant insured losses?

There are two general approaches to the frequency question: one is largely informed by statistics; the other is based on climate theory. In our experience, the approach that relies on statistics – reliable, transparent and defensible – is the only real choice.

The need for a statistical approach

Since the unprecedented 2004 and 2005 hurricane seasons, we have understood the need to provide two perspectives for US hurricane risk: a "long-term" model, which references frequencies from the complete historical record, and a "near-term," or "Warm AMO" (WAMO), model, tuned to current climate conditions.

EQECAT's WAMO model is identical to the long-term model except for the frequencies of stochastic storms. In the long-term model, stochastic storm frequencies are based on complete historical data, derived from statistical smoothing methods that compute frequencies as a function of landfall location and intensities. In the warm AMO model, frequencies are based on warm phase time series only. Over the past 111 years, the AMO has switched phases three times, with durations of between 25 to 44 years, provided by NOAA in the table below:

AMO Phase	Years
Cool	1900-1925
Warm	1926-1969
Cool	1970-1994
Warm	1995- ?

The warm phases of the AMO are associated with a higher incidence of major Atlantic storms, favouring the US Atlantic Coast, most notably Florida, the Southeast and Mid-Atlantic regions. This phenomenon was seen during the extended period between 1926 and 1969, and most recently in the current warm phase that began in 1995. The near-term risk corresponding to the warm phases of the AMO produces an average annual loss (based on modelled losses from stochastic events) that is approximately 37 percent higher than the long-term risk. Sampling from the warm series' historic pattern provides a better match for understanding near-term risk.

Annual frequency of hurricanes – US mainland

Storm Frequency	Long -Term Frequency (Observed)	EQECAT v 3.16 Long-Term Frequency	WAMO Frequency (Observed)	EQECAT v 3.16 WAMO Frequency
Category 3-5	0.6	0.7	0.8	0.9
Category 1-2	1.4	1.3	1.5	1.6
Total	2.0	2.0	2.3	2.6

The table above compares observed frequencies and EQECAT's modelled frequencies for both long-term and WAMO for US mainland hurricanes. As you can see, there is general agreement between the two. The variances are driven by a number of factors, including the spatial wind speed smoothing process along the US mainland, and the use of long-term frequency as a floor for the warm AMO frequency regionally.

Alternative approaches based on climate theories

What if the past is irrelevant for understanding the future? What if the world is changing and we need to shift paradigms to understand risk in the future? Is the world becoming riskier? At EQECAT, we employ many complex techniques to building risk models. Our teams are engaged in original research and are active participants in the important debates within the scientific community.

Over the past 20 years there has been a robust dialogue that falls under the general category of "climate change." There has been a significant amount of research into questions such as:

- Is there a general trend of global temperatures increasing?
- If so, to what extent is it caused by manmade activities such as the use of carbon-based fuels?
- Regardless of cause, do increased global temperatures imply an increase in frequency and/or severity of tropical cyclones in general, and hurricanes in particular?

Each of these questions has spurred intense debate, both inside and outside the scientific community. The complexities of the atmospheric and oceanic climate system, and the practical difficulties in using observational weather data to assess changes over broad areas and long periods of time, conspire to make the uncertainties in the answers to such questions very significant. And while much of the research has been done with great scientific rigor, sadly, this has become a highly politicised field.

In any case, the question of increased global temperatures raising the frequency and/or severity of hurricanes is the most critical with respect to catastrophe risk modelling. This topic has also been widely explored, notably by Kerry Emmanuel, a well-respected professor of atmospheric science at MIT. Yet, despite all the investigation, the results are still inconclusive. Some "what-if" studies favour an increase in tropical cyclone activity due primarily to increased sea surface temperatures, while other studies favour a decrease in tropical cyclone activity due to increased vertical wind shear. In fact, a recent paper that appeared in the journal Nature Geoscience (Knuston et al, 2010), summarised the work of several scientists in this area, spanning a broad range of expertise and perspectives on this issue. One of the main conclusions of the paper was: whether past variations in tropical cyclone activity are out of line with natural variability remains uncertain. Due to the variation in the outcomes of such studies, there is no consensus in forecast trends in tropical cyclone activity decades into the future with the assumptions of the continued increase in atmospheric carbon dioxide. This is intriguing research deserving of examination and consideration. However, because of the high degree of uncertainty it introduces into the process, it does not meet our criteria for use in a risk model.

Considering the simplicity, transparency and elegance of using a statistical approach to modelling hurricane frequency, it is easy to understand why we use it. Our goal is simple: to help clients set rational expectations about risk. This requires a disciplined approach to vetting the underlying assumptions in our risk models. ●

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