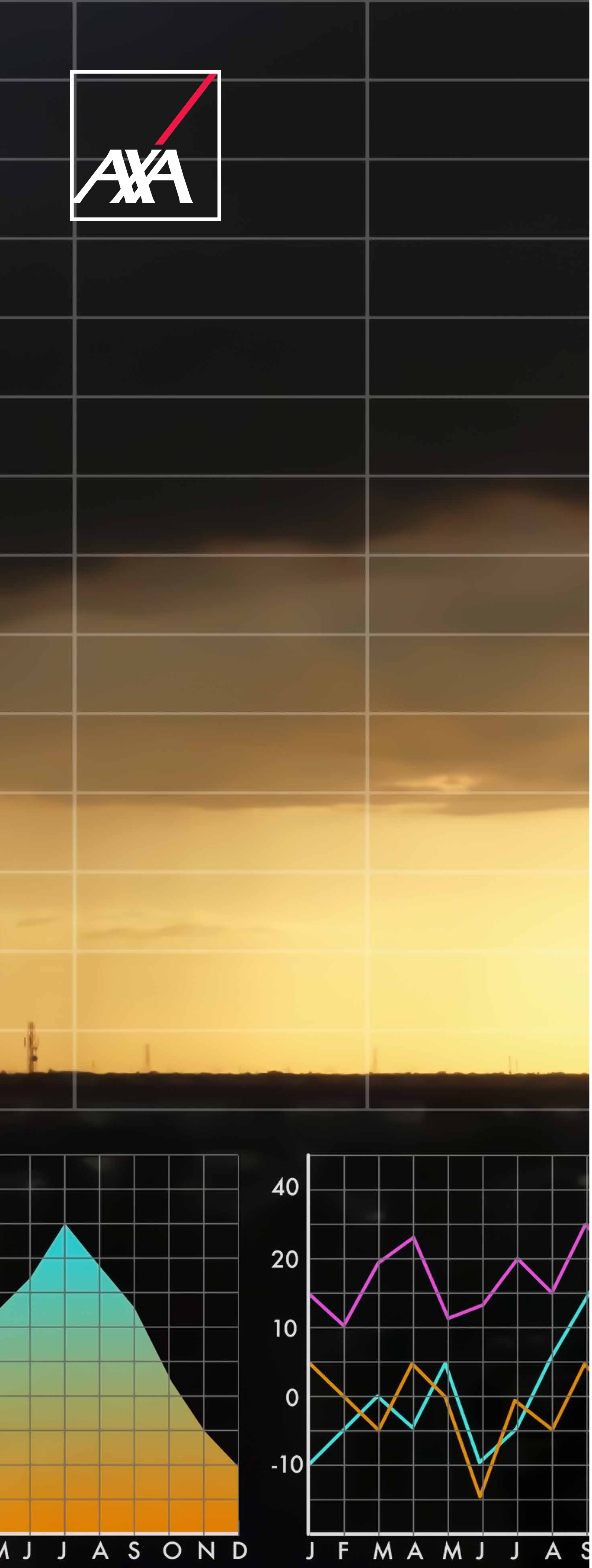

North Atlantic Hurricane Risk: Counterfactuals

The global (re)insurance industry often uses catastrophe (cat) models to quantify risk arising from extreme events. These models are multi-disciplinary, usually incorporating scientific, engineering and economics-based modules that combine to produce risk probabilities and subsequent loss estimates. The extreme events of interest to cat modelling are, by definition, rare. Thus, quantifying the risk of the impacts of these events in a statistically robust manner is extremely difficult.

Contemporary cat modelling attempts to appropriately quantify the risk of these events by taking a relatively sparse historical record, and applying stochastic methods to generate a much larger, artificial dataset to help better inform decision makers. One of the largest limitations of these stochastic-set methods is that the statistics of the underlying dataset are, to at least some extent, preserved. Thus, any biases from an under-representative historical record may be incorrectly reinforced.

The HURDAT2 (historical record for North Atlantic Hurricanes) (NAHUs) is unique in length and detail for extreme weather perils; in its current format, it ranges from 1851-present, and provides (among other things) estimates of geolocation, central pressure and maximum sustained surface (10m) windspeed for the vast majority of storms in its record. Although quite remarkable and valuable, the dataset is known to be rife with uncertainty, particularly in the years before the dawn of the satellite era (Landsea & Franklin, 2013)[1]. Any single stochastic dataset that is created from it will be subject to uncertainty.

The advent of climate reanalysis simulations, which utilise contemporary climate modelling techniques but run through periods of history, has increased the completeness and reliability of historical records for many climate and weather perils, but the

Continued ➲

By Catherine Pigott and
John Wardman

methods are far from perfect, particularly for extreme events. For example, Befort et al. (2016)[2] showed how the use of different reanalyses would lead to different conclusions about long-term trends in EU Windstorm activity in the pre-satellite era. On top of this, in the case of North Atlantic Hurricane (NAHU) specifically, the existing reanalysis projects also don't run as far into history as the raw HURDAT2 (Hurricane data set) observational record. As a result of these issues, it is widely recognised within the cat modelling community that contemporary methods for quantifying risk from NAHUs (and any other extreme weather peril) may be misrepresentative of the true risk of the peril. A question therefore arises: can we utilise techniques employed in other areas of cat modelling or climate and weather forecasting/modelling in order to better understand risk from NAHUs? It is with this question in mind that we come to the topic of counterfactual risk analysis.

Working with academics at the University of Exeter and University of Reading, AXA XL have embarked upon an exercise to explore the use of historical, dynamical, ensemble forecast data to create a suite of alternative histories. The assumption within the stochastic cat modelling process is that the observed historical record accurately represents the mean of possible outcomes. We are testing this assumption by looking to compare alternative, but realistic, histories to that which we have observed. What if the hurricanes we have observed had taken a different, but realistic course? Our objective is to explore where our observed history sits in a distribution of alternative histories and so to assess potential deviations from the mean but also look at both tails of the distribution.

This is a first step into a different way of thinking about history. If successful and insightful, AXA XL hopes to extend this work outside of USHU to other tropical cyclone basins around the globe.

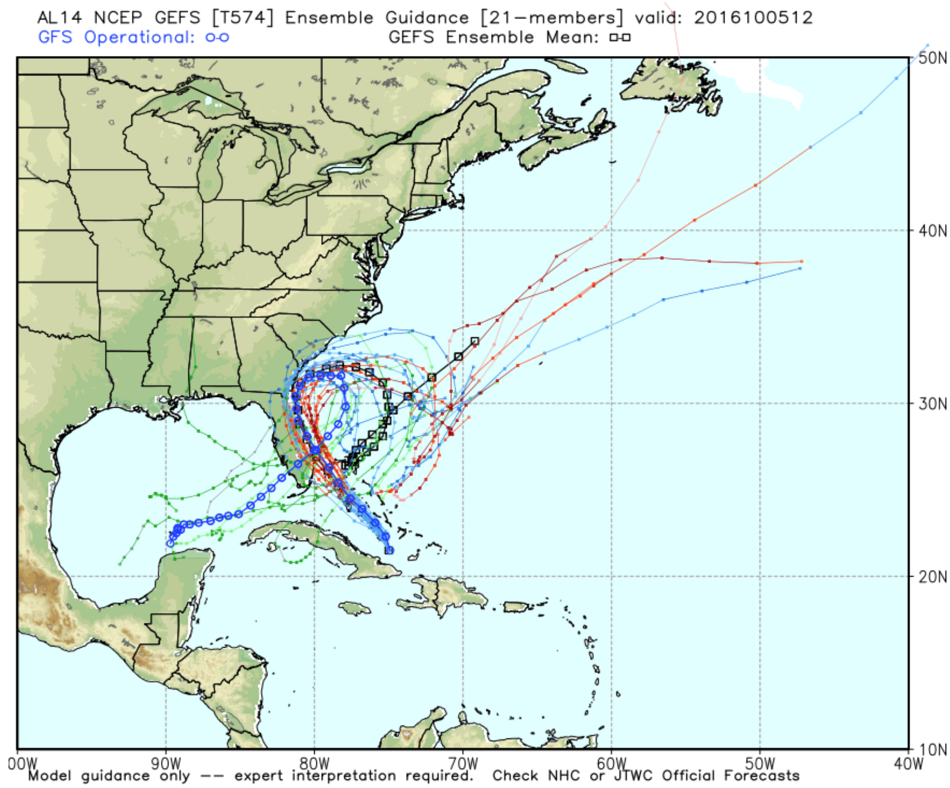

Figure: Hurricane Matthew skirted along the Floridian coastline in 2016. The actual observed path is shown in blue with alternative predictions by National Centers for Environmental Protection (NCEP) also shown.

References

1 Landsea, C. W., & Franklin, J. L. (2013). Atlantic hurricane database uncertainty and presentation of a new database format. Monthly Weather Review, 141(10), 3576-3592.

2 Befort, D. J., Wild, S., Kruschke, T., Ulbrich, U., & Leckebusch, G. C. (2016). Different long‐term trends of extra‐tropical cyclones and windstorms in ERA‐20C and NOAA‐20CR reanalyses. Atmospheric Science Letters, 17(11), 586-595.

About the Authors

Catherine Pigott has a BSc. Mathematics and FIA. She leads AXA XL's divisional Science & Natural Perils team, which is responsible for driving applied scientific research and academic collaborations within AXA XL. The team are also responsible for third party cat model evaluations, cat model development and cross segment portfolio analytics in the area of natural perils within the division. Catherine joined AXA XL, previously Catlin, in 2009 as the Business Group Actuary for Short Tailed Treaty lines and has held several positions since then, predominately focusing on catastrophe exposed business. Catherine is based in the UK and can be reached at: catherine.pigott@axaxl.com.

John Wardman, PhD, FGS, is a Senior Specialist on the AXA XL Science & Natural Perils Team where he helps to build and inform views of catastrophe risk, assist CAT model evaluation and validation, and support product development. John's role also includes engaging with scientists and university departments from around the world, facilitating the translation of academic research into business impacting information and data. John is based in the UK and can be reached at: john.wardman@axaxl.com.