



 Insurance
Reinsurance

 **Understanding Risk**
through science

AXA XL's Science & Natural Perils team works both independently and with external specialists to investigate scientific data across a wide range of targeted projects. These are designed to deepen our understanding of natural peril risk, enhance our ability to accurately price and monitor present-day risks, while also anticipating any future changes.

Through these initiatives, AXA XL's scientific experts aim to (i) develop better present-day views of risk, (ii) anticipate future changes in risk, (iii) raise awareness and communicate real-world present-day climatic conditions, and (iv) drive company and market innovation through industry-wide contributions. These initiatives encourage effective risk management and resilience planning. The following sections summarise our 2026 projects and collaborations on these key strategic areas.



Present-day view of risk



1. National Centre for Atmospheric Research (NCAR) Partnership - Exploring Variability in Past Hurricane Frequency

U.S. hurricane landfall frequency has fluctuated significantly from 1900 to the present. This makes it challenging to calibrate catastrophe models to the average of historical activity, particularly when there have been anomalous climatic periods, trends over time, and extreme years of very high hurricane landfalling frequency or complete hurricane drought. AXA XL funds research and its scientists work with NCAR scientists to explore the variability in past hurricane frequency within the NCAR Community Earth System Model High Resolution ensemble (CESM) data. This helps AXA XL to understand how likely these landfall variations are to re-occur in the near-future, better ascertain present-day US hurricane landfall risk and quantify the impact of catastrophe model loss estimates.

2. Lambda Ltd Climate Research Partnership - Enhancing (Re) Insurance Decision-Making through Better Integration of Statistics and Applied Science

AXA XL funds research and its scientists work with the Lambda Research Network to explore how to best implement model adjustments and better integrate statistics into risk modelling. This joint analysis includes using statistics around best use of historical experience to calibrate our catastrophe models, and to apply adjustments to corresponding stochastic event sets. The collaboration also supports other innovative research on natural hazard risk, e.g., quantifying changes in natural hazard frequency and / or severity over the past and into the future, exploring the use within (re) insurance of seasonal hurricane predictions from forecasting agencies, and exploring historical variability in risk across various perils.

3. International Institute for Hydraulic and Environmental Engineering (IHE) Delft Institute for Water Education - Addressing Challenges in Modelling and Quantifying Coastal Flood Risk

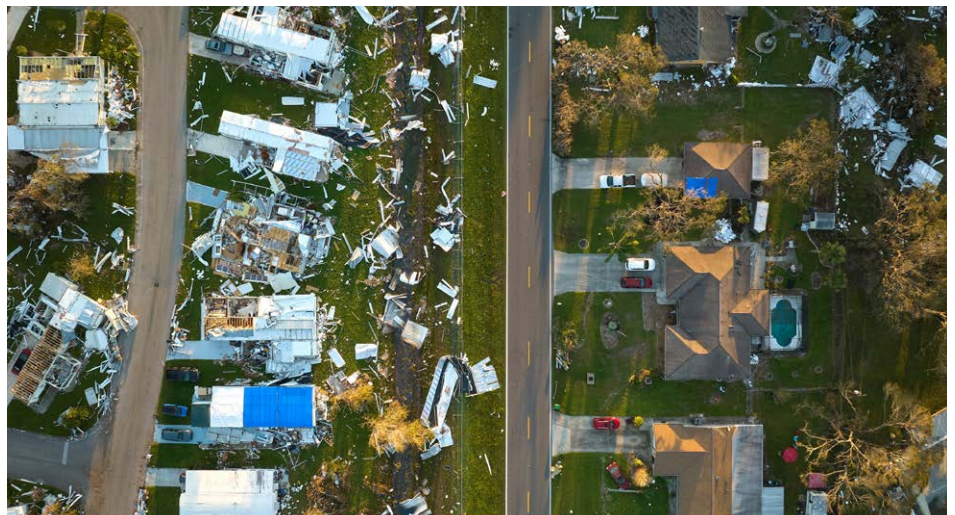
AXA XL funds research and its scientists work with the IHE Delft Institute for Water Education to evaluate and enhance our understanding of coastal flooding risks, focusing on three key challenges: quantifying the sensitivity of flood risk to (i) sea level rise (considering ongoing global sea level rise), (ii) defences (acknowledging the difficulty in surveying and modelling all real-world flood defences), and (iii) horizontal resolution in flood modelling (recognising the limitations imposed by computational power when creating stochastic and very large event sets). Ultimately this project seeks to help us quantify the impact of these specific modelling challenges, with the goal of adjusting our in-house catastrophe models to minimise existing limitations.

4. External Scientific Project - Developing a Historically Consistent Severe Convective Storms Frequency and Severity Dataset

Severe convective storms (SCS), such as tornadoes, hail, and straight-line wind gusts, are among the most frequent and most damaging natural hazards.

“Risk is evolving, and through scientific collaboration and analysis, we are evolving too”

However, observational records of their occurrence are often affected by a reporting bias, which limits their utility and effectiveness to understanding present-day risk. More specifically, due to the small scale of events (often less than 1km wide), frequency and severity observations in the US and Europe largely rely on local human reports rather than satellite detection, with these databases therefore being influenced by changes in societal behaviour and awareness of extreme weather. Therefore, these records can include an artificial increasing trend, since past events more frequently went unnoticed or unrecorded in less populated areas. We aim to explore historically consistent SCS datasets that more accurately reflect the occurrence of hail, tornado and straight-line wind gusts over time using high-resolution atmospheric modelling, thereby improving our understanding of current risk. We also aim to refine the accuracy of our future global severe convective storms frequency and severity projections, using high-resolution atmospheric modelling in future climate states.



Present-day view of risk



5. University College London (UCL) - Developing a Framework to Determine Present-Day Flood and Wind Vulnerability Using Historical Claims Experience

Alongside the AXA XL's Risk Consulting team, AXA XL scientists work with experts from UCL on research AXA XL helps to fund to refine and expand our internal database of vulnerability functions for hydrological (rain-driven flood) and meteorological (wind-driven) perils. Additionally, we seek to evaluate existing vulnerability functions against historical claims data. Currently, there is a notable gap in the market's ability to validate vulnerability functions within catastrophe models for these perils. This initiative is designed to address that gap, by developing a methodology to derive skilful vulnerability curve estimations given observed claims. Ultimately, this research will strengthen our model evaluation and risk consulting efforts, enabling us to develop a more precise understanding of present-day risks.

6. AXA XL Coastal Risk Index (CRI) - Assessing the Importance of Nature-Based Defences in Mitigating Risk

Assessing the importance of marine ecosystems and the impact of increased sea levels on coastal communities, both now and in the future, is part of the broad AXA XL 'Coastal Risk Index' (CRI) project. Led by the Ocean Risk & Resilience Action Alliance (ORRAA), the CRI project aims to stress the importance of natural ecosystems in offering protection against natural hazards, and hence why they may be better protected. Building on previous efforts, the Science Team are actively exploring how natural defences mitigate surge damage, to potentially refine loss estimates from industry catastrophe models.

7. In-House Scientific Analysis - Catastrophe Model Evaluation

AXA XL leverages a diverse range of external catastrophe models and other risk tools to accurately quantify current natural hazard risks worldwide. To ensure these models deliver reliable insights, AXA XL's Science Team rigorously evaluates their performance and implements internal adjustments where necessary, to improve these 'off-the-shelf' products. Limitations of these models may arise from biases in input data, the selection of specific methodologies, or changes in the frequency and severity of natural hazards over time. The Science Team regularly reviews and calibrates these models to support more precise and effective pricing and risk management.

“Communicating real-world climatic conditions today enables more accurate risk assessment and resilient decision-making.”

“Deepening our understanding of natural peril risks empowers us to better protect communities and adapt to a changing climate.”



Future changes in risk

8. NCAR - High-Resolution Sub-Peril Hurricane Footprints (Wind, Storm Surge, and Rainfall) in Present-day and Future Climates

Hurricanes are multi-faceted and inflict damage through extreme wind speeds, coastal flooding from storm surges and in-land flooding from rainfall. To accurately anticipate how hurricane-related damage may change in the future, we aim to comprehensively understand how each hurricane sub-peril impact total loss, and how the contribution of each sub-peril may change if global temperatures increase. AXA XL funds and its scientists work with experts from the National Centre for Atmospheric Research (NCAR) to explore all hurricane sub-perils (wind, storm surge and rainfall) in a future climate and understand how they all may contribute and accumulate to overall future hurricane risk in the US. The research relies upon NCAR's high-resolution models to produce realistic hurricane sub-peril footprints in present-day and future climates.

“Collaboration between industry and academia drives innovation, ensuring we stay ahead of future risks.”

9. Imperial College Storm (IRIS) Consortium - Developing the Imperial College Storm Model to Gain Risk Insights

Given the short period of reliable US landfalling hurricane observations and the biases within these datasets, assessing tropical cyclone risk on a global scale remains a challenge. Synthetic longer-term (e.g., 1,000 years +) hurricane datasets could help overcome the shortcomings of observations and uncover greater understanding of present-day US landfalling hurricane risk. AXA XL is an active member of the Imperial College

Storm (IRIS) Consortium, providing funding and guidance to develop the IRIS stochastic hurricane model to derive event sets in varied climate states, so that it can be reliably used to better understand variability in regional present-day and future climate hurricane risk.

10. University College London (UCL) - Anticipating Future Changes in Vulnerability

Risk is shaped not only by changes in hazard frequency and severity, but also by shifts in exposure and vulnerability. But projected changes in exposure and vulnerability are often overlooked in future risk assessments. We have witnessed significant changes in exposure and vulnerability in the past and we anticipate further important changes throughout the 21st Century, which will alter the future risk landscape in addition to direct changes in hazard frequency and / or severity. The AXA XL Science Team funds and helps to supervise a PhD project with University College London (UCL) to examine possible future changes in vulnerability and exposure (i.e., the built environment), thus providing a clearer understanding of how these risk elements may drive changes in risk in the present-day and future. This project focuses on hurricane wind as the primary driver of losses, and on the hurricane states in the US, given the relevance of this peril to the (re)insurance industry.

11. In-House AXA XL Project - Projections of Future Physical Risk

Observed increases in global air temperatures have already influenced, and will continue to affect, the frequency and severity of natural hazards. To evaluate and anticipate these changes in both the near-term (next 10 years) and longer-term (next 10+ years), the AXA XL Science Team projects future changes in risk for all material global natural hazards. This is achieved through internal analysis, review of scientific literature, and collaboration with external experts, which provides AXA XL with a comprehensive and scientifically robust projection of how the natural hazard risk landscape may evolve into the future.

Additionally, the Science Team supports AXA XL's efforts to evaluate future changes across all risk management pillars, including litigation and transition risks, providing a holistic understanding of potential future changes in risks, and their potential impact on our business.

12. University of Bucharest - Understanding the Weakening and Tipping Point of the Atlantic Meridional Ocean Circulation (AMOC) and the Impacts on Risk

In addition to increases in the frequency and severity of acute risks such as hurricanes and floods, future changes in global air temperatures may also trigger long-term, irreversible climate shifts known as tipping points. These tipping points involve gradual yet irreversible changes in the Earth's systems, which, in addition to atmospheric air temperature changes, could lead to additional impacts on acute hazard frequency and/ or severity. Experts from the University of Bucharest and AXA XL are co-investigating how potential future changes in the Atlantic Meridional Overturning Circulation (AMOC) could affect sea surface temperatures in the North Atlantic, and how this can in turn affect extreme weather in Europe and US.

13. In-House AXA XL Project - Quantifying the Financial Impacts of a Global Sea Level Rise Tipping Point

Further to our collaboration with the University of Bucharest, AXA XL is conducting in-house scientific research around quantifying the potential financial impacts of global sea level rise on chronic and recurrent high-tide flooding and acute storm surges from hurricanes and extra-tropical cyclones. Through this work we aim to improve our understanding of future consequences of global tipping points, such as the collapse of the Antarctic and Greenland ice-shelves, as tipping points become increasingly likely and impacted by further increases in global air temperatures.

Communicate Real-world present-day climatic conditions

14. Colorado State University (CSU) / Barcelona Supercomputing Centre (BSC) Collaboration - Developing and Maintaining our Seasonal Hurricane Prediction Website

AXA XL sponsors a renowned, expert-driven online platform / website which tracks seasonal hurricane predictions over the North Atlantic basin, developed in collaboration with CSU and the BSC. The platform consolidates forecasts from all major agencies, universities or research groups, providing comprehensive and up-to-date insights on the upcoming or developing hurricane season. The collaboration offers a unique vantage point: direct access to expert opinions and invaluable insights from CSU and BSC scientists, who can explain to the AXA XL community the atmospheric drivers behind these seasonal predictions, enabling us to better anticipate and manage hurricane risk throughout the course of the year.

15. Internal Monitoring and Communication of Present-Day Climatic Conditions with focus on ENSO

ENSO (El Niño-Southern Oscillation) describes the naturally occurring oscillation in sea surface temperatures over the central and eastern equatorial Pacific Ocean. ENSO impacts global weather and the frequency and severity of some natural perils. To inform internal stakeholders on the current state and forecasts of ENSO and how this may impact expected upcoming losses, AXA XL's Science and Natural Perils Team quarterly publishes 'ENSO Bulletins' for the US and Australia business units.

16. Internal Refinement of our Physical Risk Projections Through Monitoring of Greenhouse Gas Emissions and Future Global Air Temperature Projections

The global geopolitical landscape is constantly evolving, along with international commitments to mitigate changes in global air temperatures. The AXA XL Science Team regularly updates current risk projections given present-day air temperature levels, incorporating shifts in global geopolitical climate action commitments into our future

risk assessments. This involves utilising the latest available projections of future warming, staying informed through scientific reports and research papers, and regularly updating our future risk projections accordingly. These efforts ensure an up-to-date understanding of how future risks may evolve, supporting more effective risk management strategies.

17. Science Team's Active Participation in Industry-Wide Conference and Workshops

Scientific innovation depends on collaboration, sharing challenges, and exchanging solutions. AXA XL scientists regularly participate in industry-wide conferences and workshops to showcase their research and engage in discussions on common industry challenges with experts from other (re)insurance companies and academia. This participation helps AXA XL stay up-to-date with the latest scientific advancements and enables strategic allocation of resources toward emerging research areas. These efforts can ultimately drive internal and industry-wide improvements in risk modeling and management, which may trickle down to benefit clients.

18. Internal Collection and On-Levelling of Historical Natural Hazard Loss Data

The AXA XL Science and Natural Perils team maintains and manages an internal natural hazard loss database that records the impact of historical events on the (re)insurance industry. The team also have developed an internal application to visualise and analyse historical losses per region and per peril. To enhance the accuracy of this data beyond external raw sources, the team applies internal on-levelling adjustment factors to recalibrate historical events to current conditions. For example, recent decades have seen rapid urbanisation and population growth, which increase the exposure of financial assets to natural hazards and expand the pool of potential (re) insurance clients and claimants. As a result, a natural event from the 1990s would likely cause greater damage if it occurred today. By contextualising historical events within the present-day environment, the AXA XL science team ensures a more precise assessment of current risk.



“By continuously refining our models and leveraging scientific insights, we can anticipate and mitigate tomorrow’s challenges.”



Industry-wide contributions

19. AXA XL Science Team Annual Market-wide Science Event

Over the past 3 years, the AXA XL Science Team have been proactively organising their own market-wide Science Event, uniting academic and (re)insurance professionals. This conference provides a platform for AXA XL scientists and external scientific collaborators to showcase applied research projects, highlighting how their research can improve current and future risk management and modeling. This event is set to return in 2026, reaffirming AXA XL's commitment to innovation and thought leadership in risk science.

20. Journal of Catastrophe Risk and Resilience Sponsorship

AXA XL provide funding for the Journal of Catastrophe Risk and Resilience, with a member of the AXA XL Science Team also serving on the editorial board of the journal, the industry's first 'diamond open-access', peer-reviewed journal dedicated to catastrophe research. This unique platform fosters vital debate and collaboration between academia and the insurance industry, providing a shared space for scientific discussion and publication. Free to read and publish, the journal features peer-reviewed research and expert opinions from industry leaders and academics worldwide, advancing the understanding of risk and resilience.

21. RIAGE (Re)Insurance-Academia Global Earthquake Workshop (RIAGE)

Scientific progress depends on collaboration and knowledge-sharing. The AXA XL Science Team is sponsoring and co-organising an industry-wide (re)insurance conference on earthquake risk, bringing together academics and professionals to exchange insights and discuss current challenges in earthquake related risk management. This initiative aims to foster a deeper understanding across the (re)insurance sector, ultimately enabling the delivery of improved services to AXA XL clients.

22. Supporting the Global Earthquake Model (GEM) Foundation

We are extending our relationship with the Global Earthquake Model (GEM) Foundation, a globally accepted standard for seismic risk assessment, for academic work, and public and private organisations. In addition to furthering the understanding of global earthquake risk, GEM also innovates methods to collect global exposure information through remote sensing and artificial intelligence (AI) algorithms. AXA XL benefits from using GEM's global databases, tools, and standards for internal model evaluation, risk consulting as well as earthquake risk mapping and risk management worldwide.

23. Supporting the Next Generation of (Re)Insurance Scientists Through MSc and PhD Supervision

The AXA XL Science Team maintains strong collaborations with numerous UK universities, actively working to bridge the gap between academia and the (re)insurance industry. We support emerging early-career scientists by guiding them through applied research projects that address industry challenges and providing real-world experience through MSc dissertations and PhD supervision. This engagement includes suggesting MSc and PhD research topics and co-supervising students alongside experts from the host university to help guide their research so that it is relevant and potentially implementable within the (re)insurance industry. Such effort fosters innovation and ensures fresh insights are integrated into the industry's evolving risk landscape.

One collaboration with the University of Reading explores the variability in European windstorm risk, aiming to uncover physical explanations for the recent 20-year lull in event damages.

Another project enhances our ability to predict hurricane damage by better understanding how hazard, exposure, and vulnerability factors relate to historical impacts—seeking to refine a hurricane severity scale (the Saffir-Simpson scale) beyond extreme wind-speeds alone, for

a more accurate provision of damage forecasts and early warnings. This method is being expanded beyond North Atlantic Hurricane risk, and we are exploring refining the Storm Severity Index, which is currently being used to communicate European Windstorm Risk.

A further collaboration aims to quantify the collective risk from extreme winds, cold spells, snow, and ice across North America, addressing a gap in many (re)insurance models that focus solely on storm tracks and overlook other phenomena such as Cold Air Outbreaks.

24. Leverhulme Centre for Wildfire, Environment and Society

The AXA XL Science Team actively engages with the Leverhulme Centre for Wildfire, Environment, and Society to stay at the forefront of global wildfire risk research by attending and presenting at workshops and conferences centred on wildfire risk. These discussions have inspired the formation of an additional research group, in which AXA XL scientific are active members, dedicated to better quantifying regional urban conflagration risk. Urban conflagration can play a significant role in amplifying wildfire spread and damage across populated areas, as demonstrated by the 2025 Los Angeles Wildfires, but it remains a challenge to be integrated within current industry catastrophe models and therefore loss estimates. This research group aims to better ascertain how the likelihood of urban conflagration may vary across the US.

“Sharing knowledge and fostering industry-wide contributions strengthen collective resilience and promote smarter risk management.”



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