# Diversification Of Atmospheric Perils

## Climate Research

Innovation is often portrayed as an exciting new product or a new market, some of which we described in other parts of this brochure. However, we should not neglect research as another key strand of innovation. At AXA XL, we partner with a number of academics in a variety of areas, who are helping us to shape some of the innovation which leads to a deeper understanding of the risks that we take on and, ultimately the products and services we deliver to our clients.

Global (re)insurance of atmospheric perils such as floods and tropical cyclones works through the ability to diversify such events internationally. There are however large-scale climate patterns (oscillations) that modulate the dependence between precipitation and temperature over space and time which in turn drives important seasonal changes in atmospheric perils.

To explicitly represent how the spatiotemporal dynamics of the climate system drive atmospheric perils, we have developed global peril models and stochastic catalogues for riverine flood and tropical cyclone wind that are driven by a global climate model. Climate models reflect decades of scientific development in representing the large-scale physics of the atmosphere and ocean. As such, they are the ideal tools to study how climate oscillations in space and time impact the correlations between perils. Focusing on the El Niño Southern Oscillation (ENSO), due to its global-scale impacts and level of predictability, we find a far more nuanced picture of correlations between atmospheric perils and interesting implications for risk management.

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## Does Spatial Diversification Imply Risk Diversification?

When we dig into the issue of spatial and risk diversification, it is important to distinguish how a (re)insurance portfolio (exposure) interacts with a natural hazard. One may find that flood hazard is spatially correlated over several other locations but ultimately, the impact on the risk side depends on the company's exposure over these areas. As such, an insurance portfolio can magnify or reduce spatial dependence of a natural hazard.

So, does spatial diversification imply risk diversification? The short answer is no. To measure the effects of spatial diversification on risk diversification, one needs detailed exposure data. This also means that it is possible to potentially reduce the effects of spatial dependence through portfolio optimization.

## What is the Level of Correlation that Exists Globally between Regions and Perils?

We have analysed the spatial diversification of riverine floods and tropical cyclones and find that flood occurrence and severity are positively correlated across watersheds that are within 1,000 km, indicating that flood risk is likely not diversifiable within such range. Our research also finds that regions connected to the same cyclogenesis basins (such as the United States and Central America / Caribbean) show strong correlations, meaning that tropical cyclone risk is not diversifiable within a common cyclogenesis basin. This might suggest that floods are diversifiable beyond 1,000 km and that tropical cyclones are diversifiable across cyclogenesis basins.

One may also wonder whether we can diversify across atmospheric perils. We have thus analysed flood occurrence with tropical cyclone winds and found that such dependence appears weak. This might also suggest that diversification across perils, such as European flood with U.S. tropical cyclone perils, is feasible. Our ability to diversify beyond 1,000 km, across cyclogenesis basins or perils is however subject to large-scale climate patterns such as El Niño Southern Oscillation (ENSO). This shows the potential limits to diversification of atmospheric perils, thus emphasizing the importance of controlling a portfolio's exposure.

## Does ENSO Affect Correlations and Diversification?

An important question that remains is whether ENSO affects correlations and diversification. For both floods and tropical cyclones, we find systematic and material differences in hazard over different ENSO phases. This is confirmed over a wide variety of regions worldwide and our results are consistent with established ENSO impacts. We further show that if the exposure is as diversified as wealth (GDP), then it is possible to diversify flood risk and reduce the effects of ENSO within a large territory (for example, Canada, Western Europe, or Australia). An important exception is the case of U.S. flood risk, which remains significantly affected by ENSO. Our work thus highlights the importance of differentiating spatial diversification (hazard) from risk diversification, emphasizing the role of portfolio risk management and optimization in controlling the effects of ENSO.

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**Fig 1: Difference in flood risk between La Niña years and all years. Risk difference is measured in terms of GDP disrupted ($, pseudo log10) and calculated using 160 000 simulated years.**

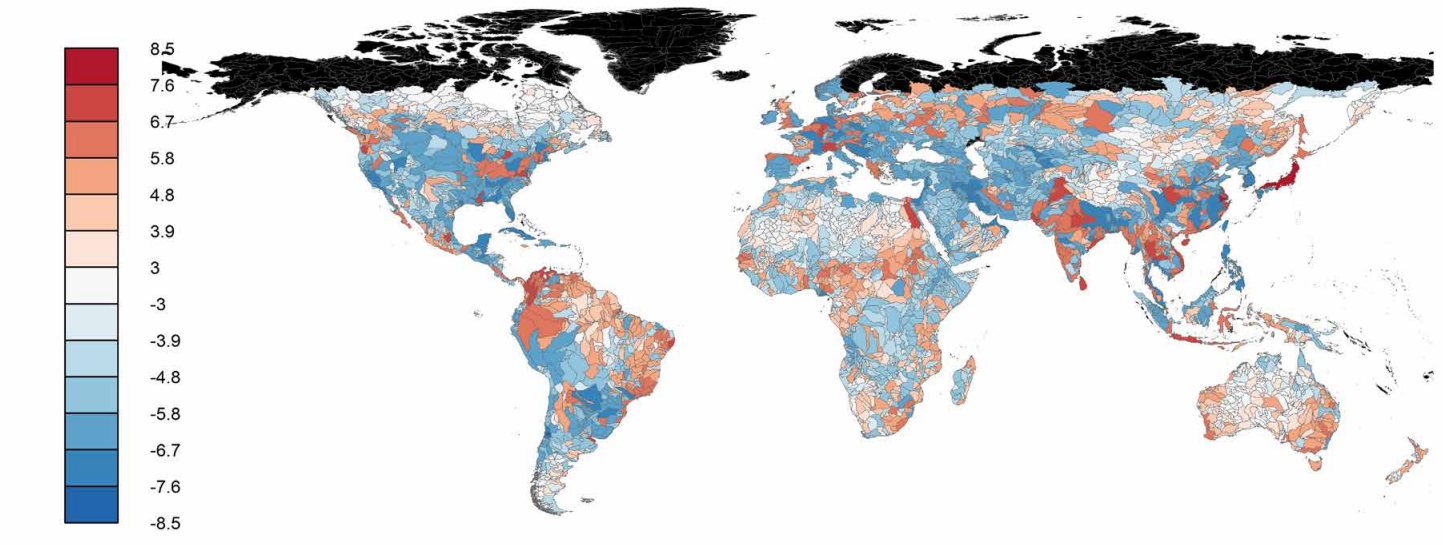
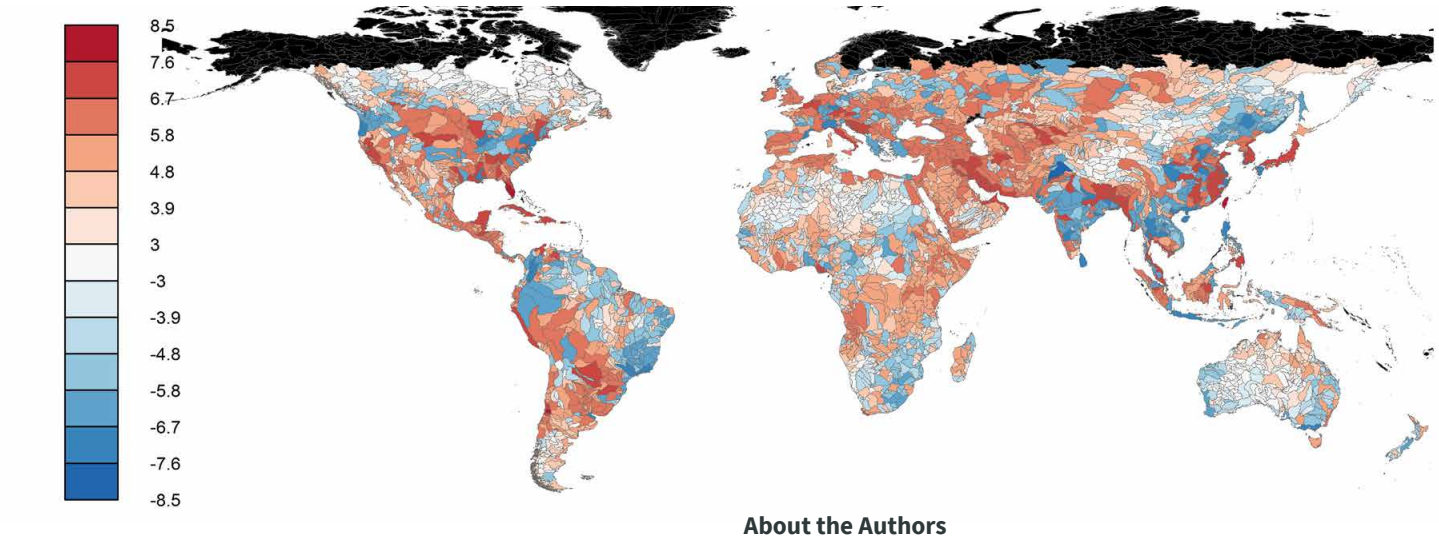


**Fig 2: Difference in flood risk between El Niño years and all years. Risk difference is measured in terms of GDP disrupted ($, pseudo log10) and calculated using 160 000 simulated years.**




This work will allow us to further develop our understanding of potential impacts of a changing climate, allowing the (re) insurance industry to develop strategies to improve resilience in the face of a changing climate.

## How can we manage the influence of ENSO?

ENSO is potentially a systematic risk over a global portfolio but fortunately, it also provides a natural hedging solution. In many regions, we find that ENSO has opposing effects in its cold versus warm phase, meaning that portfolio management should seek to optimize exposure over regions with opposing impacts. ENSO is also a relatively cyclical phenomenon, meaning there are benefits to temporal diversification.

## Current and future research

Our work has showed the importance of global climate dynamics on (re)insurance portfolio management. We are currently refining our modelling framework to better integrate local-scale dynamics consistent with higher resolution exposure data. This work will allow us to further develop our understanding of potential impacts of a changing climate, allowing the (re)insurance industry to develop strategies to improve resilience in the face of a changing climate.



### About the Authors

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