GuyCarpenter

THE EVOLVING PHYSICAL RISK LANDSCAPE- RAMIFICATIONS FOR PUBLIC ENTITIES

2024 NLC-RISC Staff Conference

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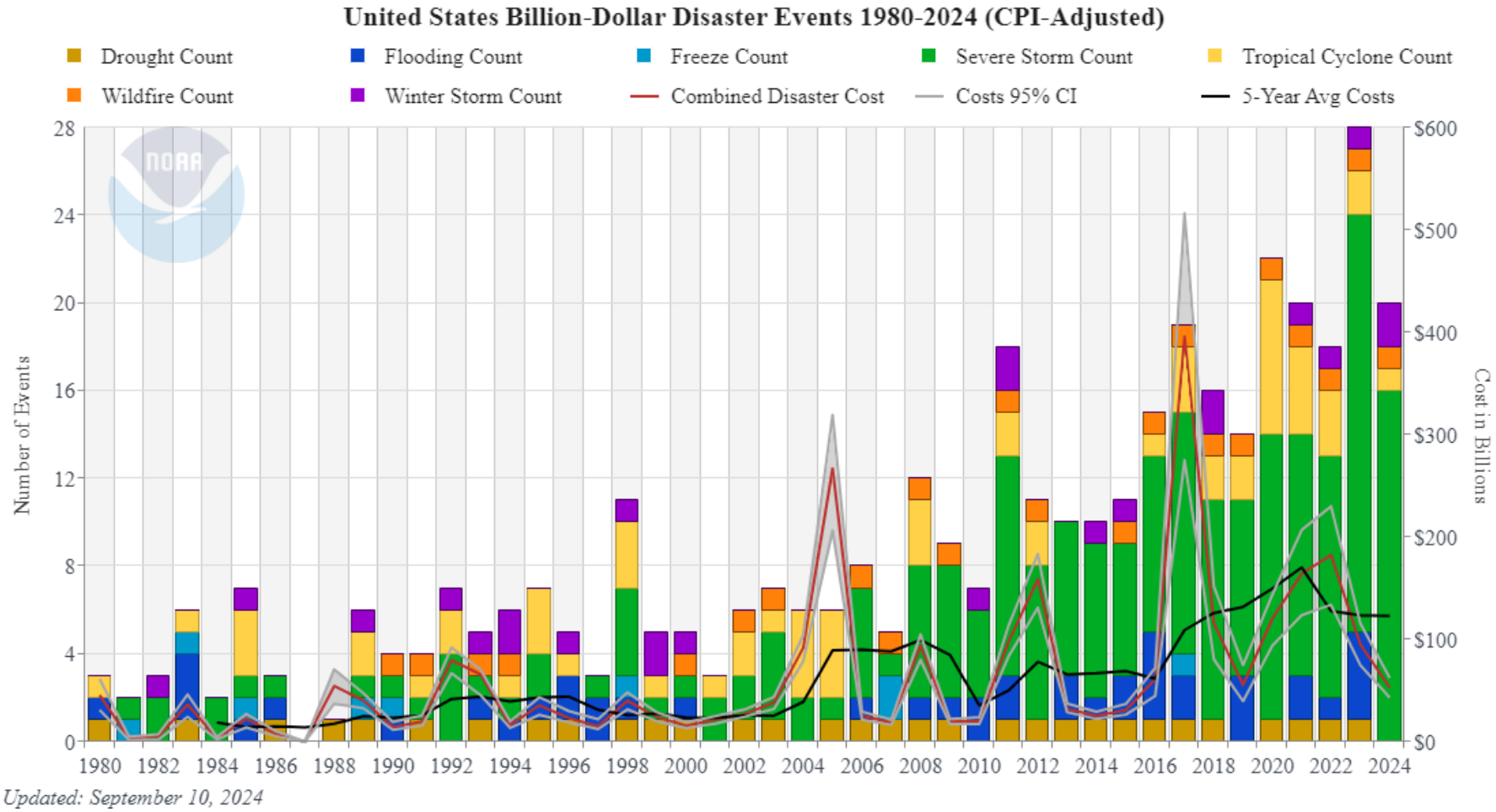
A business of Marsh McLennan

1. The Insurance Industry and Climate Change
2. Climate Change and Catastrophe Models
3. Guy Carpenter Offering - Climate Change Adjustment of Catastrophe Models

Agenda

The Insurance Industry and Climate Change

Increasing Frequency of US Billion Dollar Loss Events

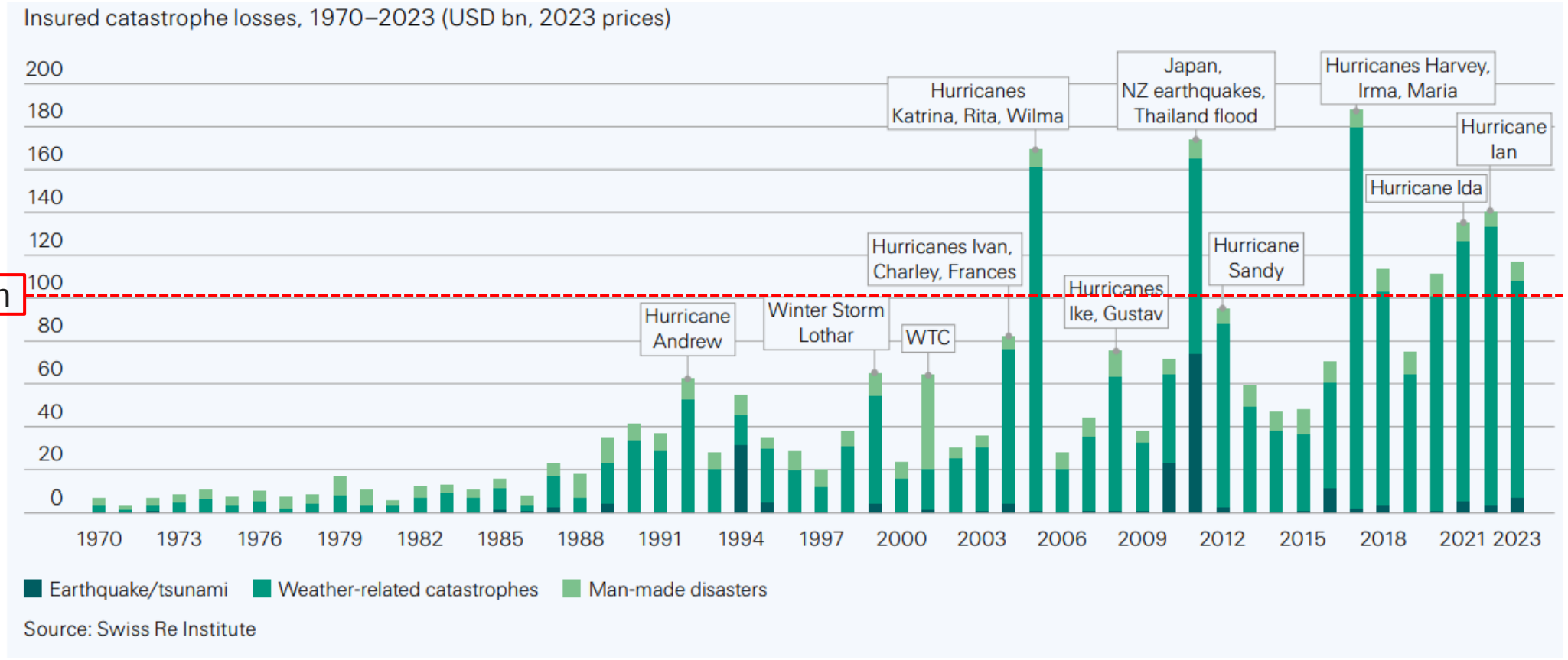


28 billion-dollar loss events were recorded in 2023 which broke the previous record (23 events) for most billion-dollar loss events in a year.

Global Insured Losses Increasing Rapidly

4 years in a row and 6 of the last 7 years exceeded $100 billion

$100 Billion



The share of insured losses from secondary perils was roughly 81% (thunderstorms, hail and tornadoes, floods, droughts, wildfires, landslides, snow, freeze) in 2023, almost double the share in 2022.

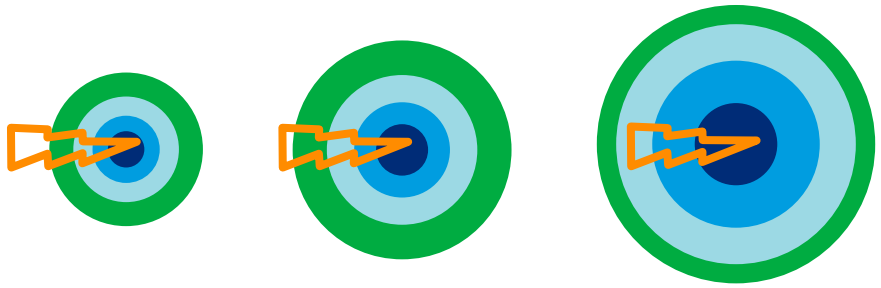
What Is Driving Loss Escalation?

Other factors besides hazard changing in the global insurance marketplace

Inflation, Social or Otherwise

- Supply Chain Disruption
- Monetary Policy
- Claims Litigation
- Widening Wealth Gap
- Cost of Goods

Population Growth



- Bullseye effect of population sprawl
- Footprint of severe thunderstorms, hurricanes, coastal flood, wildfire
- Expansion amplifies risk

Climate Change

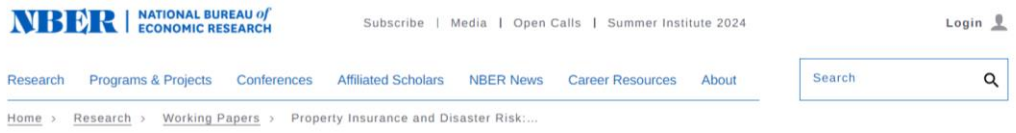
Physical Risk
Adverse losses Increased volatility

Transition Risk
Investments lose value due to abrupt industry transitions

Liability Risk
Could challenge law statutes, disclosures, compliance

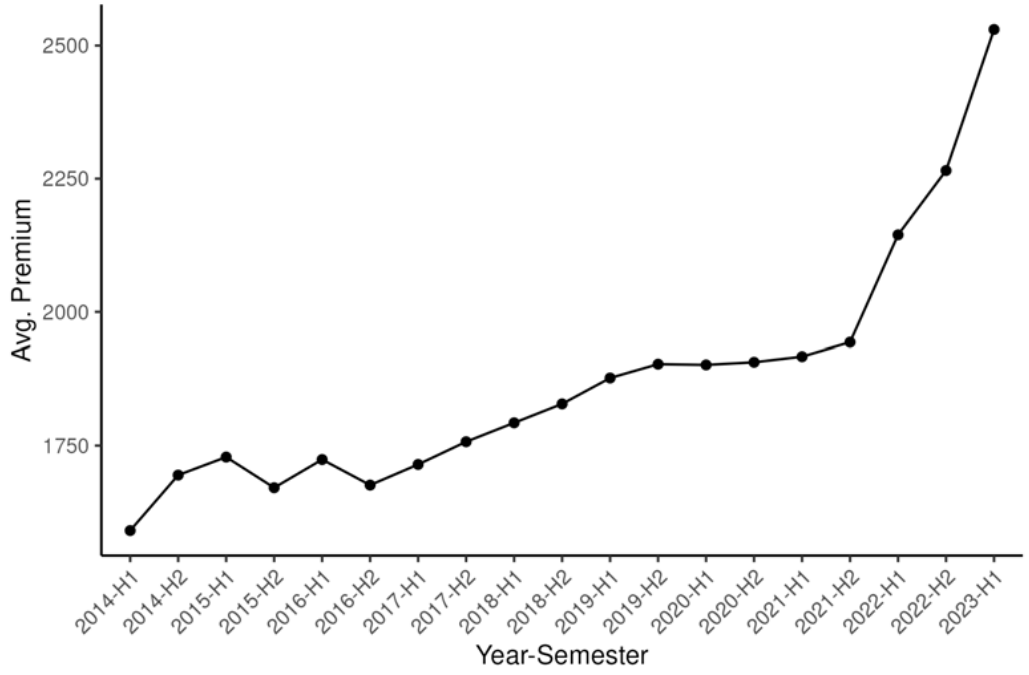
Insurance Premiums Are Responding

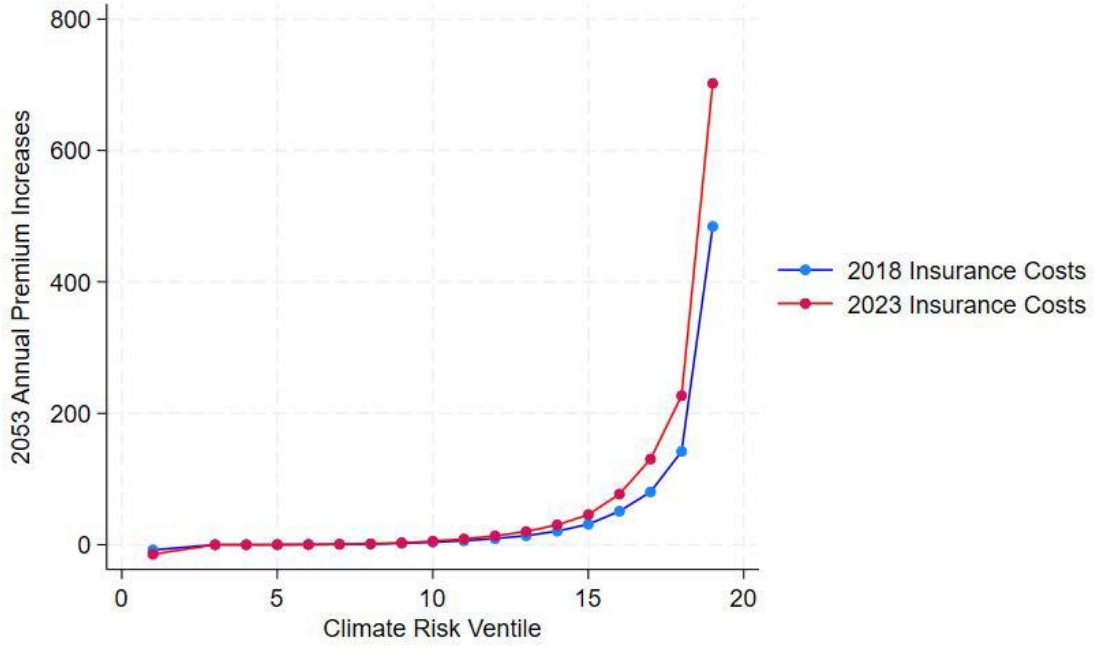
Study shows premiums have skyrocketed; forecasts premiums in higher risk locations to increase faster



Property Insurance and Disaster Risk: New Evidence from Mortgage Escrow Data

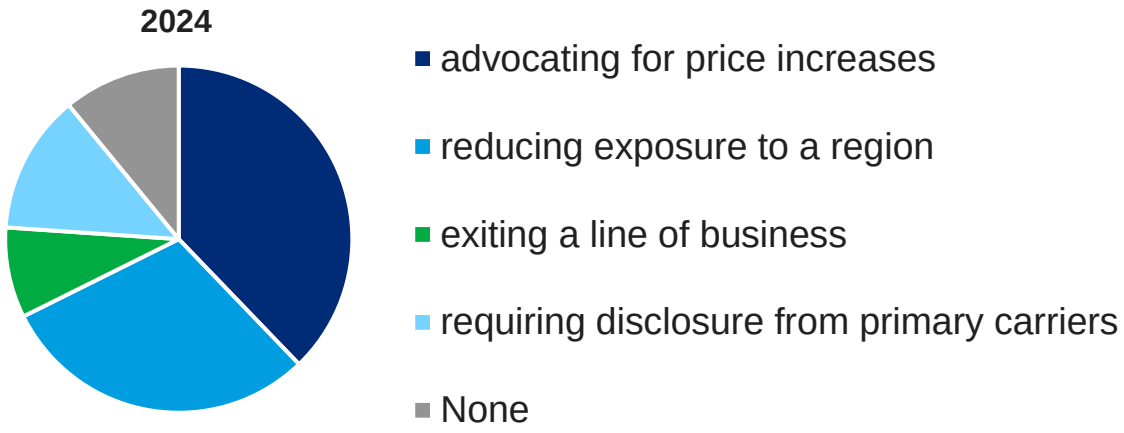
Benjamin J. Keys & Philip Mulder

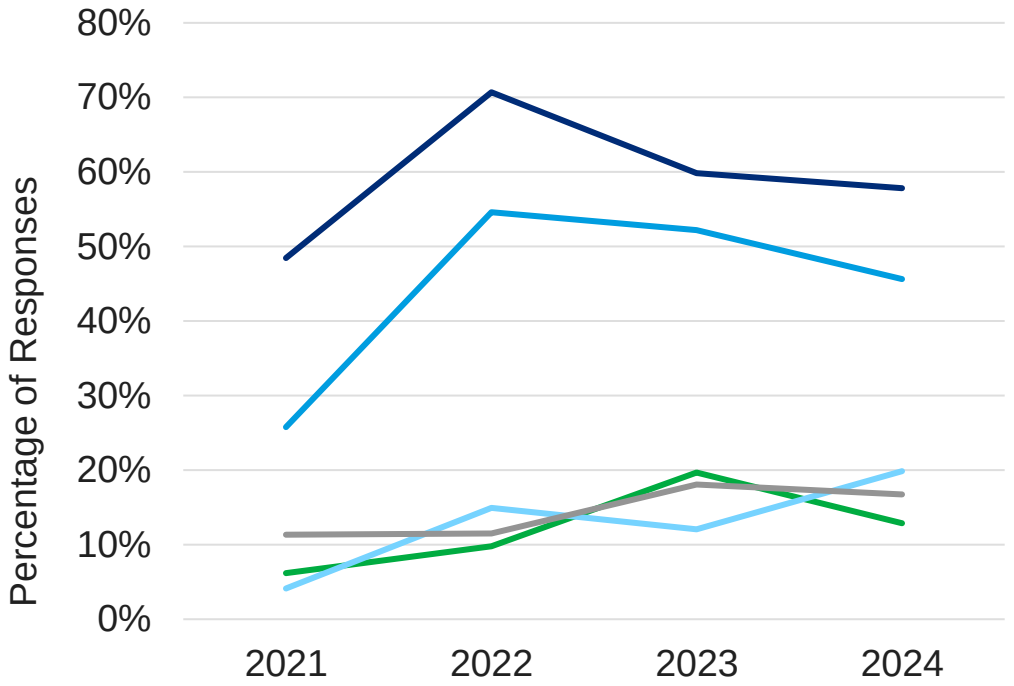




Climate Change Renewal Sentiment- GC Broker Survey

What actions do markets take when concerned about climate change?





Additional Individual Responses

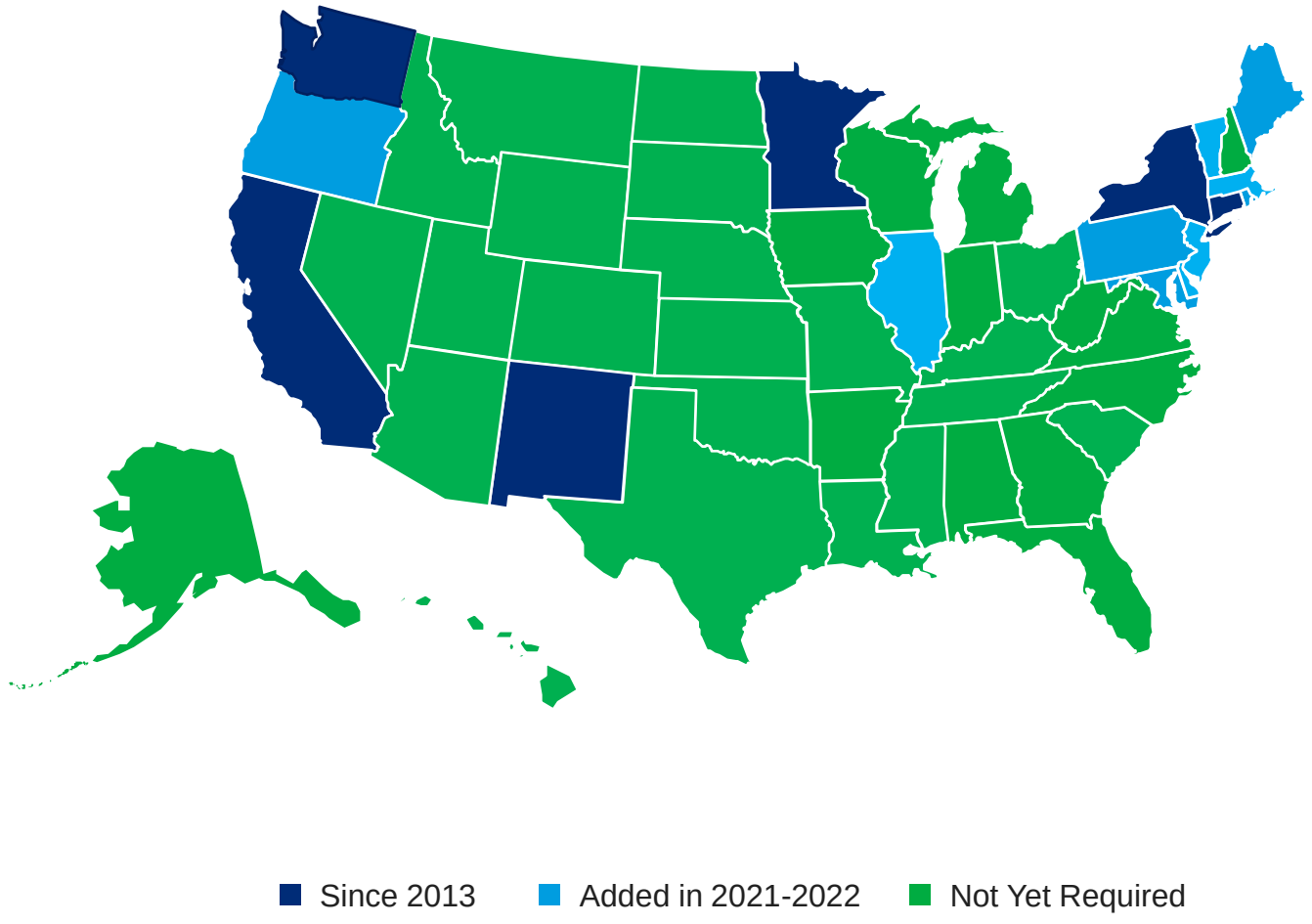
- Higher attachment points
- Reducing hours in loss occurrence and limiting hours for aggregation
- Increased retentions
- Exclusions on fossil fuel intensive activities
- Adjusting models and view of risk

The percent of responses that answered "requiring disclosure from primary carriers" has quadrupled from 2021 to 2024.

National Association of Insurance Commissioners Survey

NAIC aligned climate risk survey with TCFD standard

- In 2022, Illinois became the 16th state requiring NAIC survey participation for insurers with $100 million or more in premiums. The survey covers well over 80% of the entire US insurance market.
- NAIC Notice to Insurers is typically sent in July and survey responses are due at the end of August.
- Close-ended questions are mandatory for the first time in 2024.



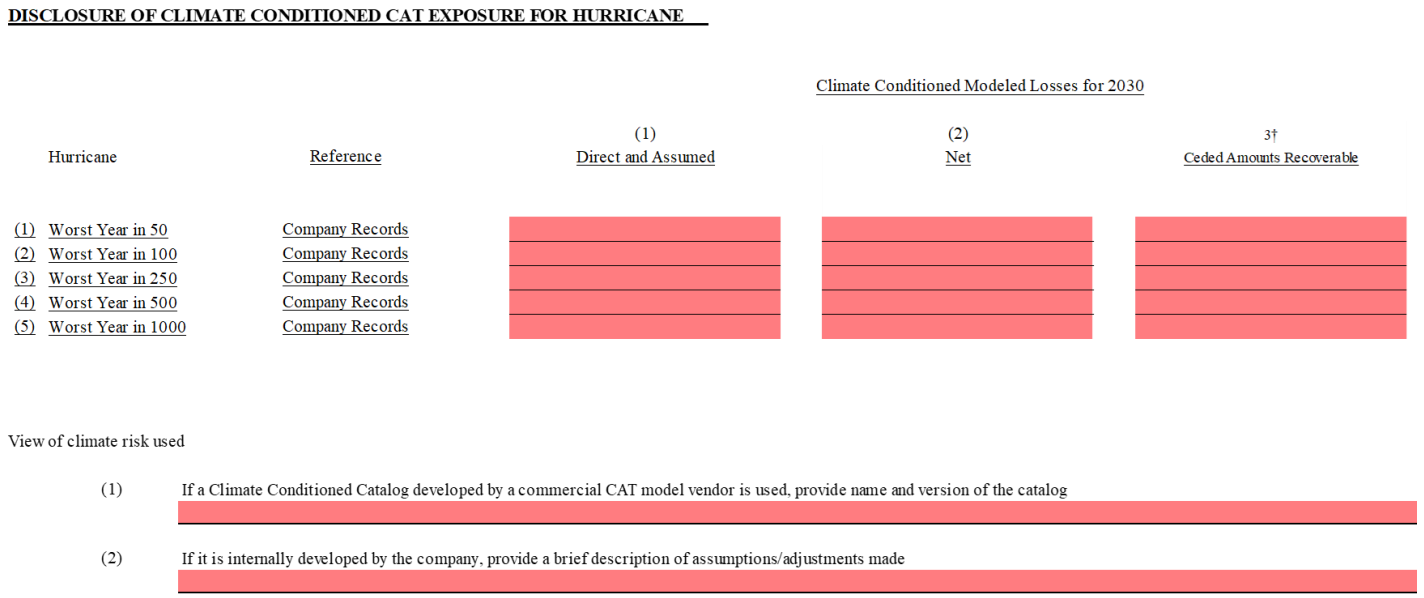
NAIC Climate Risk Disclosure Survey

2024 NAIC Requiring Disclosure of Climate Impact on Catastrophe Exposure for all RBC Filers

The New York State Department of Financial Services would like to invite your company to participate in a pilot climate scenario survey…The NAIC has been tasked by the Solvency Workstream of the Climate and Resiliency (EX) Task Force with the development of a climate scenario methodology for property and casualty insurers that are exposed to weather-related risks in the US, in conjunction with their property portfolios…

The proposed NAIC climate scenario methodology **compares baseline Probable Maximum Losses** (PMLs) filed in RBC filings for hurricane and wildfire perils **to "Climate-conditioned" PMLs** for the same book of business. Climate-conditioned PMLs reflect the view of CAT modelers of the impact of climate risk on severity and frequency of hurricanes and wildfires over future time horizons (2030, 2040 and 2050).

Excerpt From Excel Template for Client



DISCLOSURE OF CLIMATE CONDITIONED CAT EXPOSURE FOR HURRICANE

Hurricane	Reference	Climate Conditioned Modeled Losses for 2030 (1) Direct and Assumed	(2) Net	3† Ceded Amounts Recoverable
(1) Worst Year in 50	Company Records			
(2) Worst Year in 100	Company Records			
(3) Worst Year in 250	Company Records			
(4) Worst Year in 500	Company Records			
(5) Worst Year in 1000	Company Records			

View of climate risk used

(1) If a Climate Conditioned Catalog developed by a commercial CAT model vendor is used, provide name and version of the catalog

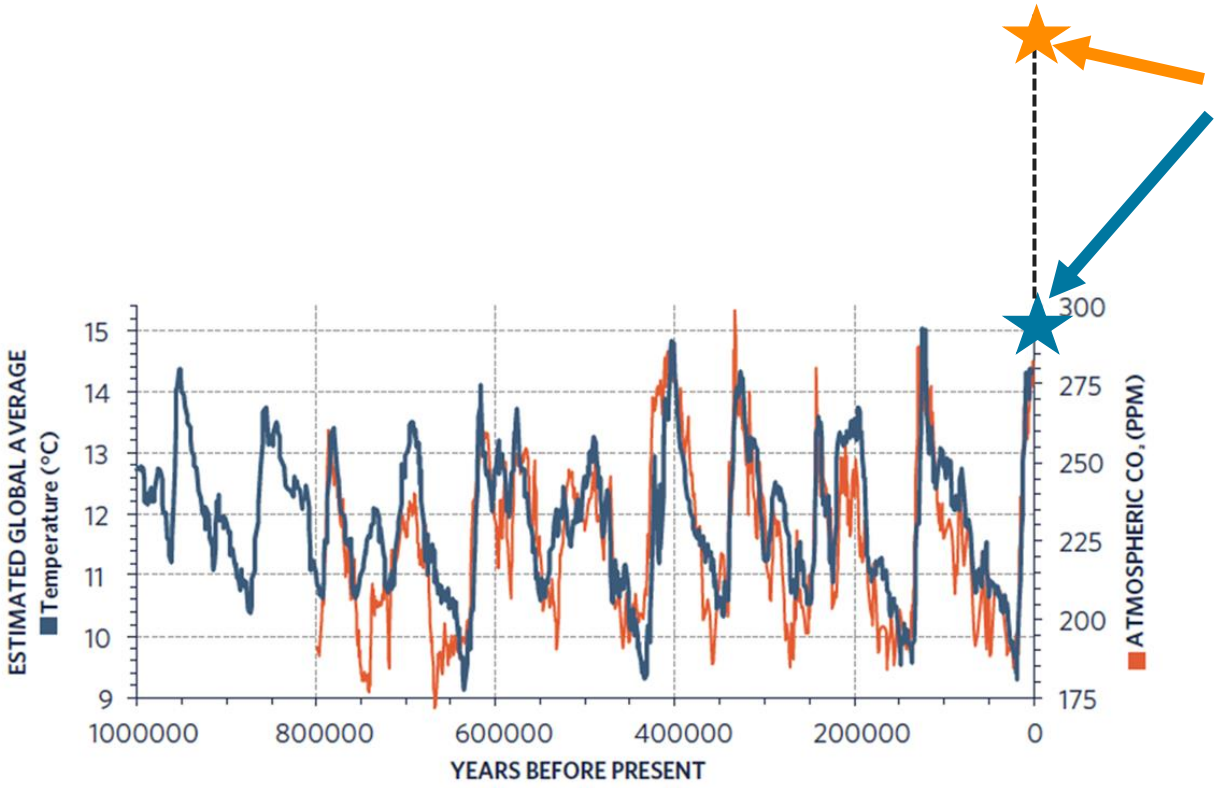
(2) If it is internally developed by the company, provide a brief description of assumptions/adjustments made

Excerpt From Letter to Client

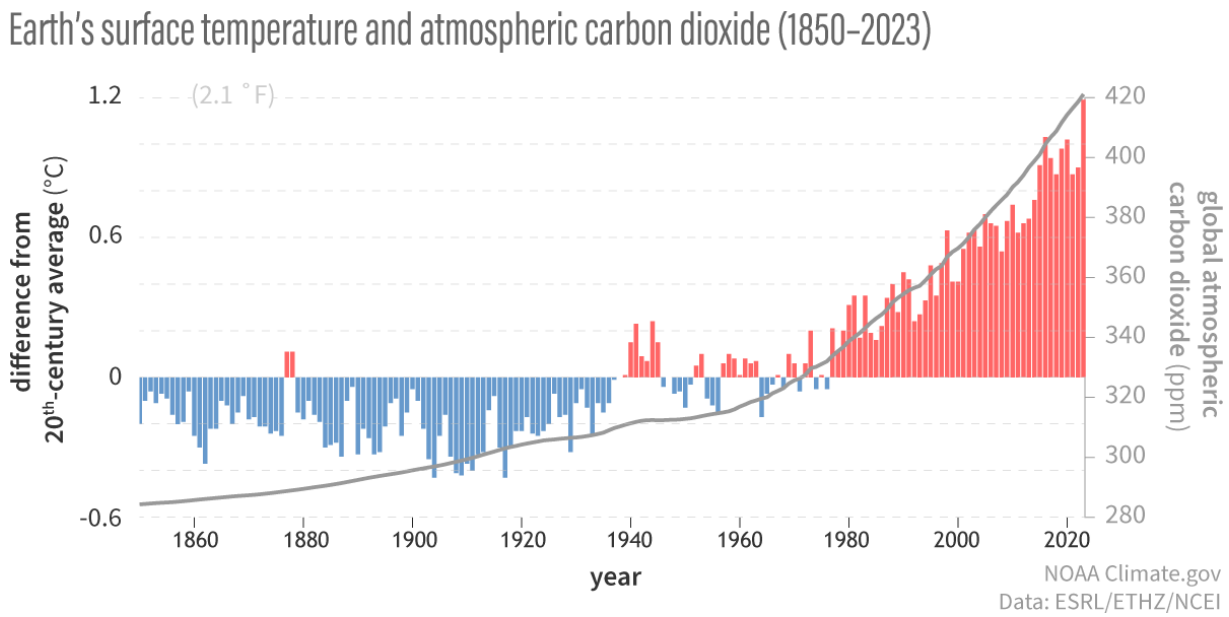
Climate Change and Catastrophe Models

Inflection Point in the Global Climate

Over the last 160 years, the climate has warmed 10X faster than any post-Ice Age period

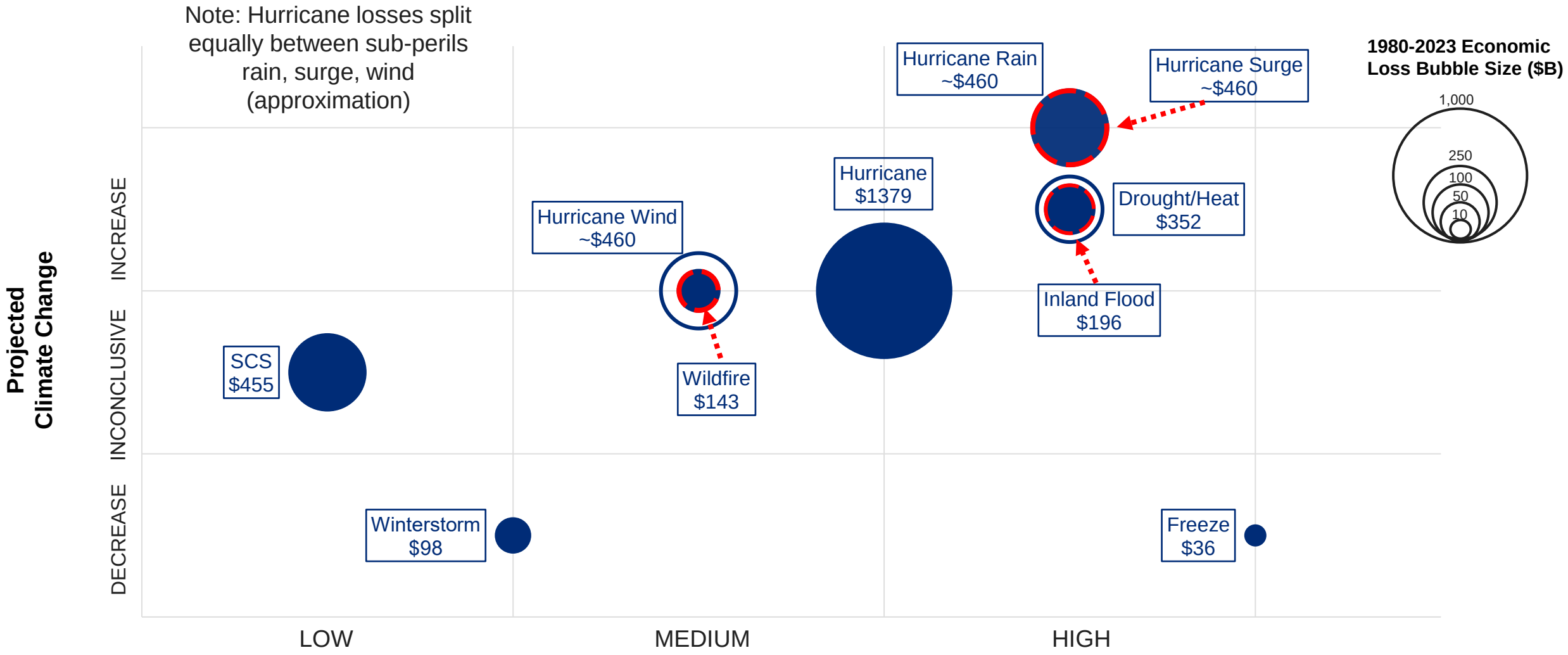


Last million years of temperature and carbon dioxide behavior <u>until 1850</u>



Temperature and carbon dioxide behavior <u>after 1850</u>

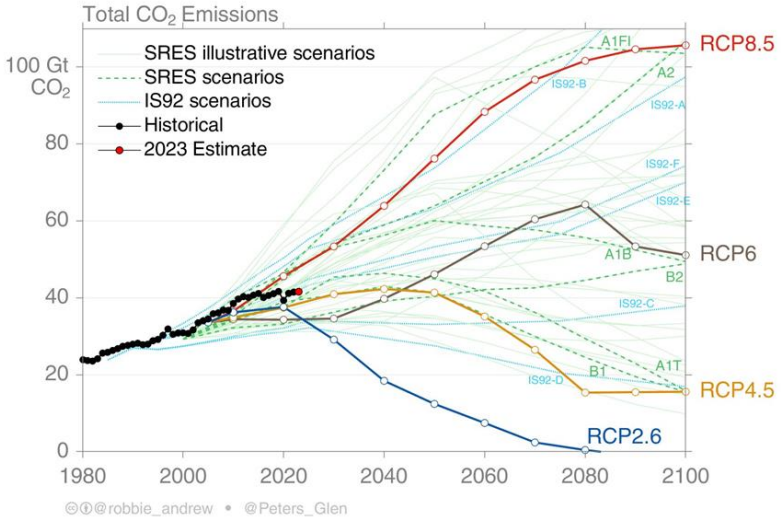
US 2024 Peril Assessment of Climate Change Impact
1980-2023 Economic Loss Bubble Size ($B)

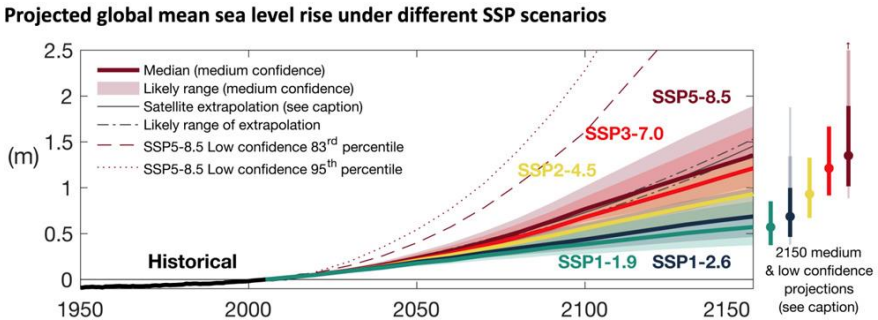


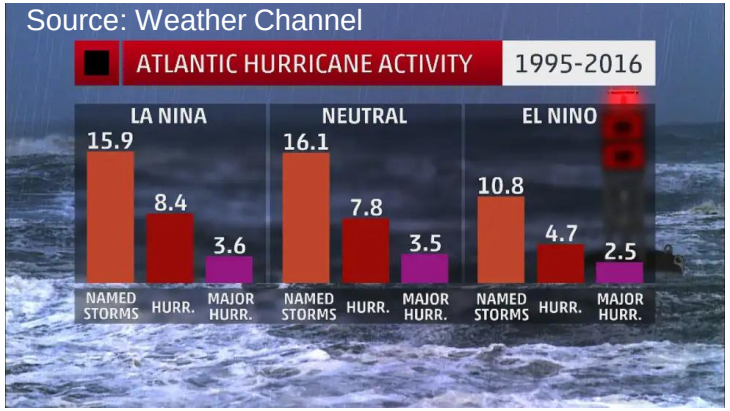
Source: NOAA Billion Dollar Database

Climate Change Projections: Sources of Uncertainty

Emissions, model, and climate variability uncertainty all contribute to an uncertain future







Emissions/Scenario Uncertainty

Model Uncertainty

Climate Variability

RCPs, SSPs

Ensemble Metrics (e.g. %tiles)

ENSO PDO AMV

?

Future Risk

What is a Catastrophe Model?

Hazard Module

Generates the pattern and intensity of physical disturbance from an event (hurricane wind, wildfire burn area, flood depth, etc.) based on a stochastic event set

Vulnerability Module

Defines how a structure responds to differing levels of hazard (such as ground motion or wind speed) and predicts the associated damage

Financial Module

Evaluates insured loss given structural values as well as the applicable insurance and reinsurance structures

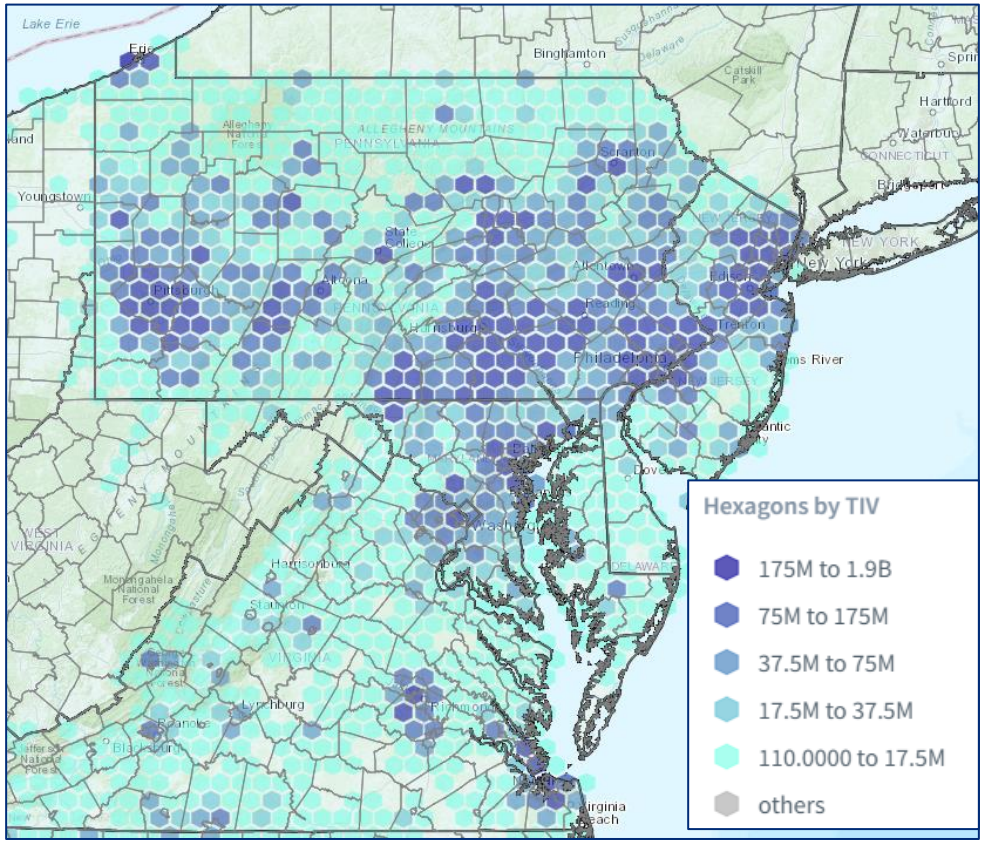
Commentary

- Catastrophe models utilize thousands of years of simulated and physically realistic event scenarios
- Draw on engineering principles to quantify the physical damage sustained to a structure under a certain hazard stress.
- Coupled with an exposure base, the output from these models includes actionable metrics such as Average Annual Loss (AAL), and loss exceedance probabilities
- Helps inform reinsurance purchasing or fund sizing, pricing and viability

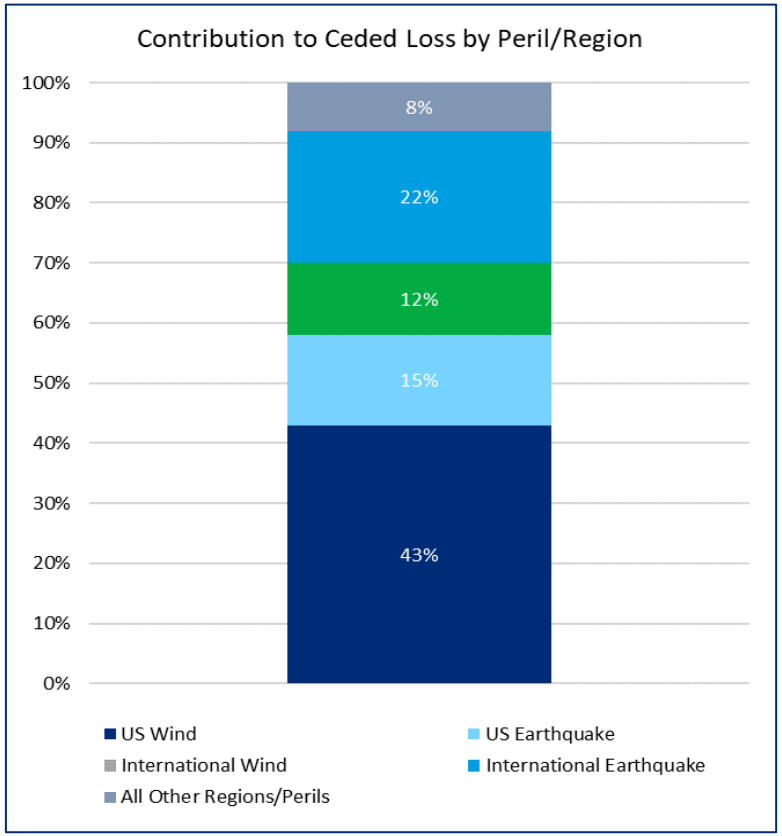
How is Catastrophe Modeling output used?

Portfolio management examples

Concentration Analysis



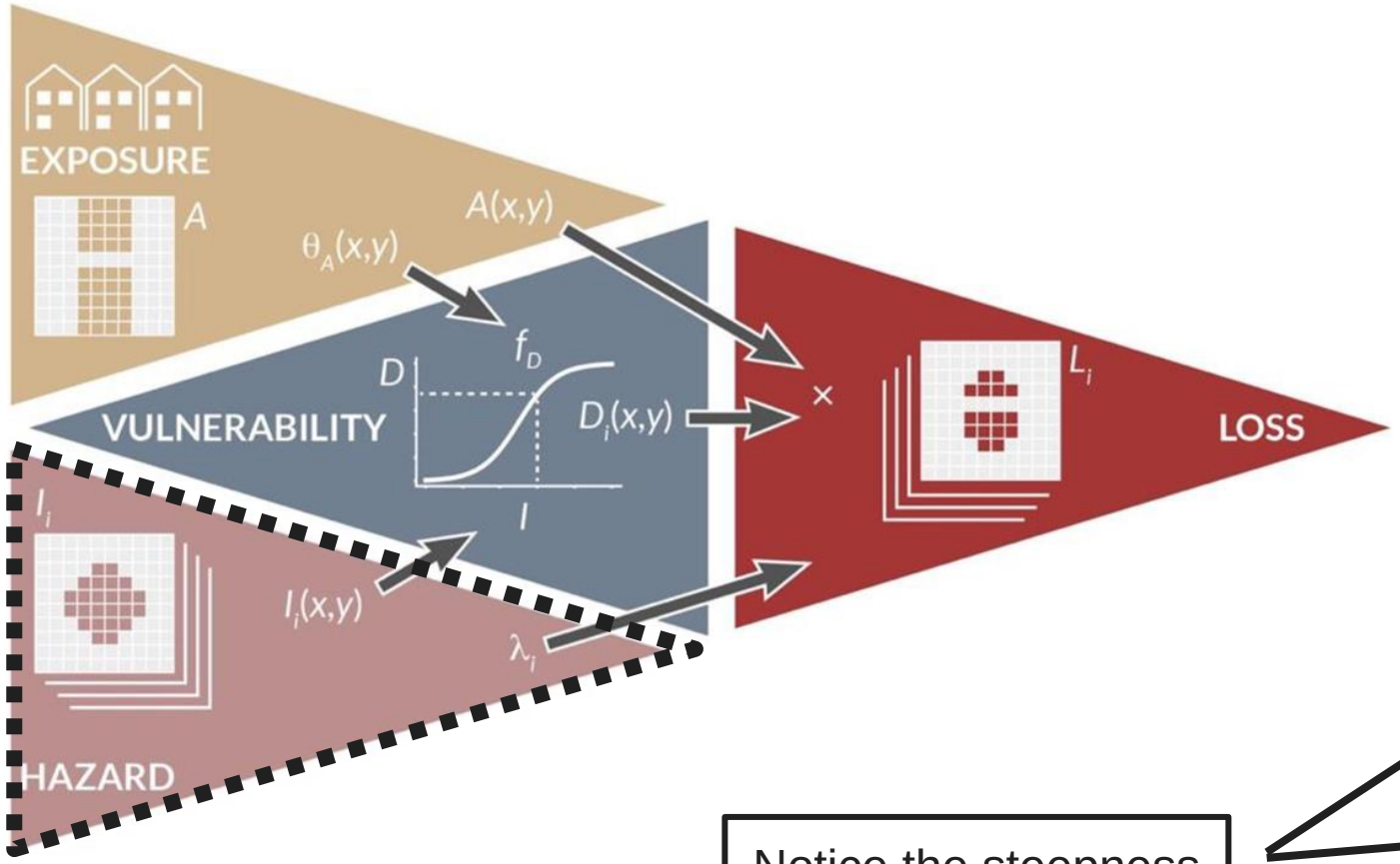
Reinsurance Peril/Region Drivers



- At what point will I need to buy additional reinsurance?
- What Peril/Region is driving my reinsurance expected loss?
  - Are there portfolio concentrations I should monitor?

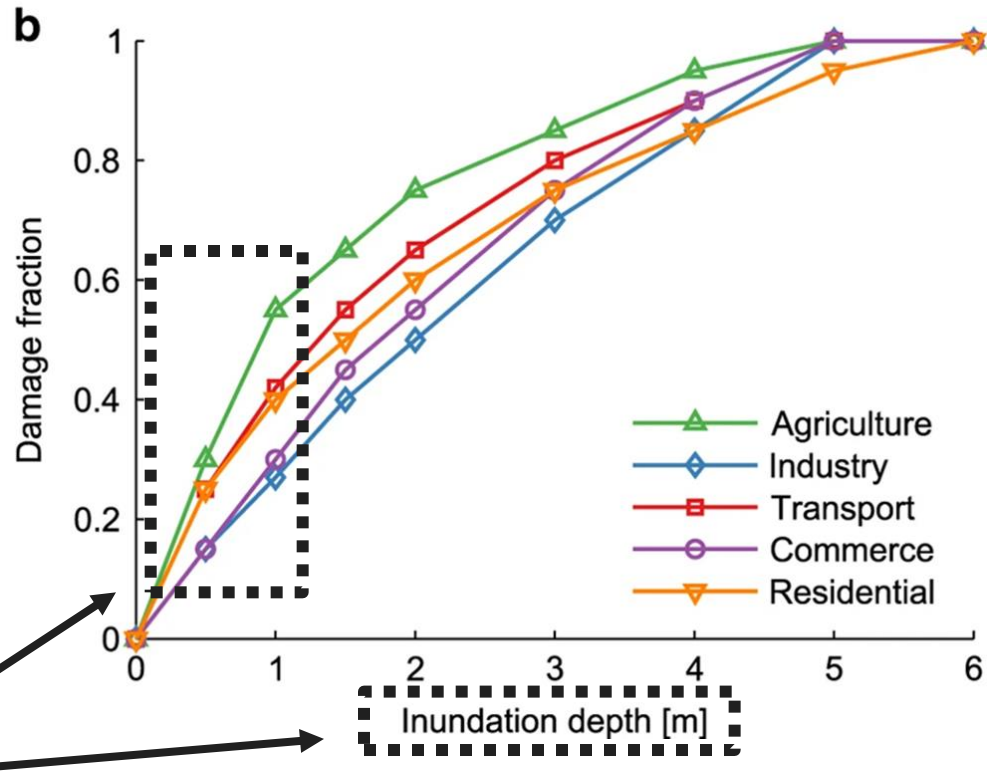
How Does a Changing Climate Impact Catastrophe Models?

Climate change impacts hazard which intersects with vulnerability/loss to alter loss outcomes



Source: Mignan (2022)

Notice the steepness of damage curve between 0-1 meter

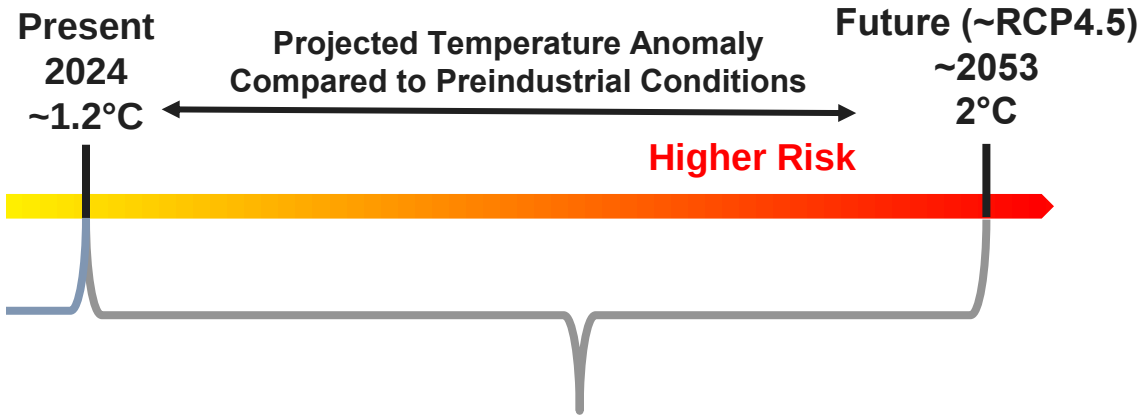


Source: Prahl et al. (2008) depth-damage functions-adapted from Huizinga (2007)

Future Risk

Observed Change ~

Projected Change ~ 0.8°C



Present Day Risk

- Stationarity in the hazard is assumed when catastrophe models are developed, but the temperature has changed during the historical period which equates to a change in risk.
- Near term projections using this baseline will imply a large increase in risk from present day because the middle of the catastrophe training period for the hazard is ~1960.

Future Risk

- Most common assessment of climate risk by the insurance industry, which is also the focus of regulators.
- Over the next 30 years, an additional ~1.5°F of global warming is projected (a rate of increase which is almost 3X faster than the last 90 years) which has consequences for future risk.

Guy Carpenter Offering- Climate Change Adjustment of Catastrophe Models

Climate Change Analysis Toolkit

Overview of offering

Perils

	Climate Risk Score	Cat Model Adjustment
Wildfire	✓	ETA: Q4 2024
Convective Storm	✓	ETA: ~2025
Tropical Cyclone	✓	✓
Sea Level Rise/ Storm Surge	✓	ETA: ~2025
Heat/Flood	ETA: ~2025	TBD

Scenarios

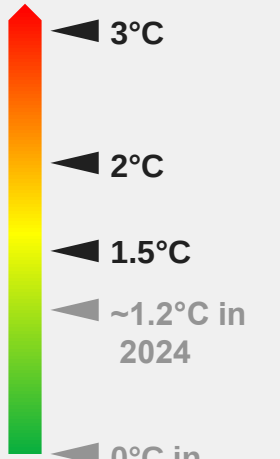
Emission scenarios

High-emission
pathway SSP5-8.5
or RCP8.5

Mid-emission
pathway SSP2-4.5
or RCP4.5

Low-emission
pathway SSP1-2.6
or RCP2.6

Warming level scenarios



Tools

Education
Briefings, Executive Trainings, White Papers

Climate Change Risk Scores
Portfolio-Specific Insights

Catastrophe Model Adjustments
AAL and PML Projected Changes

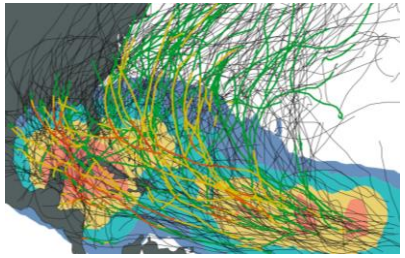
Model Suitability Analysis
Climate Adjustments for Present-Day View of Risk

GC climate change offering has four pillars. Today, we will dive into our catastrophe model adjustments for hurricane.

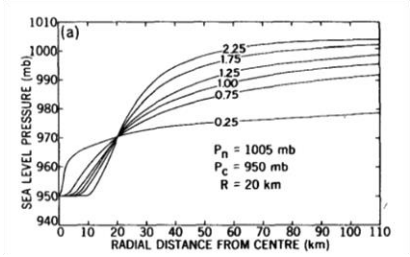
GC Hurricane Risk Score Methodology

Models and data

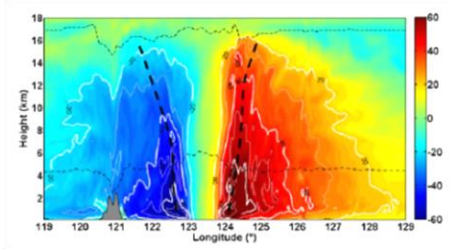
Tim Hall NASHM Stochastic Track Set



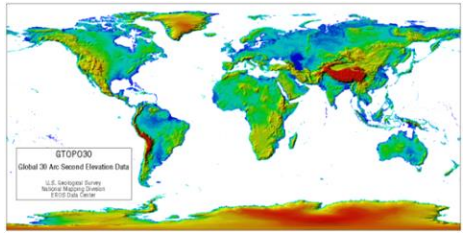
Holland and Powell Tangential Wind Profile



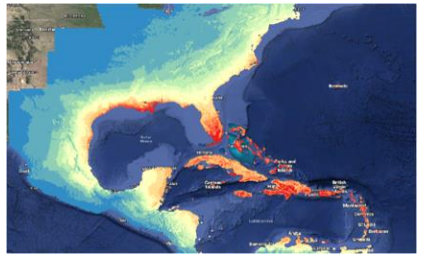
Kepert and Wang Surface Wind Model

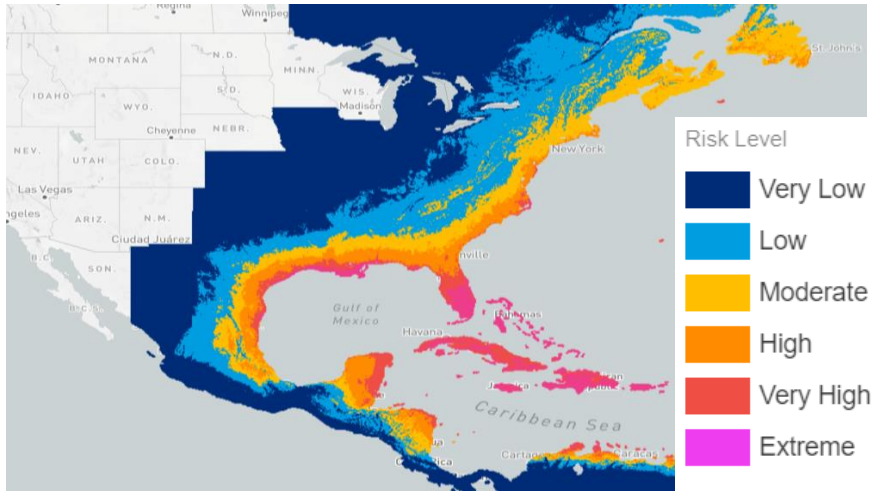


Land Cover and Elevation Model



Risk Score Binning





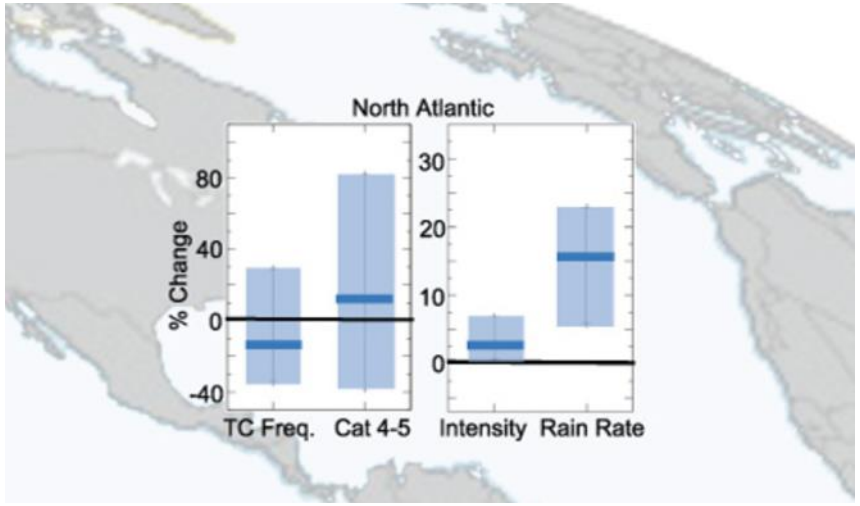
At Guy Carpenter, we create our own view of hurricane risk by using all the ingredients of a catastrophe model.

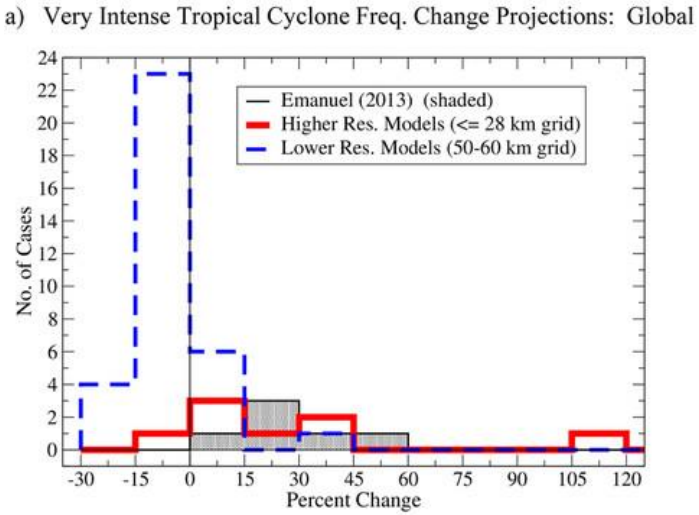
Climate Change Methodology for Hurricane Risk Score

Overview

Scientific Foundation for Projected Views

- Present-Day events reweighted to account for a potential increase in severe category 4-5 hurricanes under projected climate states while preserving net basin landfalls for overall tropical cyclones
- Projected increase in category 4-5 hurricanes estimated following Knutson et al., (2020) and Jewson (2021)
- Emphasis on higher-percentile scenarios, as justified by more recent high-resolution hurricane modeling research





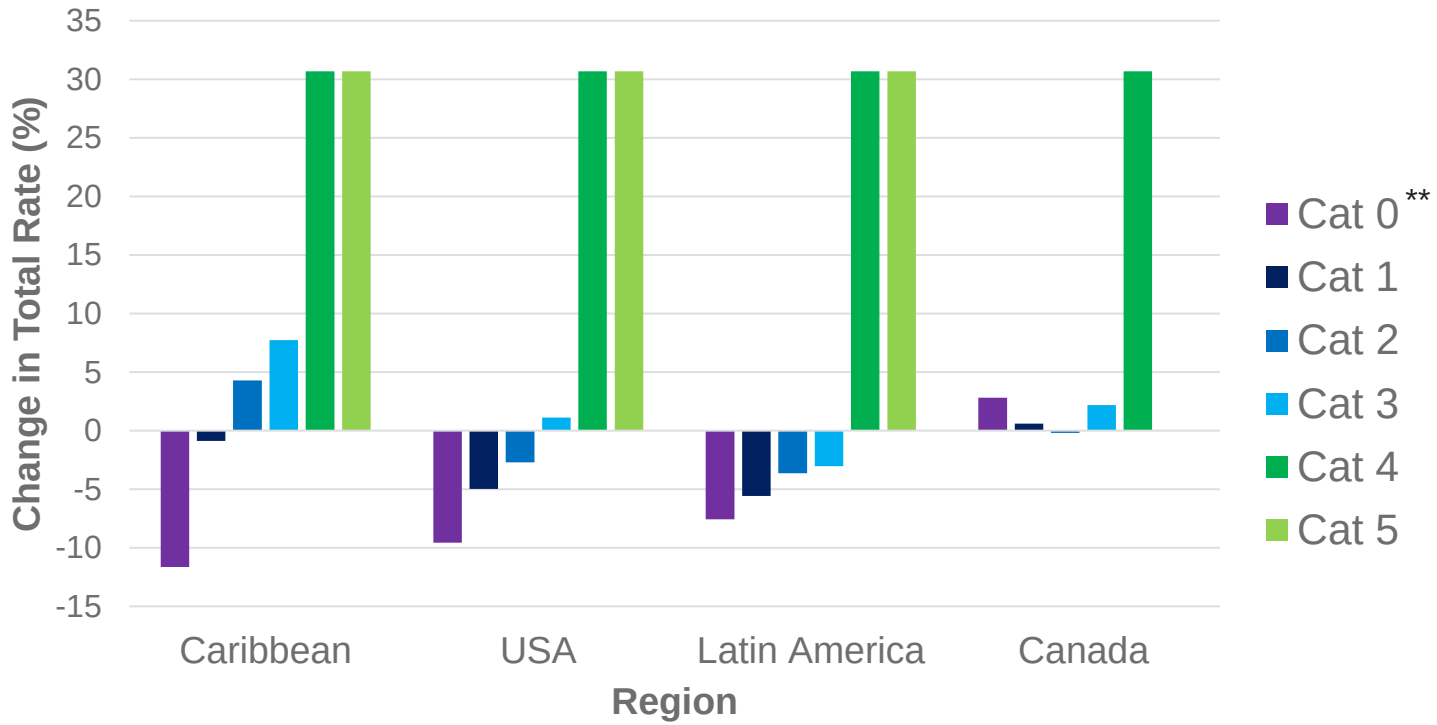
Projecting tropical cyclones in the North Atlantic to be more intense but not exhibit any change in frequency.

North Atlantic Tropical Cyclone – Methodology

Methodology details – most likely 2050 example

Adjustment impact on total rates by region

- Category 4-5 storms are increased to the target rate for the entire basin
- For multi-landfall events, the rate is adjusted based on the highest category across all landfalls
- Weaker storms see a greater reduction in frequency. The weaker the storm, the less likely it was/becomes a category 4-5, therefore reducing the chance of a rate increase.



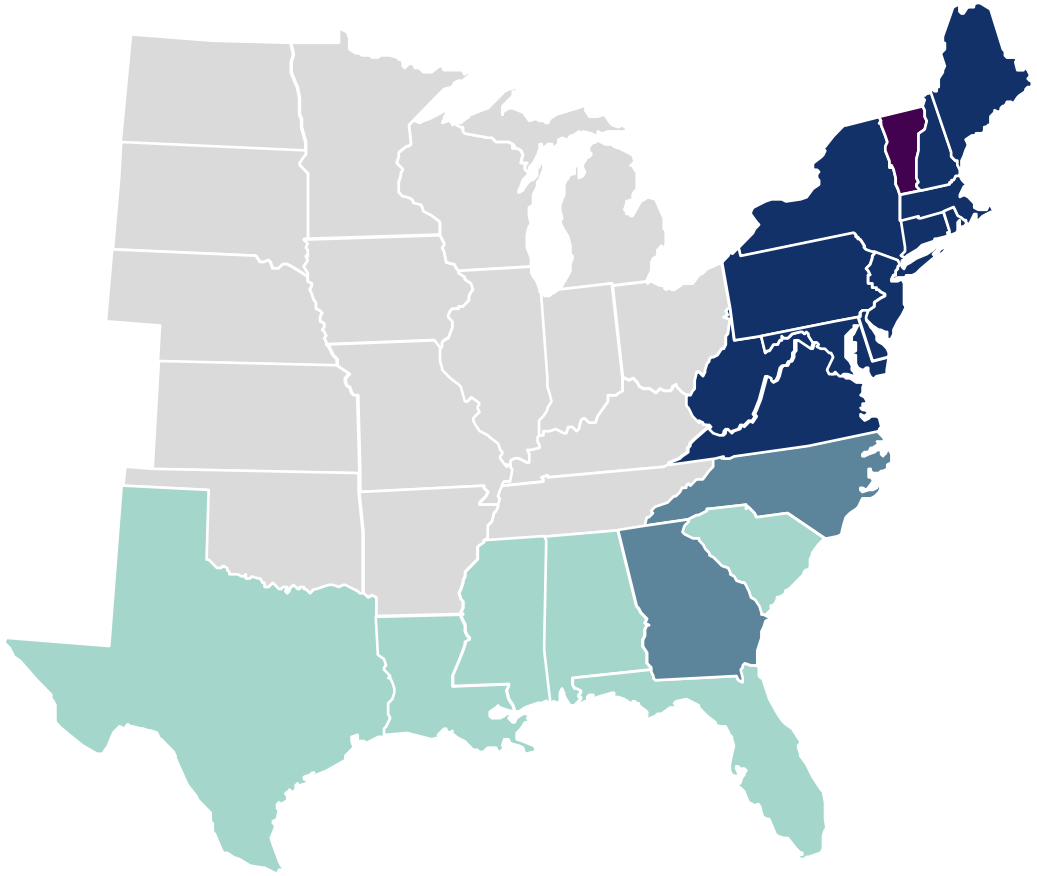
**Note that Cat 0 (tropical storms) are not well-calibrated in the catastrophe models.

AAL Increase by State- Likely

2050 Projection: RCP4.5, 75th Percentile

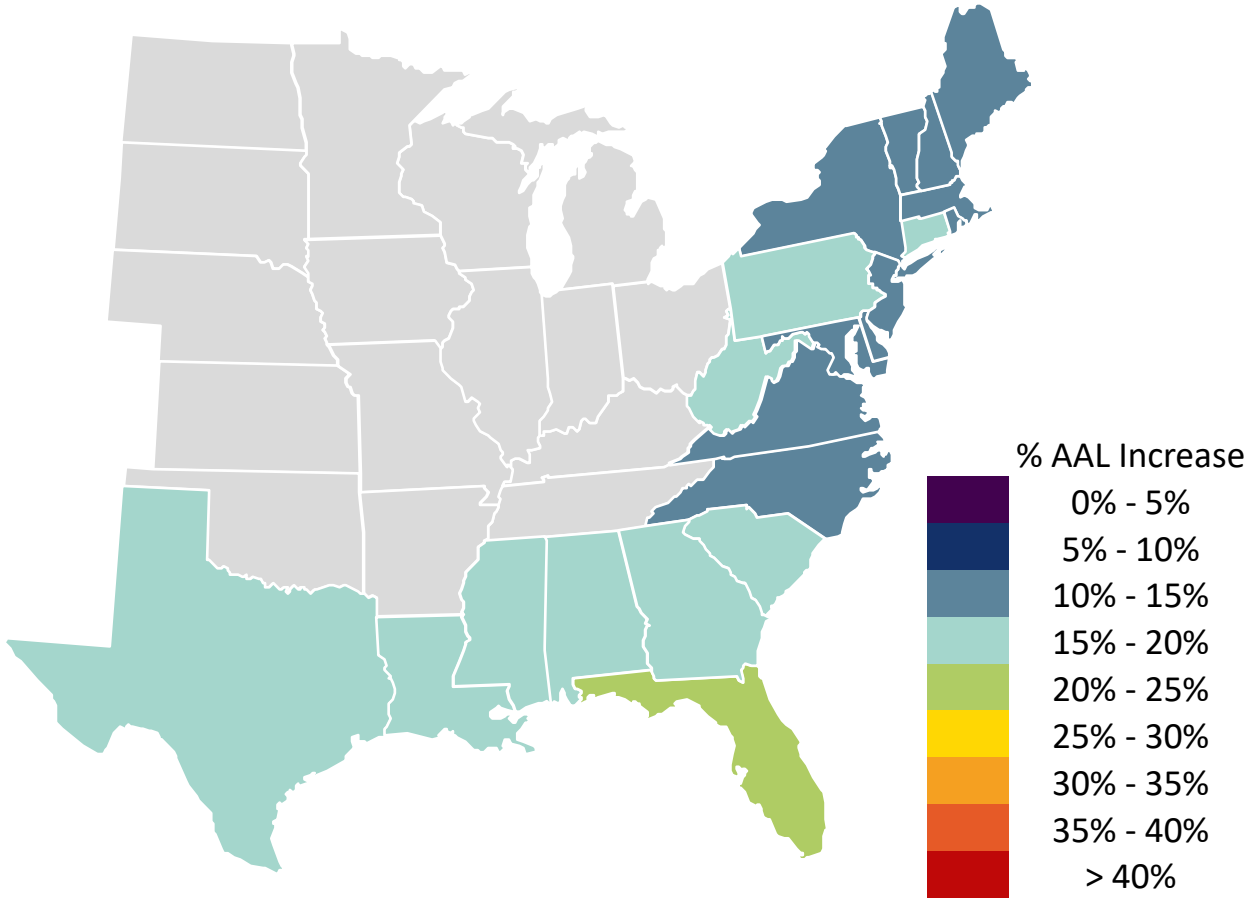
Applied to Vendor Model A

Overall ~ 16.4%



Applied to Vendor Model B

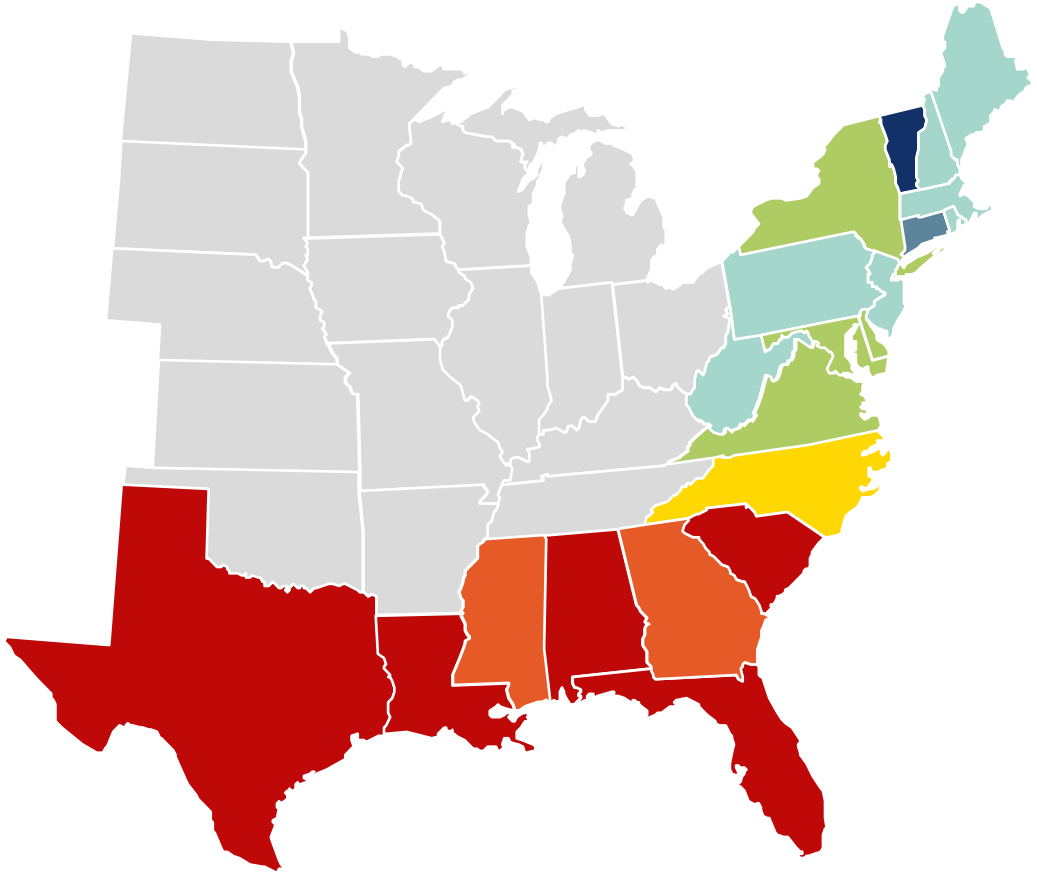
Overall ~ 18.4%



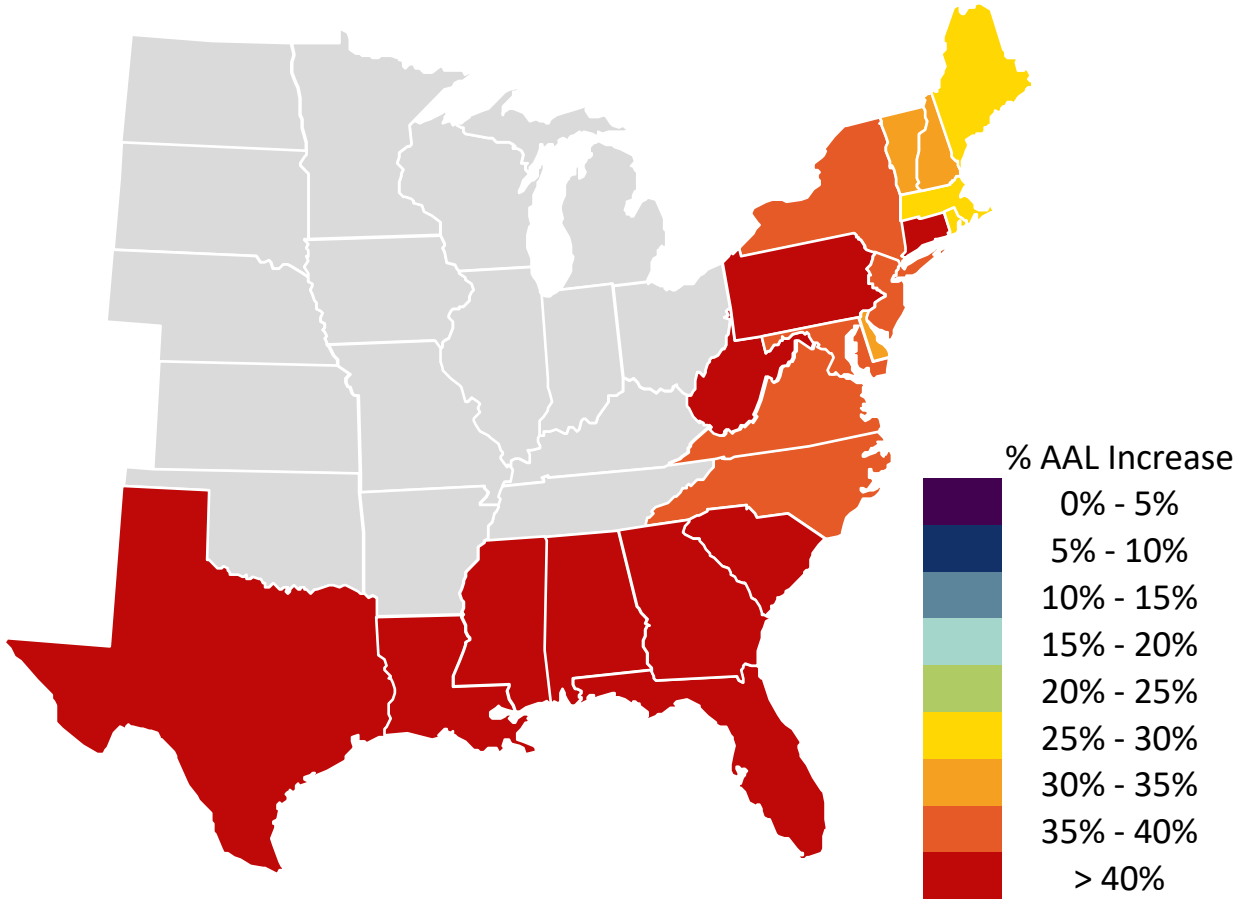
AAL Increase by State: Extreme

2050 Projection: RCP8.5, 90th Percentile

Applied to Vendor Model A
Overall ~ 43.9%

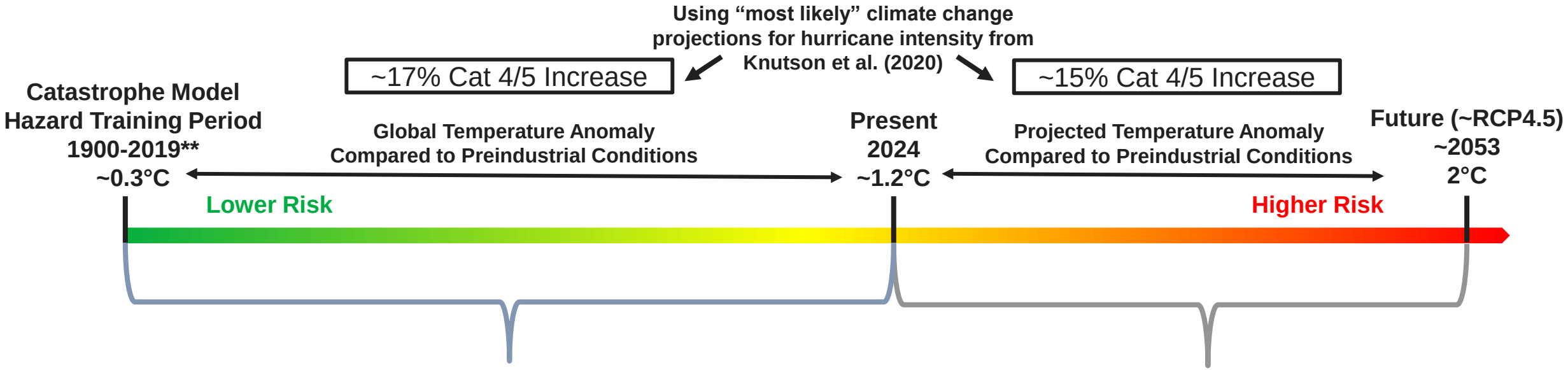


Applied to Vendor Model B
Overall ~ 47.4%



Climate Change Analysis Toolkit

Suitability of vendor models in present climate (tropical cyclone example)



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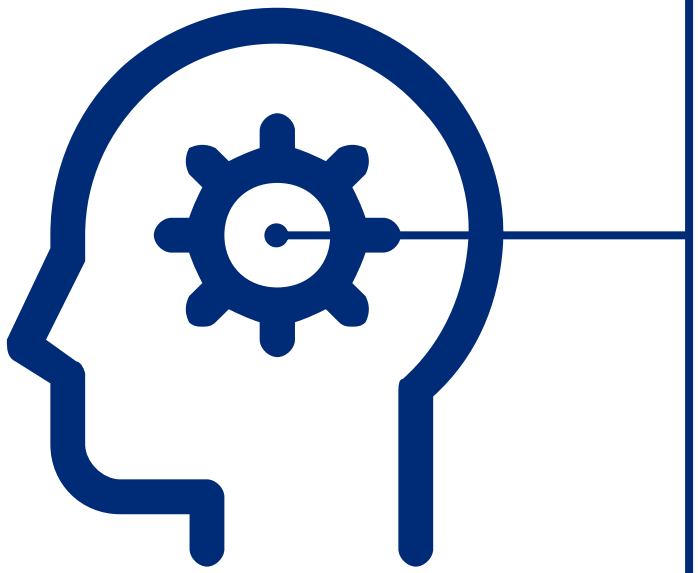
Future Risk

- Most common assessment of climate risk by the insurance industry, which is also the focus of regulators.
- Over the next 30 years, an additional ~1.5°F of global warming is projected (a rate of increase which is almost 3X faster than the last 90 years) which has consequences for future risk.

**The calibration periods for most catastrophe models for the tropical cyclone hazard are approximately these years.

Conclusions: Climate Change and Severe Weather



Simultaneous changes in climate, exposure growth, and inflation have resulted in a sharp increase in industry losses over the last decade. The increase in catastrophe losses has put the impact of climate change on the insurance industry under a microscope, and companies/regulators are responding.

The acceleration of climate change coupled with the already observed warming suggests a continued increase in insured losses over the next decade. Specific regions and perils (e.g. Northeast flooding) are projected to affected more than others.

Catastrophe modelling developed purely on historical records is no longer sufficient for providing an expectation of hazard behavior over the next decade. Modelling techniques for developing plausible but not yet observed catastrophic events are increasingly important. Additionally, incentivizing resilience measures and greenhouse gas mitigation will be crucial for managing the accelerating impacts of climate change.