# NatCat risk in a changing climate

## An algorithm for stress-testing Hurricane risk in the Atlantic

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# Potential scenarios for the future development of the climate all lead to more extreme weather

## Core message of the IPCC (World Climate Council)

From the sixth assessment report of the IPCC (August 9th, 2021)

- We're on course to reach 1.5 °C of warming within the next two decades. On a carbon-intensive pathway, global warming could climb to 3.3 - 5.7 °C by the end of the century.
- Limiting global warming to 1.5 °C by the end of the century is still within reach, but requires transformational change.
- Our understanding of climate science — including the link to extreme weather — is stronger than ever.
- The changes we are already seeing are unprecedented in recent history and will affect every region of the globe.
- Every fraction of a degree of warming leads to more dangerous and costly impacts.

Quelle: World Resources Institute - https://www.wri.org/insights/ipcc-climate-report

## Three plausible scenarios under consideration

Reference scenarios of the Bank of England – next to macro-economic scenarios these also contain capital market variables. These are based on the scenarios by the Network for Greening the Financial System (NGFS) which are considered a standard in the industry.

| | Early Action | Late Action | No Additional Action |
|---|---|---|---|
| **Transition risks** | Medium | High | Limited |
| Transition begin in | 2021 | 2031 | n.a. |
| Nature of transition | Early and orderly | Late and disorderly | Only policies that were in place before 2021 |
| **Physical risks** | Limited | Limited | High |
| Global mean GST by 2050 | +1.8°C | +1.8°C | +3.3°C |
| **Macro-financial risks** | Temporarily lower growth | Sudden contraction (recession) | Permanently lower growth and higher uncertainty |

Quelle: https://www.bankofengland.co.uk/stress-testing/2022/results-of-the-2021-climate-biennial-exploratory-scenario

# Risk drivers of these scenarios under review

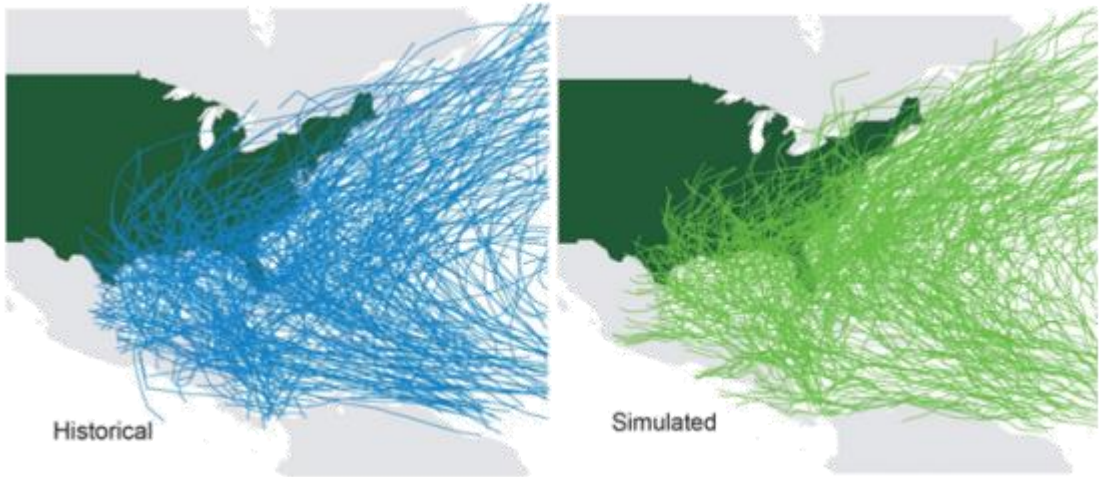
| Shock/ Risk Driver | Story | Transmission & Mapping | | | Impact by Epic: Soft Transition medium-term | Soft Transition long-term | Steep Transition medium-term | Steep Transition long-term | Business as usual medium-term | Business as usual long-term |
|---|---|---|---|---|---|---|---|---|---|---|
| **Transition Risks** | | | | | | | | | | |
| **Carbon Pricing** | Globally, the abrupt implementation of strong climate policies (e.g. cap-and-trade systems or carbon taxes) leads to a sharp increase in the price of CO2. As a result, energy prices for fossil fuels are rising in line with their carbon intensity. | Economic Transmission (i.e. impact on firms, households, and the economy) | Impact on Insurers (i.e. on underwriting, investments and operations) | Impact on net income, own funds, and capital requirements (SCR) | medium | medium | high | high | low | low |
| **Renewable Energies** | Driven by high investments in research and development of renewable energy generation and storage, there are unexpected technological breakthroughs that allow to significantly increase the share of renewable energy in the energy mix. Energy becomes cheaper and less fossil-intensive. | | | | high | high | medium | medium | low | low |
| **Electric Vehicles** | Advances in the range of electric vehicles and the price development of lithium-ion batteries (LIB) are leading to an increase in the share of electric vehicles and a reduction in the CO2 intensity of fuels. | | | | high | high | medium | medium | low | low |
| **Eco-Activism/ Market Sentiment** | Increasing eco-activism and a high level of media and public attention are leading to long-term behavioral changes among consumers. Large segments of the population are switching their diets to plant-based food. Up-cycling and recycling become popular on a large scale. There is high transparency pressure on companies. | | | | medium | medium | high | high | low | low |
| **Physical Risks** | | | | | | | | | | |
| **Riverine and Coastal Floods** | Changing rainfall patterns as a result of global warming will greatly increase the risk of river flooding in many places. Flooding not only causes damage to buildings and infrastructure but can also cause supply chain disruptions. | | | | low | medium | low | medium | medium | high |
| **Tropical Cyclones** | Global average cyclone intensity will increase and the global proportion of tropical cyclones that reach very intense levels will increase while the frequency of all tropical cyclones is predicted to decrease globally. | | | | low | medium | low | medium | medium | high |
| **Food Supply** | Extreme weather events, rising sea levels, heavy rainfalls and increasing temperatures are causing crop failures and a reduction in agriculturally productive land. Climate conditions and diseases further affect livestocks and fishing. This bears the risk of food and water shortages and price hikes. | | | | low | medium | low | medium | medium | high |
| **Disease Occurrence** | Due to climate change, vector-borne infectious diseases such as yellow fever, dengue fever and malaria are increasingly spreading in many regions of the world. The advance and survival of certain vectors and / or pathogens in temperate zones such as Germany is considered possible. | | | | low | medium | low | medium | medium | high |
| **Litigation Risks** | | | | | | | | | | |
| **Climate Change Litigation/ Policy** | National and international legal frameworks are revised to strengthen environmental law and facilitate the initiation of proceedings and liability of companies and states concerning actions or omissions related to climate change. There is an increase in climate-related lawsuits. | | | | medium | medium | high | high | low | low |
| **Climate Change Litigation/ Physical** | Along with the increase in extreme weather events and chronic physical impacts of climate change, such as sea level rise, the frequency and diversity of legal actions related to climate change is also increasing. | | | | medium | medium | medium | medium | high | high |

# Stressing US Hurricane risk via a resampling approach

Assumptions provided by AIR, 2021 (Responding to the Bank of England Climate Biennial Exploratory Scenario 2021)

| U.S. Hurricane | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature (°C) | | Annual frequency of category 4-5 typhoons (% change) | | Typhoon intensity (% change) | | Typhoon precipitation rate (% change) | | Sea level rise (average annual change in meters) | |
| | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA |
| 2020 | 1.1 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0 |
| 2030 | 1.4 | 2.5 | 2.9 | 29.9 | 1.5 | 7.0 | 3.7 | 18.0 | 0.03 | 0.14 |
| 2050 | 1.8 | 3.3 | 6.7 | 47.0 | 3.4 | 11.0 | 8.7 | 28.9 | 0.09 | 0.24 |

Actual footprints of Atlantic Hurricanes vs. Simulation in NatCat model



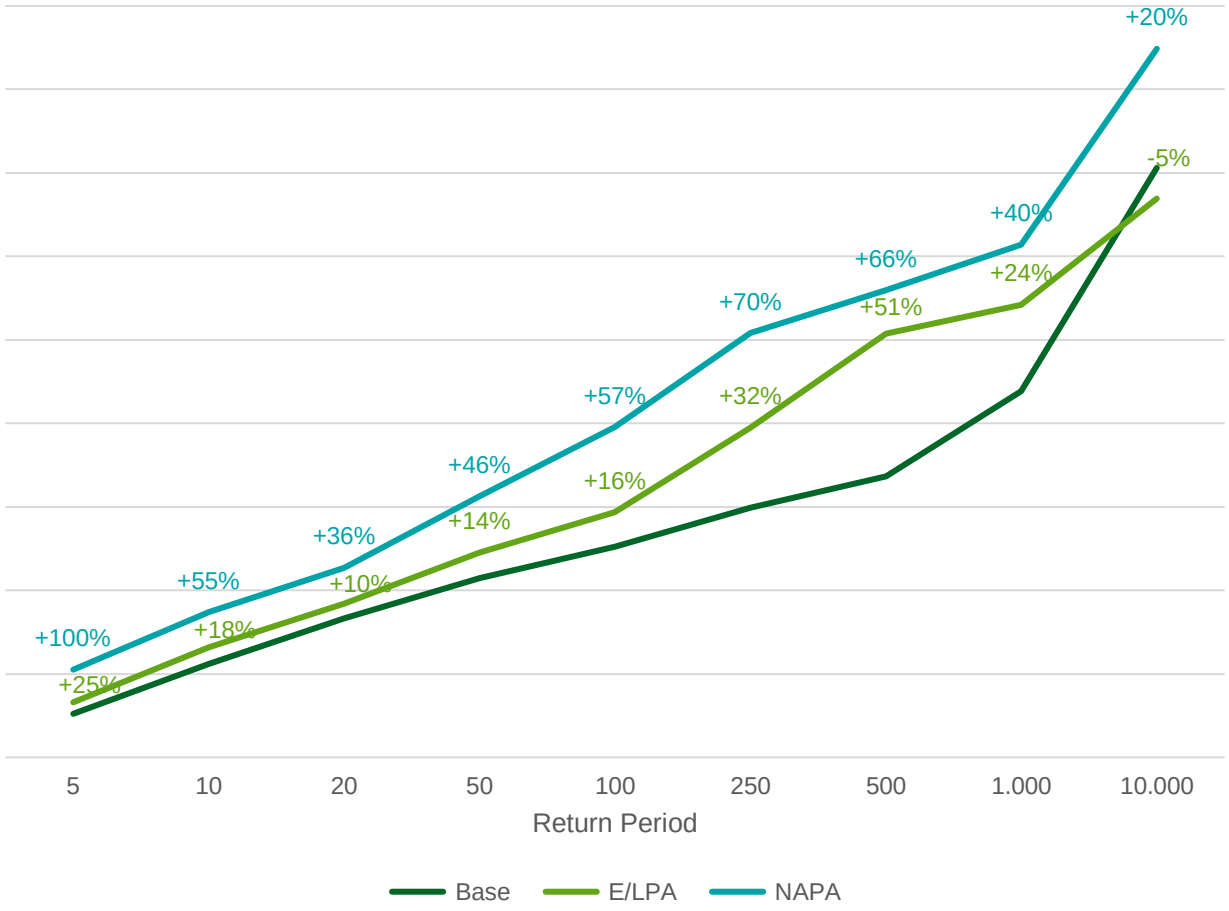

## Resampling Algorithm

Using the original event characteristics of the Nat Cat model, we resample its event catalogue to match the stressed frequencies, intensities and precipitation.

1. Get current values of precipitation/intensity/frequency and calculate respective target values under climate change scenario
2. Following steps carried out individually for minor (Cat 0-3) and major (Cat 4-5) events
   a) Select random start event
   b) Loop over number of total required events: select random event and check following criteria:
      i. Is a landfall in respective area still possible?
      ii. Does the random event help achieving the target values for intensity/precipitation?
      iii. Assign the event to a random year (not too many events in one year)
   c) Calculate changes in market losses
3. Repeat several times to get a measure of uncertainty
4. Pick final model close to average

# Results of resampling approach & Outlook

**Stressed US Hurricane risk**
Change over Base scenario




## Outlook

Further scenarios to be added in future stress tests

- Japan Typhoon *

| Japan Typhoon | Temperature (°C) | | Annual frequency of category 4-5 typhoons (% change) | | Typhoon intensity (% change) | | Typhoon precipitation rate (% change) | | Sea level rise (average annual change in meters) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA |
| **2020** | 1.1 | 1.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2030** | 1.4 | 2.5 | -1.2 | -14.6 | 1.5 | 7.0 | 3.7 | 18.0 | 0.06 | 0.20 |
| **2050** | 1.8 | 3.3 | -3.0 | -23.1 | 3.4 | 11.0 | 8.7 | 28.9 | 0.16 | 0.33 |

- Europe Flood * (U.K. done, contl. EU in progress)

| U.K. Inland Flood | Temperature (°C) | | Precipitation rate, average summer: UK (% change) | | Precipitation rate, average winter: UK (% change) | | Precipitation rate, average annual: UK (% change) | | Precipitation rate for London, average annual (% change) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA | E/LPA | NAPA |
| **2020** | 1.1 | 1.1 | -3.7 | -3.7 | 2.8 | 2.8 | 1 | 1.0 | 0.5 | 0.5 |
| **2030** | 1.4 | 2.5 | -5.7 | -0.7 | 4.9 | 22.3 | 0.9 | 10.6 | 1.7 | 17.5 |
| **2050** | 1.8 | 3.3 | -11.2 | -2.3 | 5.0 | 24.4 | 0.3 | 11 | 0.2 | 15.8 |

* CBES projections for relevant variables relative to 1981-2000 baseline (Bank of England, 2021b)

# Thank you for your attention

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