Climate change considerations for crop insurance

Julia Borman, PhD

Prepared for the 2023 CIRB Annual Meeting
February 9, 2023

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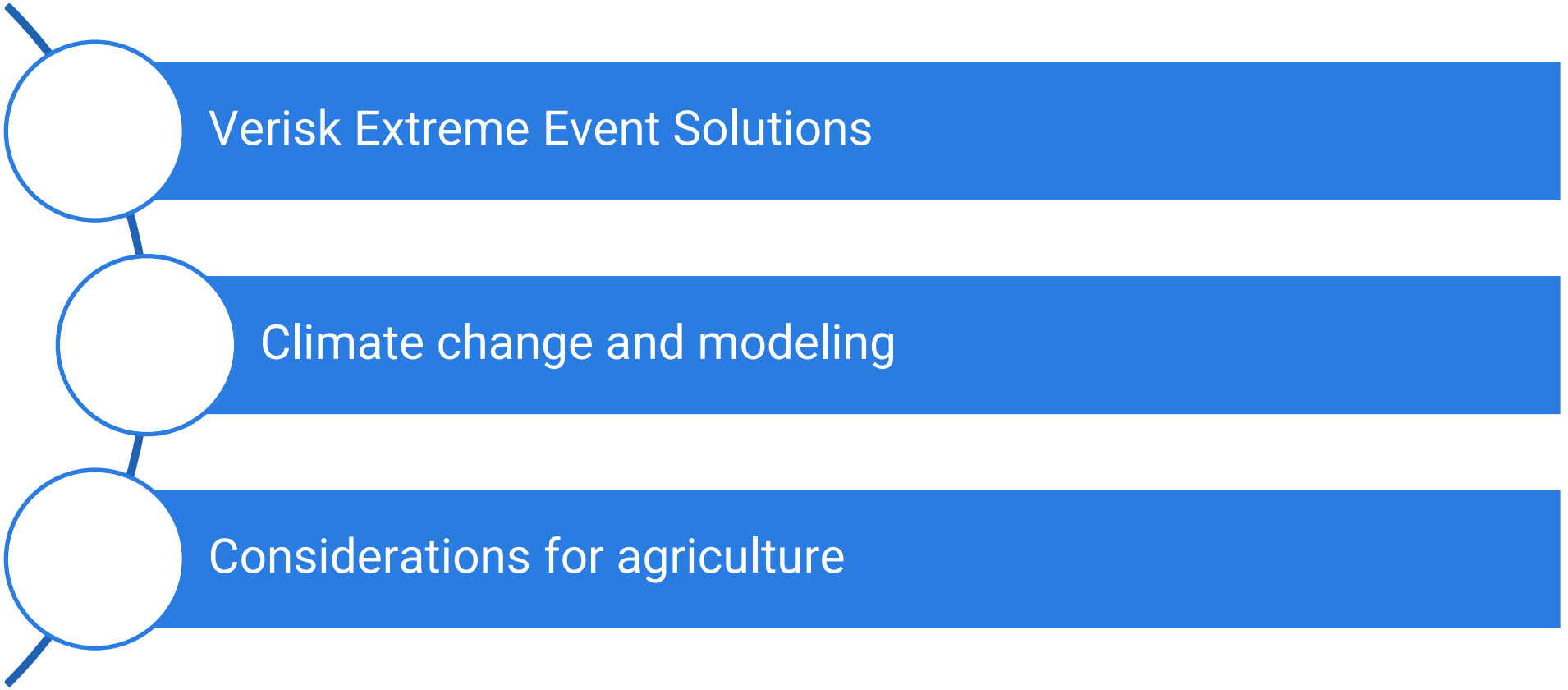
Agenda



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A Brief History

Formerly known as AIR Worldwide

- Founded the catastrophe modeling industry in 1987
- Scientific leader of risk modeling software and consulting services
- Locations in Boston, San Francisco, Halifax, London, Munich, Beijing, Tokyo, Singapore, and Hyderabad
- Grown to serve more than 400 clients in a wide range of industries, including insurance, reinsurance, finance, corporate, and government

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Extreme Event Models in 110+ Countries

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Strong Portfolio of Agricultural Models and Services

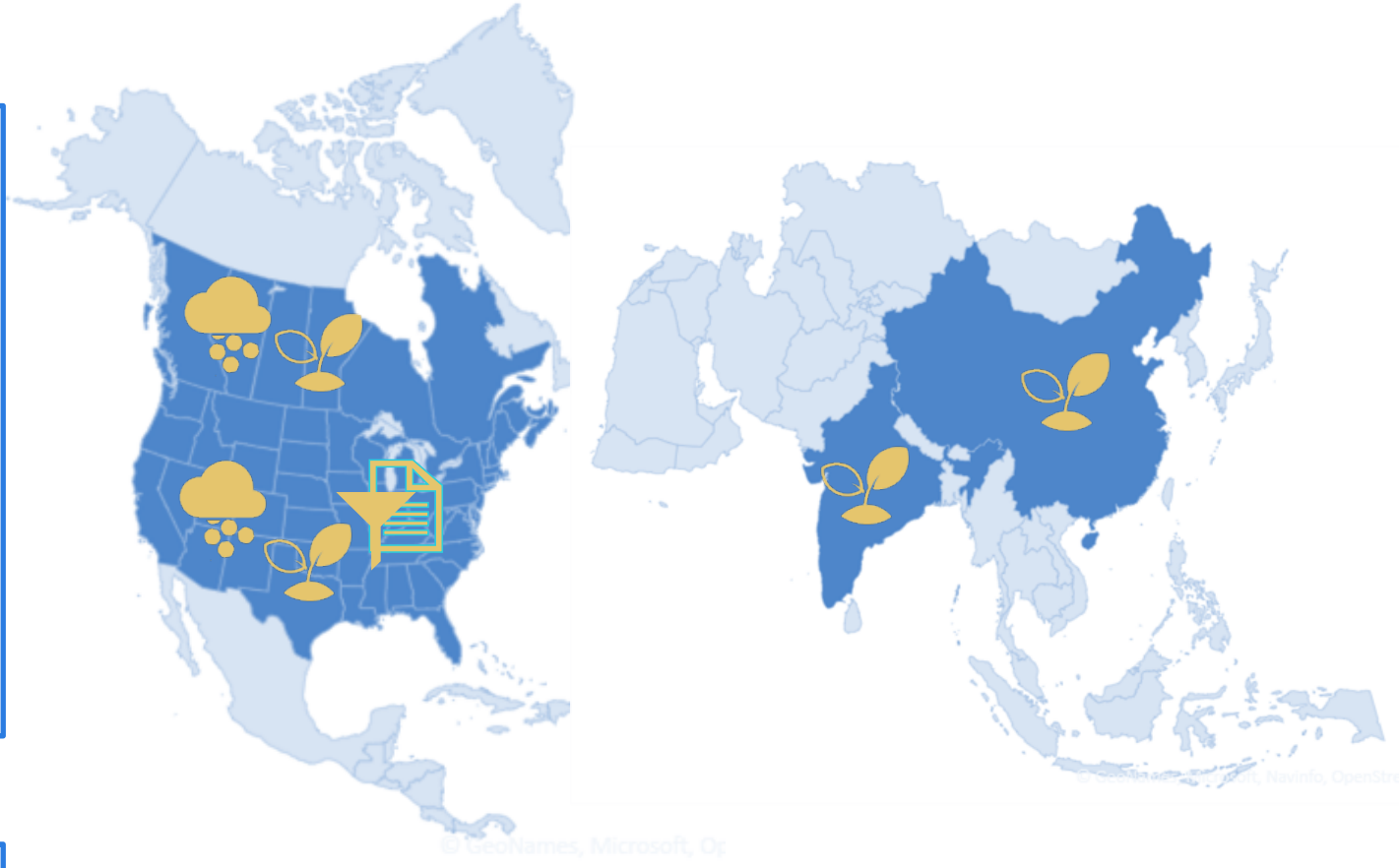
Leading Models
(Touchstone Re™)

- **Canada Crop Hail** (2017 release)
- **Canada MPCI*** (2018 release)
- **China MPCI**** (2023 update)
- **India MPCI** (2019 release)
- **U.S. Crop Hail** (2022 release)
- **U.S. MPCI** (2023 update)

*MPCI — multiple peril crop insurance
**China model Includes MPCI, forest, and livestock

Consulting Service

- **U.S. MPCI fund designation**



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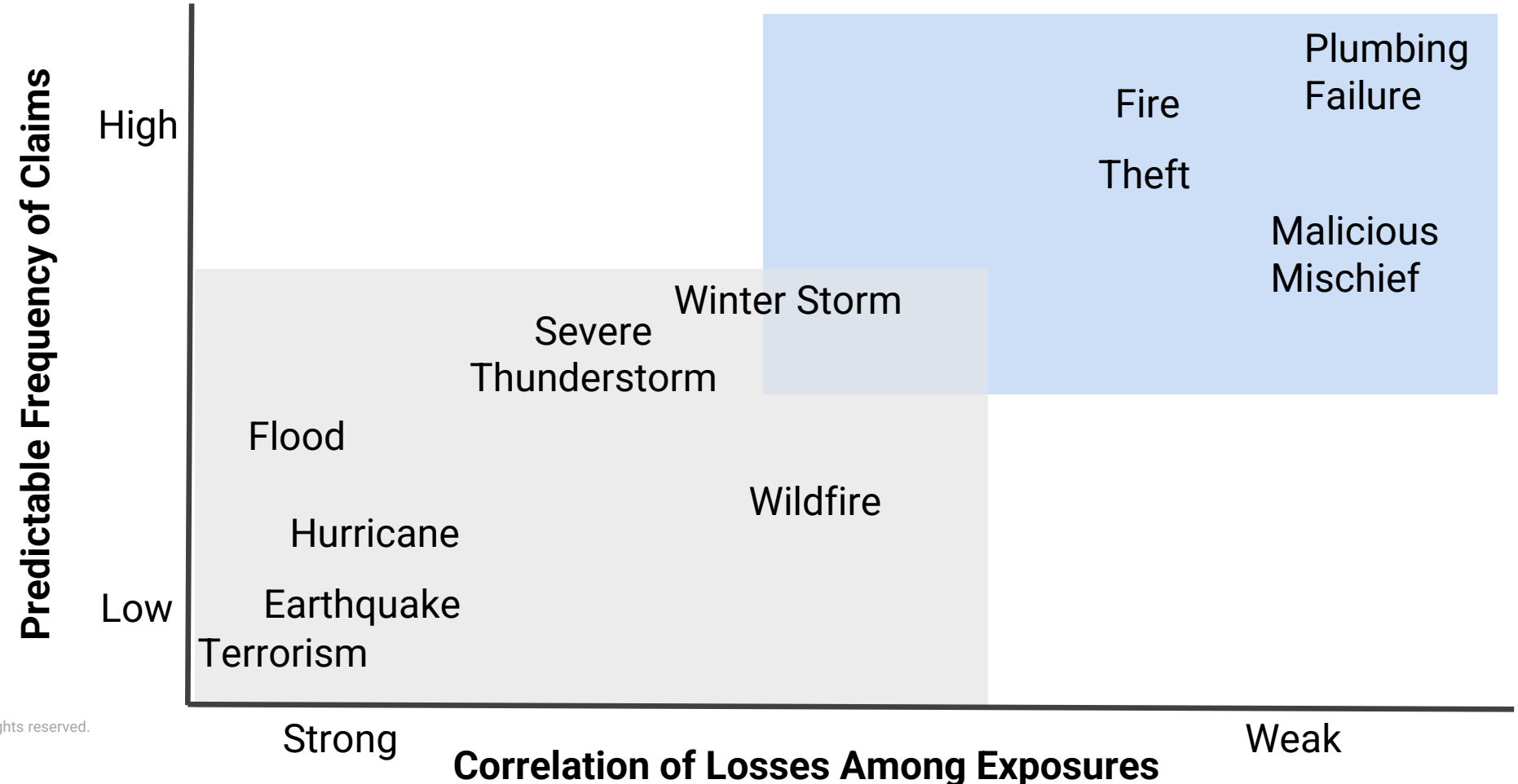
Traditional Methods of Estimating Loss Ineffective For Catastrophe Risk Management

"Catastrophe Events Violate the Two Major Conditions Needed to Apply the Law of Large Numbers" - American Academy of Actuaries



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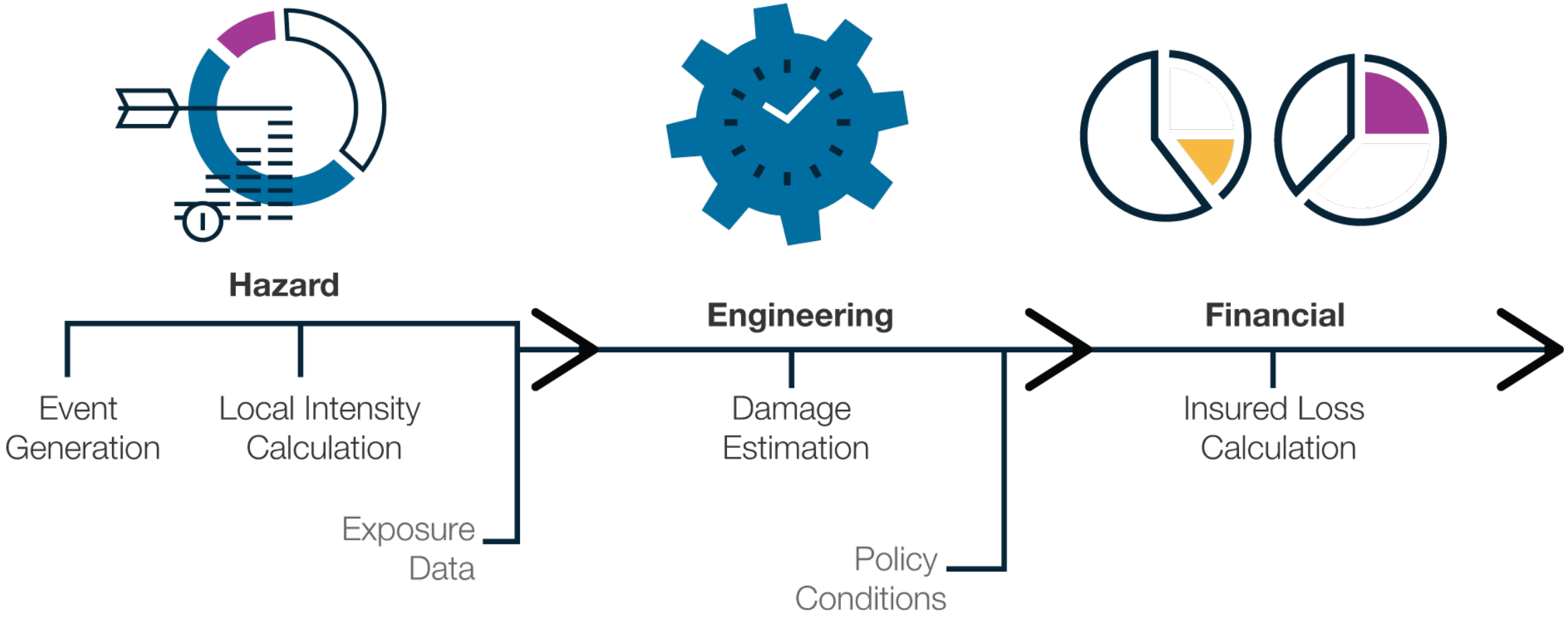
Extreme Event Modeling Framework



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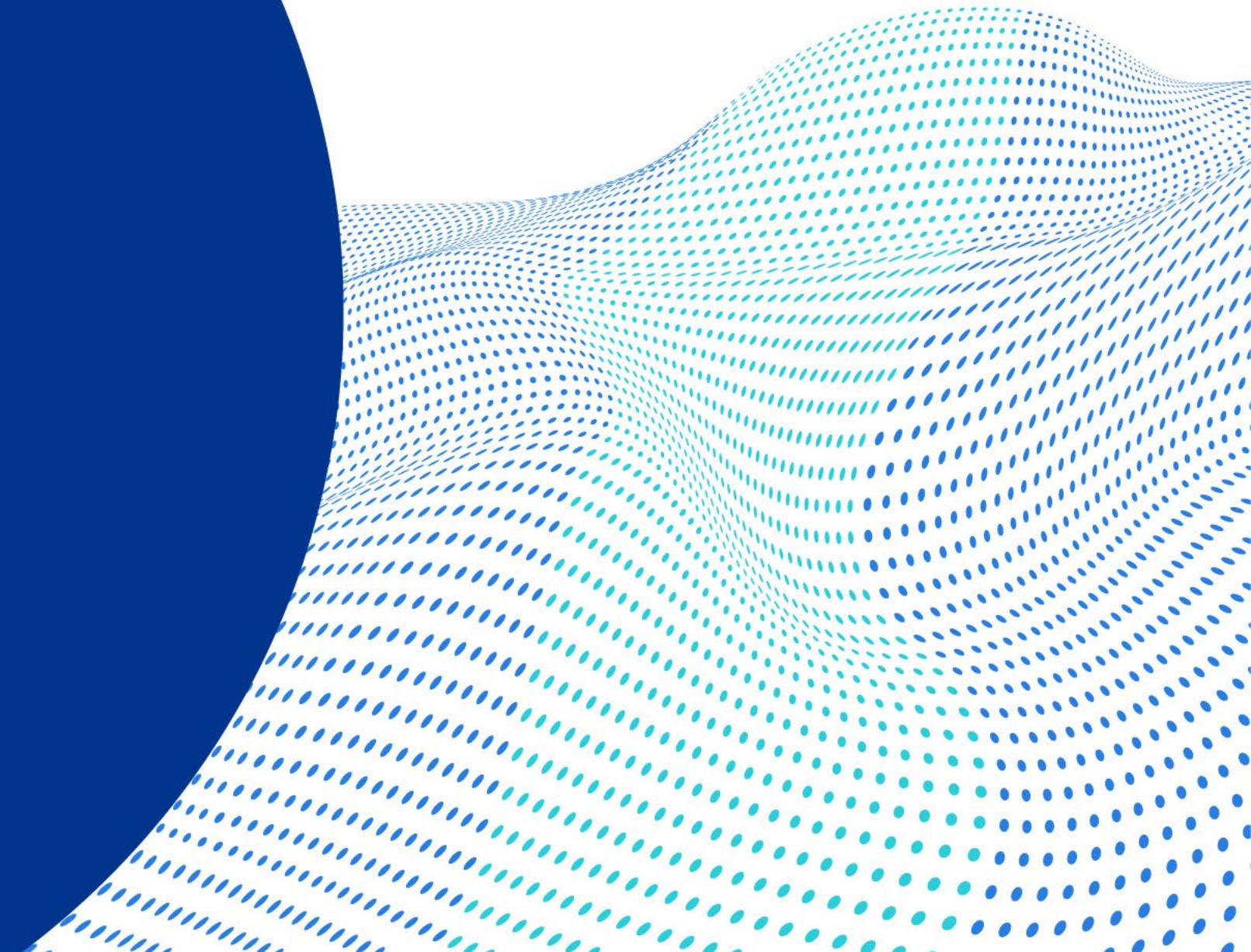
Climate change and modeling



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A timeline of our climate change activities

Company formerly known as AIR is founded in 1987; is now Verisk

1987 — Hurricane Andrew

1997 — 2004-2005 Atlantic Hurricane Seasons

2004 — We release warm SST catalog as a possible climate change tool

2005 — ABI RESEARCH PAPER NO 19, 2009 — THE FINANCIAL RISKS OF CLIMATE CHANGE — Examining the financial implications of climate change using climate models and insurance catastrophe risk models — Report by AIR Worldwide Corp. and the Met Office

2007 — World Bank, Geosciences Australia funds our study on climate change impacts on SOPAC TCs

2009 — We begin including climate change sessions at Executive Summit

2011 — PCRAFI — Better Risk Information for Smarter Investments — CATASTROPHE RISK ASSESSMENT METHODOLOGY

2013 — Envision Conference in Philadelphia

Verisk's Global Resilience Practice established

2016 — Climate Change Impacts on Extreme Weather — June 2017 — Peter J. Sousounis, Ph.D. — Christopher M. Little, Ph.D.

2017 — UK Windstorms and Climate Change — An update to ABI Research Paper No 19, 2009 — AIR WORLDWIDE — Met Office

2019 — We appoint Director of Climate Change Research

We conduct a survey to evaluate clients' interest in climate change

Clients begin asking us how climate change is included in catastrophe models

Potential Impacts of Climate Change on U.S. Wildfire Risk by Mid Century

Potential Impacts of Climate Change on U.S. Inland Flood Risk by Mid Century

Verisk Climate Advisory Council

2020 — Quantifying the Impact from C… Change on U.S. Hurricane Risk

Climate Change Impacts on U.S. Corn Yields

BANK OF ENGLAND PRUDENTIAL REGULATION AUTHORITY

The 2021 Biennial Exploratory Scenario: Financial risks from climate change

BMA Climate Change Exposure Assessment

BMA — BERMUDA MONETARY AUTHORITY

Reimagining the Future of Simulating Atmospheric Perils — A New Framework for Modeling Weather and Climate Extremes

2021

2022

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Evolution of Climate Change Focus Across Stakeholder Groups

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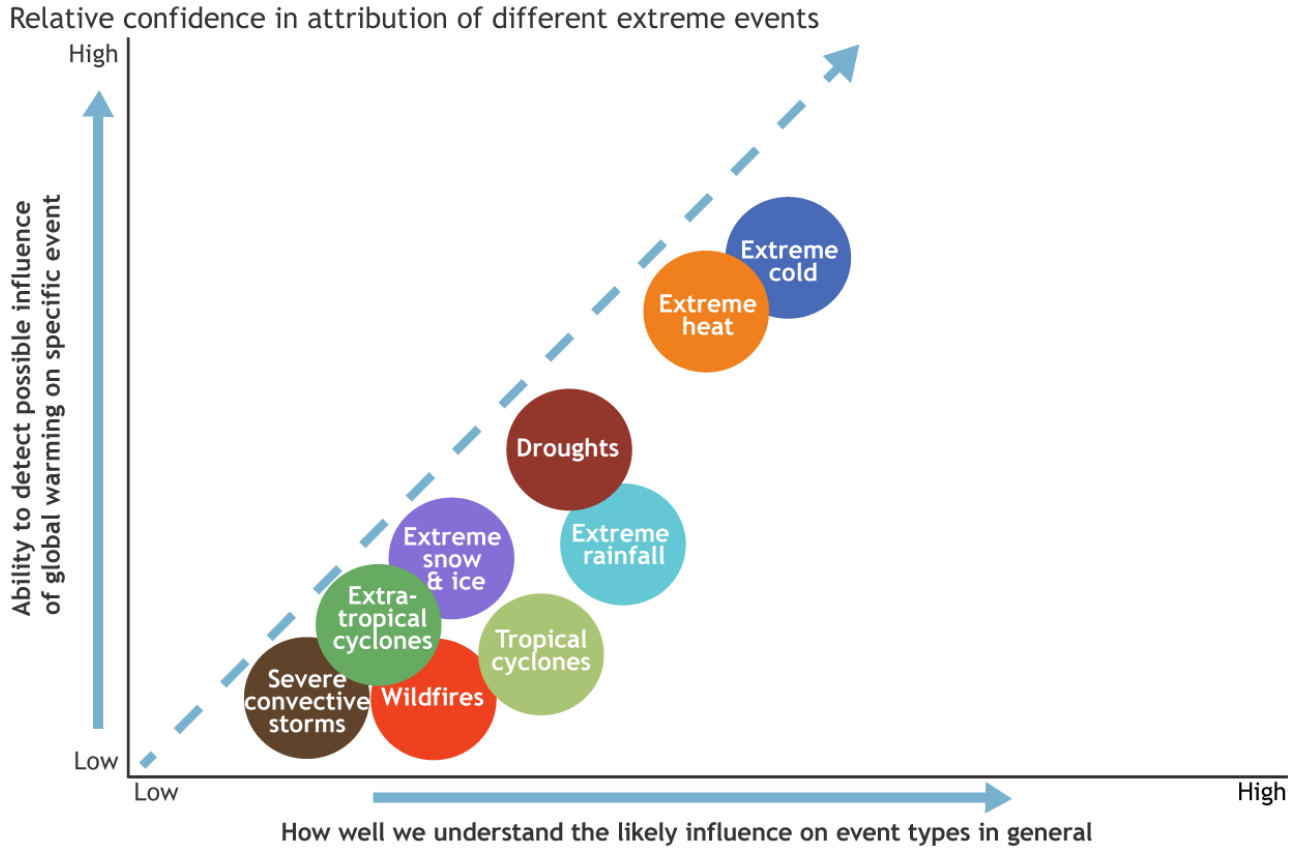
There is high confidence in how climate change is impacting some extremes

Overall confidence in event attribution is strongest for extreme event types that:

- are adequately simulated in climate models
- have a long-term historical record of observations
- are linked to human-caused climate change through an understood and robustly simulated physical mechanism



NOAA Climate.gov, adapted from NAS 2016

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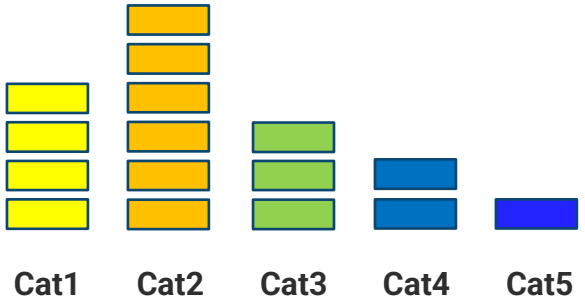
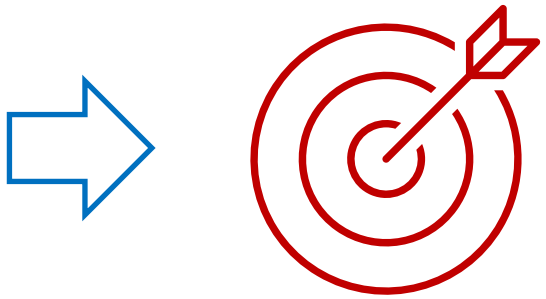
Subsampling for frequency and intensity

Inventory

Existing catalog



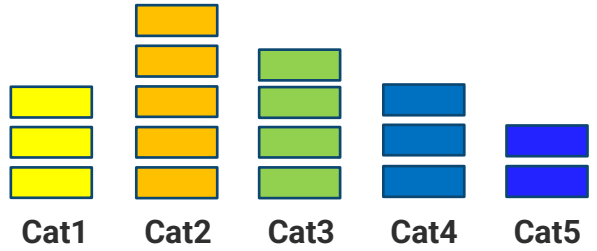
Climate Change Projections



Expected impact on peril activity for different time horizons and climate scenarios

Conditioned Catalog

New catalog



Draw events from current climate catalog in a way to meet the climate change projection

Hail

Tropical Cyclone

Wildfire

Agriculture

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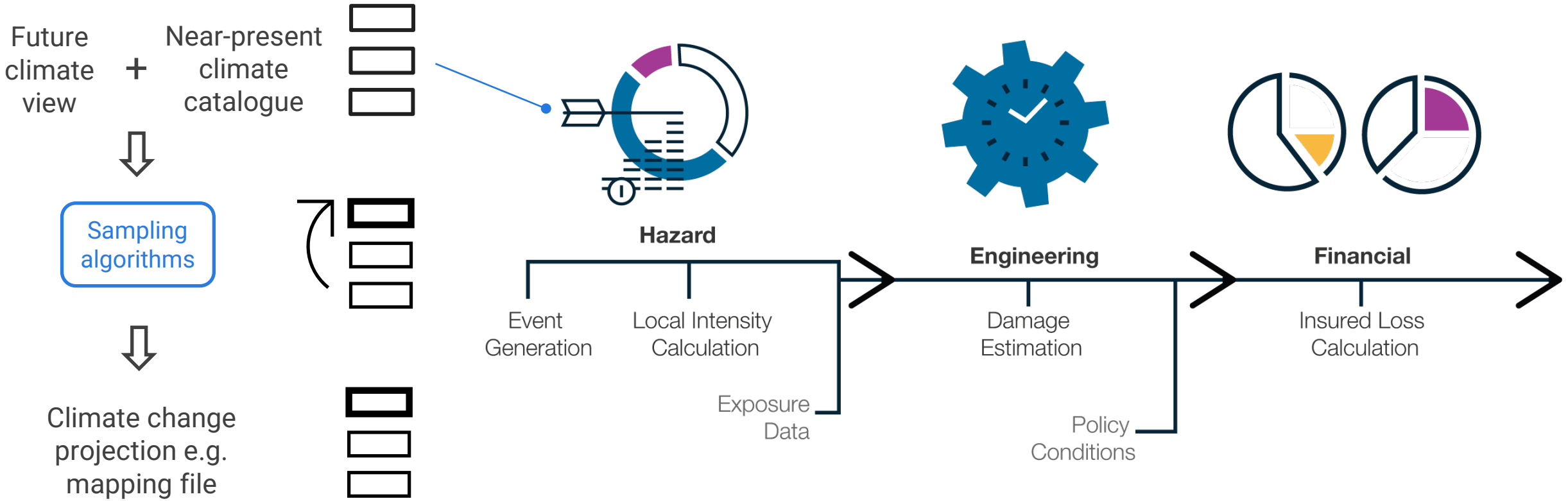
Conditioning catastrophe models using physical climate models



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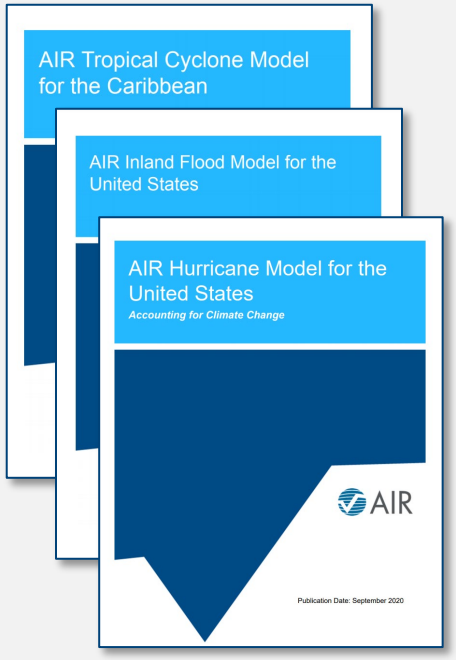
Verisk's Climate Change Practice

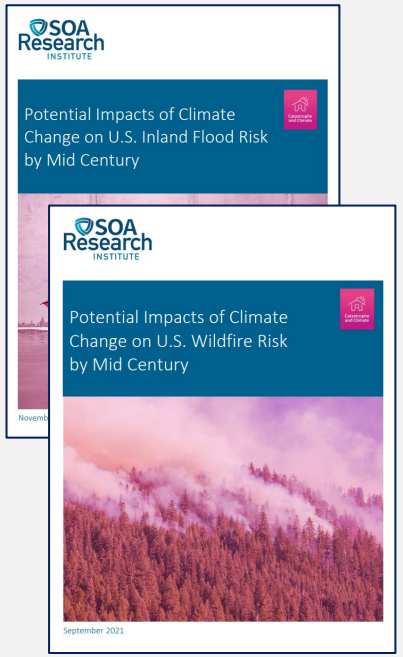


Accounting for climate change in our models

Responding to the Bank of England Climate Biennial Exploratory Scenario 2021 – Physical Risks

Responding to the BMA Climate Change Exposure Assessment 2021

Consulting services and regulatory support



Research and communication

Draw events from current climate catalog in a way to meet the climate change projection

Tropical Cyclone

Wildfire

Products offerings

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Considerations for Agriculture

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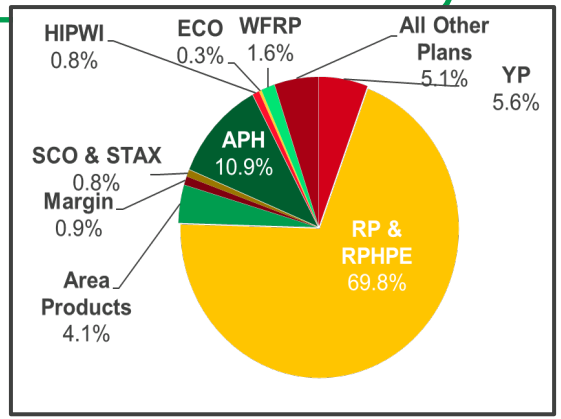
Quantifying agricultural risk requires consideration of several factors

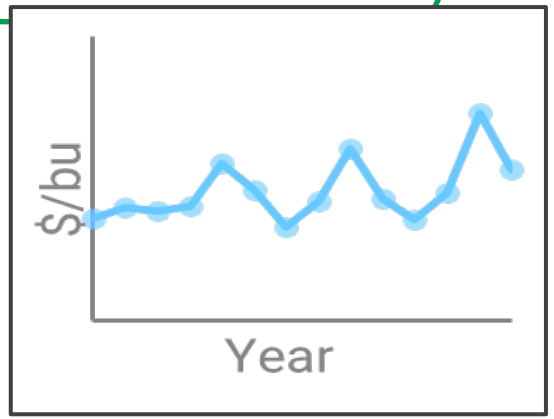
Influences of weather on crop production

Technological advancements

Changes in the insurance program



Changes in commodity prices



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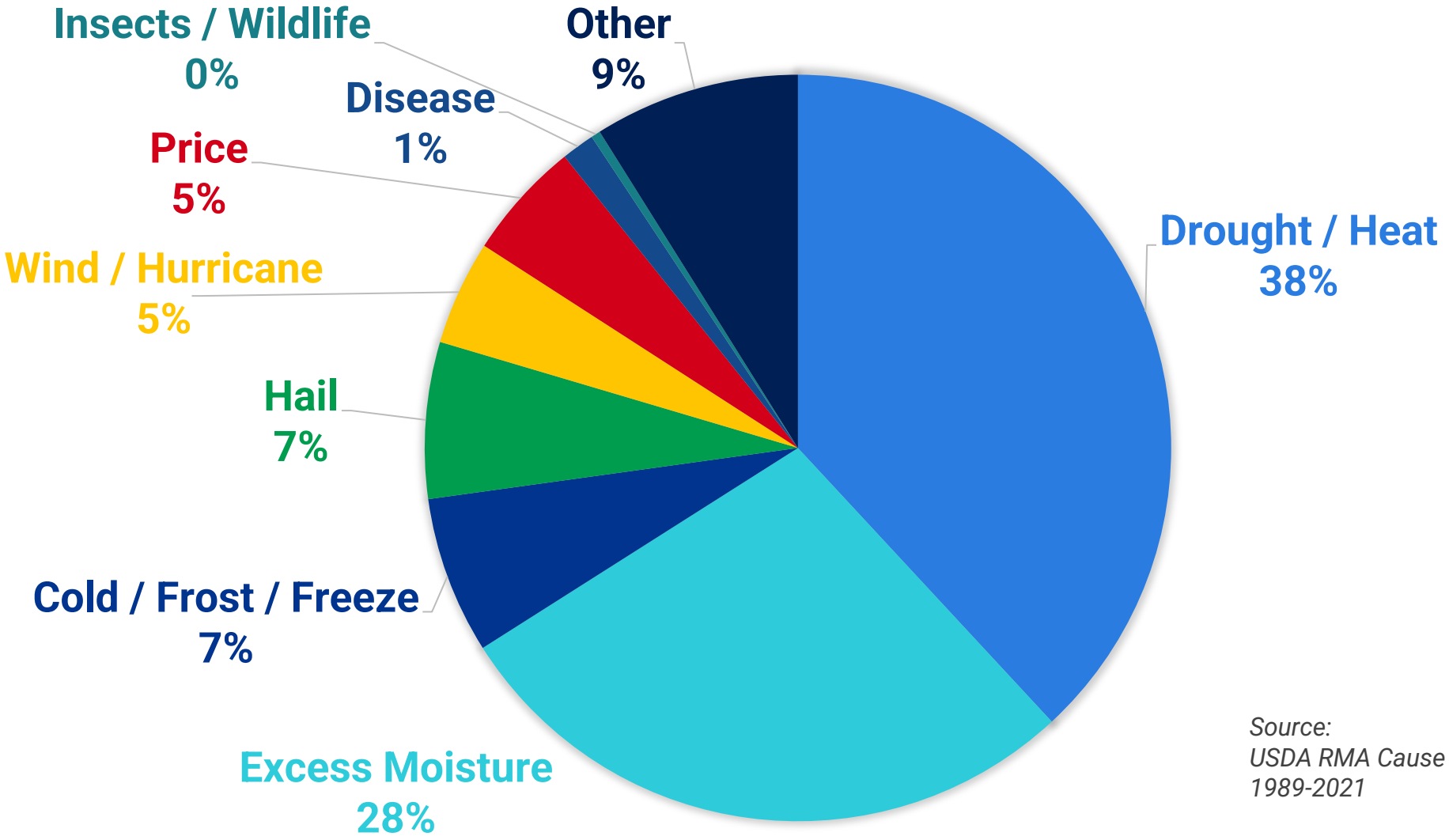
Extreme weather is the primary reason for crop insurance losses



Source:
USDA RMA Cause of Loss Data 1989-2021

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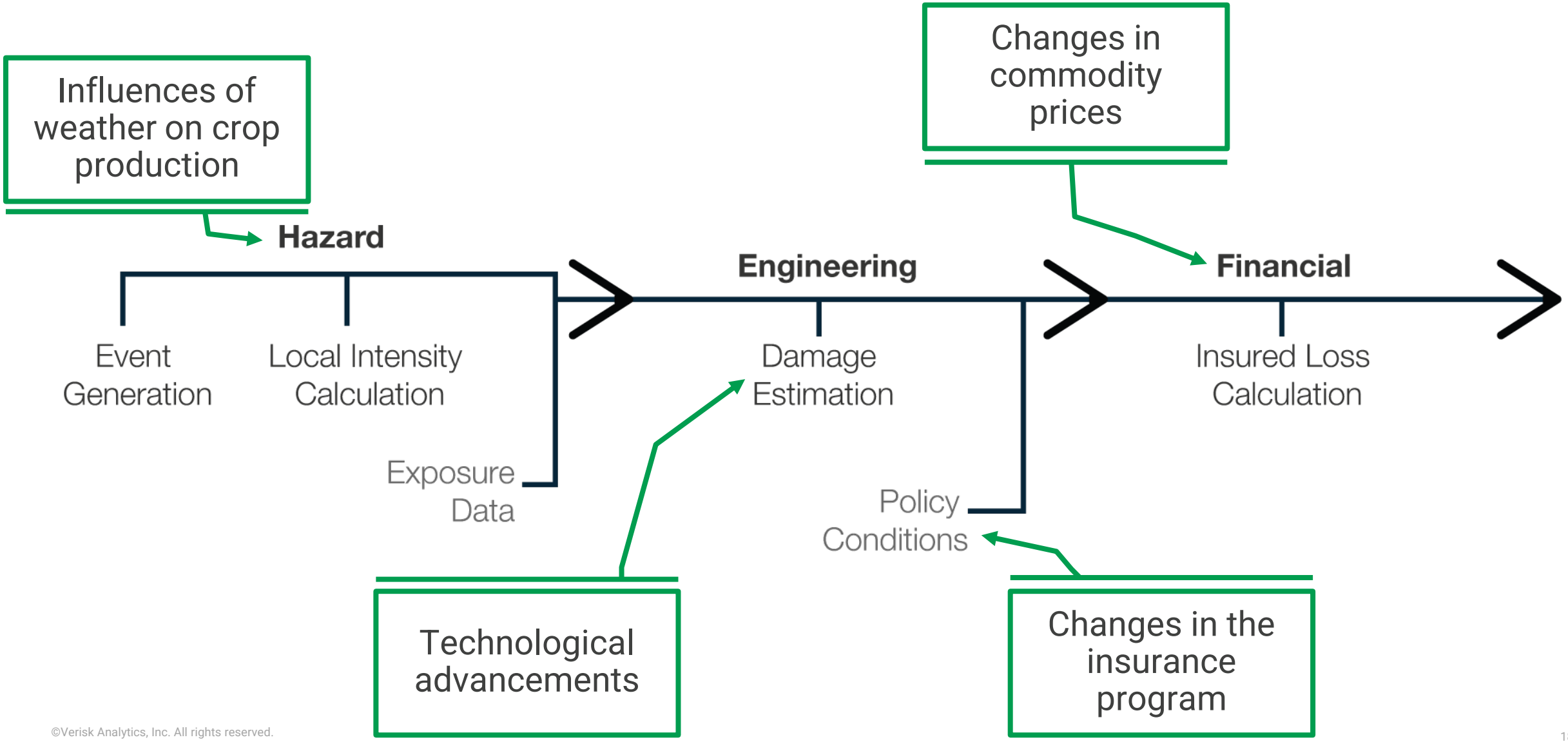
Extreme event modeling framework



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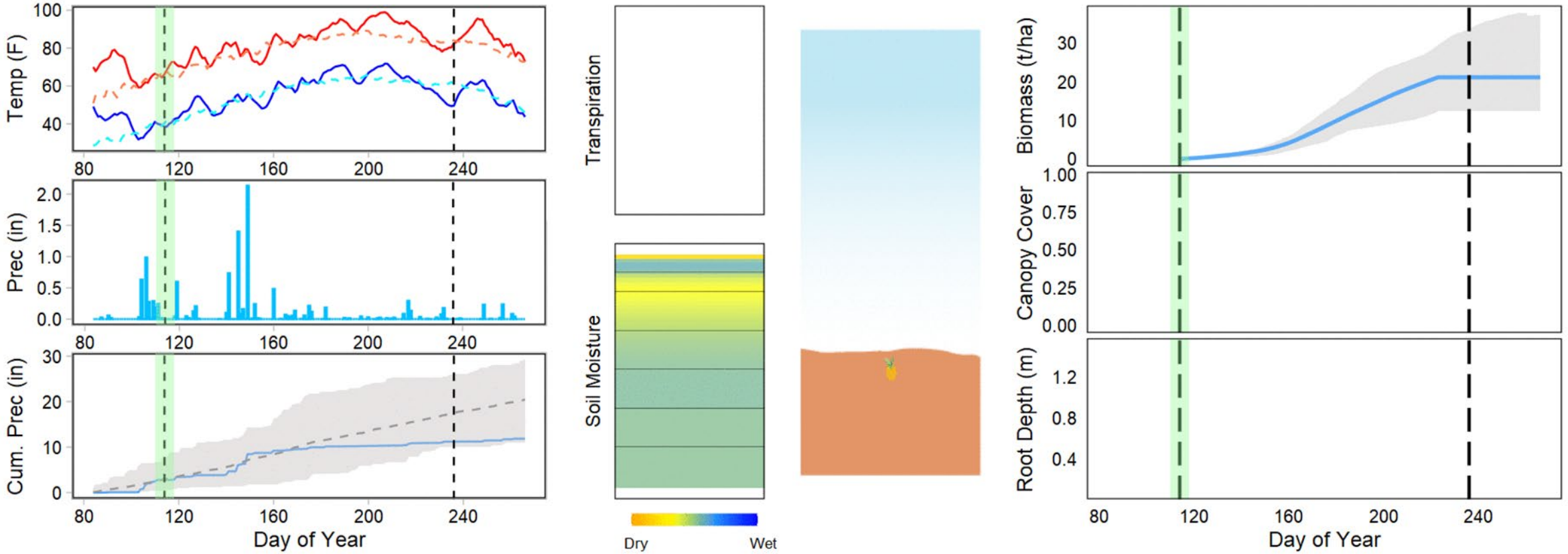
What is a process-based model?



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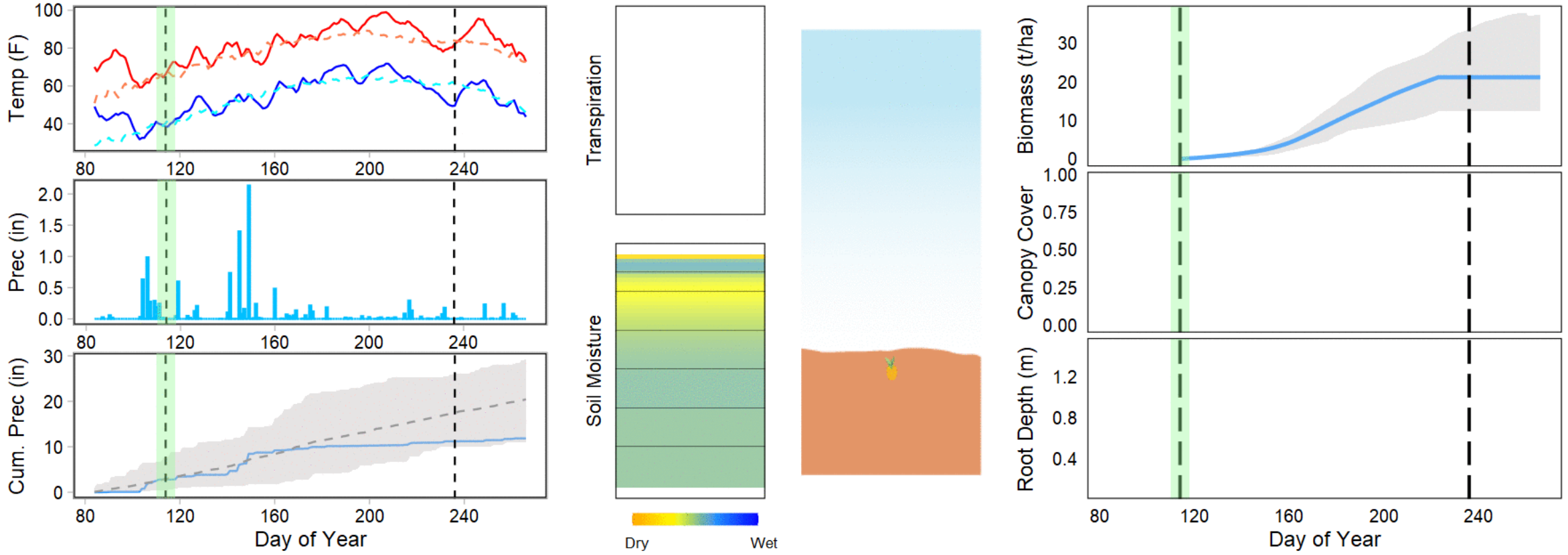
What is a process-based model?



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Short-term vs. long-term agricultural risk

Short-Term
(next year/next few years)

What could the next year's losses be if …

- *A 1-in-20-year drought hits the Midwest?*
- *Spring is too wet, causing widespread prevented planting?*

Guide current business decisions

Long-Term
(next few decades)

- *How will climate change impact the risk to business portfolios?*
- *Will loss-years be more frequent in the future?*

Guide strategies for future risk mitigation and resilience

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Experimental design

Historical Experiment: How has historical (1974-2019) climate change impacted yields?

CPC gridded temperature and precipitation data

Use process-based model to simulate corn yields using historical weather data as input

Future Experiment: How will future climate change impact yields?

GCM projected temperature and precipitation for both historical and future period

Use process-based model to simulate corn yields at end of 20th century (1991-2000) and mid 21st century (2046-2055)

Acronyms:

CPC = Climate Prediction Center

GCM = General Circulation Model

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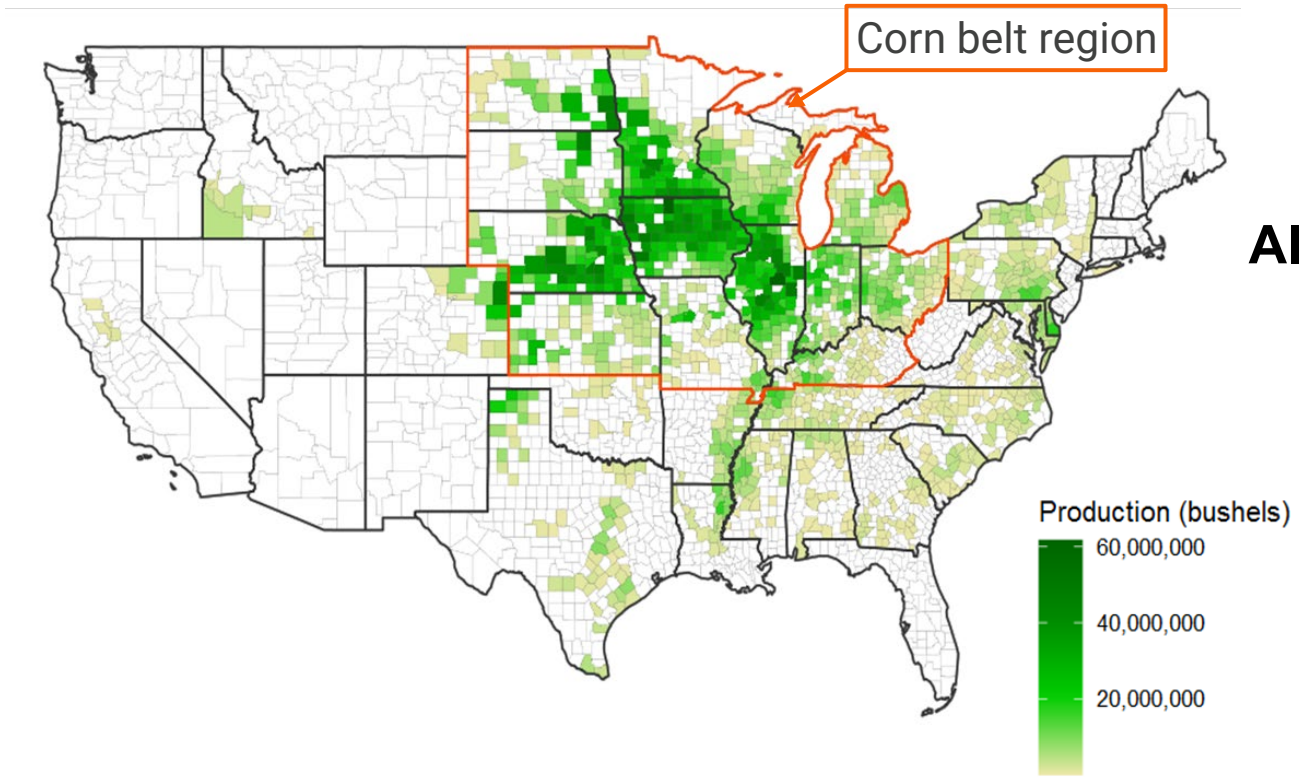
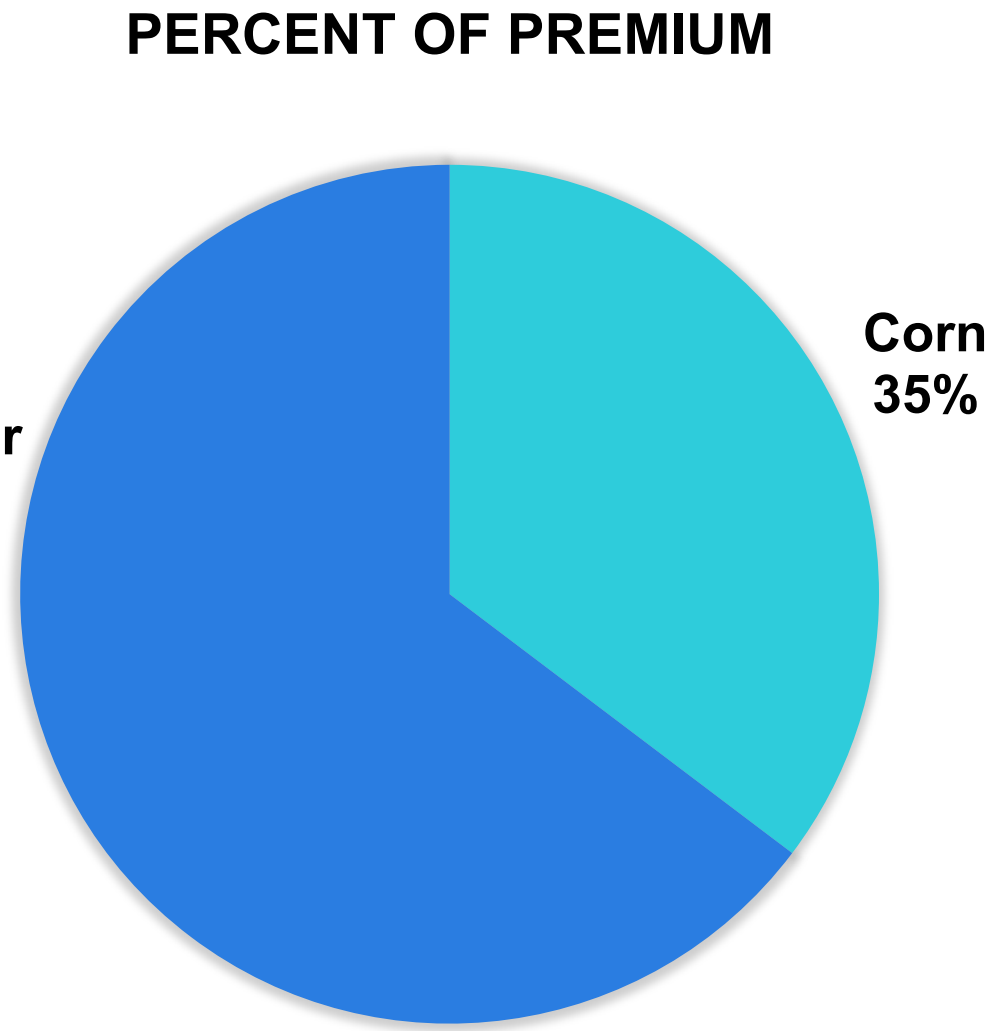
Modeling climate change impacts on US corn





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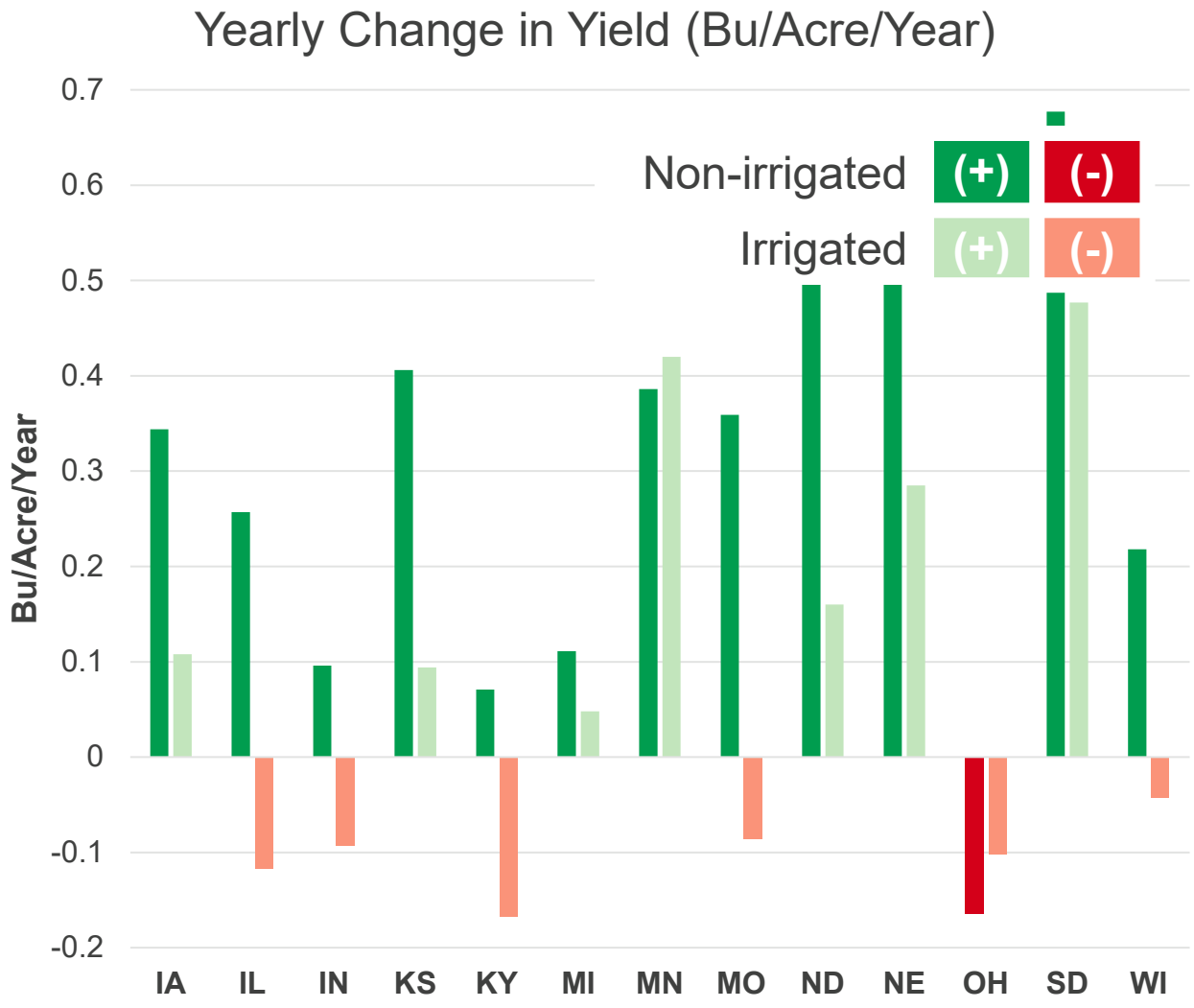
Historical experiment: recent climatic changes (1974–2019)

Historical Experiment: How has historical (1974-2019) climate change impacted yields?

CPC gridded temperature and precipitation data.

Use process-based model to simulate corn yields using historical weather data as input with *crop-genetics held constant at 2019 levels*



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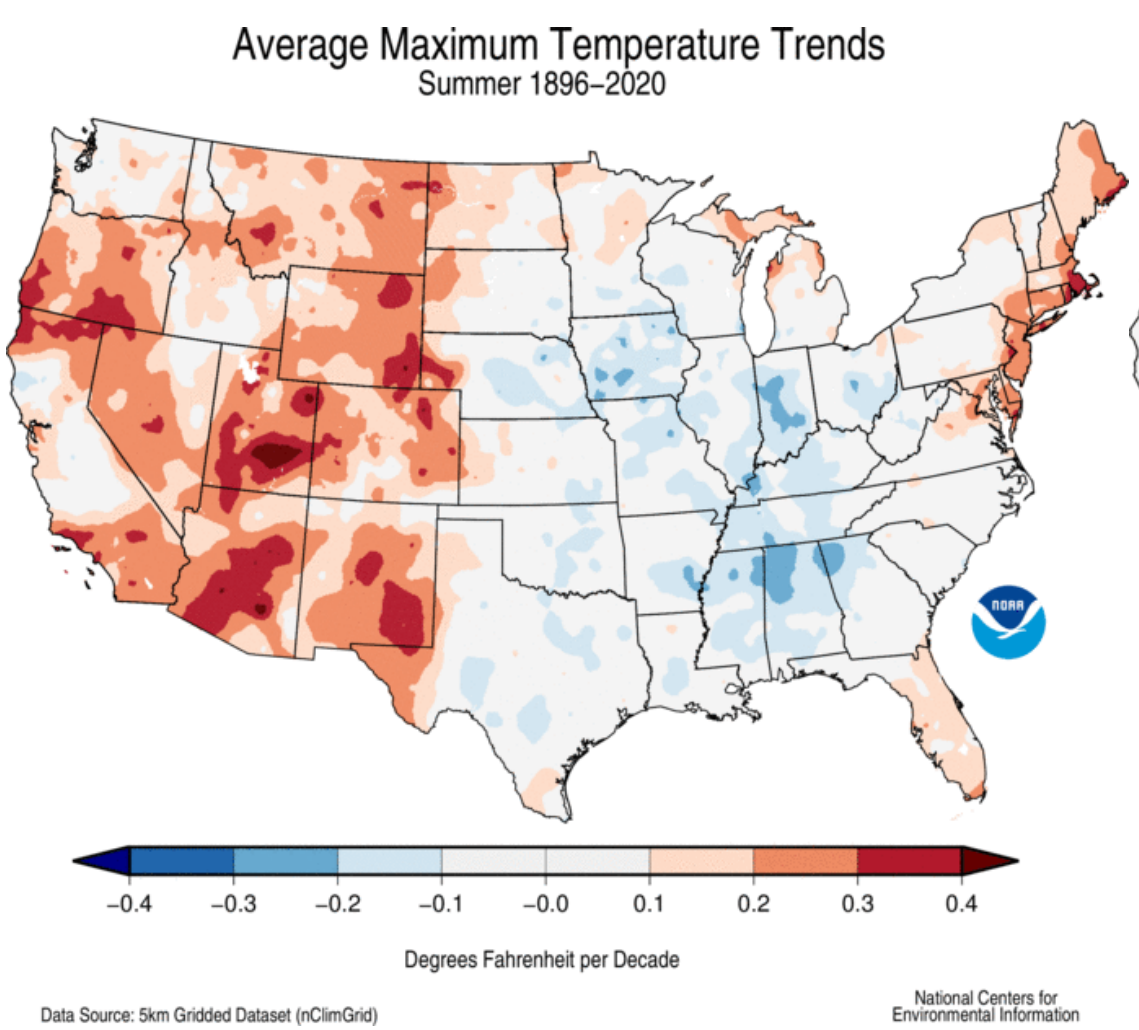
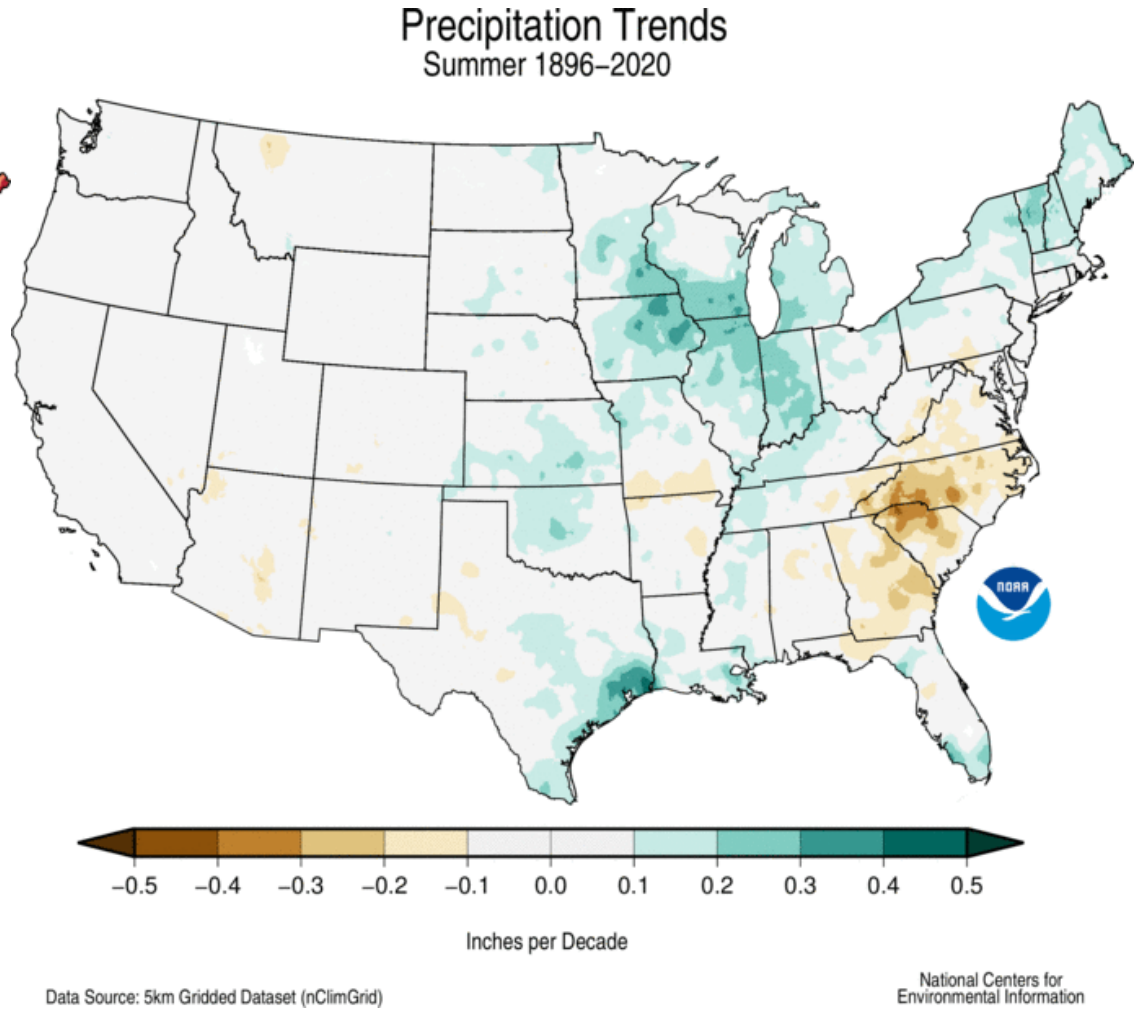
Midwest warming hole is beneficial to historical yields





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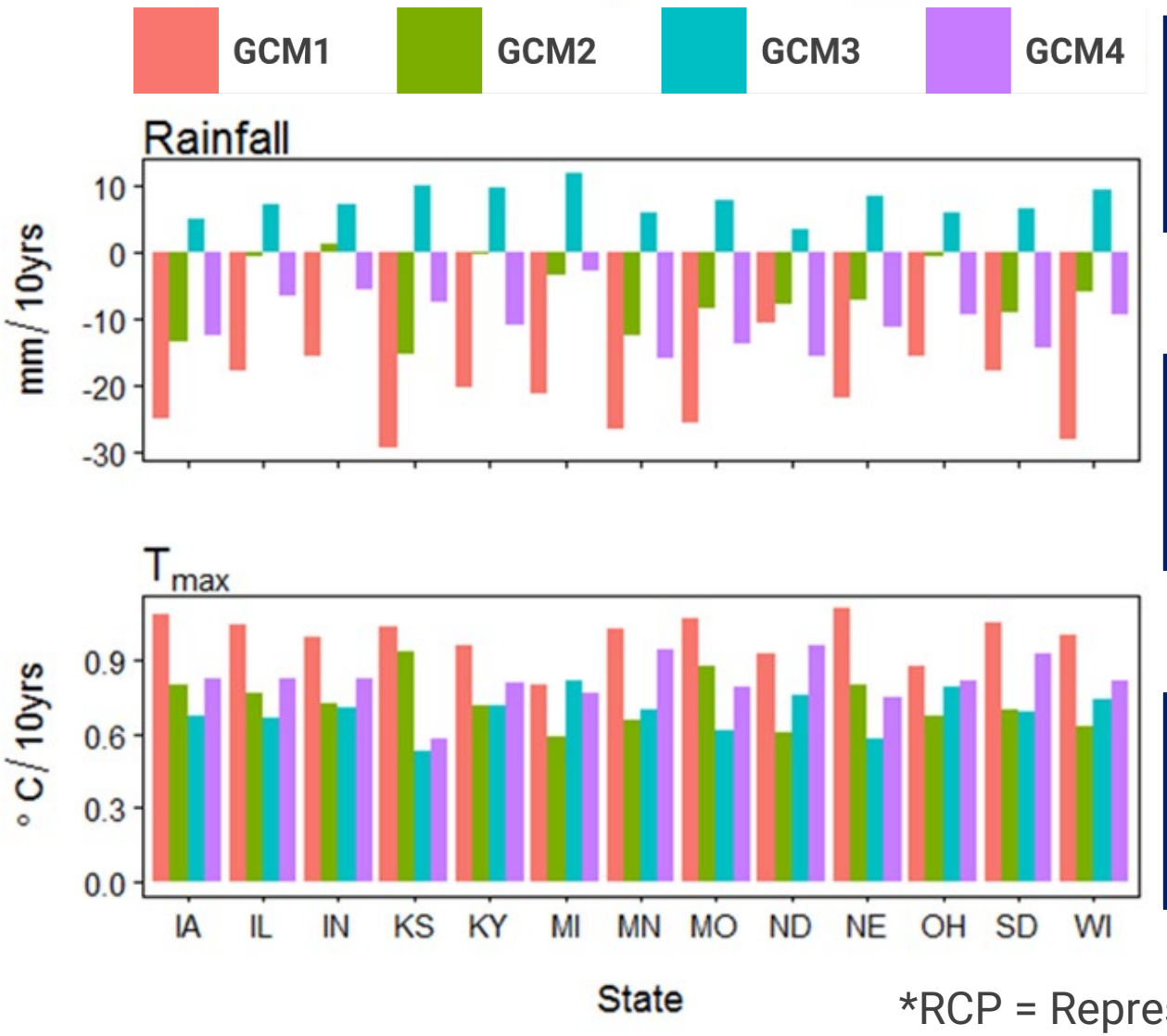
Future experiment: corn yields under projected climate in the 2050s



Future Experiment: How will future climate change impact yields?

GCM projected temperature and precipitation for both historical and future period. RCP* 8.5 Scenario

Use process-based model to simulate corn yields at end of 20th century (1991-2000) and mid 21st century (2046-2055)

*RCP = Representative Concentration Pathway

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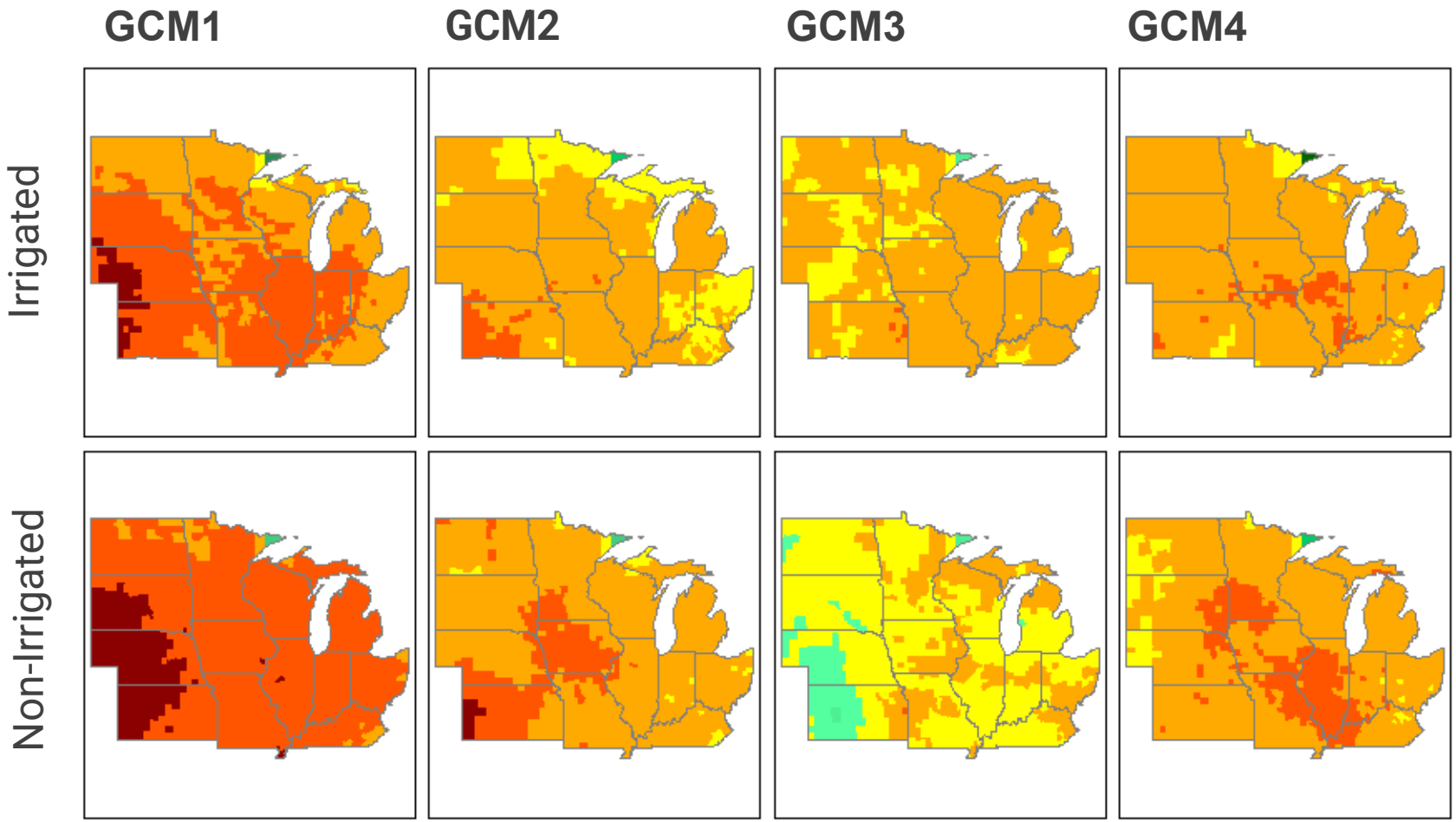
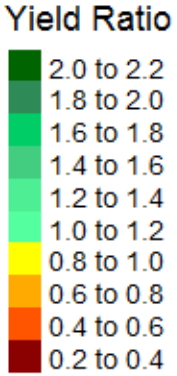
Modeled county-scale yields in 2050s are significantly lower compared to the 1990s





Yield ratio

$$\frac{\text{yield 2046–2055}}{\text{yield 1991–2000}}$$

Crop genetics held at 2019 levels; only variable is weather

Irrigated – top
Non-Irrigated – bottom

Average decline per °C of warming

Irrigated: 6.5 %; Non-Irrigated: 7.1%

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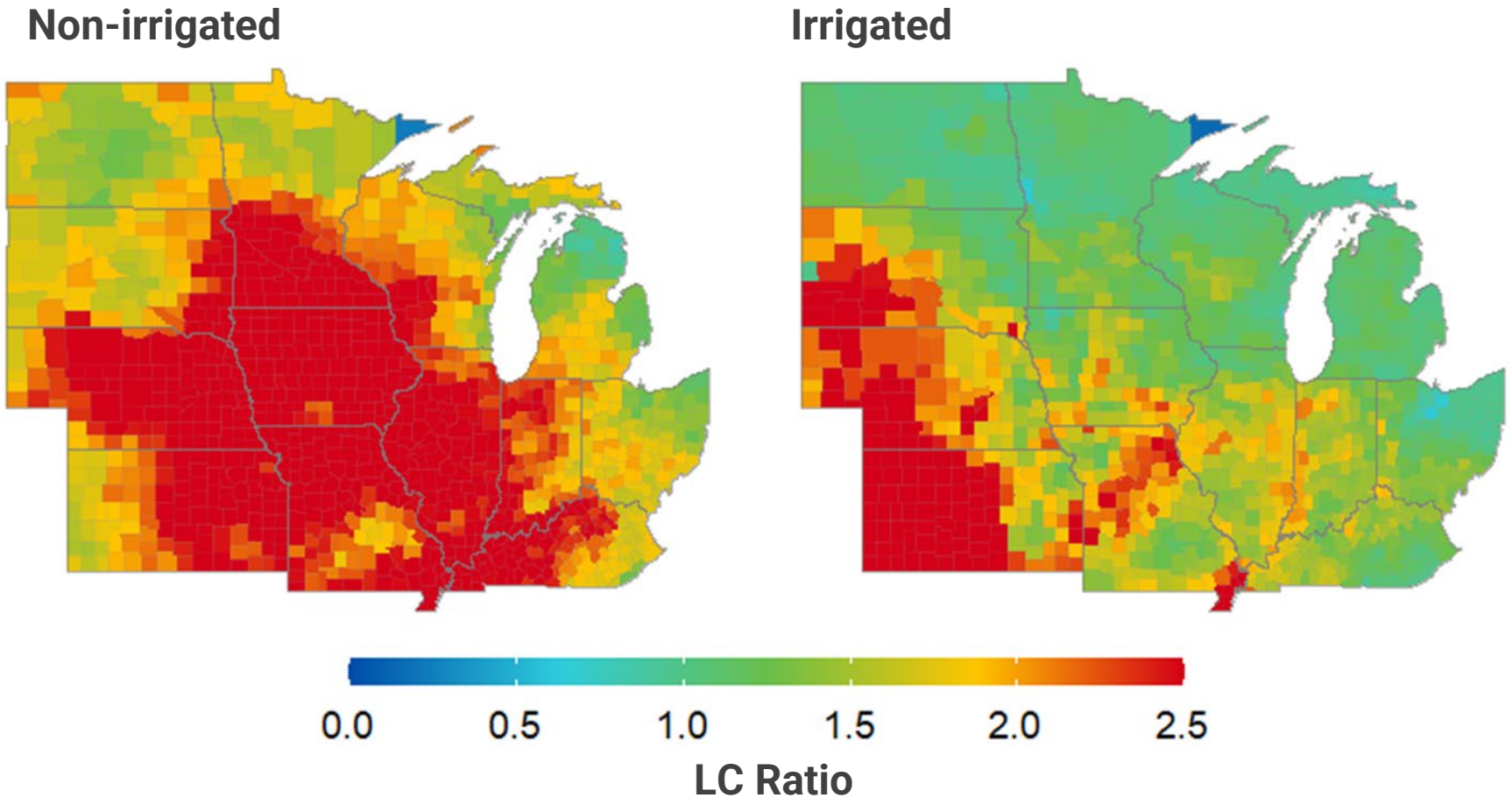
Increased loss costs under projected climate

More interannual variability in yields

More “bad” or below-normal yield years

Greater losses

$$\text{LC ratio} = \frac{\text{Average Loss Cost 2050's}}{\text{Average Loss Cost 1990's}}$$



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Summary

Science of climate change is complex and there are still uncertainties about the impact of climate change on different perils/regions

Incorporating the science into catastrophe models requires extensive knowledge of climate change and modeling expertise

Insurers and reinsurer need to consider a wide range of outcomes for different climate scenarios and timelines

There are many climate change solutions on the market, and it’s crucial for the insurers to understand the methodologies used to build these solutions

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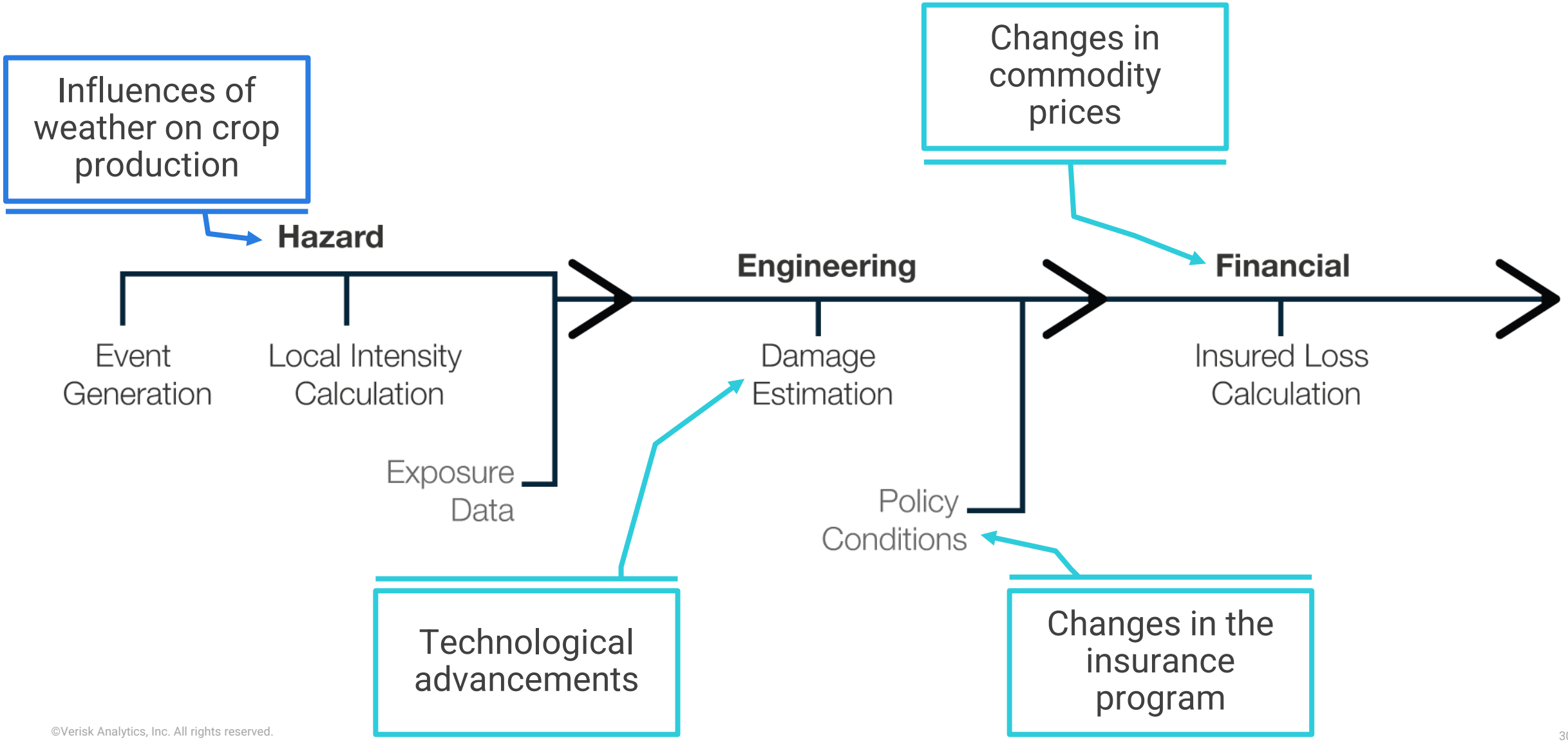
Extreme event modeling framework



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Thank You

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