CLIMATE CHANGE AND CATASTROPHE MODELING

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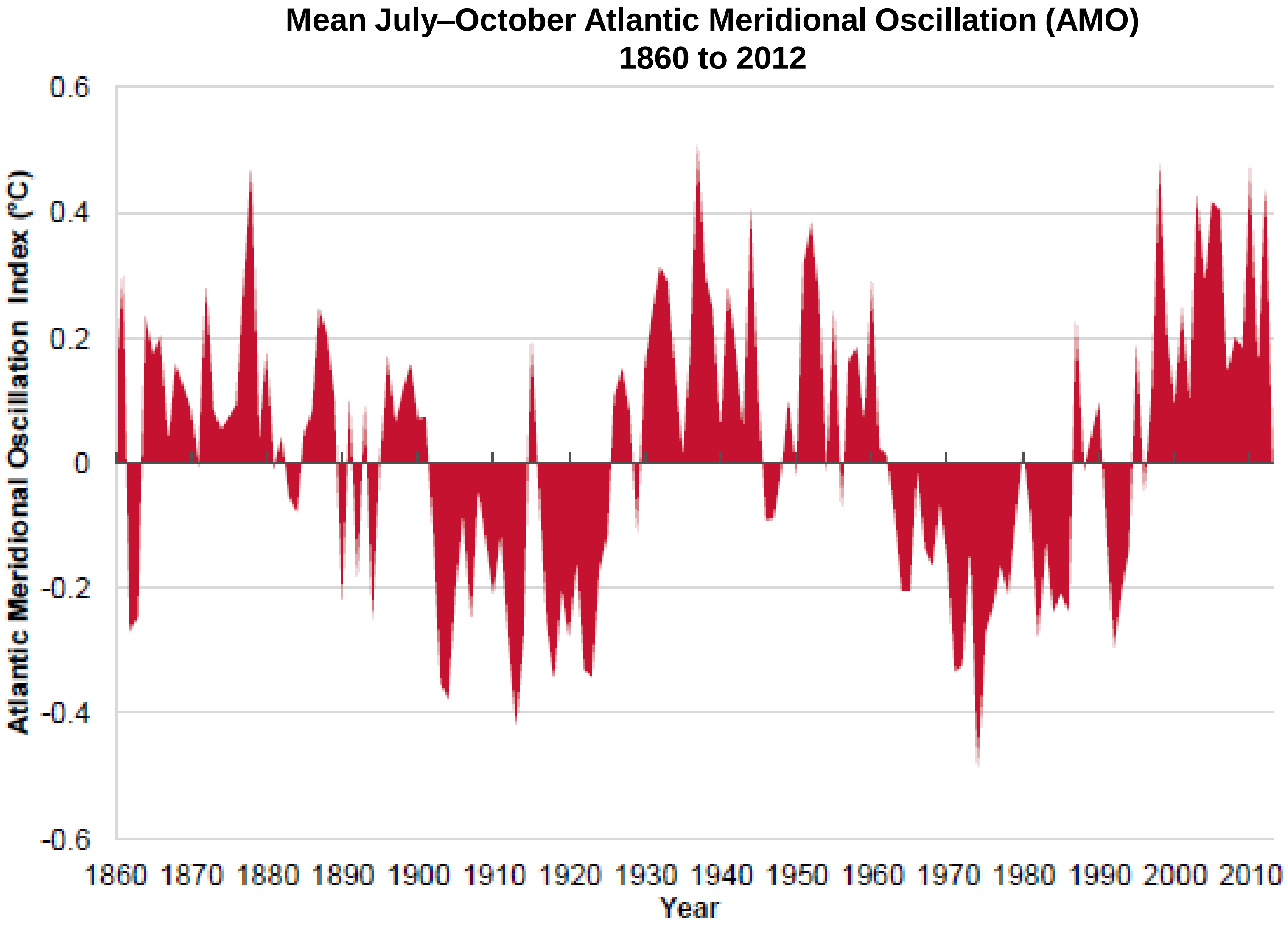
PURPOSE OF CATASTROPHE MODELS

RMS REGULARLY ASSESSES THE STATE OF THE CLIMATE AND THE POSSIBLE RELEVANCE TO OUR MODELS

- Goal is to ensure catastrophe models reflect the latest science, data, and methods on the underlying risk

- In cases where climate variability or change has impacted the risk landscape, RMS provides the necessary tools to better quantify those impacts
  - Alternative views of risk
  - Adjustments to the RMS reference view
  - Additional sensitivity tests and diagnostics



FACTORS THAT ARE CONSIDERED WHEN BUILDING CATASTROPHE MODELS

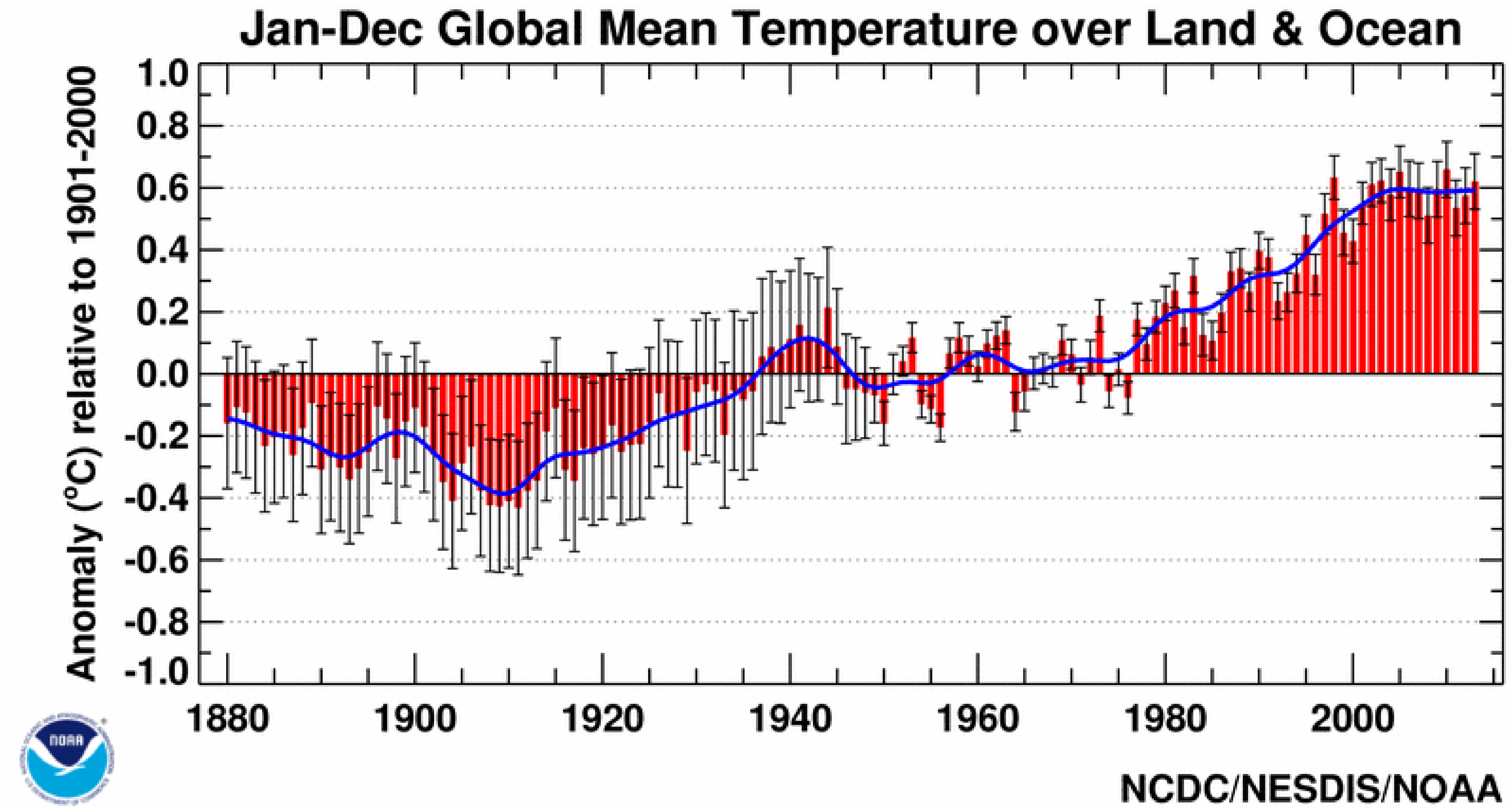
CLIMATE VARIABILITY AND CLIMATE CHANGE TO-DATE

Noticeable for some variables

- Global temperatures
- Sea-level

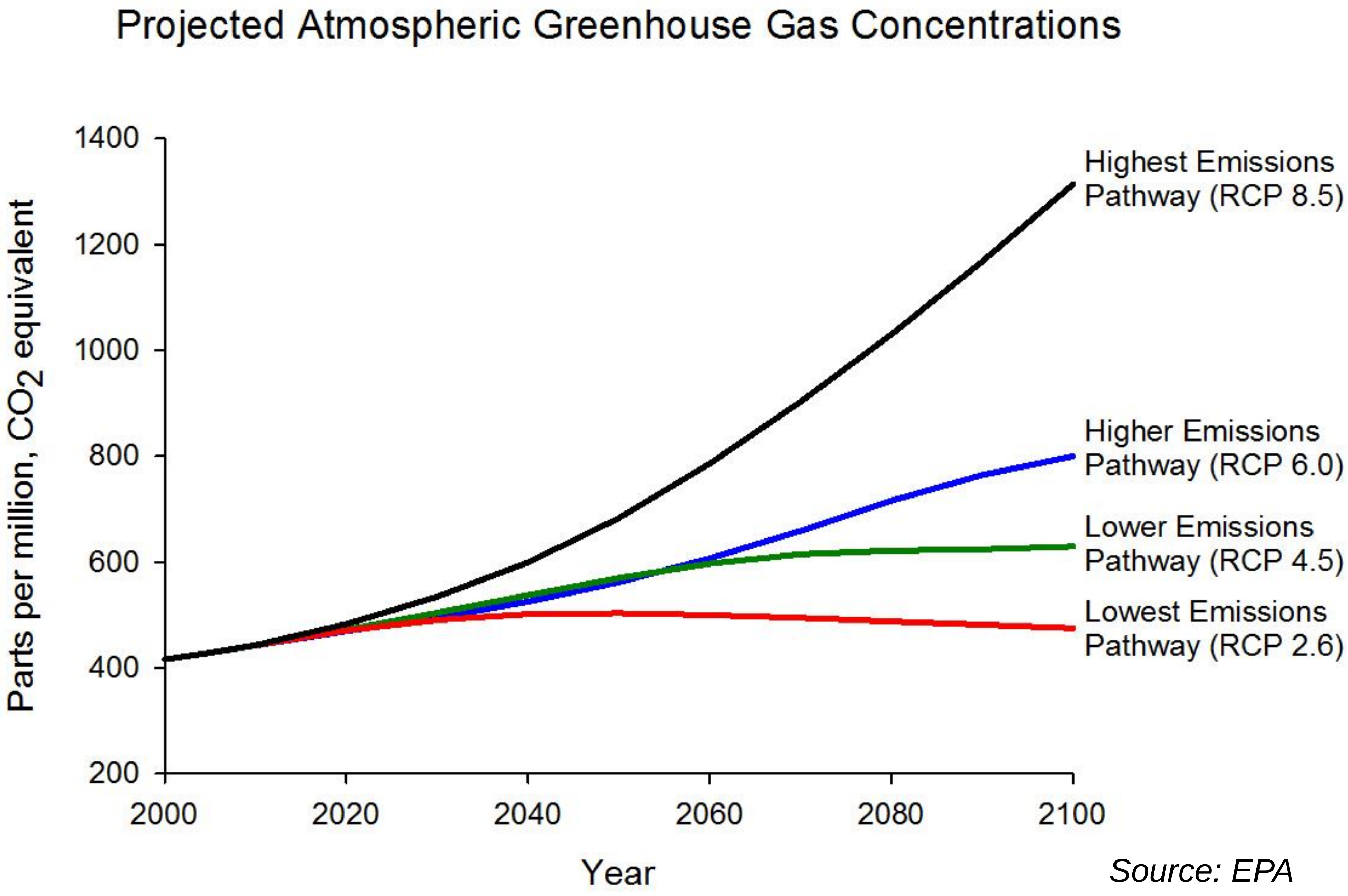
For others, it's more difficult to separate the signal between climate change and natural variability

Evidence of climate change that is sufficiently predictable over the next 1-5 years



FUTURE IMPACTS OF CLIMATE CHANGE OVER THE NEXT 1-5 YEARS

Often not incorporated because climate change takes place on time scales that are longer than those of interest to the (re)insurance industry (1-5 years)



Source: EPA

HOW AND WHERE DO WE OBTAIN THIS INFORMATION?

IPCC
INTERGOVERNMENTAL PANEL ON climate change

Risk Prediction Initiative
Connecting Science and (Re)Insurance

AGU PUBLICATIONS

Geophysical Research Letters

RESEARCH LETTER
10.1002/2015GL063652

The frequency and duration of U.S. hurricane droughts

Timothy Hall[1] and Kelly Hereid[2]

[1]NASA Goddard Institute for Space Studies, New York, New York, USA, [2]ACE Tempest Re, Stamford, Connecticut, USA

Key Points:
- Nine years without major U.S. hurricane landfall is a record
- The average wait time for 9 year major hurricane droughts is 177 years
- The 9 year drought is even more unusual within the recent active period

Abstract As of the end of the 2014 hurricane season, the U.S. has experienced no major hurricane landfall since Hurricane Wilma in 2005, a drought that currently stands at 9 years. Here we use a stochastic tropical cyclone model to calculate the mean waiting time for multiyear landfall droughts. We estimate that the mean time to wait for a 9 year drought is 177 years. We also find that the average probability of ending the drought with a major landfall in the next year is 0.39 and is independent of the drought duration, as one would expect for a Bernoulli process.

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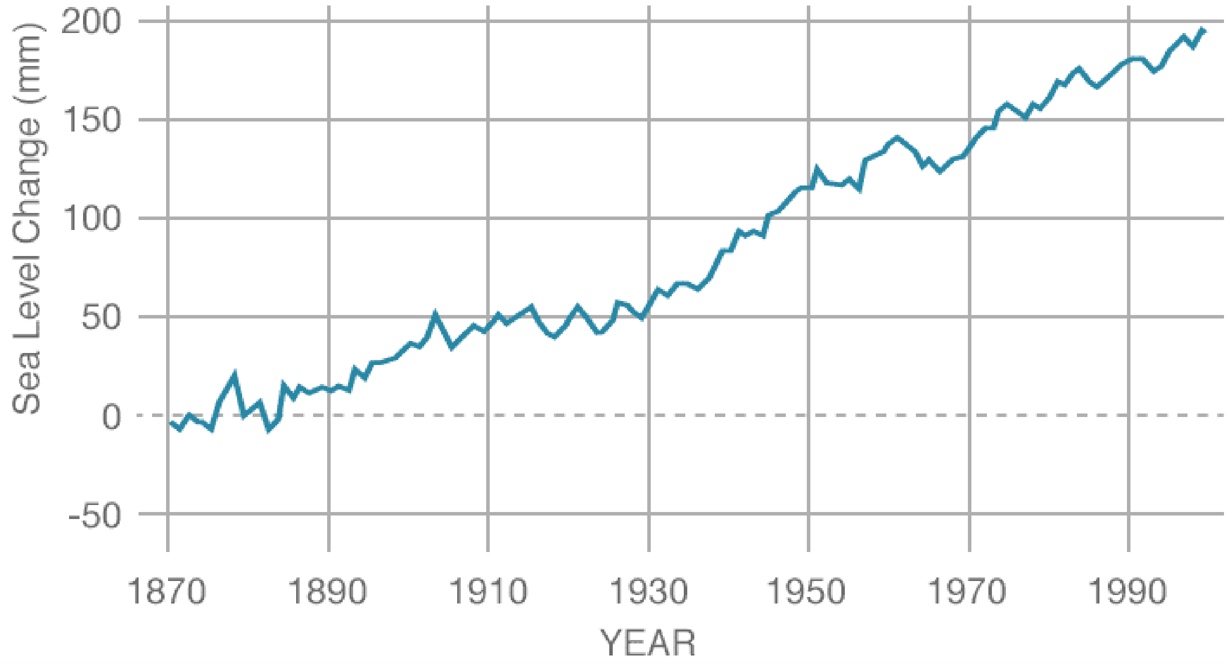
EXAMPLES OF HOW RMS INCORPORATES CLIMATE VARIABILITY AND CLIMATE CHANGE INTO CATASTROPHE MODELS

ADJUSTMENTS TO REFERENCE VIEWS OF RISK

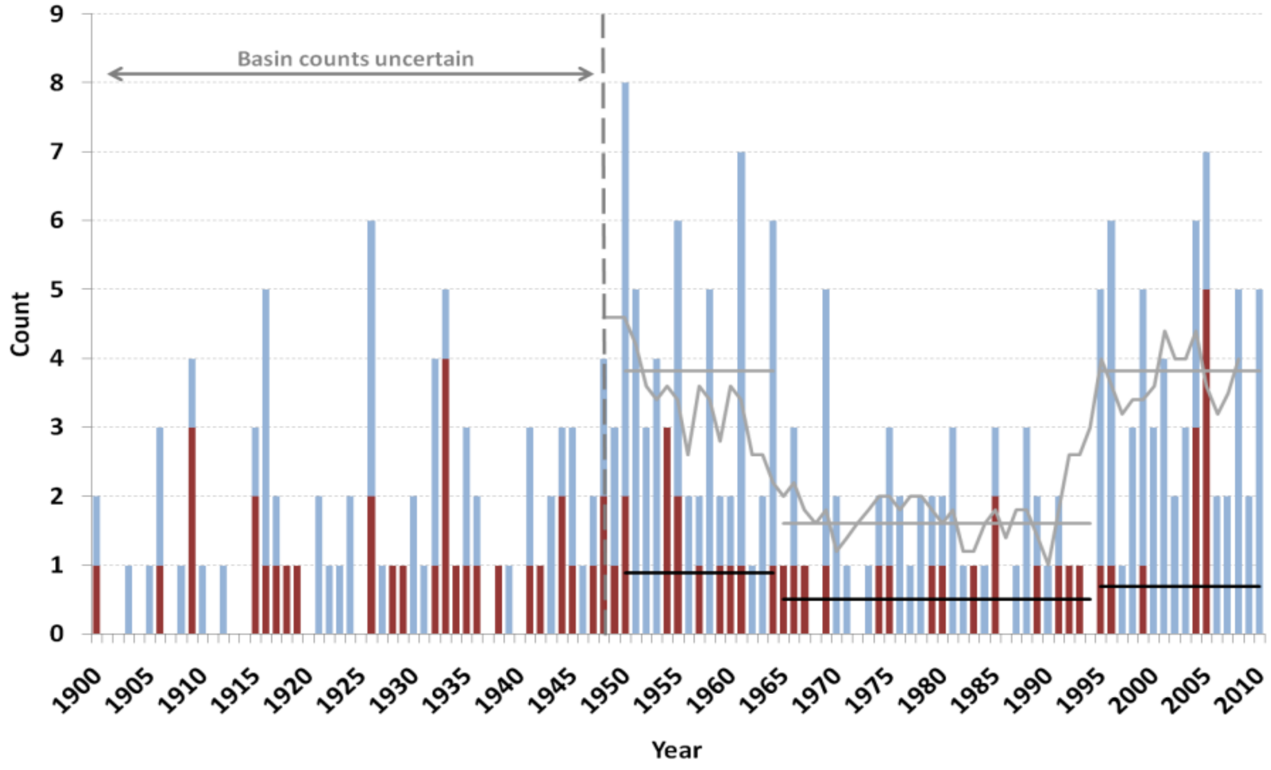
Sea-level rise in the context of storm surge risk

Hurricanes and decadal variability



Sea-level rise: 1870-2000

Source: Coastal tide gauge records, CSIRO



U.S. landfalling hurricanes since 1900

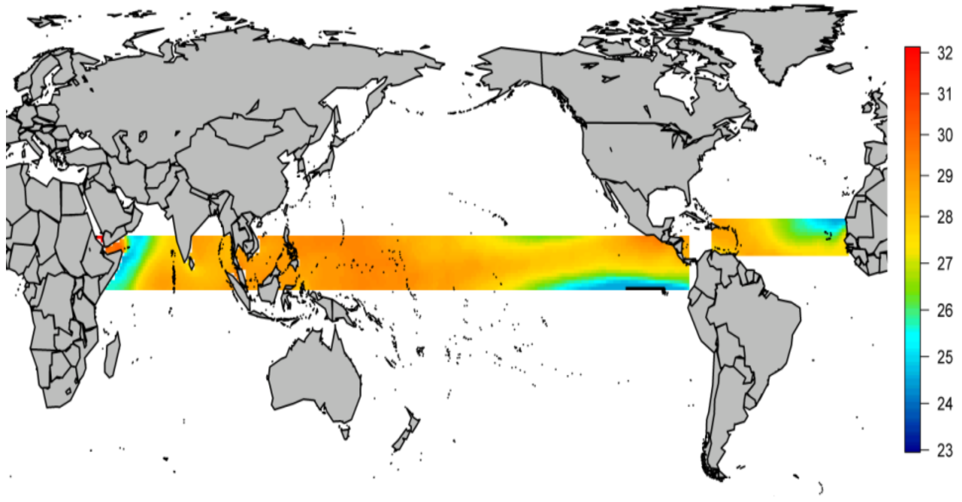
Major hurricane (category 3-5) frequency (blue) and U.S. landfalls (red)

Source: NOAA

ALTERNATIVE VIEWS OF RISK

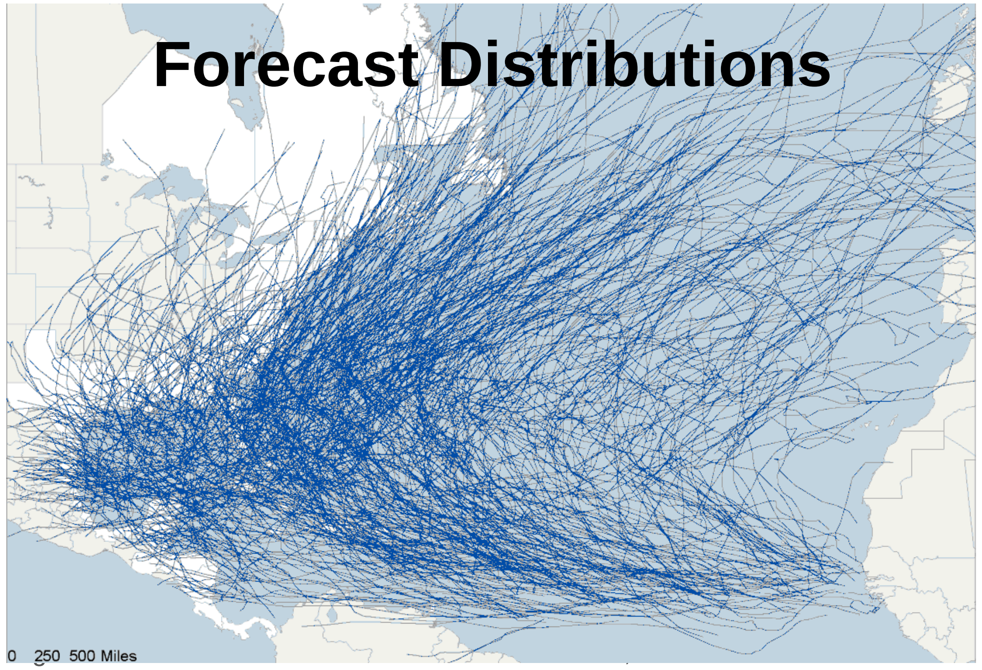
North Atlantic Hurricane Medium-Term Rates

Forecast Predictors

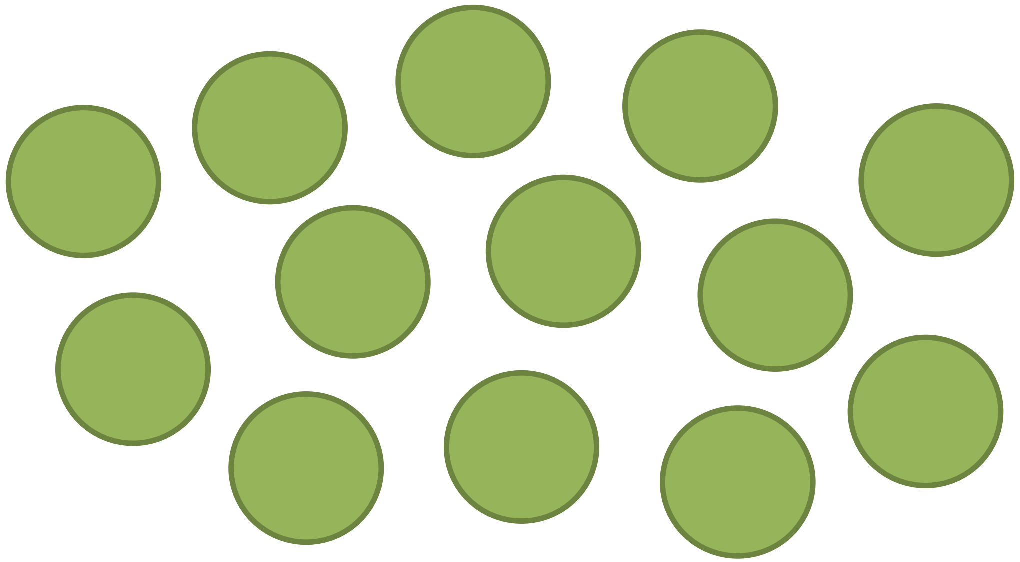


Sea Surface Temperatures

Forecast Distributions



Forecast U.S. Landfalls



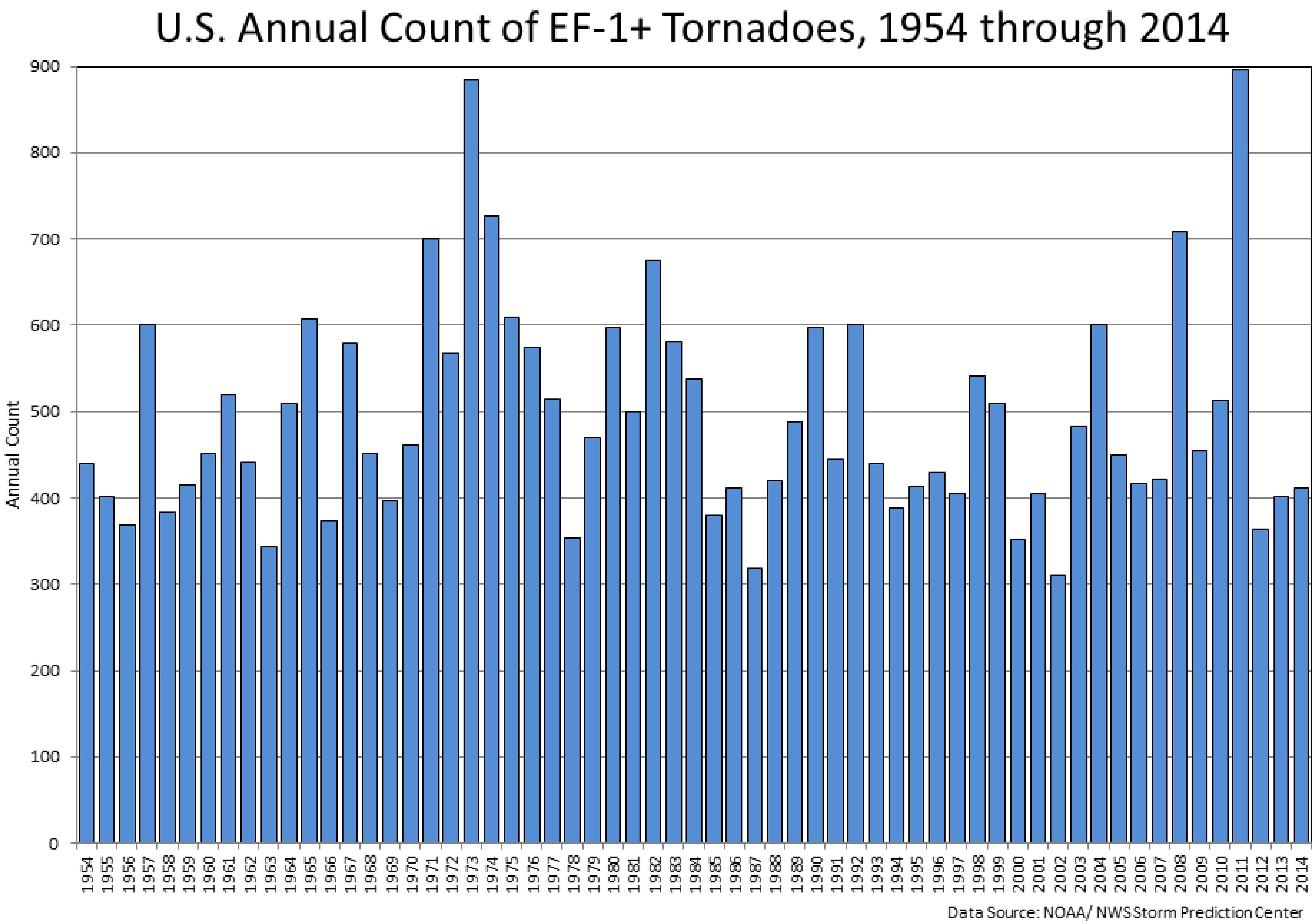
13 statistical models to make probabilistic forecasts of the number of landfalling Atlantic hurricanes

Take a weighted average to get a 5-year probabilistic forecast of Atlantic basin landfall rates

UNADJUSTED REFERENCE VIEWS OF RISK

Lack of scientific consensus on the causes and subsequent impacts – both historical and forward-looking

- European Flood
- Severe Convective Storm

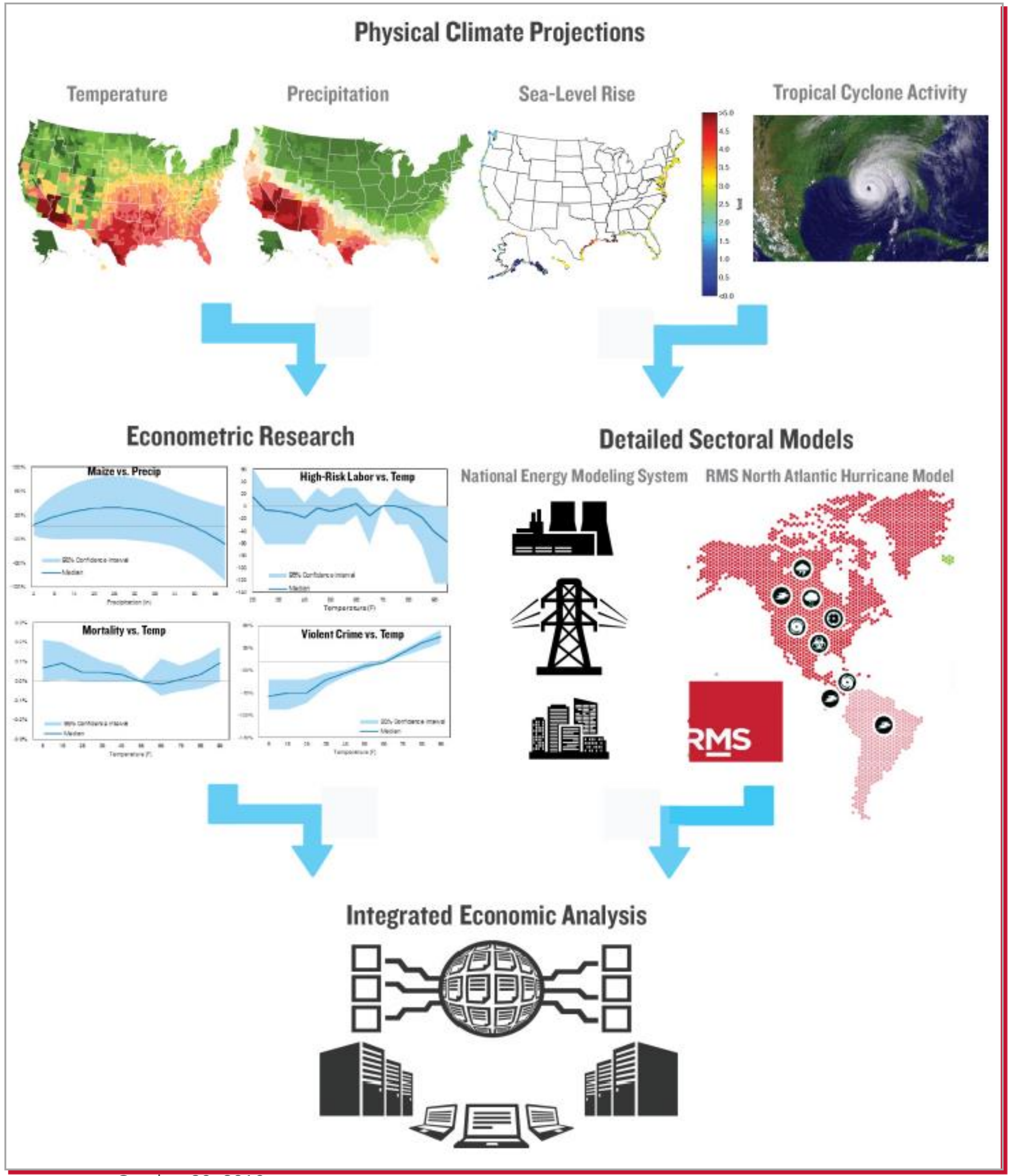


RESEARCH EFFORTS TO BETTER UNDERSTAND IMPACTS OF CLIMATE CHANGE


RISKY BUSINESS
The Economic Risks of Climate Change in the United States
A CLIMATE RISK ASSESSMENT
FOR THE UNITED STATES

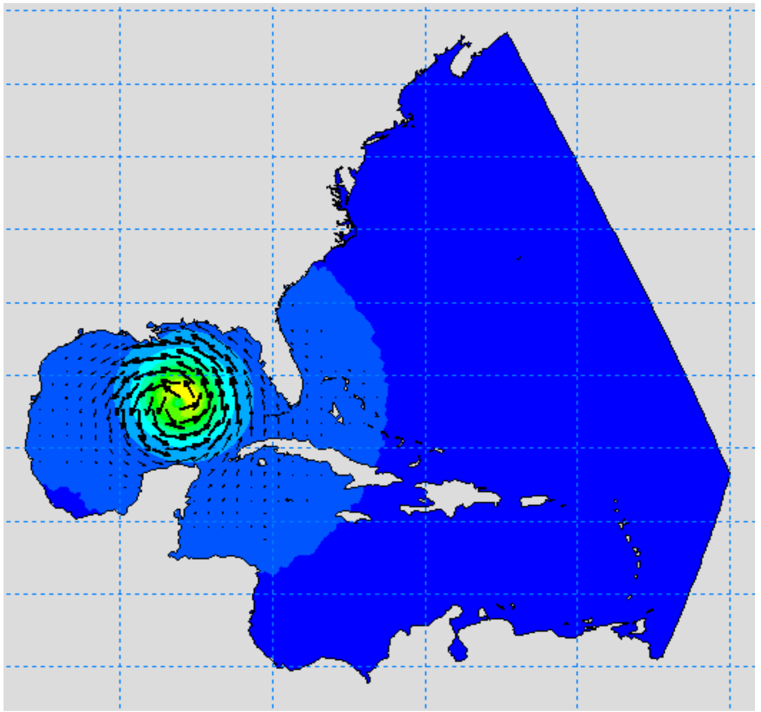
A climate risk assessment

“We aim to provide decision makers in business and government with the facts about economic risks and opportunities climate change poses in the U.S.”

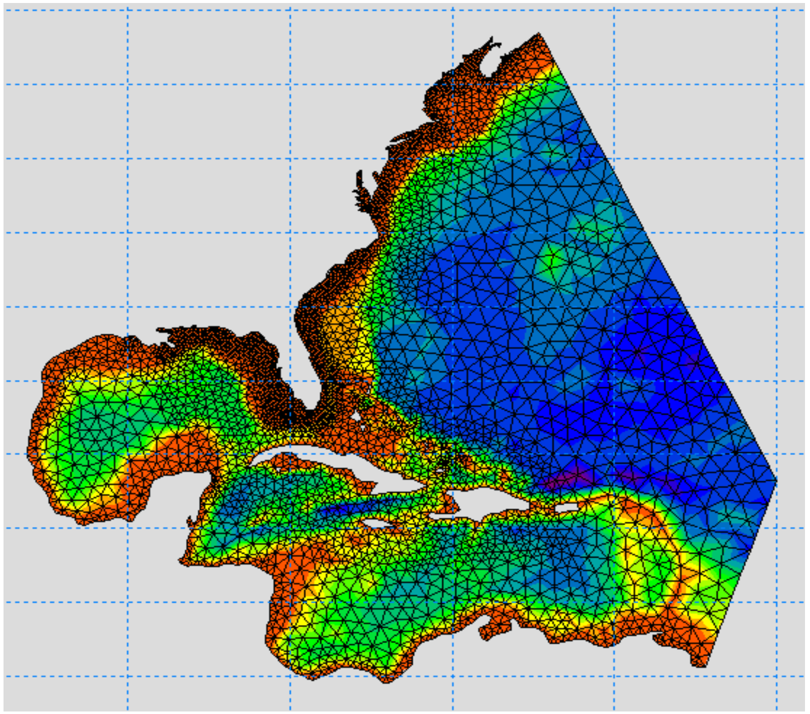


RMS MODELING PART 1 – STORM SURGE

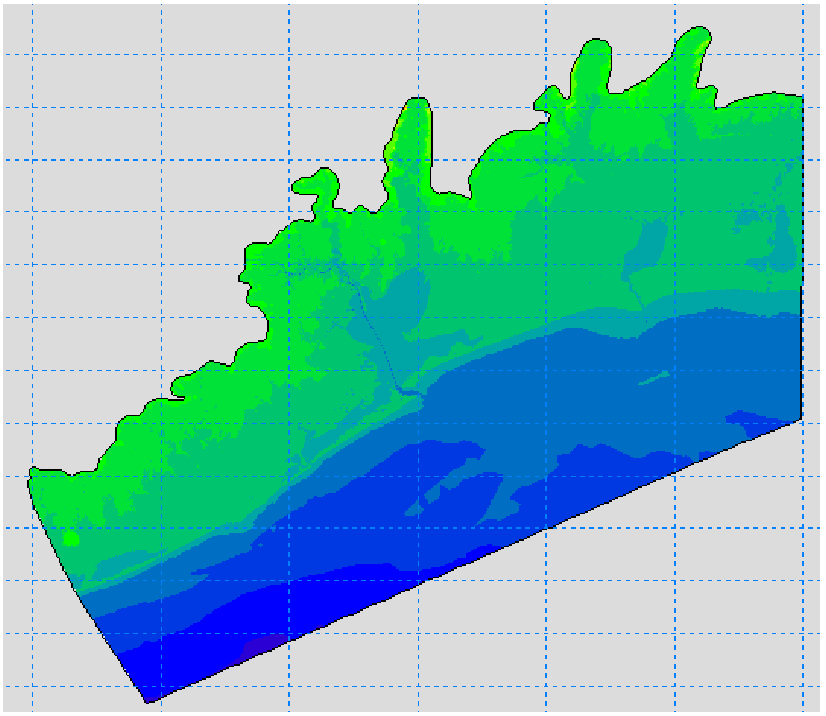
Wind and Pressure Fields



Regional Surge Mesh



Houston Local Mesh

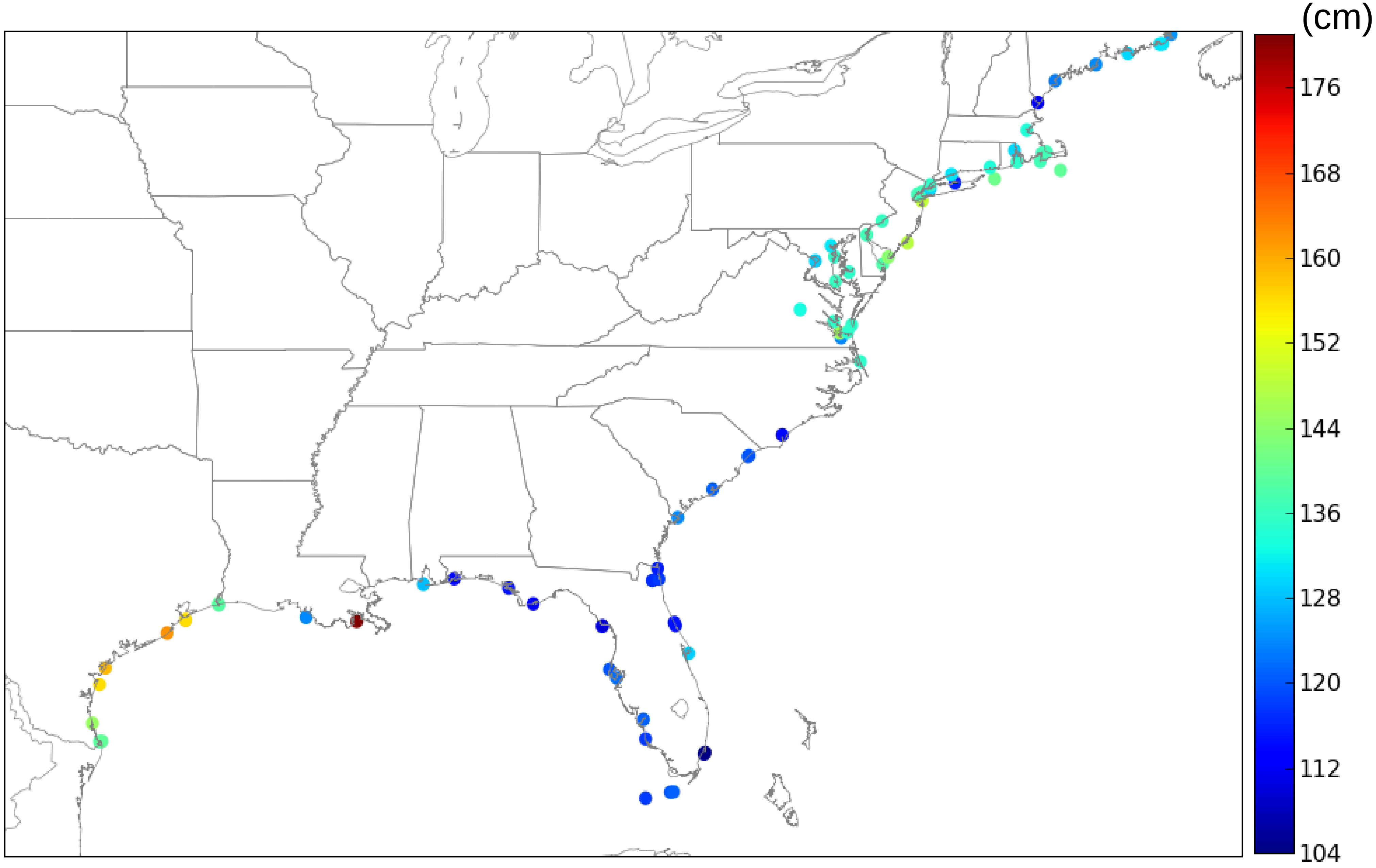


- Time-stepping wind and pressure fields based on present-day sea-levels and tides
- Water levels obtained using a hydrodynamic numerical model in a large scale regional mesh and 18 high-resolution local meshes

PROJECTED SEA-LEVEL RISE AT U.S. TIDAL GAUGES

RMS surge model informed with regional sea-level rise projections to determine impacts of climate change on coastal flood risk

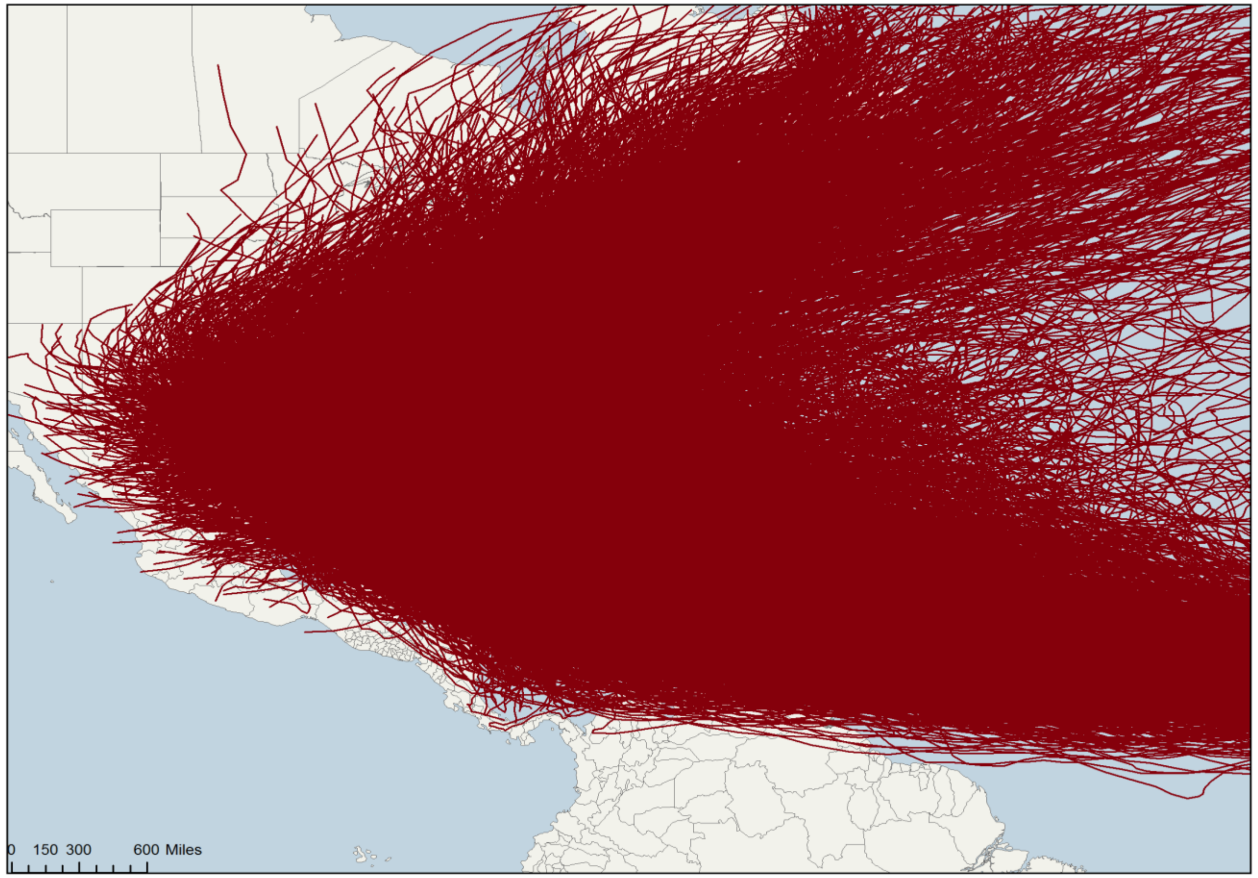
Sea-level rise across 79 gauges within the RMS North Atlantic Hurricane surge model domain



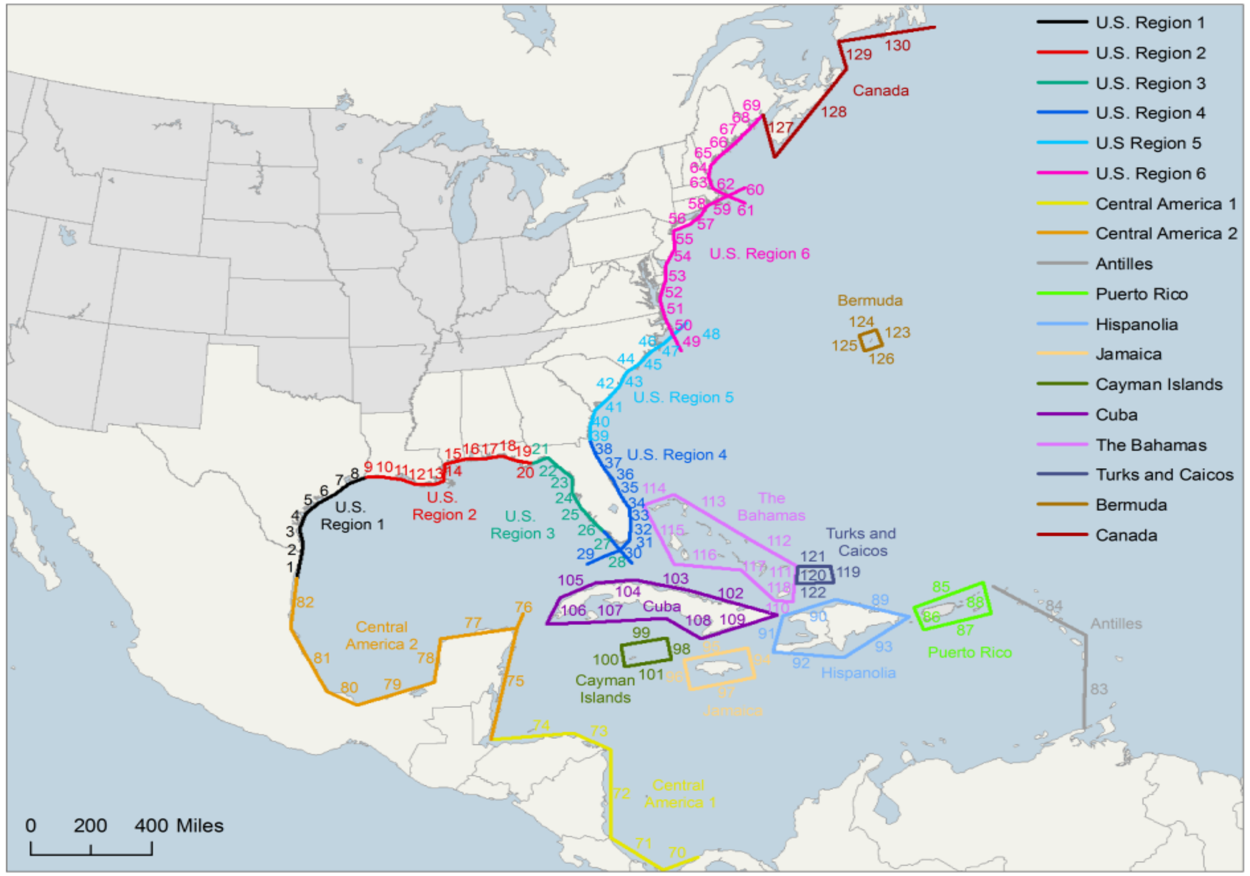
Source: Kopp et al. (2014), Risky Business

RMS MODELING PART 2 – HURRICANE ACTIVITY RATES

Subset of 5000 Storms within RMS U.S. Hurricane Stochastic Track Set



RMS U.S. Hurricane Landfall Gates

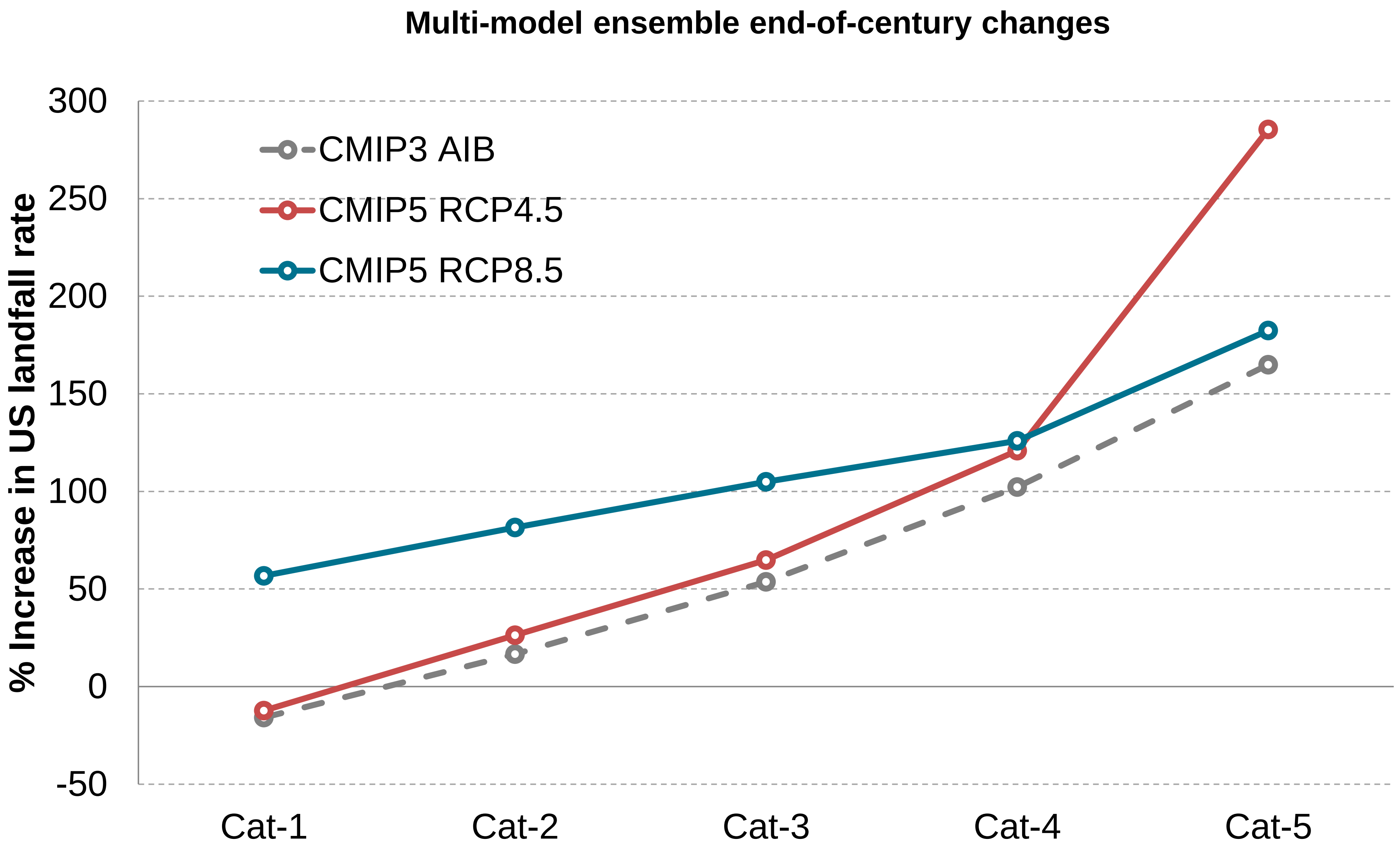


- Stochastic track model that produces many more storms than seen in history
- Simulates genesis, central pressure, velocity, path, landfall and dissipation of tens of thousands of hypothetical events, based on characteristics seen in history

PROJECTED CHANGES IN HURRICANE RATES

RMS stochastic track model informed with projected changes in hurricane rates to determine impacts of climate change on overall hurricane landfall frequency and intensity

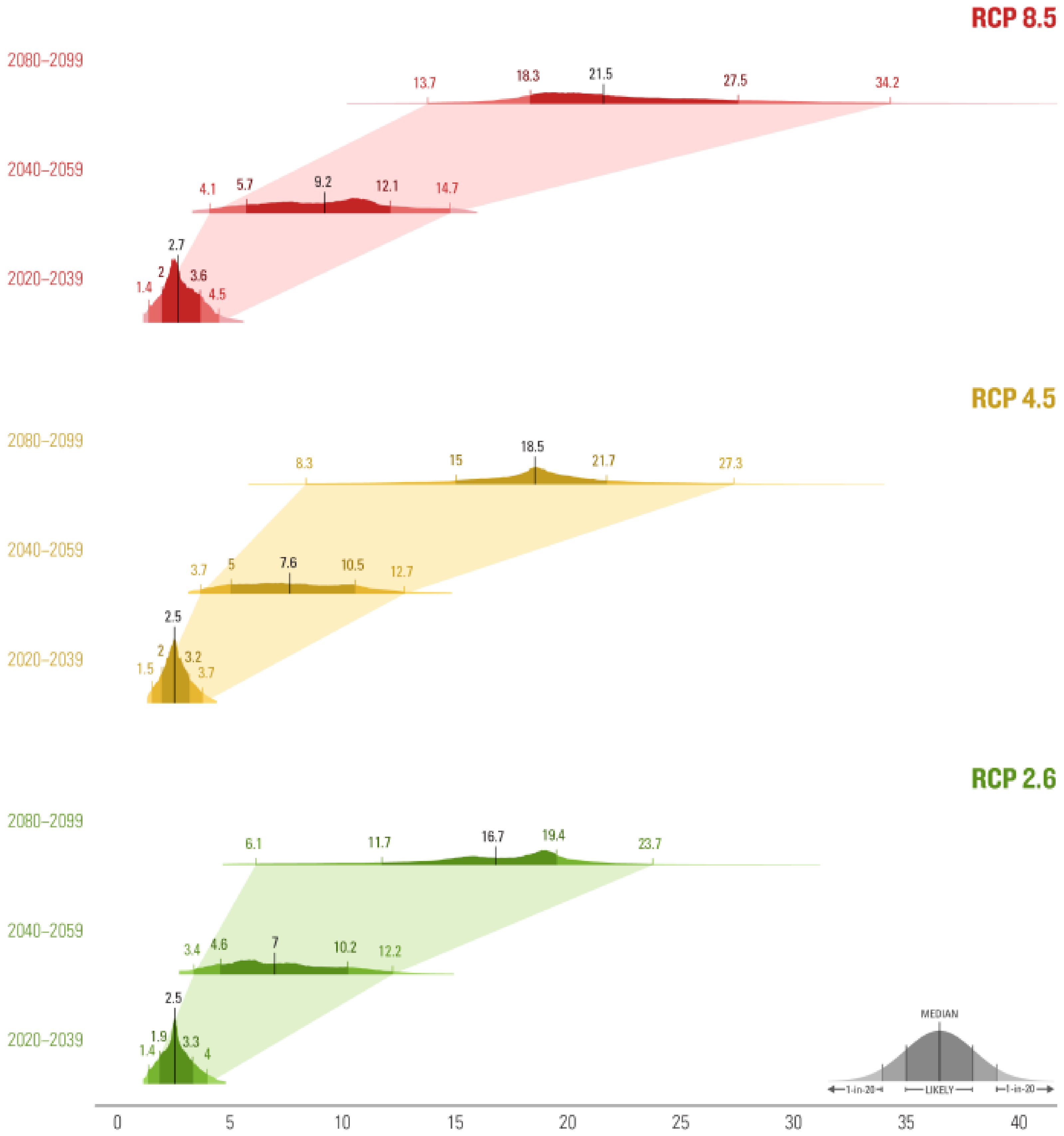
Projected percentage changes in hurricane rates (by intensity) mapped to the RMS stochastic event set



CMIP3 A1B & CMIP5 RCP4.5 following Knutson et al. (2013)
CMIP5 RCP8.5 following Emanuel et al. (2013)

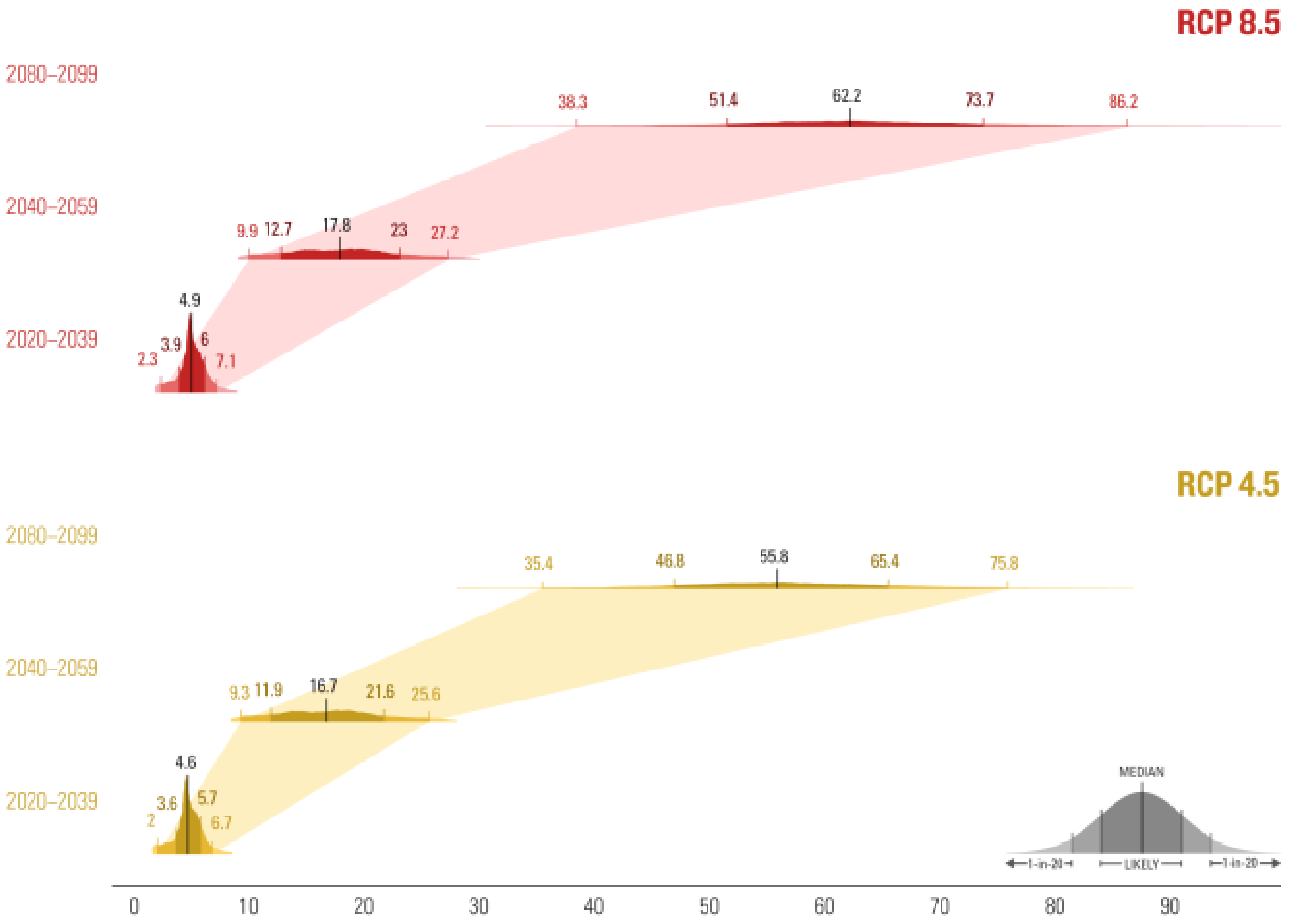
Increase in annual losses from hurricanes and storm surge from sea-level rise alone

Assuming historical frequency and intensity of storms



Increase in annual losses from hurricanes and storm surge from sea-level rise

Including projected changes in the frequency and intensity of storms



RISKY BUSINESS – KEY FINDINGS

- Within the next 15 years, higher sea levels combined with storm surge will likely increase average annual cost of coastal storms…by $2-3.5 billion
- Adding in potential change in hurricane activity, the likely increase grows to $7.3 billion, bringing the total annual price tag for hurricanes and other coastal storms to $35 billion
- If we continue on our current path, by 2050 between $66 billion and $106 billion worth of existing coastal property will likely be below sea-level nationwide
- There is a 1-in-20 chance that by the end of the century, more than $701 billion worth of existing coastal property will be below mean sea level, with more than $730 billion of additional property at risk during high tides

SUMMARY AND CONCLUSIONS

- RMS regularly assesses the state of understanding climate variability and change, and its possible relevance in RMS models
  - Monitoring the latest data and scientific literature
  - Participating in research initiatives with government organizations and other third parties

- Goal is to keep RMS models up-to-date and consistent with well-established science
  - Updating the reference view where it is clear that climate change has impacted the near-term risk landscape of that peril
  - Providing alternative views of risk where climate change may have a material impact, but a scientific consensus is still lacking

- RMS will continue to monitor the state of climate science and the potential impacts on the risk landscapes for all peril models, providing additional guidance and tools where warranted

ABOUT RMS

RMS is the world's leading provider of products, services, and expertise for the quantification and management of catastrophe risk. More than 400 leading insurers, reinsurers, trading companies, and other financial institutions rely on RMS models to quantify, manage, and transfer risk. As an established provider of risk modeling to companies across all market segments, RMS provides solutions that can be trusted as reliable benchmarks for strategic pricing, risk management, and risk transfer decisions.