Understanding the Impacts of Climate Change on Atmospheric Perils

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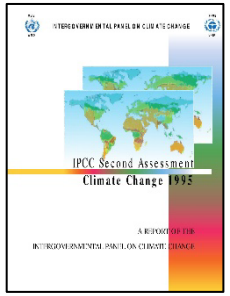
Scientific Understanding of Climate Change Summarized by the IPCC

First Assessment Report (FAR)

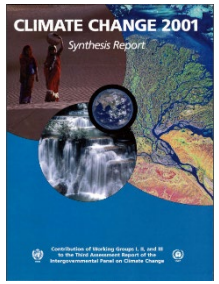
1990

Second Assessment Report (SAR)



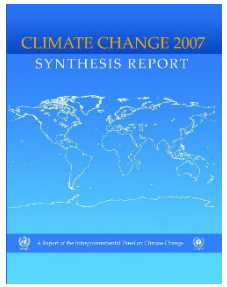
1995

Third Assessment Report (TAR)



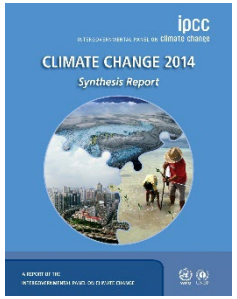
2001

Fourth Assessment Report (AR4)



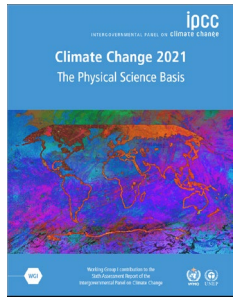
2007

Fifth Assessment Report (AR5)



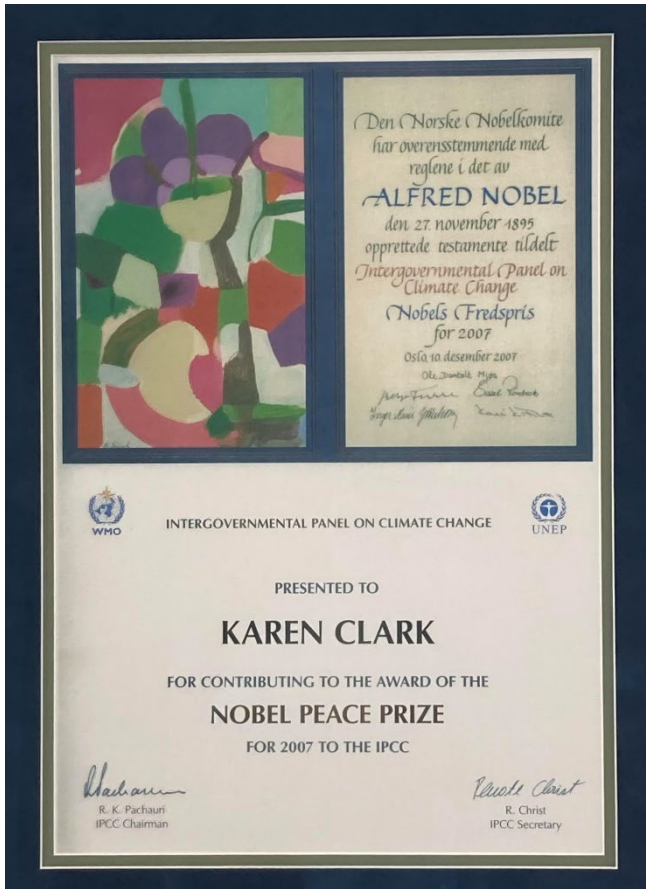
2014

2021



Sixth Assessment Report (AR6)

KCC Involvement with the IPCC



IPCC Assessment Report 5 (AR5)

1

Introduction

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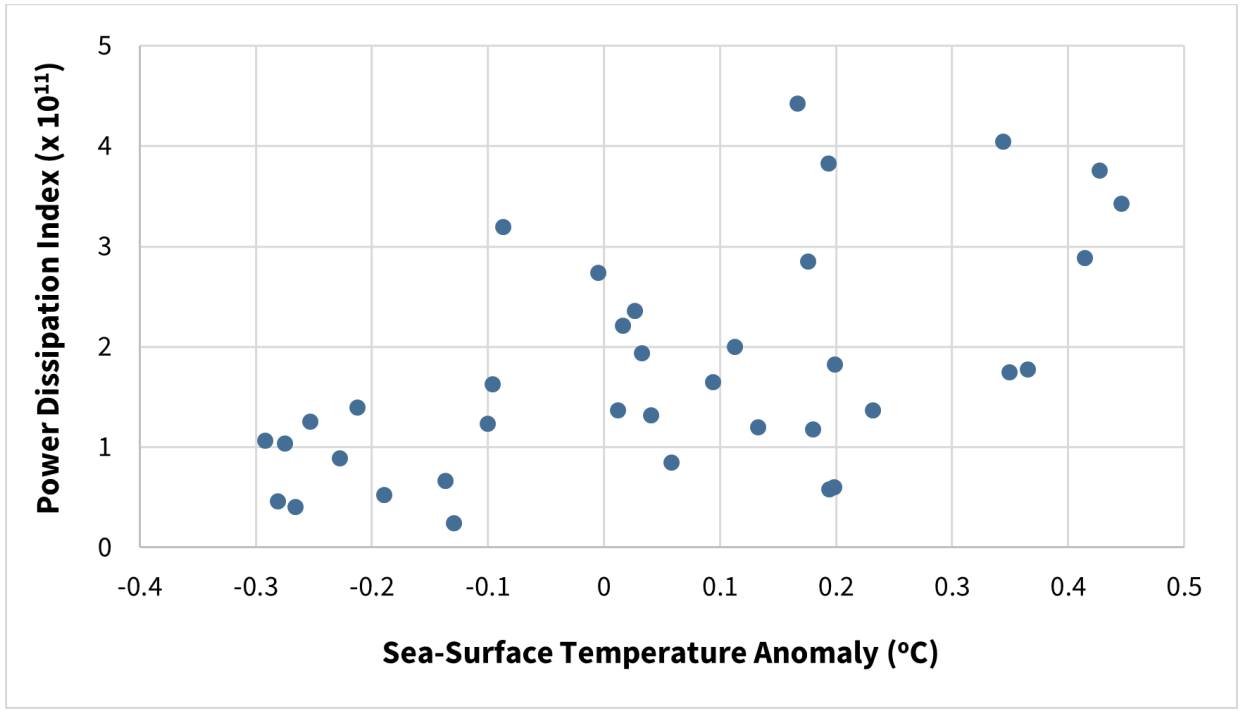
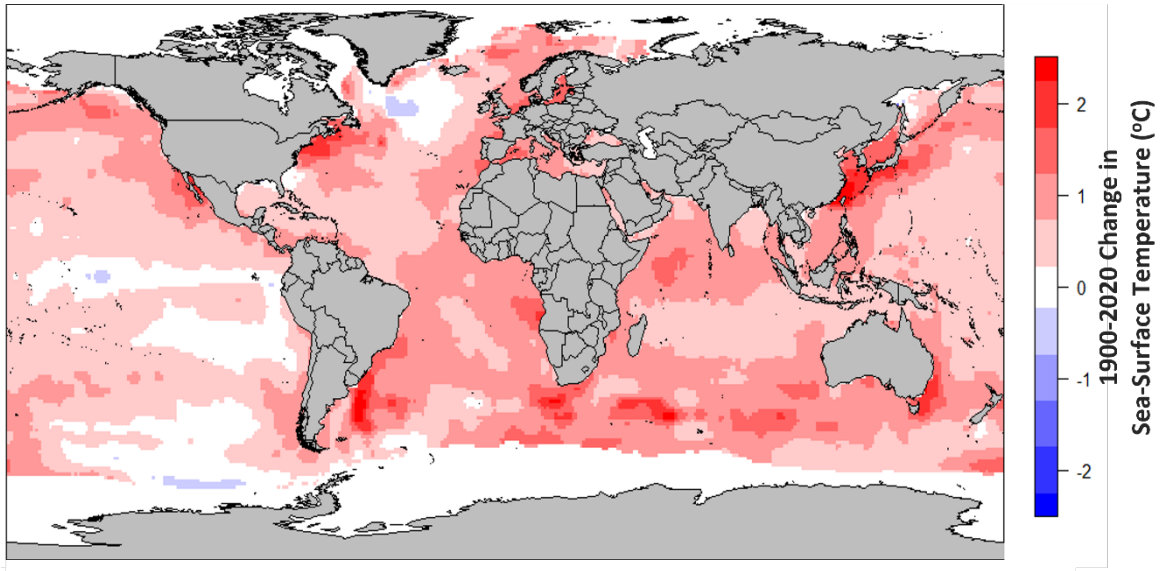
How are Atmospheric Perils Generally Expected to Change in the Future?

	Frequency	Severity	Confidence
Hurricane Wind Intensity	No change	Increase	High
Coastal Flooding	Increase	Increase	High
Wildfires*	Increase	Increase	High
Inland Flooding*	Increase	Increase	Medium
Winter Storms	Uncertain	Increase	Medium
Severe Convective Storms	Uncertain	Uncertain	Low

*Impacts of climate change on these hazards is highly region-dependent

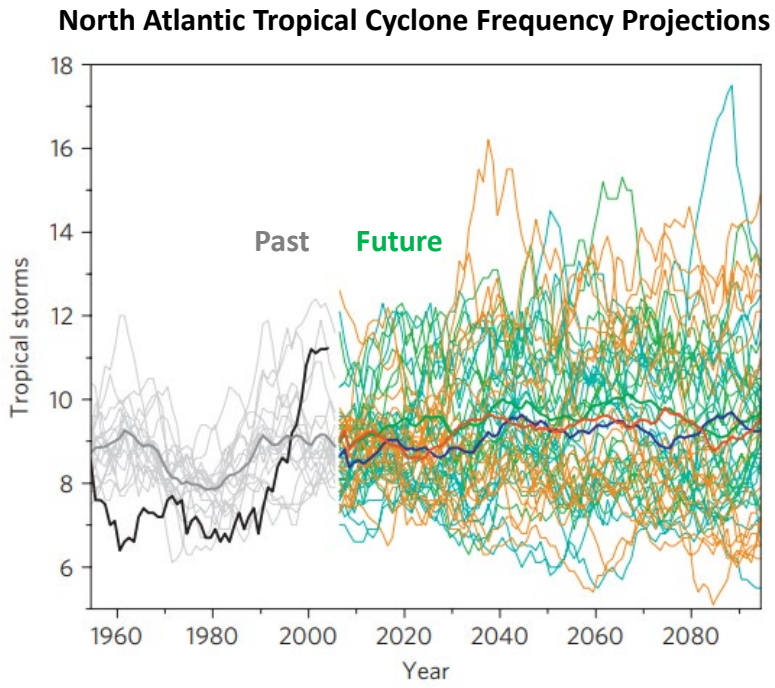
How Does Warming Influence Hurricanes?



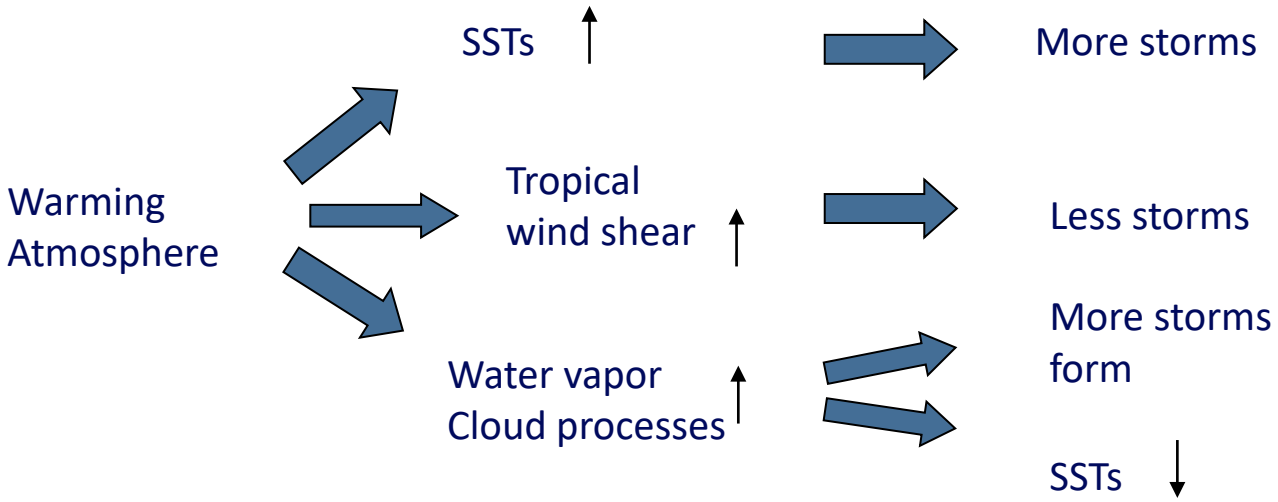


Projections of Tropical Cyclone Frequency Highly Uncertain

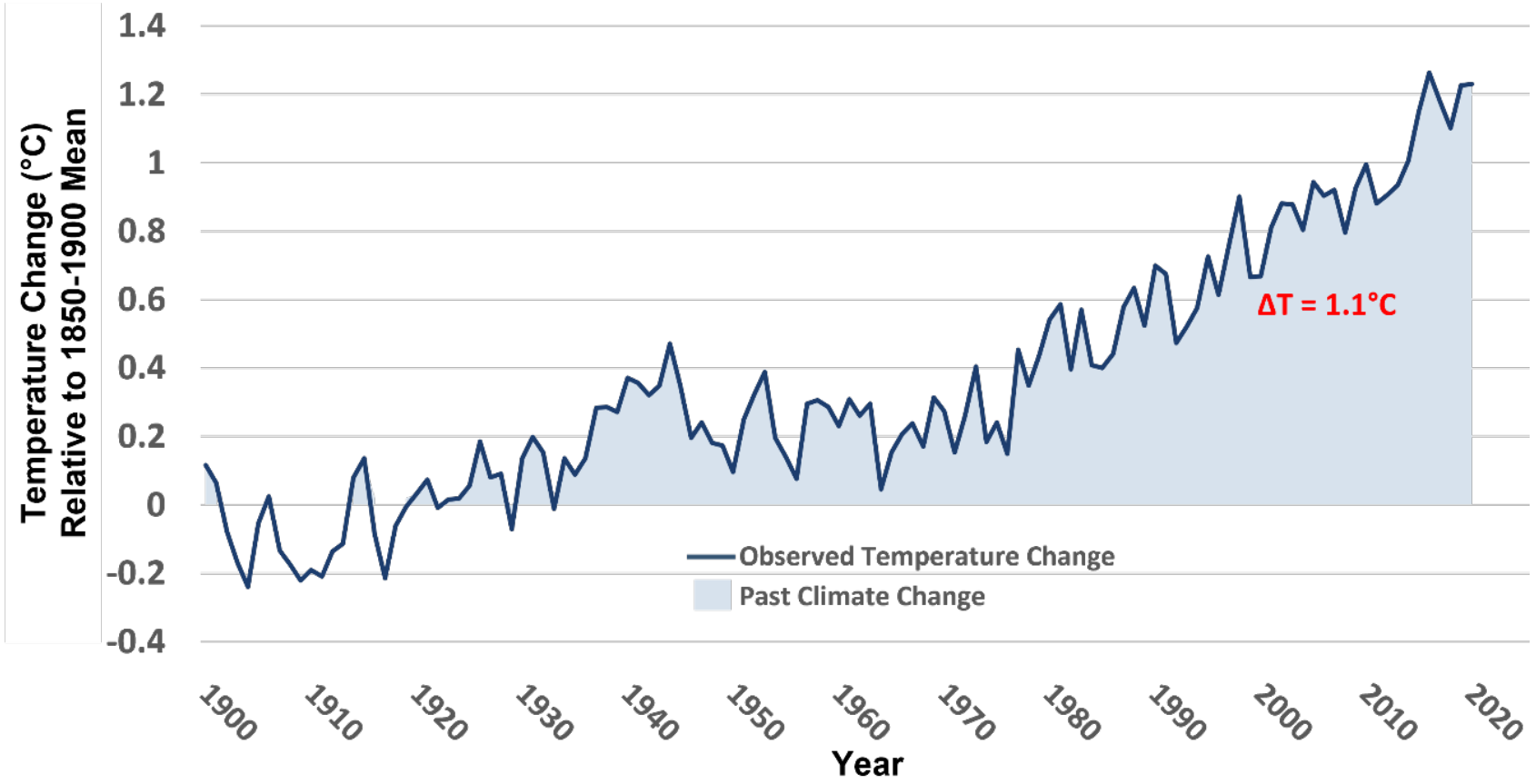
Global climate models disagree



Complex feedback mechanisms in atmosphere



Assessment of the Current Climate – How Much has Global Climate Changed?



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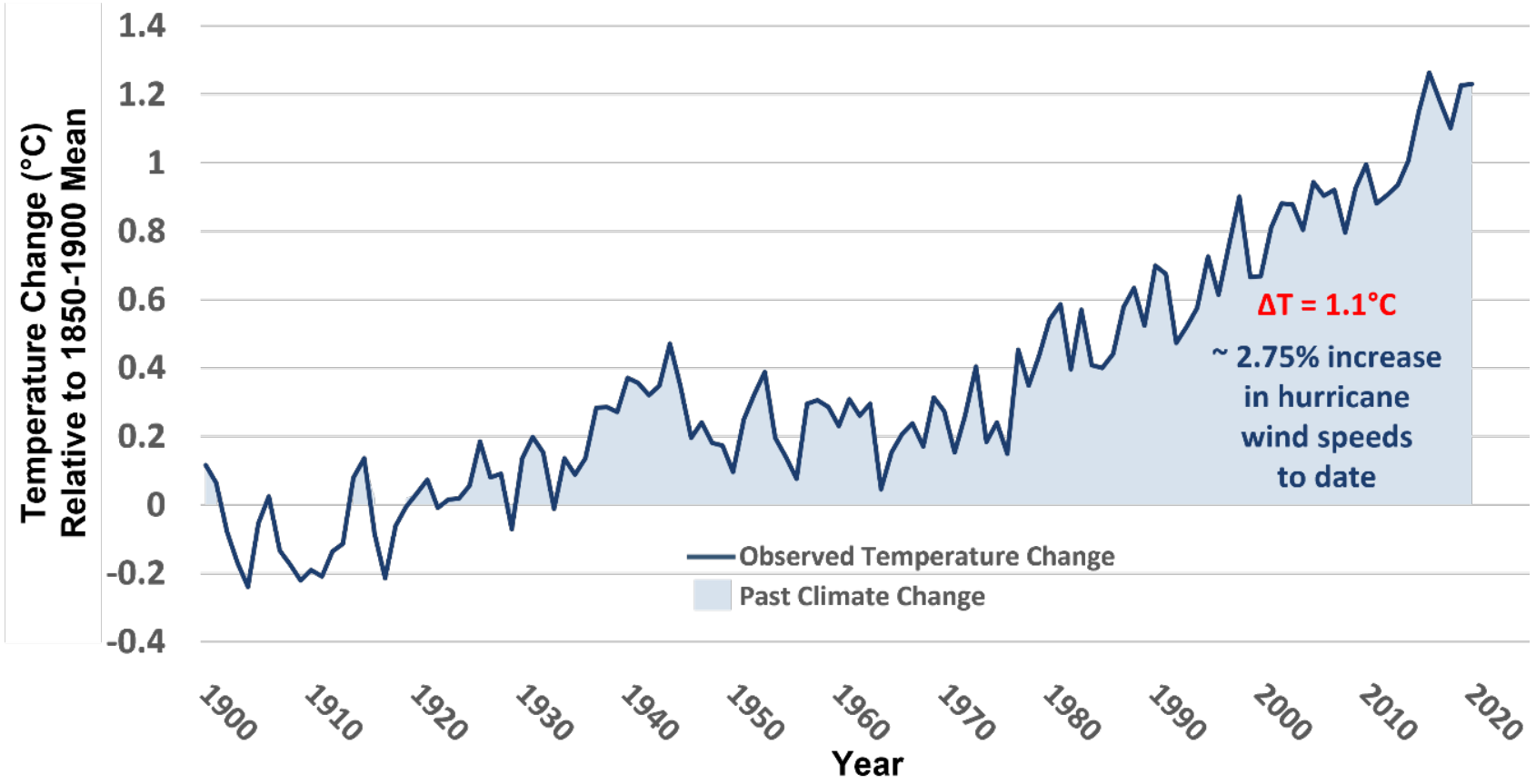
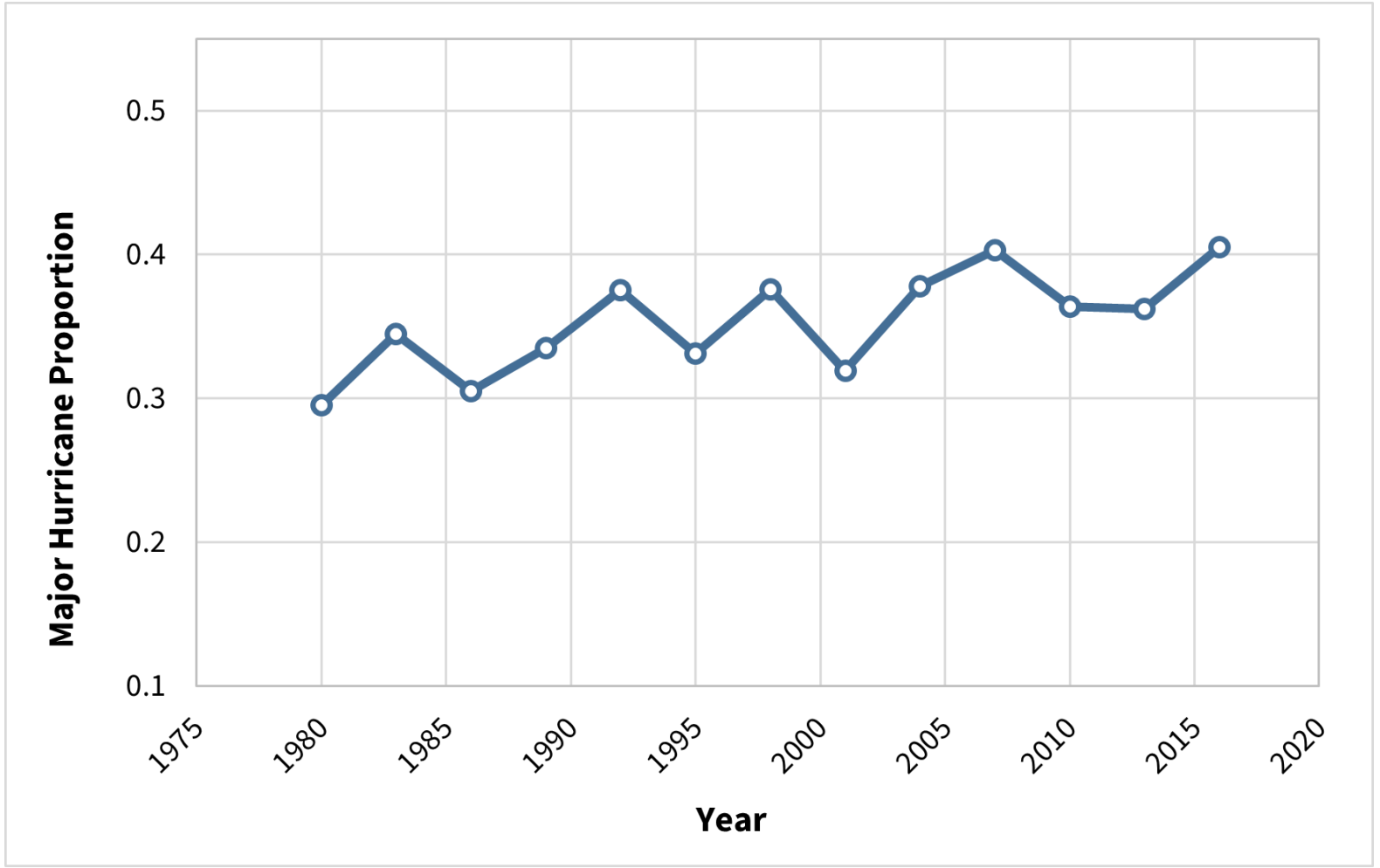


IPCC studies:

2.5% increase in hurricane wind speed for each 1°C warming

Increased Hurricane Intensity has led to Higher Proportion of Major Hurricanes Globally

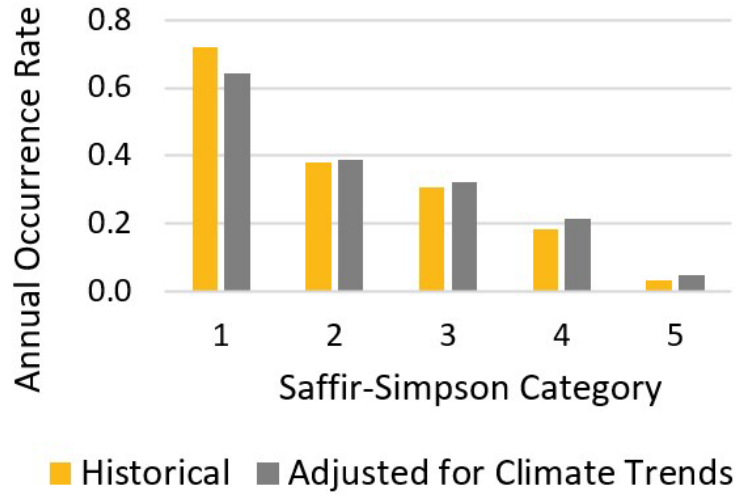
Major Hurricane: Category 3-5 on Saffir-Simpson Wind Scale



KCC US Hurricane Reference Model Version 3.0 Accounts for Climate Change To Date

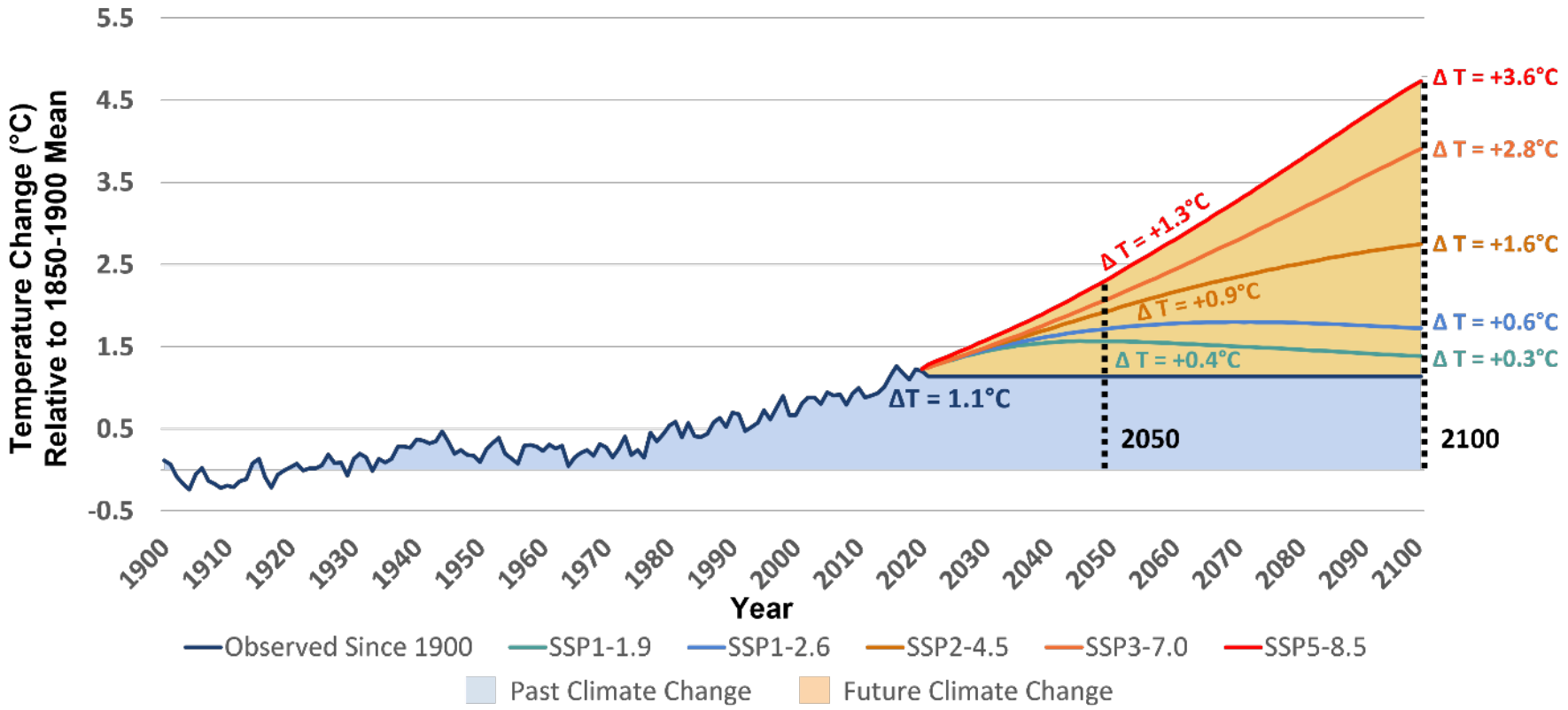
Historical Landfall Rates versus Adjusted for Global Climate Trends To Date

Proportion of Landfalling Hurricanes		
	Non-Major	**Major**
Historical	68%	32%
Adjusted for Global Climate Trends To Date	64%	36%



- Maximum sustained winds adjusted to present-day climate
- Directly informs KCC US Hurricane Reference Model Version 3.0
- **11%** increase in insured loss relative to model based purely on historical data

What Does the Future Look Like Using the SSPs?



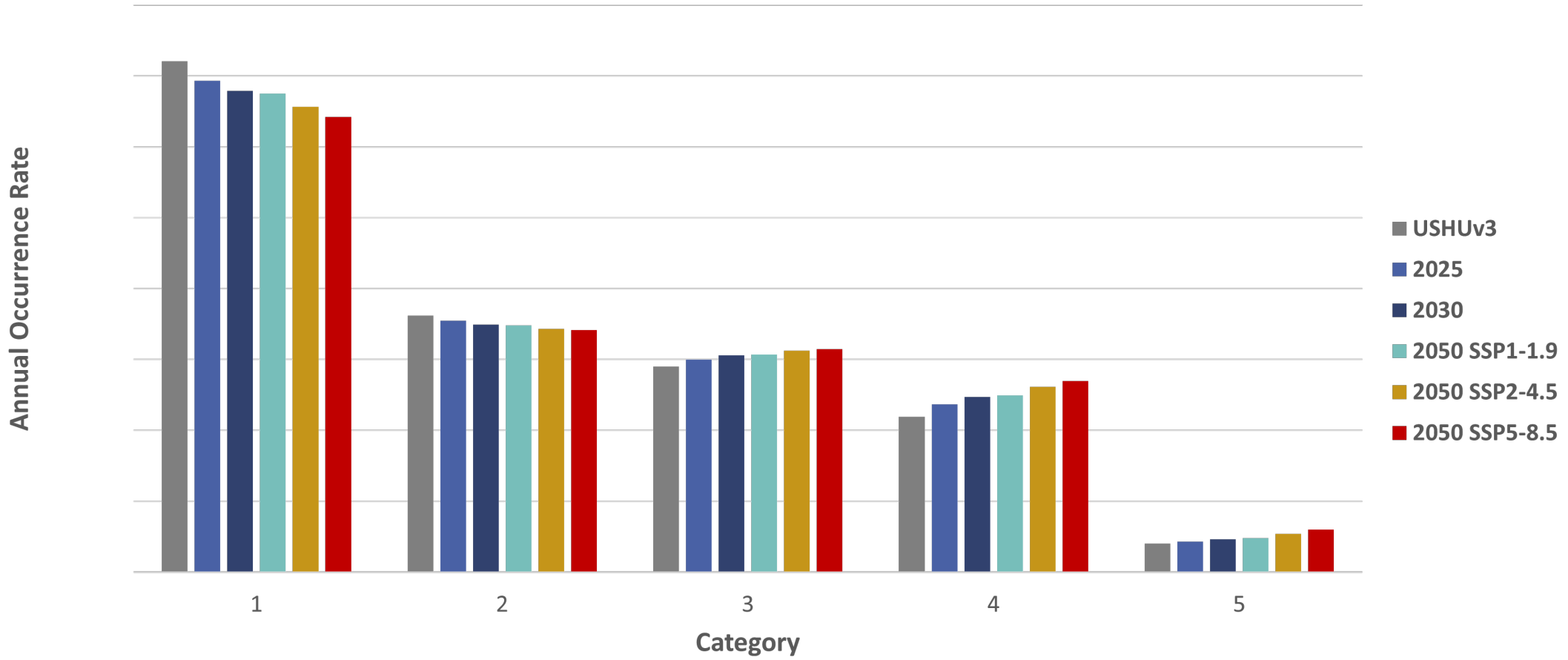
How Are Catalogs Constructed?

- Modeled increases in wind speed intensities using seasonal Power Dissipation Index projections
- PDI increases with warming temperatures and represents a shift from weak to strong wind speed intensities

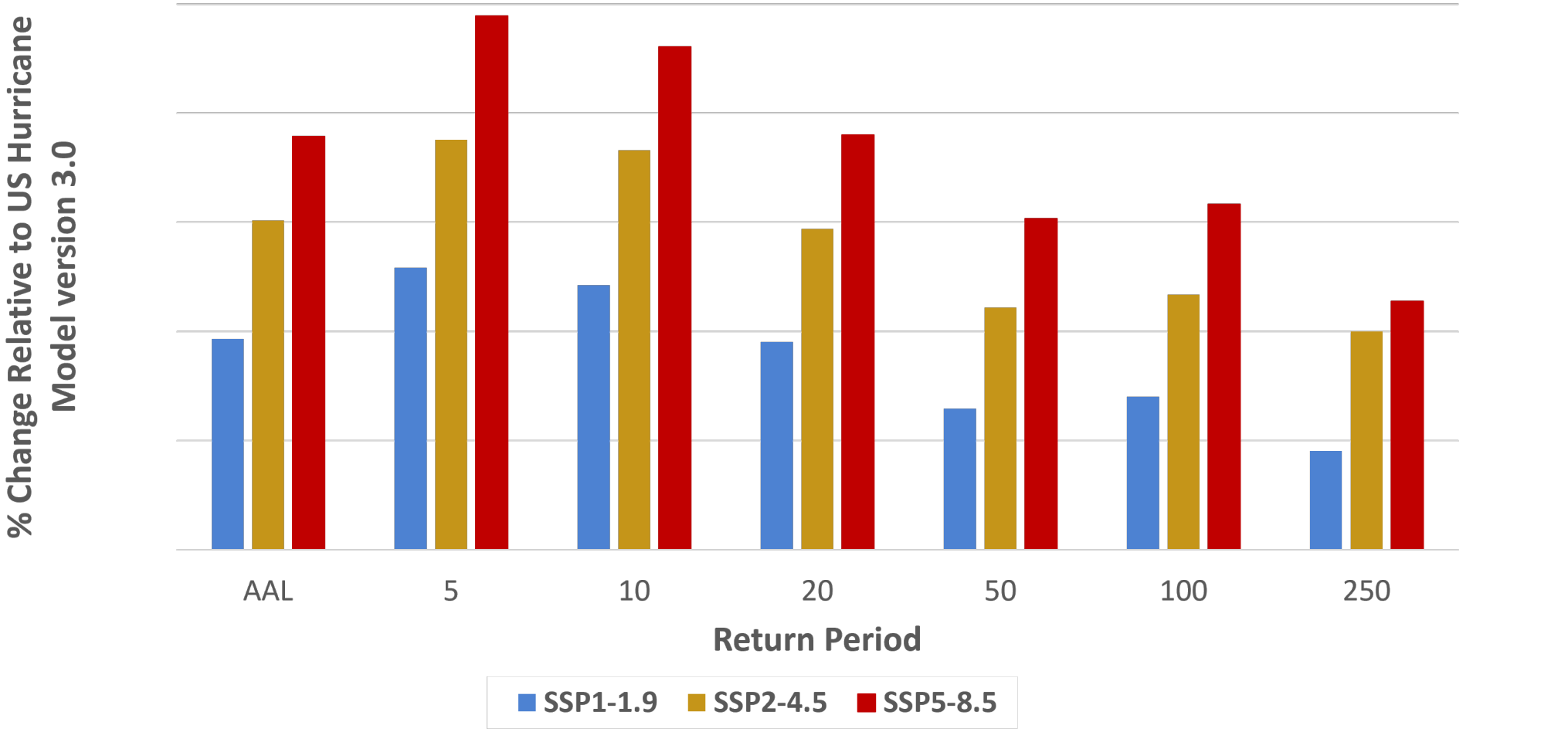
	Power Dissipation Index Relative to 2020 (10^{11} m^3 s^{-2})		
	2025	2030	2050
SSP1-1.9	0.32	0.65	0.80
SSP2-4.5			1.60
SSP5-8.5			2.30

$$v_{m,new} = v_{m,0} * \left(\frac{PDI_{new}}{PDI_0}\right)^{-3}$$

Projected Increases in Atlantic Hurricane Intensity for All Scenarios



Shape of Individual Insurer and EP Curves Projected to Change

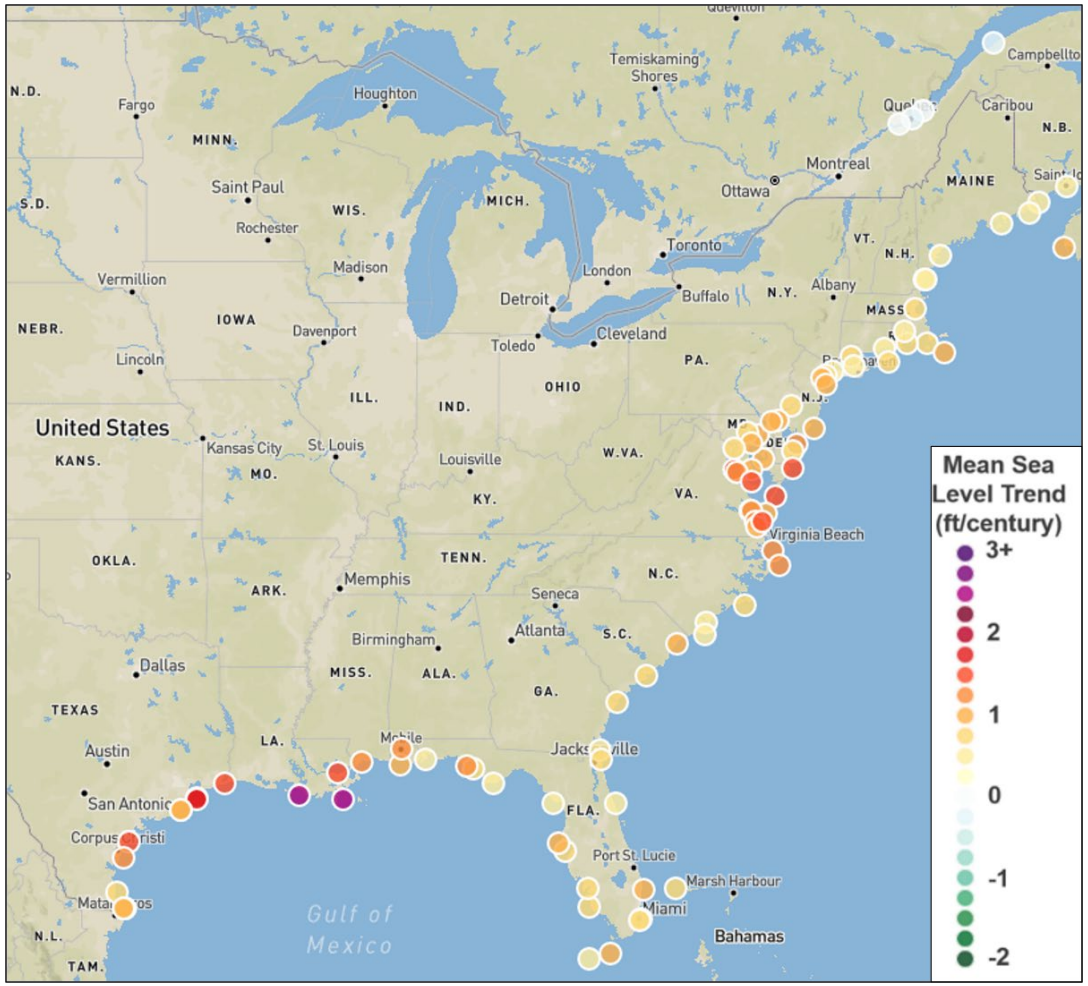


Wind Increases Combine with Sea-Level Rise to Impact Storm Surge

Increase in Intense Hurricanes

Sea-Level Rise

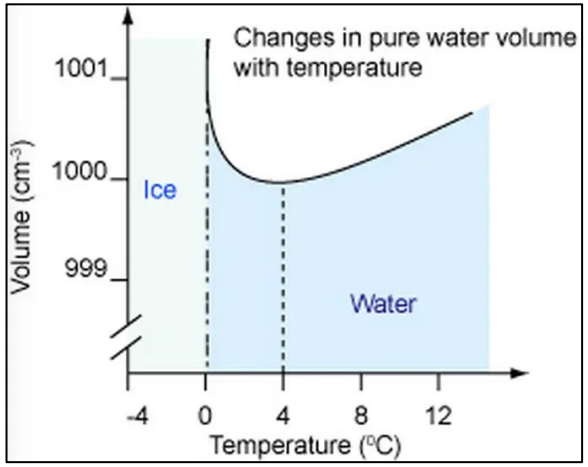
More Severe Coastal Flooding from Storm Surge

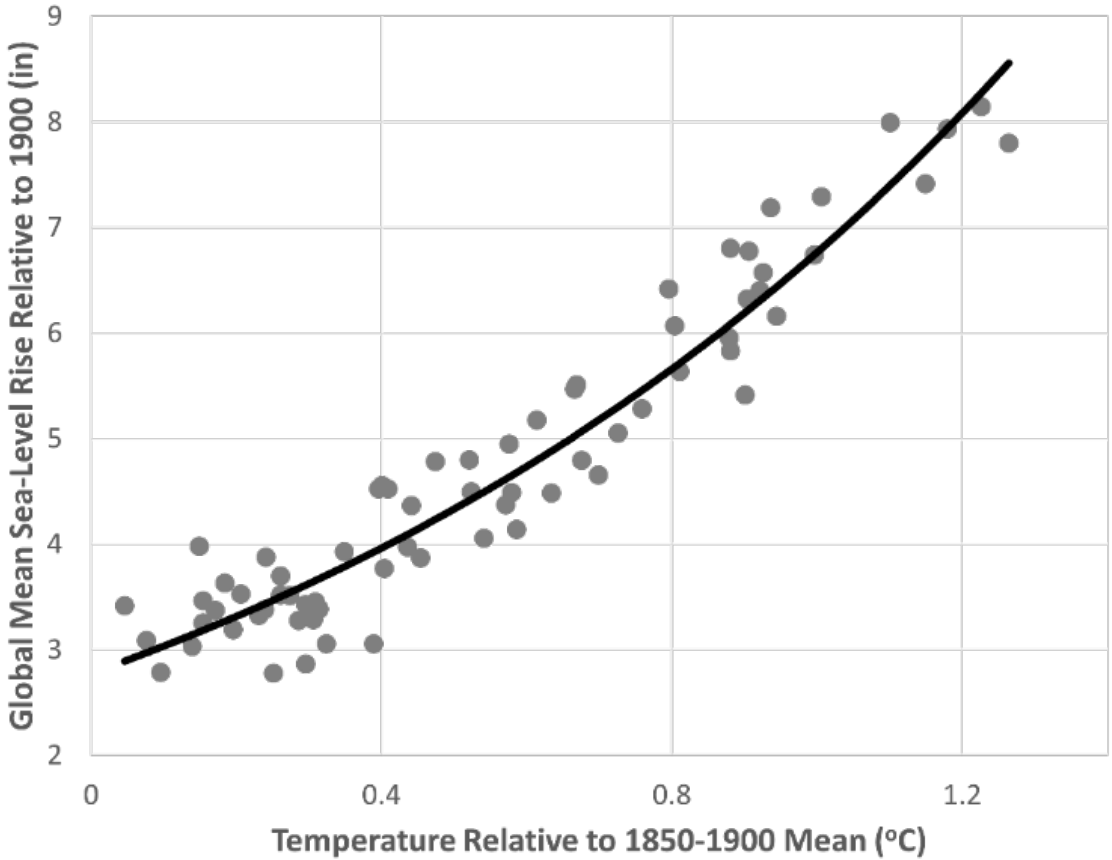


Current Rate of Sea Level Rise Projected to Accelerate

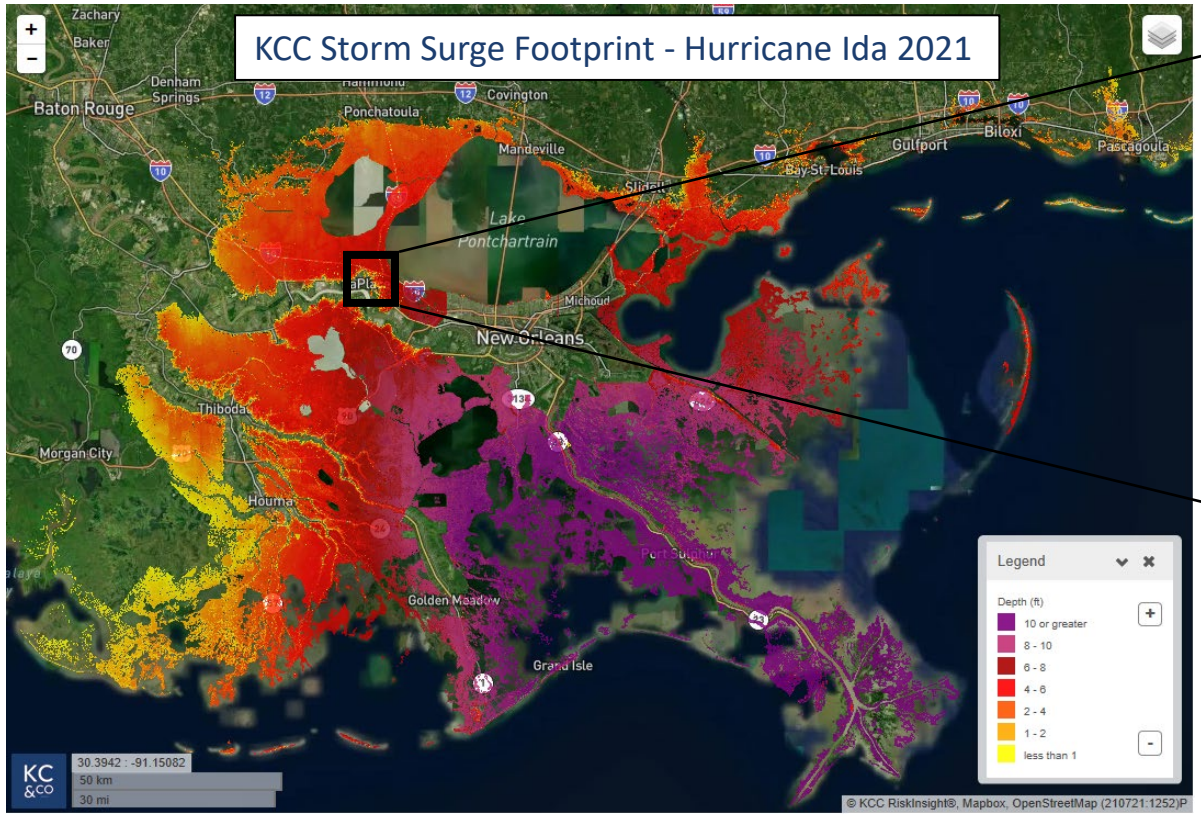
Ice Melt

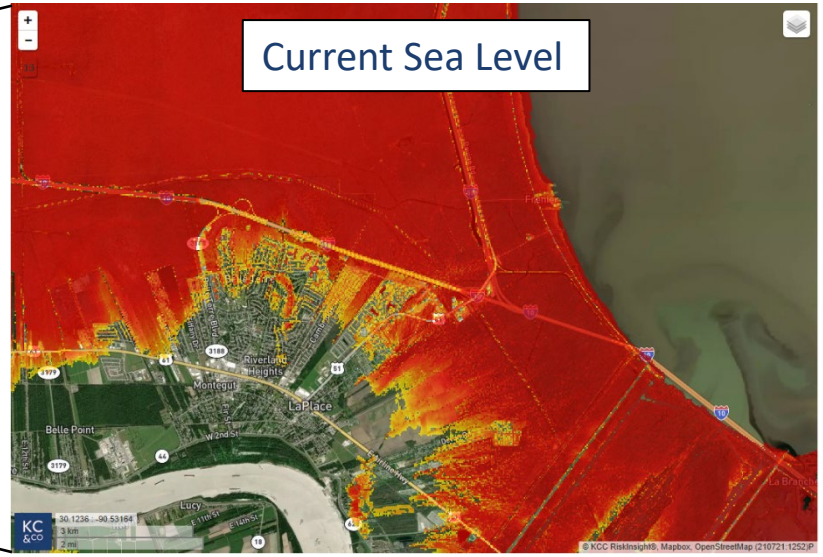
Thermal Expansion

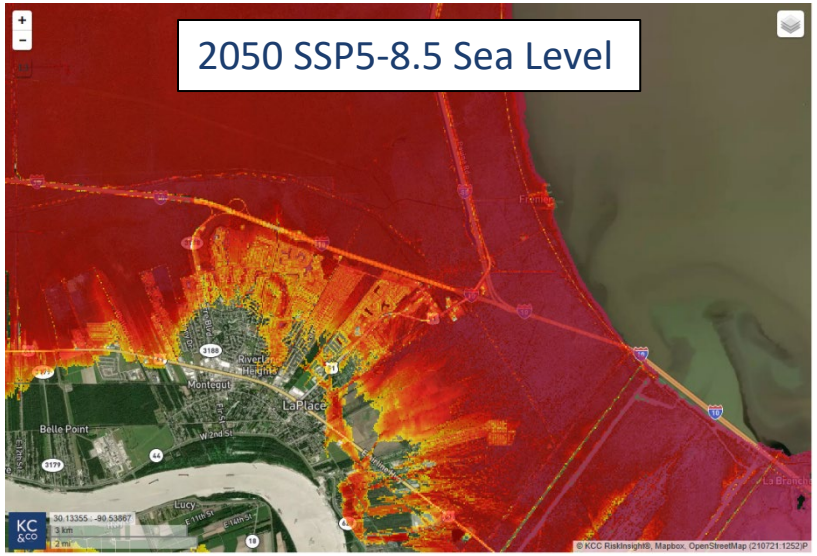




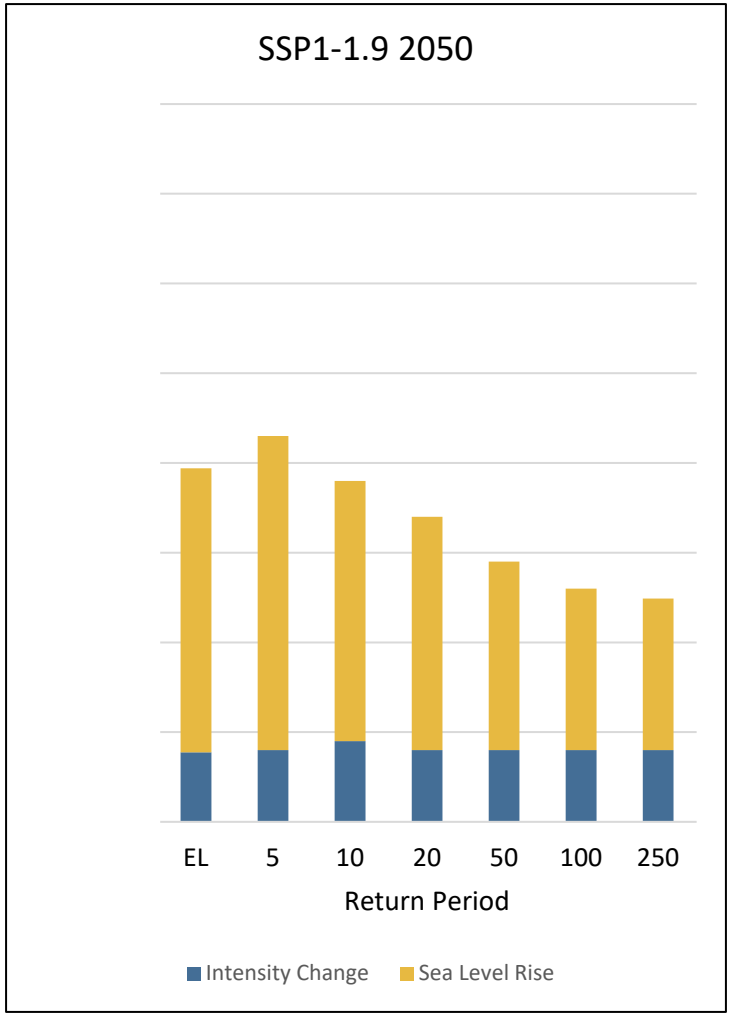
Impact of Sea-Level Rise on Storm Surge Events

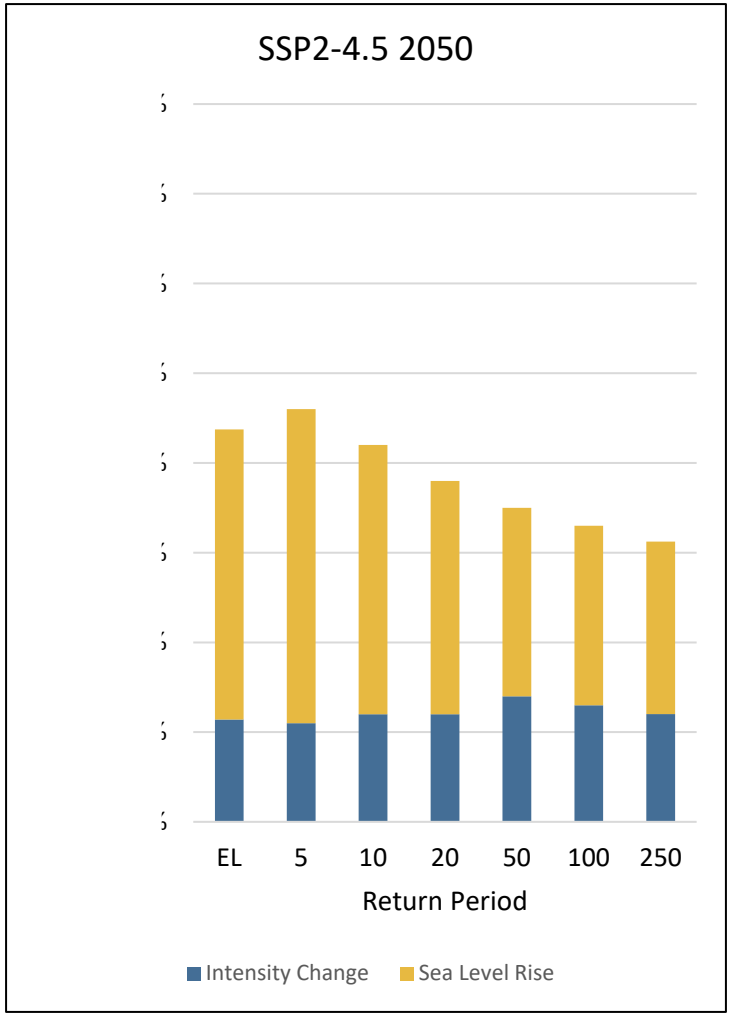


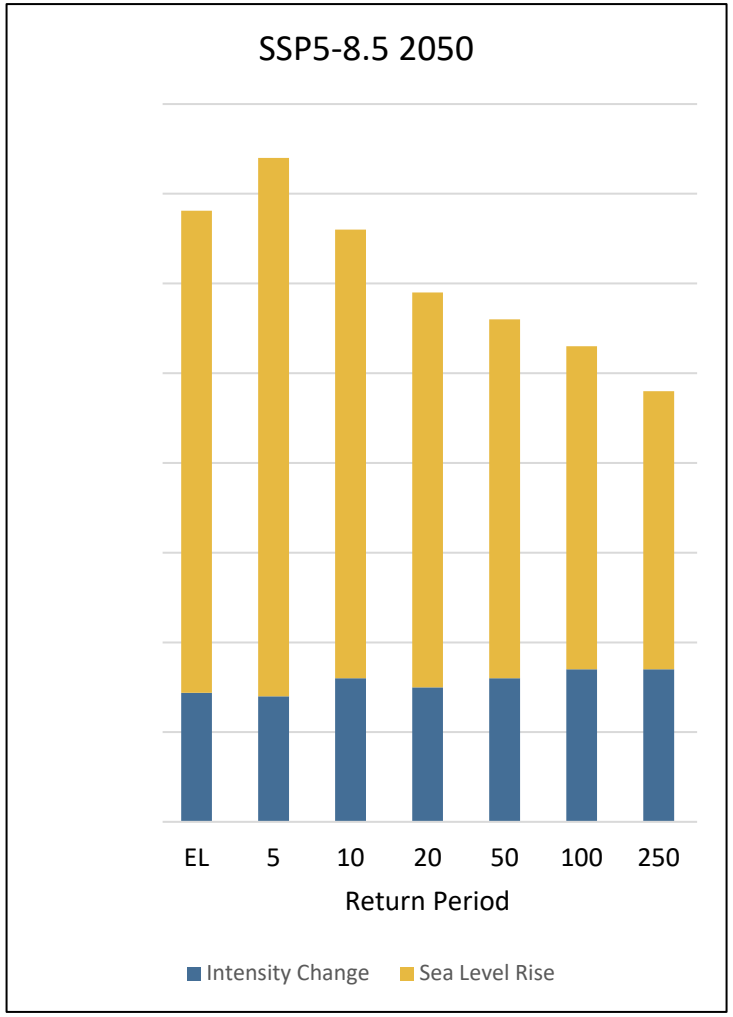




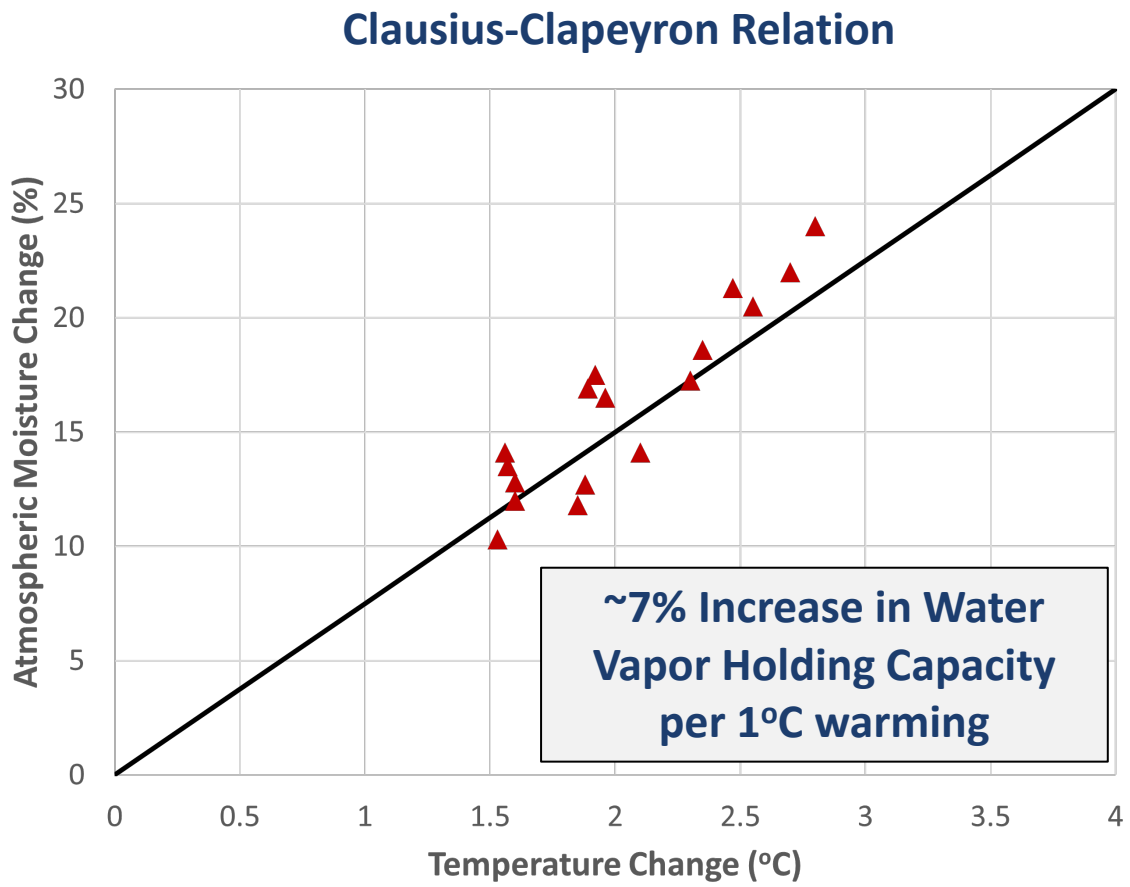
Sea-Level Rise Leads to Majority of Increased Storm Surge Loss

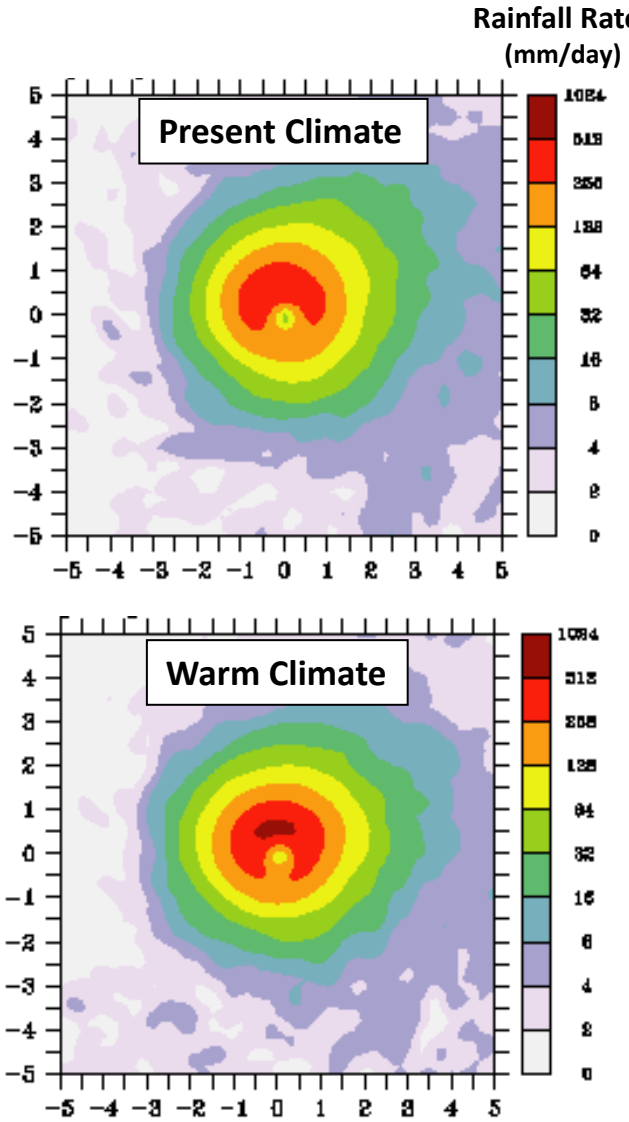




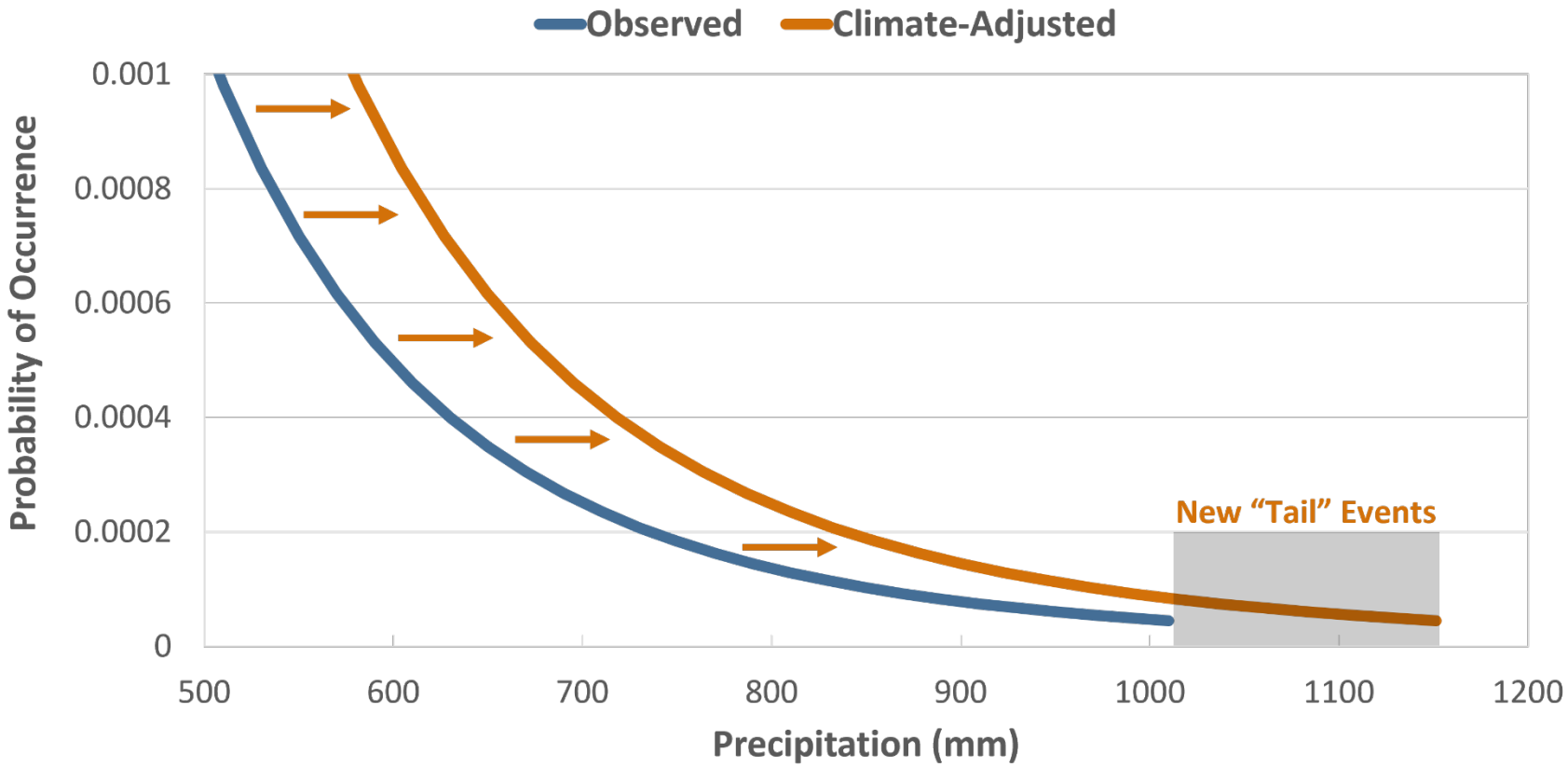


Warming Increases Potential for Flooding from Tropical Cyclones





Precipitation Intensity Shift Leads to More Extreme Tail Events



Frequency of Major Tropical Cyclone-Related Floods is Projected to Increase

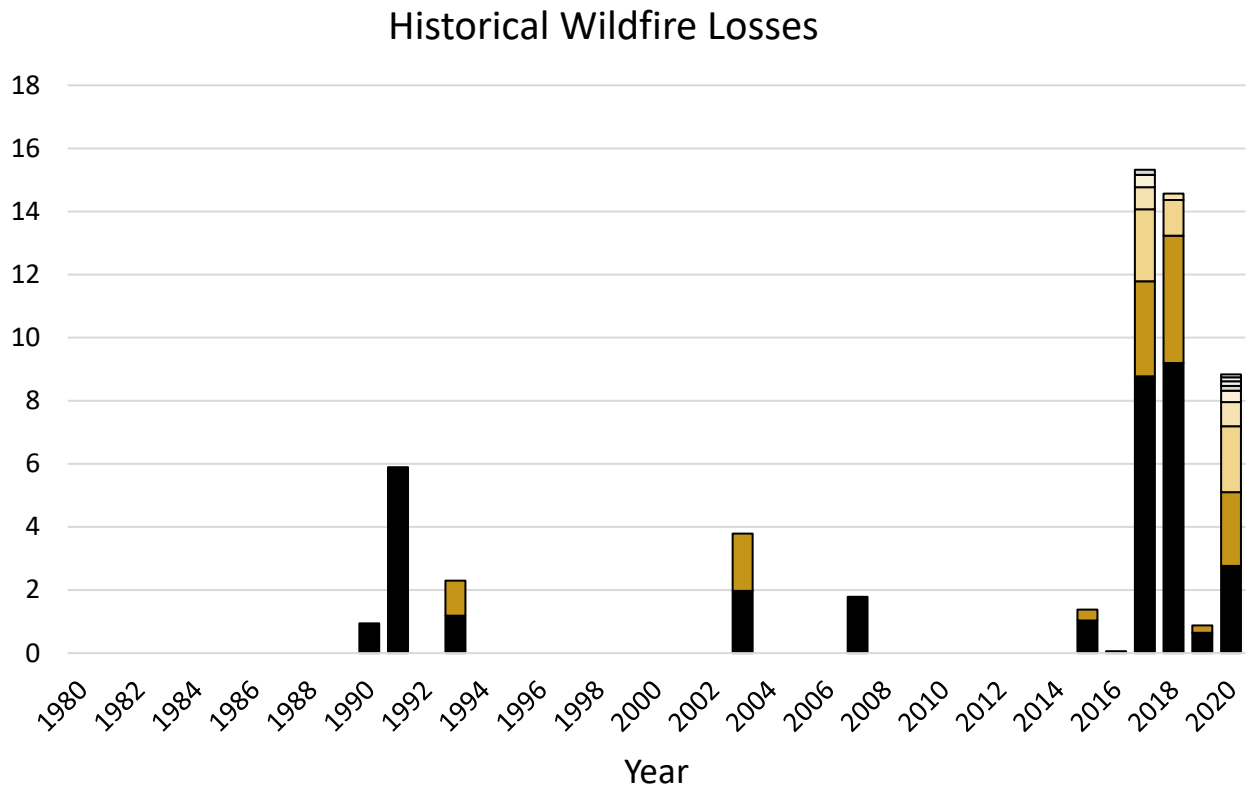
Change in Precipitation Amount Due to Warming

	Temperature Increase Relative to 2020 (°C)			Precipitation Change Relative to 2020 (%)		
	2025	2030	2050	2025	2030	2050
SSP1-1.9	0.1	0.3	0.4	0.7	2.1	2.8
SSP2-4.5	0.1	0.3	0.9	0.7	2.1	6.3
SSP5-8.5	0.2	0.5	1.3	1.4	3.5	9.1

Change in Annual Rate of Hurricane-related Inland Floods

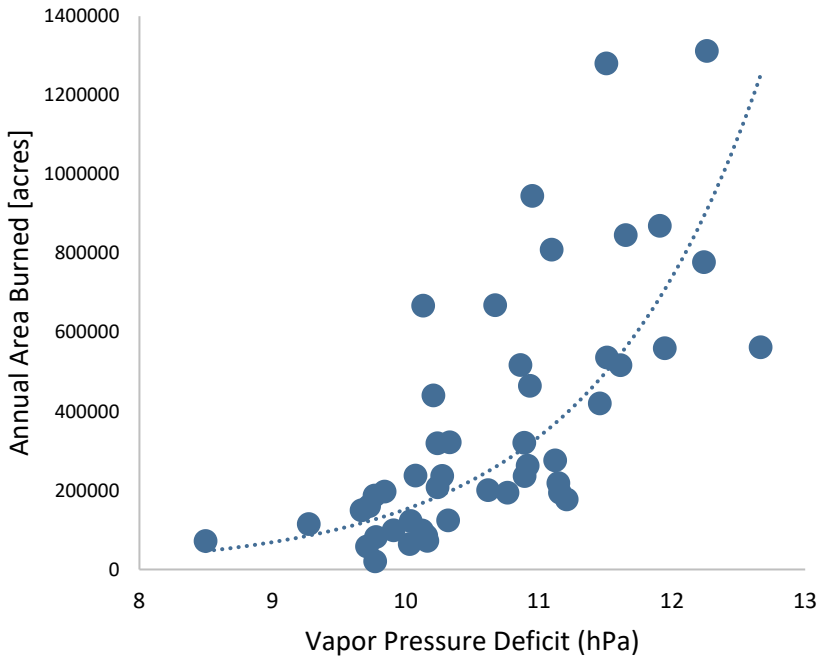
2050 SSP1-1.9	2050 SSP2-4.5	2050 SSP5-8.5
+8%	+20%	+30%

What's Happening with Wildfires—Trend or Short-Term Aberration?

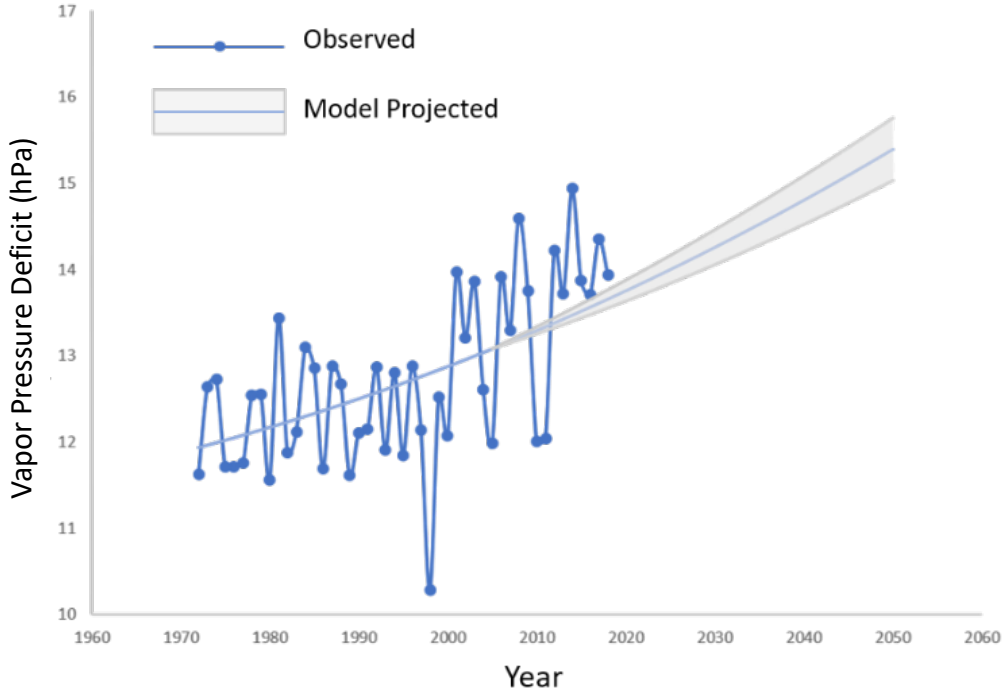


Changes in Wildfires in the Western US

Response of Fires to VPD Changes (Western US)



Projected Increase in VPD (Western US)

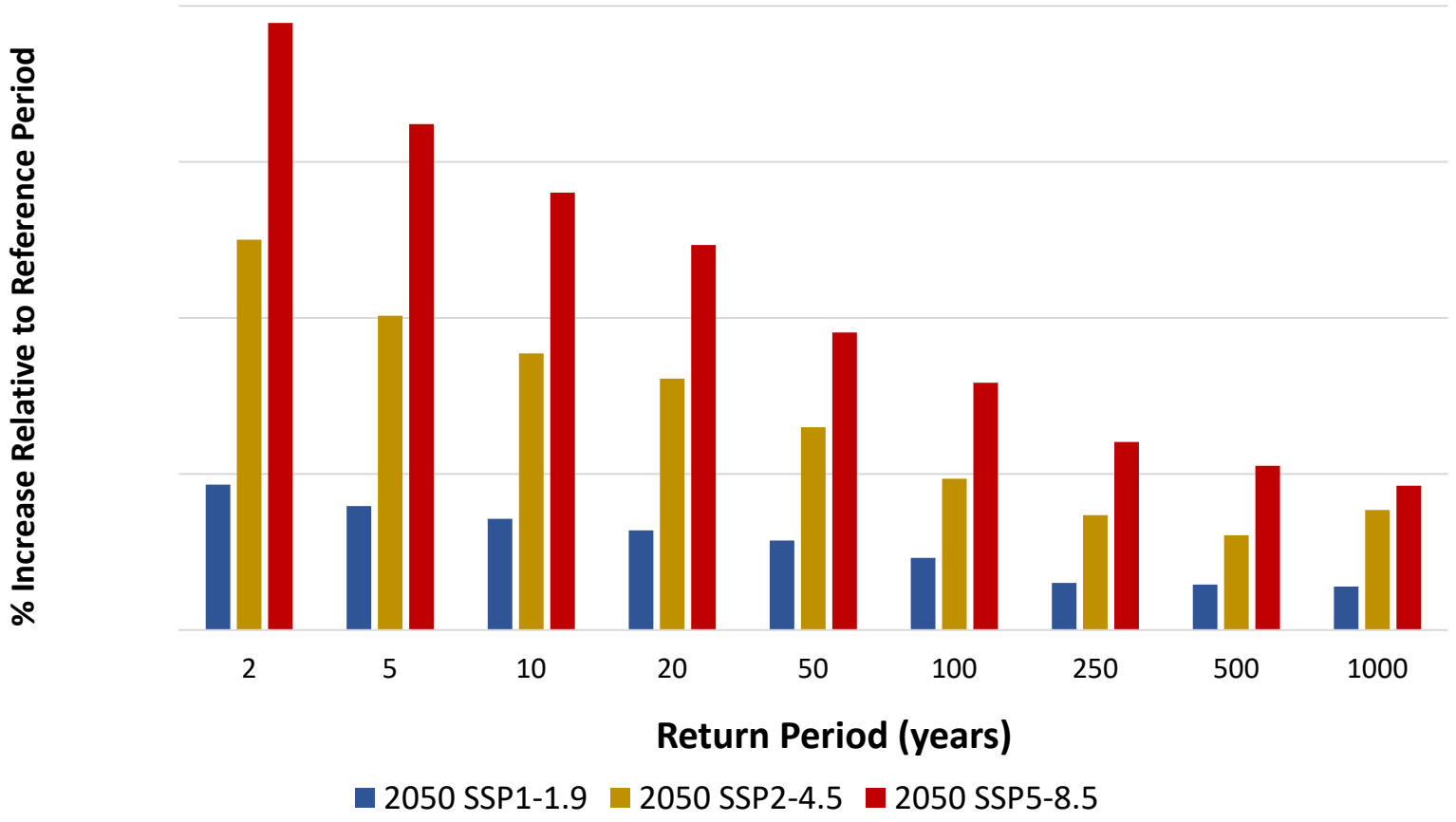


Vapor Pressure Deficit (VPD): Capacity of an airmass to hold moisture beyond what is available in the atmospheric environment

Increases directly with warming air temperature

KCC Wildfire Model Converts Those Projections into Projected EP Curves

	VPD Change Relative to 2020 (%)		
	2025	2030	2050
SSP1-1.9	3.2	4.5	5.2
SSP2-4.5			11.8
SSP5-8.5			17.5



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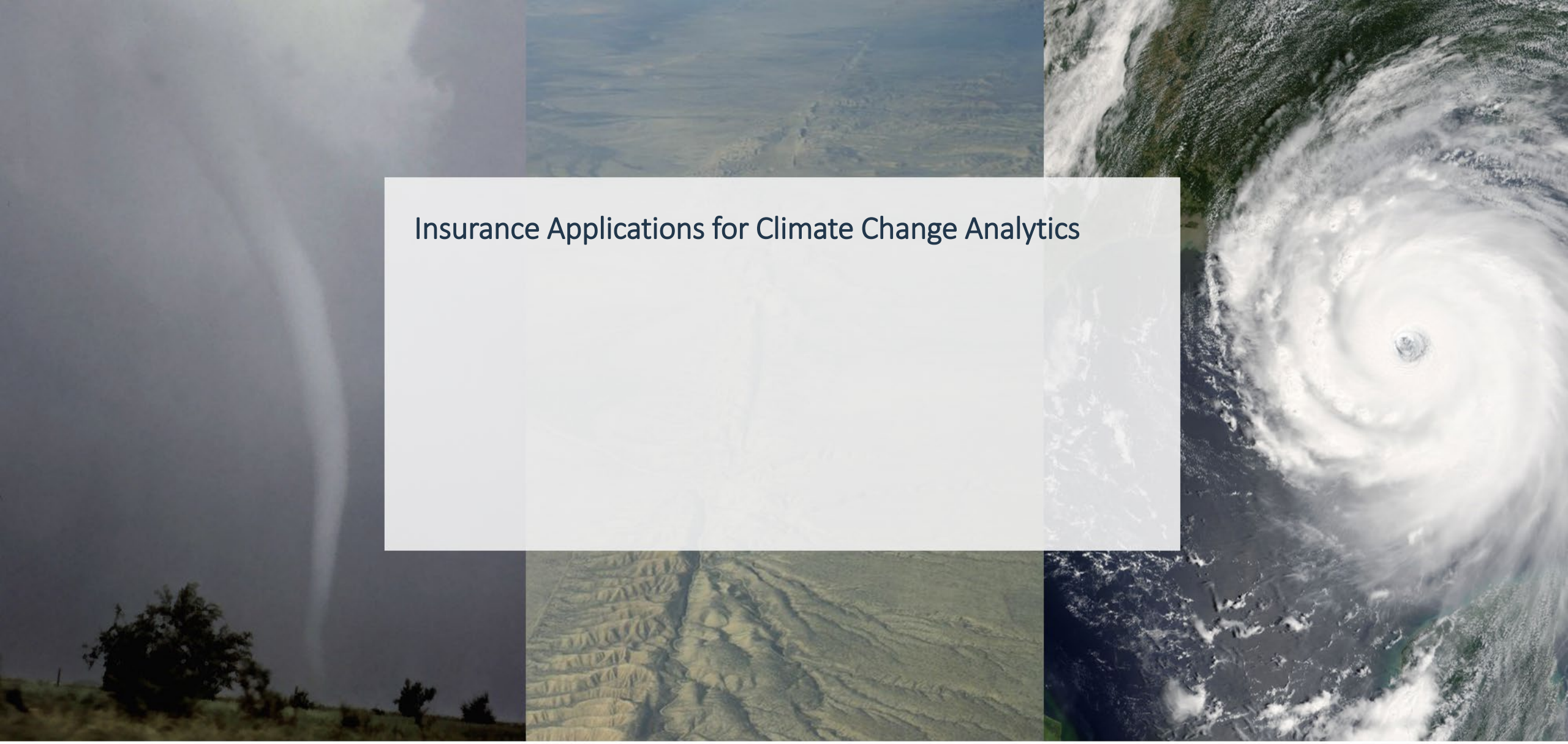


Insurance Applications for Climate Change Analytics

KC &CO

The Innovation and Technology Leader in Catastrophe Risk Modeling

Climate-Related Regulatory & Rating Agency Reporting

- Task-Force on Climate-related Financial Disclosures
  - Purpose: TCFD was established in 2015 by the Financial Stability Board (FSB) to improve and increase reporting of climate-related financial information
- Recommendations
  - TCFD developed a framework to help companies disclose climate-related risks and opportunities
- Four Categories
  - Governance
  - Strategy
  - Risk Management
  - Metrics and Targets
- Two Risk Types
  - Transitional
  - Physical

For more information on the Task-Force on Climate-related Financial Disclosures
www.fsb-tcfd.org

Use Cases

- Risk Mitigation
- Pricing
- Reporting
- Other Actuarial Activities

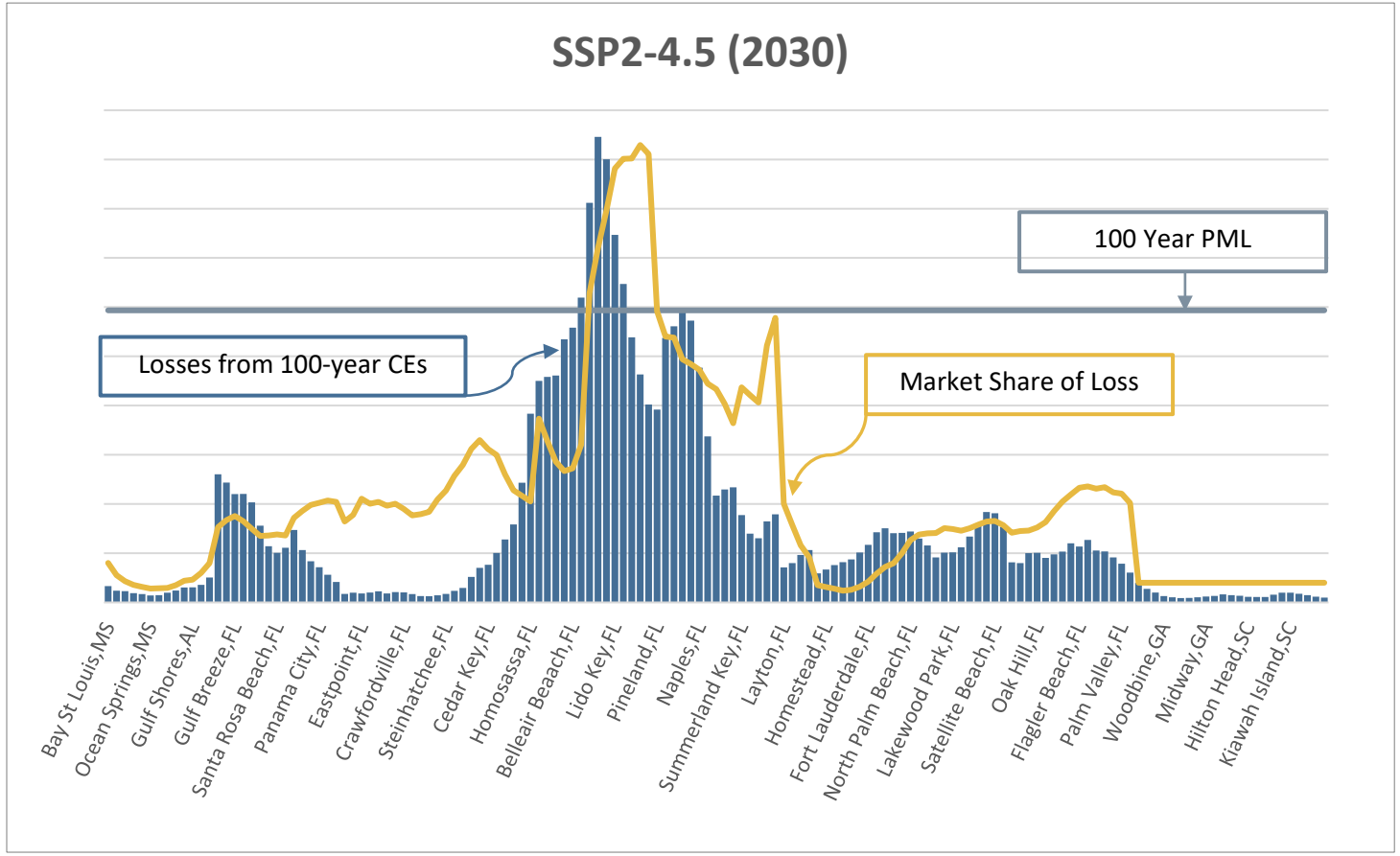
Integrating Climate Projections Into Insurance Use Cases – Risk Mitigation

Using Selected Scenario, compare Company and Industry results

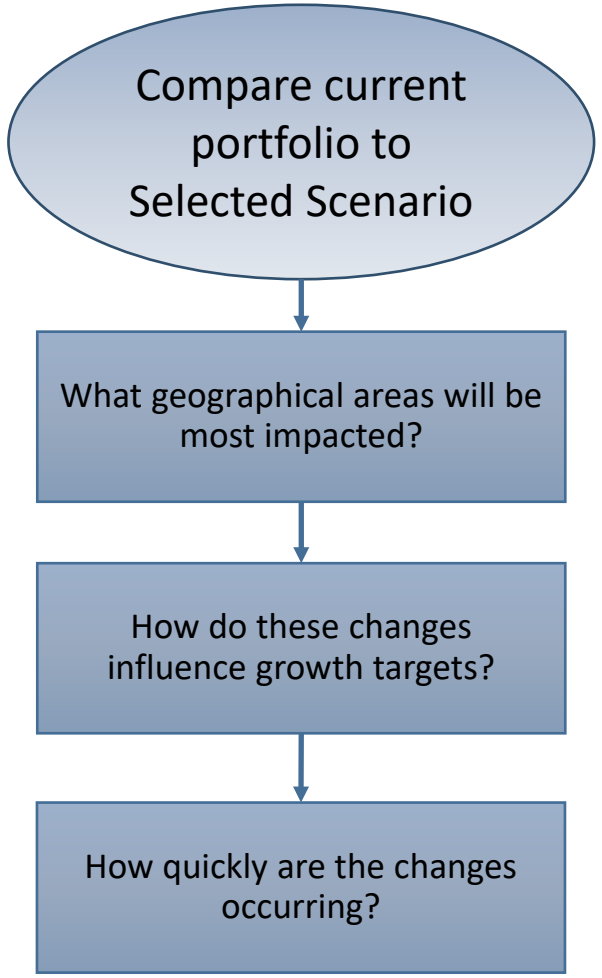
Where does the Company risk an outsized loss?

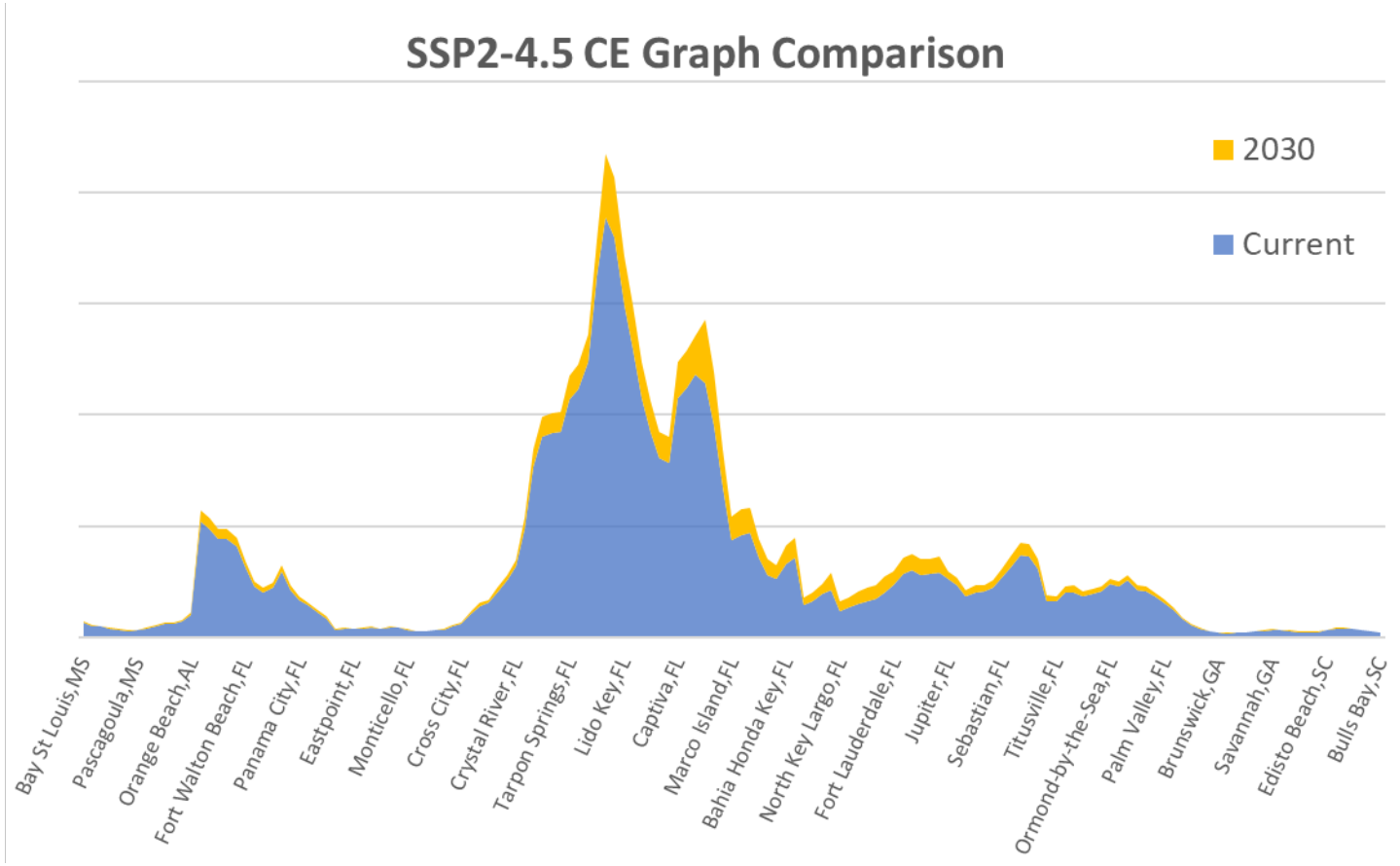
How might the results modify Underwriting rules?

Does this change the Company's view of their current risk?

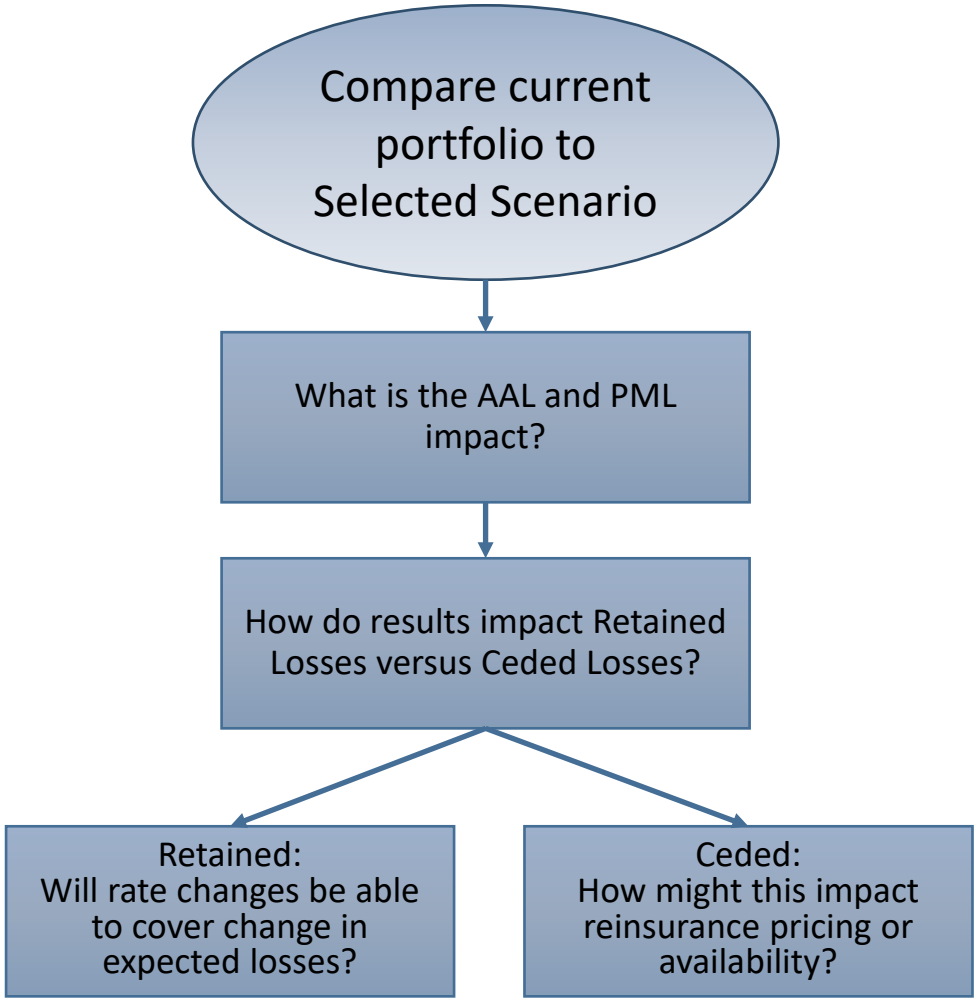


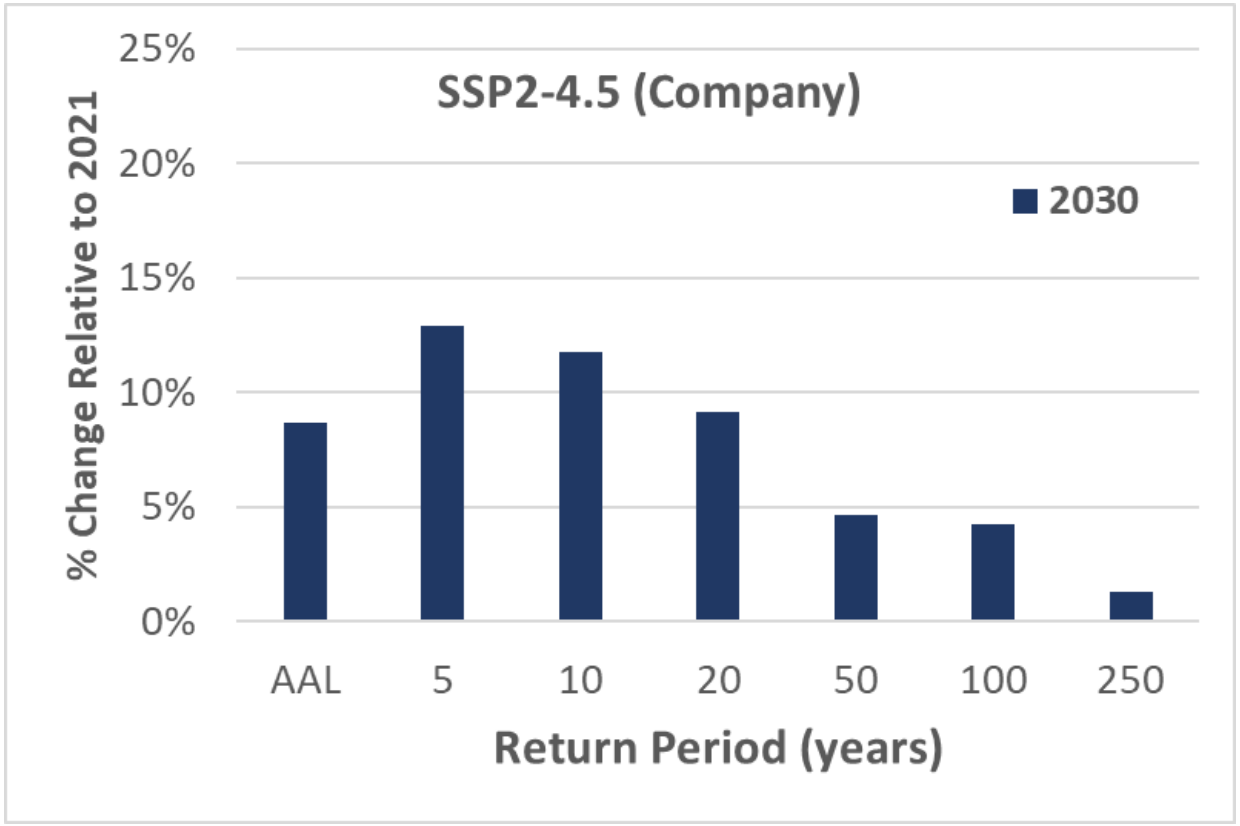
Integrating Climate Projections Into Insurance Use Cases – Risk Mitigation



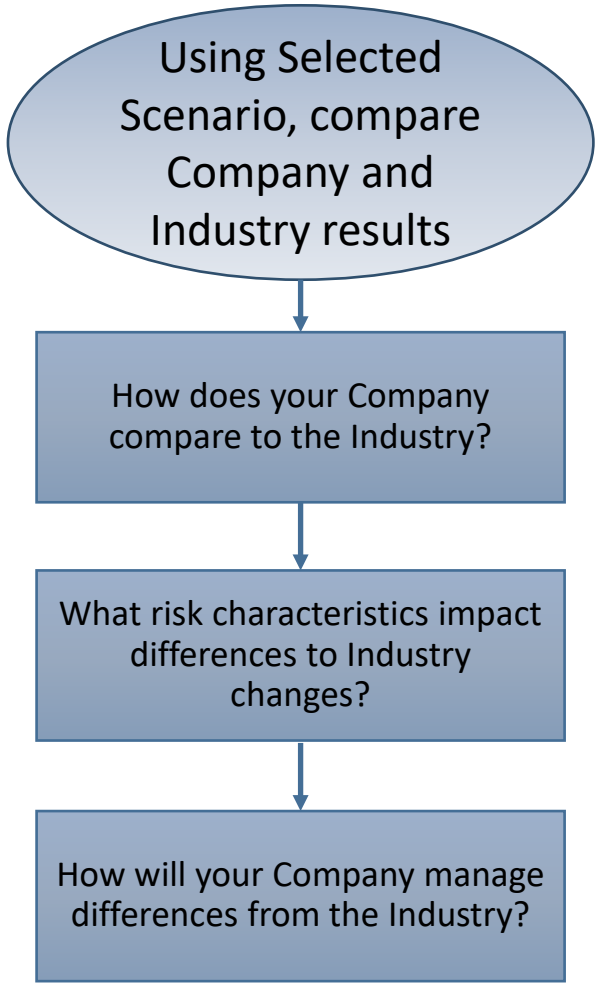


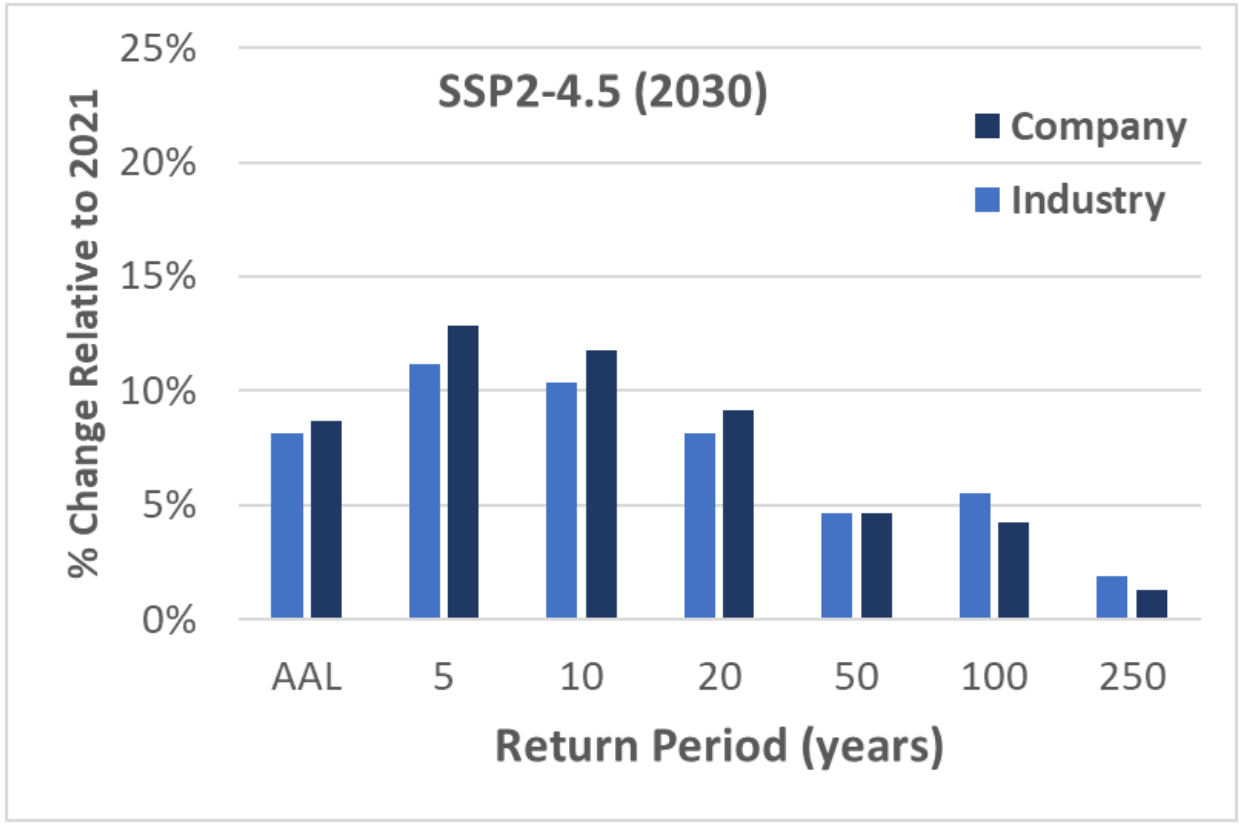
Integrating Climate Projections Into Insurance Use Cases – Pricing





Integrating Climate Projections Into Insurance Use Cases – Reporting

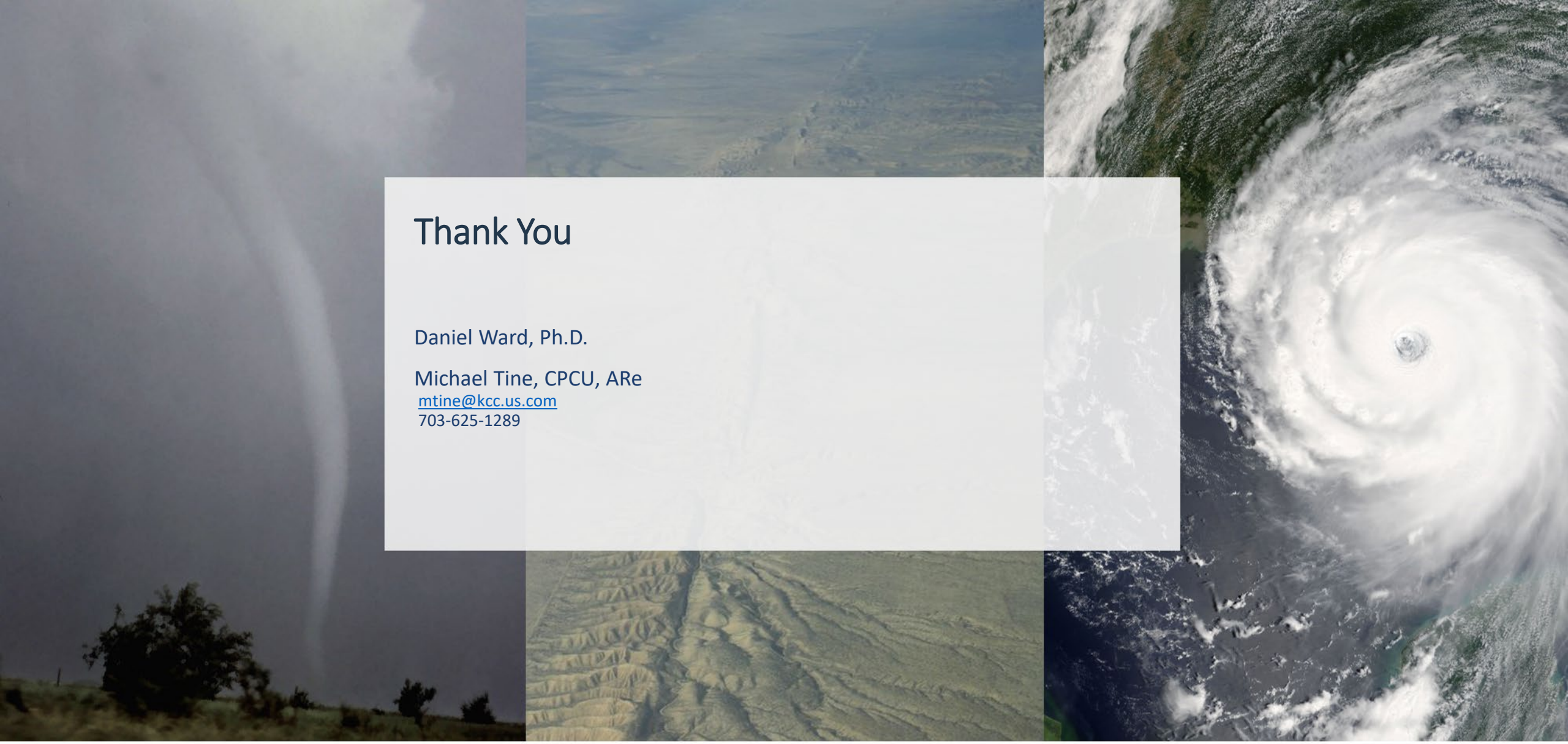




Integrating Climate Projections Into Insurance Use Cases – Reporting, Additional Options

- Replicate these for additional scenario tests such as:
  - Best-case vs. worst-case (SSP1-1.9 vs. SSP5-8.5)
    - Where are areas that are consistent in the predicted change; where is the most uncertainty?
  - Current portfolio shown on a time-line (SSP2-4.5 @ current, 2025, 2030, 2050)
    - Can rate changes keep pace with expected changes going forward?
  - Is your Company currently changing its portfolio?
    - Current portfolio vs. Projected portfolio

- Conduct other High-Level Confidence scenario tests such as:
  - Wildfire
  - Flood
- Conduct stress tests for Catastrophes with uncertain changes
  - Severe Convective Storm
  - Winter Storm



Thank You

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