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North Carolina Institute for Climate Studies

NC Executive Order 80 – Section 9

North Carolina Climate Science Report

Overview of Climate Change in North Carolina
September 3, 2020

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Asheville, NC

Agenda

➔ **Overview**

➔ **North Carolina Climate Science Report (NC CSR)**

- Report Development Process and Team
- Report Findings
- Regional Highlights (examples)

Overview

- **Supports Governor Cooper's Executive Order 80 (EO80)**
  – "North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy"

- **Independent peer-reviewed scientific assessment for NC**
  - Historical climate trends
  - Anticipated future climate change under increasing greenhouse gas concentrations

- **Key subjects**
  - Temperature and precipitation
  - Storms – hurricanes, thunderstorms, winter storms
  - Sea level rise
  - Other physical aspects
    - Air quality
    - Wildfire
    - Urban heat island
    - Flooding

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Overview

Author Team

- University and Federal scientists from across the state
- CISESS and NCEI
- NC State Climate Office

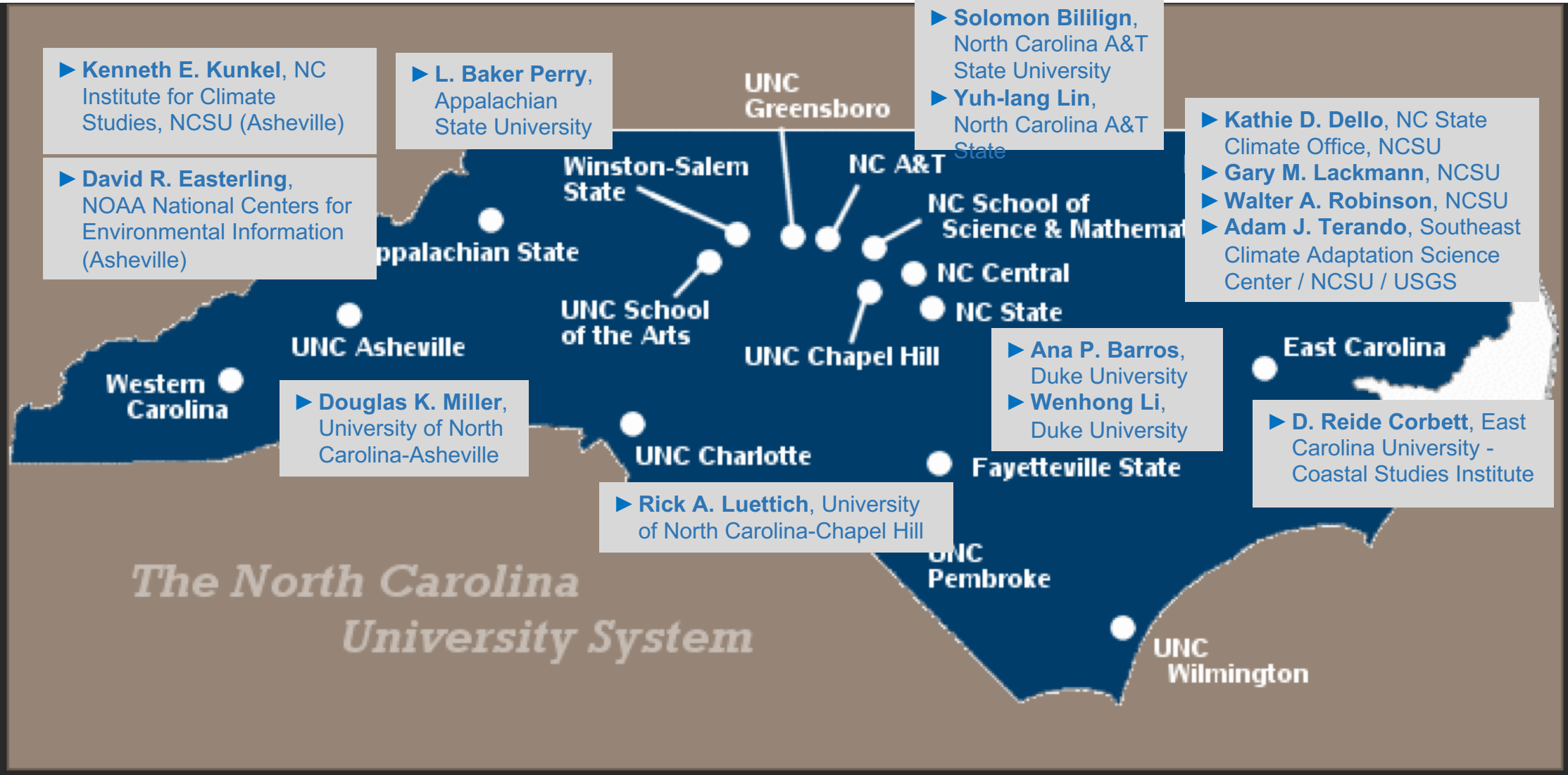
Climate Science Advisory Panel

- Some members of author team
- Other subject matter experts with national / international scientific reputations

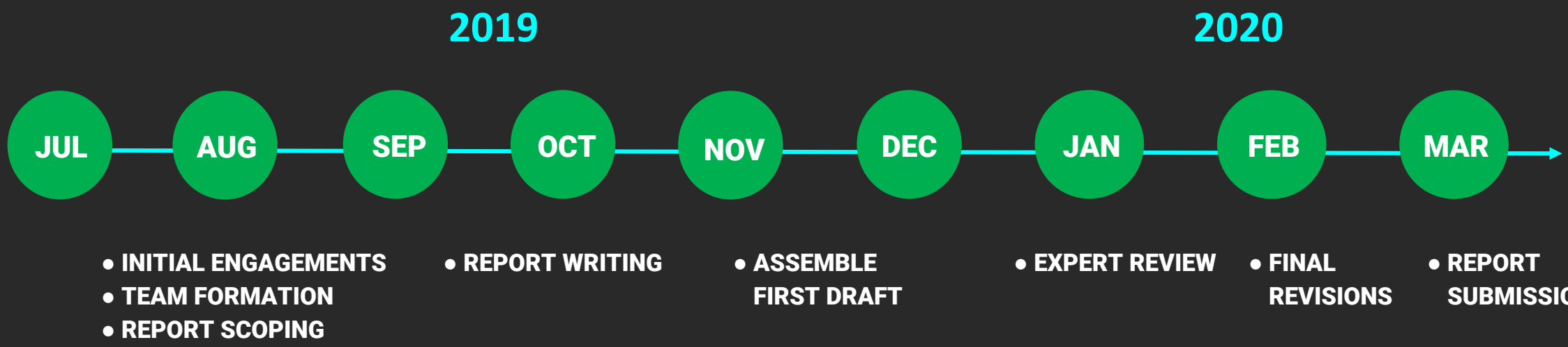
NCEI Assessments Technical Support Unit

- Authors
- Project management
- Science editing and copyediting
- Graphic design and production

NC CSR: Climate Science Advisory Panel



NC CSR: Timeline



NC Risk Assessment and Resiliency Plan Activities

Report Review Process

➔ **Several review cycles**

- Climate Science Advisory Panel
- Anonymous external climate experts
- All comments were addressed and written responses recorded

➔ **Review process meets federal Information Quality Act standards**

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Climate Science Consensus

- ➔ CO_2 concentrations are increasing rapidly
- ➔ The primary cause is burning of fossil fuels
- ➔ CO_2 is a greenhouse gas and contributes to warming surface temperatures
- ➔ The Earth is warming
- ➔ Increasing concentrations of CO_2 and other greenhouse gases are most likely causing much, if not all, of the warming

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Climate Science Consensus

Exhaustive research has examined other potential causes of this warming, and the increase in greenhouse gas concentrations is the only plausible cause that is consistent with the observed data and the physics that governs the climate system.

Climate Science Consensus

Definitions for Upcoming Slides

Virtually certain	99–100% probability of outcome
Very likely	90–100% probability of outcome
Likely	66–100% probability of outcome
Low confidence	inconclusive evidence, disagreement, or lack of expert opinions
Medium confidence	high agreement/limited evidence, medium agreement/medium evidence, or low agreement/robust evidence

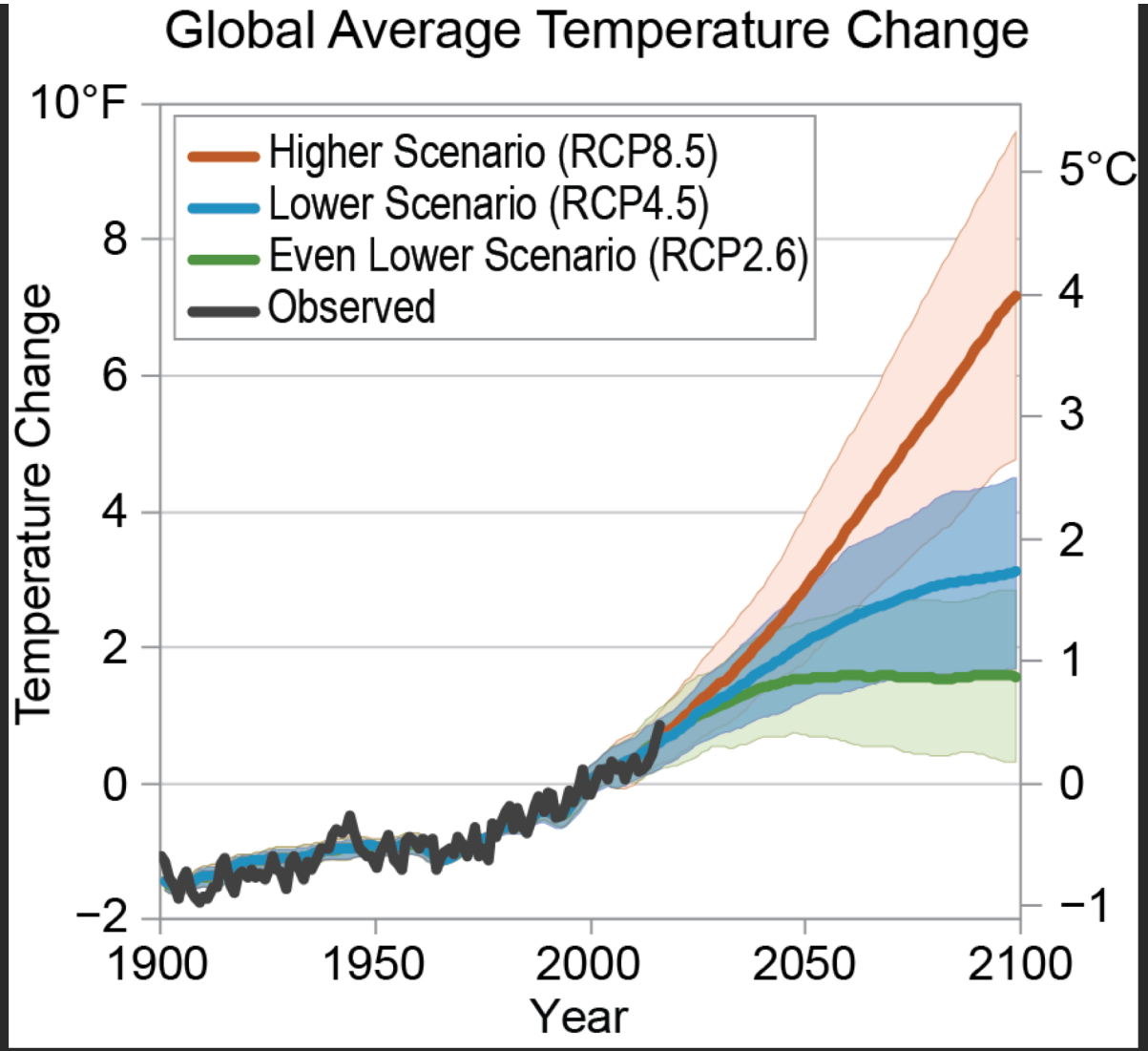
Global Context – Temperature

- ➔ Global average temperature has increased about 1.8°F since 1895
- ➔ This increase is largely due to human activities that have significantly increased greenhouse gas (GHG) concentrations (***very high confidence***)
- ➔ ***Virtually certain*** that global warming will continue, assuming GHG concentrations continue to increase

Global Context – Temperature

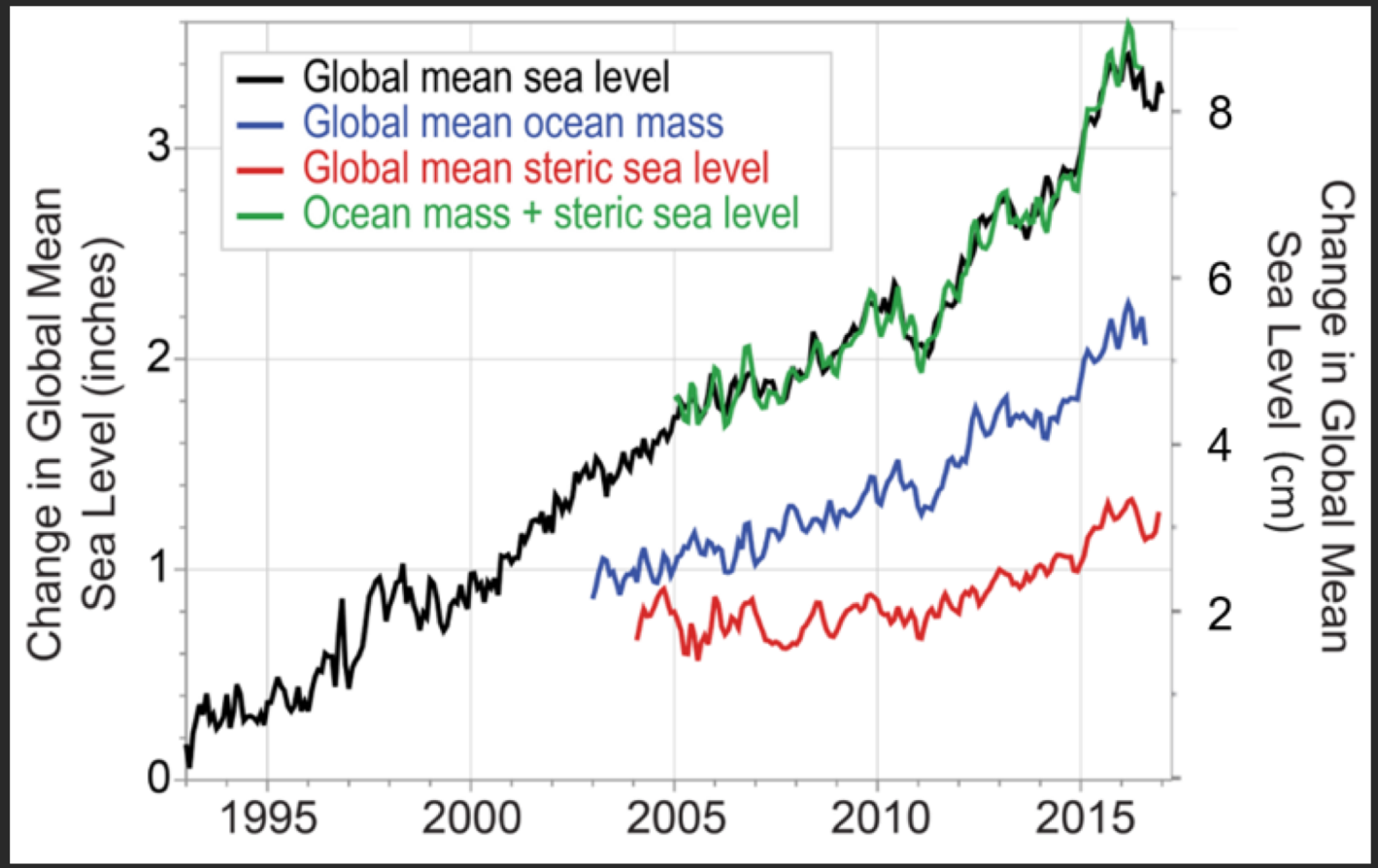
➔ Projected global temperature increases for 2080–2099 compared to 1996–2015:

- about 4°– 8°F under a higher scenario (RCP8.5)
- about 1°– 4°F under a lower scenario (RCP4.5)



Global Context – Sea Level

- Global average sea level has increased by about 7– 8 inches since 1900
- Almost half of this increase since 1993



Global Context – Sea Level

➔ ***Virtually certain*** that global sea level will continue to rise, due to:

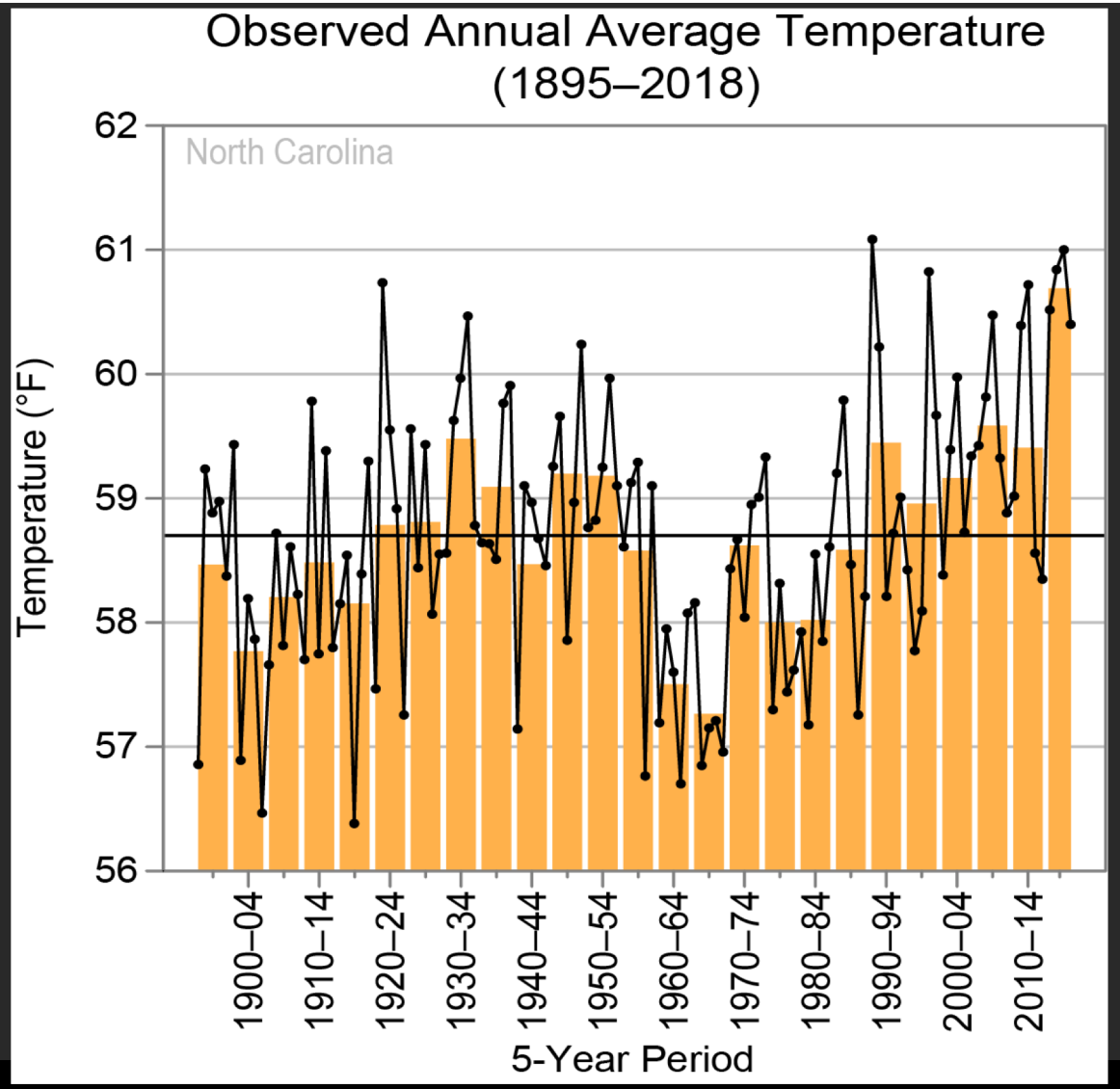
- expansion of ocean water from warming
- melting of ice on land, including Greenland and Antarctic ice sheets

Report Findings

Large changes in North Carolina's climate—much larger than at any time in the state's history—are ***very likely*** by the end of this century under both the lower and higher scenarios.

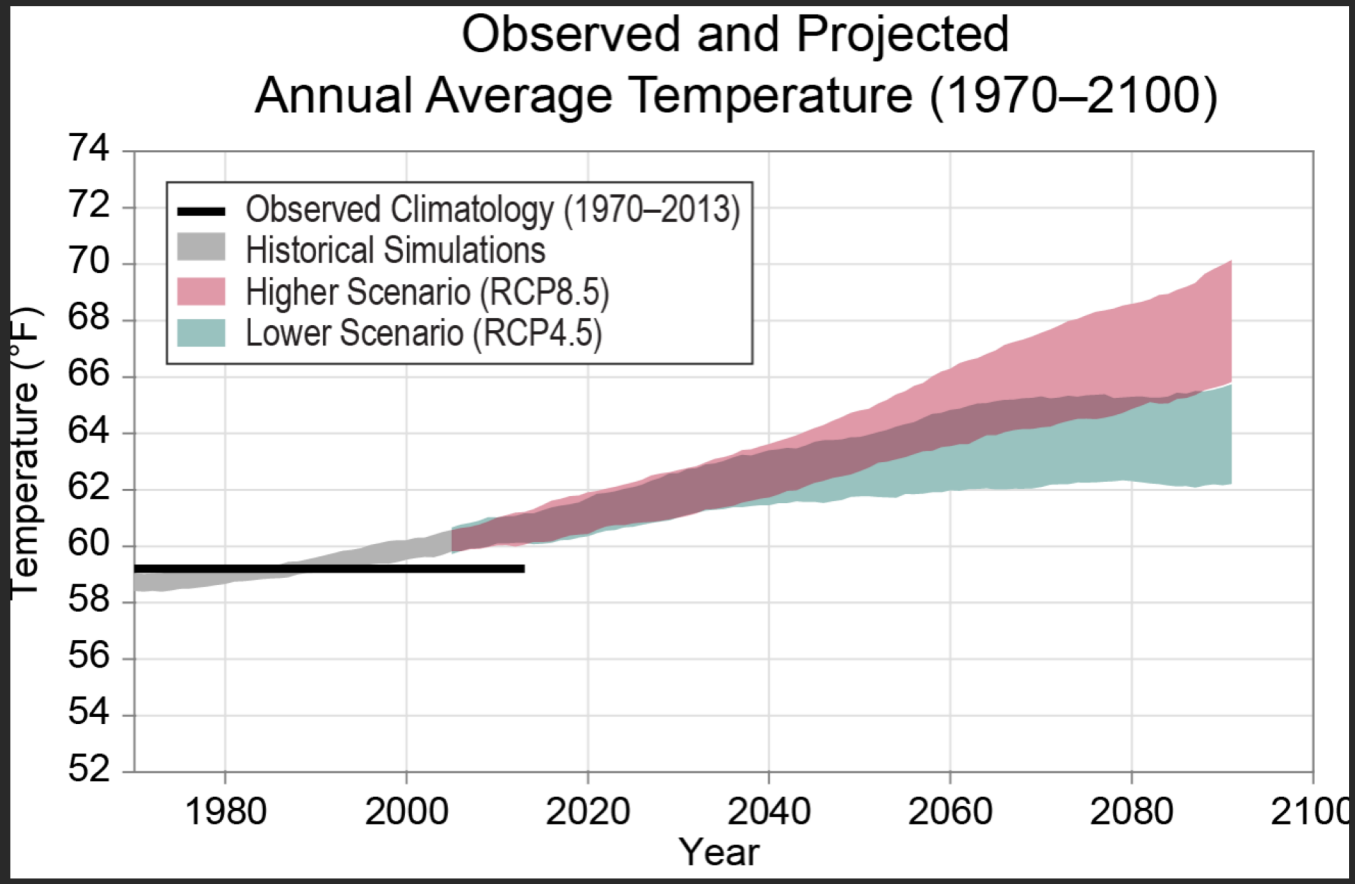
Report Findings – Temperature

- ➔ 2009–2018: warmest 10-year period on record in North Carolina*
- ➔ 0.6°F warmer than the warmest decade in the 20th century (1930–1939)
- ➔ *2019:
  - warmest year on record for NC
  - second-warmest globally



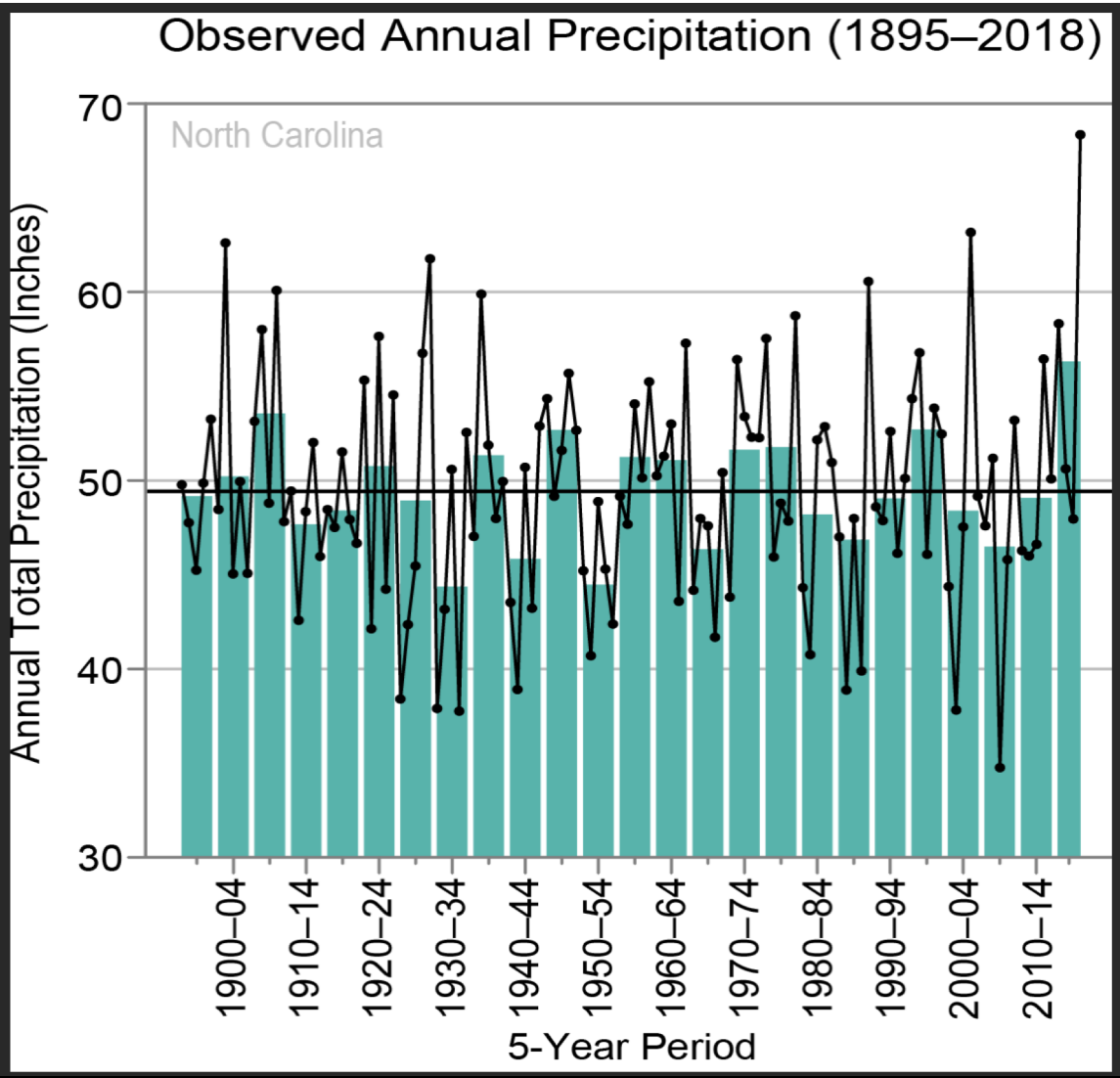
Report Findings – Temperature

- ➔ ***Very likely*** that NC temperatures will increase substantially in all seasons
- ➔ ***Very likely*** increase in number of very warm nights
- ➔ ***Likely*** increase in number of hot days
- ➔ ***Likely*** decrease in number of cold days



Report Findings – Precipitation

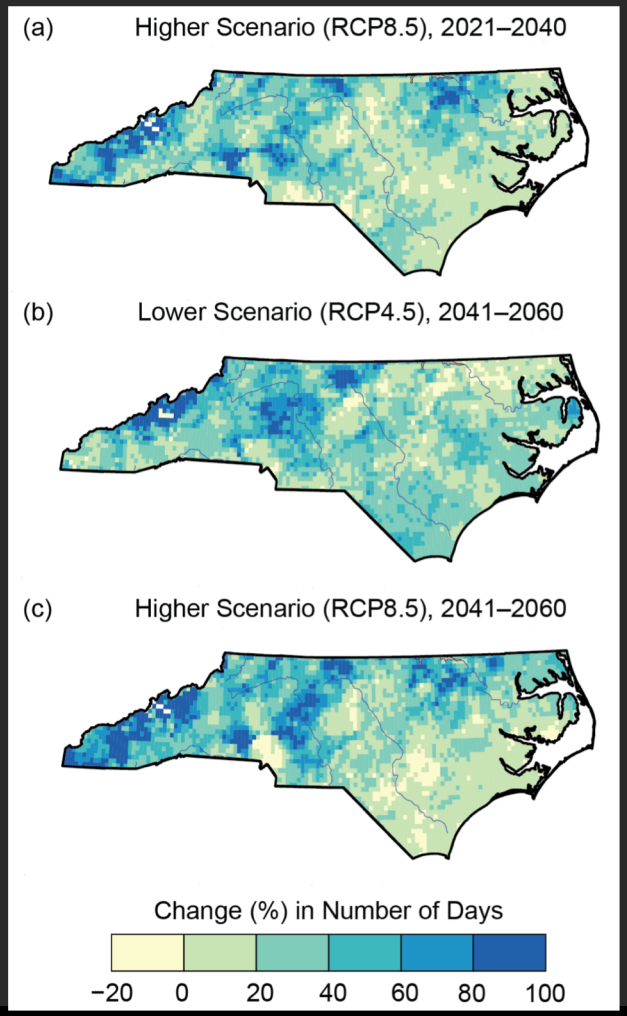
- ➔ No long-term trend in annual total precipitation averaged across the state
- ➔ 2018 wettest on record (includes Florence)
- ➔ Upward trend in number of heavy rainfall events
- ➔ 2015–2018 saw largest number of heavy precipitation events



Report Findings – Precipitation

- ***Likely*** that annual total precipitation for North Carolina will increase
- ***Virtually certain*** that atmospheric water vapor content over North Carolina will rise due to warming of ocean and atmosphere
- As a result, it is ***very likely*** that extreme precipitation frequency and intensity in North Carolina will increase

Projected Changes in Annual Number of Extreme Precipitation Events (Days with ≥3")



Report Findings – Sea Level

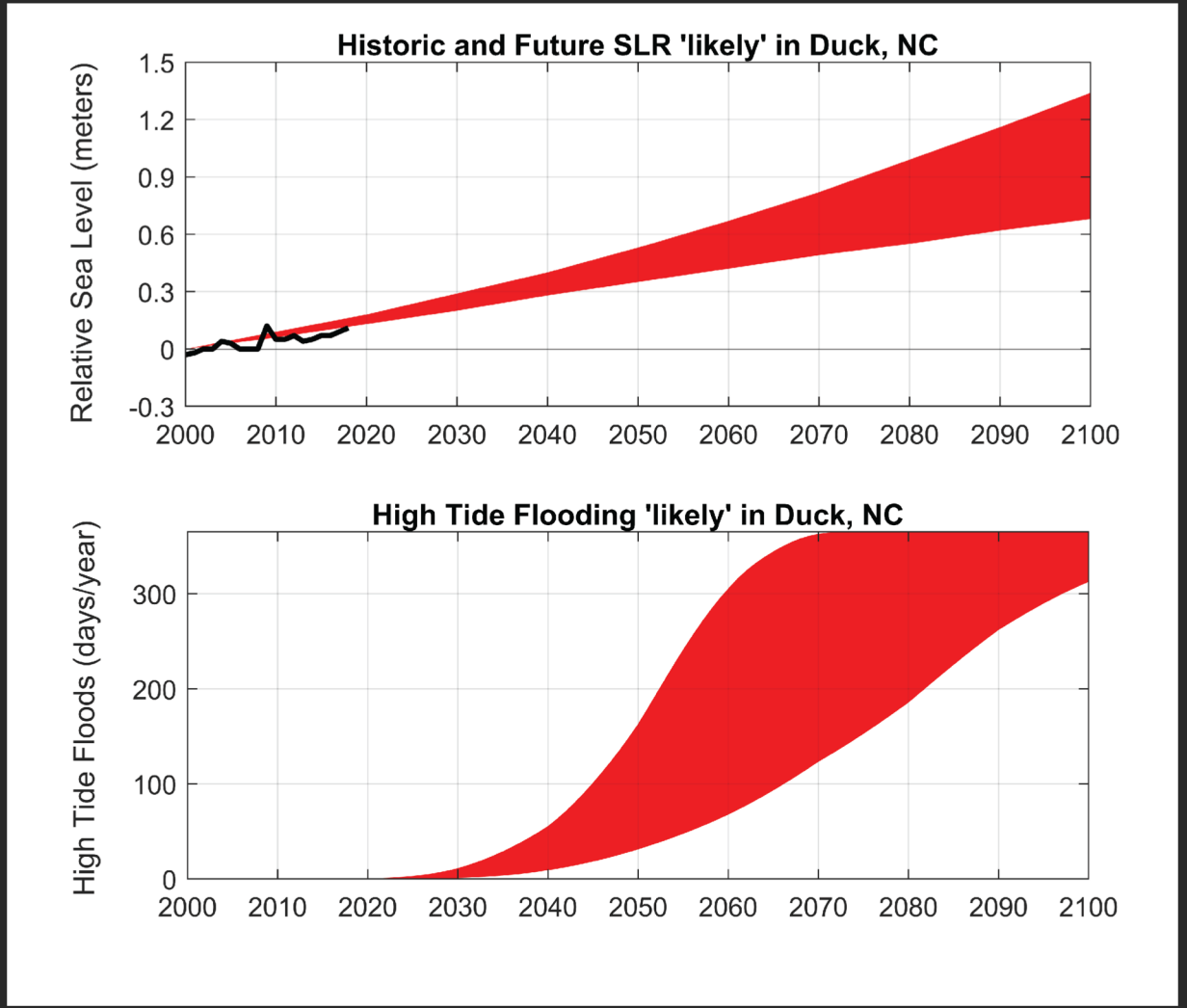
➔Sea level is rising about twice as fast along the northeastern coast of North Carolina as along the southeastern coast

- 1.8 inches per decade at Duck, NC
- 0.9 inches per decade at Wilmington, NC

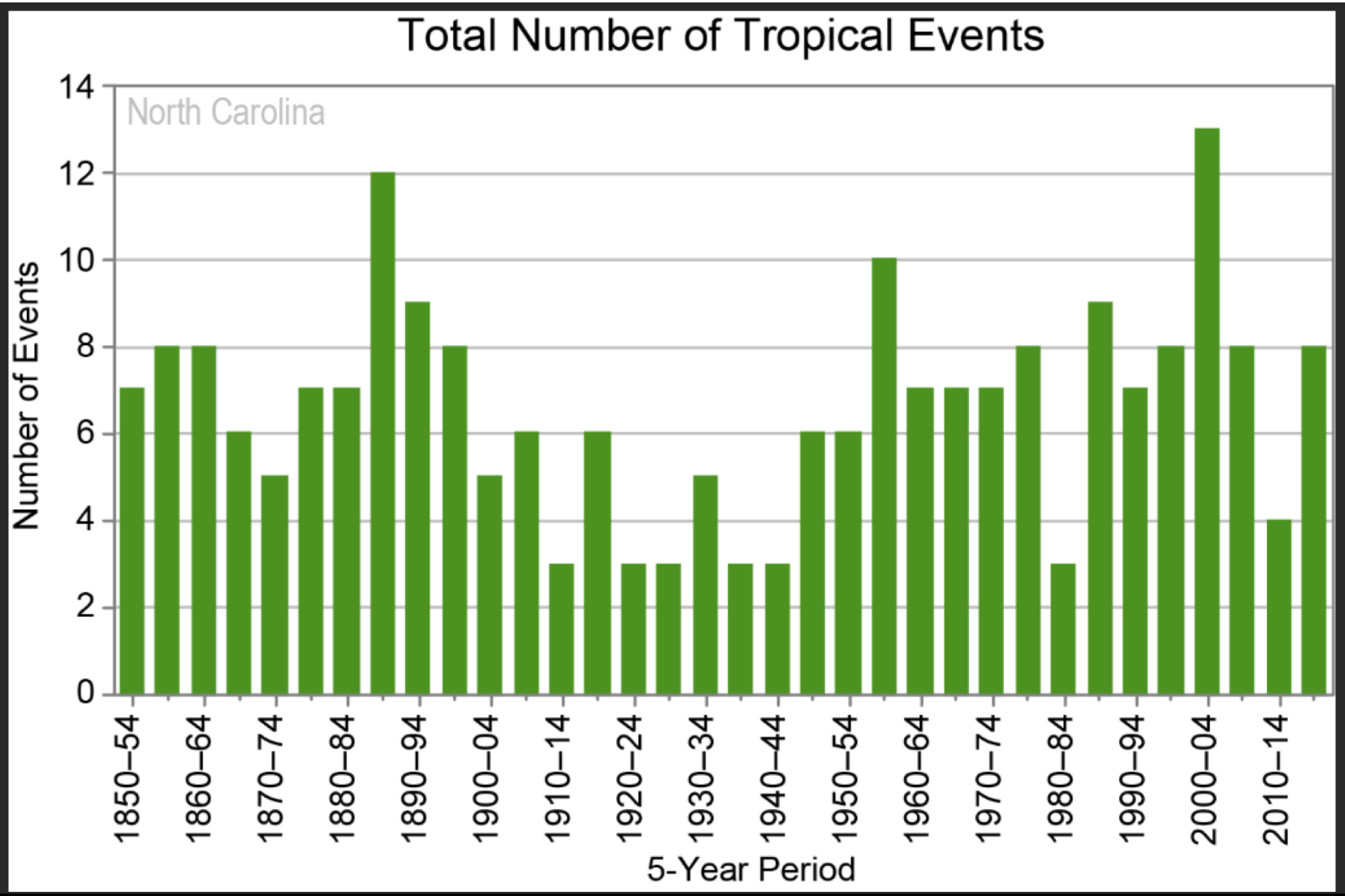
Report Findings – Sea Level

- ➔ ***Virtually certain*** that sea level will continue to rise along North Carolina coast
- ➔ Storm-driven high water levels that have a 1% chance of occurring each year now may increase to 30-100% by the end of the century under the higher emissions scenario
- ➔ High tide flooding projected to become nearly a daily occurrence by 2100

Report Findings – Sea Level



Report Findings – Hurricanes



Report Findings – Hurricanes

- ➔ Hurricanes are driven by high amounts of water vapor
- ➔ Hurricanes develop and intensify over warm ocean waters (because water vapor is high)
- ➔ Other factors are necessary, particularly low wind shear, for hurricane formation and development

Report Findings – Hurricanes

- ➔ Intensity of strongest hurricanes ***likely*** to increase
- ➔ Could result in stronger hurricanes impacting North Carolina
- ➔ ***High confidence*** for global changes, but ***medium*** confidence for North Carolina

Report Findings – Hurricanes

- ➔ Heavy precipitation accompanying hurricanes passing near or over North Carolina is ***very likely*** to increase
  - ◆ increasing freshwater flood potential in the state

- ➔ ***Low confidence*** concerning future changes in the number of landfalling hurricanes in North Carolina

Report Findings – Storms

- ***Likely*** that frequency of severe thunderstorms will increase
- ***Likely*** that total snowfall and number of heavy snowstorms will decrease due to increasing winter temperatures
- ***Low confidence*** concerning future changes in number of winter coastal storms and ice storms

Report Findings – Floods

- ***Virtually certain*** that rising sea level and increasing intensity of coastal storms, especially hurricanes, will lead to increases in storm surge flooding in coastal North Carolina

- ***Likely*** that increases in extreme precipitation will lead to increases in inland flooding

Report Findings – Compound Events/Impacts

➔ ***Likely*** that severe droughts will be more intense in the future
- ◆ higher temperatures leading to increased evaporation

➔ As a result, ***likely*** increase in the frequency of climate conditions conducive to wildfires

Report Findings – Compound Events/Impacts

- ***Likely*** that urban growth will increase magnitude of urban heat island effect, resulting in stronger warming in urban centers

- ***Low confidence*** concerning future changes in conditions favorable for near-surface ozone formation
  - counteracting influences from increases in both temperature and water vapor

Report Findings – Infrastructure Design

- ***Very likely*** that some current climate design standards for North Carolina buildings and other infrastructure will change by the middle of this century
  - Includes increases in design values for precipitation and dry-bulb and wet-bulb temperatures

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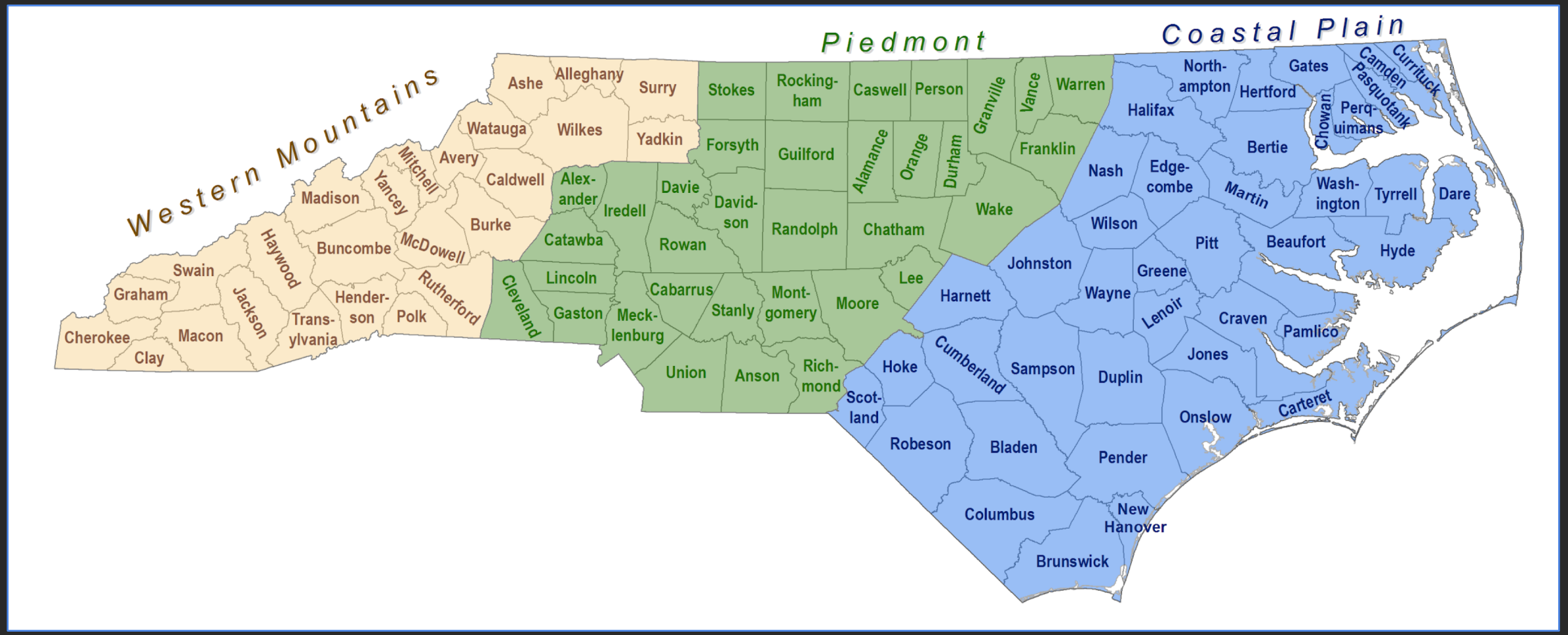
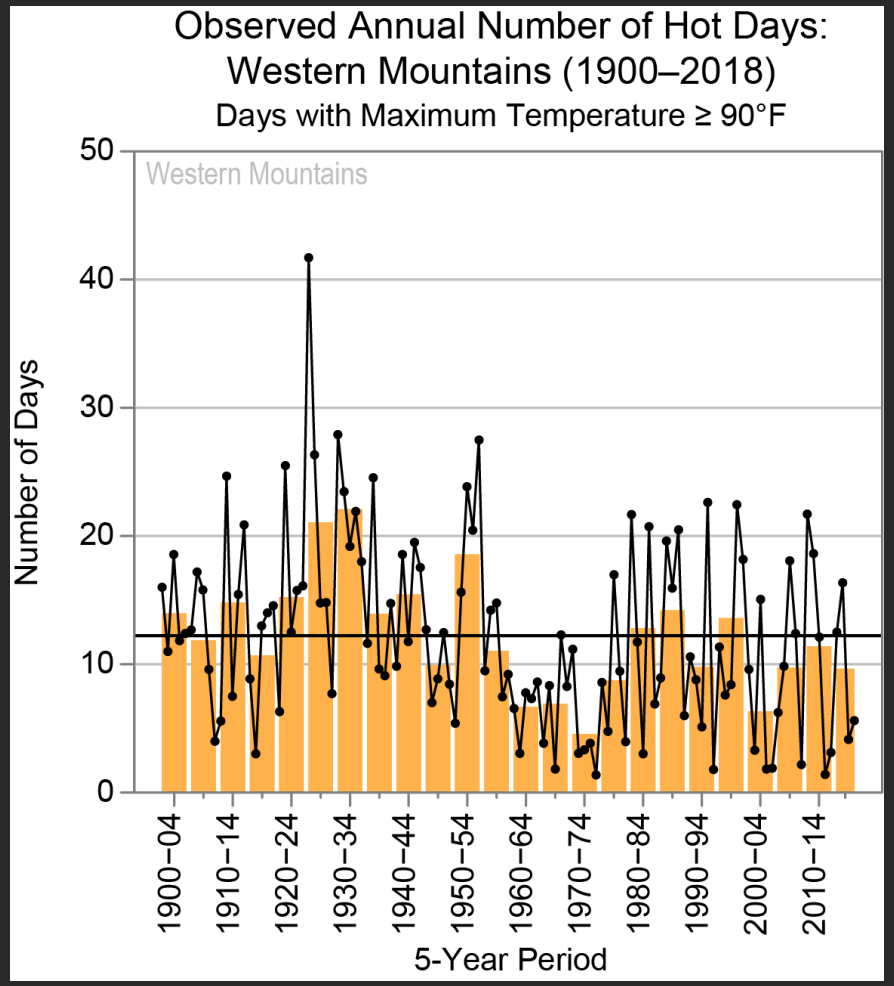
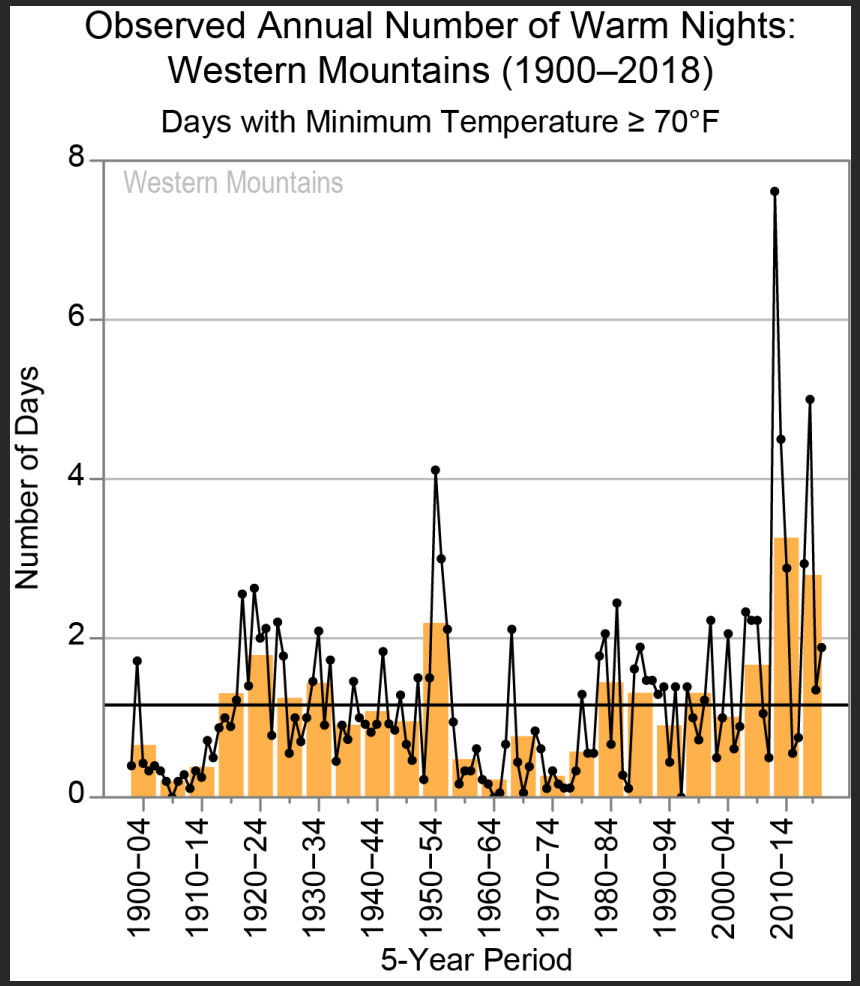
Regional Highlights



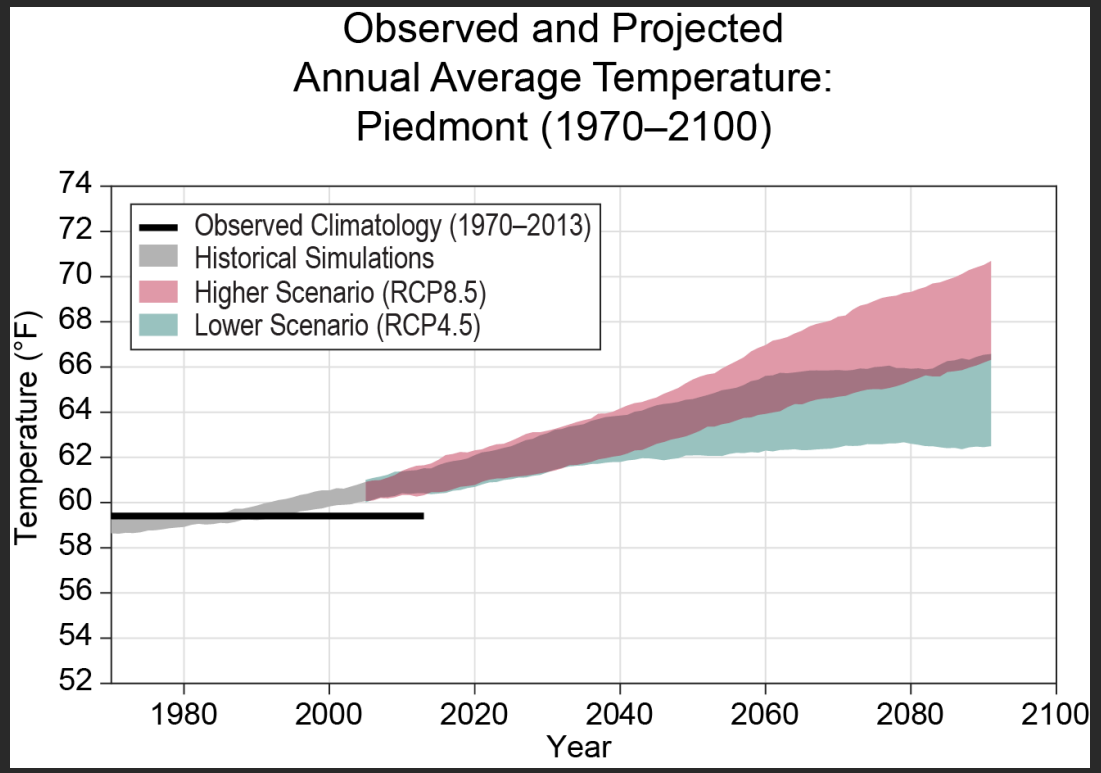
The report includes standalone sections for these three regions

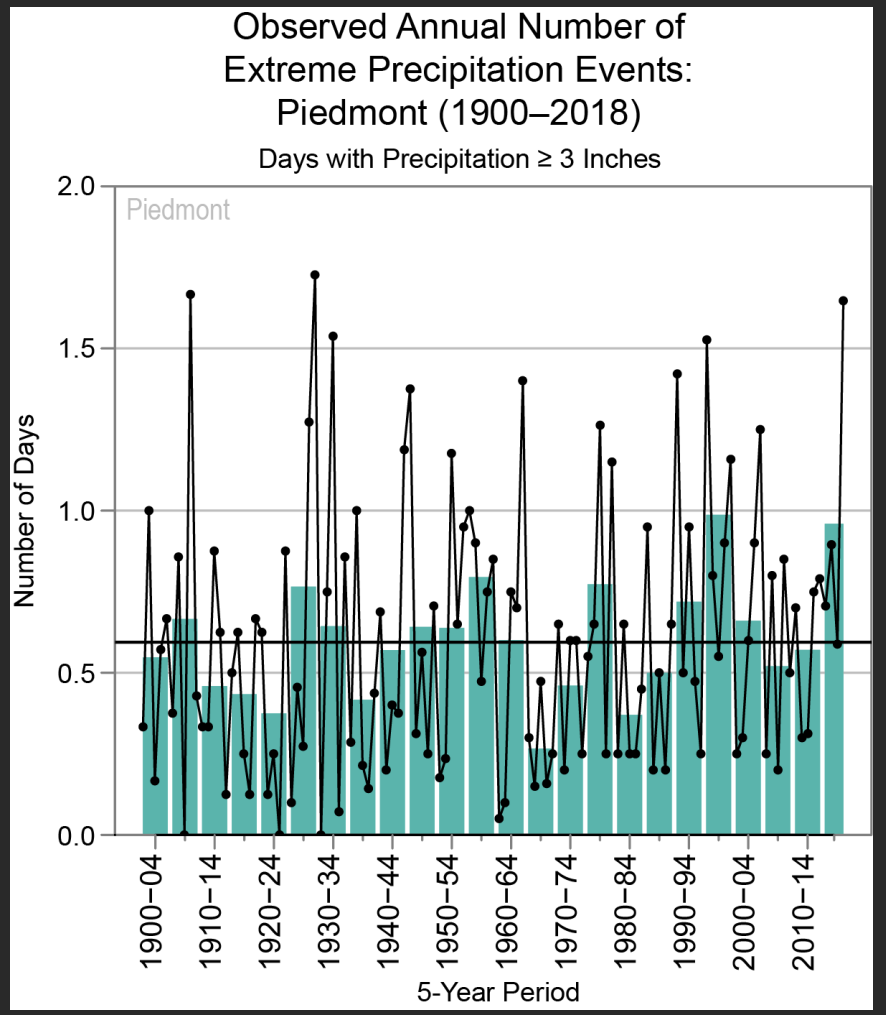
Regional Examples — Western Mountains



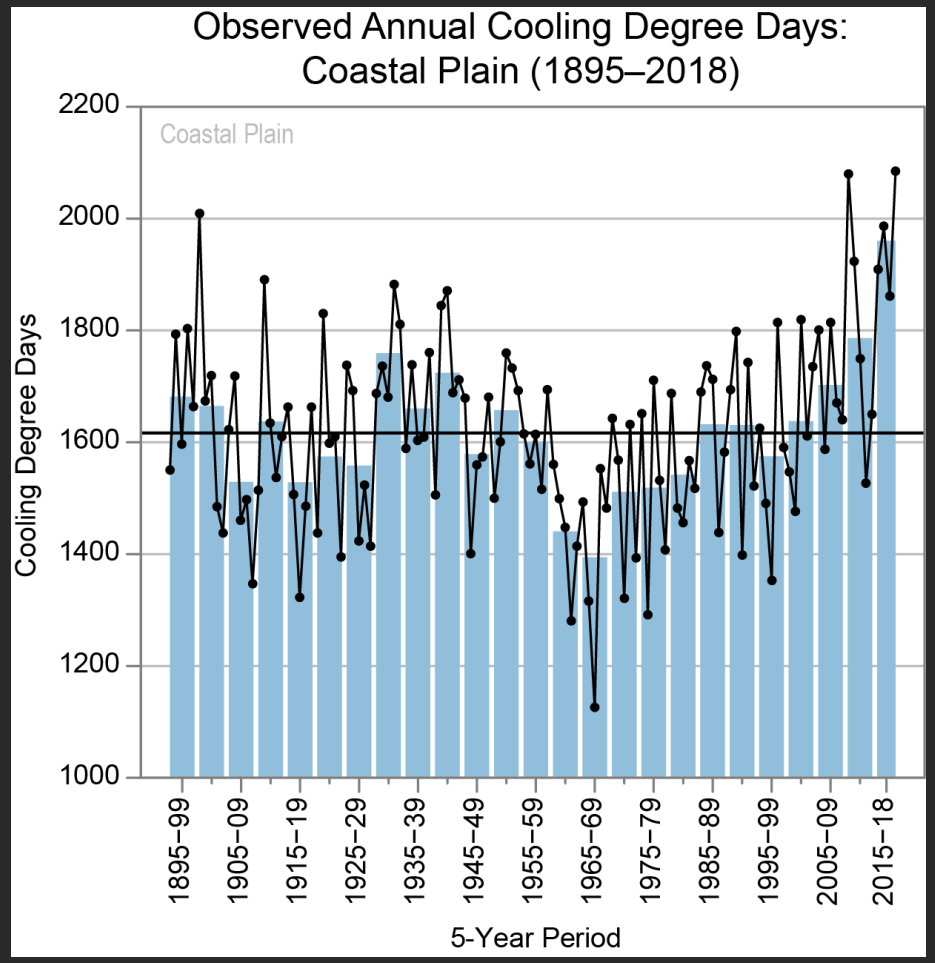


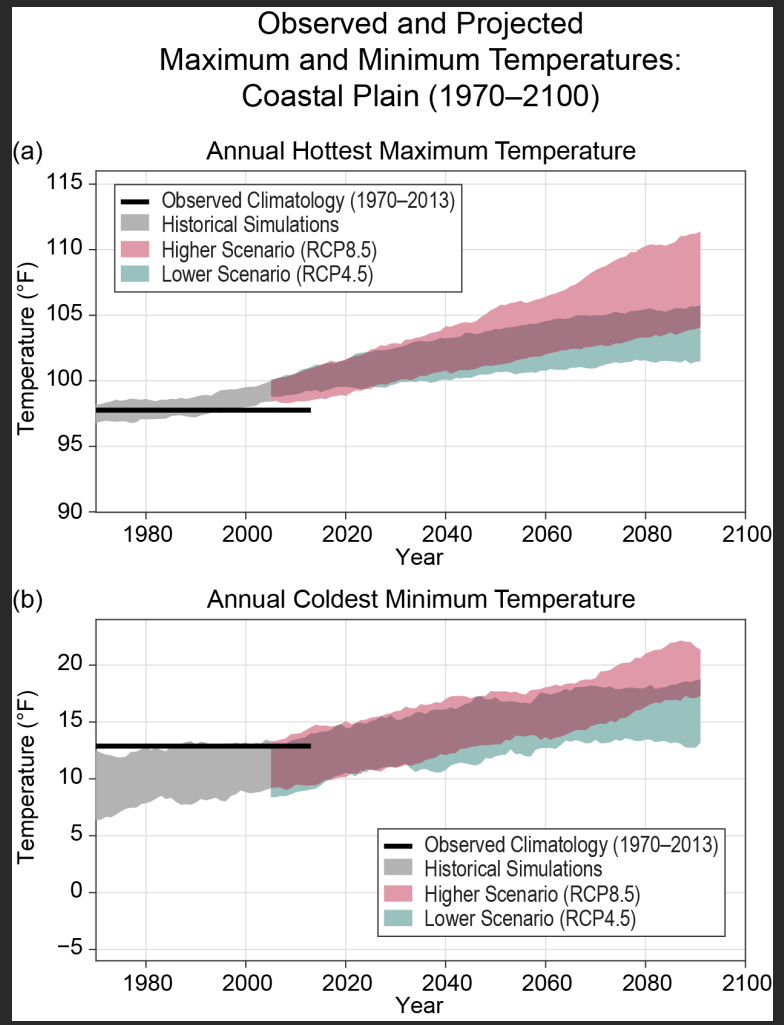
Regional Examples — Piedmont





Regional Examples — Coastal Plain





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Final Thoughts

Large future climate changes for North Carolina if our current reliance on fossil fuels for energy continues

- ➔ Temperatures outside of historical envelope
- ➔ Disruptive sea level rise
- ➔ Increases in intensity and frequency of extreme rainfall
- ➔ More intense hurricanes
- ➔ Higher absolute humidity levels

Thank you

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Thank you

Questions and Discussion

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