North Carolina

# Climate Change Interagency Council

## Executive Order No. 80: NC's Commitment to Address Climate Change and Transition to a Clean Energy Economy

*6th Meeting*

*January 22, 2020*

*Raleigh, North Carolina*

# *Meeting Agenda & Objectives*

**1. Welcome and Introductions (15 mins)** **1:30-1:45**

a. Welcoming remarks (DEQ)
b. Introductions (Council designees)
c. Meeting objectives (Sushma Masemore, DEQ)

**2. North Carolina Climate Science Report (75 mins)** **1:45-3:00**

a. NOAA Technical Support for NCCSR (David Easterling, NOAA)
b. Overview and key findings of the North Carolina Climate Science Report (Kenneth Kunkel, NCICS)
c. Q&A from NC Institute for Climate Studies

**3. NC Risk Assessment and Resilience Plan (10 mins)** **3:00-3:10**

a. Plan Status Update (Sushma Masemore, DEQ)

**4. Break (10 mins)** **3:10-3:20**

**5. Public engagement (25 mins)** **3:20-3:45**

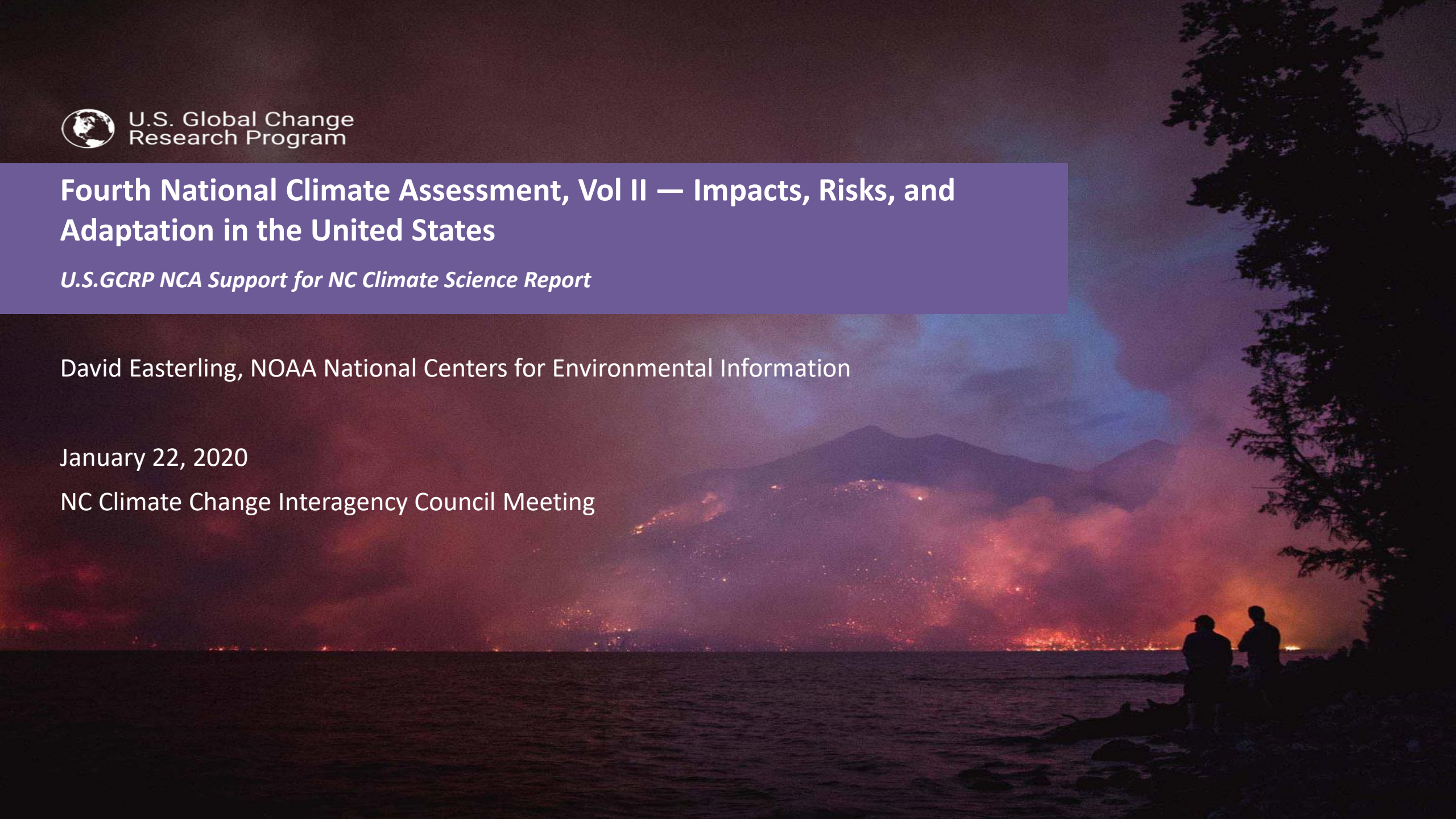
a. Individuals and organizations may provide input to cabinet agencies on their implementation of the EO. Oral presentations will be limited to 2 minutes. Sign-up will be required upon arrival.

# Council Introductions

# N.C. Climate Science Report

*North Carolina Institute for Climate Studies*

North Carolina
**Climate Change Interagency Council**



U.S. Global Change Research Program

# Fourth National Climate Assessment, Vol II — Impacts, Risks, and Adaptation in the United States

***U.S.GCRP NCA Support for NC Climate Science Report***

David Easterling, NOAA National Centers for Environmental Information

January 22, 2020

NC Climate Change Interagency Council Meeting

# Key Messages

## The NC Climate Science report

- Applies methodologies and processes developed for the **National Climate Assessment**
- Leverages and builds upon the expertise of **NOAA's Assessments Technical Support Unit (TSU)**
  - Comprised of NCICS and NOAA NCEI experts in Assessments
- Hence,
  - The NCCSR is a robust, peer-reviewed climate science report
  - The TSU role also entails compliance with the Evidence Act, ensuring traceability and validity for data and information used in the analysis for the report.

# 1 Federal Role and Context

## U.S. Global Change Research Program

- USGCRP began as a Presidential initiative in 1989
- Mandated by Congress in the U.S. Global Change Research Act (GCRA) of 1990 "to assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change"
- Overseen by Principals representing the 13 member agencies of the Subcommittee on Global Change Research (SGCR)

# 4 Federal Context

## National Climate Assessment (NCA) in the GCRA

*GCRA (1990), Section 106:*

Not less frequently than every 4 years [USGCRP] shall prepare and submit to the President and Congress an assessment which:

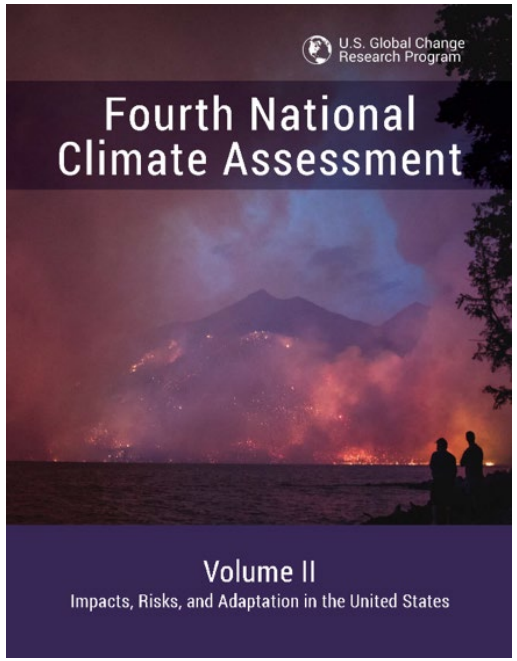
- Integrates, evaluates, and interprets the findings of [USGCRP] and discusses the scientific uncertainties associated with such findings
- Analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity
- Analyzes current trends in global change, both human- induced and natural, and projects major trends for the subsequent 25 to 100 years.

# 5 Federal Context

## NCA 4 is a two-volume effort


Released Nov 3, 2017

Read and download the report at
**science2017.globalchange.gov**



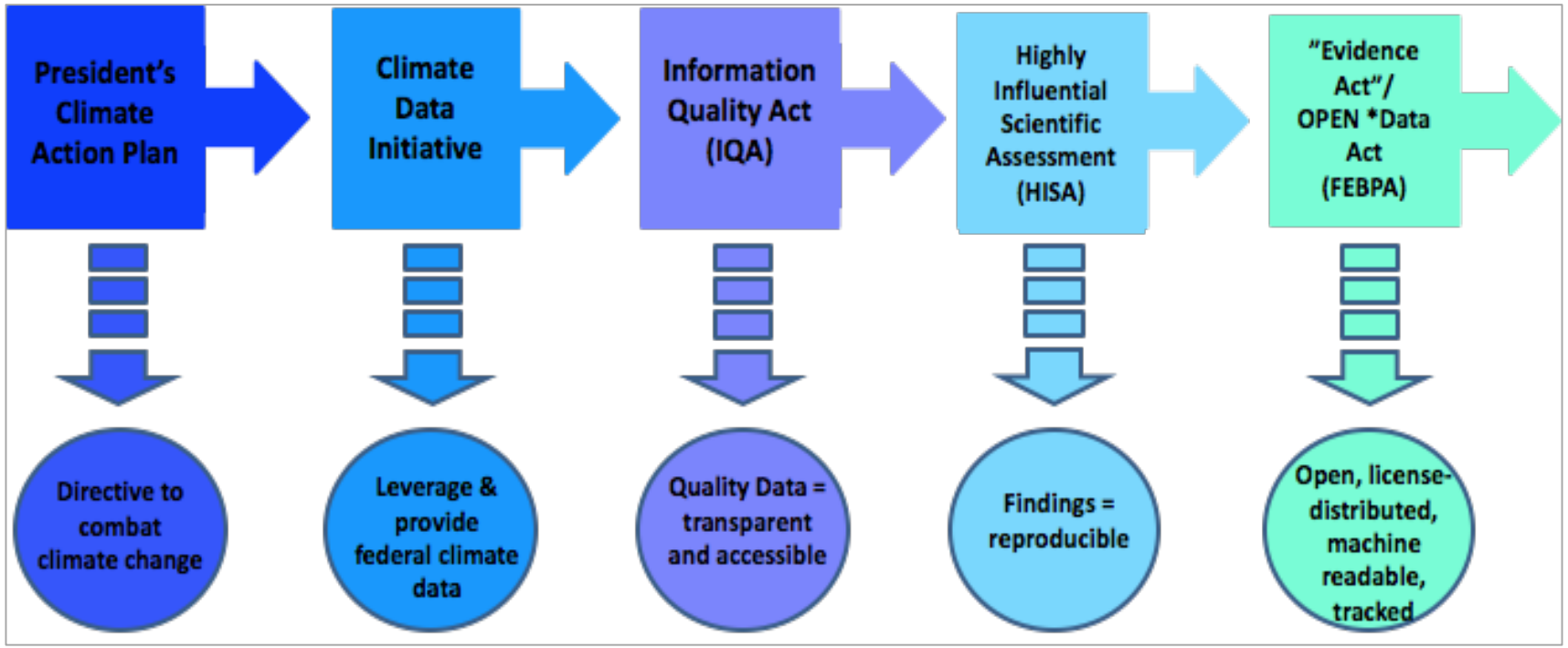

Released Nov 23, 2018

NCA4 Vol II will be available at
**nca2018.globalchange.gov**

# 6 NCA → NCCSR

## NC CSR: Information Quality & Integrity

## NC CSR will use the National Climate Assessment Guiding Principles and the Extensive Peer-Reviewed Findings



# 7 NCA → NCCSR

## NCA Process Provides Guidance for NCCSR

- ✓ Draw on a wide range of scientific and technical inputs
- ✓ Operate on clear science communication principles
- ✓ Ensure transparency of process and information
- ✓ Employ an extensive review process
- ✓ Describe and document the process and rationale used for reaching conclusions
- ✓ Include calibrated confidence level and, where appropriate, likelihood
- ✓ Identify areas with limited and/or emerging data or scientific uncertainty

# Thank you

**For more information:**

- **nca2018.globalchange.gov**
- **David.Easterling@noaa.gov**

NCICS
North Carolina Institute for Climate Studies

## NC Executive Order 80 – Section 9

# North Carolina Climate Science Report

**NC Climate Change Interagency Council Meeting**
**January 22, 2020 | Museum of Natural History**

**Kenneth E. Kunkel[1] & David R. Easterling[2]**
**NCICS Technical Support Unit and Engagement Staff[1]**

*[1]North Carolina Institute for Climate Studies, North Carolina State University*
*NOAA Cooperative Institute for Satellite Earth System Studies (CISESS)*
*[2]NOAA National Centers for Environmental Information (NOAA NCEI)*

NC STATE UNIVERSITY

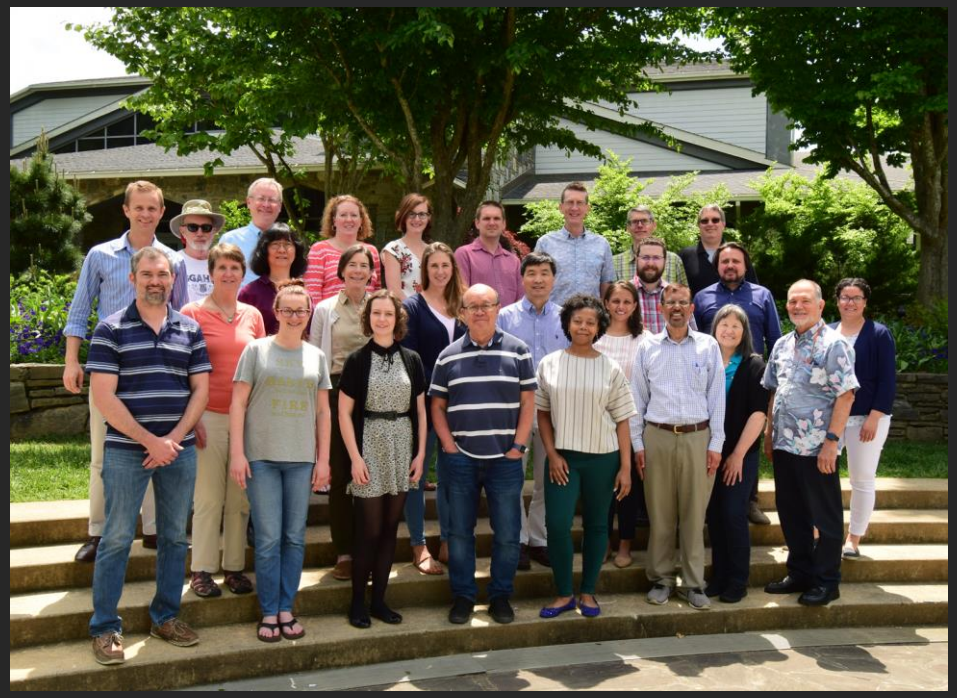
# Agenda

- ➔ **NCICS – Who We Are**
- ➔ **North Carolina Climate Science Report (NC CSR)**
  - ◆ Report Development Process and Team
- ➔ **NC Climate Science Report**
  - ◆ Report Findings
  - ◆ Regional Highlights (preliminary)

# Who We Are

## North Carolina Institute for Climate Studies (NCICS)
## Cooperative Institute for Satellite Earth System Studies (CISESS)

*ncics.org/programs/cisess*



- ➔ NCICS's primary activity is the Cooperative Institute for Satellite Earth System Studies (CISESS)—a NOAA/NC State University Cooperative Institute
- ➔ Co-located with NOAA's National Centers for Environmental Information (NCEI) in Asheville, NC
- ➔ CISESS is a multidisciplinary team of experts collaborating in climate and satellite research to support NCEI's "research to operations" strategy
  - ◆ Includes the NOAA Technical Support Unit for the National Climate Assessment

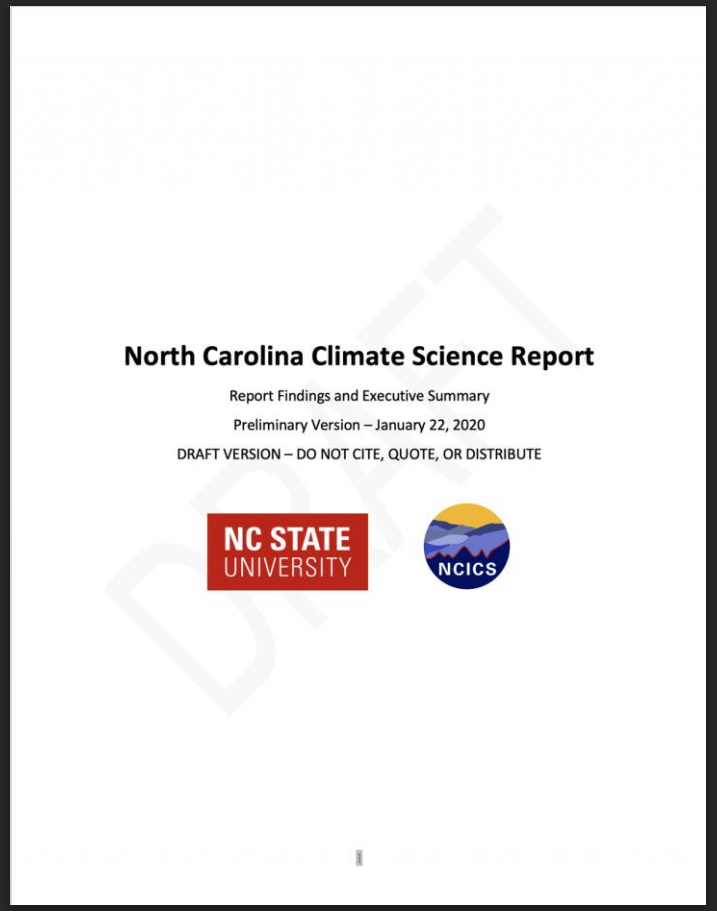
[March 2019 Newsletter]

# NC Climate Science Report: Overview

*A comprehensive report on the state of the science for North Carolina*

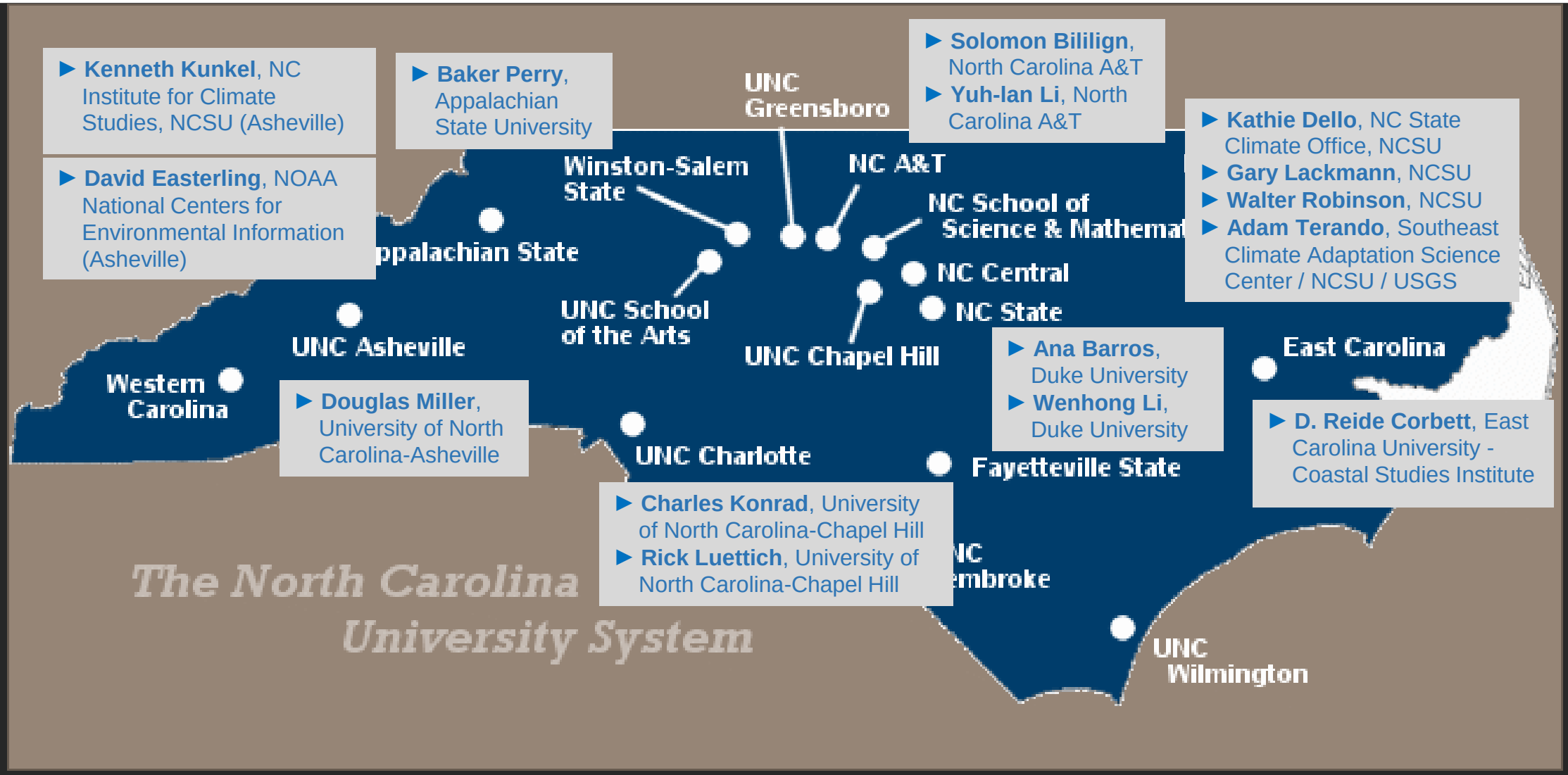
### *Key Inputs*

- ➔ National Climate Assessment
- ➔ North Carolina State Climate Summary
- ➔ Peer-reviewed scientific literature
- ➔ Climate science expertise of authors, advisory panel, and reviewers
- ➔ NC Departments and Cabinet Designees needs

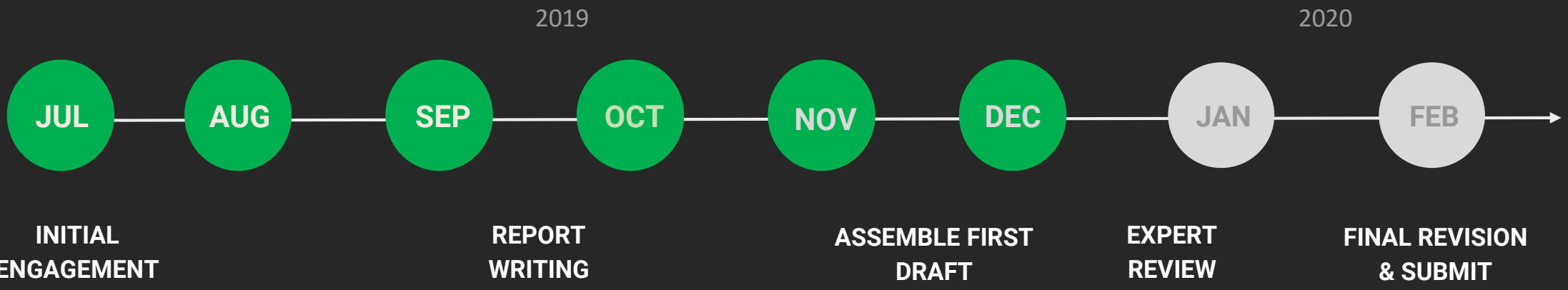



Report serves as the scientific contribution to the North Carolina Risk and Resiliency Report as part of Section 9 of Executive Order 80

# NC CSR: Climate Science Advisory Panel

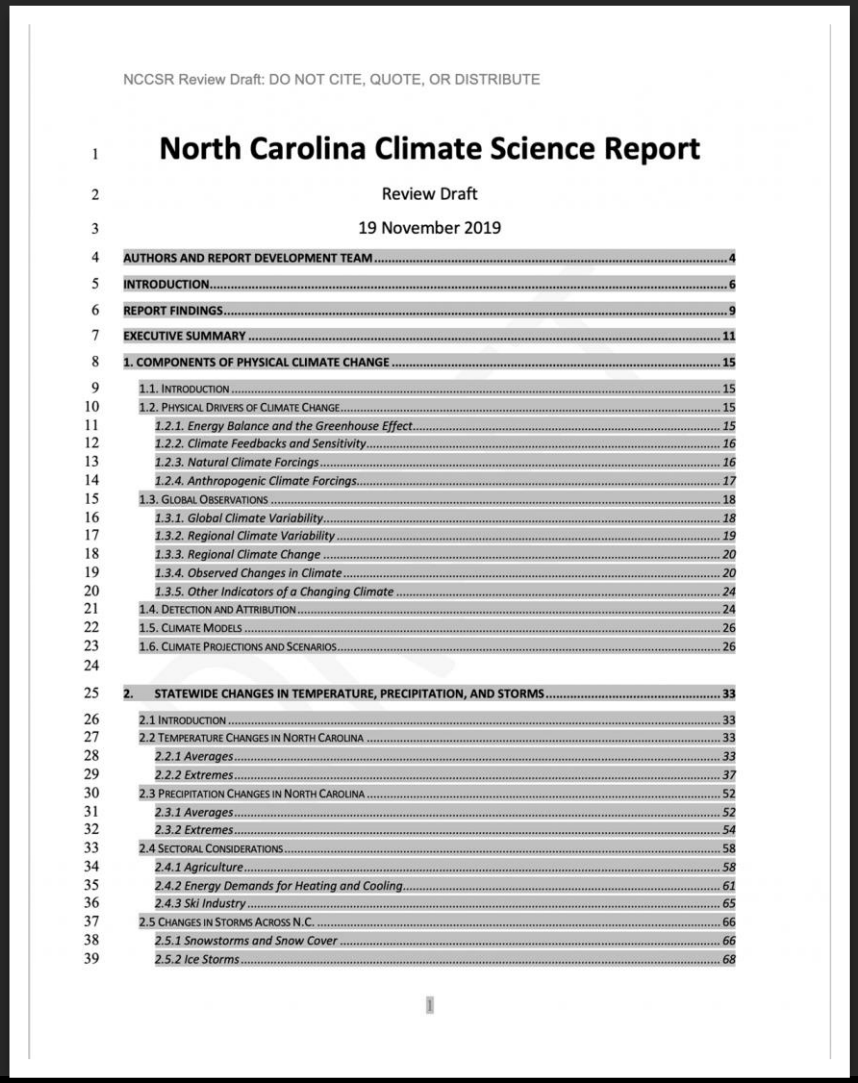


# NC CSR: Timeline




NC Risk Assessment and Resiliency Plan Activities

# NC CSR - Report



NCCSR Review Draft: DO NOT CITE, QUOTE, OR DISTRIBUTE

## North Carolina Climate Science Report

Review Draft

19 November 2019



- ☑ Global State of the Science
- ☑ Historical Changes in NC
- ☑ Projections for NC

# Climate Science Consensus

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

# 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.

*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 |

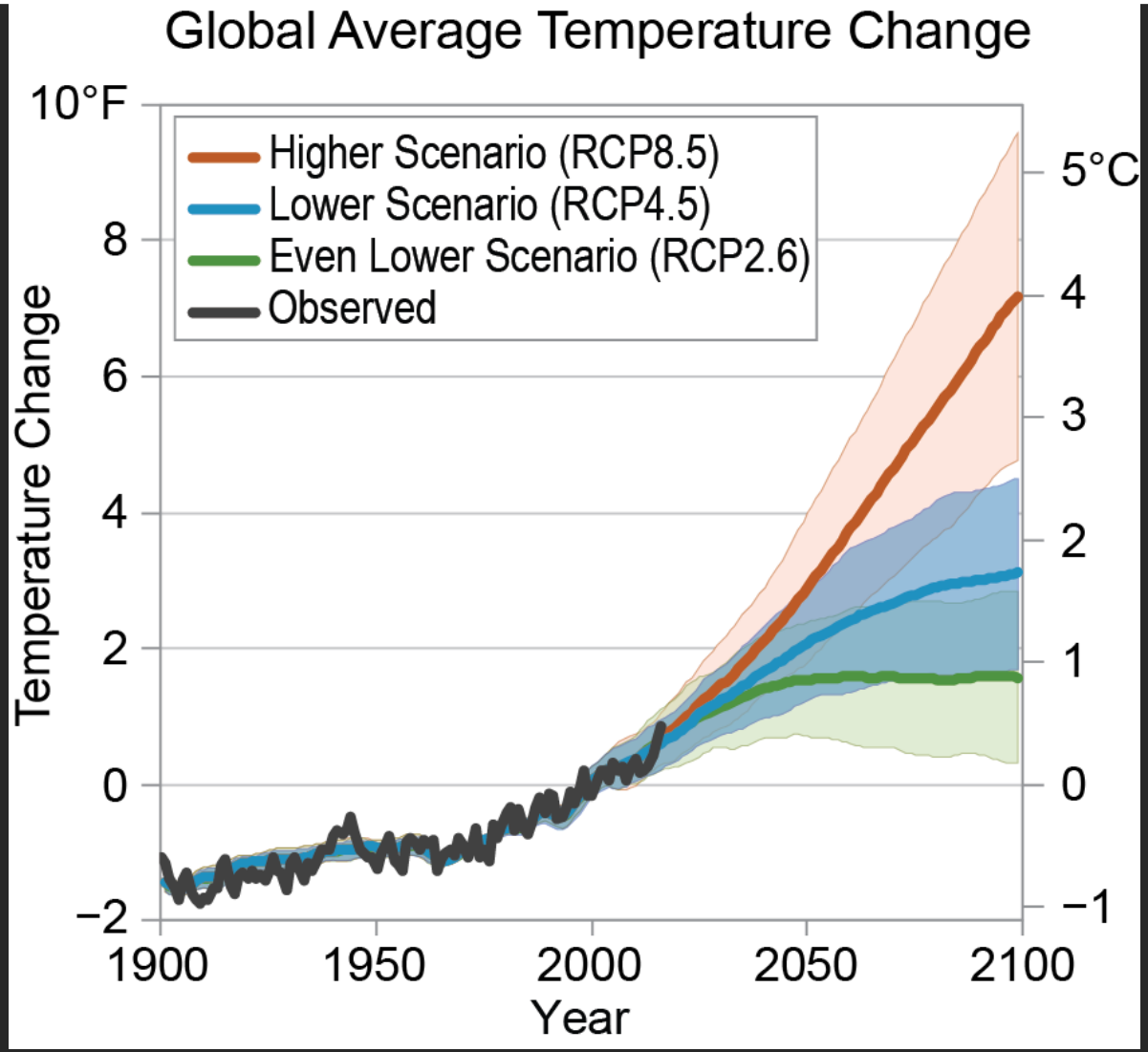
# Global Context – Temperature

- ➔ 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

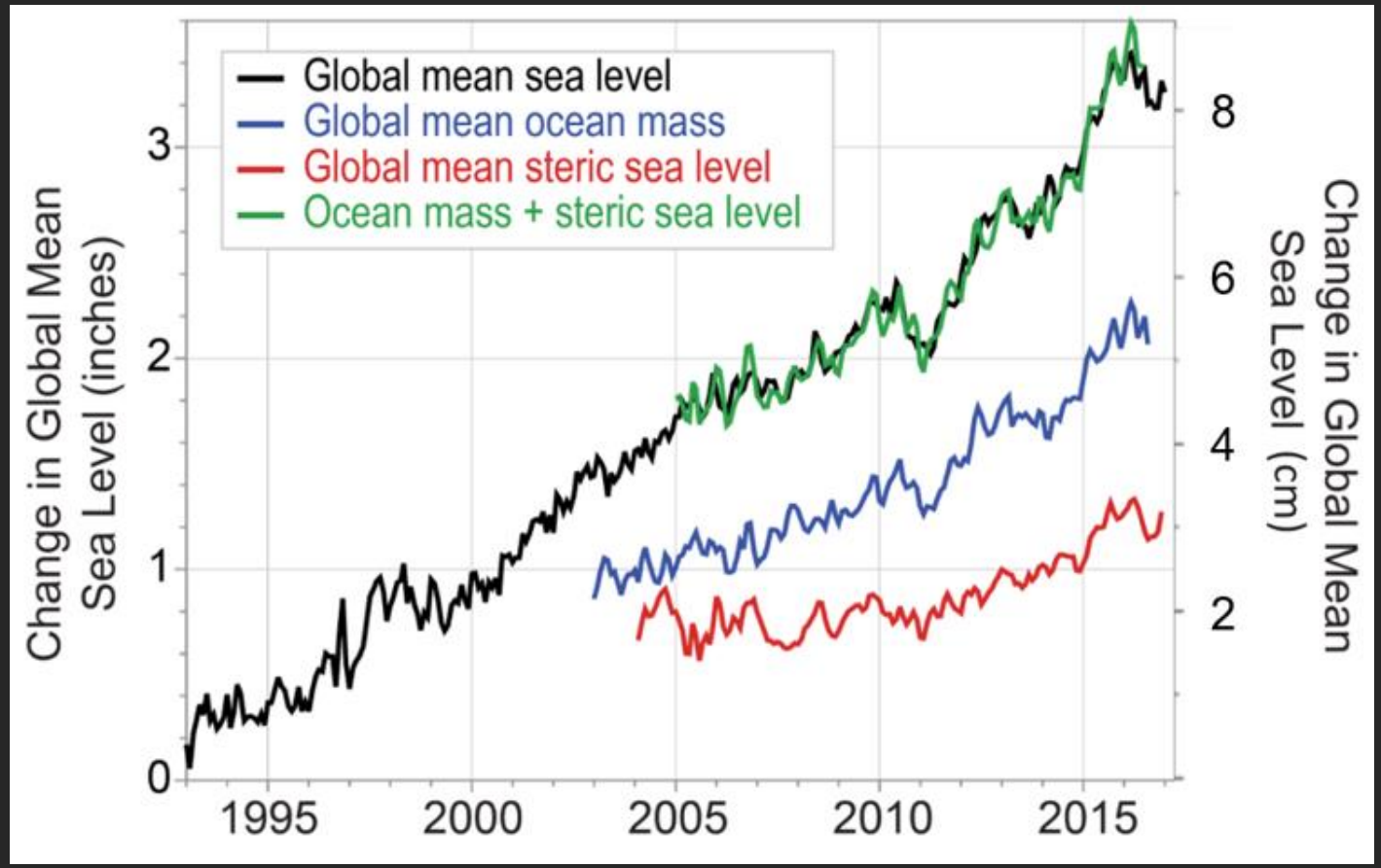
➔ Projected global temperature increases for 2080–2099 compared to 1986–2015:

- about 4°– 9°F under a higher scenario (RCP8.5)
- about 2°– 4°F under a lower scenario (RCP4.5)



# Global Context – Sea Level

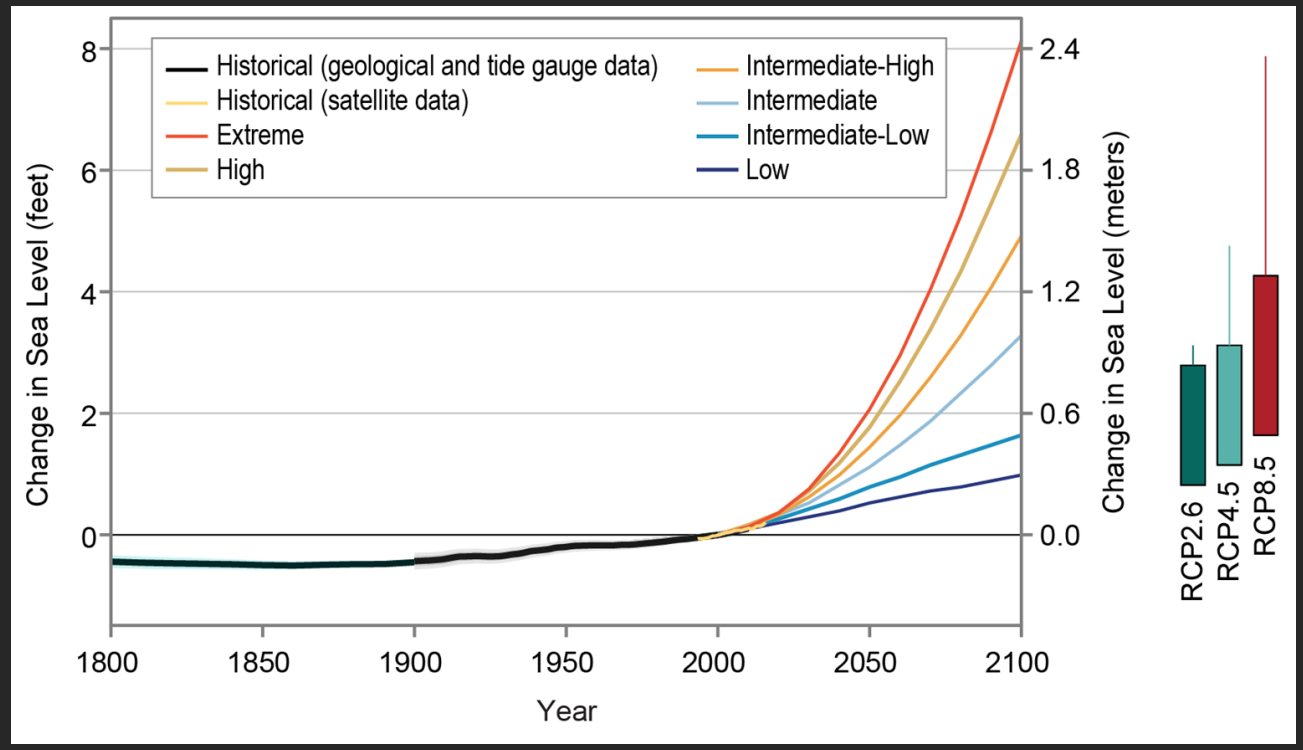
- ➔ Global average sea level has increased by about 7– 8 inches since 1900
- ➔ Almost half of this increase since 1993



# 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

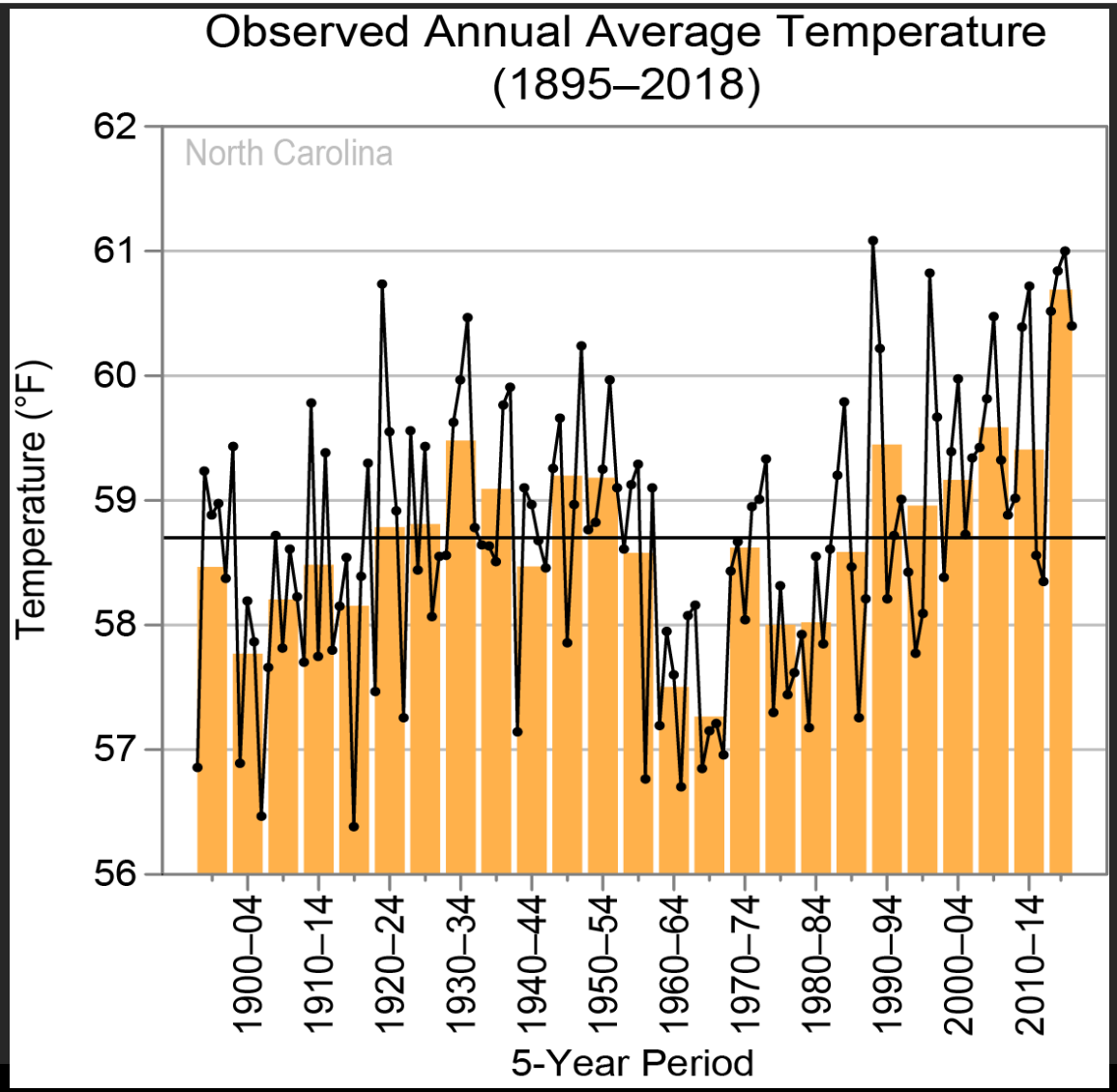


# Report Findings

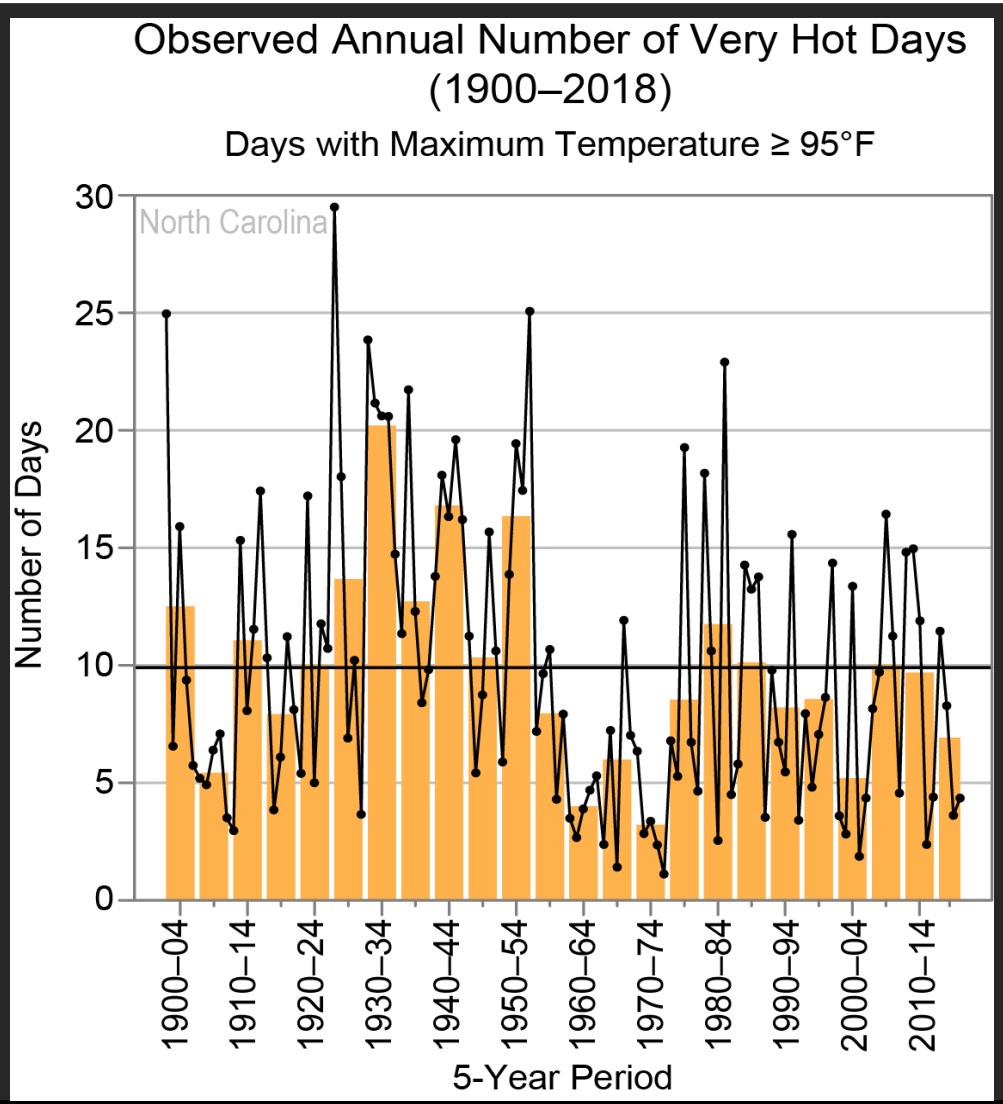
Large changes in North Carolina's climate—much larger than at any time in the state's history—are ***very likely*** by the end of this century under both the lower and higher scenarios.

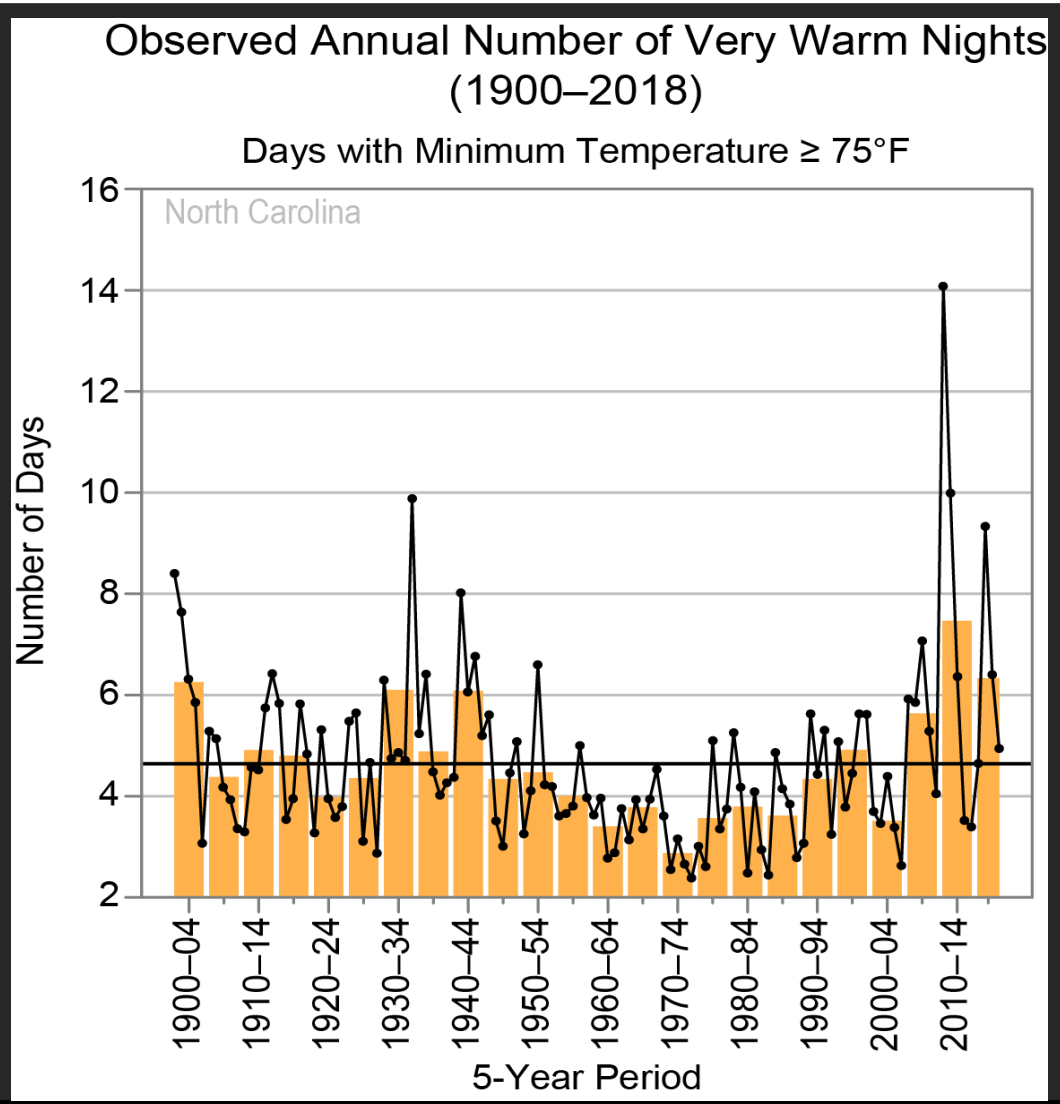
# Report Findings – Temperature

- ➔ 2009–2018: warmest 10-year period on record in North Carolina*
- ➔ 1.2°F above the long-term (1895–2018) average
- ➔ 0.6°F warmer than the warmest decade in the 20th century (1930–1939)
- ➔ *2019:
  - ◆ warmest year on record for NC
  - ◆ second-warmest globally



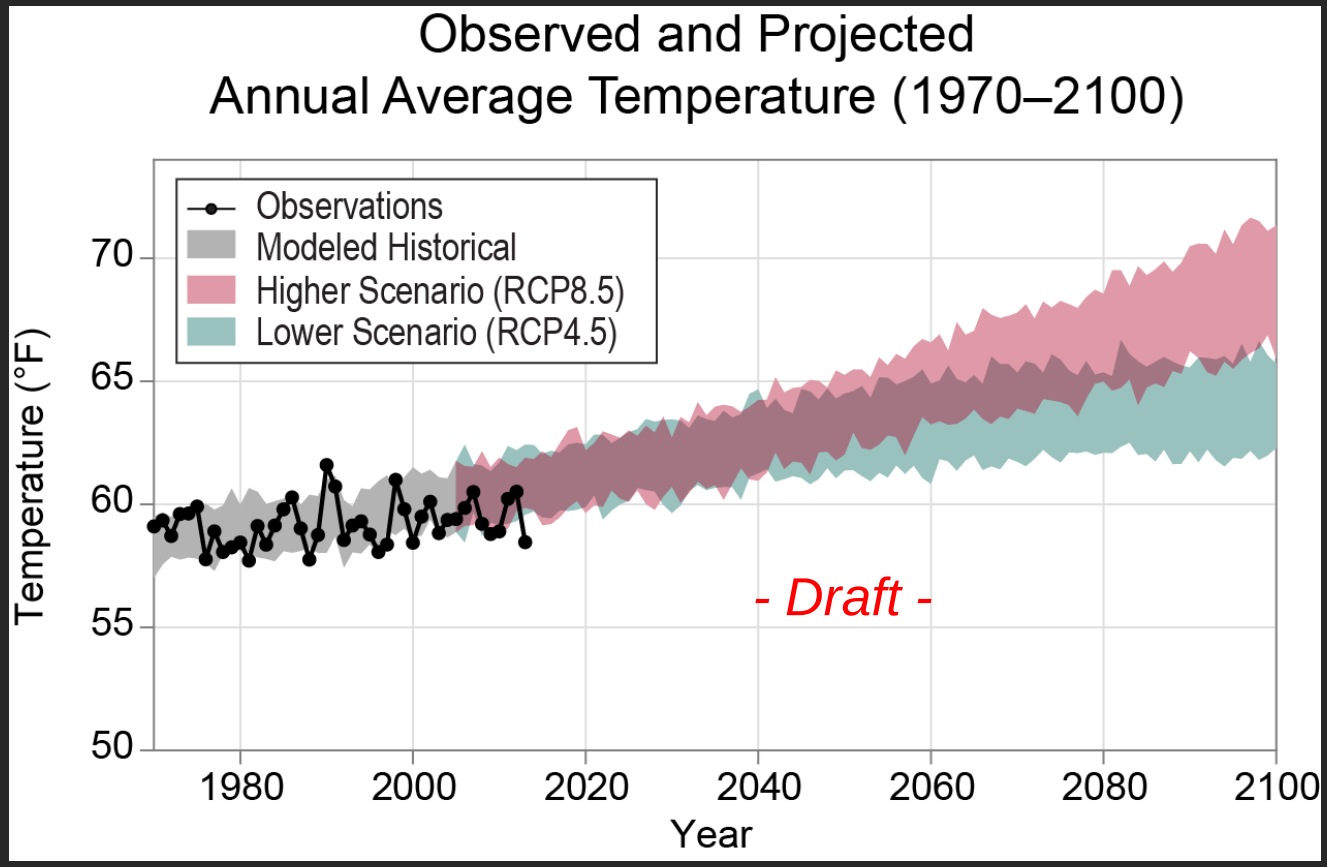
# Report Findings – Temperature



# 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

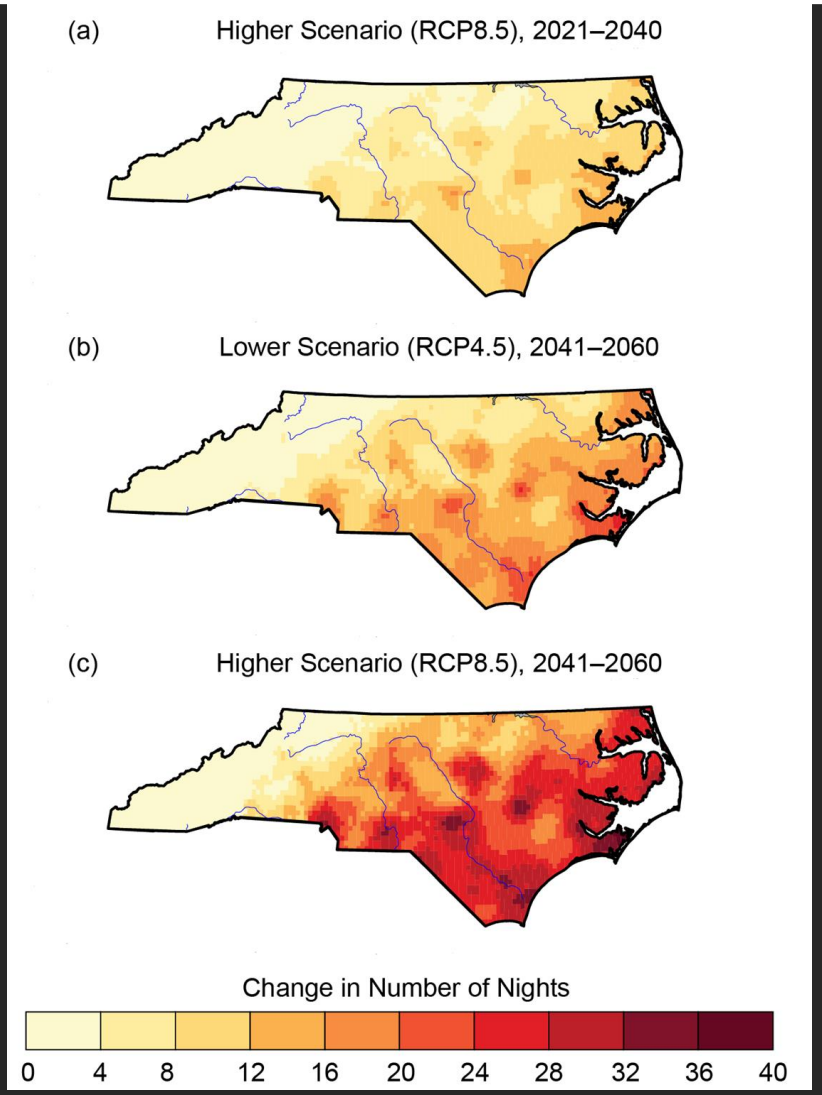


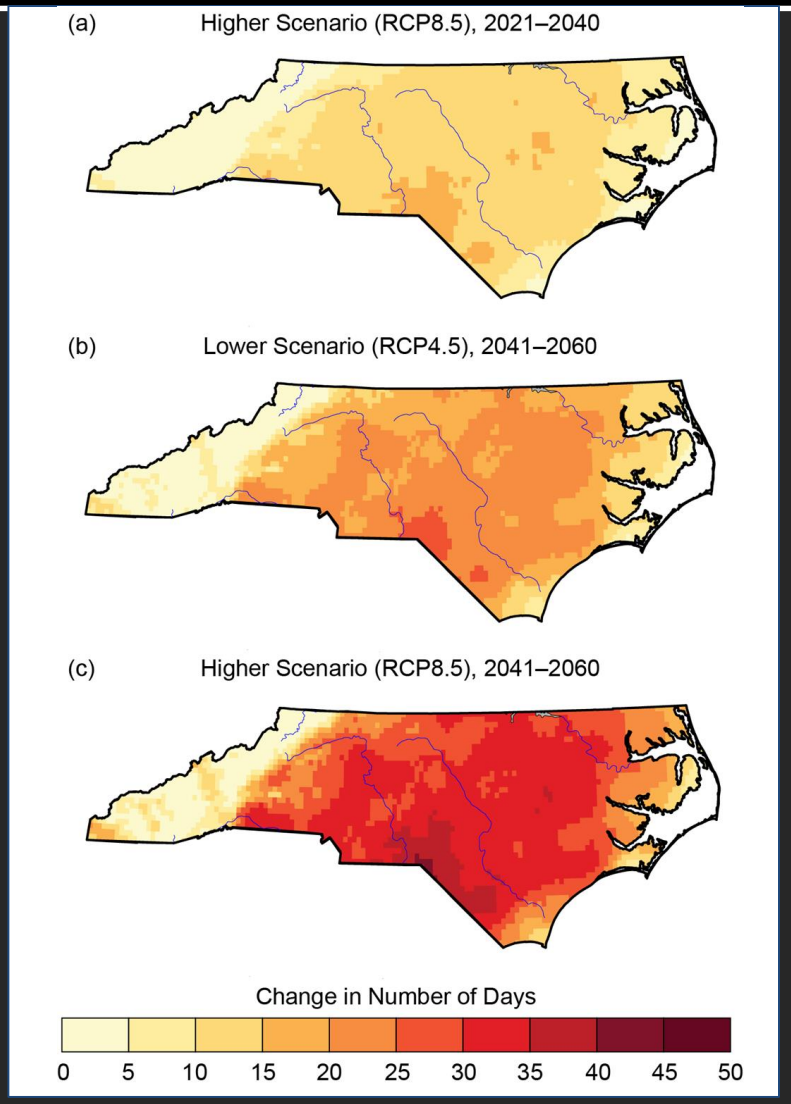

**Values shown are preliminary and undergoing revisions; updated information made available in the Final Report*

# Report Findings – Temperature

**Projected Changes in Annual Number of Very Warm Nights**

**Days with Min Temp ≥ 75°F**



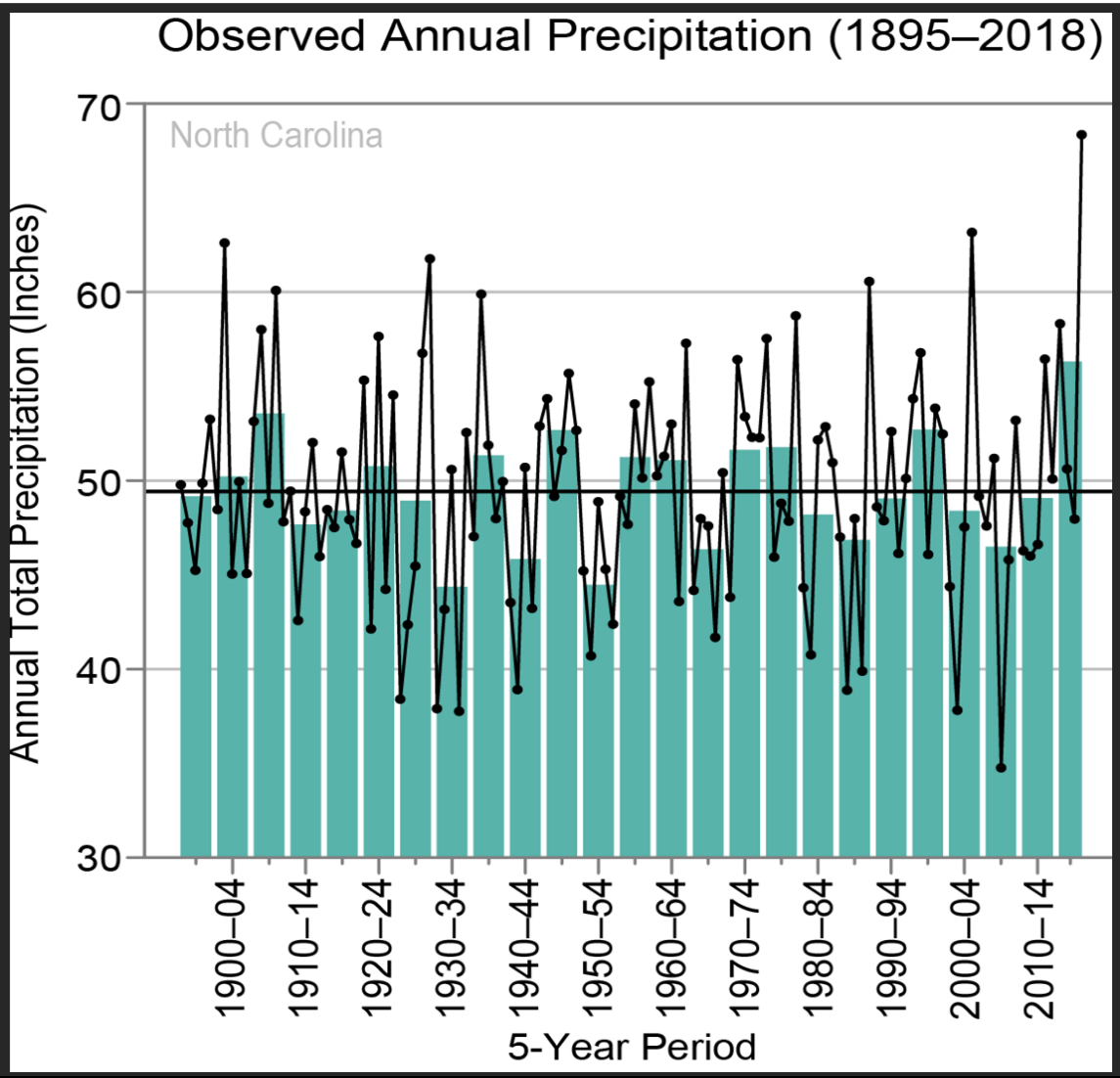




**Projected Changes in Annual Number of Very Hot Days**

**Days with Max Temp ≥ 95°F**

# Report Findings – Precipitation

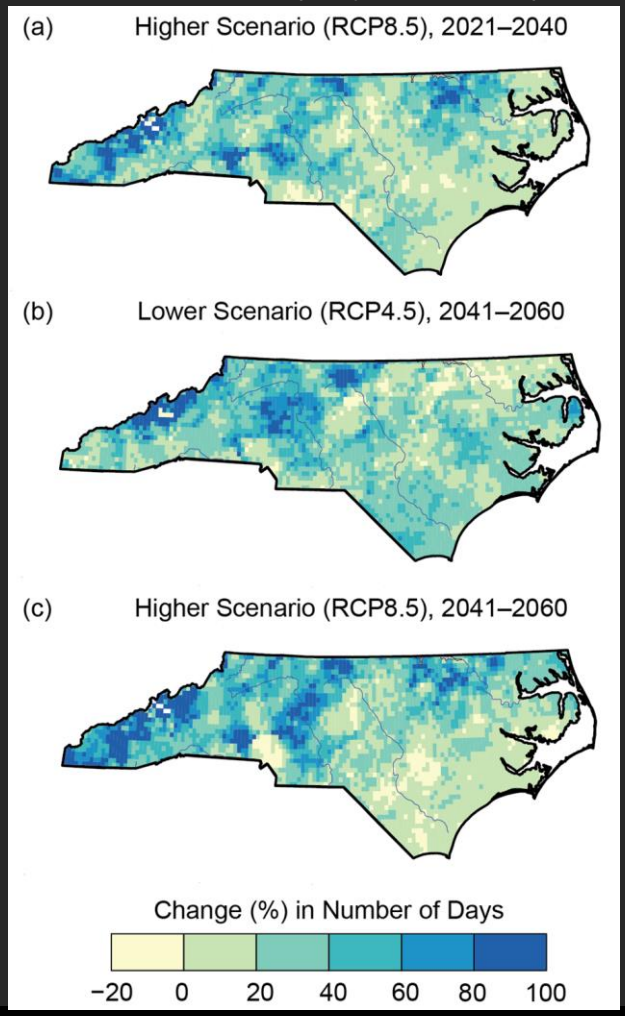
- ➔ No long-term trend in annual total precipitation averaged across the state
- ➔ 2018 wettest on record (includes Florence)
- ➔ Upward trend in number of heavy rainfall events
- ➔ 2015–2018 saw largest number of heavy precipitation events



# 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

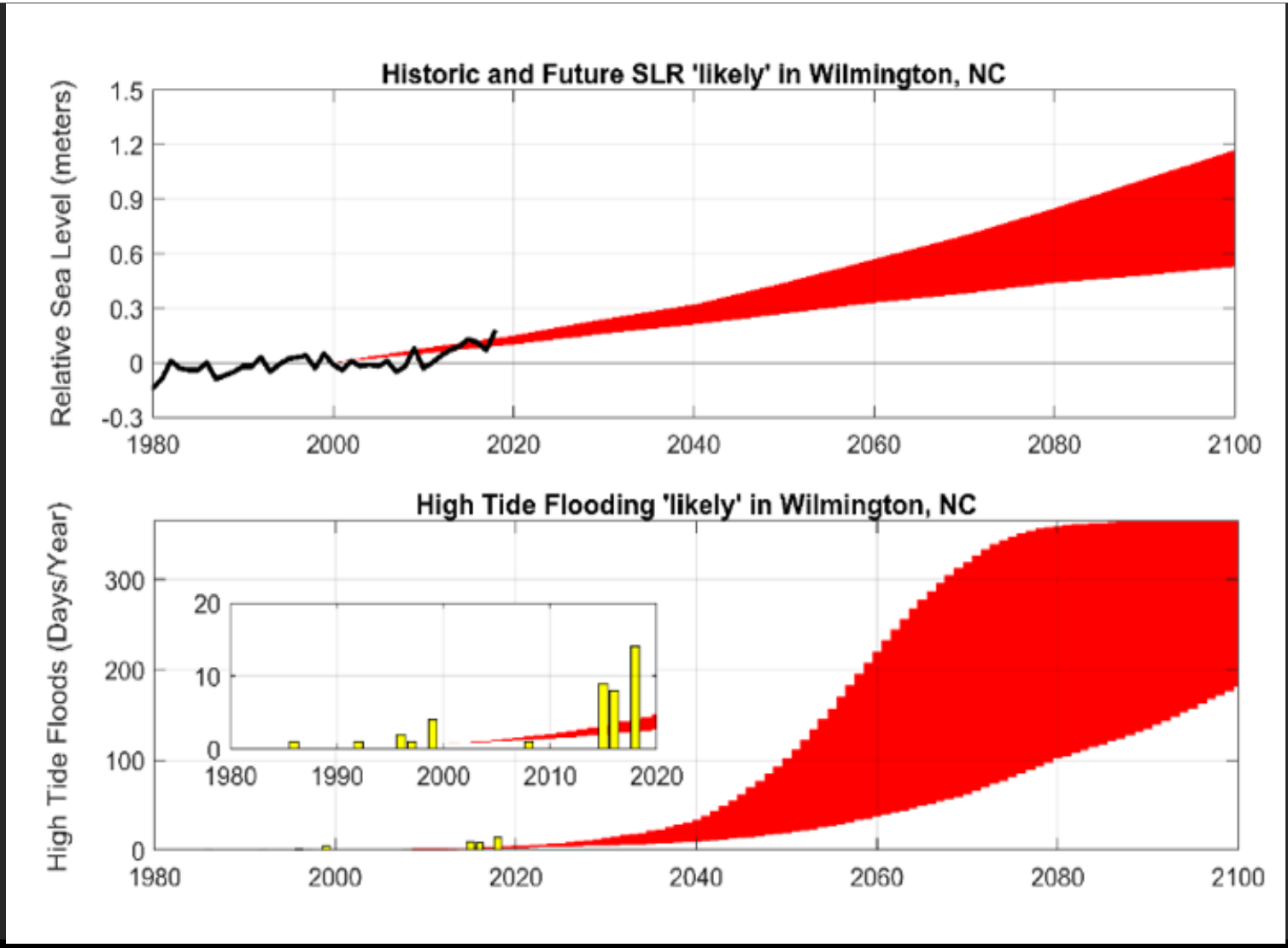
# Report Findings – Sea Level

➔ ***Virtually certain*** that sea level will continue to rise along North Carolina coast

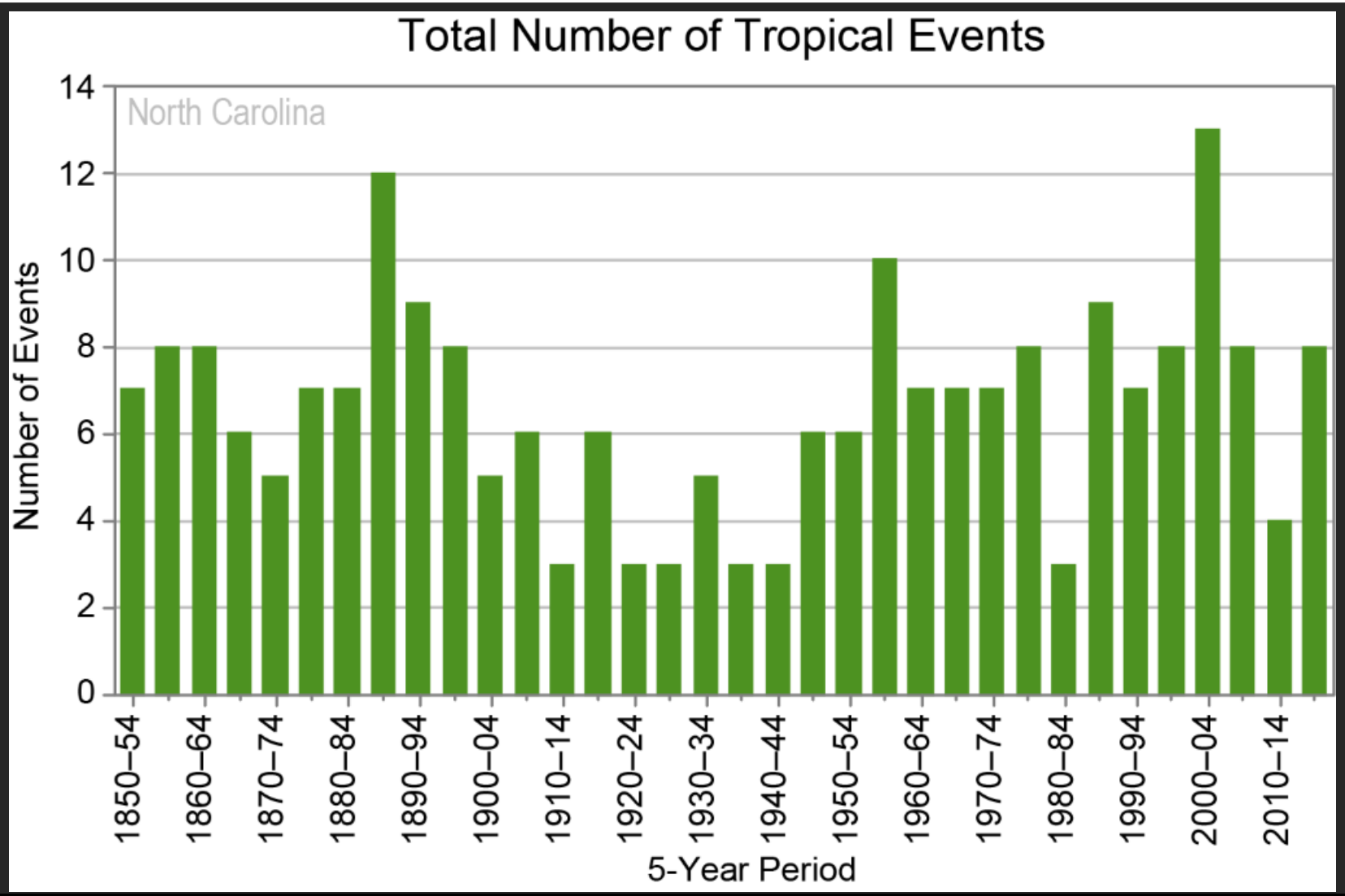
➔ Projected sea level rise by 2100 under lower scenario (RCP4.5)
- ◆ 1.7–3.9 feet at Duck, NC
- ◆ 1.2–3.3 feet at Wilmington, NC

➔ 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 lower confidence at regional scales

# 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

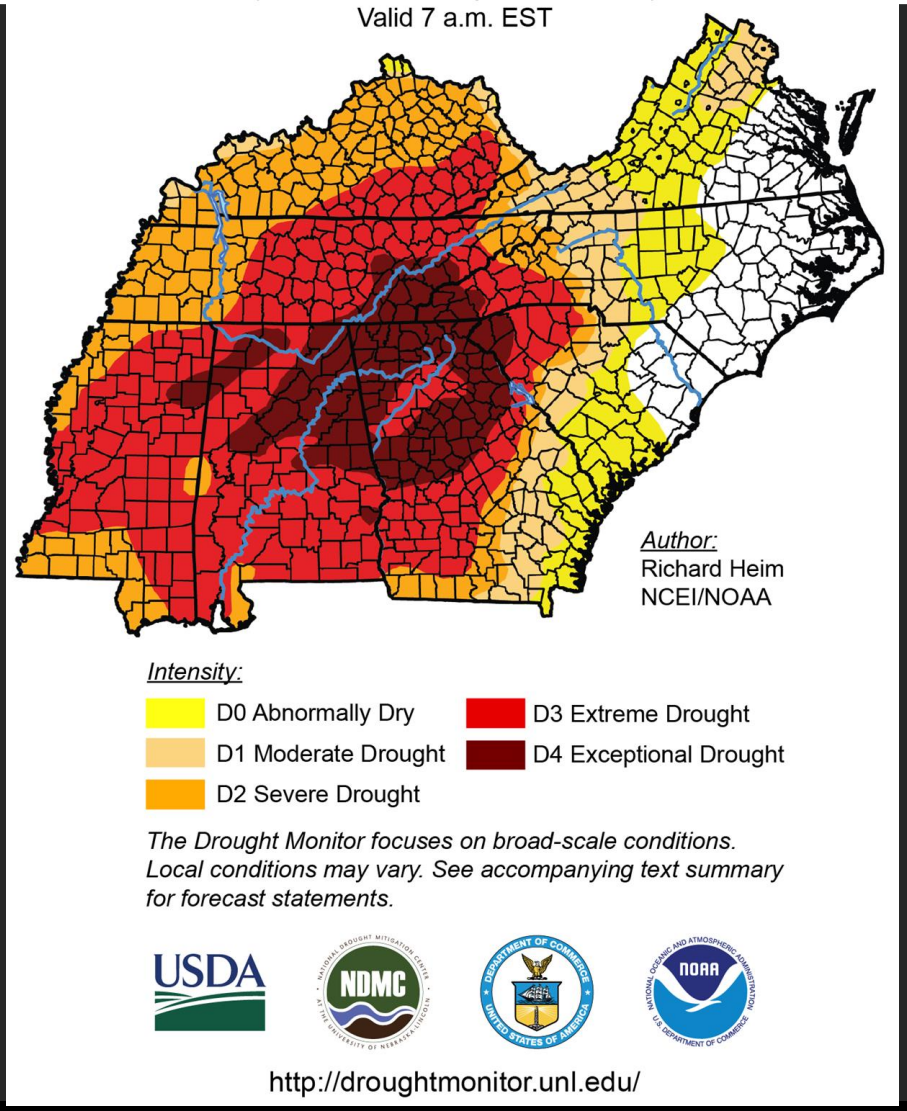
➔ ***Likely*** that severe droughts will be more intense in the future
- ◆ higher temperatures leading to increased evaporation

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

# Report Findings – Compound Events/Impacts

➔ Link between high temperatures, lack of precipitation, and wildfire risk

➔ Drought Monitor for November 29, 2016



# Report Findings – Compound Events/Impacts

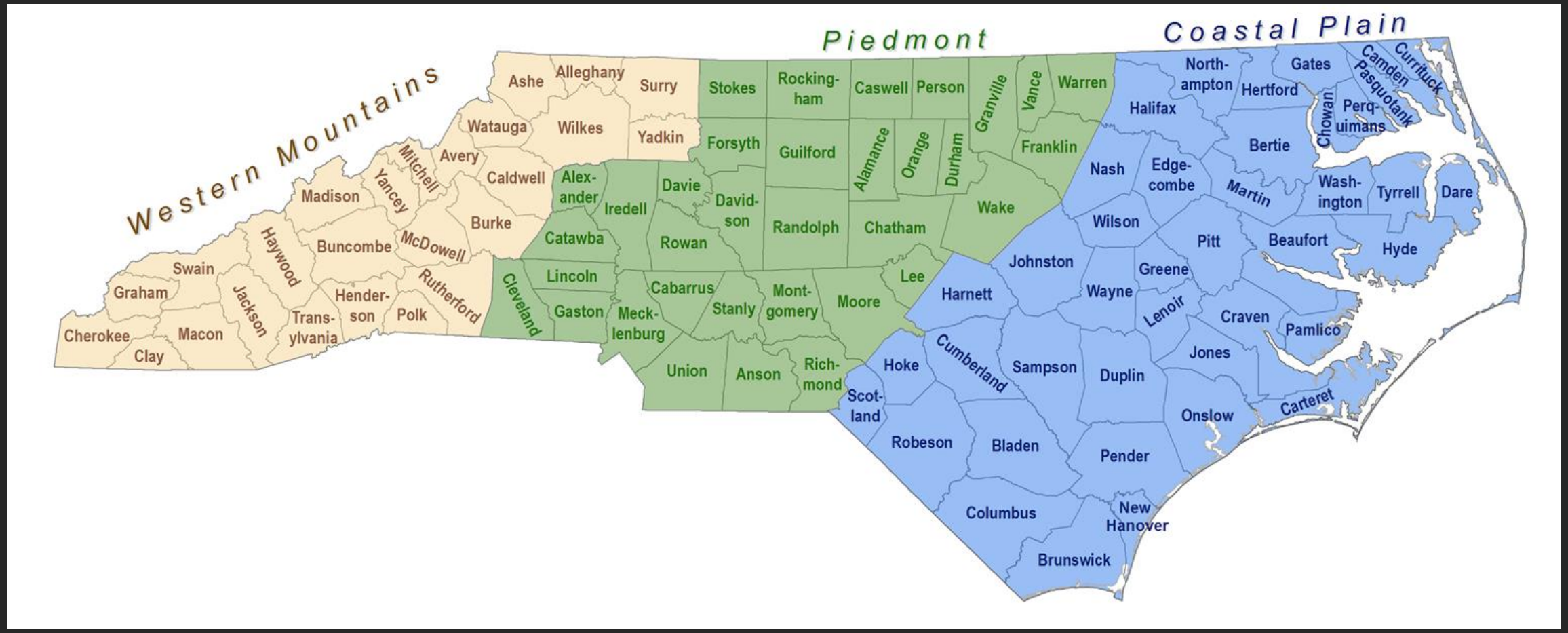
- ***Likely*** that urban growth will increase magnitude of urban heat island effect, resulting in stronger warming in urban centers

- ***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

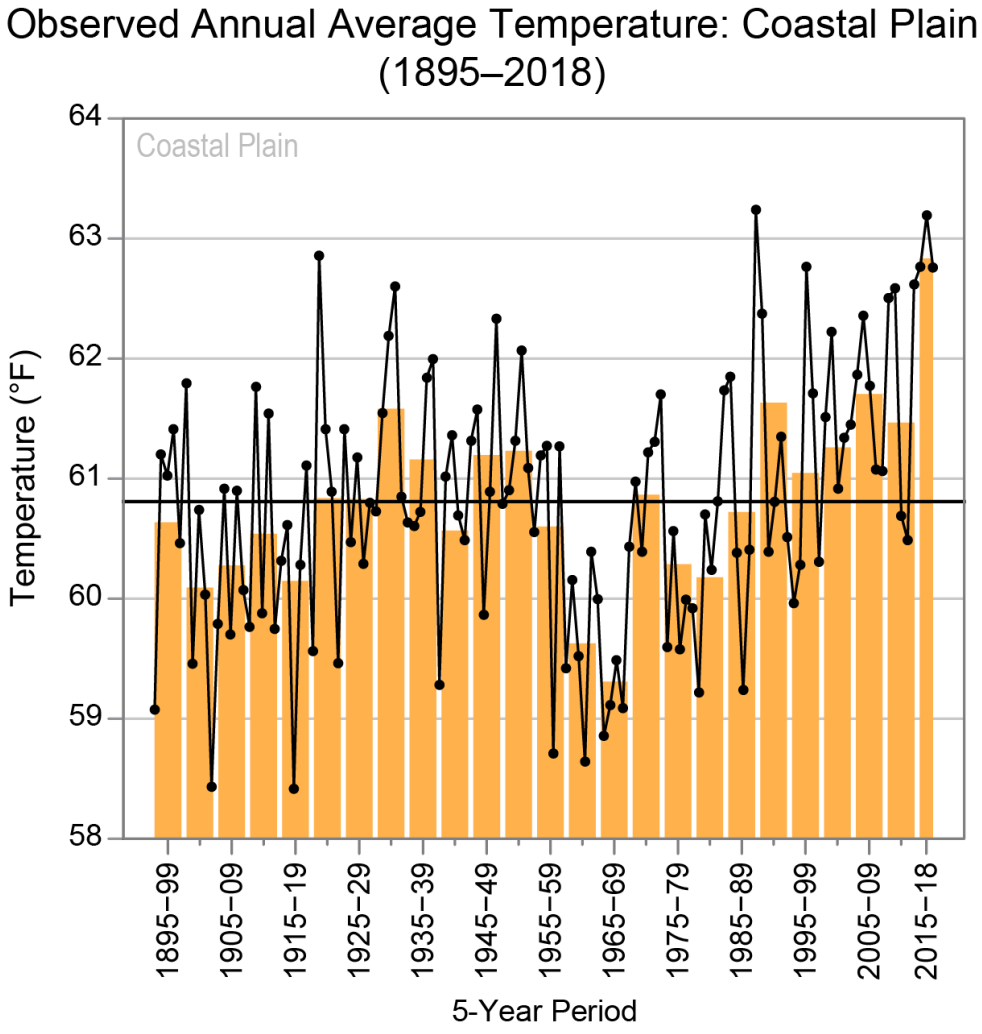
- ➔ ***Very likely*** that some current climate design standards for North Carolina buildings and other infrastructure will change by the middle of this century
  - ◆ Includes increases in design values for precipitation and dry-bulb and wet-bulb temperatures

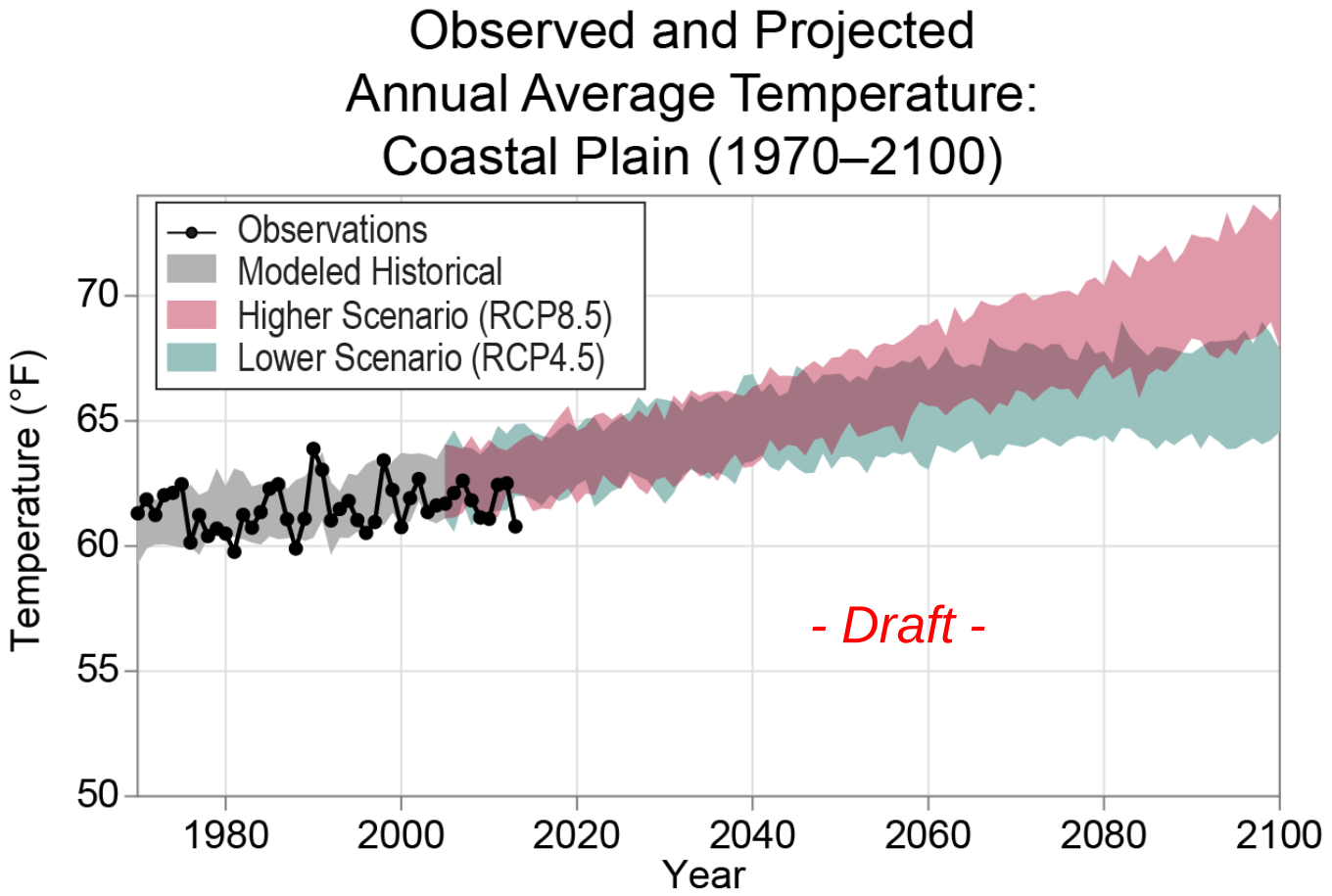
# Regional Highlights




NOTE: These regional highlights should be considered preliminary, as the full report is still being revised in response to review comments.

# Coastal Plain

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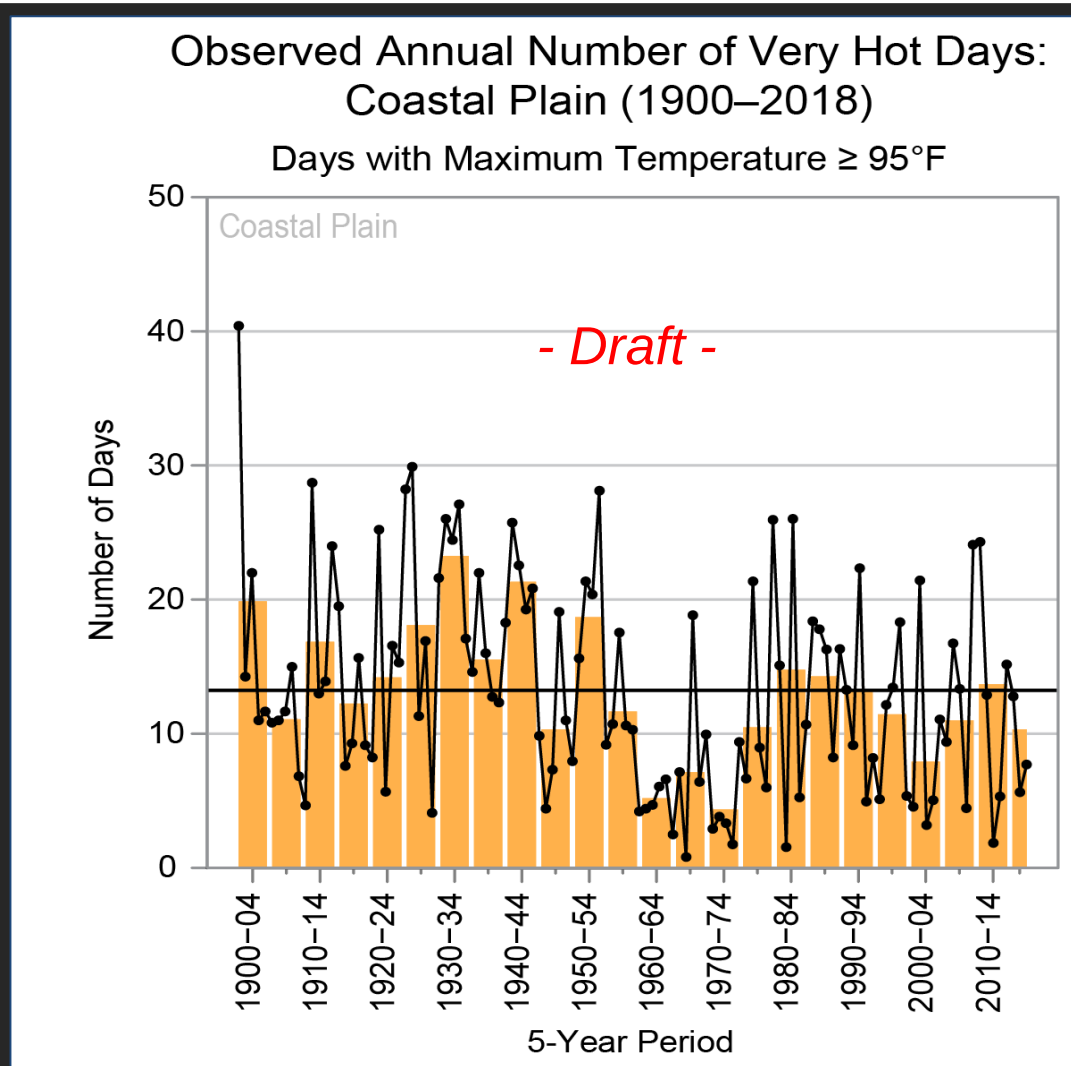
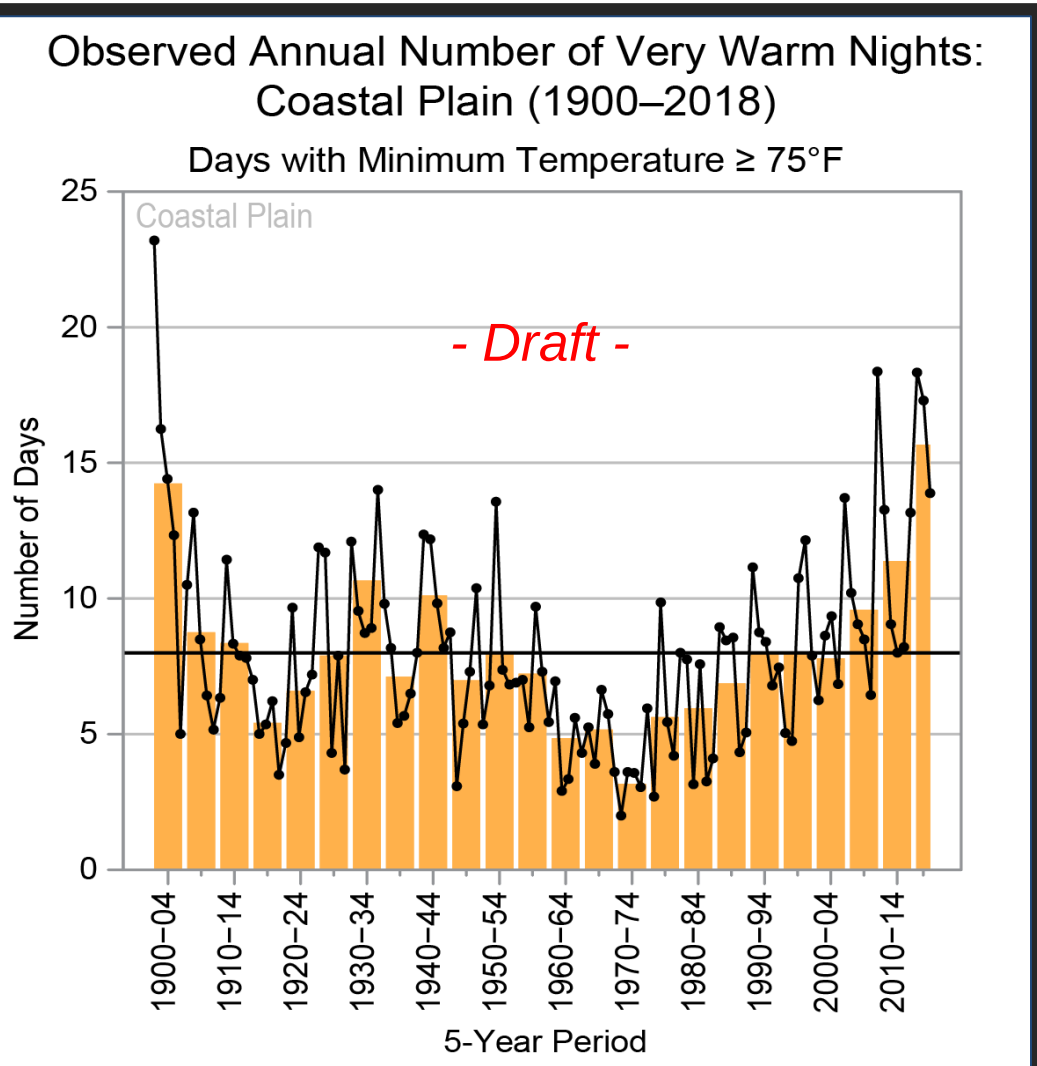
# Coastal Plain

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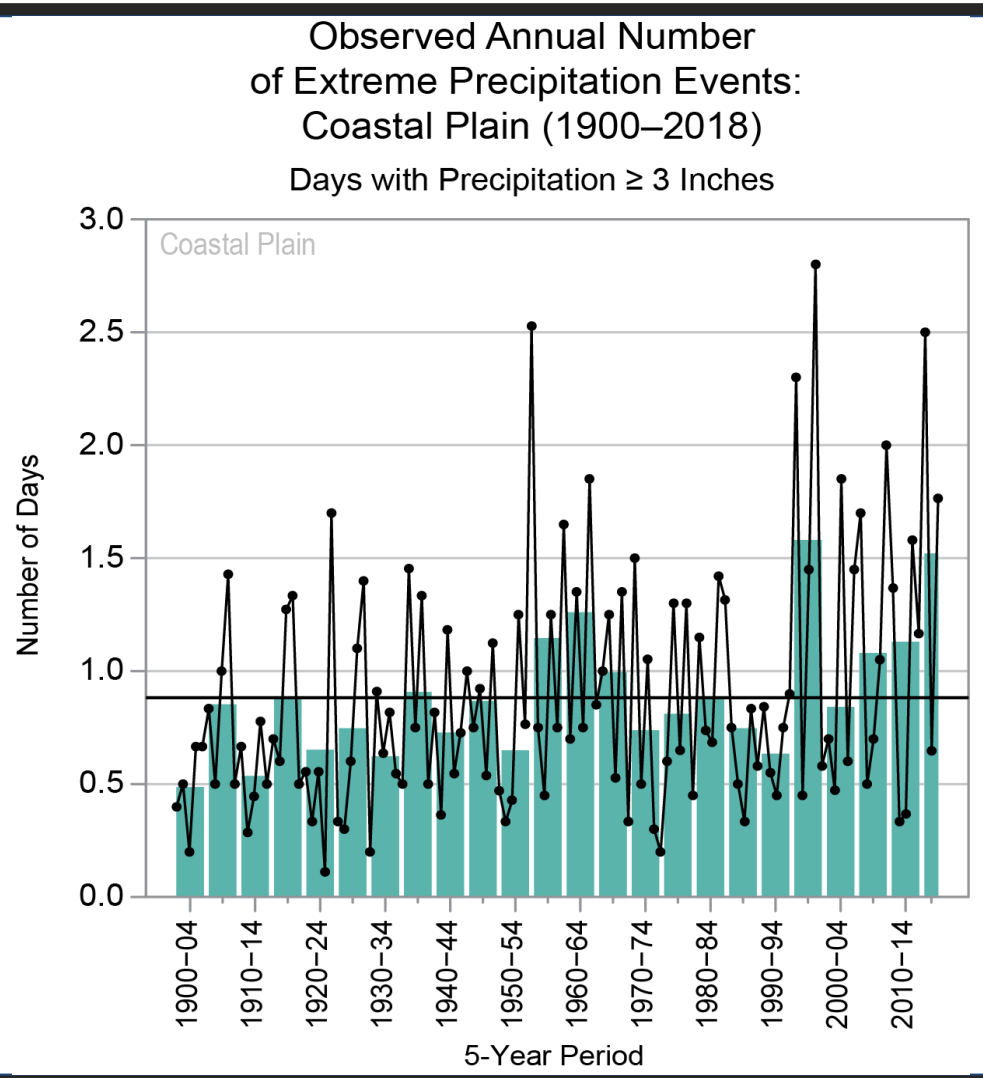
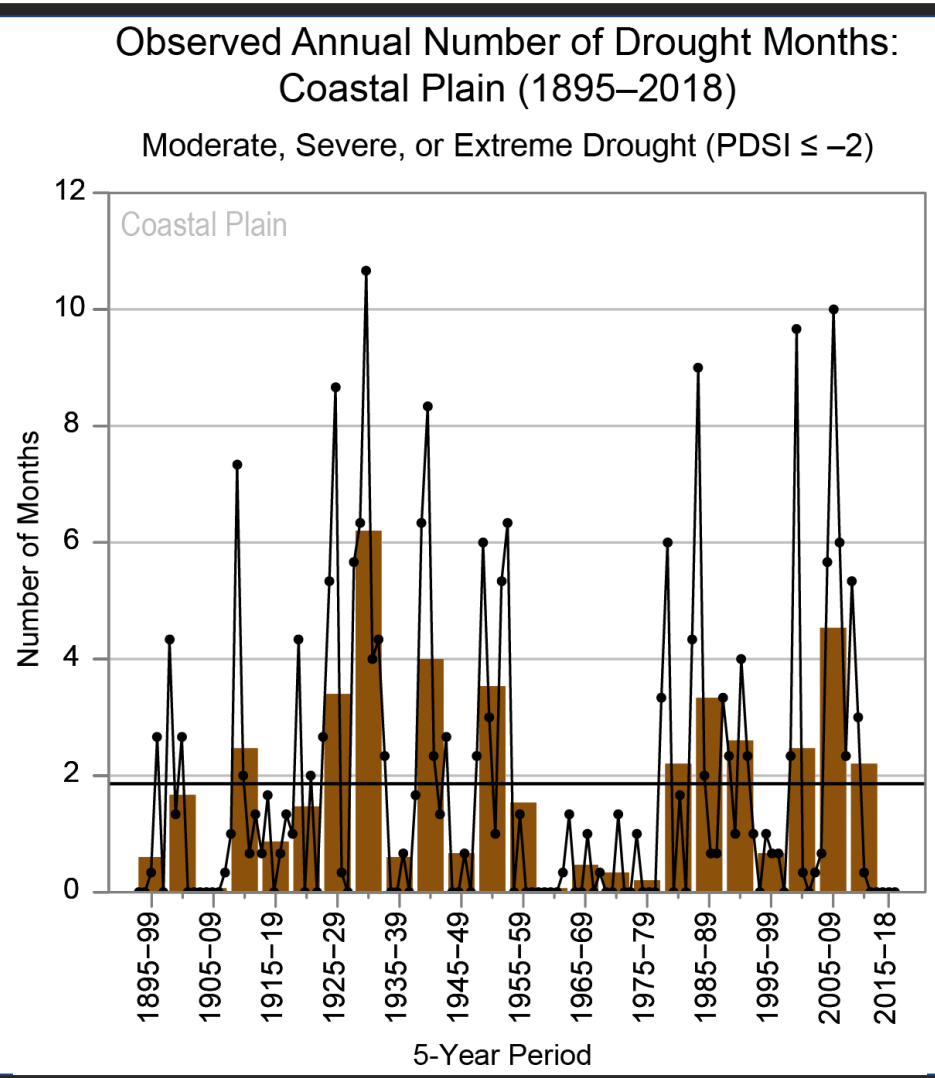
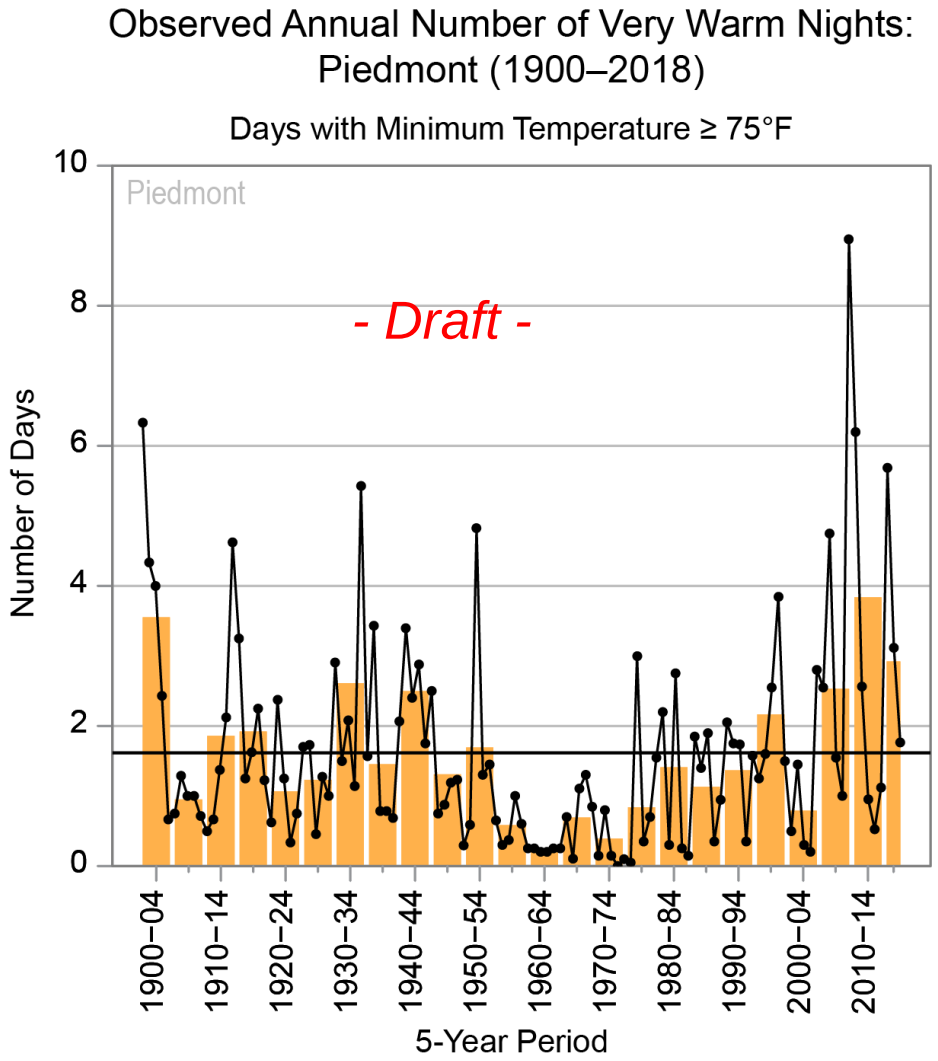
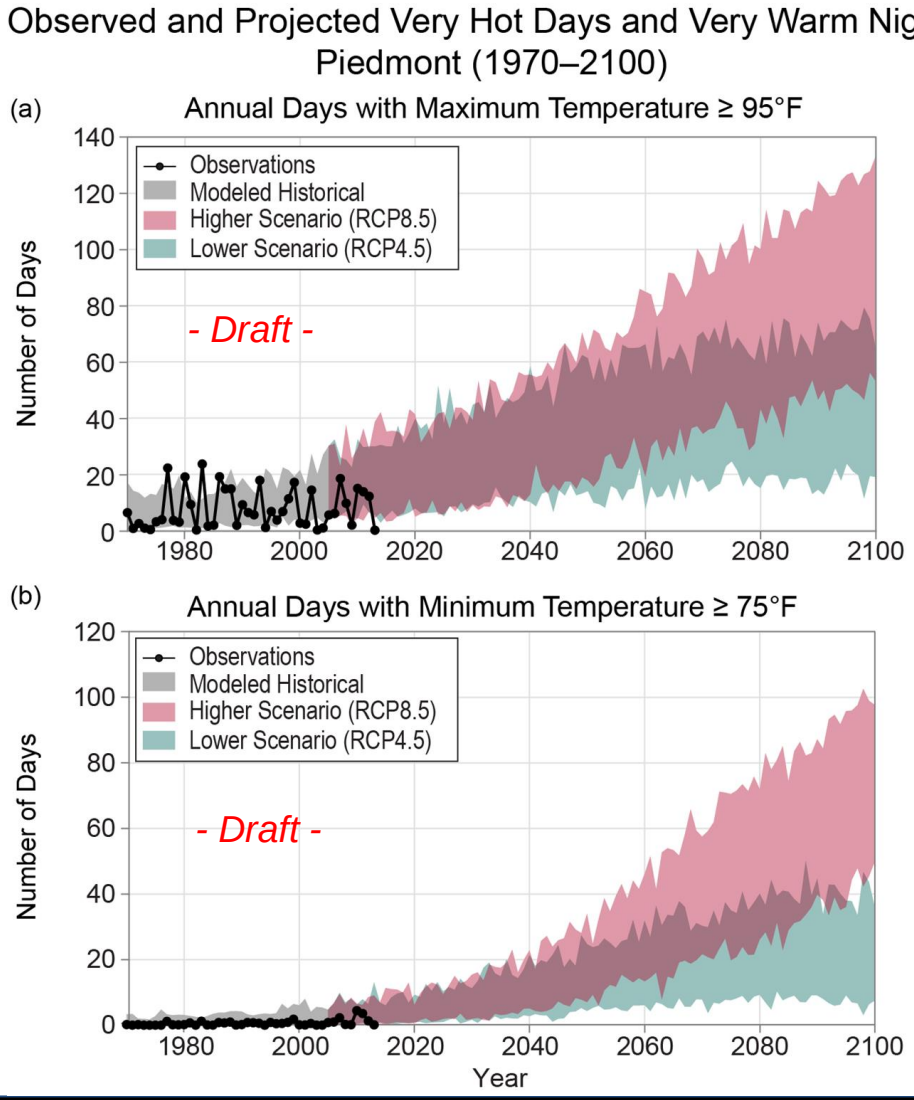
# Coastal Plain



# Piedmont

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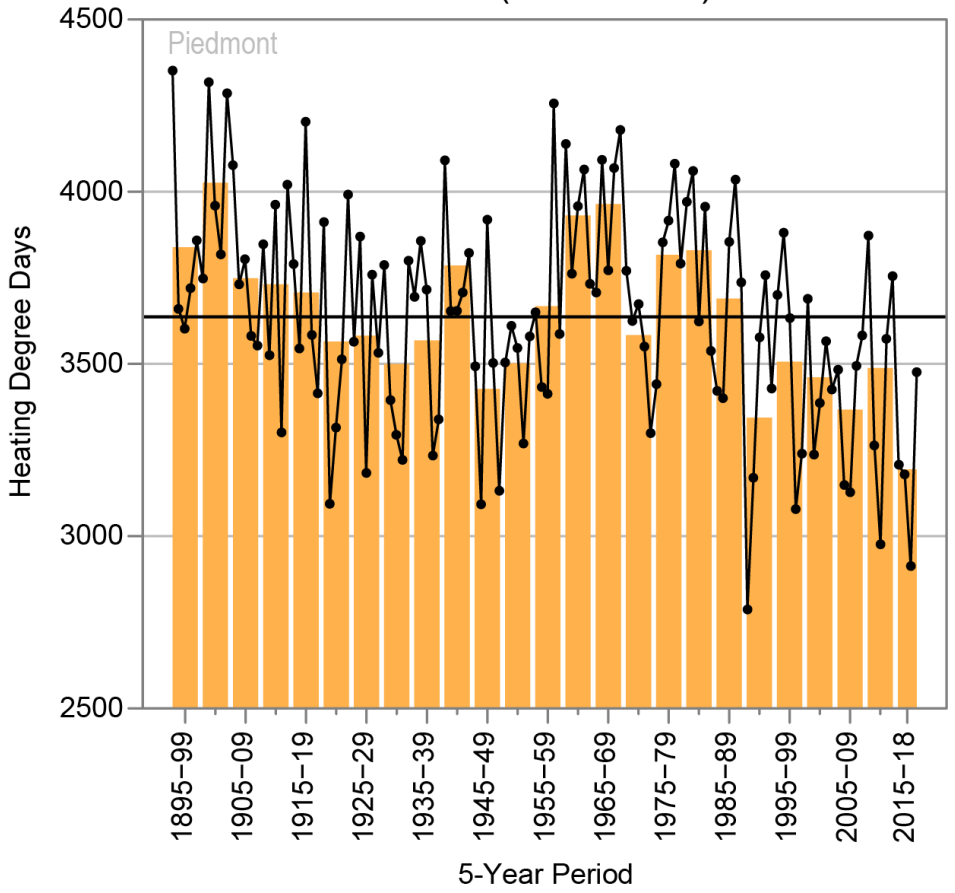
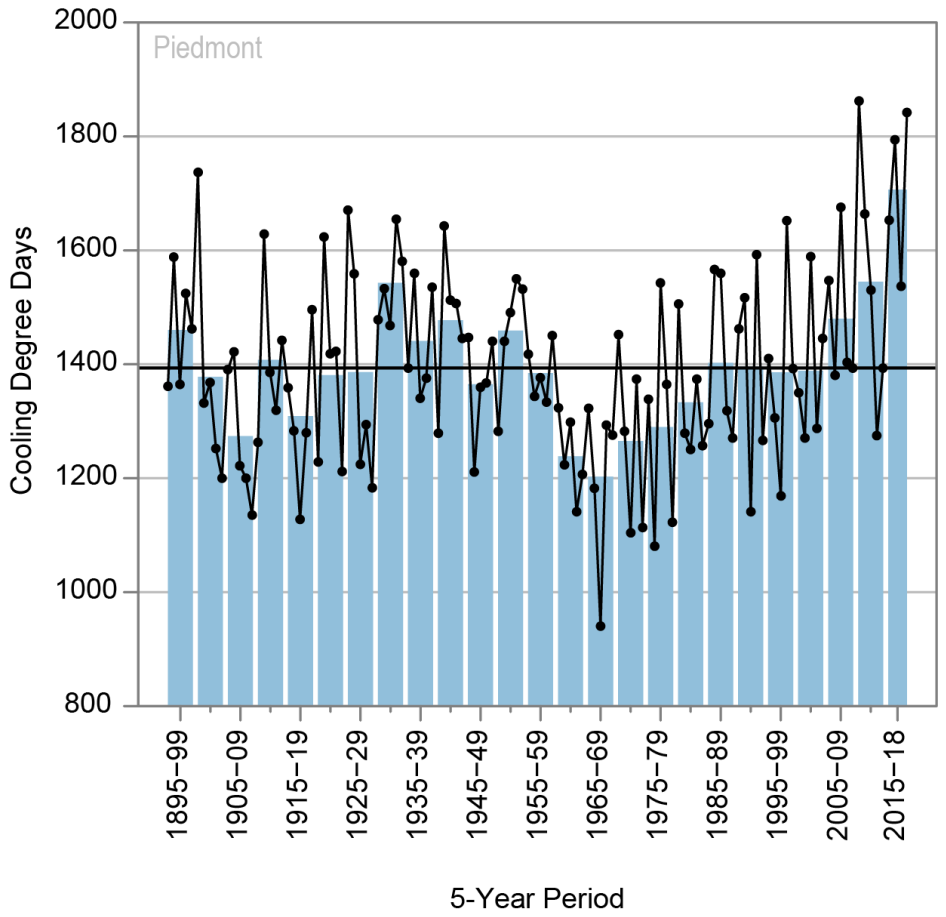
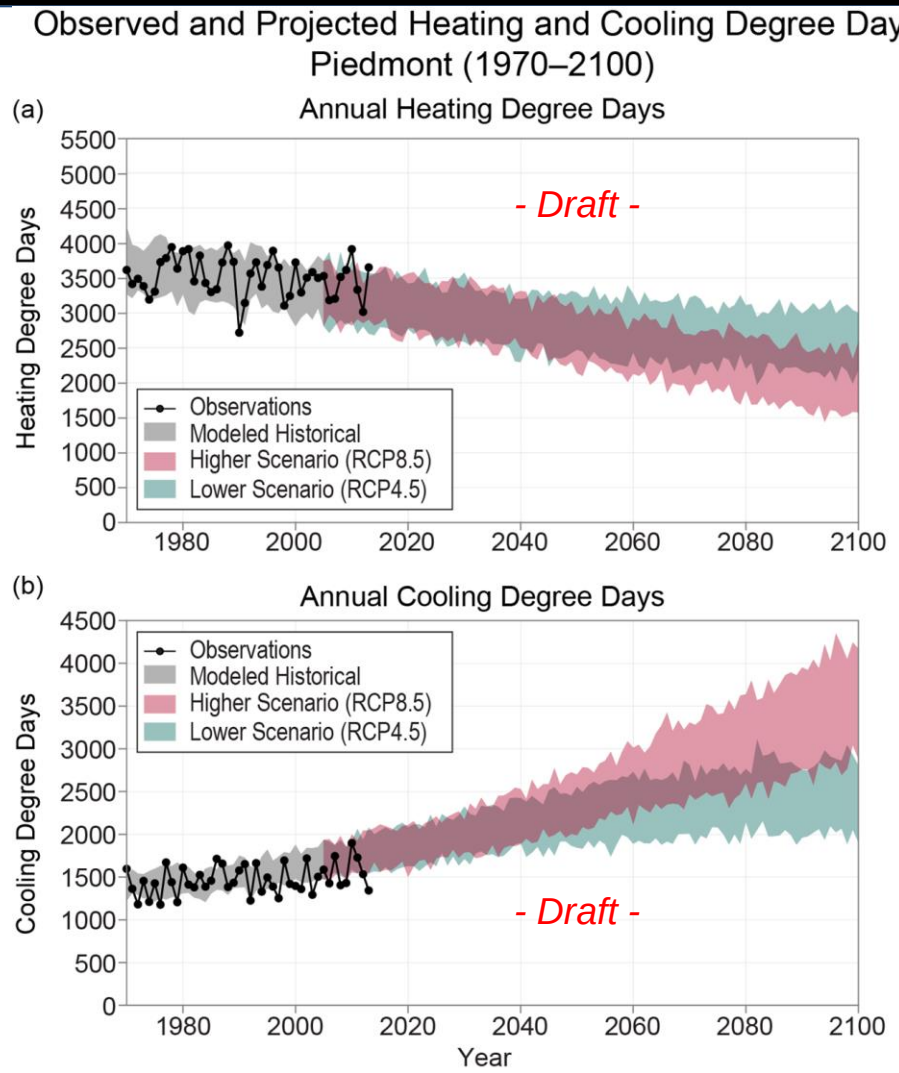
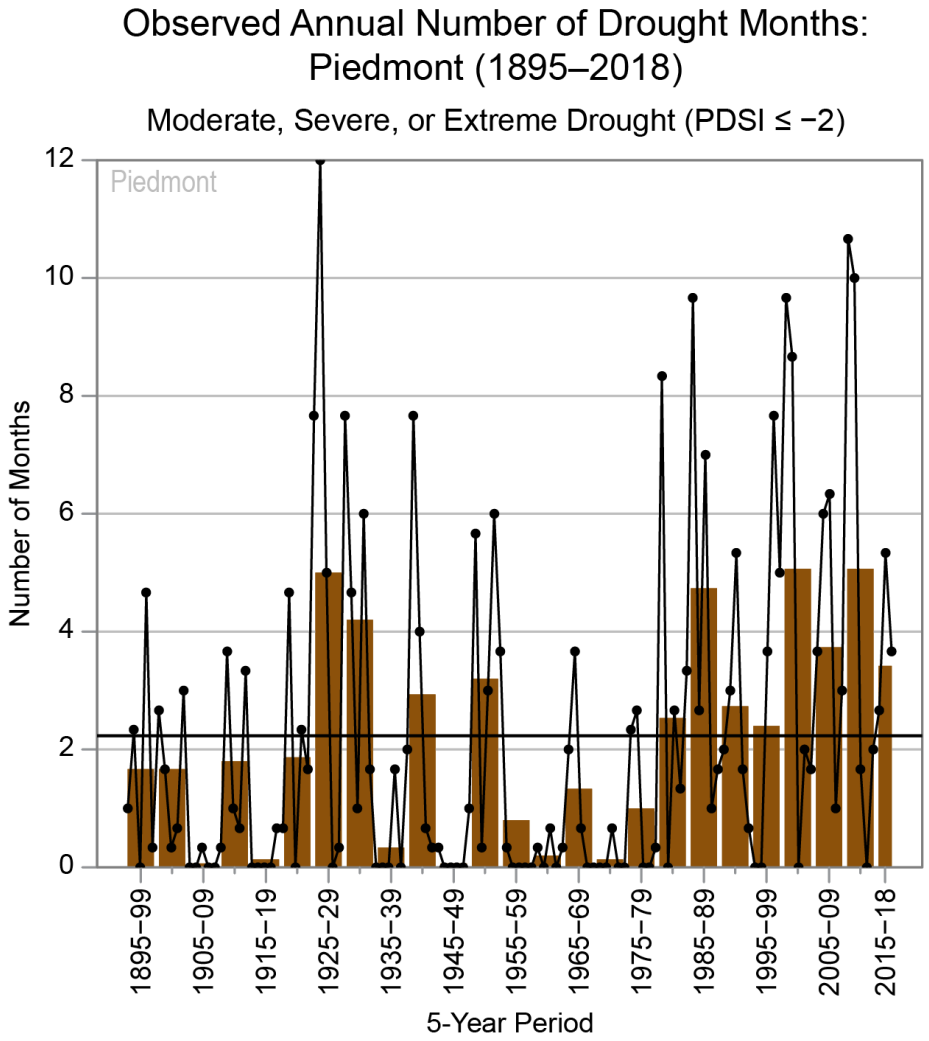
# Piedmont


Observed Annual Heating Degree Days:
Piedmont (1895–2018)
Piedmont
Heating Degree Days
4500
4000
3500
3000
2500
1895–99
1905–09
1915–19
1925–29
1935–39
1945–49
1955–59
1965–69
1975–79
1985–89
1995–99
2005–09
2015–18
5-Year Period


Observed Annual Cooling Degree Days:
Piedmont (1895–2018)
Piedmont
Cooling Degree Days
2000
1800
1600
1400
1200
1000
800
1895–99
1905–09
1915–19
1925–29
1935–39
1945–49
1955–59
1965–69
1975–79
1985–89
1995–99
2005–09
2015–18
5-Year Period

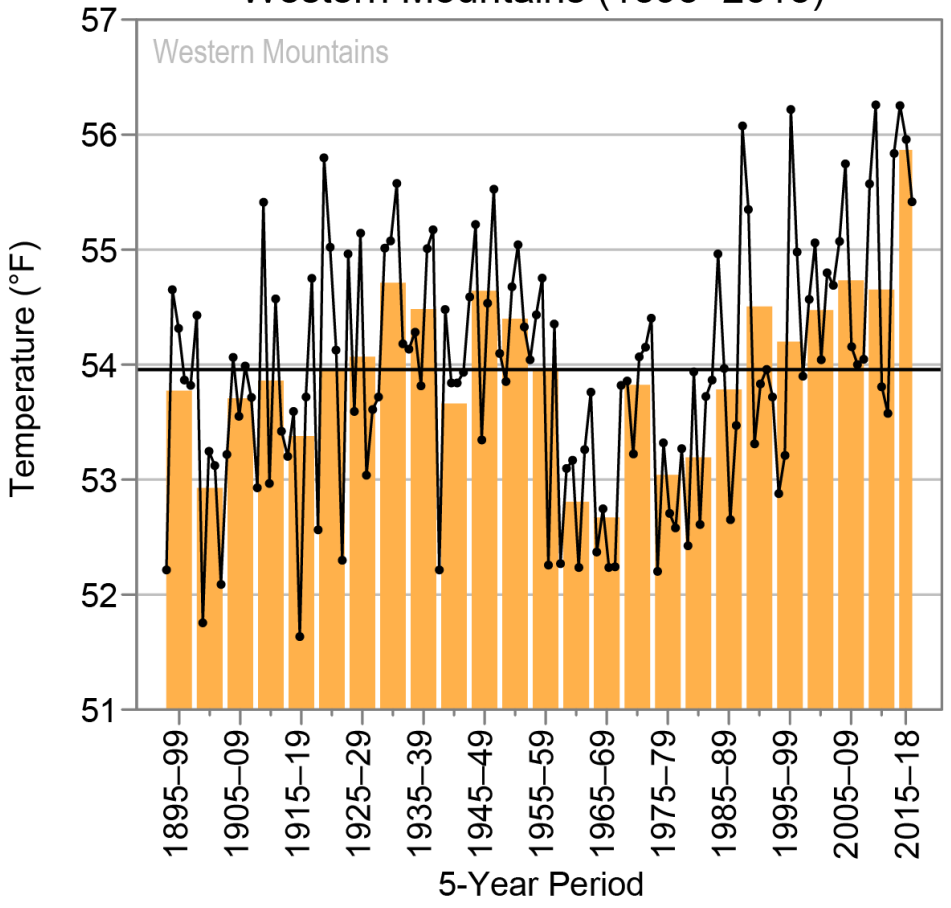
# Piedmont

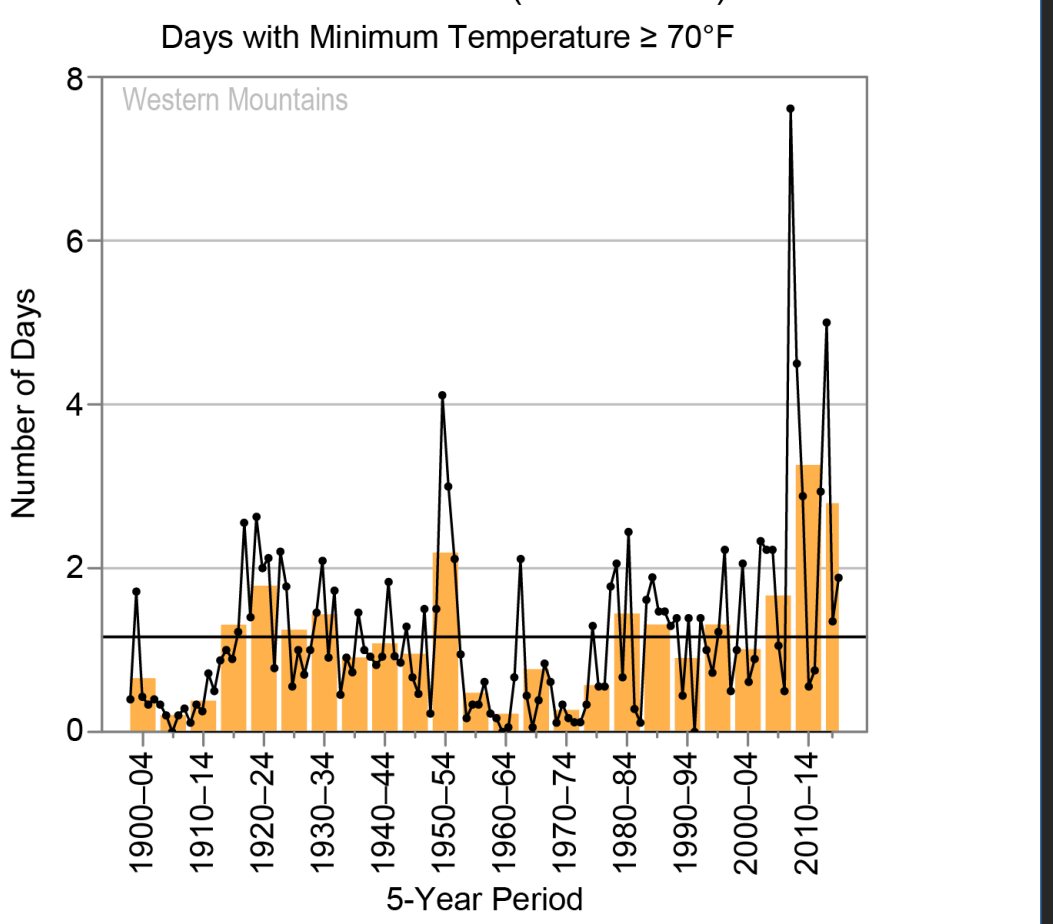


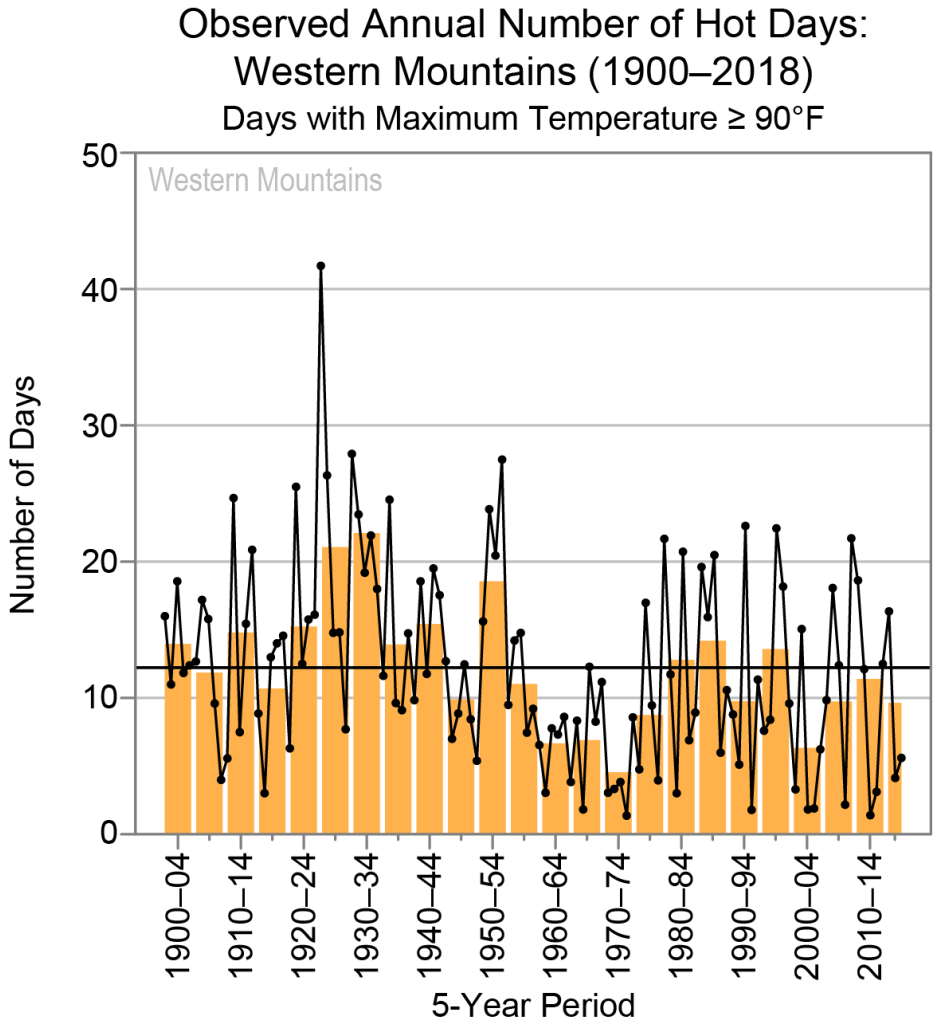

*Values shown are preliminary and undergoing revisions; updated information made available in the Final Report

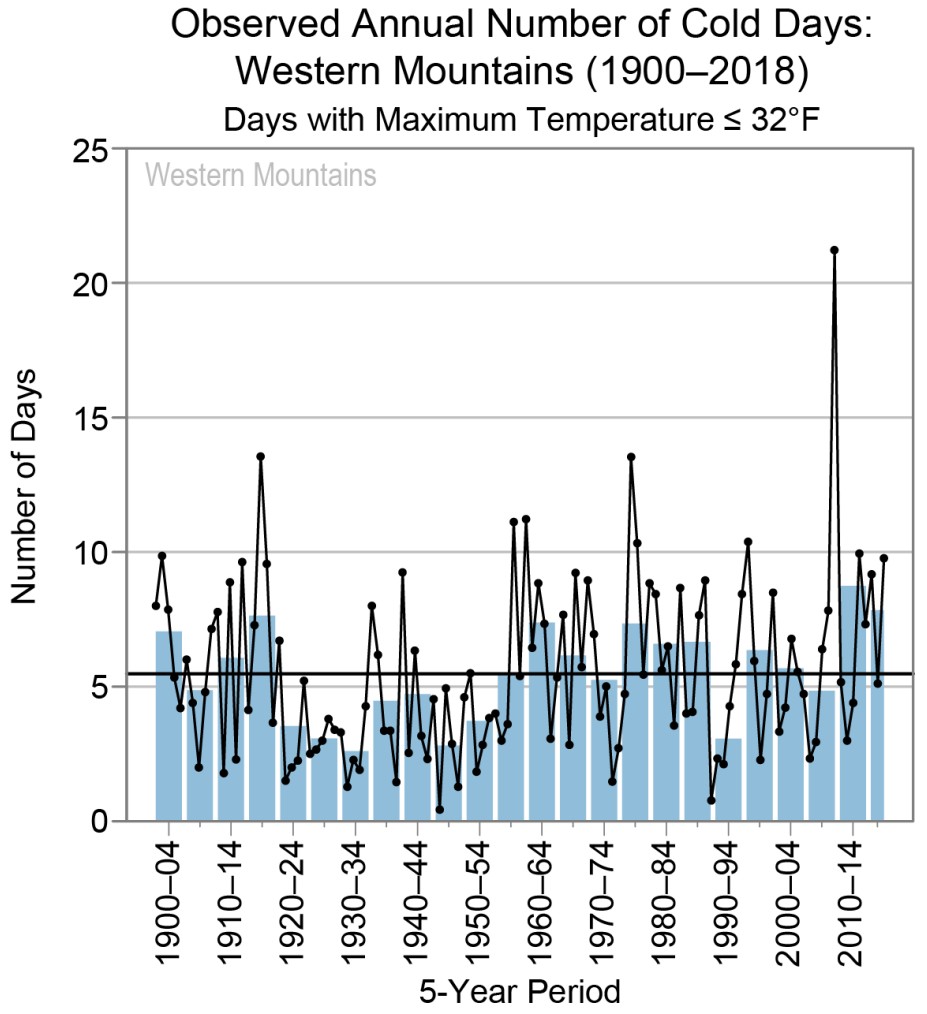
# Western Mountains



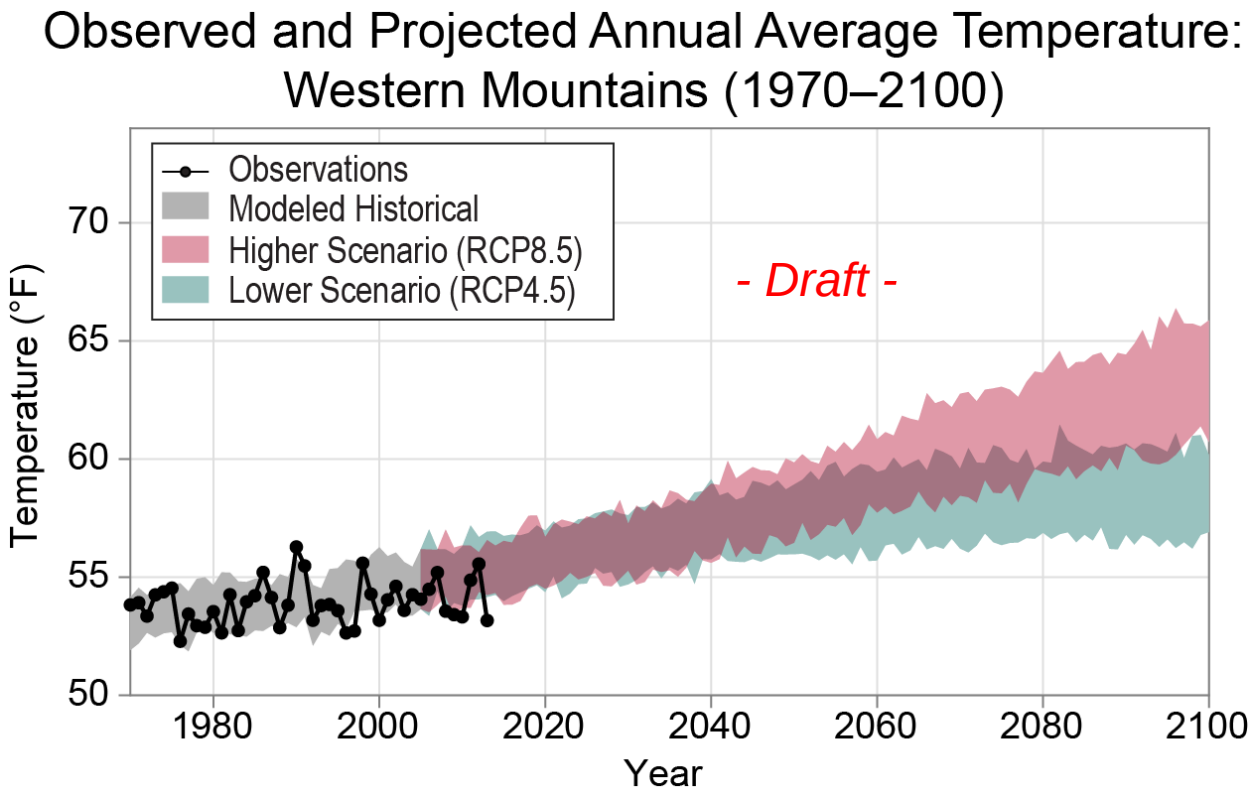



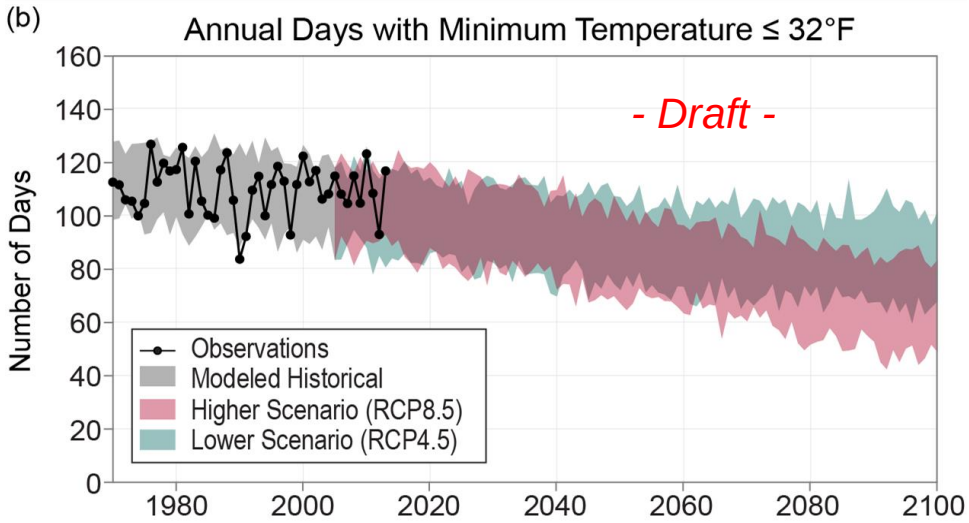
# Western Mountains

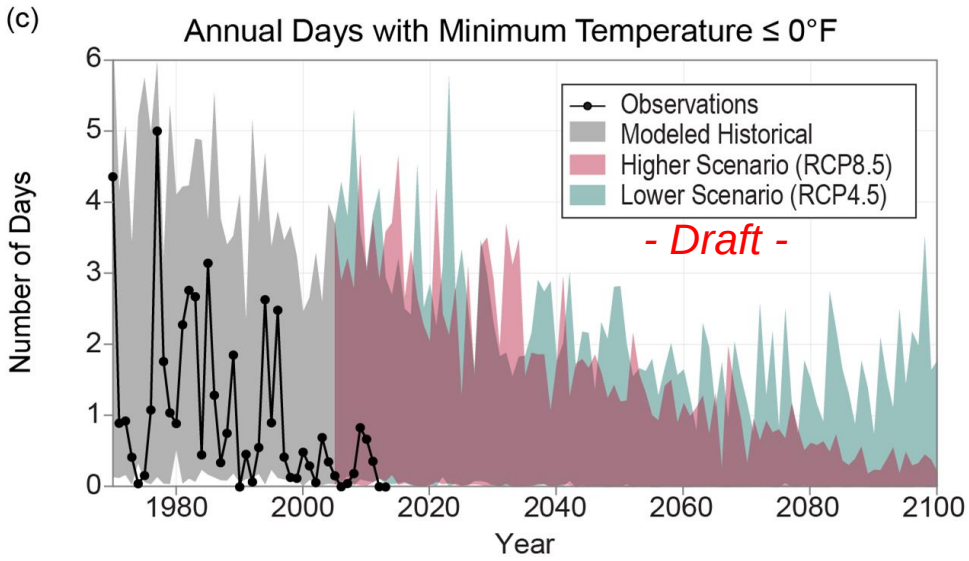


# Western Mountains

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# Next Steps

- ➔ We are continuing to respond to expert reviewer comments on the body of the report
- ➔ We hope to finish in February and obtain final approval from the Climate Science Advisory Panel

# 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


**NC DEQ**
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- Tancred Miller
- Tira Beckham

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- EO80 Section 9 Working Group Leads
- Expert Reviewers


→ **Questions: please email nccsr2020@ncics.org**

NCICS
North Carolina Institute for Climate Studies

# Thank you

## Questions and Discussion

NC STATE UNIVERSITY

# N.C. Risk Assessment and Resilience Plan Development

*NC DEQ*

North Carolina
Climate Change Interagency Council

# *EO80 Section 9*
# *Climate Change Science, Impacts, Risks and Resiliency*

## N.C. Climate Risk Assessment and Resiliency Plan Development

- DEQ will lead a process to provide a scientific assessment of current and projected climate impacts on North Carolina and prioritize effective resiliency strategies.

- All cabinet agencies will assess and address climate change by:
  - Evaluating the impacts of climate change on agency programs and operations
  - Integrating climate change mitigation and adaptation practices into agency programs and operations
  - Supporting communities and sectors vulnerable to climate change impacts

- Collective efforts will be documented in the Risk and Resiliency Plan due March 1, 2020

NORTH CAROLINA
Department of Environmental Quality

# Risk Assessment and Resiliency Plan Strategy

*Climate science assessment*

**Goal 1a**
Dec 2019

***Science Report***

*Lead: DEQ*
*NCORR/DPS, DOT, DNCR, DHHS, DHS, DOA, DMVA, DOR, DOC*
*NCICS, NC Climate Science Advisory Panel*

→ ***NC Climate Science Report***

*Exposure to climate-related hazards*

**Goal 1b**
Oct 11, 2019

***Hazard Identification***

*Lead: DEQ*
*NCORR/DPS, DOT, DNCR, DHHS, DHS, DOA, DMVA, DOR, DOC*
*NOAA, NEMAC, NCICS*

→ *Agency Workshop 1*
***Hazard/Asset Matrix***

*Assess Vulnerability and Risks*

**Goal 2**
Dec 2019

***Risk Assessment***

*Lead: DEQ*
*NCORR/DPS, DOT, DNCR, DHHS, DHS, DOA, DMVA, DOR, DOC*
*NOAA, NEMAC, NCICS*

→ *Agency Workshop 2*
***NC Climate Risk Assessment***

***State Agency Strategies***

*Lead: DEQ / NCORR*
*DPS, DOT, DNCR, DHHS, DHS, DOA, DMVA, DOR, DOC*
*NOAA, NEMAC, NCICS*

*Develop Actions*

**Goal 3**
March 2020

***Local Government Strategies***

*Lead: DEQ / NCORR, COGs, Cabinet agencies*
*NGOs, local governments, NOAA, NEMAC*

***Recovery and Resilience Support Strategies***

*Lead: NCORR*
*State Disaster Recovery Task Force members*

***Nature Based Solutions***

*Lead: DEQ, Natural & Working Lands Stakeholders*

→ *Agency Workshop 3*

***NC Climate Resiliency Plan***

# *Risk Assessment and Resiliency Plan Strategy*

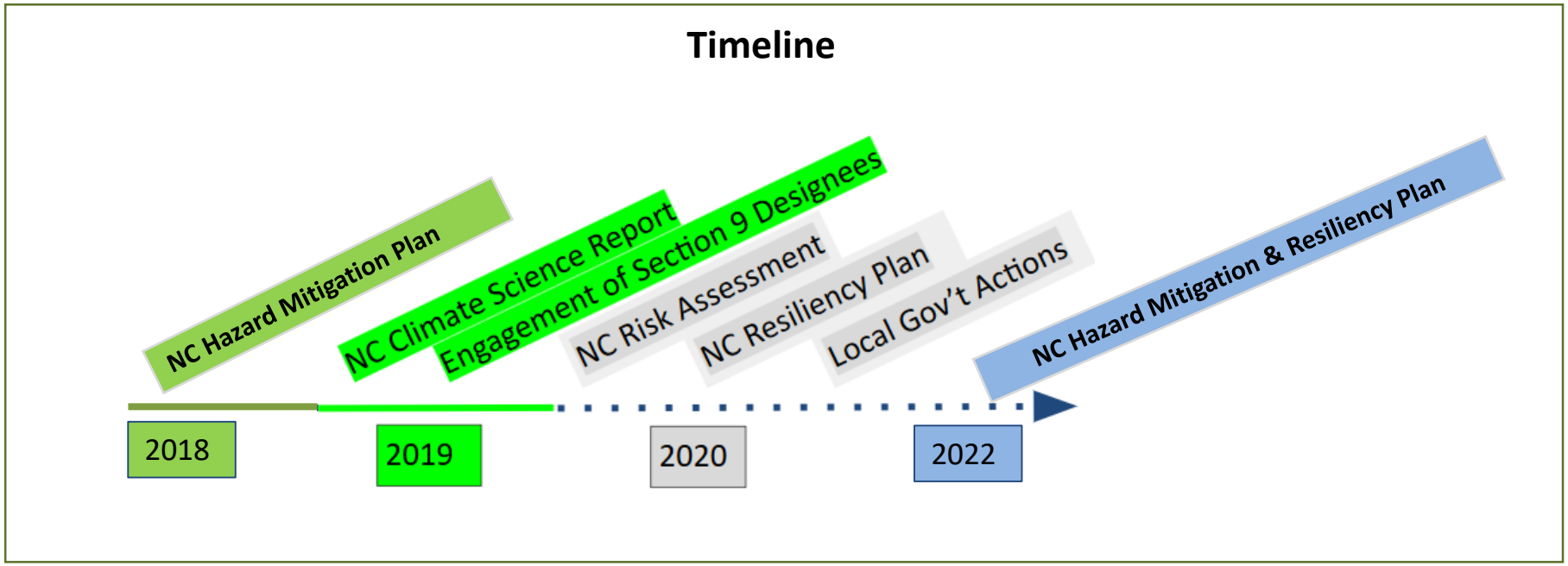
*Local Government and Community Assistance*

**Goal 4**
On going

***Local and Regional Resilience Plans & Actions***

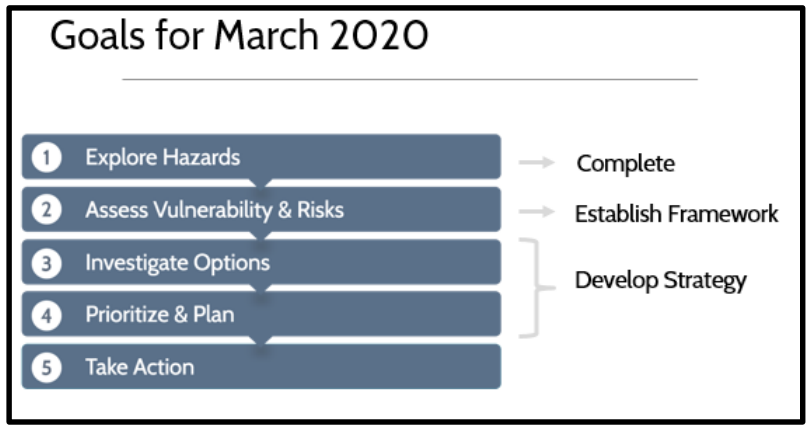
*Lead: NCORR*
*Cabinet agencies, COGs, local governments, NGOs*

*Local Government Assistance: Planning, Tools, Funding, Resources, etc.*



**Goal 1b** Oct 11 → **Goal 2** Dec 2019 → **Goal 3** March 2020

# *State Agency Strategies*




| Sept 27, 2019 | Oct 11, 2019 | Nov/Dec 2019 | Late Jan 2020 | March 1, 2020 |
|---|---|---|---|---|
| Kick-off | Workshop One | Workshop Two | Workshop 3 | Delivery |
| • NC Agency Buy-in of Data Approach<br>• Outline Roles and Responsibilities | • Integration of Science Team Findings<br>• Define Impact Pairs<br>• Exposure | • Vulnerability and Resilience Rulesets<br>• Detailed Example of 2 impact pairs<br>• Link to Regions | • Options to consider at State level<br>• Examples of options at Regional level | • Outline and Resources for Risk Assessment and Resiliency Plan<br>• Criteria for RFP and Funding Requirements |

## Resilience Plan Focus Sectors

- Agriculture & Forestry
- Coastal Resources and Structures
- Commerce & Business
- Cultural Resources
- Ecosystems
- Housing, Buildings, and Support Services
- Public Health
- Public Safety
- Transportation
- Water and Land Resources
- Energy
- Climate Justice

CPO Climate Program Office — Advancing scientific understanding of climate; improving society's ability to plan and respond

University of North Carolina Asheville

NCICS North Carolina Institute for Climate Studies

# *NC Risk Assessment and Resilience Plan: Phased Approach for a Long-Term Resilience Strategy*

Phase I (March 2020) – understanding climate stressors; assessing impacts to assets, programs and services; qualitatively assessing vulnerabilities and risks; defining preliminary actions; framing path to continuous resilience building.

Phase II (~2021) - quantitative data driven risk assessment to prioritize actions; requires significant planning resources, investment and stakeholder engagement; led and coordinated through NCORR with support from state agencies.

Phase III (~2023) – Evaluating integration of Phase I and II into next cycle of NC Hazard Mitigation Plan

# *NC Executive Order 80*
# *Climate Risk Assessment & Resilience Plan*
# *Phase I*
# *Impacts, Vulnerabilities, Risks, and Preliminary Actions*

**Draft Outline**

Foreword

1. Introduction
2. Roadmap:  Phased Approach for a Long-Term Resilience Strategy
3. NC Climate Science Report
4. Climate Justice
5. Risk Assessment:  Climate Impacts, Risks and Vulnerabilities
    - **Agriculture and Forestry**
        - Impacts
        - Vulnerabilities
        - Risks
        - Preliminary Actions

# *Draft Outline (Cont'd)*

- **Coastal Resources and Infrastructure**
- **Commerce and Business**
- **Cultural Resources**
- **Ecosystems**
- **Housing, Buildings and Support Services**
- **Public Health and Human Services**
- **Public Safety**
- **Transportation**
- **Water and Land Resources**
- **Energy**
- **Cross Sector – TBD**

6. **Natural and Working Lands**
7. **Path to Climate Resiliency**
8. **Appendix**

**Contributing State Agencies**

- Department of Environmental Quality
- Department of Agriculture and Consumer Services
- Department of Public Safety
- Department of Transportation
- Department of Natural and Cultural Resources
- Department of Health and Human Services
- Department of Commerce
- Department of Information Technology
- Department of Military and Veterans Affairs

# BREAK

*10 minutes*

# Public Engagement

*Individuals and organizations may provide input to cabinet agencies on their implementation of EO 80*

*(Limit: 2 minutes)*