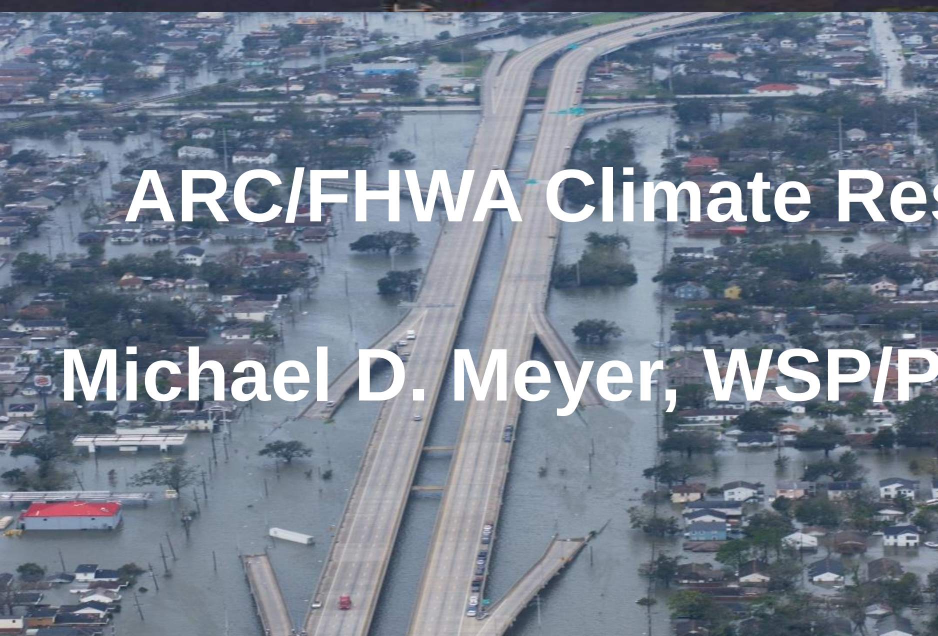
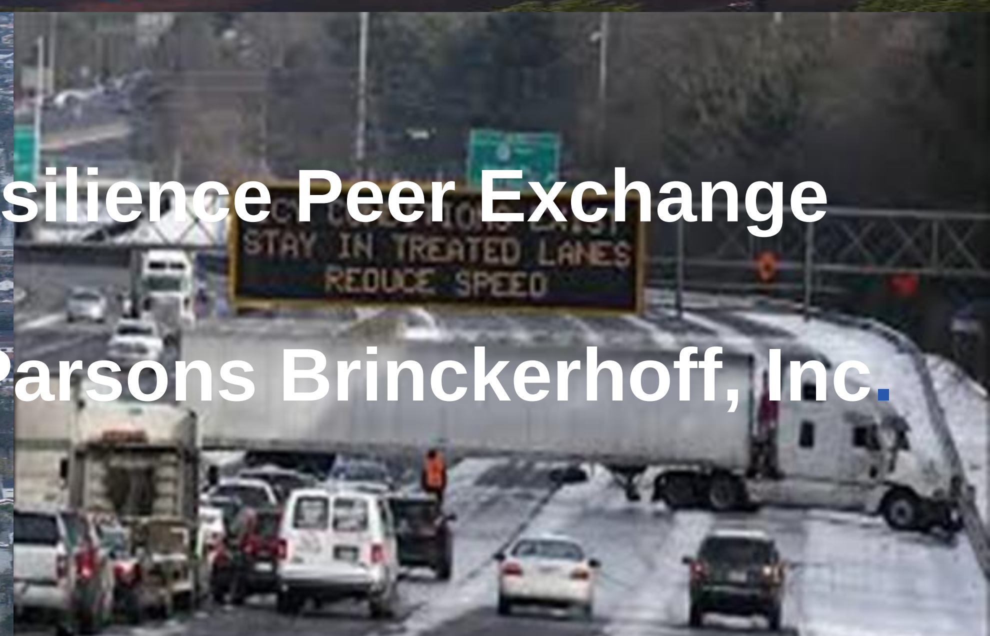


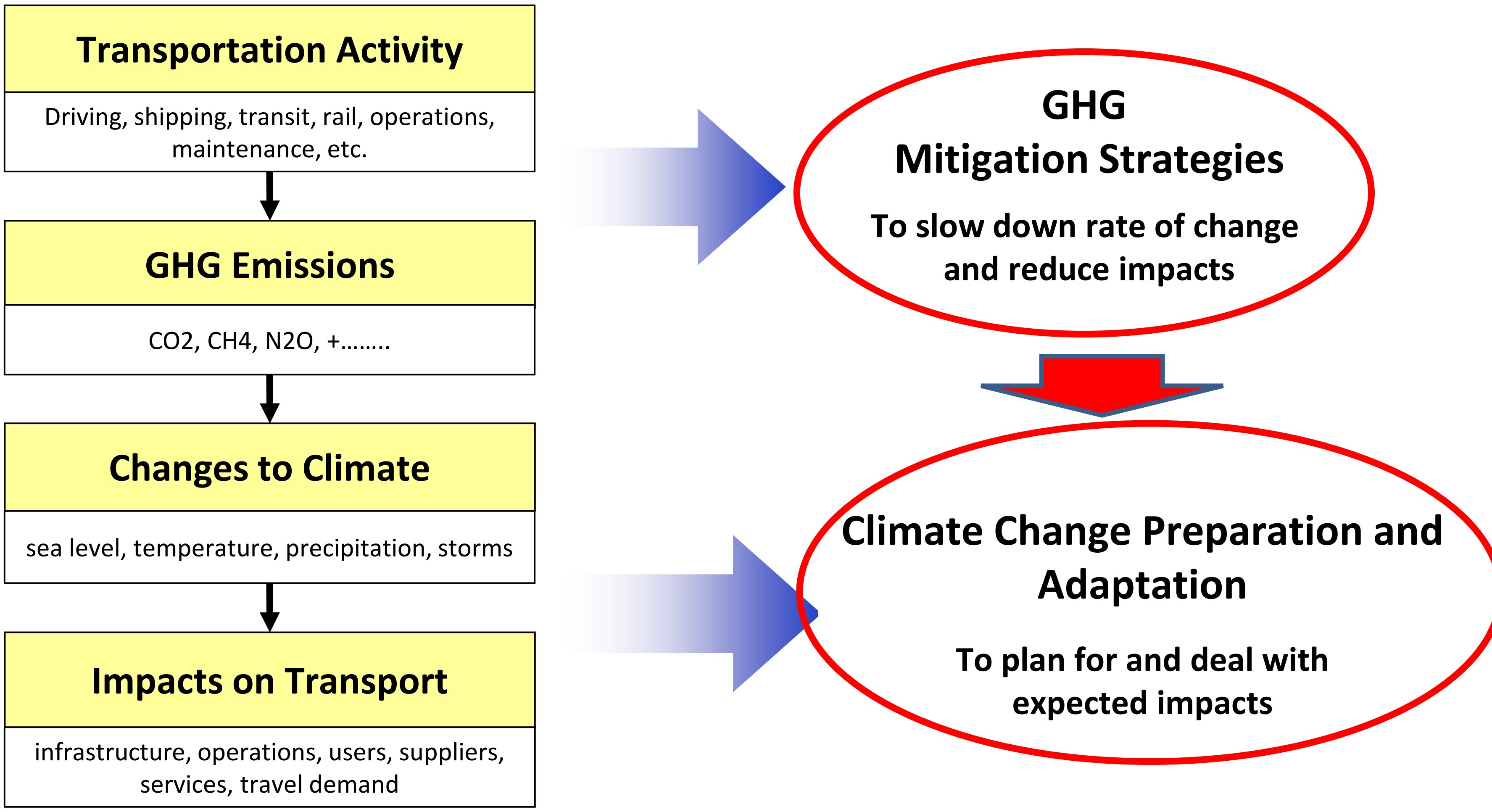
Climate Change Overview

ARC/FHWA Climate Resilience Peer Exchange

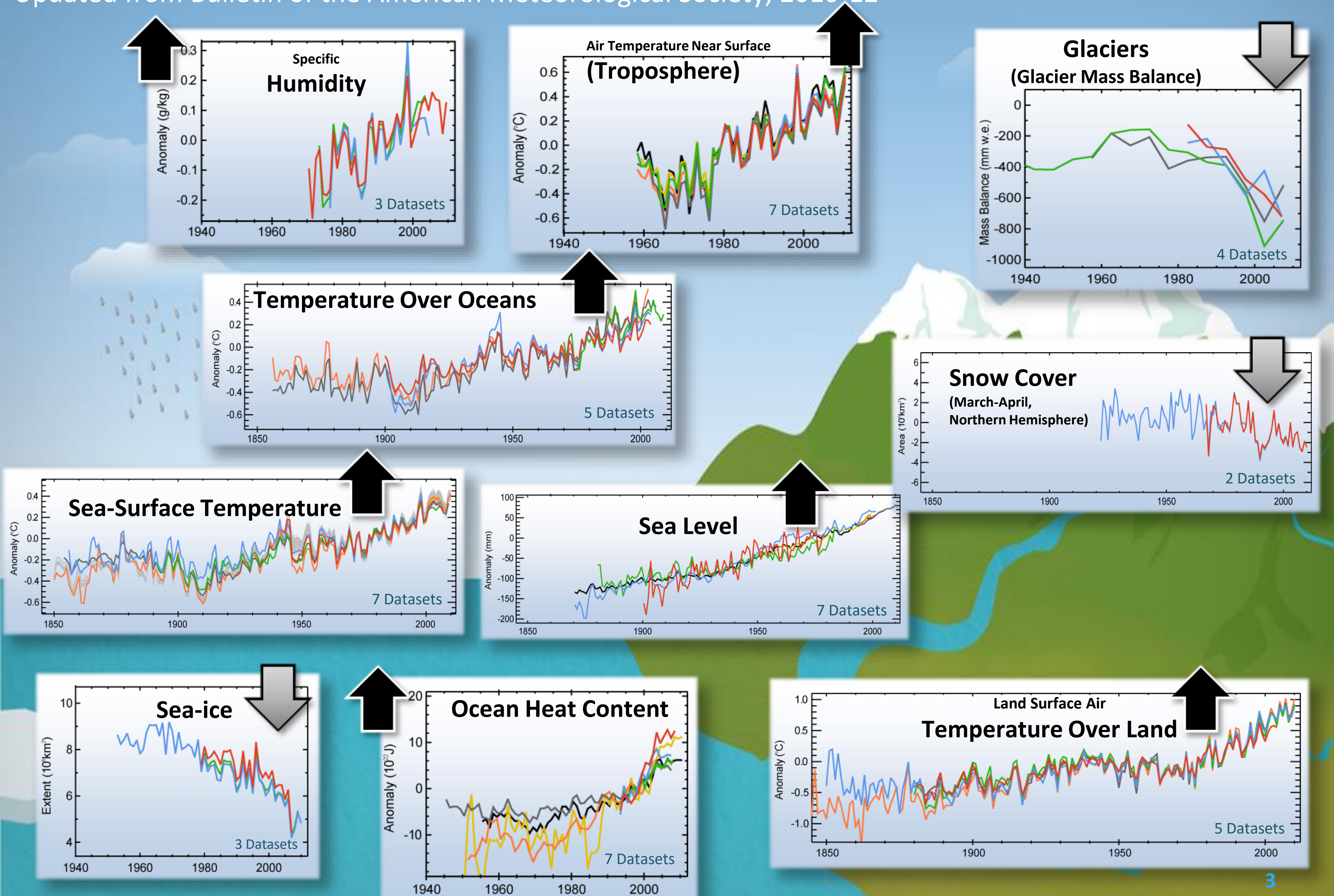
Michael D. Meyer, WSP/Parsons Brinckerhoff, Inc.

What is the Difference between Mitigation & Adaptation?

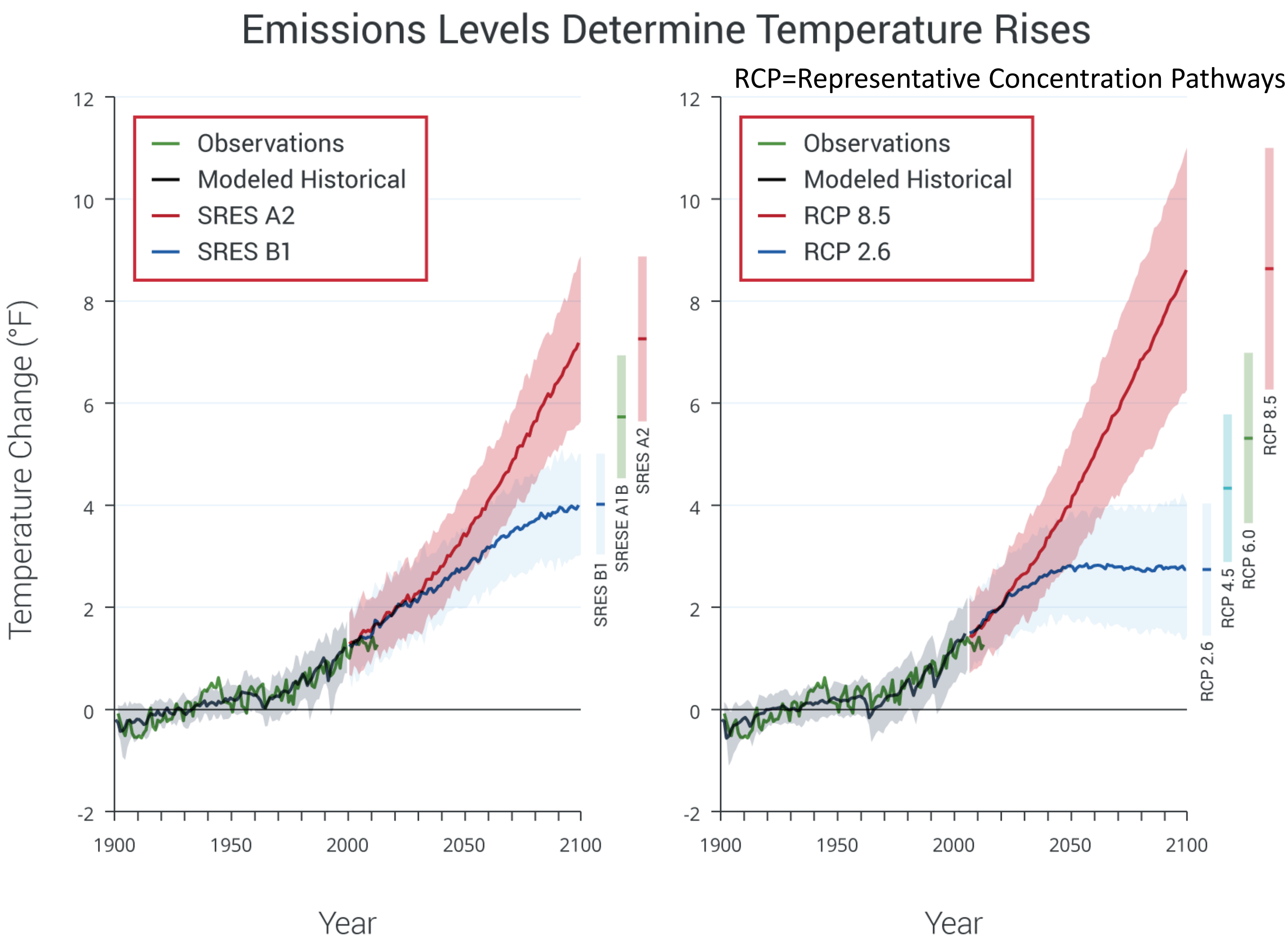


The Changing State of the Climate

Updated from Bulletin of the American Meteorological Society, 2010-12

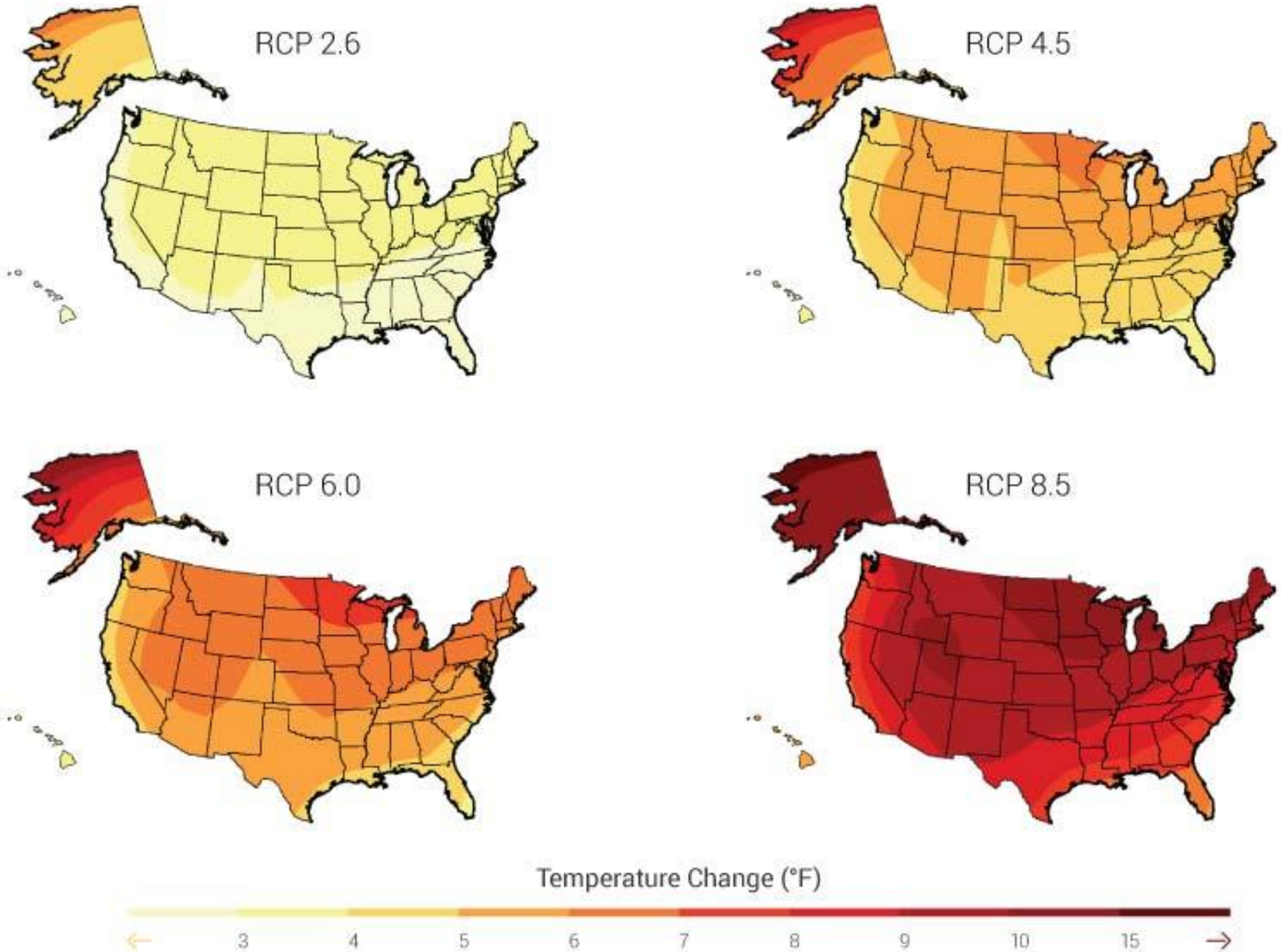


Projected Change in Average Annual Temperature-IPCC

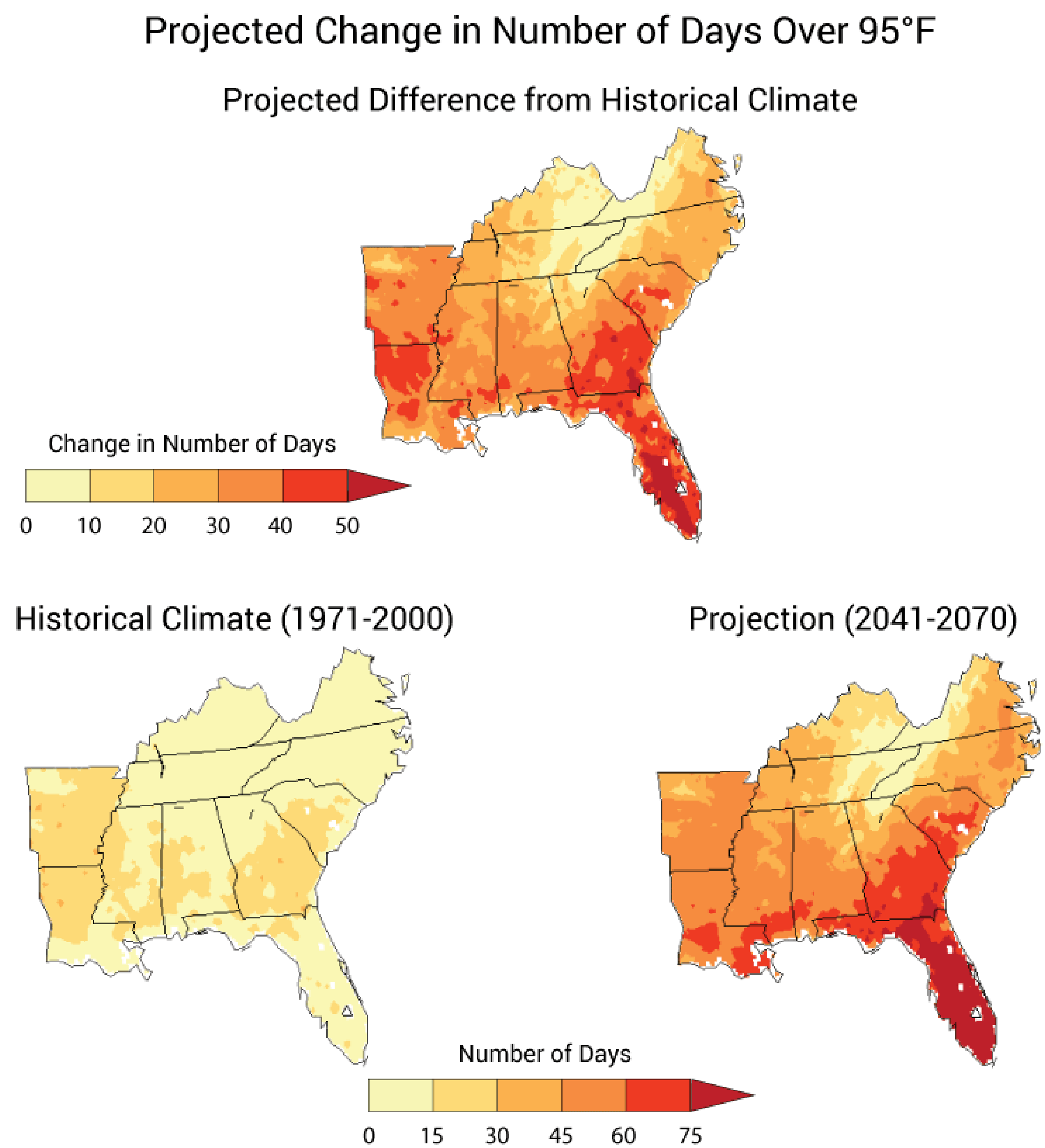


US Global Change Research Program, National Climate Assessment, 2014. Accessed at, http://nca2014.globalchange.gov/report

Projected Change in Average Temperatures, 2071-2099 Compared to 1970-1999

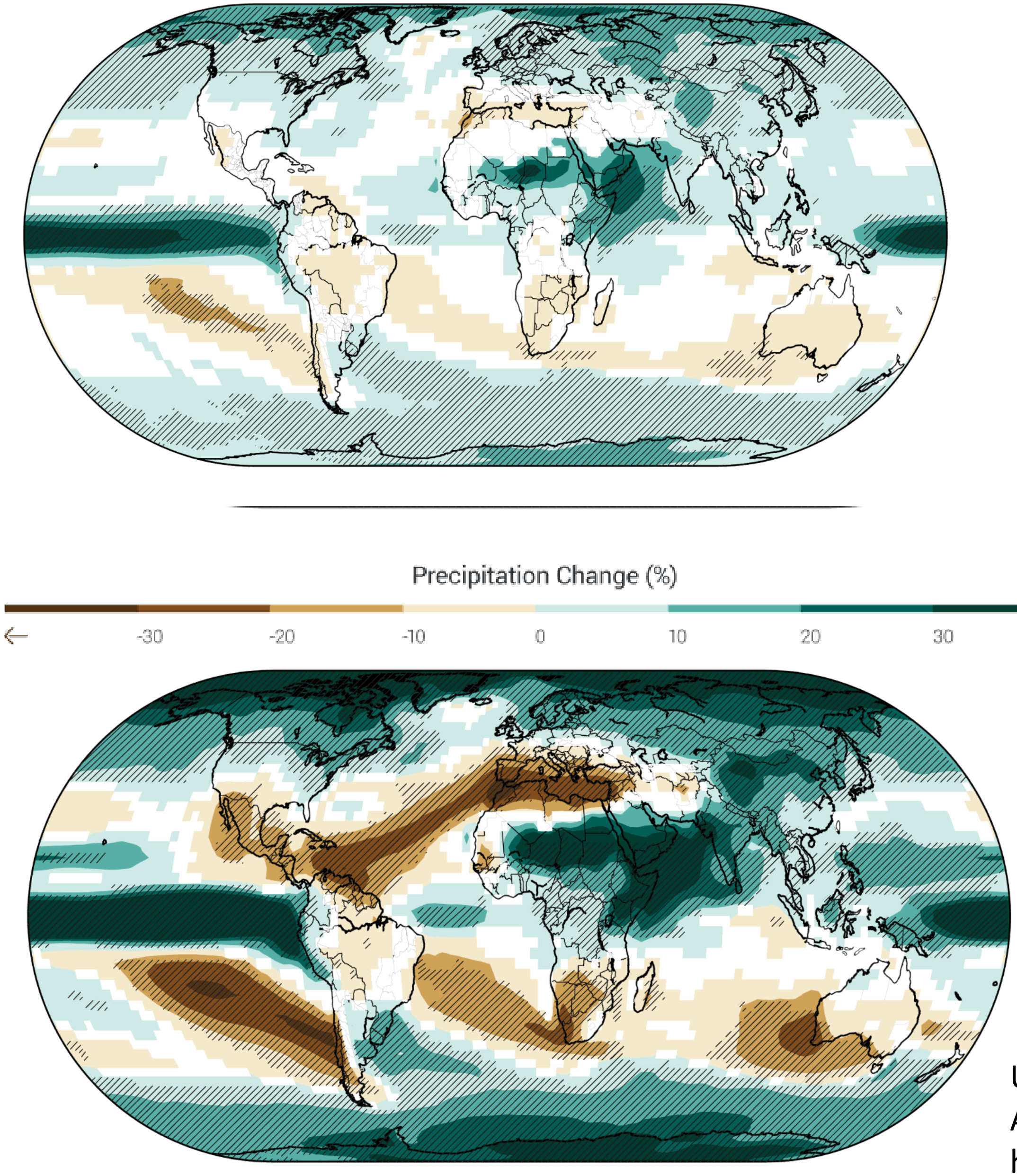


US Global Change Research Program, National Climate Assessment, 2014. Accessed at, http://nca2014.globalchange.gov/report



Source: U.S. Global Change Research Program, National Climate Assessment, Southeast Region, Accessed from, http://nca2014.globalchange.gov/report/regions/southeast

Rapid Emissions Reductions (2.6)

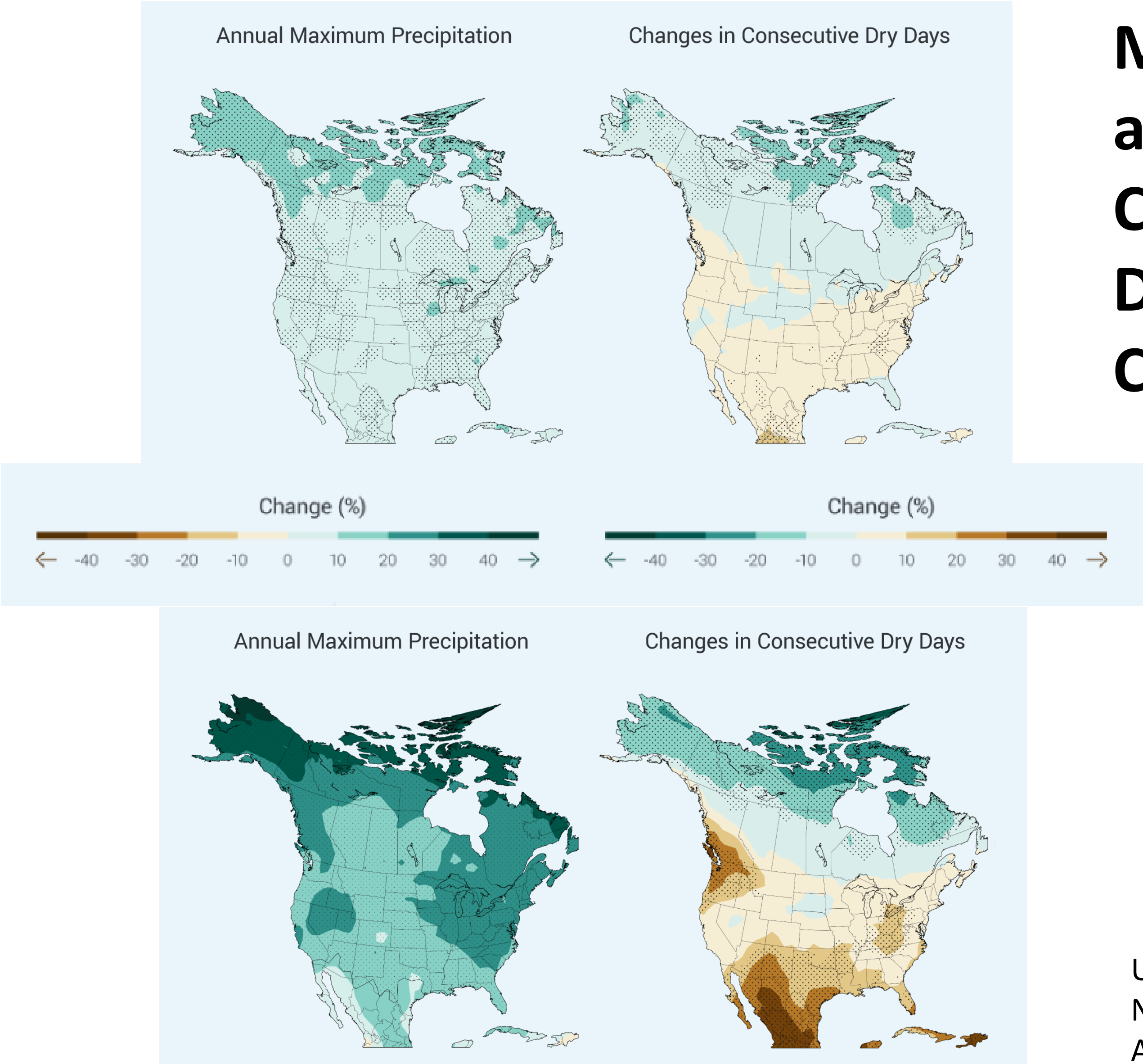


Continued Emissions Increase (8.5)

Projected Change in Average Annual Precipitation, 2071-2099 Compared to 1970-1999

US Global Change Research Program, National Climate Assessment, 2014. Accessed at, http://nca2014.globalchange.gov/report

Rapid Emissions Reductions (2.6)

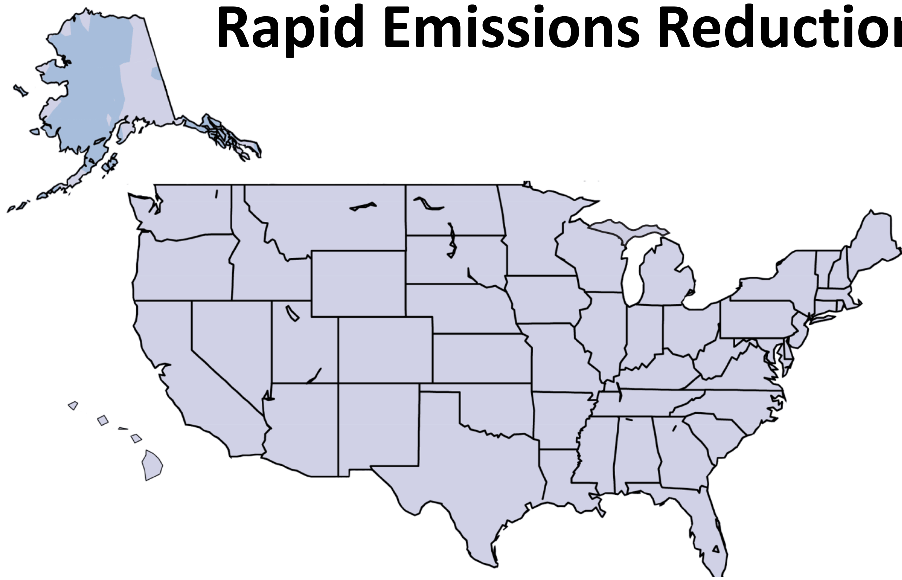


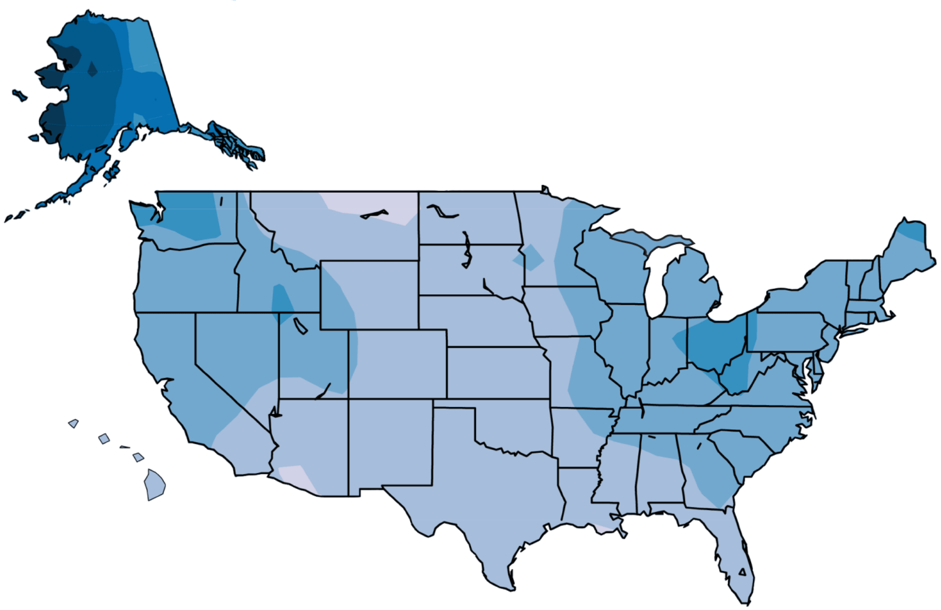
Continued Emissions Increase (8.5)

Changes in Annual Max. Precipitation and Changes in Consecutive Dry Days, 2070-2099, Compared to 1971

US Global Change Research Program, National Climate Assessment, 2014. Accessed at, http://nca2014.globalchange.gov/report

Rapid Emissions Reductions (2.6)





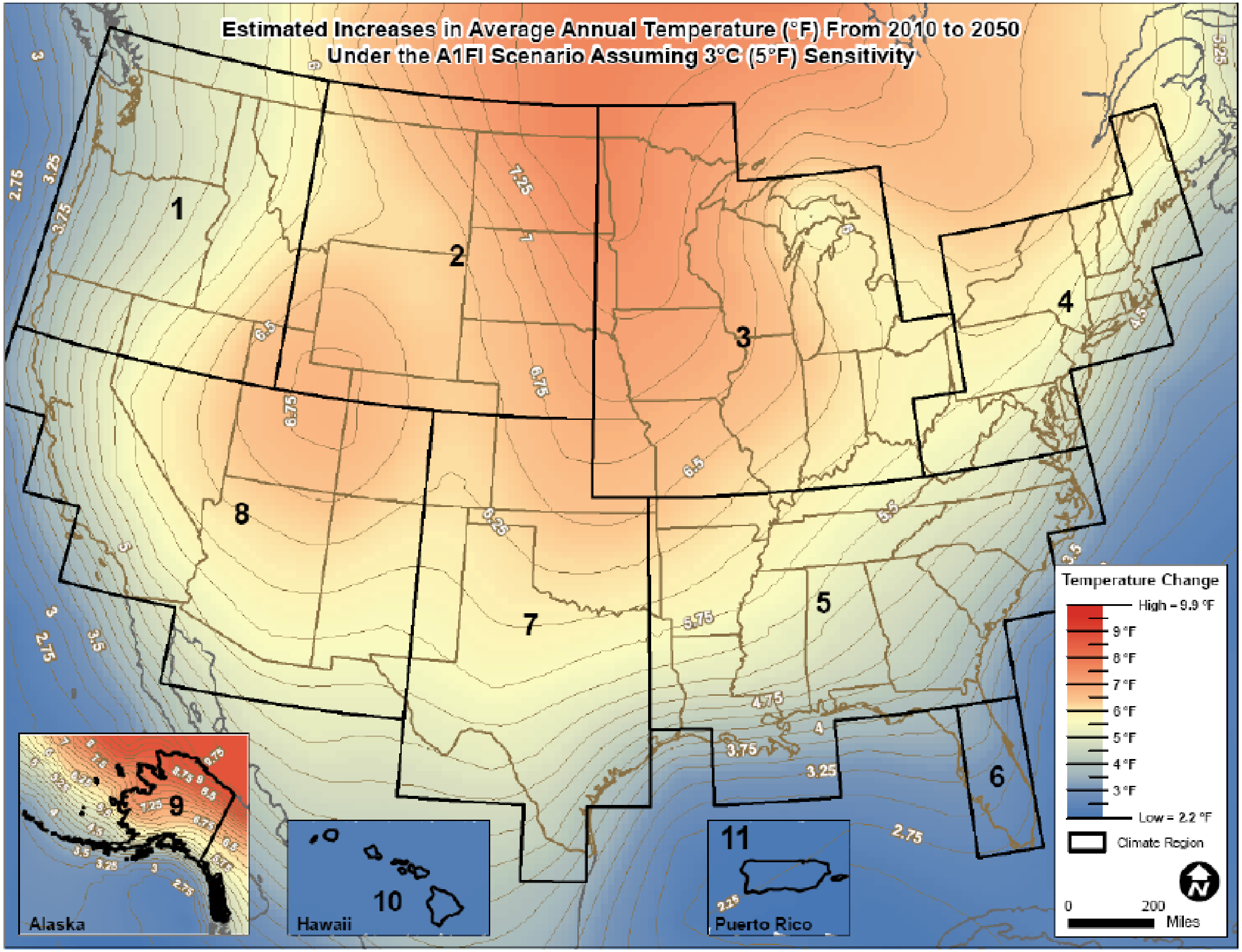
Continued Emissions Increase (8.5)

Change in Frequency of 20-year Precip Events, 2081-2100, Compared to 1981-2000

US Global Change Research Program, National Climate Assessment, 2014. Accessed at, http://nca2014.globalchange.gov/report

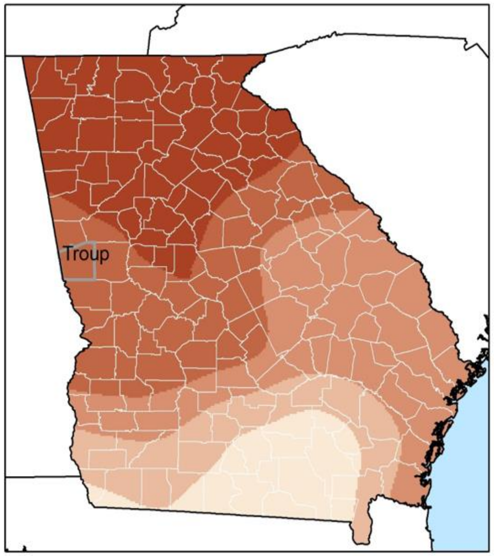
IT ALL DEPENDS…..

Figure 4-1: Estimated Increases in Temperature (°F) in 2050 Relative to 2010 Using A1F1 Scenario, 3°C Sensitivity



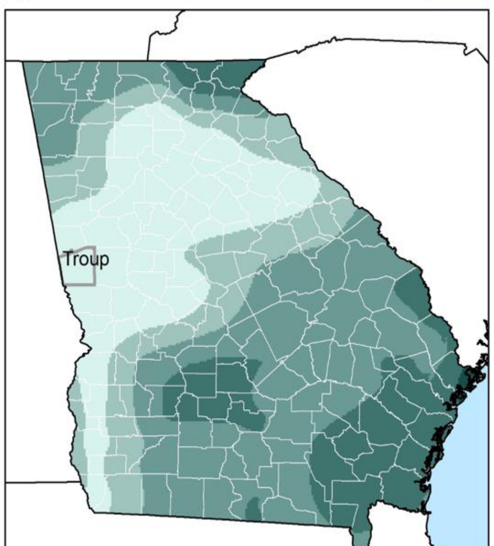
…Even Within One State

Projected Changes in Climate Stressor in Georgia by 2080, 50th% Scenario



Temp Increase in Fahrenheit

- 1.3 – 2.5
- 2.6 – 3.6
- 3.7 – 4.7
- 4.8 – 5.8
- 5.9 – 7.0



Precip Increase in Inches

- -.3 - .6
- .61 – 1.19
- 1.2 – 1.59
- 1.6 – 2.4
- 2.41 - 4

Resilient Analytics, 2016.IPSSTM Vulnerability Summary:
The Ray Troup County, Georgia

Why should we be interested?

Extreme Events

Katrina

Katrina

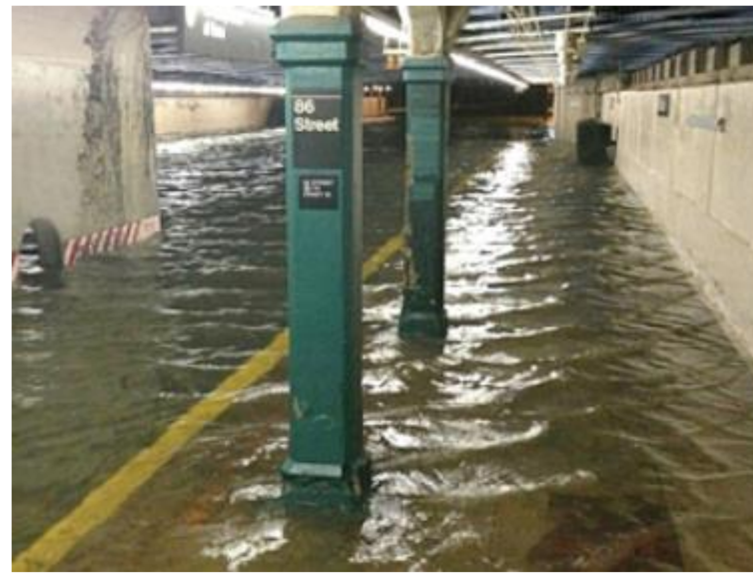
Katrina

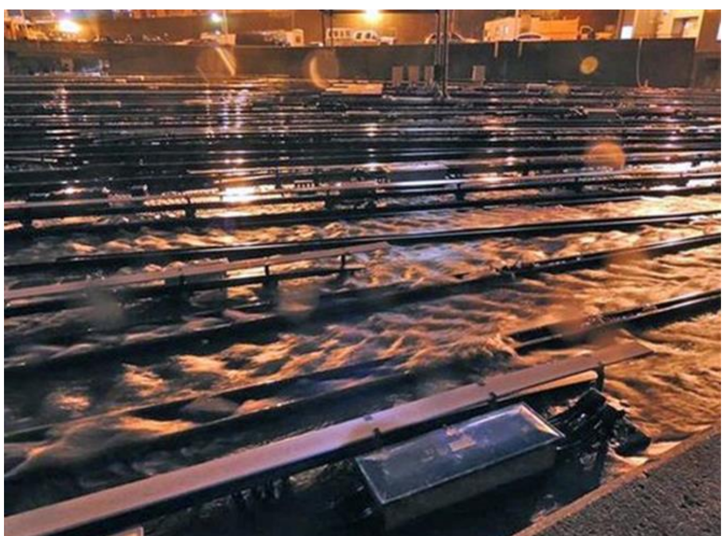
Katrina

Irene

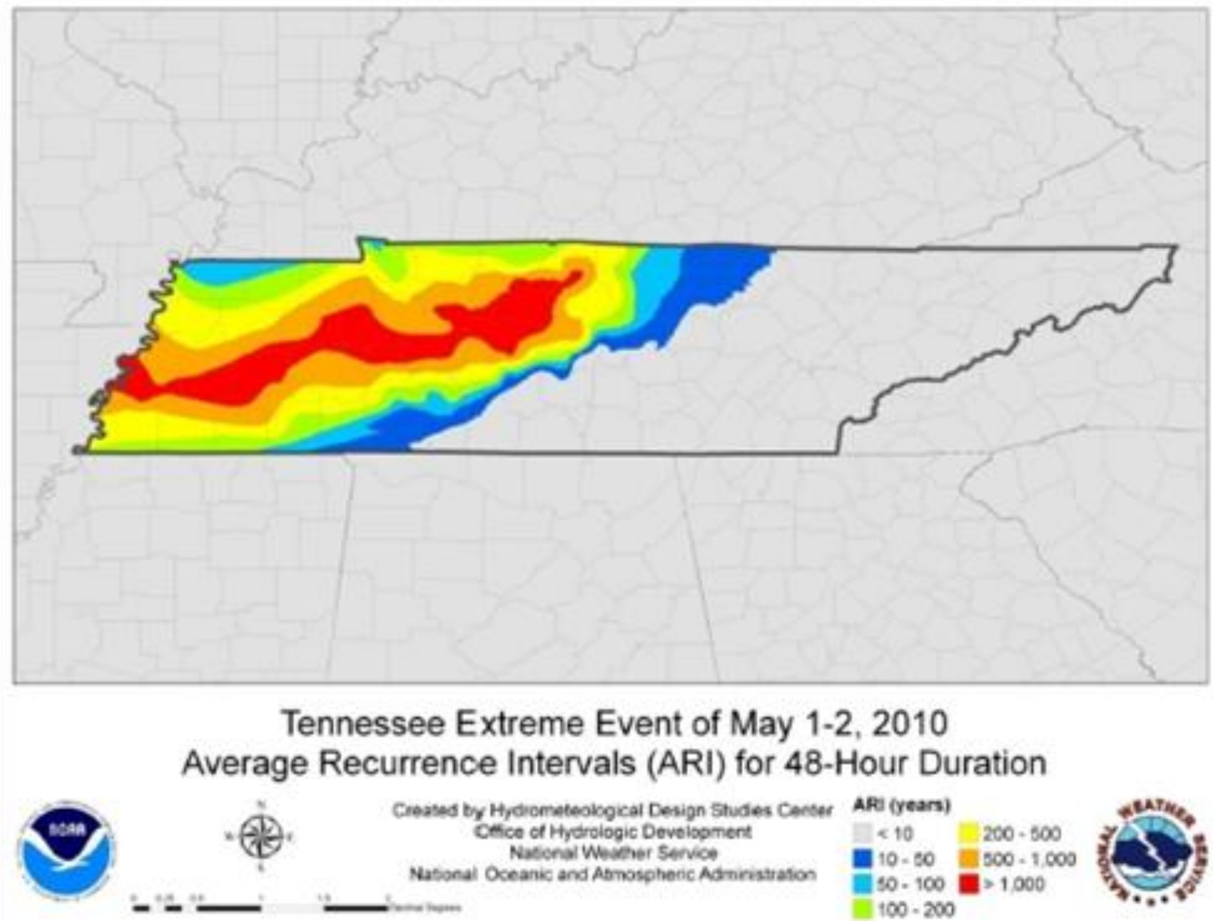
Sandy

Sandy





Tennessee Superflood, 2010



Tennessee Superflood, 2010

Approach Roadway Damage

Structural Damage

Structural Damage

Bridge Scour

I-680 Iowa

Ice Storms

Metro Atlanta TIME Task Force

Long-term Environmental Changes

Long-term Environmental Changes

Implications of Heat Waves

"Climate models project that the same summertime temperatures that ranked among the hottest 5% in 1950-1979 will occur at least 70% of the time by 2035-2064 in the U.S. if global emissions of heat-trapping gases continue to grow. By the end of this century, what have previously been once-in-20-year extreme heat days (1-day events) are projected to occur every two or three years over most of the nation."

U.S. National Climate Assessment, http://nca2014.globalchange.gov/report/our-changing-climate/extreme-weather

Implications of Heat Waves

Design

- *Instability of materials exposed to high temperatures* over longer periods of time (such as causing pavement heave or track buckling) can result in increased failures. Pavement design, in particular, is very sensitive to temperature.
- *Ground conditions and less water saturation* (due to drought conditions) can alter the design factors for foundations and retaining walls, such as is occurring with the loss of permafrost in Alaska.
- Encased equipment such as traffic control devices and signal control systems for rail service *might fail due to higher temperatures inside the enclosure*.

Implications of Heat Waves

Operations/Users

- Increased electricity usage and power outages during heat waves might affect electrical power supply to rail operations and supporting ancillary assets for highway operations (such as electronic signing).
- Extended periods of high temperatures will affect safety conditions for employees that work long hours outdoors, such as those working on infrastructure reconstruction and maintenance activities.
- Right-of-way landscaping and vegetation will have to be more drought resistant, and be able to survive longer periods of high temperatures.
- Other water-use activities in a transportation agency might have to be curtailed, at least on a temporary basis (e.g., washing of transit vehicles).
- Extreme temperatures will create dangerous conditions for many users of the transportation system, placing greater emphasis on the use of air conditioning for transit vehicles and stations, and increase use of green design approaches.

Implications of Heat Waves

- Extreme temperatures could result in increased maintenance activities, such as replacing tracks that have buckled and pavement sections that have experienced heave, as well as removing landslides and erosion that occurs with extreme precipitation events after drought or extreme temperatures have dried out the soil.
- Extended periods of high temperatures will likely result in changes in rail operations, at a minimum requiring mandatory reduced speeds in areas where the track has been exposed to high temperatures over many days.
- Similarly, extended periods of high temperatures will negatively affect bicycle use and the desire and propensity of individuals to walk outdoors.

Heavy Rainfall, Flooding, and Sea Level Rise

National and Regional Trends Regional Trends	Projections
Increases in heavy rainfall, esp. in East and Midwest Riverine streamflow records show both increases and decreases in flooding Many coastal areas are experiencing frequent/severe flooding In many Western locations, changes in snow accumulation and snowmelt alters the timing of peak flows	Increases in frequency and severity of strong storms in many parts of the country Sea level rise is a given

Joe Casola, C2ES
Staff Scientist, Director of Science and Impacts
Center for Climate and Energy Solutions

Relationship Between Climate Change Adaptation and Transportation Planning

- Climate change as a trend/factor in future system performance (scenarios)
- …… as part of the vision of a resilient and sustainable transportation system
- …… as reflected in system performance measures
- …… as part of defining state or regionally significant parts of the network (redundancy)

Relationship Between Climate Change Adaptation and Transportation Planning

- Climate change as helping to define parts of the study area where special consideration might be necessary during project development process
- …… as part of the data collection and analysis process
- …… as part of the evaluation and project prioritization process
- …… as part of the system performance monitoring effort

Planning Involvement in Considering Resiliency

Minimal

Proactive

Resiliency

Goals

Performance Metrics

Data Background/Analysis

Peer Assessment and Application

Site-specific Studies

Network Analysis

Scenario Planning

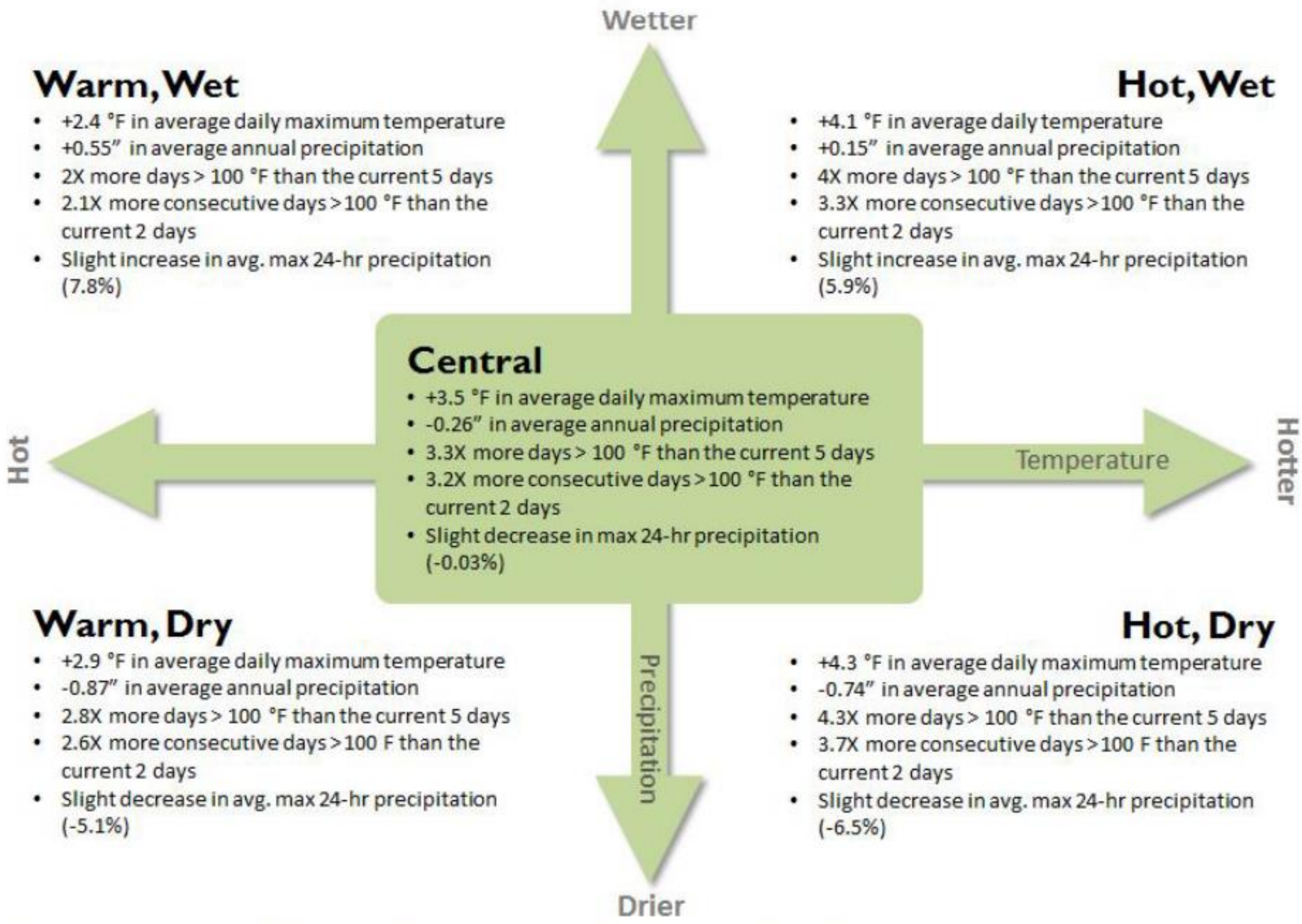
Prioritization Criteria

Extreme Weather Sensitivity Thresholds in Central Texas

Impact	Modes Affected	Threshold
Flooding	Highways, Rail, Transit	General flood risk increases when >2” in less than 12 hours; Rural roads >3.44” in 24 hours; principal arterials >7.64” in 24 hours; Major highways >10.2” in 24 hours
Pavement cracking or other deterioration	Highways, Aviation	Extended temps. >100 °F; average 7-day max. temp >108 °F; drought lasting longer than 14 days; alternating wet and dry weather patterns; extremely wet conditions for >1 month; temps. < 50 °F
Thermal misalignment	Rail	Risk increases when surface temps. >100 - 115°F
Air conditioning stress and failures	Rail, Transit, Aviation	Temps. >100 °F
Limited ability for maintenance and construction work	Highways, Rail, Transit	Temps. >100 °F
Icy, unsafe road conditions	Highways	Surface temps < 32 °F and precipitation (any)
Damage to switches	Rail	Surface temps < 32 °F and (precipitation > 3/16” of ice)
Wildfire	Highways, Rail, Transit	Drought index > 575; relative humidity <20%; winds > 15-20 mph; La Nina conditions favoring wildfire outbreaks

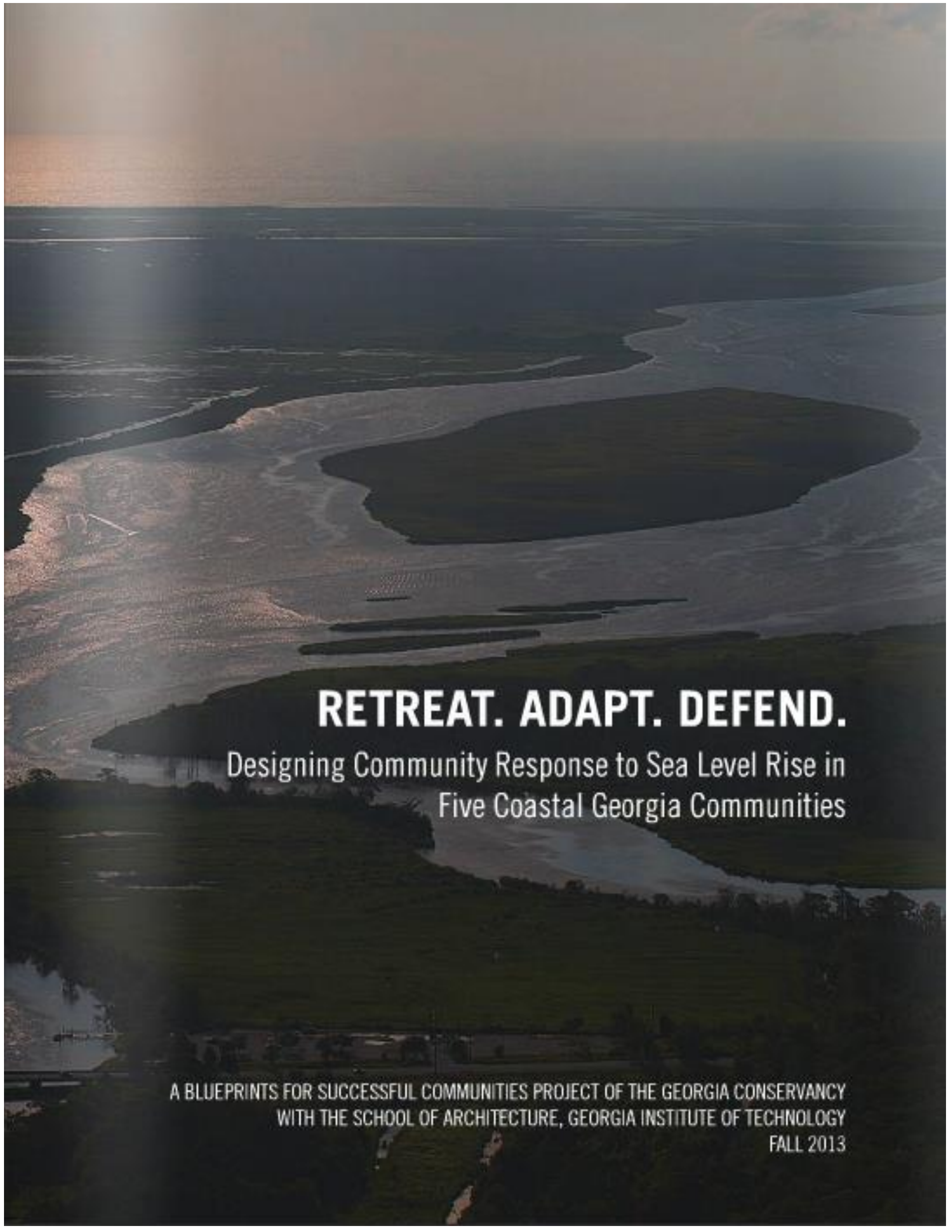
Scenarios in Transportation Planning

Central New Mexico Climate Change Scenario Planning Project



Council on Environmental Quality (CEQ)

"A NEPA review should consider an action in the context of the future state of the environment. In addition, climate change adaptation and resilience — defined as adjustments to natural or human systems in response to actual or expected climate changes — are important considerations for agencies contemplating and planning actions with effects that will occur both at the time of implementation and into the future."



"Think feet, not years."

Thank you.