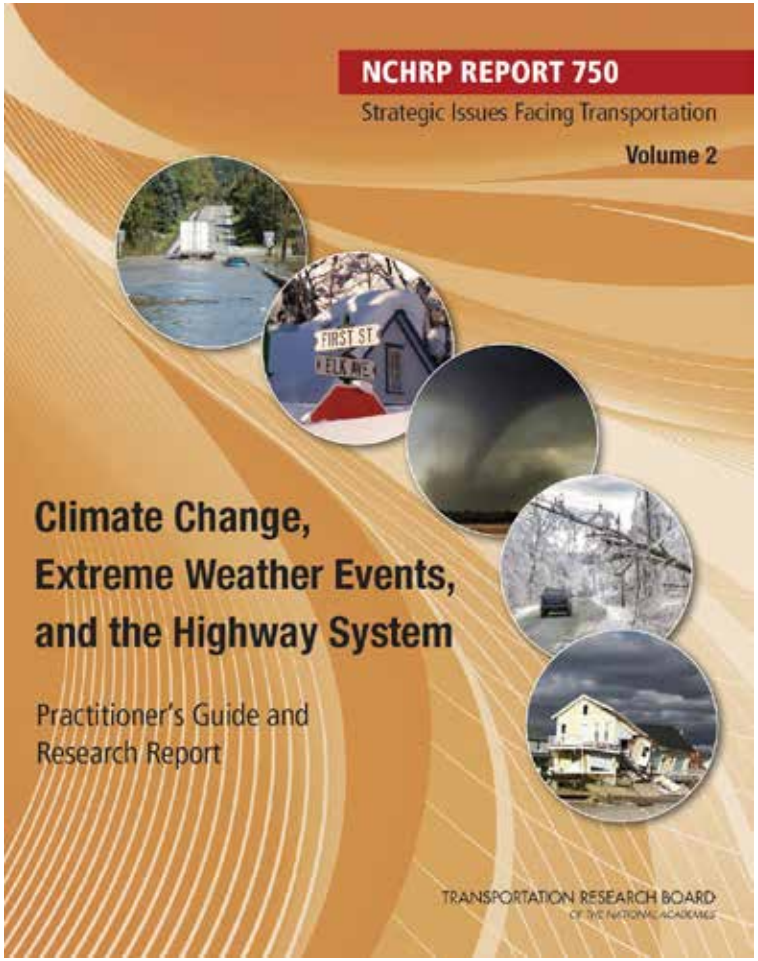
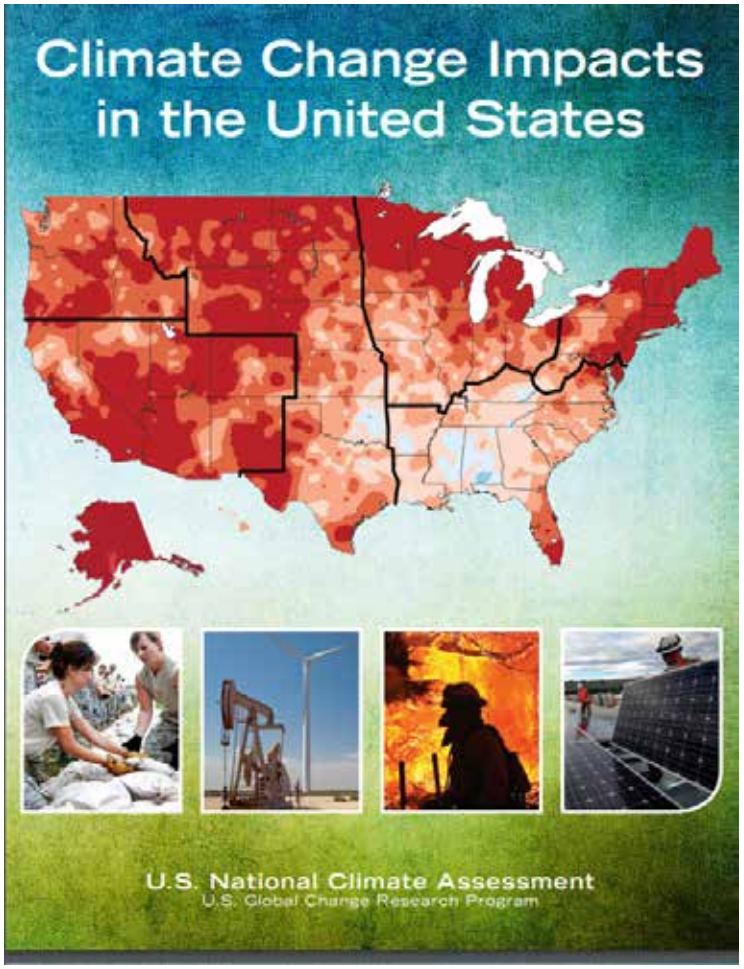
What's Driving all this Change? – Climate Change

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

Two Major Sources

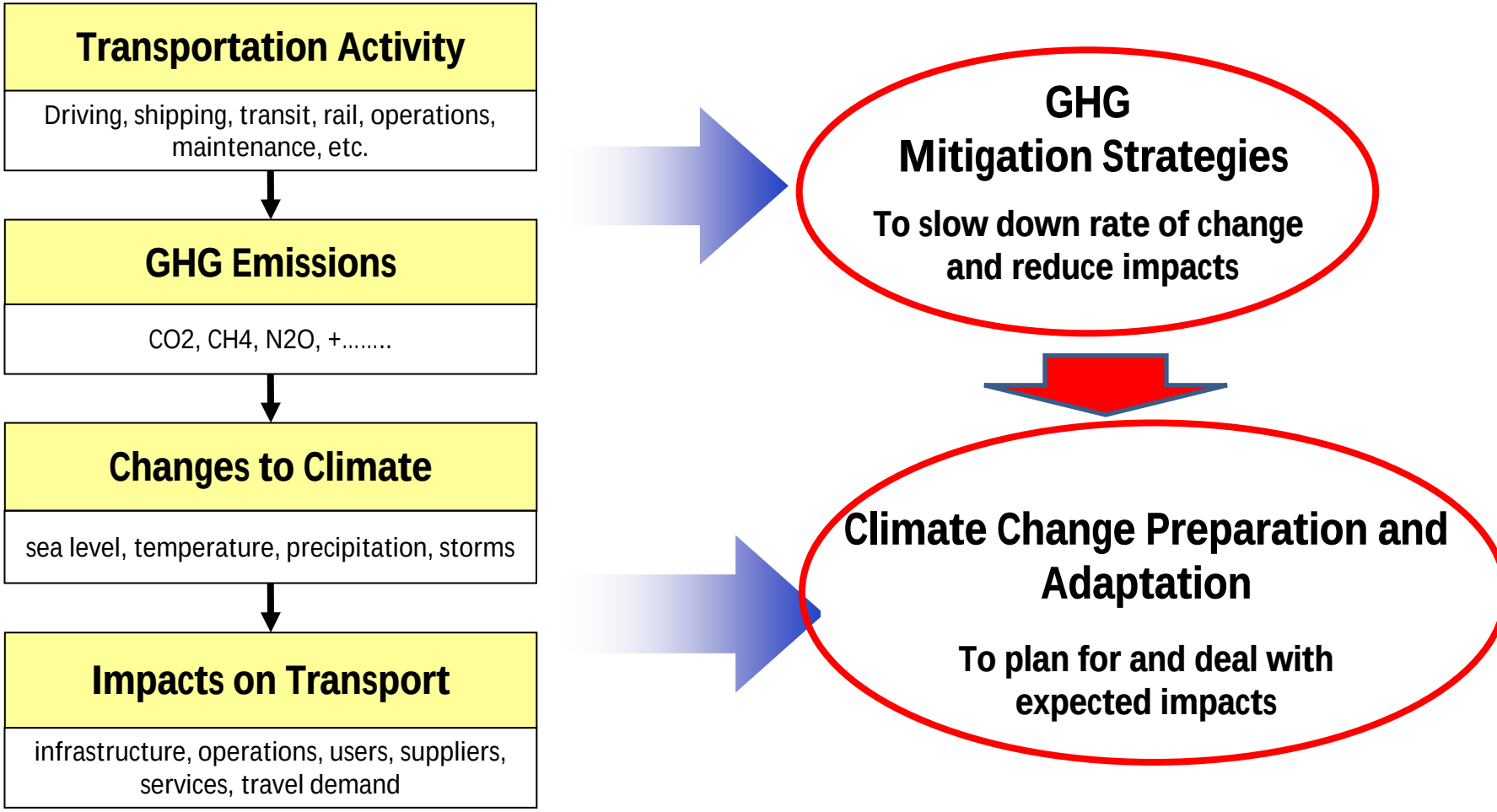


NCHRP 750, VOL. 2



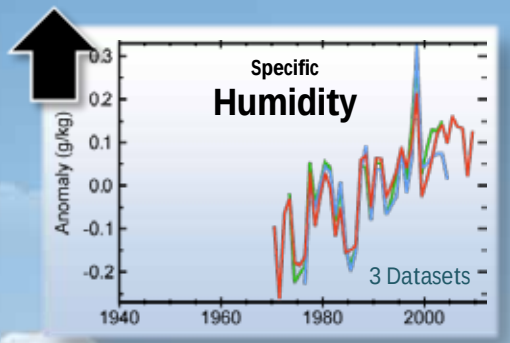
National Climate Assessment, 2014

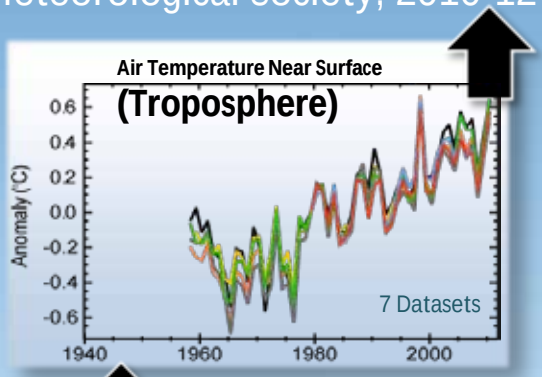
What is the Difference between Mitigation & Adaptation?

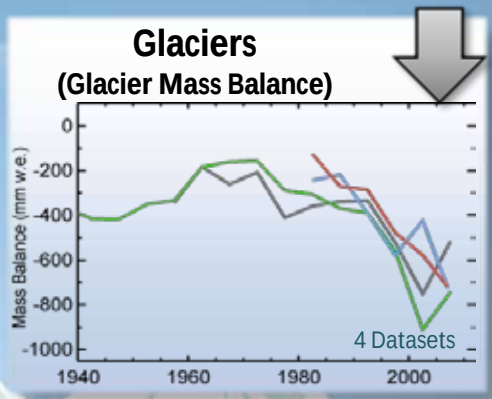


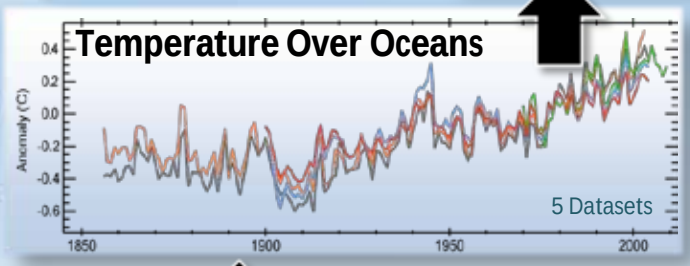
The Changing State of the Climate

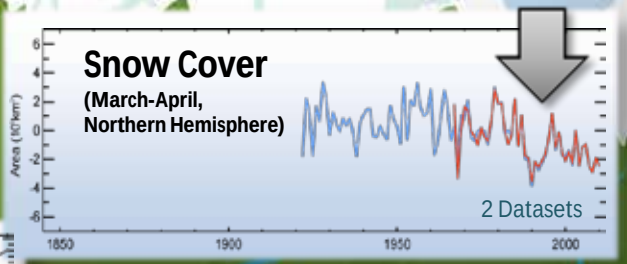
Updated from Bulletin of the American Meteorological Society, 2010-12

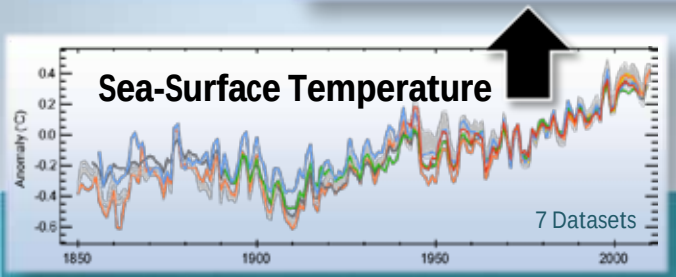


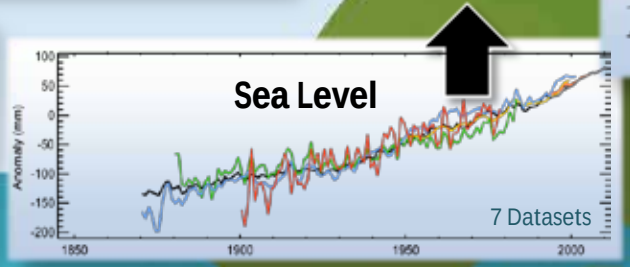


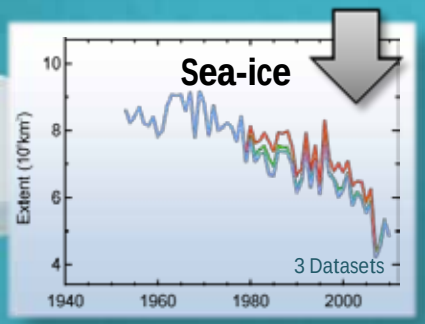


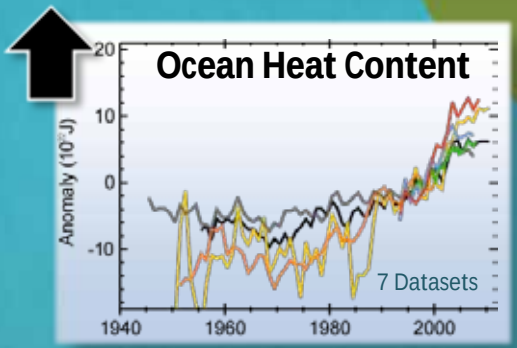


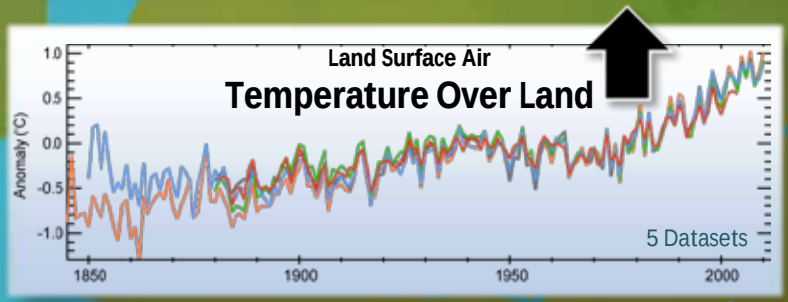




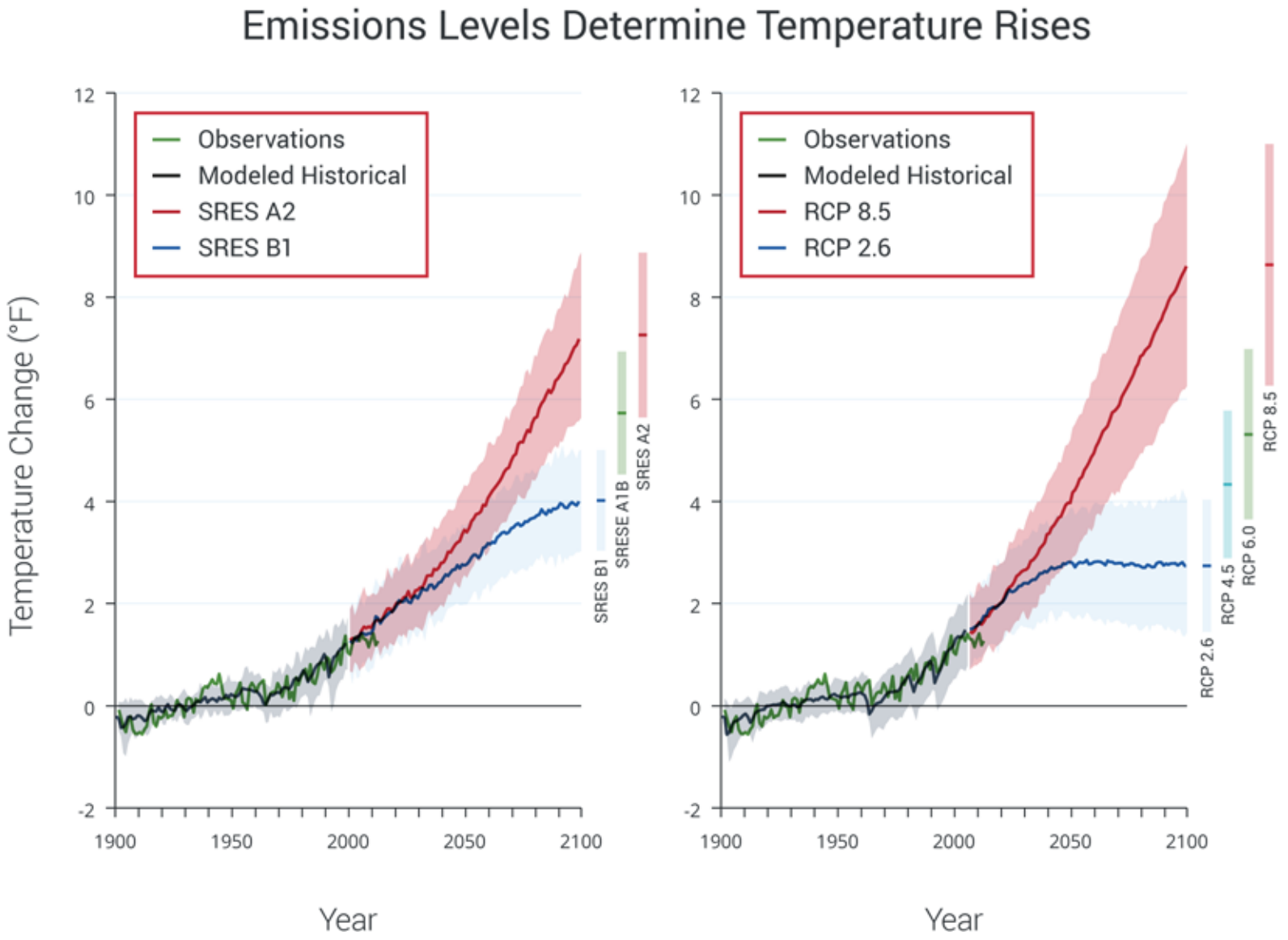






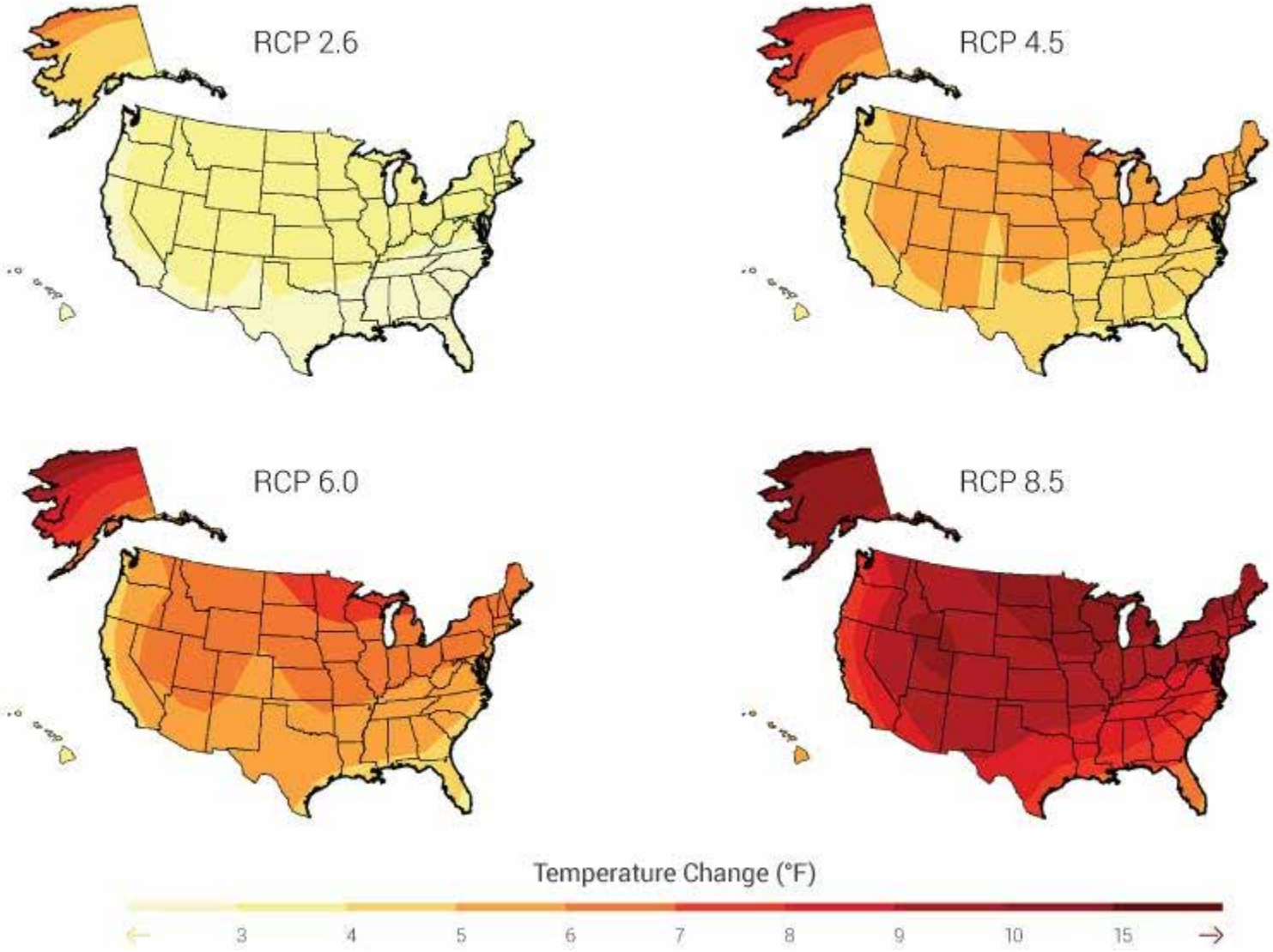


Projected Change in Average Annual Temperature



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



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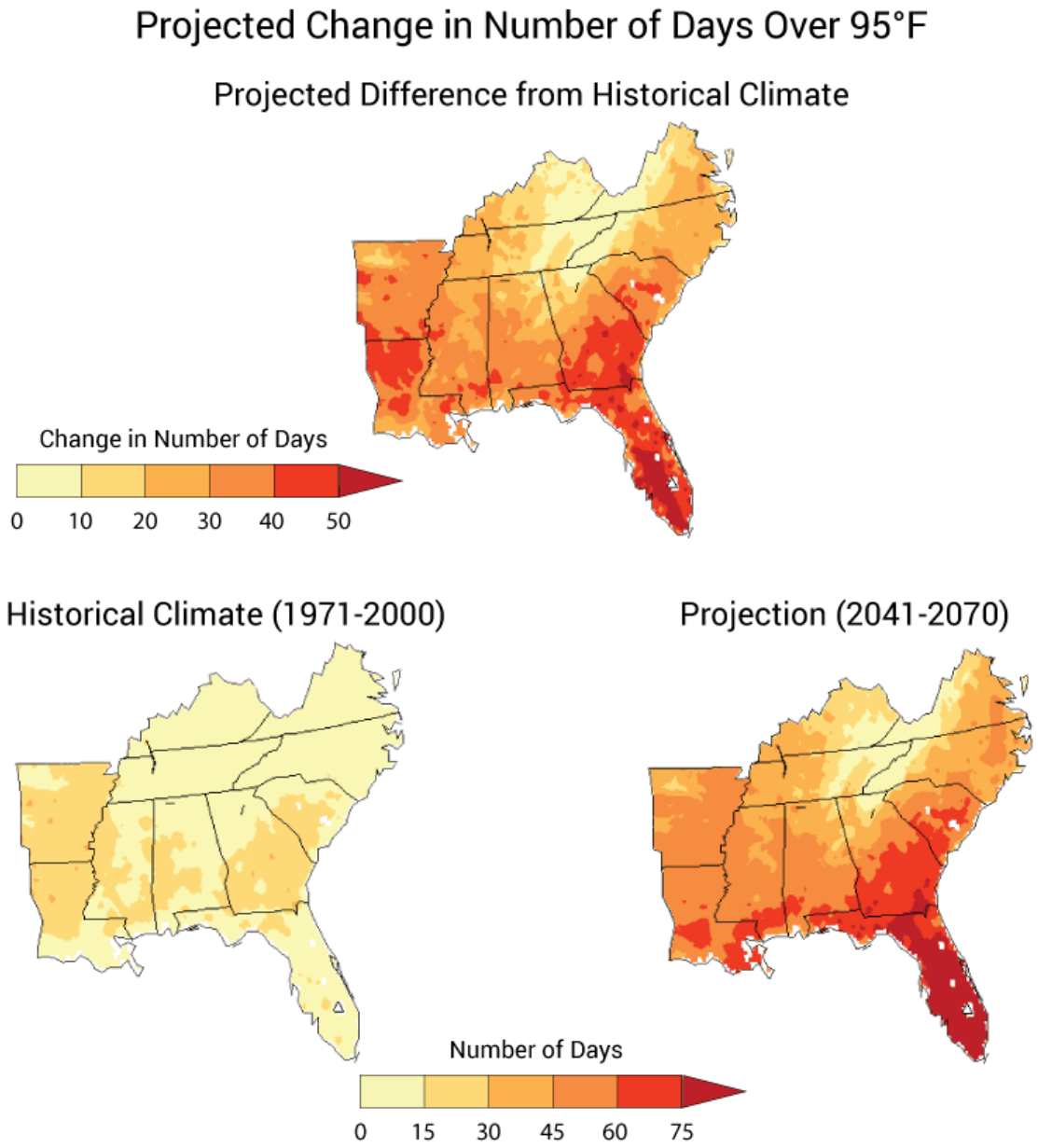
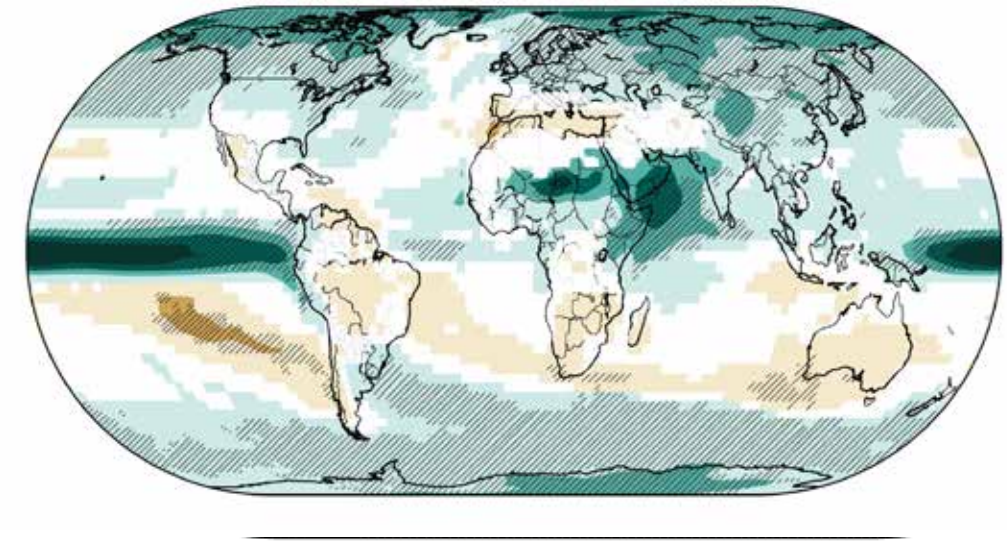
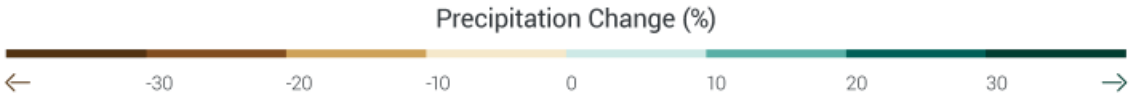
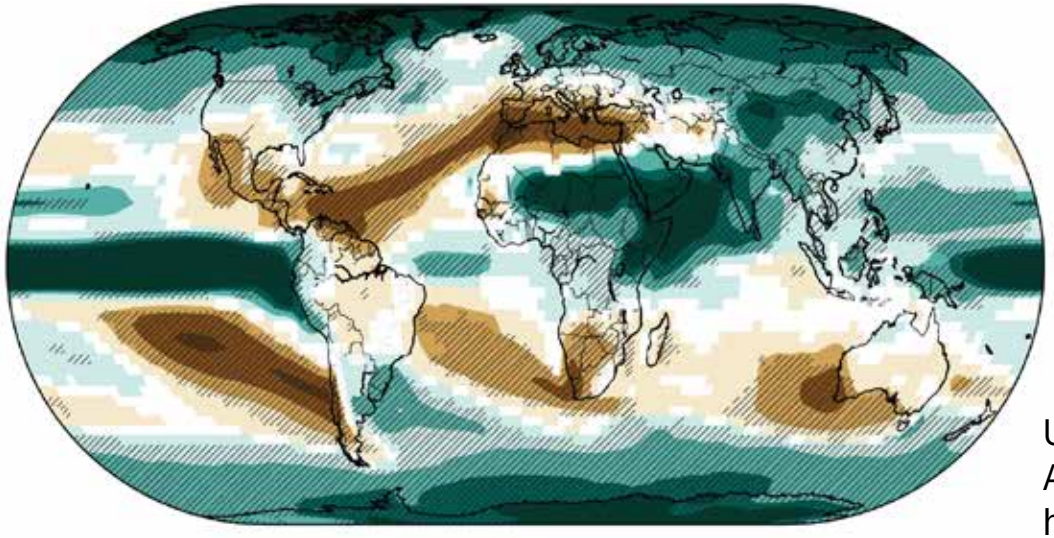


Source: U.S. Global Change Research Program, National Climate Assessment, Southeast Region, Accessed from, http://nca2014.globalchange.gov/report/regions/southeast

Rapid Emissions Reductions (2.6)





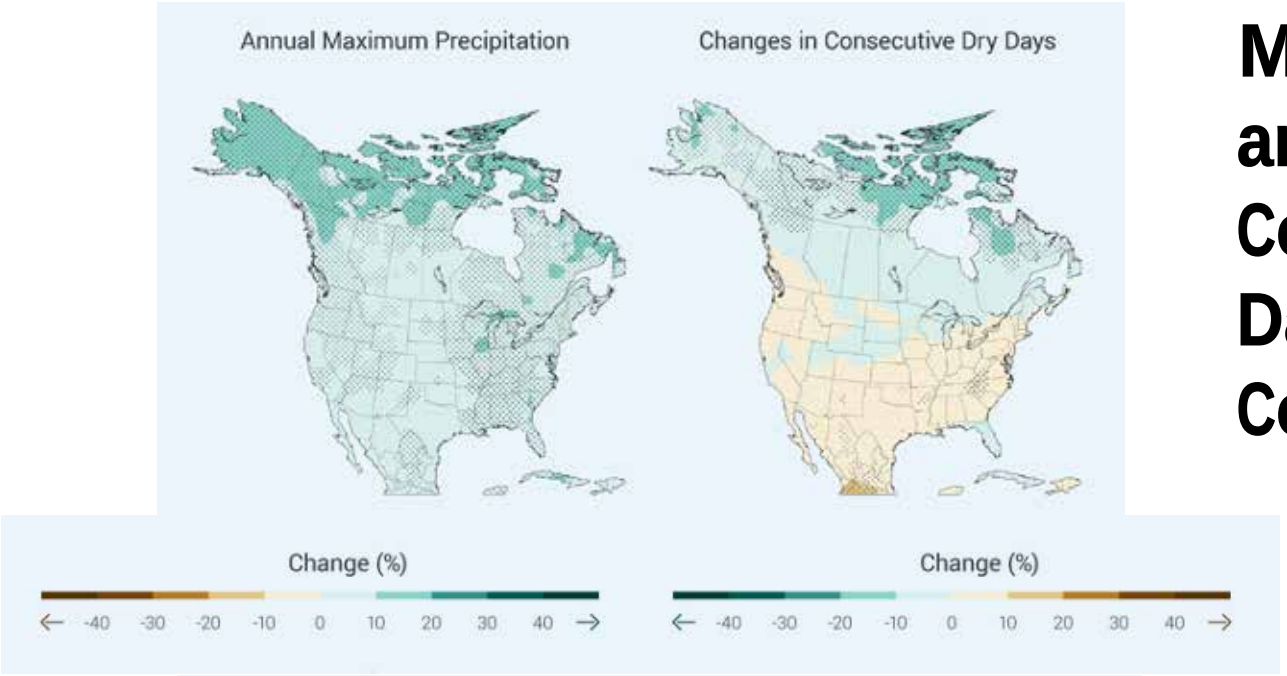


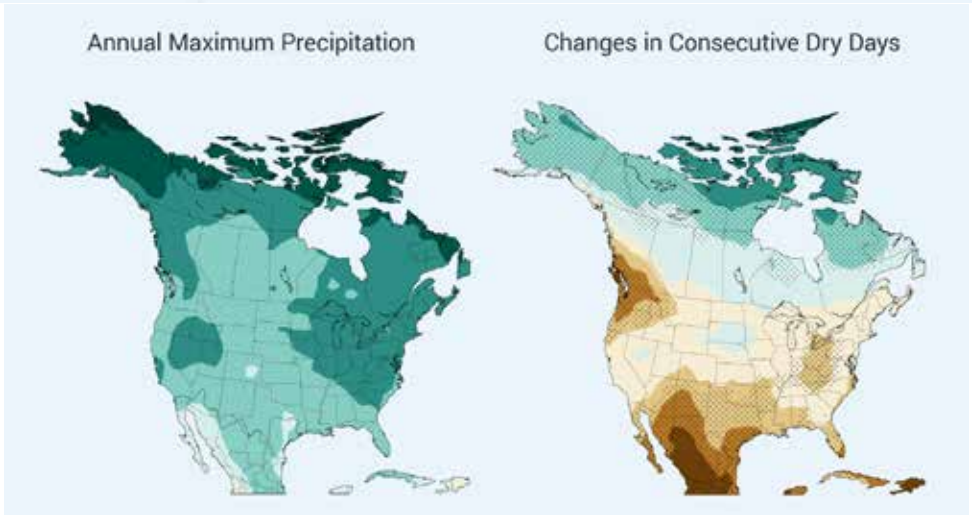
Continued Emissions Increase (8.5)

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)



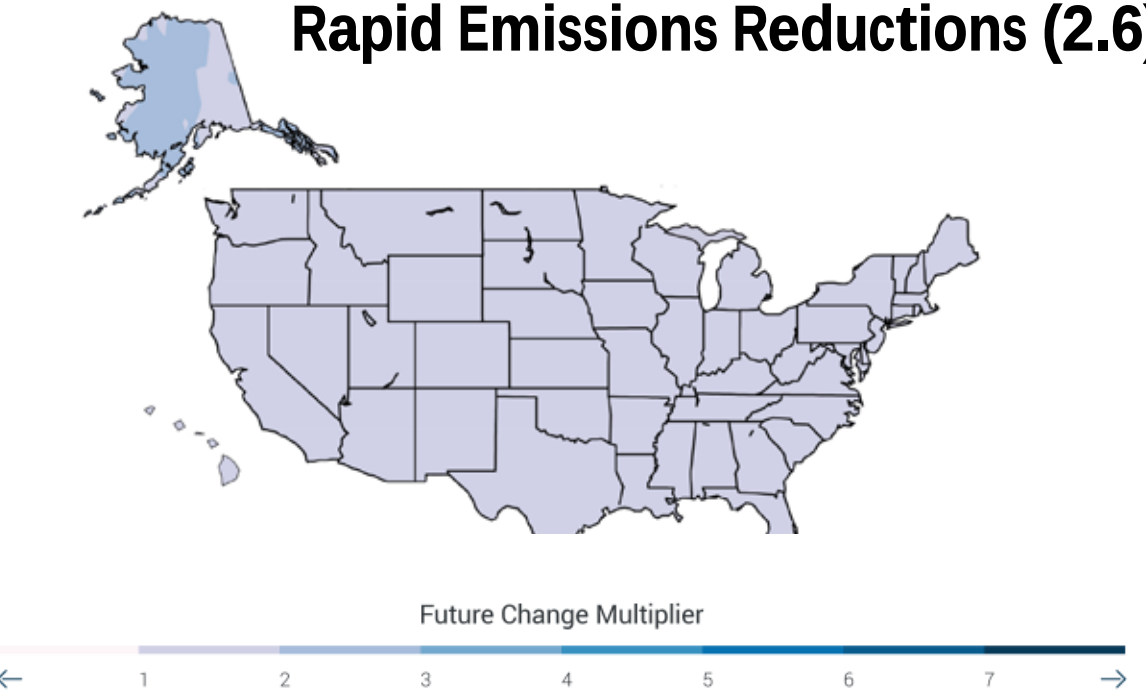


Continued Emissions Increase (8.5)

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)

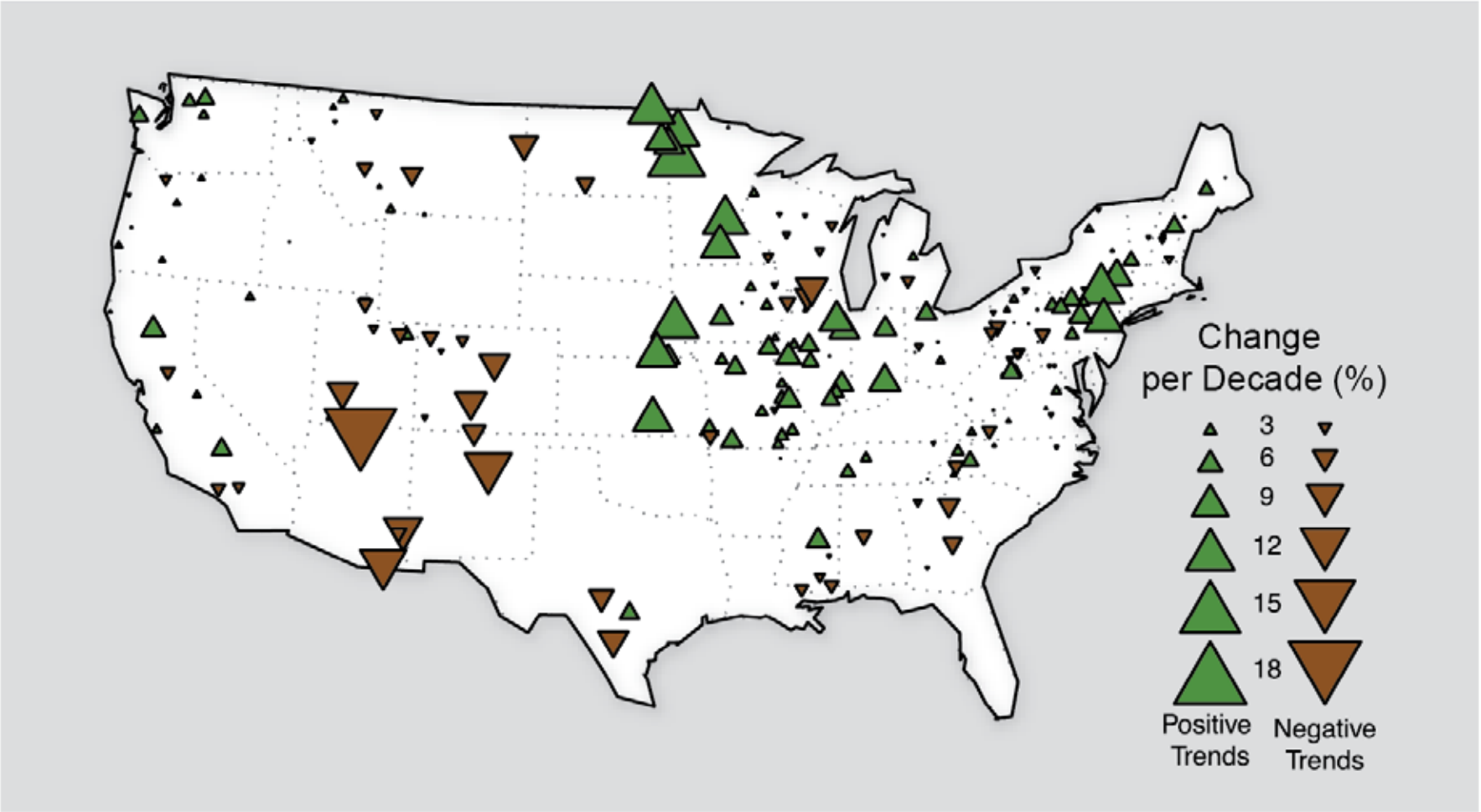


Continued Emissions Increase (8.5)

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

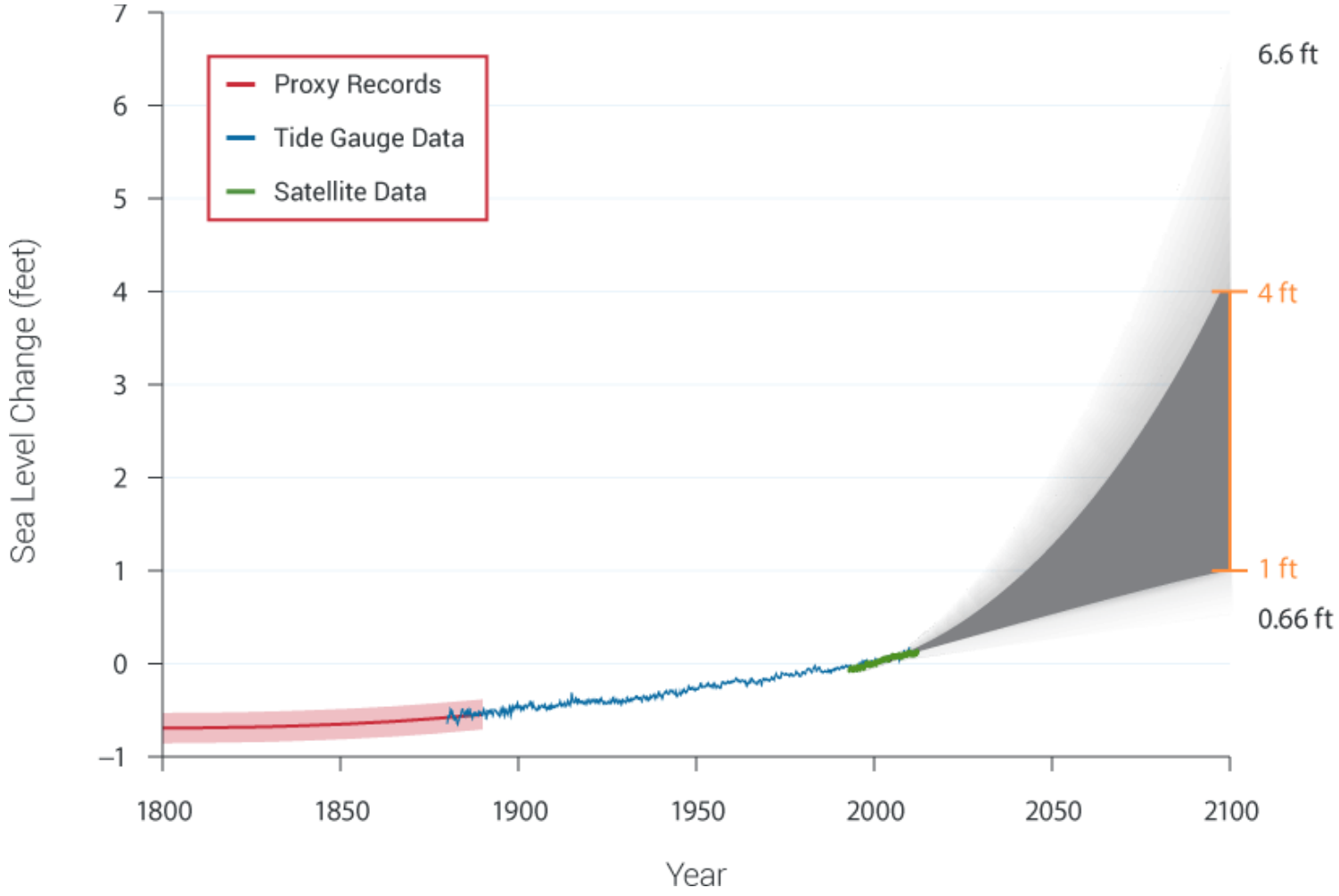
US Global Change Research Program, National Climate Assessment, 2014. Accessed at, http://nca2014.globalchange.gov/report

Trends in Flood Magnitude



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

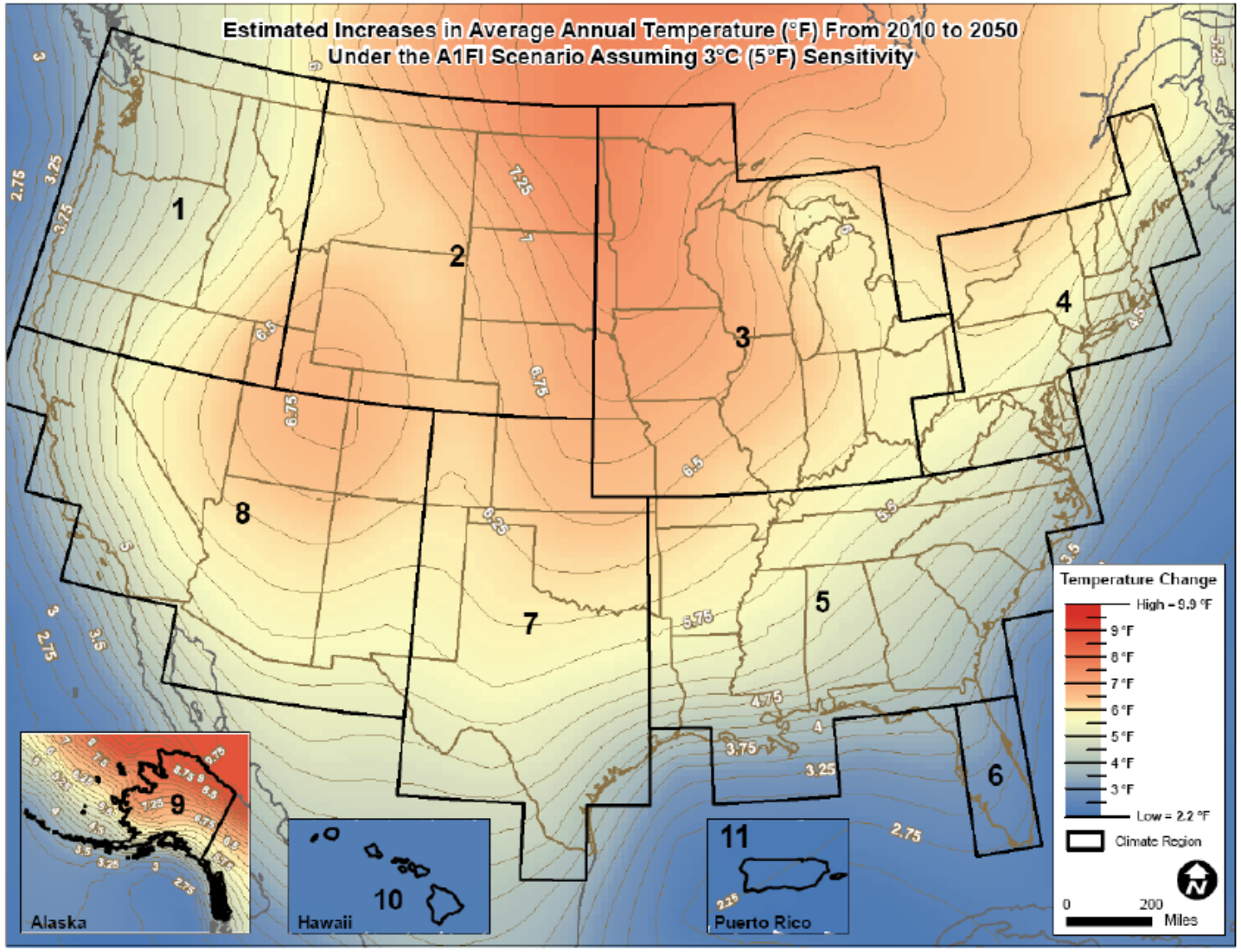
Past and Projected Changes in Global Sea Level Relative to 2000



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



Extreme Events

Katrina

Katrina

Katrina

Katrina

Irene

Irene

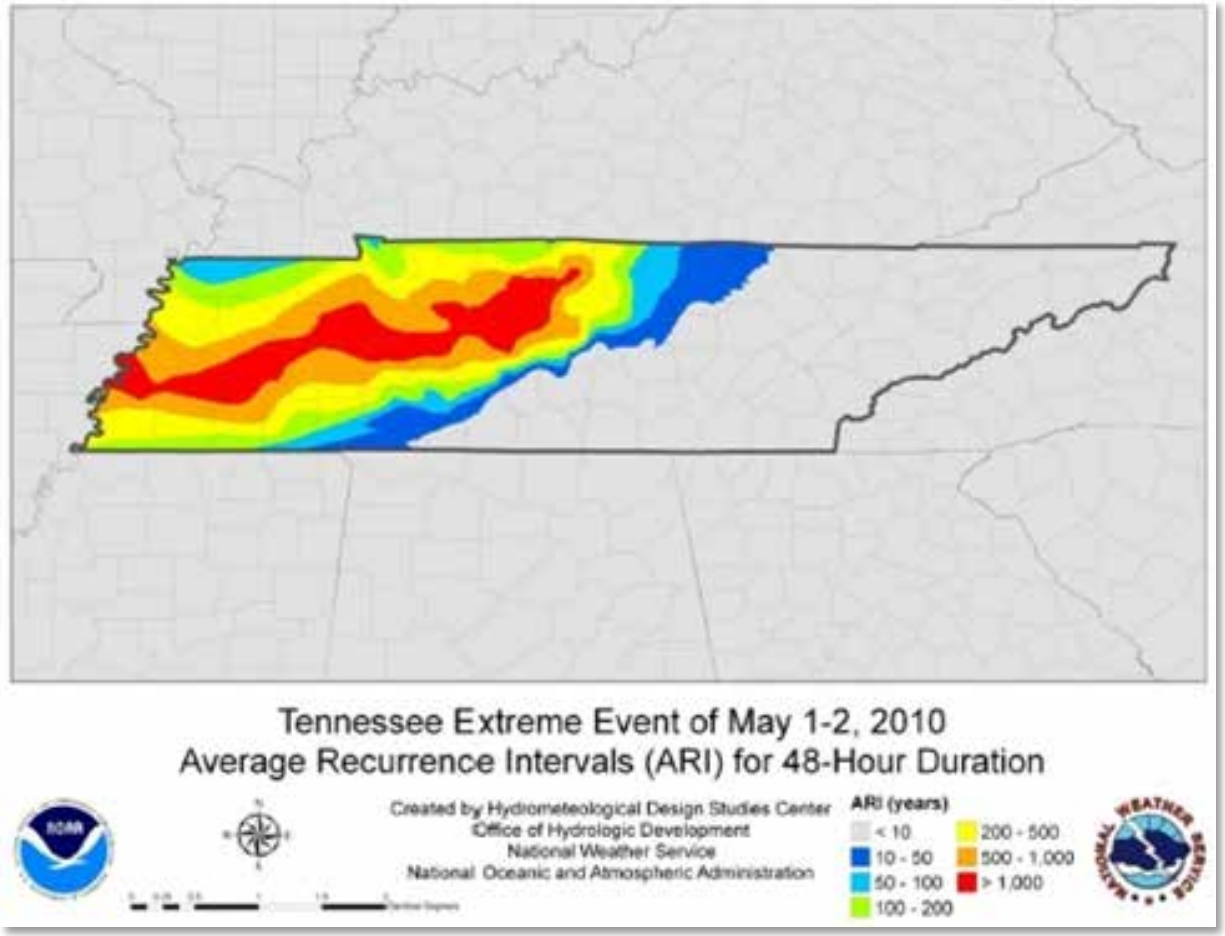
Irene

Before and After

Sandy

Sandy

Tennessee Superflood, 2010



Tennessee Superflood, 2010

Approach Roadway Damage

Structural Damage

Structural Damage

Bridge Scour

I-680 Iowa


ICY CONDITIONS EXIST
STAY IN TREATED LANES
REDUCE SPEED

Long-term Environmental Changes

Long-term Environmental Changes

Heat Waves

National and Regional Trends Regional Trends	Projections
Nationally-averaged, more frequent high temperatures and heat waves Many recent record-breaking hot summers Strongest trends in West, less warming in SE	Increases in severity and intensity in all regions

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

Drought and Wildfire

National and Regional Trends Regional Trends	Projections
Country as a whole has gotten slightly wetter, led by Northern areas. Southwest has gotten slightly drier.	Droughts expected to be exacerbated by higher temperatures
No strong drought trends; periods of intense drought have periodically occurred in different regions	Decreases in rainfall in the Southwest expected to increase frequency/severity of drought
More area burned in wildfires (management likely plays a role)	Wildfires expected to be more extensive and severe

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

Wind Events: Tropical storms, Tornadoes, and Strong Storms

National and Regional Trends Regional Trends	Projections
Tropical storms have become more intense in the Atlantic basin No clear trend or clear mechanism for changes in thunderstorms and tornadoes No clear/strong trends in overall storminess; evidence that storm tracks are shifting northward through the Northern Hemisphere	Atlantic tropical storms expected to become more intense, but potentially less frequent Considerable uncertainty regarding the magnitude and direction of changes (if any) in overall storminess or thunderstorms/tornadoes

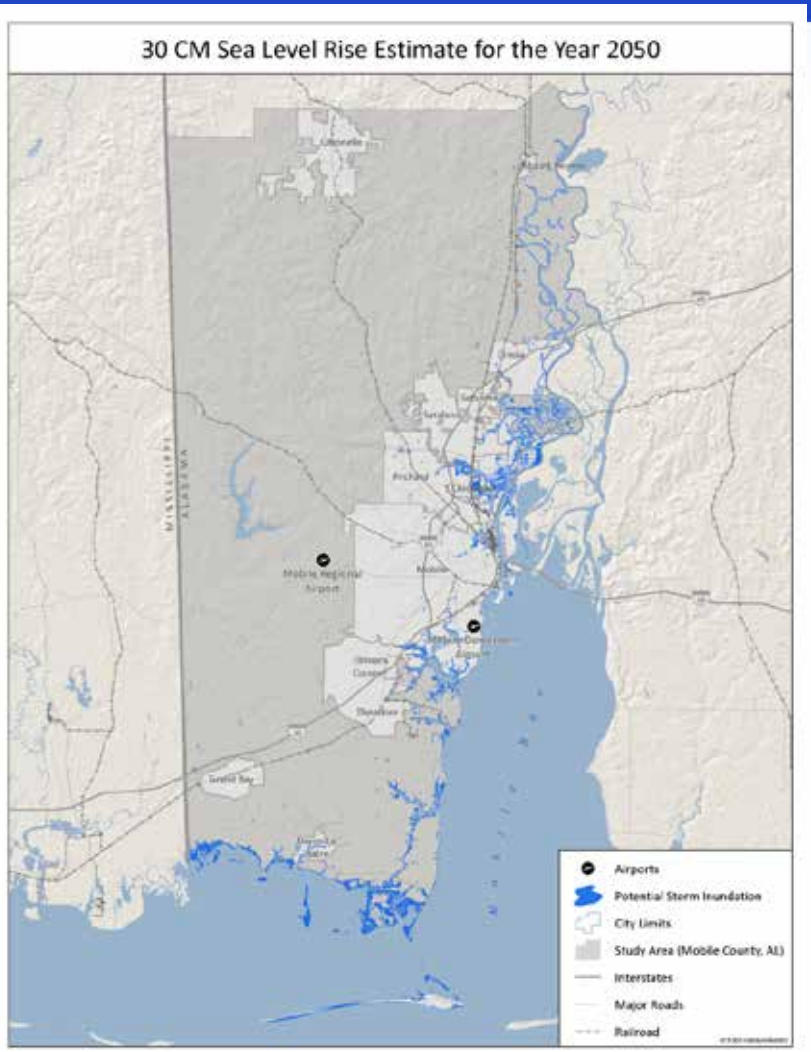
Joe Casola, C2ES
Staff Scientist, Director of Science and Impacts
Center for Climate and Energy Solutions

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

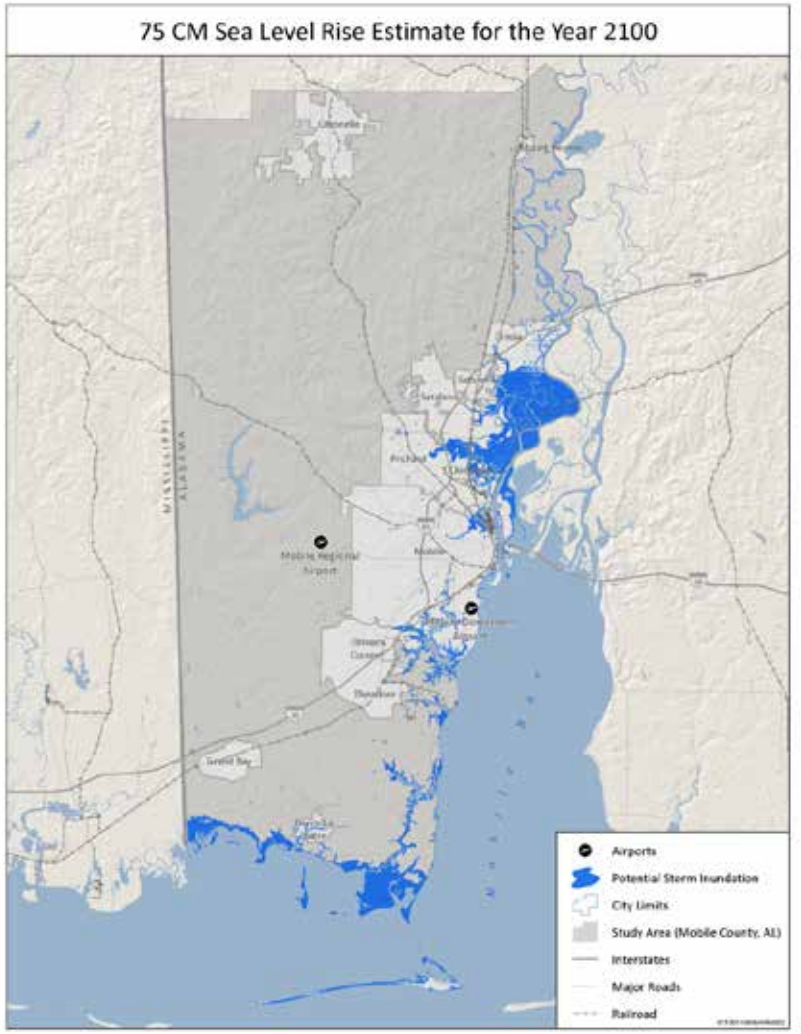
Joe Casola, C2ES
Staff Scientist, Director of Science and Impacts
Center for Climate and Energy Solutions

Sea Level Rise Modeling, Gulf Coast 2



ICF International, 2013. Task 2: Climate Variability and Change in Mobile, Alabama. Report No.: FHWA-HEP-12-053. http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task2/mobile_variability/task2_main.pdf

Sea Level Rise Modeling, Gulf Coast 2



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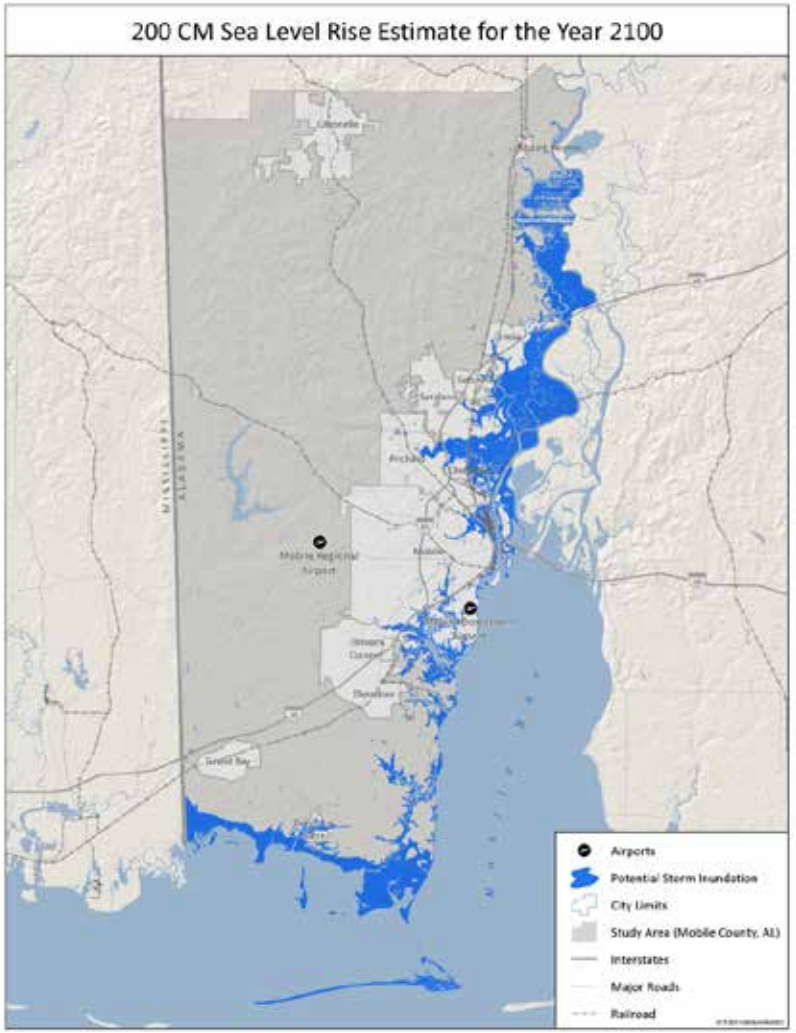
Sea Level Rise Modeling, Gulf Coast 2

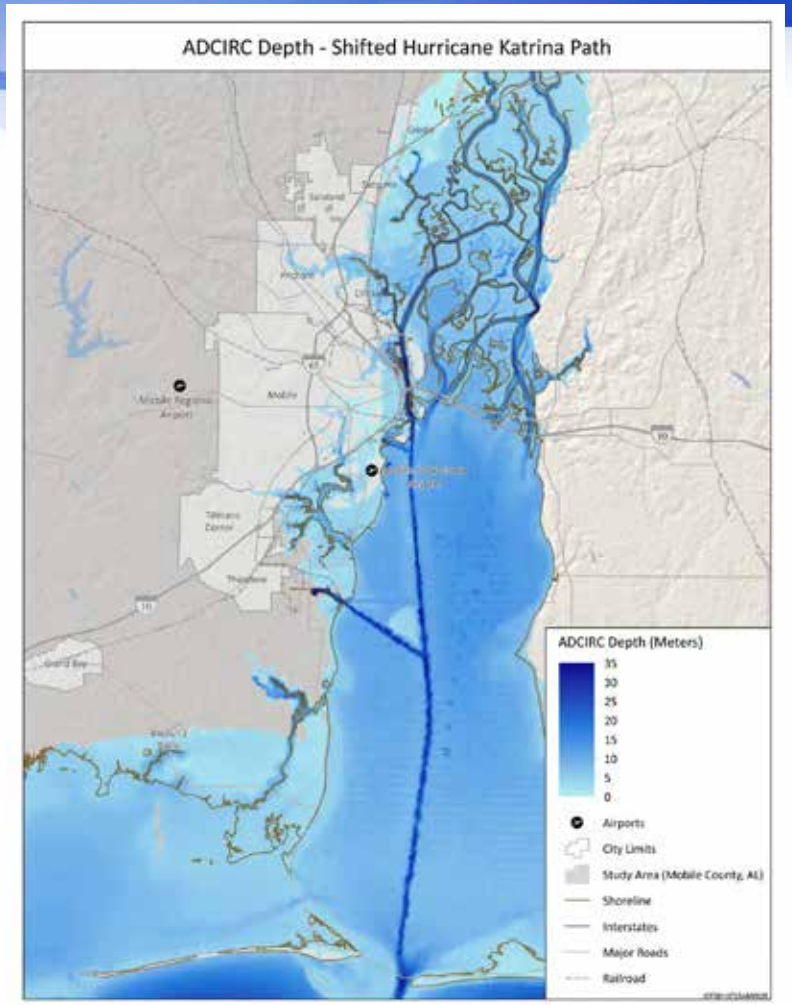


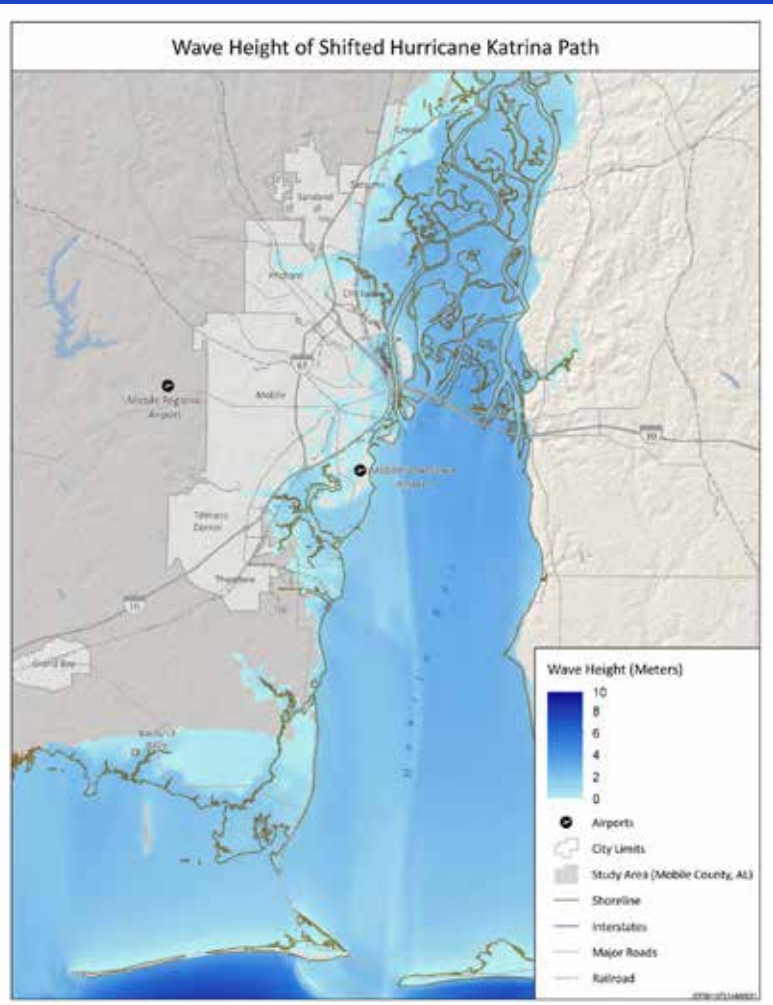
ICF International, 2013. Task 2: Climate Variability and Change in Mobile, Alabama. Report No.: FHWA-HEP-12-053. http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task2/mobile_variability/task2_main.pdf

Shifting the Hurricane Katrina Path

ICF International, 2013. Task 2: Climate Variability and Change in Mobile, Alabama. Report No.: FHWA-HEP-12-053. http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task2/mobile_variability/task2_main.pdf

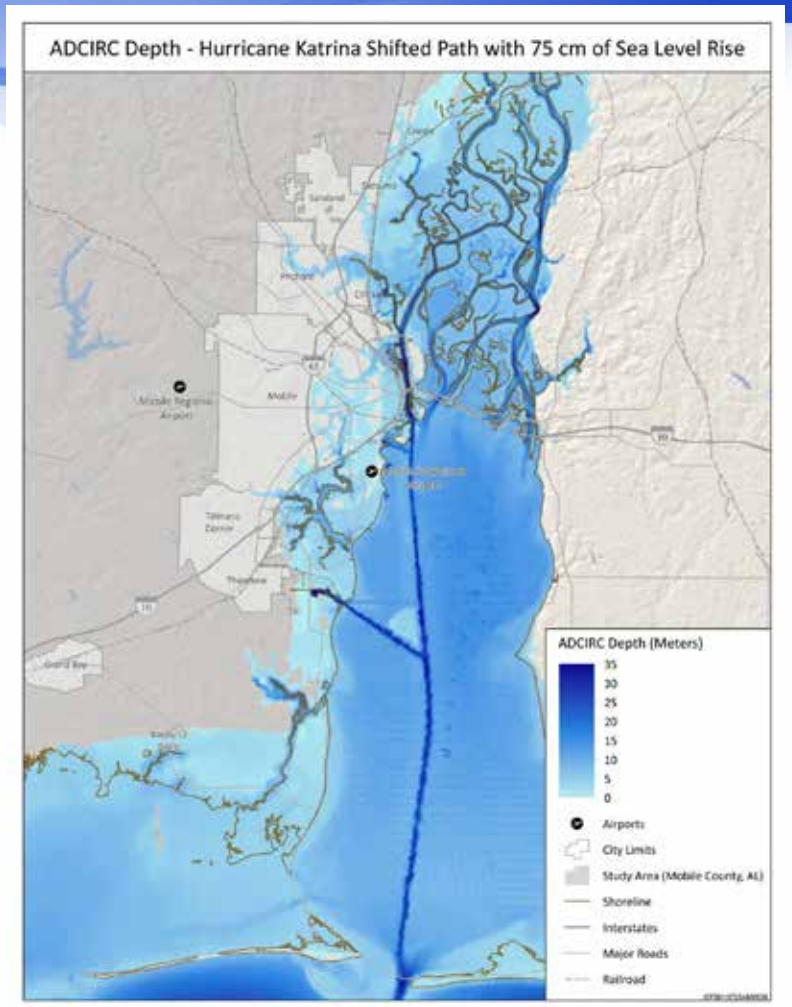
Katrina Shifted, No Sea Level Rise

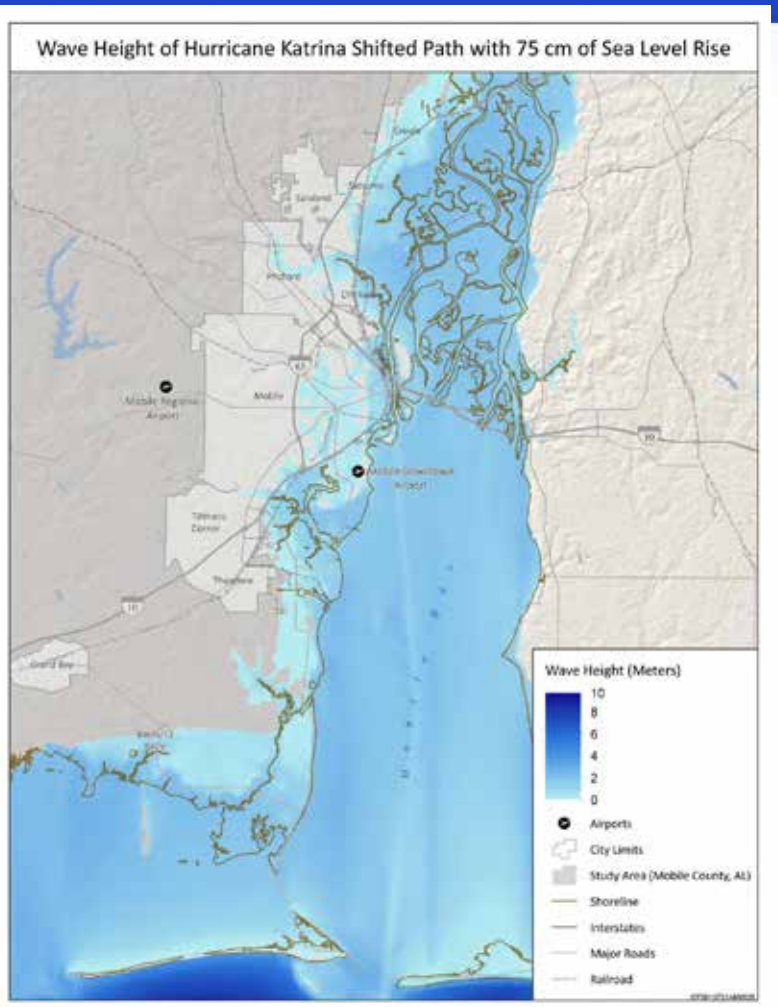




ICF International, 2013. Task 2: Climate Variability and Change in Mobile, Alabama. Report No.: FHWA-HEP-12-053. http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task2/mobile_variability/task2_main.pdf

Katrina Shifted, 75 CM Sea Level Rise





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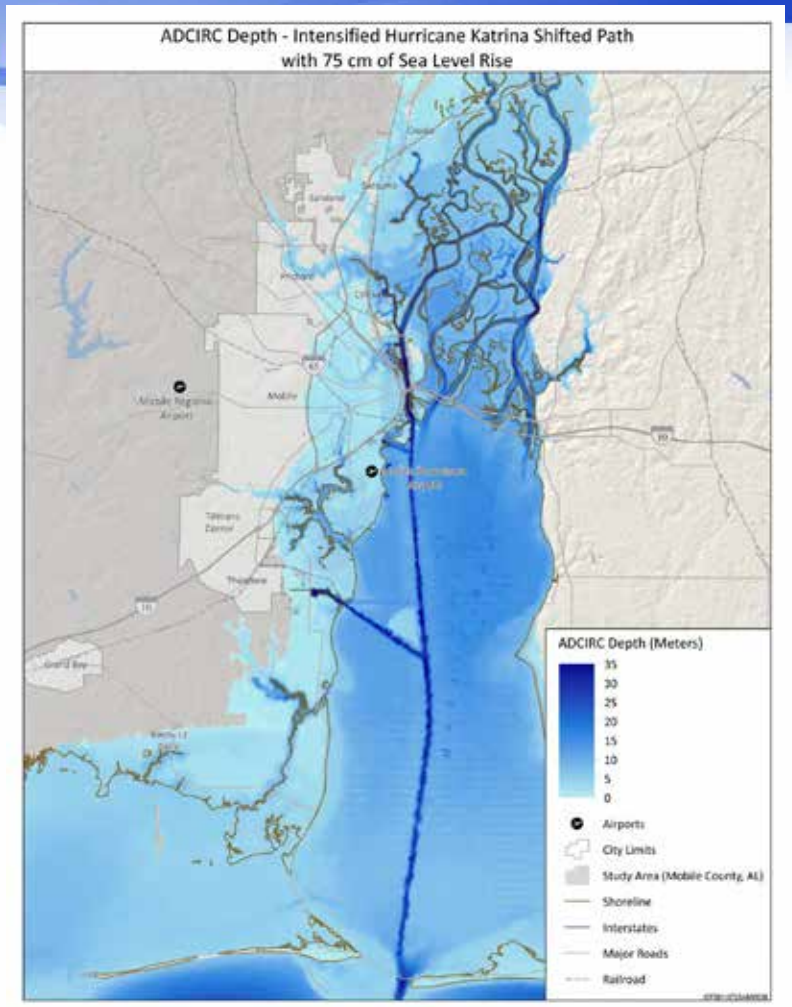
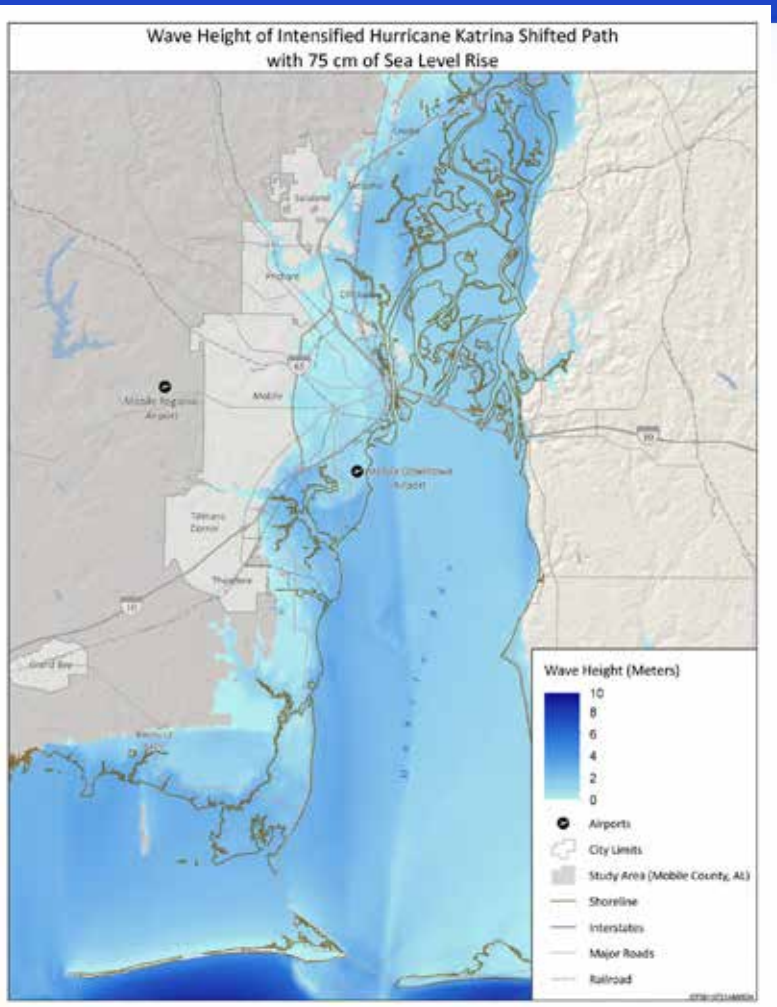
Katrina Shifted, Intensified, 75 CM Sea Level Rise





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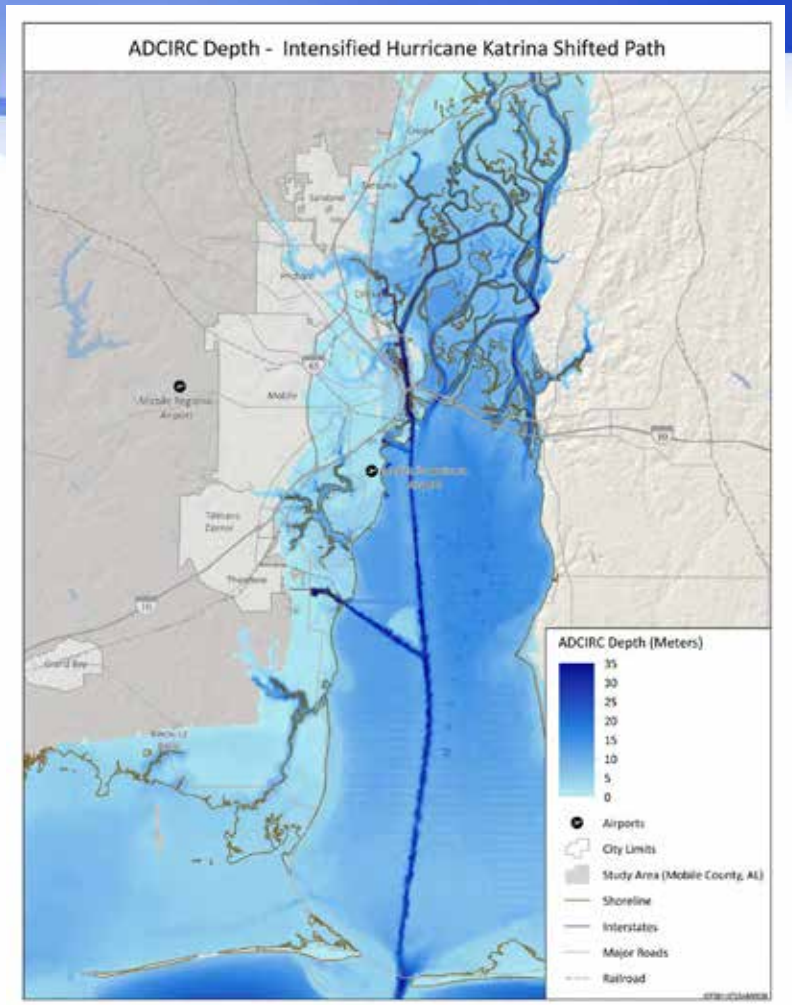
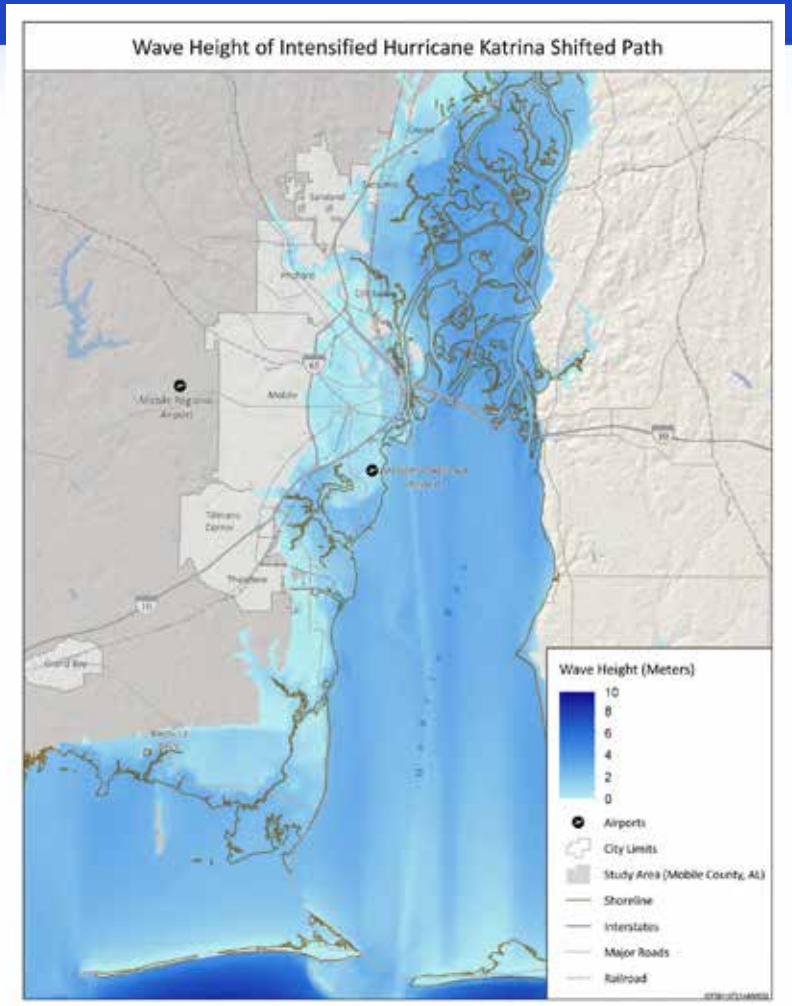
Katrina Shifted, Intensified, No Sea Level Rise





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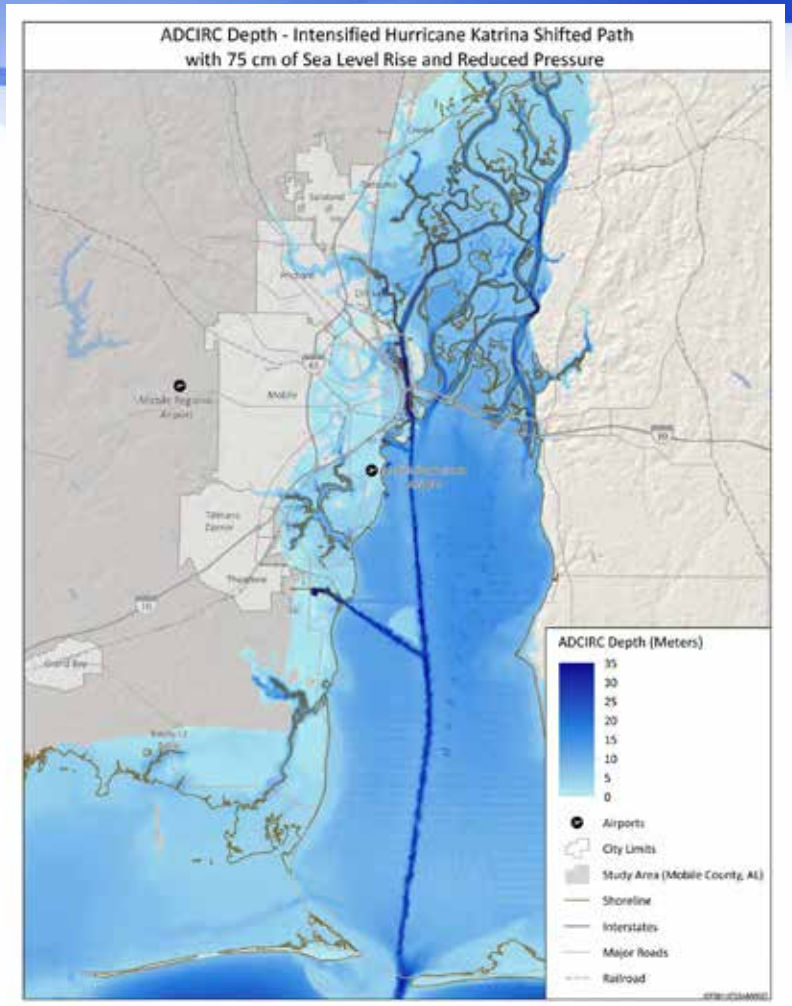
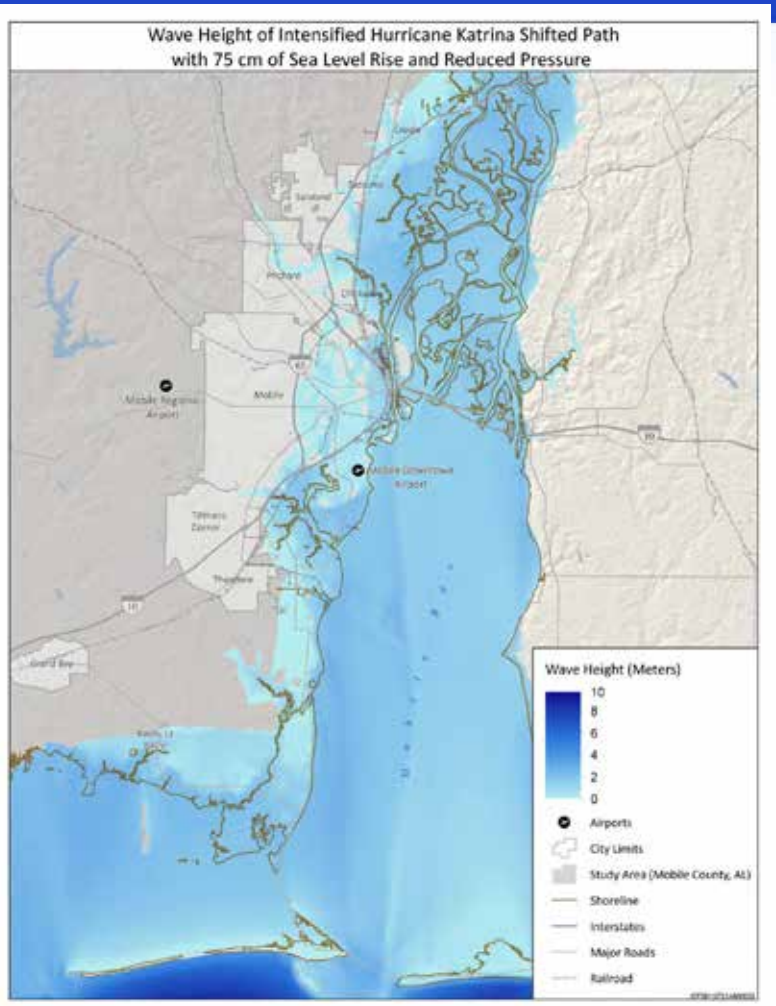
Katrina Shifted, Intensified, Pressure Reduced, 75 CM Sea Level Rise





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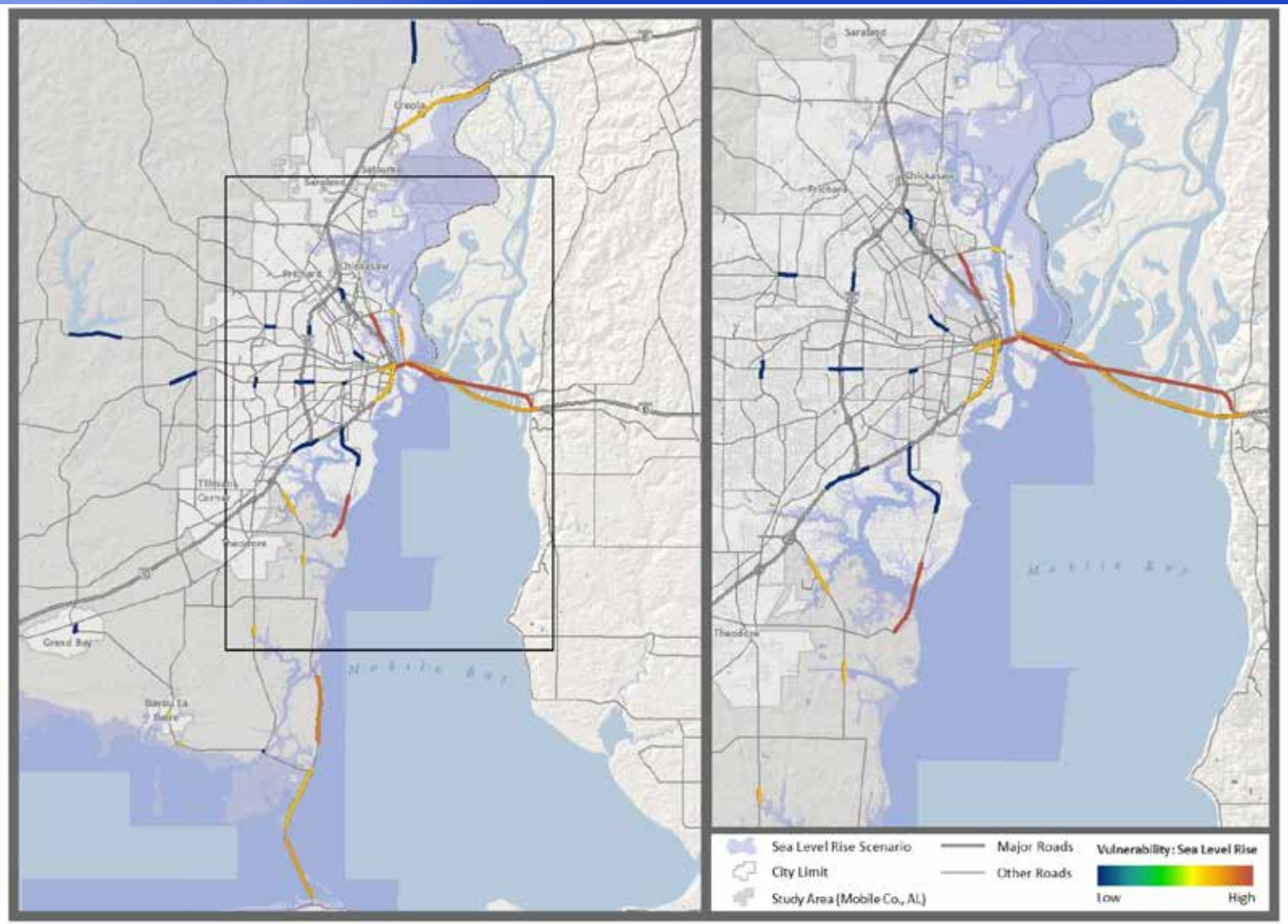
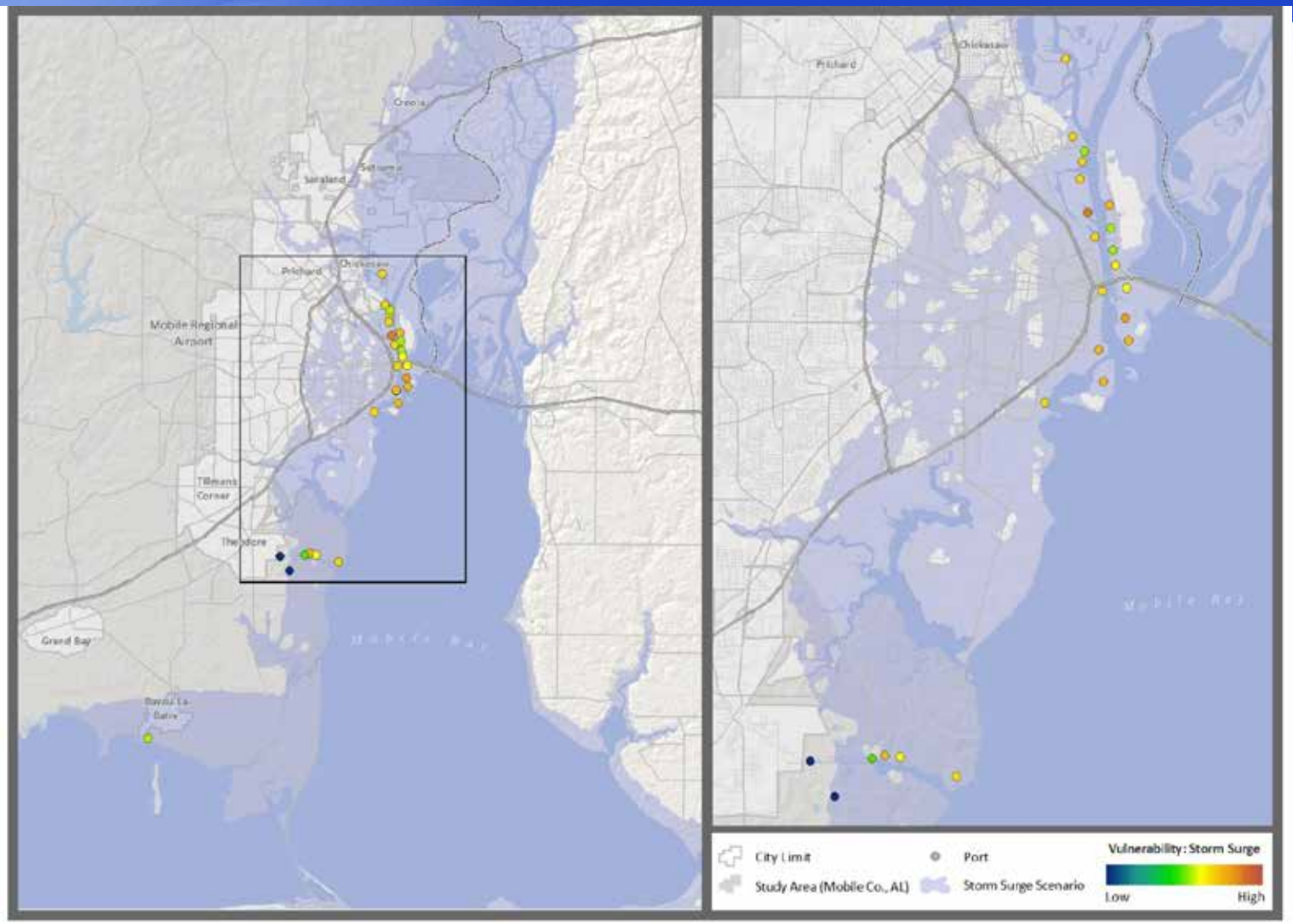
Vulnerability of Roads to Sea Level Rise: 200cm



ICF International, 2013. Task 2: Climate Variability and Change in Mobile, Alabama. Report No.: FHWA-HEP-12-053. http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task2/mobile_variability/task2_main.pdf

Vulnerability of Ports to Storm Surge: Katrina, Shifted, Pressure Reduced, 75cm SLR



ICF International, 2013. Task 2: Climate Variability and Change in Mobile, Alabama. Report No.: FHWA-HEP-12-053. http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task2/mobile_variability/task2_main.pdf

Scenarios in Transportation Planning

Central New Mexico Climate Change Scenario Planning Project

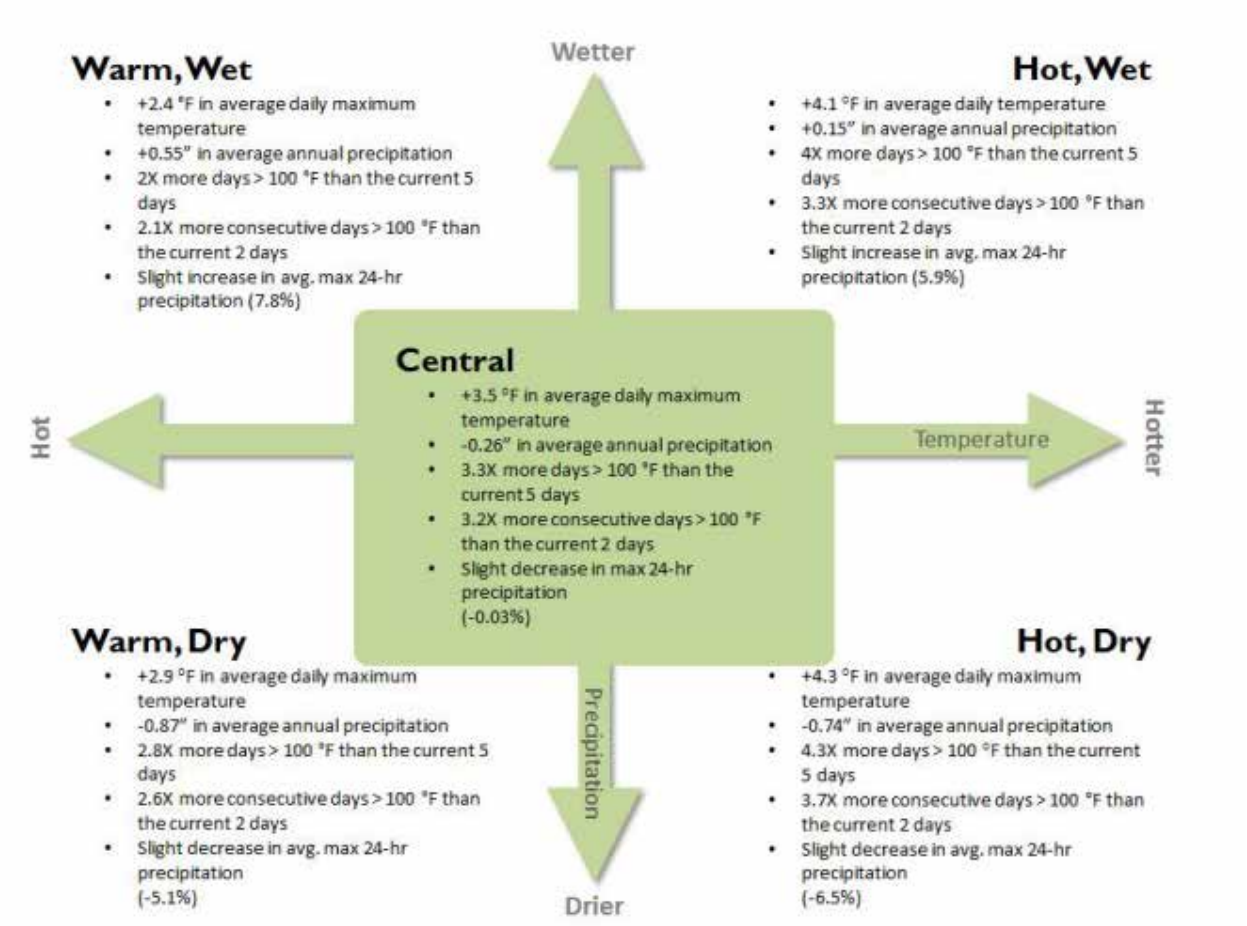


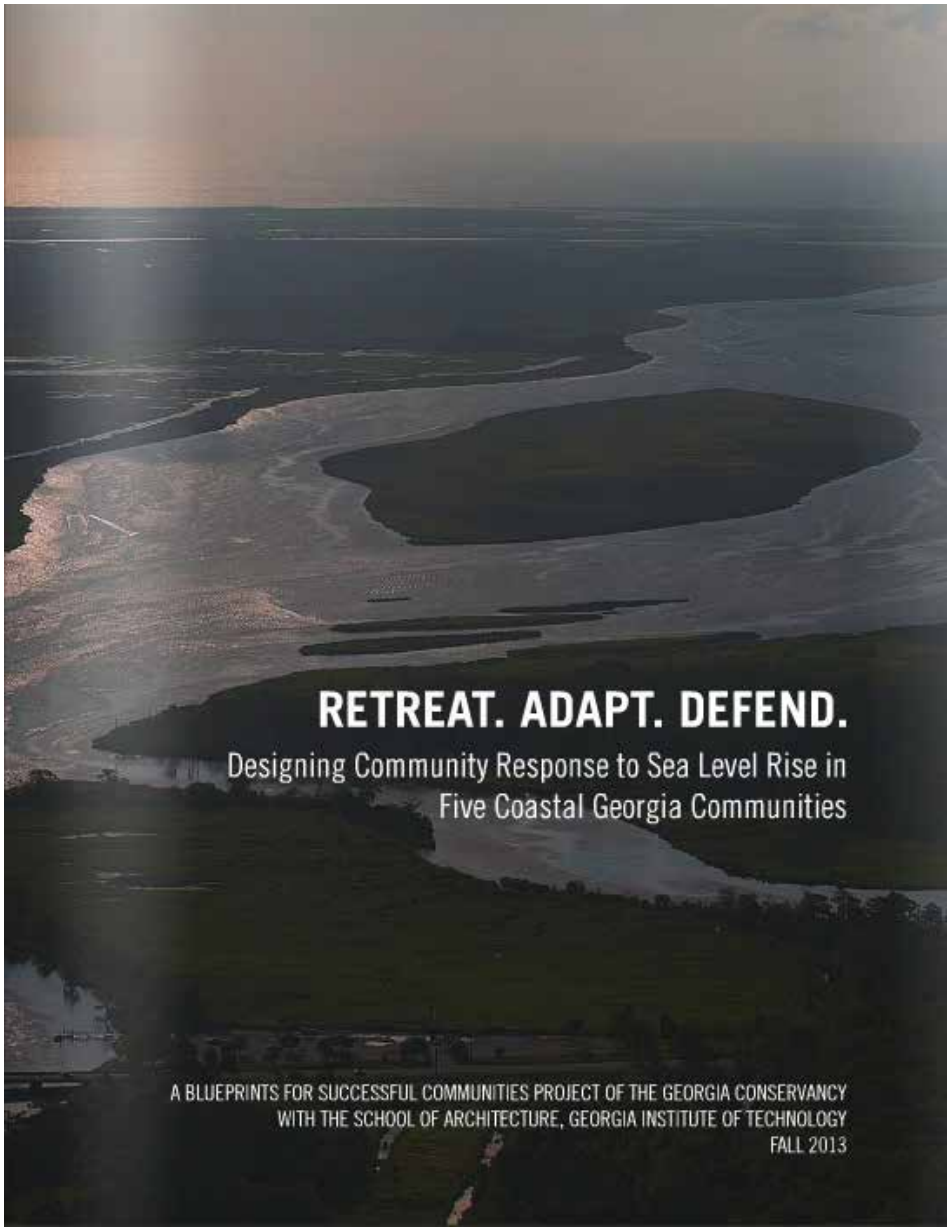
Figure 2: Central New Mexico 2040 Climate Futures. Source: Volpe Center.

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



“Think feet, not years.”

Thank you.