



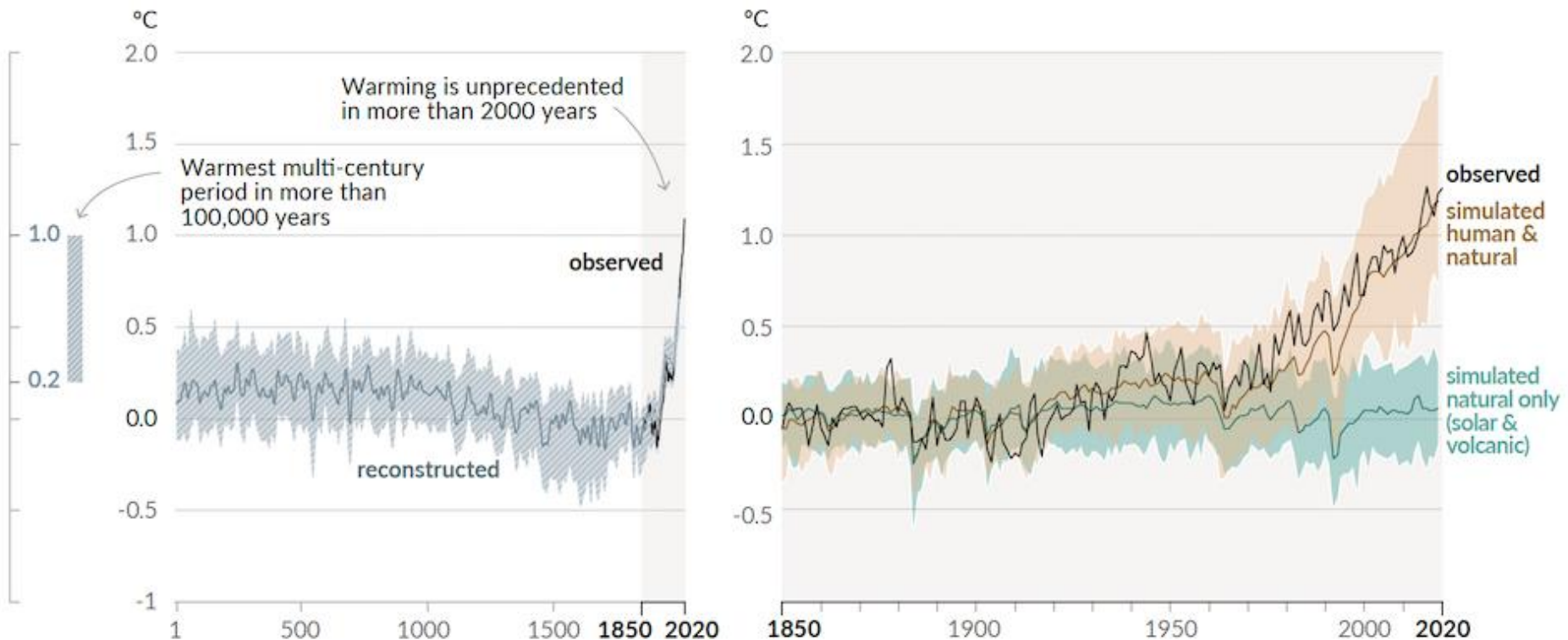
# Air, Climate, and Energy (ACE)

Science Needs to Understand Climate Change Impacts

BOSC Subcommittee Meeting, October 12 - 14, 2021  
Andy Miller, ACE Associate National Program Director



# The World is Changing



Source: [IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change](#)

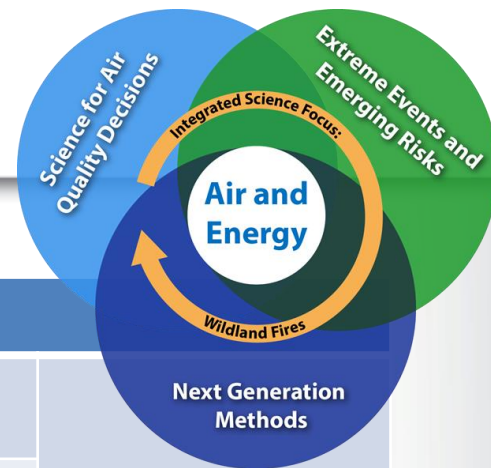


# Impacts of Climate Change

- **We are experiencing the early impacts of climate change today**
  - Changes in mean and extreme air temperatures are causing heat stress and deaths, worsening air quality, and changing ecosystems
  - Extremes in precipitation, from floods to drought, have serious implications for infrastructure design, flood resilience, and supplies of clean water for tens of millions of people
  - Climate change is directly impacting human health through higher heat and humidity, and more extreme swings in temperature (including cold spells)
  - Climate change also impacts human health indirectly, through higher ozone levels, combined heat and pollutant exposures, exposure to flood-mobilized contaminants, degradation of ecosystems, and increased exposure to wildfire smoke
  - Ecosystems are impacted by changing habitability ranges, higher river and ocean temperatures, increasing acidification, sea level rise, drought, and more
- **We have just experienced one of the coolest and calmest weather years we will see for the rest of our lives**



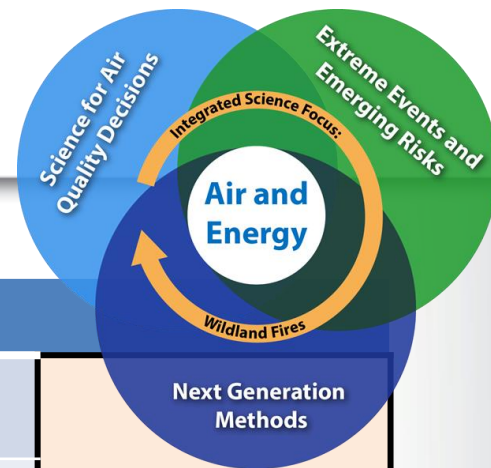
# Program Structure



Topic	Research Areas			
Science for Air Quality Decisions	#1: Approaches to support air quality management programs for multiple pollutants at multiple scales	#9: Wildland Fires (Integrated Science Focus)		
	#2: Approaches for characterizing source emissions, air quality, exposure, and mitigation strategies			
	#3: Public health and environmental responses to air pollution			
Extreme Events and Emerging Risks	#4: Public health and ecosystem exposures and responses to emerging air pollutants and sources		#9: Wildland Fires (Integrated Science Focus)	
	#5: Methods to evaluate environmental benefits and consequences of changing energy systems			
	#6: Methods to enable resilience to future environmental stressors			
Next Generation Methods to Improve Public Health and the Environment	#7: Emerging approaches to improve air quality and exposure characterization			#9: Wildland Fires (Integrated Science Focus)
	#8: Novel approaches to assess human health and ecosystem impacts and risks			



# Program Structure



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Next Generation Methods to Improve Public Health and the Environment	#7: Emerging approaches to improve air quality and exposure characterization
	#8: Novel approaches to assess human health and ecosystem impacts and risks

#9: Wildland Fires (Integrated Science Focus)

# Climate Change and Air Quality

- Higher temperatures lead to higher rates of ozone formation
- Climate change is resulting in changes in meteorological patterns that affect pollutant formation and transport
- Downscaled global model results are used as the basis for regional air quality modeling
- Climate change generally increases O<sub>3</sub> concentrations, even with no change in emissions

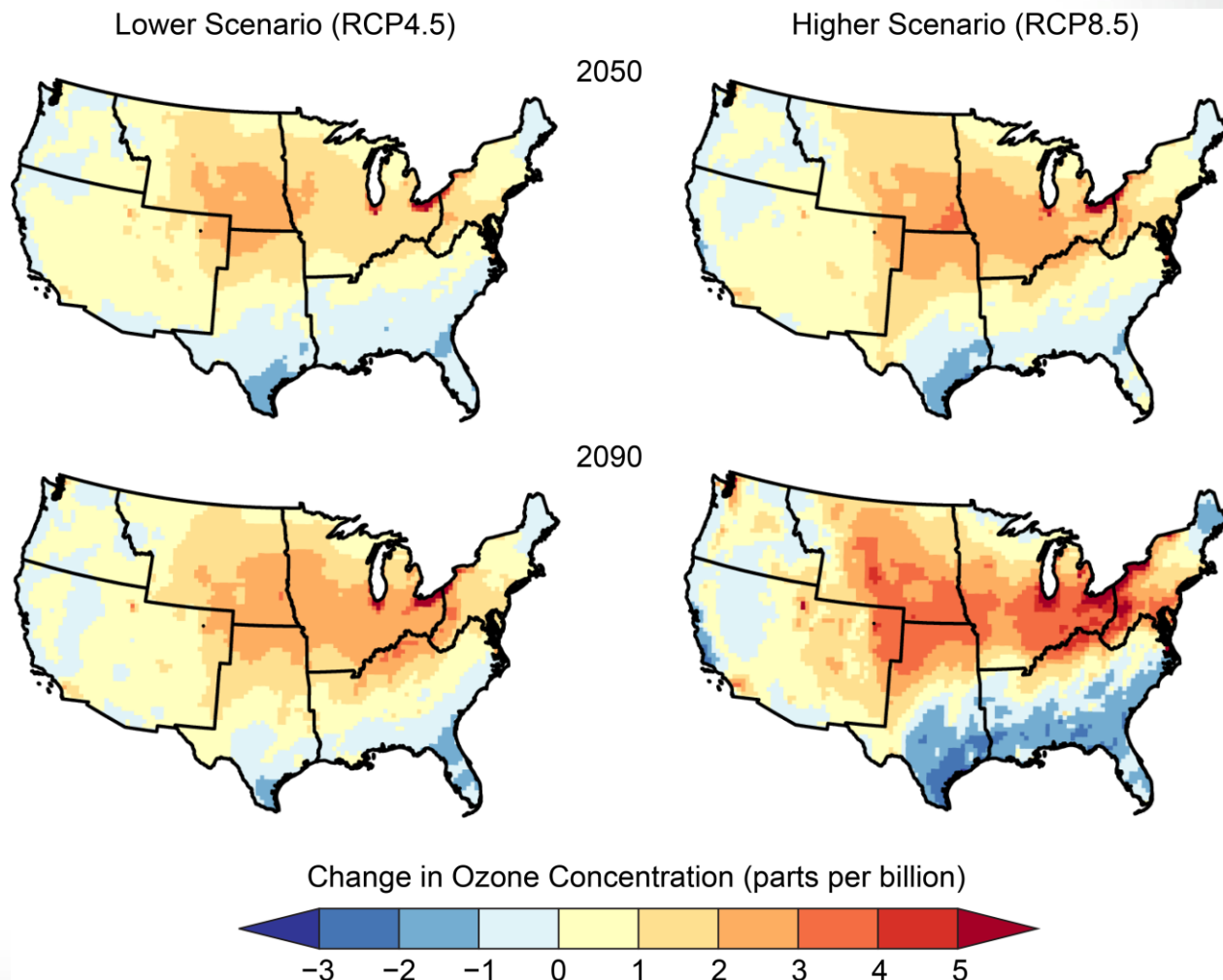


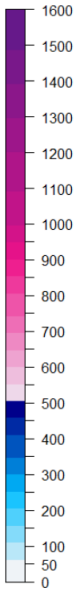
Figure 13.2. Projected Changes in Summer Season Ozone, Nolte et al., Chapter 13: Air Quality, in Fourth National Climate Assessment, 2018



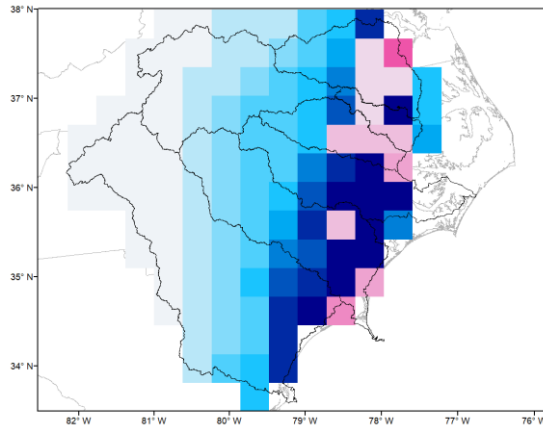
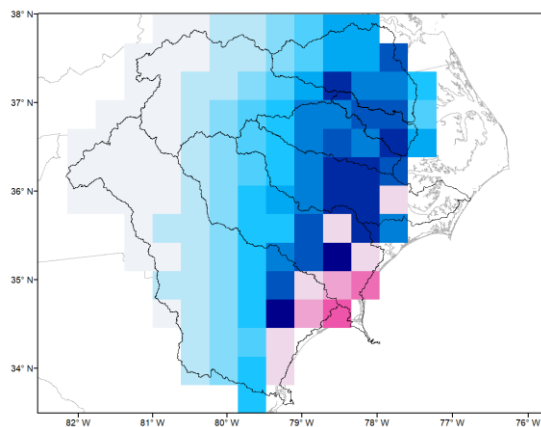
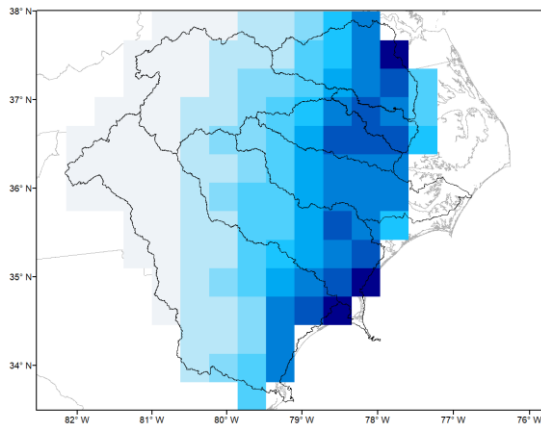


# Extreme Precipitation

Total rainfall (mm)



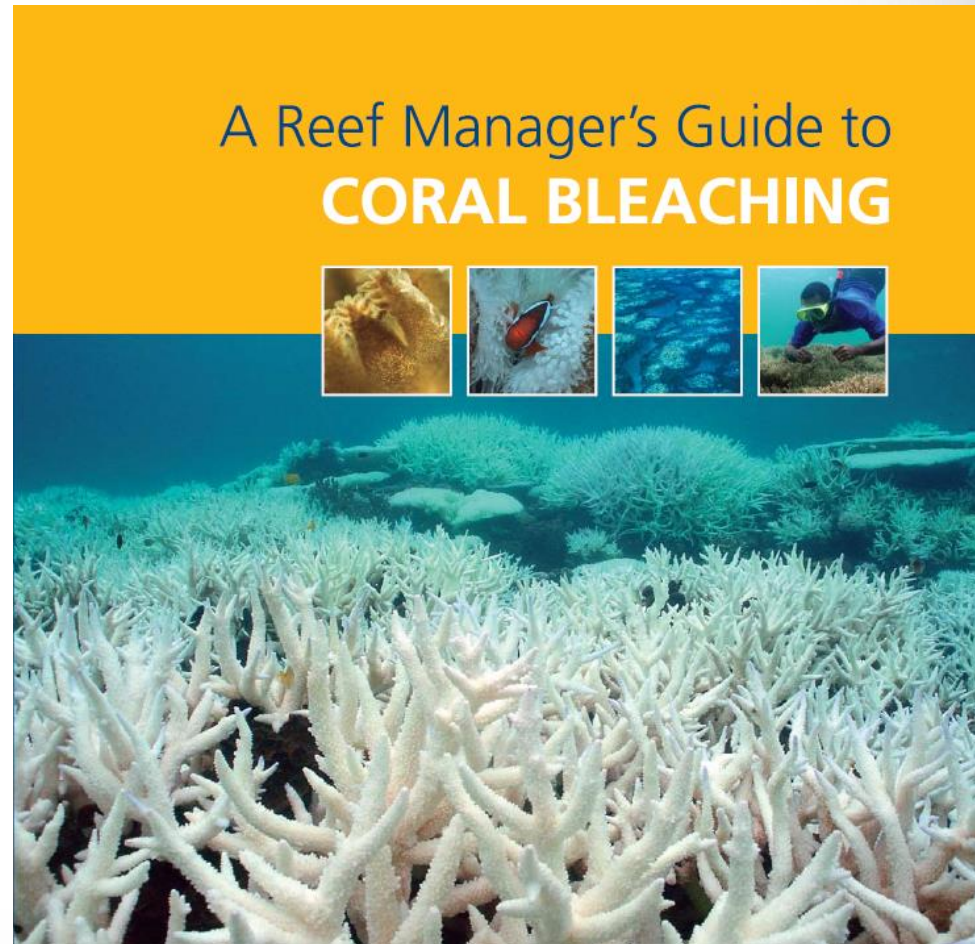
**OBSERVATIONS**  
max = 499 mm



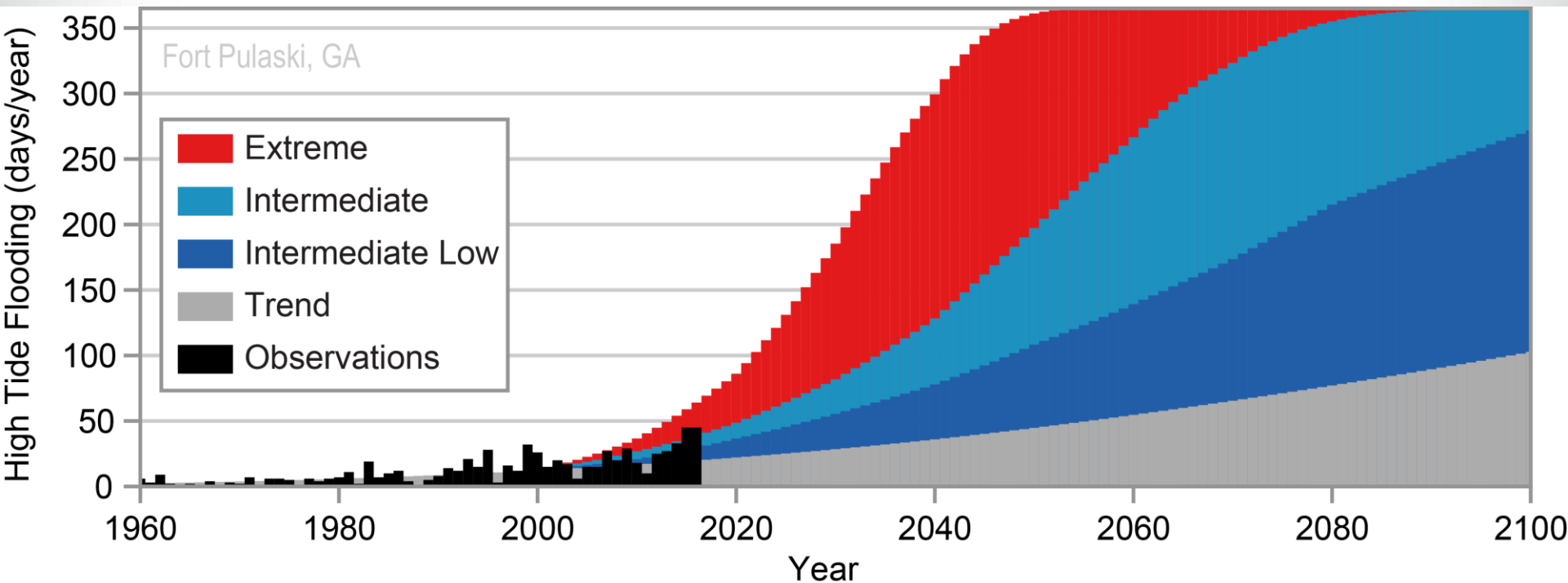
**Left: 2100, CESM RCP8.5**  
max = 754 mm

**Right: 2100, CM3 RCP8.5**  
max = 793 mm

- **Climate impacts to ecosystems, from coral reefs to estuaries to rivers and forests**
- **Change or loss of local ecosystems often leads to larger-scale ecosystem impacts**
- **Beyond the inherent value of ecosystems, impacts to ecosystems affect individuals, communities, and broader human systems**





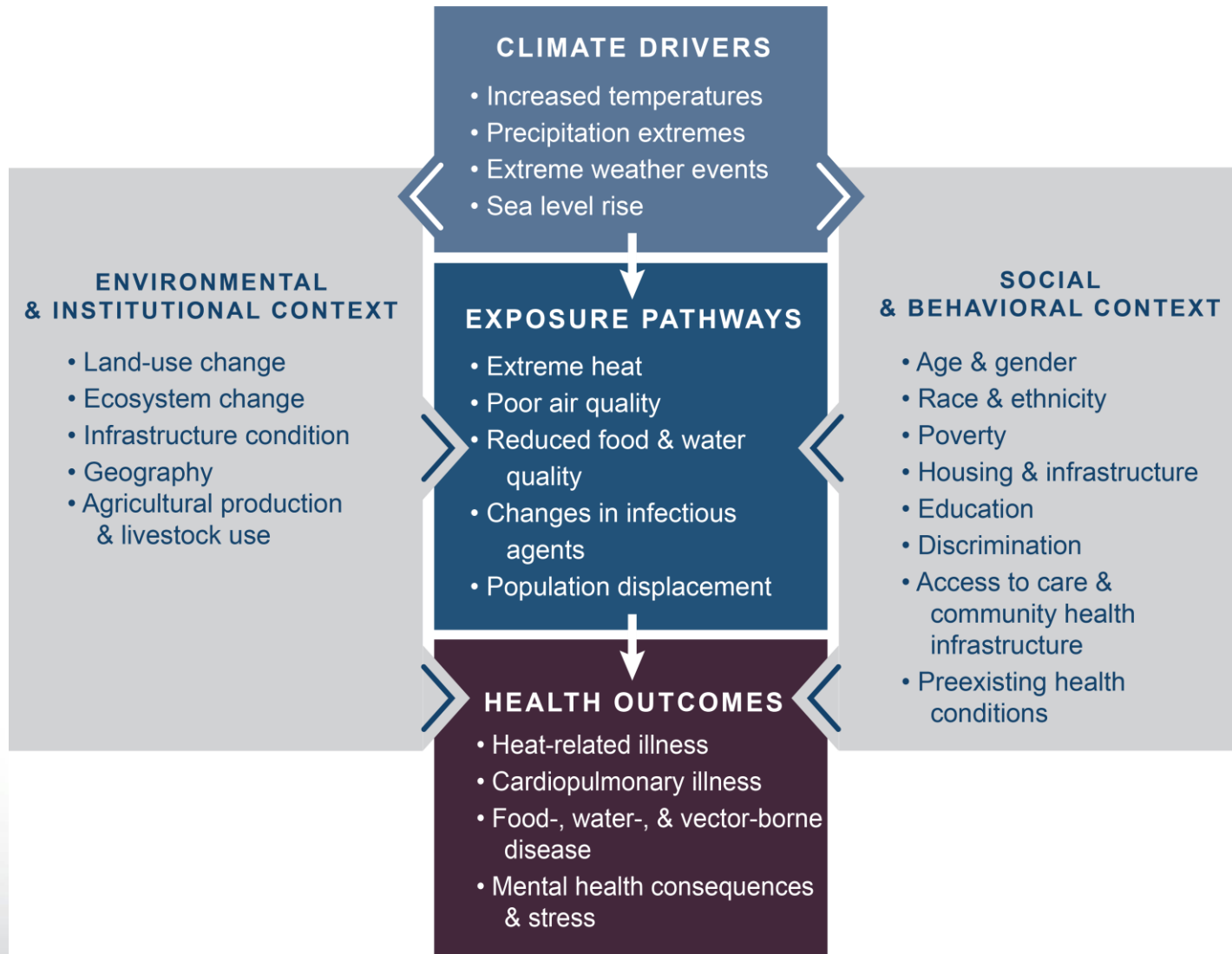


- Sea level rise impacts coastal infrastructure through floods, intrusion of saltwater into freshwater sources, and higher total water levels during storms and other extreme events



# Climate Change and Health

## Climate Change and Health





# The Role of ACE Research

- Provides scientific and technical information needed by federal, local, state, and tribal decision makers, and in business and industry
- Supports decisions that
  - Apply across substantial ranges of time and space and involve multiple environmental media
  - Help respond to and recover from immediate events
  - Involve near- and longer-term preparation for future conditions
  - Anticipate emerging problems
- Considers the different climate impacts in areas across the country, requiring a balance between informing national-scale policies and conducting research to respond to local-scale implementation needs
  - Our researchers have worked to find opportunities to conduct place-based research that can be applied more broadly



## The Role of ACE Research

- Climate impacts also cut across media, requiring approaches that are foundational or integrate across media.
  - Our researchers have worked to develop and apply approaches across media, for example, research on downscaling climate modeling results applied to air quality and extreme precipitation
- Other efforts are media-independent, such as the LASSO tool for identifying appropriate climate scenarios and the ICLUS series of land use scenarios and data.



## Collaborative Activities

- Work connects Research Areas on wildfires (RA9), energy system analysis (RA5), and air quality (RA1 & RA3)
- Work spans the ORD National Research Programs, connecting SSWR, SHC, and HSRP (e.g., Stormwater Calculator)
- Work is collaborative with multiple agencies, including NOAA, USGS, NASA, USDA, and DOE at the PI, Center, and Program levels to continually exchange information and expand opportunities
  - Interagency connections through the US Global Change Research Program facilitated opportunities for ACE researchers to contribute to the Fourth and Fifth National Climate Assessments



- Developing methods to downscale global model projections to scales needed by decision makers and analysts
- Investigating the impacts of changes in land use on aquatic and terrestrial ecosystems
- Working with communities to develop approaches for community-based adaptation decisions





## Charge Question 2

Climate change is expected to continue to increase the negative environmental and human health impacts of wildfires, flooding, drought, and other extreme events. Developing the knowledge and approaches to build resilience and adapt to these events is critical to preparing communities and protecting vulnerable populations and ecosystems.

- **What suggestion(s)/recommendation(s) does the Subcommittee have on ORD's implementation of research to understand effects of climate-driven changes on natural and human systems, adverse impacts on human health and the environment from climate stressors, and approaches to prevent or reduce these impacts? [RA6]**

- ORD scientists from the Center for Public Health and Environmental Assessment (CPHEA) and the Center for Environmental Measurement and Modeling (CEMM) are addressing these scientific challenges.
- Next, a panel of EPA scientists will provide an overview of the Centers' scientific approaches to deliver outputs and products related to the impacts of climate change and how their programs are using this work.

