RUTGERS

THE STATE UNIVERSITY OF NEW JERSEY

The Climate Ahead: Global Changes and Local Impacts

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Rutgers University

New Jersey Society for Public Health Education
2019 Annual Program
Rutgers University
December 6, 2019

Weather
ACID RAIN
High: 54
Low: 54

The Daily Targum

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RUTGERS UNIVERSITY—NEW BRUNSWICK, CAN. | TURDSDAY NOVEMBER 26, 1 B.C.E. | ONLINE AT YOUPORN.COM

Student says Busch geese stole left shoes, Gucci belt

TONY SOPRANO
MOB BOSS

The Rutgers University Police Department (RUPD) is currently investigating the report of a break-in and robbery in a residence hall on Busch campus, according to a University-wide alert.

In the incident, which occurred on Monday, Nov. 25 at approximately 4:30 a.m., residents of Mattia Residence Hall reported that a group of geese had forcefully entered the building and continued to enter multiple rooms.

The victims reported that once the geese entered the building, they then proceeded to remove various belongings from the premises, according to the alert.

RUPD reported that the geese allegedly gained access by assaulting a student and removing his student ID to swipe into the building. The victim was treated for minor injuries at a local hospital and has since been released.

Borey Cooker, a School of Engineering junior, said he was studying in the common area when the geese broke in.

"I've honestly never seen anything like it, it was such a terrifying experience," Cooker said. "You always walk by them on

SEE **BELT** ON PAGE 4

Students waiting for the bus have the opportunity to inhale fossil fuels as it breaks down. FERRIS BUELLER HIMSELF

Climate change caused by Rutgers buses, study finds

MARGARET THATCHER
GHOST WRITER

The Rutgers University bus system is the sole cause of climate change, according to a recent study from the Rutgers University Climate Institute.

The buses produce approximately 142 times the average amount of carbon dioxide emissions compared to other public transportation systems in the country, according to the study. This increase is partially due to the number of Rutgers bus drivers who park their buses and leave them running while they take a break.

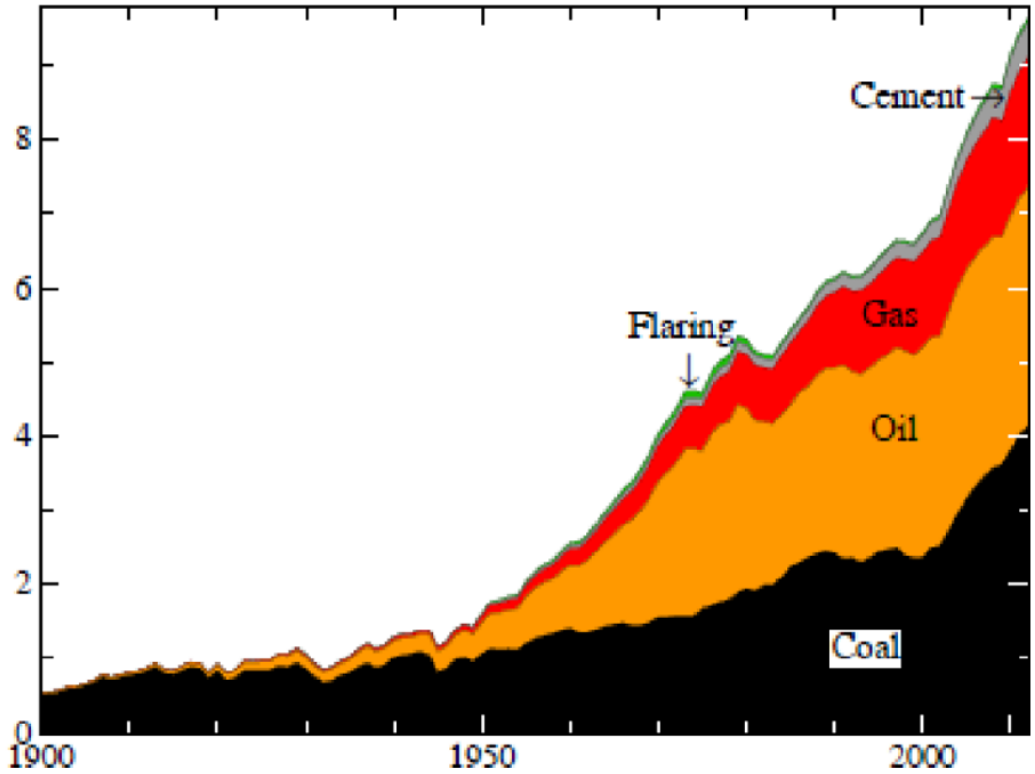
SEE **STUDY** ON PAGE 4

Recent changes in climate and their causes

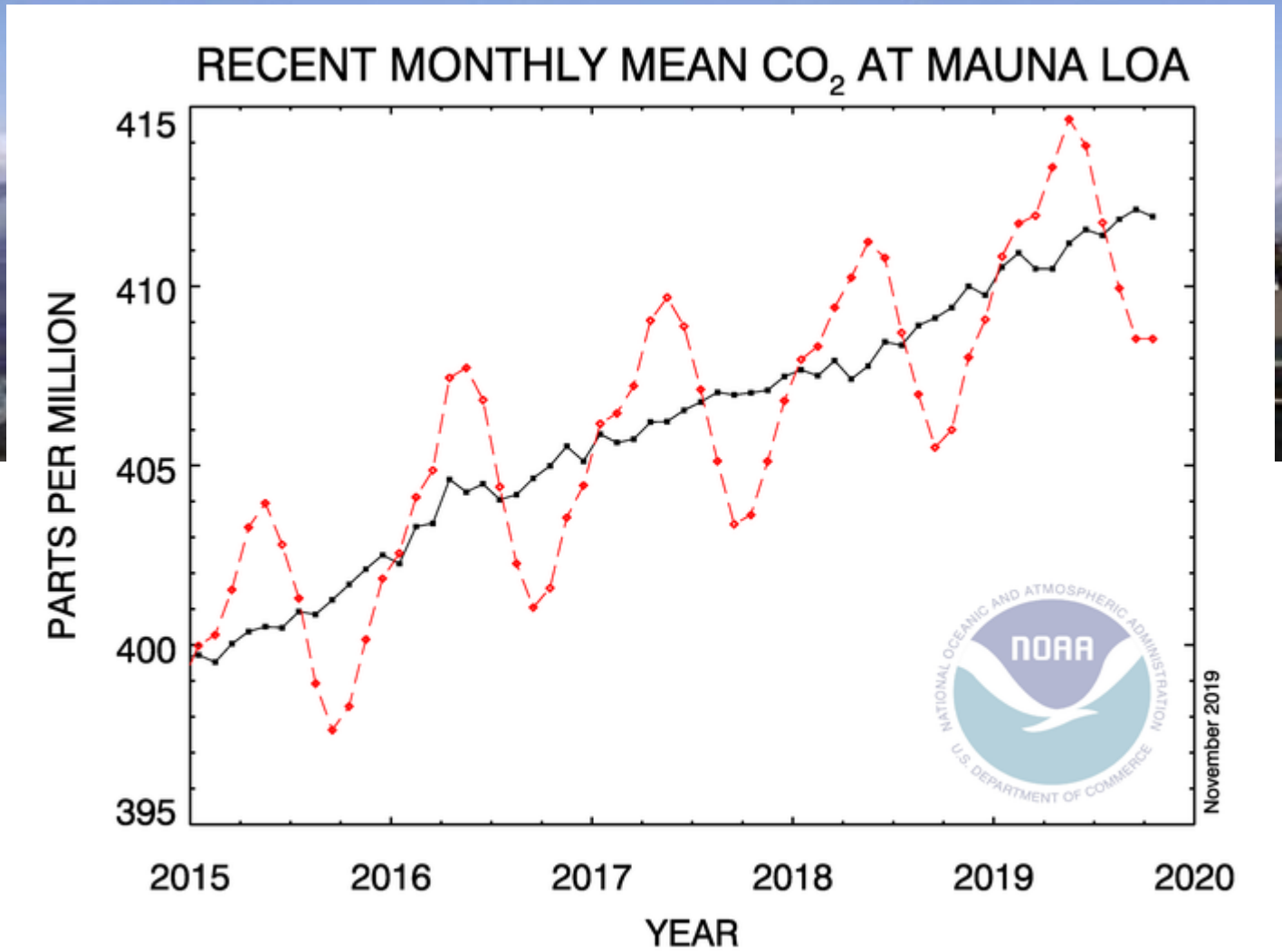
Climate Change 101: The Basics

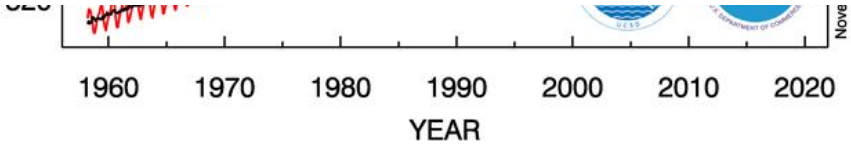
- Combustion of fossil fuels (coal, petroleum, natural gas) emits carbon dioxide into the atmosphere (currently about 10 billion tons of carbon per year)
- Roughly half of the carbon dioxide remains in the atmosphere; the remainder is taken up by vegetation on land or goes into the ocean (causing ocean acidification)
- Increasing carbon dioxide heats the earth; global temperatures have risen by ~2°F during the past century.
- Increasing temperatures also cause other changes in climate and sea level.

Annual Emissions of CO_2 from Fossil Fuels



Source: James Hansen, Columbia University

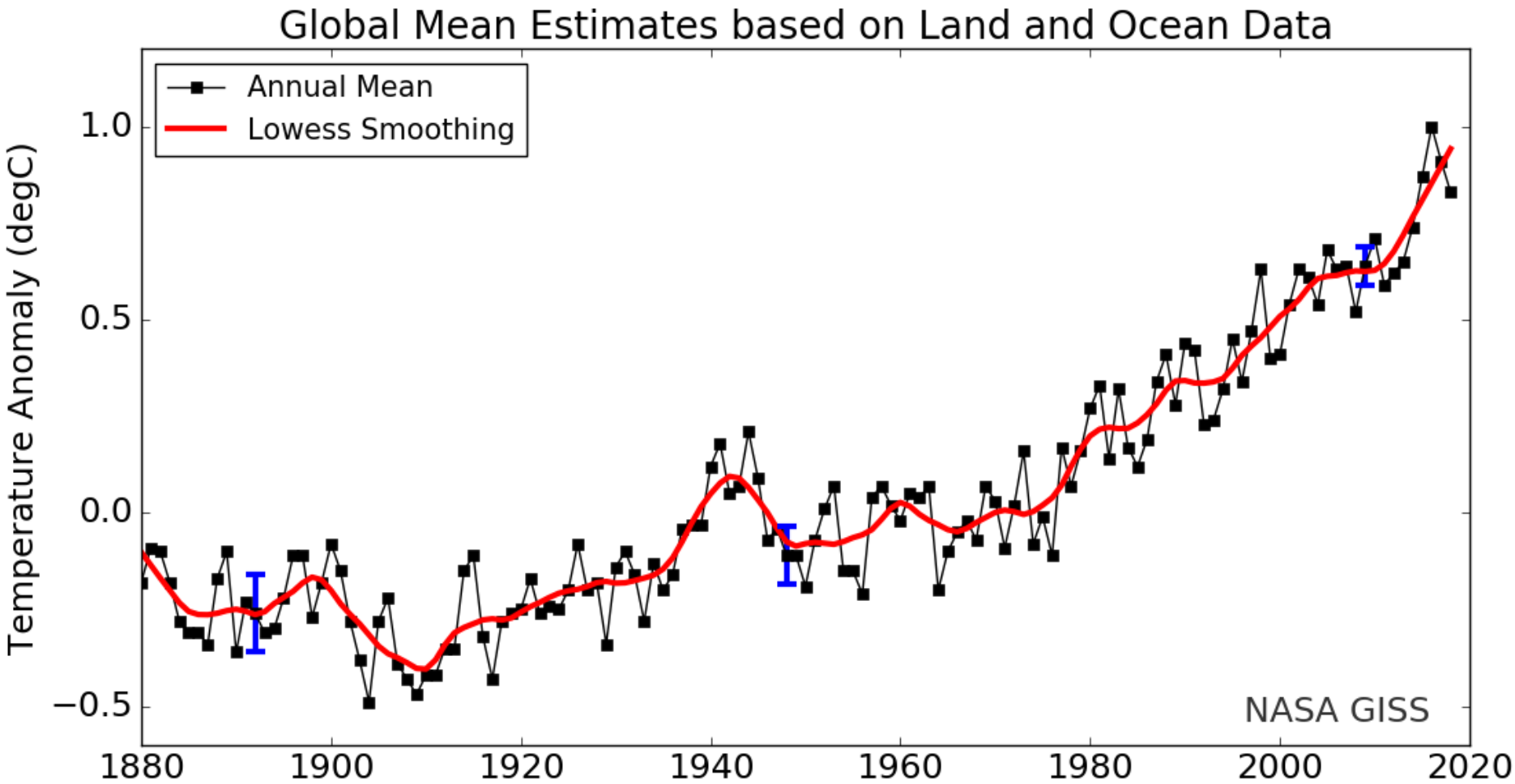

RECENT MONTHLY MEAN CO_2 AT MAUNA LOA
PARTS PER MILLION
415
410
405
400
395
2015
2016
2017
2018
2019
2020
YEAR
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
November 2019


1960
1970
1980
1990
2000
2010
2020
YEAR

Basic physics of CO_2 and climate

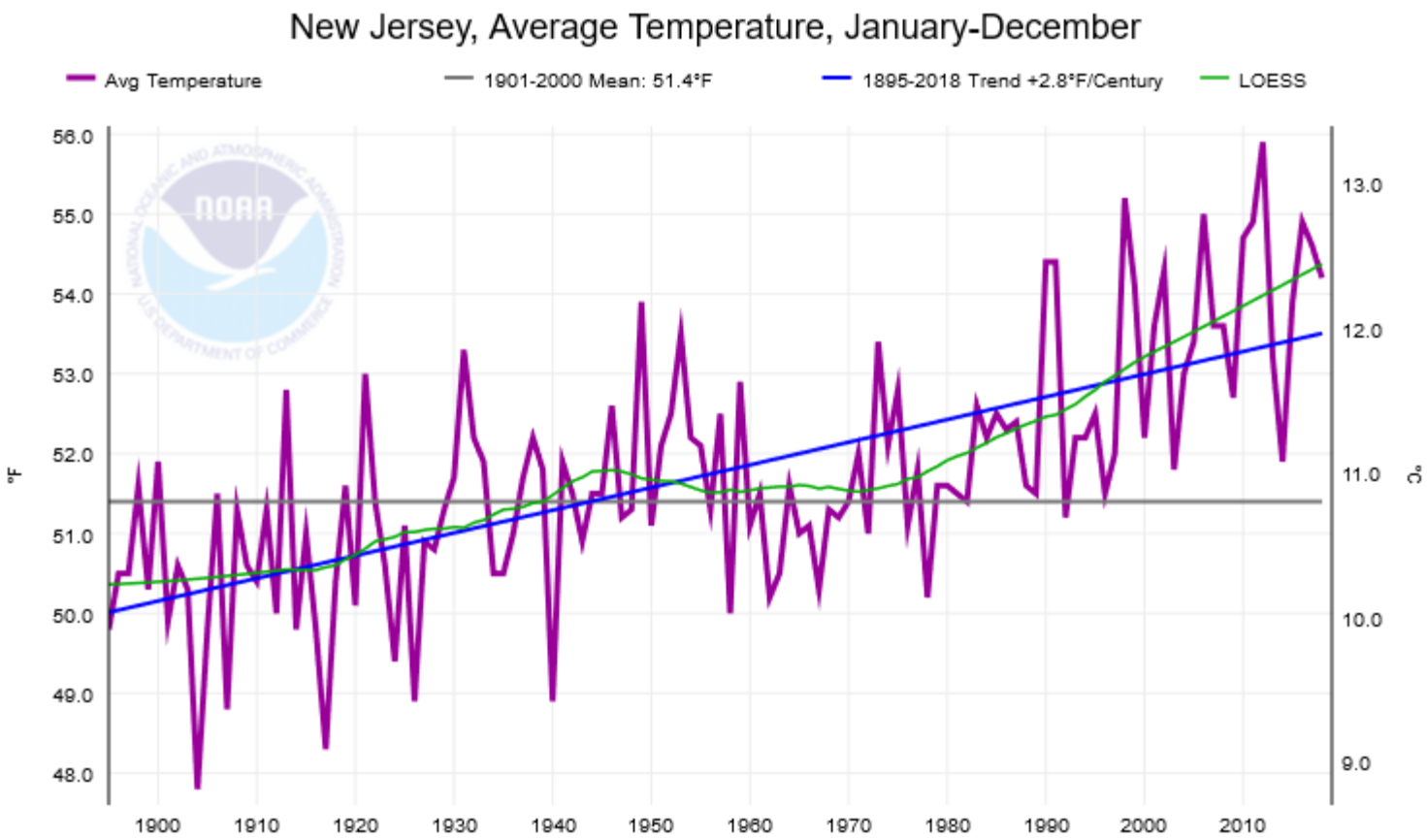
- If an object receives energy in the form of visible light, as the earth does from the sun, it warms up.
- The warmer an object is, the more energy it emits in the form of infrared light. This is the earth's cooling mechanism that balances the heating from the sun's visible light.
- CO_2 and water vapor are "greenhouse gases" that absorb infrared light, making it more difficult for energy to escape into space.
- Without greenhouse gases the earth would be much colder (i.e., its average temperature would be well below freezing).

Trends in global average temperature



Source: NASA/Goddard Institute for Space Studies

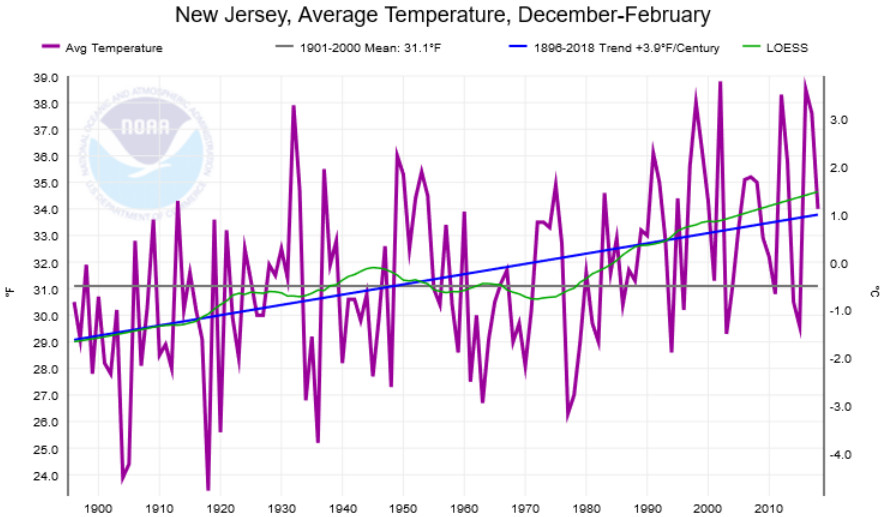
Trends in annual mean New Jersey temperature

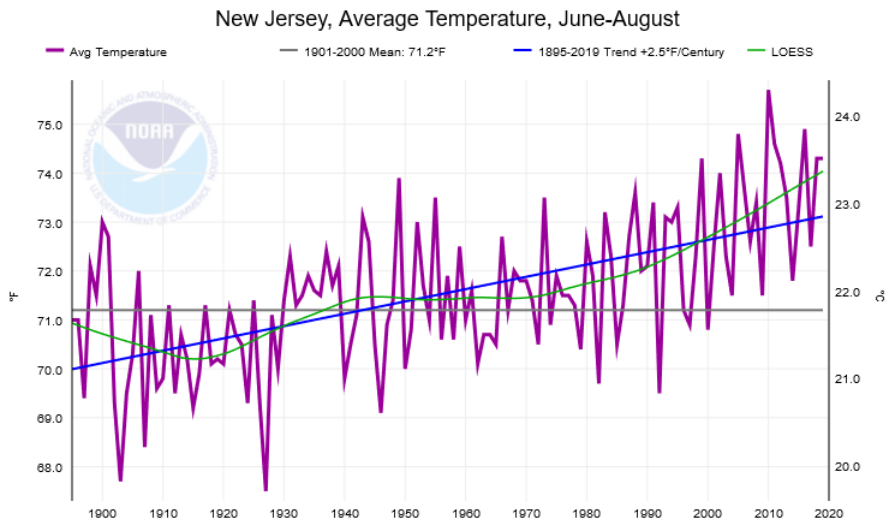


- Long-term upward trend of 2.8°F per 100 years
- More rapid warming since 1970
- The seven warmest years have occurred since 1998
- The 12 warmest years have occurred since 1990.
- 2012 was the warmest year on record

Source: National Centers for Environmental Information

Trends in winter and summer temperature in N.J.

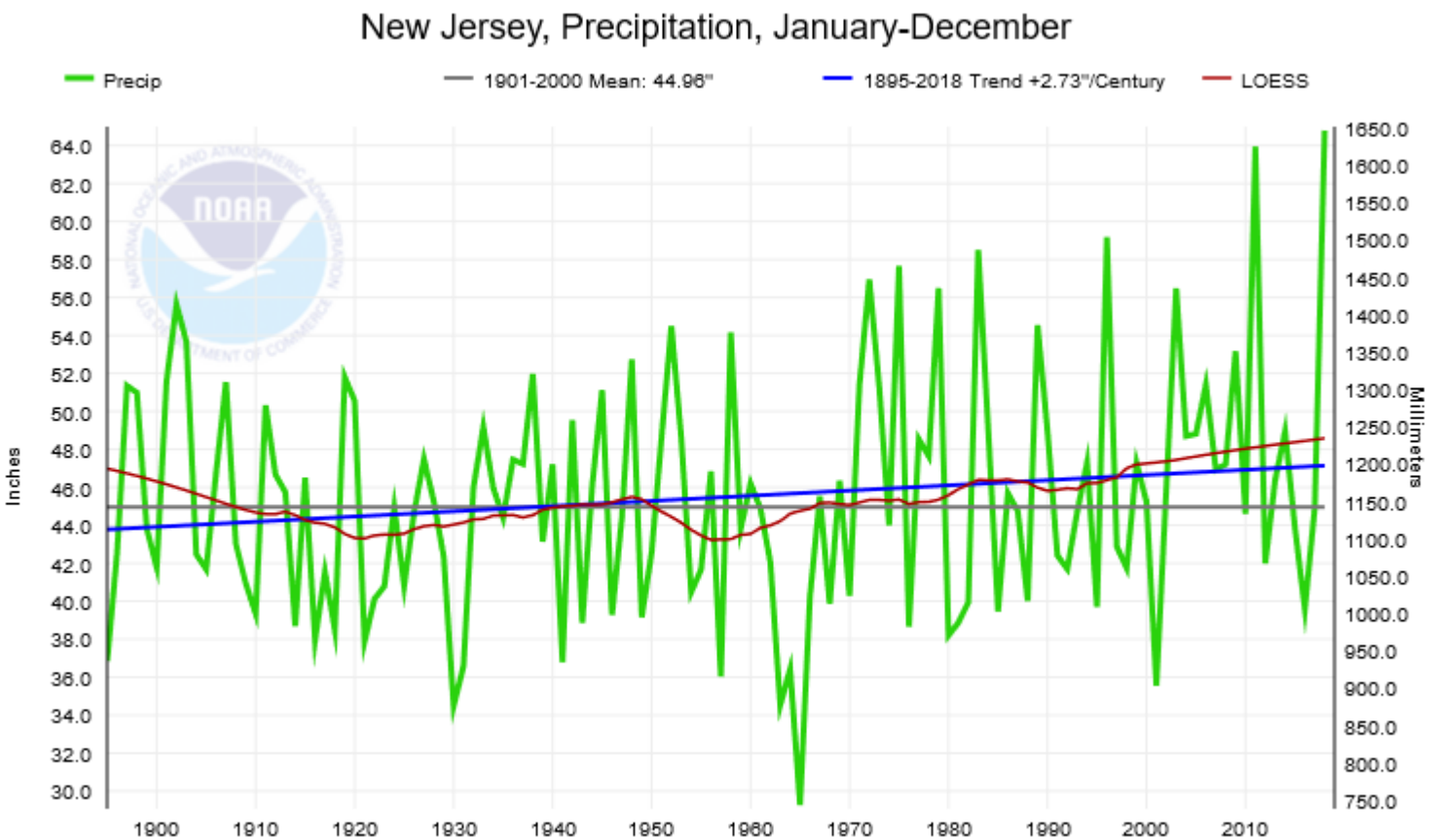




- Larger warming trend in winter (3.9°F/100 yrs) than in summer (2.5°F/100 yrs)
- Year-to-year temperature variability is much larger in winter, which can make it harder to perceive long-term trends
- The four warmest winters have occurred since 1998
- The nine warmest summers have occurred since 1999

Source: National Centers for Environmental Information

Trends in annual mean New Jersey precipitation

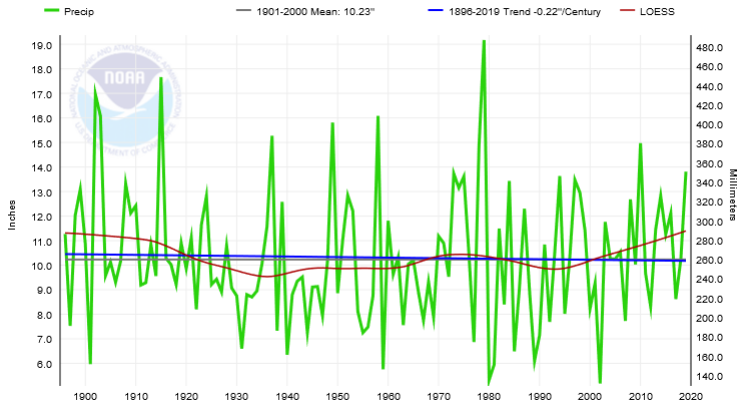


- Long-term upward trend of 2.7” per 100 years
- Large decadal variability (early 1960s drought, wet 1970s, very wet in 2000s)
- Most of the upward trend comes from changes in spring and fall

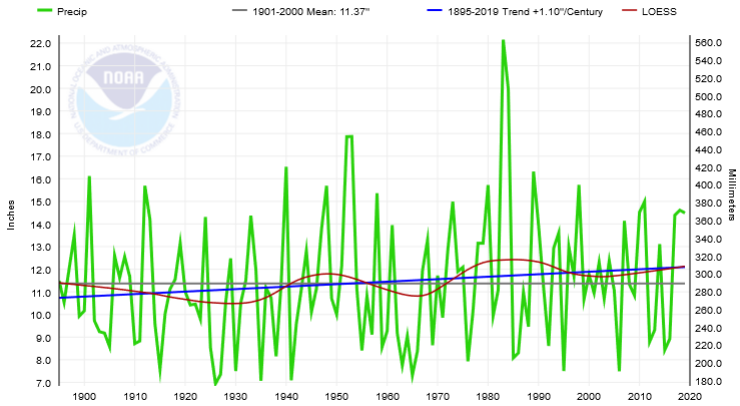
Source: National Centers for Environmental Information

Trends in New Jersey precipitation by season

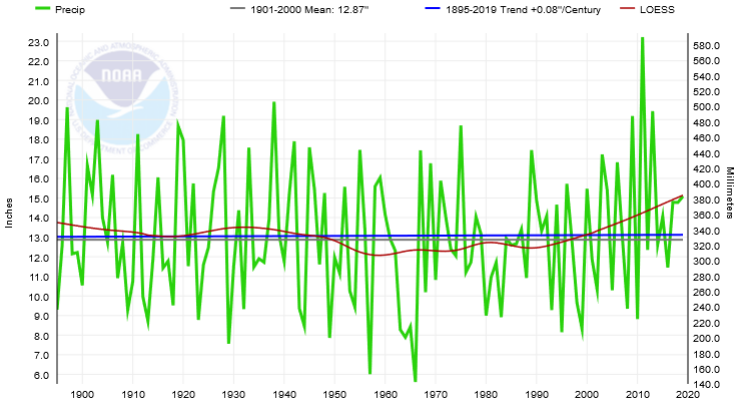
Winter



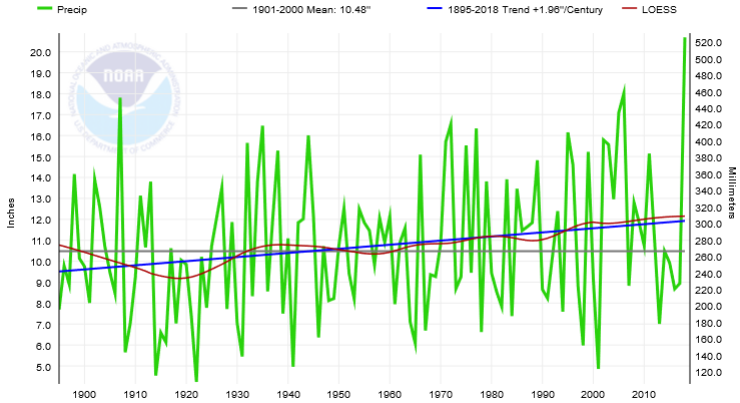
Spring



Summer

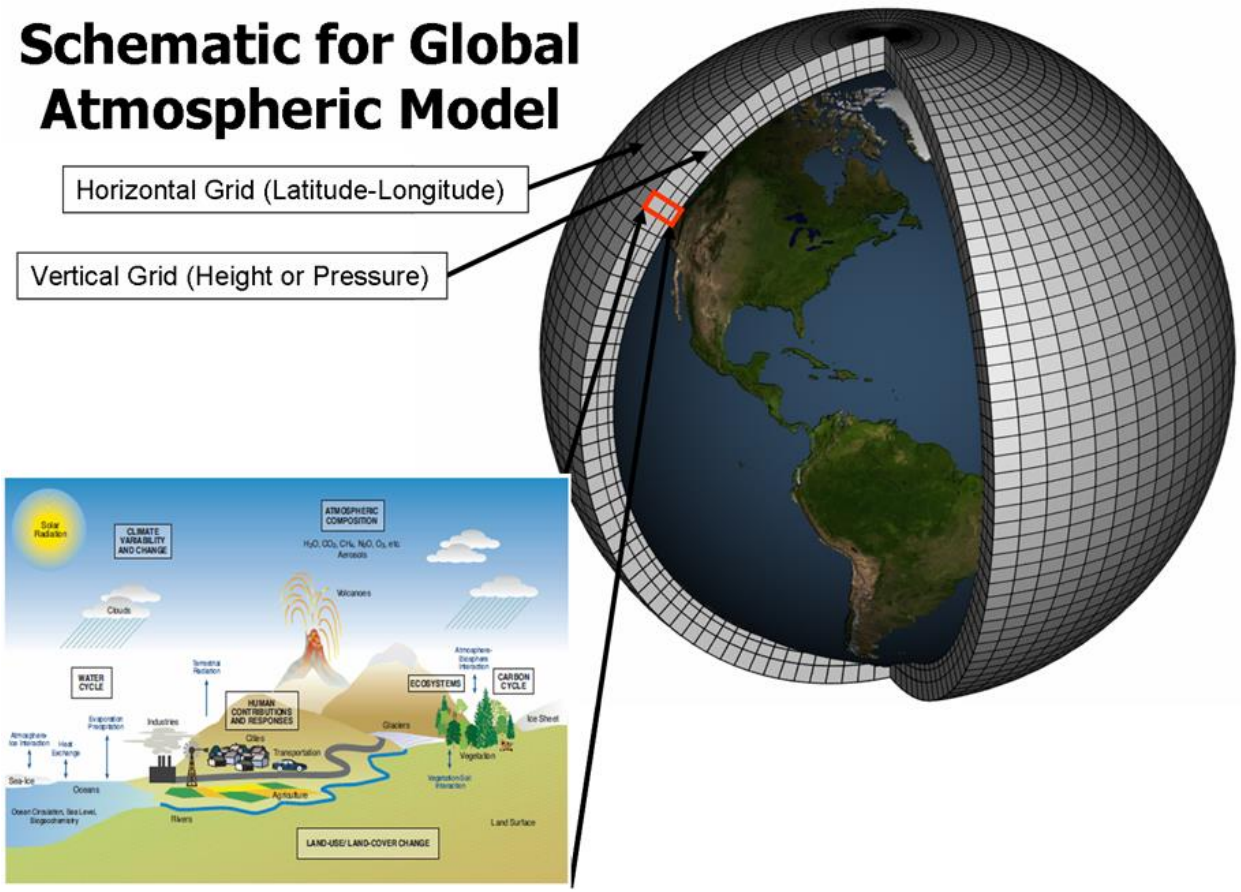


Fall

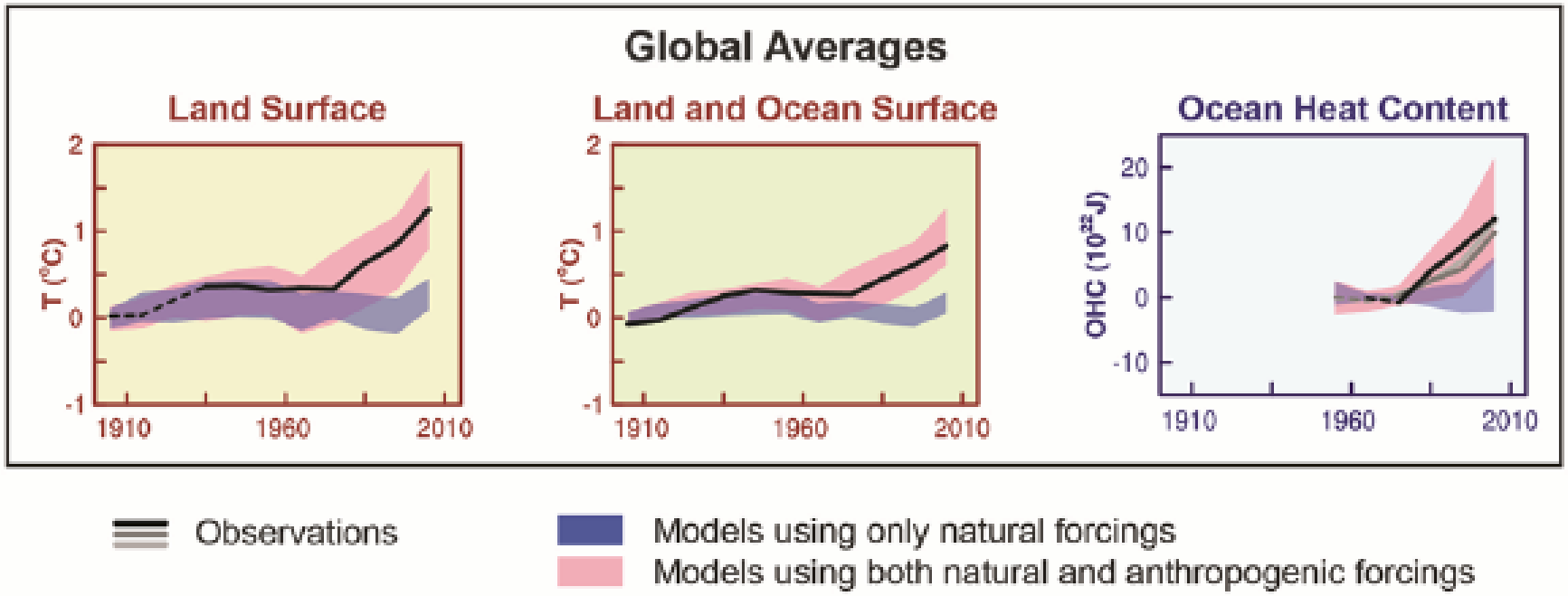


What does the future hold?

What Are Climate Models?

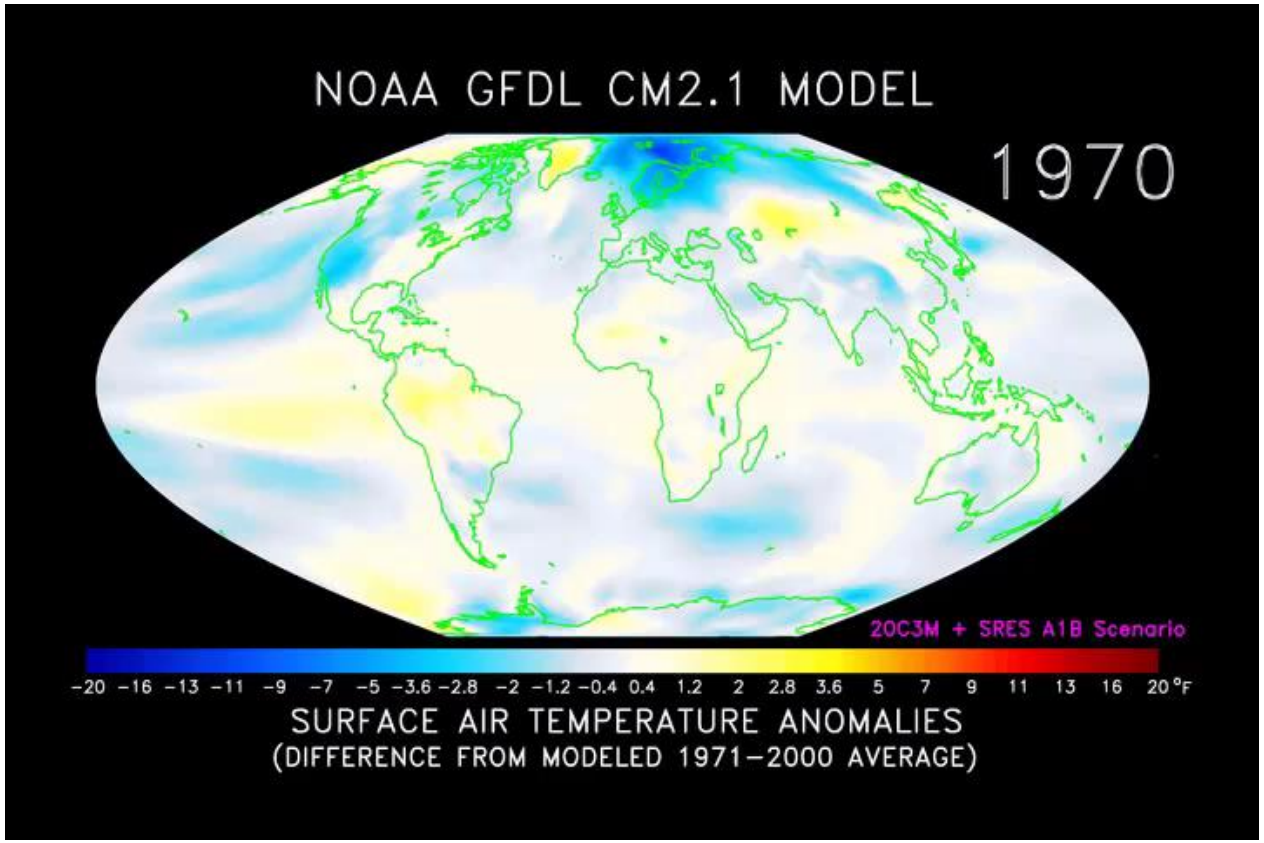


"What would happen if…" experiments

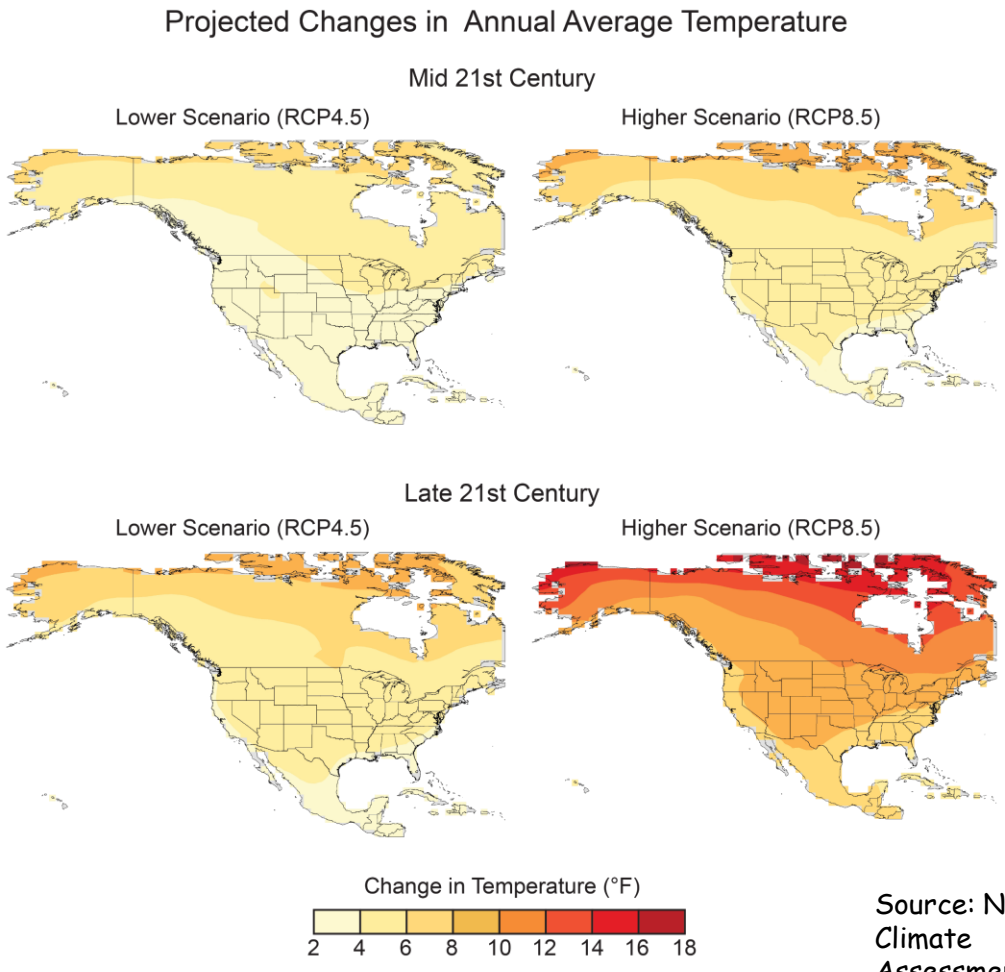


Source: Intergovernmental Panel on Climate Change

Simulating Future Climate Change



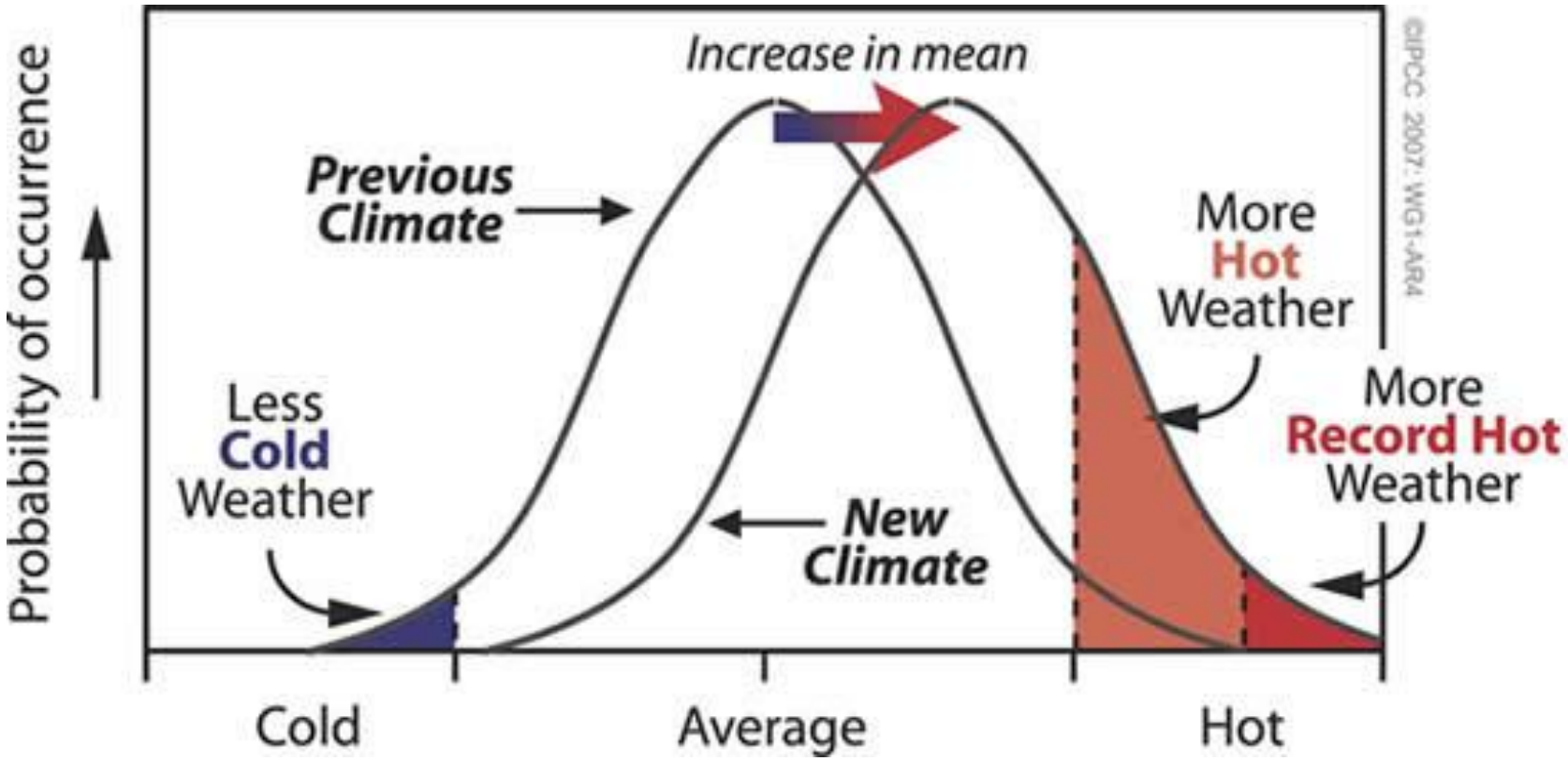
Source: NOAA Geophysical Fluid Dynamics Laboratory



Source: National Climate Assessment (2017)

Heat Waves

Changes in average temperature lead to changes in extremes



Source: Intergovernmental Panel on Climate Change

Unusually warm and cold months in New Jersey

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jan																				
Feb																				
Mar																				
Apr																				
May																				
Jun																				
Jul																				
Aug																				
Sep																				
Oct																				
Nov																				
Dec																				

Unusually warm and cold months in New Jersey

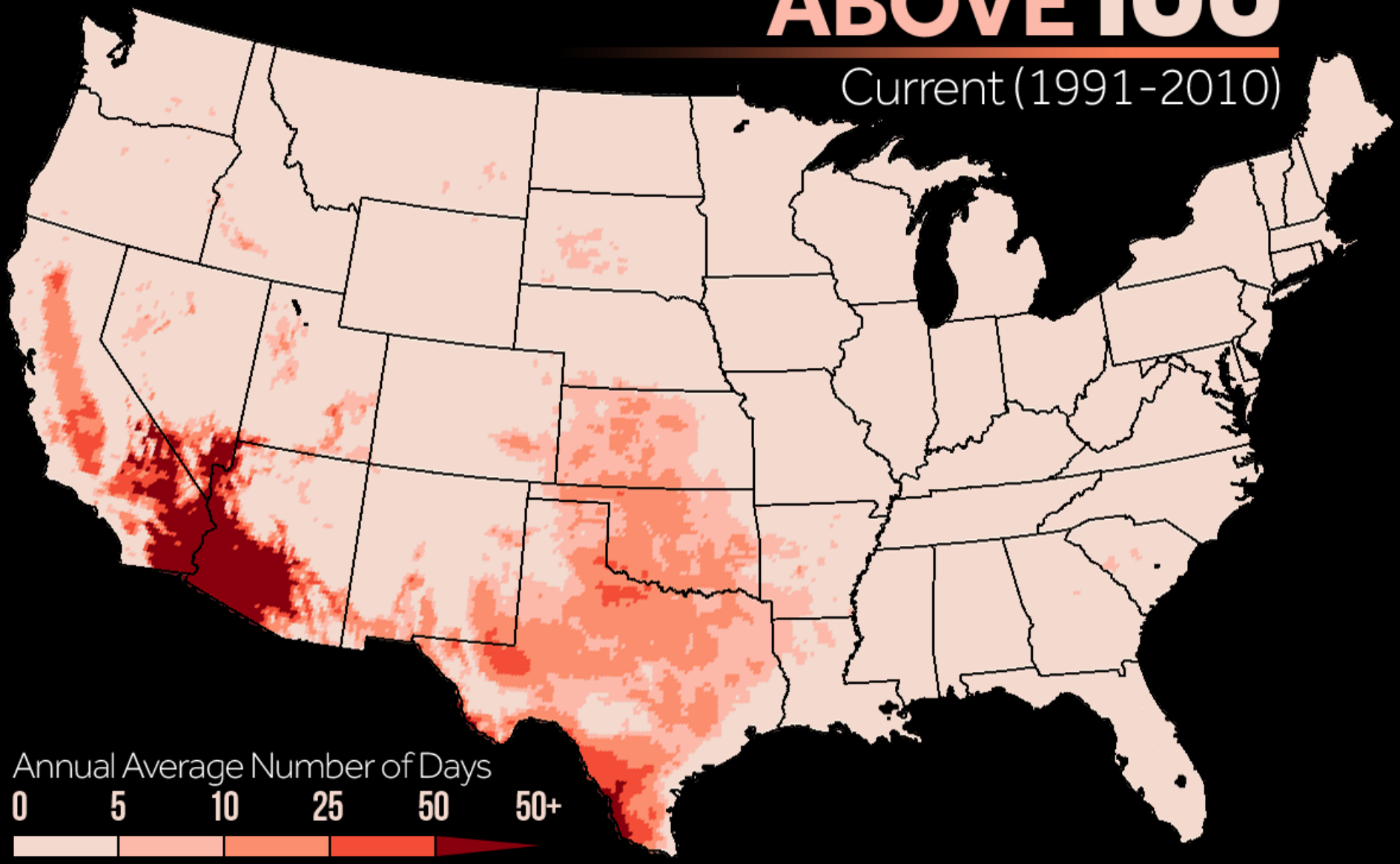
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Jan							3													
Feb			5										4					1	2	
Mar													1				4			
Apr											2							1		5
May					2								4			1			4	
Jun									3		1									
Jul											4	1								5
Aug			4			3											1		1	
Sep						4										2	5		3	
Oct								2										1		
Nov							1			3		4				1				
Dec		3					2					5	4			1				

- Unusually warm and cold months are defined as the five warmest and coldest for each calendar month (total of 60 warm and 60 cold plus ties)
- Since 2000, there have been 38 unusually warm months and 0 unusually cold months

Source: National Centers for Environmental Information

DAYS ABOVE 100°

Current (1991-2010)

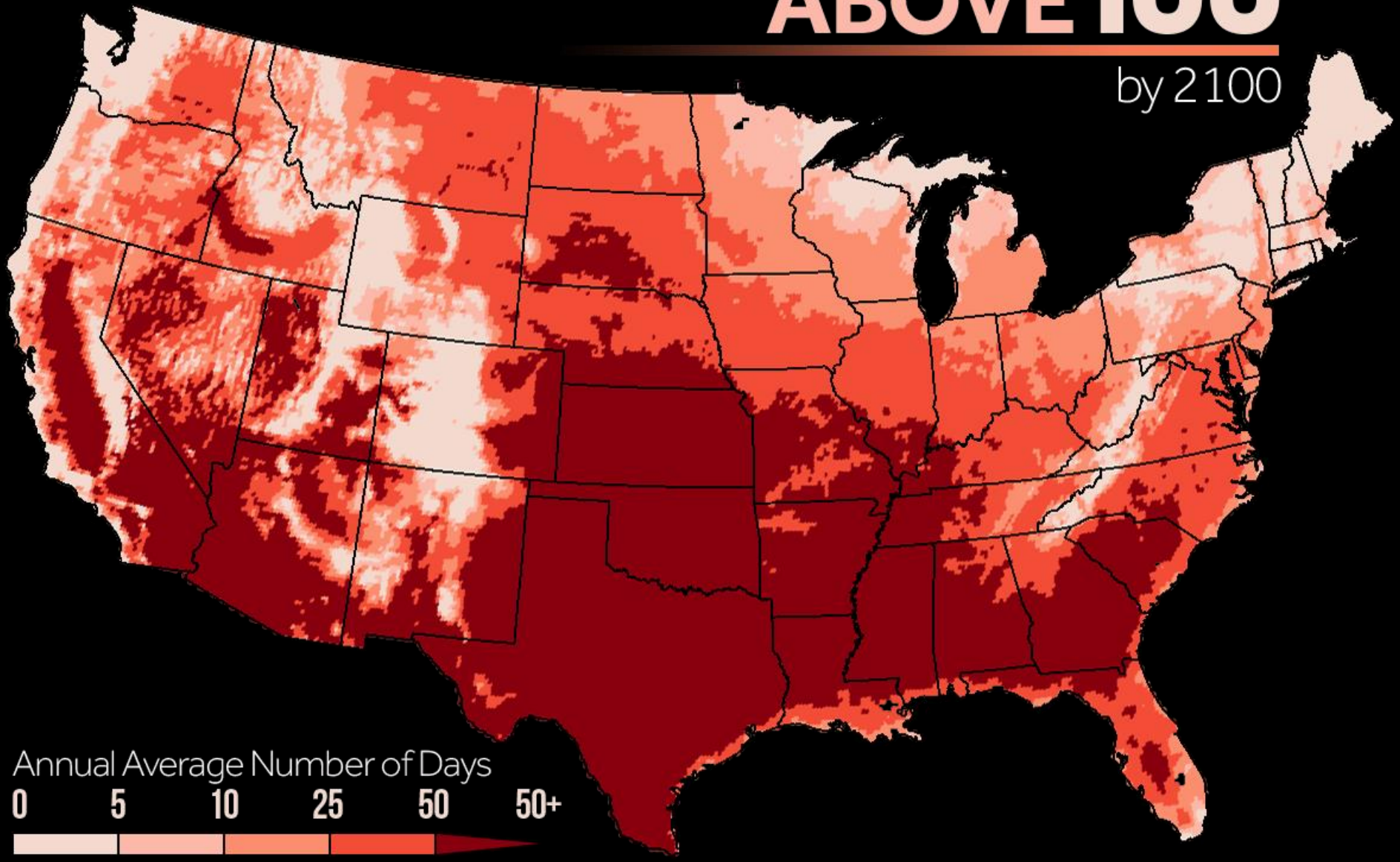


Source: Maurer et al. (2002), Santa Clara University

CLIMATE CENTRAL

DAYS ABOVE 100°

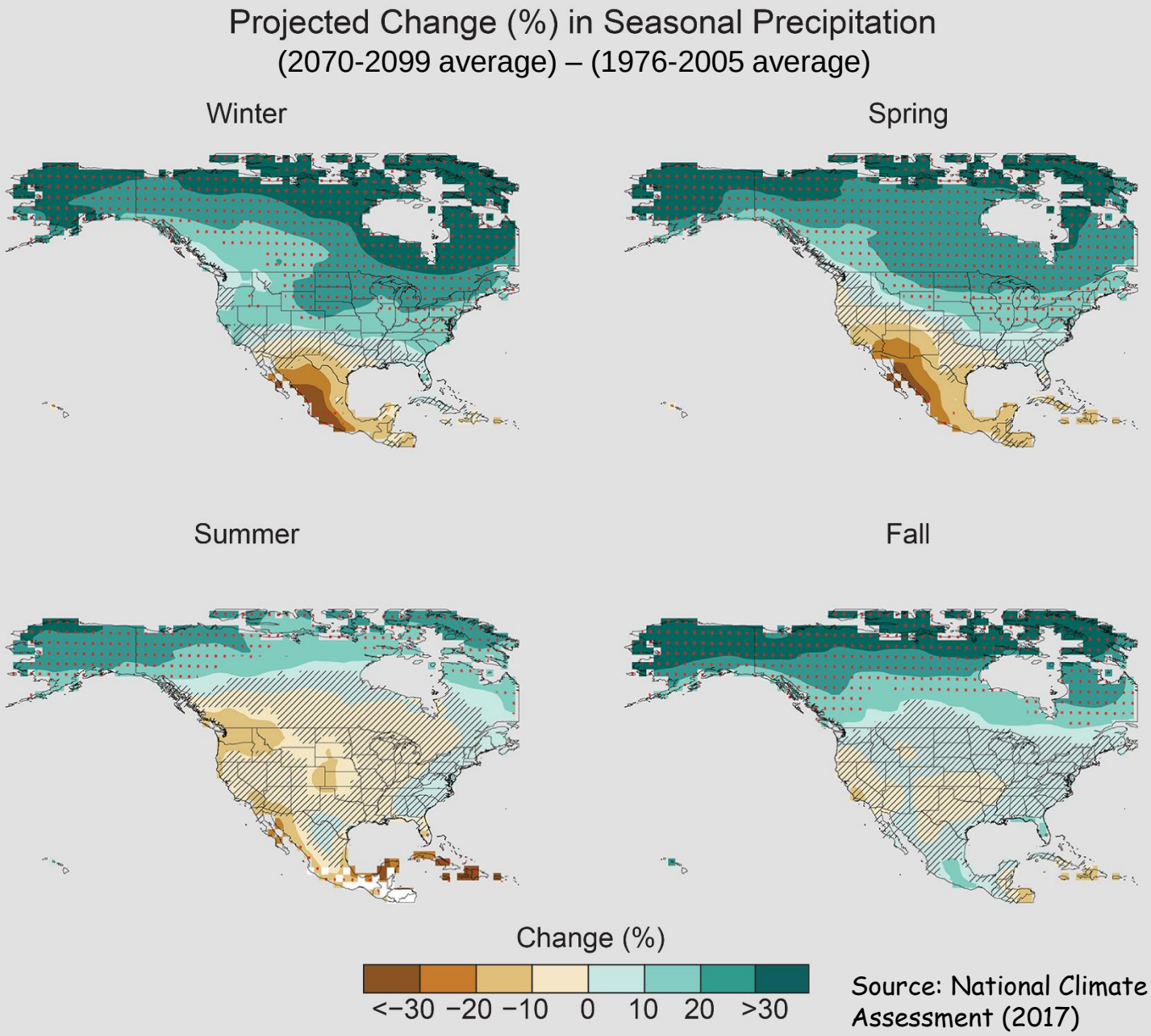
by 2100



Source: CMIP5 model projections of daily maximum temperature averaged over 20 year periods.

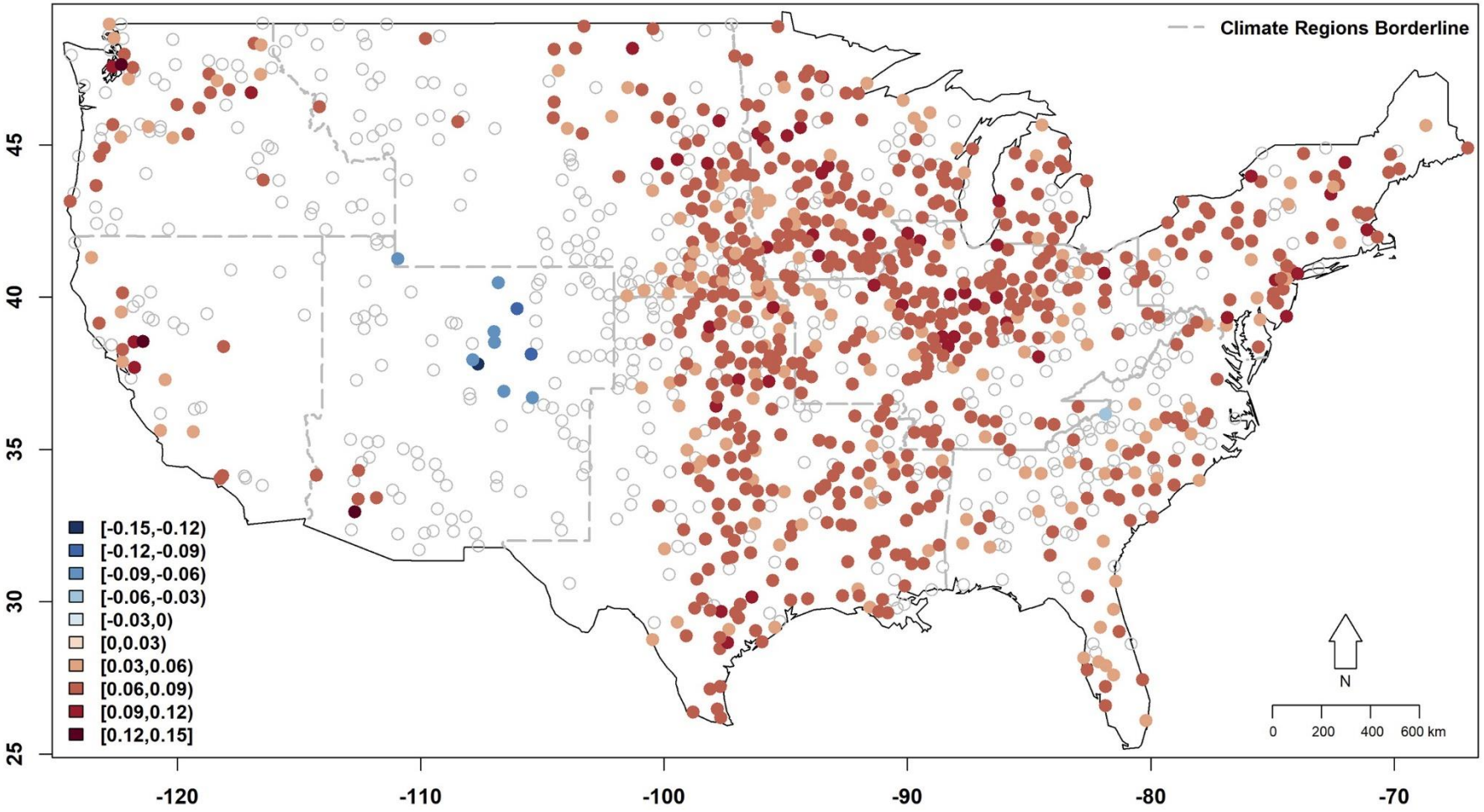
CLIMATE CENTRAL


STOP
4-WAY



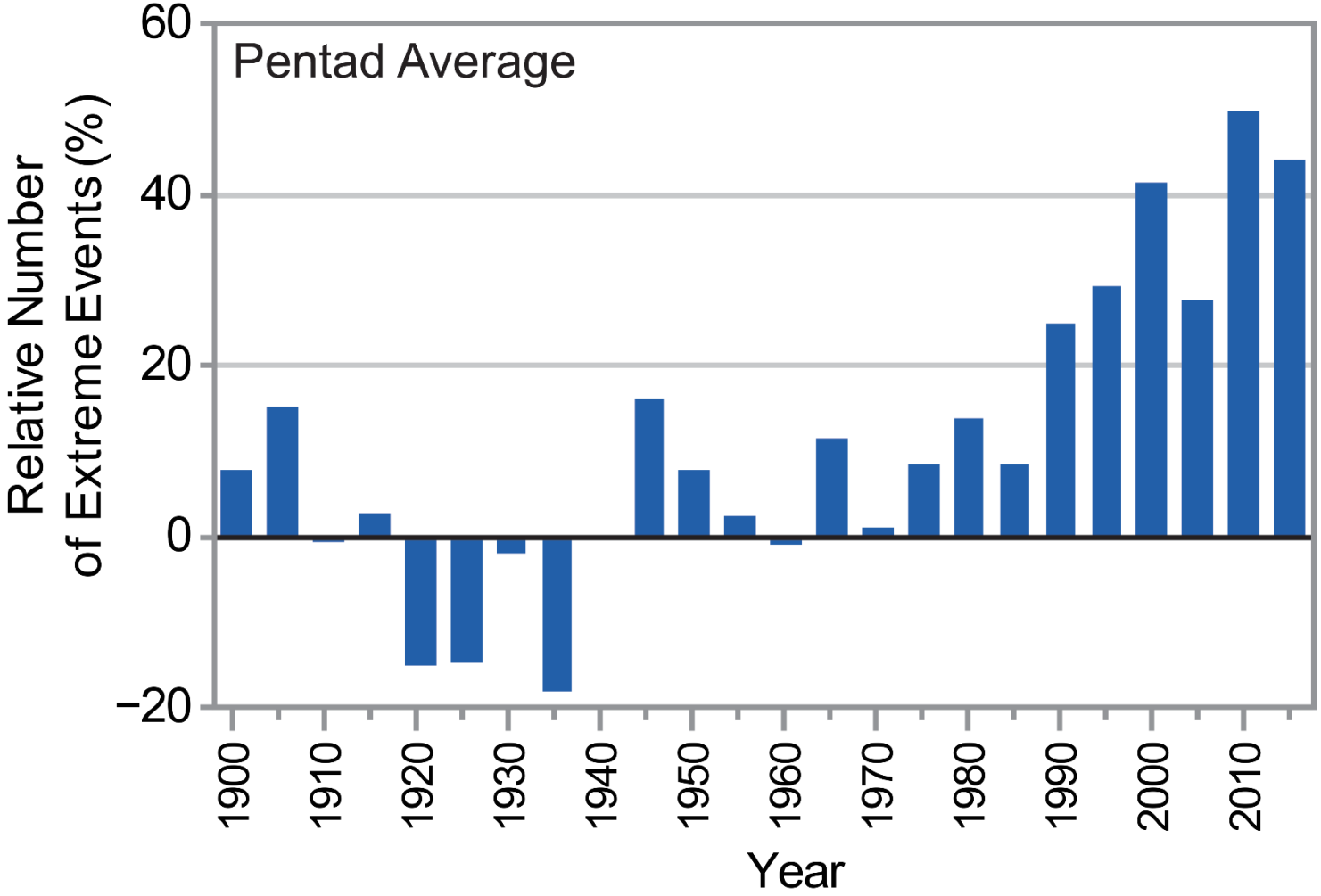
Source: National Climate Assessment (2017)

Stations exhibiting statistically trends in heavy precipitation (>95th percentile)



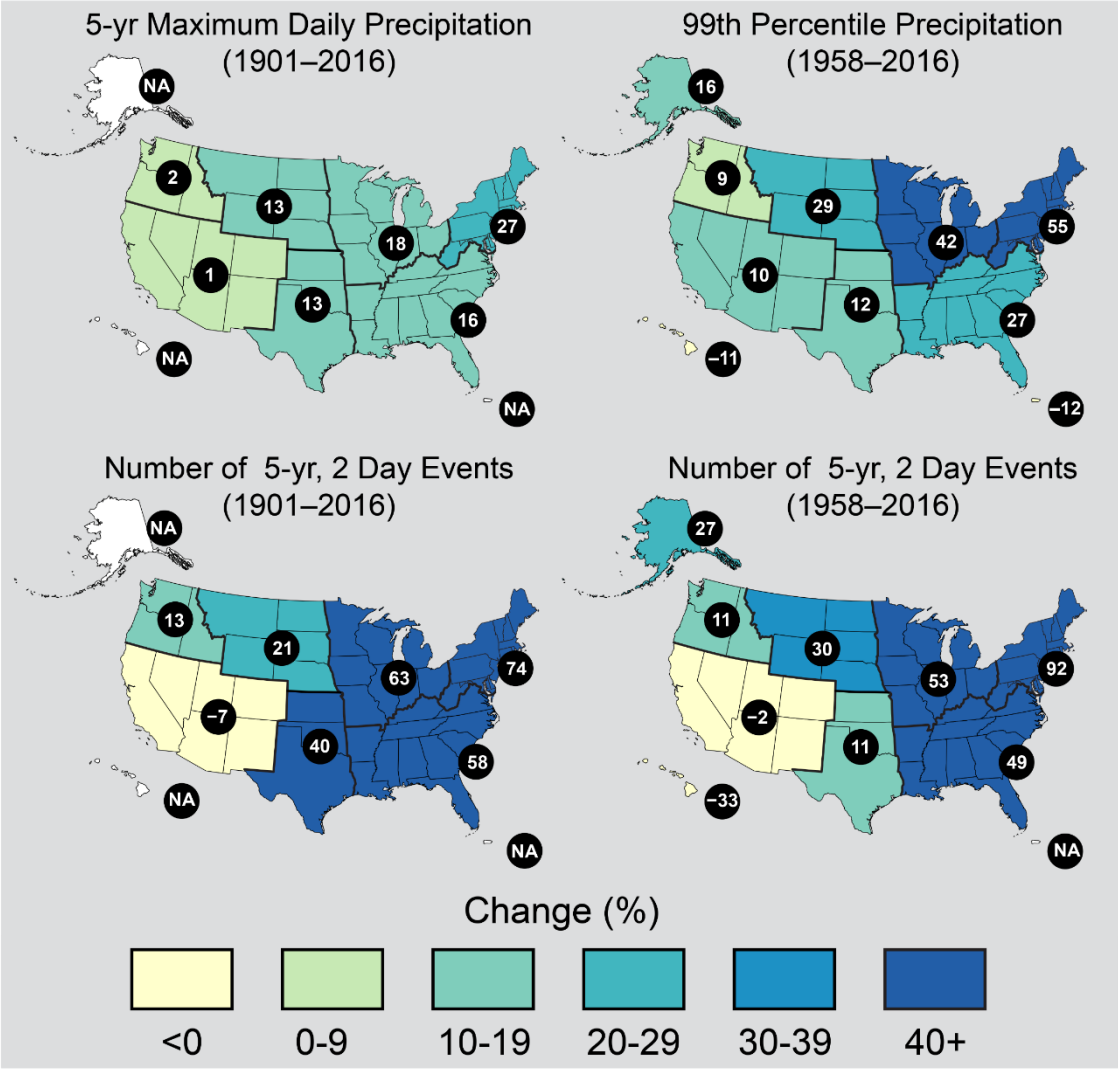
Source: Armal et al. 2018, *J. Climate*

2-Day Precipitation Events Exceeding 5-Year Recurrence Interval



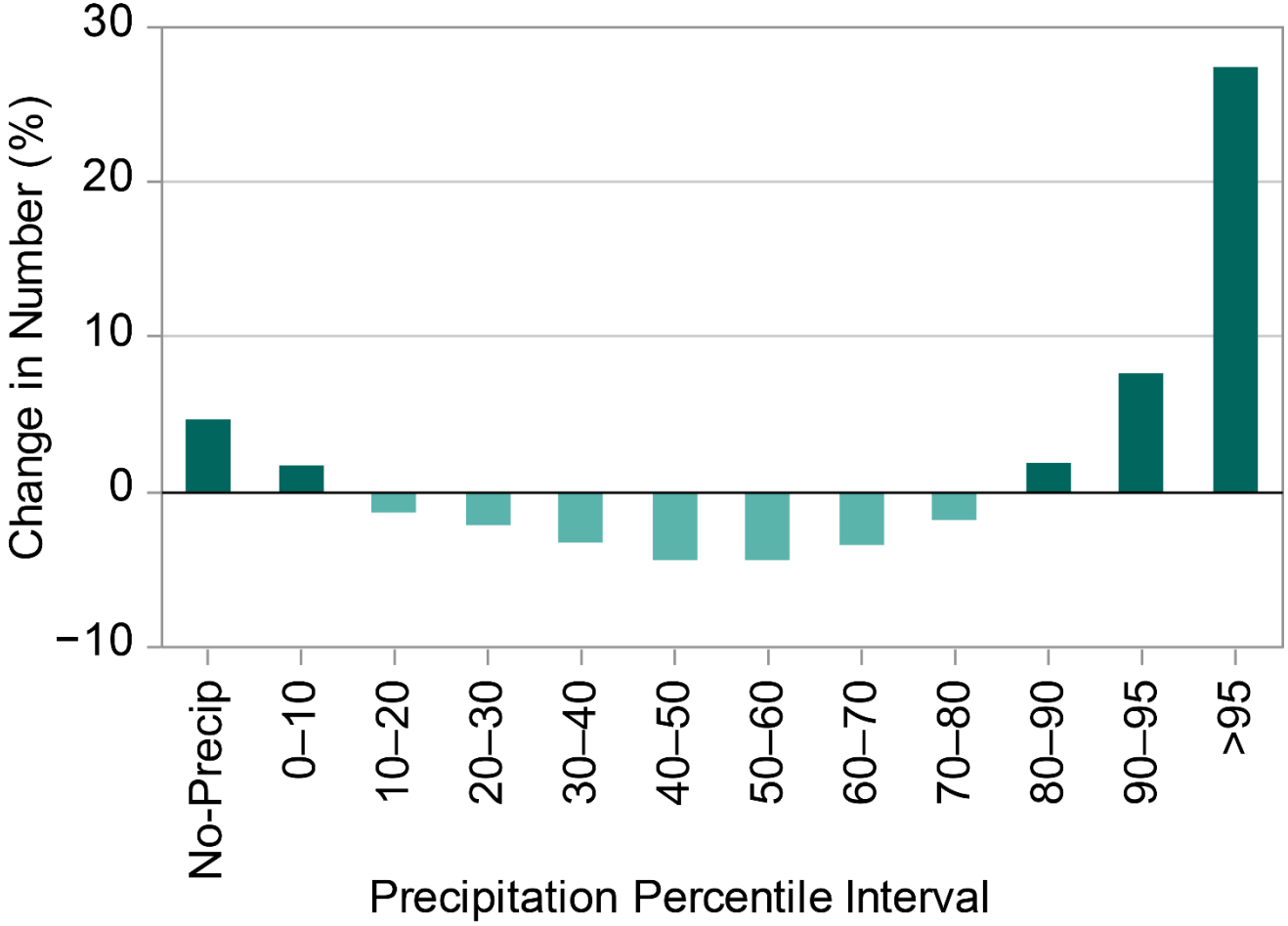
Source: National Climate Assessment (2017)

Observed Change in Heavy Precipitation



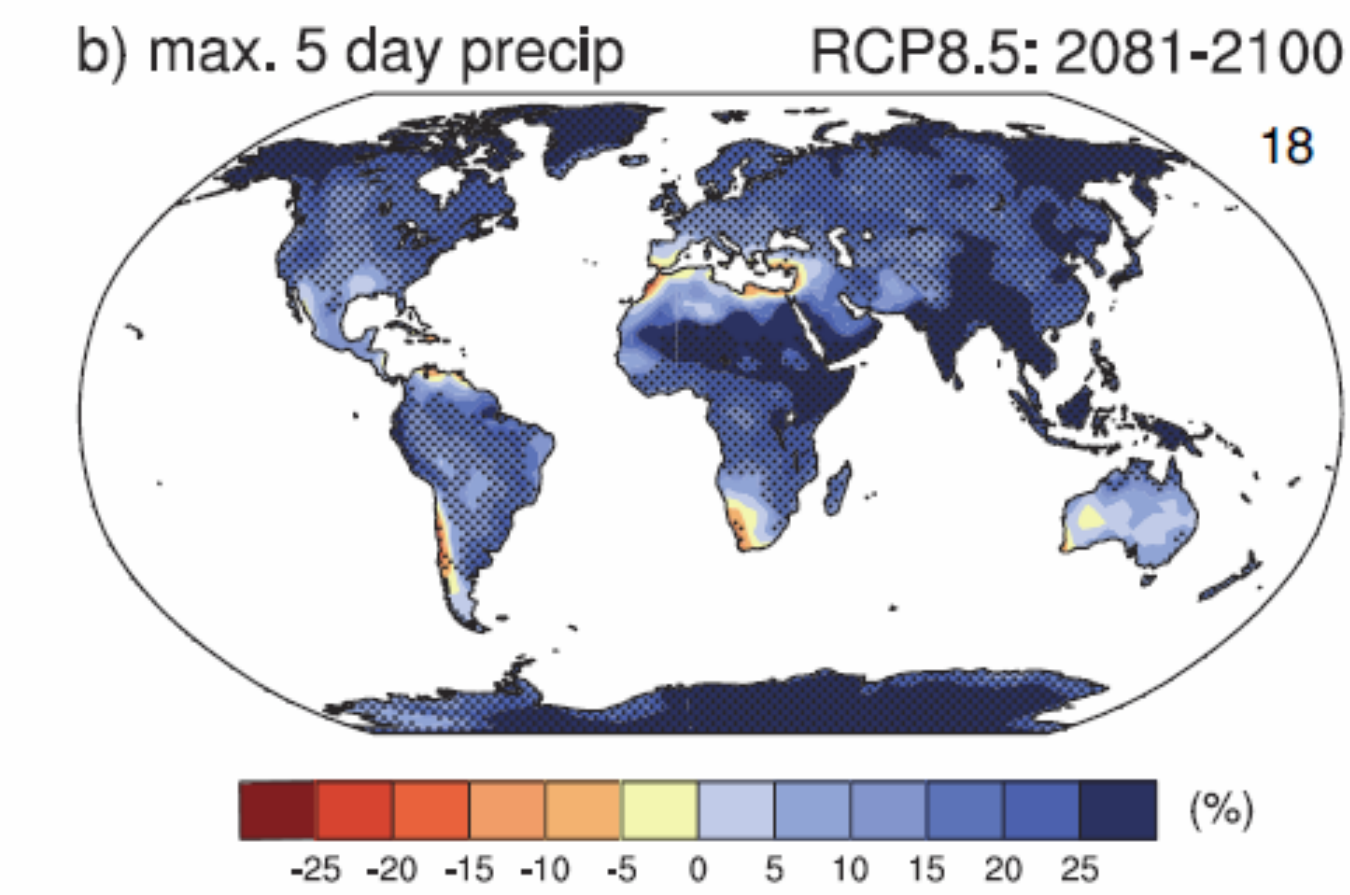
Source: National Climate Assessment (2017)

Change in the Number of Days Within Precipitation Percentile Intervals



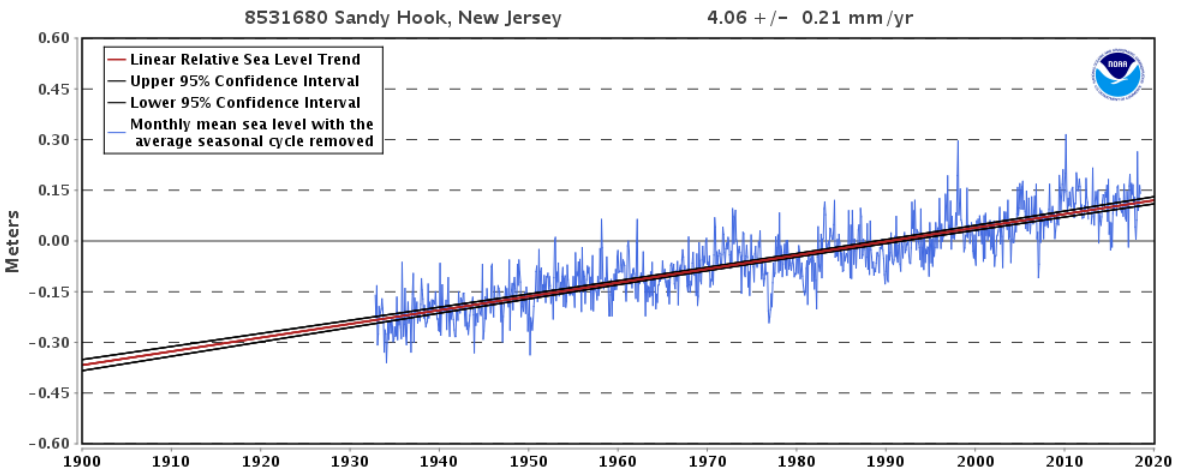
Source: National Climate Assessment (2017)

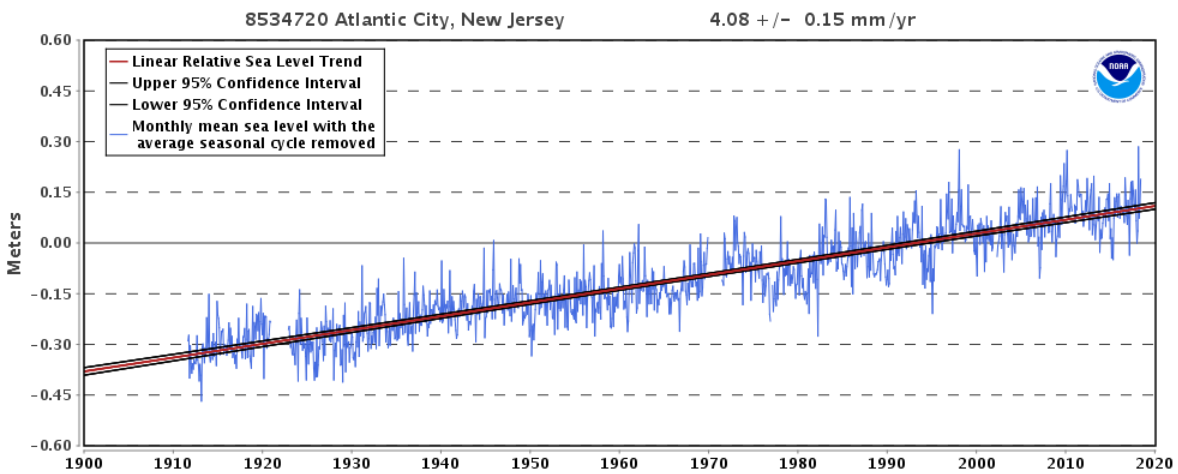
Heavy rains may become heavier…



Projected change in the amount of precipitation during the wettest 5-day period in a year.

New Jersey sea level trends





- Century-scale global sea level rise has been 1.7±0.3 mm/yr.
- This rate has nearly doubled in the past two decades.

New Jersey sea level projections

- Sea level in New Jersey is rising more rapidly than the global average.
- Projected changes in ocean currents are also expected to add to the rate of sea level rise on the New Jersey coast.
- A recent analysis by a Rutgers-led team of scientists projects that by 2030, sea level on the NJ coast will likely rise by 0.6-1.0 feet (relative to 2000), with a central estimate of 0.8 feet.
- In 2050, the range is 1.0-1.8 feet with a central estimate of 1.4 feet.
- By 2100, the range is 1.7-3.1 feet (best estimate of 2.3 feet) for a lower emissions scenario and 2.4-4.5 feet (best estimate 3.4 feet) for a higher emission scenario.

Source: Kopp, R. E. et al., 2016: *Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel.*

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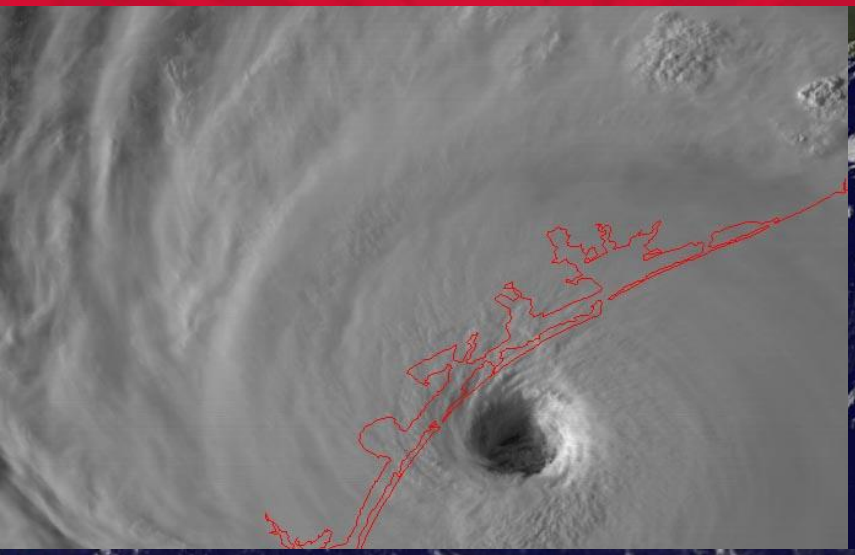
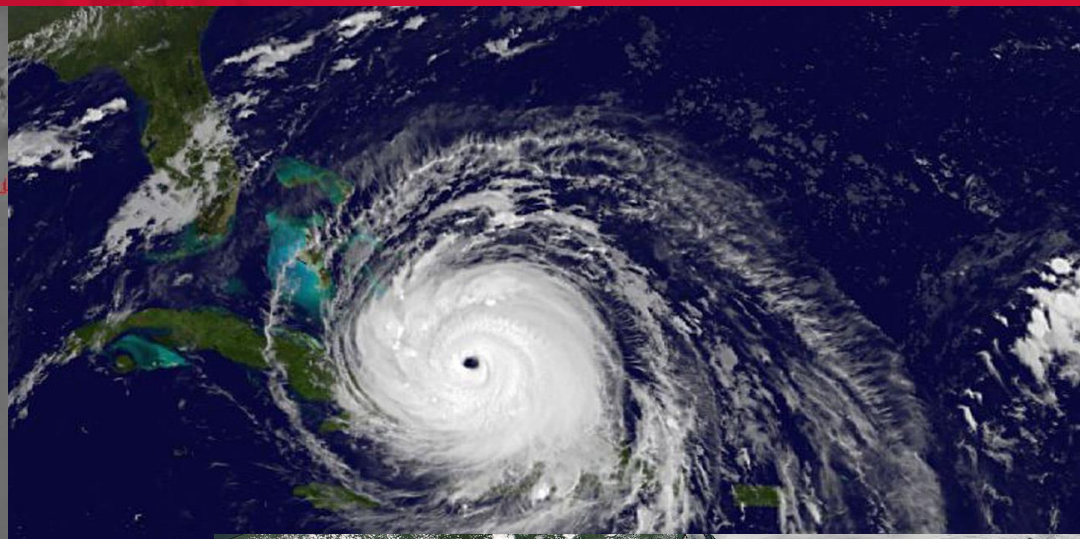
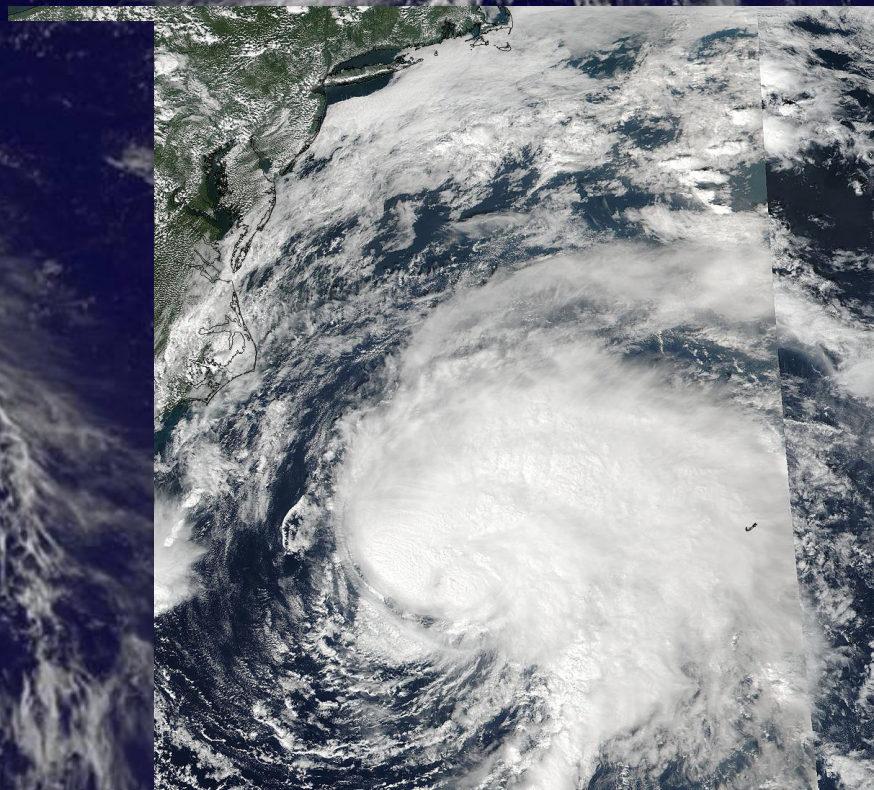






How will tropical cyclones change?

- The overall global number of tropical cyclones is expected to decrease or remain essentially unchanged.
- The average maximum wind speed in tropical cyclones is expected to increase. (Intensity of strongest TCs will increase.)
- Heavy rainfall events accompanying tropical cyclones are expected to increase.
- Confidence in these results is moderate; this remains an area of active research.

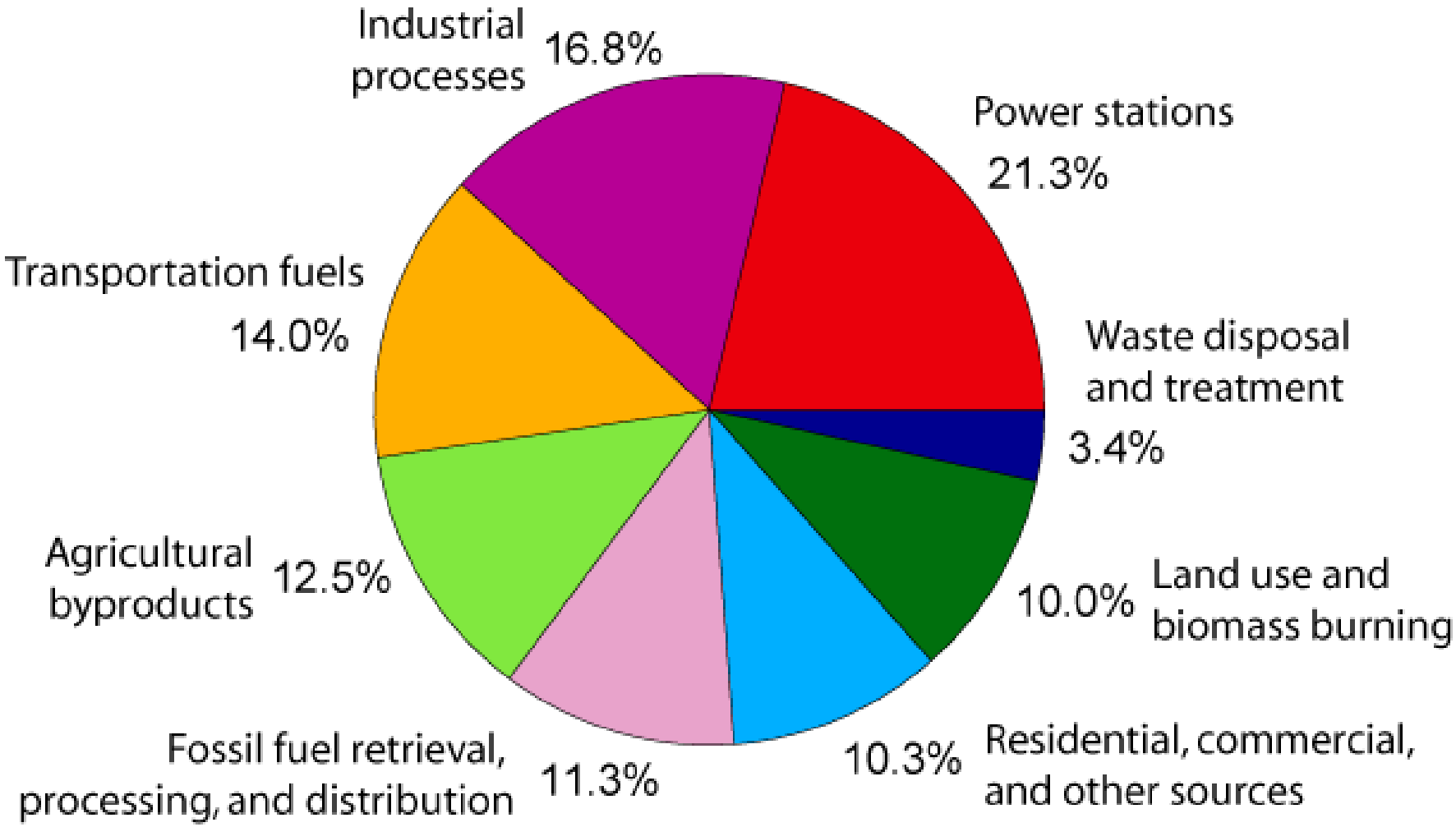
Will hurricanes and nor’easters affecting New Jersey become more intense or more frequent?

We don’t yet know the answer to this question, but…

Rising sea level will raise the baseline for coastal flooding, increasing the risk of floods comparable to those caused by Hurricane Sandy.

What can we do?

Annual Greenhouse Gas Emissions by Sector

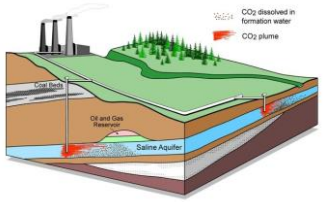


Options for dealing with climate change

- Mitigation—Efforts to reduce or prevent the emission of greenhouse gases
- Adaptation—Planning for the changes in climate that are expected to occur, particularly by taking actions to avoid the adverse impacts
- Geoengineering—Deliberate large-scale manipulation of the planetary environment to counteract human-caused climate change

Examples of emissions reduction strategies

- Energy efficiency
- Fuel switching
- Carbon capture and storage
- Nuclear electricity
- Solar electricity
- Wind electricity
- Biofuels
- Natural sinks



Source: Carbon Mitigation Initiative, Princeton University

Examples of adaptation strategies

- Warning systems to reduce exposure to extreme heat, including cooling stations for people without air conditioning
- Expanding flood zones and increasing the capacity of storm water drainage systems
- Making building roofs more reflective
- Raising outflows of wastewater treatment plants
- Raising residential buildings in coastal areas

Examples of geoengineering

- Carbon dioxide removal
  - Enhancing uptake and storage by terrestrial biosphere
  - Enhancing uptake and storage by oceanic organisms
  - Using engineered systems
- Solar radiation management
  - Modifying land or ocean reflectivity
  - Modifying cloud properties
  - Altering upper-atmospheric composition (sulfate aerosols)
  - Space-based reflectors

Source: The Royal Society, *Geoengineering the Climate*, Sep. 2009