APA S&R Series

Climate Science & Planning

The Basics

APA's Sustainability & Resilience Series

Planning for sustainability means balancing social, economic, and environmental resources, incorporating resilience, and linking local actions to regional and global concerns.

Planning for resilience means supporting the capacity of individuals, communities and systems to survive, adapt and thrive in the face of chronic stresses and acute shocks and even transform when conditions require it.

APA's Sustainability & Resilience Series

* 2 years, 12 topics, 2 levels = 24 events by 2024!
* Free of charge
* Diverse perspectives
* Live & recorded offerings for AICP credit
* Earns new Sustainability & Resilience CM credit

* Interested speakers: please email karla@ebenbach.com

Today's Panel:

Climate Science & Planning – The Basics
February 18, 2022

Matt Bucchin
AICP LEED Green Associate

Regional Practice Leader, Halff Associates

Rachel Riley

Director, Southern Climate Impacts Planning Program, Univ. of Oklahoma

Matt Bucchin, AICP

HALFF

APA Sustain

- Regional Practice Leader, Halff Associates, Inc., Austin, TX
- Past Chair of APA's Sustainable Communities Division
- Core Author of APA's Climate Change Policy Guide
- Co-Author of APA's Climate Change PAS Report (pending)

LEARNING OBJECTIVES

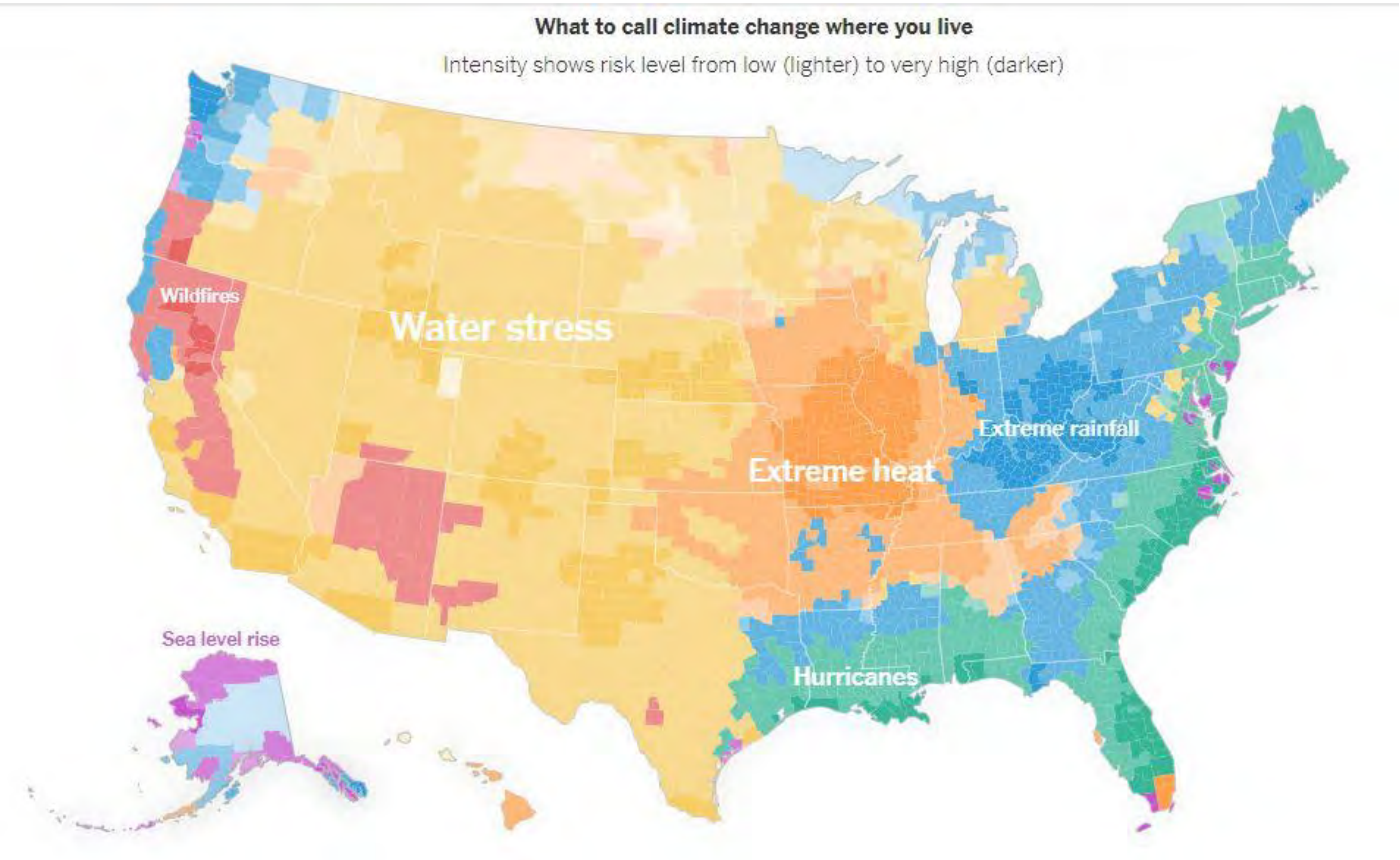
- Why planners?
- Introduction to climate change
- Climate data limitations and resources
- Climate resources from APA

"Climate Point: 2021 among the warmest, most disastrous years on record."

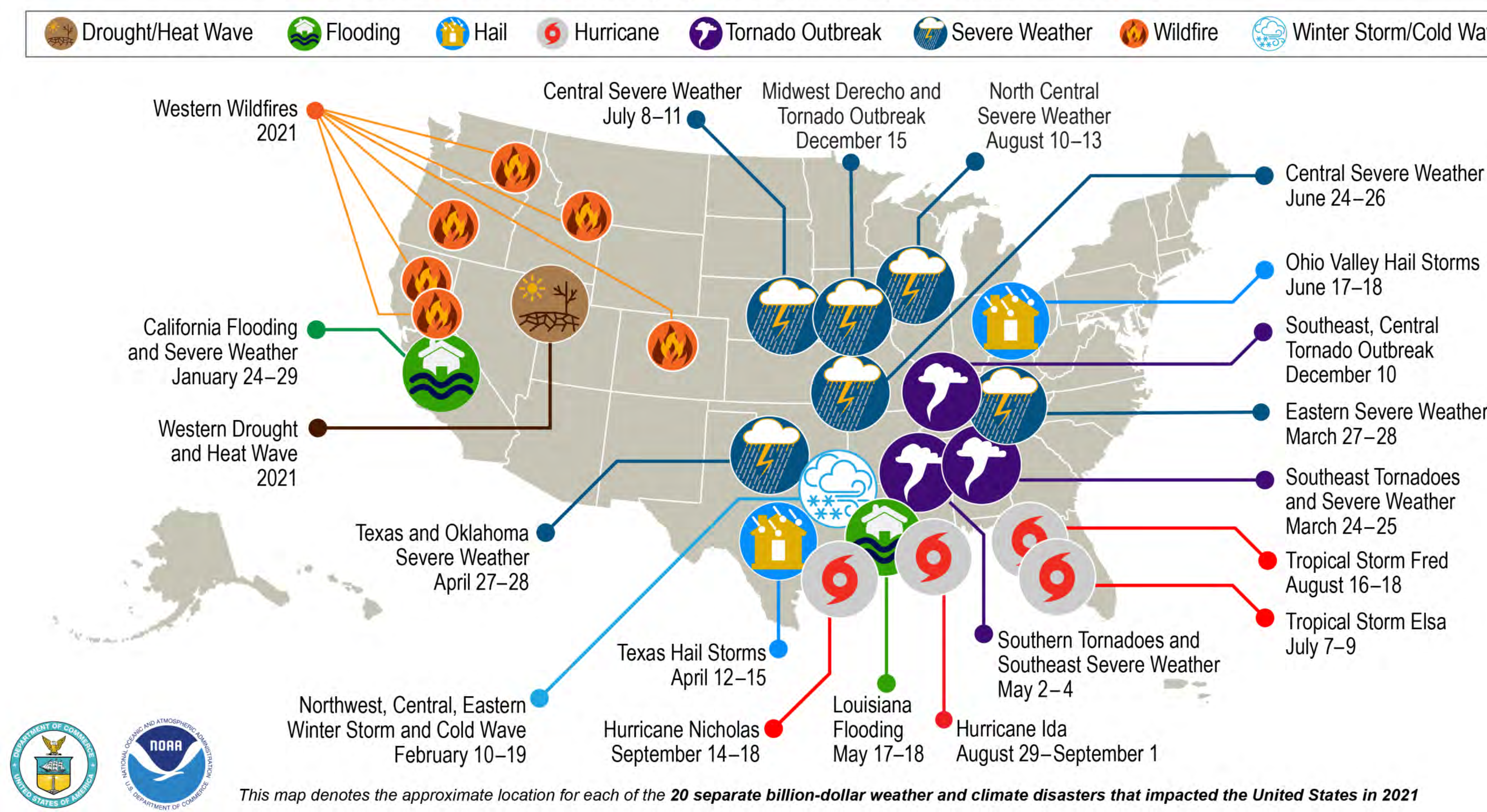
Climate Point: 2021 among the warmest, most disastrous years on record

IMAGE SOURCE: GETTY IMAGES

QUOTE SOURCE: USA TODAY



SOURCE: REUTERS/STEVE MARCUS/FILE PHOTO



*This map denotes the approximate location for each of the **20 separate billion-dollar weather and climate disasters that impacted the United States in 2021***

IMAGE SOURCE: CLIMATE.GOV

CLIMATE CHANGE IMPACTS

- **More frequent and intense storm events**
- **Increasing temperatures and extreme heat**
- Warmer ocean temperatures
- Declining arctic sea ice
- **Sea level rise**
- Acidification of the Earth's oceans
- **Inland flooding**
- **Drought and threatened water supplies**
- **Increased fire activity**
- Melting permafrost
- **Decreasing biodiversity**
- **Species migration**

CLIMATE CHANGE IMPACTS

ENERGY	TRANSPORTATION	LAND USE	INFRASTRUCTURE	BUILDINGS	MATERIALS	NATURAL SYSTEMS	PUBLIC HEALTH
▪ Changing energy supply portfolio ▪ Changes in seasonal energy demands ▪ Decreased grid reliability ▪ Extreme weather disruptions ▪ Changes in water availability	▪ Roadway failure ▪ Decreased system reliability ▪ Transition to Electrification ▪ Changes in mode choice ▪ Inadequate design for future climate conditions ▪ Increasingly vulnerable fixed facilities ▪ Extreme weather disruptions	▪ Decreased agricultural productivity ▪ Increased droughts ▪ Wildland urban interface issues ▪ Mass migration ▪ Increased economic activity disruptions	▪ Coastal erosion ▪ Storm surge ▪ Decreased water supply ▪ Increased water demand ▪ Reduced infrastructure reliability ▪ Infrastructure failure ▪ Increased impacts from extreme weather events	▪ Increased urban heat ▪ Urban flooding ▪ Extreme storm events ▪ Inadequate building envelopes ▪ Increasing risk ▪ Increasing insurance costs	▪ Increasing quantities of waste from disasters ▪ Changing material requirements ▪ Changing material processing requirements ▪ Increasing source/waste material transportation costs	▪ Decreased snowpack ▪ Earlier Snowmelt ▪ Increased wildfires ▪ Sea level rise ▪ Reduced biodiversity ▪ Species migration and extinction	▪ Inequitable health disparities ▪ Increased vector borne diseases ▪ Increased water-related illnesses ▪ Increased food insecurity ▪ Decreased air quality

Source: Authors

Why Planners?

- Comprehensive perspective
- Long-range outlook
- Focus on place-based solutions
- Systems perspective and focus on unintended consequences
- Engagement and consensus building skillset
- Strategic role in community growth and development process

Climate Science: The Basics

Rachel Riley
Director, Southern Climate Impacts Planning Program
University of Oklahoma

SCIPP
A NOAA RISA TEAM

APA S&R Webinar Series, 18 February 2022

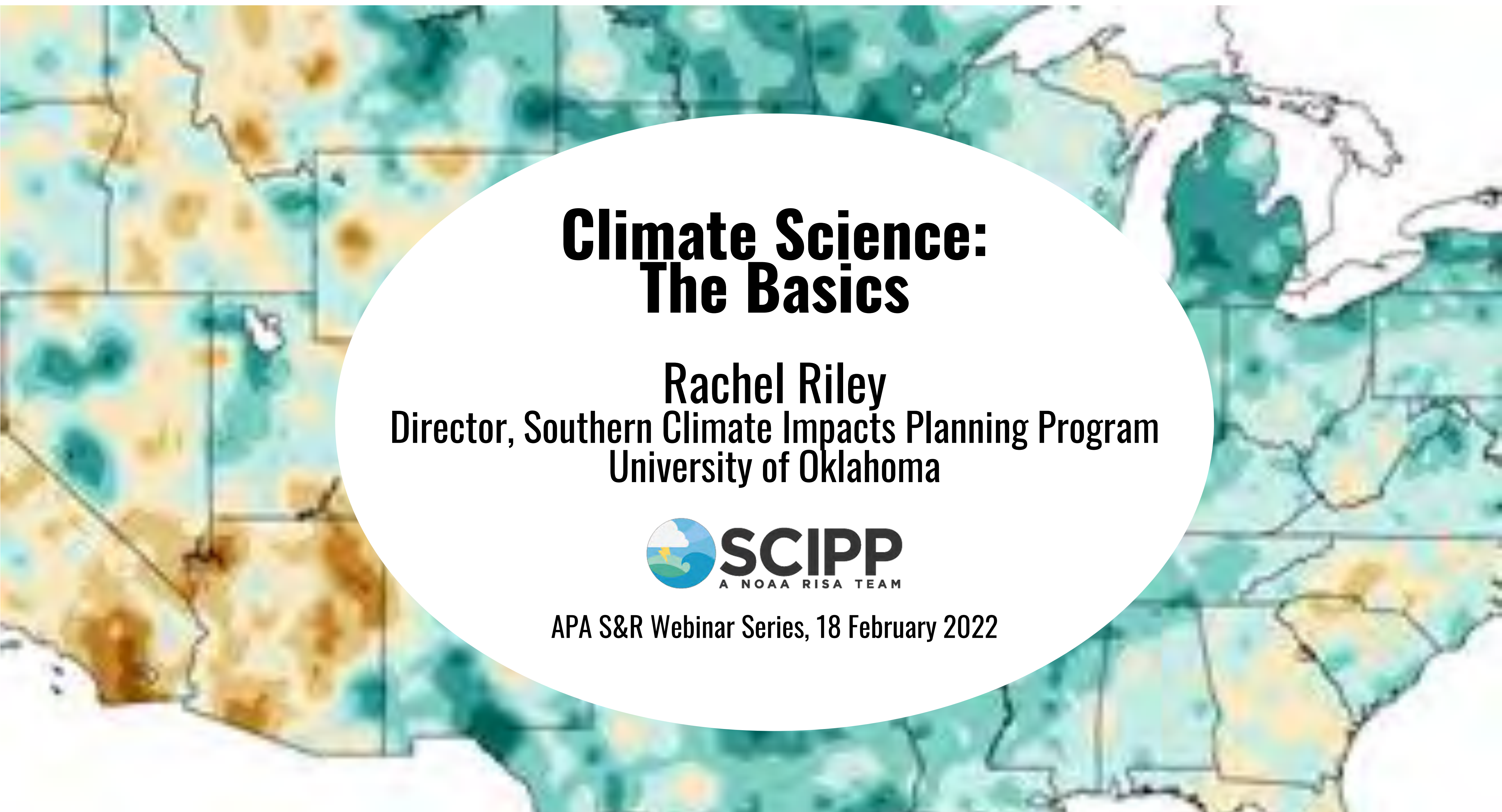


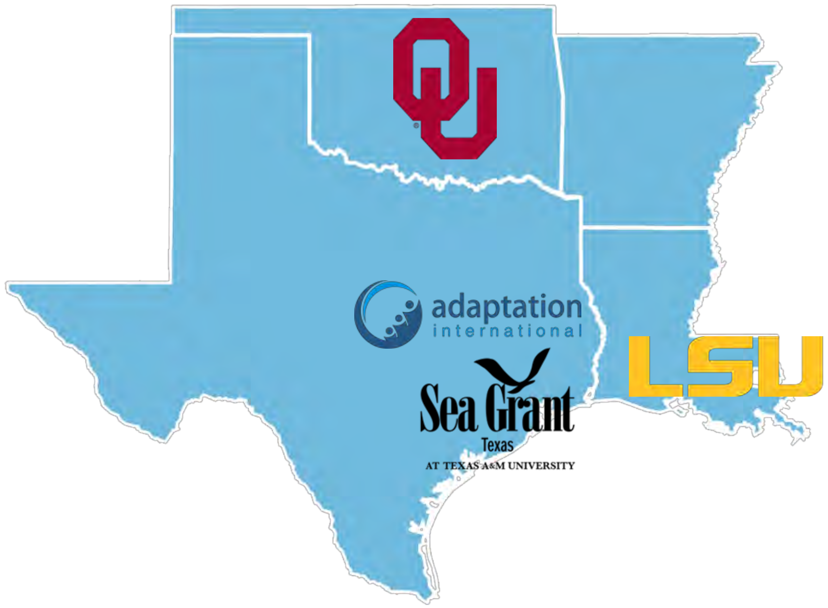
Image source: USGCRP, 2017 Climate Science Special Report

Who We Are & What We Do

Our Mission: ***Assist organizations with making decisions that build resilience by collaboratively producing research, tools, and knowledge that reduce weather and climate risks and impacts across the South Central United States.***

www.southernclimate.org

NOAA RISA
Regional Integrated Sciences and Assessments

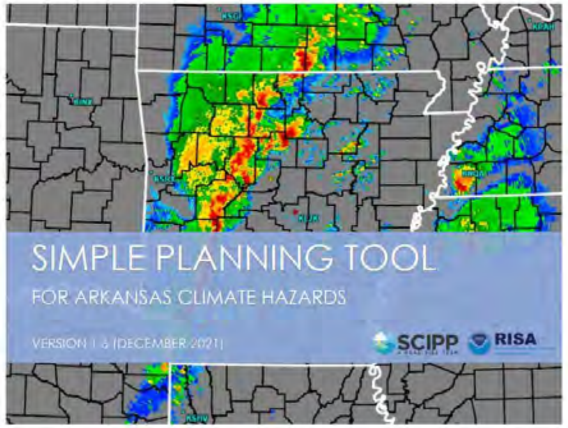


The SCIPP region is home to many tribal nations. We fully recognize the sovereign rights of those tribal nations.

Collaborations with Planning Officials

Exploratory Workshops with Planners and Emergency Managers in Oklahoma and Arkansas (2017-2018)

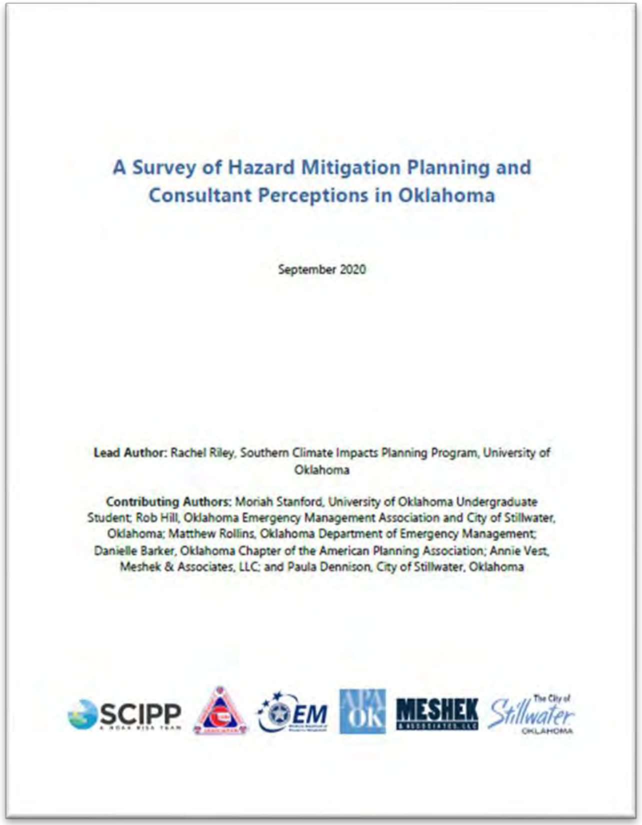
Development of the *Simple Planning Tools* for Oklahoma and Arkansas (2018, Texas and Louisiana versions coming soon)



Collaborations with Planning Officials

Regional and State APA Conferences (2017-present)

Hazard Mitigation Planning and Consultant Perceptions Survey (2019)



A Survey of Hazard Mitigation Planning and Consultant Perceptions in Oklahoma

September 2020

Lead Author: Rachel Riley, Southern Climate Impacts Planning Program, University of Oklahoma

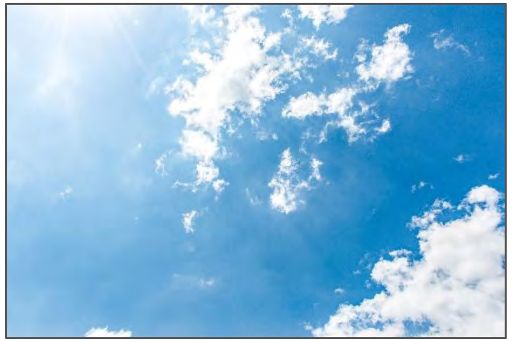
Contributing Authors: Moriah Stanford, University of Oklahoma Undergraduate Student; Rob Hill, Oklahoma Emergency Management Association and City of Stillwater, Oklahoma; Matthew Rollins, Oklahoma Department of Emergency Management; Danielle Barker, Oklahoma Chapter of the American Planning Association; Annie Vest, Meshek & Associates, LLC; and Paula Dennison, City of Stillwater, Oklahoma

Oklahoma Planning Officials' Handbook Revision (ongoing)

Weather vs. Climate

Weather

The state of the atmosphere at a particular time and place, mainly with respect to life and human activities.






Climate

- The statistical collection of weather conditions at a place over a period of years.
- The accumulation of daily and seasonal weather events over a long period of time (weeks, months, years, centuries).
- Includes weather and weather extremes (e.g., heat waves, cold waves, heavy precipitation, tornadoes).
- Represented by long term averages of weather variables and departures of weather variables from those averages.

Weather vs. Climate

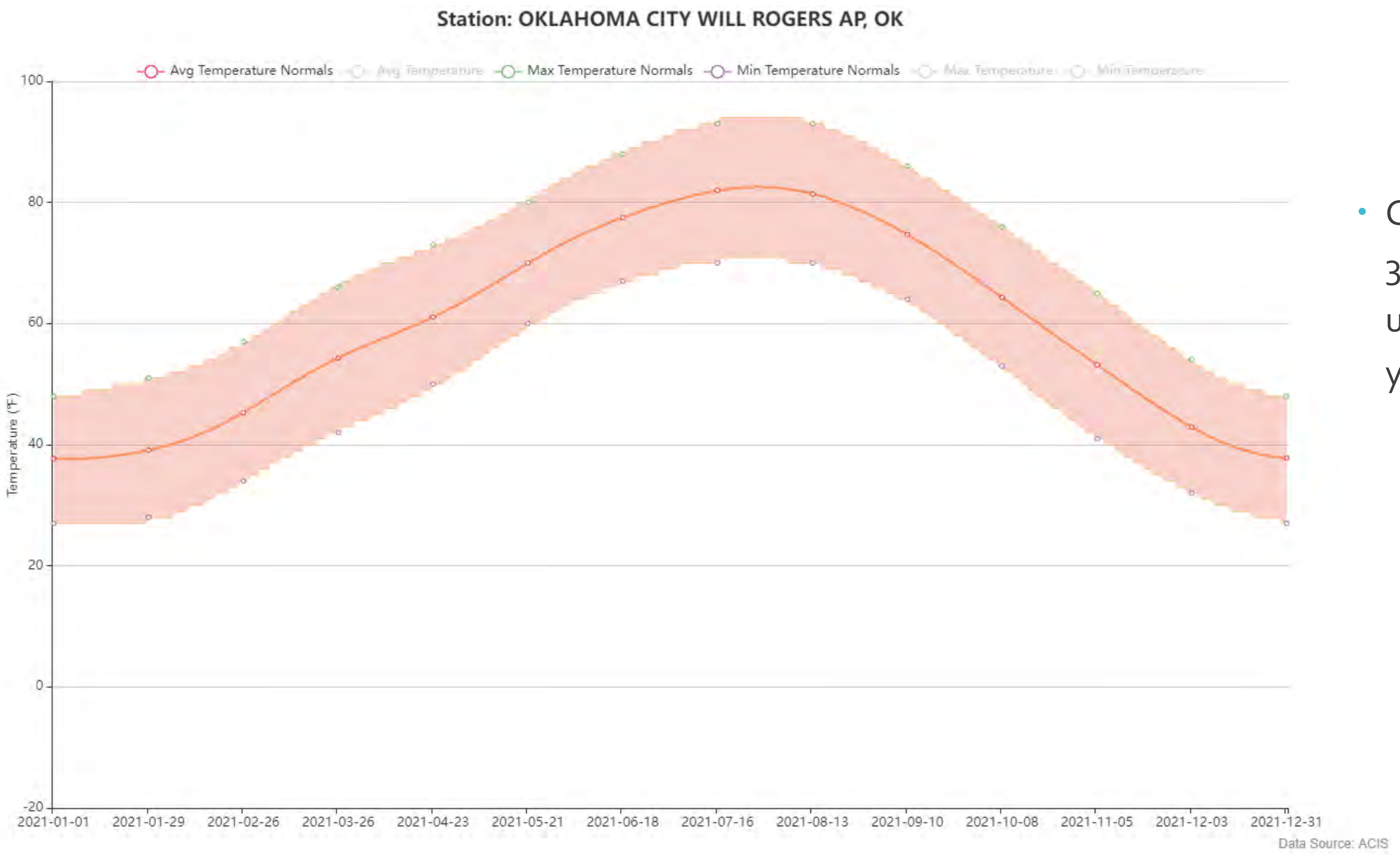
What <u>weather</u> determines:

- Type of clothing we wear today.
- Snow plows out today or not?
- Operations

What <u>climate</u> determines:

- Type of clothing we buy and keep.
- Should our city purchase snow plows or not?
- Planning and design

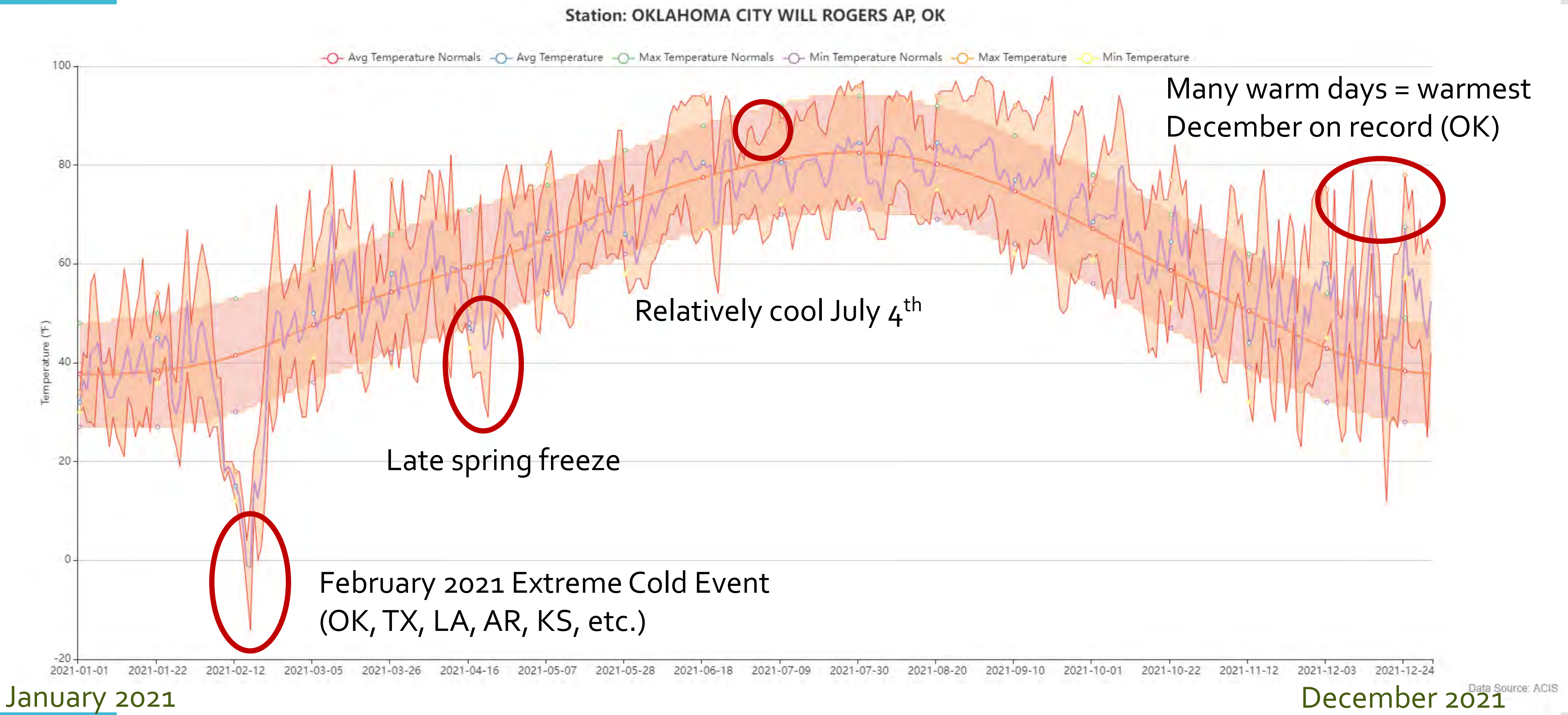
Weather vs. Climate – Oklahoma City Example



- Climate Normal = 30-year average, updated every 10 years

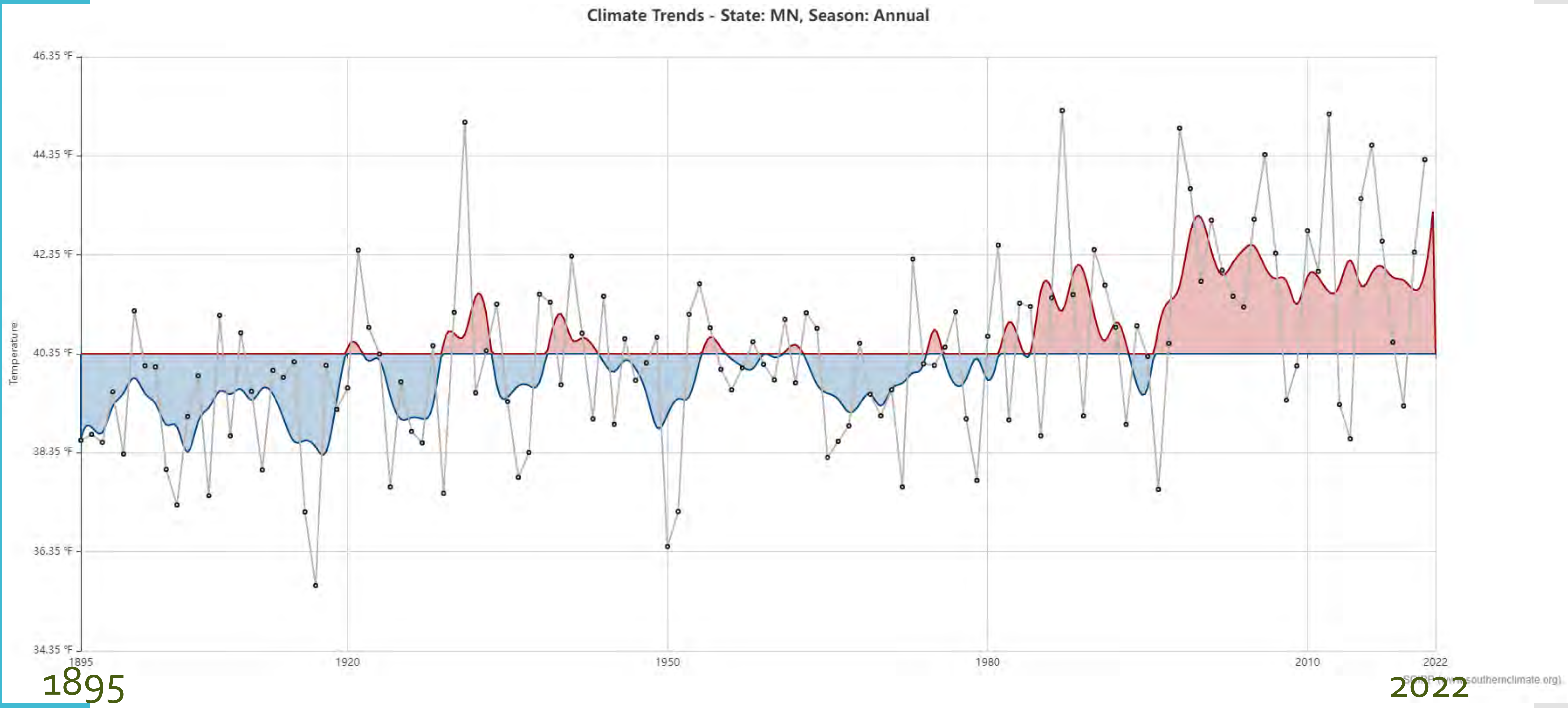
http://www.southernclimate.org/pages/data-tools

Weather vs. Climate – Oklahoma City Example



http://www.southernclimate.org/pages/data-tools

Historical Climate – Annual Minnesota Temperature Trend

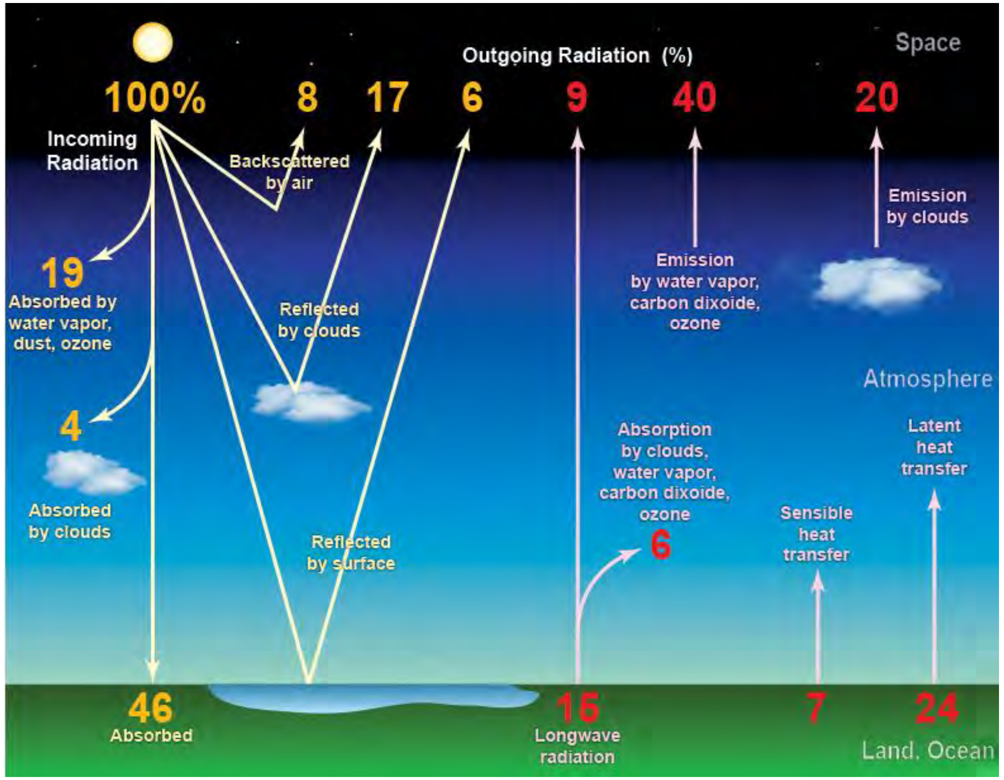


http://www.southernclimate.org/pages/data-tools

What Determines Climate?

Earth-Atmosphere Energy Balance

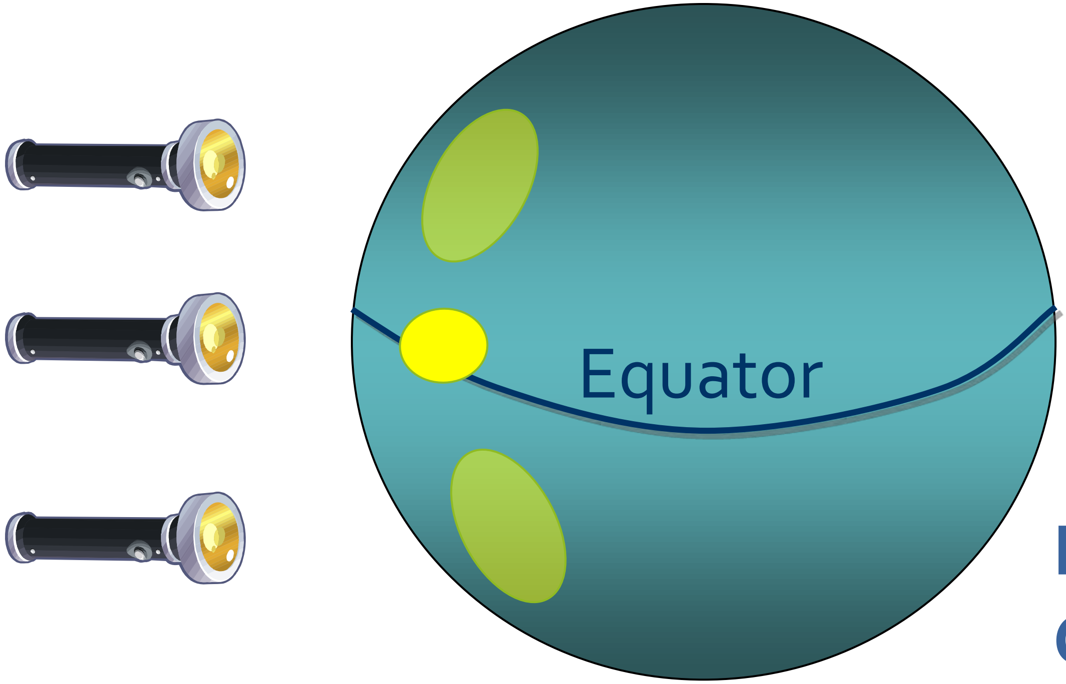
- Incoming energy from the sun (short wave radiation) heats Earth.
- Some energy is reflected by clouds or the atmosphere back into space.
- Some of the energy is absorbed by Earth and re-emitted as longer-wave radiation.
- Atmospheric gasses trap some of the longer-wave radiation, keeping Earth at an average temperature of 58°F.



Source: NOAA National Weather Service JetStream

What determines climate?

- The sun and uneven heating of Earth.
- Different places on Earth receive direct (more intense) vs. oblique (less intense) energy.



Less direct energy**:**
Colder temps!

More direct energy**:**
Warmer temps!

Less direct energy**:**
Colder temps!

But wait…there's more!

- Factor 2: Revolution and Tilt
- Factor 3: Rotation
- Factor 4: Latitude
- Factor 5: Elevation
- Factor 6: Land and Water are Different

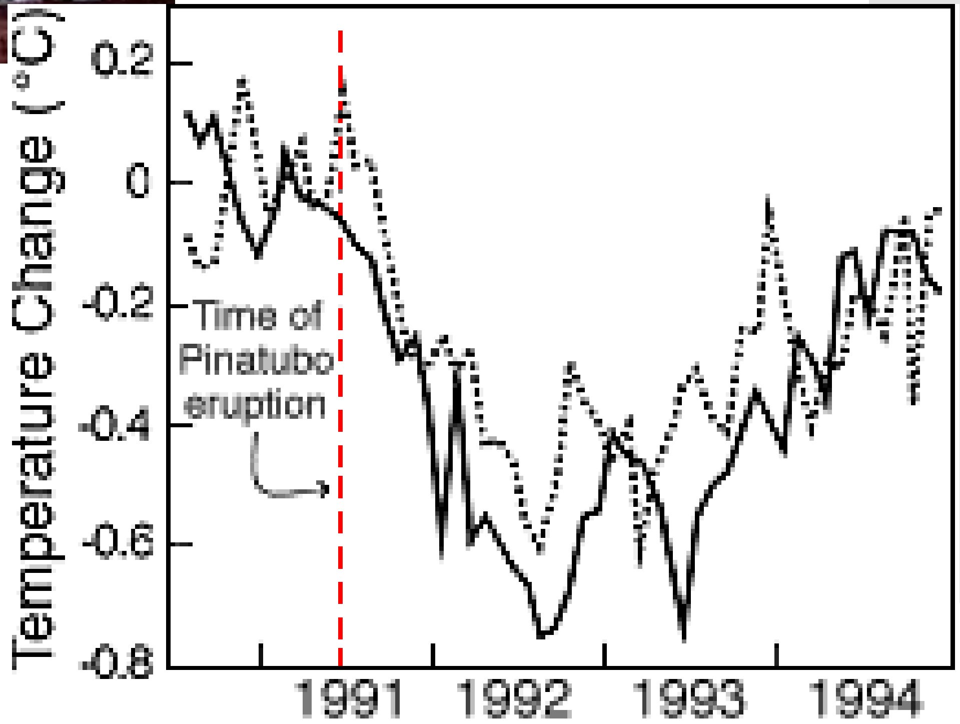
Mt Washington, NH (44N, 6288ft)
Average annual temperature: 27.3˚F

Rapid City, SD (44N, 3,202 ft)
Average annual temperature: 46.3˚F

Other Natural Factors

- Solar Variability
- Ocean Circulation
- Tectonics
- Atmospheric gases such as volcanic emissions

Source: USGS



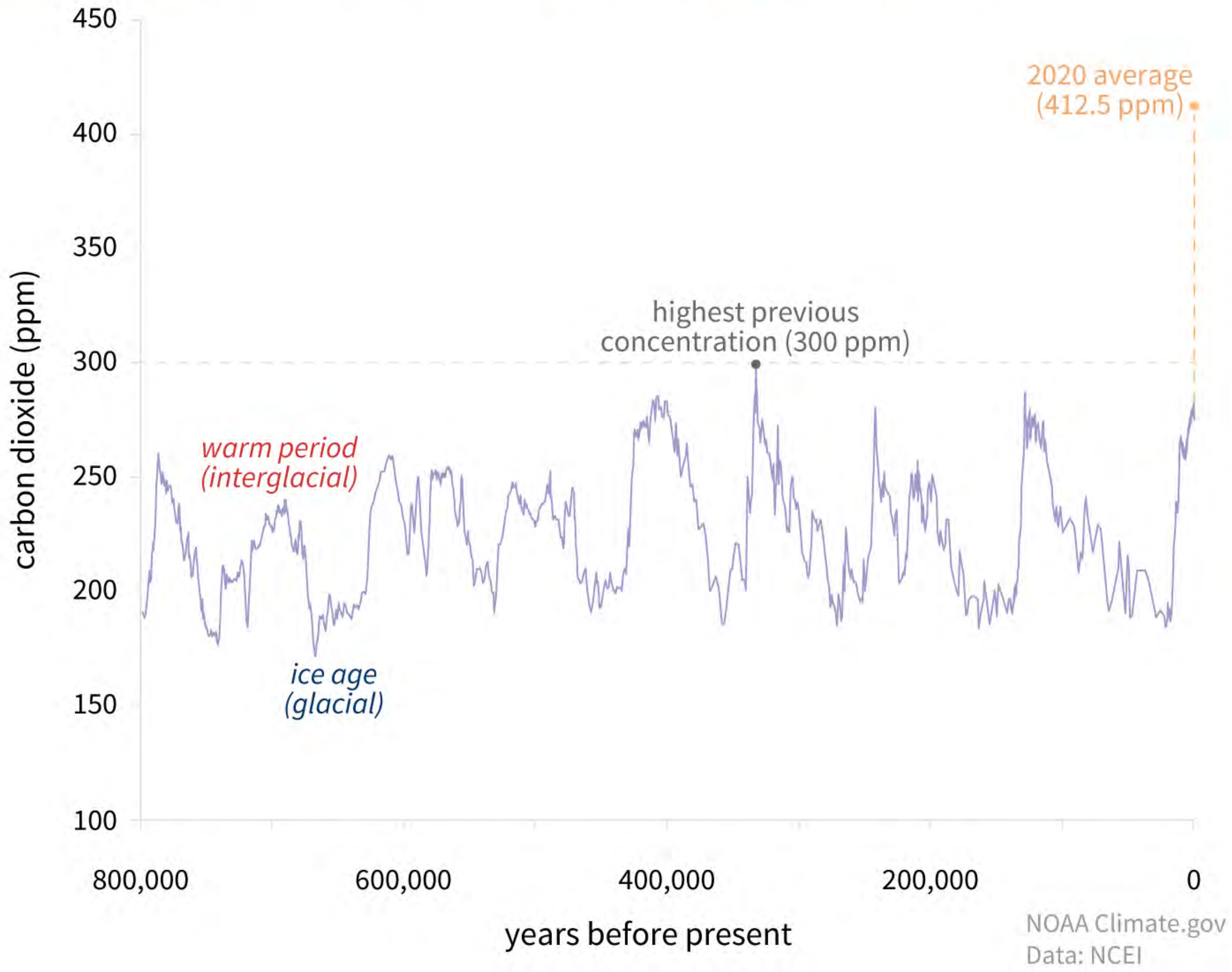
Source: NASA

Climate Change

Atmospheric Gases

- Four gases comprise about 99.998% of the atmosphere:
  - Nitrogen 78.084%
  - Oxygen 20.947%
  - Argon 0.934%
  - Carbon dioxide 0.033%
- Water vapor is present in variable amounts, near 0% to up to 4%.

CARBON DIOXIDE OVER 800,000 YEARS

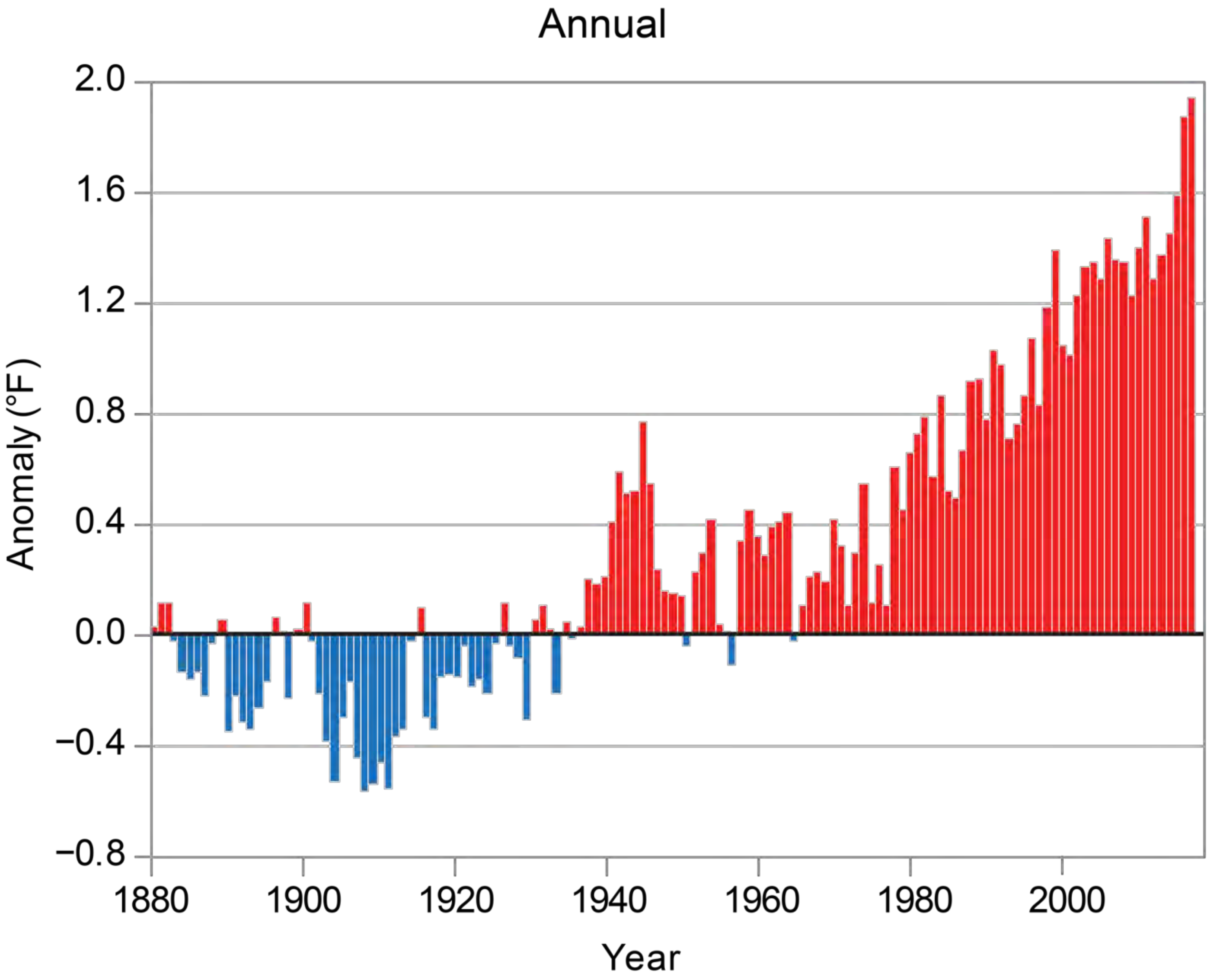


Greenhouse Gases - Lifetime in the Atmosphere

Greenhouse Gas	Average lifetime in the atmosphere	Global warming potential of one molecule of the gas over 100 years (Relative to carbon dioxide = 1)
Carbon dioxide	50-200+ years	1
Methane	12 years	21
Nitrous oxide	120 years	310
Fluorinated gases (HFCs, PFCs, SF6)	1-50,000 years	140-23,900

Source: EPA

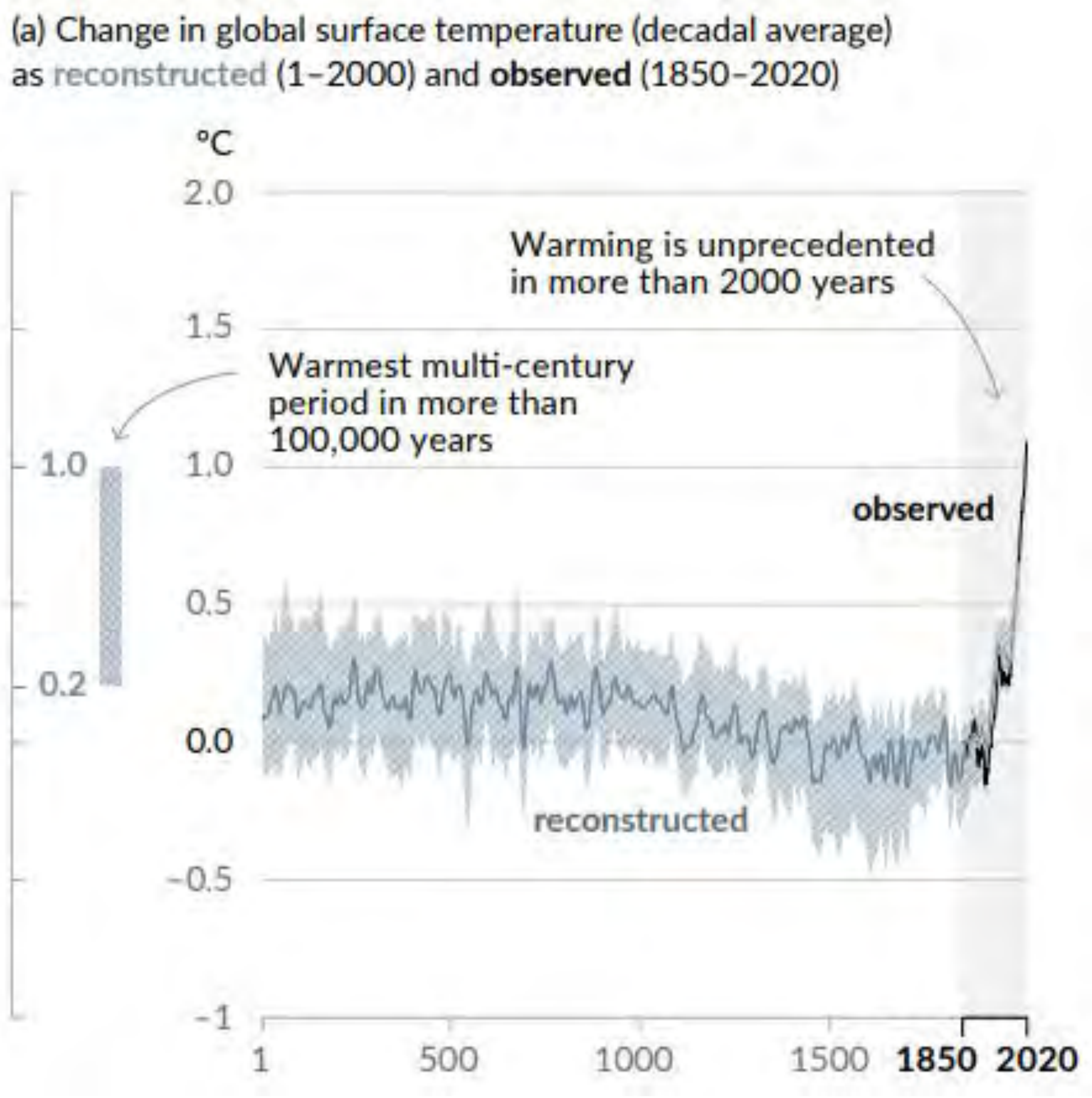
Global Land and Ocean Temperature Anomalies



Source: USGCRP Climate Science Special Report 2017

Anomaly calculation based on

1986-2016
vs.
1901-1960

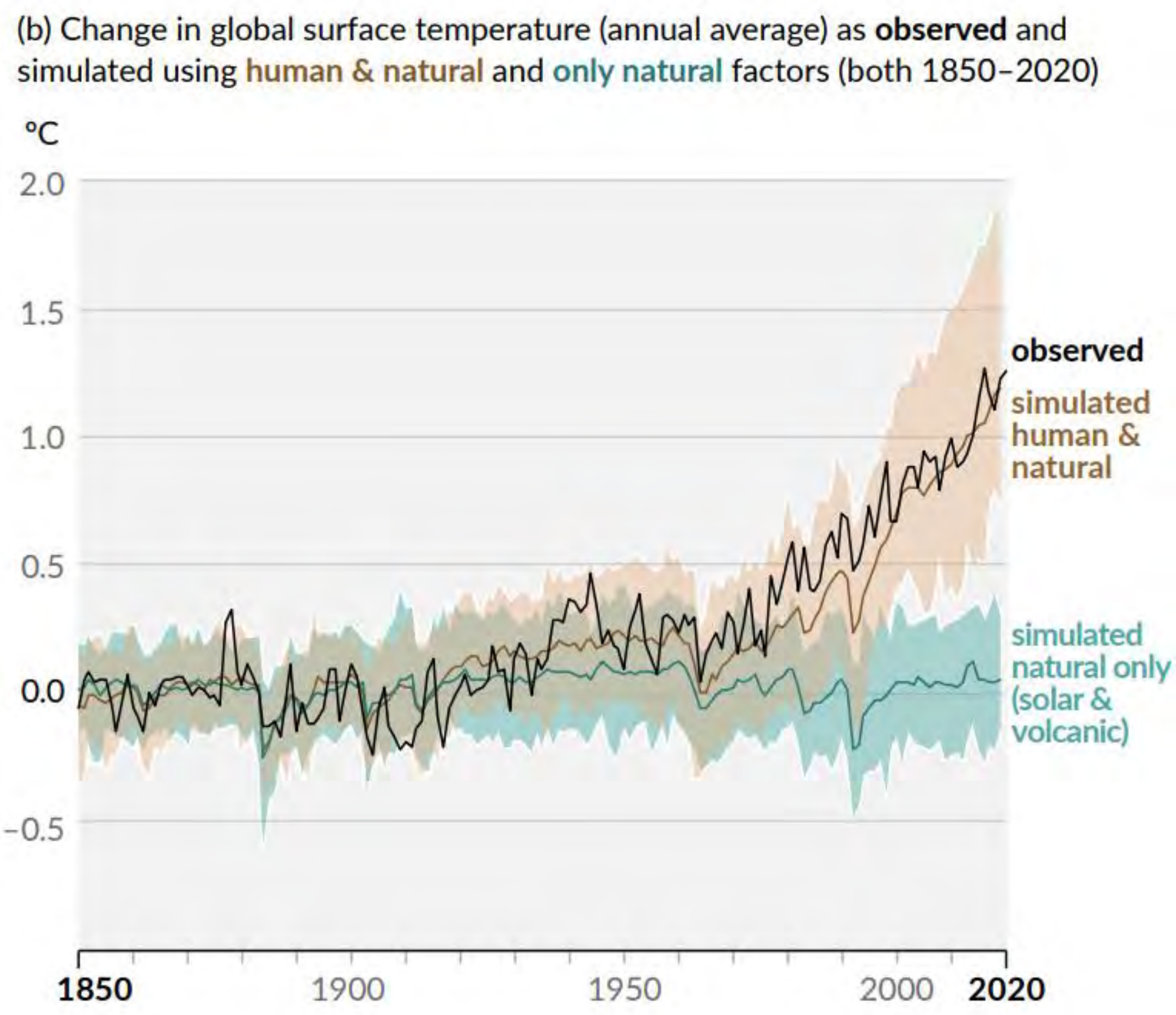


Source: Intergovernmental Panel on Climate Change 6th Assessment Report 2021

- The climate factors discussed lead to almost all the subtle variations on this chart.

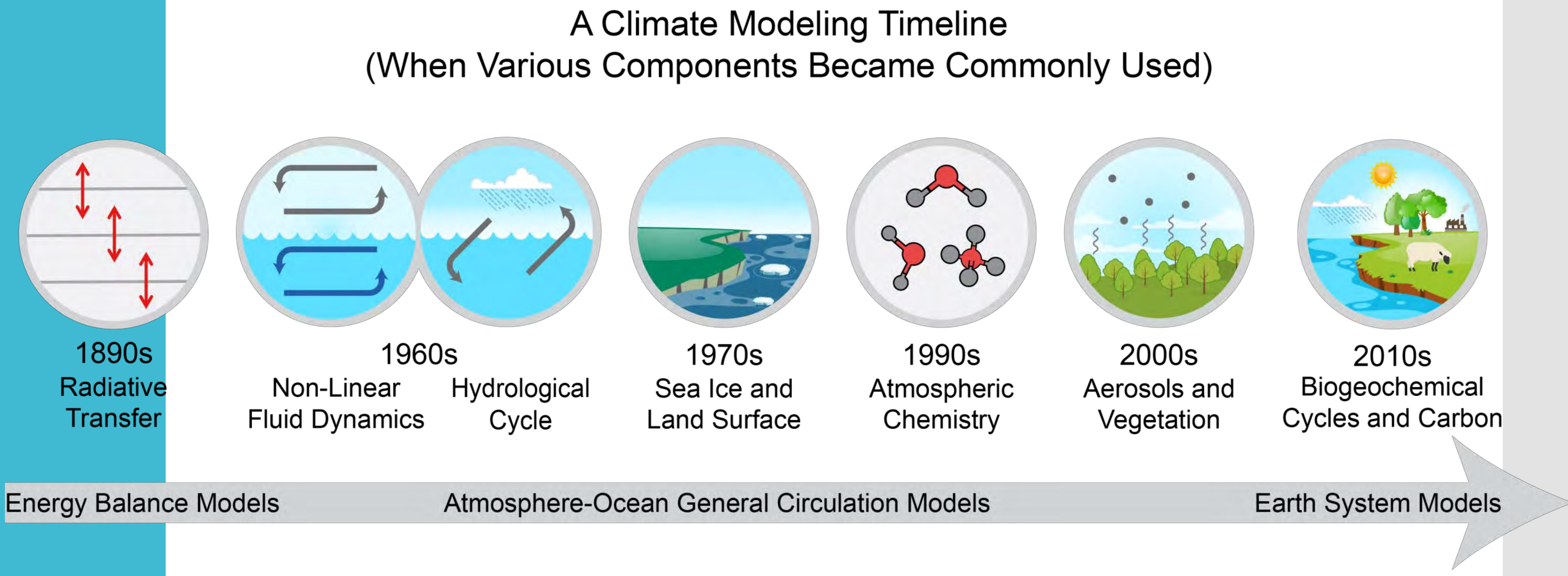
- However, the warmth over the past 60+ years is unusual compared to the prior 2000 years.

Global Surface Temperature Reconstruction



Source: Intergovernmental Panel on Climate Change 6th Assessment Report 2021

Climate models have become increasingly sophisticated



Source: USGCRP Climate Science Special Report 2017

Increased spatial resolution

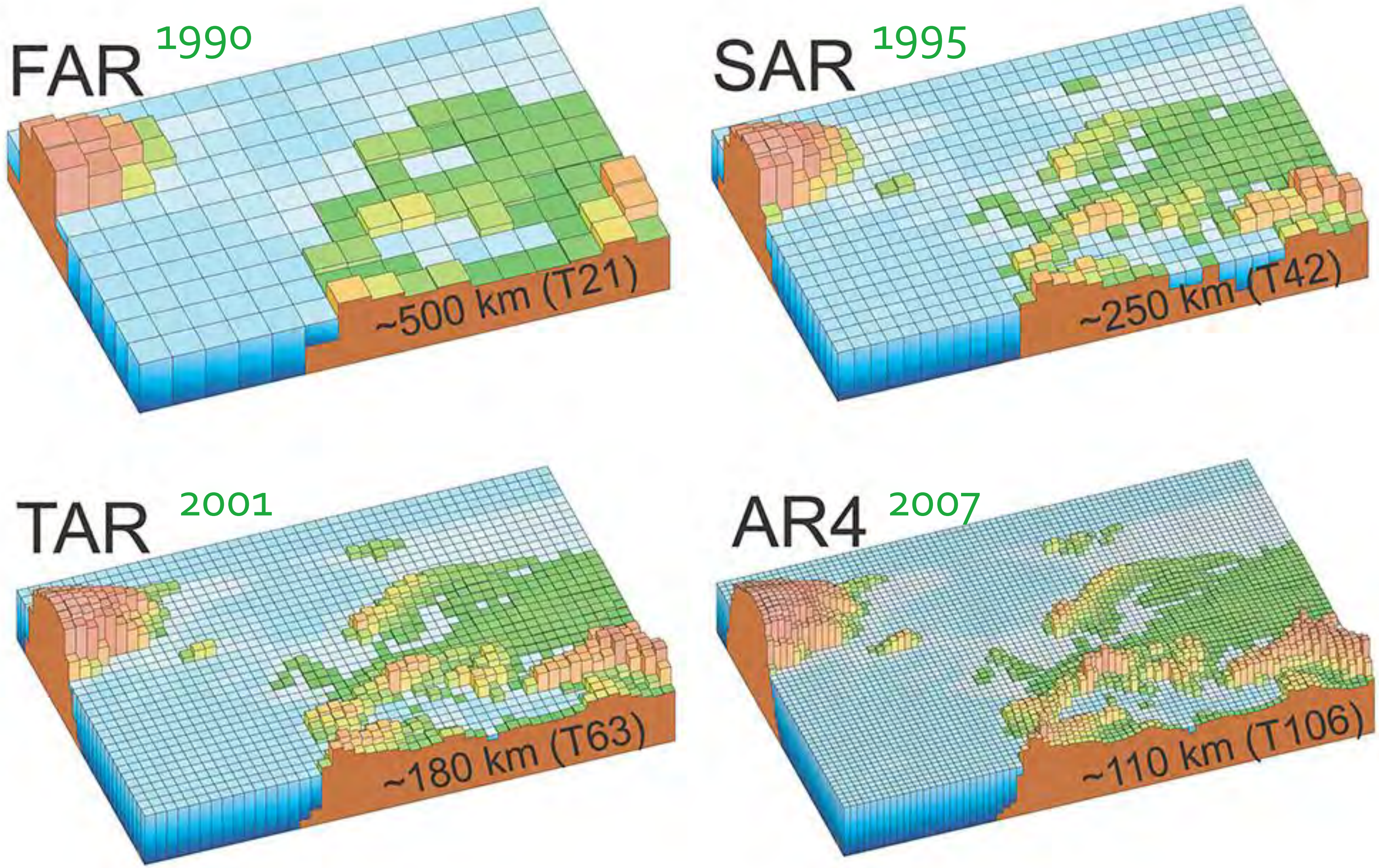
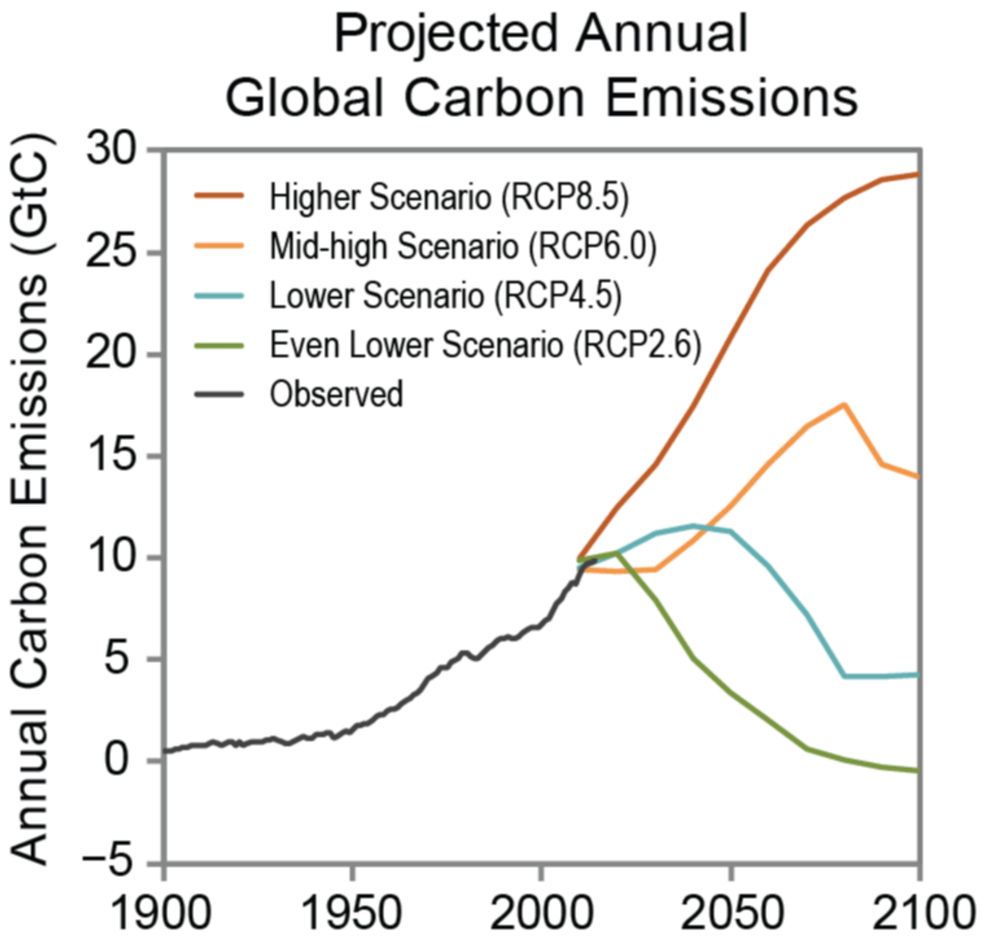
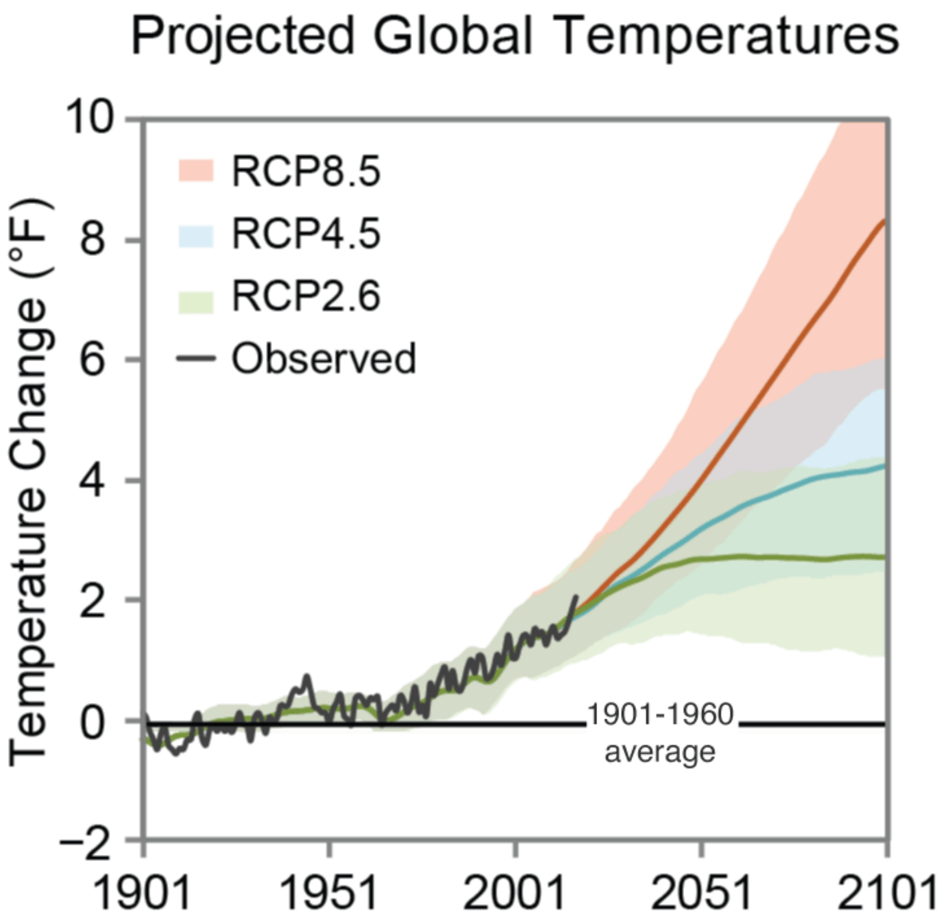


Figure Source: Intergovernmental Panel on Climate Change 4th Assessment Report

Global Climate Projections

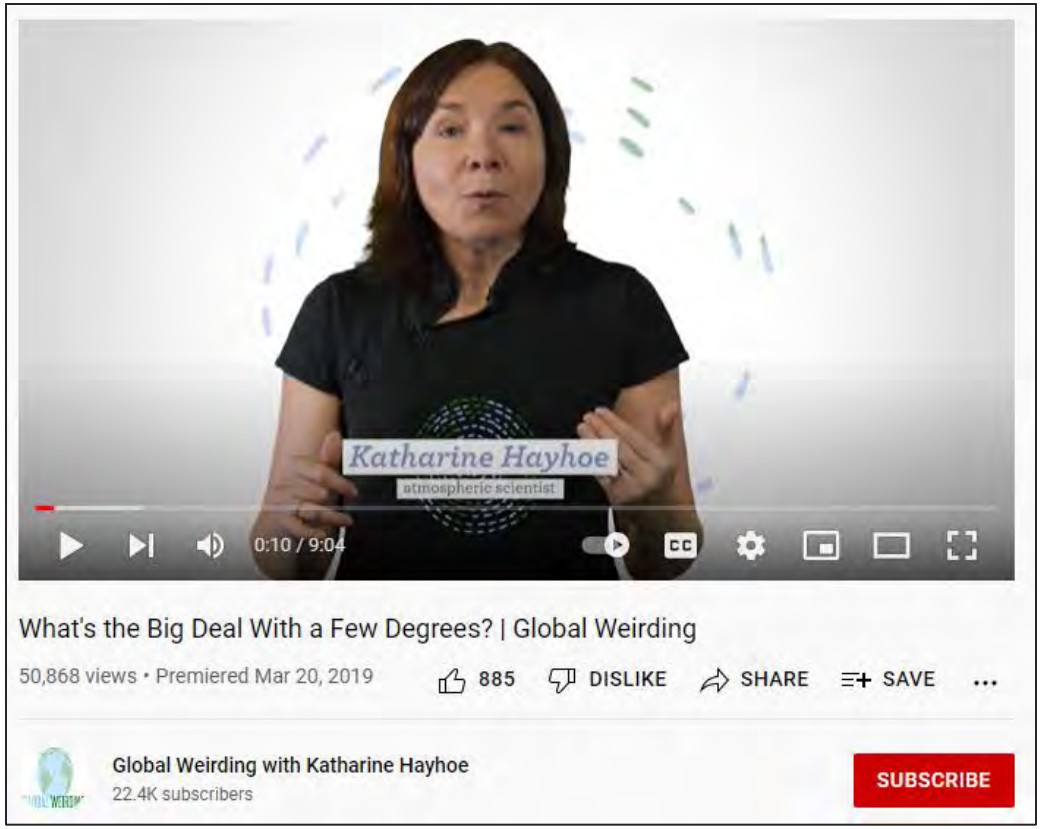




2017 Climate Science Special Report, Figure ES-3

Source: Image by Katharine Hayhoe, from U.S. Global Change Research Program 2017 Climate Science Special Report

Do a couple of degrees really matter?



- Check out “What’s the Big Deal with a Few Degrees?” by Dr. Katharine Hayhoe on YouTube.

Arctic Sea Ice is Declining

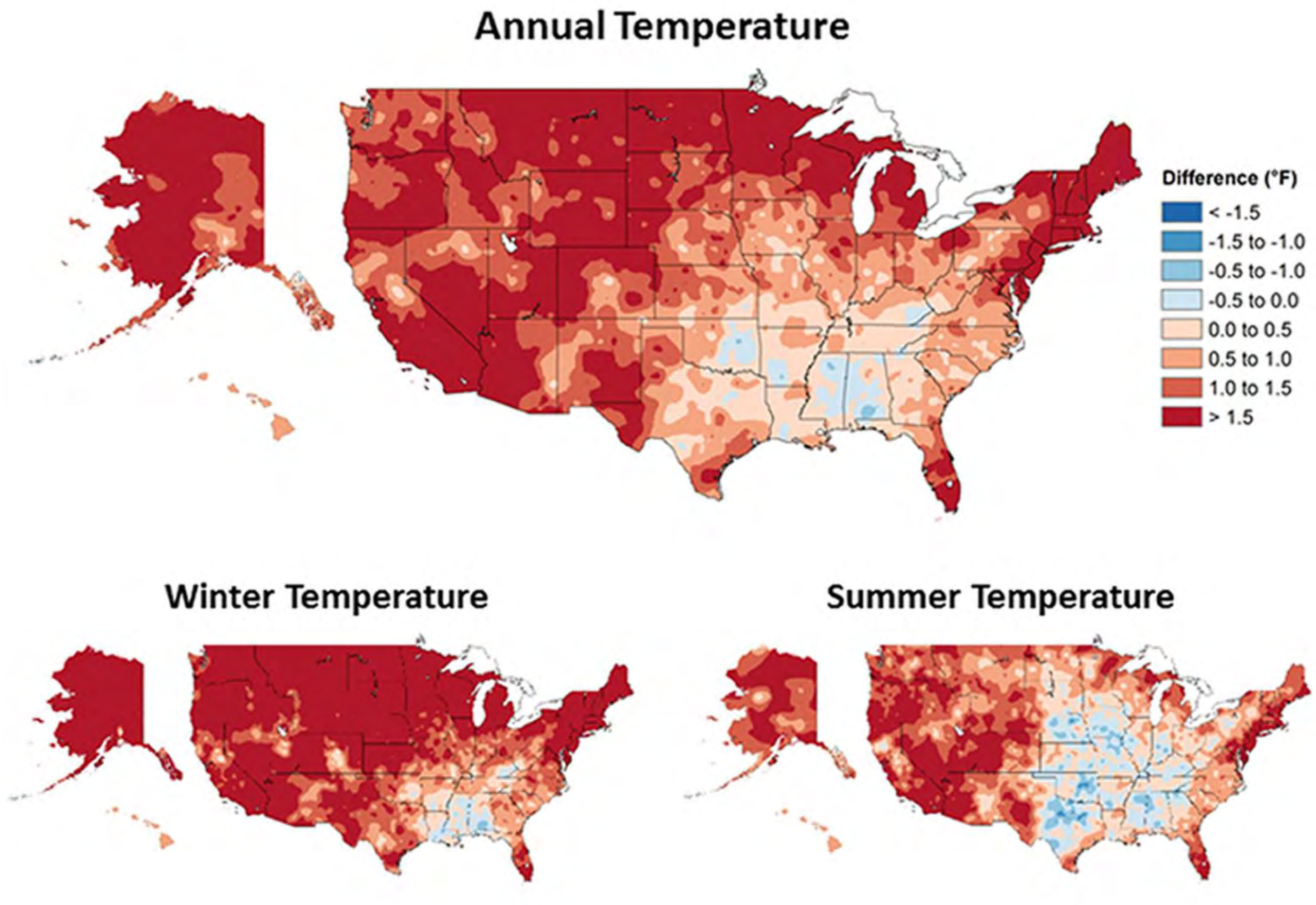
The Science is Settled

> "It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.
>
> ipcc
> INTERGOVERNMENTAL PANEL ON climate change
> WMO UNEP

Source: Intergovernmental Panel on Climate Change 6th Assessment Report 2021

United States Climate Trends & Projections

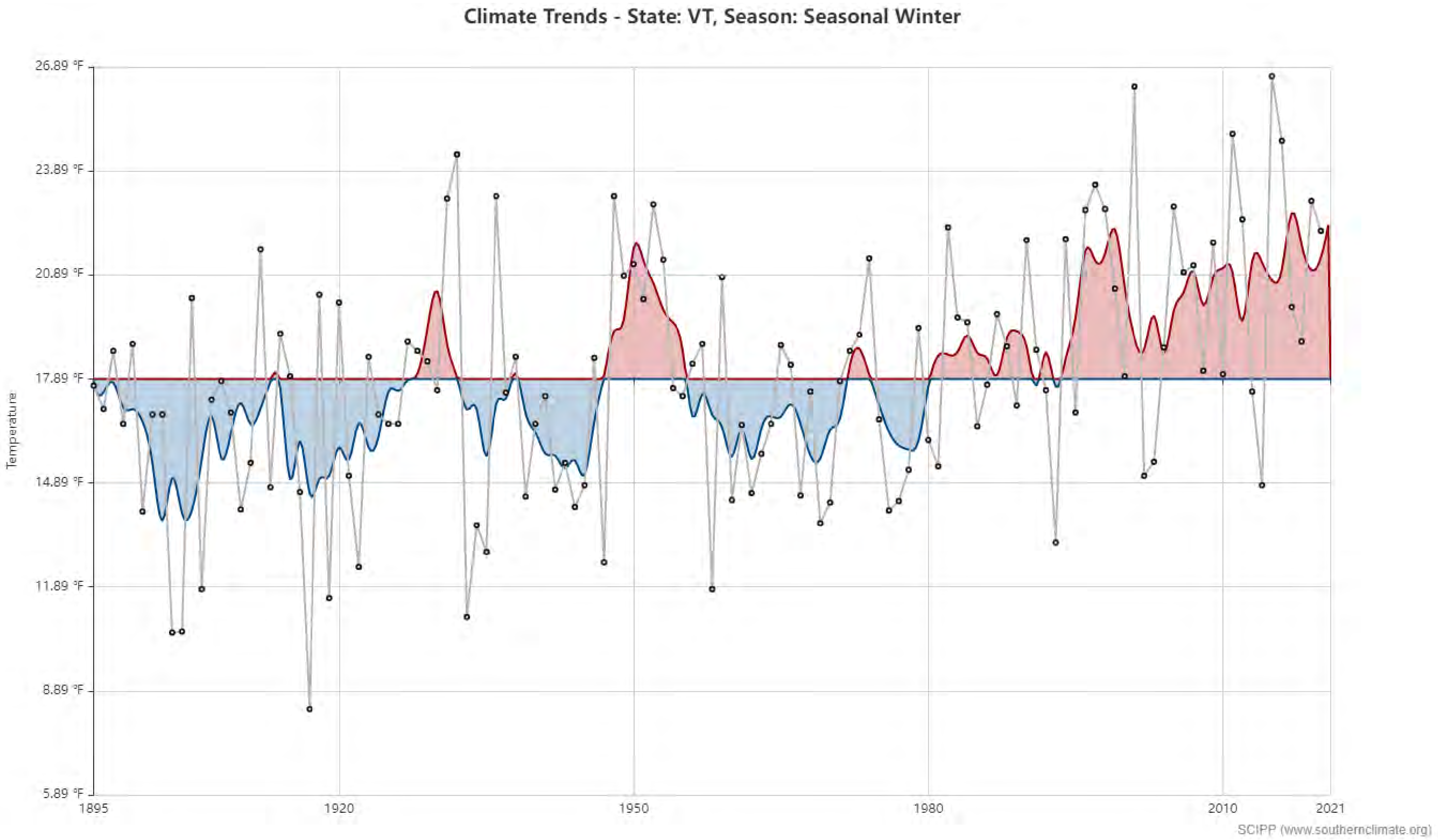
Trend: Temperature Change 1986-2016 vs. 1901-1960



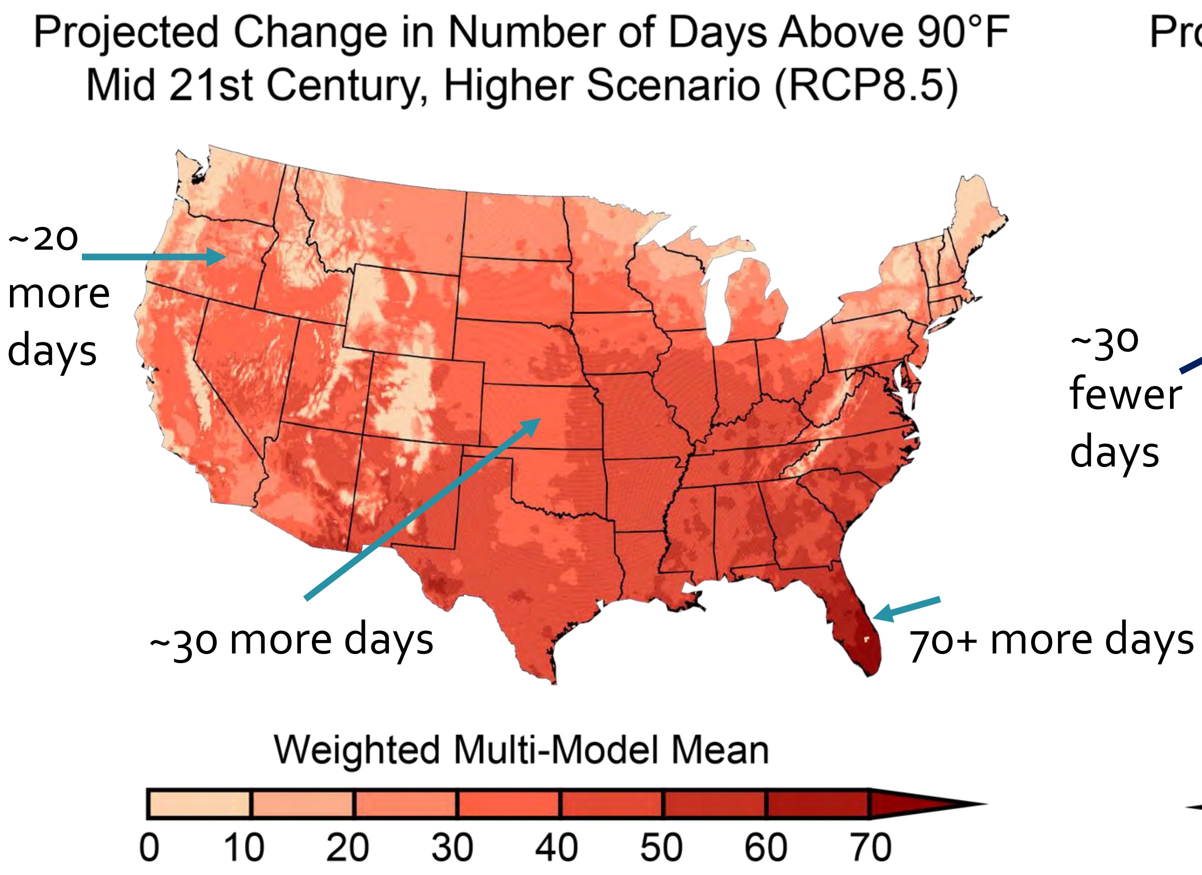
- "Warming hole" in southeast U.S. due to reforestation (Ellenburg et al. 2016).
- More warming has occurred in the winter.

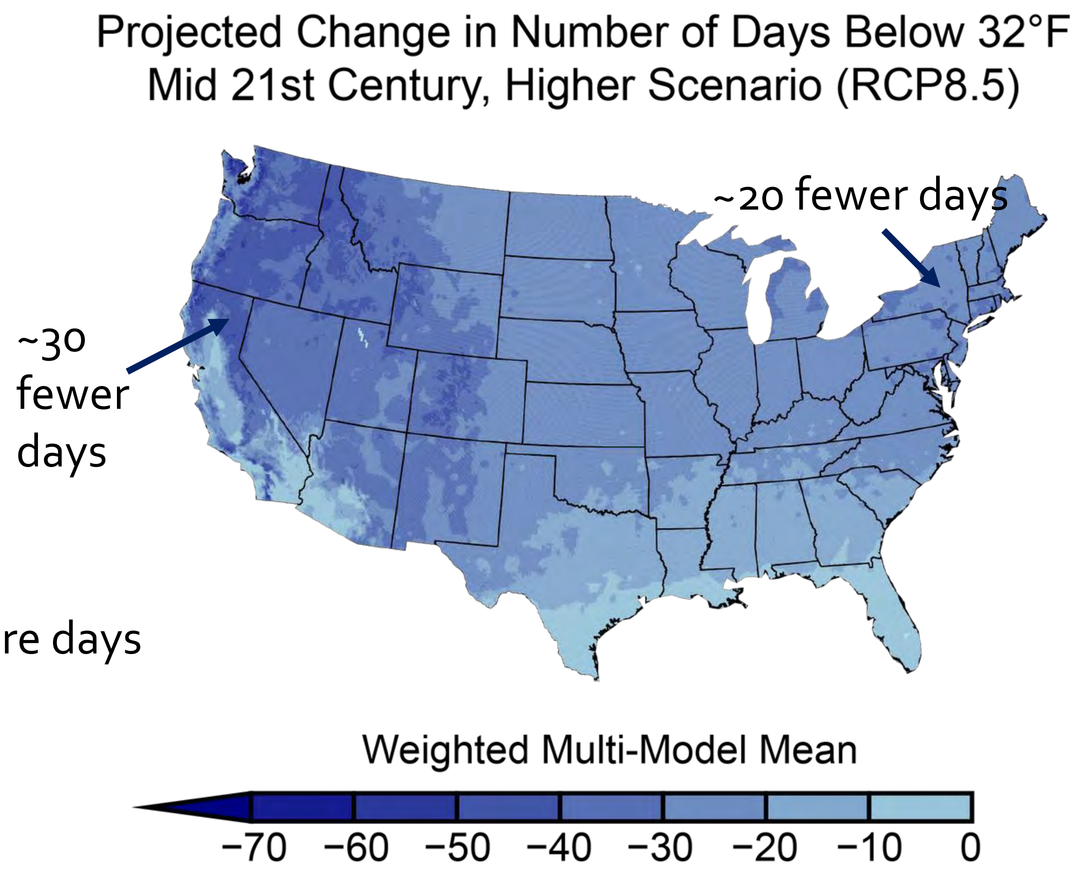
Source: USGCRP Climate Science Special Report 2017

Trend: Vermont Winter Temperature



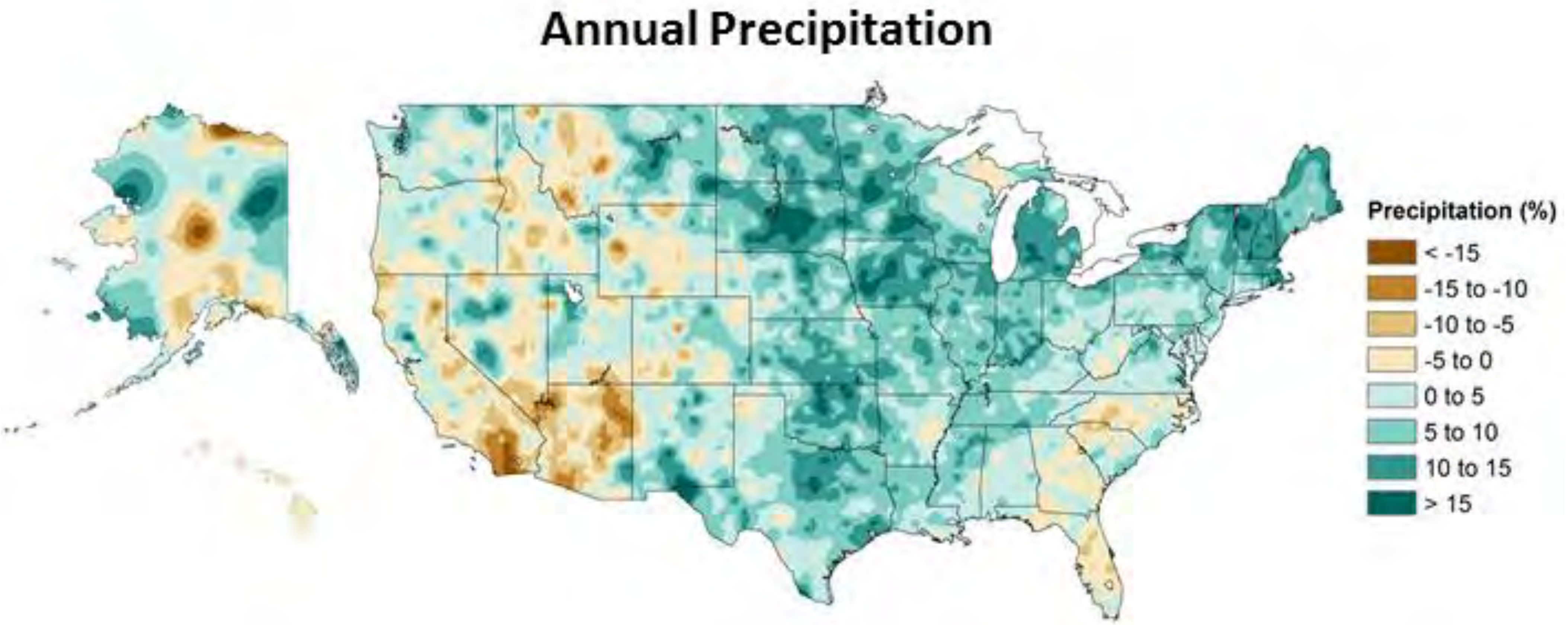
Projection: Heat and Cold





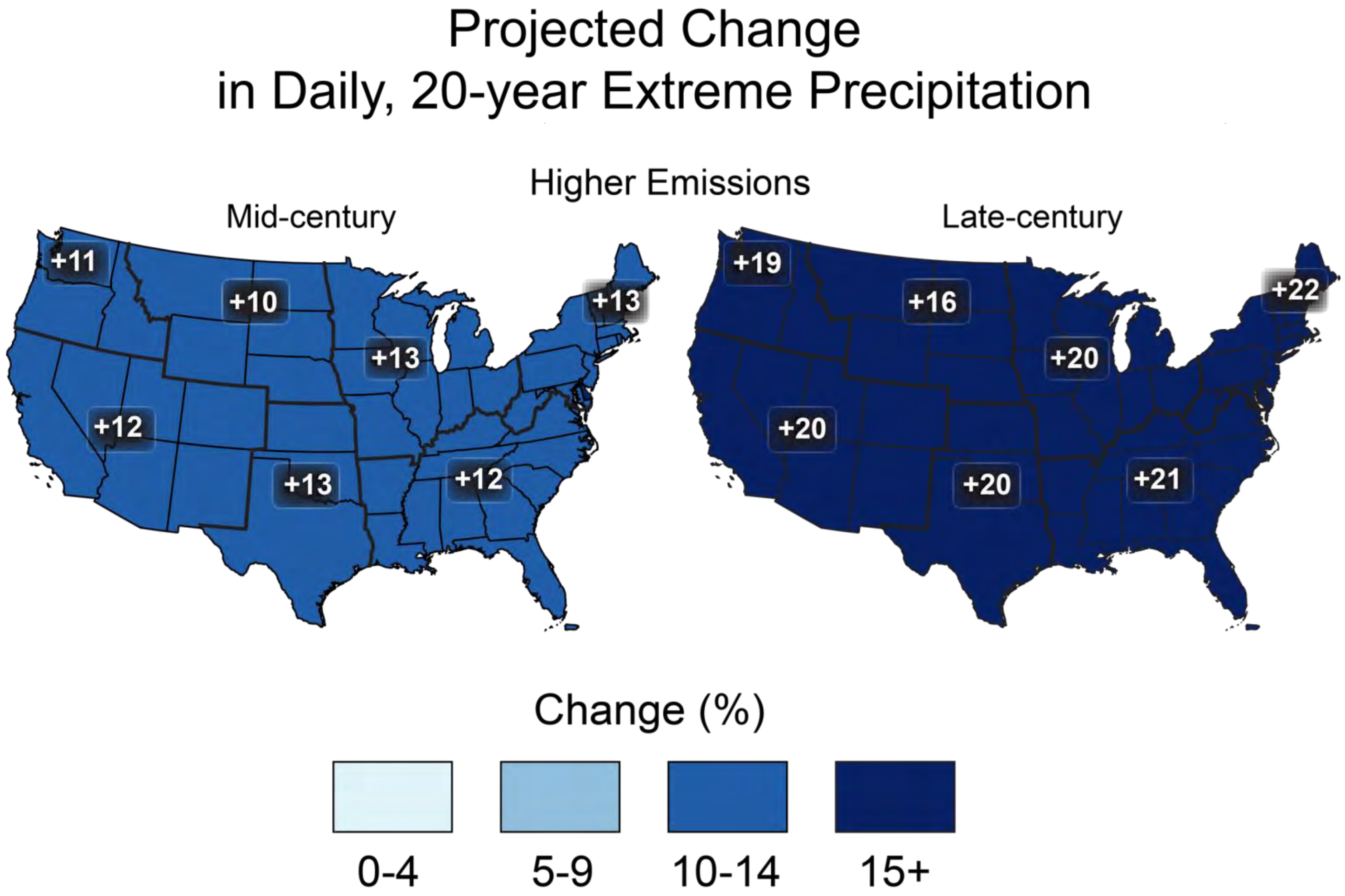
Source: USGCRP Climate Science Special Report 2017 / NOAA NCEI, CICS-NC

Trend: Precipitation, 1986-2015 vs. 1901-1960



Source: USGCRP Climate Science Special Report 2017 / Petersen et al. 2013

Projection: Precipitation



Source: USGCRP Climate Science Special Report 2017 / CICS-NC and NOAA NCEI

Current daily "20-year events" for reference:

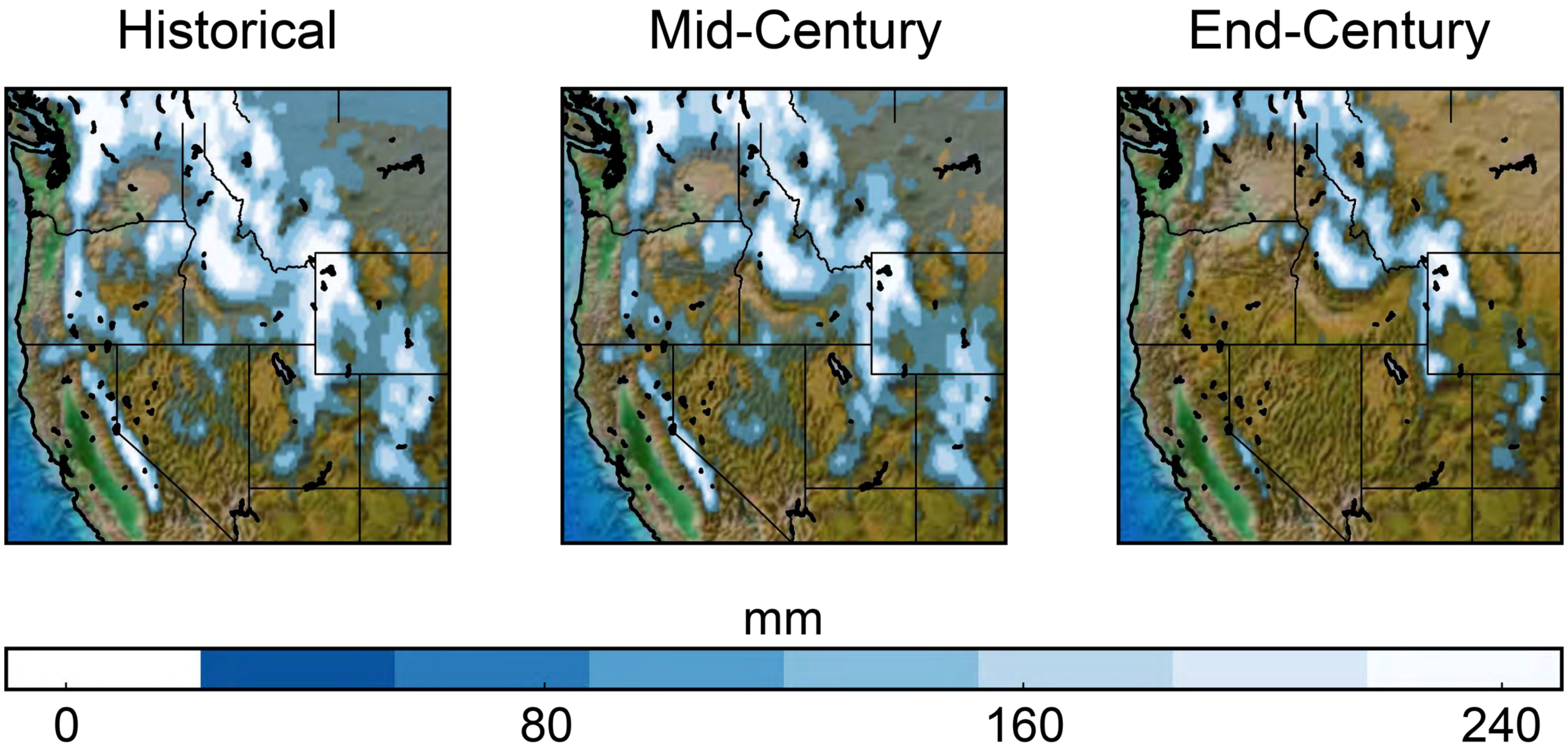
- Pittsburgh, PA: ~3.7"
- Nashville, TN: ~5.25"
- New Orleans, LA: ~10.0"
- Tucson, AZ: ~2.8"

Source: NOAA Atlas 14

Drought

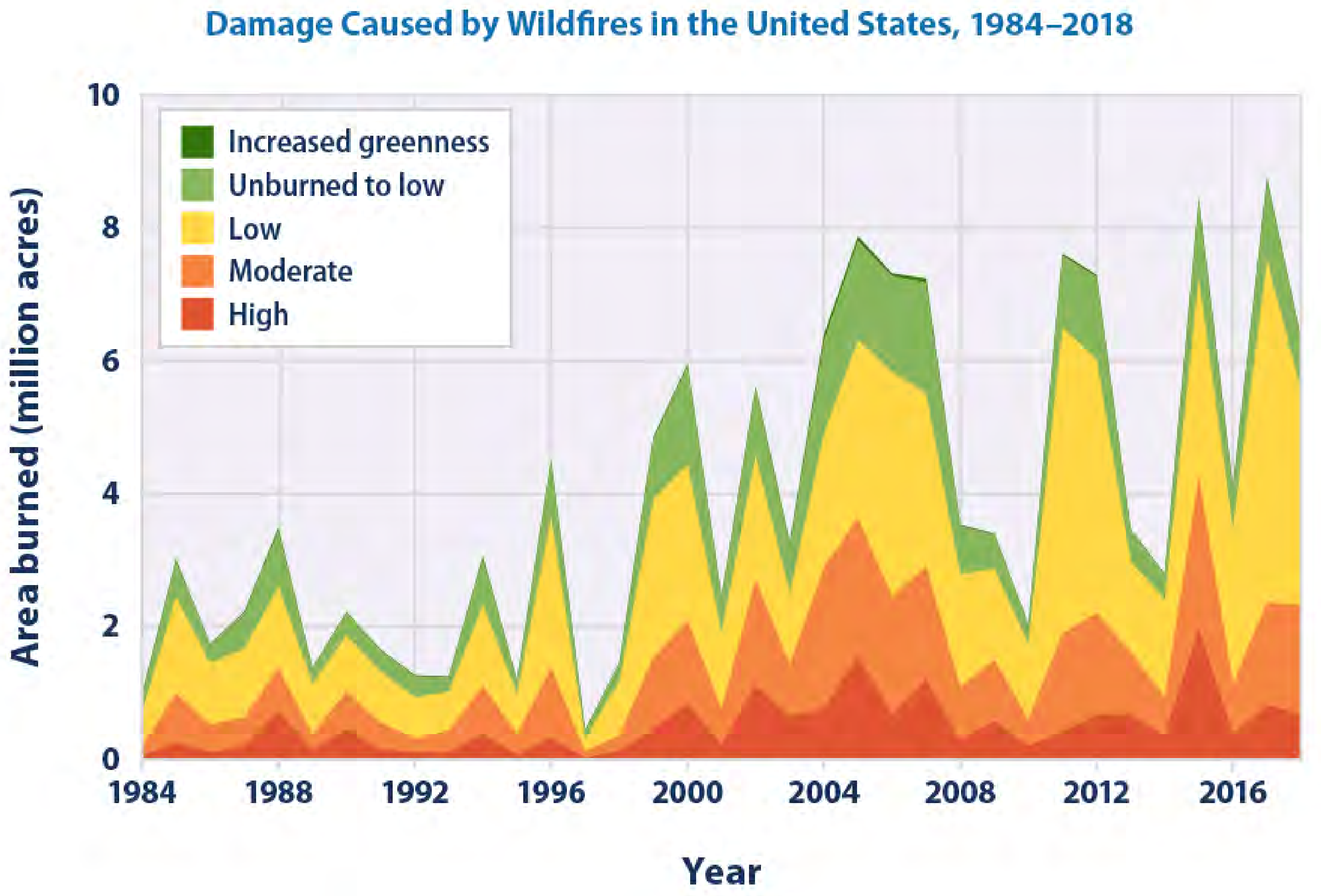
- Is a natural part our climate.
- Different kinds: Meteorological, agricultural, hydrological.
- The 1930s "Dust Bowl" era remains the drought of record for the U.S. by geographical scale and duration (Climate Science Special Report 2017).
- Climate Science Special Report (2017) Key Finding: "The human effect on recent major U.S. droughts is complicated. **Little evidence is found for a human influence on observed precipitation deficits, but much evidence is found for a human influence on surface soil moisture deficits** due to increased evapotranspiration caused by higher temperatures. (*High confidence*)"

Projection: Snow water equivalent, Western U.S.



Source: USGCRP Climate Science Special Report 2017 / H. Krishnan LBNL

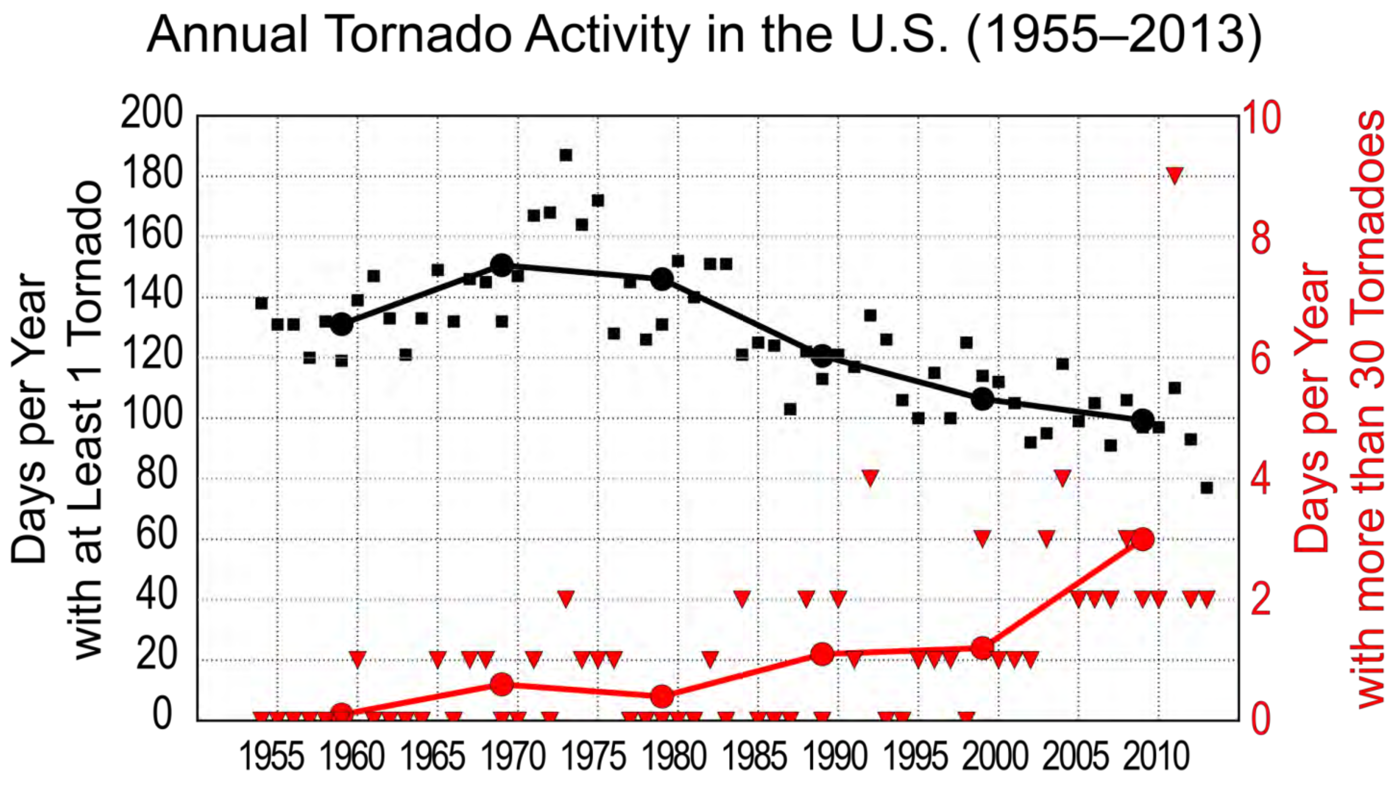
Trend: Wildfire Acres Burned (large fires)



Source: U.S. EPA / National Interagency Fire Center / USDA Forest Service

- Complex: Climate stressors + built environment + historical forest management practices.

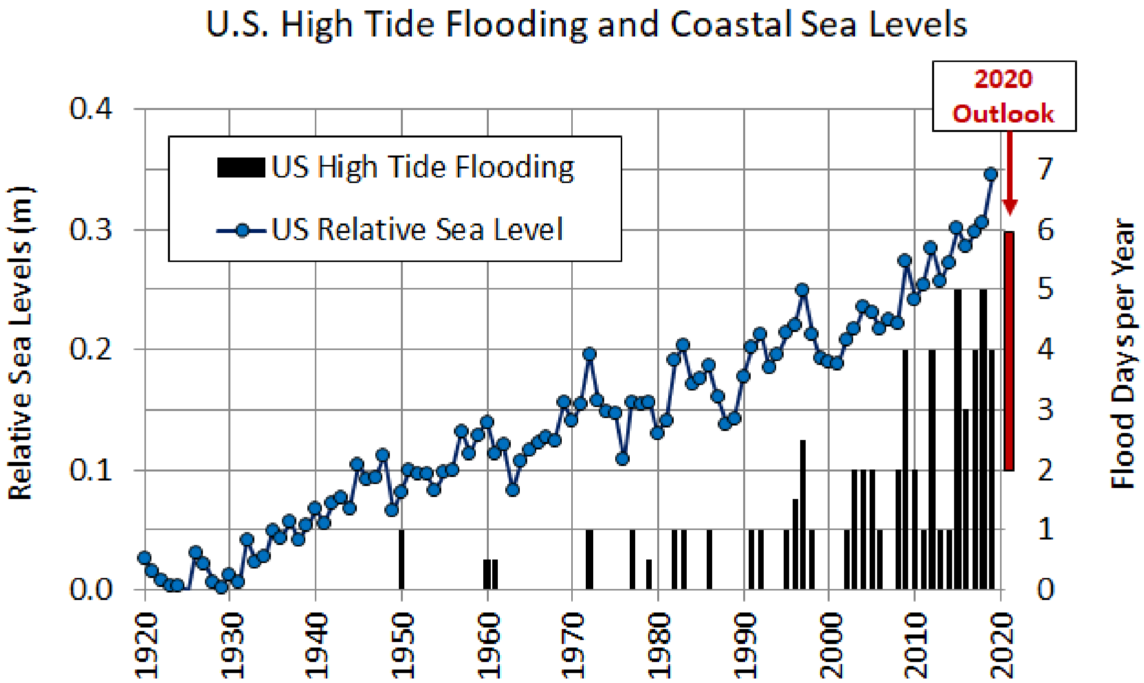
Severe Storms (tornadoes, wind, hail)



- Projection: Possibly more tornado outbreak days, but not necessarily more tornadoes overall.
- Projected increased in severity and frequency of severe thunderstorms. Low Confidence
- Increased damages due to increases in population and built environment.

Source: USGCRP Climate Science Special Report 2017 / figure redrawn from Brooks et al. 2014

Trend: High Tide Flood Days



(NOAA)

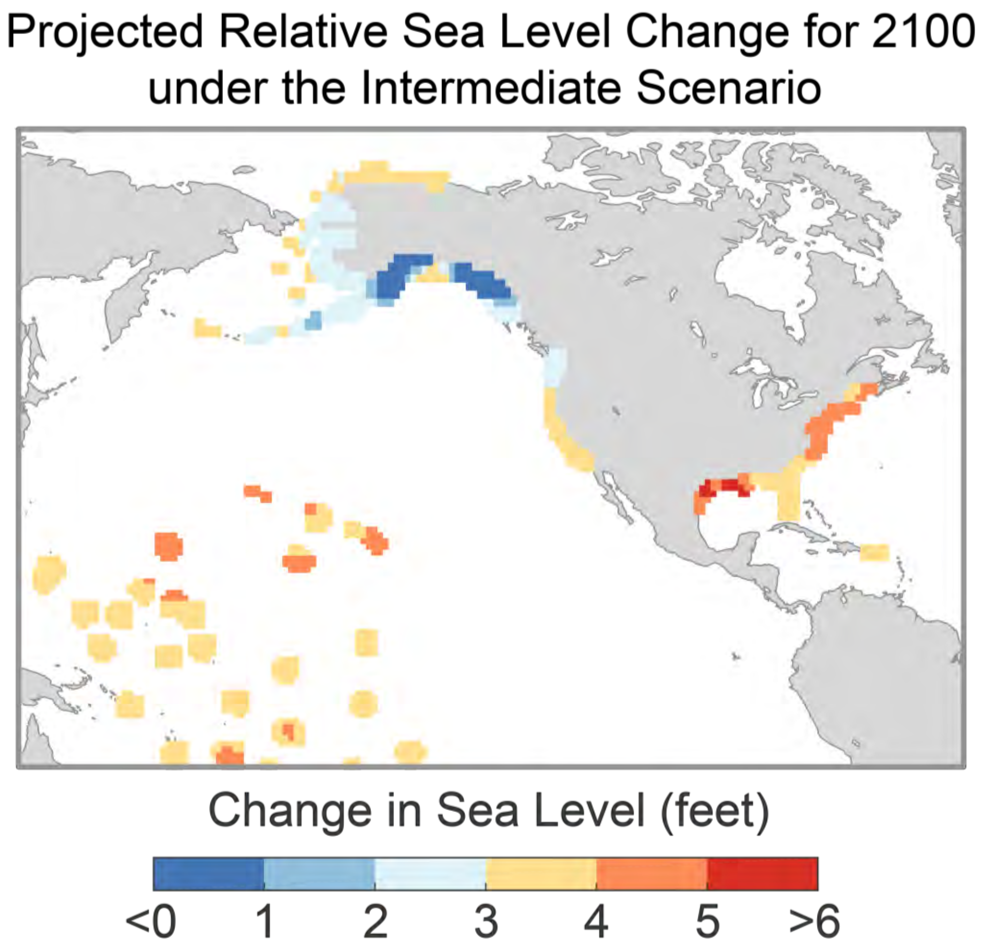
Source: Christine Burns / NC King Tides Project UNC-IMS

- Also known as “sunny day” or “nuisance” flooding.

Sea Level Rise

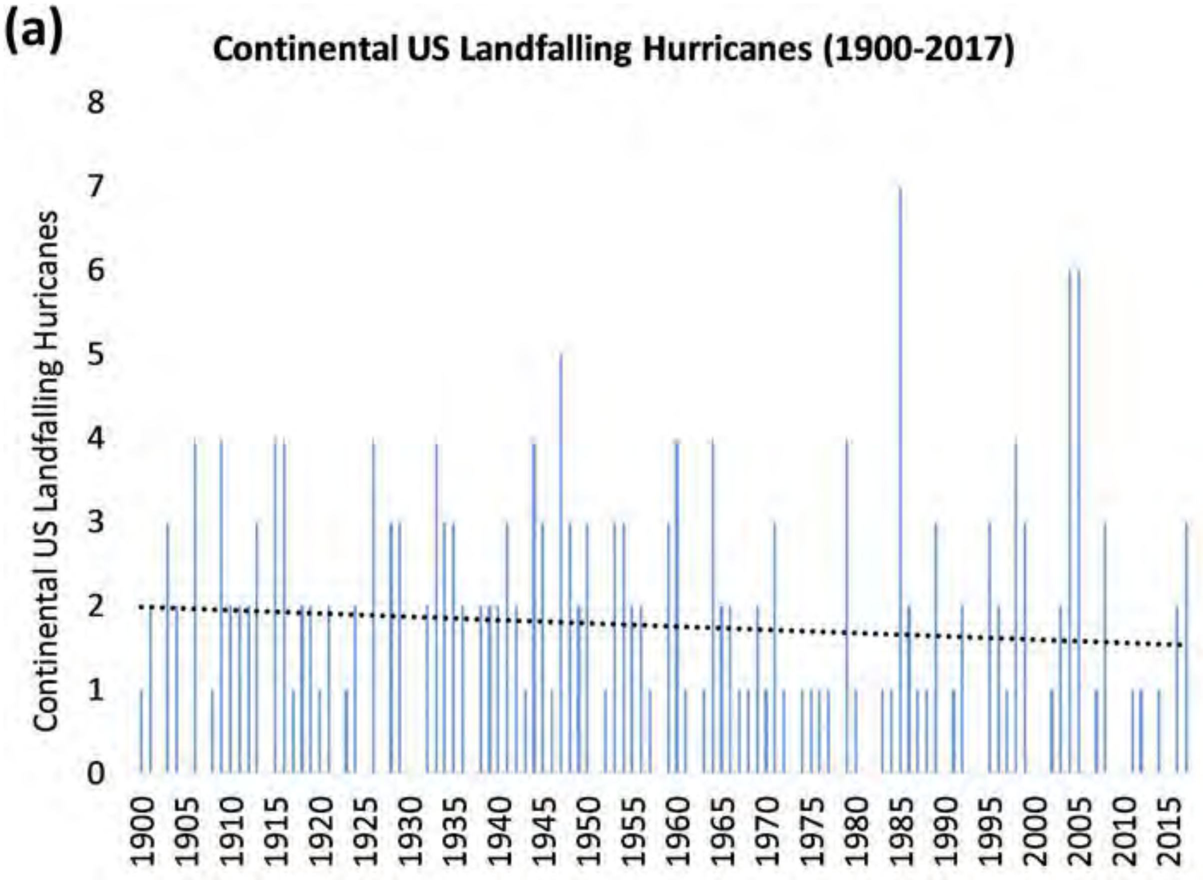
- Globally, sea level rose 4-5 inches between 1901 and 1990.
- An additional 3 inches since 1990.
- A substantial fraction of the rise is due to human-caused climate change.

(b)



Source: USGCRP Climate Science Special Report 2017

Hurricanes and Tropical Storms



Source: Klotzbach et al. 2018

- Proportion that are intense are expected to increase. *high confidence*
- Total number globally projected to decrease or stay the same globally. *medium confidence*

Source: USGCRP Climate Science Special Report 2017

What to do about it?

Climate Mitigation

Rachel Riley

Reduce greenhouse gas emissions through energy reductions and transitions to renewable energy sources.

Climate Adaptation / Hazard Mitigation

Scott Keeler/Tampa Bay Times

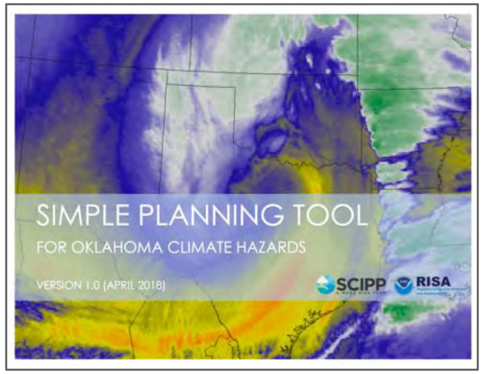
Alter planning, practices and built environment to reduce and better manage climate-related risks and impacts.

Climate and Hazard Data Resources

Simple Planning Tool for [state] Climate Hazards

- PDF documents currently available for Oklahoma & Arkansas. Soon for Texas (very soon) and Louisiana. Other states: Many of the tools included will apply to you.

www.southernclimate.org -> **DATA TOOLS tab**

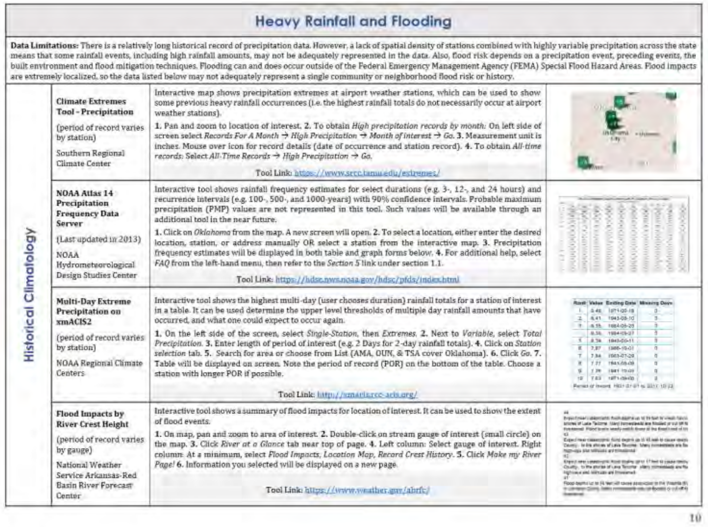


- Western U.S.: Utah version will be available soon at https://wwa.colorado.edu/

- Multiple Hazards

- Data tools are focused on historical climatologies.

- Future trend summaries by hazard and state.



Heavy Rainfall and Flooding

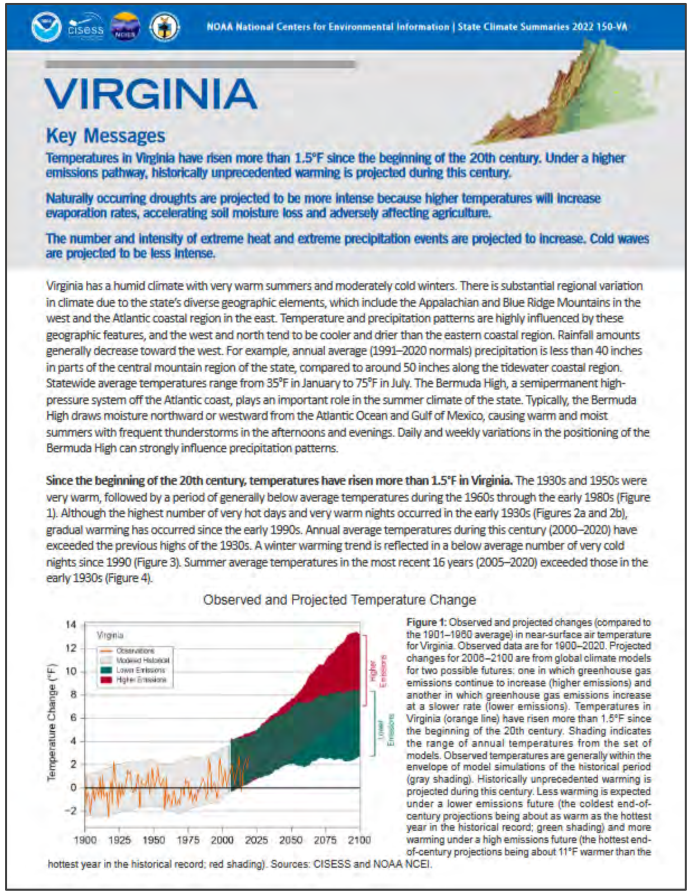
Data Limitations: There is a relatively long historical record of precipitation data. However, a lack of spatial density of stations combined with highly variable precipitation across the state means that some rainfall events, including high rainfall amounts, may not be adequately represented in the data. Also, flood risk depends on a precipitation event, preceding events, the built environment and flood mitigation techniques. Flooding can and does occur outside of the Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas. Flood impacts are extremely localized, so the data listed below may not adequately represent a single community or neighborhood flood risk or history.

Historical Climatology	**Climate Extremes Tool - Precipitation** (period of record varies by station) Southern Regional Climate Center	Interactive map shows precipitation extremes at airport weather stations, which can be used to show some previous heavy rainfall occurrences (i.e. the highest rainfall totals do not necessarily occur at airport weather stations). **1.** Pan and zoom to location of interest. **2.** To obtain *High precipitation records by month:* On left side of screen select *Records For A Month* → *High Precipitation* → *Month of interest* → *Go.* **3.** Measurement unit is inches. Mouse over icon for record details (date of occurrence and station record). **4.** To obtain *All-time records:* Select *All-Time Records* → *High Precipitation* → *Go.* Tool Link: https://www.srcc.tamu.edu/extremes/	
	NOAA Atlas 14 Precipitation Frequency Data Server (Last updated in 2013) NOAA Hydrometeorological Design Studies Center	Interactive tool shows rainfall frequency estimates for select durations (e.g. 3-, 12-, and 24 hours) and recurrence intervals (e.g. 100-, 500-, and 1000-years) with 90% confidence intervals. Probable maximum precipitation (PMP) values are not represented in this tool. Such values will be available through an additional tool in the near future. **1.** Click on *Oklahoma* from the map. A new screen will open. **2.** To select a location, either enter the desired location, station, or address manually OR select a station from the interactive map. **3.** Precipitation frequency estimates will be displayed in both table and graph forms below. **4.** For additional help, select *FAQ* from the left-hand menu, then refer to the *Section 5* link under section 1.1. Tool Link: https://hdsc.nws.noaa.gov/hdsc/pfds/index.html	
	Multi-Day Extreme Precipitation on xmACIS2 (period of record varies by station) NOAA Regional Climate Centers	Interactive tool shows the highest multi-day (user chooses duration) rainfall totals for a station of interest in a table. It can be used determine the upper level thresholds of multiple day rainfall amounts that have occurred, and what one could expect to occur again. **1.** On the left side of the screen, select *Single-Station,* then *Extremes.* **2.** Next to *Variable,* select *Total Precipitation.* **3.** Enter length of period of interest (e.g. 2 Days for 2-day rainfall totals). **4.** Click on *Station selection* tab. **5.** Search for area or choose from List (AMA, OUN, & TSA cover Oklahoma). **6.** Click *Go.* **7.** Table will be displayed on screen. Note the period of record (POR) on the bottom of the table. Choose a station with longer POR if possible. Tool Link: http://xmacis.rcc-acis.org/	
	Flood Impacts by River Crest Height (period of record varies by gauge) National Weather Service Arkansas-Red Basin River Forecast Center	Interactive tool shows a summary of flood impacts for location of interest. It can be used to show the extent of flood events. **1.** On map, pan and zoom to area of interest. **2.** Double-click on stream gauge of interest (small circle) on the map. **3.** Click *River at a Glance* tab near top of page. **4.** Left column: Select gauge of interest. Right column: At a minimum, select *Flood Impacts, Location Map, Record Crest History.* **5.** Click *Make my River Page!* **6.** Information you selected will be displayed on a new page. Tool Link: https://www.weather.gov/abrfc/	

10

State Climate Summaries

- http://stateclimatesummaries.globalchange.gov
- Or search for "NC CICS climate summaries"
- PDF and interactive web version
- Short narratives (5 pages) but do not provide information about all hazards.



NOAA National Centers for Environmental Information | State Climate Summaries 2022 150-VA

VIRGINIA

Key Messages

Temperatures in Virginia have risen more than 1.5°F since the beginning of the 20th century. Under a higher emissions pathway, historically unprecedented warming is projected during this century.

Naturally occurring droughts are projected to be more intense because higher temperatures will increase evaporation rates, accelerating soil moisture loss and adversely affecting agriculture.

The number and intensity of extreme heat and extreme precipitation events are projected to increase. Cold waves are projected to be less intense.

Virginia has a humid climate with very warm summers and moderately cold winters. There is substantial regional variation in climate due to the state's diverse geographic elements, which include the Appalachian and Blue Ridge Mountains in the west and the Atlantic coastal region in the east. Temperature and precipitation patterns are highly influenced by these geographic features, and the west and north tend to be cooler and drier than the eastern coastal region. Rainfall amounts generally decrease toward the west. For example, annual average (1991–2020 normals) precipitation is less than 40 inches in parts of the central mountain region of the state, compared to around 50 inches along the tidewater coastal region. Statewide average temperatures range from 35°F in January to 75°F in July. The Bermuda High, a semipermanent high-pressure system off the Atlantic coast, plays an important role in the summer climate of the state. Typically, the Bermuda High draws moisture northward or westward from the Atlantic Ocean and Gulf of Mexico, causing warm and moist summers with frequent thunderstorms in the afternoons and evenings. Daily and weekly variations in the positioning of the Bermuda High can strongly influence precipitation patterns.

Since the beginning of the 20th century, temperatures have risen more than 1.5°F in Virginia. The 1930s and 1950s were very warm, followed by a period of generally below average temperatures during the 1960s through the early 1980s (Figure 1). Although the highest number of very hot days and very warm nights occurred in the early 1930s (Figures 2a and 2b), gradual warming has occurred since the early 1990s. Annual average temperatures during this century (2000–2020) have exceeded the previous highs of the 1930s. A winter warming trend is reflected in a below average number of very cold nights since 1990 (Figure 3). Summer average temperatures in the most recent 16 years (2005–2020) exceeded those in the early 1930s (Figure 4).

Observed and Projected Temperature Change

Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for Virginia. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in Virginia (orange line) have risen more than 1.5°F since the beginning of the 20th century. Shading indicates the range of annual temperatures from the set of models. Observed temperatures are generally within the envelope of model simulations of the historical period (gray shading). Historically unprecedented warming is projected during this century. Less warming is expected under a lower emissions future (the coldest end-of-century projections being about as warm as the hottest year in the historical record; green shading) and more warming under a high emissions future (the hottest end-of-century projections being about 11°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.

National Reports

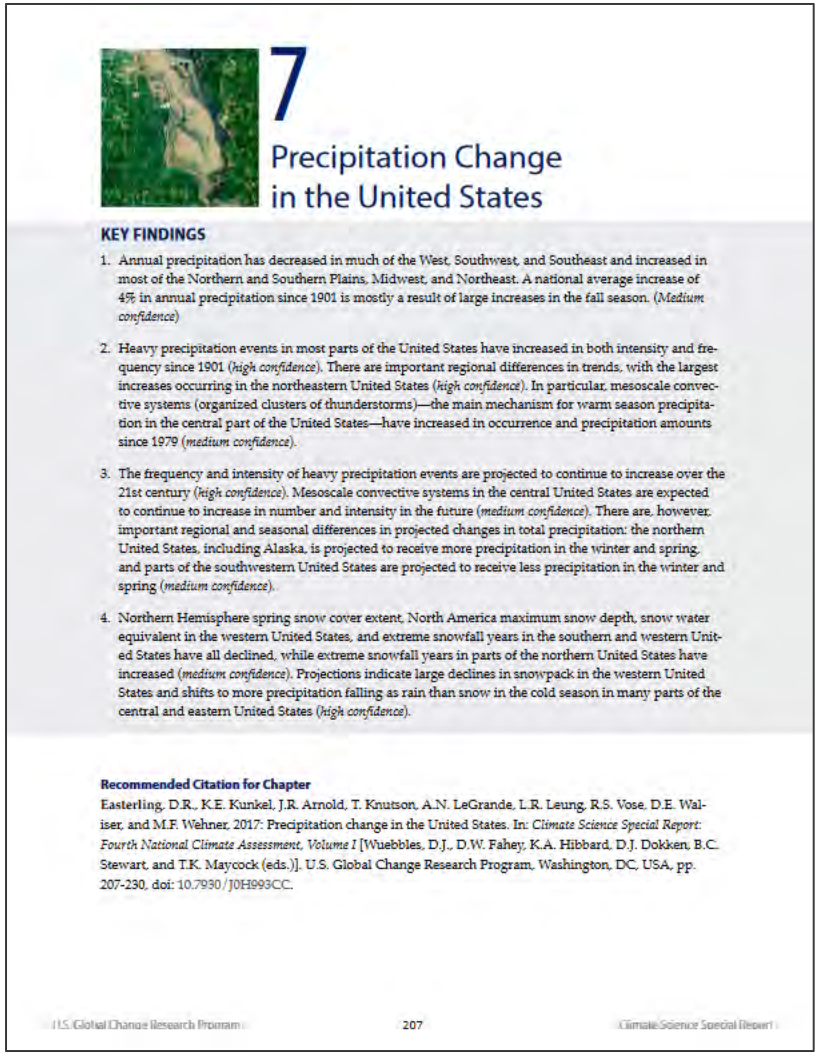
- **4^{th} NCA Vol. I Climate Science Special Report (2017)** - authoritative assessment of the science of climate change, U.S. focus.

https://science2017.globalchange.gov/

- **4^{th} National Climate Assessment Vol. II (2018)** – impacts, risks, and adaptation

https://nca2018.globalchange.gov/

- PDFs and interactive web versions
- Lots of narratives and graphics but may be overwhelming.
- May not always provide the geographic specificity you need.



7

Precipitation Change in the United States

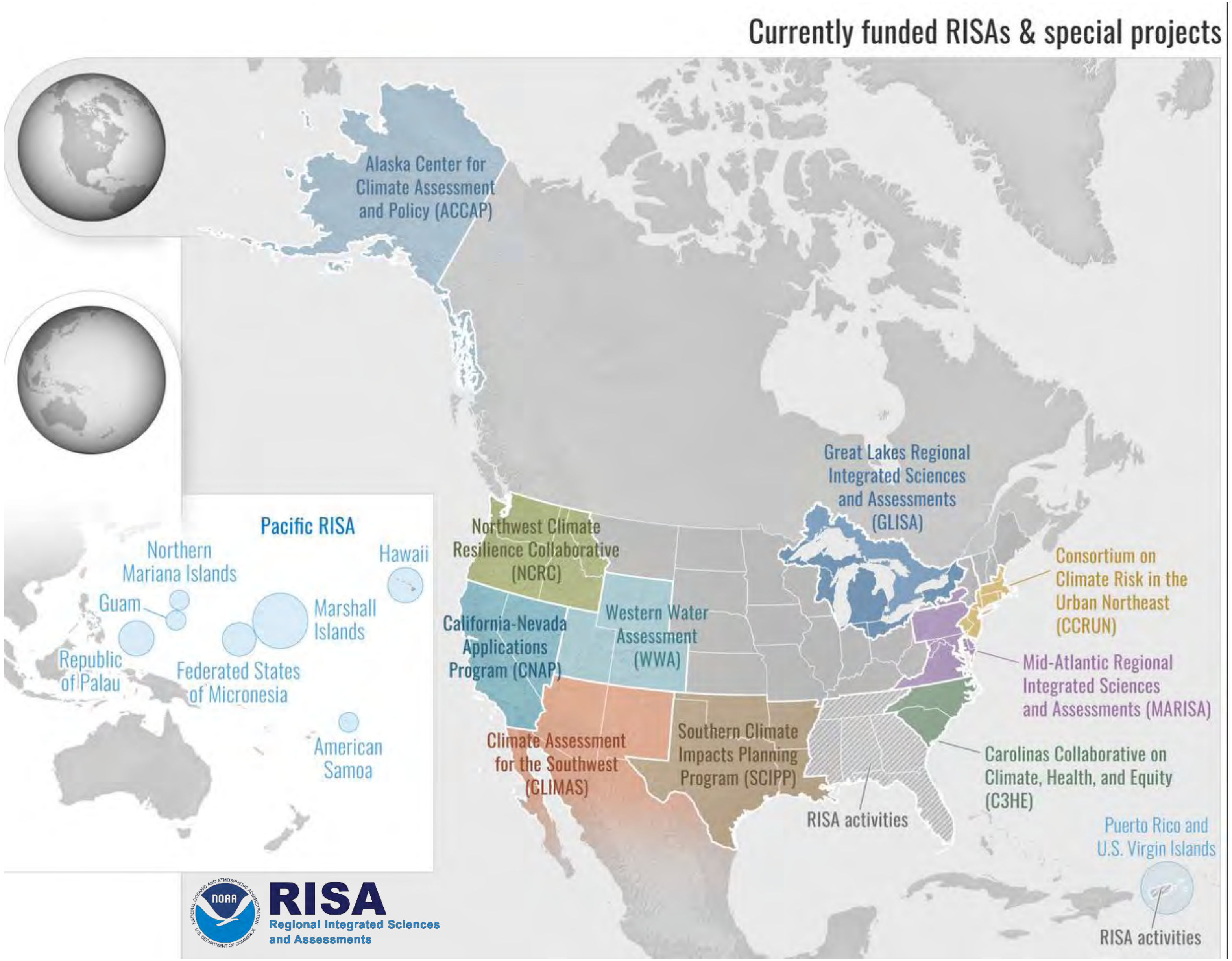
KEY FINDINGS

1. Annual precipitation has decreased in much of the West, Southwest, and Southeast and increased in most of the Northern and Southern Plains, Midwest, and Northeast. A national average increase of 4% in annual precipitation since 1901 is mostly a result of large increases in the fall season. (*Medium confidence*)
2. Heavy precipitation events in most parts of the United States have increased in both intensity and frequency since 1901 (*high confidence*). There are important regional differences in trends, with the largest increases occurring in the northeastern United States (*high confidence*). In particular, mesoscale convective systems (organized clusters of thunderstorms)—the main mechanism for warm season precipitation in the central part of the United States—have increased in occurrence and precipitation amounts since 1979 (*medium confidence*).
3. The frequency and intensity of heavy precipitation events are projected to continue to increase over the 21st century (*high confidence*). Mesoscale convective systems in the central United States are expected to continue to increase in number and intensity in the future (*medium confidence*). There are, however, important regional and seasonal differences in projected changes in total precipitation: the northern United States, including Alaska, is projected to receive more precipitation in the winter and spring, and parts of the southwestern United States are projected to receive less precipitation in the winter and spring (*medium confidence*).
4. Northern Hemisphere spring snow cover extent, North America maximum snow depth, snow water equivalent in the western United States, and extreme snowfall years in the southern and western United States have all declined, while extreme snowfall years in parts of the northern United States have increased (*medium confidence*). Projections indicate large declines in snowpack in the western United States and shifts to more precipitation falling as rain than snow in the cold season in many parts of the central and eastern United States (*high confidence*).

Recommended Citation for Chapter

Easterling, D.R., K.E. Kunkel, J.R. Arnold, T. Knutson, A.N. LeGrande, L.R. Leung, R.S. Vose, D.E. Waliser, and M.F. Wehner, 2017: Precipitation change in the United States. In: *Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 207-230, doi: 10.7930/J0H993CC.

Other NOAA RISA Teams



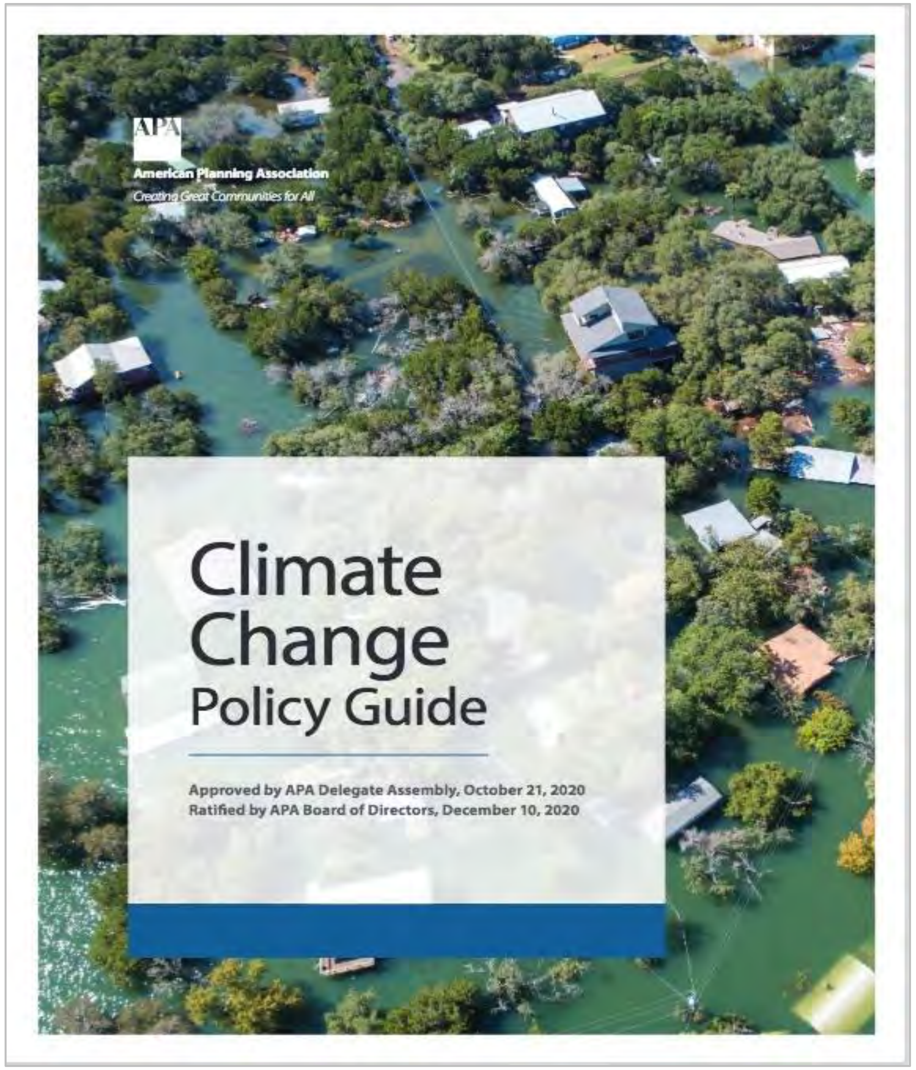
Thank You.

Rachel Riley
Director, Southern Climate Impacts Planning Program
University of Oklahoma
rriley@ou.edu

APA & Planning Resources

APA CLIMATE CHANGE POLICY GUIDE

- Replaces the 2008 Policy Guide on Planning and Climate
- Represents APA's official position on critical planning issues
- Organized by the six APA Sustainability Comprehensive Plan Standards categories:
  - Livable Built Environment
  - Harmony with Nature
  - Resilient Economy
  - Interwoven Equity
  - Healthy Communities
  - Responsible Regionalism
- Separate category focused on needed federal and state policies



DATA COLLECTION PROCESS GUIDE

- A guide for municipalities in documenting energy and climate existing conditions and creating indicators for measuring success relative to their goals

Sector
All Data Collection
Buildings
Renewable Resources
Transportation
Demographic Information
Waste
Existing Policies and Plans

Buildings	Buildings and energy consumption are often significant contributions to a community's greenhouse gas emissions, though data accessibility or transparency of building energy use is sometimes difficult to track down. The guide includes suggestion on how to collect building energy consumption by energy type (electricity or natural gas), as well as by sector (commercial and industrial or residential). There are also notes on common building characteristics, like building square footage, that can be valuable in extrapolating energy consumption or creating community targets.

Data Collection Process Guide

Existing Conditions Component of Climate Action Workplans

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Data	Description	Sources and Optional Methods
Total Electricity use (annually)	Total annual electricity use is necessary to set use reduction targets and calculate GHG emissions (and set any targets or reductions)	**State Energy Office, Public Utilities Commission** - Some states require utilities to report energy data by community, for at least some subset of communities. New York, Massachusetts have data at the community level. State Energy Offices will collect electric sales data by geographic units, such as counties and sometimes cities. The **National Renewable Energy Laboratory** (NREL) developed the State and Local Planning for Energy Platform (SLOPE), which provides both state- and county-specific electricity consumption estimates (by sector) as well as dollars spent on electricity. Data is available for public download. **The U.S. Department of Energy** publishes estimates of energy use for geographies through their State and Local Energy data portal The **U.S. Census** also provides some estimates If you're going the route of extrapolation, you can reference the Annual Energy Outlook (AEO) annually from the **Energy Information Administration (EIA)** to check your numbers, though the AEO is national in scope. as is the **U.S. Energy Information Administration** data on average U.S. residential utility customer consumption
Total Natural Gas use (annually)	Total annual natural gas use is necessary to set use reduction targets and calculate GHG emissions (and set any targets or reductions)	Acquiring data directly through your **local natural gas utility** (or utilities if multiple utilities provide service within the community boundaries) is the best way to get complete use data for your community. When requesting natural gas consumption data by sector, utilities can provide a breakdown of residential, commercial, and industrial annual natural gas usage, typically measured in therms or MMBtu. **State Energy Office, Public Utilities Commission** - Some states require utilities to report energy data by community, for at least some subset of communities. New York, Massachusetts have data at the community level. State Energy Offices will collect electric sales data by geographic units, such as counties and sometimes cities. For communities where utilities refuse to share data, you can get estimates on the number of households and commercial / industrial facilities and multiply by a constant use threshold. Otherwise, the **National Renewable Energy Laboratory (NREL)** developed the State and Local Planning for Energy Platform (SLOPE), which provides both state- and county-specific natural gas consumption estimates (by sector). It also includes estimates on dollars spent on natural gas by sector. Data is available for public download. The **U.S. Department of Energy** publishes estimates of energy use for geographies through their State and Local Energy data portal. The **U.S. Census** also provides some estimates If you're going the route of extrapolation, you can reference the Annual Energy Outlook (AEO) annually from the **Energy Information Administration EIA)** to check your numbers, though the AEO is national in scope.
Utility Generation and Emissions Factor	The generation mix includes the input of energy sources that are used to generate electricity for the utility that serves your community. The generation mix is used to calculate the emissions factor to determine the greenhouse gas emissions that result from electricity consumption. This information may be available from your utility or the generation and transmission entity that your utility purchases electricity from. There are additional resources for this information in situations where it's not available.	Utility service territory data may be available through: • the **state's Utilities Commission** • or as a state-specific utility territory GIS file; host for shapefile may vary by state. Emission factors for a given utility can be calculated using the reported generation mix (% by fuel composition and heat factors for various fuel types). Detailed state-level information on the mix of generation fuels by state can be found through the **U.S. Energy Information Administration**. That mix can be used to calculate the an emission factor for the state by multiplying the ratio of each fuel type to the greenhouse gas equivalency of that fuel. The greenhouse gas equivalency for a given fuel can be found through the **U.S. EPA.** There are also datasets available through **EIA** that detail the U.S. Electric Power Industry Estimated Emissions by State, as well as the Net Generation by State by Type of Producer by Energy Source which can be used as a similar proxy for emissions factor, and may allow a community to aggregate fuel production within their specific utility territory. Electric substation data is also available through **HIFLD.** If you need more advanced electric transmission or infrastructure data because the community is, for example, exploring utility-scale renewable energy deployment, or wants to assess proximity to energy infrastructure, electric power transmission line data is available through the **Homeland Infrastructure Foundation-Level Data (HIFLD)**
Current Solar Generation	Knowing the in-boundary solar generation can be used to offset emission calculations for total electricity consumption if the	Current solar generation will be available either through the **utility** or from individual solar installs in the community. This data may require sleuthing if the utility is not forthcoming. **EIA** publishes annual electricity data reporting (form 860), which includes specific power generation data, including solar. Identify which power generators are within the boundary of your geography and sum their total generation for that year.

... All Data Collection | Buildings | Renewable Resources | Transportation | Demographic Information | Waste | Existing Policies and Plans

DEVELOPMENT REVIEW CHECKLIST

- Communities can customize the Development Review Checklist to their own specific climate goals
- Categories include:
  - Commercial Industrial Efficiency
  - Electric Grid Mix
  - Renewable Energy
  - Electrification and Fuels
  - Residential Efficiency
  - Transportation Strategies
  - Waste Strategies

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Overall Climate Goals	Is proposal consistent with community's climate goals?
The City of Climateopolis has adopted climate action goals to lower total GHG emissions across the city by 80% by 2040. Does the proposed project address reduction of GHG emissions?	☐ Does not contribute to the goal ☐ More information is needed ☐ Contributes to the goal
Commercial/Industrial Efficiency	
The City of Climateopolis has identified that commercial building energy efficiency needs to be substantially more efficient than minimum energy code standards in order to meet the City's GHG reduction targets.	☐ Contributes to the goal ☐ More information is needed ☐ Does not contribute to the goal
Does the proposed project exceed (meet a higher level of efficiency) minimum energy code requirements?	☐ Meets code ☐ Exceeds code (describe) ☐ Third party certification (provide)
Does the proposed project enable future adaptation strategies for increasing building energy efficiency?	☐ No strategies identified ☐ Includes adaptation strategies (describe)

CLIMATE ORDINANCE INVENTORY

- Model climate ordinances and example ordinance language
- Searchable Web Tool
- Filter by topics

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Filter by Type

- ◯ Model Ordinance
- ◯ Example Ordinance Language from Communities
  - ◯ City
  - ◯ County

Filter by Population

- ☐ Less than 10,000 (rural)
- ☐ 10,000 to 50,000 (small urban area)
- ☐ 50,000 to 1 million (metro)
- ☐ Greater than 1 million (large metro area)

Filter by Sector

- ☐ Transportation
- ☐ Energy / Renewable Energy
- ☐ Climate
- ☐ Buildings
- ☐ Land Use
- ☐ Waste

Search:

Name	Topic	Author	Example Language	Locati
Model Solar Zoning Ordinance for New Hampshire	Solar	New Hampshire Sustainable Energy Association	--	New H
Model Small-Scale Solar Siting Ordinance	Solar	Columbia Law School Center for Climate Change Law	--	Natior
Model Solar Zoning Ordinance for Kentucky	Solar	Kentucky Resources Council	--	Kentu
Model Solar Zoning Ordinance for Georgia	Solar	Emory Law School, Georgia Institute of Technology, and University of Georgia	--	Georg
Model Solar Energy Local Law - New York State Solar Guidebook	Solar	NYSERDA	--	New Y
Model Ordinance - Solar Tax Exemption	Solar	Virginia Department of Environmental Quality	--	Virgin
Model Utility, Community, & Residential Scale Wind	Wind	Virginia Department of Environmental Quality	--	Virgin

Download Current Results | Open Table in New Tab | Download Spreadsheet

PRINCIPLES FOR CLIMATE ACTION

- Use whole systems thinking
- Plan and design for resilient and sustainable outcomes
- Develop diverse, flexible cross-sector strategies
- Prioritize for multi-benefit outcomes
- Integrate implementation and monitoring into the planning process
- Set ambitious, yet achievable goals
- Maximize the toolbox
- Engage, educate, and foster equity outcomes
- Build interdisciplinary partnerships and cross-sector collaboration
- Address vulnerabilities and uncertainties

CLIMATE PLANNING

ENGAGEMENT

EDUCATION

CONSENSUS BUILDING

+ 10 STEPS

PLANNERS COMMITMENT

1) Get educated
2) Talk about it
3) Network
4) Promote policy and take action

Q&A