Making the Connections: A Changing Climate

U.S. Global Change Research Program

Fourth National Climate Assessment, Vol II — Impacts, Risks, and Adaptation in the United States

Highlights

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NARBA
North American Raspberry & Blackberry Association

Agenda

- **National Climate Assessment Findings**
  - **2019 Overview**
- **A Few Regional Tools & Information (that may come in handy)**
- **2020 Spring Outlook**
  - **if there is time….**

US Global Change Research Program

Global Change Research Act (1990):

"To provide for development and coordination of a comprehensive and integrated United States research program which will assist the Nation and the world to **understand, assess, predict, and respond** to human-induced and natural processes of global change."

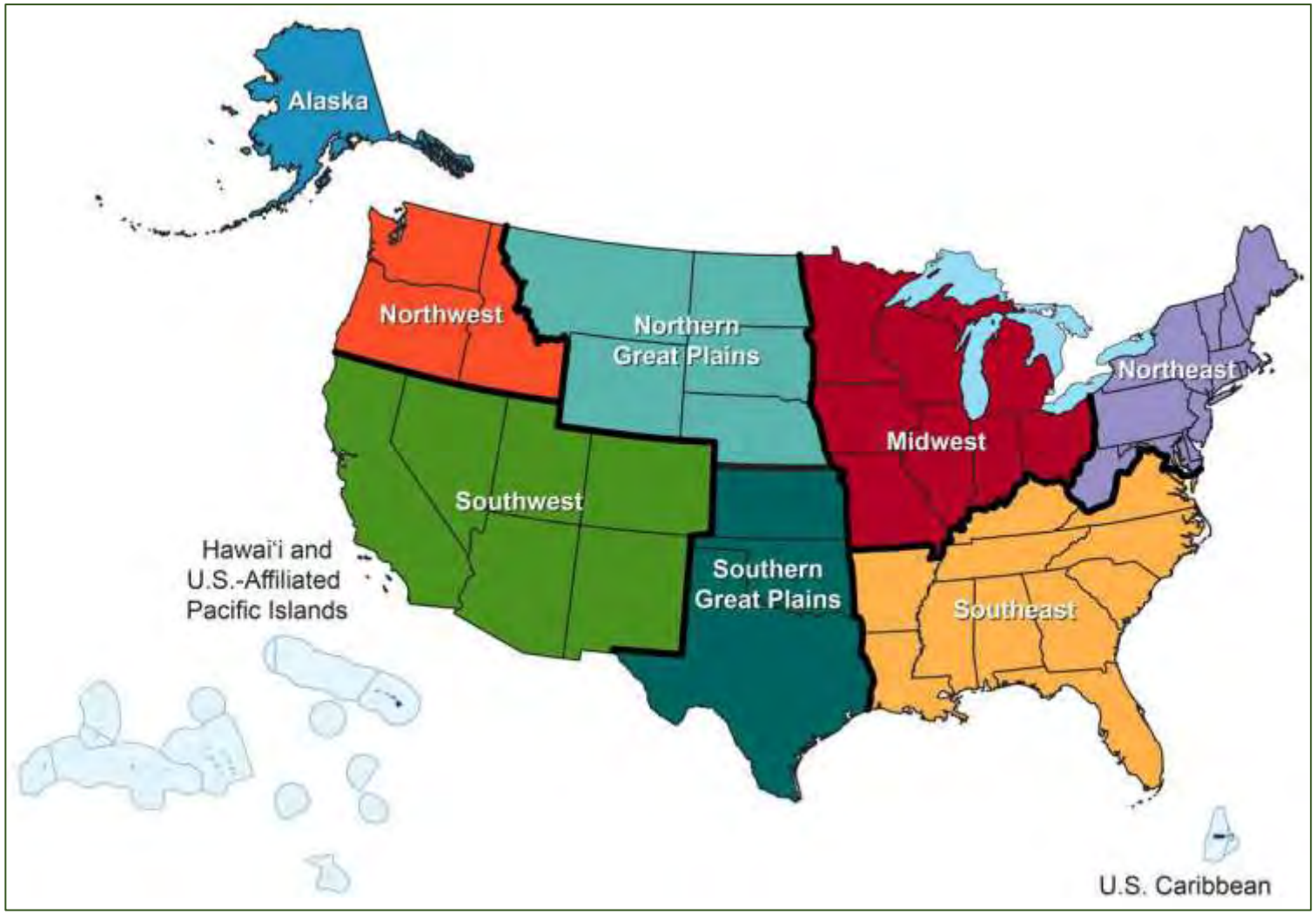
United States Global Change Research Program

- 13 Federal Departments & Agencies + Executive Office of the President
- 300+ Authors
- 2 years writing & reviews
- Every 4 years
- Public Engagement

More information:

http://www.globalchange.gov

Our Changing Climate: *Regions*



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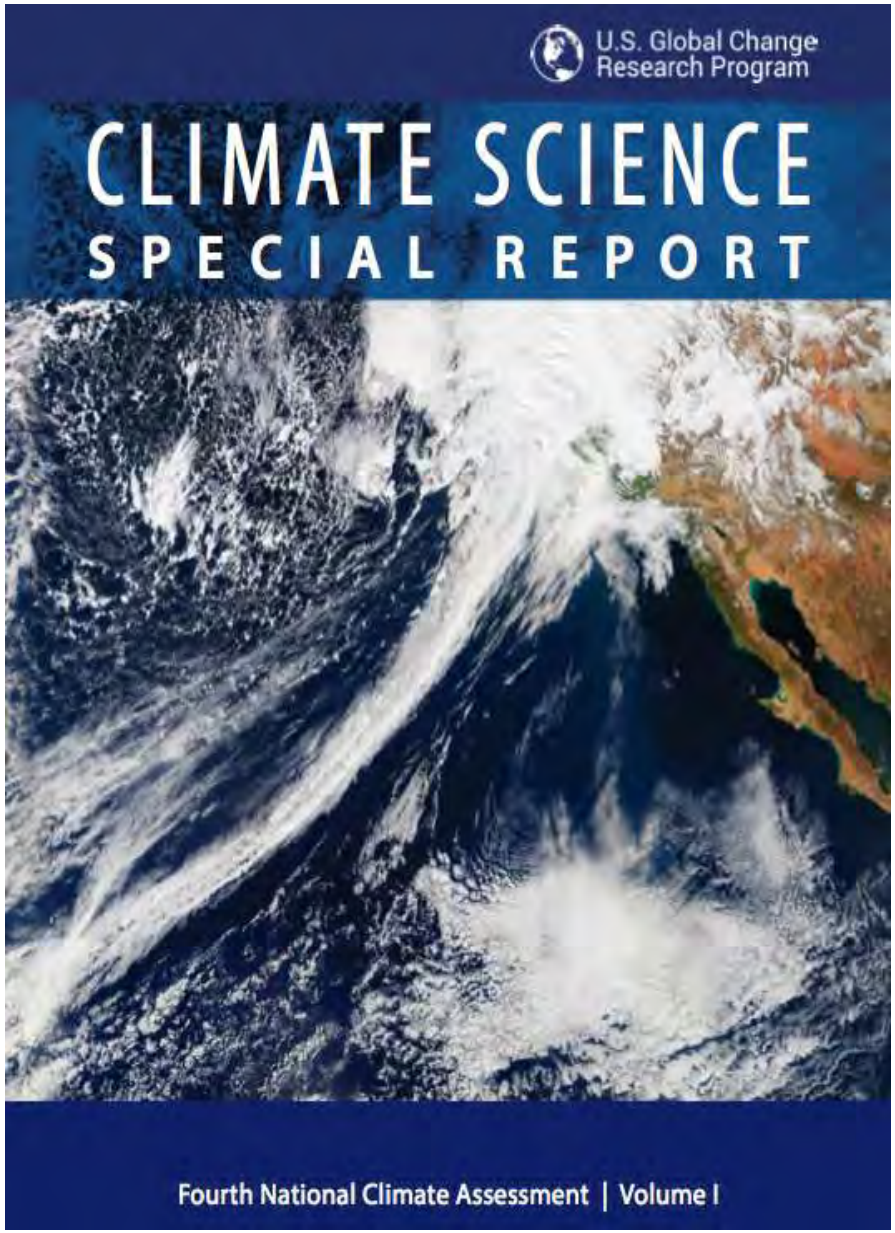
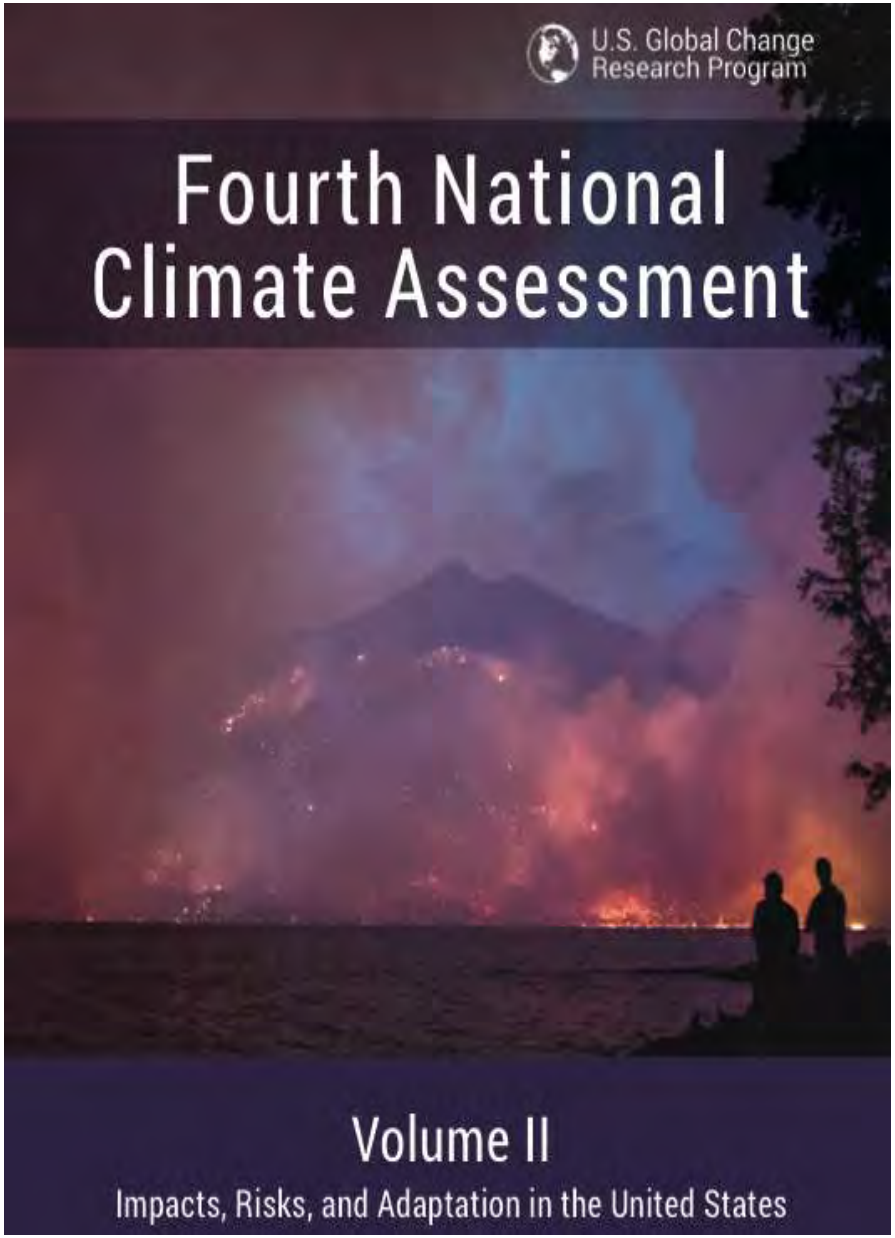
2017


U.S. Global Change Research Program
CLIMATE SCIENCE
SPECIAL REPORT
Fourth National Climate Assessment | Volume I

2018


U.S. Global Change Research Program
Fourth National Climate Assessment
Volume II
Impacts, Risks, and Adaptation in the United States

Introduction: NCA4 Vol II

- Earth's climate is now **changing faster** than at any point in modern civilization.
- These changes are primarily **the result of human activities**.
- The impacts of climate change are **already being felt** across the country.
- Americans are **responding**.
- However, neither global efforts to mitigate the causes of climate change nor regional efforts to adapt to the impacts currently approach the scales needed to **avoid substantial damages**.

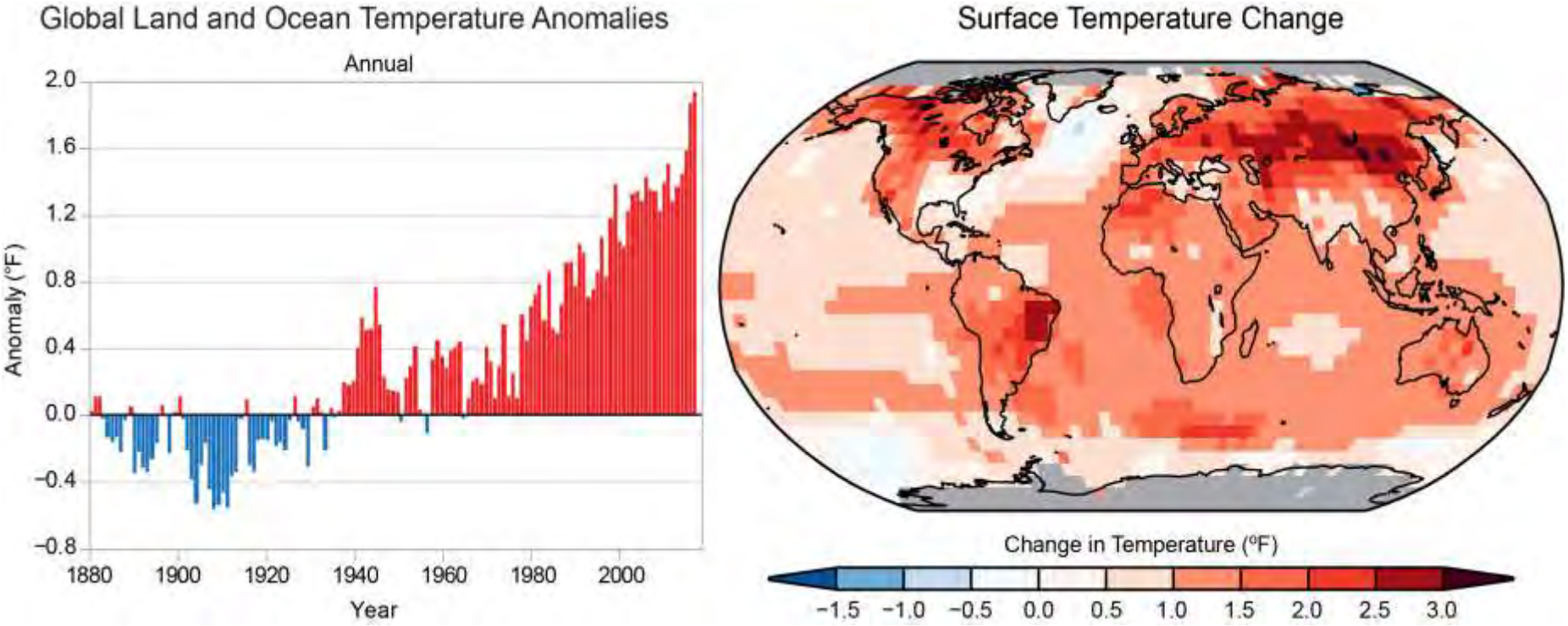
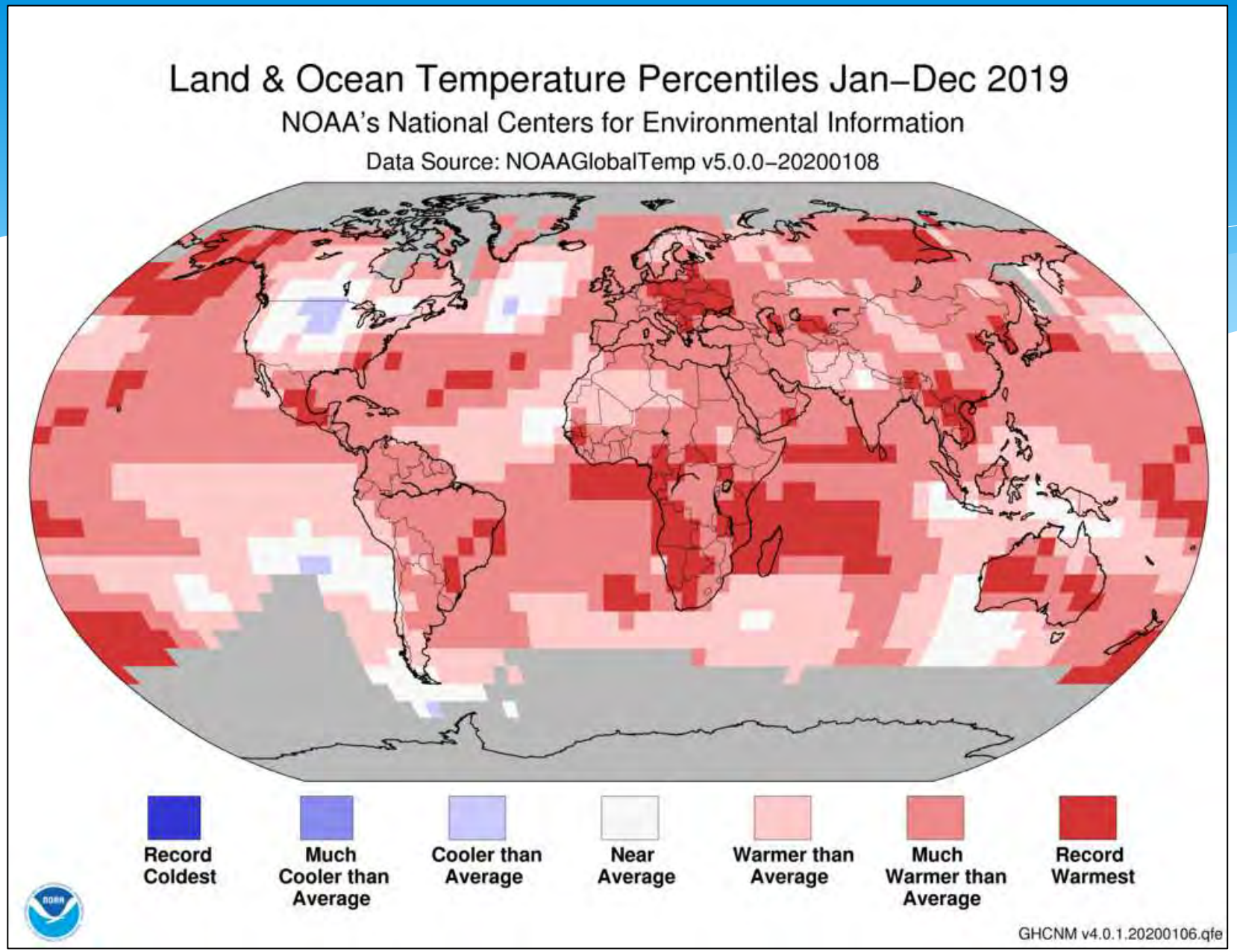


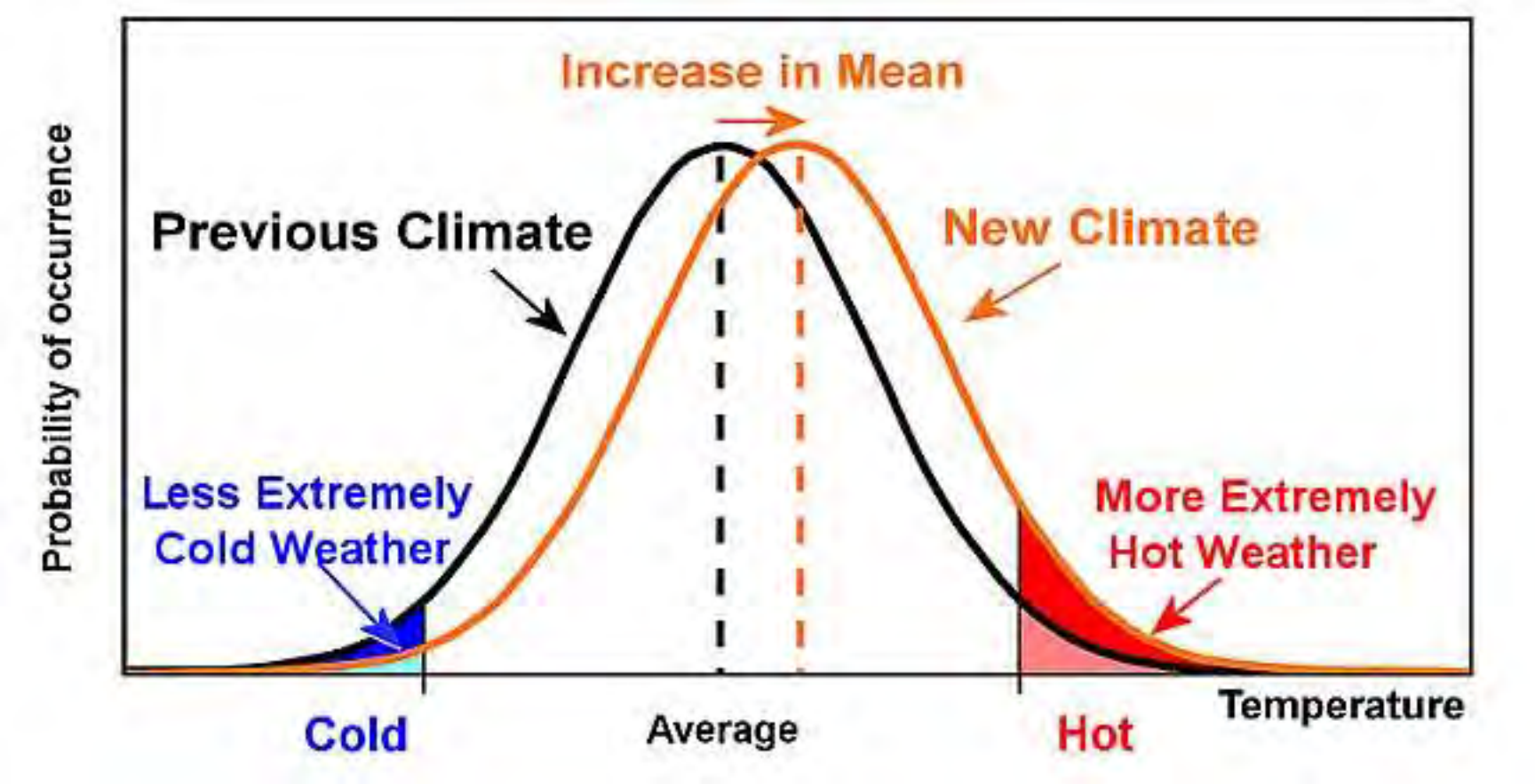
Figure 1: Global Temperature

Caption: (left) Global annual average temperature has increased by more than 1.2°F (0.7°C) for the period 1986–2016 relative to 1901–1960. Red bars show temperatures that were above the 1901–1960 average, and blue bars indicate temperatures below the average. (right) Surface temperature change (in °F) for the period 1986–2016 relative to 1901–1960. Gray indicates missing data. *From Figures 1.2. and 1.3 in Chapter 1.*



https://www.ncdc.noaa.gov/sotc/

Slight Shifts Can Have Big Impacts



The Ten Warmest Years Globally (1880–2019)

The following table lists the global combined land and ocean annually averaged temperature rank and anomaly for each of the 10 warmest years on record.

RANK 1 = WARMEST

	YEAR	ANOMALY °C	ANOMALY °F
1	2016	0.99	1.78
2	2019	0.95	1.71
3	2015	0.93	1.67
4	2017	0.91	1.64
5	2018	0.83	1.49
6	2014	0.74	1.33
7	2010	0.72	1.30
8 (tied)	2005	0.67	1.21
8 (tied)	2013	0.67	1.21
10	1998	0.65	1.17

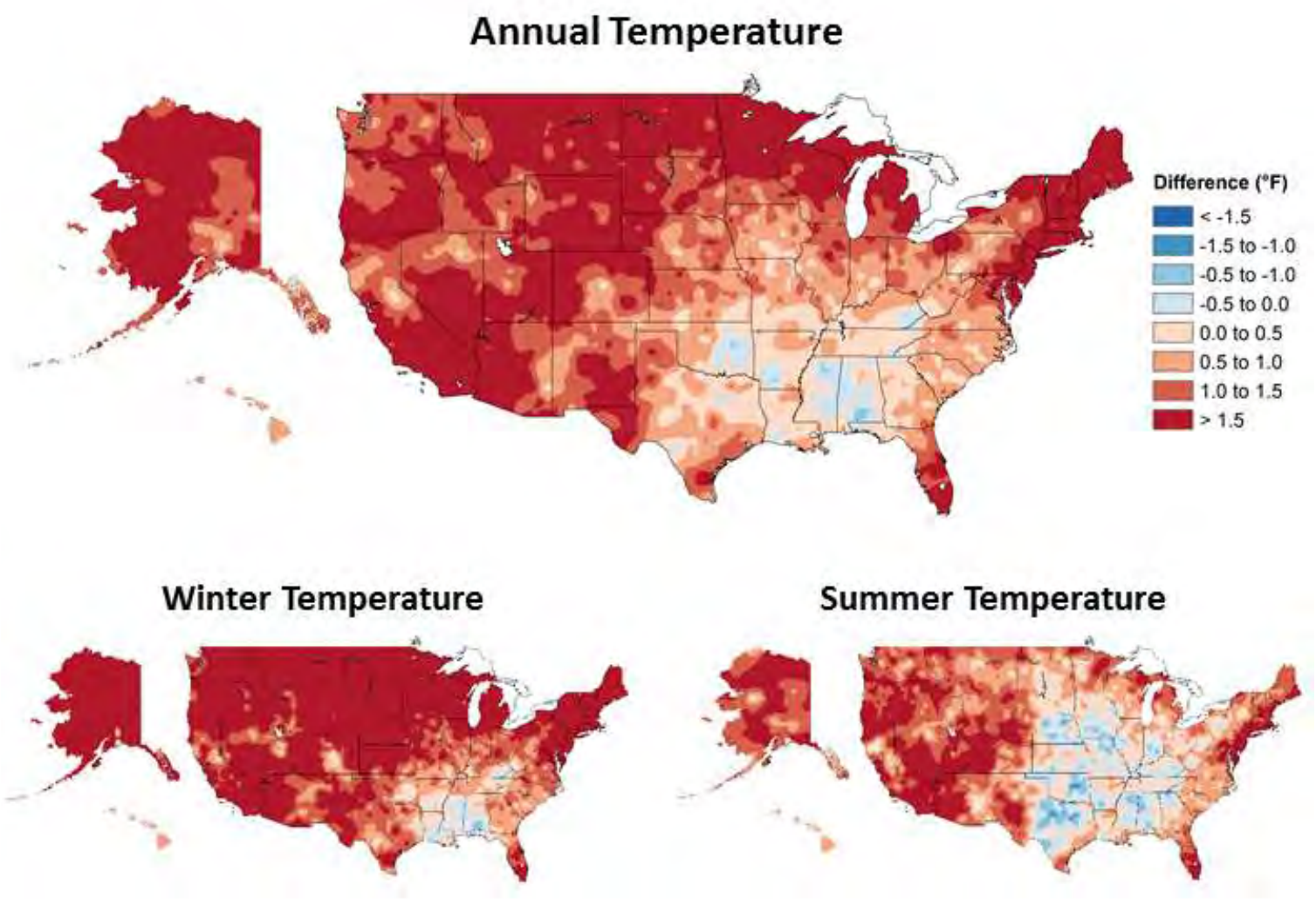
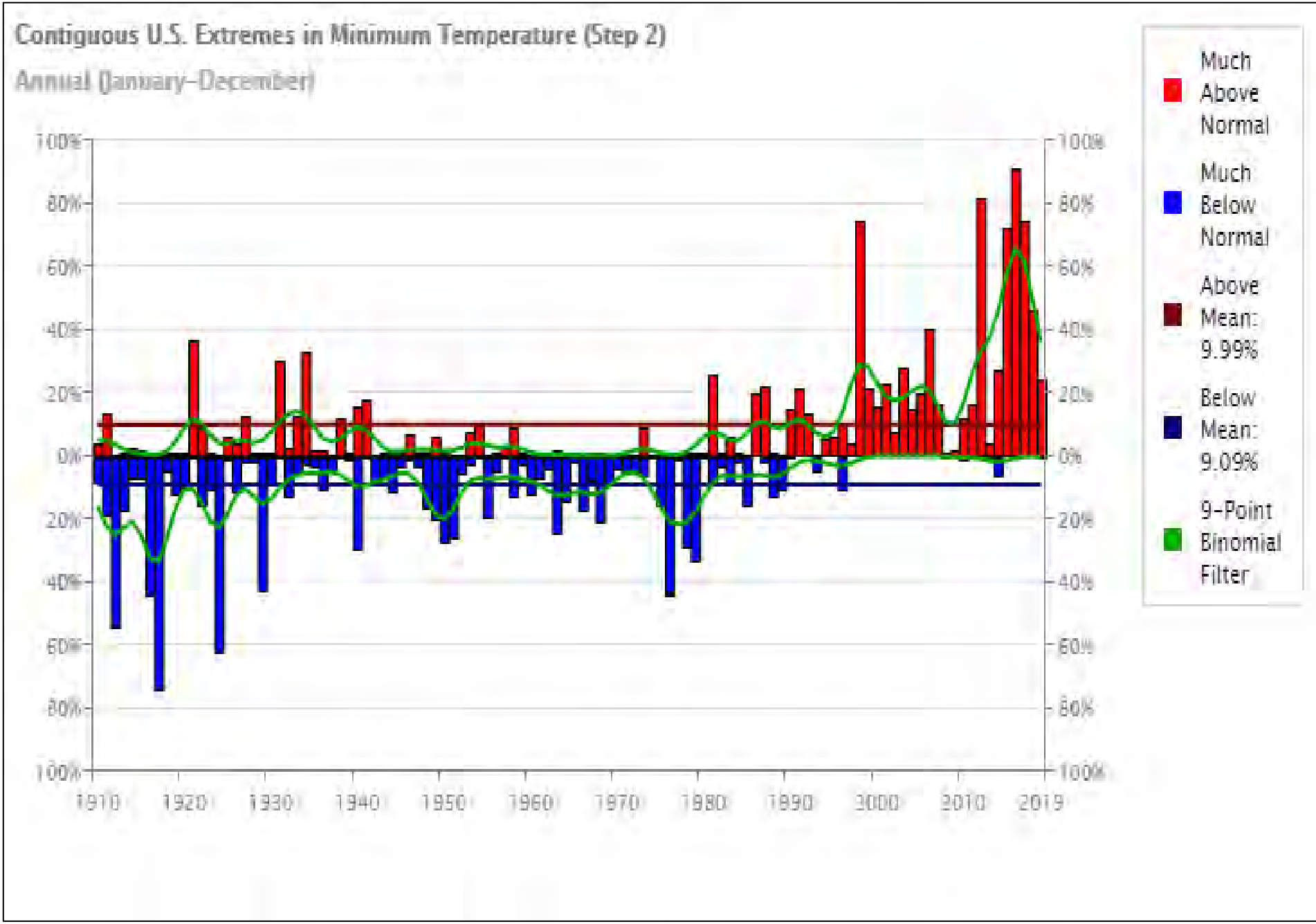
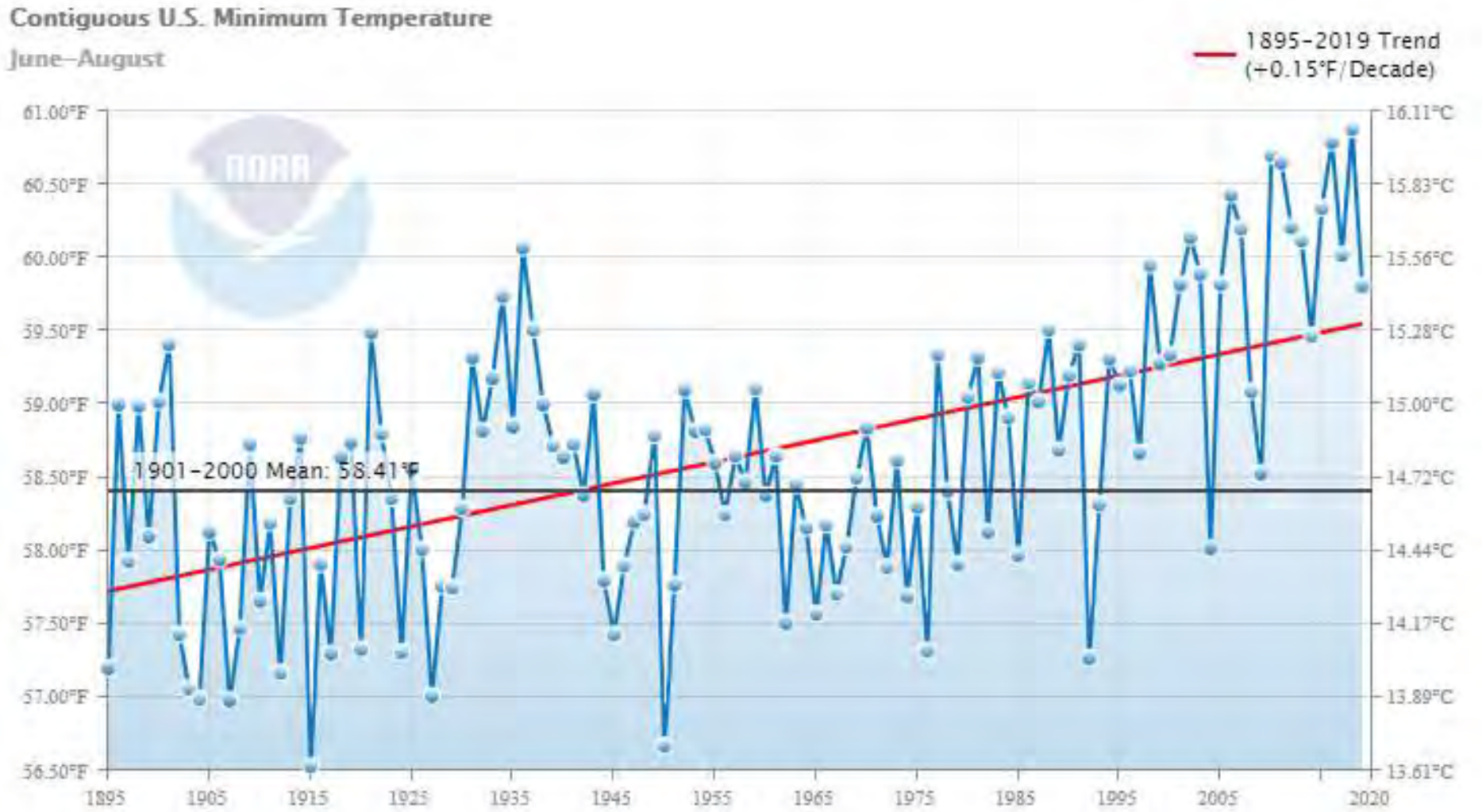


Figure 6.1: Observed Warming

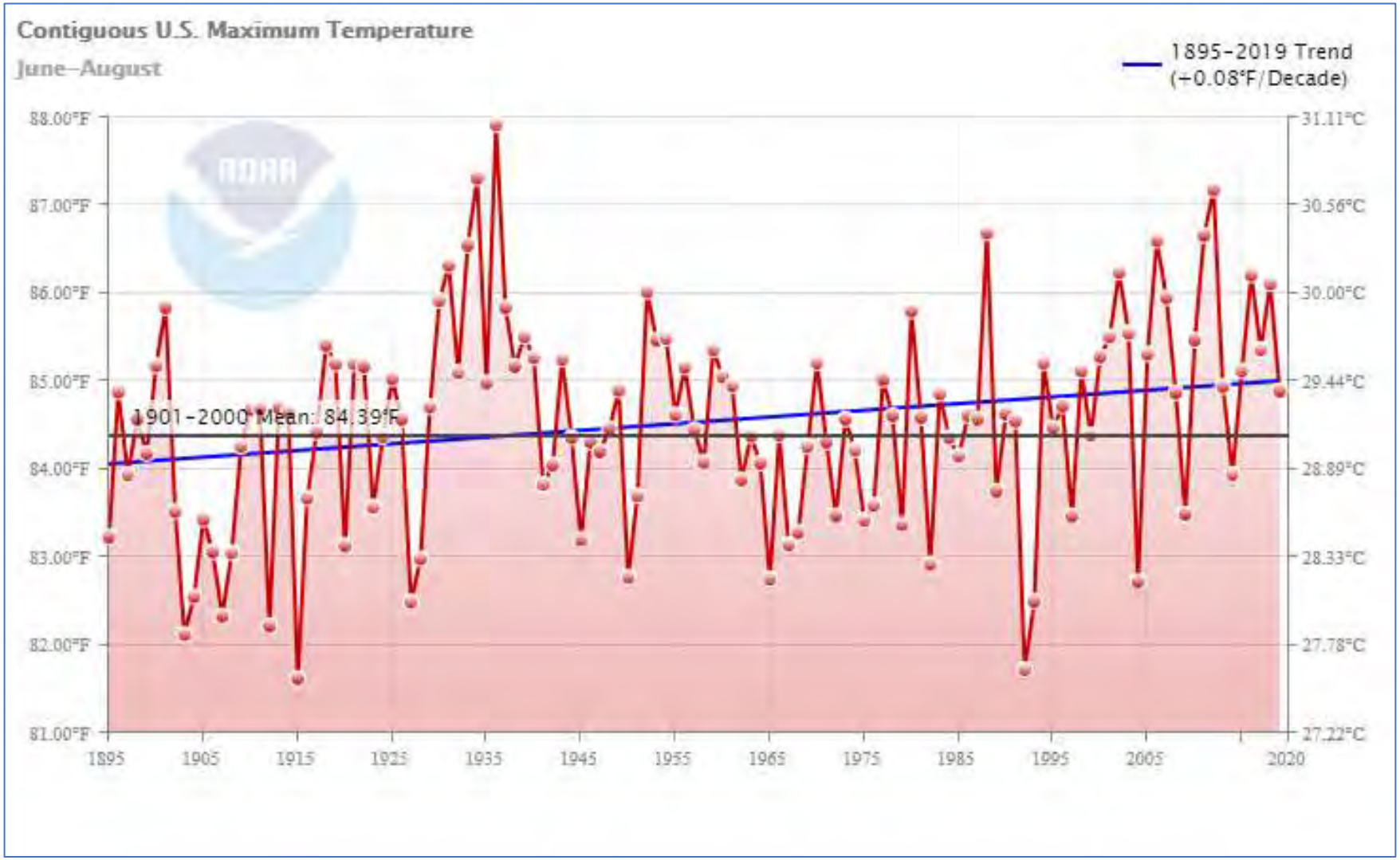
Observed changes in annual, winter, and summer temperature (°F). Changes are the difference between the average for present-day (1986–2016) and the average for the first half of the last century (1901–1960 for the contiguous United States, 1925–1960 for Alaska and Hawai'i). Estimates are derived from the nClimDiv dataset. , (Figure source: NOAA/NCEI).


Contiguous U.S. Extremes in Minimum Temperature (Step 2)
Annual (January–December)
100%
80%
60%
40%
20%
0%
20%
40%
60%
80%
100%
1910
1920
1930
1940
1950
1960
1970
1980
1990
3000
2010
2019
Much Above Normal
Much Below Normal
Above Mean: 9.99%
Below Mean: 9.09%
9-Point Binomial Filter

Minimum Temperature Trend U.S. Annual and Summer



Maximum Temperature Trend U.S. Summer



Our Changing Climate: *Scenarios*

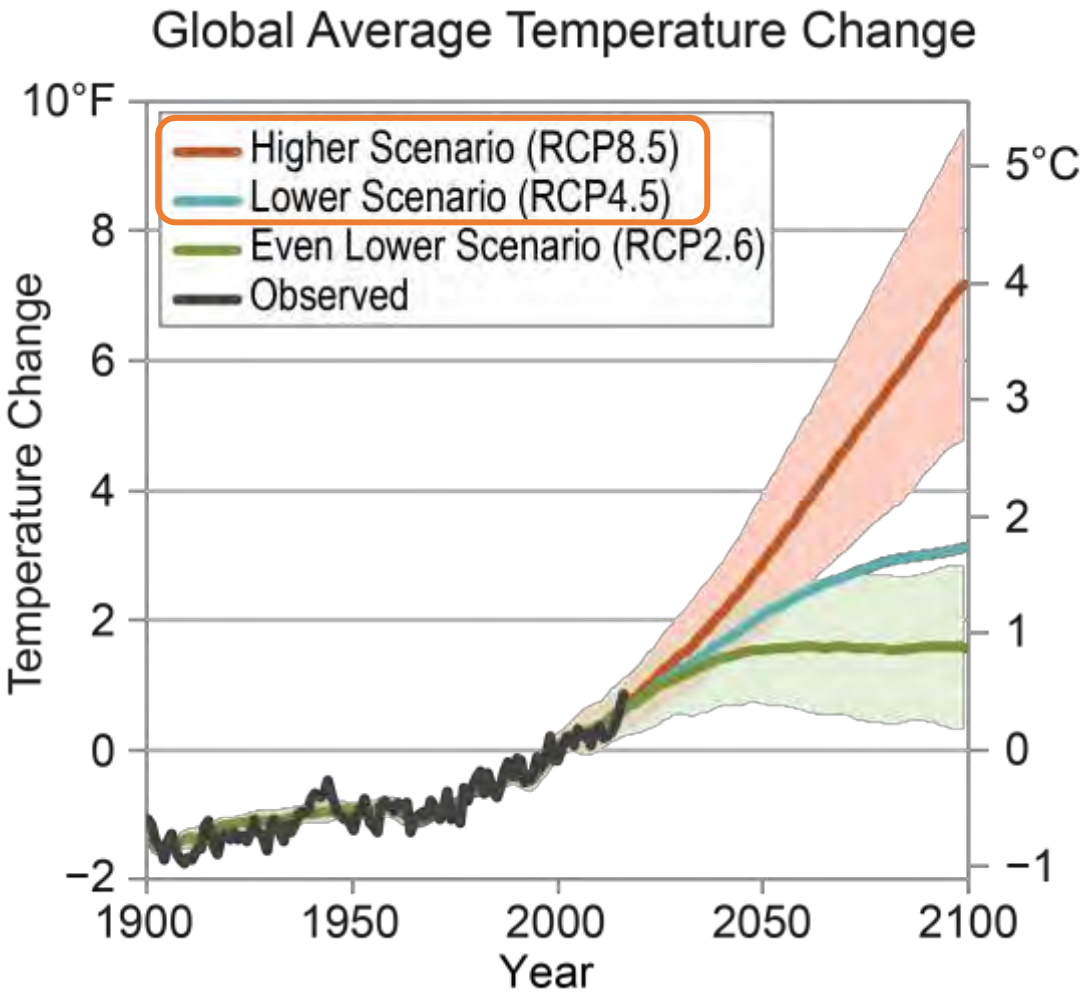


Fig. 1.3: Projected Changes in U.S. Annual Average Temperature

Annual average temperatures across the United States are projected to increase over this century, with greater changes at higher latitudes as compared to lower latitudes, and under a higher scenario (RCP8.5; right) than under a lower one (RCP4.5; left). This figure shows projected differences in annual average temperatures for **mid-century (2036–2065; top) and end of century (2071–2100; bottom)** relative to the near present (1986–2015). *From Figure 2.4, Ch. 2: Climate (Source: adapted from Vose et al. 2017).*

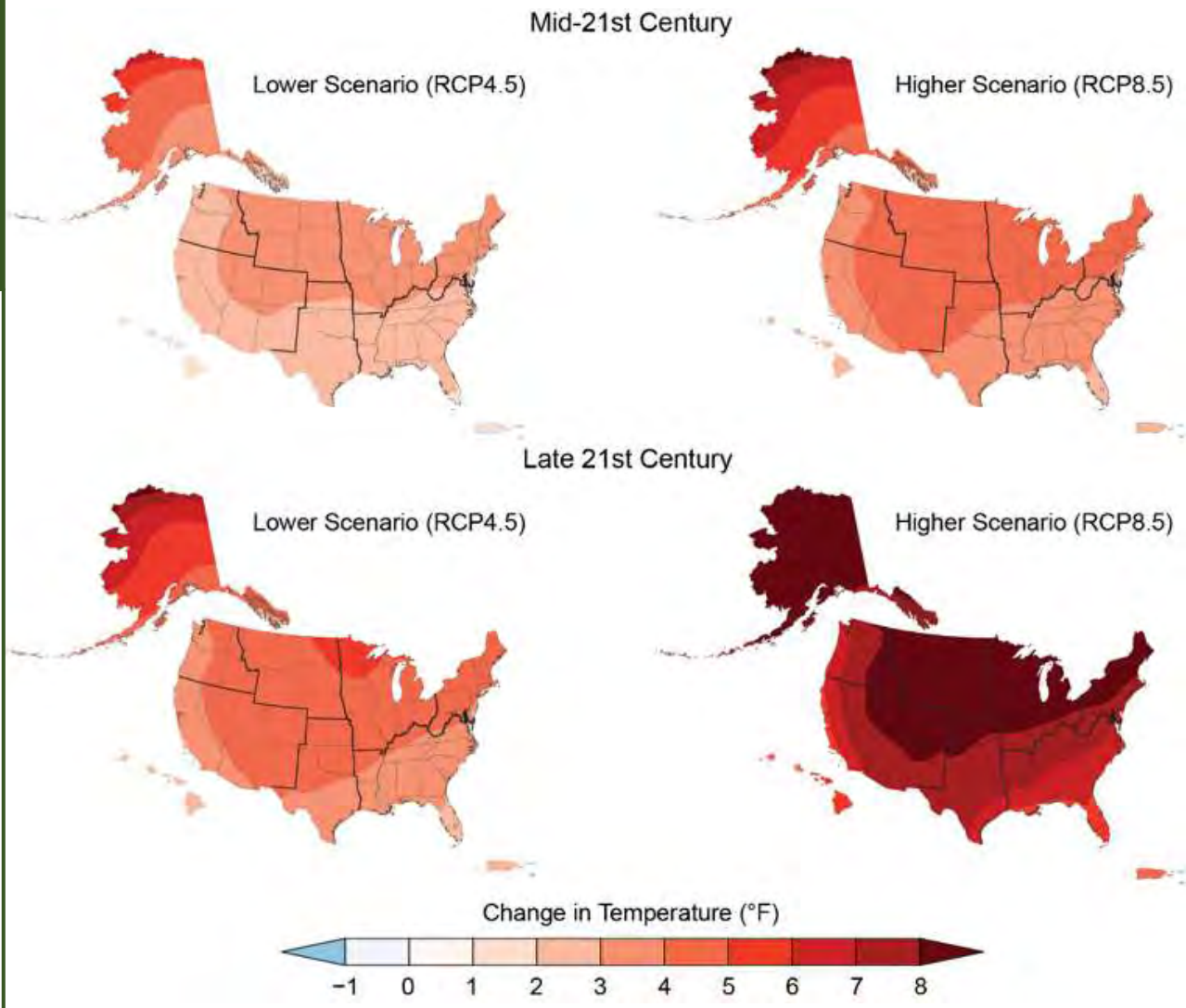
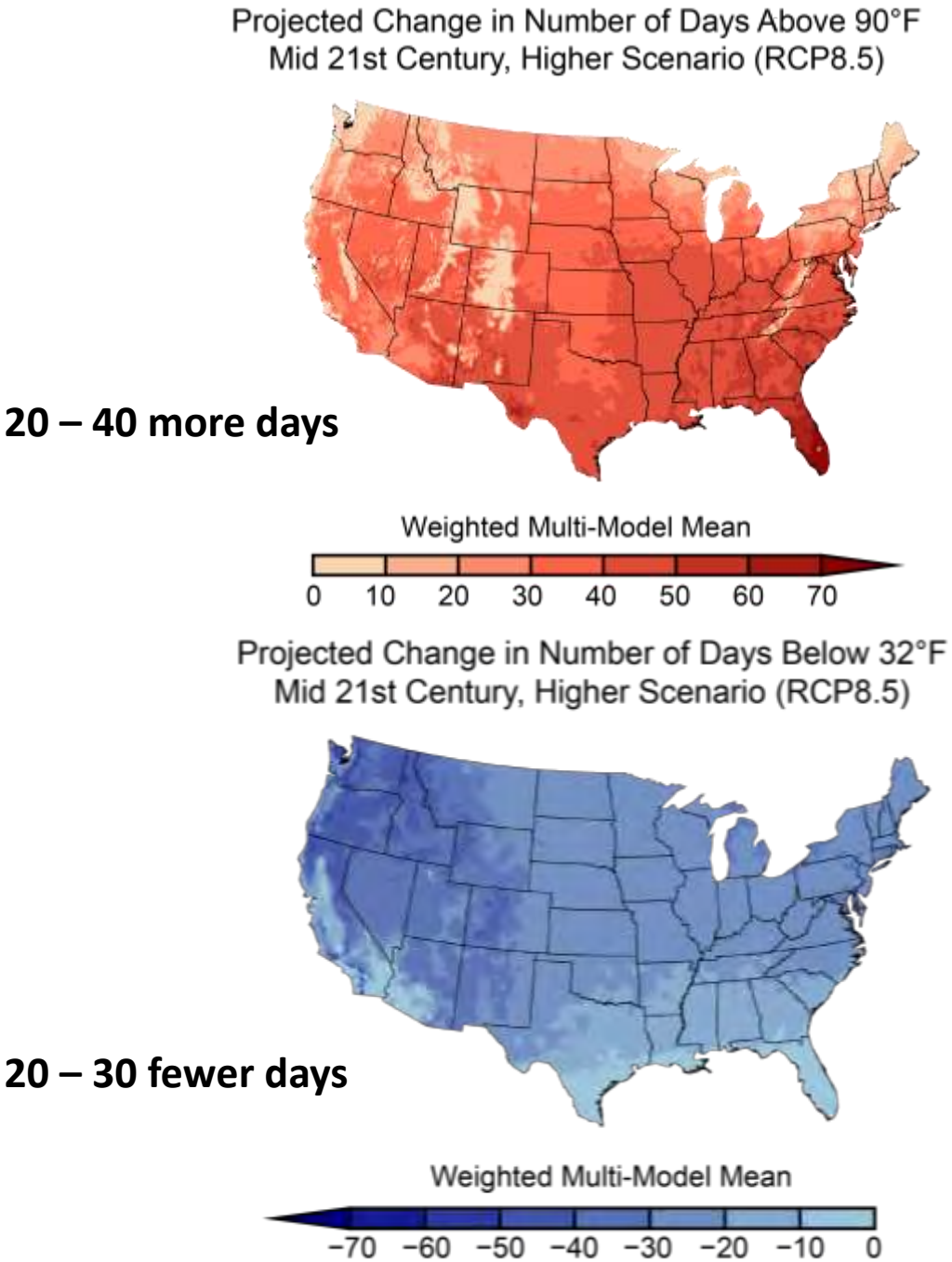


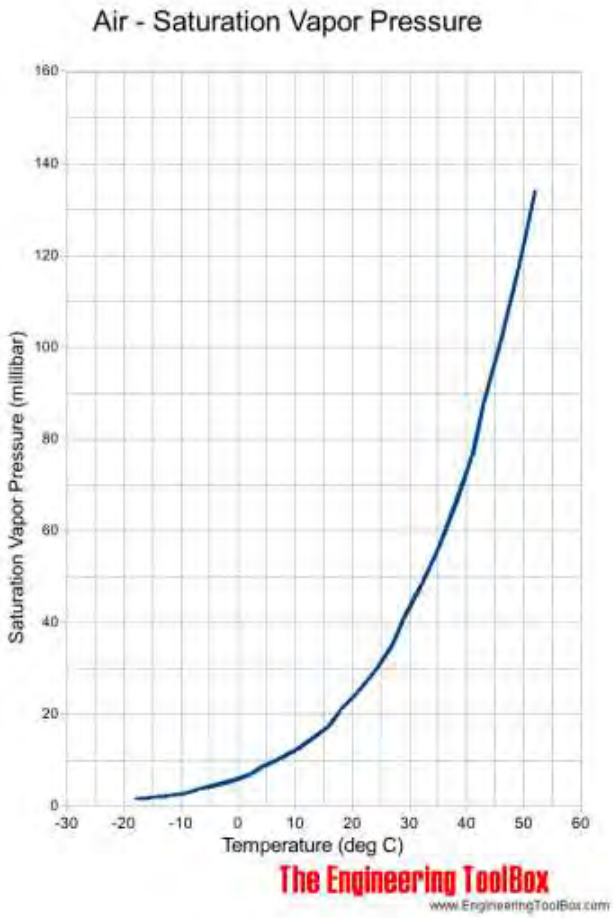
Fig. 6.9: Projected Changes in U.S. Temperature Extremes

Projected changes in the number of days per year with a **maximum above 90°F (top)** and a **minimum temperature below 32°F (bottom)** in the U.S. Changes represent the difference between the average for mid-century (2036-2065) and the near-present (1976-2005) under the higher scenario (RCP8.5). *Image from the Climate Science Special Report, 2017*.

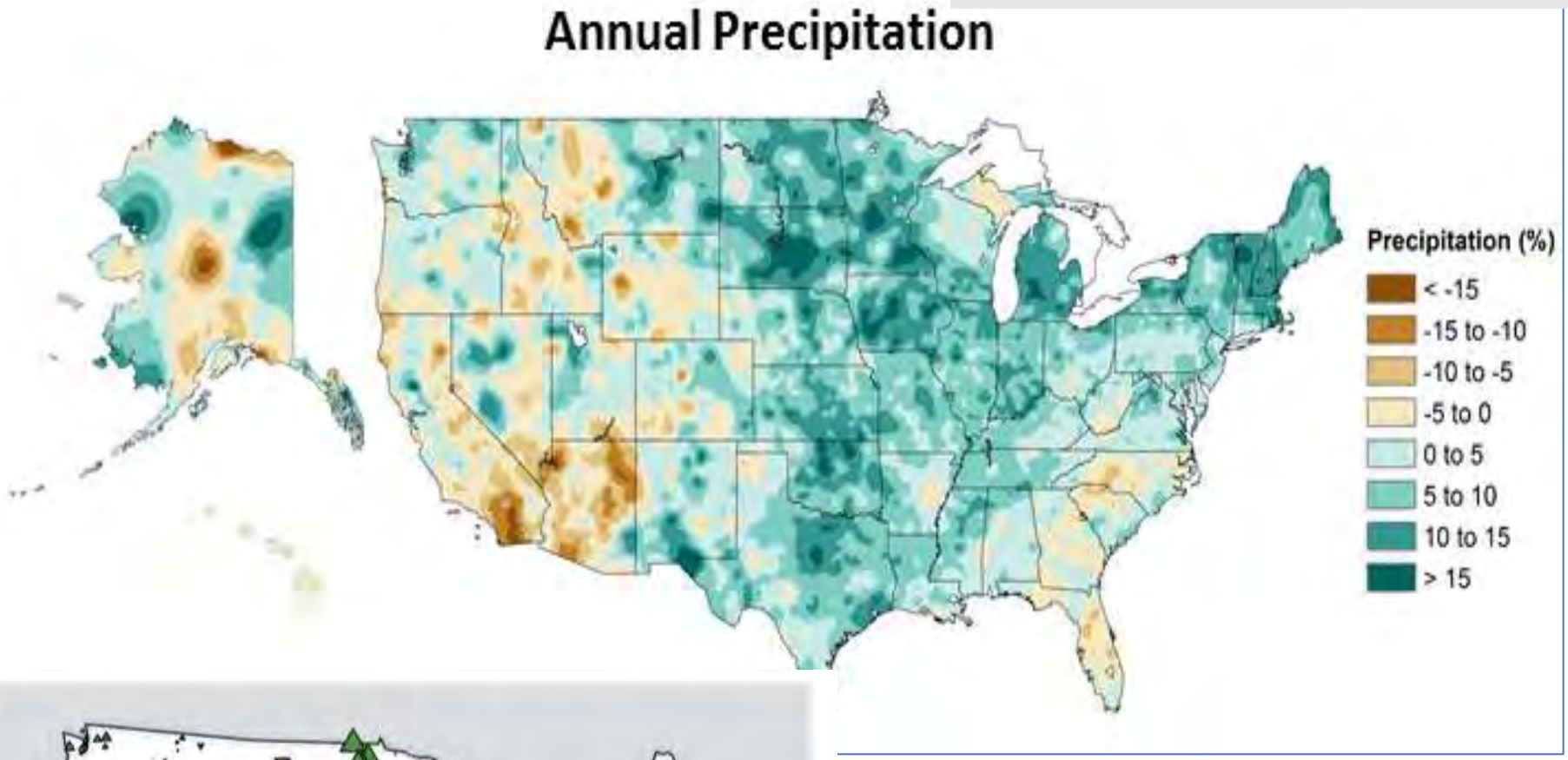


Warm Air Holds More Water Vapor

- Saturation vapor pressure is the total amount of pressure exerted if the air were saturated (relative humidity 100%)
  - Nearly doubles for every 10 deg C increase in temperature
  - Warm tropical air can hold 4-10 times as much vapor as cold, dry air
  - Consequently more latent heat release in storms, more precipitation



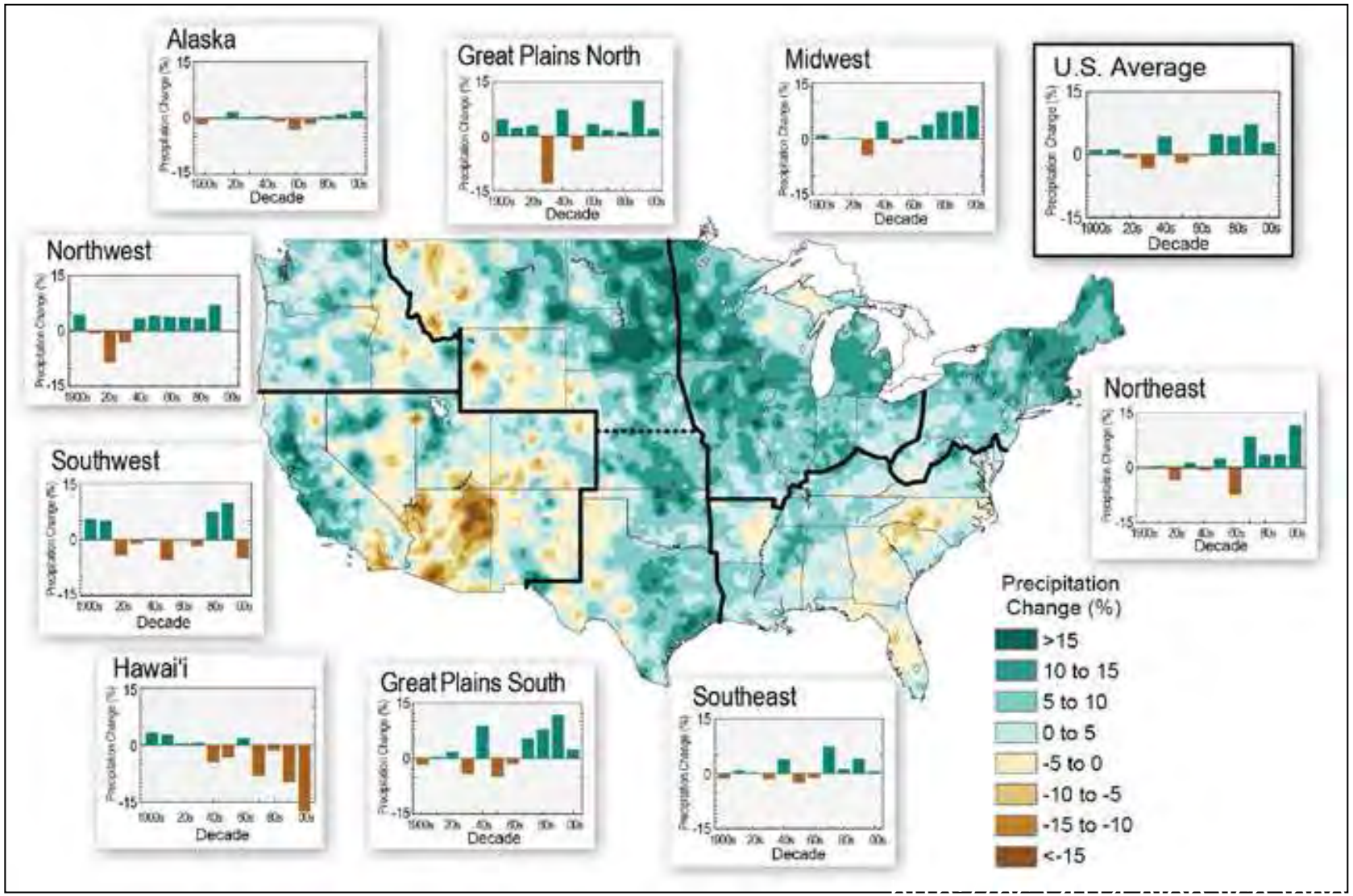
Recent 30 years (1986-2015) compared to the past (1901-1960)



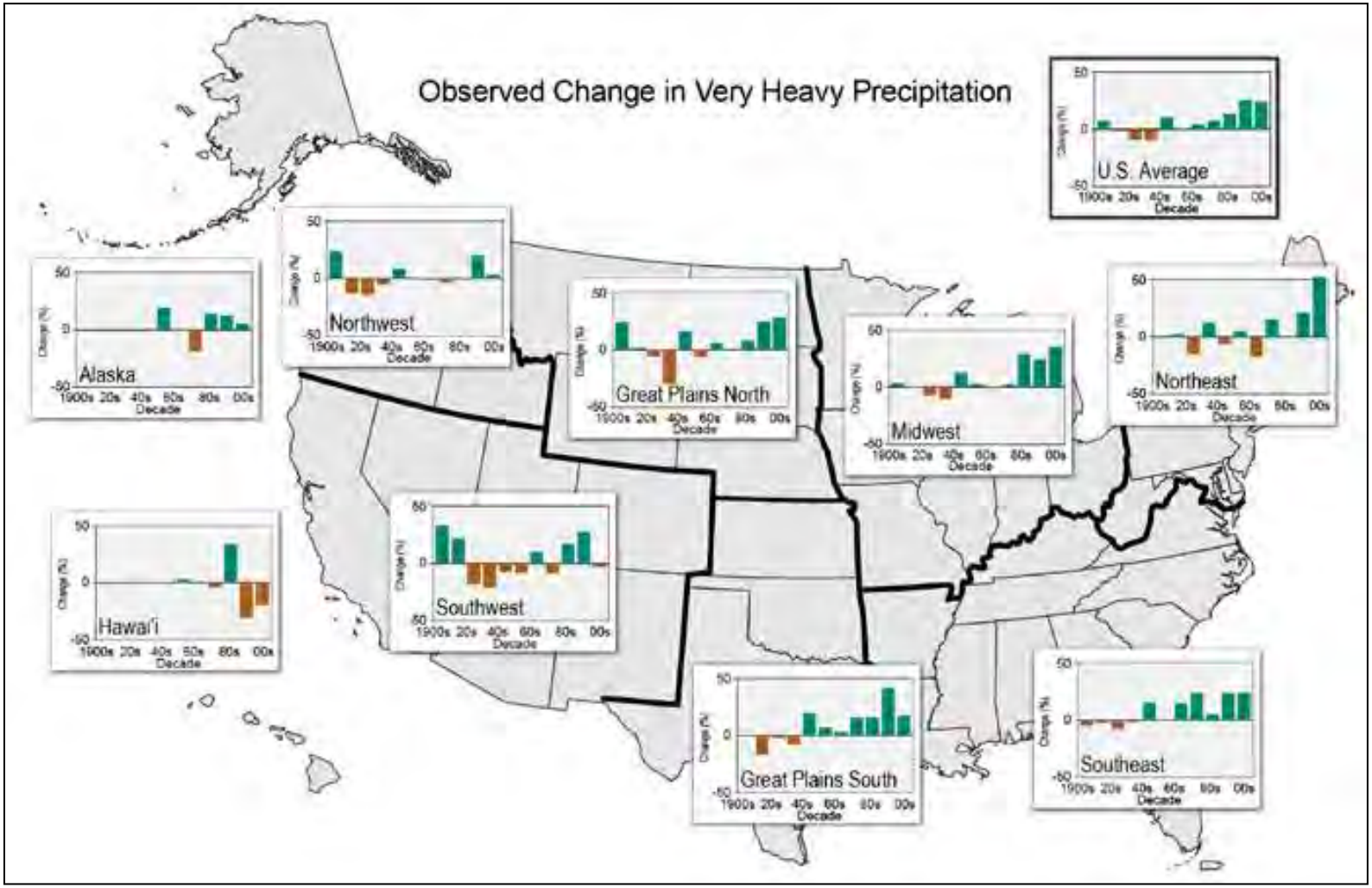
Trends in Flood Magnitude

Figure source: Peterson et al. 2013

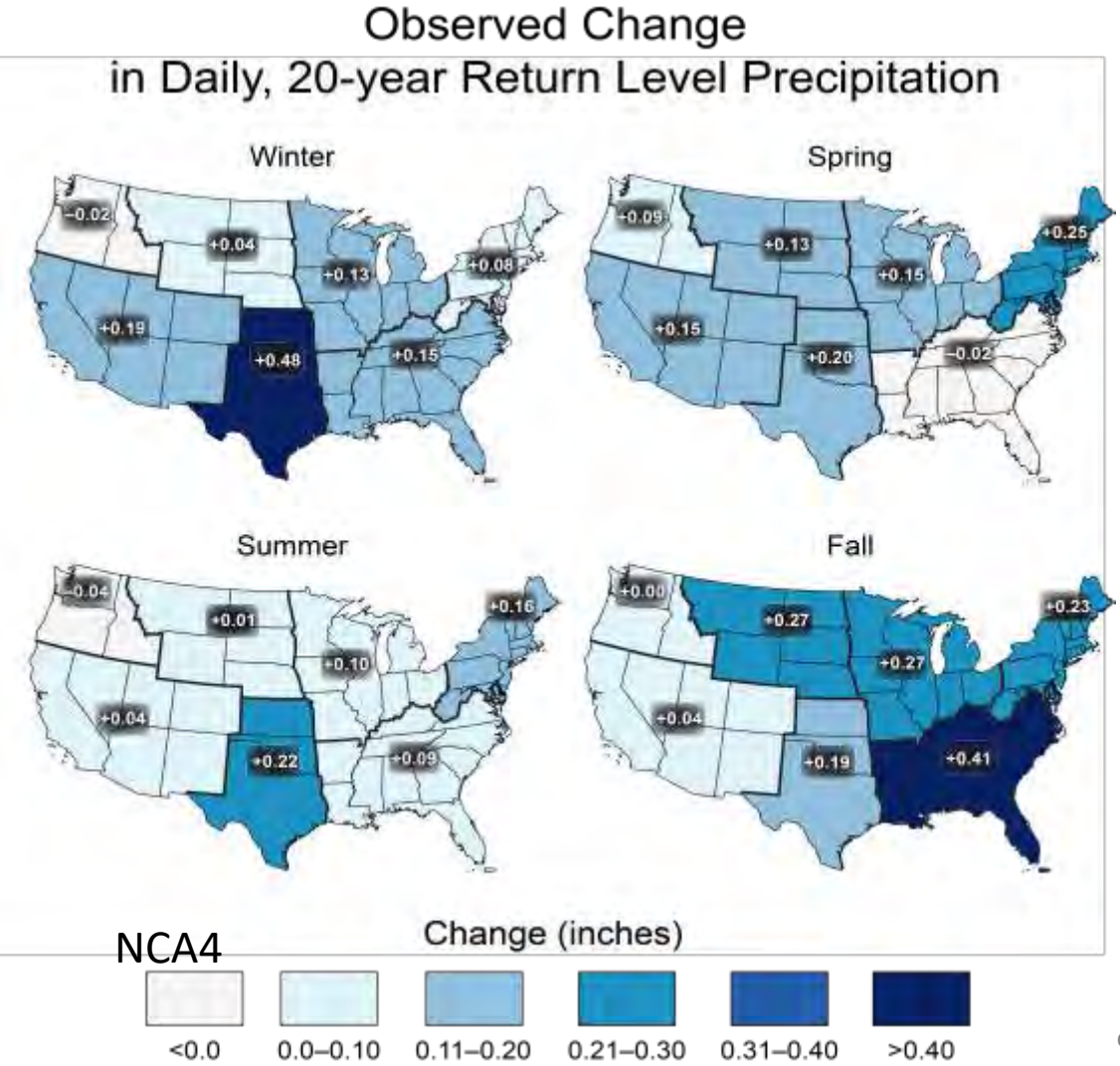
Precipitation Trends (from NCA3)



Observed Change in Very Heavy Precipitation



Heavy Rainfall



- Daily 20-year Return means amount of rainfall expected to occur, on average, once every 20 years
- Amounts have increased more than 0.4 inch in places (slight decrease in some places)
- Varies geographically by season

Fig. 2.5: Projected Changes in U.S. Seasonal Precipitation Amounts

In the future, under the higher scenario, the northern U.S. is projected to receive **more precipitation, especially in winter and spring** by 2070-2099, relative to 1986-2015. Areas with red dots show where projected changes are large compared to natural variations; areas that are hatched show where projected changes are small and relatively insignificant. *Adapted from Easterling et al. 2017.*

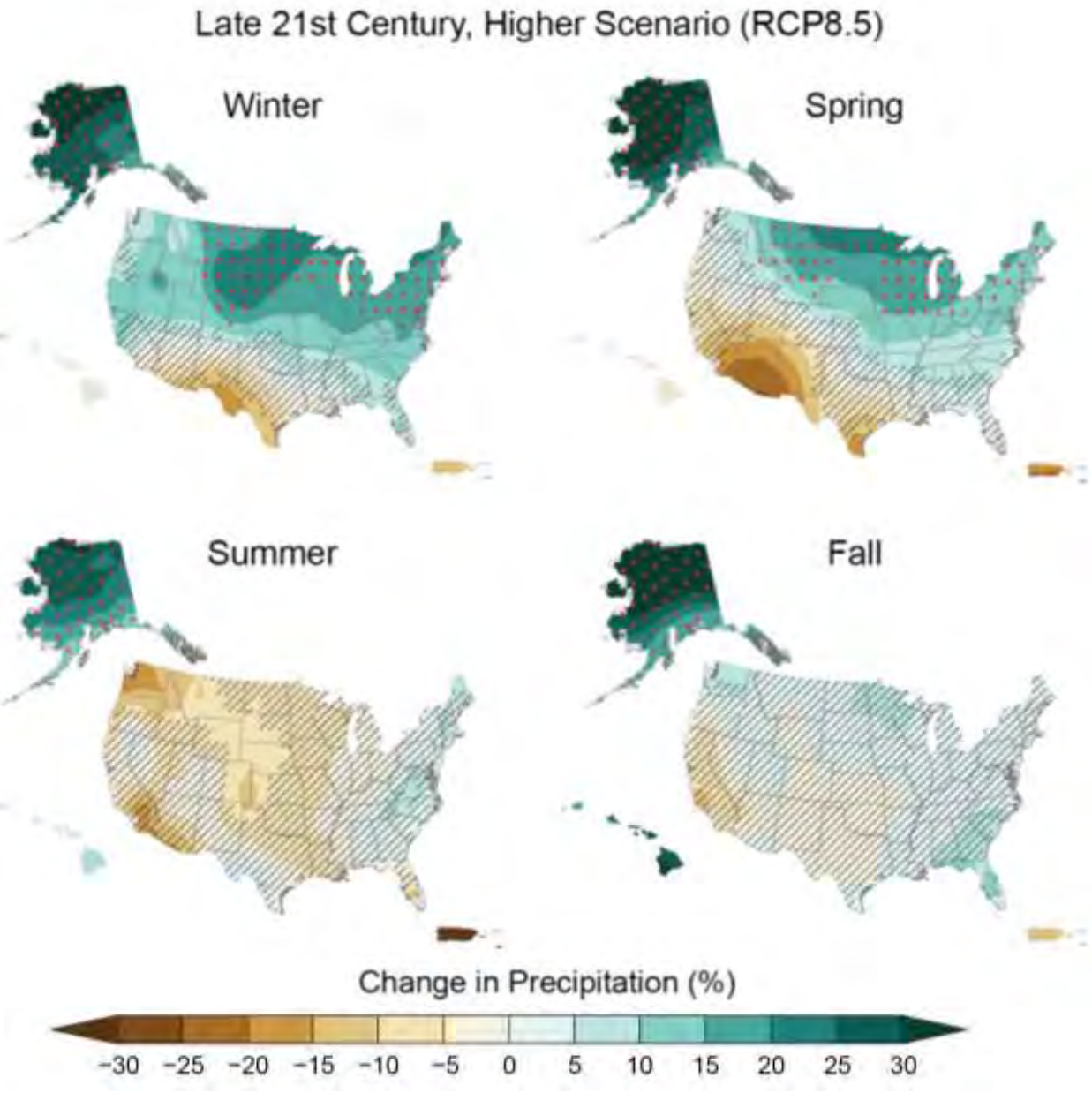
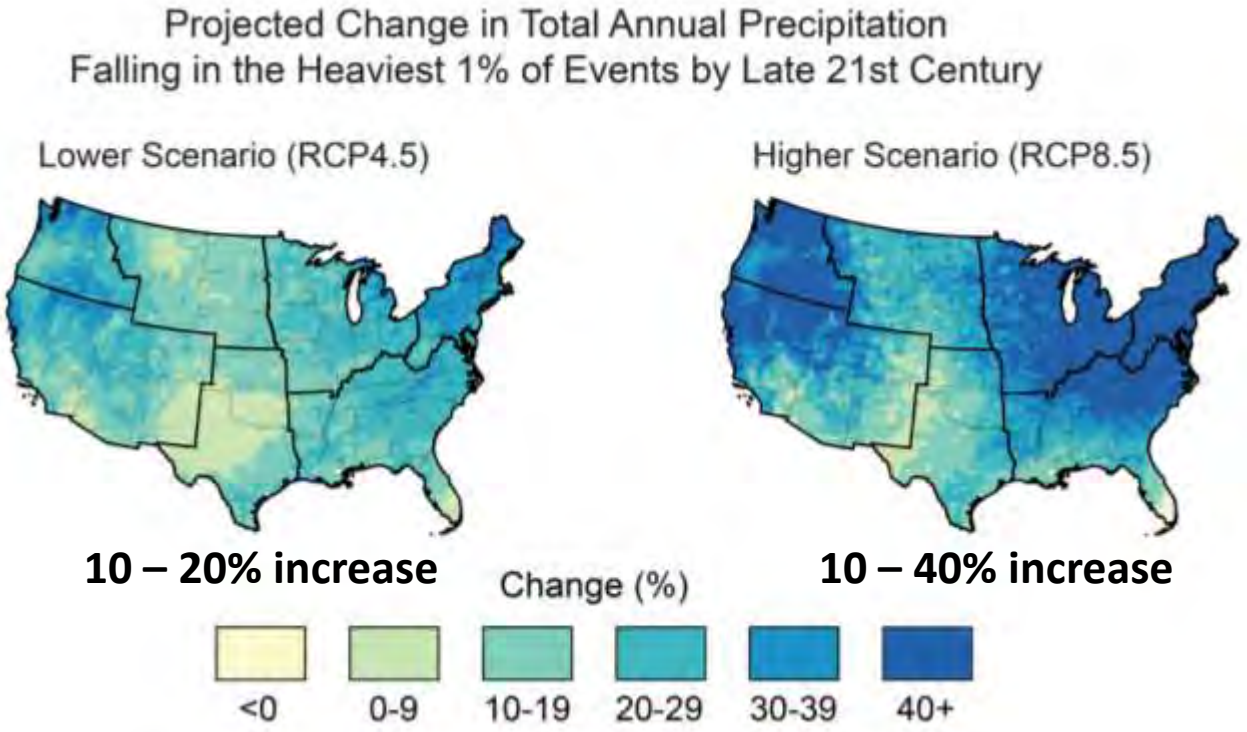
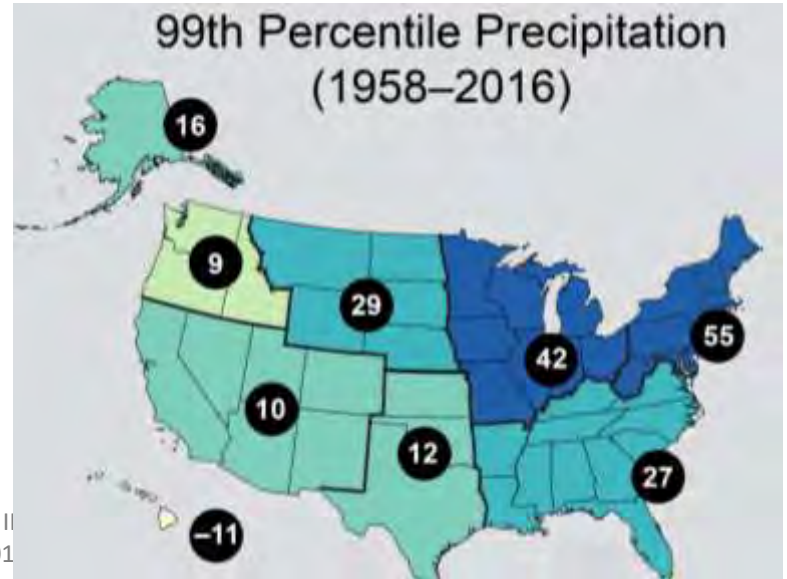


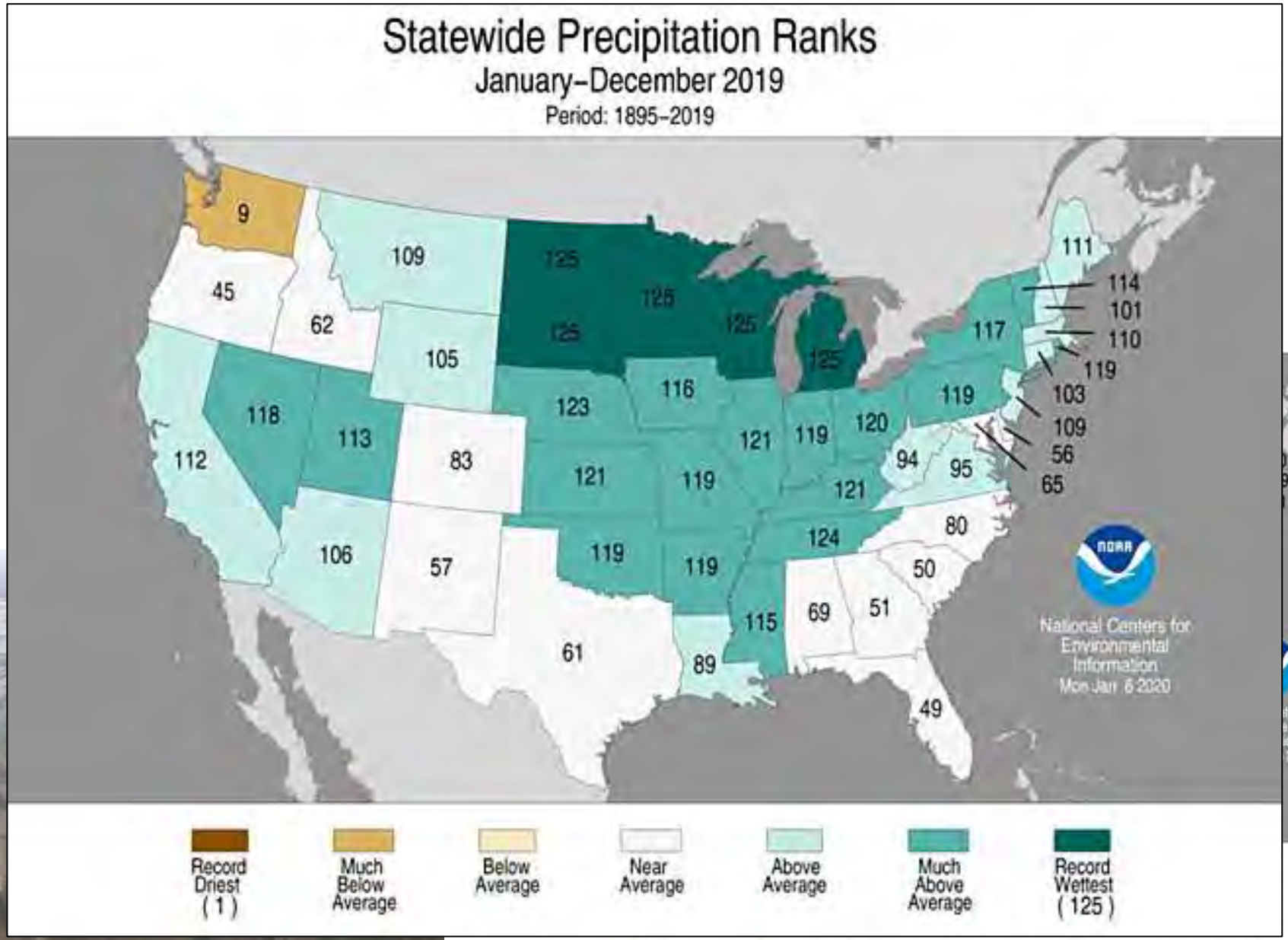
Fig. 2.6: Projected Changes in U.S. Heavy Precipitation Events

Heavy precipitation is becoming more intense and more frequent across most of the U.S., and these trends are projected to continue in the future. Projected trends are shown for a lower and a higher scenario for the period 2070-2099 relative to 1986-2015. *Adapted from Easterling et al. 2017.*





An Amazing String of Months



Ranked Listing of State & Climate Division Data
Precipitation
MRCC Region
January to December values listed in decreasing or

Rank	Year	*	Total	Normal	Dep.	%Norm
1	2019	*	46.09	36.94	9.14	125
2	2018		43.06	36.94	6.11	117
3	1993		42.73	36.94	5.79	116
4	2015		42.52	36.94	5.58	115
5	1990		42.42	36.94	5.48	115
6	2008		41.98	36.94	5.04	114
7	1973		41.81	36.94	4.87	113
8	1951		41.49	36.94	4.54	112
9	2011		40.94	36.94	4.00	111
10	1982		40.67	36.94	3.73	110

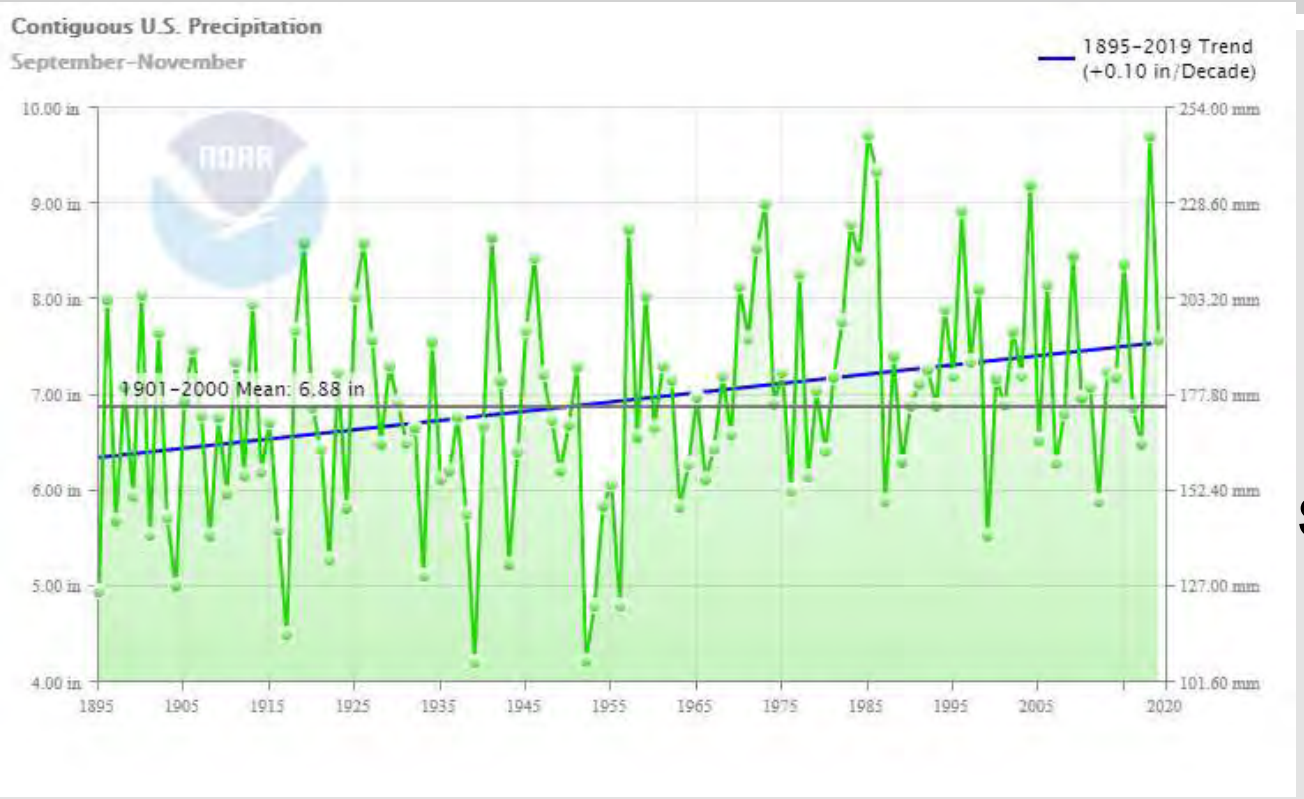
Midwest Region Wettest Ten-Year Periods

Ten-Year Period	Ten-Year Precipitation (in)	Rank
2010-2019	397.45	1
2009-2018	391.29	2
2008-2017	390.21	3
2007-2016	388.32	4
2006-2015	386.04	5
2002-2011	379.25	6
2004-2013	378.28	7
2005-2014	377.07	8
2001-2010	375.74	9
1977-1986	374.43	10
2003-2012	373.87	11

Using NCEI nClimDiv Data 1895-2019

Shows 10-year totals. Each of the past 5 (overlapping) 10-year periods was a new record. The most recent 10 10-year totals all rank in the top 11 cases with only 1977-1986 also among the top 11.

Precipitation Trends for the U.S.



Fall = 0.10”/decade

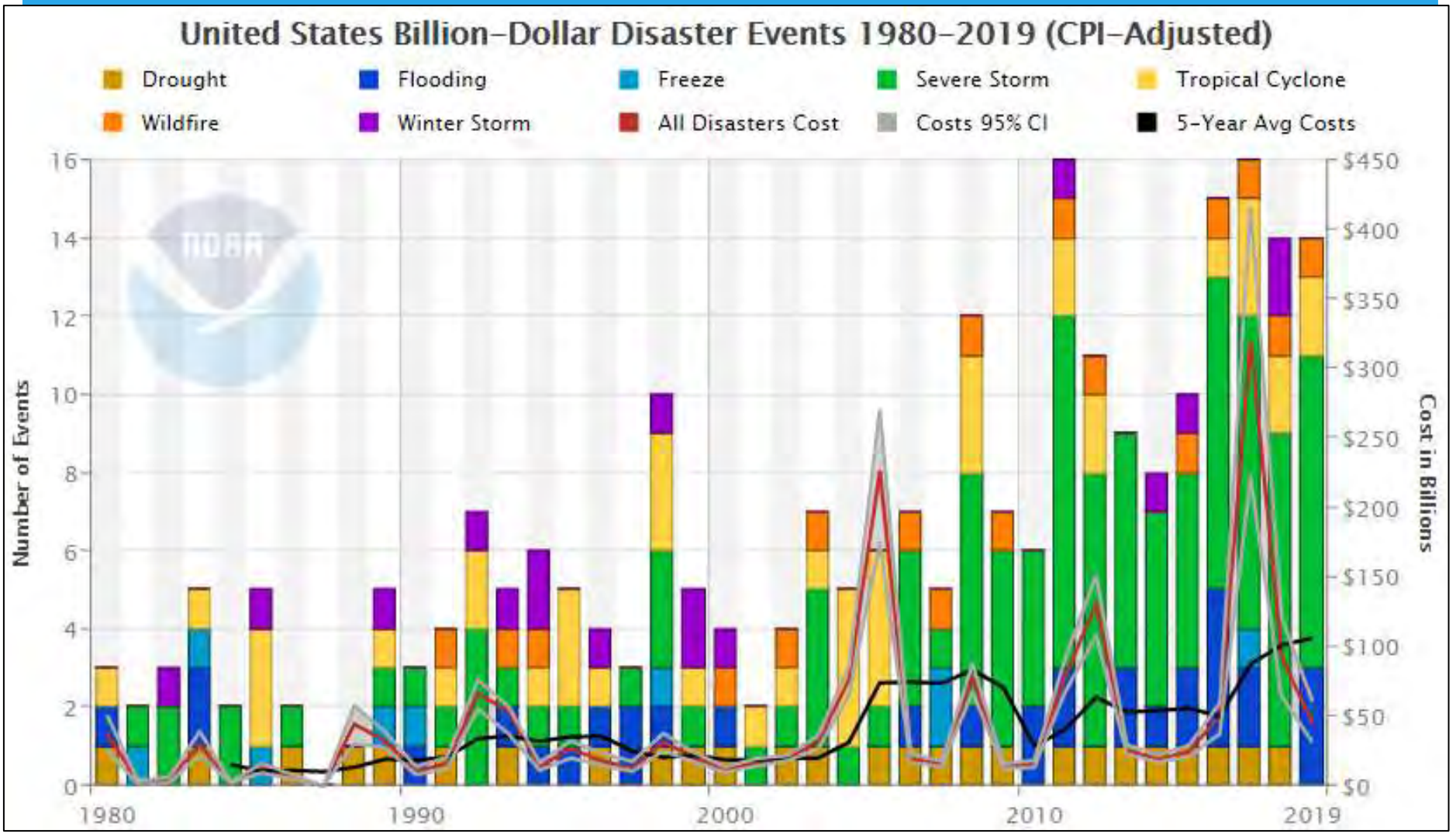
Winter = 0.02”/decade

Spring = 0.06”/decade

Summer = 0.02”/decade

"Some say it's irrevocable, others say it's irreversible. Given such an absence of consensus I suggest we do nothing drastic."

Billion Dollar Weather and Climate Events



https://www.ncdc.noaa.gov/billions/time-series

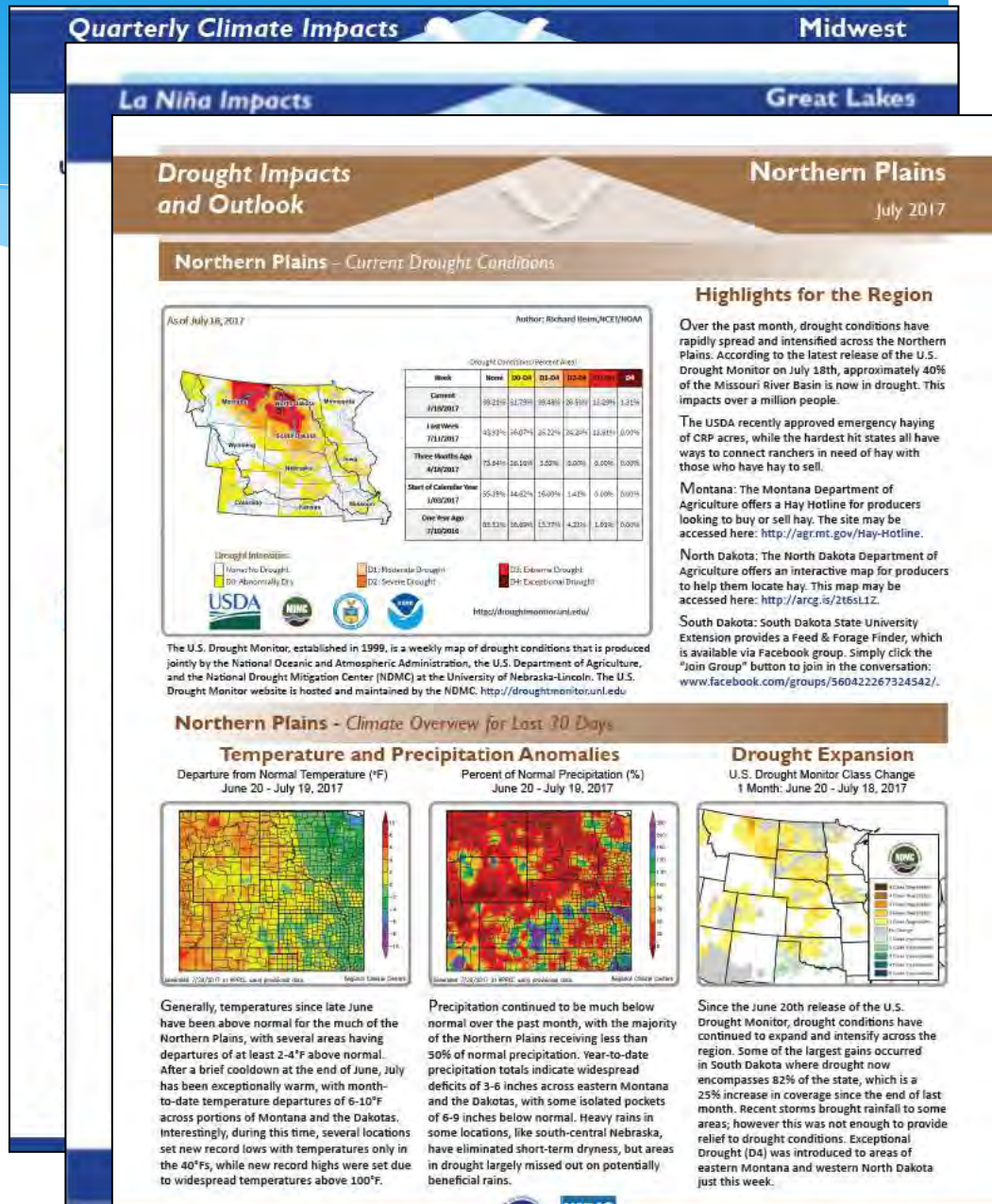
Monthly (North Central) Regional Climate Webinars
Real-Time Climate Service Support

* 16 states
* Q&A with "experts"
* Past, Current, Outlook Conditions
  * Highlight past events and anomalies
  * Discuss impacts and potential impacts
  * Outlook with potential impacts
* Presenters: State Climate Offices & NDMC & USDA

https://attendee.gotowebinar.com/register/7528179497868100876

Climate Support: Routine Briefs

* **Quarterly Regional briefs**
  * *Single page*
  * *Past, Present, Future*
  * *Non-technical*
* **Event Based**
  * *ENSO or Extreme*
  * *Non-technical*
  * *As needed*
  * *Potential regional impacts*
  * *High interest*
* **Multi-Partner**



Early Warning: 2020 Example

Central Region
Regional Operations Center

816-200-1140
crhroc@noaa.gov
weather.gov/crh

Extremely Wet Conditions Across the Region Sets the Stage for a Significant Spring Flood Season

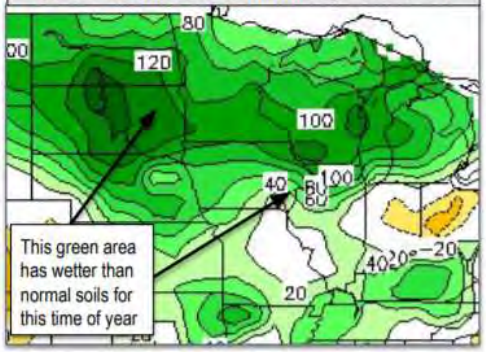
Setting the Stage:
Precipitation and Soil Moisture

Well above normal rain and snowfall throughout 2019 has led to record flooding, record high river levels, and abnormally wet ground for the winter season across the region.

Through the end of December 2019, the **Upper Mississippi River Basin and Red River Basin** have had their wettest year in 125 years of modern record keeping.

Across the region, Michigan, Minnesota, the Dakotas, Wisconsin and Illinois all recorded their top 5 wettest years (January 2019 – December 2019).

Total Soil Moisture: Percent of Normal through December 2019



ABOVE: Wet soils (green) across most of the Upper Mississippi River Basin and Red River of the North can accept very little or no more water.
Source: NOAA/NCEP/CPC

Setting the Stage:
Snowpack

The seasonal snowpack continues to build across the Upper Mississippi River and Red River Basins. As of January 22, there is between 10-25 inches of snow depth across portions of North and South Dakota and into northern Minnesota and northern Wisconsin. Isolated snow depth of 30 inches or higher have also been observed in northern Minnesota.

This snow is holding anywhere from 2-8 inches of water within it - waiting to be released. The highest amounts can be found from eastern North Dakota to the arrowhead of Minnesota and Upper Peninsula of Michigan.

Snow Water Equivalent as of 1/22/20

ABOVE: Snow Water Equivalent Map as of January 22, 2020.
Source OWP/NOHRSC

NOAA's Spring Flood Outlook
Release: March 19, 2020

Central Region
Regional Operations Center

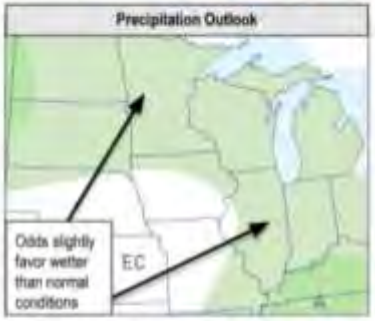
Precipitation Outlook and Potential Impacts this Spring

Late Winter/Spring 2020:
Outlook

We could be heading into the spring with wetter than normal soils and a healthy snowpack. Recent observations shows that several rivers and streams are running higher than normal.

The latest 2020 Winter Outlook suggests that odds favor a normal to **wetter than normal February through April** across much of the Upper Mississippi River and Red River basins, with higher odds farther north. We are also expecting **cooler than normal temperatures** as you head farther north, which could hold onto the snowpack longer into the spring. This increases the risk for a sudden and high-impact thaw in the spring.

Precipitation Outlook



ABOVE: The outlook indicates odds favor higher than normal precipitation from February through April across areas that already have wet soil and high river levels.
(Get the latest outlook: www.cpc.ncep.noaa.gov)

What are the ingredients of a significant spring flood season?

A repeat of 2019 is not a guarantee. There is still a lot of time and factors that would need to come together before we will know just how bad, or how uneventful it will be.

Factors that would improve the flood situation:

- A period of dry, warm weather allowing soil to drain and evaporate existing moisture
- Little to no additional snowfall with no extreme cold snaps
- Gradual transition out of winter into spring with mild daytime temperatures and night time low temperatures below freezing - this will allow snow to ripen and melt off a little bit at a time

Factors that would lead to spring flooding:

- Above normal snowpack across the basin
- A long-lived, widespread cold snap on bare ground that freezes the soil deep below the surface and builds a thick layer of river ice
- Sudden transition from winter to spring that melts the snowpack rapidly and increases the chance for ice jams on the rivers
- A significant rain event on top of snow pack that releases the water in the snow rapidly

Potential Impacts

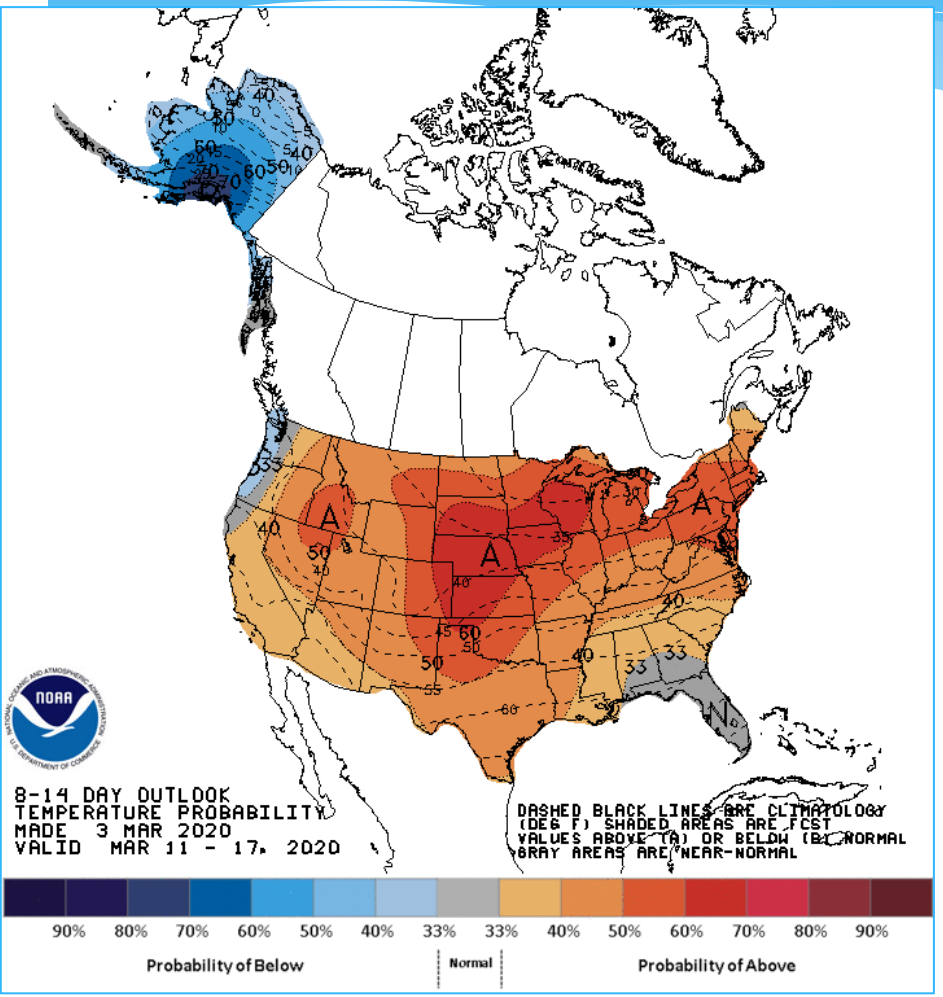
Unusually high streamflow, water levels, and abnormally wet soil suggest the following potential impacts for the upcoming spring season:

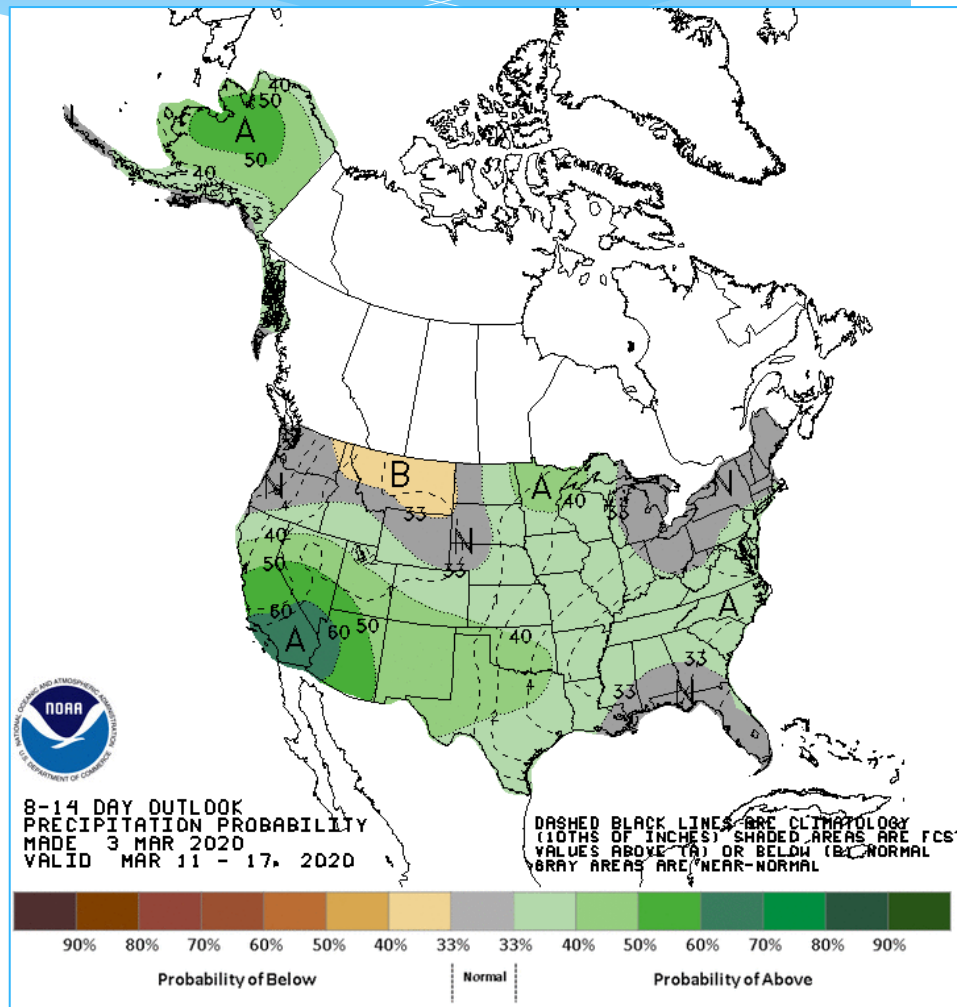
- Widespread ice jams, including on some rivers that are not usually affected by ice jams
- Widespread major flooding again this spring
- Delay or prevention of crop planting
- Long-term soil damage
- Travel impacts due to road, dam, levee, and bridge damage

For more information visit:

Local Forecast – weather.gov
Long Range Outlooks – cpc.ncep.noaa.gov
River Forecasts – water.weather.gov/ahps/forecasts.php
Weather & Climate Data – ncei.noaa.gov

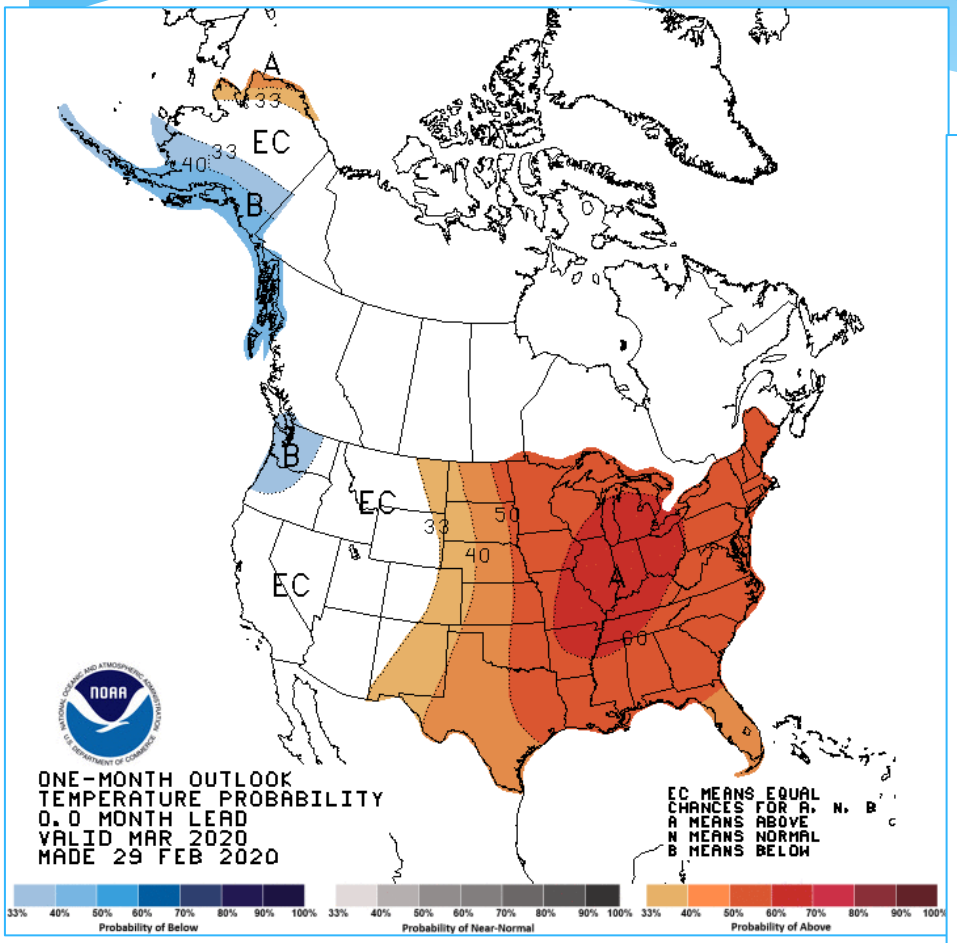
Outlooks for March 11-17, 2020

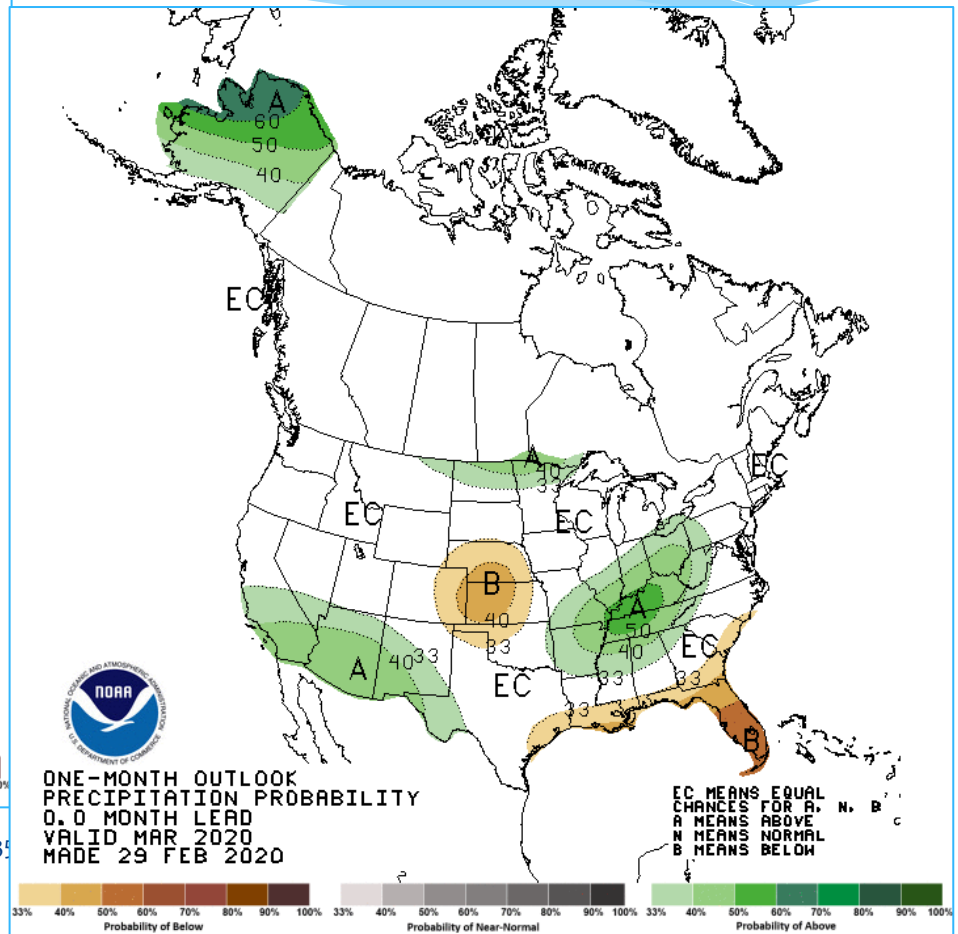




https://www.cpc.ncep.noaa.gov/

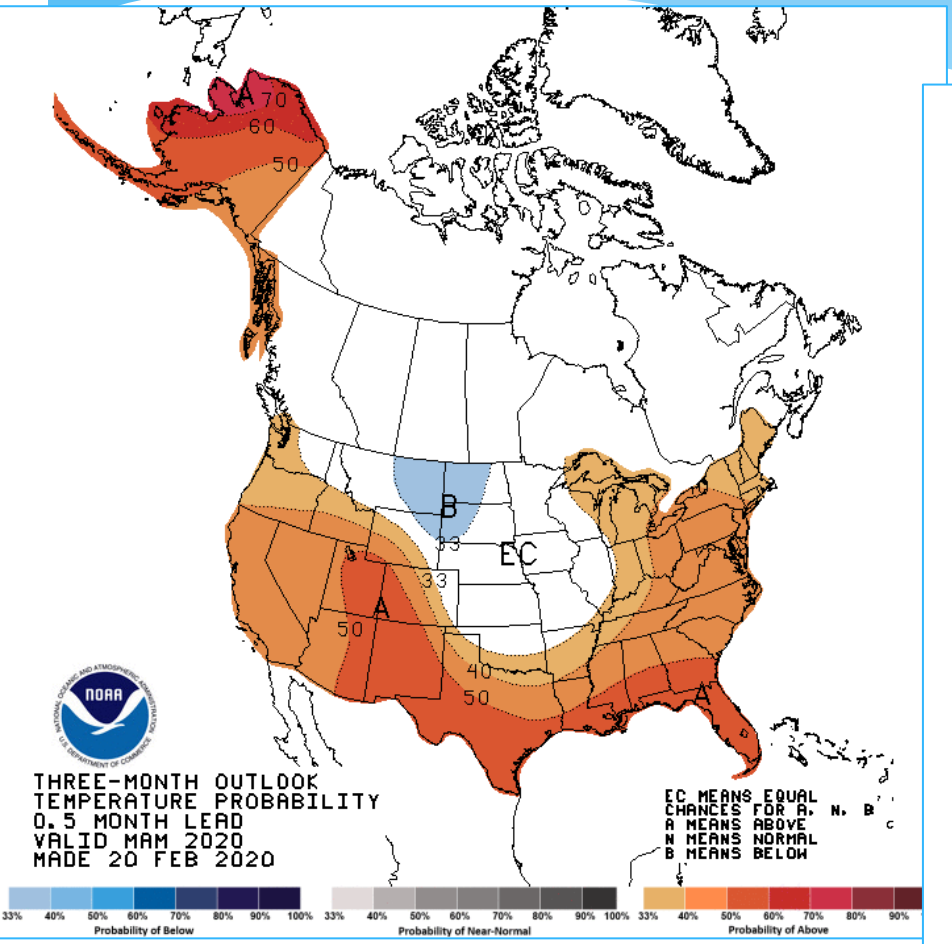
Outlook for March

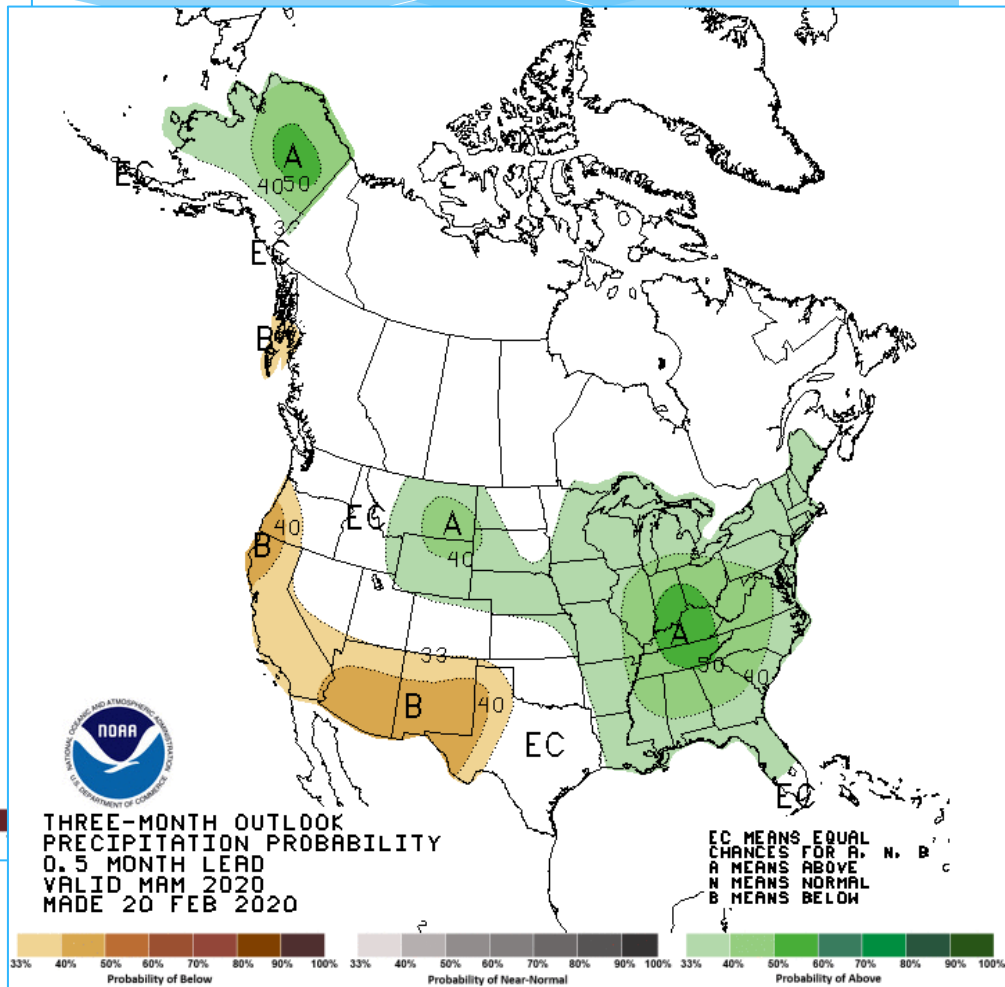




https://www.cpc.ncep.noaa.gov/

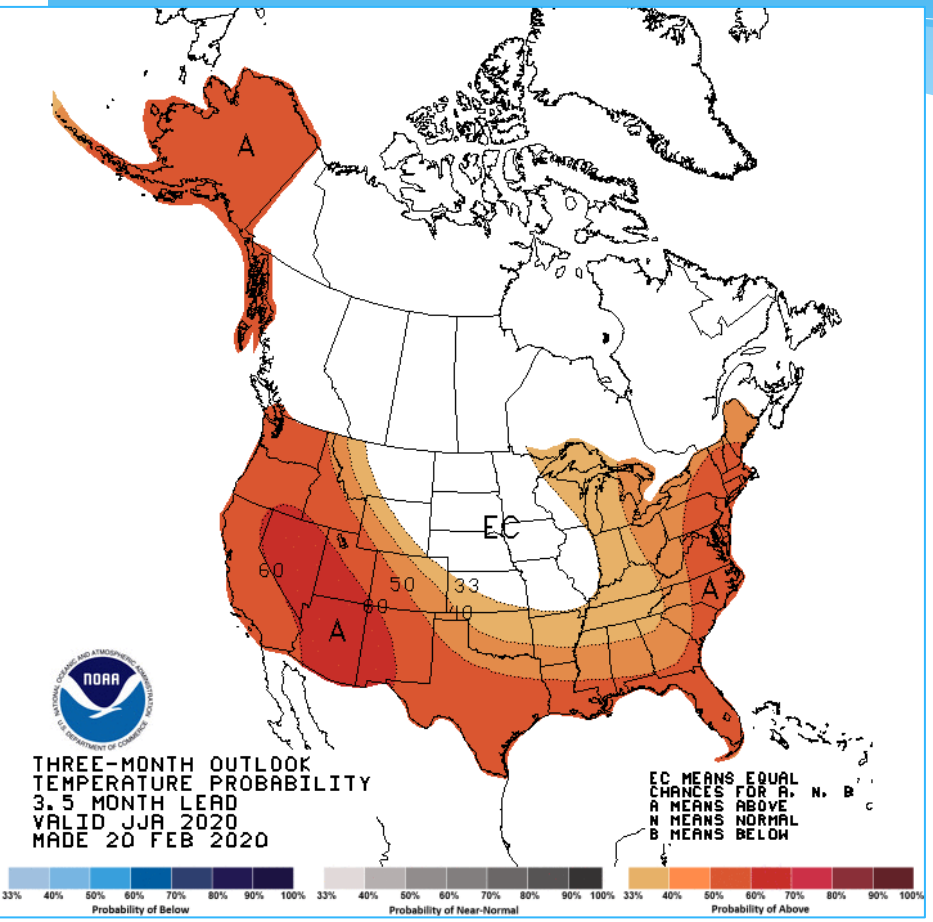
Outlook for March - May

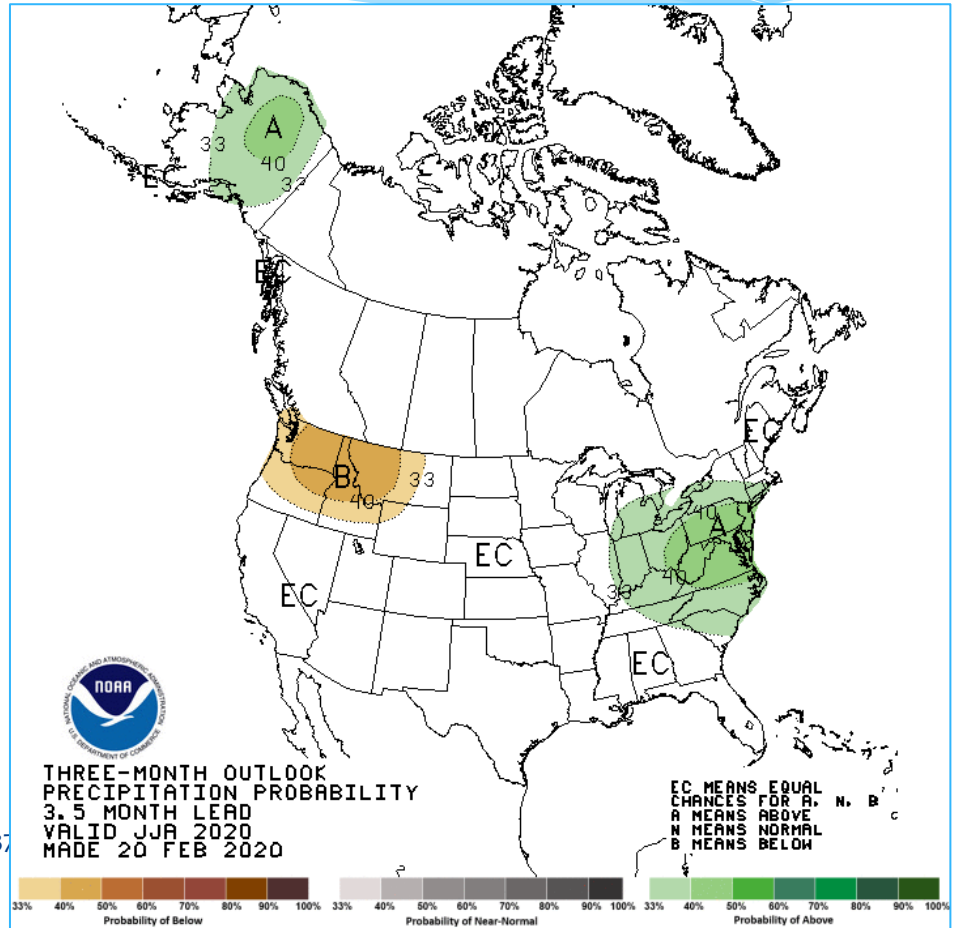




https://www.cpc.ncep.noaa.gov/

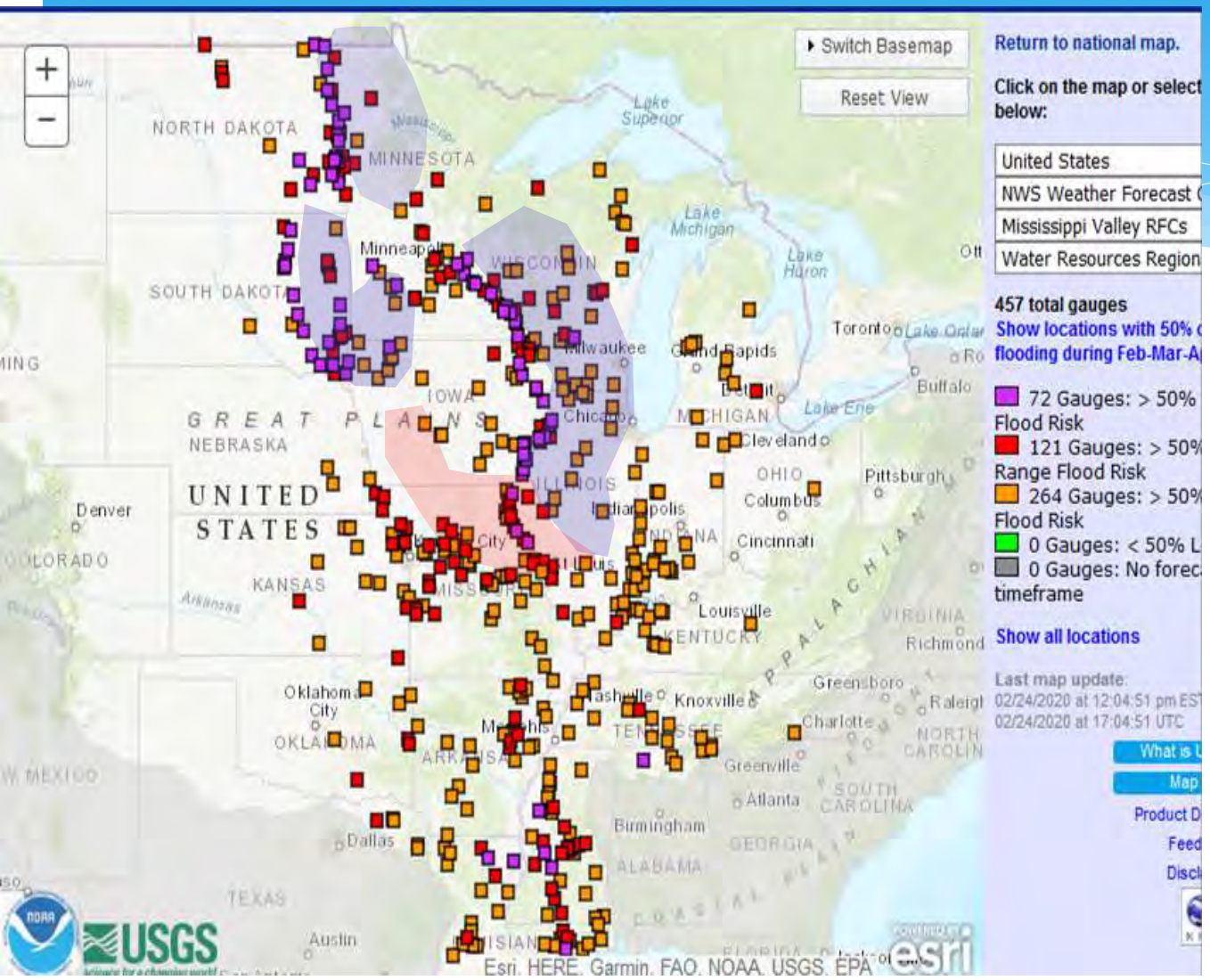
Outlook for June - August





https://www.cpc.ncep.noaa.gov/

Greater Mississippi River Valley
2020 Feb-March-April Flood Outlook



~30% of the 1500 forecast locations within the MS Basin are likely to flood.

Particular concern along:

- **Red River of the North**
- **James River**
- **Big Sioux River**
- **Upper Mississippi River**
- **Lower Missouri River***

As of 2/27/20

Thank You

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