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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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."



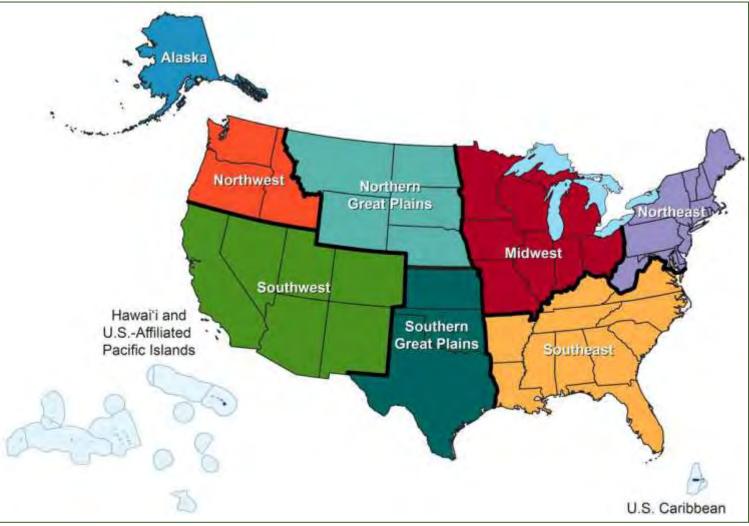
- 13 Federal Departments & Agencies + Executive Office of the President
- 300+ Authors
- 2 years writing & reviews
- Every 4 years
- Public Engagement

More information:

http://www.globalchange.gov



Our Changing Climate: *Regions*



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2017



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

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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.



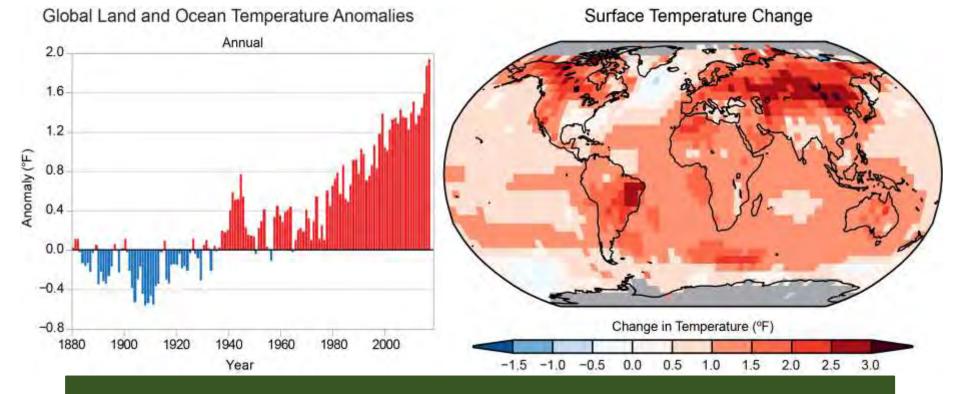


Figure 1: Global Temperature

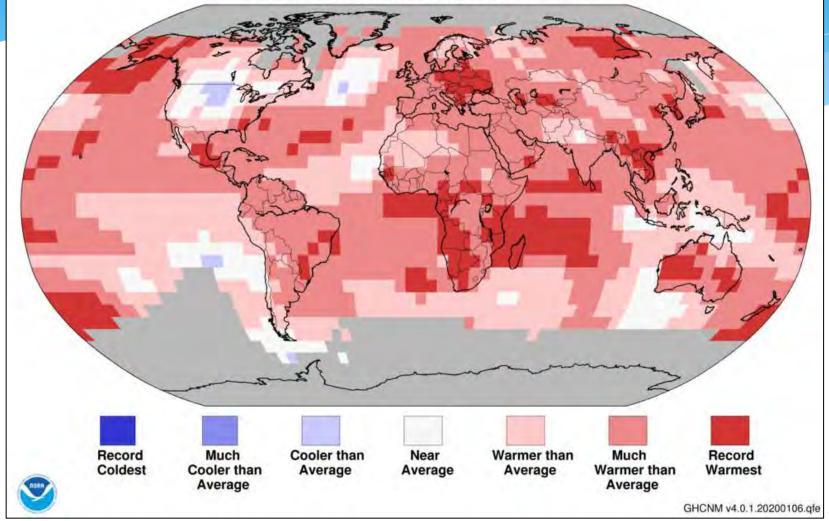
Caption: (left) Global annual average temperature has increased by more than 1.2°F (0.7°C) for the period 1986–2016 relative to 1901–1960. Red bars show temperatures that were above the 1901–1960 average, and blue bars indicate temperatures below the average. (right) Surface temperature change (in °F)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



Land & Ocean Temperature Percentiles Jan-Dec 2019

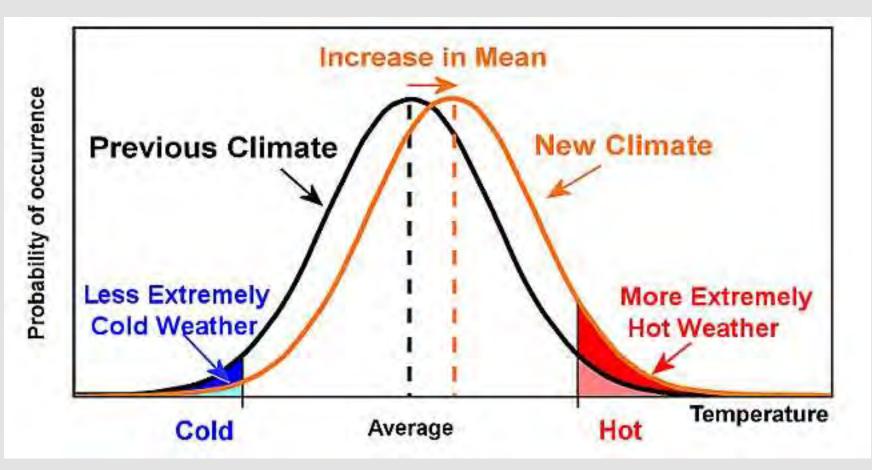
NOAA's National Centers for Environmental Information

Data Source: NOAAGlobalTemp v5.0.0-20200108



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	₁₁ 1.17

Annual Temperature

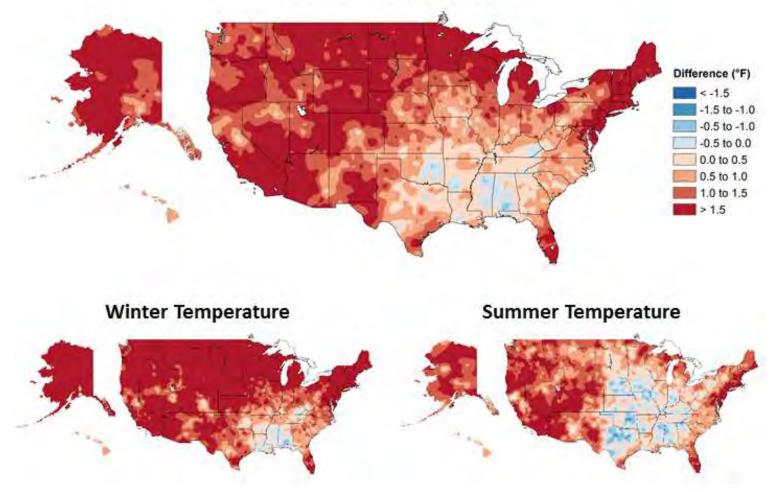
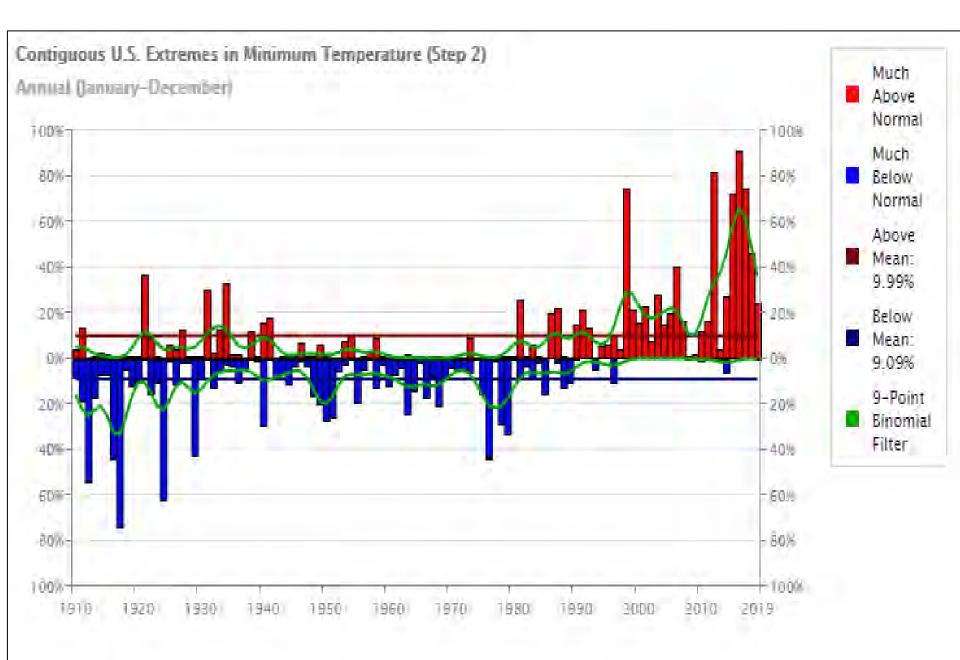


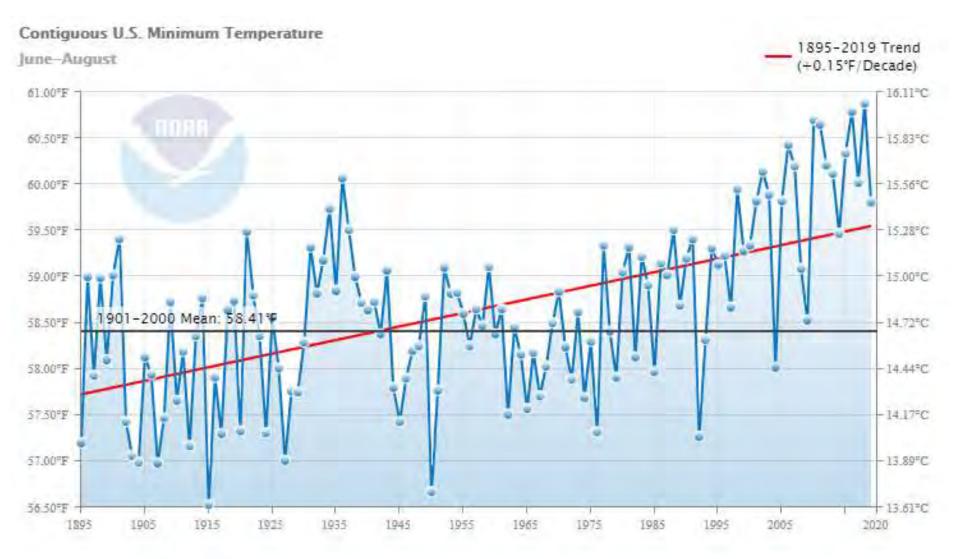
Figure 6.1: Observed Warming

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).

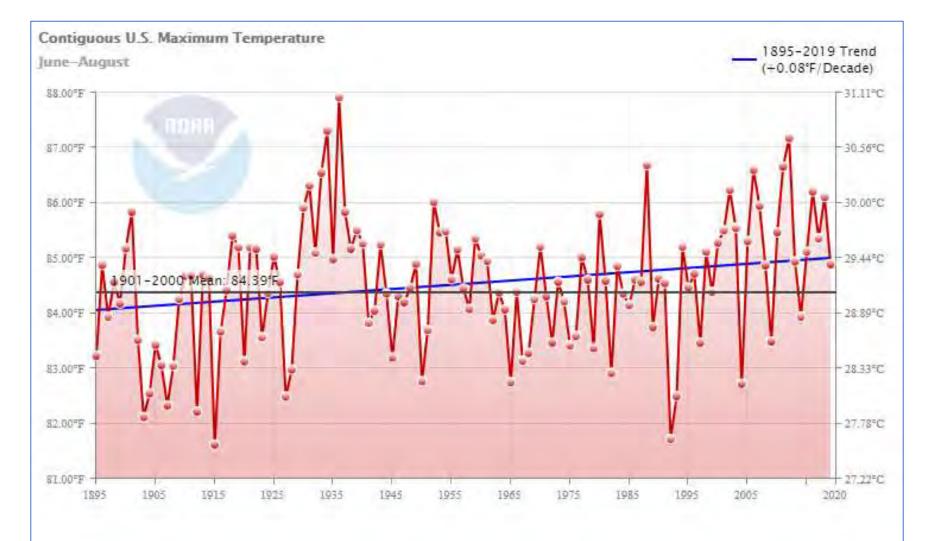




Minimum Temperature Trend U.S. Annual and Summer

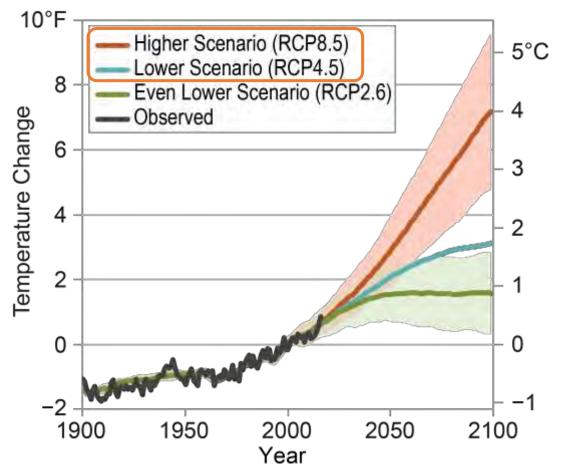


Maximum Temperature Trend U.S. Summer



Our Changing Climate: Scenarios

Global Average Temperature Change



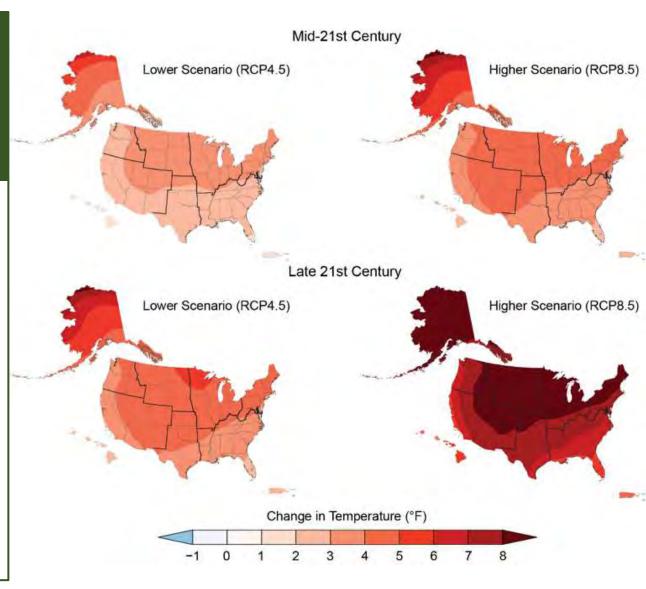


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Fig. 1.3: Projected Changes in U.S. Annual Average Temperature

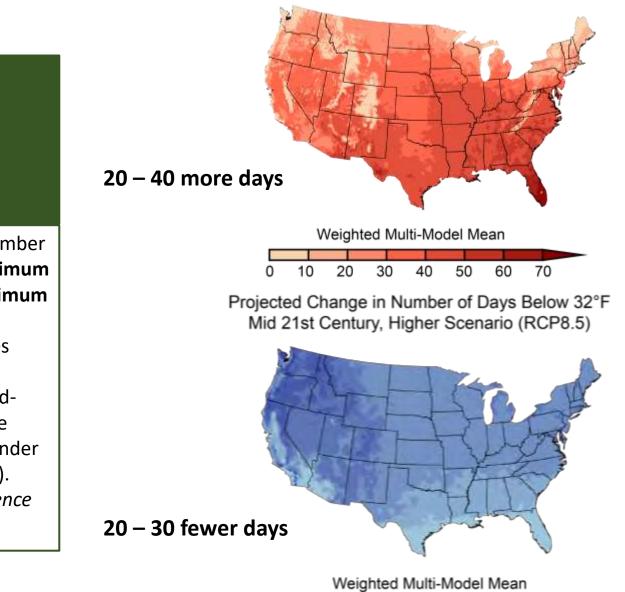
Annual average temperatures across the United States are projected to increase over this century, with greater changes at higher latitudes as compared to lower latitudes, and under a higher scenario (RCP8.5; right) than under a lower one (RCP4.5; left). This figure shows projected differences in annual 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).

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Projected Change in Number of Days Above 90°F Mid 21st Century, Higher Scenario (RCP8.5)



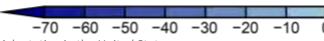


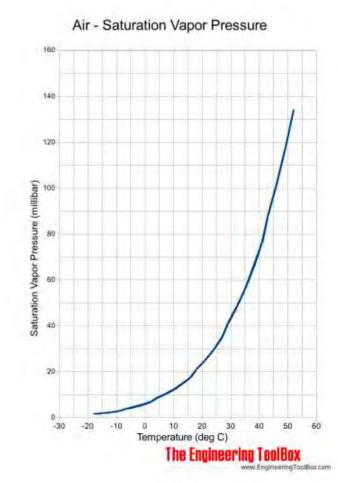
Fig. 6.9: Projected Changes in U.S. Temperature Extremes

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 midcentury (2036-2065) and the near-present (1976-2005) under the higher scenario (RCP8.5). *Image from the Climate Science Special Report, 2017*.

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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





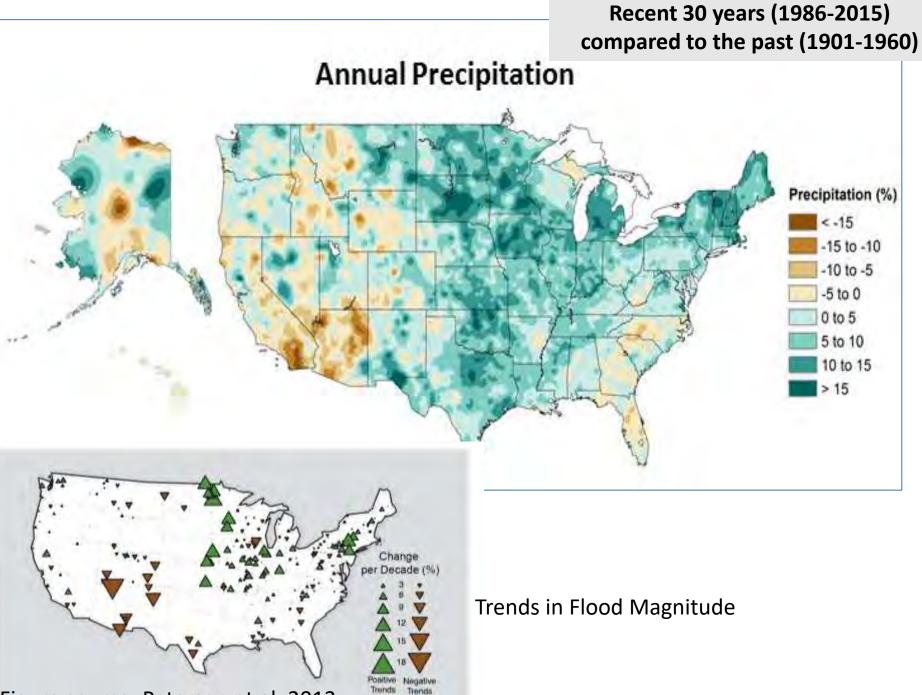
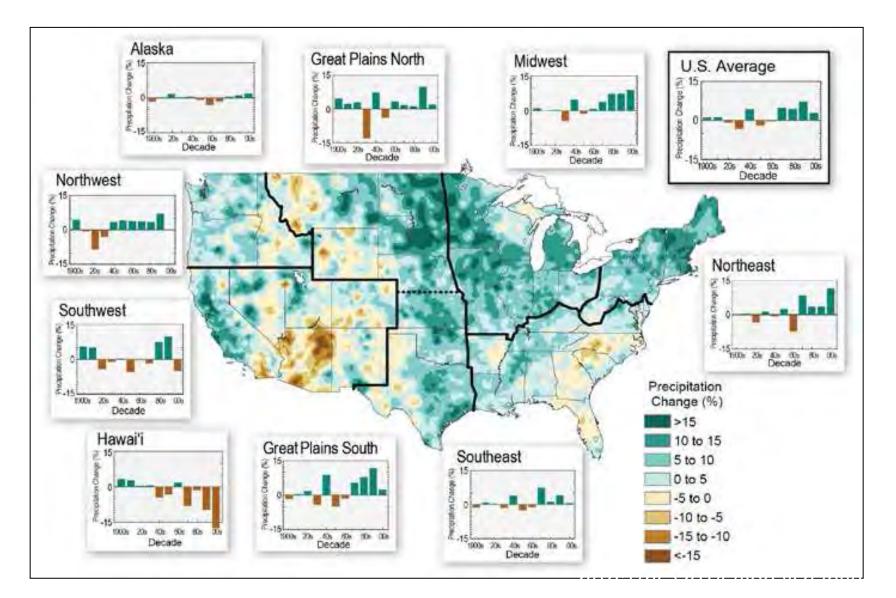
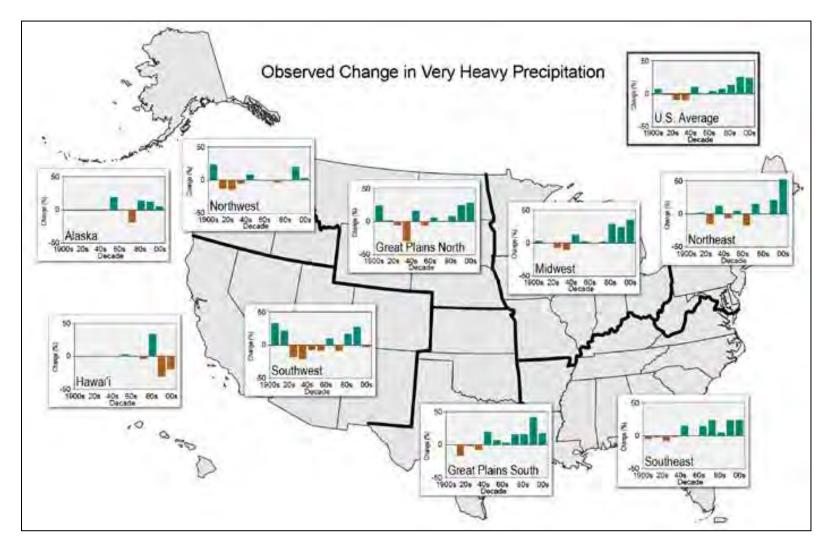


Figure source: Peterson et al. 2013

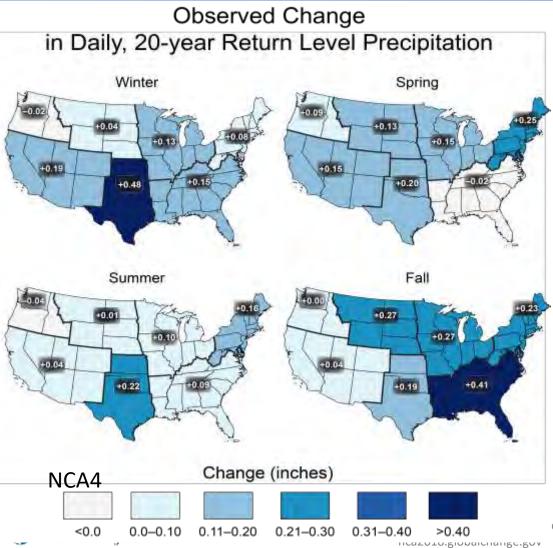
Precipitation Trends (from NCA3)



Observed Change in Very Heavy Precipitation



Heavy Rainfall

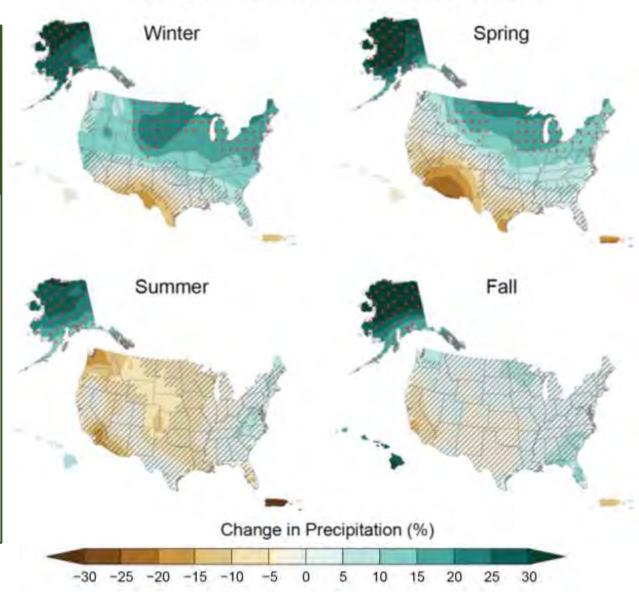


- Daily 20-year Return means amount of rainfall expected to occur, on average, once every 20 years
- Amounts have increased more than 0.4 inch in places (slight decrease in some places)
- Varies geographically by season

Late 21st Century, Higher Scenario (RCP8.5)

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.*

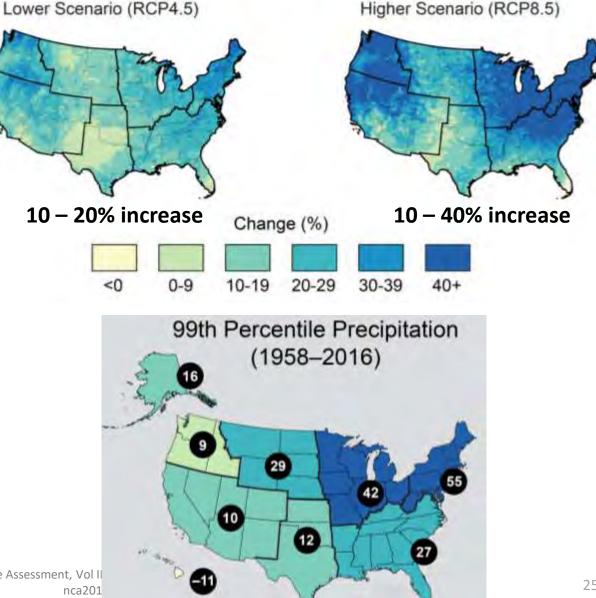




Projected Change in Total Annual Precipitation Falling in the Heaviest 1% of Events by Late 21st Century

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

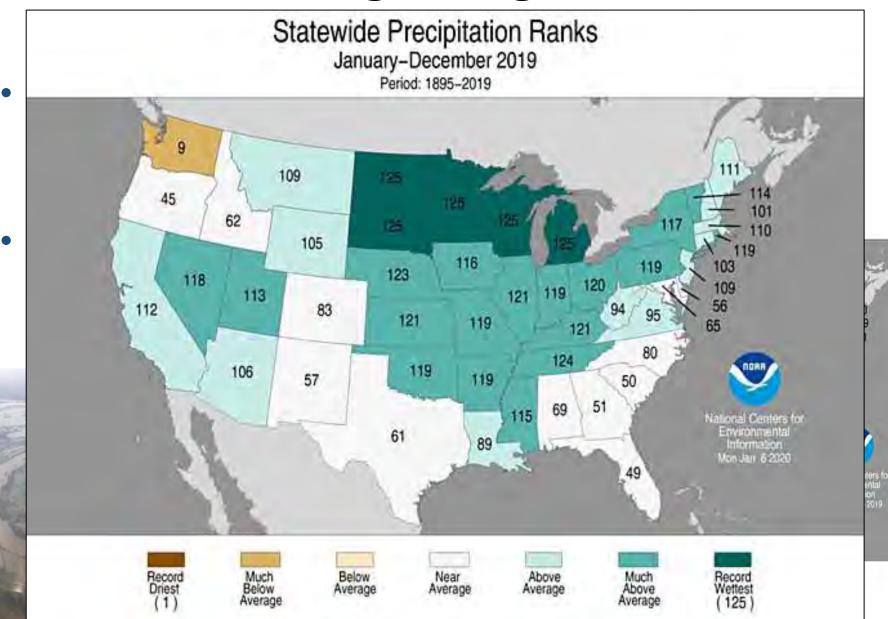
Heavy precipitation is becoming more intense and more frequent across most of the U.S., and these trends are projected to continue in the future. Projected trends are shown for a lower and a higher scenario for the period 2070-2099 relative to 1986-2015. Adapted from Easterling et al. 2017.



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Fourth National Climate Assessment, Vol II

An Amazing String of Months



Ranked Listing of State & Climate Division Data Precipitation MRCC Region

January to December values listed in decreasing or

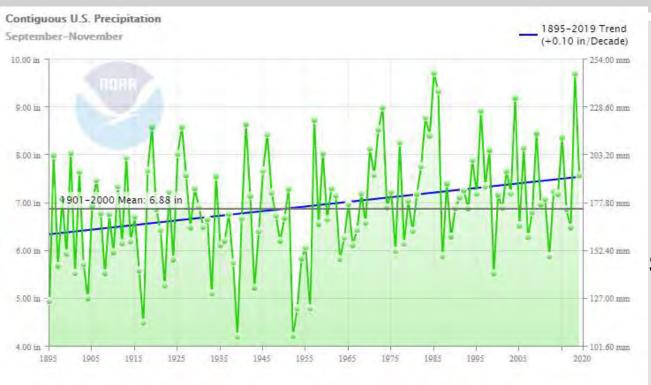
Rank	Year *	Total	Normal	Dep.	%Norm	
1	2019 *	46.09	36.94	9.14	125	
2	2018	43.06	36.94	6.11	117	
3	1993	42.73	36.94	5.79	116	
4	2015	42.52	36.94	5.58	115	
5	1990	42.42	36.94	5.48	115	
6	2008	41.98	36.94	5.04	114	
7	1973	41.81	36.94	4.87	113	
8	1951	41.49	36.94	4.54	112	
9	2011	40.94	36.94	4.00	111	
10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

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

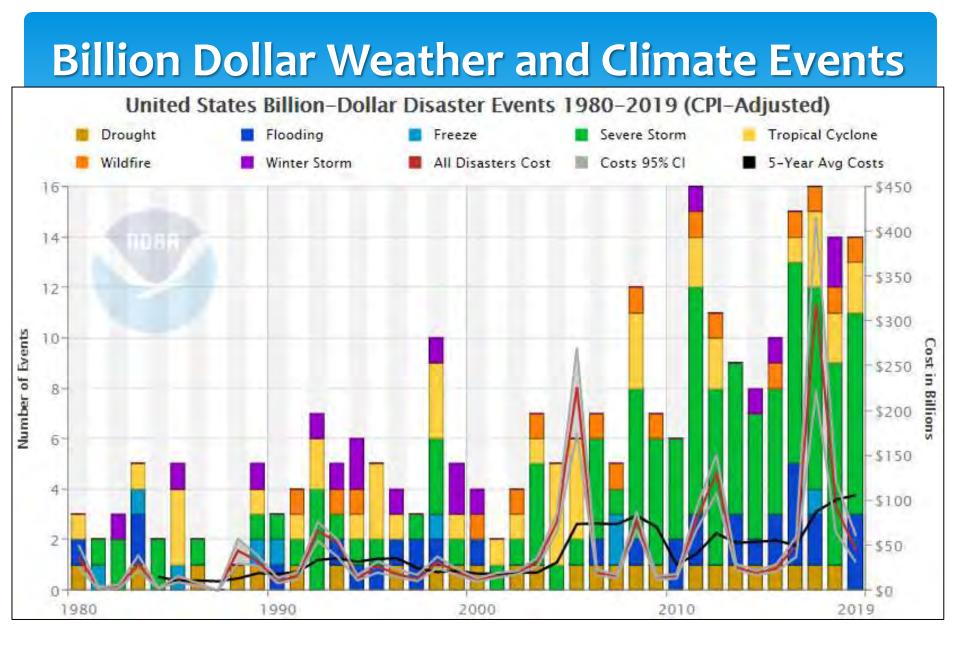
Spring = 0.06"/decade

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."





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 and Drought Outlook

Climate Specialist/ Senior RA Department of Extension/BPCRC State Climate Office of Ohio (SCOO The Ohio State University willion: 1010/ansi: edu: (614) 297-29

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**

Quarterly Climate Impacts La Niña Impacts

Drought Impacts and Outlook

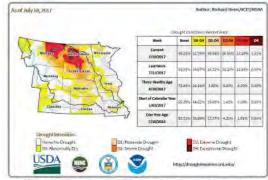
Northern Plains

July 2017

Great Lakes

Midwest

Northern Plains - Cuttent Drought Conditions

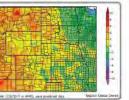


The U.S. Drought Monitor, established in 1999, is a weekly map of drought conditions that is produced jointly by the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture, and the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln. The U.S. Drought Monitor website is hosted and maintained by the NDMC, http://droughtmonitor.unl.edu

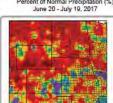
Northern Plains - Climate Overview for Last 30 Days

Temperature and Precipitation Anomalies Departure from Normal Temperature (*F) June 20 - July 19, 2017

Percent of Normal Precipitation (%) June 20 - July 19, 2017



Generally, temperatures since late June have been above normal for the much of the Northern Plains, with several areas having departures of at least 2-4"F above normal. After a brief cooldown at the end of June, July has been exceptionally warm, with monthto-date temperature departures of 6-10°F across portions of Montana and the Dakotas. Interestingly, during this time, several locations set new record lows with temperatures only in the 40°Fs, while new record highs were set due. to widespread temperatures above 100°F.



Precipitation continued to be much below normal over the past month, with the majority of the Northern Plains receiving less than 50% of normal precipitation. Year-to-date precipitation totals indicate widespread deficits of 3-6 inches across eastern Montana and the Dakotas, with some isolated pockets. of 6-9 inches below normal. Heavy rains in some locations. like south-central Nebraska. have eliminated short-term dryness, but areas in drought largely missed out on potentially beneficial rains

Highlights for the Region Over the past month, drought conditions have

rapidly spread and intensified across the Northern Plains. According to the latest release of the U.S. Drought Monitor on July 18th, approximately 40% of the Missouri River Basin is now in drought. This impacts over a million people

The USDA recently approved emergency having of CRP acres, while the hardest hit states all have ways to connect ranchers in need of hay with those who have hav to sell.

Montana: The Montana Department of Agriculture offers a Hay Hotline for producers looking to buy or sell hay. The site may be accessed here: http://agr.mt.gov/Hay-Hotline

North Dakota: The North Dakota Department of Agriculture offers an interactive map for producers to help them locate hay. This map may be accessed here: http://arcg.is/2t6sL1Z.

South Dakota: South Dakota State University Extension provides a Feed & Forage Finder, which is available via Facebook group. Simply click the "Join Group" button to join in the conversation: www.facebook.com/groups/560422267324542/





Since the lune 20th release of the U.S. Drought Monitor, drought conditions have continued to expand and intensify across the region. Some of the largest gains occurred in South Dakota where drought now encompasses 82% of the state, which is a 25% increase in coverage since the end of last month. Recent storms brought rainfall to some areas: however this was not enough to provide relief to drought conditions. Exceptional Drought (D4) was introduced to areas of eastern Montana and western North Dakota just this week.

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.

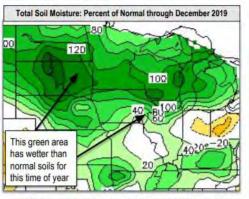
Across the region, Michigan, Minnesota, the Dakotas, Wisconsin and Illinois all recorded their top 5 wettest years (January 2019 – December 2019).

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.

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



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





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 nurving higher than normal.

The latest 2020 Winter Outlook suggests that odds favor a normal to wetter than normal Fabruary through April across much of the Upper Masinsippi River and Fed 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 sping. This increases the risk for a sudden and high-impact thew in the sping.

What are the ingredients of a significant spring flood season?

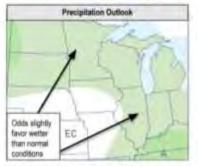
A repeat of 2019 is not a guarantee. There is still it lot of lime and factors that would need to come together before we will know just how bad, or how uneventful it will be.

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 anowfall with no extreme cold snaps
- Gradual transition out of winter into spring with mild daytime temperatures and night time low temperatures below freezing - this with allow show to ripen and mell off a title 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 freizes the soll deep below the surface and builds a thick layer of river ion
- Budden 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



ABOVE: The sufficient insticutes odds favor higher than normal precipitation from Patricery Immugh April across areas that already have wet sail and high fiver levels. (Bet the latest outflook: www.cpl.ncep.nces.good.gov)

Potential Impacts

Unusually Figh streamflow, water levels, and abnormally wet sol suggest the following potential impacts for the upcoming apring season:

- Wisinspread ice jame. Including on some rivers that are not usually affected by ica jame
- ·* Widespread major Rouding again this spring
- · Delay or prevention of crop planting
- · Long-term soll damage
- Travel impacts due to coad, dam, leves, and immige damage

For more information visit:

Local Forecast - weather gov Long Range Outsoks - opc resp.nosa gov River Rescasts - water weather govatios forecasts into Washer & Climate Data - noti rosa gov

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Outlooks for March 11-17, 2020

জিলা

60%

Probability of Above

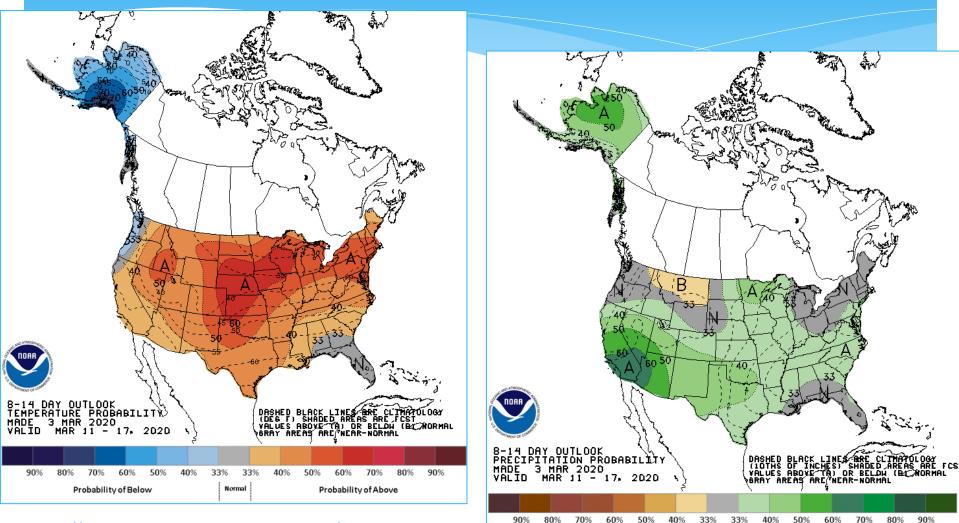
Normal

Probability of Below

70%

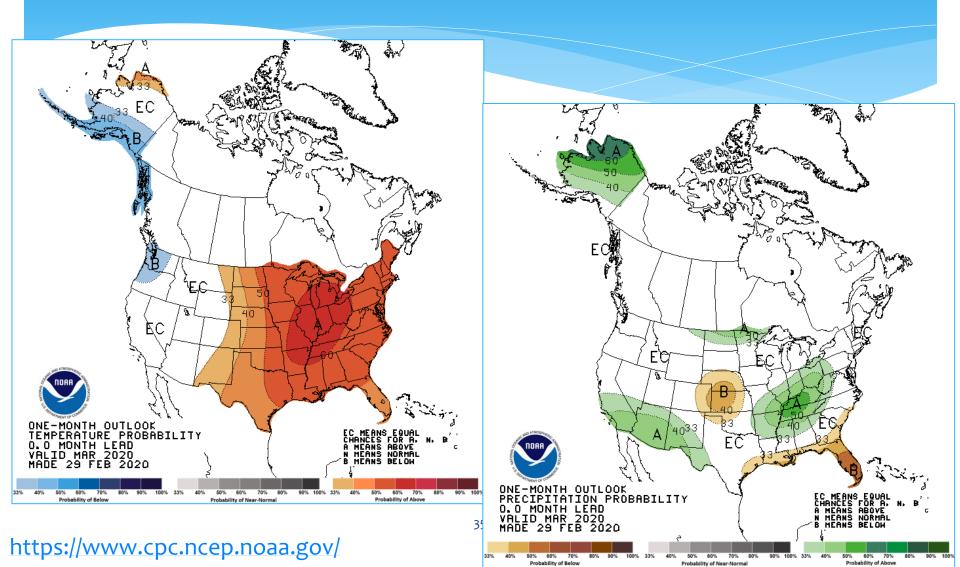
80%

90%

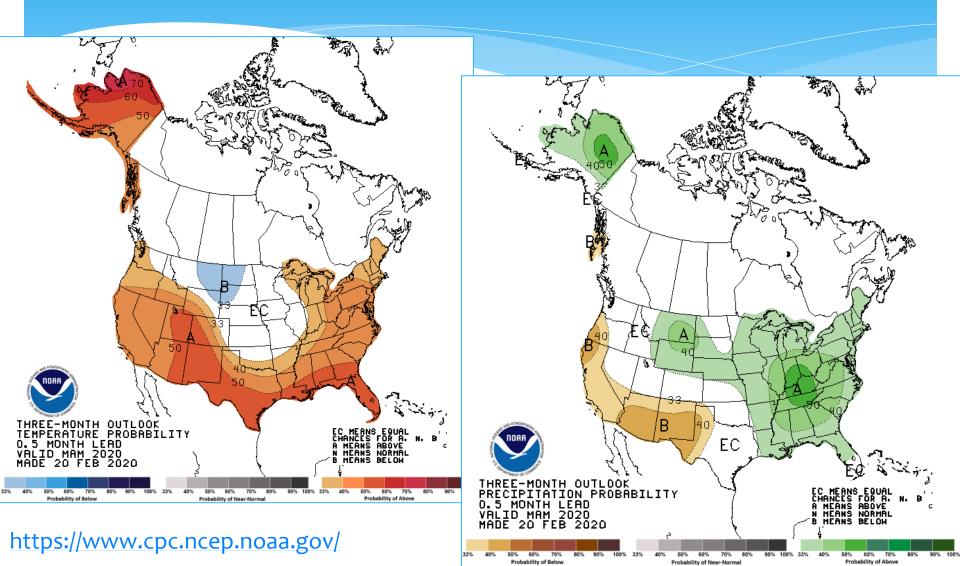


https://www.cpc.ncep.noaa.gov/

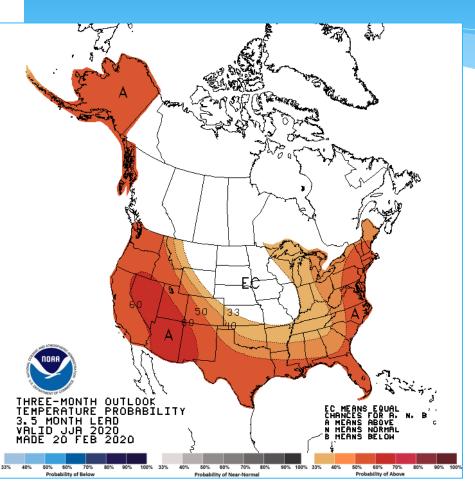
Outlook for March



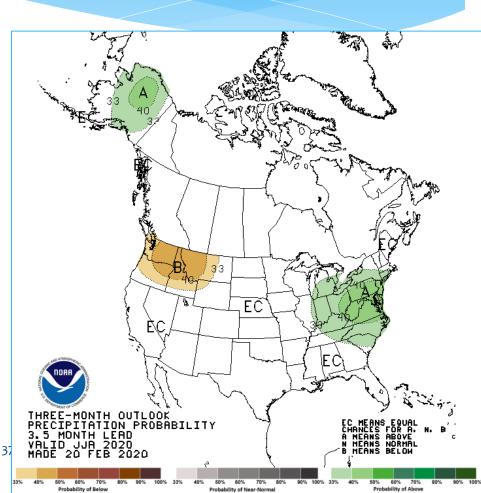
Outlook for March - May



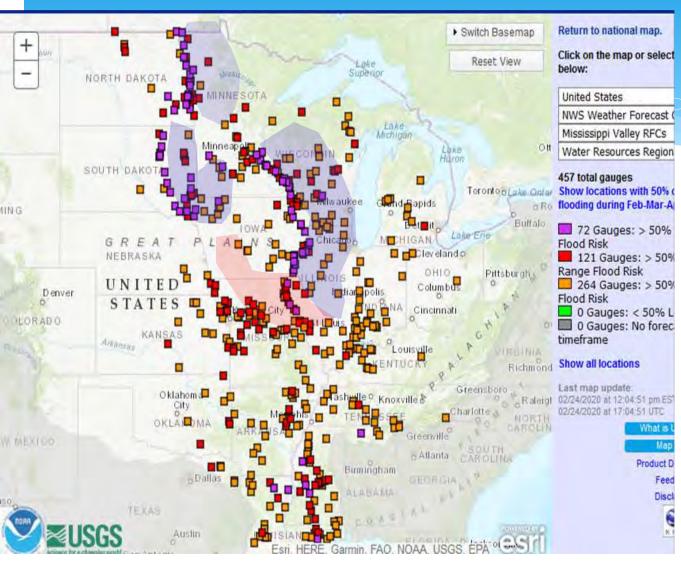
Outlook for June - August



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

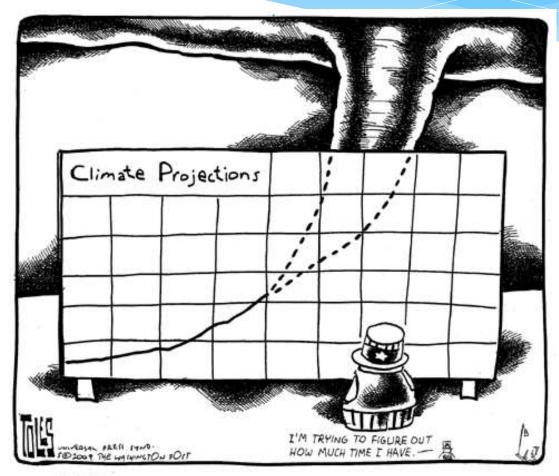
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- Big Sioux River
- Upper Mississippi River
 - Lower Missouri River*

As of 2/27/20

Thank You

Doug.kluck@noaa.gov



5.4.04