



# **Climate, Weather, and Laura Ingalls Wilder: Connecting Science to Narrative**

**Barb Mayes Boustead, Ph.D.**

NOAA/National Weather Service/Warning Decision Training Division

July 18, 2018

AMS Project ATMOSPHERE and Earth Educators Rendezvous



# A Little Bit About Me

 @windbarb

**A**ccumulated  
**W**inter  
**S**eaSon  
**S**everity  
**I**ndex





# Using Narrative to Communicate Science Information



# Laura Ingalls Wilder



Children's Book Series



# Connecting Weather/Climate to Other Subjects: Laura Ingalls Wilder

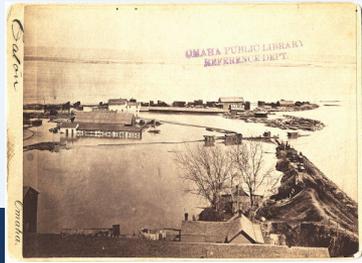
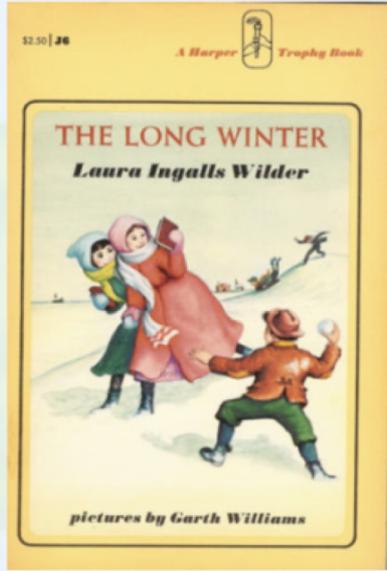
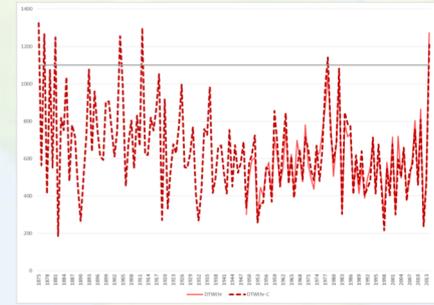


- What really happened during *The Long Winter* (1880-81)? Was it as bad as Laura said?
- How did drought affect the family?
- How is the climate different now than it was in Laura's time?





# The Long Winter: Weather, Climate, and a Narrative





**We'll Come Back to This...**



# Climate Background Information



# Weather vs. Climate

## Weather

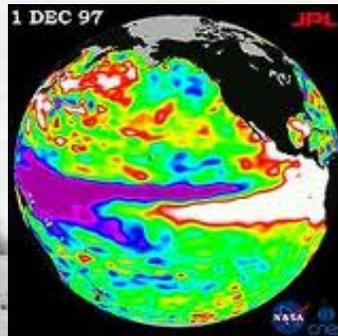


© 2004 Scott Blair

©Boustead 2012

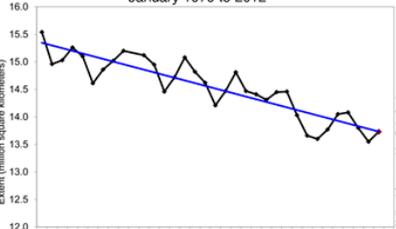
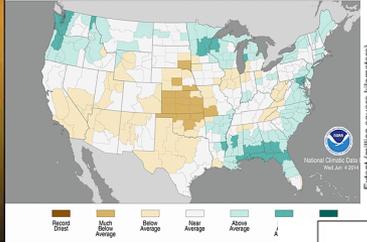


## Climate

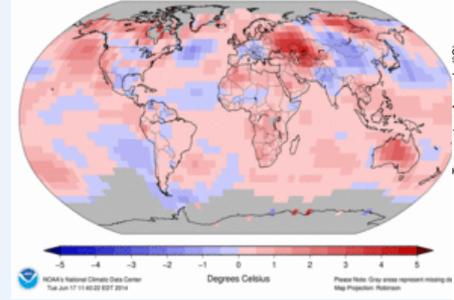


1 DEC 97  
Average Monthly Arctic Sea Ice Extent January 1979 to 2012

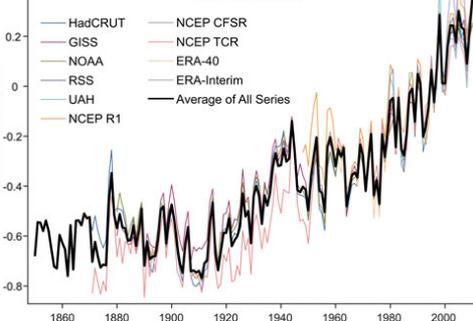
Divisional Precipitation Ranks March-May 2014  
Period: 1895-2014



Land & Ocean Temperature Departure from Average May 2014  
(with respect to a 1981-2010 base period)  
Data Source: GHCM-M version 3.2.2 & ERSST version 3b



Various Temperature Measurements (1990-2000 Baseline)

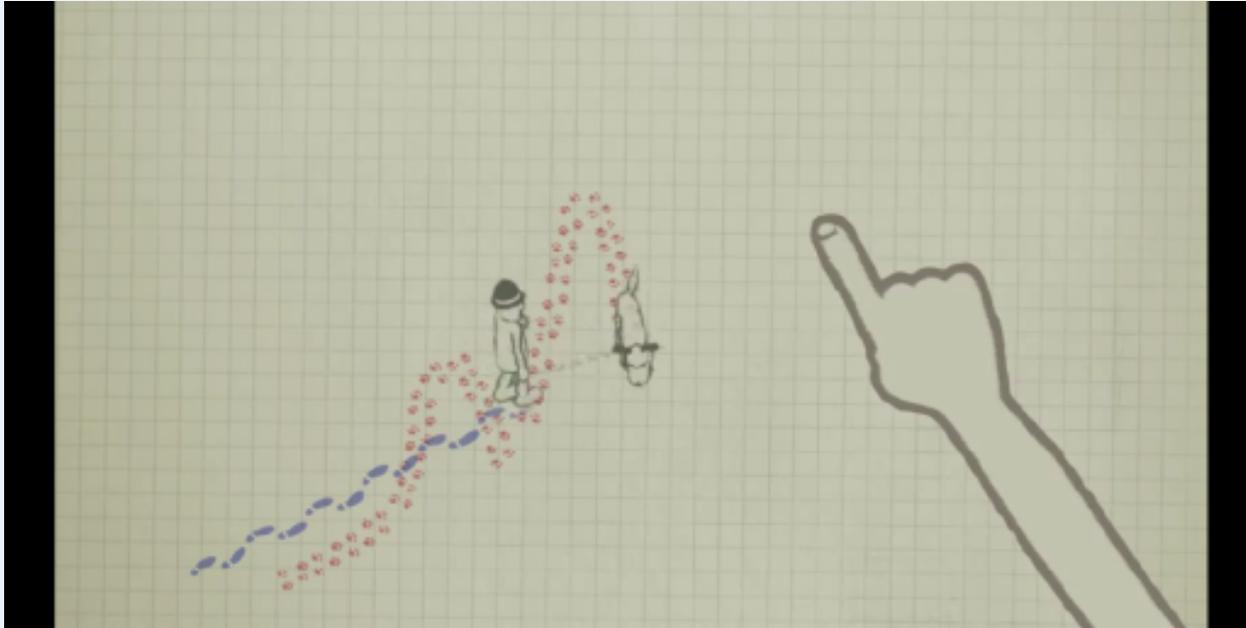




# Weather vs. Climate: Like Walking a Dog!



<http://spark.ucar.edu/video/dog-walking-weather-and-climate>

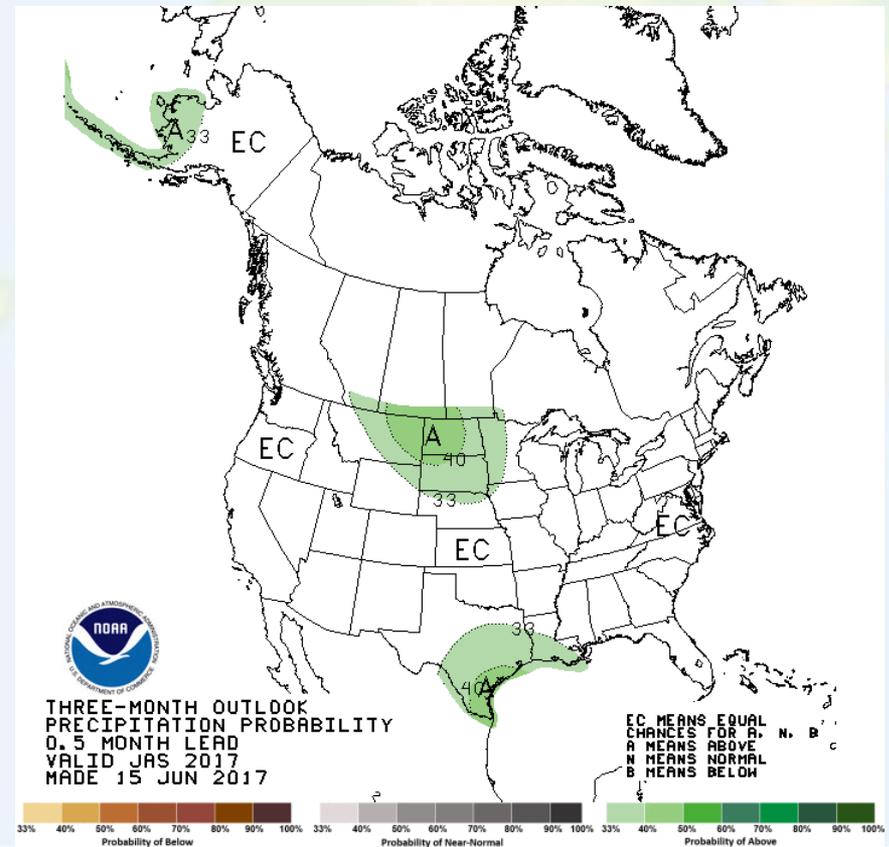
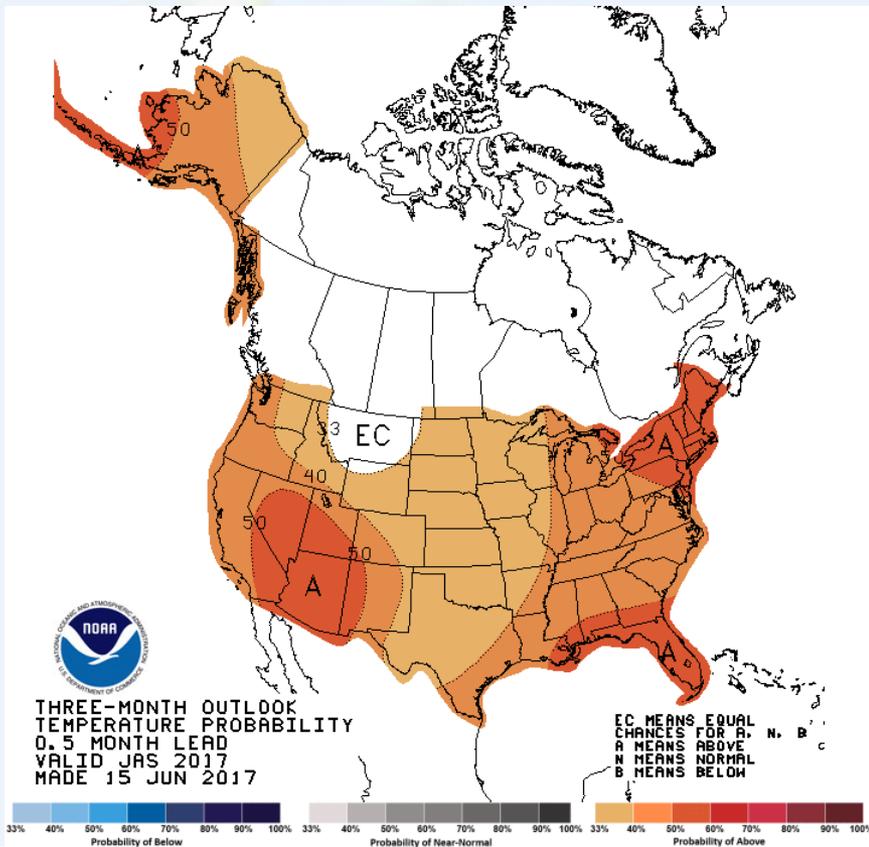




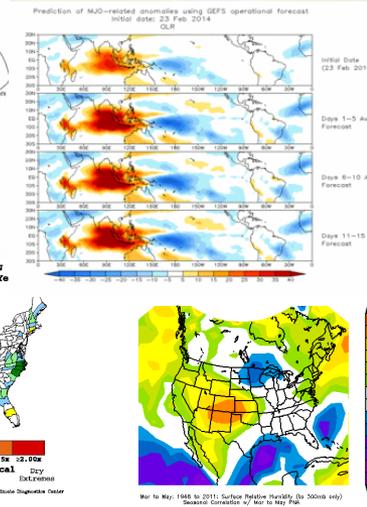
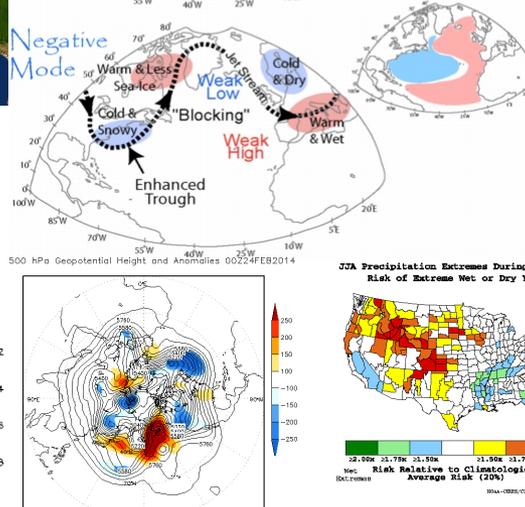
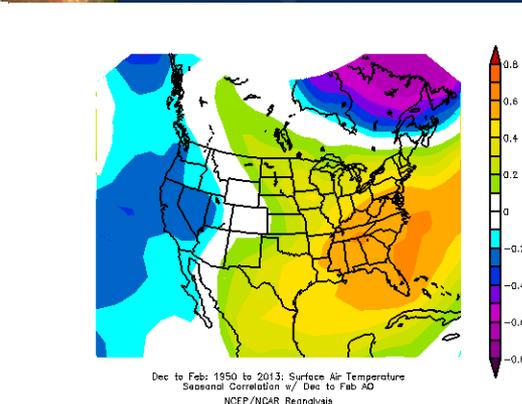
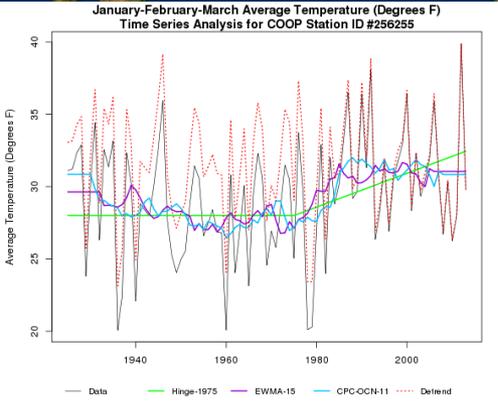
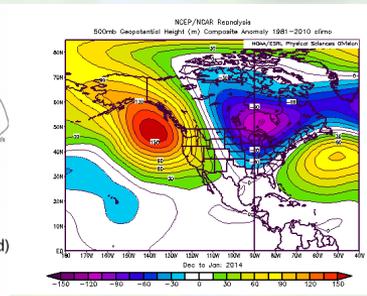
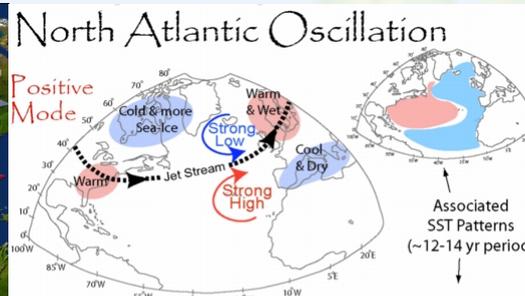
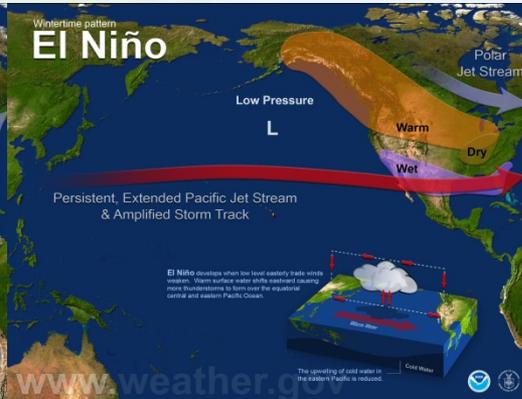
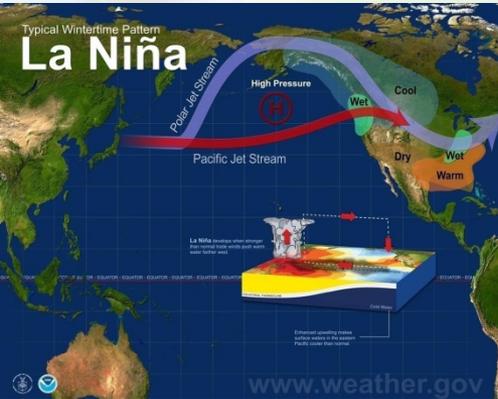
# Climate Prediction



- Not quite like weather prediction
  - In terms of odds (probabilities)
  - Averaged over longer periods of time (weeks to months)



# What Goes Into Climate Forecasts?



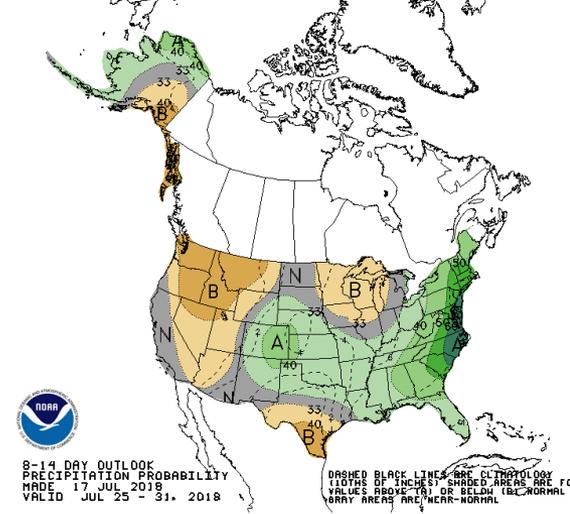
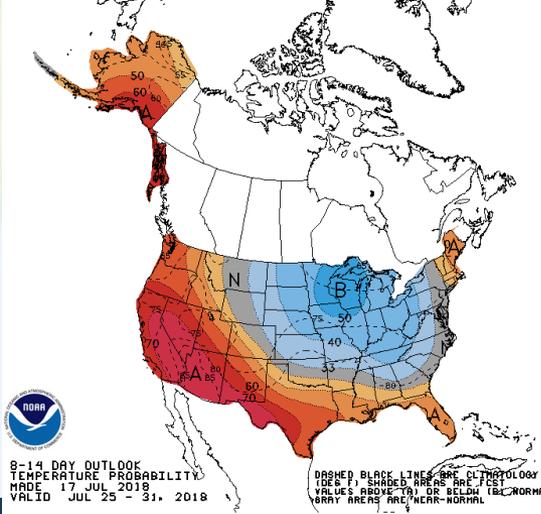
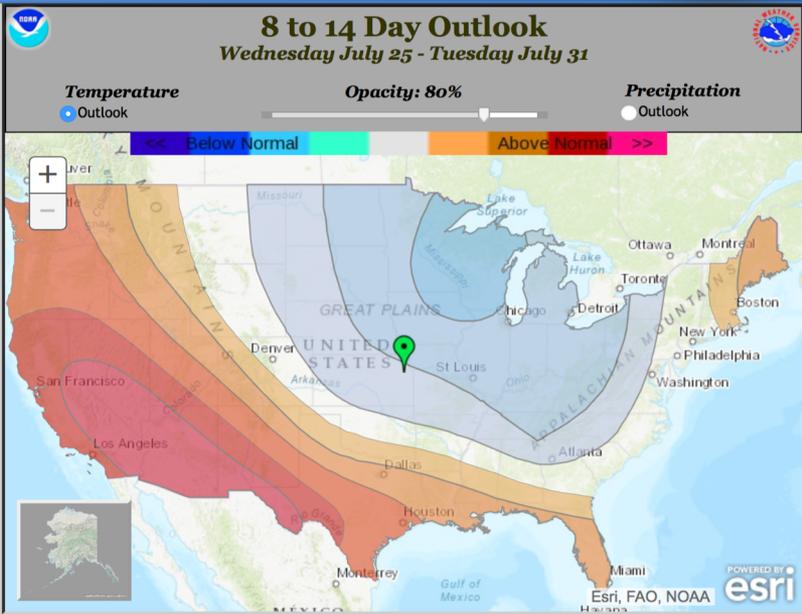
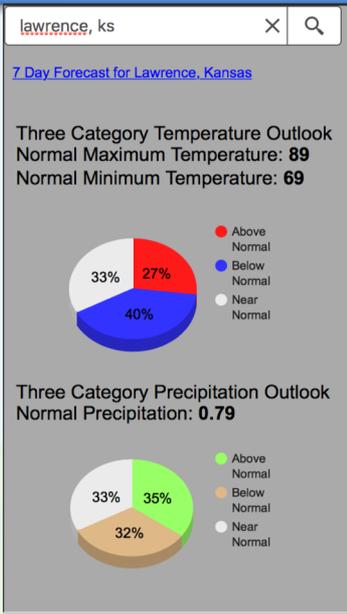
- Climate teleconnection patterns: El Niño/Southern Oscillation (!!!), North Atlantic Oscillation, Arctic Oscillation, Madden-Julian Oscillation, etc.
- Trends
- Climate model output (like weather forecasting)



# CPC Outlooks: 6- to 10-Day and 8- to 14-Day



- Predicting chances for *temperatures* and *precipitation* to fall in the *upper, middle, and lowest thirds*.
  - ◆ “40%” = 40-50% chance of that category (instead of the usual 33%)
- Issued every afternoon
  - ◆ Automated on weekends
- Mainly based on weather and climate models
- Interactive and static displays

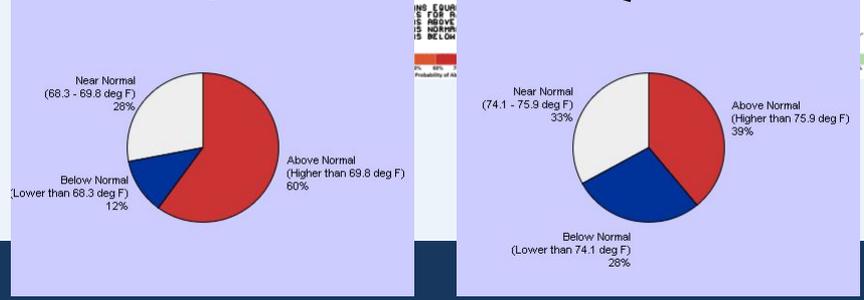
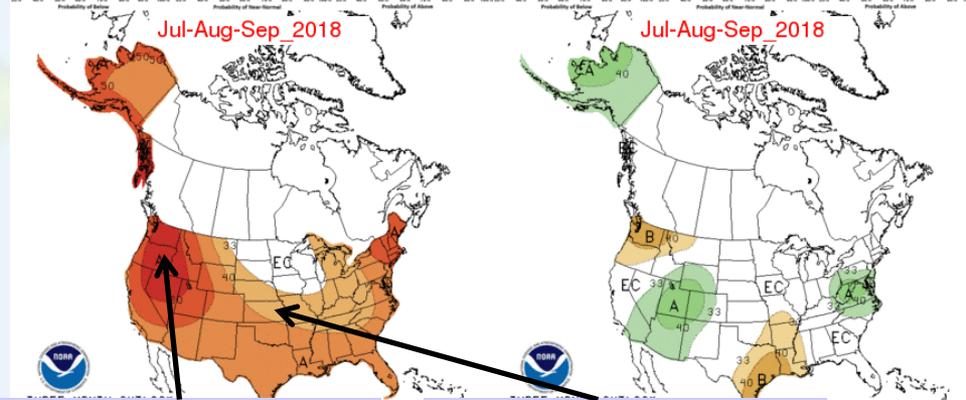
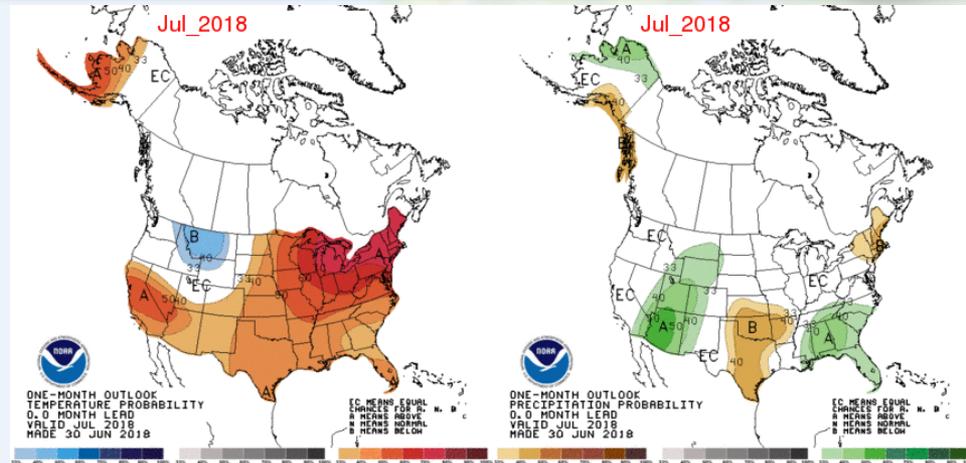




# CPC Outlooks: One-Month and Three-Month



- Predicting *chances* for *temperatures* and *precipitation* to fall in the *upper, middle, and lowest thirds*.
  - ◆ “EC” (Equal Chances) = odds of each category match climatology
  - ◆ “40%” = 40-50% chance of that category (instead of the usual 33%)
- Issued 3<sup>rd</sup> Thursday of each month
- Based on ENSO, trends, climate models, soil moisture
- Local 3-Month Temperature Outlook: recalculated for single points





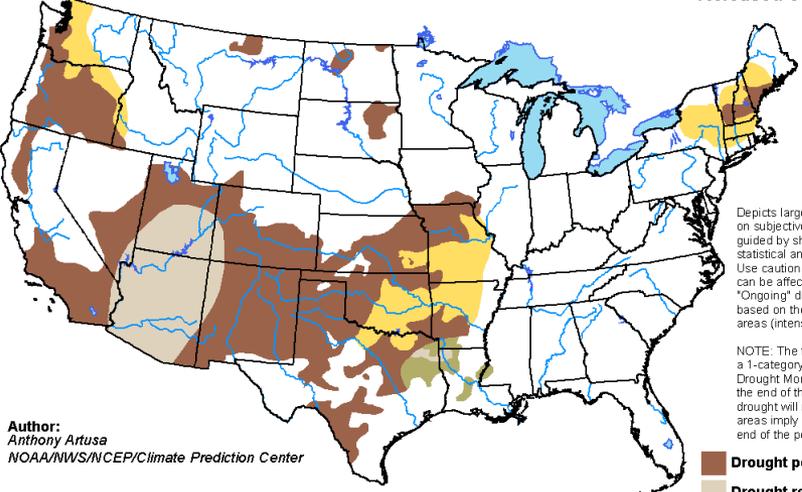
# CPC Outlooks:



# Drought (One-Month and Three-Month)

## U.S. Monthly Drought Outlook Drought Tendency During the Valid Period

Valid for July 2018  
Released June 30, 2018



Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. \*Ongoing\* drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

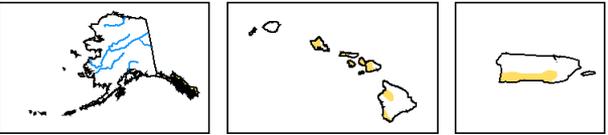
NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

Author:  
Anthony Artusa  
NOAA/NWS/NCEP/Climate Prediction Center

- Drought persists
- Drought remains but improves
- Drought removal likely
- Drought development likely

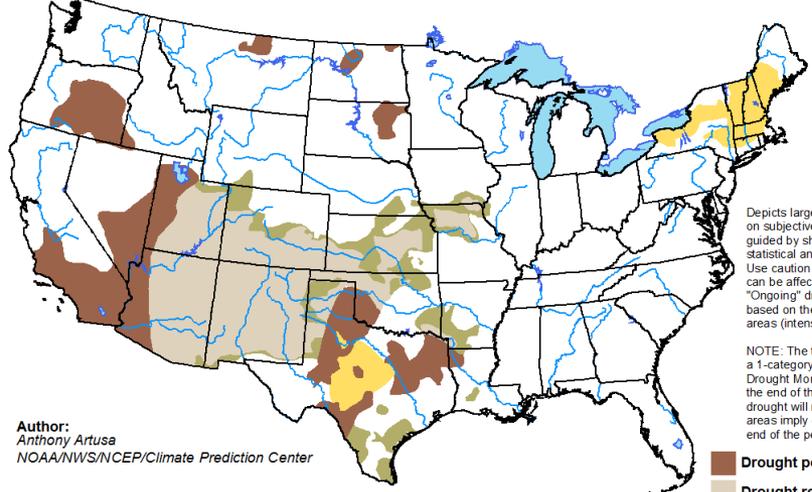


<http://go.usa.gov/3eZGd>



## U.S. Seasonal Drought Outlook Drought Tendency During the Valid Period

Valid for June 21 - September 30, 2018  
Released June 21, 2018



Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. \*Ongoing\* drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

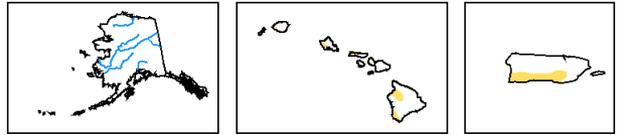
NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

Author:  
Anthony Artusa  
NOAA/NWS/NCEP/Climate Prediction Center

- Drought persists
- Drought remains but improves
- Drought removal likely
- Drought development likely



<http://go.usa.gov/3eZ73>



- Predicting changes to Drought Monitor categories during the valid period.
- Monthly outlook updated at the end of the previous month.
- Seasonal (3-month) outlook updated on the 3<sup>rd</sup> Thursday of the month with the rest of the 3-month outlooks.



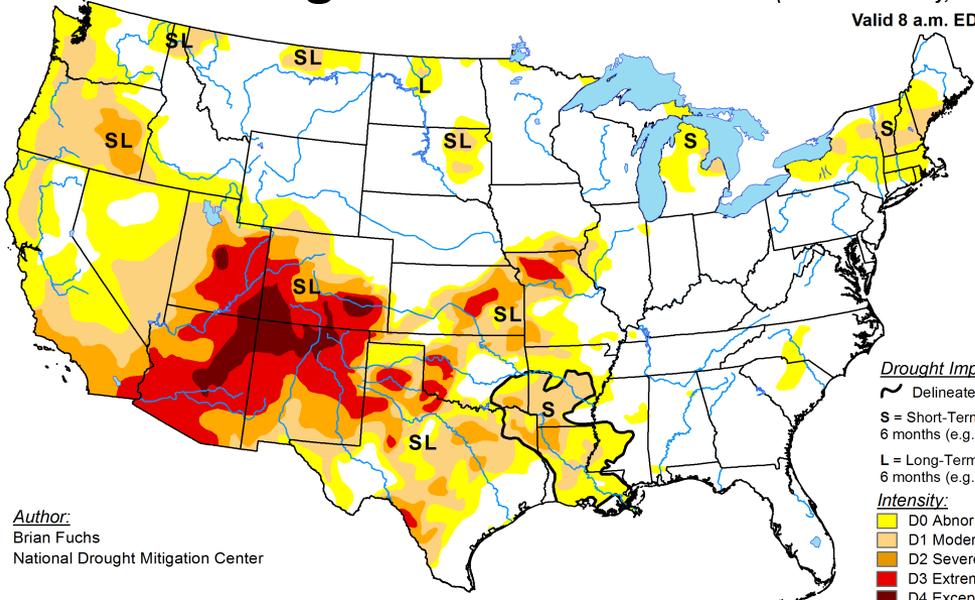
# Drought Monitoring and Prediction



- Objective (measurable) and subjective (analysis and opinion) input

## U.S. Drought Monitor

July 10, 2018  
(Released Thursday, Jul. 12, 2018)  
Valid 8 a.m. EDT



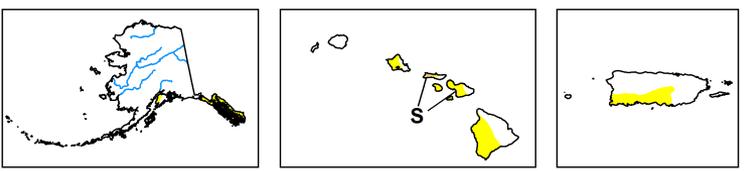
**Drought Impact Types:**  
 ~ Delineates dominant impacts  
 S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)  
 L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

**Intensity:**  
 D0 Abnormally Dry  
 D1 Moderate Drought  
 D2 Severe Drought  
 D3 Extreme Drought  
 D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

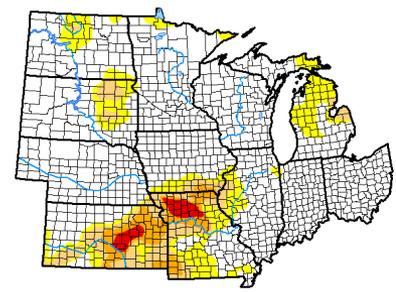


Author:  
Brian Fuchs  
National Drought Mitigation Center



## U.S. Drought Monitor North Central

July 10, 2018  
(Released Thursday, Jul. 12, 2018)  
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D1	D1-D2	D2-D3	D3-D4	D4
Current	75.88	24.12	11.95	5.14	1.36	0.00
Last Week 6/30/2018	74.72	25.28	12.00	5.21	0.61	0.00
3 Month Ago 04-10-2018	85.17	34.83	17.68	8.03	2.91	0.76
Start of Calendar Year 01-01-2018	42.74	57.26	20.79	5.47	0.71	0.00
Start of Water Year 09-26-2017	50.58	49.42	19.04	6.07	1.04	0.04
One Year Ago 07-10-2017	64.74	35.26	17.51	9.25	4.39	0.00

**Intensity:**  
 D0 Abnormally Dry  
 D1 Moderate Drought  
 D2 Severe Drought  
 D3 Extreme Drought  
 D4 Exceptional Drought

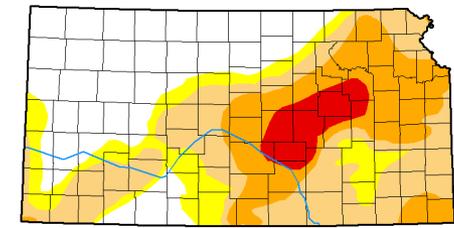
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:  
Brian Fuchs  
National Drought Mitigation Center



## U.S. Drought Monitor Kansas

July 10, 2018  
(Released Thursday, Jul. 12, 2018)  
Valid 8 a.m. EDT



**Intensity:**  
 D0 Abnormally Dry  
 D1 Moderate Drought  
 D2 Severe Drought  
 D3 Extreme Drought  
 D4 Exceptional Drought

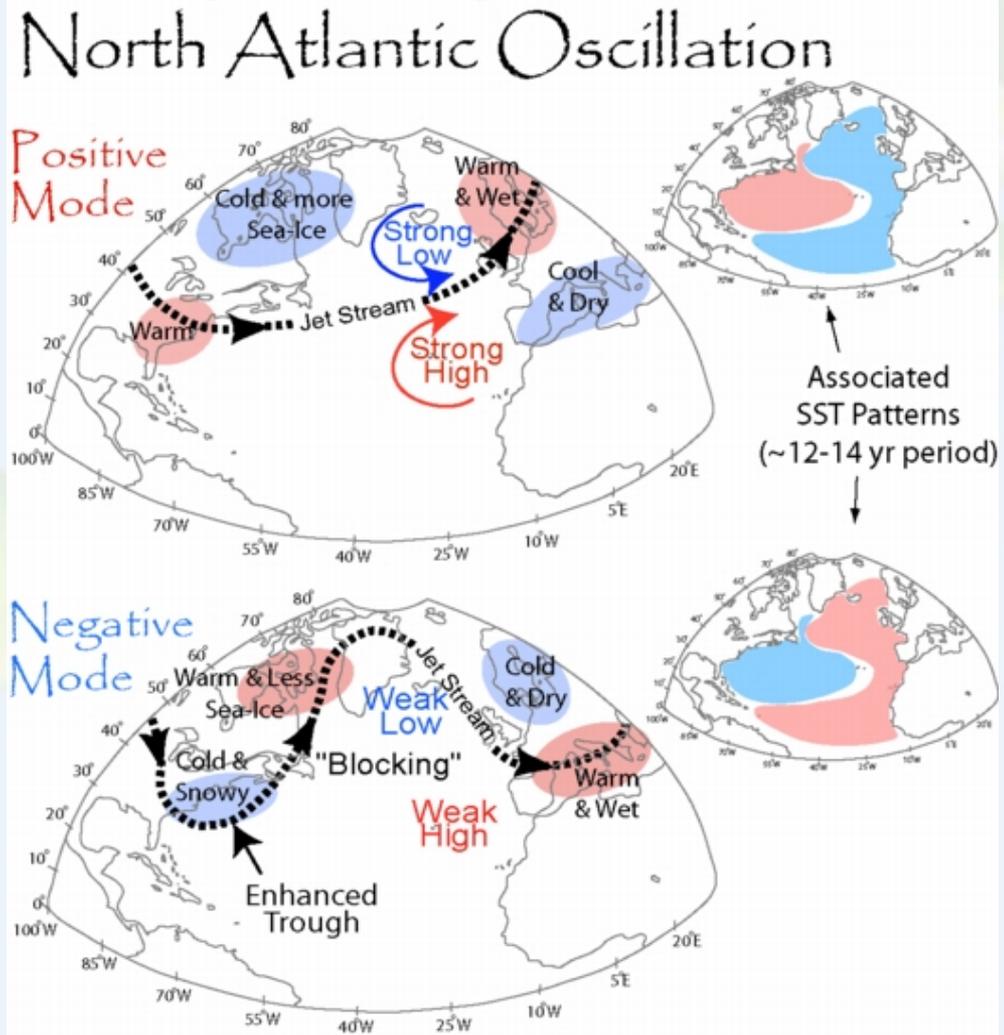
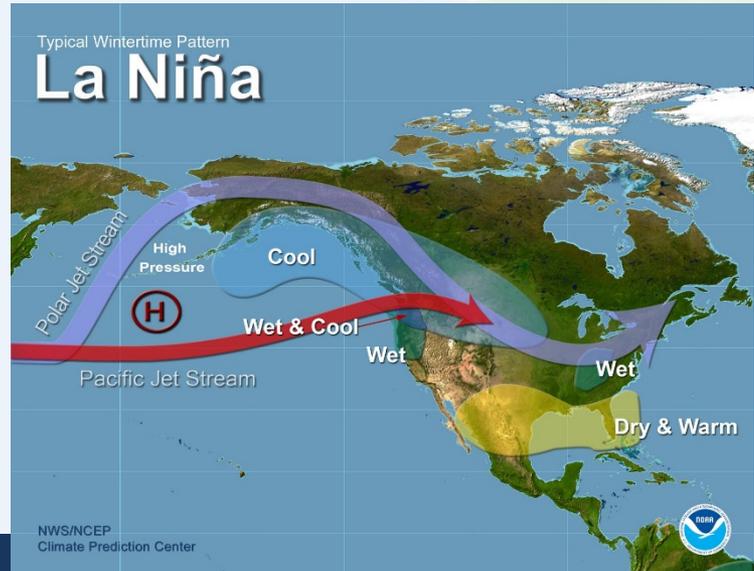
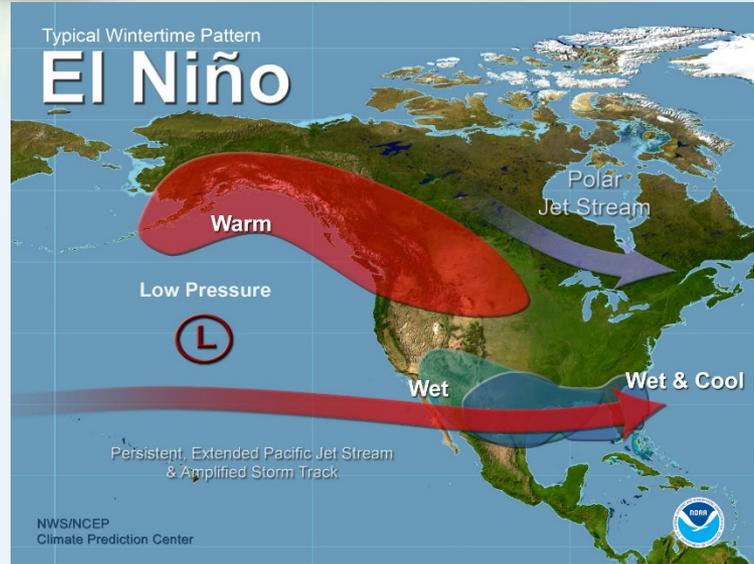
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:  
Brian Fuchs  
National Drought Mitigation Center



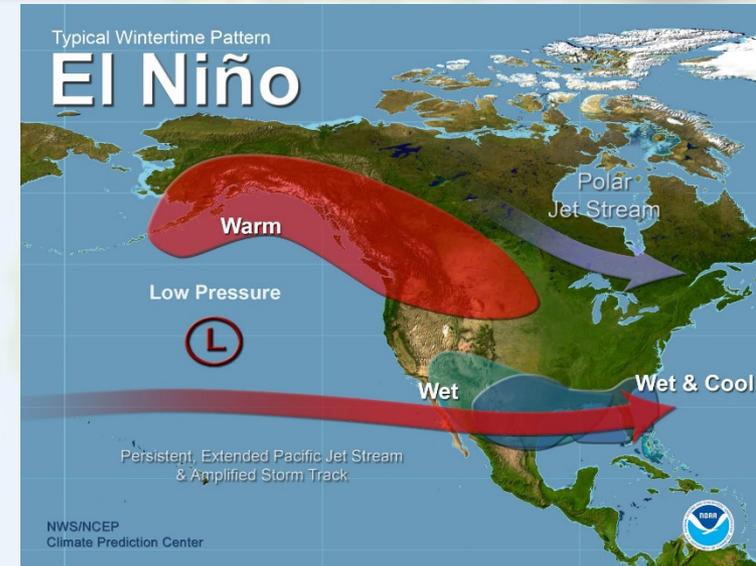


# Climate Variability: Influencing Seasons



# Background: ENSO

- El Niño typical impacts:
  - ◆ Strong jet suppressed south across the Gulf
  - ◆ Northern Plains high and dry
  - ◆ Southern states cool and wet
  - ◆ North Atlantic tropical activity suppressed



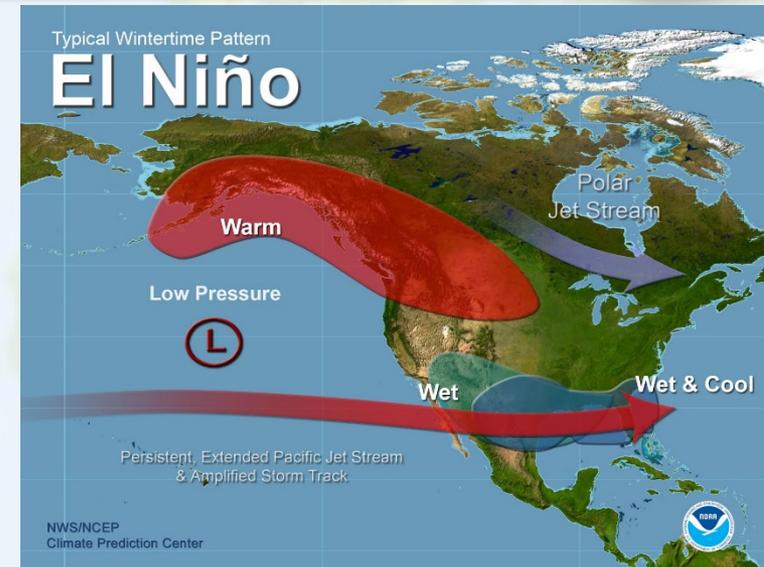
# Background: ENSO

- El Niño typical impacts:

- ◆ Strong jet suppressed south across the Gulf
- ◆ Northern Plains high and dry
- ◆ Southern states cool and wet
- ◆ North Atlantic tropical activity suppressed

- La Niña typical impacts:

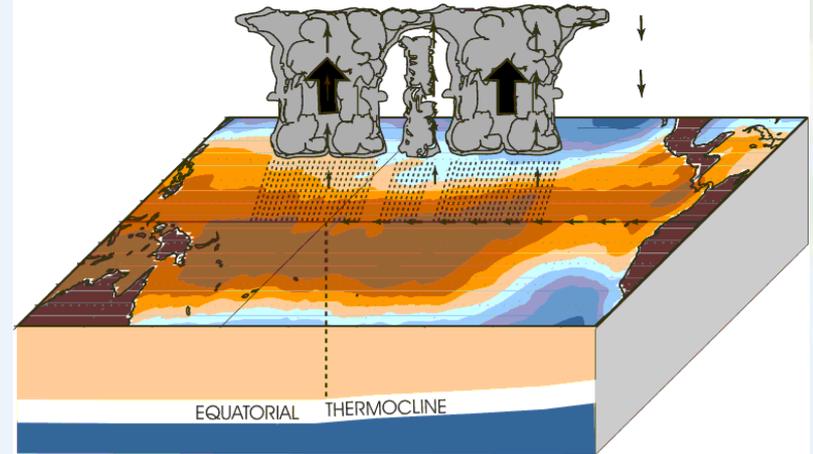
- ◆ Amplified and variable jet
- ◆ Northern Plains taking cold air dumps
- ◆ Southern states high and dry
- ◆ Ohio Valley wet
- ◆ North Atlantic tropical activity enhanced



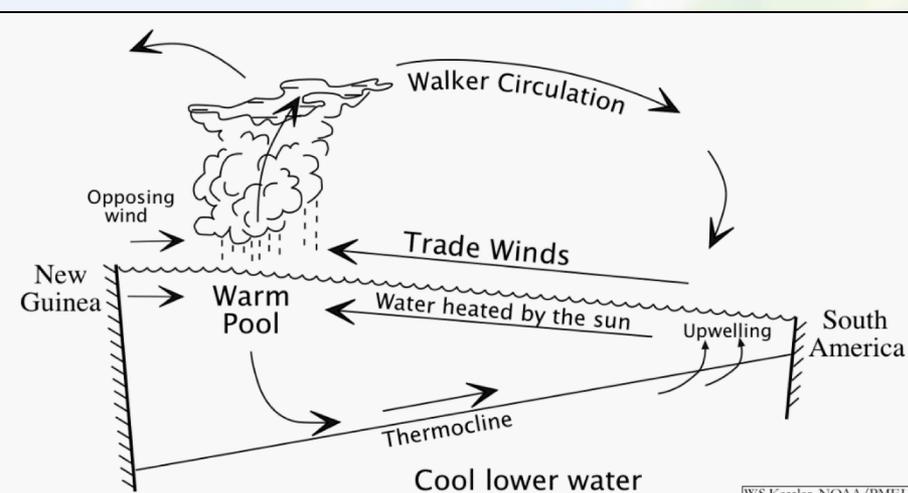
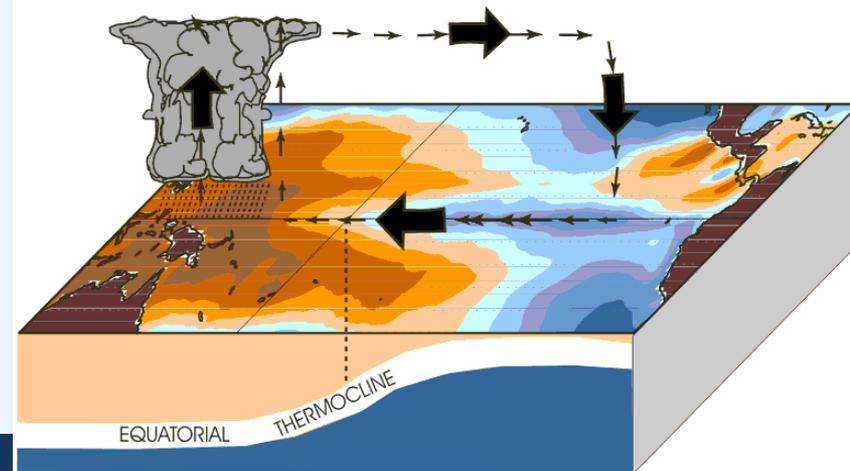
## Walker Circulation 101

- ◆ Thunderstorms develop over warm pool (which shifts based on phase)
- ◆ Thunderstorms affect subtropical jet intensity and position, and thus persistent mid-latitude weather patterns

December - February El Niño Conditions



December - February La Niña Conditions

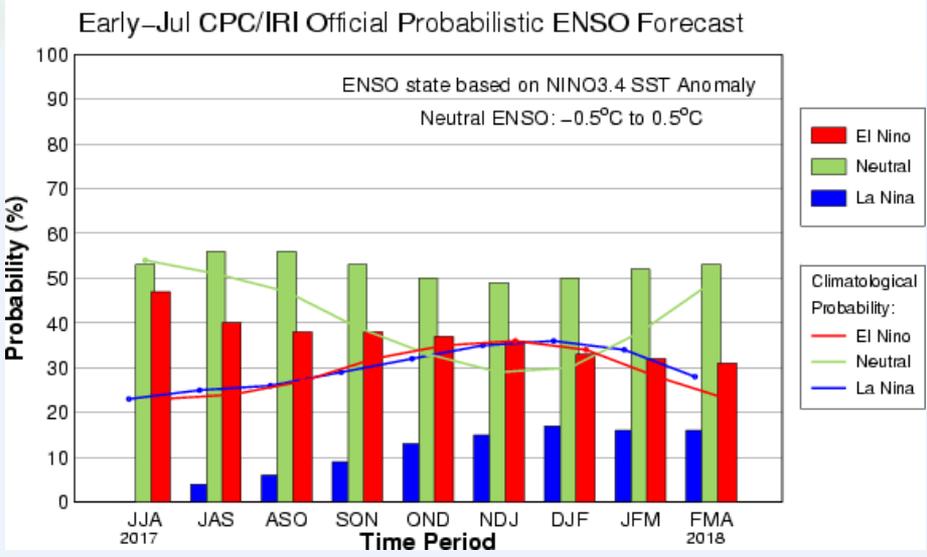
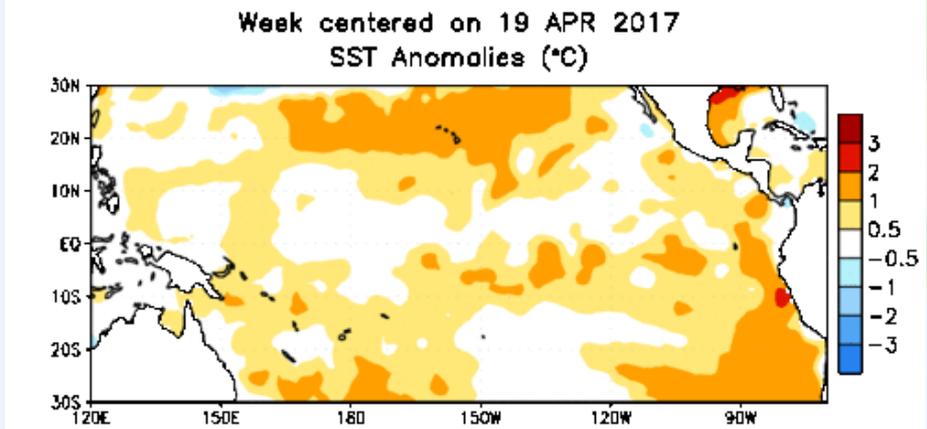




# Current ENSO State and Outlook

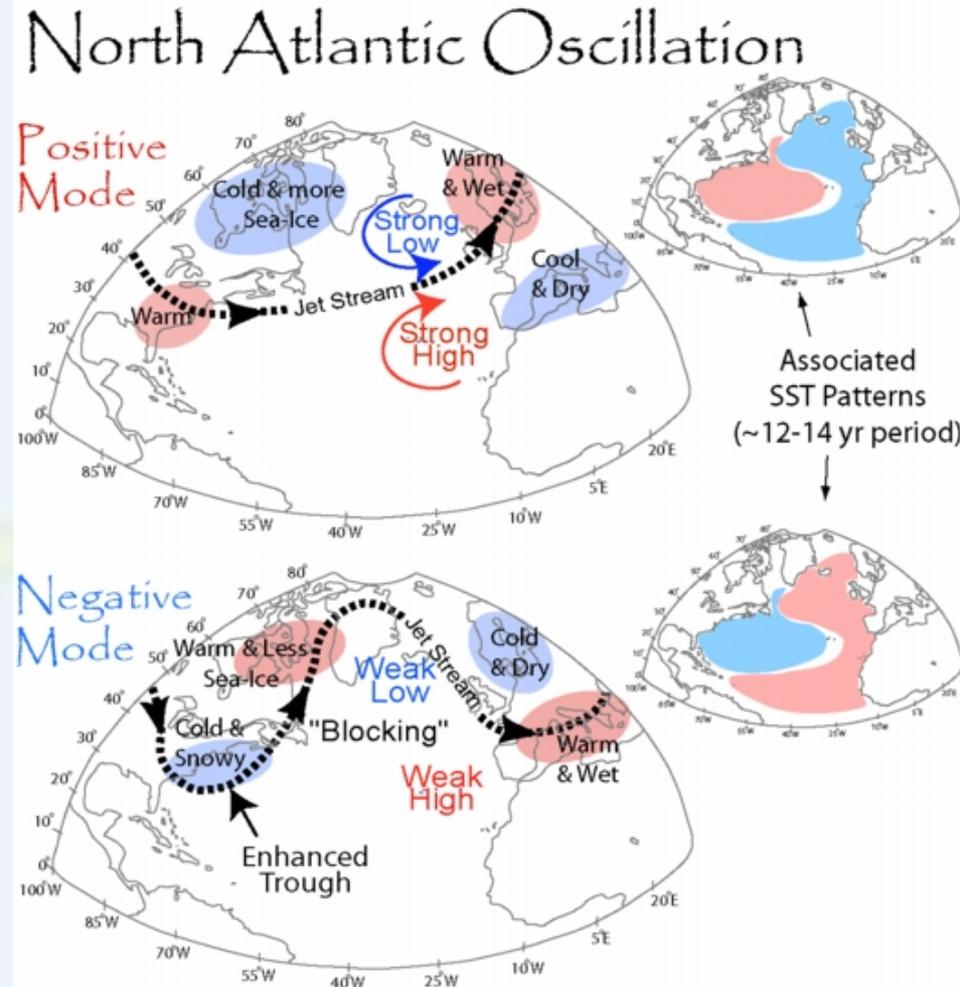


- Current state:
  - ◆ Neutral (neither **El Niño** nor **La Niña**)
  - ◆ Ocean was a little warm earlier this spring/summer
  - ◆ Atmosphere did not respond
- Outlook:
  - ◆ Neutral conditions like to continue through the winter



# Background: NAO

- Pressure difference between the Azores high and Icelandic low
- Larger difference: Positive
  - ◆ Stronger jet
  - ◆ Warmer eastern U.S.
- Smaller difference: Negative
  - ◆ Weaker, meandering jet
  - ◆ Colder, snowy eastern U.S.
- Can have a stronger effect than ENSO, but less predictable





# Climatological Context: NOWData



**National Weather Service Forecast Office**  
**Omaha/Valley, NE**

Home News Organization

Local forecast by "City, St"

Observed Weather | Climate Locations | Climate Prediction | Climate Resources | Local Data/Records | Astronomical | NOWData

**NOWData - NOAA Online Weather Data**

1. Location »  Lincoln Area

2. Product »  Daily data for a month  Daily almanac  Monthly summarized data  Calendar day summaries  Daily/monthly normals  Climatology for a day  First/last dates  Temperature graphs  Accumulation graphs

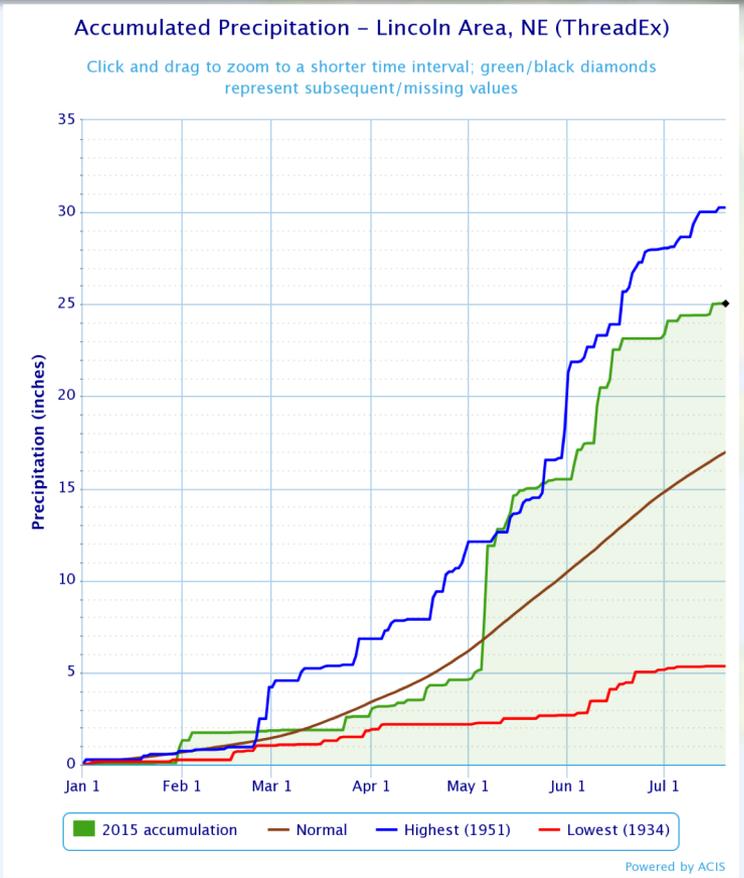
3. Options » Start date: 2015-01-01 End date: 2015-07-20 Variable: Precipitation

4. View »

**Product Description:**  
ACCUMULATION GRAPHS - plot of accumulated of precipitation, snow/fall or degree days from start to end date. For periods of 1 year or less, the normal (if available) and highest and lowest years with no more than one day missing are also plotted. For periods of more than 1 year, accumulations can be reset on a given date each year.

**Powered by ACIS**  
NOAA Regional Climate Centers

The Applied Climate Information System (ACIS) is a joint project of the Regional Climate Centers, the National Climatic Data Center and the National Weather Service. Official data and data for additional locations are available from the Regional Climate Centers and the National Climatic Data Center.



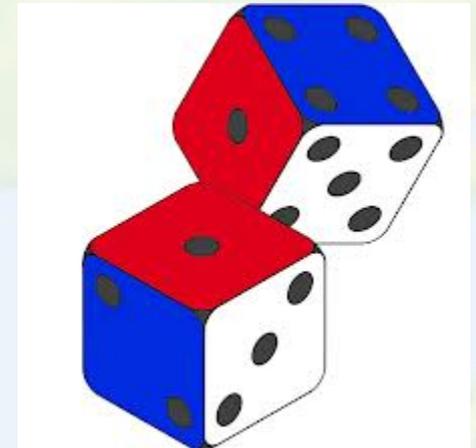
- Place events into historical context for frequency, rankings, local to regional coverage, etc.

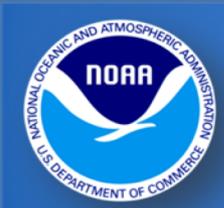


# Activity Time! Loaded dice



- Homemade foam dice can be loaded (weighted) with washers or other objects to “favor” certain outcomes.
- Will loading the dice guarantee a result, or just make it more likely than chance?
- Roll the dice with and without weights. Roll the set at least 10 times each.
- Record the results of each roll. How does the weighted set compare to the set without weights?
- How does this apply to climate outlooks?





**Now, looking on longer time  
scales...**



# Don't be afraid to talk about climate change!



- **Get comfortable with terminology**

- ◆ The terms “climate change” and “global warming” are often used interchangeably
- ◆ Scientists prefer “climate change” because it describes the changes to the whole system, not just temperatures
- ◆ Many people still say “global warming”

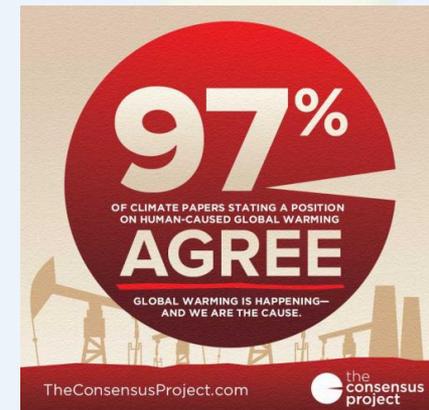
- **Be careful about your information sources!**

- ◆ Blogs, news commentators, politicians often (usually) not trained in climate
- ◆ Would you go to a dentist to get heart surgery?

~ UTOPIA THEORY ~



"Yeah, I see him too...But nobody wants to talk about it!"

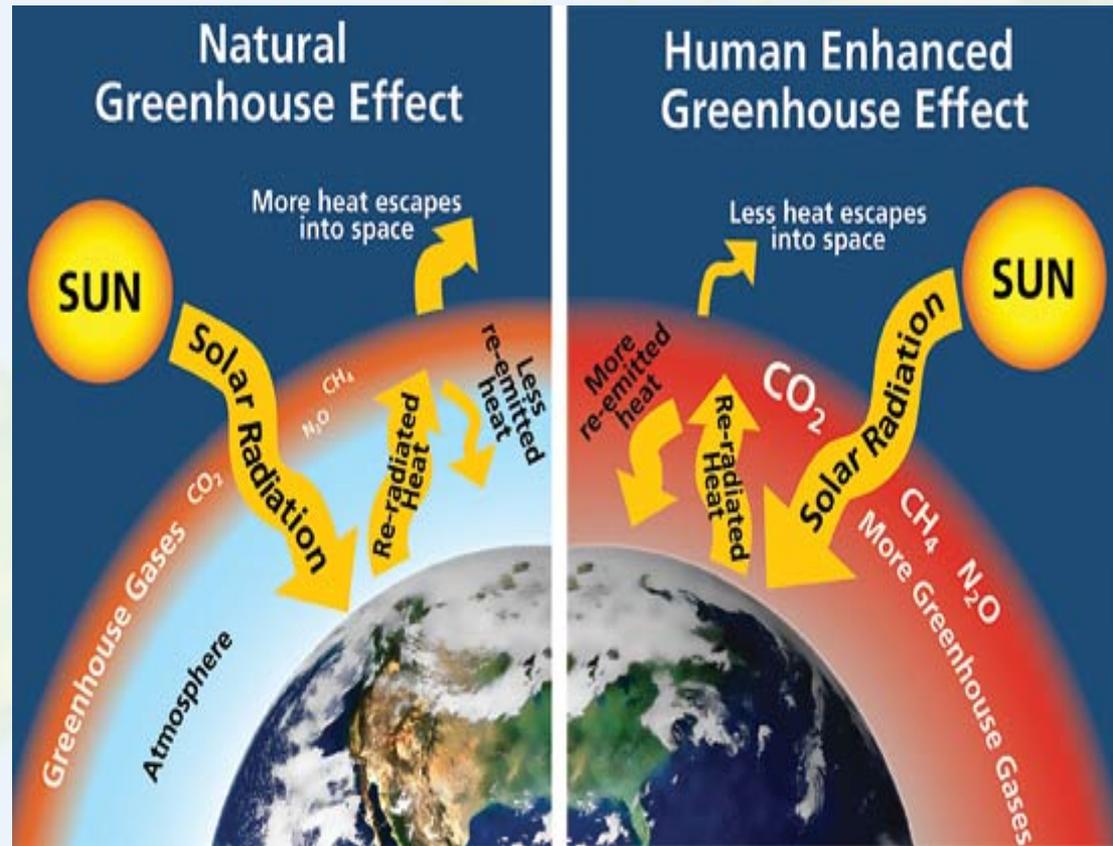




# **Climate and the Greenhouse Gases**

# Greenhouse Effect

- Greenhouse gases absorb heat (solar radiation)
  - ◆ Radiate heat back to Earth's surface
  - ◆ Major greenhouse gases include carbon dioxide ( $\text{CO}_2$ ) and water vapor ( $\text{H}_2\text{O}$ )
  - ◆ Trace gases include methane, ozone, nitrous oxide, and CFCs
- Natural greenhouse effect is necessary for life on Earth
- Concern: Human activities are *enhancing* the greenhouse effect.

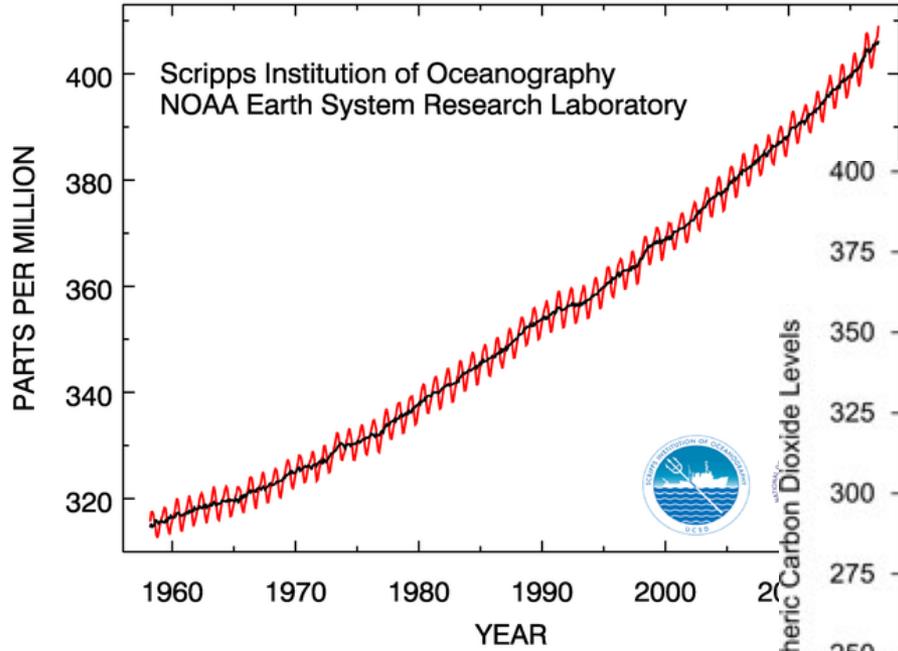




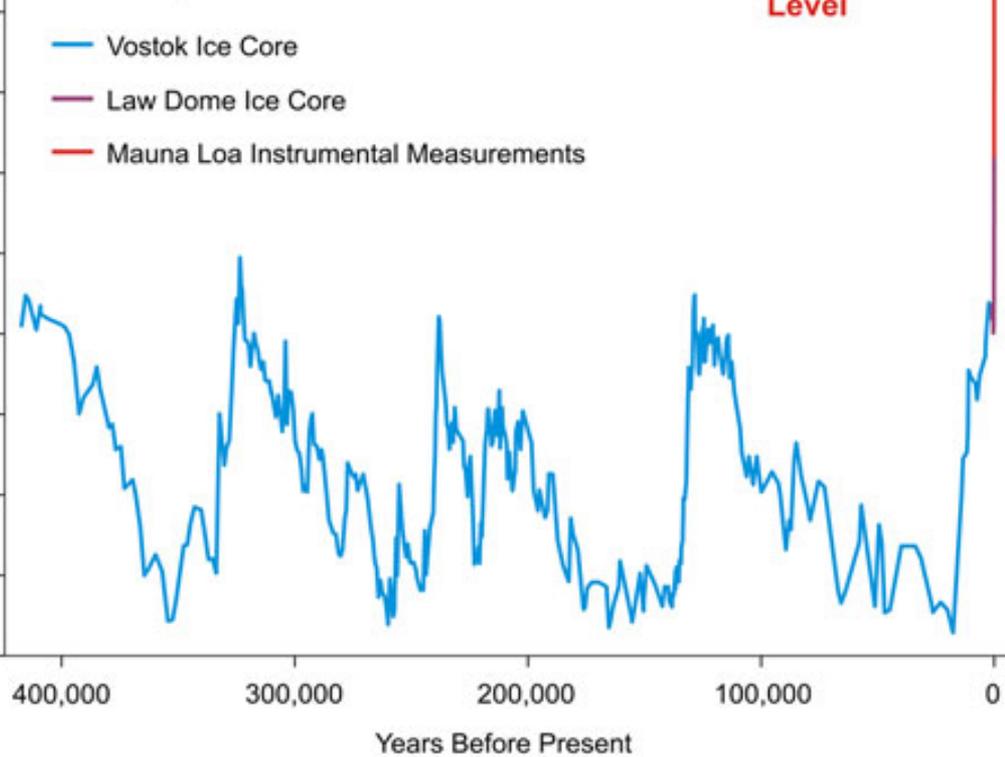
# Carbon Dioxide Increasing Due to Human Activity



### Atmospheric CO<sub>2</sub> at Mauna Loa Observatory

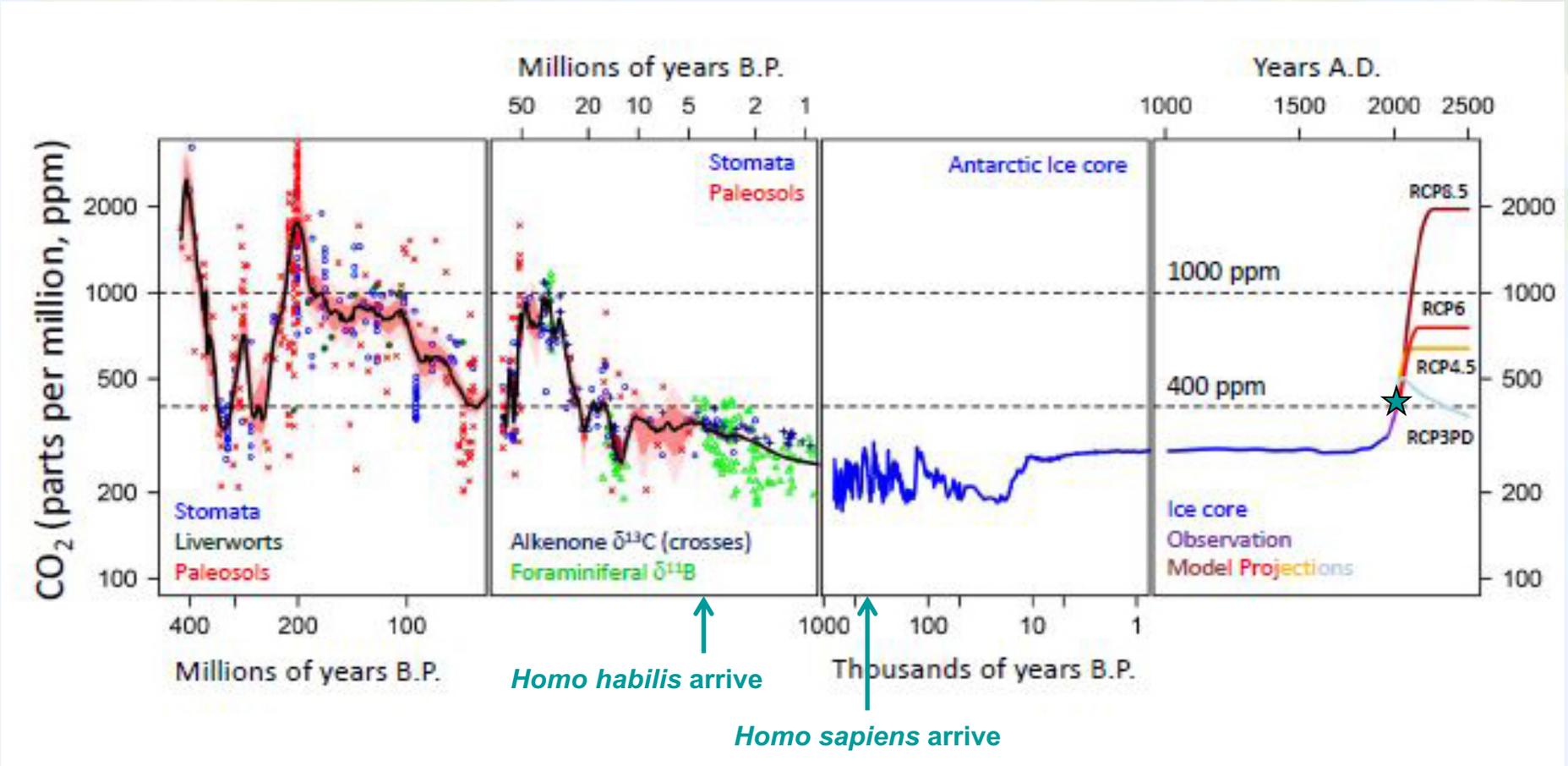


### Atmospheric Carbon Dioxide



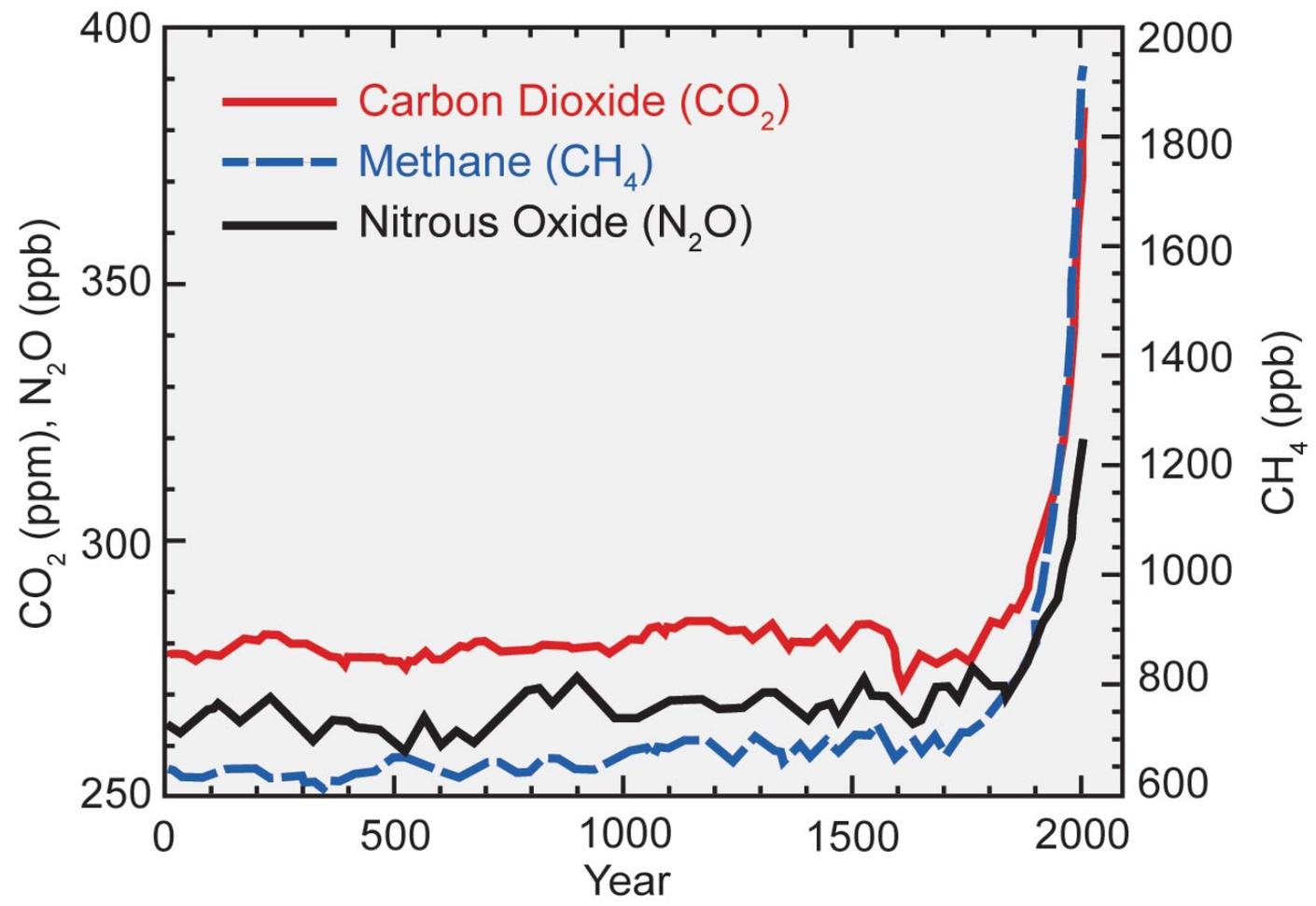


# Carbon Dioxide Increasing



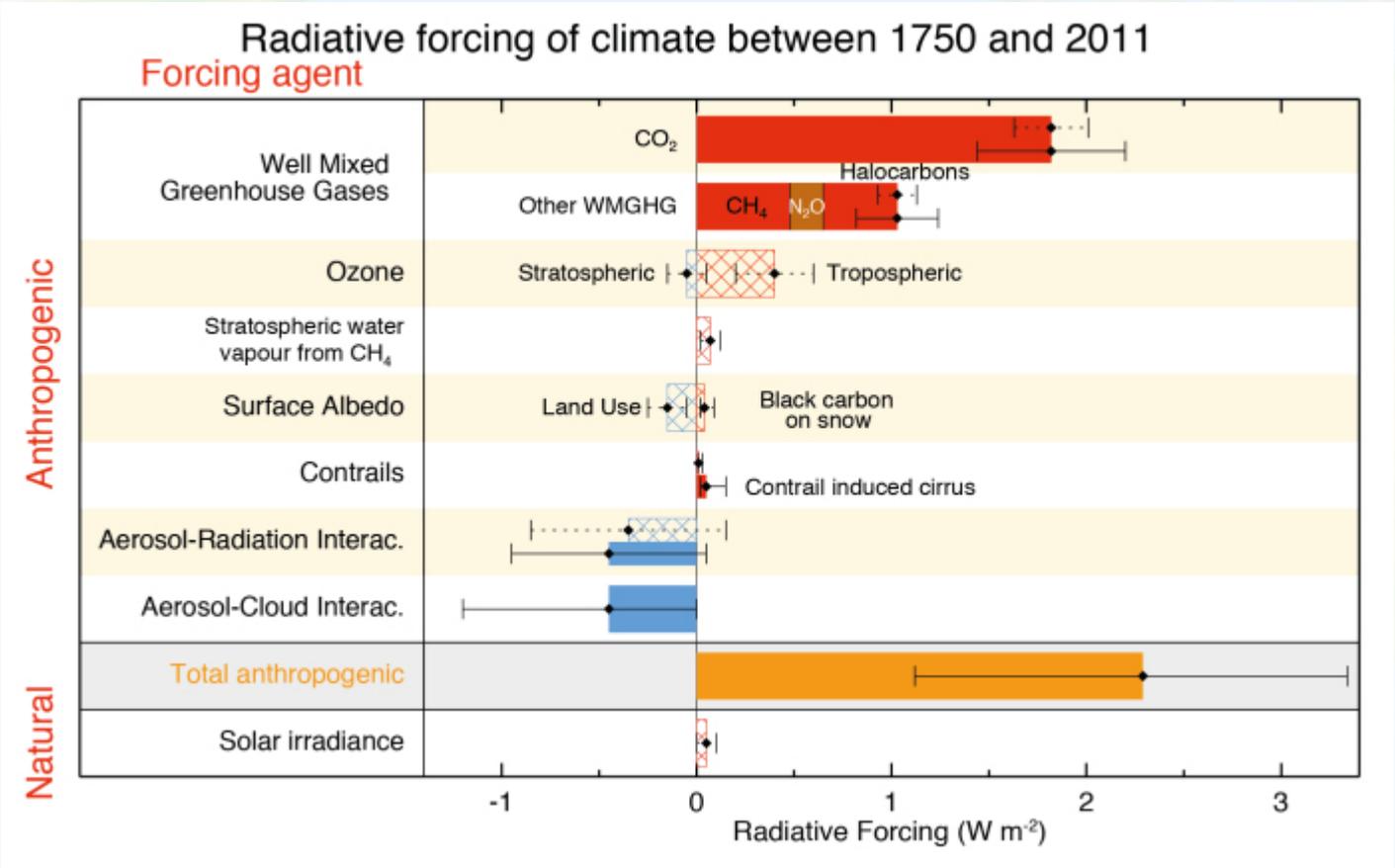


# ...And So Are Other Greenhouse Gases



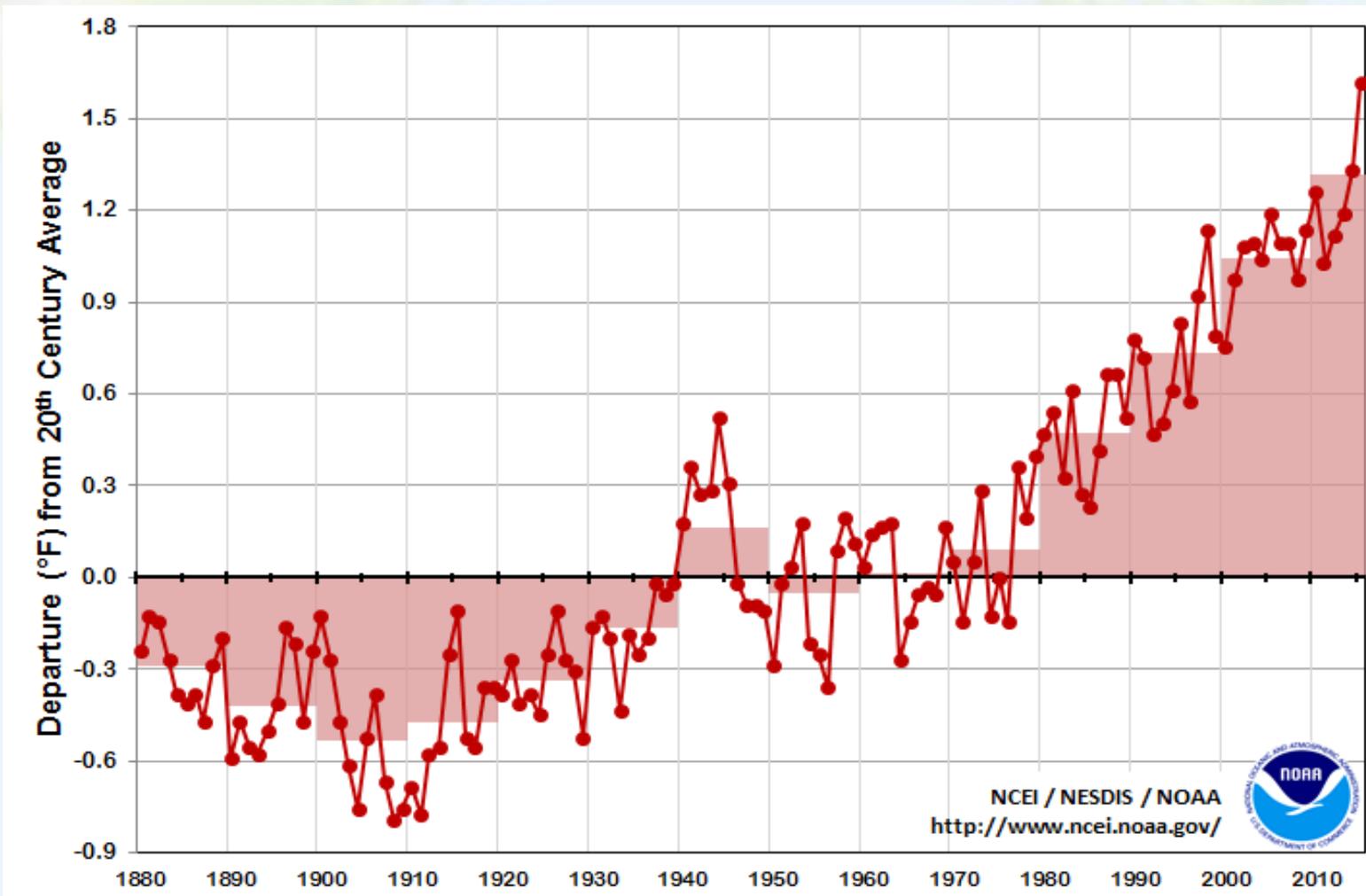


# This Changes the Radiative Forcing of the Atmosphere





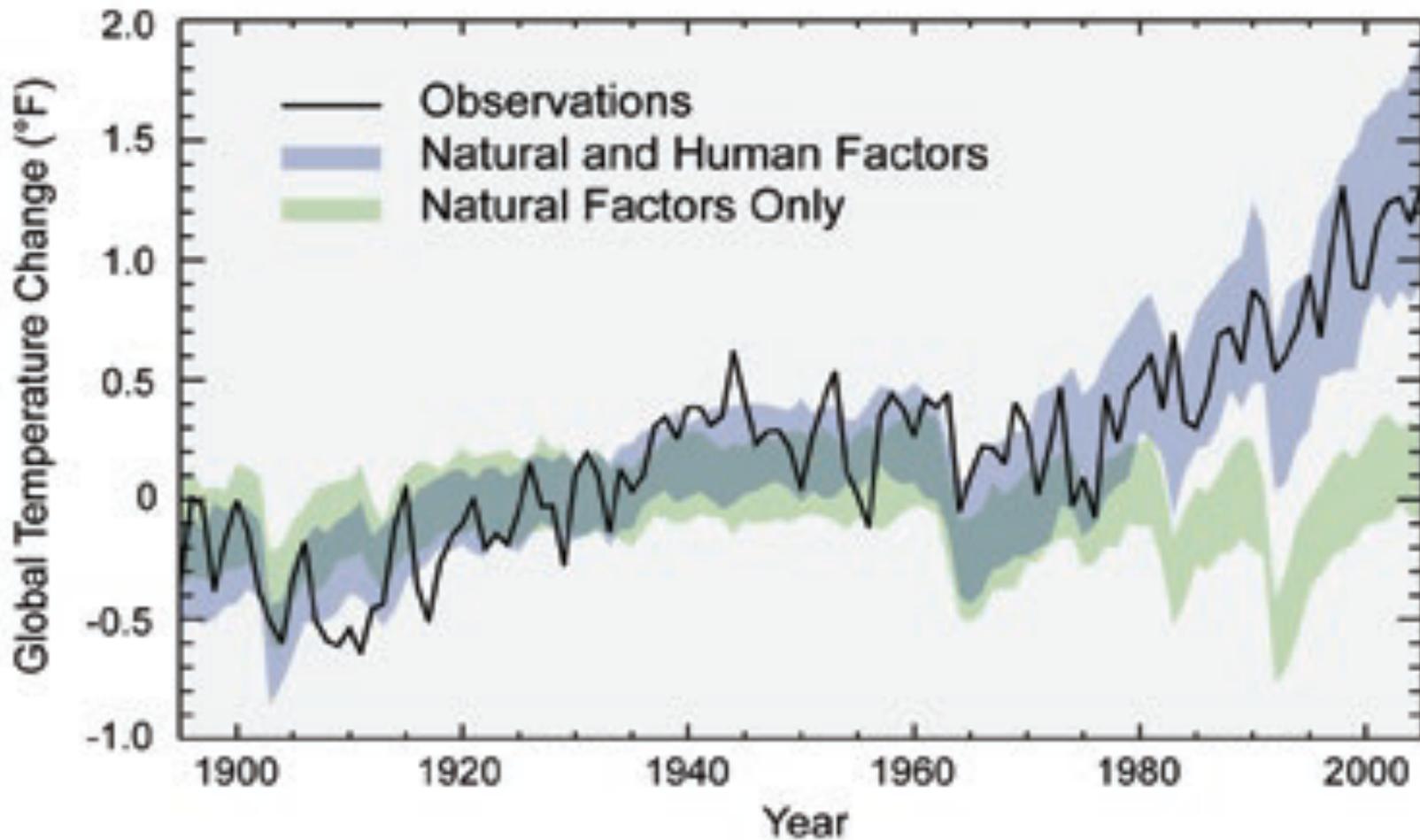
# Global Temperatures Are Increasing



Most obvious and most discussed impact of climate change



# ...And Are Explained Only When Including Increased Greenhouse Gases



Source: IPCC

A faint, light-colored world map is visible in the background of the slide, showing the continents of North America, South America, Europe, and Africa.

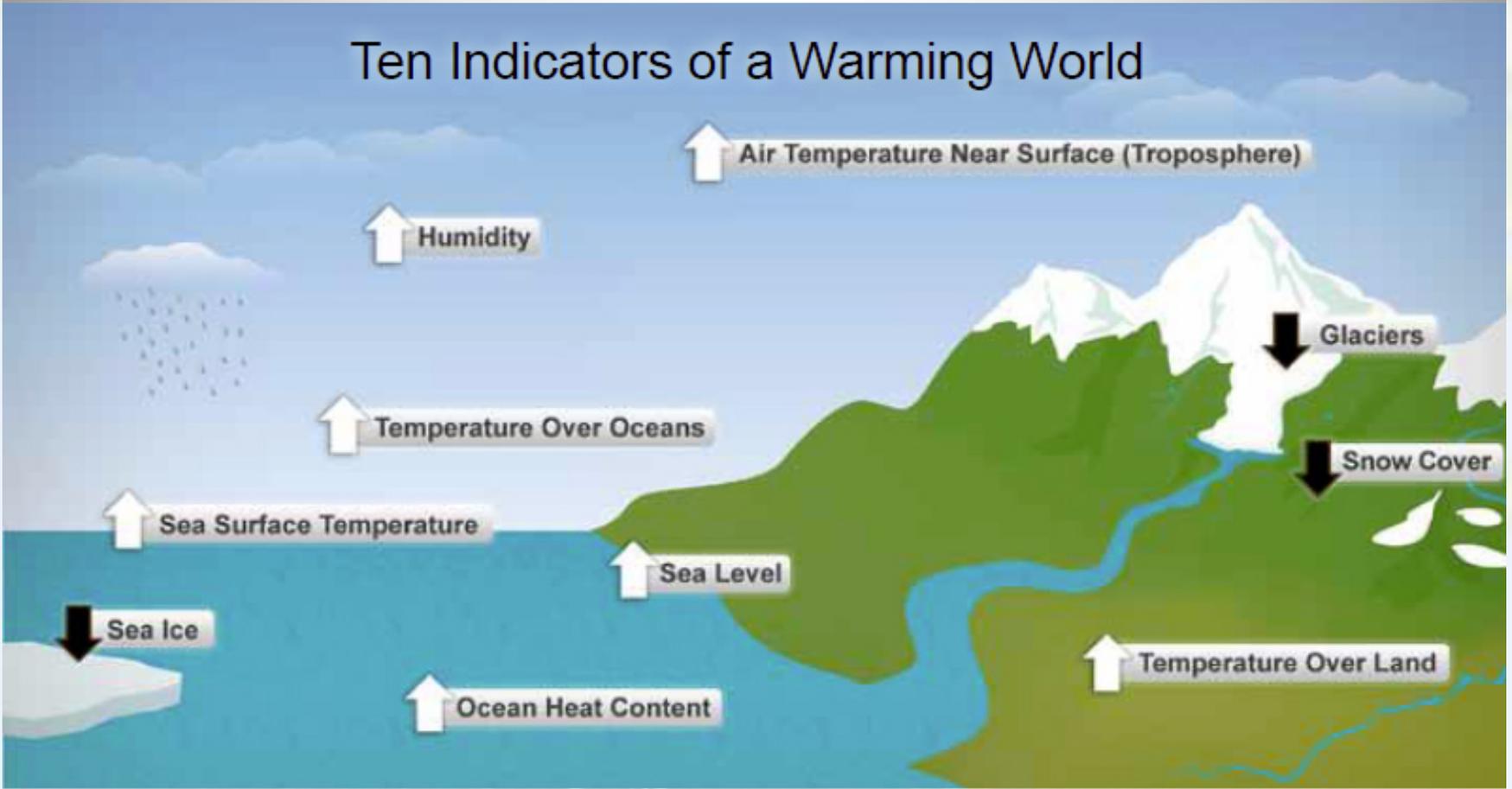
# Symptoms of Climate Change



# 10 Indicators of a Warming World

The stratosphere (up here!) is cooling

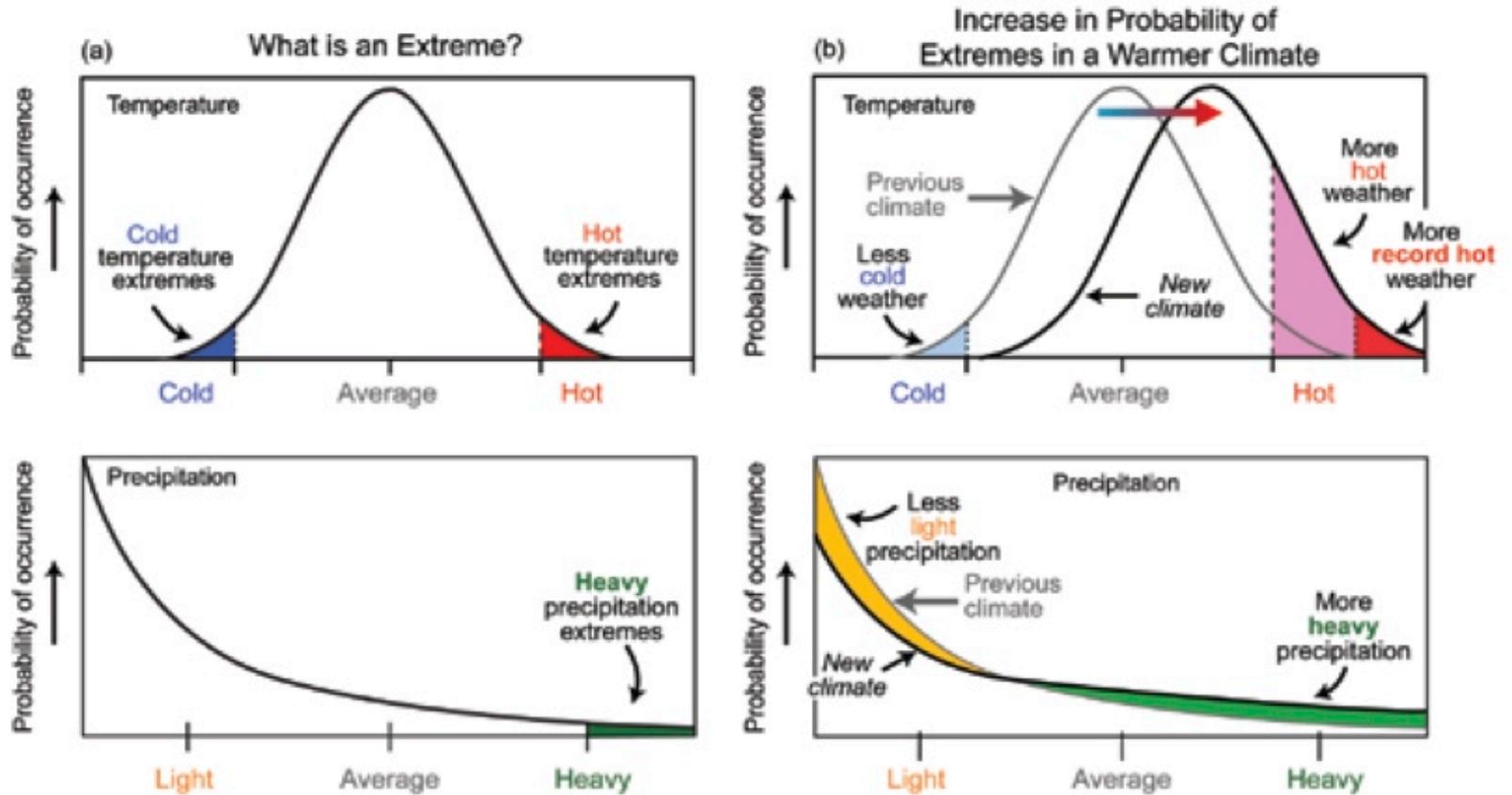
## Ten Indicators of a Warming World



Seven of these indicators would be expected to increase in a warming world and observations show that they are, in fact, increasing. Three would be expected to decrease and they are, in fact, decreasing.



# How the Averages Affect the Extremes

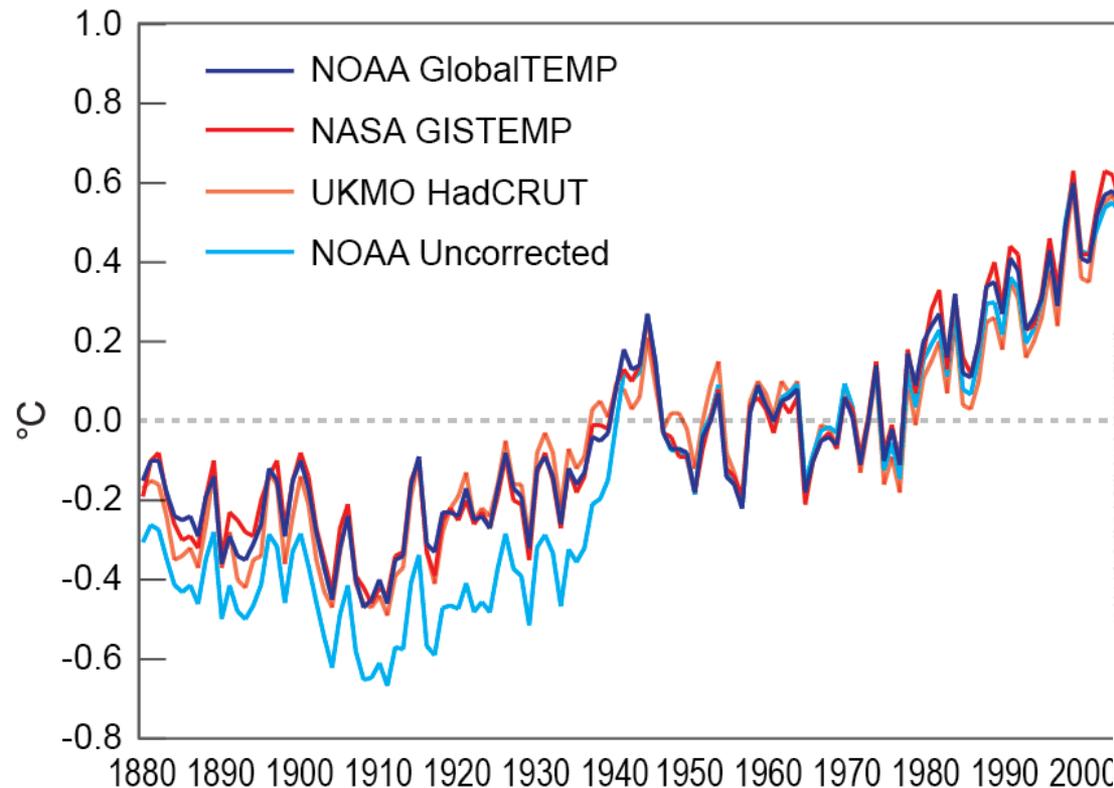




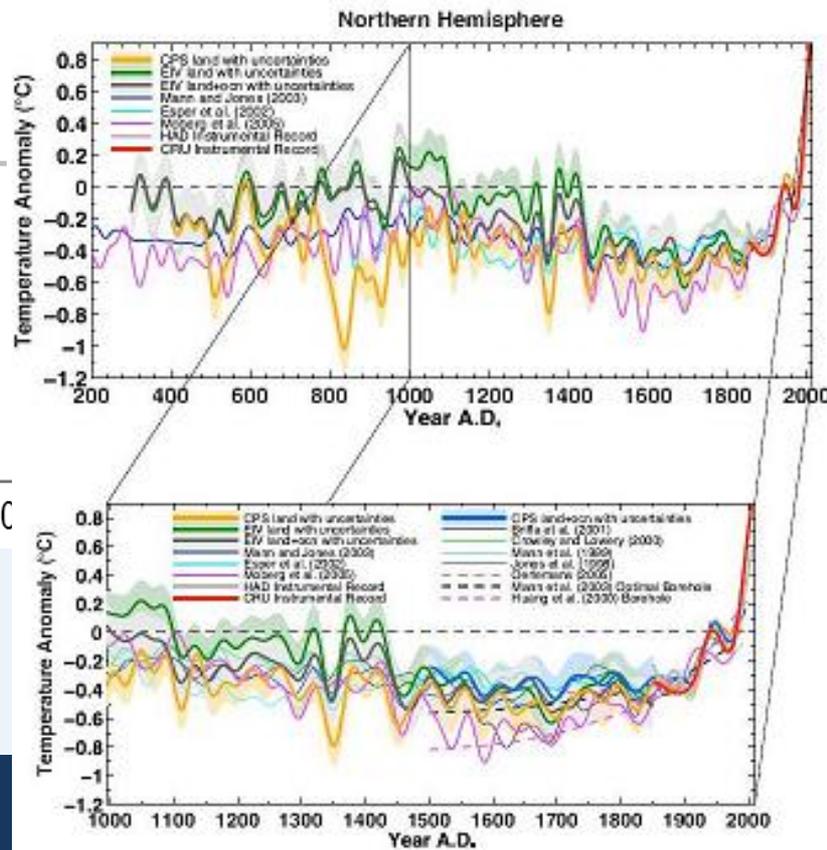
# Global Temperature Analyses Agree



NASA, NOAA, MetOffice: relative to a common 1951 – 1980 base period



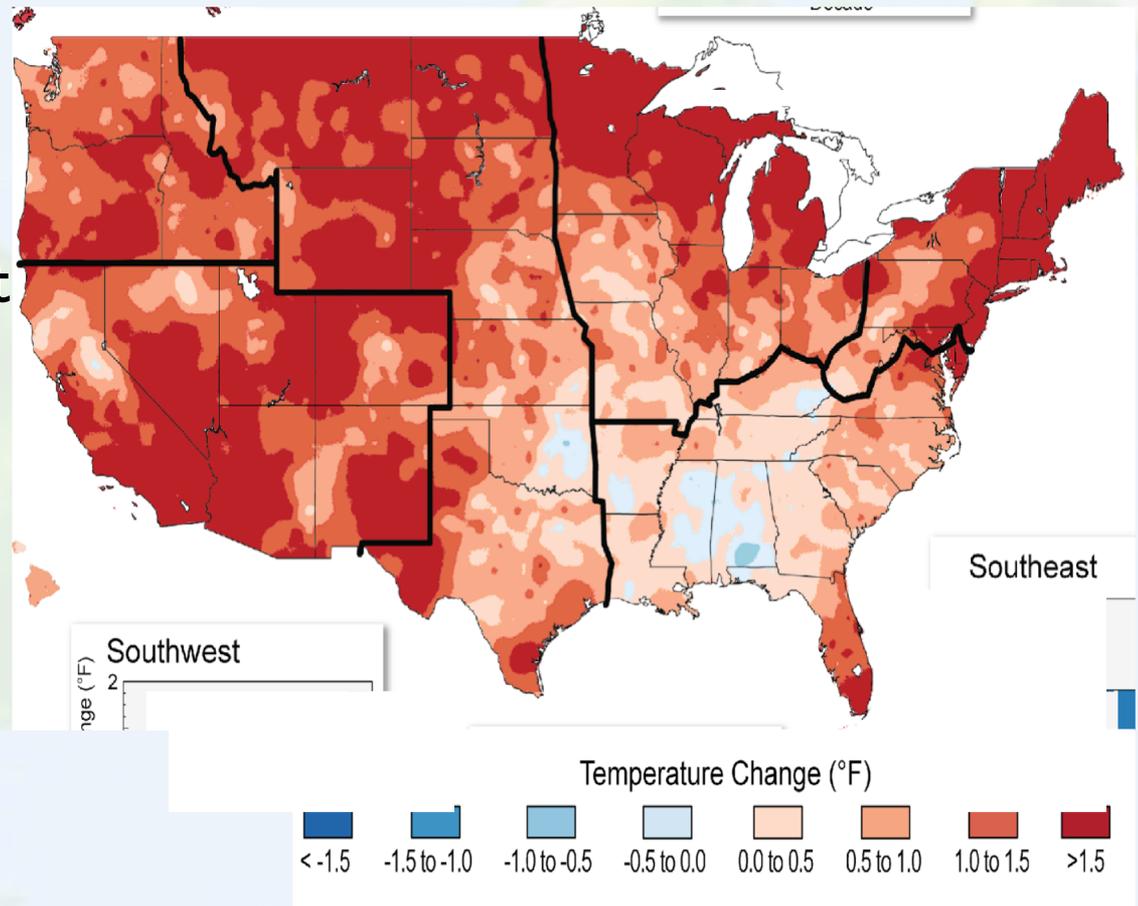
**Right:** Temperature over the past 1000-2000 years. Uncertainty increases farther back in time, when temperature reconstructions are based on “proxy” data (ice cores, tree rings, corals, lake sediments, glaciers, boreholes, stalagmites, etc.). Agreement improves with the instrumental records, beginning around 1850 A.D.



# Recent Temperature Trends

- Temperatures have warmed over the last century across the region.
- The warming is strongest during winter and for northern tier states.

Recent temperatures (1991-2012) compared to 1901-1960

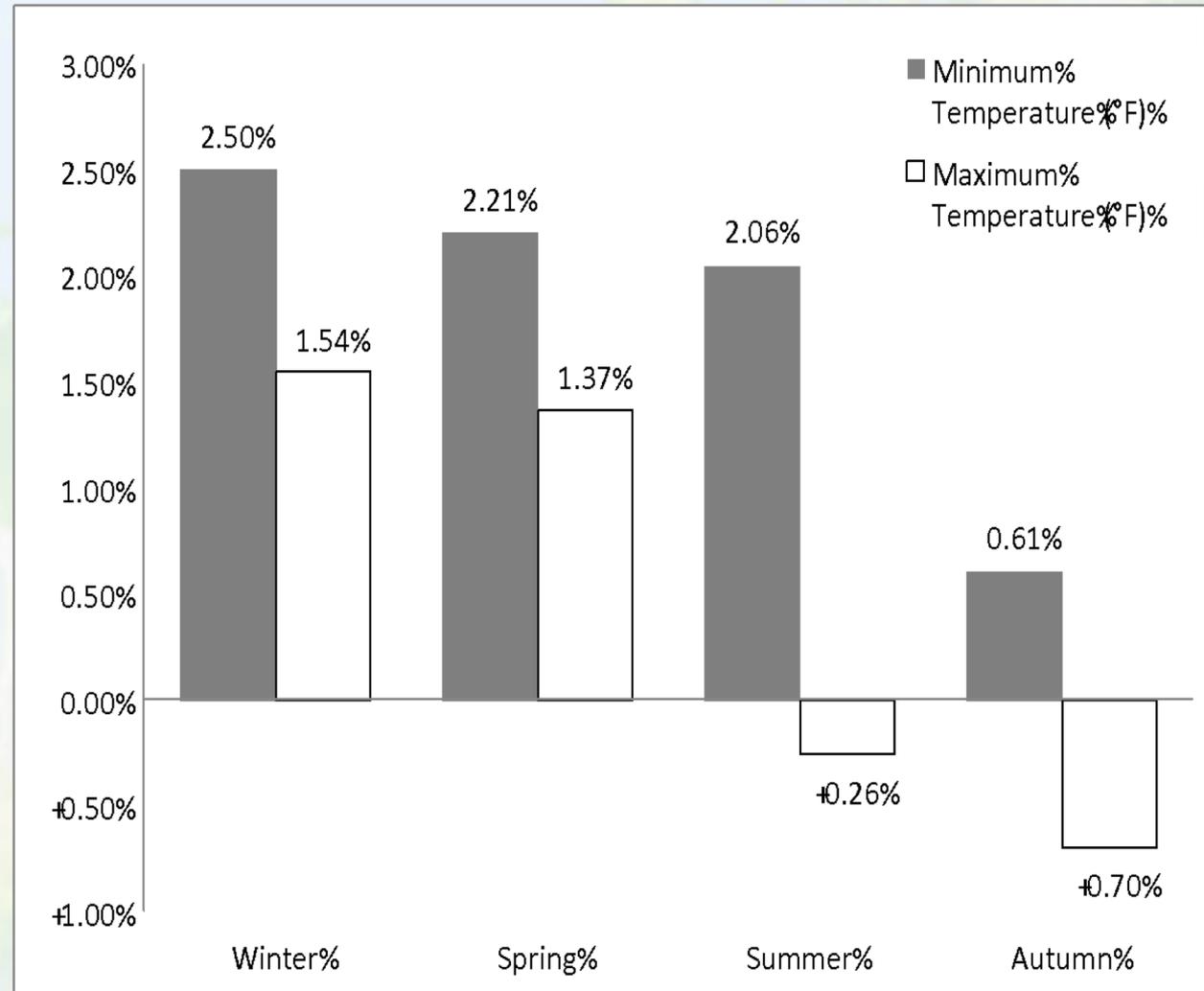




# Recent Temperature Trends



## Nebraska Seasonal Trends in Max and Min Temperatures



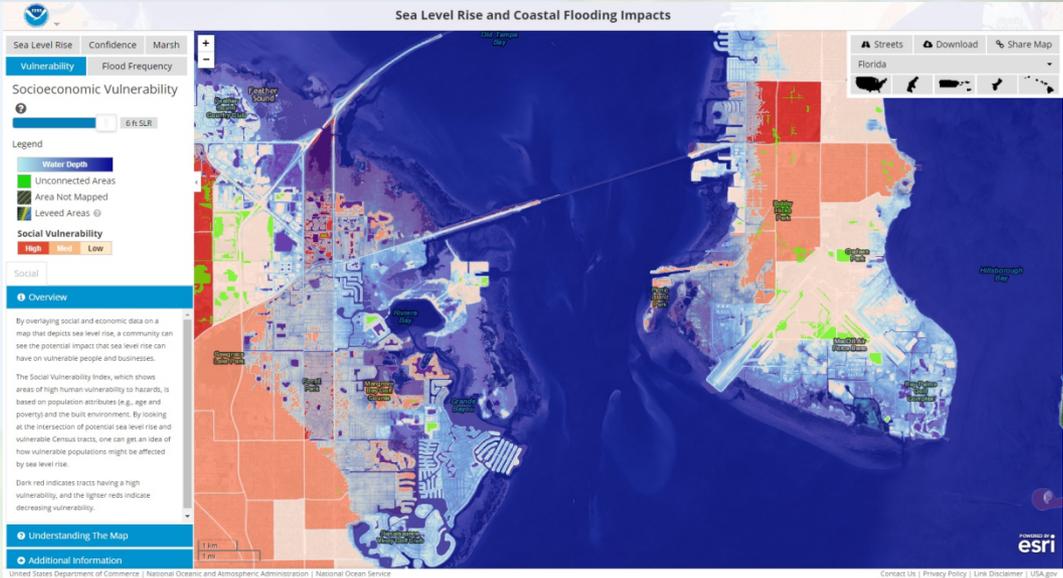
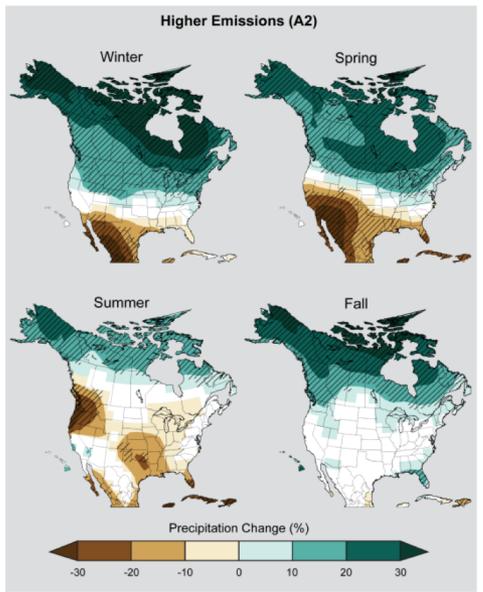
- Nighttime lows show consistent warming.
- Daytime highs have cooled in summer and autumn.



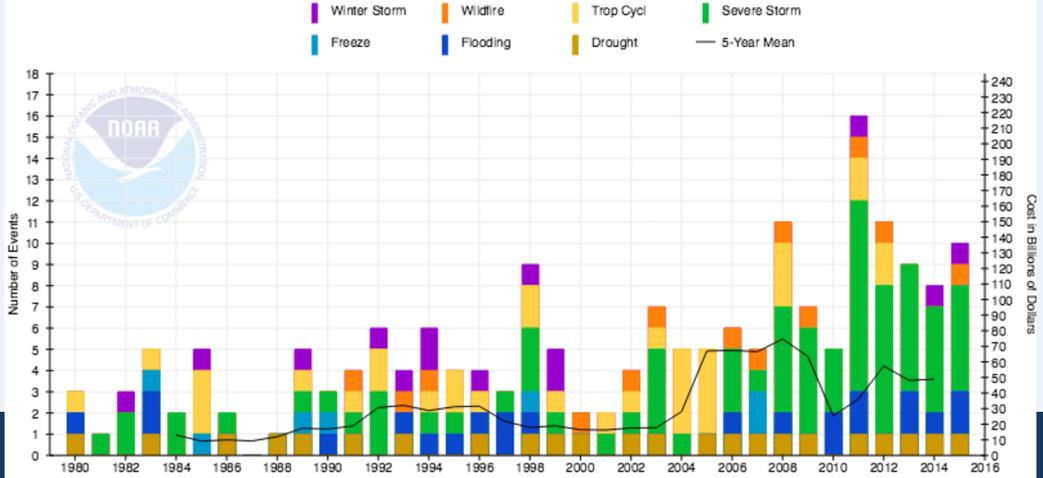
# It's More Than the Temperatures



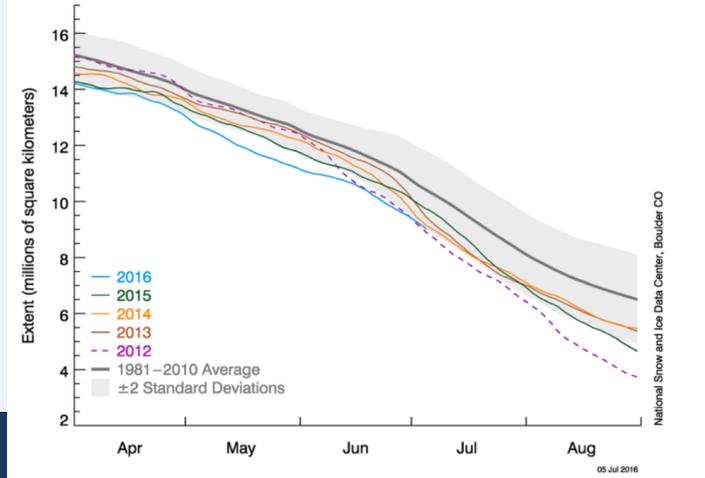
Projected Precipitation Change by Season



Billion-Dollar Disaster Event Types by Year (CPI-Adjusted)



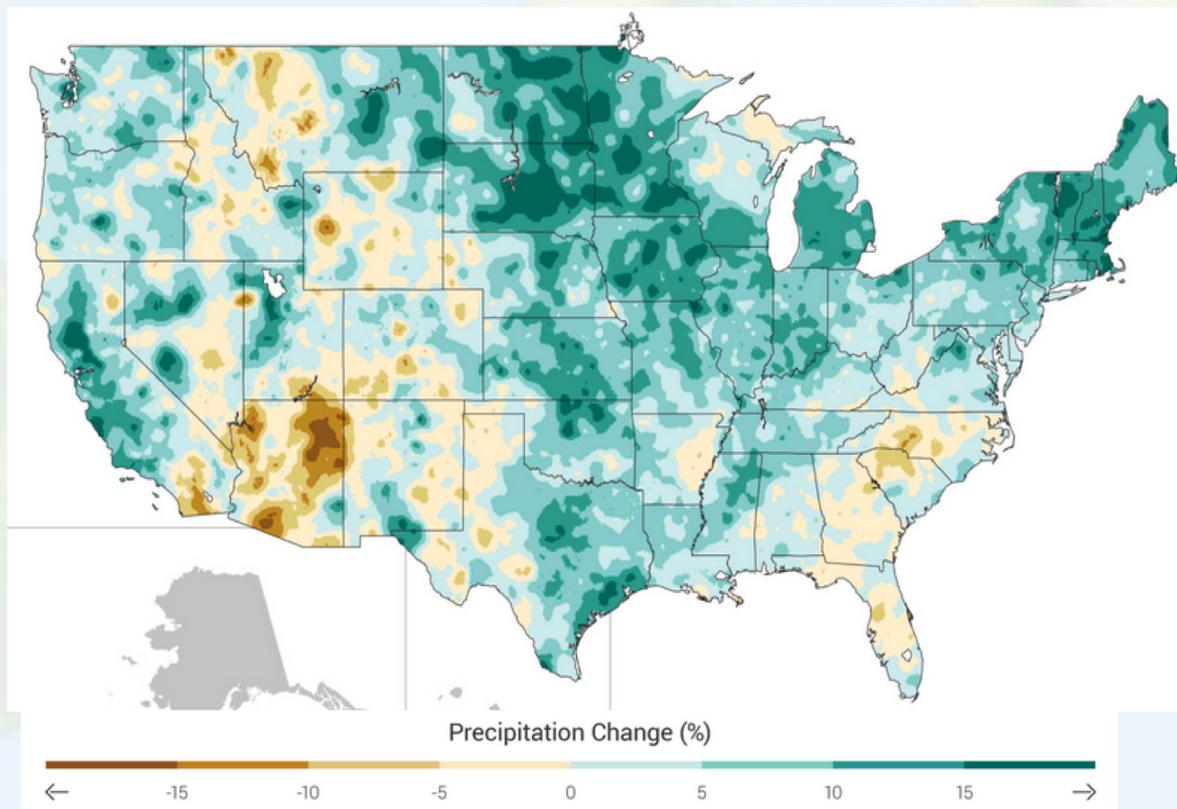
Arctic Sea Ice Extent (Area of ocean with at least 15% sea ice)



# Recent Precipitation Trends

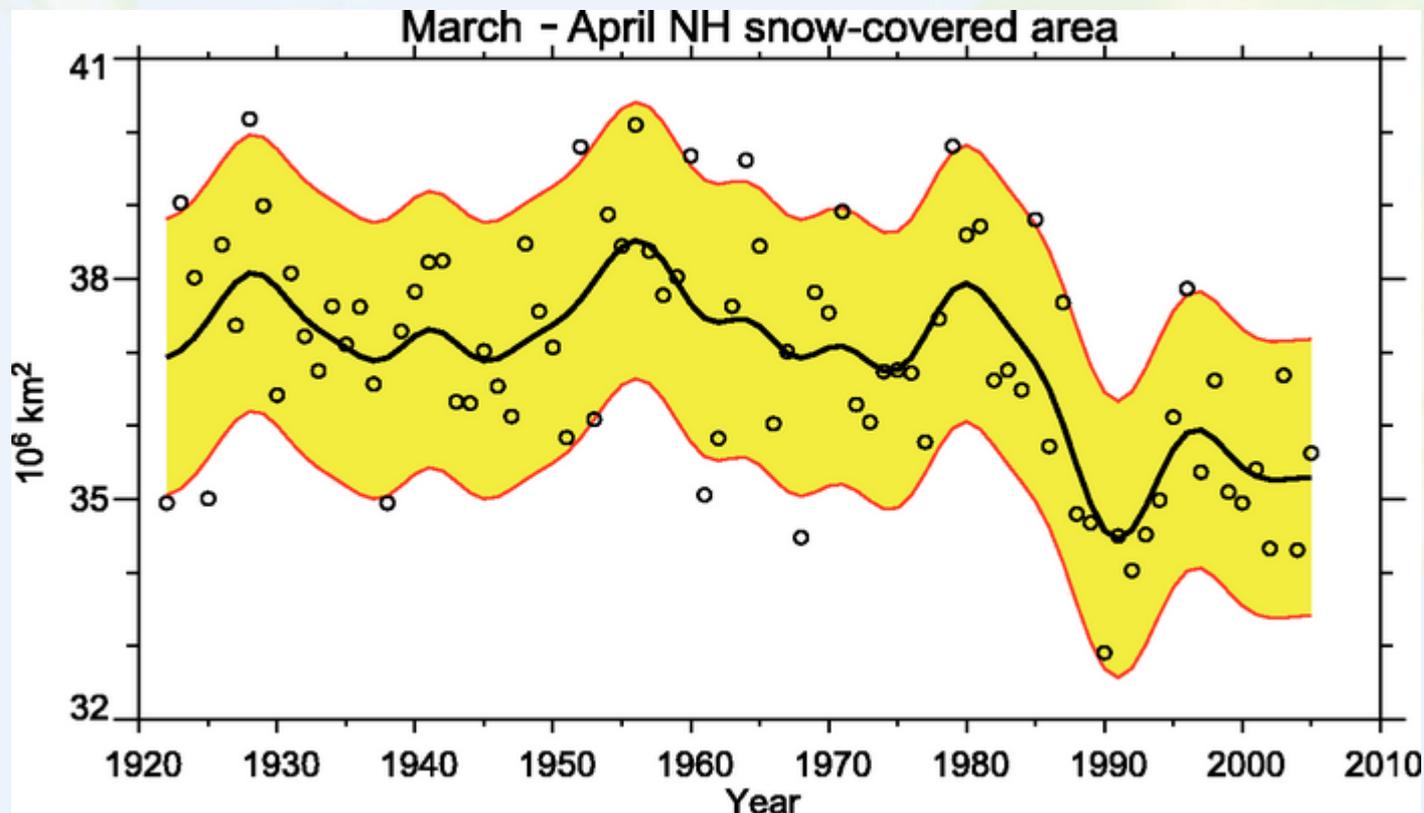
- Wetting in the north.
- Drying in the west and south.

Recent precipitation (1991-2012) compared to 1901-1960



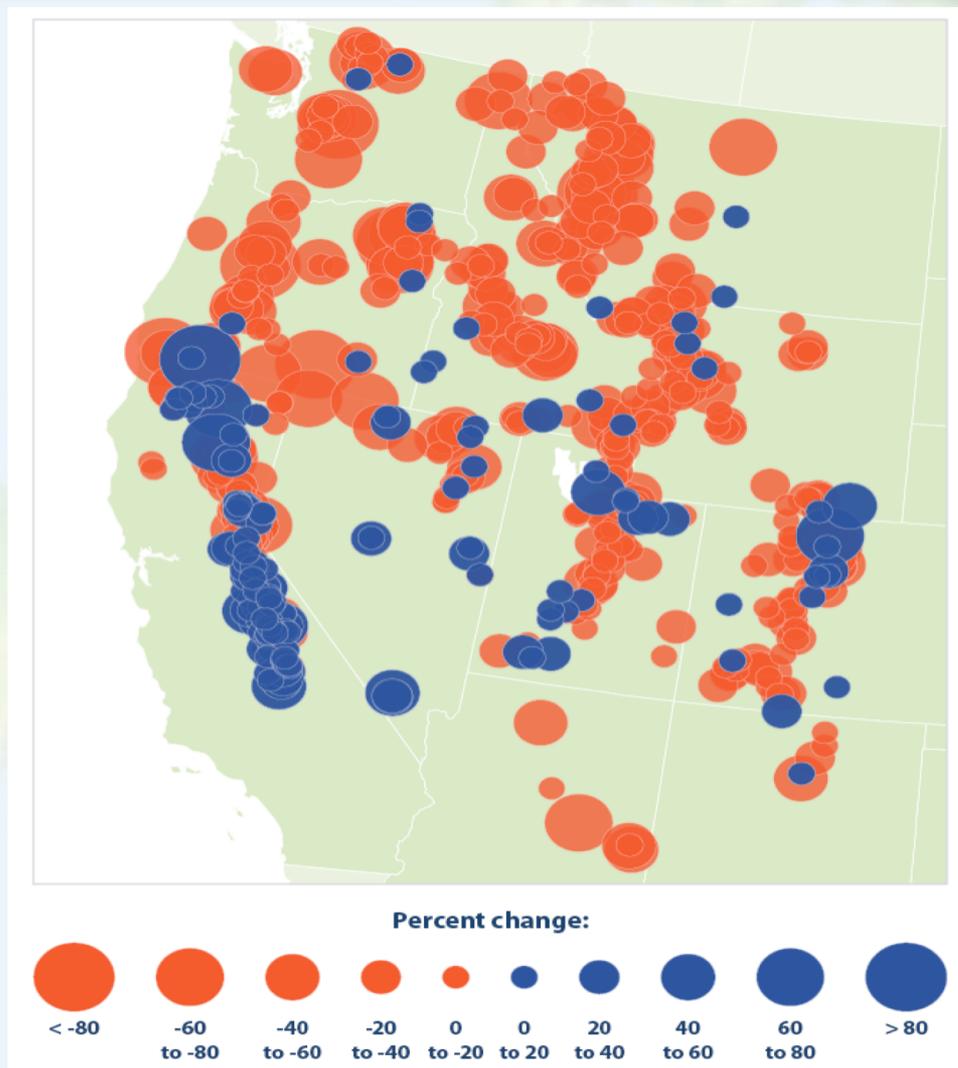
# Snow Is Melting Early

- In 2014, snow melt occurred 20–30 days earlier over North America than the 1998–2010 average.



# Snowpack Is Declining

- Snowpack is *declining* overall in the west.
- The onset of spring snowmelt is occurring *earlier* in the year.

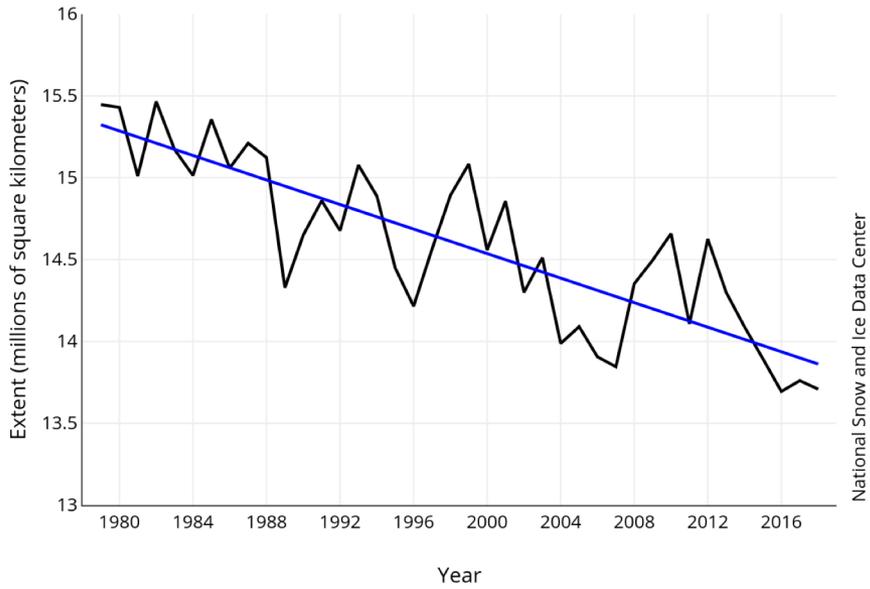




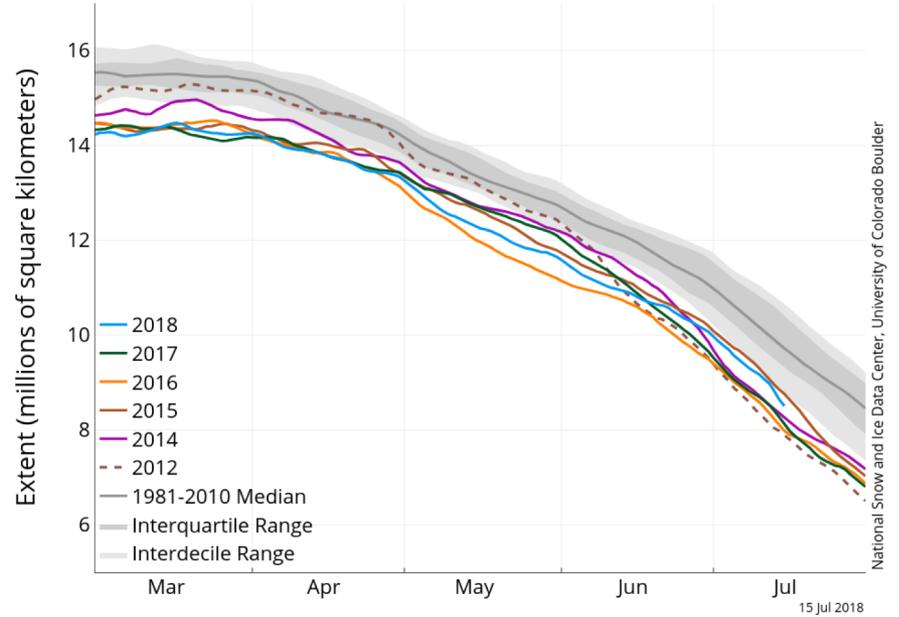
# Arctic Sea Ice Is Melting



Average Monthly Arctic Sea Ice Extent  
April 1979 - 2018



Arctic Sea Ice Extent  
(Area of ocean with at least 15% sea ice)

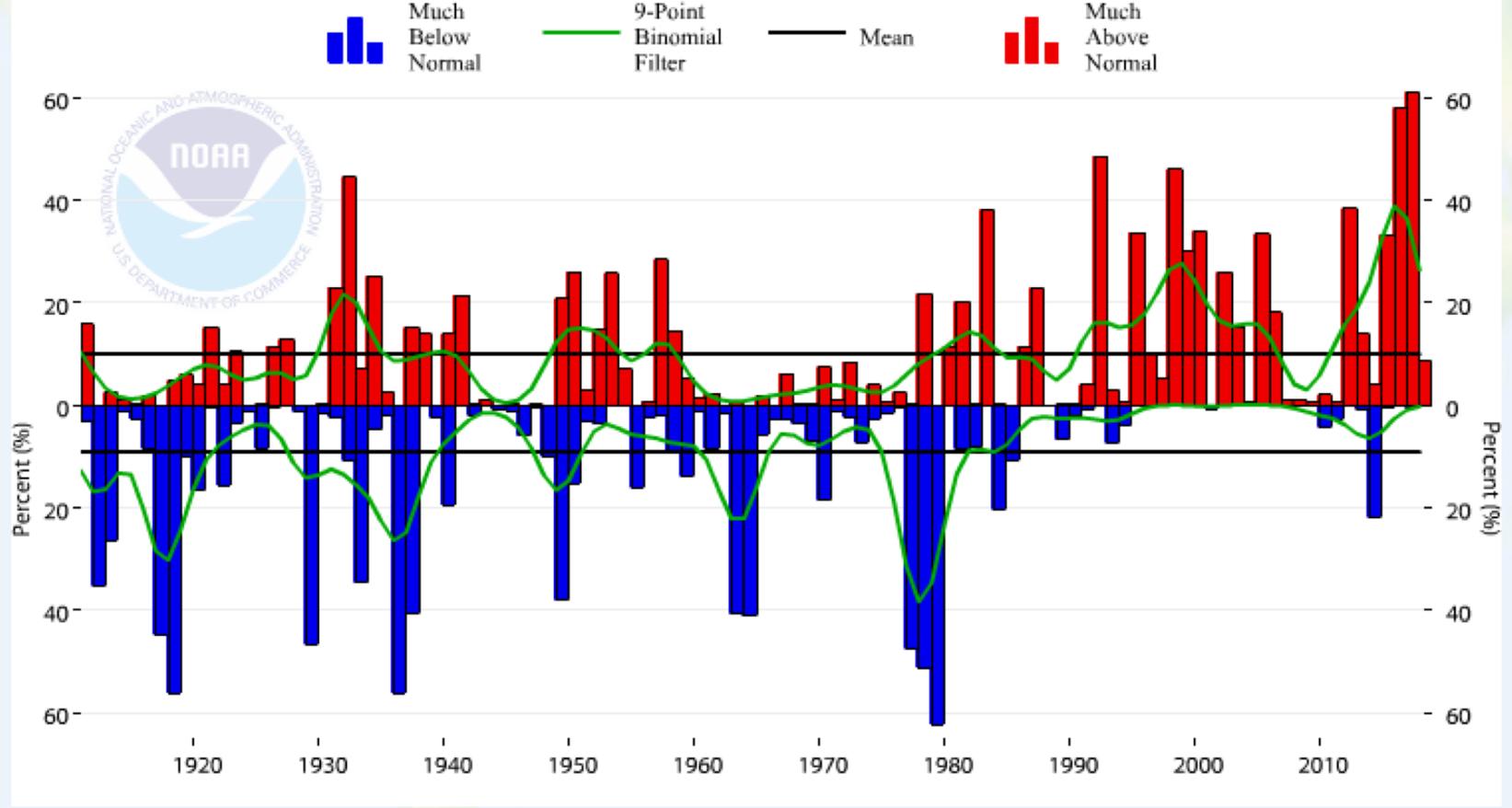


- 10 lowest minimum sea ice extents are the last 10 years.
- Multi-year ice is decreasing (ice is thinning).
- September Arctic sea ice extent is declining at a rate of -13.3% per decade.



# Big Heat Is Increasing

Contiguous U.S. Extremes in Minimum Temperature (Step 2)  
Winter (December-February) 1911-2018



*(Big Cold is generally decreasing)*





# Frost-Free Season Is Lengthening



Recent length (1991-2012) compared to 1901-1960

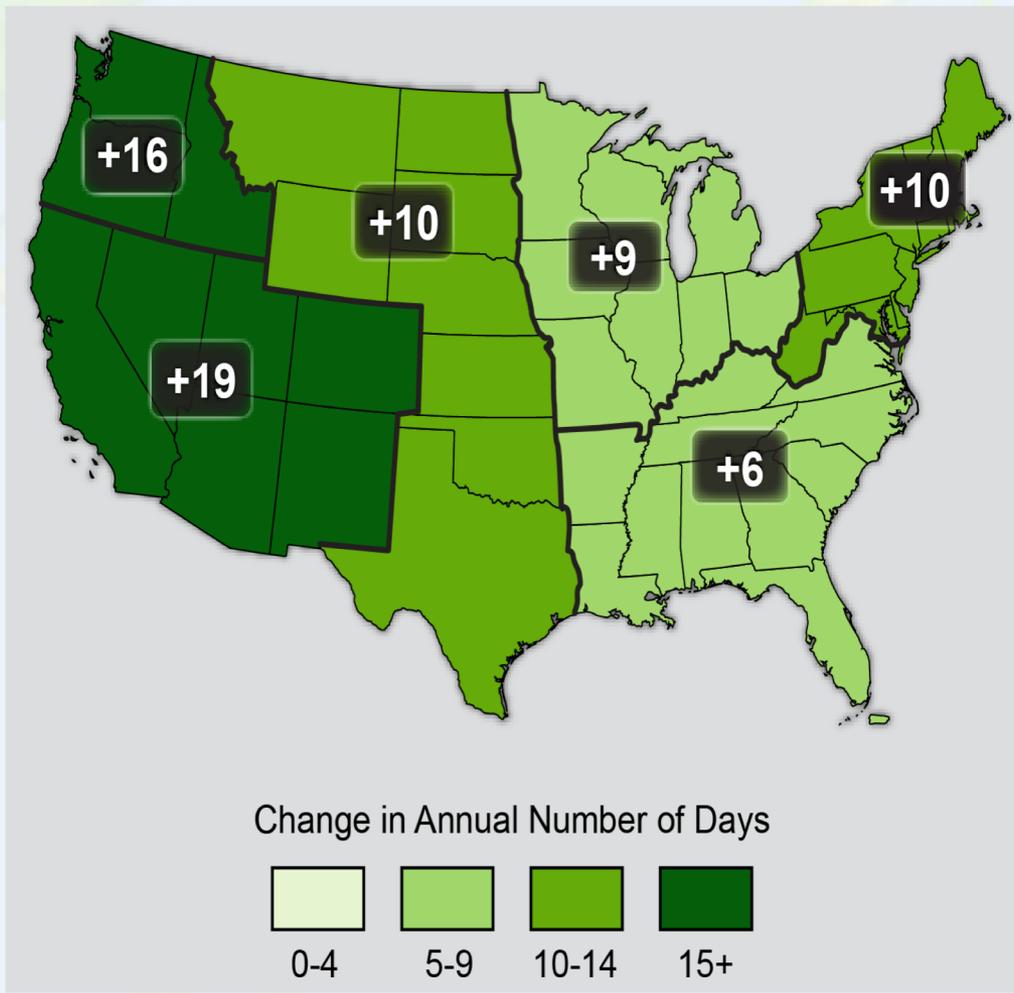


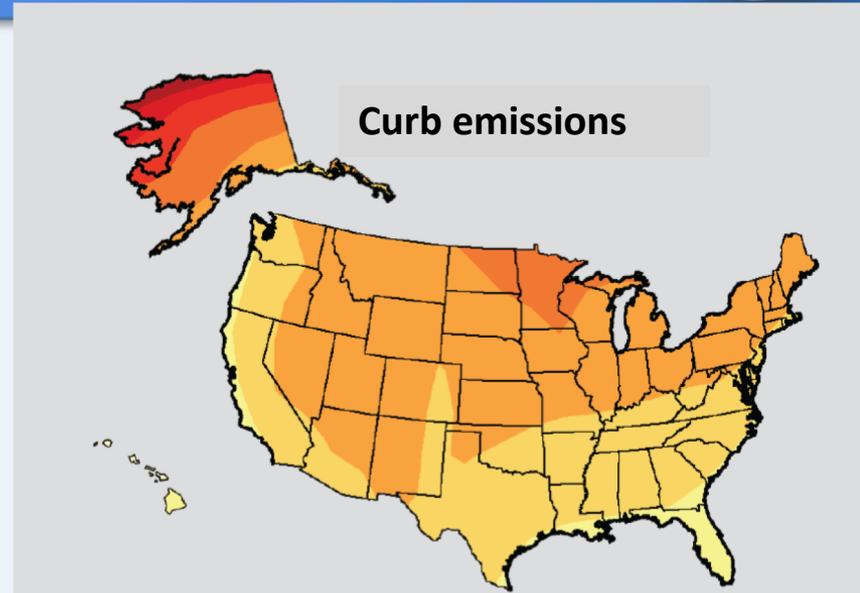
Figure 2.10 Our Changing Climate, National Climate Assessment. <http://nca2014.globalchange.gov>



# Projected Temperature Change



- Temperatures will warm across the region, annually and for all seasons.
- Extremes of temperature and precipitation are expected to be more frequent.
- Uncertainty lies in greenhouse gas emissions scenarios.



Mean annual temperature 2071-2099 compared to 1970-1999

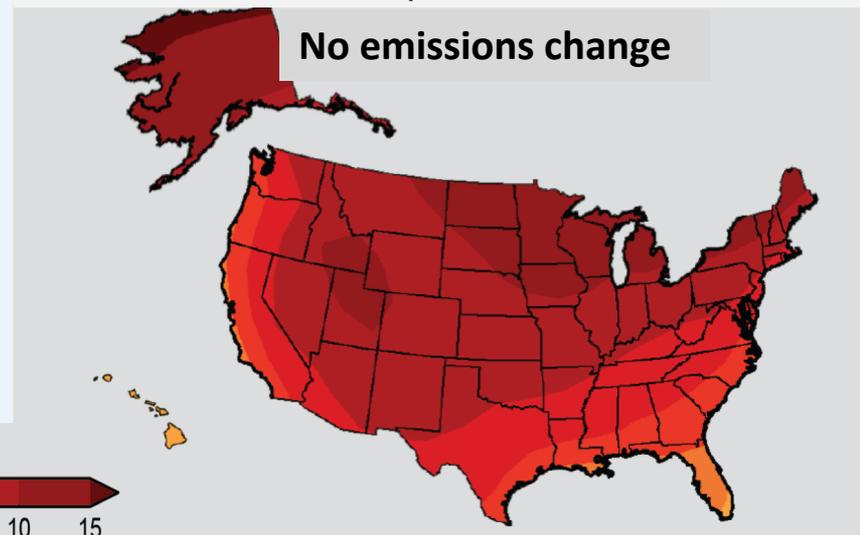
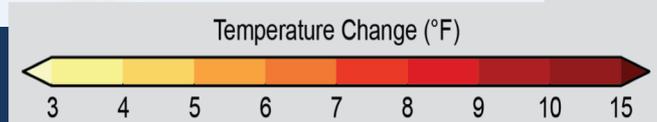


Figure 2.9 Our Changing Climate  
National Climate Assessment  
[nca2014.globalchange.gov](http://nca2014.globalchange.gov)



# Projected Precipitation Change

- Wetting trend north, especially winter and spring.
- Drying trend south, especially winter and spring.
- Drying trend in the central US in the summer.

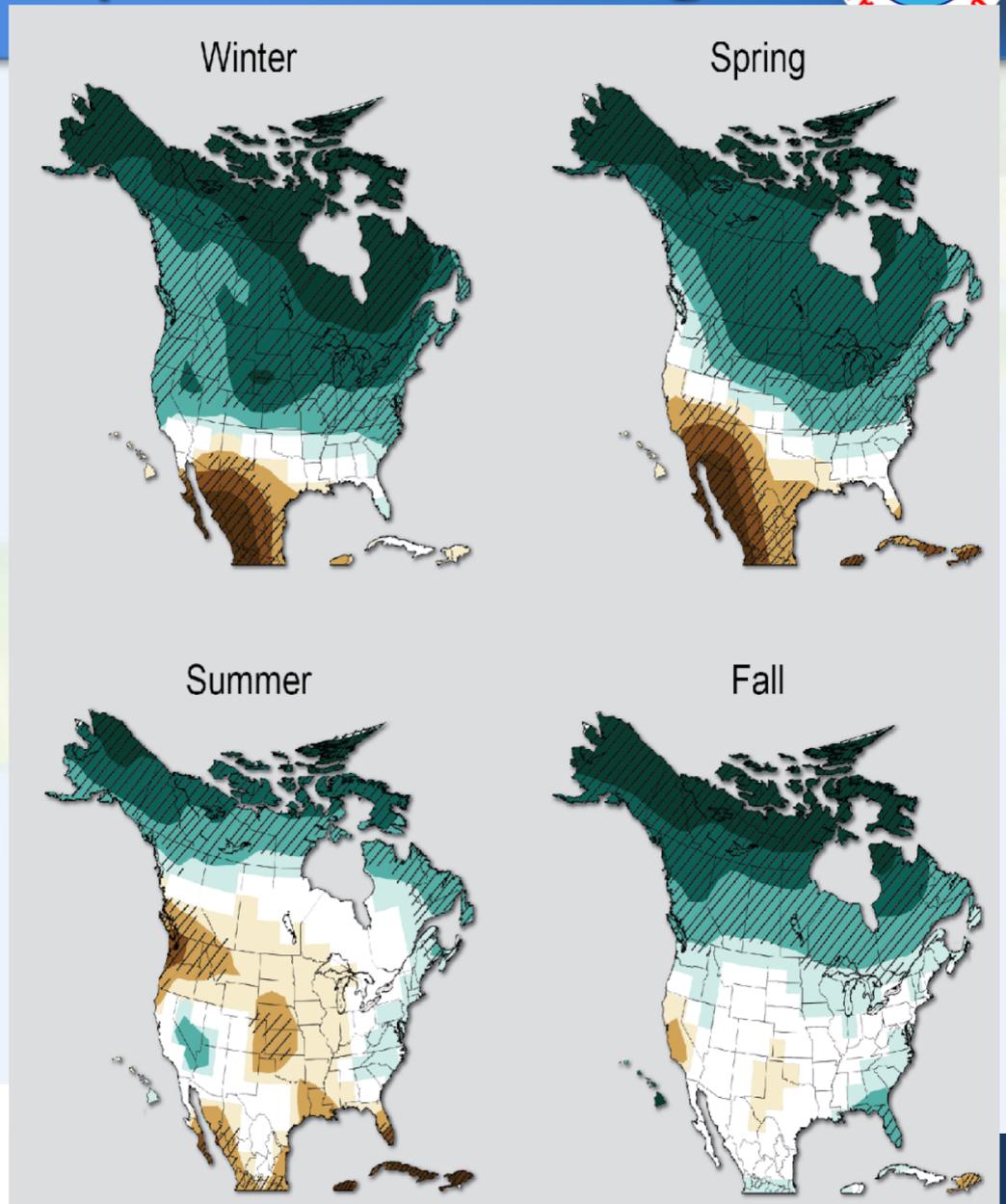


Figure 2.15 Our Changing Climate  
National Climate Assessment  
[nca2014.globalchange.gov](http://nca2014.globalchange.gov)





# Projected Precipitation Change

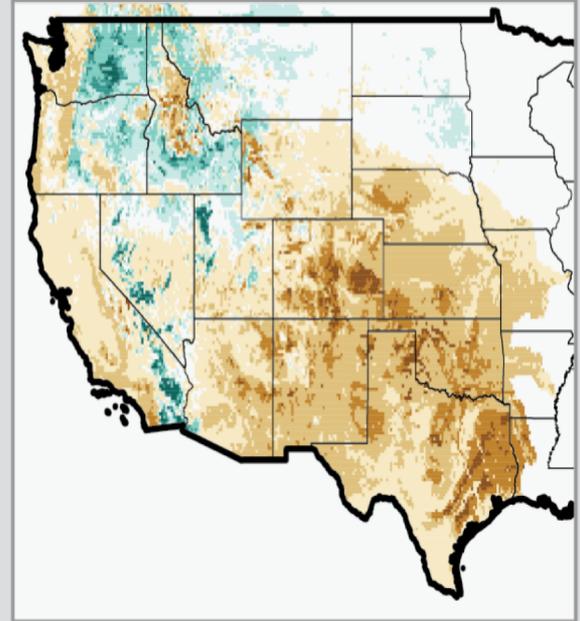
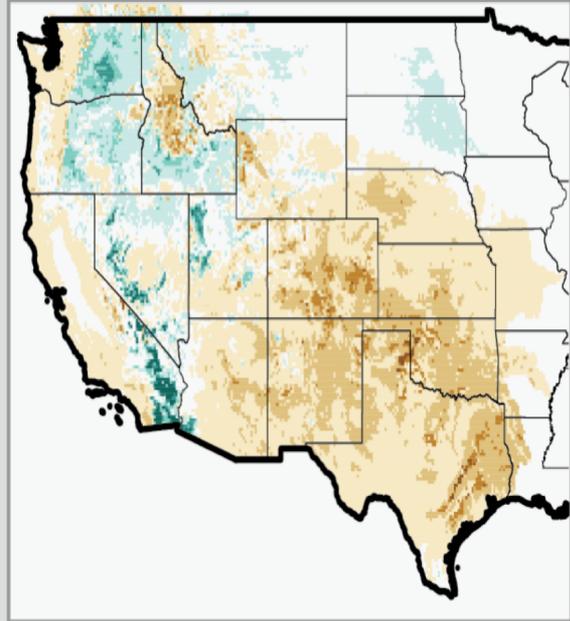


- Trends are already projected by mid-century, with strengthening signals by end of the century.

Mid-Century Changes

End-of-Century Changes

Higher Emissions Scenario (A2)





# Takeaway Messages



- It's real.
- It's us.
- Experts agree.
- It's mostly bad.
- It's not too late to fix it.

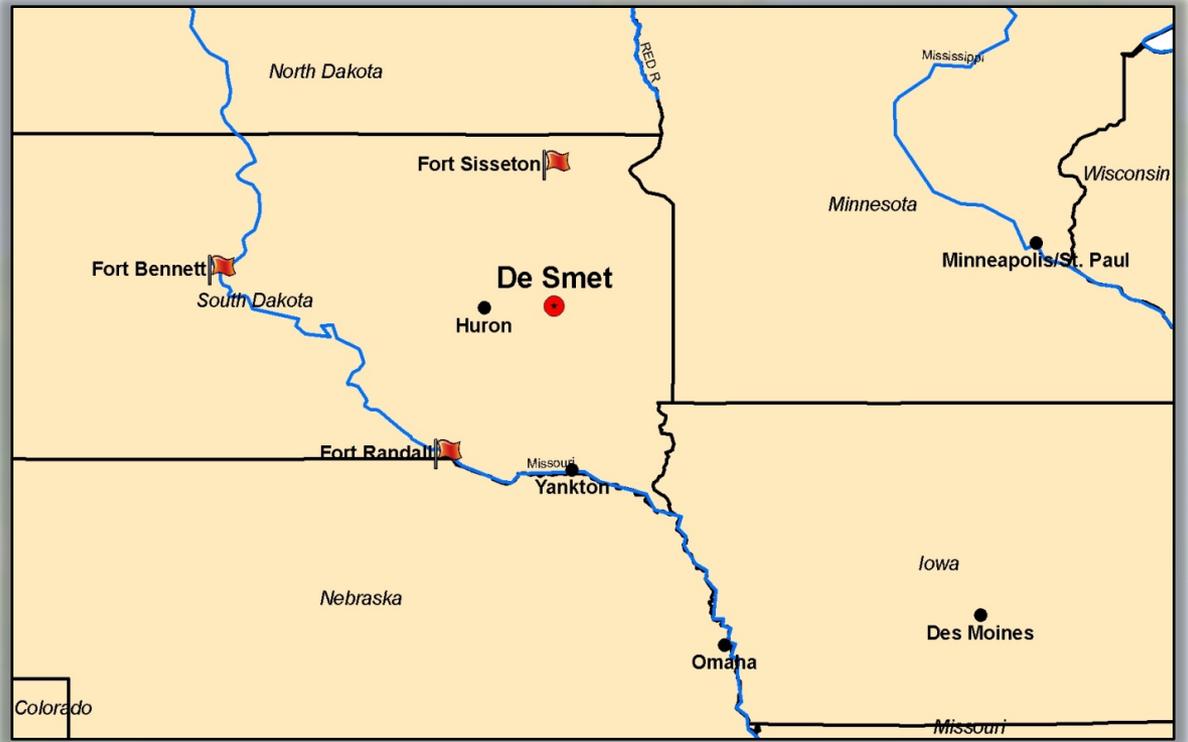
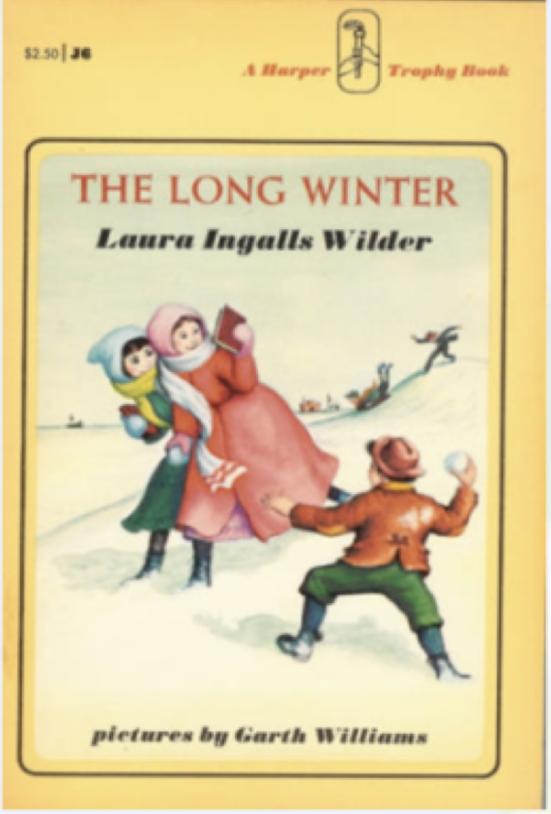
Adapted from Ed Maibach, George Mason University's Center for Climate Change Communication



**Back to Our Narrative**



# The Long Winter







# The Schoolhouse Blizzard: November or early December 1880





# The Trains Stop Running

## January 3, 1881



**Kelly's Cut, 0.5 mi west of Sleepy Eye, MN – March 1881.  
Courtesy of Chicago & North Western Railroad Archives.**



# ...and Supplies Run Short





# Storms Blur Together

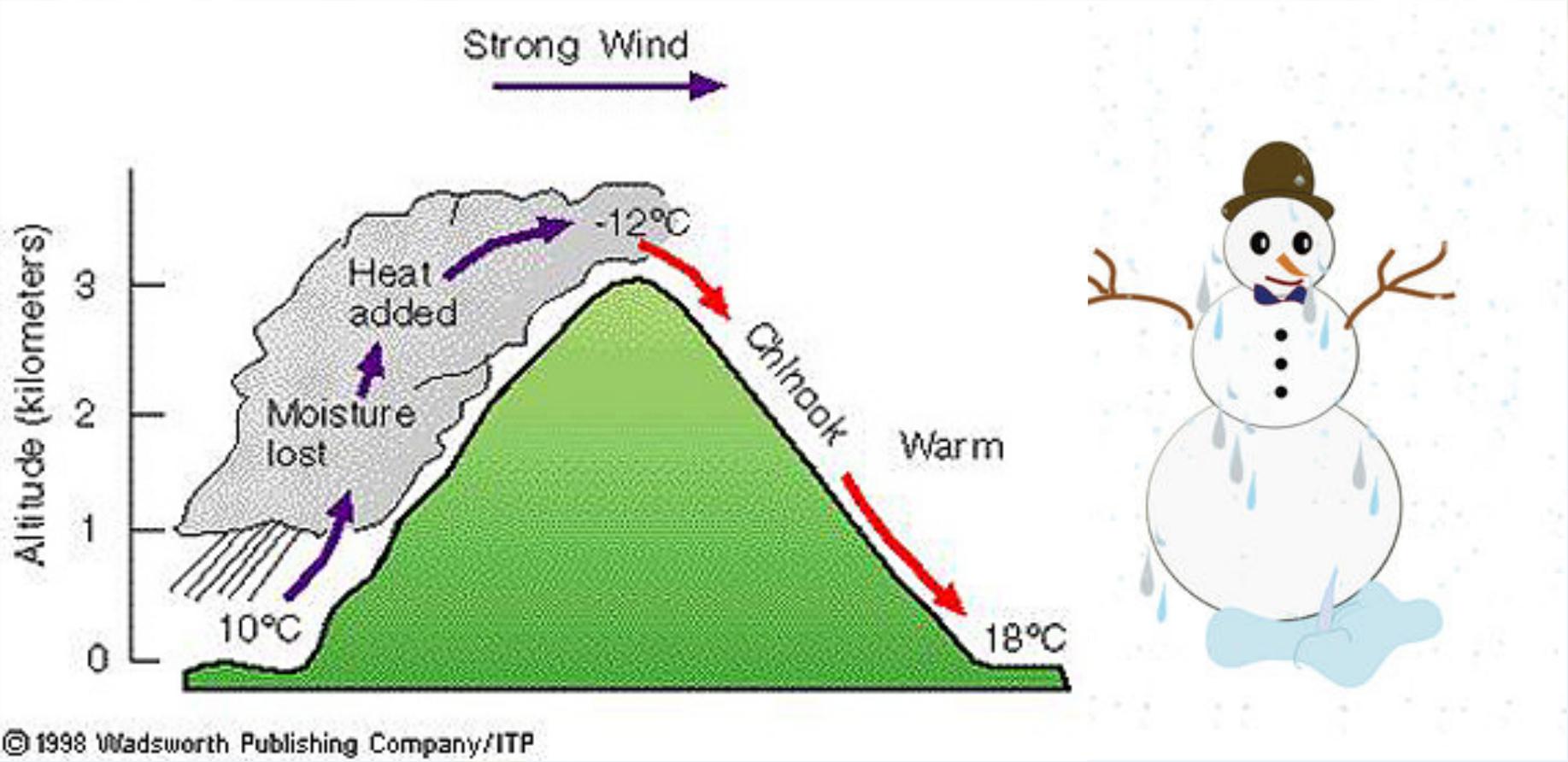
## Mid-January through February 1881





# “The Chinook Is Blowing!”

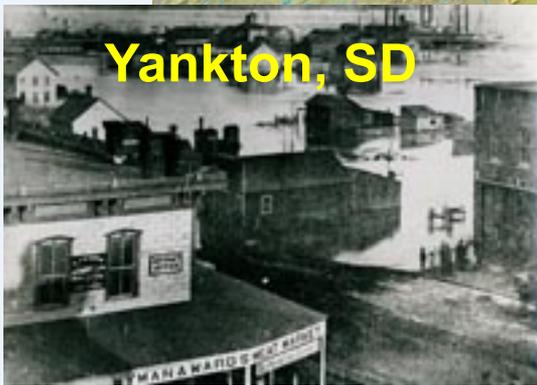
April 15, 1881



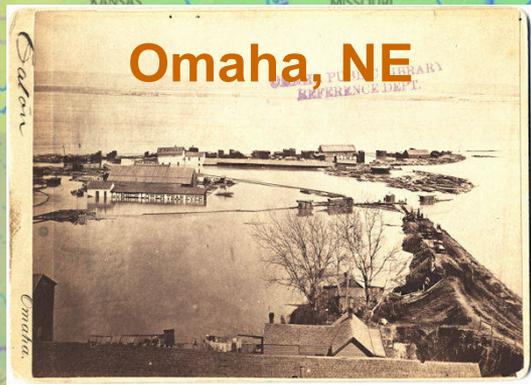
© 1998 Wadsworth Publishing Company/ITP



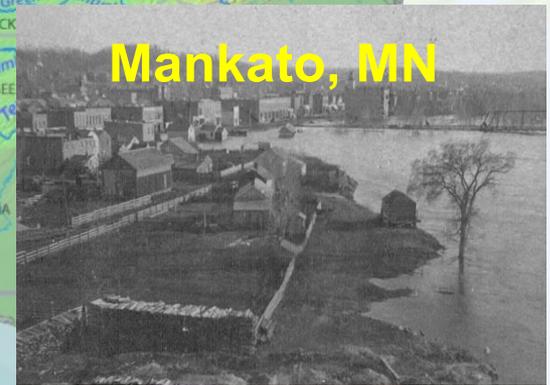
# Floods of Spring 1881



**Yankton, SD**



**Omaha, NE**



**Mankato, MN**

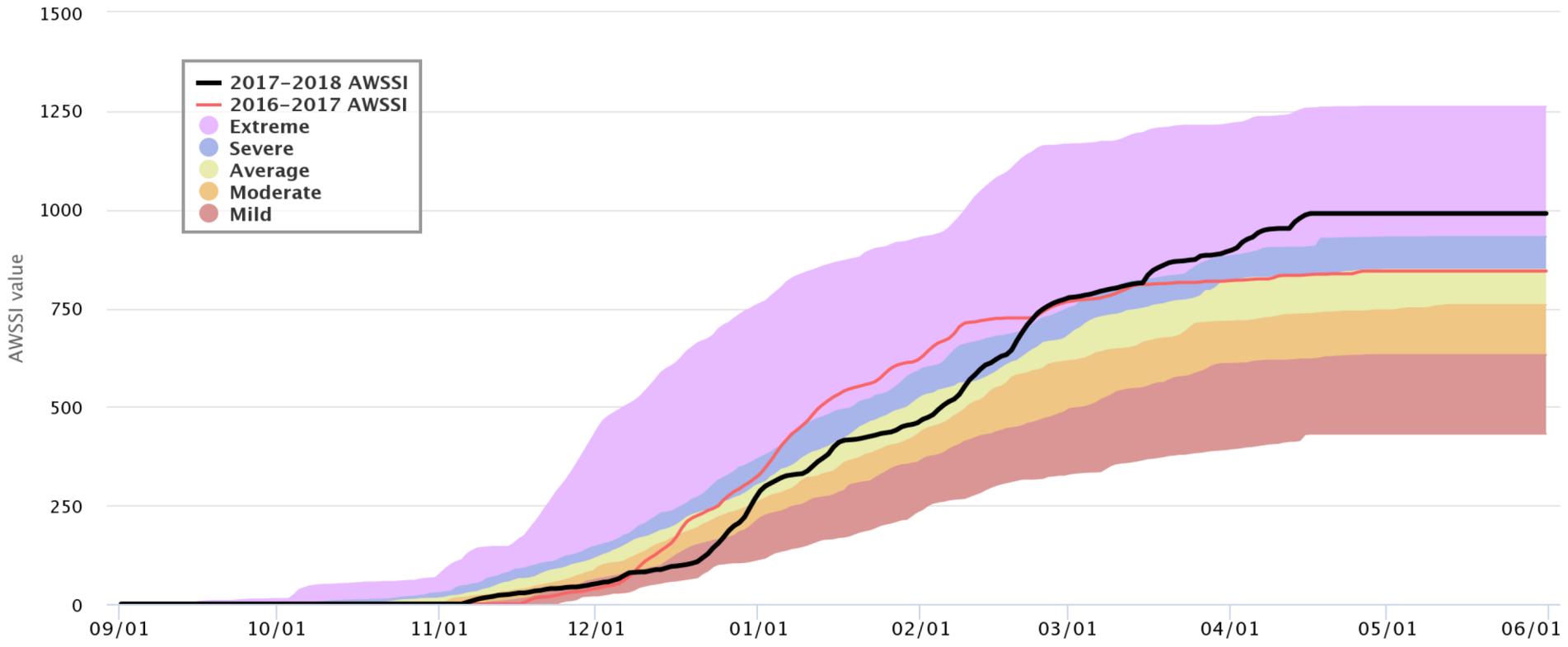
About 2,000 miles (3,219 km) across



# Accumulated Winter Season Severity Index (AWSSI)



2017-2018 AWSSI: "SD - Rapid City"  
Season: 2017-11-06 to 2018-04-16, 162 days



© Midwestern Regional Climate Center

Click and drag to zoom



# AWSSI Online



## RESEARCH: ACCUMULATED WINTER SEASON SEVERITY INDEX (AWSSI)

**A**ccumulated  
**W**inter  
**S**eason  
**S**everity  
**I**ndex

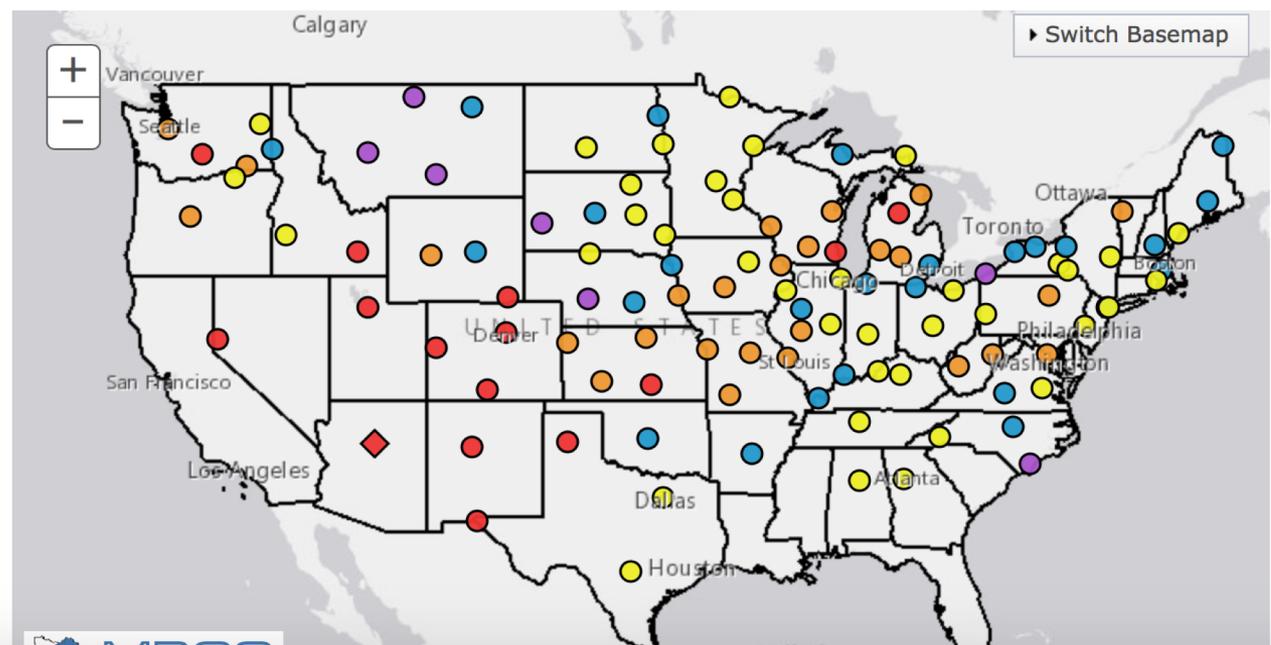
Winter seasons have significant societal impacts across all sectors ranging from direct human health and mortality to commerce, transportation, and education. The question "How severe was this winter?" does not have a simple answer. At the very least, the severity of a winter is related to the intensity and persistence of cold weather, the frequency and amount of snow, and the amount and persistence of snow on the ground. The Accumulated Winter Season Severity Index (AWSSI) was developed to objectively quantify and describe the relative severity of the winter season.

### Current Season

#### AWSSI Category

- Extreme
- Severe
- Average
- Moderate
- Mild
- ◆ = Record

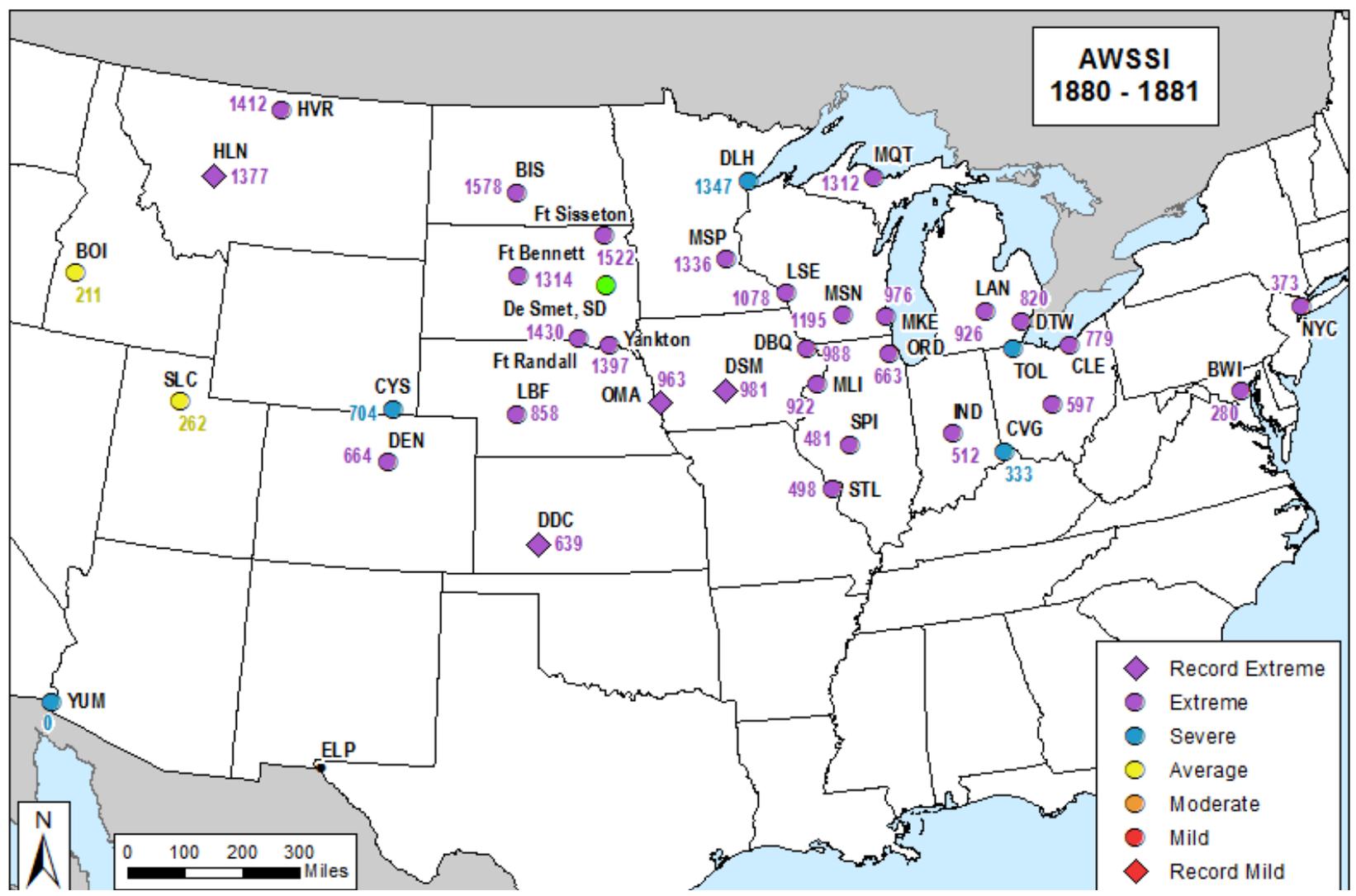
**Data Last Updated:**  
3/29/2018 19:20 CDT



<http://mrcc.isws.illinois.edu/research/awssi/indexAwssi.jsp>



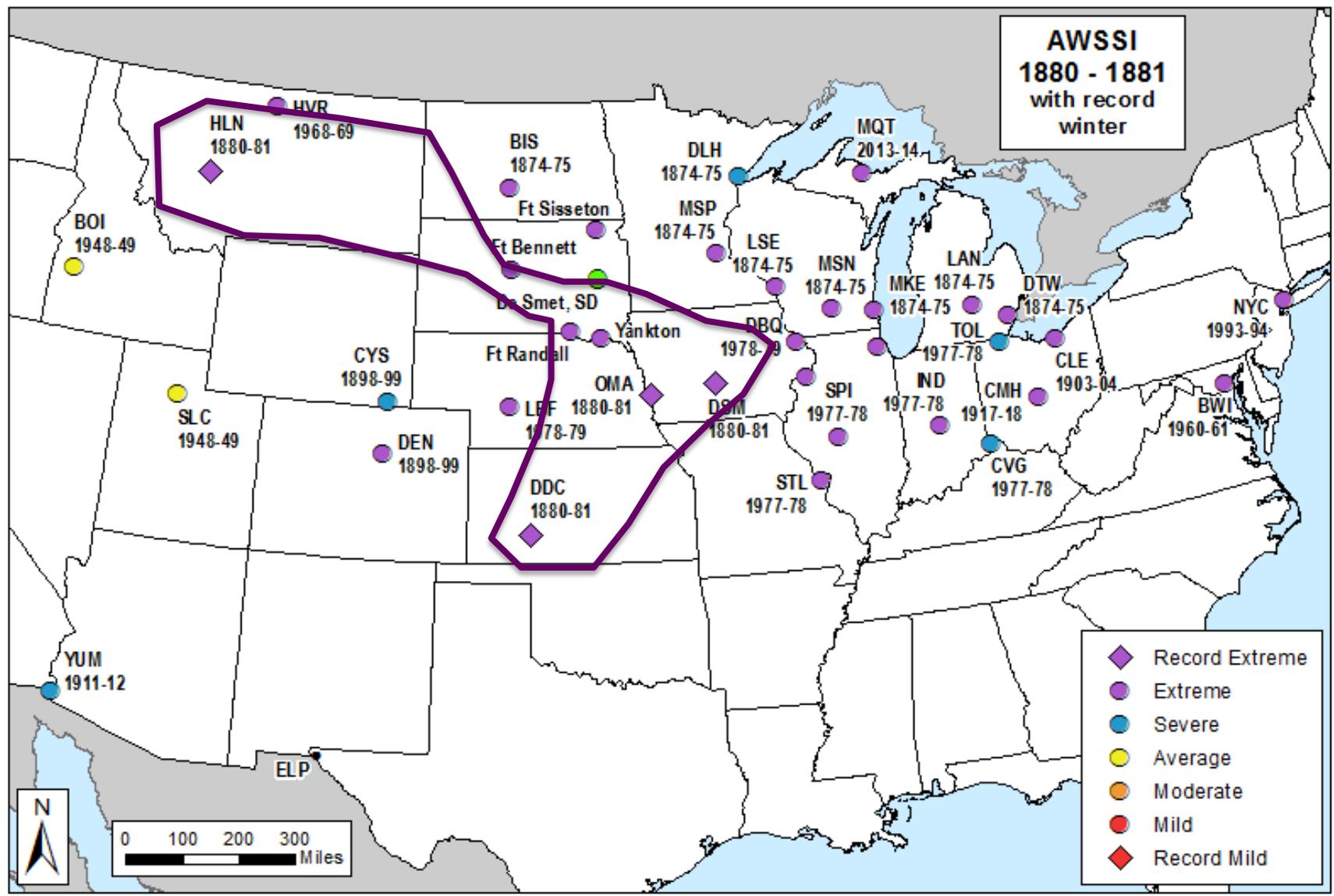
# 1880-1881 AWSSI Compared to Climatology



<http://mrcc.isws.illinois.edu/research/awssi/indexAwssi.jsp>

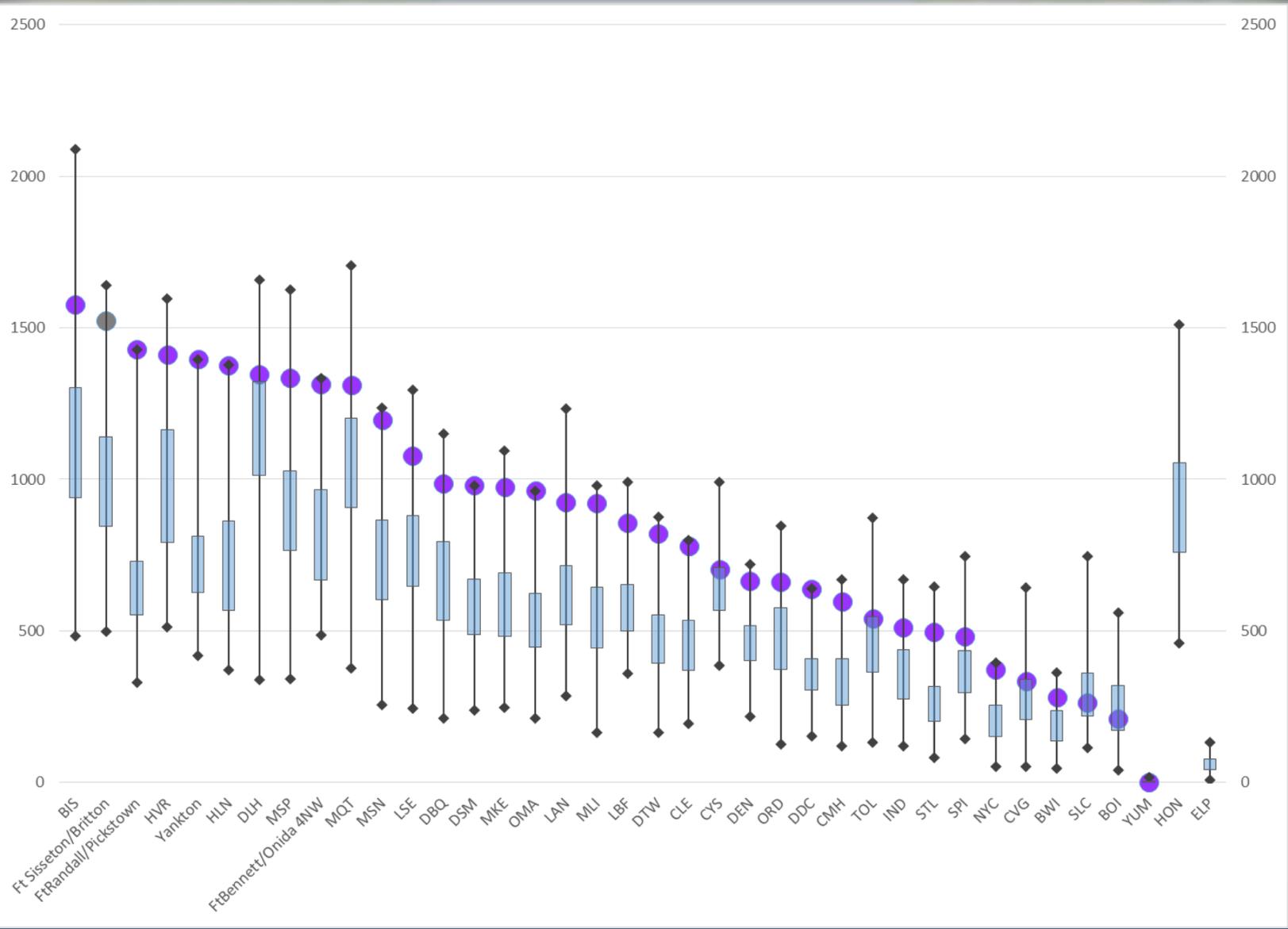


# Region Where 1880-1881 Ranks As Record Extreme





# Severity of 1880-1881 Compared to Climatology

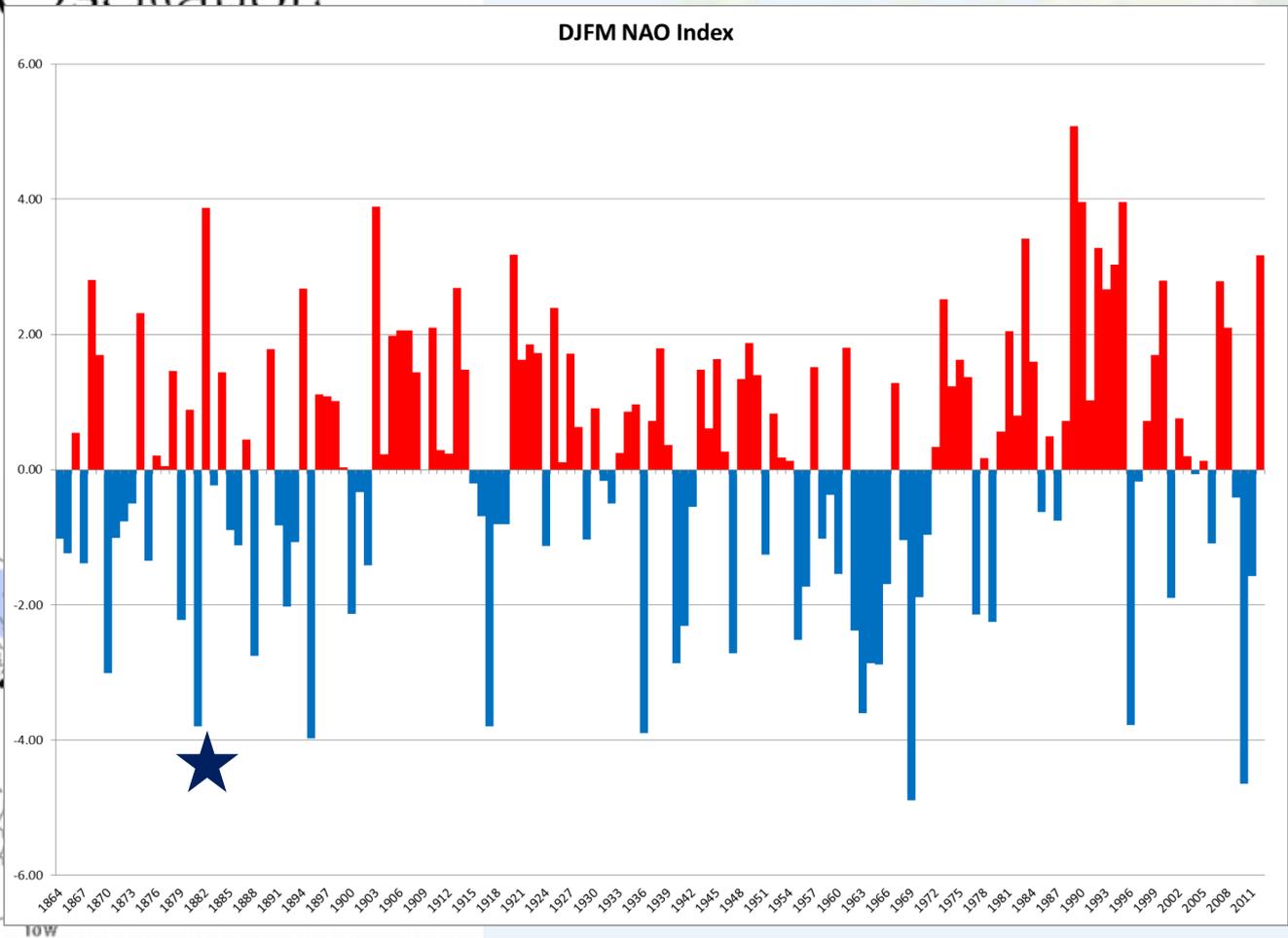
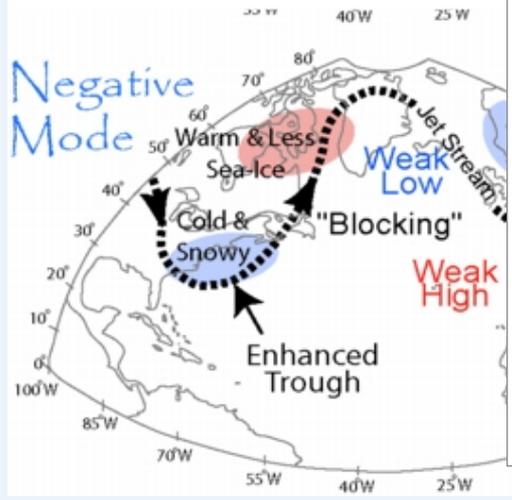




# Why So Cold?

## North Atlantic Oscillation (NAO)

### North Atlantic Oscillation





# Why So Cold? El Niño

Typical Wintertime Pattern

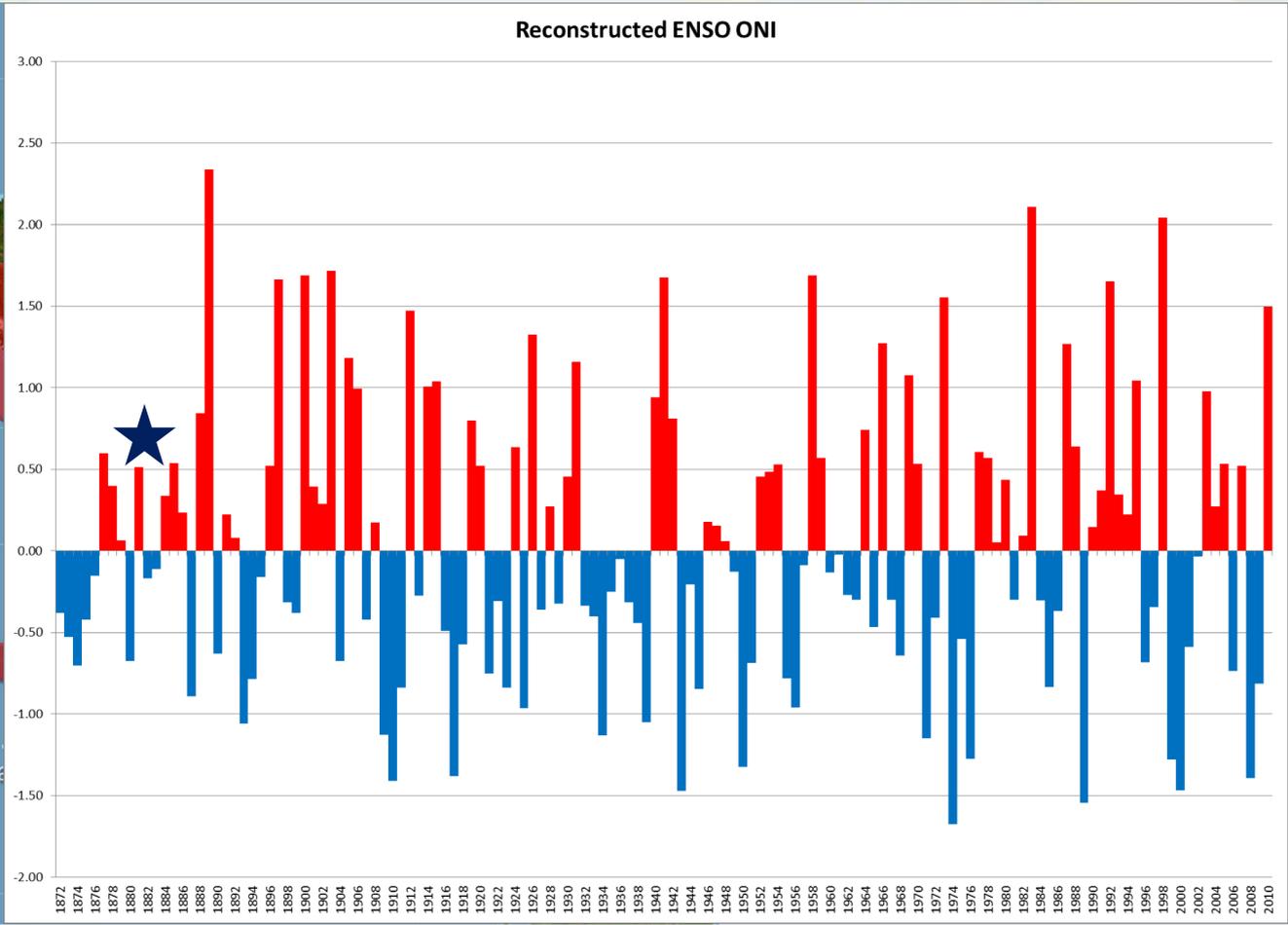
## El Niño

Warm

Low Pressure

Persistent, Extended Pacific  
& Amplified Storm Tra

NWS/NCEP  
Climate Prediction Center



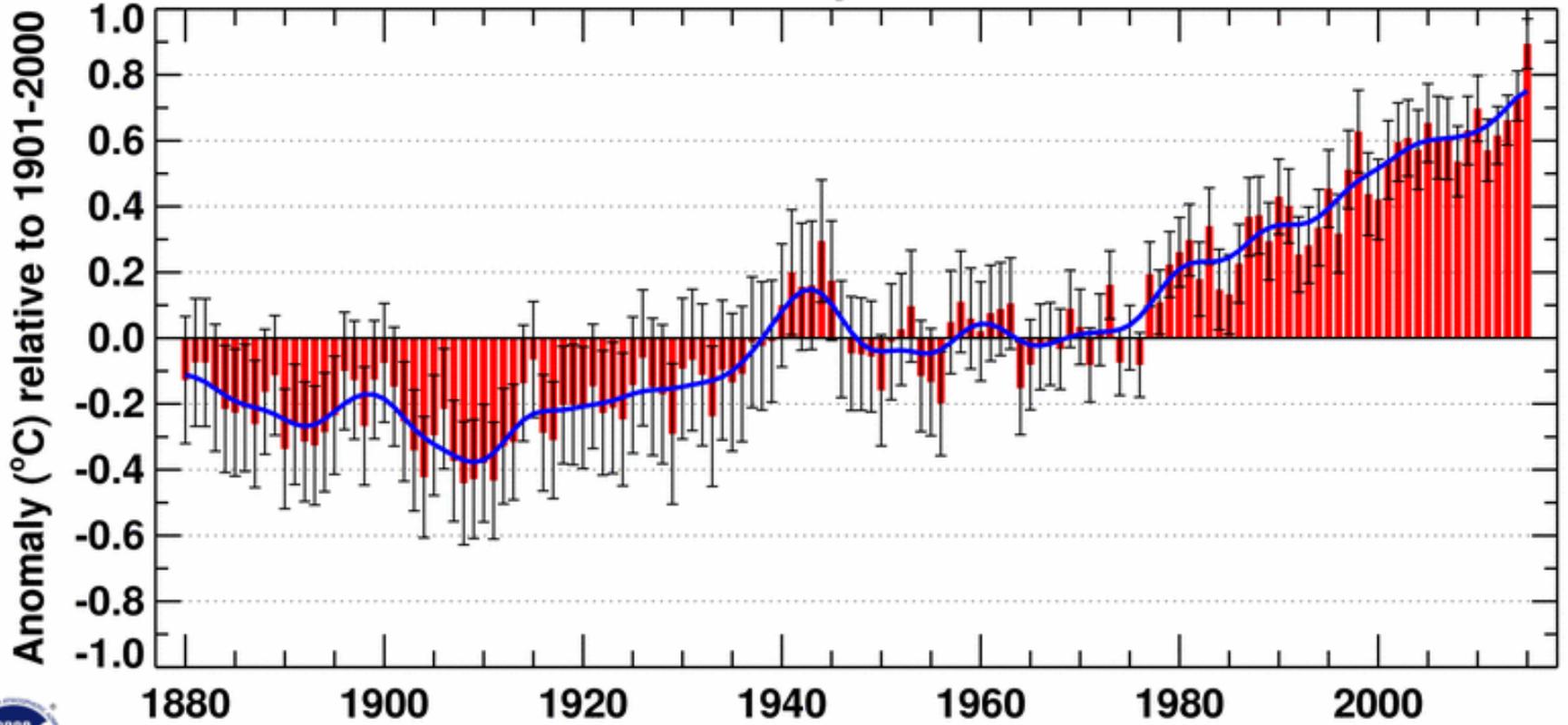


# Why So Cold?

## Colder Climate in 1880s



### Jan-Dec Global Mean Temperature over Land & Ocean



NCEI/NESDIS/NOAA



# How Do We Know? Data Sources



- Continuous weather records:

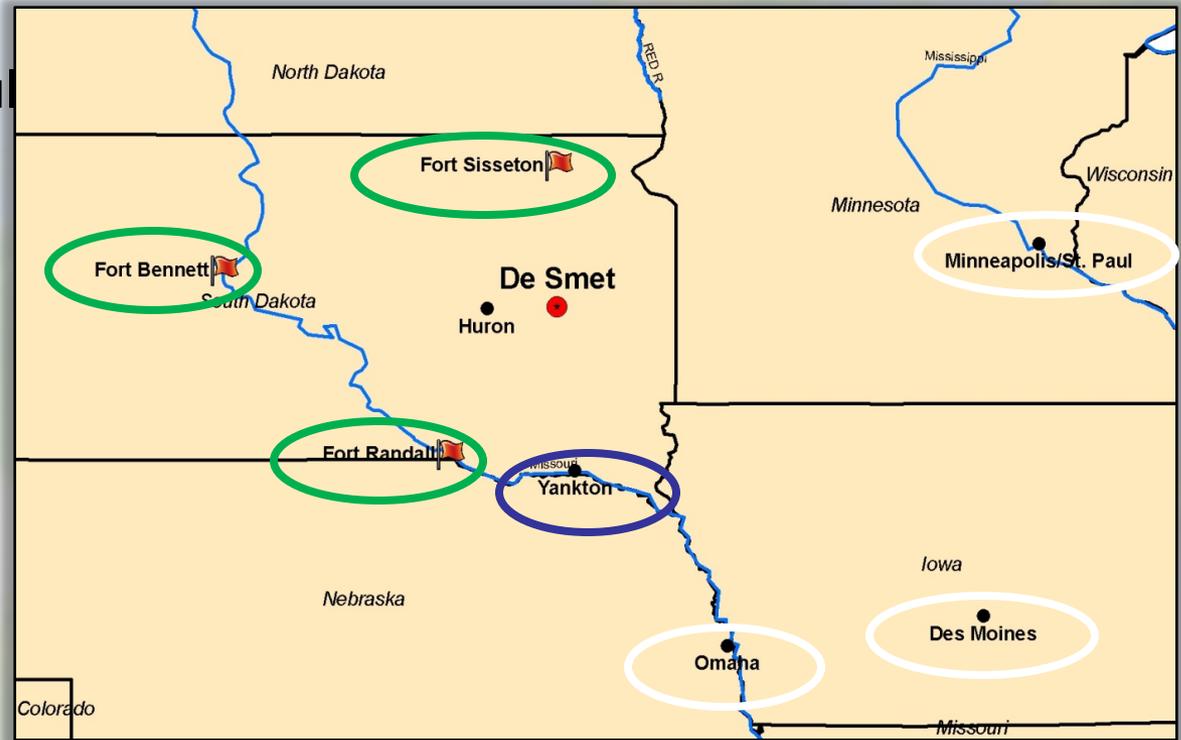
- ◆ Omaha
- ◆ Minneapolis/St. Paul
- ◆ Des Moines

- Historical forts

- ◆ Fort Randall
- ◆ Fort Bennett
- ◆ Fort Sisseton

- “Hybrid”

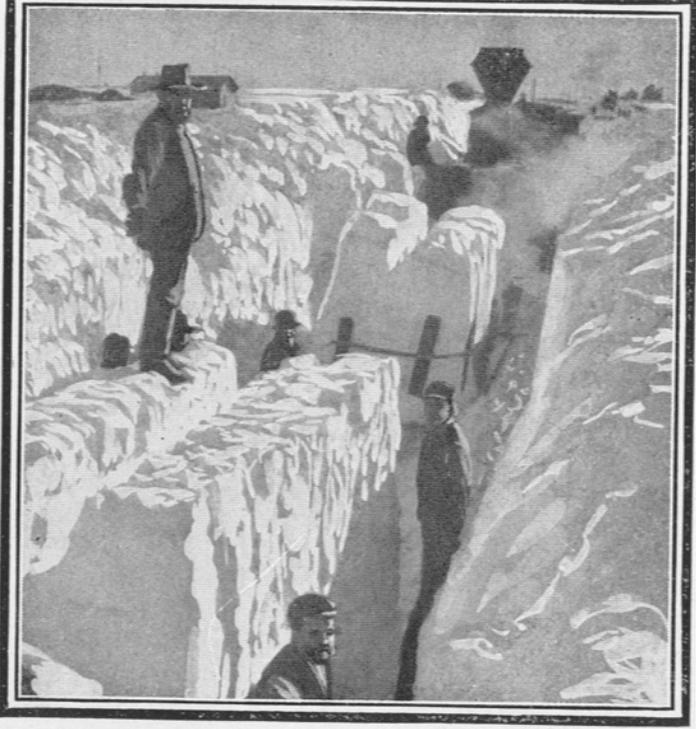
- ◆ Yankton



**Note: No direct snow measurements!  
No data in DeSmet!**



# Blizzard and Severe Winter Impacts Pioneer and Modern Eras

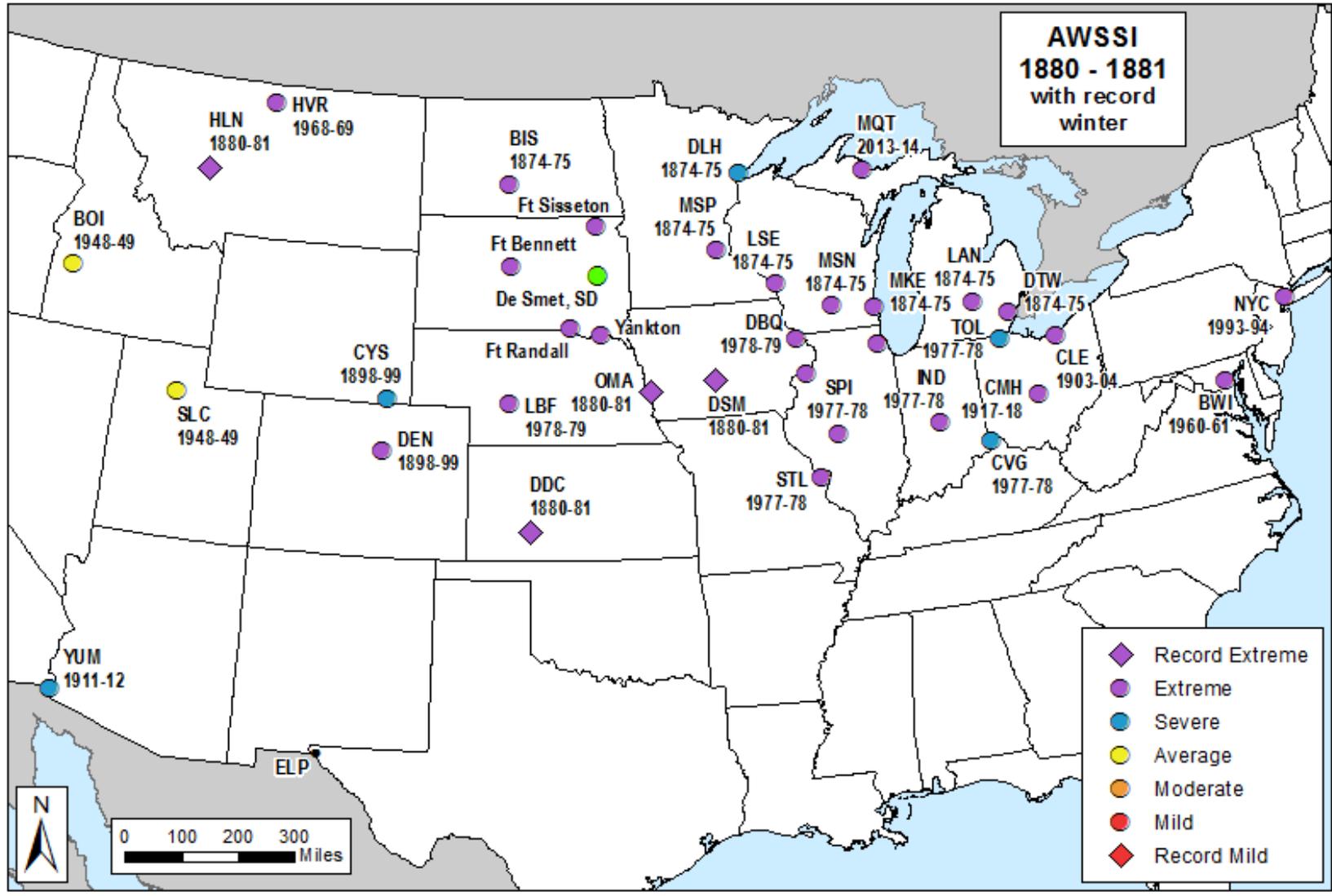


OPENING THE ROAD IN 1881.





# Is 1874-75 the "Real" Long Winter?





# Laura Ingalls Wilder



Children's Book Series

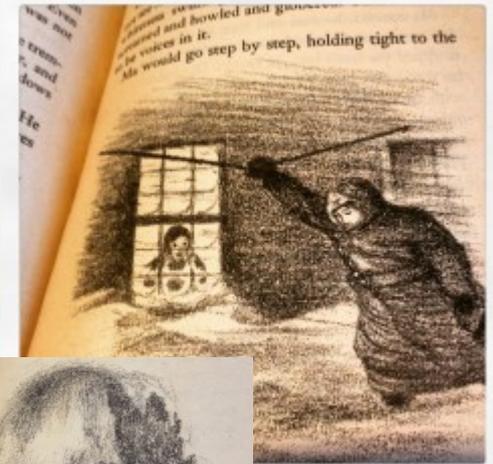


# The Hard Winter on Plum Creek



- Laura's description of hard winter in *On the Banks of Plum Creek* (even if out of order):

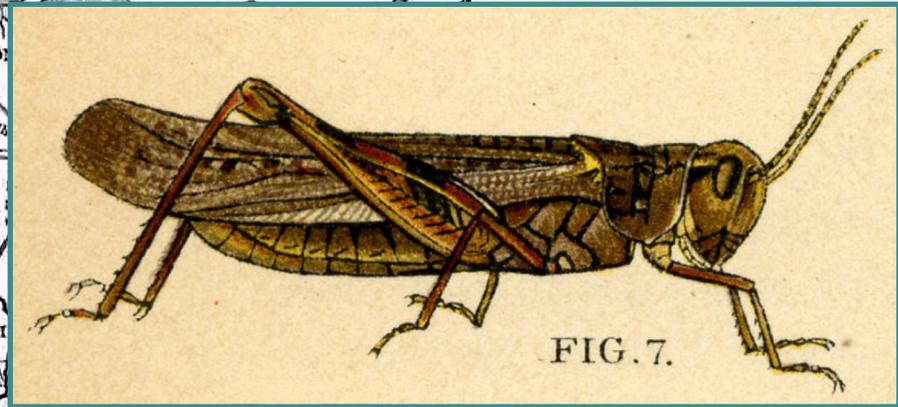
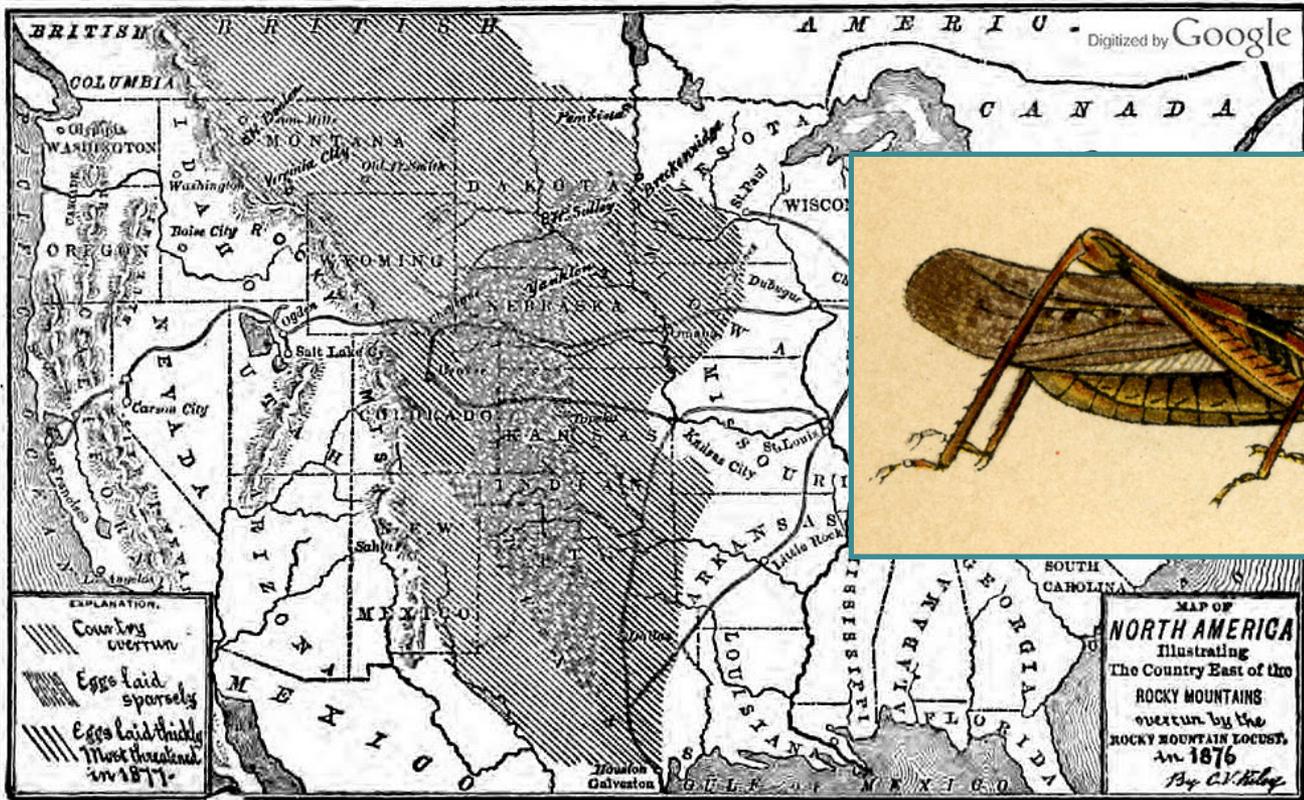
- Grasshoppers gone; Pa still has to leave for harvest work
- When he returns, "already a hard winter to the north"
- Blizzard strikes after a warm day
- After the first one, "blizzard after blizzard"
- Blizzard just before Christmas
  - Pa stranded outside
  - Ball lightning observed in the house



- Observations for winter of 1874-1875 (at MSP):
  - Began 10/30 with snow
  - Increasing frequency of snows mid to late November
  - December snow storms on 12/13 (moderate), 12/16 (moderate), 12/22-12/24 (light)
  - Last snow 4/1 (heavy)
  - End of AWSSI accumulations: 4/16 (high 20°, low 10°)



# 1874-1875: "Drought" and Locusts: "Grasshopper Weather"





# Laura Ingalls Wilder



Children's Book Series



# July 4<sup>th</sup> Freeze: Tall Tale or Real Event?

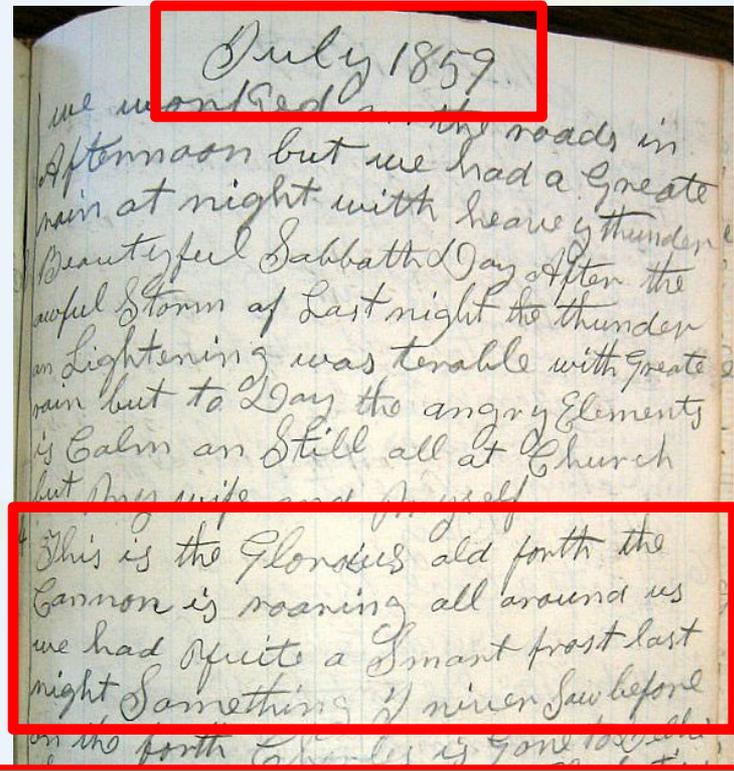


COLD SNAP



were only four inches high. They seemed to feel that danger threatened them, and to be afraid to grow.

It was three days to Independence Day, the fourth day of July. Then it was two days. Then it was one day, and that night Almanzo had to take a bath, though it wasn't Saturday. Next morning they were all going to the celebration  
168



This is the Glorious old fo[u]rth the Cannon is moaning all around us we had quite a smart frost last night Something I niver saw before on the fo[u]rth



# Laura Ingalls Wilder



Children's Book Series



# Cold Snap at Bouchie School

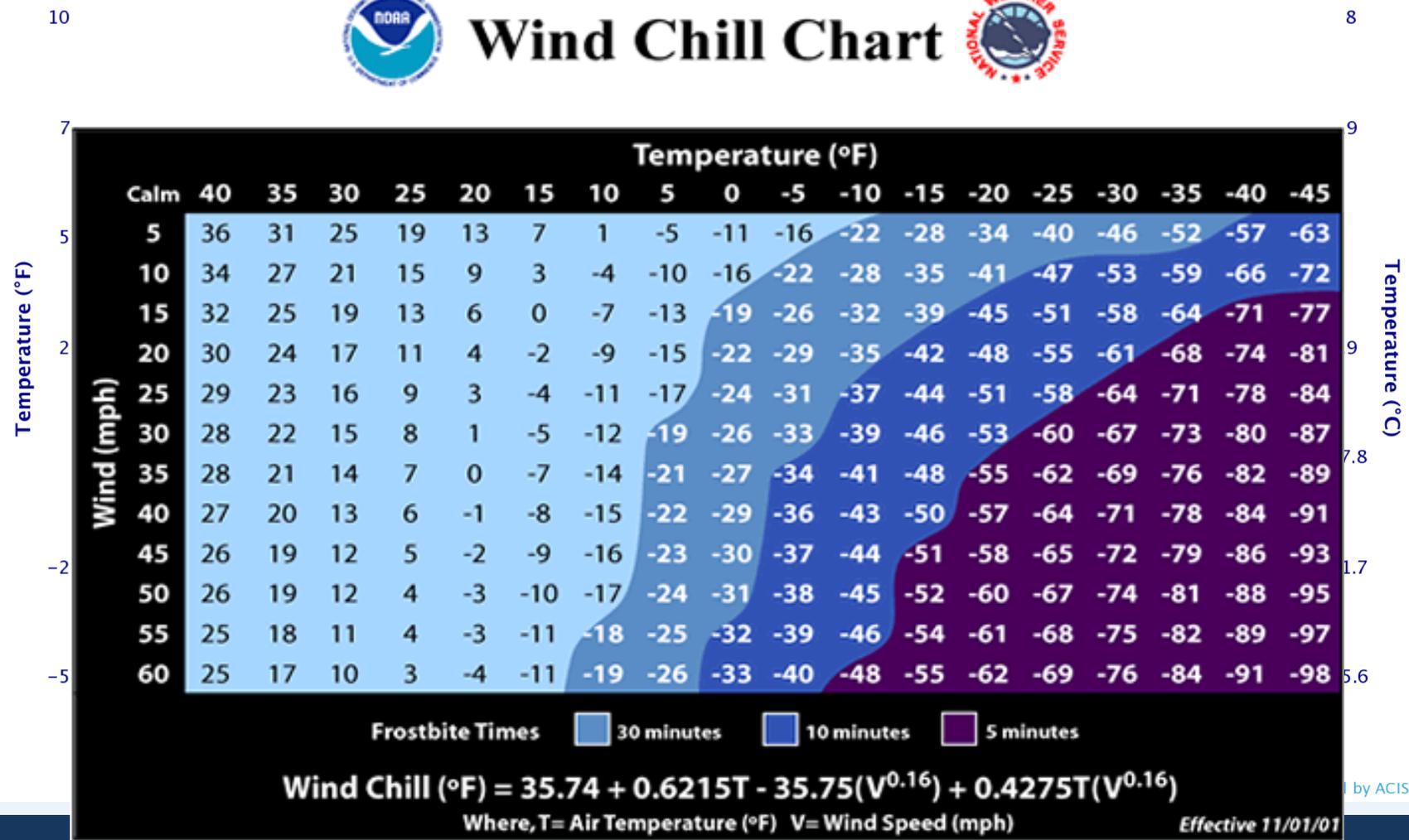


## Daily Temperature Data - Huron Area, SD (ThreadEx)

Period of Record - 1881-07-01 to 2018-02-08. Normals period: 1981-2010. Click and drag to zoom chart.

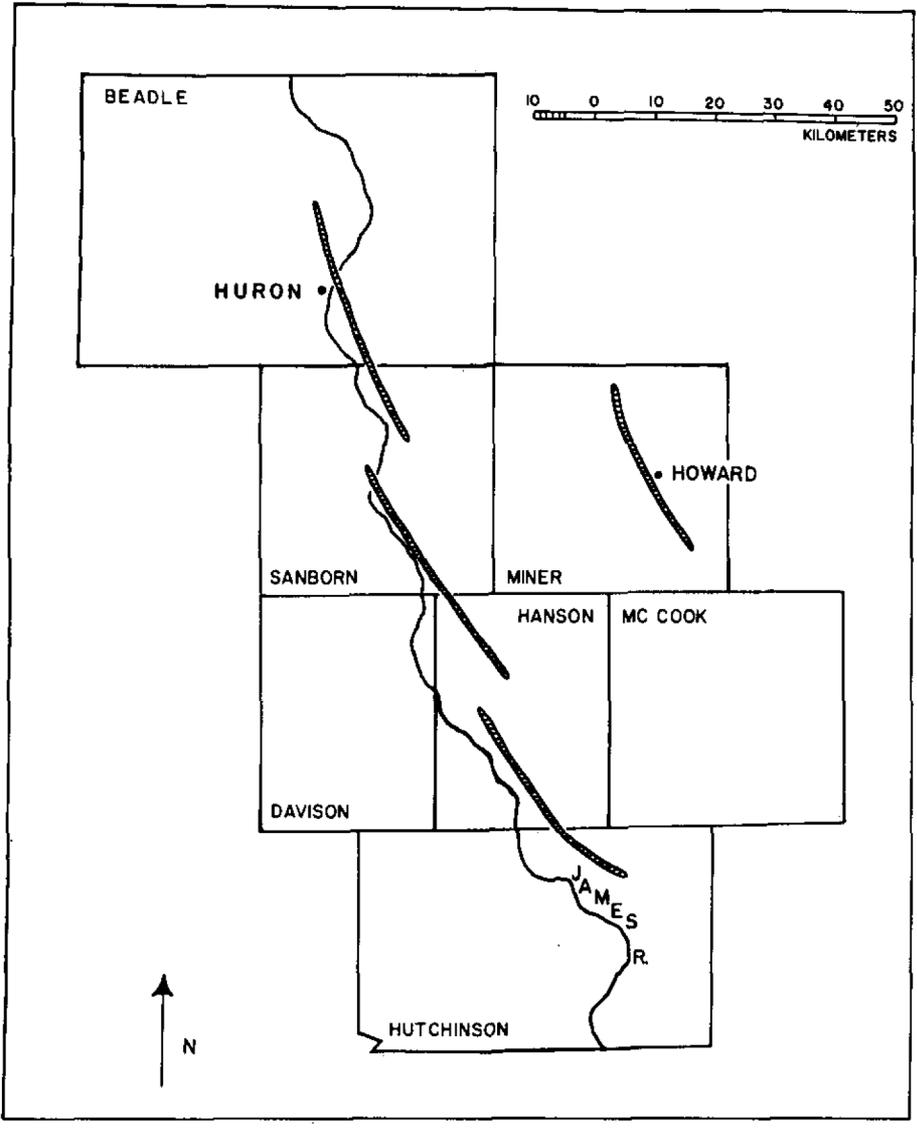
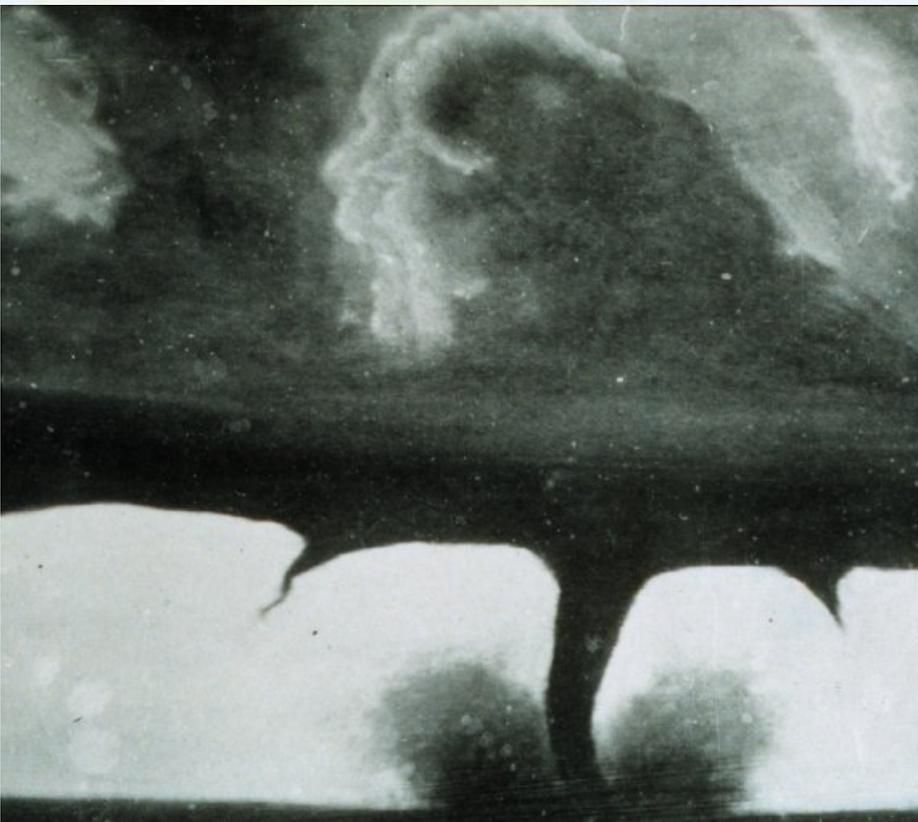


### Wind Chill Chart





# Tornadoes: August 28, 1884





# Laura Ingalls Wilder



Children's Book Series



# Drought and Ingalls Family Migration

Rocky Mountain locusts invade Minnesota



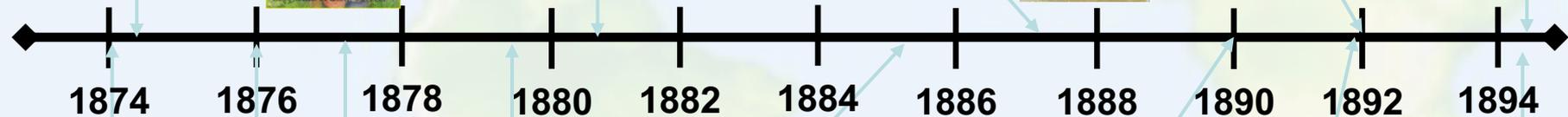
The "Hard Winter" strikes the Plains, Midwest

Dry period begins



Drought conditions peak

Drought resurges



Ingallses reach Plum Creek

Ingallses return to Walnut Grove

Laura marries Almanzo

Wilders leave De Smet for Minnesota, Florida

Wilders leave De Smet for good

Ingallses leave Plum Creek for Minnesota, Iowa

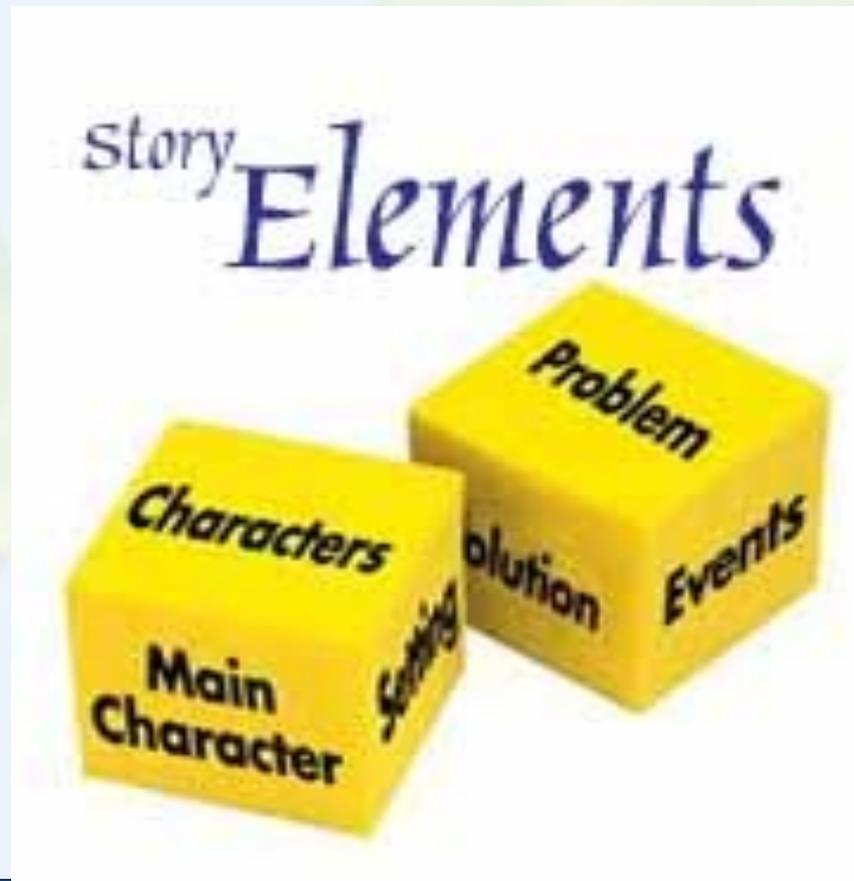
Ingallses move to near De Smet, Dakota Territory

Wilders return to De Smet

# Strategy: Create a Narrative

Listeners hear effective story if:

- Is congruent
- Transports them
- Trust storyteller
- Relate to hero





# Lessons Learned from Laura



- Follow forecasts and heed warnings
- Prepare in advance
- Know the climate in your area
  - Range of possible weather
  - Changes and trends
- Continue lifelong learning

National Weather Service Weather Forecast Office  
**Sioux Falls, SD**

Home Site Map News Organization Search for: [ ] NWS

Top News of the Day **Recently Issued: Public Information**

**Band of heavy snow expected late tonight and Thursday**

Watches & Warnings Observations Forecast Graphics Rivers & Lakes Climate Winter Weather

Click on the map below for the latest forecast.

Last map update: Wed, Feb. 22, 2012 at 6:25:17 pm CST

Read watches, warnings & advisories

Winter Storm Warning  
Winter Weather Advisory  
Wind Advisory  
Winter Storm Watch  
Hazardous Weather Outlook

Latest Conditions in **Sioux Falls, SD** Choose Your Front Page City

Feb 22  
**5:56 pm** **40°F**  
(4°C)

Select A City: [ ]



# Credible Information Sources



# Sources of Information: NCEI

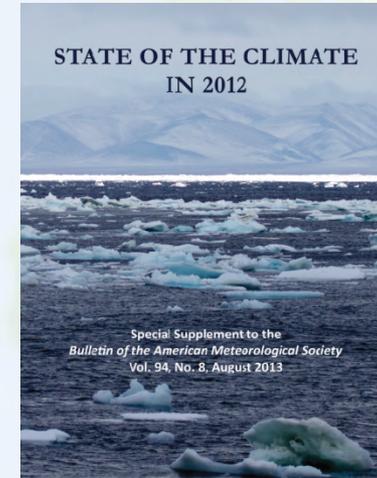


- **State of the Climate report**

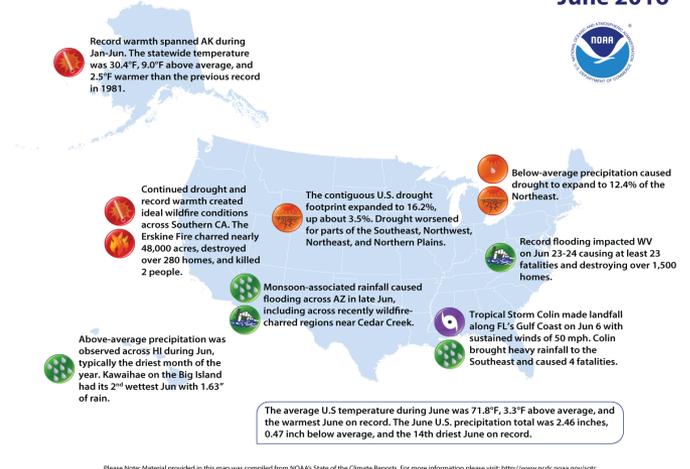
- ◆ Published in the *Bulletin of the American Meteorological Society* every summer
- ◆ Led by NCEI
- ◆ Hundreds of authors from dozens of countries

- **Monthly State of the Climate summaries from NCEI**

- ◆ Updated online around the middle of the month
- ◆ Global and national overviews

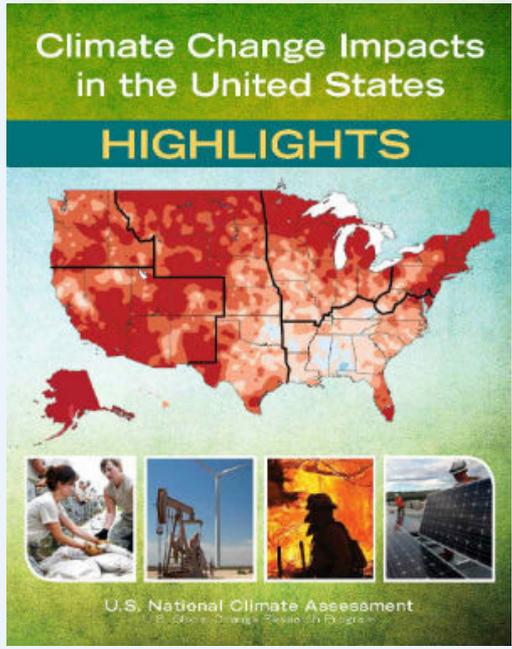


## U.S. Selected Significant Climate Anomalies and Events June 2016





# Sources of Information: National Climate Assessment



Latest report released in Spring 2014.

NCA 4 coming soon!



Focus on impacts in different regions of the U.S.

Printable PDFs for each region

Can focus on your specific area to talk with your students

<http://www.globalchange.gov/>



# Sources of Information: Principles of Climate Literacy



English

en Español

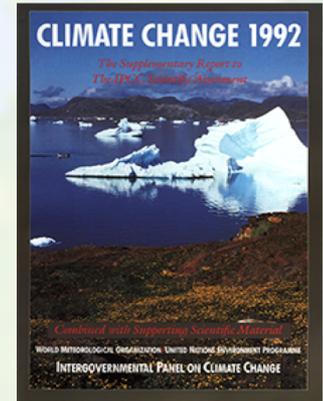
1. Sun is primary energy
2. Climate is complex
3. Life affects climate; climate affects life
4. Climate is variable
5. Our understanding of climate
6. Humans affect climate
7. Climate change has consequences



# Sources of Information: IPCC



- IPCC = Intergovernmental Panel on Climate Change
- UN chartered group of leading scientists charged with assessing the state of climate change science and its impacts
  - ◆ Involved more than 130 governments, over 450 lead authors and scientists, and over 2500 scientific reviewers
- Synthesizes reproducible peer-reviewed research
- Contributors must agree on *every word* of the document
- Reports made in 1988, 1990, 1995, 2001, 2007, and 2013-2014

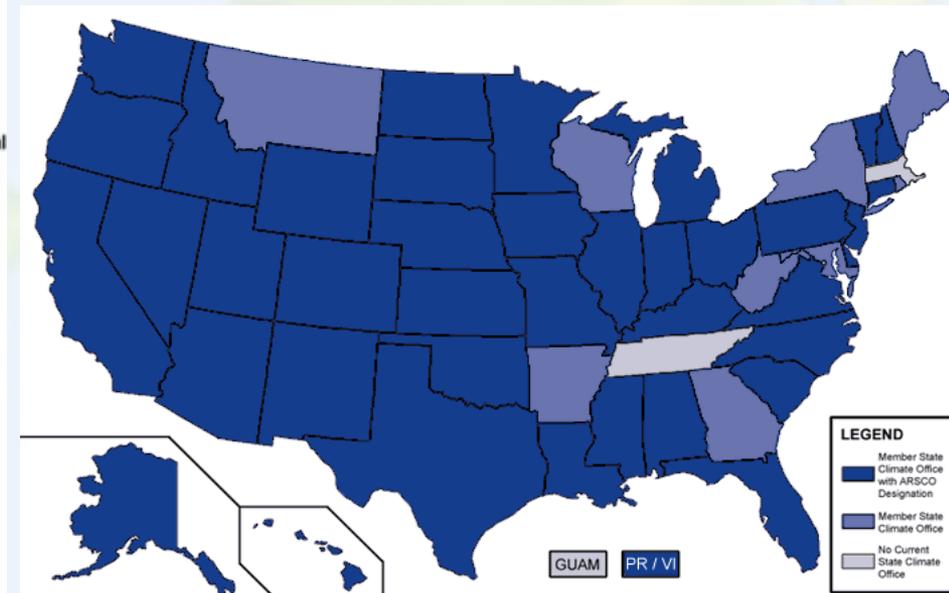
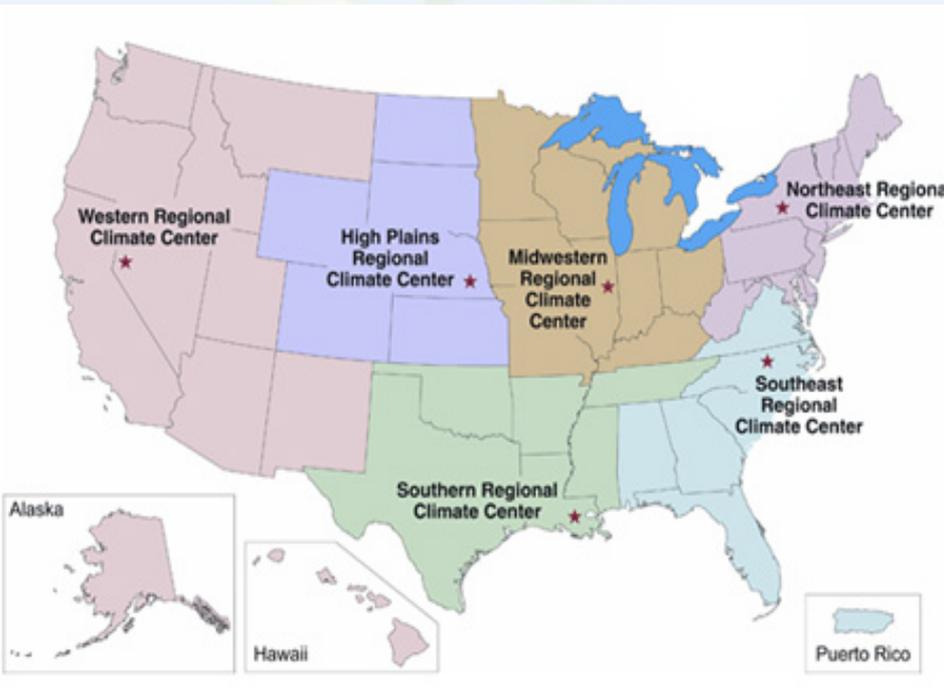




# Sources of Information: State and Regional Climate Centers



- 6 Regional Climate Centers
- Almost every state has a state climatologist



<http://www.ncdc.noaa.gov/customer-support/partnerships/regional-climate-centers>

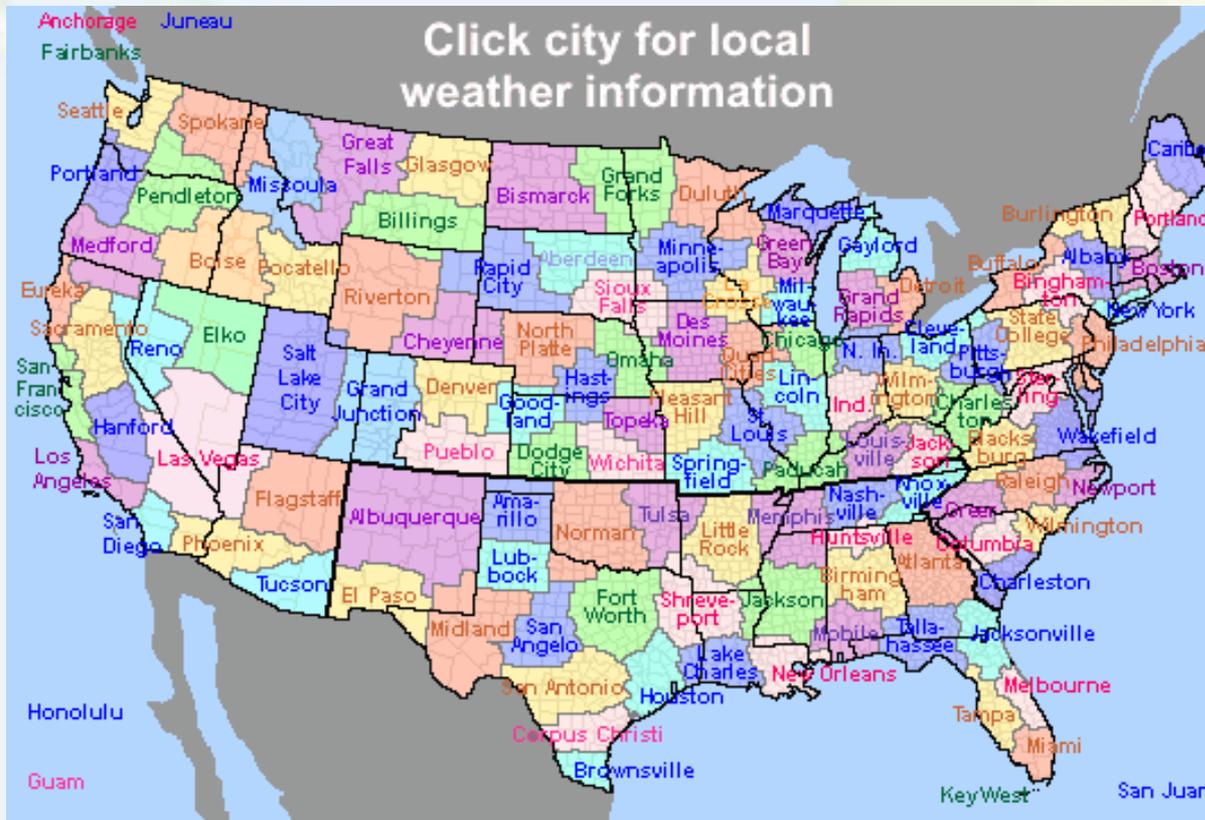
<http://www.stateclimate.org/>



# Sources of Information: NWS



- 122 local NWS offices
- Each has a website with contact information
- If seeking contact about climate, be specific about request

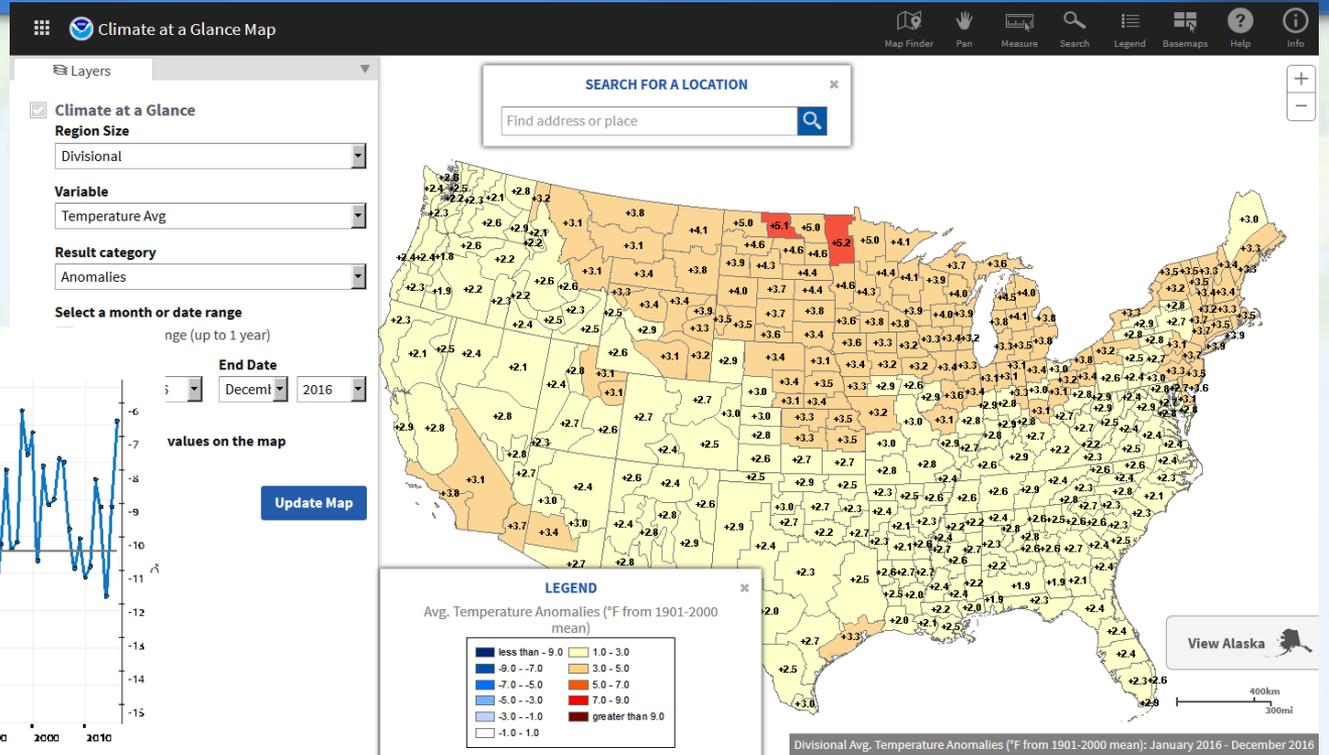




# Climate Change Tools



# NCEI Climate at a Glance



- Time series charts, maps
- City, climate division, state, US, or global scale
- Temperature (average, min, max), precipitation, degree days, and drought measures



# Climate.gov Global Climate Dashboard



## Global Climate Dashboard

▼ Climate Change

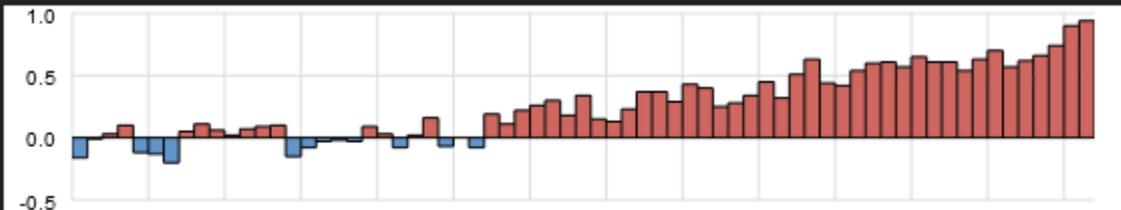
▶ Climate Variability

▶ Climate Projections

### Global Average Temperature (°C)

The temperature near Earth's surface is rising: the bars show each year's average temperature compared to the 20th century average.

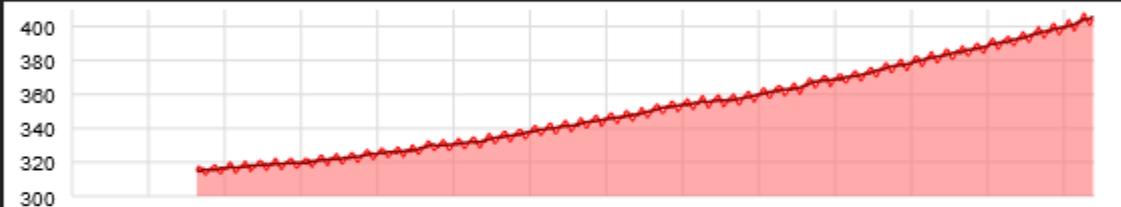
[learn more >>](#)



### Carbon Dioxide (ppm)

The amount of carbon dioxide in the atmosphere has risen by 25% since 1958, and by about 40% since the Industrial Revolution.

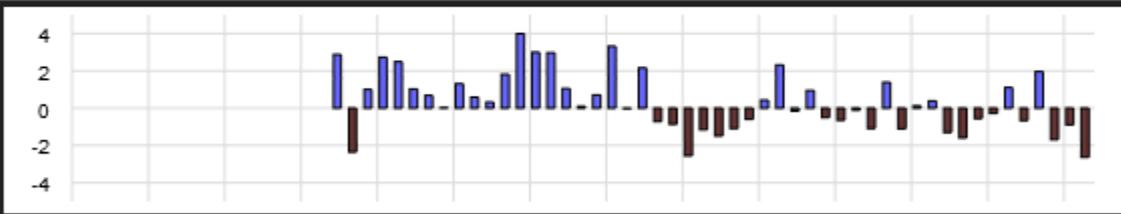
[learn more >>](#)



### Spring Snow Cover (million km<sup>2</sup>)

Snow is melting earlier: each bar shows spring snow cover in the Northern Hemisphere compared to the long-term average.

[learn more >>](#)



- ▲ Temperature
- ▶ Sea Level
- ▶ Sun's Energy

- ▲ Carbon Dioxide
- ▶ Arctic Sea Ice
- ▶ Glaciers

- ▲ Snow
- ▶ Ocean Heat
- ▶ Heat-Trapping Gases



# Climate Resilience Toolkit



U.S. Climate  
Resilience  
Toolkit

Steps to Resilience

Case Studies

Tools

Expertise

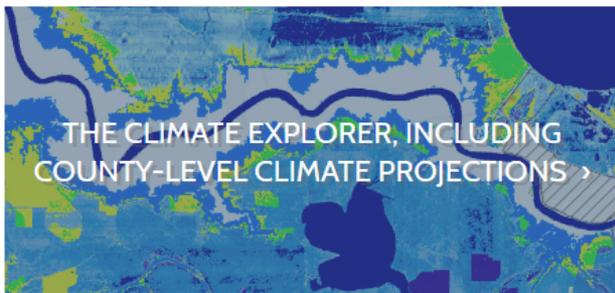
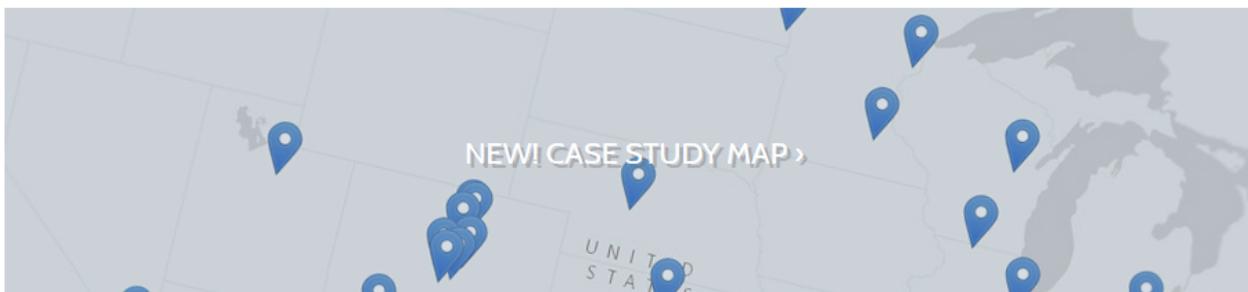
Regions

Topics

Search



## FEATURED





# Links and References, pg 1



## Data Sources

National Weather Service: <http://www.weather.gov/climate/>

Regional Climate Centers: <http://www.ncdc.noaa.gov/customer-support/partnerships/regional-climate-centers>

NASA Climate Time Machine: <https://climate.nasa.gov/interactives/climate-time-machine/>

NASA Global Climate Change Vital Signs: <https://climate.nasa.gov/vital-signs/carbon-dioxide/>

CoCoRaHS: <http://www.cocorahs.org/>

## Climate Predictions

NOAA Climate Prediction Center: <http://www.cpc.ncep.noaa.gov/>

## Climate Information

NOAA Climate Services: <http://www.climate.gov/>

U.S. Drought Information: <http://www.drought.gov/>

Difference between Weather and Climate (NASA): [http://www.nasa.gov/mission\\_pages/noaa-n/climate/climate\\_weather.html](http://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html)



# Links and References, pg 2



## Teacher Resources

NOAA Education Resources: <http://www.noaa.gov/education> (Climate: <http://www.noaa.gov/resource-collections/climate-education-resources>)

NOAA NWS Education: <https://www.weather.gov/owlie/>

NOAA National Ocean Service Education: <http://oceanservice.noaa.gov/education/pd/climate/>

NASA Climate Change for Educators: <https://climate.nasa.gov/resources/education/>

USDA Forest Service Conservation Education: <https://www.fs.usda.gov/conservationeducation> (?)

PBS Learning Media: [https://mpt.pbslearningmedia.org/?fq\\_hierarchy=k12.sci.ess.watcyc.climate](https://mpt.pbslearningmedia.org/?fq_hierarchy=k12.sci.ess.watcyc.climate)

UCAR Understanding Climate Change: <http://www2.ucar.edu/news/backgrounders/understanding-climate-change-global-warming>

UCAR Global Change Instruction Program: <http://www.ucar.edu/communications/gcip/>

UCAR Kids Crossing: <http://eo.ucar.edu/kids/index.html>

UCAR Kids' Crossing – Living in the Greenhouse: <http://eo.ucar.edu/kids/green/>

UCAR Climate Discovery: Difference between Weather and Climate:  
[http://eo.ucar.edu/educators/ClimateDiscovery/LIA\\_lesson1\\_9.28.05.pdf](http://eo.ucar.edu/educators/ClimateDiscovery/LIA_lesson1_9.28.05.pdf)

Skeptical Science: <https://skepticalscience.com/>

## Videos

NASA Climate Reel: <http://climate.nasa.gov/ClimateReel/>

The Water Channel: <http://www.thewaterchannel.tv/categories/760-climate-change>



# CoCoRaHS!



- Volunteer precipitation observation network
- Use standard, low-cost tools
- Report observations online
- Data used by weather, water, and climate experts
- Provides access to educational webinars, materials



CoCoRaHS COMMUNITY COLLABORATIVE RAIN, HAIL & SNOW NETWORK  
"Because every drop counts"

Home | States | View Data | Maps My Data | My Account | Admin | Logout

Welcome to CoCoRaHS! "Volunteers working together to measure precipitation across the nation."

2011 RAIN GAUGE CALENDARS  
Click here to order

Daily Precipitation (inches x.xx)  
USA  
2/9/2011

Things to know about...  
Rain  
Hail  
Snow

Purchase an official CoCoRaHS 4" Rain Gauge  
"The official CoCoRaHS Rain Gauge supplier"  
WEATHERYOURWAY.COM  
Fast, Friendly service from a meteorologist and



# Thank you!



For questions and discussion, ask here or contact:

Barb Mayes Boustead, PhD:

[barbara.mayes@noaa.gov](mailto:barbara.mayes@noaa.gov)

(405) 325-3004

Twitter: @windbarb

Wilder Weather blog: [http://www.bousteadhill.net/wilder\\_weather/](http://www.bousteadhill.net/wilder_weather/)

Wilder Weather on Facebook: <http://www.facebook.com/wilderweather>