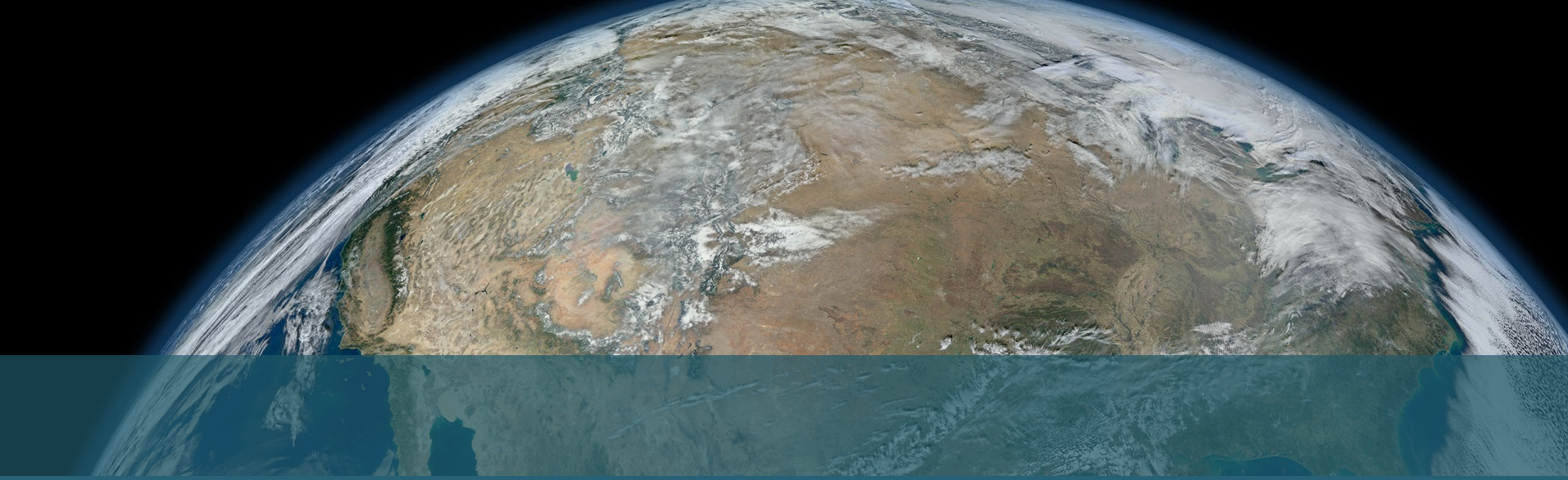
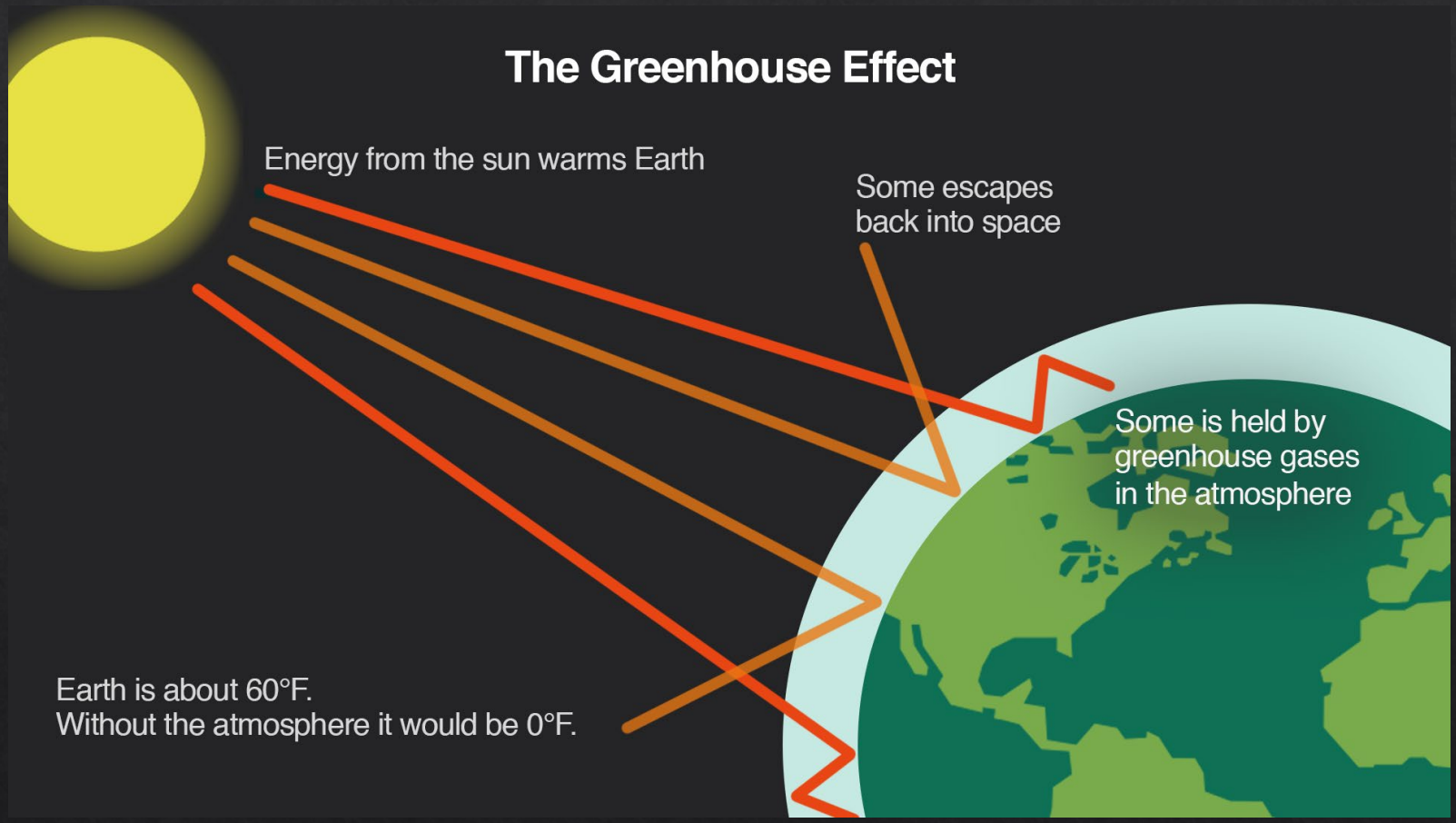


The Changing Climate and Kansas

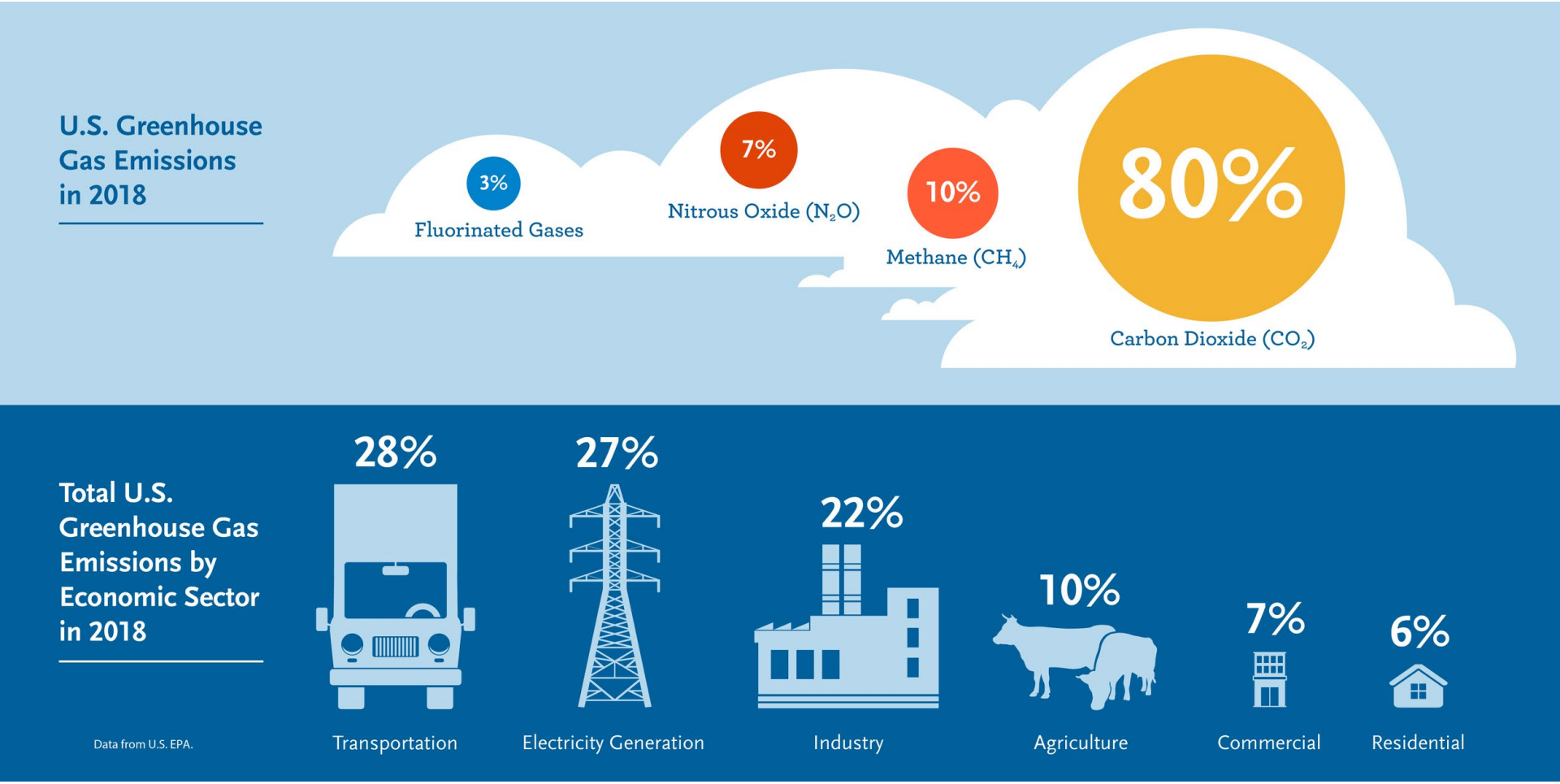
Agenda

- Changing Climate
- Impacts
- Outlooks
  - (weeks/months)

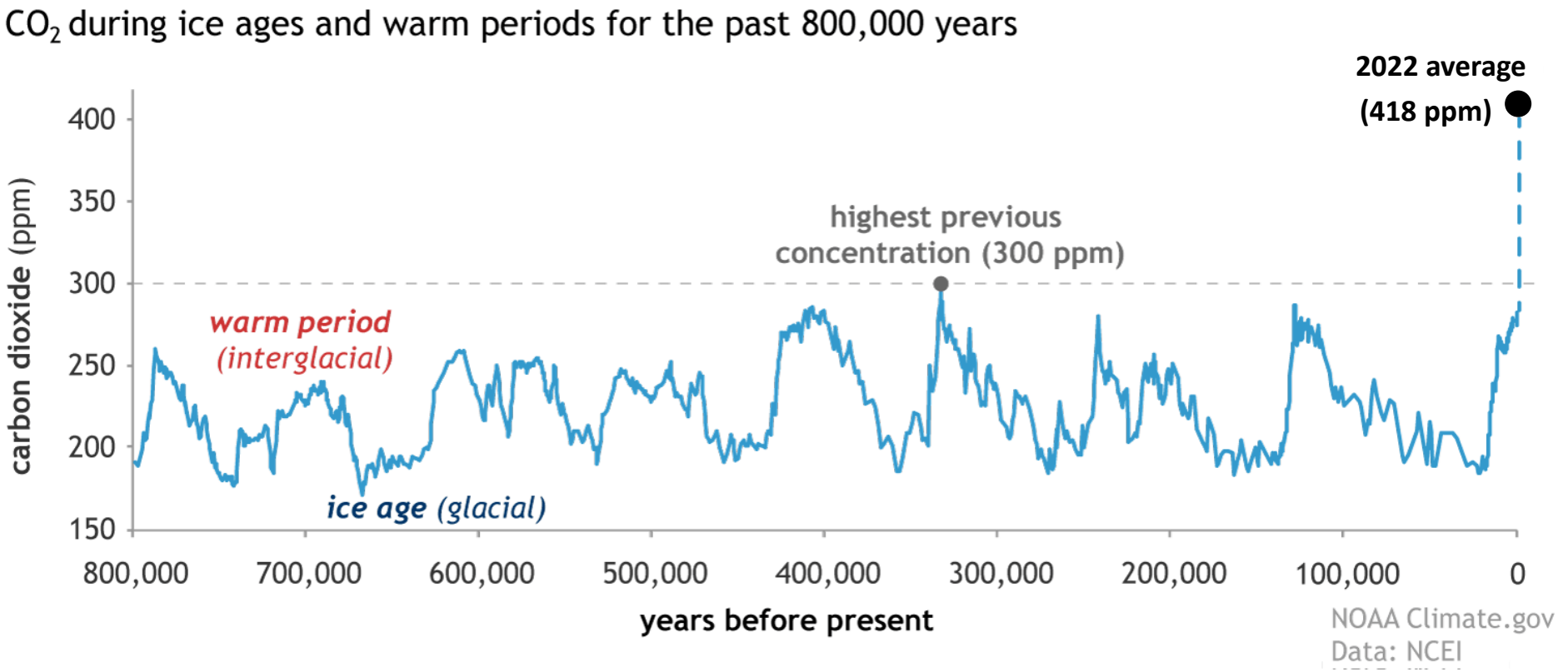
Science: Greenhouse Effect



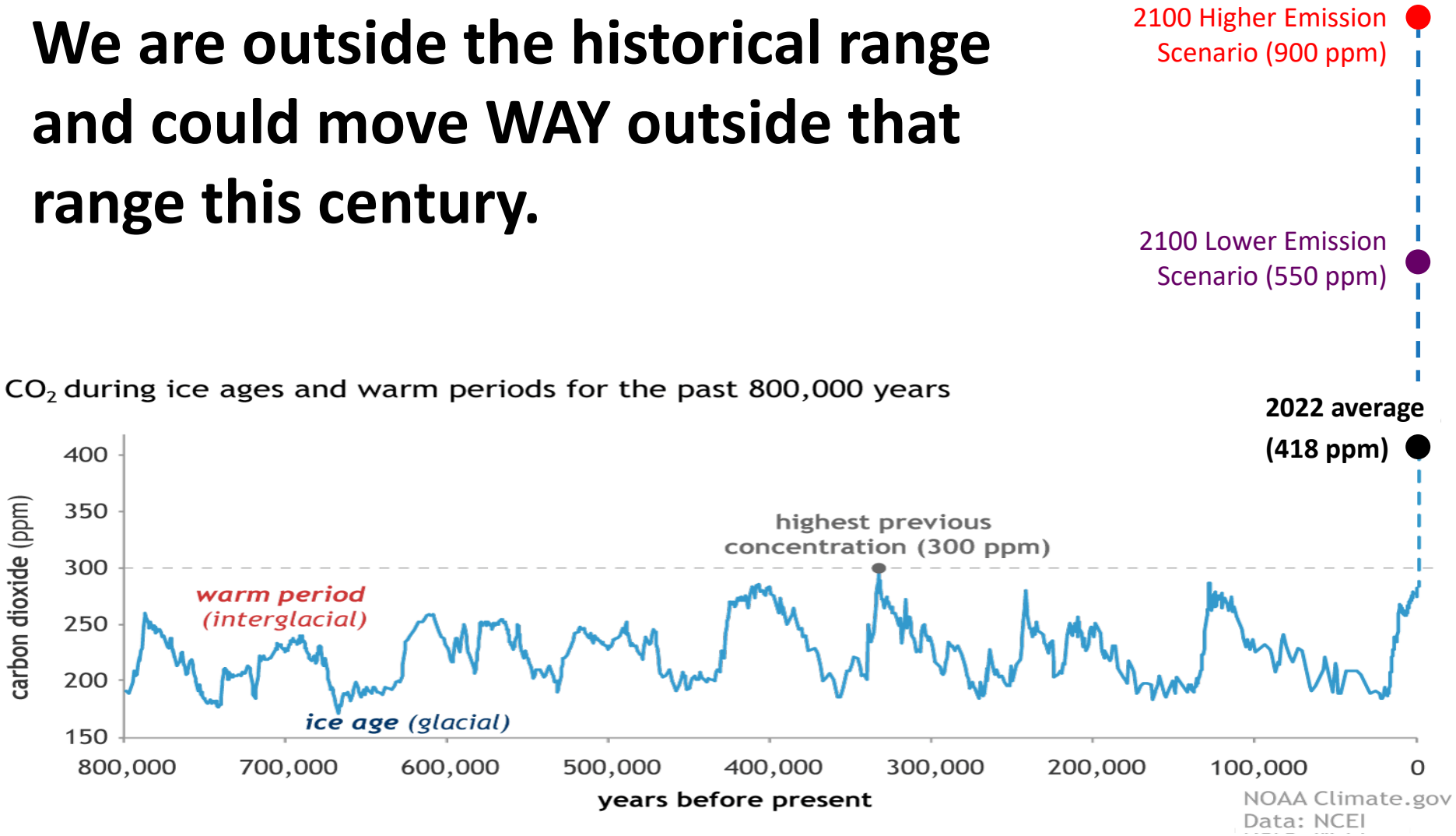
U.S. greenhouse gas emissions in 2018



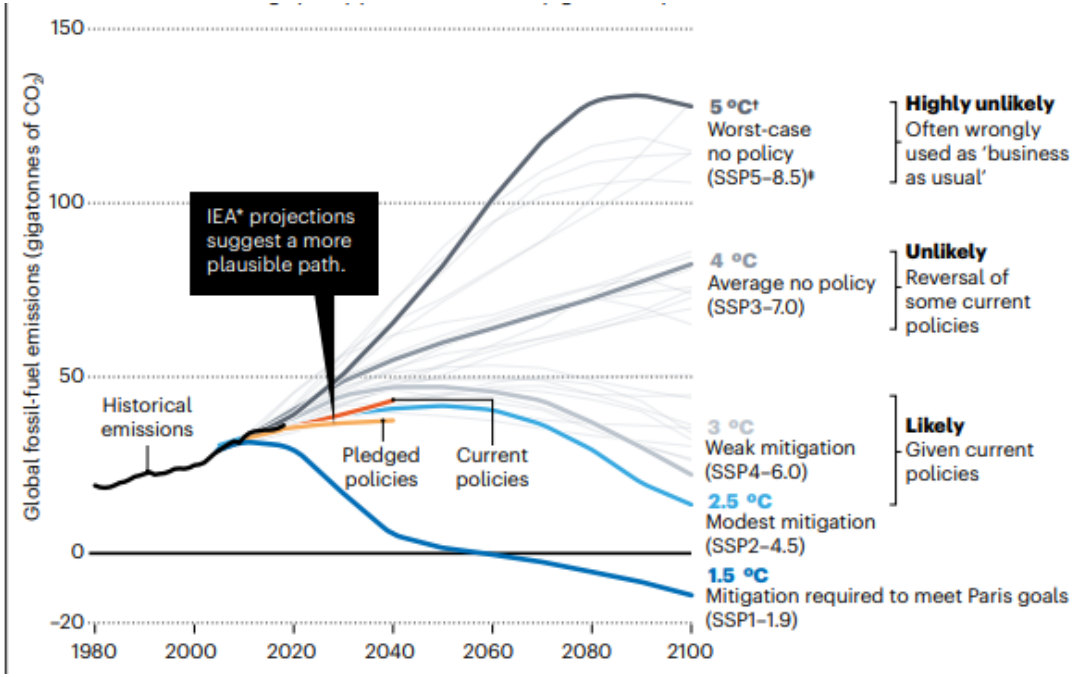
Today's CO_2 values compared to the long term



We are outside the historical range and could move WAY outside that range this century.



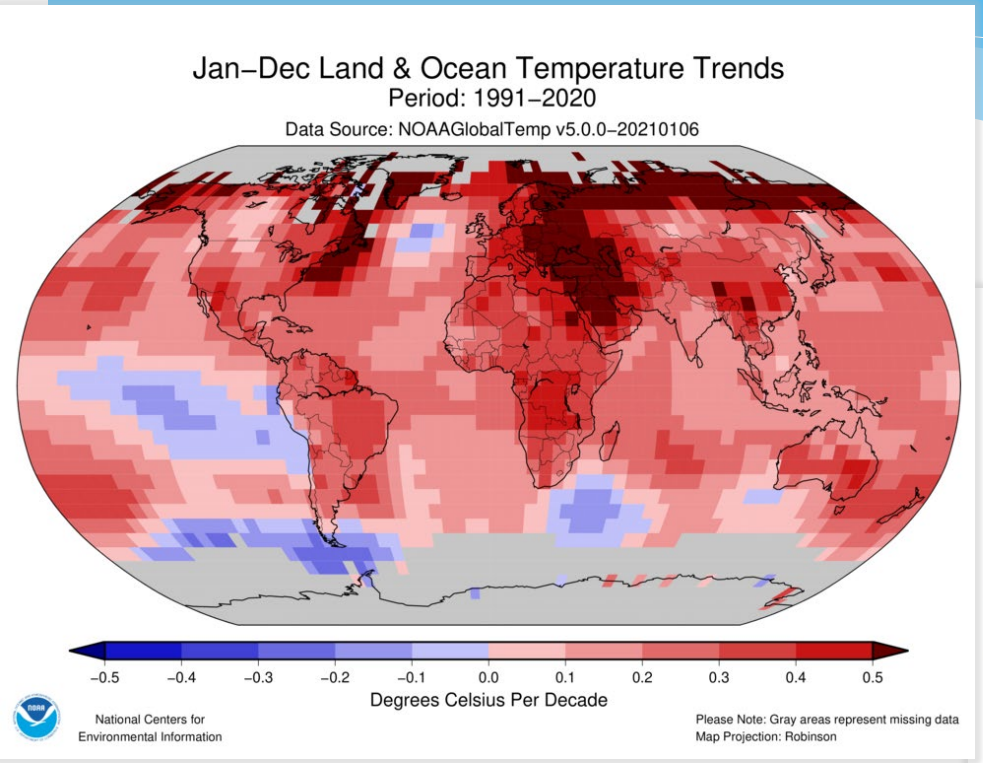
Good news and Bad news…Worst Case scenario implausible (good)…more likely 2.5-3C warming (bad)



Source: IEA/IPCC

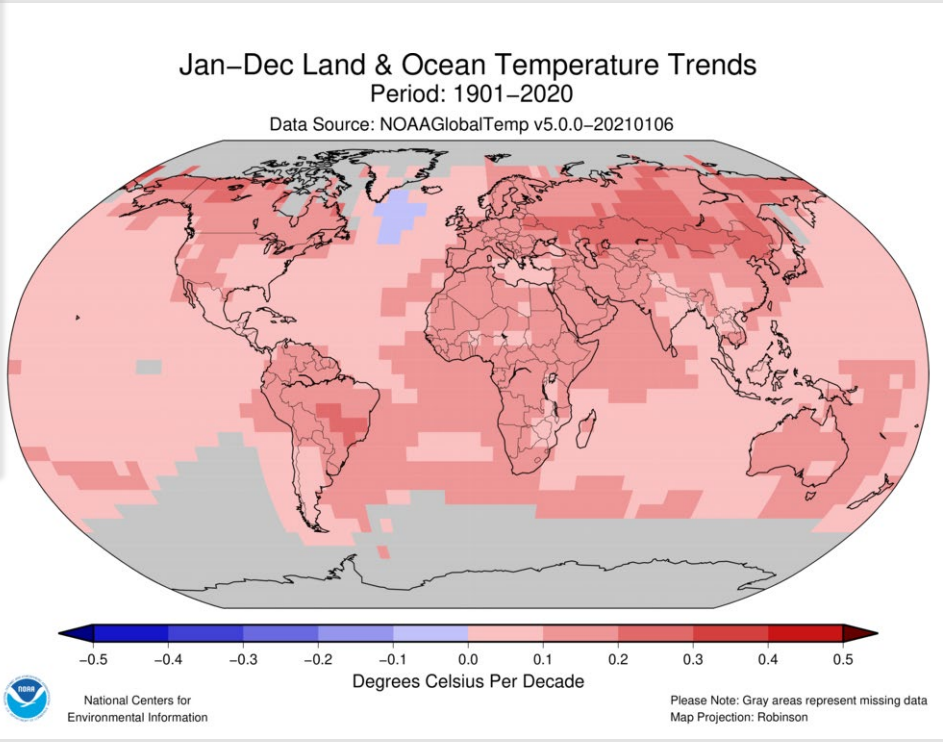
Annual Trends through 2020

Increase in rate of warming over the past three decades in most areas



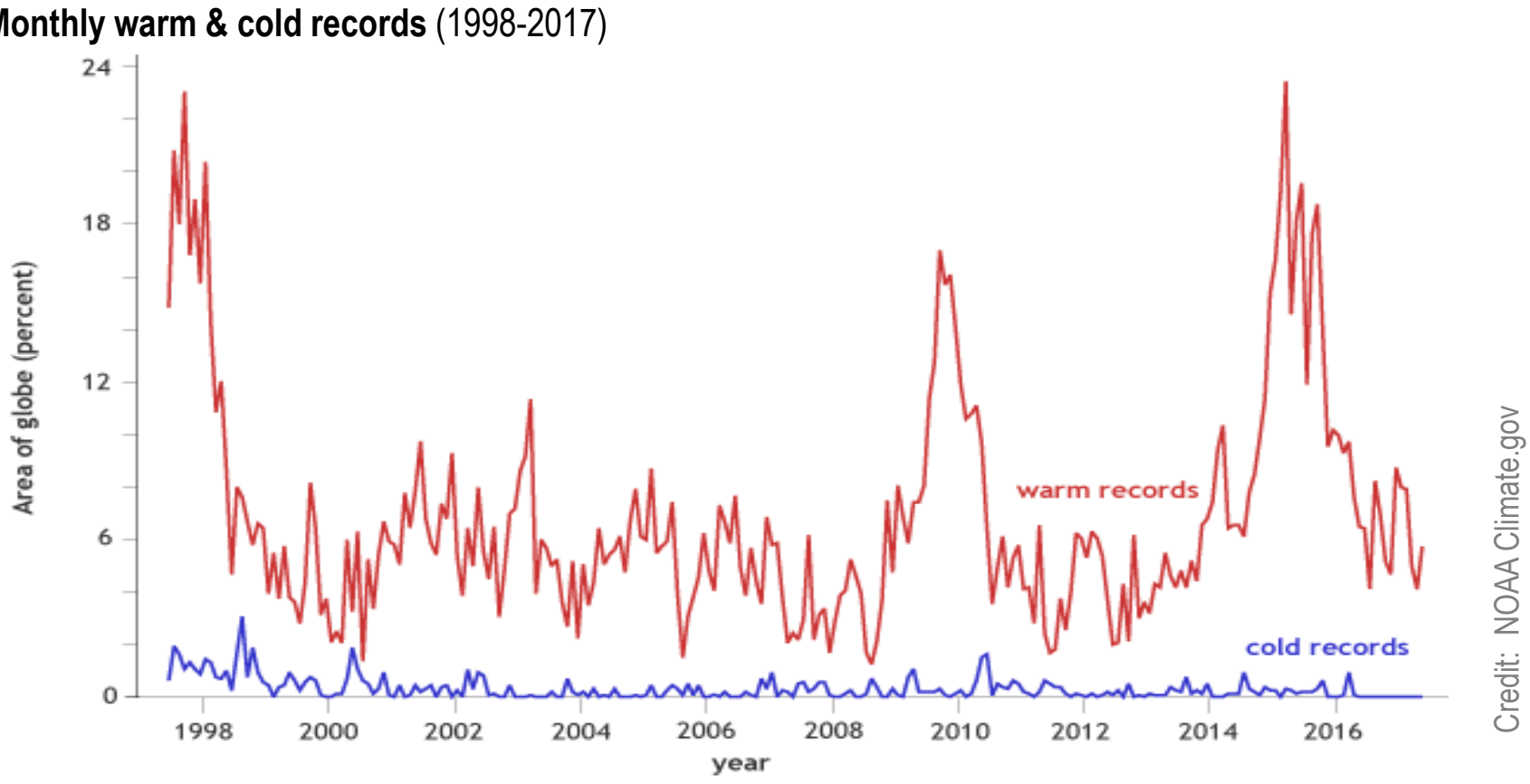
Last 30 years

Last 120 years

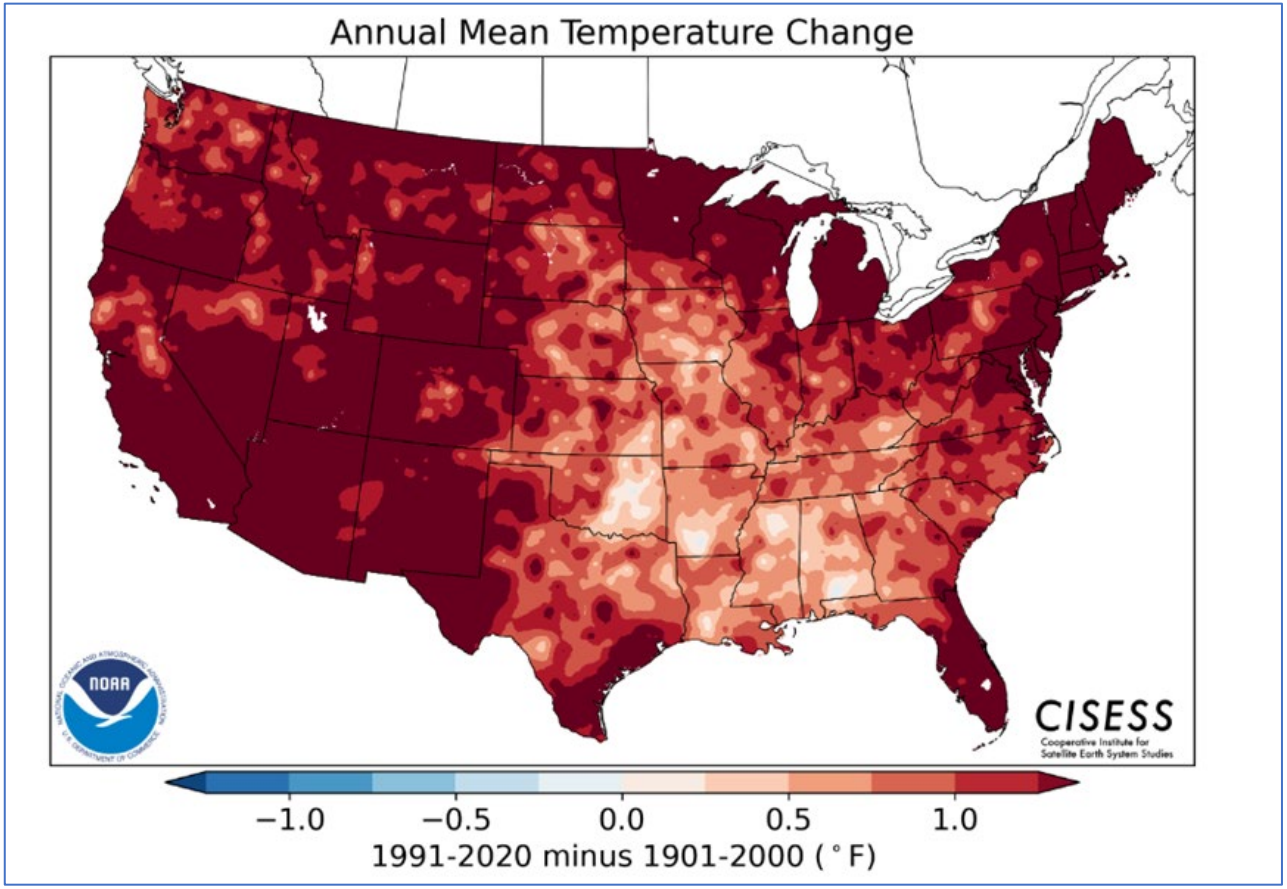


https://www.ncdc.noaa.gov/sotc/

Winter will still occur, but the odds favor more warm temperature records being broken than cold records

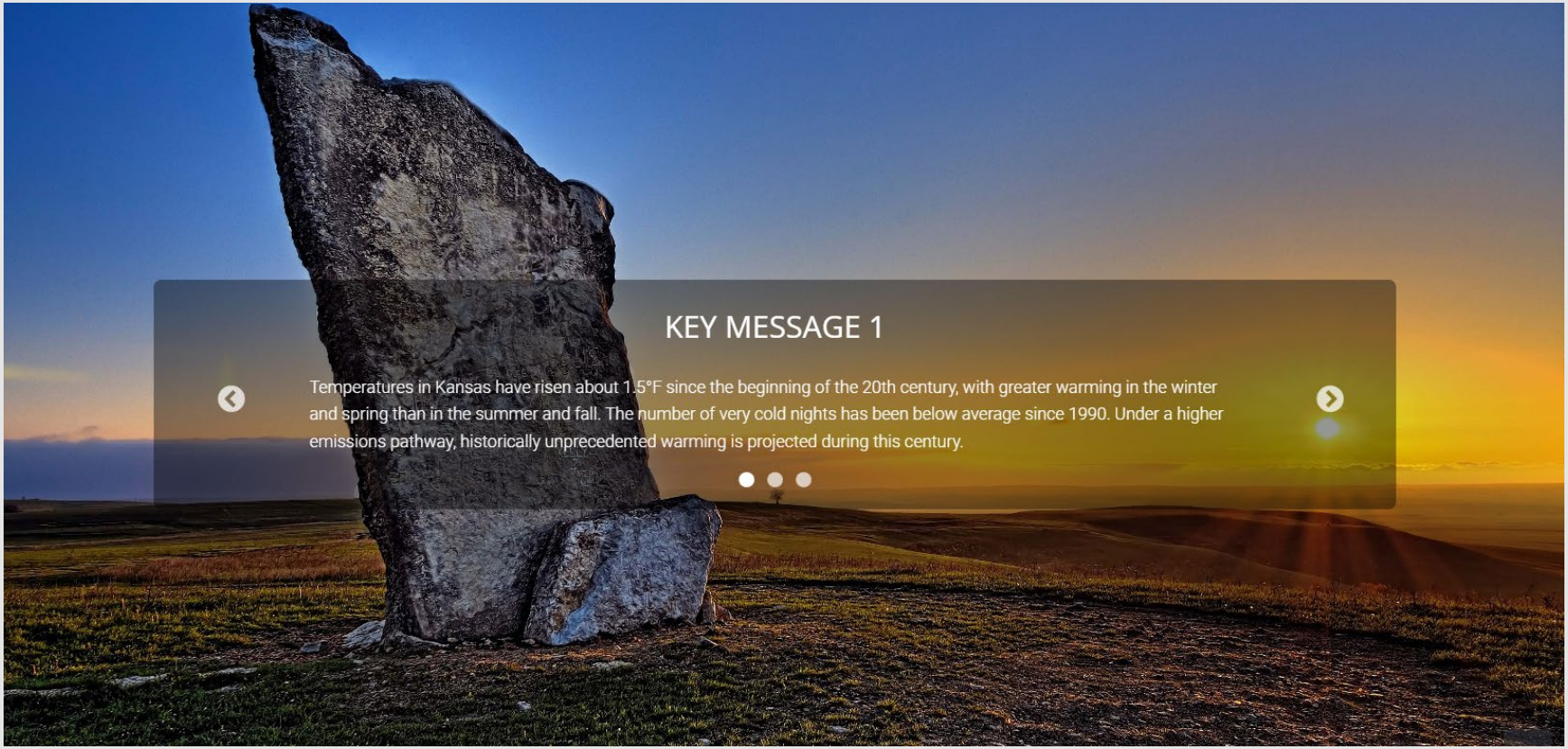


Comparing 1991-2020 to 1901-2000



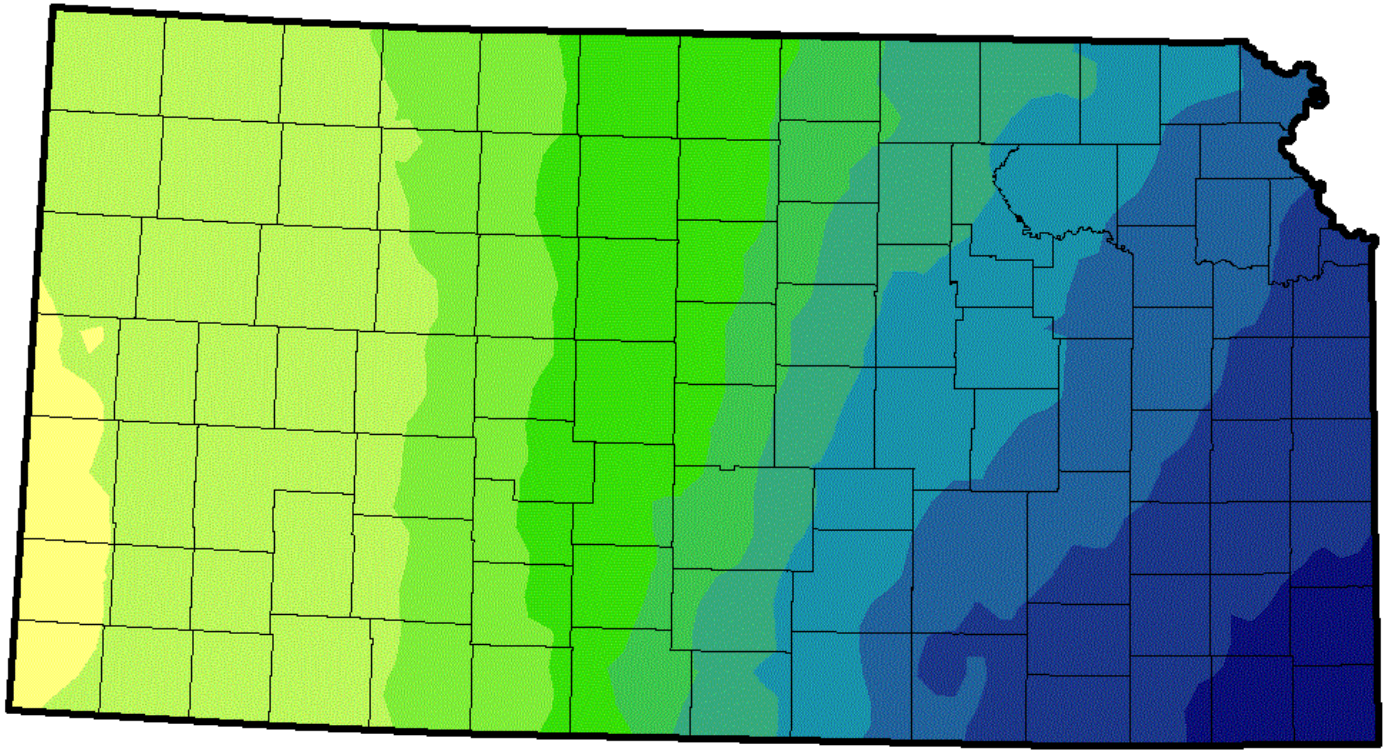
- Warming trend is clearly seen in comparing the new normals to the Twentieth Century averages “teasing out” short term trends from longer term data

Kansas Changes



Normal Annual Precipitation

based on data from 1991-2020



0 25 50 100 Miles

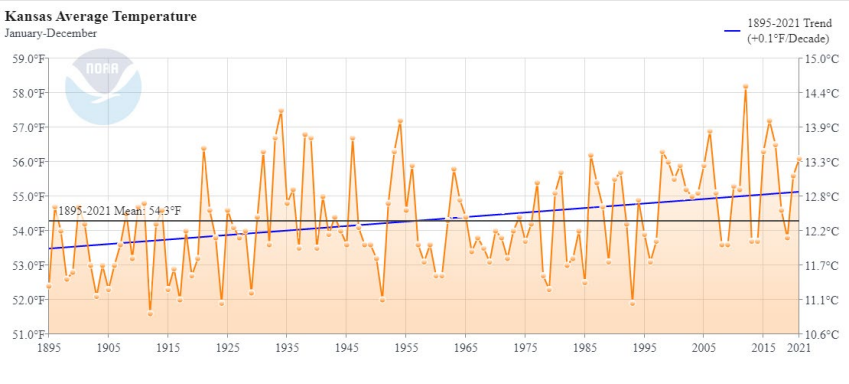
Total Precipitation (Inches)

13.13 – 18.00	31.00 – 33.00
18.00 – 23.00	33.00 – 36.00
23.00 – 26.00	36.00 – 39.00
26.00 – 29.00	39.00 – 44.00
29.00 – 31.00	44.00 – 49.97

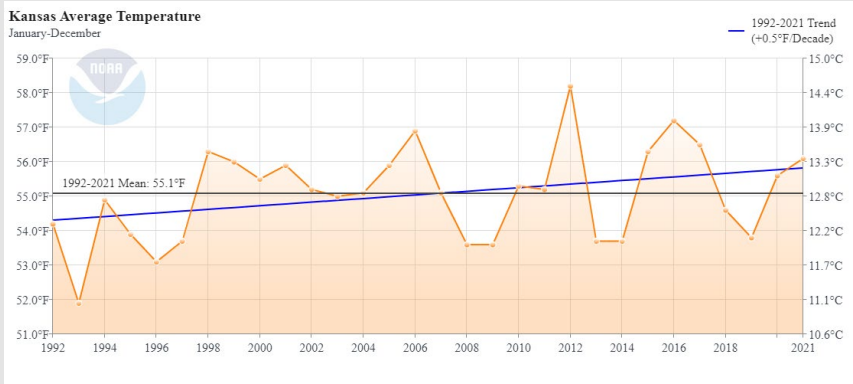
Produced by Weather Data Library
Department of Agronomy
Kansas State University

Kansas Trends Temperature

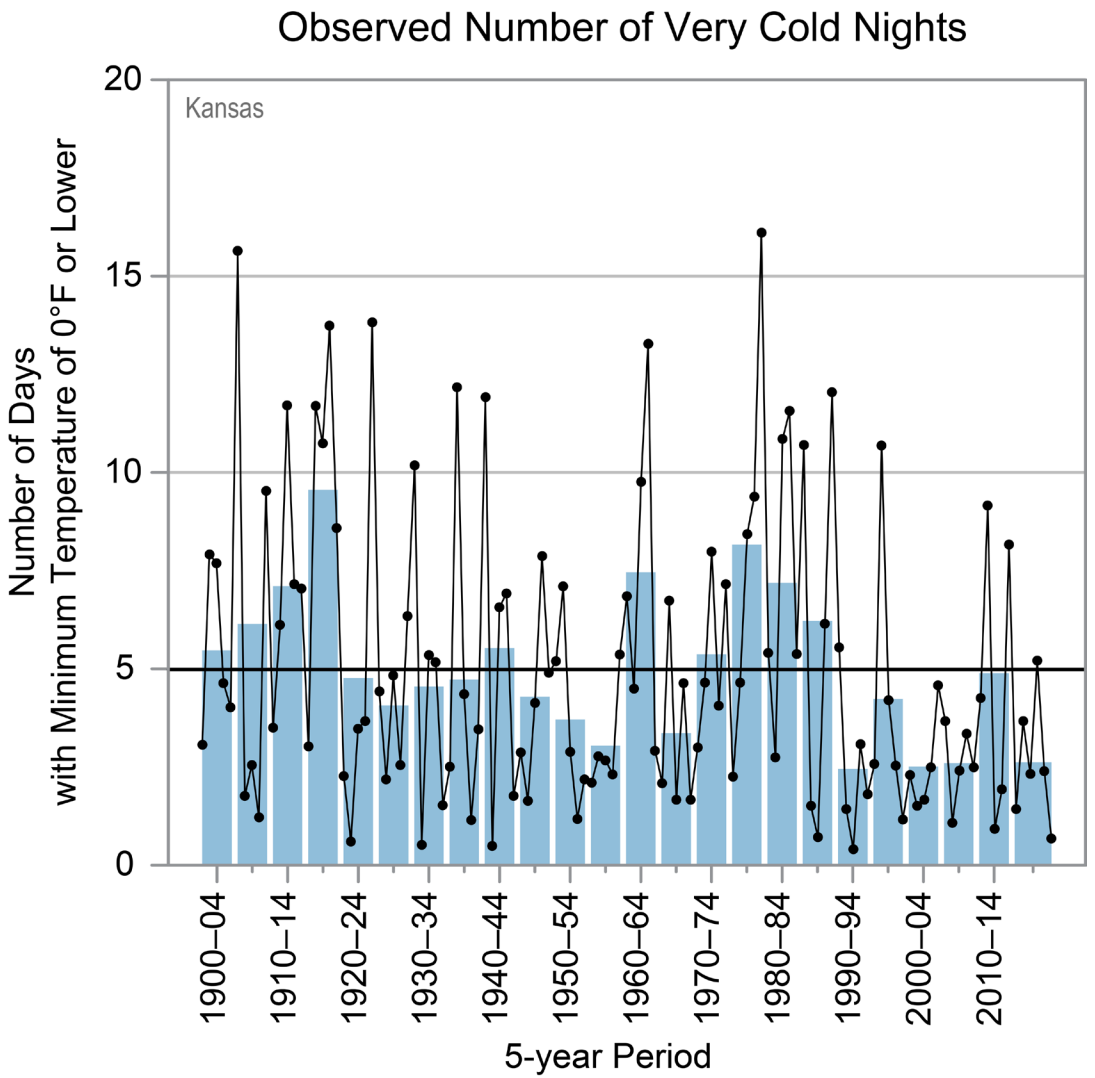
1895-2021 Avg Temp



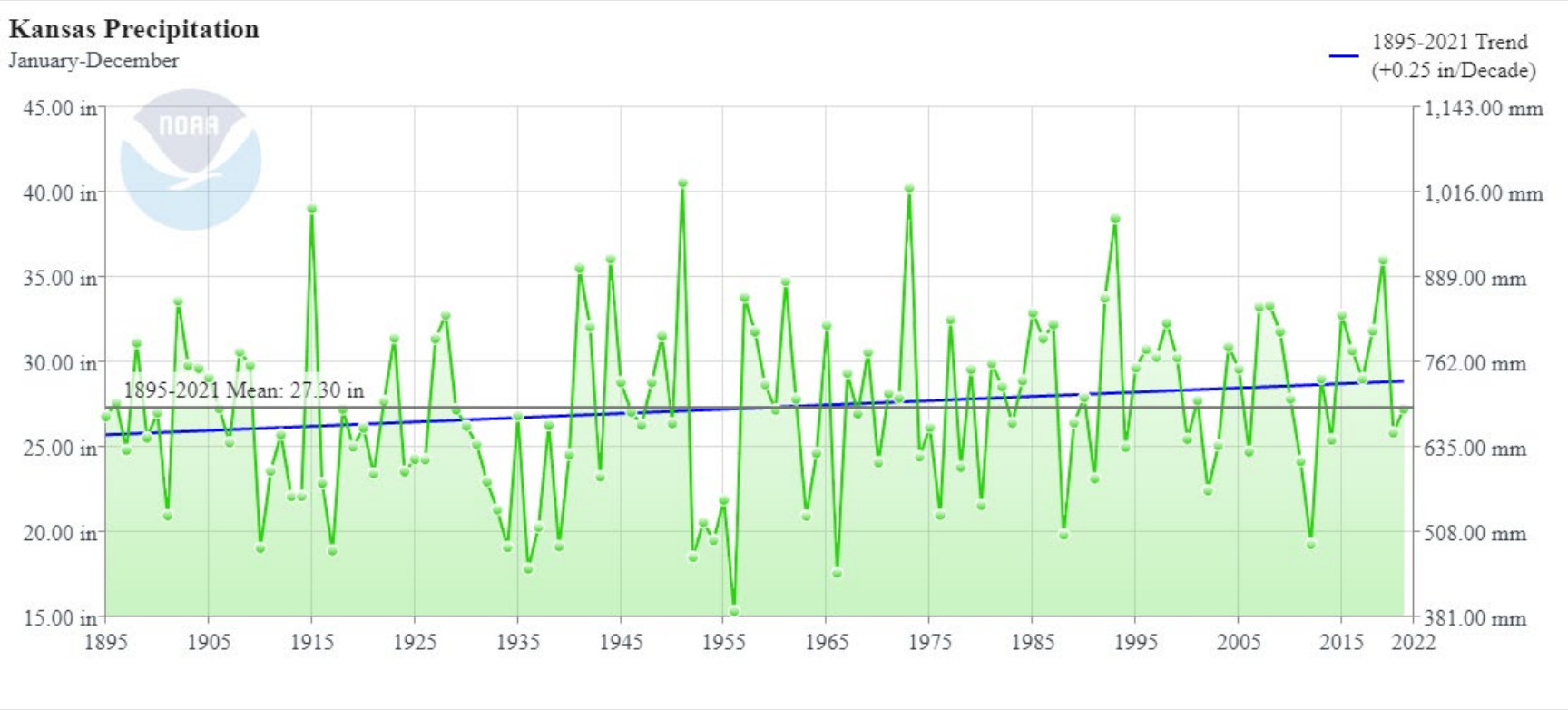
1992-2021 Avg Temp



Observed number of low temperatures below zero since 1900 in Kansas has decreased in frequency i.e. fewer extreme cold outbreaks in winter

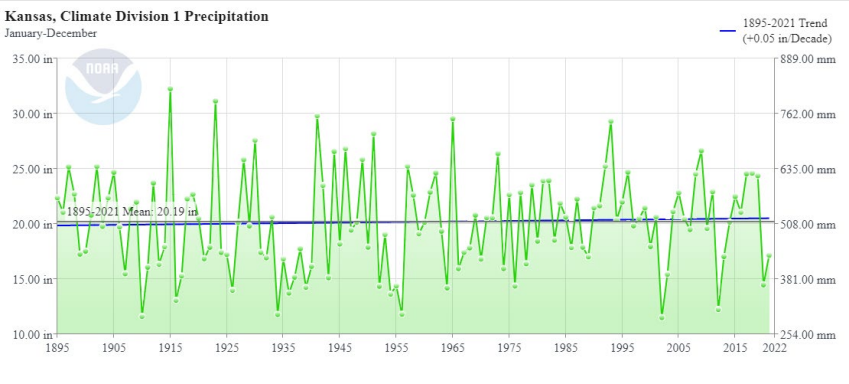


Kansas Preciptation Trends

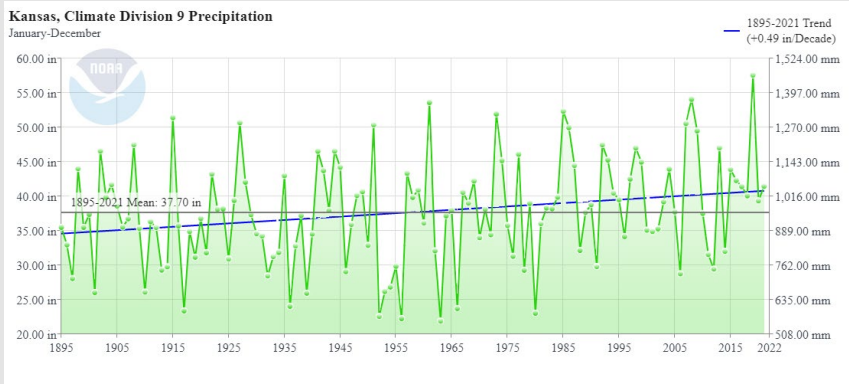


Kansas Trends Precipitation

1895-2021 Avg Precip NW Kansas

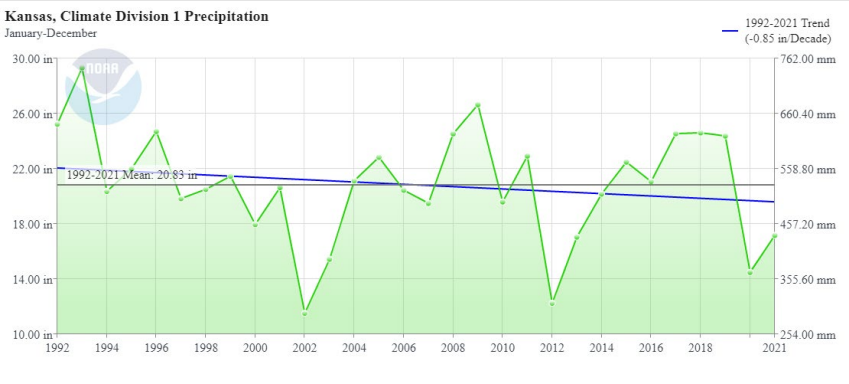


1895-2021 Avg Precip SE Kansas



Kansas Trends Precipitation

1992-2021 Avg Precip Trend NW Kansas



1992-2021 Avg Precip Trend SE Kansas

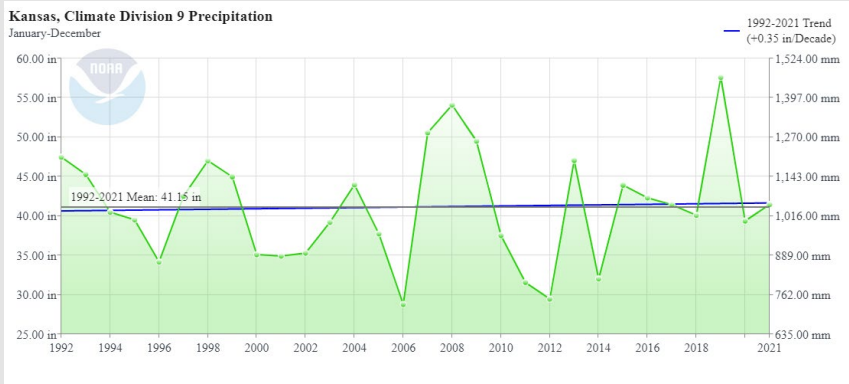
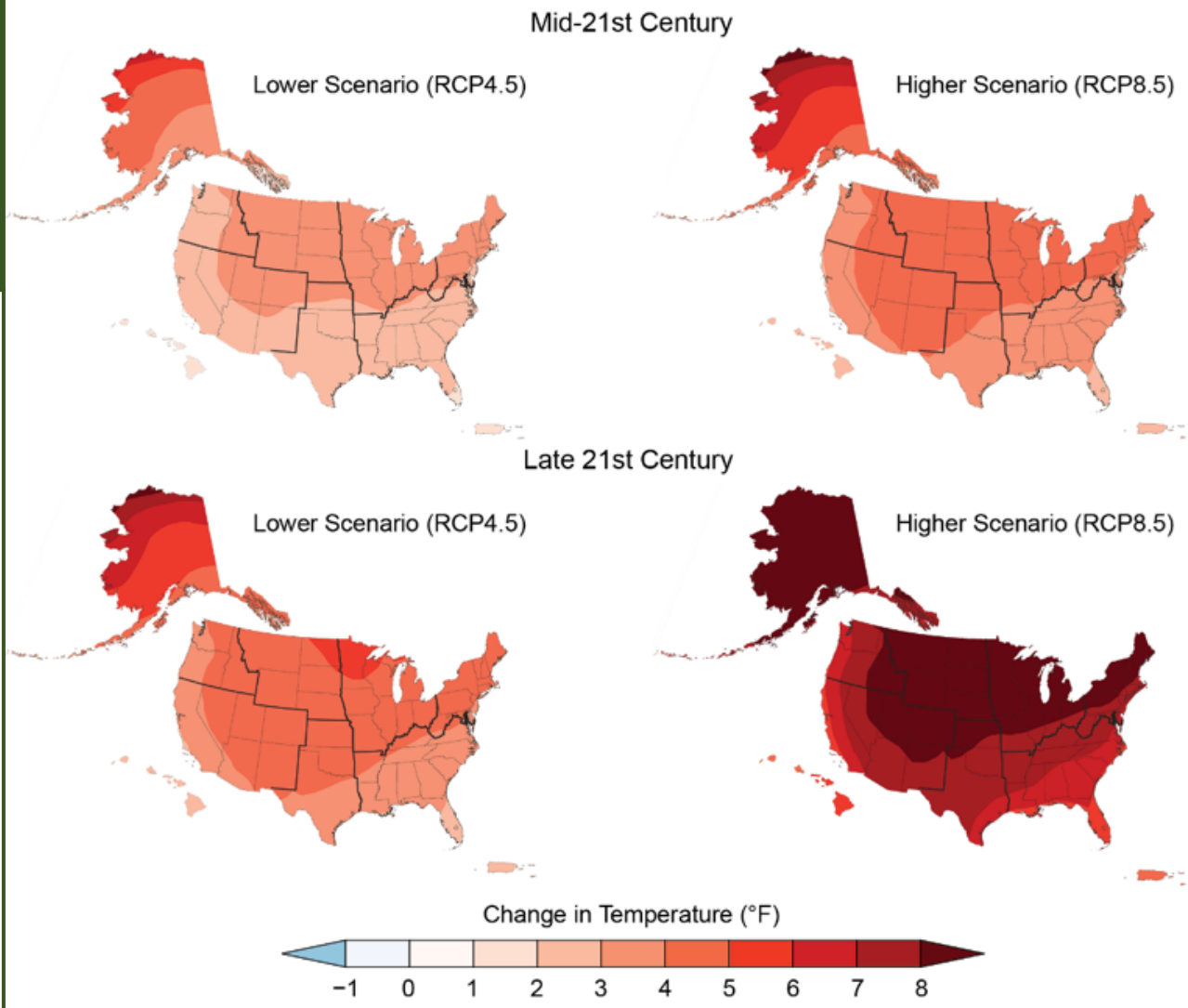


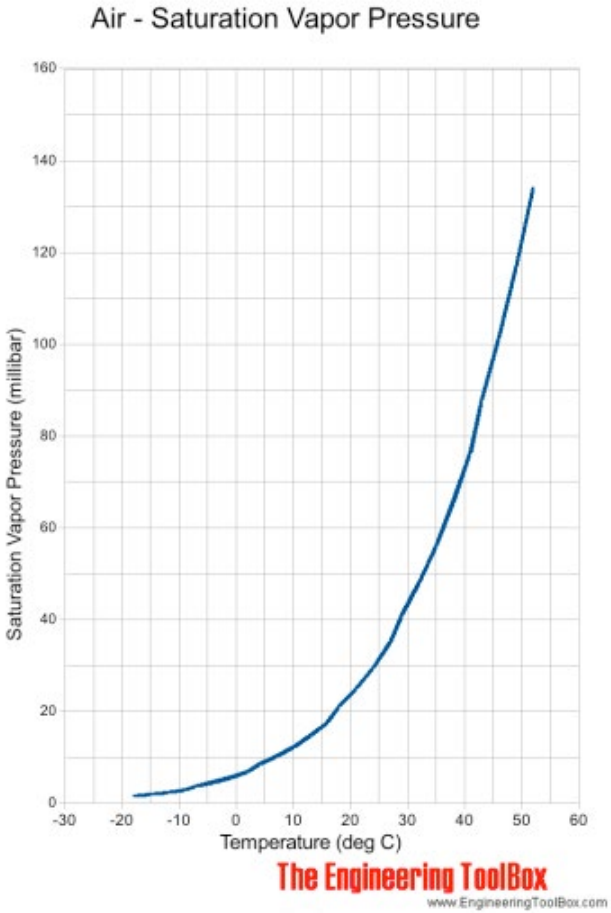
Fig. 1.3: Projected Changes in U.S. Annual Average Temperature

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).*

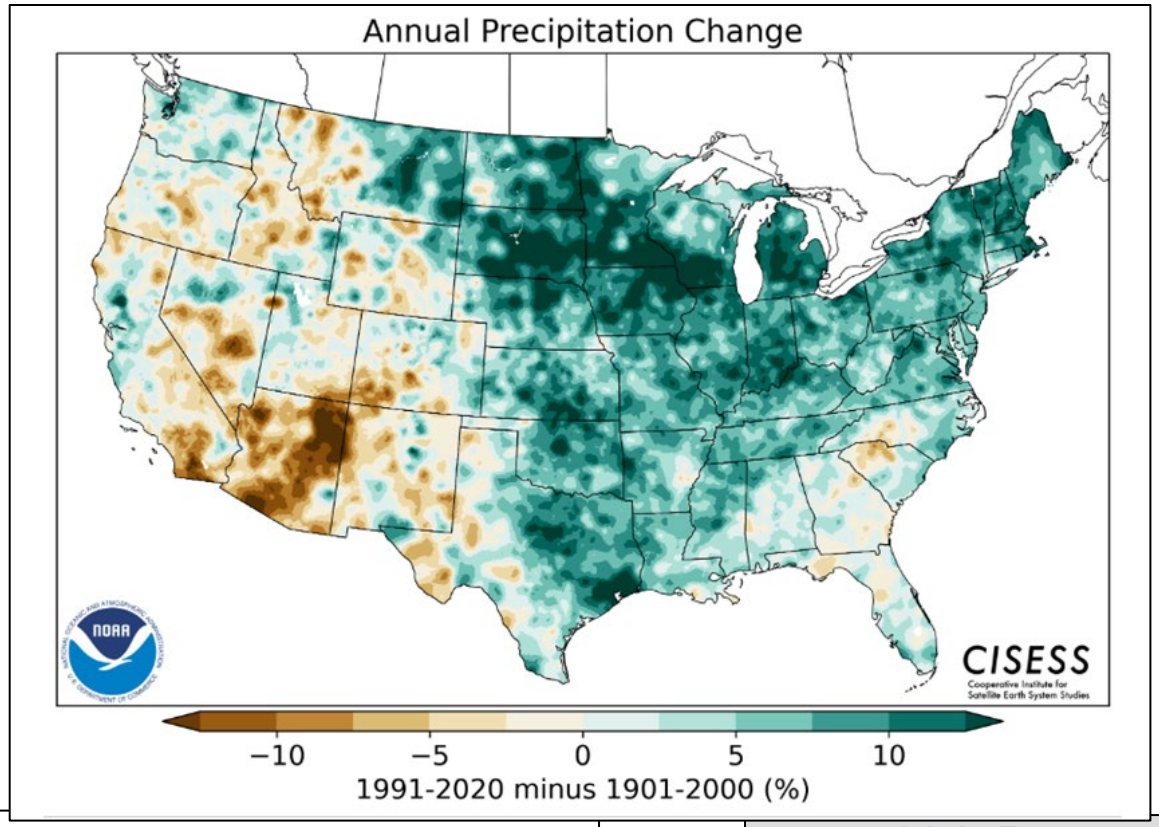


Warm Air Holds More Water Vapor: A lot more

- 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 (1991-2020) compared to the past (1901-2000)



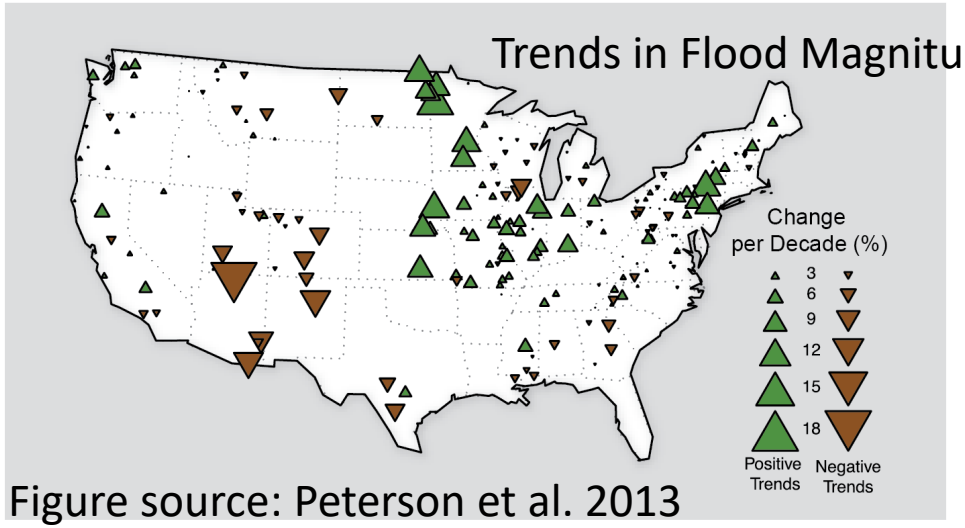
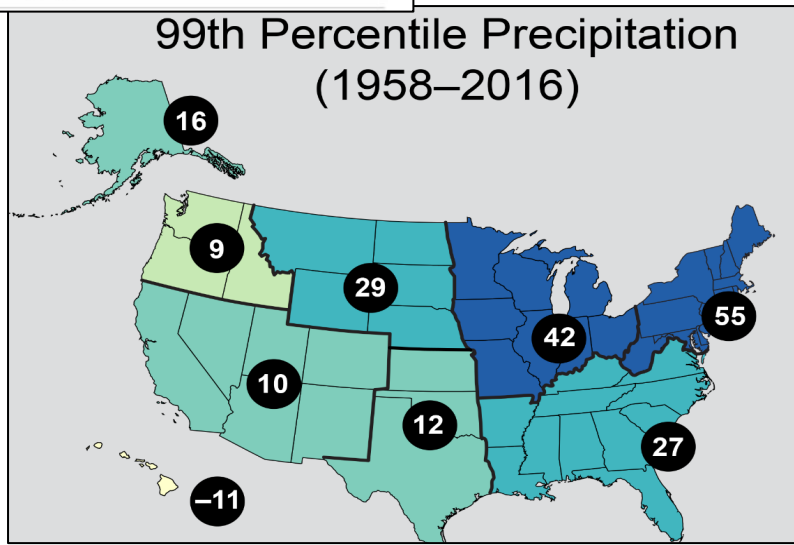
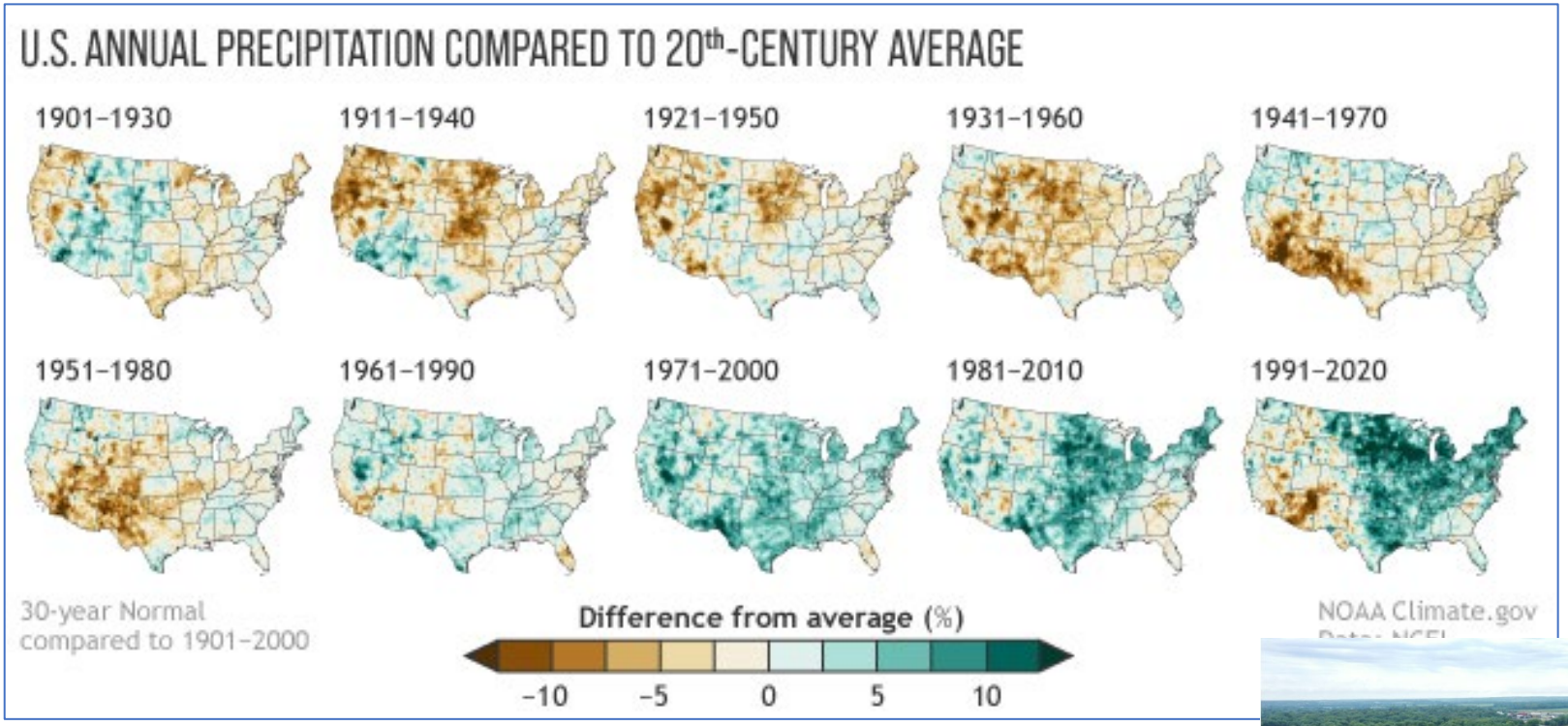


Figure source: Peterson et al. 2013

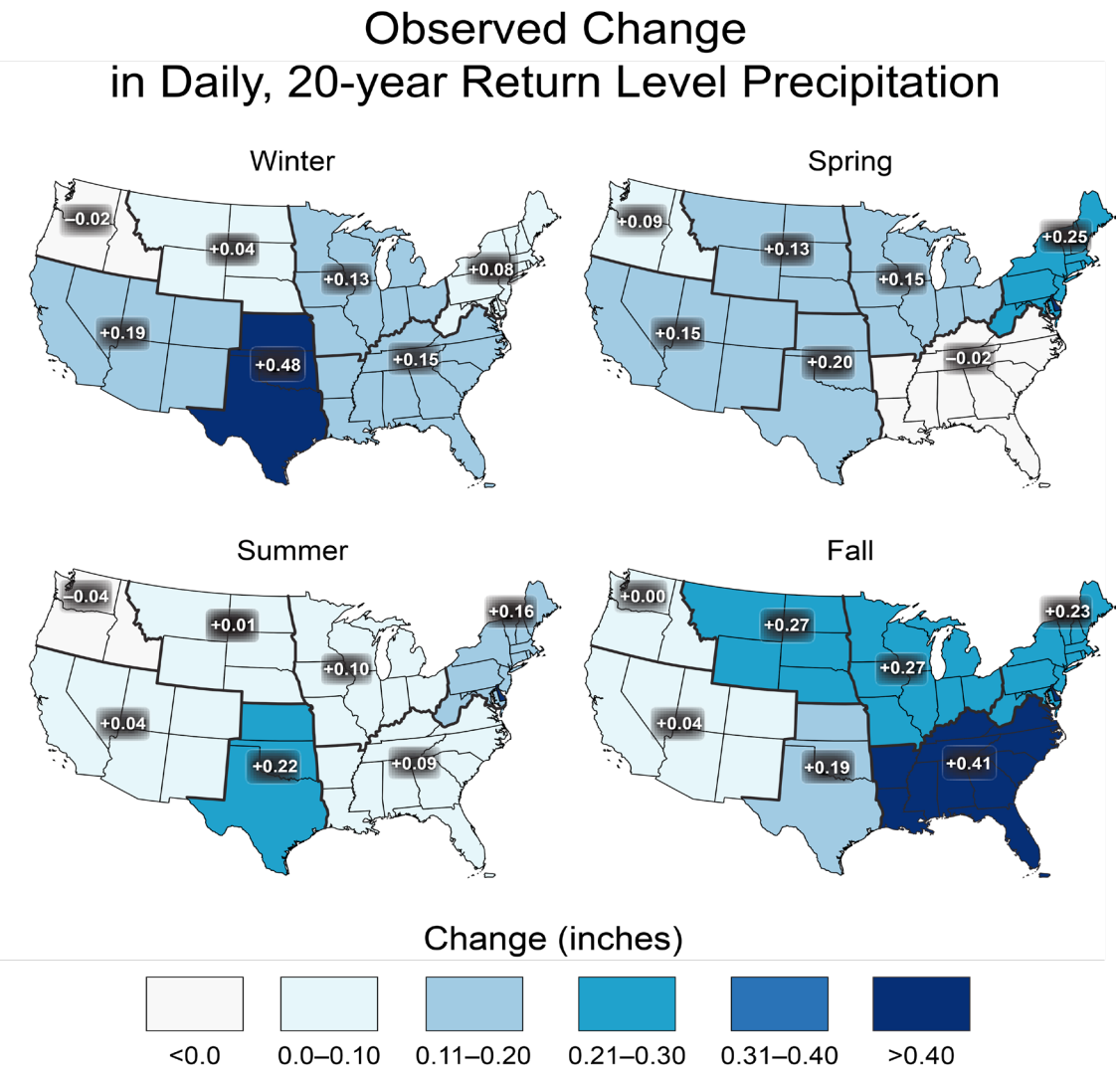


Precipitation Changes Over the Decades (1901 -2020)



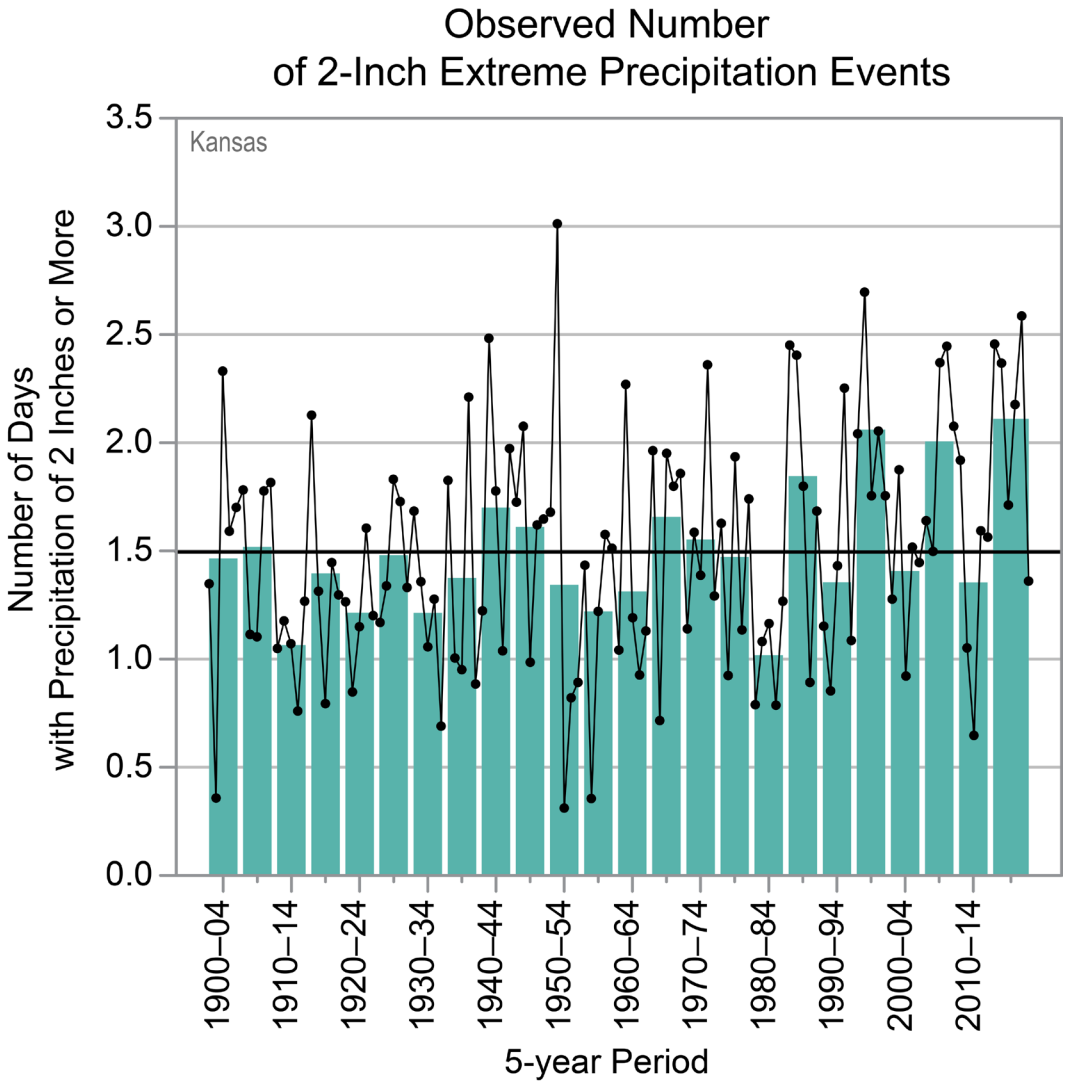
Ottawa, Kansas Thursday, Aug. 1, 2019.

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

Heavy Rainfall



- Daily 2+ inch rainfall events has shown an increase in occurance since 1900 across Kansas
- Varies geographically by season

Fig. 11.6: Cascading Consequences of Heavy Rainfall for Urban Systems

With heavy downpours increasing nationally, urban areas experience costly impacts. (top) In cities with combined sewer systems, storm water runoff flows into pipes containing sewage from homes and industrial wastewater. Intense rainfall can overwhelm the system so untreated wastewater overflows into rivers. Overflows are a water pollution concern and increase risk of exposure to waterborne diseases. (bottom) Intense rainfall can also result in localized flooding. Closed roads and disrupted mass transit prevent residents from going to work or school and first responders from reaching those in need. Home and commercial property owners may need to make costly repairs, and businesses may lose revenue. *Source: EPA.*

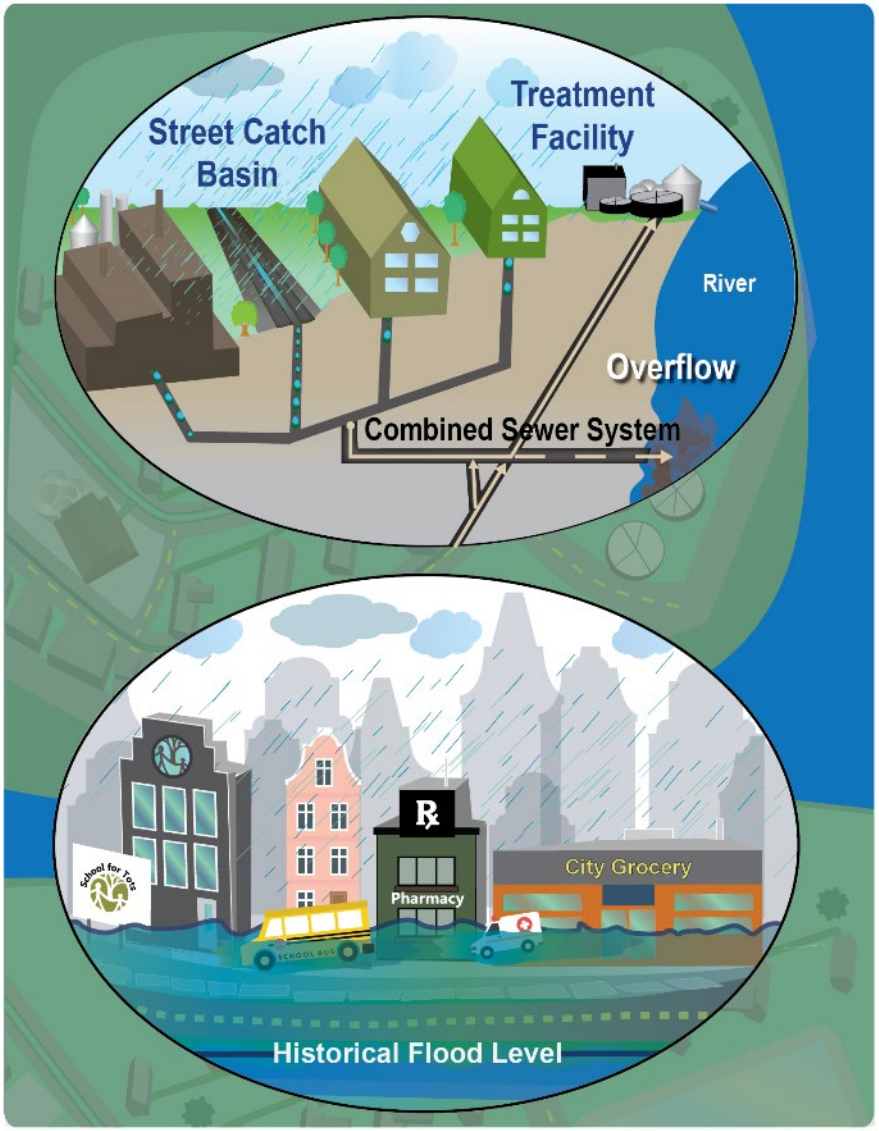
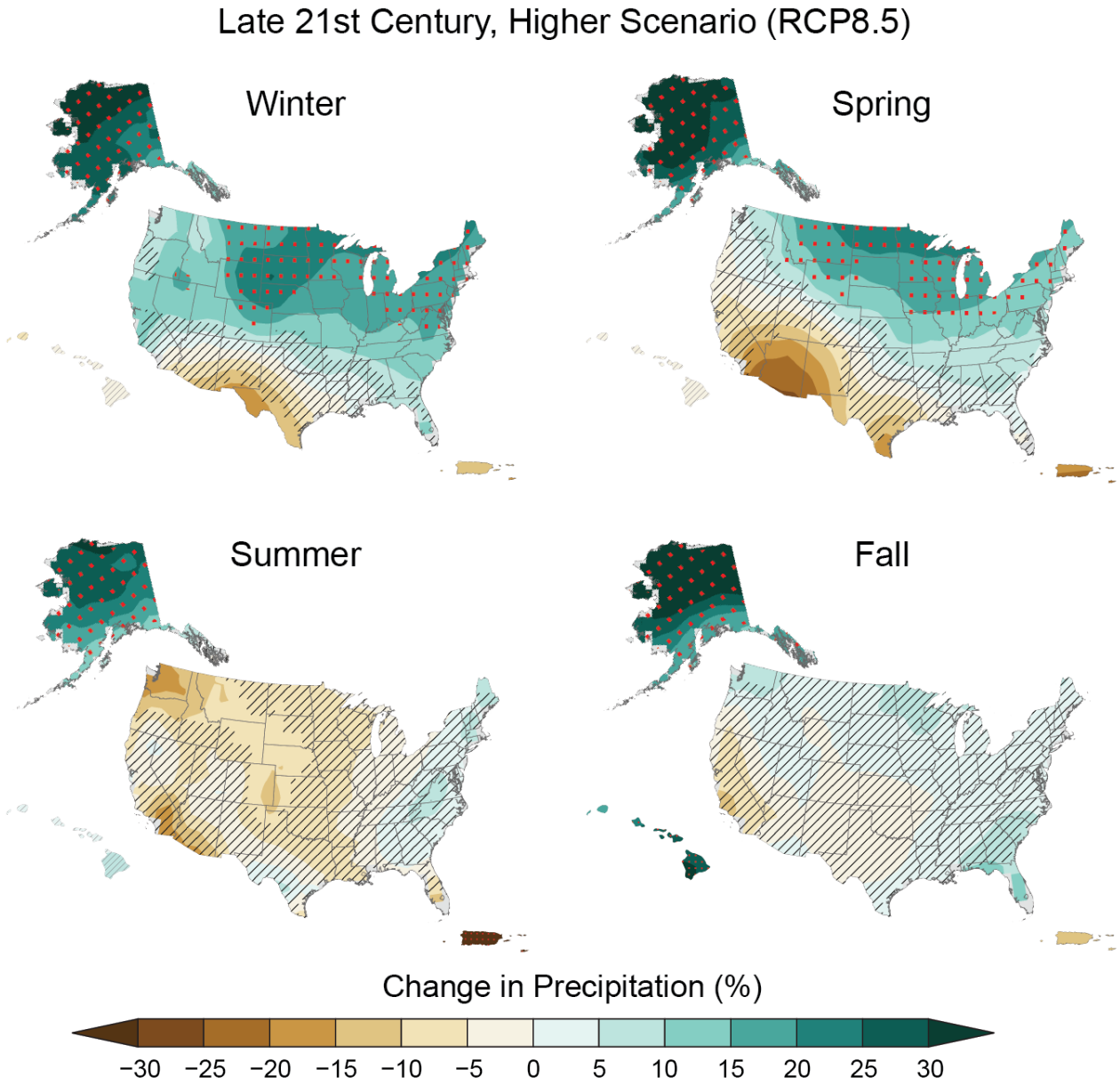


Fig. 2.5: Projected Changes in U.S. Seasonal Precipitation Amounts

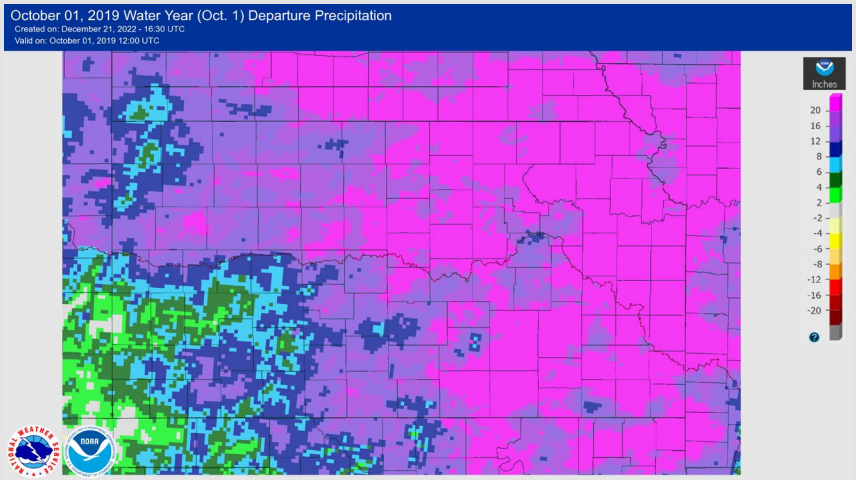
In the future, under the higher scenario, the northern U.S. is projected to receive **more precipitation, especially in winter and spring** by 2070-2099, relative to 1986-2015. Areas with red dots show where projected changes are large compared to natural variations; areas that are hatched show where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



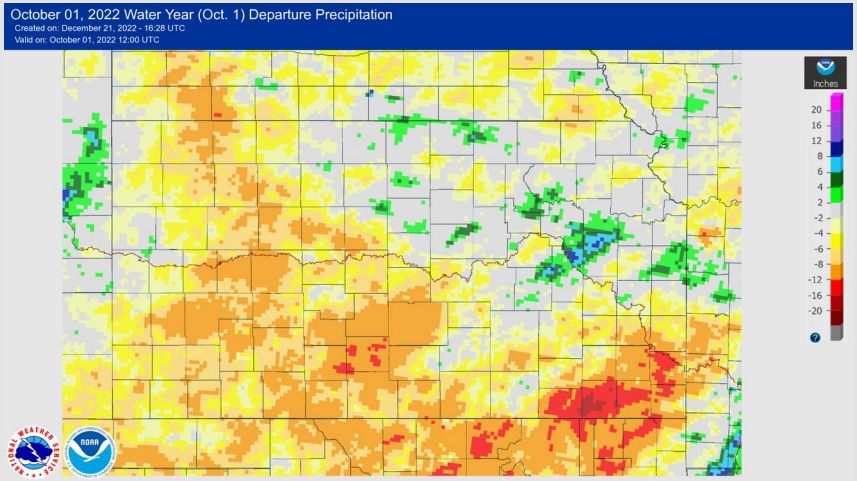
Extremes…Recent Past

Recent Extremes

2019 Precip Departure



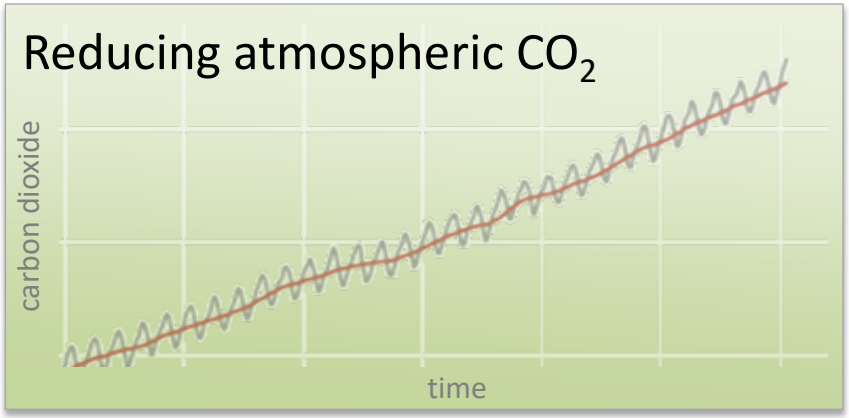
2022 Precip Departure



What Can We Do About It?

Mitigation

Reducing greenhouse gas emissions &/or removing carbon dioxide from the atmosphere may be able to lessen the severity of climate change & its impacts over the very long term.



Adaptation

Improving our ability to cope with or avoid harmful impacts; or taking advantage of newly favorable conditions. Reducing risk and vulnerability, and exploiting opportunities.

Adaptation: Anticipating & adjusting to new conditions

What changes are coming?

What changes do **we** need to make?

- **Stop building and re-building in vulnerable areas (exposure and vulnerability are driving many of the losses)**
- Develop infrastructure to manage water extremes
- Plant different crops
- Install green roofs or reflective roofs
- Make assets & supply chains more resilient

Kansas Impacts

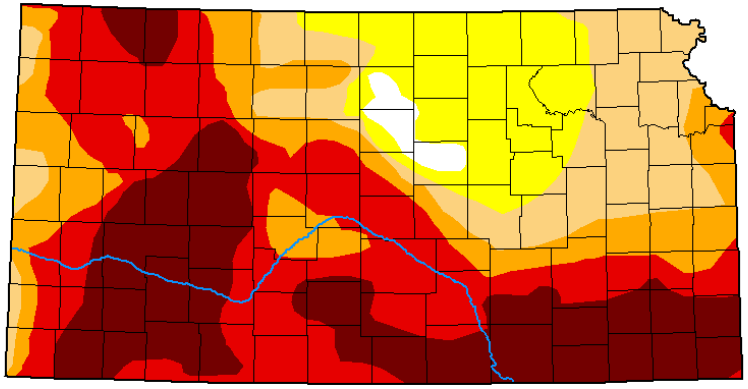
- It is getting warmer ~1.5F since 1900 and potential for another ~5F by end of century
- Increased evaporation and water loss even with average precipitation
- Heavier rainfall events/more intense could exacerbate erosion and sedimentation of reservoirs
- Longer growing season later frost and earlier green up –Ag impacts

Kansas Impacts

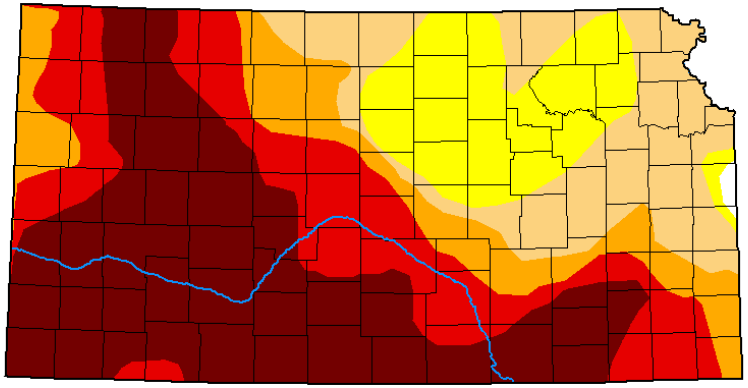
- The *intensity* of future droughts is projected to increase (increased evaporation soil drying. *Frequency* of droughts uncertain
- Frequency and severity of wildfires could also increase especially if the precipitation projections below occur
- It is getting wetter in some places
  - Increase in winter/spring but less in summer/fall good for winter wheat bad for corn other summer crops?

Current Drought Status

October 4 2022



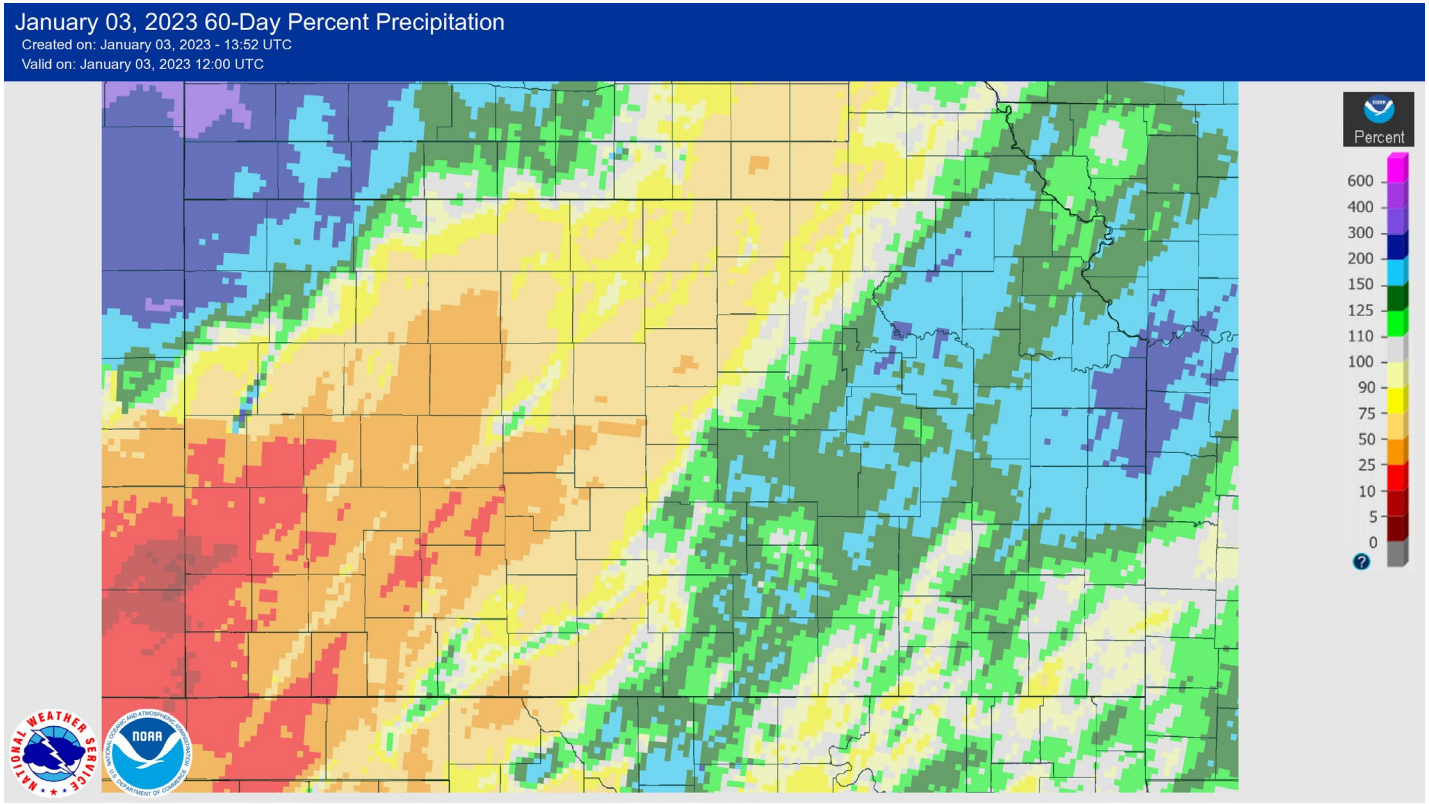
December 27th 2022



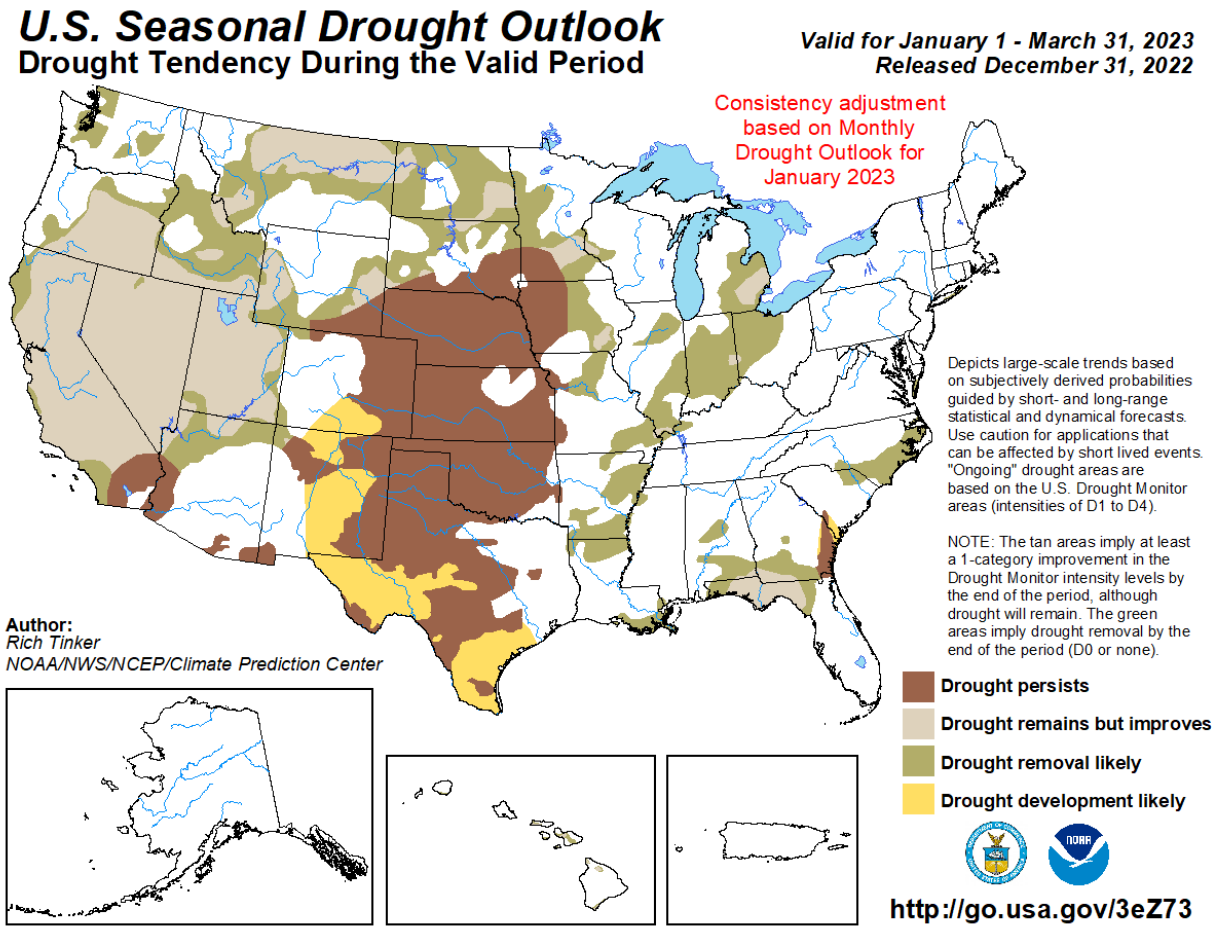
Drought Classification

- None
- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
- No Data

Last 60 days Precip % of Average



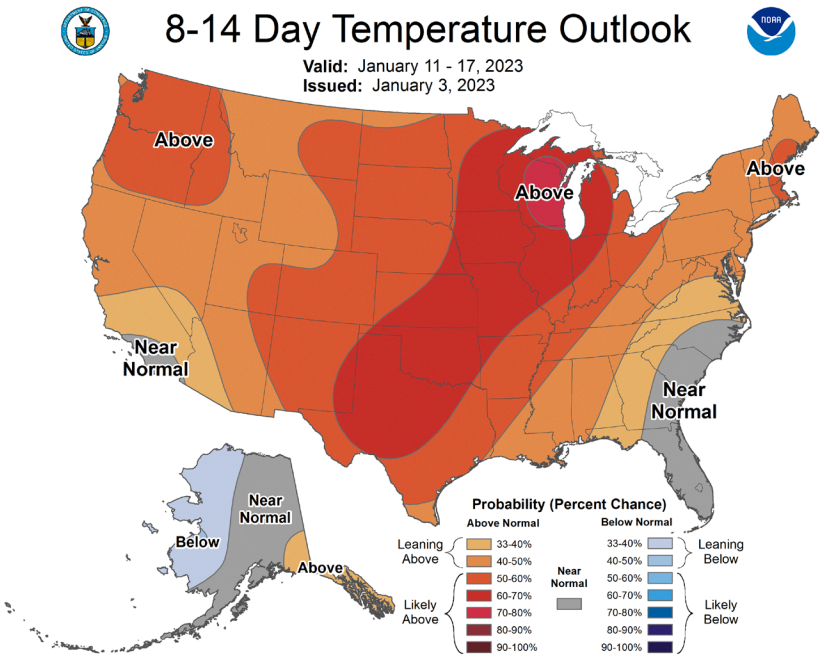
Seasonal Drought Outlook

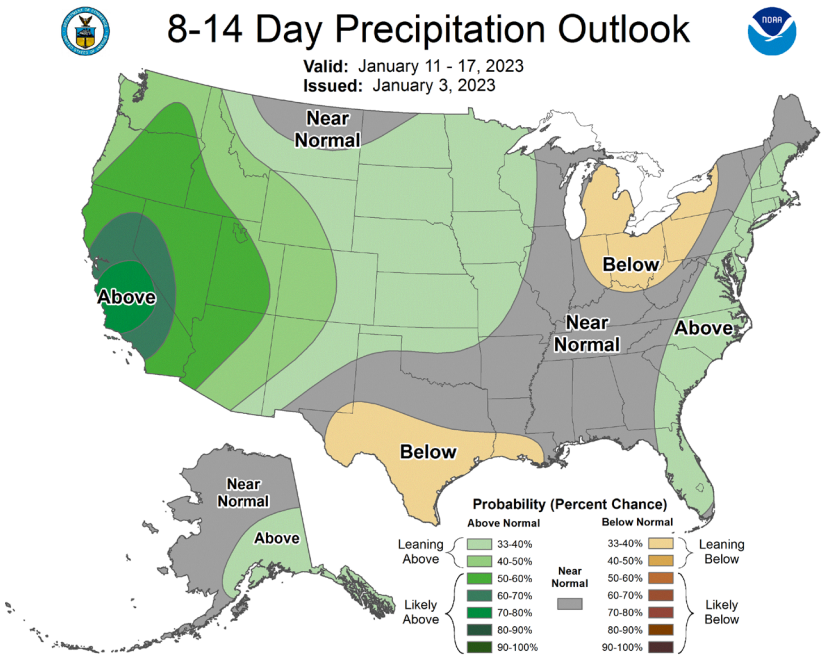


8-14 Day Outlook

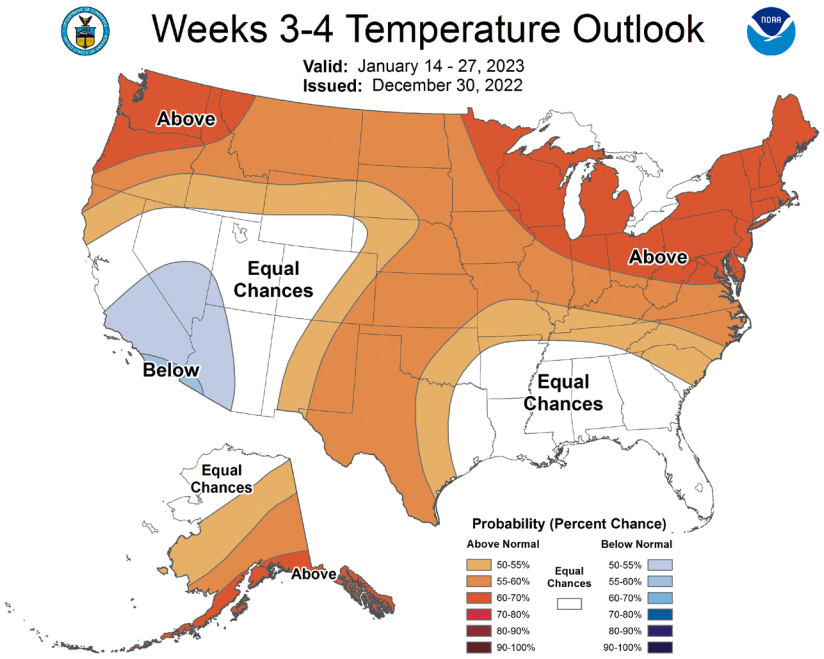
caution (old data) see

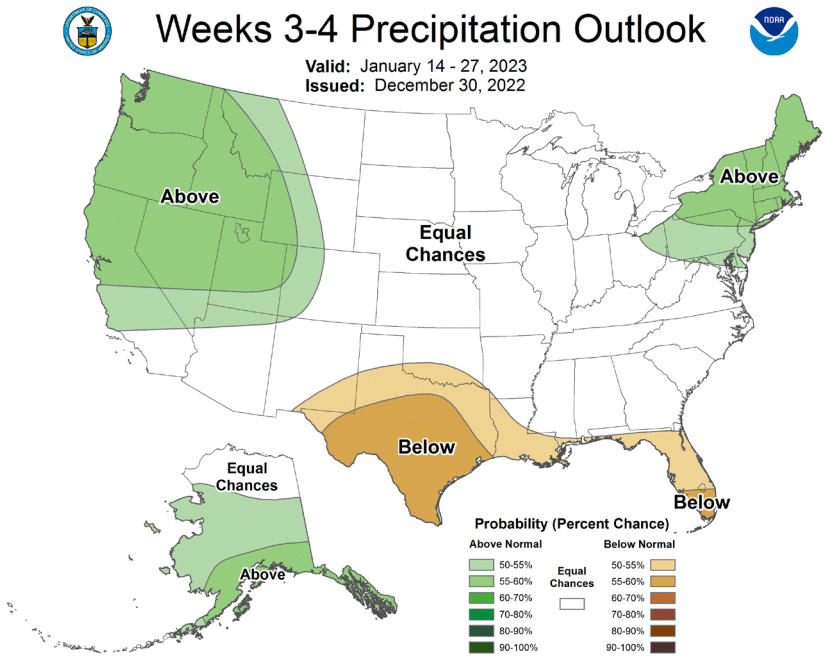
https://www.cpc.ncep.noaa.gov/products/predictions/814day/814temp.new.gif



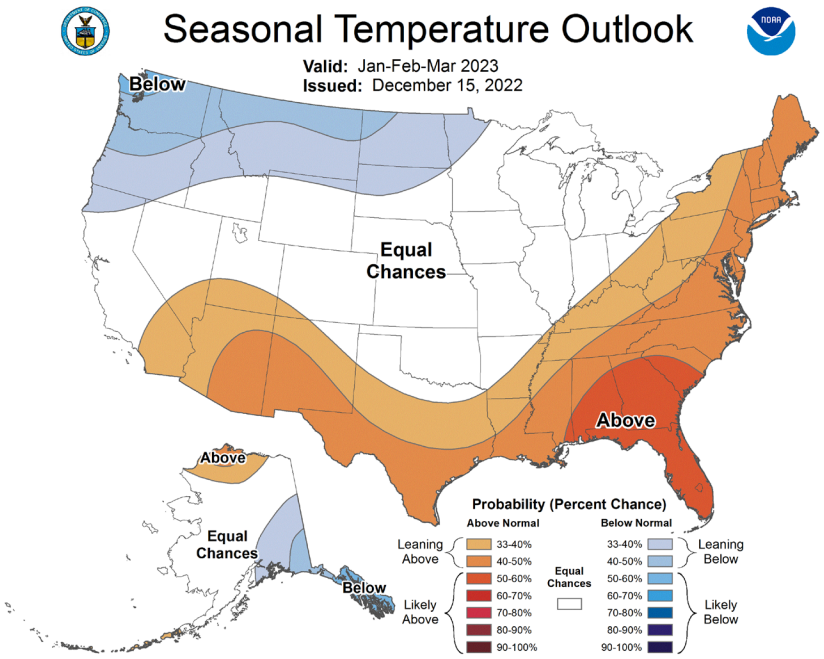


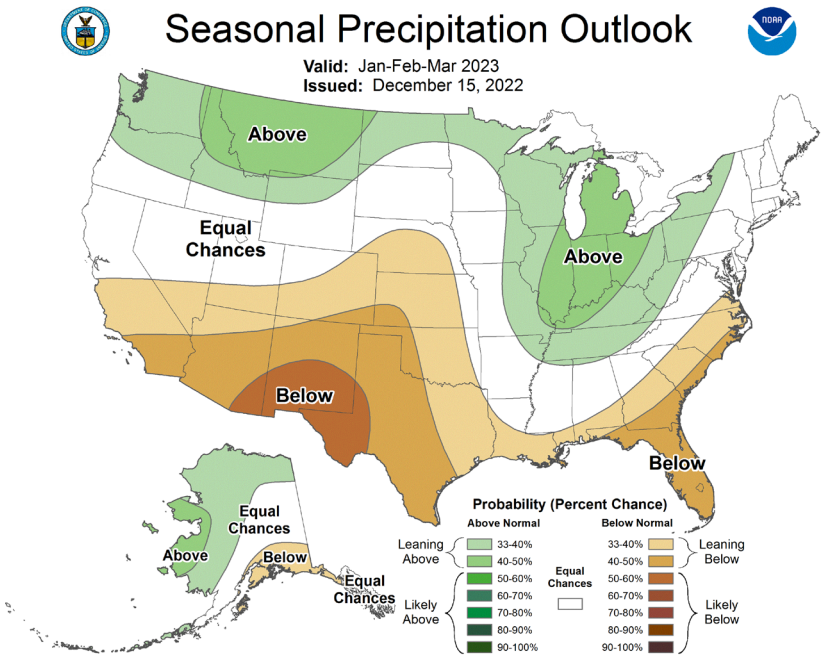
Weeks 3-4 Outlook for updated forecast see https://www.cpc.ncep.noaa.gov/products/predictions/WK34/gifs/WK34temp.gif



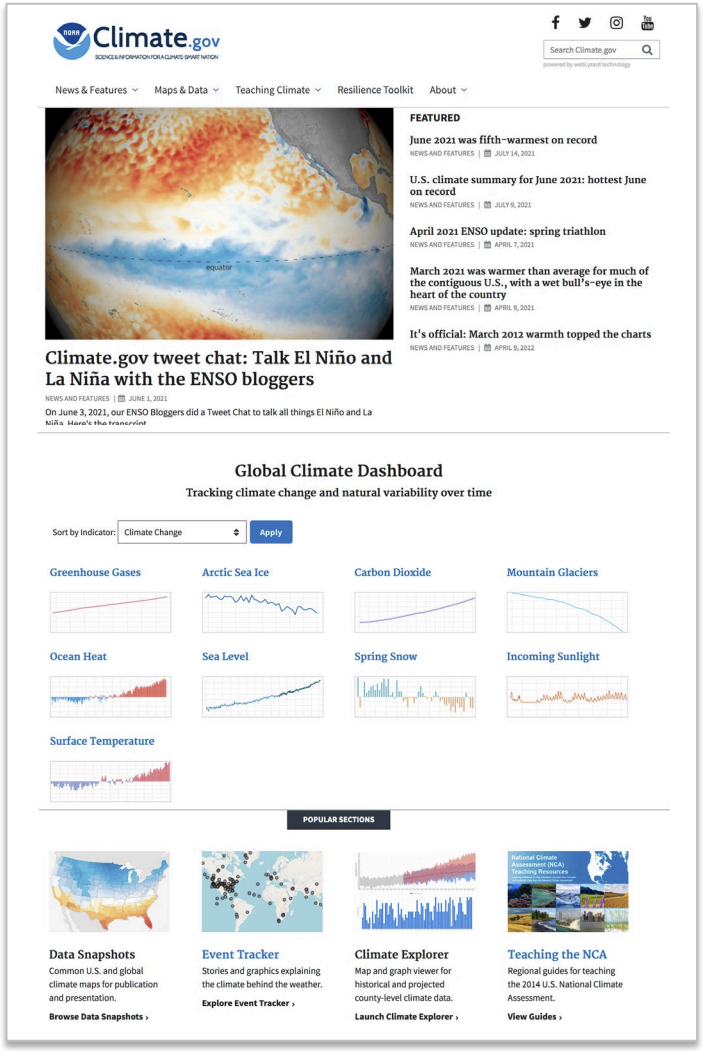


3 Month Outlook
Jan-Feb-Mar 2023

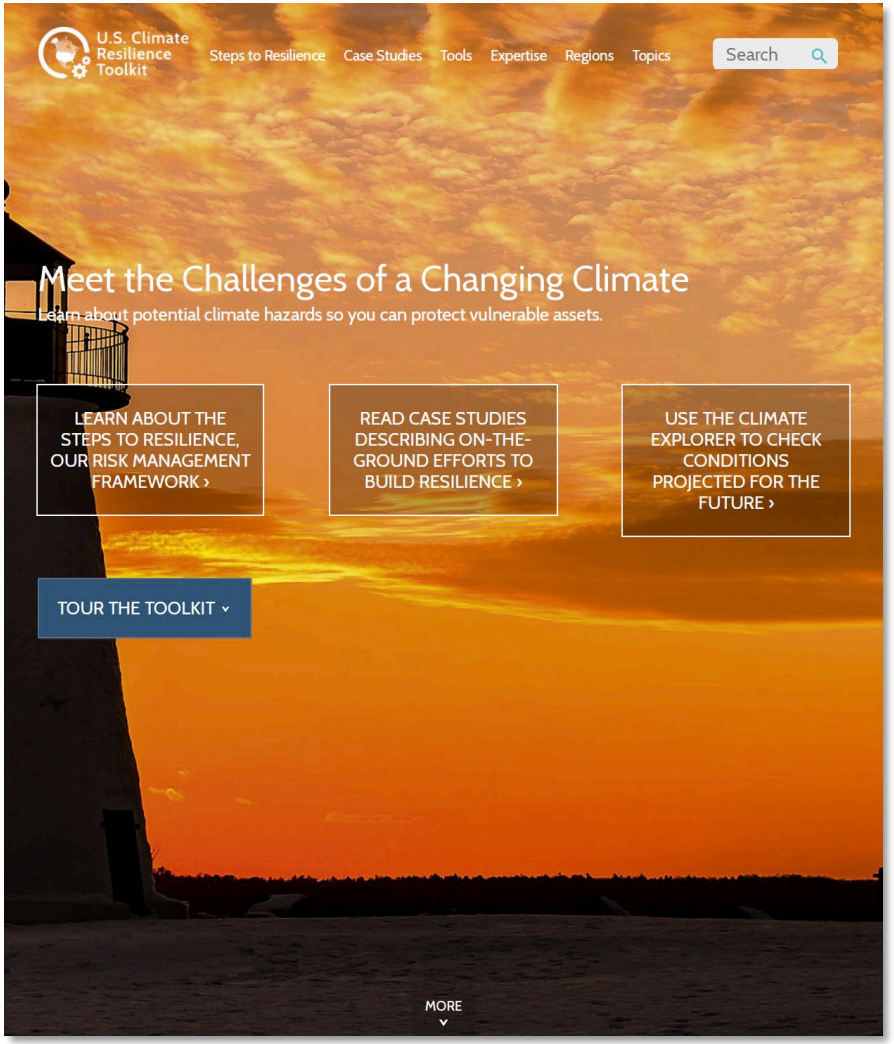




Free, authoritative online sources of information about climate change, impacts, and projections.



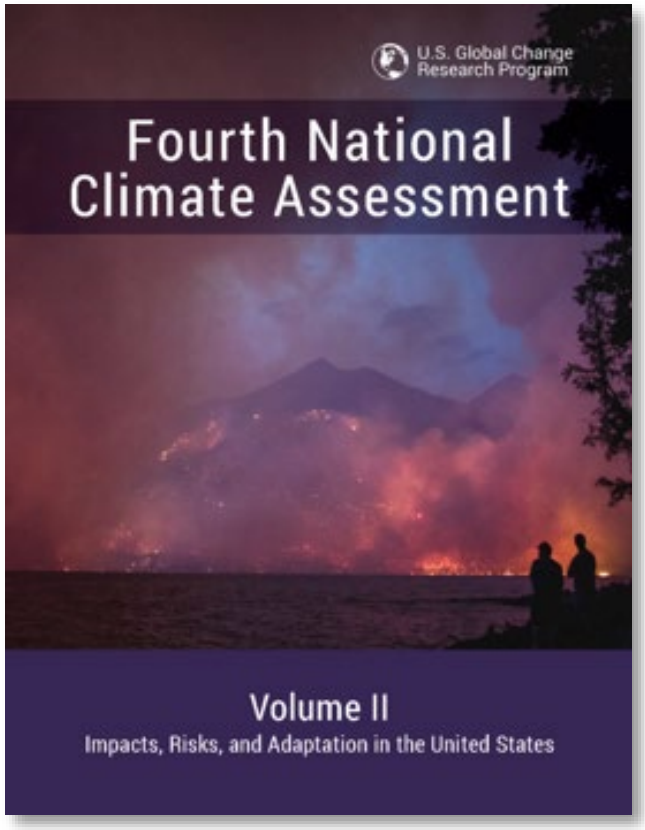
www.climate.gov



toolkit.climate.gov

FOURTH NATIONAL CLIMATE ASSESSMENT

- https://nca2018.globalchange.gov/
- https://statesummaries.ncics.org/
- NOAA ATLAS point precipitation frequency estimates

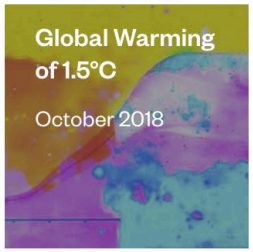


Intergovernmental Panel on Climate Change (IPCC)

https://ipcc.ch

WORKING GROUP REPORT

WORKING GROUP REPORT



WORKING GROUP REPORT

WORKING GROUP REPORT

WORKING GROUP REPORT

WORKING GROUP REPORT

Thank You

www.ncei.noaa.gov
www.climate.gov

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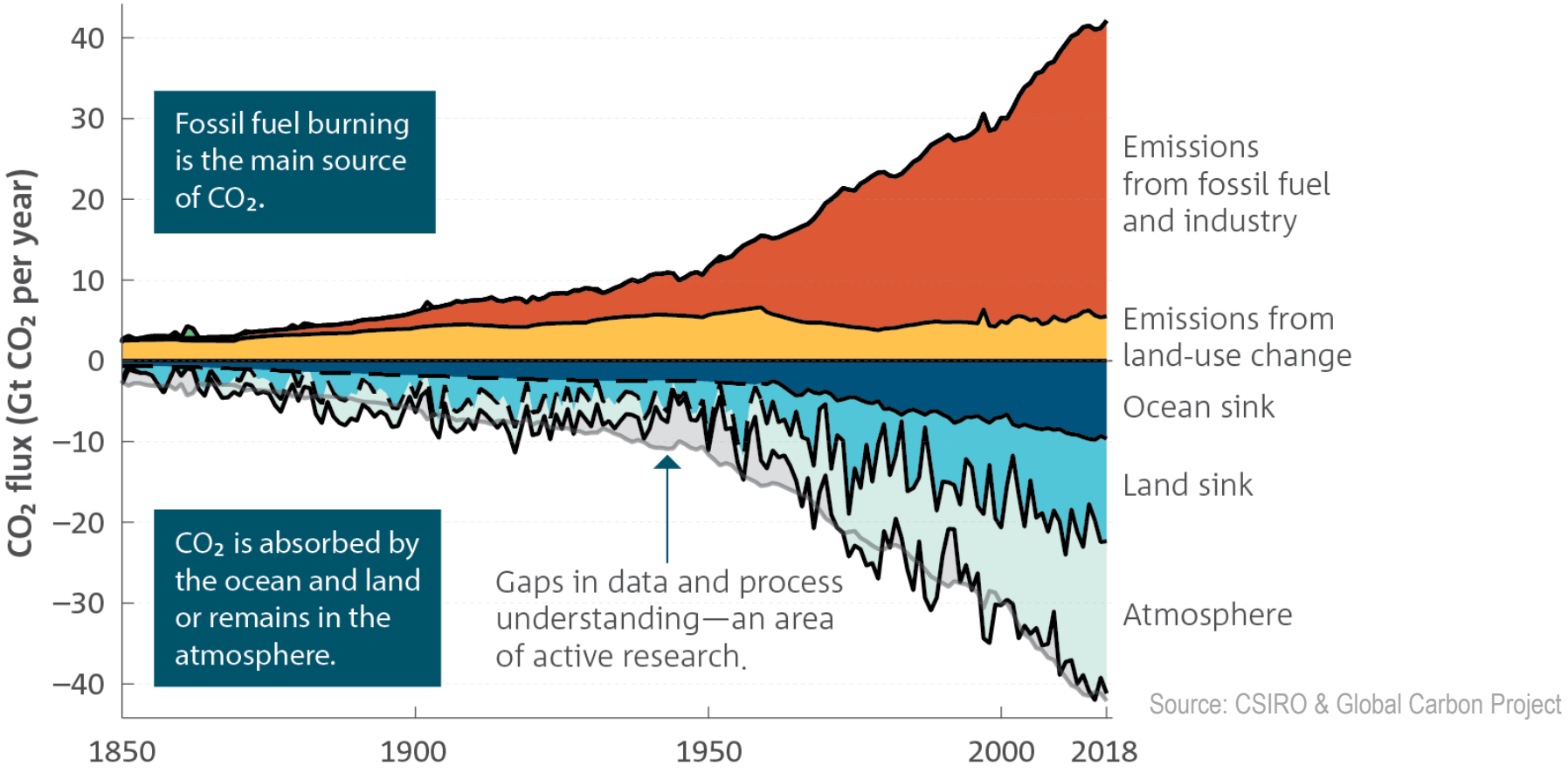
NCEI Ocean & Geophysics Facebook: http://www.facebook.com/NOAANCEIoceangeo
NCEI Climate Twitter (@NOAANCEIclimate): http://www.twitter.com/NOAANCEIclimate
NCEI Ocean & Geophysics Twitter (@NOAANCEIocngeo): http://www.twitter.com/NOAANCEIocngeo

Global sources & sinks of CO_2 from 1850-2018



Our Changing Climate: *Regions*