



ILLINOIS STATE
WATER SURVEY
PRAIRIE RESEARCH INSTITUTE

Climate Change in Illinois

TRENT FORD

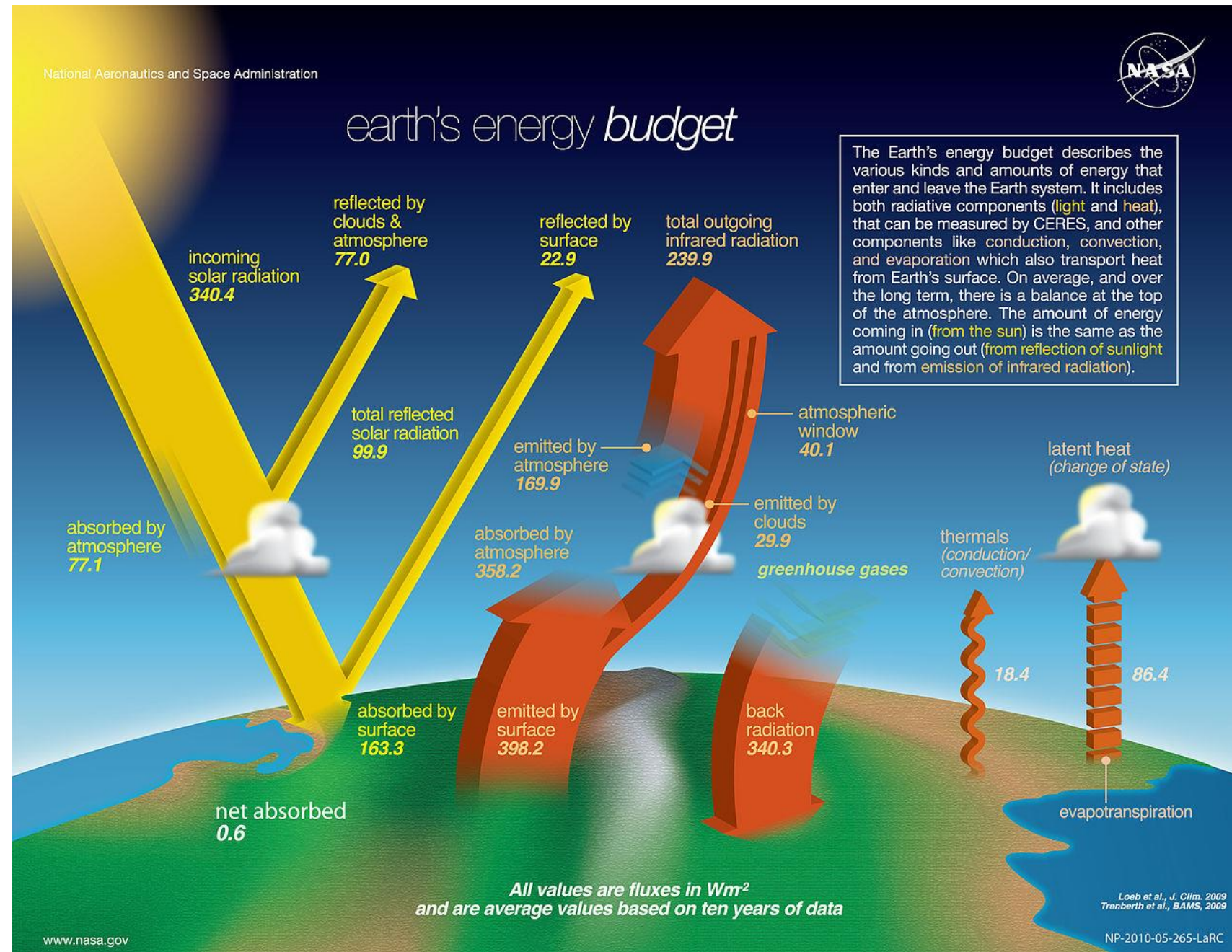
ILLINOIS STATE CLIMATOLOGIST

ILLINOIS STATE WATER SURVEY/PRAIRIE RESEARCH INSTITUTE

UNIVERSITY OF ILLINOIS, URBANA-CHAMPAIGN

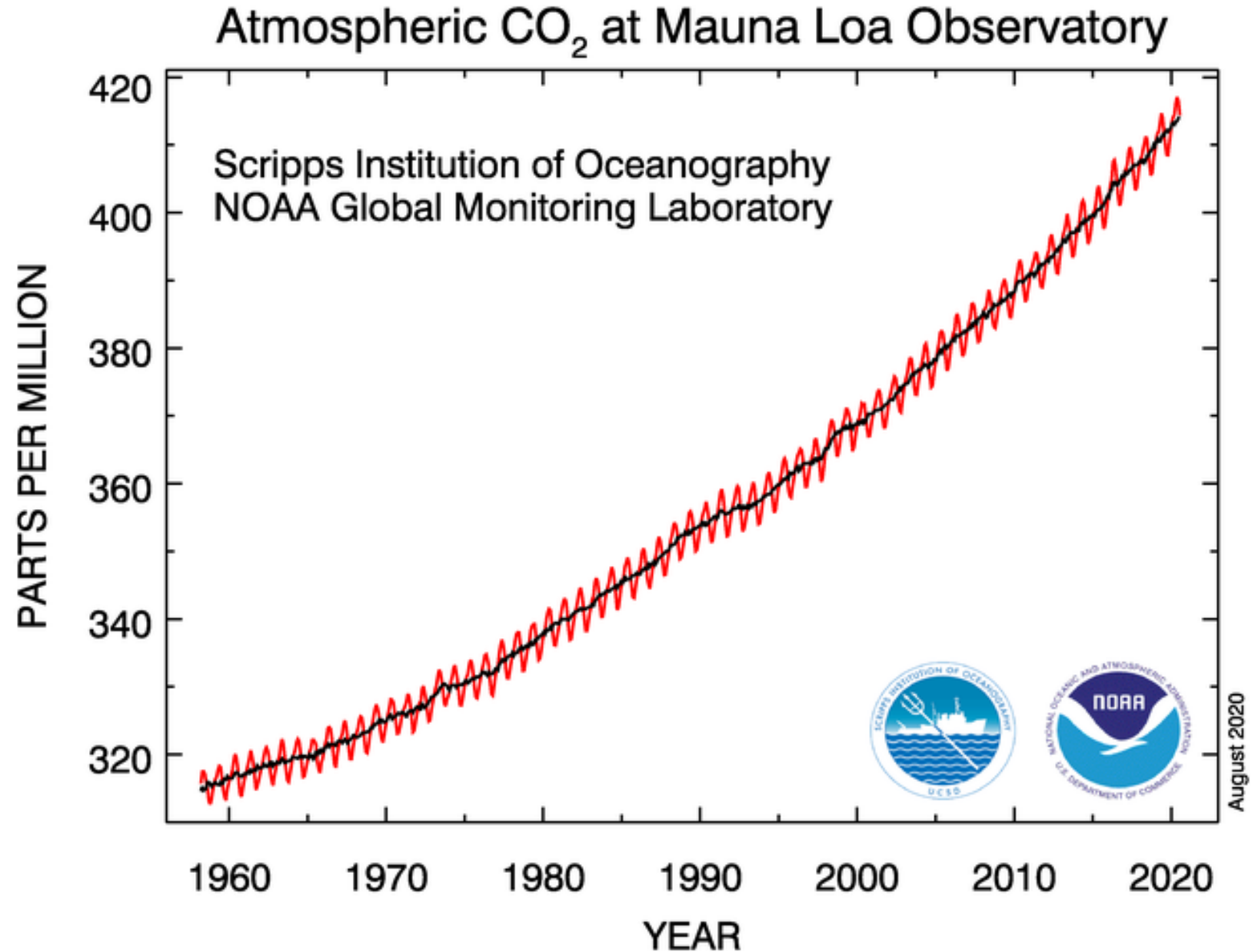


- Carbon dioxide, methane, water vapor (among others) permit solar radiation to enter the Earth system, but absorb outgoing terrestrial radiation
- Their concentration of these gases, namely CO₂, CH₄, H₂O, varies in time due to natural and anthropogenic causes



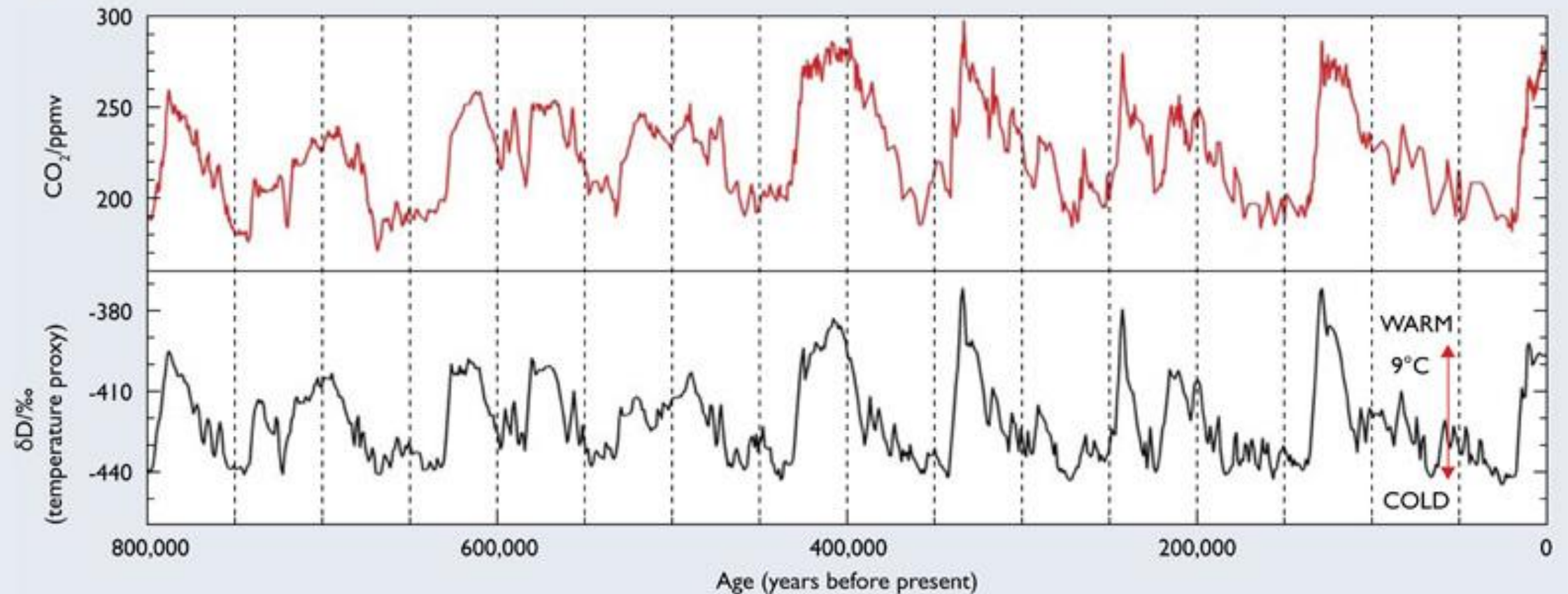
The Earth's greenhouse effect

- We have observed a consistent increase in CO₂ concentrations over the last 60 years
- December 2019: 414 ppm



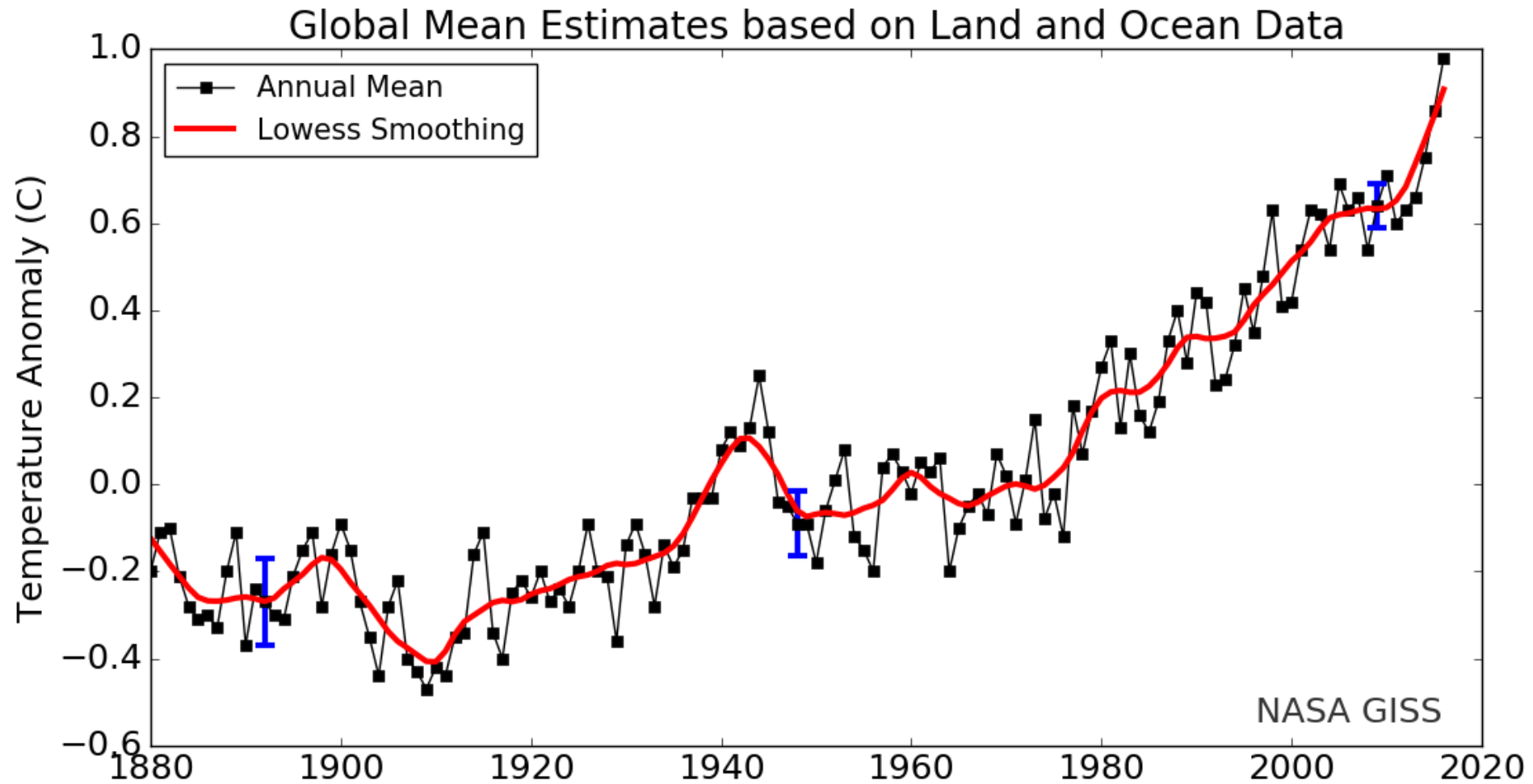
The Earth's greenhouse effect – Historically

Fig. 3: Ice core data from the EPICA Dome C (Antarctica) ice core: deuterium (δD) is a proxy for local temperature; CO_2 from the ice core air^(5,6)



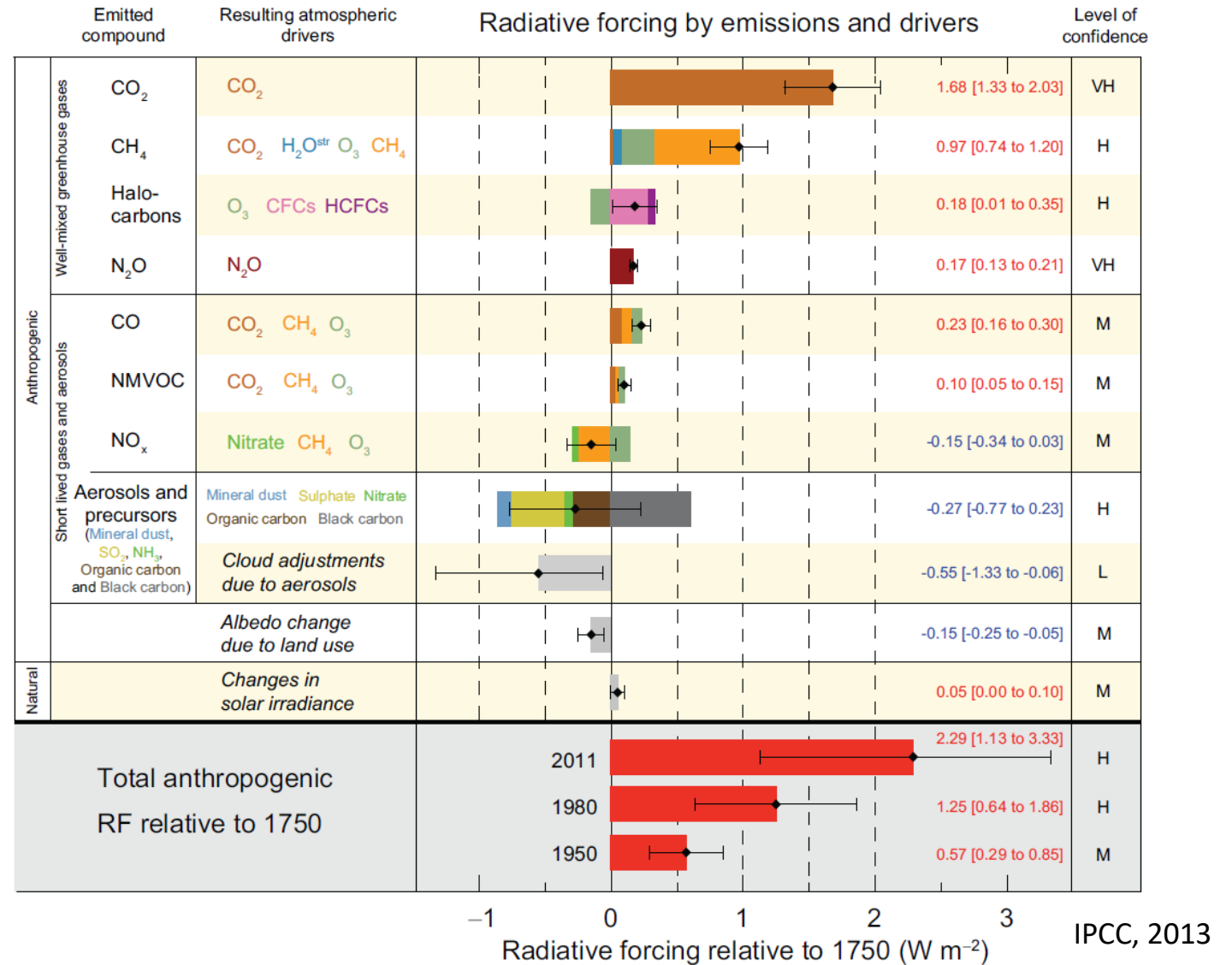
British Antarctic Survey

Global Warming

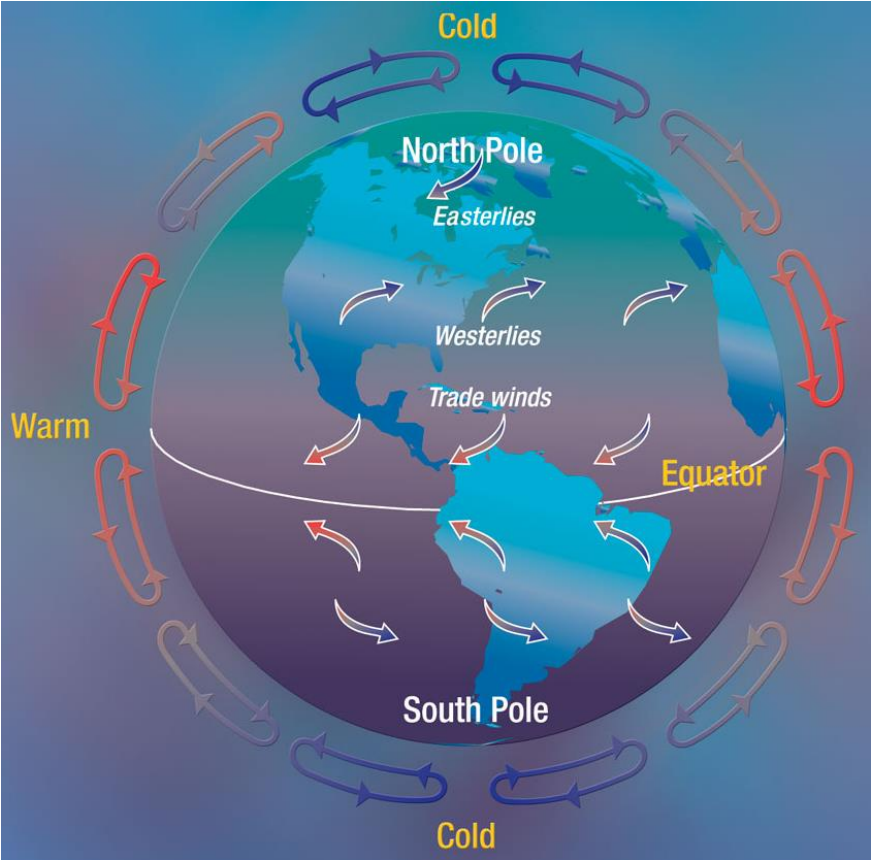


The Earth's greenhouse effect

- Increased radiative forcing is primarily due to increased carbon dioxide and methane
- Studies in atmospheric science, chemistry, physics, and engineering have attributed nearly all of the over century-long to human activity

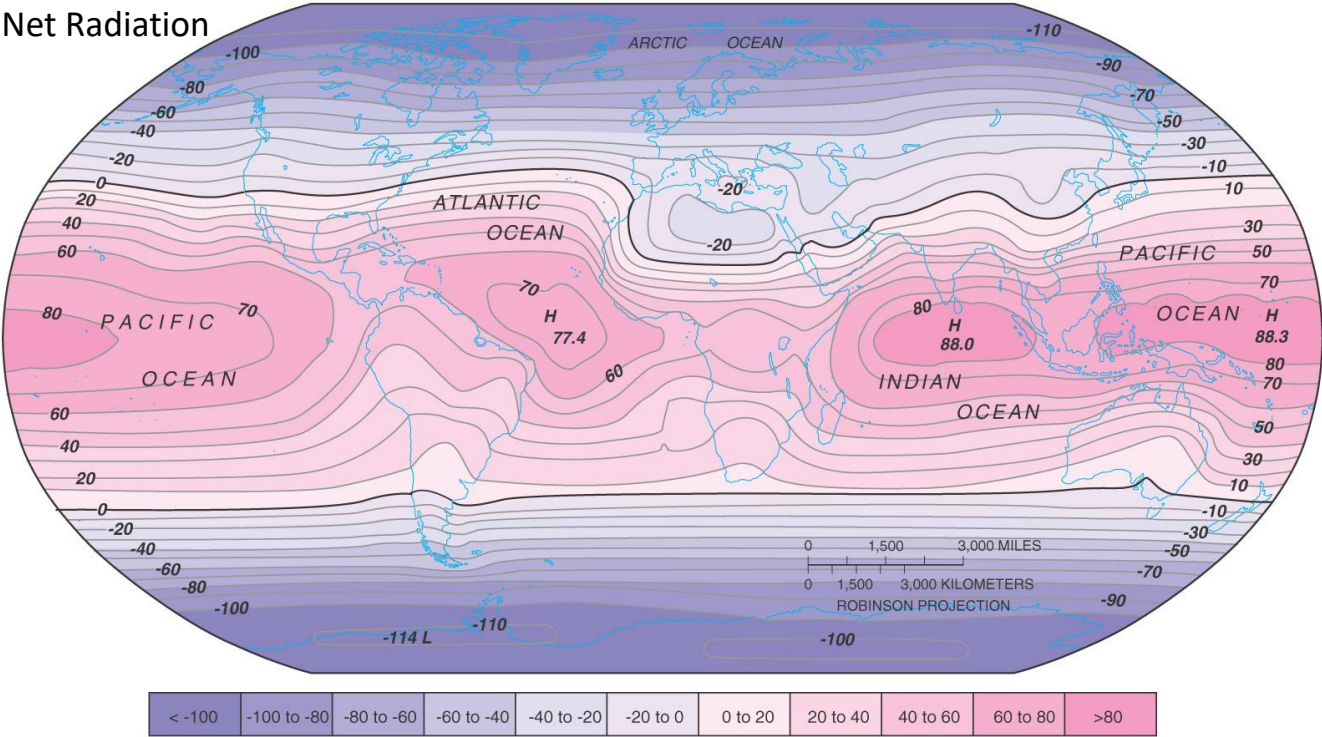


Climate Change

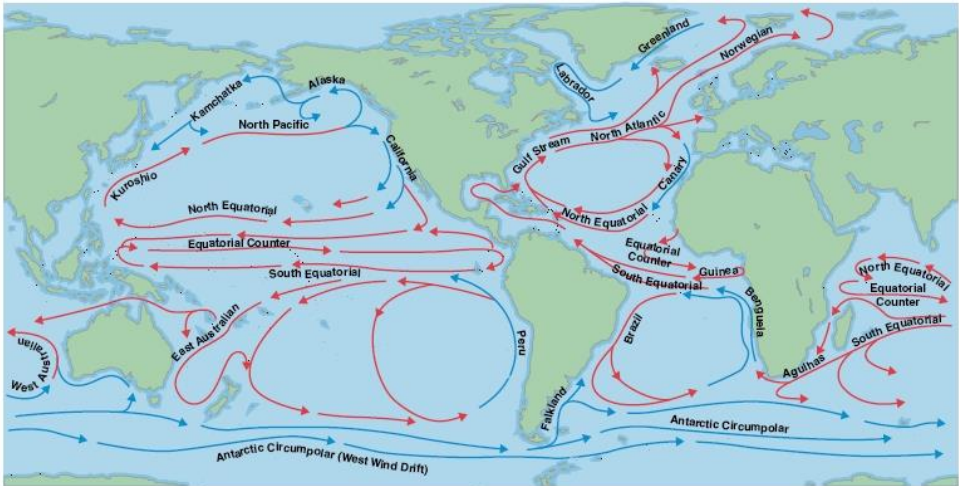


Atmospheric Circulation

Annual Net Radiation



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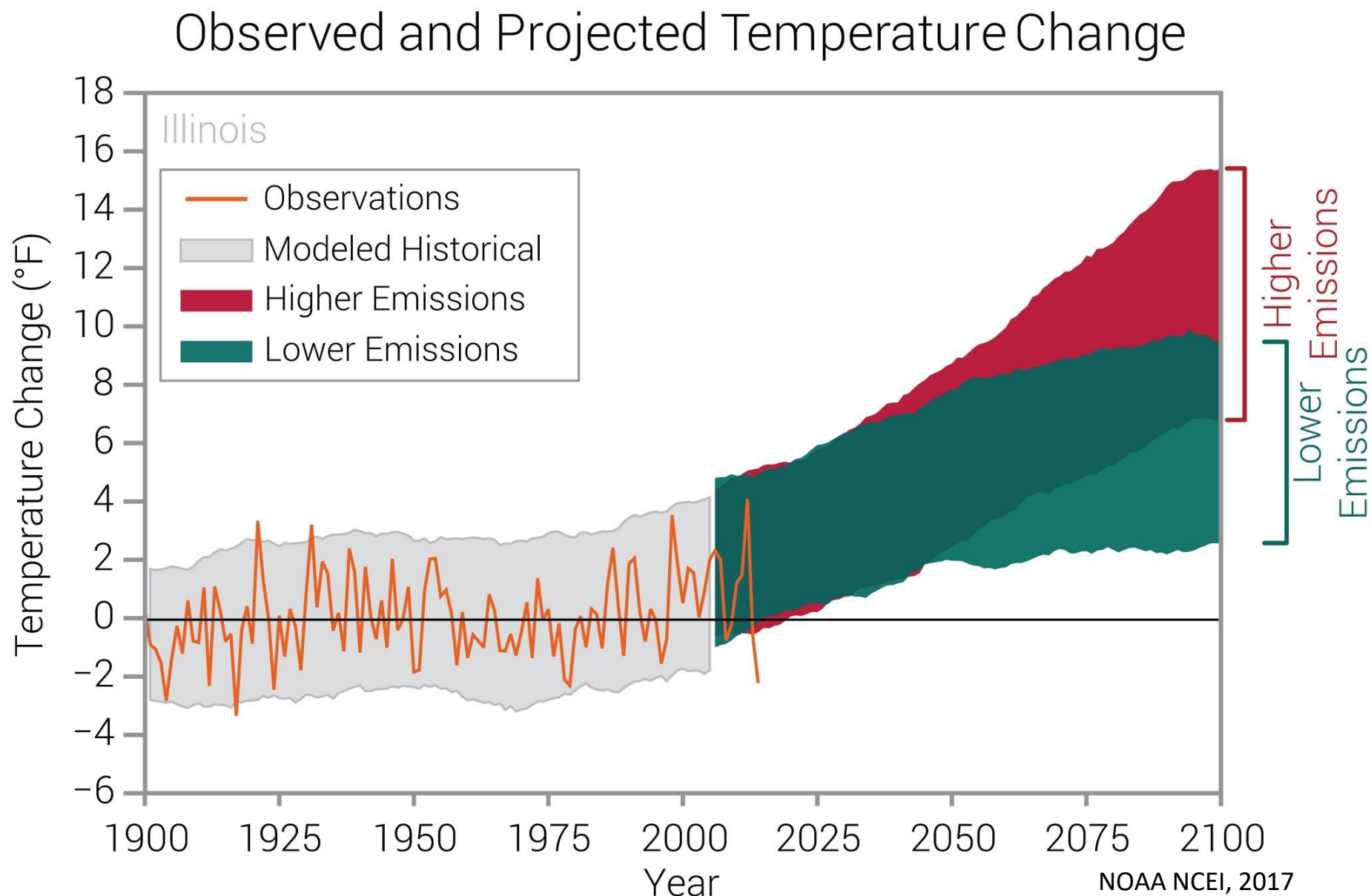


Ocean Circulation



Temperature

- Mean temperatures in Illinois have increased ~ 1°F since 1900
- Continued warming out to 2100 is likely, magnitude varies based on emissions



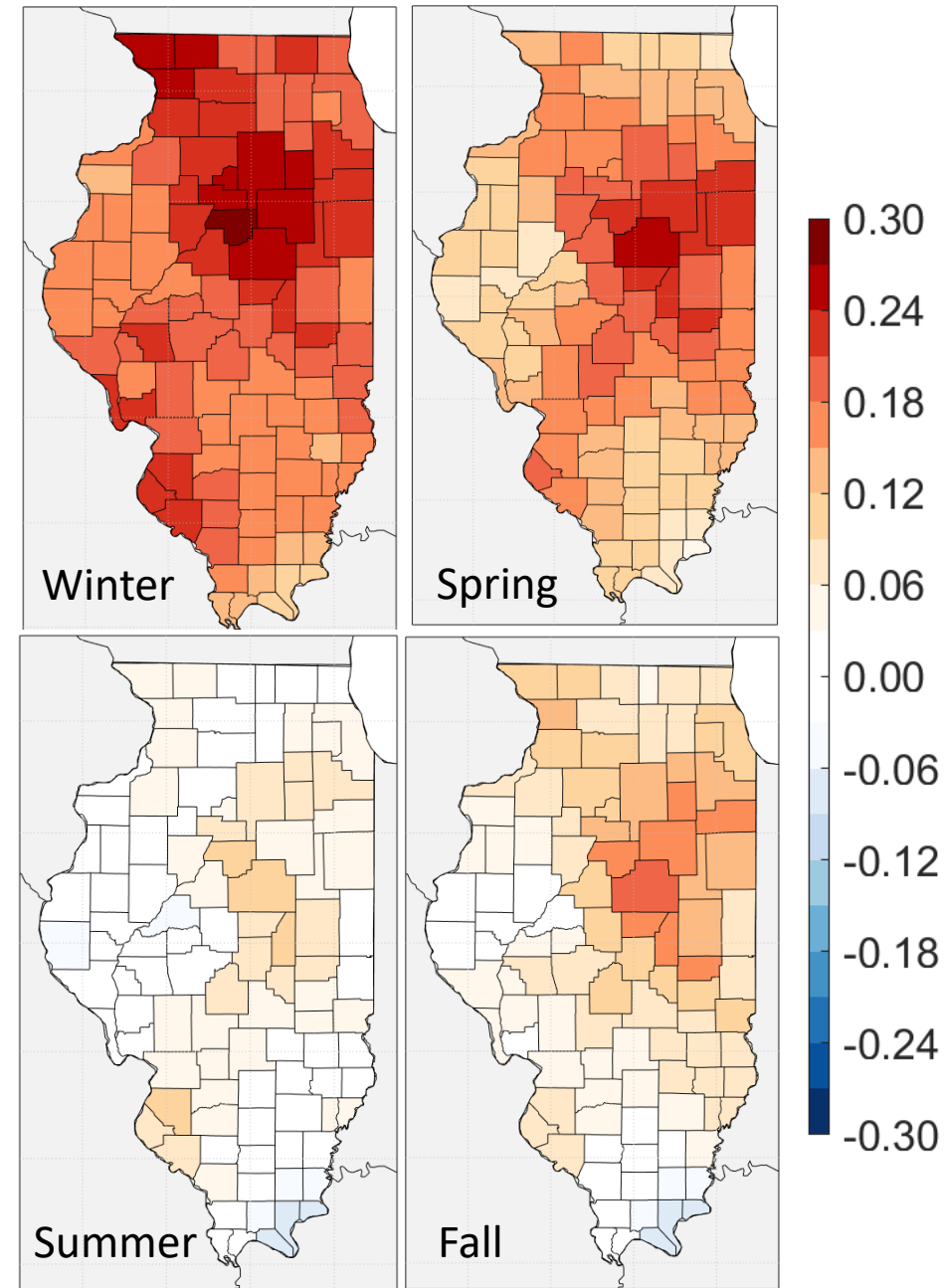
Temperature – Observed Changes

Last 120 Years:

- Statewide annual average temperature has increased by 0.10°F per decade between 1895 and 2019
- Warming trends in winter & spring are much larger than summer & fall
- Largest change in daily minimum temperatures

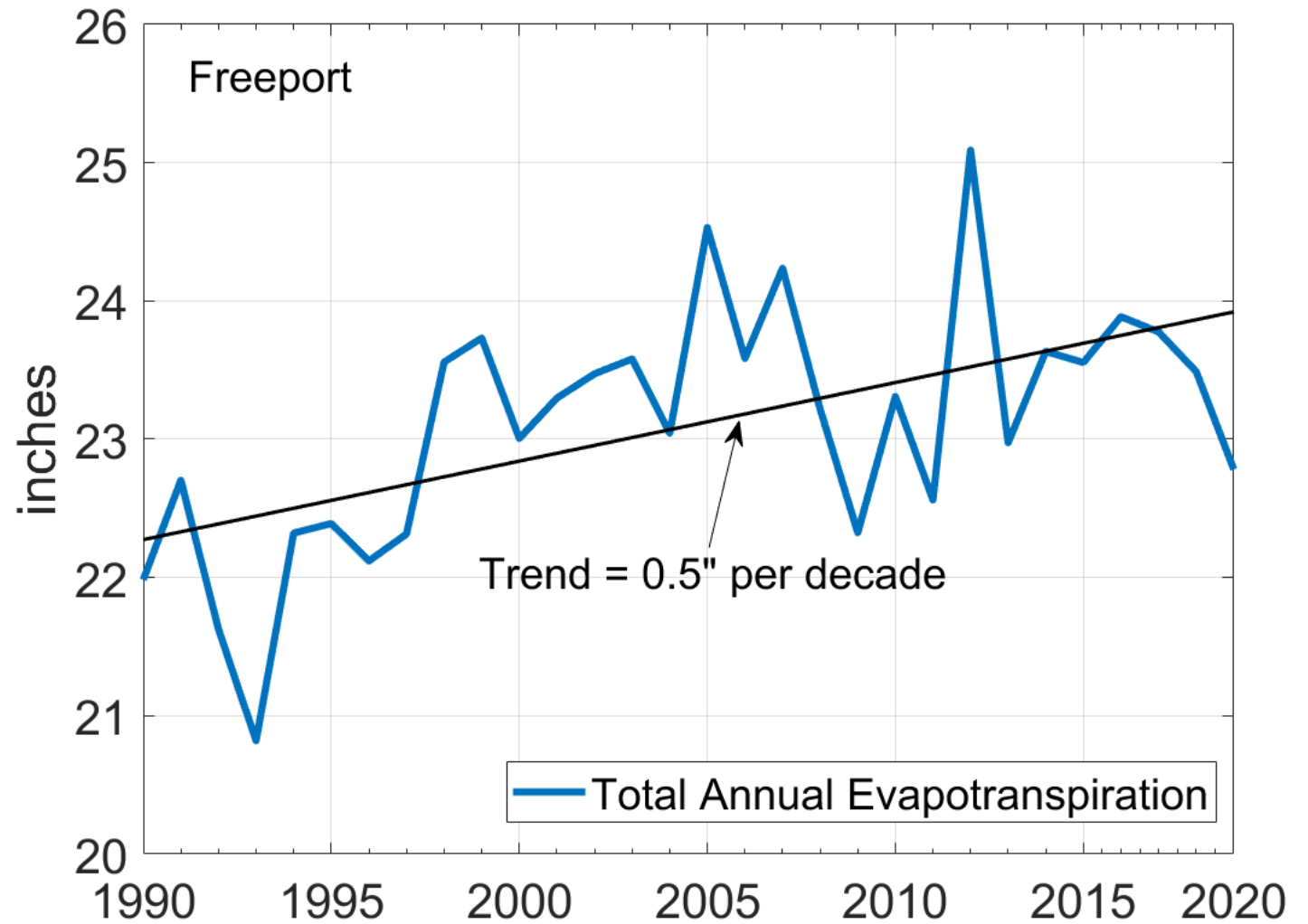
Trends (1895 – 2019)	Winter	Spring	Summer	Fall
Mean (°F dec ⁻¹)	+0.19	+0.22	+0.06	+0.13
Max (°F dec ⁻¹)	+0.17	+0.21	-0.10	+0.10
Min (°F dec ⁻¹)	+0.22	+0.23	+0.20	+0.16

Source: NOAA NCEI



Observed Changes in Evaporative Demand

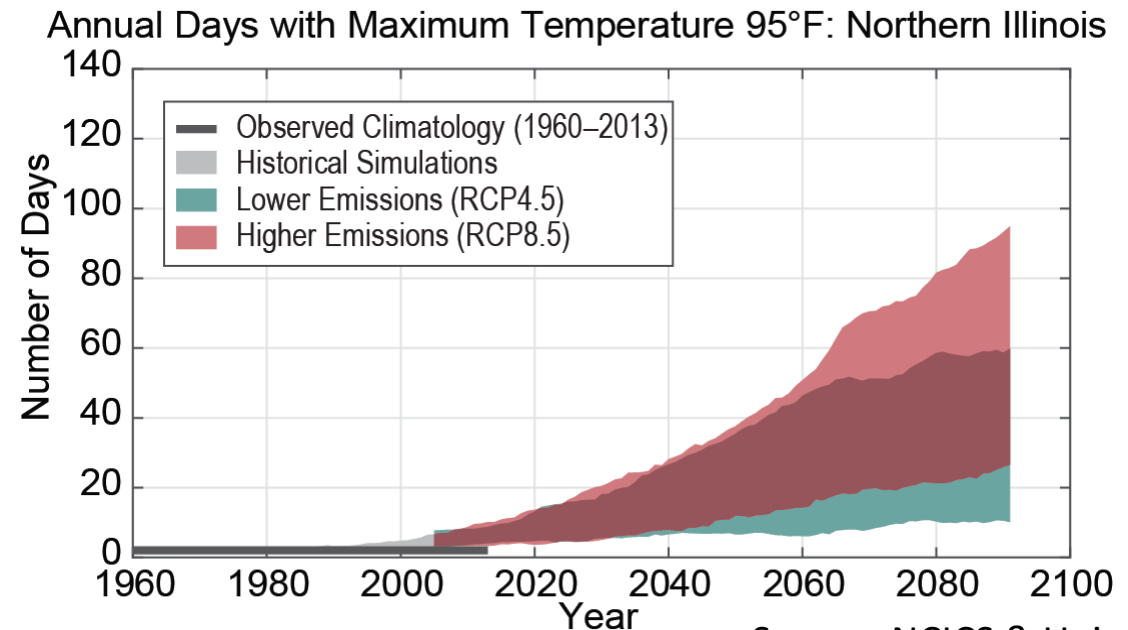
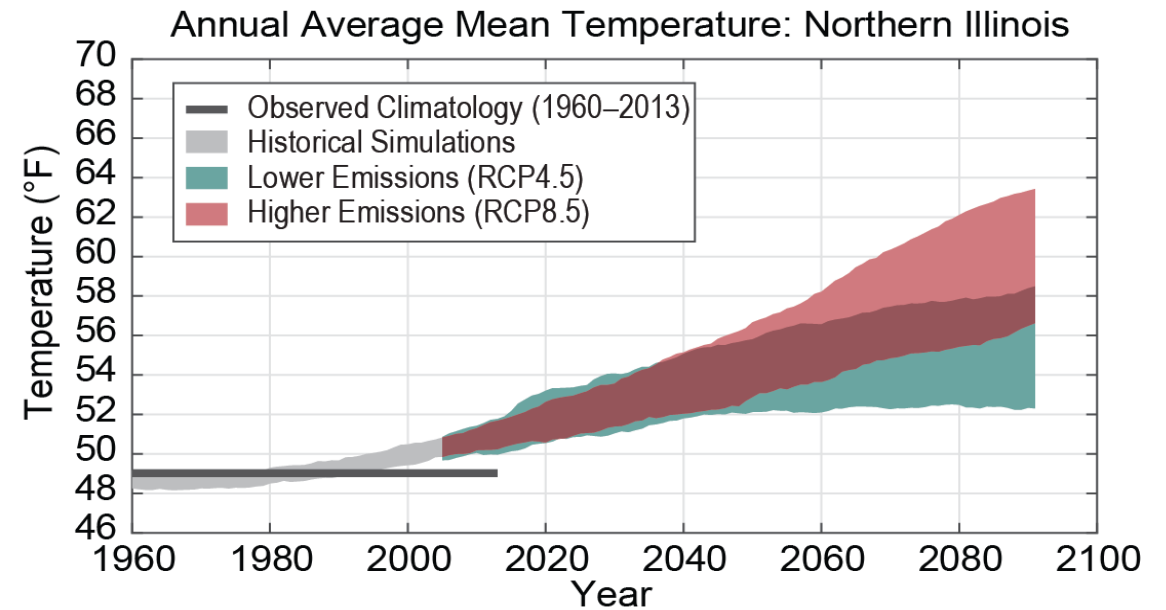
- Increased temperatures lead to more evaporation: 0.5" per decade since 1990
- Largest trends are July – September



Temperature – Projected Changes

Recent Changes

- Summer maximum temperature has increased in recent decades
- Projections indicate continued increases in all seasons' temperature
- Increase in annual frequency of very hot days (> 95°F)
- Magnitude of change is very dependent on emission scenario... fewer emissions = less warming

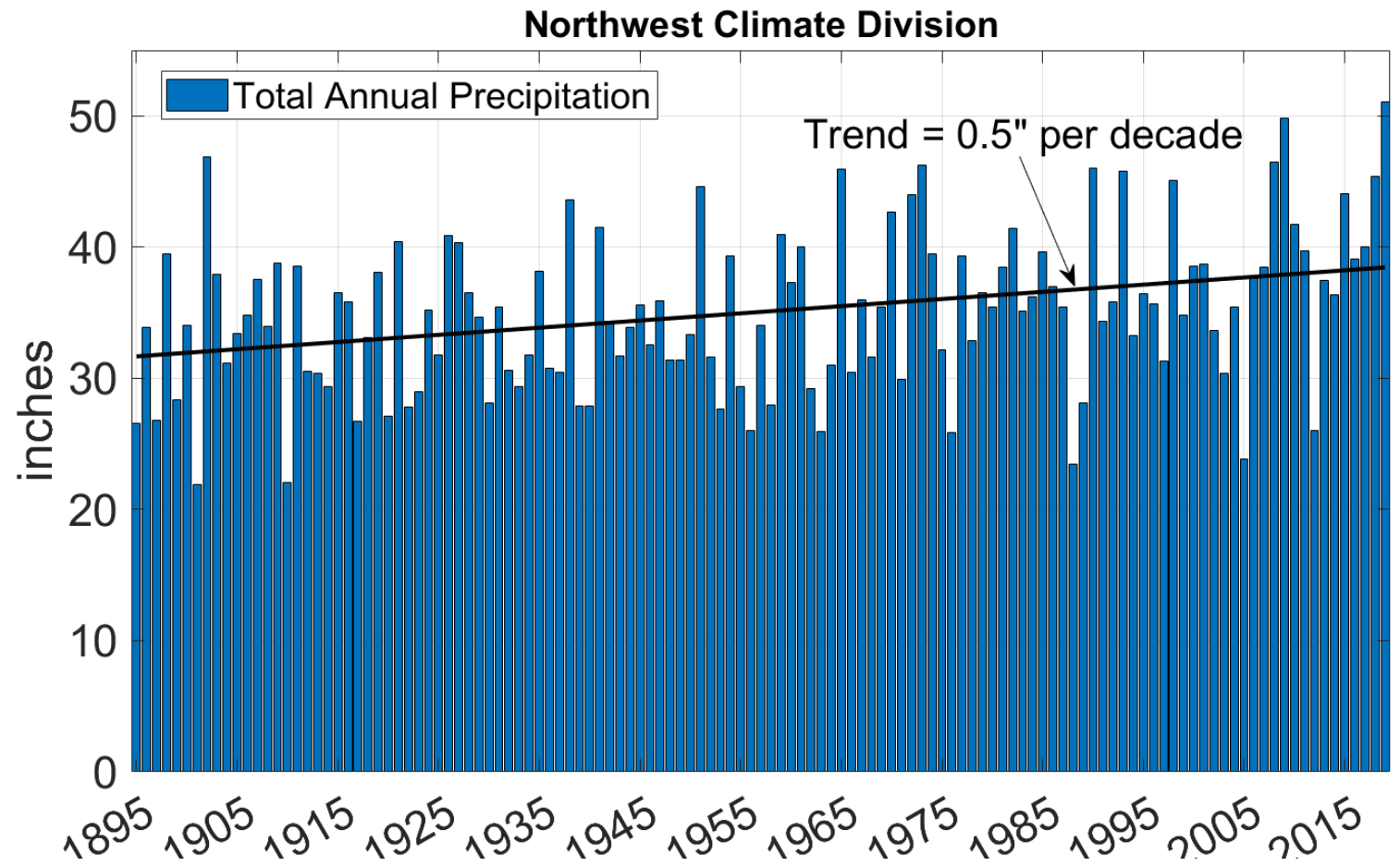


Source: NCICS & Univ. Edinburgh

Precipitation

Changes in Precipitation

- NW IL annual total precipitation has increased 0.54" per decade between 1895 and 2019
- 2019 was the first year on record with > 50" of rain
- Summer trend is 3x that of winter and fall



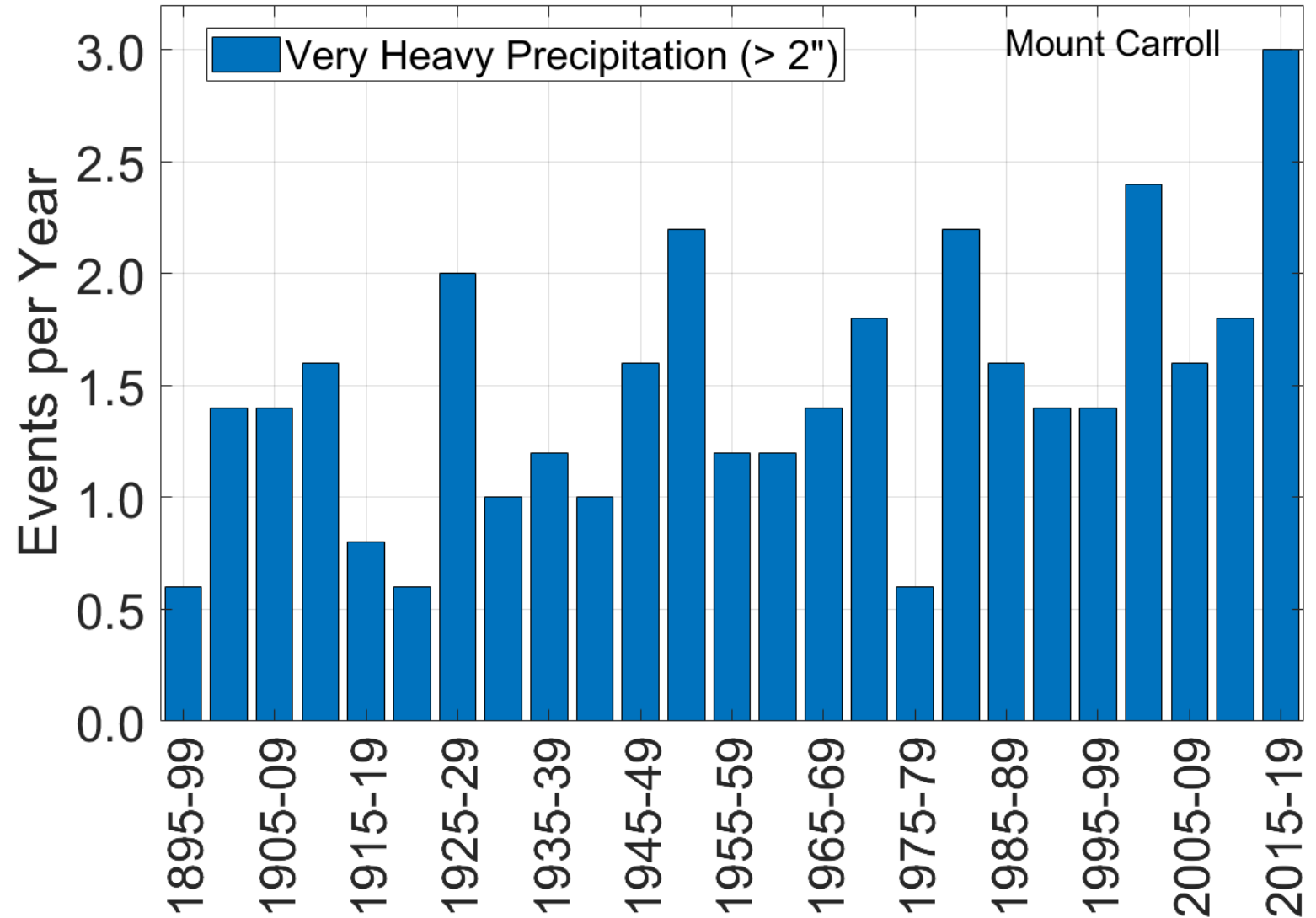
Precipitation Trends (1895 – 2019)	Winter	Spring	Summer	Fall
Northwest IL (inches per decade)	+0.08	+0.15	+0.24	+0.08

Source: NOAA NCEI



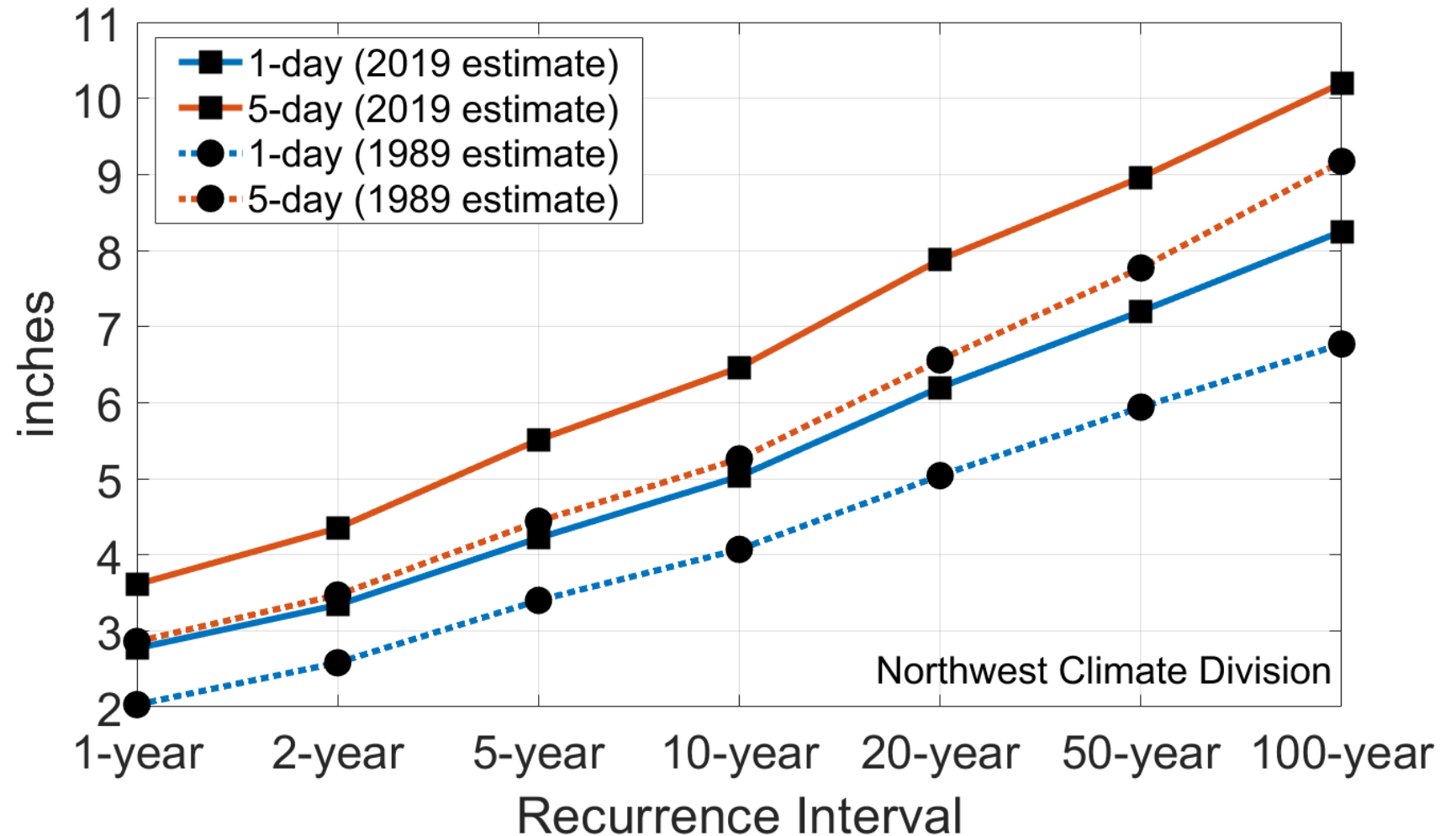
Changes in Precipitation Intensity

- Increased total precipitation & increased frequency of very heavy precipitation
- Last 5 years Mount Carroll has averaged three 2"+ rain events per year
- 2019 was the first year since 2008 with 0 very heavy precipitation events



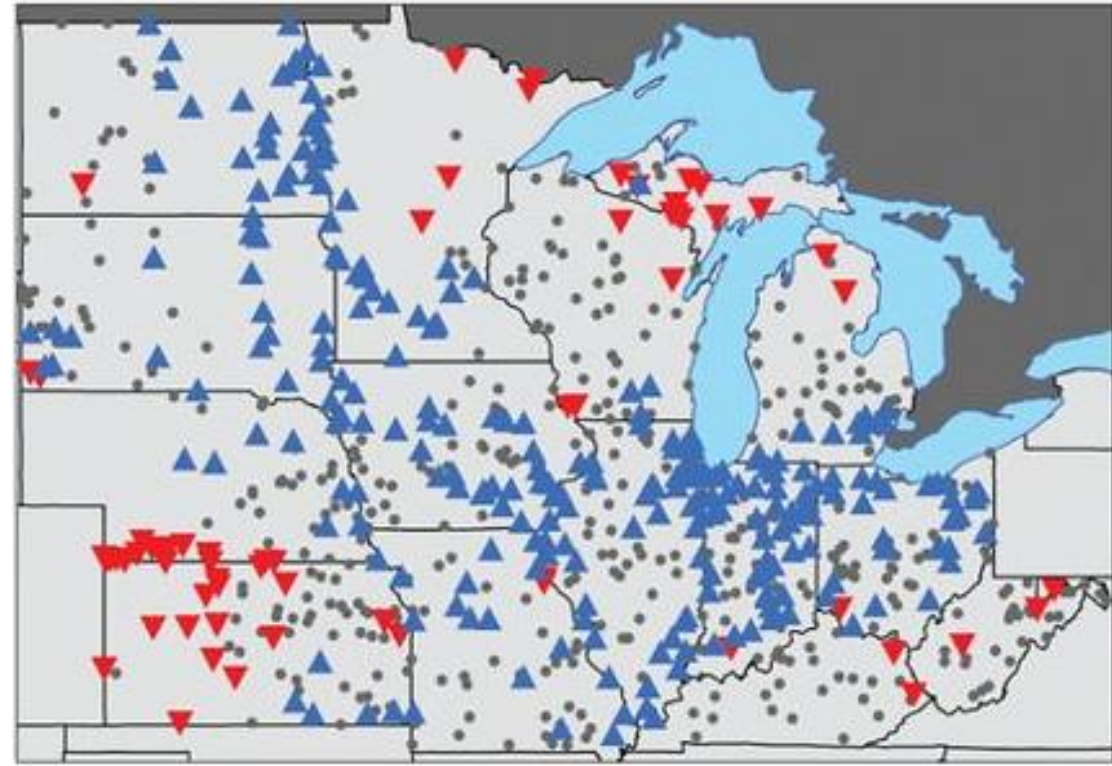
Changes in Precipitation Intensity

- 1- and 5-day storm totals have increased at all recurrence intervals since 1989



Changes in Precipitation Intensity

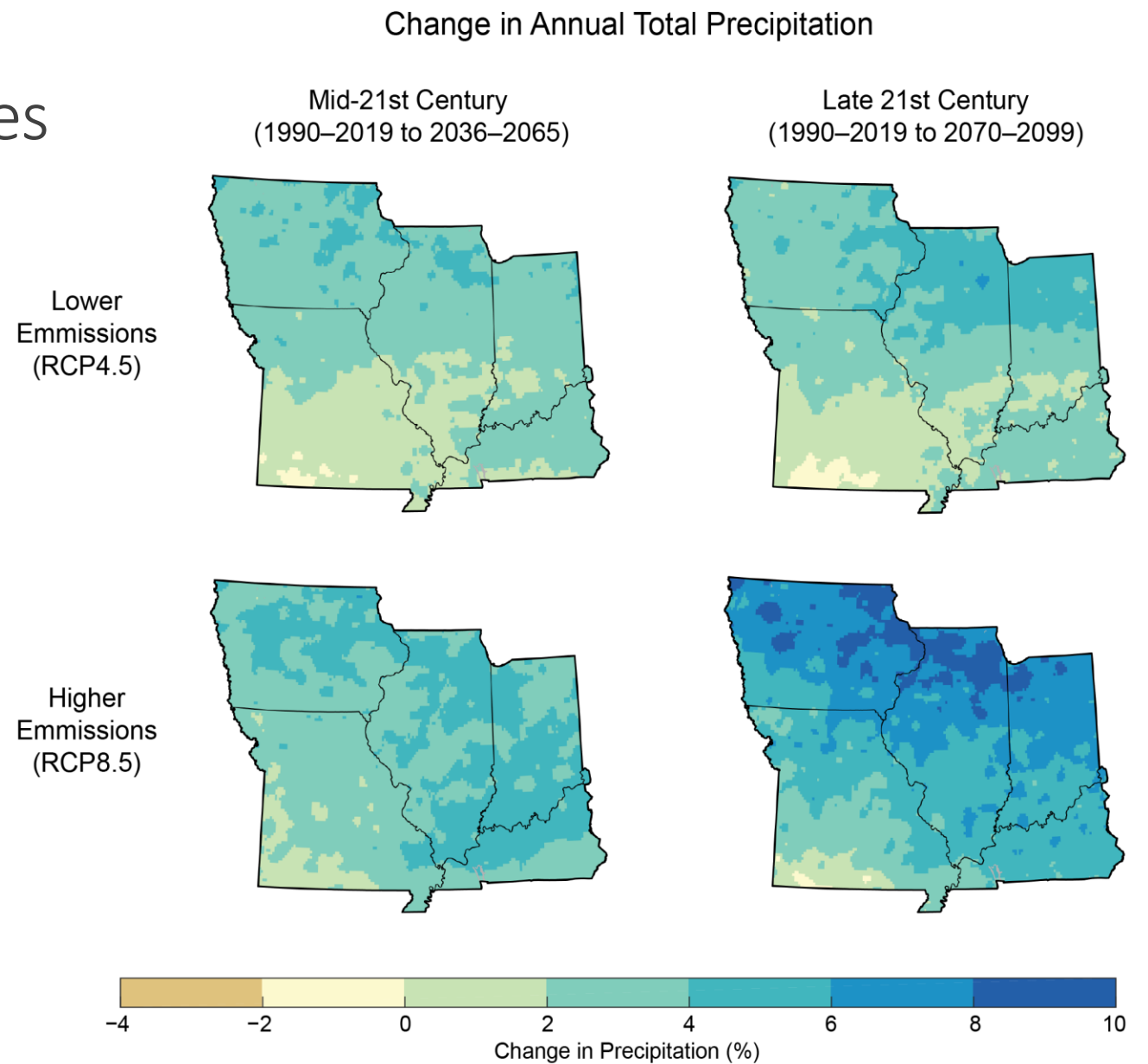
- More intense precipitation increases runoff ratio, nutrient runoff
- More precipitation partitioned to streamflow
- Less precipitation “yielded” for surface storage, could increase likelihood of drought later on



Observed trends in flooding across the Midwest Mallakpour & Villarini (2015)

Precipitation – Projected Changes

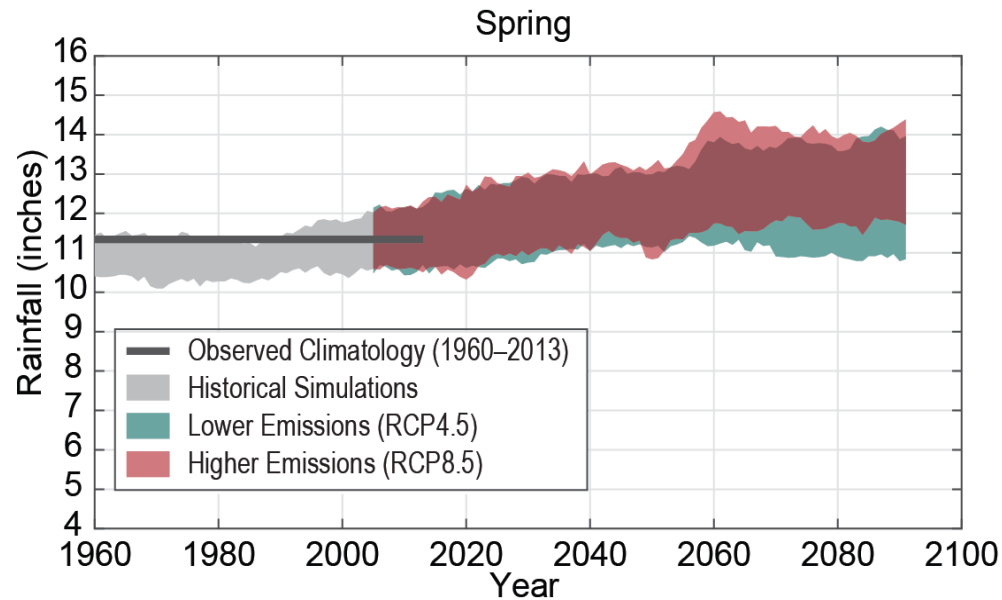
- Projections show continued increased precipitation and intensity, largest changes are projected in northern IL



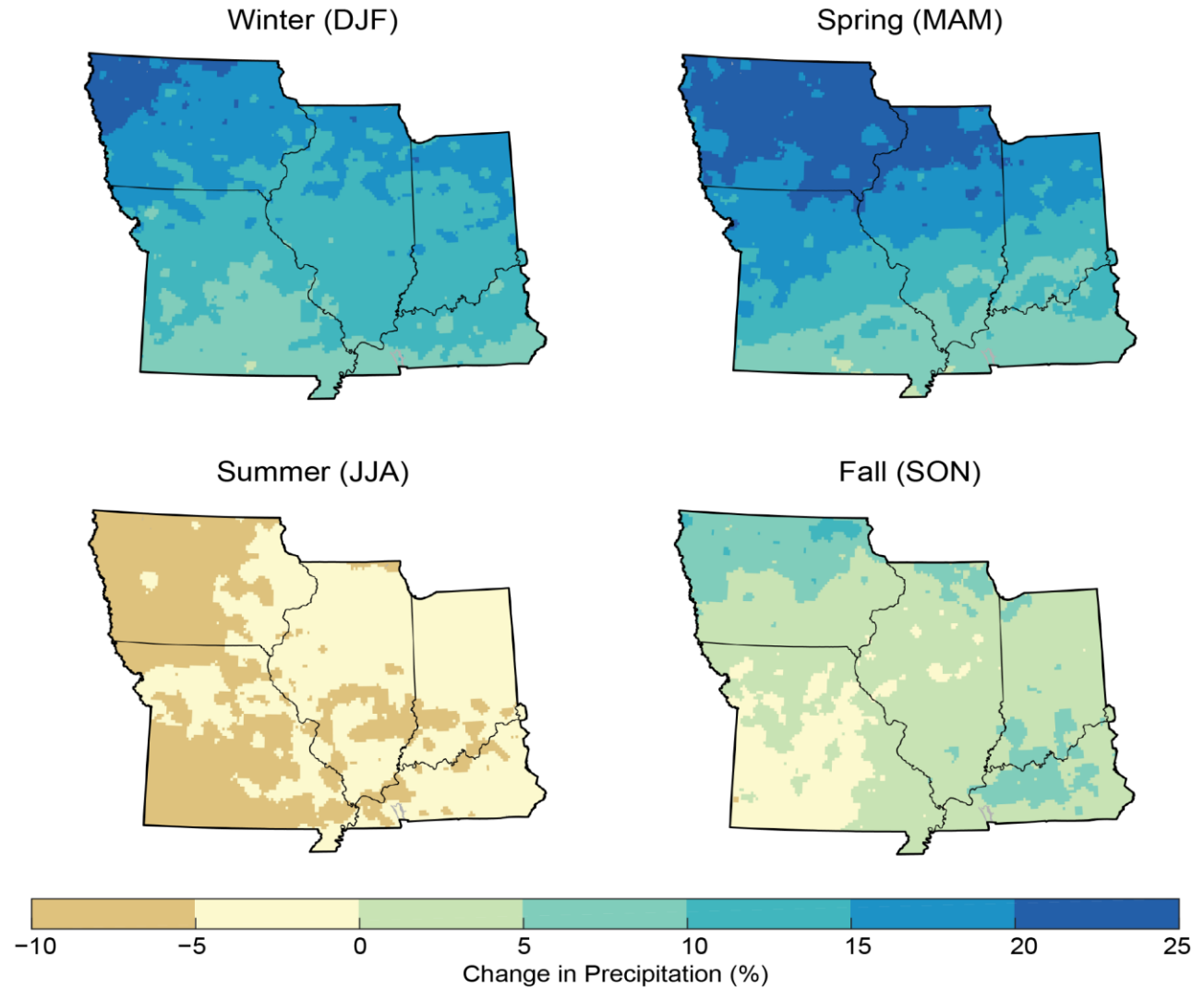
Source: NCICS & Univ. Edinburgh

Precipitation – Projected Changes

- Projections show continued increased precipitation and intensity, largest changes are projected in northern IL
- Unlike temperature, projections show large seasonal differences in future precipitation
- Wetter Winter/Spring – Drier Summer



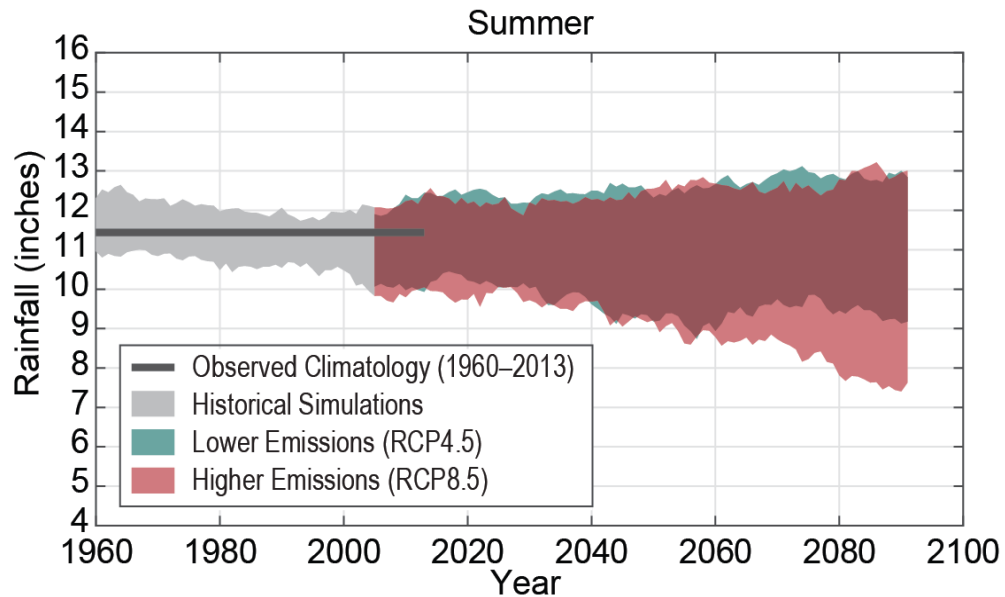
Change in Seasonal Total Precipitation
Higher Emissions (RCP8.5)
Late 21st Century (1990–2019 to 2070–2099)



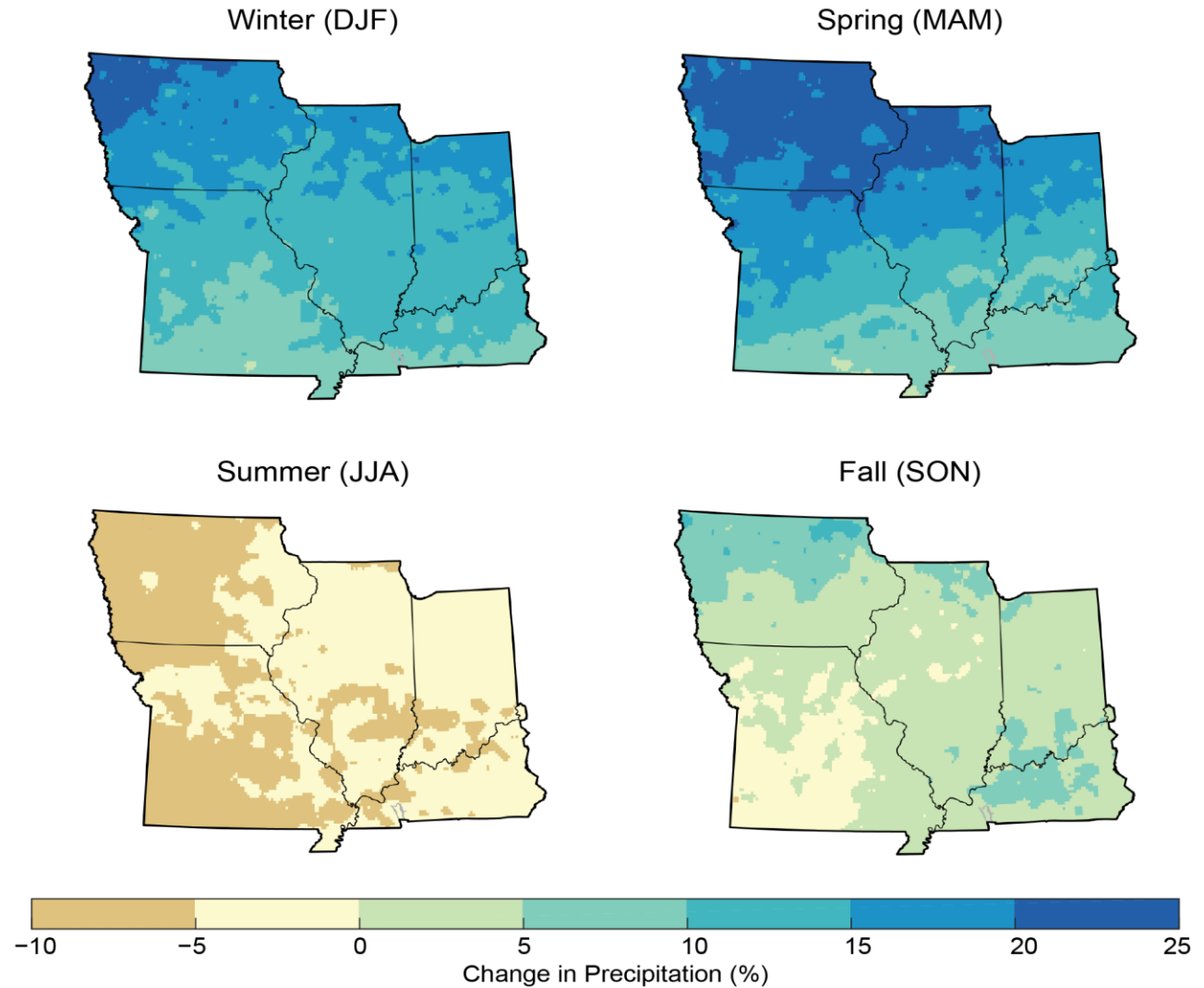
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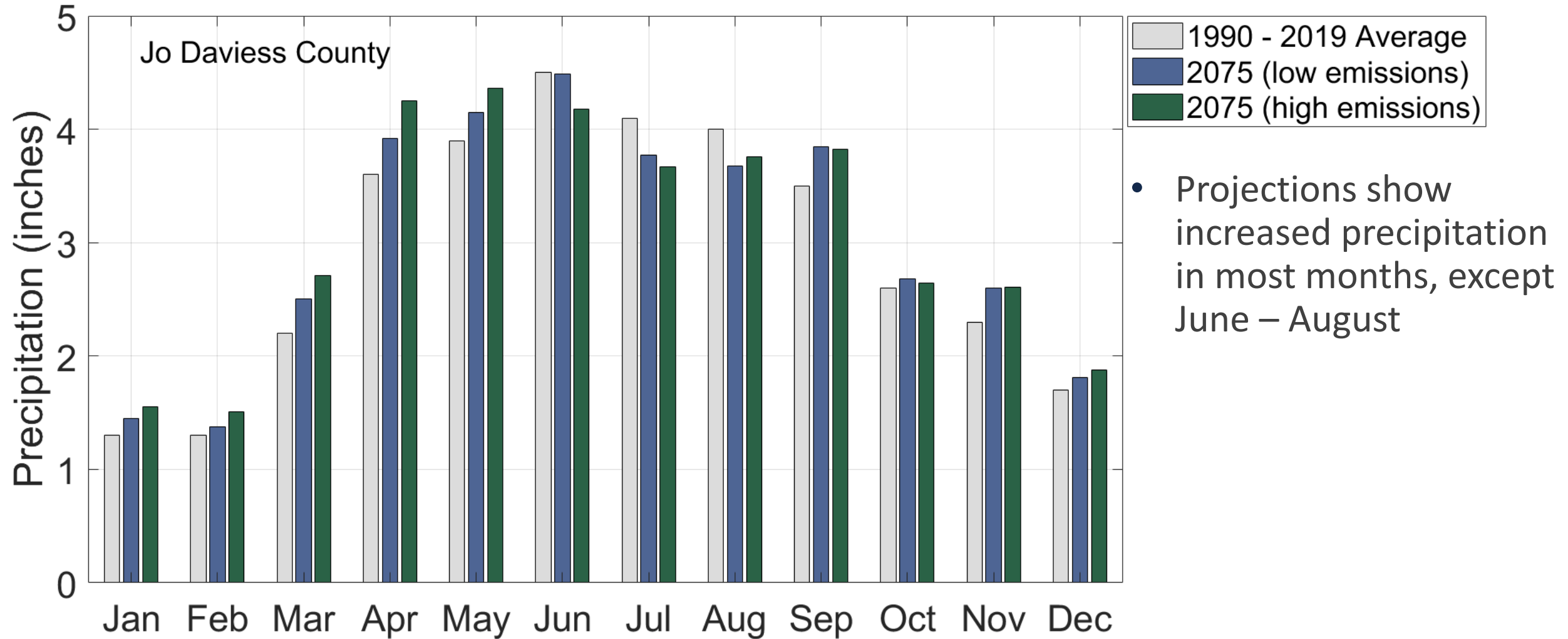


Change in Seasonal Total Precipitation
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Precipitation – Projected Future Changes

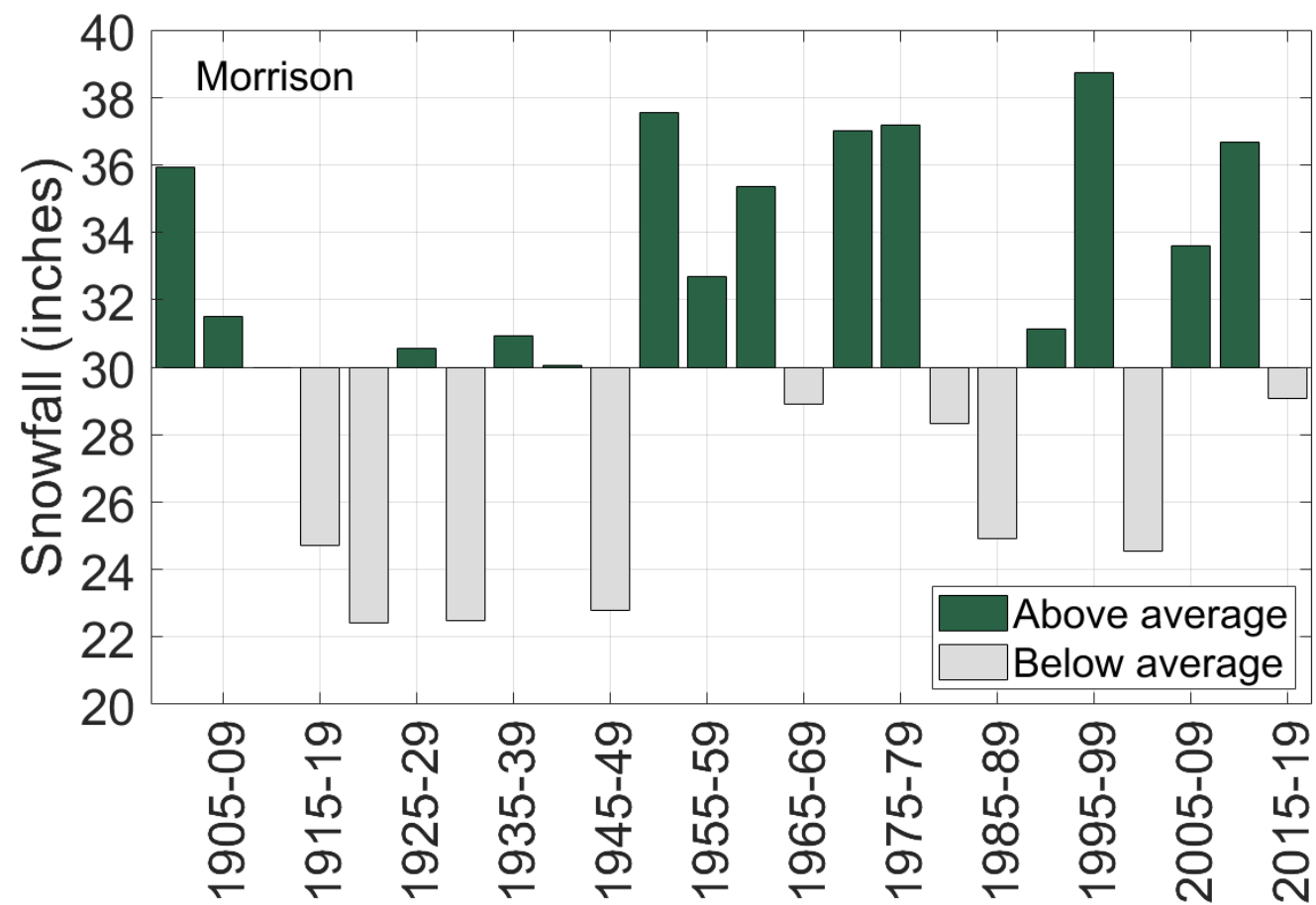
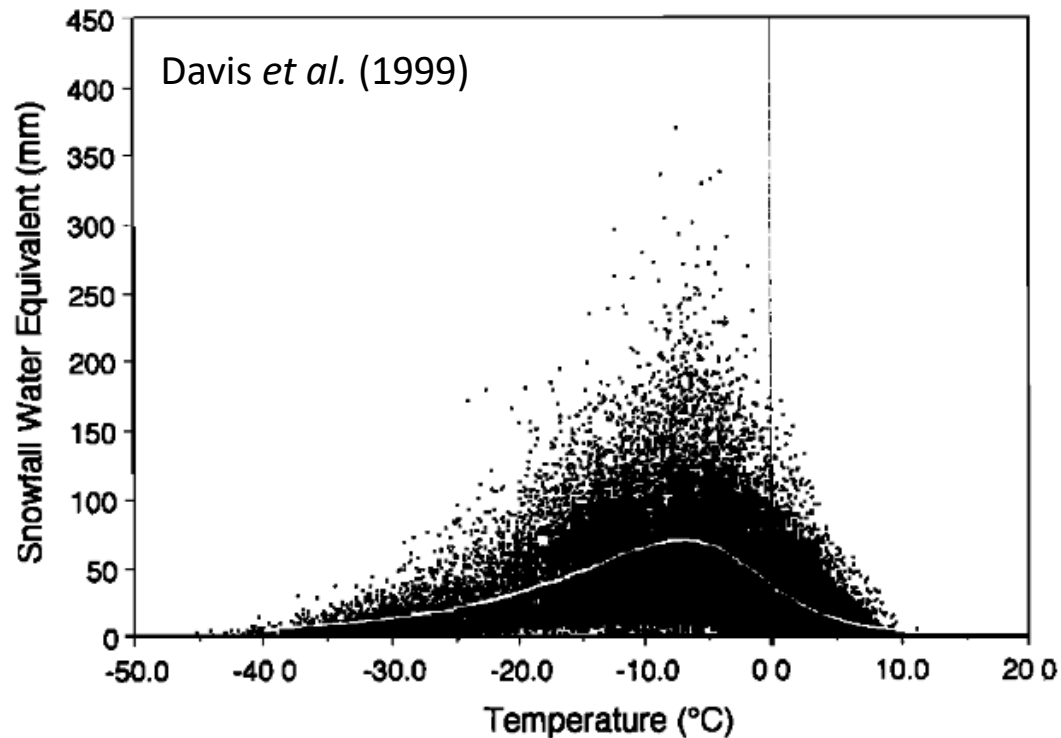


Historical observations and future projections of monthly precipitation totals from Jo Daviess County. (Source: U.S. Climate Resilience Toolkit)



Changes in Snowfall

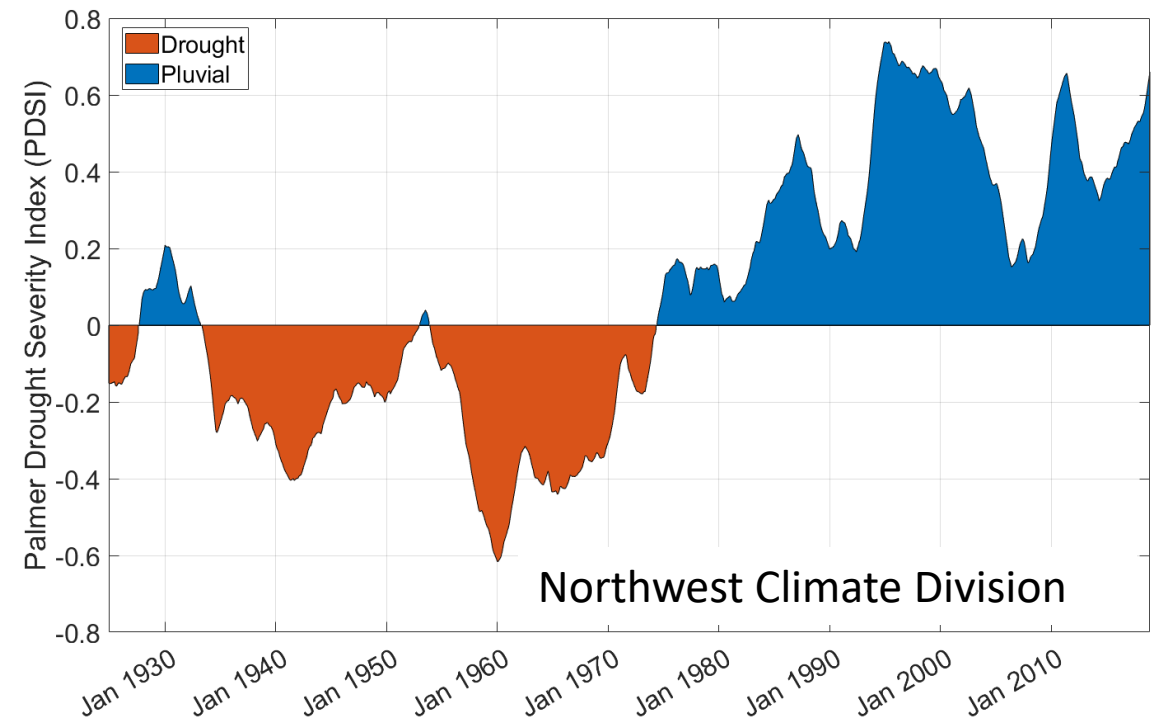
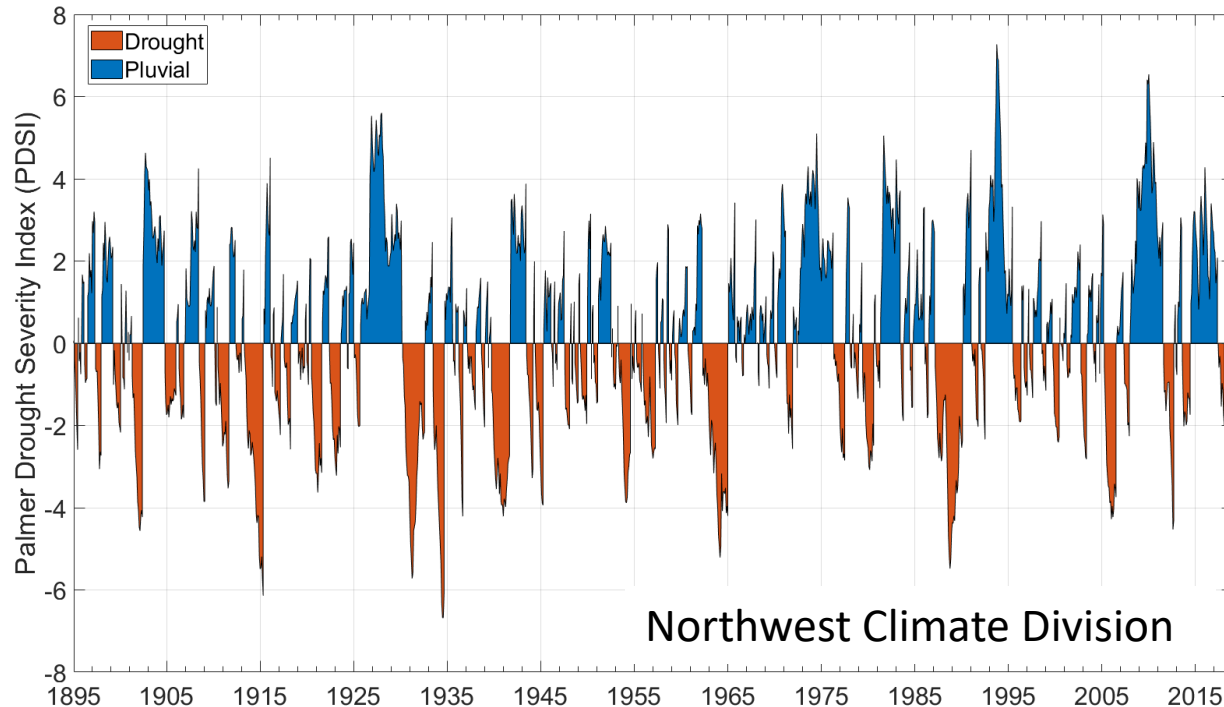
- Winter warming has caused a decrease in seasonal snowfall across the southern Midwest
- Snowfall changes in this region are more complicated, dominated by variability



- Projections show decreased snowfall, but with high uncertainty

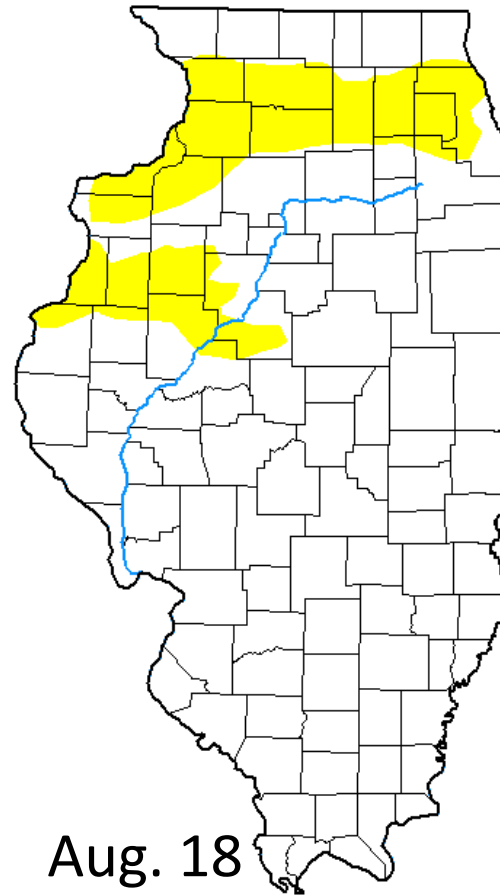
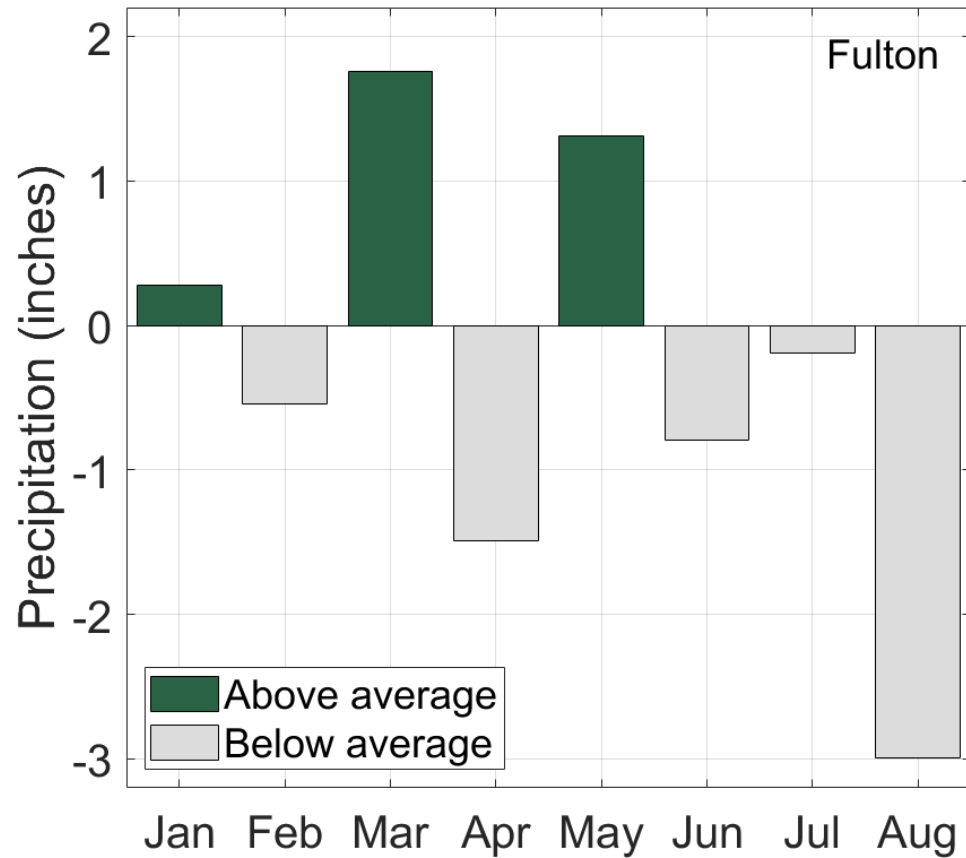
Drought – Observed Recent Changes

- The complexity of drought also complicates its measure and projection
- Using the Palmer Drought Severity Index, “extreme drought” reached in Illinois only 7 times since 1895... only twice since 1965
- The last 30 years are wetter than any 30-year period on record, back to the late 1800s
- Large, multi-year droughts are not happening as frequently

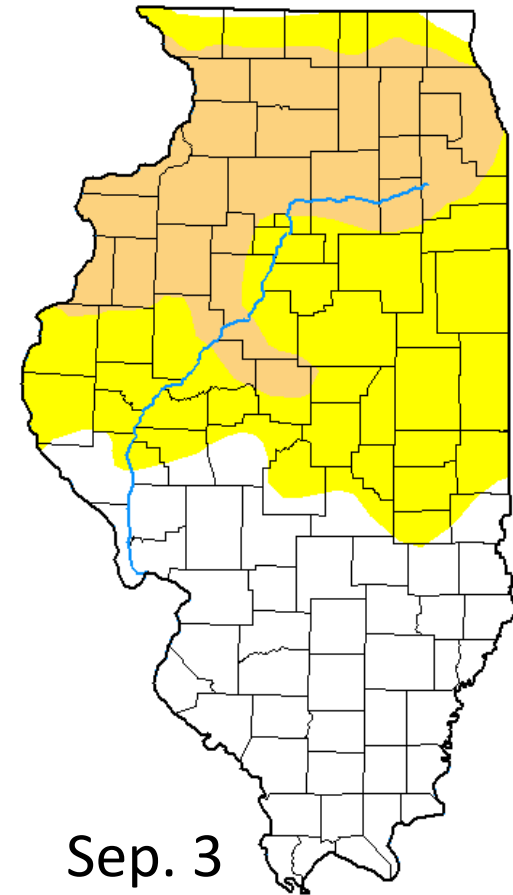


Drought – Observed/Projected Recent Changes

- Projections show more frequent “swings” from wet to dry extremes, particularly moving from wet spring to dry summer/fall
- Short term dryness with little impact on municipal water supply, but large agricultural and ecological impact



Aug. 18



Sep. 3

Summary

- Climate change – present and future – poses a significant issue for water management in NW Illinois
- Over the past 30 years...
 - Increased precipitation – and precipitation intensity have caused considerable soil erosion, runoff, flooding issues
 - Increased evaporation driven by higher temperatures has been more than offset by additional precipitation, but enhanced evaporation *during* dry spell could intensify dryness
 - Wettest period on record in this region, fewer long-term droughts
- Future climate projections show **very high confidence** that temperatures will continue to increase in Illinois, impacting:
 - Evaporation – exacerbating dry conditions during drought
 - Snowfall – less snow, more winter rain
 - Increased extreme heat
- It is **highly likely** that as temperatures increase, precipitation will continue to increase in the spring:
 - Continued, worsening flooding issues
 - Soil erosion and nutrient runoff

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