

Climate Change Impacts

TRENT FORD

ILLINOIS STATE CLIMATOLOGIST

ILLINOIS STATE WATER SURVEY/PRAIRIE RESEARCH INSTITUTE

UNIVERSITY OF ILLINOIS, URBANA-CHAMPAIGN



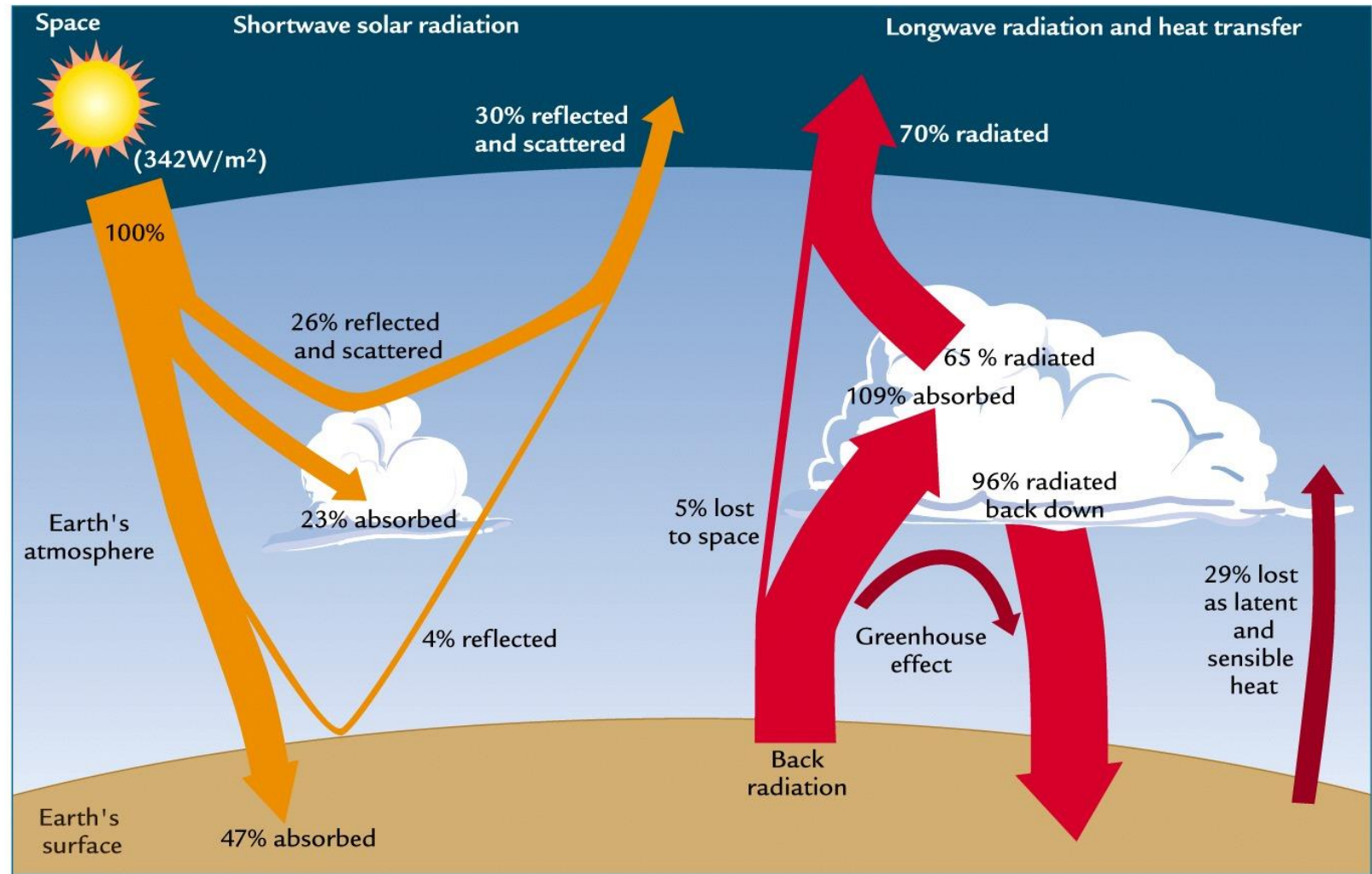
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Illinois State Water Survey

PRAIRIE RESEARCH INSTITUTE

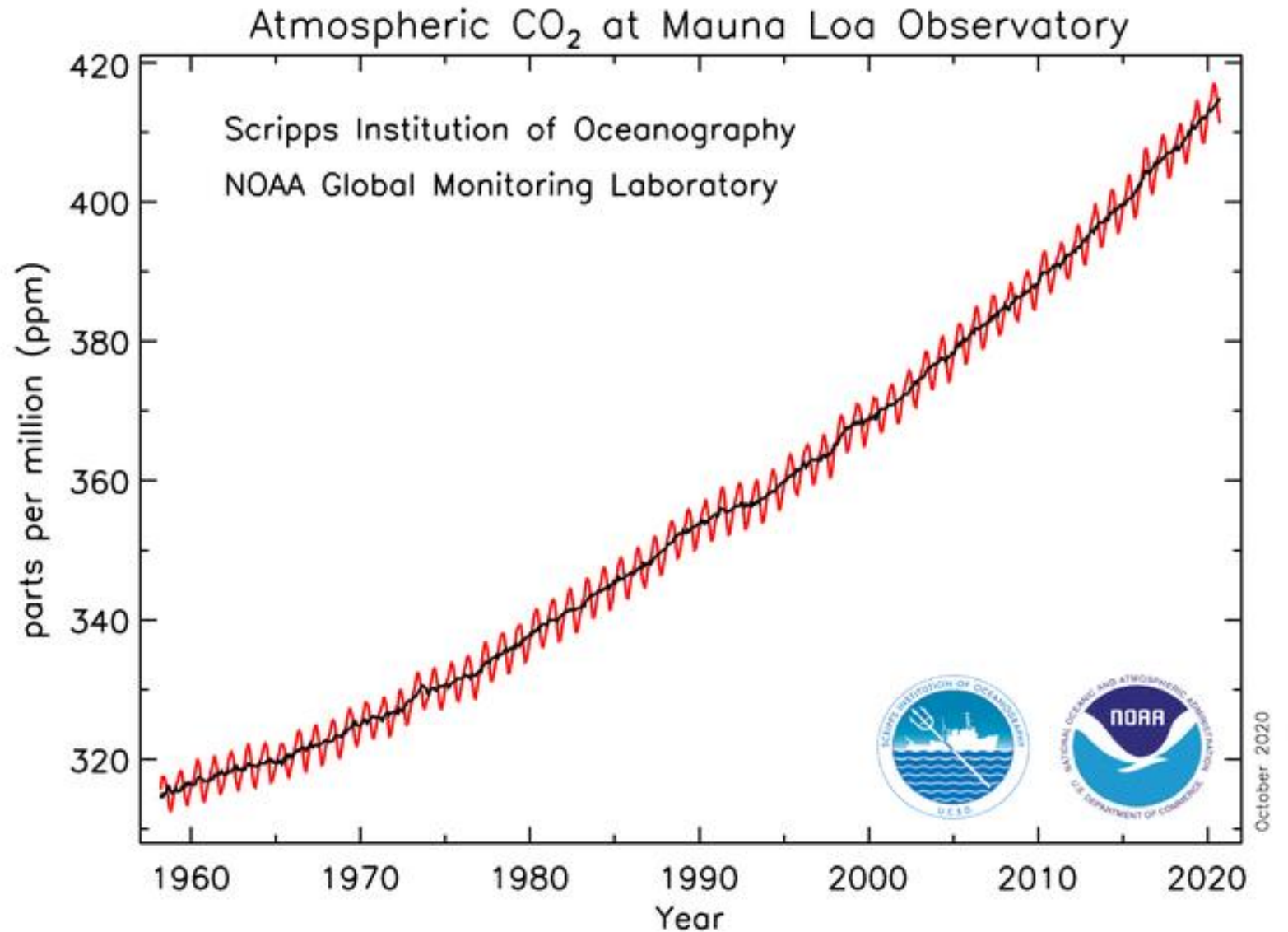
The Earth's greenhouse effect

- Certain gases in the atmosphere permit solar radiation to enter the system, but absorb outgoing terrestrial radiation
- The concentration of these gases, namely CO₂, CH₄, H₂O, varies in time due to natural and anthropogenic causes
- Causes initial **radiative forcing**



The Earth's greenhouse effect

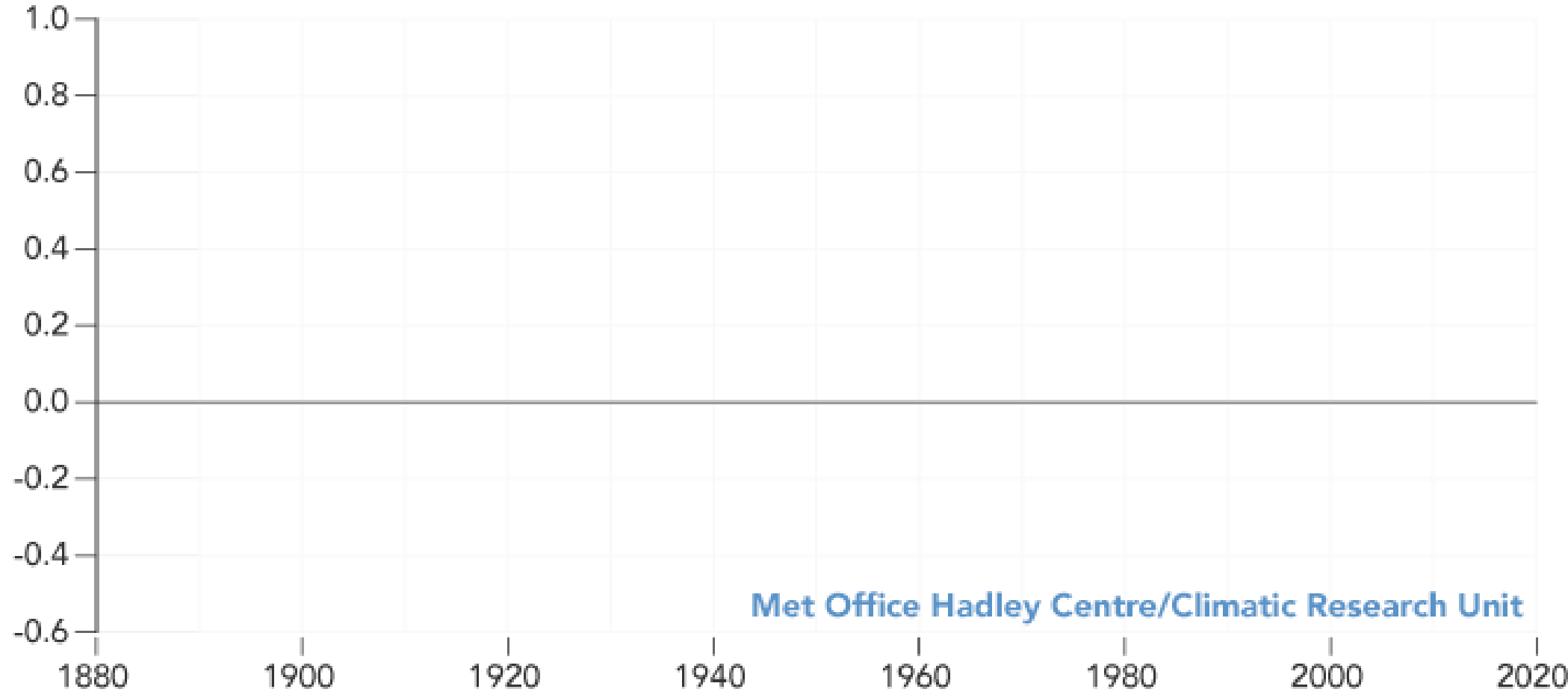
- We have observed a consistent increase in CO₂ concentrations over the last 60 years (since direct observations)
- December 2020: 414 ppm



Global Warming

Source: NASA Earth Observatory

A World of Agreement: Temperatures are Rising
Global Temperature Anomaly (relative to 1951-1980, °C)



Met Office Hadley Centre/Climatic Research Unit



Temperature Changes

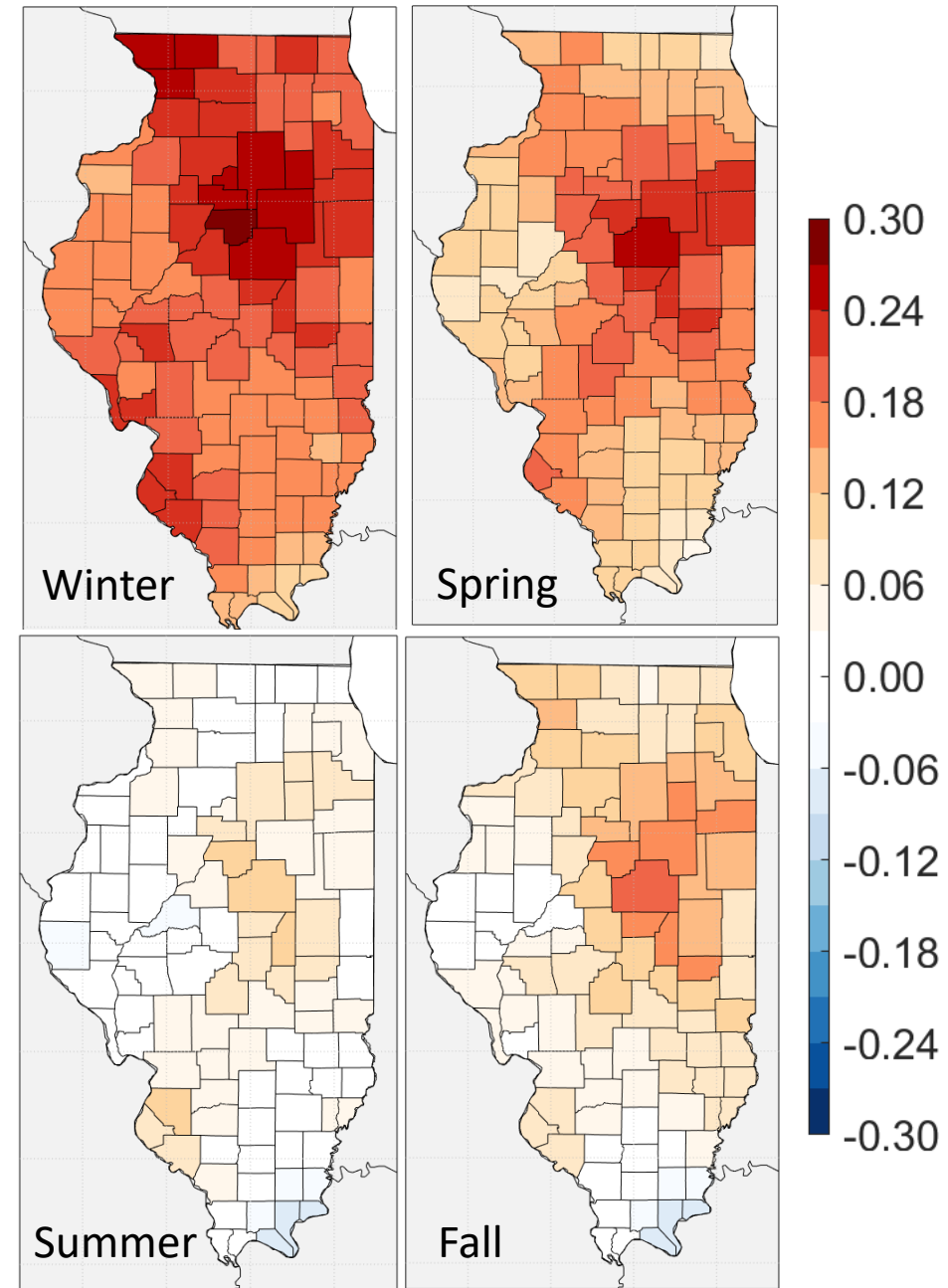
Temperature – Observed Changes

Last 120 Years:

- Statewide annual average temperature has increased by 0.10°F per decade between 1895 and 2020
- Warming trends in winter & spring are much larger than summer & fall
- Largest change in daily minimum temperatures

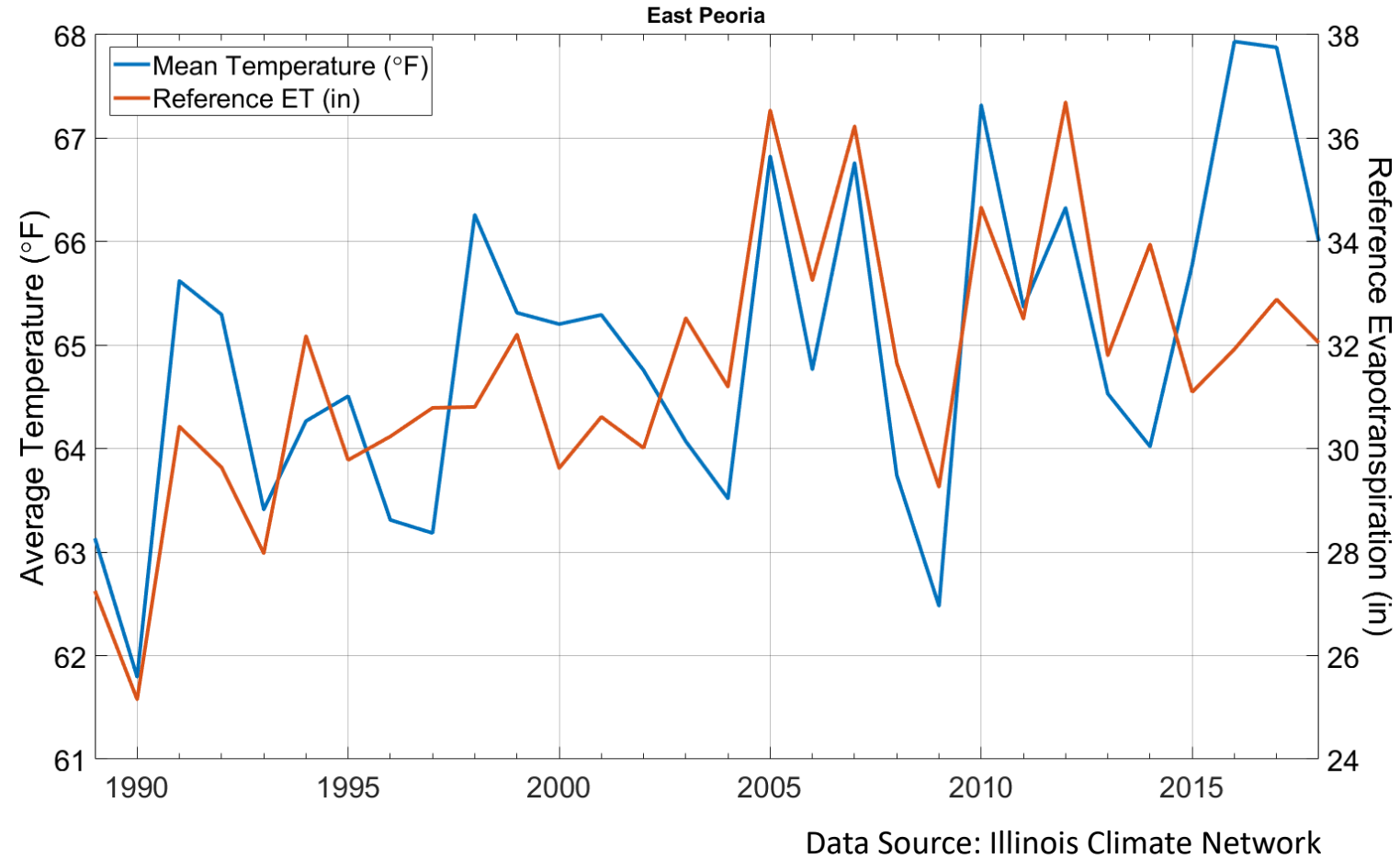
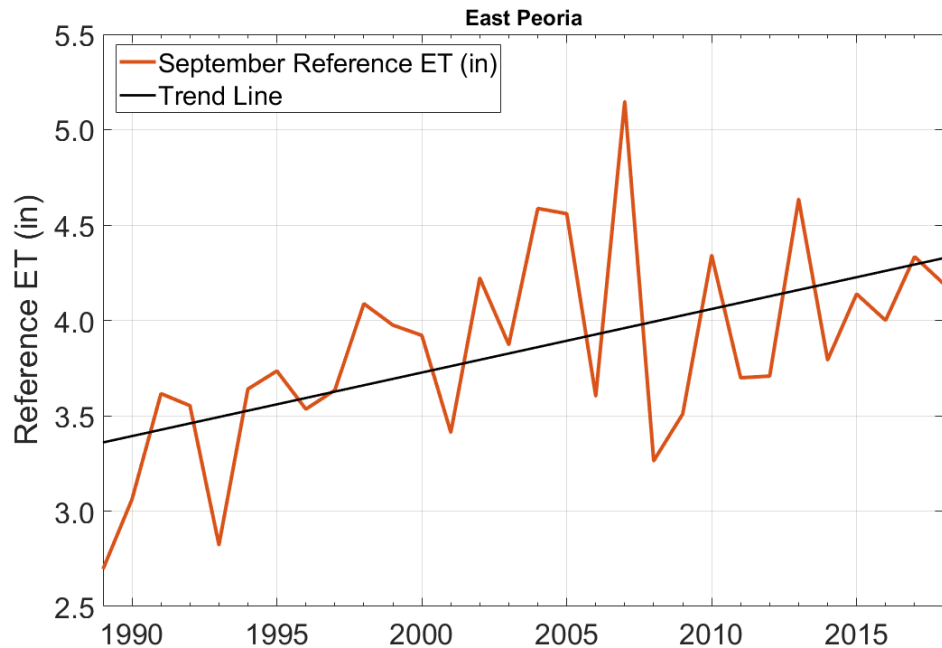
Trends (1895 – 2020)	Winter	Spring	Summer	Fall
Mean (°F dec ⁻¹)	+0.19	+0.22	+0.06	+0.13
Max (°F dec ⁻¹)	+0.17	+0.21	-0.10	+0.10
Min (°F dec ⁻¹)	+0.22	+0.23	+0.20	+0.16

Source: NOAA NCEI



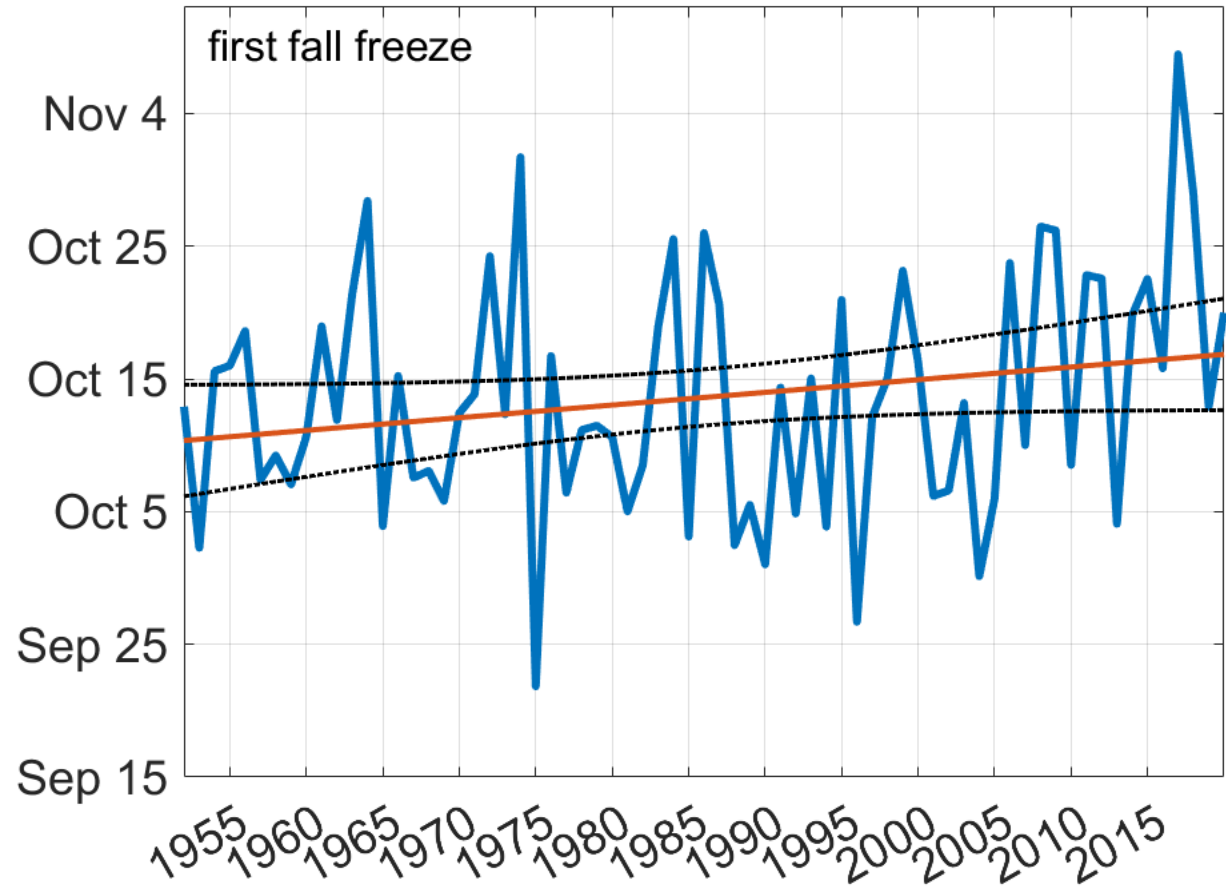
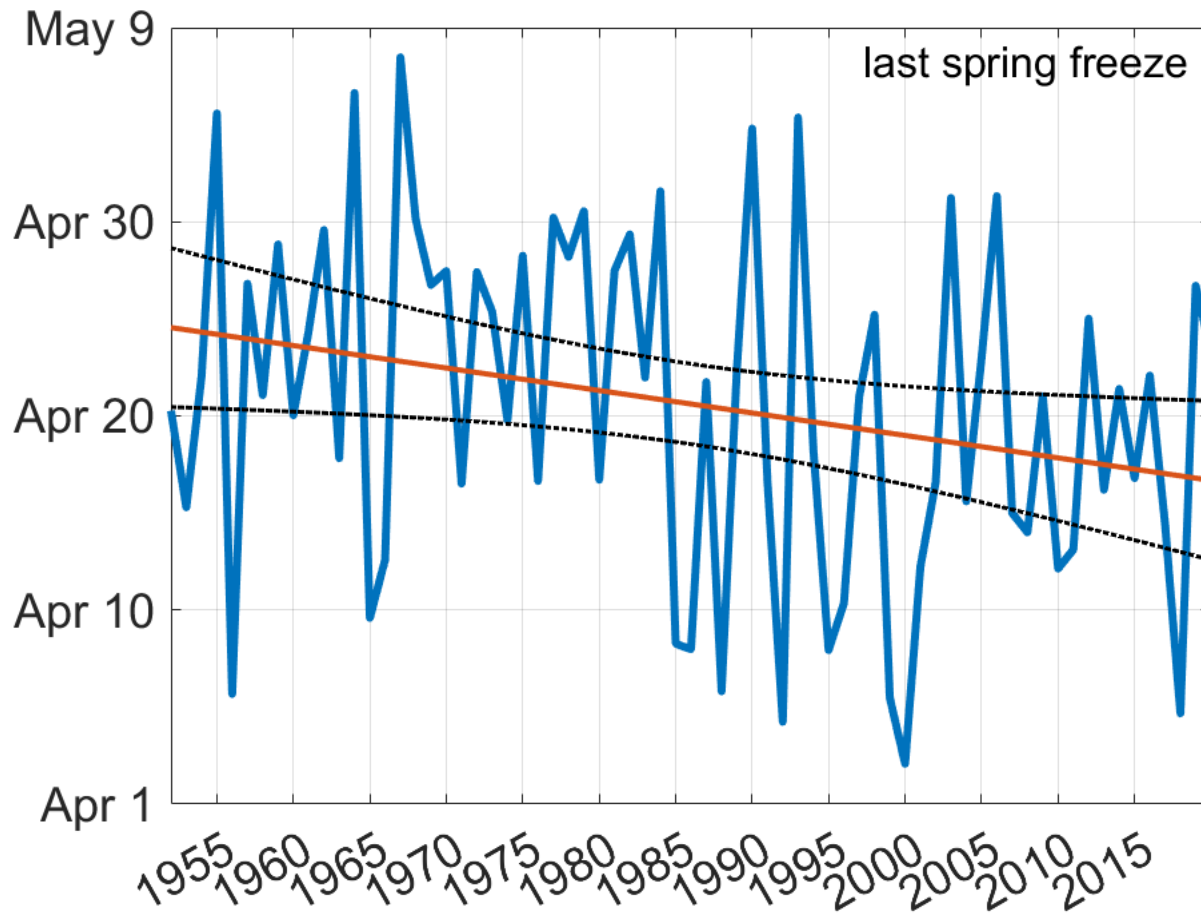
Observed Changes in Evaporative Demand

- Increased temperatures lead to increased evaporative demand, evaporation: 0.18" per year since 1989
- Largest trends (% of normal monthly ET) are in September (0.8% per year)



Temperature – Freeze Events

Source: NOAA NCEI



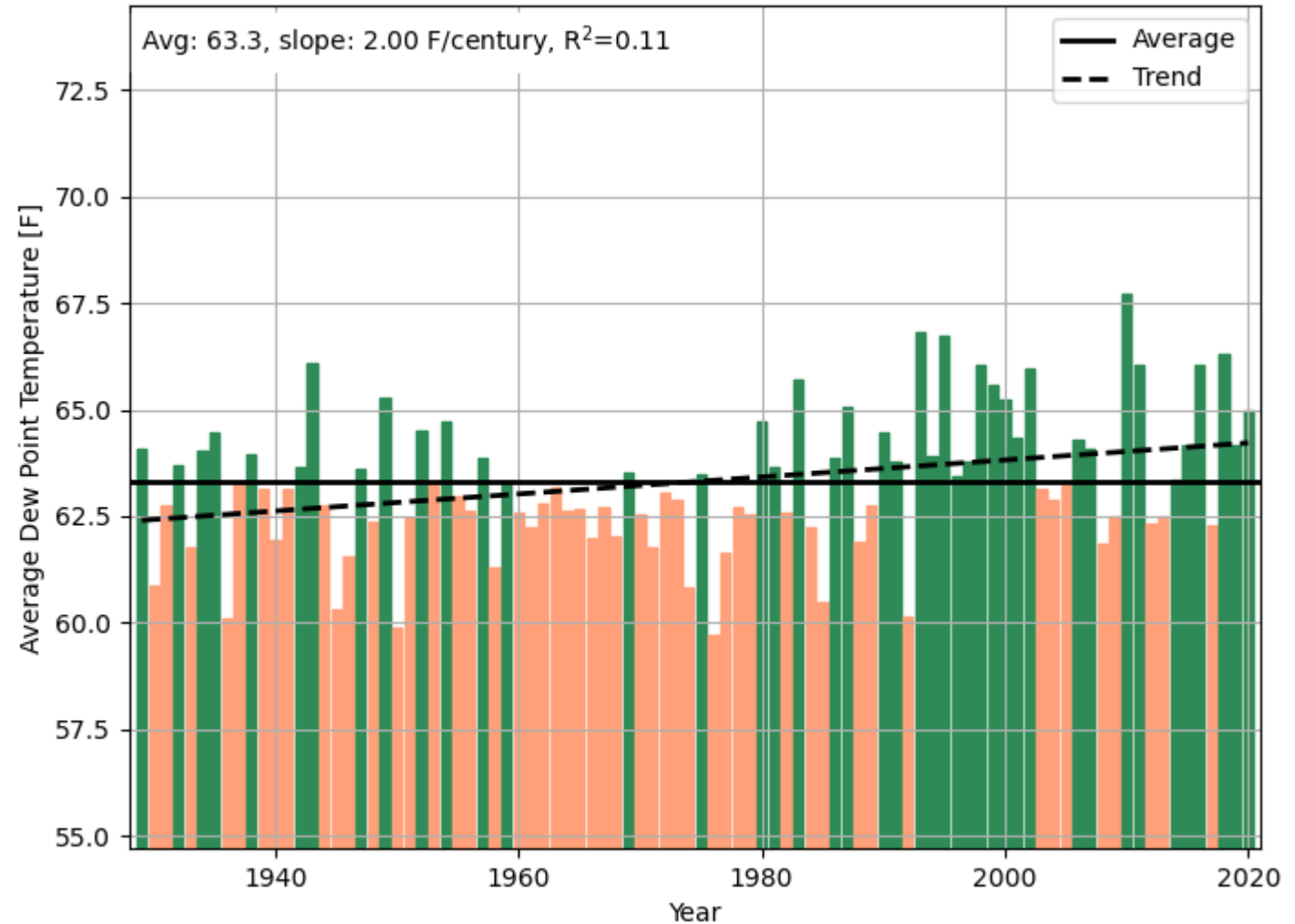
- Last spring freeze date is trending earlier
- First fall freeze date has weak trend (caused by 70s and 80s), but has been trending later in recent decades



Temperature – Humidity & Warm Nights

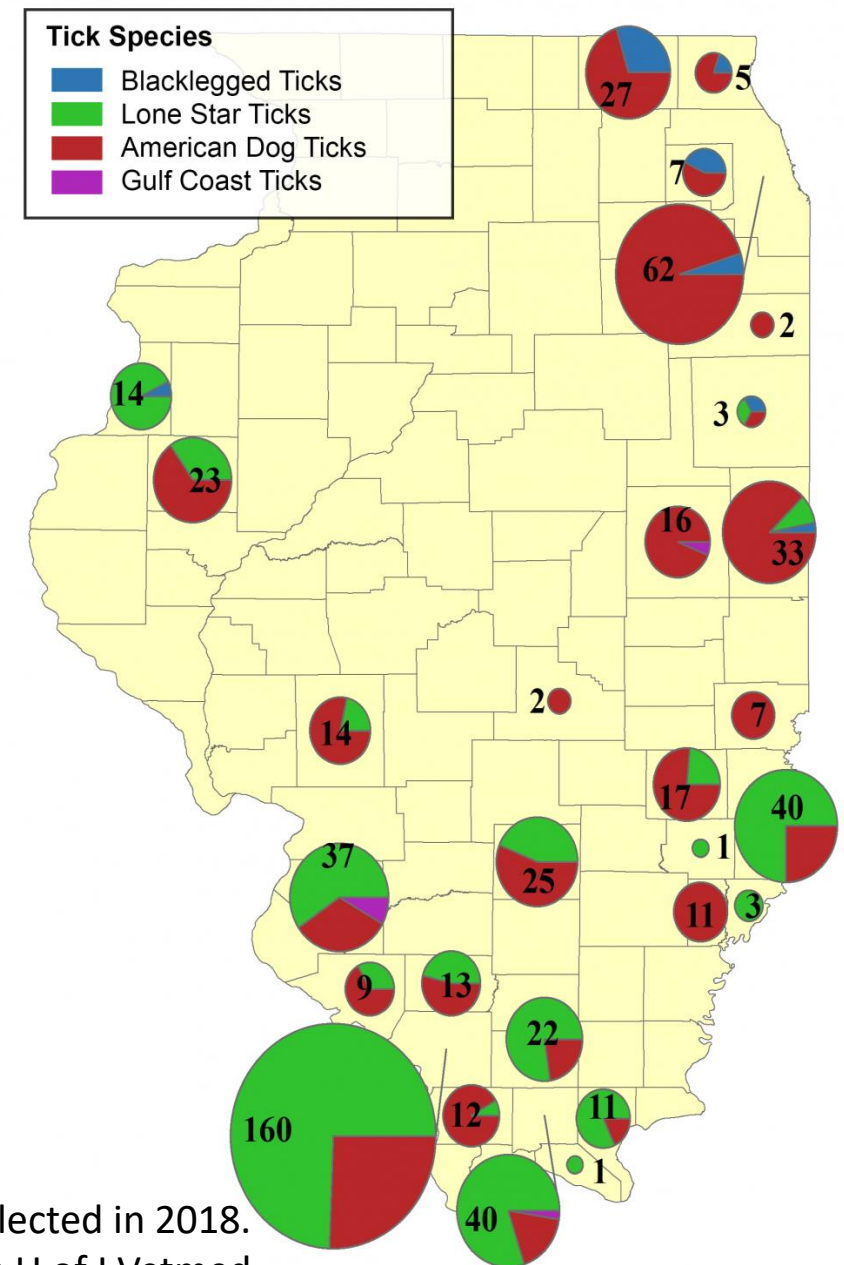
- Humidity has increased in all seasons except Fall, most in summer
- More very warm nights, fewer cool nights in spring and summer

Moline Summer Average Dewpoint Temperature



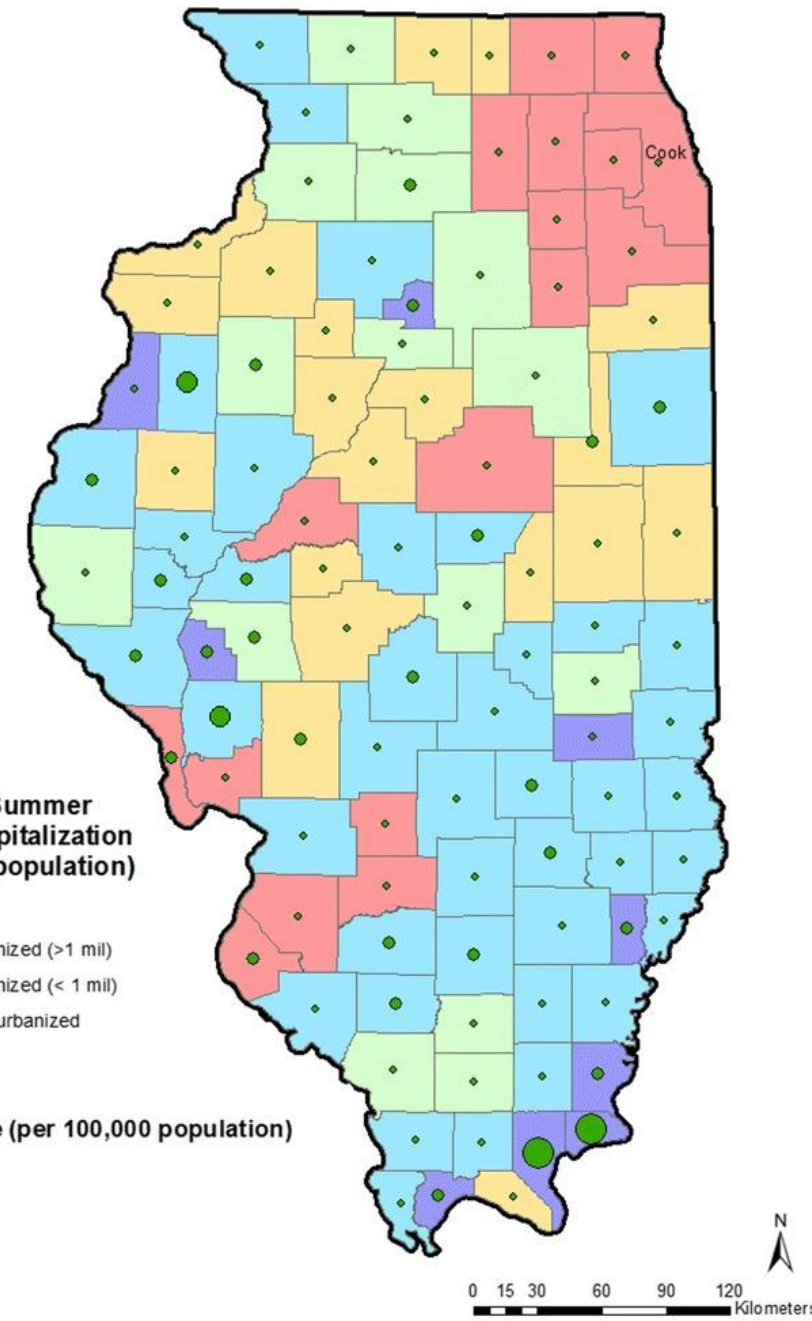
Climate Change Impacts – Health

- Increased temperatures have helped expand range of ticks and mosquitoes, leading to vector-borne disease
- Heartland disease – spread by Lone Star tick – was confirmed in Kankakee County for the first-time 2019
- Higher prevalence of Lyme Disease and West Nile in Chicagoland (related to short dry spells)
- Gulf Coast tick expanding northward into southern Illinois



Climate Change Impacts – Health

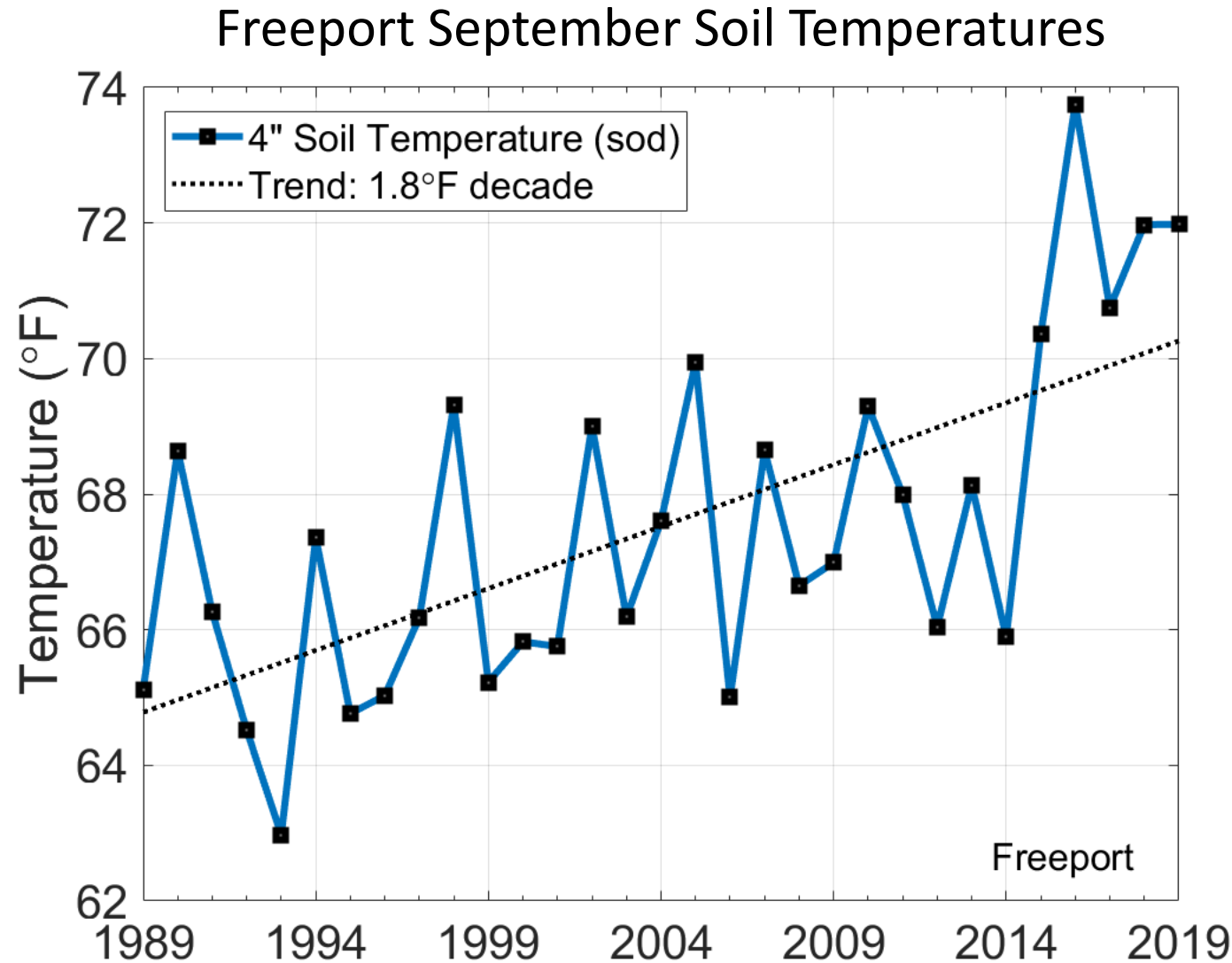
- Increasing temperatures results in higher risk of heat-related illness
- Research shows several rural counties have higher risk, rate of hospitalization, than urban counties in Illinois
- Increased extreme heat health issues among farm workers in Illinois



Source: BRACE, UIC:
<https://braceillinois.uic.edu/>

Soil Temperatures

- Soil temperatures exhibit similar trend as air temperature
- Largest soil temperature increase in late summer/early fall
- 4" soil temperature under sod in Freeport has increased 0.18°F per year since 1989



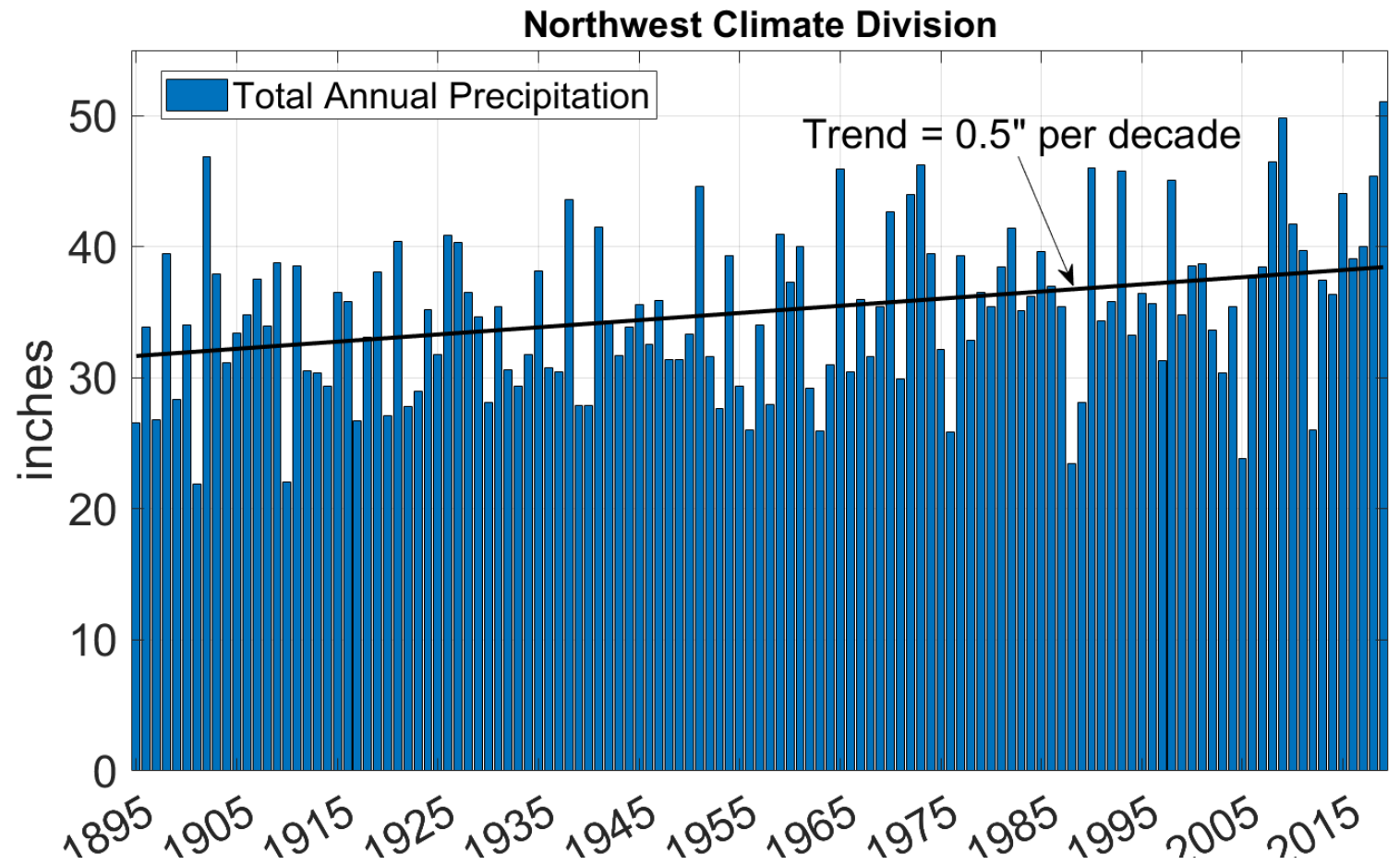
Illinois Climate Network,
<https://www.isws.illinois.edu/warm/soil/>



Precipitation Changes

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



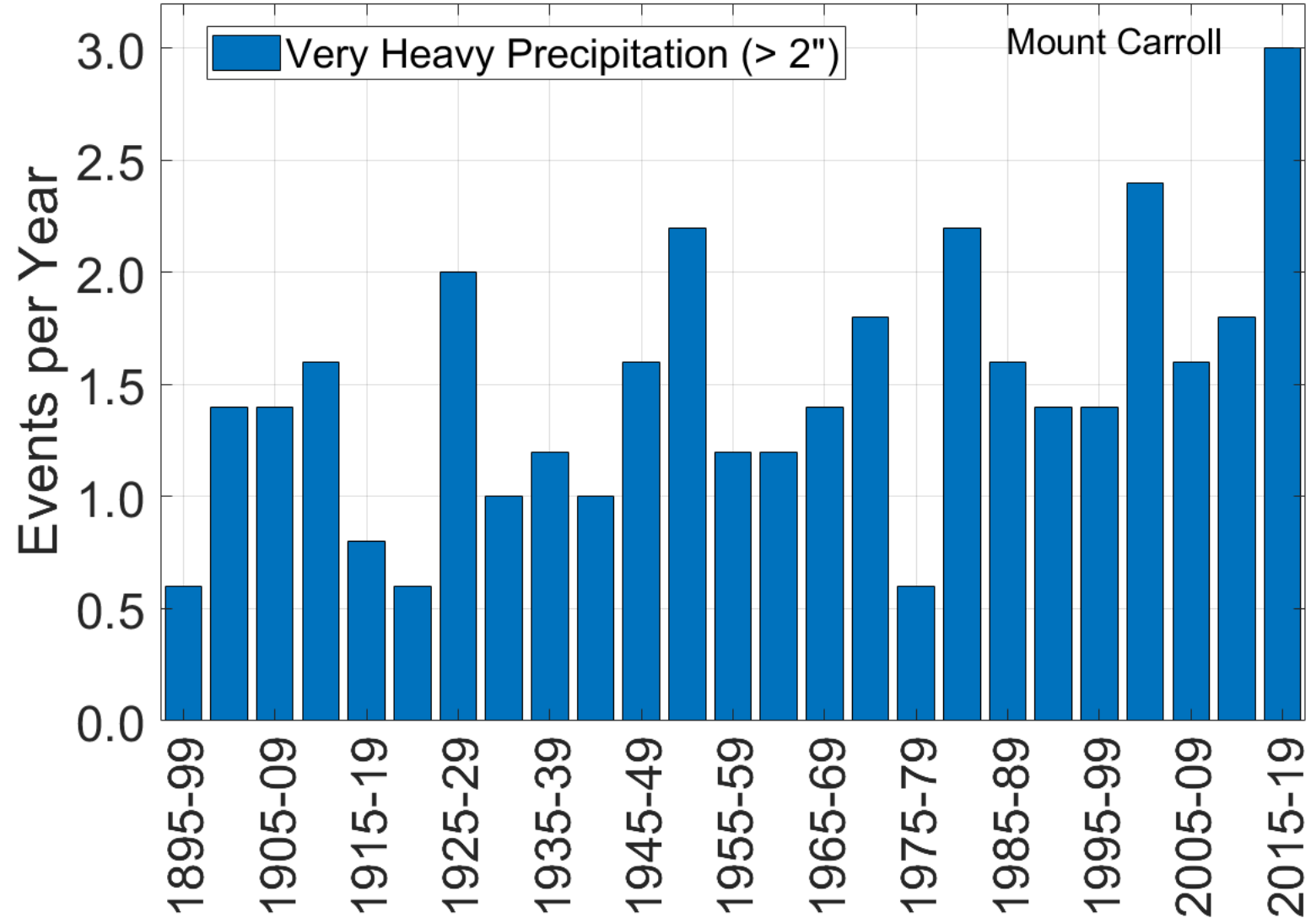
Precipitation Trends (1895 – 2020)	Winter	Spring	Summer	Fall
Northwest IL (inches per decade)	+0.08	+0.15	+0.24	+0.08

Source: NOAA NCEI



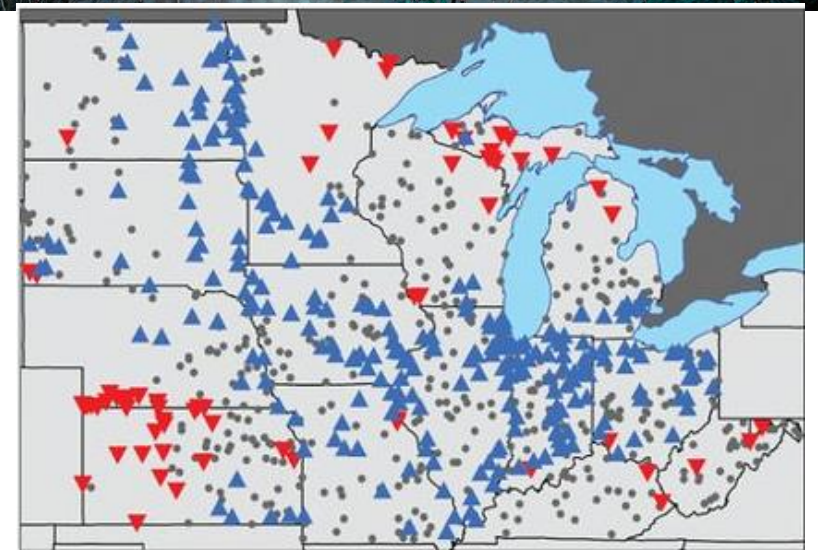
Changes in Precipitation Intensity

- 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

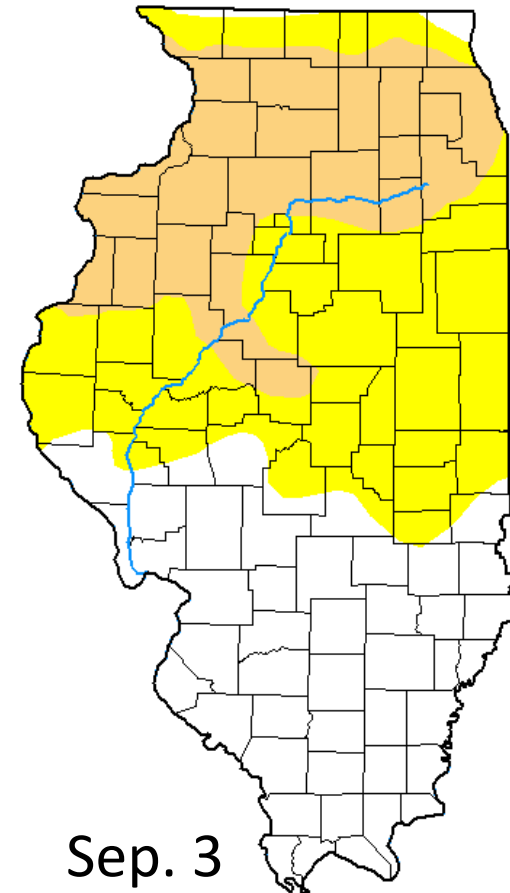
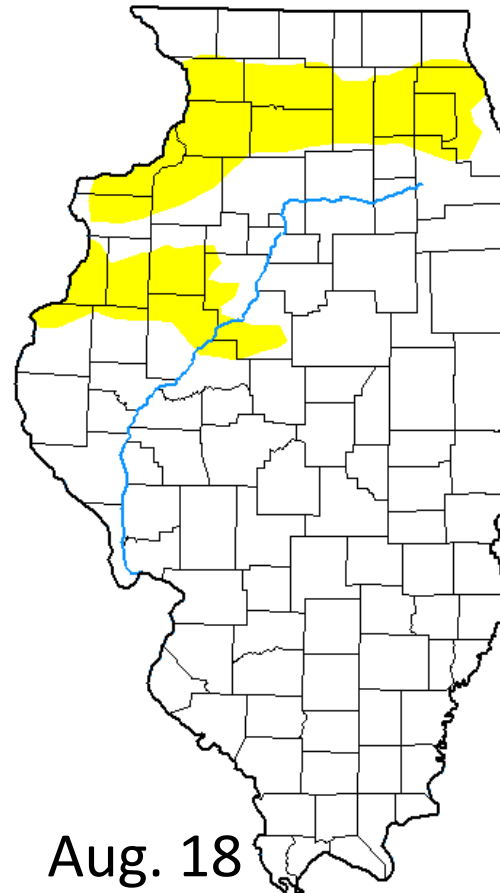
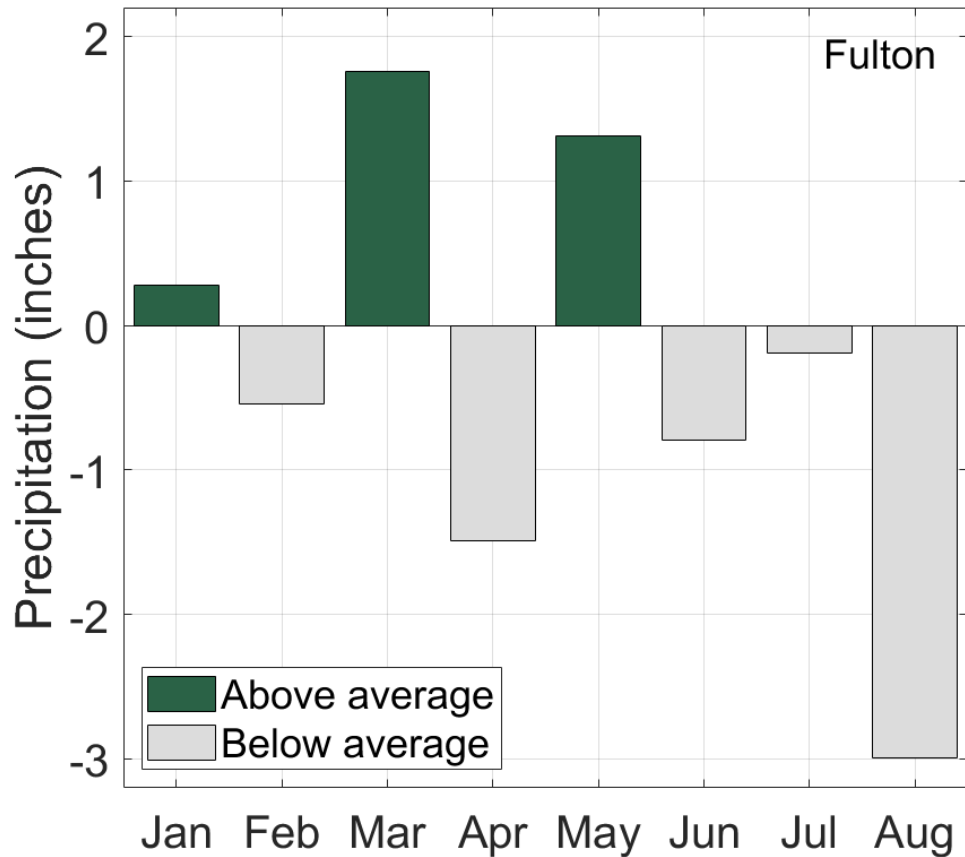
- More intense precipitation increases runoff ratio, nutrient runoff
- More precipitation goes to streamflow, not to soil moisture
- Less precipitation “yielded” for surface storage, could increase likelihood of drought later on



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

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

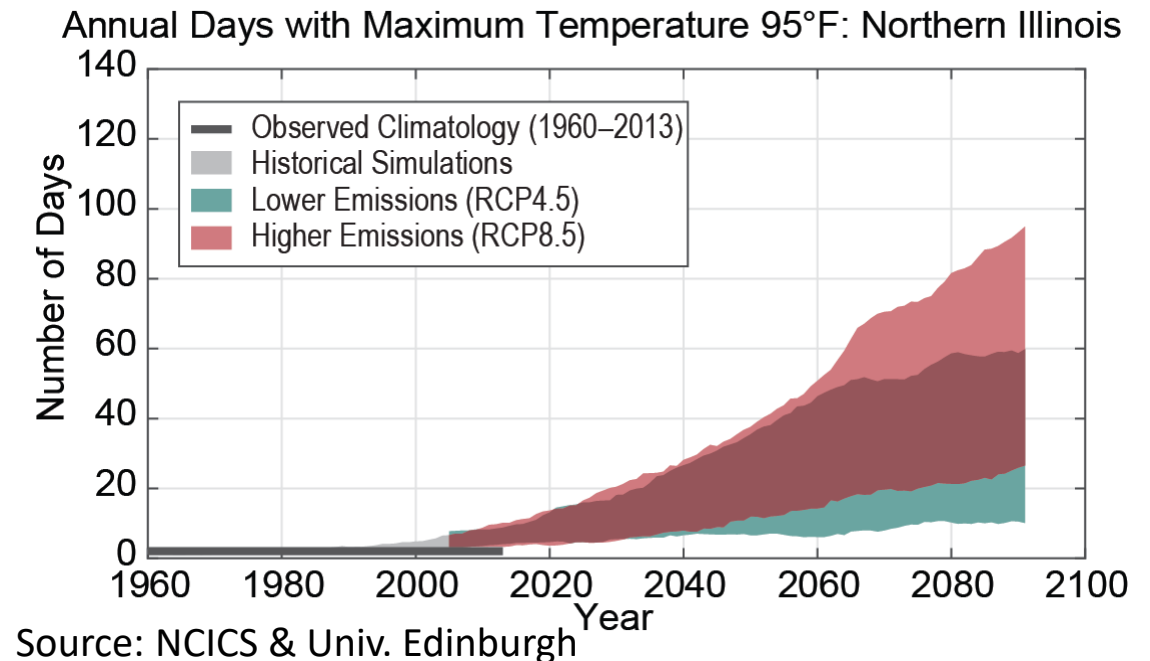
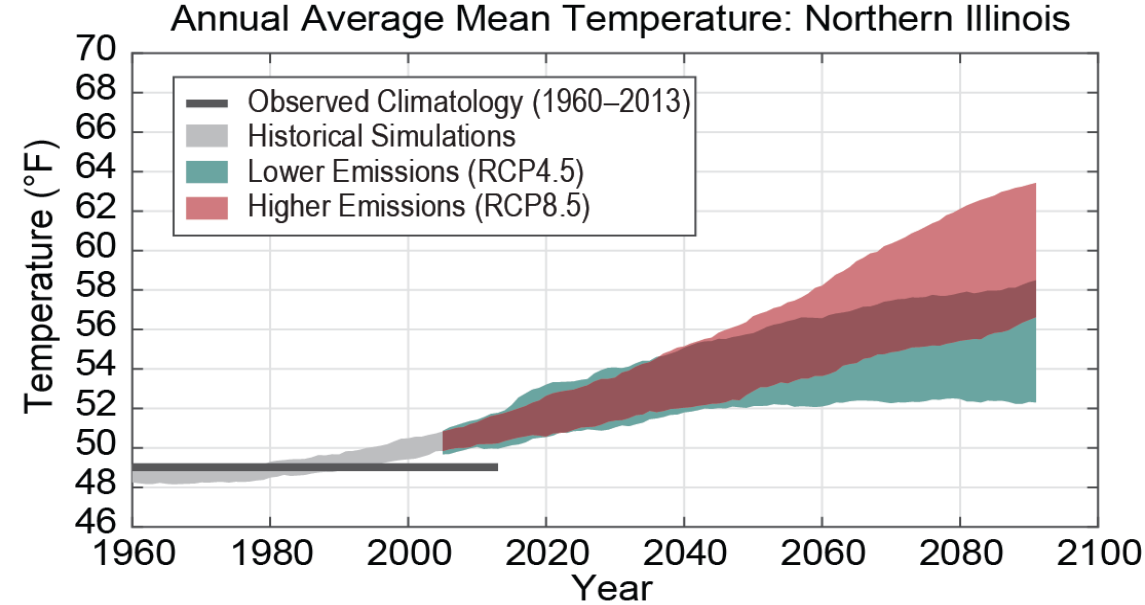


Projected (Future) Changes

Temperature – Projected Changes

- Projections indicate continued increases in all seasons' temperature
- Increase in annual frequency of very hot days (> 95°F)
- Largest increase in very warm nights (> 75°F)
- Continued winter warming, reduced very cold nights

Magnitude of change is very dependent on emission scenario... fewer emissions = less warming

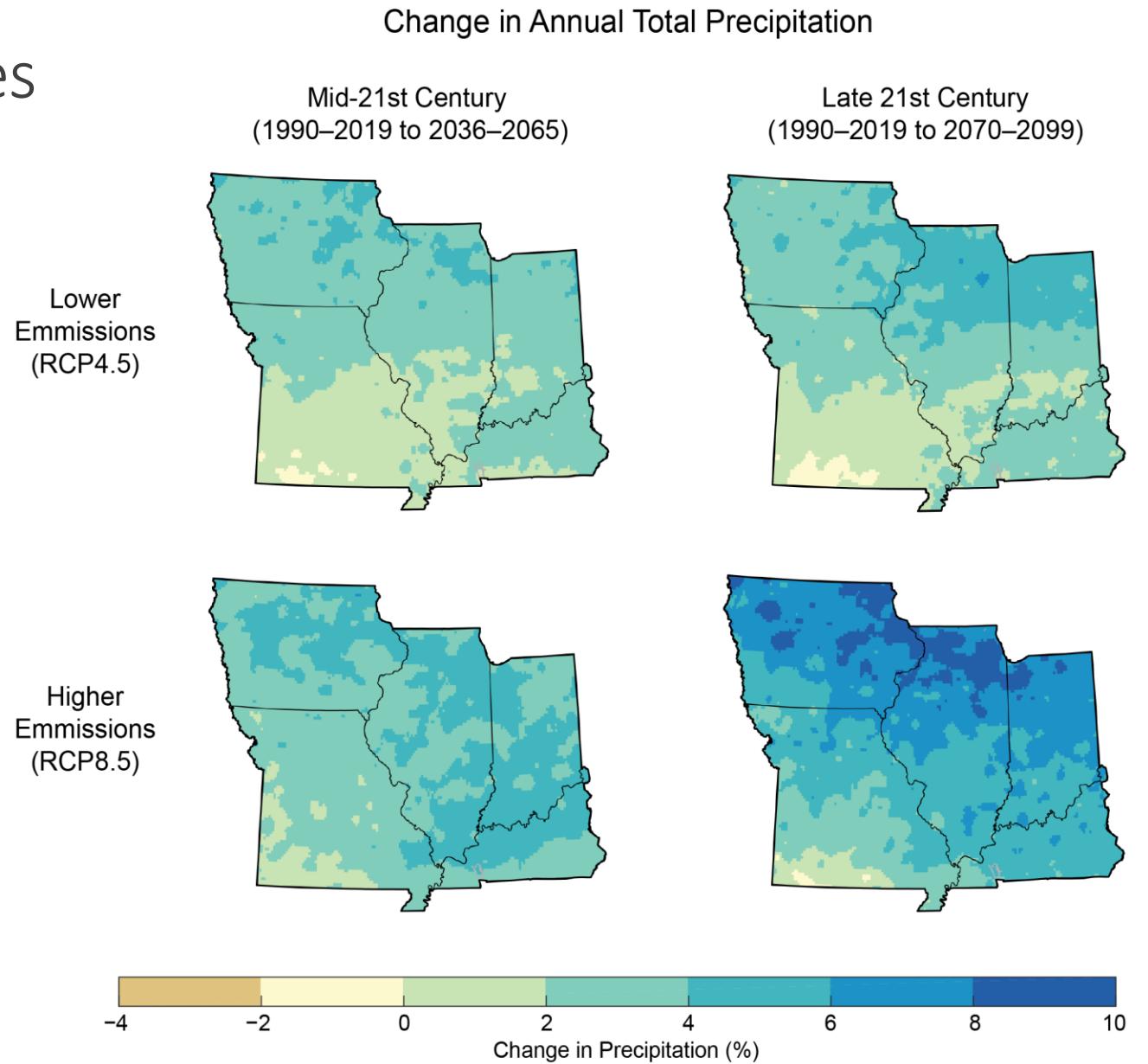


Source: NCICS & Univ. Edinburgh



Precipitation – Projected Changes

- Projections show continued increased precipitation and intensity



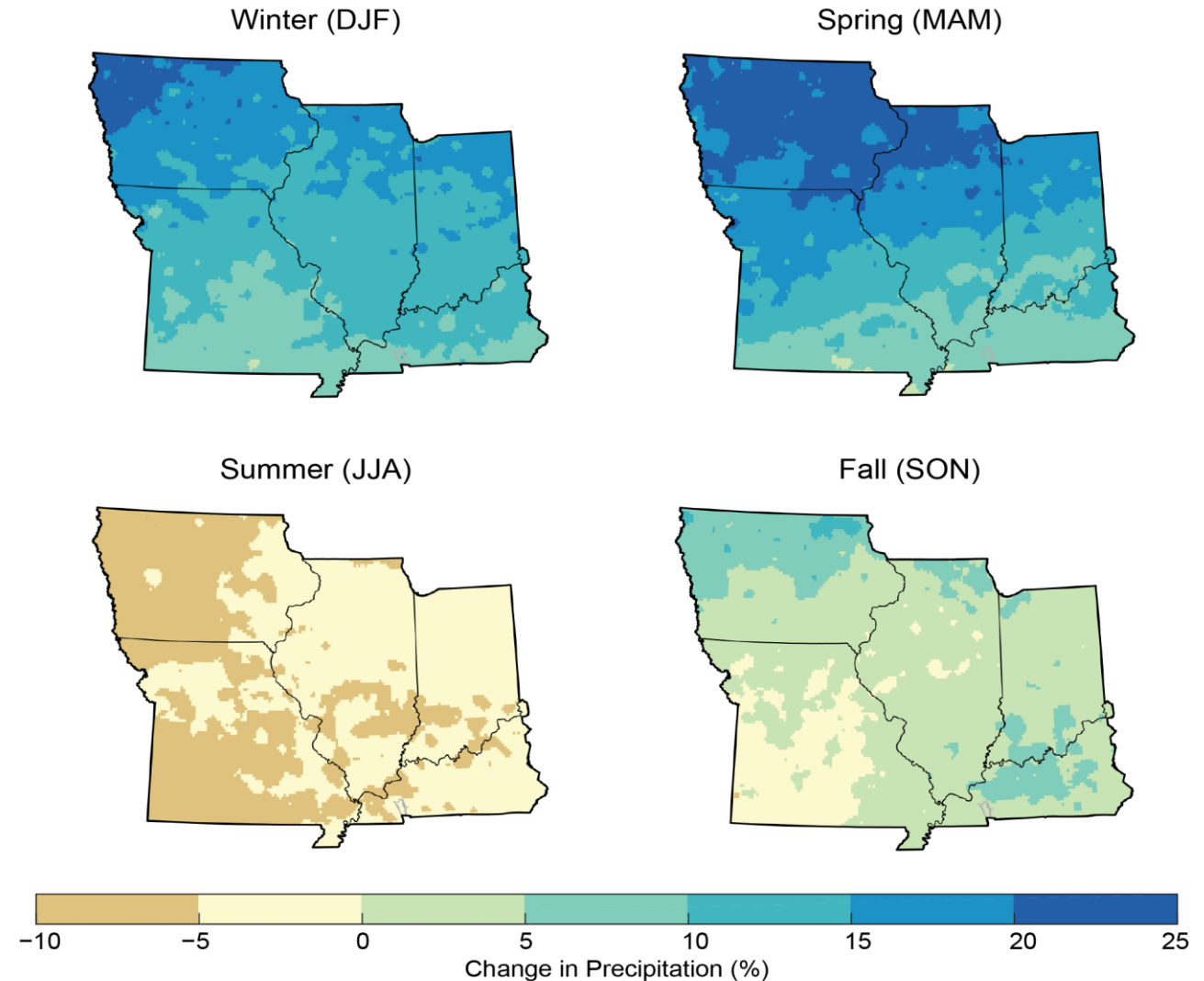
Source: NCICS & Univ. Edinburgh



Precipitation – Projected Changes

- Projections show continued increased precipitation and intensity
- Unlike temperature, projections show large seasonal differences in future precipitation
- Wetter Winter/Spring – Drier Summer
- Projections of extreme precipitation (2"+ in a single day)
- Increased frequency in southern Illinois, up to 1.5 to 2 additional days annually
- Large differences (~ 1 additional day) between higher and lower emissions scenarios

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



Source: NCICS & Univ. Edinburgh

Summary

- Climate change – present and future – poses a significant issue for agriculture and ecosystems in 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
 - Increased winter temperature promotes higher VBD incidence and creates phenology issues (chill hours, false springs)
 - Increased summer minimum temperatures reduce crop efficiency
- Future climate projections show **very high confidence** that temperatures will continue to increase in Illinois, impacting:
 - Heat – human & animal heat stress
 - Nighttime temps
 - Evaporation – exacerbating dry conditions during drought
- Future climate projections show **moderate confidence** that precipitation will continue to increase in Illinois, particularly in spring and winter

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