
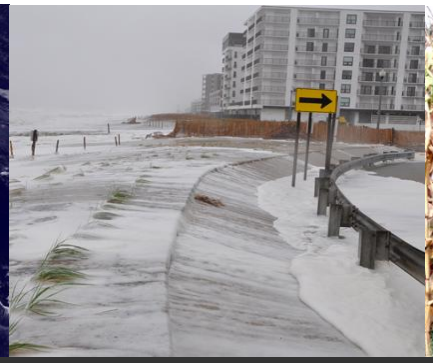

DELAWARE CLIMATE CHANGE IMPACT ASSESSMENT

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Delaware Division of Energy and Climate

Delaware Department of Natural Resources and Environmental Control (DNREC)

Chesapeake Bay Program Modeling Group

January 8, 2014

Why did we develop the Delaware Climate Change Impact Assessment ?

To understand and communicate the current and future impacts and risks from a changing climate.

To summarize the best available science on climate change and the potential impacts for Delaware.

To help Delaware's citizens, communities and businesses prepare for and adapt to climate change.

How will the Assessment be used?

- The Assessment is a scientific summary written for policy-makers, practitioners, and non-scientist readers.
- State agencies, local governments, business and community leaders will find the Assessment a useful reference and resource for more in-depth planning and development of strategies to adapt to changing climate conditions.
- **Scientists and researchers can use climate projection data with other models and assessment tools.**

Overview of the Assessment: Scientific Sources

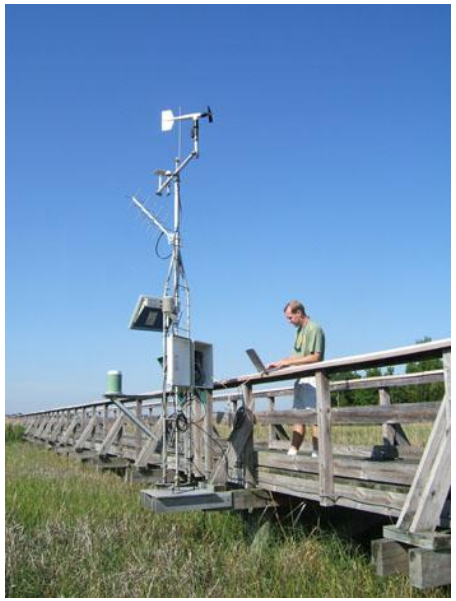
Sources of best available peer-reviewed science include:

- Scientific literature
- Scientific assessments
- Expert interviews
- Steering Committee of scientists and practitioners
- Delaware historic climate trends analyzed by Dr. Dan Leathers, DE State Climatologist (UD)
- Delaware climate projections developed by Dr. Katharine Hayhoe (ATMOS Research and Consulting)

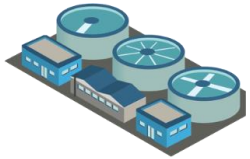
Overview of the Assessment: Two main components

Delaware's Climate

- **Climate Trends** (observations)
- **Climate Projections** (models)



Delaware's Resources



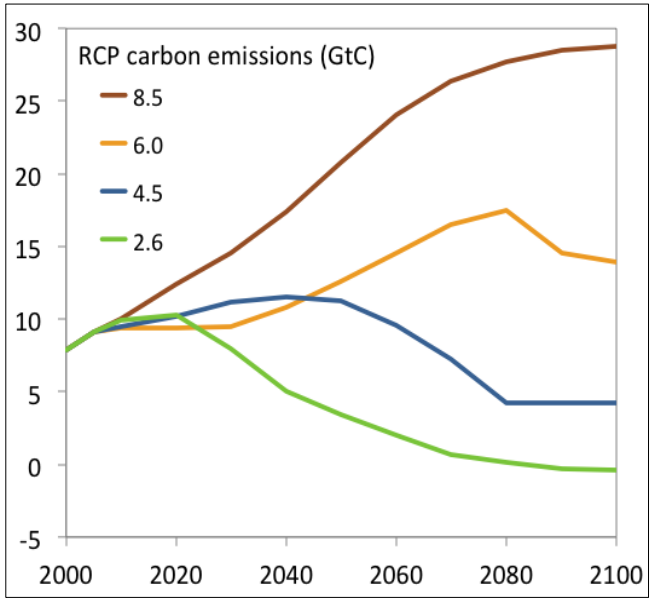
- **Public Health**
- **Water Resources**
- **Agriculture**
- **Ecosystems and Wildlife**
- **Infrastructure**

CLIMATE PROJECTIONS: Methodology and Findings

Katharine Hayhoe and Anne Stoner

ATMOS Research & Consulting

FOR THIS PROJECT



IPCC: 2010 Representative Concentration Pathways (RCP)

SCENARIOS

- We have developed climate projections for a **higher** (RCP 8.5) and a **lower** (RCP 4.5) future scenario

MODELS

- Climate projections are based on simulations from four (older) **CMIP3 global climate models** and nine (newer) **CMIP5 global climate models**

Climate indicators

- Temperature, precipitation, and secondary indicators (165 total) have been calculated for 14 individual long-term weather stations in Delaware
- Relative humidity, heat index, and potential evapotranspiration was calculated for 3 airport locations with long-term data available

Climate Indicators

TEMPERATURE INDICATORS

Annual – Seasonal Temperature Indicators:

- Maximum Temperatures (10)
- Minimum Temperatures (10)
- Average Temperatures (10)
- Temperature Range (5)
- Standard Deviation of Temperature (10)

Other Temperature Indicators:

- Temperature Extremes (17)
- Growing Season (4)
- Energy-Related Temperature Indicators (2)
- Temperature Extreme Percentiles (4)

PRECIPITATION INDICATORS

Annual – Seasonal Precipitation Indicators:

- Average Precipitation (10)
- 3-Month Precipitation Change (12)
- 6- and 12-Month Precipitation Change (13)

Other Precipitation Indicators:

- Dry Days (4)
- Precipitation Indices (3)
- Extreme Precipitation (22)

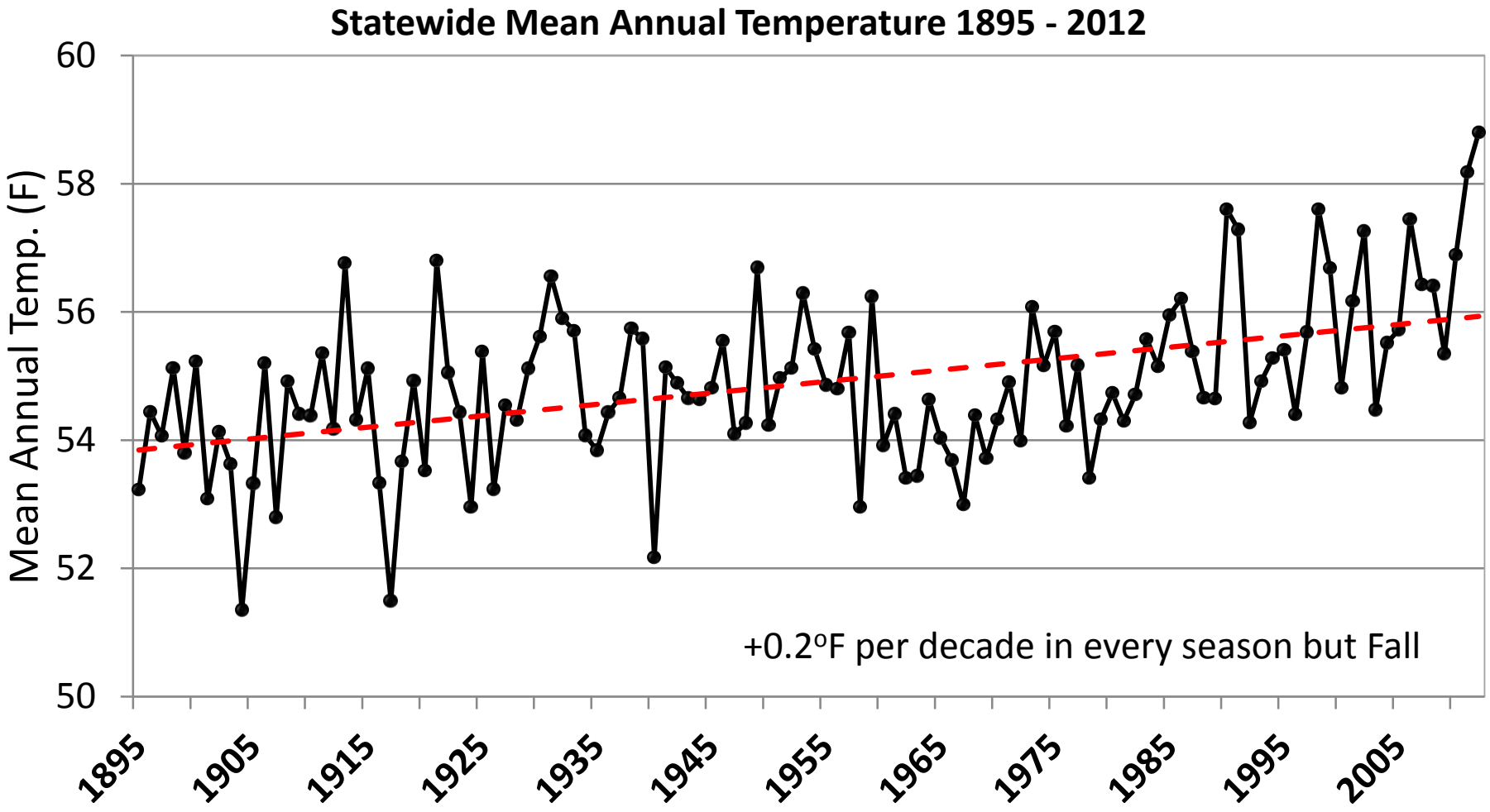
HUMIDITY HYBRID INDICATORS

- Dewpoint Indicators (10)
- Relative Humidity (10)
- Heat Indices (4)
- Potential Evapotranspiration (5)

TEMPERATURE

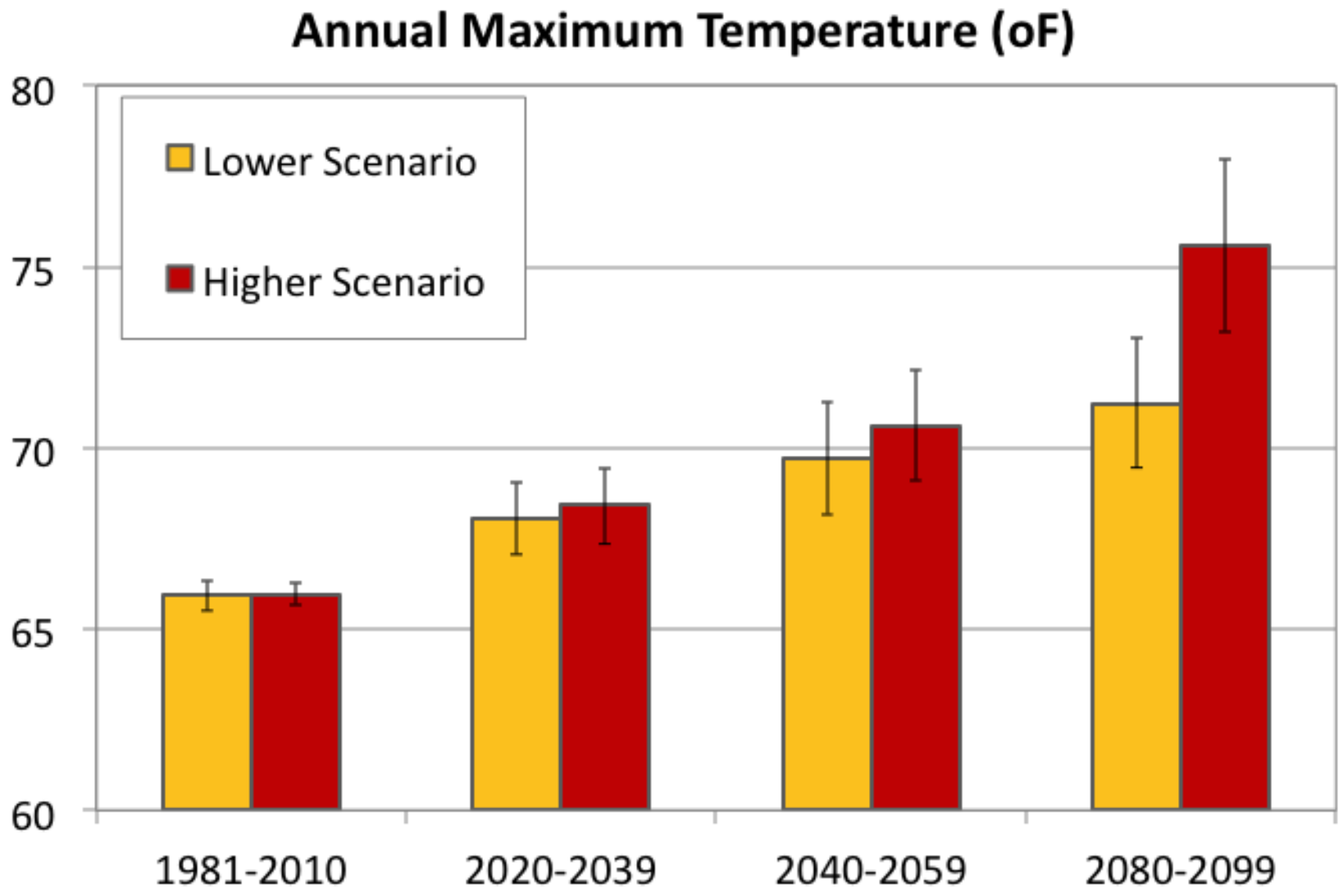
Climate projections for Delaware

Observation: Temperature is increasing

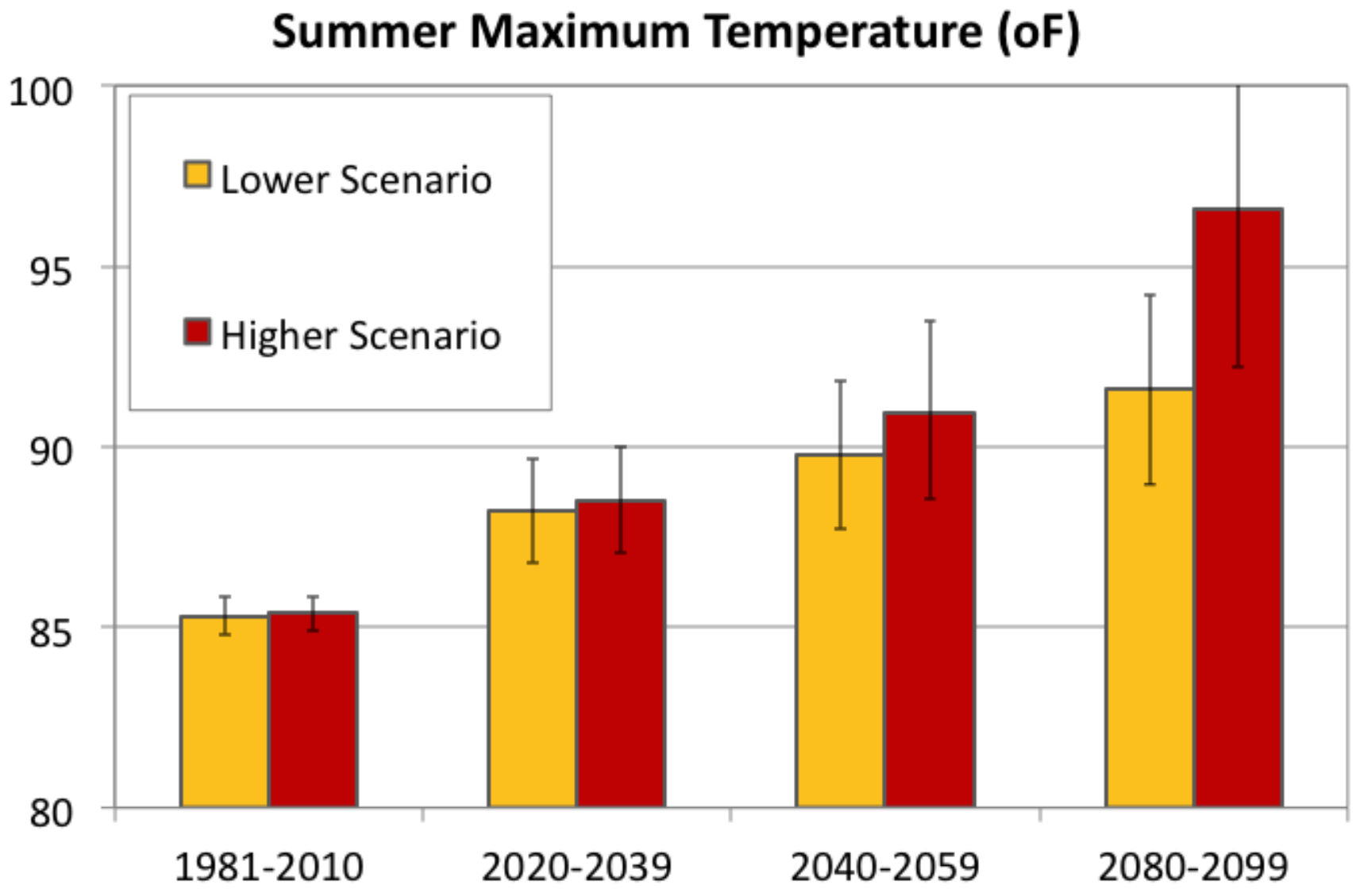


Dan Leathers, State Climatologist

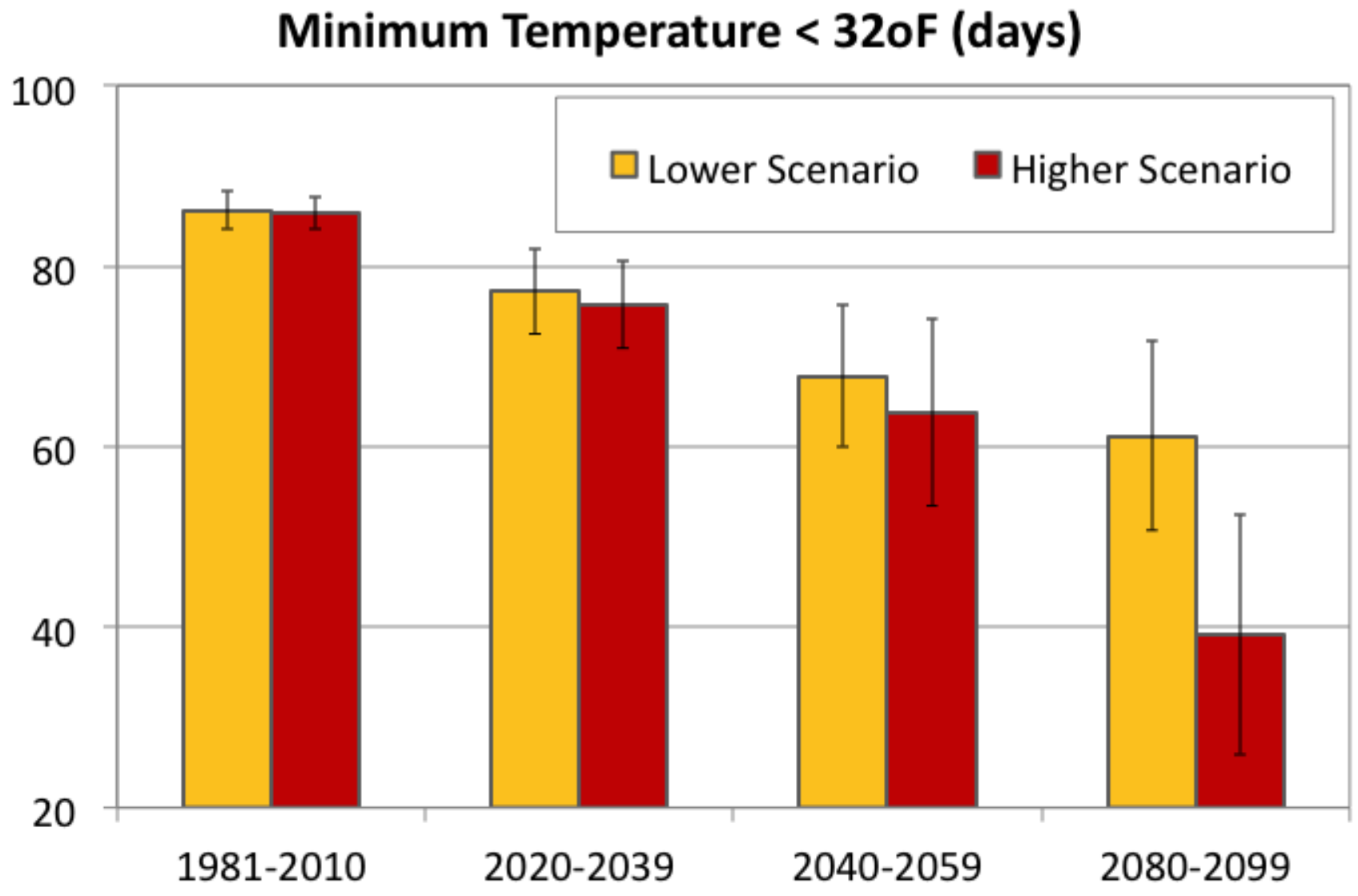
Temperature is projected to continue to rise



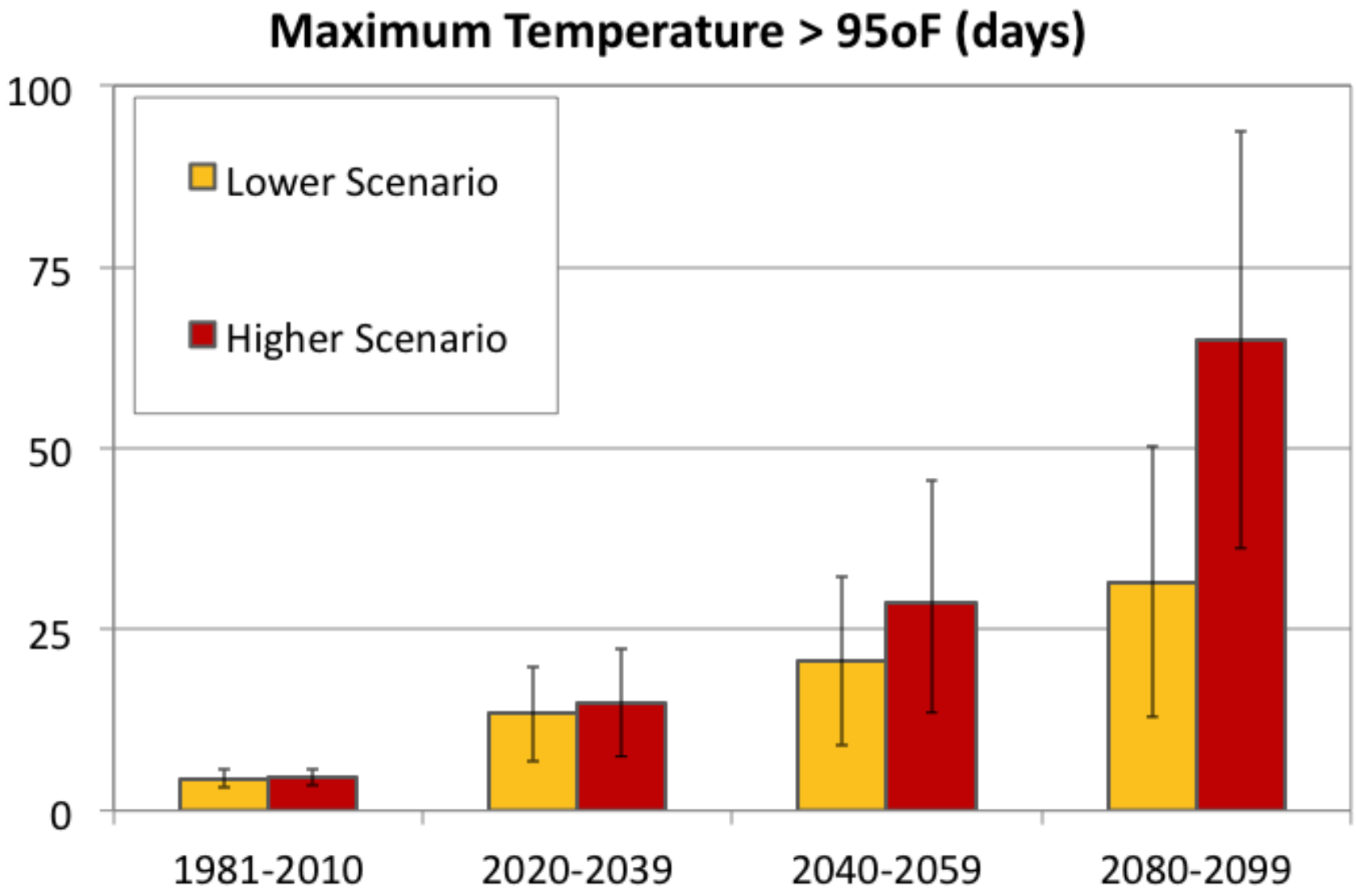
Larger increases projected in summer



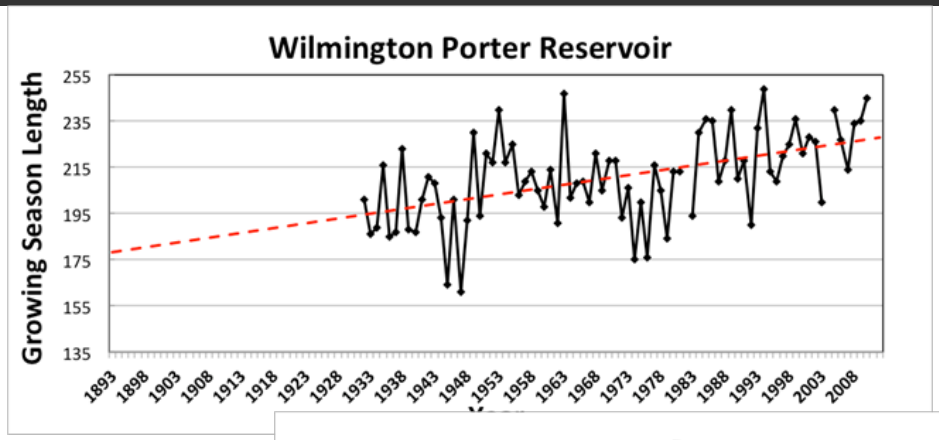
Fewer days below freezing

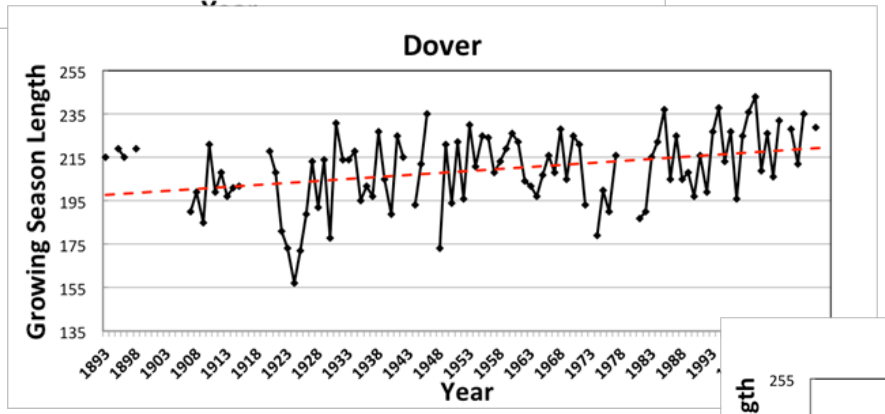


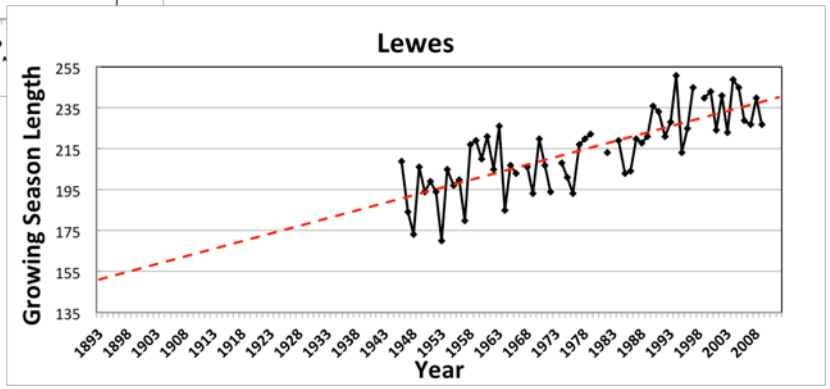
More days above 95 F˚



Observation: Length of growing season is increasing

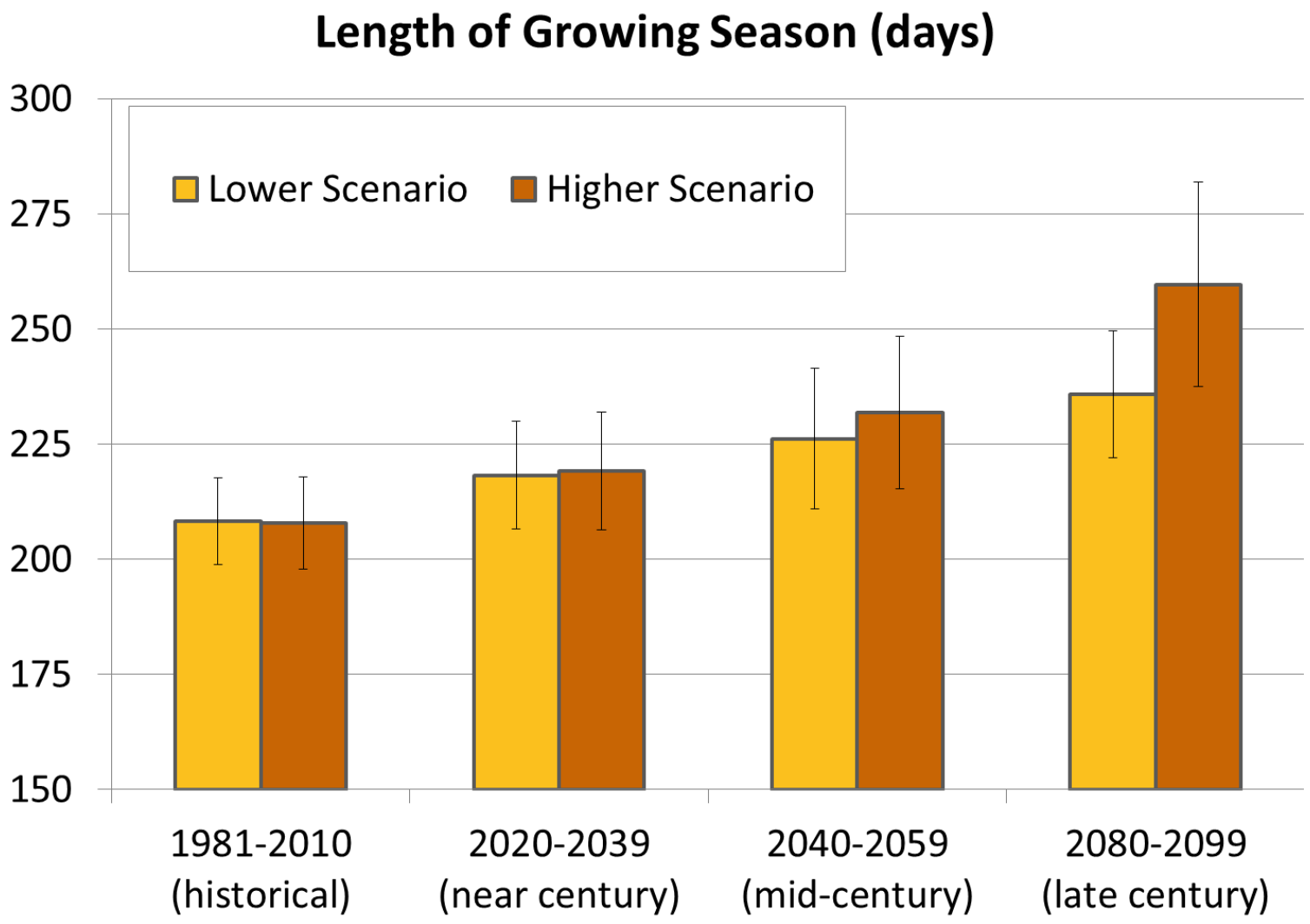






Dan Leathers, State Climatologist

Projected increase in growing season



TEMPERATURE summary

Annual and seasonal temperatures are projected to increase, with slightly greater increases in summer as compared to winter.

TEMPERATURE summary

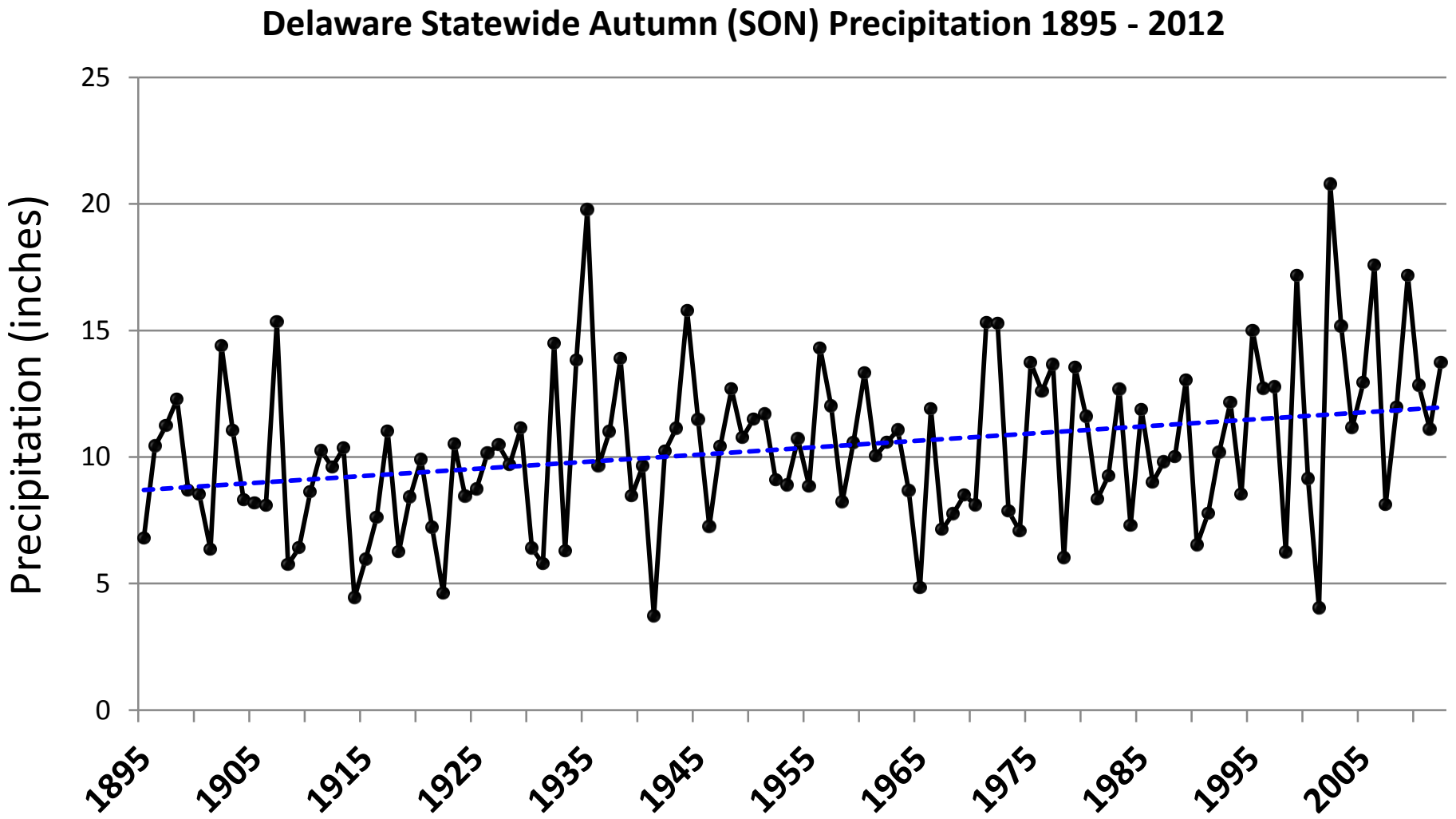
Annual and seasonal temperatures are projected to increase, with slightly greater increases in summer as compared to winter.

Extreme heat days and heat waves are becoming more frequent; extreme cold, less frequent.

PRECIPITATION

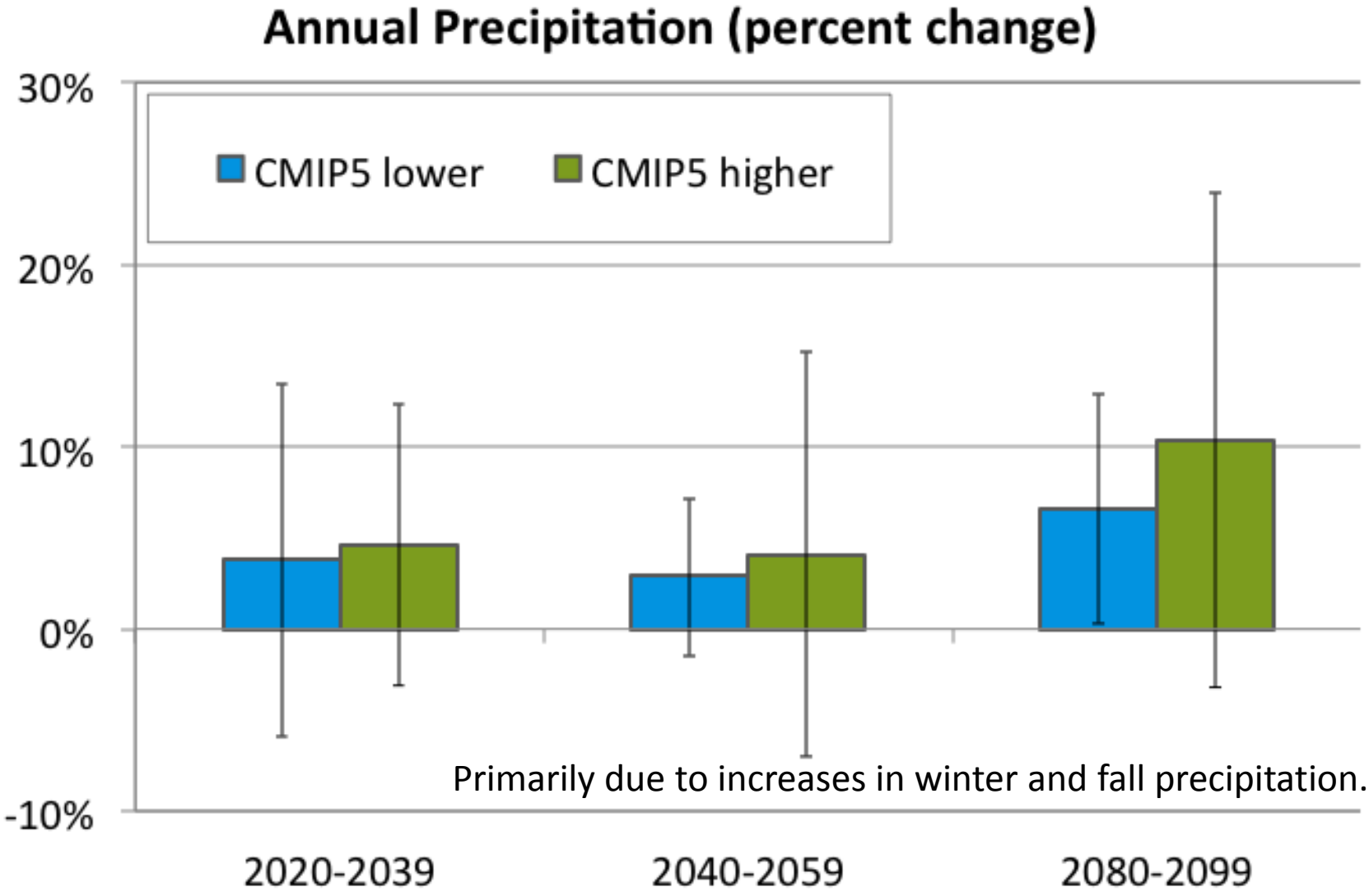
Climate projections for Delaware

Observation: Fall precipitation has increased



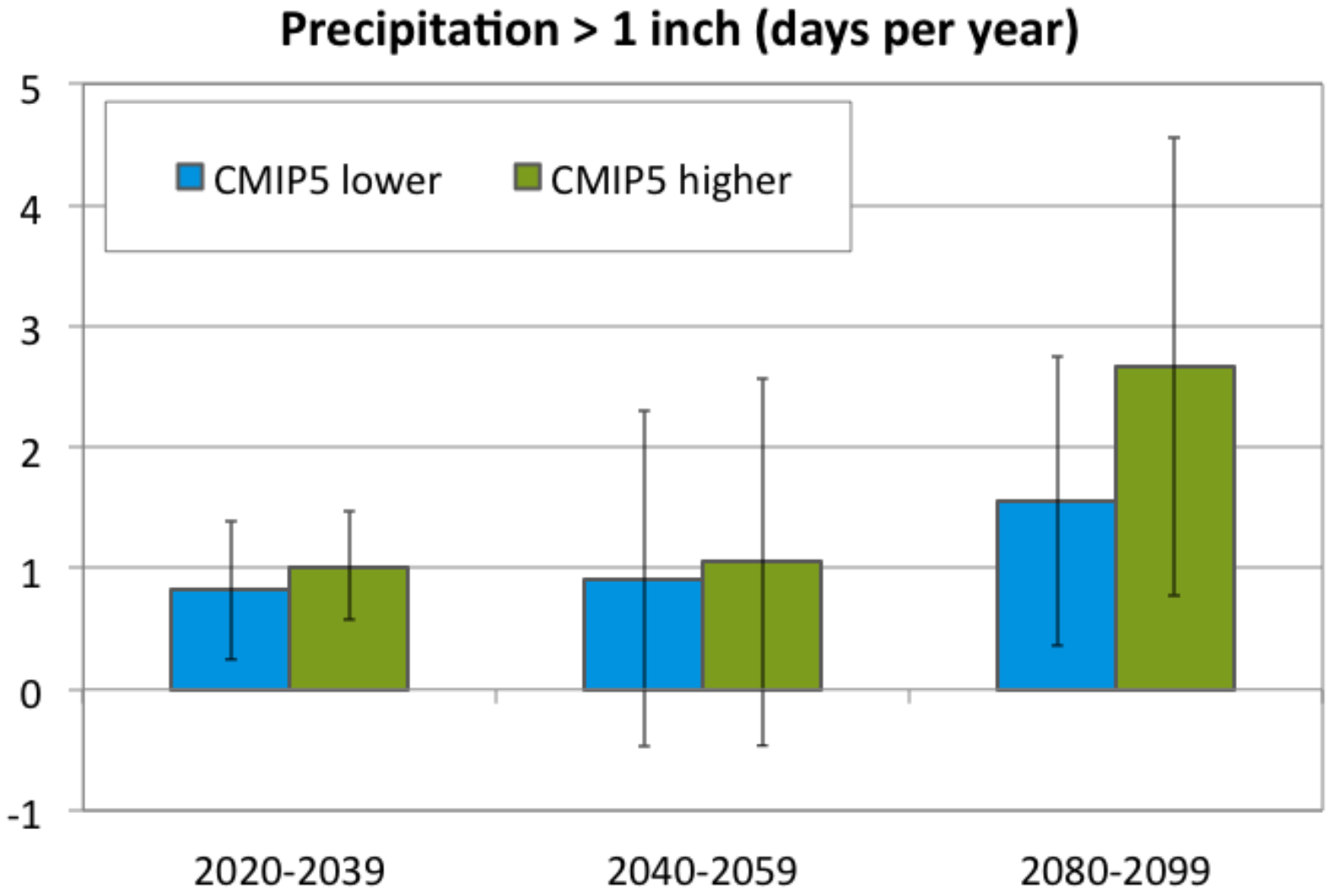
Dan Leathers, State Climatologist

Annual precipitation projected to increase



Primarily due to increases in winter and fall precipitation.

This trend is projected to continue



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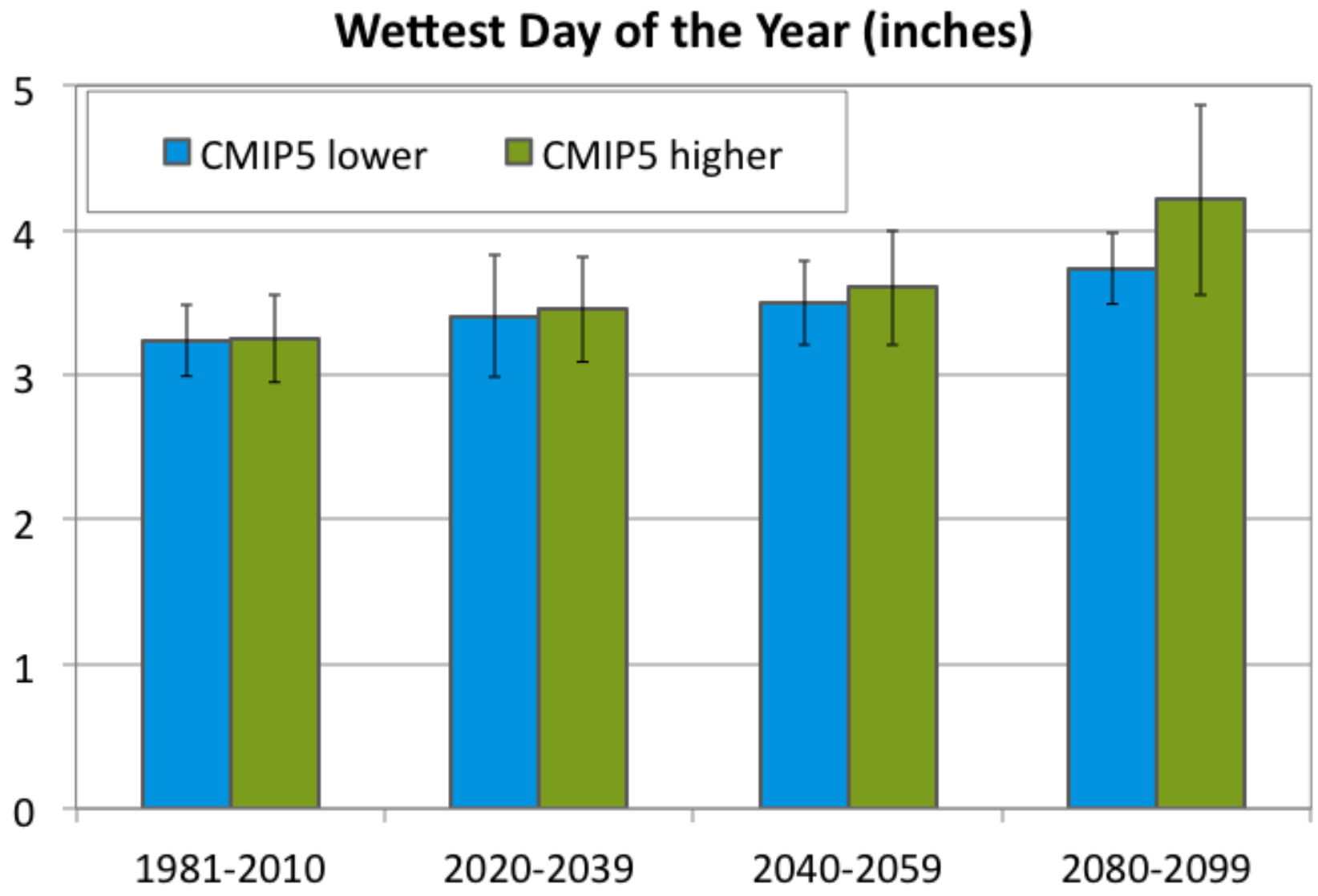
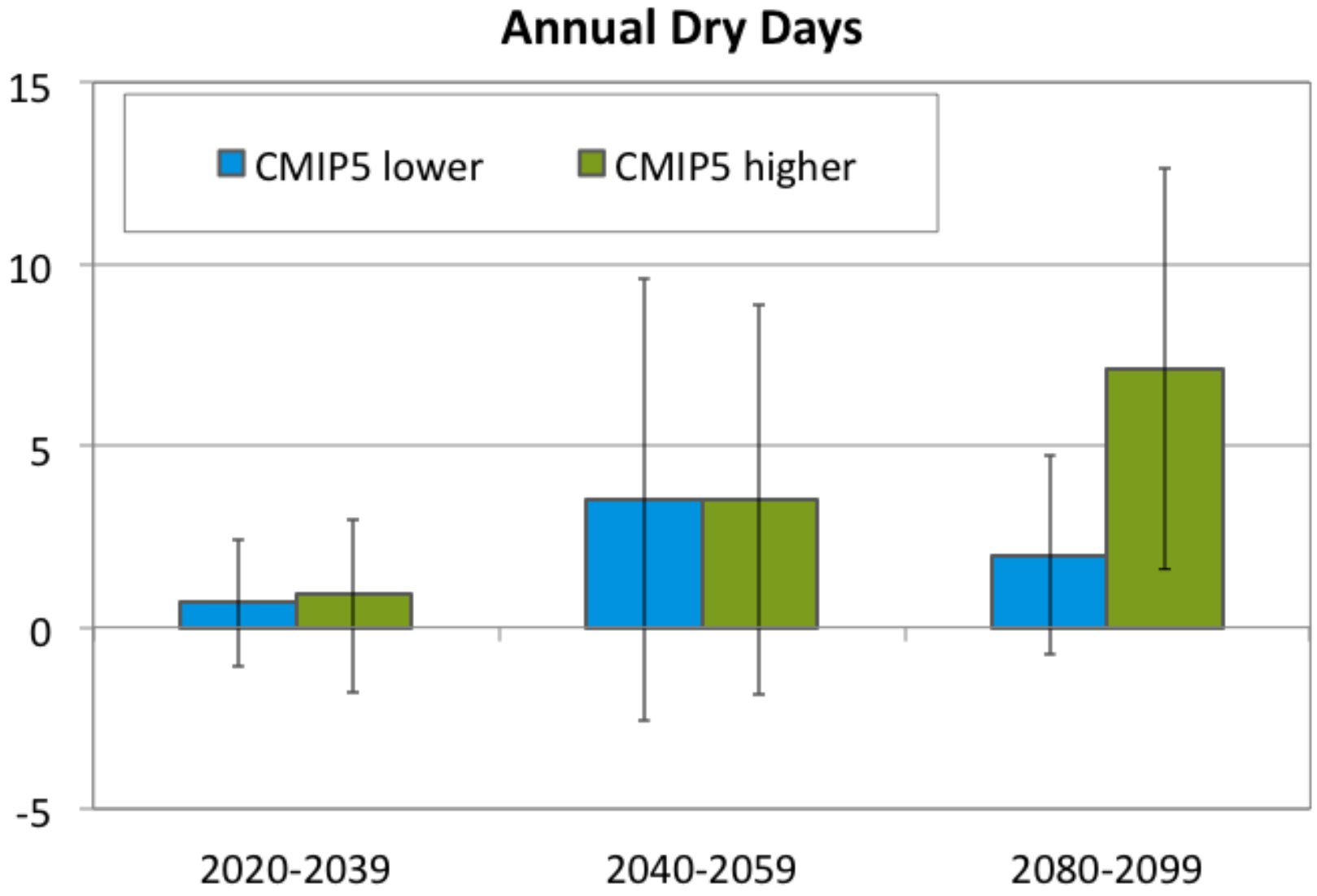


… with increases in dry days also.



PRECIPITATION summary

Annual precipitation projected to increase, mostly due to changes in winter and fall.

- Winter snowfall may not change much, since more winter precipitation means a greater chance of precipitation occurring on a day when it's cold enough to snow.

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Heavy precipitation and dry days both expected to become more frequent as precipitation becomes more intense.

- Projected increases in average precipitation are not enough to compensate for increases in heavy precipitation. That's why dry days are also expected to increase.

POTENTIAL IMPACTS

Delaware's Resources

Potential Impacts to Water Resources

Increased temperatures		
Higher temperatures at peak summer ➔ increased water demand for irrigation, power generation, and domestic use Higher water temperatures ➔ reduced dissolved oxygen and poorer water quality		

Potential Impacts to Water Resources

Increased temperatures	Increased variability in precipitation	
Higher temperatures at peak summer ➔ increased water demand for irrigation, power generation, and domestic use Higher water temperatures ➔ reduced dissolved oxygen and poorer water quality	Potential increase in heavy rain events ➔ peak flows exceeding capacity of water and stormwater systems ➔ contaminated runoff and pollutant transport More precipitation as rain than snow ➔ changes in timing of seasonal flows	

Potential Impacts to Water Resources

Increased temperatures	Increased variability in precipitation	Sea level rise
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Potential Impacts to Agriculture

Increased temperatures		
Extreme heat events or sustained heat waves ➔heat stress for poultry and other livestock ➔increased water demand for irrigation ➔increased energy costs for cooling and irrigation pumping A longer growing season ➔some benefits for crop production ➔increased competition from weed species and insect pests		

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Climate Change Impacts and Nutrient Management

Climate Change Stressor	Potential Vulnerability
Increasing temperatures	• **Increased volatilization losses of ammonia-N**, a nutrient associated with animal production, are known to occur as temperature increases; animal facilities may require new technology solutions to prevent air quality impacts from ammonia release. • **Increased volatilization of surface-applied ammonia-based fertilizers or poultry manures**, both commonly used for crops in Delaware, occurs as temperatures increase. This can reduce N use efficiency (economic cost) and may be a potential air quality impact; wider use of practices such as soil incorporation of manures and fertilizers to mitigate ammonia volatilization losses may be required. • **Manure organic N will be converted to nitrate-N more quickly and completely in warmer soils**, assuming adequate soil moisture. Thus, practices to prevent nitrate leaching from Delaware's sandy soils will likely need to be more efficient.

Climate Change Impacts and Nutrient Management

Climate Change Stressor	Potential Vulnerability
Changing precipitation patterns – extreme rain events	• Prolonged and intense periods of precipitation will **increase runoff of sediment and nutrients** to surface waters. • Extreme rain events increase the risk of **nutrient losses** from overflow of manure storage facilities. • Application of organic nutrient sources may be delayed or made more difficult in wet conditions following extreme rain events, and may lead to increased nutrient losses.
Extreme weather events	• Structures related to **best management practices** may fail or be damaged, resulting in losses of nutrients and sediment; this can include buffer strips, drainage structures, constructed wetlands, and manure storage facilities.

For more information

Climate Change Projections and Analysis for Delaware
(Hayhoe, et al) Estimated release January 2014

Delaware Climate Change Impact Assessment
Estimated release March 2014

Delaware Division of Energy and Climate, DNREC
http://www.dnrec.delaware.gov/energy/Pages/Climate.aspx

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