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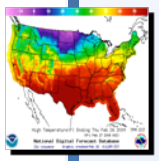
NOAA/NWS
Ohio River Forecast Center

Water Resources Committee
Climate Trends and Change

Jim Noel

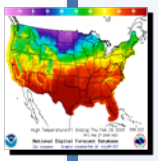
Service Coordination Hydrologist

November 27, 2012



Today's Discussion

- Climate Trends
- Climate Change vs Variability vs Warming
- Climate Changes Underway and Projections
- Climate Impacts on Ohio Valley – Example
- Ohio River Basin Climate Change Pilot Project
- NOAA/NWS National Water Resources Outlook
- Summary
- Questions/Comments



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Global Trends and Projections

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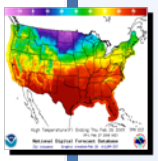
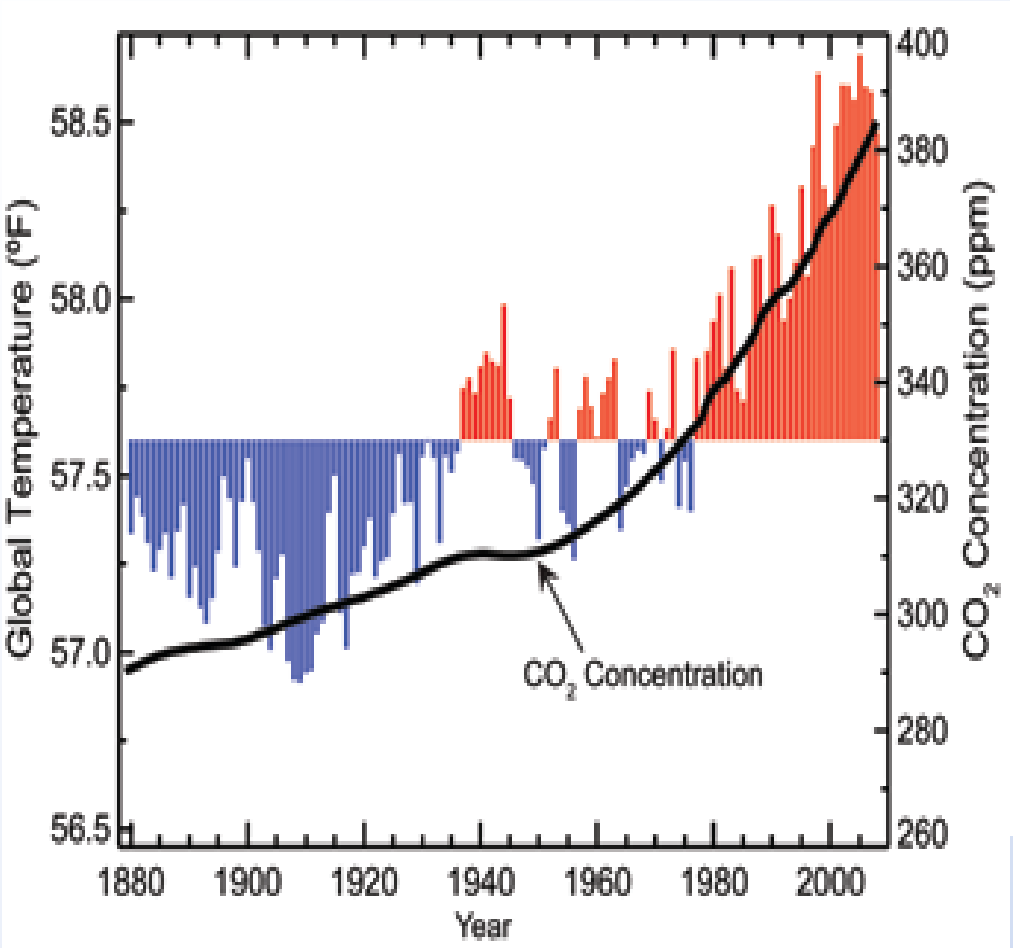
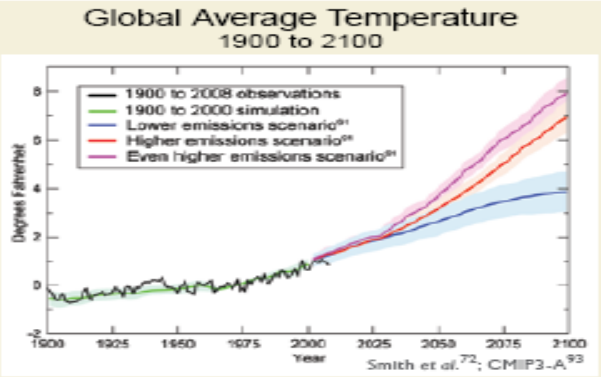
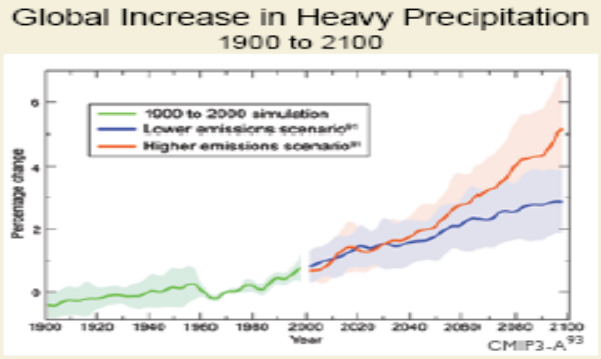


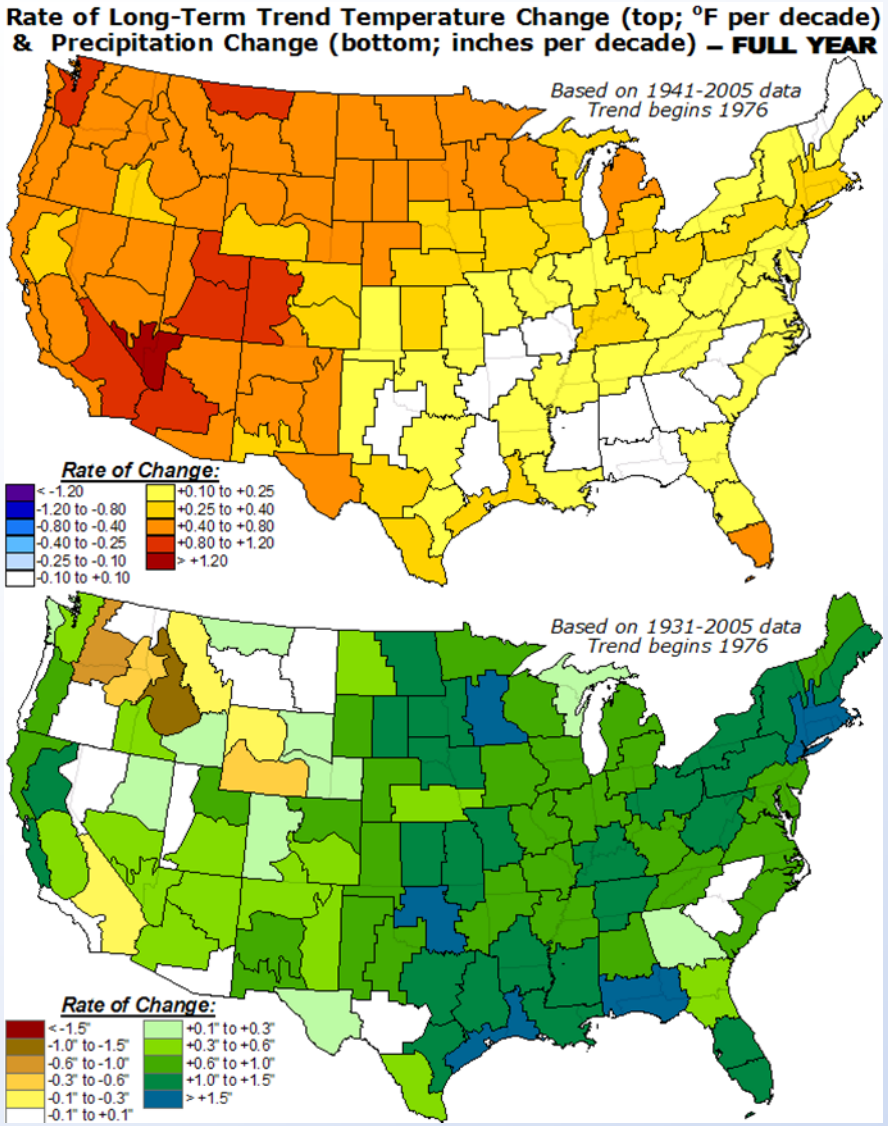




Observed and projected changes in the global average temperature under three IPCC no-policy emissions scenarios. The shaded areas show the likely ranges while the lines show the central projections from a set of climate models. A wider range of model types shows outcomes from 2 to 11.5°F.[90] Changes are relative to the 1960-1979 average.



Regional Temperature/Rainfall Trends



- *Trend in Ohio has been for warming from 1976 to recently*
- *Trend in Rainfall has been for increased rainfall from 1976 to recently*
- *Much of the increase has been in late summer through autumn*

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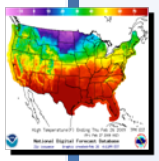
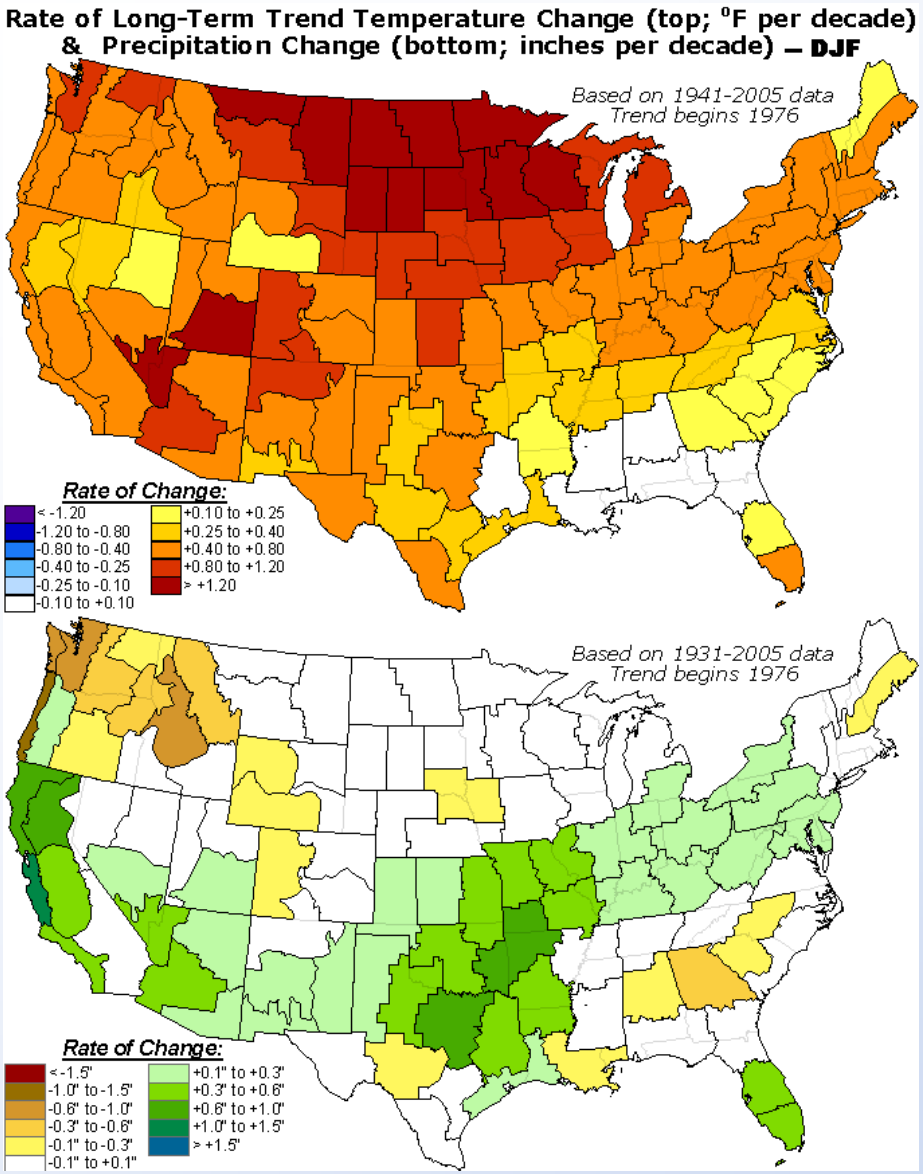
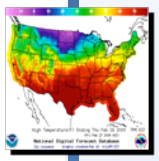


Temperature/Rainfall Winter Trends



- *Most significant warming has occurred in the winter season*
- *Only minor increases in winter precipitation*



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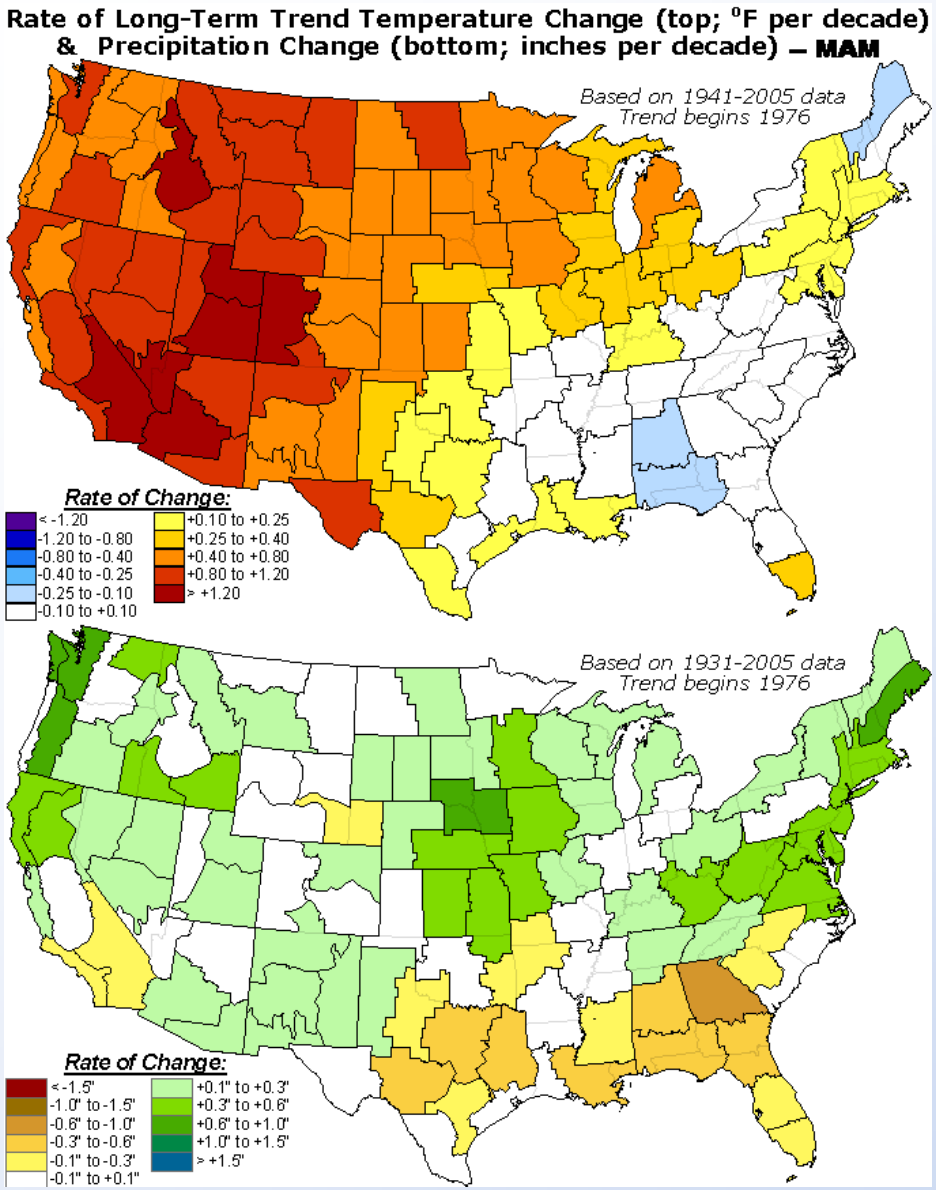
Temperature/Rainfall Spring Trends



- *Some warming in spring in Ohio*
- *Only slight increase in peak flood season rains*

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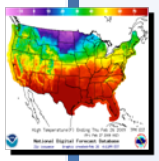
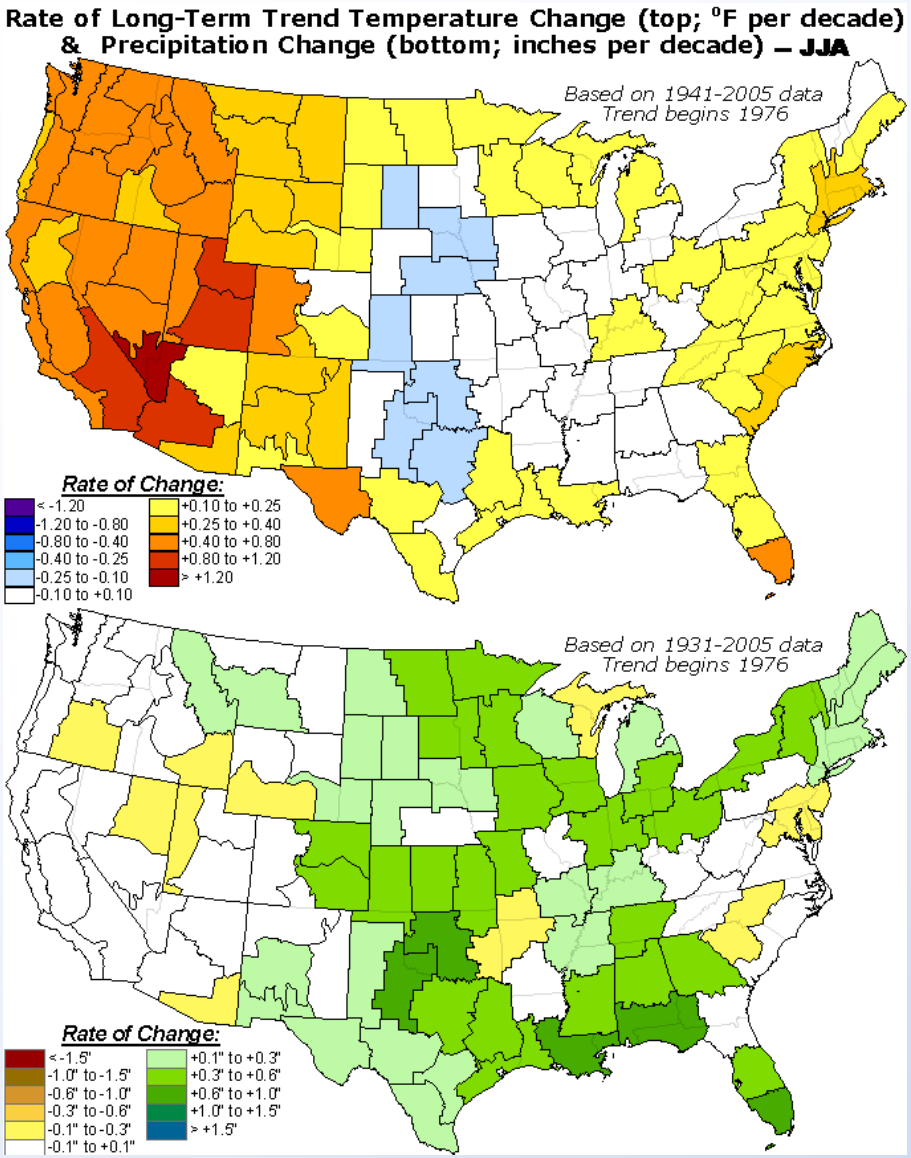


Temperature/Rainfall Summer Trends



- *Little change in overall summer temperatures*
- *Some increase in summer rainfall*

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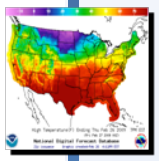
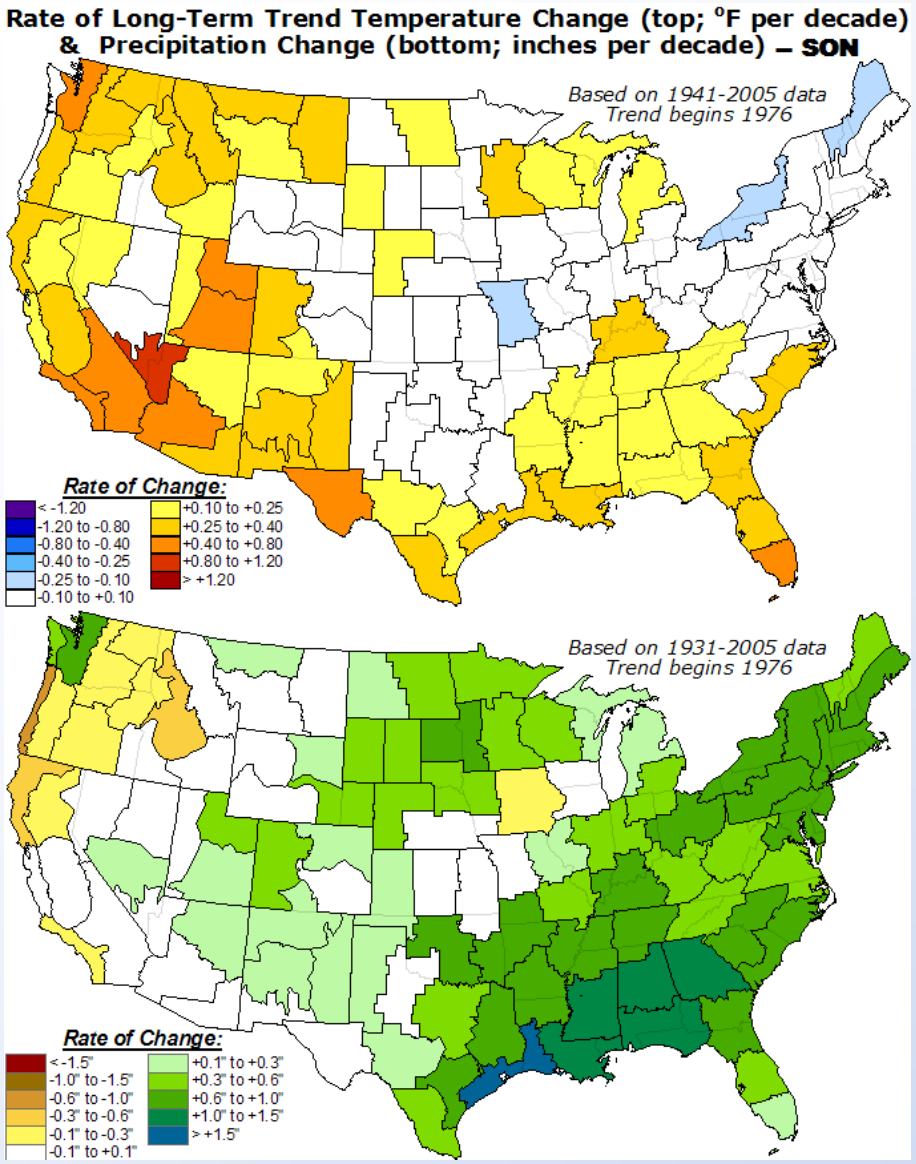


Temperature/Rainfall Autumn Trends



- *No change in autumn temperatures*
- *Most significant increase have come in fall low flow season and harvest season*

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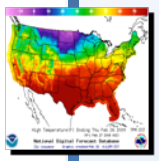
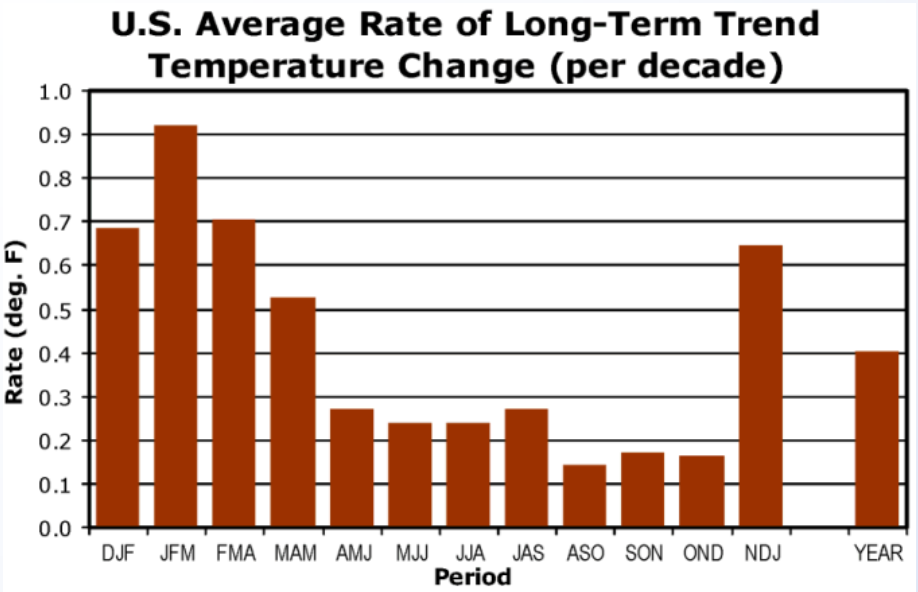
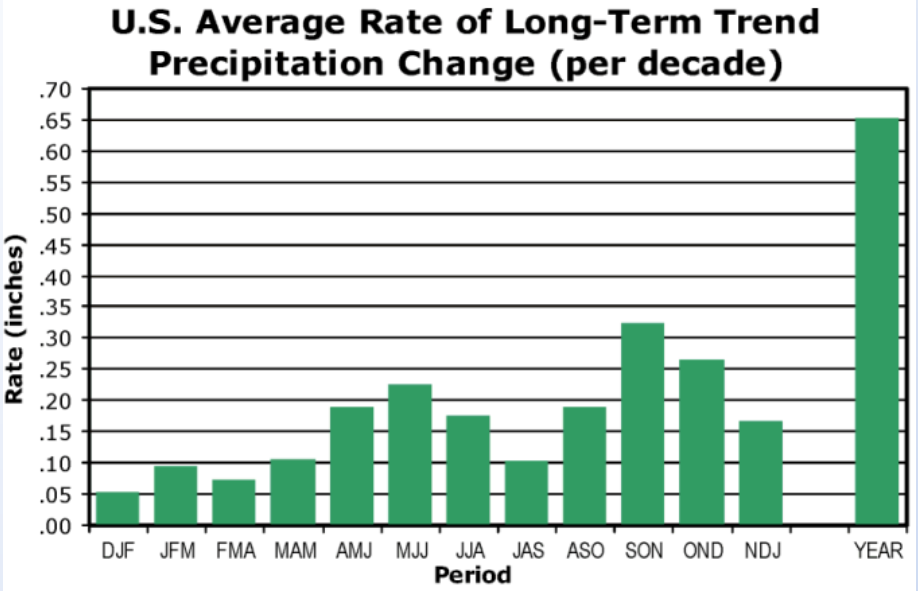


Temperature/Rainfall Autumn Trends





- *Ohio fits composite of United States generally*
- *Greatest warming in cool season*
- *Greatest increase in rainfall in autumn*

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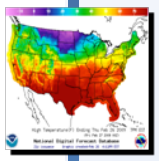
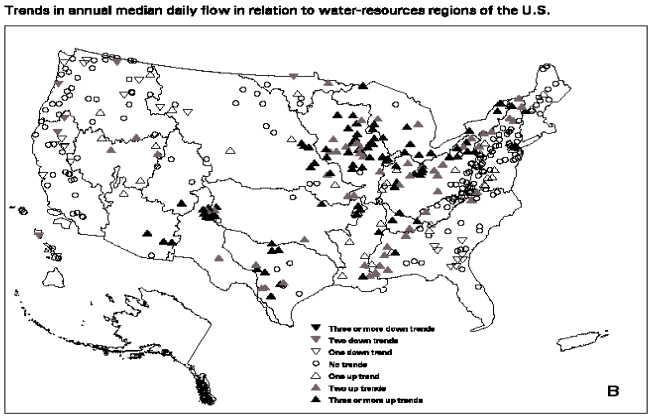
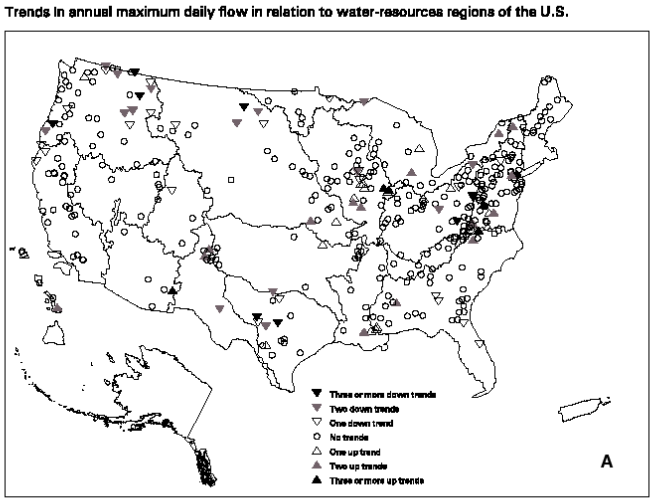


Climate Trends in Hydrology



USGS Median Daily Flows



USGS Maximum Daily Flows

- Most trends are up especially from Deep South to Ohio Valley and Northeast.
- For Ohio, streamflows trends are up in 2-3 of the 4 seasons for minimum and median flows, especially autumn and late summer
- Little change to all seasons in Ohio for maximum flows

Credit: USGS

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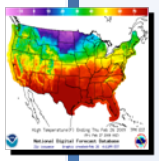


Regional Storm Trends

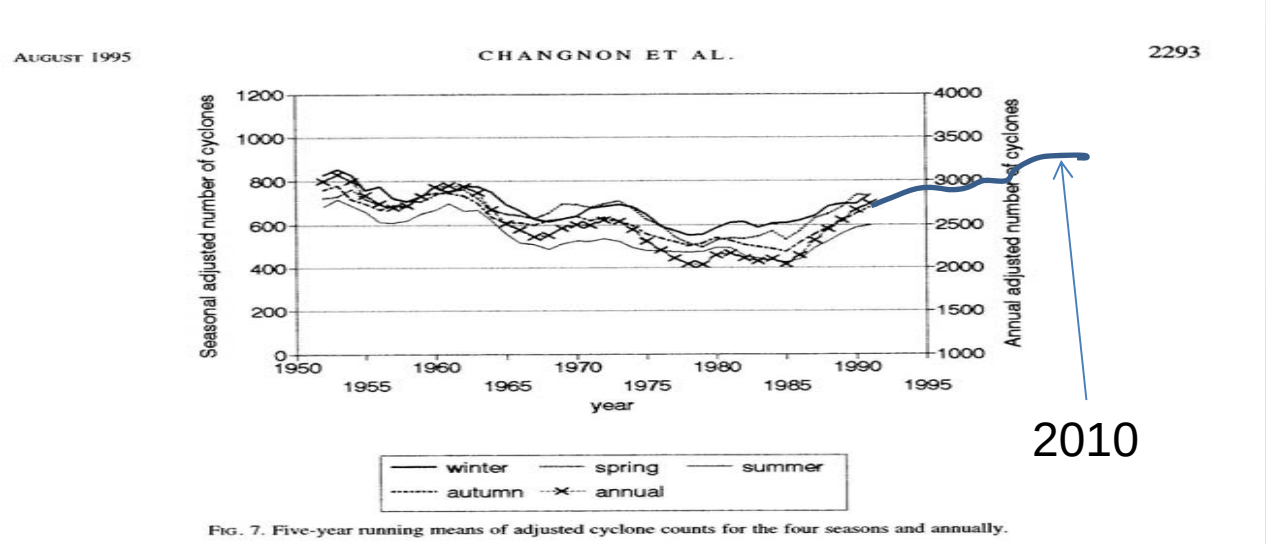
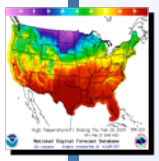
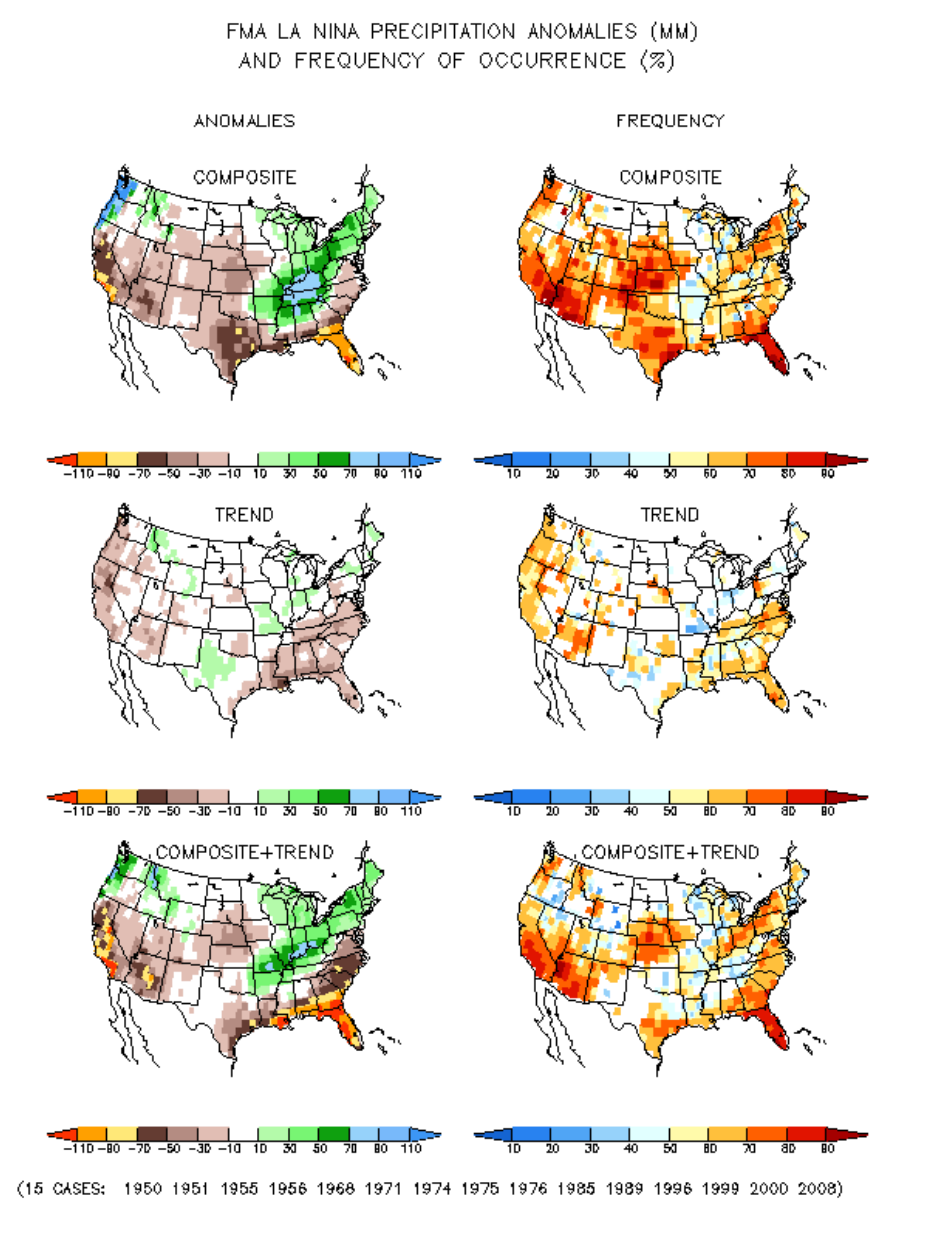


FIG. 7. Five-year running means of adjusted cyclone counts for the four seasons and annually.

- *Natural variability in the system does account for some of the change, climate system is always changing, but we can't explain all the change through natural processes*
- *1900 to 1950s was very active then less active period from 1960s to 1990s*
- *We have now returned to a more active period with INCREASED RISK!*



Climate Trends/Change Impacts – La Nina Risk



- Typically La Nina events have their best relationship during the winter and early spring
- The stronger the La Nina the better the relationship
- Heavy rain along the Ohio River and adjacent areas is common

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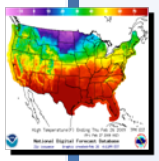
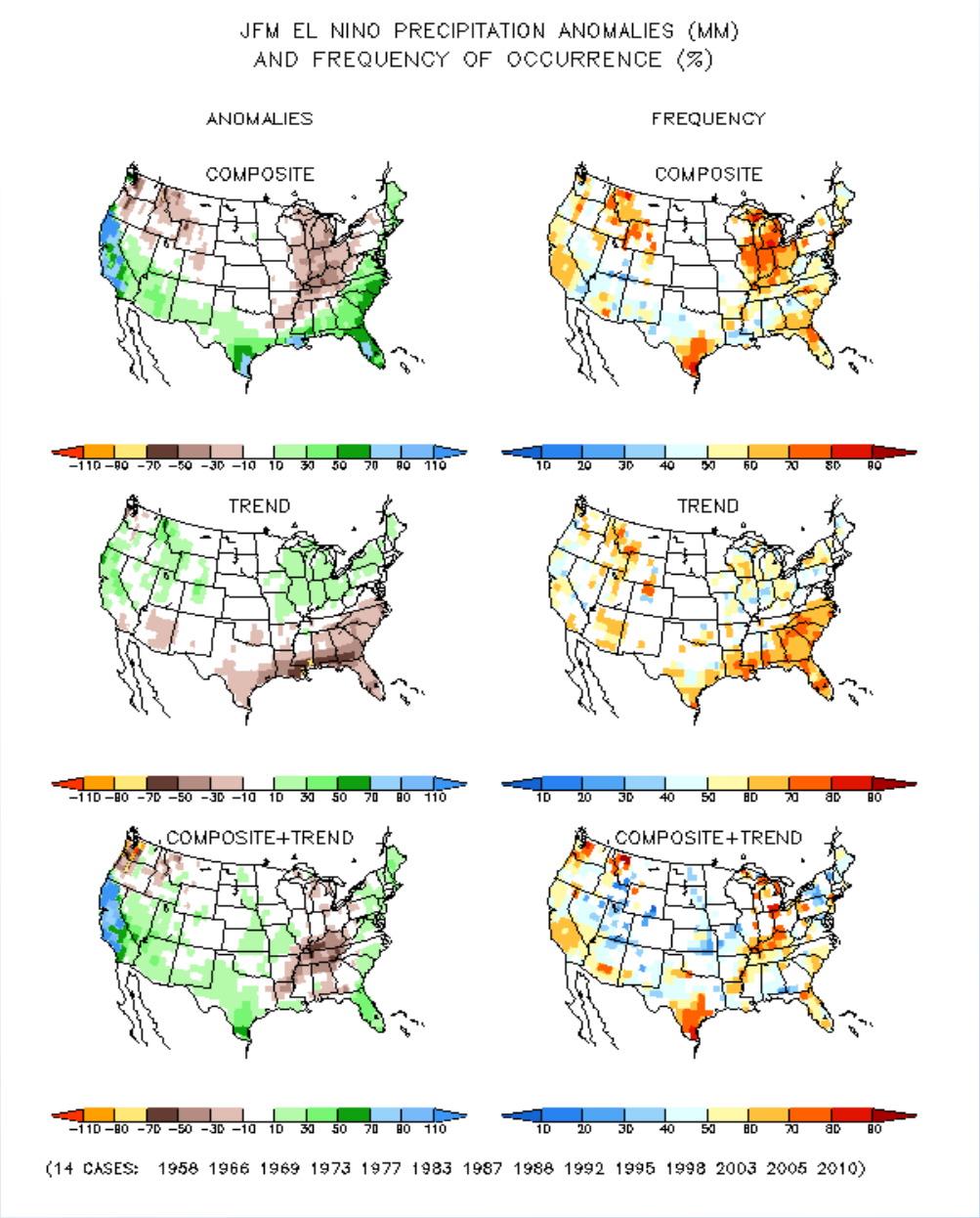


Climate Trends/Change El Nino Risk



- Typically El Nino events have their best relationship during the winter and early spring
- The stronger the El Nino the better the relationship
- It tends to be drier in Ohio

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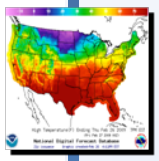

Change vs Variability vs Warming

- **Climate Change - the one constant:** The Earth's climate continues to change naturally over time (ice ages etc…)
- **Global Warming:** associated with human induced global influence (post agriculture, post industry)
- **Natural Variability:** Seasonal, Interannual, decadal, multi-decadal climate shifts/cycles that would occur with or without us
  - *Often cyclic (ENSO or PDO or NAO) sometimes not (volcanoes)*
  - *Varies from seasonal cycles to decades*

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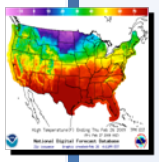
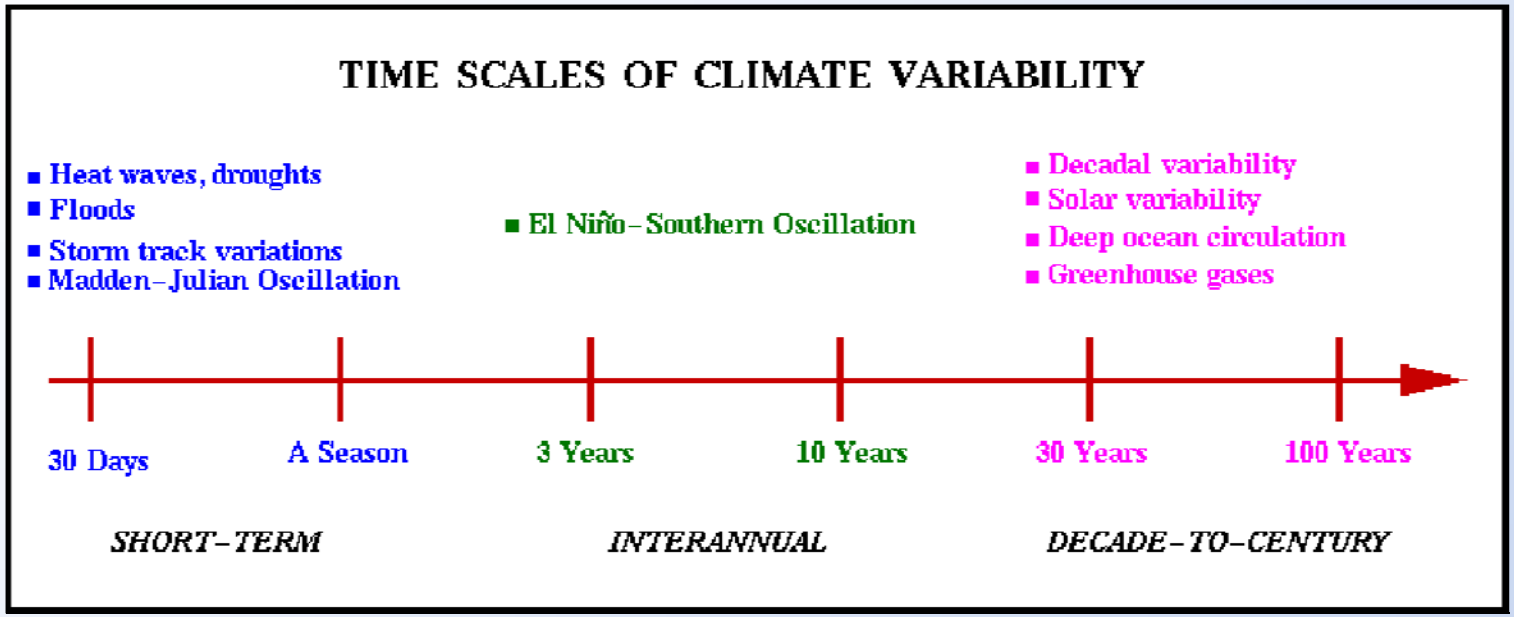


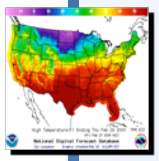
Change vs Variability vs Warming

Decadal + ENSO + Regional + Local + Noise

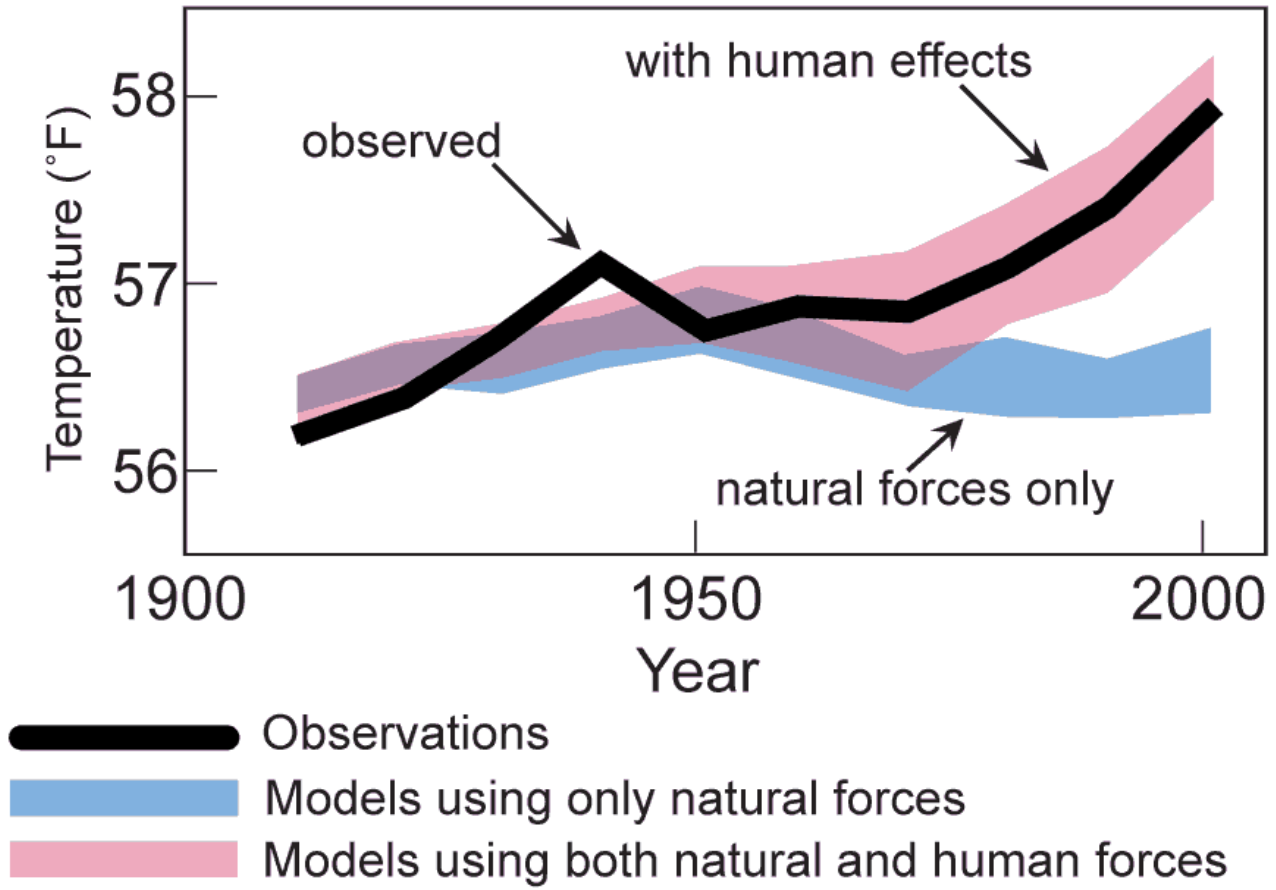
Should not underestimate the "noise"=our (in-) ability to measure correctly: leaving room for surprises!



In the face of uncertainty, adaptation procedures need to be developed which do not rely on absolutely precise projections of change



Separating Human and Natural Influences on Climate



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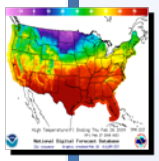
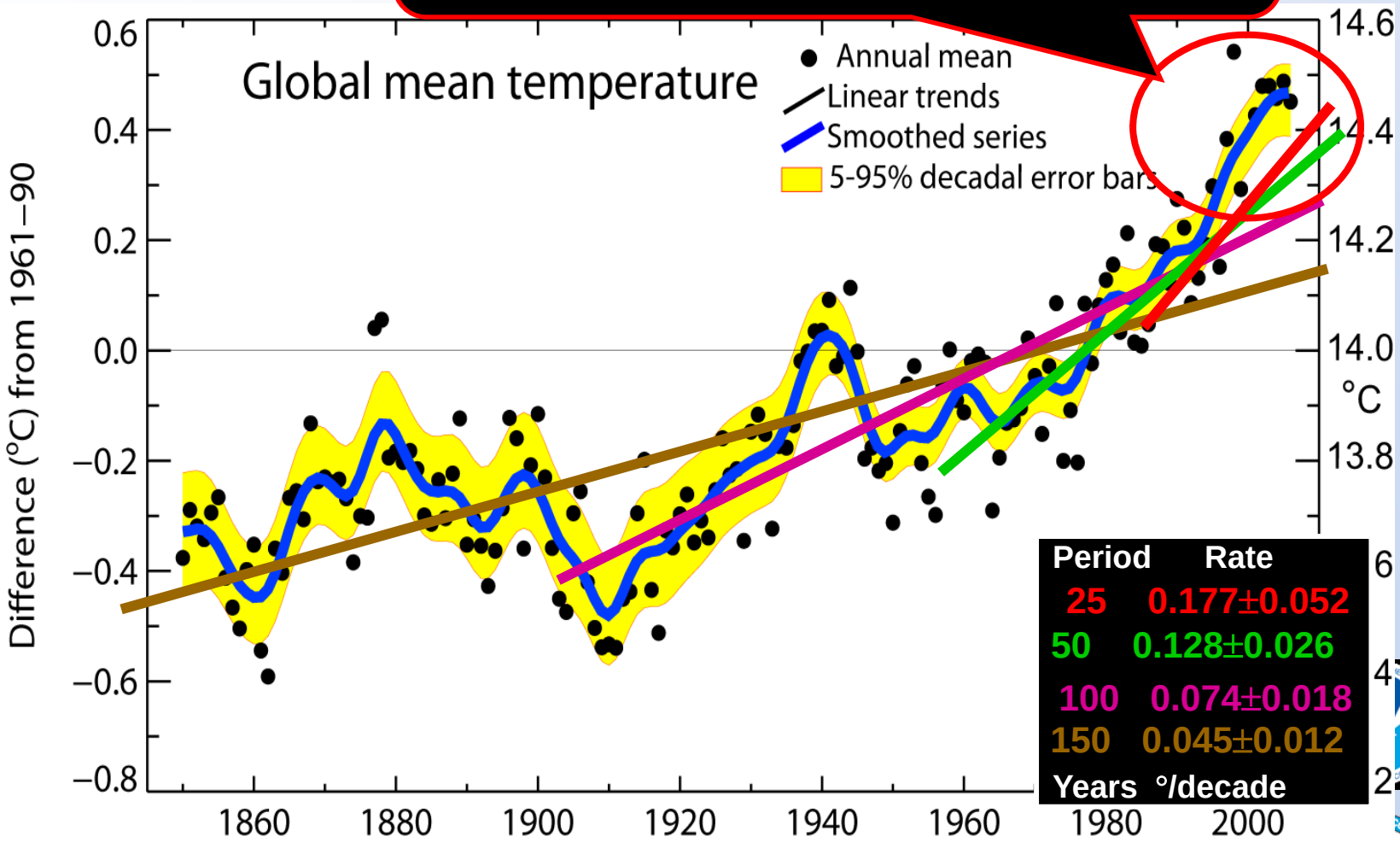


Global mean temperatures are rising faster with time

Warmest 13 years:
2010,1998,2005,2003,2002,2004,
2006, 2001,1997,1995,1999,1990,2000



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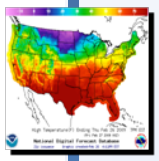

Trenberth

Climate changes are underway in the U.S. and are projected to grow

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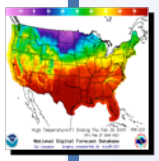
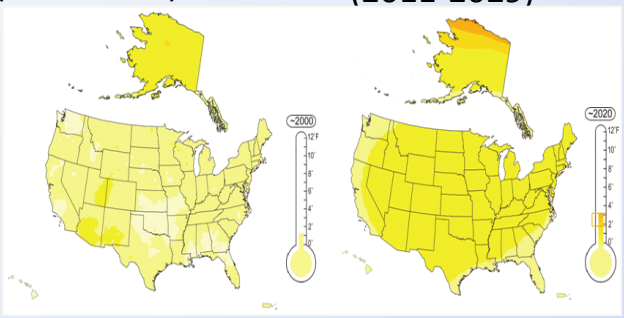
Significant impacts on:

- Water resources
- Energy supply and use
- Transportation
- Agriculture
- Ecosystems
- Human health
- Society



Present-Day Change (1993-2007)

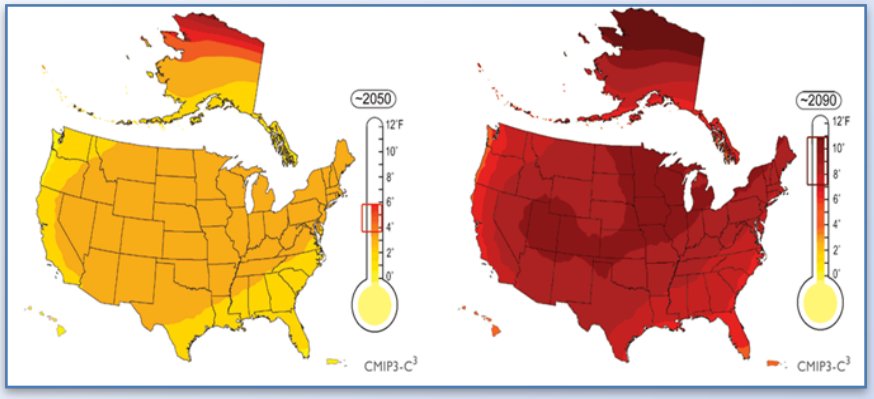
Near-Term Projected Change (2011-2029)



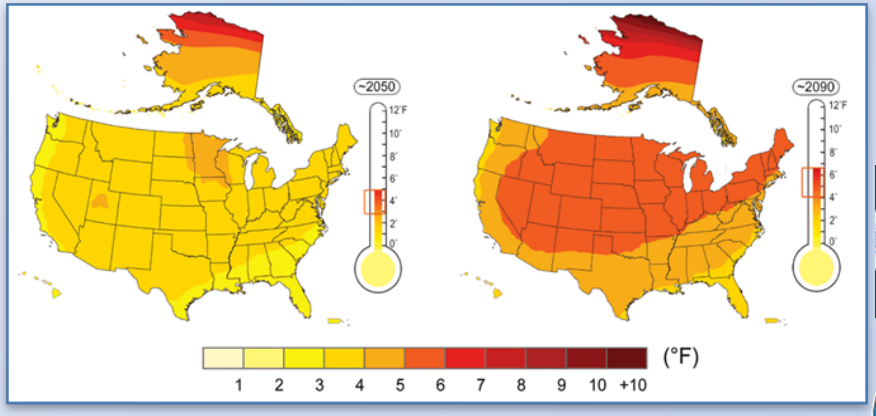
Projected Temperature Change (°F) from 1961-1979 Baseline

Mid-Century (2041-2059 average) End of Century (2081-2099 av.)

Higher Emissions Scenario



Lower Emissions Scenario



Climate changes are underway in the U.S. and are projected to grow

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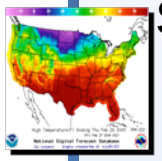
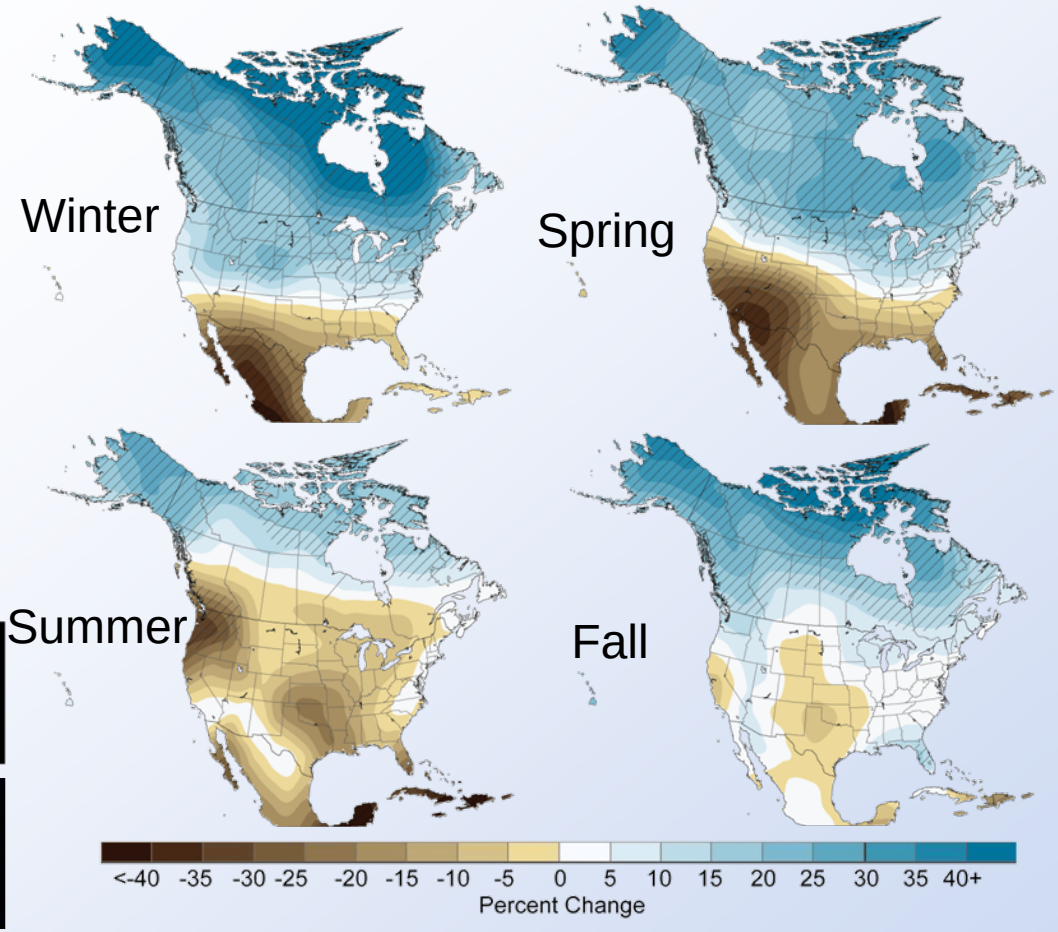


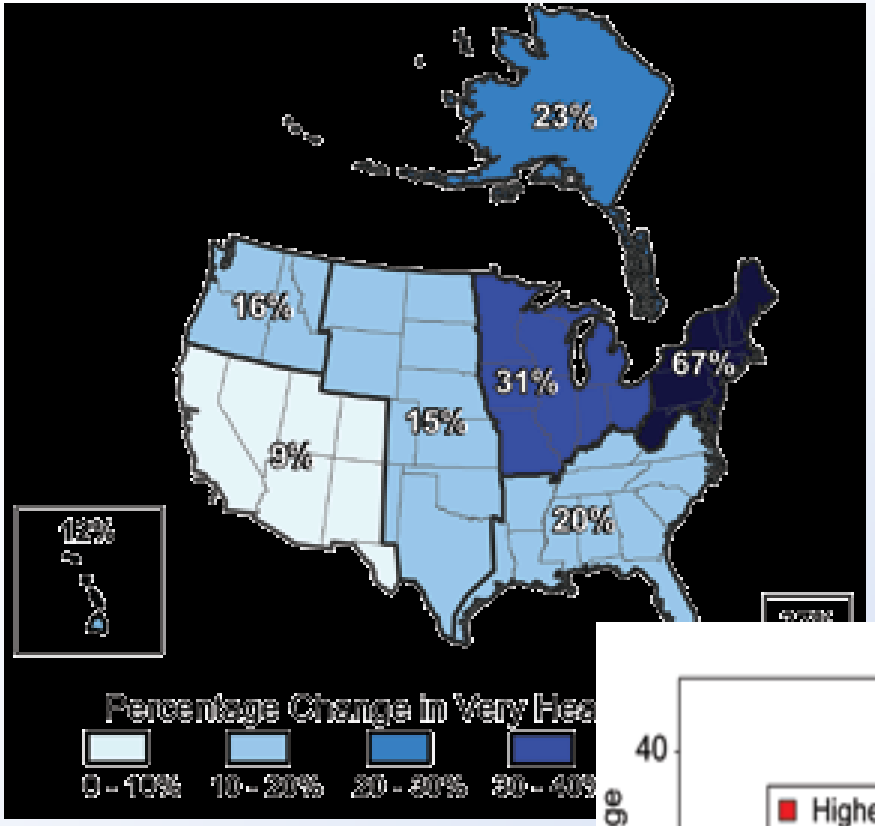
Projected Change in Precipitation by 2080-2099

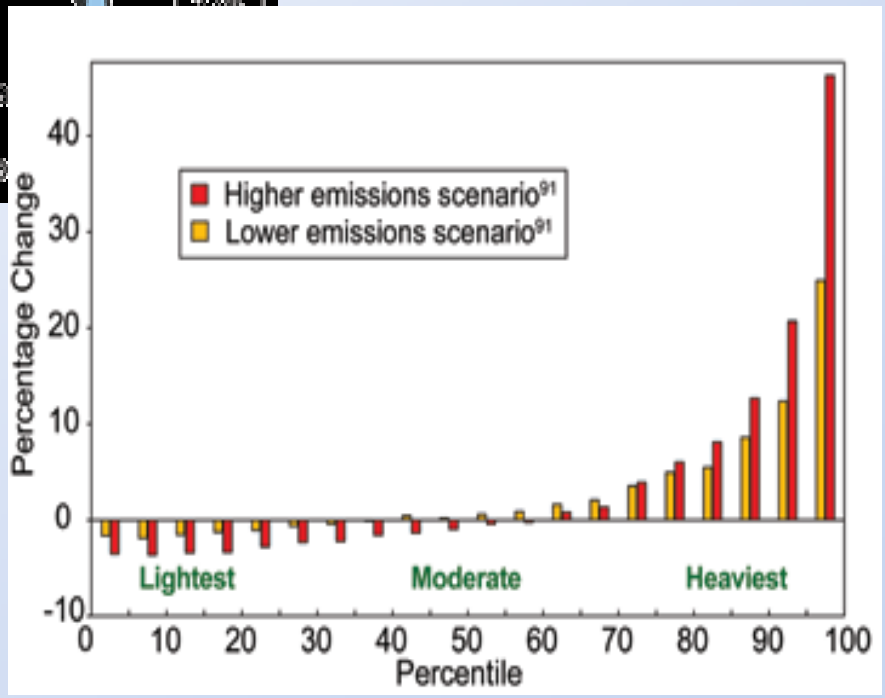


Higher emission scenario

- Confidence in precipitation projections generally lower than for temperature
- Good confidence in overall pattern (wetter north, drier south)
- Less confidence in exact location of transition

Climate Change -Heavy Rainfall





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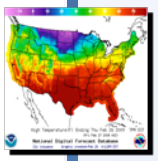
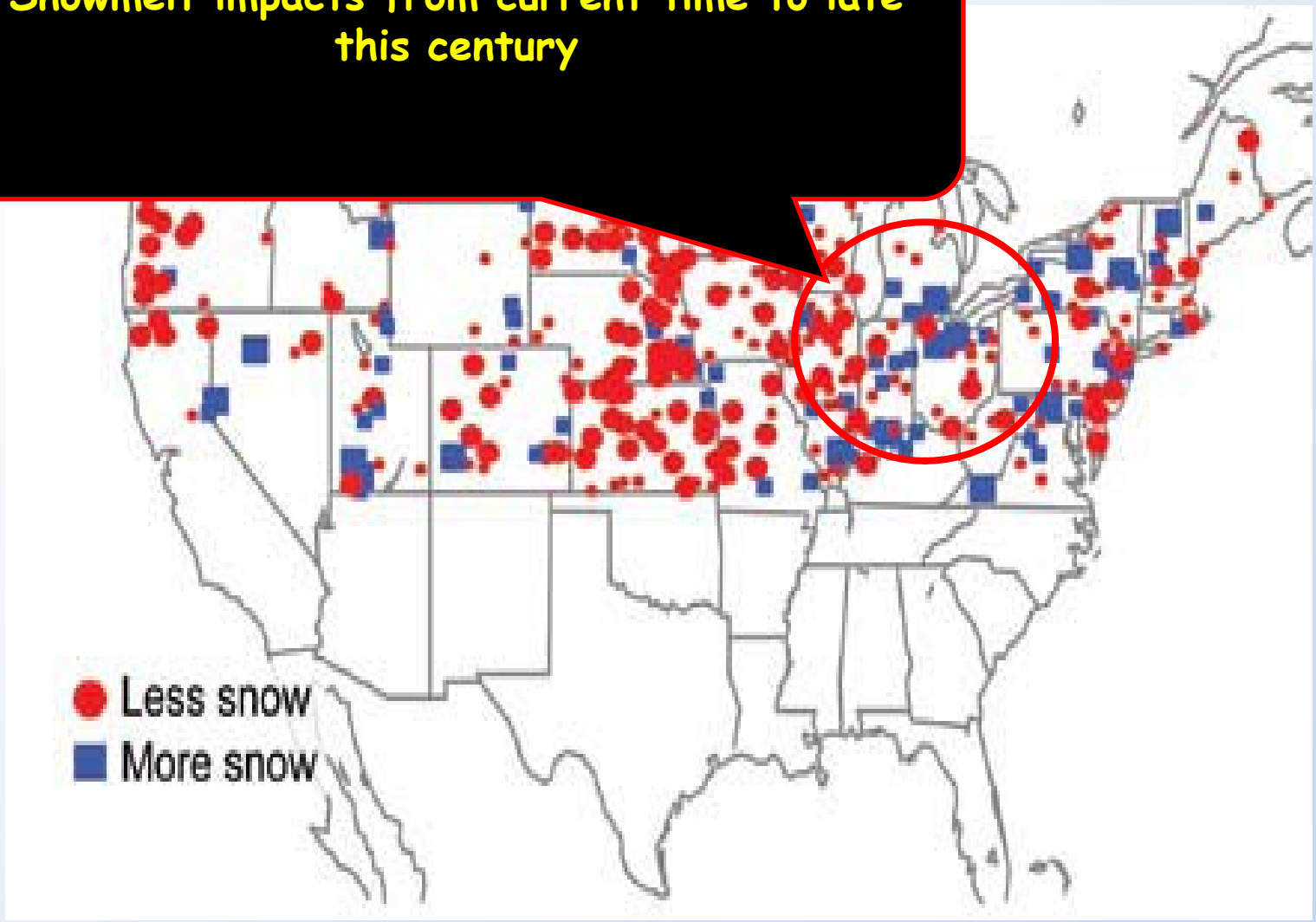


Snowfall, Melt and Streamflow

Snowmelt impacts from current time to late this century



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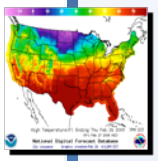

Widespread climate-related impacts are occurring now and are expected to increase

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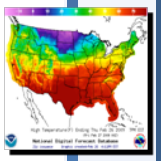
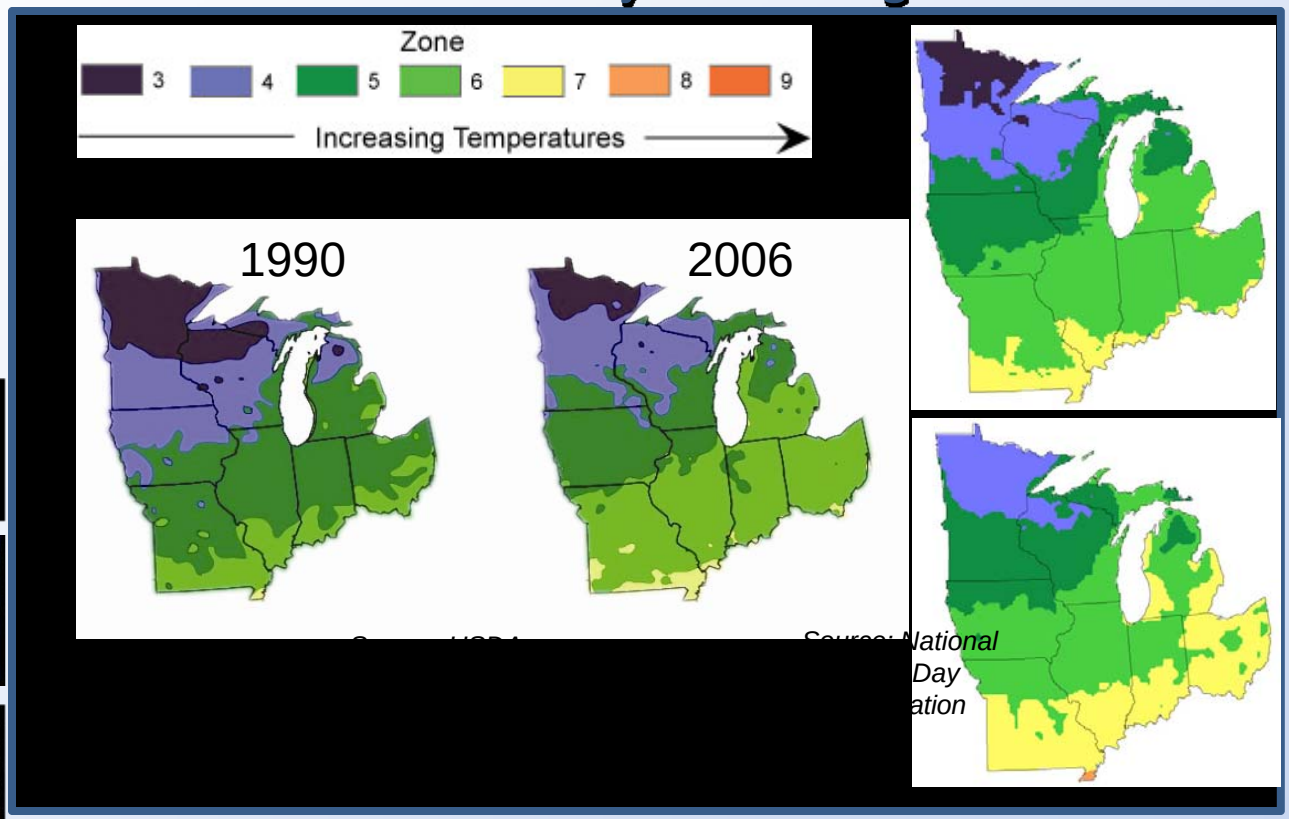


Your own backyard

Major shifts in species are expected, such as maple-beech-birch forests being replaced by oak-hickory in the Northeast. Insect infestations and wildfires are projected to increase as warming progresses.

Observed and Projected Changes in Plant Hardiness Zones



Lower Emissions Scenario by 2090

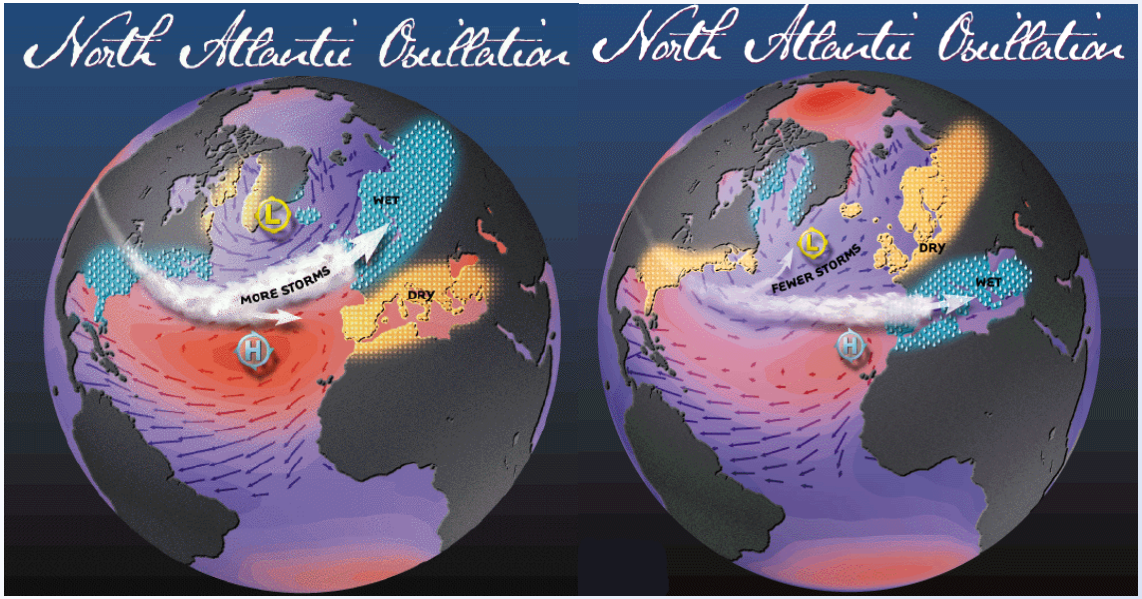
Source: CMIP-3

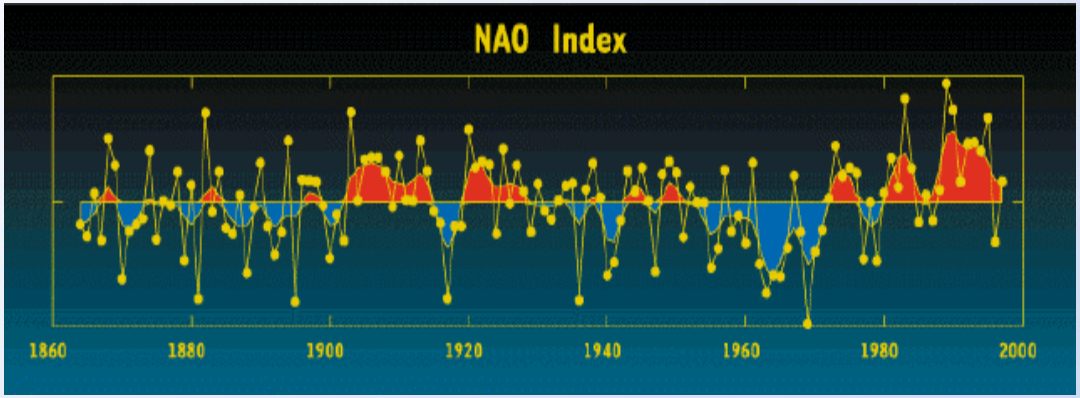
Higher Emissions Scenario by 2090

Source: CMIP-3

Source: National Day ation

Climate Impacts on Ohio Valley - Example





Credit: Columbia University

- North Atlantic Oscillation – relationship between low pressure near Greenland and high pressure in the Atlantic
- Great influence on Ohio weather
- Longer-term climate change can impact shorter-term weather and climate events
- NAO has been more negative since early 2000s

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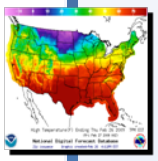
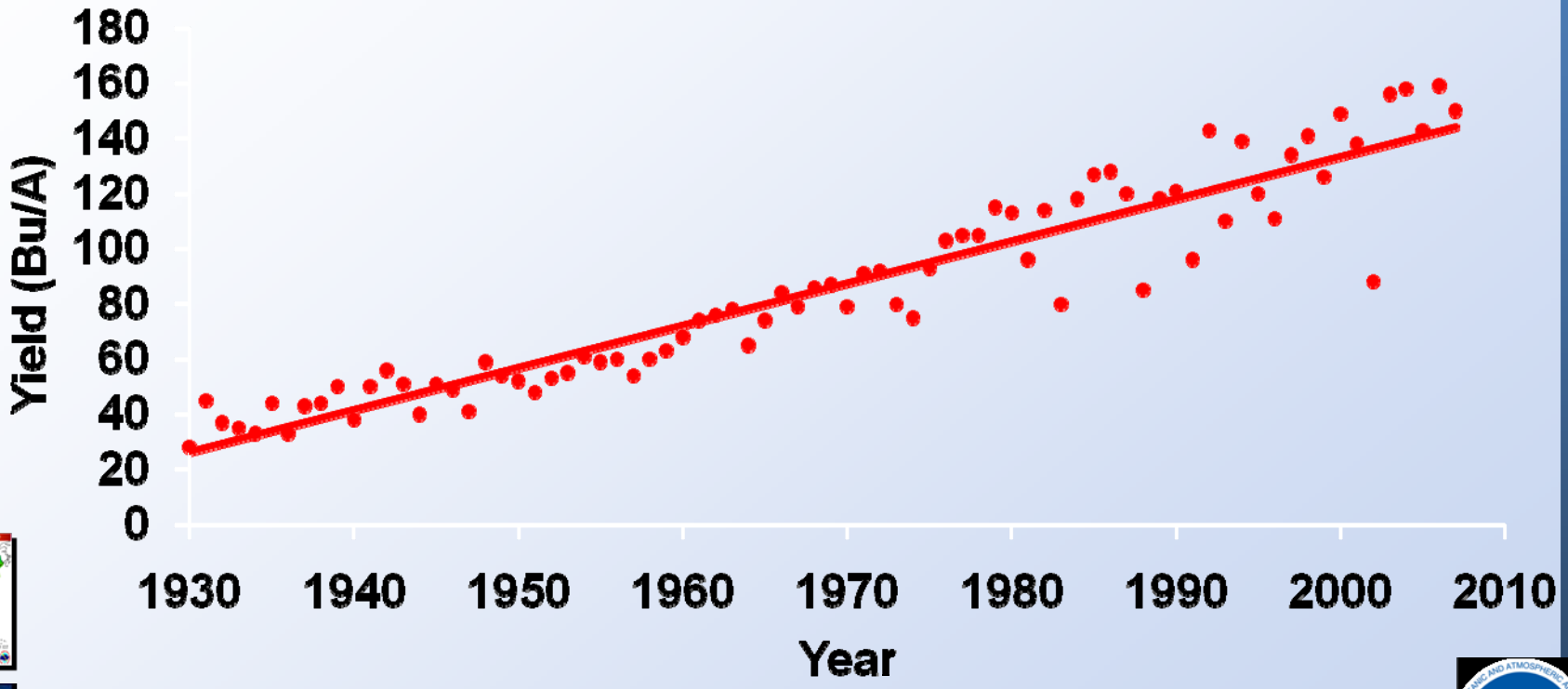


Ohio Corn Production
Historical Yield Data, 1930-2007



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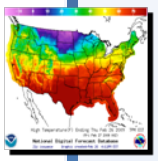
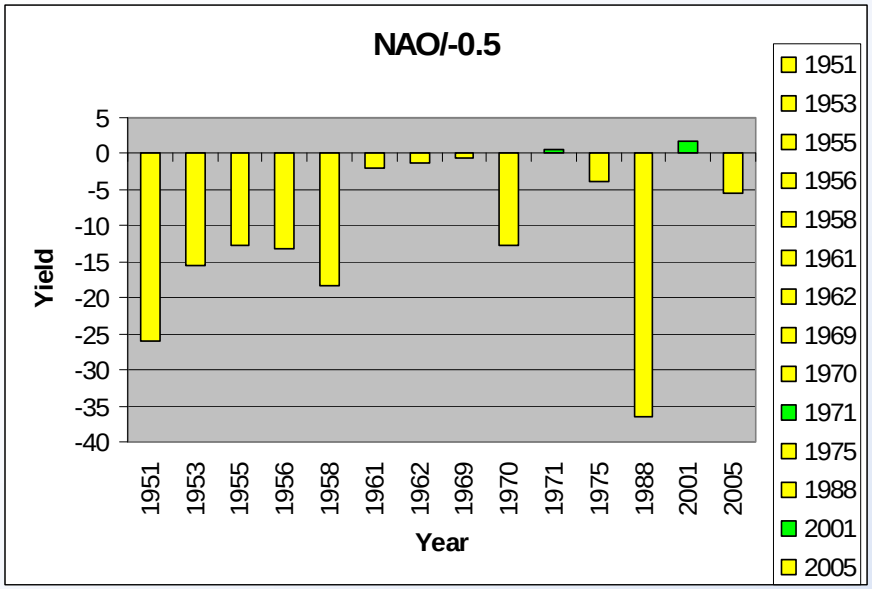
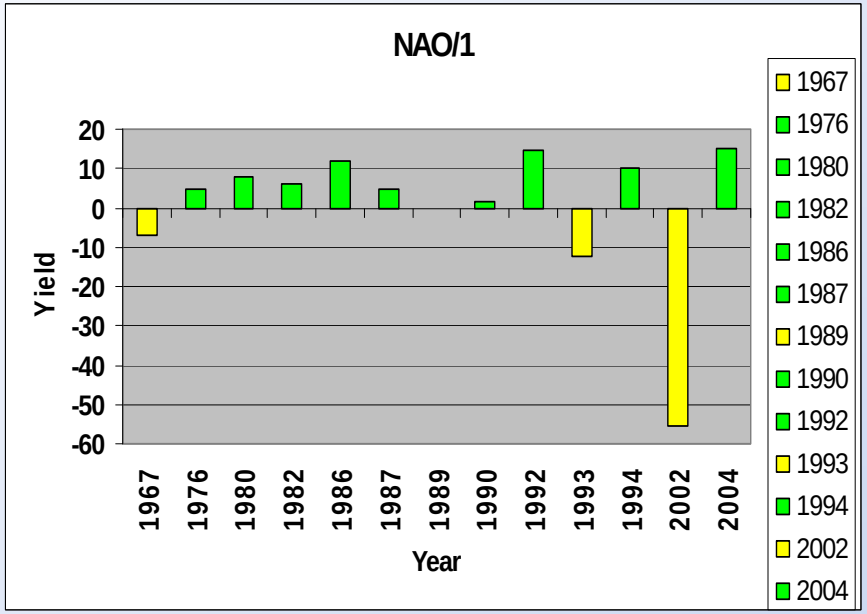


Climate Impacts on Ohio Valley - Example





- When NAO is negative, corn yields 10% below normal in Ohio
- When NAO is positive, corn yields up 8% above normal in Ohio
- NAO does change over time and is influenced by many factors

Research: Joint Ohio State University and NOAA/NWS/Ohio River Forecast Center

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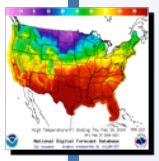
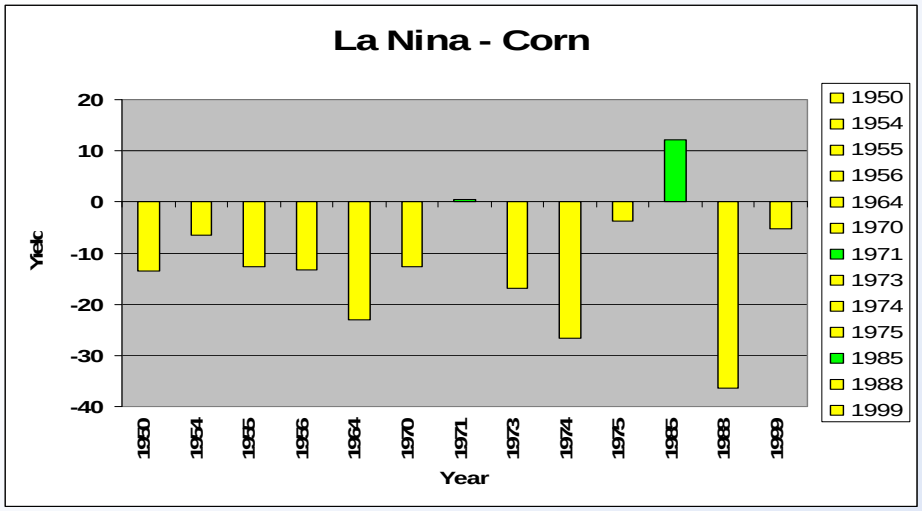
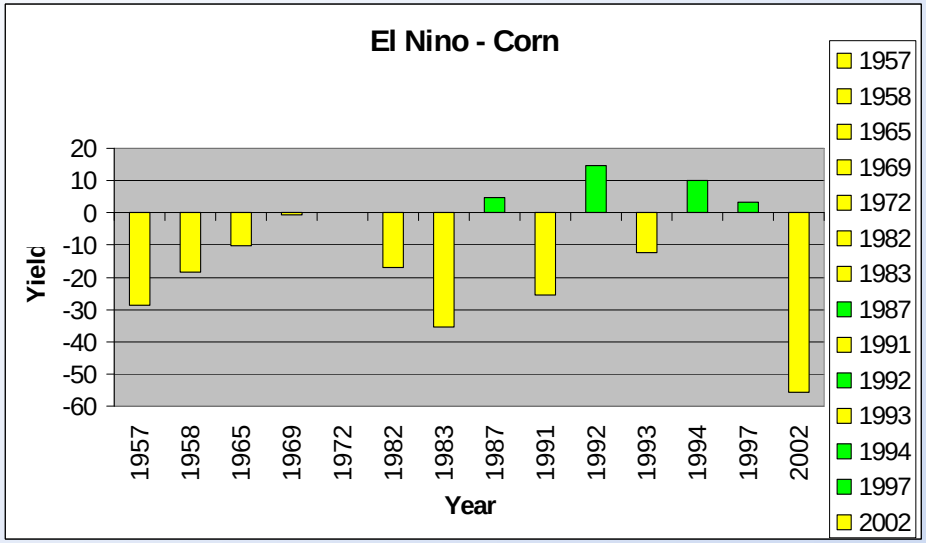


Climate Impacts on Ohio Valley - Example





- Crop yields fall typically 10-12% below normal when a La nina or El Nino event occurs in the Pacific.
- More fluctuations in our climate will yield greater fluctuations in ENSO which will have an impact on Ohio agriculture

Research: Joint Ohio State University and NOAA/NWS/Ohio River Forecast Center

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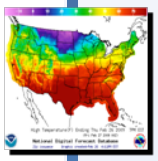

Ohio River Basin Climate Change Pilot Project

- Multiple agencies working together on a USACE funded pilot project that will be discussed more here shortly
- Currently, we are in the process of gathering the data from an ensemble of climate models for rainfall and temperatures
- We will run this through our hydrologic model and pass flow outcomes to the group.

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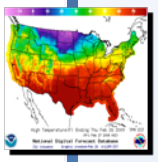

Ohio River Basin Climate Change Pilot Project

- This project will use the process used in the Red River Project for accessing climate change.
- They will work take the outcomes to work on adaptation strategies etc.

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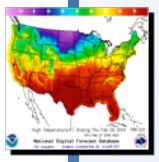

Water Resources Outlooks

http://www.erh.noaa.gov/ohrfc/WRO.shtml

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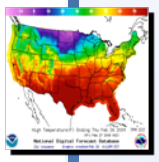

Water Resources Outlooks

- *Subscribe to the Ohio River Forecast Center Water Resources Outlook*
- *Monthly Outlook talking about flood and drought risk*
- *Probability maps*
- ***Send an email to me at James.Noel@noaa.gov to be added to list***
- ***Get it without the email at this website***

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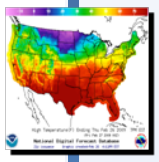

Discussion:
http://www.erh.noaa.gov/ohrfc/HAS/text/wro.txt

http://www.erh.noaa.gov/ohrfc/WRO.shtml

Summary

- Climate is changing and will continue to do so – it's a part of our system
- We can explain some of the change through natural variability but we can't explain all of it through that process
- Climate Change will impact the things going on right here in the Ohio Valley (such as water quantity, quality and shifts of hydrologic seasons some)
- No matter how you look at it, risk will be on the rise the next 50 years!

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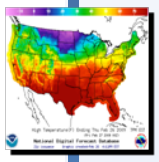

Summary

- **Multiple agencies are working together on the Ohio River Basin Climate Change Pilot Project through 2013.**

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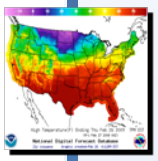

Summary

- Some parts of the country climate models do better than others. The Ohio Valley is a tough place as the jet stream flows through here.
- The climate will change. Variability will likely increase. Predictability will not be high in our region.
- It is all in the details and the details will be tough to resolve regionally here.
- Developing innovative and flexible adaptation will be the best and smartest thing to do.

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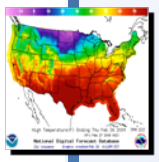

Questions!

- James.Noel@noaa.gov

NOAA/NWS/Ohio River Forecast Center

Service Coordination Hydrologist

THANKS!

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