

Climate change in the Northeast US: Past, Present, and Future

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Outline

1. Global climate change context
2. Historical climate change in the Northeast U.S.
3. Future climate change in the Northeast U.S.

Take-home messages

- The Northeast US has gotten warmer and wetter; precipitation has become more intense
- These trends will continue in the coming decades
- There is a large sensitivity to the emissions scenario, but not until mid century
- Natural variability is important, particularly for precipitation

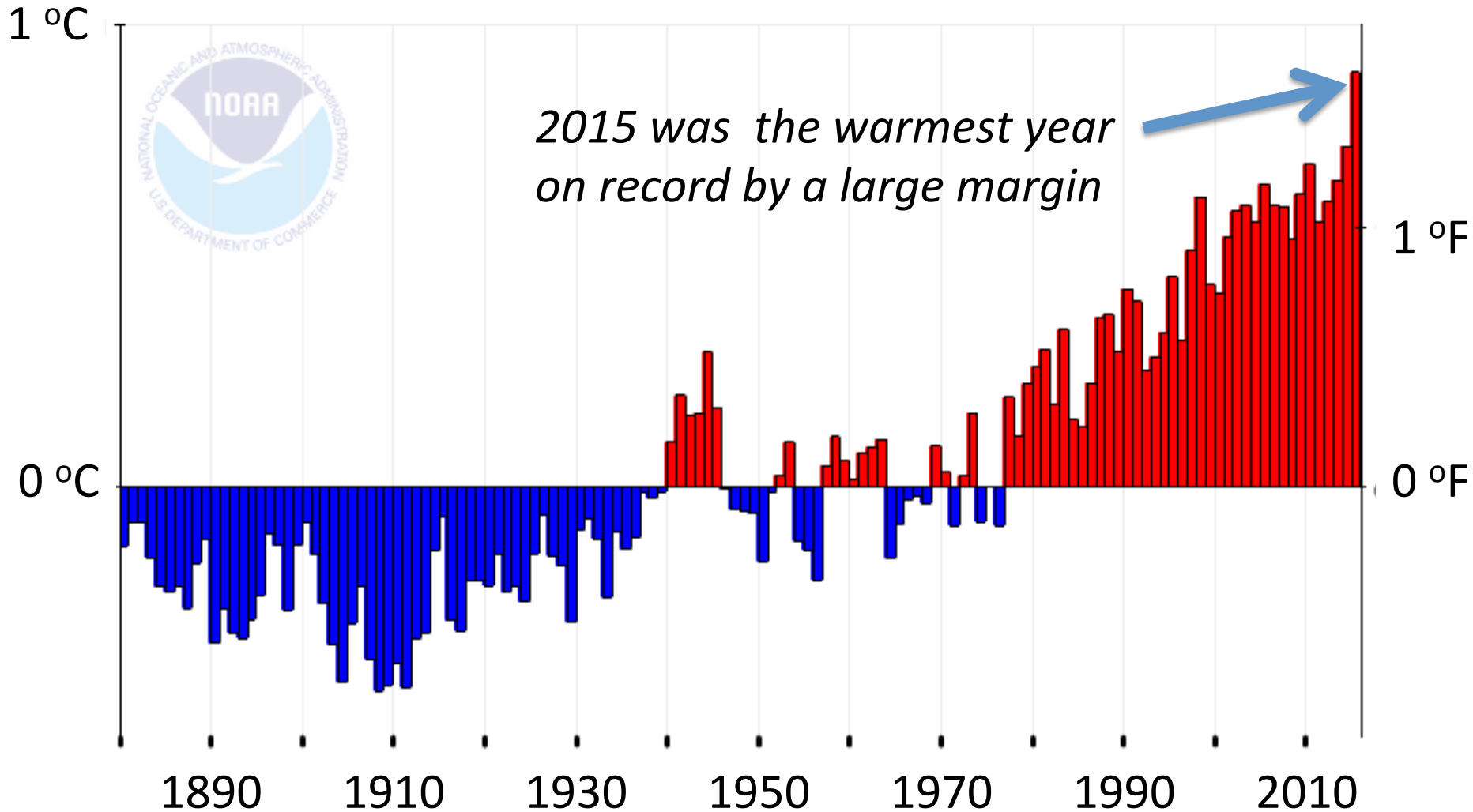
Global context:
IPCC Fifth Assessment
Report (2013)
The Physical Science Basis



- *“Warming of the climate system is **unequivocal**”*
- *“Many of the observed changes since the 1950s are **unprecedented** over decades to millennia”*
- *“It is **extremely likely** that human influence has been the dominant cause of the observed warming since the mid-20th century”*

Climate system warming of is unequivocal

Earth's mean surface temperature change over the past 135 years





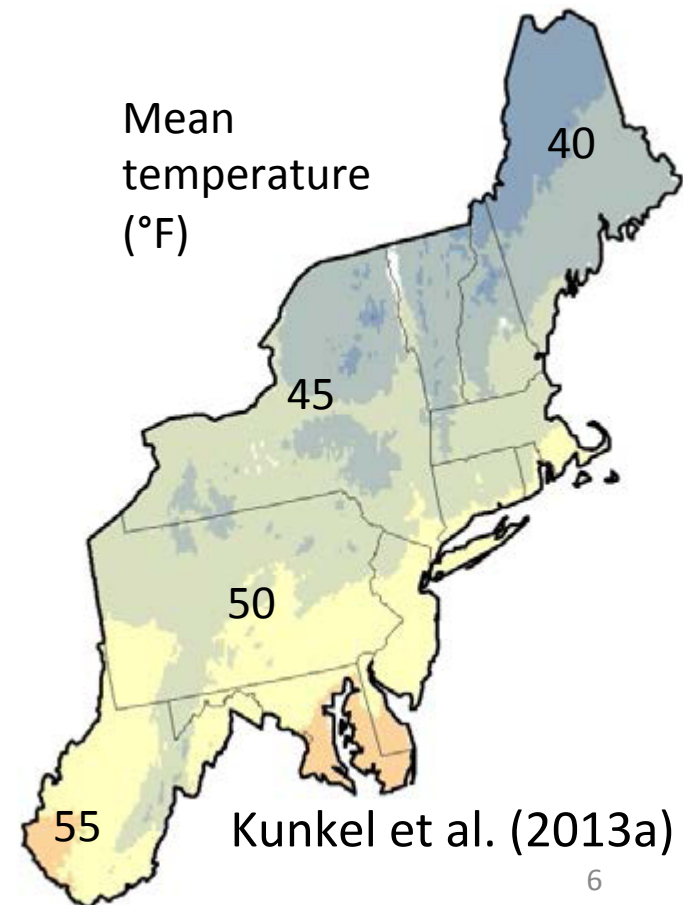
U.S. Global Change Research Program

National Climate Assessment

- NCA released in 2014
- Northeast climate data and model analysis released January 2013

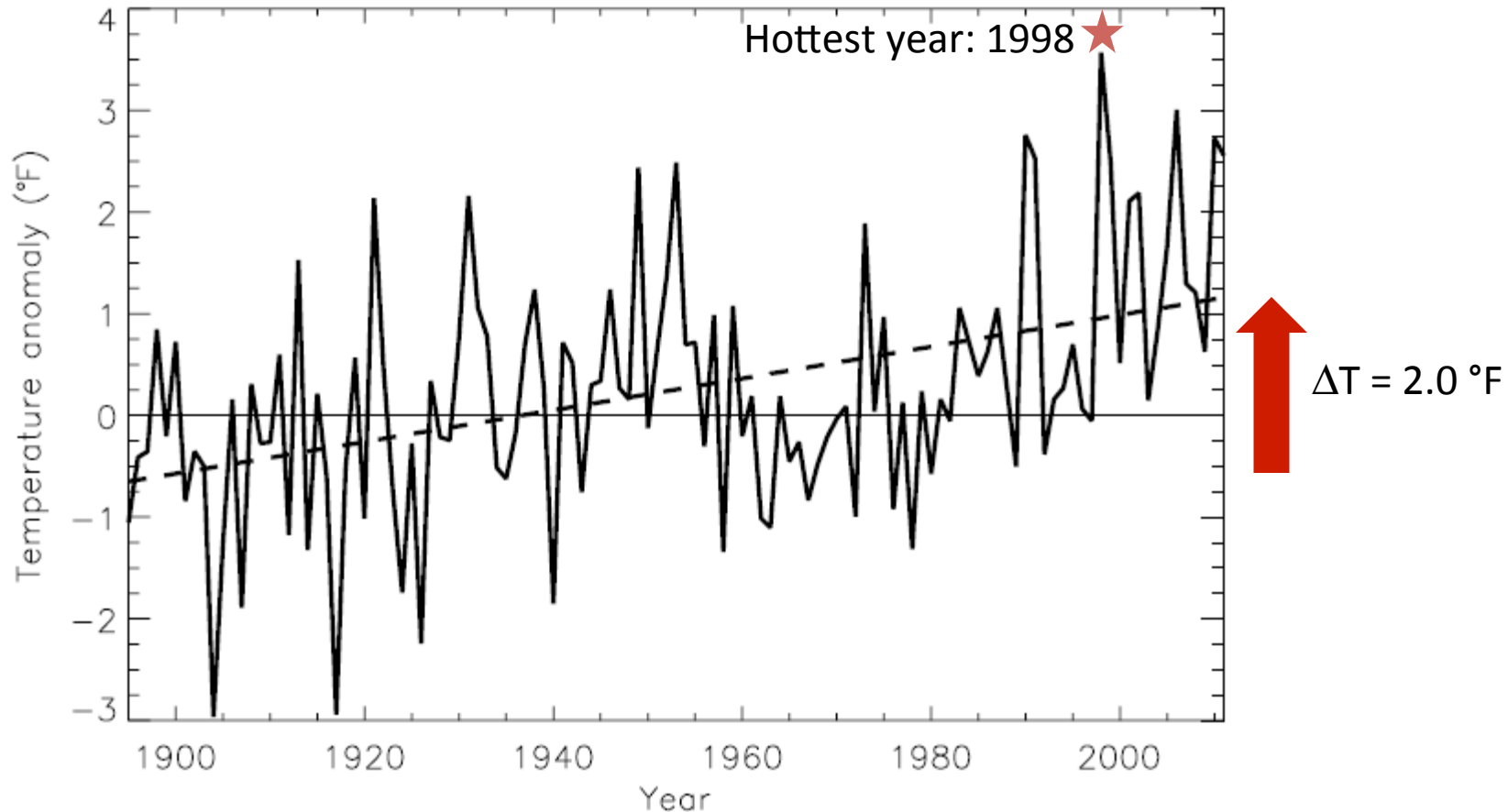


Kenneth Kunkel



The Northeast US has warmed

Temperature anomaly for the Northeast U.S.: 1985-2011

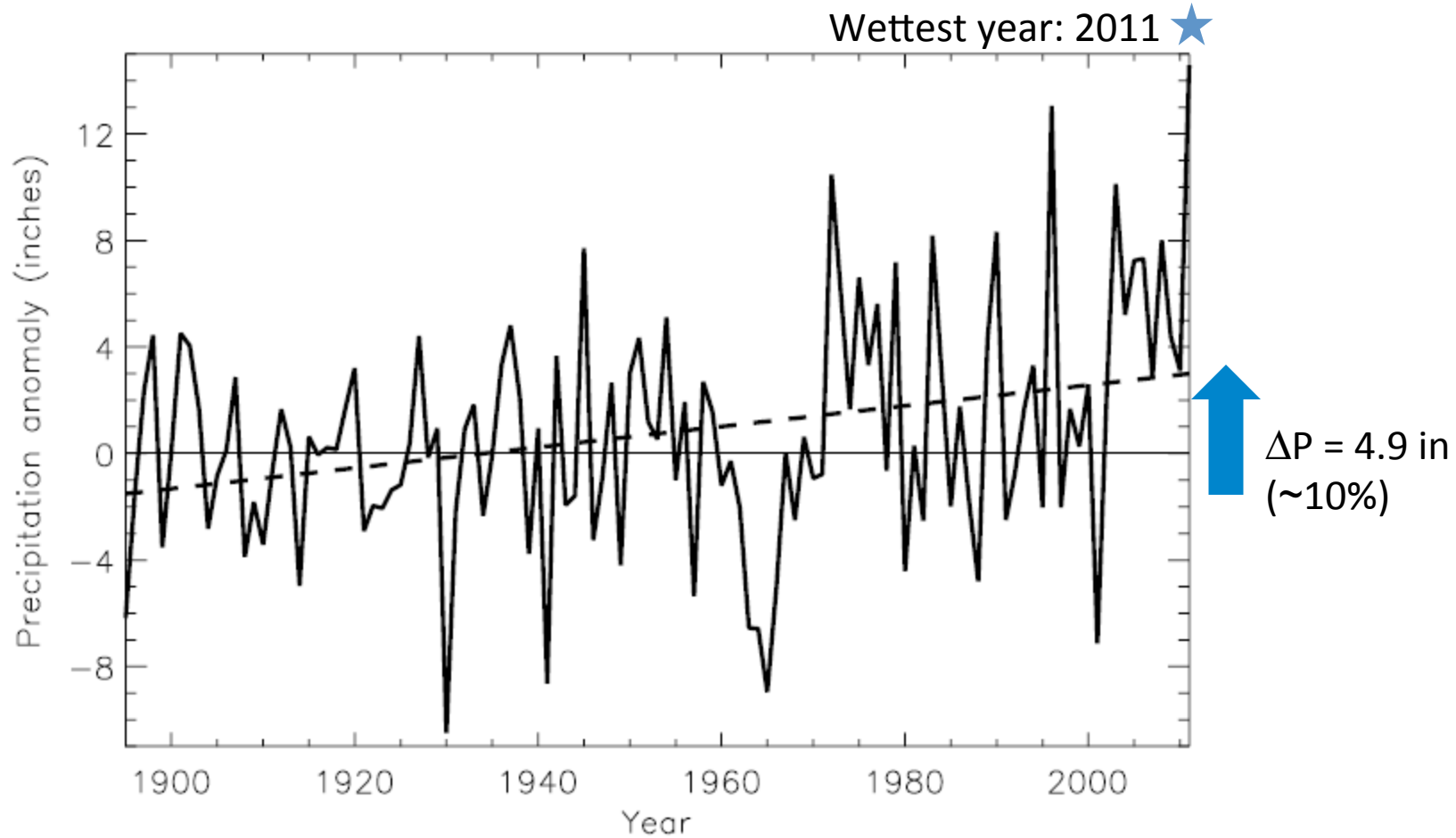


>95% significance annually and in all seasons

Kunkel et al. (2013a)

The Northeast U.S. has gotten wetter

Annual precipitation anomaly for the Northeast U.S.



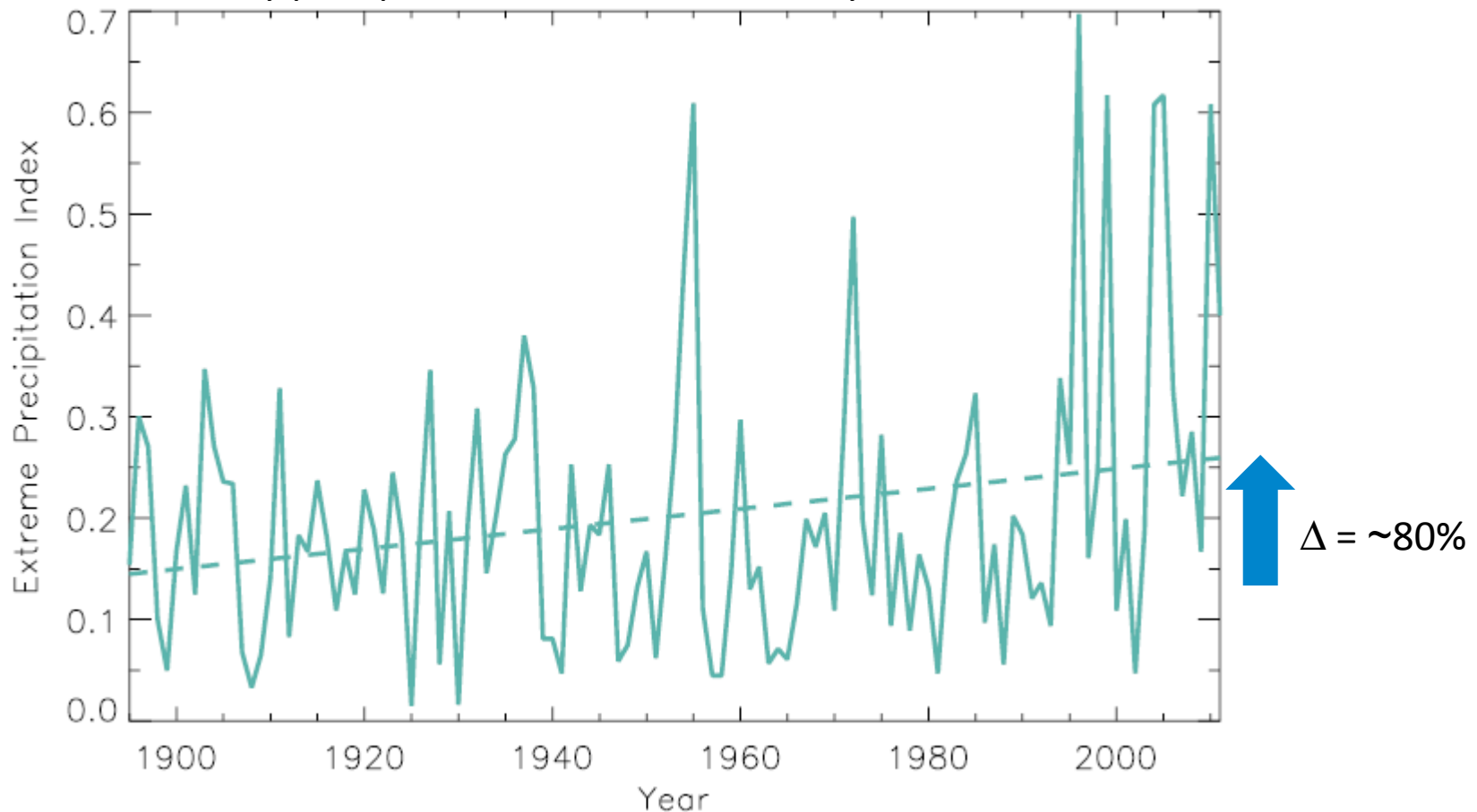
>95% significance in annually and in the fall

Kunkel et al. (2013a)

Precipitation has become more extreme

Extreme precipitation for the Northeast: 1985-2011

Based on daily precipitation events with a five-year recurrence interval

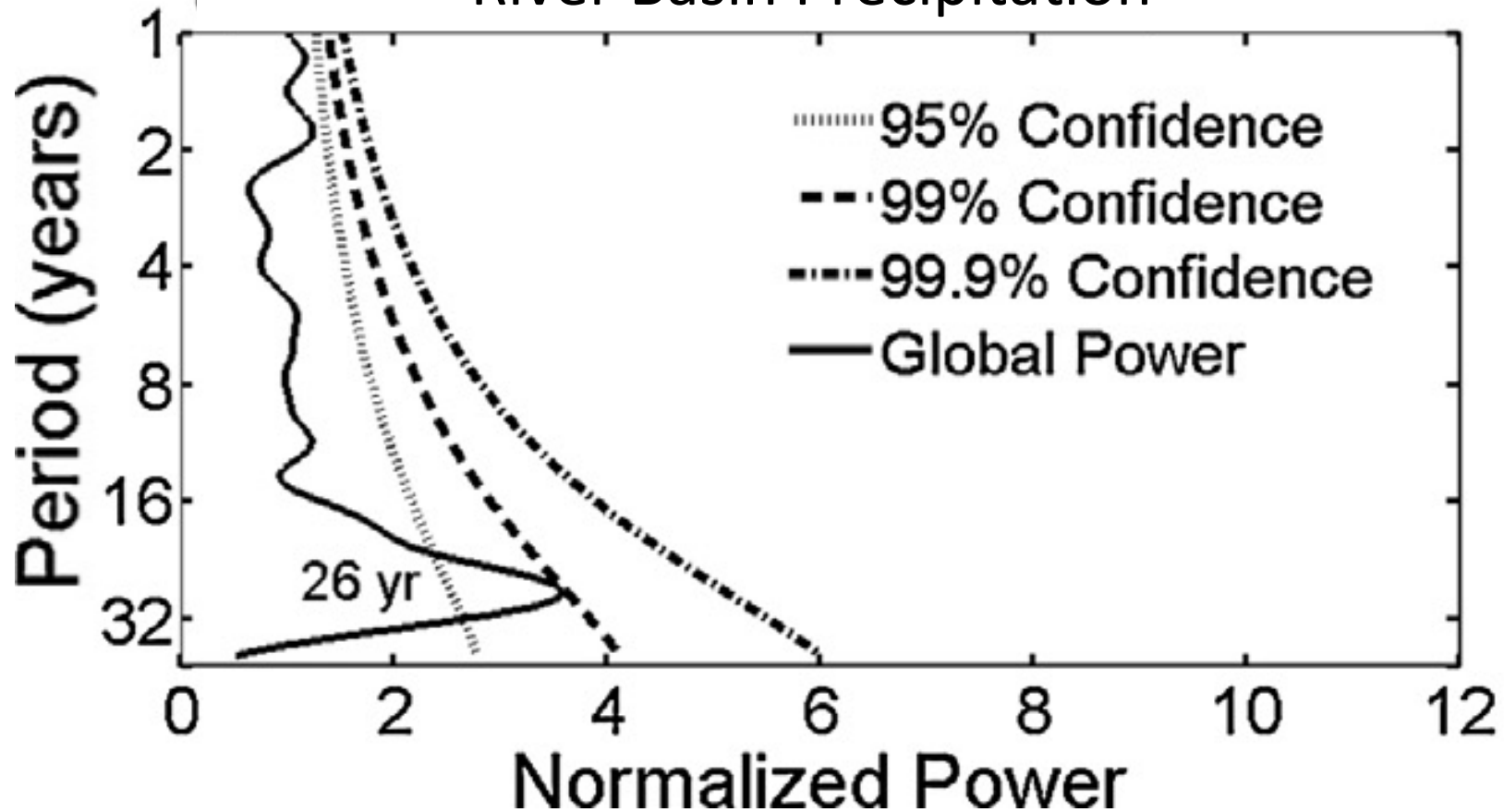


Not >95% significance!

Kunkel et al. (2013a)

Natural variability is important

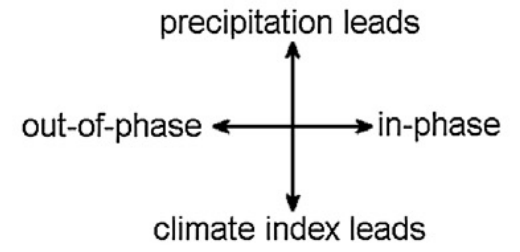
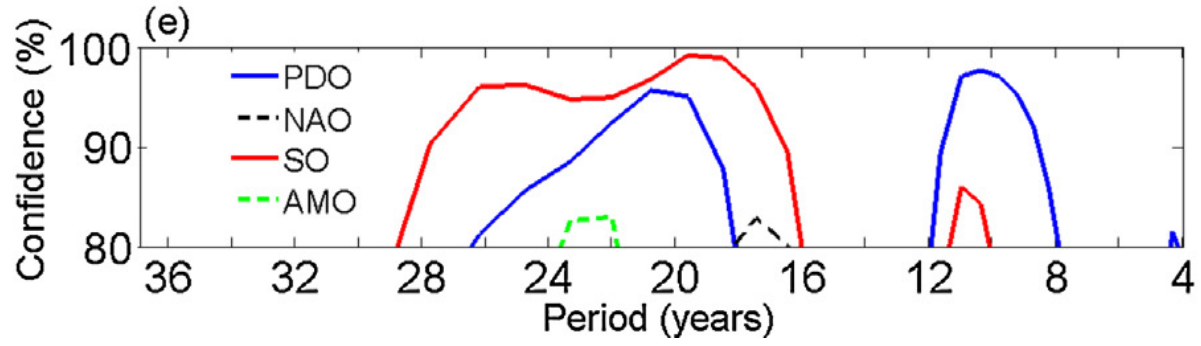
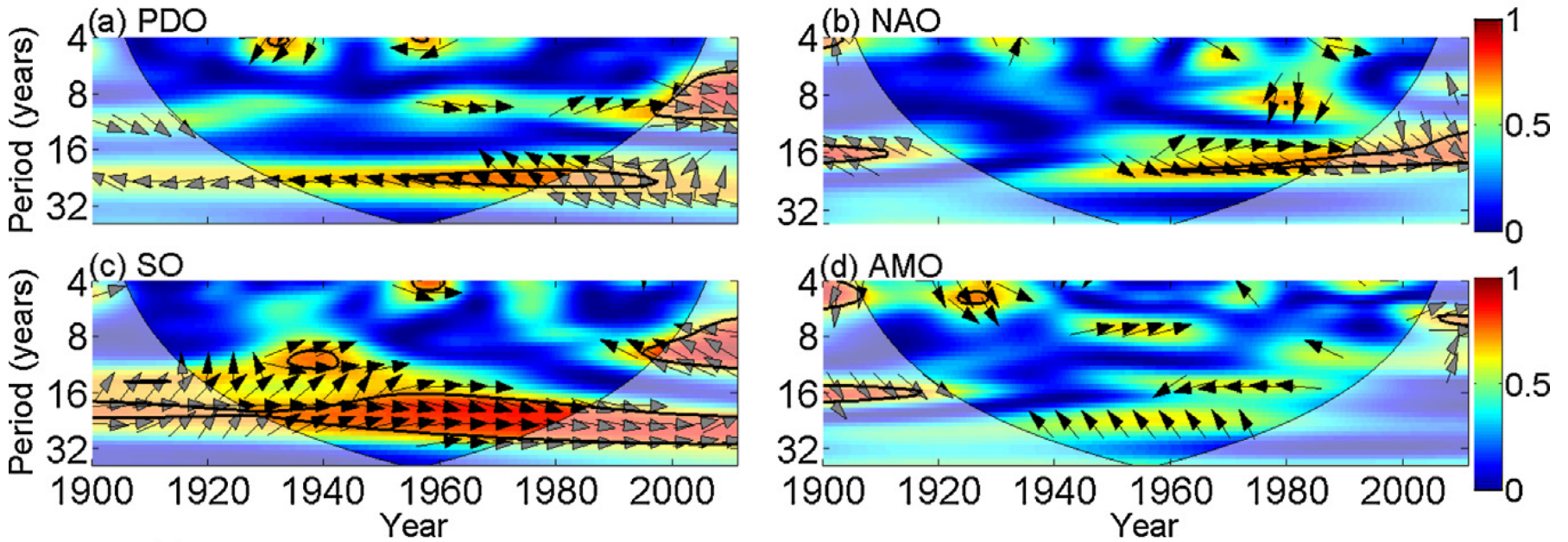
Global Wavelet Power of Susquehanna River Basin Precipitation



Significant power at a period of 20-30 years. Related to Pacific Ocean climate modes (PDO and ENSO).

Decadal-scale variability in Susquehanna Basin precipitation is linked to the Pacific Ocean climate modes

Wavelet Coherence Between SRB Precipitation and Climate Indices



US Climate Projections



U.S. Global Change Research Program

National Climate Assessment

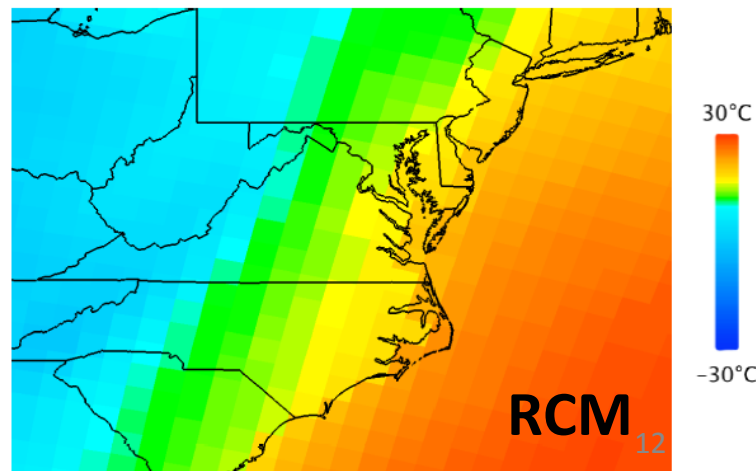
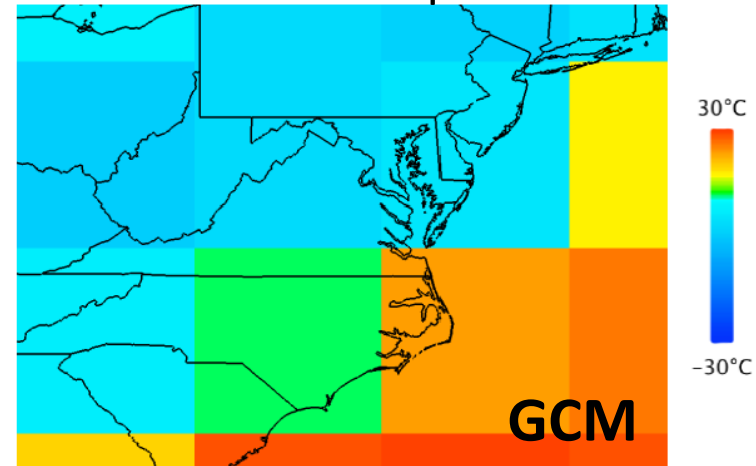
15 Global Climate Models (GCMs)

Coarse resolution, multiple emissions scenarios, full 20th-21st century

11 Regional Climate Models (RCMs)

finer resolution, single emissions scenario, late 20th / mid 21st century

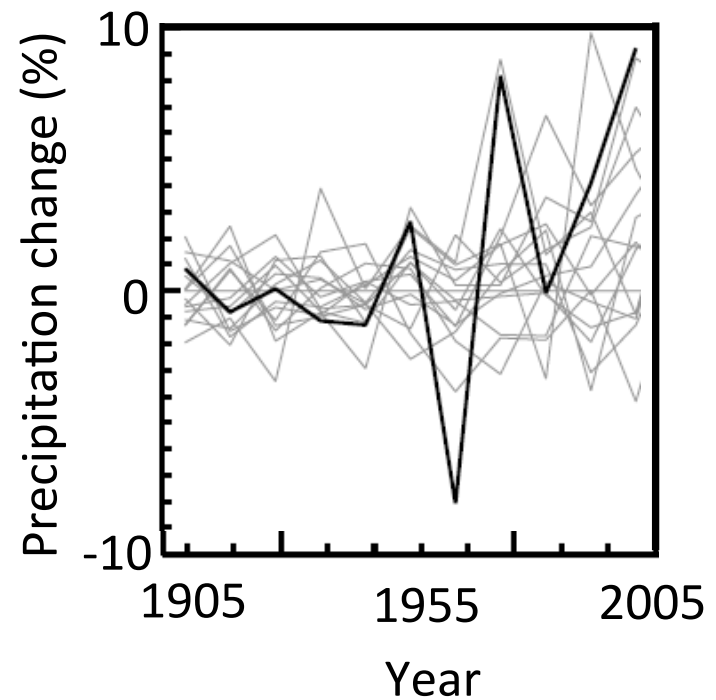
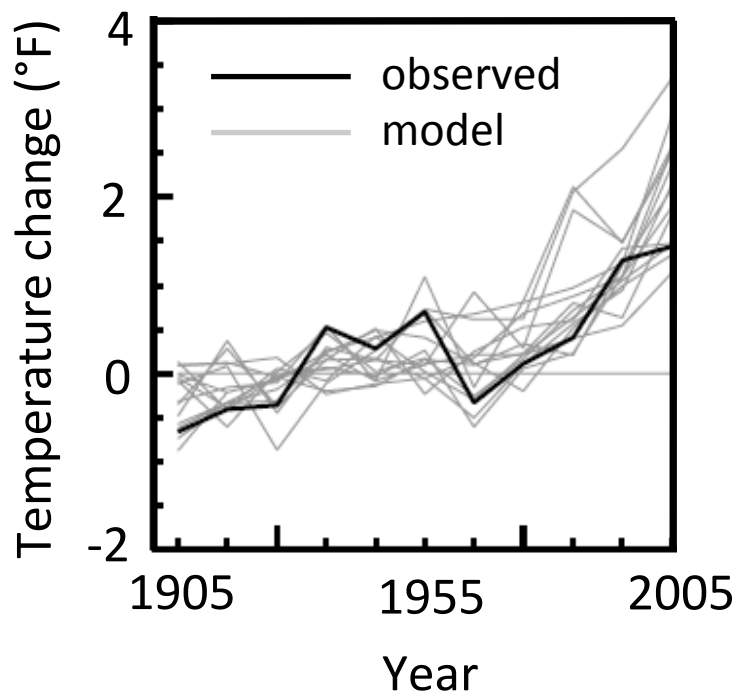
Surface air temperature



Graphics courtesy Andrew Ross

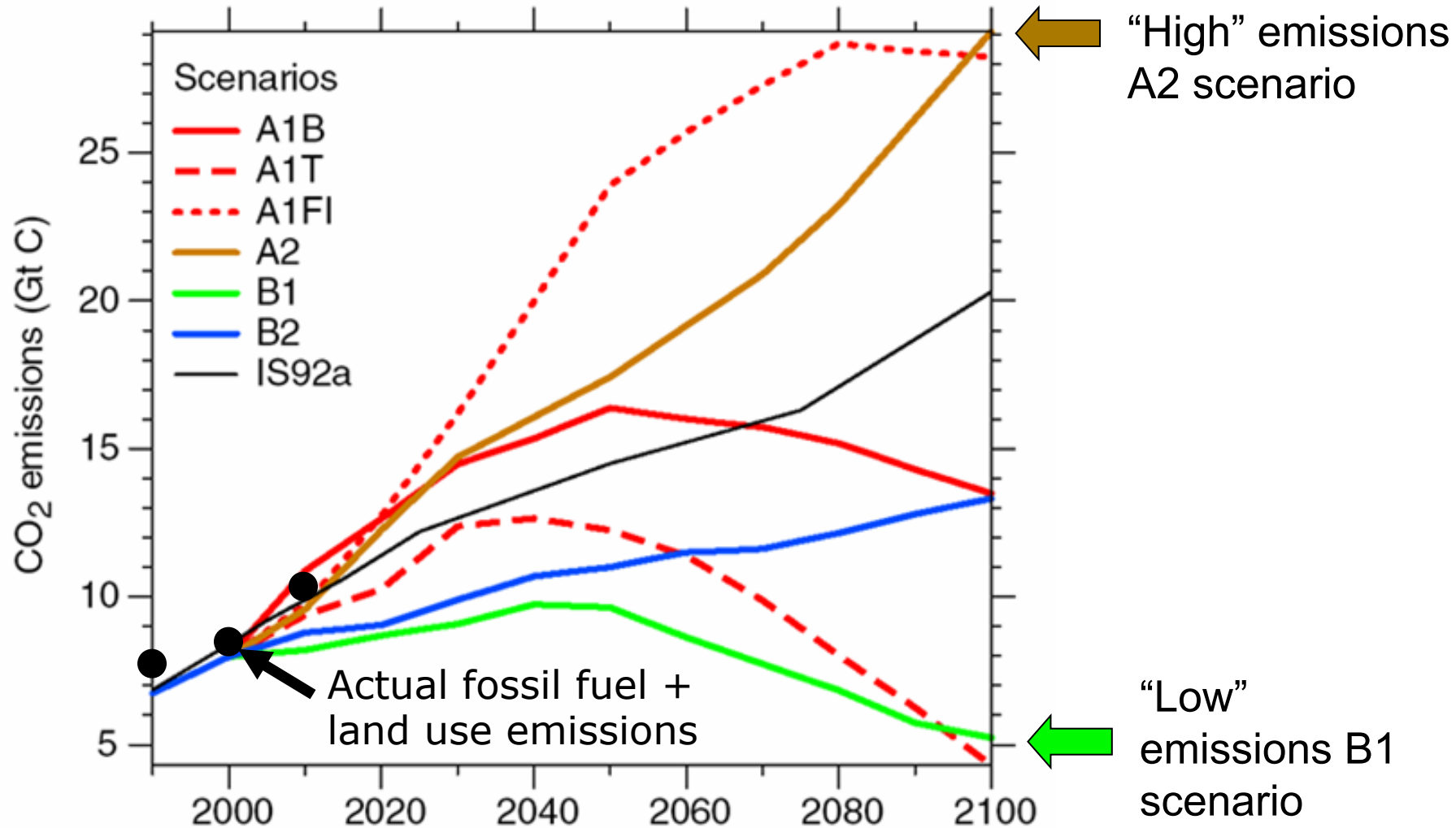
Models suggest past warming is human induced and past precipitation change is mostly natural

Observed and simulated temperature and precipitation change in the Northeast U.S.



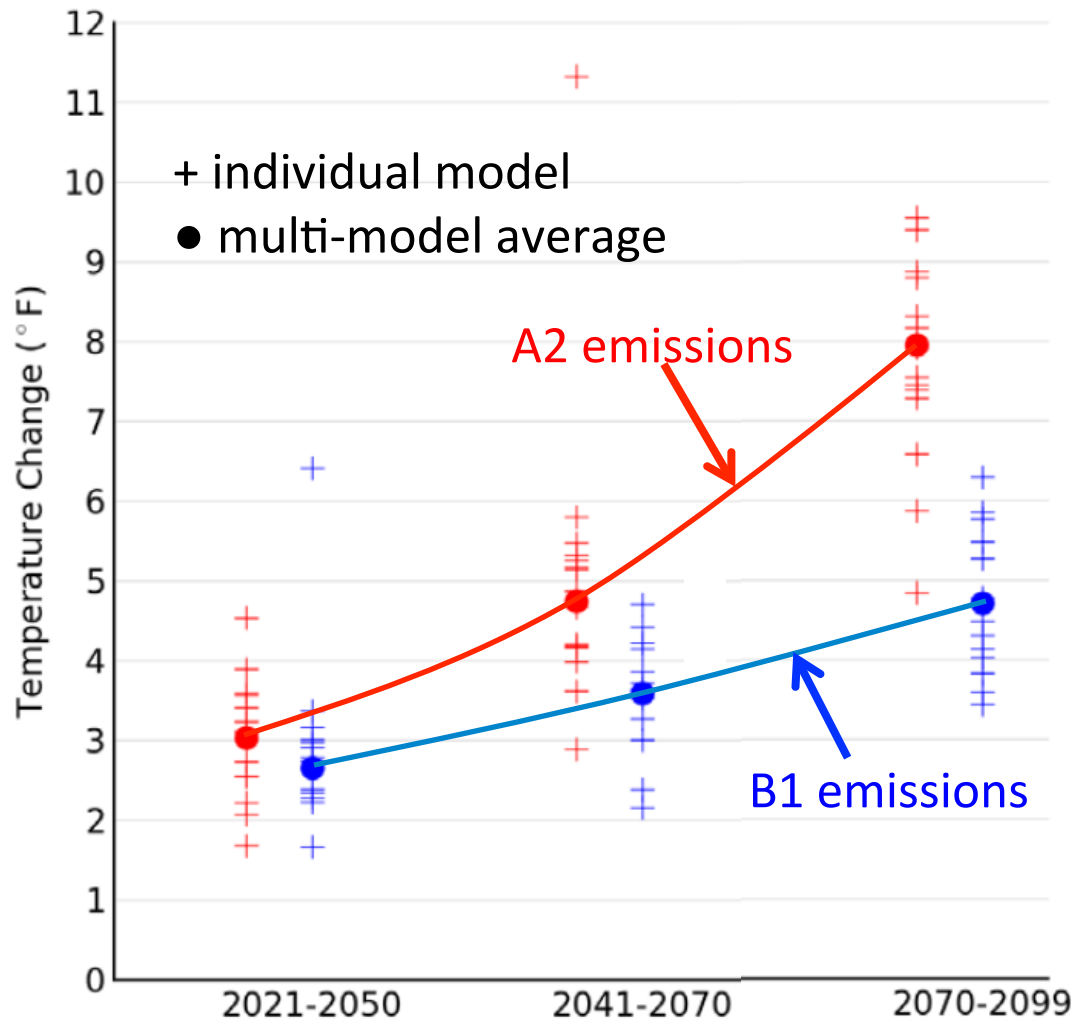
Decadal averages; deviation from 1901-1960 average

Future emissions scenarios



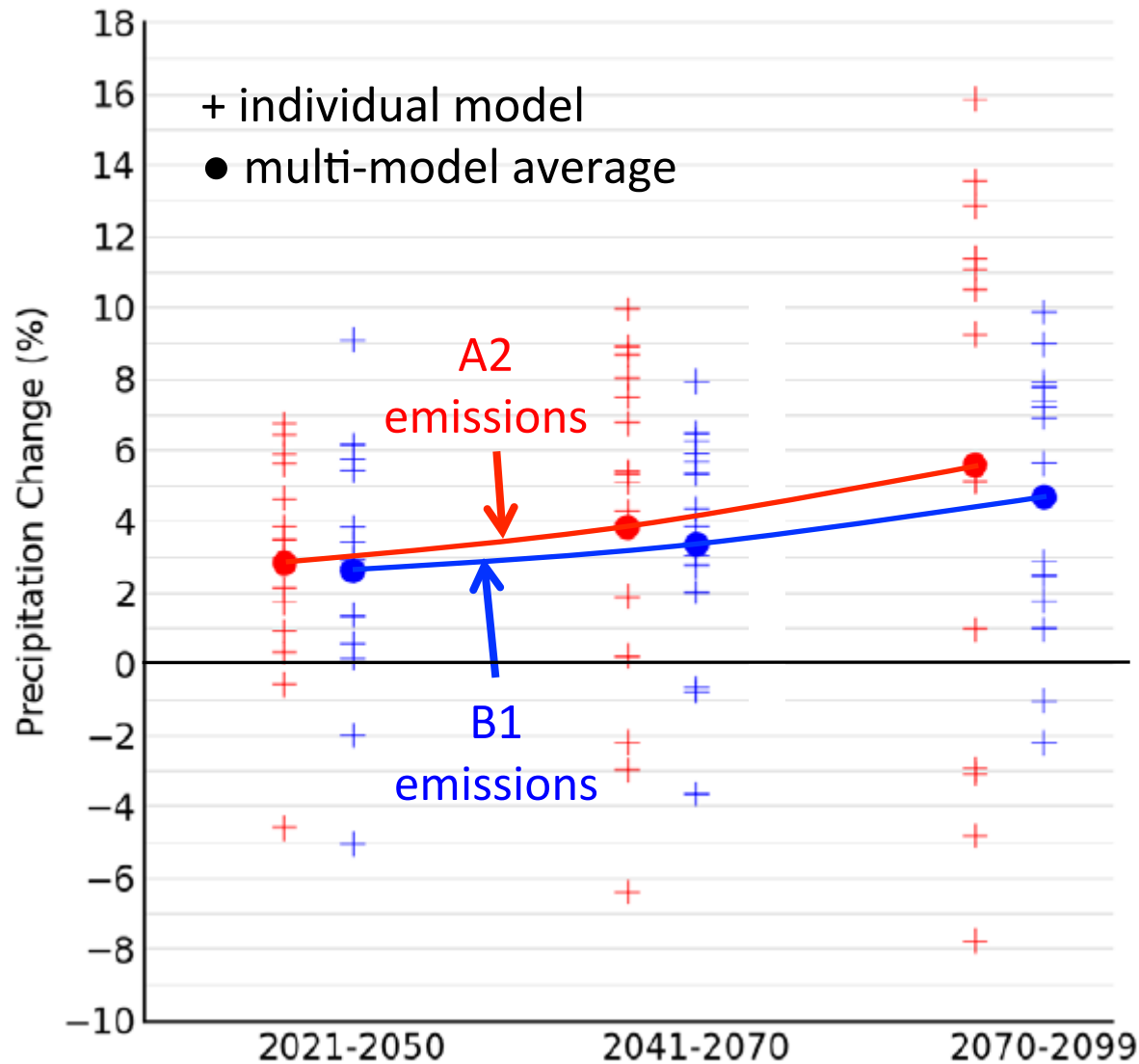
Continued warming is projected; emissions scenario really matters by mid century

Projected 21st century **temperature** change from 15 global climate models under two climate scenarios



Kunkel et al. (2013a)

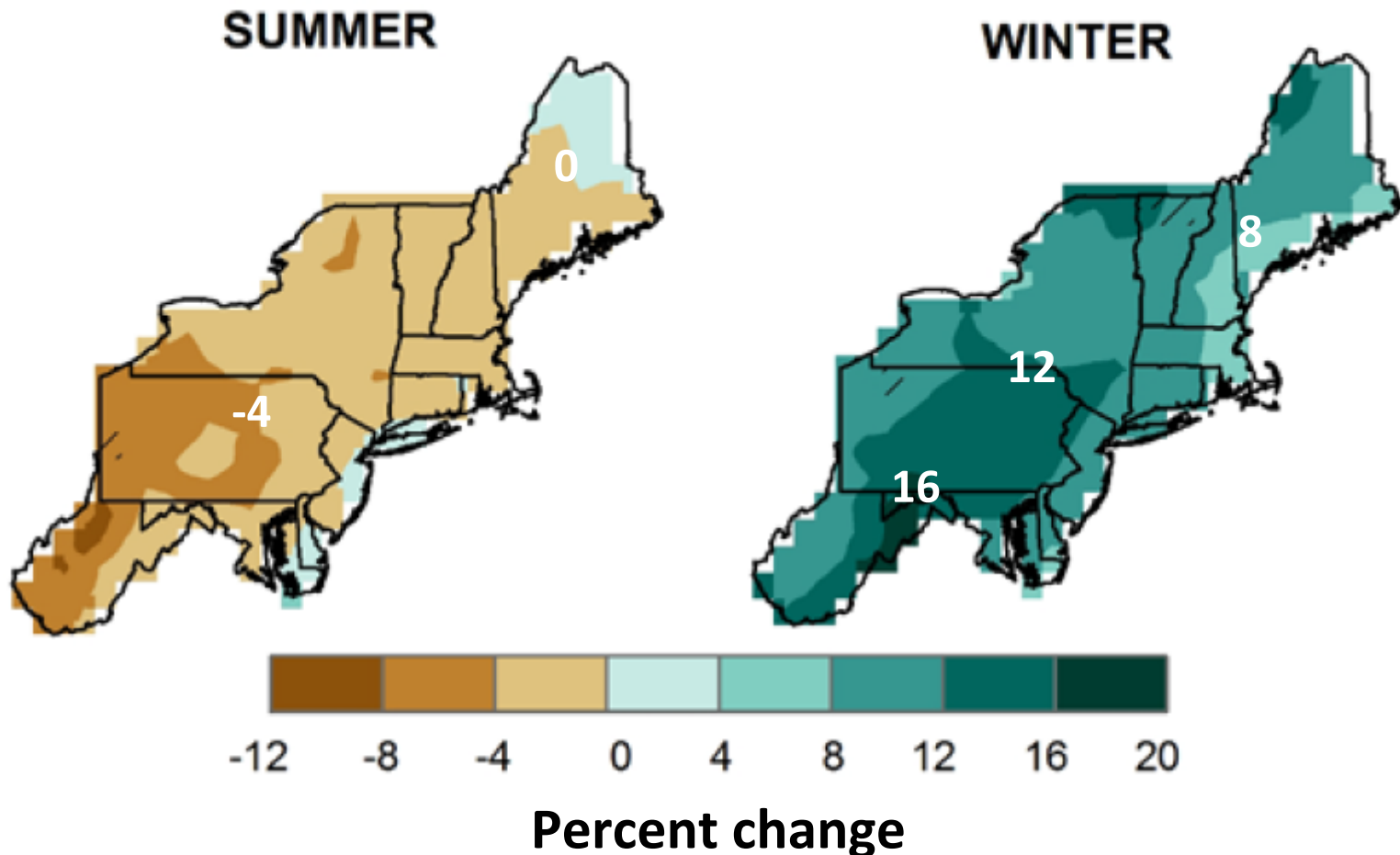
Continued precipitation increases are projected, though with less certainty than projected warming



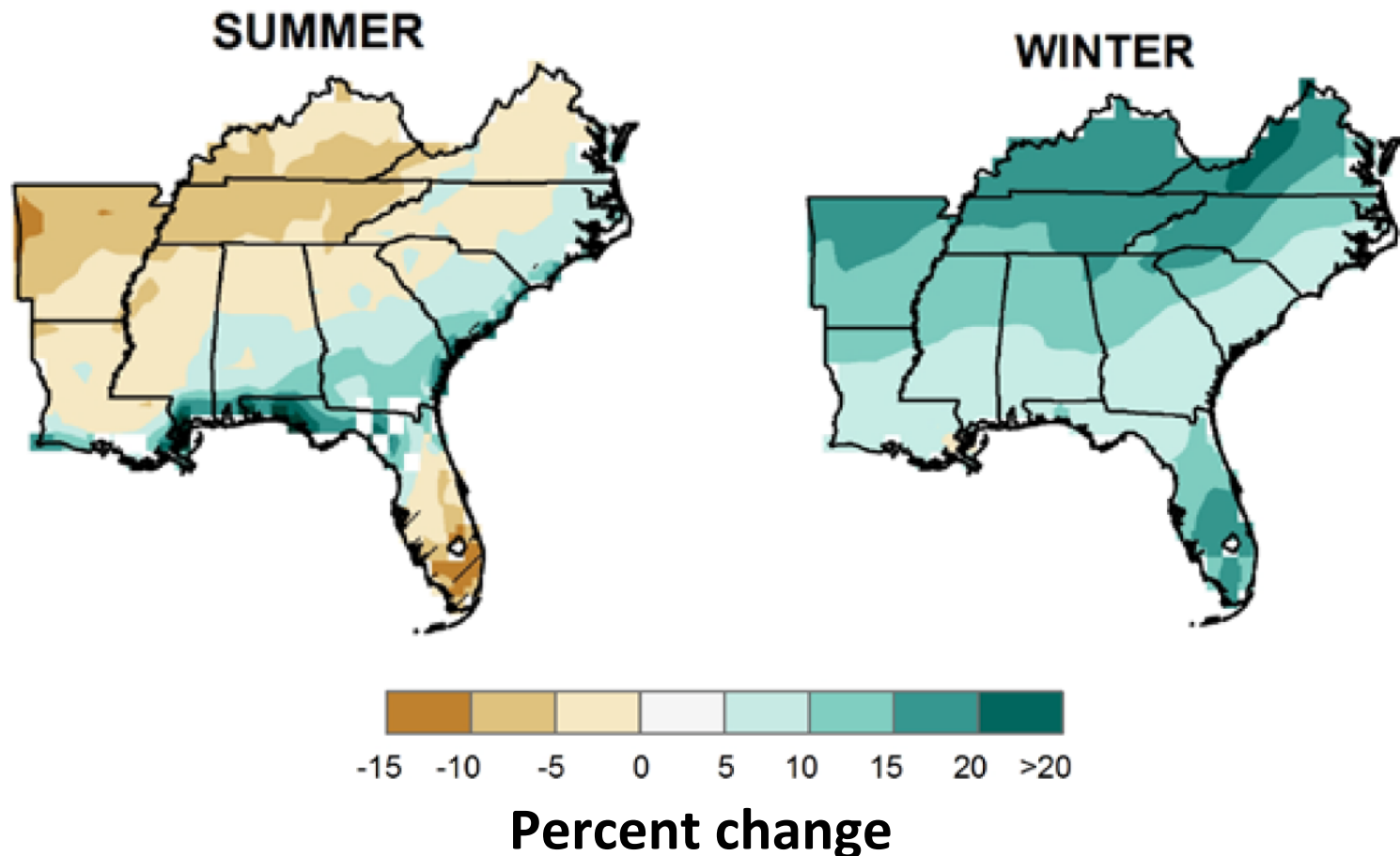
Kunkel et al. (2013a)

Winter projected to get wetter, summer drier

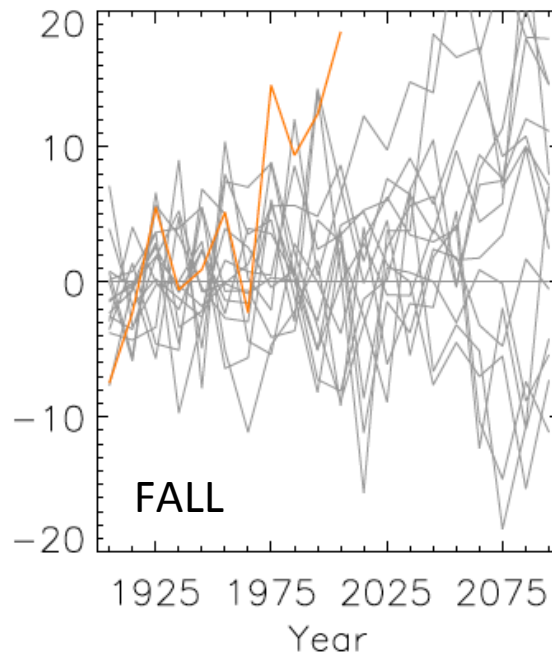
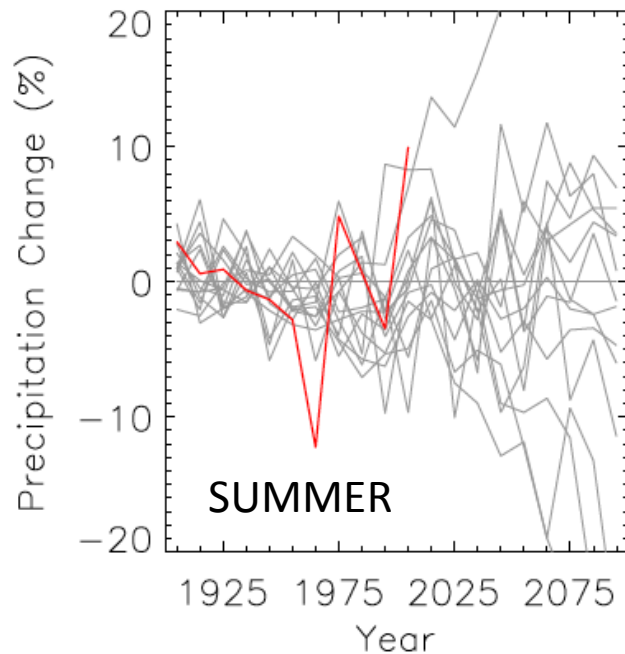
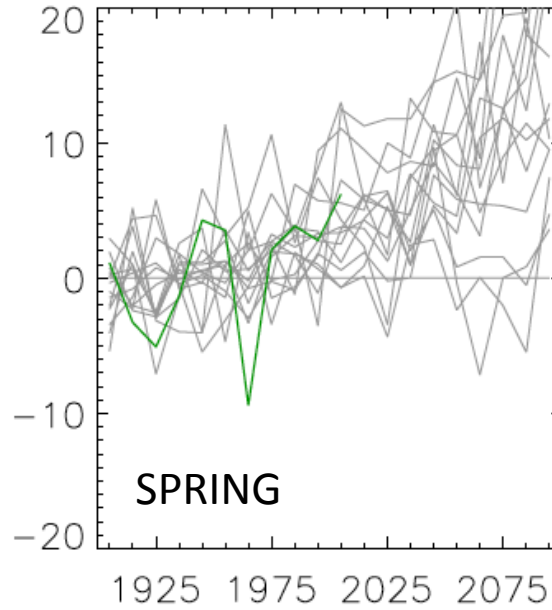
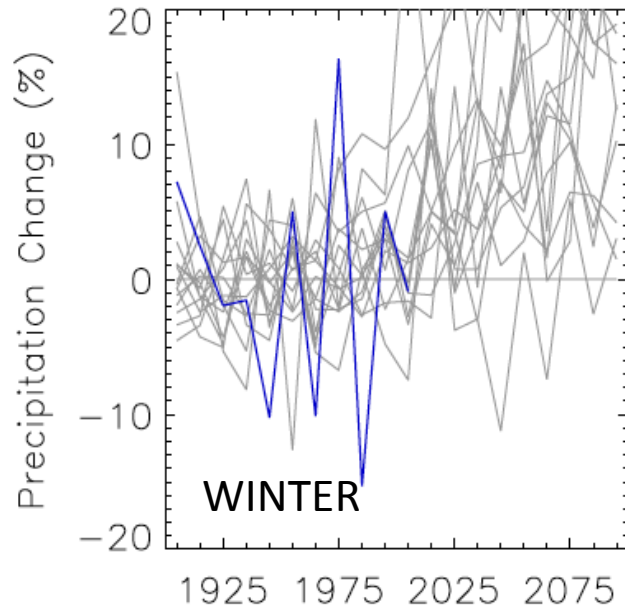
Projected precipitation change in the Northeast U.S. by 2041-2070 using RCMs (A2, multi-model average)



Projected precipitation change in the Southeast U.S. by 2041-2070 using RCMs (A2, multi-model average)



Colors = observed; Gray = models

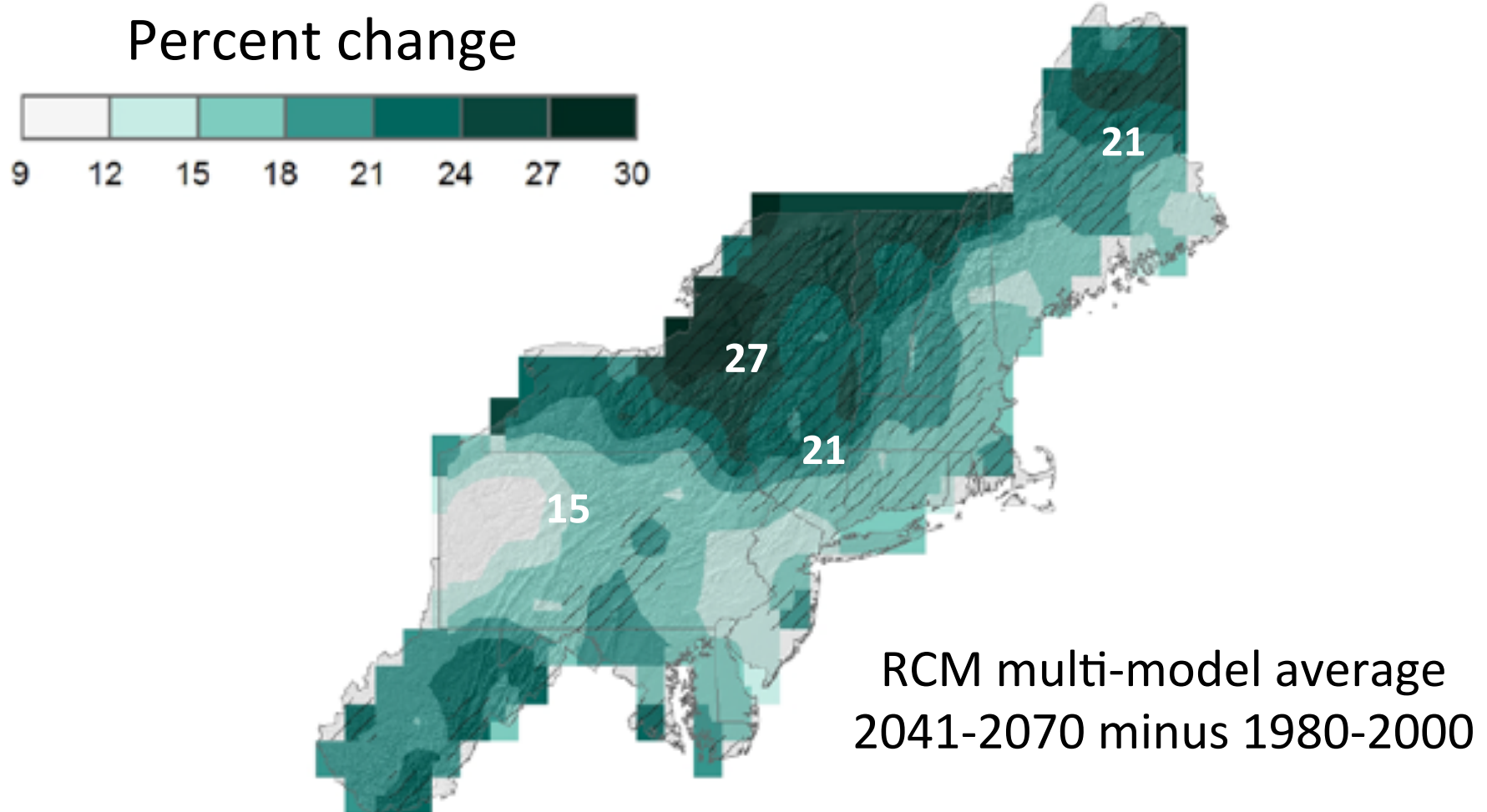


A disconnect between past and projected precipitation: past NE US increases were in the fall; future increases are projected to be in the winter and spring. Emphasizes importance of natural variability.

Kunkel et al. (2013a)

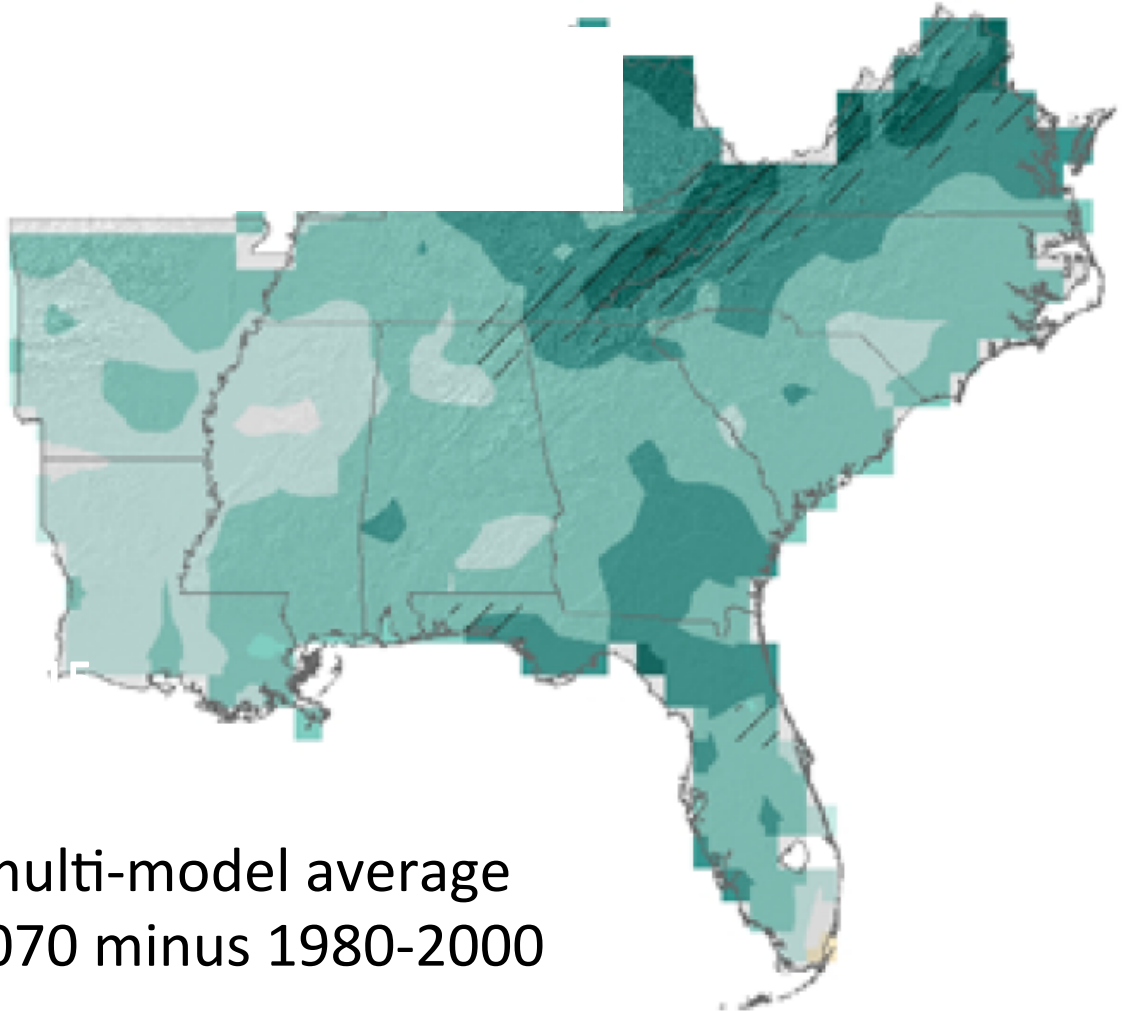
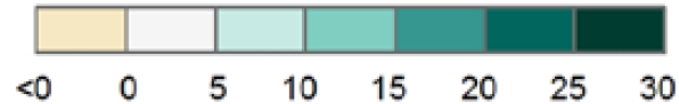
Precipitation projected to be more extreme

Change in extreme precipitation: number of days > 1 inch



Change in extreme precipitation: number of days > 1 inch

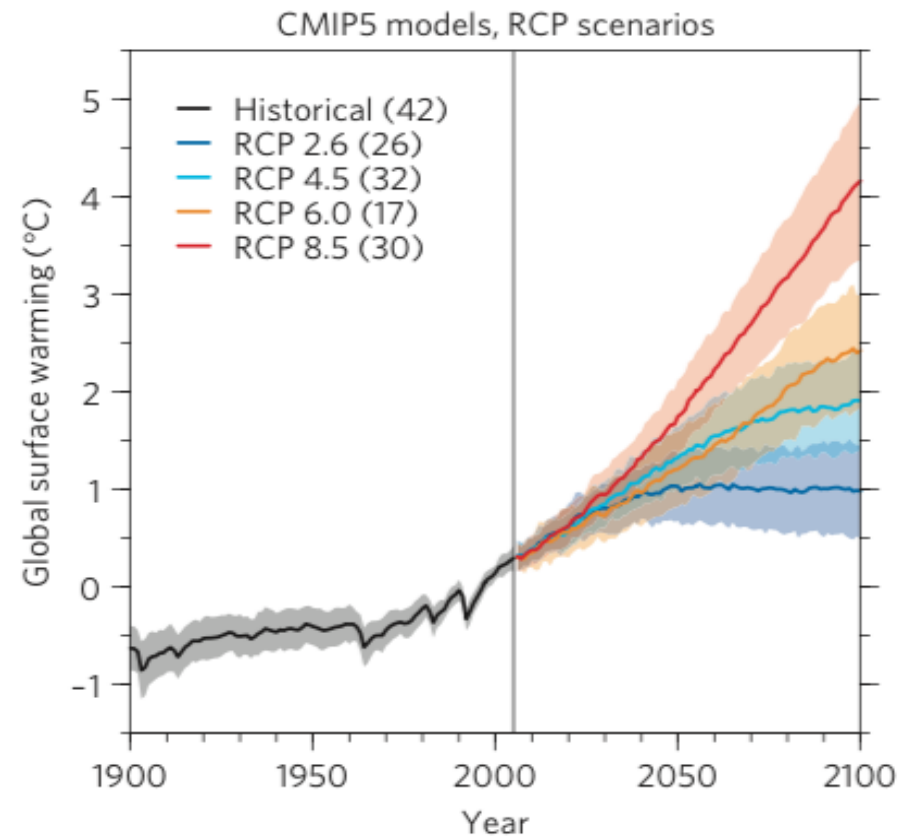
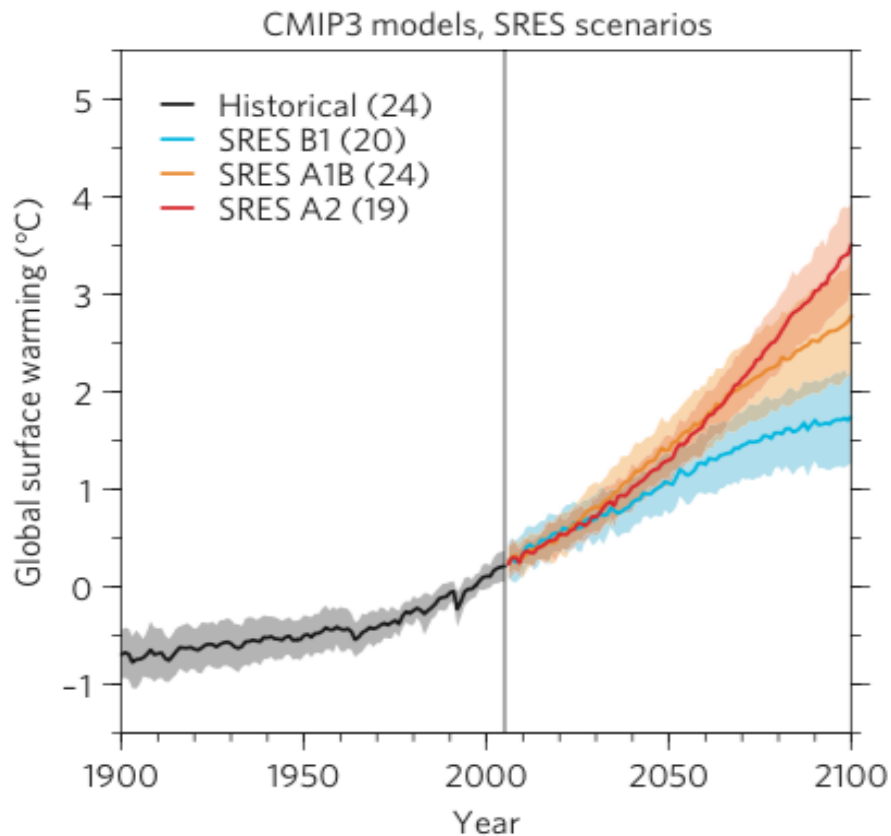
Percent change



RCM multi-model average
2041-2070 minus 1980-2000

Newer scenarios (RCP) have greater range

SRES and RCP Scenarios: Impact on global mean surface temperature



Take-home messages (repeated)

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- Natural variability is important, particularly for precipitation

References

- IPCC, 2013. Summary for Policymakers. In: T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, P.M. Midgley (Editors), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
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