The Science of Climate as Applied to Respiratory Health – a Look at the National Climate Assessment

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My Background

- B.S. in physics, M.S. and Ph.D. in meteorology
- 35 years working on climate research and applications
- Research focus on climate extremes
- National Climate Assessment Activities
  - Lead author on 4 sections of Third National Climate Assessment (May 2014)
  - Contributing author to Climate and Health Assessment (April 2016)
  - Lead author on Climate Science Special Report (Nov. 2017)
  - Lead author on two chapters of Fourth National Climate Assessment

National Climate Assessment

- Mandated by the 1990 Global Change Research Act
- Quadrennial assessments
- Past assessments published in 2000, 2009, 2014
- Climate Science Special Report published on November 3; considered to be Vol. 1 of the Fourth National Climate Assessment (NCA4)
- Draft of NCA4, Vol. 2, released for public comment on Nov. 3

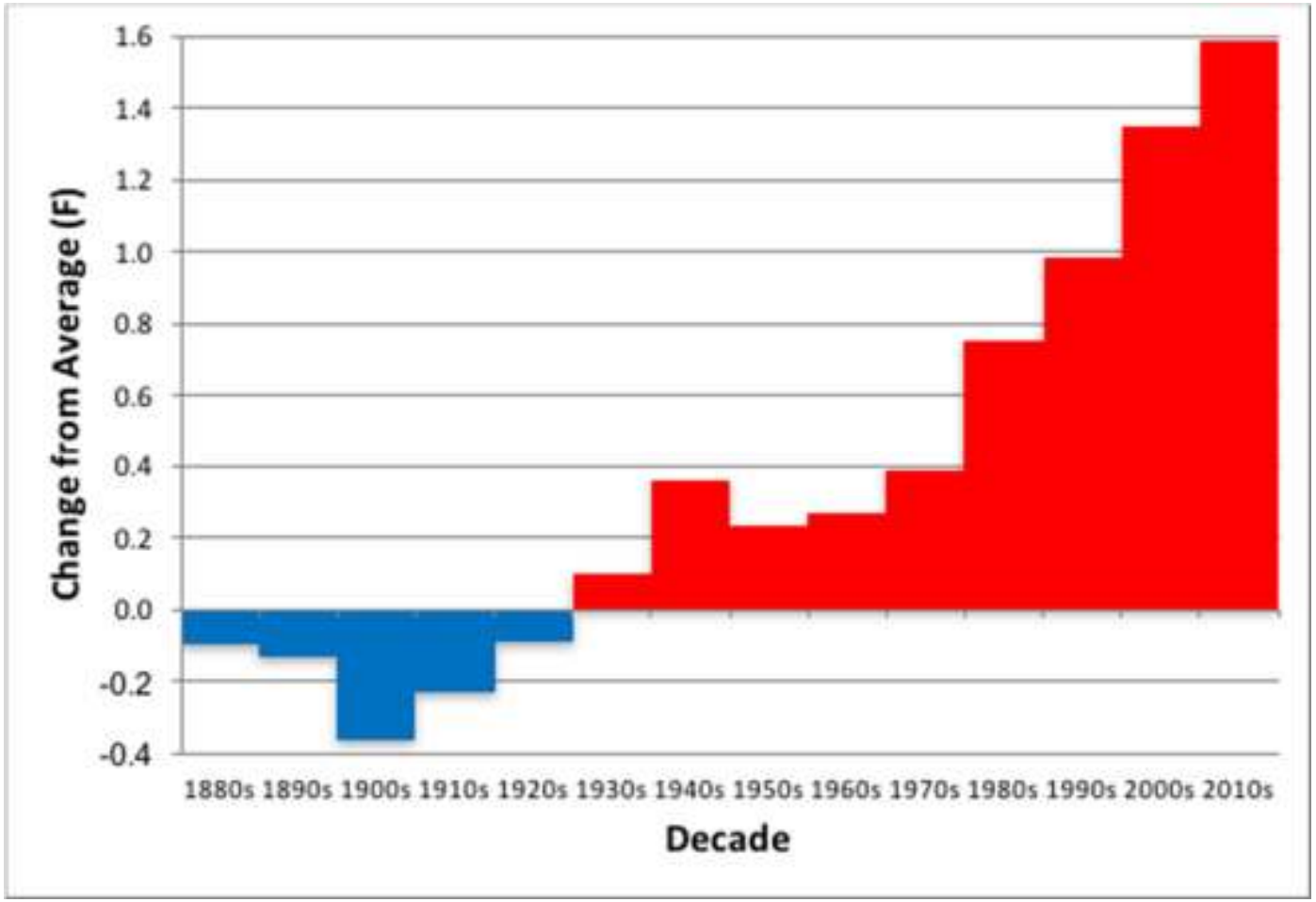
NCA Climate Science

- NCA3
- CSSR (aka NCA4 Vol. 1)
- NCA4 preliminary results

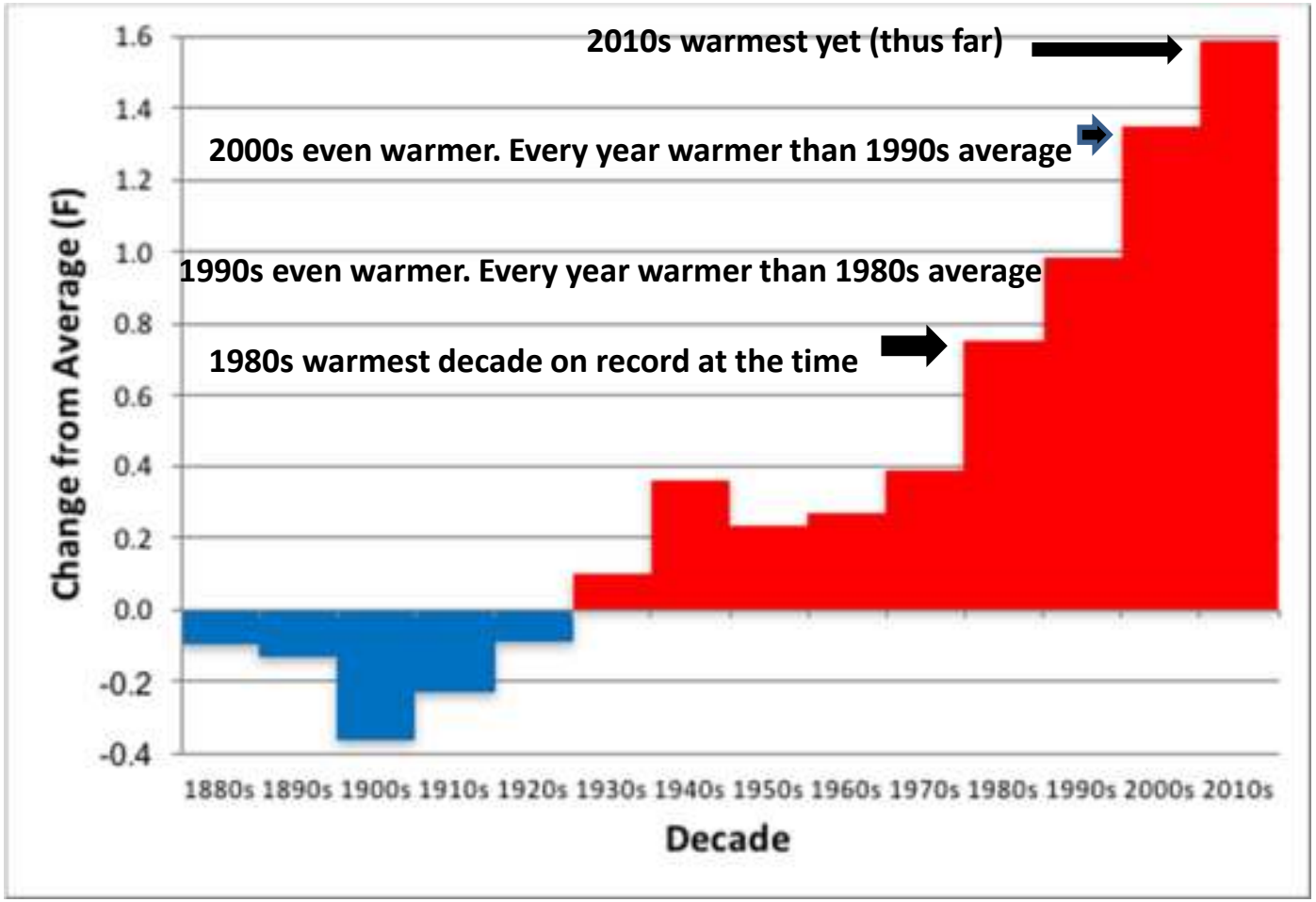
Respiratory Health Context

- Air quality
- Extreme temperatures (heat and cold)
- Extreme humidity

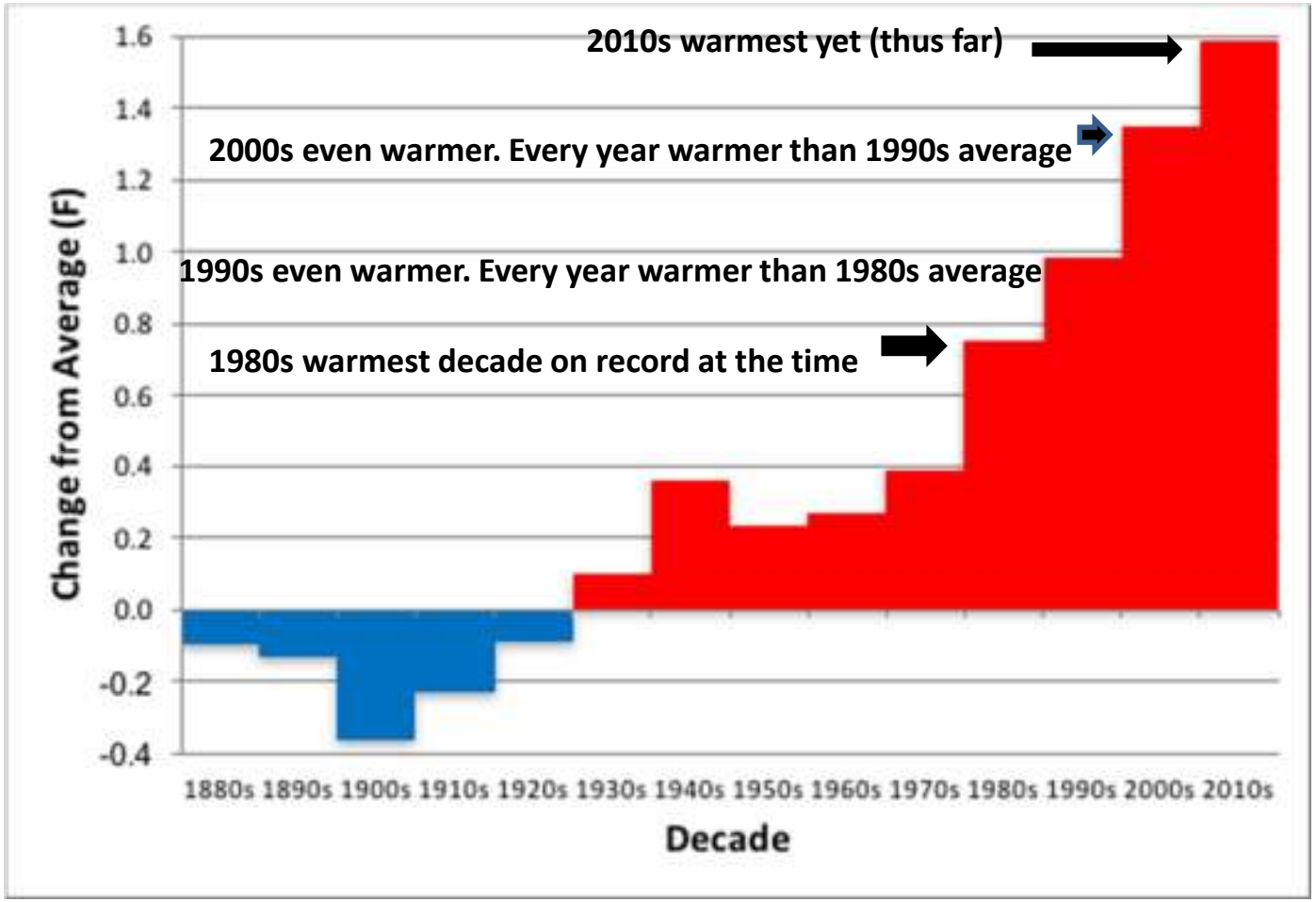
Global Temperature Change by Decade



Global Temperature Change by Decade



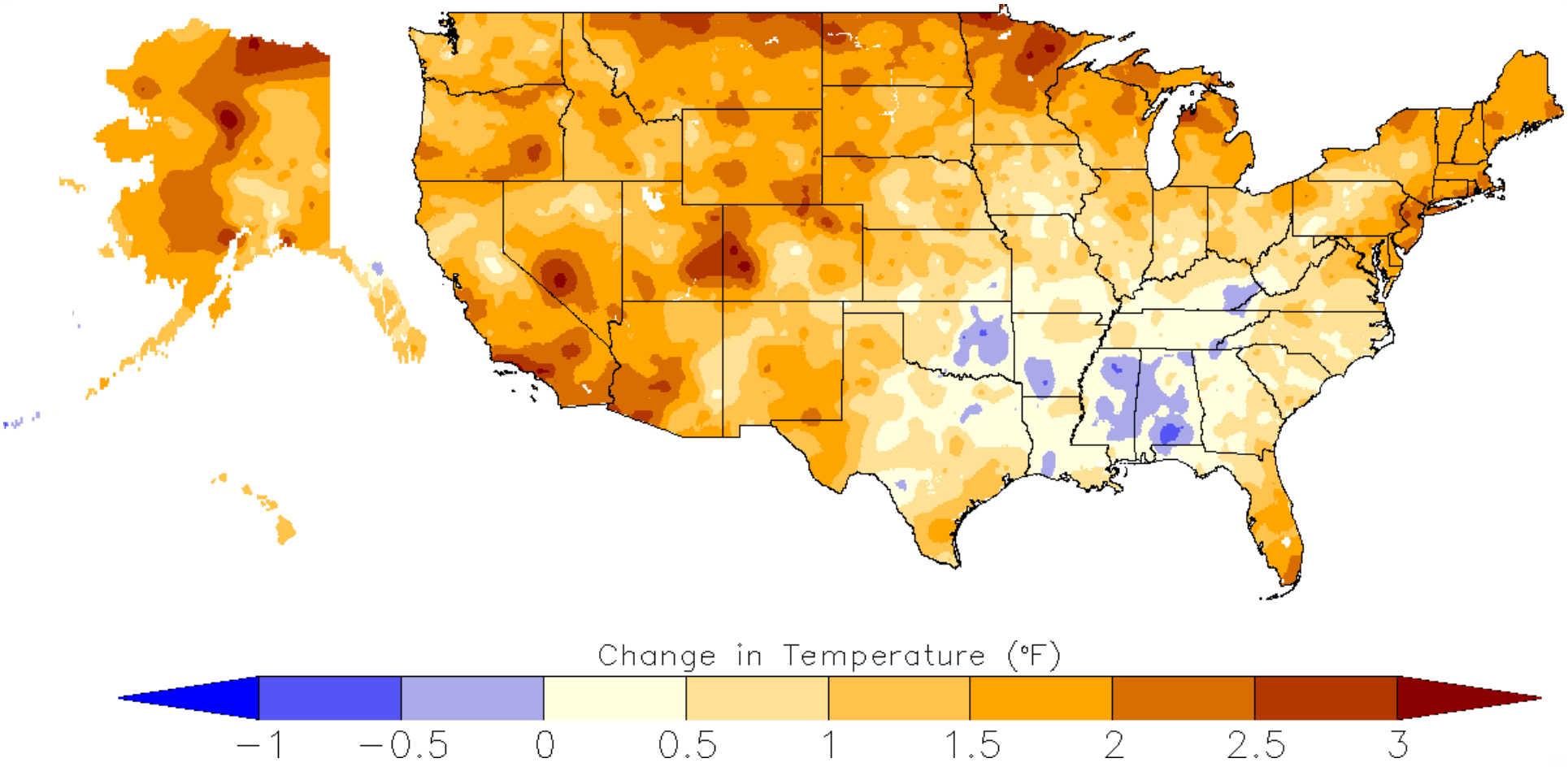
Global Temperature Change by Decade



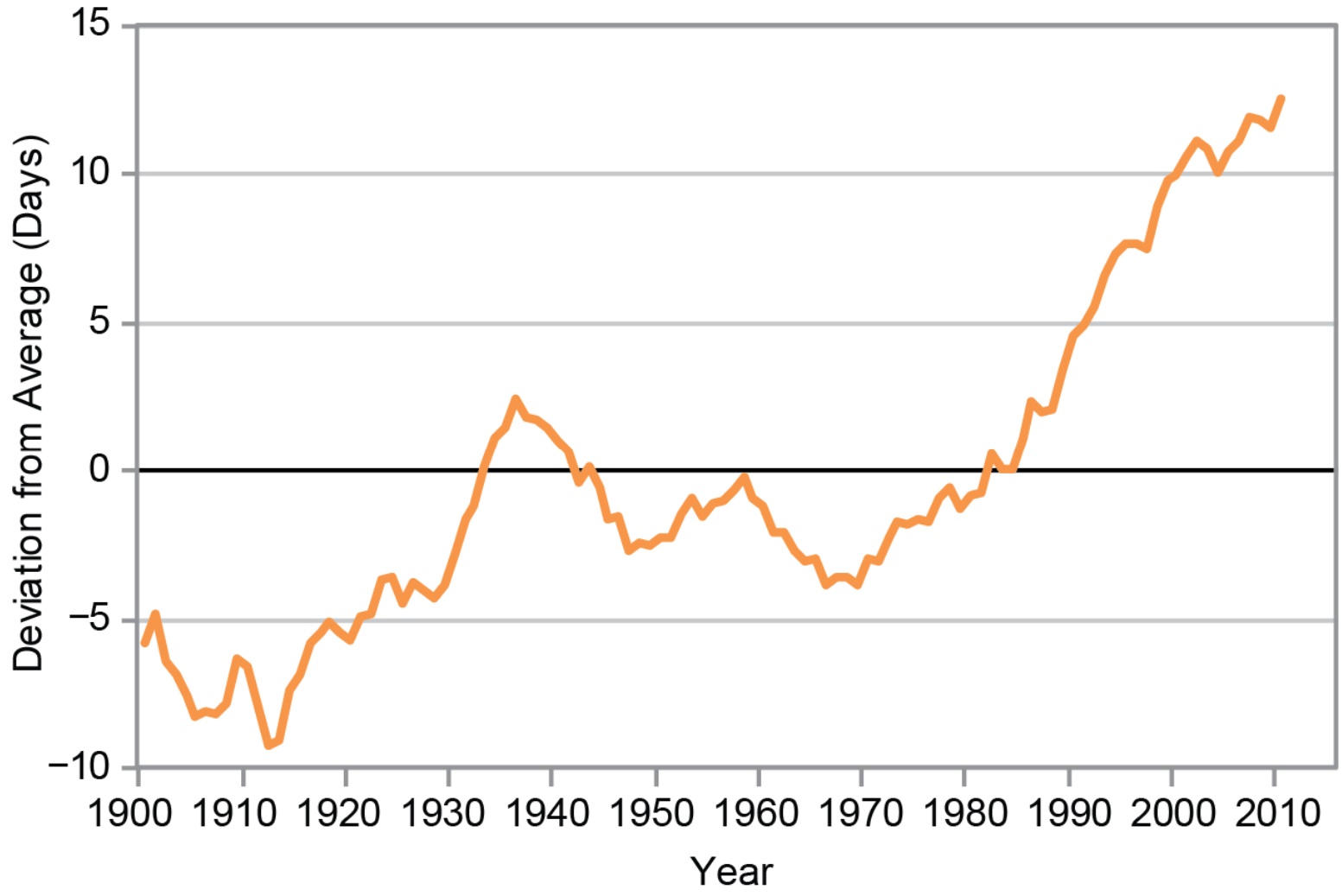
2014 warmest year on record at time

2015 broke 2014 record and then 2016 broke 2015 record

U.S. Temperature Change



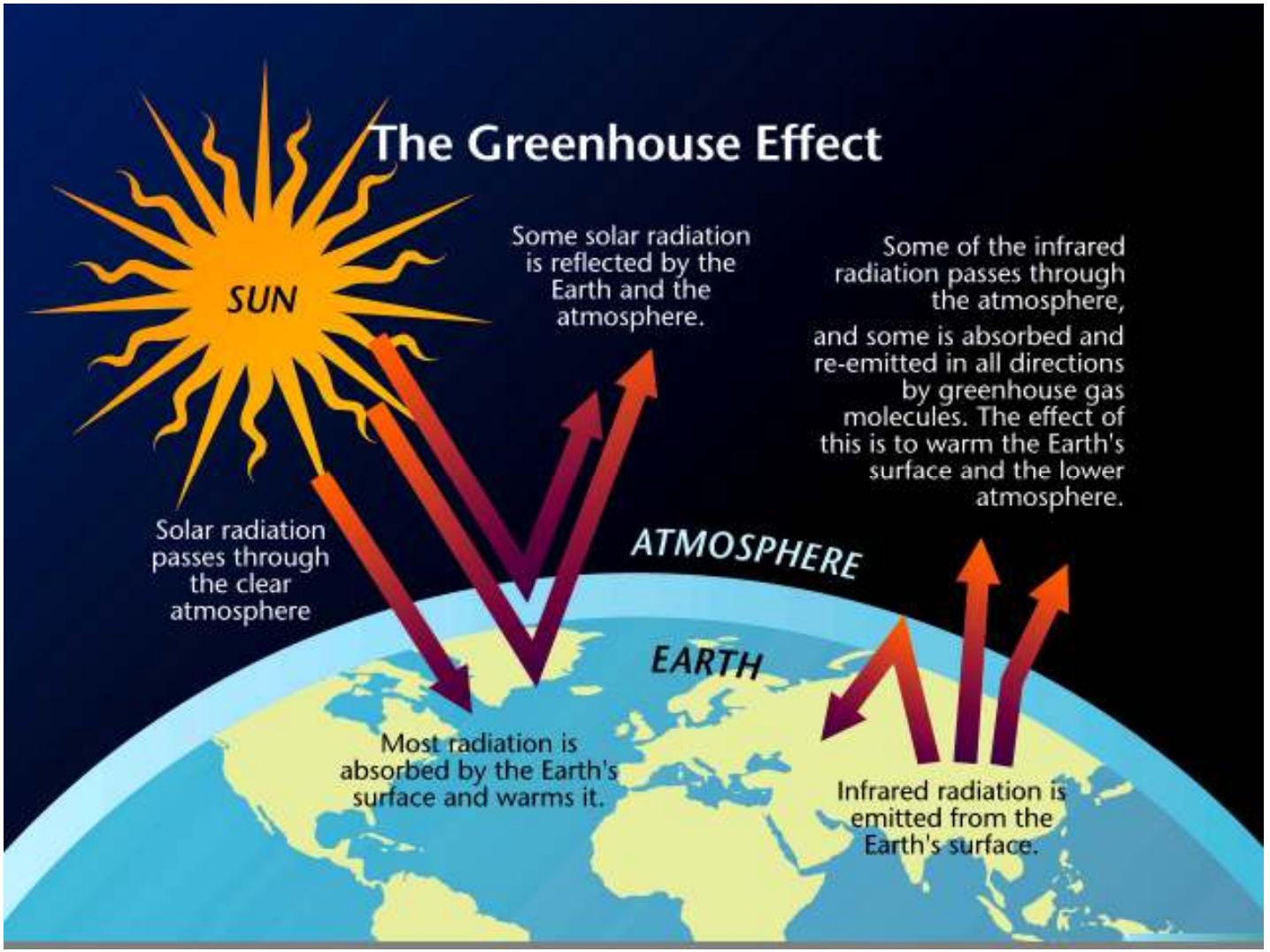
Change in Freeze-Free Season Length



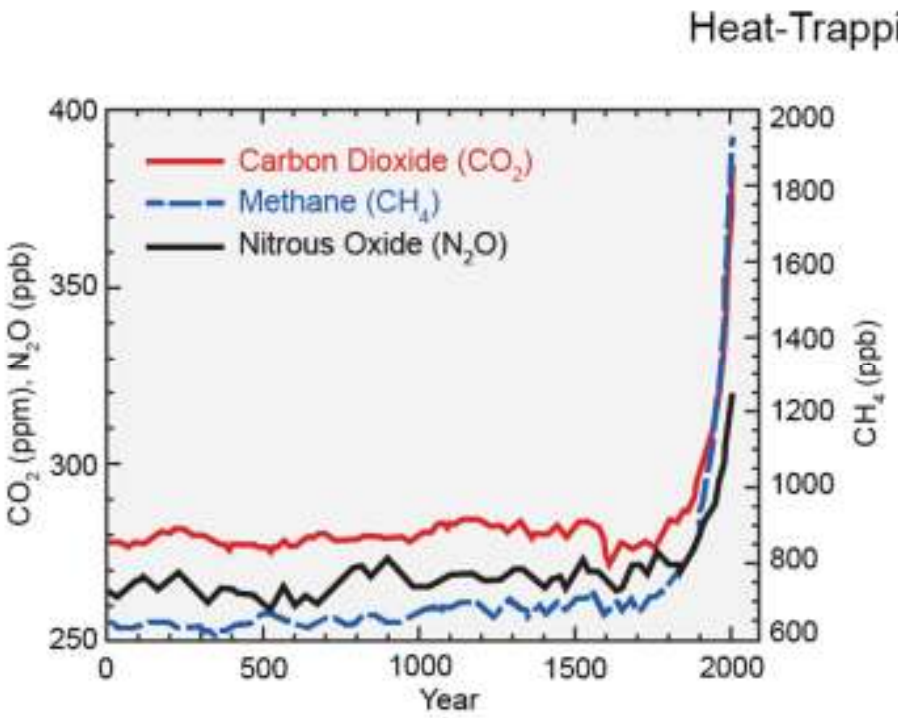
Why is the earth warming?

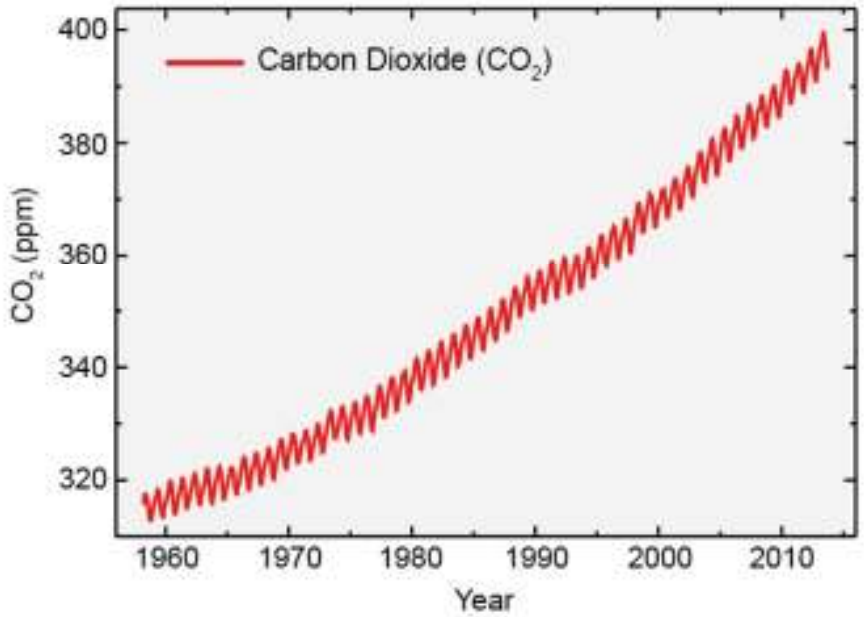
- How could humans affect the global climate?
- The answer is through the "**Greenhouse Effect**" – critical climate system process (with or without human activity)

Earth's Atmosphere



Historical Greenhouse Gas Concentrations

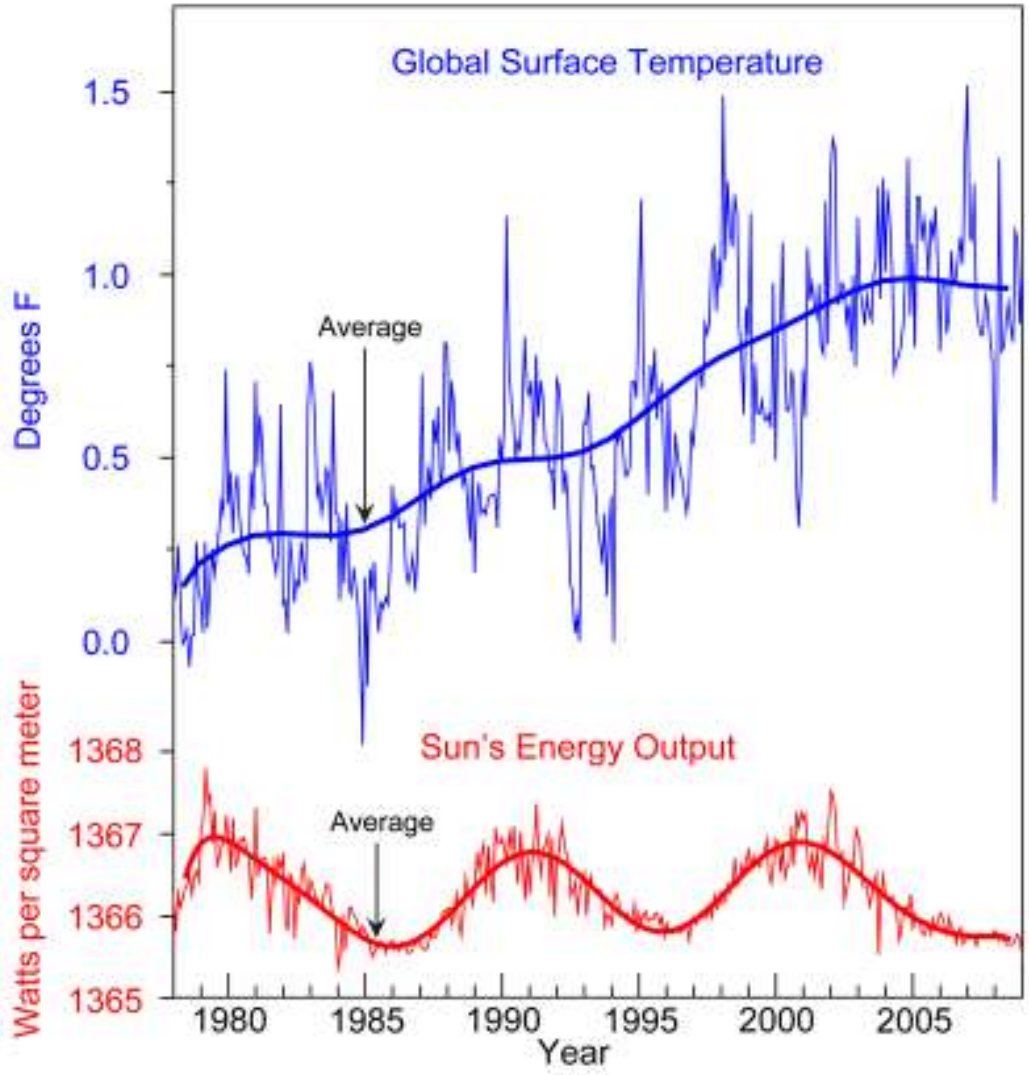




Alternate/Additional warming causes

- The sun
- Small particles in the atmosphere – for example, from volcanic eruptions
- Heat release from earth itself into the atmosphere (the most important is the ocean)

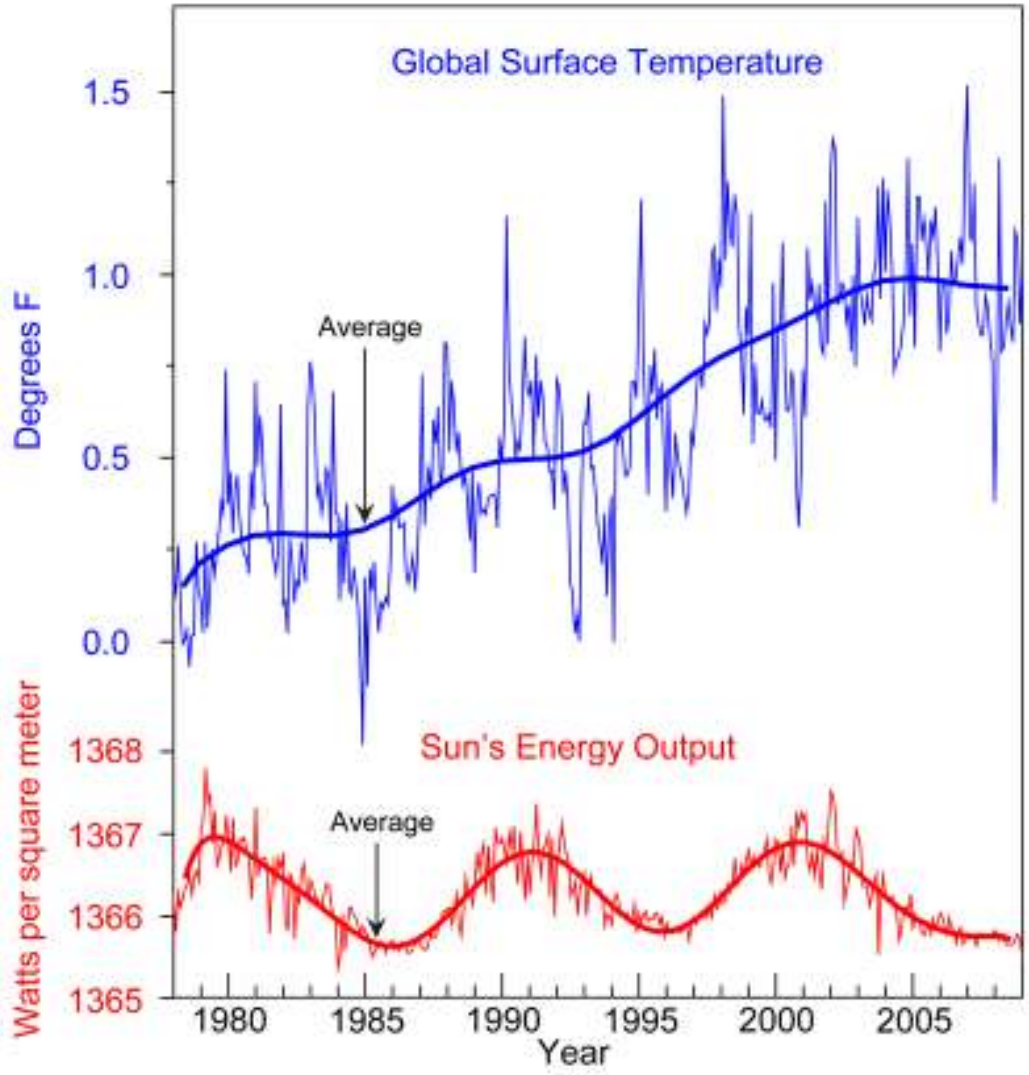
Temperature vs Sun's Energy Output



Global surface temperature going up

Sun's energy output is not going up, just going through 11-year sunspot cycle

IT'S NOT THE SUN



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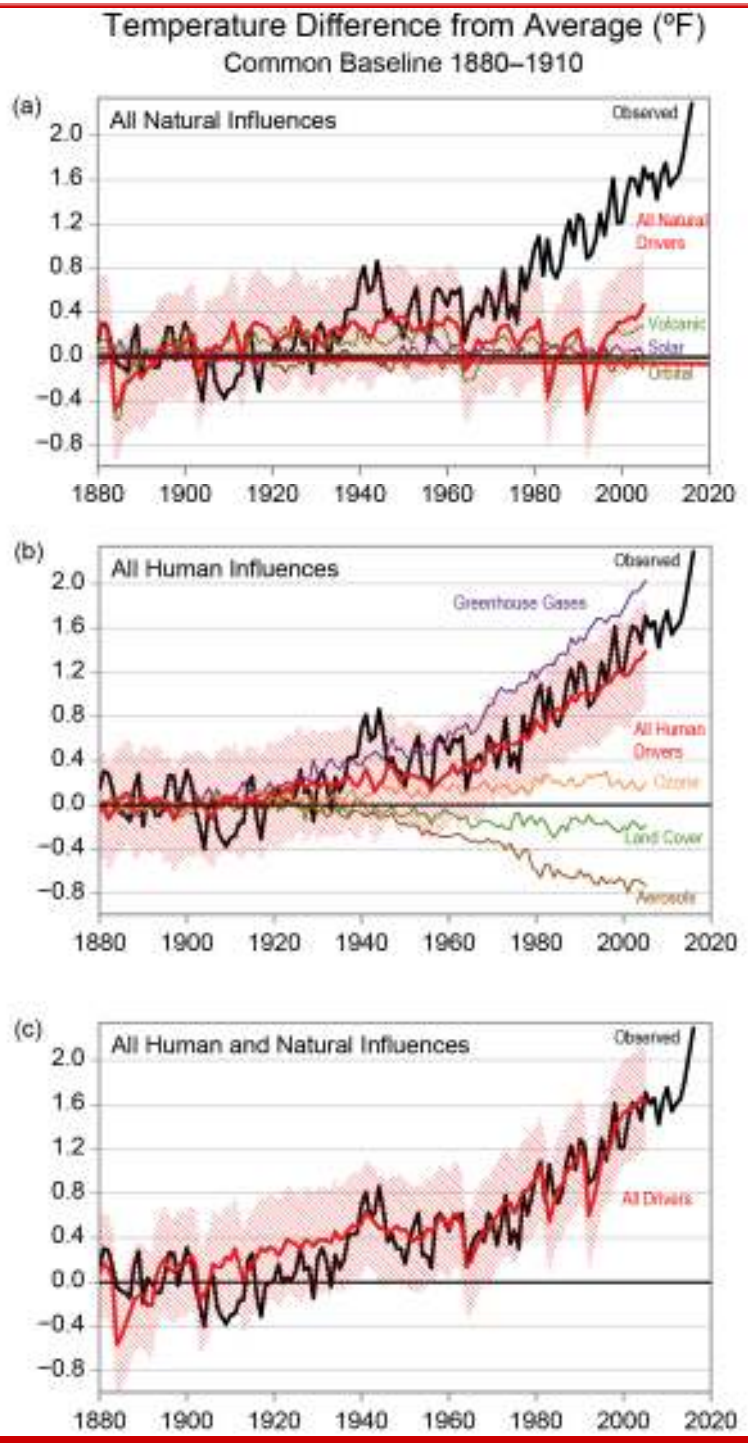
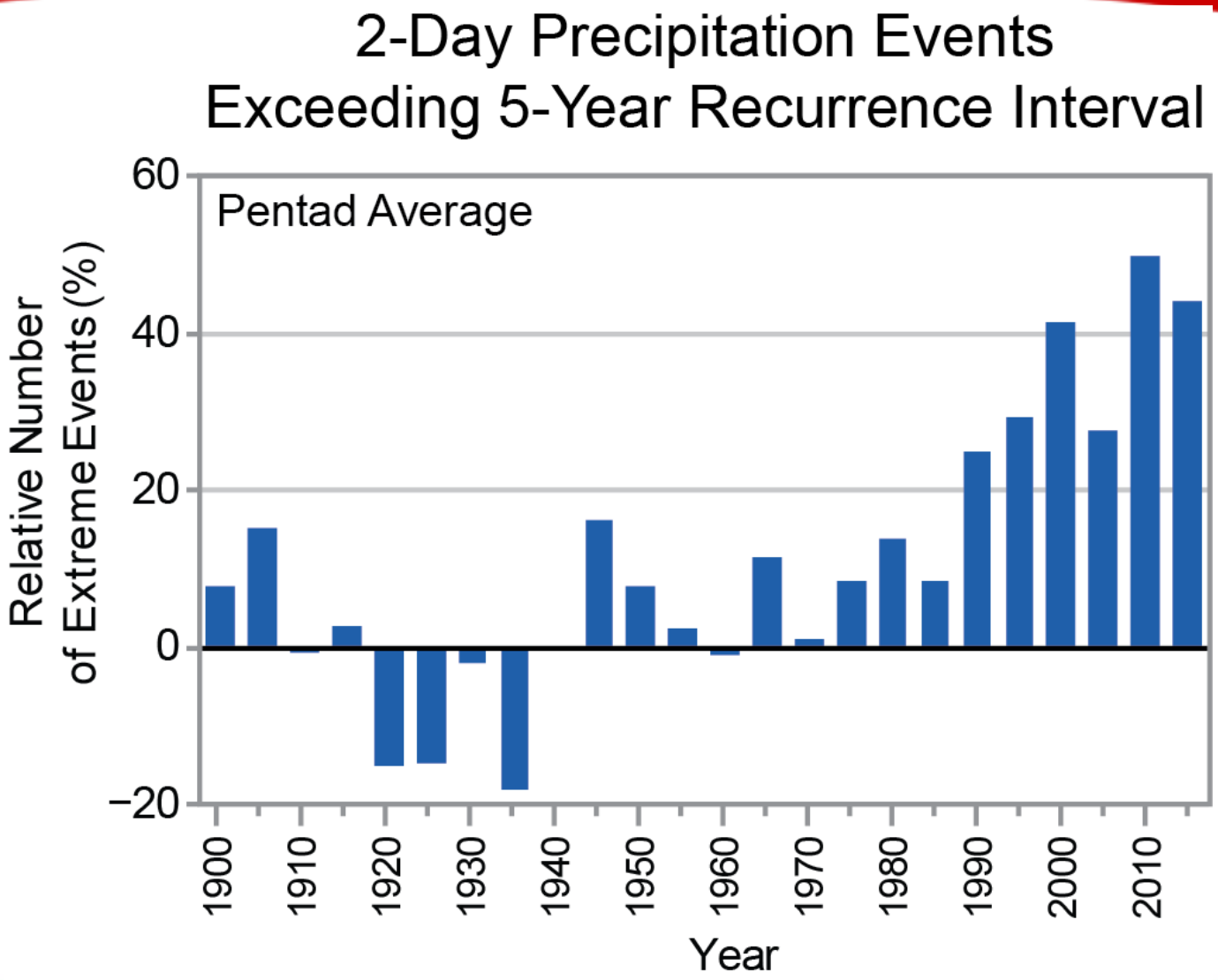

Temperature Difference from Average (°F)
Common Baseline 1880–1910
(a)
All Natural Influences
Observed
All Natural Drivers
Volcanic
Solar
Orbital
(b)
All Human Influences
Observed
Greenhouse Gases
All Human Drivers
Ozone
Land Cover
Aerosols
(c)
All Human and Natural Influences
Observed
All Drivers
2.0
1.6
1.2
0.8
0.4
0.0
−0.4
−0.8
1880
1900
1920
1940
1960
1980
2000
2020

Importance of Identifying Causes

- Essential to project the future
  - If greenhouse gases are causing the observed warming, then there is a firm basis for projections since concentrations almost certainly will rise substantially

Other Trends

U.S. Extreme Precipitation Trends



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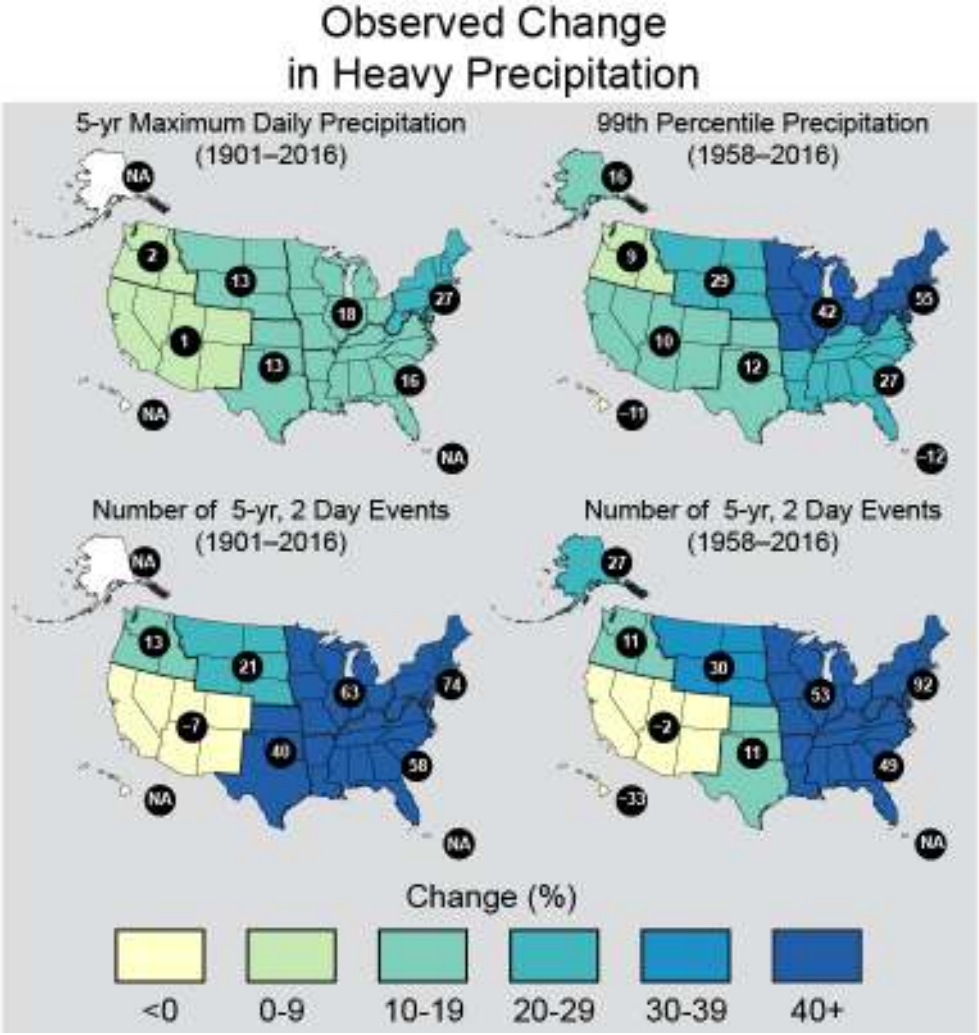
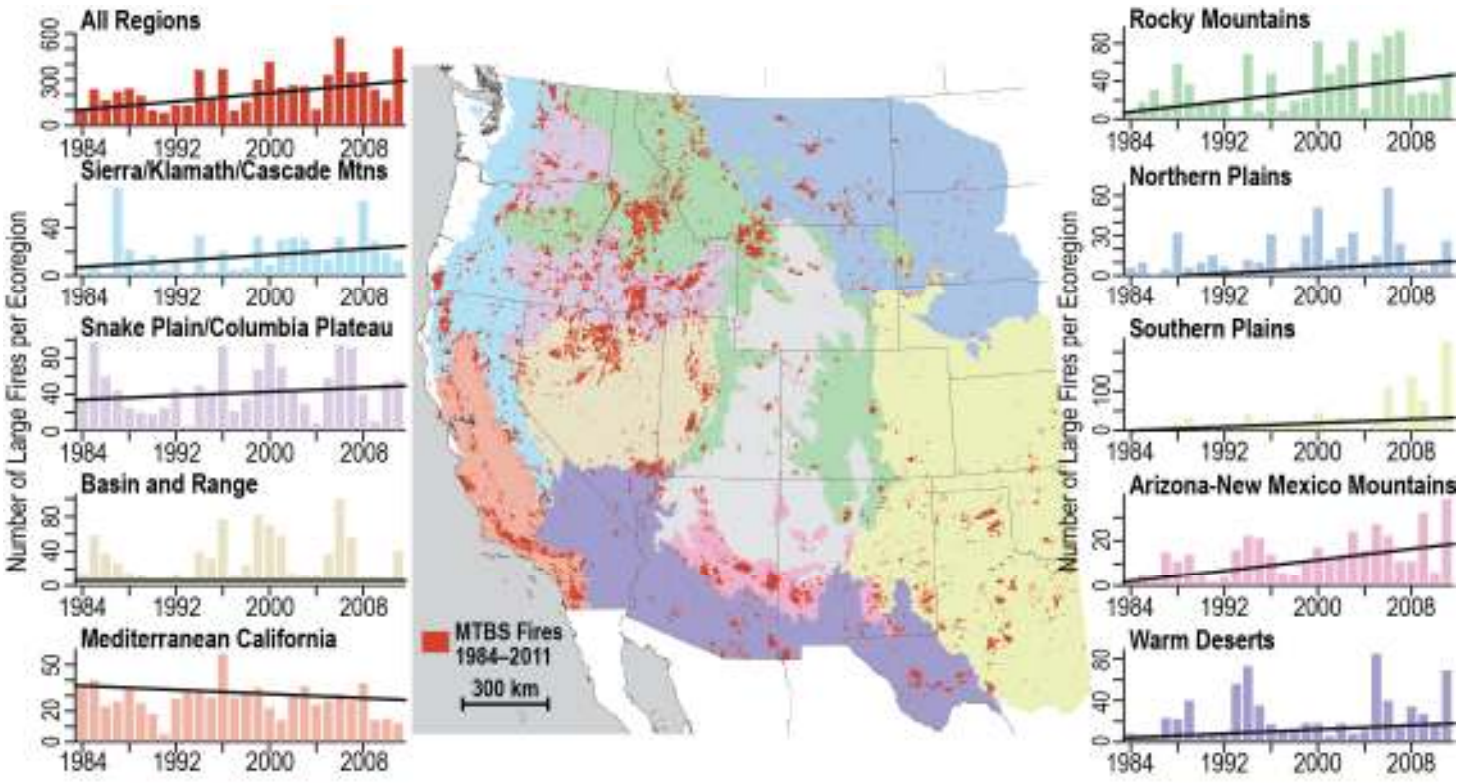


Number of Western Wildfires



How much will it warm in the future?

- Depends on future greenhouse gas emissions
- On current pathway, temperatures will likely **far exceed historical records**
- Climate models provide central info for projecting future climate

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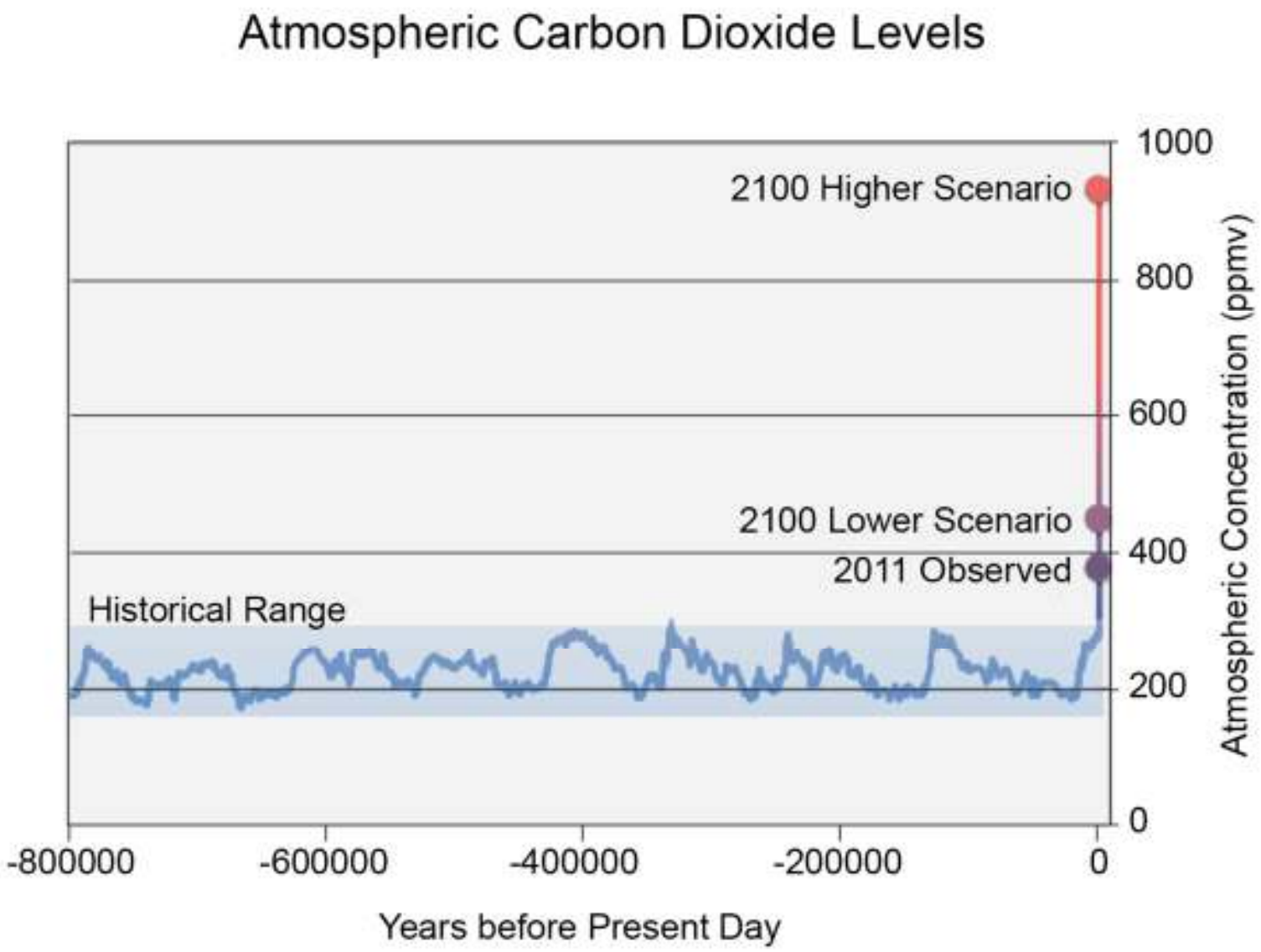
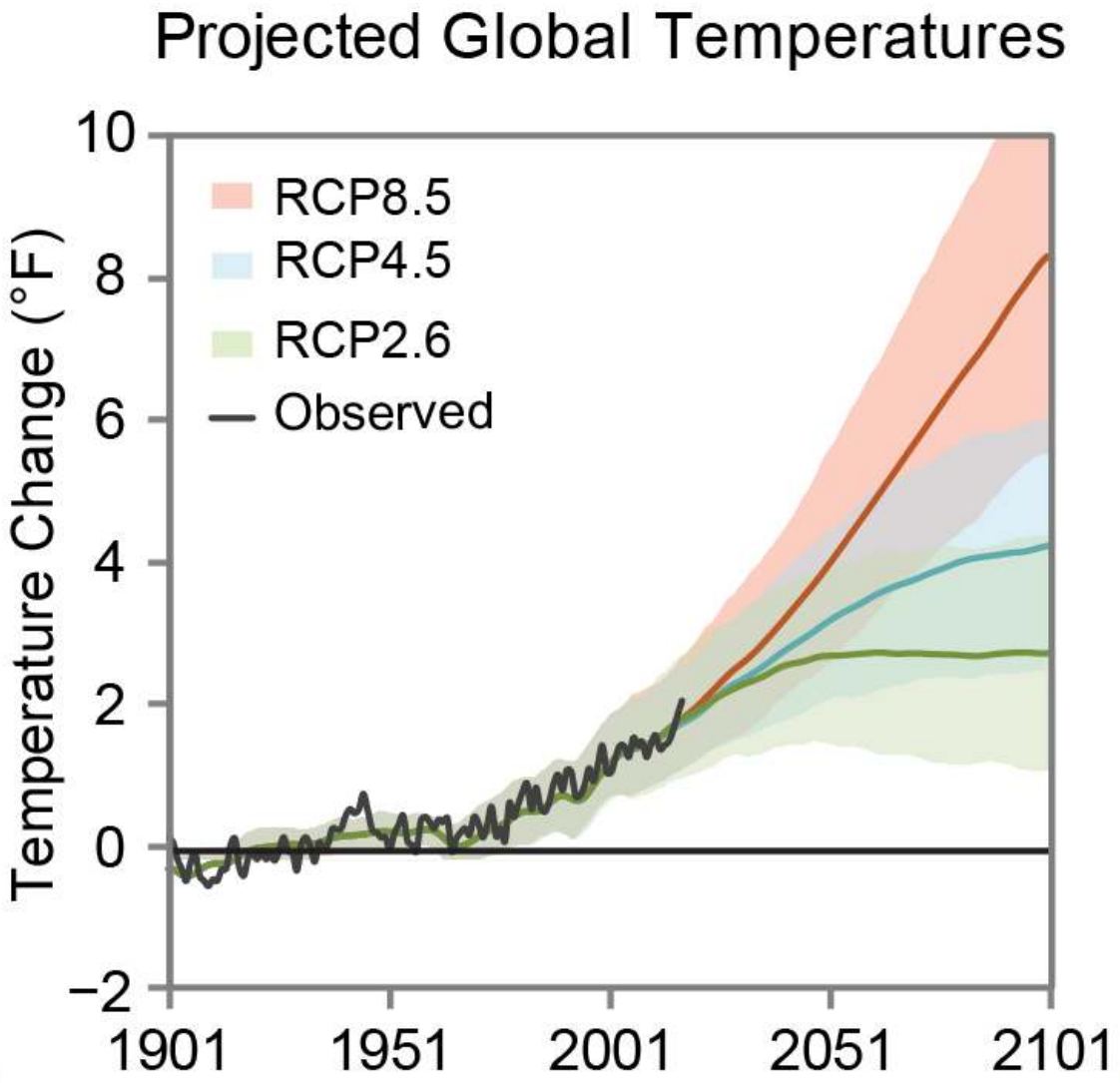
Climate Models

- The atmosphere is a highly complex and non-linear system
- Models have had a transformative impact on our understanding and ability to provide glimpses of the future

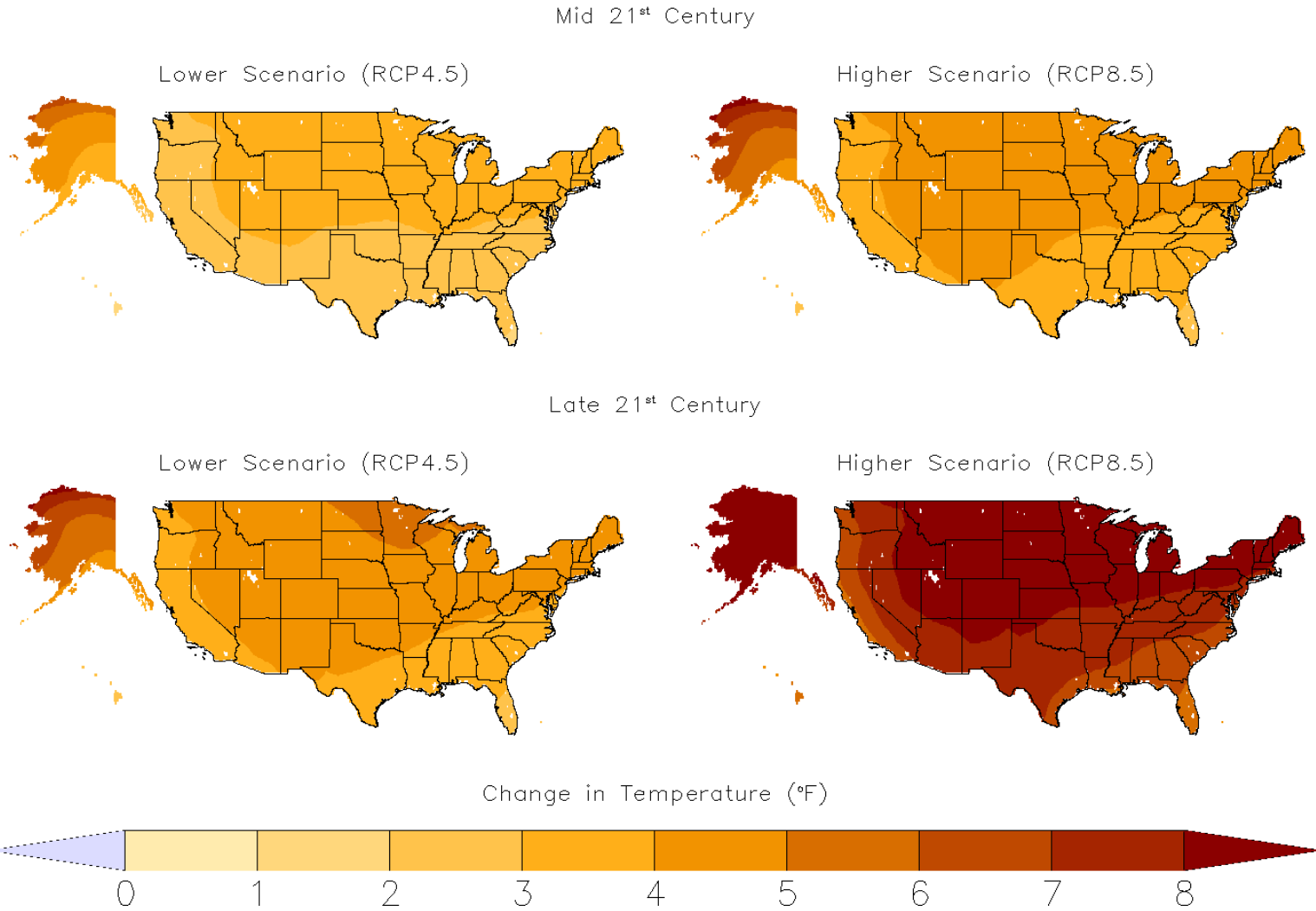
Historical/Projected CO2 Concentrations



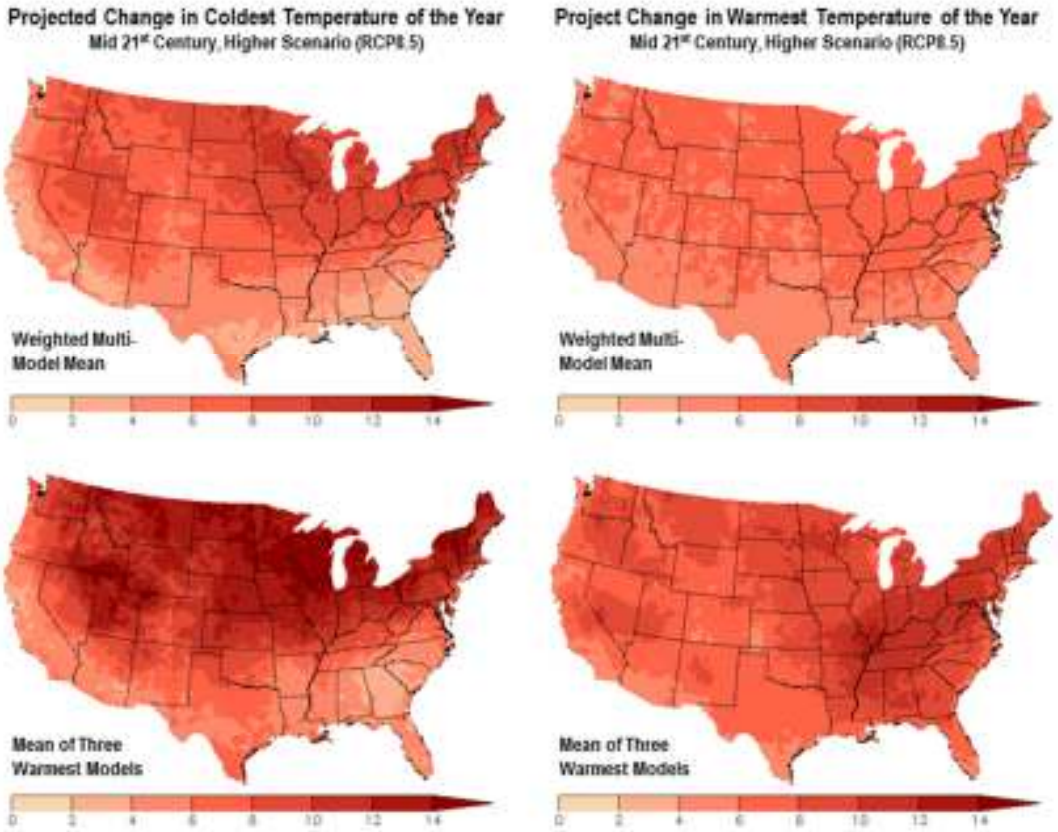
Temperature Projections



U.S. Temperature Projections

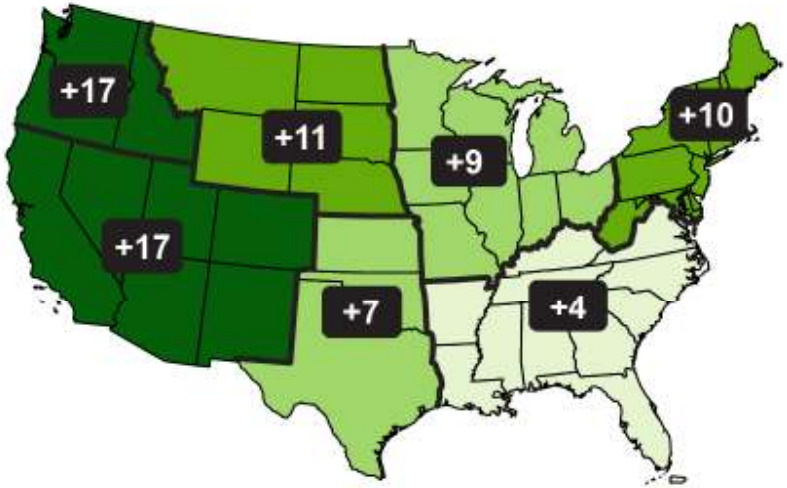


Change in Extreme Temperatures



Change in Freeze-Free Season

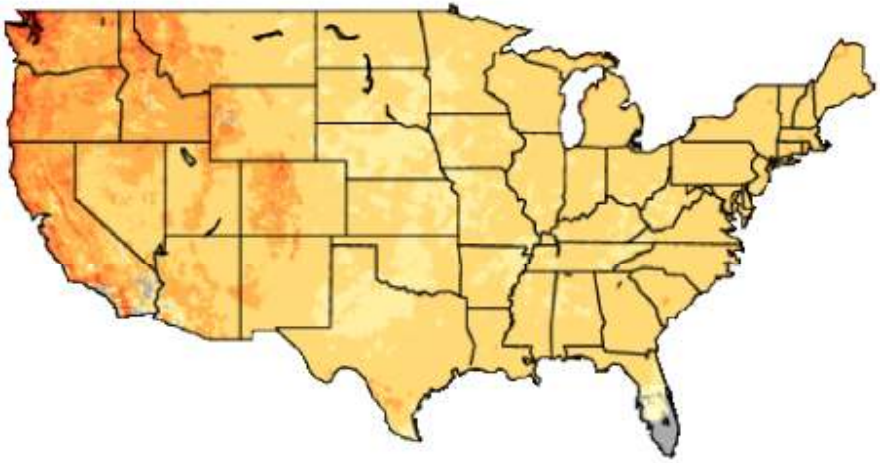
(a) Observed Increase in Frost-Free Season Length



Change in Annual Number of Days

0–4 5–9 10–14 15+

(b) Projected Changes in Frost-free Season Length

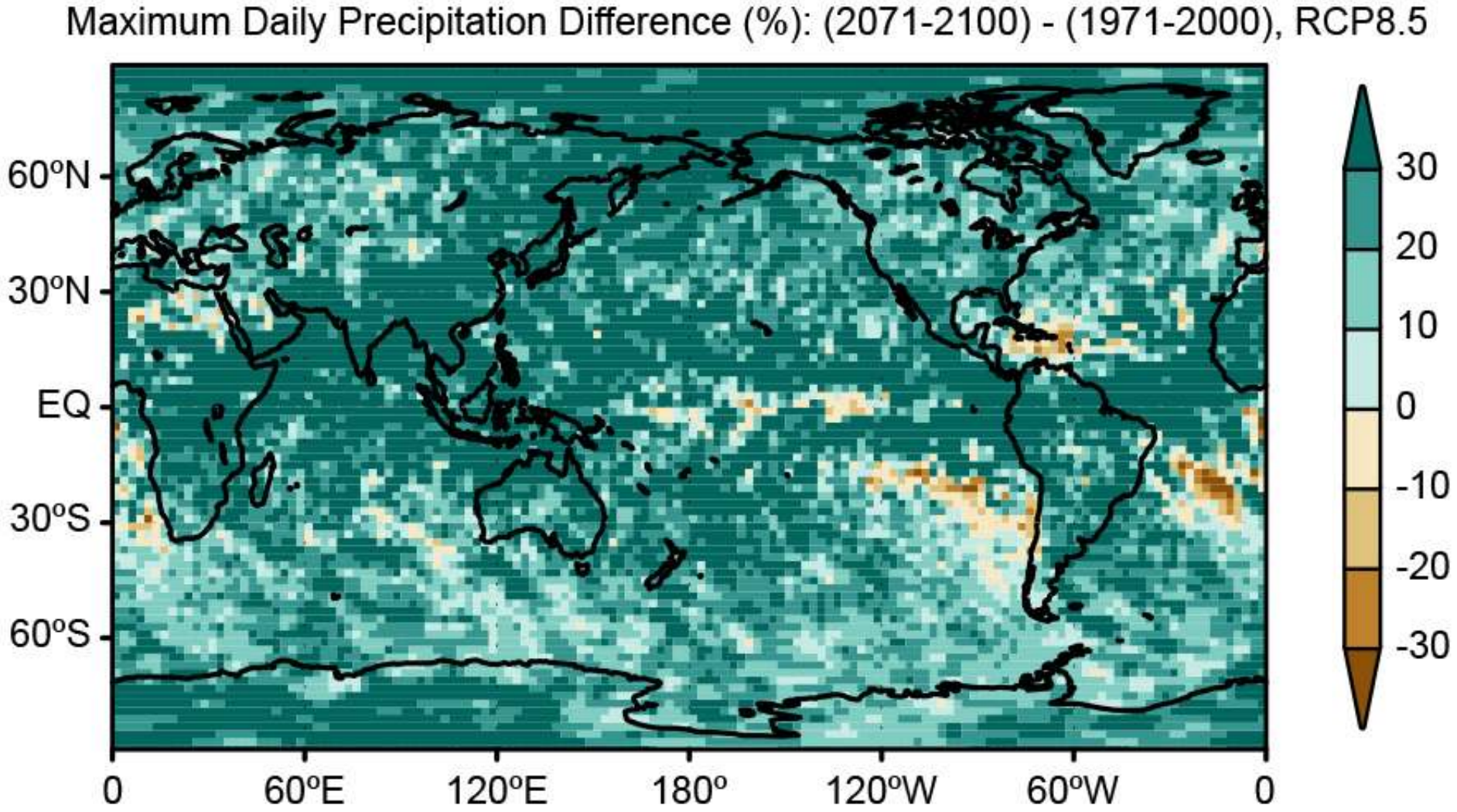


Change in Annual Number of Days

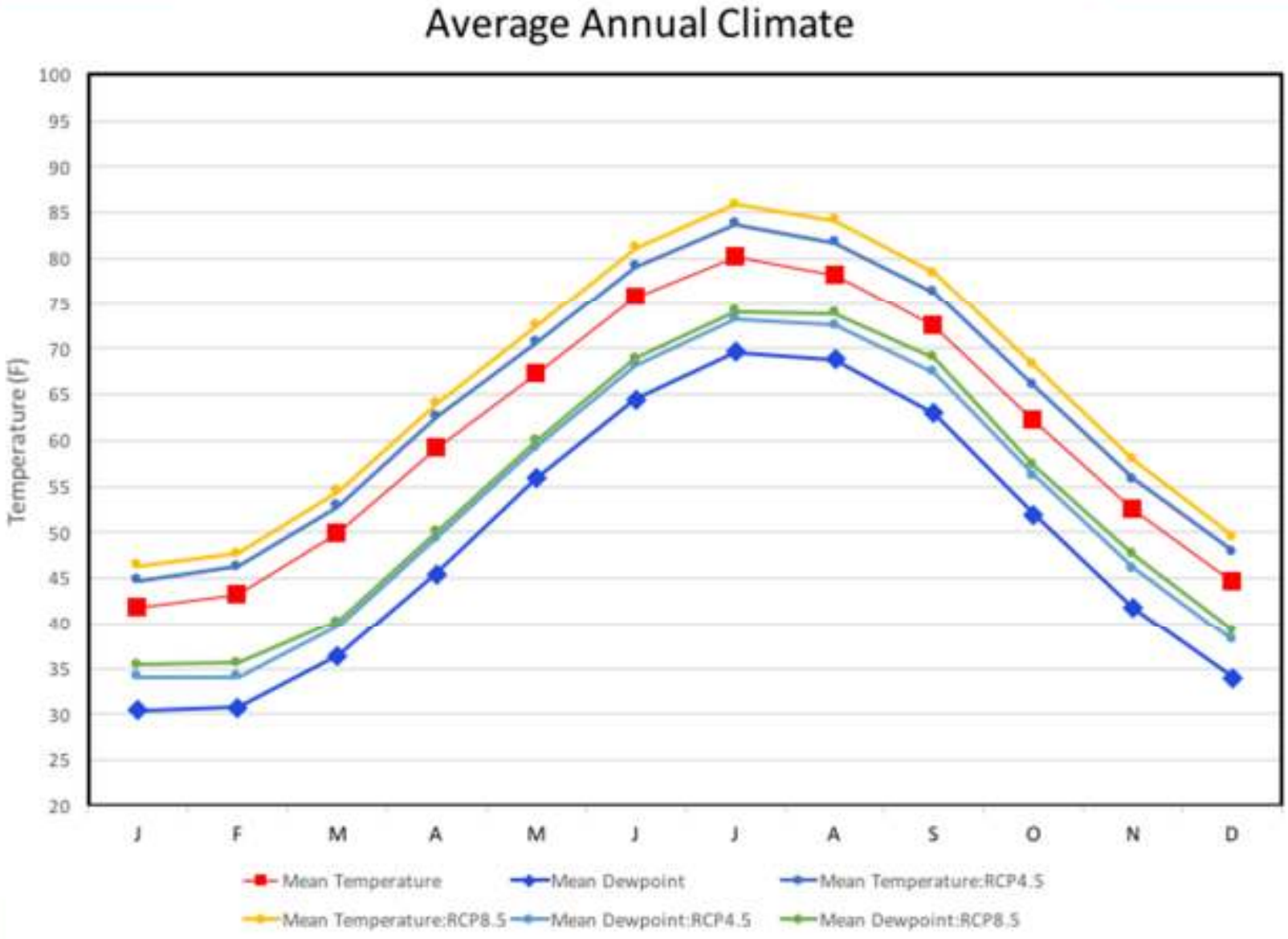
0 10 20 30 40 50 60 70 80 90

30-yr Maximum Daily Precipitation

Projected 100-yr trends



Langley, VA projections



2016 Climate and Health Assessment

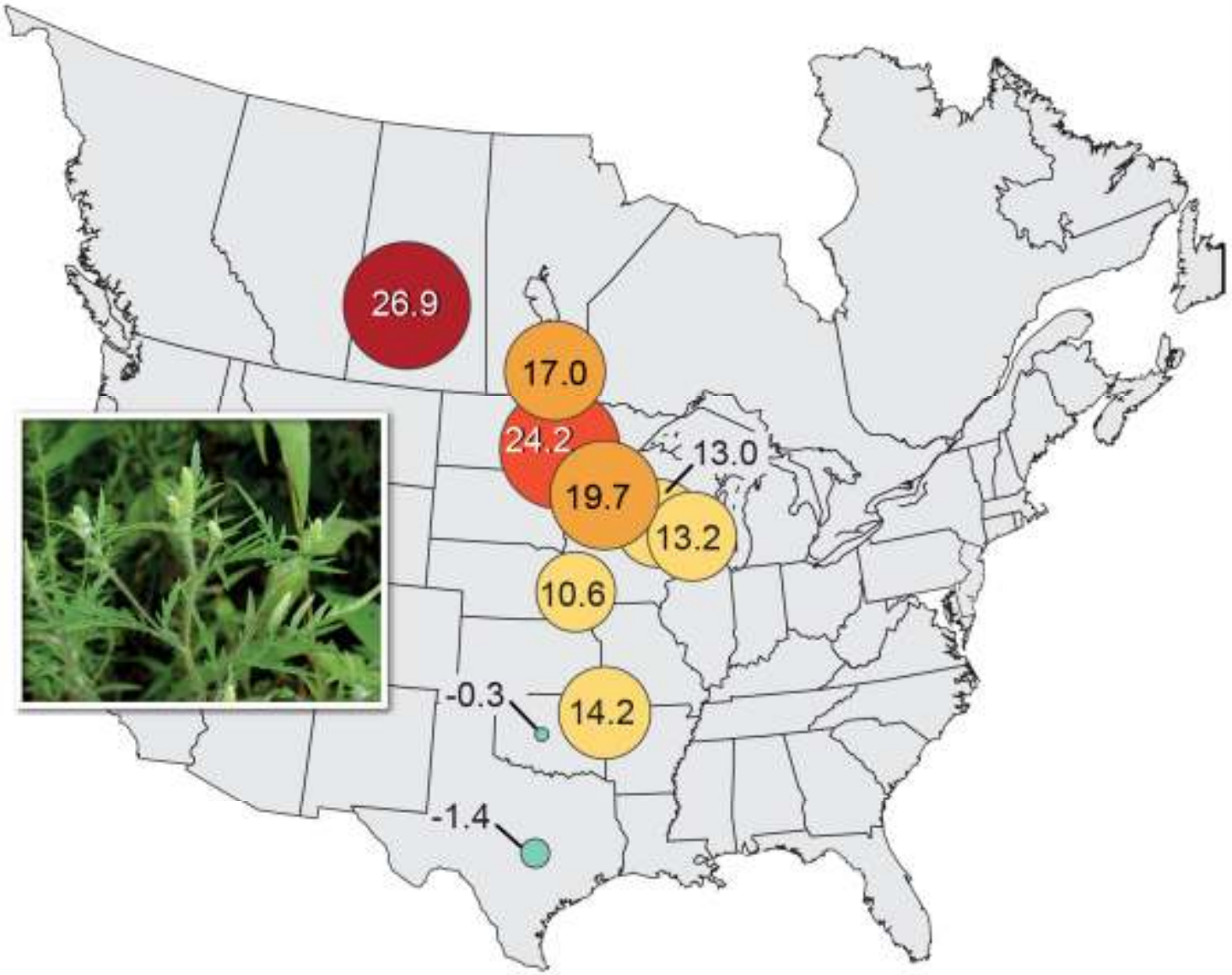
- Changes in climate, specifically rising temperatures, altered precipitation patterns, and increasing concentrations of atmospheric carbon dioxide, are expected to contribute to increases in the levels of some airborne allergens and associated increases in asthma episodes and other allergic illnesses *[High Confidence]*

2016 Climate and Health Assessment

- Asthma is exacerbated by changes in pollen season and allergenicity and in exposures to air pollutants affected by changes in temperature, humidity, and wind

Implications for Respiratory Health

- Increased heat wave intensityv
  - Ozone
  - Increased absolute humidity
- Longer pollen season
- Increased flooding
  - Mold
- Less intense cold waves



Change in Ragweed Season Length (Days)

Concluding Thoughts

- **What are the primary climate science uncertainties?**
  - The amount of warming for a given increase in CO_2
  - A number of the specifics of possible changes in weather
  - Atmosphere-earth system is highly complex and our understanding of it is far from complete

Questions?