EPA
United States
Environmental Protection
Agency

Air Quality in a Changing Climate

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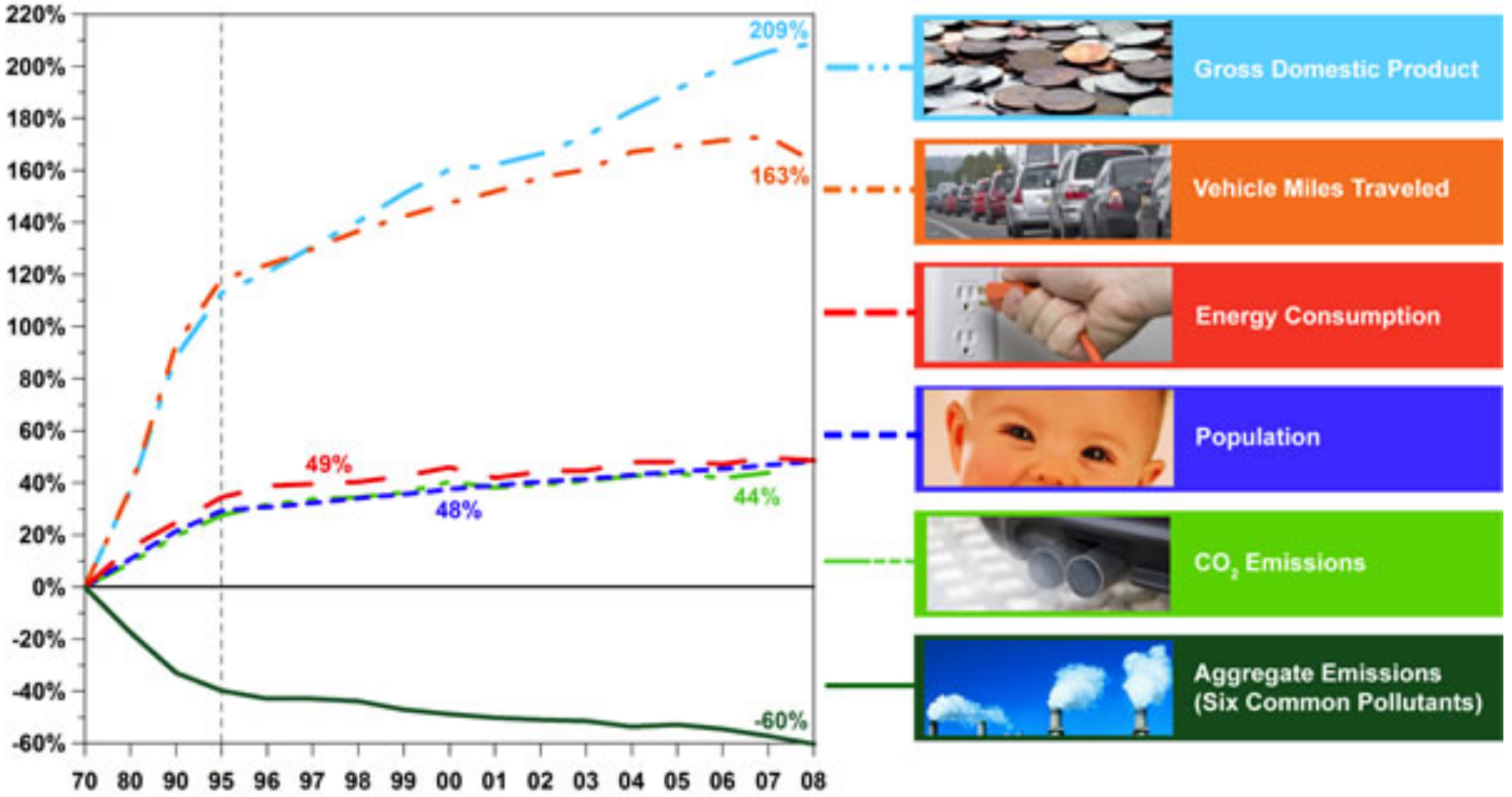
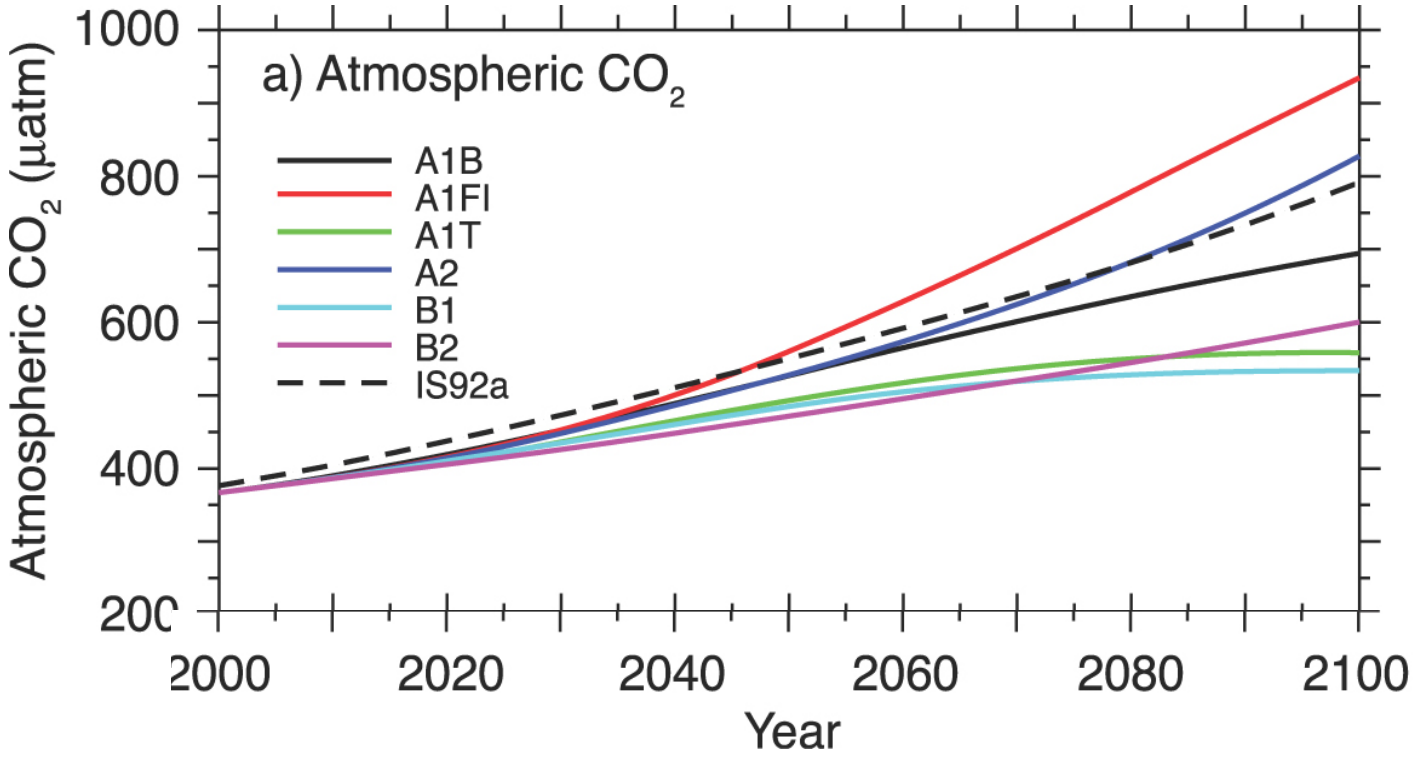
U.S. energy use and vehicle miles traveled have dramatically increased since 1970 CAA.



At the same time, air pollution has been reduced (but not CO_2)

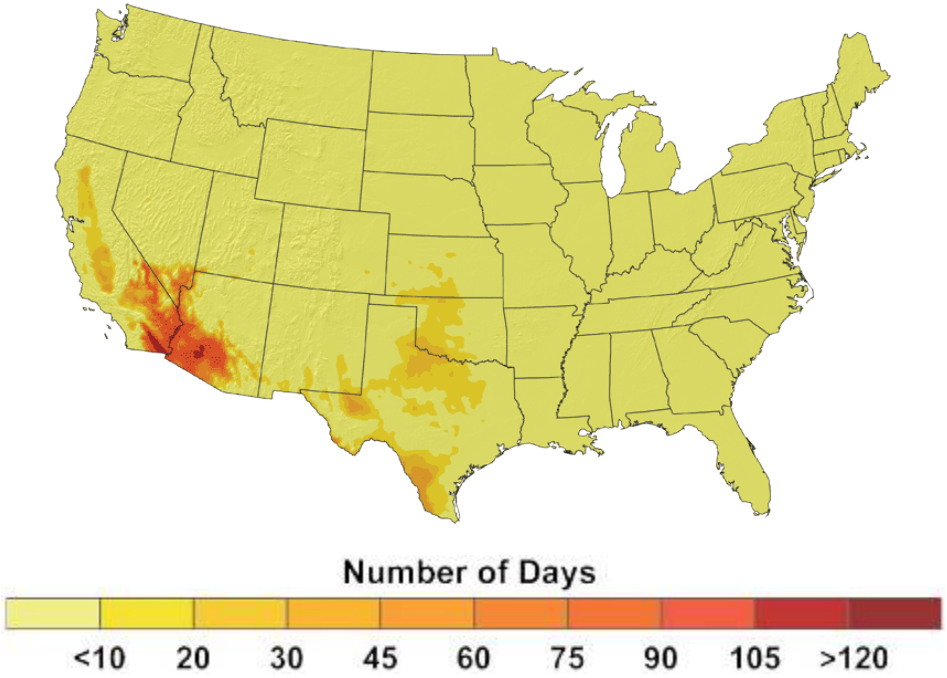
Global greenhouse gas emissions will continue to increase in the future.



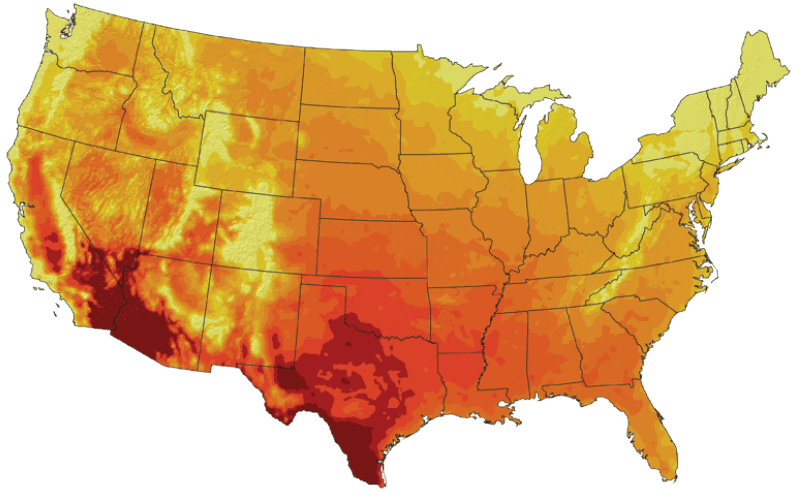
Increases in very high temperatures will have wide-ranging effects.

Number of Days Over 100ºF

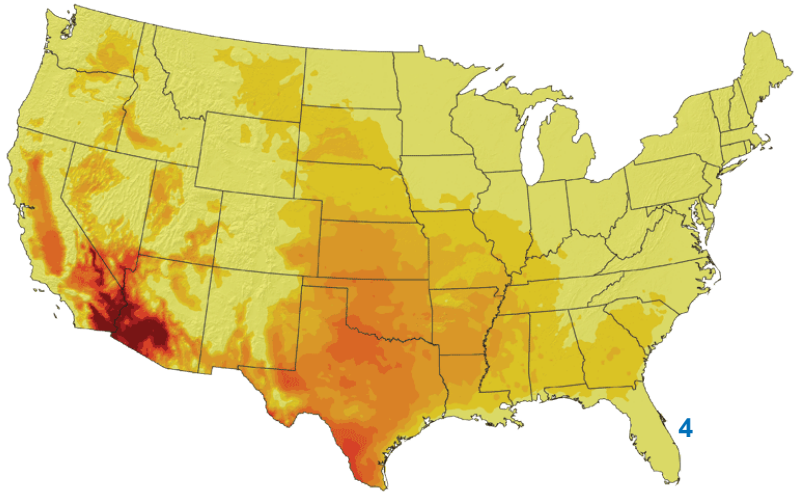
Recent Past, 1961-1979



Higher Emissions Scenario, 2080-2099

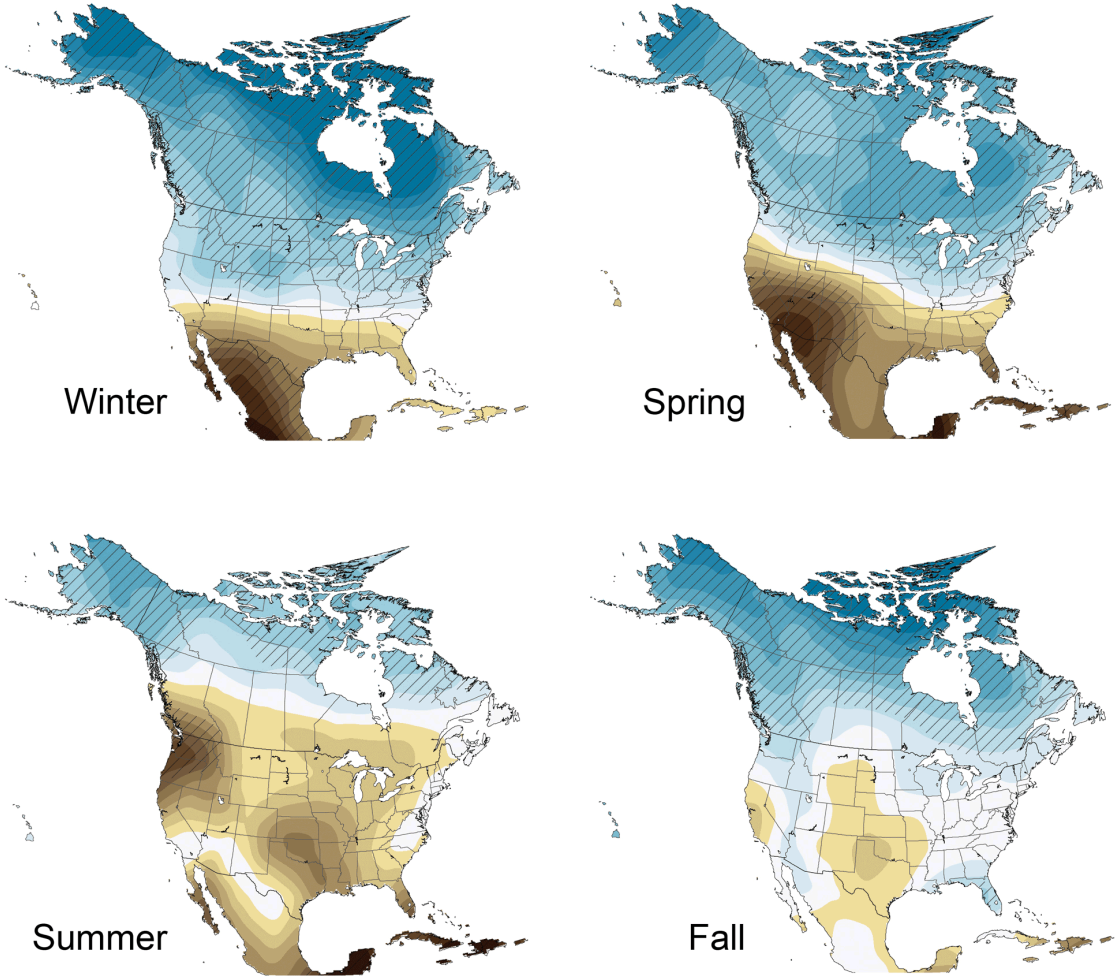


Lower Emissions Scenario, 2080-2099



Water resources will be affected by changing precipitation patterns and increasing temperatures.

Projected Change in Precipitation by 2080-90s

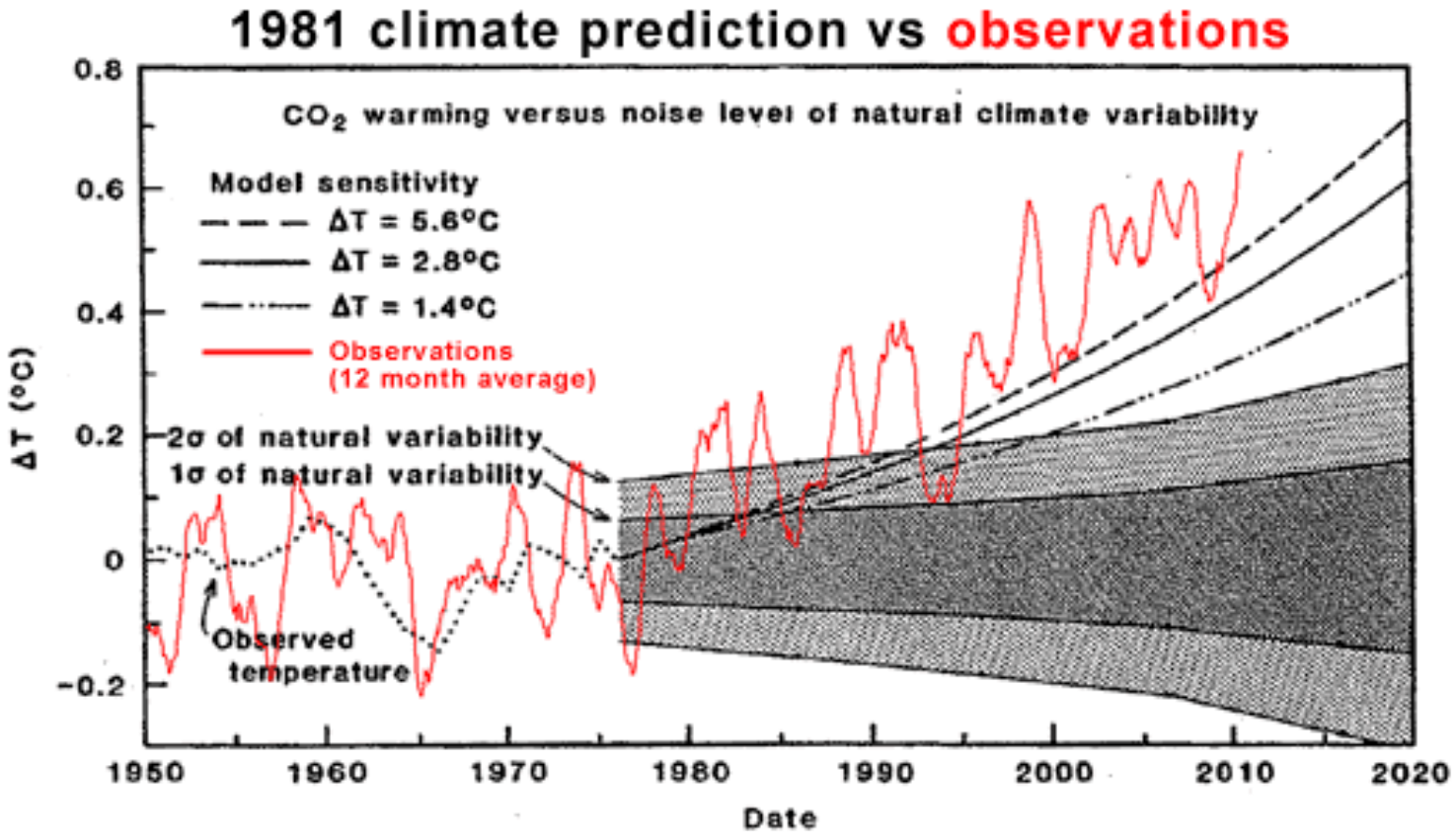


The latest Intergovernmental Panel on Climate Change (IPCC) report demonstrates:

- The role of greenhouse gases is **well understood** and their increases are well identified.
- The net effect of human activities is now quantified and known to cause a **warming** at the Earth's surface.
- Evidence for warming of the climate system is **undeniable**.

IPCC report, *Climate Change 2007* (http://www.ipcc.ch/)

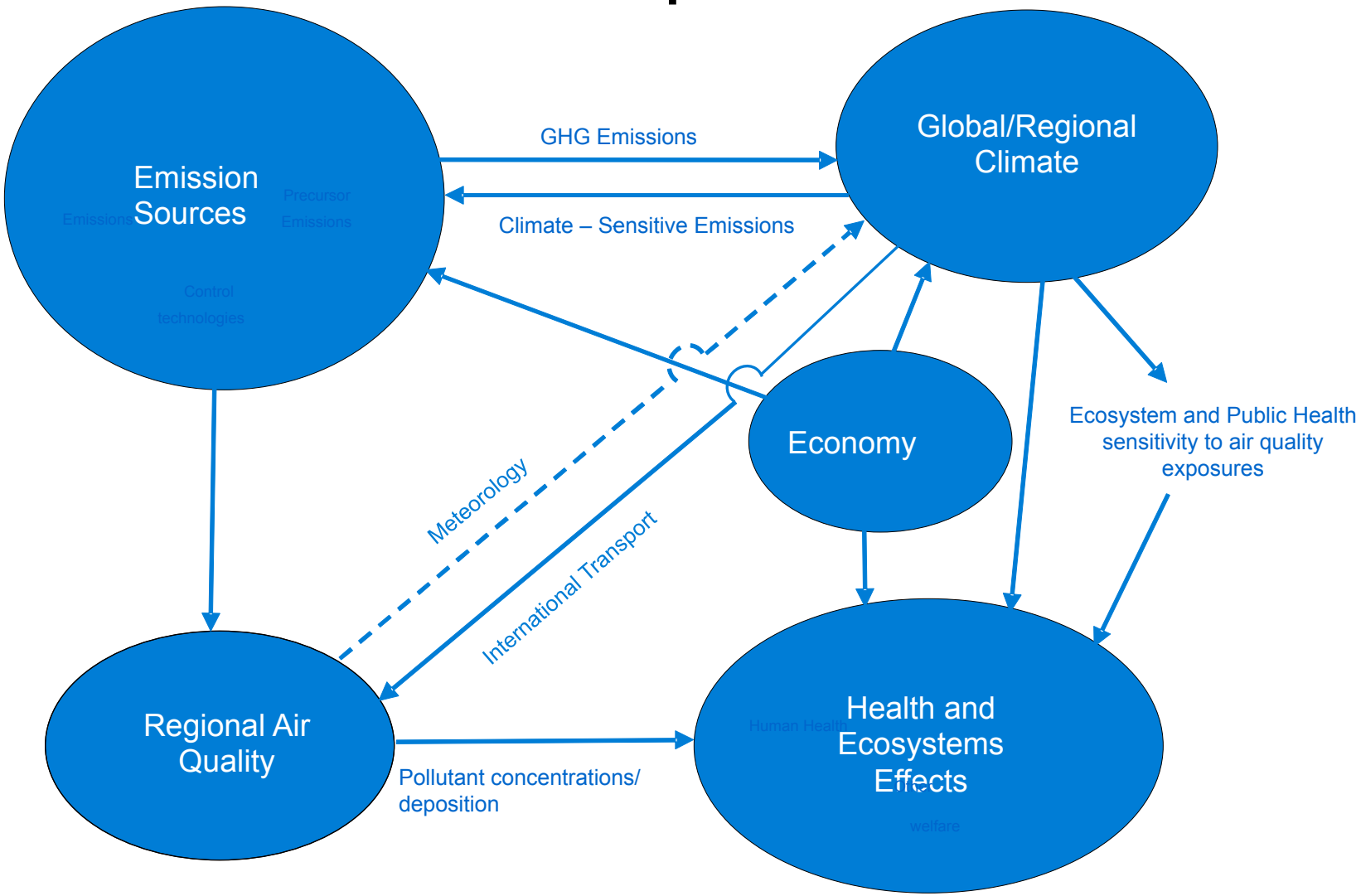
Temperatures are rising as predicted 30 years ago.



Modified Figure 7 from Climate Impact of Increasing Atmospheric Carbon Dioxide, J. Hansen, D. Johnson, A. Lacis, S. Lebedeff, P. Lee, D. Rind, and G. Russell (28 August 1981), *Science* 213, 957-966.

Overlay of smoothed GISSTemp anomalies through 2010 from http://www.skepticalscience.com/Hansen-hit-a-home-run.html

The Interactions between Air Quality and Climate are complex.

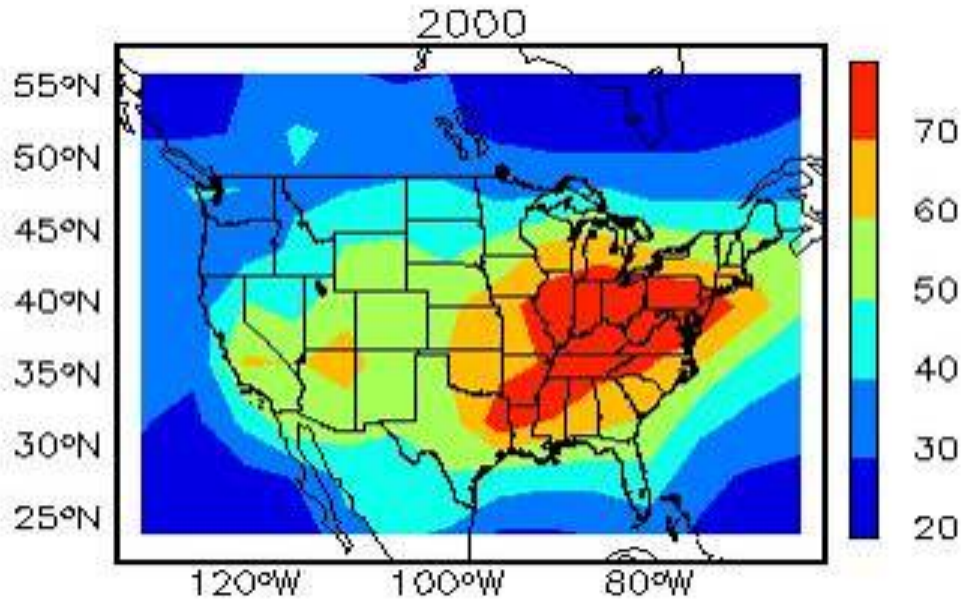


Air pollutants can cause both warming and cooling.

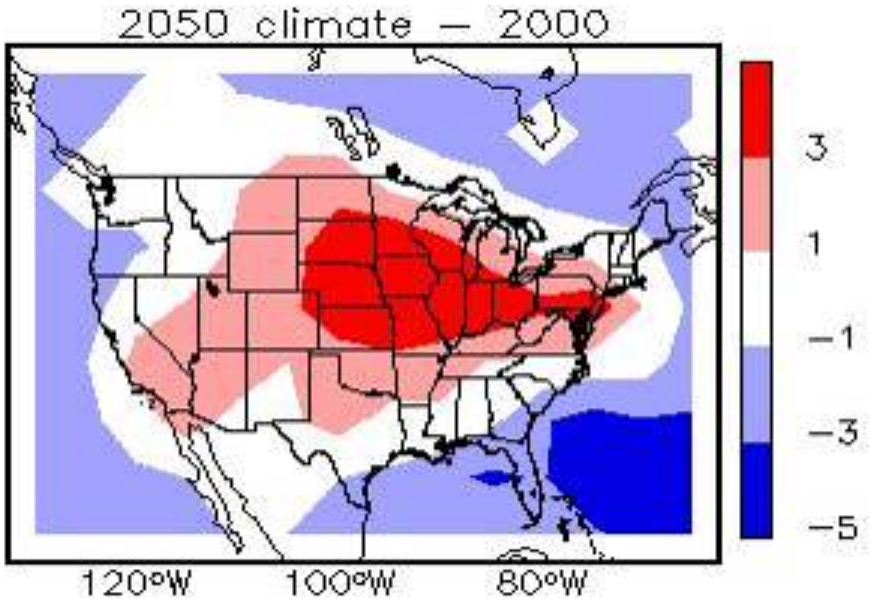
- Ozone is greenhouse gas
- Black carbon portion of $PM_{2.5}$ is warming
- Sulfate portion of $PM_{2.5}$ is cooling
- Methane is a greenhouse gas, and also a precursor to ozone
- NO_x changes atmospheric radical chemistry, which alters lifetime of methane and impacts ozone

EPA researchers and STAR grantees use advanced modeling systems to understand the impact of climate change on regional air quality.

Base 1999-2001 Ozone, ppb



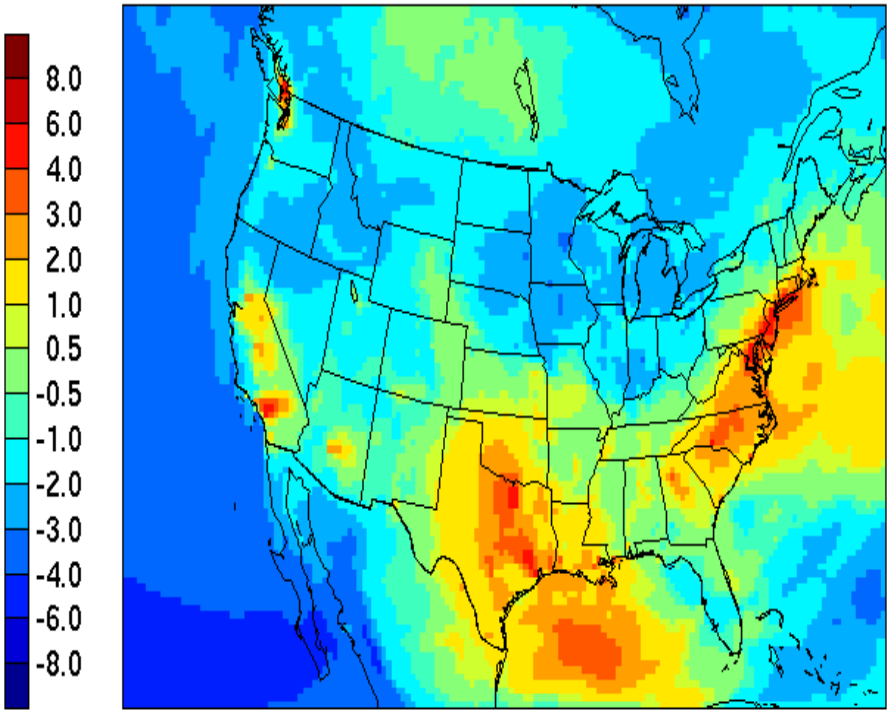
Change in Ozone from 50 yrs climate change



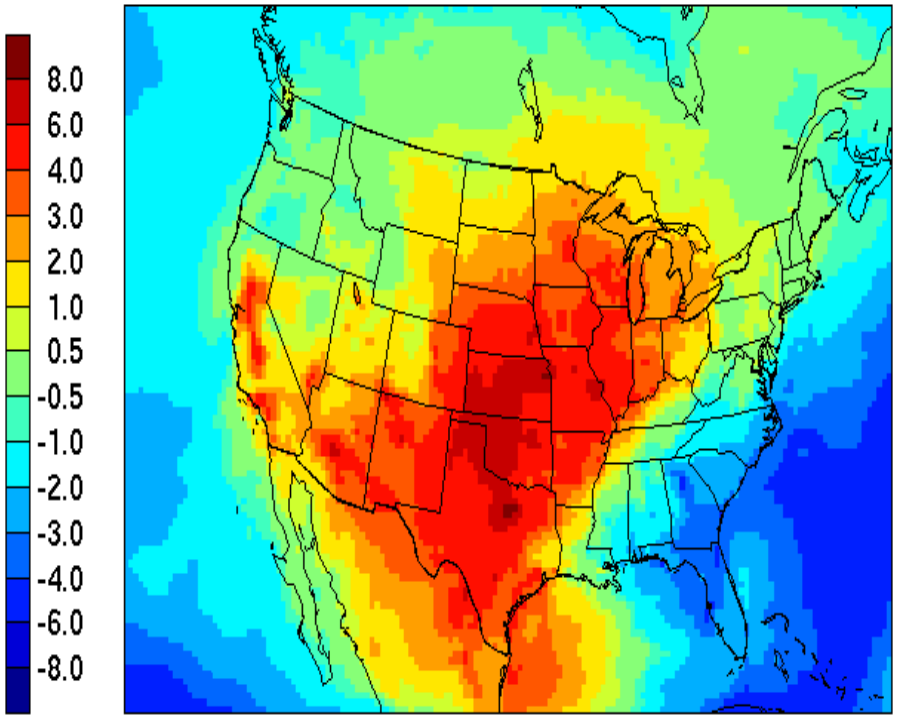
Wu et al., 2008

Future climate change will impact ozone concentrations across the U.S. and increase length of ozone season.

Change in summer ozone from 50 yrs of climate change

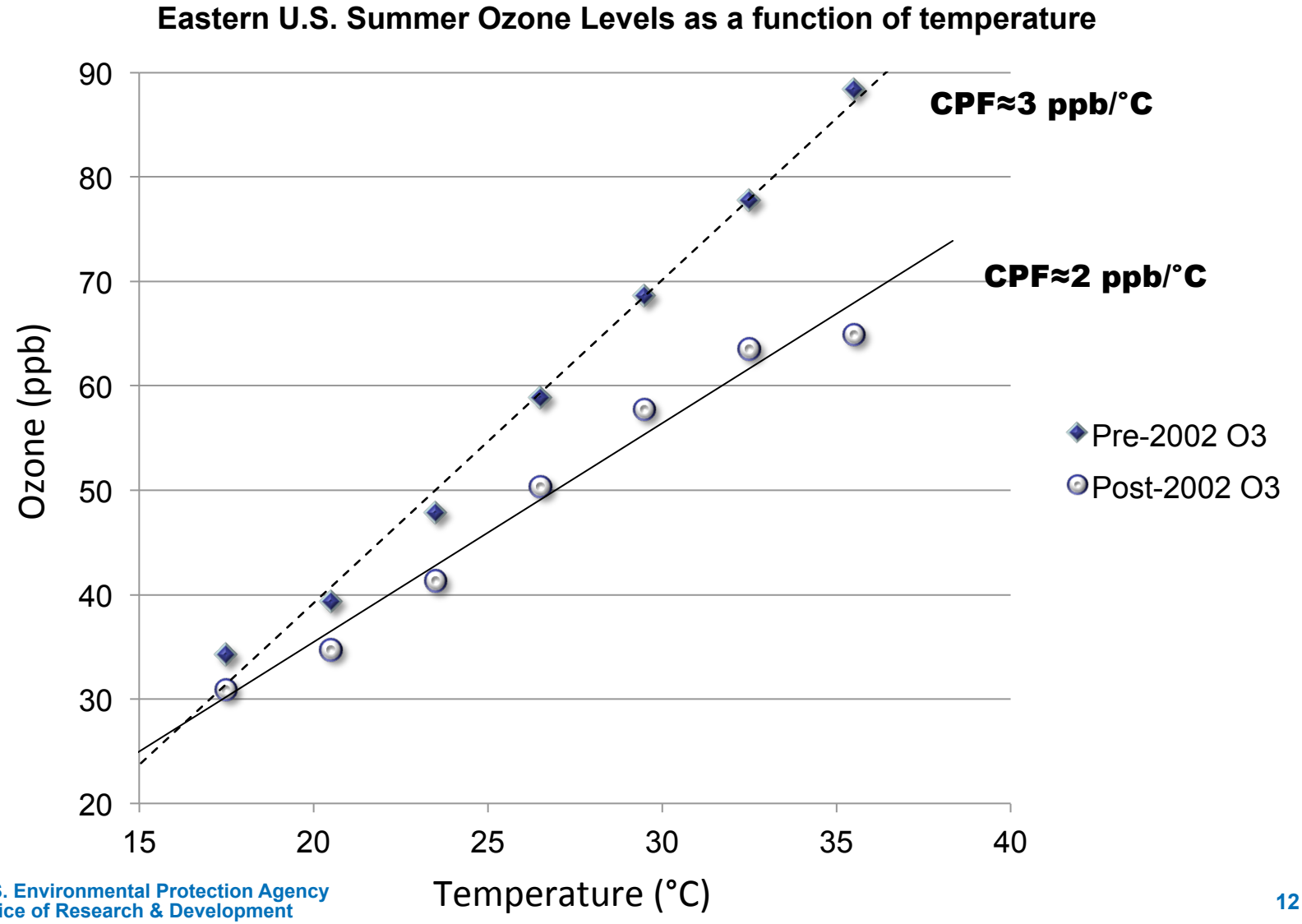


Change in fall ozone (Sep-Oct) from 50 yrs of climate change



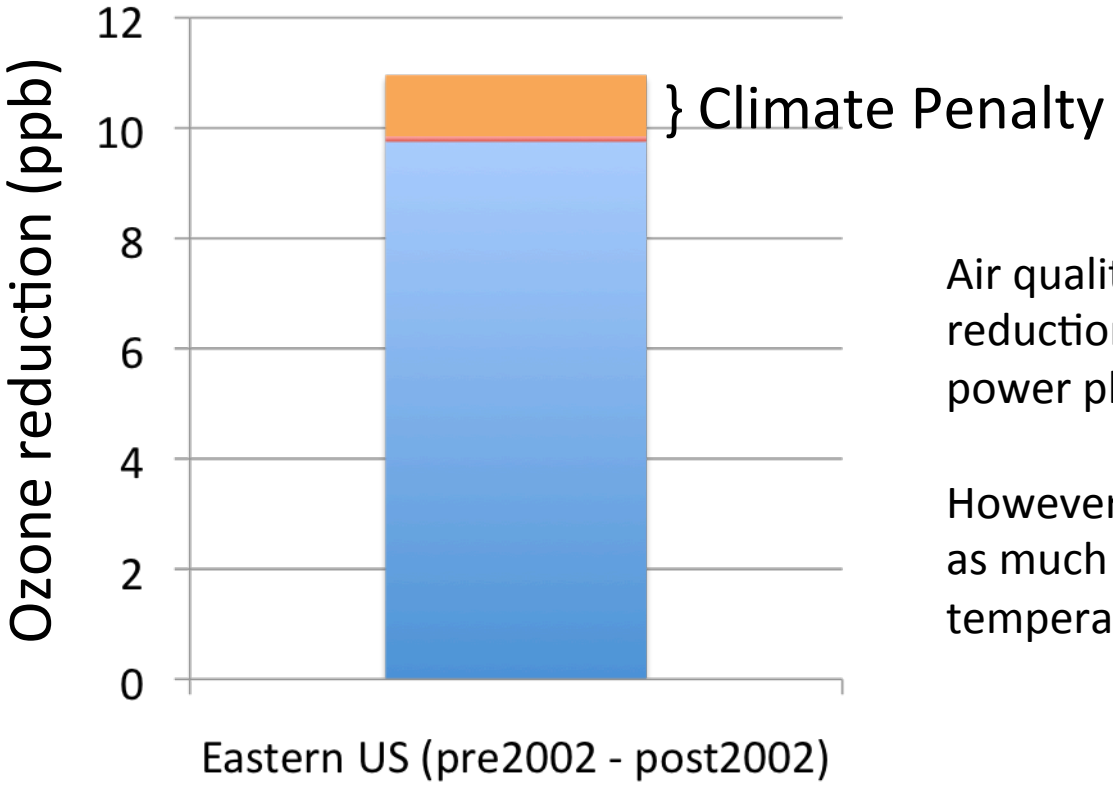
Nolte et al., J. Geophys. Res., 2008.

EPA researchers find observations that confirm the climate penalty.



Bloomer et al., GRL, 2009

Climate penalty for ozone air quality in the Eastern U.S. based on observations



Air quality improved after the 43% reduction in NOx emissions from power plants

However, air quality did not improve as much as it would have had temperatures not increased.

Bloomer et al., GRL, 2009

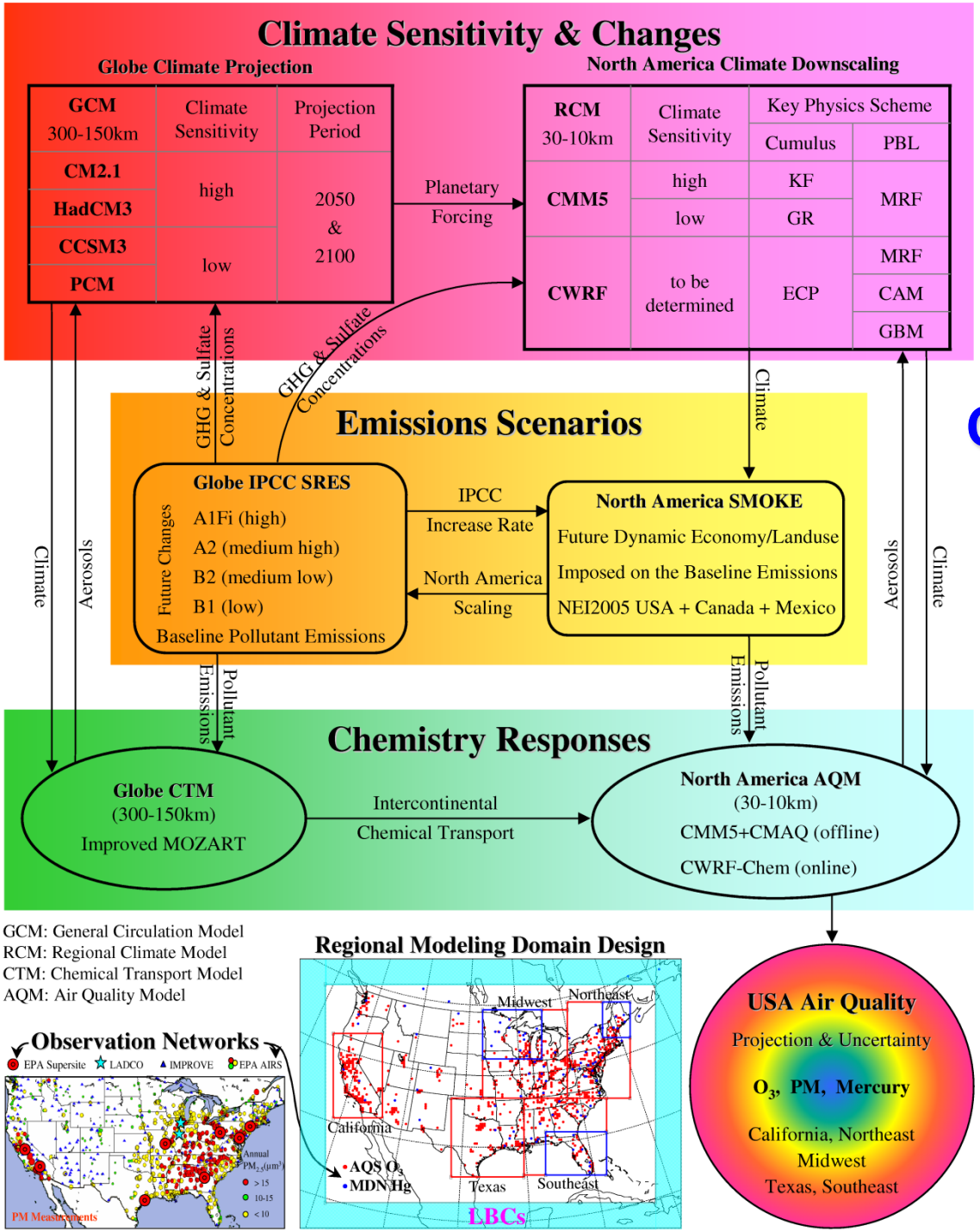
Changing climate also impacts particulate matter pollution.

- More water vapor plus changing weather patterns
  - Increasing rainout events (decreasing PM in some regions)
  - Increasing drought (increasing PM in some regions)
- Increase in number and length of stagnation events
- Changing biogenic emissions
- Changing some particles to the gaseous state
- Drought-related increases in dust emissions
- Longer wildfire seasons and larger fires

The net impact is unclear.

EPA STAR
2007-2010
X.-Z. Liang

Ensemble System Modeling Approach



FOCUS

Consolidate O_3

Elaborate PM

Explore Hg

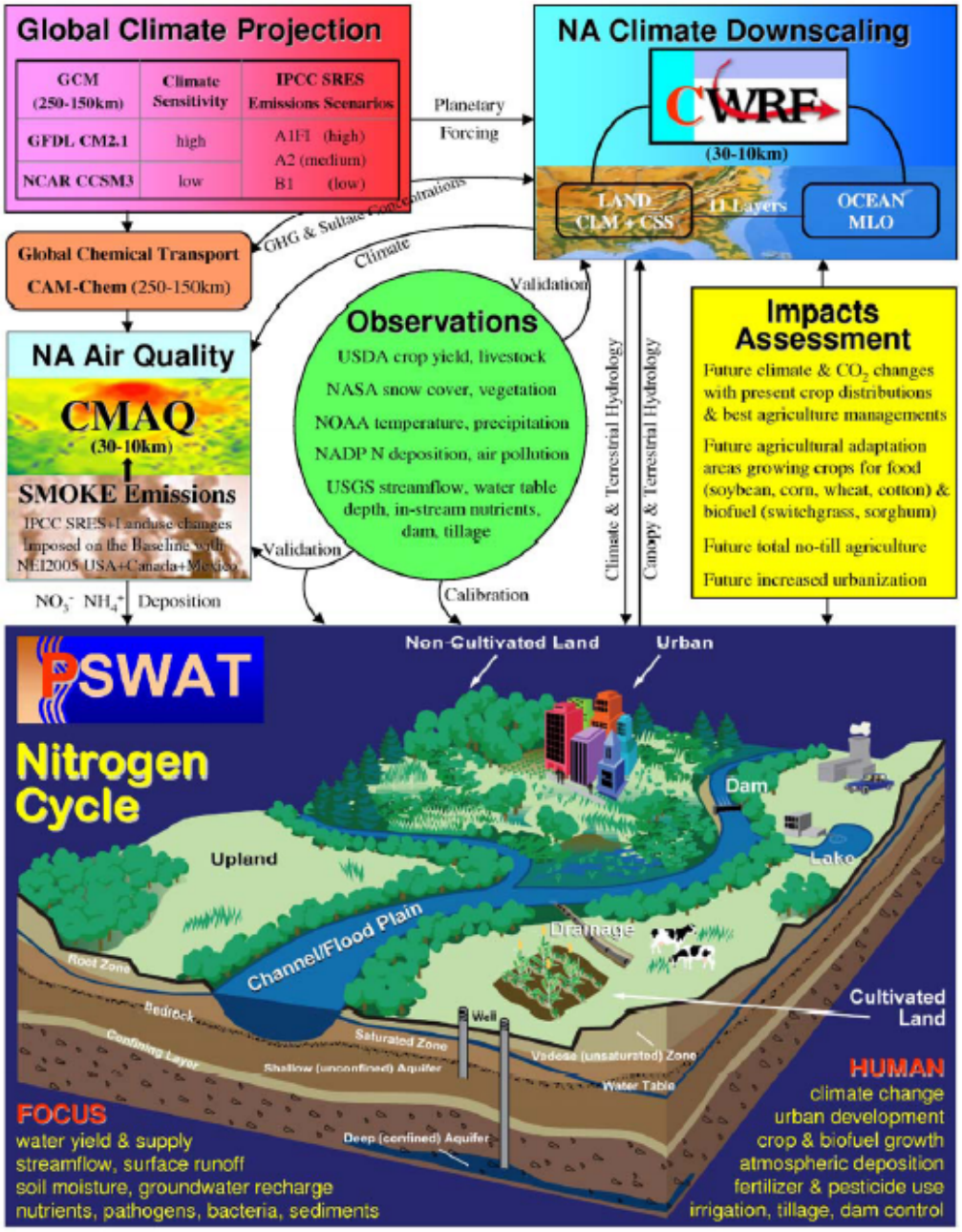
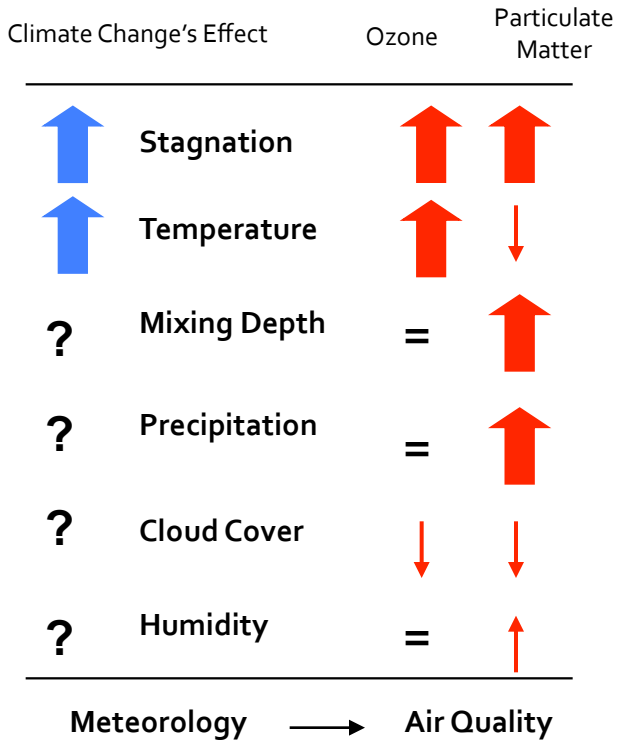


Figure 1. The integrated global-regional modeling system for projecting U.S. water quality responses and uncertainty ranges caused by global climate and emissions changes for the 2050s.

Because climate change will increase ozone concentrations, stronger emissions controls will be needed to achieve air quality standards in the future.



For example, to meet ozone pollution reduction goals in the Midwest we need…

40% reduction in NOx emissions in **today's climate**

or

50% reduction in NOx emissions in a **2050 climate**

…to achieve the same result.

Jacob and Winner 2009, "Effect of climate change on air quality"

"The emissions of Greenhouse Gases cause or contribute to endangerment of public health and welfare."

"The evidence concerning adverse air quality impacts *provides strong and clear support* for an endangerment finding."

The Administrator relied upon the contributions of over 10 years of research to arrive at this central conclusion

Administrator Lisa Jackson signing the Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases under the Clean Air Act 12/2009

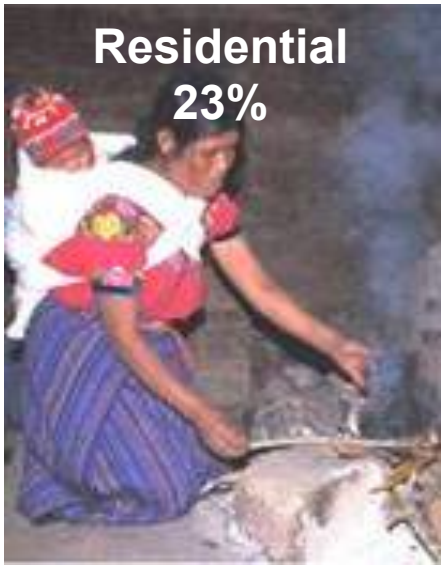
Research challenges that arise from these interactions are:

- How do we continue to improve air quality in the face of a changing climate? (Adaptation)

- How can we effectively and efficiently tackle climate change? (Mitigation and co-benefits)

Of special global importance is the study of black carbon, a part of $PM_{2.5}$.

- BC is associated with premature mortality and morbidity.
- BC causes immediate climate warming
- BC emissions come from a number of sectors which vary in different regions of the world.



Cookstoves – a large source of BC

- Nearly 3 billion people use polluting, inefficient stoves or open flames to cook their food.

- Exposure to cookstove smoke
  - kills nearly 2 million people every year
  - doubles a child's risk of contracting pneumonia.

- The World Health Organization estimates harmful cookstove smoke to be the fourth worst overall health risk factor in developing countries.

The Global Alliance for Clean Cookstoves: 100 by 20

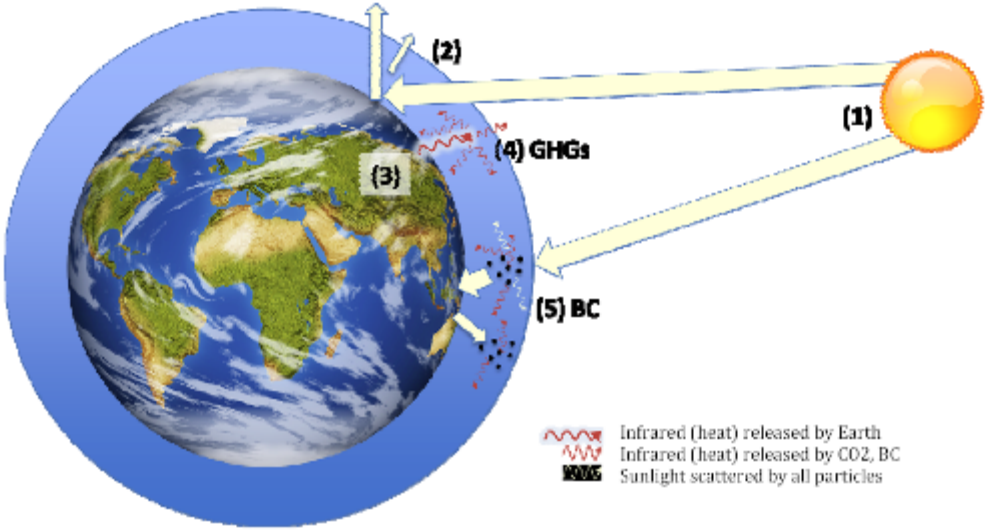
- New public-private initiative to save lives, improve livelihoods, empower women, and combat climate change by creating a thriving global market for clean and efficient household cooking solutions.

- The Alliance's '100 by 20' goal calls for **100 million homes to adopt clean and efficient stoves and fuels by 2020**, toward a long-term vision of universal adoption of clean and efficient cooking solutions.

"The U.S. is committing close to $60 million over the next five years with an eye toward sharing expertise, utilizing sound R&D practices and understanding the cultural nuances from country to country."
-EPA Administrator Lisa Jackson

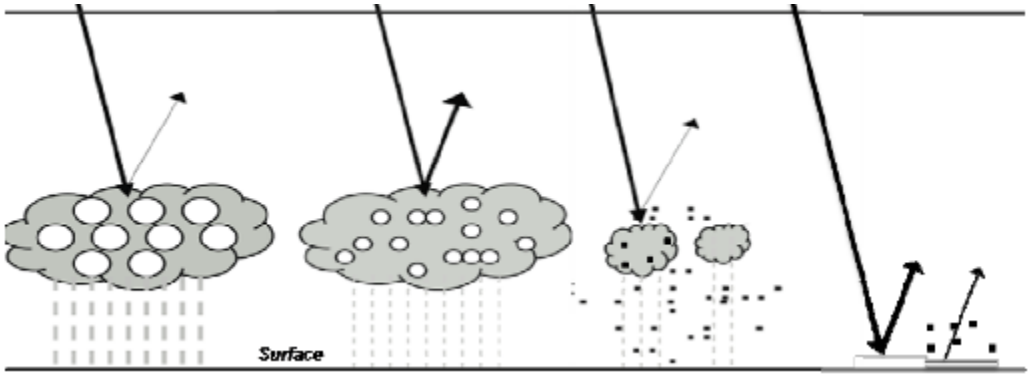
www.cleancookstoves.org

Black carbon impacts climate.



Directly absorbs radiation

Indirect effects on snow/ice



Indirect effects on clouds

Conclusions

- Air quality and climate are heavily intertwined.
- Adapting to climate change must include air quality concerns.
- The air quality management system must account for changing climate.
- There are great opportunities to slow climate change while improving global public health (e.g. black carbon from cookstoves)
- Important research questions need investigation to guide optimal strategies to meet air quality standards and address climate change

Acknowledgements

- Dan Costa, ORD/NPD
- Doug Grano, Susan Anenberg, Bryan Hubbell OAR/OAQPS
- Anne Grambsch, Chris Weaver ORD/NCEA
- Bryan Bloomer, John Dawson ORD/ NCER
- Chris Nolte, ORD/NERL
- Daniel Jacob, Harvard