Air quality impacts of extreme weather events: Historical analysis and future projection

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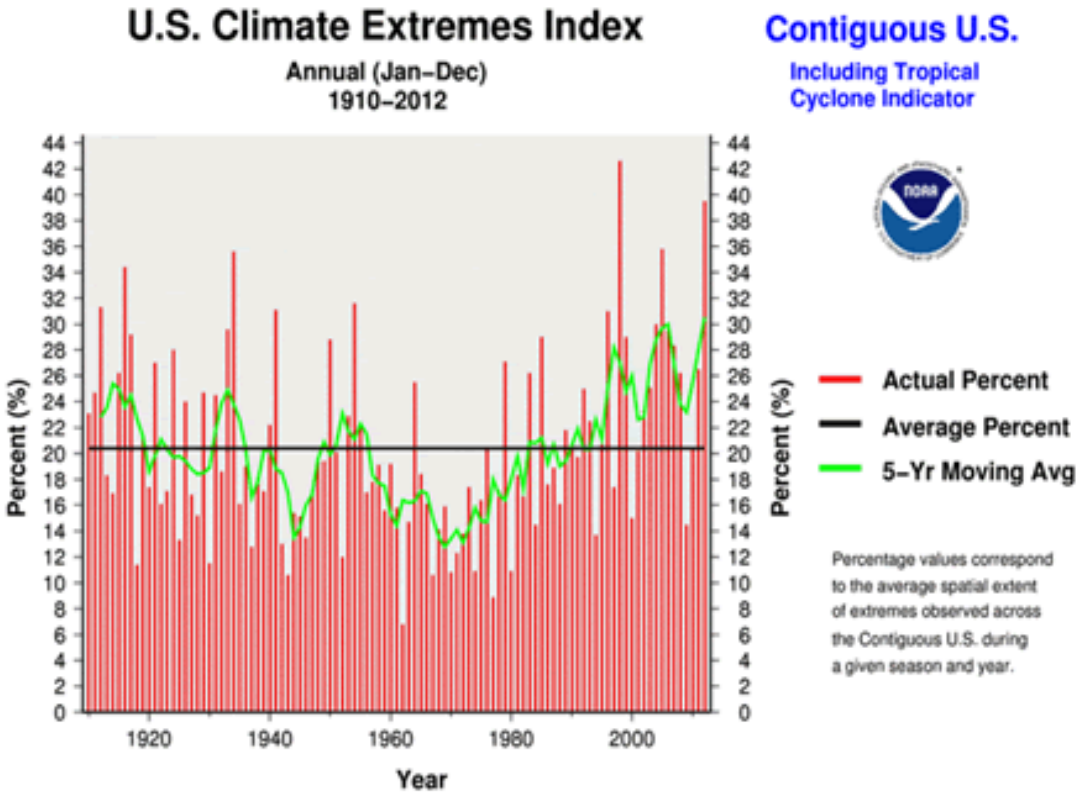
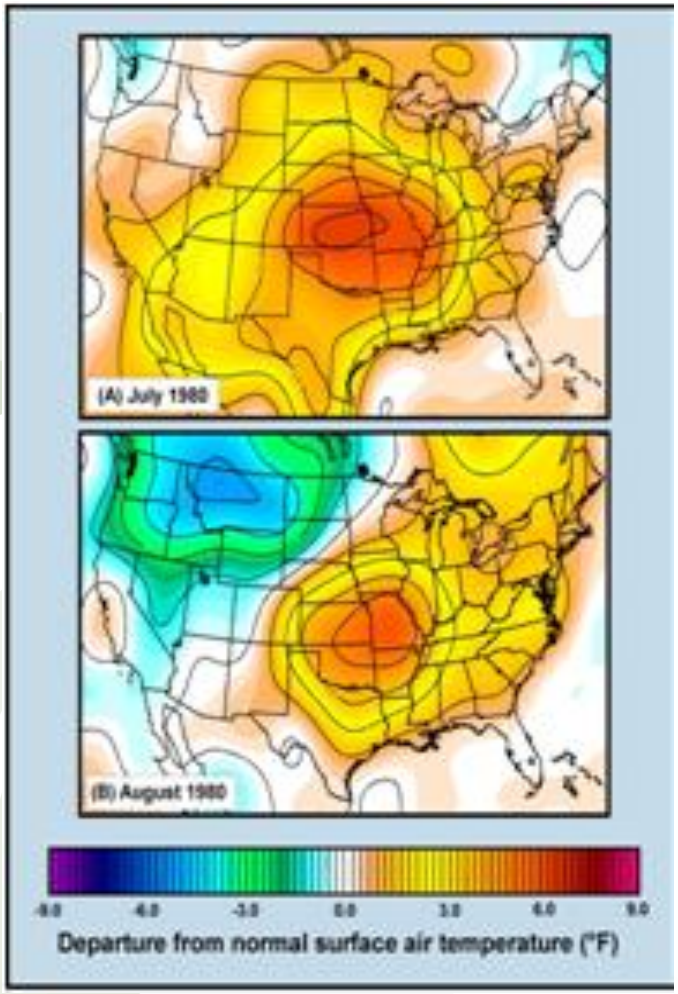
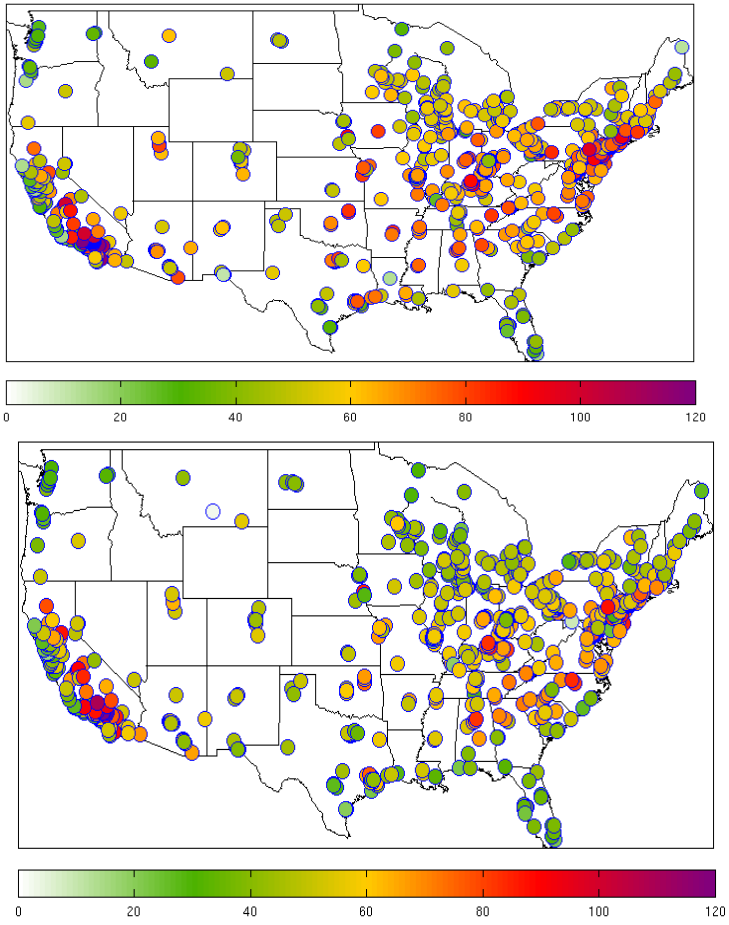
Motivation



"The combination of the exceptional warmth and historic drought conditions placed 2012 as the second most extreme on record."

Heat wave and extreme ozone





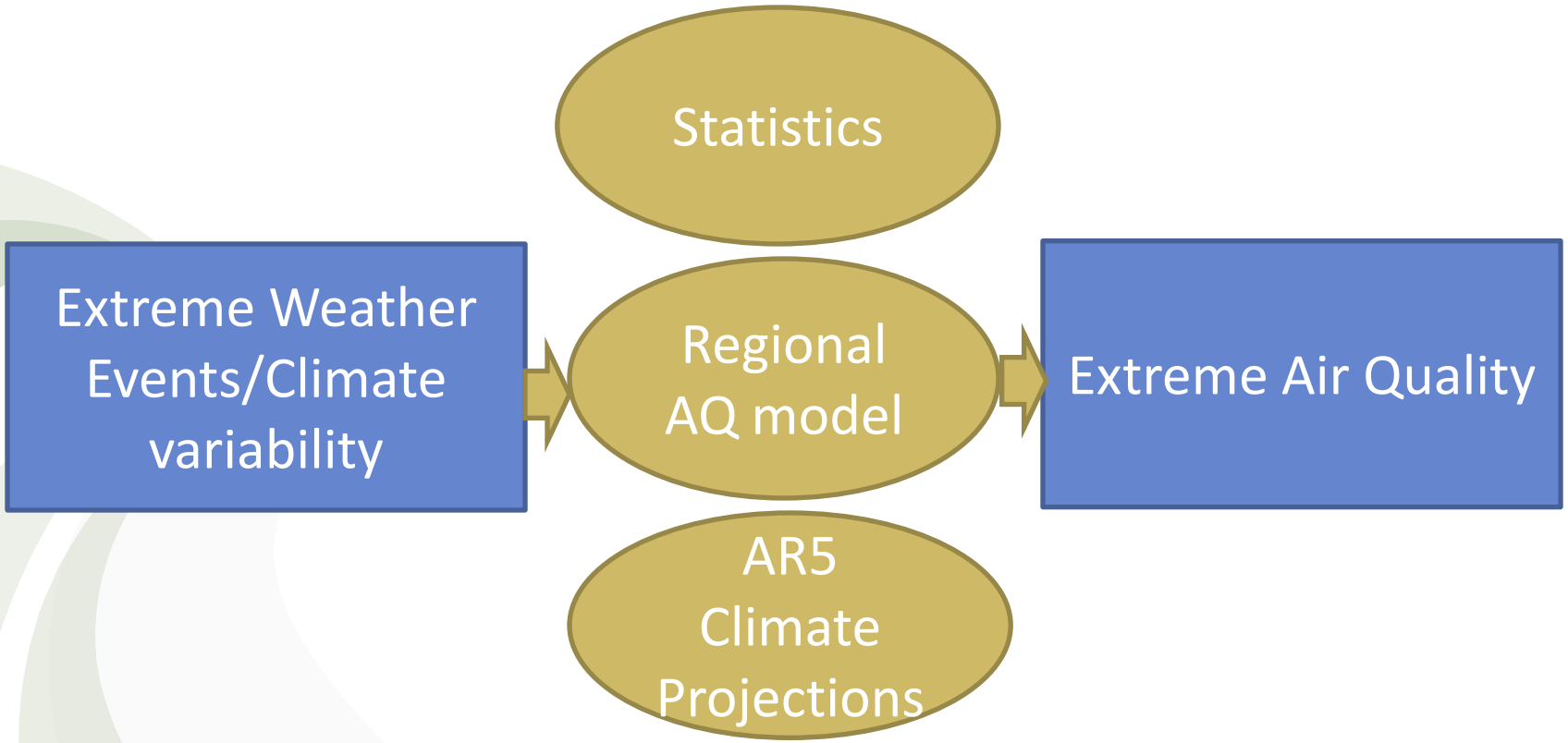
Extreme haze events

NY Times *January 14, 2013,* "…PM 2.5…exceeded 900 micrograms per cubic meter, on par with some of the worst days of the killer smog in London in the mid-20th century."

Objectives

- Quantify occurrences of extreme weather and air quality events and characterize the duration, frequency, magnitude, and spatial-temporal scales of extreme events based on historical data.
- Quantify the effects of extreme weather events on air quality extremes using observations in the past decades.
- Investigate the mechanisms through which air quality is affected by extreme weather events and quantify how future emission changes will affect the sensitivity of air quality to extreme weather events.
- Project the impact of climate variability/change on air quality due to changes in extreme weather events using an ensemble of climate simulation results.

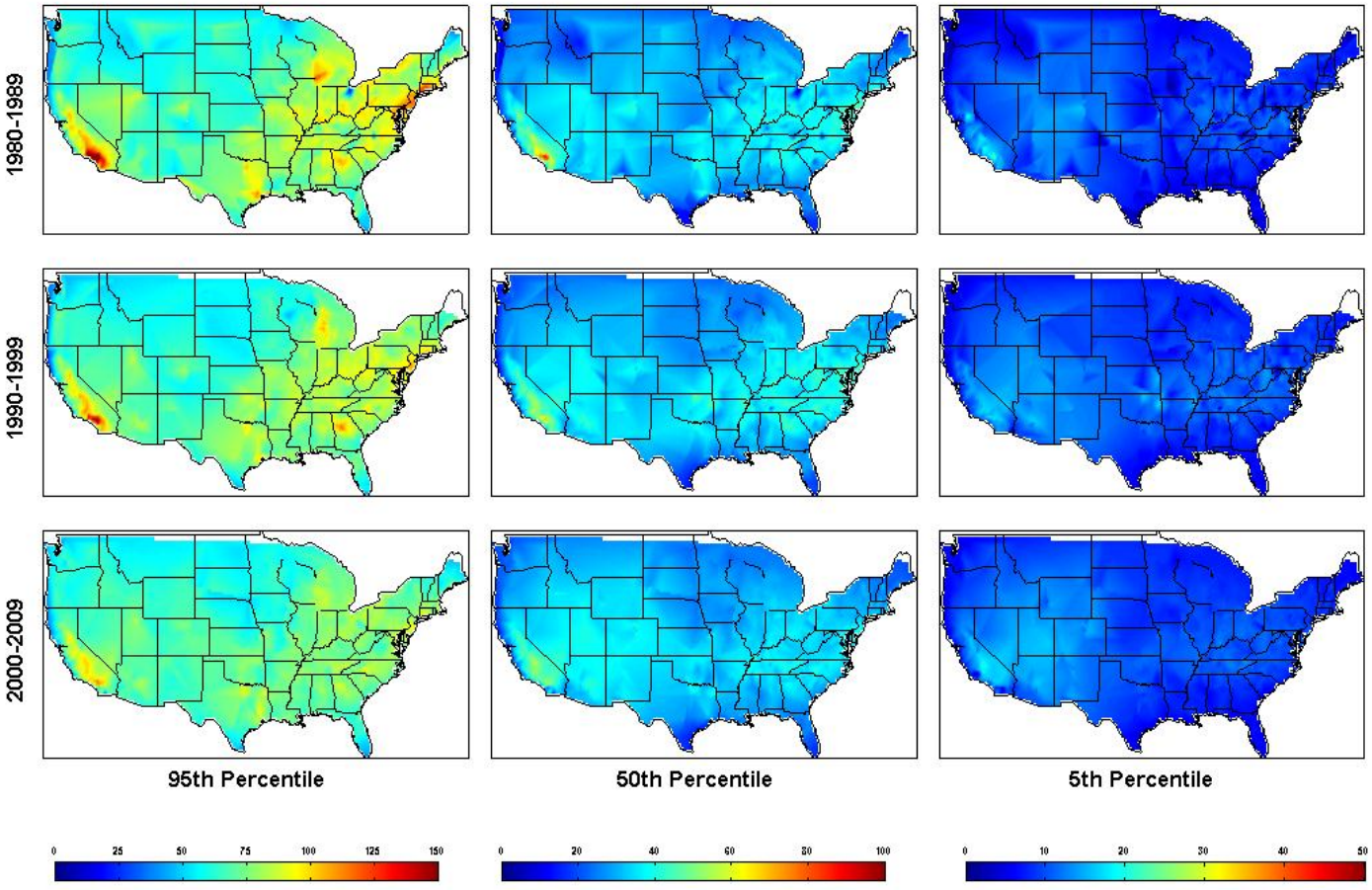
Analysis approach



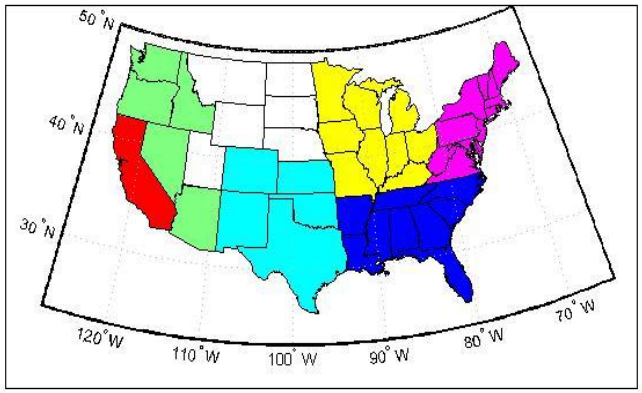
Key research questions

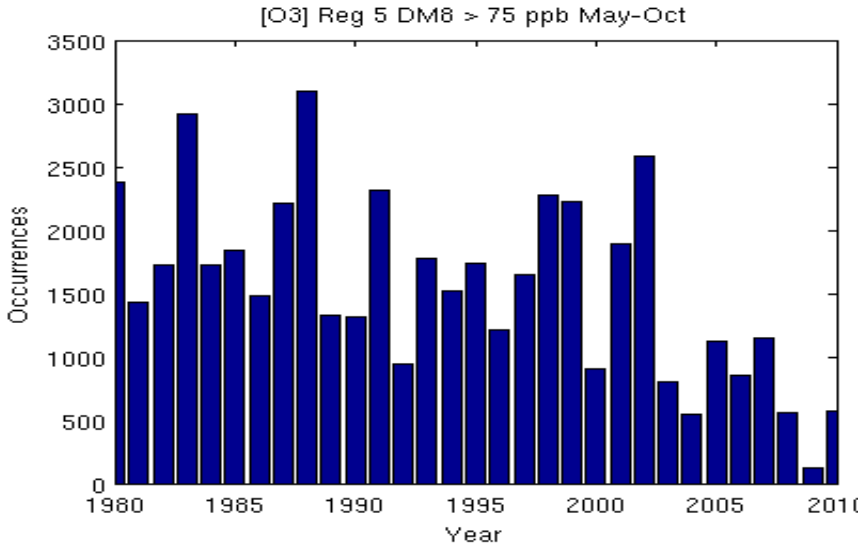
- What are the characteristics of extreme weather and air quality events?
  - How do we define these extreme events in a consistent manner such that they can be analyzed in one framework?
- How do we quantify the relationship between extreme weather and air quality events?
  - Localized statistics are informative and somewhat easier to obtain, but they do not lead to clear understanding of the fundamental processes.
  - Regional climate variability is likely an important driving factor for systematic changes in the occurrences of extreme events.
- How do we make best use of regional AQ modeling and climate projection capabilities?
  - Our modeling capability of extreme events is not well characterized. We believe a combined statistical and numerical modeling approach is necessary.

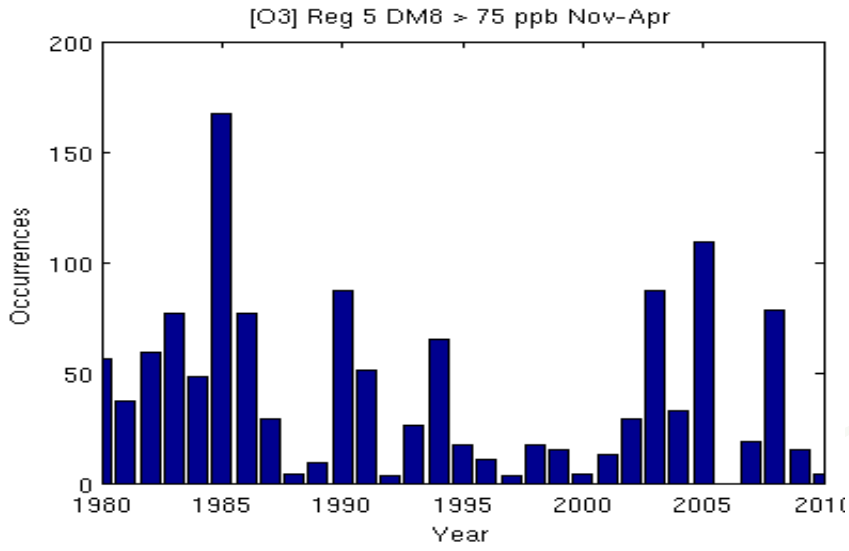
Historical ozone analysis: Distribution



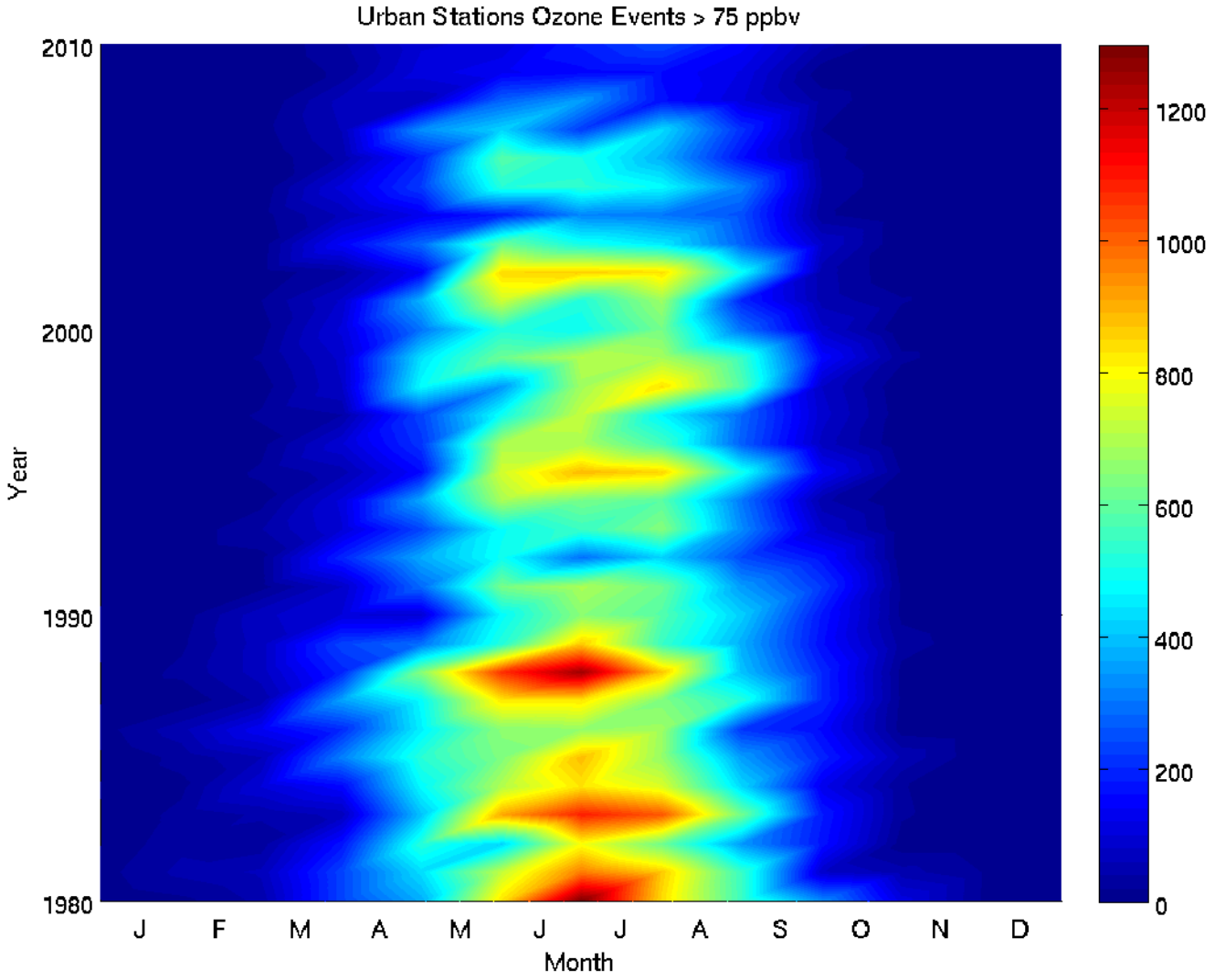
Historical ozone analysis: Seasonal variation in the NE



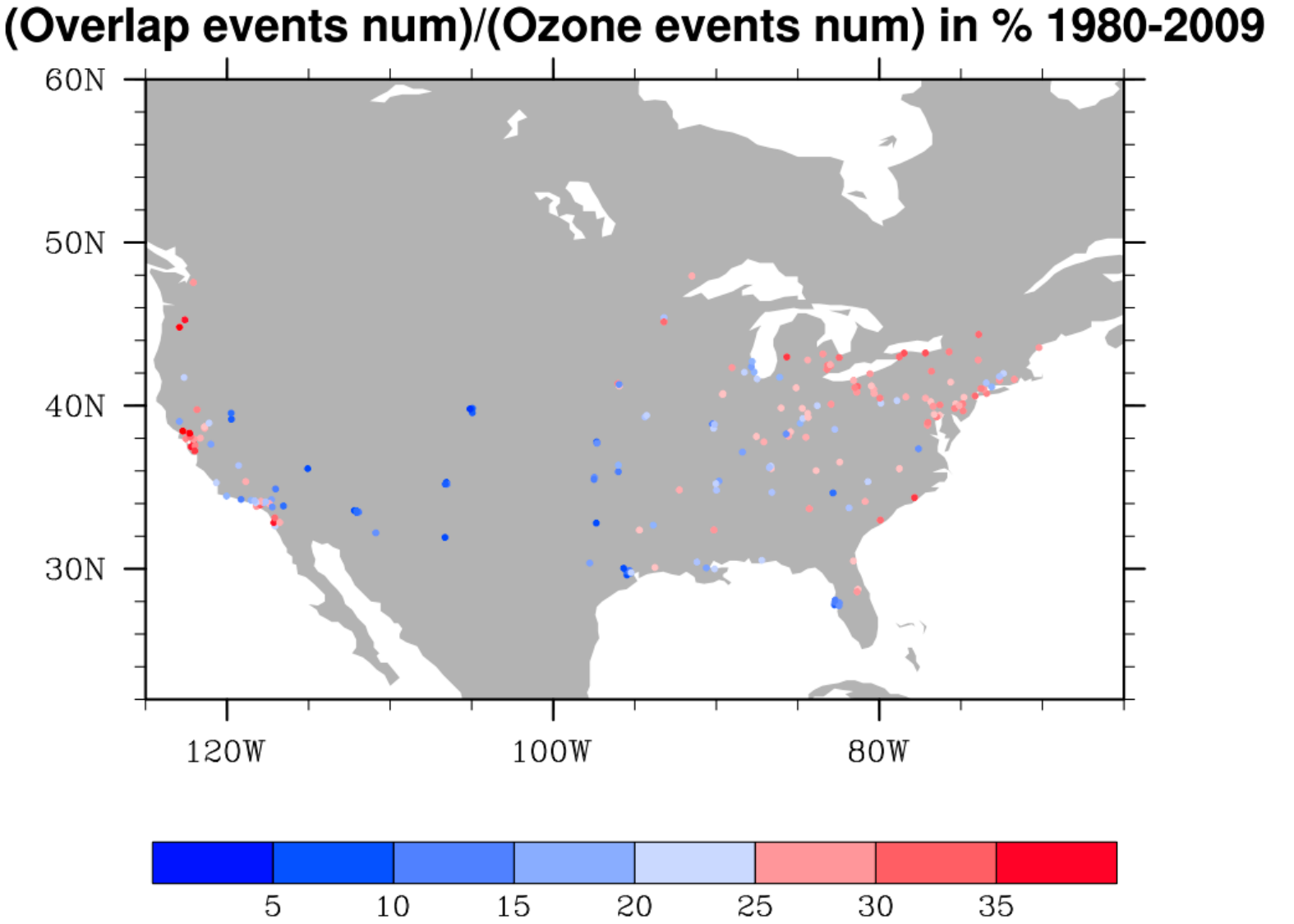




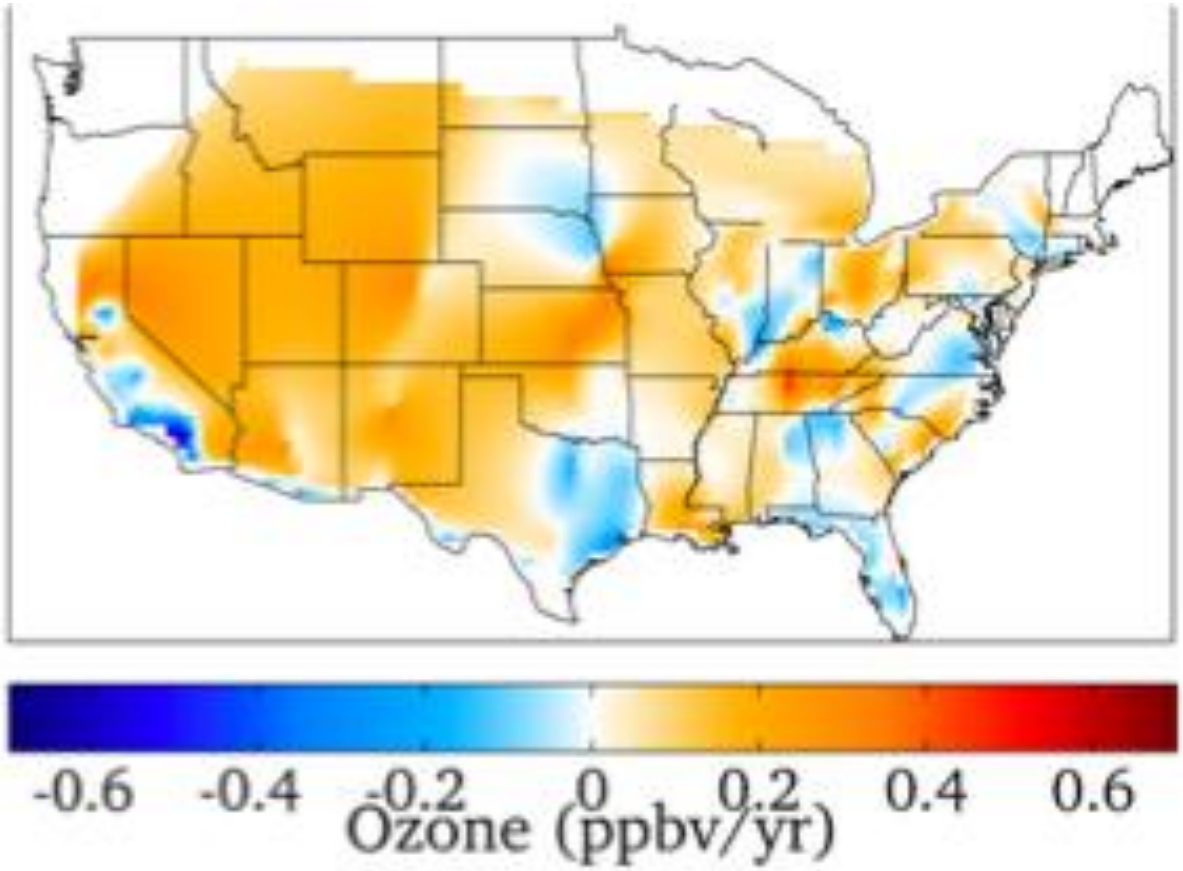
Historical ozone analysis: Station type



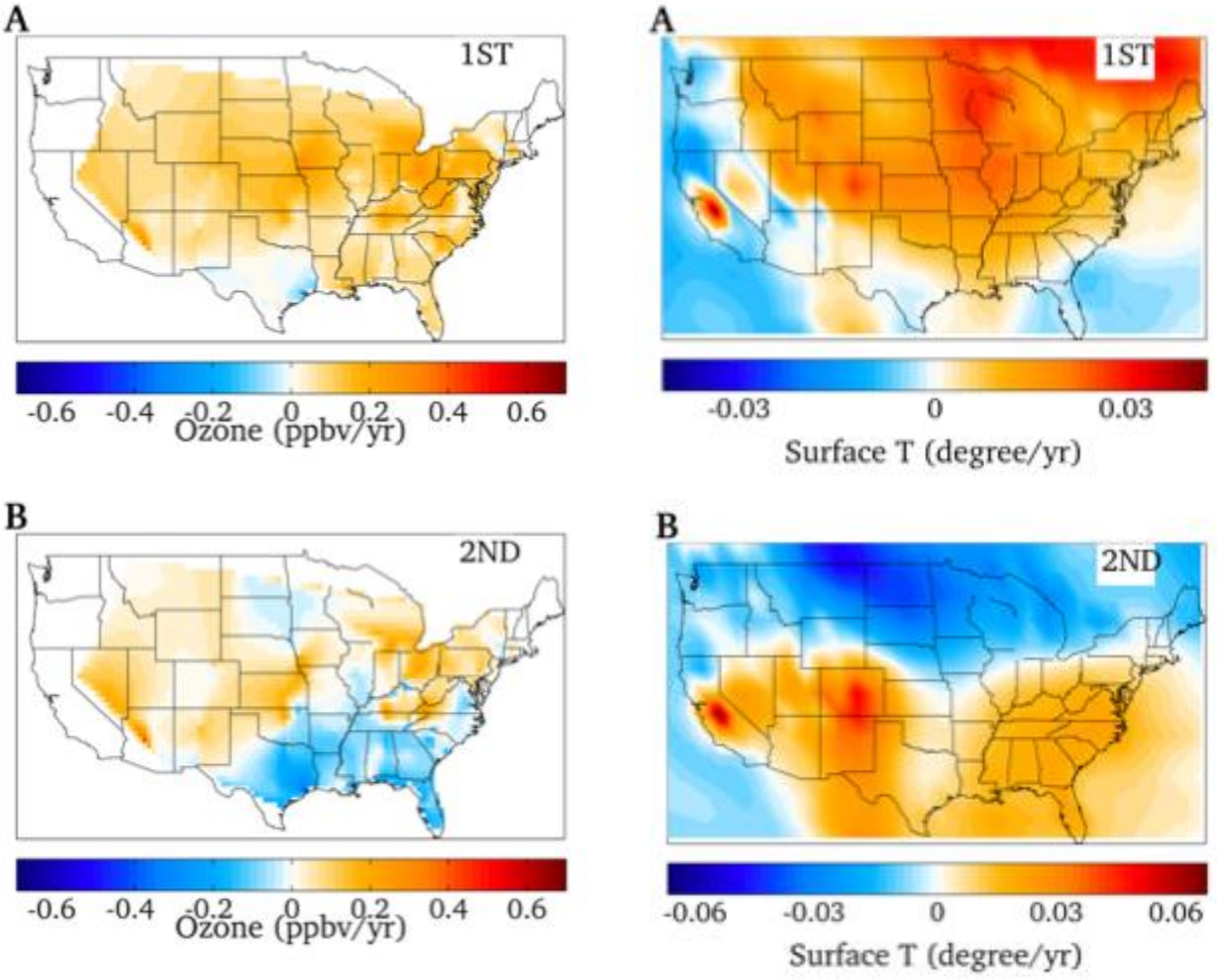
Extreme heat and ozone



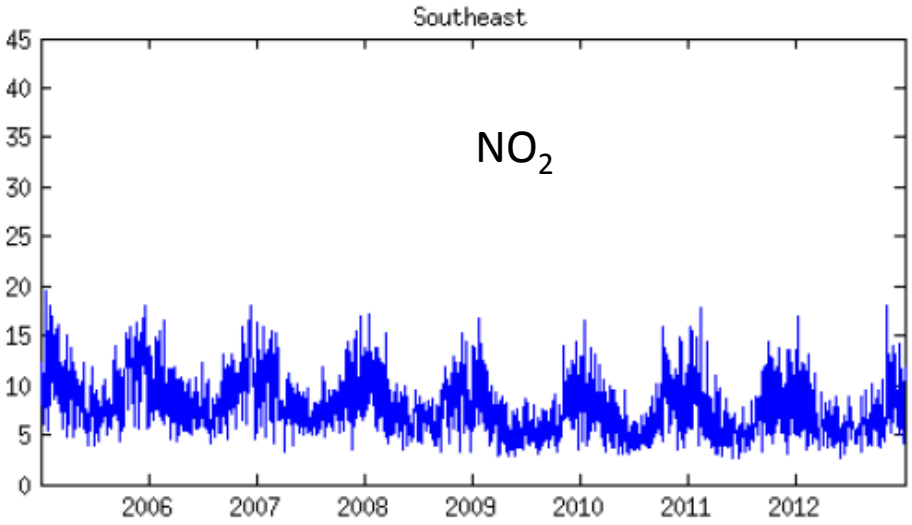
Effects of regional climate variability

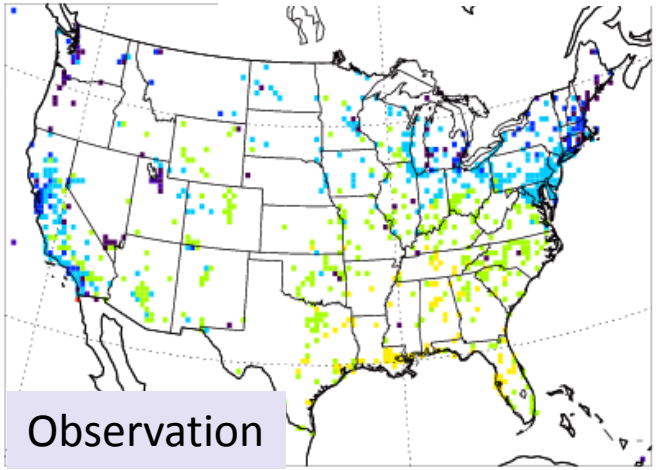


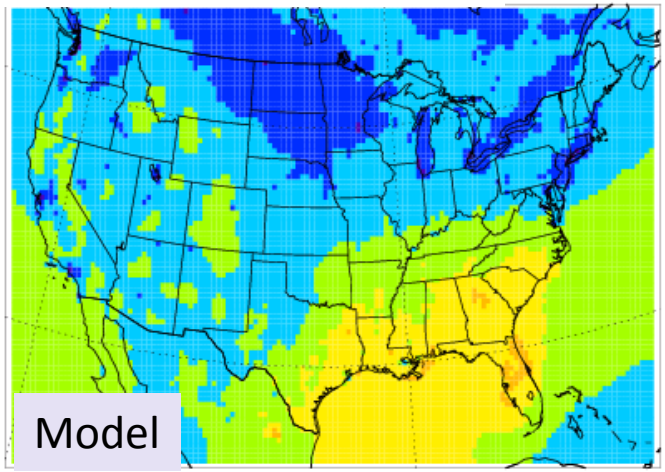
Effects of regional climate variability



Extreme ozone: Regional AQ modeling caste study







Research progress and plan

- What are the characteristics of extreme weather and air quality events?
  - Define these extreme events in a consistent manner such that they can be analyzed in one framework.
  - Understand the difference between “regulatory” and statistical extreme events and Investigate their characteristics.
- How do we quantify the relationship between extreme weather and air quality events?
  - Localized and temporospatial correlation statistical analyses.
  - Examine the effects of regional climate variability.
- How do we make best use of regional AQ modeling and climate projection capabilities?
  - Carry out mechanistic modeling studies.
  - Evaluate our modeling capability of extreme events.
  - Develop a combined statistical and numerical modeling approach.