



# **Dust, Fire, and Stagnation**

Terry Keating and John Dawson

U.S. Environmental Protection Agency

# Air Quality Management is, at least partly, about managing for “extreme” weather.

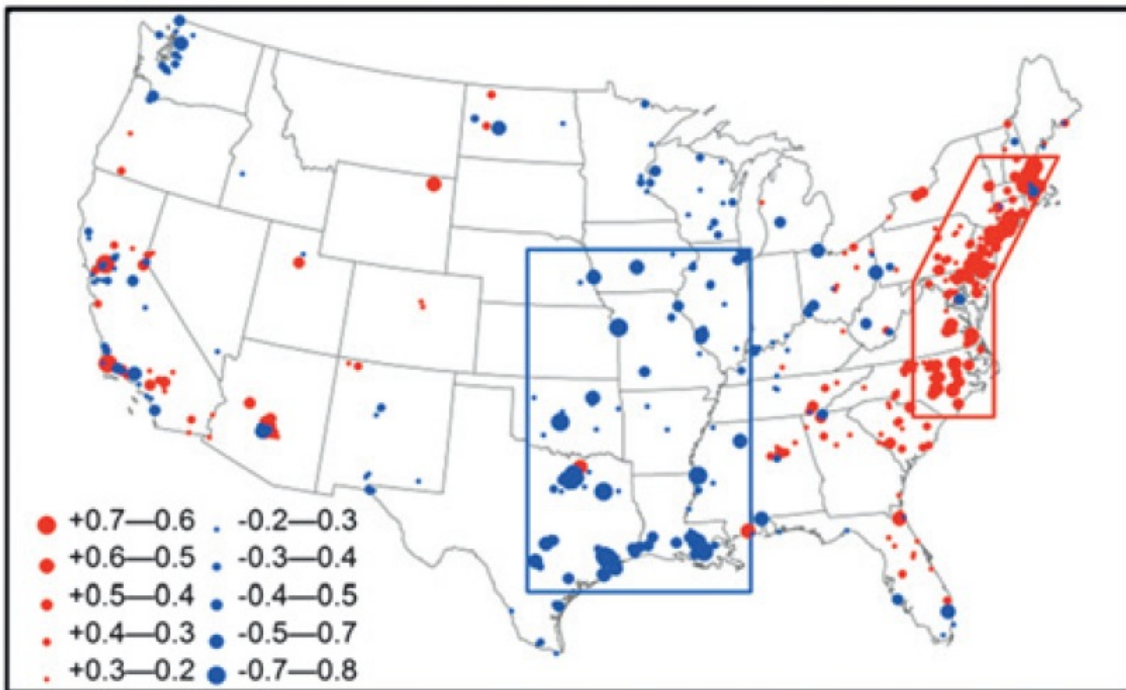
NAAQS	Averaging Time	Form	Non-Attainment Counties
CO	1 hour	Not to be exceeded more than once per year	0
NO <sub>2</sub>	1 hour	98th percentile, averaged over 3 years	0
SO <sub>2</sub>	1 hour	99th percentile of 1-hour daily maximum concentrations, averaged over three years	38
SO <sub>2</sub>	3 hours	Not to be exceeded more than once per year	9
CO	8 hour	Not to be exceeded more than once per year	0
O <sub>3</sub>	8 hour	Annual fourth highest daily maximum 8-hour concentration, averaged over 3 years	227
PM <sub>2.5</sub>	24 hour	98th percentile, averaged over 3 years	104
PM <sub>10</sub>	24 hour	Not to be exceeded more than once per year, averaged over three years	33
Pb	3 month	Not to be exceeded	22
NO <sub>2</sub>	1 year	annual mean	0
PM <sub>2.5</sub>	1 year	annual mean, averaged over 3 years	135

# “Extreme Weather” from an Air Quality Perspective

- High Winds
  - $\text{PM}_{10}$
- Surface Temperature Inversions
  - $\text{CO}$ ,  $\text{NO}_2$ ,  $\text{SO}_2$ ,  $\text{PM}_{2.5}$
- Stagnant High Pressure Systems
  - $\text{O}_3$ ,  $\text{PM}_{2.5}$
- Stratospheric Intrusion
  - $\text{O}_3$

# Location of Bermuda High and Jet Stream Are Drivers of O<sub>3</sub> Extremes in Eastern U.S.

Correlation between Bermuda High Index  
and Summertime Average MDA8 Ozone  
(1993-2008)



Zhu and Liang, J Clim, 2013

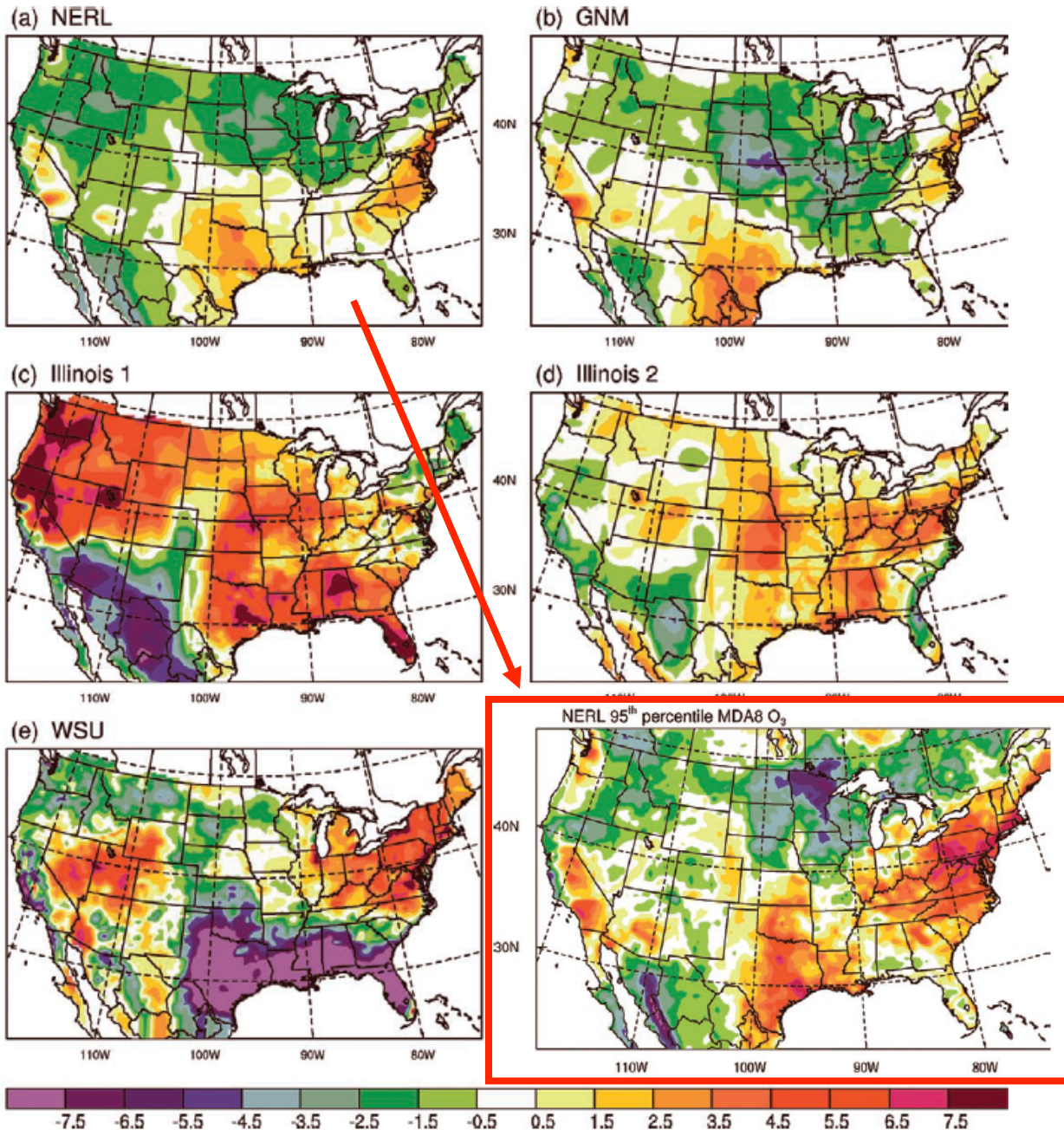
Under climate change  
scenarios (RCP 4.5 and  
RCP8.5 to 2100),

- jet stream migrates northward, leading to
- more interannual variability in ozone in North
- and less interannual variability in ozone in South.

Barnes and Fiore, GRL, 2013



## Difference in Summer Mean MDA8 Ozone in 2050



## Impact of Climate Change on U.S. Ozone

Different models and climate scenarios yield different changes in ozone.

However across these models, changes in extremes appear more pronounced than changes in averages.

Difference in 95<sup>th</sup> Percentile MDA8 Ozone in 2050

# PM<sub>2.5</sub>: Averages are only part of the story

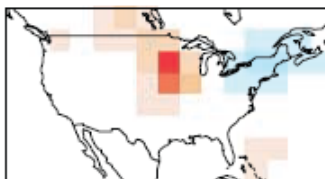
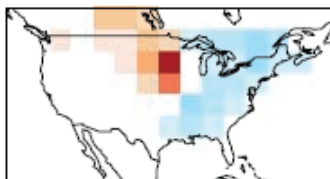
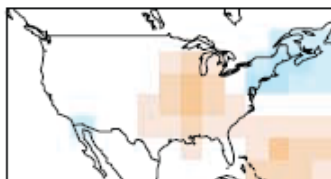
Change in PM due 2000 to 2050 Climate (A1B)

Sulfate

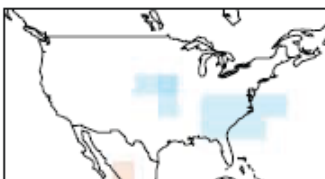
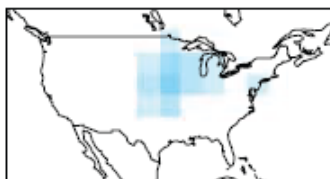
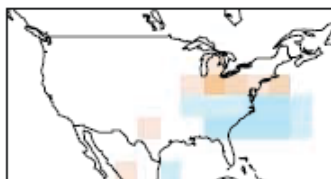
Nitrate

Ammonium

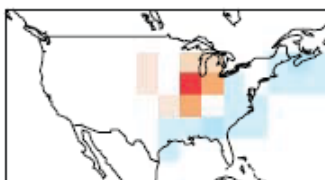
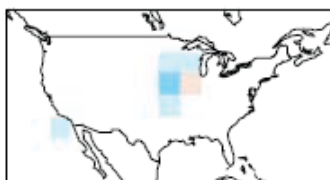
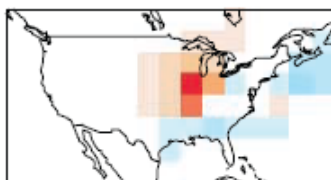
DJF



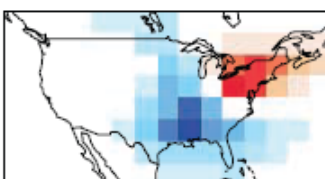
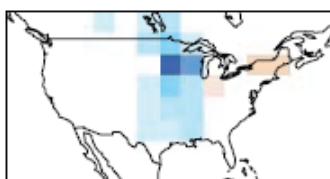
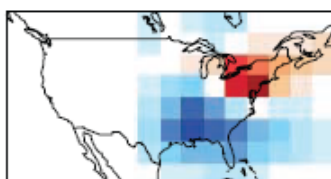
MAM



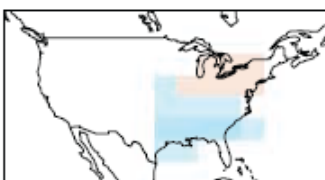
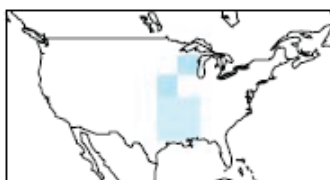
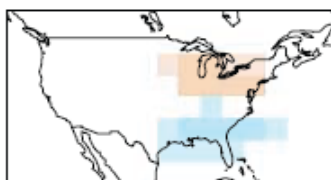
JJA



SON



Annual Average



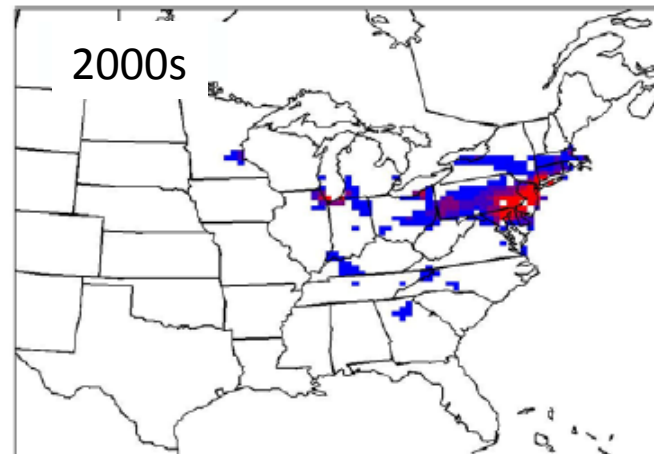
-1.30 -0.43 0.43 1.30

-1.00 -0.33 0.33 1.00

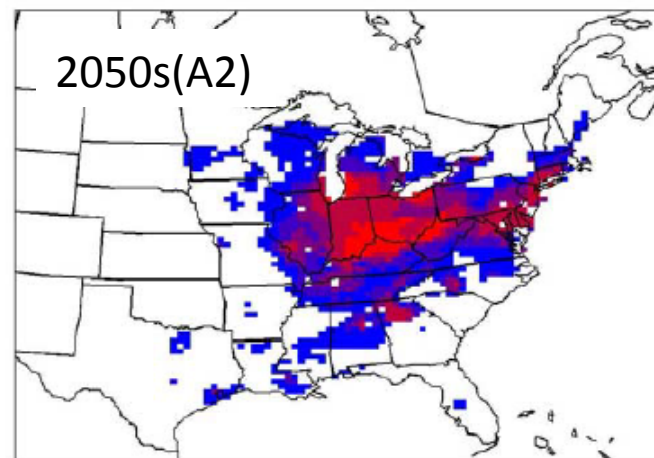
-0.55 -0.18 0.18 0.55 [ $\mu\text{g}/\text{m}^3$ ]

“Julys” in which PM<sub>2.5</sub> exceeds 24 hr NAAQS

2000s



2050s(A2)



0 1 2 3 4 5+

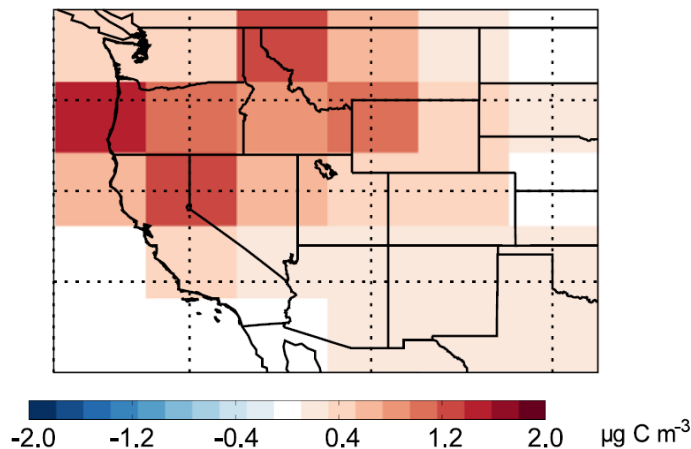
# Exceptional Events Rule

- States can petition EPA to exclude observations from attainment status determinations if the event:
  - Affects air quality
  - Is not reasonably controllable or preventable
  - Is caused by human activity that is unlikely to recur at a particular location, or is a natural event
  - Is associated with a measured concentration in excess of normal historical fluctuations, including background.
  - Has a clear causal relationship with a measured exceedance that would not have occurred but for the event.
- Guidance and examples are available at <http://www.epa.gov/ttn/analysis/exevents.htm>
- Most applications are related to dust and fires. New applications are being considered for stratospheric ozone intrusion.

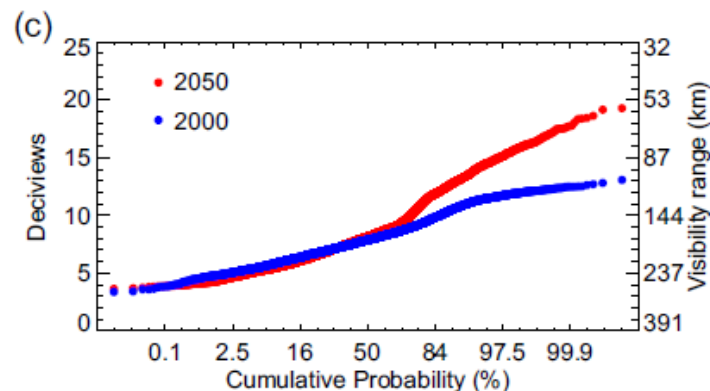
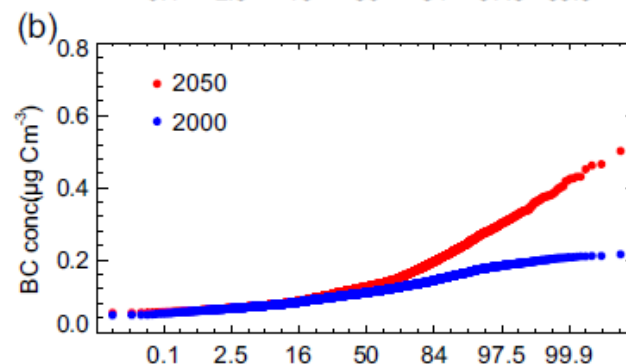
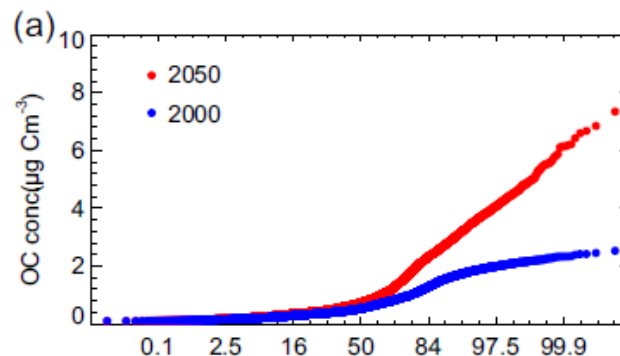
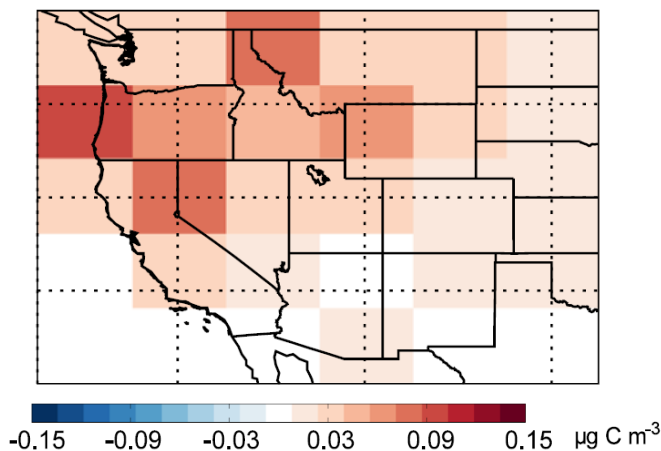
# PM due to Wildfires in a 2050 Climate

Is exceptional becoming commonplace?

Change in Organic Carbon  
2000 to 2050



Change in Black Carbon  
2000 to 2050



Changes in the  
Western U.S. in

- Organic Carbon

- Black Carbon

- Visibility

Yue et al., Atmos  
Env, 2013



# USGCRP Special Report on Climate and Health

- Coordinated by Climate Change Human Health Working Group
- Lead by NIH, CDC, NOAA, EPA with USDA, DOE, and others
- Building upon current 3<sup>rd</sup> National Climate Assessment and the 2008 CCSP SAP 4.6

## **Assessment of literature on:**

- Thermal Extremes: Heat and Cold Waves
- Air Quality Impacts
- Vectorborne and Zoonotic Disease
- Waterborne and Foodborne Diseases
- Food Safety
- Extreme Weather and Climate Events
- Mental Health and Stress-Related Disorders
- Other Health Threats

## **Efforts to quantify national-scale impacts related to:**

- Extreme Heat
  - Air Quality
  - Vectorborne Disease (Lyme)
  - Waterborne Disease (Vibrio)
- 
- Public Review Draft expected May 2015, Final Publication expected Late 2015