Presenter

David B. Peden, MD, MS, FAAAAI
Senior Associate Dean for Translational Research
Chief, Division of Pediatric Allergy, Immunology & Rheumatology, Department of Pediatrics
Director, Center for Environmental Medicine, Asthma & Lung Biology
University of North Carolina at Chapel Hill School of Medicine
&
President-Elect, American Academy of Allergy, Asthma and Immunology

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Climate Change and Ambient Air Pollution

Outdoor pollution

General facts about pollutant exposure and asthma exacerbation

- Generally, increases in asthma exacerbation occurs 24-48 hours after the pollutant exacerbation
- Often, exacerbations occur with pollutant exposures less than current NAAQS standards
- Pollutants enhance response to allergen

Actions of Inhaled Pollutants

- Ozone
  - **Acute airway inflammation**
  - Increased airway reactivity
  - Temporarily immediate decrease in lung function
  - Increased airway reactivity (twitchiness)
- PM
  - **Acute airway inflammation**
  - Some increased airway reactivity (twitchiness)
  - May decrease lung function
  - CV effects
    - Coagulation
    - HRV

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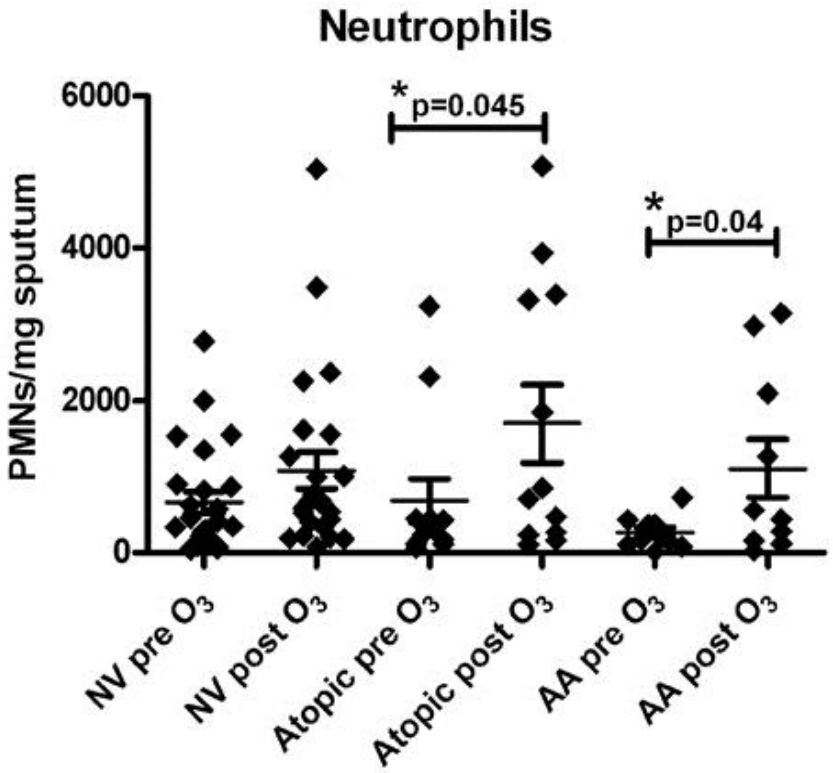
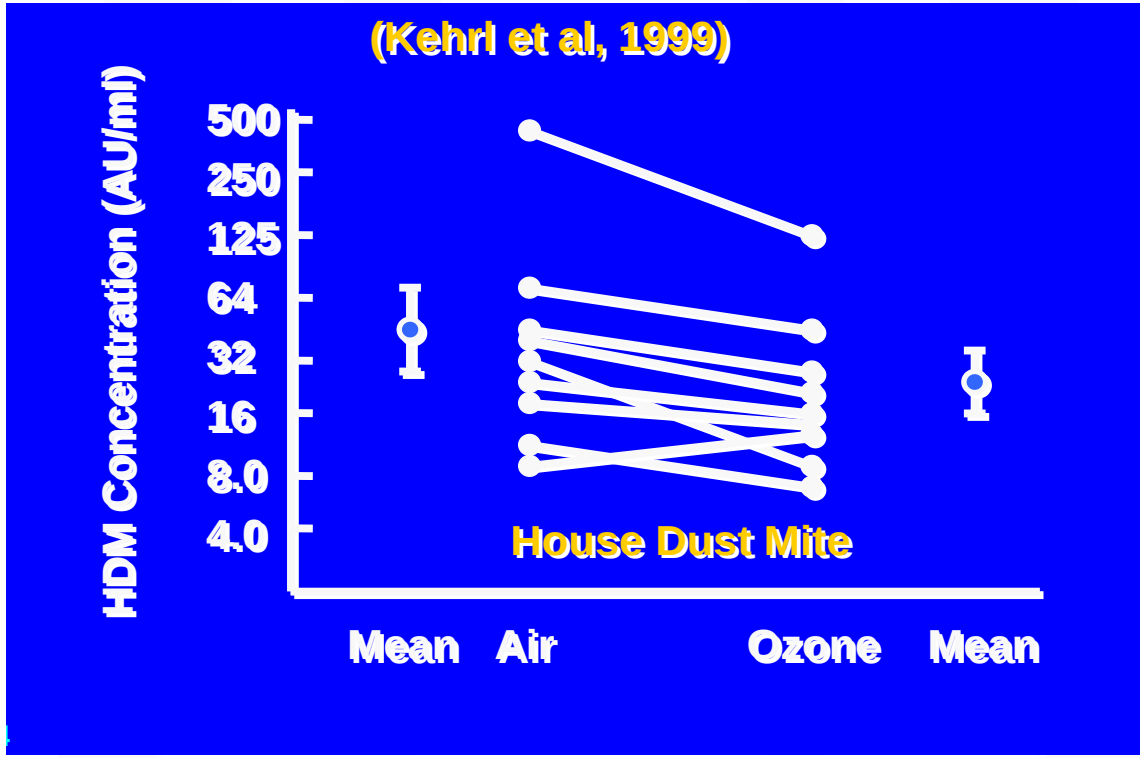
Asthmatics are more susceptible to ozone effects and have increased response to allergens after ozone exposure





Air Quality Index for Ozone

Index Values (Conc. Range)	Air Quality Descriptors	Cautionary Statements for Ozone
0 – 50 (0-60 ppb)	Good	**No health impacts are expected when air quality is in this range.**
51 – 100 (61-75 ppb)	Moderate	**Unusually sensitive people should consider limiting prolonged outdoor exertion**
101 – 150 (76-104 ppb)	Unhealthy for Sensitive Groups	**Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion**
151 – 200 (105-115 ppb)	Unhealthy	**Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children should limit prolonged outdoor exertion.**
201 – 300 (116-374 ppb)	Very Unhealthy	**Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.**

AQI-PM

Air Quality Guide for Particle Pollution				
Adjective	**Air Quality Index (AQI)**	**Concentration PM 2.5 (ug/m3- 1-3 hr. avg.)**	**Cautionary Statement**	**Health Effects Statement**
Good	0-50	0-38	None	
Moderate	51-100	39-88	Unusually sensitive people should consider reducing prolonged or heavy exertion	
Unhealthy for Sensitive Groups	101-150	89-138	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.	Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly.
Unhealthy	151-200	139-351	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion	Increased aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population.
Very Unhealthy Alert	201-300	352-526	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.	Significant aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; significant increase in respiratory effects in general population.
Hazardous	300+	526+	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.	Significant aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; significant increase in respiratory effects in general population.

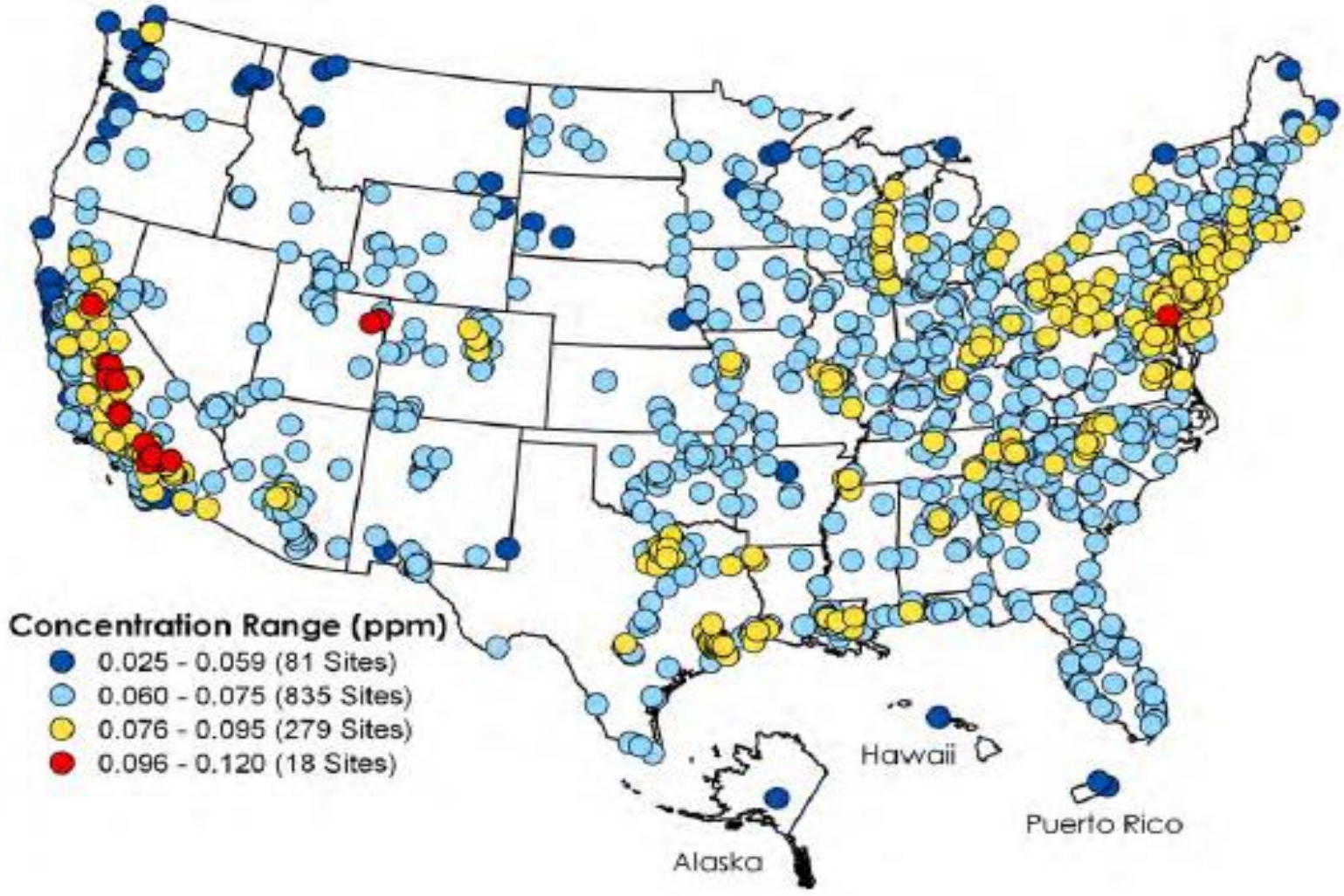
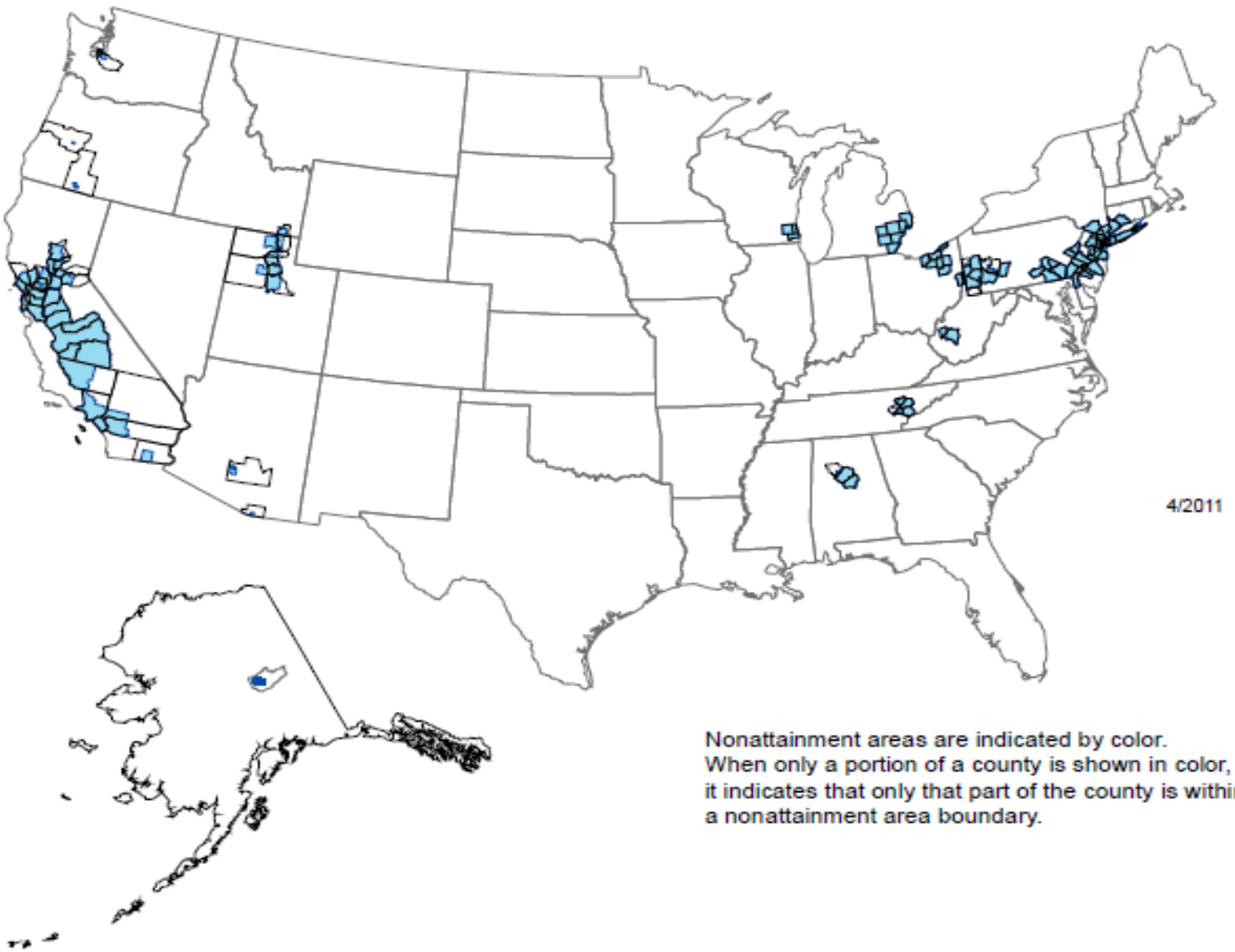


Figure 8. Ozone concentrations in ppm, 2010 (fourth highest daily maximum 8-hour concentration).

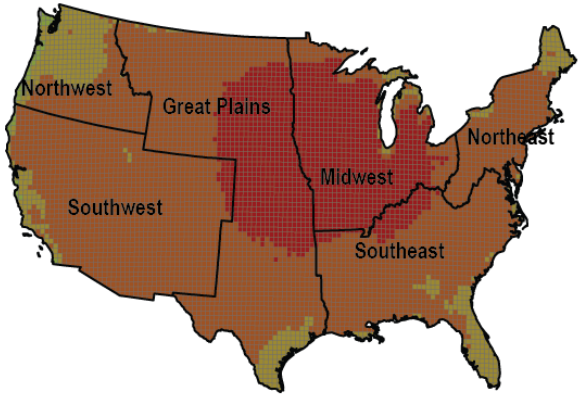
PM-2.5 Nonattainment Areas (2006 Standard)



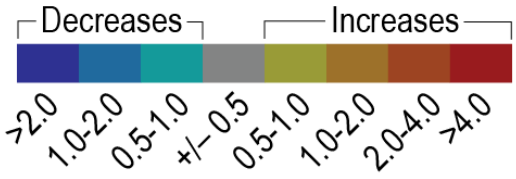
Nonattainment areas are indicated by color.
When only a portion of a county is shown in color, it indicates that only that part of the county is within a nonattainment area boundary.

Anticipated increases in ozone levels in 2030 due to increased greenhouse gas emissions

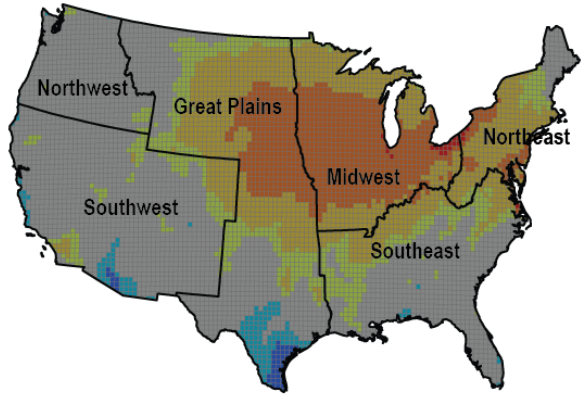
Change in Average Daily Maximum Temperature



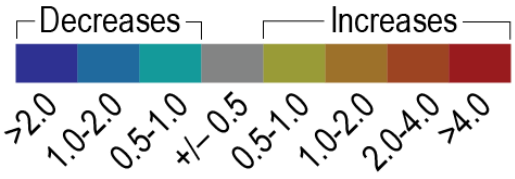
Change in Temperature (°F)



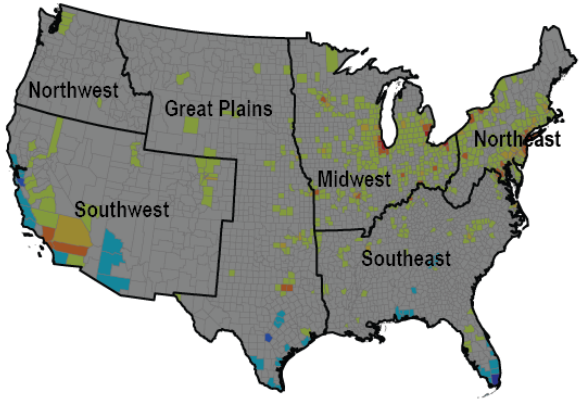
Change in Daily 8-hr Maximum Ozone



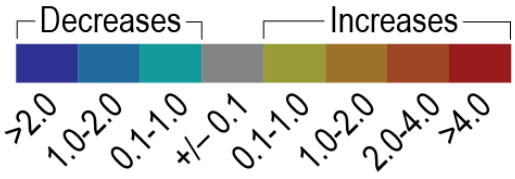
Climate-Attributable Change in Summer Season Daily 8-hr Maximum Ozone (ppb)



Excess Ozone-Related Deaths



Climate-Attributable Change in Ozone-Related Premature Deaths by County

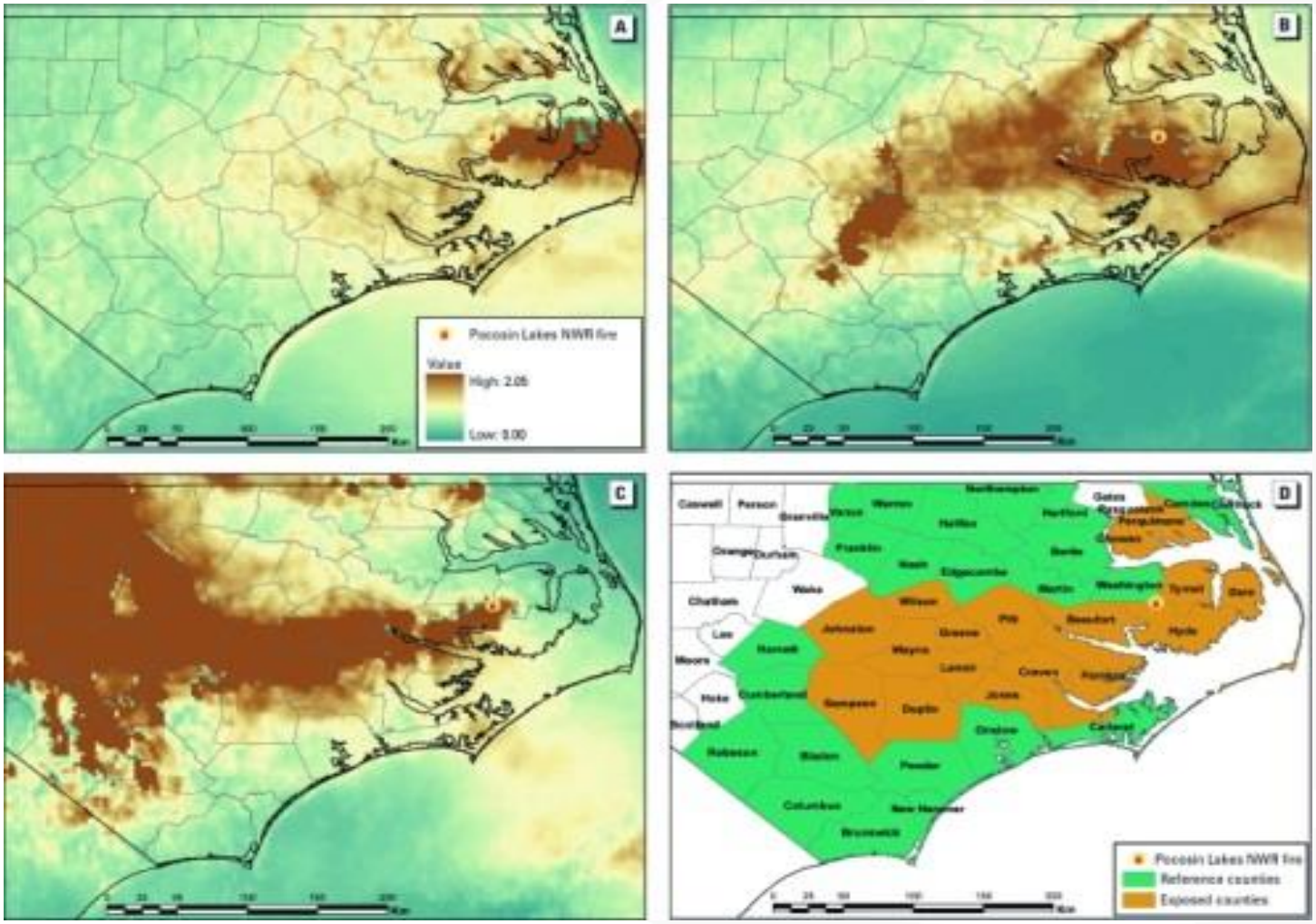


Similar increases in particulate matter as well

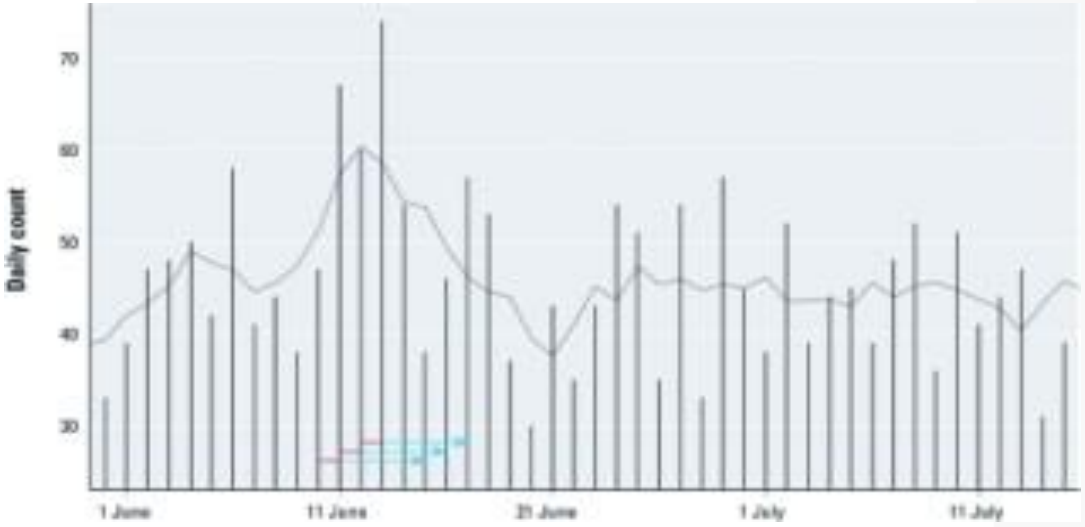
Wildfires and woodsmoke

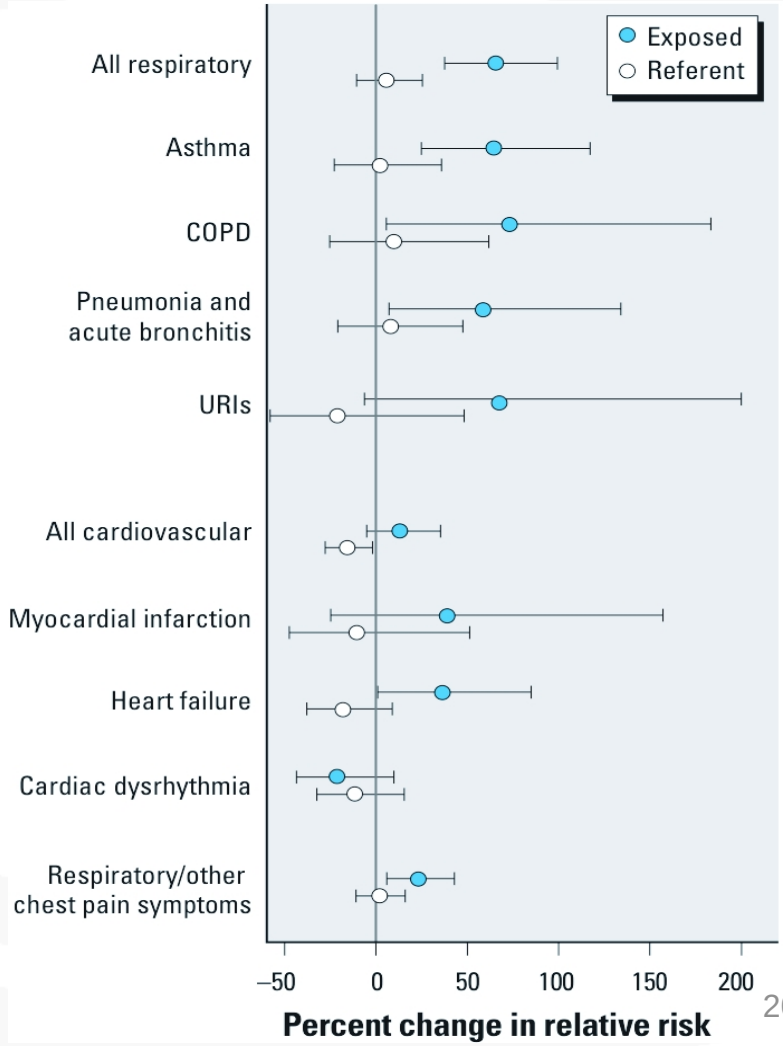
An emerging threat

Aerial Photos of exposed areas of NC with 2008 Eastern NC wildfires



Asthma ED visits and risk of adverse health outcomes with the wildfires





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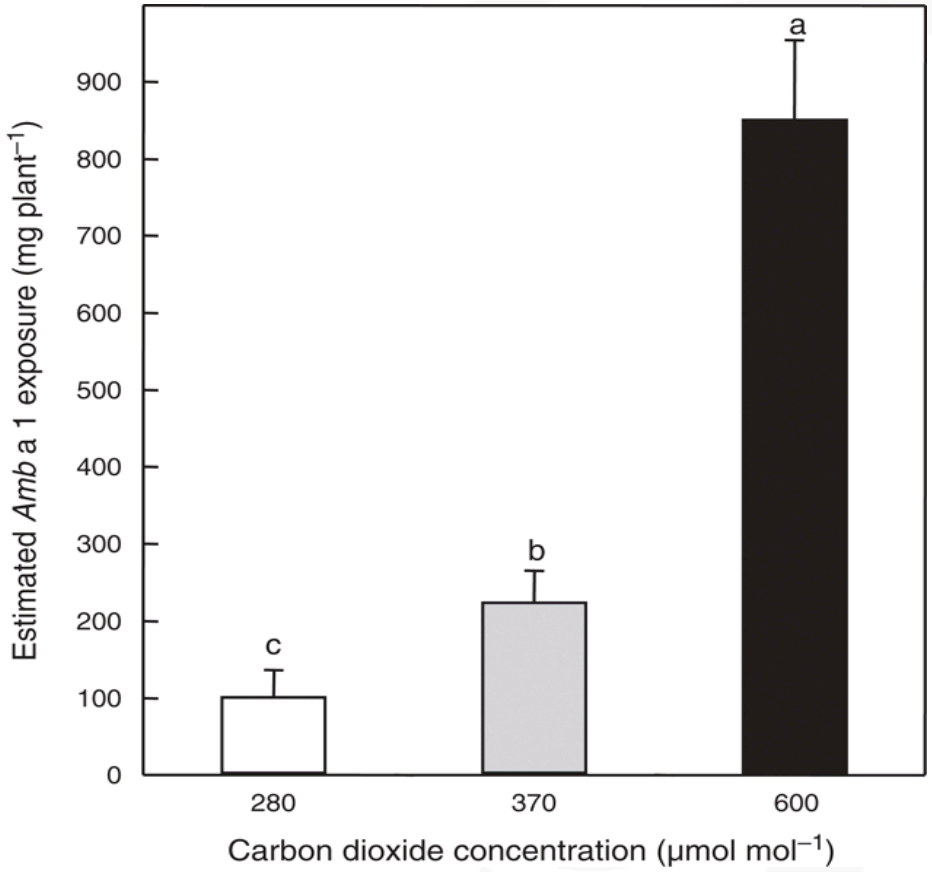
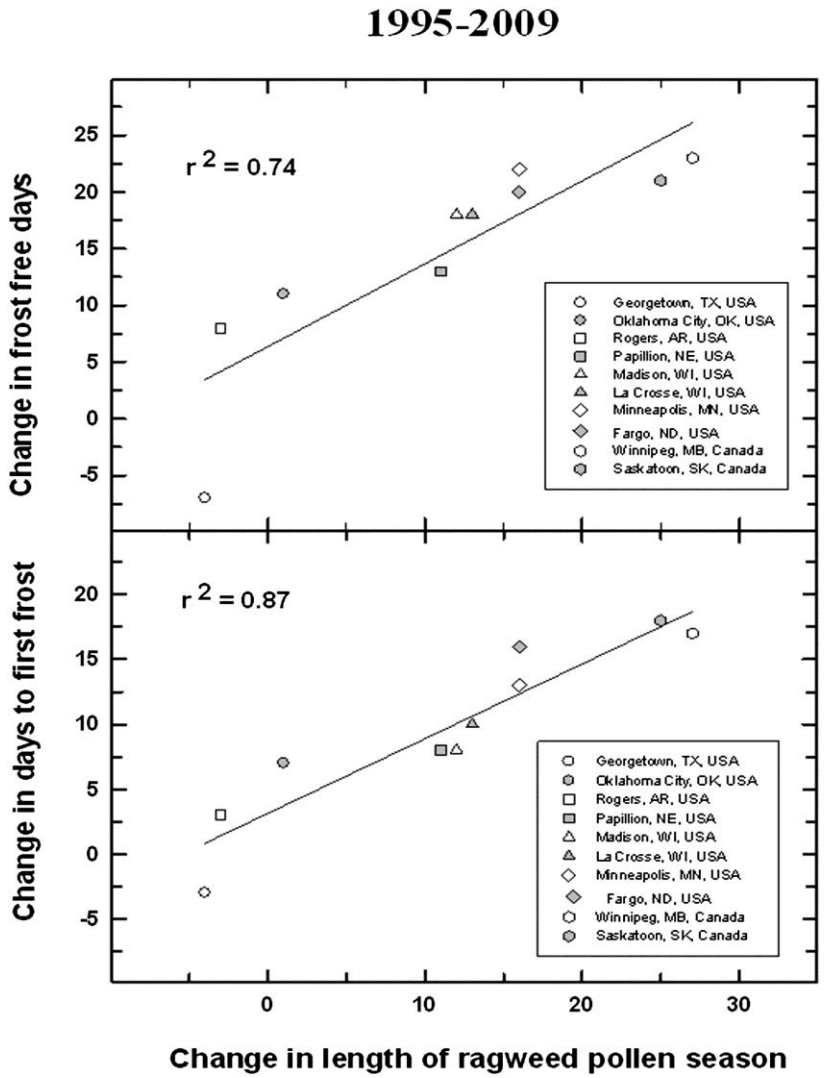
Climate Change: Impact on Allergens and Viruses

Singer BD, Ziska LH, Frenz DA, Gebhard DE, Straka JG (2005) Increasing Amb a 1 content in common ragweed (Ambrosia artemisiifolia) pollen as a function of rising atmospheric CO2 concentration. Functional Plant Biology 32, 667–670.



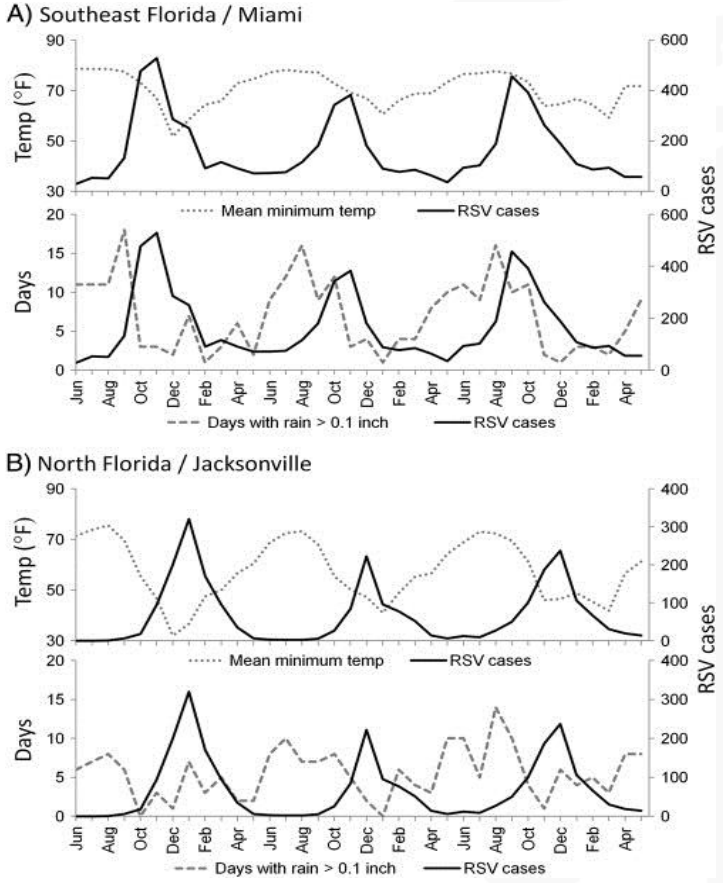
Increased CO_2 linked to increased Ragweed Pollen and increased *Amb a 1* concentration/mg pollen

Change in the length (days) of ragweed pollen season as a function of frost-free days with latitude for the period 1995–2009.



Ziska L et al. PNAS 2011;108:4248-4251

Fig. 2. RSV incidence in Florida compared to temperature and rainfall (June 2010 to May 2013).



Stuart Paynter, Peter D. Sly, Robert S. Ware, Gail Williams, Philip Weinstein

The importance of the local environment in the transmission of respiratory syncytial virus ☆ ☆☆

Science of The Total Environment, Volume 493, 2014, 521–525

http://dx.doi.org/10.1016/j.scitotenv.2014.06.021

Potential Interventions

Personal and Societal

Fluticasone Propionate Protects against Ozone-Induced Airway Inflammation and Modified Immune Cell Activation Markers in Healthy Volunteers

Neil E. Alexis,[1,2] John C. Lay,[1] Angela Haczku,[3] Henry Gong,[4,5] William Linn,[4,5] Milan J. Hazucha,[1] Brad Harris,[1] Ruth Tal-Singer,[6] and David B. Peden[1,2]

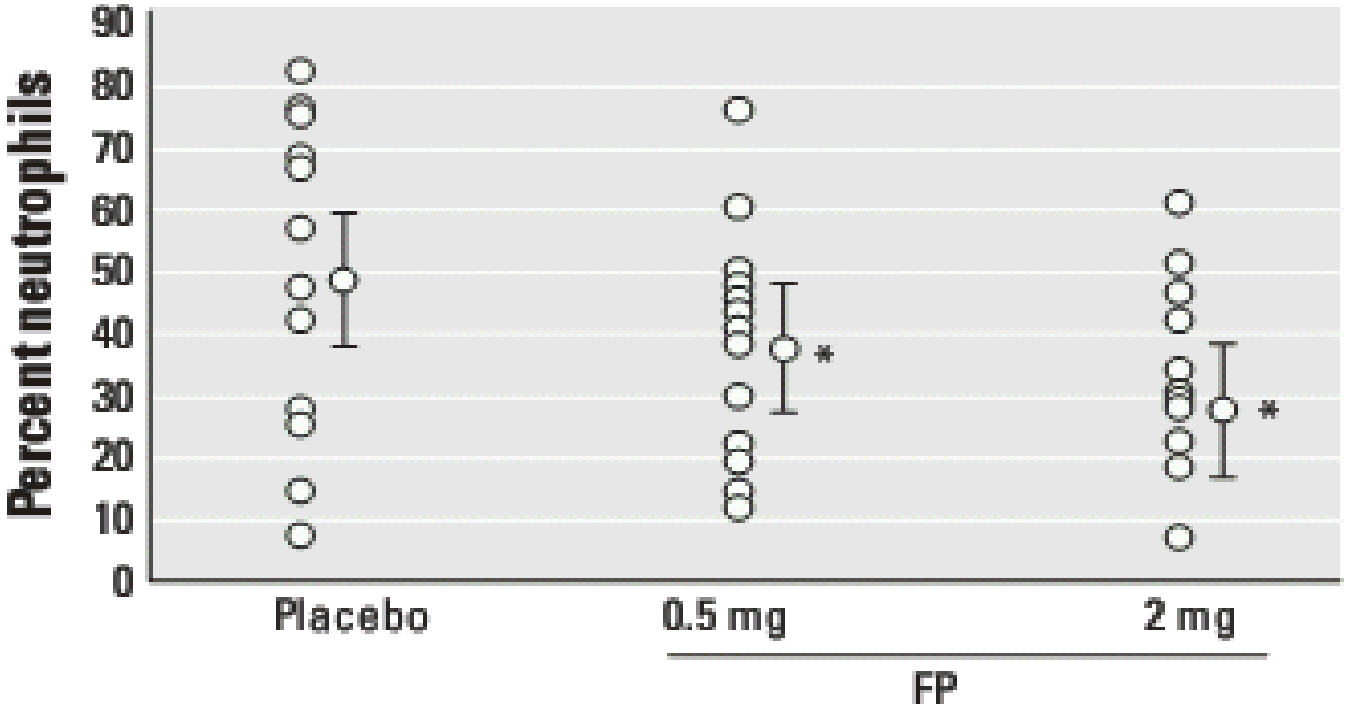
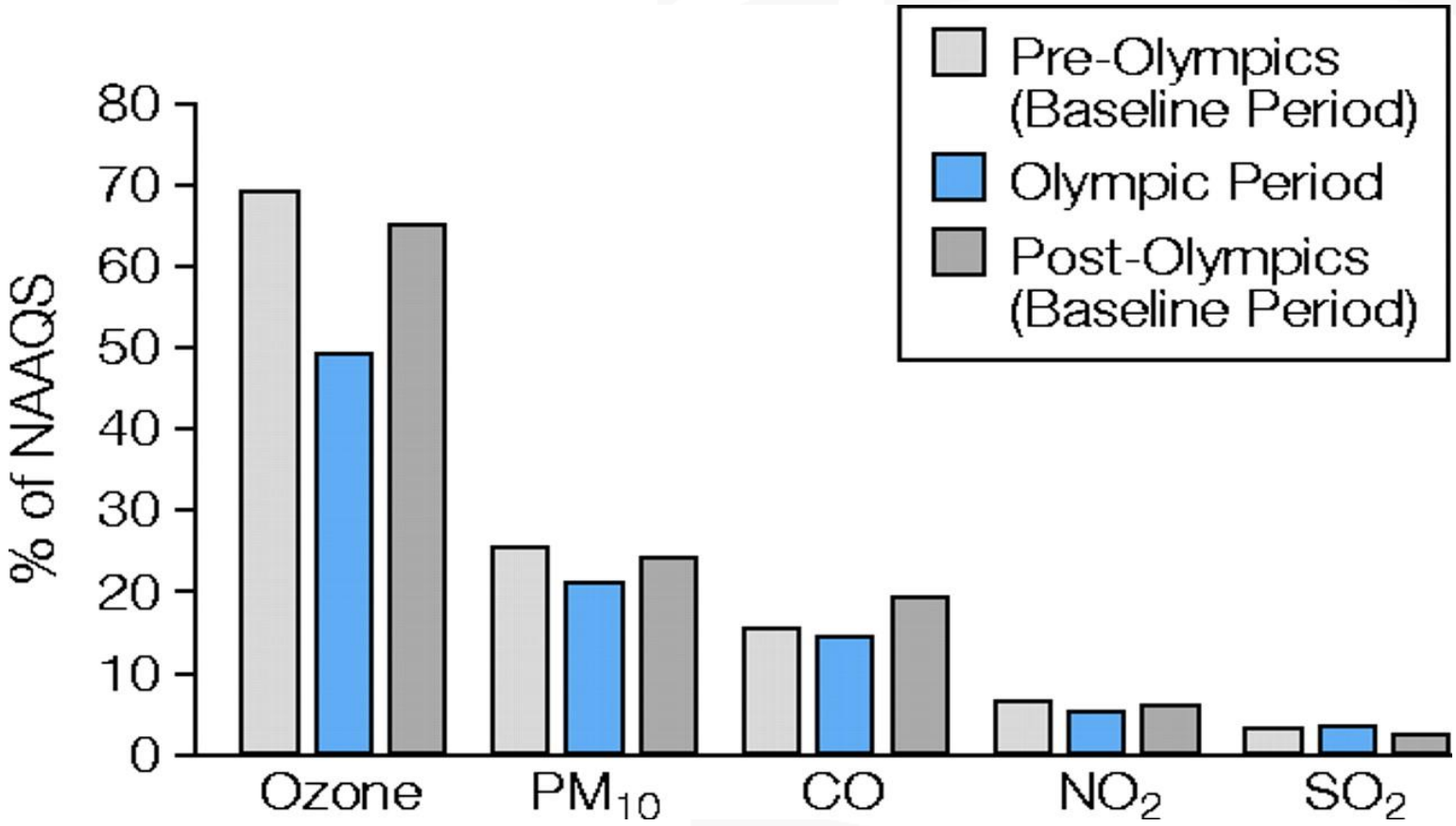


Figure 2. The percent sputum neutrophils after O_3 exposure for each pretreatment dose of FP (0.5 or 2 mg) or placebo.
*$p < 0.05$ compared with placebo.

Mean Levels of Major Pollutants Before, During, and After the 1996 Summer Olympic Games as a Percentage of the National Ambient Air Quality Standard (NAAQS)



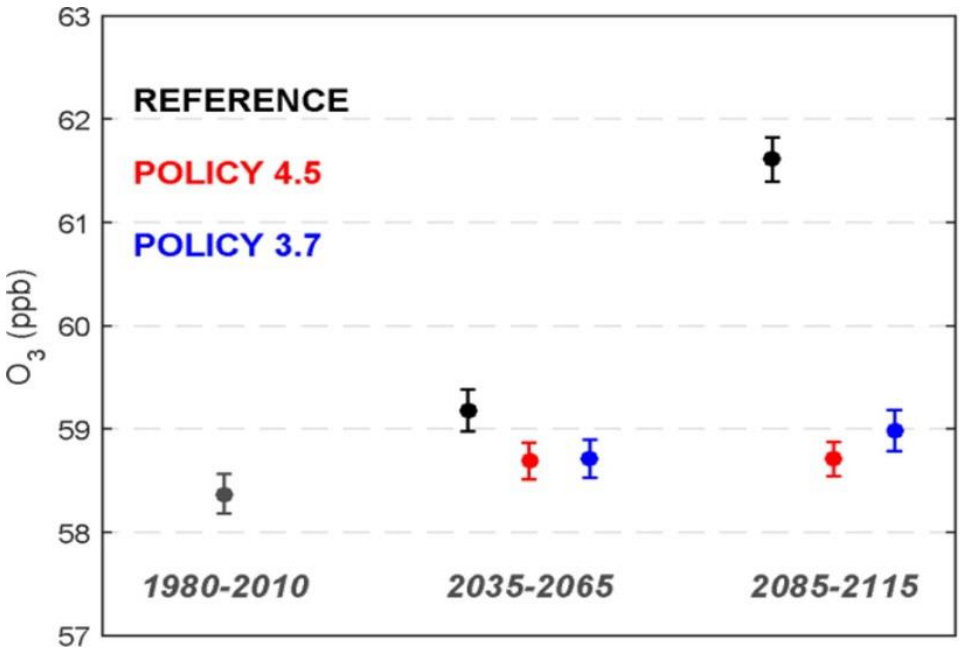
Friedman, M. S. et al. JAMA 2001;285:897-905.

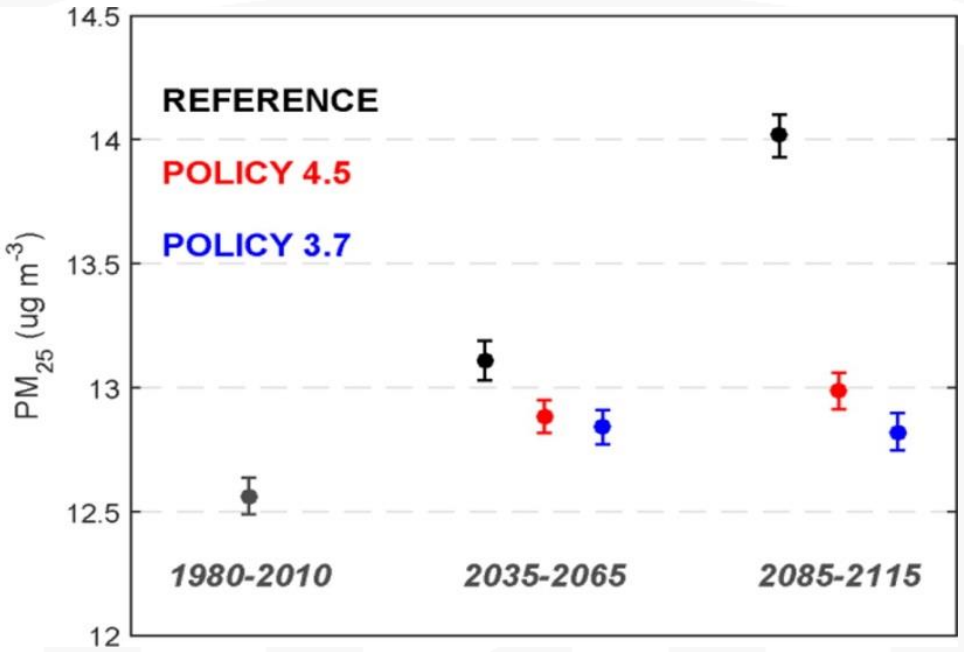
Friedman, M. S. et al. JAMA 2001;285:897-905.

Table 1. Acute Asthma Events and Acute Nonasthma Events Among Children and Youth During the 1996 Summer Olympic Games Compared With the 1996 Summertime Baseline Period

		Acute Asthma Events			Acute Nonasthma Events		
		Mean (SD) No. of Events Per Day			Mean (SD) No. of Events Per Day		
Data Source	Type of Asthma Event	Baseline Period*	Olympic Period†	% Change	Baseline Period*	Olympic Period†	% Change
Georgia Medicaid claims file	Emergency care and hospitalizations	4.23 (2.81)	2.47 (1.46)	−41.6	100.5 (18.6)	97.4 (16.4)	−3.1
Health maintenance organization	Emergency care, urgent care, and hospitalizations	1.36 (1.63)	0.76 (0.83)	−44.1	37.6 (19.6)	38.1 (18.4)	+1.3
Pediatric emergency departments	Emergency care and hospitalizations	4.77 (2.52)	4.24 (2.49)	−11.1	118.4 (20.5)	115.9 (15.9)	−2.1
Georgia Hospital Discharge Database	Hospitalizations	2.04 (1.53)	1.65 (1.50)	−19.1	19.7 (5.1)	19.9 (3.5)	+1.0

*Defined as June 21–July 18 and August 5–September 1, 1996.
†Defined as July 19–August 4, 1996.





Ensemble-mean U.S.-average population-weighted annual 8-h-max O3 and PM2.5 in 2000, 2050, and 2100 under REF, POL4.5, and POL3.7 scenarios.

Published in: Fernando Garcia-Menendez; Rebecca K. Saari; Erwan Monier; Noelle E. Selin; *Environ. Sci. Technol.* **2015,** 49, 7580-7588.
DOI: 10.1021/acs.est.5b01324

Summary

- Asthma is characterized by increased response to a number of agents
  - Air pollutants
  - Allergens
  - Viruses
- Climate Change will increase:
  - Air pollutants
  - Allergens
  - Viral seasons
- It is still possible for:
  - People to protect themselves from asthma attacks due to pollution and other agents
  - Decrease the impact of climate change with environmental policy