Public Health Impacts of Climate Change: Regional Health Vulnerabilities to Heat, Air Pollution, and Pollen

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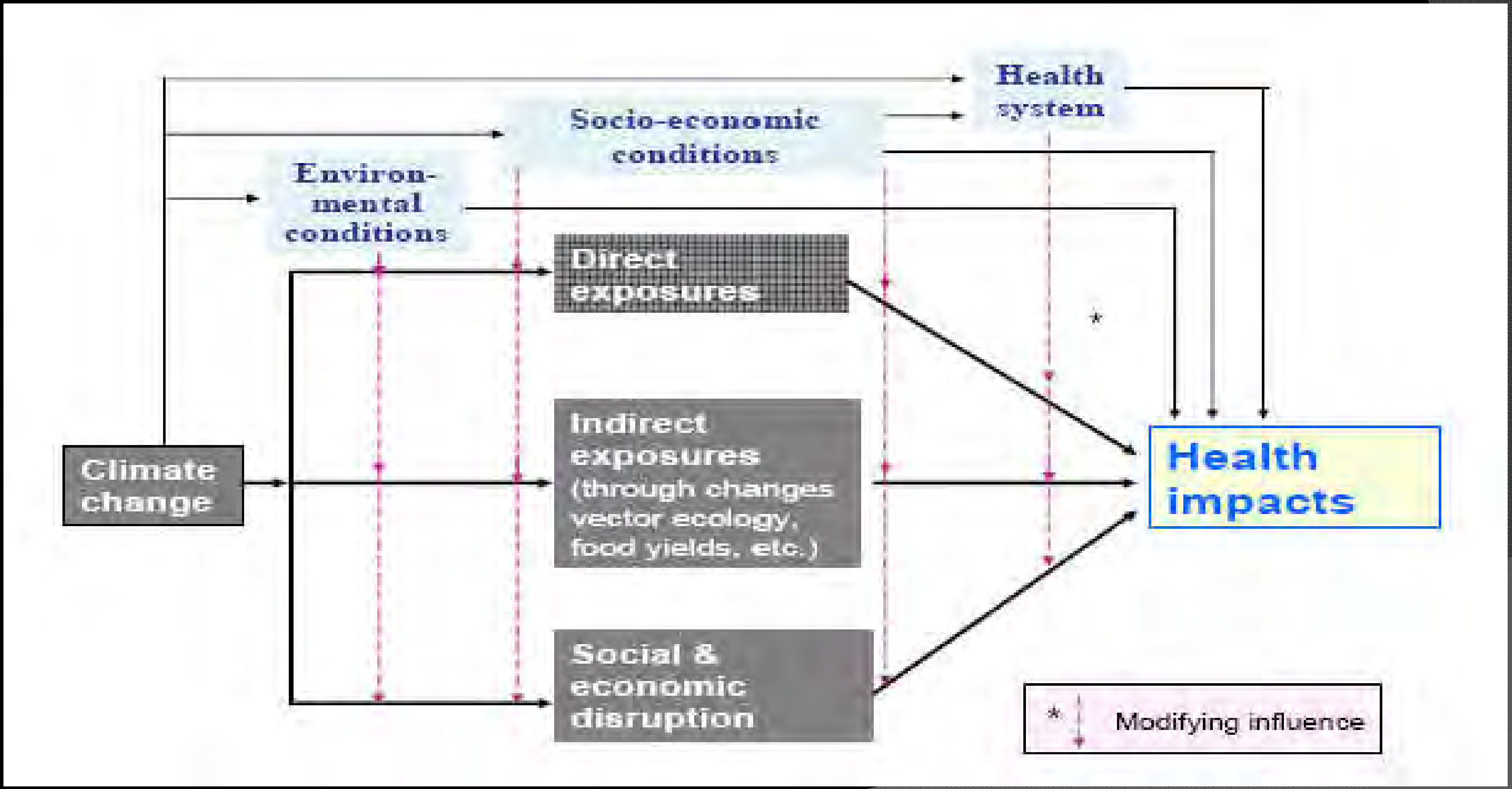
With acknowledgements to Dr. Pat Kinney

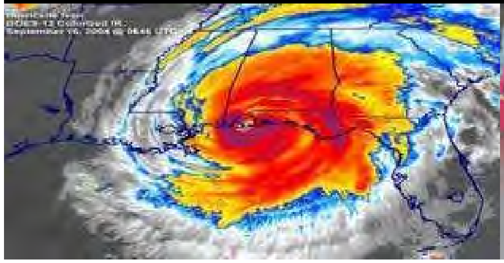
Pathways by Which Climate Change May Affect Human Health



IPCC 2007

Health Effects of Climate Change - Direct

Climate Impacts	**Direct Health Effects**
More intense and frequent Heat Waves	Heat stress, cardiovascular disease
Stagnant Air Masses, Air Pollution	Asthma, respiratory illness, cardiovascular disease
More Frequent Heavy Rainfall Events	Drowning, direct injury



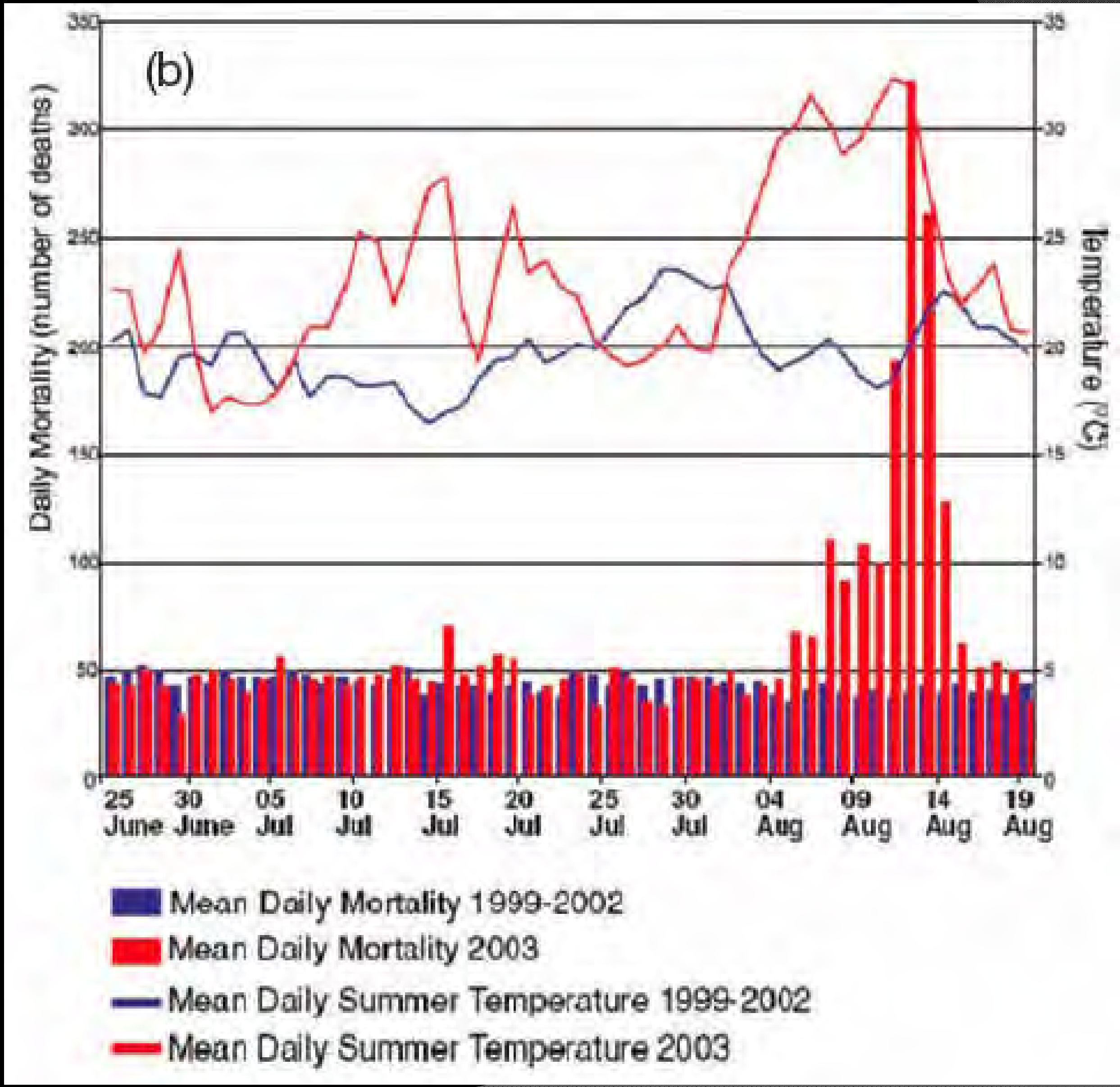

Health Effects of Climate Change - Indirect

Climate Impacts		Indirect Health Effects
Effects on key ecosystem parameters	❱	Impacts on vector-borne and zoonotic disease
Heavy precipitation events will become more frequent	❱	Water-borne diseases, harmful algal blooms,
Increase in areas affected by drought	❱	Changes in food sources, malnutrition, forced migration

What is Needed to Fill the Knowledge Gap

- Expanded surveillance systems to track key indicators of climate-relevant exposures, vulnerabilities, and health responses
- Expanded empirical research to better understand climate-health mechanisms, including vulnerability factors
- Expanded research to project future health impacts under climate change and vulnerability scenarios

Deadly Paris Heatwave 2003



Adapted by IPCC 2007 from: Vandentorren et al., AJPH 2004,94:1518-1520.

O'Neill and Ebi, JOEM, 2009

CME Available for this Article at ACOEM.org

Temperature Extremes and Health: Impacts of Climate Variability and Change in the United States

Marie S. O'Neill, PhD
Kristie L. Ebi, PhD, MPH

Learning Objectives

- Discuss the evidence (and limitations of evidence) relevant to assessing the health impacts of extreme temperatures.
- Review the physiologic effects, mortality burden, and factors affecting vulnerability to the health effects of cold and hot temperatures.
- Demonstrate familiarity with the likely impact of climate change on temperature and health, including the factors that will affect temperature-related morbidity and mortality.

Objective: *We evaluated temperature-related morbidity and mortality for the 2007 U.S. national assessment on impacts of climate change and variability on human health.* ***Methods:*** *We assessed literature published since the 2000 national assessment, evaluating epidemiologic studies,*

Exposures to temperature extremes have been associated with both mortality and morbidity. At the population level, the distribution and magnitude of these health impacts depend on intrinsic factors, including population and regional vulnerabilities; social and cultural context; t ronment; ture; and Other det the magn tween te both spac public's p ity of hum

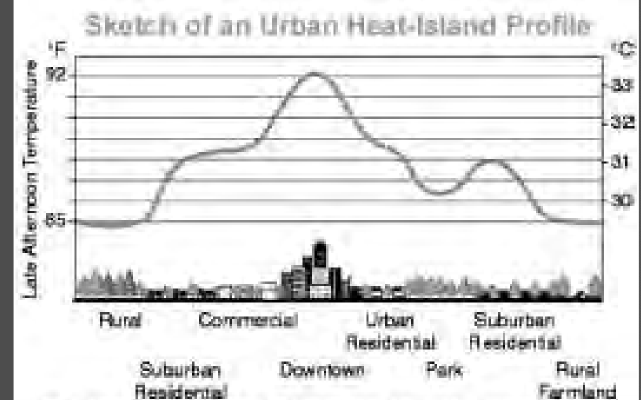


Fig. 2. Urban Heat Island Source: EPA. Heat Island Effect. U.S. Environmental Protection Agency; 2008 http://www.epa.gov/heatisland/about/index.html.

Curriero et al., AJE, 2002

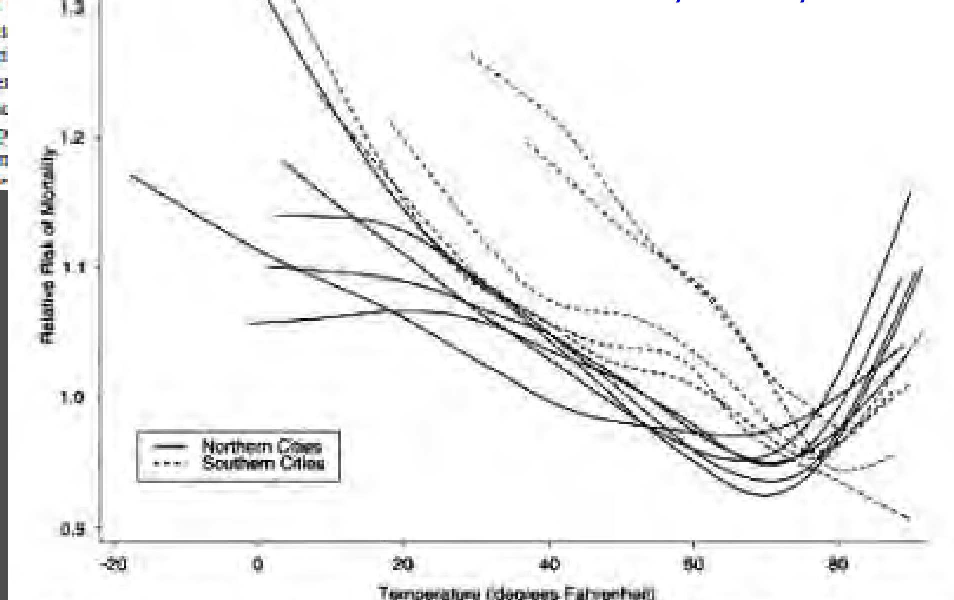
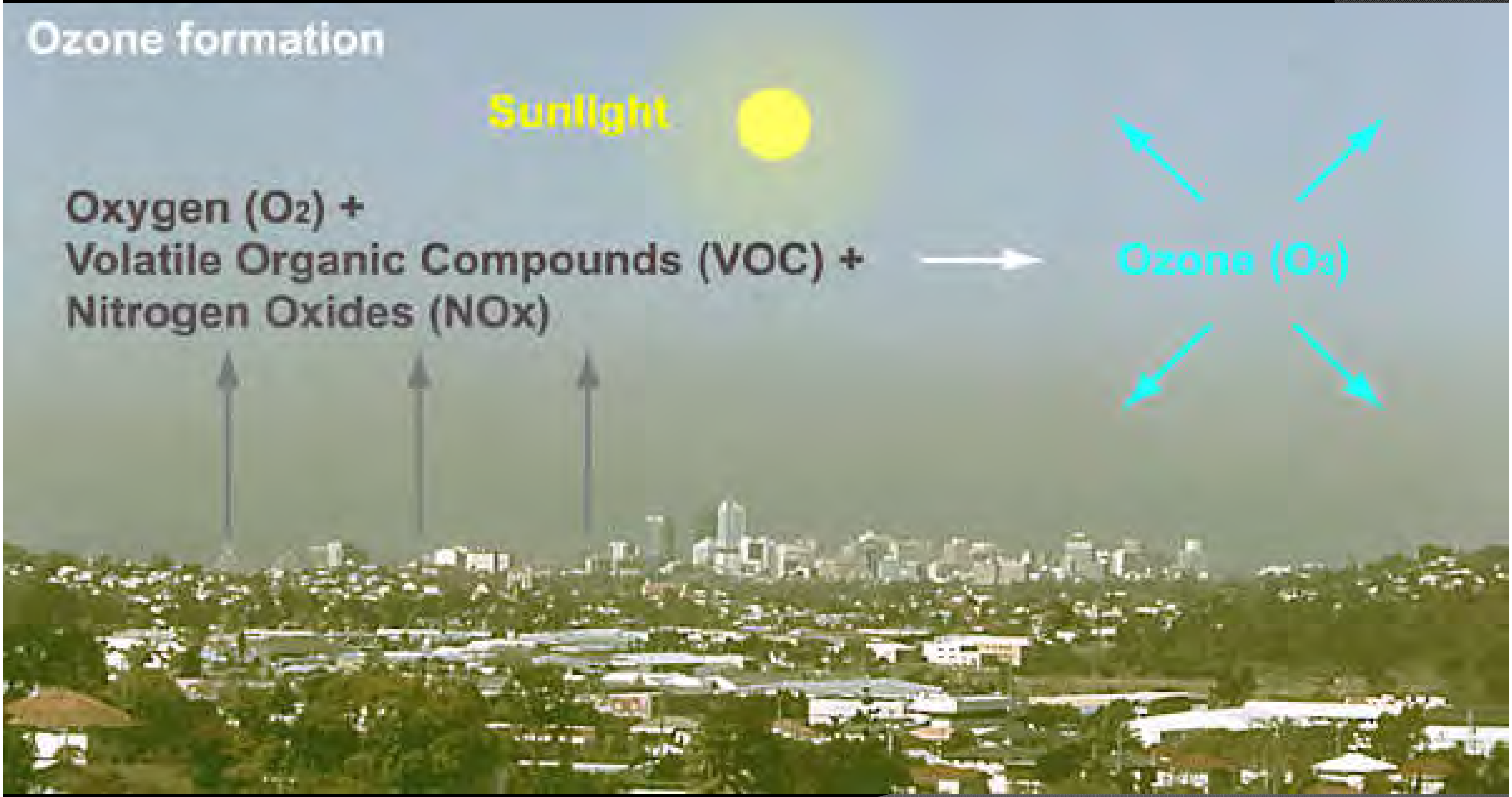


Fig. 1. Temperature-mortality relative risk functions for 11 US cities, 1973–1994. Northern cities: Boston, Mass; Chicago, Ill; New York, NY; Philadelphia, Pa; Baltimore, Md; and Washington, DC. Southern cities: Charlotte, NC; Atlanta, Ga; Jacksonville, Fla; Tampa, Fla; and Miami, Fla. °C = 5/9 × (°F − 32). Reprinted with permission from *Am J Epidemiol*.[11]

Vulnerability factors *(O'Neill & Ebi, JOEM 2009)*

1. Underlying medical conditions
   - Heart and lung diseases, e.g.
2. Demographics
   - Race, age, education
3. Housing
   - Top floor apartments, air conditioning
4. Community geography
   - Heat island, vegetation density

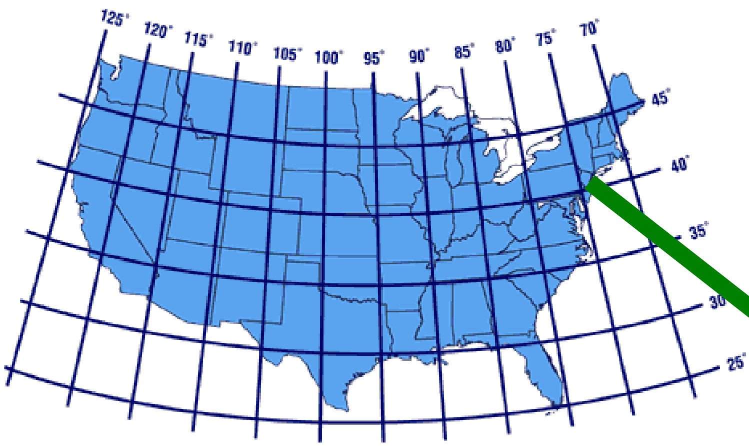
Ground-level ozone formation is sensitive to temperature, sunlight, and other climate factors, as well as local pollution precursor emissions



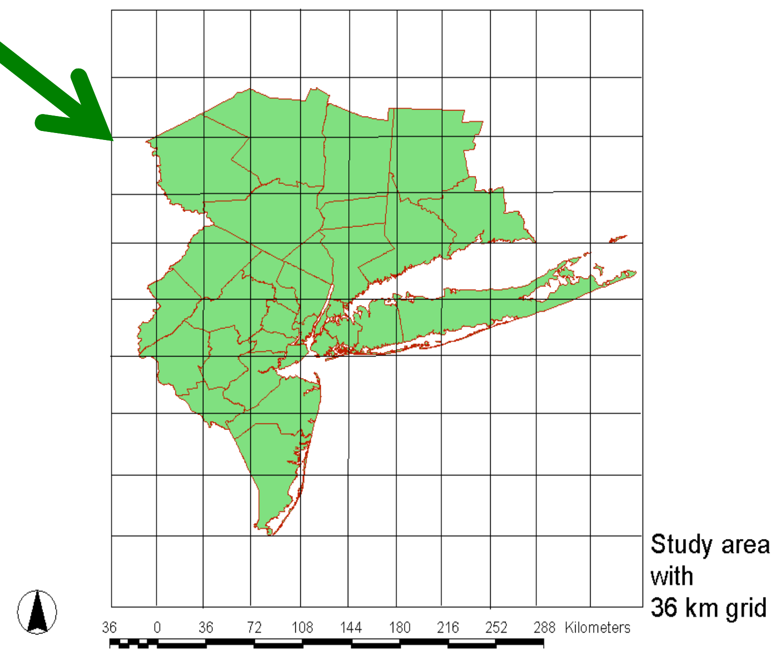
Source: Queensland Government EPA, www.epa.qld.gov.au

Downscaling climate and air quality projections to regional scales

Can we project future health impacts at policy-relevant spatial scales?



400x500 km grid from global-scale model



36x36 km grid from regional-scale model

Hogrefe et al., J Geophysical Research, 2004

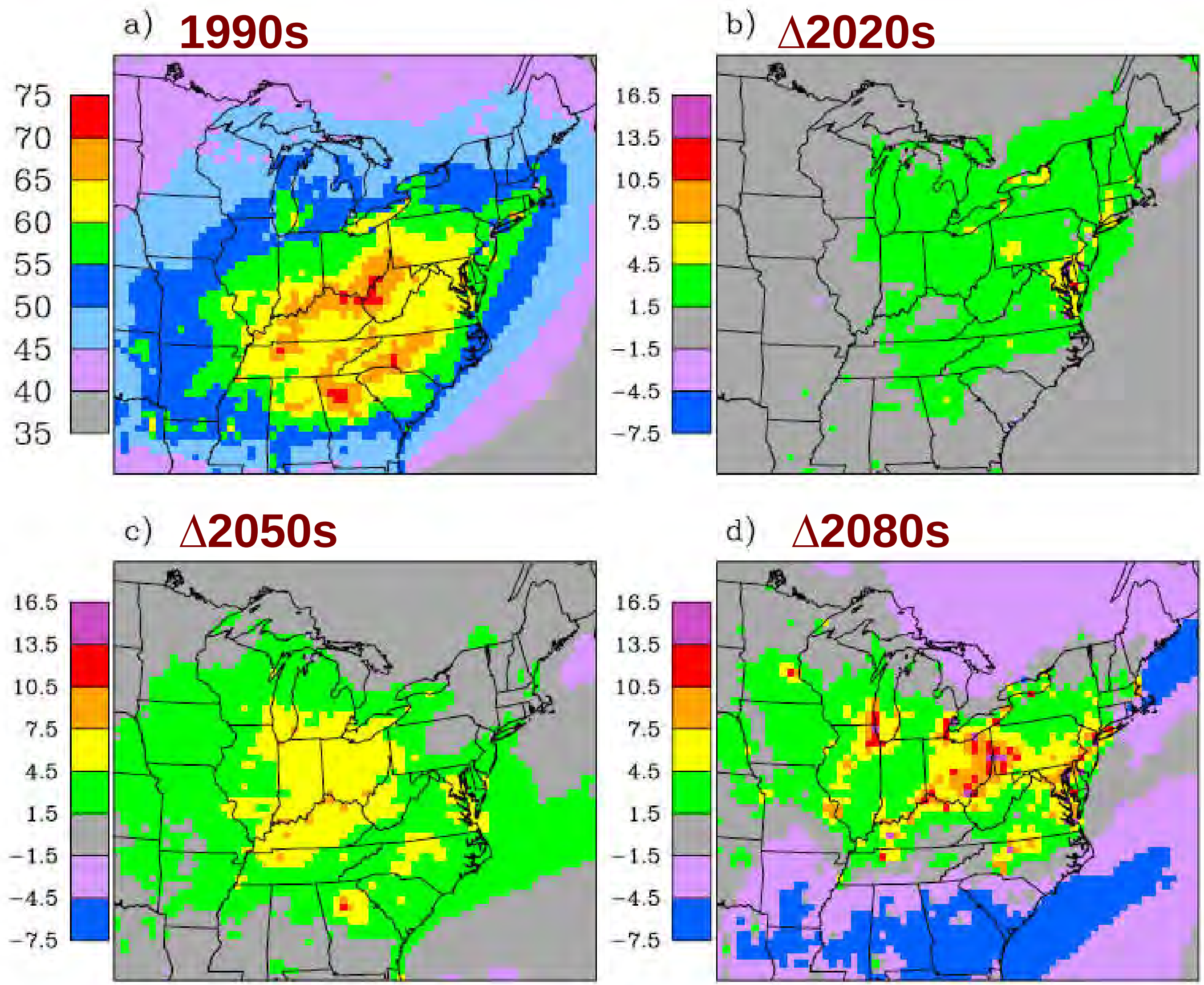


Figure 2. (a) Summertime average daily maximum 8-hour O_3 concentrations for the 1990s and changes in summertime average daily maximum 8-hour O_3 concentrations for the (b) 2020s, (c) 2050s, and (d) 2080s A2 scenario simulations relative to the 1990s, in parts per billion. Five consecutive summer seasons were simulated in each decade.

Modeled changes in:

Mean 1-hr max O3 (ppb) O3-related deaths (%)

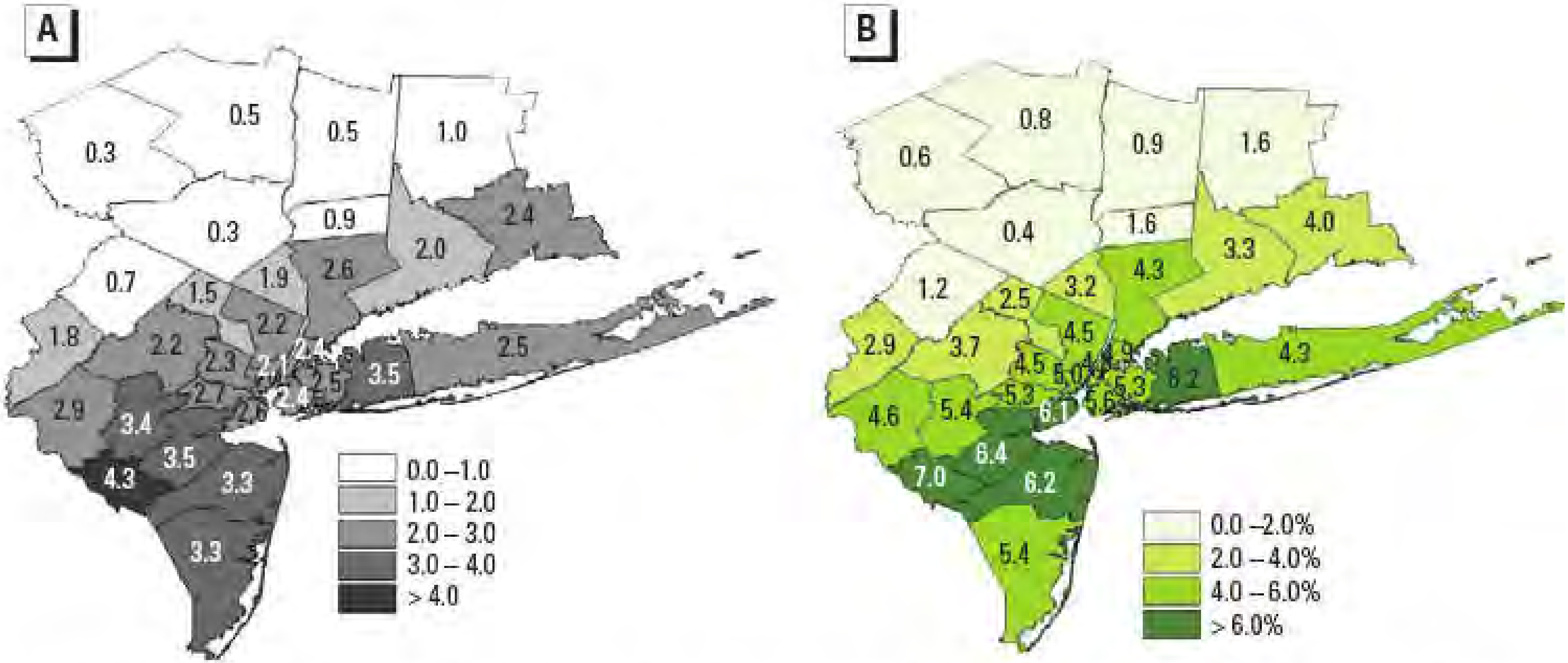
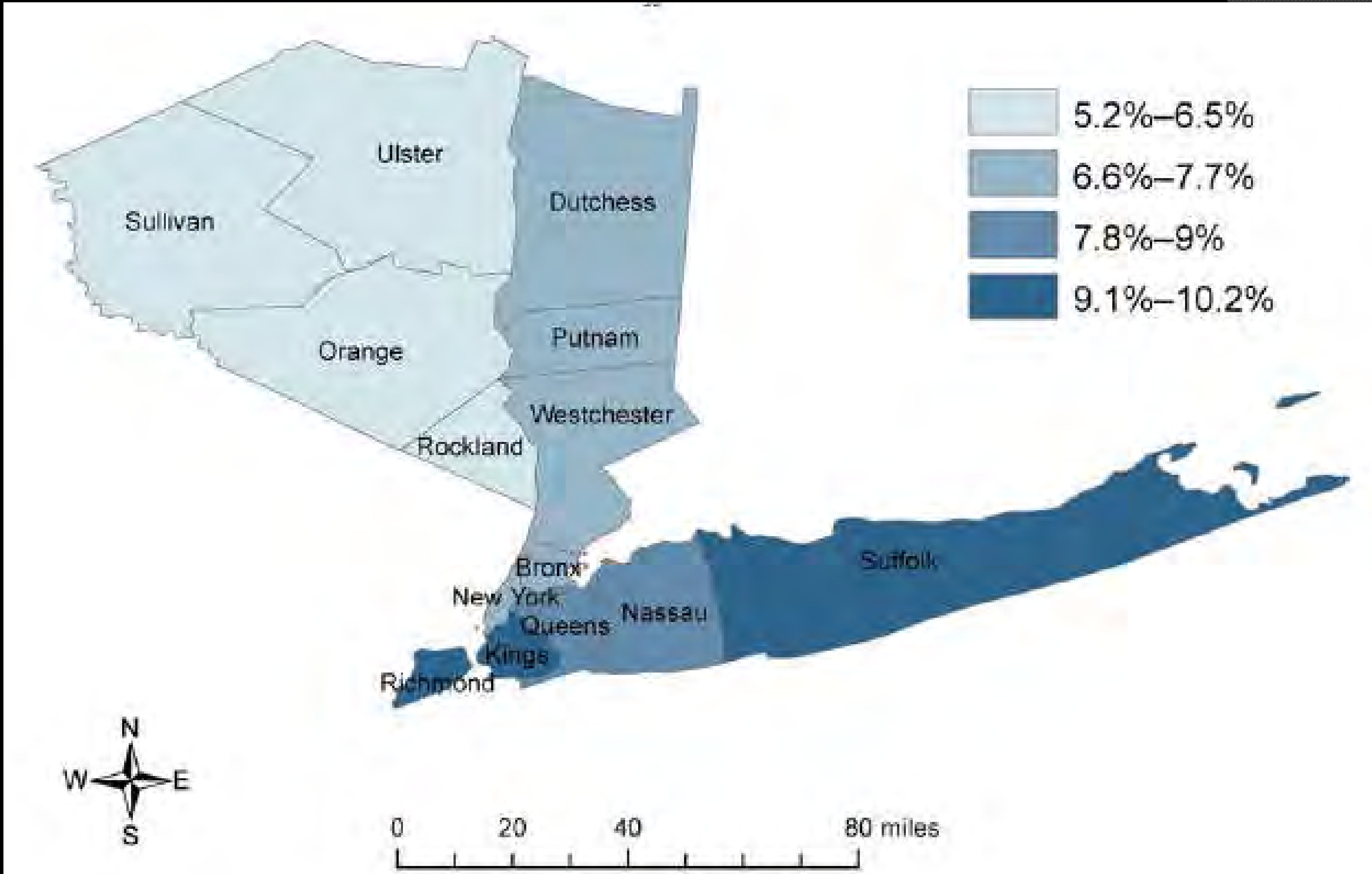


Figure 2. Estimated changes in O_3 and associated summertime mortality in the 2050s compared with those in the 1990s for M1, where climate change alone drives changes in air quality. (*A*) Changes in mean 1-hr daily maximum O_3 concentrations (ppb). (*B*) Percent changes in O_3-related mortality.

Knowlton et al., EHP, 2004

% change in O3-related asthma ED visits (2020s A2 vs 1990s) for children aged 0–17 years in 14 metropolitan NYC counties



Sheffield et al., AJPM, 2011.

Percent increases in summer daily 1-hr max O3 in 50 large cities

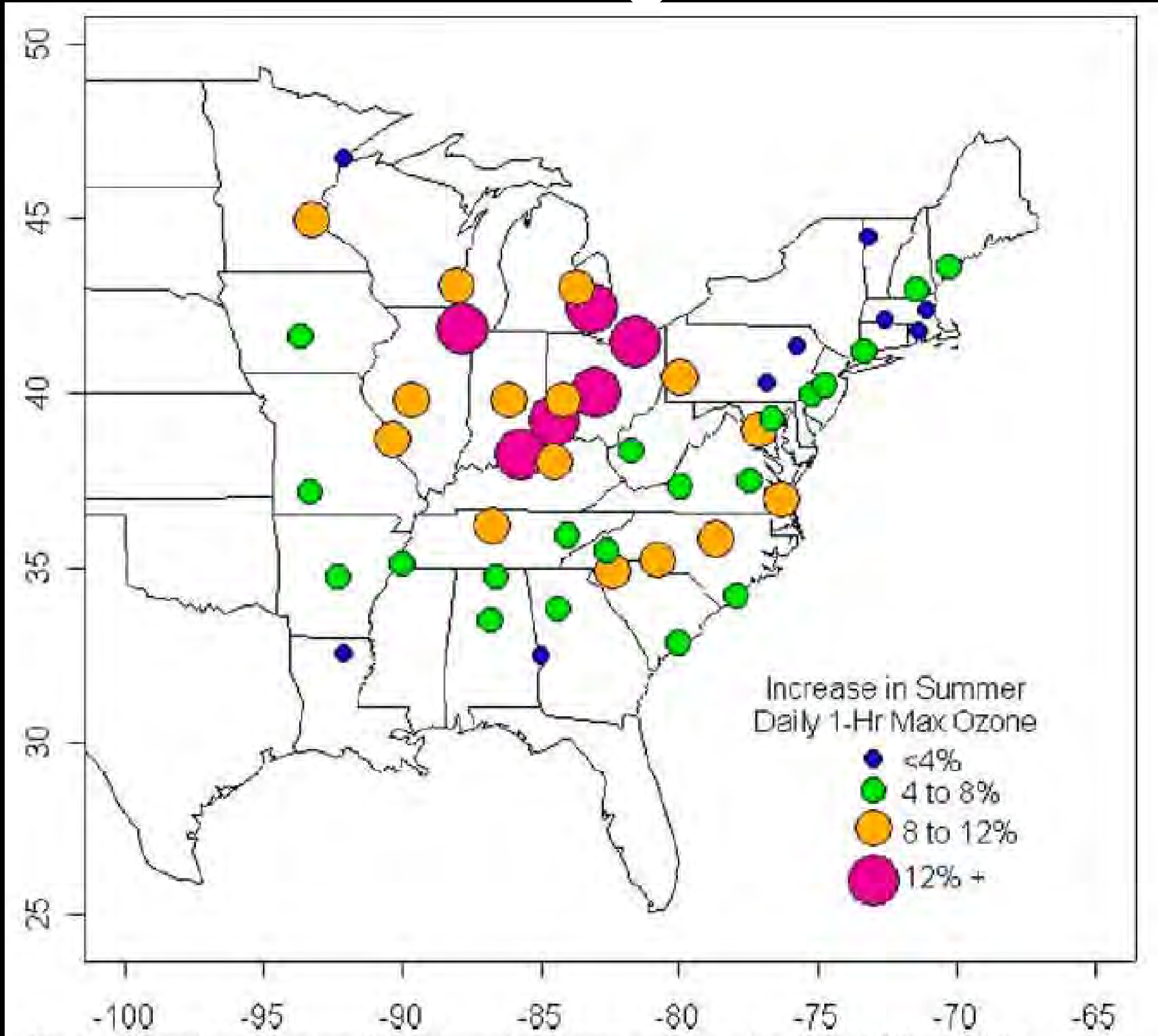
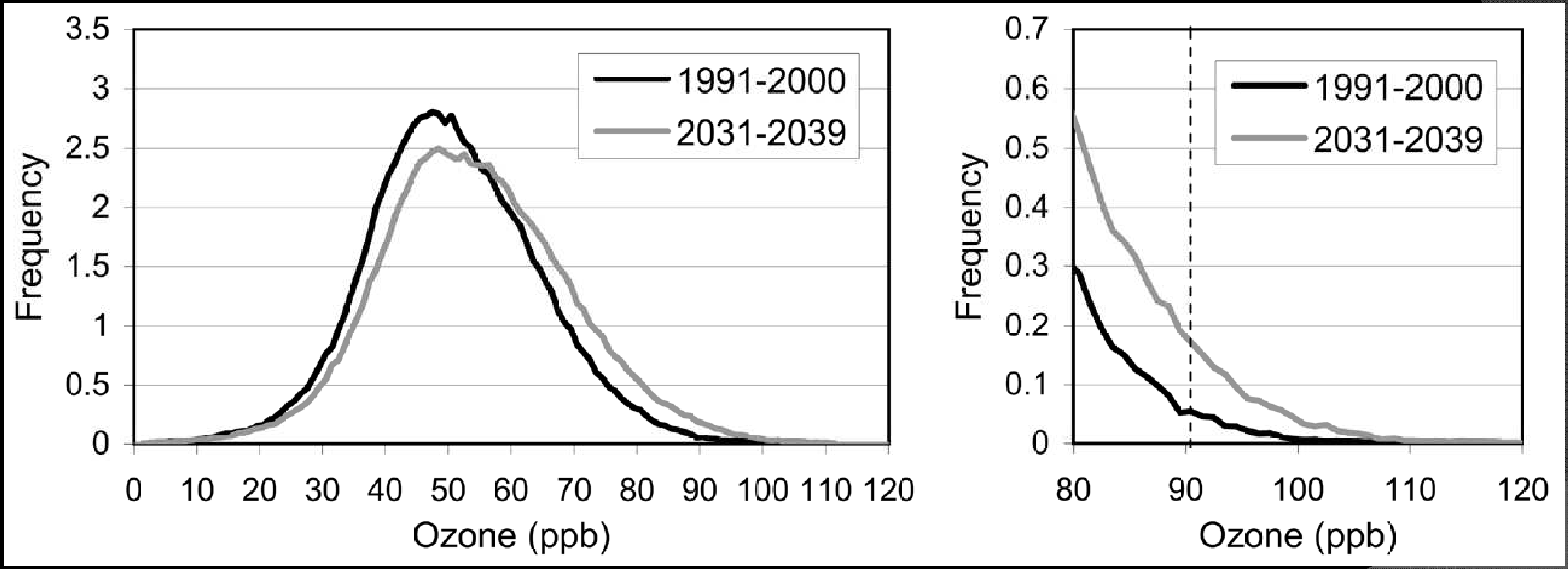


Fig. 1 Increase in summertime daily 1-h maximum ozone concentrations (from 1990s to 2050s)

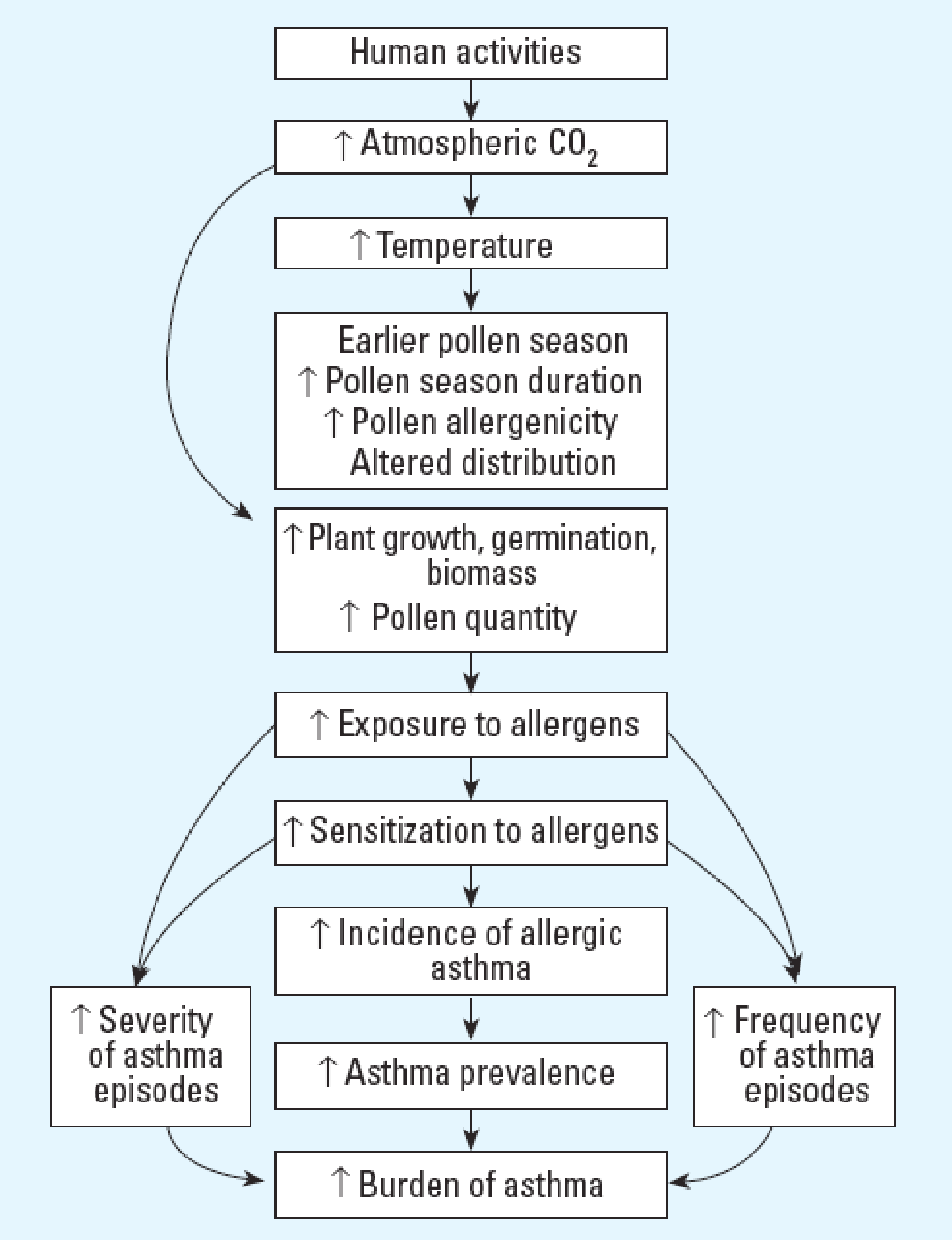
Bell et al, Climatic Change, 2007

Upper tail of ozone concentration distribution is more sensitive to climate



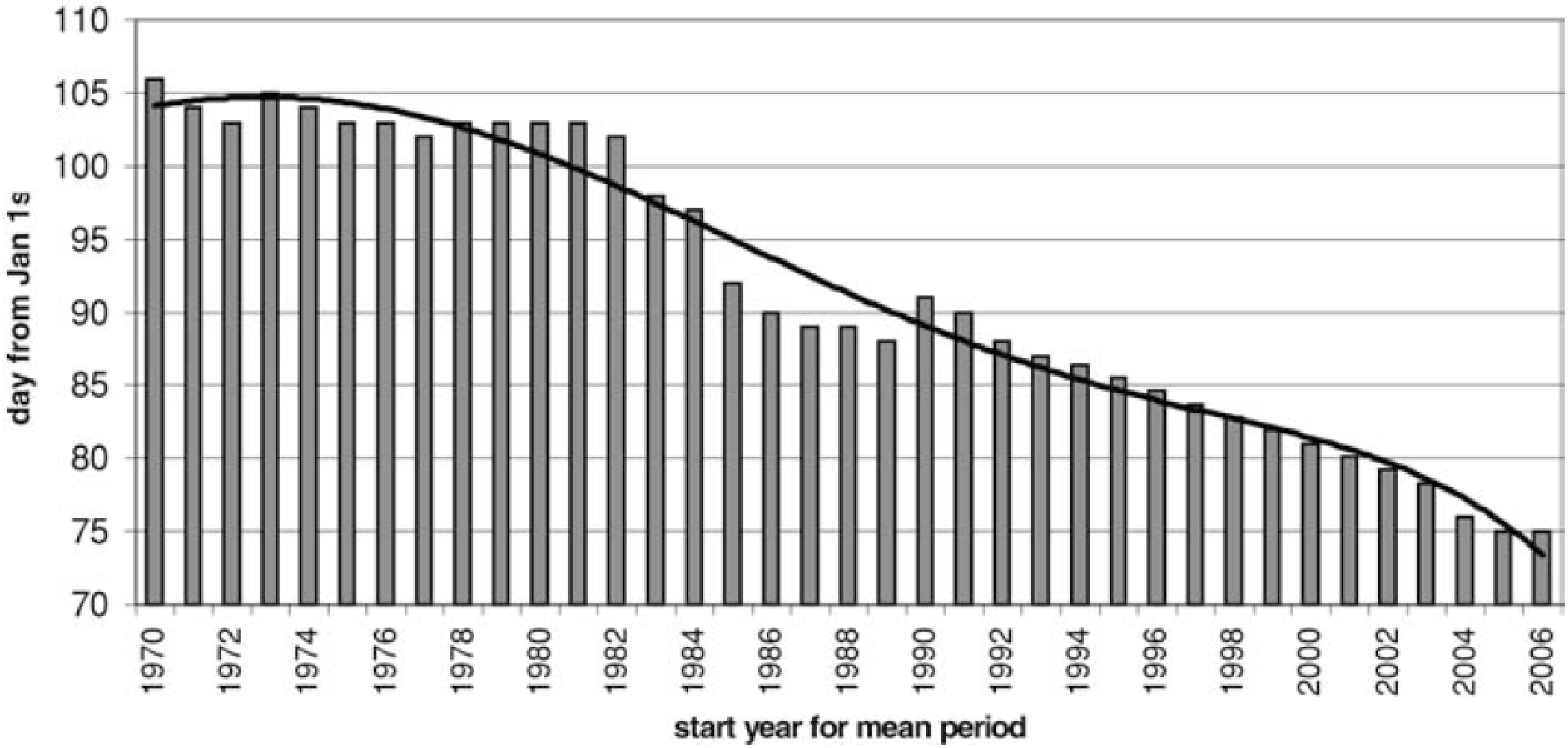
Frequency distribution of the simulated daily ozone maxima averaged over southern Germany during summer (June-August) for the years 1991-2000 and 2031-2039. Right side: zoom of the high-ozone portion of the curve. Forkel and Knoche 2006.

Climate, Pollen and Asthma: *possible mechanisms*



From: Beggs and Bambrick, EHP 2005

Start Date of Birch Pollen Season in Brussels 1970-2006 Days after Jan 1 (5-year running means)



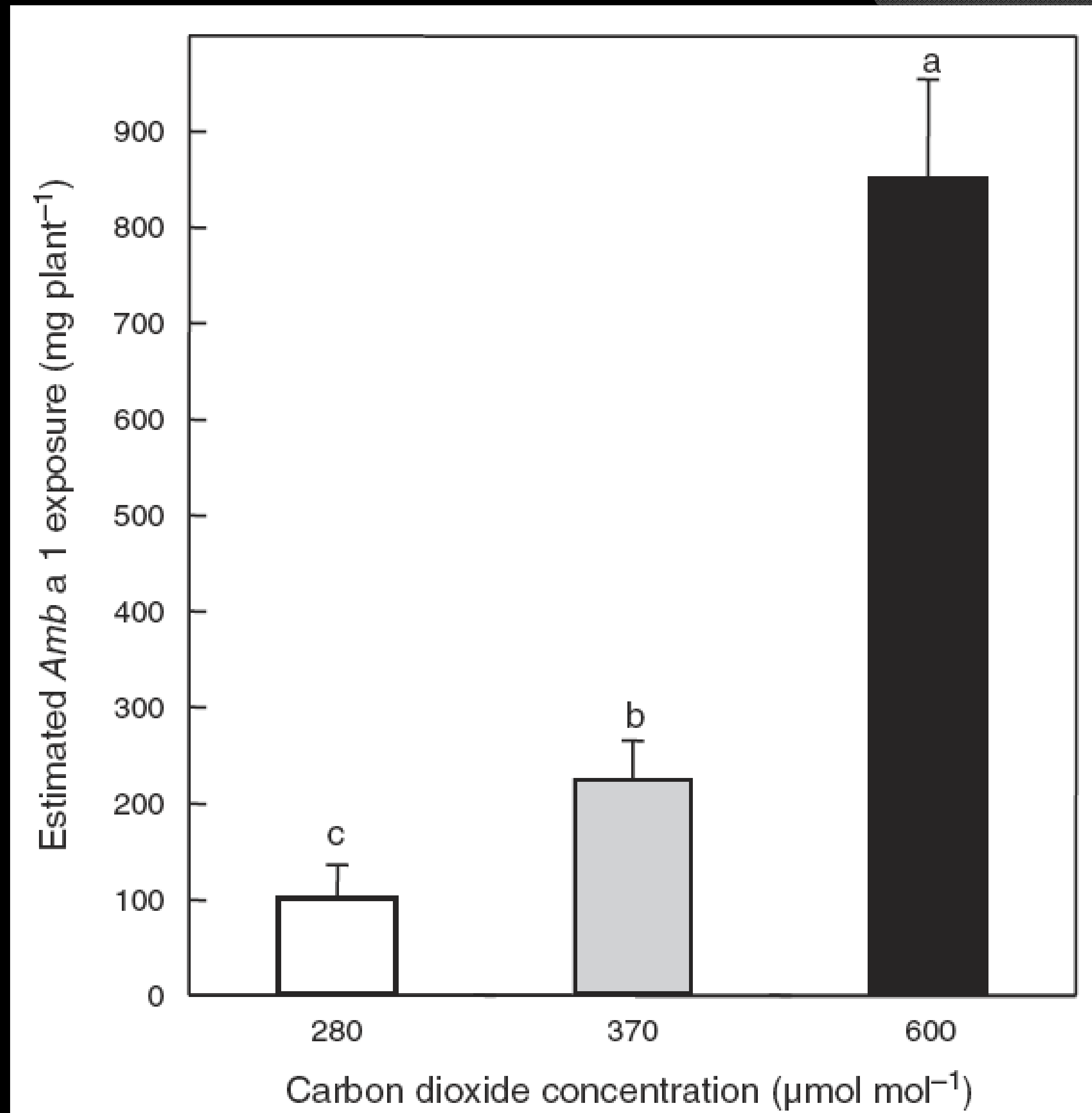
Emberlin et al., *Int J Biomet*, 2002

Warming by latitude and increased length of ragweed pollen season in central North America

Location	Latitude	Years of data	1995 Start	1995 End	2009 Start	2009 End	Change
Georgetown, TX	30.63°N	17	198 ± 7	320 ± 7	195 ± 7	313 ± 7	−4 d
Oklahoma City, OK	35.47°N	19	212 ± 7	300 ± 10	227 ± 9	316 ± 15	+1 d
Rogers, AR	36.33°N	15	231 ± 7	295 ± 8	227 ± 6	296 ± 8	−3 d
Papillion, NE	41.15°N	21	212 ± 3	281 ± 6	208 ± 4	288 ± 10	+11 d
Madison, WI	43.00°N	27	208 ± 2	272 ± 4	205 ± 3	281 ± 6	+12 d
LaCrosse, WI	43.80°N	22	213 ± 3	271 ± 3	205 ± 5	276 ± 5	+13 d*
Minneapolis, MN	45.00°N	19	208 ± 5	270 ± 6	206 ± 7	284 ± 7	+16 d*
Fargo, ND	46.88°N	15	216 ± 4	252 ± 8	217 ± 4	269 ± 8	+16 d*
Winnipeg, MB, Canada	50.07°N	16	207 ± 7	264 ± 6	197 ± 7	279 ± 7	+25 d*
Saskatoon, SK, Canada	52.07°N	16	206 ± 12	250 ± 6	197 ± 13	268 ± 7	+27 d*

Ziska et al. 2011. PNAS.

Ragweed allergen production increases as a function of CO_2 concentration



Singer et al., Functional Plant Biology 2005, 32, 667-670.

Key Take-Home Messages

- Health effects from heat, air pollution, and pollen are more challenging to address as climate changes in the U.S.
- Along with climate change, vulnerability factors will be key in determining health impacts
- Empirical research is beginning to reveal links between climate and adverse health outcomes
- Scenario-based modeling will play an important role in regional adaptation planning