

Climate Change, Air Pollution and Sustainable Urban Health

Session 2.1. Urban Health and Air Pollution

Health in All Policies Workshop

WHO, ASPPH & NEHA

Washington, DC, June 19, 2018

Jonathan Patz

Professor and John P Holton Chair

Director, Global Health Institute

University of Wisconsin-Madison



Global Health Institute
UNIVERSITY OF WISCONSIN-MADISON

Group think #1

How do the problems of
air pollution and climate change
affect each other?

How are they bi-directional problems?

Marcelo showed this slide yesterday

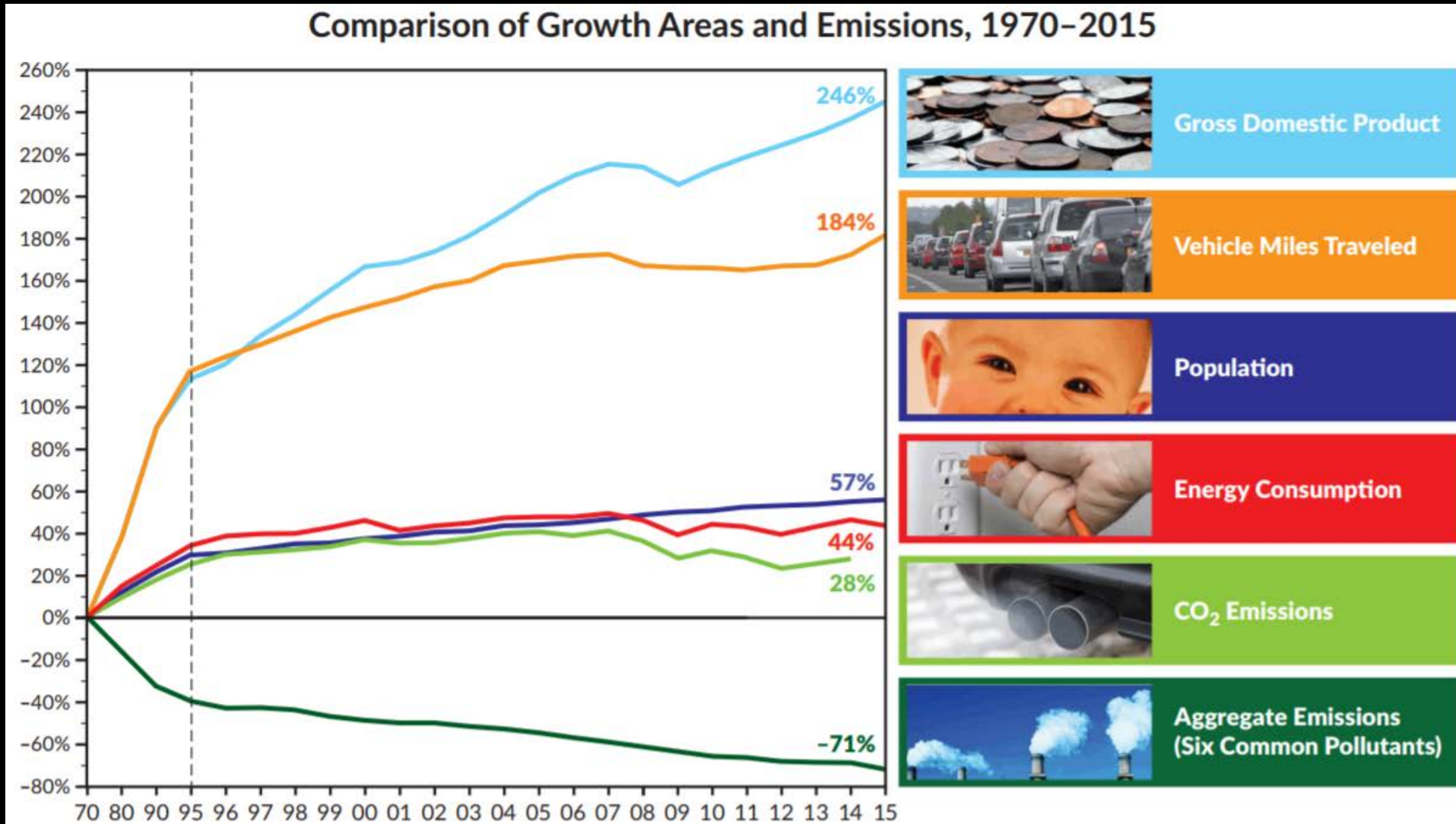
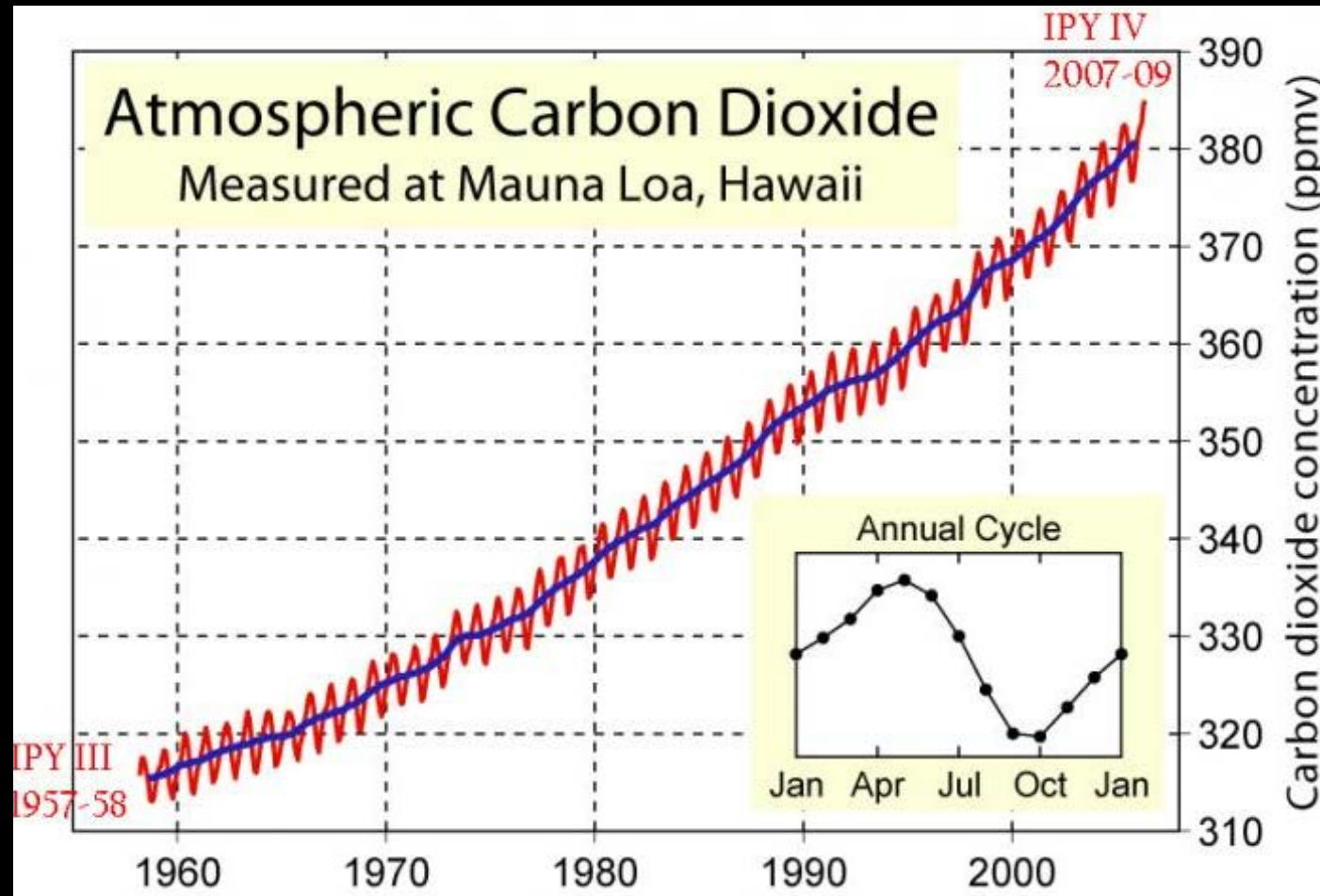


Figure 1: Air pollution emissions continue to drop steadily since 1970 thanks to the Clean Air Act. As the economy continues to grow, emissions that cause ozone and particle pollution continue to drop. Source: U.S. EPA, Air Trends: [Air Quality National Summary](#), 2017.

Fossil fuels: emit both pollution & Greenhouse gases



Greenhouse gases

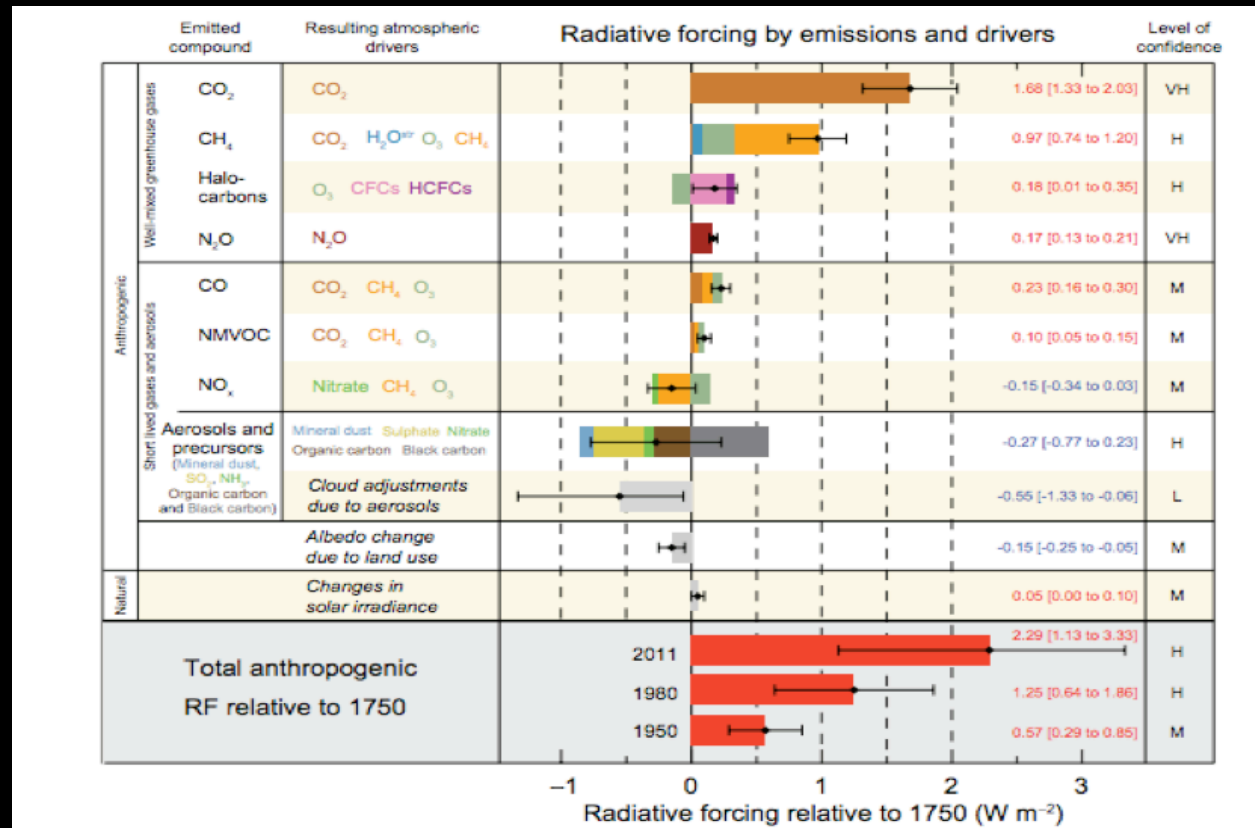
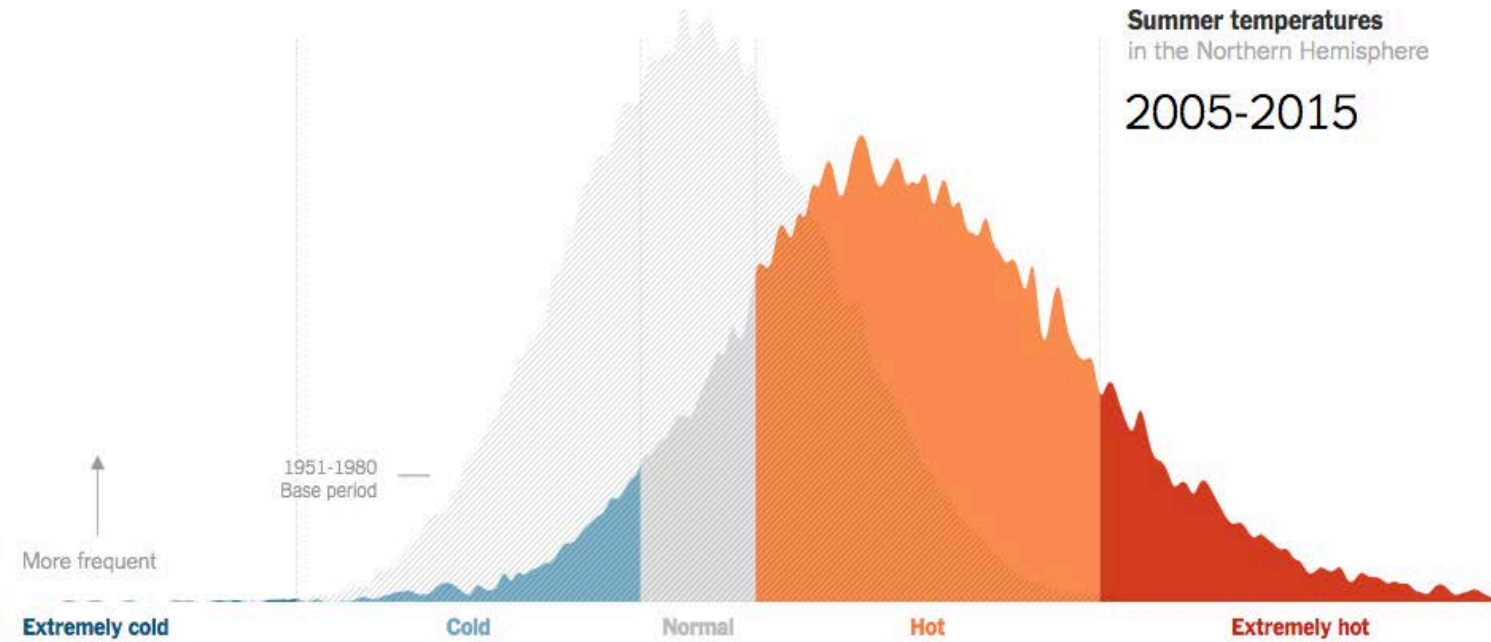


Figure SPM.5 | Radiative forcing estimates in 2011 relative to 1750 and aggregated uncertainties for the main drivers of climate change. Values are global average radiative forcing (RF^{1a}), partitioned according to the emitted compounds or processes that result in a combination of drivers. The best estimates of the net radiative forcing are shown as black diamonds with corresponding uncertainty intervals; the numerical values are provided on the right of the figure, together with the confidence level in the net forcing (VH – very high, H – high, M – medium, L – low, VL – very low). Albedo forcing due to black carbon on snow and ice is included in the black carbon aerosol bar. Small forcings due to contrails (0.05 W m⁻², including contrail induced cirrus), and HFCs, PFCs and SF₆ (total 0.03 W m⁻²) are not shown. Concentration-based RFs for gases can be obtained by summing the like-coloured bars. Volcanic forcing is not included as its episodic nature makes it difficult to compare to other forcing mechanisms. Total anthropogenic radiative forcing is provided for three different years relative to 1750. For further technical details, including uncertainty ranges associated with individual components and processes, see the Technical Summary Supplementary Material [B.5; Figures 8.14–8.18; Figures TS.6 and TS.7]

Source: IPCC summary doc: http://ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf

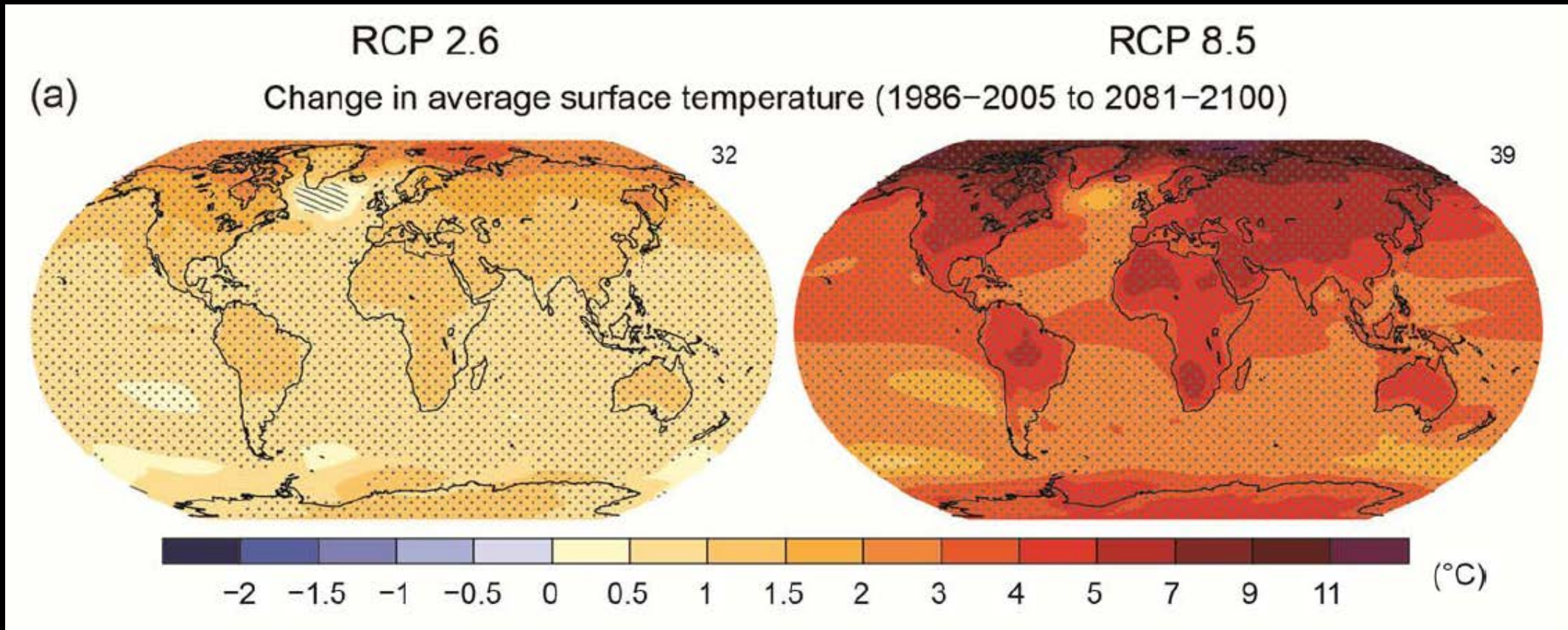
It's Not Your Imagination. Summers Are Getting Hotter.

By NADJA POPOVICH and ADAM PEARCE JULY 28, 2017



Source: Columbia University Earth Institute. Data via Makiko Sato and James Hansen.
Based on: Hansen et al., 2012; 2016 update.

Future Projections



Range: from 1 – 7° C average global warming by 2100

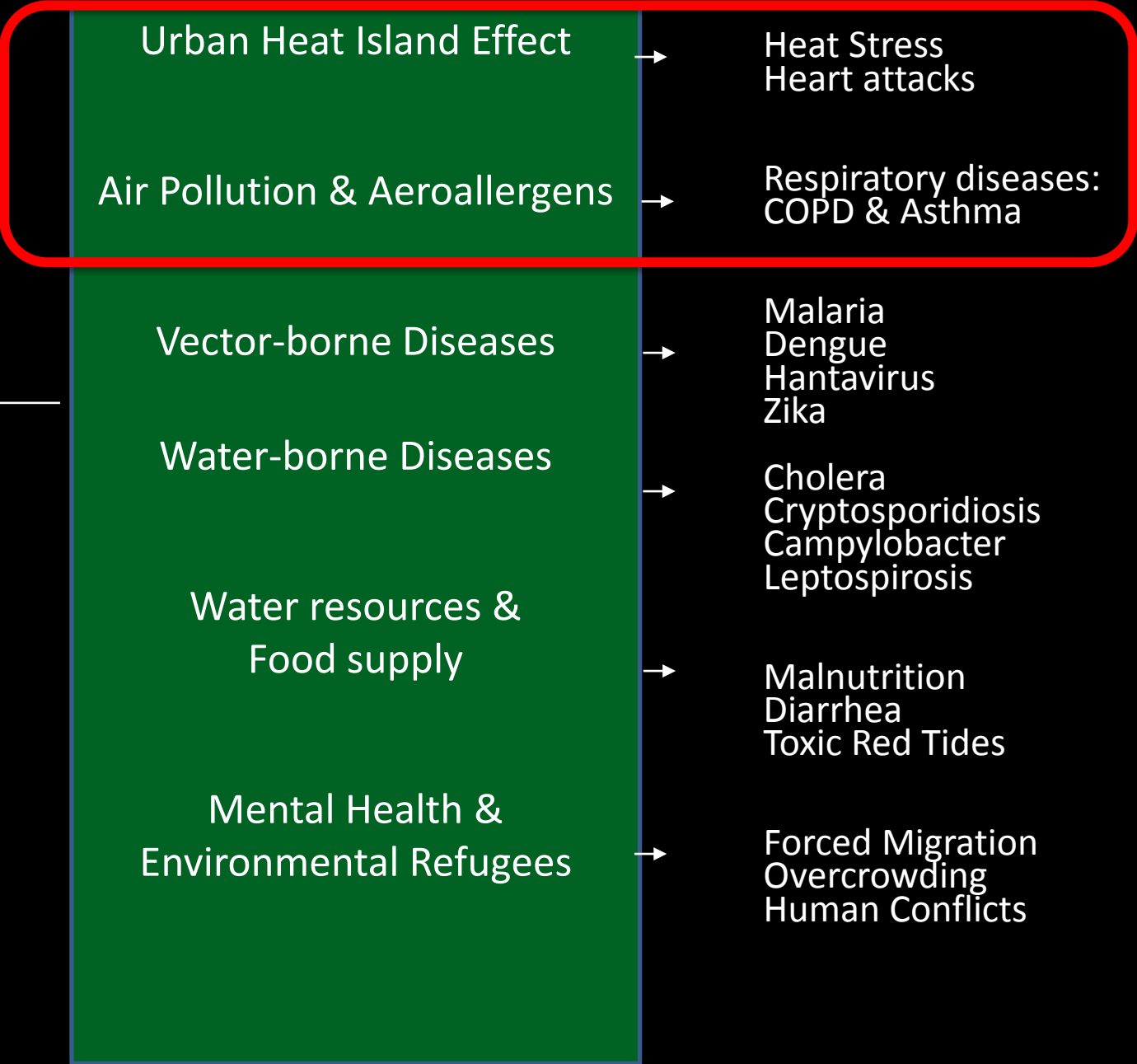
IPCC, AR5, 2013

Health effects of climate change

CLIMATE CHANGE

Temperature Rise
Sea level Rise
Hydrologic Extremes

Droughts
Floods
Fires



nature

CLIMATE CHANGE

Regional health impacts
from North America to Africa

PLASMON OPTICS
Towards the perfect lens

EMERGING DISEASES
The Typhoid Mary factor

STAR FORMATION
Boost for a collapsing theory

- “The severity and duration of summertime regional air pollution episodes are projected to increase in the Northeast and Midwest US by 2045-2052 due to **climate-change-induced decreases in the frequency of surface cyclones.**” (IPCC, 2007)

- By 2050, warming alone may **increase by 68% the number of Red Ozone Alert days** across the Eastern US. (IPCC, 2007; Bell, Patz, et al, 2006)

Ozone formation increases with temperature

- Ozone is the primary component of smog
- Ozone formation:



- Warmer temperatures favor ozone formation

Climate change impact on emissions: Biogenic



- Higher temperatures cause increased VOC emissions from trees
- (e.g. isoprenes)

Biogenic VOCs increase 22-30% per 1° C rise in temperature.

(Geunther, 2003)

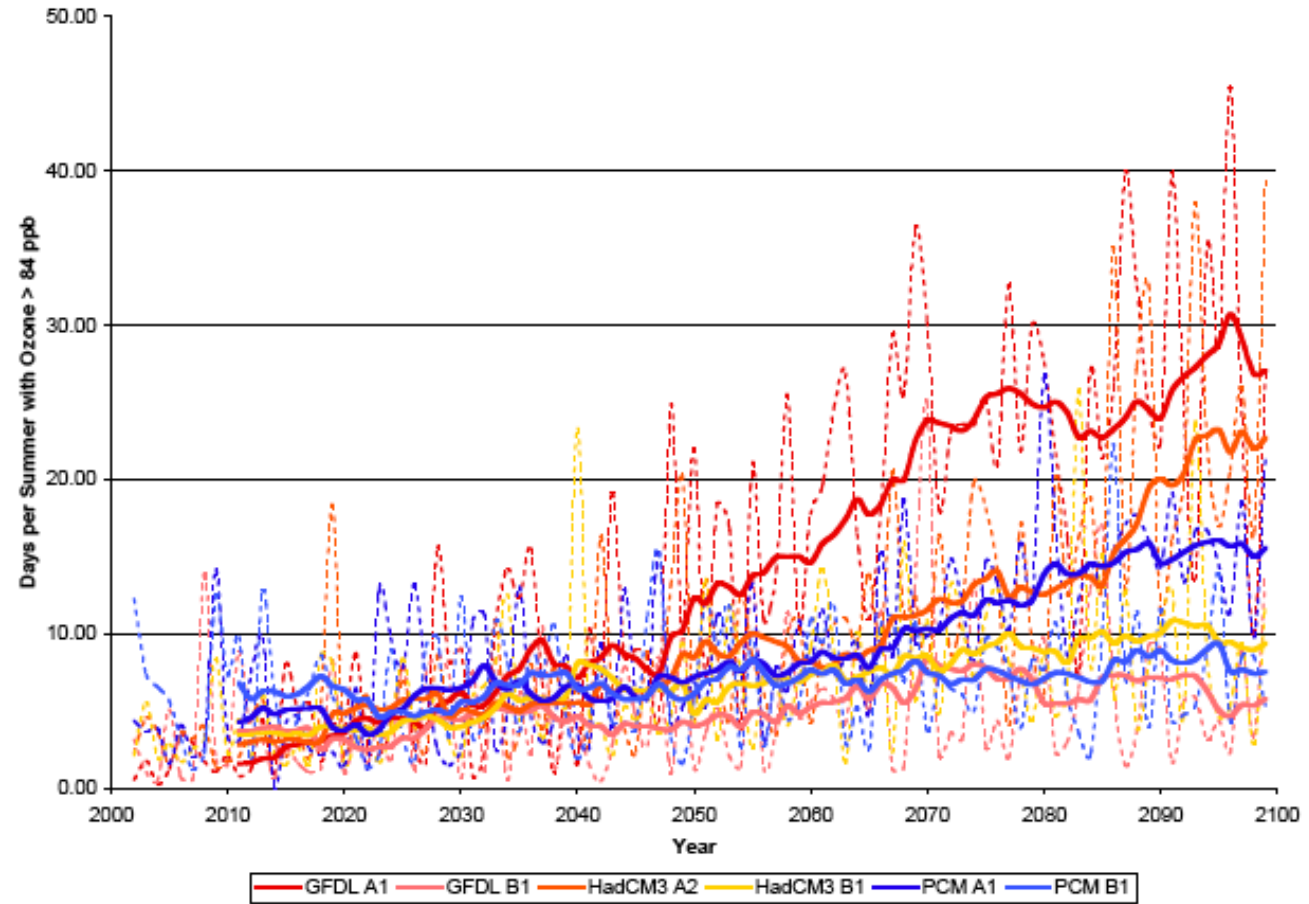
CLIMATE CHANGE AND CHICAGO

PROJECTIONS AND POTENTIAL IMPACTS

EXECUTIVE SUMMARY 09-16-2008

Assuming future ozone responds to climate in the future as has over the past 10 years, **the number of unhealthy ozone days in Chicago would increase by 3x - 8x by 2100 due to changes in climate** (temperature, wind, and cloud cover)

Projected High-O₃ Days



Holloway et al., JGR (2008)

Flooding and air quality

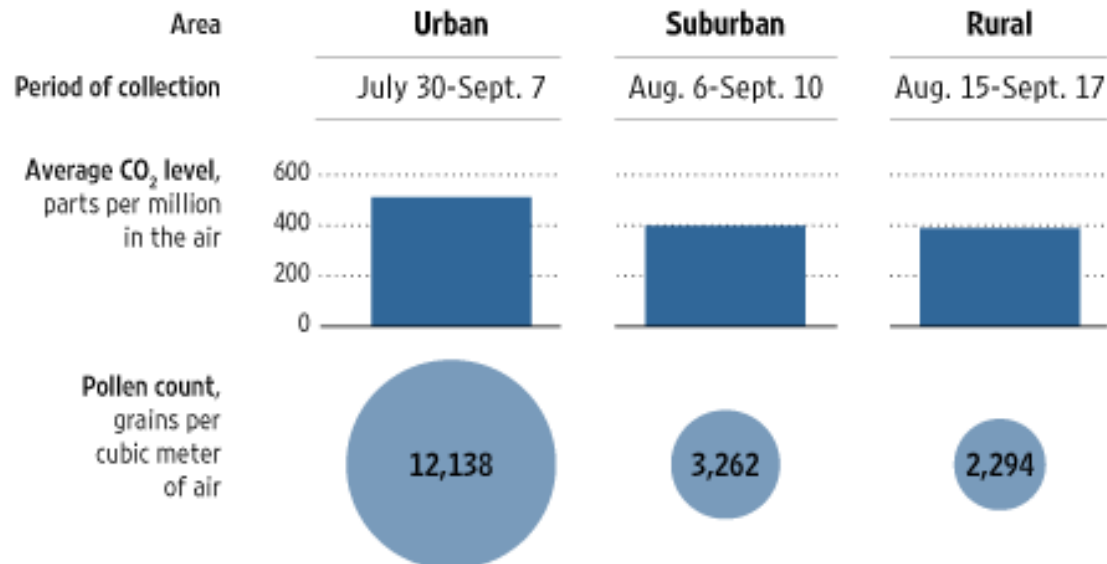
- **Flooding** can: a) promote mold and fungal growth
- b) increase respiratory disease in overcrowded shelters.

Ragweed

- Genus *Ambrosia*
- ↑ CO₂ and temperature →
↑ pollen counts, longer
growing season

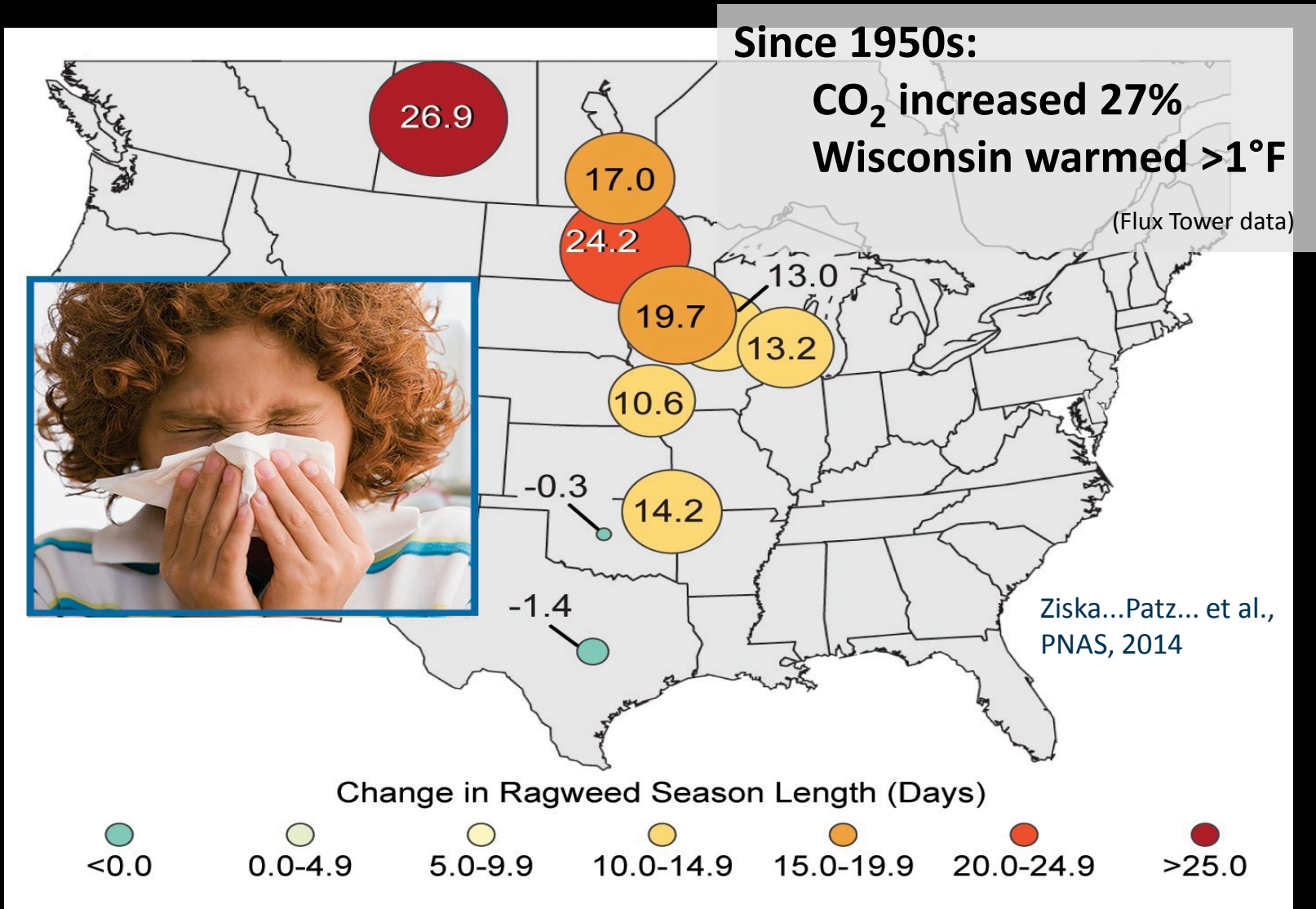
Something in the Air

Researchers at the U.S. Dept. of Agriculture planted ragweed in and around Baltimore in 2001 to test how the plant responds to different concentrations of CO₂. The results:



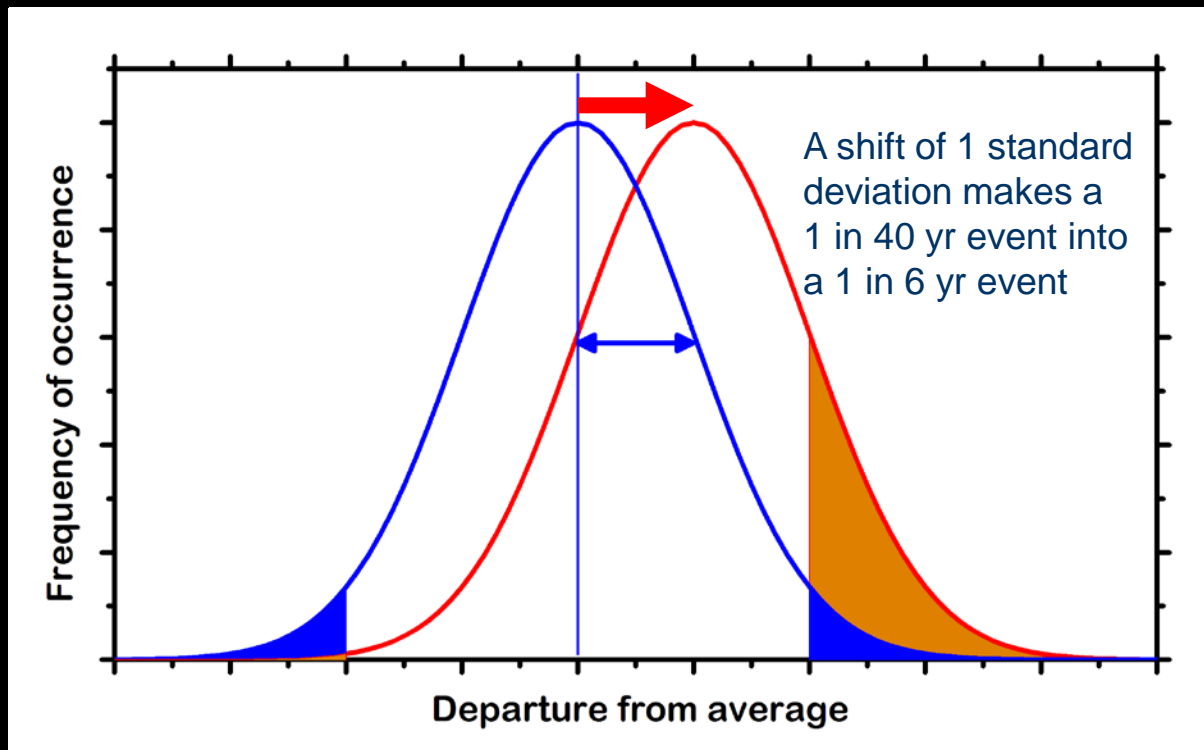
Source: Ziska et al., *J Allerg Clin Immunol* 2003;111:290-95;
Graphic: *Wall Street Journal*, 3 May 2007.

Warming, CO₂ and ragweed season



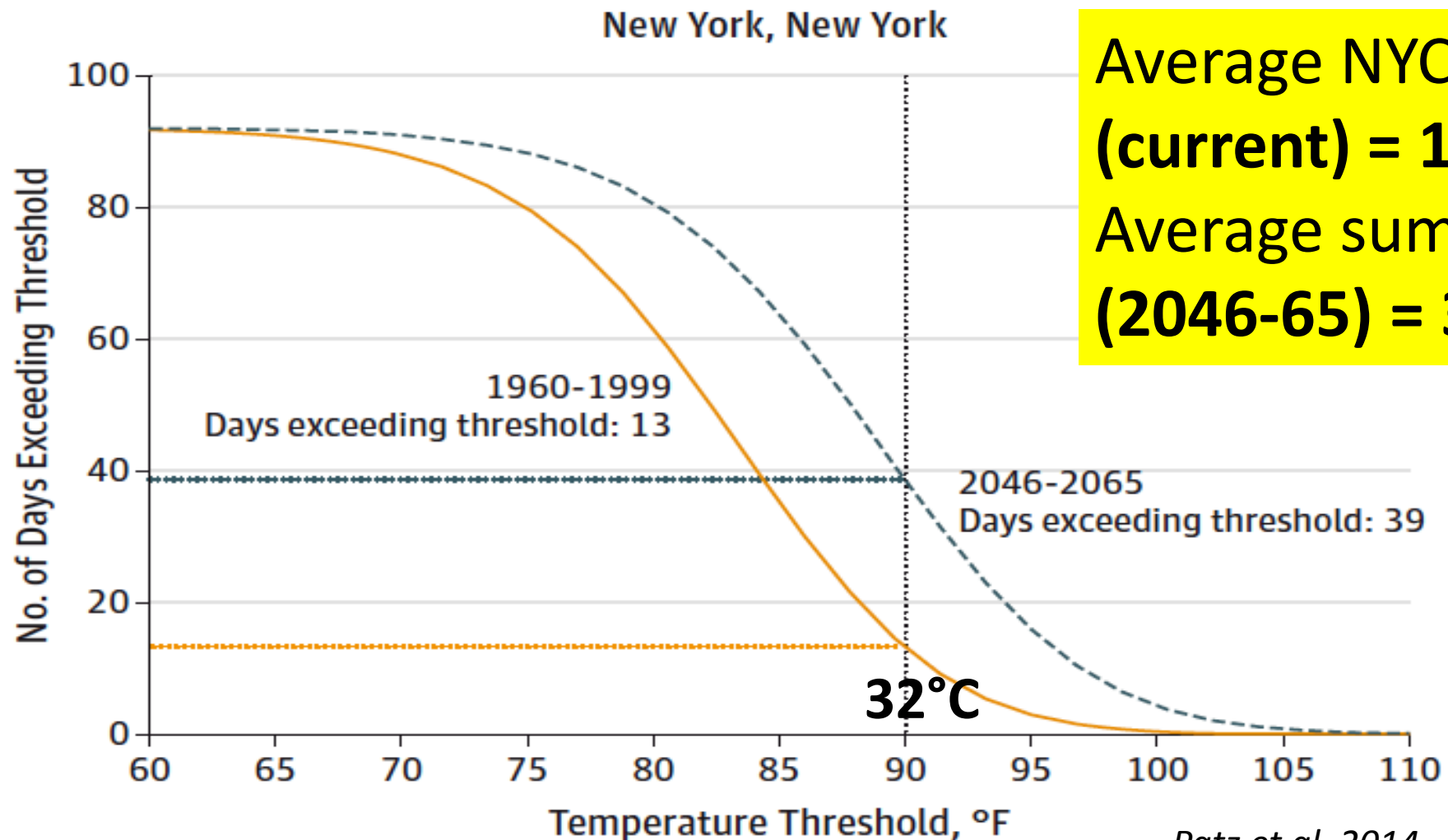
Calculus of extremes

Climate change can involve change in the average, or the spread around the average (standard deviation), or both.



A shift in the distribution of temperatures has a much larger relative effect at the extremes than near the mean.

Projected # of days over 32° C

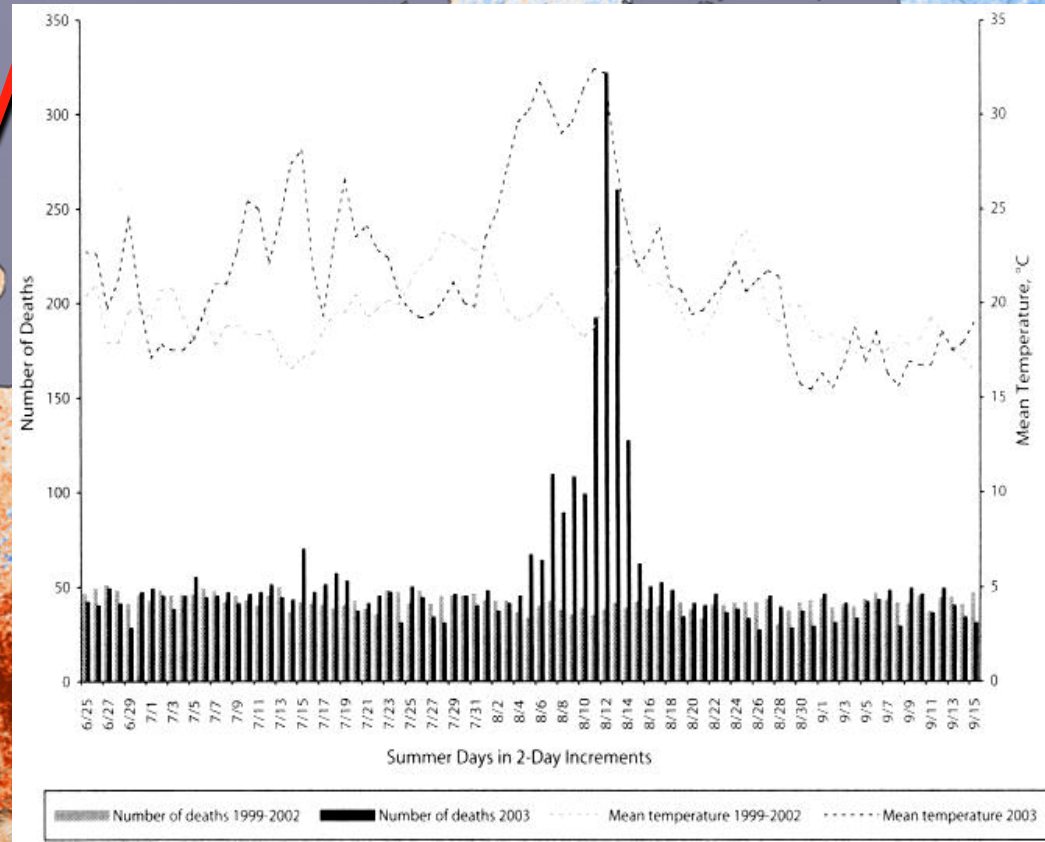


Average NYC summer
(current) = 13 days
Average summer
(2046-65) = 39 days

TIME LINE (FRANCE)

HEAT WAVE

➤ **70,000 deaths**
in 11 days

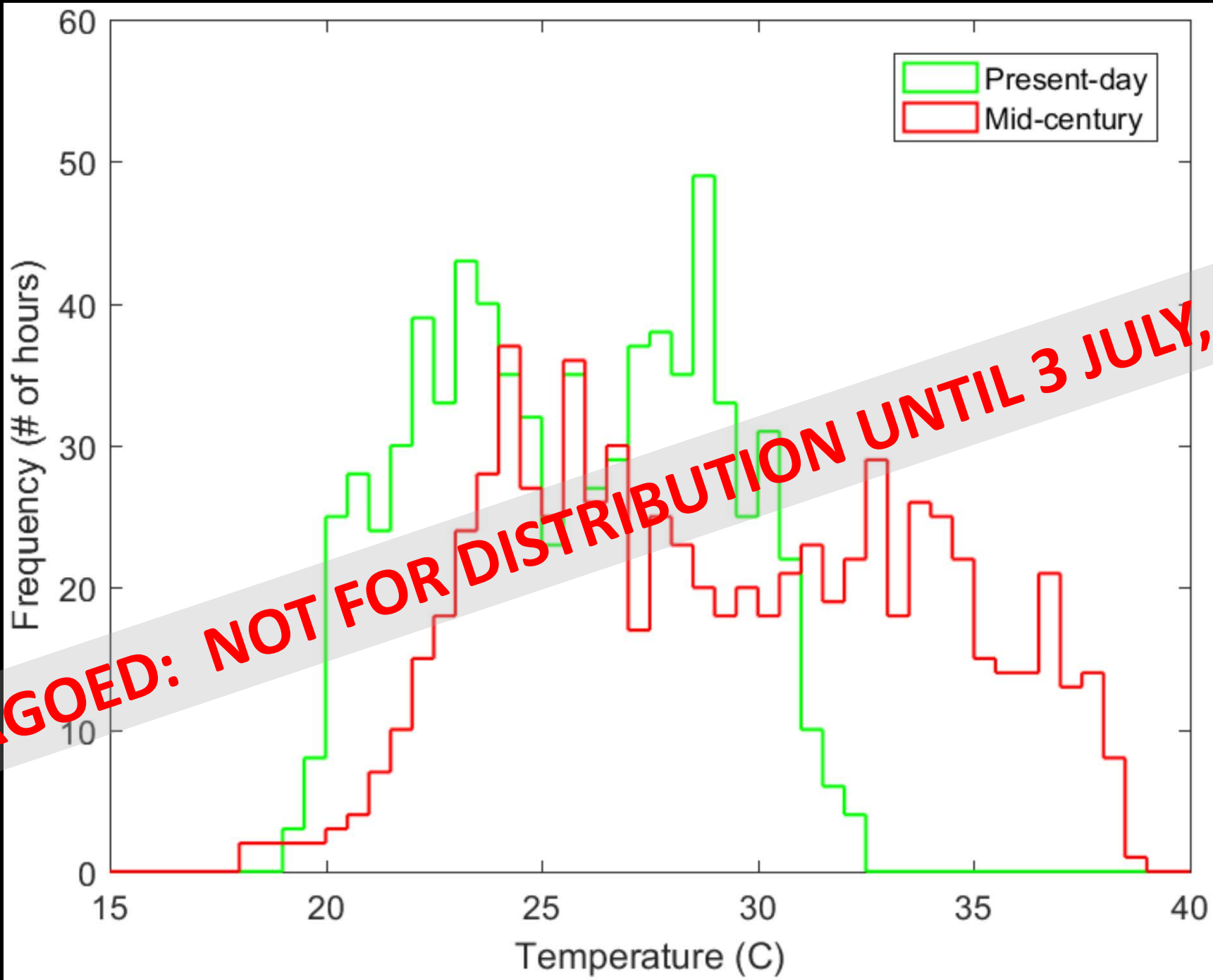


Vandentorren et al. Mortality in 13 French cities during the August 2003 heat wave. *Am J Public Health* 2004; 94(9):1518-20.

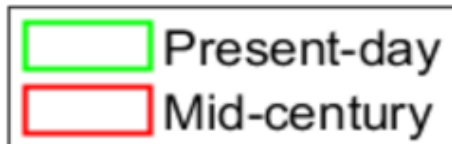
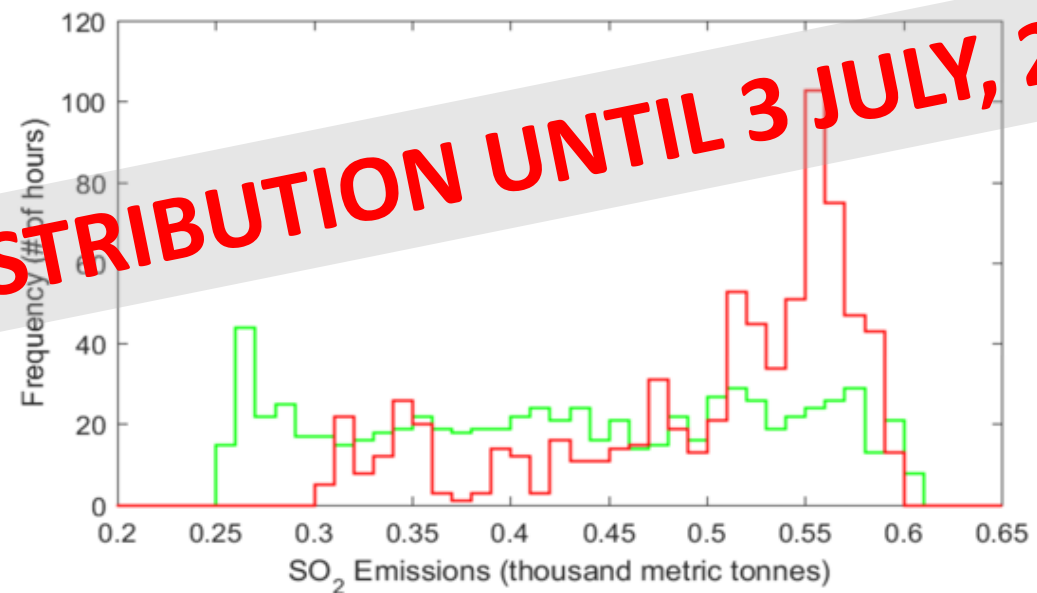
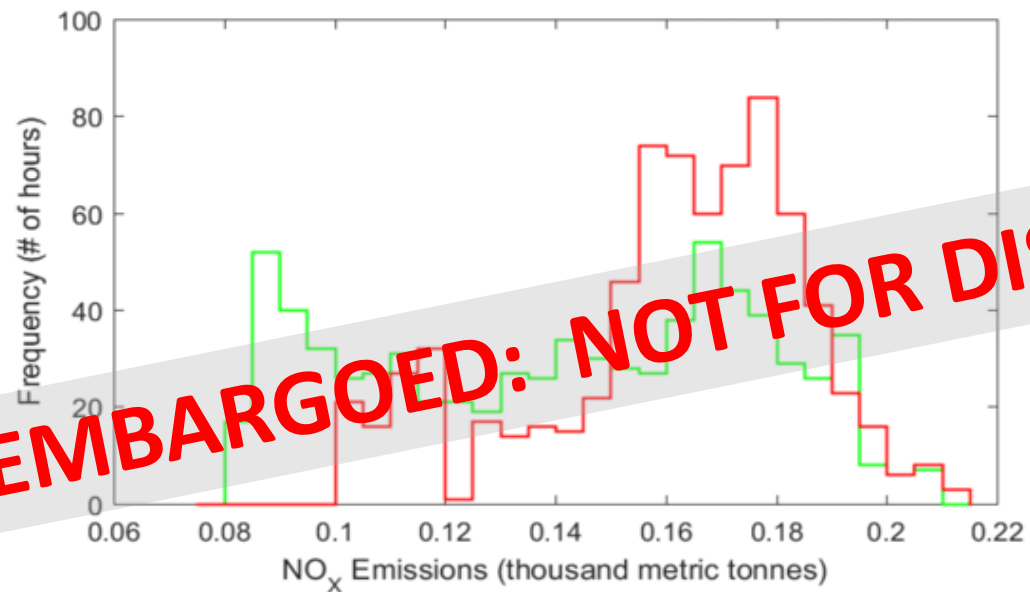
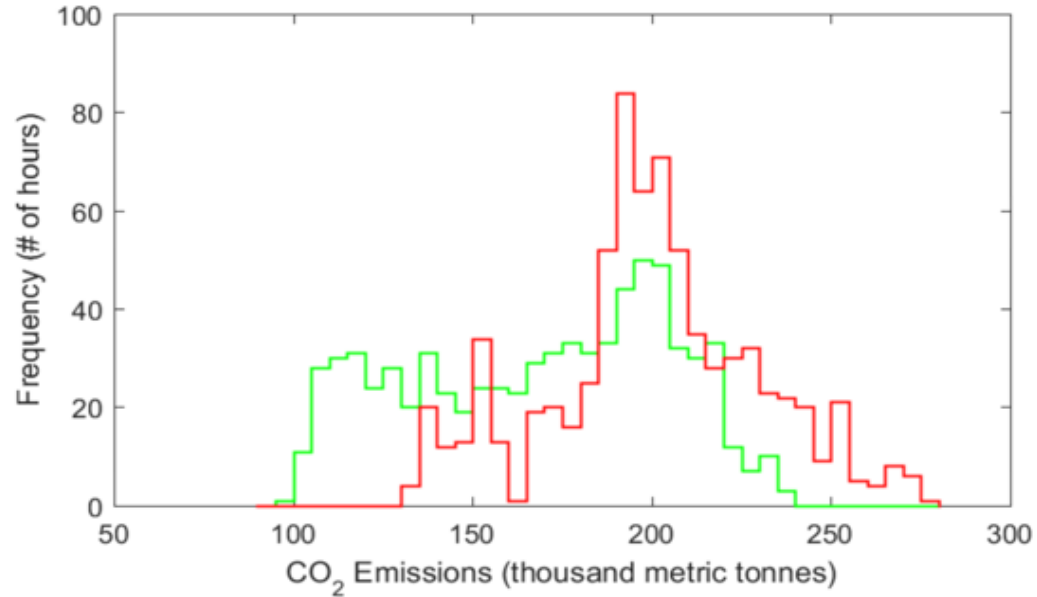
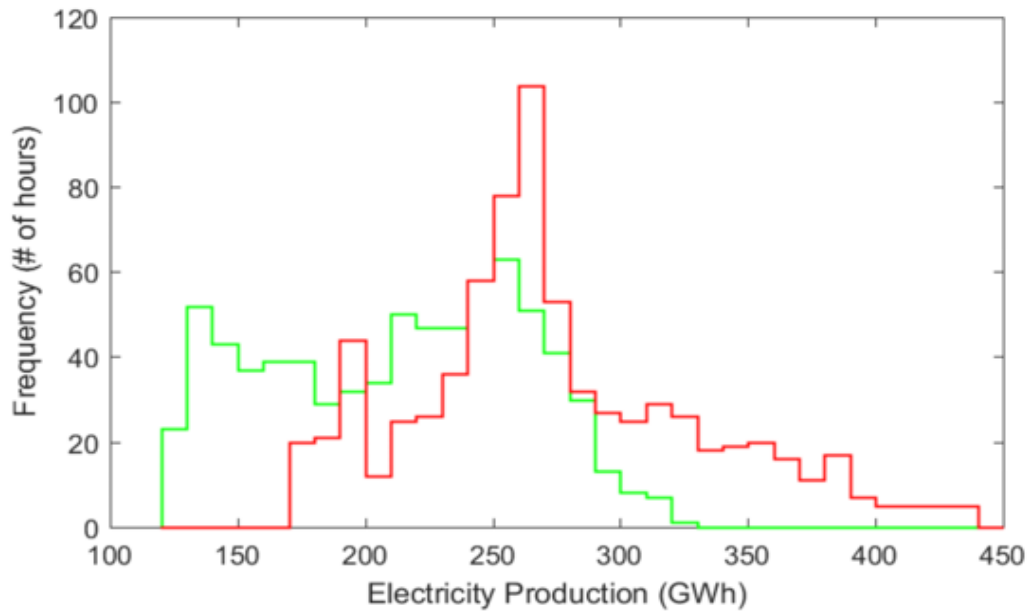
Heat Index Summer 2003

Group think #2

How might adaptation to heat waves affect air quality?



EMBARGOED: NOT FOR DISTRIBUTION UNTIL 3 JULY, 2018



EMBARGOED: NOT FOR DISTRIBUTION UNTIL 3 JULY, 2018

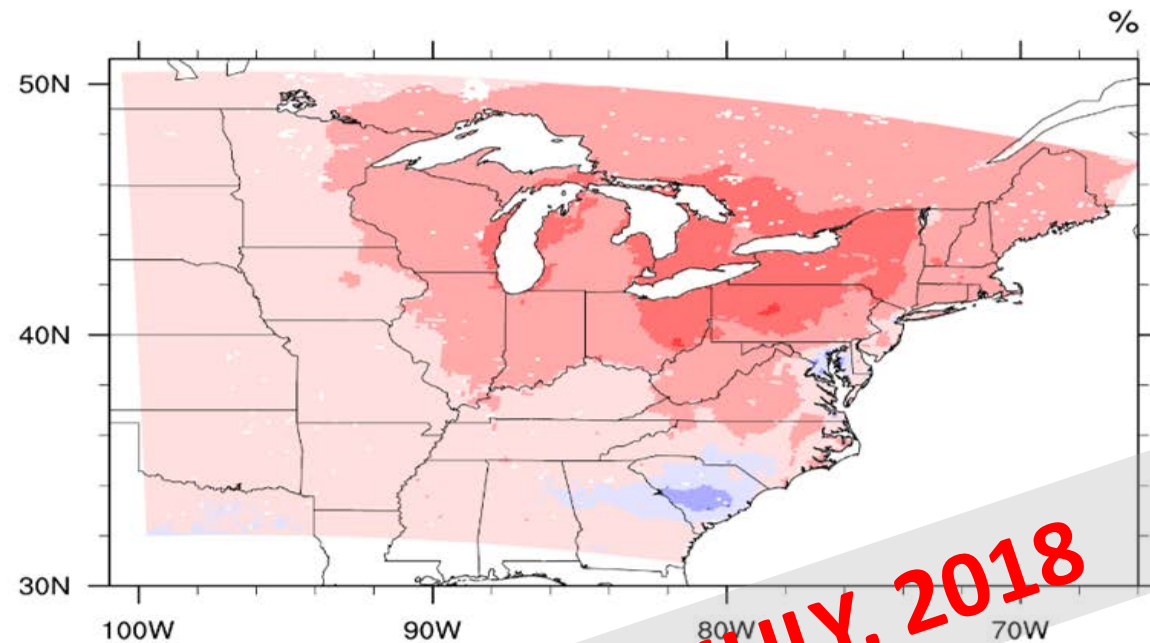
Abel et al., in press, PLOS Med.

How does electric power demand for cooling, affect regional air quality?

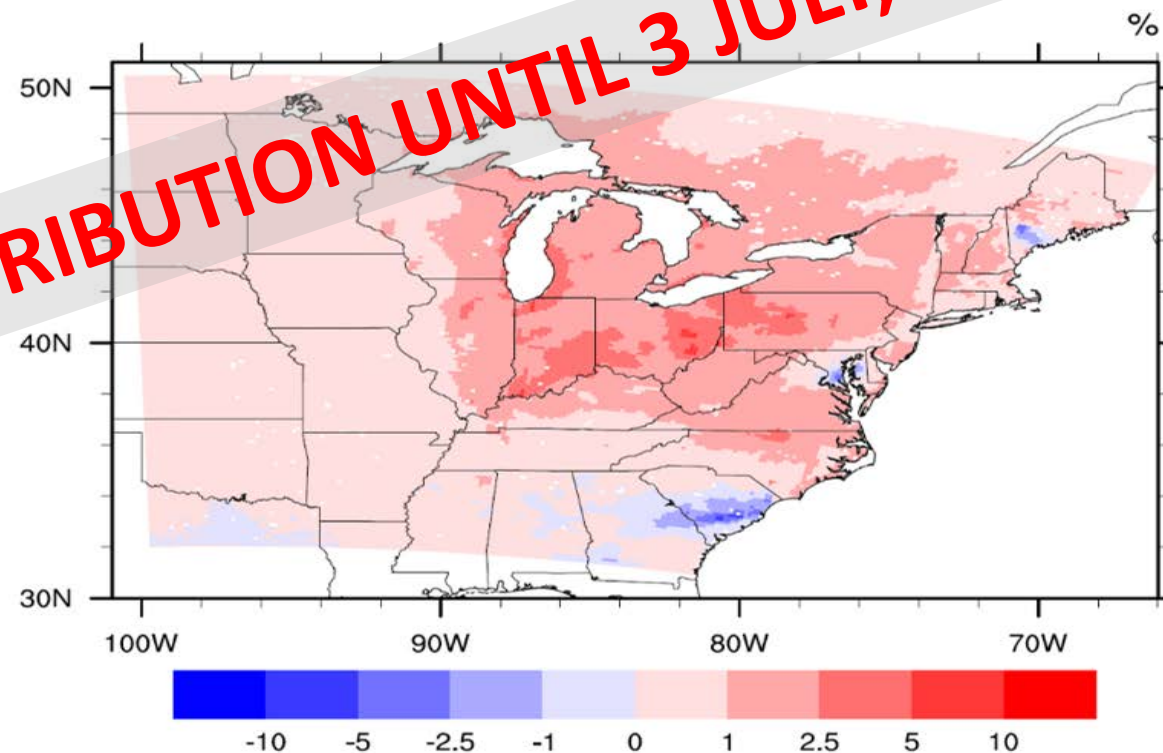
EMBARGOED: NOT FOR DISTRIBUTION UNTIL 3 JULY, 2018

Abel et al., in press, PLOS Med.

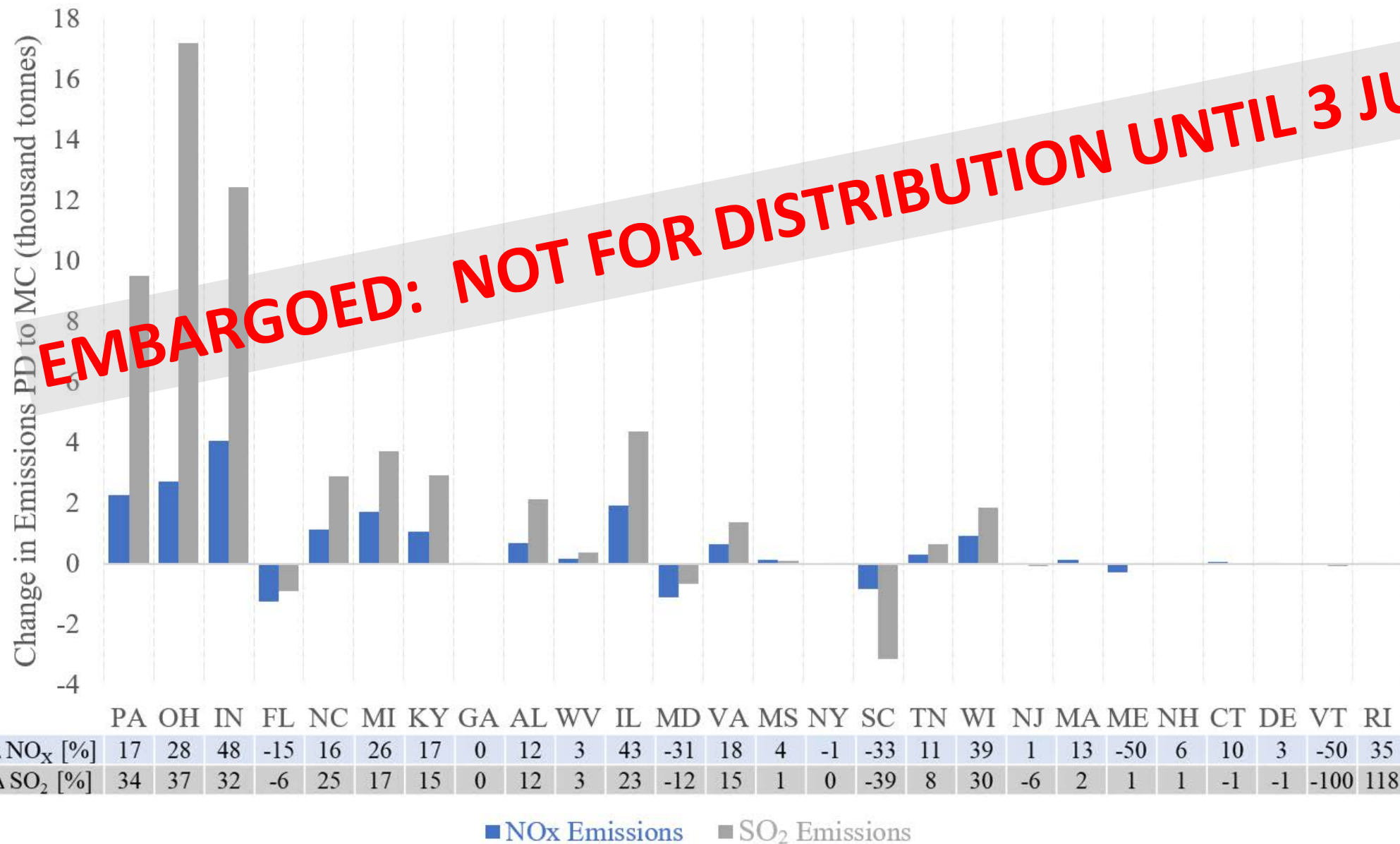
a) PM_{2.5}



b) O₃

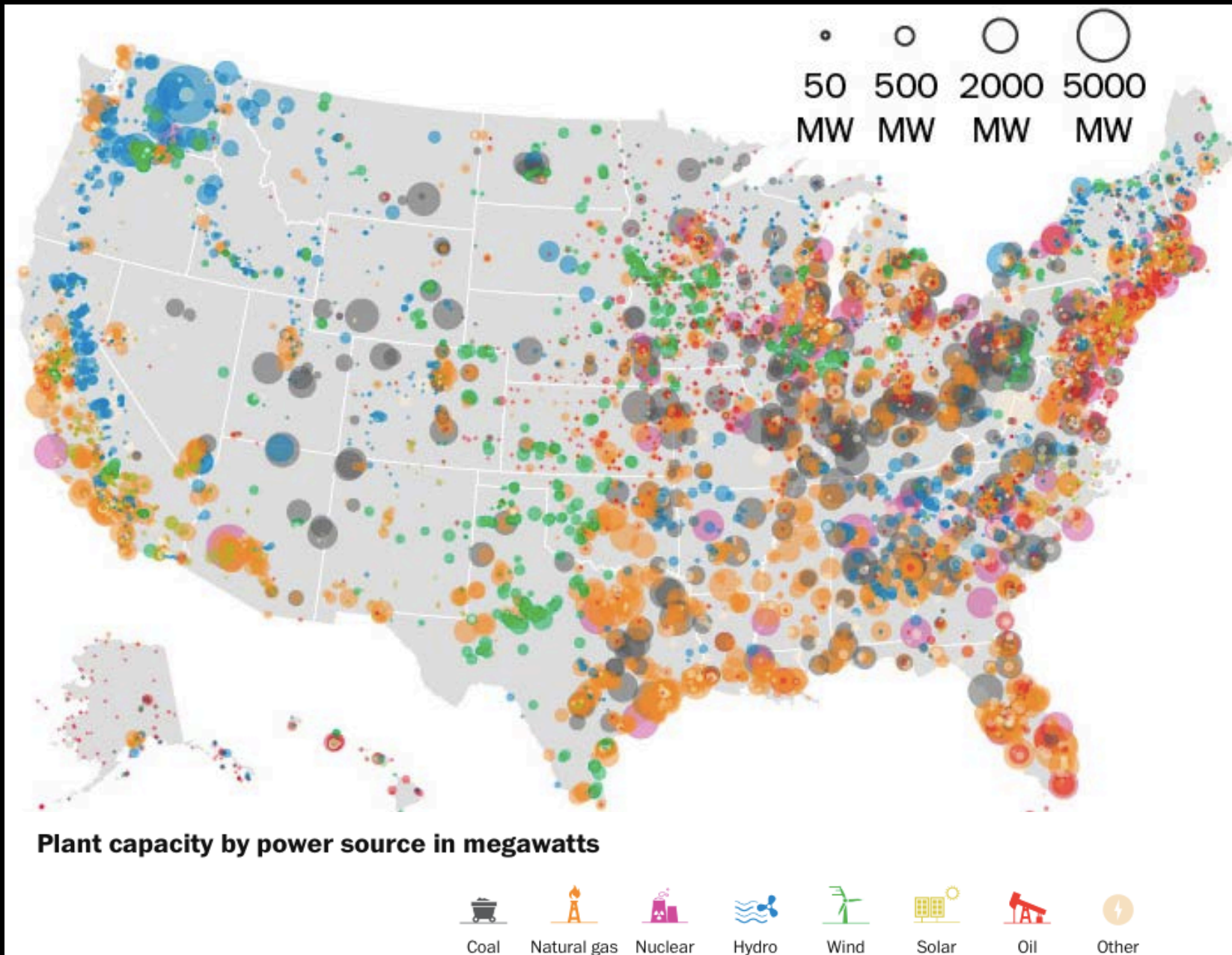


State by state changes in NO_x & SO₂ emissions

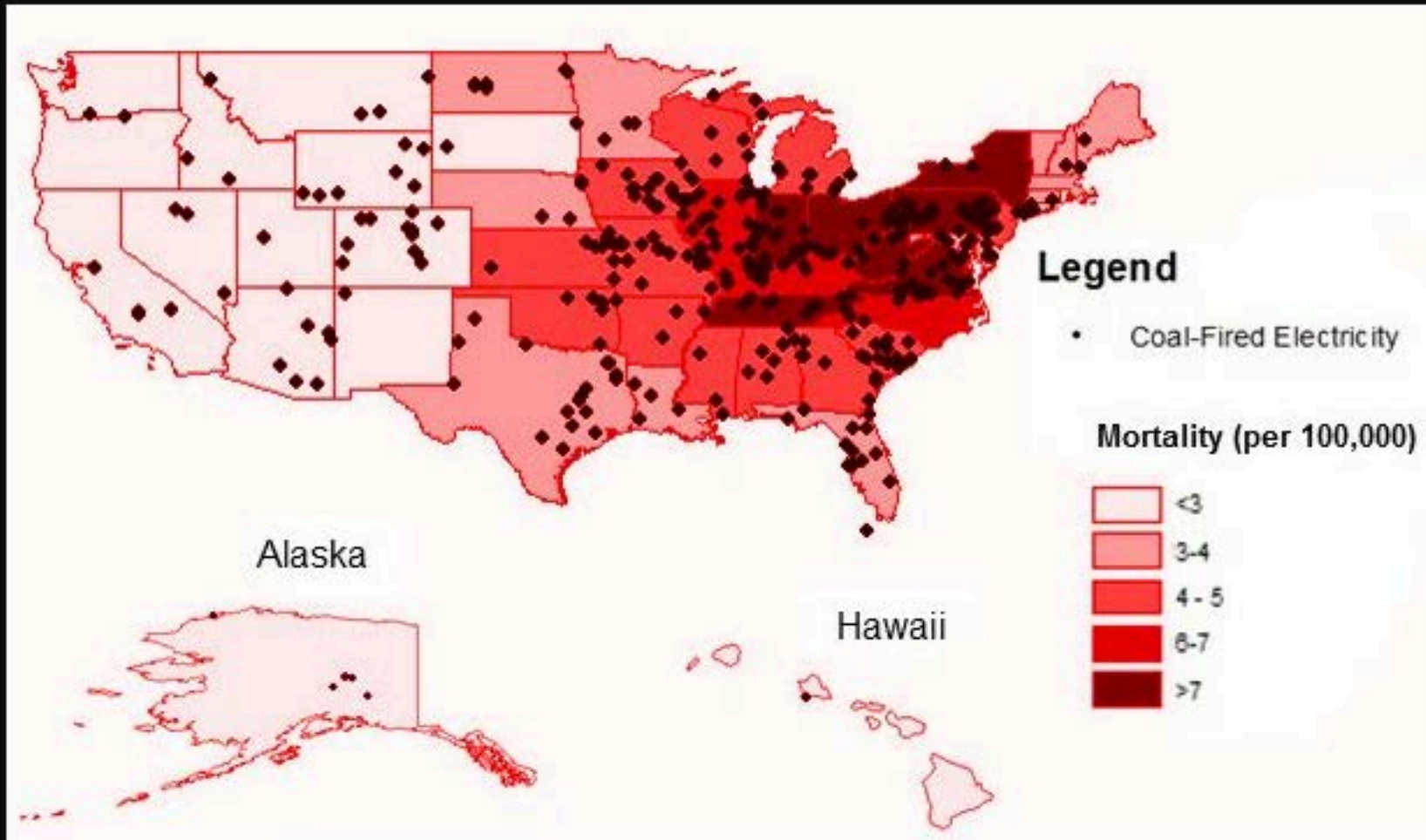


EMBARGOED: NOT FOR DISTRIBUTION UNTIL 3 JULY, 2018

Abel et al., in press, PLOS Med.



- Map showing where coal fired electricity pollution kills people in the U.S.

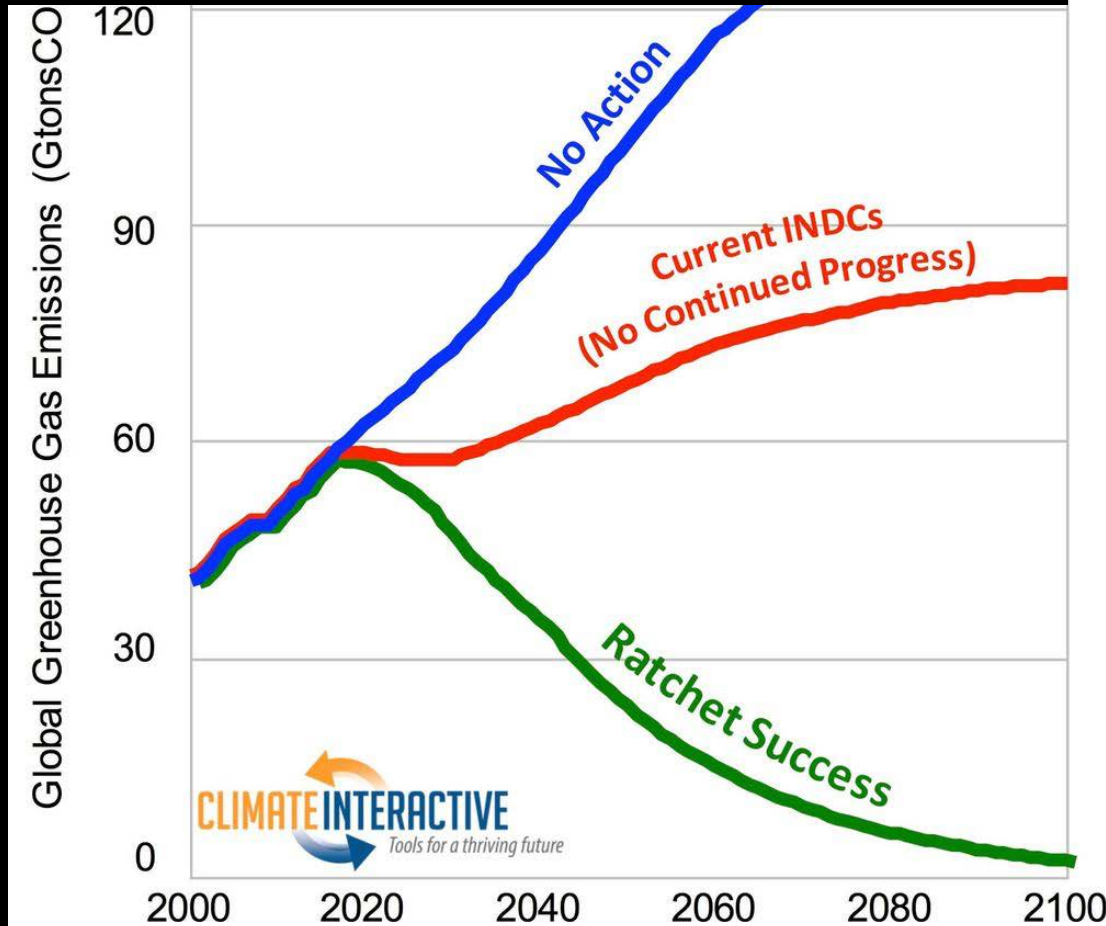


Prehoda & Pearce, 2017.

Projections for COP21

IMPORTANTANCE OF THE HEALTH FRAME

Need for immediate and substantial actions



Estimated 2100 temp:

4.5°C
8.1°F

3.5°C
6.3°F

1.8°C
3.2°F

A systems approach to evaluating the air quality co-benefits of US carbon policies

Tammy M. Thompson^{1*†}, Sebastian Rausch^{1†}, Rebecca K. Saari² and Noelle E. Selin^{2,3}

Because human activities emit greenhouse gases (GHGs) and conventional air pollutants from common sources, policy designed to reduce GHGs can have co-benefits for air quality that may offset some or all of the near-term costs of GHG mitigation. We present a systems approach to quantify air quality co-benefits of US policies to reduce GHG (carbon) emissions. We assess health-related benefits from reduced ozone and particulate matter (PM_{2.5}) by linking three advanced models, representing the full pathway from policy to pollutant damages. We also examine the sensitivity of co-benefits to key policy-relevant sources of uncertainty and variability. We find that monetized human health benefits associated with air quality improvements can offset 26–1,050% of the cost of US carbon policies. More flexible policies that minimize costs, such as

“...health benefits...can offset 26-1050% of the cost of US carbon policies”

Cost of cleaner
energy:

$< \$30/ tCO_2$

Benefits of cleaner
energy:

$\$200^*/ tCO_2$

WHICH NUMBER IS BIGGER???



West et al. 2013

(* Range: \$50 to \$380)

For E. Asia, co-benefits are **10 to 70 times** greater

Co-Design

Health in all policies required to convene
the expertise required to optimize
solutions

...or beware of single-disciplined perspectives

Life cycle analysis of transportation fuel options

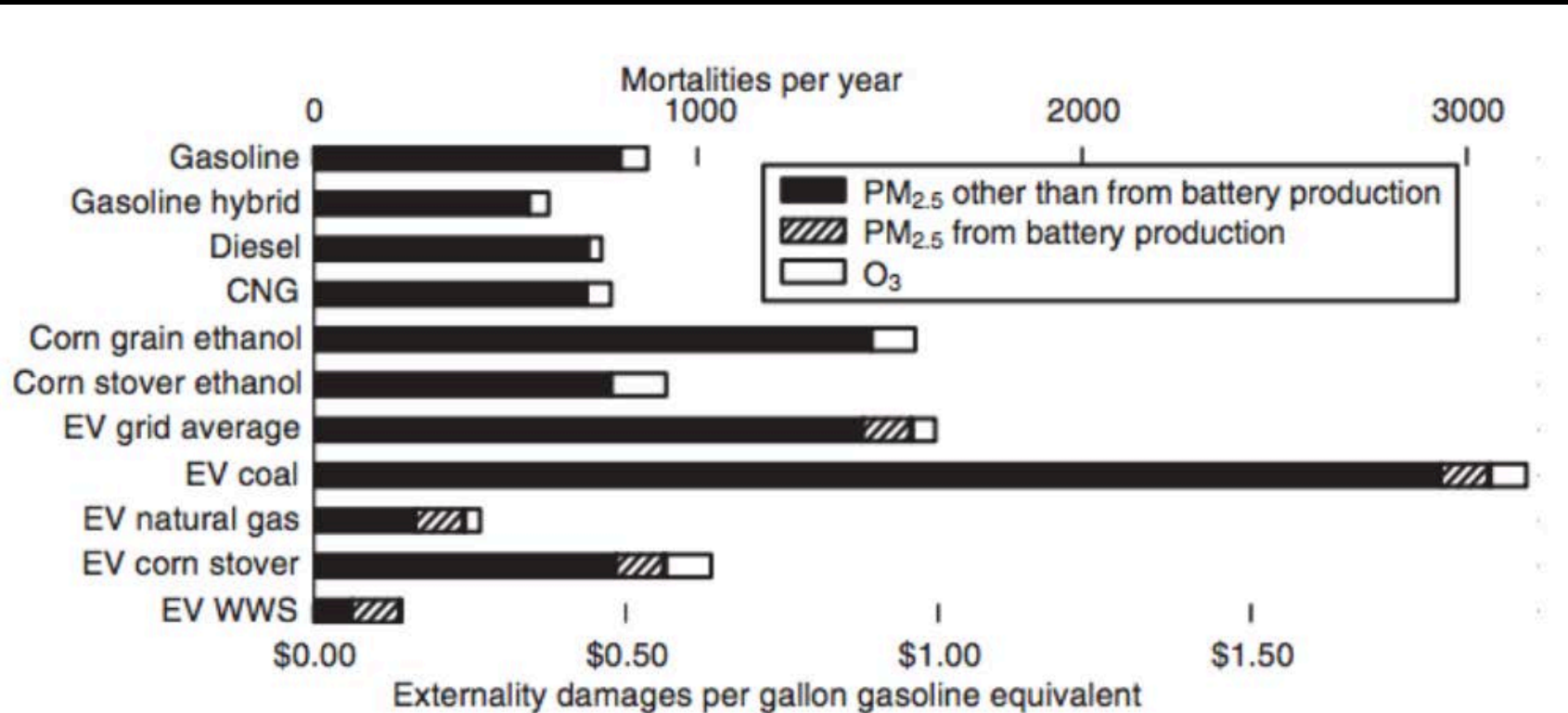
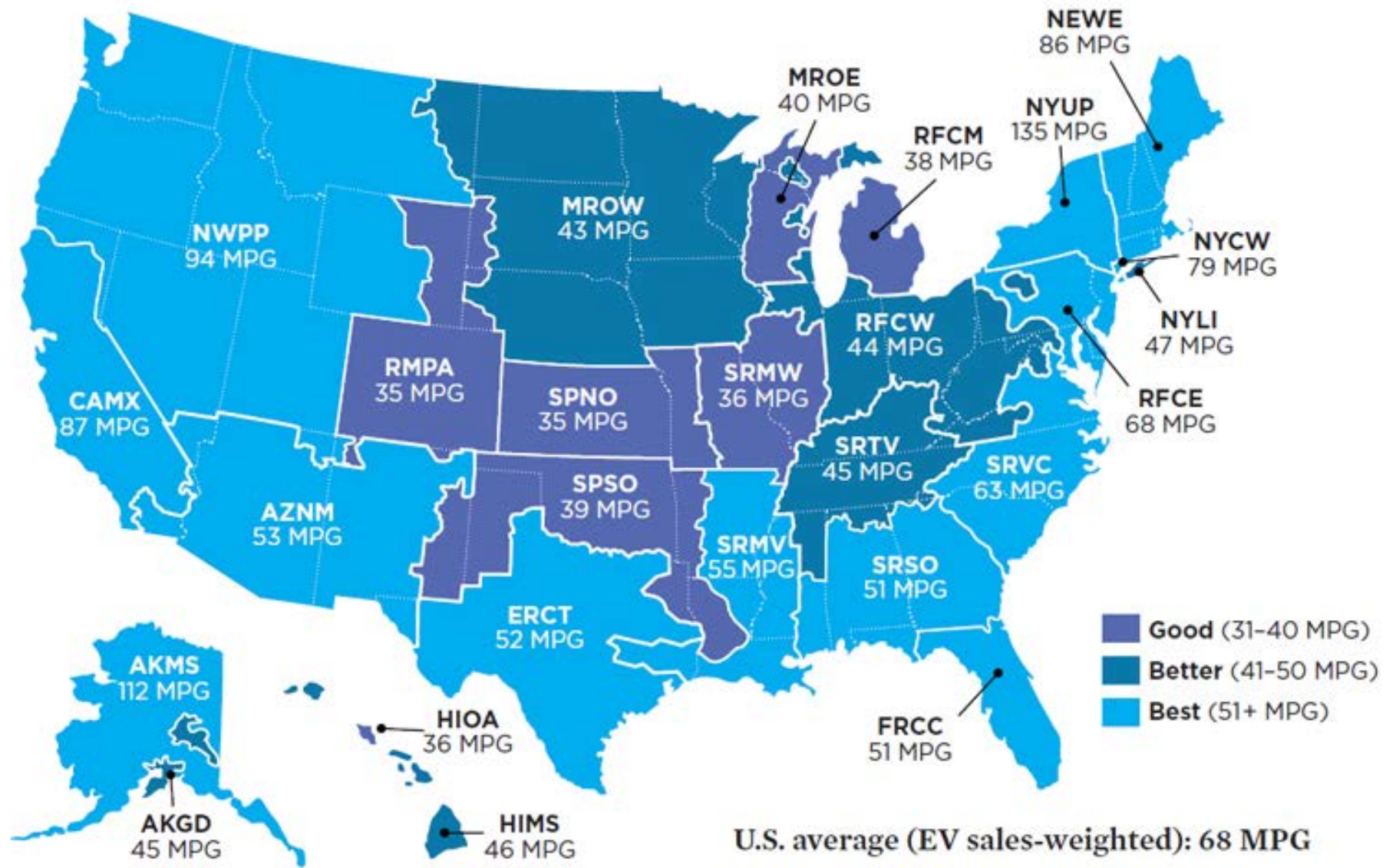


Fig. 2. Air quality health impacts in the United States for each scenario: attributable increases in annual mortality (upper scale) and the resulting monetized health impacts (lower scale).

Tessum et al. 2014

Electric Vehicle Global Warming Pollution Ratings and Gasoline Vehicle Emissions Equivalents by Region



Group think #3

In addition to air pollution,

Why is the Health in all policies approach ESPECIALLY ESSENTIAL in addressing climate change and urban health?

U.S. transportation contributing to sedentary lifestyles

- 60% of American adults do not meet minimum recommended levels of physical activity.
- In 2016, obesity rates in the U.S. climbed to 40% in adults, 18% in children.
- 600,000 Americans die of heart disease every year.

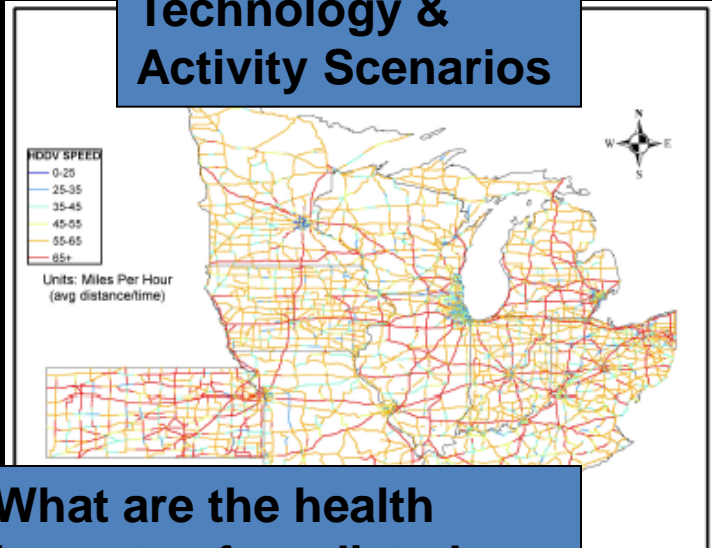
Centers for Disease Control and Prevention (CDC), 2017

40% of trips by car are less than 2 mi (~3 km)

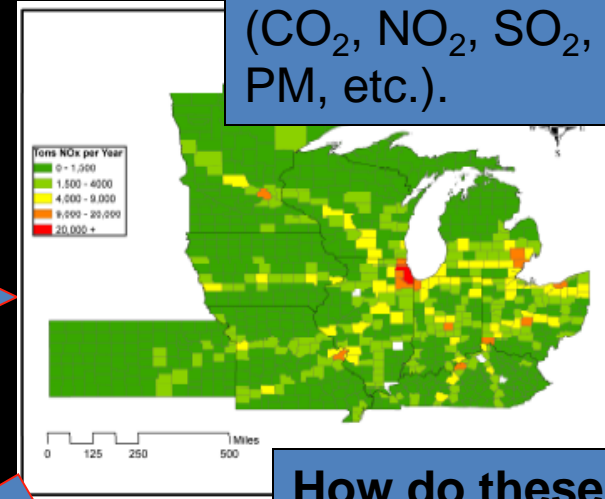
US Dept. of Transportation

From transportation...to human health

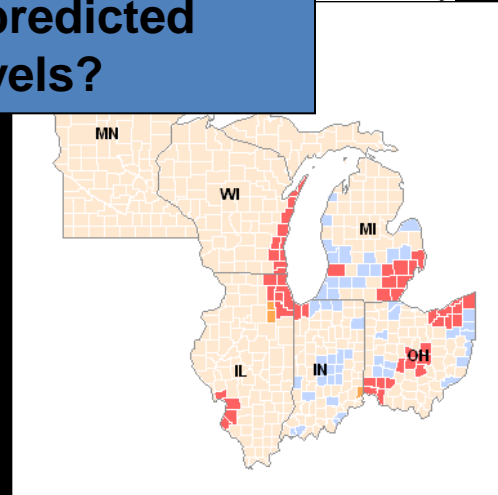
Technology & Activity Scenarios



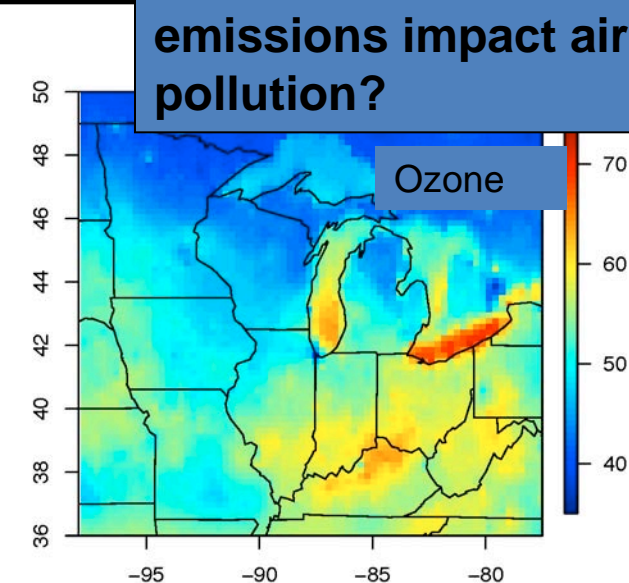
What are the associated emissions? (CO₂, NO₂, SO₂, VOCs, PM, etc.).



What are the health impacts of predicted pollution levels?



How do these emissions impact air pollution?



Opportunity for Midwest, U.S.

**Swapping Tail Pipes For Pedals:
Small Changes Could Pay Huge
Dividends For Public Health And
Economy**



1,300 lives saved annually

\$8 billion/yr. in savings from
avoided hospitalization,
absenteeism and mortality



Exercise also reduces the risk of:

Heart disease

Cancer

Dementia

Depression

compared with U.S. cities with the lowest rates of walking and cycling.

Pucher et al. 2010

Image courtesy of Shutterstock

Green Space and Mental Health

- Depression, stress & anxiety reduction

Beyer et al. 2014

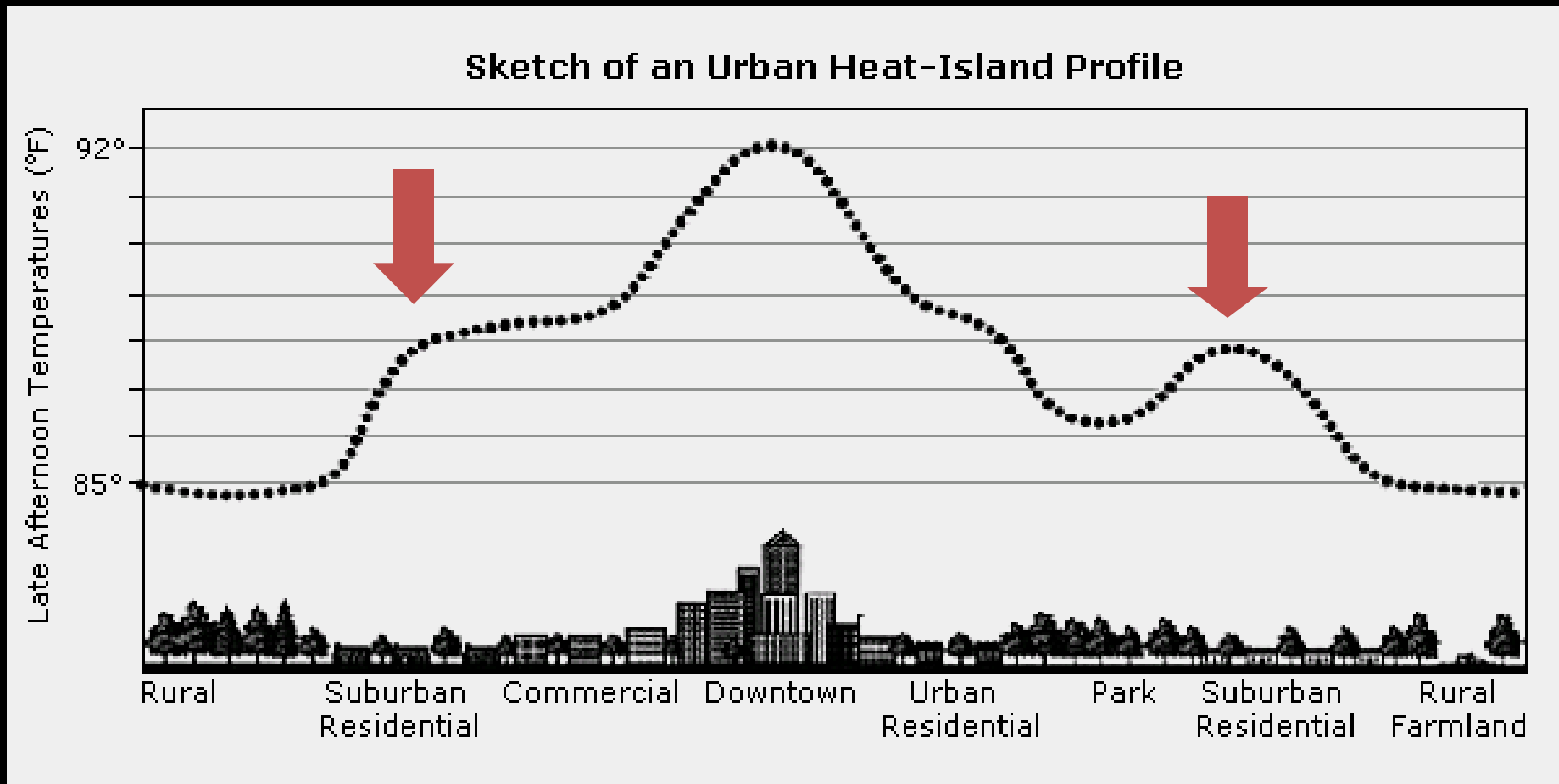
- Neighborhood social cohesion and reductions in crime and violence

CAVEAT:

Species composition of tree canopy: red maples emit 70% less **biogenic volatile organic compounds** than oaks



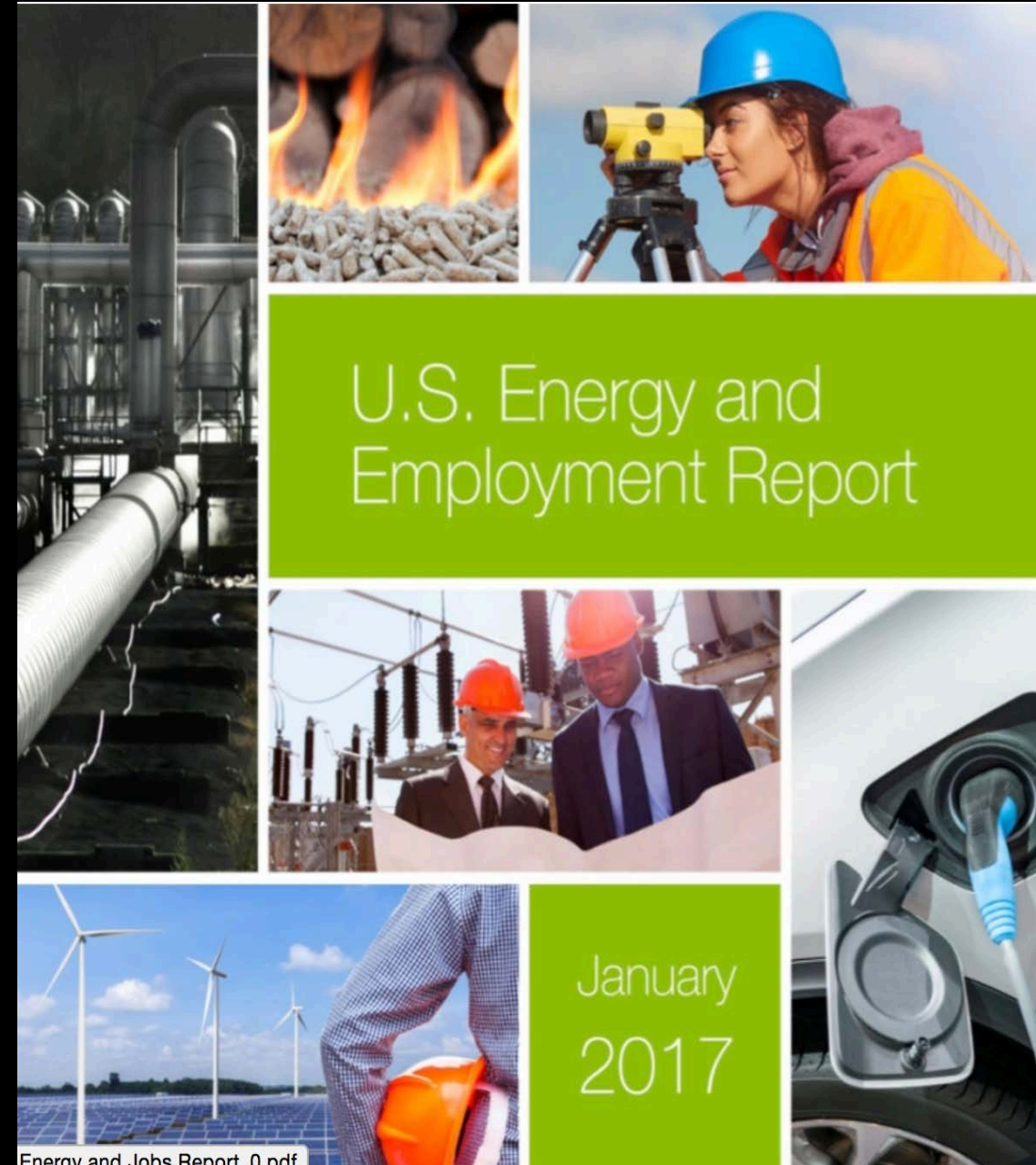
The Heat Island



**1 million U.S. jobs in
renewable energy**

**~5x more employment
compared to jobs in
coal, oil and gas
combined.**

Jobs and income = Health



Role of HiAP-savvy Public Health Champions?

- Recognize that policies for electric power, transportation, greenspace (even tree species selection) urban heat islands, and energy-related jobs absolutely are **health** policies
- Therefore, reach out & create diverse **partnerships** to address climate change, energy, and urban planning **for health**
- ...Or else, you actions (in isolation) won't be optimal...nor lasting

Reminder: Preventive Measures

Youth smoking dropped when cigarette prices rose.

Like tobacco, it's time to put a price on carbon.

Parallel to tobacco, climate change disinformation campaigns abound.



Image courtesy of Shutterstock

A child wearing a blue hoodie, blue jeans, and a black helmet is riding a red bicycle away from the camera on a paved path. The path has a white line on the left and a white bicycle symbol on the ground. The background is a blurred green landscape with trees and a fence.

Regardless of one's views on climate change science, we can all support:

Safe routes to schools

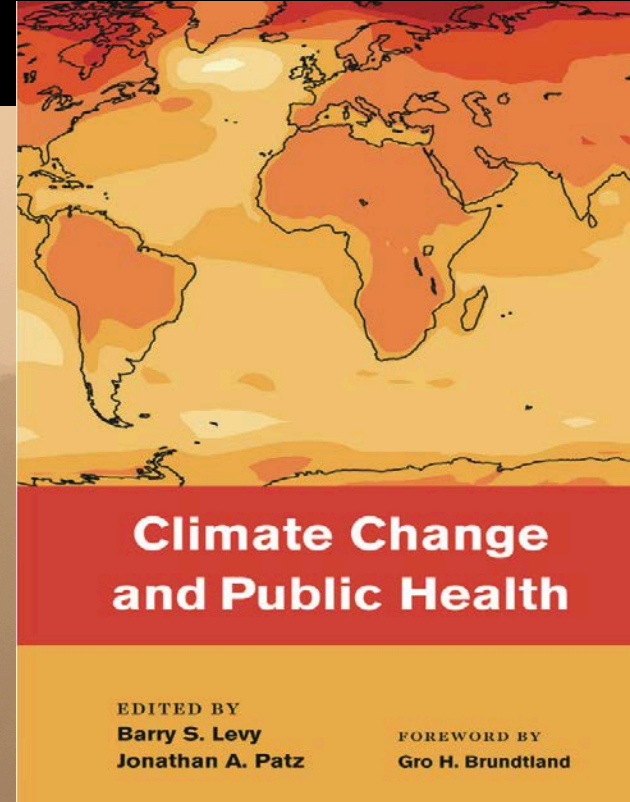
Physically fit children & adults from cities designed for people, not just cars

Clean air from low-carbon energy

Green jobs ...and lots of them

Green spaces for mental health and stress reduction

Public health community has a responsibility to act as upstream as possible, communicate that climate change is a **health** crisis, and with a HiAP approach, achieve effective solutions



Thank you!

Twitter: @jonathanpatz



Global Health Institute
UNIVERSITY OF WISCONSIN-MADISON

Google: "Jonathan Patz TEDx"