

# *Climate Change and Health: Great Risks AND Opportunities*

Climate Change & Health Plenary

APHA Annual Conference

Washington, Nov.6, 2007

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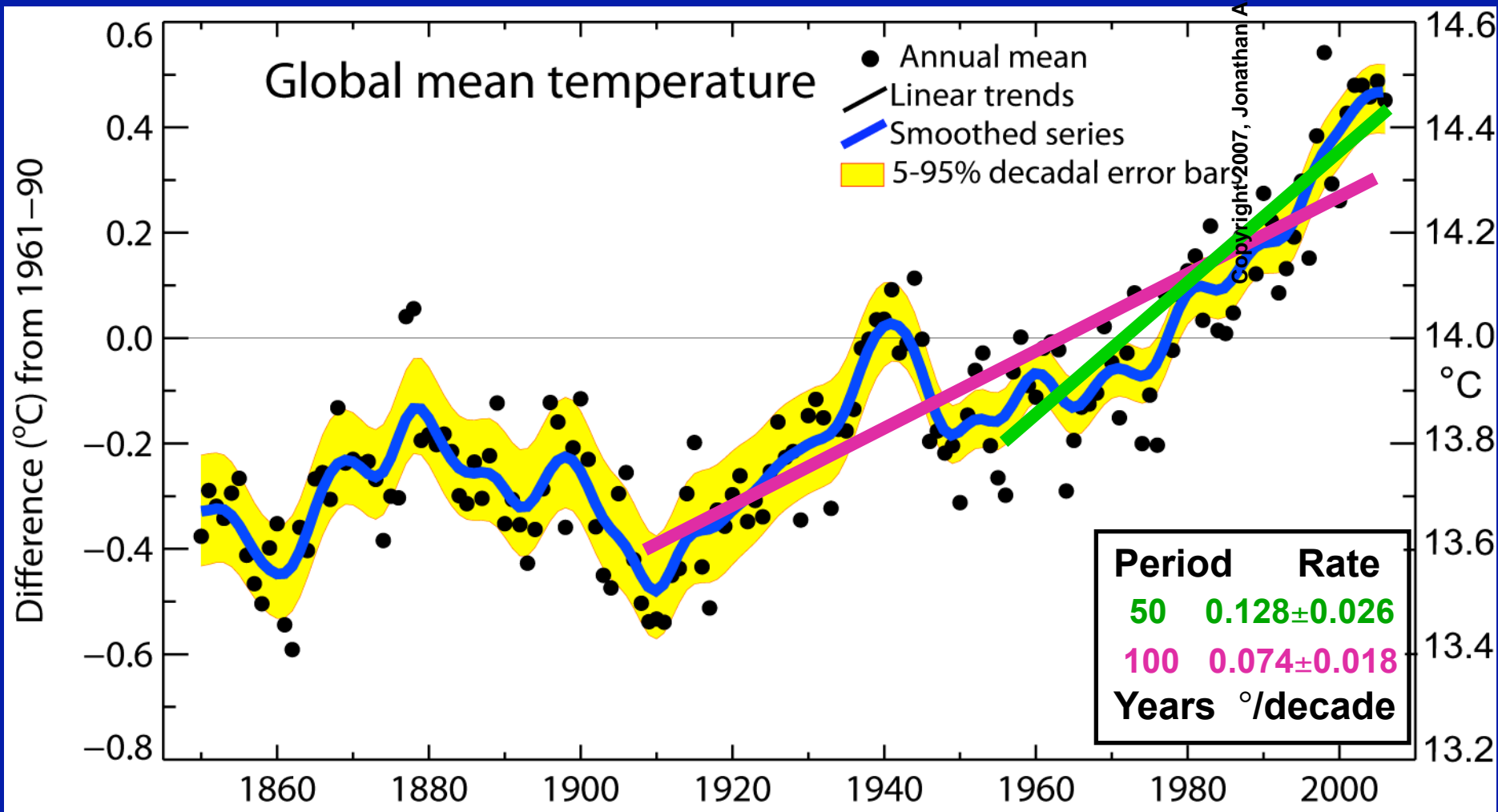
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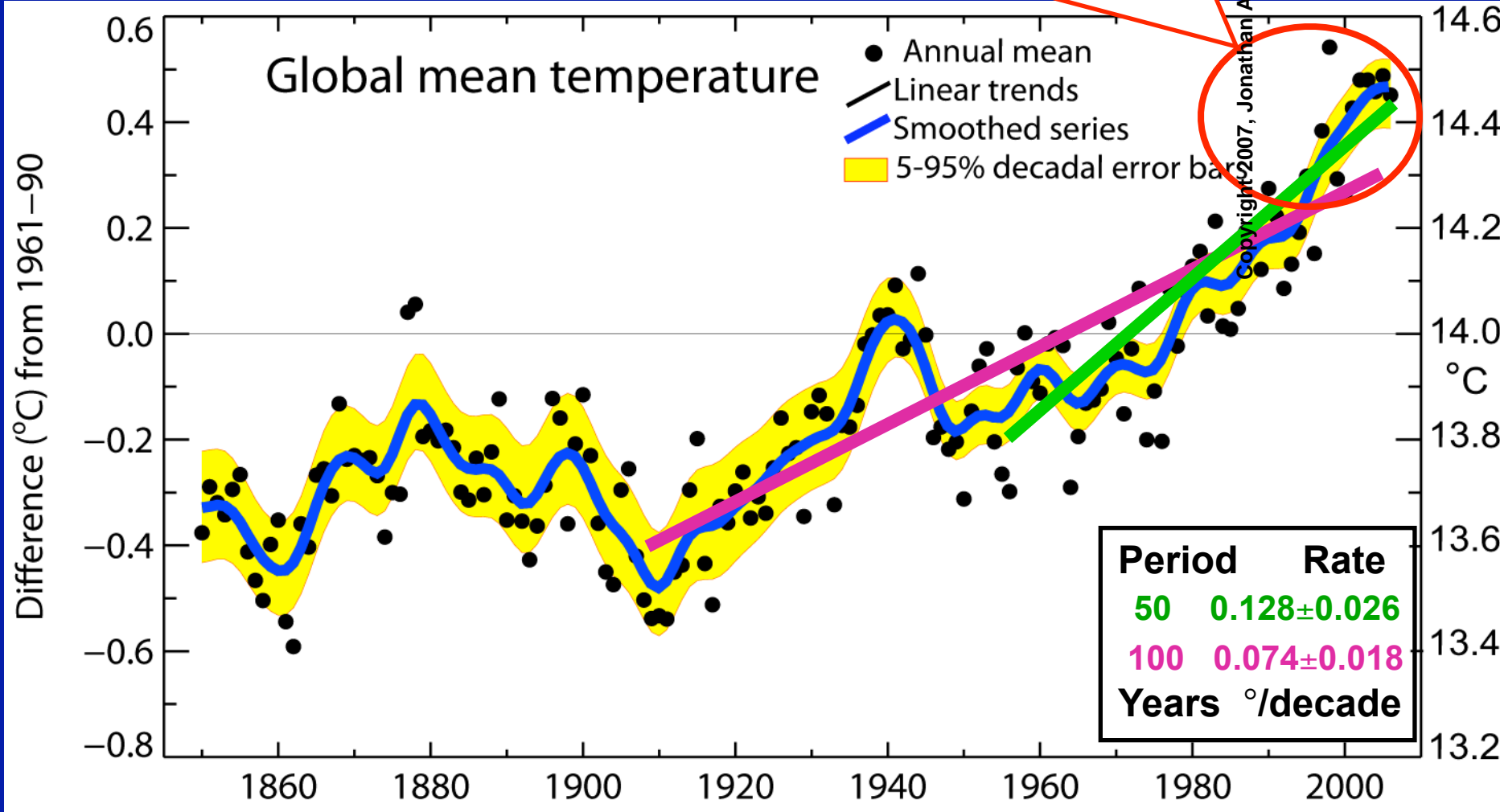
# Global mean temperatures are rising faster with time

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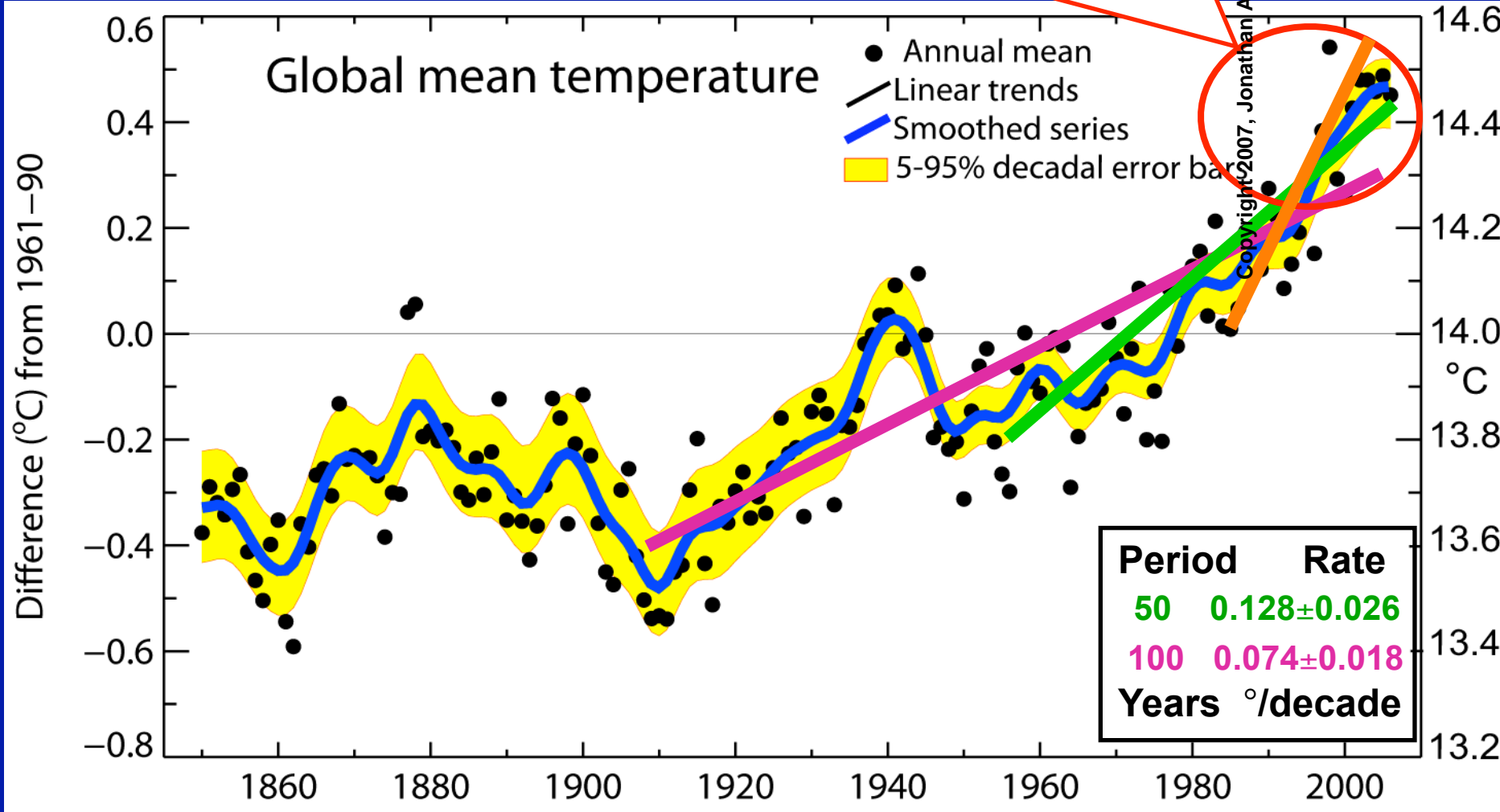
# Global mean temperature difference from 1961-90

**Warmest 12 years:**  
 1998, 2005, 2003, 2002, 2004, 2006,  
 2001, 1997, 1995, 1999, 1990, 2000



# Global mean temperature difference from 1961-90

**Warmest 12 years:**  
 1998, 2005, 2003, 2002, 2004, 2006,  
 2001, 1997, 1995, 1999, 1990, 2000





But the polar bear might not be the only threatened species



But the polar bear might not be the only threatened species

“How it threatens your health”



# HEALTH EFFECTS OF CLIMATE CHANGE

**CLIMATE CHANGE**

*Temperature Rise*<sup>1</sup>

*Sea level Rise*<sup>2</sup>

*Hydrologic Extremes*

<sup>1</sup> 3°C by yr. 2100

<sup>2</sup> 40 cm " "

IPCC estimates

*Patz, 1998*

**Urban Heat Island Effect**

Heat Stress  
Cardiorespiratory failure

**Air Pollution & Aeroallergens**

Respiratory diseases, e.g.,  
COPD & Asthma

**Vector-borne Diseases**

Malaria  
Dengue  
Encephalitis  
Hantavirus  
Rift Valley Fever

**Water-borne Diseases**

Cholera  
Cyclospora  
Cryptosporidiosis  
Campylobacter  
Leptospirosis

**Water resources & food supply**

Malnutrition  
Diarrhea  
Toxic Red Tides

**Mental Health & Environmental**

Forced Migration  
Overcrowding  
Infectious diseases  
Human Conflicts

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## Heat Related Deaths in Chicago in July 1995

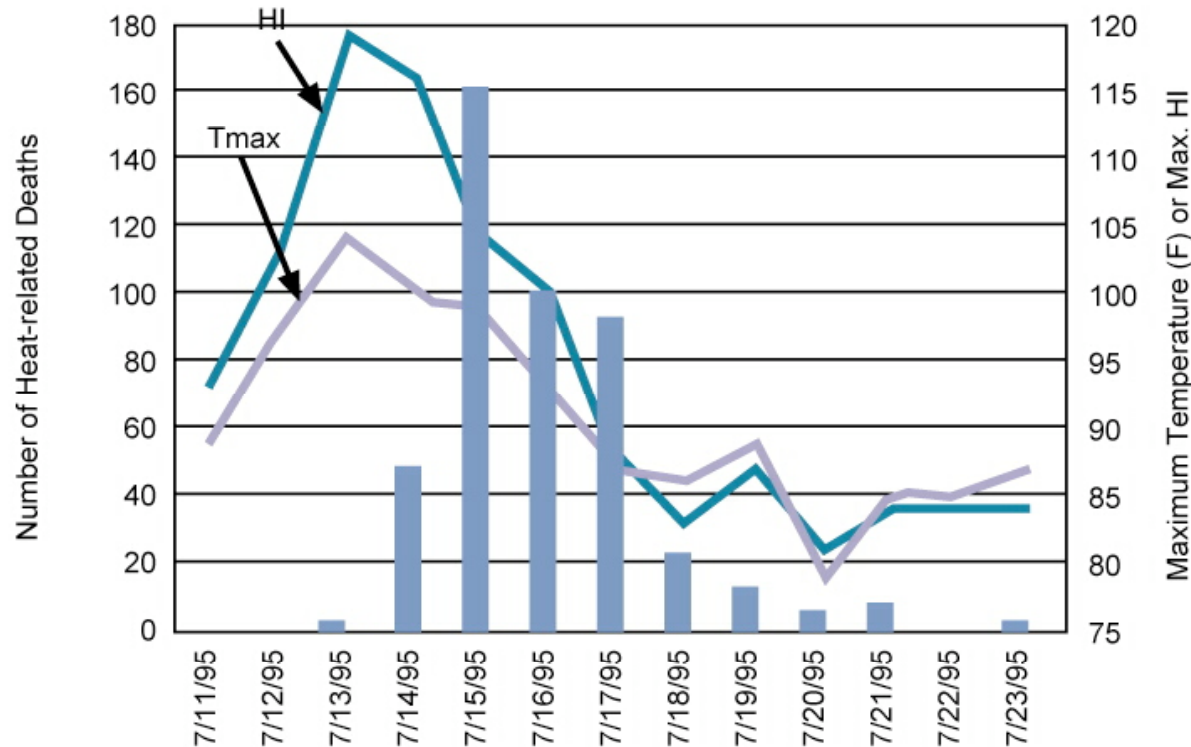


Figure 3: This graph tracks the maximum temperature (Tmax), heat index (HI), and heat-related deaths in Chicago each day from July 11 to 23, 1995. The gray line shows maximum daily temperature, the blue line shows the heat index, and the bars indicate the number of deaths each day. Source: NOAA/NCDC.

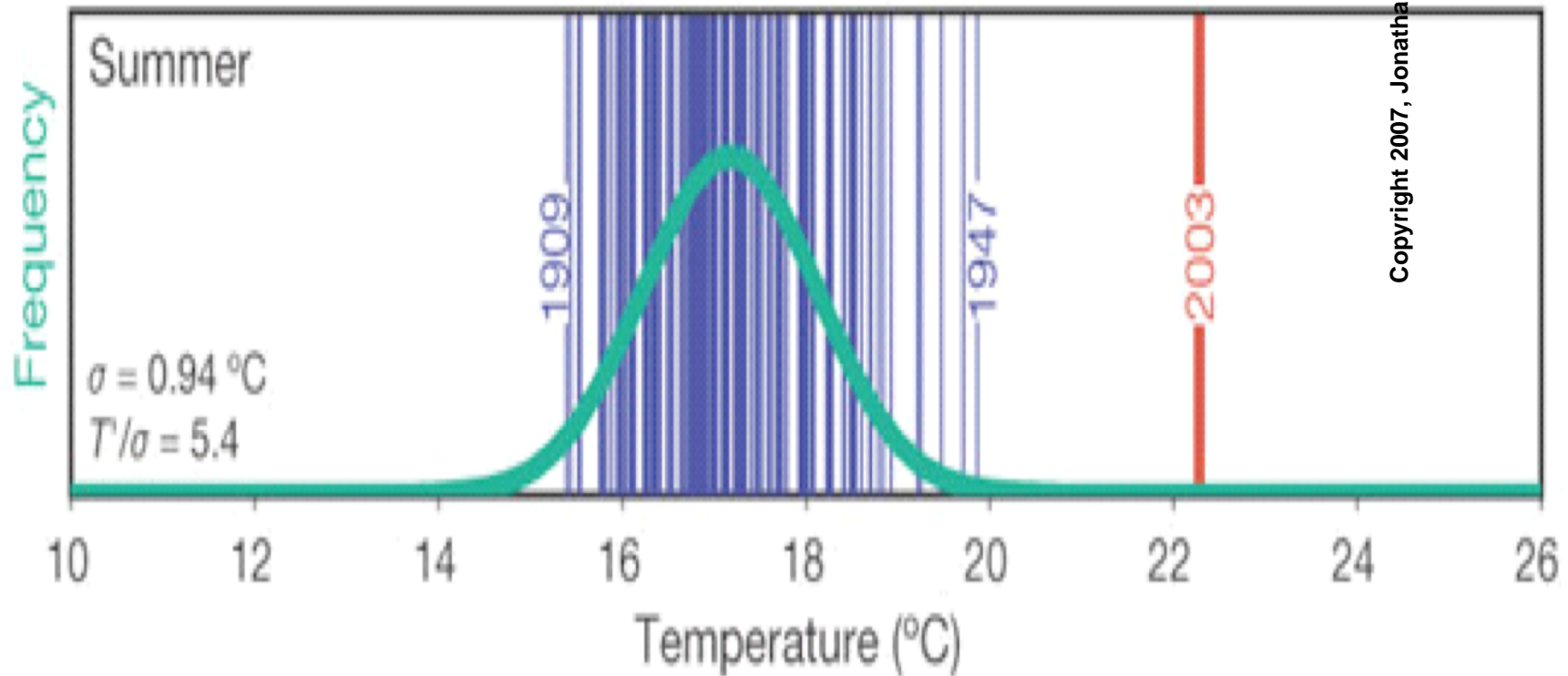
# HEAT WAVE - EUROPE



**> 70,000  
deaths over  
11 days**

**Heat Index Summer 2003**

# Comparing the 2003 Heatwave to past summer climate



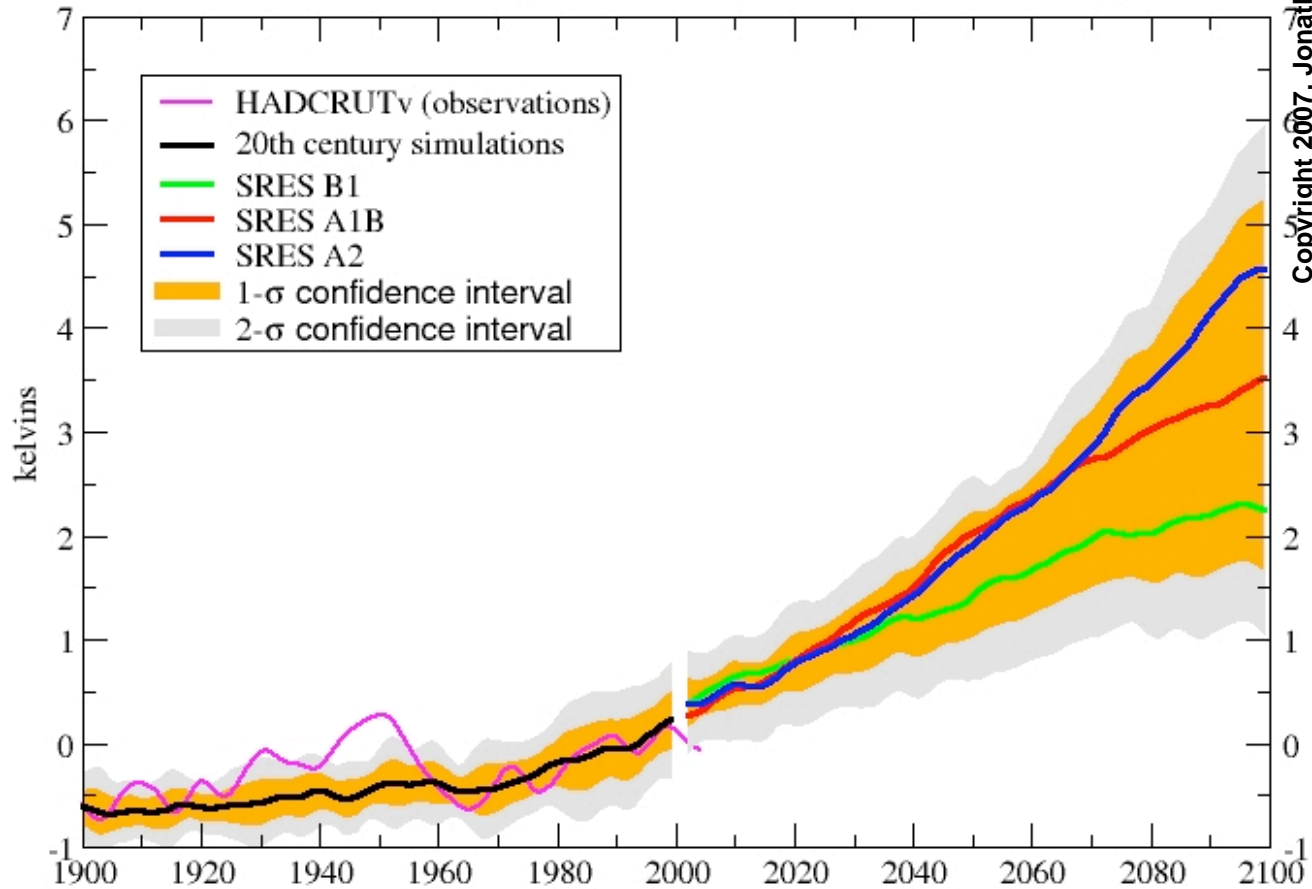
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European heat wave of 2003, from Schär et al., 2004

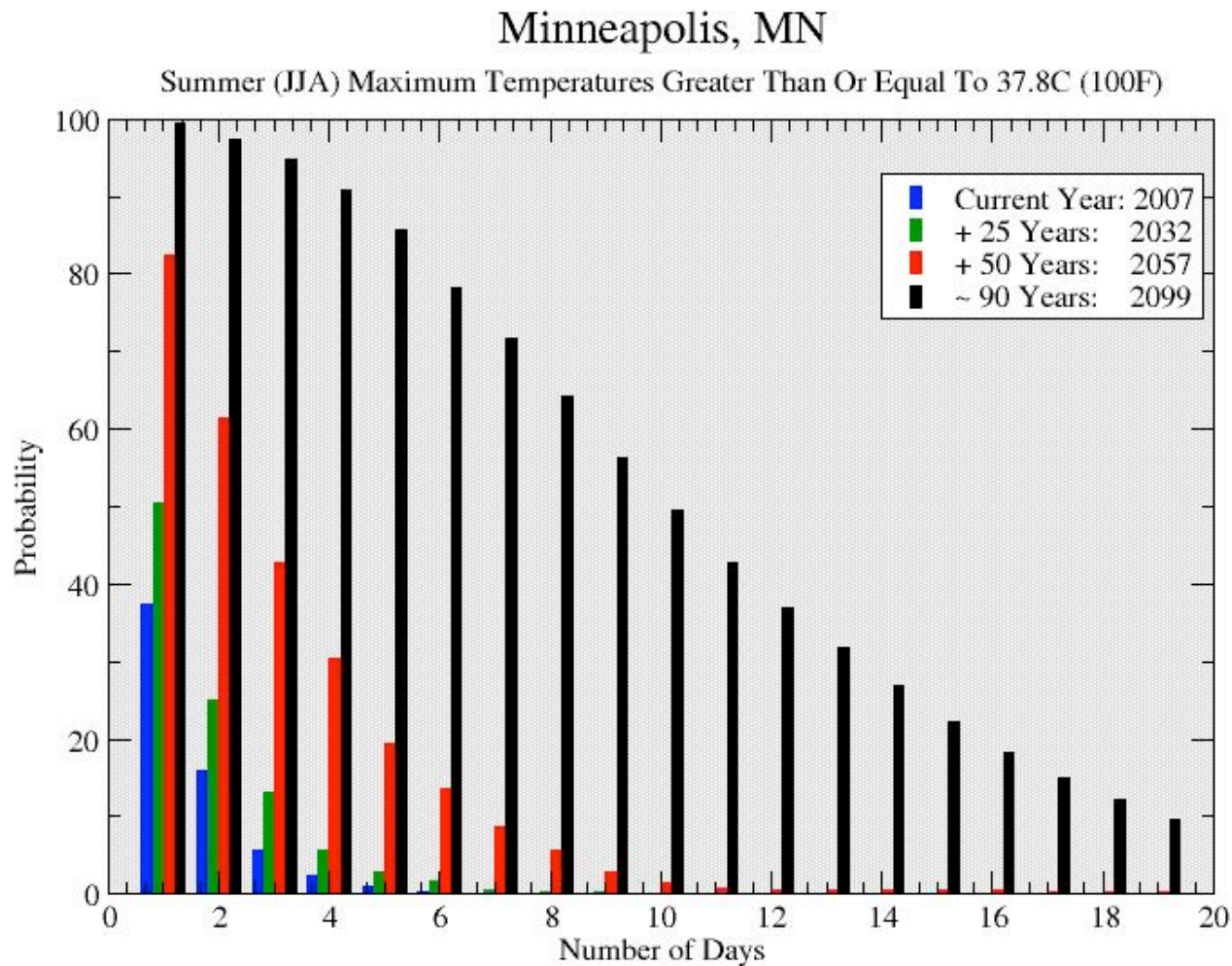


# Eastern USA

Annual surface air temperature anomaly from the 1990-1999 average



# Probabilities of future extremes can be estimated given projections of mean temperature



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Peterson et al.,

# 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



# nature

## CLIMATE CHANGE

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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)

# nature

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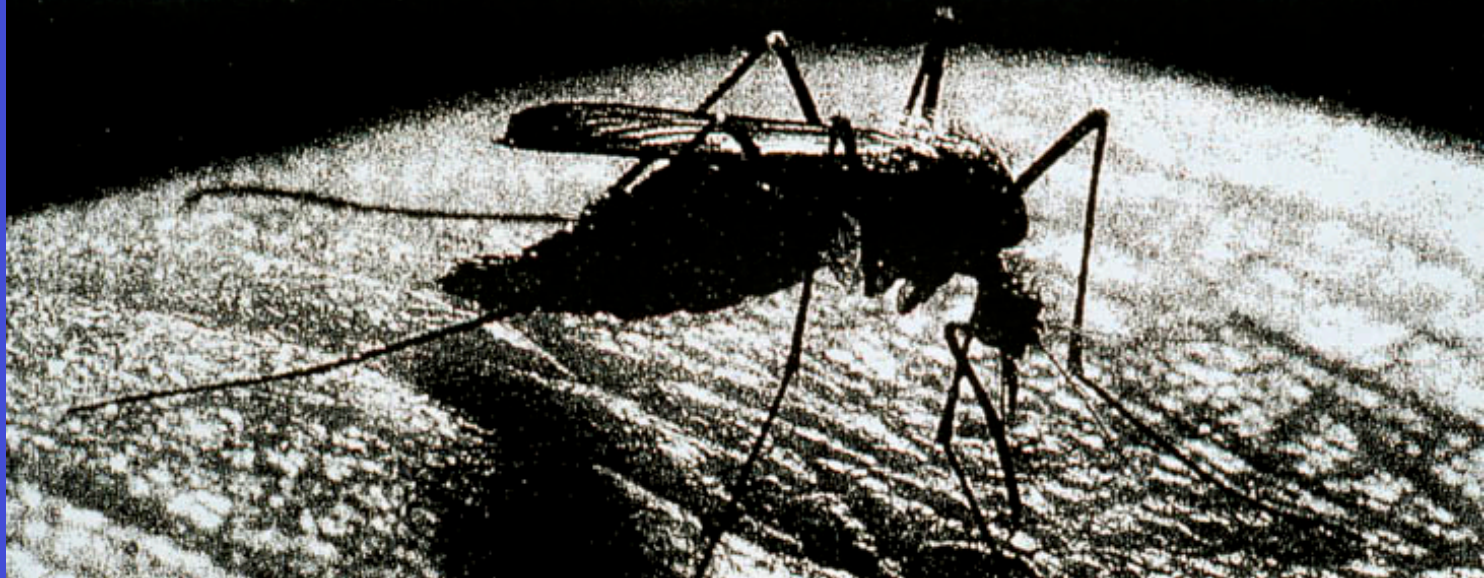
- “The severity and duration of summertime regional air pollution episodes are projected to increase in the Northeast and Midwest US by 2045-2052 due to **climate-change-induced decreases in the frequency of surface cyclones.**” (IPCC, 2007)
- By 2050, warming alone may **increase by 68% the number of Red Ozone Alert days** across the Eastern US. (IPCC, 2007 -Bell et al, 2006)

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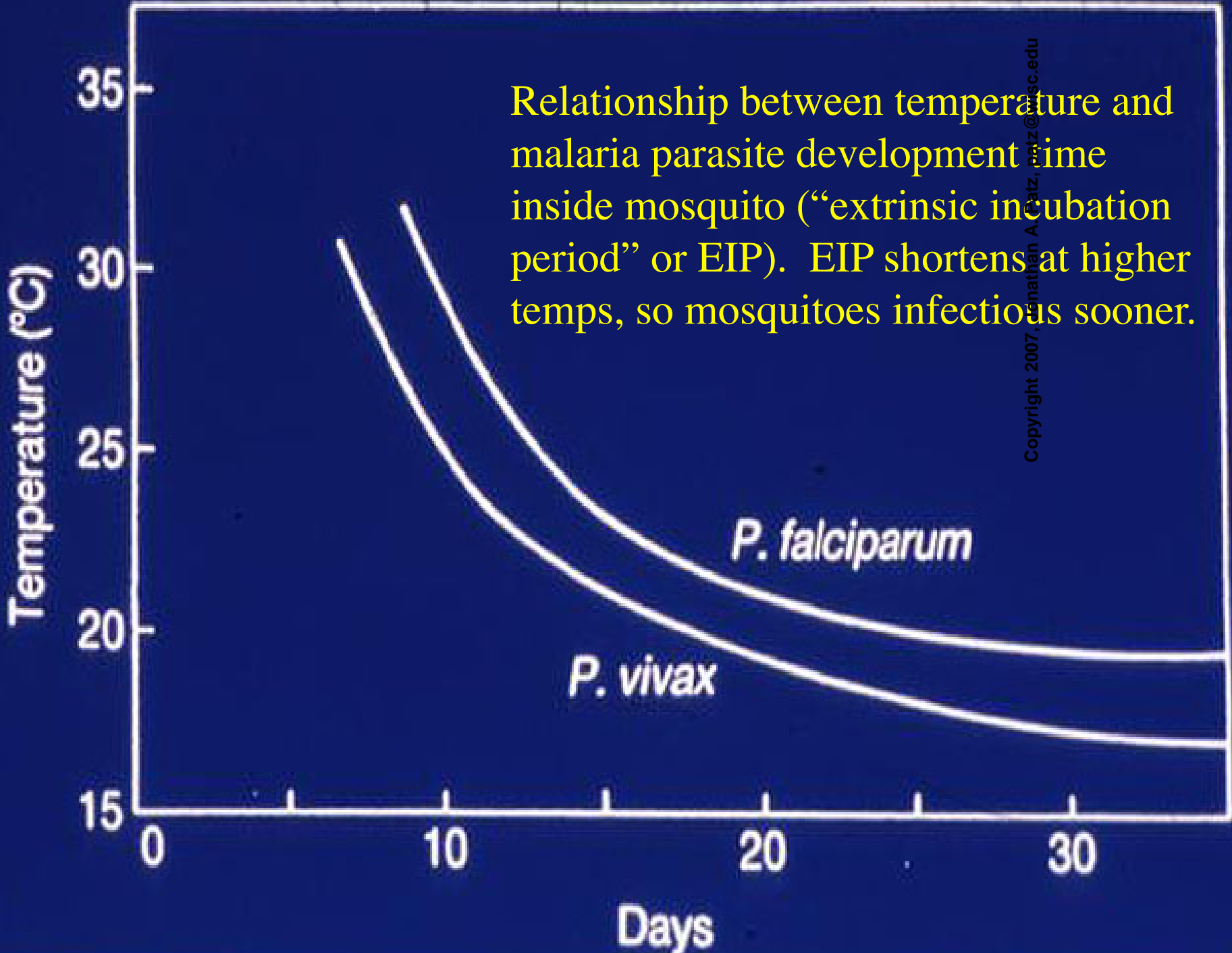


HEALTH PROFESSIONALS AND SCIENTISTS WARN OF SPREADING INFECTIOUS DISEASES.

# Global Warming's **greatest** threat may also be the **smallest.**







Relationship between temperature and malaria parasite development time inside mosquito (“extrinsic incubation period” or EIP). EIP shortens at higher temps, so mosquitoes infectious sooner.

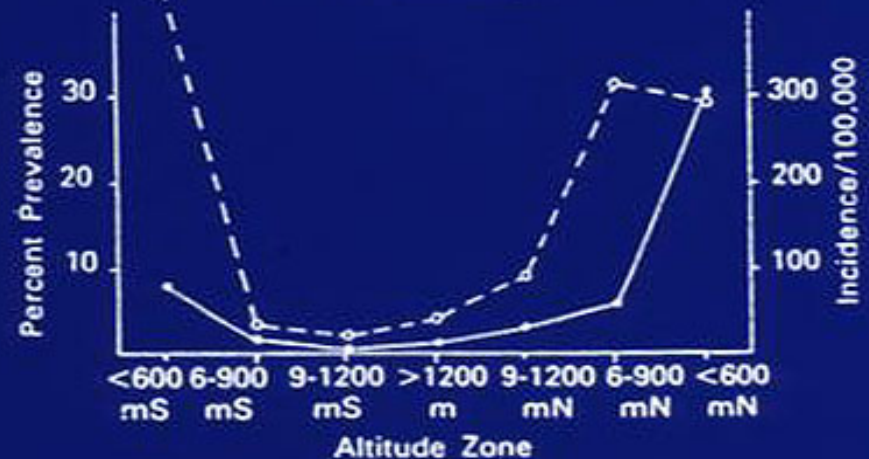
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# Relationship between malaria and altitude, Zimbabwe.

Altitude a good surrogate for temperature: the average temperature decrease with height =  $6^{\circ}\text{C}$  per 1000 meters



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Average annual prevalence and incidence/100,000 population of malaria by altitude zone for the years 1969-1981 and 1972-1981, respectively (Taylor & Mutambu, *Trans. Royal Soc. Trop. Med. & Hyg.*, 1986; 80: 12-19).

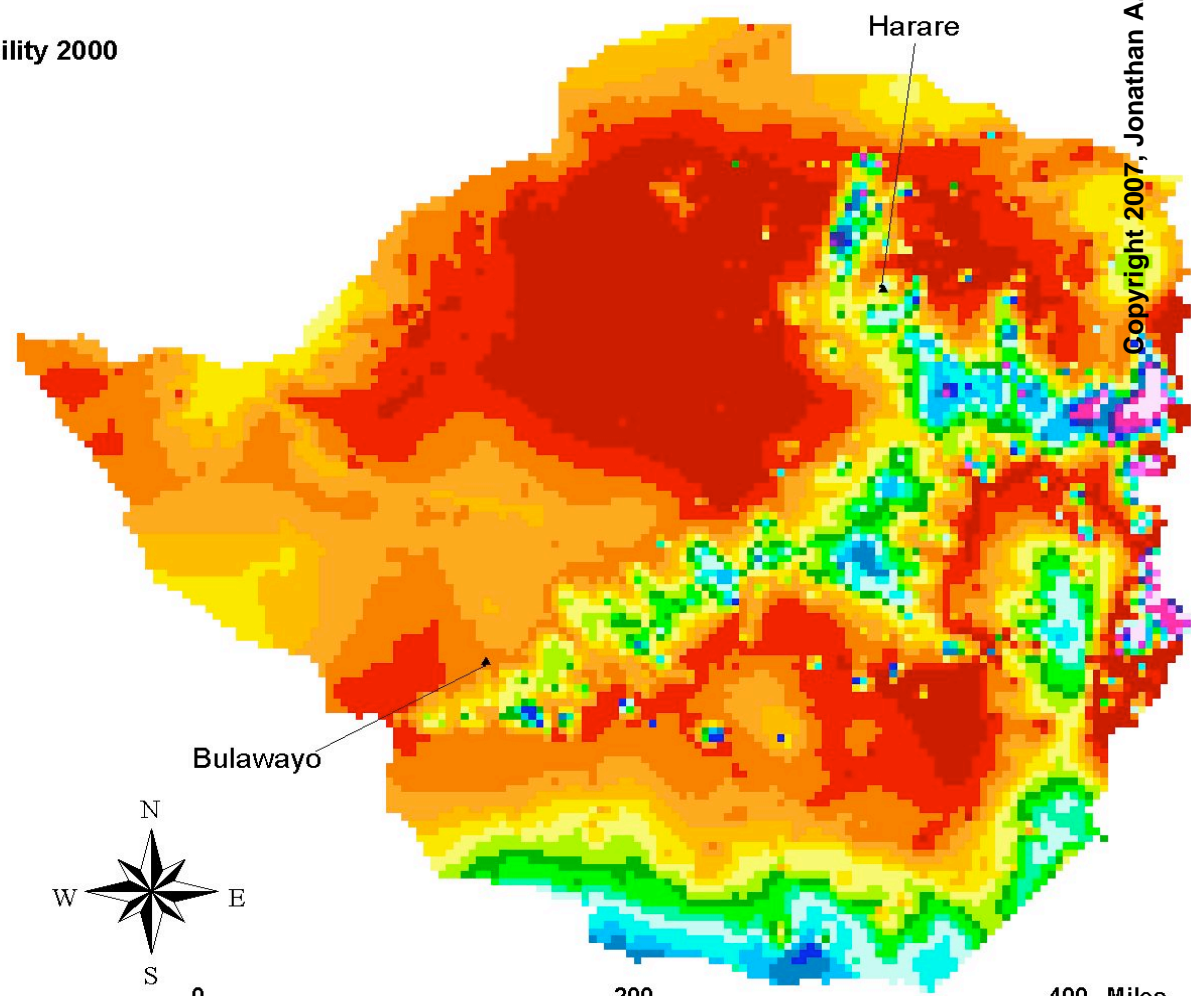
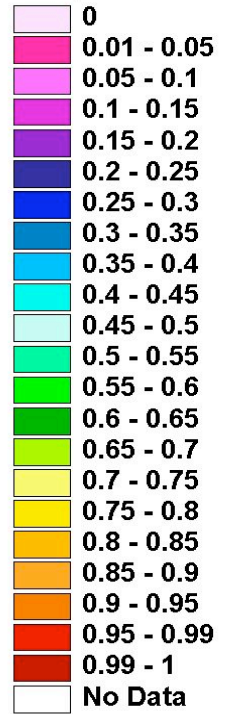
Source: Taylor and Mutambu, 1986

# Baseline 2000 2025 2050 2075 2100

Source: Ebi et al 2005

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▲ Cities  
Fuzzy Climate Suitability 2000

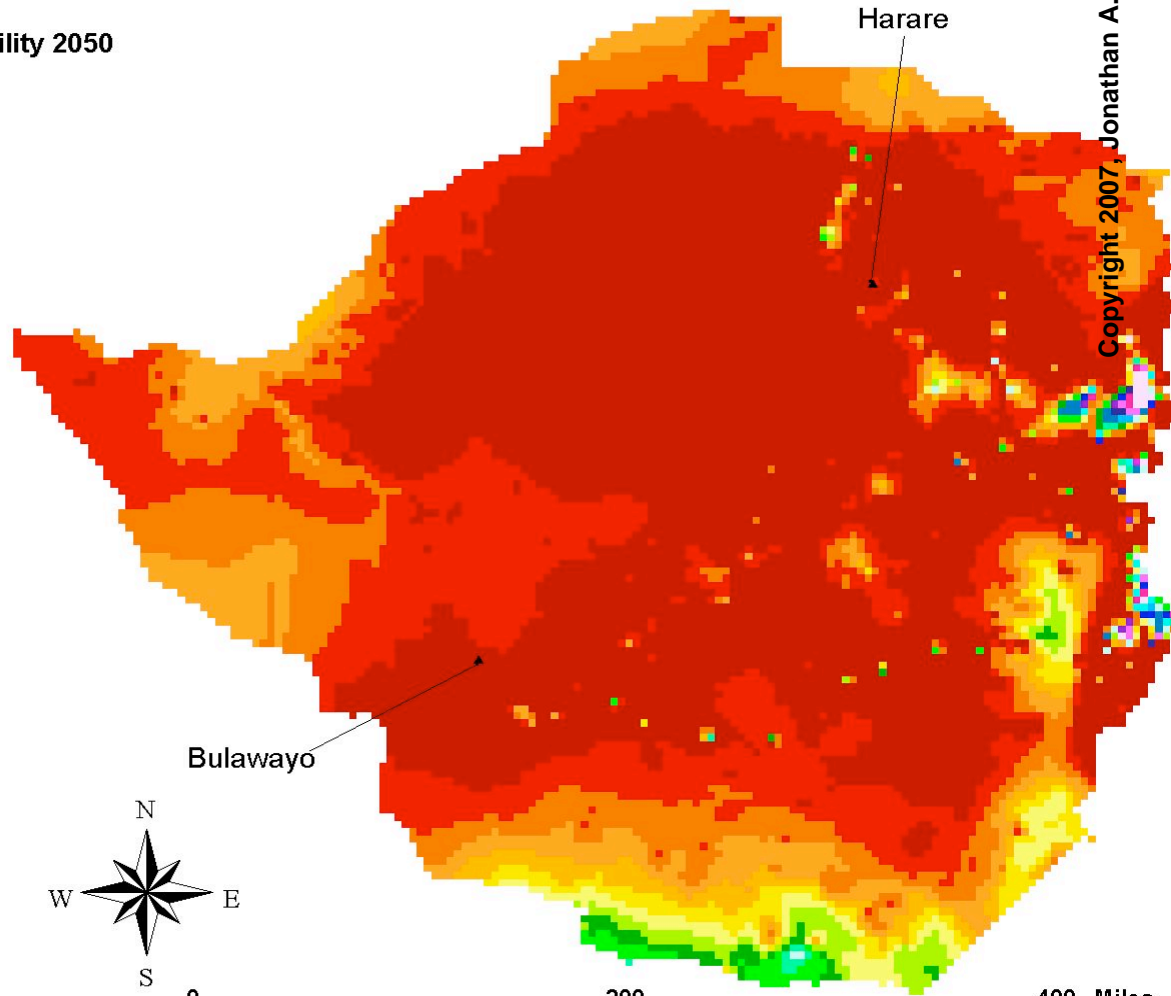
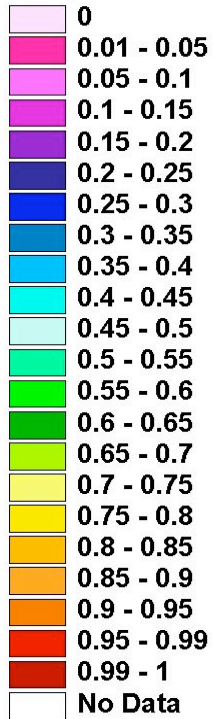


Baseline 2000 2025 **2050** 2075 2100

Source: Ebi et al, 2005

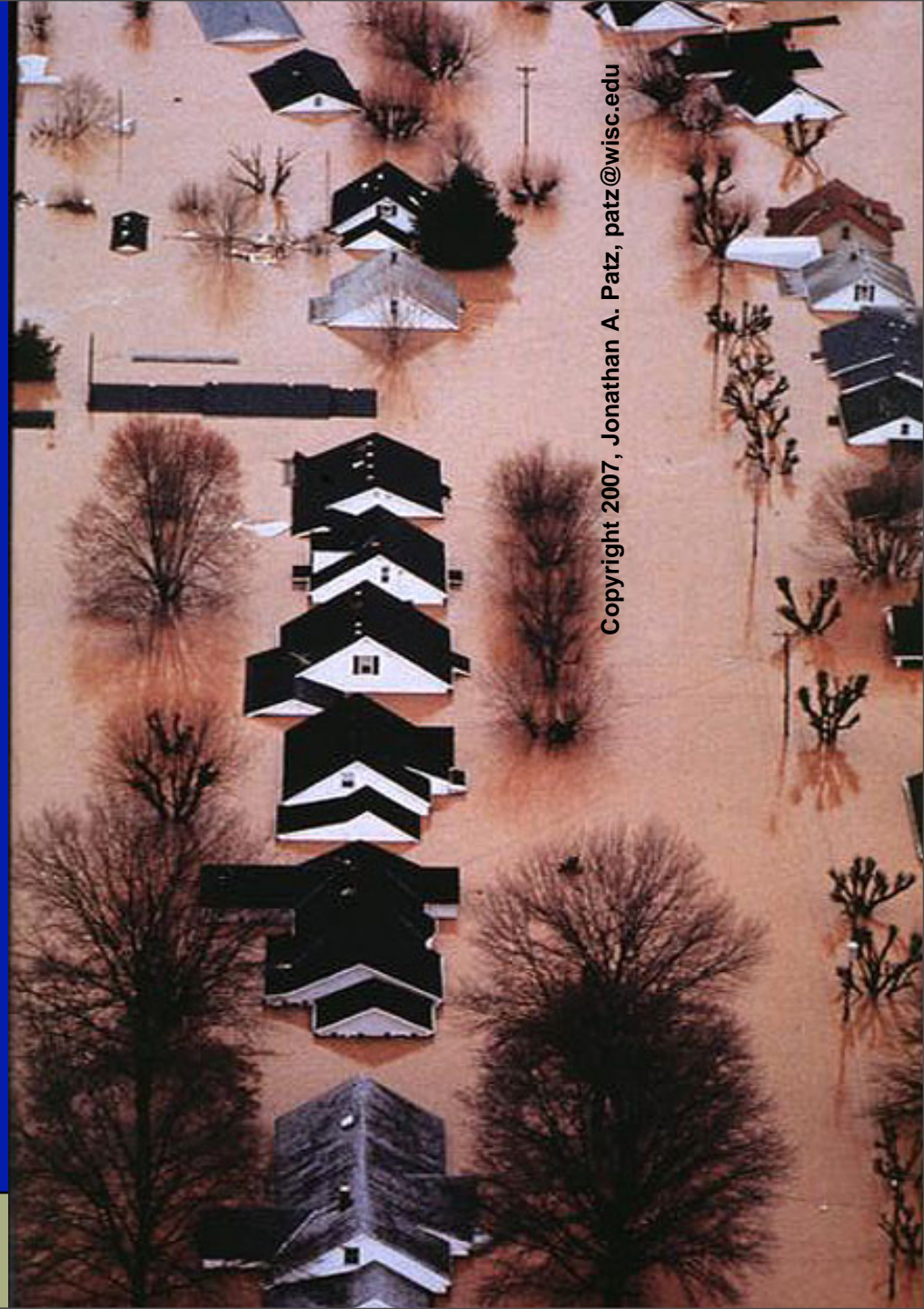
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▲ Cities  
Fuzzy Climate Suitability 2050





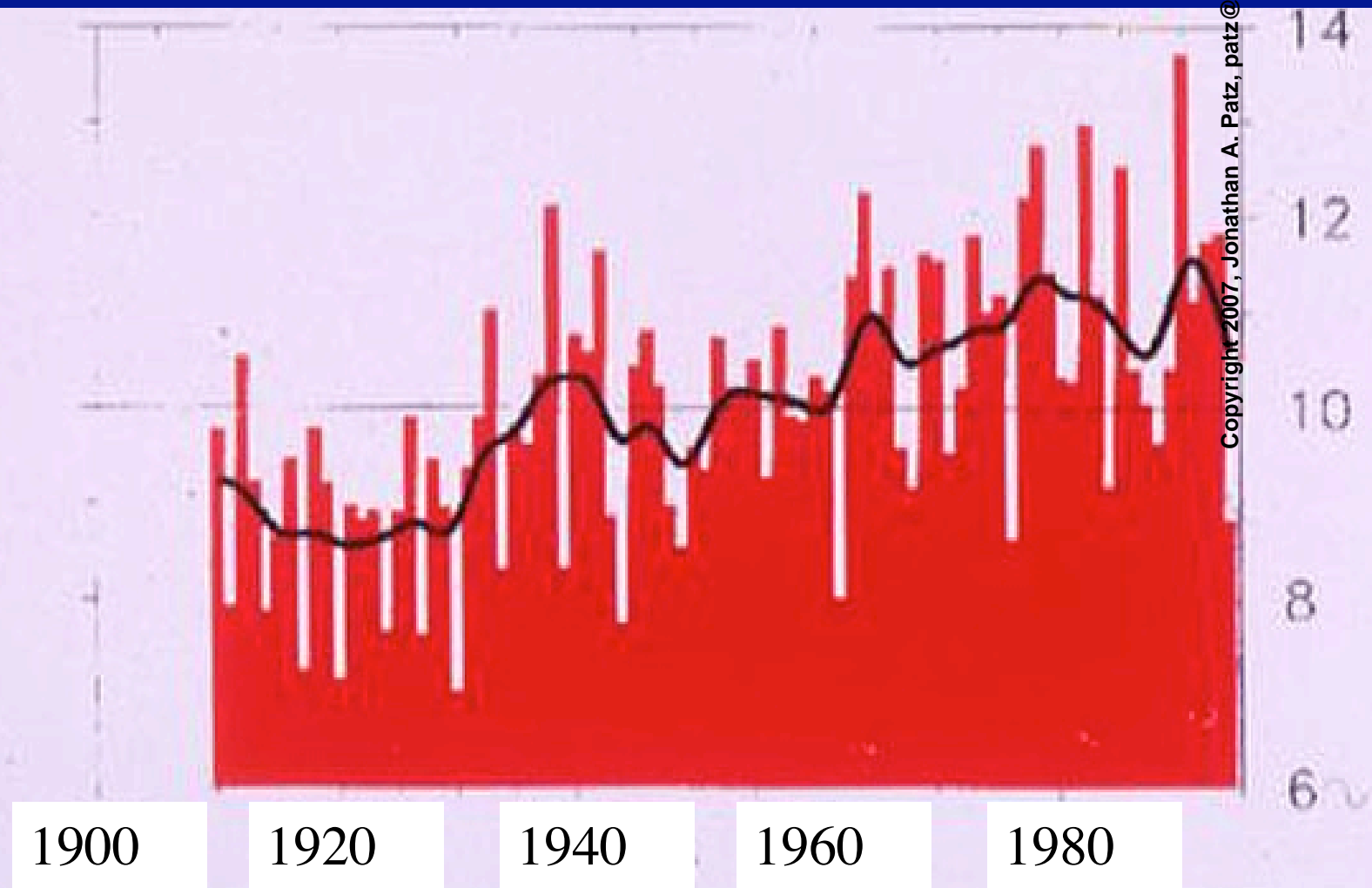
**Climate change:  
It's not just about  
warming.**



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# Proportion of the USA affected by much above normal annual precipitation from extreme events (>2 inches/day)

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Source: Karl et al. 1996

annual precipitation derived from extreme daily precipitation events (more than 2 inches)

# **Extreme Precipitation and Waterborne Disease Outbreaks in the United States, 1948 -1994**

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**Project Sponsor:  
US EPA, Office of Research & Development**

**PI: J. Patz**

# Results

- **67%** of waterborne disease outbreaks were preceded by precipitation above the 80th percentile (across a 50 yr. climate record),  $p < 0.001$
- **51%** of outbreaks were preceded by precipitation above the 90th percentile,  $p < 0.002$
- Surface water-related outbreaks had strongest correlation with extreme precipitation in the month of outbreak; groundwater-related outbreaks lagged 2 months following extreme precipitation.



# USA: Combined sewer overflows (CSOs)

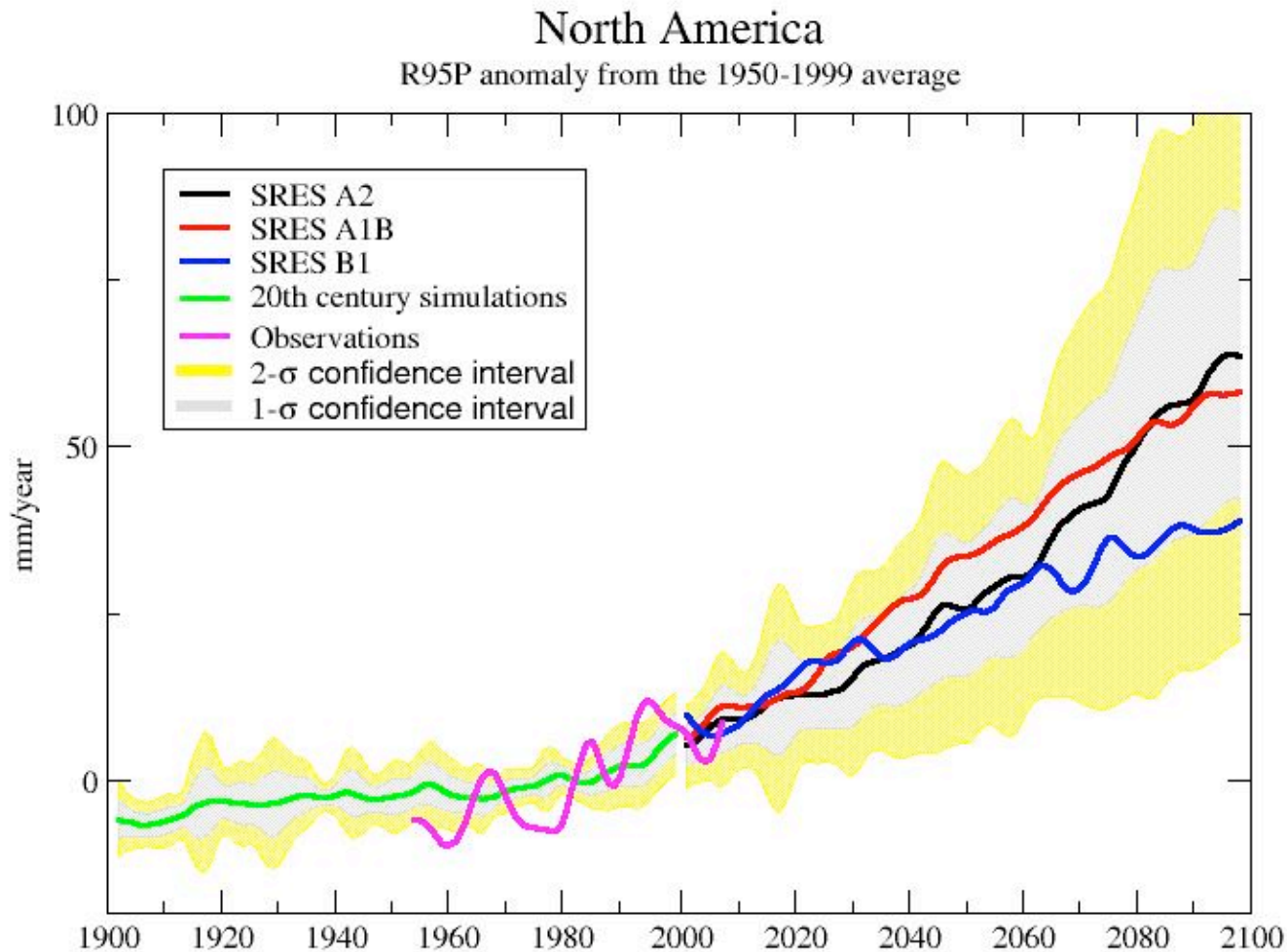


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**1.2 trillion gal of sewage & stormwater a year  
discharged during combined sewer overflows  
– would keep Niagara Falls roaring for 18 days**

*Center for Water & Health, JHU Bloomberg School of Public Health*

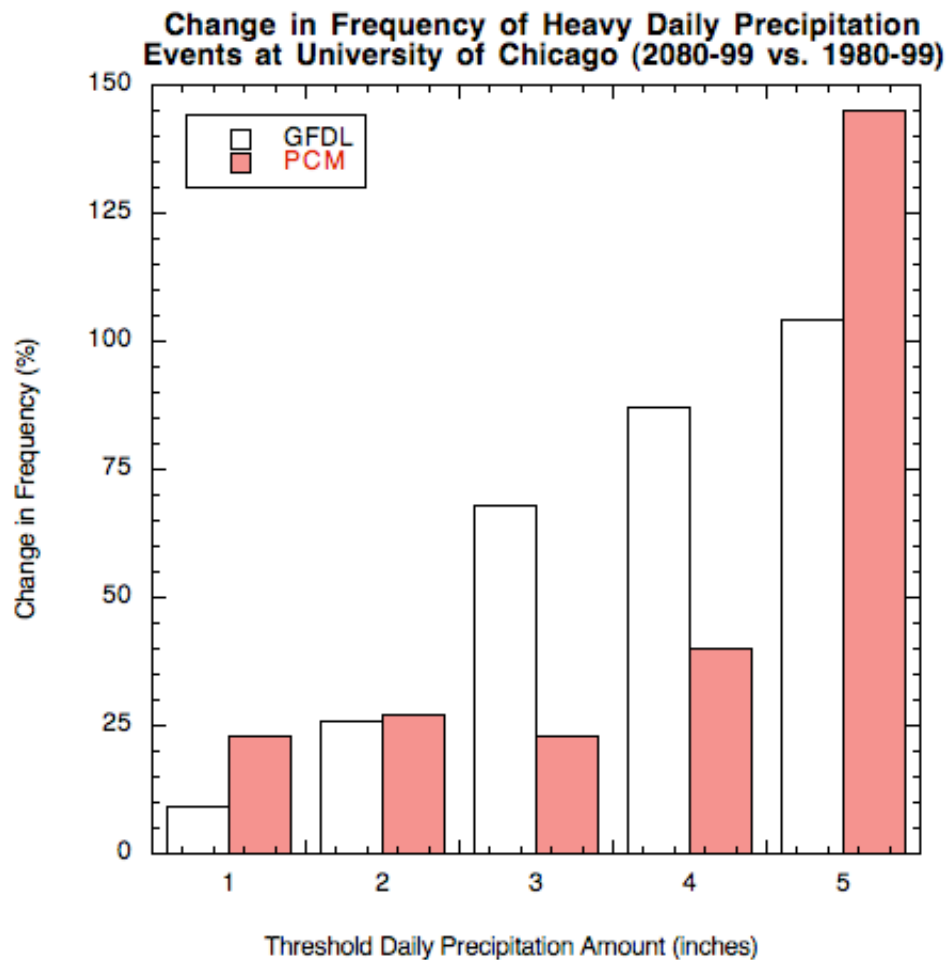
# Heavy precipitation is projected to increase



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Figure courtesy of M. Wehner

# Projected change in the frequency of heavy precipitation in Chicago by the late 21<sup>st</sup> century, based on downscaled climate model output from two GCMs used in the Chicago Climate Impact Assessment.



Courtesy: S. Vavrus

University of Wisconsin-Madison

Unpublished data

EPA STAR Grant project

J Patz, PI



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2007 Nobel Laureate Al Gore



A photograph of Al Gore, a 2007 Nobel Laureate, speaking on a stage. He is wearing a dark suit jacket over a light blue shirt and a dark bow tie. He is gesturing with his right hand. Behind him is a large, glowing globe of the Earth, showing the continents and oceans. The background is dark, making the globe and the speaker stand out.

**“Climate Change  
is a MORAL  
issue”**

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2007 Nobel Laureate Al Gore

# New Orleans after Hurricane Katrina

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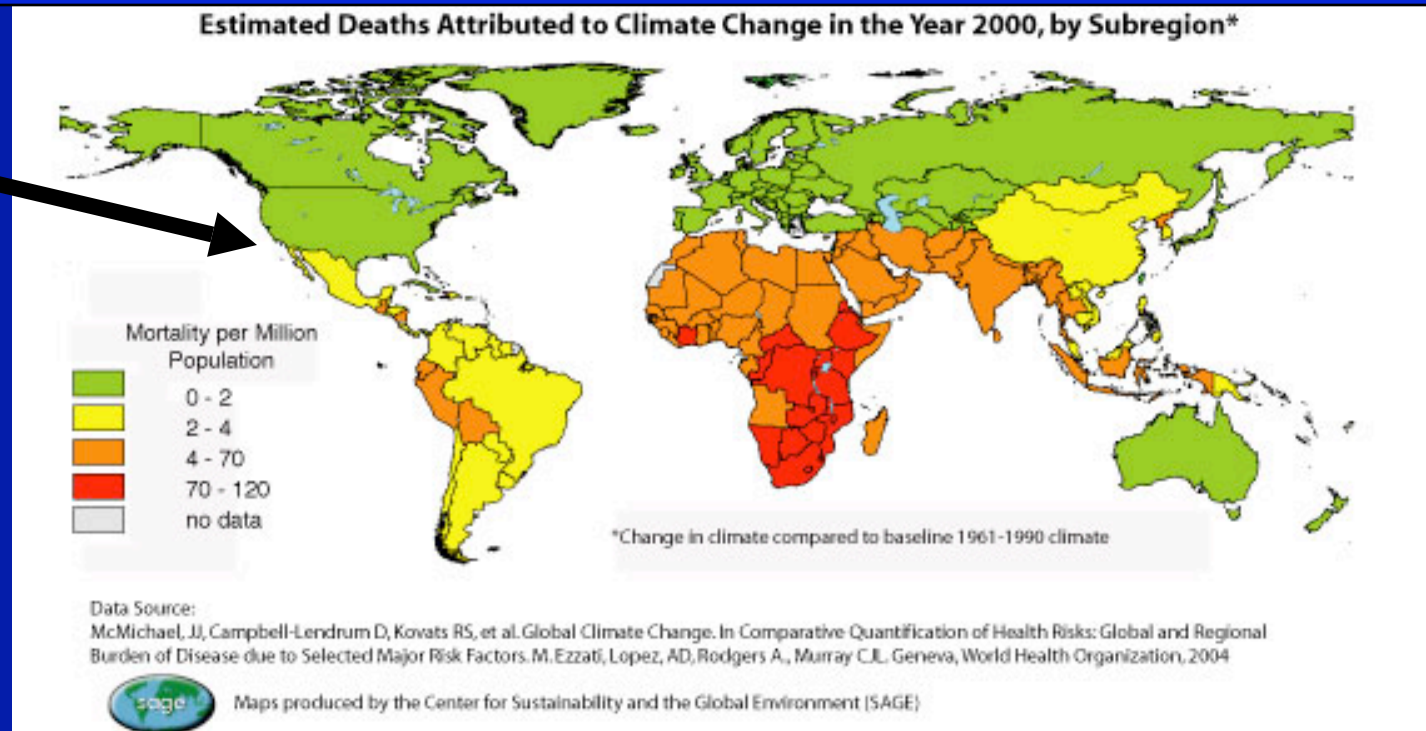
# Climate change is already contributing to morbidity and mortality

Warming during 1970-2000 is estimated to have caused at least 160,000 deaths and 5 million DALYs annually (from just 4 outcomes: malaria, diarrhea, malnutrition, and flooding). WHO, 2004.

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VS

*Climate-related burden of disease*



Sources:

McMichael et al;  
2003

Campbell-  
Lendrum et al;  
2004

Patz et al. 2005



**GLOBAL WARMING: the largest ethical problem today?**

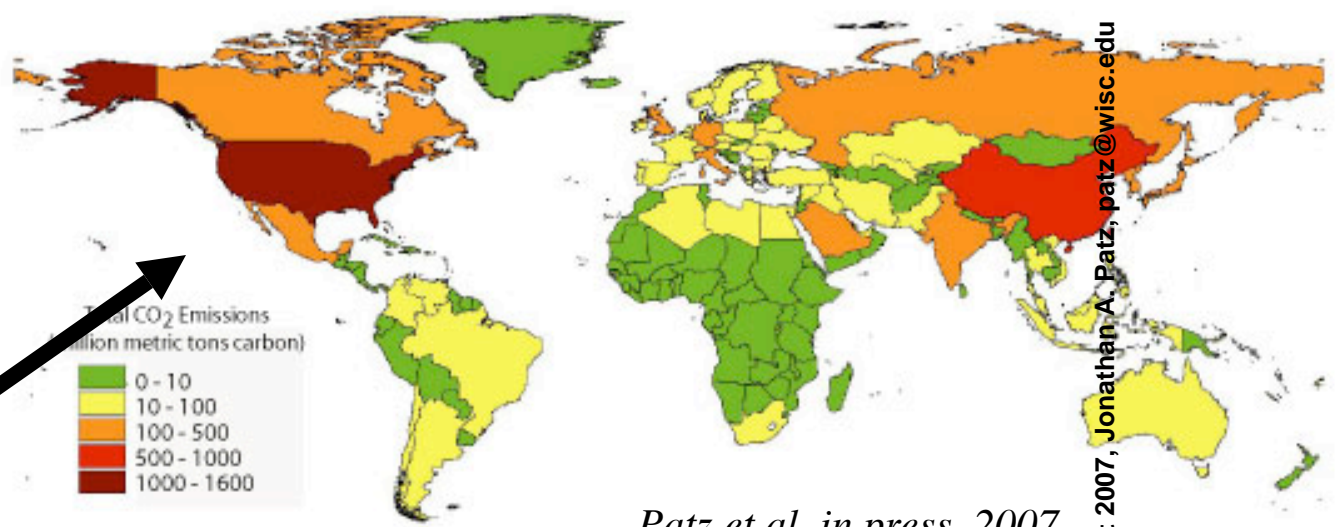
*CO<sub>2</sub> emissions*

VS

*Climate-related burden of disease*

**Sources:**  
**McMichael et al; 2003**  
**Campbell-Lendrum et al; 2004**  
**Patz et al. 2005**

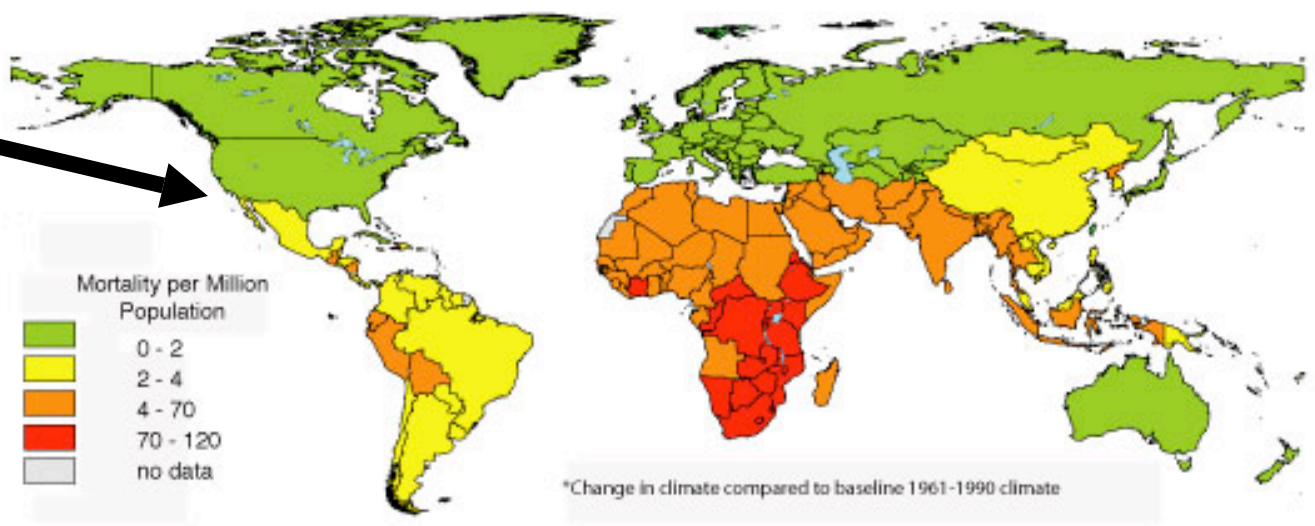
**Total CO<sub>2</sub> Greenhouse Gas Emissions in the Year 2000, by Country**



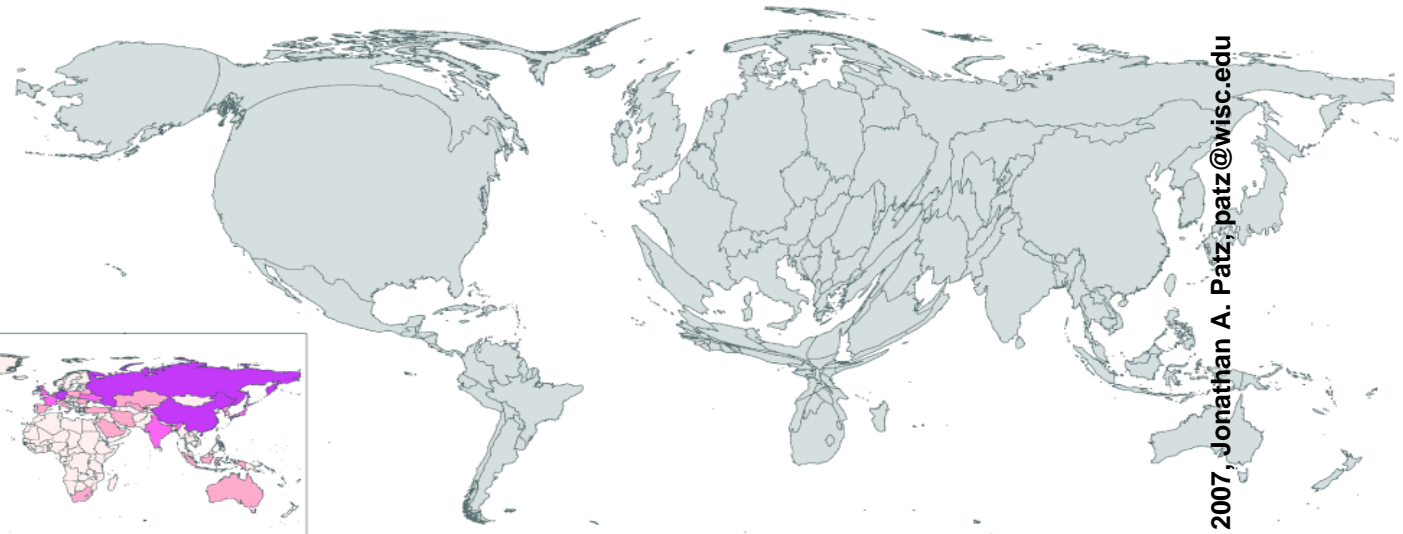
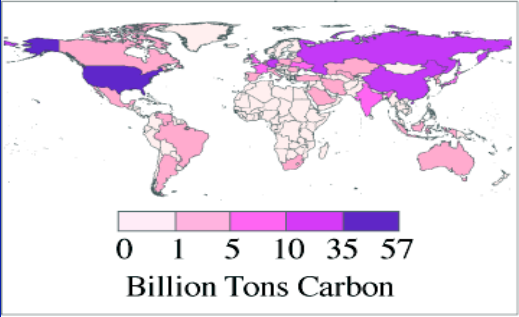
Data Source: Marland, G., T.A. Boden, and R. J. Andres. 2003. Global, Regional, and National Fossil Fuel CO<sub>2</sub> Emissions. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A.

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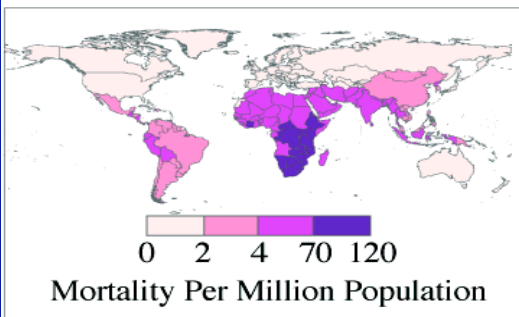
**Estimated Deaths Attributed to Climate Change in the Year 2000, by Subregion\***

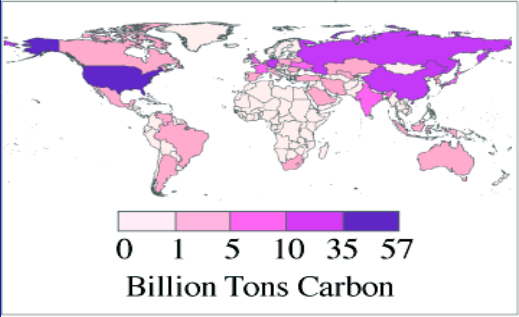
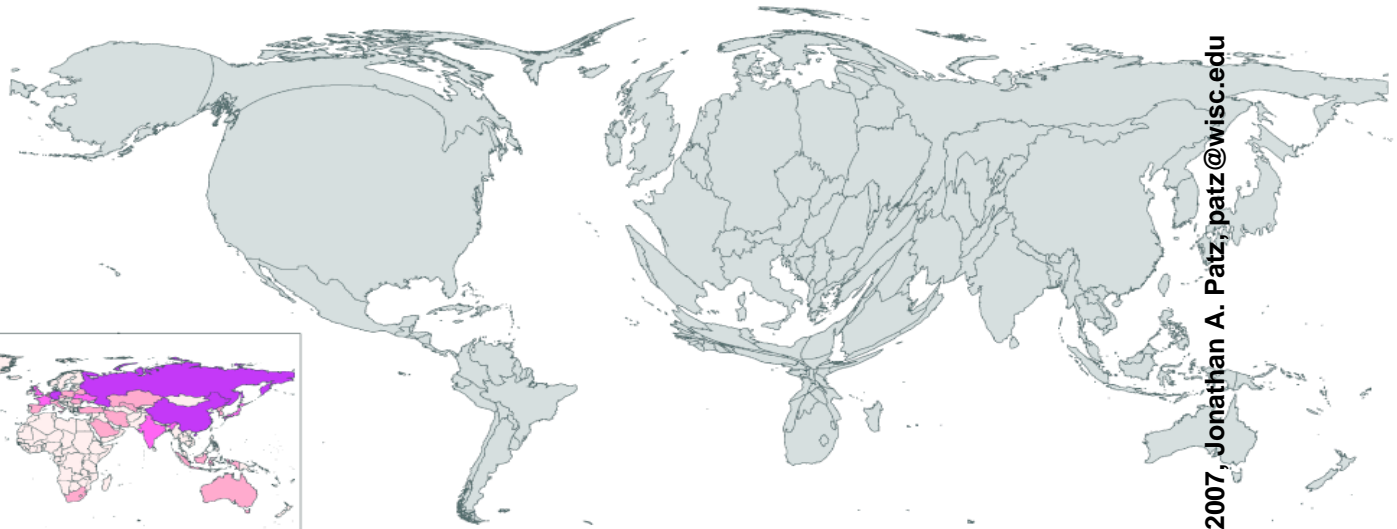


Data Source: McMichael, J.J, Campbell-Lendrum D, Kovats RS, et al. Global Climate Change. In Comparative Quantification of Health Risks: Global and Regional Burden of Disease due to Selected Major Risk Factors. M.Ezzati, Lopez, AD, Rodgers A., Murray C.J.L. Geneva, World Health Organization, 2004

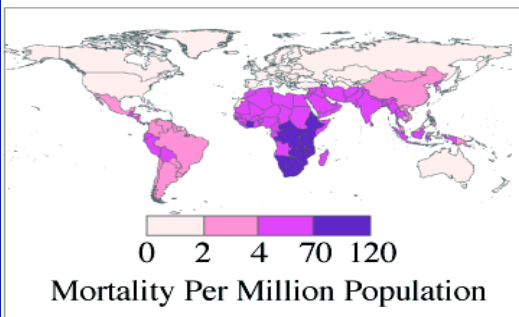


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Patz et al., to be released next week



**Key reason for banning smoking. Shouldn't we consider climate change in the same way?**



# “GROWING FUEL: *The Wrong Way: The Right Way*”

October, 2007, National Geographic



Green  
Dreams

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Source: National Geographic

# Biofuels and Food Security

- Food **aid shipments** from the USA are inversely correlated to commodity prices

(Naylor et al. 2007)

- For 1% increase in the real prices of staple foods, **16 million more people** could become food-insecure

(Runge, 2003)

# Status of Americans

- $\approx 2/3$  U.S. adults  $\geq 20$  are overweight or obese
- $\approx 15\%$  of children and adolescents age 6-19 are overweight (CDC 2004).
- 20.8 million people have diabetes (7% of the population) (CDCP 2005)
- **60%** of American adults do not meet recommended levels



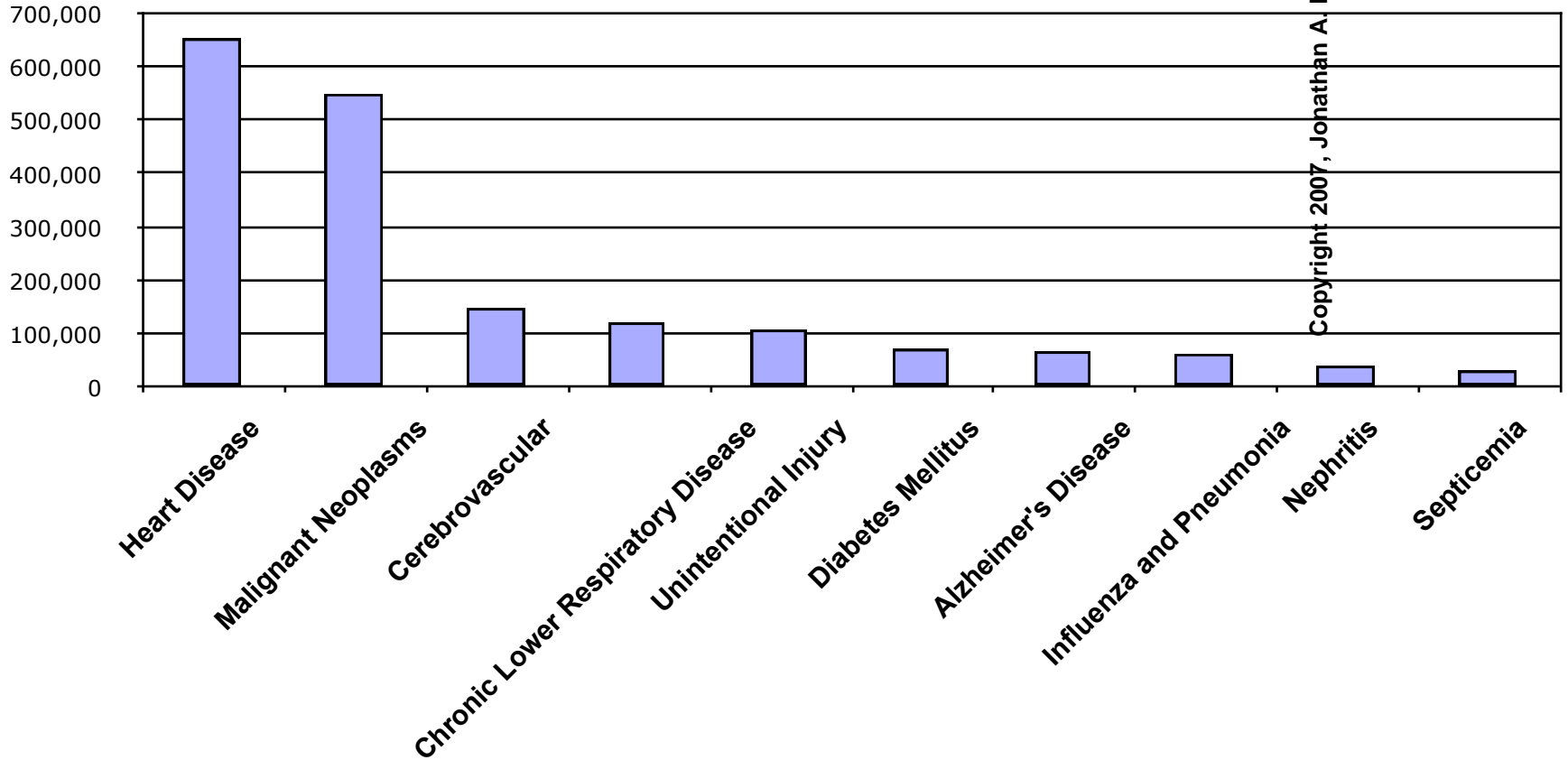
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**40% of trips by car are < 2 miles**

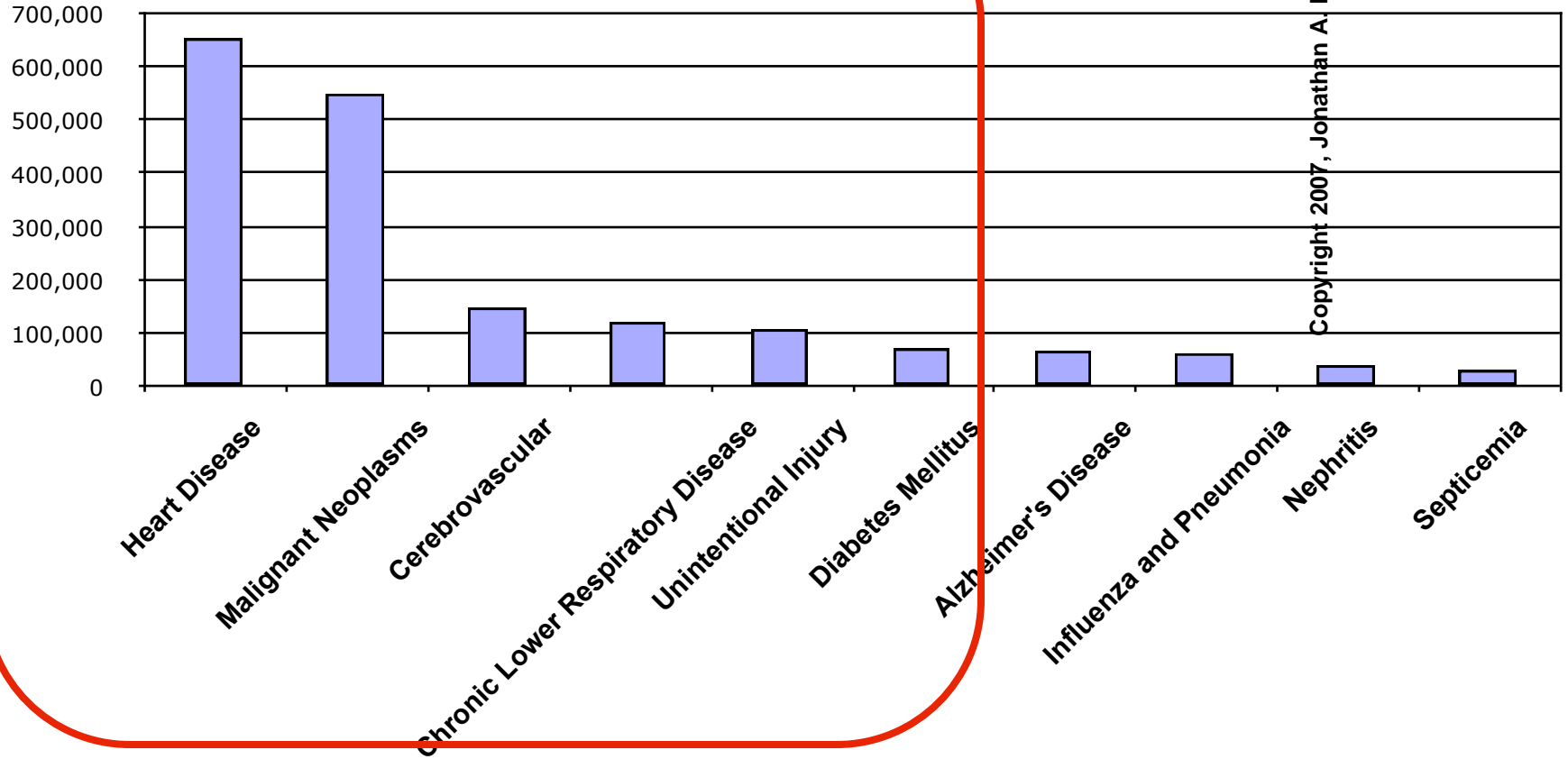
(Dept of Transportation)

# Ten Leading Causes of US Deaths per Year (CDC 2004)



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# Ten Leading Causes of US Deaths per Year (CDC 2004)



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# Triple Win Bike Project



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**1. Health** *(personal)*

**2. Local Air Pollution** *(local)*

**3. Global Climate Change** *(global)*





# Triple Win Bike Project



... Why global climate change could be the **greatest public health opportunity** we've had in over a century!

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# For Madison, if 20% of car trips were replaced by bike trips:

Grabow et al, in preparation

1. **10 lbs (4.5 kg) lost /person/yr** (for 6.8 mi. roundtrip commute)
  2. 12% fall each in **Ozone** and **NOx** : **2% drop in  $\text{PM}_{2.5}$**
  3. 17,990 fewer lost-work days/yr
  4. 1,906 fewer Asthma admissions/yr
  5. 14,586 fewer acute respiratory cases/yr
  6. \$40 million saved in health costs/yr
- 
3. 16,687 **tons of  $\text{CO}_2$**  not emitted

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## The Triple Win





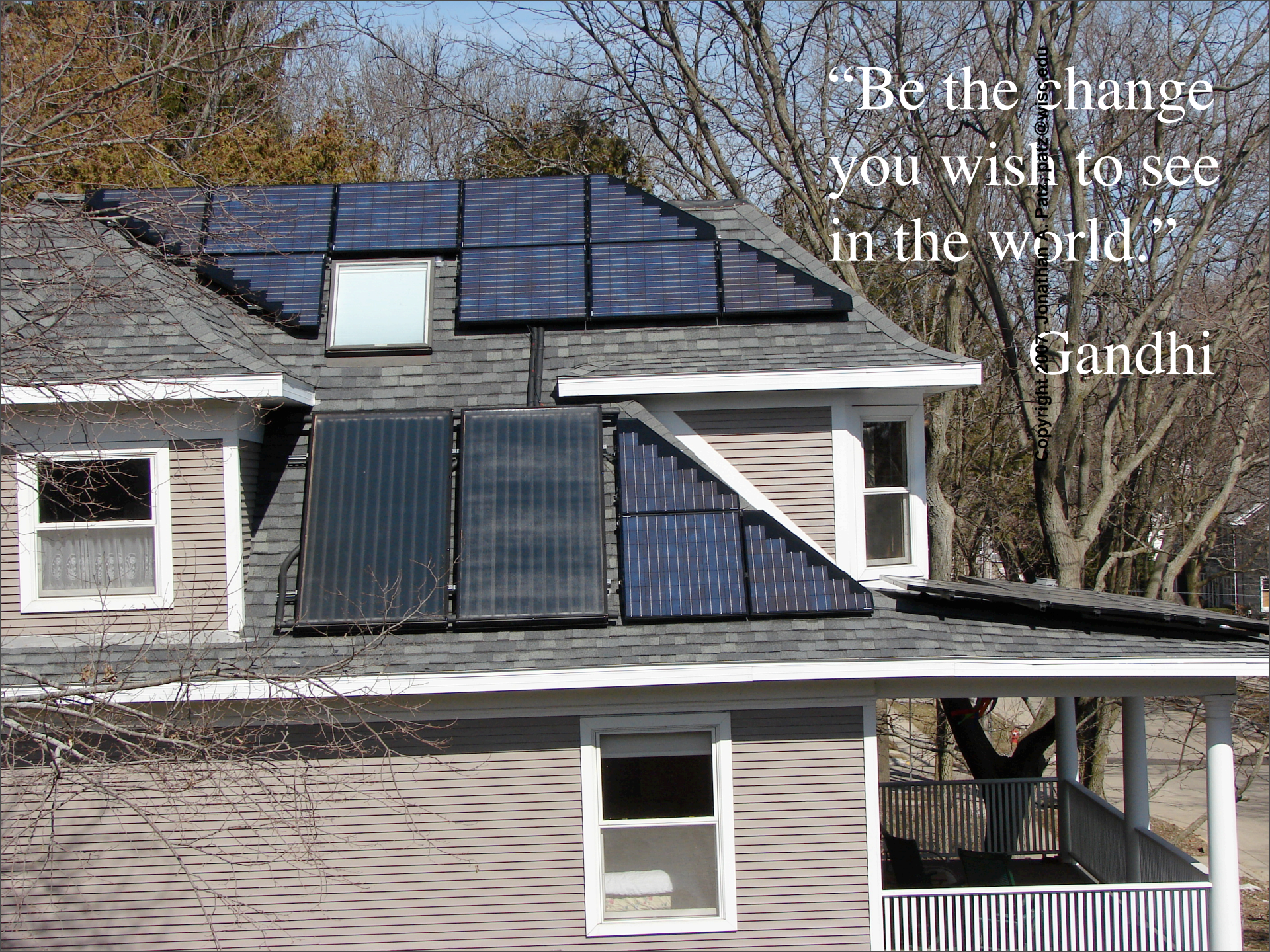
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“Be the change  
you wish to see  
in the world.”

Gandhi

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Information for middleschool teachers  
students, and the general public

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**ECO HEALTH** 

ENVIRONMENTAL CHANGE AND OUR HEALTH

Earth has more people than ever before. New technologies have improved the quality of life for many. But our quest for a better life is also changing the face of the planet – and putting our health at risk.



*THANK YOU !*