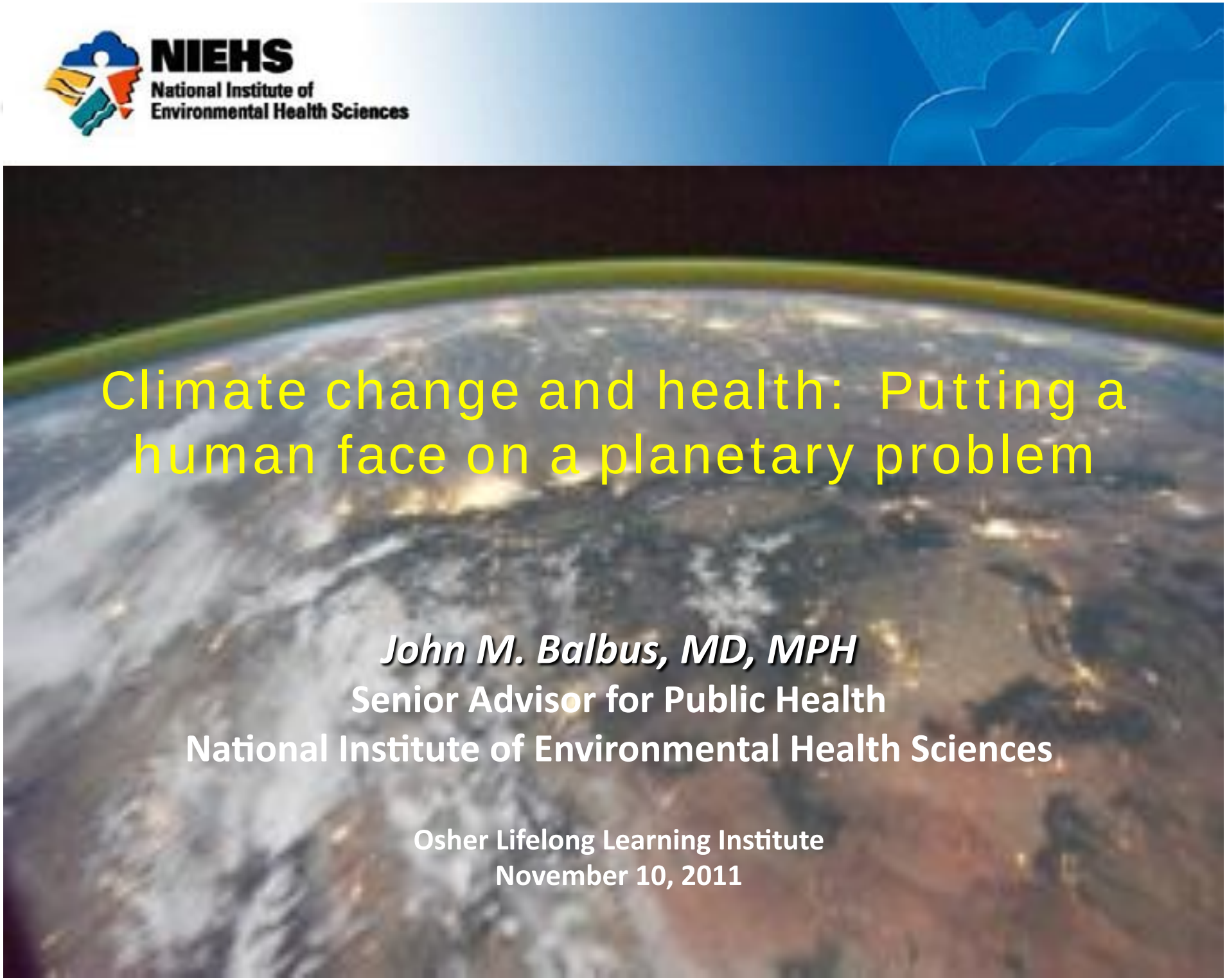
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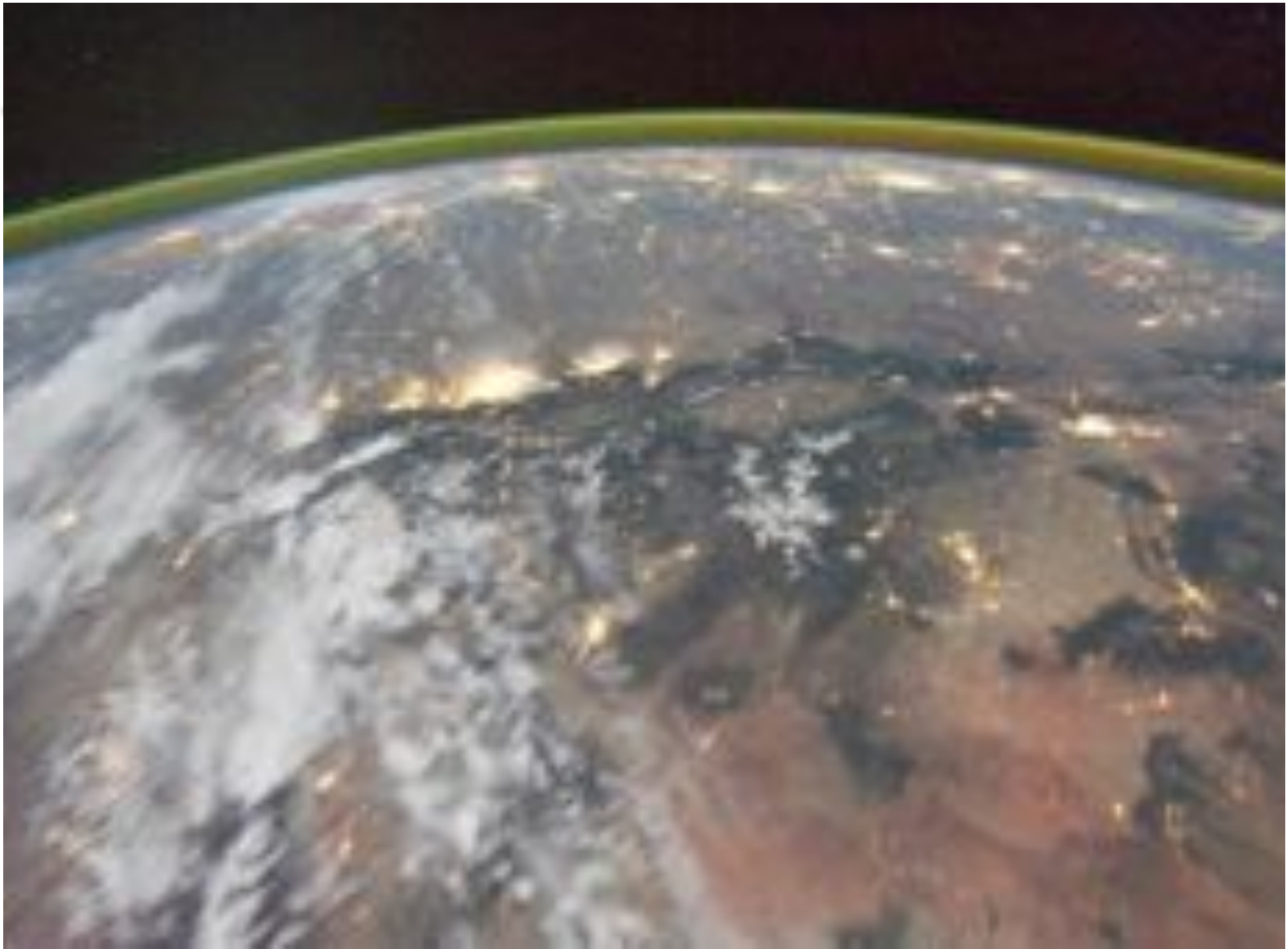
Climate change and health: Putting a human face on a planetary problem
John M. Balbus, MD, MPH
Senior Advisor for Public Health
National Institute of Environmental Health Sciences
Osher Lifelong Learning Institute
November 10, 2011



Overview

- Health impacts: what are we observing now?
- Health impacts: what do models and predictions tell us?
- Solutions: what are we doing to reduce risks and increase resilience?
- Solutions: how reducing emissions of greenhouse gases is good for us
- Solution: opportunities for engagement


Life-threatening 'Bering Sea superstorm'
'Extremely dangerous... storm of an epic magnitude'
1
2
3
4

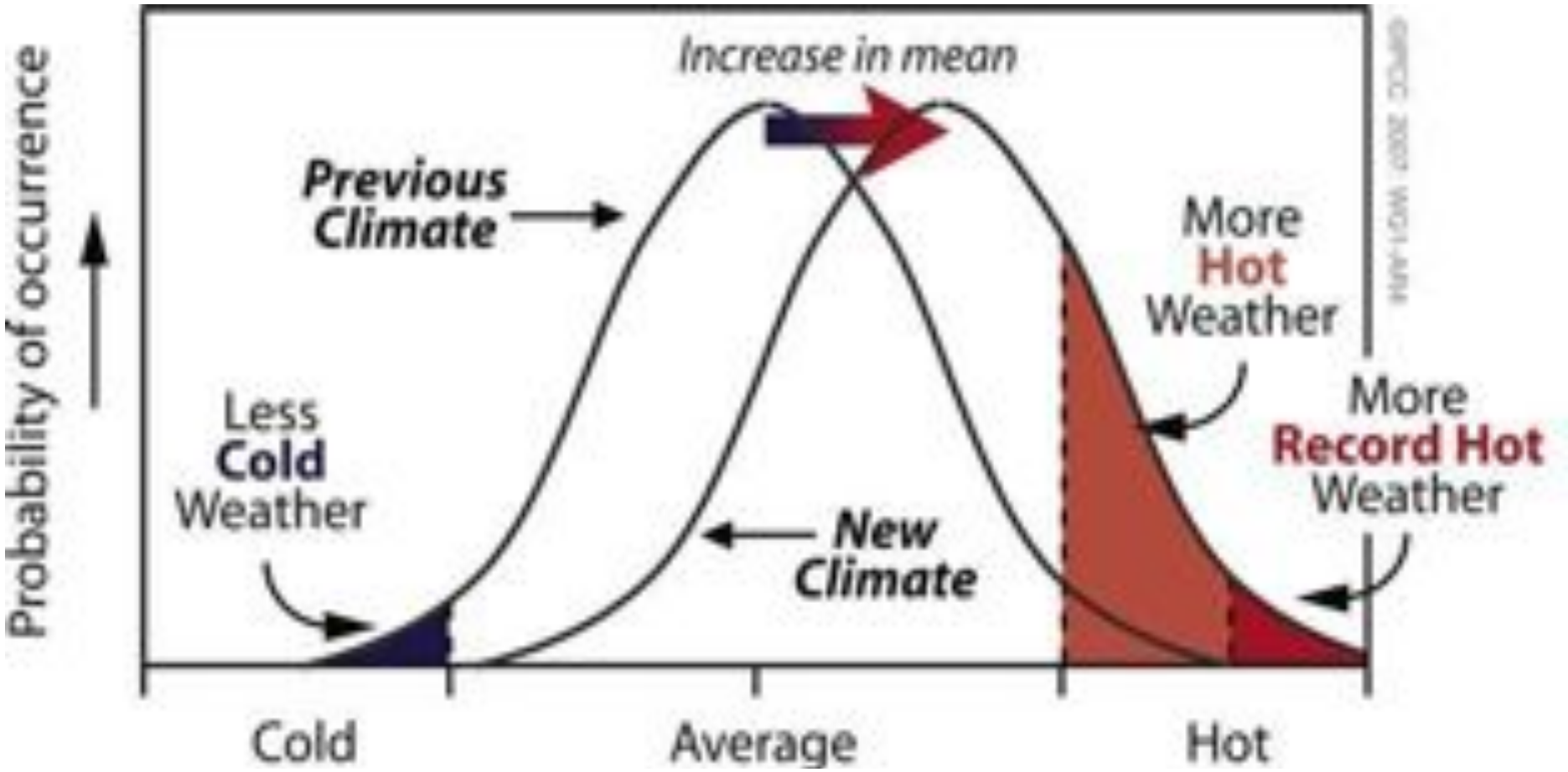

http://www.aaas.org/news/releases/2006/images/1204alaska_

http://www.thelastdaysofshishmaref.com/shishmaref3/files/0c/975_949_P1010873.jpg

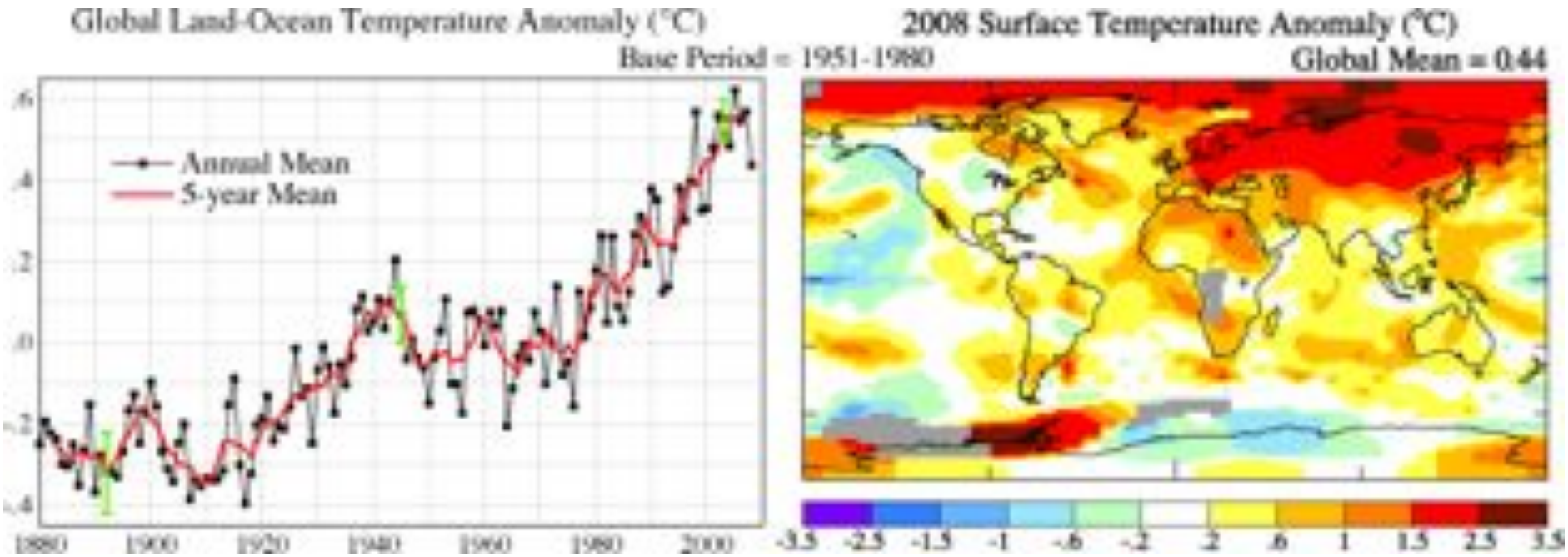
Manifestations of a changing climate

- Increasing average temperatures
- Increasing peak temperatures
- Increasing minimum temperatures
- Increasing ocean temperatures
- More rapid soil drying = greater risk of drought
- More moisture carrying capacity = heavier precipitation
- Earlier spring, later first frost
- Retreating glaciers, loss of polar ice
- Rising sea level

Increasing mean temperatures means new extremes, too



Temperature changes vary with location as well as time



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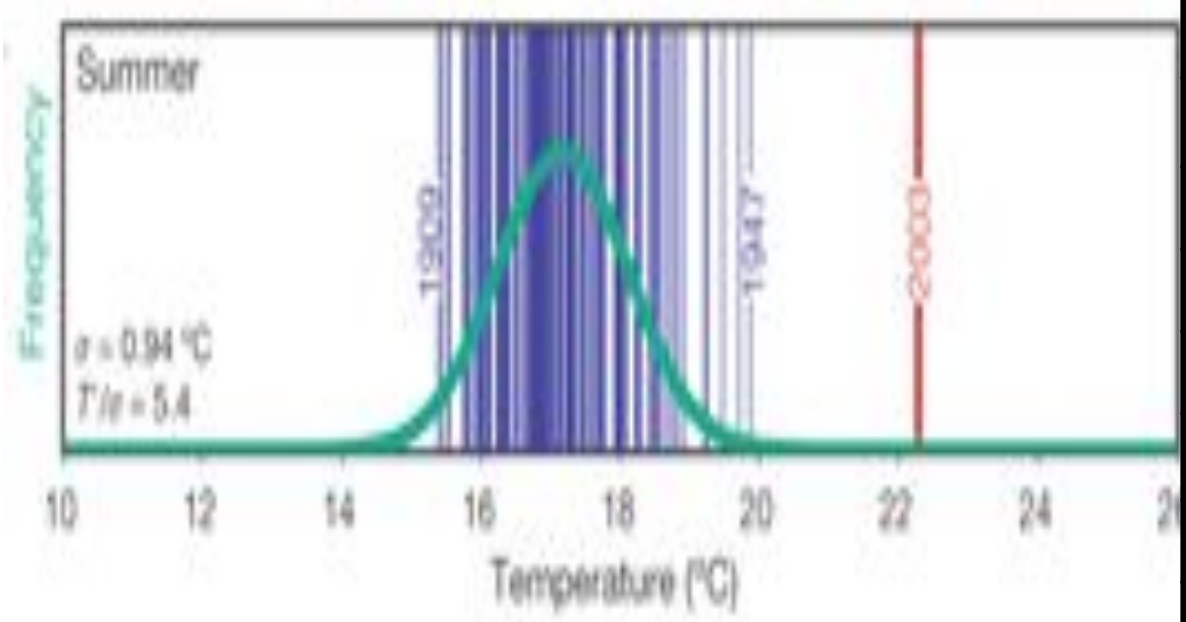
Heat stress- greatest cause of weather-related mortality

- Average 688 deaths/year
- Risk factors
  - Male
  - Elderly
  - socially isolated
  - Poor
- California, 2006
  - 655 deaths estimated
  - $5.35 B costs

Europe 2003: well beyond historical experience

European Heat Wave of 2003

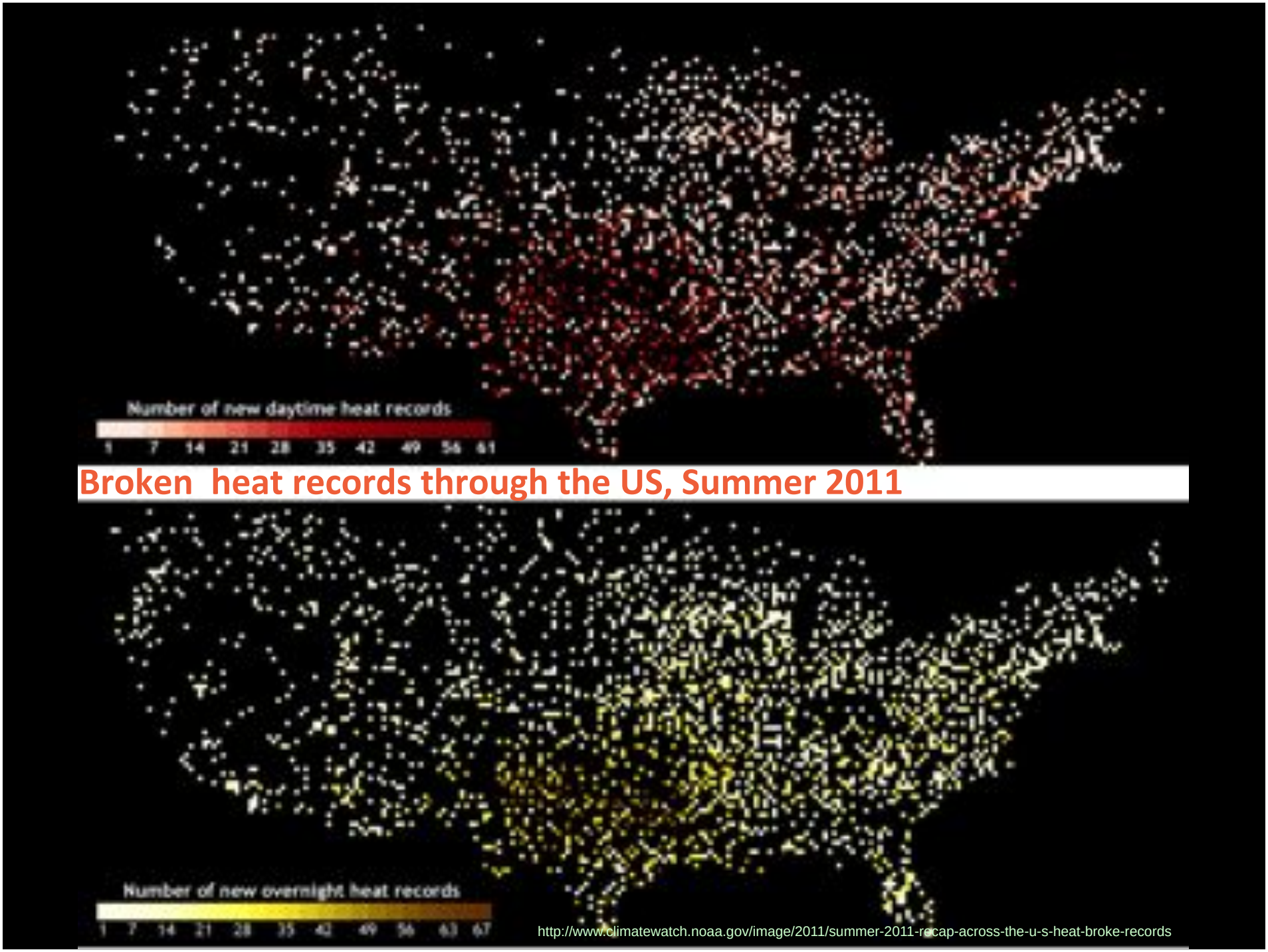


Confirmed Mortality

UK	2,091
Italy	3,134
France	14,802
Portugal	1,854
Spain	4,151
Switzerland	975
Netherlands	1,400-2,200
Germany	1,410
TOTAL	29,817-30,617

Haines et al. *Public Health* 2006;120:585-96.

Vandentorren et al. *Am J Public Health 2004; 94(9):1518-20.*



Broken heat records through the US, Summer 2011

http://www.climatewatch.noaa.gov/image/2011/summer-2011-recap-across-the-u-s-heat-broke-records

Disproportionate heat mortality in Chicago, 1995

TABLE 2—Relative Risk (RR; With 95% Confidence Intervals [CIs]) of Death on July 15, 1995: Chicago

Outcome	RR (95% CI)
All deaths	1.74 (1.67, 1.81)
Deaths, age ≥ 75	1.72 (1.63, 1.81)
Deaths, age < 75	1.59 (1.51, 1.68)
Male gender	1.79 (1.68, 1.89)
Female gender	1.64 (1.56, 1.72)
White race	1.52 (1.45, 1.59)
Black race	1.98 (1.86, 2.10)
Less than high school education	1.64 (1.55, 1.74)
High school or post-high school education	1.45 (1.36, 1.54)
Cardiovascular deaths	2.39 (2.22, 2.59)
Respiratory disease deaths	1.35 (1.23, 1.48)
Sudden deaths[a]	3.44 (3.22, 3.69)

Note. Relative risk was adjusted for long-term trend, season, day of the week, minimal temperature same day, maximal temperature 1 day before, dew point, and average of lag 0 to 1 of PM_{10}. July 15, 1995, was the day with the highest mortality during the Chicago heat wave that year.
[a]Sudden deaths were defined as "outpatient death" or "dead on arrival to emergency room."

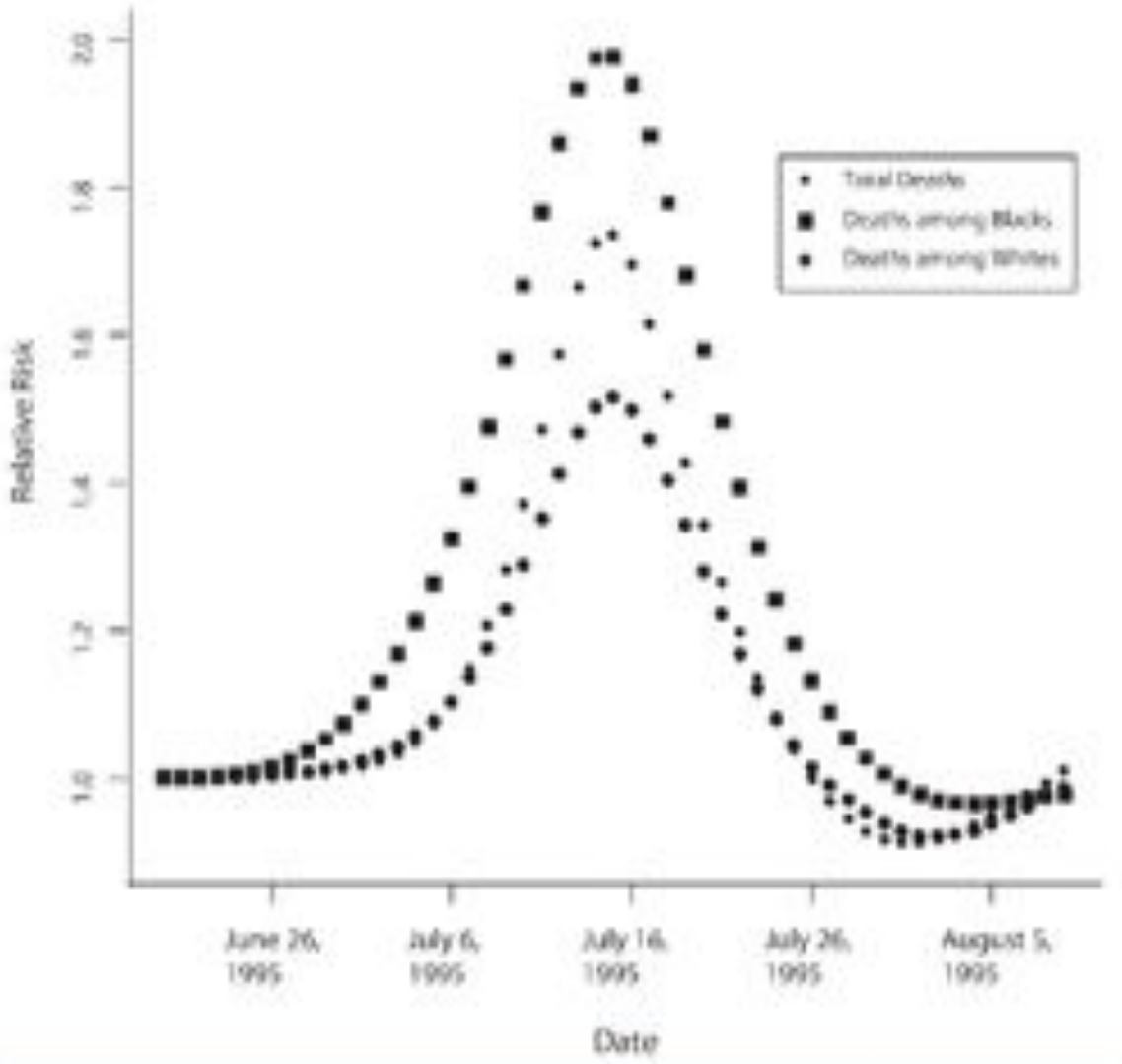


FIGURE 2— Daily relative risk of death for all-cause mortality in the general population and among Blacks and Whites for a 50-day period during the Chicago heat wave: 1995.

Kaiser et al., AJPH 2007

Impact(Risk)= Hazard x Exposure x Vulnerability

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Droughts + High Temperatures = Wildfires

West Texas, 2011

Moscow, 2010

Melbourne, 2009

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Louisiana Diaspora

The number of people displaced by Hurricane Katrina is staggering. Using information collected by the Federal Emergency Management Agency, the map below depicts the evacuated location (by ZIP code) of approximately 800,000 Louisiana citizens requesting federal assistance as of September 20, 2005 (FEMA, 2005).

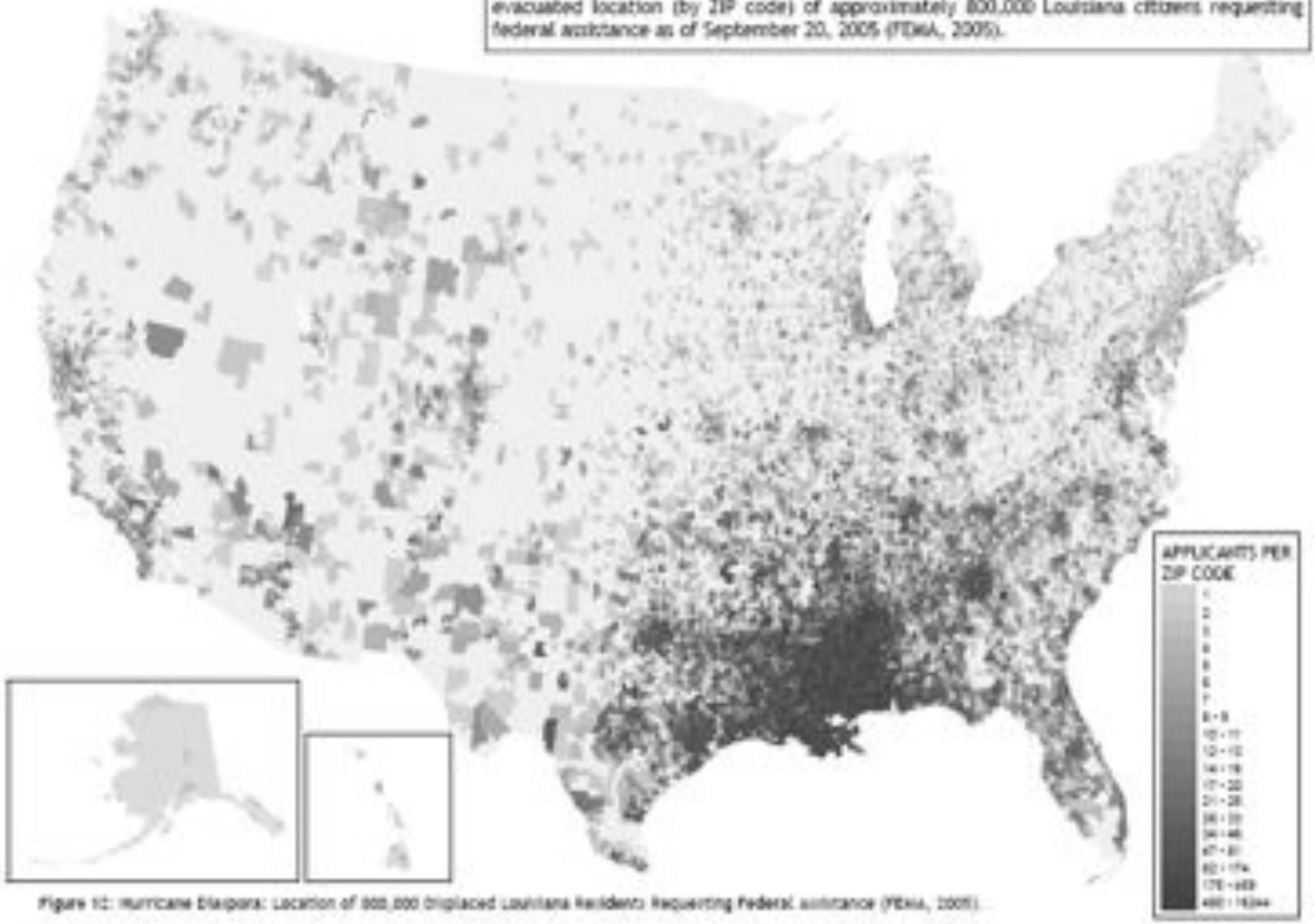

Figure 12: Hurricane Diaspora: Location of 800,000 Displaced Louisiana Residents Requesting Federal Assistance (FEMA, 2005).

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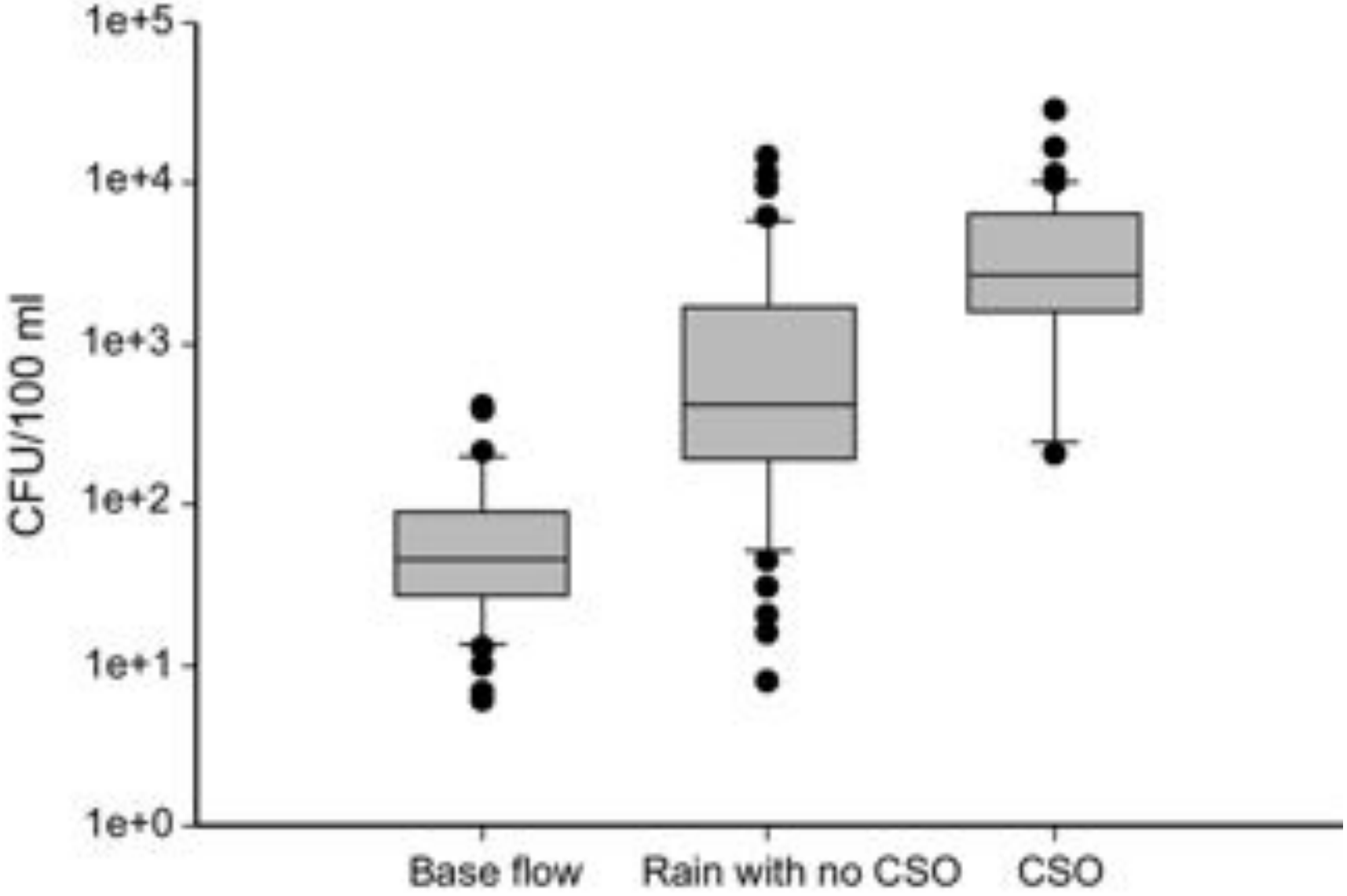
http://www.ec.gc.ca/scitech/4B40916E-16D3-4357-97EB-A6DF7005D1B3/cows_in_stream.jpg


1e+5
1e+4
1e+3
1e+2
1e+1
1e+0
CFU/100 ml
Base flow
Rain with no CSO
CSO

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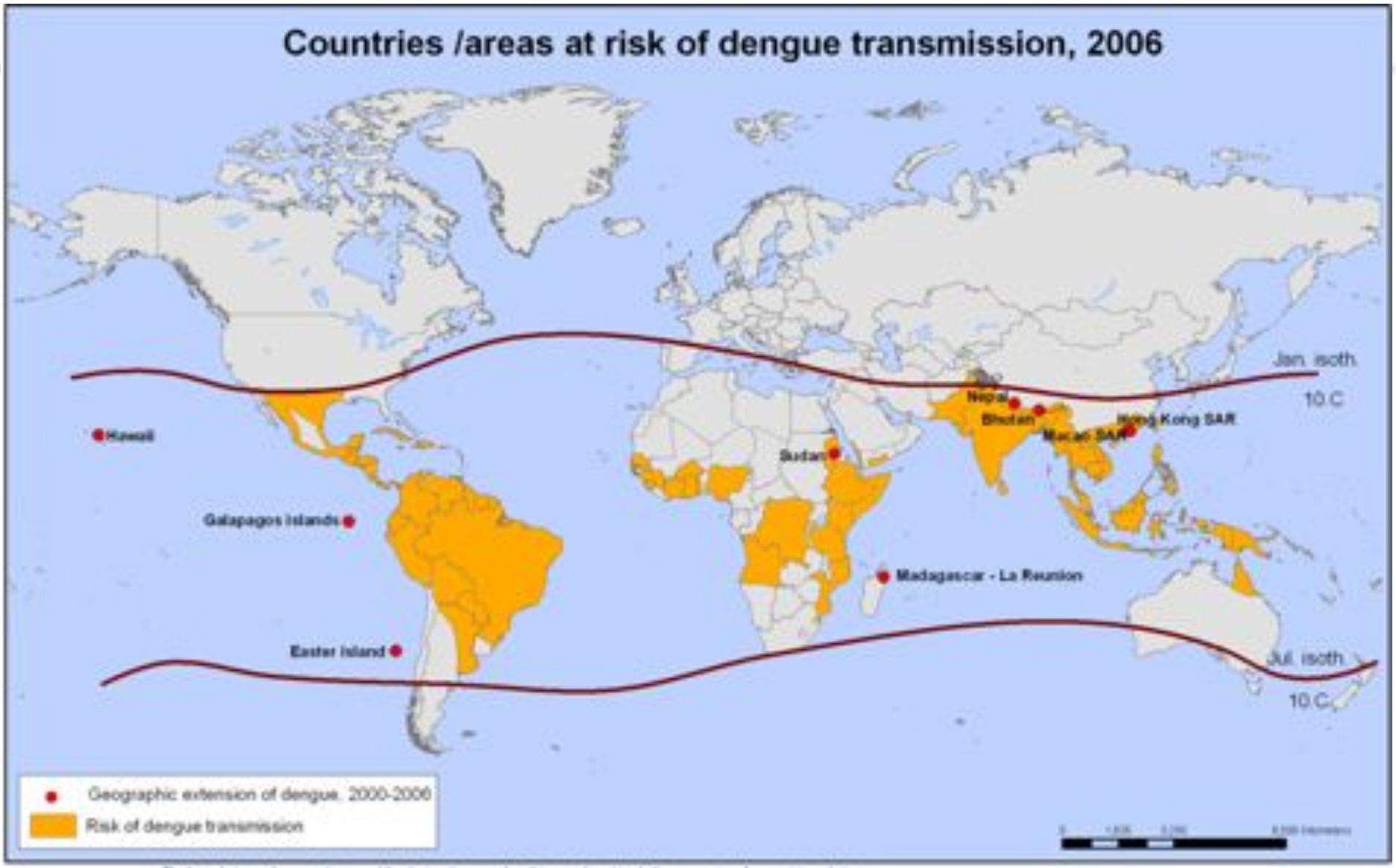
“indescribable, crazy pain”: dengue re-emerges in Florida

- First case in Florida since 1934
- Growing subclinical exposures
  - 5% of 2009 sample had evidence of infection
- Repeated exposure with different serotypes increases risk of dengue hemorrhagic fever

http://www.cnn.com/2010/HEALTH/07/22/dengue.fever/index.html



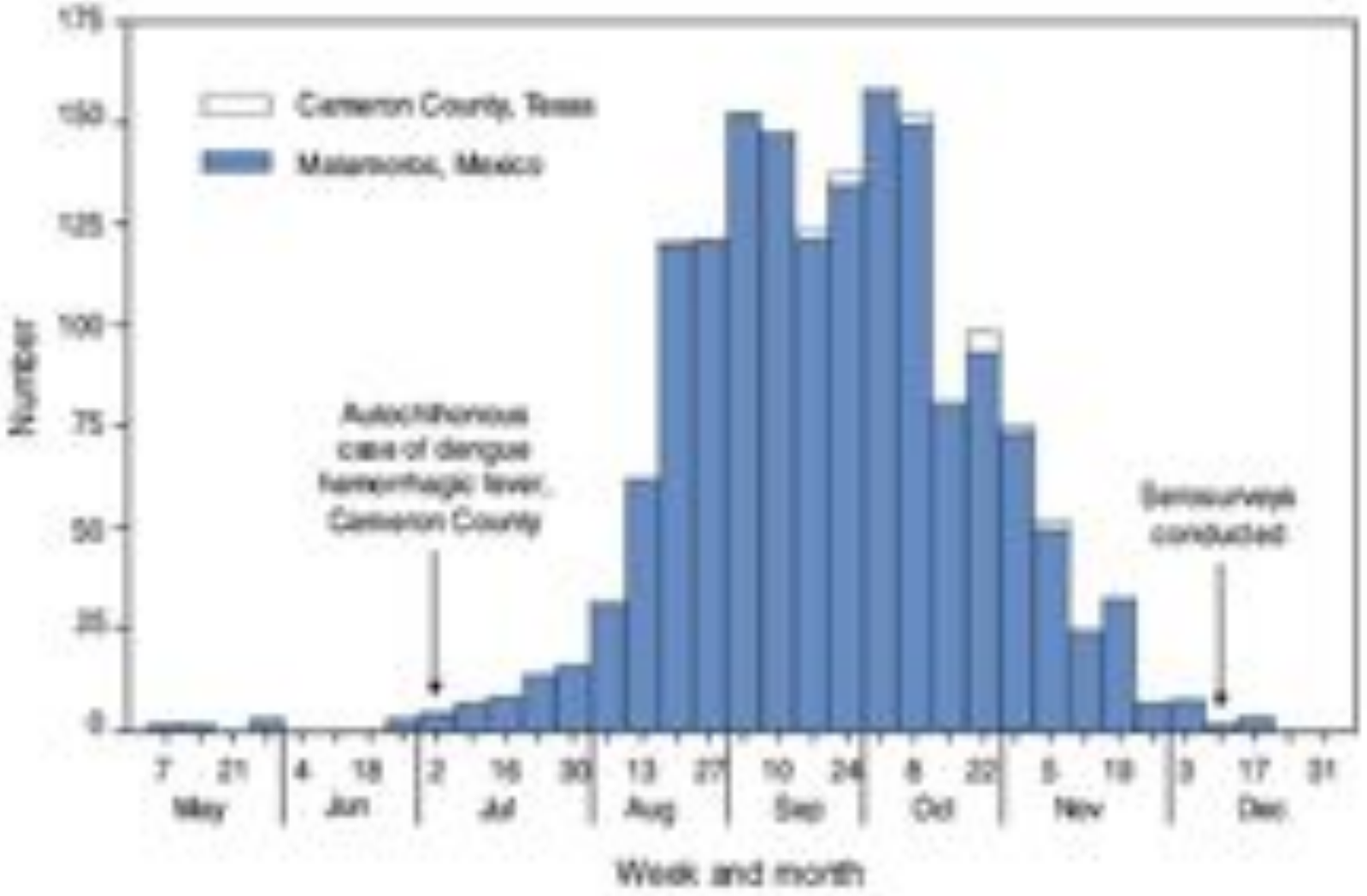
World Health Organization

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: WHO
Map Production: Public Health Mapping and GIS
Communicable Diseases (CDS) World Health Organization

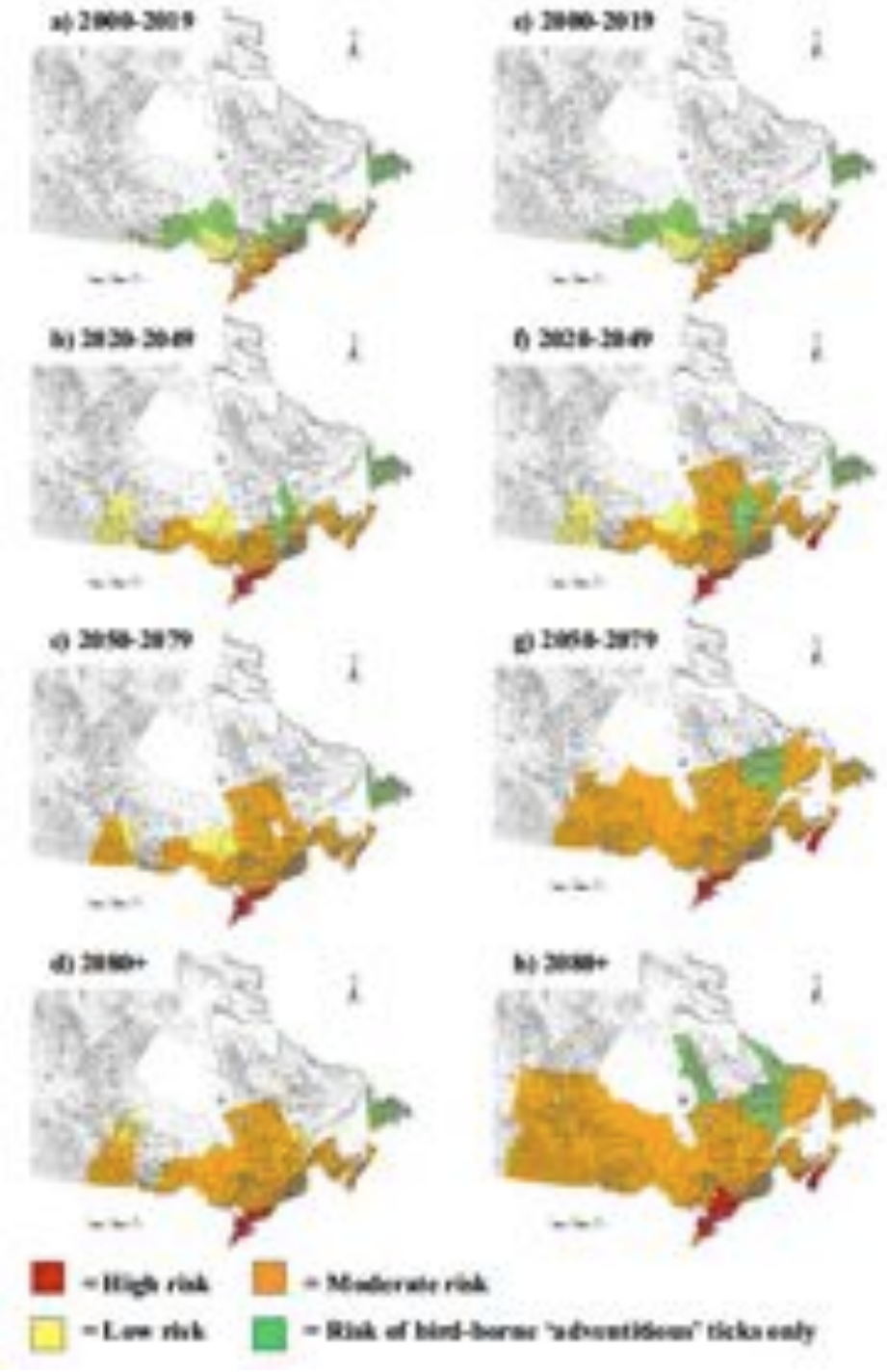
http://www.tropika.net/review/061001-Dengue_Recent_epidemiological_trends/F2.gif

Dengue Emerges in Texas



http://www.cdc.gov/MMWR/preview/mmwrhtml/mm5631a1.htm#fig2

Lyme Disease Vector *Ixodes scapularis* in Canada Now and With Climate Change



Ogden et al. 2008

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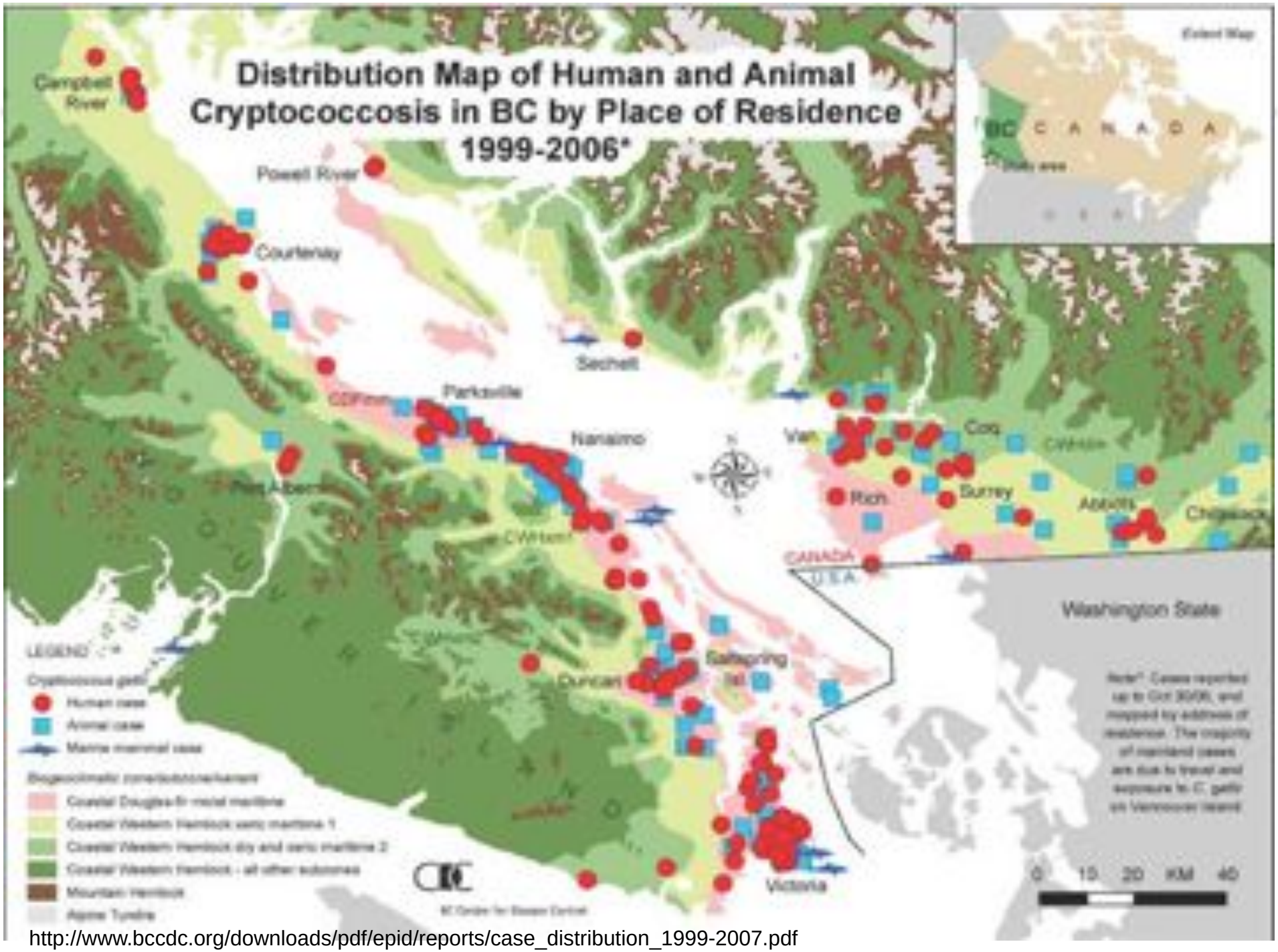


http://www.bccdc.org/downloads/pdf/epid/reports/case_distribution_1999-2007.pdf


0 1 5 10 35 57
Billion Tons Carbon


0 2 4 70 120
Mortality Per Million Population

Overwash in Tuvalu, 2005

The future ain’t what it used to be…

Curriero et al., 2002

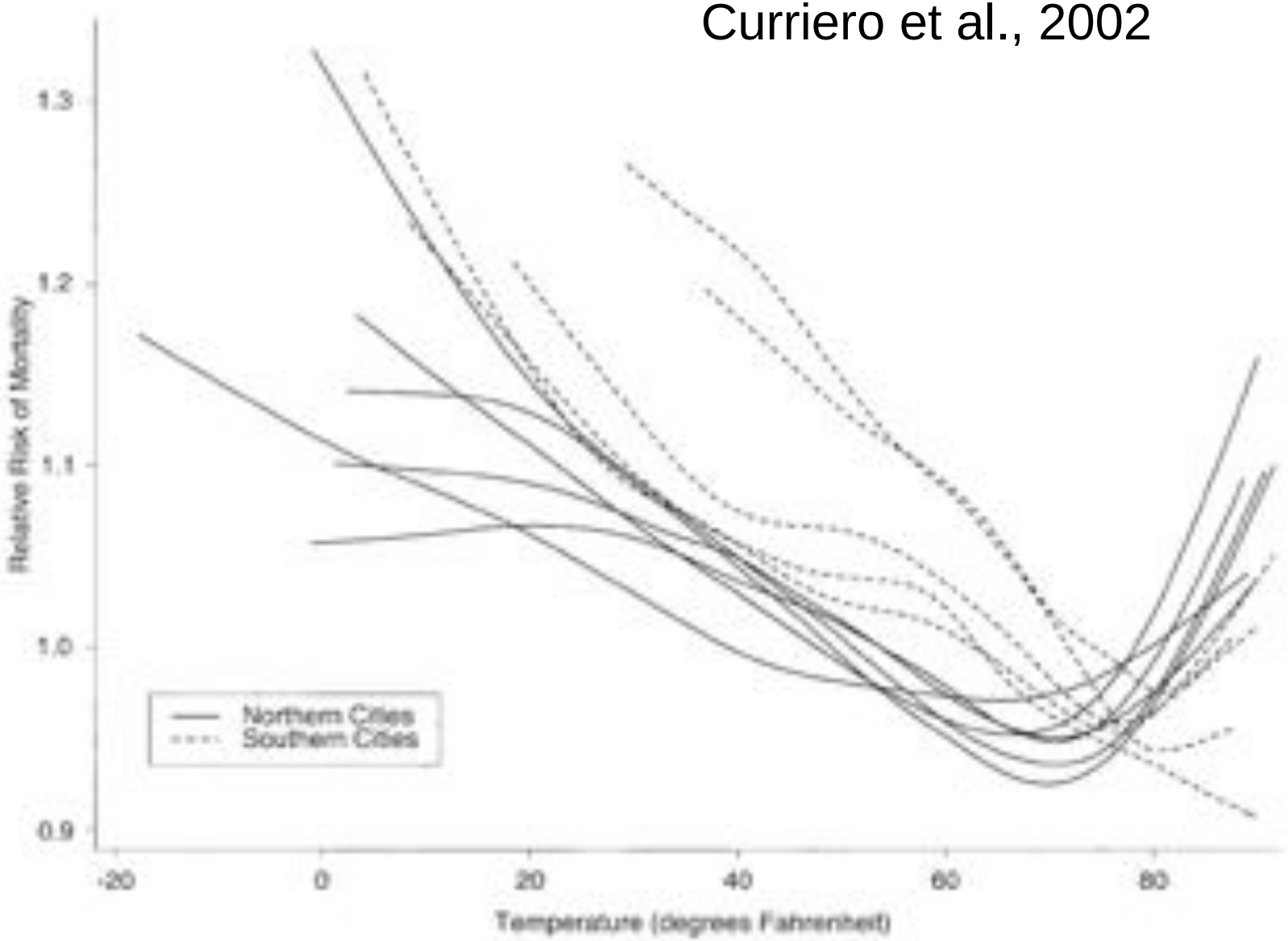
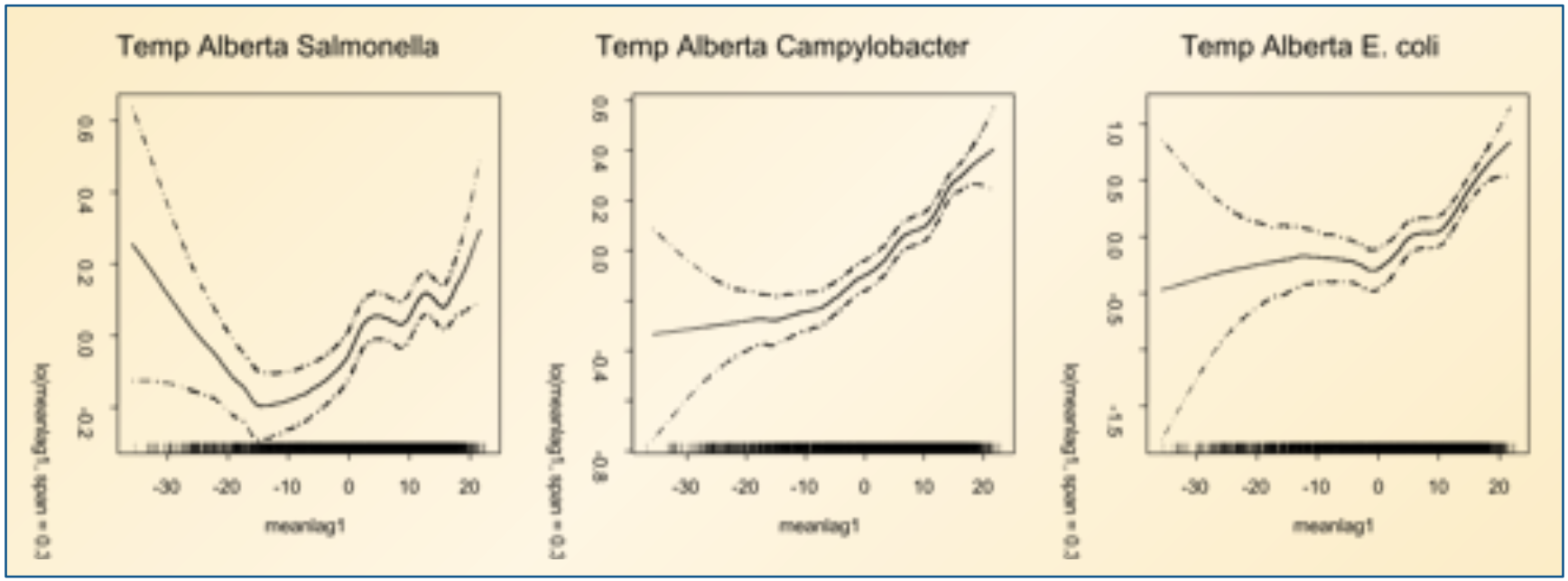


FIGURE 1. Temperature-mortality relative risk functions for 11 US cities, 1973–1994. Northern cities: Boston, Massachusetts; Chicago, Illinois; New York, New York; Philadelphia, Pennsylvania; Baltimore, Maryland; and Washington, DC. Southern cities: Charlotte, North Carolina; Atlanta, Georgia; Jacksonville, Florida; Tampa, Florida; and Miami, Florida. °C = 5/9 × (°F − 32).

Temperature and Enteric Disease



- RR of Salmonella increased by 1.2% per degree above - 10˚C
- RR of Campylobacter increased by 2.2% (4.5% in Newfoundland) per degree above - 10˚C
- RR of E. coli increased by 6.0% per degree above - 10˚C

Fleury et al. 2006

Ozone Mortality in NY, 2050

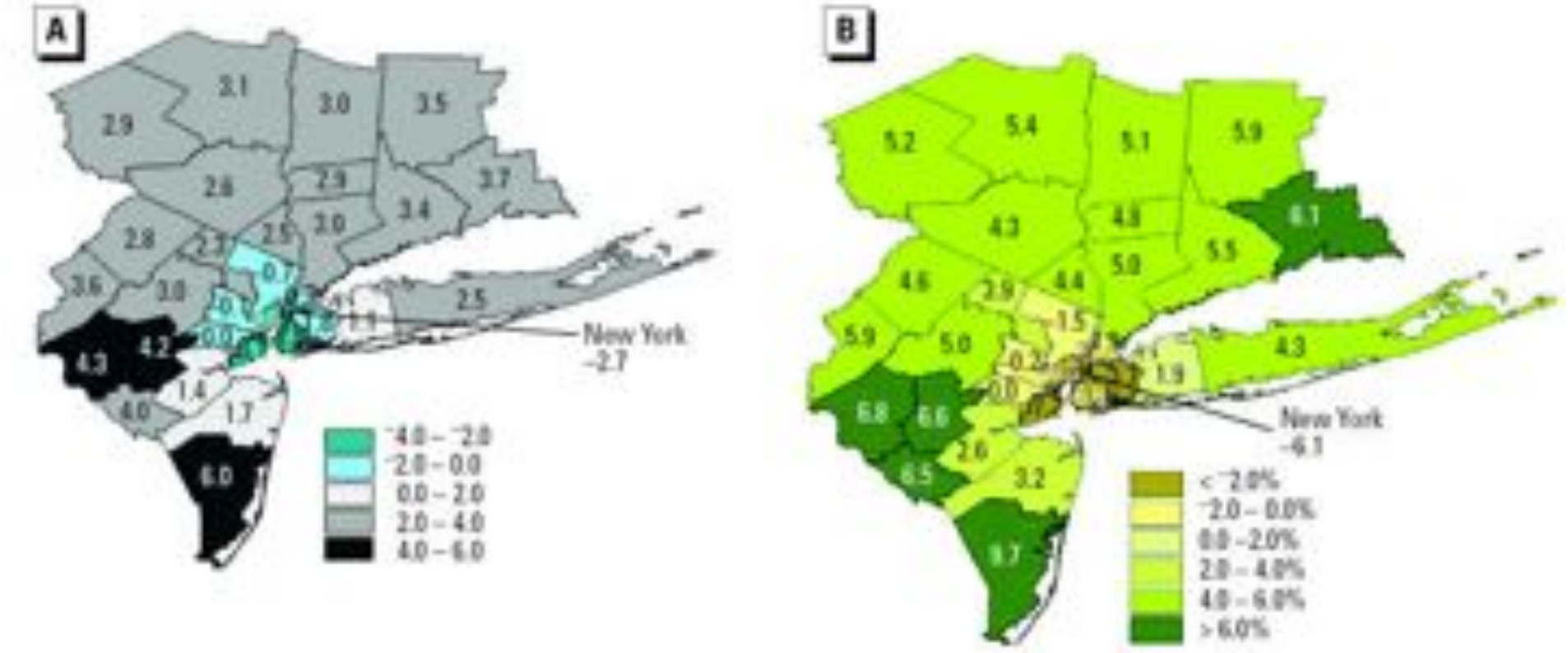


Figure 3
Estimated changes in O_3 and associated summertime mortality in the 2050s compared with those in the 1990s for M2, in which we include anthropogenic O_3 precursor emission changes along with greenhouse gas emission changes. (*A*) Changes in mean 1-hr daily maximum O_3 concentrations (ppb). (*B*) Percent changes in O_3-related mortality

Modeling malaria transmission in Tanzania

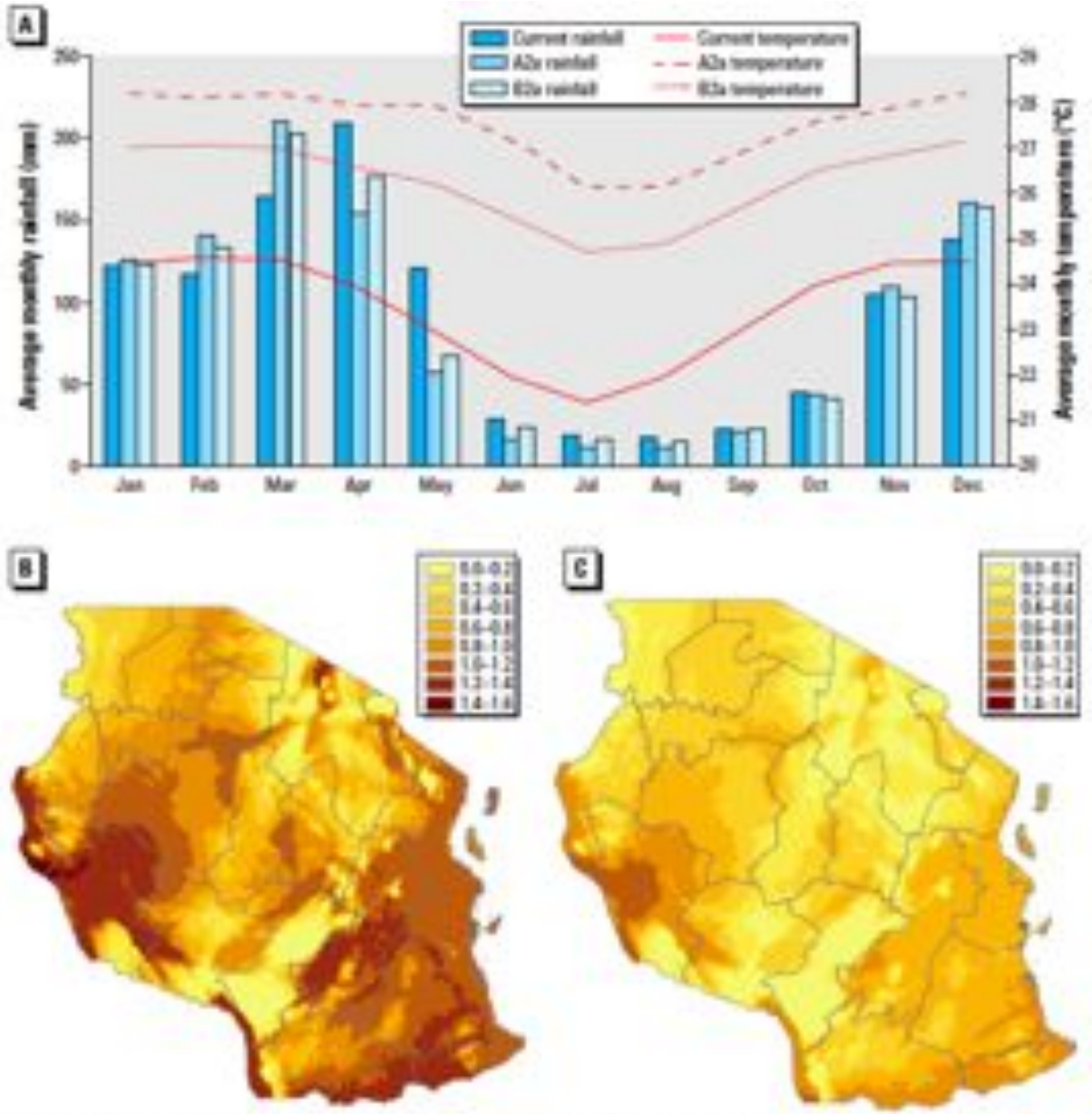


Figure 3. Rainfall and temperature profiles and predicted R_0 changes in Tanzania. (*A*) Current rainfall and temperature profiles for Tanzania versus the predictions of HadCM3 for 2080 under A2a and B2a emission scenarios (data from WorldClim 2009). Predicted changes in R_0 across Tanzania in 2080 under (*B*) A2a and (*C*) B2a emission scenarios where $r = 0.98$ and $\omega = 0.65$ at present and $r = 0.99$ and $\omega = 0.65$ under A2a and B2a.

Parham and Michael, EHP, 2010

Yogi Berra on modeling uncertainty

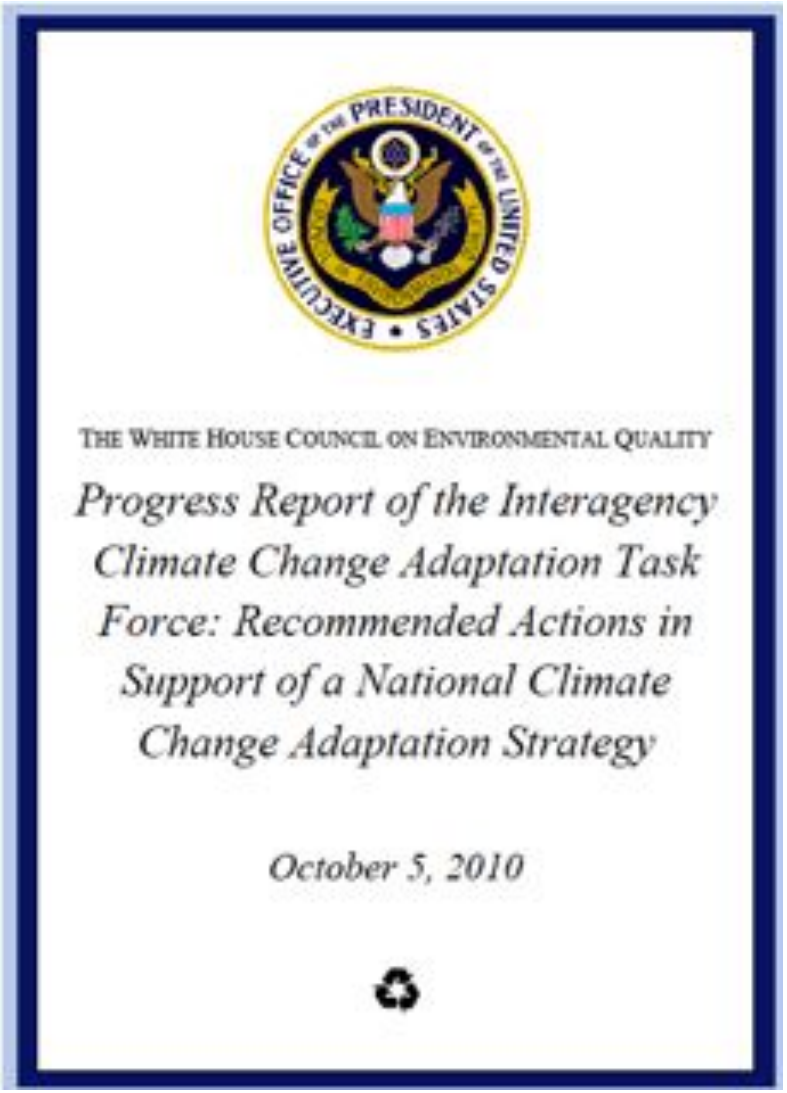
"It's tough to make predictions, especially about the future"

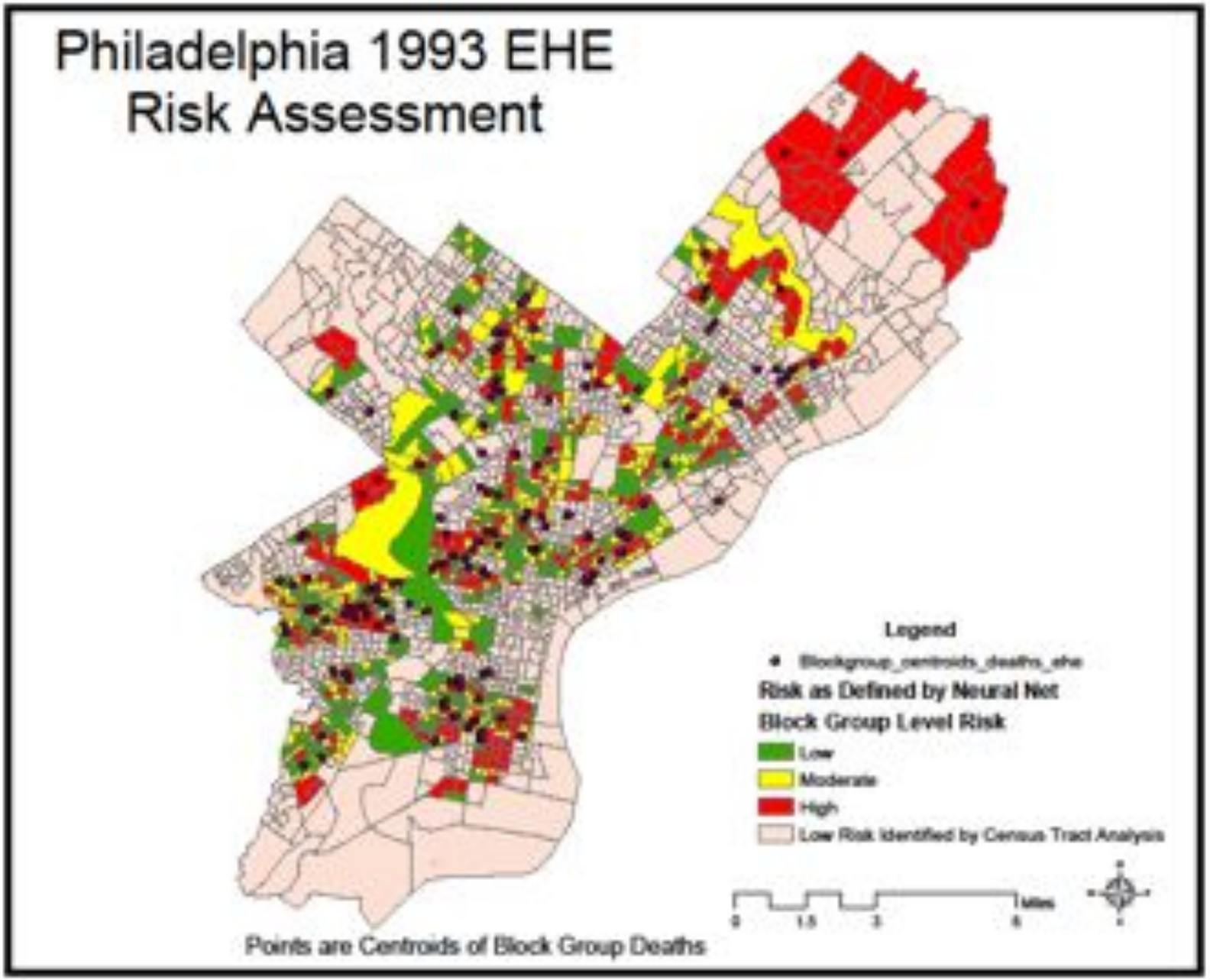
Solutions: what should we be doing to reduce risks and increase resilience?

- Vulnerability mapping, monitoring and early warning systems
- Urban infrastructure
- Health systems infrastructure
- Reduce health disparities

President's Climate Adaptation Task Force: Health Recommendation

- Protect human health by addressing climate change in public health activities
  - Enhance the ability of Federal decision makers to incorporate health considerations into adaptation planning
  - Build integrated public health surveillance and early warning systems to improve detection of climate change health risks
  - Promote resilience of individuals and communities to climate-related health risks




Philadelphia 1993 EHE
Risk Assessment
Legend
Blockgroup_centroids_deaths_ehe
Risk as Defined by Neural Net
Block Group Level Risk
Low
Moderate
High
Low Risk Identified by Census Tract Analysis
Miles
0
1.5
3
6
Points are Centroids of Block Group Deaths

Public health interventions for heat stress

- Reduce Hazard
  - Mitigate urban heat islands; mitigate greenhouse gas emissions
- Reduce Exposure
  - Set up cooling centers; subsidize utility bill payments
- Reduce vulnerability
  - Social programs; medical services; health education

Impact(Risk)=
Hazard x Exposure x Vulnerability

Sprawl vs. Heat Islands

Lessons from Katrina: NOLA Health Care System pre and post

EXHIBIT 1
Selected Characteristics Of The New Orleans Area Before And After Hurricane Katrina

Characteristic	Pre-Katrina	Post-Katrina Number/amount	Post-Katrina Change
Population			
Orleans Parish	437,186	262,200	−40.0%
Jefferson Parish	448,578	363,309	−19.0
Medicaid enrollment			
Aged, blind, and disabled	214,264	198,194	−7.5
Children and parents	724,528	750,673	3.6
Orleans Parish	134,249	122,308	−8.9
St. Bernard Parish	12,214	11,497	−5.9
Plaquemines Parish	5,389	5,170	−4.1
Jefferson Parish	83,101	86,498	4.1
East Baton Rouge Parish	80,711	87,022	7.8
West Baton Rouge Parish	4,151	4,426	6.6
Adult nonelderly uninsured			
Orleans Parish	26%	35–50%	
Jefferson Parish	21	35–50	
Plaquemines Parish	23	35–50	
St. Bernard Parish	22	35–50	
Staffed inpatient bed capacity			
Greater New Orleans area	4,083	1,971	
Orleans Parish	2,269	479	
Regional inpatient psychiatric beds	462	160	
Hospital daily census	2,500	1,677[a]	
Safety-net clinics	90	19	
Health professionals[b]			
Physicians	1,480	1,200	
Emergency medical services units	15–17	7	
Long-term care services[c]			
Nursing home providers	51	29	
Nursing home beds	4,954	2,735	
Long-term acute care beds	575	97	

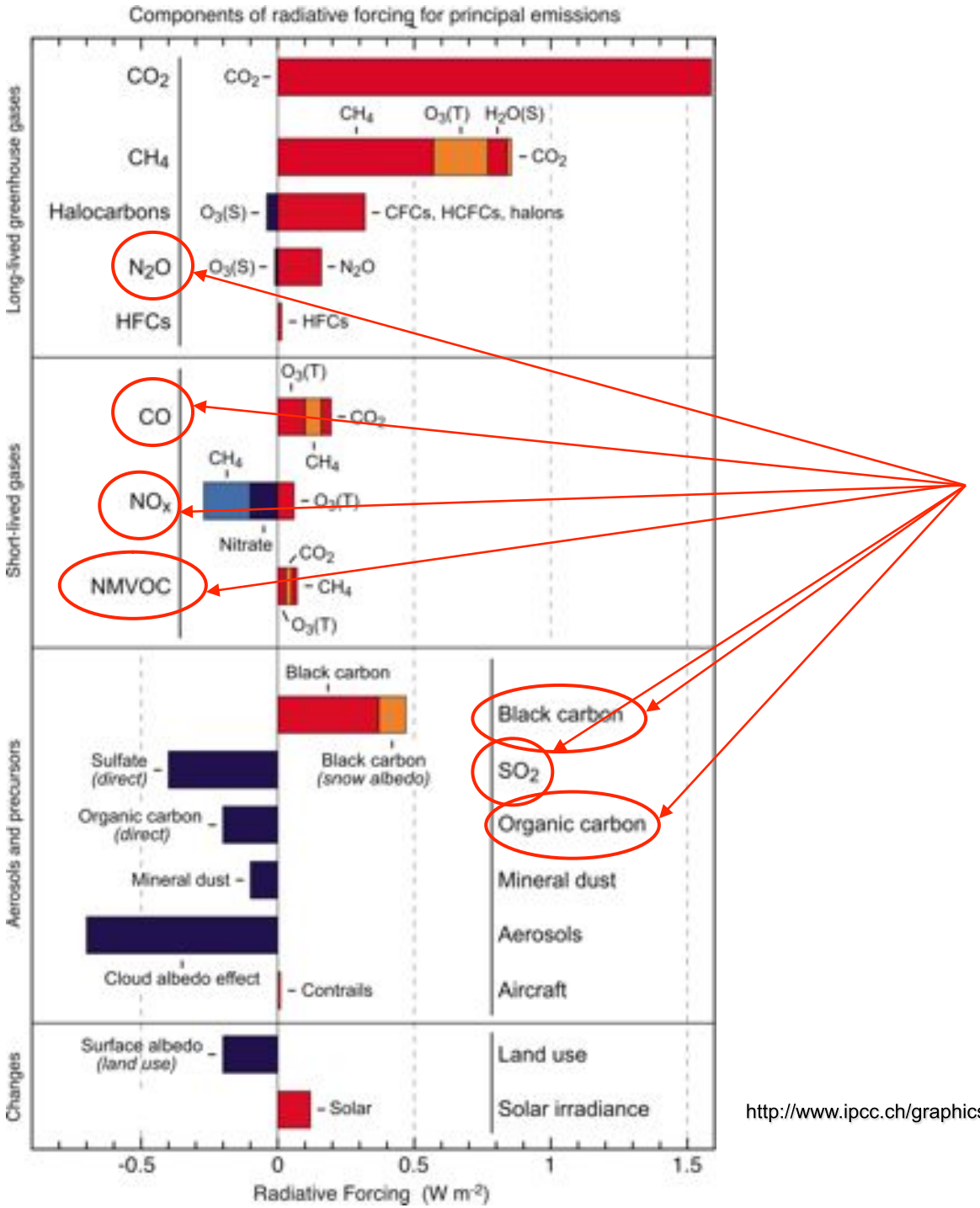
Rudowitz et al., 2006

How can adaptation planning promote improved health?

Address major health problems	Drivers
Obesity	Physical activity, food access
Cardiovascular Disease	Physical activity, food, air pollution
Respiratory Disease	Air pollution, physical activity
Heat stroke, drowning, injuries	Extreme weather, infrastructure and response

Avoid unintended consequences	Types of measures associated
Increased air pollution exposures	Siting, land use, transportation, ag
Increased disease transmission	Land use, irrigation
Increased toxic exposures	Alternative materials, water reuse, food handling


http://static.howstuffworks.com/gif/5-green-future-cities-3.jpg



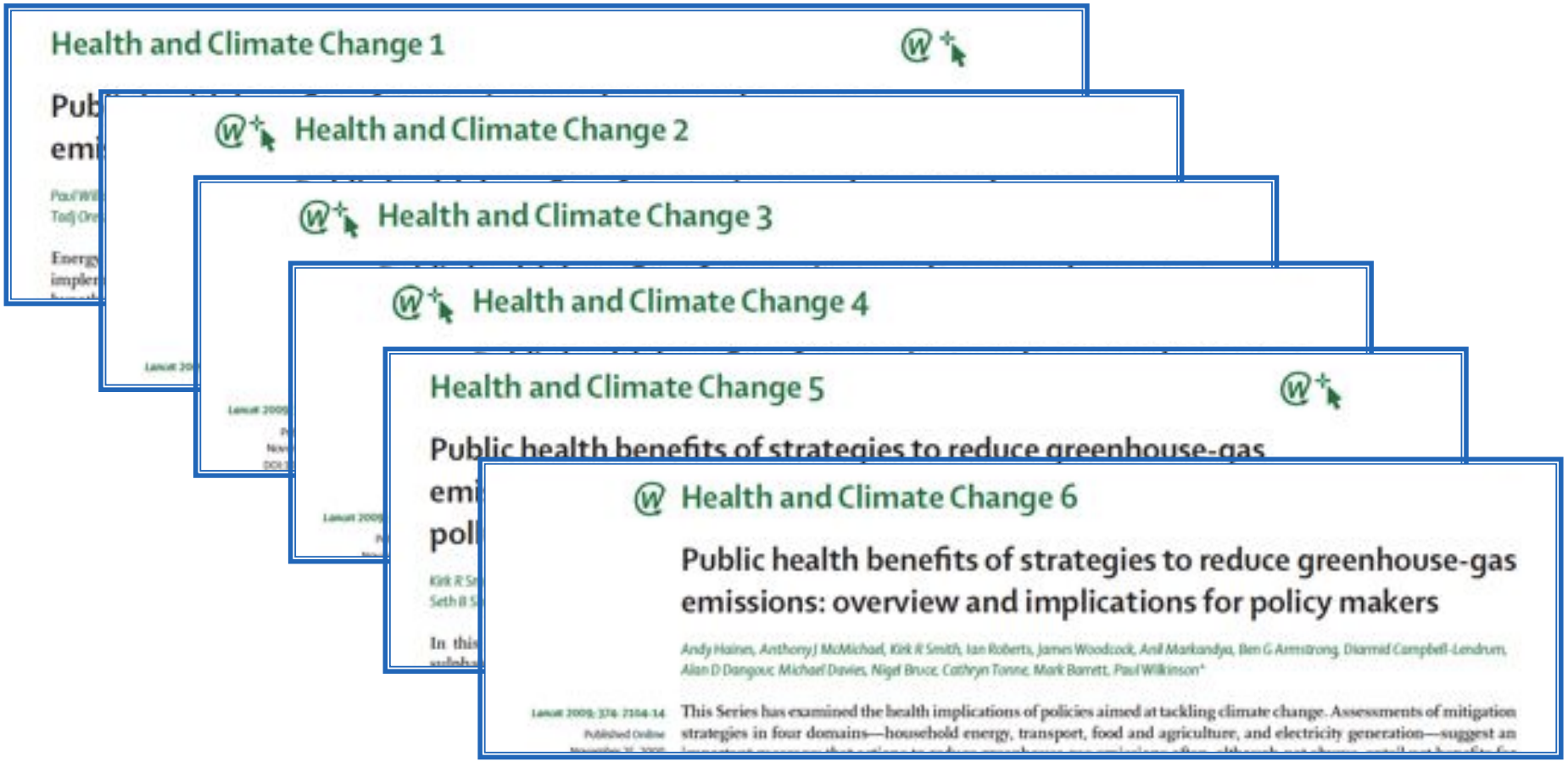
All affect human health

http://www.ipcc.ch/graphics/graphics/ar4-wg1/ppt/figure02.ppt#278,22,Figure 2.21

Potential Co-benefits of GHG Mitigation Policies

- Energy generation – decreased air pollution
- Transportation – increased physical activity, decreased air pollution, decreased injuries from collisions
- Agriculture – reduced red meat consumption
- Agriculture – improved nutrition

Identifying synergies and opportunities for co-benefits



A Human Health Perspective on Climate Change

- Identifies research needed to better understand the health effects of climate change, and choose the healthiest mitigation and adaptation strategies:
  - 11 Health Consequences Categories
  - Crosscutting issues
- Use by individual agencies to inform their research agendas and to develop a coordinated federal research agenda on climate change and health

www.niehs.nih.gov/climatereport

Some Questions

- What would you want your doctor to know about the health implications of climate change? What would you want him or her to do based on your understanding of the health implications?
- Consideration of the public health implications of climate change and societal responses to climate change introduces opportunities for synergistic solutions. What are some of the most important opportunities?
- How would you balance the unmet health needs of the present (e.g., health services for the uninsured and underinsured, obesity and diabetes epidemics, etc.) with preparing for the futures threats from climate change?

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Thank you!

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National Toxicology Program
U.S. Department of Health and Human Services

Srp
Superfund
Research Program