

# Climate Change

What every public health practitioner needs to know

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Interim Director, Center for Climate Health & the Global Environment  
Harvard TH Chan School of Public Health

# Faculty Disclosure Information

I have had no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial service(s) discussed in this lecture.

I do not intend to discuss an unapproved/investigative use of a commercial product/device in my presentation



# Learning Objectives

At the conclusion of the session, participants should:

1. Recognize the potential of climate change to produce public health surprises from infections, heat, and water contamination.
2. Advance improvements in disaster preparedness based upon the changing risks of extreme weather with climate change, especially for heat and hurricanes.
3. Evaluate the potential of climate actions to address health disparities.

**Surprises**

# **#1 Floods**



# Flooding from Fred in Worcester

~3.5in rainfall in <24 hrs



Flash flooding on Kansas Street in Worcester, MA on Aug. 19, 2021. (Boston 25 News)



A Worcester DPW worker looked to unclog a storm drain on Southbridge Street in Worcester. JOHN TLUMACKI/GLOBE STAFF



Worcester police officers inspected the intersection of Canton and Quinsigamond Streets. JOHN TLUMACKI/GLOBE STAFF

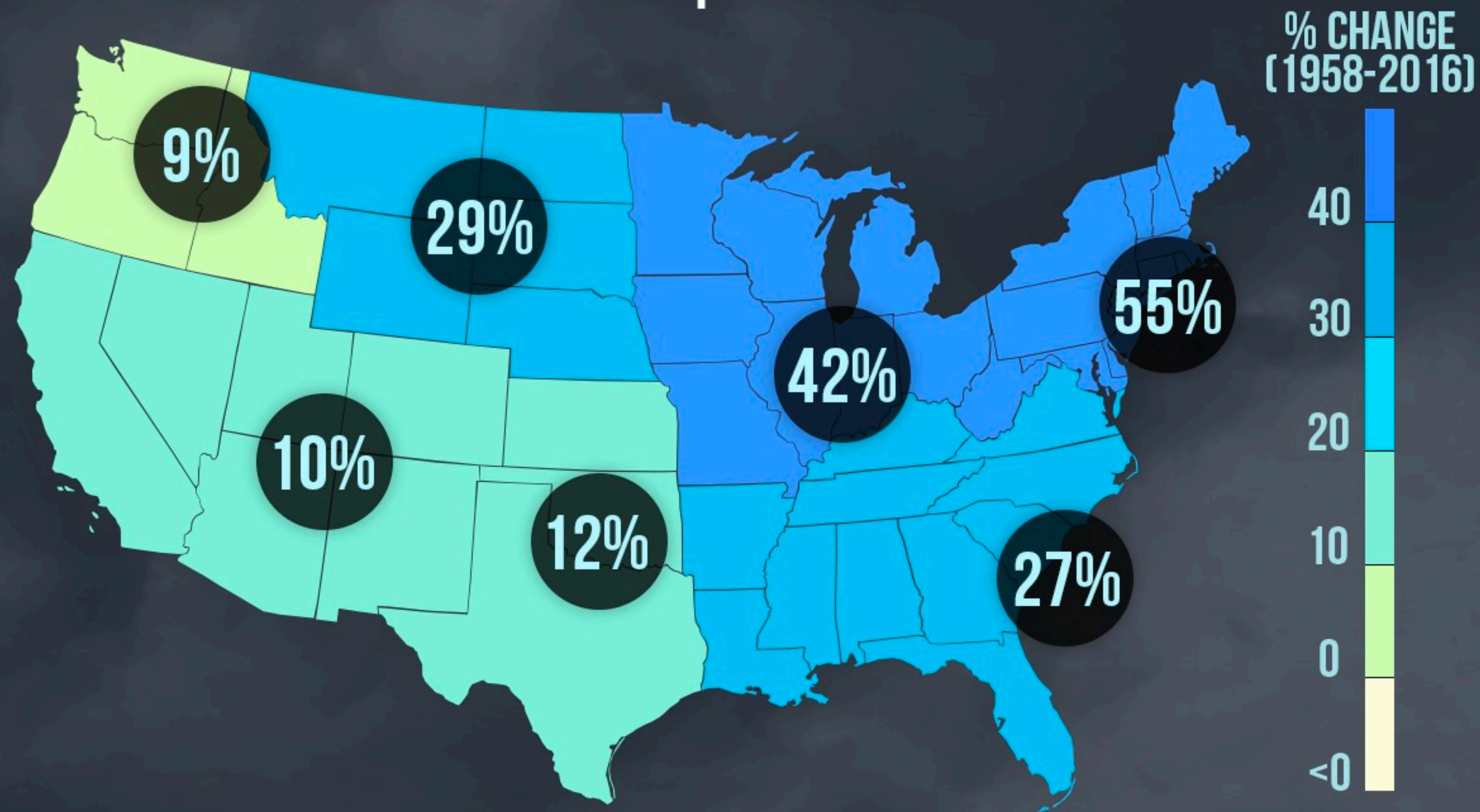


Flash flooding on Kansas Street in Worcester, MA on Aug. 19, 2021. (Boston 25 News) BOSTON 25 NEWS



# MORE DOWNPOURS

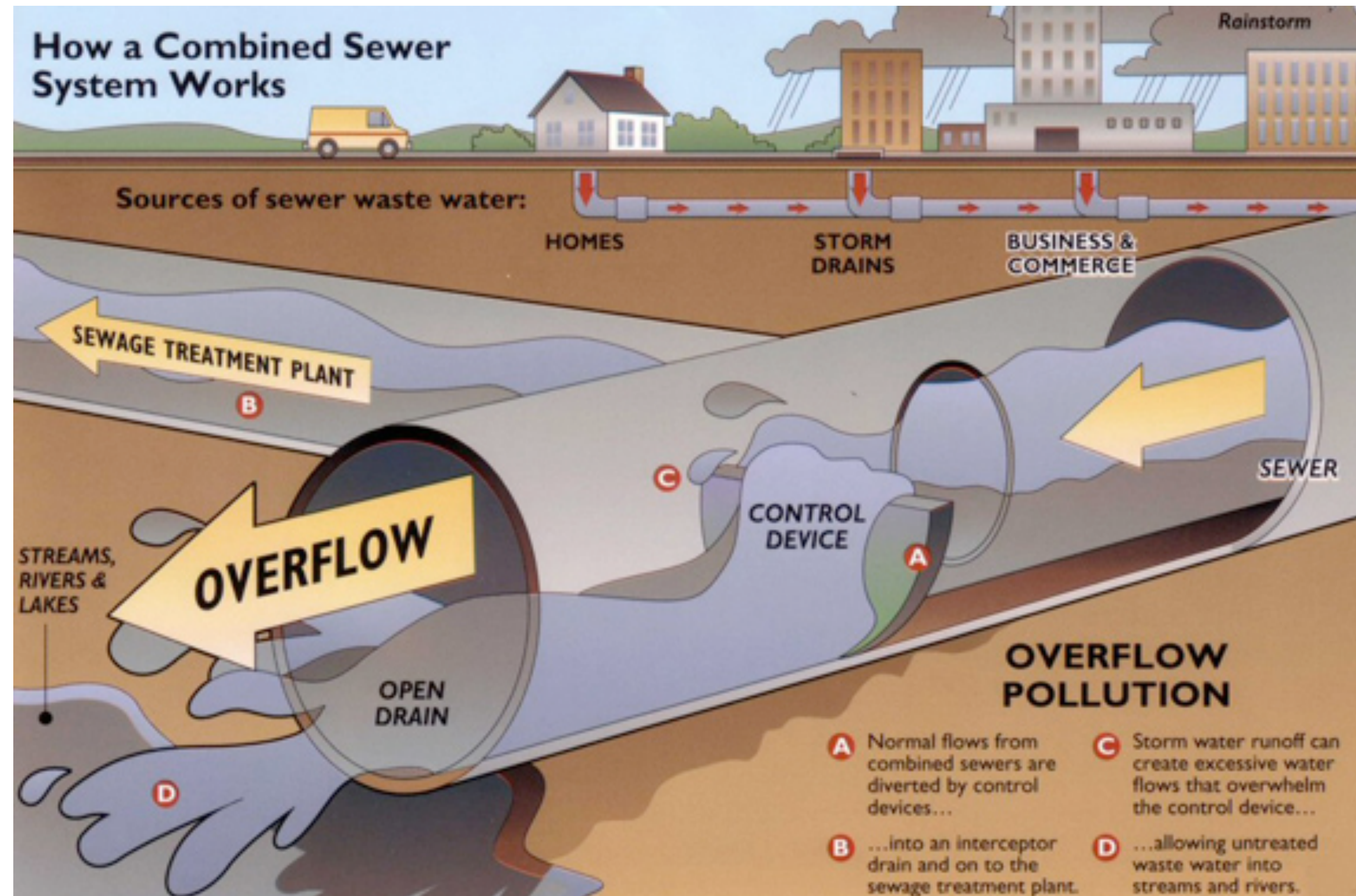
Increase in Heaviest Precipitation Events



Heaviest events defined as top 1% of events  
Source: USGCRP Climate Science Special Report 2017

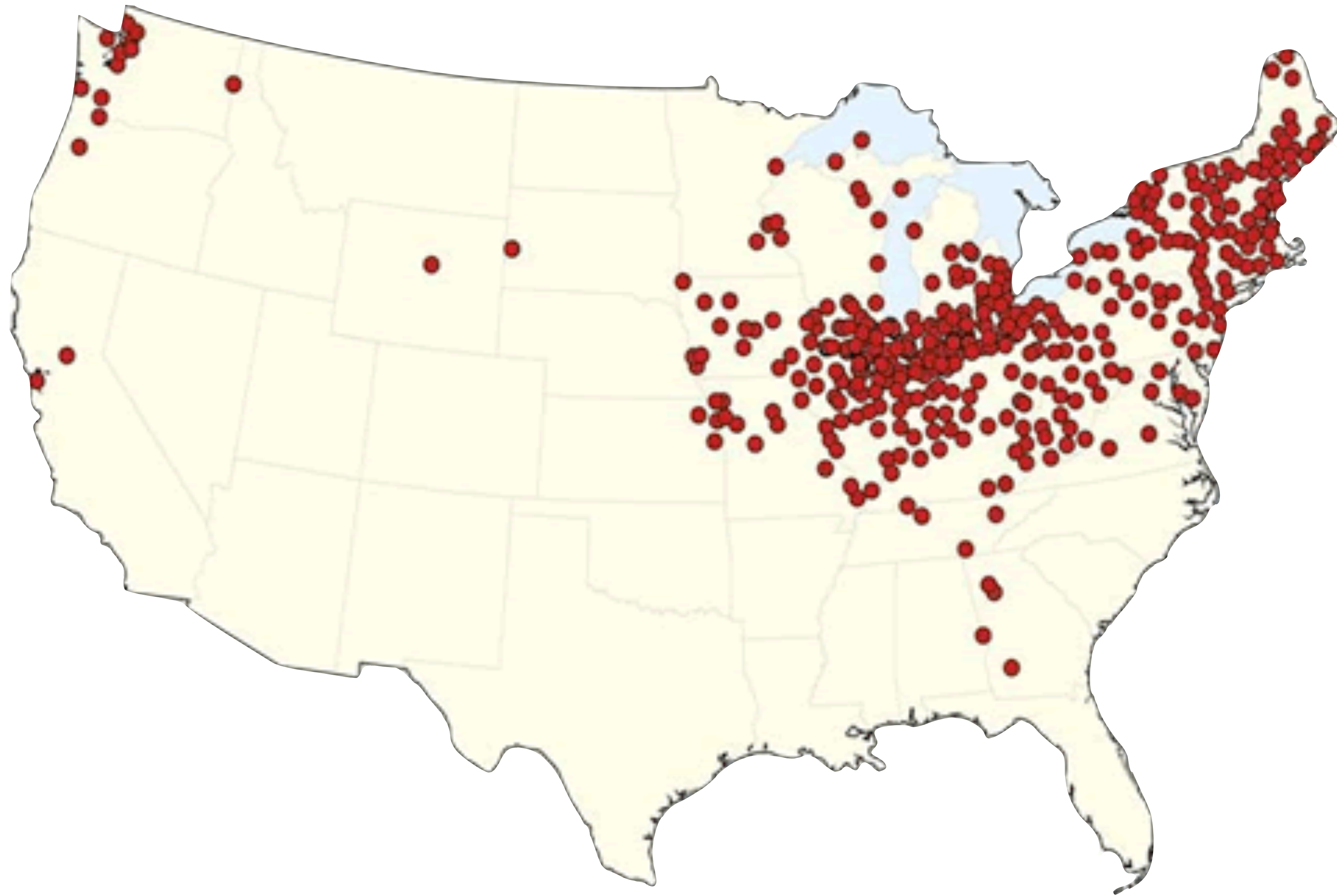


# Combined sewers: a risk for waterborne disease outbreaks with climate change





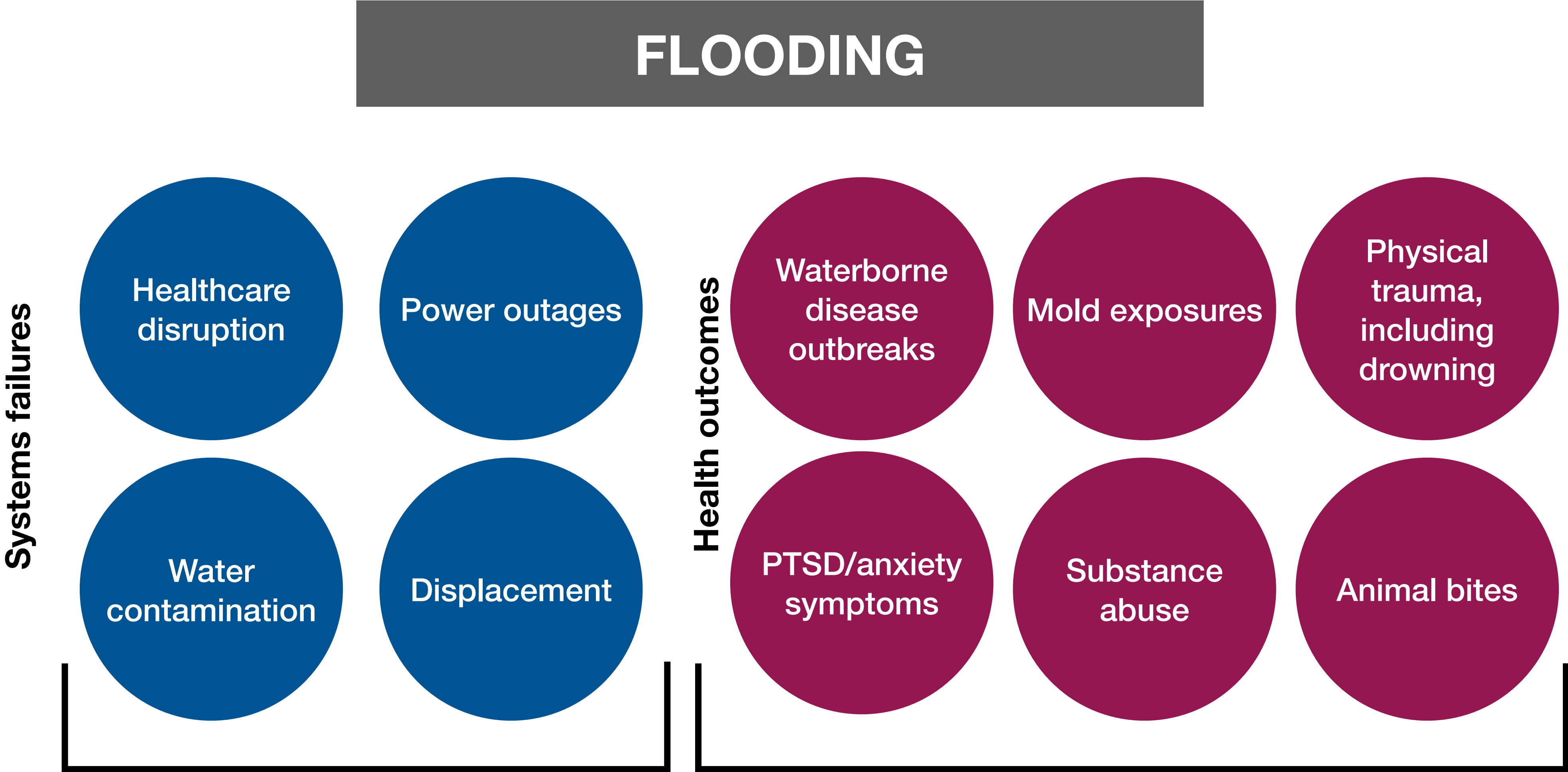
# Combined sewers: a risk for waterborne disease outbreaks with climate change



**What are the health risks after flooding?**



# Pathways from floods to health

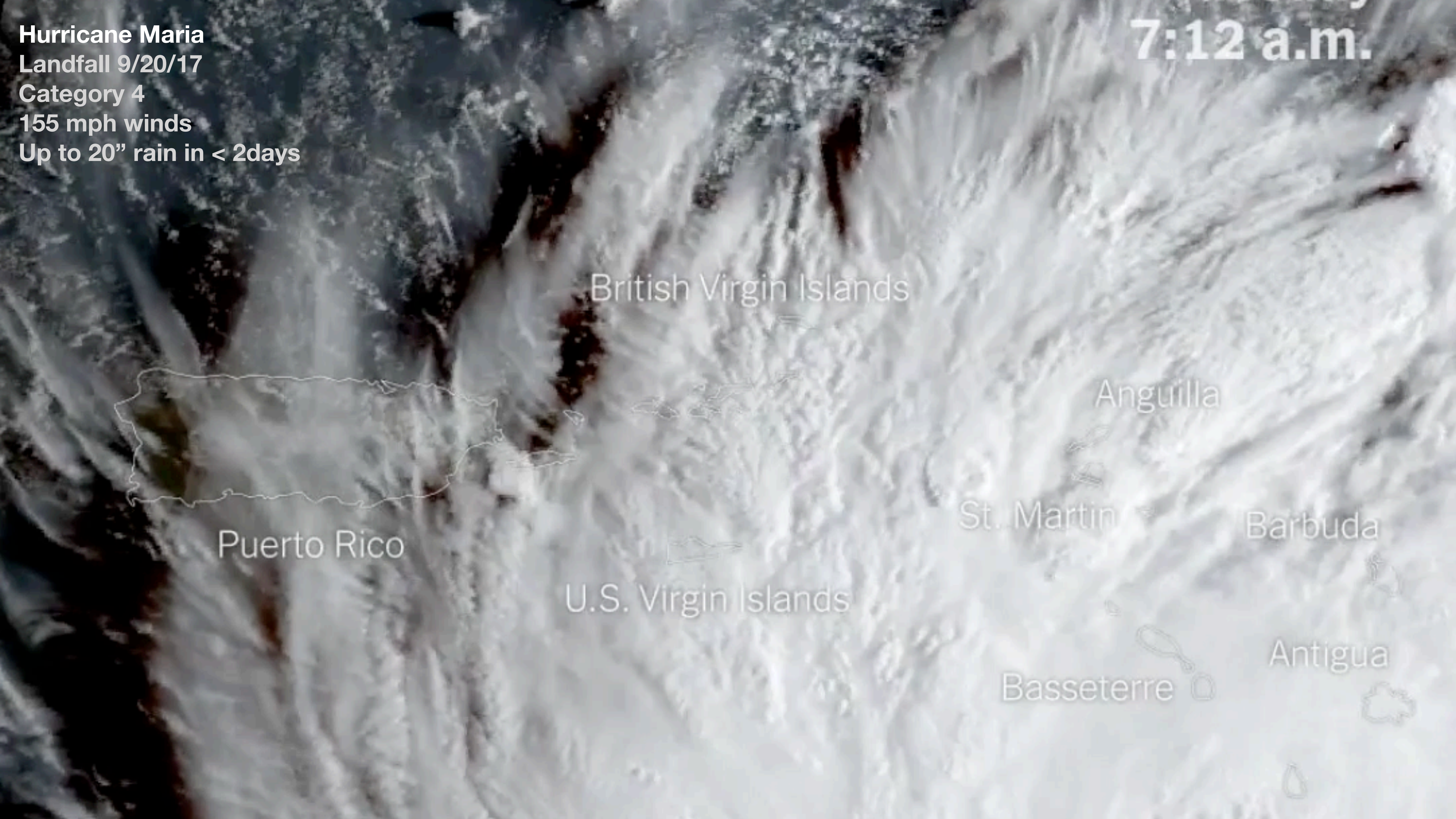


# **#2 Hurricanes**



7:12 a.m.

**Hurricane Maria**  
**Landfall 9/20/17**  
**Category 4**  
**155 mph winds**  
**Up to 20" rain in < 2days**



British Virgin Islands

Anguilla

St. Martin

Barbuda

Puerto Rico

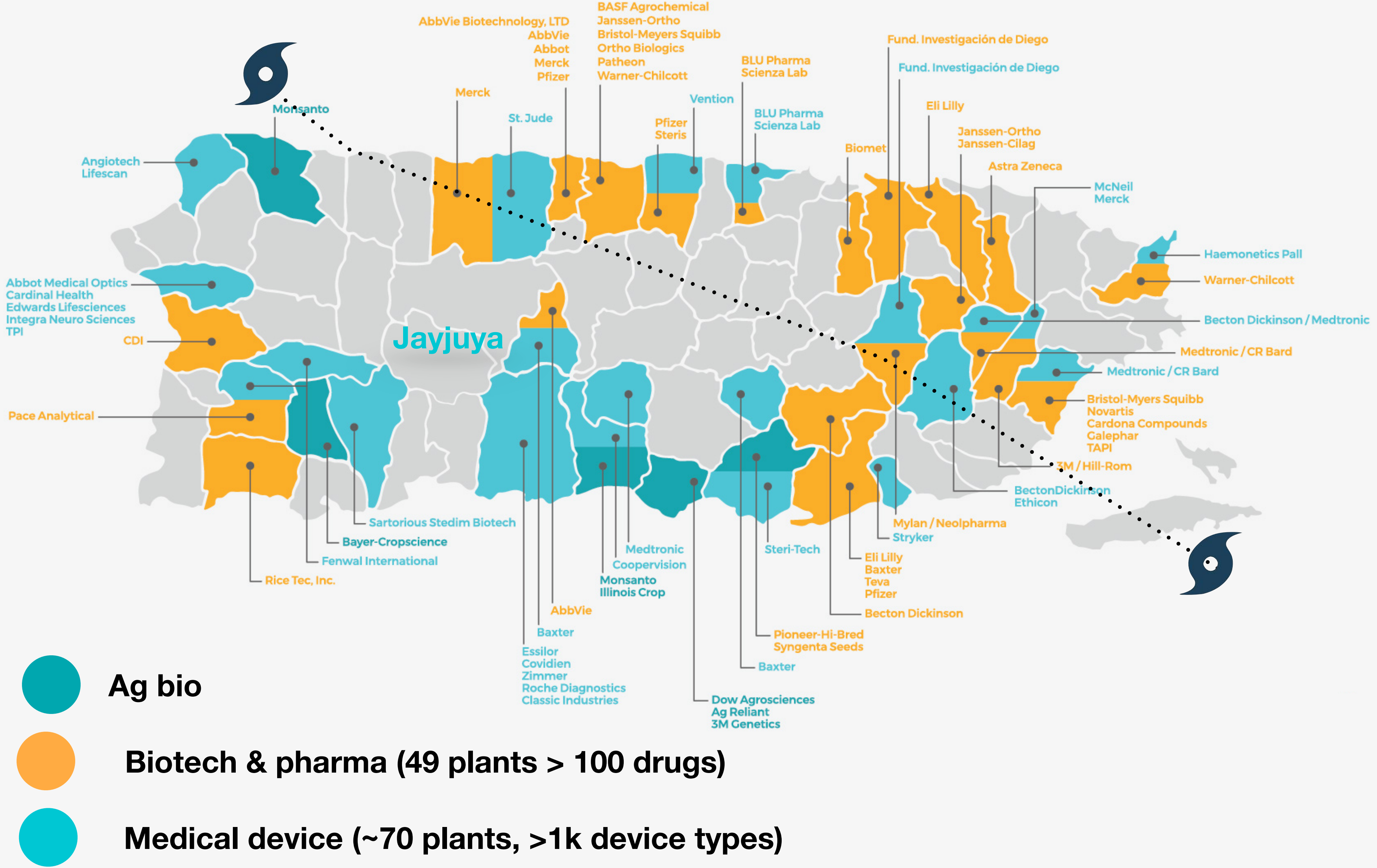
U.S. Virgin Islands

Basseterre

Antigua



# Puerto Rico Biomedical Manufacture and Maria



Data on location of factories from Pridco



**Hurricane Maria devastated Puerto Rico.  
Then it caused a ripple effect in mainland hospitals.**

PRI's The World, December 06, 2017



Hospitals in the US mainland are facing shortages of IV fluids and medicine because of Hurricane Maria's damage to Puerto Rico.  
Credit: Paulo Whitaker/Reuters





The NEW ENGLAND  
JOURNAL of MEDICINE

PERSPECTIVE

FACING THE SHORTAGE OF IV FLUIDS

## Facing the Shortage of IV Fluids — A Hospital-Based Oral Rehydration Strategy

Andrés M. Patiño, M.D., Regan H. Marsh, M.D., M.P.H., Eric J. Nilles, M.D., Christopher W. Baugh, M.D., M.B.A., Shada A. Rouhani, M.D., M.P.H., and Stephanie Kayden, M.D., M.P.H.

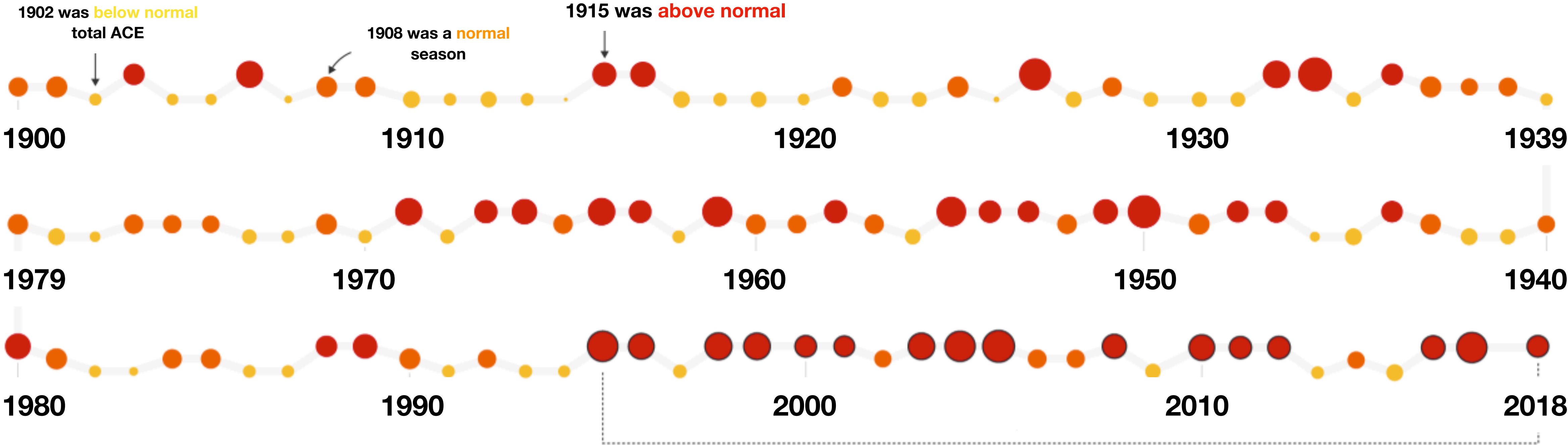
N ENGL J MED 378;16 NEJM.ORG APRIL 19, 2018



# Ocean heat is hurricane food

With climate change, hurricanes are: getting **stronger**  
intensifying **faster**  
slowing **down**  
**less frequent**

The NOAA Accumulated Cyclone Energy (ACE) Index is a measure of total wind energy for basin and landfalling tropical cyclone activity.



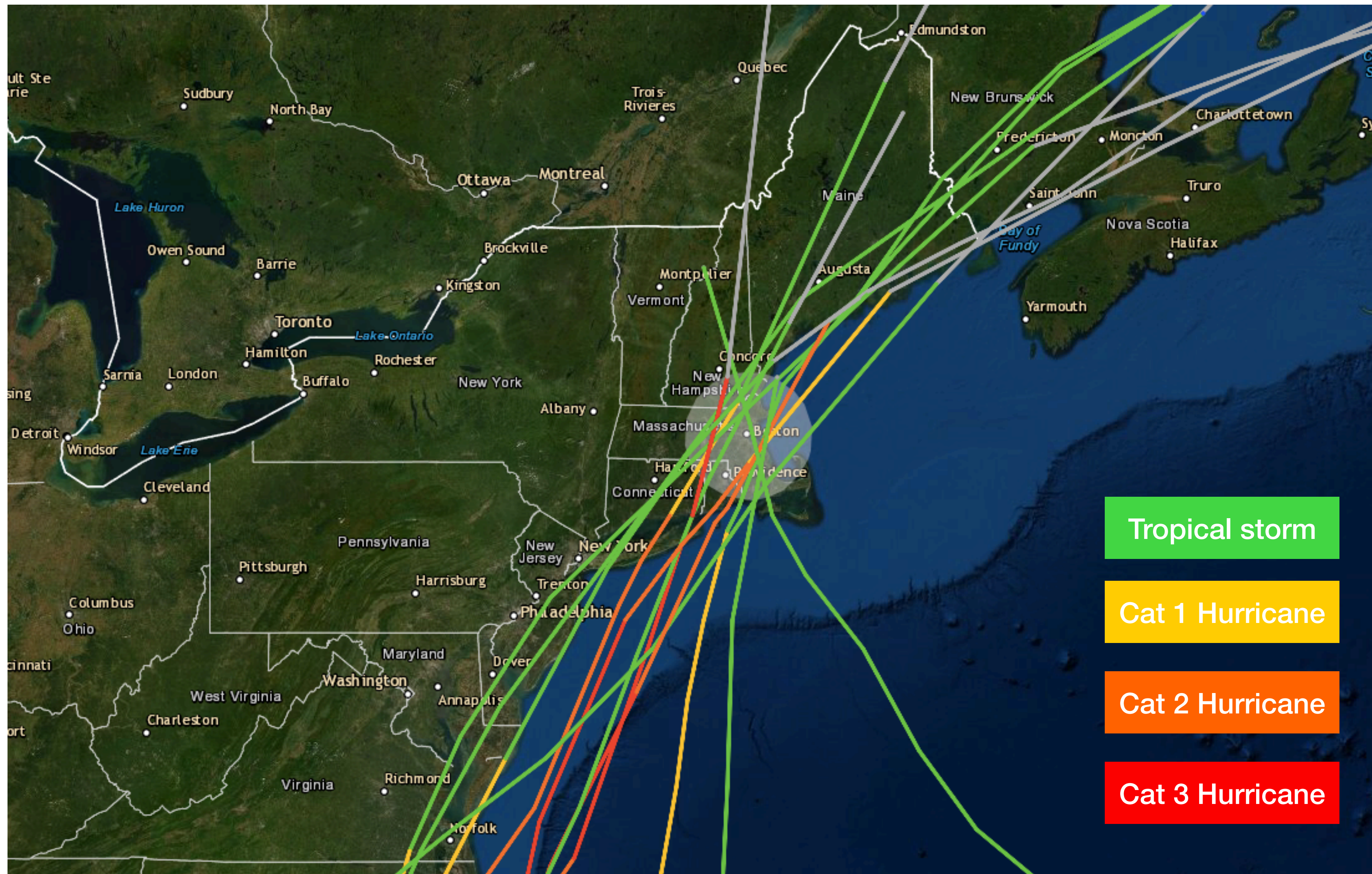
In the past 24 years there have been **16 above normal hurricane seasons**, the worst on record

Source: Earth System Research Laboratory/The Guardian



# Storm tracks within 50 nautical miles of Boston since 1900 (n=12)

(Sandy had a hurricane strength wind radius of 175mi)

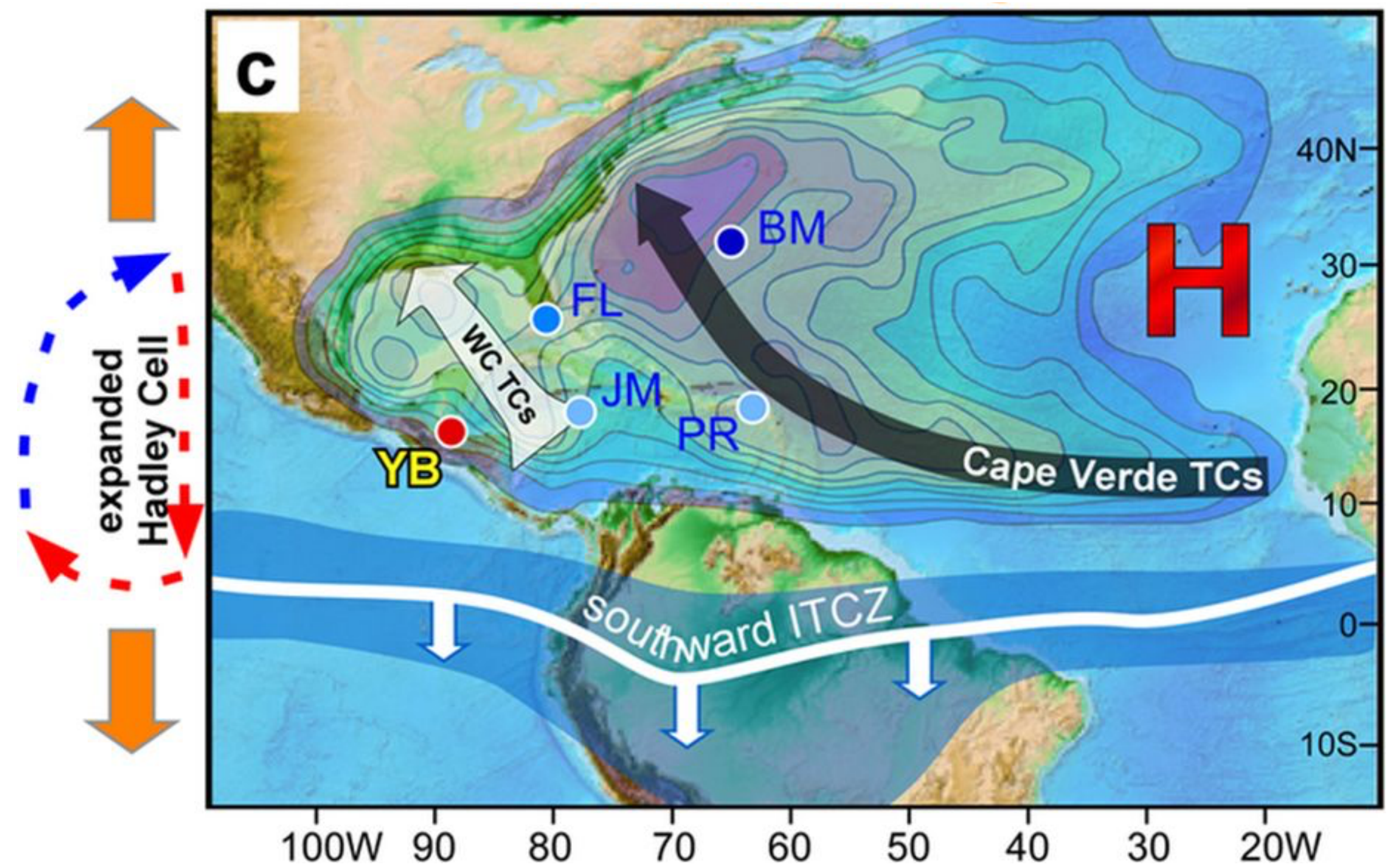
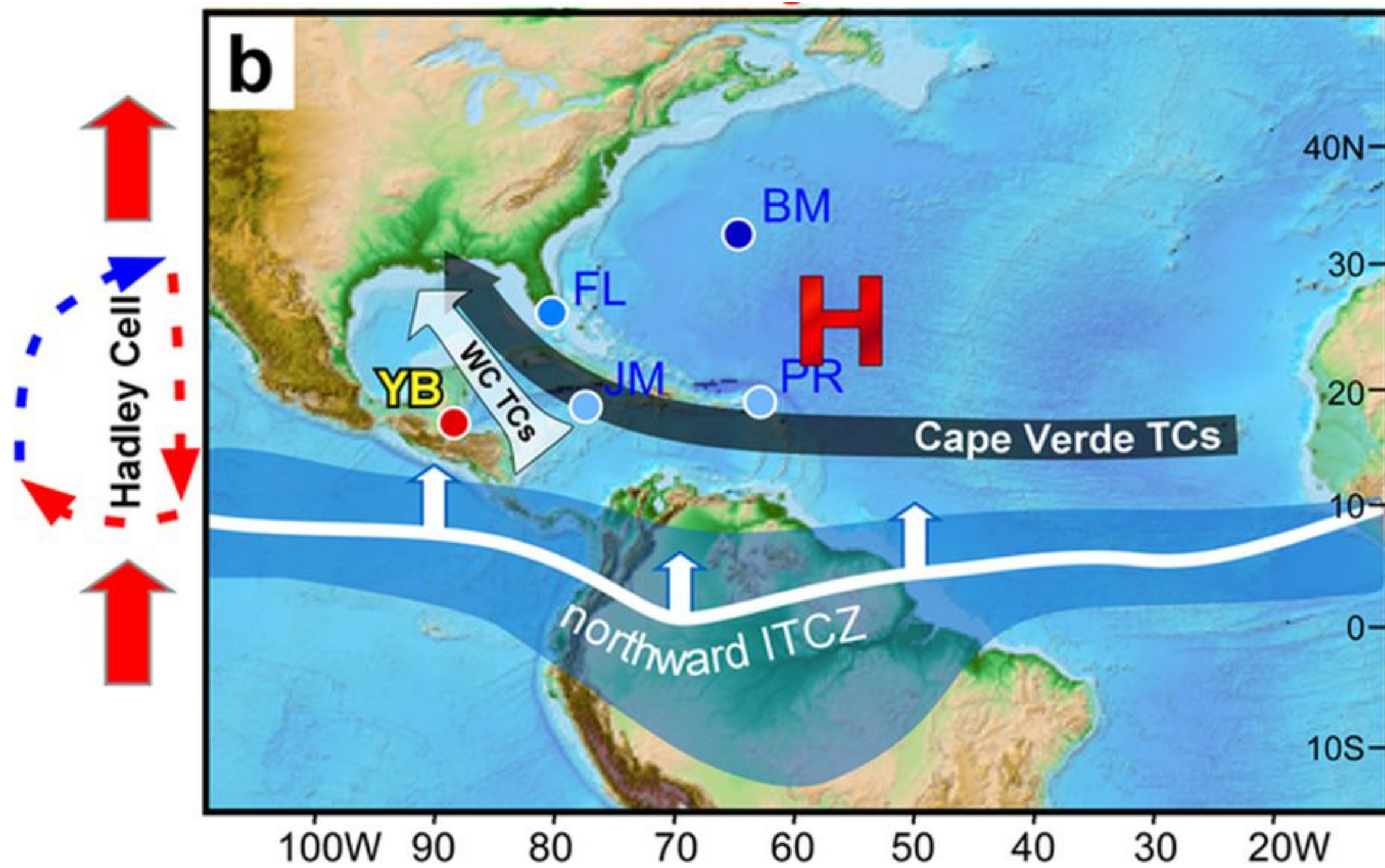




# Hurricanes are headed northward

Pre-industrial hurricane paths

Hurricane paths shift post 1870

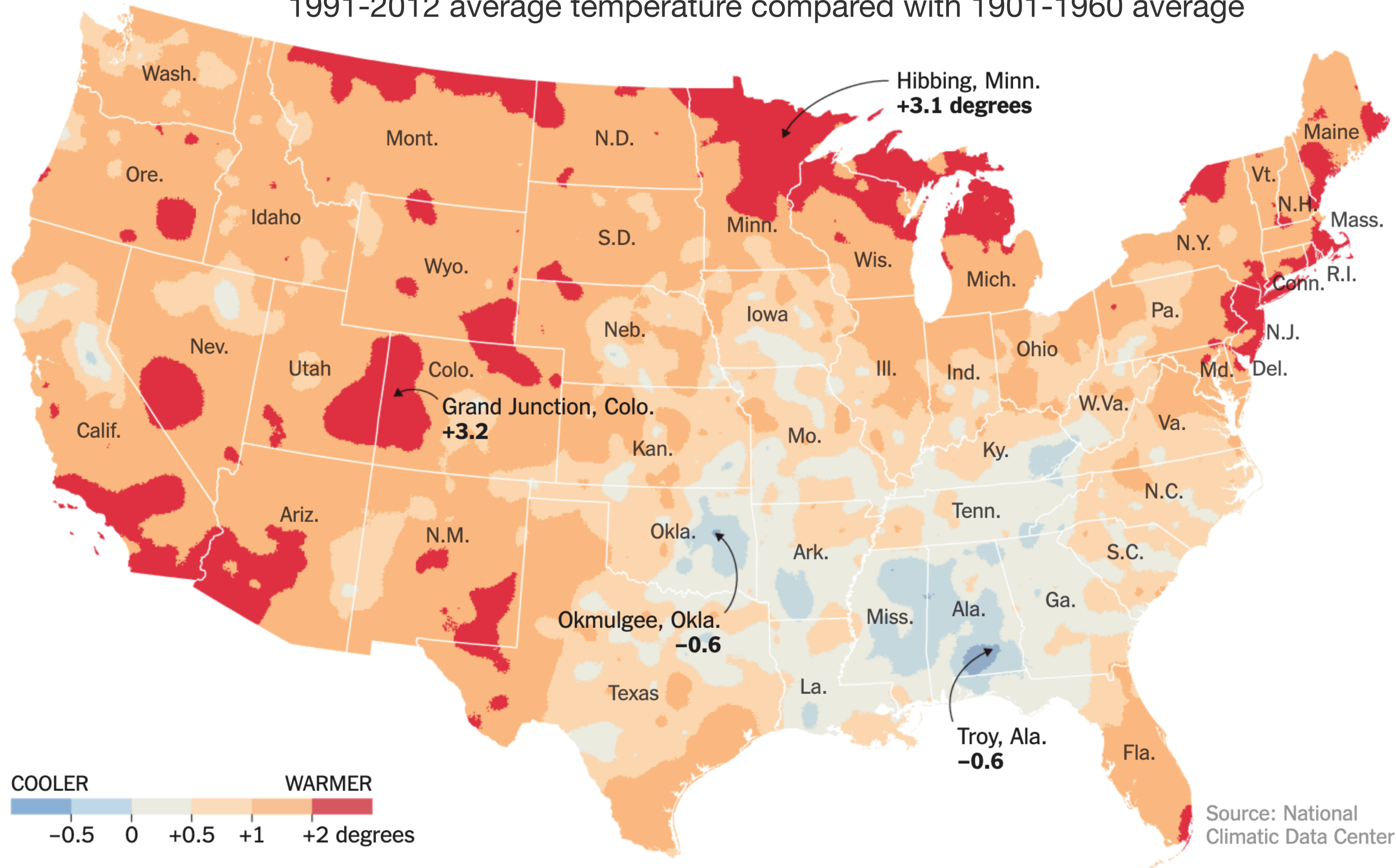




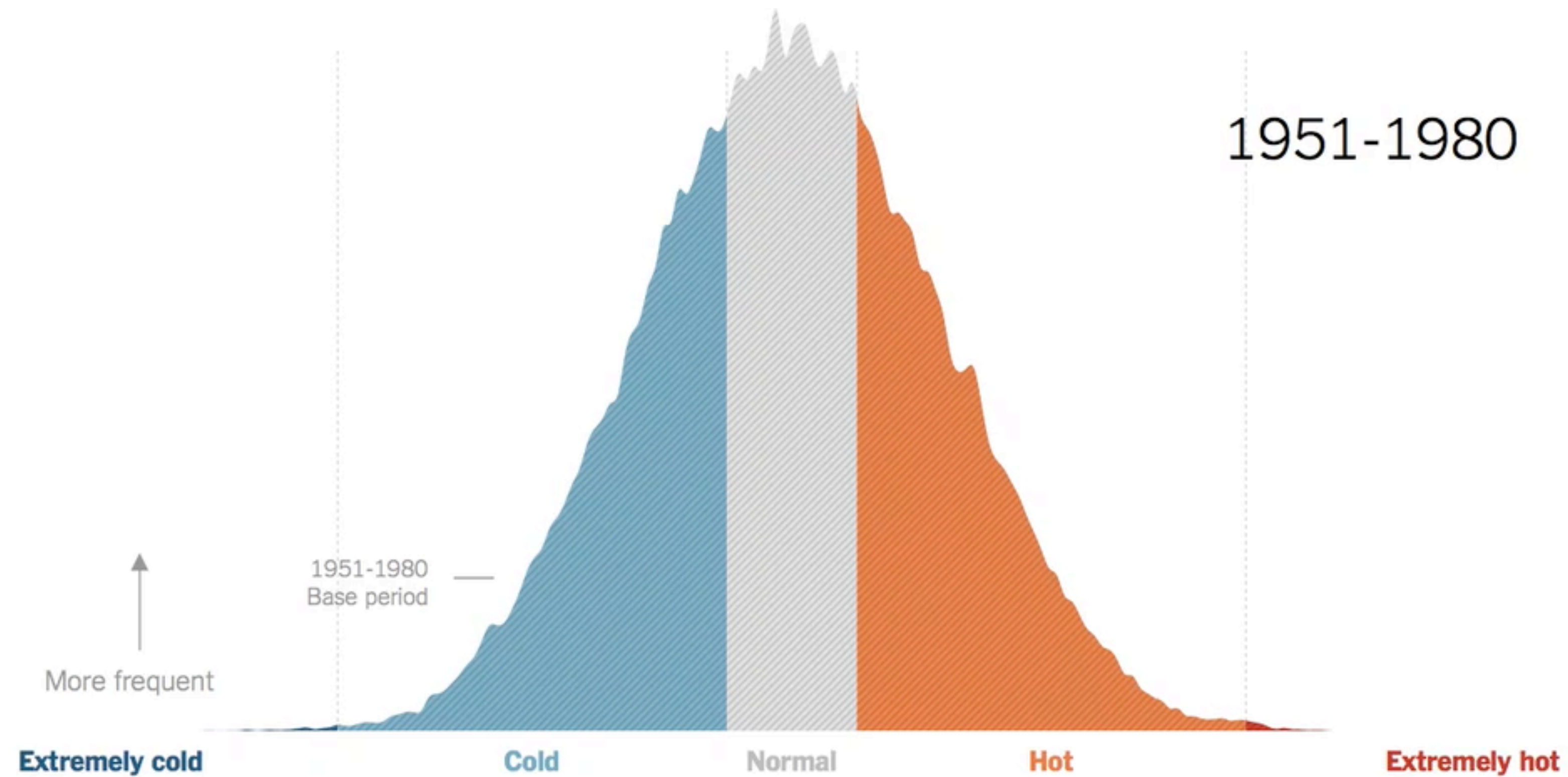
# **#3 Heat waves**

# Warming is already happening

1991-2012 average temperature compared with 1901-1960 average



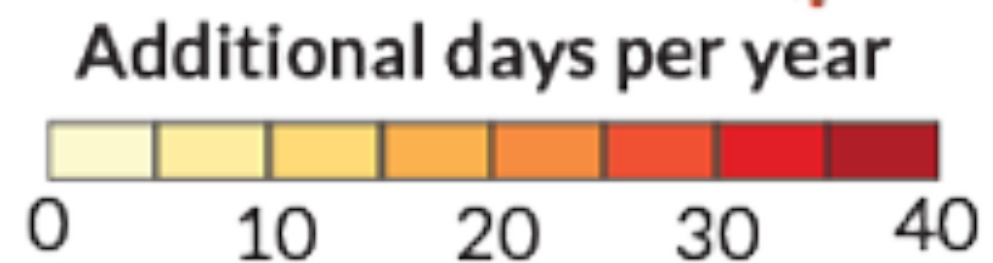
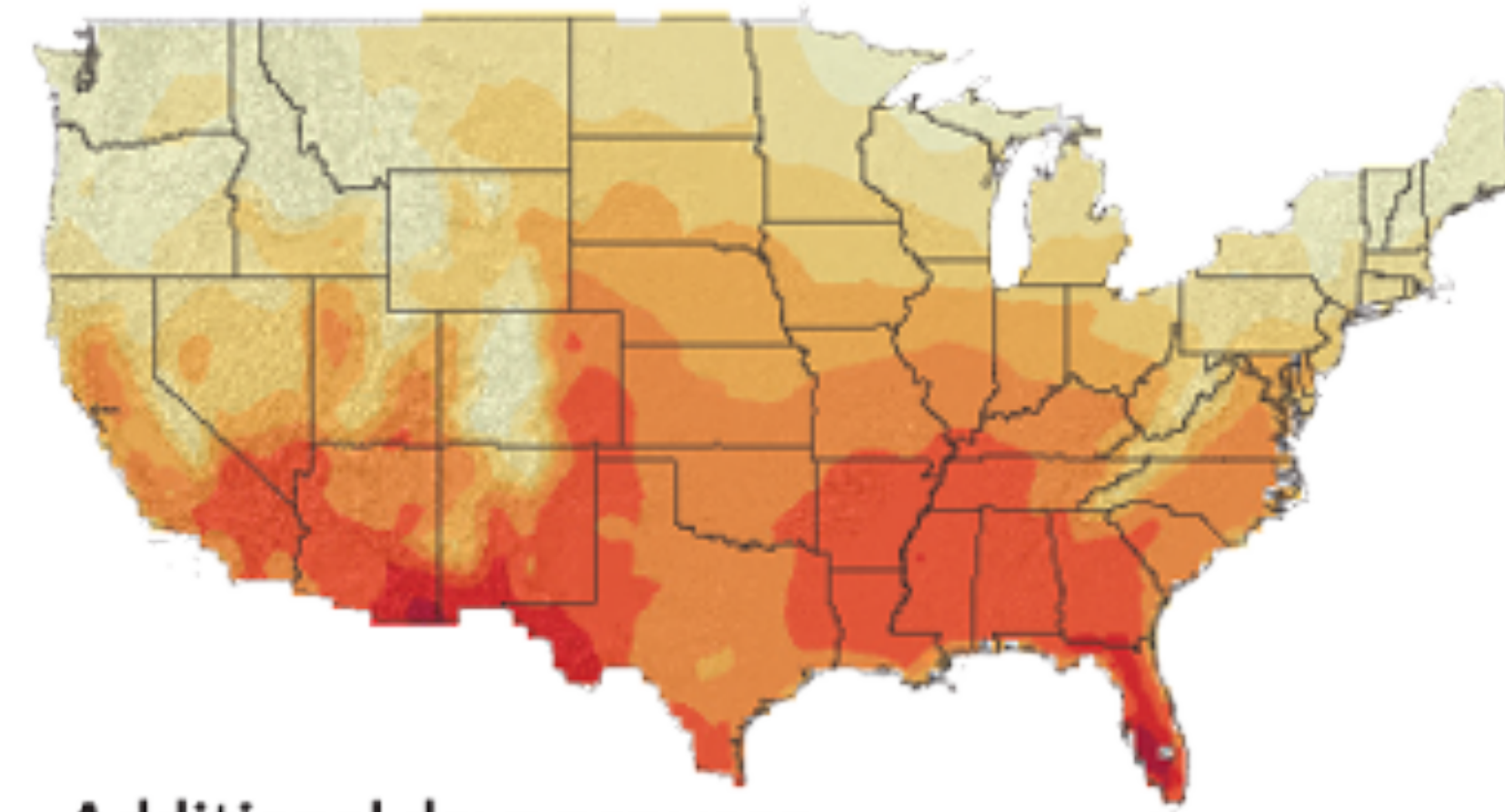
# Shifting summer temperatures across the northern hemisphere 1951-2015



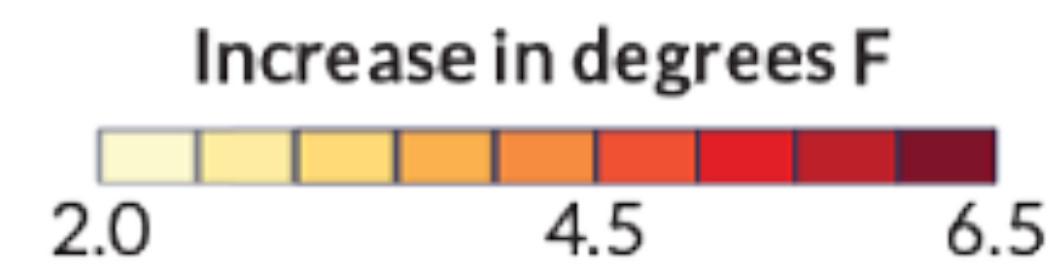
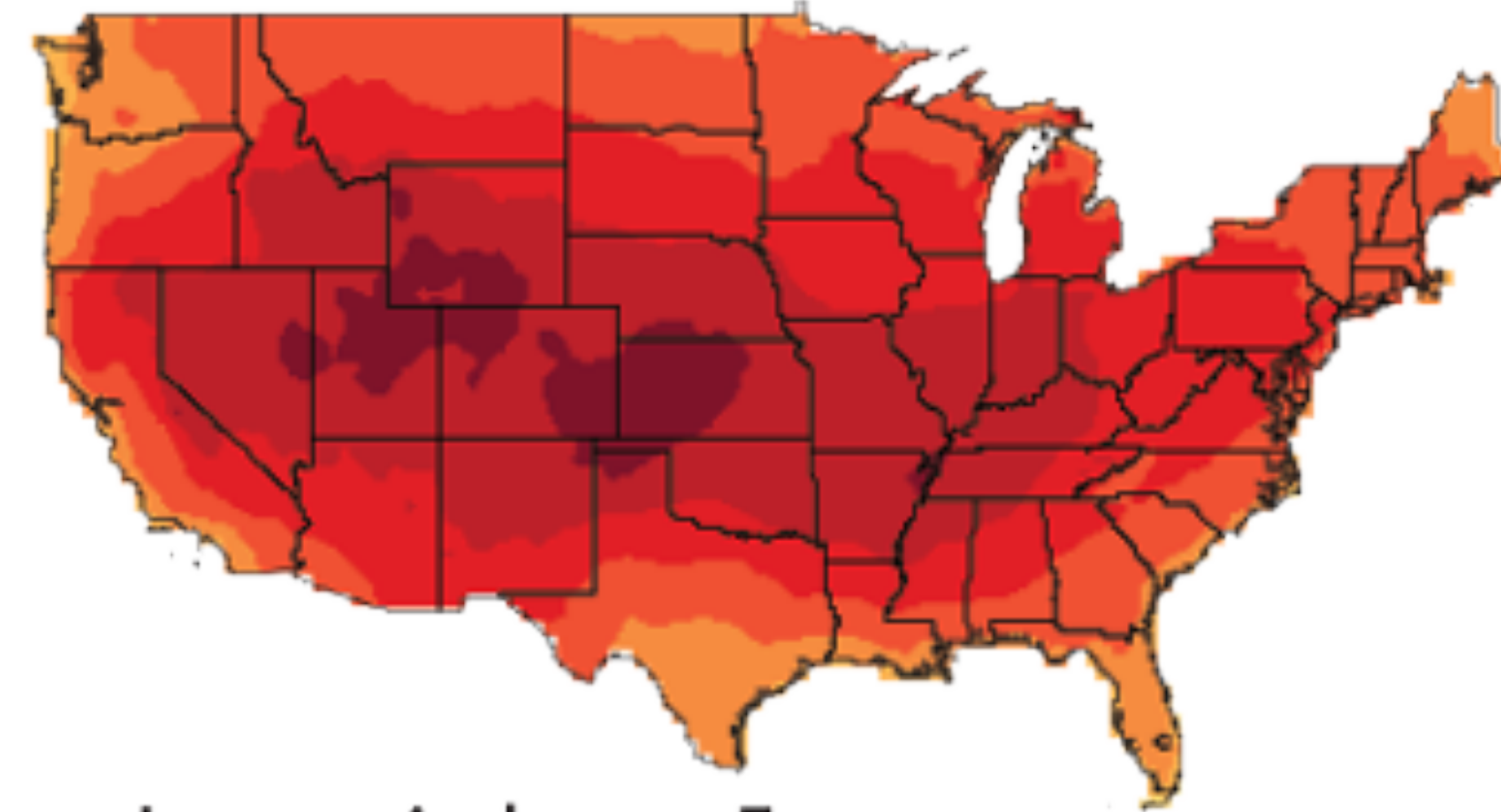


# Changes in extreme and average heat by *mid century* with business as usual greenhouse gas emissions

Change in number of days above 95° F



Change in average summer temperatures



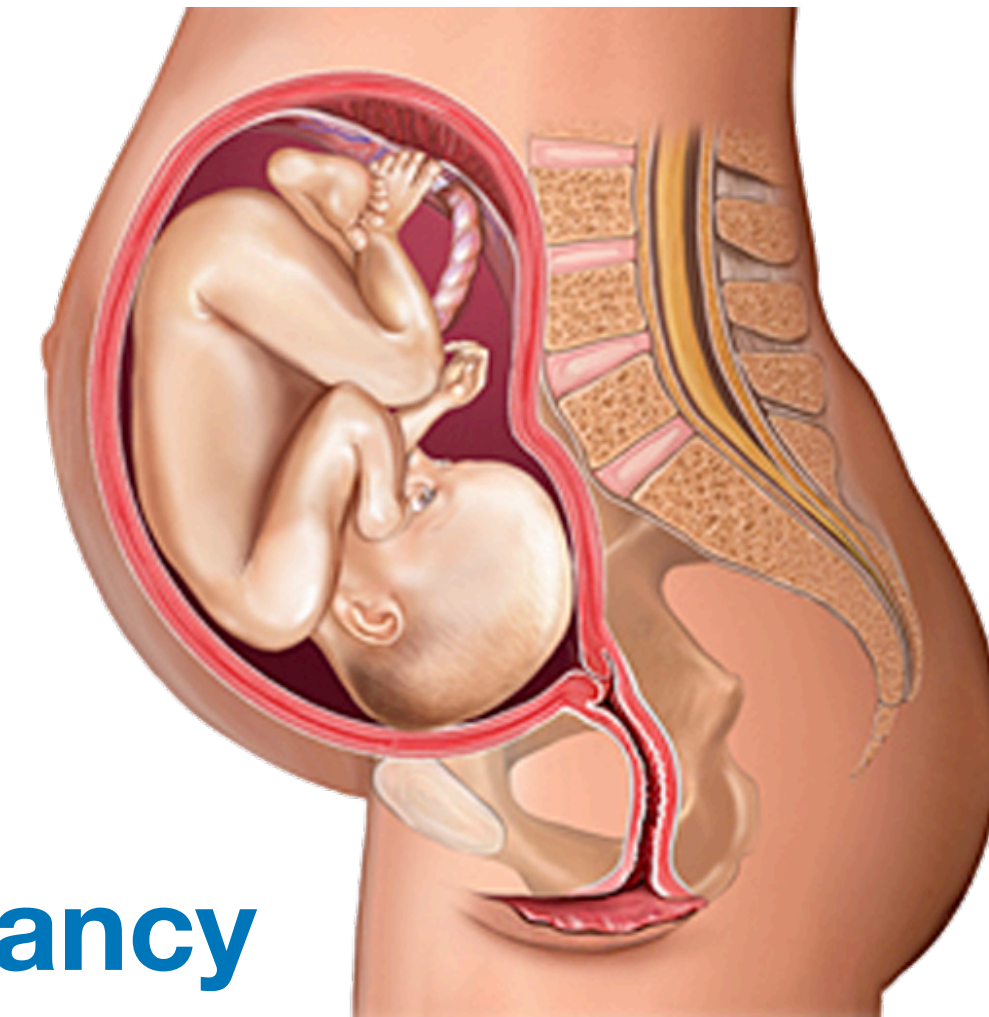
# Health effects associated with extreme heat

## Mental health



**Suicide rate 1 to 37% times higher per 1°C warming**

*Public Health*. DOI: 10.1016/j.puhe.2018.06.008



## Pregnancy

**Preterm birth odds ~1.2x higher during heat waves**

BMJ 2020;371:m3811 | doi: 10.1136/bmj.m3811



## Medications

**15% decreased dose**

60°C (car trunk) vs 4°C

*Am J Health-Syst Pharm*—Vol 62 Nov 1, 2005 2



## Job performance?

**Increased “unsafe” behaviors in workers**

~30% more @ 23°C vs 35°C

*Journal of Safety Research*, Vol. 14, pp. 105-114, 1983

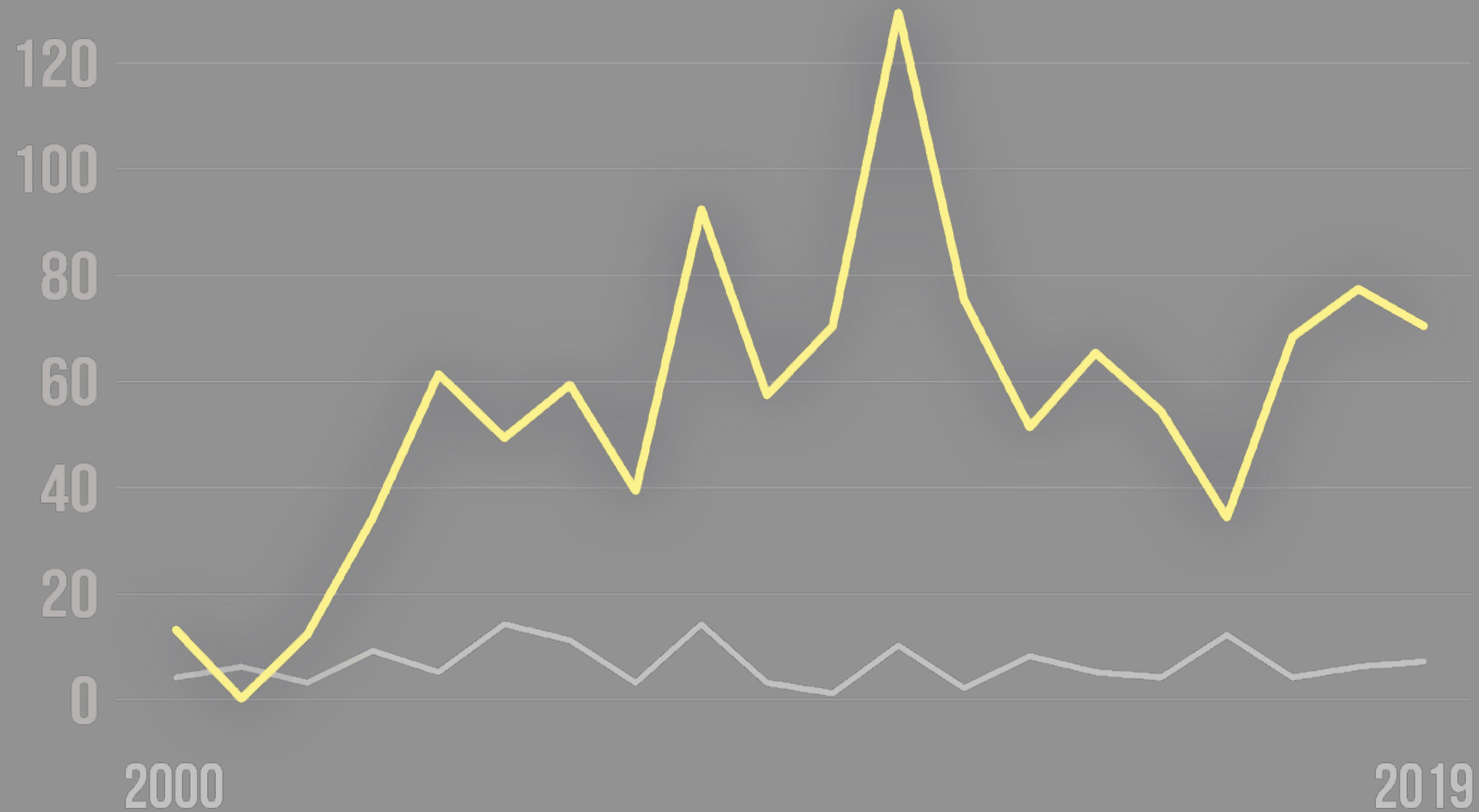
# **#4 Power outages**



Climate change is emerging as a force in causing power outages

# U.S. POWER OUTAGES

— WEATHER-RELATED — NON WEATHER-RELATED



Number of outages affecting more than 50k customers  
Source: US Department of Energy Form OE-417

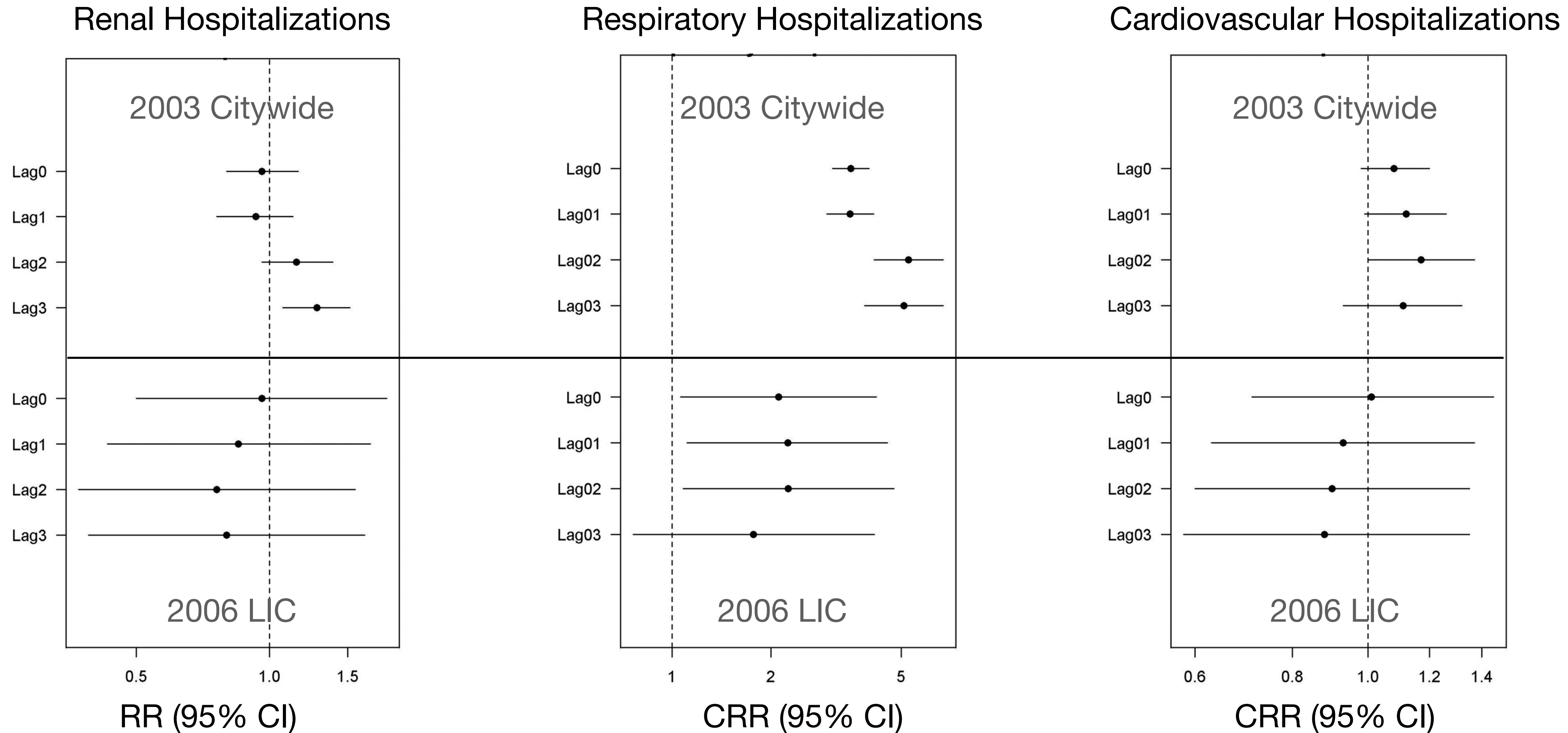


# When the power goes out, healthcare demands rise

Environmental Health Perspectives. 2018 Jun; 126(6): 067003.

## Health Impacts of Citywide and Localized Power Outages in New York City

*Christine Dominianni,<sup>1</sup> Kathryn Lane,<sup>1</sup> Sarah Johnson,<sup>1</sup> Kazuhiko Ito,<sup>1</sup> and Thomas Matte<sup>1,2</sup>*



Risks of hospitalization adjusted for temperature, day of week, holiday, year, within-season temporal trends, 9/11

# **#5 Wildfire smoke**



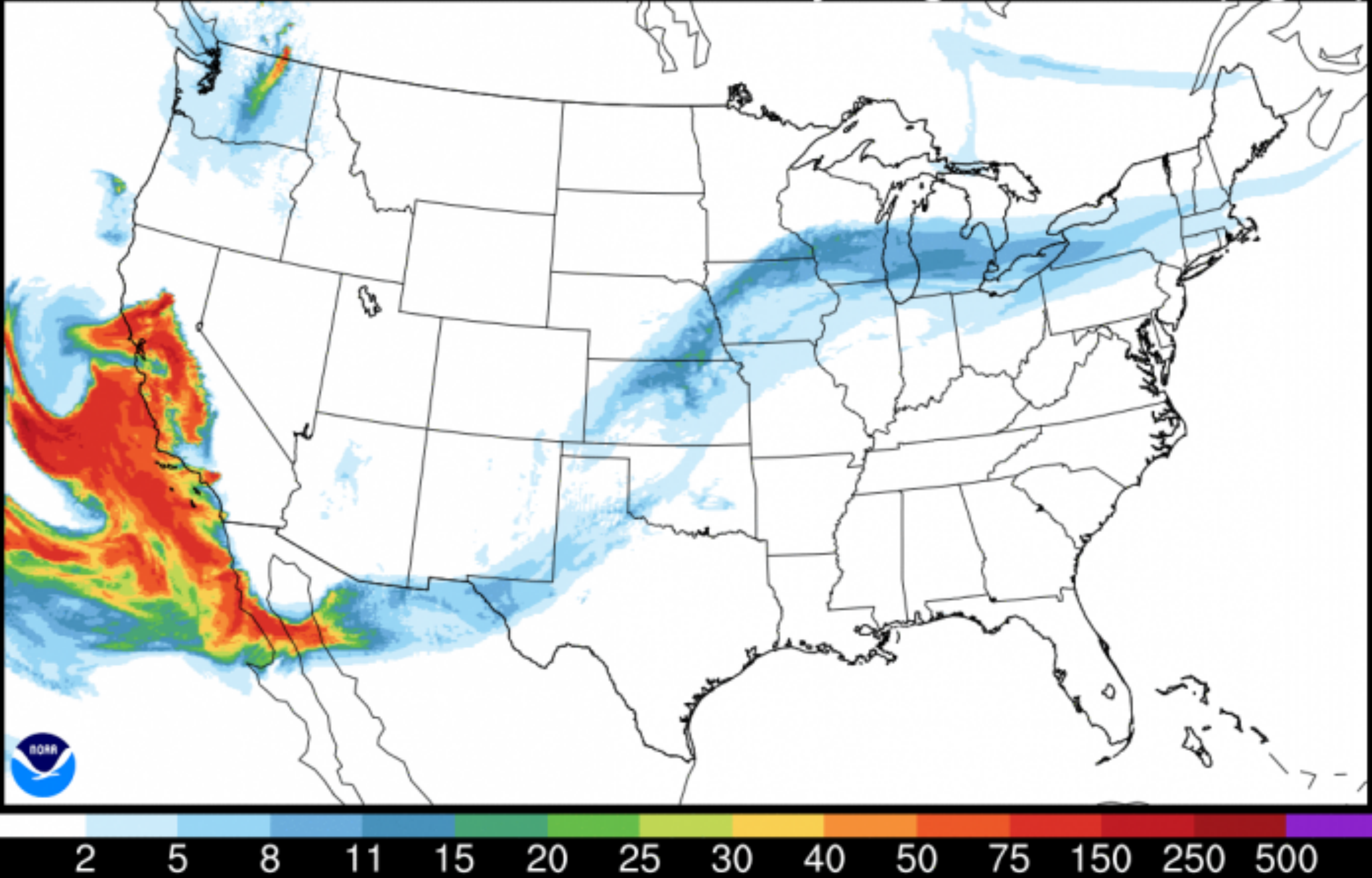




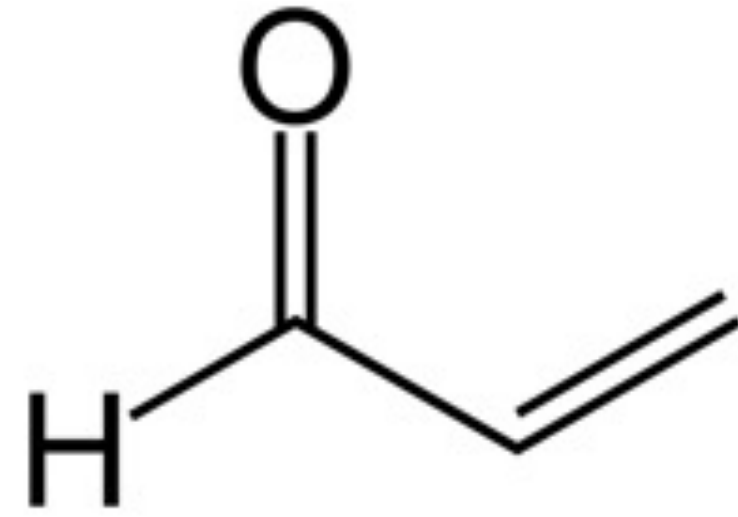
# CAN WILDFIRE SMOKE MAKE YOU SICK? PLUMES FROM WORST WILDFIRE IN CALIFORNIA HISTORY REACH MASSACHUSETTS

BY ARISTOS GEORGIU ON 11/12/18 AT 12:49 PM

HRRR-SMOKE 2018-11-12 00 UTC 7h fcst - EXPERIMENTAL Valid 11/12/2018 07:00 UTC  
Vertically Integrated Smoke (mg/m<sup>2</sup>)



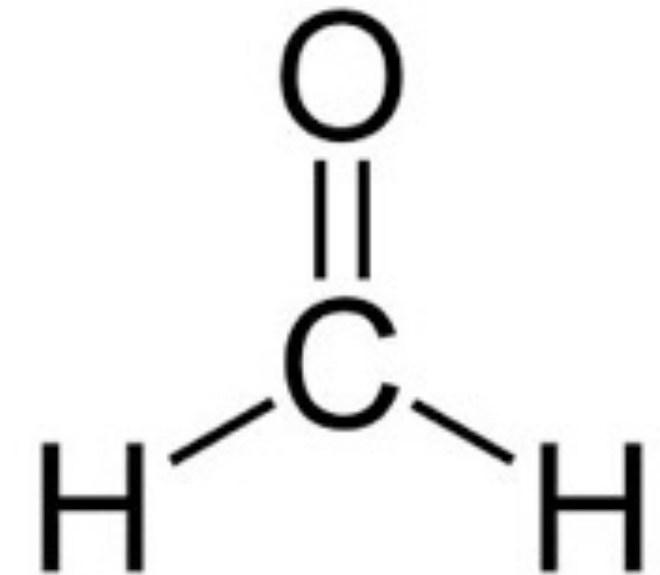
# Smoke is bad for your health



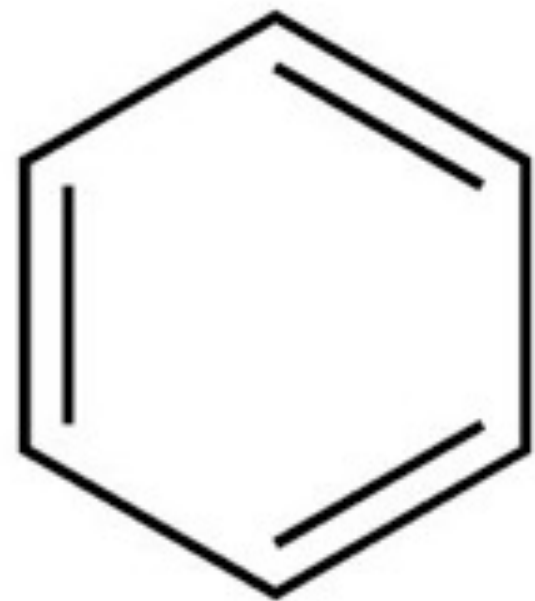
acrolein

Wildfire source PM may be more toxic than PM in general

*Nature Communications* 12.1 (2021): 1-8.

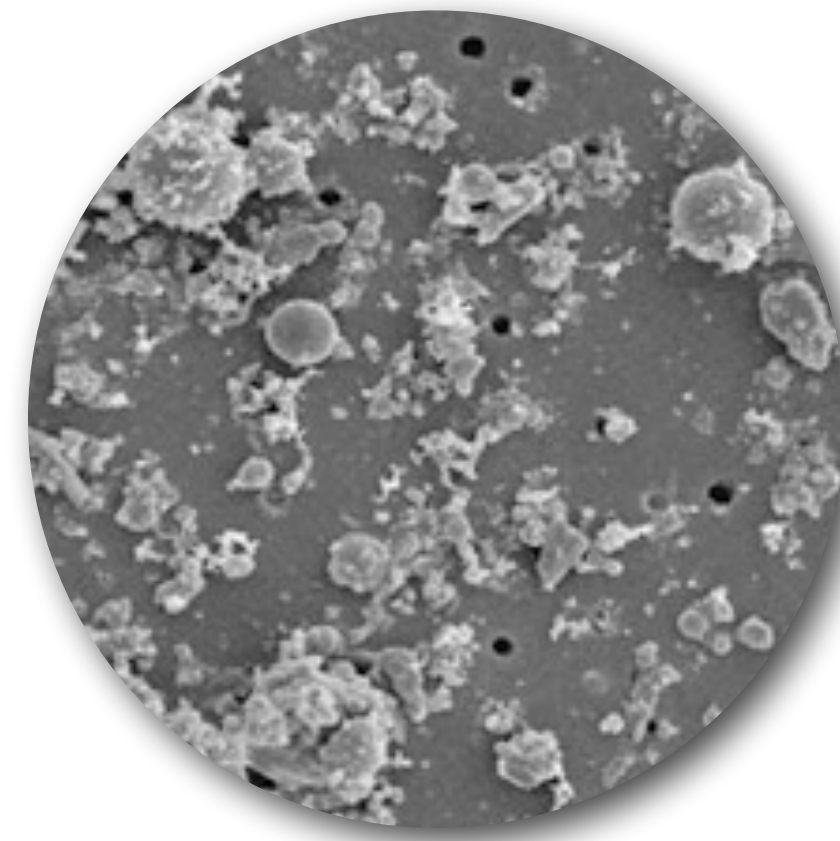


formaldehyde



benzene/PAHs

Leukemia/lymphoma  
Anxiety/depression  
ADHD



PM<sub>2.5</sub>

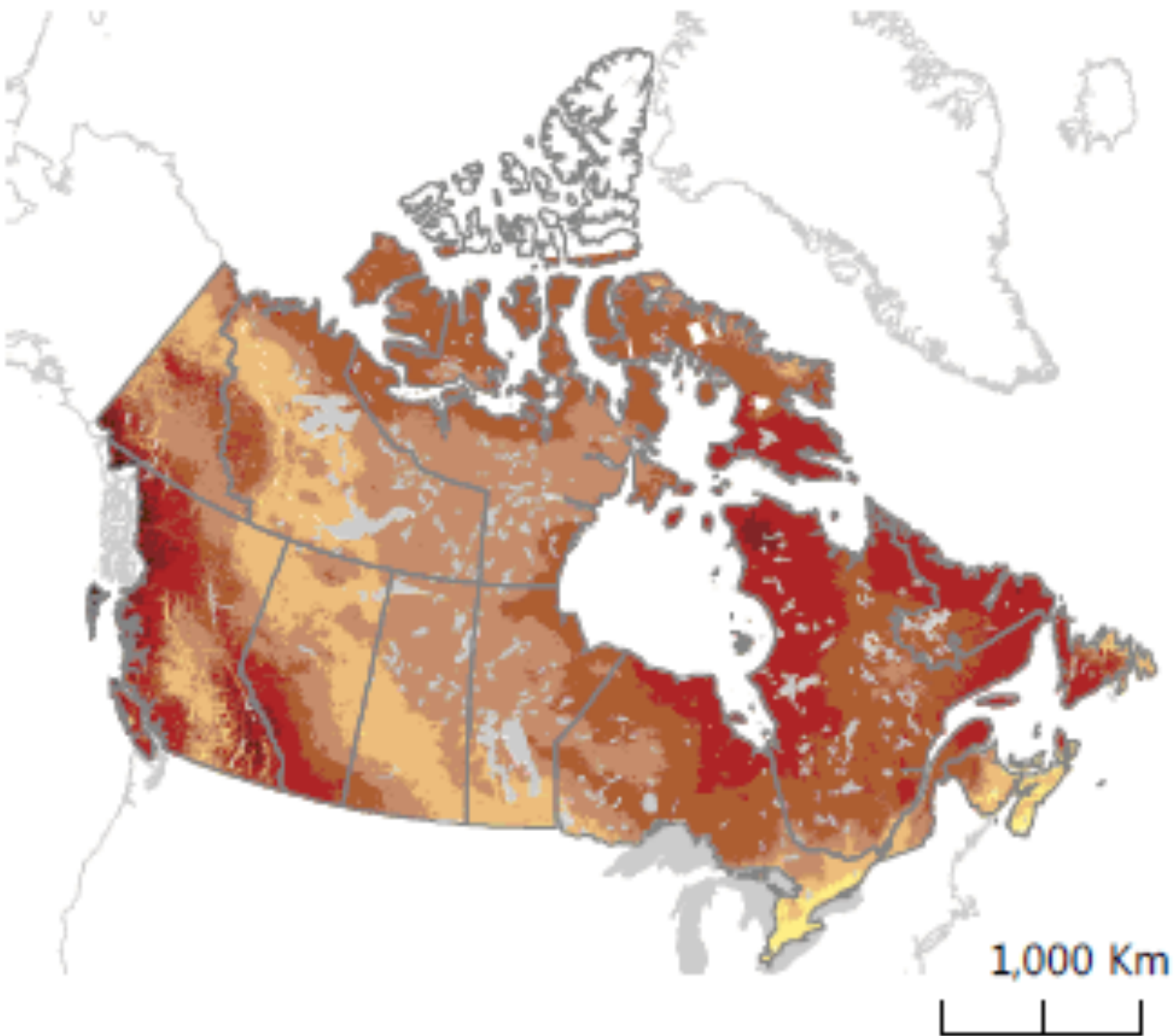
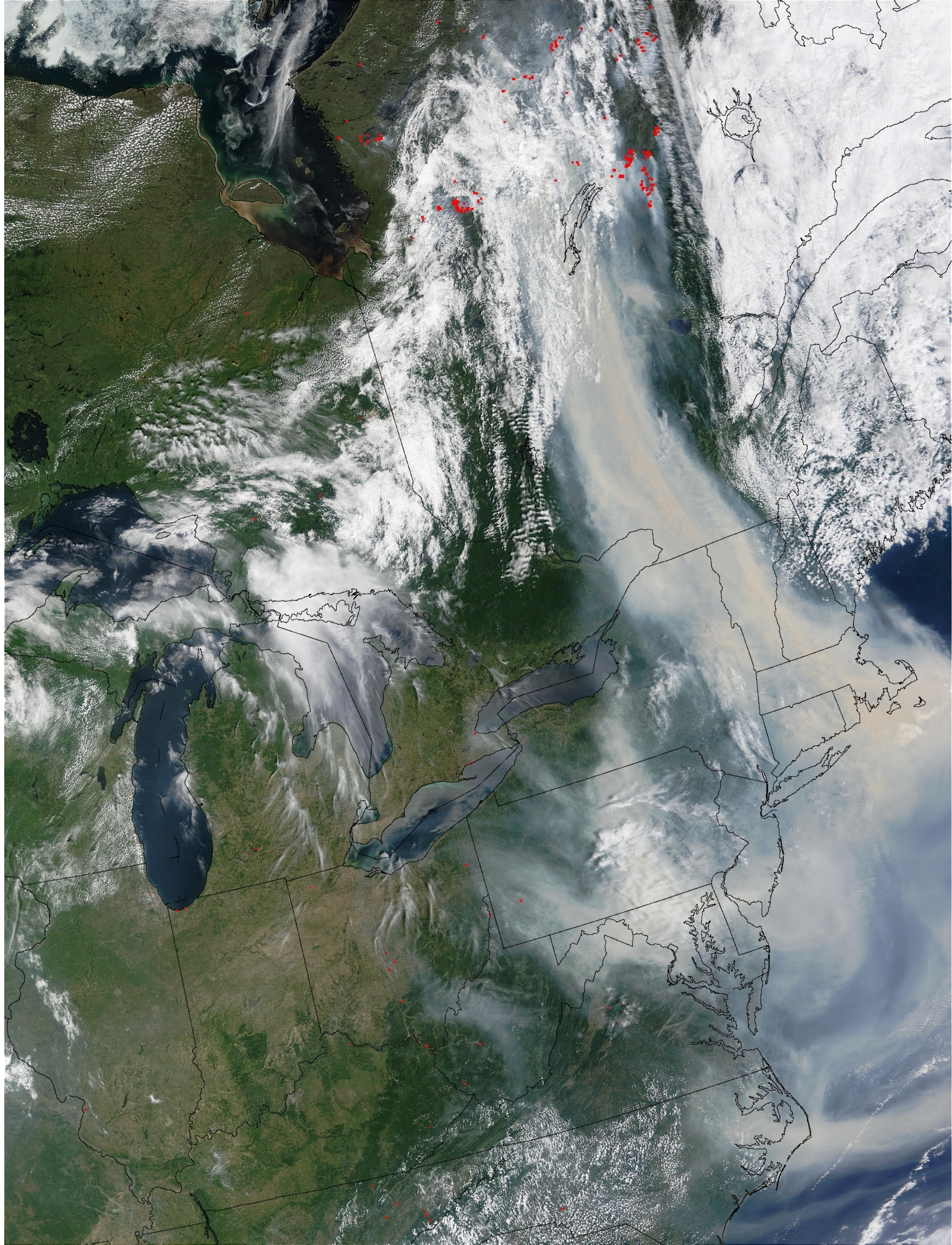
NO<sub>x</sub>

oxides of nitrogen

Asthma (causal)  
Respiratory infections



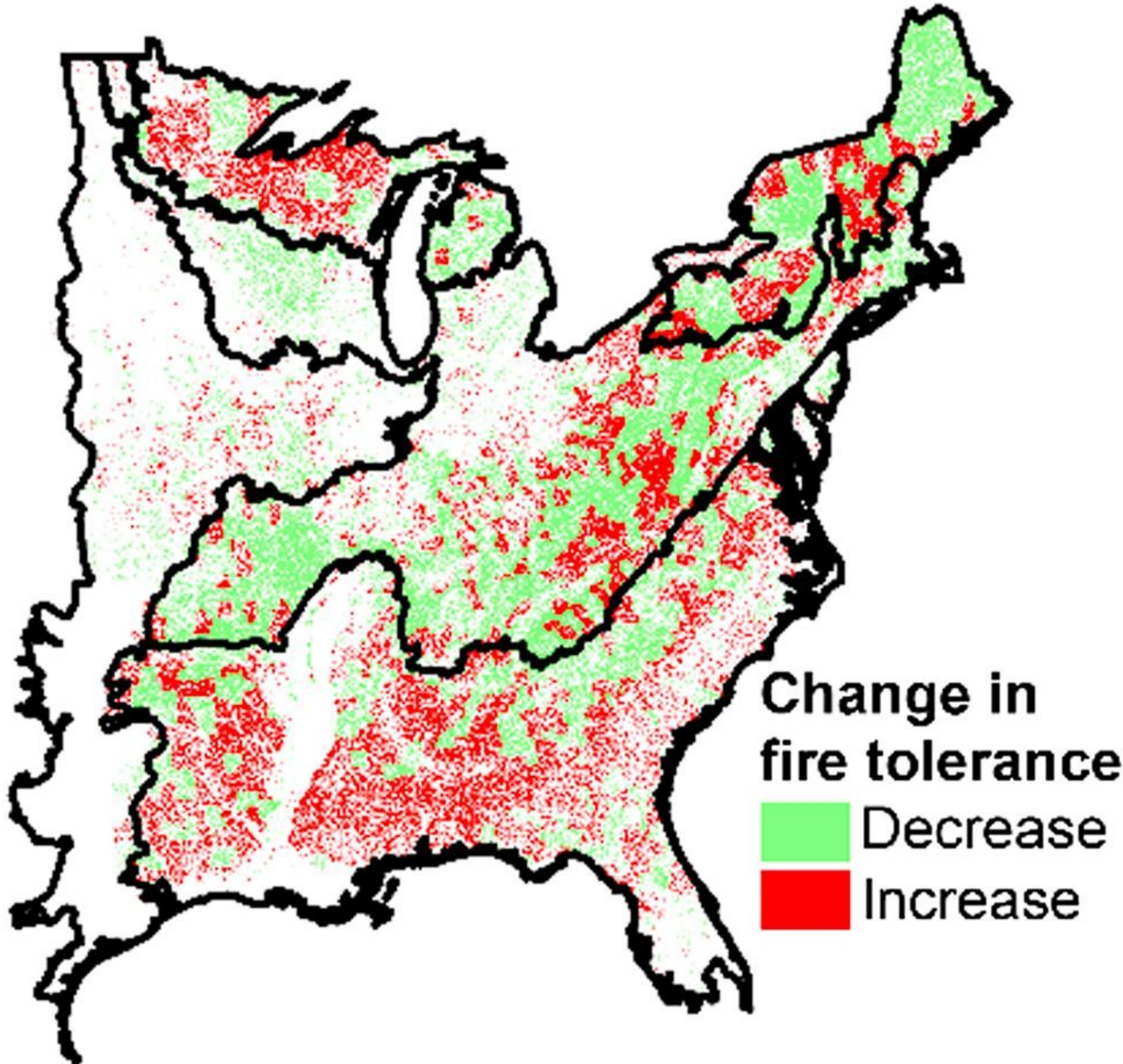
**Days added to annual wildfire season  
with unmitigated climate change  
2071-2100 vs 1981-2010**





**Change in county-level fire tolerances from the early 1980s to 2015**  
10 most prevalent tree genera

- Maple
- Ash
- Hickory
- Birch
- Tupelo
- Pine
- Poplar/Aspen
- Oak
- Cherry/Fruit
- Elm



# **#6 Emerging infections**

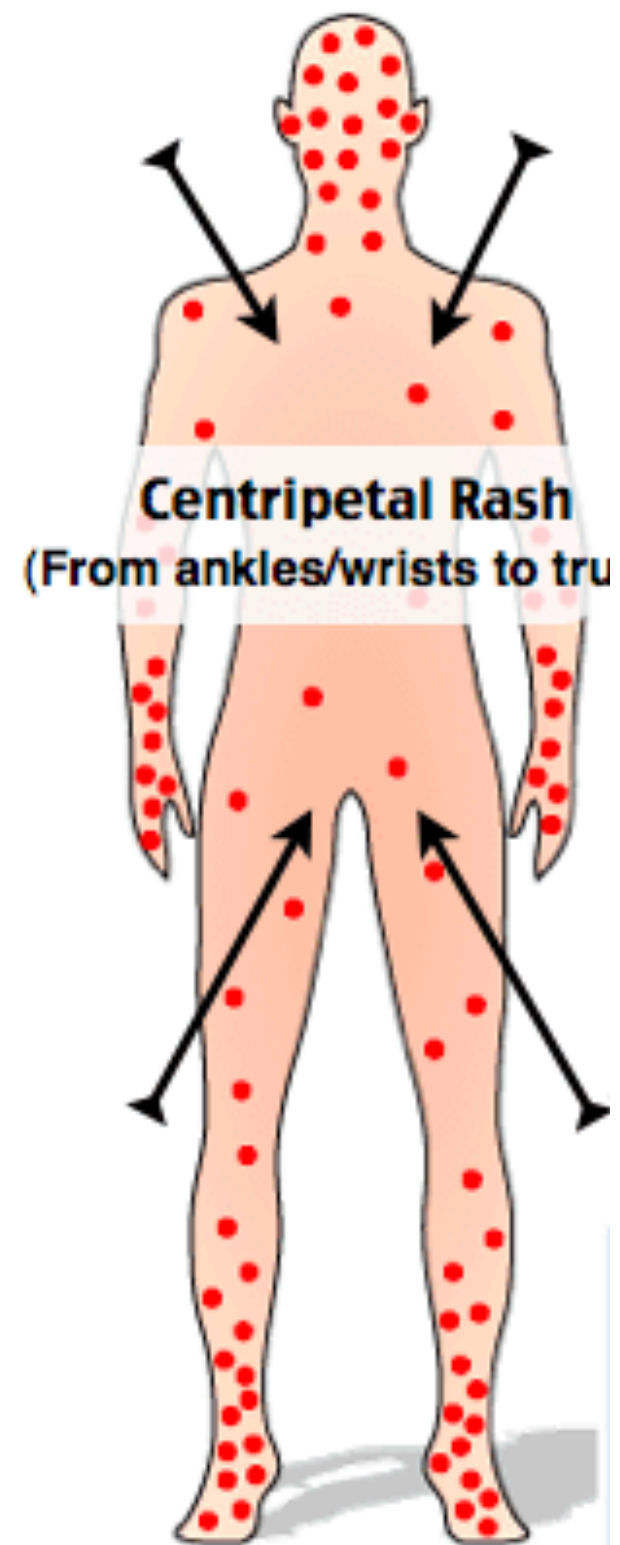




Source: K.J. Knoop, L.B. Stack, A.B. Storrow, R.J. Thurman:  
The Atlas of Emergency Medicine, 4th Edition,  
[www.accessemergencymedicine](http://www.accessemergencymedicine)  
Copyright © McGraw-Hill Education. All rights reserved.

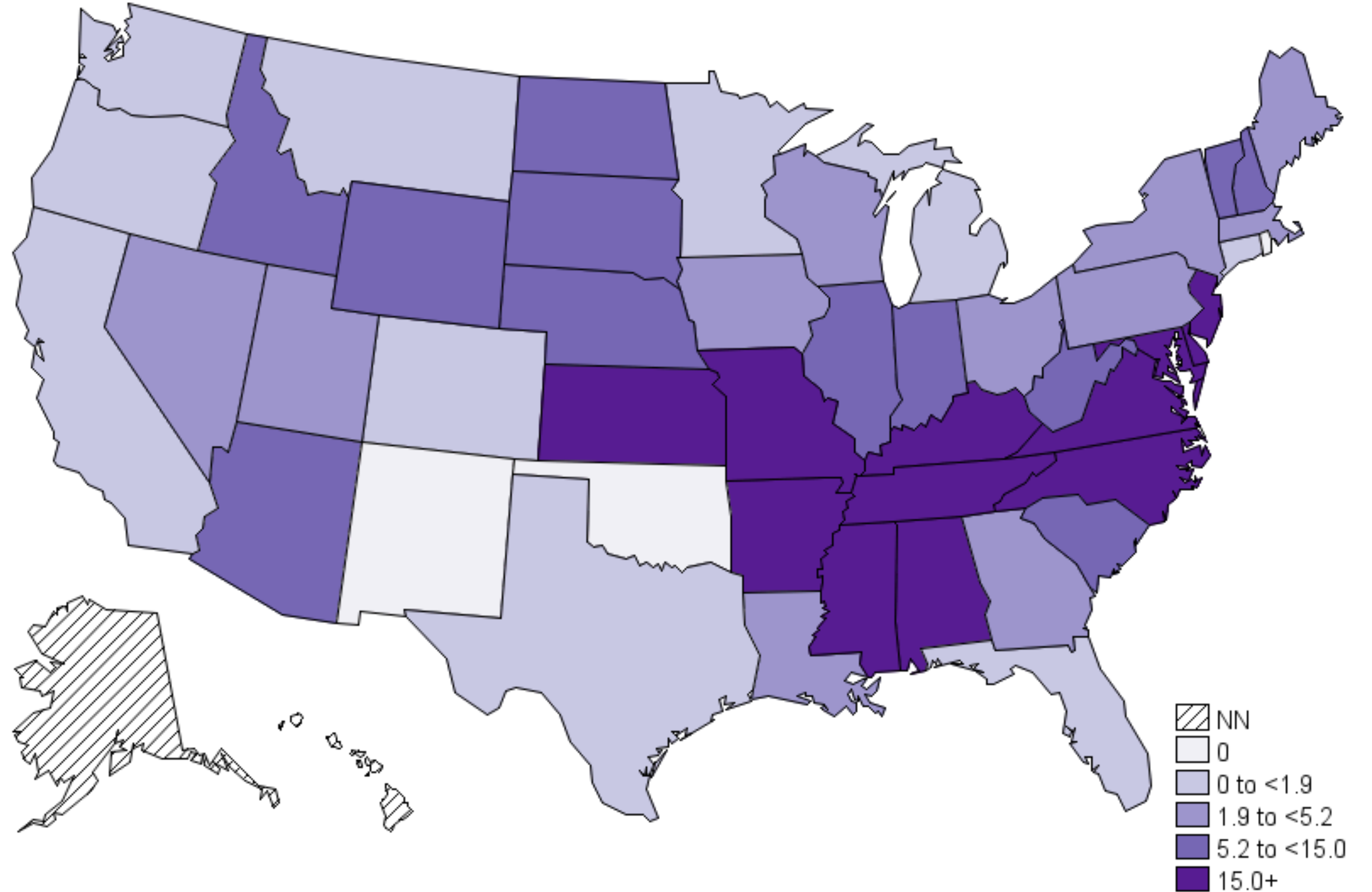


# Rocky Mountain spotted fever (RMSF)



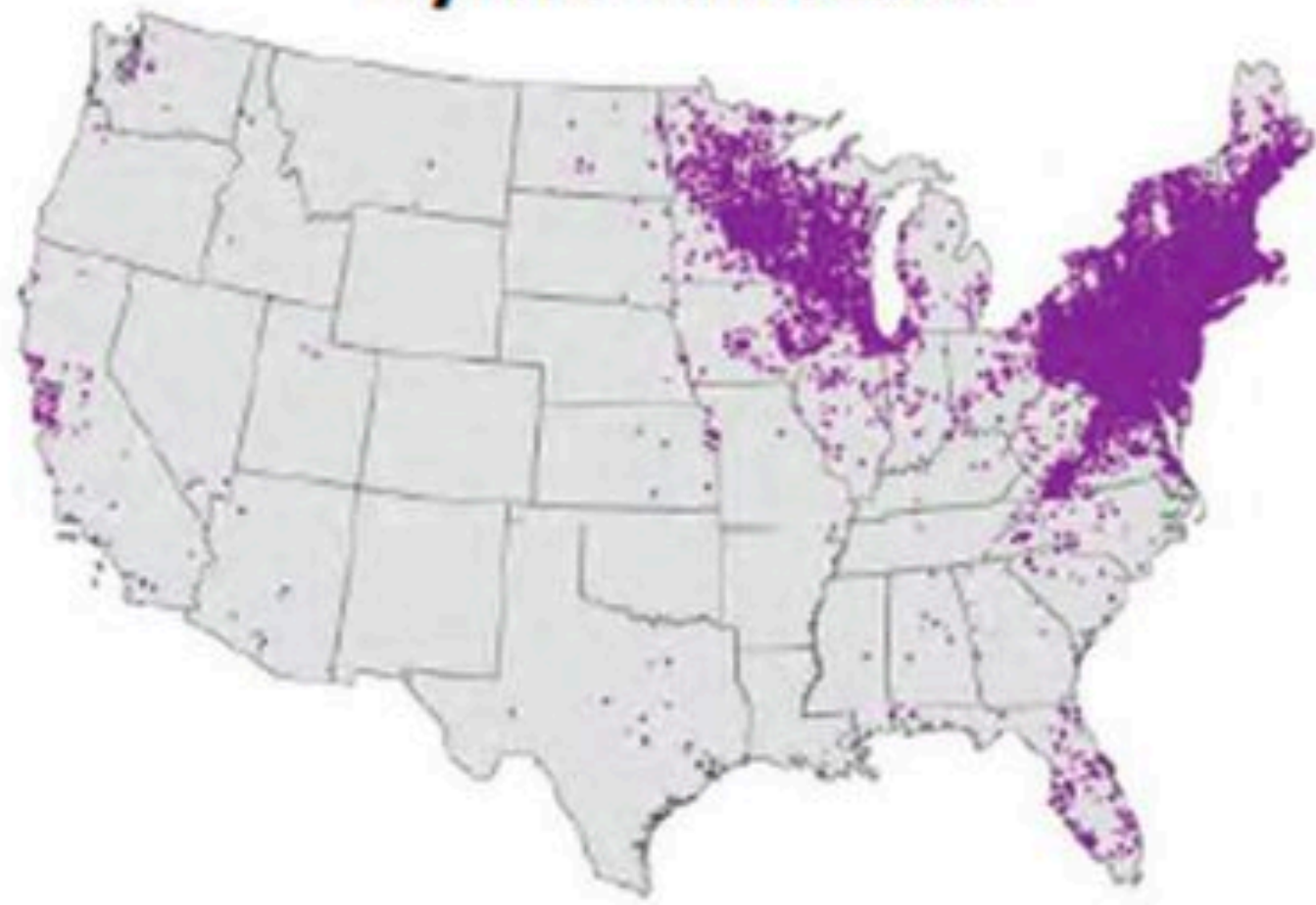
**Symptoms**  
Fever  
Headache  
Muscle Aches

**20-30% mortality rate if untreated**





**Lyme disease**



**Anaplasmosis**



**Babesiosis**



**Ehrlichiosis**



**Rocky Mountain Spotted Fever**



**Tularemia**



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Each dot represents a reported case in the county of residence



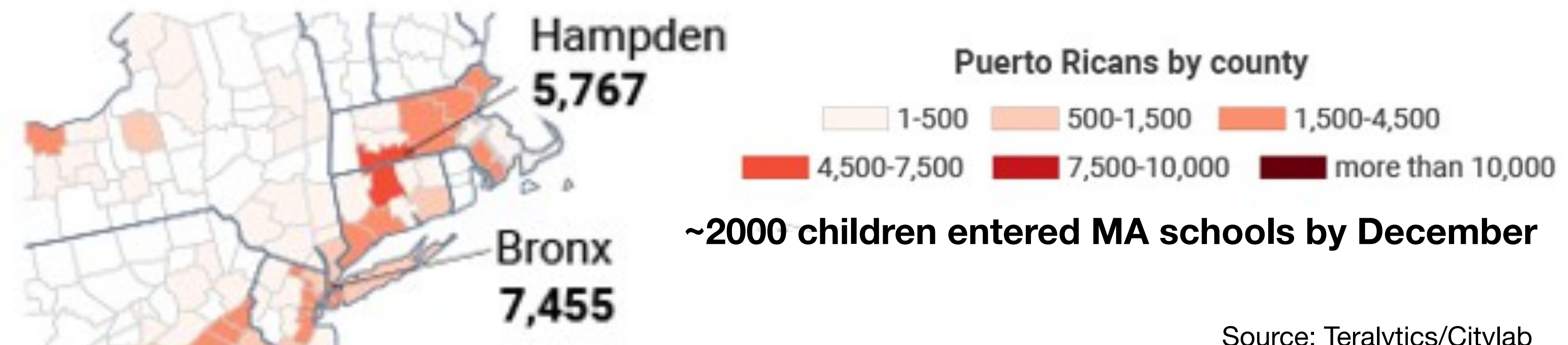
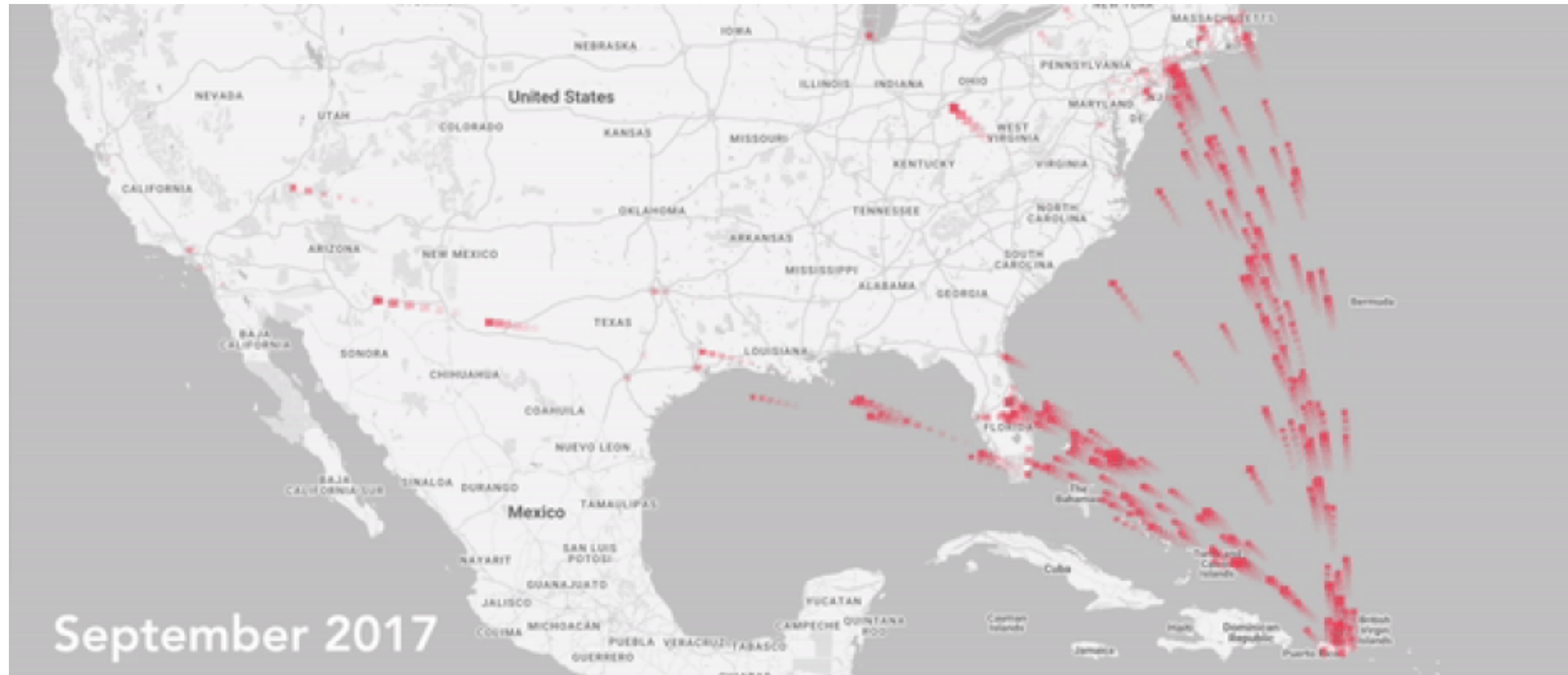
# **#7 Population migrations**



# Population movement after Hurricane Maria

~400k left between Oct & Feb

~150k went to Florida



Source: Teralytics/Citylab



**Resilience**



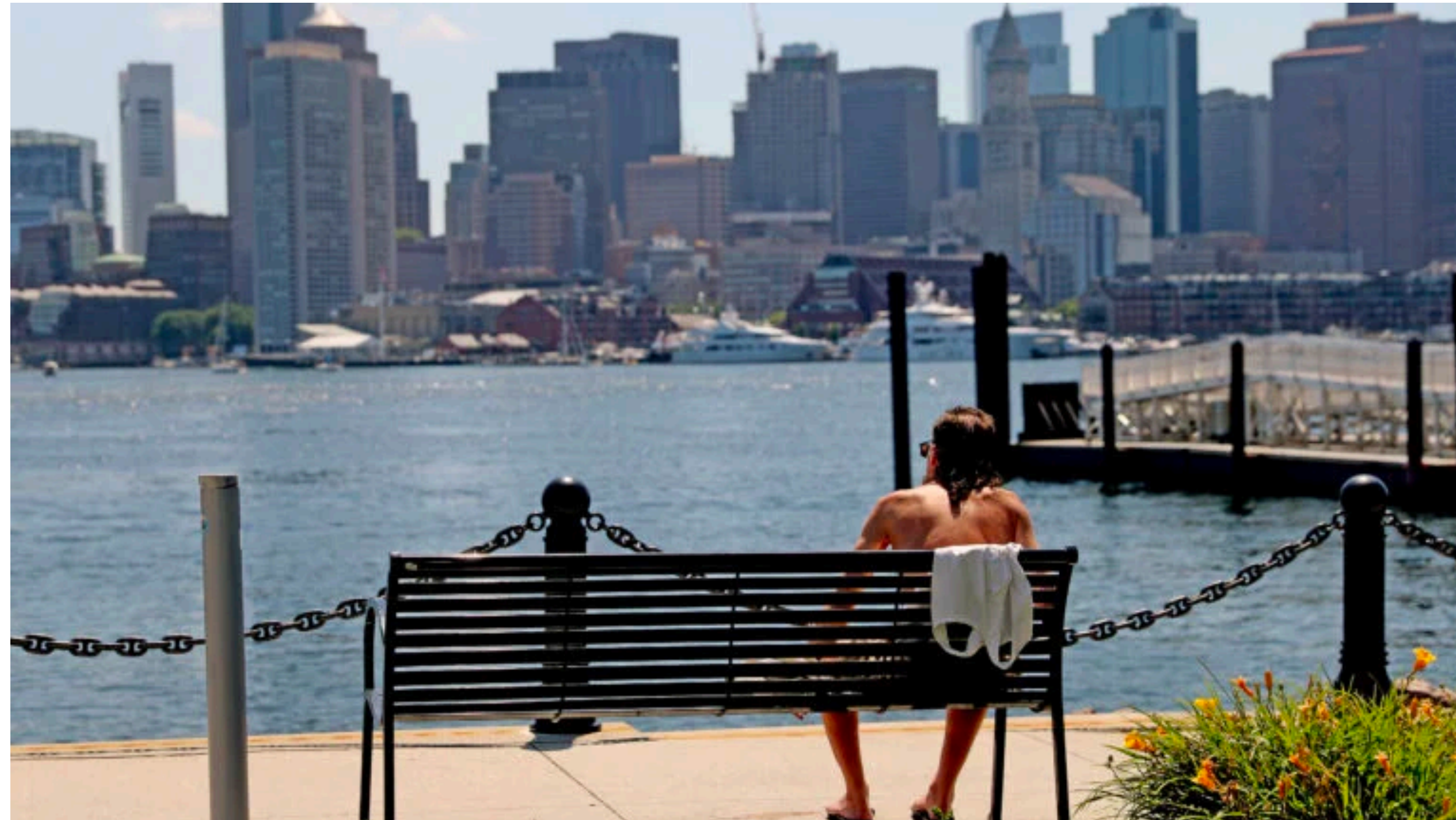
# With heat wave looming, Kim Janey declares ‘heat emergency’ for Boston

Cooling centers will be open throughout the city between Wednesday and Friday.

*David L Ryan / Globe Staff*

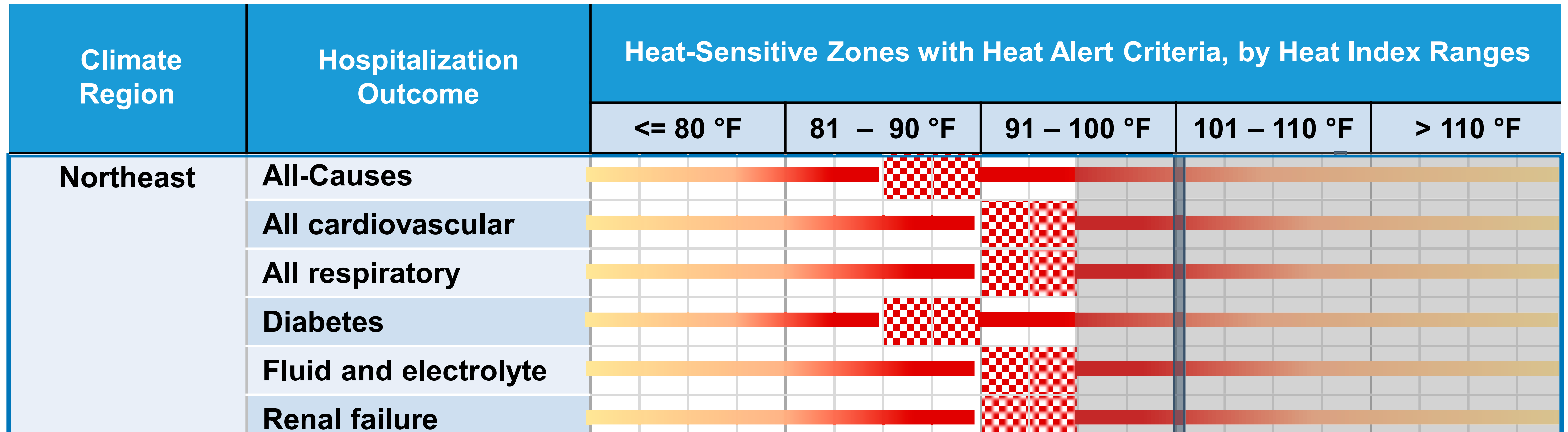
By **Christopher Gavin**

August 10, 2021





# If heat warnings happen, they may be too late



 Heat-sensitive zone

 Heat index ranges at which positively significant peak heat-attributable health risk / burden are observed

 Heat index ranges used for issuing alerts

 Median heat alert criteria



**How about a new, patient centered approach to  
heat preparedness?**





# Building Climate Resilient Community Health Clinics

HEROES WORK HERE



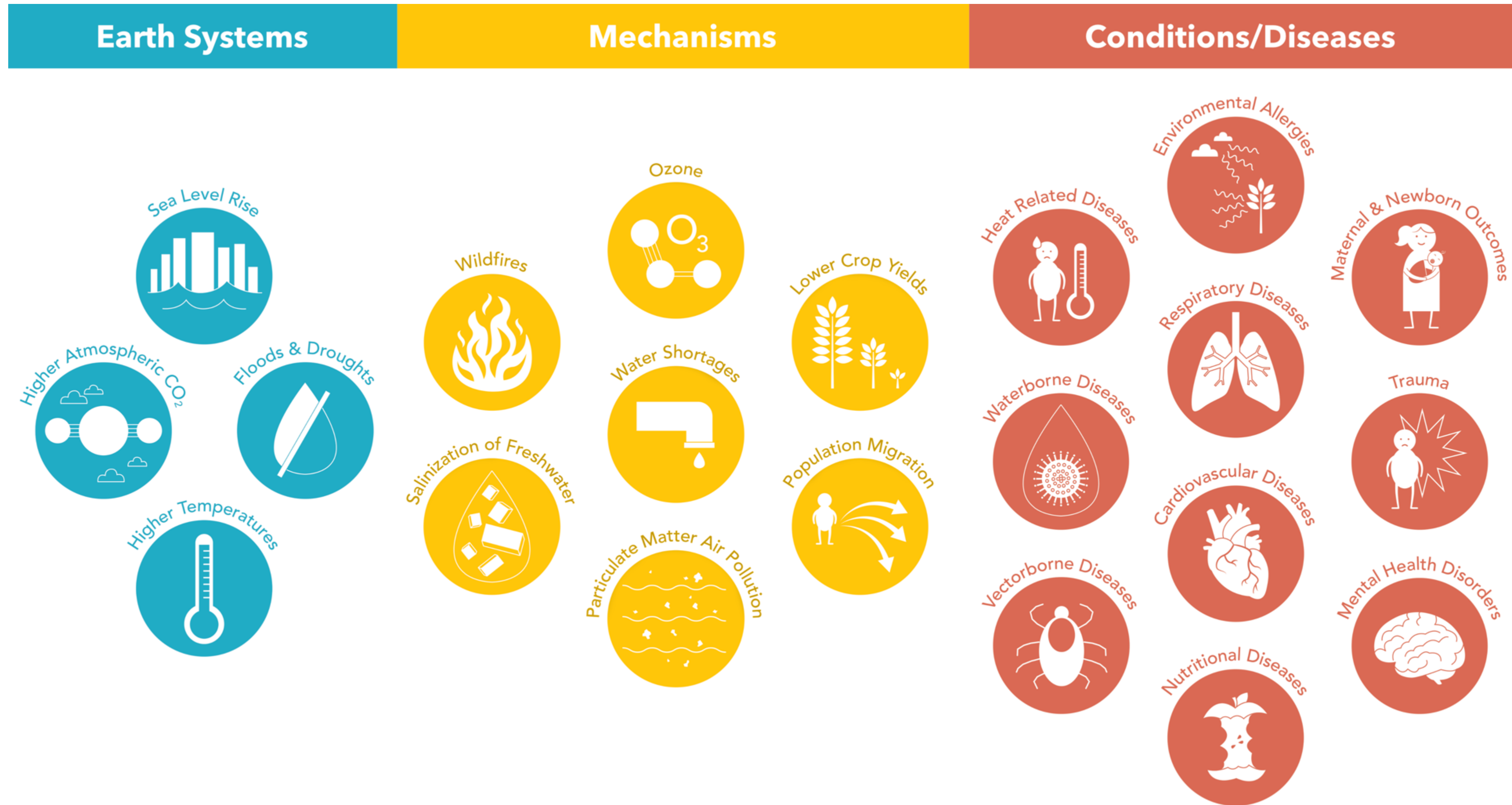
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# Pathways from greenhouse gas emissions to health outcomes



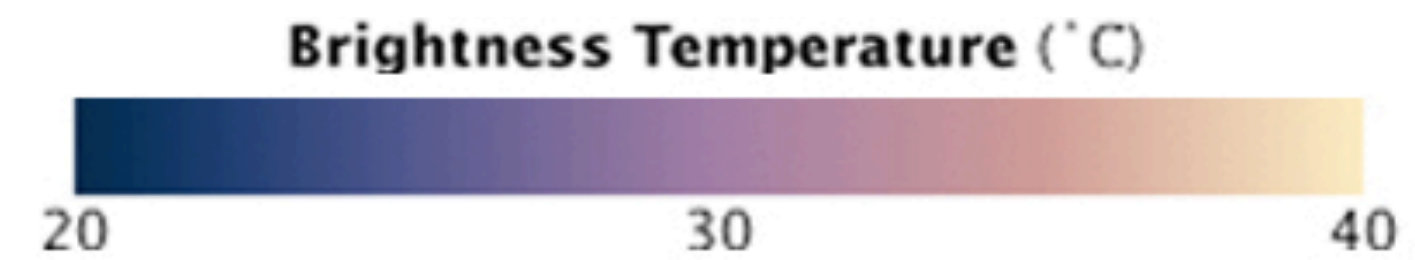
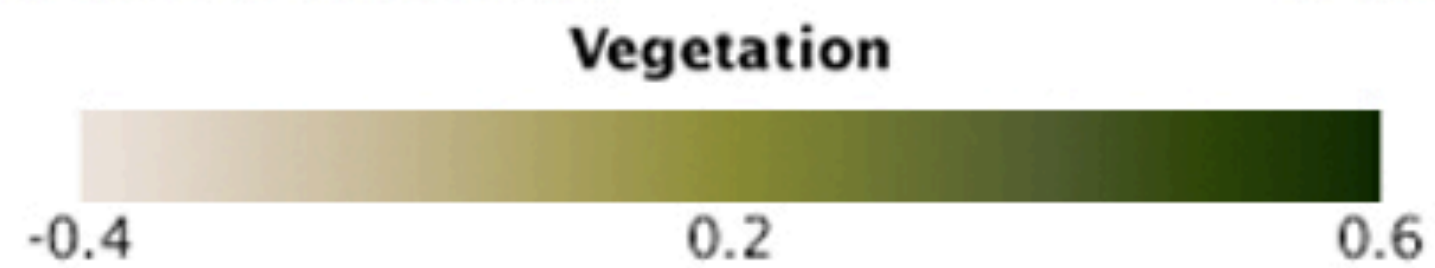
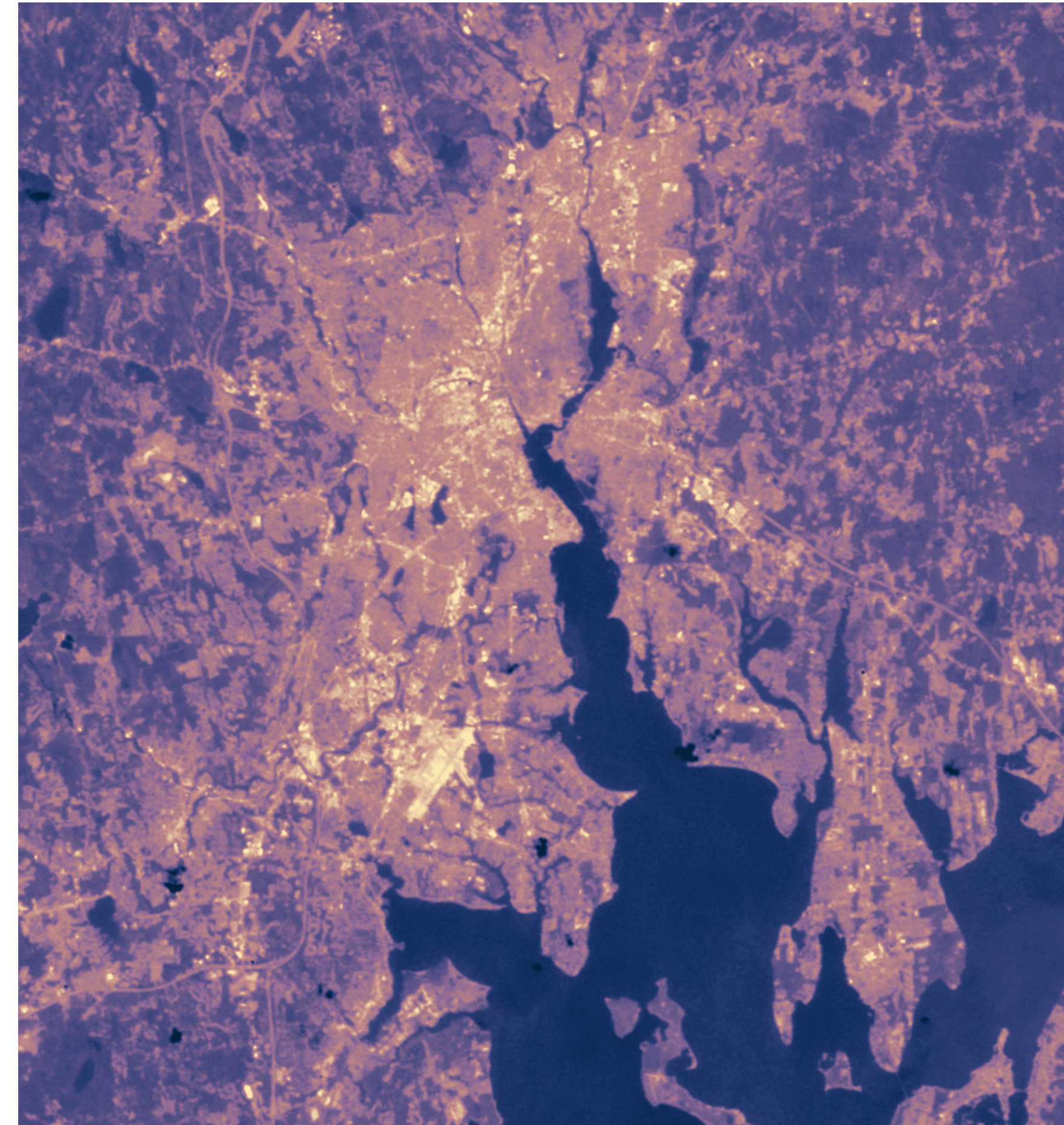
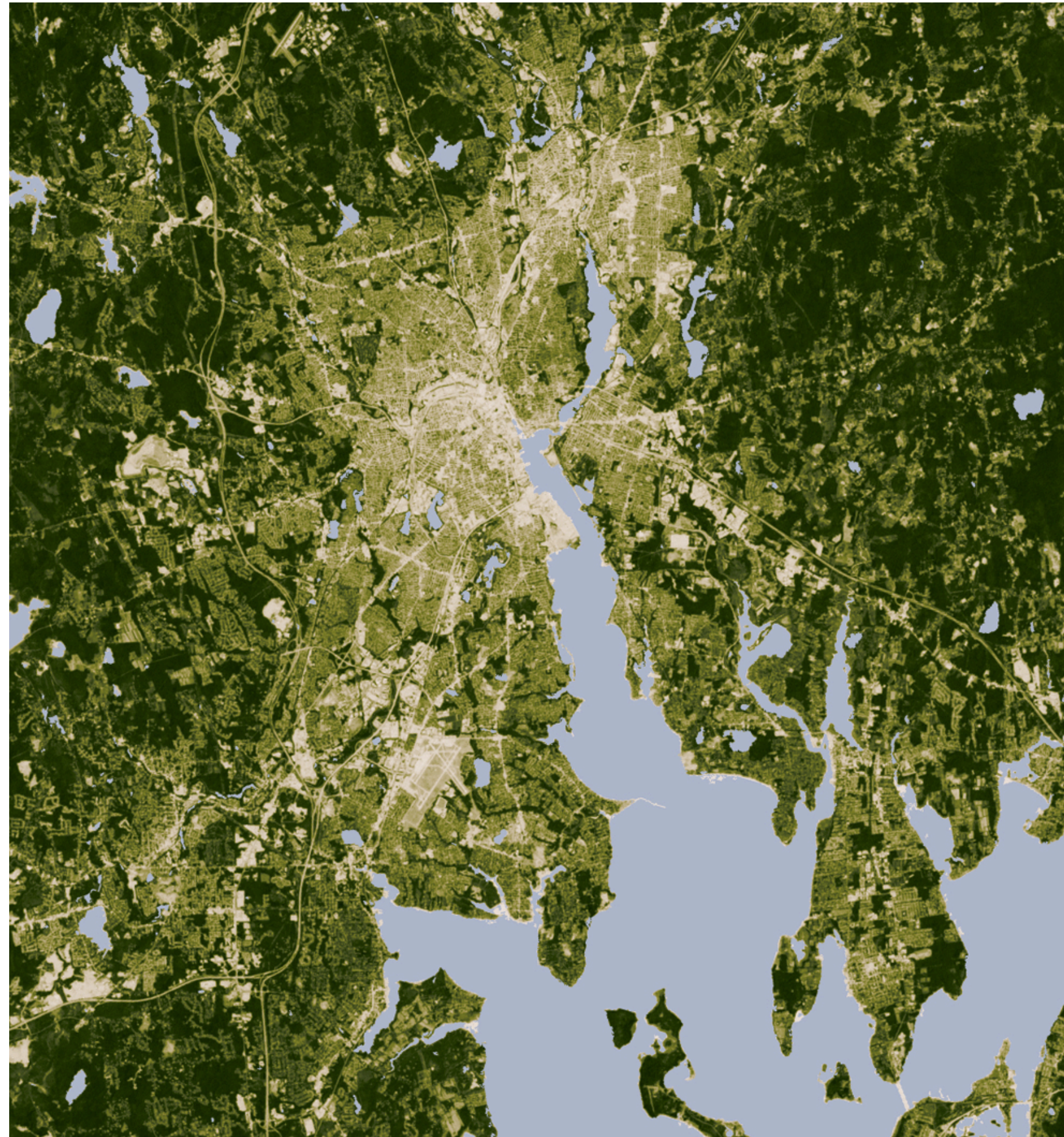


# Equity & Solutions



# Make his neighborhood cool (or green)

Providence, RI





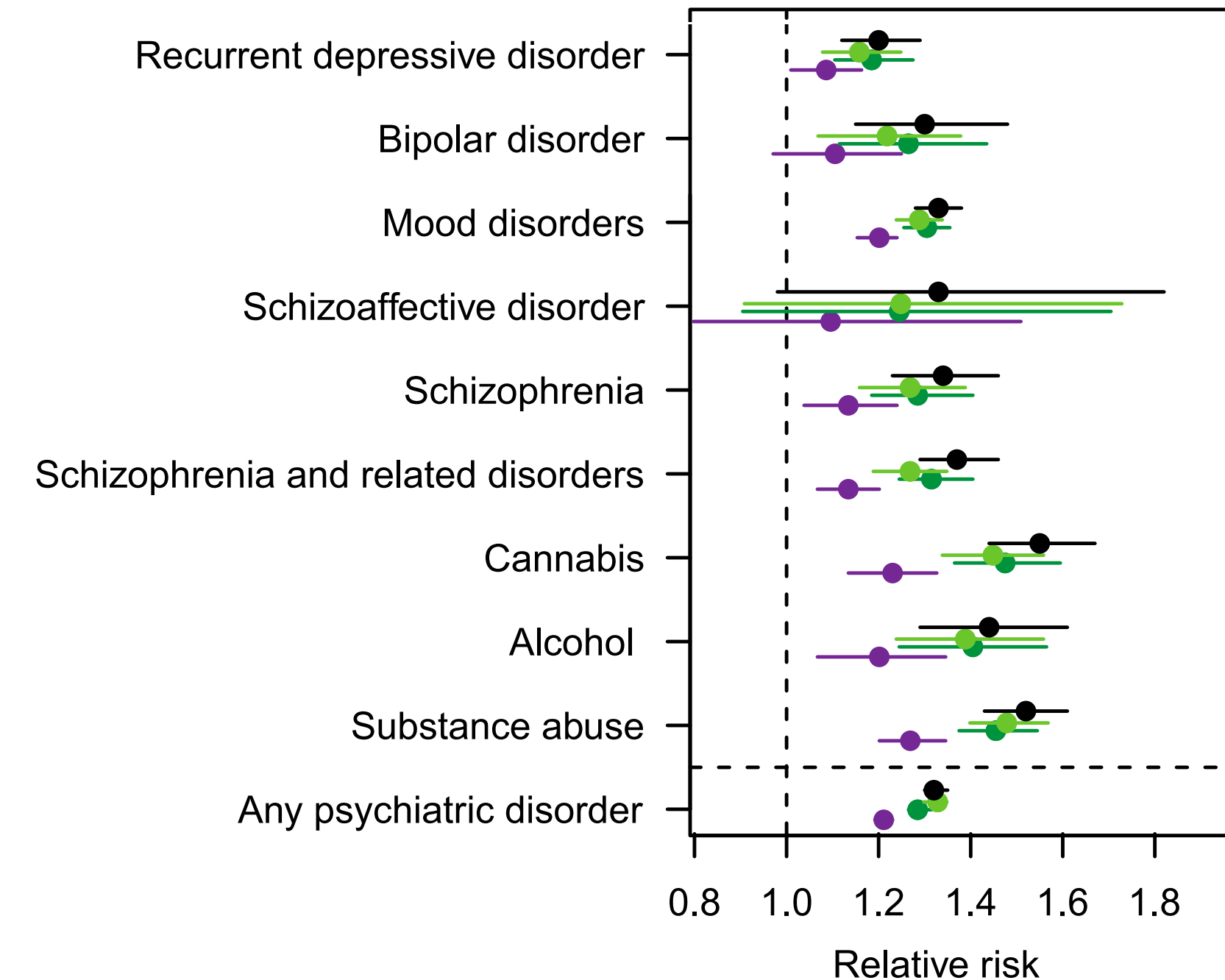
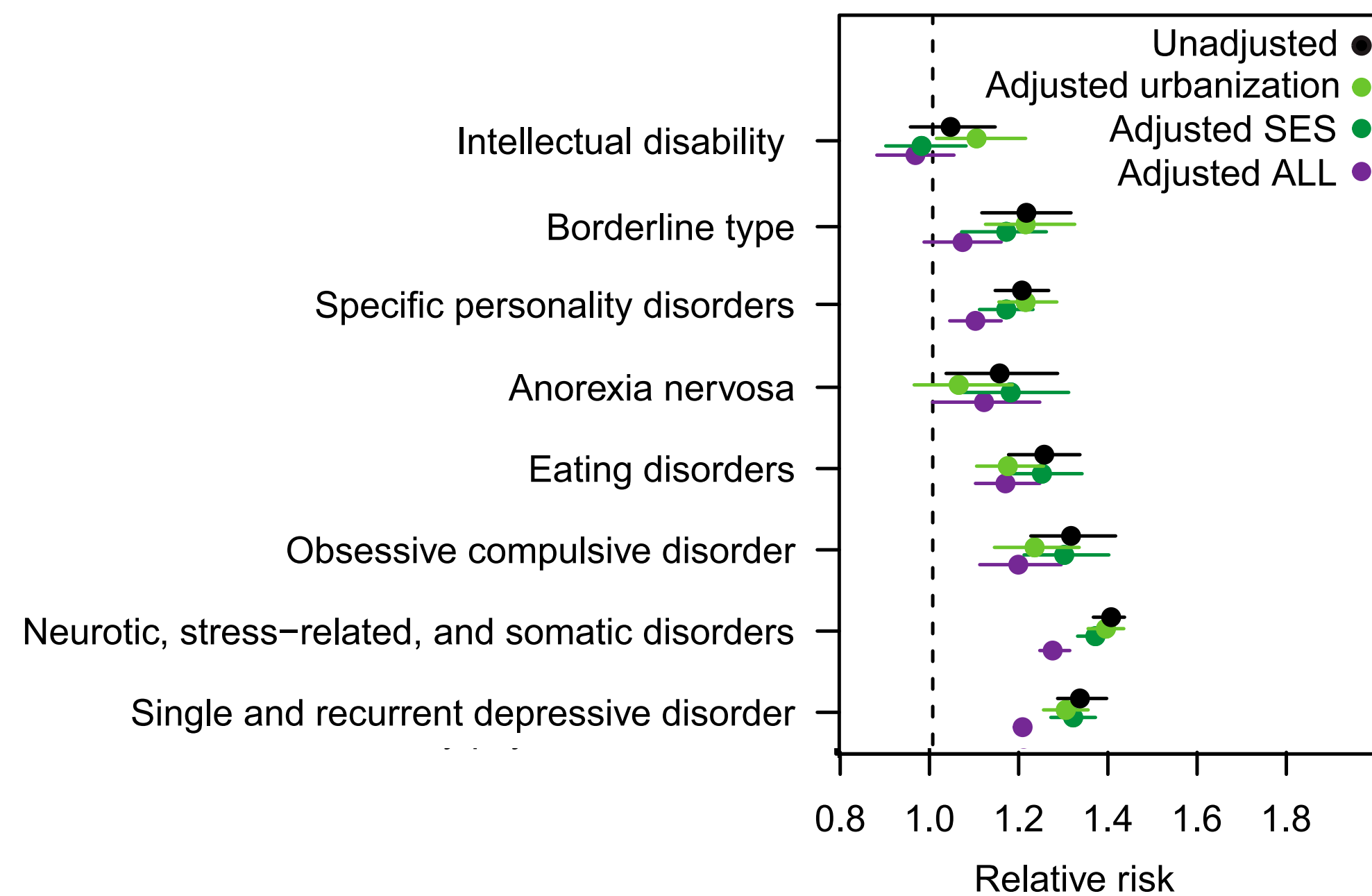
# It's easier being (around) green

## Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood

Kristine Engemann<sup>a,b,c,1</sup>, Carsten Bøcker Pedersen<sup>c,d,e</sup>, Lars Arge<sup>f</sup>, Constantinos Tsirogiannis<sup>f</sup>, Preben Bo Mortensen<sup>c,d,e</sup>, and Jens-Christian Svenning<sup>a,b</sup>

# 55% fewer mental health problems

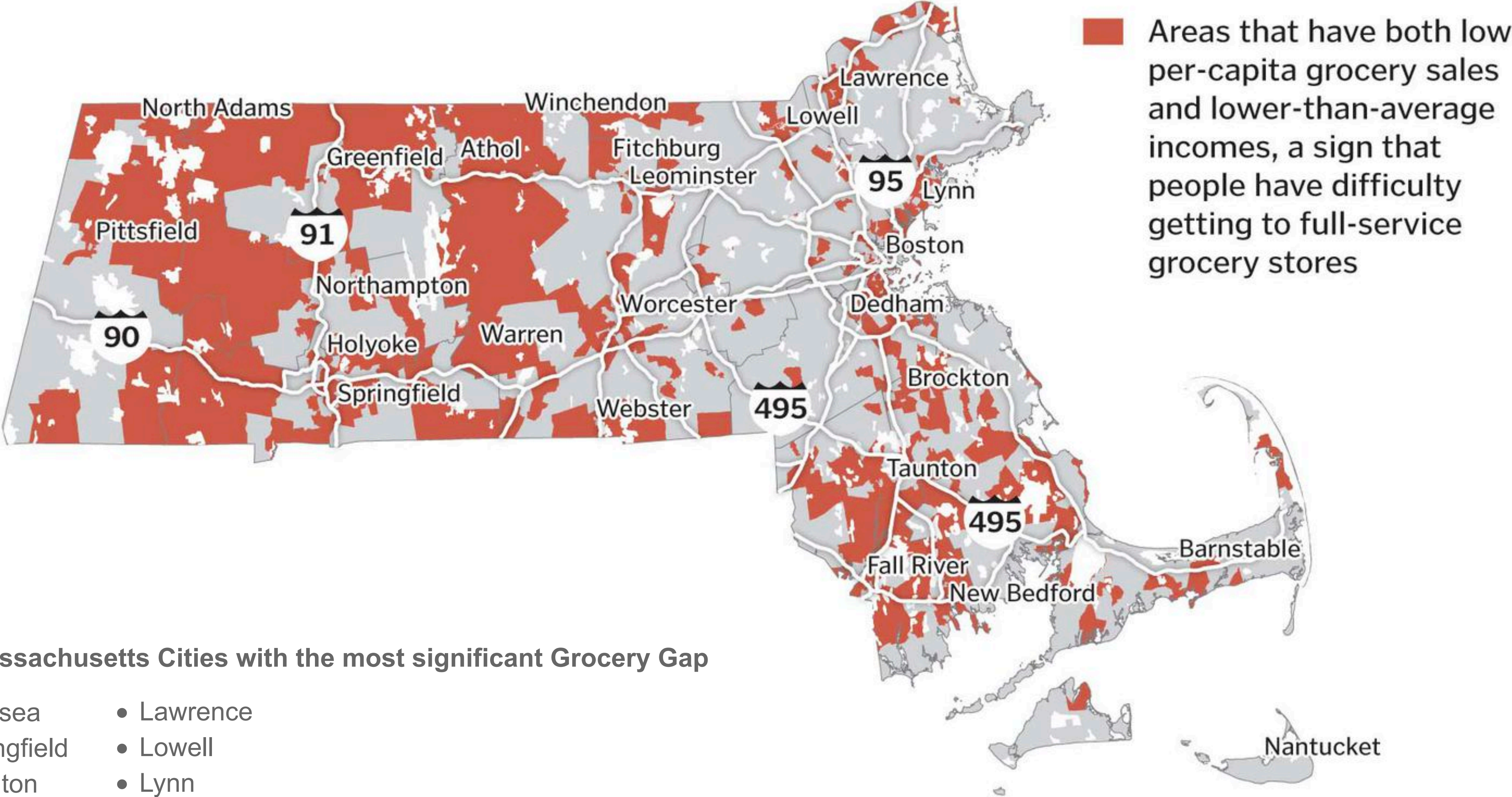
Greenspace assessed birth to 10yo via normalized difference vegetation index @ 30m  
943,000+ 10 year olds



RR compared to highest decile of green space, adjustment for urbanization, socioeconomic factors, parental history of mental illness, and parental age



# Healthy food access



## Top Massachusetts Cities with the most significant Grocery Gap

- Chelsea
- Springfield
- Taunton
- Everett
- Revere
- Lawrence
- Lowell
- Lynn
- Brockton
- Chicopee

SOURCE: The Food Trust GLOBE STAFF





**Low cost prepared meals and produce, teaching kitchen/student education, preventing food waste**





# IF FOOD WASTE WERE A COUNTRY



Greenhouse Gas Emissions

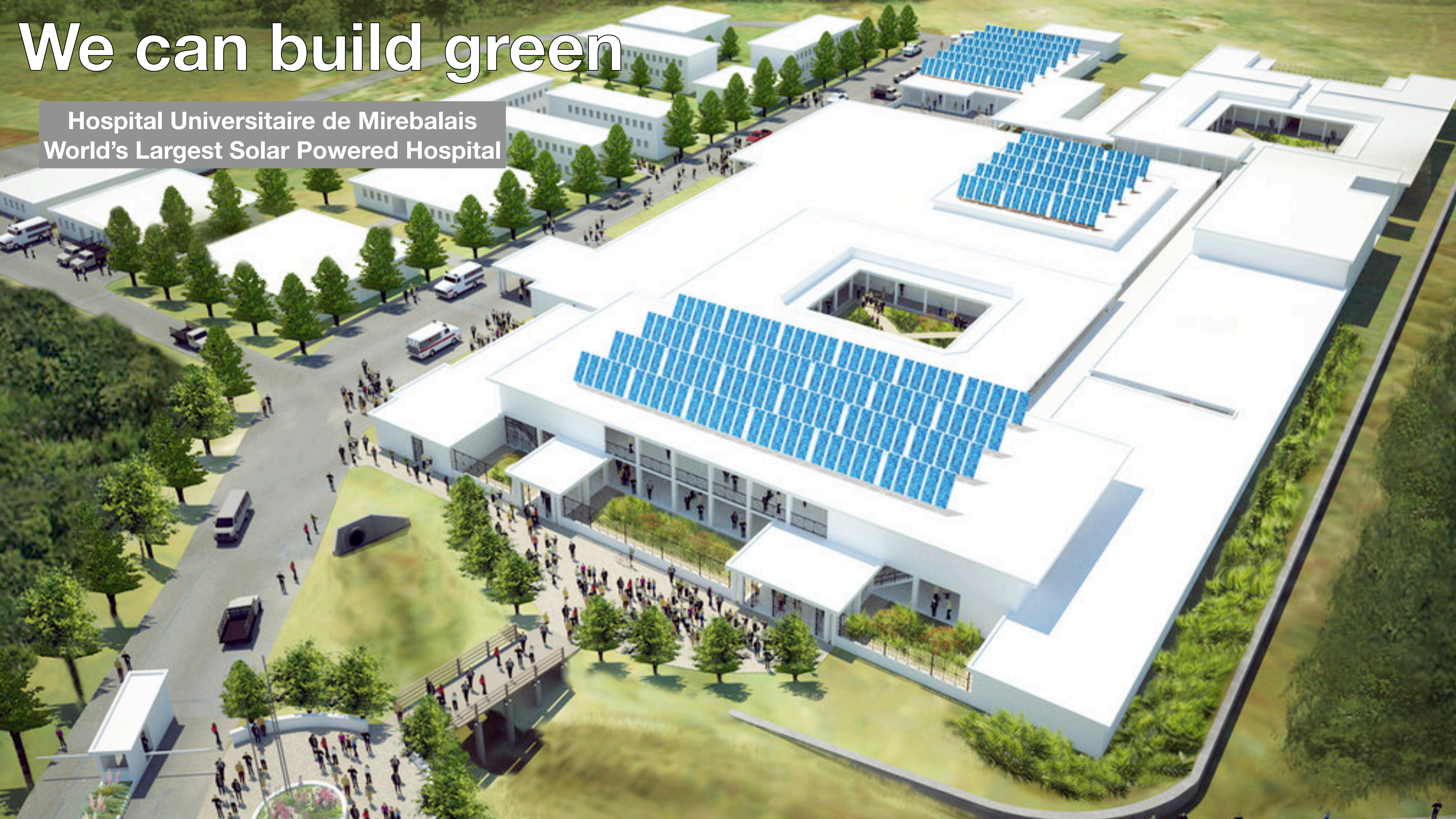
© Carrier Corporation 2015

Source: Food and Agriculture Organization of the United Nations, Food Waste Footprint Impacts on Natural Resources, 2013



# We can build green

Hospital Universitaire de Mirebalais  
World's Largest Solar Powered Hospital



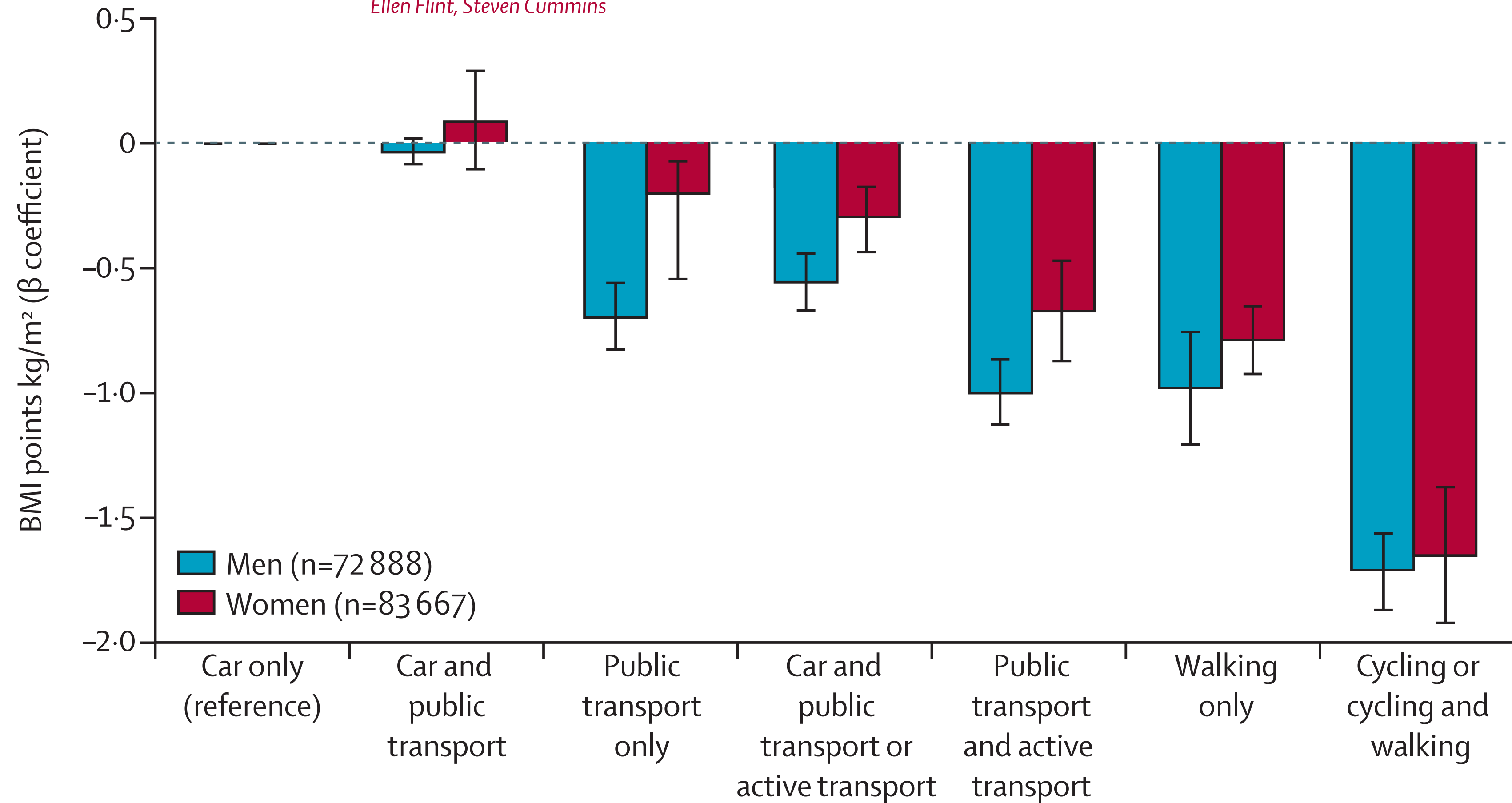


# How we commute and BMI



## Active commuting and obesity in mid-life: cross-sectional, observational evidence from UK Biobank

Ellen Flint, Steven Cummins





# Benefits of active transportation



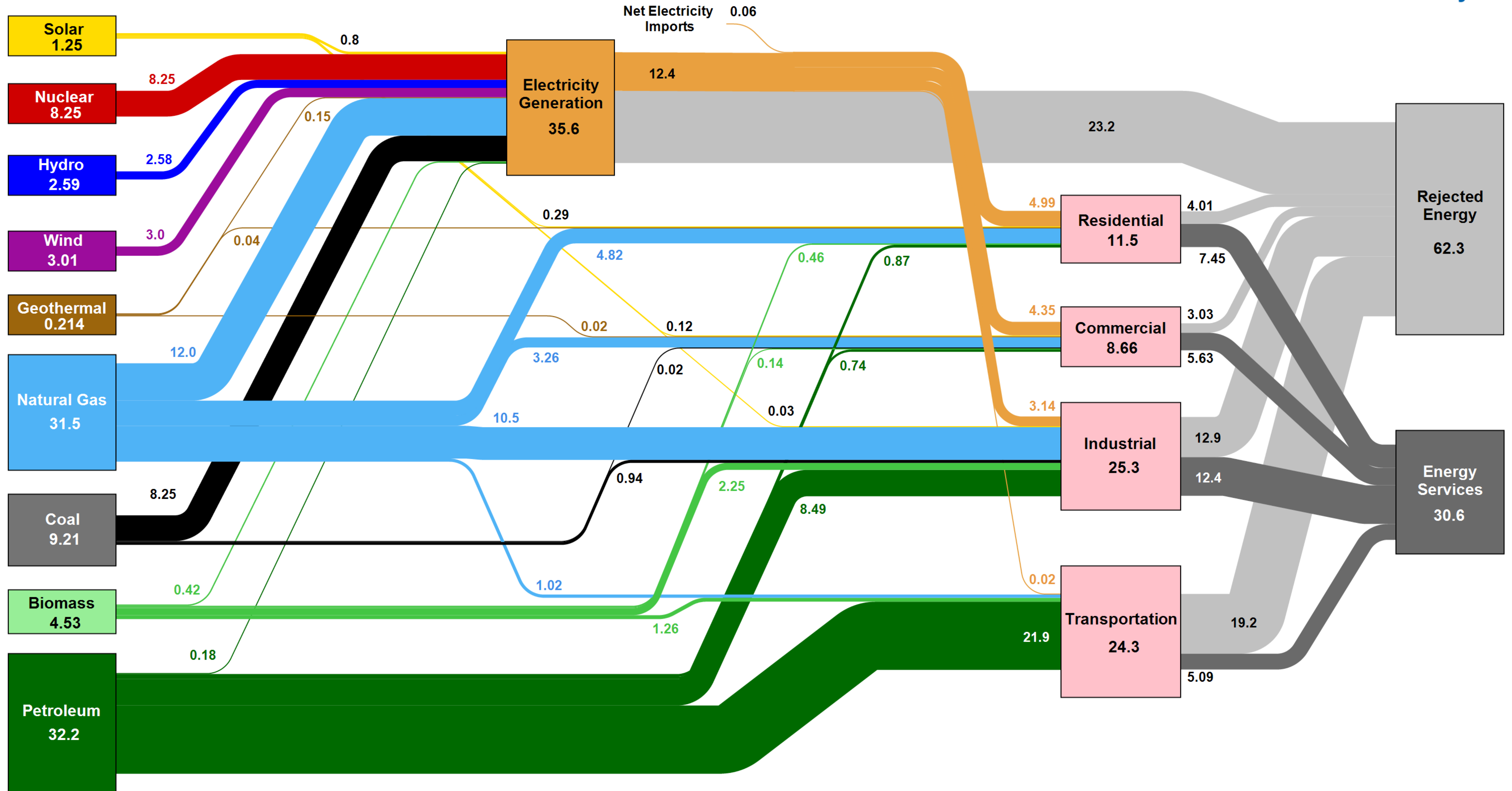
## What you can do

**Support staff active transportation to work:  
locked bike cages, showers, lockers, pay incentives**



# Accelerate adoption of clean, renewable energy

Estimated U.S. Energy Consumption in 2020: 92.9 Quads





# New Study Suggests Burning Fossil Fuels Contributed to 1 in 5 Deaths in 2018

The staggering number is more than twice previous estimates

By TESSA STUART



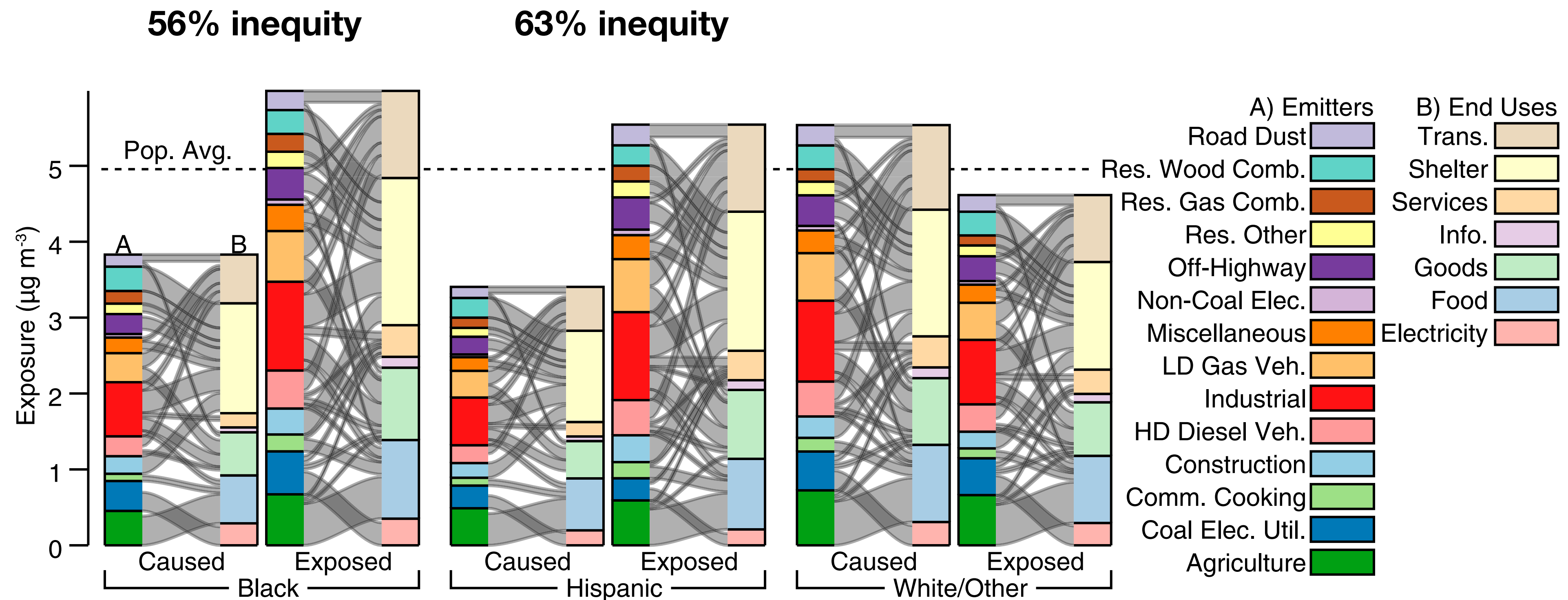
**An aircraft flies over traffic travelling along a highway near the airport during the enforcement of the Odd-Even road space rationing scheme in New Delhi, India, on Tuesday, Nov. 5, 2019. Millions of Indians are breathing in the worlds most toxic air. Each winter, thick smog envelops the capital of New Delhi and numerous cities across the dusty and densely populated North Indian plains.**

Ruhani Kaur/Bloomberg/Getty Images



# Climate actions promote health equity

Air pollution is not an equal opportunity killer







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Optimist**

It's real. It's now. We have solutions.



**Your monthly dose of *good news*  
about climate change.**

Climate heroes are not only designing and building the healthier future we need; they are also defending against actions that threaten science and our health. This issue highlights key stories from this month.