Cooling the Capital Region: From Models to Implementation

Webinar #1 Understanding Our Regional Heat Island Challenge

CAPITAL REGION
CLIMATE READINESS
COLLABORATIVE

SACRAMENTO METROPOLITAN
AIR QUALITY
MANAGEMENT DISTRICT

February 13, 2020 | 1:00 PM – 2:00 PM

Webinar Agenda

- Webinar Logistics
- Overview of CRC
- Overview of Project, Shelley Jiang, SMAQMD
- Deep Dive: Sacramento's Heat Island, Haider Taha, Altrostratus
- Heat Islands & Public Health Impacts, Jason Vargo, CDPH
- Participant Q&A

Webinar Logistics

Questions:

At any point during the webinar, you can submit a question through the Zoom control panel. All questions will be read aloud and answered during Q&A as long as time permits.

You can also use the ‘hand raising’ feature to be unmuted and ask a question during Q&A.

About CRC

The Capital Region Climate Readiness Collaborative is a multidisciplinary network of local and regional agencies, organizations, businesses, and associations working together to advance climate mitigation and adaptation efforts in their own communities and throughout California's Capital Region.

Membership


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YUBA WATER AGENCY

Featured Presenters

Shelley Jiang
Climate Change Coordinator

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Featured Presenters

Altostratus Inc.

Haider Taha

President & Scientist

Featured Presenters

Jason Vargo

Lead Scientist, Climate Change and Health Equity

California Department of PublicHealth

Featured Presenters

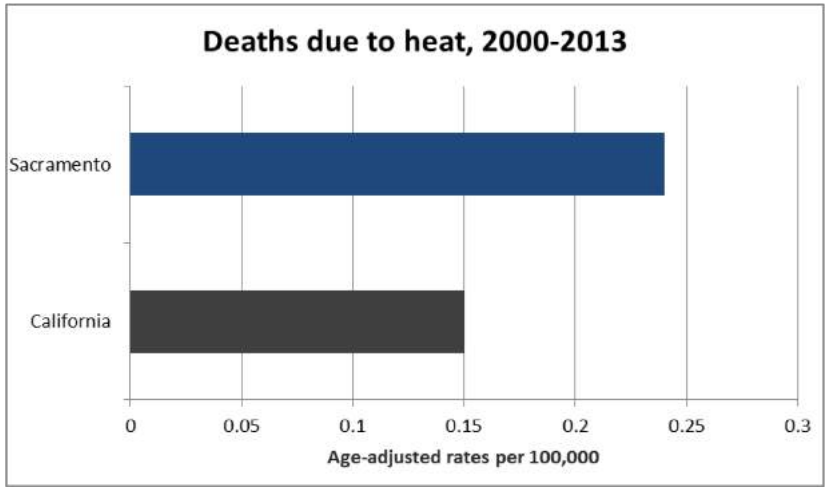
Shelley Jiang
Climate Change Coordinator

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

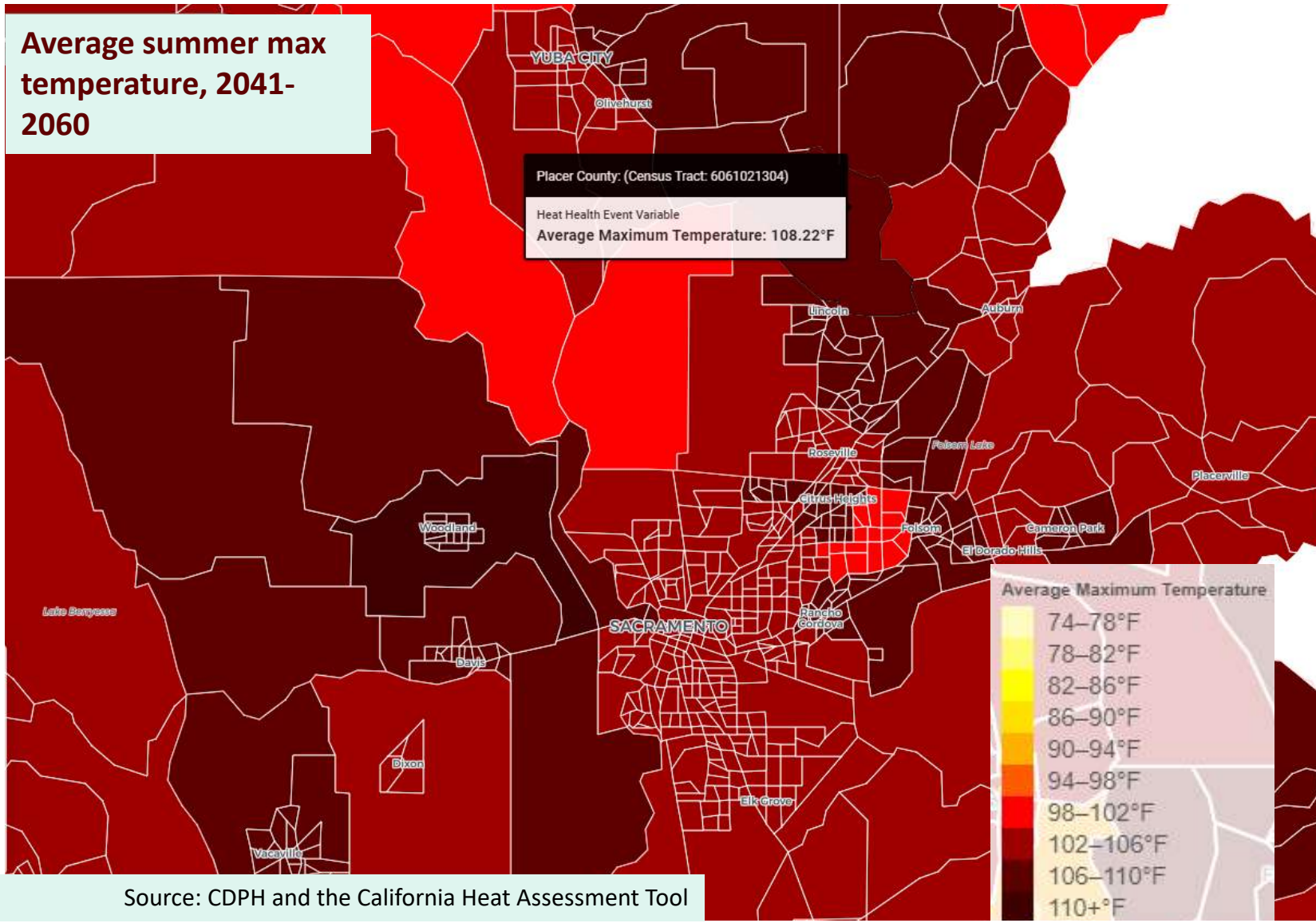
Capital Region Transportation Sector Urban Heat Pollution Reduction Project

- **Funding:** $487,775 from Caltrans SB1 Adaptation Planning Grants.
- **Project timeline:** May 2018 to February 2020
- **Partners:** Sacramento Metropolitan Air Quality Management District, Local Government Commission, Altostratus, and WSP

The extreme heat challenge for Sacramento



As a result of climate change Sacramento faces increasingly hotter days



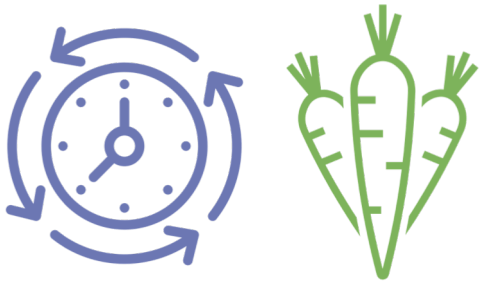
Source: CDPH and the California Heat Assessment Tool

Why do we care about heat pollution?

Worse air quality and ozone pollution

More emergency room visits, heat strokes, and other related illnesses

Heat strokes and other risks for outdoor workers



Reduced productivity

Lower test scores & educational performance

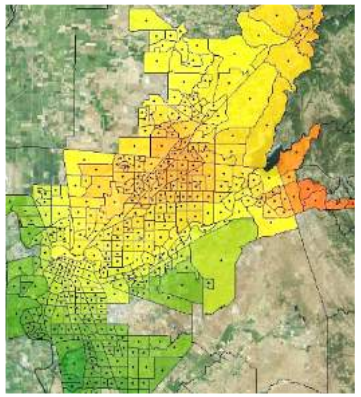
Higher rates of aggression, violence, and suicide

Lower birth weights & premature births

Higher energy costs & grid instabilities

Heat & transportation

Project Concept



Heat Island Model

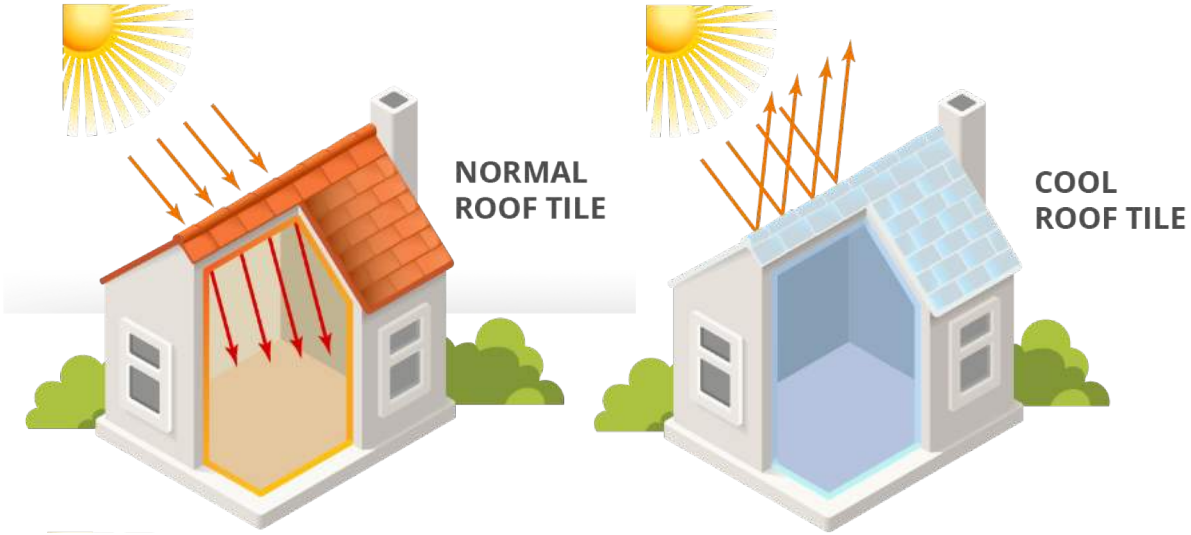
Cooling Solutions

Community Input

Transportation Plans

A comprehensive Heat Pollution Reduction Plan, with specific recommendations for integrating heat-mitigation strategies into transportation plans, projects, guidelines, and codes.

Solutions: Cool roofs



A normal roof absorbs more heat from the sun, warming the interior. Cool roofs reflect and radiate more heat, helping to keep the house cool.

Benefits of cool roofs

Save energy and money: Cool roofs help your house stay cooler, reducing A/C needs by 20%

Improve air quality: By reducing the heat island effect, a cool roofs can help reduce ozone (smog) formation.

A healthier indoor environment: Cool roofs help keep vulnerable residents safe from heat at lower costs.

Reduce maintenance costs: A cool roof can be 35-65°F cooler than a dark roof, reducing heat stress and damage to roofing equipment and materials.

Solutions: Cool Pavements

Like cool roofs, cool pavements can be considerably cooler than normal asphalt, and they can take a range of materials and fit a variety of functions – for everything from roads to bike paths to playgrounds.

Permeable pavers, for example, can help to absorb stormwater, store water, and reduce localized flood risks. They can be used on driveways, sidewalks, patios, and garden paths.

Benefits:

- **Cooler temperatures** for people exercising, working, and playing outdoors
- **Improve air quality**
- **Increased driver safety**
- **Reduced street lighting cost**
- **Improve water quality**
- **Reduced maintenance costs**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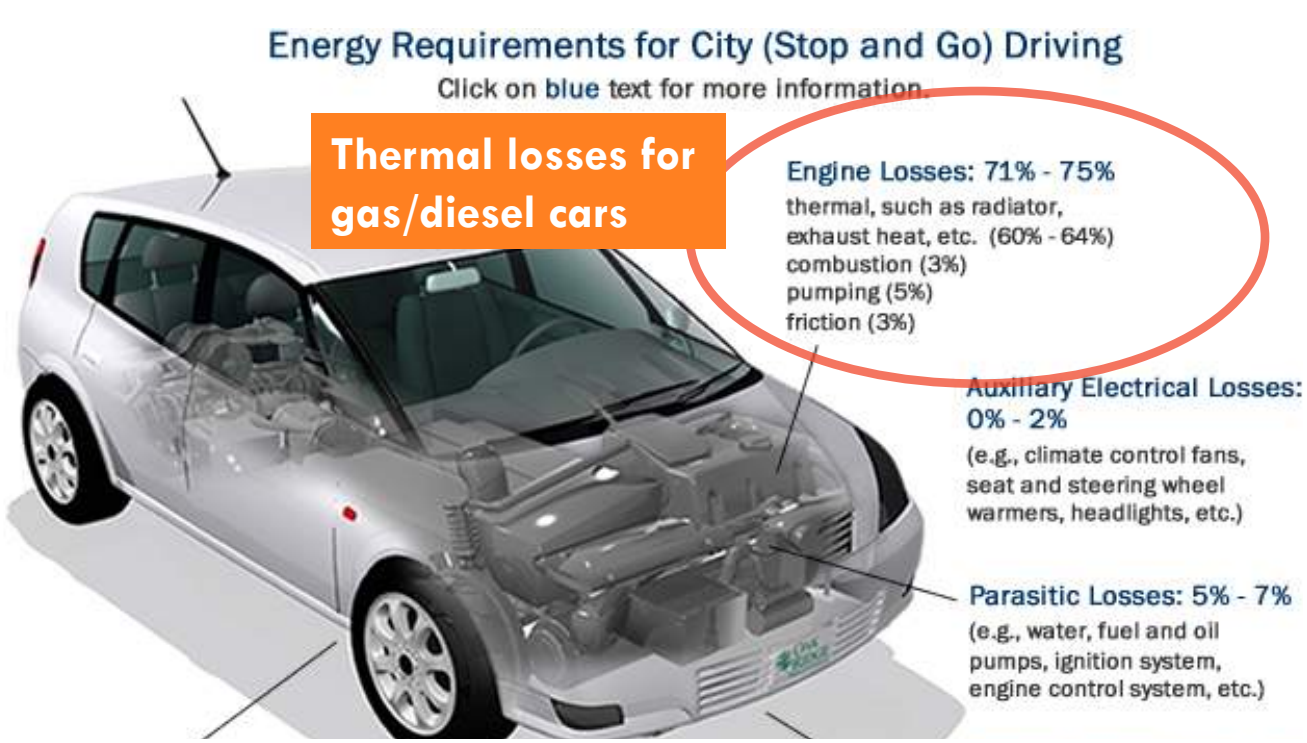
Solutions: Trees

Trees help to:

- Clean our air and improve air quality
- Provide shade and comfort for people outdoors
- Save energy bills
- Filter stormwater
- Provide habitat for wildlife
- Store carbon
- Reduce the urban heat island effect
- Build neighborhood pride and social cohesion
- Improve property values
- Reduce soil erosion
- Block noise
- And more!

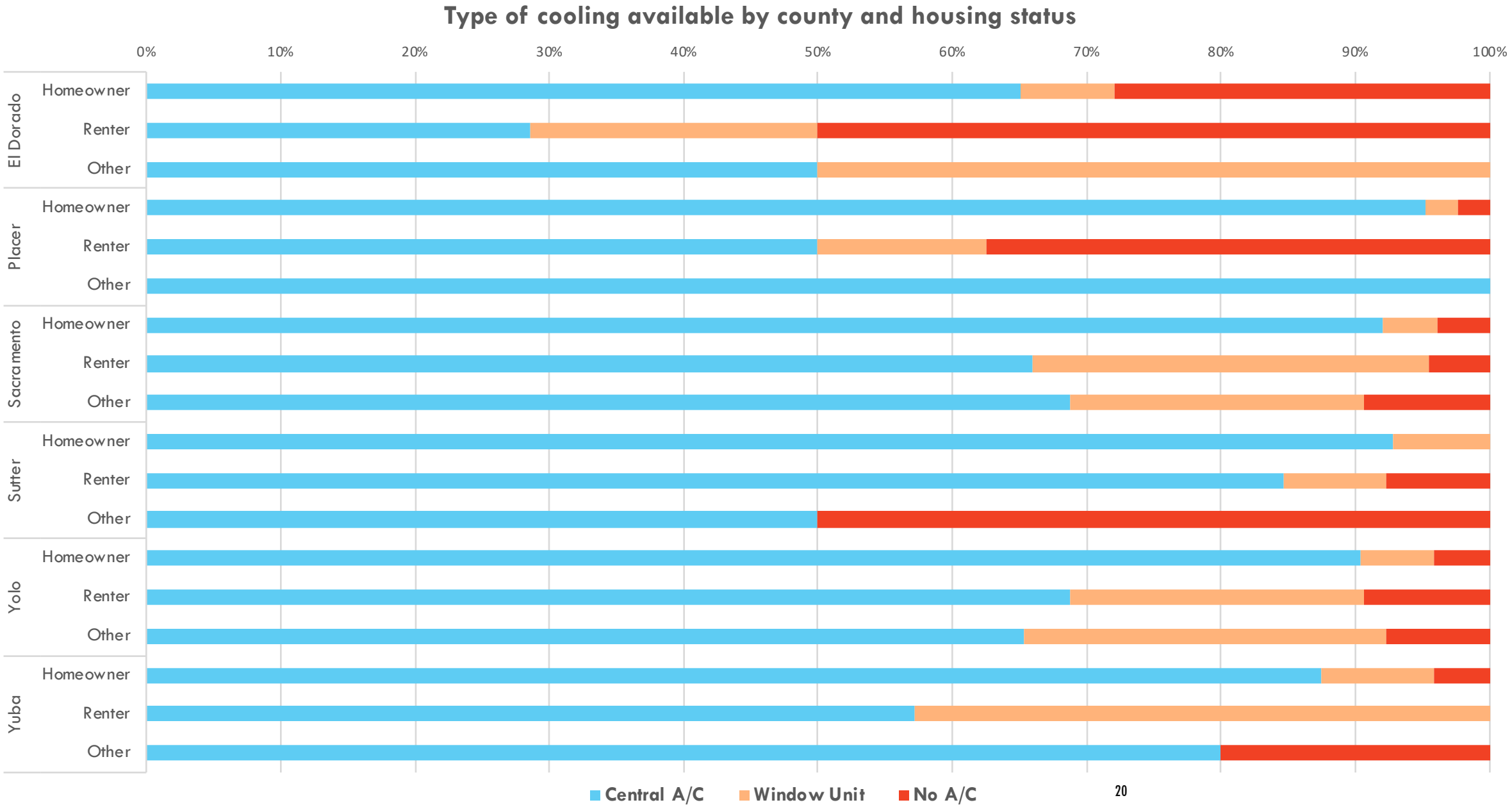
Solutions: Zero-Emissions Vehicles

Only about 12%–30% of the energy from the fuel you put in a conventional gas (or diesel) car is used to move it down the road.

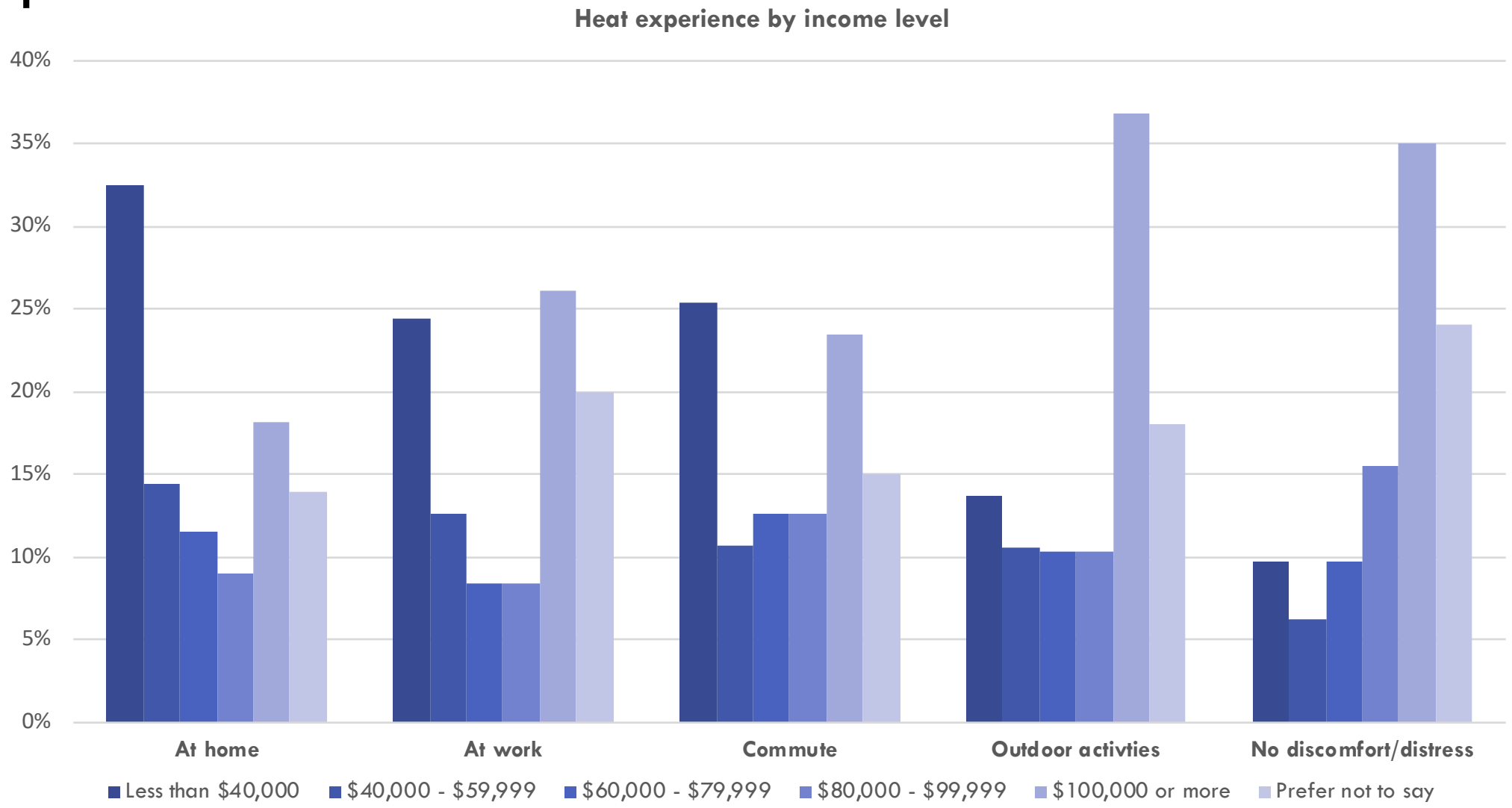


Electric vehicles emit only 20% of the waste heat compared to combustion-engine vehicles.

Communities priority survey



Thinking back to this past summer, where did you experience the most discomfort or stress due to hotter temperatures?

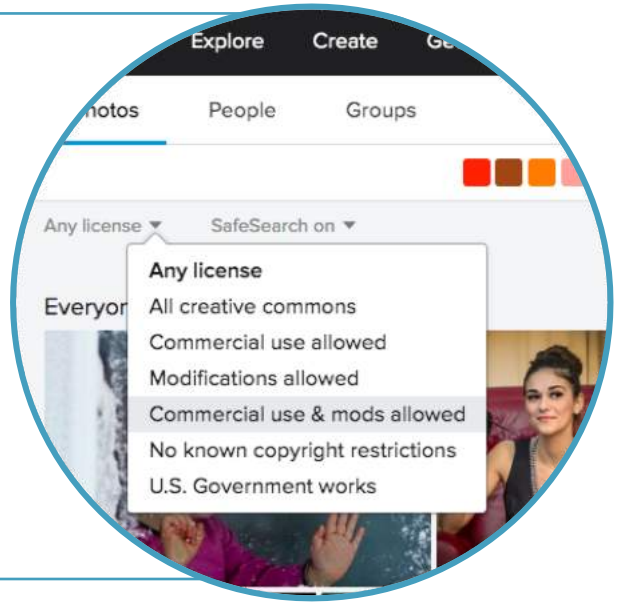


Featured Presenters

Altostratus Inc.

Haider Taha

President & Scientist



CAPITAL REGION UHI PROJECT

Atmospheric Modeling for the Development of a
Regional Heat Pollution Reduction Plan for the
Capital Region

SMAQMD / LGC (SB-1 Caltrans)

CRC / SMAQMD Webinar

Background and results at the regional scale

February 13, 2020

Haider Taha
Altostratus Inc.
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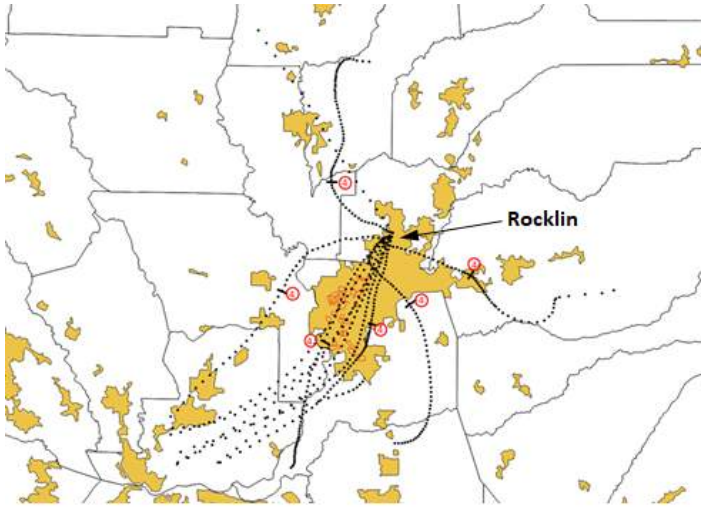
CONCEPTS AND DEFINITIONS

- What is a UHI? What is a UHII?
  - A temperature differential, instantaneous, cumulative
- What is the goal of heat-mitigation measures?
  - Cooling down
- So why bother about UHI / UHII?
  - A reference, a yardstick
- A-UHI versus S-UHI
  - UHI based on air temperature, not “hot spots”
  - Relevance to thermal environment, emissions, air quality
  - Spatial patterns
  - Surface temperature evaluated for transportation system
- Why is all this important?
  - Urban exacerbation of heat, emissions, air pollution



Arriving Rocklin area at 1400 PDT on 13 different days

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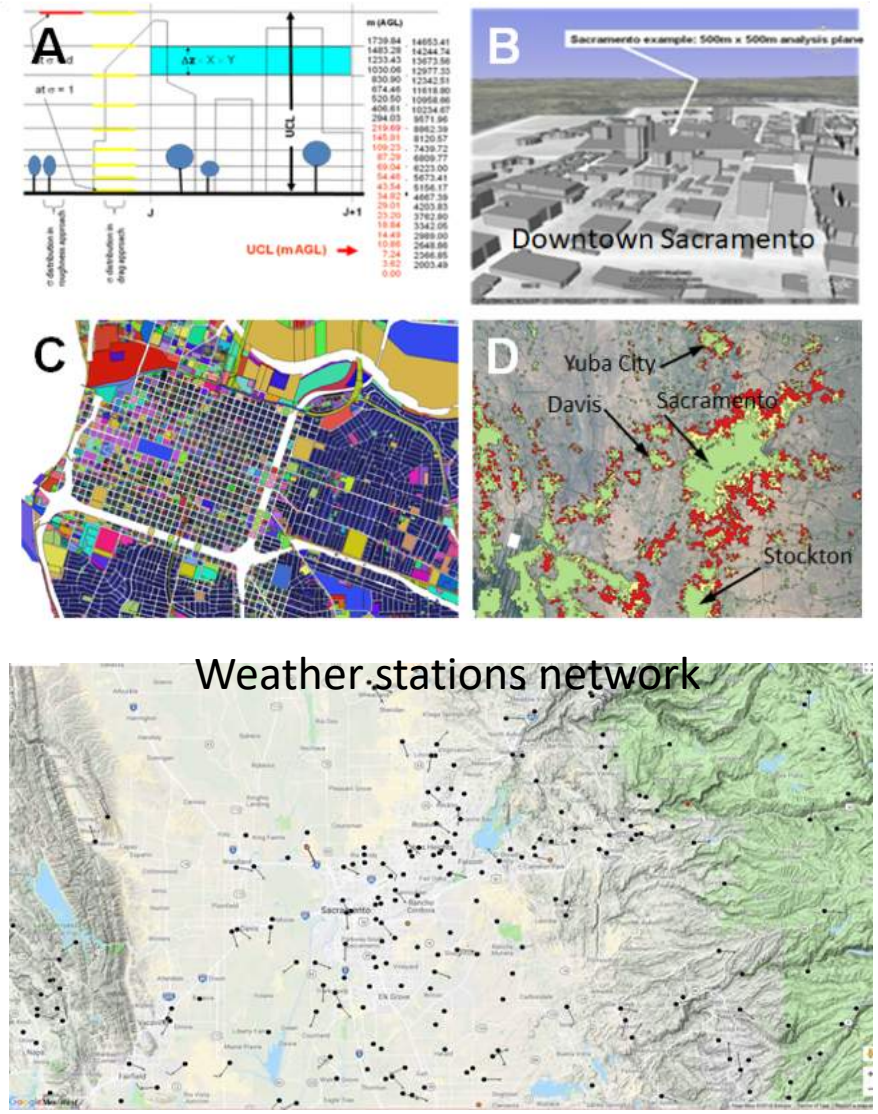
TECHNICAL TASKS

- Land-use / Land-cover, current, future
- Observational weather data
- Base atmospheric modeling and MPE
- Modeling of mitigation measures under current climate and LULC (2013 – 2016)
- Modeling of mitigation measures under future climate and urbanization (2050, RCP 4.5 and RCP 8.5)
- Metrics, thresholds, rankings
  - Residents / Communities
  - Transportation system



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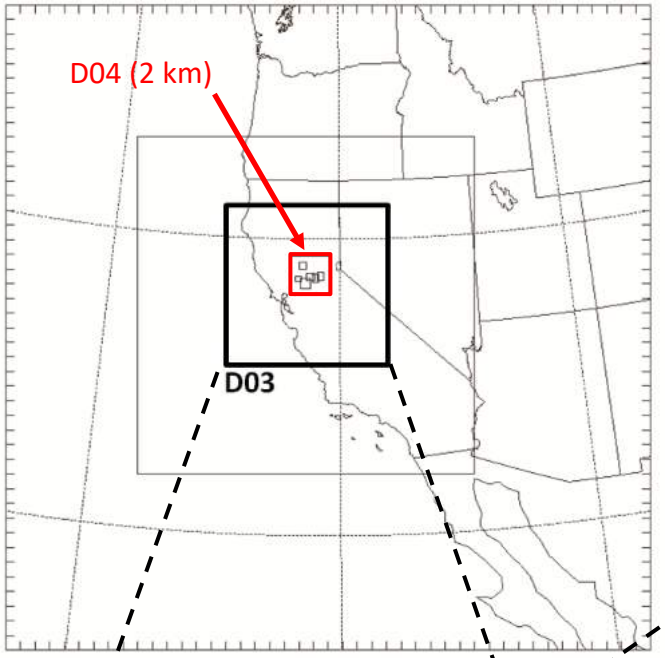
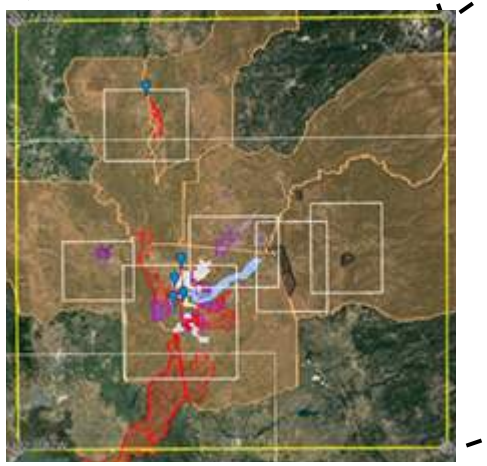
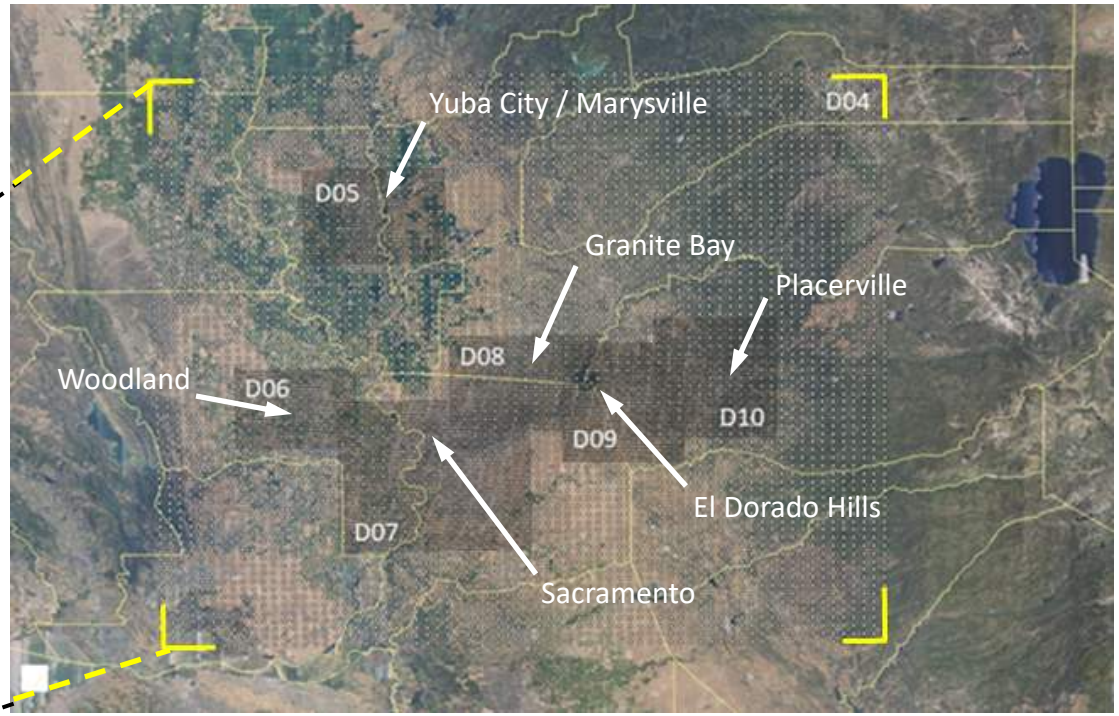
Selection of study domains per input from SMAQMD / LGC, cities, communities, and the project technical advisory committee (TAC)



Ten-domains configuration
54, 18, 6, 2 km, 500 m



500-m domains



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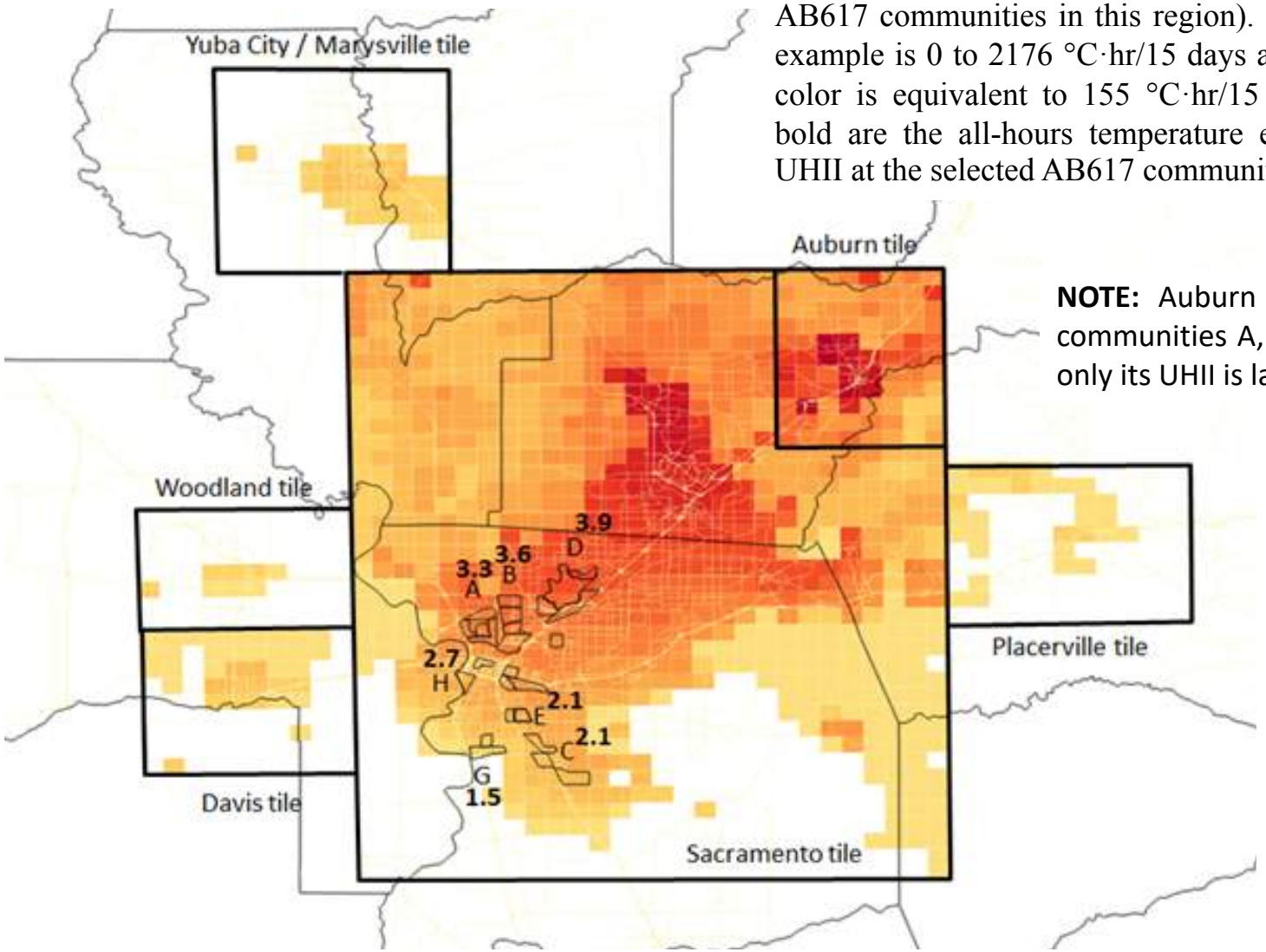
CAPITAL REGION COMPOSITE URBAN HEAT ISLAND INDEX (UHII)

Composite of UHII, July 16-31, 2015 for **all-hour** averages in six tiles in the Capital region (A – H are some of the AB617 communities in this region). The UHII range in this example is 0 to 2176 °C·hr/15 days and each step change in color is equivalent to 155 °C·hr/15 days. The numbers in bold are the all-hours temperature equivalents (ºC) of the UHII at the selected AB617 communities.



NOTE: Auburn is **NOT** warmer than communities A, B, and D, for example, only its UHII is larger.

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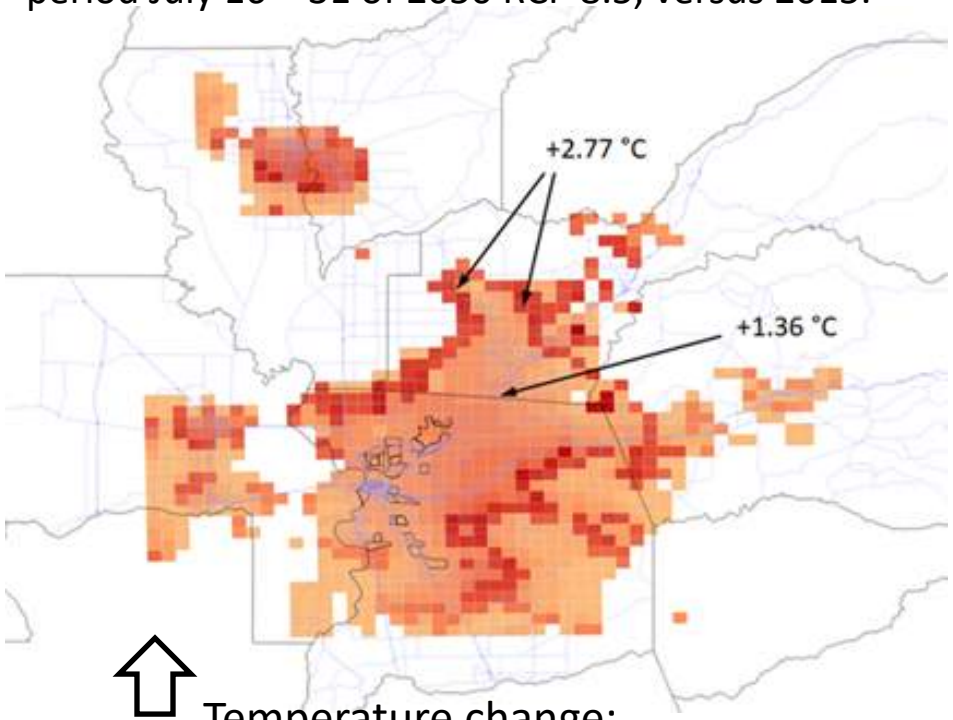
Effects of climate and land-use changes on temperature and the UHII

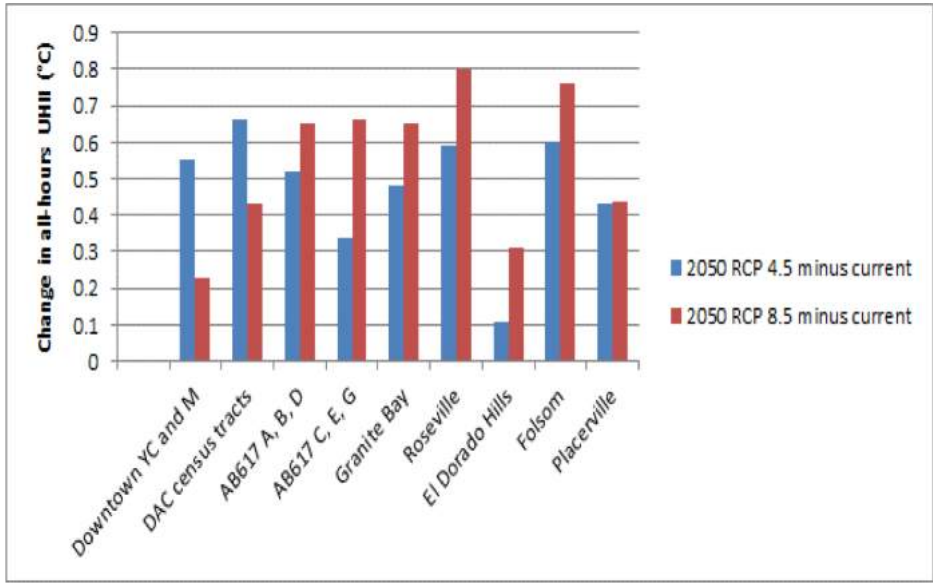
Temperature equivalent, °C (DH hr^{-1}), of the all-hours averaged change in the UHII during the period July 16 – 31 of 2050 RCP 8.5, versus 2015.



Temperature change:

- ≡ New urban areas up to 2.77 °C: clim. + LU
- ≡ Current urban are up to 1.36 °C: clim. only

Changes (increases) in the all-hours **UHII** from current climate and LULC to 2050, averaged over each sub-domain



Impacts of land-use change (urbanization) on temperature/UHII are similar in magnitude to local impacts of climate change

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HEAT MITIGATION MEASURES

- Urban-wide

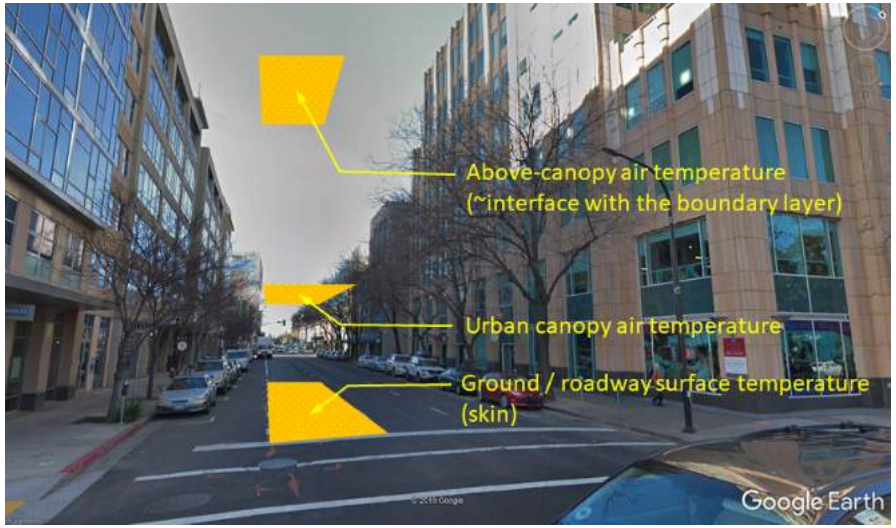
  (effects benefiting urban area as a whole and also the transportation system)

  - Cool roofs
  - Cool pavements
  - Vegetation canopy
  - Cool walls
  - EV ownership / fleet electrification
  - Solar PV

- At transportation corridors

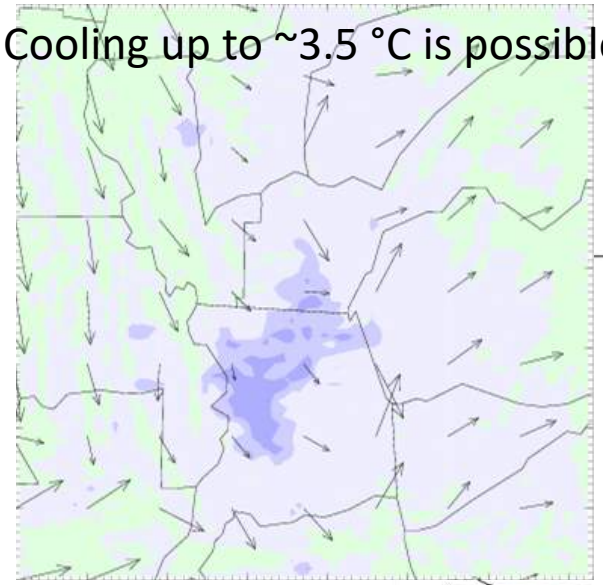
  (effects more localized in transportation corridors)

  - Increased albedo
    - White topping
    - Concrete
    - High albedo materials / cool pavements
  - EV / electrification



REGIONAL-SCALE COOLING AND FETCH EFFECTS: OFFSETTING UHII

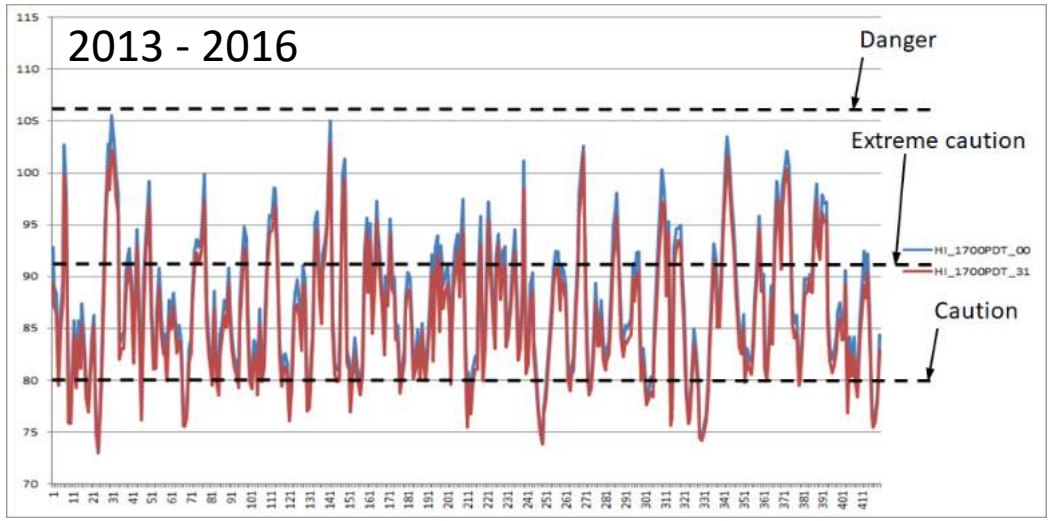
Cooling up to ~3.5 °C is possible



- **UHI-mitigation measures can also benefit areas that are downwind of modifications**
- **Temperature-depression half lifetime reached about 2 – 4 km downwind of urban edge (on average)**

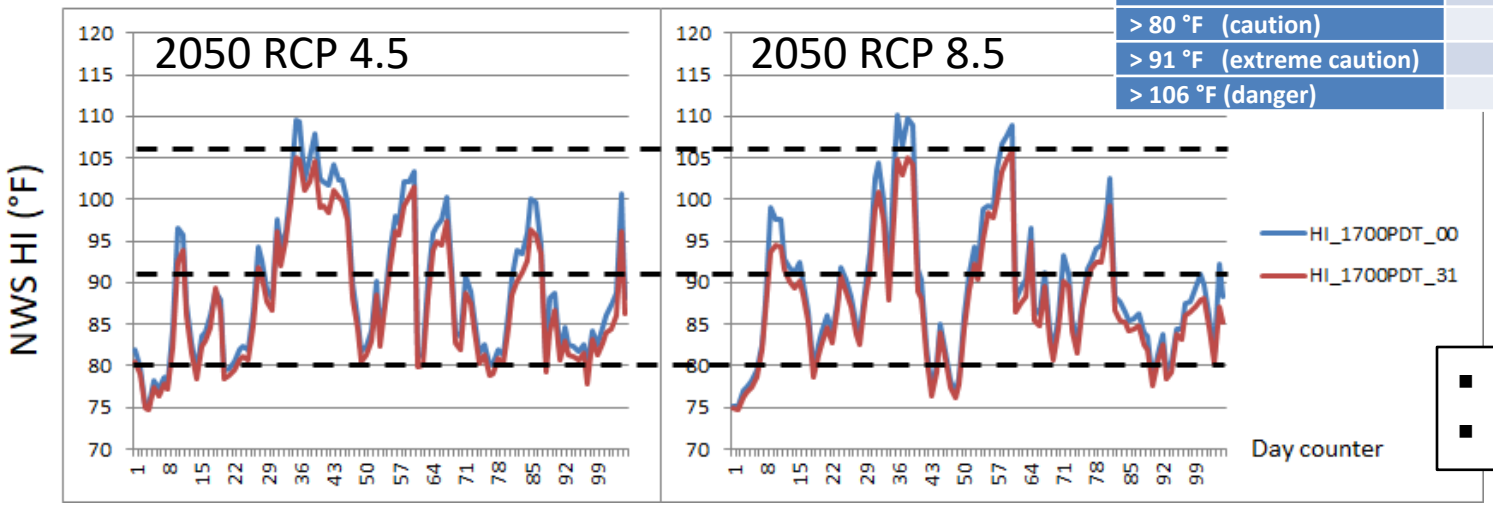
Heat health: Changes in NWS HI at 1700-PDT hours (case00, case31)
Example: JJAS Sacramento area, current and 2050 RCP 4.5 and 8.5

Example at: probing station P0011 in AB617 community



P0011 AB617	Percent of DH (out of total) above threshold		
NWS HI thresholds	2013-2016	2050 RCP 4.5	2050 RCP 8.5
> 80 °F (caution)	90.0%	91.0%	89.0%
> 91 °F (extreme caution)	32.0%	40.0%	39.0%
> 106 °F (danger)	0%	3.5%	8.0%

P0011 AB617	Decrease in exceedance following case 31		
NWS HI thresholds	2013-2016	2050 RCP 4.5	2050 RCP 8.5
> 80 °F (caution)	-9.0%	-7.7%	-4.1%
> 91 °F (extreme caution)	-28.0%	-9.8%	-29.0%
> 106 °F (danger)	N/A	-100.0%	100.0%



- NWS HI = *f* (*Tair, RH*)
- Reported as *Tair* (°F)

AB 617 community

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Local reductions in heat-wave days in current climate

Number of consecutive days with NWS HI 105 – 110 ºF during three excessive heat events.

		Number of days with NWS HI 105 – 110 ºF					
Probing location	Heat wave?	6/30 – 7/4, 2013		6/30 – 6/31, 2016		7/28 – 7/30, 2016	
		base	case31	base	case31	base	case31
P0001 AB617 (Sac)	yes	5	1	0	0	2	0
P0004 AB617 (Sac)	yes	3	1	0	0	2	0
P0008 AB617 (Sac)		1	0	0	0	0	0
P0011 AB617 (Sac)		1	0	0	0	0	0
P0013 Citrus Heights	yes	5	1	1	0	1	0
P0014 Roseville	yes	5	2	1	0	2	0
P0018 Lincoln	yes	4	3	1	0	2	0
P0020 El Dorado Hills		1	0	0	0	0	0
P0022 Placerville		0	0	0	0	0	0
P0026 Woodland	yes	3	0	0	0	0	0
P0028 Davis	yes	4	0	0	0	0	0
P0029 Marysville	yes	4	4	2	0	3	2
P0032 Yuba City	yes	4	4	2	0	3	1

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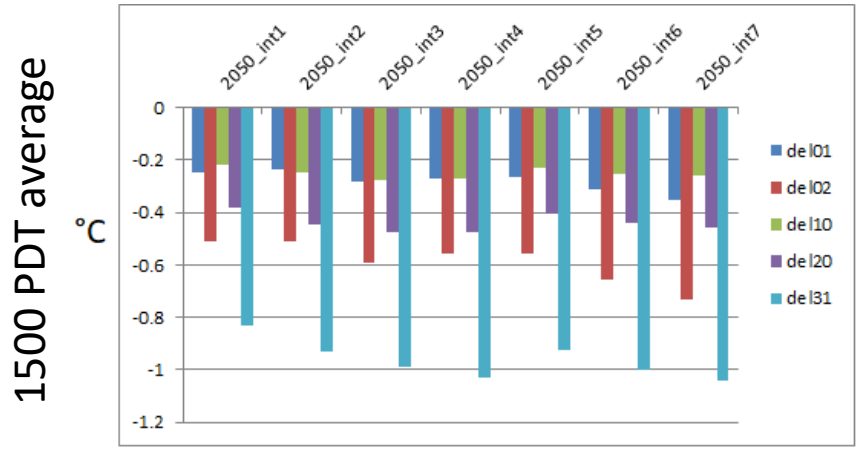
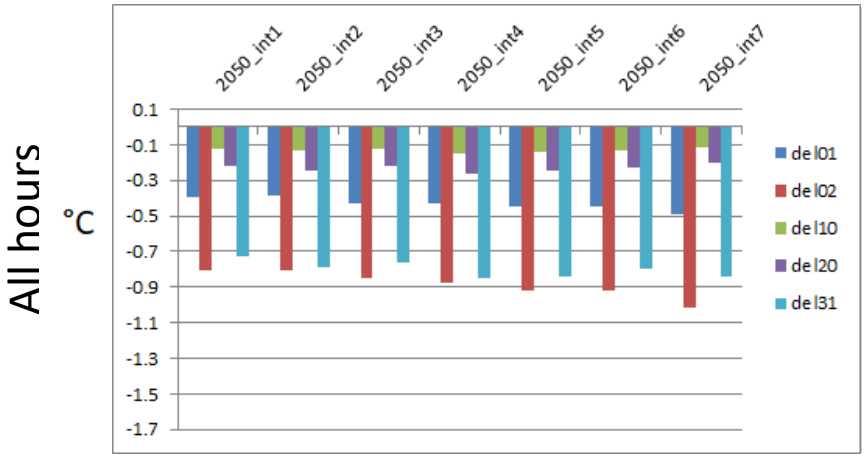
Impacts of mitigation measures on future microclimates: Example – El Dorado Hills and Auburn, *Tair* changes



El Dorado Hills 2050 RCP 4.5

4 Small canopy increase
2 Large canopy increase
5 Small albedo increase
3 Large albedo increase
1 Combined albedo + canopy cover

Ranking



Auburn 2050 RCP 4.5

3 Small canopy increase
1 Large canopy increase
5 Small albedo increase
4 Large albedo increase
2 Combined albedo + canopy cover

Ranking

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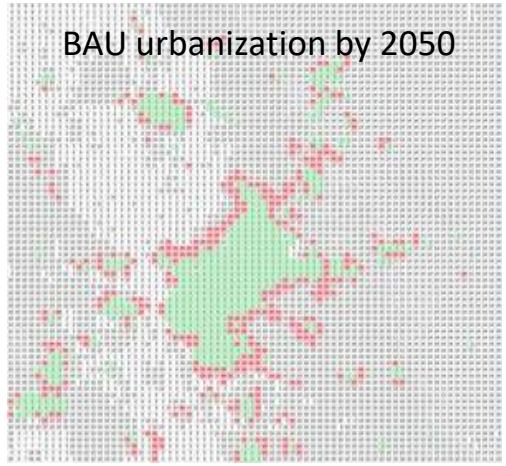
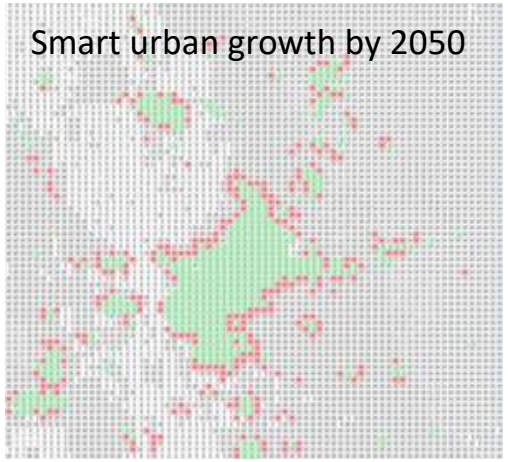
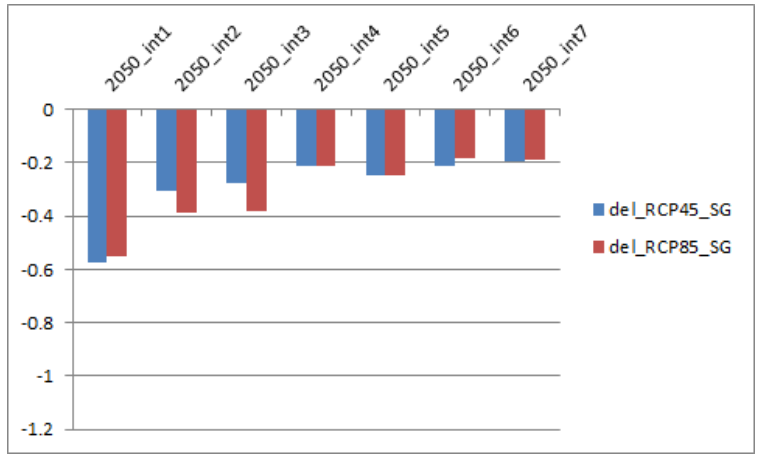
Impacts of smart growth on future microclimates: Example – El Dorado Hills and Auburn, *Tair* changes





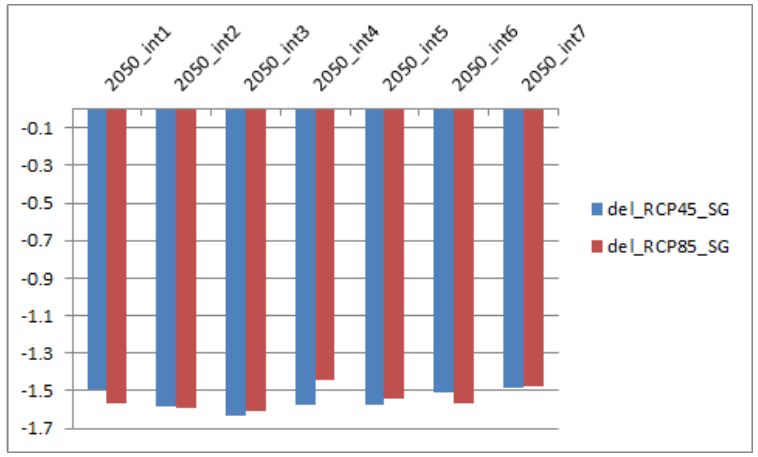
15% less urbanization

Temp. diff.: 1500-PDT average (avoided warming)



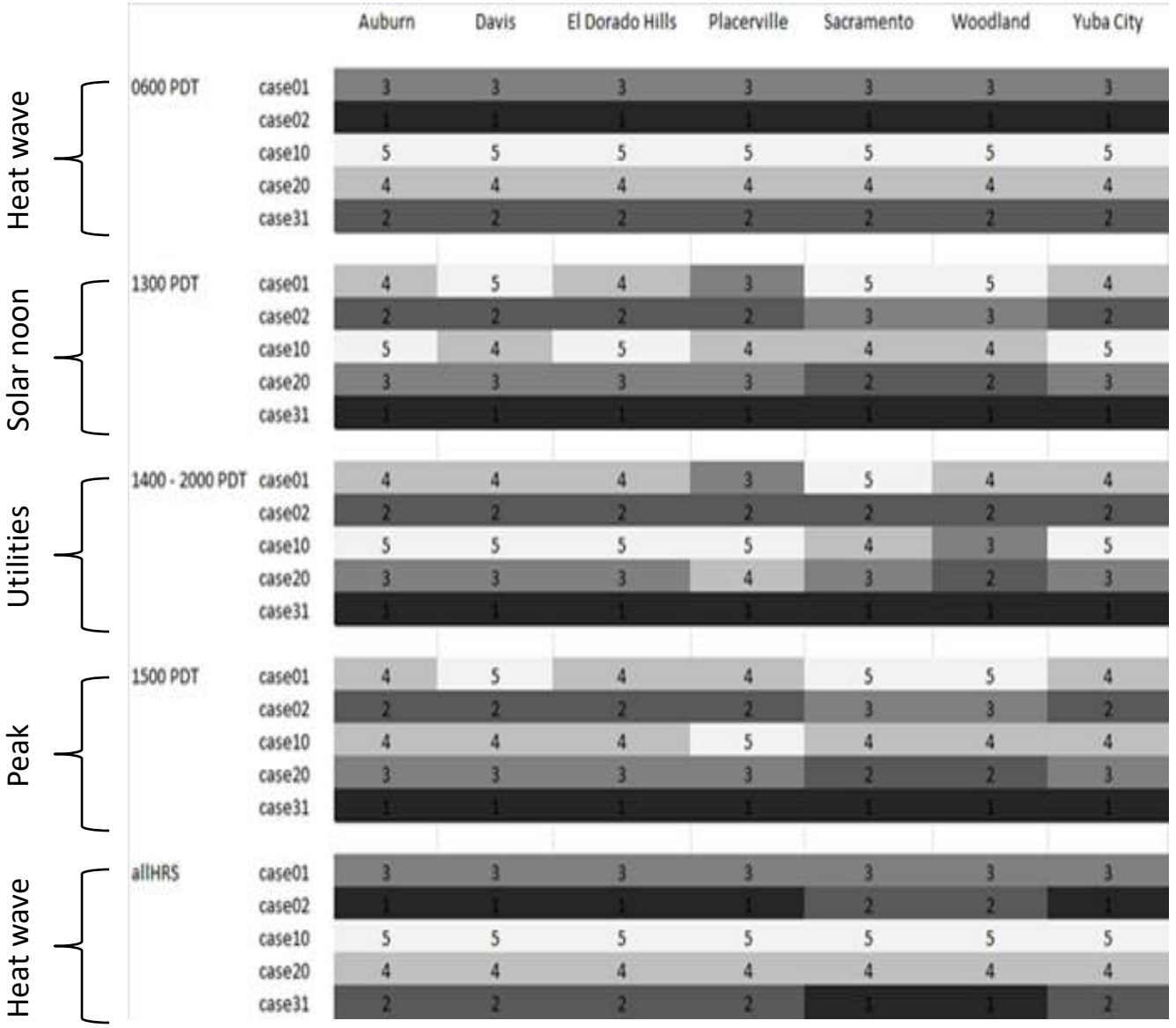
El Dorado Hills 2050 smart growth
Impacts in avoided urbanization areas only

Temp. diff.: All-hours average (avoided warming)



Auburn 2050 smart growth
Impacts in avoided urbanization areas only

Regional-scale effectiveness of cooling measures under current climate and urbanization



			Auburn	Davis	El Dorado Hills	Placerville	Sacramento	Woodland	Yuba City
Heat wave	0600 PDT	case01	3	3	3	3	3	3	3
		case02	1	1	1	1	1	1	1
		case10	5	5	5	5	5	5	5
		case20	4	4	4	4	4	4	4
		case31	2	2	2	2	2	2	2
Solar noon	1300 PDT	case01	4	5	4	3	5	5	4
		case02	2	2	2	2	3	3	2
		case10	5	4	5	4	4	4	5
		case20	3	3	3	3	2	2	3
		case31	1	1	1	1	1	1	1
Utilities	1400 - 2000 PDT	case01	4	4	4	3	5	4	4
		case02	2	2	2	2	2	2	2
		case10	5	5	5	5	4	3	5
		case20	3	3	3	4	3	2	3
		case31	1	1	1	1	1	1	1
Peak	1500 PDT	case01	4	5	4	4	5	5	4
		case02	2	2	2	2	3	3	2
		case10	4	4	4	5	4	4	4
		case20	3	3	3	3	2	2	3
		case31	1	1	1	1	1	1	1
Heat wave	allHRS	case01	3	3	3	3	3	3	3
		case02	1	1	1	1	2	2	1
		case10	5	5	5	5	5	5	5
		case20	4	4	4	4	4	4	4
		case31	2	2	2	2	1	1	2

Summary of urban-heat mitigation potential: ranking the effectiveness of measures case01 through case31 in current climate.

Darker to lighter = largest to smallest cooling.

Note that case02 should be excluded in some analysis and that these are impacts on temperature, not UHII.

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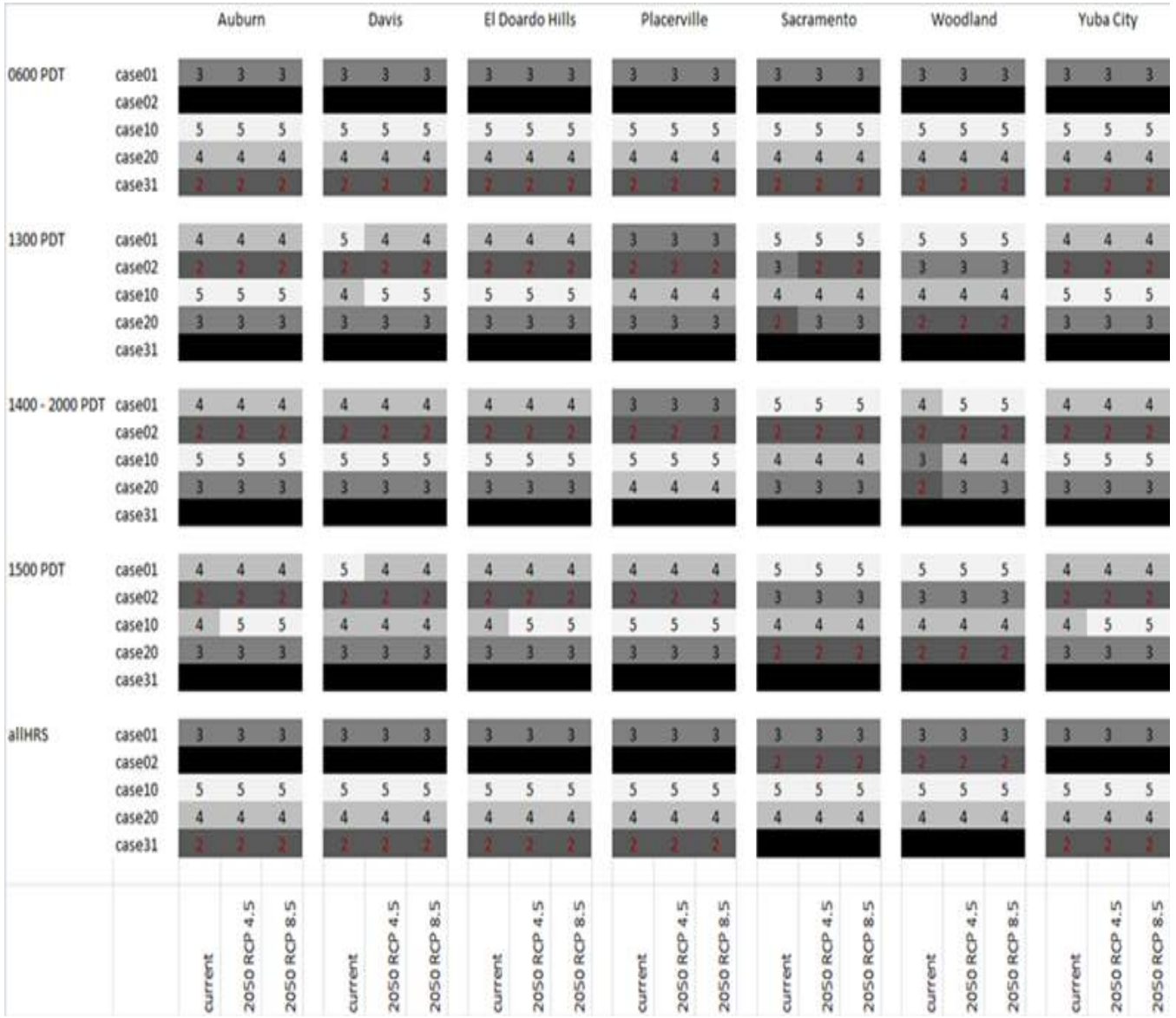
Regional-scale effectiveness of cooling measures under future climate and urbanization



Ranking of measures case01 through case31 by cooling effectiveness (darker to lighter color = largest to smallest cooling) in future climate (2050) compared to rankings in current climate.

Note that case02 should be excluded in some analysis. Also note that this is impacts on air temperature, not UHII.

Altostratus Inc.

THANK YOU !

Takeaways, both quantitative and qualitative, will be provided in the next two webinars.

Featured Presenters

Jason Vargo

Lead Scientist, Climate Change and Health Equity

California Department of PublicHealth

Health Impacts of Urban Heat

LGC's Cooling the Capital Region:
Understanding Our Regional Heat Island Challenge

Feb 13, 2019

Jason Vargo
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Climate Change and Health Equity Program
California Department of Public Health

New-York Daily Times.

VOL. I....NO. 267. NEW-YORK, TUESDAY, JULY 27, 1852. PRICE ONE CENT.

a few dimes as a present, and that they often are constrained to pay their demands, that they may retain the good will of the bands to which they belong. Kursaal, the common meeting-place for strangers. This is a large building of Grecian architecture, which you enter by a noble portico of six lofty policy for the speediest possible union between the Provinces and the United States; for the fisheries are so important to our navigating and naval interests, that we cannot possibly yield the shore... part of the lake; sixteen hundred weight being caught by three men during six weeks. As to game, I inquired if they took any moose about

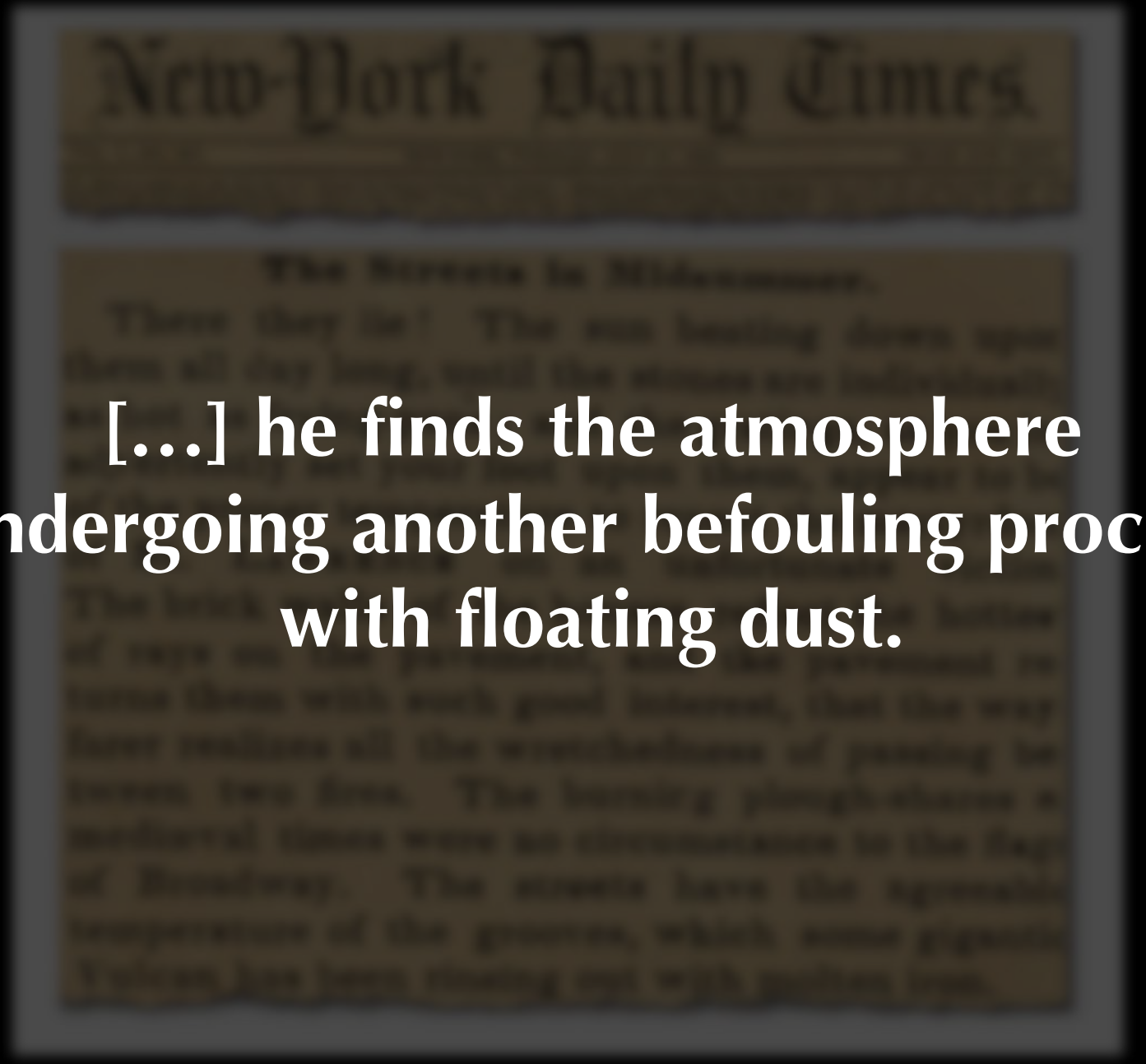
The Streets in Midsummer.

There they lie! The sun beating down upon them all day long, until the stones are individually as hot as frying-pans; and the gratings, as you inadvertently set your foot upon them, appear to be of the proper temperature to repeat the martyrdom of St. LAWRENCE on an unfortunate victim. The brick walls of the houses reflect the hottest of rays on the pavement, and the pavement returns them with such good interest, that the wayfarer realizes all the wretchedness of passing between two fires. The burning plough-shares of mediæval times were no circumstance to the flags of Broadway. The streets have the agreeable temperature of the grooves, which some gigantic Vulcan has been rinsing out with molten iron.

The brick walls of the houses reflect the hottest of rays on the pavement, and the pavement returns them with such good interest, that the wayfarer realizes all the wretchedness of passing between two fires.

George Grantham Bain Collection/Library of Congress

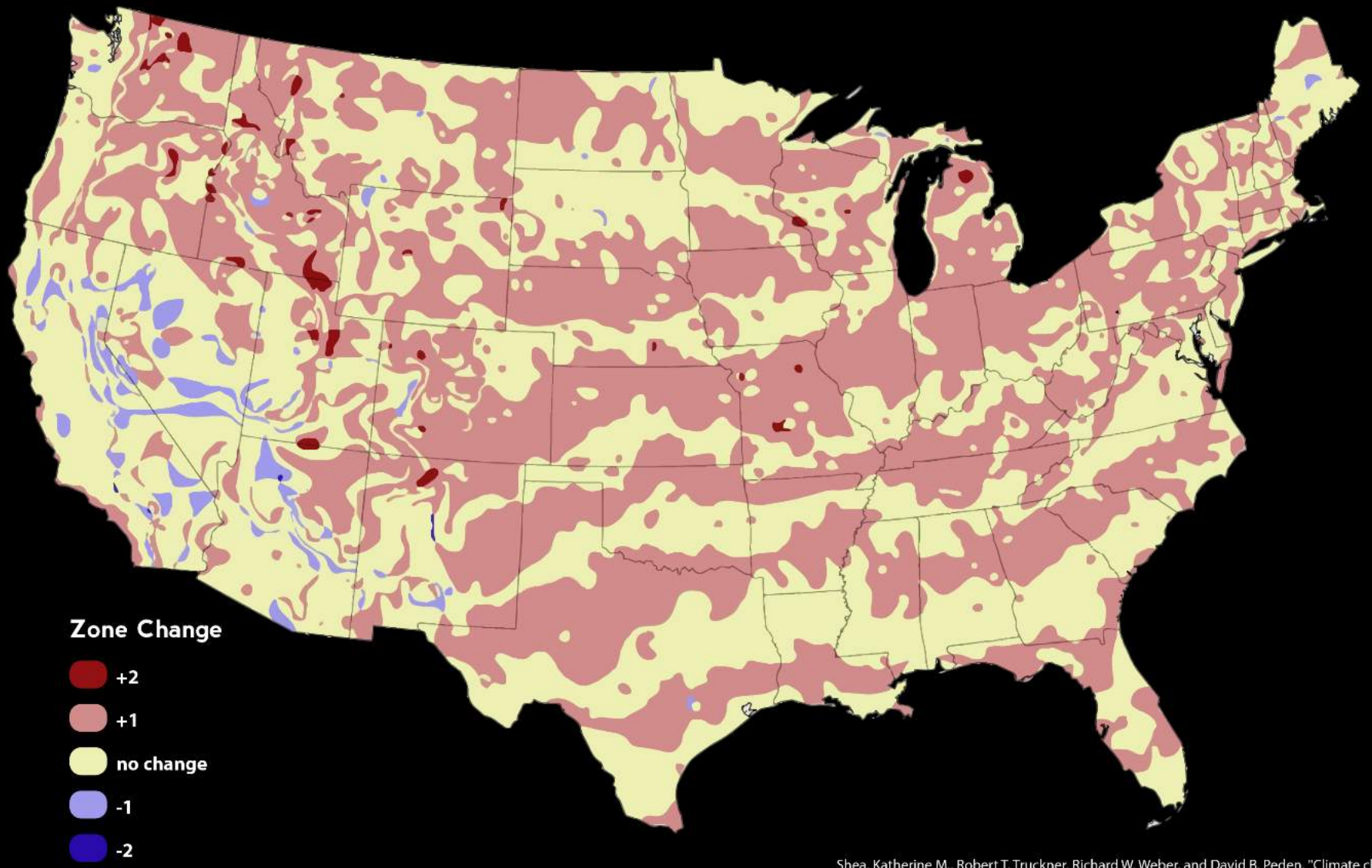
The air is so rarified by heat, as to oblige his lungs to do double duty in order to get the requisite quantum of the vivific element; and when they do get it, it is so disgustingly alloyed with poison and pestilence, as to cheat him of health, and put him out of humor with himself and existence.



[…] he finds the atmosphere undergoing another befouling process with floating dust.

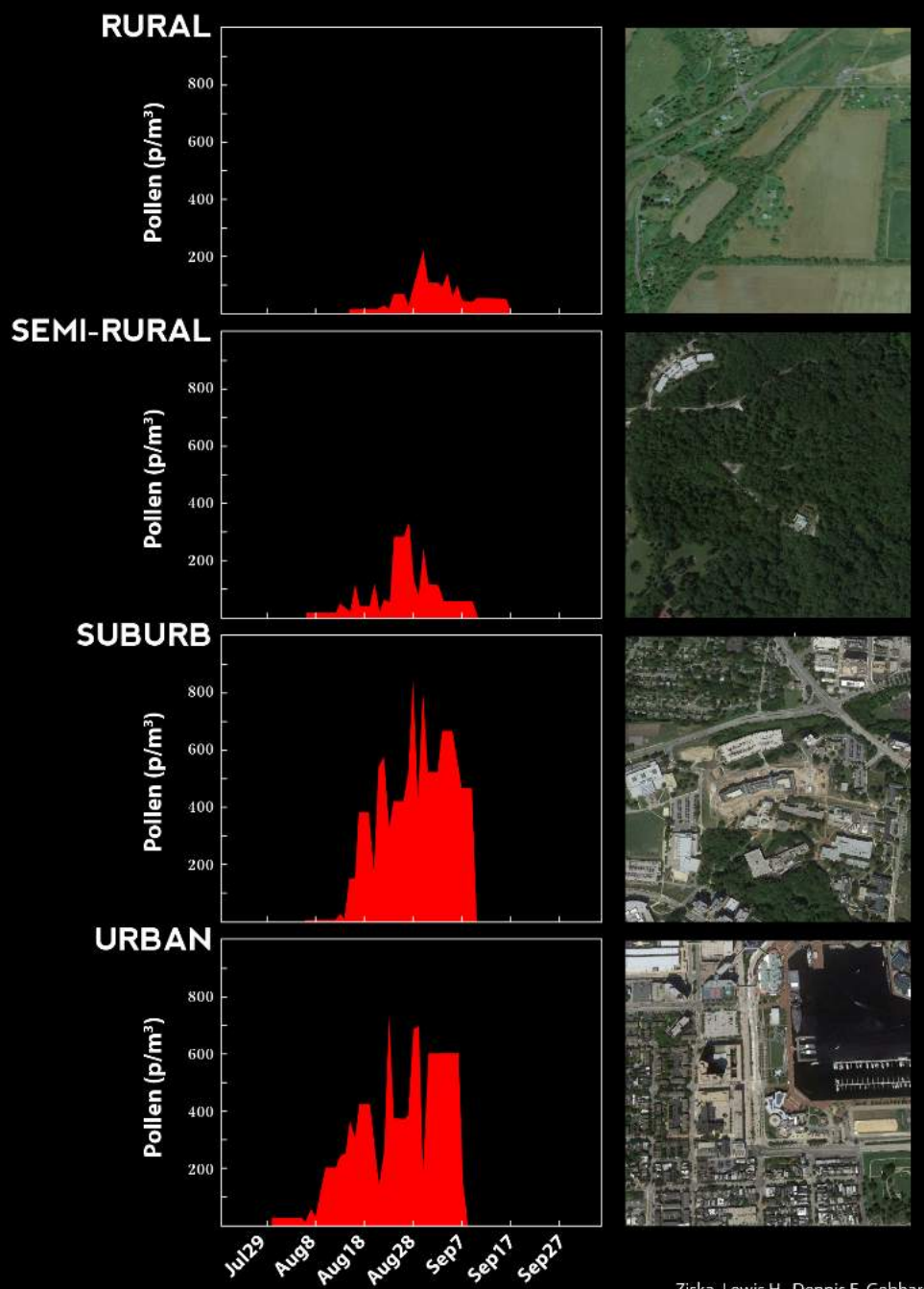
Plant Hardiness Zone Changes

(1990-2006)



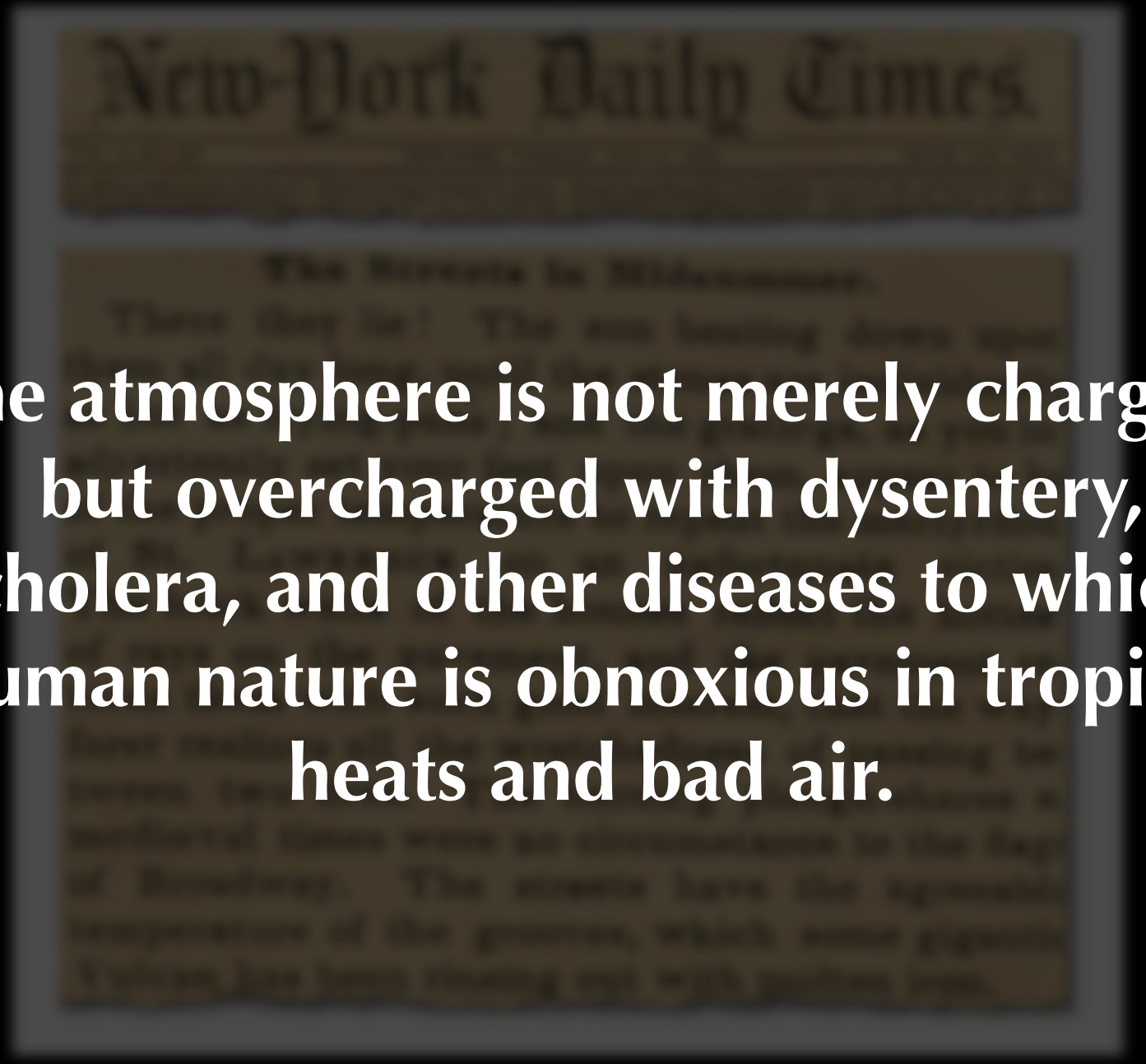
Shea, Katherine M., Robert T. Truckner, Richard W. Weber, and David B. Peden. "Climate change and allergic disease." Journal of allergy and clinical immunology 122, no. 3 (2008): 443-453.

Ragweed Pollen (2001)



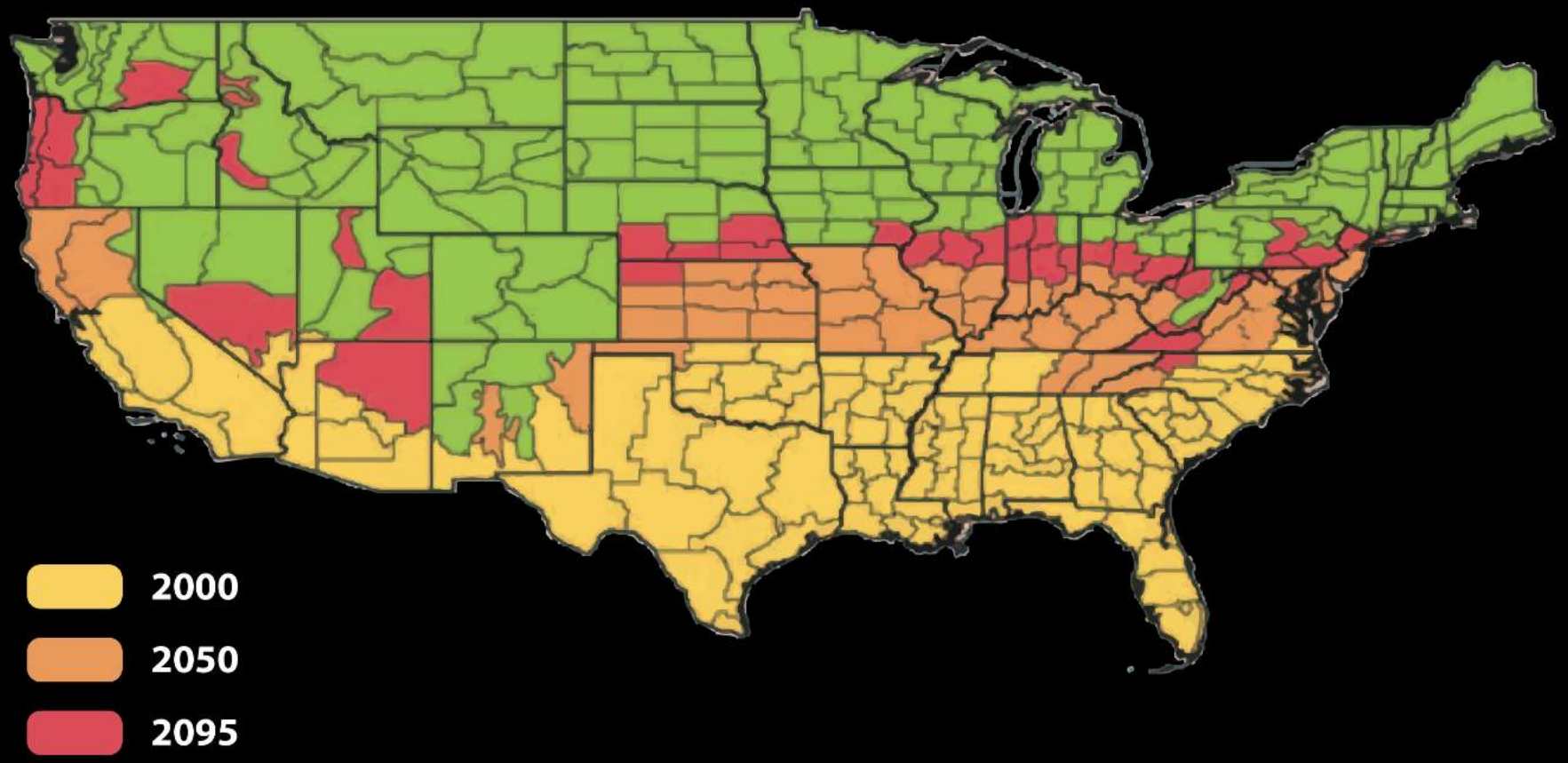
	PEAK	DATE
RURAL	228	Aug 30
SEMI-RURAL	338	Aug 27
SUBURB	845	Aug 27
URBAN	729	Aug 23

Ziska, Lewis H., Dennis E. Gebhard, David A. Frenz, Shaun Faulkner, Benjamin D. Singer, and James G. Straka. "Cities as harbingers of climate change: common ragweed, urbanization, and public health." Journal of Allergy and Clinical Immunology 111, no. 2 (2003): 290-295.



The atmosphere is not merely charged, but overcharged with dysentery, cholera, and other diseases to which human nature is obnoxious in tropical heats and bad air.

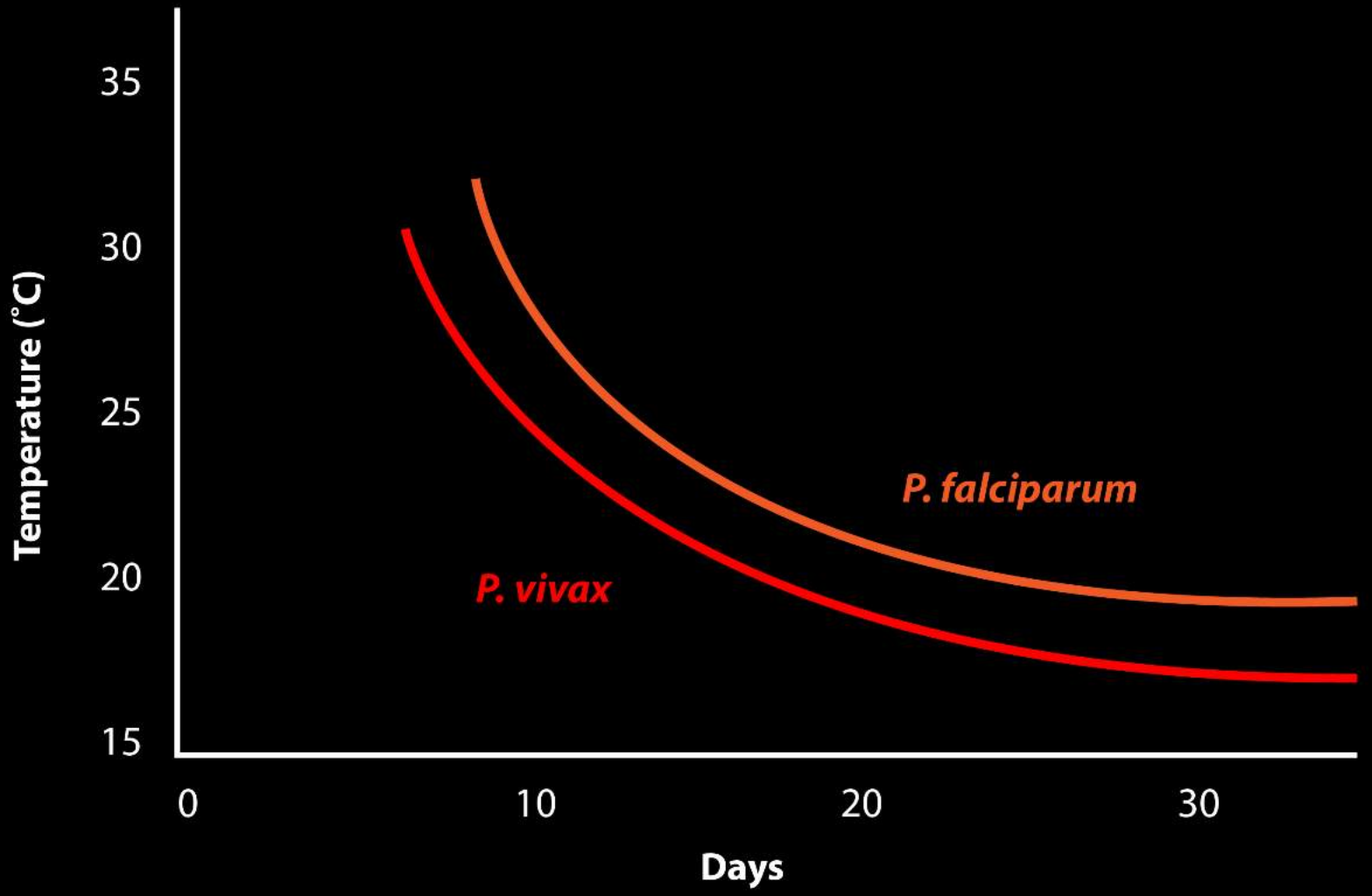
Nephrolithiasis
(kidney stones)



Fakheri, Robert J., and David S. Goldfarb. "Ambient temperature as a contributor to kidney stone formation: implications of global warming." Kidney international 79, no. 11 (2011): 1178-1185.

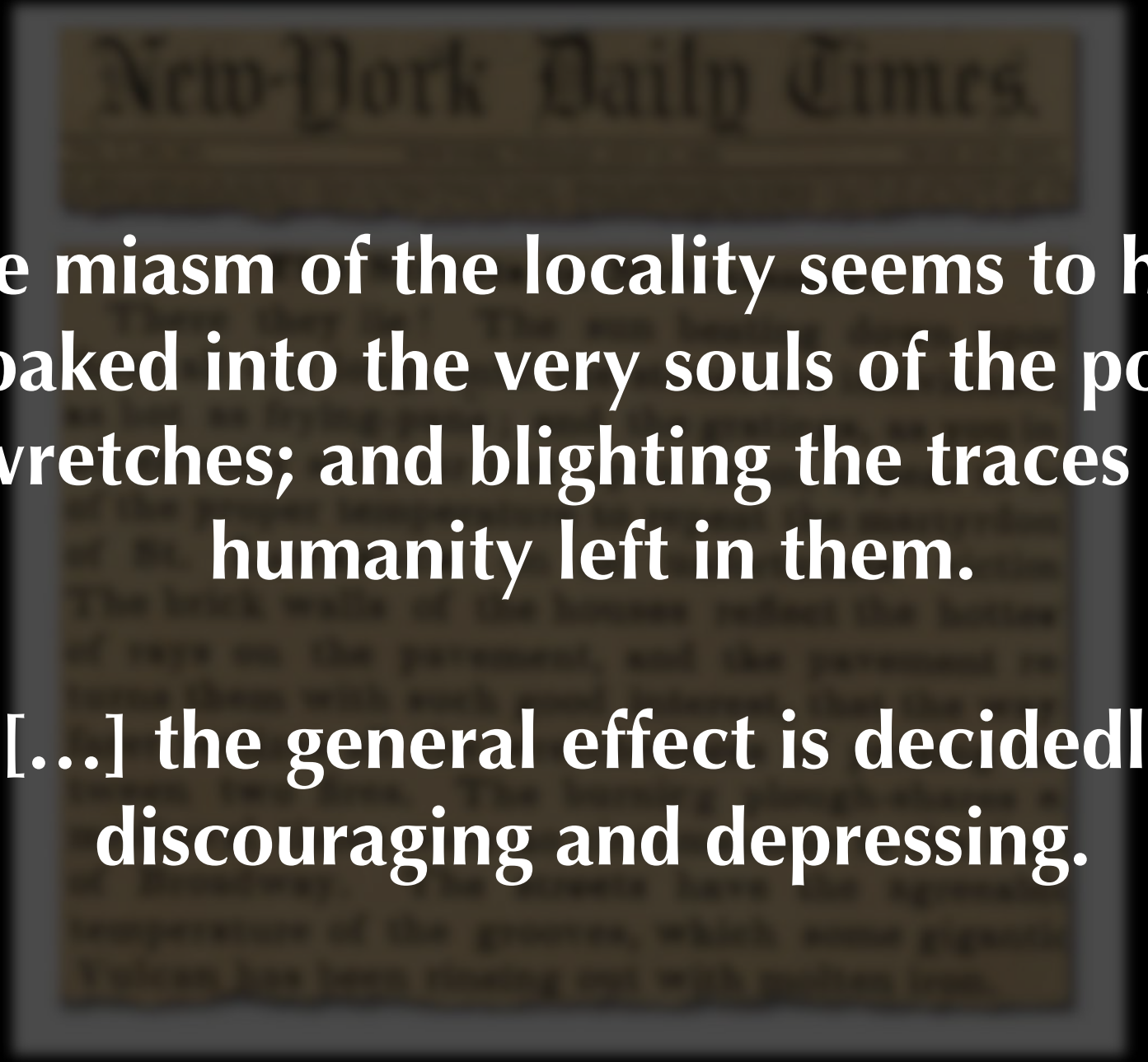
Brikowski, Tom H., Yair Lotan, and Margaret S. Pearle. "Climate-related increase in the prevalence of urolithiasis in the United States." Proceedings of the National Academy of Sciences 105, no. 28 (2008): 9841-9846.

Malaria Extrinsic Incubation



Patz, Jonathan A., and Sarah H. Olson. "Malaria risk and temperature: Influences from global climate change and local land use practices." Proceedings of the National Academy of Sciences 103, no. 15 (2006): 5635-5636.

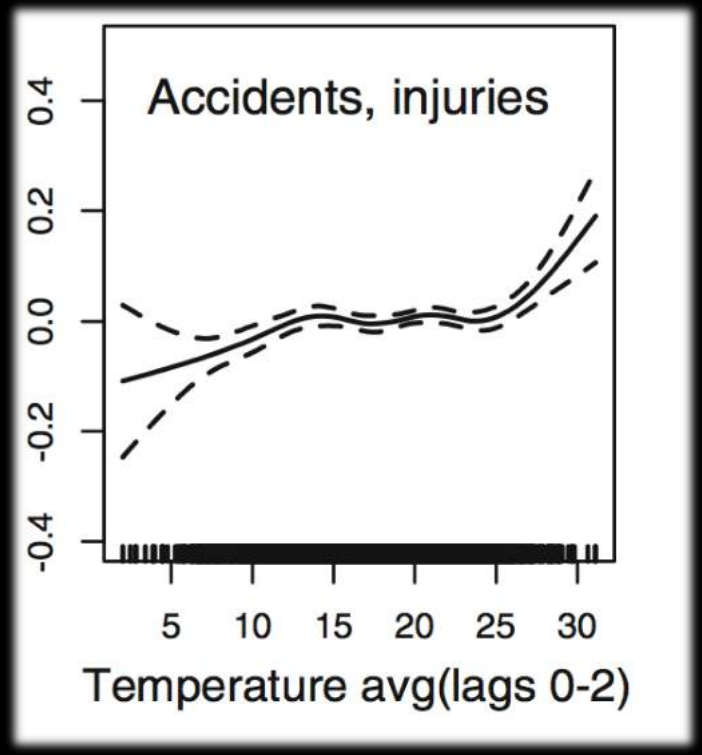
Cator, Lauren J., et al. "Characterizing microclimate in urban malaria transmission settings: a case study from Chennai, India." Malar J 12.10 (2013): 10-1186.



The miasm of the locality seems to have soaked into the very souls of the poor wretches; and blighting the traces of humanity left in them.

[…] the general effect is decidedly discouraging and depressing.

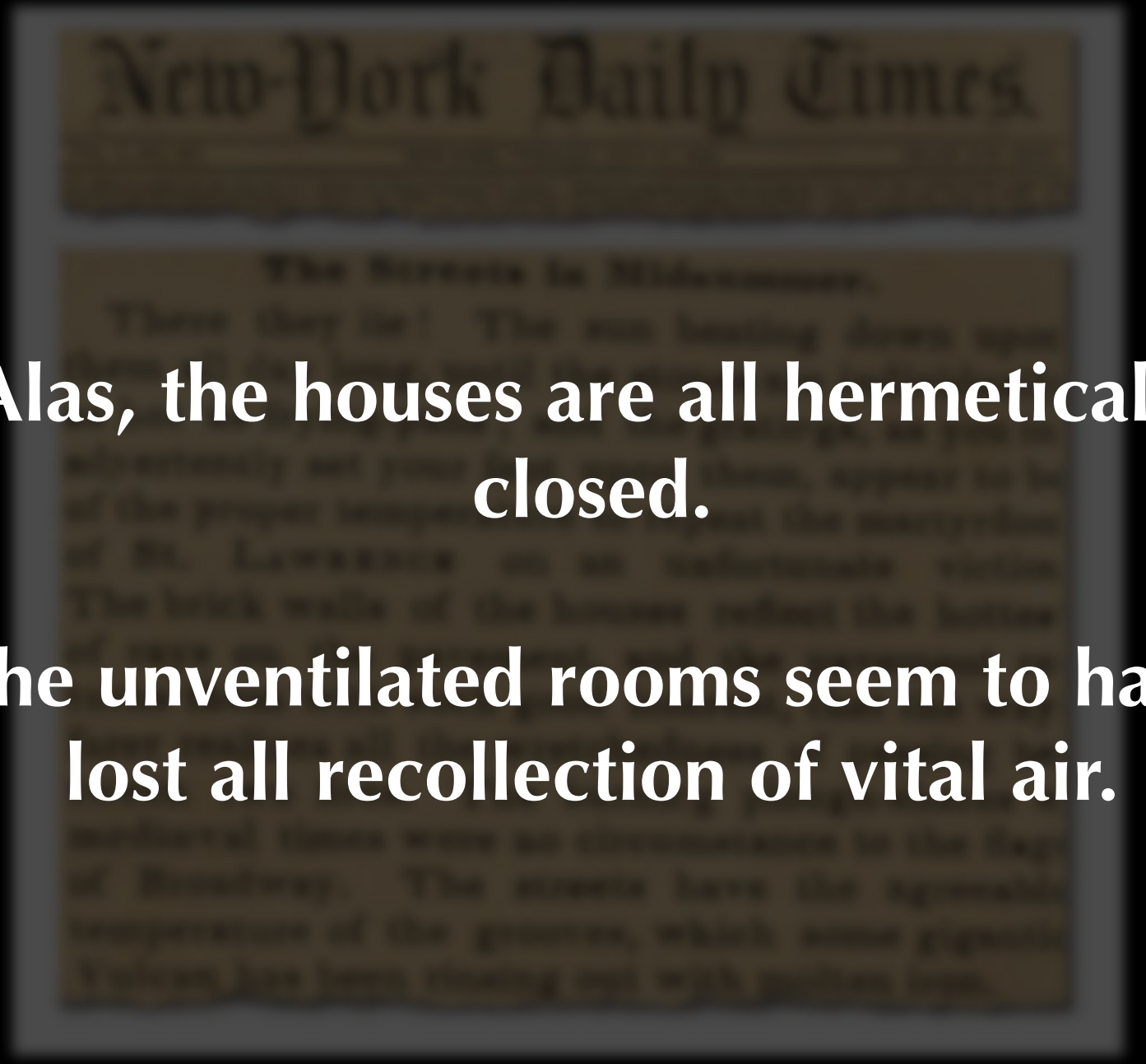
Mental Health



physical health

mental health

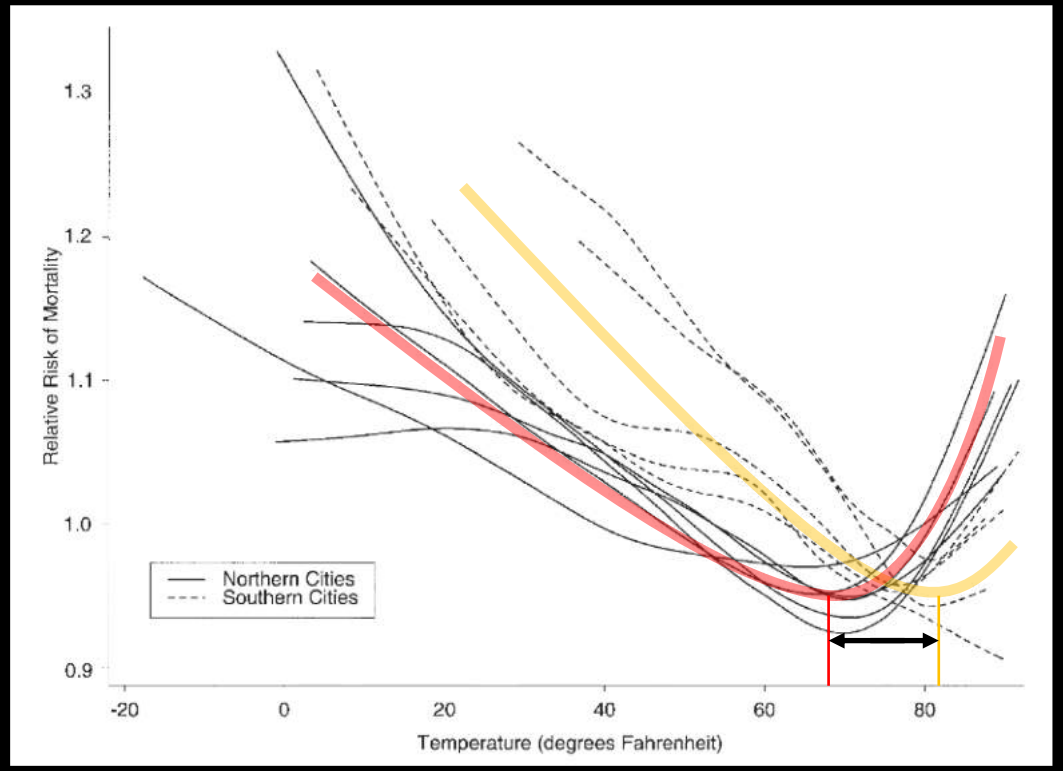
Li, Bo, Steve Sain, Linda O. Mearns, Henry A. Anderson, Sari Kovats, Kristie L. Ebi, Marni YV Bekkedal, Marty S. Kanarek, and Jonathan A. Patz. "The impact of extreme heat on morbidity in Milwaukee, Wisconsin." *Climatic change* 110, no. 3-4 (2012): 959-976.



Alas, the houses are all hermetically closed.

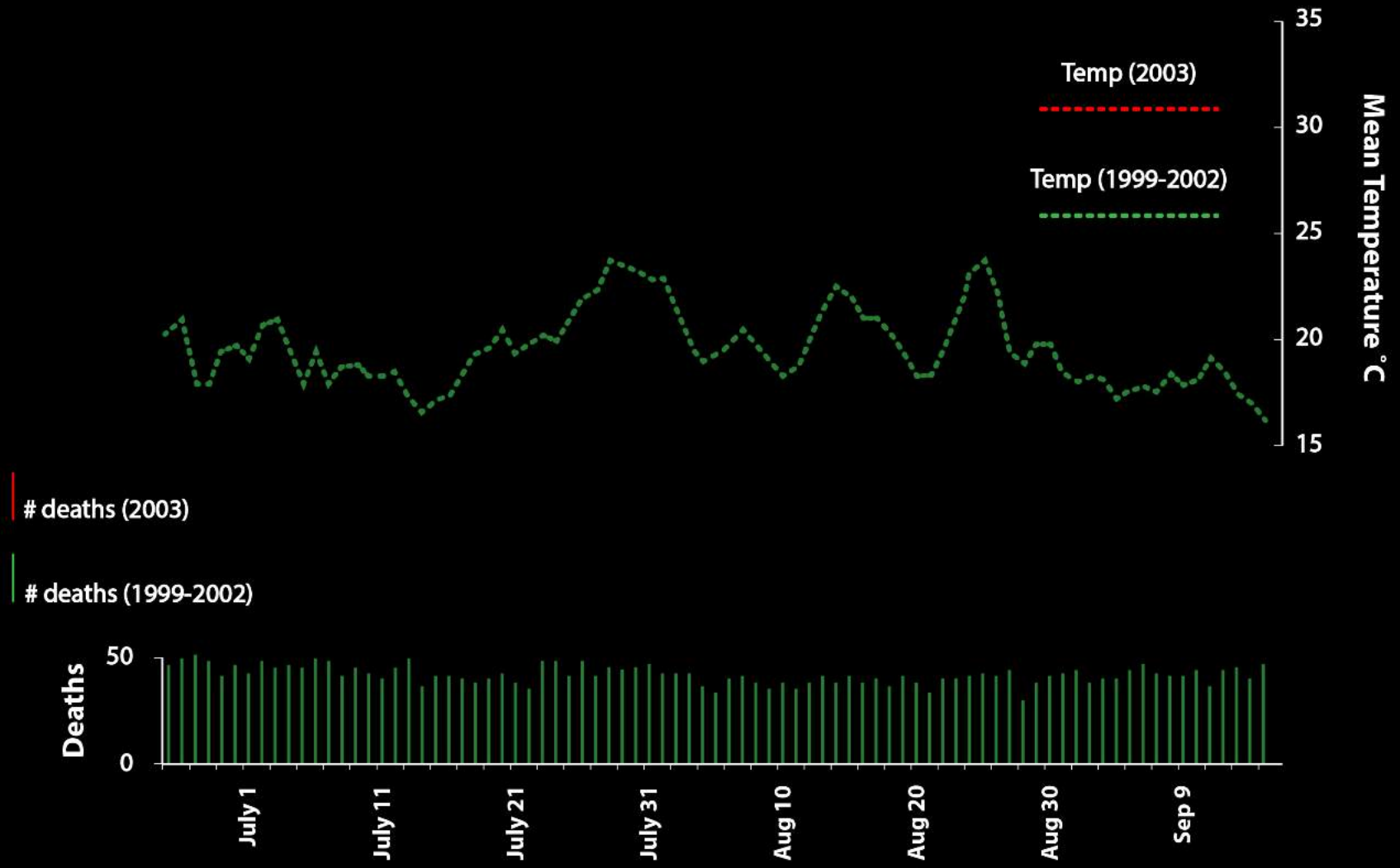
The unventilated rooms seem to have lost all recollection of vital air.

Latitude is strongly associated with with temperature-mortality relationships. Cold temperatures have a greater effect on mortality risk in **southern cities**, and warmer temperatures have a greater effect on mortality risk in **northern cities**.



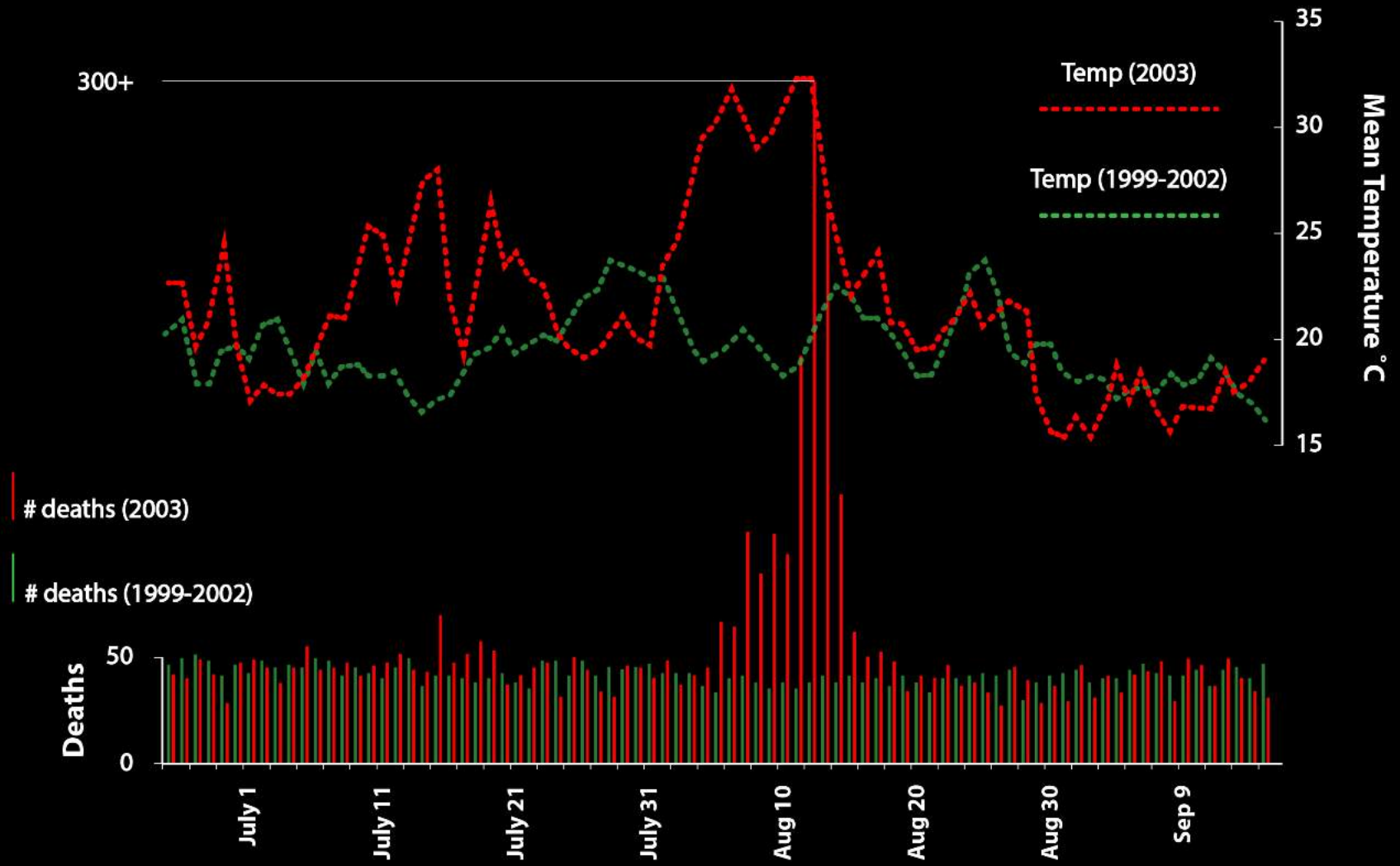
Curriero, F. C., K. S. Heiner, J. M. Samet, S. L. Zeger, L. Strug, and J. A. Patz. 2002. Temperature and mortality in 11 cities of the eastern United States. Am. J. Epidemiol. 155: 80–87.

Extreme Heat and Excess Mortality



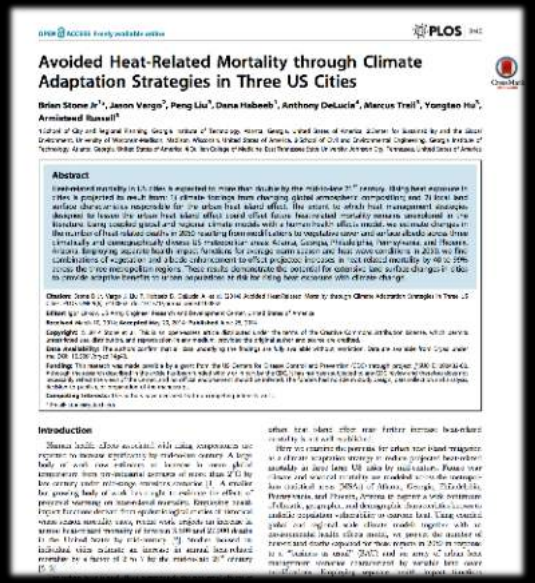
Vandentorren, Stéphanie, Florence Suzan, Sylvia Medina, Mathilde Pascal, Adeline Maulpoix, Jean-Claude Cohen, and Martine Ledrans. "Mortality in 13 French cities during the August 2003 heat wave."American Journal of Public Health 94, no. 9 (2004): 1518-1520.

Extreme Heat and Excess Mortality



Vandentorren, Stéphanie, Florence Suzan, Sylvia Medina, Mathilde Pascal, Adeline Maulpoix, Jean-Claude Cohen, and Martine Ledrans. "Mortality in 13 French cities during the August 2003 heat wave."American Journal of Public Health 94, no. 9 (2004): 1518-1520.

Avoided Heat-Related Mortality through Climate Adaptation Strategies in Three US Cities. PLOSone



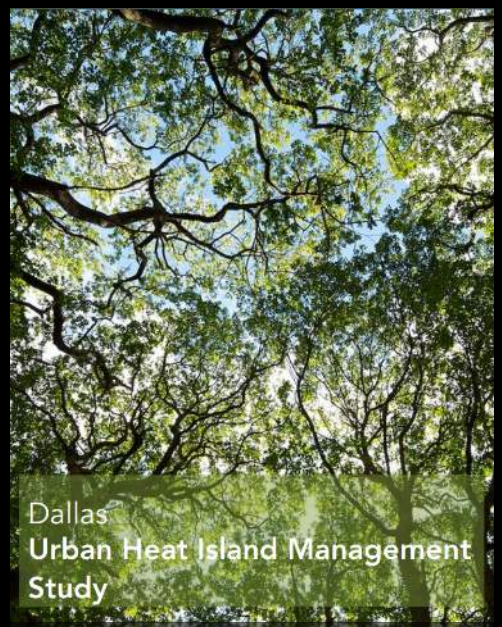
Avoided Heat-Related Mortality through Climate Adaptation Strategies in Three US Cities

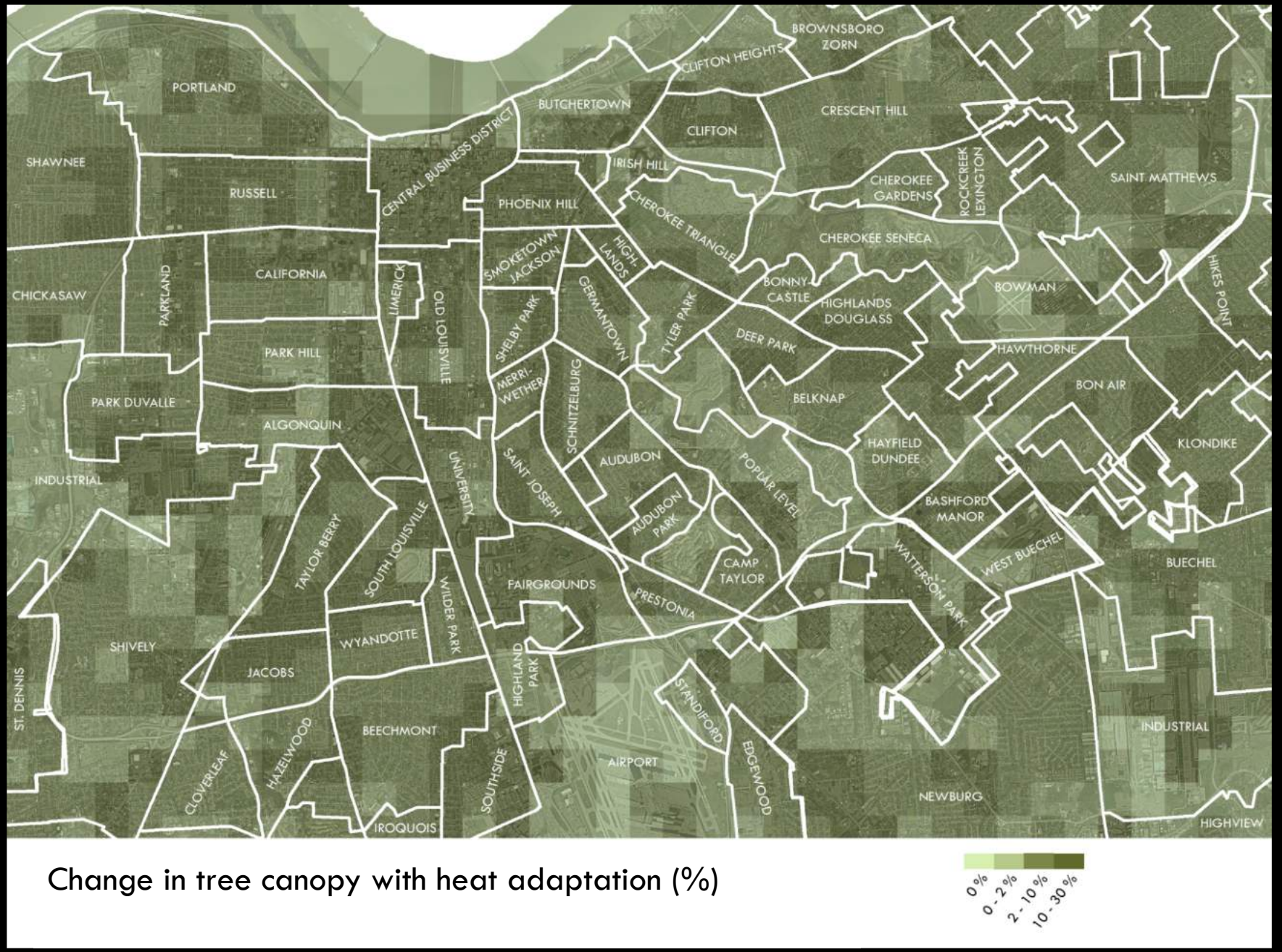
Abstract

Introduction

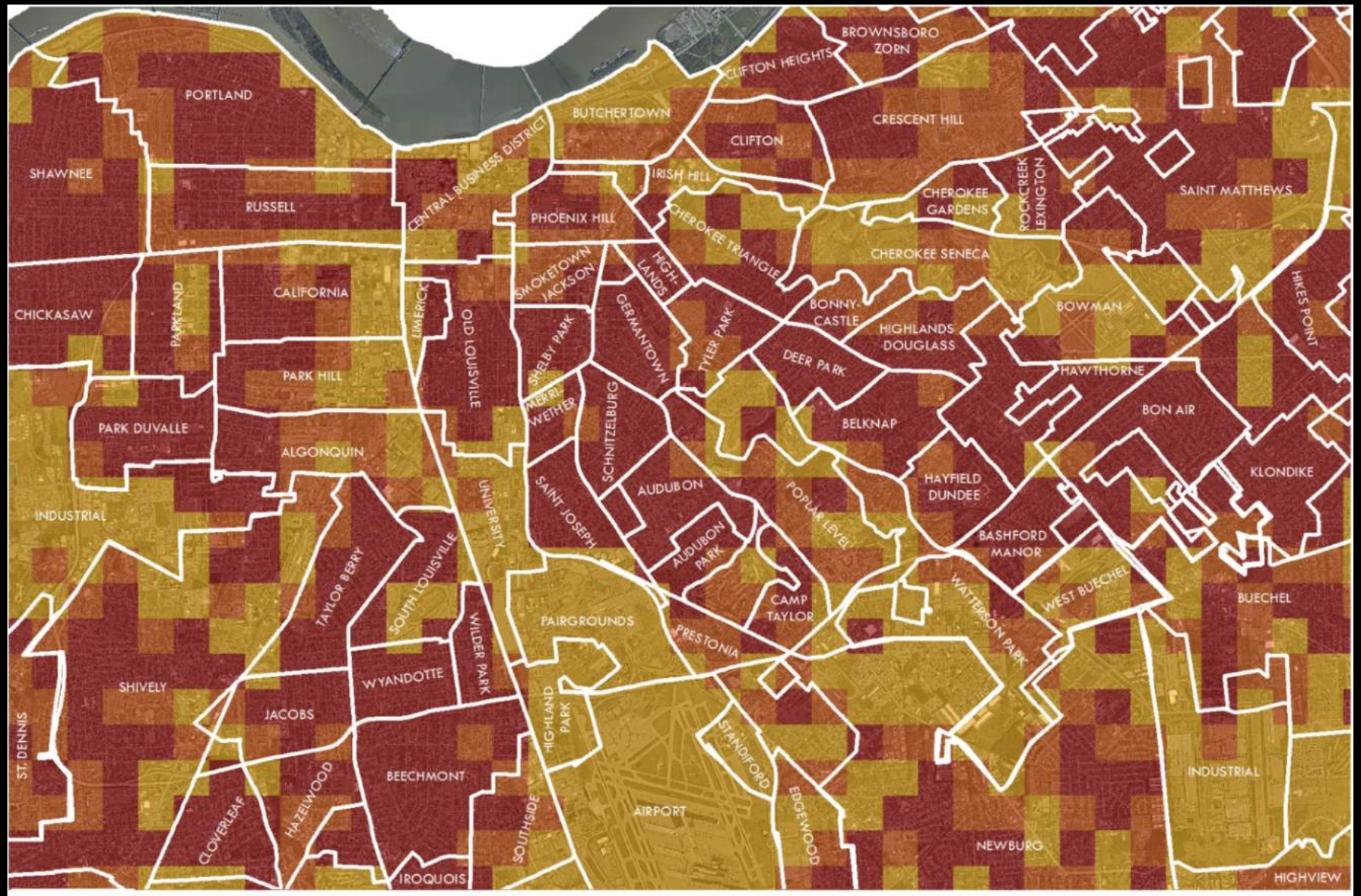
louisvilleky.gov/government/sustainability/urban-heat-island-project

www.texastrees.org/



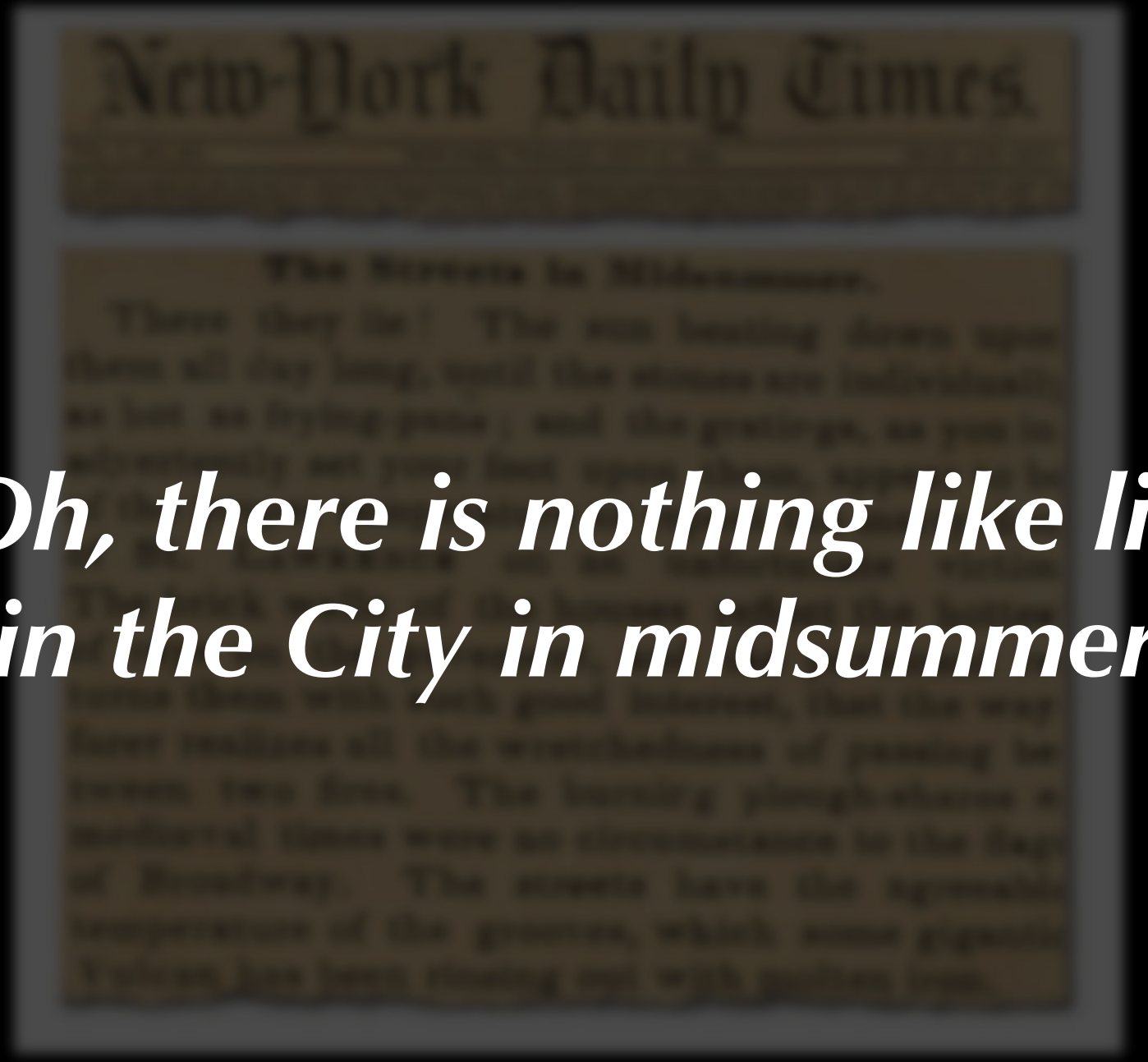


Change in tree canopy with heat adaptation (%)



Summer heat mortality under current conditions

Low
Medium
High



Oh, there is nothing like life in the City in midsummer!

Health Impacts of Urban Heat

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Feb 13, 2019

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Participant Q&A

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

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California Department of PublicHealth

Closing Remarks

Learn more about the Capital Region Climate Readiness Collaborative and how to join at ClimateReadiness.Info!