Columbia Climate and Health Program
at the Mailman School of Public Health

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HEALTH IMPACTS MODELING AND RISK MANAGEMENT NEEDS IN THE URBAN SETTING: NYC AND BEYOND

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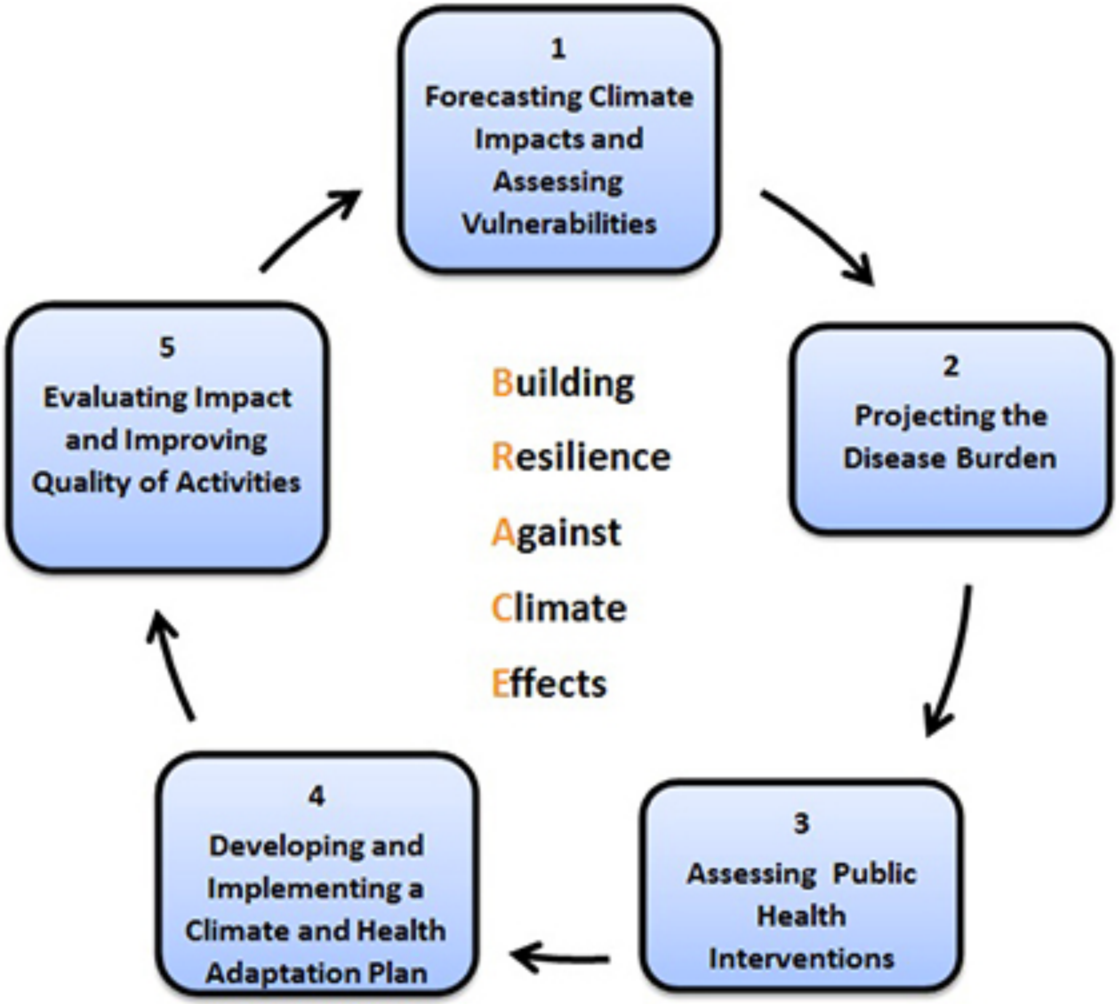
Topics I'll Cover

- How does health fit into the climate change discussion?
- The importance of matching model outputs to spatial scale of population characteristics.
- The importance of projecting other inputs to health risk in addition to climate.
- Parting thoughts.

How can public health science inform climate solutions?

- Identify and prioritize health adaptation actions, leading to more cost-effective policies
- Quantify health co-benefits of climate change mitigation actions, leading to more effective and healthy policies
- More generally, motivate support for mitigation policies

US Centers for Disease Control “BRACE” framework



Impact Modeling Case Study:
Direct Effects of Temperature on Mortality

nature climate change

LETTERS

PUBLISHED ONLINE: 19 MAY 2013 | DOI: 10.1038/NCLIMATE1902

Projections of seasonal patterns in temperature-related deaths for Manhattan, New York

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Methods

- ***Historical Data***

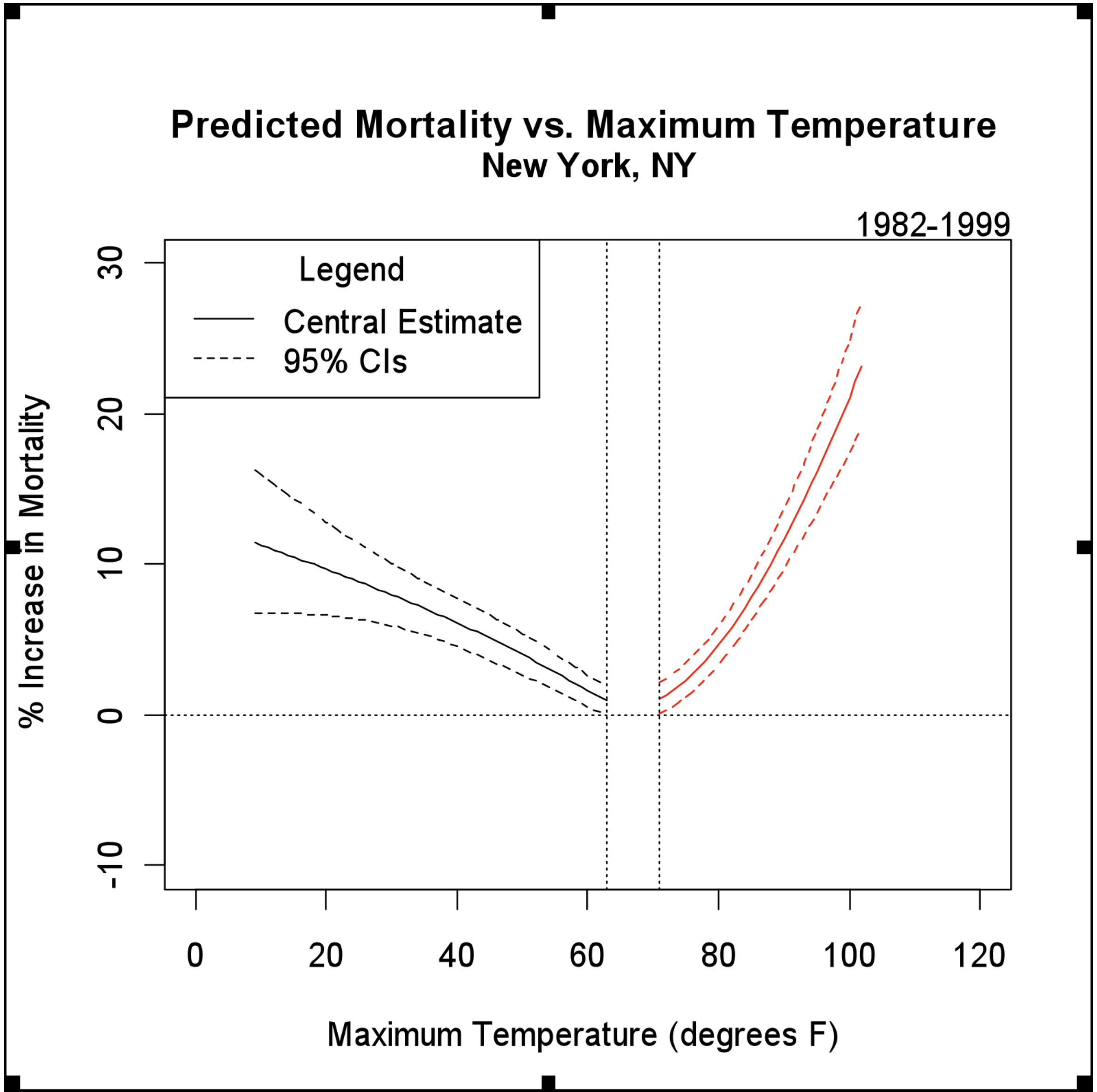
  Maximum daily temperature and daily mortality counts for New York county (Manhattan) from 1982 to 1999

- ***Statistical Modeling***

  Poisson GLM regression

daily mortality ~ natural spline($Temp_{max\_lag}$, 3df) + natural spline(time, 7df) + day of week indicator

Results: Exposure-Response Function



Future temperature modeling:

- Projected future Tmax using 32 combinations of global climate models and greenhouse gas emissions scenarios.
  - *Two IPCC emissions scenarios (A2 and B1)*
  - *16 Global Climate Models from IPCC 4th assessment report*
- Statistical downscaling to Central Park, NY station for 2020s, 2050s and 2080s. Baseline period is the 30 year climatological baseline of 1970 to 1999 (referred to here as “1980s”)

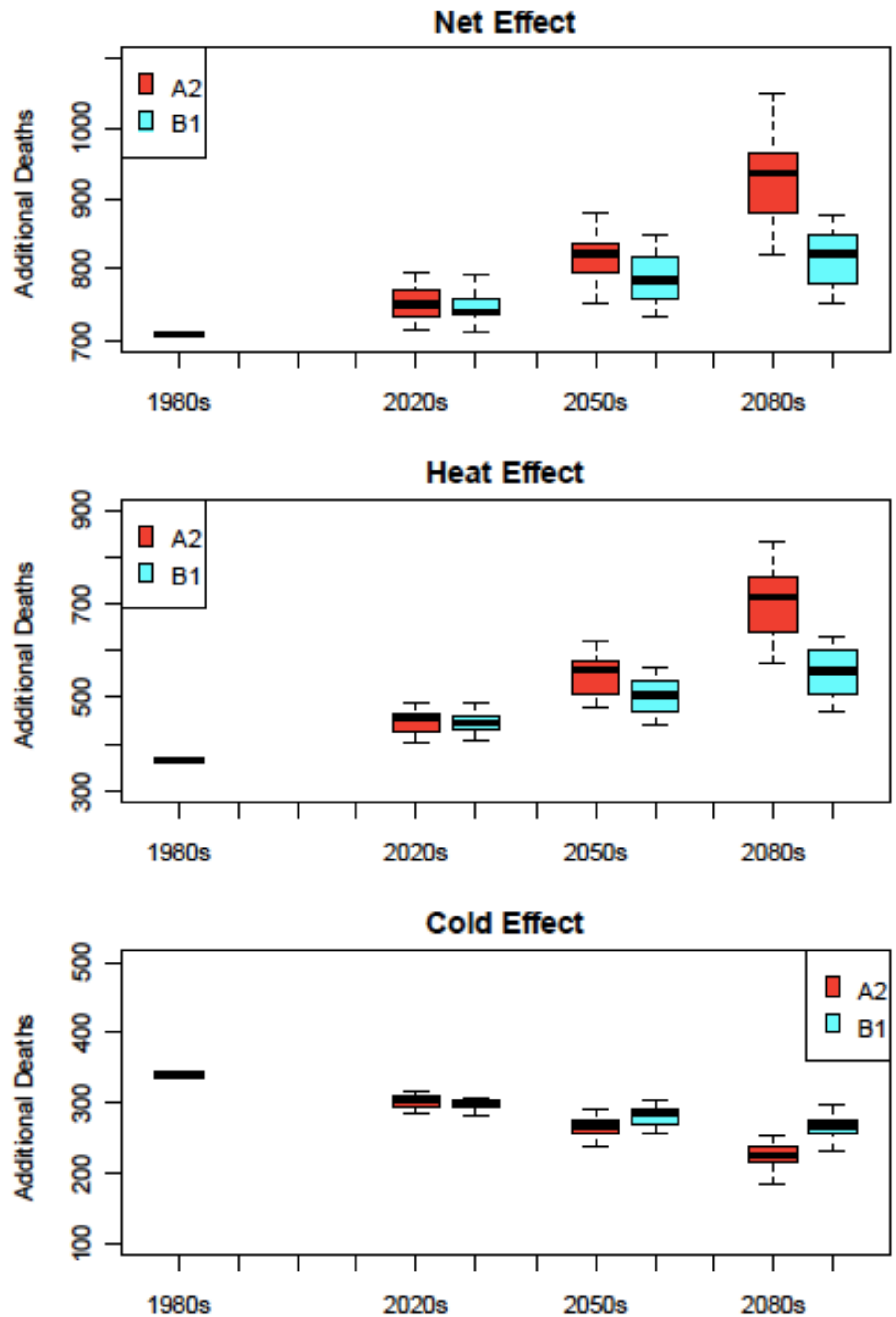
Mortality Impact Model

$$\Delta Mortality = Y_0 \times ERF \times \Delta T$$

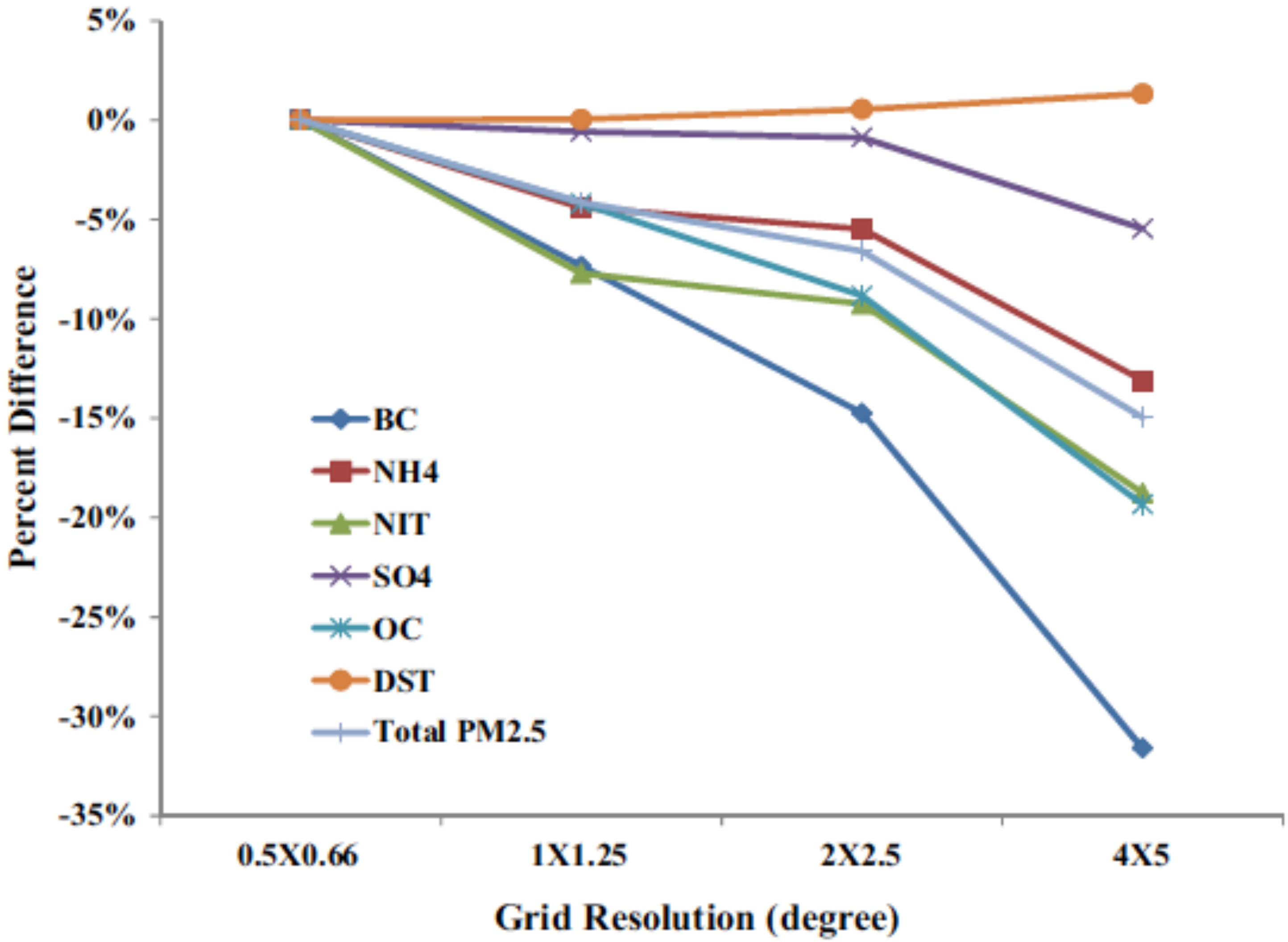
$\Delta Mortality$ is daily temperature-related deaths

- Y_0 is baseline average total daily death count in Manhattan
- *ERF* (exposure response function) describes the non-linear percentage change in mortality per unit change temperature.
- ΔT is daily projected Tmax minus the minimum mortality temperature (MMT)

Annual temperature-related deaths in baseline and future periods



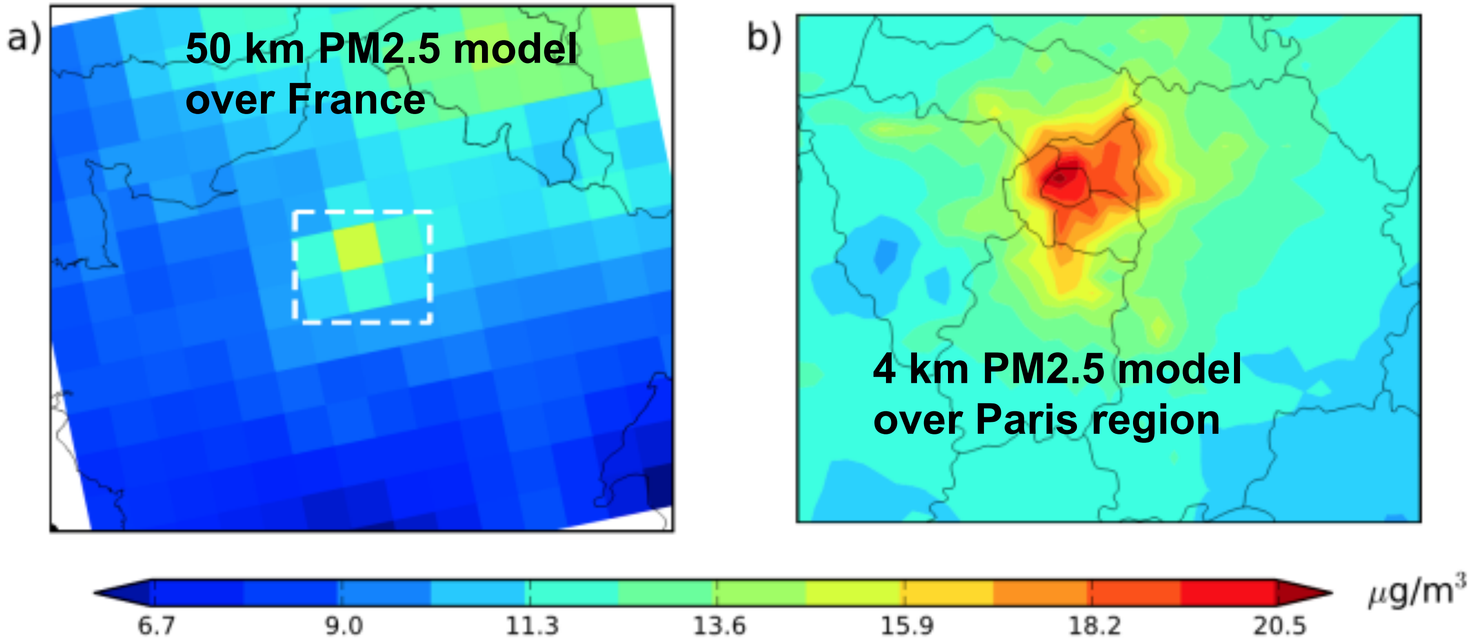
The Importance of Spatial Scale



Percent difference in estimates of US all-cause mortality due to PM2.5 and component species, between re-gridded resolution and fine-model resolution. From: Li, Henze, Jack and Kinney, Air Qual Atmos Health, 2015

Model resolution should match basic pattern of population density: example from Paris climate and air pollution projection study

10yr mean of daily avg PM2.5 concentrations (DJF)



From: Likhvar et al., Science of the Total Environment, 2015

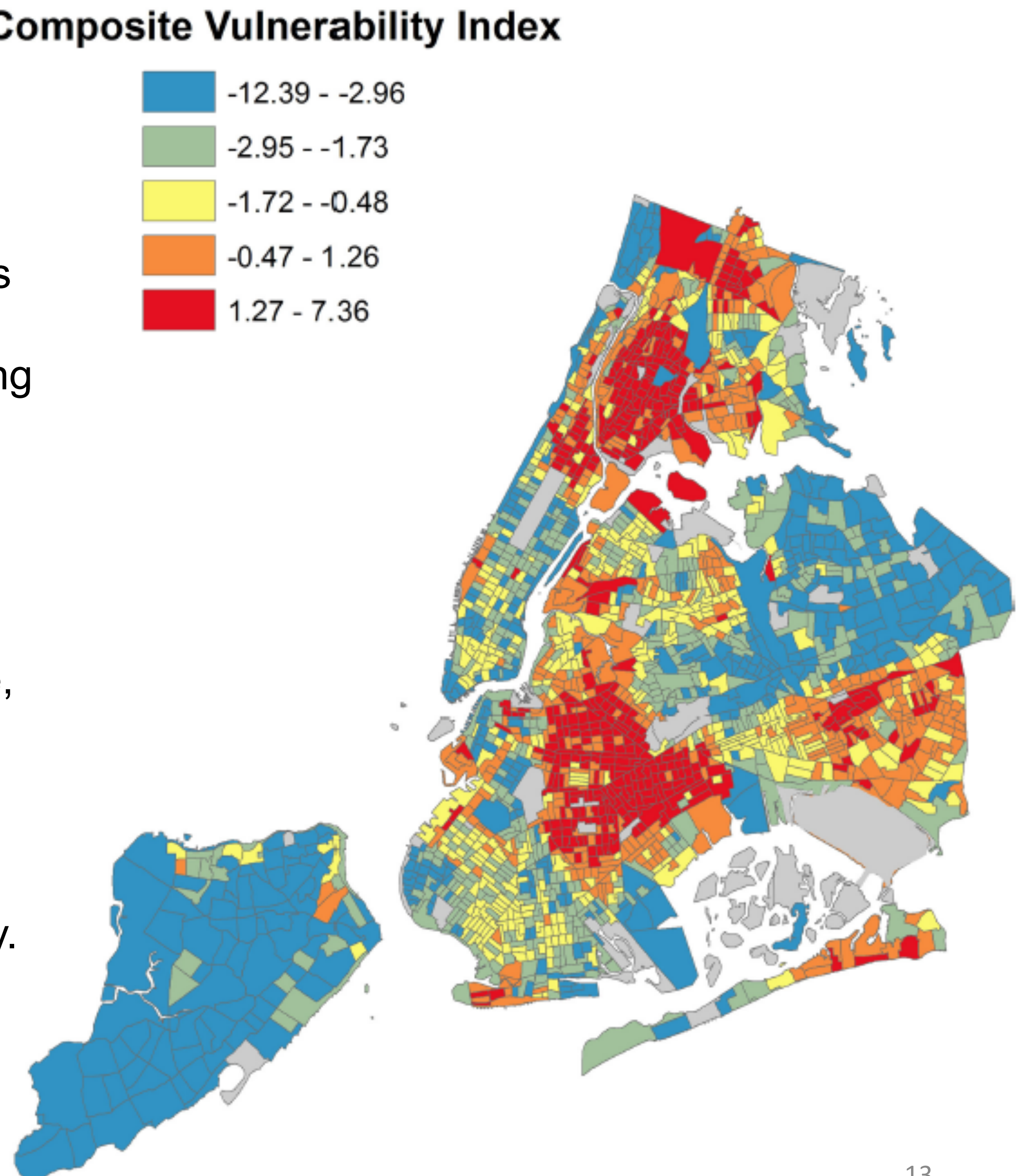
Population Density

Heat Vulnerability Index at Census Tract Level in NYC

The index is comprised of z-scores of the following variables:

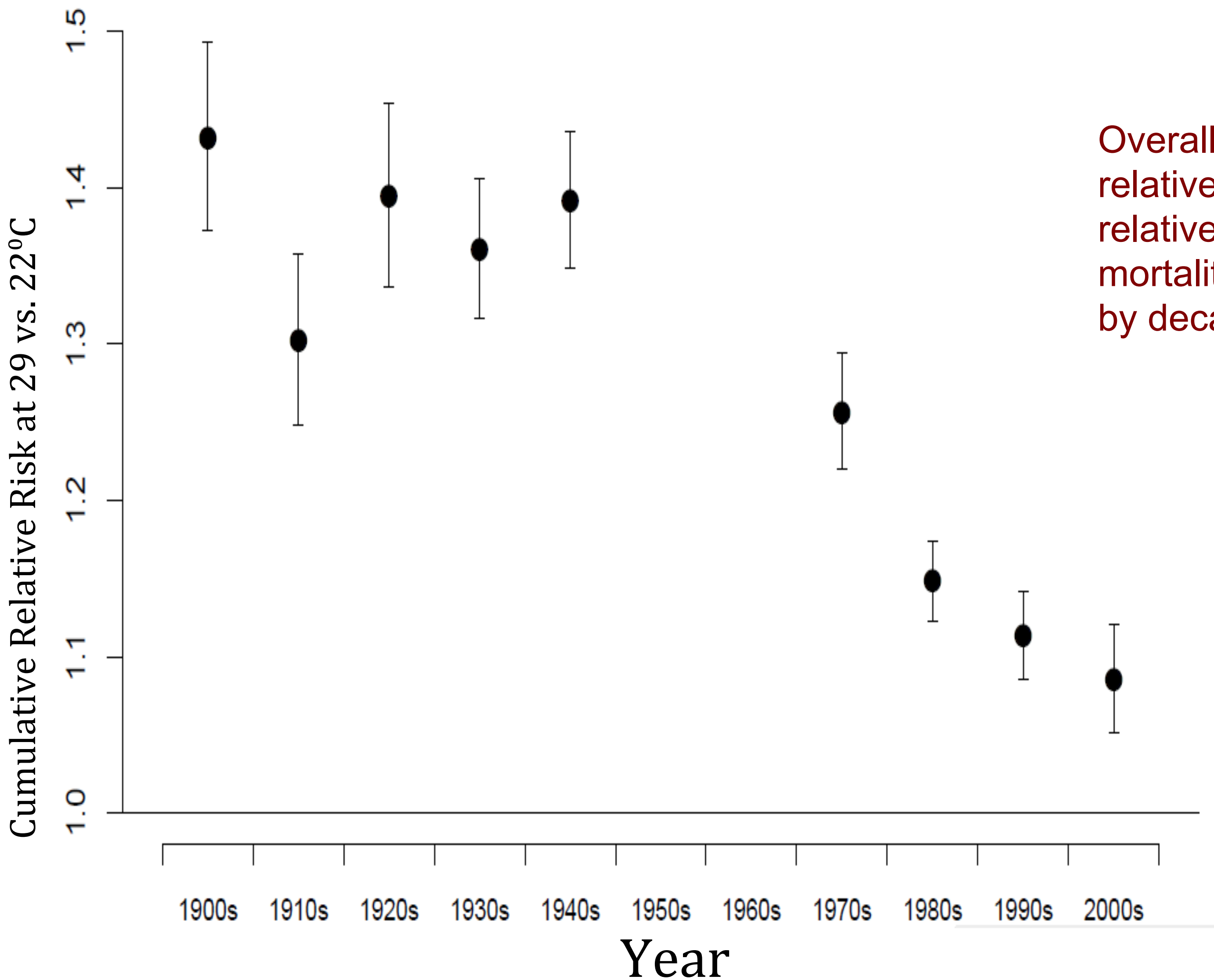
- (+) proportion of homes receiving public assistance,
- (+) proportion of non-Hispanic black residents,
- (+) proportion of overall deaths
- occurring in the home,
- (+) relative surface temperature,
- (-) proportion of trees.

A higher composite index score indicates a residential area with a higher risk of heat-related mortality.



Madrigano et al., Environ Hlth Perspect, 2015

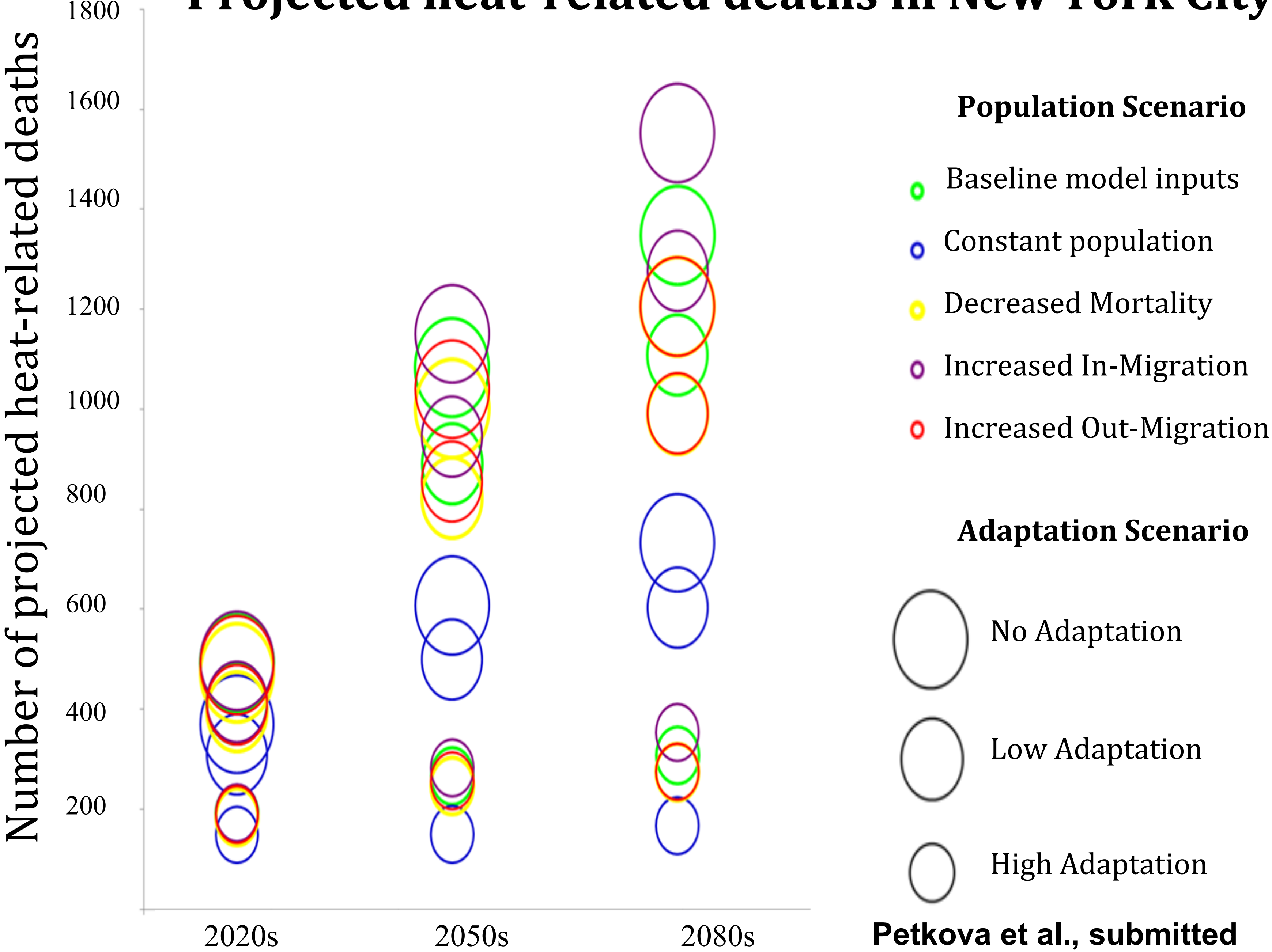
Changes over time in exposure-response function for heat and mortality in NYC



Overall cumulative relative risk at 29°C relative to 22°C on mortality in New York City by decade, 1900s-2000s

[4]Petkova, E. P., Gasparrini, A, Kinney, P. L. (2014). Heat and mortality in New York City since the beginning of the 21st century. *Epidemiology*

Projected heat-related deaths in New York City



Petkova et al., submitted

Challenges for Health Impact Modeling

- Human health is highly buffered from climate risks, more so with higher economic status, complicating attribution studies and future projections.
- To project future health impacts of climate, or health benefits of mitigation and adaptation, we need to model other key factors in addition to climate (e.g., pop #, age structure, vulnerability).
- Worst case scenarios are of growing interest as risk management tools, calling for better representation of extremes in downscaled climate model outputs
- To date, health assessment has been little used in decision making