Hurricanes and Health

Atlantic-basin tropical cyclones and associated risk to all-cause, accidental, cardiovascular, and respiratory mortality in 78 United States communities, 1988–2005

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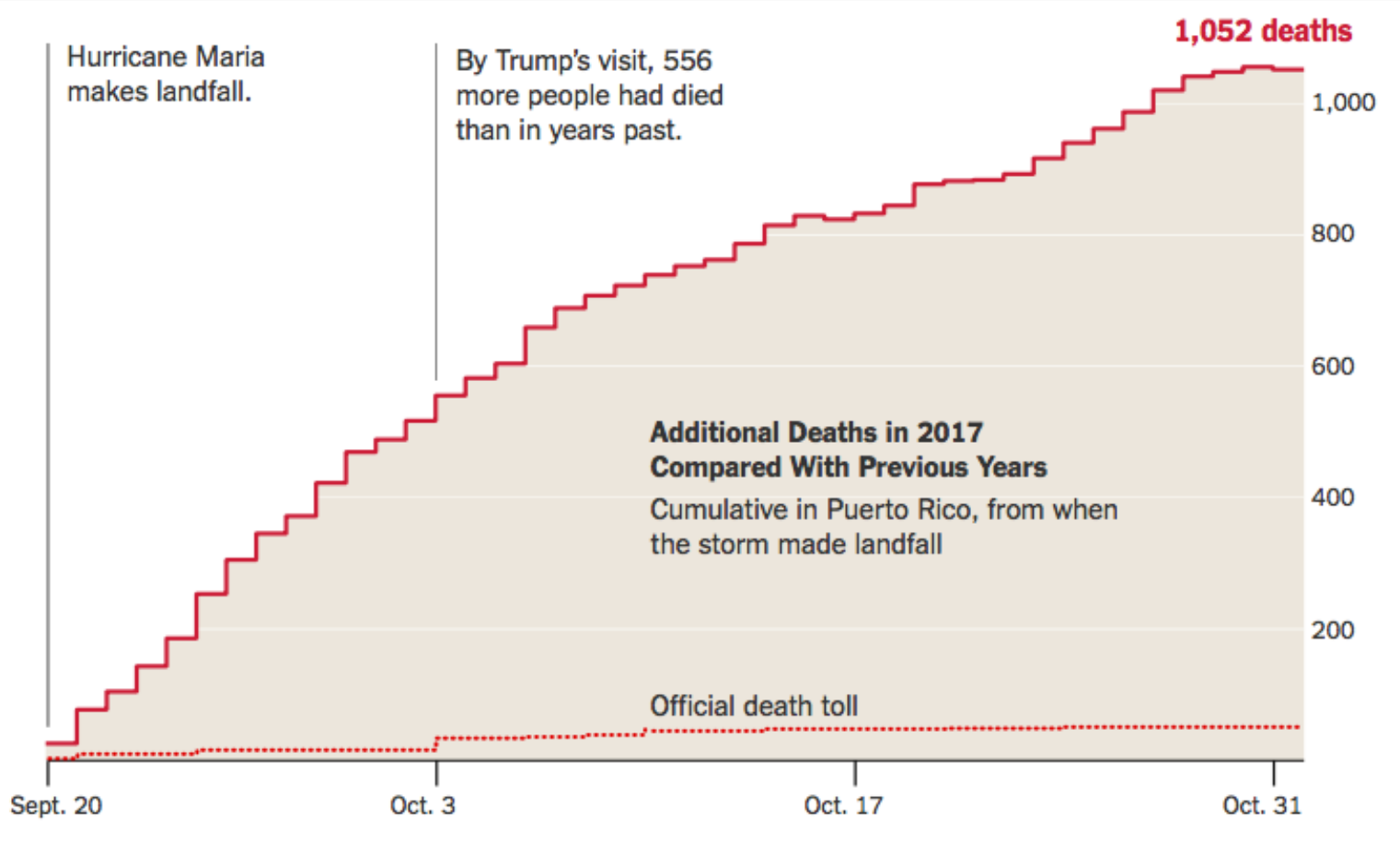
Motivation

Impacts in excess of official death tolls

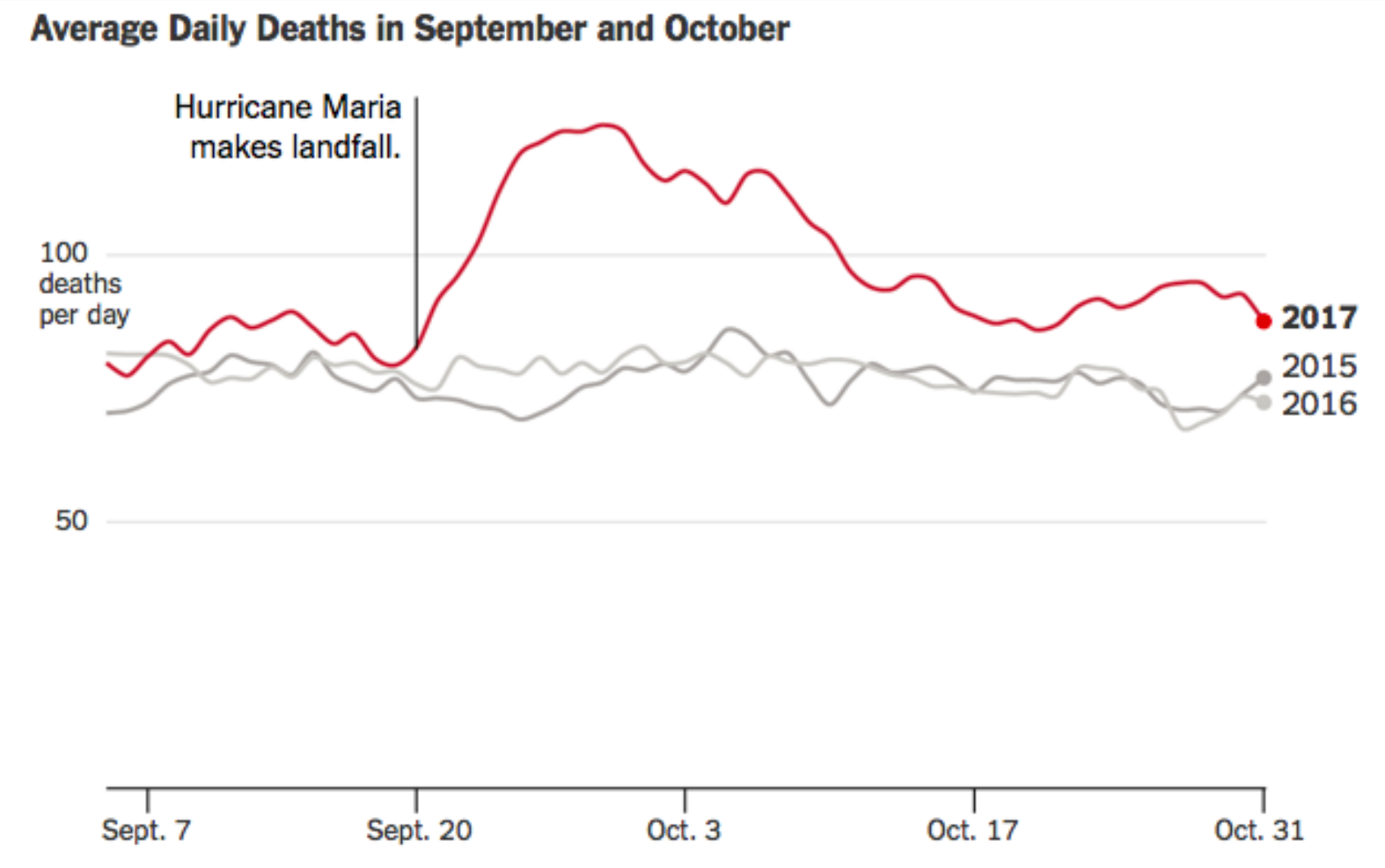
Evidence from Hurricane Maria in Puerto Rico of extensive mortality impacts.



Source: The New York Times

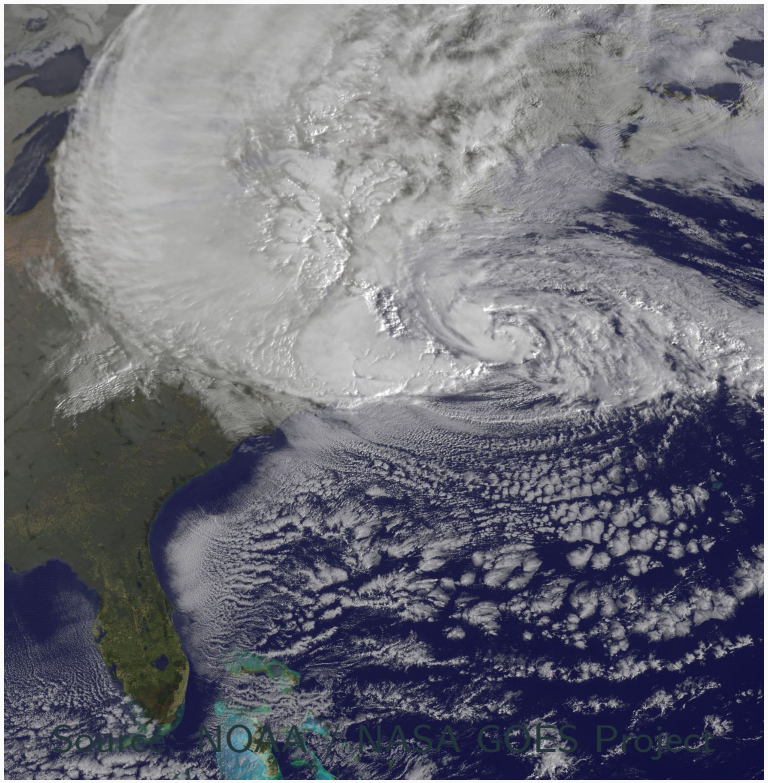
Impacts in excess of official death tolls

Evidence from Hurricane Maria in Puerto Rico.



Source: The New York Times

Health risks associated with Hurricane Sandy (2012)



Health risks in storm-affected areas

- Change in patterns of emergency department visits (Kim et al. 2016)
- Increased outpatient cases of food and waterborne disease among elderly (Bloom et al. 2016)
- Increased rate of myocardial infarctions (Swerdel et al. 2014)
- Increased hospitalizations for dehydration (Lee et al. 2016)
- Difficulty obtaining medical care, medications, and medical equipment (Davidow et al. 2016)

Study goals

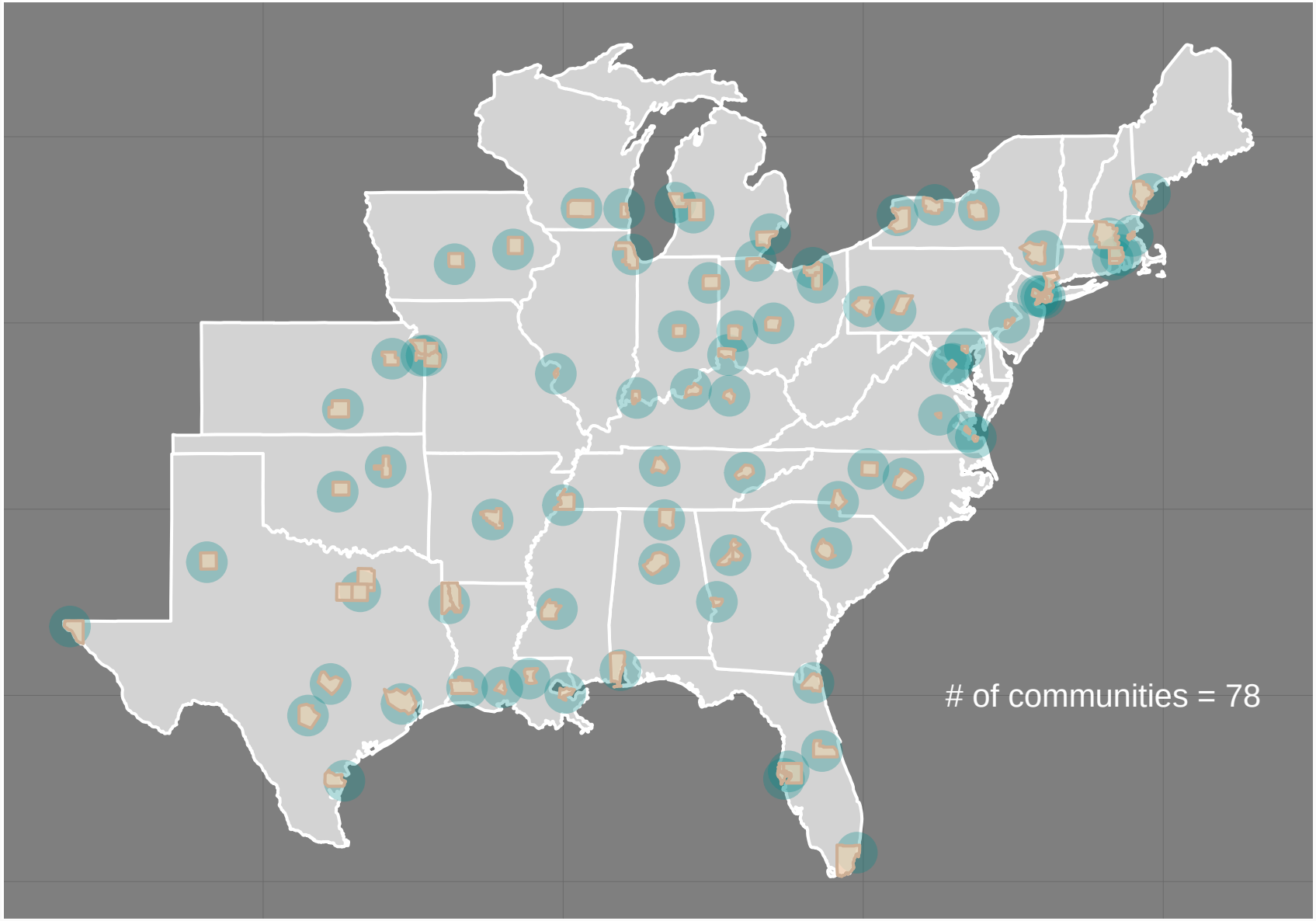
- Quantify the association between tropical cyclone exposure and community mortality risks within a large set of exposures and counties
- Explore the temporal pattern in risks in the days surrounding the storm
- Investigate how estimated associations change with changing definitions of tropical cyclone exposure

Methods

All study storms and counties

Communities considered in our study

Data from the National Morbidity, Mortality, and Air Pollution Study (NMMAPS)



Potential for seasonal confounding

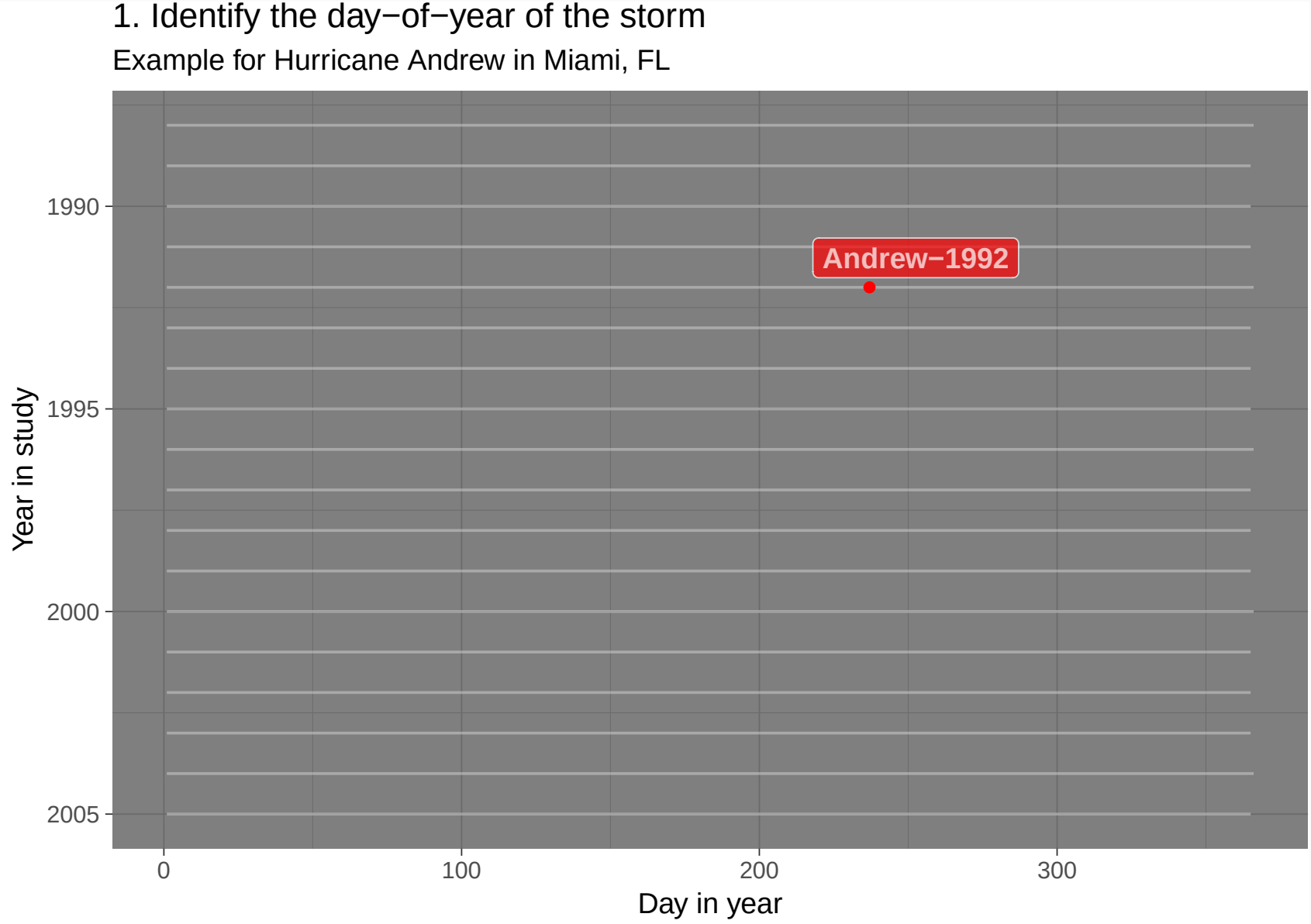
Analysis aim: Estimate the change in mortality during tropical cyclone exposures compared to if the storm had not hit the community.

It is important to control for potential seasonal confounding because:

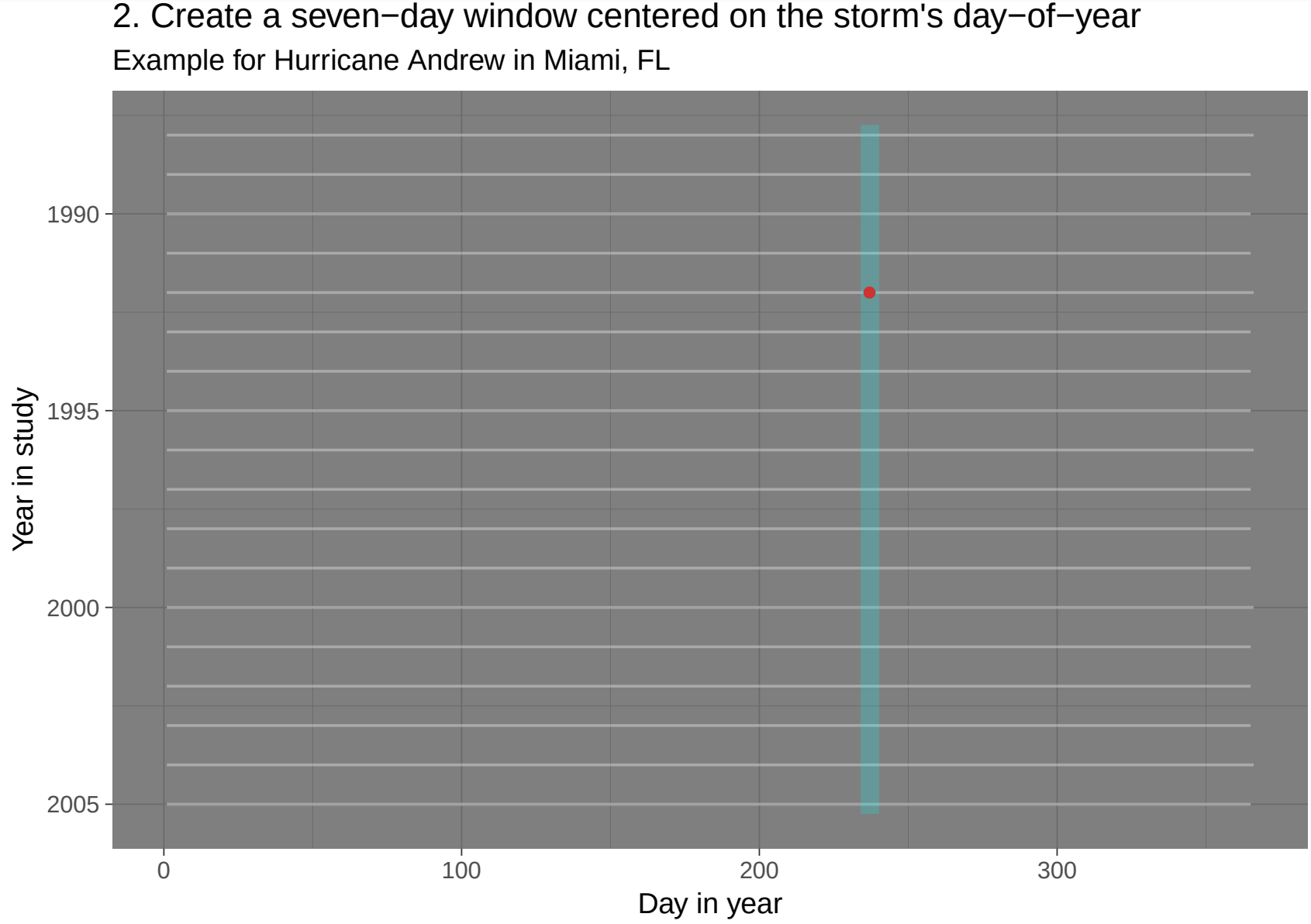
- There are strong seasonal patterns in many **health outcomes**
- There are strong seasonal patterns in **tropical cyclone exposures**

Given this potential for seasonal confounding, we used **a matched analysis** to ensure that the seasonal distribution was similar for exposed and unexposed days, matching across years within a community.

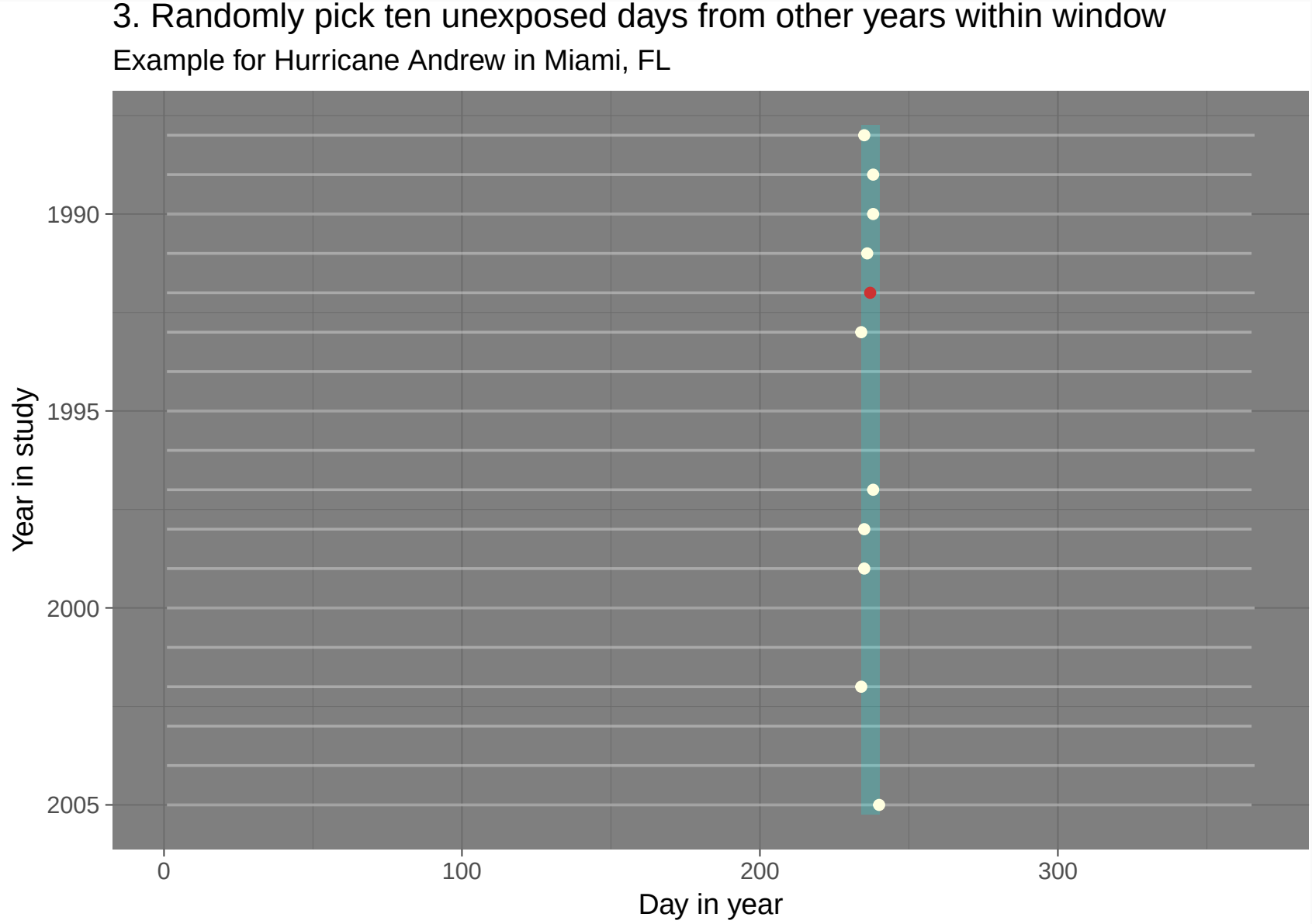
Selecting matched unexposed days



Selecting matched unexposed days



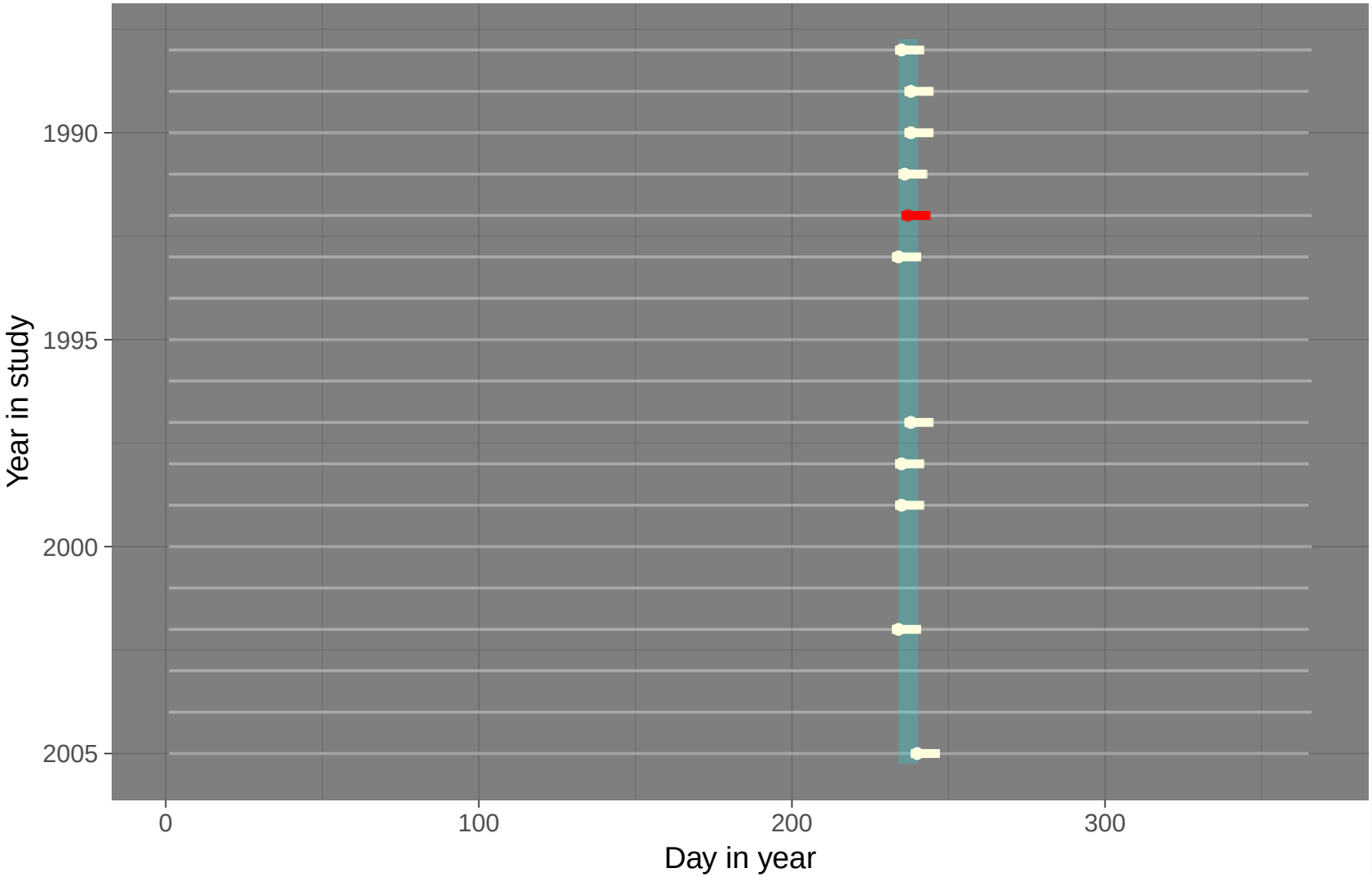
Selecting matched unexposed days



Selecting matched unexposed days

4. Determine the number of deaths for a period around each day

Example for Hurricane Andrew in Miami, FL

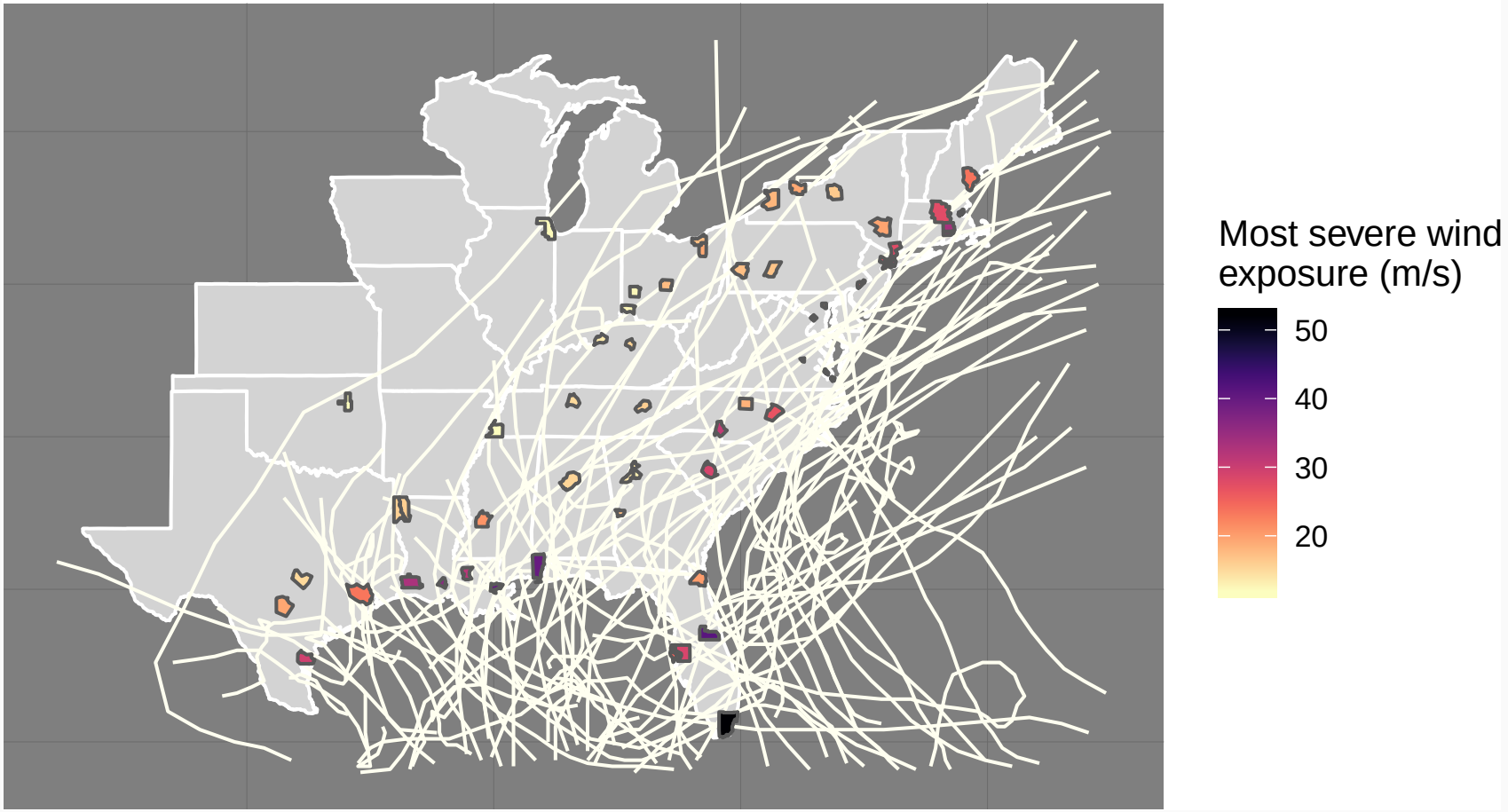


Results

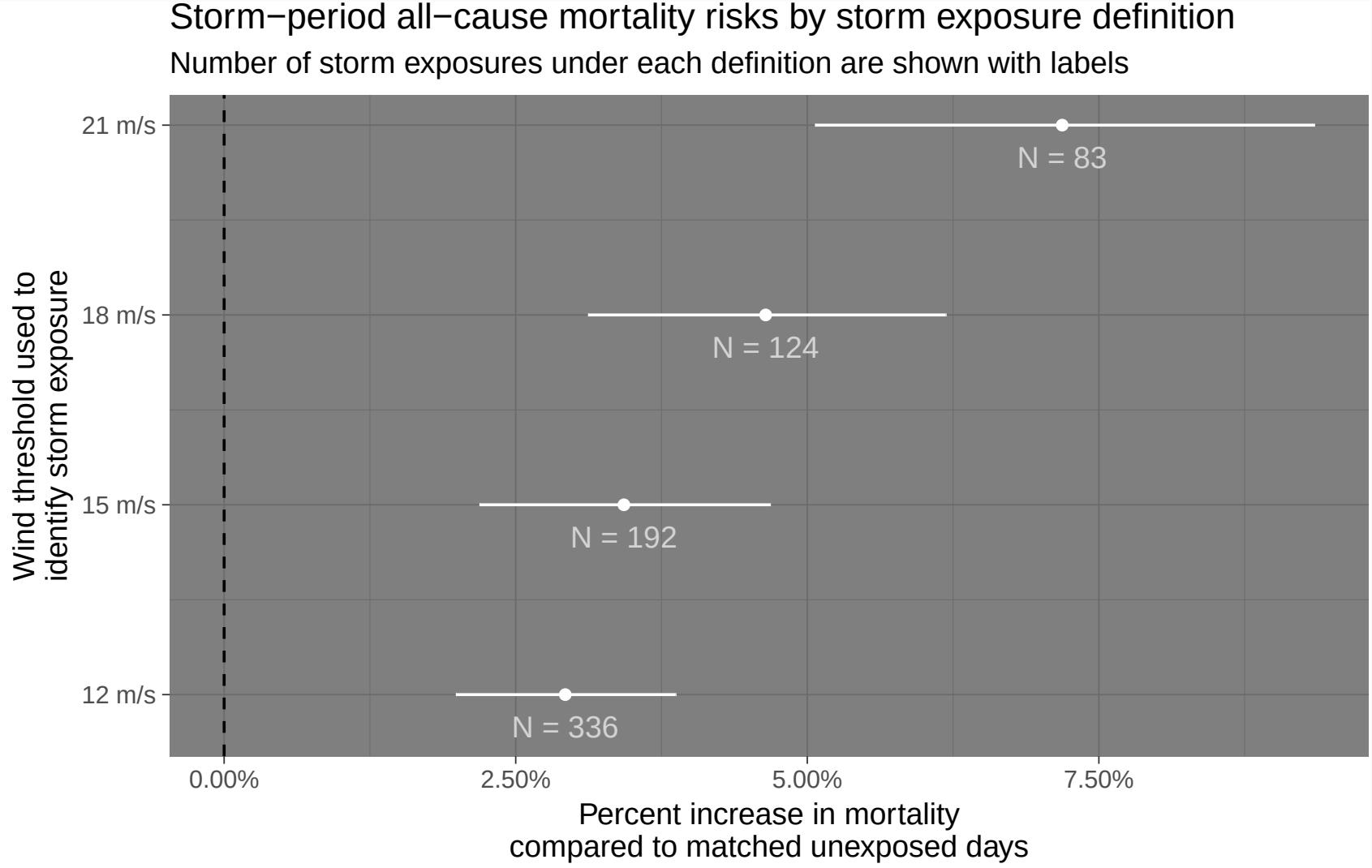
Wind-based exposures in study communities

All tropical cyclone wind exposures

Counties and storms with at least one exposure of 21 m/s or higher



Storm-period risks by storm exposure threshold



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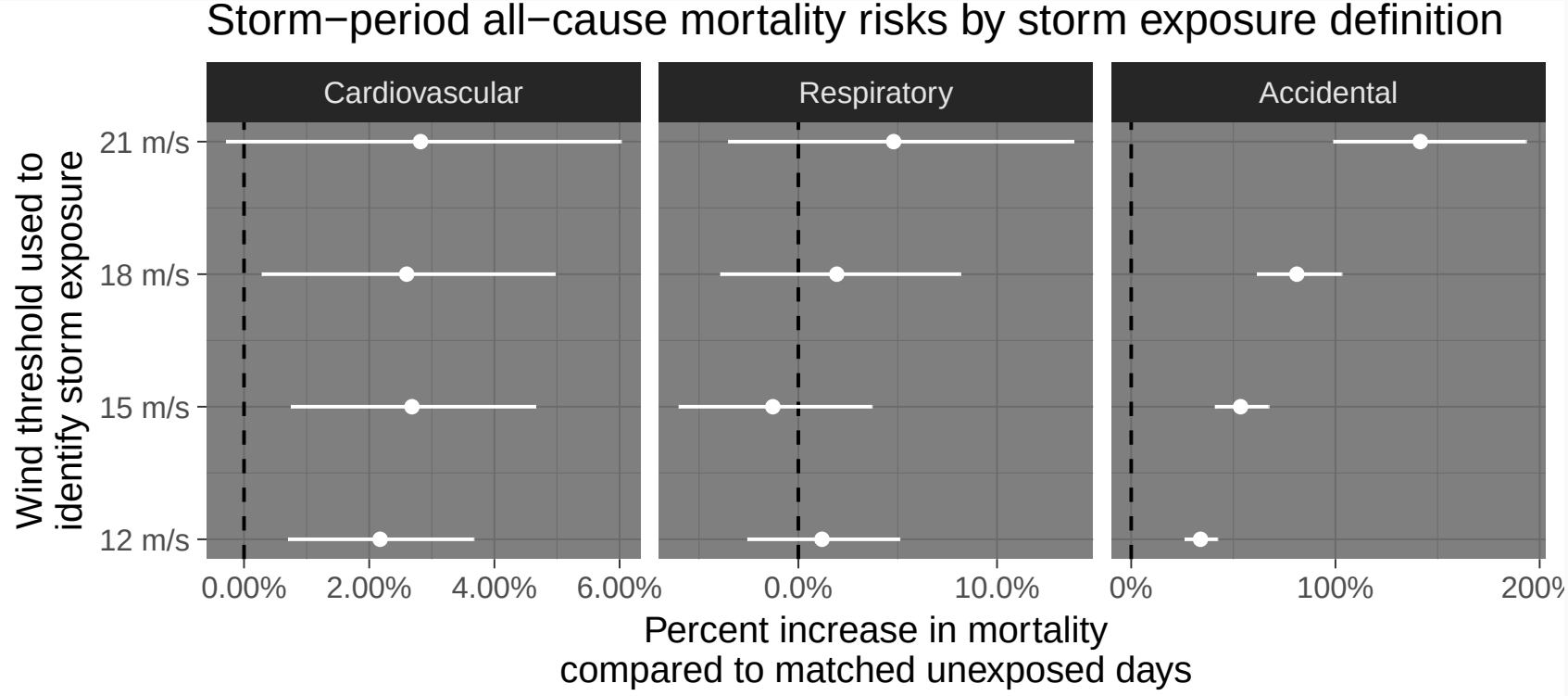
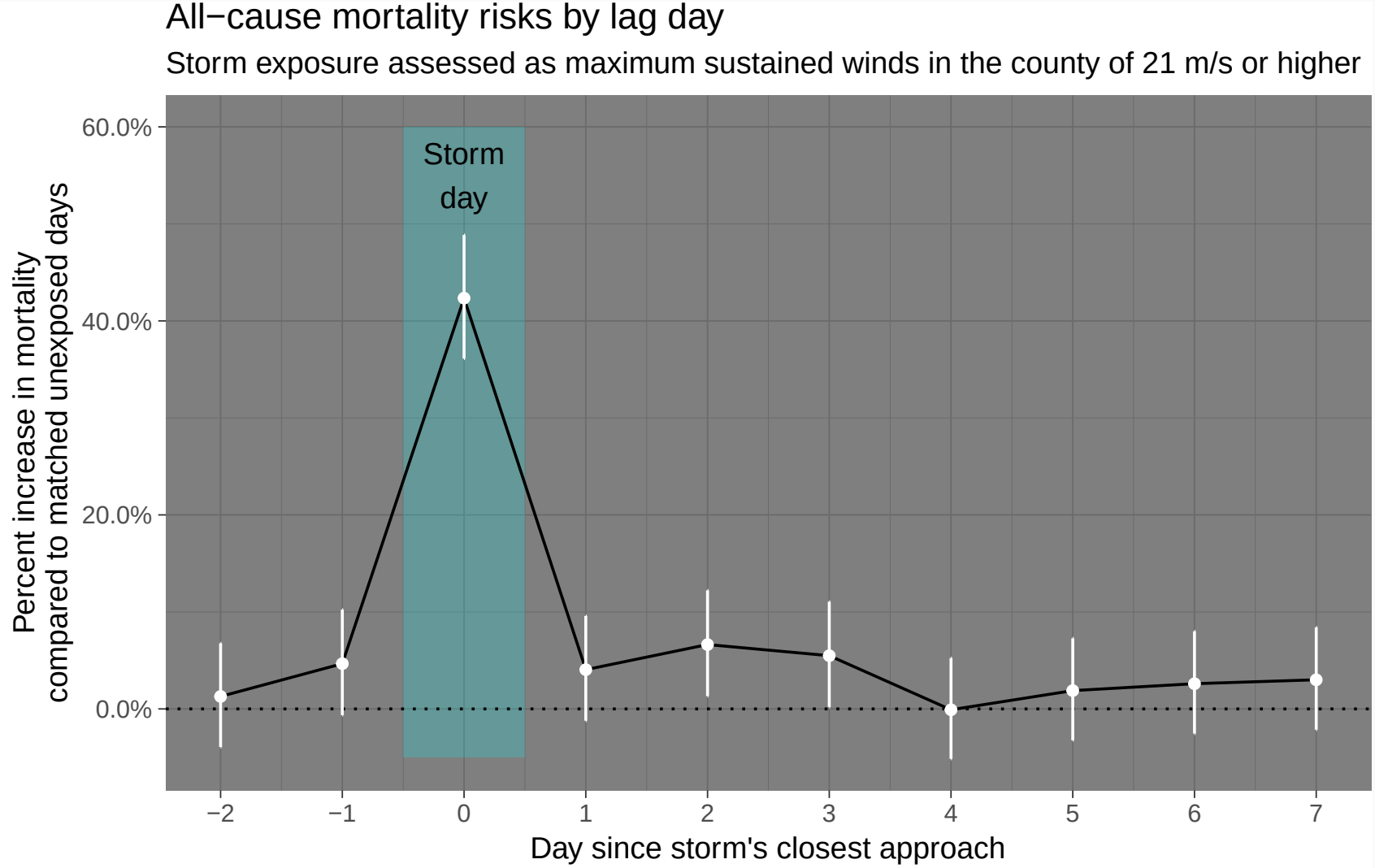
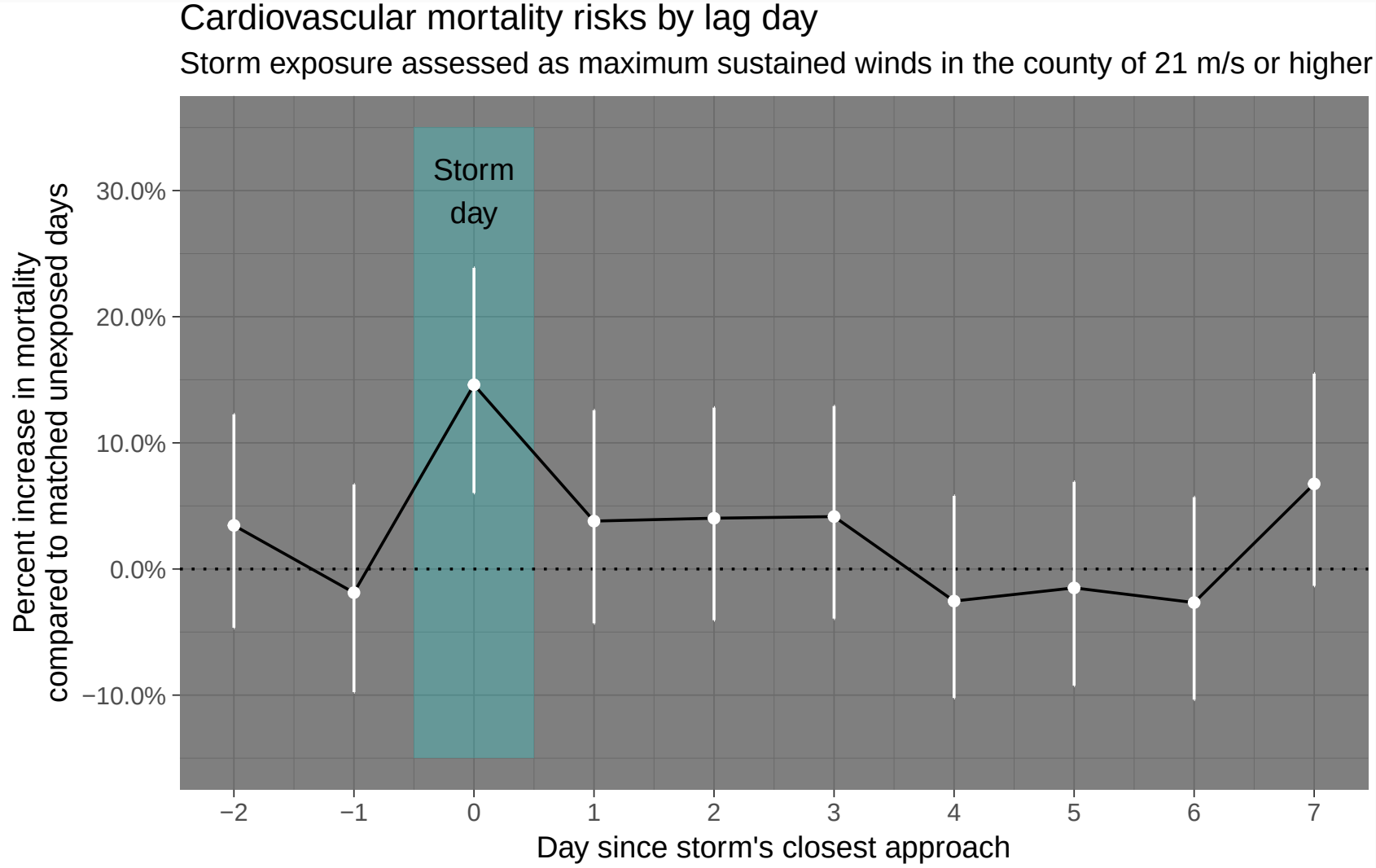


Mortality risks by lag day



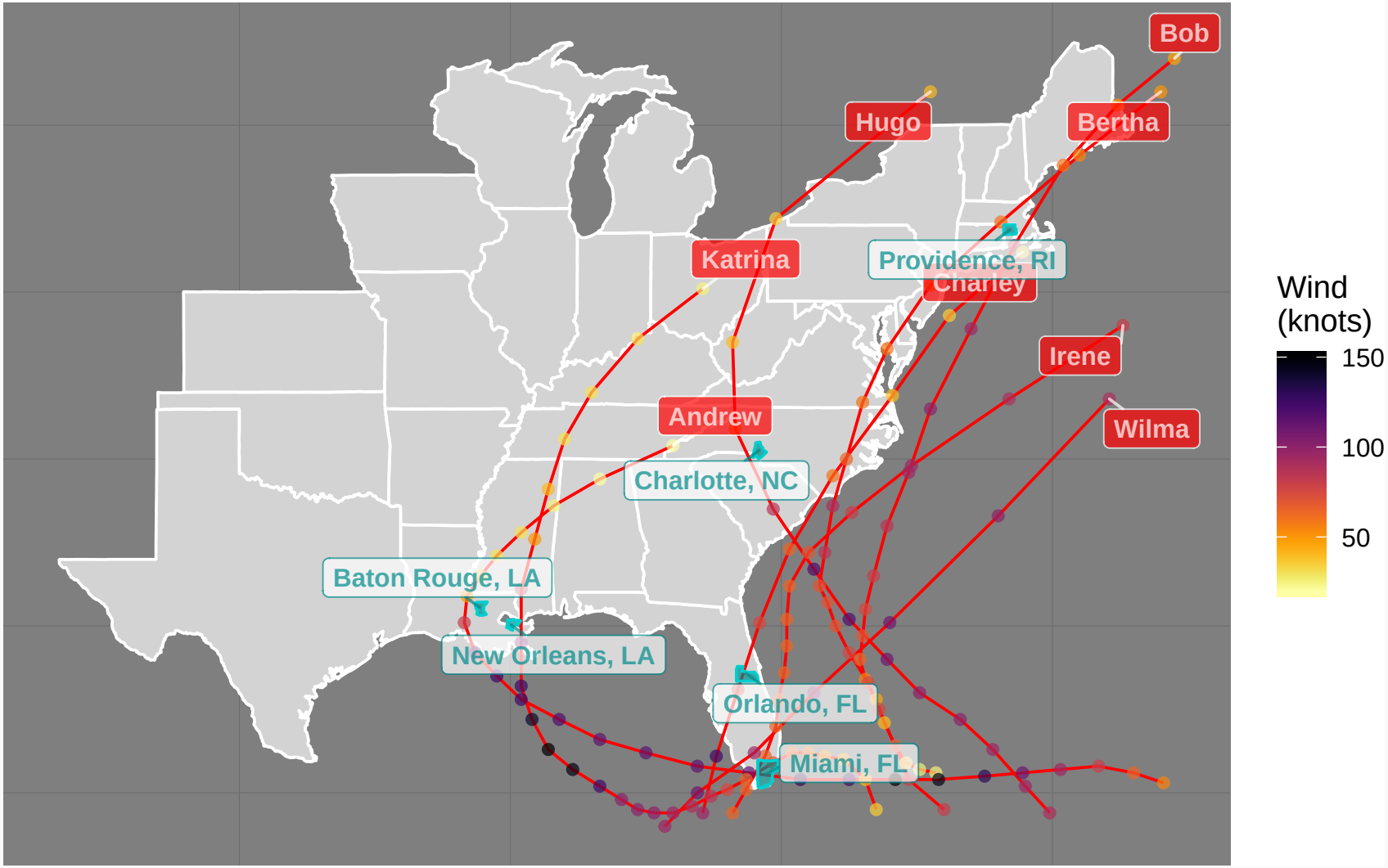
Mortality risks by lag day



Top 10 wind-based exposures in our study

Storms and counties for top 10 wind−based exposures

Color of points corresponds to storm's maximum 1−minute sustained surface winds



Cardiovascular mortality

Cardiovascular mortality risks during the top 10 wind-based storm exposures compared to matched unexposed days

Tropical cyclone	County	Wind[a]	Percent increase[b]
Andrew (1992)	Miami, FL	52	38 (20, 58)
Charley (2004)	Orlando, FL	41	9 (-22, 51)
Katrina (2005)	New Orleans, LA	40	146 (80, 236)
Bob (1991)	Providence, RI	34	5 (-21, 39)
Katrina (2005)	Miami, FL	32	15 (-3, 36)
Andrew (1992)	Baton Rouge, FL	32	17 (-18, 68)
Irene (1991)	Miami, FL	31	17 (2, 35)
Wilma (2005)	Miami, FL	31	-3 (-18, 15)
Hugo (1989)	Charlotte, NC	31	-2 (-33, 42)
Bertha (1996)	Providence, RI	31	-9 (-31, 21)

[a] Modeled maximum sustained surface wind (m/s) at community center

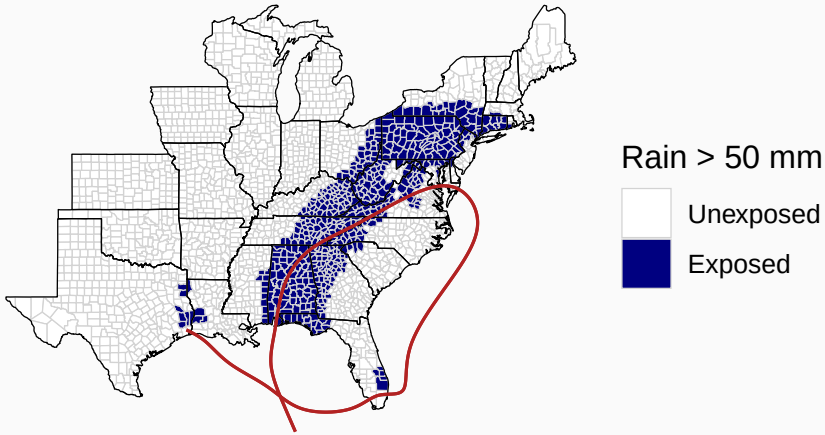
[b] % increase in cardiovascular mortality compared to matched unexposed days

Discussion

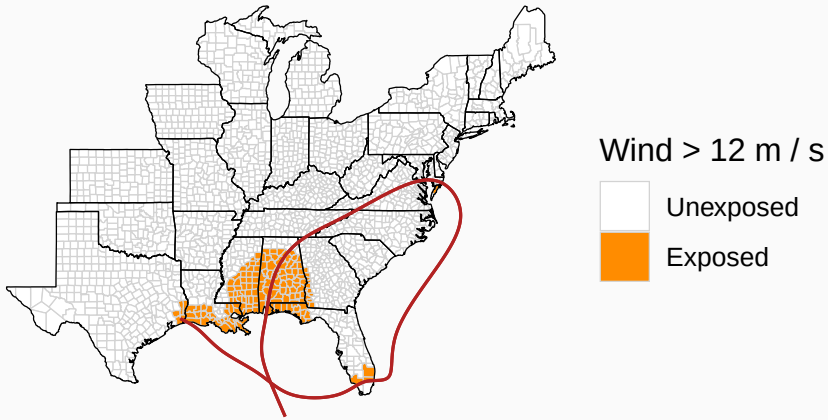
Differences in exposures by hazard

The counties assessed as "exposed" to tropical cyclones can differ substantially based on the hazard metrics considered in assessing exposure.

Rain exposures during Ivan, 2004



Wind exposures during Ivan, 2004



Exposures for Hurricane Ivan based on rain measurements (left) and modeled maximum sustained winds (right).

Understanding variation across storms in health effects

Tropical Storm Allison (2001) caused extensive flooding in Houston, TX

Source: National Oceanic and Atmospheric Administration

Tropical cyclones under climate change

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Search NOAA sites

NEWS & FEATURES

Study: Climate warming to boost major hurricanes in active Atlantic seasons

Research | hurricanes measuring and modeling climate research

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Based on recent research, climate change is likely to increase the number of major hurricanes in active hurricane seasons.

Climate attribution studies

LETTER

Quantitative attribution of climate effects on Hurricane Harvey's extreme rainfall in Texas

S-Y Simon Wang[1,2], Lin Zhao[3], Jin-Ho Yoon[4,6], Phil Klotzbach[5] and Robert R Gillies[1,2]

Increased threat of tropical cyclones and coastal flooding to New York City during the anthropogenic era

Andra J. Reed[a,1], Michael E. Mann[a,b], Kerry A. Emanuel[c], Ning Lin[d], Benjamin P. Horton[e,f], Andrew C. Kemp[g], and Jeffrey P. Donnelly[h]

HURRICANE SANDY BEFORE 1900 AND AFTER 2100

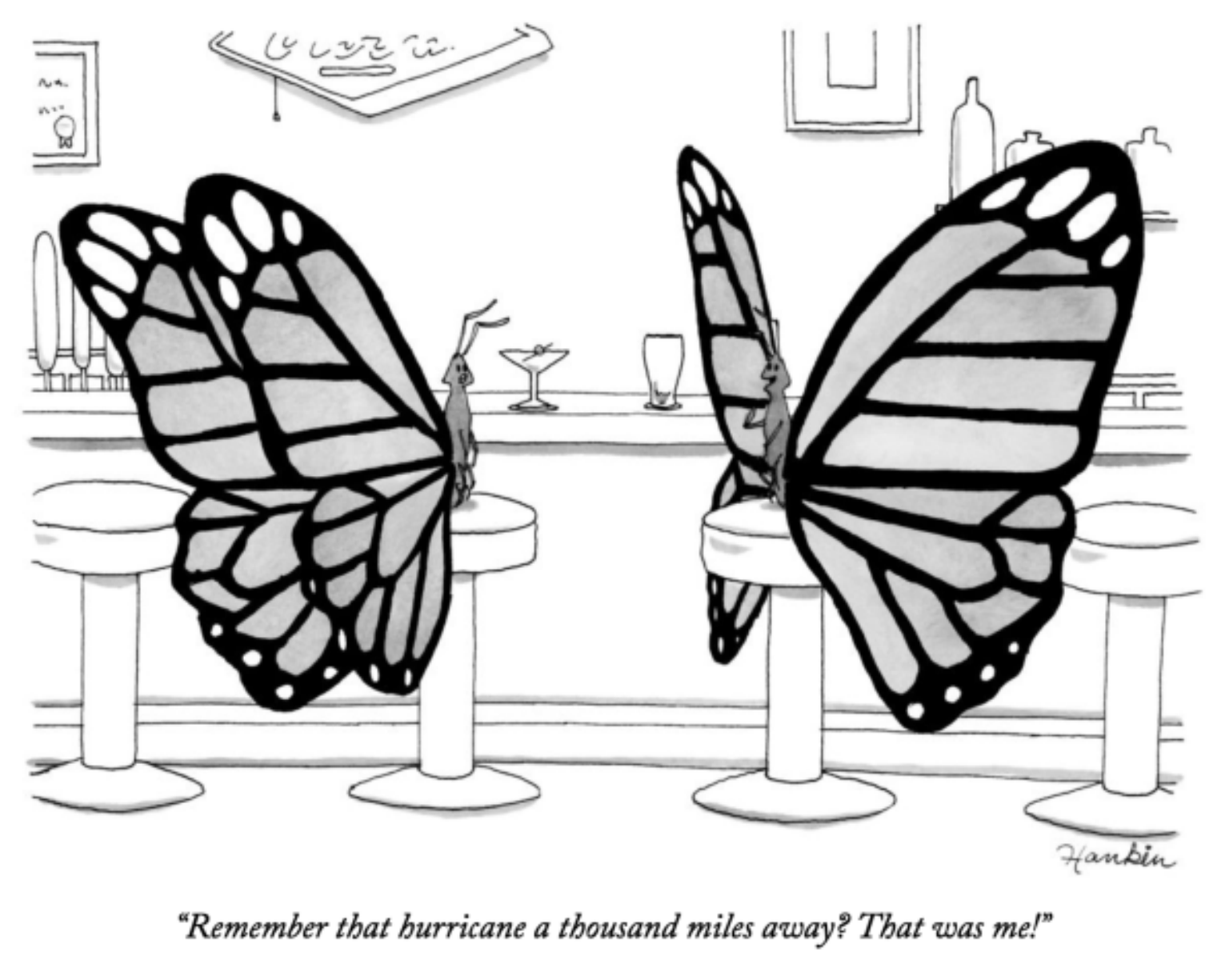
BY GARY M. LACKMANN

Other related research in our research group

We have a number of related research projects ongoing in our research group:

- Estimating associations between tropical cyclone exposures and cardiorespiratory Medicare hospitalizations
- Exploring how the associations between tropical cyclone exposure and health outcomes change across definitions of tropical cyclone exposure
- Open source software: Enabling access to county-level tropical cyclone exposure data for multiple storm hazards (wind, rain, floods, tornadoes)
- Developing methods for epidemiological research on climate-related disasters
- Quantifying health-related risks for other climate-related disasters, especially extreme temperatures and heat waves

Questions?



Source: The New Yorker