Update– NSF SEES

Annual Meeting, NSF SEES Investigators

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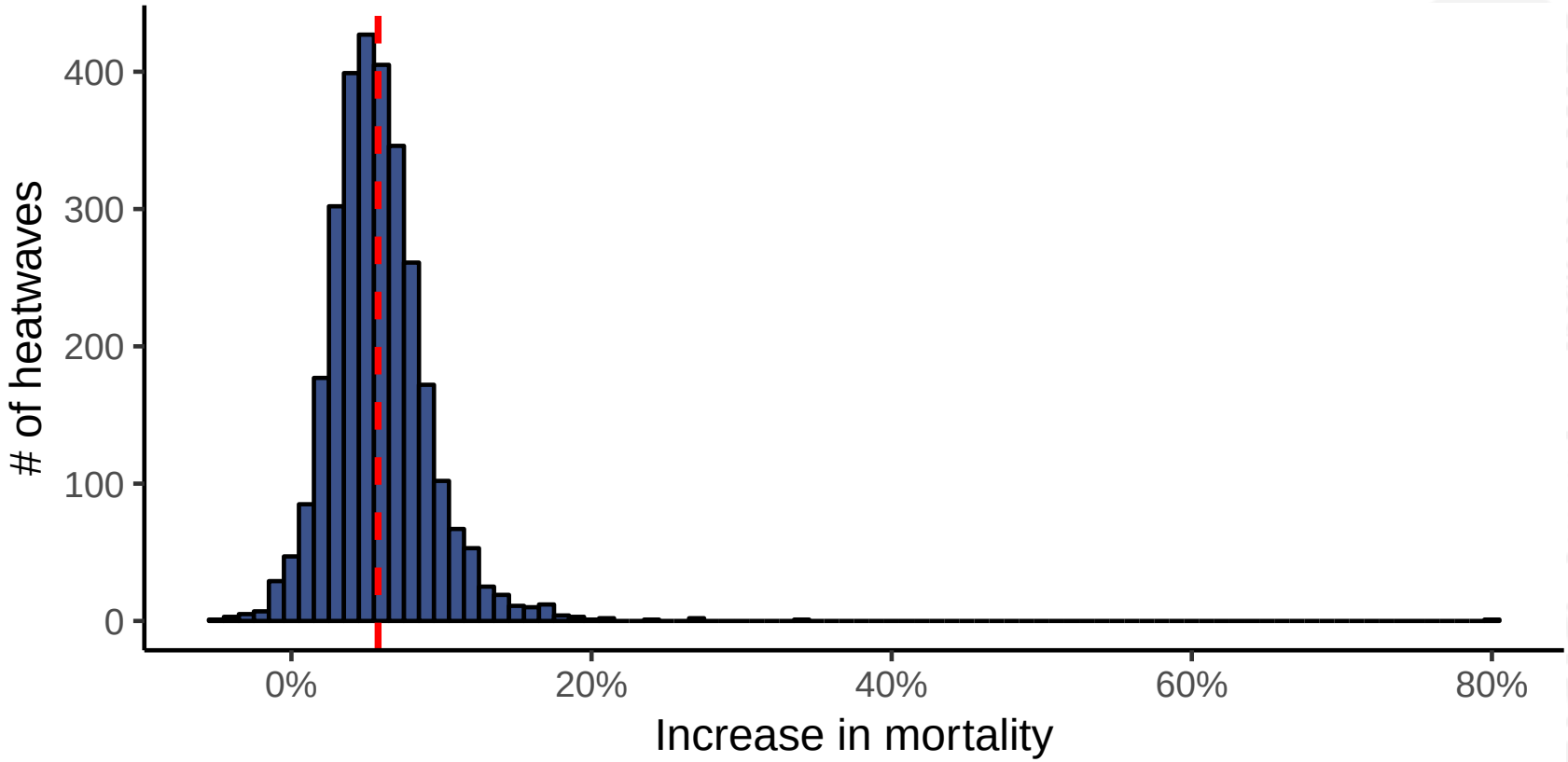
Projecting heat wave-related mortality impacts

Historical heat waves

Variation across heat waves in increased mortality risk.



The red line shows the central estimate across all heat waves. The graph shows estimates from 2,980 heat waves identified in 83 U.S. communities, 1987-2005.

Health-based model

Model goal

Predict heat wave-related mortality for a heat wave based on a number of its characteristics.

Model development

1. Identified historical heat waves in 83 U.S. communities, 1987 to 2005. (Heat wave $= \geq 2$ days $\geq 98^{th}$ percentile temperature.)
2. Used epidemiological model to estimate relative risk of mortality observed for 2,980 historical heat waves.
3. Built a Random Forests model to predict the relative risk of a heat wave based on 20 heat wave characteristics.
4. Validated model through cross-validation, tuned, compared to other models.

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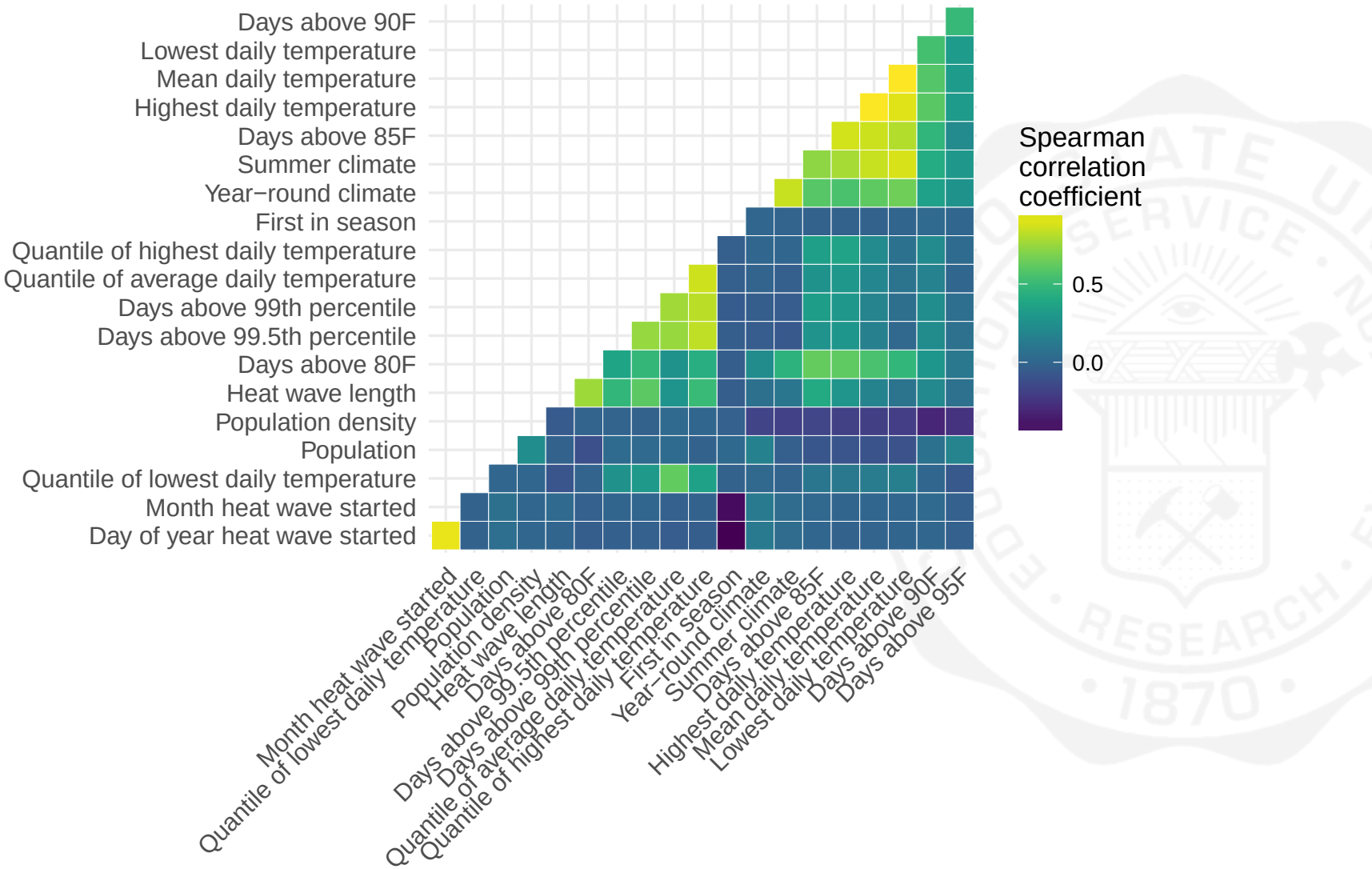
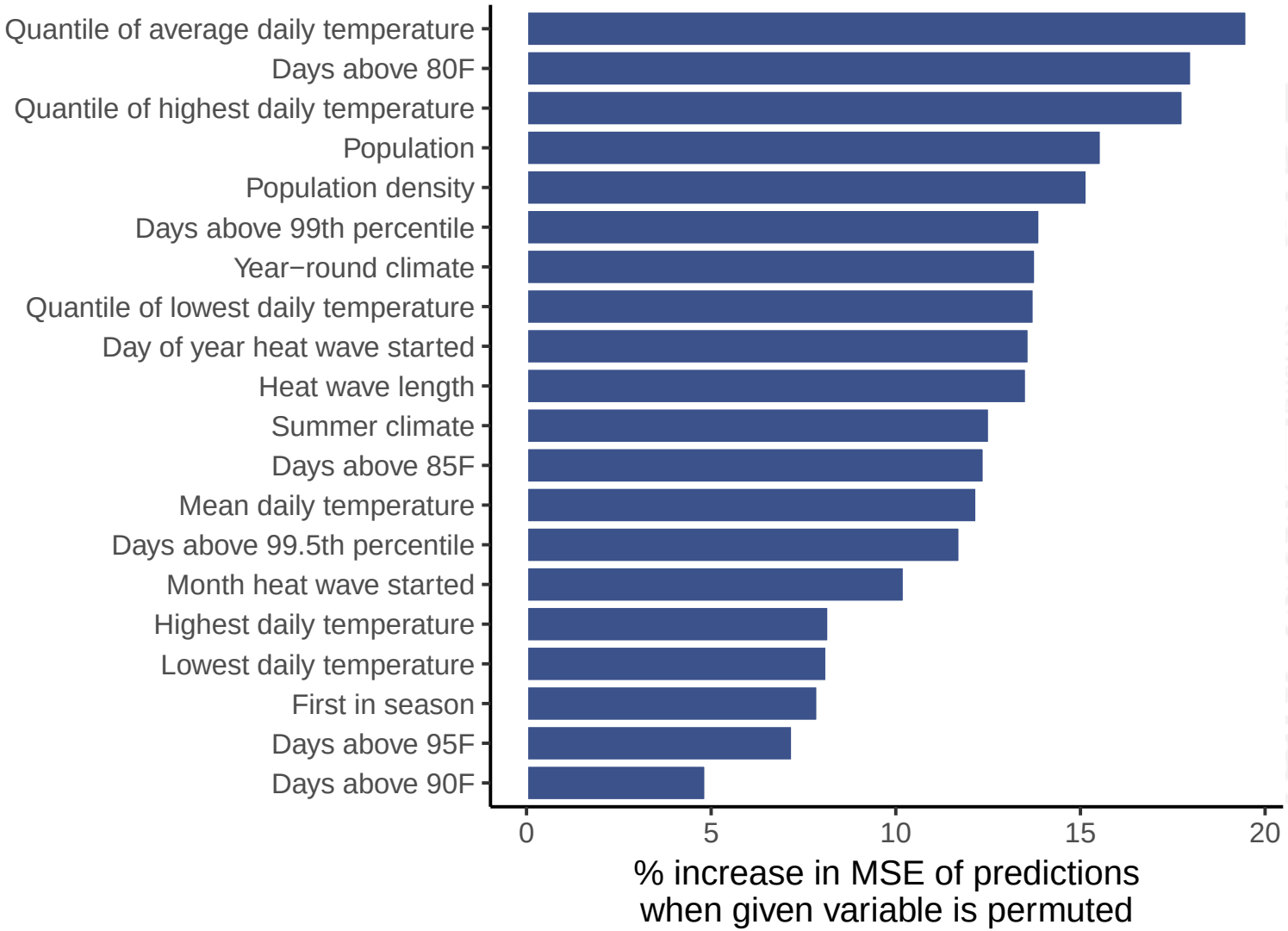
Heat wave characteristics

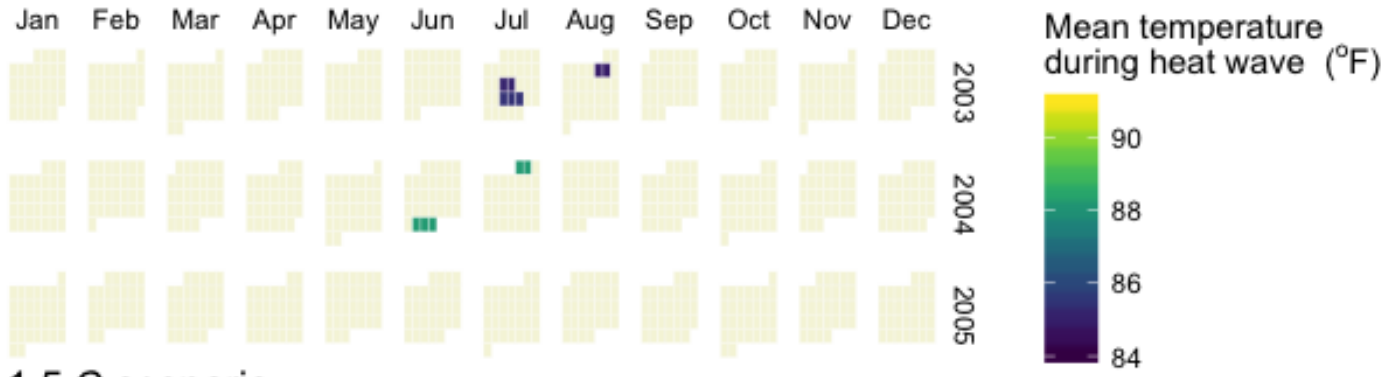


Variable importance for heat-health model



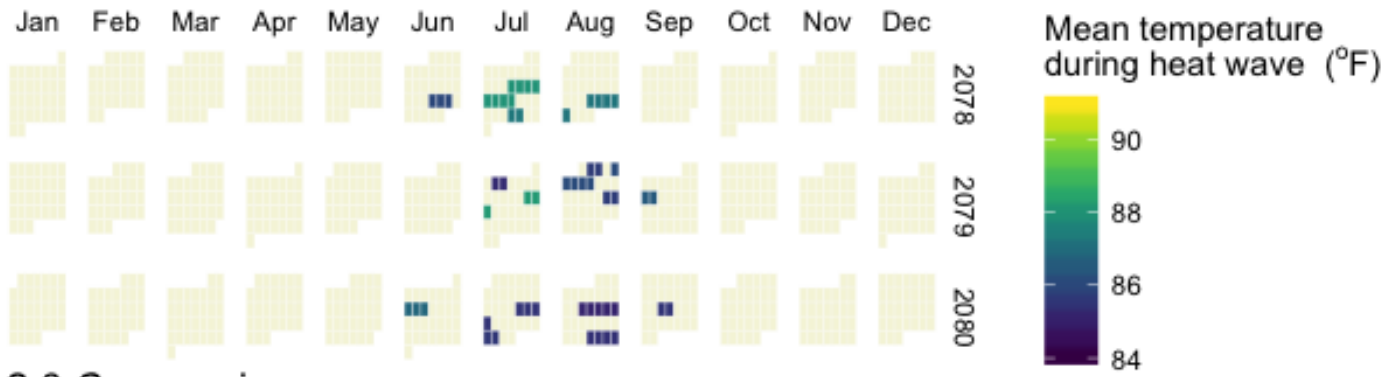
Present

Ensemble member 002



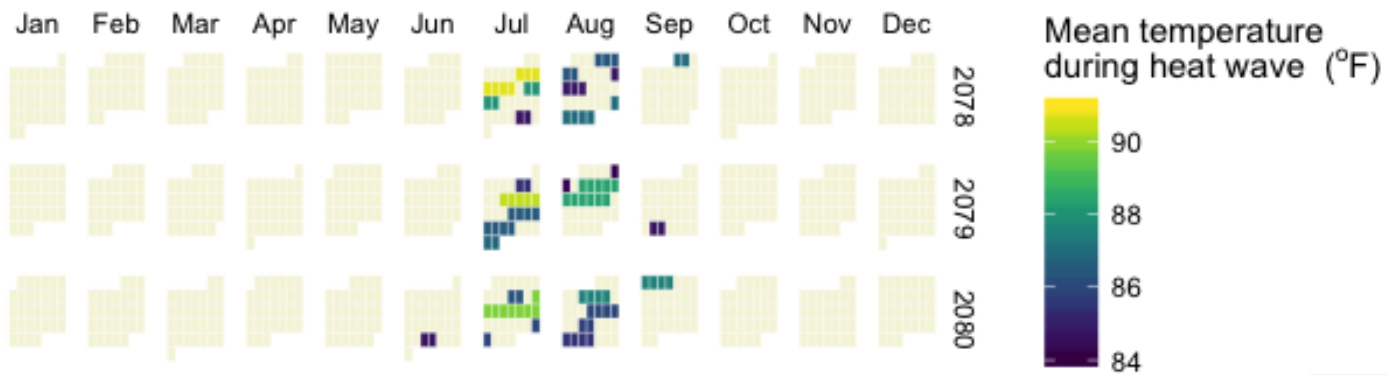
1.5 C scenario

Ensemble member 002

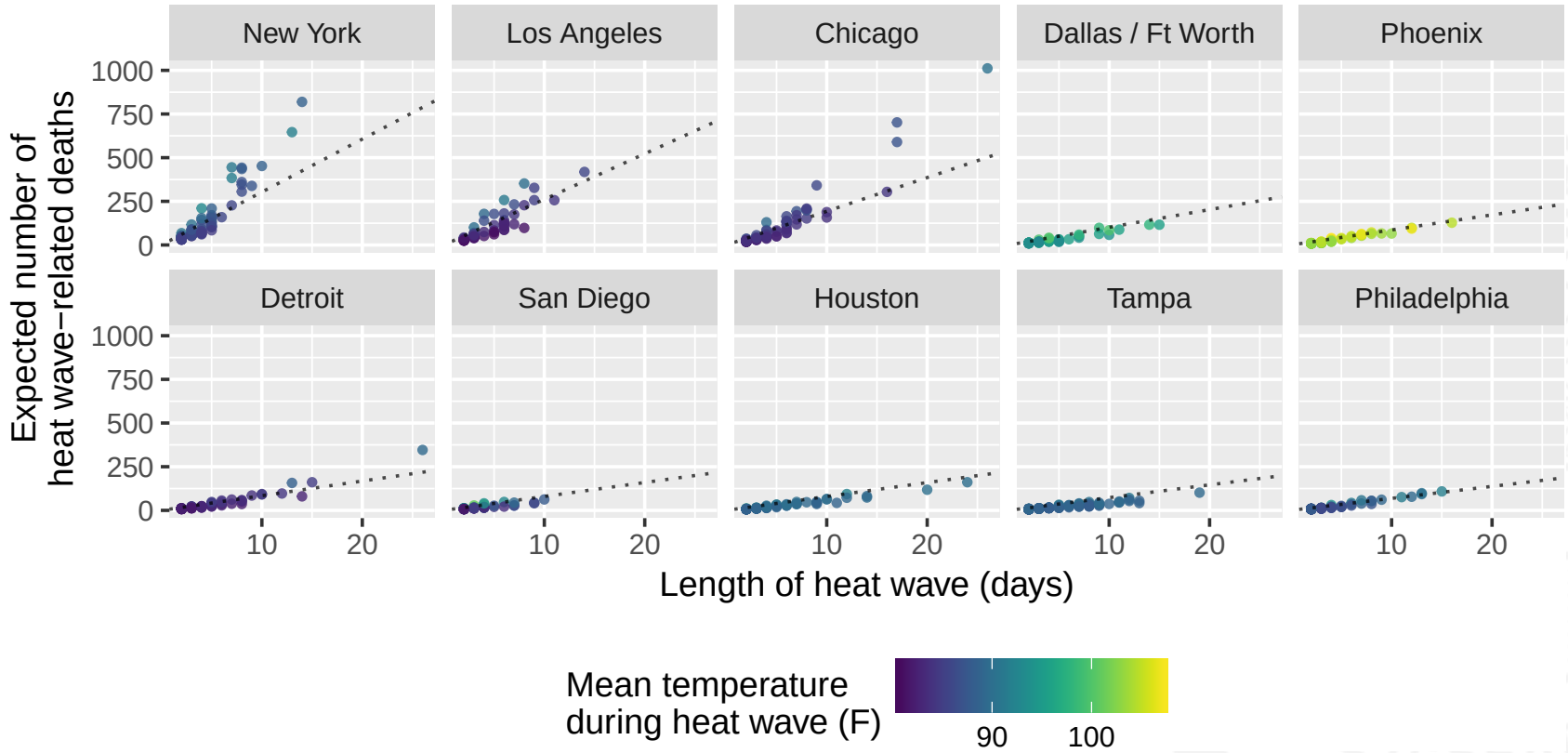


2.0 C scenario

Ensemble member 002

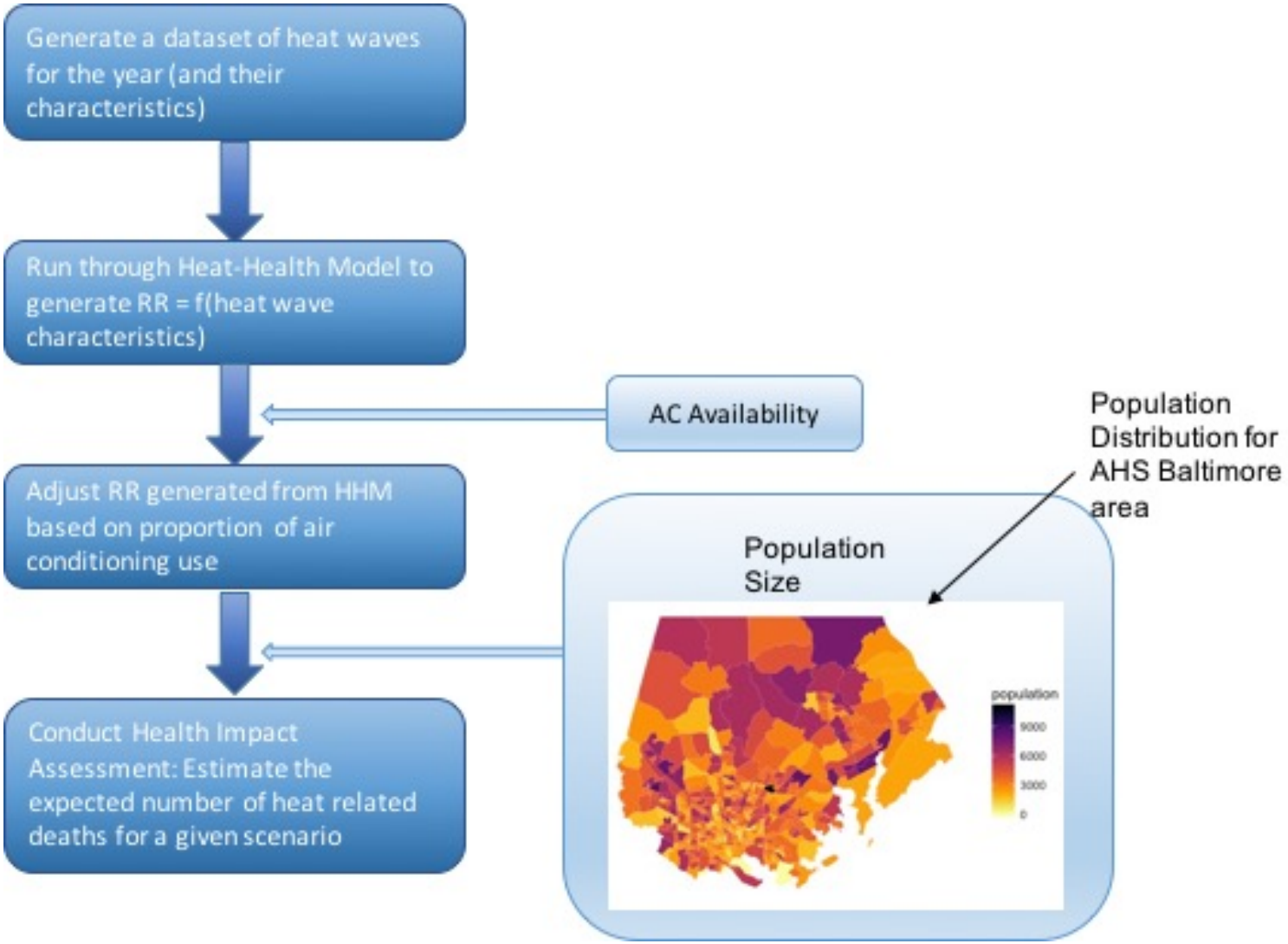


Projected excess heat wave mortality



Example from one ensemble member of the $1.5^{o}C$ model output, showing characteristics and projected mortality for heat waves in ten larger U.S. communities. The dotted line shows where points would fall for heat waves with a 10% increase in daily mortality.

Incorporating A/C effect modification



Tropical storm exposure in U.S. counties

Hazard-specific tropical storm metrics

Tropical storm hazard metrics

- Distance from the storm
- High winds
- Rainfall
- Storm surge
- Flood events
- Tornado events

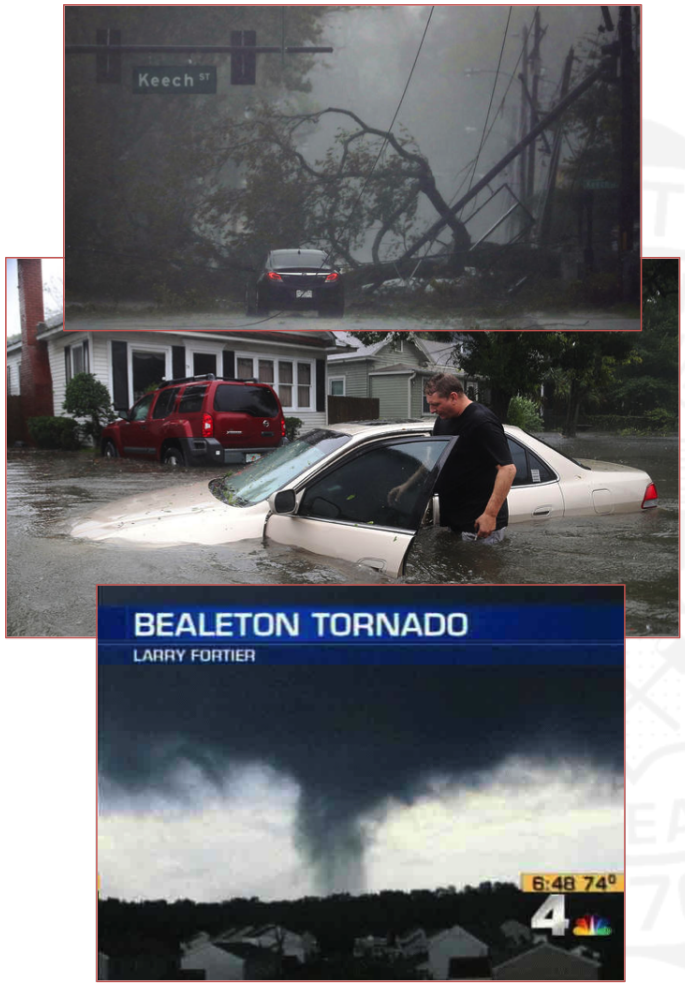
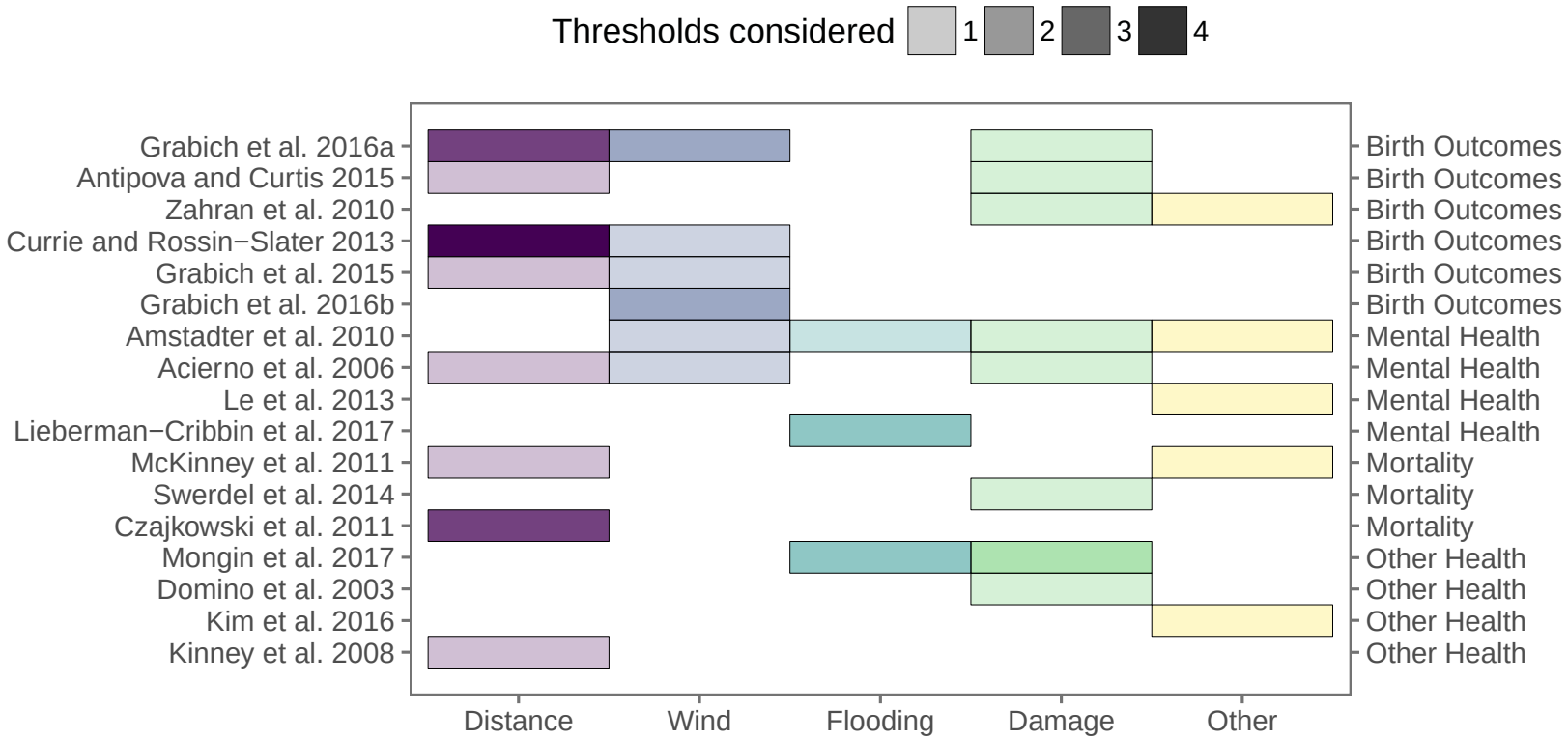


Image sources: Los Angeles Times, NBC

Assessing tropical storm exposure

Challenge for epidemiological research

How to determine whether a county was exposed to a tropical storm?

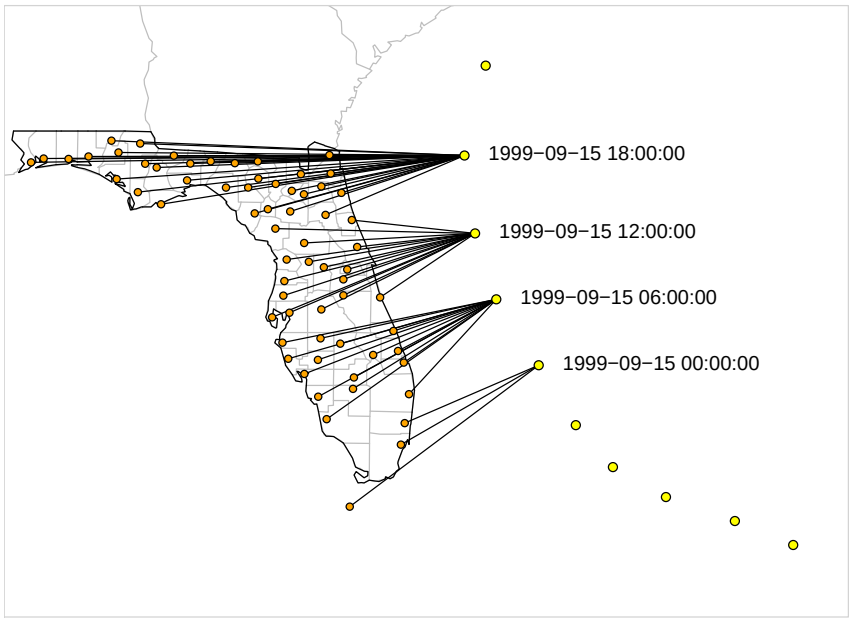


Project aims

Work on tropical storm exposure

- Develop exposure classifications of all U.S. Atlantic basin tropical storms, 1996–2011, based on reasonable measurements of tropical storm hazards
- Assess agreement between hazard-based county-specific exposure classifications
- Make exposure assessments accessible to other researchers for epidemiological and other impact studies

Assessing tropical storm exposure



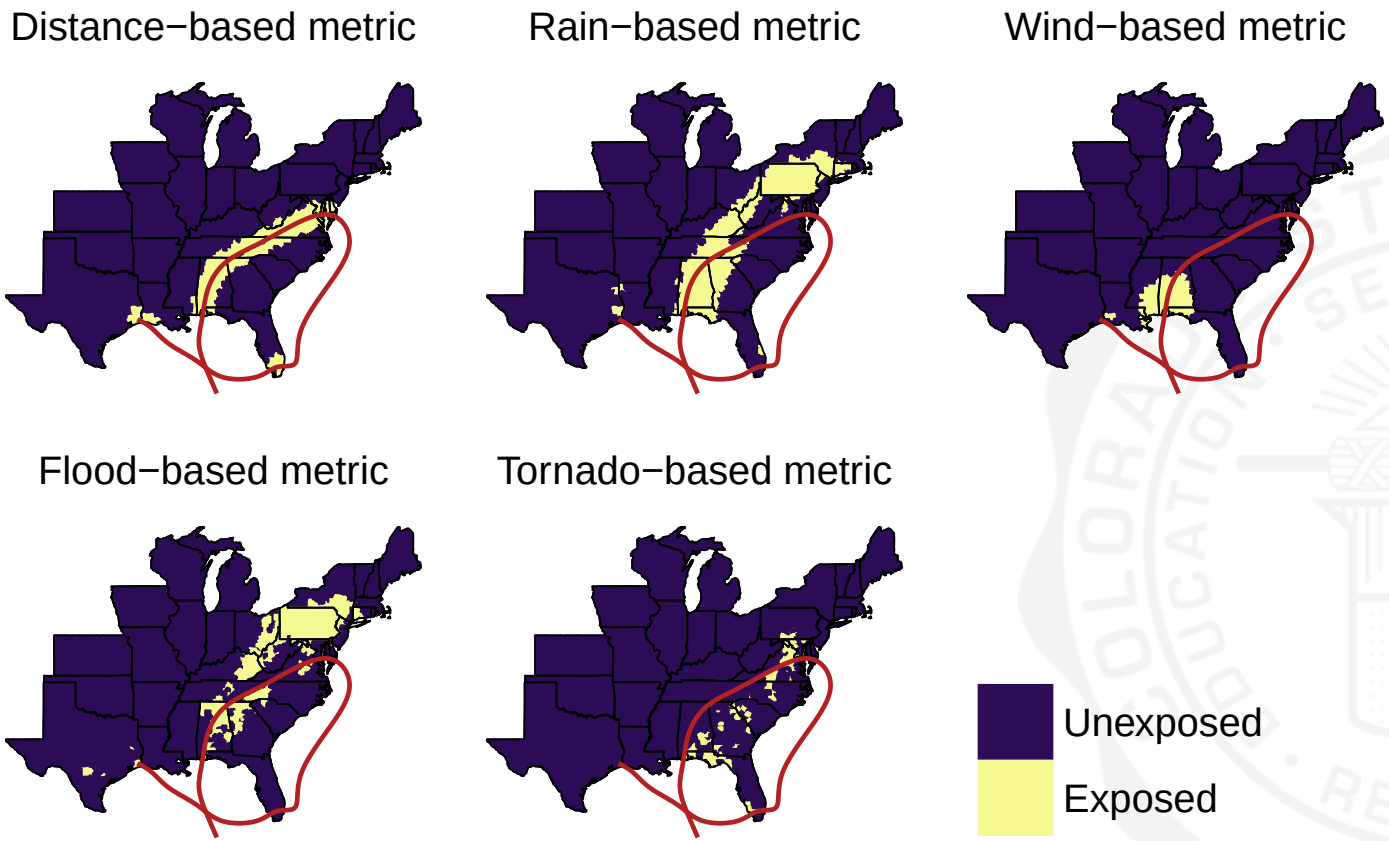
Example of "Best Tracks" data

Distance metric

- **Distance:** National Hurricane Center Best Tracks data
- **Wind:** Wind model based on Willoughby et al. (2006)
- **Rain:** Re-analysis rain data (NLDAS-2)
- **Flood and tornado events:** NOAA Storm Events database

Agreement between exposure metrics

County-level exposure to Hurricane Ivan (2004)



Criteria for exposure classifications: **Distance:** Within 100 kms of storm track. **Rain:** $\geq$ 75 mm of rain total for two days before to one day after storm. **Wind:** Modeled wind of $\geq$ 15 m/s. **Flood, Tornado:** Listed event in NOAA Storm Events database.

County-level agreement in storm exposure

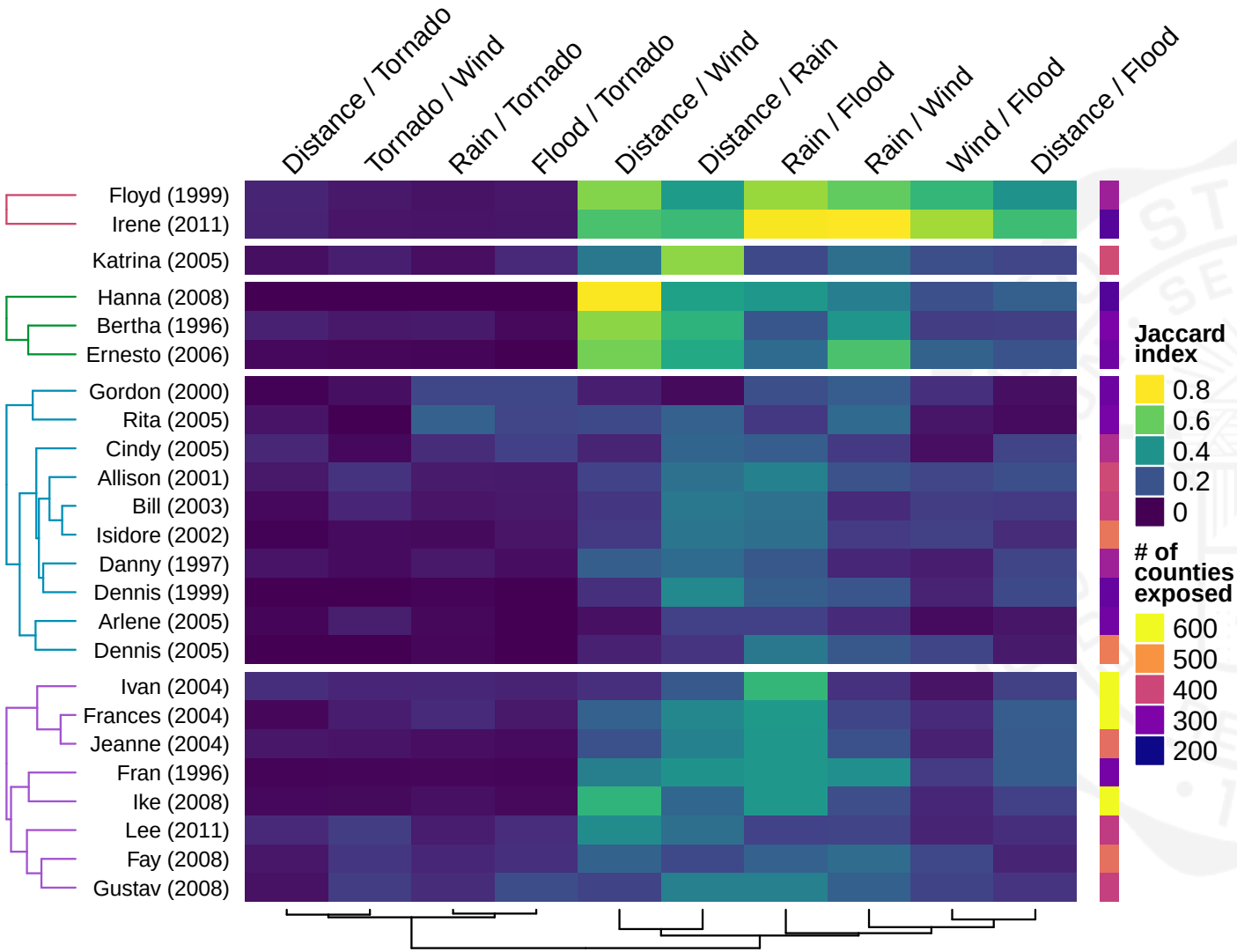
Assessing agreement in county classifications

For each storm and each pair of metrics, we measured the *Jaccard index* as a measure of county-level agreement in exposure classification for a storm:

$$J = \frac{X_1 \cap X_2}{X_1 \cup X_2}$$

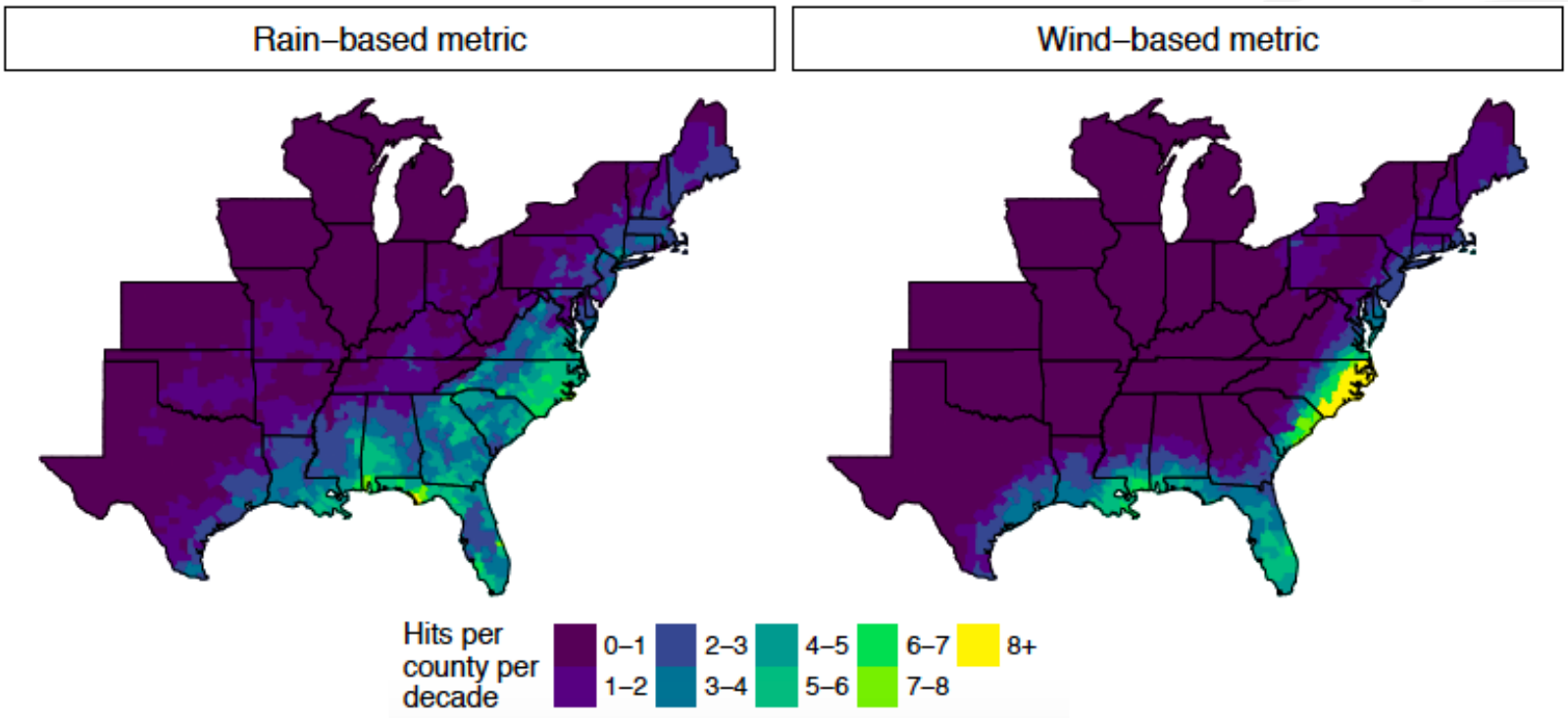
where X_1 is the set of counties exposed to a storm based on the first metric and X_2 is the set of counties exposed to the storm based on the second metric.

County-level agreement in storm exposure



Tropical storm exposure in U.S. counties

Storm hits per county per decade based on rain (left) and wind (right) exposure metrics.



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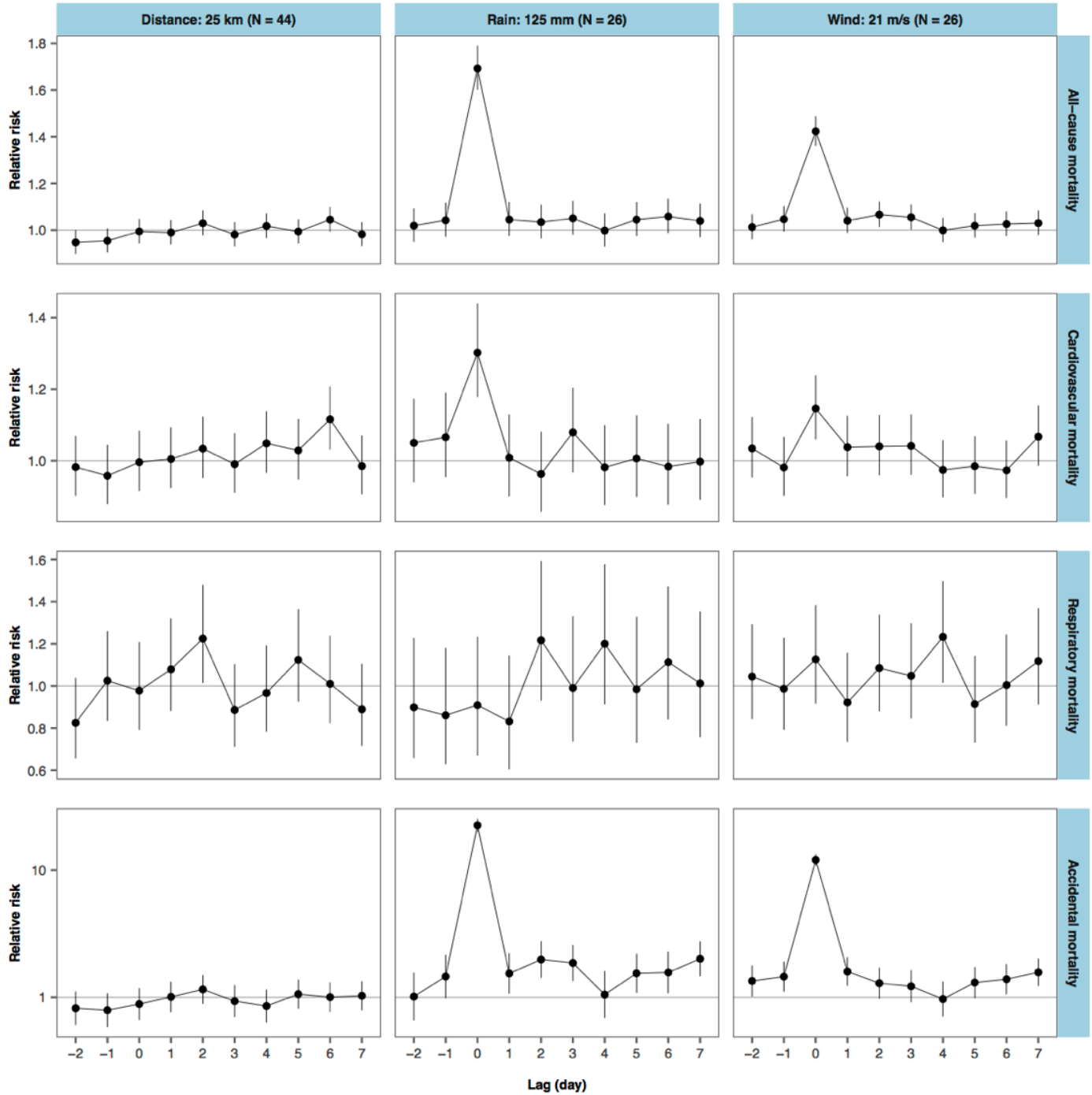

Distance: 25 km (N = 44)
Rain: 125 mm (N = 26)
Wind: 21 m/s (N = 26)
All−cause mortality
Cardiovascular mortality
Respiratory mortality
Accidental mortality
Relative risk
Lag (day)

Software

Project software

'hurricaneexposure'

Create county-level exposure time series for tropical storms in U.S. counties. Exposure can be determined based on several hazards (e.g., distance, wind, rain), with user-specified thresholds. On CRAN.

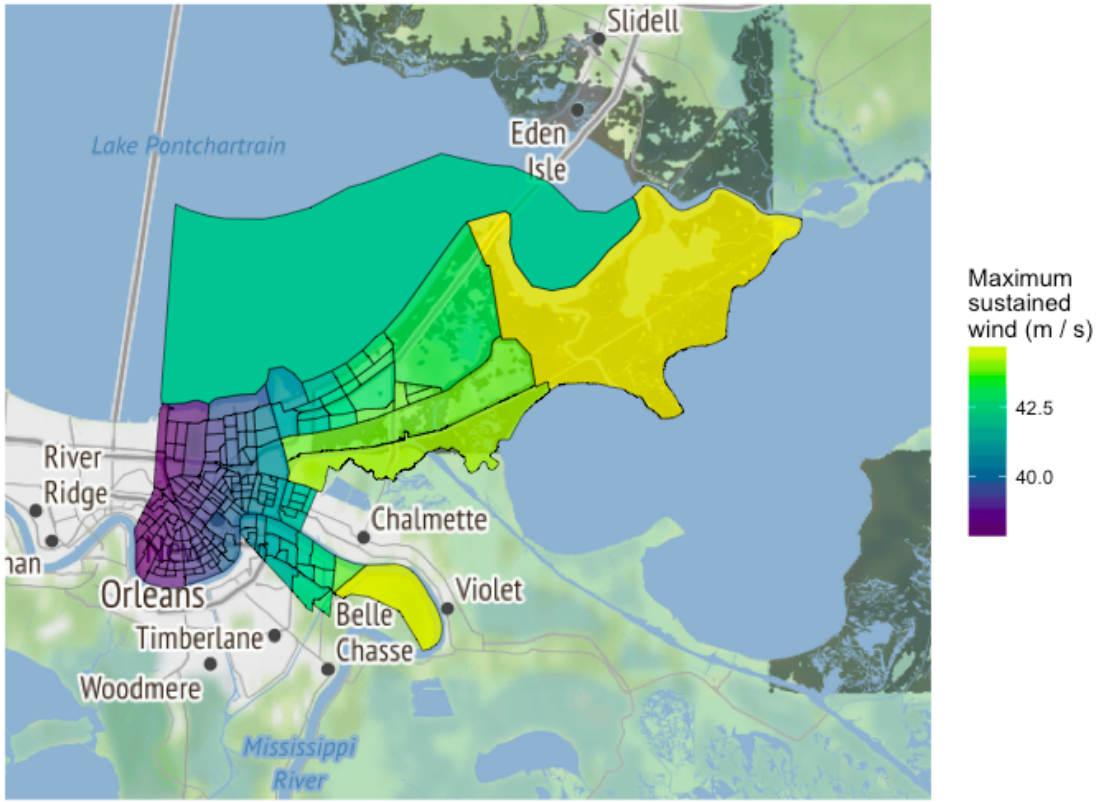
```
county_rain(counties = c("22071", "51700"), rain_limit = 100,
            start_year = 1995, end_year = 2005, dist_limit = 100,
            days_included = c(-1, 0, 1))
```

```
## # A tibble: 4 x 5
##       storm_id  fips closest_date storm_dist tot_precip
##          <chr> <chr>        <chr>      <dbl>      <dbl>
## 1    Bill-2003 22071   2003-06-30   38.78412      141.1
## 2 Charley-2004 51700   2004-08-14   43.01152      136.2
## 3   Cindy-2005 22071   2005-07-06   32.21758      113.2
## 4   Floyd-1999 51700   1999-09-16   46.50729      207.5
```

Project software

'stormwindmodel'

Model storm winds from Best Tracks data at U.S. locations. Includes modeling sustained and gust winds, as well as duration of sustained and gust winds above a specified threshold. On CRAN.



Project software

‘countyweather‘, ‘countyfloods‘

Download weather monitor data through NOAA and USGS APIs by U.S. county. Includes functions to map available monitors / gages for each county. On CRAN.

‘noaastormevents‘

Download and explore listings from the NOAA Storm Events database. Includes the ability to pull events based on a tropical storm, using events listed close in time and distance to the storm’s tracks. On CRAN.

‘countytimezones‘

Convert time-stamps from UTC to local time zones for U.S. counties based on county FIPs. Facilitates merging weather observations with locally measured data, including health outcomes. On CRAN.