

Exposure Data Package for US-based Tropical Cyclone Epidemiology

hurricaneexposure package

The hurricaneexposure R package: An open-source software to explore and map county-level hurricane exposure in the United States.

Key goals:

1. Incorporate measures of **different hazards** of each storm.
2. Create exposure data for tropical cyclones in the US at the **county level**.
3. Share the data in a way that is easy to use in a way that is **efficient** and **reproducible**.

Getting started with the hurricaneexposure package

We have an article in *Environmental Health Perspectives* that describes the data.

Research

A Section 508-conformant HTML version of this article
is available at <https://doi.org/10.1289/EHP6976>.

Assessing United States County-Level Exposure for Research on Tropical Cyclones and Human Health

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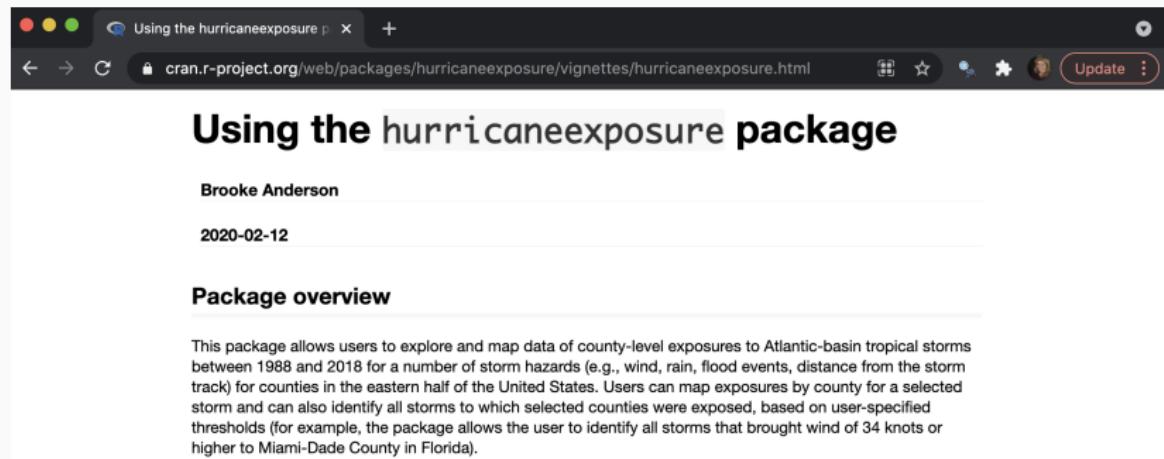
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<https://ehp.niehs.nih.gov/doi/pdf/10.1289/EHP6976>

Getting started with the hurricaneexposure package

We have an online tutorial that describes how to work with the data using the hurricaneexposure R package.

A screenshot of a web browser window. The title bar says "Using the hurricaneexposure p X". The address bar shows "cran.r-project.org/web/packages/hurricaneexposure/vignettes/hurricaneexposure.html". The page content is titled "Using the hurricaneexposure package" by Brooke Anderson on 2020-02-12. A section titled "Package overview" is visible, describing the package's purpose of exploring county-level exposures to tropical storms between 1988 and 2018.

Using the hurricaneexposure package

Brooke Anderson

2020-02-12

Package overview

This package allows users to explore and map data of county-level exposures to Atlantic-basin tropical storms between 1988 and 2018 for a number of storm hazards (e.g., wind, rain, flood events, distance from the storm track) for counties in the eastern half of the United States. Users can map exposures by county for a selected storm and can also identify all storms to which selected counties were exposed, based on user-specified thresholds (for example, the package allows the user to identify all storms that brought wind of 34 knots or higher to Miami-Dade County in Florida).

<https://cran.r-project.org/web/packages/hurricaneexposure/vignettes/hurricaneexposure.html>

Tropical cyclone hazards

HAZARDS SUMMARY

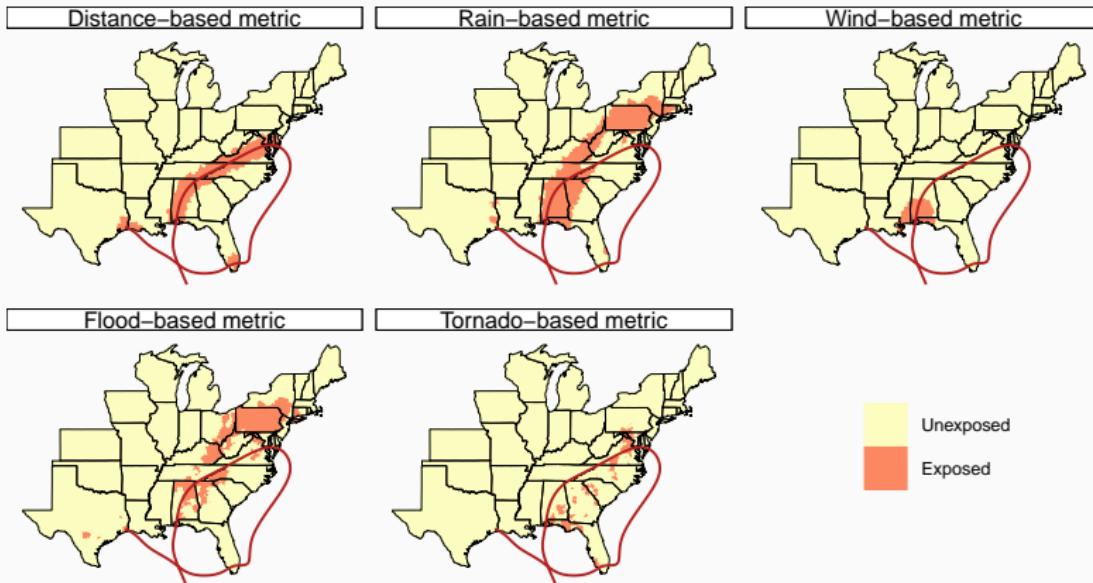
September 11, 2018 – 8AM

HURRICANE FLORENCE



HAZARD	DETAILS	IMPACTS	THREAT
Storm Surge	S of Cape Fear: 4-6' Cape Fear-Cape Lookout: 6-12' (Neuse & Pamlico Rivers) Cape Lookout-Ocracoke Inlet: 5-8' N of Ocracoke Inlet: 3-5'	Very dangerous inundation amounts are expected along the NC coast Thu-Sat.	Extreme
Inland Flooding	Portions of Eastern NC: 15-20+" Central/Eastern: 6-15" (Up to 30" along track)	Sig. threat to life and property, impassable roads; road wash-outs. Heavy rain will begin Thu and could continue through the weekend. Longer-term river flooding likely, and mountain landslides possible.	Extreme
Damaging Winds	Hurricane-Force winds are likely near the coast Tropical Storm-Force winds likely across much of state	Significant downed trees and widespread/prolonged power outages across the state; significant structure damage possible as Florence could make landfall as a Category 4 hurricane.	Extreme
Tornadoes	A few tornadoes are possible Thu and Fri, especially across eastern NC. Tornadoes in tropical systems are typically short-lived and weak.		Moderate
Marine & Coastal	Life-threatening surf and rip currents will continue for much of the week.		Extreme
Threat Levels:	None	Low	Moderate
	High	Extreme	

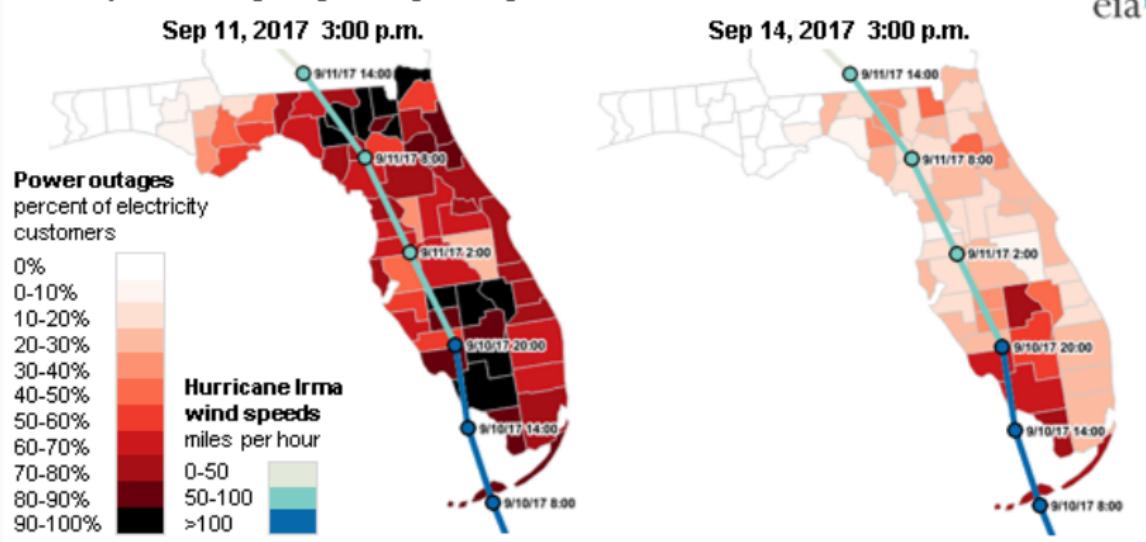
Different patterns in hazards



Alignment between weather and human impacts data

Human impacts data are often aggregated by **geopolitical boundaries**.

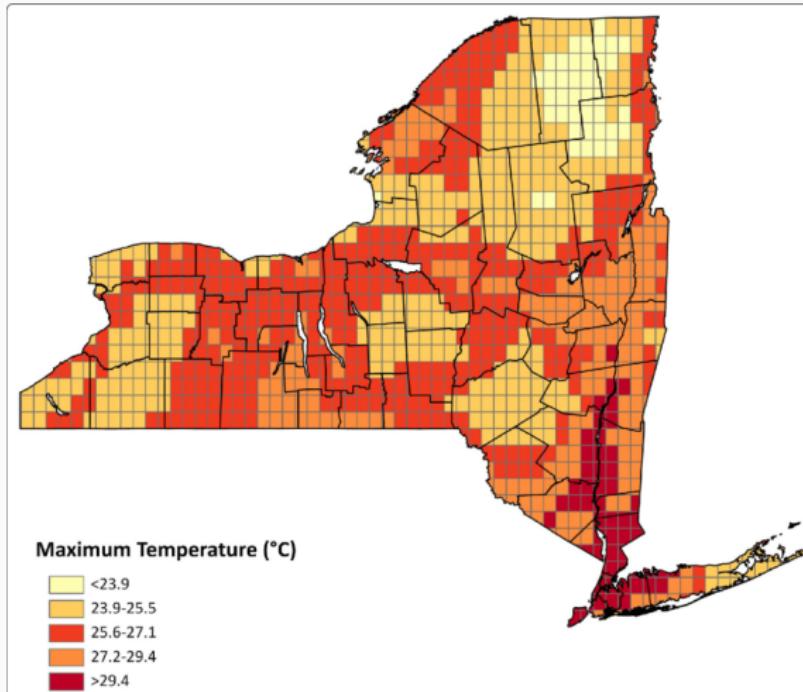
Florida power outages by county during Hurricane Irma



Source: US Energy Information Administration

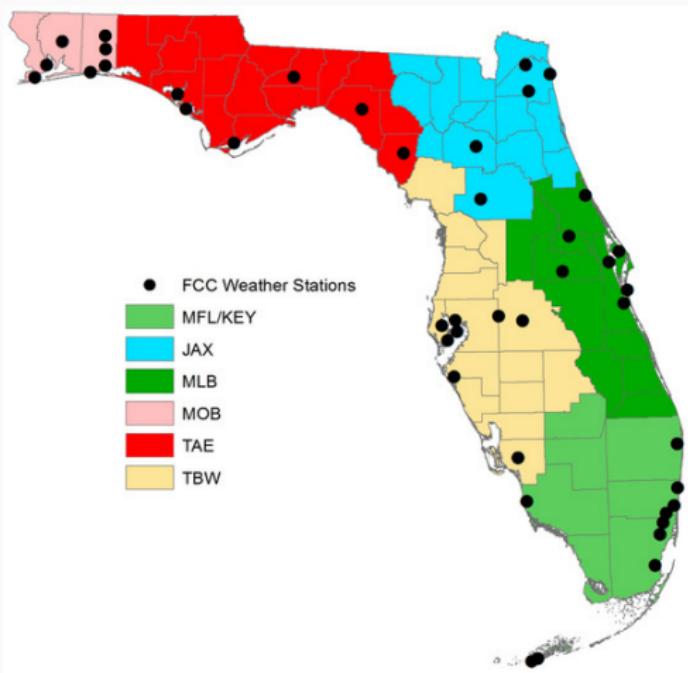
Alignment between weather and human impacts data

North American Land Data Assimilation System (NLDAS) 12-km grid of maximum temperature (C) in New York State for July 21, 2010.



Alignment between weather and human impacts data

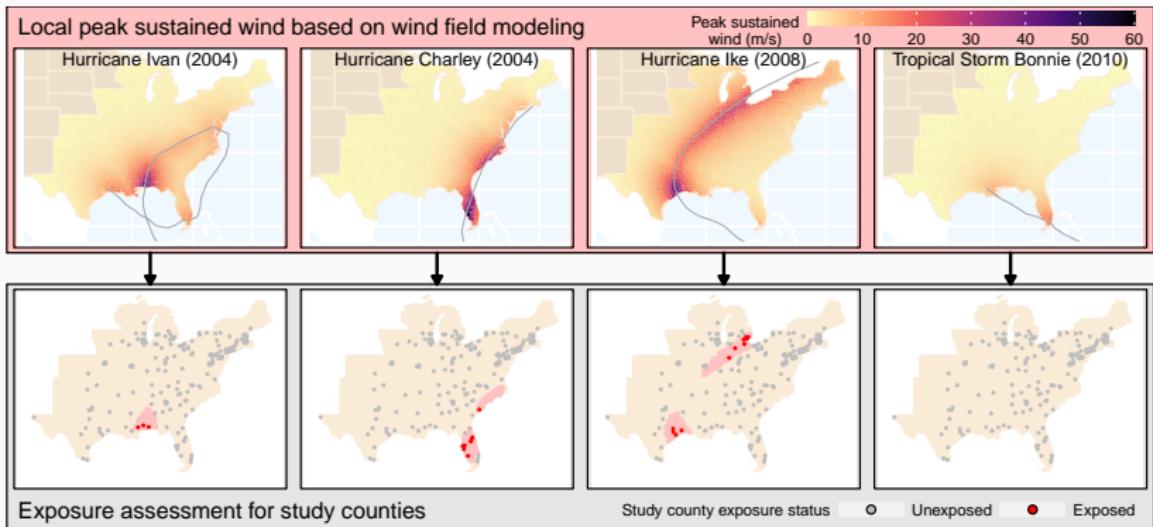
National Weather Service regions and locations of Florida Climate Center monitors within Florida.



Source: Learry et al., 2017

County-level exposure assessment

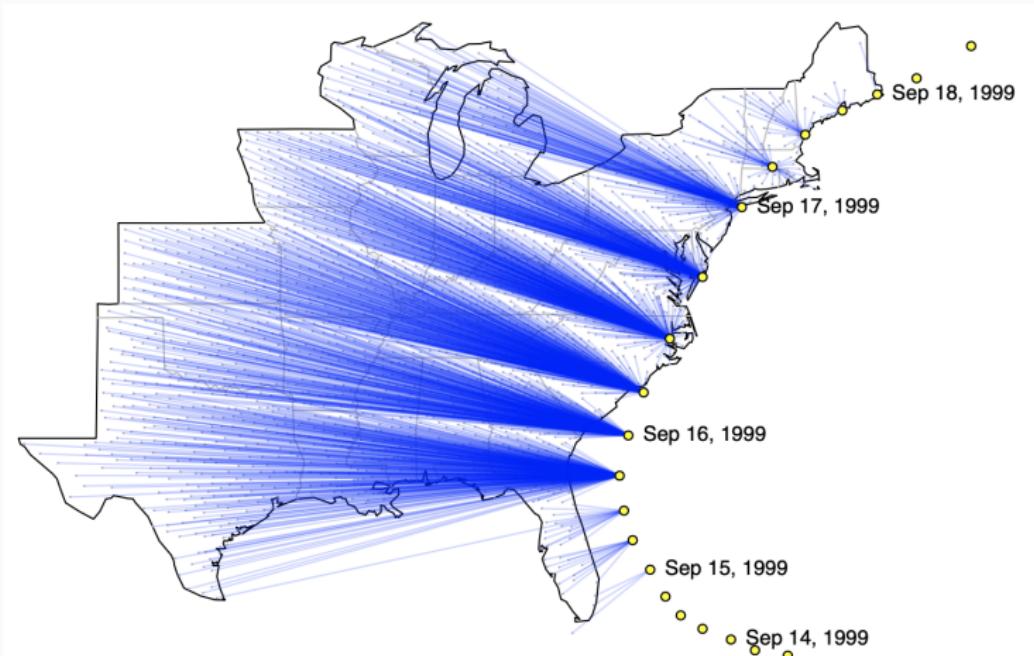
We used a wind model to assess county-level exposure.



Adapted from Yan et al., *Epidemiology*, 2021.

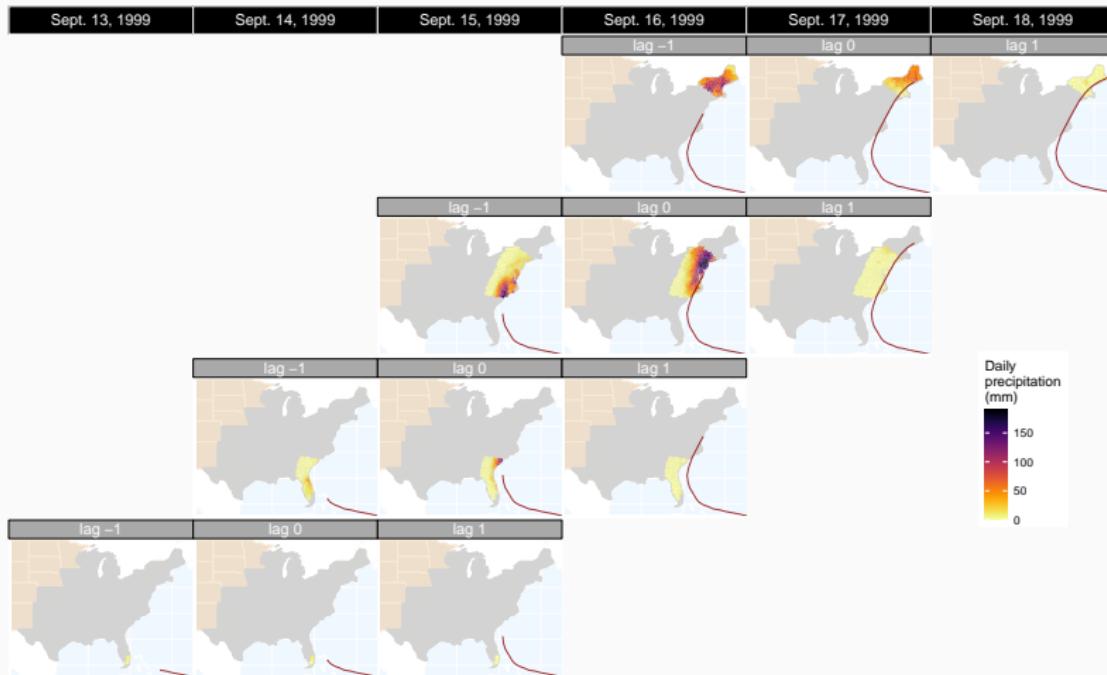
County-level exposure assessment

Identifying date of storm's closest approach to each county.



County-level exposure assessment

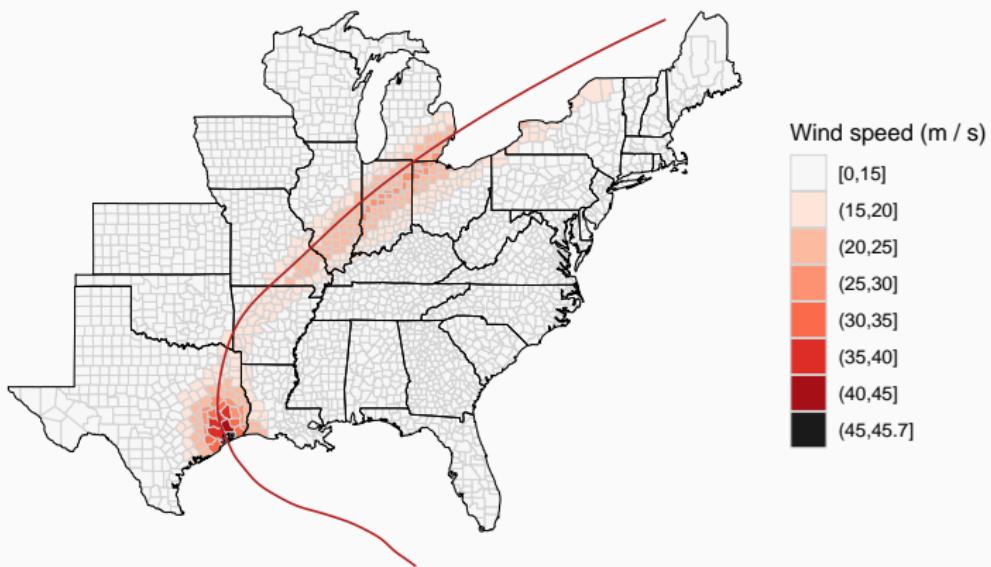
Precipitation during Hurricane Floyd, 1999, for three day windows surrounding the storm's closest approach to each county.



County-level exposure assessment

Use `map_counties` with `metric = "wind"` to map county-level peak sustained wind from a storm:

```
map_counties(storm = "Ike-2008", metric = "wind")
```



All wind exposures for a specific county

If you want to get values for a specific county, you can identify all exposures that match a certain threshold for those counties.

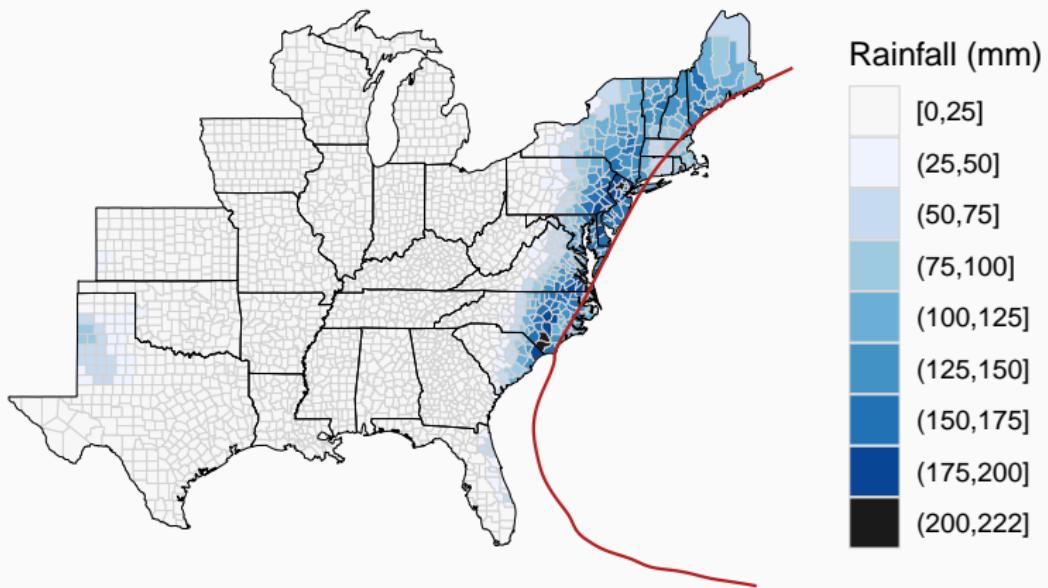
```
county_wind(counties = "12086", wind_limit = 17.5,  
            start_year = 1990, end_year = 2000)
```

```
##      storm_id  fips vmax_sust vmax_gust sust_dur gust_dur usa_atcf_id  
## 1: Andrew-1992 12086  56.60869  84.34695     615       960   AL041992  
## 2: Mitch-1998 12086  18.79781  28.00873      0       285   AL131998  
## 3: Harvey-1999 12086  23.01816  34.29706     75       285   AL101999  
## 4: Irene-1999 12086  31.88419  47.50744     615      1290   AL131999  
##      closest_time_utc storm_dist      local_time closest_date  
## 1: 1992-08-24 09:00    30.48032 1992-08-24 05:00  1992-08-24  
## 2: 1998-11-05 12:45   130.19217 1998-11-05 07:45  1998-11-05  
## 3: 1999-09-21 20:45   48.90460 1999-09-21 16:45  1999-09-21  
## 4: 1999-10-15 23:15   43.07201 1999-10-15 19:15  1999-10-15
```

County-level exposure assessment

The hurricaneexposure package can be used to map exposures for specific storms:

```
map_counties(storm = "Floyd-1999", metric = "rainfall")
```



County-level exposure assessment

The hurricaneexposure package can also be used to identify all exposures meeting specific criteria:

```
county_rain(counties = c("22071", "51700"), rain_limit = 100,  
            start_year = 1995, end_year = 2005, dist_limit = 100,  
            days_included = c(-1, 0, 1))  
  
##       storm_id   fips closest_date storm_dist tot_precip  
## 1: Bill-2003 22071 2003-06-30    47.74045    141.1  
## 2: Charley-2004 51700 2004-08-14    55.58752    136.2  
## 3: Cindy-2005 22071 2005-07-06    26.62602    113.2  
## 4: Floyd-1999 51700 1999-09-16    49.43163    207.5
```

Sharing data through an R package

1. Data access is **scripted**—easy to reproduce and adapt later.
2. Dataset is **versioned**—the version of the data package changes as the dataset is updated. The version number can be included as part of Methods section of studies.
3. Data can be **easily integrated** with other tools available through R. These include mapping and statistical tools.
4. Data creation is **documented and reproducible** on GitHub starting from public data and software.

Recent and ongoing research with this exposure assessment data

This tool is being used to study how tropical cyclone wind exposures are associated with:

1. Risk of pre-term birth
2. Risk of hospitalizations among Medicare beneficiaries
3. Risk of broad-cause mortality
4. Risk of death among those on dialysis

Future directions

1. Creating exposure datasets for human impacts data at other geopolitical spatial scales (e.g., ZIP codes).
2. Expand to measure some hazards outside the US.
3. Continue updates with new years of data.

Questions?



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