Package 'hurricaneexposure'

February 13, 2020

Type Package

Title Explore and Map County-Level Hurricane Exposure in the United States

Version 0.1.1

Date 2020-02-12

Description Allows users to create time series of tropical storm exposure histories for chosen counties for a number of hazard metrics (wind, rain, distance from the storm, etc.). This package interacts with data available through the 'hurricaneexposuredata' package, which is available in a 'drat' repository. To access this data package, see the instructions at <https://github.com/geanders/hurricaneexposure>. The size of the 'hurricaneexposuredata' package is approximately 20 MB. This work was supported in part by grants from the National Institute of Environmental Health Sciences (R00ES022631), the National Science Foundation (1331399), and a NASA Applied Sciences Program/Public Health Program Grant (NNX09AV81G).

URL `https://github.com/geanders/hurricaneexposure`

BugReports `https://github.com/geanders/hurricaneexposure/issues`

License GPL (>= 2)

LazyData TRUE

Imports data.table (>= 1.12.8), dplyr (>= 0.8.3), ggmap (>= 3.0.0), ggplot2 (>= 3.2.1), lazyeval (>= 0.2.2), lubridate (>= 1.7.4), mapproj (>= 1.2.6), maps (>= 3.3.0), purrr (>= 0.3.3), RColorBrewer (>= 1.1.2), rlang (>= 0.4.2), stringr (>= 1.4.0), tidyr (>= 1.0.0)

RoxygenNote 7.0.2

Encoding UTF-8

Depends R (>= 3.6)

Suggests hurricaneexposuredata (>= 0.1.0), knitr (>= 1.26.0), pander (>= 0.6.3), rmarkdown (>= 2.0.0), weathermetrics (>= 1.2.2)

VignetteBuilder knitr

Additional_repositories https://geanders.github.io/drat

Language en-US

NeedsCompilation no

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Repository CRAN

Date/Publication 2020-02-13 14:30:02 UTC

R topics documented:

`county_distance` *Hurricane exposure by distance for counties*

Space needed ↓

Description

This function takes a list of US counties,based on their 5-digit Federal Information Processing Standard (FIPS) codes, boundaries on the range of years to be considered, and thresholds for distance between each county and the storm track for the county to be considered "exposed" to the storm. Based on these inputs, the function returns a dataframe with the subset of Atlantic basin storms meeting those criteria for each of the listed counties.

Usage

```
county_distance(counties, start_year, end_year, dist_limit)
```

Arguments

`counties`	Character vector of the five-digit Federal Information Processing Standard (FIPS) codes for counties for which the user wants to determine storm exposure.
`start_year`	Four-digit integer with first year to consider.
`end_year`	Four-digit integer with last year to consider.
`dist_limit`	Maximum distance, in kilometers, of how close the storm track must come to the county's population mean center to classify the county as "exposed" to the storm.

Details

For more information on how distances between counties and storm tracks are calculated for this function, see the documentation for the `closest_dist` dataset that comes with this package.

Value

Space needed ↓

Returns a dataframe with a row for each county-storm pair and with columns for:

- `storm_id`: Unique storm identifier with the storm name and year, separated by a hyphen(e.g., "Alberto-1988", "Katrina-2005"). ← period needed
- `fips`: County's 5-digit Federal Information Processing Standard (FIPS) code
- `closest_date`: Date (based on local time) of the closest approach of the storm to the county's population mean center.
- `storm_dist`: Minimum distance (in kilometers) between the storm's track and the county's population mean center.
- `local_time`: Local time of the closest approach of the storm to the county's population mean center, based on storm tracks linearly interpolated to 15-minute increments.
- `closest_time_utc`: Time, in UTC, of the closest approach of the storm to the county's population mean center, based on storm tracks linearly interpolated to 15-minute increments.

Note

Only counties in states in the eastern half of the United States can be processed by this function.

Examples

```
# Ensure that data package is available before running the example.
#  If it is not, see the `hurricaneexposure` package vignette for details
# on installing the required data package.
if (requireNamespace("hurricaneexposuredata", quietly = TRUE)) {

  county_distance(counties = c("22071", "51700"),
              start_year = 1995, end_year = 2005,
              dist_limit = 75)

}
```

---

county_events *Find events for storms by county*

Description

Takes a list of US counties, based on their 5-digit Federal Information Processing Standard (FIPS) codes, boundaries on the range of years to be considered, and the type of event (e.g., "flood", "tornado") and returns a list of all storms with listings for that type of event for the counties. This output is based on listings in the NOAA Storm Events database. See the help documentation for the `storm_events` dataset for more information and references on the data source used by this function.

Usage

```
county_events(counties, start_year, end_year, event_type)
```

Arguments

`counties`	Character vector of the five-digit Federal Information Processing Standard (FIPS) codes for counties for which the user wants to determine storm exposure.
`start_year`	Four-digit integer with first year to consider.
`end_year`	Four-digit integer with last year to consider.
`event_type`	Character string with the type of event to use to identify county exposures. Options include `"flood"`, `"tornado"`, `"wind"`, and `"tropical_storm"`.

Value

Returns a dataframe with a row for each county-storm pair and with columns for:

- `fips`: County's 5-digit Federal Information Processing Standard (FIPS) code
- `storm_id`: Unique storm identifier with the storm name and year, separated by a hyphen (e.g., "Alberto-1988", "Katrina-2005")

period needed

- usa_atcf_id: United States Automated Tropical Cyclone Forecasting storm identifier.
- closest_time_utc: Time, in UTC, of the closest approach of the storm to the county's population mean center, based on storm tracks linearly interpolated to 15-minute increments.
- storm_dist: Minimum distance (in kilometers) between the storm's track and the county's population mean center.
- local_time: Local time of the closest approach of the storm to the county's population mean center, based on storm tracks linearly interpolated to 15-minute increments.
- closest_date: Date (based on local time) of the closest approach of the storm to the county's population mean center.

Note

Of the event types that this function can pull, only "tornado" and "wind" are available for years before 1996. Therefore, this function will pull listed tornado events or wind events for all years, but for any other event type, you should not use a start year prior to 1996, as events of other types were not recorded in the database before 1996.

Examples

```
# Ensure that data package is available before running the example.
#  If it is not, see the `hurricaneexposure` package vignette for details
# on installing the required data package.
if (requireNamespace("hurricaneexposuredata", quietly = TRUE)) {

county_events(counties = c("37031", "37053", "37055"),
              start_year = 1996, end_year = 2018,
              event_type = "flood")

county_events(counties = c("37055"),
              start_year = 1996, end_year = 2018,
              event_type = "tropical_storm")
}
```

---

county_rain *Hurricane exposure by rain for counties*

Description

This function takes a list of US counties, based on their 5-digit Federal Information Processing Standard (FIPS) codes, boundaries on the range of years to be considered, thresholds for distance between each county and the storm track, as well as minimum rainfall over a certain time window for the county to be considered "exposed" to the storm. Based on these inputs, the function returns a dataframe with the subset of Atlantic basin storms meeting those criteria for each of the listed counties.

Usage

```
county_rain(
  counties,
  start_year,
  end_year,
  rain_limit,
  dist_limit,
  days_included = c(-2, -1, 0, 1)
)
```

Not sure if this is important but looks like there is a space after their words and their commas

Arguments

counties	Character vector of the five-digit Federal Information Processing Standard (FIPS) codes for counties for which the user wants to determine storm exposure.
start_year	Four-digit integer with first year to consider.
end_year	Four-digit integer with last year to consider.
rain_limit	Minimum amount of rainfall, in millimeters, summed across the days selected to be included (days_included), that must fall in a county for the county to be classified as "exposed" to the storm.
dist_limit	Maximum distance, in kilometers, of how close the storm track must come to the county's population mean center to classify the county as "exposed" to the storm.
days_included	A numeric vector listing the days to include when calculating total precipitation. Negative numbers are days before the closest date of the storm to a county. For example, c(-1,0,1) would calculate rain for a county as the sum of the rainfall for the day before, the day of, and the day after the date when the storm center was closest to the county center. Values can range from -5 to 3 (i.e., at most, you can calculate the total rainfall from five days to three days after the day when the storm is closest to the county).

Is the days_included argument required for rain_limit, or will it select a default value if you don't specify?

Value

Space needed

Returns a dataframe with a row for each county-storm pair and with columns for:

- storm_id: Unique storm identifier with the storm name and year, separated by a hyphen(e.g., "Alberto-1988", "Katrina-2005"). ← period needed
- fips: County's 5-digit Federal Information Processing Standard (FIPS) code. ← period needed
- closest_date: Date (based on local time) of the closest approach of the storm to the county's population mean center.
- storm_dist: Minimum distance (in kilometers) between the storm's track and the county's population mean center.
- tot_precip: Cumulative rainfall, in millimeters, in the county for the days selected using the days_included option.
- local_time: Local time of the closest approach of the storm to the county's population mean center, based on storm tracks linearly interpolated to 15-minute increments.
- closest_time_utc: Time, in UTC, of the closest approach of the storm to the county's population mean center, based on storm tracks linearly interpolated to 15-minute increments.

References

Al-Hamdan MZ, Crosson WL, Economou SA, Estes MG, Estes SM, Hemmings SN, Kent ST, Puckette M, Quattrochi DA, Rickman DL, Wade GM, McClure LA, 2014. Environmental public health applications using remotely sensed data. Geocarto International 29(1):85-98.

North America Land Data Assimilation System (NLDAS) Daily Precipitation years 1979-2011 on CDC WONDER Online Database, released 2012. http://wonder.cdc.gov/wonder/help/Precipitation.html

Rui H, Mocko D, 2014. README Document for North America Land Data Assimilation System Phase 2 (NLDAS-2) Products. Goddard Earth Sciences Data and Information Services Center.

Examples

```
# Ensure that data package is available before running the example.
#  If it is not, see the `hurricaneexposure` package vignette for details
# on installing the required data package.
if (requireNamespace("hurricaneexposuredata", quietly = TRUE)) {

county_rain(counties = c("22071", "51700"),
            start_year = 1995, end_year = 2005,
            rain_limit = 100, dist_limit = 100)
}
```

`county_wind` *Hurricane exposure by wind for counties*

Not sure if a comma is needed between the 2 sets of parenthesis or not

Description

This function takes a list of US counties, based on their 5-digit Federal Information Processing Standard (FIPS) codes, boundaries on the range of years to be considered, and thresholds for wind speed (in meters per second) (or, alternatively, duration of winds at or above 20 m / s in minutes) for each county to be considered "exposed" to the storm. Based on these inputs, the function returns a dataframe with the subset of Atlantic basin storms meeting those criteria for each of the listed counties.

Usage

```
county_wind(
  counties,
  start_year,
  end_year,
  wind_limit,
  wind_var = "vmax_sust",
  wind_source = "modeled"
)
```

Arguments

counties	Character vector of the five-digit Federal Information Processing Standard (FIPS) codes for counties for which the user wants to determine storm exposure.
start_year	Four-digit integer with first year to consider.
end_year	Four-digit integer with last year to consider.
wind_limit	A numeric vector of length one giving the minimum wind speed (in meters per second) or duration of winds of 20 m / s or more (in minutes) to use in the filter. The units of this variable will depend on the user's choice for the wind_var parameter. If the Extended Best Tracks wind radii are used as the source of the wind data, the sustained winds will only be available for cutpoints of 34 knots, 50 knots, and 64 knots, so these values should be used (e.g., to get all counties with winds of 34 knots or higher, you could use wind_limit = 17.4, with the limit given as a value just below 34 knots in the units meters per second).
wind_var	A character string giving the wind variable to use. Choices are "vmax_sust" (maximum sustained winds; default), "vmax_gust" (maximum gust winds), "sust_dur" (minutes of sustained winds of 20 m / s or higher) and "gust_dur" (minutes of gust winds of 20 m / s or higher). If the Extended Best Tracks wind radii are used as the source of wind data, the "gust_dur" option cannot be selected.
wind_source	A character string specifying the source to use for the winds. Options are "modeled", for estimates based on running a wind model from Best Tracks data inputs, and "ext_tracks", for estimates based on the wind radii in the Extended Best Tracks data. See the help files for the datasets storm_winds and ext_tracks_wind in the hurricaneexposuredata package for more details on each of these sources for wind estimates. For the gust wind estimates, these are based on applying a gust factor of 1.49 to the sustained wind estimates in both wind data sources.

Details

For more information on how wind speeds are modeled in this data, see the documentation for the stormwindmodel R package.

Value

Returns a dataframe with a row for each county-storm pair and with columns for:

- storm_id: Unique storm identifier with the storm name and year, separated by a hyphen(e.g., "Alberto-1988", "Katrina-2005") .
- fips: County's 5-digit Federal Information Processing Standard (FIPS) code .
- max_sust: Maximum sustained wind speed (in m / s) .
- max_gust: Maximum gust wind speed (in m / s) .
- sust_dur: Minutes sustained wind speed was 20 m / s or higher .
- gust_dur: Minutes gust wind speed was 20 m / s or higher (only returned if the modeled winds are requested using wind_source) .

Space needed

periods needed?

- `usa_atcf_id`: United States Automated Tropical Cyclone Forecasting storm identifier
- `closest_time_utc`: Time, in UTC, of the closest approach of the storm to the county's population mean center, based on storm tracks linearly interpolated to 15-minute increments.
- `storm_dist`: Minimum distance (in kilometers) between the storm's track and the county's population mean center.
- `local_time`: Local time of the closest approach of the storm to the county's population mean center, based on storm tracks linearly interpolated to 15-minute increments.
- `closest_date`: Date (based on local time) of the closest approach of the storm to the county's population mean center.

Note

Only counties in states in the eastern half of the United States can be processed by this function. Winds are modeled at 15-minute increments, so all duration estimates (`sust_dur` and `gust_dur` in the output) will be divisible by 15.

Examples

```
# Ensure that data package is available before running the example.
#  If it is not, see the `hurricaneexposure` package vignette for details
# on installing the required data package.
if (requireNamespace("hurricaneexposuredata", quietly = TRUE)) {

county_wind(counties = c("22071", "51700"),
            start_year = 1988, end_year = 2005,
            wind_limit = 20, wind_var = "vmax_sust")
}
```

`default_map` *Create a default map with eastern US states*

Description

Creates a `ggplot` object with the underlying map of all states in the eastern section of the US that might be prone to hurricane-related exposure. Other lines and points can be added to the output using `ggplot2` plotting functions.

↑ exposures (plural)?

Usage

```
default_map()
```

Details

Only states in the eastern half of the United States (i.e., ones prone to exposure to Atlantic basin tropical storms) are included on this map.

Value

A ggplot object that maps the states of the Eastern United States

Examples

```
default_map()
```

`distance_exposure` *Write storm distance exposure files*

Description

This function takes an input of locations (either a vector of county FIPS or a dataframe of multi-county FIPS, with all FIPS listed for each county) and creates a dataframe with storm listings and dates that can be merged with time series of health or other outcomes, giving the dates and exposures for all storms meeting the given storm distance criteria.

Usage

```
distance_exposure(
  locations,
  start_year,
  end_year,
  dist_limit,
  out_dir,
  out_type = "csv"
)
```

Arguments

`locations`	Either a vector of FIPS county codes, for county-level output, or a dataframe with columns for community identifier (`commun`) and associated FIPS codes (`fips`), for multi-county community output. See the examples for the proper format for this argument.
`start_year`	Four-digit integer with first year to consider.
`end_year`	Four-digit integer with last year to consider.
`dist_limit`	Maximum distance, in kilometers, of how close the storm track must come to the county's population mean center to classify the county as "exposed" to the storm. ← 1 word or 2 words?
`out_dir`	Character string giving the pathname of the directory in which to write output. This directory should already exist on your computer.
`out_type`	Character string giving the type of output files you'd like. Options are `"csv"` (default) and `"rds"`.

Value

Writes out a directory with rain exposure files for each county or community indicated. For more on the columns in this output, see the documentation for `county_rain` and `multi_county_rain`.

Examples

```
## Not run:
# Ensure that data package is available before running the example.
#  If it is not, see the `hurricaneexposure` package vignette for details
# on installing the required data package.
if (requireNamespace("hurricaneexposuredata", quietly = TRUE)) {

# For these examples to work, you will need to have a directory called "tmp"
# as a subdirectory of your home directory. These examples will create new
# directories with exposure output to that "tmp" directory.

# By county
distance_exposure(locations = c("22071", "51700"),
              start_year = 1995, end_year = 2005,
              dist_limit = 75,
              out_dir = "~/tmp/storms")

# For multi-county communities
communities <- data.frame(community_name = c(rep("ny", 6), "no", "new"),
                          fips = c("36005", "36047", "36061",
                          "36085", "36081", "36119",
                          "22071", "51700"))
distance_exposure(locations = communities,
              start_year = 1995, end_year = 2005,
              dist_limit = 75,
              out_dir = "~/tmp/storms")
}

## End(Not run)
```

`events_exposure` *Write storm events exposure files*

Description

This function takes an input of locations (either a vector of county FIPS or a dataframe of multi-county FIPS, with all FIPS listed for each county) and creates a dataframe with storm listings and dates that can be merged with time series of health or other outcomes, giving the dates and exposures for all storms meeting the given storm events criteria.

Usage

```
events_exposure(
  locations,
```

```
  start_year,
  end_year,
  event_type,
  out_dir,
  out_type = "csv"
)
```

Arguments

locations	Either a vector of FIPS county codes, for county-level output, or a dataframe with columns for community identifier (commun) and associated FIPS codes (fips), for multi-county community output. See the examples for the proper format for this argument.
start_year	Four-digit integer with first year to consider.
end_year	Four-digit integer with last year to consider.
event_type	Character string with the type of event to use to identify county exposures. Options include "flood", "tornado", "wind", and "tropical_storm".
out_dir	Character string with the filepath to the directory where the data will be saved. ← period needed
out_type	Character string with the type of file to save to. Options are "csv" for a comma-separated file (default) and "rds" for an R object file.

Value

Writes out a directory with rain exposure files for each county or community indicated. For more on the columns in this output, see the documentation for county_rain and multi_county_rain.

Examples

```
## Not run:
# Ensure that data package is available before running the example.
#  If it is not, see the `hurricaneexposure` package vignette for details
# on installing the required data package.
if (requireNamespace("hurricaneexposuredata", quietly = TRUE)) {

# To run this example, you will need to have a directory named "tmp"
# as a subdirectory of your home directory.

# By county
events_exposure(locations = c("22071", "51700"),
                start_year = 1995, end_year = 2005,
                event_type = "flood",
                out_dir = "~/tmp/storms")
                }

## End(Not run)
```

`filter_storm_data` *Filter hurricane datasets*

Description

This function is a helper function for many of the the other functions in this package that measure exposure.

Usage

```
filter_storm_data(
  counties = NULL,
  storm = NULL,
  year_range = NULL,
  distance_limit = NULL,
  rain_limit = NULL,
  include_rain = FALSE,
  days_included = NULL,
  output_vars = c("fips")
)
```

Arguments

`counties`	A character vector listing all 5-digit county FIPS codes for a subset of counties.
`storm`	A character string giving the storm ID (e.g., "Floyd-1999").
`year_range`	A numeric vector of length two with the starting and ending year to subset to.
`distance_limit`	A numeric vector of length one giving the maximum distance (in kilometers) to use in the filter.
`rain_limit`	A numeric vector of length one giving the minimum rain (in millimeters) to use in the filter.
`include_rain`	A logical specifying whether to pull in rain data to use in the filter or give as output (default is FALSE).
`days_included`	A numeric vector giving the lag numbers for days to include when calculating the total rain over the storm period (e.g., `c(-1,0,1,2)` would calculate the rain from the day before the storm until two days after the storm). Values in this vector cannot be lower than -3 or higher than 3.
`output_vars`	A character vector listing all the columns to include in the output.

Value

A dataframe with storms filtered based on the input criteria to the function. Columns in the output will vary depending on the user's selections for the `output_vars` argument.

Examples

```
# Ensure that data package is available before running the example.
#  If it is not, see the `hurricaneexposure` package vignette for details
# on installing the required data package.
if (requireNamespace("hurricaneexposuredata", quietly = TRUE)) {

filter_storm_data(counties = c("22071", "51700"), year_range = c(1988, 2011),
                  distance_limit = 250, rain_limit = 150,
                  include_rain = TRUE, days_included = c(-1, 0, 1),
                  output_vars = c("fips", "storm_id", "closest_date",
                                  "storm_dist", "tot_precip"))
filter_storm_data(storm = "Floyd-1999", include_rain = TRUE,
                  days_included = c(-1, 0, 1),
                  output_vars = c("fips", "tot_precip"))
}
```

`filter_wind_data` *Filter hurricane wind dataset*

Description

This function is a helper function for many of the the other functions in this package that measure wind exposure.

Usage

```
filter_wind_data(
  counties = NULL,
  storm = NULL,
  year_range = NULL,
  wind_limit = NULL,
  output_vars = "fips",
  wind_var = "vmax_sust",
  wind_source = "modeled"
)
```

Arguments

`counties`	A character vector listing all 5-digit county FIPS codes for a subset of counties.
`storm`	A character string giving the storm ID (e.g., "Floyd-1999"). ← period needed
`year_range`	A numeric vector of length two with the starting and ending year to subset to.
`wind_limit`	A numeric vector of length one giving the minimum wind speed (in meters per second) or duration of winds of 20 m / s or more (in minutes) to use in the filter. The units of this variable will depend on the user's choice for the `wind_var` parameter. If the Extended Best Tracks wind radii are used as the source of the wind data, the sustained winds will only be available for cutpoints of 34 knots, 50 knots, and 64 knots, so these values should be used (e.g., to get all counties

with winds of 34 knots or higher, you could use `wind_limit = 17.4`, with the limit given as a value just below 34 knots in the units meters per second).

`output_vars` A character vector listing all the columns to include in the output.

`wind_var` A character string giving the wind variable to use. Choices are `"vmax_sust"` (maximum sustained winds; default), `"vmax_gust"` (maximum gust winds), `"sust_dur"` (minutes of sustained winds of 20 m / s or higher) and `"gust_dur"` (minutes of gust winds of 20 m / s or higher). If the Extended Best Tracks wind radii are used as the source of wind data, the `"gust_dur"` option cannot be selected.

`wind_source` A character string specifying the source to use for the winds. Options are `"modeled"`, for estimates based on running a wind model from Best Tracks data inputs, and `"ext_tracks"`, for estimates based on the wind radii in the Extended Best Tracks data. See the help files for the datasets `storm_winds` and `ext_tracks_wind` in the `hurricaneexposuredata` package for more details on each of these sources for wind estimates. For the gust wind estimates, these are based on applying a gust factor of 1.49 to the sustained wind estimates in both wind data sources.

Value

A dataframe with storms filtered based on the input criteria to the function. Columns in the output will vary depending on the user's selections for the `output_vars` argument.

Examples

```
# Ensure that data package is available before running the example.
#  If it is not, see the `hurricaneexposure` package vignette for details
# on installing the required data package.
if (requireNamespace("hurricaneexposuredata", quietly = TRUE)) {

filter_wind_data(counties = c("22071", "51700"), year_range = c(1988, 2011),
                 wind_limit = 20,
                 output_vars = c("fips", "storm_id", "vmax_sust"))
}
```

Should Eastern be capitalized?

`get_eastern_map` *Get map data for eastern US states*

Description

Get map data for eastern US states

Usage

```
get_eastern_map(map = "county")
```