Indicators and Data

An environmental public health indicator provides information about a population's health status with respect to environmental factors. Tracking Indicators were developed in collaboration with national, state, and local environmental health partners. Here you can access detailed information about each indicator available on the Tracking Network.

Content Area: View Data Explorer

Heat & Heat-related Illness (HRI)

Indicator:

Historical Temperature & Heat Index

Type of EPHT Indicator	Climate Change
Measure(s)	1. Number of Extreme Heat Days 2. Dates of Extreme Heat Days 3. Number of Extreme Heat Events 4. Dates of Extreme Heat Events 5. Daily Estimates of Maximum Temperature for Summer Months (May-September) 6. Daily Estimates of Maximum Heat Index for Summer Months (May–September) 7. Weekly Average Maximum Temperature

| **Derivation of Measure(s)** | **Measures 1 – 6:** |

These measures are derived from estimates of air temperature (K) at 2 meters above the surface, specific humidity (kg/kg) at 2 meters above the surface, and surface pressure (Pa) from Forcing File A of Phase 2 of the North American Land Data Assimilation System (NLDAS-2). NLDAS-2 is available at the 1/8th-degree grid (approximately 14x14 km) and consists of 103,936 grid cells that cover the entire United States, excluding Alaska and Hawaii.

The gridded raw data were summarized to the U.S. county or census tract level to aid in estimating population exposure to high temperature and heat index conditions and to enable linkage with health-related datasets. To accomplish this, U.S. census block group centroids were attributed to individual NLDAS grid cells based on a containment relationship. Maximum daily temperature and heat index were determined for each block group by identifying the maximum hourly value for each day. Using census block group population as weights, population-weighted averages by U.S. county and census tract were calculated.

Heat index was estimated using a modified version of the Rothfusz regression as implemented by the National Weather Service [1]. Relative humidity (needed for heat index calculation) was calculated from specific humidity data acquired from NLDAS-2 using the Wexler saturated water vapor pressure equation [2].

The 90th, 95th, 98th, and 99th percentile values of the daily heat metrics were determined for each county and census tract for the period between 1979 and 2019 (May – September values only). Extreme heat days are classified according to the following thresholds: (1) absolute (e.g., 90°F, 95°F, 100°F, 105°F) and (2) relative (e.g., 90th, 95th, 98th, and 99th percentile) values.

Extreme heat events are periods in which an absolute or relative threshold is surpassed for a duration of at least 2 or 3 consecutive days (specific value can be selected in the advanced options). Annual values for extreme heat events represent the total number of days in which an extreme heat event was ongoing.

Measure 7:

This measure is derived from the National Oceanic and Atmospheric Administration's (NOAA's) National Centers for Environmental Information (NCEI) nCLIMGRID dataset (https://www1.ncdc.noaa.gov/pub/data/daily-grids/). The dataset contains 5km gridded fields of daily maximum, minimum, and average temperature and daily precipitation amount for the contiguous United States between January 1, 1951 and the present.

Gridded maximum temperature data are ingested and converted to the Fahrenheit scale each day. A 7-day average is then generated for each grid cell in the contiguous United States (Alaska and Hawaii data are not available). The 7 days chosen to generate the average reflect the latest Morbidity and Mortality Weekly Report (MMWR) week (https://wwwn.cdc.gov/nndss/document/MMWR_week_overview.pdf). All 7

days must be available before an average is taken. The 7-day averages are then aggregated to U.S. counties, using a point-in-polygon approach. The measure is updated weekly.

For more information on the nCLIMGRID dataset, refer to this document: https://www1.ncdc.noaa.gov/pub/data/daily-grids/docs/nclimdiv-description.pdf

Unit	1. Temperature (degrees Fahrenheit) 2. Heat index (degrees Fahrenheit) 3. Days
Geographic Scope	State and National
Geographic Scale	**Measures 1-6:** Census Tract, County **Measure 7:** County
Time Period	**Measures 1-6:** 1979 - ongoing **Measure 7:** 2017 -ongoing
Time Scale	**Measures 1-6:** Annual, summer months (May-September) **Measure 7:** Weekly
Rationale	High ambient temperatures can lead to negative health outcomes such as heat cramps, heat exhaustion, heat syncope, and heat stroke [3]. Monitoring health conditions associated with extreme heat requires temperature and relative-humidity data at highly resolved spatio-temporal scales. Though reliable temperature and relative-humidity data are available from National Weather Service Office weather stations, these stations are designed to provide climatologic observations and many are far from population centers. NLDAS provides modeled, quality controlled, spatially and temporally continuous meteorological data covering the entirety of the United States, except Alaska and Hawaii.
Use of the Measure(s)	Monitoring spatial and temporal patterns of extreme heat and temperature.

Limitations of the Measure(s)	**Measures 1-6:** • Modeled data perform relatively well in estimating meteorological variables [2]; however, the estimates may differ when compared to weather station-based observations. • Census tract and county level estimates are obtained by processing modeled data, which are available within a 1/8th degree grid. The process of converting grid-level data to census tract and county-level estimates using census block group centroids may lead to misclassification in some areas. • Individuals may have varying degrees of acclimatization to climate conditions. Therefore, these data may not reflect what is perceived as extreme across all geographic regions. **Measure 7:** • The nCLIMGRID data are not published in real-time. There is a lag of at least 3 days of availability.
Data Source(s)	• Forcing File A of Phase Two of the North American Land Data Assimilation System (NLDAS-2) • NLDAS-2 Forcing Dataset Inforamtion: https://ldas.gsfc.nasa.gov/nldas/v2/forcing [4] • Gridded 5km GHCN – Daily Temperature and Precipitation Dataset (nCLIMGRID) - Gridded 5km GHCN-Daily Temperature and Precipitation Dataset, Version 1 (noaa.gov) [5]
Limitations of Data Source(s)	NLDAS modeled meteorological data may not accurately reflect the true maximum air temperature and heat index in all locations. The nCLIMGRID dataset is a public beta release and not considered operational under NCEI procedures. The dataset needs to pass requirements under the auspices of the NCEI Operational Readiness Review (ORR), which includes methods published in a peer-reviewed journal.
Related Indicator(s)	Vulnerability & Preparedness: Heat Heat-related Emergency Department Visits Heat-related Hospitalizations Heat-related Mortality Temperature & Heat Projections Historical Precipitation Precipitation & Flooding Projections Vulnerability & Preparedness: Precipitation & Flooding

Reference(s)

1. Heat Index Equation. The National Weather Service. Last modified May 2014. https://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml

2. Cosgrove, B. A., Lohmann, D., Mitchell, K. E., Houser, P. R., Wood, E. F., Schaake, J. C., … & Luo, L. (2003). Real-time and retrospective forcing in the North American Land Data Assimilation System (NLDAS) project. Journal of Geophysical Research: Atmospheres, 108(D22).

3. McGeehin, M. A., & Mirabelli, M. (2001). The potential impacts of climate variability and change on temperature-related morbidity and mortality in the United States. Environmental health perspectives, 109(suppl 2), 185-189.

4. NLDAS Land Data Assimilation Systems: NLDAS-2 Forcing Dataset Information. (2020, February) Retrieved from: https://ldas.gsfc.nasa.gov/nldas/v2/forcing

5. Vose, Russell S., Applequist, Scott, Squires, Mike, Durre, Imke, Menne, Matthew J., Williams, Claude N. Jr., Fenimore, Chris, Gleason, Karin, and Arndt, Derek (2014): Gridded 5km GHCN-Daily Temperature and Precipitation Dataset (nCLIMGRID), Version 1. NOAA National Centers for Environmental Information. DOI:10.7289/V5SX6B56

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