CalHeatScore Methods Documentation

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Table of Contents

Introduction

California, like most regions around the globe, is experiencing an increase in the frequency, duration, and intensity of extreme heat events compared with historical climate conditions (IPCC, 2021; USGCRP, 2023). Heat waves put people at risk of adverse health effects, including serious heat-related illnesses and even death (Ebi *et al.*, 2021). In response, California has been exploring how to best prepare for the increased burdens associated with these extreme heat events. In 2021, the California Department of Insurance - Climate Insurance Working Group published a comprehensive report on recent notable climate events, associated impacts on communities, and recommendations for improving climate resilience to wildfires, floods, and extreme heat (California, 2021b). Following this report, the legislature and Governor of California signed a new law, Assembly Bill 2238 (L. Rivas, 2022), to establish a statewide extreme heat ranking system called CalHeatScore. AB2238 mandates the CalHeatScore ranking system be operational and public facing by January 1, 2025.

In response to AB2238, on behalf of the California Environmental Protection Agency, the Office of Environmental Health Hazard Assessment (OEHHA) has led the development of CalHeatScore. OEHHA's mission is to protect and enhance the health of California's people and environment through scientific evaluations that inform, support, and guide regulatory and other actions. The development of CalHeatScore was conducted in collaboration with state agencies: California's Office of Emergency Services, the Department of Insurance, Department of Public Health, and the Governor's Office of Land Use and Climate Innovation. In consultation with OEHHA, the University of California Los Angeles – Center for Healthy Climate Solutions developed the underlying model used in CalHeatScore with collaborators from Oregon State University and Applied Climatologists, Inc.

CalHeatScore (CHS) is a web tool that uses a heat-health ranking system to provide information on local and regional extreme heat events in California. The purpose of CHS is to assist individuals and communities in preparing for extreme heat and ultimately reduce heat-related health impacts for those most vulnerable to heat. CHS translates weather information into easy-to-understand heat scores ranging from 0 to 4 to indicate levels of human health risk from low to severe. These scores are displayed on the web tool along with supplementary community and demographic information. CHS is updated daily, incorporating current temperature forecasts to indicate the severity of upcoming extreme heat events based on historical health responses to heat. The ranges for the heat scores are calculated for individual zip codes as the historical health data are available at the zip code level.

This document provides descriptions of the methods used to inform the development of the CHS ranking approach and supplementary information on the tool's dashboard. The following sections include descriptions of the climate and health data sources used; the main regression equation used to quantify heat-health impacts to inform the ranking scheme; and detailed information regarding supplementary community and demographic data sources, such as the location of cool centers, incorporated into the tool. This document also provides a brief discussion of future areas of research relevant for the continued development of the webtool.

The current version of the web tool can be accessed here: CalHeatScore Tool.

Methods

The CHS ranking system is based on estimated historical relationships between climate conditions and human health across California. The climate and health datasets described below are used to quantify these relationships at the California zip code level. Temperature ranges based on these relationships are then used to establish rankings that describe different levels of heat-related health risks.

Climate

Data

The climate datasets used for the development and operations of the CHS ranking system includes historical climate data and weather forecasts. Below are more details on the datasets used.

Historical Climate

To represent historical climate conditions in locations across California, CHS uses GridMET, which is a daily 1/24th degree (~4 km) resolution gridded surface meteorological dataset that provides data from 1979 to near-present day (Abatzoglou, 2013). Daily near-surface air temperature and relative humidity are used in the calculation of historical daily maximum apparent temperature. More information on GridMET can be found at the GridMET dataset provider website.

Weather Forecasts

CHS reads in gridded forecasts from the National Weather Service (NWS) National Digital Forecast Database (NDFD) for each zip code in California. The NWS NDFD provides 2.5 km resolution digital gridded forecasts from local NWS weather forecast offices in collaboration with a national blend of forecast models (Glahn and Ruth, 2003). Hourly apparent temperature is used in the calculation of forecasted daily maximum apparent temperature. More information about NDFD data can be accessed at the NOAA NDFD webpage.

Calculations

Zip code-level historical climate conditions and weather forecasts are retrieved from the nearest grid cell to the population-weighted or geometric centroid of the zip code. These centroids are based on a combination of the 2023 Housing and Urban Development zip code population-weighted centroids (HUD, 2023; HUD Open Data Site, accessed January 2024), 2020 US census ZCTA polygons (Census, 2020; 2020 TIGER/Line® Shapefiles, accessed September 2024), and the zip code polygons from the CA state geoportal, last updated in 2021 (California, 2021a; California State Geoportal), accessed September 2024). Population-weighted centroids are used whenever possible based on quality and availability, and geometric centroids are used for the remaining zip codes. Zip code centroids that were biased due to having at least a 20 percent overlap with the ocean were moved to the nearest inland grid cell. The final list consists of one centroid per zip code.

Maximum apparent temperature (AT) is used to characterize daily heat conditions at the zip code-level. AT, which is often referred to as the heat index in warm conditions, quantifies how current temperature conditions feel to the human body. AT considers weather variables such as air temperature, relative humidity, and wind speed. Depending on these variables, AT can be higher or lower than the surrounding air temperature. The current implementation of CHS uses the NOAA NWS implementation of AT (the heat index).

Human Health

Data

Emergency Department (ED) Visits

The California Department of Health Care Access and Information (HCAI) maintains a dataset of ED encounters from hospitals licensed to provide emergency medical services across the state. This dataset includes patients' medical records along with other personal health information, such as demographic information and health insurance details, and is therefore bound by the provisions of the Health Insurance Portability and Accountability Act (HIPAA). As such, this data is only available to specified entities after an extensive review process.

We analyzed ED visits in California obtained from HCAI's Emergency Department dataset using records from 2016-2018. It is important to note that when an ED encounter leads to an admission to the same hospital, that record is maintained as a hospital inpatient record and is not included in the ED visits dataset. Thus, only encounters that began and ended in the ED are included. This dataset is used to calculate the daily number of ED visits in California due to heat-related illnesses (HRI), by zip code. HRI are defined with the following ICD10 diagnostic codes: dehydration (E86); acute and chronic kidney failure (N17-N19); and heat illness and heat stroke (T67) (Basu *et al.*, 2012). The definition of HRI may expand in future versions of CHS. For each California zip code, the residential zip code of each ED patient and zip code-specific population estimates are used to calculate the daily heat-related illness rate per 10,000 people.

Heat-Health Model

To determine zip code-specific temperature thresholds for individual rankings, the current CHS approach employs a spatiotemporal Poisson regression model developed by the University of California, Los Angeles – Center for Healthy Climate Solutions and collaborators from Oregon State University and Applied Climatologists, Inc.[1] The model relies on historical climate and health data, as well as other covariates including:

- Climate zones[2]: to incorporate historical similarities of zip code-level climate conditions into the model;
- Year: to account for annual variation;
- Day of the year: to capture seasonal trends; and
- Day of the week: to account for differences in trends that may be due to the day of the week on which an event occurs.

[1] Poisson regression is used when the outcome variable is a count, such as the expected number of ED visits. This regression model assumes that the number of daily ED visits has a Poisson distribution.
[2] Thirty climate zones across California were constructed based on daily mean apparent temperature from May-October 2021-2022 data from the ECMWF (European Center for Medium-Range Weather Forecasts) Reanalysis v5 dataset (ERA5) (Hersbach et al. 2020). See Figure A1 in the Appendix for more detail.

The heat-health relationship is represented as:

$$\log(\lambda_i) = \beta_{0,z_i} + f(cz) + year.fct_i + f(\mathrm{doy}_i) + \mathrm{dow.fct}_i + \beta_{1,z_i}\mathrm{heat}_i + f(\mathrm{heat}_i)$$

λ_i: Expected number of ER visits for observation i;
β_{0,z_i}: Intercept (baseline ED visit rate), with spatial smoothing[3], for observation i in zip code z;
f(cz): Unstructured random effect[4] on climate zones with independent identically distributed model;
$\mathrm{year.fct}_i$: Fixed effect[5] for the year;
$f(\mathrm{doy}_i)$: Random walk[6] of order 1 to capture seasonal trends throughout the year;
$\mathrm{dow.fct}_i$: Categorical fixed effect for the day of the week;
$\beta_{1,z_i}\mathrm{heat}_i$: Interaction between zip code and heat (daily maximum AT) to model the effect of heat exposure with spatial smoothing;
$f(\mathrm{heat}_i)$: Random walk on heat (daily maximum AT) to capture temporal trends.

This heat-health model quantifies the relationship between daily maximum AT (°F) (heat_i) and the daily number of daily ED visits (λ_i). Using the model output, the Relative Risk (RR) is calculated, describing the relative change in ED visit rate for a given day and zip code compared to average conditions.

To calculate the RR for any given day and zip code, the modeled ED visit rate for that day (λ_{doy_i,z_i}) is divided by the modeled average ED visit rate across all days in the study period ($\overline{\lambda_{doy_i,z_i}}$):

$$Relative\ Risk = \lambda_{doy_i,z_i} / \overline{\lambda_{doy_i,z_i}}$$

If there is no difference between the modeled daily and average ED visit rates, then RR = 1. RR values above 1 indicate an increased relative risk of heat-related ED visits, while RR values below 1 indicate a reduced relative risk of ED visits. RRs below 1 can occur when observed ED visits fall below the expected number of visits for any given day and zip code.

In summary, we obtained a RR value and a corresponding maximum AT value for every day within the time frame of the analysis (May-Oct 2016-2018) for each zip code.

Temperature Thresholds

Using the historical RR values described above, zip code-level relationships were developed between daily RRs and maximum apparent temperature values. For all zip codes, the relationship between maximum apparent temperatures and RR values was modeled with a fitted quartic polynomial equation. Then, maximum apparent temperature values corresponding to specific RR values from the fitted equation were used to delineate the different CHS ranks for

[3] Spatial smoothing is an approach that uses neighboring values to smooth values to reduce noise due to small population size or low data availability.
[4] Random effects are used to broadly incorporate variations and differences in groups into statistical models.
[5] Fixed effects are used to treat specific factors as constants in statistical models.
[6] Random walks are stochastic processes that can describe factors with gradual changes (e.g., ED visits).

each zip code. Below, **Figure 1** shows an example of the RR and apparent temperature values for an individual zip code.

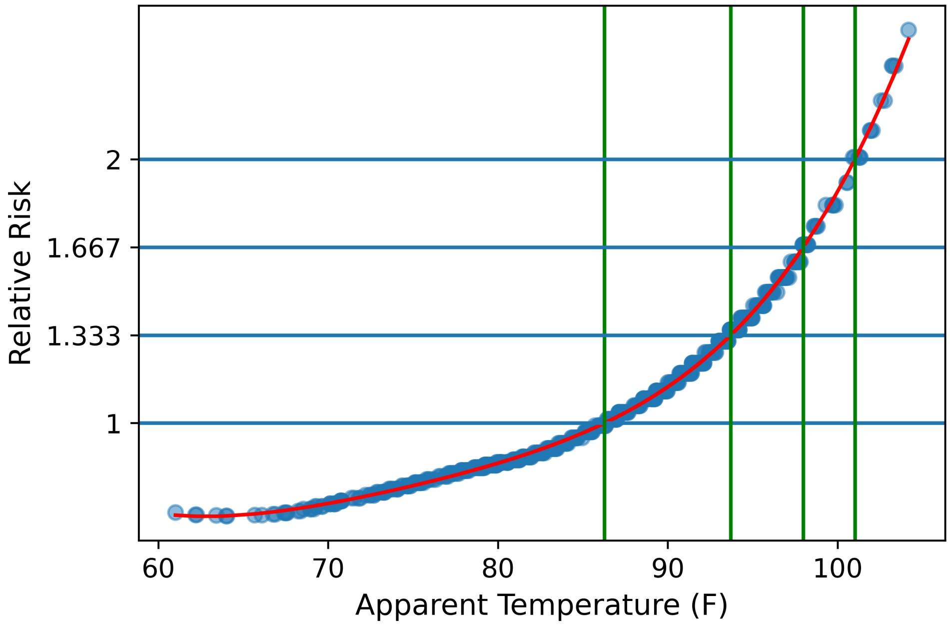

Figure 1. Relationship between apparent temperature and relative risk for an example zip code. Values for each day from May-October 2016-2018 are shown as points and the fitted polynomial equation is shown in red. The horizontal blue lines denote RR at 1, 1.333, 1.667, and 2. The vertical green lines denote the corresponding maximum apparent temperature at those RR values.

CHS uses 33.3% (RR = 1.333), 66.7% (RR = 1.667), and 100% (RR = 2.0) relative increases in ED visit rates to break daily heat conditions into different ranks. Below, **Table 1** describes the RR values that correspond to CHS of 0-4.

Table 1. CalHeatScore ranks and the corresponding relative risk (RR) values.

CalHeatScore (CHS) Rank	Corresponding RR ranges
CHS 0	0 < RR ≤ 1
CHS 1	1 < RR ≤ 1.333
CHS 2	1.333 < RR ≤ 1.667
CHS 3	1.667 < RR ≤ 2
CHS 4	2 < RR

With the corresponding zip code-specific apparent temperature thresholds, CHS translates daily maximum AT into its corresponding rank. Each zip code has unique AT thresholds that reflect the climatology of the local area.

For zip codes with little to no population data or with a lack of definitive modeled heat-health relationships, CHS uses inverse distance weighting, to interpolate temperature thresholds based on the closest available zip codes. Inverse distance weighting is a form of spatial estimation where available values are weighted by distance from the point of interest.

Temperature quantiles of relevant zip codes associated with the 1991-2020 NOAA climatology period are used to interpolate the quantiles for the zip code of interest and then translated back into temperature values using the same climatology period. All CHS values are displayed using the zip code polygons from the CA state geoportal (California, 2021a; California Zip Codes | California State Geoportal, accessed September 2024).

Supplementary Data

In addition to the daily CalHeatScore, the CHS webtool also provides locally relevant information and resources that can help Californians prepare for and adapt to upcoming extreme heat.

Cool Centers

The CHS mapping tool includes locally available feature layers of cool centers located throughout California. These feature layers are created and published by external entities (typically California counties) on ArcGIS Online, and they are not maintained by the Office of Environmental Health Hazard Assessment. The map includes layers that are publicly available and have been updated in the past 12 months. Each feature layer is accessed by the CHS tool by using the layer's published URL, which ensures that any updates to the hosted feature layers are automatically updated on the map. These feature layers are not exhaustive and may have inconsistencies with regards to the currently available information.

Cool centers are important community resources that provide a cool environment where the public can gather during an extreme heat event. Counties designate their own cool centers, which may include libraries, community / senior centers, government facilities, public swimming pools and splash pads, or any other location determined by county officials. Some cool centers may only be open or having extended hours during extreme heat events. Therefore, it is important to contact the facility directly to determine its current operating status. Additional cool center details such as facility name, address, and hours of operation may be available depending on the feature layer source.

Forecasted Weather and Historical Climate

When a user of the CHS tool clicks on a specific zip code shown on the map, the forecasted weather for that day and other historical climate information is displayed in a side panel. This data comes from the NWS weather forecast and the gridMET historical climate dataset outlined in the Climate Methods section.

The data shown include:

- Daily maximum temperature forecast: The forecasted daily maximum air temperature for the current or forecasted date.
- Daily "feels like" temperature forecast: The forecasted daily maximum apparent temperature for the current or forecasted date.
- Historical maximum temperature: The highest maximum air temperature of the current calendar day from 1979 to near-present day.
- Historical average temperature: The average daily maximum air temperature of the current calendar day from 1979 to near-present day.

Population Demographics

Various zip code-specific population estimates are derived using US Census data (website) from the 2022 American Community Survey (ACS; Bureau, 2024) and a census tract-to-zip code USPS crosswalk dataset (PD&R, 2023)[7] to obtain estimates at the zip code level. Population estimates are initially calculated at the census tract level using the 2022 ACS data and then estimated at the zip code level utilizing the proportions from the crosswalk dataset.

When a user of the CHS tool clicks on a specific zip code shown on the map, local population demographic information populates on a side panel. This demographic information is presented visually with infographics, depicting the estimated count and rate of these subgroups relative to the total population (or another denominator as defined in the Appendix). Information on the following demographic variables can be found below. This list of demographic variables is not exhaustive and methods for identifying subgroups of interest are under development.

Total Population

We utilize data from the ACS DP05 table to calculate an estimate of the total population associated with all types of addresses, including residential, business, and other address types.

Age

Younger and older age groups are identified as being more vulnerable to extreme heat events (Basu *et al.*, 2012; Benmarhnia *et al.*, 2015; Forsyth and Solan, 2022; Knowlton *et al.*, 2009; Meade *et al.*, 2020; Ou *et al.*, 2023; Schapiro *et al.*, 2024). Therefore, utilizing data from the ACS DP05 table, we calculate estimates of the total population broken down by relevant age groups: under 5 years old, 5-17 years old, 18-64 years old, and 65 years and older.

Race and Ethnicity

The impact of extreme heat on health varies by racial and ethnic groups (Basu *et al.*, 2017, Dialesandro *et al.*, 2021). This can be due to many factors including, but not limited to natural and built environmental variations, such as tree canopy coverage, heat island effect, and access to air-conditioned spaces. These factors are influenced by systemic drivers such as historical redlining and economic disparities (Wilson, 2020). Utilizing data from the ACS DP05 table, we calculate estimates of total population broken down by mutually exclusive race and ethnicity groups – Hispanic or Latino, White, Black, Asian, American Indian / Alaskan Native (AIAN), and Other / Multiple. For these analyses, all individuals who identify as ethnically Hispanic or Latino are grouped together, regardless of race, and are not included in any other race groups. See the Appendix for more detail about these groupings.

Linguistic Isolation

A linguistically isolated household is defined as any household without a member at least 14 years old who can speak English well. This can impact a household's understanding and adherence to public health warnings, leaving them vulnerable to preparing and responding to

[7] We utilize the TRACT_ZIP_122023 table in the December 2023 HUD-USPS ZIP Code Crosswalk. This table provides estimates of proportion of the specified Census Tract population that overlaps with the Zip code boundaries at time of HUD-USPS crosswalk publication.

extreme heat events (CalBRACE, 2016, Uejio *et al.*, 2010). We utilize data from the ACS S1602 table to calculate the proportion of households in each zip code that are linguistically isolated.

Outdoor Workers

Prolonged exposure to extreme heat, such as that which may be experienced by individuals who work outdoors, can cause occupational heat stress, resulting in illness, injury, and even death (Abokhashabah *et al.*, 2021; Kjellström *et al.*, 2019). We utilize data from the ACS S2401 table to calculate the proportion of workers in each zip code who work outdoors.

Uninsured

When experiencing a heat-related illness or injury, it may be necessary to seek medical treatment. Individuals without health insurance may be reluctant to seek medical care during earlier stages of heat illness, when treatment is more effective and less expensive (Abokhashabah *et al.*, 2021; Schmeltz *et al.*, 2016). If there is a delay in medical care, health symptoms may be severe and emergency medical care may be needed, which could lead to worse health outcomes. We utilize data from the ACS S2701 table to calculate the proportion of individuals in each zip code who do not have health insurance.

References

Abatzoglou JT (2013). Development of gridded surface meteorological data for ecological applications and modelling. *International Journal of Climatology* **33**(1):121-31.

Abokhashabah T, Jamoussi B, Summan AS, Abdelfattah E, I. A (2021). Effects of Heat Stress Exposure and Climate Change on Health and Safety of Outdoor Workers. *Curr World Environ* **16**(3).

Basu R, Chen H, Li DK, Avalos LA (2017). The impact of maternal factors on the association between temperature and preterm delivery. *Environ Res* **154**:109-14.

Basu R, Pearson D, Malig B, Broadwin R, Green R (2012). The effect of high ambient temperature on emergency room visits. *Epidemiology* **23**(6):813-20.

Benmarhnia T, Deguen S, Kaufman JS, Smargiassi A (2015). Vulnerability to Heat-related Mortality: A Systematic Review, Meta-analysis, and Meta-regression Analysis. *Epidemiology* **26**(6):781-93.

Bureau USC (2024). United States Census Bureau Data: United States Census Bureau.

CalBRACE (2016). California Building Resilience Against Climate Effects (CalBRACE) Project: Percent of households with no one aged ≥ 14 years speaking English': California Department of Public Health and University of California, Davis.

California DoE (2021a). California Zip Codes: California Department of Education.

California DoI (2021b). *Protecting Communities, Preserving Nature and Building Resiliency*.

Census US (2020). 2020 TIGER/Line Shapefiles. United States Census Bureau.

Dialesandro J, Brazil N, Wheeler S, Abunnasr Y (2021). Dimensions of Thermal Inequity: Neighborhood Social Demographics and Urban Heat in the Southwestern U.S. *Int J Environ Res Public Health* **18**(3).

Ebi KL, Vanos J, Baldwin JW, Bell JE, Hondula DM, Errett NA*, et al.* (2021). Extreme Weather and Climate Change: Population Health and Health System Implications. *Annu Rev Public Health* **42**:293-315.

Forsyth N, Solan T (2022). It's getting hot in here: heat stroke in children and young people for paediatric clinicians. *Paediatrics and Child Health* **32**(12):471 – 5.

Glahn HR, Ruth DP (2003). The New Digital Forecast Database of the National Weather Service. *Bulletin of the American Meteorological Society* **84**(2):195-202.

HUD (2023). Zip Code Population Weighted Centroids.

IPCC (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* V Masson-Delmotte, P Zhai, A Pirani, SL Connors, C Péan, S Berger, N Caud, Y Chen, L Goldfarb, MI Gomis, M Huang, K Leitzell, E Lonnoy, JBR Matthews, TK Maycock, T Waterfield, O Yelekçi, R Yu and B Zhou, ed. (Vol. In Press). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Kjellström T, Maître N, Saget C, Otto M, Karimova T (2019). *Working on a warmer planet: The effect of heat stress on productivity and decent work*ed.: International Labour Organization.

Knowlton K, Rotkin-Ellman M, King G, Margolis HG, Smith D, Solomon G*, et al.* (2009). The 2006 California heat wave: impacts on hospitalizations and emergency department visits. *Environ Health Perspect* **117**(1):61-7.

Meade RD, Akerman AP, Notley SR, McGinn R, Poirier P, Gosselin P*, et al.* (2020). Physiological factors characterizing heat-vulnerable older adults: a narrative review'. *Environ Int* **144**.

Ou Y, Wang F, Zhao J, Deng Q (2023). Risk of heatstroke in healthy elderly during heatwaves: a thermoregulatory modeling study. *Building and Environment* **237**.

PD&R (2023). HUD USPS ZIP Code Crosswalk Files: United States Department of Housing and Urban Development Office of Policy Development and Research.

Rivas L (2022). Assembly Bill No. 2238. Extreme heat: statewide extreme heat ranking system.

Schapiro LH, McShane MA, Marwah HK, Callaghan ME, Neudecker ML (2024). Impact of extreme heat and heatwaves on children's health: a scoping review. *The Journal of Climate Change and Health* **19**.

Schmeltz M, Petkova E, Gamble J (2016). Economic Burden of Hospitalizations for Heat-Related Illnesses in the United States, 2001–2010. *International Journal of Environmental Research and Public Health* **13**(9):894.

Uejio CK, Wilhelmi OV, Golden JS, Mills DM, Gulino SP, Samenow JP (2010). Intra-urban societal vulnerability to extreme heat: The role of heat exposure and the built environment, socioeconomics, and neighborhood stability. *Health & Place* **17**(2):498-507.

USGCRP (2023). *Fifth National Climate Assessment* AR Crimmins, CW Avery, DR Easterling, KE Kunkel, BC Stewart and TK Maycock, ed. Washington, DC, USA: U.S. Global Change Research Program.

Wilson B (2020). Urban Heat Management and the Legacy of Redlining. *Journal of the American Planning Association* **86**(4):443-57.

Appendix

Climate Zones

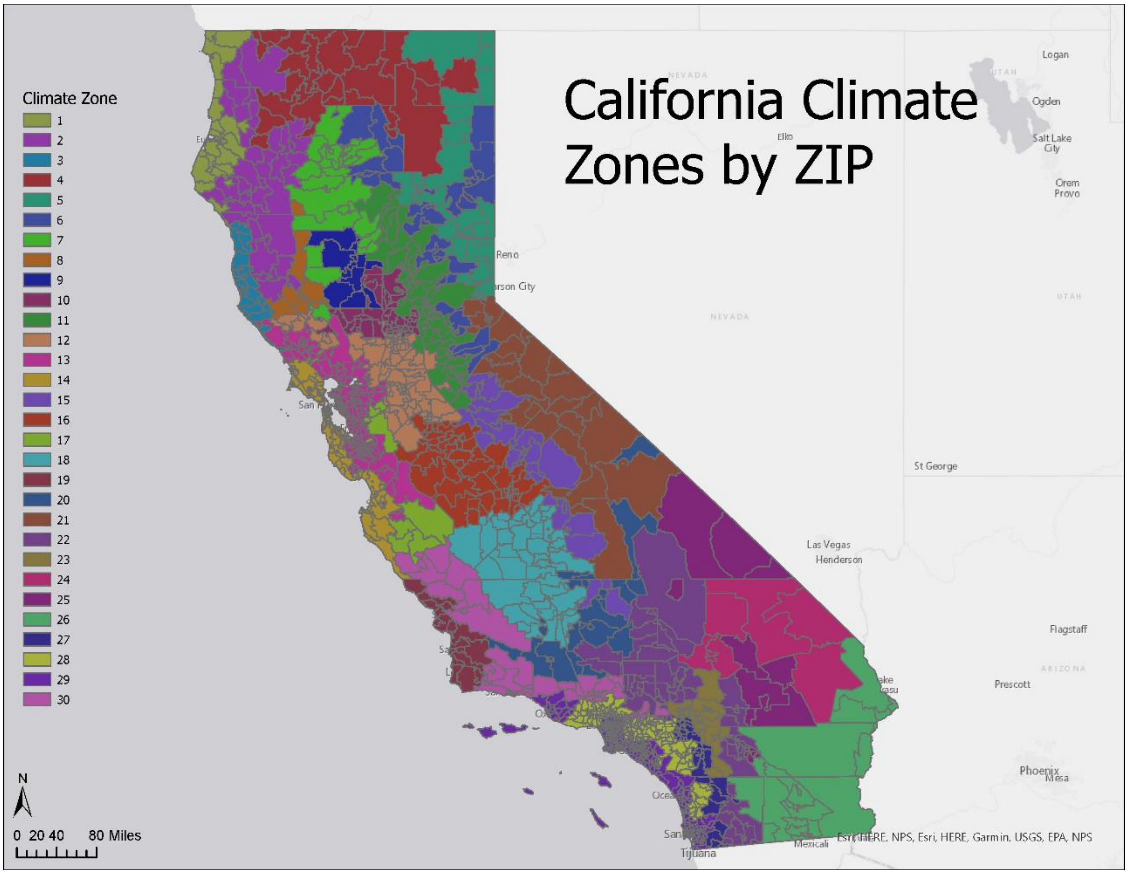

Figure A1. Climate zones across California. Each individual zip code in California is assigned a climate zone designation based on where the zip code population centroid is located. For zip codes that fall between climate regions, further assessment of each zip code's elevation and annual climate statistics are used to classify the zip codes to climate regions. These zones were developed by Applied Climatologists for use in the heat-health regression model.

Data Dictionary for Supplementary Data

All population estimates for supplemental data are derived using the December 2023 HUD-USPS ZIP Code Crosswalk (TRACT_ZIP_122023) which provides estimates of the proportion of the specified Census Tract population that overlaps with the Zip code boundaries at time of HUD-USPS crosswalk publication. Each field and Census Tract population estimate is initially identified in the associated 2022 ACS 5-year estimates tables, then estimated at the Zip code level with the proportions from the HUD-USPS ZIP Code Crosswalk. The data dictionary table with detailed information on each supplemental data variable and associated data source on can be accessed at – Data Dictionary for Supplementary Data.

Supplementary Analyses Methods

Zip Code Identification

The United States Postal Service (USPS) periodically updates zip codes by adjusting existing zip code boundaries, and by adding new or decommissioning zip codes as the population changes and the needs for postal services change. Because of the dynamic nature of zip codes over time, not all boundary maps cover the same geographic regions and populations. CalHeatScore derives zip code boundaries from a range of sources. As previously described, population estimates are derived from applying the HUD-USPS December 2023 tract to zip code HUD-USPS crosswalk ratio to the 2022 ACS Census tract population estimates. For climate and weather calculations, described above, ZCTA polygons, zip code polygons, and zip code population-weighted centroids were used. The completeness and discrepancy of identified zip codes and population estimates is detailed below.

2,425 California zip codes were identified using the HUD-USPS crosswalk to estimate total population at the zip code level from the 2022 ACS census tract data from the US Census data website. The zip code polygons from the CA state geoportal used for CHS identified 1,721 zip codes. Of these, 32 zip codes have no population, according to 2017 estimates, and begin with three leading zeros (i.e., “000”).

Of the remaining 1,689 populated zip codes, 1,662 zip codes matched the Dec 2023 HUD-USPS crosswalk used for the population estimates. 763 zip codes were identified by the HUD-USPS crosswalk but were not in the CA state geoportal. One zip code, 93519, was identified by the CA State geoportal but was not in the HUD-USPS crosswalk.

Zero Values and Associated Average Population Size

CHS presents population estimates for a variety of relevant demographic groups, including age, race/ethnicity, outdoor workers, linguistically isolated households, and individuals without health insurance. Because of the variation in total population estimates and sub-group population distributions, there can be zip codes that do not have an estimated population size for one of the sub-groups. In these cases, the estimated sub-group population is zero. To provide a clearer picture of the relevance of these zero values, the tables below present both the number of zip codes with zero values for the given group, as well as the average population estimates of the associated zip codes.

Age

	Children < 5 years	Children 5-17 years	18-64 years	65+ years
# Zip codes with Zero value	56	14	1	22
Average population size[8]	420.2	2.7	0.4	552.1

Race and Ethnicity

	Latino	White	Black	Asian	AIAN	Other / Multiple
# Zip codes with Zero value	10	2	149	83	264	45
Average population size	3.5	4.4	1021.4	575.4	5482.3	1204.4

Outdoor Workers

	Total Workers	Outdoor Workers	Not Outdoor Workers
# Zip codes with Zero value	2	53	3
Average population size	0.80	614.1	4.4

Linguistically Isolated Households

	Households	Not Linguistic Isolation	Linguistic Isolation
# Zip codes with Zero value	2	3	184
Average population size	0.8	95.4	1146.8

Health Insurance

	Civilian Noninstitutionalized[9]	With Health Insurance	Without Health Insurance
# Zip codes with Zero value	1	1	34
Average population size	0.4	0.4	301.5

[8] Average population size is measured by number of people.
[9] People over 15 years old, living in US States or the District of Columbia, and who are not active-duty military or in an institution (such as homes for aged, mental health facilities, or penal institutions).