

Supplemental Materials for *Fine-scale Twitter Big Data Reveals Neighborhood Inequalities in Mental Health Effects of High Temperatures*

S1 Alternative Sentiment Algorithms to Estimate Mood

S1.1 Hedonometer

In addition to the Valence Aware Dictionary for Sentiment Reasoning (VADER) method [1], we also used the hedonometer method [2]. This metric yielded very similar findings to those presented in the main paper with the VADER method.

The Hedonometer [3] is a corpus-based technique to get mood scores from multi-lingual texts. The core steps are (1) building human evaluations of the happiness of a set of individual words, and (2) using an algorithm for scaling up from individual words to texts. For the English corpus, Dodds and others [3] collect 10,222 unique words and used crowd-sourcing platform Amazon Mechanical Turk to get human evaluation of happiness degree for each word in an integer scale from 1 to 9, representing a sad to happy spectrum. Score 5 represents neutral words. Some illustrative example of words are:

$$h_{avg}(\text{laughter}) = 8.50$$

$$h_{avg}(\text{the}) = 4.98$$

$$h_{avg}(\text{hate}) = 2.34$$

The score for single text will be the mean happiness score for all words in the text.

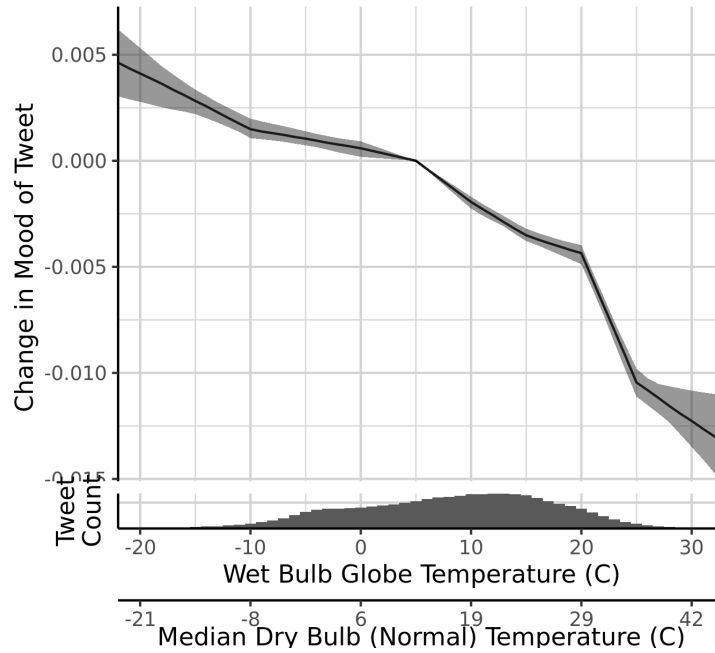


Figure S1: Effects of temperature on mood, measured with the hedonometer method.

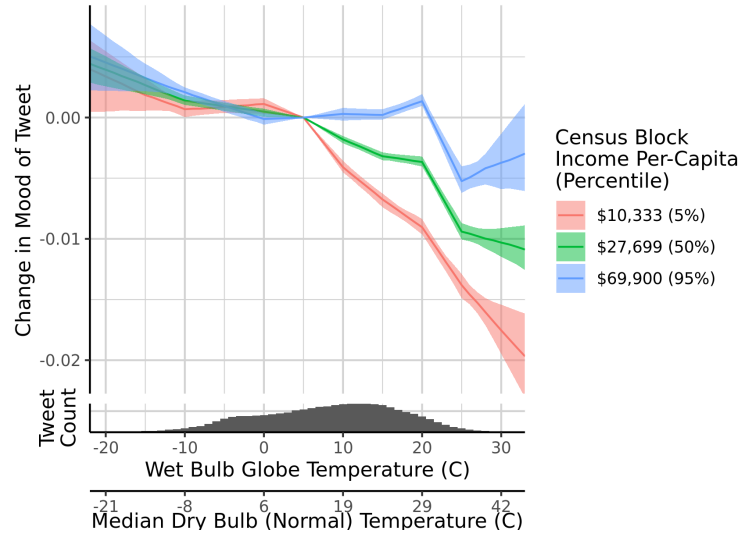


Figure S2: Effects of temperature on mood and moderated by income, measured with the hedonometer method.

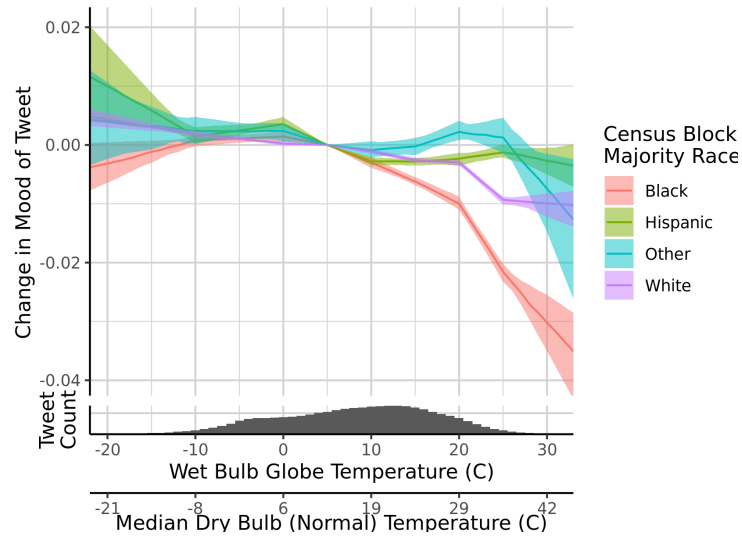


Figure S3: Effects of temperature on mood and moderated by race, measured with the hedonometer method.

S1.2 AFINN

AFINN is another wordlist used in mood analysis and designed for microblogs like twitter [4].

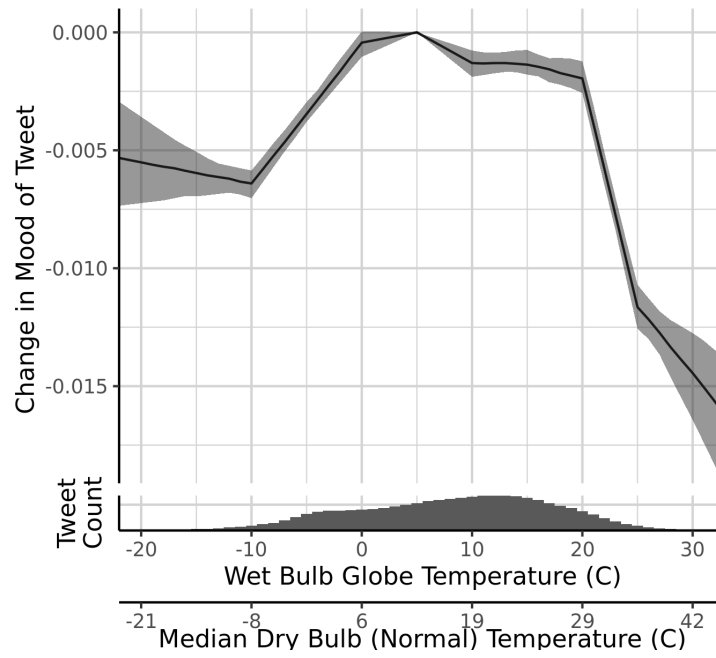


Figure S4: Effects of temperature on mood, measured with the AFINN method.

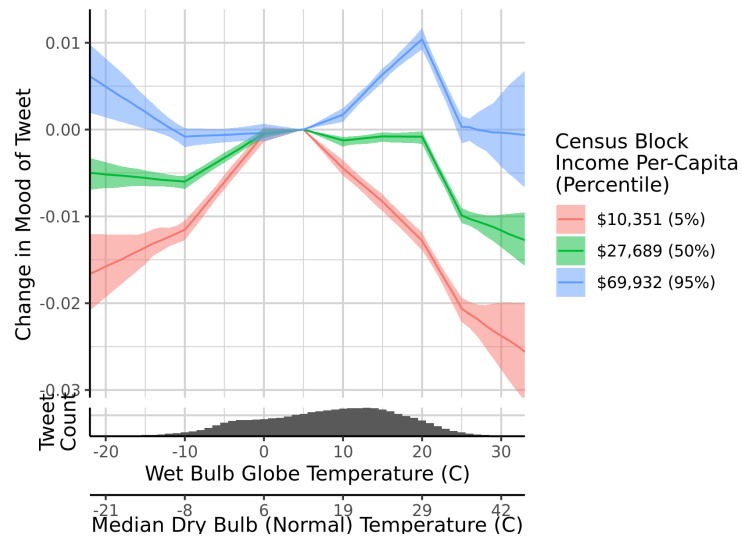


Figure S5: Effects of temperature on mood and moderated by income, measured with the AFINN method.

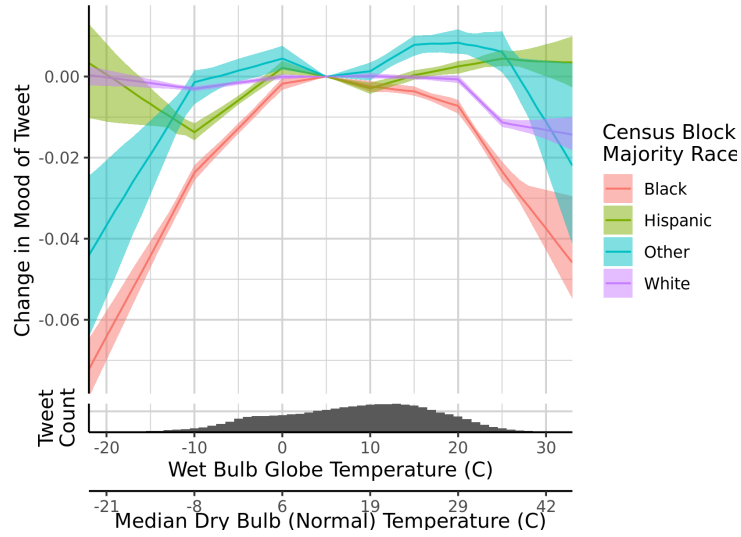


Figure S6: Effects of temperature on mood and moderated by race, measured with the AFINN method.

S2 Alternative Interaction Variables

For our main analysis, we treated income as a continuous (log-transformed) variable and race as a categorical variable. We ran similar analyses with income as a categorical variable and race as a continuous variable (the percent of a census block's population that was non-white/minority).

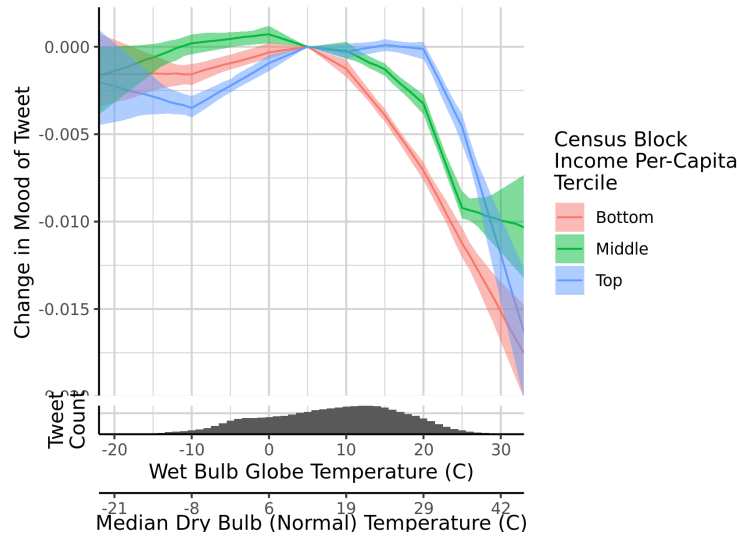


Figure S7: Effect of temperature on mood and moderated by income, with income as a categorical variable.

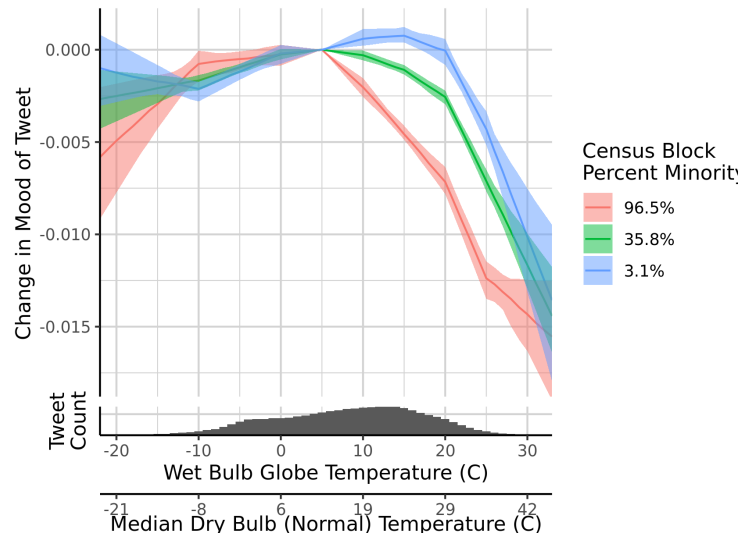


Figure S8: Effect of temperature on mood and moderated by race, with race as a continuous variable.

S3 Effects of Precipitation and Sunshine

While our main variable of interest was temperature as measured by Wet Bulb Globe Temperature, we also interacted our variables of interest with a binary variable for whether it was raining or not, as well as a continuous variable for the amount of shortwave radiation in (W/m^2), or sunshine.

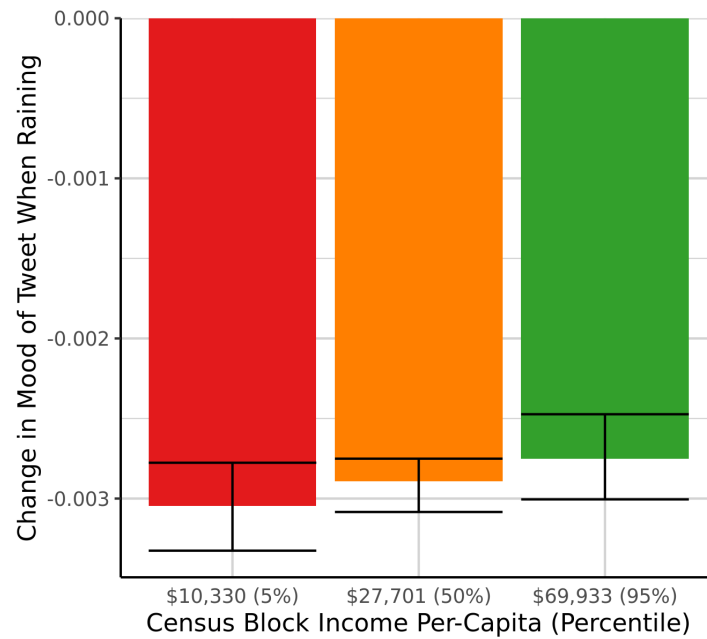


Figure S9: Effect of rain on mood and moderated by income.

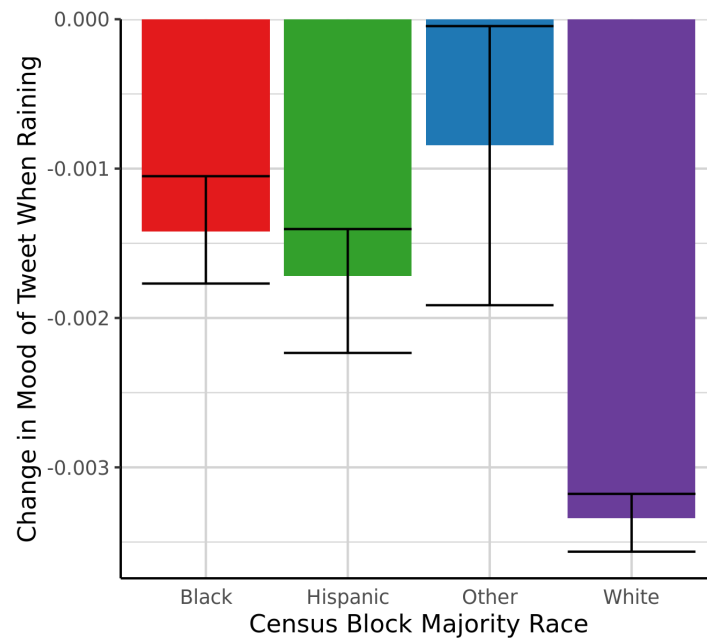


Figure S10: Effect of rain on mood and moderated by race.

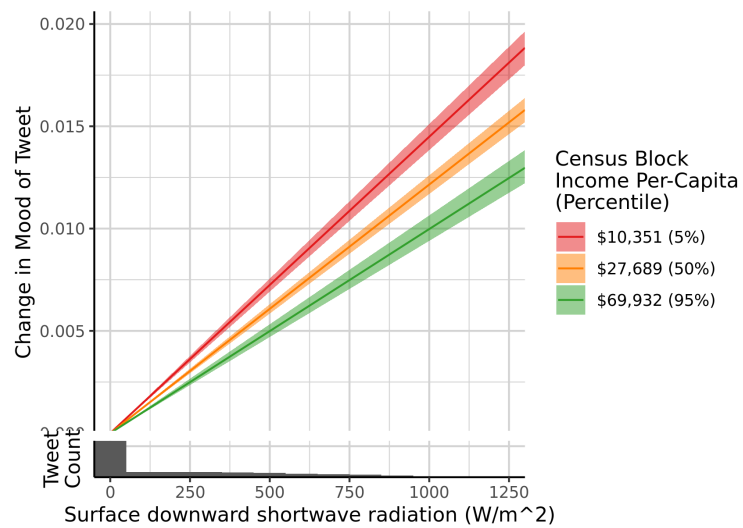


Figure S11: Effect of sunshine on mood and moderated by income.

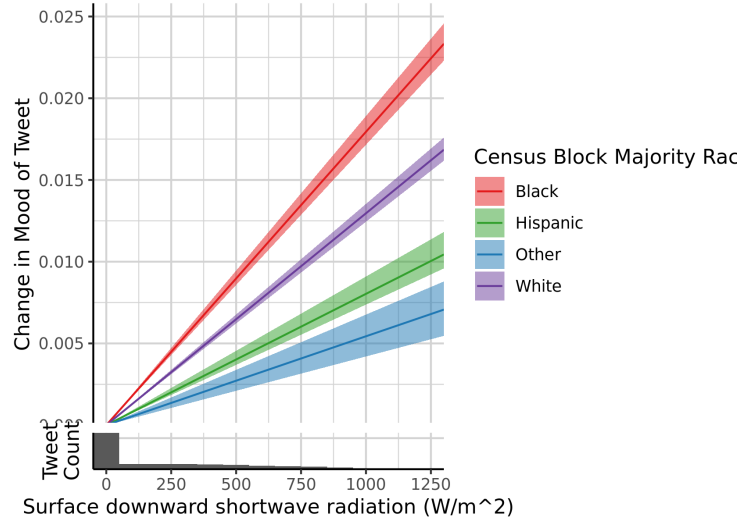


Figure S12: Effect of sunshine on mood and moderated by race.

Temperature Effects by Combined Statistical Area

To explore whether cultural or environmental baselines may affect the relationship between heat and mood, we examine the impact of temperature on mood across Combined Statistical Areas (CSAs) and Metropolitan Statistical Areas (MSAs) containing over 1 million people (hereafter: city regions). We find that higher temperatures are associated with declining mood in 83.6% of city regions (see Fig. S13) and the effect is significant in 35.3% of these. Furthermore, we find no significant association between higher temperatures and increased mood in any of the cities.

For this analysis by city, we run models with a similar form to Model 2, including the same fixed effects, although we fit a linear effect for $f_t()$. Because we are not accounting for non-linearities in $f_t()$, we exclude tweets with a WBGT of less than 5°C, as our initial analysis showed that this is the temperature at which mood peaks.

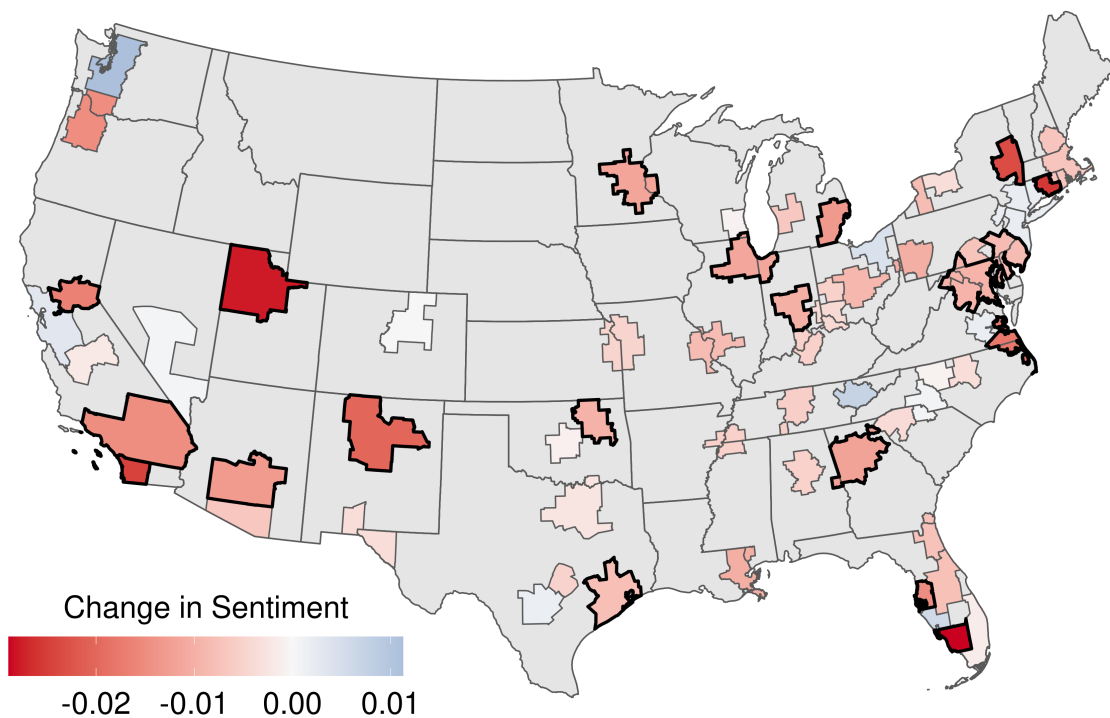


Figure S13: The change in mood for a 25-degree increase in WBGT for city regions with a population of over 1 million. For cities shown with a dark outline, the effect is significant at a 95% confidence interval.

S4 Weather Terms

For all of our analysis, we excluded tweets that contained the following weather-related terms: aerovane, air, airstream, altocumulus, altostratus, anemometer, anemometers, anticyclone, anticyclones, arctic, arid, aridity, atmosphere, atmospheric, autumn, autumnal, balmy, baroclinic, barometer, barometers, barometric, blizzard, blizzards, blustering, blustery, blustery, breeze, breezes, breezy, brisk, calm, celsius, chill, chilled, chillier, chilliest, chilly, chinook, cirrocumulus, cirrostratus, cirrus, climate, climates, cloud, cloudburst, cloudbursts, cloudier, cloudiest, clouds, cloudy, cold, colder, coldest, condensation, contrail, contrails, cool, cooled, cooling, cools, cumulonimbus, cumulus, cyclone, cyclones, damp, damp, damper, damper, dampest, dampest, degree, degrees, deluge, dew, dews, dewy, doppler, downburst, downbursts, downdraft, downdrafts, downpour, downpours, dried, drier, dries, driest, drizzle, drizzled, drizzles, drizzly, drought, droughts, dry, dryline, fall, fahrenheit, flood, flooded, flooding, floods, flurries, flurry, fog, fogbow, fogbows, fogged, fogging, foggy, fogs, forecast, forecasted, forecasting, forecasts, freeze, freezes, freezing, frigid, frost, frostier, frostiest, frosts, frosty, froze, frozen, gale, gales, galoshes, gust, gusting, gusts, gusty, haboob, haboobs, hail, hailed, hailing, hails, haze, hazes, hazy, heat, heated, heating, heats, hoarfrost, hot, hotter, hottest, humid, humidity, hurricane, hurricanes, ice, iced, ices, icing, icy, inclement, landspout, landspouts, lightning, lightnings, macroburst, macrobursts, maelstrom, mercury, meteorologic, meteorologist, meteorologists, meteorology, microburst, microbursts, microclimate, microclimates, millibar, millibars, mist, misted, mists, misty, moist, moisture, monsoon, monsoons, mugginess, muggy, nexrad, nippy, NOAA, nor'easter, nor'easters, noreaster, noreasters, overcast, ozone, parched, parching, pollen, precipitate, precipitated, precipitates, precipitating, precipitation, psychrometer, radar, rain, rainboots, rainbow, rainbows, raincoat, raincoats, rained, rainfall, rainier, rainiest, raining, rains, rainy, sandstorm, sandstorms, scorcher, scorching, searing, shower, showering, showers, skiff, sleet, slicker, slickers, slush, slushy, smog, smoggier, smoggiest, smoggy, snow, snowed, snowier, snowiest, snowing, snowmageddon, snowpocalypse, snows, snowy, spring, sprinkle, sprinkles, sprinkling, squall, squalls, squally, storm, stormed, stormier, stormiest, storming, storms, stormy, stratocumulus, stratus, subtropical, summer, summery, sun, sunnier, sunniest, sunny, temperate, temperature, tempest, thaw, thawed, thawing, thaws, thermometer, thunder, thundered, thundering, thunders, thunderstorm,

thunderstorms, tornadic, tornado, tornadoes, tropical, troposphere, tsunami, turbulent, twister, twisters, typhoon, typhoons, umbrella, umbrellas, vane, warm, warmed, warming, warms, warmth, waterspout, waterspouts, weather, wet, wetter, wettest, wind, windchill, windchills, windier, windiest, windspeed, windy, winter, wintery, and wintry.

References

- [1] C. H. E. Gilbert and Erric Hutto. “Vader: A parsimonious rule-based model for sentiment analysis of social media text”. In: *Eighth International Conference on Weblogs and Social Media (ICWSM-14)*. Available at (20/04/16) <http://comp.social.gatech.edu/papers/icwsm14.vader.hutto.pdf>. Vol. 81. 2014, p. 82. URL: <http://eegilbert.org/papers/icwsm14.vader.hutto.pdf>.
- [2] Peter Sheridan Dodds et al. “Temporal Patterns of Happiness and Information in a Global Social Network: Hedonometrics and Twitter”. In: *PLOS One* 6.12 (Dec. 2011), e26752. ISSN: 1932-6203. DOI: 10.1371/journal.pone.0026752.
- [3] Peter Sheridan Dodds et al. “Temporal Patterns of Happiness and Information in a Global Social Network: Hedonometrics and Twitter”. In: *PLOS One* 6.12 (Dec. 2011), e26752. DOI: 10.1371/journal.pone.0026752. URL: <http://dx.doi.org/10.1371/journal.pone.0026752> (visited on 01/27/2016).
- [4] Finn Årup Nielsen. “A new ANEW: Evaluation of a word list for sentiment analysis in microblogs”. In: *arXiv preprint arXiv:1103.2903* (2011).