**California Building Resilience Against Climate Effects (CalBRACE) Project**

**Short Title:** Ozone Air Pollution
**Full Title**: Average Daily Maximum Ozone Concentration

**CalBRACE Domain:** Environmental Exposures

**Healthy Community Framework:** Quality and sustainability of environment

**What is our aspirational goal:** Clean air, soil and water, and environments free of excessive noise

## Why is this important to health?

Higher temperatures increase ground-level ozone and other secondary air pollutants created from chemical reactions with pollutants directly emitted from power plants, motor vehicles, and other sources, creating smog and air pollution.[1] With the projected increasing temperatures, demand for electric power generation will increase and may contribute further to poor air quality. The health impacts of air pollution are likely to be modified by climate change, due mainly to the exposure of populations to increased levels of air pollutants and the enhanced pollutant emission and production rates in a warmer climate.[2] Climate change is projected to increase cardiovascular and respiratory morbidity and mortality associated with ground-level ozone.[3] Most California residents are currently exposed to levels at or above the current State ozone standard during some parts of the year.[1] Studies have shown that exposure to ozone is associated with decreased lung function, respiratory symptoms, hospitalizations for cardiopulmonary causes, emergency room visits for asthma, and premature death.[1] At higher daily concentrations, ozone increases asthma attacks, hospital admissions, daily mortality, and days of restricted activity and school absences.[1, 4] In California, the Air Resources Board estimated that 630 deaths, 4,200 hospital admissions, and 4.7 million lost school days could be prevented each year if California met its current statewide standard of 0.070 ppm for ozone (8-hour average).[1] Populations at increased risk include people with chronic diseases (e.g., respiratory diseases), agricultural and outdoor workers, and those who are active outdoors.[1, 2, 4] Besides harming human health, ground level ozone can harm crops and potentially alter food quality and costs. Ozone can cause significant damage to a wide range of materials found in the built environment, which can shorten material life span and increase maintenance costs.

## Summary of Evidence for Climate and Health

Laboratory studies in which human subjects were exposed to measured concentrations of ozone for brief periods demonstrate that ozone can reduce lung function, increase respiratory symptoms, increase airway hyper-reactivity, and increase airway inflammation. Numerous community-based epidemiologic studies have shown that exposure to ozone is also associated with decreased lung function, respiratory symptoms, hospitalizations for cardiopulmonary causes, emergency room visits for asthma, and premature death. At higher daily concentrations, ozone increases asthma attacks, hospital admissions, daily mortality, and days of restricted activity and school absences. Children may be more affected by ozone than the general population due to effects on the developing lung and to relatively higher exposure than adults.[1, 2, 4]

*Key References:*


1. Drechsler DM, Garcia C, Tran H, et al. Review of the California Ambient Air Quality Standard For Ozone. Vol 4. Table B-5: California Annual Health Impacts of Current Ozone Concentrations Compared to the State 8-hour Ozone Standard of 0.070 ppm. Sacramento, CA: California Environmental Protection Agency, Air Resources Board; 2005.
2. Sujaritpong S, Dear K, Cope M, et al. Quantifying the health impacts of air pollution under a changing climate – a review of approaches and methodology. *International Journal of Biometeorology.* 2013; 58: 149-160.
3. Confalonieri U, Menne B, Akhtar R, et al. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.
4. Committee On Estimating Mortality Risk Reduction Benefits From Decreasing Tropospheric Ozone Exposure. Estimating Mortality Risk Reduction and Economic Benefits from Controlling Ozone Air Pollution. Washington, DC: National Academy of Sciences; 2008.


**What is the indicator?**

Detailed Definition

- Indicator = Mean of summer months (May-October) of the daily maximum 8-hour ozone concentration (ppm), averaged over three years (2012-2014).
- Stratification: 8 race/ethnicity strata (African American, American Indian/Native Alaskan, Asian, Latino, Multiple, Native Hawaiian and Other Pacific Islander, White, Total).
- Interpretation: Climate resilient communities will have lower ozone levels

Data Description and Methodology

- Air Monitoring Network, California Air Resources Board (CARB); CalEnviroscreen 3.0 (http://www.arb.ca.gov/aqmis2/aqmis2.php); (https://oehha.ca.gov/calenviroscreen/maps-data/download-data)
    - Years available: 3-year average of 2012-2014
    - Geographies available: census tracts, county (derived), region (derived), state (derived)
- American Community Survey (ACS) (http://factfinder2.census.gov).
    - Years available: 2011-2015
    - Geographies available: census tract, county, region (derived), state

California Air Resources Board, local air pollution control districts, tribes and federal land managers maintain a wide network of air monitoring stations in California. These stations record a variety of different measurements including concentrations of the six criteria air pollutants and meteorological data. In certain parts of the state, the density of the stations can provide high-resolution data for cities or localized areas around the monitors. However, not all cities have stations. The information gathered from each air monitoring station audited by the California Air Resources Board includes maps, geographic coordinates, photos, pollutant concentrations, and surveys.

Daily maximum 8-hour average concentrations for all monitoring sites in California were extracted from California Air Resources Board's air monitoring network database for the summer months (May to October) for the years 2012-2014. The mean of summer months (May-October) were calculated by averaging all of the daily maximum 8-hour ozone concentration, during those months over three years (2012 to 2014). The mean concentrations from the monitoring stations were used to model ozone concentrations across the state of California. A modeling technique called Inverse Distance Weighting (IDW) was used. The basis of IDW is that the ozone concentrations measured at nearby monitors influence the estimated concentration at a given location more than ozone concentrations measured at monitors further away. Using the IDW model, daily maximum 8-hour concentrations were estimated for the center of each census tract. These were averaged to obtain a single value for each census tract. Ozone values at census tracts with centers more than 50 km from the nearest monitor were not estimated using the model. For these tracts, the ozone value of the nearest air monitor was used.

Population weighted ozone concentration averages by race/ethnicity were calculated for census tracts, counties, regions, and the state, from census tract air quality estimates merged with census tract population data.