

Air disparities in the Bay Area

Hyperlocal data insights to support climate action



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Aclima is pioneering an entirely new way to diagnose the health of our air and track climate-changing pollution. Powered by our network of roving and stationary sensors, Aclima measures air pollution and greenhouse gases at unprecedented scales and with block-by-block resolution. Our professional analytics software, Aclima Pro, translates billions of scientific measurements into environmental intelligence for governments, companies, and communities. Our free app, air.health, maps address-level air and climate insights for the communities we serve. Aclima is a purpose-driven technology company catalyzing bold climate action that protects public health, reduces emissions, and delivers clean air for all.

To learn more, visit aclima.io.



UrbanFootprint Builds Resilience. We serve the world's first Urban Intelligence Platform to public and private-sector organizations taking on the urban, climate, and social equity challenges of the 21st century. The UrbanFootprint Platform is powered by a deep contextual data core, representing 160 million parcels and covering 97% of the United States. This is the most comprehensive consolidated view available today. This empowers governments, utilities, financial institutions, and urban planners to answer fundamental resource questions—where to invest, where to deploy resources, and where to optimize for risk, return, and resilience. Never Wonder Where with UrbanFootprint.

To learn more, visit: urbanfootprint.com

Tracking Pollution & Diagnosing Air Health

In May 2022, Aclima released a groundbreaking collection of data from California: block-by-block air pollution and greenhouse gas measurements collected across more than 5,000 square miles, 101 cities, and nearly eight million in the Bay Area.

This data brief covers Aclima and UrbanFootprint's analysis of the Bay Area data in the first-ever application of the **Community Impact and Investment Index**, a decision-support tool designed to help drive investments, interventions, and multi-benefit solutions in communities. It highlights the profound disparities in exposure to pollution based on race and income. The findings were the topic of a 2022 story in *[The Washington Post](#)*.

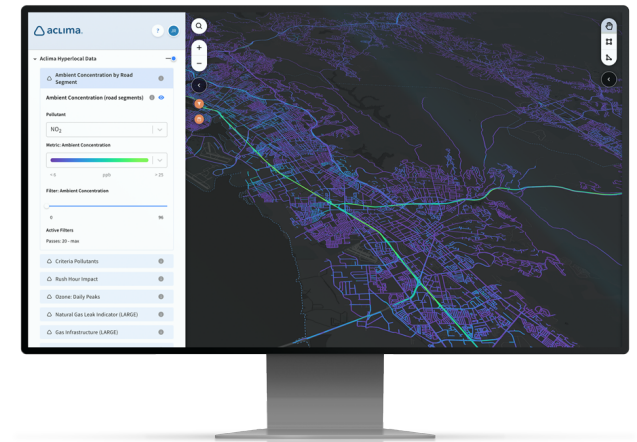
Tracking Pollution & Diagnosing Air Health

Air pollution is hyperlocal — Aclima research shows it can vary up to 800%¹ from one end of a block to the other. Historically, air has not been measured at the neighborhood level, where people live, work, and play.

Aclima is pioneering an entirely new way to diagnose the health of our air and track climate-changing pollution. Powered by a network of roving and stationary sensors, Aclima measures air pollution and greenhouse gasses at unprecedented scales and block-by-block resolution. Aclima's technology allows governments, corporations, and communities to zero in on what's really in their air — so they can take action that protects public and planetary health.

Over the past decade, Aclima has collected hundreds of billions of hyperlocal air quality data points in more than 150 cities and 14 countries, generating the largest dataset of hyperlocal air pollution and greenhouse gas measurements in the world. Every second, the company is collecting new measurements to add to their cloud-based platform. Those measurements flow into **Aclima Pro**, a professional analytics software that enables customers to visualize and analyze trillions of air quality measurements in context with demographic, land use, and climate hazard data.

Aclima recently launched a free web app, [air.health](#), which enables anyone to look up a Bay Area address and see persistent levels of measured pollution at that location, compared with both **US Environmental Protection Agency (EPA)** and **World Health Organization (WHO)** standards.



¹ [Mobile-Platform Measurement of Air Pollutant Concentrations in California: Performance Assessment, Statistical Methods for Evaluating Spatial Variations, and Spatial Representativeness](#)

Paul A. Solomon, Dena Vellano, Melissa Lunden, Brian LaFranchi, Charles L. Blanchard, and Stephanie Shaw

Historic Data Initiative

In January of 2020, the **Bay Area Air Quality Management District (BAAQMD)** and Aclima announced a historic partnership to map air pollutants and greenhouse gasses block-by-block, in all nine counties of the Bay Area. The goal of this partnership was to bring an unprecedented level of granularity and visibility to air pollution at the neighborhood level across the entire Bay Area region.

Aclima deployed its specialized fleet of sensor-equipped low-emission vehicles to map air quality on every public street in the Bay Area. The first year's results from Aclima's Bay Area mobile network, released in May 2022, reveals environmental and health disparities faced by many in the region. The main insights from the analysis, leveraging the Community Impact and Investment Index, are covered in this data brief.



Measuring air, street by street

Using cutting-edge air pollution sensors installed on low-emission vehicles, Aclima measures climate-changing emissions and air pollution wherever its fleet is deployed. Aclima's sensor system, the **Aclima Mobile Node (AMN)**, is a specially-designed, temperature controlled device located inside the **Aclima Mobile Platform**. Before hitting the road, Aclima specialists calibrate the sensors to ensure device precision and accuracy. Each driver receives a daily route plan that is scientifically designed to measure a specific area.

Once they're on the road, Aclima's Mobile Platform collects measurements every second. To ensure scientific validity, Aclima vehicles drive an individual road segment (equal to 330 feet or 100 meters), at least 20 separate times — and at different times of the day, night, and year. It's important to collect data this way, because air quality can change with the weather, season, and the regular human patterns of the time of day (like traffic and business operations).



While driving, the AMN uploads the measurements to the cloud, where they undergo verification and analysis and then become searchable in Aclima Pro.

Science first

Aclima's hardware, software, scientific measurements, and insights are backed by methods that have been rigorously tested, peer-reviewed, and validated by leading scientists at some of the world's top research institutions including the US EPA.

Ensuring data integrity:

- 1.** Air pollution sensors in the Aclima Mobile Node (AMN) are tuned based on measurements of known values; i.e., calibrated before and after collection.
- 2.** 1-second data are consistently verified during collection based on quality criteria.

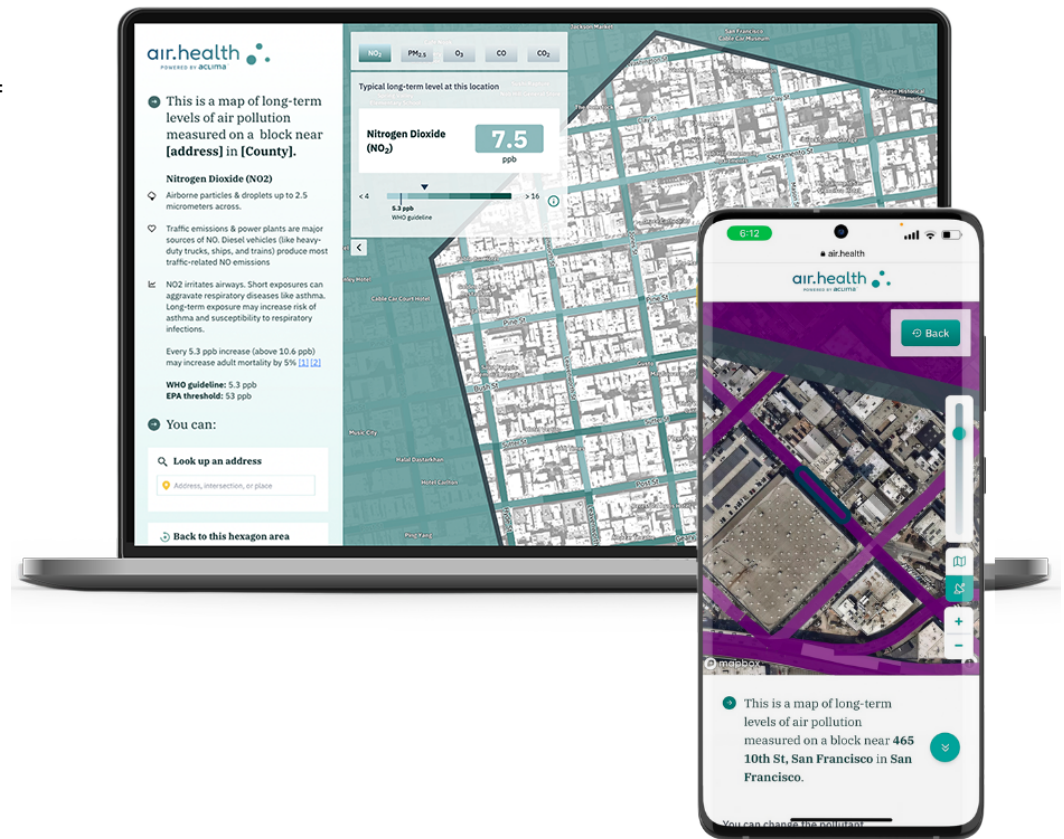
Maps undergo extensive scientific review in order to enable insights that are based on ten years of research and development by Aclima's world-class engineers and scientists.
- 3.**

Increasing access

air.health is a first-of-its kind tool that allows anyone in the Bay Area to explore typical pollution levels for their block, their neighborhood, and across the region. Insights from the first year of mapping are now available.

Aclima's mobile sensing platform complements traditional air measurement efforts by **BAAQMD** and other regulators. Aclima introduces a new body of knowledge and understanding about air pollution and emissions at the block level.

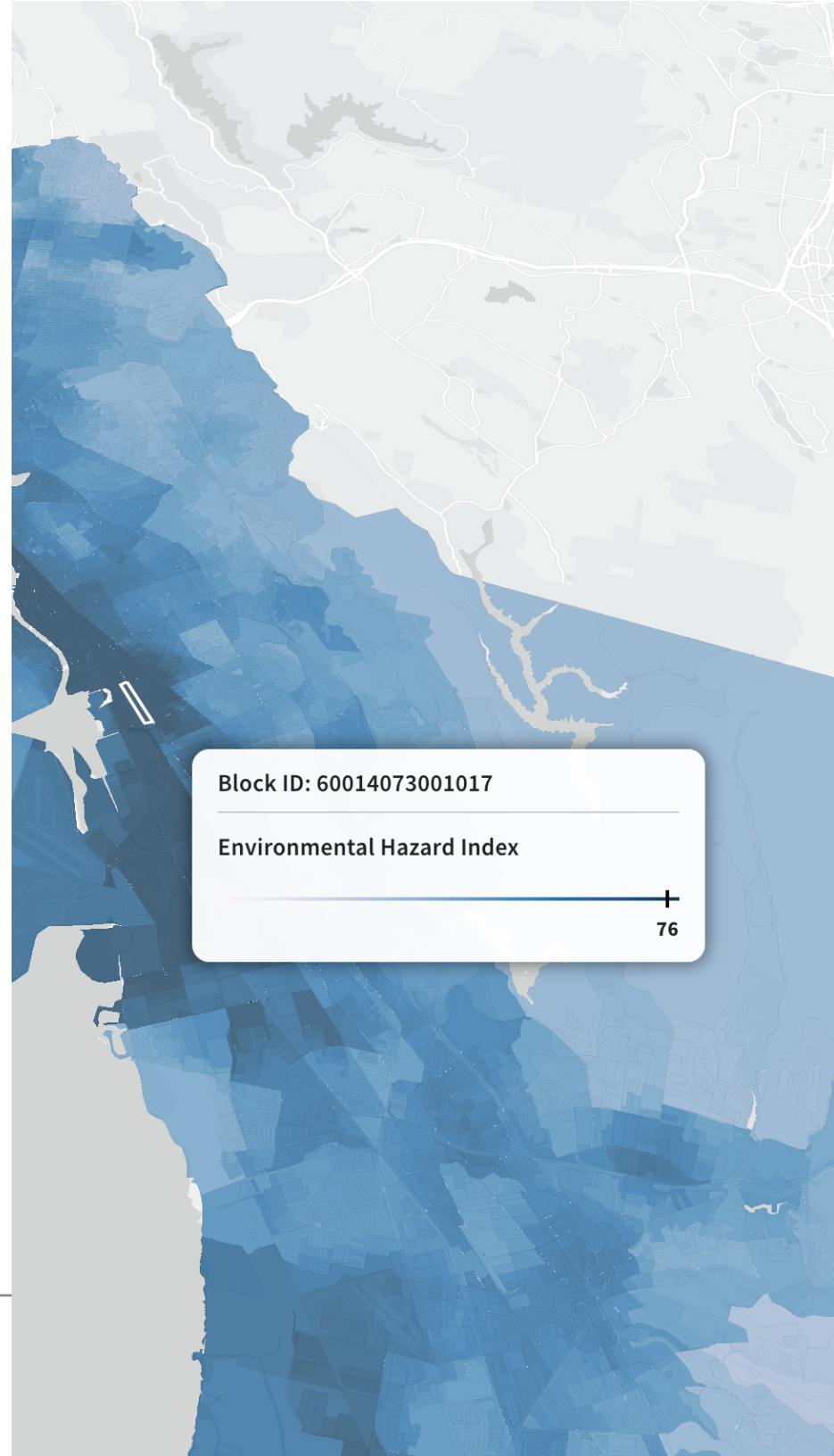
Block-by-block measurements provide a new resolution of data that tells us where air pollution burdens may be higher or lower. Hyperlocal data also helps identify sources so regulators and policymakers can intervene at a neighborhood level.



Combining forces: The Community Impact and Investment Index

To better understand the environmental and health disparities across the Bay Area, Aclima partnered with UrbanFootprint, the leading Urban Intelligence Provider, to put an important community and equity lens on their findings. Aclima combined their hyperlocal air quality and greenhouse gas emissions data with UrbanFootprint's vast datasets covering the built environment, social demographics, and infrastructure assets to create a new way to analyze pollution: the **Community Impact and Investment Index**.

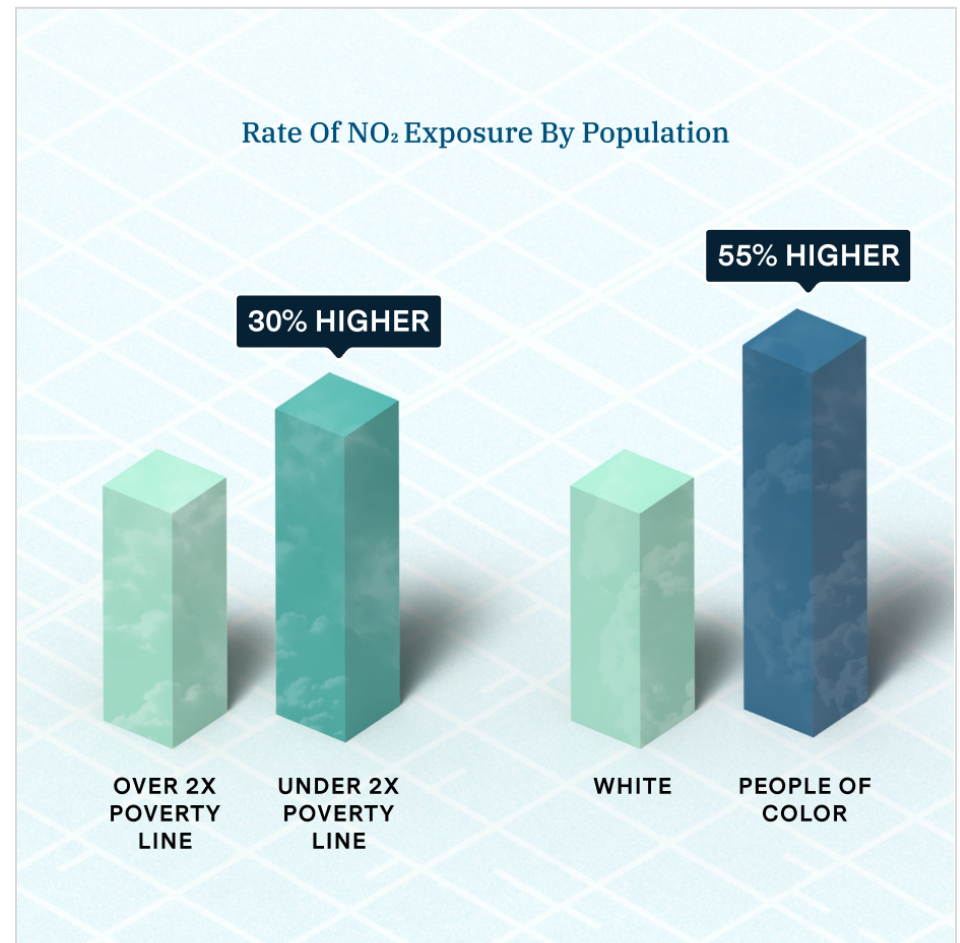
The **Community Impact and Investment Index**, which is exclusively available in Aclima Pro, puts air quality and greenhouse gas measurements into context by overlaying Aclima's air data with information about race, income, health, pollution exposure, climate impacts, and other socioeconomic factors that historically limit access to support and resources. Aclima Pro customers can use the Community Impact and Investment Index to more efficiently target pollution mitigation and climate action in the communities that need it most.



Revealing environmental and health disparities

Through their product partnership, Aclima and UrbanFootprint combined their data science expertise to analyze the billions of data points collected from across the Bay Area. **For the first time, the results prove through data what people on the frontlines of pollution and climate hazards have been saying for years: that poor air quality disproportionately impacts communities of color.**

It is well known that communities living near freeways and other air pollution sources have higher rates of asthma, strokes, heart attacks, lung cancer, and preterm birth. However, the broad regional measurements collected by stationary air monitors often fail to capture local pockets of poorer air quality. These neighborhoods, which are more likely to include low income populations and communities of color, now have air quality and emissions data to support their health and environmental concerns.



This analysis focuses on three main pollutants²:



Nitrogen dioxide (NO₂), a highly reactive gas produced by burning fuels, commonly via diesel engines in traffic and power plants.



Carbon monoxide (CO), a colorless, odorless gas produced by burning fuels, especially fossil fuels, commonly from traffic and industrial activities.



Fine particulate matter (PM_{2.5}), airborne particles and droplets up to 2.5 micrometers wide, produced by smoke, vehicle exhaust, industry, cooking emissions, and even sea spray.

And three main Community Impact and Investment Index data components:



Race/ethnicity, using demographics data from the US Census Bureau's 2015-2019 American Community Survey (ACS) 5-Year Estimates



Poverty, using demographics data from the US Census Bureau's 2015-2019 American Community Survey (ACS) 5-Year Estimates



Homeownership, using demographics data from the US Census Bureau's 2015-2019 American Community Survey (ACS) 5-Year Estimates

² Aclima measures many more pollutants than the three highlighted here, but these were the focus of the 2022 analysis. For a complete list of the pollutants Aclima measures, see the appendix.



Results

The Community Impact and Investment Index aligns the billions of data points gathered by Aclima with the hundreds of datasets from the UrbanFootprint platform, making it possible to pinpoint areas where communities are disproportionately impacted by air pollution and emissions.

UrbanFootprint applies industry-leading data science methodologies to show how factors among these datasets interact at national, state, city, and neighborhood levels. From these capabilities, UrbanFootprint developed granular community resilience and hazard metrics, which provide highly detailed measures of economic stress, social vulnerability, and natural hazard and climate risk. The results from this analysis were informed by demographics data from the 2015-2019 American Community Survey (ACS) from the US Census Bureau.

Results: Region-wide

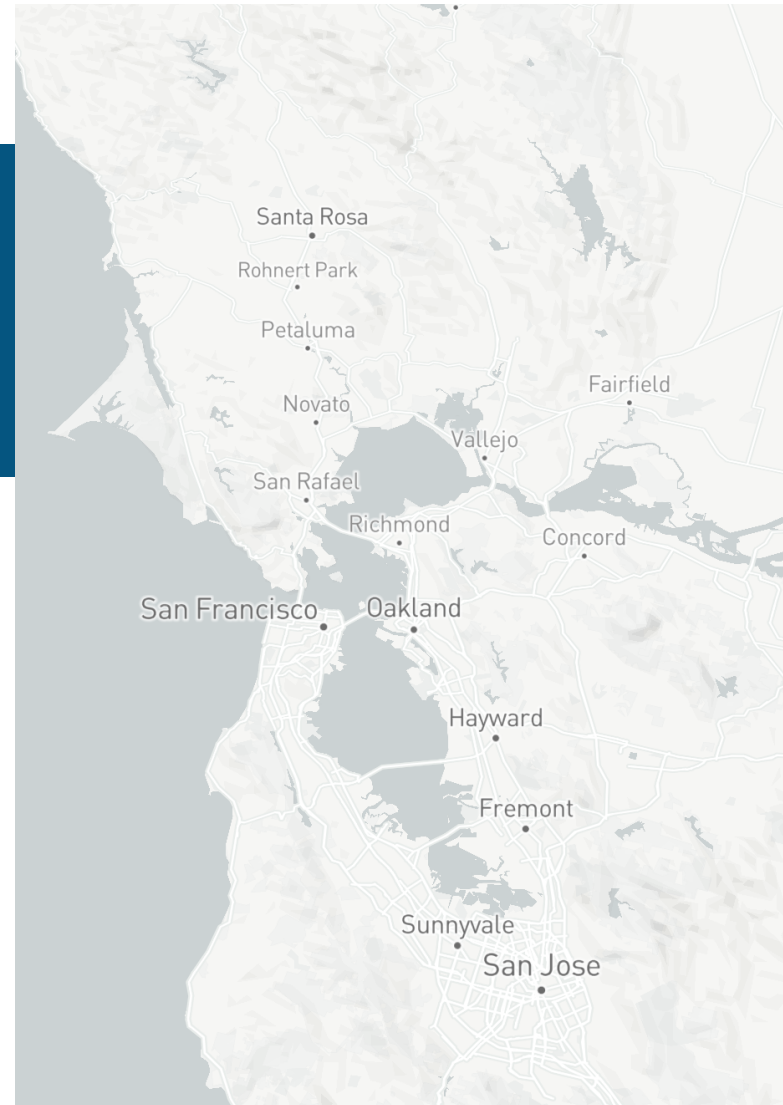
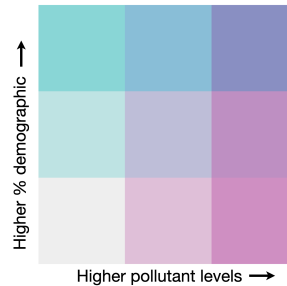
At the Bay Area level, patterns start to emerge.



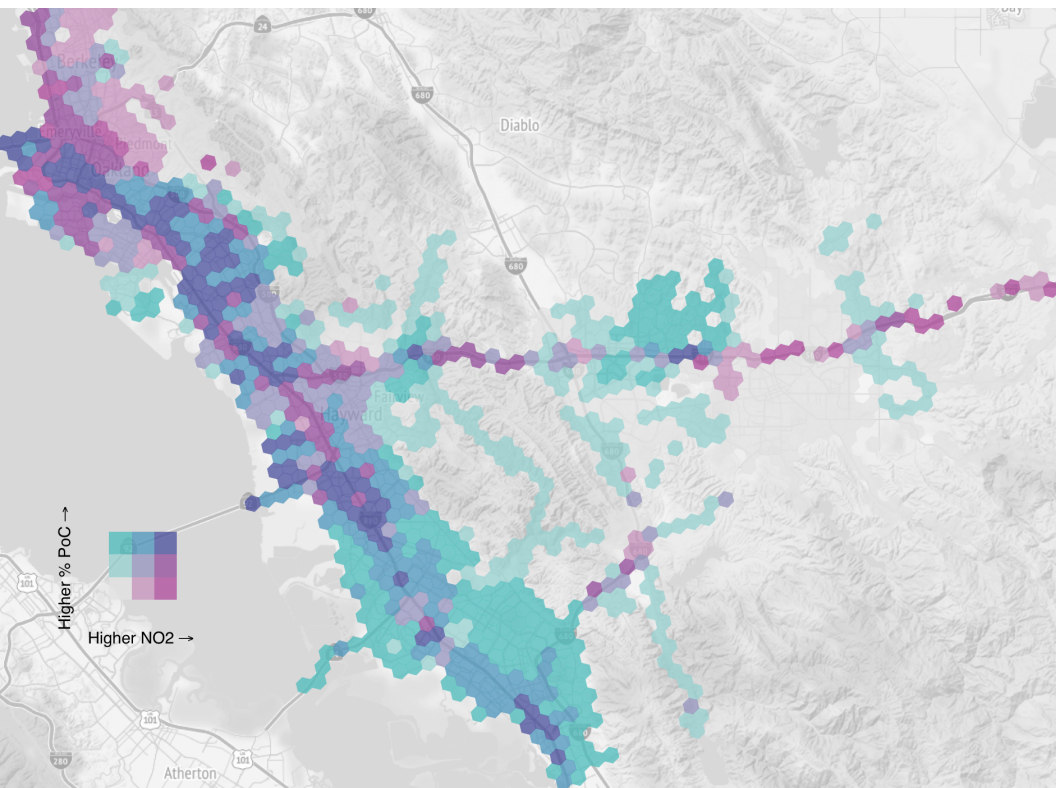
Key Takeaway

Across the San Francisco Bay Area, people of color are exposed to up to 55% more NO₂ than white populations.

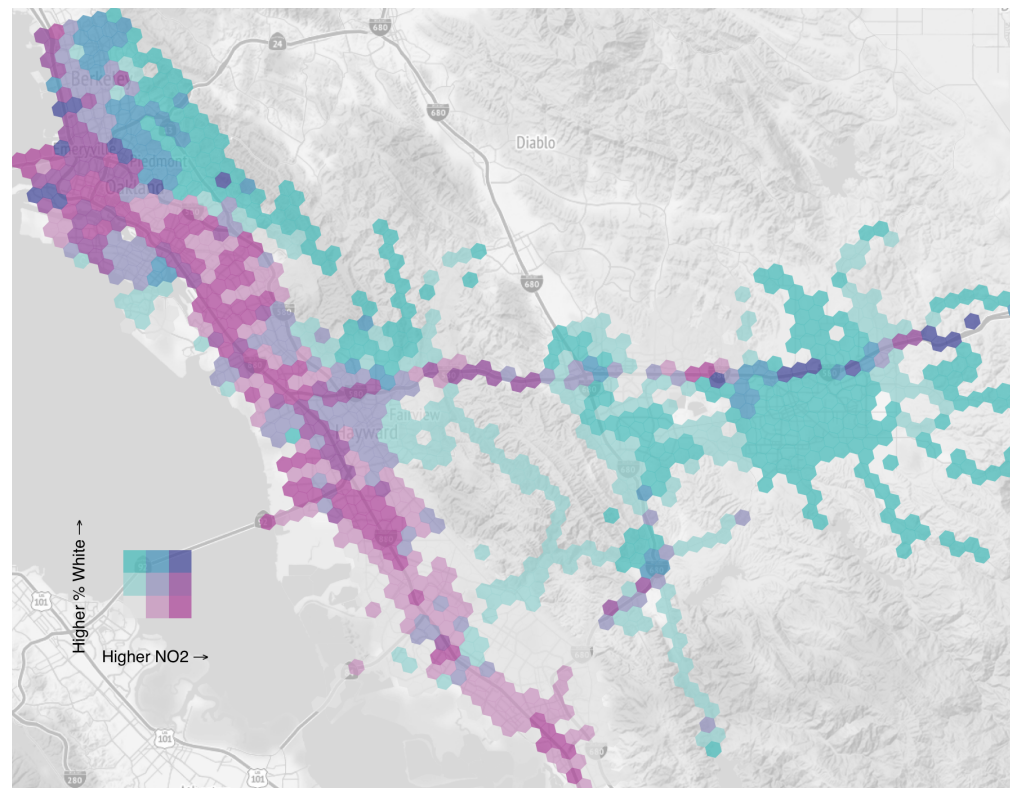
How to read the following maps: as cells become more green, they indicate more % of the demographic in question (e.g., people of color). As cells become more magenta, they indicate higher levels of pollutant in question (e.g., NO₂). Finally, as cells become dark purple, they indicate where these two attributes converge (e.g., higher % demographic AND high pollution).



Alameda County, NO₂, People of Color



Alameda County, NO₂, White



In these maps of Alameda County, the dark purple hexagons represent areas with high percentages of people of color as well as high levels of NO₂. Compare the amount of dark purple between maps to understand the overlap of where high percentages of White people live compared to where high levels of NO₂ exist.

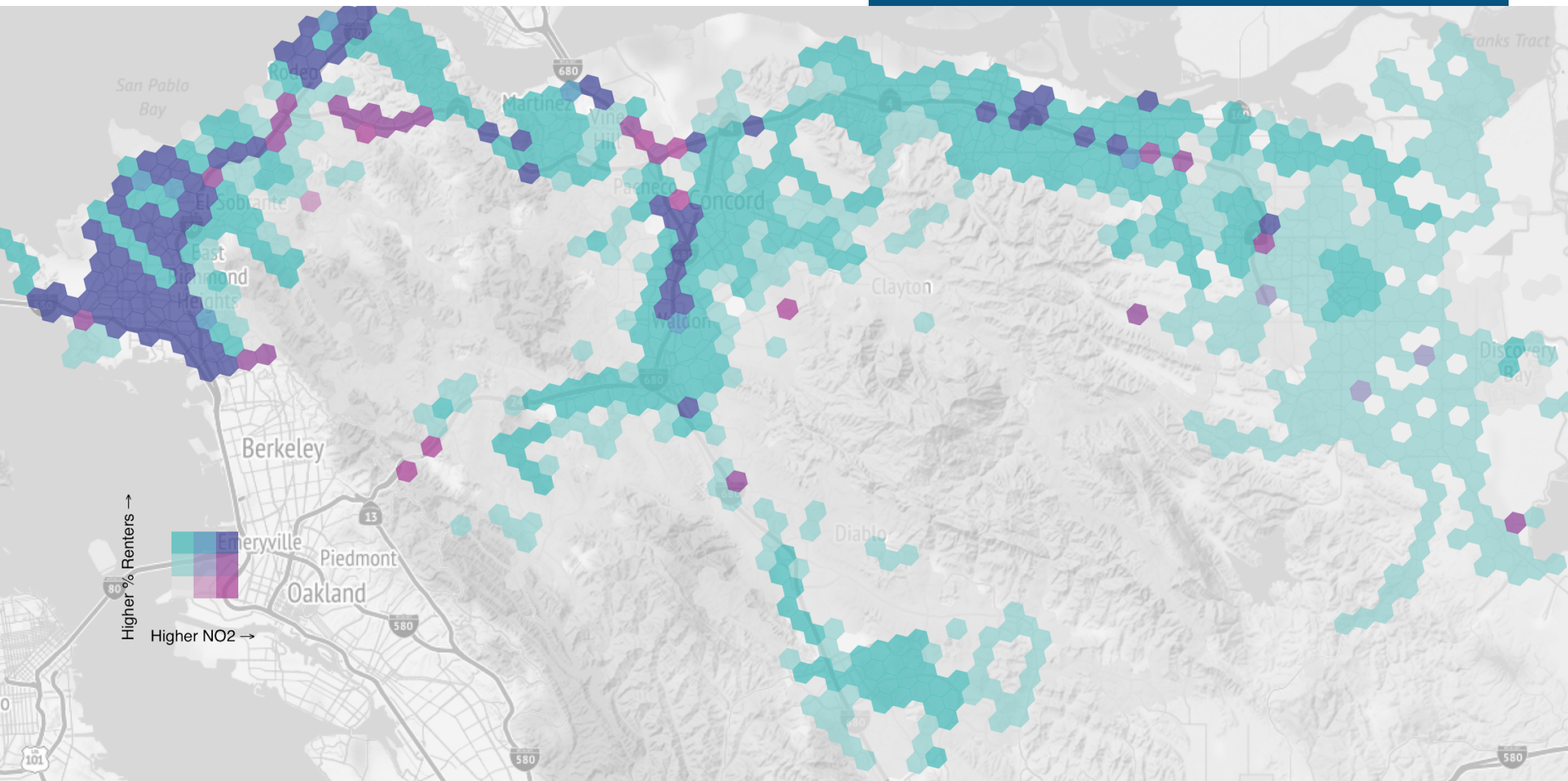
Contra Costa County, NO₂, Renters

In this map of Contra Costa County, the dark purple hexagons represent areas with high percentages of rental housing as well as high levels of NO₂. Conversely, magenta hexagons show similarly high levels of NO₂, but low percentages of rental housing (i.e., more home ownership). When the amount of dark purple exceeds that of magenta, it indicates that NO₂ pollution burden is experienced more by people renting housing



Key Takeaway

Populations living in rental housing are exposed to up to 10% more NO₂.

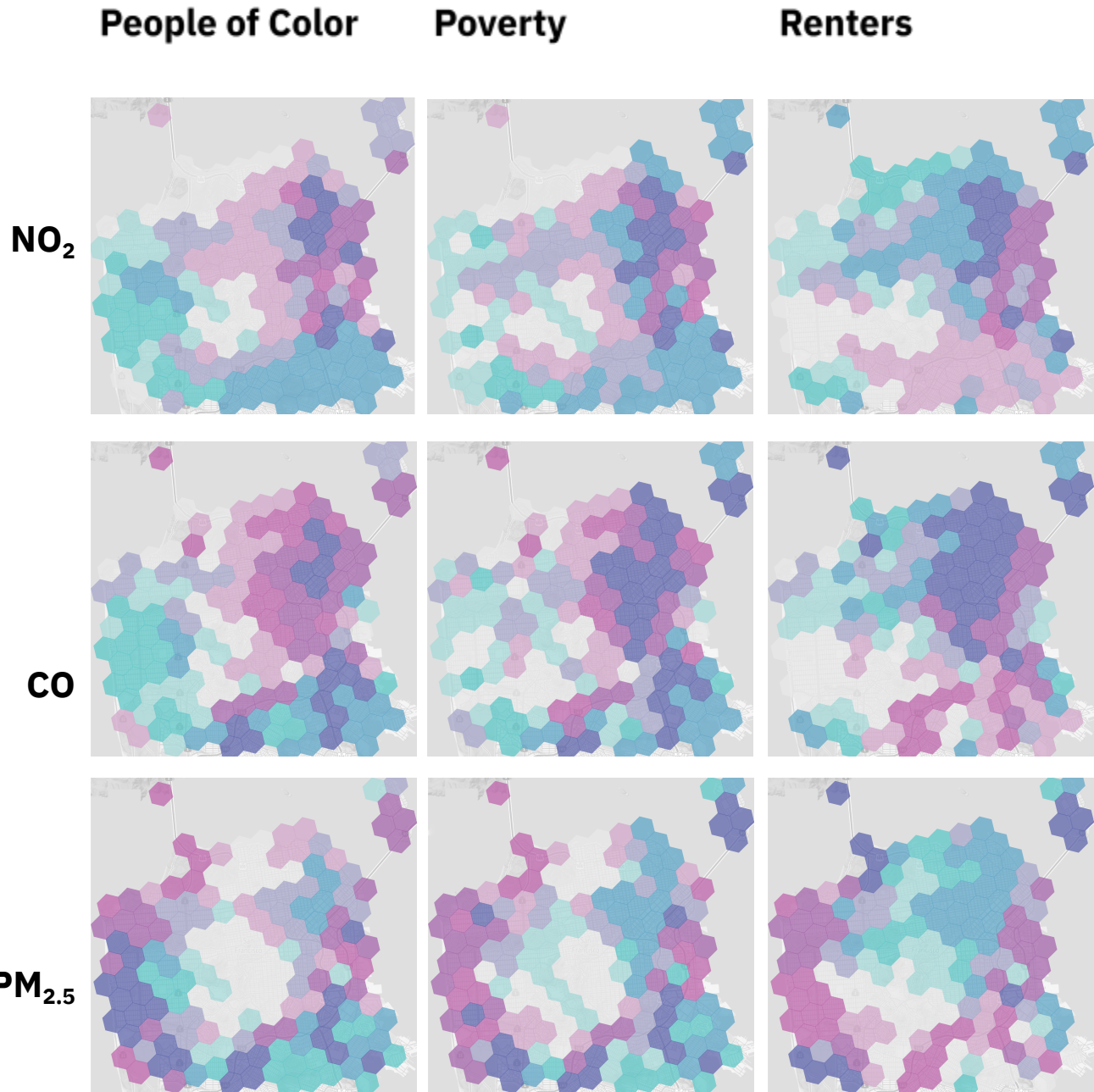
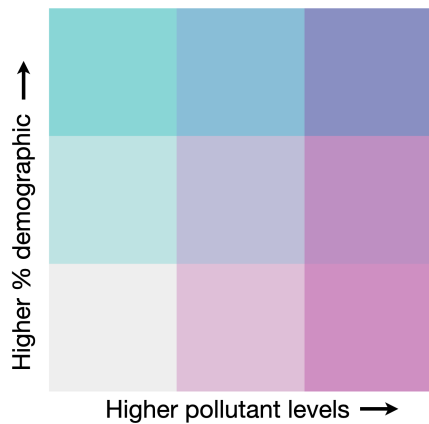


Results: County-level

San Francisco

When we combine the layers at the county level, it is possible to explore the disparities through another lens. To the right, see a matrix showing how three key Community Impact and Investment Index components intersect with three harmful pollutants in San Francisco.

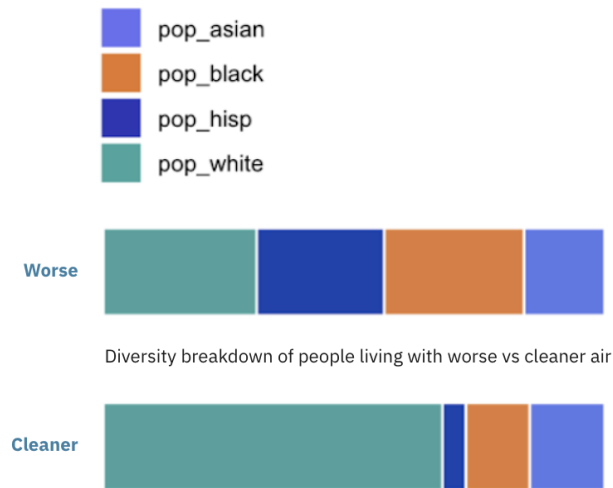
Community Impact and Investment Index Components: People of color, poverty, renters
Pollutants: NO₂, CO, PM_{2.5}



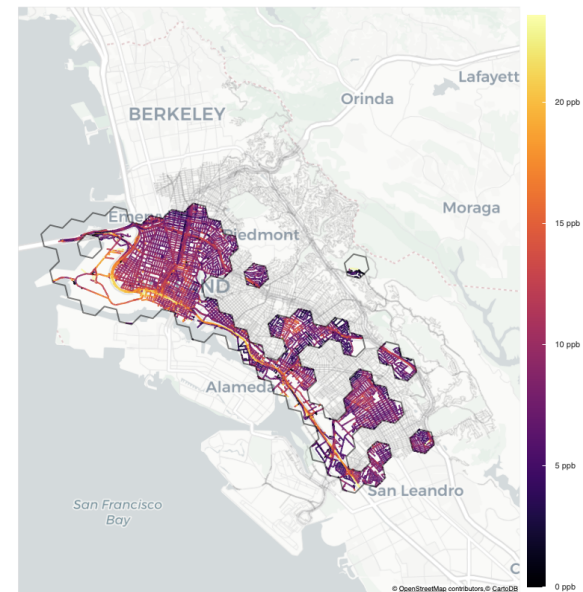
Results: Block-level

Zooming in even further to the neighborhood block level, where people live, work, and play, the differences in air quality from one block to the next are clearly visible. Within any of the cities where Aclima has conducted monitoring, we see patterns of disparity repeat themselves at the local level.

Oakland, NO₂



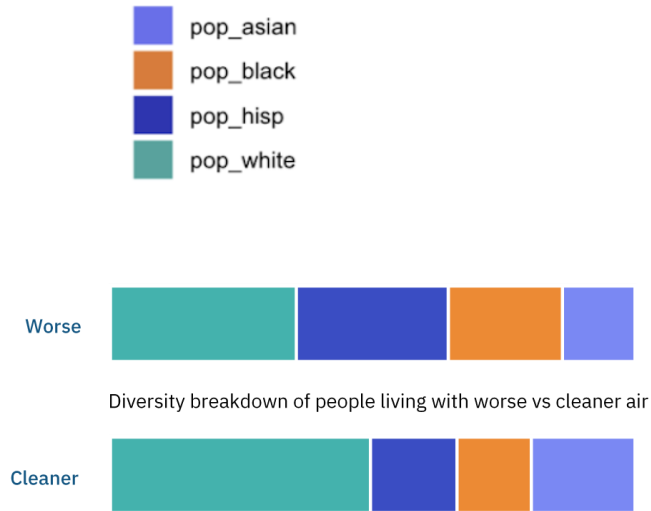
In the city of Oakland, the bar charts show the diversity of people who are exposed to worse air and cleaner air.



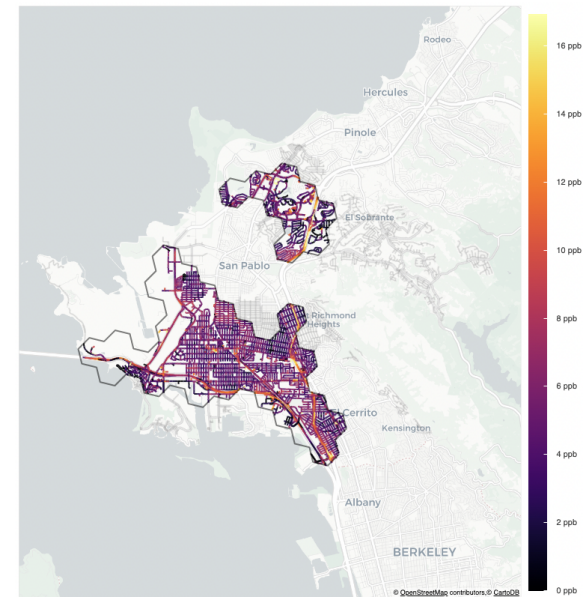
The highlighted hexagons show where NO₂ is highest (in the top 25% of all measurements in the county).

In other cities around the Bay, the hyperlocal maps show similar trends around economic and racial disparities.

Block Level Results: Richmond

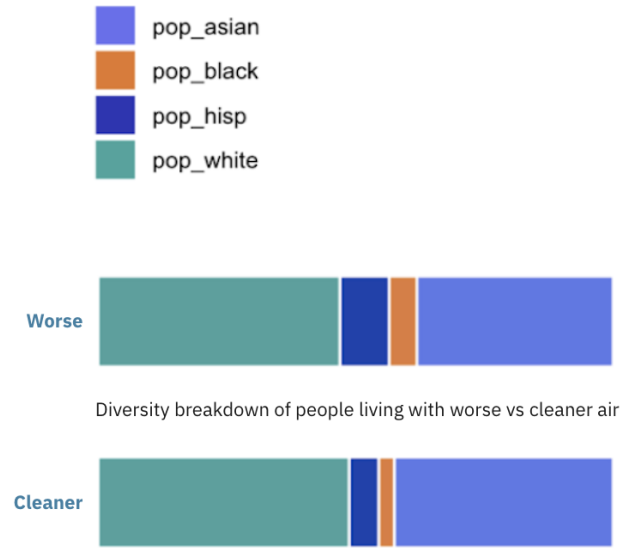


In the city of Richmond, the bar charts show the diversity of people who are exposed to worse air and cleaner air.

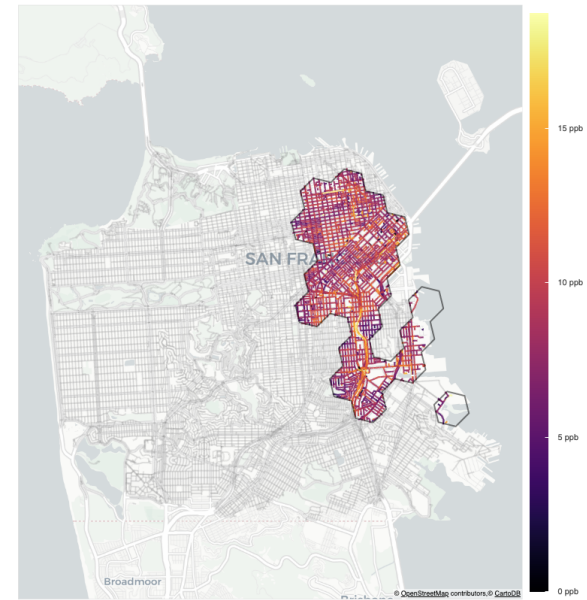


The highlighted hexagons show where NO₂ is highest (in the top 25% of all measurements in the county).

Block Level Results: San Francisco

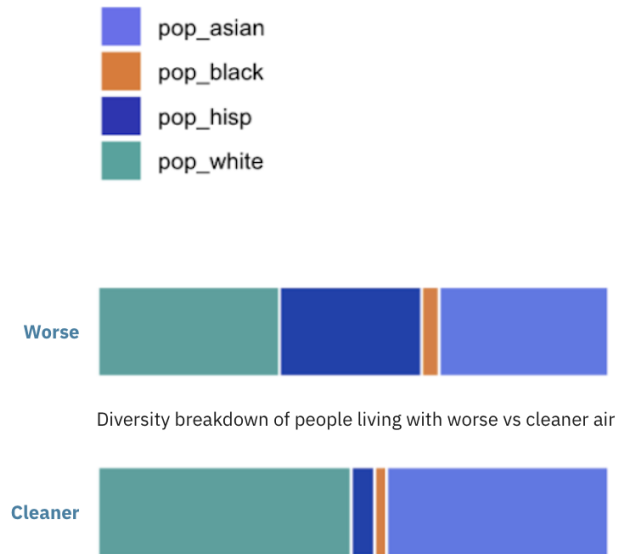


In the city of San Francisco, the bar charts show the diversity of people who are exposed to worse air and cleaner air.

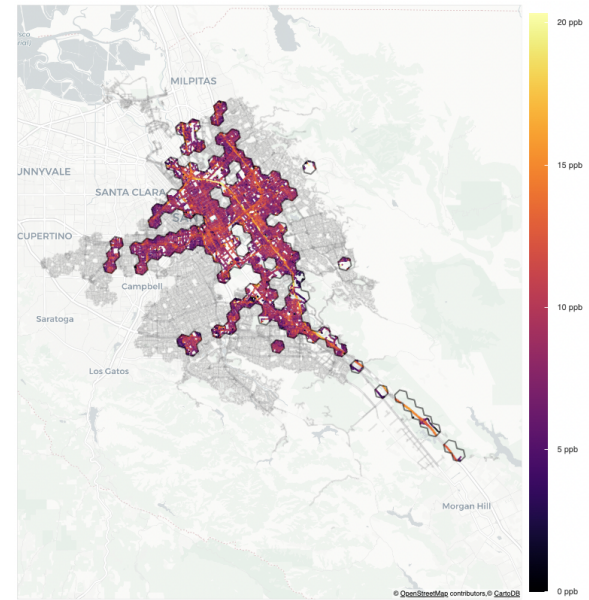


The highlighted hexagons show where NO₂ is highest (in the top 25% of all measurements in the county).

Block Level Results: San Jose

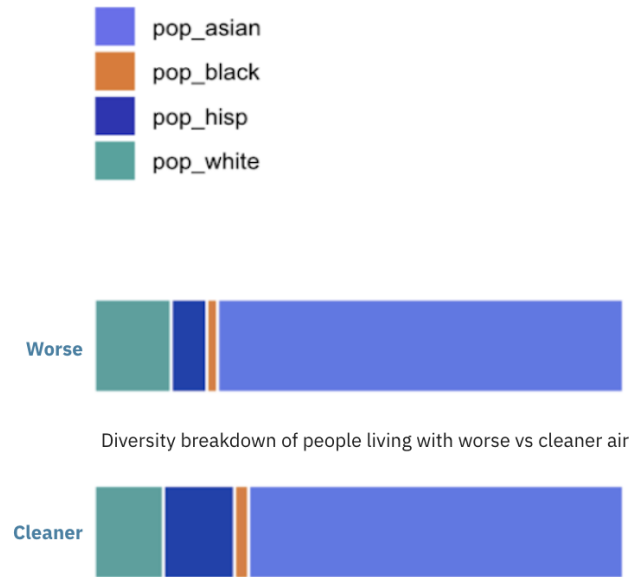


In the city of San Jose the bar charts show the diversity of people who are exposed to worse air and cleaner air.

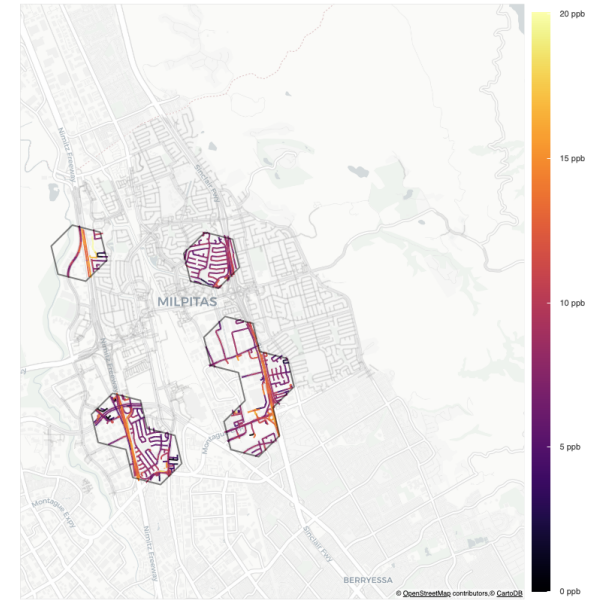


The highlighted hexagons show where NO₂ is highest (in the top 25% of all measurements in the county).

Block Level Results: Milpitas



In the city of Milpitas, the bar charts show the diversity of people who are exposed to worse air and cleaner air.

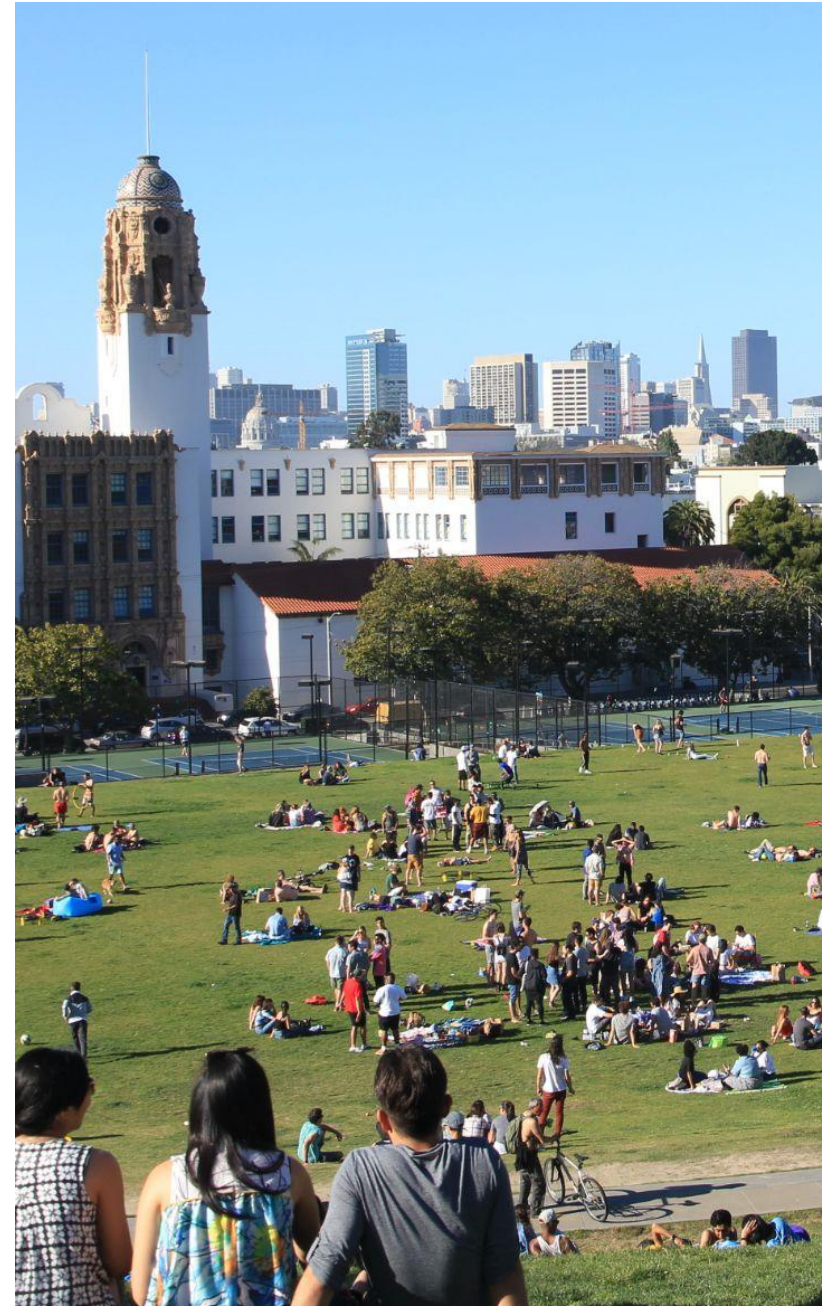


The highlighted hexagons show where NO₂ is highest (in the top 25% of all measurements in the county).

Moving Towards Solutions

We live in a time of extremes — a global climate crisis and rising disparities, combined with historic government budgets for infrastructure and climate action, and private sector mobilization on climate. With the Community Impact and Investment Index, Aclima is bringing a critical tool to regulators, utilities, and community stakeholders — to turn crisis into opportunity. By understanding the precise location of pollution hotspots and cumulative exposure at scale and with granularity, governments and industry can better target interventions and track progress over time.

The Community Impact and Investment Index, exclusively available on the Aclima Pro platform, can help track and locate sources of pollution and catalyze bold climate action that reduces emissions, protects public health, and delivers clean air for all.



Appendix: Glossary

Aclima Mobile Node (AMN): A proprietary temperature-controlled sensing device developed by Aclima, located inside the Aclima Mobile Platform, containing modular, small air pollution sensors that measure air quality and greenhouse gases every second as well as electronics that control and transmit data to Aclima.

Aclima Mobile Platform: A zero- or low-emission vehicle outfitted with Aclima sensors that collects air quality and greenhouse gas measurements block-by-block throughout a specified region.

Aclima Pro: Aclima's professional analytics software, which translates billions of scientific measurements into environmental intelligence for governments, companies, and communities.

air.health: Aclima's free app, which maps address-level air and climate insights for the communities we serve.

Community Impact and Investment Index: A data-driven tool exclusively available in Aclima Pro. It is the only national decision-support tool of its kind, overlaying Aclima's hyperlocal air quality and greenhouse gas data with nationwide urban, climate, community vulnerability and additional socioeconomic data from UrbanFootprint. The Index empowers governments, energy utilities, corporations, and communities with the information they need to understand where air pollution and climate hazards are highest, and guides where they need to deploy investments and mitigation efforts to protect vulnerable communities.

Bay Area Air Quality Management District (BAAQMD): The Bay Area Air Quality Management District is the regional agency responsible for protecting air quality in the nine-county Bay Area.

US Environmental Protection Agency (EPA): The Environmental Protection Agency is an independent executive agency of the United States federal government tasked with environmental protection matters.

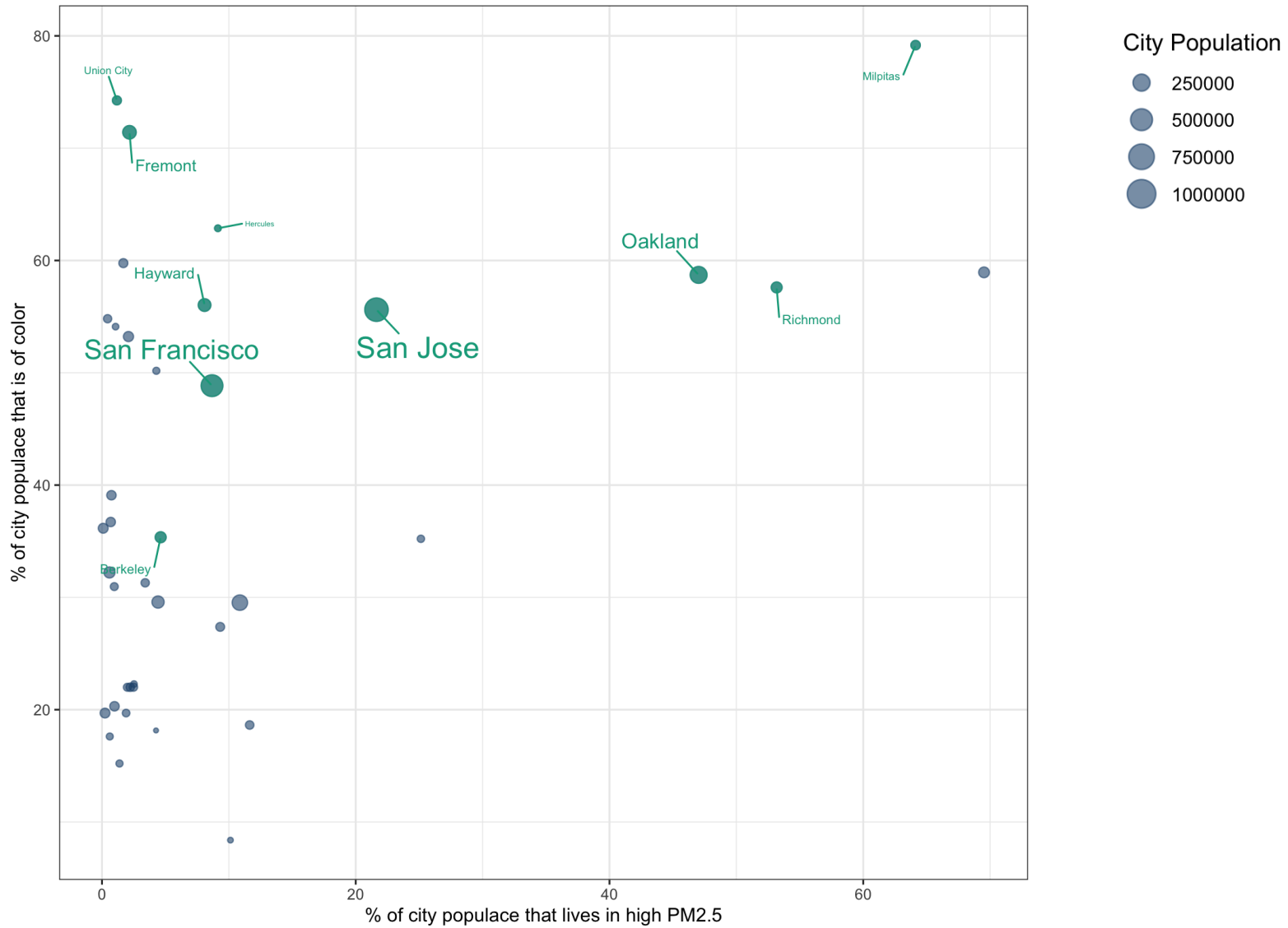
World Health Organization (WHO): A part of the United Nations that deals with major health issues around the world. The World Health Organization sets standards for disease control, health care, and medicines; conducts education and research programs; and publishes scientific papers and reports.

Appendix: Understanding American Community Survey Limitations

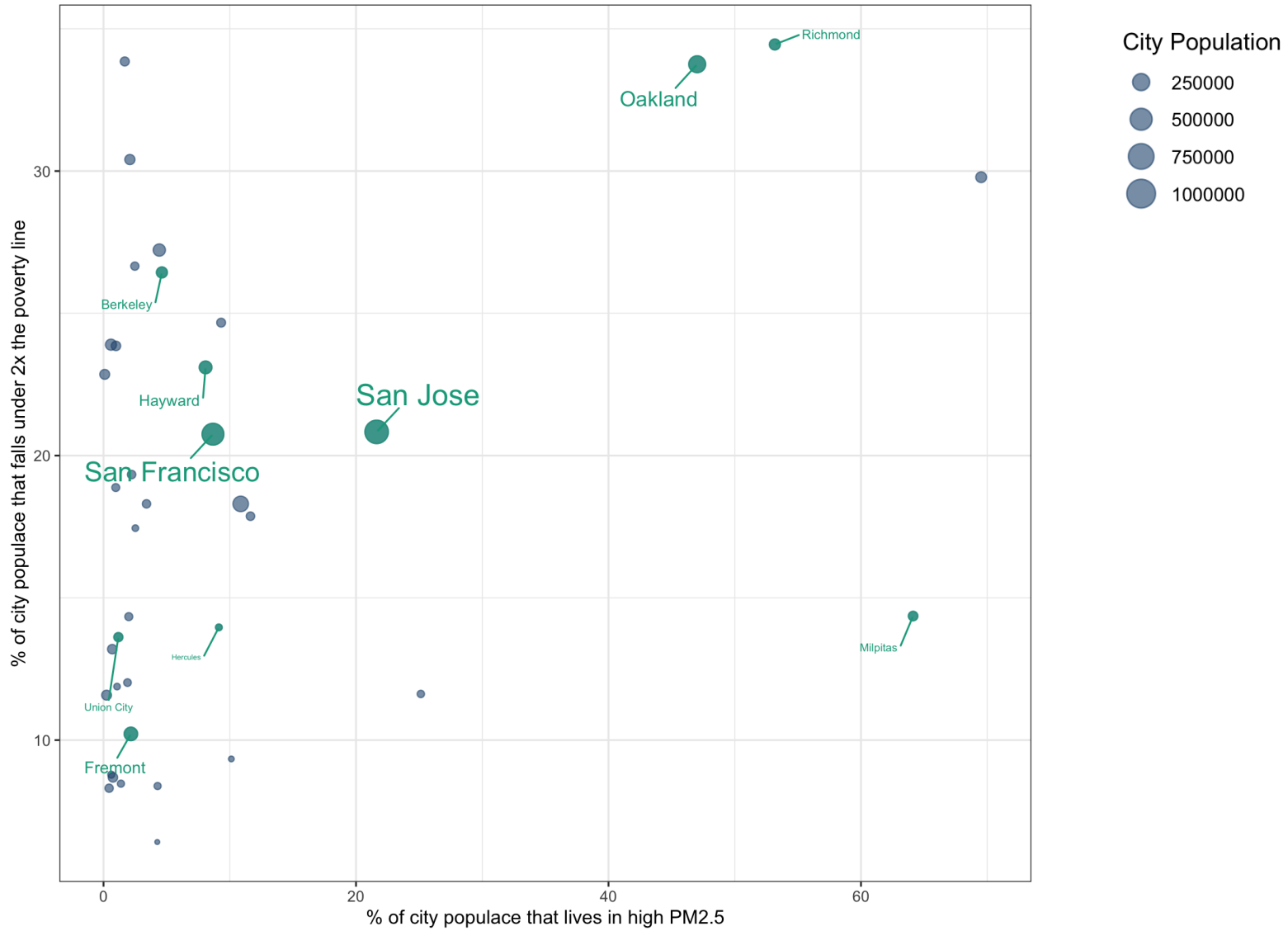
When exploring the details of this analysis, it must be noted that the ACS does not differentiate between Asian ethnicity categories, which is a clear limitation, especially in a region as diverse as the Bay Area where enclaves of differing Asian backgrounds almost certainly experience different air quality that is not captured by this analysis.

Further, we must contemplate the level of ethnic variance which is not highlighted in this analysis. Given historical trends, it is probable that the existing information on ethnicity were intersected with immigration history, it would reveal how pockets of communities that traditionally serve as immigrant hubs may perhaps be disproportionately impacted by pollution than other populations within the city.

Appendix: Air Disparity Charts



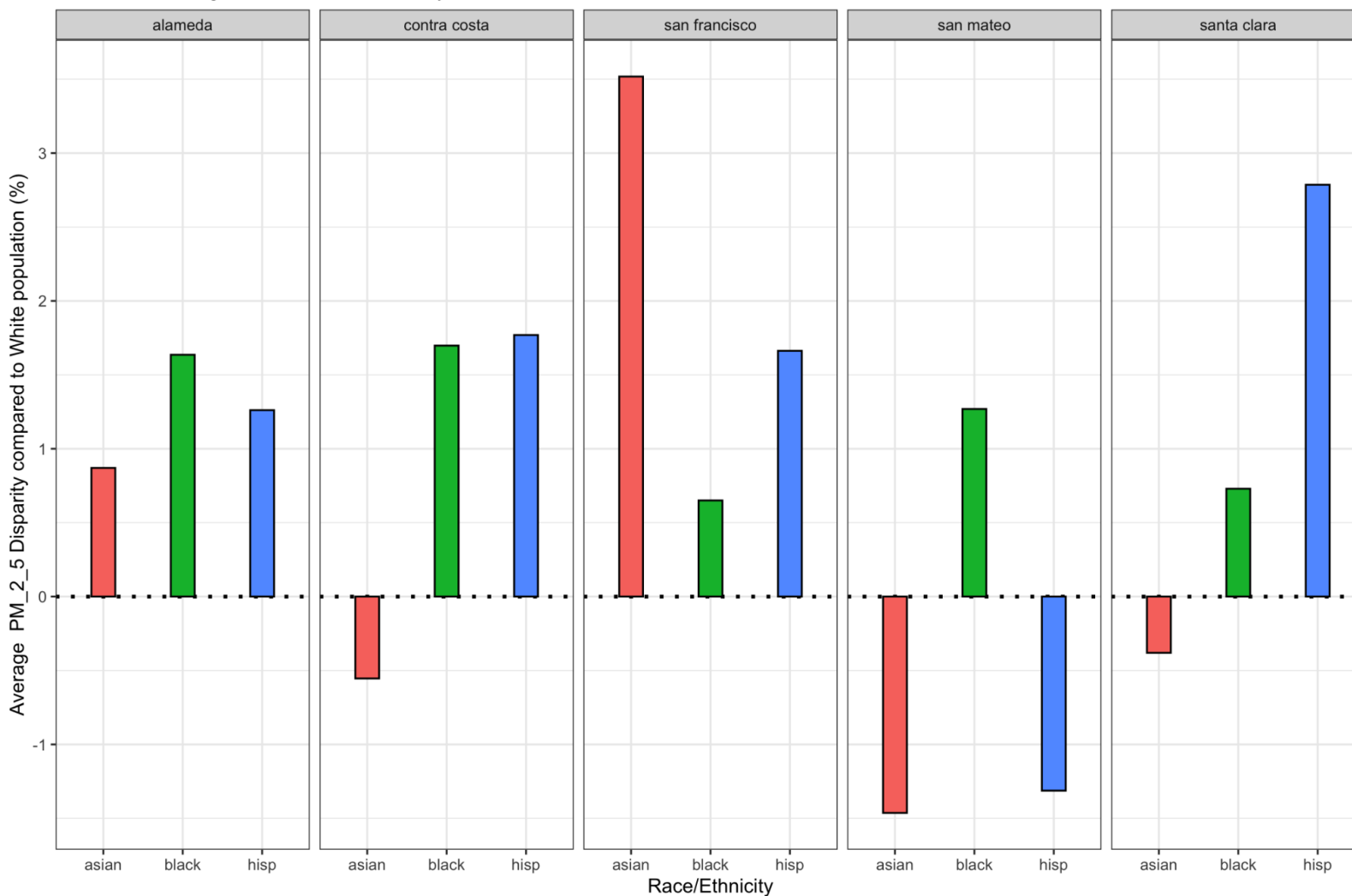
Appendix: Air Disparity Charts



Appendix: Air Disparity Charts

Average PM_{2.5} disparity w.r.t. White population, by county

Each bar is average of all cities within county



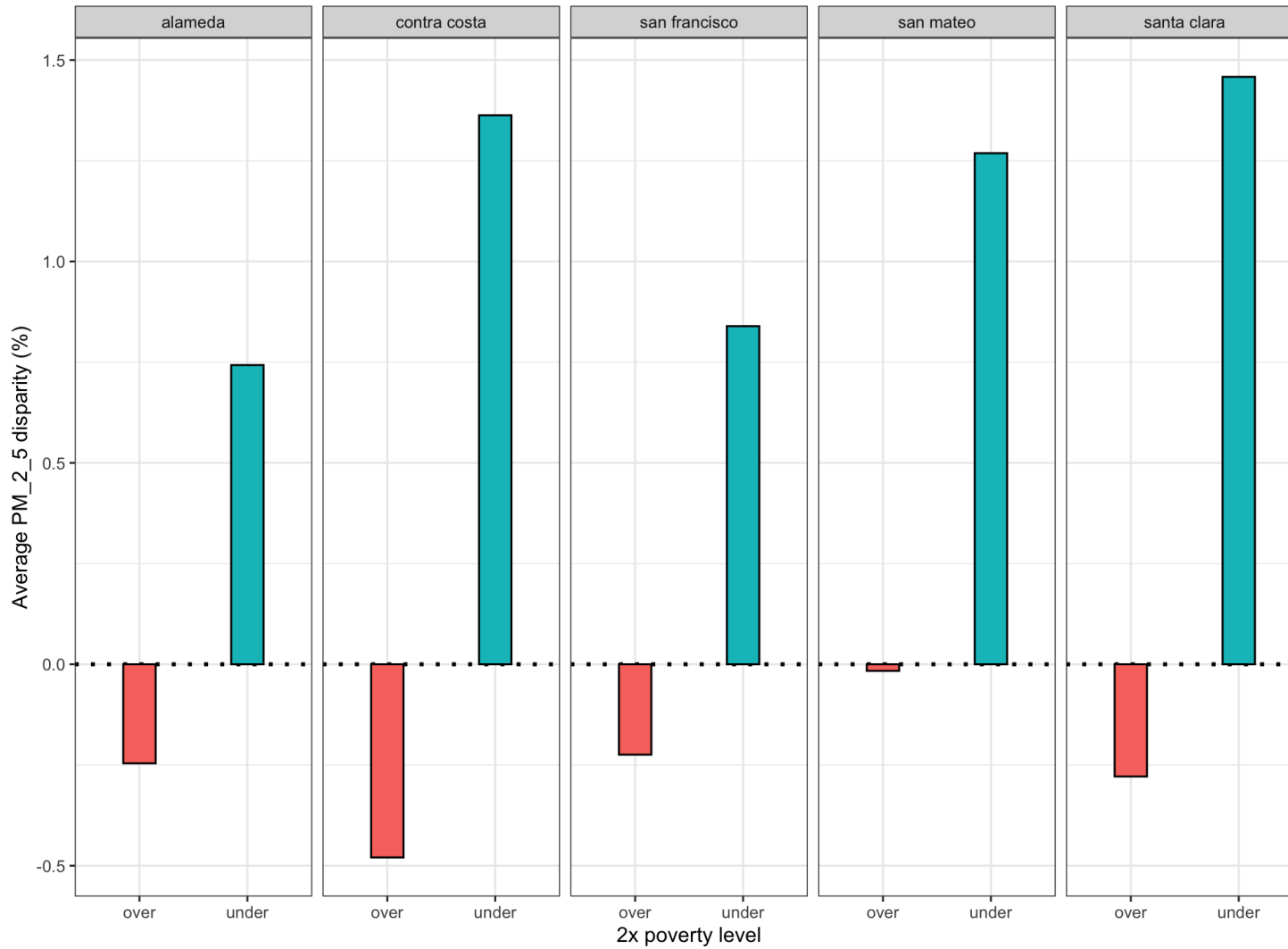
Appendix: Air Disparity Charts

Home ownership statuses of city populace living in cleaner and worse air w.r.t. PM2.5



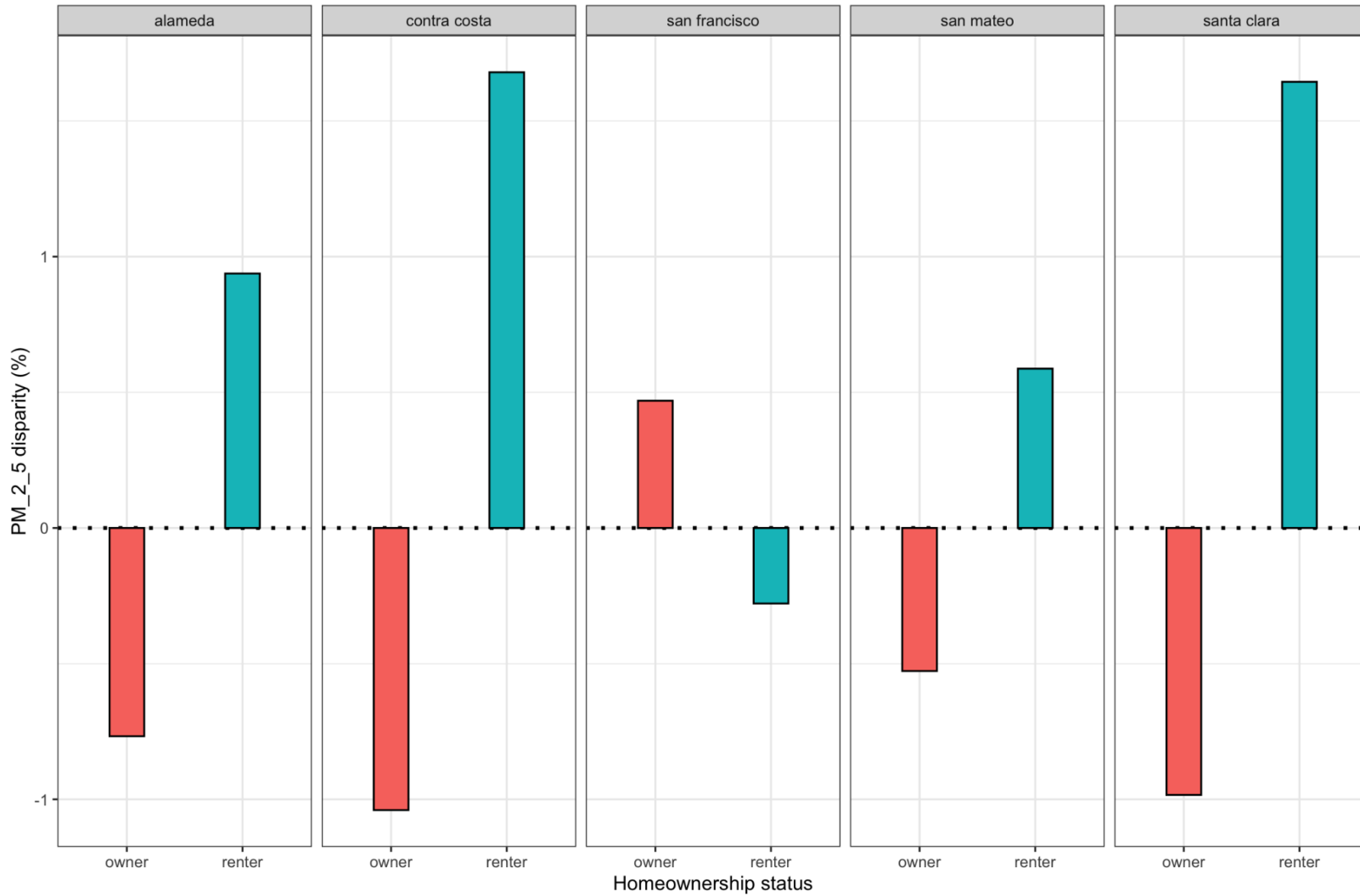
Appendix: Air Disparity Charts

Average PM_{2.5} disparity among two economic groups, by county
Each bar is average of all cities within county

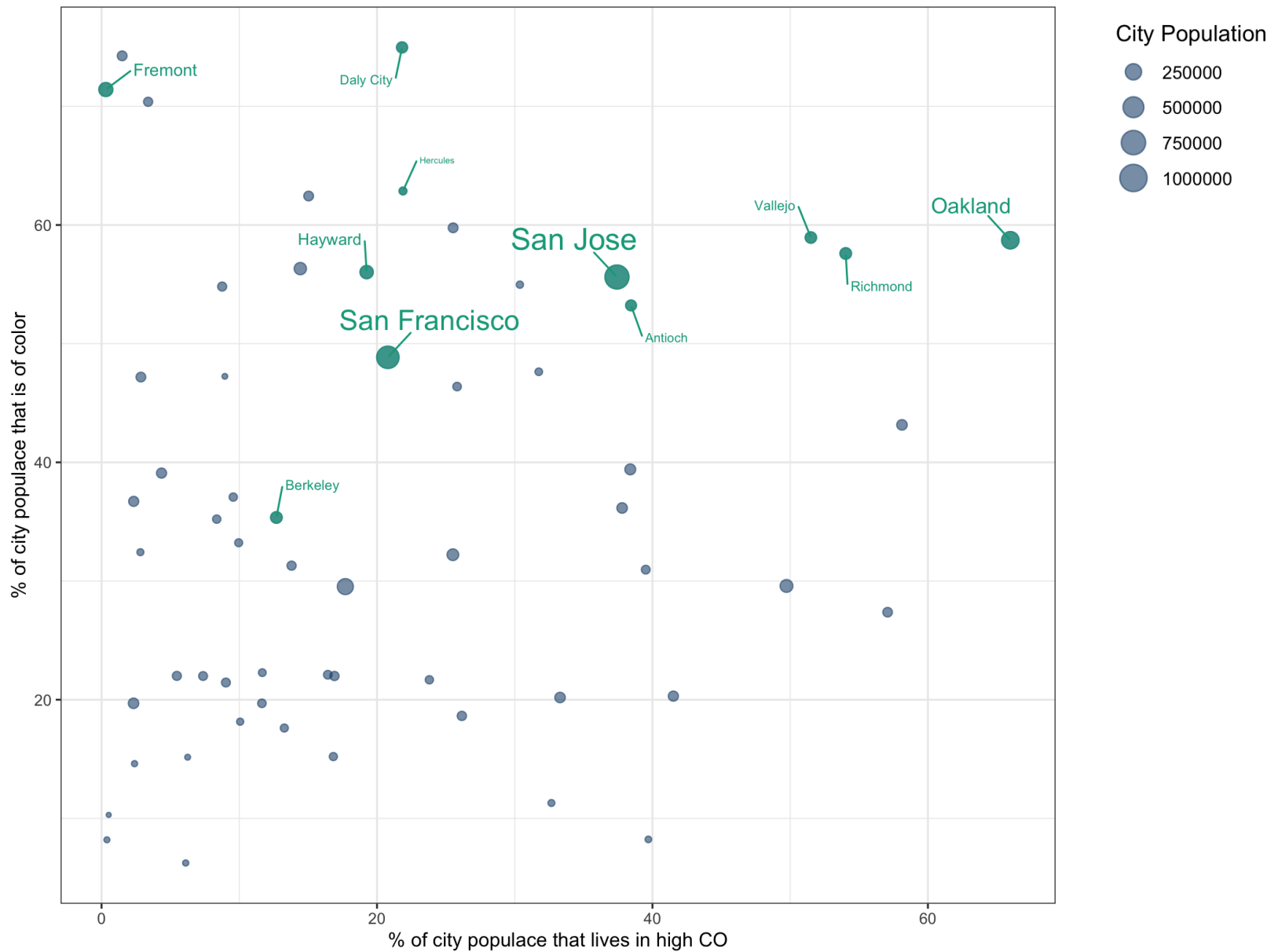


Appendix: Air Disparity Charts

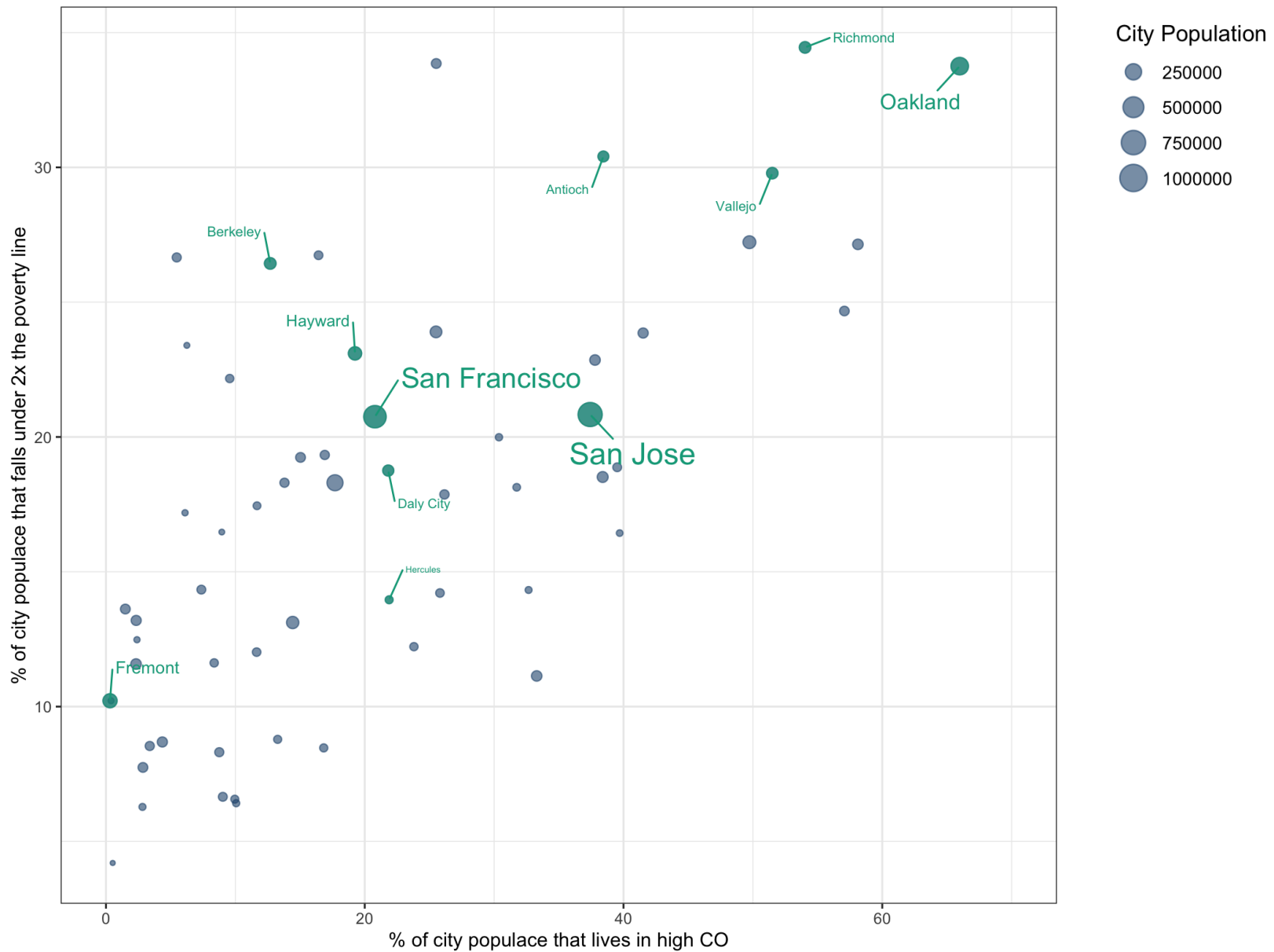
Distribution of PM_{2.5} disparities among two home ownership groups, by county
Each dot is a city, and each box summarizes all cities within county



Appendix: Air Disparity Charts



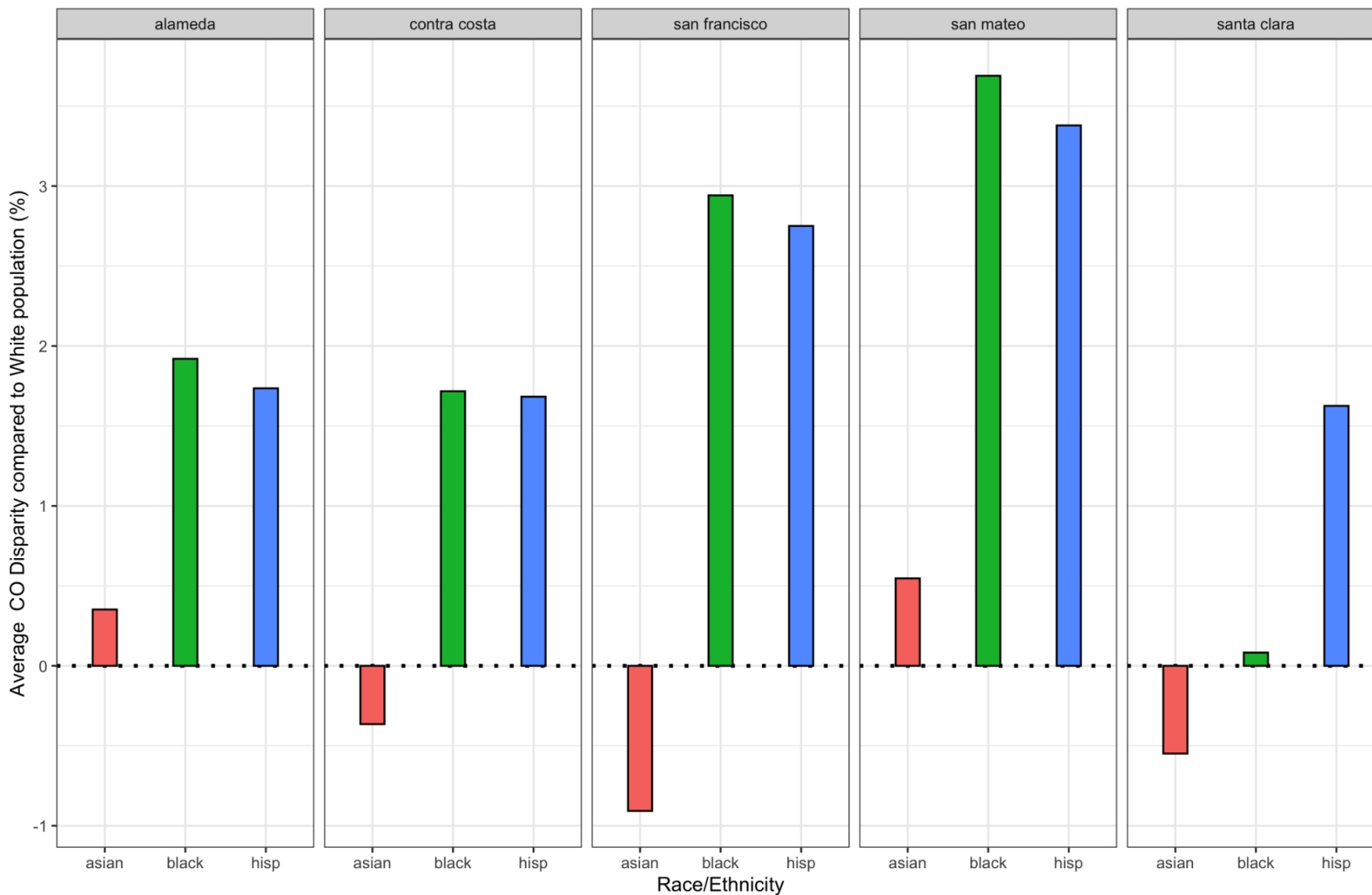
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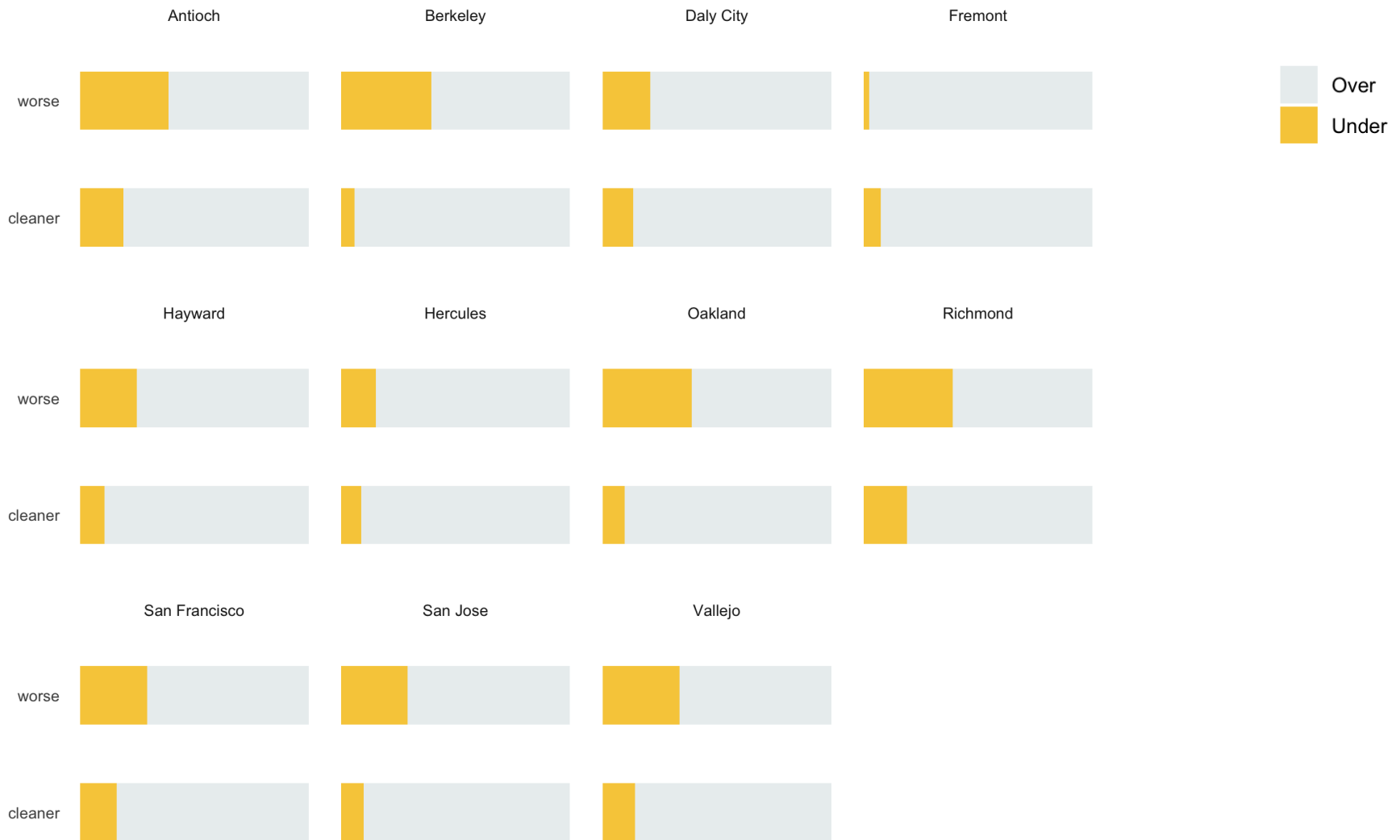
Average CO disparity w.r.t. White population, by county

Each bar is average of all cities within county



Appendix: Air Disparity Charts

Economic status of city populace living in cleaner and worse air w.r.t. CO
 Economic status shown w.r.t. 2x poverty line



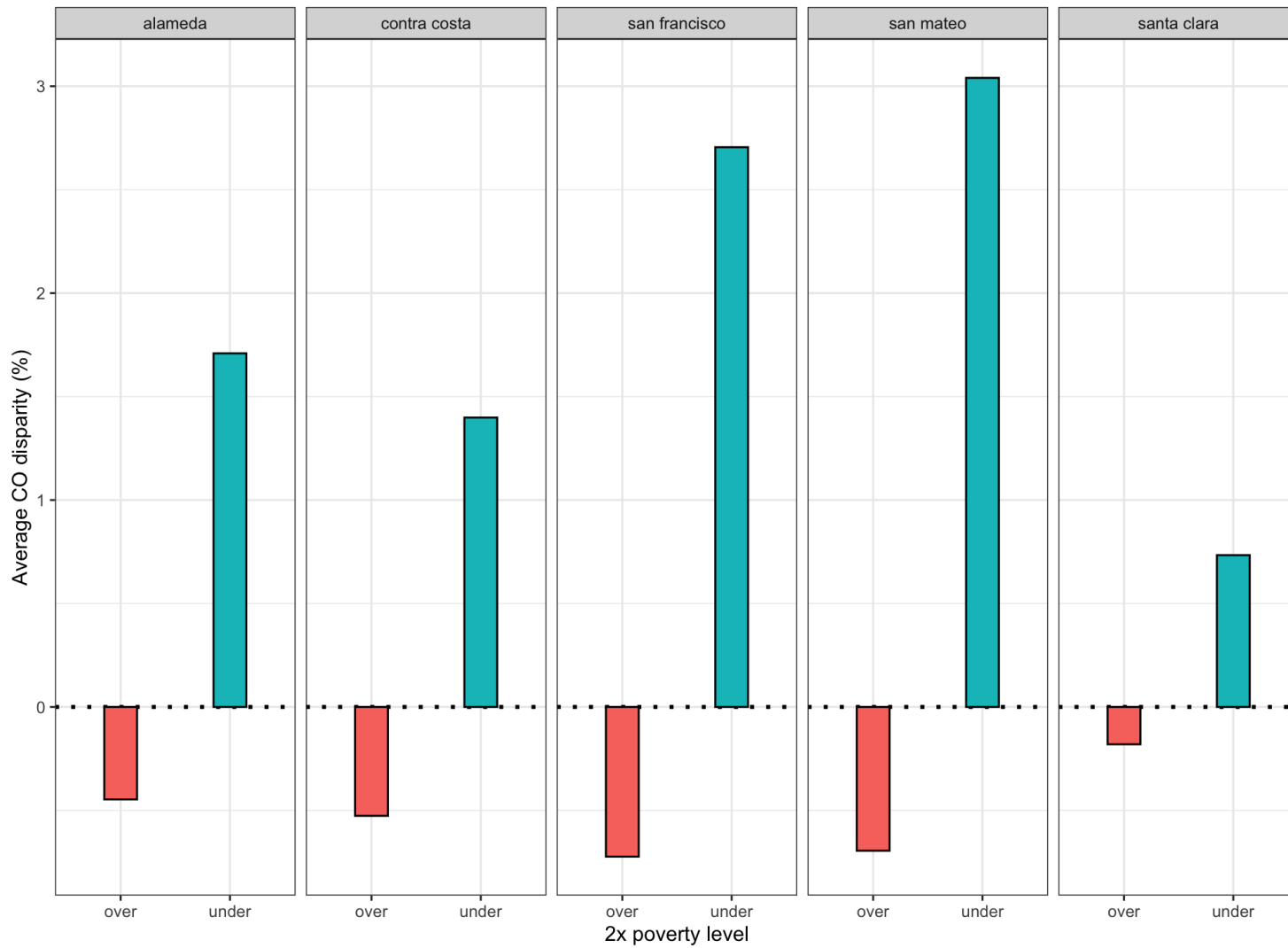
Appendix: Air Disparity Charts

Home ownership statuses of city populace living in cleaner and worse air w.r.t. CO



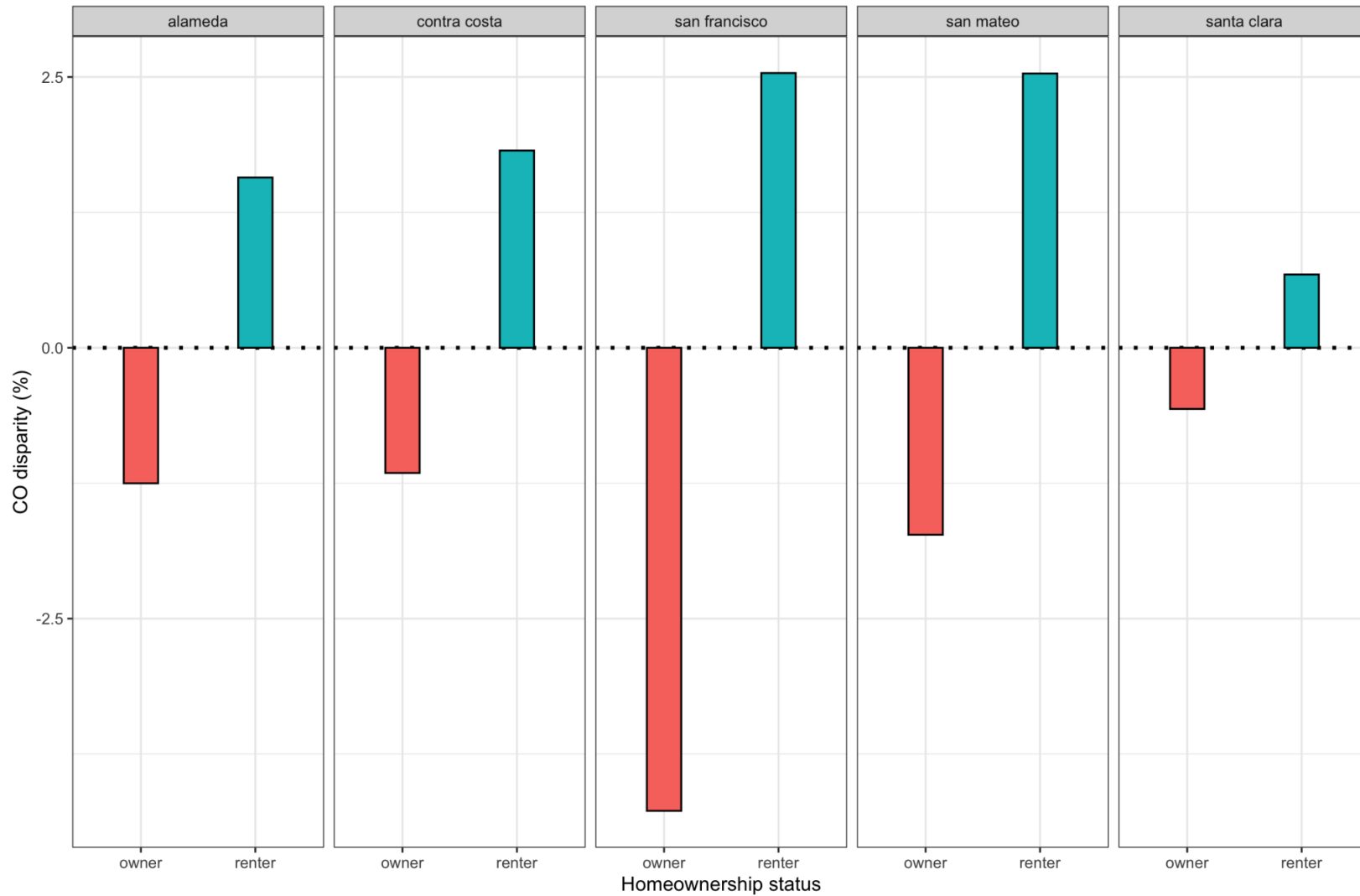
Appendix: Air Disparity Charts

Average CO disparity among two economic groups, by county
Each bar is average of all cities within county



Appendix: Air Disparity Charts

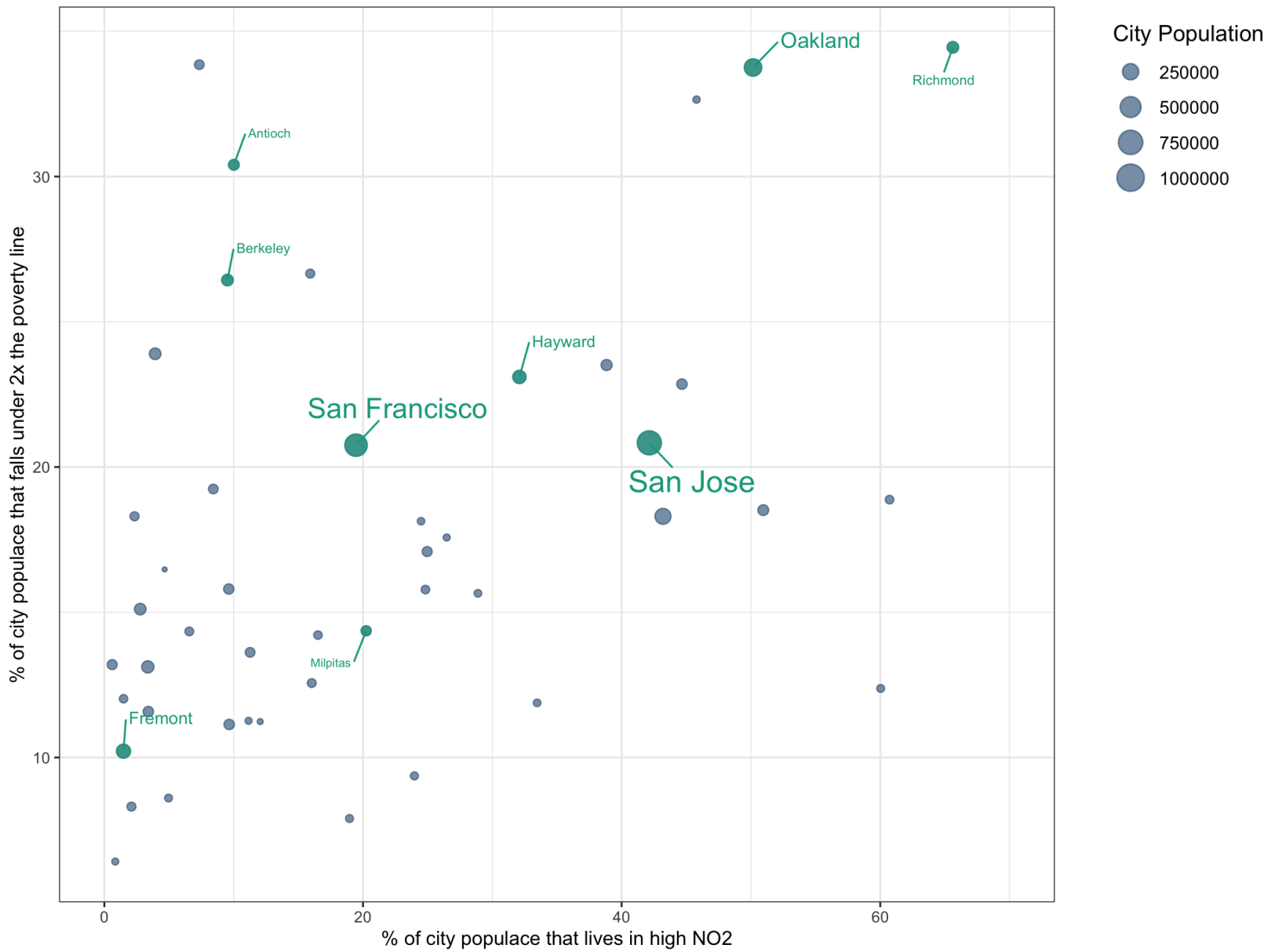
Distribution of CO disparities among two home ownership groups, by county
Each dot is a city, and each box summarizes all cities within county



Appendix: Air Disparity Charts

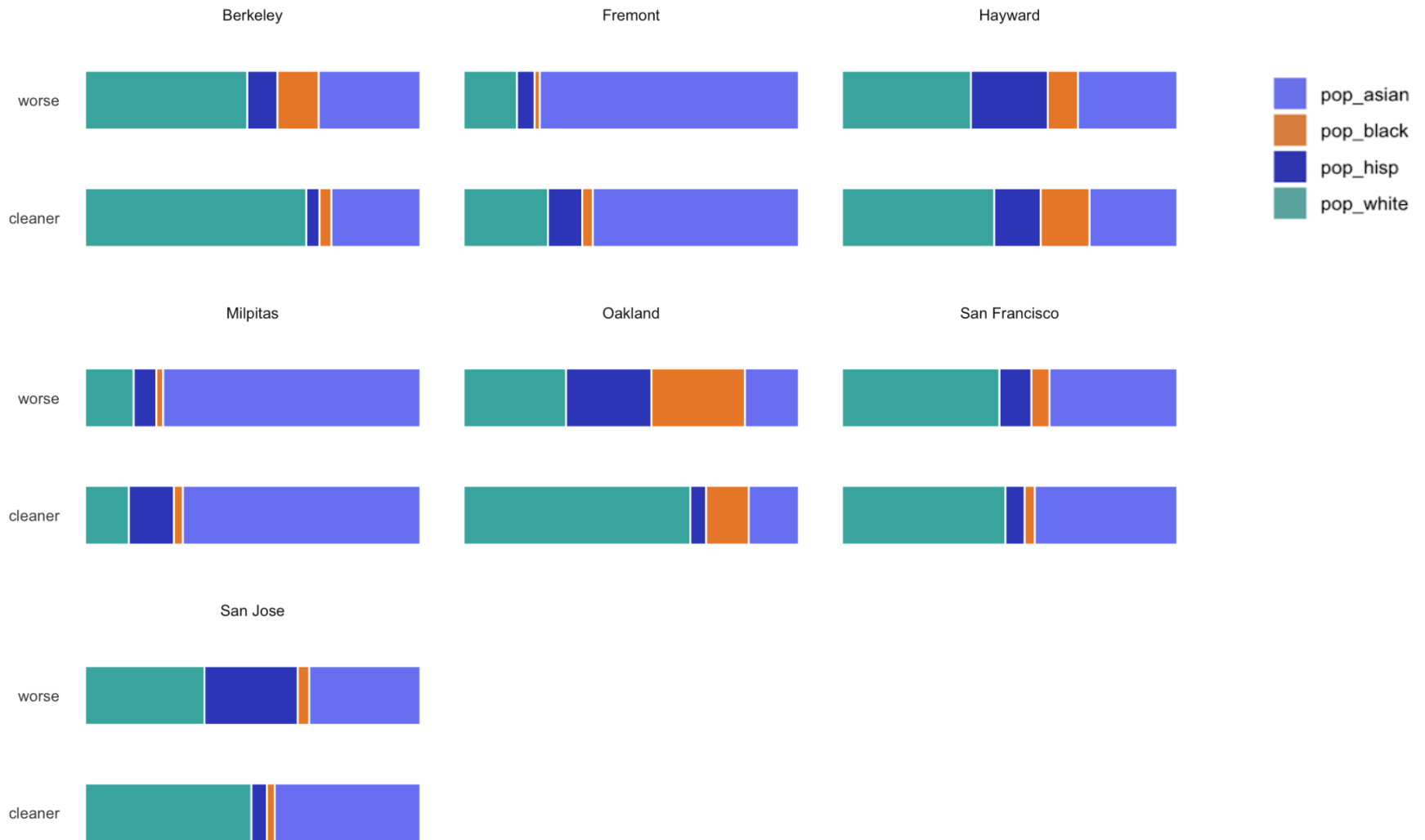


Appendix: Air Disparity Charts



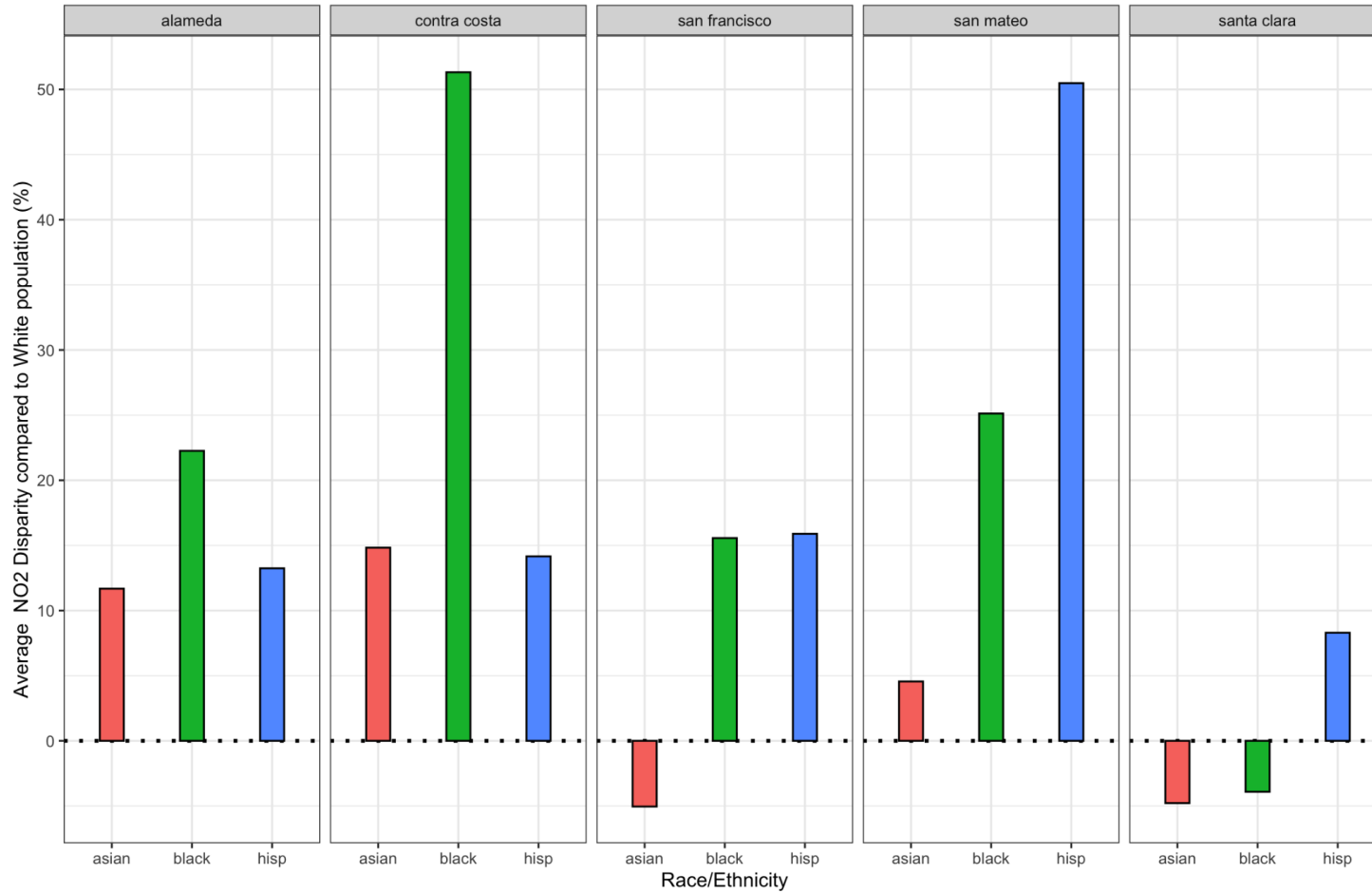
Appendix: Air Disparity Charts

Racial/ethnic mix of city populace living in cleaner and worse air w.r.t. NO2



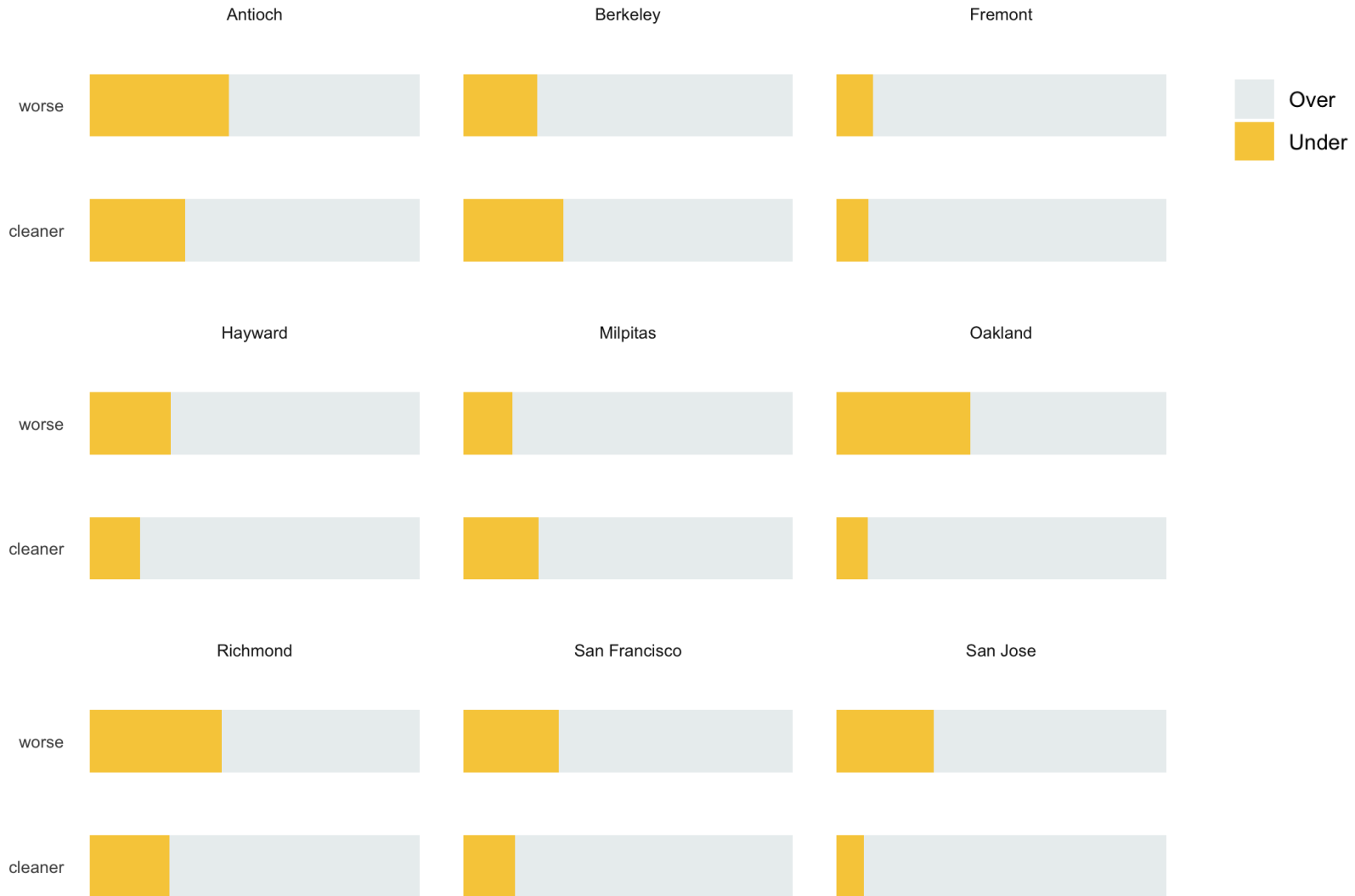
Appendix: Air Disparity Charts

Average NO2 disparity w.r.t. White population, by county
Each bar is average of all cities within county



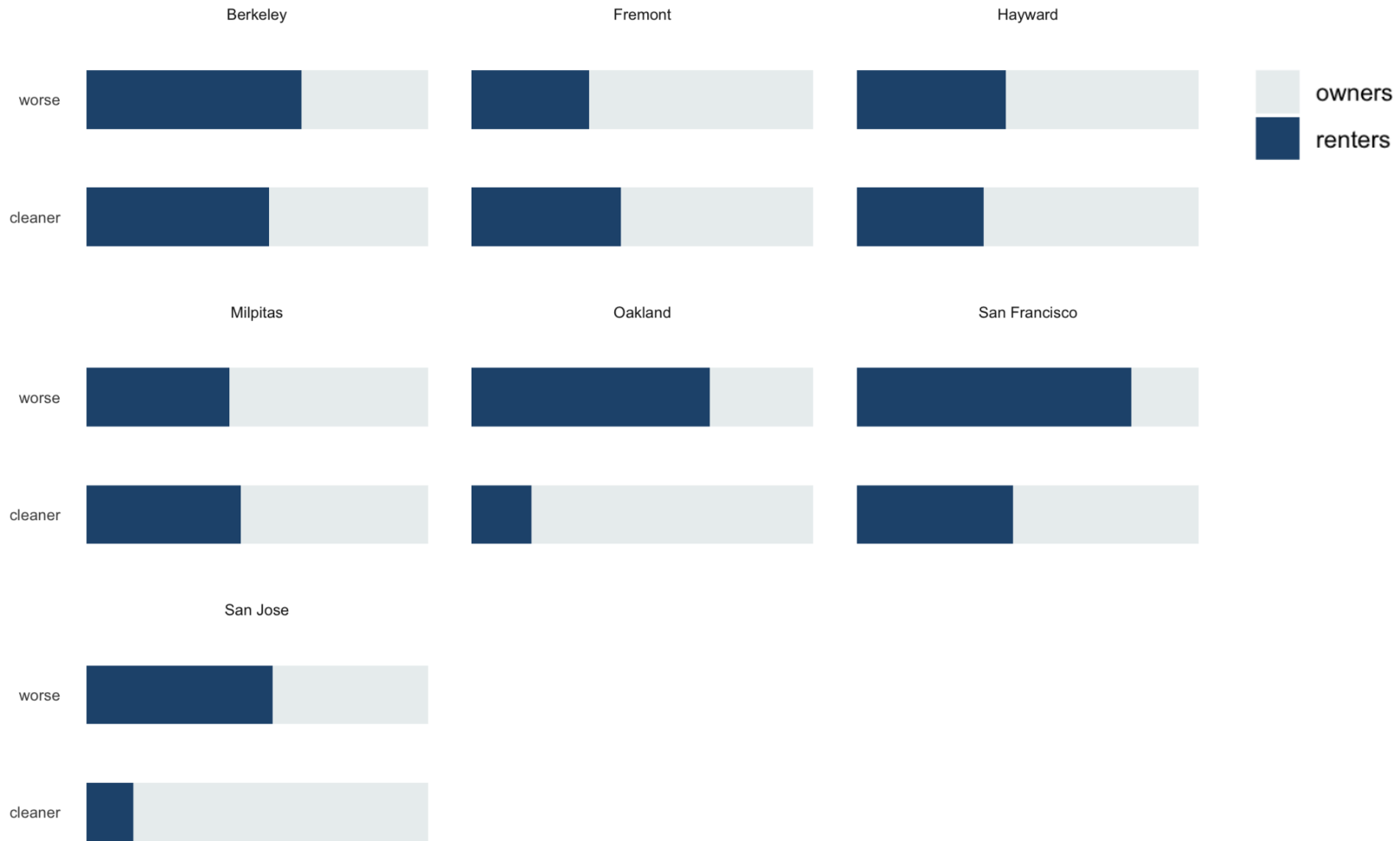
Appendix: Air Disparity Charts

Economic status of city populace living in cleaner and worse air w.r.t. NO2
 Economic status shown w.r.t. 2x poverty line



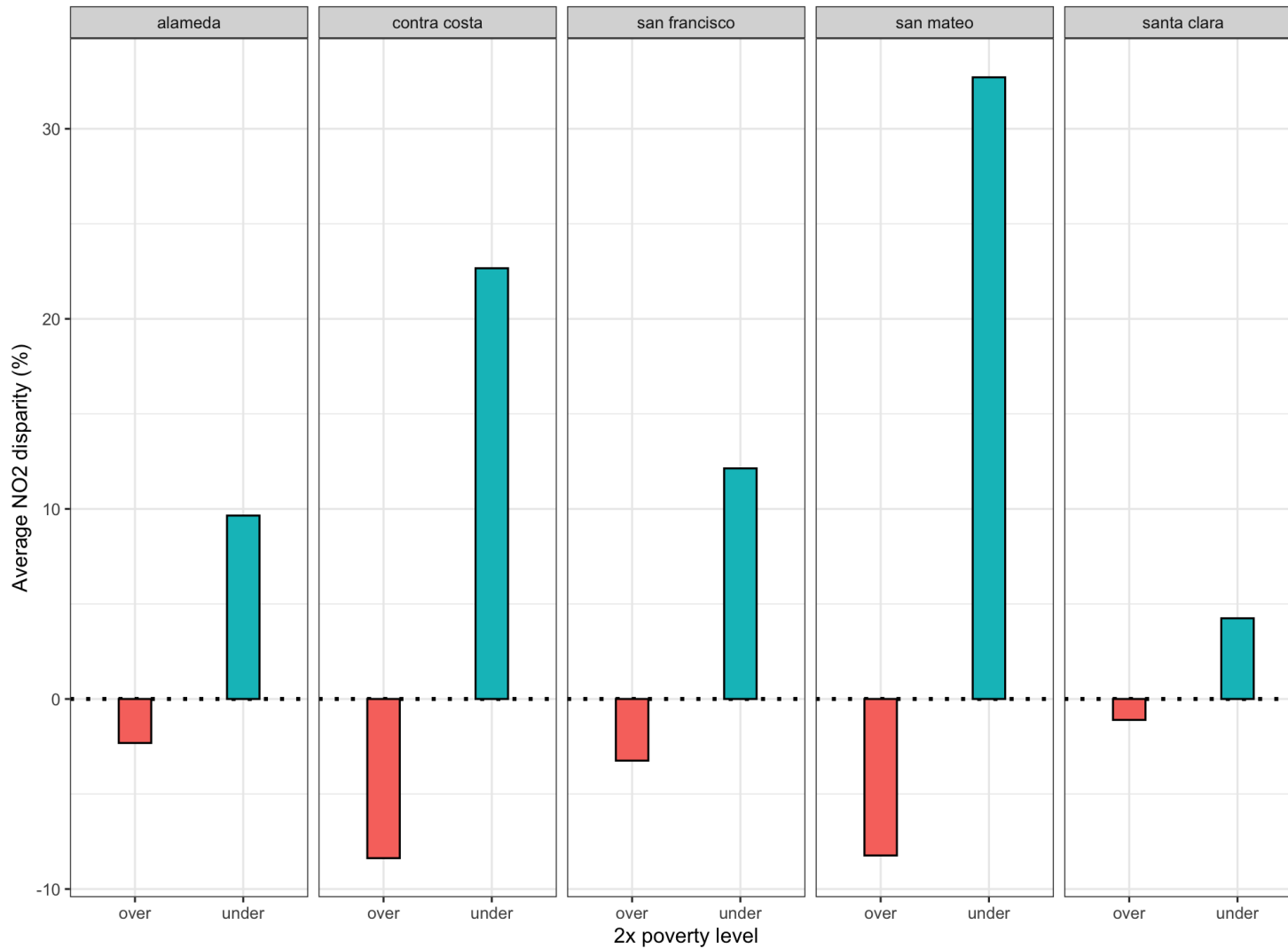
Appendix: Air Disparity Charts

Home ownership statuses of city populace living in cleaner and worse air w.r.t. NO2



Appendix: Air Disparity Charts

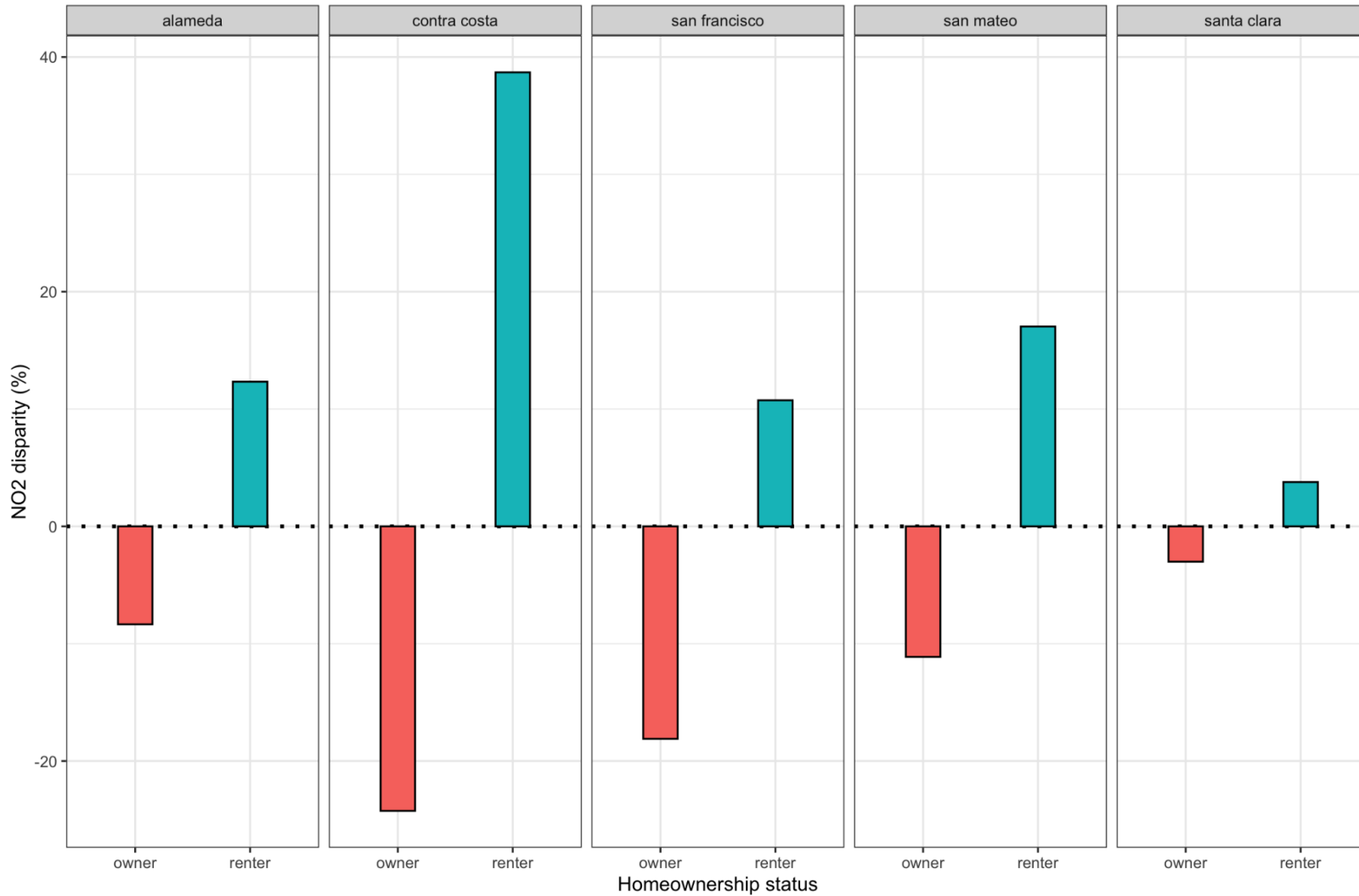
Average NO2 disparity among two economic groups, by county
Each bar is average of all cities within county



Appendix: Air Disparity Charts

Distribution of NO2 disparities among two home ownership groups, by county

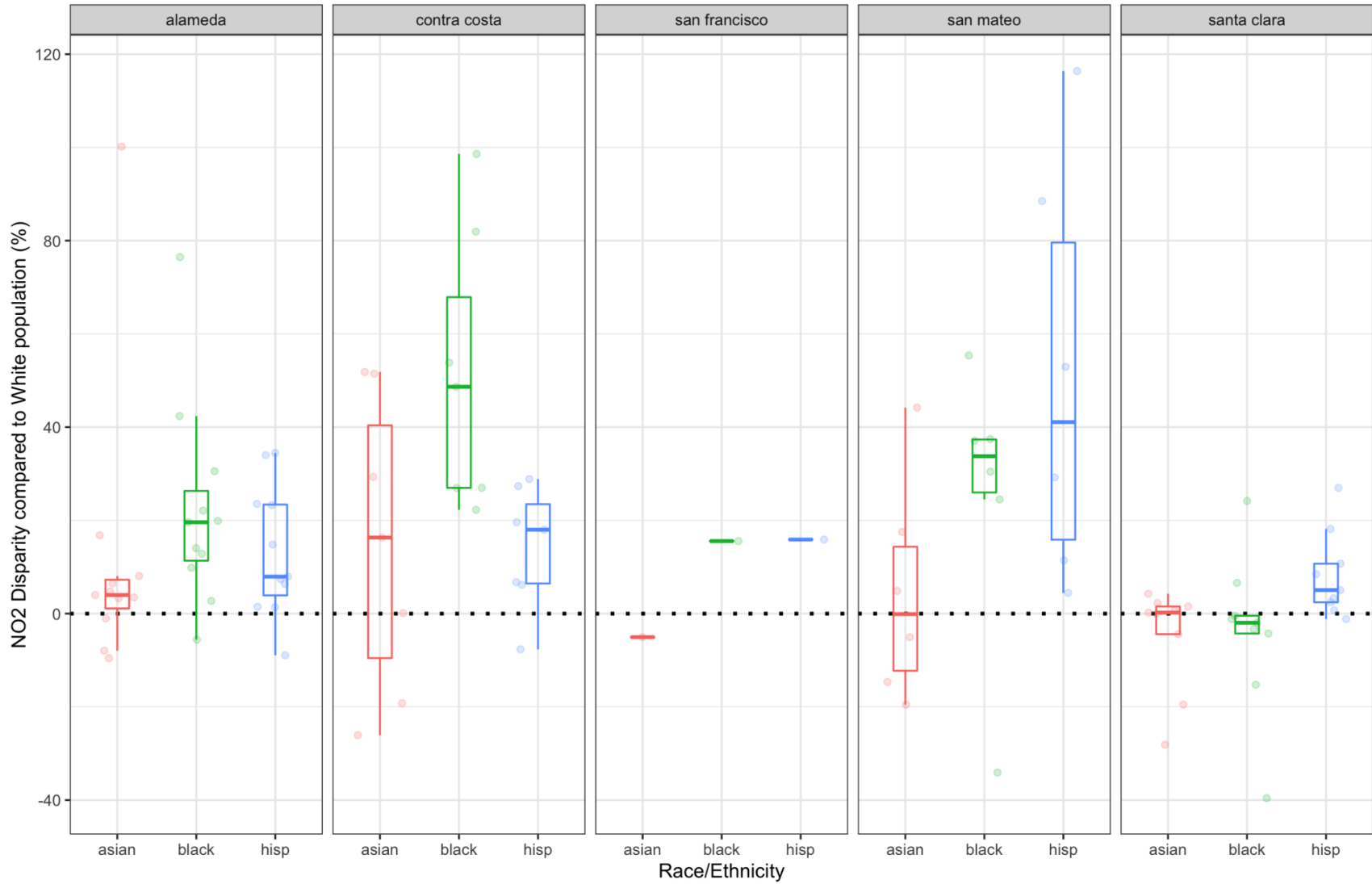
Each dot is a city, and each box summarizes all cities within county



Appendix: Air Disparity Charts

Distribution of NO2 disparities w.r.t. White population, by county

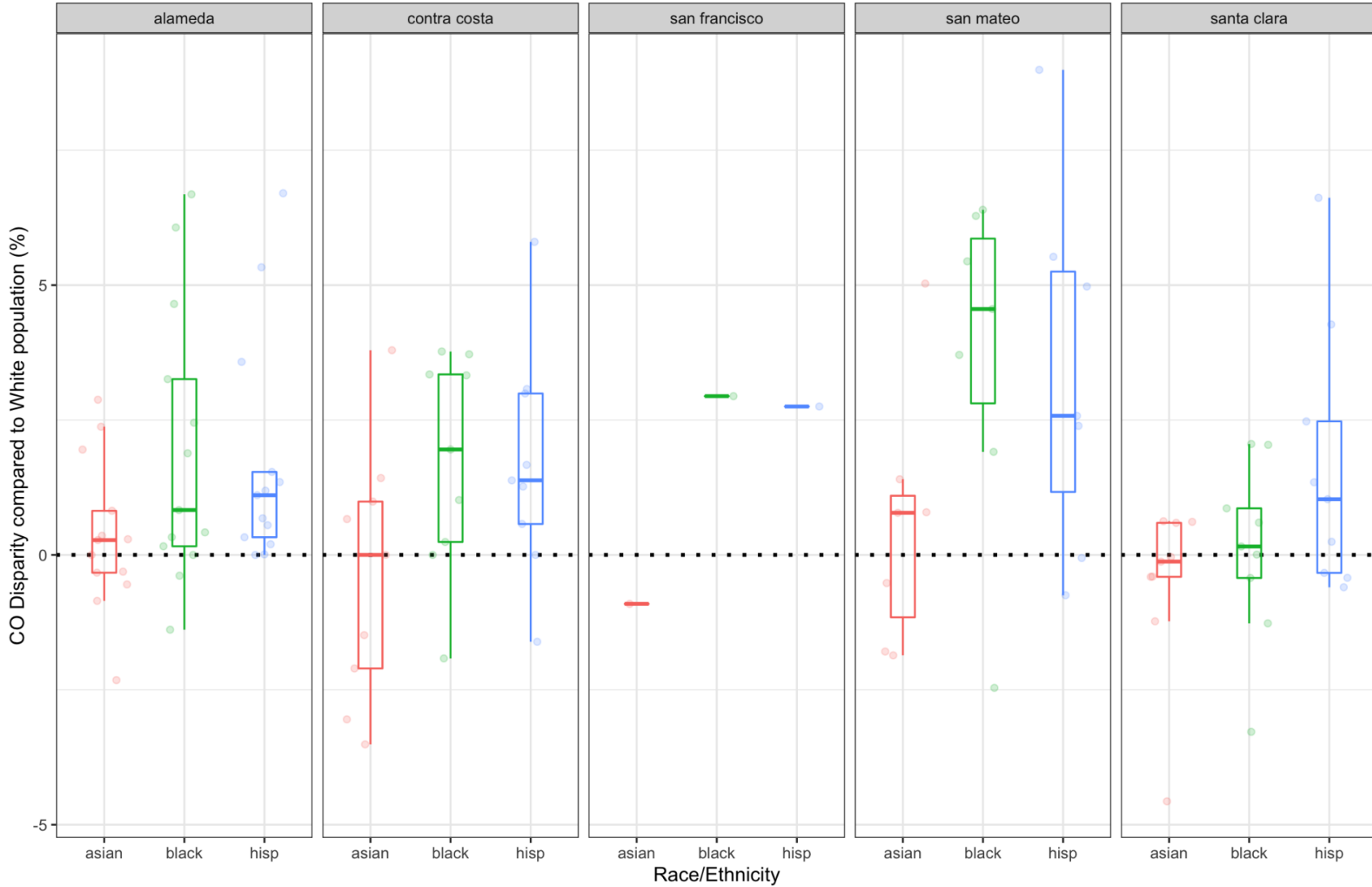
Each dot is a city, and each box summarizes all cities within county



Appendix: Air Disparity Charts

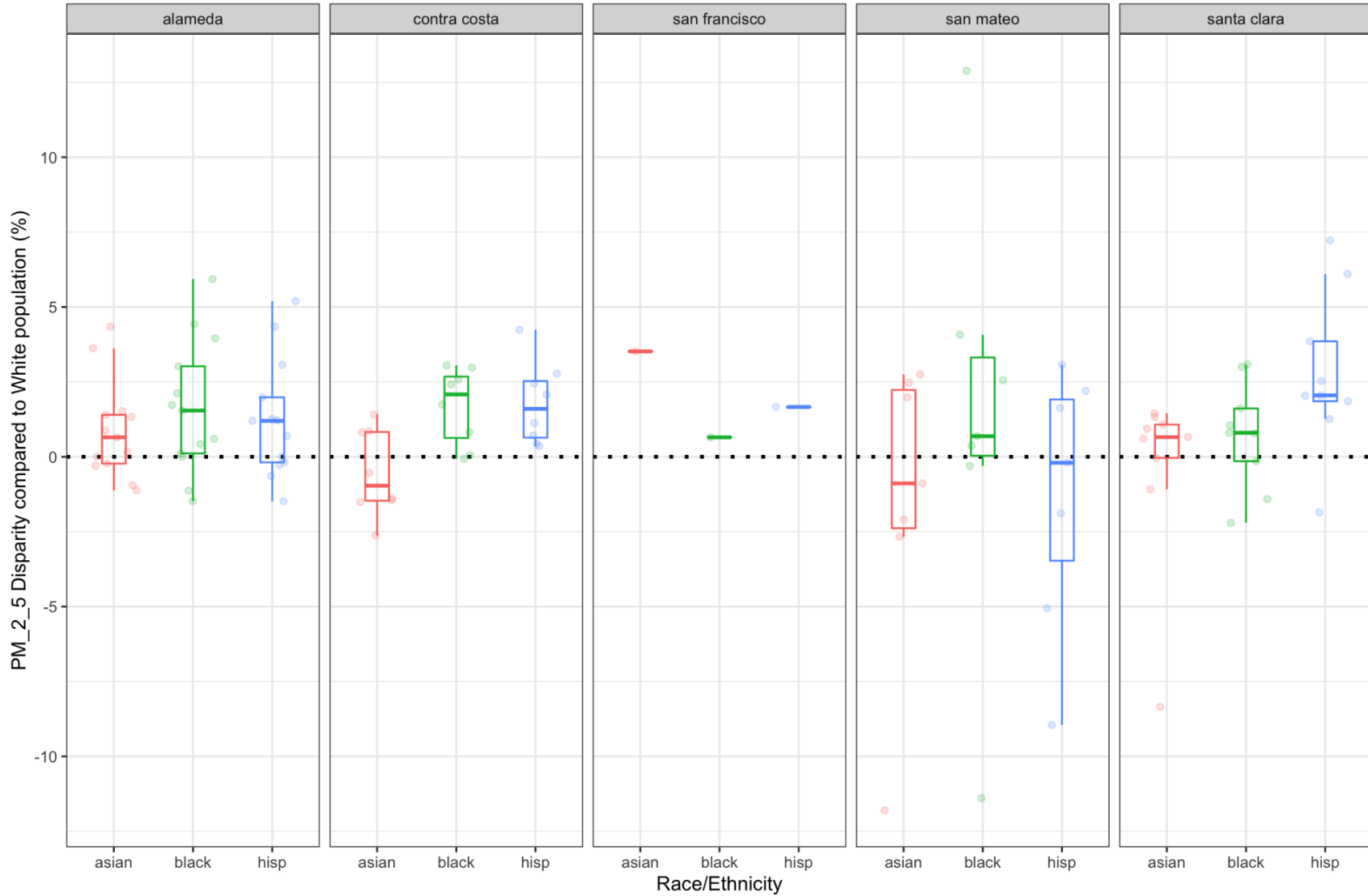
Distribution of CO disparities w.r.t. White population, by county

Each dot is a city, and each box summarizes all cities within county



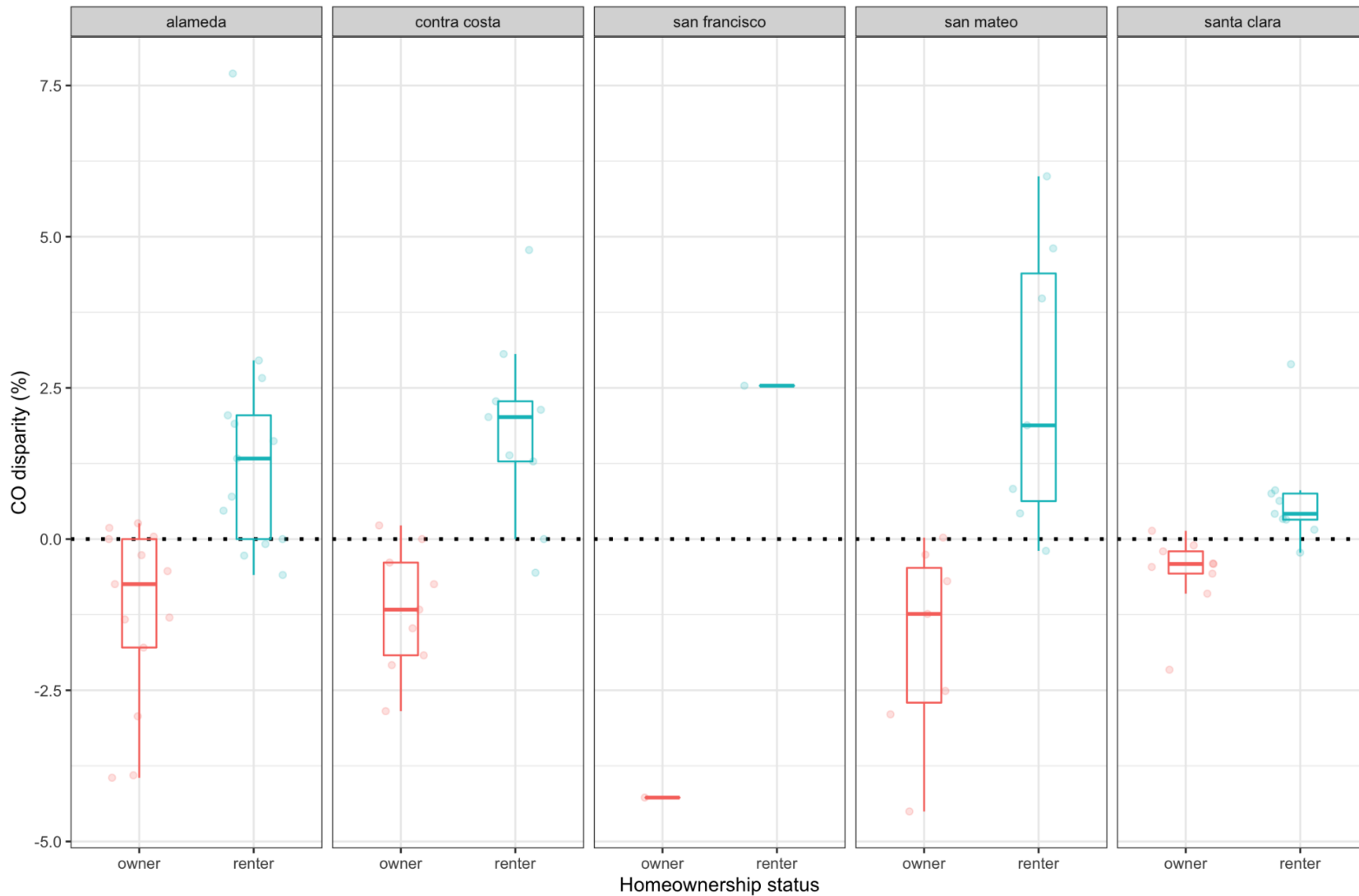
Appendix: Air Disparity Charts

Distribution of PM_{2.5} disparities w.r.t. White population, by county
Each dot is a city, and each box summarizes all cities within county



Appendix: Air Disparity Charts

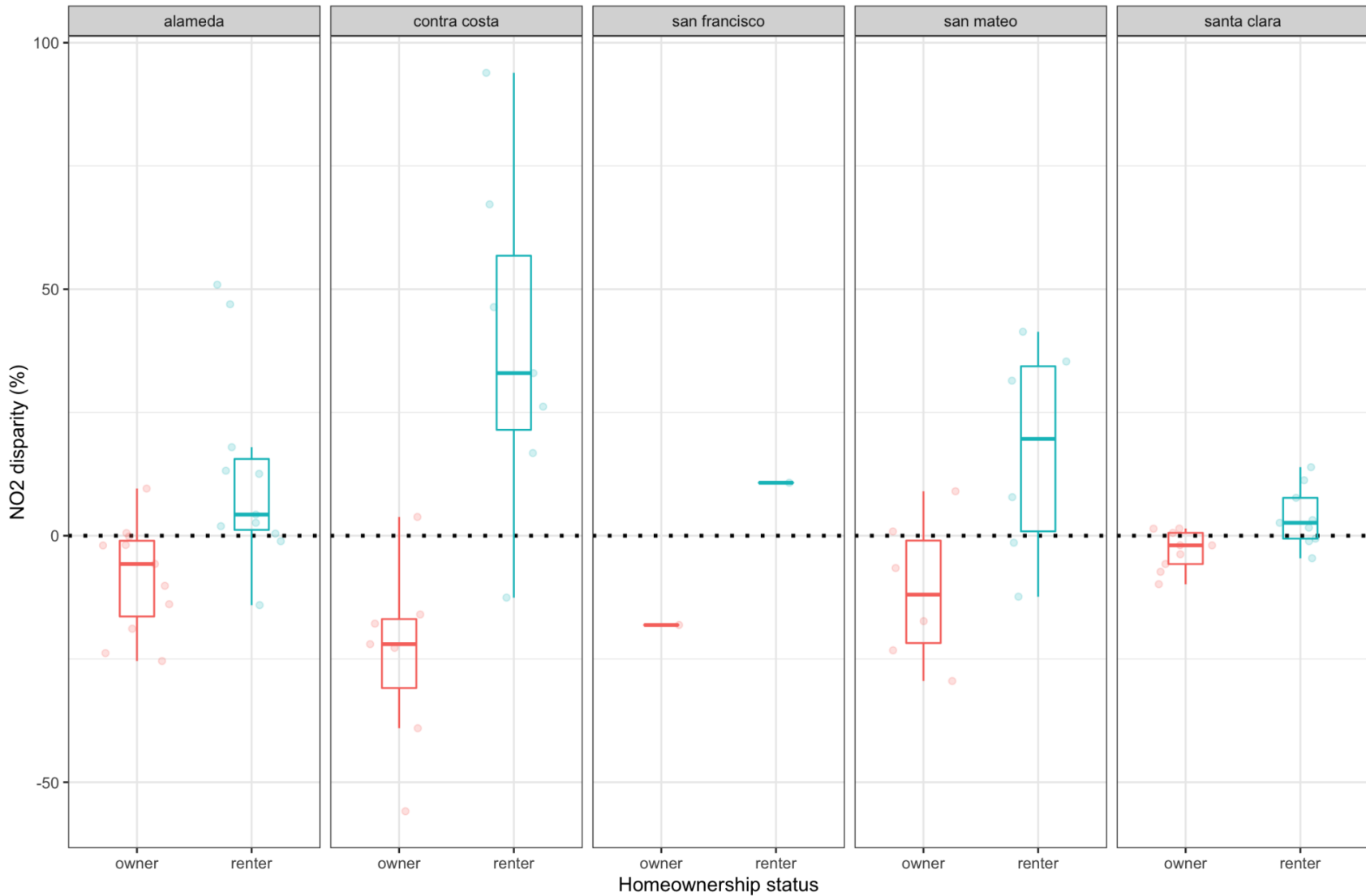
Distribution of CO disparities among two home ownership groups, by county
Each dot is a city, and each box summarizes all cities within county



Appendix: Air Disparity Charts

Distribution of NO2 disparities among two home ownership groups, by county

Each dot is a city, and each box summarizes all cities within county



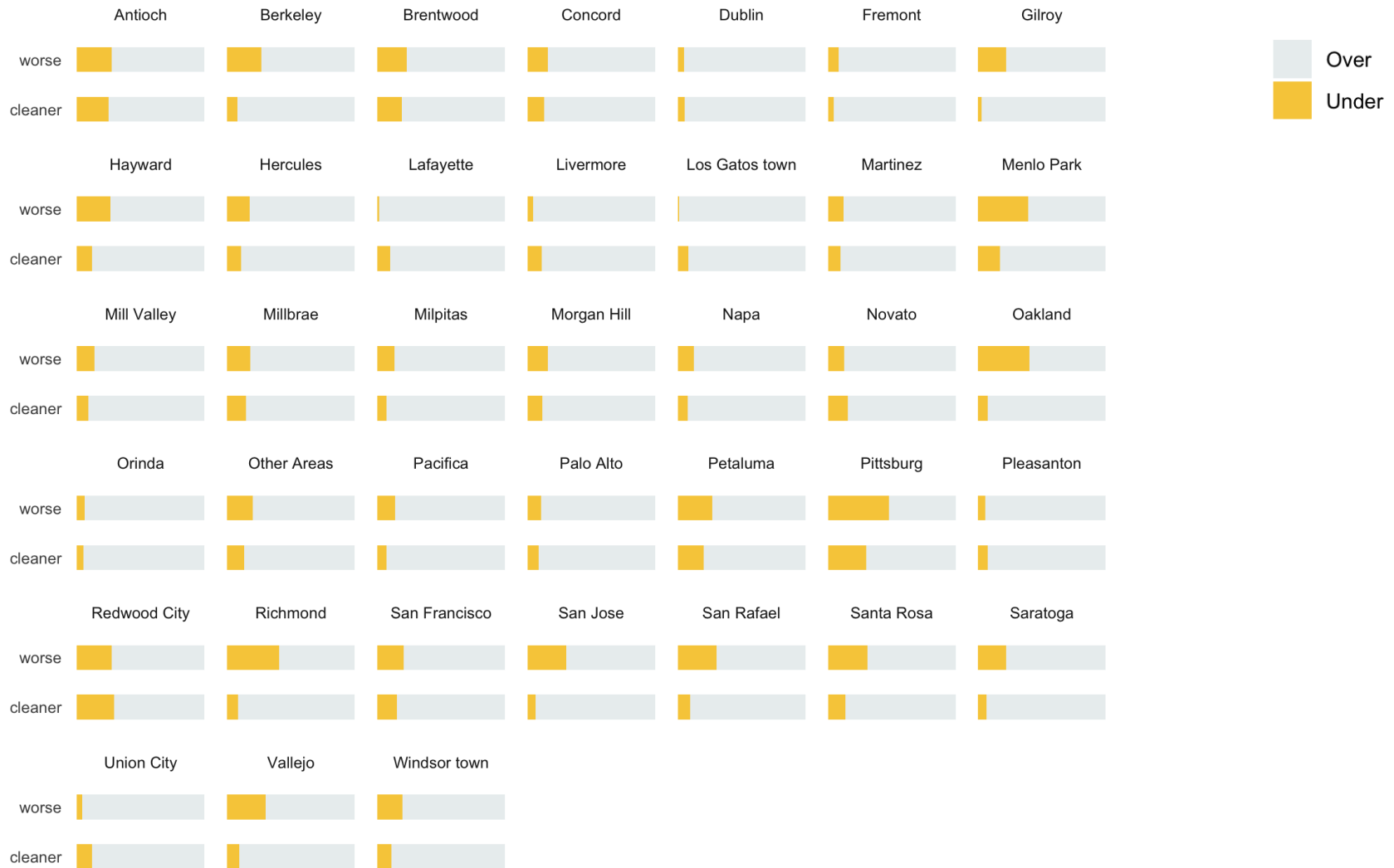
Appendix: Air Disparity Charts

Racial/ethnic mix of city populace living in cleaner and worse air w.r.t. PM2.5



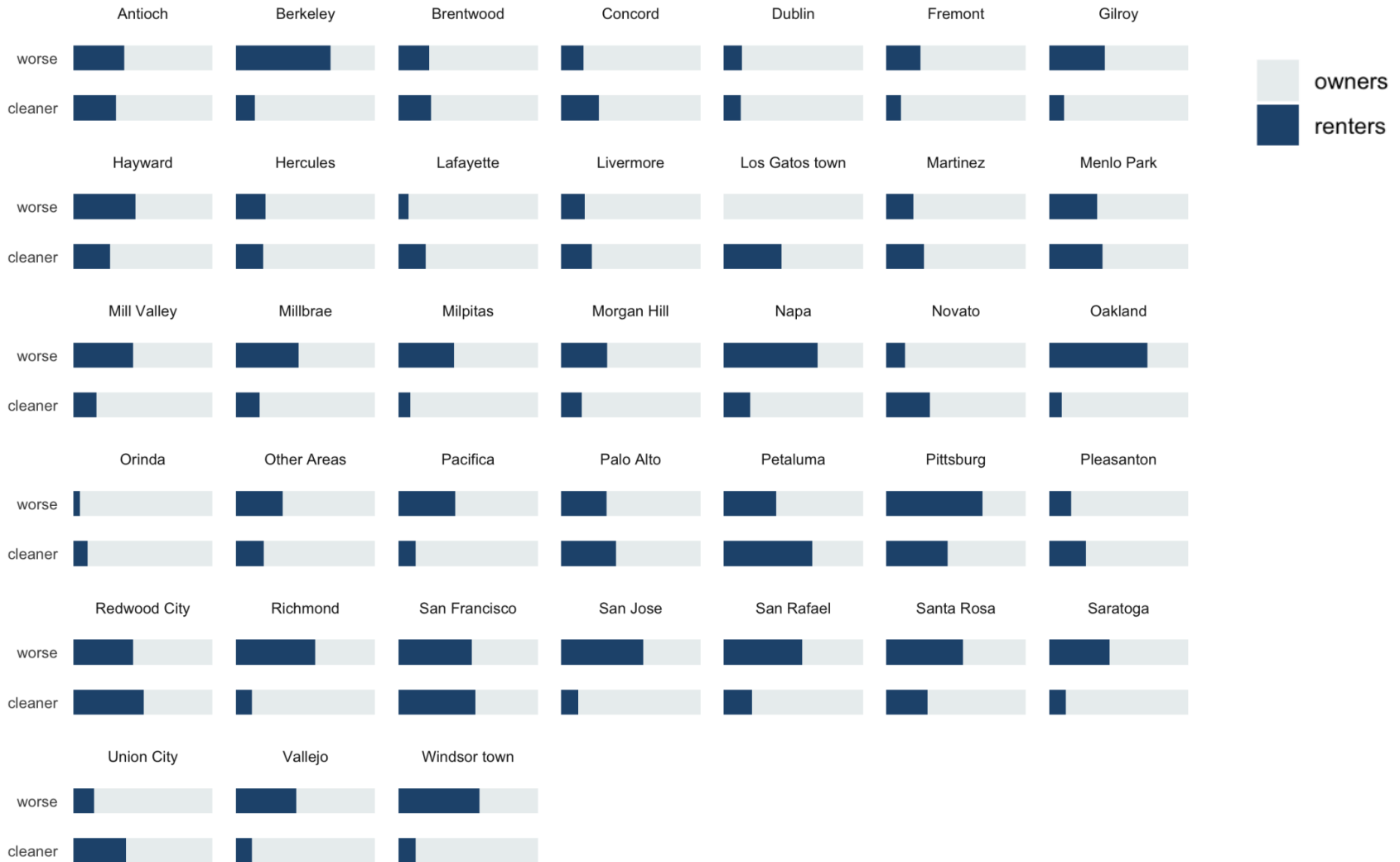
Appendix: Air Disparity Charts

Economic status of city populace living in cleaner and worse air w.r.t. PM2.5
 Economic status shown w.r.t. 2x poverty line



Appendix: Air Disparity Charts

Home ownership statuses of city populace living in cleaner and worse air w.r.t. PM2.5



Appendix: Air Disparity Charts

Racial/ethnic mix of city populace living in cleaner and worse air w.r.t. CO



Appendix: Air Disparity Charts

Economic status of city populace living in cleaner and worse air w.r.t. CO
 Economic status shown w.r.t. 2x poverty line



Appendix: Air Disparity Charts

Home ownership statuses of city populace living in cleaner and worse air w.r.t. CO



Appendix: Air Disparity Charts

Racial/ethnic mix of city populace living in cleaner and worse air w.r.t. NO2



Appendix: Air Disparity Charts

Economic status of city populace living in cleaner and worse air w.r.t. NO2
Home ownership statuses of city populace living in cleaner and worse air w.r.t. NO2



