Response to CARB RFI

2023CARB_SMMI-RFI001

October 2023

Prepared by Herve Borrel, CEO of Airlib Inc.

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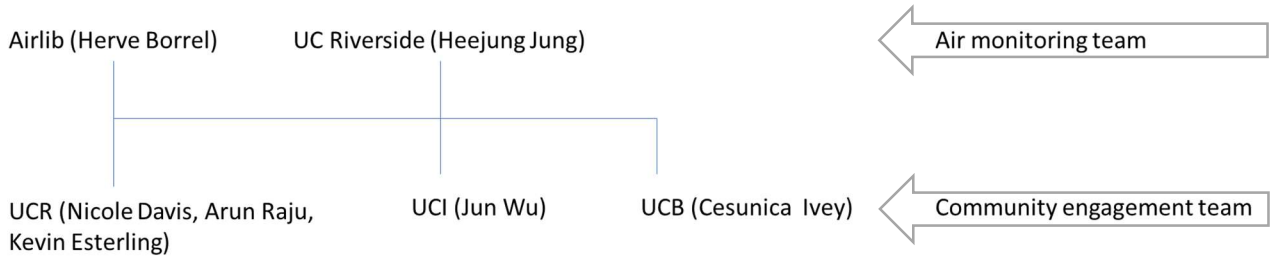
I certify that the responses provided in this document are true and accurate to the best of my knowledge.

Attachment A: Vendor profile

1. Airlib Inc. 12820 N 103rd pl Scottsdale AZ 85260 Tel: (832) 283 64 81
   AND
   University of California, Riverside, 900 University Ave, Riverside, CA

2. Main contact: Herve Borrel, CEO herveborrel@airlib.co,
   Secondary contact: Heejung Jung, Technical Advisor, Professor at the University of California, Riverside, heejung@engr.ucrc.edu

Team organization chart



3. Airlib is a software company specializing in creating real-time hyper-local air quality maps using a network of vehicles (or mobile platforms) equipped with air quality sensors. The company aims to use the real time air quality map to reduce exposure to air pollutants. The company's main application is a connected service to car HVAC systems, using real-time air quality maps to manage the cabin air intake. One of the other applications (or service) is providing optimum air quality routes (walk, bike or drive) to the public based on real-time air quality maps.

   Airlib was founded in October 2015.
   Clients include cities, air quality organizations, car manufacturers, tier 1 suppliers to car manufacturers, mapping companies and individuals.

4. The company is privately owned and independent. It does not have any subsidiaries. The company currently has 3 employees and works with independent contractors and technical advisors (including Professor Heejung Jung) on a case by case basis.

   The company collects air quality data using low cost air quality sensors on-board regular cars (taxis, personal cars, ride-hailing cars etc.) and create near real-time hyper-local air quality maps. The company's main market is automotive air quality. Airlib offers a real-time connected service to cars that optimizes cabin air intake to minimize car users exposure to traffic pollution. Airlib's map are also intended for consumer use. They enable features such as: personal exposure monitoring, identification of less polluted routes for pedestrians and riders. The company published some results on multi-city air quality mapping in the SAE journal https://doi.org/10.4271/2023-01-0049 and https://doi.org/10.4271/2023-01-0139.

5. An air quality data project paid by the city of Bordeaux France and the local branch of the national air surveillance organization (Atmo Nouvelle Aquitaine). 50 city cars were outfitted with an Airlib sensor for 18 months. About 20

thousand trips were collected. Airlib co-managed the project with the city and Atmo, provided the raw data and the maps to the customer and discussed with them further exploitation of the data.

If there are specific measurement accuracy targets, we may not be able to achieve them with the low- cost sensors we are using. The sensors we use were however tested by EPA (Sensor Evaluation Report **EPA 600/R-14/143 | May 2014 | www.epa.gov/ord)**.
There is an important trade-off between cost and accuracy when it comes to mobile monitoring. If accuracy is the most important aspect that cannot be sacrificed then each mobile platform must include expensive lab instruments worth tens of thousands of dollars . Depending on target species and accuracy this cost can go even higher, up to $100k per mobile platform. In this case another downside is the project team has to have a designated vehicle (or a mobile platform) and a driver (who is an experienced technician or researcher), which brings the operational cost even higher. Airlib's operation has been on the other side of this trade off. We use low cost AQSs (air quality sensors) that automotive manufacturers have been using for the past 3 decades. Such low cost sensors can be installed on any car and their operational cost is minimal. This allows to collect very large volumes of data and cover wide areas with multiple measurements every day or week. Airlib's approach therefore significantly increases air quality data spatial and temporal coverage and resolution. To improve overall accuracy of the data, Airlib proposes to combine its mobile monitoring solution with some high accuracy instruments data collection. A few cars will be equipped with both high accuracy instruments and low-cost air quality sensors for some defined periods of time, for the purpose of real time calibration. This hybrid solution will provide the required coverage and data volume, while ensuring that the data is within reasonable accuracy.

Attachment B: Vendor questions

General questions

1. Deployment of sensors on at least 100 cars for at least one year 1 year would be a minimum project size for us. We believe the scope of work described in this RFI is well above that threshold.
2. Independently of this RFI, we are planning to map air quality for the top 50 US cities for at least a year with ride-hailing cars to obtain nationwide urban air quality maps.
3. Advantages: scalable nationwide and even worldwide at realistic cost. Ease of deployment. Large amounts of data collected fast. Thorough city coverage. Continuous mapping (monitoring) as opposed to "snapshots". Allows real-time alerts/alarms in case of excessive pollution. Data collection system is now totally automated.
   Disadvantages: lower accuracy than more expensive equipment. Our proposal to overcome this lower accuracy was answered in Attachment A Question 7. In Brief we will have a few cars performing simultaneous measurements with low cost air quality sensors and high accuracy lab instruments both operated by mobile platforms. This way we can calibrate the air quality data collected with low cost air quality sensors.

Engagement and coordination

1. We would involve community members at every step of the project. We will hold a workshop to introduce ourselves and our capability to general community members at large. We will work with community members in the planning stage of the monitoring. We will survey to understand their needs and concerns. Once planning is done we will hold another training workshop to have them learn how to install sensors in their car and how to collect data. For that purpose we would need to get in contact with community representatives and attend meetings to present our project and explain what our method consists of and what the community would gain from it. We would also recruit ride-hailing drivers as we usually do to maintain high coverage of the area. In addition we will designate our team members, who have experience in community engagement in air quality monitoring through AB617, to be in charge of community engagement. Professor Jung at UCR may serve as a technical advisor and an overall project manager for the team. He has already reached out to people at UCI, UC Berkeley, and UCR to form a team who can handle community engagement through their experience in their AB617 projects. The data will be disseminated to community members once QA/QC process is put in place by researcher participants. Workshops and training sessions will be held regularly to educate how to interpret the data and how to make use of them to find hot spots and to reduce exposure to air pollutants.
2. Airlib participated in a project paid by the city of Bordeaux, France. We had to convince and recruit city employees and had to explain everyone that no private information was going to be disseminated. We also have experience recruiting ride-hailing drivers for air quality data collection purposes in several cities. Airlib and professor Jung at UCR formed a large team to bid for the project. Within the team professor Jung and Airlib has formed we have people who have worked in AB617 projects. See team members' (who were involved with AB617 or similar projects) bios in appendix.
3. Airlib has worked with Atmo Nouvelle Aquitaine (a branch of the French EPA) on air quality data collection and on exchange and exploitation of the data. We have worked with UC Riverside on the same subject and continue to interact with them (Professor Heejung Jung) on a weekly basis. Professor Jun Wu at UCI, Arun Raju (UCR), Nicole Cleary (UCR) and professor Cesunica Ivey at UC Berkeley agreed to be part of the team to work with communities. They all have strong communication skills and experience with community engagement for air monitoring.
4. We ran air quality data collection project in 4 different cities with budget of $20k to $100k each.
5. Airlib's data collection software is ready to scale nationwide as it is. To map air quality in the 67 priority communities identified in California, we plan to deploy 800 sensors. 130 of them would be on community ride-hailing cars and 670 on regular community member cars. We would train local "installers" in the communities and communicate with community stakeholders to provide enough training and information to all participants. One person full time will manage installation planning, community member payments, and one dedicated software engineer will maintain the system, fix any issues and develop ad-hoc custom data formats.

Mobile monitoring technologies and capabilities

1. We can describe it as a single platform. It currently covers 6 active cities and can grow to 100 cities without significant changes. On-boarding a new city on the platform takes only a few hours. Our data collection platform started operation in 2017 and has since then been upgraded to use the latest Google cloud tools.
   1.a Phoenix AZ, The bay area, Paris, London, Bordeaux, Seoul. Urban areas. Sensors on-board cars moving in traffic on city roadways.
   1.b The city of Bordeaux, France, is using the data for their own research and their ultimate goals are to inform the population and reduce their exposure. We are currently developing an app which can provide minimum exposure route for pedestrians and drivers.
   As a company, we use the data to create hyperlocal air quality maps that are used by the automotive industry to manage the car air intakes real-time. Our maps replace on-board sensors and allow to improve air quality inside car cabins.
2. Our data collection platform is running 24/7 and is fully automated. It stores and processes air quality data coming from all our active cities
   a. A new city can be created and operational on our platform in a few hours. Sensors can be installed in a new target city within 2 to 6 weeks depending on the number of sensors involved.
   b. Running automatically 24/7. Data will flow as soon as a car with a sensor is started.
   c. VOCs, NO2, and PM1, PM2.5, PM4 and PM10. 4 readings per second for VOCs and NO2. One reading per second for PMs. In addition, we collect temperature and relative humidity data every second. We can also add other miniaturized sensors that do not require short periodic maintenance at a reasonable cost for example miniaturized CO, CO2, and CH4 sensors. BC is more challenging because even a miniaturized BC monitor such as MicroAeth requires frequent maintenance and it is bulkier than other air quality sensors Airlib has been using. Special gases and metals may require high accuracy instruments and long sampling time due to low concentrations as such it will require employment and building of short-term mobile laboratories. Professor Jung has experience in building mobile labs and if an appropriate amount of funding is provided, this is also doable. Staffing and maintaining short-term mobile labs is more costly but is doable.
   d. Automotive type Air Quality sensors for VOCs and NO2. They are semiconductor sensors. We use sensors from SGX Sensortech and Sensirion. We use optical PM sensors from Sensirion. We collect vehicle location with timestamp every 3 seconds. The data travels via a smartphone inside the car. The Airlib app on the smartphone uploads the data to our Airlib server every 15 seconds.
   e. We typically aim at 50 car passages per grid location (50 meters apart) per month. Some quiet areas will be measured once or twice while some busy areas might be measured 500 times per month. We obtain detailed air quality maps that can be shown for individual pollutant and for time tranches of 30 minutes. We have not worked on identifying individual sources of pollution based on these maps. We believe that after 3 months of data collection with our nominal ratio of about 20 ride-hailing cars (or 100 private cars) per million inhabitants, the maps would be statistically meaningful to be exploited for source identification.
   f. The number of car passages, or measurements, is our key measure. We call it coverage. We aim at a coverage of 50 per month on average over the measured area.
   g. Sensors on-board cars communicate via Bluetooth with the Airlib app on a smartphone inside the cars (available on Google play). The app sends the data to our server real-time. It is stored and processed continuously.
3. Our typical approach is to have enough cars equipped with sensors to be able to rely on their randomly distributed trips to cover the whole target area.
   a. Installation of sensors is easy and takes about 10 minutes. After installation the car can simply be used as usual and little interaction with drivers is required.

    b. We hire local installers and train them in person or via video call. Some of our drivers become installers themselves.
    c. No external power needed. The sensors consume less than 500mW and use the car power (direct battery connection or in-cabin USB).
    d. None
    e. The data is monitored daily from our platform to check for any problem with a sensor or with connections.
    f. We rely on redundancy and statistical distribution to obtain air quality maps with statistically meaningful values. Coupling our method with regular high accuracy measurements in the same city would allow to calibrate our data.
    g. All our data is safely stored 24/7
    h. We have automatic alerts in place to notify us if something is abnormal with the data inflow. Communication back to drivers is done on a regular basis not only to pay them but to inform them of any problem with the sensor or their driving patterns.
4. Our main monitoring cost is driver compensation (paid to community members). More than half of our total monitoring budget returns to communities. We will have a separate budget for community engagement.
    a. Cost estimates:
        i. Direct costs: $150 per sensor, $75 per install, $6k/month for admin/logistics, $8k per month for communication/coordination with community stakeholders, $1k/month for Google cloud tools, and $100/month for ride-hailing drivers and $40/month for regular community members. Additional high accuracy mobile platform will cost approximately $100k per vehicle or platform. $100k includes the cost of high accuracy monitoring instruments and operation of a vehicle. This will enable real time calibration of low -cost air quality sensors as explained earlier.
        ii. Indirect costs: $10k/month for software platform maintenance/support, $6k for project management and overhead. The team will include university researchers from UCI, UCR, and UC Berkeley and their indirect rate will follow typical rate between UC and CARB.
        iii. Data management: included in the $10k/month for software maintenance/support. If we are in charge of ingesting and harmonizing the data from several different sources (besides our own), then additional work and resources might be needed.
    b. Monthly
5. We would need about 4 months to get the sensors available for installation
    a. From the go on the project we expect to need 20 months to achieve a full year of monitoring with the target number of sensors.
    b. We can deploy the 800 sensors on community cars before early 2025. That is to map air quality with a coverage of 50/month in areas where the priority populations and communities live. We can assume that these populations represent 20 million inhabitants in California.
6. The university researchers included in this team took part in AB617 projects and they have extensive experience in developing monitoring plans, data analysis, and communication with communities and agencies. Professor Jung at UCR will oversee the overall activities of university participants and community engagement along with Professor Jun Wu at UCI.
7. We have a data collection monitoring plan, and we have a set of documents, forms and videos used for recruiting, training and monitoring.

Data Collection, Storage, Reporting

1. It varies with their needs. The raw data is stored as JSON and csv files. We can export it in various formats upon request. Our final product is a combination of raw data, statistics on pollution levels over the target area, color coded maps, server based response to http requests issued by cars in traffic or client devices, pollution indices over specified routes etc. We are also developing a personal exposure tracker that community members will be able to use to track their personal exposure based on the data collected in their community.

2. We mostly use public Python libraries and Google cloud platform products and services to collect, process and display the air quality data. These products are either compatible with mobile monitoring data or were customized by Airlib to deliver the required output.
3. We have been doing it for several years. We have tested or used several publicly available products. We have limited experience with ESRI but could definitely use it upon request.
4. We have generated or participated in the generation of air quality maps with the city of Bordeaux, France and Atmo Nouvelle Aquitaine. Dissemination was a sensitive subject as the information needed to be easily understandable and not generate unnecessary worries with the population, while being compatible with the city's plan and intentions.
5. We would ingest all sources in a common Google cloud storage volume and process it to harmonize the formats. We have good experience working with large amounts, storing them safely and making them accessible for processing and display.
   For example: we use H3 (Uber Hexagonal Hierarchical spatial index) as a tool for referencing locations.
   For data storage we recommend Redis of Google as it is a very versatile tool that enables quick and safe access to data.
   For data visualization, using ArcGIS (ESRI) might be the best tool as it is widely used and is a mature platform with many options. We have experience with several standard geographical visualization libraries.

Feedback

1. Airlib's platform is operational, automated and allows us to scale air quality data collection at very competitive cost. We do not know of any other company that can collect roadway level air quality data on a large scale and so cost efficiently.
2. AB617 projects were great but the SMMI could consider funding air quality mapping on a broader scale without limiting it to a set of communities.
   The RFP should recognize the trade -off between accuracy of air quality data and the cost and the area covered and the spatial resolution. We strongly suggest the RFP to include the use of low-cost air quality sensors to significantly widen the area of monitoring to unprecedently large area compared to the previous AB617 projects. The RFP should allow teams to cover much bigger areas such as the whole Bay Area, the whole South Coast Air Basin, the part or whole central California. By doing so the RFP may let the bidders think how to combine low cost air quality sensors with high accuracy and high cost lab instruments to make a hybrid monitoring system. We already propose such a novel calibration and deployment method in this response. By doing so some innovative method which can improve the accuracy of low cost sensors and reduce the need to research level instruments may come up.
   The RFI could mention a time limited data collection project and a permanent surveillance data collection that would remain active indefinitely. Our plan at Airlib is to keep monitoring key US cities on a permanent basis to have very recent data for mapping purposes but also for alert or warning purposes.

Attachment C: Rough order of magnitude cost estimate

The following are approximate numbers, for information only. We assume:

- a 6 to 8 month preparation and planning period: procurement of sensors, planning and coordination with communities, training of participants, sensor installations
- a full 12 month data collection period
- 800 sensors on community cars: combination of ride-hailing cars and regular community member cars.

Sensor procurement:	$120 k	
Sensor installations on cars:	$60 k	
Full data collection for 12 months		
Administration/logistics	$72 k / year	$6 k / month
Payments to community drivers	$560 k over 12 months	$46.7 k / month
Technical support/software	$140 k /year	$12 k / month
Management/overhead	$60 k / year	$5k / month
External cloud resources	$24 k / year	$2k / month

Total for project = 180k + 856k + community relations/coordination budget to be assessed later

Of that amount more than 50% is used for compensation of community participants for installations and car use.

Not included are the costs of reference equipment on-board a few cars for calibration purposes + the work associated with the data processing and calibration itself. Rough order of magnitude is $400k.

Not included are the costs of community engagement and university researchers and their activities for the project. We have an innovative method to get representative input from multiple communities with large populations developed by professor Kevin Esterling using a specially designed web platform. We have experienced university researchers who took part in AB617 projects or similar projects.

State's questions:

1. Our main platform is currently operational on 6 cities and can accommodate 100 cities with no significant architecture change. We are planning to map the top 50 US cities within 3 years and are currently raising funds to do so.
2. With 800 cars operational over a month, we would collect data for approximately 40000 hours per month. That is approximately 1.5 billion sensor readings over 1 million miles driven each month. Over a year it is 12 times these amounts.
3. Accuracy of the sensor readings could be below CARB's requirements. That is why we suggest that our cost effective solution be coupled with some monitoring performed by more accurate instruments or short term mobile labs.
4. Not that we know of.

Vendor's assumptions: No other assumptions than the ones mentioned above.

Appendix: Team members information

Arun Raju, arun@engr.ucr.edu

Associate Research Engineer Associate Director-Operations, CECERT Dept, UC Riverside

https://profiles.ucr.edu/arunsatheeshkumar.raju1

Coordinated the CARB funded Community Air Monitoring grant for CE-CERT. Participated in Community Air Group meetings, student symposiums, and other events. Also serving as UCR Principal Investigator for the Eastside Climate Collaborative, a Transformative Climate Communities project that involves community investment. UCR's role is developing and implementing a performance tracking plan, including multiple, air quality, climate, renewable energy, economic and other benefits to the community over a five year period.

Cesunica Ivey iveyc@berkeley.edu

Assistant Professor of Civil and Environmental Engineering at UC Berkeley

- Contract # G18-CAGP-11; $300k; Subawardee to CCAEJ; Co-PI; Ivey led the technical research portion of a community air grant in West San Bernardino. Results corroborate lived experiences regarding disproportionate exposure burdens for PM2.5 for residents living nearest to the BNSF intermodal facility.
- Contract # 22RD020; $75k; PI; White paper contract to develop a guidance document for the deployment of low-cost sensors in impacted communities for the support of community-led indoor air quality monitoring.
- Contract # 21RD011; $25k; PI; White paper contract to compile the state-of-the-science research in time-activity patterns to improve air pollution exposure estimates.
- Contract # 20RD010; $500k; Co-PI; Subawardee to UC Riverside; Grant to understand PM2.5 formation regimes in California over the past 30 years.

Professor Kevin Esterling, kevin.esterling@ucr.edu

Professor of Public Policy and Political Science, UC Riverside

Director, Laboratory for Technology, Communication and Democracy (TeCD-Lab)

https://tecd-lab.ucr.edu/ **https://profiles.ucr.edu/kevin.esterling**

Esterling has previously received two grants totaling $100,000 from the Democracy Fund to fund the phase 1 development of Prytaneum's front and backend architecture, as well as a recent $200,000 grant from the UCR OASIS program to fund the phase 2 development that will integrate LLM-based algorithmic support for content curation and insight mining. The OASIS grant is current, and is a collaboration between the State of California Mental Health Services Oversight and Accountability Commission (MHSOAC) to evaluate Prytaneum in three upcoming, regional public meetings focused on implementing mental health services spending in Riverside County public schools. In these meetings, Esterling's team plans to host approxiamately 600 residents of Riverside County. These meetings will use this community input to inform outreach, to identify early signs of unmet mental health needs, reduce stigma and discrimination, and prevent unmet mental health needs from becoming severe and disabling, with a particular focus on the needs of historically underserved communities. This project will inform the MHSOAC as it oversees millions of dollars in grant funding in Riverside County to create support for mental health in our schools and in the community.

He currently has a grant from the Institute of Education Sciences, ``Connecting Classrooms to Congress: Fostering Civic Engagement via Online Deliberative Town Halls," (co-PI, $2,000,000, 4 years) that funds the development of a new high school curriculum module which has a capstone activity for students to meet with their member of Congress using Prytaneum. This initiative has partially funded the development of Prytaneum. His team has recruited 40 teachers and over 2,000 students to evaluate the curriculum and the platform integration. The initiative aims, in a tangible way, to create direct, healthy, and informed dialog between the nation’s youth and their representatives.

About a decade ago, in partnership with the Congressional Management Foundation, Esterling was PI for an NSF-funded research team to work with the U.S. Congress on developing a new town hall for online constituent engagement. With over $180,000 from NSF, the research team developed and evaluated the prototype for Prytaneum in collaboration with 12 Members of the U.S. House of Representatives and one U.S. Senator, from all across the United States, who conducted more than 20 online town halls involving over 2,000 constituents. In conducting the research with actual elected officials, this research observed how the online Deliberative Town Halls work in the practice of democracy, rather than how laboratory subjects behave in a hypothetical simulation of democracy.

Professor Jun Wu, junwu@uci.edu

Public health with research interest in Environmental Exposure Assessment, Environmental Epidemiology, and Environmental Health Disparity, UC Irvine

I have been serving as advisor to and/or collaborator of three Southern California community partners: Getting Residents Engaged in Empowering Neighborhoods (GREEN) - Madison Park Neighborhood Association (MPNA), Orange County Environmental Justice (OCEJ), Communities for a New California (CNC) Education Fund, and Anaheim Union High School District.

- I helped GREEN-MPNA to receive funding and further conduct research for three funded projects (funding went to the community partner through US EPA, Cal EPA, California Air Resources Board) since 2021 to present. I closely worked with GREEN-MPNA on 1) study design and implementation; 2) data analysis, result interpretation, and manuscript writing; 3) result dissemination to community members and government officials; 4) leading monthly workshops/seminars to educate different sub-groups of the community members on various topics related to air pollution, lead contamination, and health. In terms of air quality monitoring, I work with the community partner in designing and implementing field campaigns:
  - First, I helped the GREEN-MPNA in designing an US EPA funded field study called "Toxic Tours." I helped design sampling routes, select and test a portable sensor (Atmotube) and a GPS data logger (Qstarz® Travel Recorders), and help training the team on use of the sensors. Since a primary concern expressed by community members was potential air pollution originating from the industrial corridor, four air monitoring routes were established that encircled various sections of the industrial corridor along with one route that encompassed the freeway system. This work was published in the paper below:
    - Masri S, Cox K, Flores L, Rea J, **Wu J**. 2022. Community-engaged use of low-cost sensors to assess the spatial distribution of $PM_{2.5}$ concentrations across disadvantaged communities: results from a pilot study in Santa Ana, CA. Atmosphere: doi:10.3390/atmos13020304.

  - Second, I helped the he GREEN-MPNA in designing and implementing a CARB funded 3-year study, in which air pollution and noise are sampled for other communities' concerns related to non-industrial sources, including fireworks and trucks. I helped with the field campaign before, during, and after the July 4th episodes in 2022 and 2023, in which indoor and outdoor $PM_{2.5}$ concentrations were measured at 17 homes in Santa Ana. These homes were chosen based on their location (e.g. close to major firework emission sources) and willingness of the residents to participate in a sampling campaign of approximately 30 days. Part of the results from this work was included in the following publication:
    - Masri S, Flores L, Rea J, **Wu J**. 2023. Race and Street-Level Firework Legalization as Primary Determinants of July 4th Air Pollution across Southern California. Atmosphere: 14, 401. https://doi.org/10.3390/atmos14020401.

- I helped OCJE in collecting soil samples at over 500 locations in Santa Ana in October, 2019. This project aimed to address residents' concerns about the high lead levels in the soil. The sampling locations were designed to ensure that 1) each Census tract had at least 6 samples when possible; and 2) locations cover seven representative land-use types, including arterial roads, schools, parks, gardens, industrial areas, business areas, and residential units. I further helped with data analysis and the results can be found in the following published paper:
  - Masri S, LeBrón AMW, Logue MD, Valencia E, Ruiz A, Reyes A, Lawrence J, **Wu J**. 2020. Social and spatial distribution of soil lead concentrations in the City of Santa Ana, California: Implications for health inequities. Science of the Total Environment: 743:140764. doi: 10.1016/j.scitotenv.2020.140764. PubMed PMID: 32663692.
  - Rubio JM, Masri SF, Torres IR, Sun Y, Flores P, Logue M, LeBrón AMW, **Wu J**. 2022. Use of historic mapping to understand sources of soil Pb contamination: Case study of Santa Ana, CA. Environmental Research 212: 113478.

- Through my ongoing California Air Resources Board funded project (#21RD003), I have worked with CNC Education Fund in Coachella Valley, Riverside to address the concerns of community members on wildfire impacts. We administered questionnaire survey and focus group discussions related to wildfire perception and smoke impacts to the communities. We are currently analyzing the data and writing manuscripts based on this data.
- Further, I worked closely with OCEJ and GREEN-MPNA in securing NIH funding to further examine children's life course lead exposure and their academic and neurobehavior outcomes:

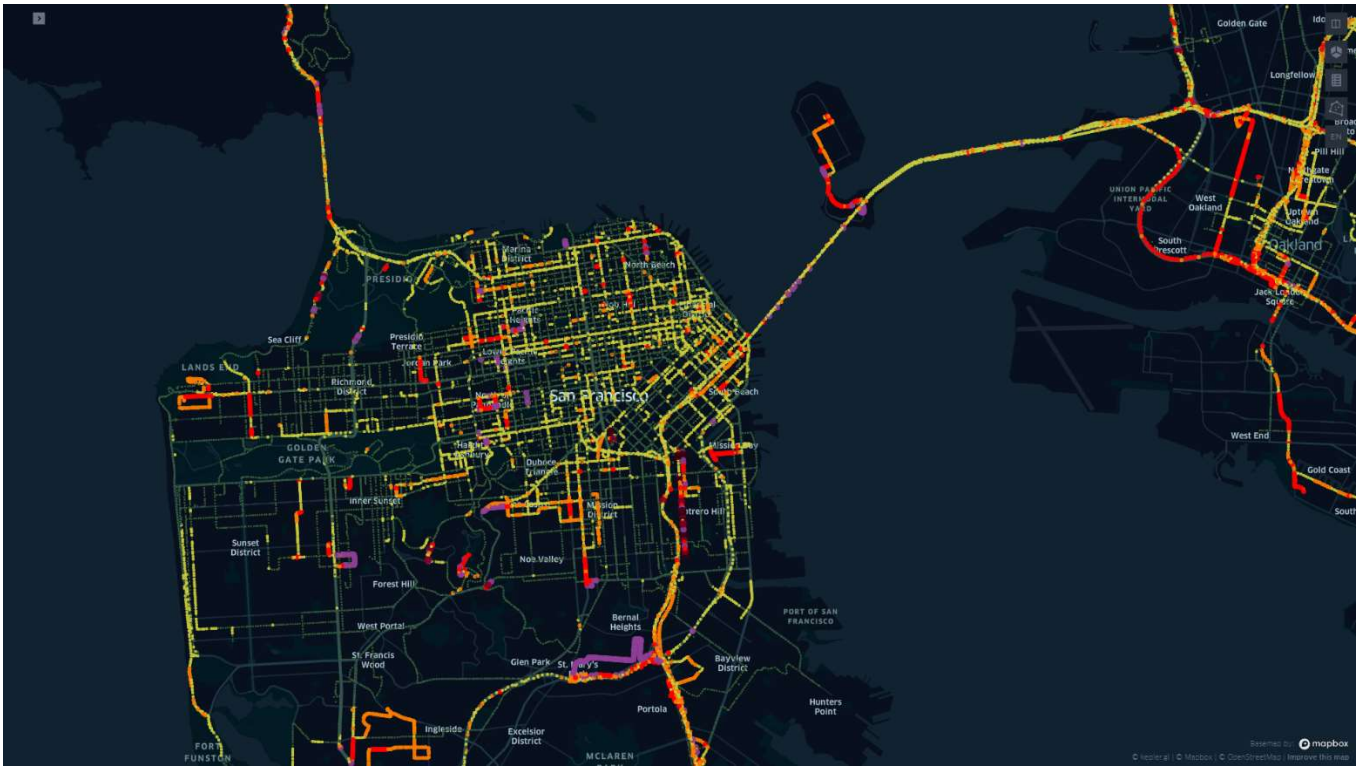
"Inequities in Childhood Life-Course Lead Exposure and Academic and Neurobehavioral Outcomes (I-CLEAN)" $2,703,783

National Institute of Environmental Health Sciences (R01ES034445)
Effective Dates: 5/9/2023 – 2/29/2028
Role: MPI with LeBron and Orange County Environmental Justice
This study will establish a prospective and longitudinal cohort of 600 elementary school children in Santa Ana focusing on the impact of life-course exposure of metals (Pb and others) on children's behavioral development and school academic performance. Children's deciduous teeth and blood will be sampled; longitudinal outcome data will be collected. Through community-academic partnership, the study will also develop, disseminate, pilot, and evaluate a multi-level (e.g. household, school,

neighborhood, city, county) Public Health Equity Action Plan to raise awareness of the health and academic implications of Pb exposures and mitigation strategies; improve childhood Pb screening and intervention; pilot community-led projects including Pb remediation and intervention.

- Finally, I have worked with the Anaheim Union High School District in monitoring the PM2.5 concentrations in their school district. I discussed the needs of the school district and found that they want to monitor indoor air rather than outdoors and that school library would be the best place to install air sensors because they are likely the most used place among students. My team installed 18 PurpleAir sensors inside each of the middle school and high school in the school district in their school libraries. In addition, we installed 4 outdoor PurpleAir sensors in selected schools whose distribution covers the entire school district.

Appendix: Airlib air quality map example

San Francisco PM 2.5 map

Grid pitch = 50 meters