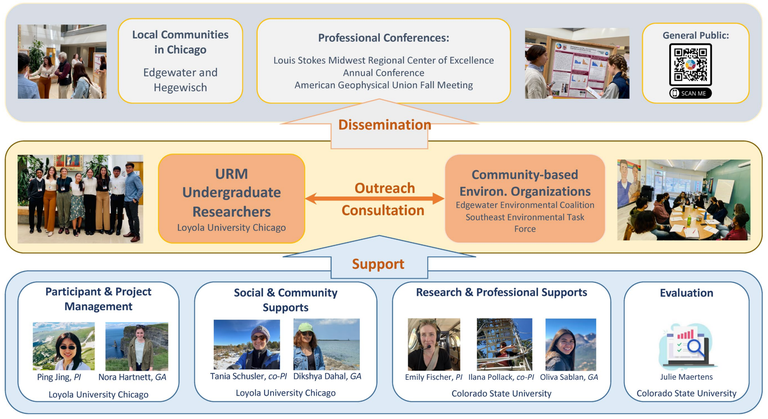
Community Air Research Experience (CARE): Engaging Students in Research on Air Pollution in Chicago Communities

Ping Jing[1*], Tania Schusler[1], Dikshya Dahal[1], Bo Zhang[1], Emily V. Fischer[2], Ilana B. Pollack[2], Olivia M. Sablan[2]
(1) Loyola University Chicago, (2)Colorado State University
*Contact: pjing@luc.edu

1 What is CARE?

- CARE engages underrepresented minority (URM) students in a paid research experience on air pollution in Chicago communities.
- CARE is a partnership involving scientists at Loyola University and Colorado State University who also work with community-based environmental groups: the Southeast Environmental Task Force (SETF) and the Edgewater Environmental Coalition (EEC).



Organizational chart of CARE.

CARE has three aims:

1) provide an applied, socially-relevant research experience for URM students,
2) increase understanding about the spatial distribution and temporal variation of particle pollution in Chicago, and
3) provide air quality data for community discussions about how to reduce air pollution and better protect public health.

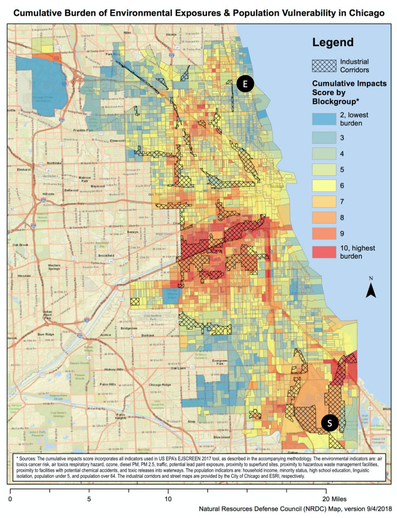
2 Motivation

Fine particle air pollution is a major issue in Chicago. Monitoring of particle pollution in the city is too sparse.

Over 5 million people in Chicago are at risk from high levels of ozone and particle pollution (American Lung Association, 2022). Residents of low-income or high-minority neighborhoods of Chicago share a greater burden of air pollution than more affluent areas (King, 2015; Yeo, 2019), which makes air pollution in Chicago an environmental justice issue.

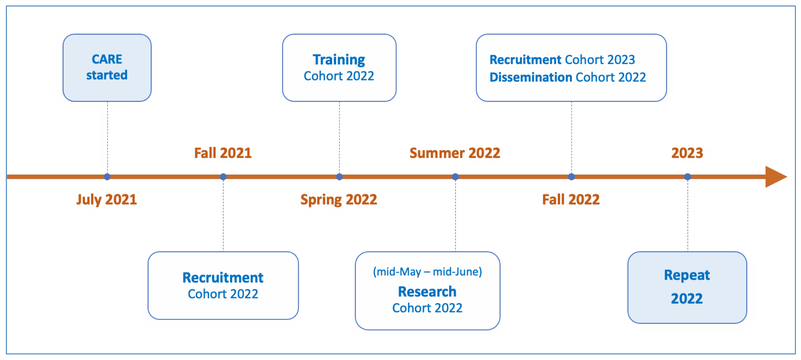
Our hypothesis is that we can increase students' interests and competencies in the geosciences by engaging them in air pollution research that has a direct impact on local communities.

We deployed PurpleAir Sensors to two communities in Chicago. We use these sensors because PurpleAir data is already being integrated into experimental maps (fire.airnow.gov) developed by the Environmental Protection Agency and U.S. Forest Service. Our project also leverages the PurpleAir network because prior work has evaluated the performance of these monitors. Newly established correction factors can be used to adjust reported $PM_{2.5}$ values to agree better with Federal Equivalent Method (FEM) measurements (Magi et al., 2020; Malings et al., 2020; Mehadi et al., 2020; Barkjohn et al., 2020).



Map of Cumulative Burden of Environmental Exposures and Pollution Vulnerability in Chicago (Yeo, 2019). Locations of Edgewater and Southeast Chicago are marked as "E" and "S" in black circles on the map, respectively.

3 What Does the Experience Include?

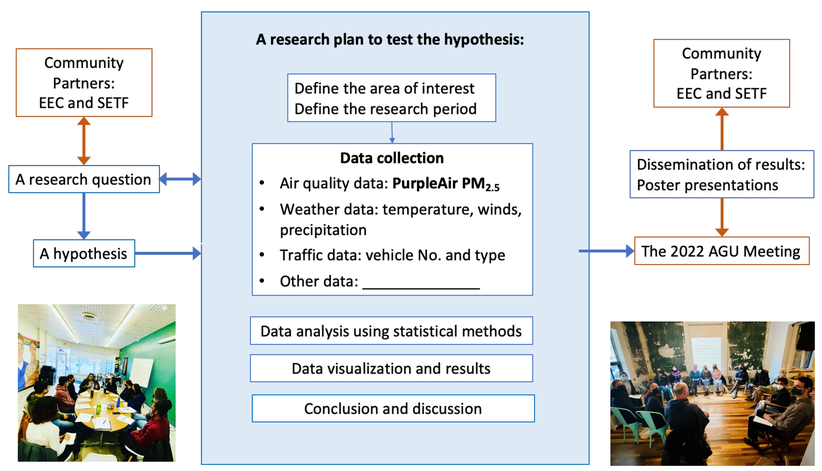


A timeline of CARE activities

The CARE experience for Cohort 2022 included:

- Eight 1-hour training sessions: Introduced students to fine particle pollution, PurpleAir, environmental justice, community-based research methods, and careers in geosciences.
- Field trips to the 2 communities: Visited Edgewater and Southeast Chicago, discussed concerns about air pollution with representatives from SETF and EEC.
- A 4-week research experience: From May 16 to June 10, 2022, students installed 9 PurpleAir sensors, learned and practiced computer programming, and analyzed data to answer research questions of interest to local communities.
- Presentations to the community organizations (SETF and EEC) and at the 2022 American Geophysical Union Fall Meeting.

CARE students learned how to conduct scientific research and how to build and sustain a scientist-community partnership.



CARE students met with SETF in March 2022.

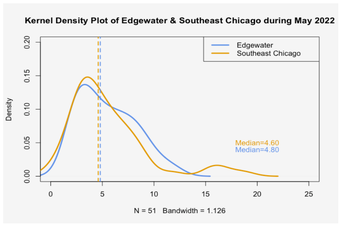
A diagram that shows how a CARE student makes a research plan to test the hypothesis

CARE students met with EEC in March 2022.

4 CARE Students' Contributions

- CARE students installed a total of 9 PurpleAir sensors in 2022 in Edgewater and Southeast Chicago.
- CARE students analyzed PurpleAir and other data to investigate these 8 topics:

Walkability & $PM_{2.5}$	Relationship between Land Development & $PM_{2.5}$	Non-English-Speaking Communities & $PM_{2.5}$	Coarse Particulate Matter (PM_{10}) in Chicago
Evaluating Air Quality Improvement in Chicago's Southeast Side	Proximity to a Major Road & $PM_{2.5}$ in Chicago	Contribution of Traffic to Hourly $PM_{2.5}$ in Chicago	Demographics & $PM_{2.5}$ in Southeast Chicago & Edgewater



A CARE student's Kernel density plot of $PM_{2.5}$ concentrations for Edgewater and Southeast Chicago in May 2022.

Two CARE students installed a PurpleAir sensor in Southeast Chicago in May 2022.

CARE students' research results support these arguments:

1. Air quality improvement in Chicago region is not equal
   - Less improvement in south than north sides of Chicago
2. Fine particle pollution remains a real concern for residents in Southeast Chicago
   - Wildfires upwind aggravate this concern
3. Traffic contributes to fine particle pollution in Southeast Chicago
   - Residents living within 450 feet from major road should be alerted of air pollution impacts
   - Episodic peaks (>35 μg/m³) were often observed, causing greater health concern
4. Greater efforts needed to monitor the unequal air pollution burden in Southeast Chicago, understand how it affects residents' daily outdoor activities and health, and devise effective strategies to improve air quality.
   - Including concerns for residents who speak languages other than English

5 Future Directions

- Direct students to further study research topics that interest the 2 communities, e.g., the impacts of traffic, urban heat, and lake breezes on fine particle pollution.
- Devote more interaction with community groups especially during the summer research experience.
- Seek ways to expand our scientist-community partnership on air pollution to include more low-income or high-minority neighborhoods, while we sustain the current partnerships with EEC and SETF.

Acknowledgements

CARE is funded by the National Science Foundation's GEOPAths program through awards 2119465 (LUC) and 2119541 (CSU). We thank the Southeast Environmental Task Force and the Edgewater Environmental Coalition for important contributions as partners in this project. We also thank 6018|North, Centro Romero, Emanuel Congregation, Immanuel Lutheran Church, and five households for hosting PurpleAir sensors.

SCAN ME

References

American Lung Association (2022) State of the Air 2022, www.lung.org/research/sota

Barkjohn, K.K., Gantt, B., Clements, A.L. (2020) Development and Application of a United States wide correction for $PM_{2.5}$ data collected with the PurpleAir sensor. Atmos. Meas. Tech., 14, 4617–4637, doi: 10.5194/amt-14-4617-2021

King, K.E. (2015) Chicago residents' perceptions of air quality: objective pollution, the built environment, and neighborhood stigma theory. Population and Environment, 37, 1–21., doi: 10.1007/s11111-014-0228-x

Magi, B.I., Cupini, C., Francis, J., Green, M., Hauser, C. (2020) Evaluation of PM2. 5 measured in an urban setting using a low-cost optical particle counter and a Federal Equivalent Method Beta Attenuation Monitor. Aerosol Science and Technology, 54, 147–159, doi: 10.1080/02786826.2019.1619915

Malings, C., Tanzer, R., Hauryliuk, A., Saha, P.K., Robinson, A.L., Presto, A.A., Subramanian, R. (2020) Fine particle mass monitoring with low-cost sensors: Corrections and long-term performance evaluation. Aerosol Science and Technology, 54, 160–174, doi: 10.1080/02786826.2019.1623863.

Mehadi, A., Moosmüller, H., Campbell, D.E., Ham, W., Schweizer, D., Tarnay, L., Hunter, J. (2020) Laboratory and field evaluation of real-time and near real-time PM2. 5 smoke monitors. Journal of the Air & Waste Management Association, 70, 158–179, doi: 10.1080/10962247.2019.1654036.

Yeo, S. (2019, January 15) A clever new map shows which Chicago neighborhoods are most at risk from pollution. Pacific Standard, psmag.com/environment/which-chicago-neighborhoods-are-most-at-risk-from-pollution