Air Quality Sensors on NYC Buses

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Proposal Abstract

Relevant city, state and private interests (to be named) should install air quality sensors on a sample of MTA buses that cover all bus routes. These sensors will transmit real-time data on PM 2.5, Nitrous Oxide, and Black Carbon to a central database, which will be publically accessible as open data. This project will benefit environmental researchers, help set and monitor emissions standards, and lead to the improving of public health. In the long run it will provide a proof of concept to other cities, and allow for the expanding of mobile air quality monitoring across the globe.

Background

Importance

Currently New York City has a relatively small amount of air quality sensors, considering the total land mass involved, and all of these are stationary. The New York State Department of Environmental Conservation (NYSDEC) has 18 locations[1], the New York Community Air Survey (a joint project of the NYC Health Department and Queens College) has around 100 locations[2], and the Environmental Protection Agency (EPA) has 9 locations[3]. Most of these are at schools, and the frequency of reading collection varies from near real time to every two weeks.

Air pollution is a huge problem in cities. According to the World Health Organization, 80% of people living in cities that measure air pollution are exposed to toxins over the recommended limit. These levels of air pollution can increase stroke, heart disease, lung cancer, and chronic and acute respiratory diseases, among other issues[4]. The World Health Organization attributes 4.2 million premature deaths globally to to ambient air pollution[5].

The city, state and federal government are all invested in a decrease in air pollution. In OneNYC, a plan for the future of NYC OneNYC: A plan for the future of NYC, there is a stated goal to achieve "cleanest air quality of any big U.S city" by 2030[6]. At the state and federal level, federal law requires the NYSDEC to submit reports showing plans to

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[1] https://www.dec.ny.gov/chemical/8539.html
[2] https://www1.nyc.gov/site/doh/data/data-publications/air-quality-nyc-community-air-survey.page
[3] https://www.epa.gov/outdoor-air-quality-data
[4] http://www.who.int/airpollution/data/cities/en/
[5] https://www.who.int/airpollution/ambient/health-impacts/en/
[6] https://onenyc.cityofnewyork.us/plan/

decrease air pollution over time[7]. The MTA is aiming to reduce emissions by switching to an all-electric bus fleet by 2040[8], and has shown an interest in minimizing environmental impact.

Examples of Mobile Sensor Implementation

AirCasting is a citizen science project, run by HabitatMap that equips volunteers with wearable air sensors and creates detailed air quality maps. Their newest sensor is called the AirBeam2 (Figure 2) and is sold for $249[9]. In an interview, Michael Heimbinder, founder of HabitatMap expressed his view that "the more observations the better" and "really is no downside to logging more measurements.[10]"

One interesting finding that AirCasters discovered was that subway exhaust which comes through the grates on the street is high in PM 2.5[11]. Masoud Ghadehari, Ph.D, a researcher with published works on pollution monitoring, says the data from citizen science networks, such as HabitatMap is good enough to be used in research exploring the human response to the pollution agent and that there is value in spatiotemporal analysis[12].

Google Streetview cars, using air pollution monitors from a company called Aclima, have driven around London and the Bay Area, taking readings of pollutants every 30 meters.

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[7] https://www.dec.ny.gov/chemical/281.html
[8] https://insideclimatenews.org/news/26042018/nyc-air-pollution-electric-bus-public-transportation-mta-clean-technology
[9] http://www.takingspace.org/airbeam2-technical-specifications-operation-performance
[10] personal interview with Michael Heimbinder, conducted by Ursula Kaczmarek, Oct 31 2018
[11] http://www.takingspace.org/
[12] personal interview with Masoud Ghadehari, conducted by Marium Sultan and Ursula Kaczmarek, Nov 13 2018.

The data is publicly available upon request, and it has revealed that air quality can vary greatly even on the same street.[13][14]

The Mailman School of Public Health, in September 2018, did a study about air pollution exposures in NYC bicycle commuters. Participants wore air quality sensors, vital trackers and GPS while biking.

Findings revealed that bikers were exposed to larger levels of PM and Black Carbon than walkers, and looking at the map showed many bike routes were close to truck routes. This would have been hard to determine through fixed sensors.[15]

More specific to sensors on public transit, University of Utah researchers installed sensors on the TRAX light rail (figure 1)[16] and a community-based group called OpenSense installed air quality sensors on Zurich buses[17]. The laboratory working on the Zurich project says since the bus system is "mobile, secure, predictable, and spread out over a given area, buses are an ideal data collection base."

Innovation Roadmap

Constituents

-New York State Department of Environmental Conservation (NYSDEC)

-Metropolitan Transit Authority (MTA)

-New York City Department of Environmental Protection (NYCDEP)

- New York City Department of Information Technology & Telecommunications (DoITT)

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[13] https://www.foxnews.com/us/google-street-view-cars-to-be-outfitted-with-pollution-sensors-to-measure-us-europe-air-quality

[14] http://social.techcrunch.com/2018/06/21/google-streetview-cars-to-help-map-pollution-in-london/

[15] https://asic.aqrc.ucdavis.edu/sites/g/files/dgvnsk3466/files/inline-files/Darby%20Jack%20-%20Jack_ASIC_september2018_oakland%20%281%29.pdf

[16] https://gcn.com/articles/2018/07/06/trains-pollution-sensors.aspx

[17] https://www.treehugger.com/clean-technology/zurich-buses-outfitted-with-air-quality-sensors-for-mobile-monitoring.html

-Private sensor manufacturers (such as Alicma[18] or Plume Labs[19])

- Mayor's Office of Sustainability

Timeline

-The NYCDEP will purchase sensors from a private manufacturer and corroborate readings with NYSDEC and EPA sensor results to prove accuracy

- DoITT will finalize software backend for data feed. There will be provisions for an API, data downloads, and an app for result monitoring.

- The MTA will install sensors on up to five bus routes for the initial implementation

- DoITT will hold a training session for researchers on how to access and best analyze this data

- DoITT will hold a hackathon where the goal is to garner policy change proposals from this data, to gain publicity and buy in

-The MTA will install sensors on more bus routes

-The DEP, DEC and EPA will continue to analyze data and advertise its use to researchers from various backgrounds

-The Mayors Office of Sustainability will create actual policy change from results of analysis

- The Mayors Office of Sustainability will team up with other cities to expand this system

Beneficiaries

- New York City, as it can more efficiently get to its 2030 goal of being the cleanest big city in the US

[18] https://aclima.io/
[19] https://plumelabs.com/en/

- Researchers, as they get air quality data of a much higher granularity than what is currently available. This will help discover causes of pollution when the numbers are correlated with environmental factors (traffic, construction)

-New Yorkers, as they can avoid areas of high pollution and advocate for reductions in the exact places they are needed. The average citizen will also have to spend less on healthcare as air pollution decreases.

-Insurance companies, as there will be less claims filed for air pollution related ailments

-Other cities, when the model is tested and proven to be useful it will be easier to get the traction to expand it

Obstacles

"It's not technology standing in the way, it is politics, finance, and governance standing in the way." – Masoud Ghadehari, Ph.D[20]

-Cost

Initial

Sensor purchase

Sensor installation

Data backend setup

Ongoing

Sensor maintenance

Data backend upkeep

Awareness campaigns

[20] personal interview with Masoud Ghadehari, conducted by Marium Sultan and Ursula Kaczmarek, Nov 13 2018.

These costs will have to be provided for by budget allocations, and potentially private sponsorship. A convincing argument will have to be made for long term benefits that outweigh financial considerations. Perhaps a study can be done on dollars saved from projected reduction in air pollution related hospital visits and deaths.

- Political Risk

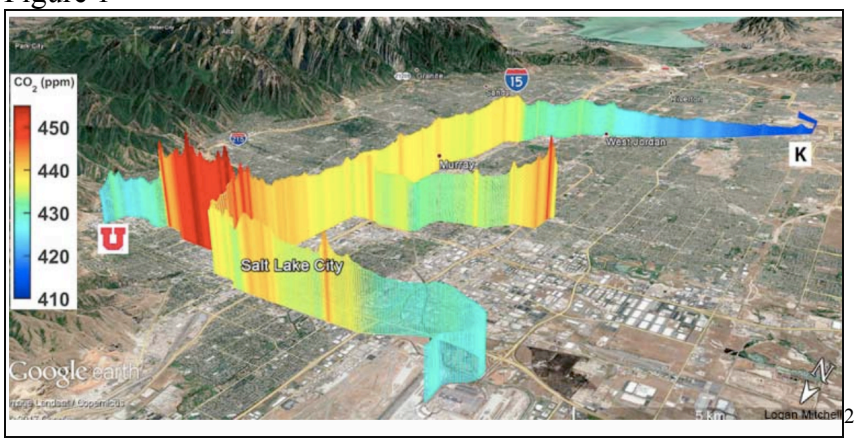
There is no proven large scale implementation of mobile air quality sensors, so the first city to do it will be taking a leap. However, when the first tries go well it'll grease the wheels for further implementation. This is why the timeline suggests starting on a smaller scale, with just a few bus routes and scaling up.

Conclusion

It is generally accepted, by health organizations and governments alike, that air pollution is a huge problem for public health in cities. Installing mobile air quality sensors on street level public transit with accessible real-time feeds will raise the amount of information available on air pollution in the city by orders of magnitude, and add a dynamic spatiotemporal dimension currently lacking. This new trove of information can be used for targeted policy changes to decrease emissions. The major obstacles to overcome are financing and political risk, but these can both be offset from the prioritization of air pollution reduction and a gradual scaling up of implementation.

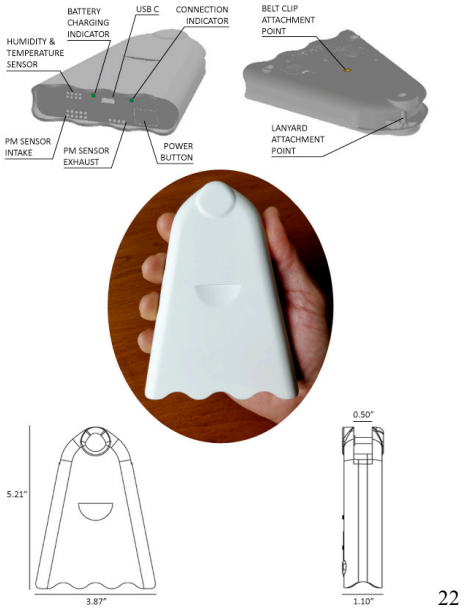
Appendix

Figure 1



[21]

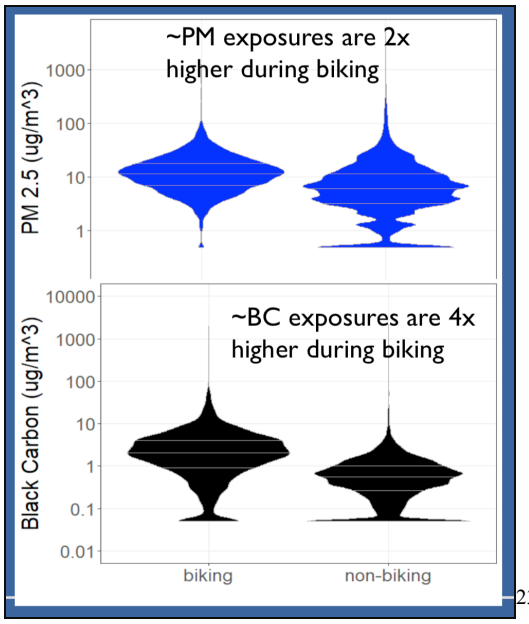
Figure 2



[22]

Figure 3

[21] https://gcn.com/articles/2018/07/06/trains-pollution-sensors.aspx
[22] http://www.takingspace.org/airbeam2-technical-specifications-operation-performance/



[23]

[23] https://asic.aqrc.ucdavis.edu/sites/g/files/dgvnsk3466/files/inline-files/Darby%20Jack%20-%20Jack_ASIC_september2018_oakland%20%281%29.pdf