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FNR 498: Ecological Sensors and Data

8 May 2021

Can increased VOCs indoors be detected by inexpensive sensors?

Volatile organic compounds (VOCs) are generally human-made chemicals used in a variety of industrial and household products. In industry, they are typically solvents, fuel oxygenates, or by-products from water chlorination. VOCs are commonly observed ground water pollutants. Organic compounds are found in many household products such as paints, varnishes, wax, cleaners, hobby products, refrigerants, pharmaceuticals, and fuels. All of these can release organic compounds during use and storage (EPA, n.d.).

VOCs are emitted into the air as gases, and some VOCs include chemicals that have short-term and long-term negative health effects. Short-term health effects include eye, nose, and throat irritation, fatigue, headache, shortness of breath, dizziness, and skin problems. In high concentrations, VOCs can cause lung, liver, kidney, and central nervous system damage. Long-term health effects include an increased risk of cancer. These health effects depend on the concentration and length of exposure to VOCs (HealthLinkBC, n.d.)

Research suggests that VOC levels are consistently higher indoors than outdoors with the number of VOCs being up to 10 times higher indoors (EPA, n.d.). My objective was to determine if the data collected by our air quality sensors was consistent with this trend. These findings will help determine if these inexpensive sensors collect viable data that demonstrates similar trends to other studies. If so, accessibility of these types of sensors will increase allowing for more detailed data collection on air quality.

**Methods**

In the dataset we used, students deployed Particle’s Argon air quality monitoring kits at various sites in Indiana, USA. These kits included a Shinyei PPD42 Dust Sensor, BME280 Temperature and Humidity Sensor, and a Seeed Studio Grove Air Quality Sensor v1.3 with metal-oxide sensor. Students deployed sensors inside and outside of their homes to measure temperature, barometric pressure, humidity, VOCs, low pulse occupancy, and dust ratio.

I ran an ANOVA to determine if there was a significant difference in the levels of VOCs indoors versus outdoors. I also created a boxplot that compares the number of VOCs indoors and outdoors, and it includes error bars based on the 95% confidence intervals.

**Results**

The ANOVAyielded an *F*-value of 328900 and a *p*-value of <0.01. Figure 1 indicates that the mean level of VOCs was much higher indoors than it was outdoors. The error bars do not overlap suggesting that this difference is significant. VOC levels indoors were approximately 3 times higher than outdoor levels.

**Conclusion**

My findings based on the data collected displays similar trends observed by other studies and acknowledged by the EPA (Figure 1). Our ability to replicate these results with inexpensive sensors supports the use of this upcoming technology in future scientific research. Current sensors that measure air quality based on metrics established by the EPA cost tens of thousands of dollars, and they also need a large amount of infrastructure and experienced personnel to operate them. New and upcoming air quality sensors such as Particle’s Argon used in this study are a couple hundred dollars or less. This significant decrease in cost and personnel allows for citizen scientists and community groups to contribute to air quality monitoring and tracking (Great Basin Unified Air Pollution Control District, n.d.).

I observed that VOC levels indoors were significantly higher than VOC levels outdoors (*p* < 0.01) which supports previous research that VOC levels are much higher in indoor settings compared to outdoor settings (EPA, n.d.). This information coupled with the short-term and long-term human health effects VOCs can have supports the need for further research on VOCs and the related health effects that can result from different types of exposure. Further research should be conducted on the effects VOC intensity and duration of exposure can have on human health as well as how certain VOCs relate to health conditions.

**References**

EPA. (n.d.). *What are volatile organic compounds (VOCs)?* <https://www.epa.gov/indoor-air-quality-iaq/what-are-volatile-organic-compounds-vocs#:~:text=Volatile%20organic%20compounds%20(VOCs)%20are,ten%20times%20higher)%20than%20outdoors>.

HealthLinkBC. (n.d.). *Indoor Air Quality: Volatile Organic Compounds (VOCs)* <https://www.healthlinkbc.ca/healthlinkbc-files/air-quality-VOCs#:~:text=VOCs%20include%20a%20variety%20of,kidney%2C%20or%20central%20nervous%20system>.

Great Basin Unified Air Pollution Control District. (n.d.) *Low-Cost Air Quality Sensors* <https://www.gbuapcd.org/AirMonitoringData/LowCostSensors/>

Figure 1. The mean level of volatile organic carbons (VOCs) detected by air quality sensors placed indoors and outdoors at various sites in Indiana, USA. Error bars are based on 95% confidence intervals.