Volatile Organic Compounds Measured in West Lafayette, IN

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I. Introduction

The question we wanted to answer using our data was how levels of volatile organic compounds change over the course of a day outside, and what activities might influence these fluctuations. We predicted that things like lawn mowing, bonfires, and gasoline cars might affect the levels of VOCs in the air because they involve combusting organic compounds.

To begin, VOCs, or volatile organic compounds, represent a large class of gases that are emitted into the atmosphere from industrial, residential, and other sources. VOC's can be emitted from many sources including paints, cleaning supplies, cars, fires and gas stoves. VOC are organic compounds, meaning they are made of primarily carbon, but may contain other elements as well. Some common VOCs include benzene, ethylene glycol, formaldehyde, methylene chloride, tetrachloroethylene, toluene, and xylene.

Some VOCs pose risks to human health. According to the EPA, " VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects." A few health complications associated with short-term VOC exposure are eye, nose, and throat irritation, headaches, dizziness, and worsened asthma symptoms. Long-term, VOC exposure can lead to cancer, liver and kidney damage, and nervous system damage, according to the Minnesota department of health.

For our experiment, we used the argon air quality monitor kit, which included a dust sensor, air quality sensor to measure VOCs, and barometer, which measured temperature, humidity, and pressure. The kit also came with all the necessary cables to set it up and an LED screen to display values.

We primarily used data from the air quality sensor to measure VOCs. It is important to note that these air quality sensors pick up all kinds of organic compounds and are influenced by many different environmental factors, so the data is not representative of just the harmful VOCs. Despite this, analyzing the air quality data is still beneficial in order to find patterns and locate potential sources of VOCs.

II. Methods

Four sensors were deployed between April 23rd to May 3rd: Gainesville FL Duckpond, Oakland, hix101 and MJC Lafayette IN. For the majority of our project, however, we will be looking at the sensor set up at MJC Lafayette, IN. Each of these sites used the Particle Argon air quality kit mentioned above. To set up the kits, we followed the instructions found on Particle's website: https://docs.particle.io/quickstart/aqmk-project/.

We started by connecting each of the sensors and the OLED screen to the Grover shield in the appropriate places. Then, we created a project using the Particle Workbench, which is built on Visual Studio Code. The only variation to the coding was the sensor_reading_interval, which was initially set at 30,000 milliseconds or 30 seconds. This was changed to 900,000 milliseconds or 15 minutes to make the dataset more manageable for analysis.

The sensor we used was deployed outside on a Southeast corner in a residential area of West Lafayette, IN. The air quality kit was kept in a plastic container with holes, which prevent moisture from damaging electronics while maintaining airflow. Each sensor was attached to container with tape to ensure they were able to function properly and remain in place.

Data was integrated with a webhook and displayed through code on Jupyter notebook accessed through MyGeoHub. Data was shown through a scatter plot to show each event collected for each parameter.

III. Results

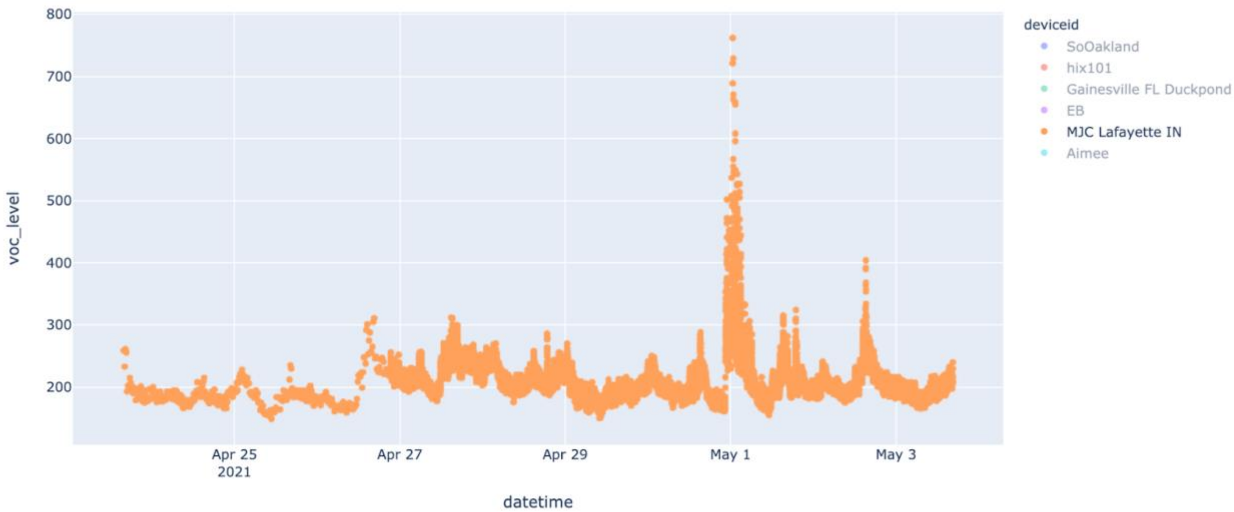

Figure 1: VOC level of MJC sensor

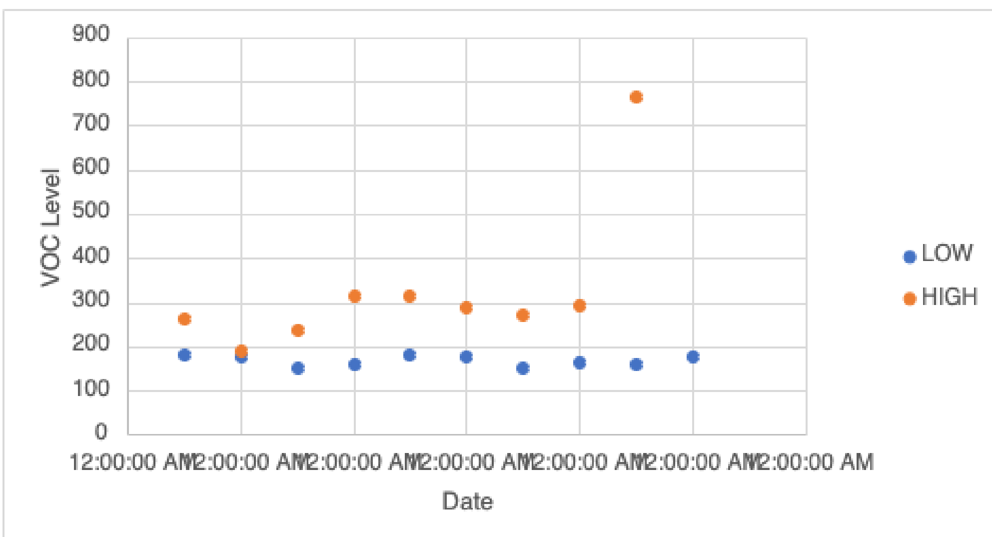

Figure 2: VOC level minima and maxima

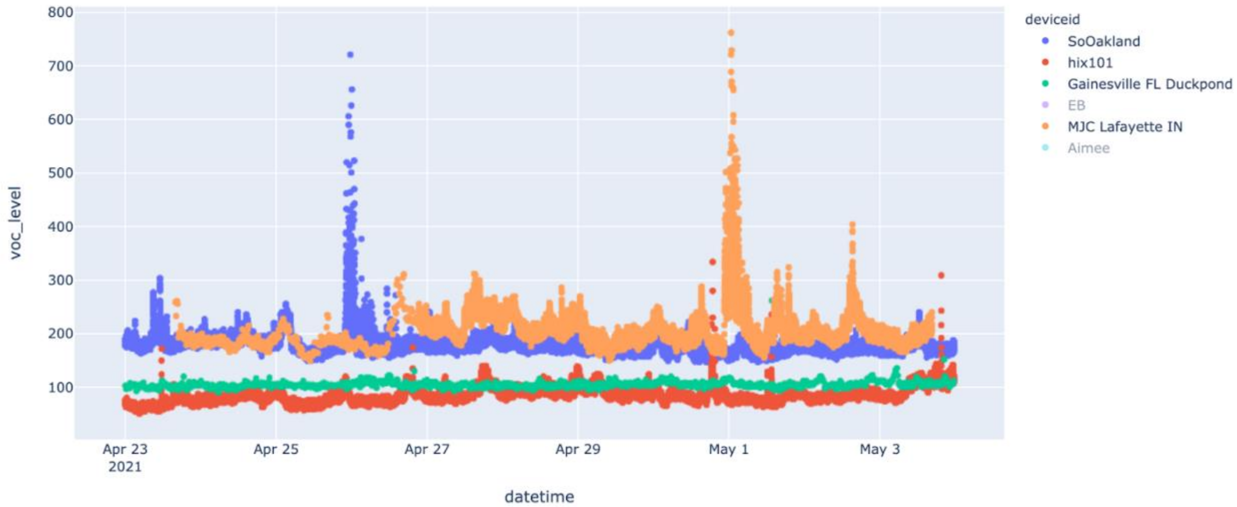

Figure 3: All sensors VOC data

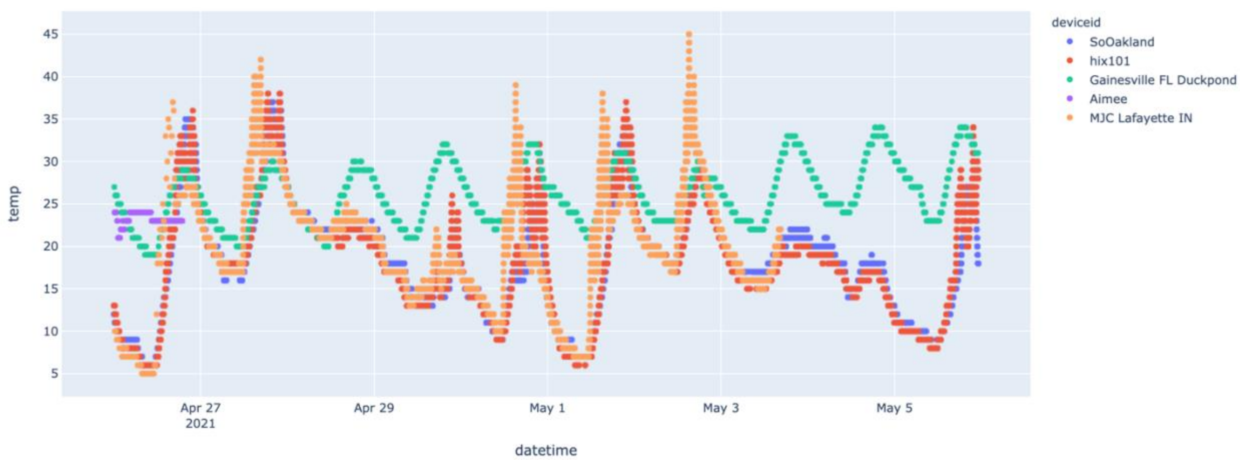

Figure 4: All sensors temperature data

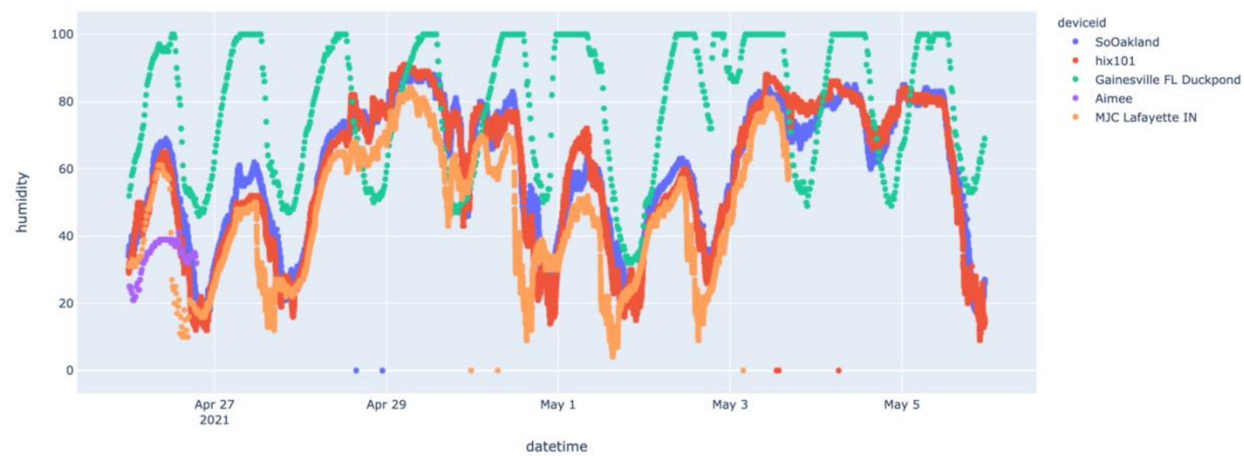

Figure 5: All sensors humidity data

We found that the highest VOC level was 762 and occurred at 12:31 on May 1st, and the lowest level was 149 on April 25th at 10:42. There were several peaks which can be most likely be associated with human activities. First, the largest peak was May 1st, which coincided with a large bonfire nearby. Another peak occurred on April 30th at 3:11 pm during a smaller bonfire around 20 ft from the sensor. We concluded that the smoke in the air was picked up by the sensor as smoke from wood fires contains many organic compounds, including VOCs.

Another trend that we observed from this data was that VOCs in the air usually increased at night and were lower during the day. Referring the figure 3, it can be seen that many of the sensors followed the trend of higher VOCs at night. We had several hypotheses for this phenomenon, including influence of temperature and humidity and influence of plants in carbon fixation and the carbon cycle. One reason we believed that temperature and humidity played a role in VOC level was that the sites where temperature and humidity fluctuated diurnally in a significant way also showed the VOC diurnal fluctuation. The one site that had the least diurnal VOC change was the Gainesville, FL duck pond sensor, which has a much higher temperature and humidity.

IV. Conclusions

In conclusion, we observed changes in VOC levels throughout the day with noticeable peaks surrounding events which increased particles in the air. We believe that these peaks are caused by human activities like the bonfires, but other peaks may have occurred due to lawn mowing, laundry, and cars that were not recorded. If this experiment was done again in the future, we would also record more human activities that could have caused these additional peaks.

Some biases to note are having few sites and a short period of time. With a limited sample size and timeframe, this data may have some flaws and outliers that were overlooked. It is also important to note that VOCs are a very vague category, therefore we cannot pin down exactly which compound it is to determine if it is toxic or not.

In addition, future research on this topic could include more time and more sites. Other sensors could also be used, for example a CO_2 sensor might be beneficial to add to determine the correlation of VOCs and CO_2 to determine overall air quality.

This research is important because finding out the diurnal increases and decreases of VOCs and some common sources of VOC’s can help protect both human and environmental health. This research could also highlight the importance of urban forestry and other methods of improving air quality.

References

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