Comparing Select Weather Parameters with Ground-Level Ozone in the Summer and Autumn Seasons

Student Researchers:

Ali Akil, Adam Ali, Jelal Muflahi

School:

Crestwood High School, Dearborn Heights, MI 48127

High School Science Teacher:

Mrs. Diana Johns

Table of Contents

Abstract:

In the stratosphere, ozone molecules play an important role absorbing ultraviolet radiation from the Sun and shielding Earth from dangerous rays. But in the troposphere, near ground-level, ozone molecules are both air pollutants, threatening the health of living things, and greenhouse gases, trapping heat and contributing to climate change. With our research, we sought to compare select weather parameters with surface ozone to determine which impact ozone levels. This would better allow researchers and scientists to prevent future increases in ozone levels. This led us to our research question, to what extent do select weather parameters impact local surface ozone levels? To successfully complete our research, we took daily measurements at our school's soccer field using the PASCO wireless weather station and the Pocket Lab weather device. It was found that ozone correlated with pressure, relative humidity, and temperature. However, there was no real correlation between light intensity and surface ozone levels.

Research Questions:

-Initial Research Question:

How do the ozone levels in a week of July differ from the ozone levels in a week of October? How does a change in pressure affect ozone levels? Does an increase in temperature correlate to an increase in ozone levels? Do changes in relative humidity affect ozone levels? Does an increase in light intensity affect ozone levels? How do local ozone levels compare with regional readings?

-Null Hypotheses:

Null Hypotheses: Null Hypothesis 1: There is no direct correlation between pressure and ozone levels. Null Hypothesis 2: There is not a direct correlation between increased humidity and ozone levels. Null hypothesis 3: There is no correlation between increased light intensity and ozone levels.

-Why this is important / Research Implications:

Scientists monitor ground-level ozone closely in many parts of the world because of the variety of health implications it has on humans. It is especially important in warmer environments as it was observed that the development of ozone increases in warmer temperatures. The numerous health problems associated with it include chest pain, coughing, throat irritation, and congestion. It may worsen to reduce lung function and the inflammation of the linings of the lungs. In severe cases, repeated exposure may lead to permanently scarred lung tissue. Even those with great health are impacted by the effects of ozone as it can lead to trouble breathing. The impact of ozone also extends to wildlife and vegetation as it leads to reduced agricultural and crop yields. By finding how select weather parameters impact ozone levels, we

can determine what factors may lead to future increases in this harmful gas. Knowing what impacts ozone levels allows researchers to focus on monitoring certain weather parameters and looking into ways that reduce those that increase ozone.

Introduction and Review of Literature:

From July of 2019 to October, Data was collected on a multitude of weather parameters, used to compared with surface ozone. The ozone layer is the lower part of the Earth's stratosphere and is 20 to 30 kilometers above the surface of the Earth (Abdalrhman Khaled Al Zahrani). Surface ozone can cause several unexpected outcomes from health issues too and even environmental issues. This can be a major issue as CHS is known for its sports and ozone can affect these activities. Furthermore, people in warmer areas tend to experience chest pains, coughing, throat irritation, and congestion (AirNow). In some severe cases, it may worsen to reduce lung function and the inflammation of the linings of the lungs which could lead permanently scarred lung tissue Throughout the year, Crestwood's fields are put to use for multiple outdoor events, so with people constantly being outside for these events and surface ozone continuously increasing, it'll only cause an increase in problems for the people of our city. Surface ozone may reduce photosynthesis in plants, species diversity, habitat quality, and changes in the water and nutrient cycles. Ozone doesn't only affect humans, but also our local community. Black cherry, an important part of Michigan's economic success during the cherry season; Tulip Poplar, a native species in Michigan that brings beauty to our city; White Pine, Michigan's state tree that not only brings beauty but is a key resource in one of our greatest industries of lumbering; and finally the Ponderosa Pine, a native species of pine trees (EPA). The trees listed before are all crucial to our community and ecosystems, from economic benefits to

keeping habitat diversity. Not only do these trees exist within Crestwood High School but also within our very homes and if the issue of increasing ozone levels continues will not only experience issues at our school but also at our very own homes.

Research Methods

Figure 1-2: Figures 1 and 2 show the areas where measurements were taken (Crestwood High School, Dearborn Heights, MI 48127) The exact location: 42.320672 N, -83.293938 W.

Figures 3-4: Figures 3 and 4 shows a student researcher following the protocols in order to take the surface ozone.

Results:

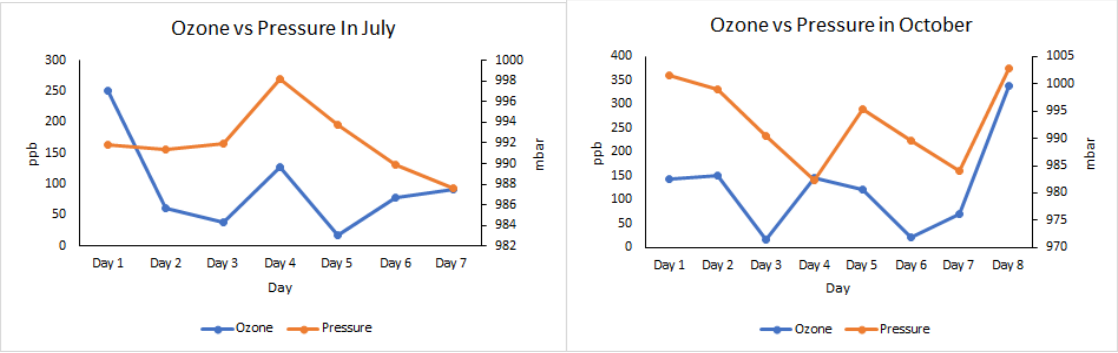


Figure 1-2: Ozone versus pressure in July vs October. These graphs compare surface ozone levels with pressure during a week in July and a week in October. As shown above you can notice a delayed correlation between ozone and pressure.

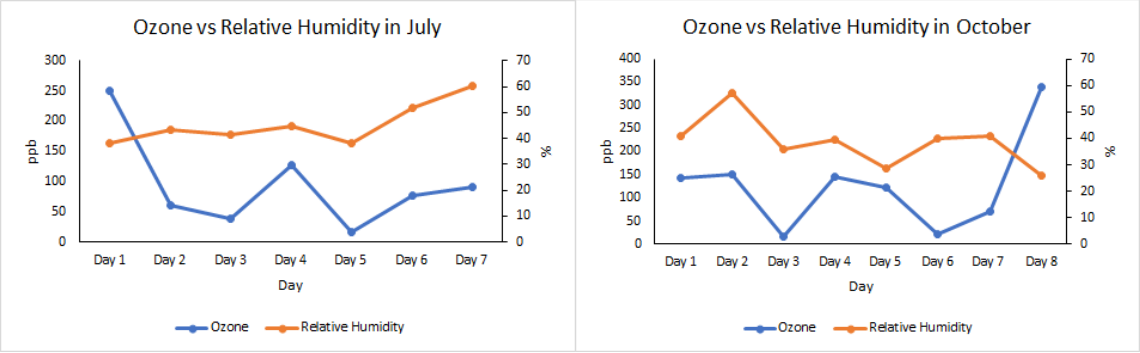


Figure 3-4: Ozone versus relative humidity. These graphs above compare surface ozone levels with relative humidity during a week in July and a week in October. You'll notice that both parameters are relatively correlated, however, if the relative humidity is low then trees will close their stomata and will not take up any ozone allowing it to build up which will result in inverse relations between the two. This is shown on day one in the July chart and on day eight of the October chart.

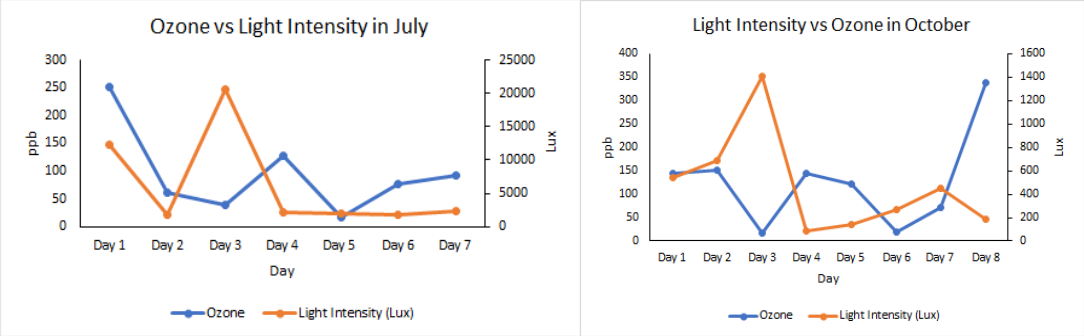
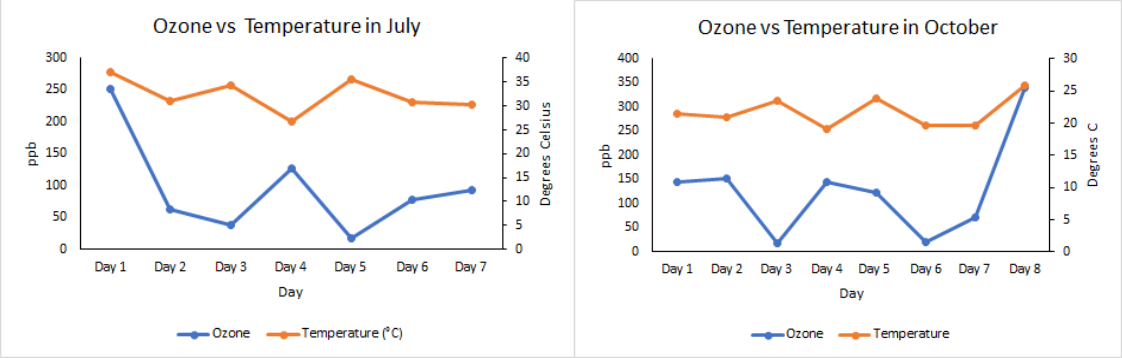
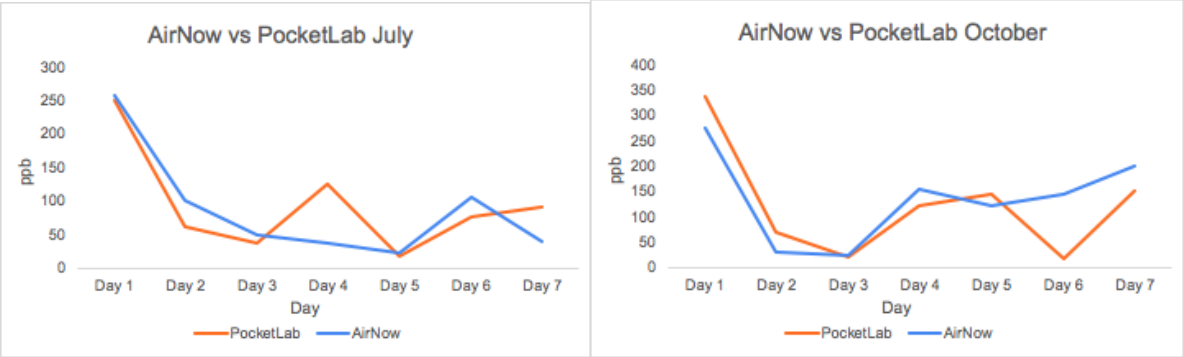


Figure 5-6: Ozone versus Light intensity. These graphs above compare surface ozone levels with light intensity during a week in July and a week in October. As shown to you above, there is no correlation between ozone and light intensity.



Figures 7-8: Ozone vs temperature: These graphs compare the ozone levels and temperature in the week of July and in the week of October. Ozone's impact is due to changes in temperature. The more ozone the more heat is retained. These graphs show a delayed correlation between the temperature and ozone levels.



Figures 9-10: AirNow vs PocketLab: These graphs compare the mean ozone levels from the PocketLab to the AirNow in the months of July and October. As shown above, there is not a significant difference in our data except on Day 4 in the month of July due to acquiring on 5 minutes of data with the PocketLab which doesn't give us a very accurate representation of the actual mean ozone. However overall, there was a clear trend between our data and the AirNow.

Discussion:

When conducting our research, we were faced with some unfortunate challenges that created imperfections in our data. With some scheduling and transportation being out of our control, on some days we were unable to collect our data at the specific time we had originally planned for. Furthermore, our daily averages were based on data recordings of at least 5 minutes, however on some days we let it run for a little longer, so some daily averages are more accurate than others. Additionally, we had hoped to be able to collect data during the winter weather, but due to busy schedules and harsh weather conditions, we were unable to. The data we did collect we converted into graphs which allowed us to see the trends and successfully answer our original research question.

Conclusion:

Upon completing our research, it was found that some of the weather parameters we monitored did correlate with ozone levels, while others did not. Our data showed a correlation of ozone with pressure, relative humidity, and temperature. However, it was found that there was no clear correlation between light intensity and surface ozone levels. These findings suggest that researchers should look into ways to control these parameters which would allow them to prevent ozone levels from becoming too high in certain areas. This would allow for cleaner and safer air where there are large events such as those at our highschool. When comparing our data with the Michigan Air Quality - AirNow, we found that our data is very similar when we took longer periods of data collection however not so similar on the days that we took a bare minimum of 5 minutes worth of data. We didn't notice any drastic differences when we compared our data from the month of July to the month in October. Overall though, both

Michigan's Air Quality and our data on surface ozone, temperature, light intensity, relative humidity, and barometric pressure seem to match. Future research may include testing different ways ozone and the weather parameters it is correlated to can be controlled and reduced. Overall, with minimal sources of error, we were able to collect the data needed to answer our original research questions.

Bibliography/ Citations:

Kavassalis, Sarah C., and Jennifer G. Murphy. “Understanding Ozone-Meteorology Correlations: A Role for Dry Deposition.” *AGU Journals*, John Wiley & Sons, Ltd, 31 Mar. 2017, agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016GL071791.

Good Up High Bad Nearby - What Is Ozone? www.airnow.gov/index.cfm?action=gooduphigh.index.

“NASA GISS: Research Features: Ozone and Climate Change.” *NASA*, NASA, www.giss.nasa.gov/research/features/200402_tango/.

“Ozone Generators That Are Sold As Air Cleaners.” *EPA*, Environmental Protection Agency, 23 Dec. 2019, www.epa.gov/indoor-air-quality-iaq/ozone-generators-are-sold-air-cleaners.

Burrows, Leah. “The Complex Relationship between Heat and Ozone.” *Harvard Gazette*, Harvard Gazette, 15 Mar. 2019, news.harvard.edu/gazette/story/2016/04/the-complex-relationship-between-heat-and-ozone/.

Badges:

Data Scientist: Our collection of daily measurements of ozone, relative humidity, etc. were all major contributions to answering our research questions and testing our hypotheses. We uploaded the data we collected to GLOBE's visualization system then analyzed this data in the form of charts in graphs.

Collaborator: In order to collect sufficient data, we had trained other Crestwood students on how to properly record data which played a big role because they often reported to the site and took necessary measurements at various times of the day. Meeting with experienced GLOBE members from our school also allowed us to understand how to properly access and analyze data which was key. Our team of two proved to be efficient in completing and putting the research together, even under great time constraints.