Comparing the Observable Seasonal Trends in Aerosol Measurements in Kingsburg, CA Over 2018-2020

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Abstract
Aerosol are particulates, both naturally and anthropogenically produced, capable of affecting the passage of sunlight (Lara). This is measured in the form of Aerosol Optical Thickness readings, or AOT. Typically, an increased presence of particles results in a higher reading. The burning of organic materials, pollen, dust, pesticides, and vehicular emissions can result in the collection of particulates in the air. They can then be transported by the wind over large distances, as was observed in the AOT readings at Kingsburg. Aerosol Optical Thickness (AOT) reading collections were taken and analyzed in order to detect average aerosol trends. The rainy season in the Central Valley tends to be between December and March. Precipitation attracts aerosol particulates, removing them from the atmosphere which contributed to the observations in this study where average AOT readings decreased in the rainy season (Chu).

Research Question
This study was set in motion after trends were observed in weather data collected from the weather station in Kingsburg. Aerosol Optical Thickness (AOT) reading collections were taken and analyzed in order to detect average aerosol trends. The rainy season in the Central Valley tends to be between December and March. Precipitation attracts aerosol particulates, removing them from the atmosphere which contributed to the observations in this study where average AOT readings decreased in the rainy season (Chu).

Hypothesis
An expected visible trend of average aerosol readings throughout the year would be higher in the fall and lower in the spring due to the typical annual rainy season lasting from December to March. An inversion layer of warm air characteristic of valleys tends to trap pollutants/particulates for prolonged periods of time. Since rain droplets attract particulates in the air and carry them out of the atmosphere it can be presumed that in the following days after a rain event that average aerosol readings would be lower (Chu). It is anticipated that there would be a higher average aerosol reading in the 2019-2020 season than 2018-2019 due to a stronger fire occurring in Nov. 2018. This trend is expected to be supported by the use of standard error in a test of comparing an occurrence of an anomaly in data collection.

Investigation Plan
In order to determine a correlation, data was collected based on weather clearings on school days in Kingsburg, CA.

1. Throughout the months of October to March 2018-2019 and 2019-2020, data was collected at the Kingsburg High School Building Weather Station.
   a. This consisted of current air and soil temp, atmospheric pressure, humidity, cloud coverage, precipitation amount and pel, along with aerosols.
   b. Collected data was submitted to the GLOBE website and through the GLOBE app along with aerosol data collection using a smartphone. The aerosol values were collected over groups of 5 per day and the average of each day that was collected was then placed onto the spreadsheet.
   c. Using the averages per day, we graphed each year’s average aerosol values into individual graphs. This is then compared to analyze the values throughout the year, following the progression of Fall to Spring, to the other year.
2. This was then compared to known rain events.

Research Methods
Observations were made using data from the RSS Science Building weather stations (KHS) collected daily air temp, including current, min, and max along with relative humidity, cloud data, and precipitation. Typically, data collection occurred within an hour (max) of solar noon, as per GLOBE atmosphere protocols. These observations were collected through a series of sensors/buoys beginning with a pressure gauge in the station 30 min before collection, then collecting the temperature from the station and barometric pressure from the sensor and Weather Underground. Aerosol were collected on clear days suitable for AOT measurements that were also school days. These readings were taken on collection day to order to formulate accurate data. After all of these observations were written down as automatic input does not exist yet in our outdoor - the GLOBE observer app and online Data Entry Forms were utilized to record both cloud and aerosol observations. Precipitation was established to avoid any obstructions in order to take the best possible images and make the most accurate observations.

Data Summary
Figure 1 displays the average AOT readings from October 18th, 2018 through March 15th, 2018 data collection period. The trend line suggests the year-long decline in average AOT readings. The two obvious outliers of 0.467 and 0.54 dated 11-15-2018 and 11-26-2018 support the impact of the Camp Fire on particulate matter readings within the region. Figure 2 shows the average AOT readings from October 14th, 2019 through March 15th, 2020 data collection period. The trend line suggests the year-long decline in average AOT readings. Figure 3 illustrates the graph of the average AOT readings from 2018-2019 and 2019-2020. It also includes the trend lines from both years, comparing the obvious decline but the contrasting difference in slope. There is a much more rapid decline from 2018-2019 from 2019-2018.

Data Analysis
Within this data collection set, the data points used in the graph all have a minimal standard error that shows they are precise and accurate, meaning that they are not a result of improper data collection. The observed trend lines shown in both Figure 1 and Figure 2 are composed in Figure 3, which indicates that a general drop in average AOT readings is an annual occurrence. The 2018-2019 season had greater average AOT readings than 2019-2020, likely due to the wildfires forming as a result of the Camp Fire in Nov. 2018 influencing the trendline to move stagnant. Fires on such a magnitude of the Camp Fire release mass amounts of aerosols into the air, therefore impacting the readings during the following weeks. However, the rainy season normalized the readings in Dec. 2019. The 2019-2020 trendline would be the more representative of an annual average AOT decline as the occurrence of outliers is not present.

A gradual decline in values through December to March in both years correlates with the rainy season, characteristics of CA. A typical characteristic of this region is to have collections of particulates within the inversion layers present, gathering during the summer and fall when precipitation is rare, which are then released into the air during periods of rainfall. Precipitation typically coincides with periods that are present in the sky (Chu). Due to its position, the rain droplets attract the particulates and descend together, removing them from the atmosphere (Chu). The removal of particulates would contribute to lower average AOT readings during the rainy season when such phenomena is occurring; further explaining the trends observed in the figures.

GLOBE Data
Figure 1: Average Aerosol Values Over 2018 - Mar. 2019
Figure 2: Average Aerosol Values from Oct. 2019 to March 2019. It shows a general trend of the values given.

Conclusions
Based on the data collected and research done, it is apparent that Kingsburg’s geographical location has a major impact on particulate matter within the inversion layers of the Central Valley. Natural occurrences of precipitation and the preceding inversion layer, which traps the particulate matter in the basin, allows for aerosols to create an optimal environment for a general decline in aerosol readings as this reservoir of aerosols can be significantly depleted by a singular rain event. The rain season and the observed decreasing trends in AOT readings occur simultaneously, as apparent in the figures provided. The rainy season, typically falling between December and March for the CA location, contributes to lower concentrations of particulate matter within the air. In the months leading up to the rainy season, AOT readings are relatively high in comparison to those taken in early spring. The trends observed in our data figures display a downward trend around this window of time, there is a strong conclusive lean towards the claim that the rainy season and observed decreasing aerosol readings coincide with one another on a cause-effect basis. If this study was to be furthered, it would be ideal to have collections of agricultural burn days, pollen counts, and air quality measurements as these factors have a significant impact on the readings of this region. Despite natural cycles such as precipitation that tend to lower the levels of particulate matter in the air, average AOT readings could be manipulated to be increasing as a result of inversion layers, fog, fogs, and wind patterns, as well as anthropogenic impacts such as agriculture over long periods of time. This progressive change in readings would need to be the topic for further studies or projects using other forms of data including this study as a baseline for trends of this region.

Limitations/ Sources of Error
In 2018-2019 limited data collection resulted in only thirteen aerosol measurements being taken, with five measurements being removed due to incorrect trends within our figures due to the improper handling of the calibers. In 2019-2020 eight measurements were removed due to the same issue. A limited occurrence in October of 2019 as the on-site barometer ceased to operate, therefore we relied upon Weather Underground, a website with daily barometric data, for readings. Additionally, on Jan. 9th, 2020 at 11:56 AM the battery was changed in the weather station, and therefore on Jan. 14th at 11:56 AM. Another limitation was that we did not have the resources to obtain pollen measurements or agricultural burn days. Finally, the interference of COVID-19 interrupted our data collection, missing days to analyze, as well as communicate, therefore the project was not as comprehensive as it could have been. Computerized collection of data will likely help stabilize the inconsistency of collection of days along with providing more substantial evidence. Taking into consideration the fluctuations in surrounding regions can also help solidify the proposed hypothesis.

Bibliography