CHAPMAN UNIVERSITY
SCHMID COLLEGE OF SCIENCE AND TECHNOLOGY

What's Better: Fresh Air or Keck's Air?

Monitoring Indoor and Outdoor Air Quality

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Air Quality in Keck Center and Reason for Research

Our team's grand challenge is investigating and comparing indoor and outdoor air quality in reference to particulate matter. Particulate matter (PM) refers to a mixture of solid particles and liquid droplets found in the air that pose a threat to human health ("What is Particulate Matter?" 2017). Since PM particles are microscopic, they can be easily inhaled and can cause severe respiratory problems and heart malfunctions that can lead to death (Yuna et al., 2015). Consequently, we decided to collect and analyze the air quality present and surrounding Chapman University in order to compare the differences between indoor and outdoor air. More specifically, we looked at the three most common sizes of particulate matter present in the air, PM 1.0, PM 2.5, and PM 10.0, and analyzed how temperature and humidity affects these particulate matters (Zhao et al., 2016). We set up Purple Air sensors inside and outside Chapman's Keck Center to monitor PM concentration levels. We hypothesized that outdoor air will have higher PM concentration levels, regarding all sizes of PM being analyzed, than indoor air due to Chapman's ventilated buildings. We also tested how variables such as temperature and humidity affect PM concentration. We predicted that low temperatures mixed with high humidity would create the best conditions for PM particles to thrive.

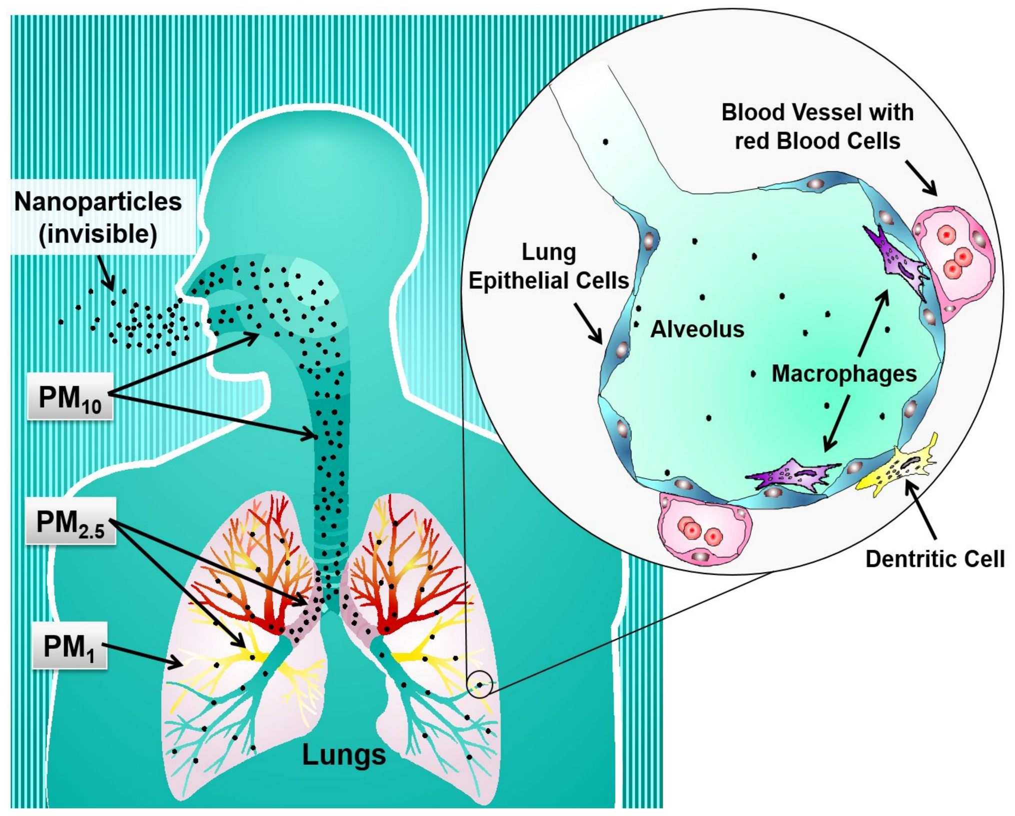

Figure 1: PM passage through lungs.

Purple Air Technology

Purple Air PM sensors were used to measure and collect data. The sensor uses a fan which draws in air and a laser that directs light at the incoming particles . The particulate matter reflects the laser and the reflected light is sensed by a detection plate as a pulse of energy. The length of the pulse indicates the size of the particle and the number of pulses indicates the number of particles. The data can then be seen on the Purple Air website.

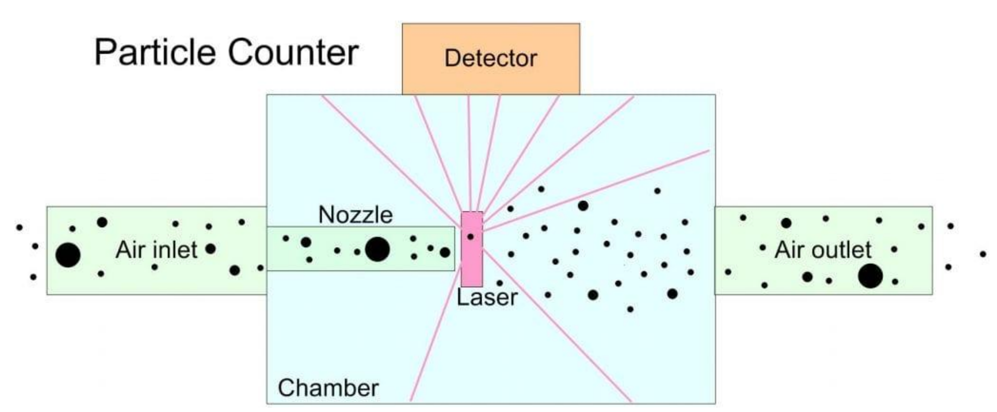

Figure 2: Model of PM sensor particle counter mechanism.

Analysis of PM 1.0, 2.5, and 10.0 Levels

The data we collected from Purple Air showed evidence that supported our hypotheses. Figure 6 shows for all levels of particulate matter, the outdoor presence was higher than the indoor presence. This shows the Keck Center air is probably well-circulated, ensuring that indoor PM levels don't reach the same levels as outdoor PM levels. Because this sensor was placed in a specific room (Keck 153) the concentrations might be different around the building. Figure 5 shows that the strongest and most reliable correlation found was between temperature and humidity. Additionally, with increasing humidity, there was an increasing concentration of PM at all levels and in both locations. However, this data is not as strong because the coefficient of determination is moderate.

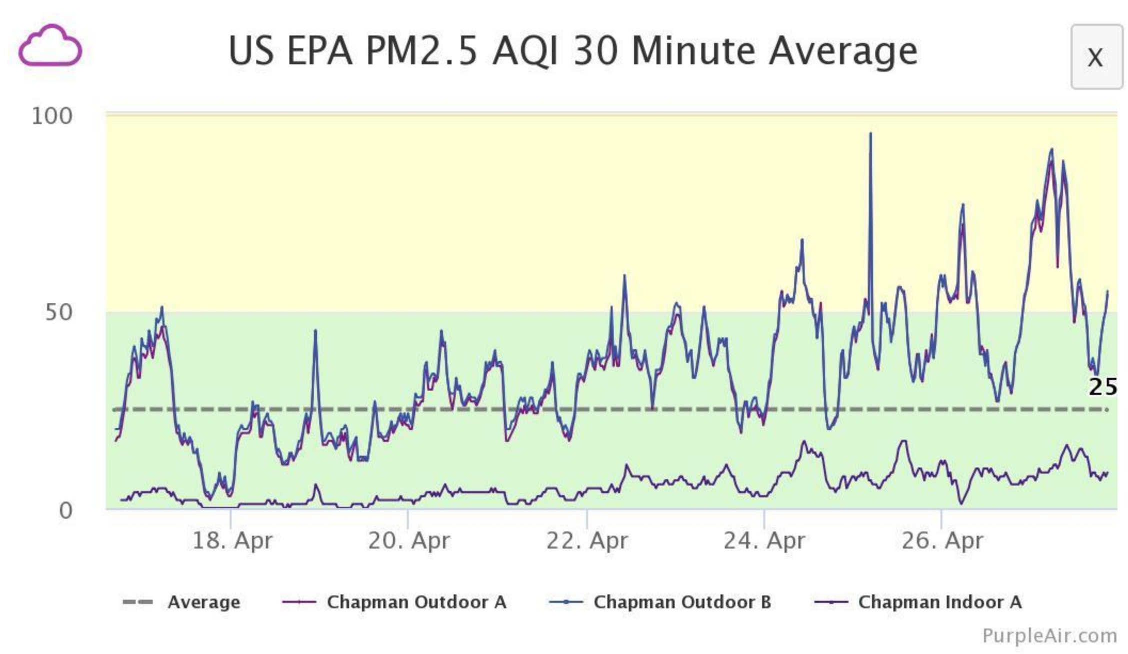

Figure 3: Line graph comparing indoor and outdoor PM levels.

Variables	R Value	R Squared Value
Temperature versus PM 1.0	-0.7156872	0.5122
Temperature versus PM 2.5	-0.6970943	0.4859
Temperature versus PM 10.0	-0.7013954	0.4920
Humidity versus PM 1.0	0.7543828	0.5690
Humidity versus PM 2.5	0.7669412	0.5882
Humidity versus PM 10.0	0.7472883	0.5584
Temperature versus Humidity	-0.9461563	0.8952117

Figure 4: Table of correlation coefficients (R values) and coefficients of determination (R-squared values).

What's next for monitoring Keck Air Quality?

The correlation coefficients for humidity and temperature both show moderately strong relationships in reference to PM concentrations. High humidity and low temperature result in higher PM levels, while low humidity and high temperature indicate lower PM levels. There is also a strong inverse relationship between temperature and humidity, shown in Figure 5, that supports the findings of the relationships between the individual variables and the PM concentrations. This data shows that PM levels are higher on cold, wet days like a rainy winter day compared to a hot, dry day like in summer. Moreover, the data also provided evidence of interplay between indoor and outdoor air. The indoor air data mimicked the trends of the outdoor air's data but at lower levels. An example of which can be seen in Figure 3. In reference to PM concentration, the indoor air quality is better than the outdoor air quality. In the future, this project can be expanded to analyze other variables that may affect air quality such as ventilation and wind measurements. The culmination of this analysis would be able to provide the basis for creating a model to predict PM levels so we can all stay safe from dangerously high levels of PM.

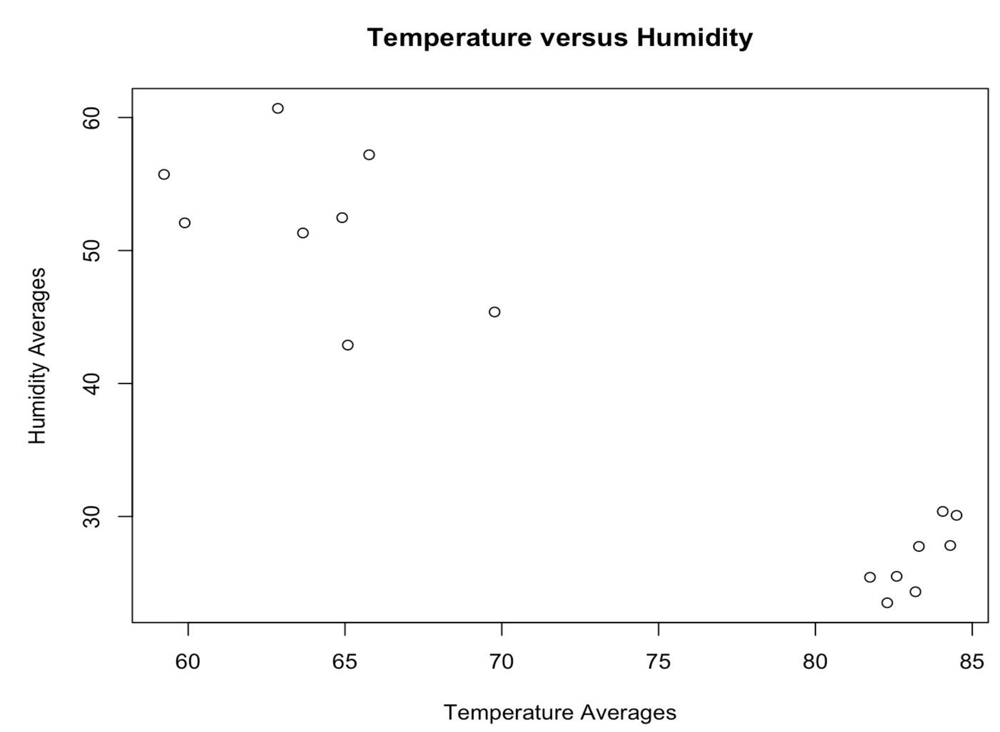

Figure 5: Scatter Plot of temperature vs. humidity.

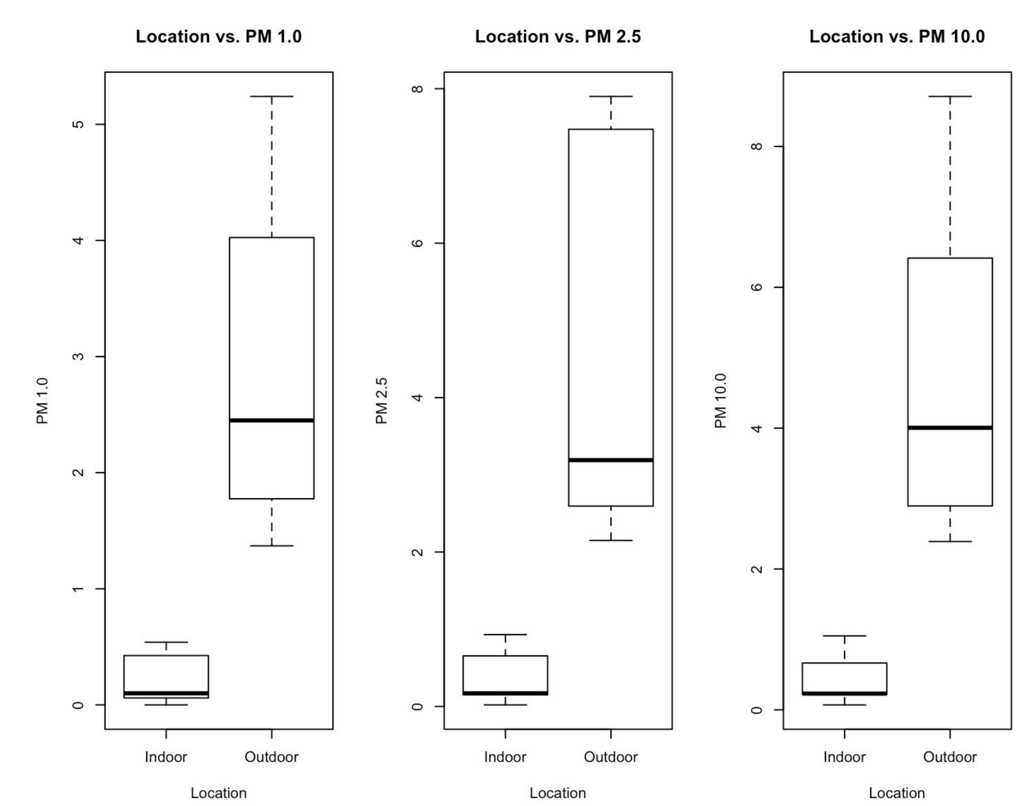

Figure 6: Boxplots of location vs. PM.

References & Contributions

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Purple Air

Figure 1: https://www.nanopartikel.info/en/nanoinfo/body-barriers/2388-nanoparticles-and-the-lung
Figure 3: https://particlesplus.com/air-quality-instrumentation-part-iii-particle-mass-pm-estimation/
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