

Effect of Ventilation, Humidity and Temperature on CO2 Concentration

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Introduction

Current research at the University of Maryland has found strong evidence that the influenza virus can be transmitted through breathing¹, thereby dispelling the popular notion that transmission of flu can only be brought about by coughing and sneezing. Infectious aerosol particles can remain suspended in the air and spur the transmission of viral disease, especially in buildings with poor air circulation and ventilation.

We studied how ventilation factors such as CO2 concentration, relative humidity, dew point, and temperature changed over time in different classrooms to analyze deficiencies in the current ventilation system and determine if changes need to be made to decrease the prevalence and spread of potential infectious aerosol particles.

We examined data collected over 17 days from six CO2 monitors - five in poorly ventilated rooms in the School of Public Health building and one mounted outside.

Our objective was to compare the differences in relative humidity, temperature, dew point, and CO2 concentration in order to provide a recommendation on if and how the current SPH ventilation system should be renovated so ideal factors are reached. We hypothesized that:

- Poor ventilation will cause high CO2 concentration
- Higher humidity will cause high CO2 concentration
- Higher temperature will cause high CO2 concentration

Methods

Data was collected using HOBO sensors.

- Sensors were mounted in SPH 301, 302, 303, 305, and 307
- Measurements were taken for 17 days at 5 minute intervals for:
 - average temperature
 - relative humidity
 - dew point, and
 - carbon dioxide concentration
- One sensor was mounted outside of the School of Public Health to serve as a baseline comparison for outdoor air quality.
- The relationship between time and each of the ventilation variables for each room was analyzed and plotted.

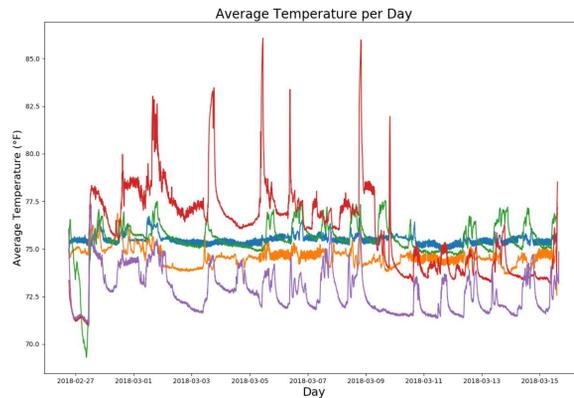


Figure 1: There appears to be a positive correlation between temperature and time of day in the SPH classes.

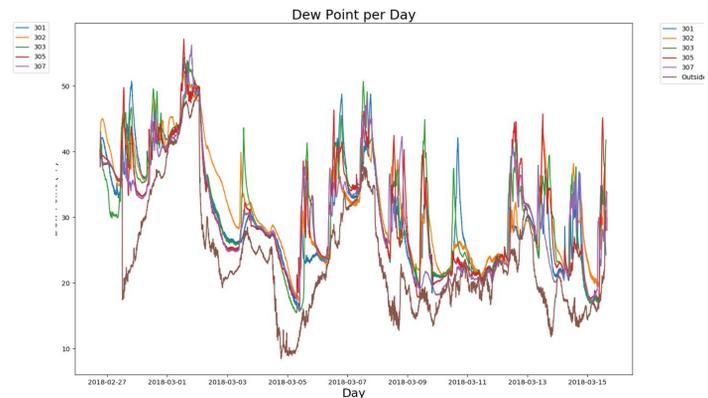


Figure 2: The dew point per day appears to be relatively constant between the rooms and the outside.

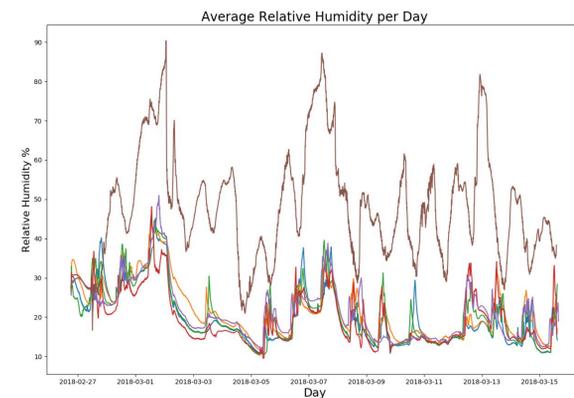


Figure 3: The average relative humidity spikes during Saturday classes between 8:00AM and 3:00PM on 3/3 and 3/10, indicating that having students in a room changes the humidity in a room, and that positively correlates to the CO2 concentration.

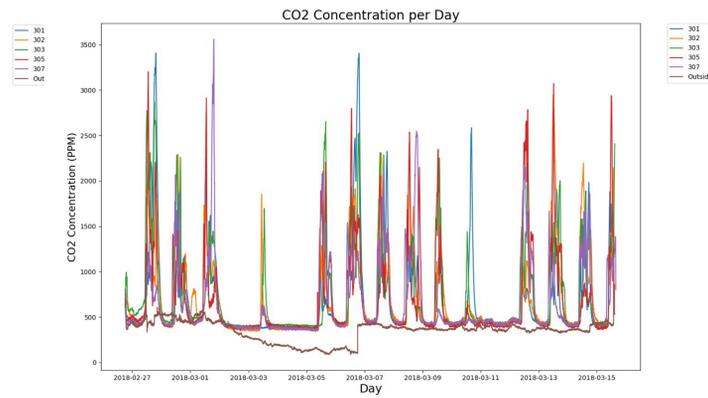


Figure 4: CO2 PPM in the rooms are close to outside CO2 PPM on weekends (late Friday to early Monday) when there are no classes except early Saturday (3/3) and (3/10) when there is a SPH class in 301, 302, and 303 from 8:00 AM to 3:00PM.

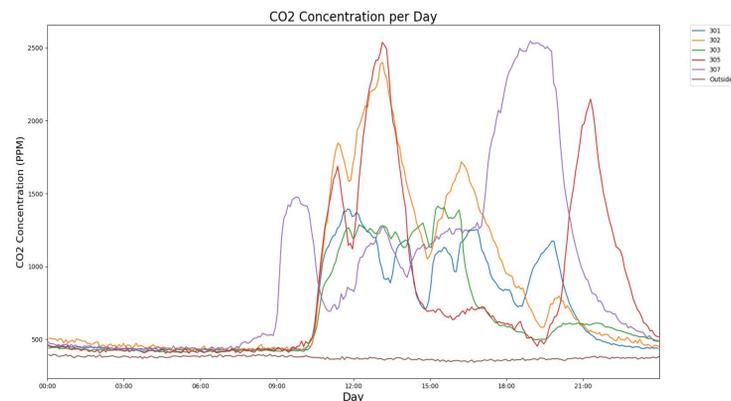


Figure 5: CO2 concentration outside remains relatively steady between 250 to 500 PPM. There are multiple spikes over 2000 PPM in CO2 PPM between 9AM to 9PM in the classrooms; these times correlate to when students have classes or are studying in those rooms.

Discussion

- Old buildings generally have poor ventilation, which can negatively affect the health of its residents and visitors.
- The current research from the University of Maryland¹ shows, breathing can expel infectious aerosols that can remain suspended in the air. We believe that having even one sick person in a room with poor ventilation can greatly impact the chances of others in the room getting sick.
- Concentrations of over 1,000ppm² in rooms have inhabitants report drowsiness and complaints of poor air. During the day, some rooms spike over 3,500ppm which can lead to decreased attention and drowsiness amongst students, and increase their chance of developing an illness if other students are ill.
- Further research should look into our initial findings and determine if renovations to change ventilation is necessary in old buildings like the School of Public Health.

1. Yan, J., Grantham, M., Pantelic, J., Mesquita, P. J., Albert, B., Liu, F., . . . Milton, D. K. (2017). Infectious virus in exhaled breath of symptomatic seasonal influenza cases from a college community. *Proceedings of the National Academy of Sciences of the United States of America*, 115(5), 1081-1086. doi:10.1101/194985
 2. What are safe levels of CO and CO2 in rooms? (n.d.). Retrieved April 02, 2018, from <https://www.kane.co.uk/knowledge-centre/what-are-safe-levels-of-co-and-co2-in-rooms>

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