Office Air Quality Monitoring

Impact of installation height on air quality measurement in an office space

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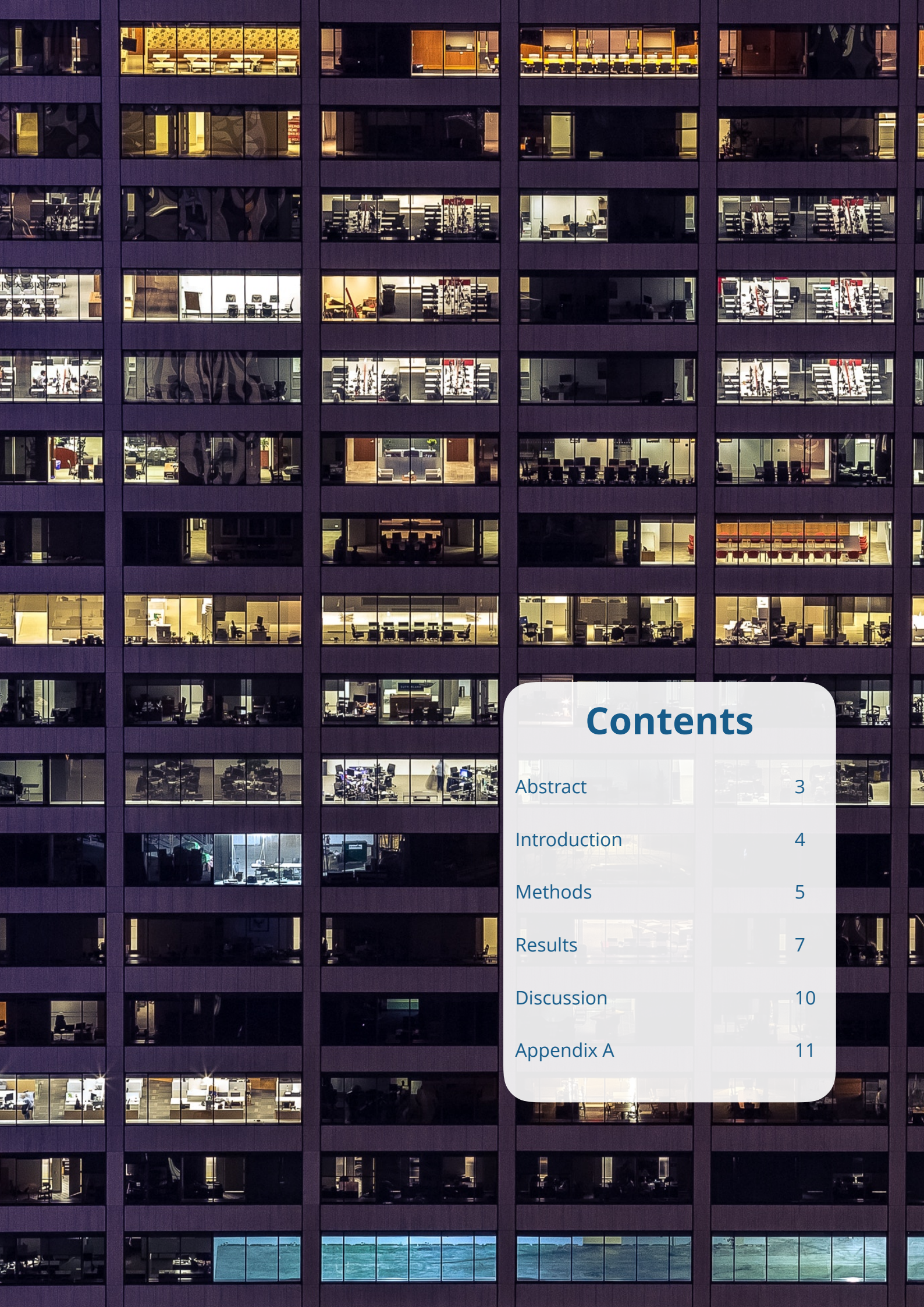

Contents

Abstract

Indoor air pollution is ranked the 9th largest Global Burden of Disease risk[1]. In urban areas people typically spend over 90% of their time indoors, where air pollution levels in some cases exceed those of outdoors. Indoor environment is fast changing due to the influence of both outdoor elements and activities indoor.

To ensure sustainable work and life environment we need not only purify spaces we live and work in, but also conduct continuous monitoring to validate compliance to safe standards. Governments and private research institutes have been concerned about this and as result of their work there are numerous standards[2,3,4], certifications and regulations that make environment monitoring mandatory. As a leading platform in environmental monitoring, gams wants to be at the forefront of best monitoring practices.

This study is part of a wider research aimed at creating demonstrable best practices for professional environmental monitoring. In this study we compare measurements taken from several monitors installed at different heights over the same period of time. This study took place in real life conditions, in an office space during the work week.

Results show that there was little to no variation in PM2.5 (particulate matter), CO2 and TVOC (total volatile organic compounds) measurement at different heights.

Introduction

Numerous devices for indoor air quality measurement are available on the market. There are devices that measure only one type of pollutant and devices that measure a spectrum of pollutants. In order to conduct high quality and reliable monitoring, the following aspects need to be considered: type and quality of measuring sensor, sensor installation position and location, devices and methods used for storing measurements.

Hardware companies have conducted scientific researches[3,4] on subject of reliability of particulate matter, TVOC, CO2 sensors. Generations of air quality sensors have been developed and tested on the market.

There are also researches and publications[2,5,6] that elaborate on suggestions for sensor positioning during monitoring. Unfortunately, none of those studies had conducted research on the impact of installation height on air quality measurement. This study tries to contribute to the technical knowledge required for professional environment monitoring.

Methods

The study was conducted in an office space located in downtown Shanghai, China. Study specific facts:

- conducted from September 15th to 20th 2017;
- outdoor particulate matter level during a test time presented in Figure 1.

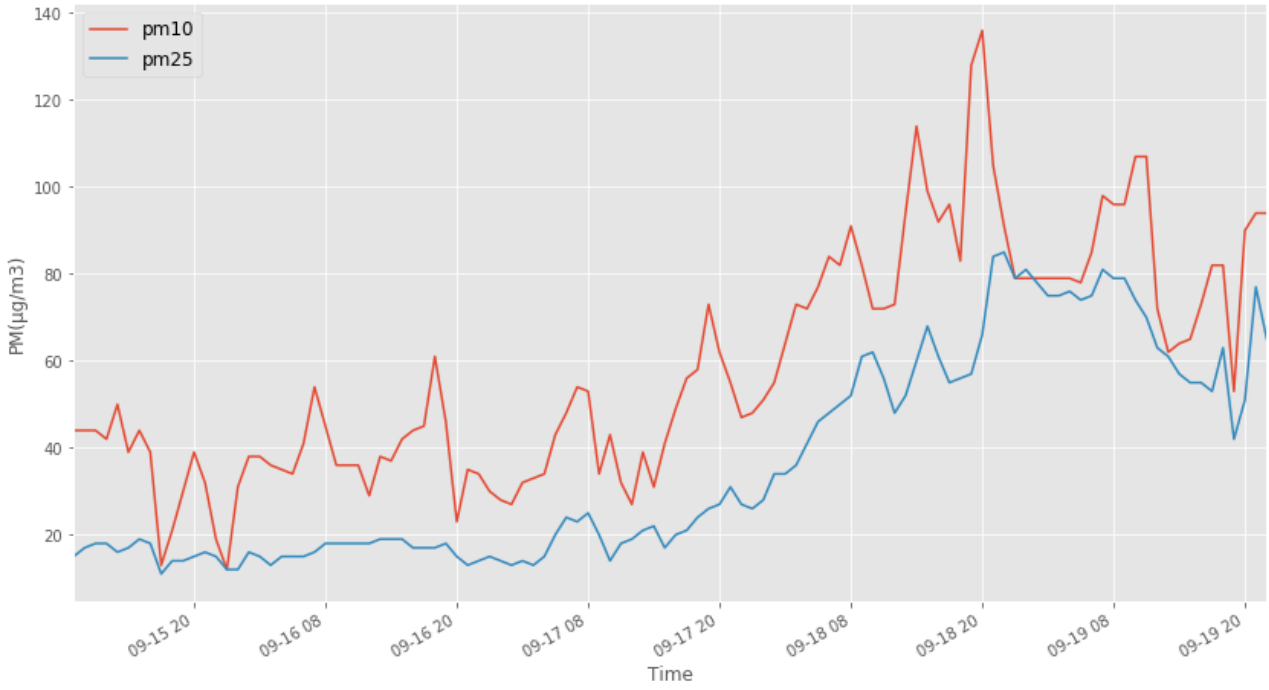

Figure 1. Outdoor particulate matter level

The office space had following characteristics:

- size of 200sqm. with ceiling height about 3.2m;
- panoramic windows on one side of the room and slide windows on another side;
- 32 people working full-time with schedule 9am-6pm Monday to Friday;
- 4 FFUs (Fan Filter Unit), unknown CFM (Central Flow Management);
- wet floor cleaning once a day with light use of soap;
- 7 Xiaomi Smart Mi Air Purifier 2, mounted with PM and activated carbon filters.

For air quality measurements three sensors Tongdy MSD-16 sensors were used. (technical specification can be found in Appendix A). The sensors were connected through the exclusive gams proprietary smart board. All the measurements were collected on the gams smart environment platform.

Figure 2 shows the test setup used during the study. Monitors 1, 2 and 3 were fixed at heights 270cm, 195cm, 120cm from ground level respectively.

Figure 2. Test setup

Data processing was conducted with the Python data analytic tools: pandas and matplotlib in Jupyter Notebook.

Testing steps included:

- initial installation of 3 monitors in chosen office space,
- continued monitoring of PM2.5, PM10, TVOC and CO2 for 24 hours during the work week,
- data extraction and processing.

Results

Figures 3, 4, 5 and 6 represent the air quality data for PM2.5, PM10, TVOC and CO2 over the test period. Legend name pm25_1, pm25_2, pm25_3 represent data from sensors 1, 2, 3 marked in Figure 2.

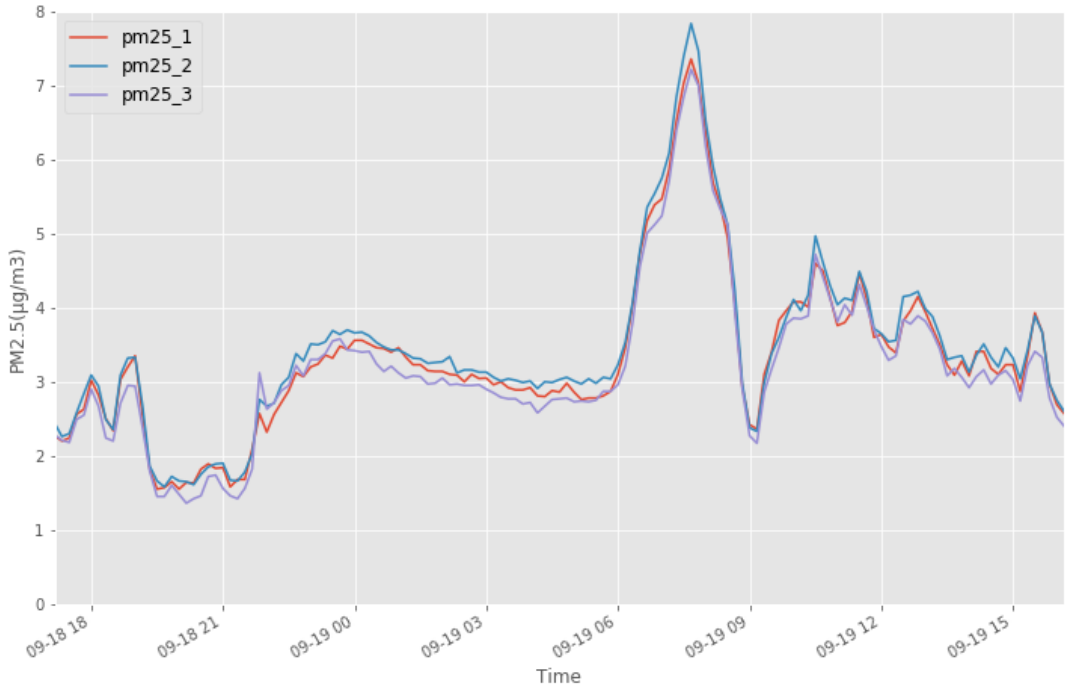

Figure 3. PM2.5 time series plot

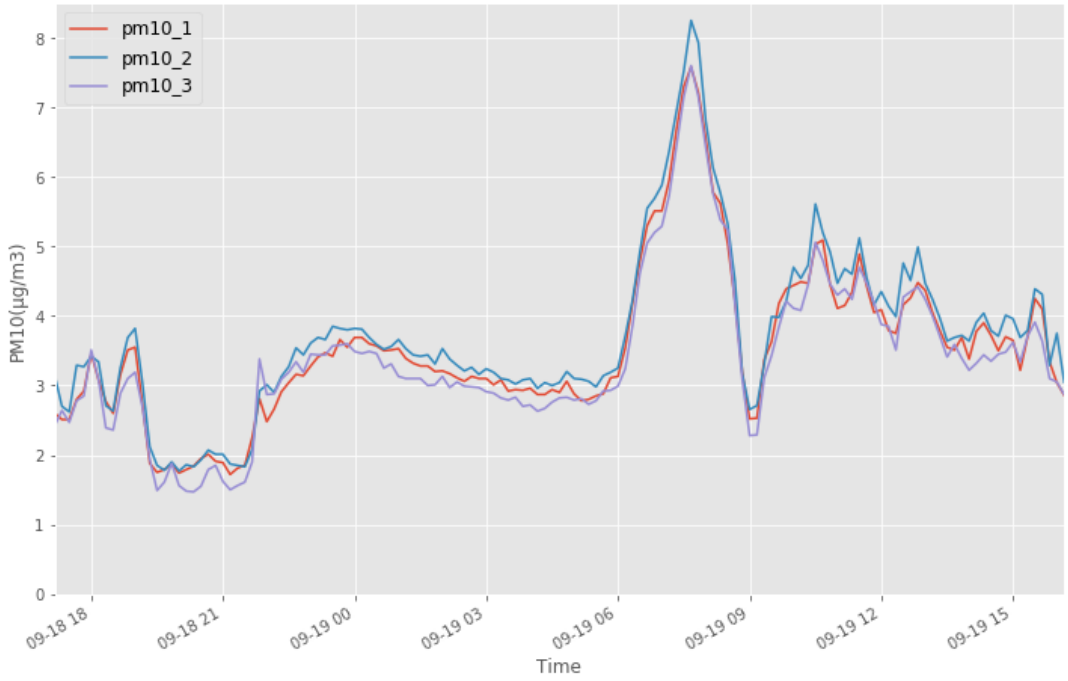

Figure 4. PM10 time series plot

The time series plots in Figure 3 and 4 show that PM2.5 and PM10 concentrations at the three installation levels are consistent during the whole test time with a value difference not higher than 0.6 µg/m3 (12%) at any given time.

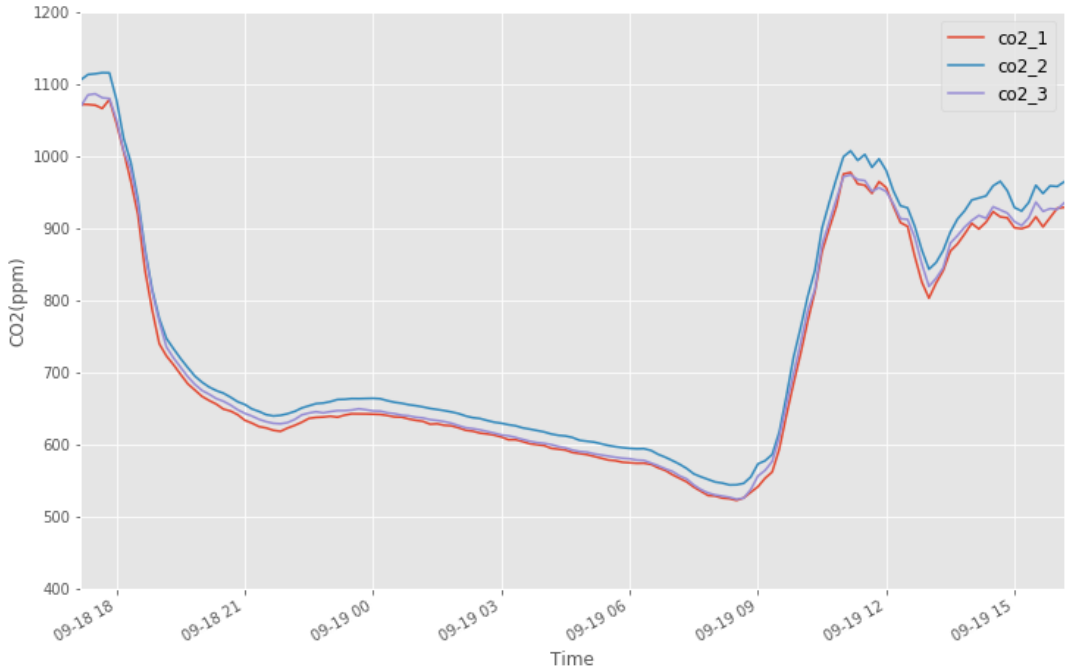

Figure 5. CO2 time series plot

Figure 5 illustrates, that CO2 concentration at the three installation levels are consistent during the whole test. Similarly to particulate matter, CO2 value difference at any given time is relatively small and never higher than 55ppm (6%).

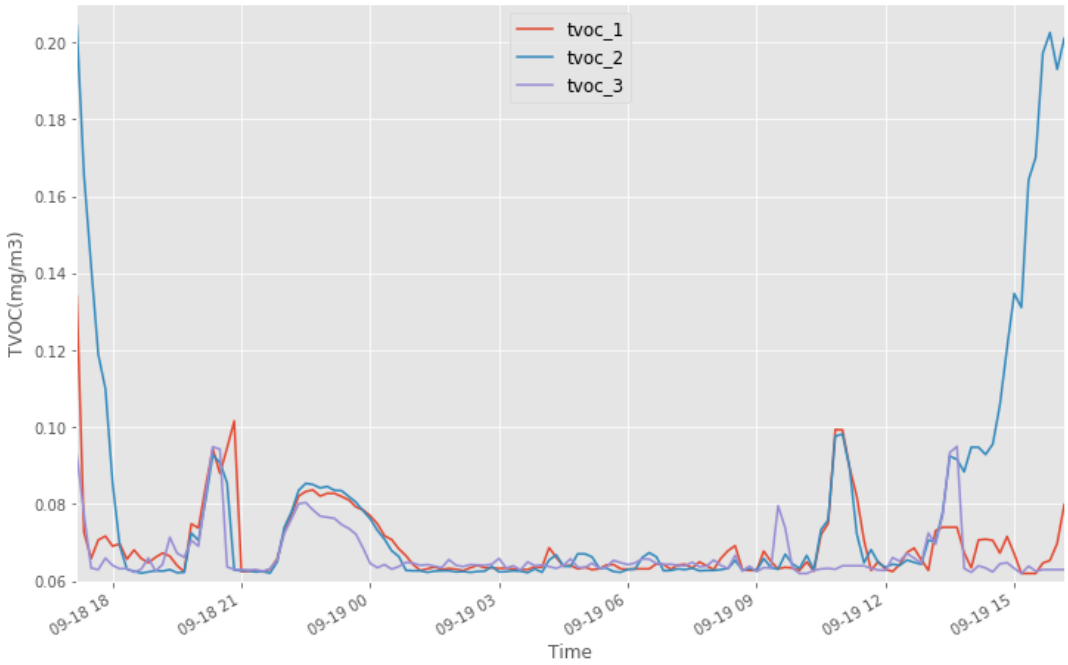

Figure 6. TVOC time series plot

Figure 6 shows that TVOC concentration at the three installation levels is mostly consistent during whole test.

Discussion

The testing results presented in the previous section highlight that installation height has little to no impact on air quality measurement in an office space, considering an environment similar to the one used in this study. The low impact of installation height could be explained by the diffusion in air.

TVOC value spikes at certain points could be explained by sensing technology used in this study and nature of TVOC . Those observations don't have any systematic character and don't affect conclusion of this study.

It is worth mentioning that the testing level heights were determined by the room ceiling and its construction. A study on the impact of installation height in an office space with ceilings higher than 3 meters should take place as a next step.

Appendix A

Tongdy MSD-16 sensor block technical specification

General Information		
Detection parameters	PM2.5; PM 10; CO2; TVOC; Environment Temperature & RH	
Operating Environment	Temperature 0~5O° C Humidity 0~99%RH	
Power Supply	12~36VDC; or 100~24OVAC	
Sensors data measuring range		
PM2.5/PM10	TONGDY own design	PM2.5: 0 ~ 1000 mg /m^3 PM10: 0 ~ 1000 mg /m^3
Temperature and humidity	Sensirion/SHT30	Temperature: 0 ~ 50° C Humidity: 0 ~ 99 %HR
CO2	Amphenol/T6703	0 ~ 5000ppm
TVOC	AMS/IAQ-Core	0 ~ 2.0 mg/m^3

License

References

1. Forouzanfar et al., The Lancet 2015.
2. Howell N: Building environmental assessment methods in practice: in Proceedings of the 2005 World Sustainable Building Conference, September, 2005.
3. Preethichandra, D.M.G. Design of a smart indoor air quality monitoring wireless sensor network for assisted living. In Proceedings of the IEEE International Instrumentation and Measurement Technology Conference, May 2013.
4. Chuck W. F. Yu, Jeong Tai Kim, Building Environmental Assessment Schemes for Rating of IAQ in Sustainable Buildings, Indoor Built Environ, Volume: 20 issue: 1.
5. Health, Wellbeing & Productivity in Offices. WORLD GREEN BUILDING COUNCIL.
6. Indoor Air Quality Monitoring 2.0. REHVA Journal, June 2017.

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