

Air Quality Monitoring in Manila Using an Affordable Raspberry Pi and Arduino Based Sensors: Impacts of Covid-19

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**International Meeting on Air Pollution in Asia-
Inventories, Monitoring, and Mitigation**

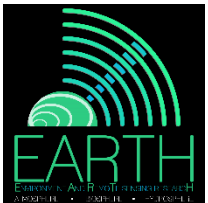
February 1-3, 2023

Hanoi Club Hotel, Hanoi, Vietnam



Outline of Presentation

- What we are doing?
- Health Impacts of Air Pollution in Manila
- Low-Cost AQMS and how the pandemic affects the Air Quality in Manila



Health Impacts of the Air Pollution in Manila

* Air pollution is the fifth leading risk factor for mortality worldwide with the Philippines ranking number 10 in terms of the highest mortality burden attributable to air pollution [1].

* Expos
cardic



atmosphere



Article

Genotoxicity of PM_{2.5} and PM_{1.0} Particulates on Human Peripheral Blood Lymphocytes in Manila, Philippines

Ma. Katrina Gale Estonilo ¹, Joedith Anne Cazeñas ¹, Carlos Josef Villafuerte ¹, Custer Deocaris ^{2,3},
Gloriamaris Caraos ², Gerardo Jose Robles ², Maria Cecilia Galvez ^{1,4}, Celia Asaad ² and Edgar Vallar ^{1,4,*}

[1] M.E.I. Health Effects Institute. 2019. State of Global Air 2019. Special Report. Boston, “A SPECIAL REPORT ON GLOBAL EXPOSURE TO AIR POLLUTION AND ITS DISEASE BURDEN What is the State of Global Air? Who is it for? How can I explore the data?,” Boston, MA:Health Effects Institute., 24, 2019.

[2] B. Chen, H. Kan, “Air pollution and population health: A global challenge,” *Environmental Health and Preventive Medicine*, **13**(2), 94–101, 2008, doi:10.1007/s12199-007-0018-5.



COLLECTION OF PM SAMPLES

PM1.0 SAMPLES WERE OBTAINED FROM THE METONE E-SAMPLER INSTRUMENT

PM2.5 SAMPLES WERE OBTAINED FROM THERMO SCIENTIFIC INSTRUMENT



Size-segregated roadside air samples were obtained from 2015-2017

The PM samples were collected using a MetOne E-sampler Instrument (PM1.0)

Thermo Scientific Instruments tapered element oscillating microbalance (TEOM) for PM2.5

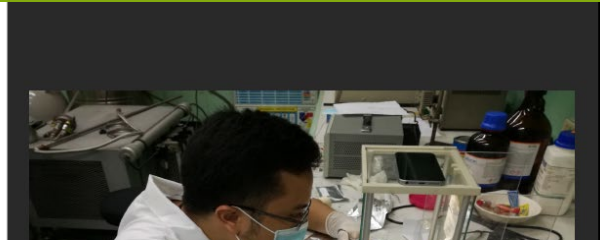
In vitro micronucleus and cytokinesis-block proliferation tests was used

EXTRACTION OF PM

FINAL WEIGHT OBTAINED:

PM1.0 = 9.6 μ g

PM2.5 = 6.7 μ g



PROCEDURE OF IN-VITRO MICRONUCLEUS ASSAY

TG-487 WAS FOLLOWED TO DO THE EXPERIMENTATION OF THE STUDY



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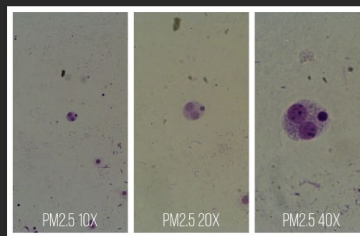
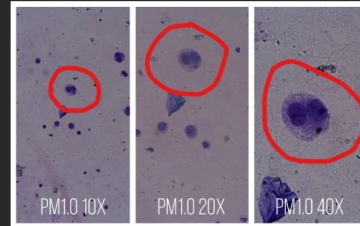
METHOD OF MN ANALYSIS

MN analysis was done by visual microscopy using:

OLYMPUS BX15
Microscope

and

Nikon DS-F13



PROCEDURE OF IN-VITRO MICRONUCLEUS ASSAY

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In vitro micronucleus (MN) and cytokinesis-block proliferation tests.

Based on the dose-dependent increase in micronuclei frequency of lymphocytes exposed to PM_{1.0} and PM_{2.5}, air pollutants in Manila may have the potential to lead to long-term DNA damage.

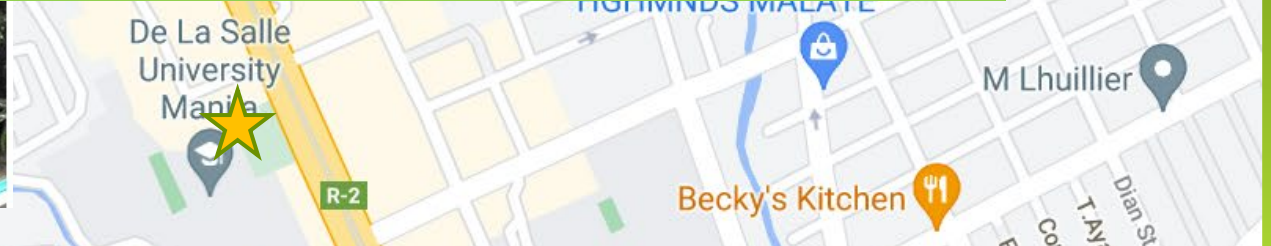
Sampling Site



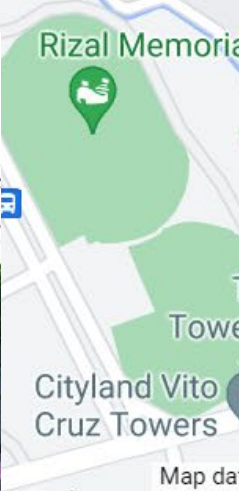
Metro Manila Area



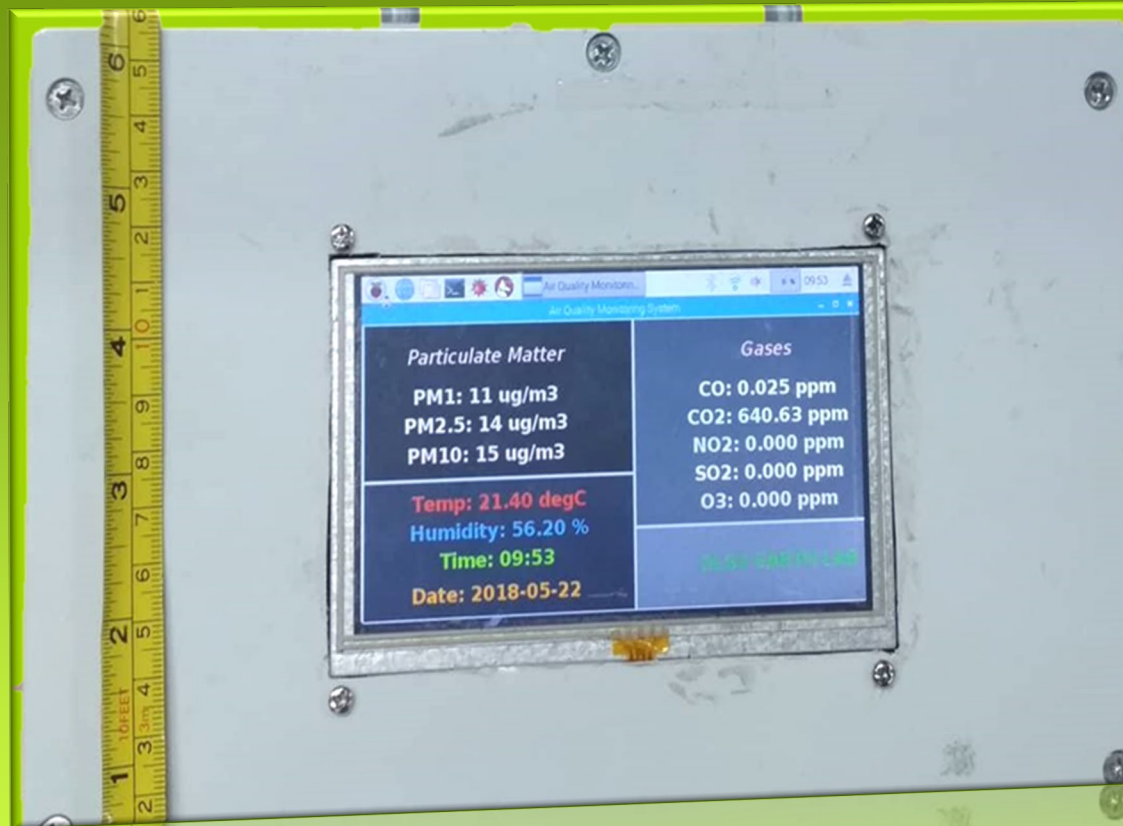
Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB) Air Quality Monitoring Station Measures the following:
Particulate matter, Ozone, NO₂, CO, SO₂



Medical Center
a Yacht C
Philippin
Headq



The EARTH – Air Quality Monitoring System (EARTH-AQMS)



Prototype of EARTH AQMS



**Weatherproof Enclosure
240x160x92mm ABS NEMA**

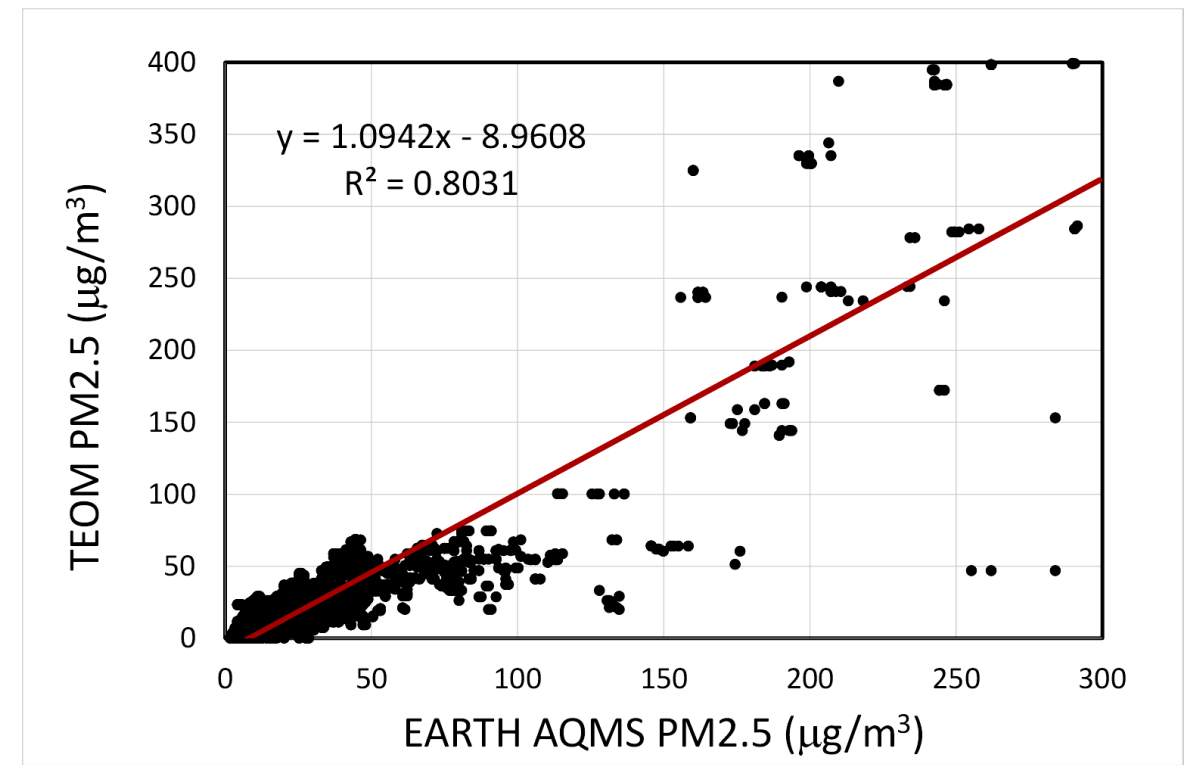
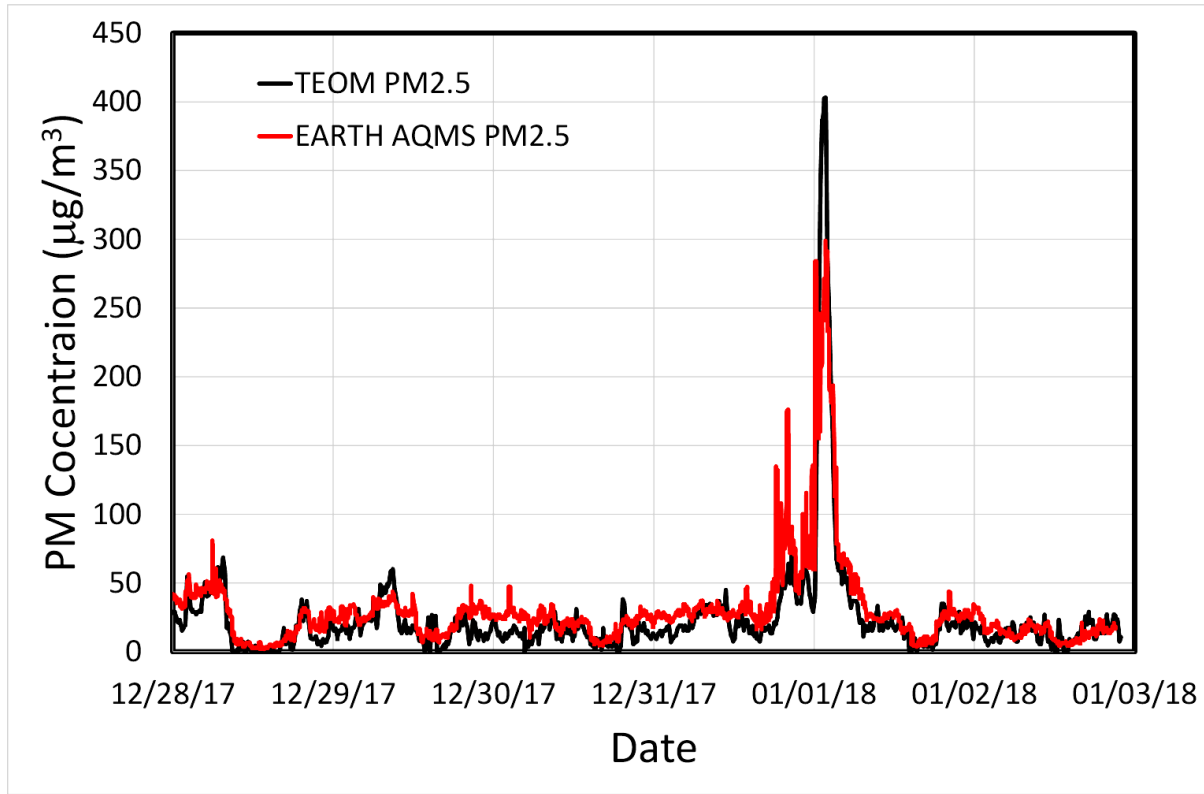


Front



Back

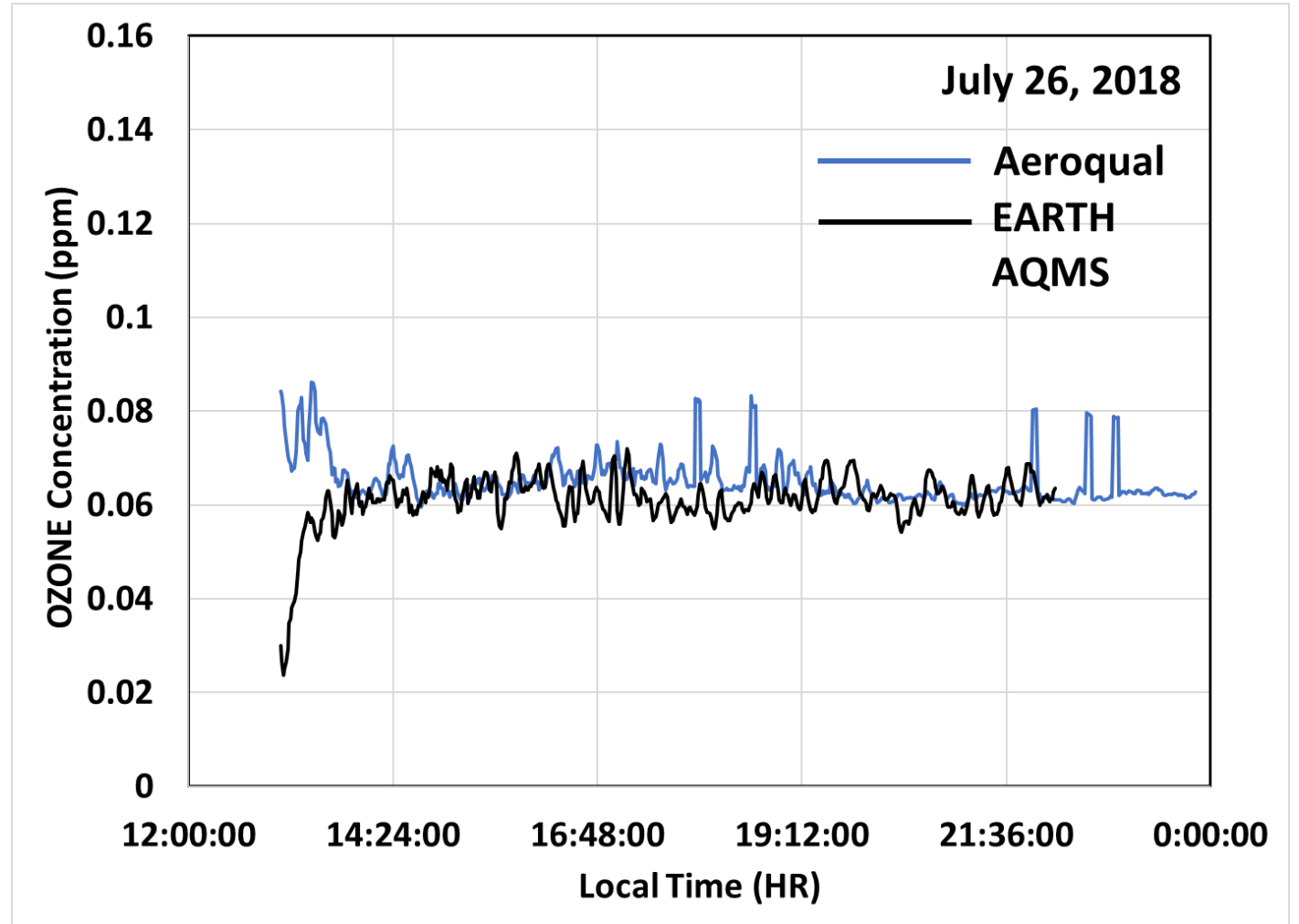
Co-location with a reference instrument

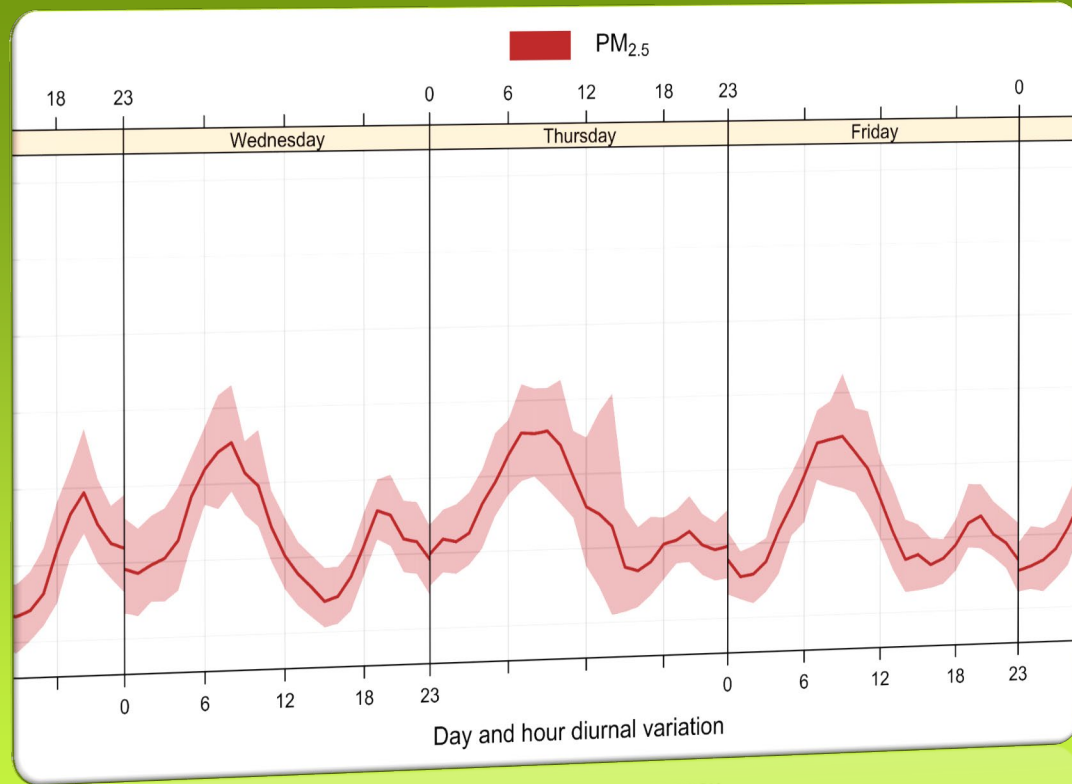


- Tapered Element Oscillating Microbalance (TEOM) – DENR-EMB AQMS

Comparison of O₃ measurement with a commercial instrument

EARTH AQMS measurement was compared with commercial sensors. For gases, we used AEROQUAL gas sensors for comparison





Measurement results (2018-2020)



PM_{2.5} CONCENTRATION AQI Breakpoints

DENR		
PM _{2.5} (µg/m ³) 24 HR Averaging Time		
	Air Quality Breakpoints	Cautionary Statements
GOOD	0 – 25.0	None
FAIR	25.1 - 35.0	None
UNHEALTHY FOR SENSITIVE GROUPS	35.1 – 45	People with respiratory diseases such as asthma, should limit outdoor exertions
VERY UNHEALTHY	45.1 – 55	Pedestrians should avoid traffic areas. People with heart or respiratory disease should stay indoors. Unnecessary trips should be postponed. People should voluntarily restrict the use of vehicles
ACUTELY UNHEALTHY	55.1 -90	People should limit outdoor exertion. People with heart or respiratory disease should stay indoors. Unnecessary trips should be postponed. Motor Vehicles use may be restricted. Industrial activities may be curtailed.
EMERGENCY	> 91	Everyone should remain indoors (doors and windows closed). Motor vehicles use should be prohibited except for emergency situations. Industrial activities, except that which is vital for public safety and health, should be curtailed.

US EPA AQI	
PM _{2.5} (µg/m ³) 24-HR Averaging Time	
	Air Quality Breakpoints
GOOD	0 – 12
MODERATE	12.1 - 35.4
UNHEALTHY FOR SENSITIVE GROUPS	35.5 – 55.4
UNHEALTHY	55.5 – 150.4
VERY UNHEALTHY	150.5 – 250.4
HAZARDOUS	> 250.4

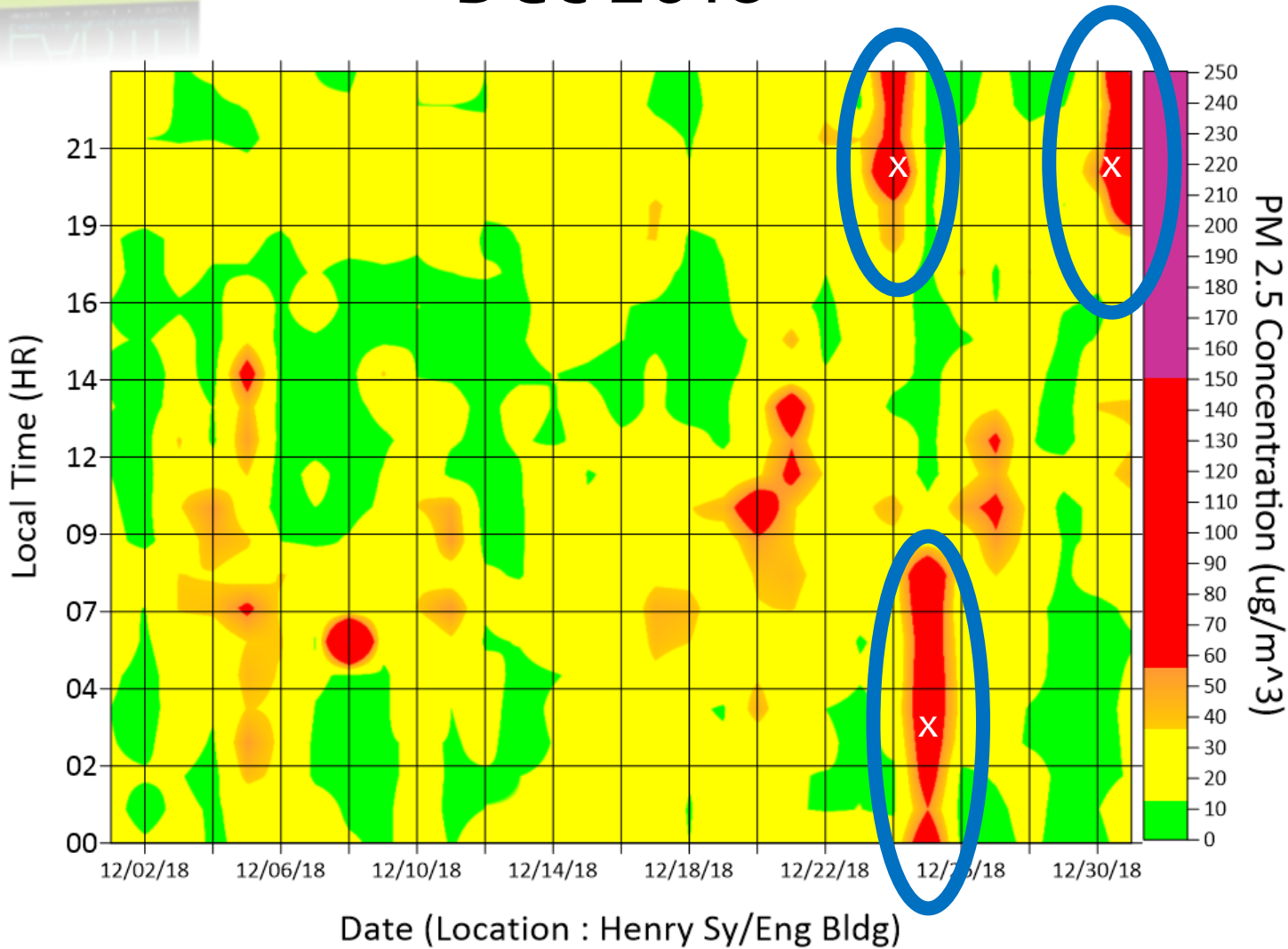
DAO-2020-14: October 21, 2020



DAY-TIME-PM_{2.5} CONCENTRATION

Surface plot

Dec 2018



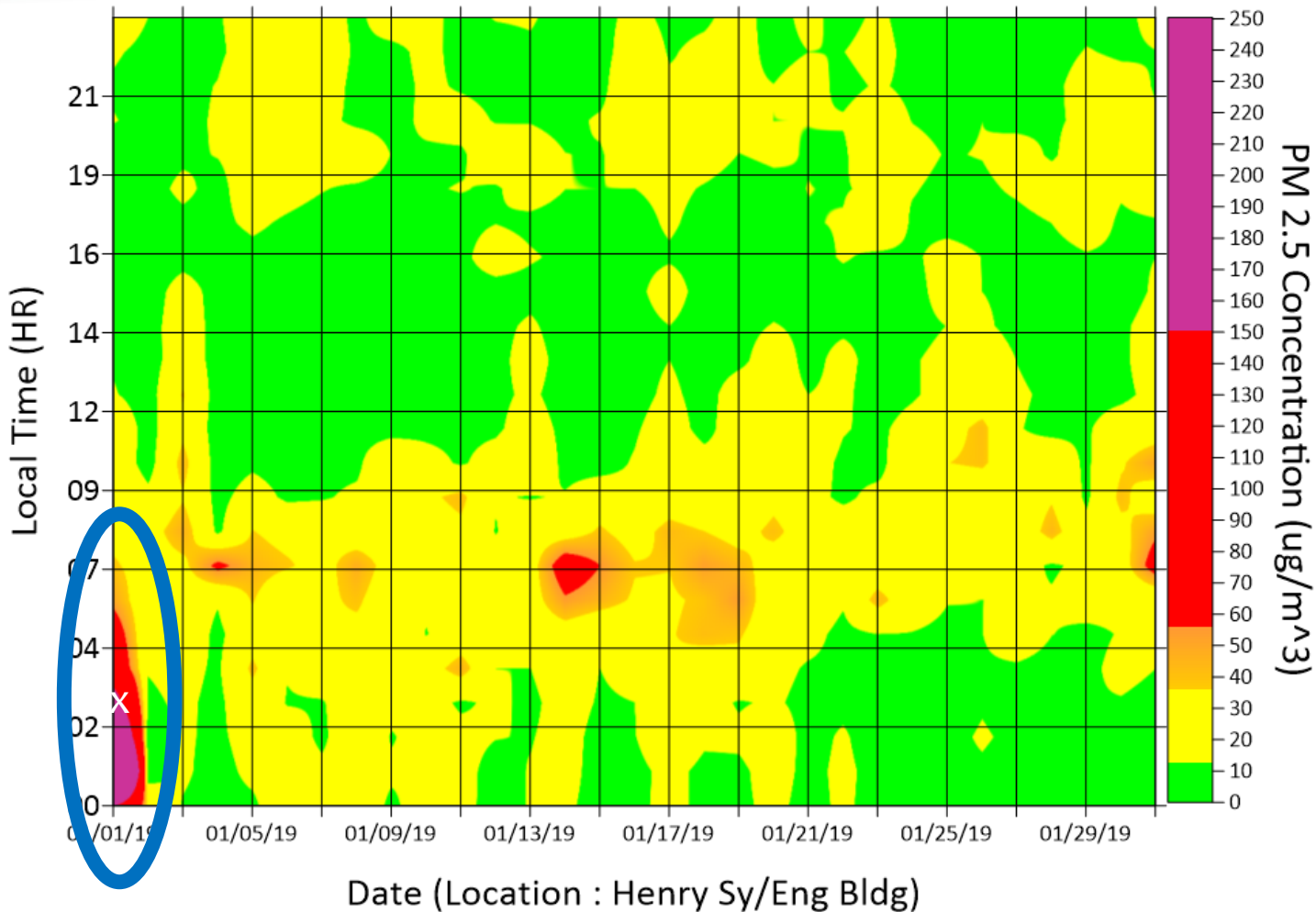
US EPA AQI	
PM _{2.5} ($\mu\text{g}/\text{m}^3$) 24-HR Averaging Time	
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DAY-TIME-PM_{2.5} CONCENTRATION

Surface plot

January 2019

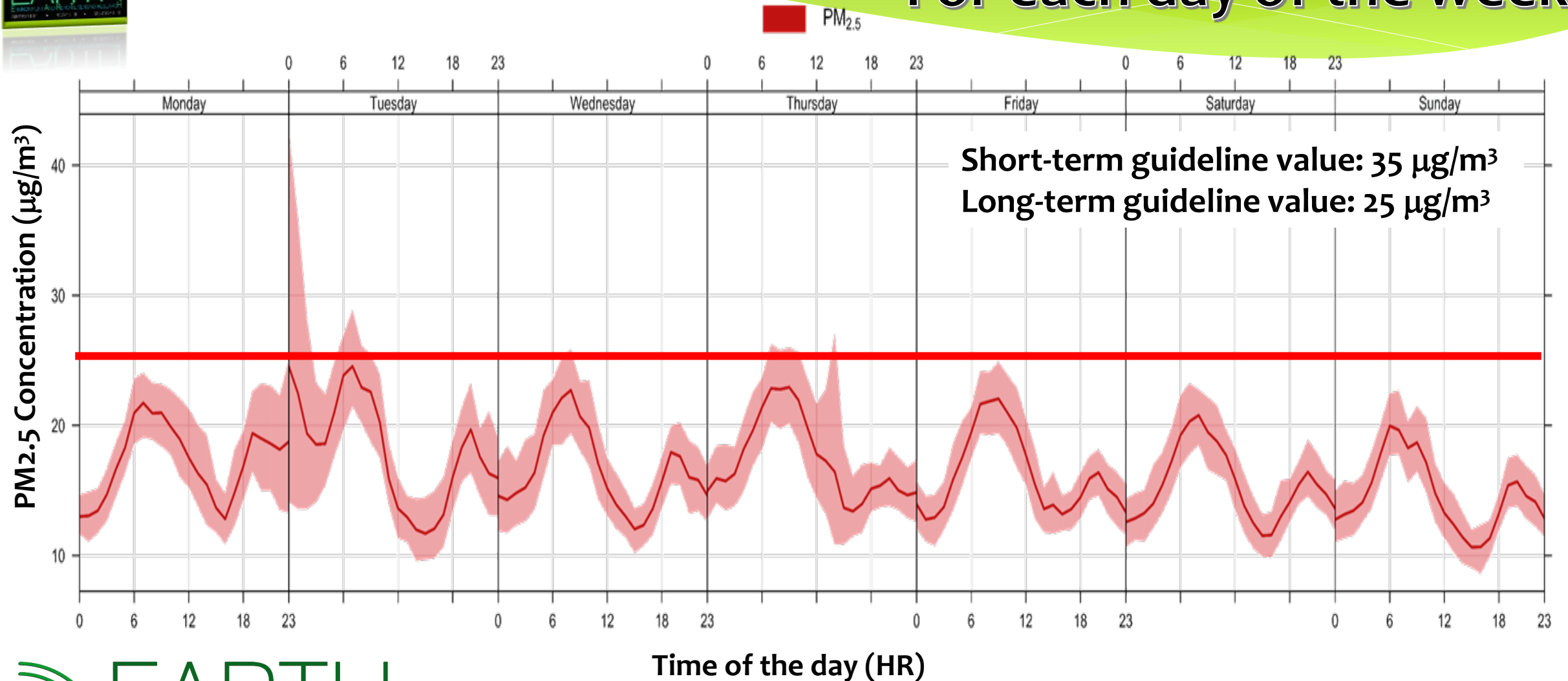


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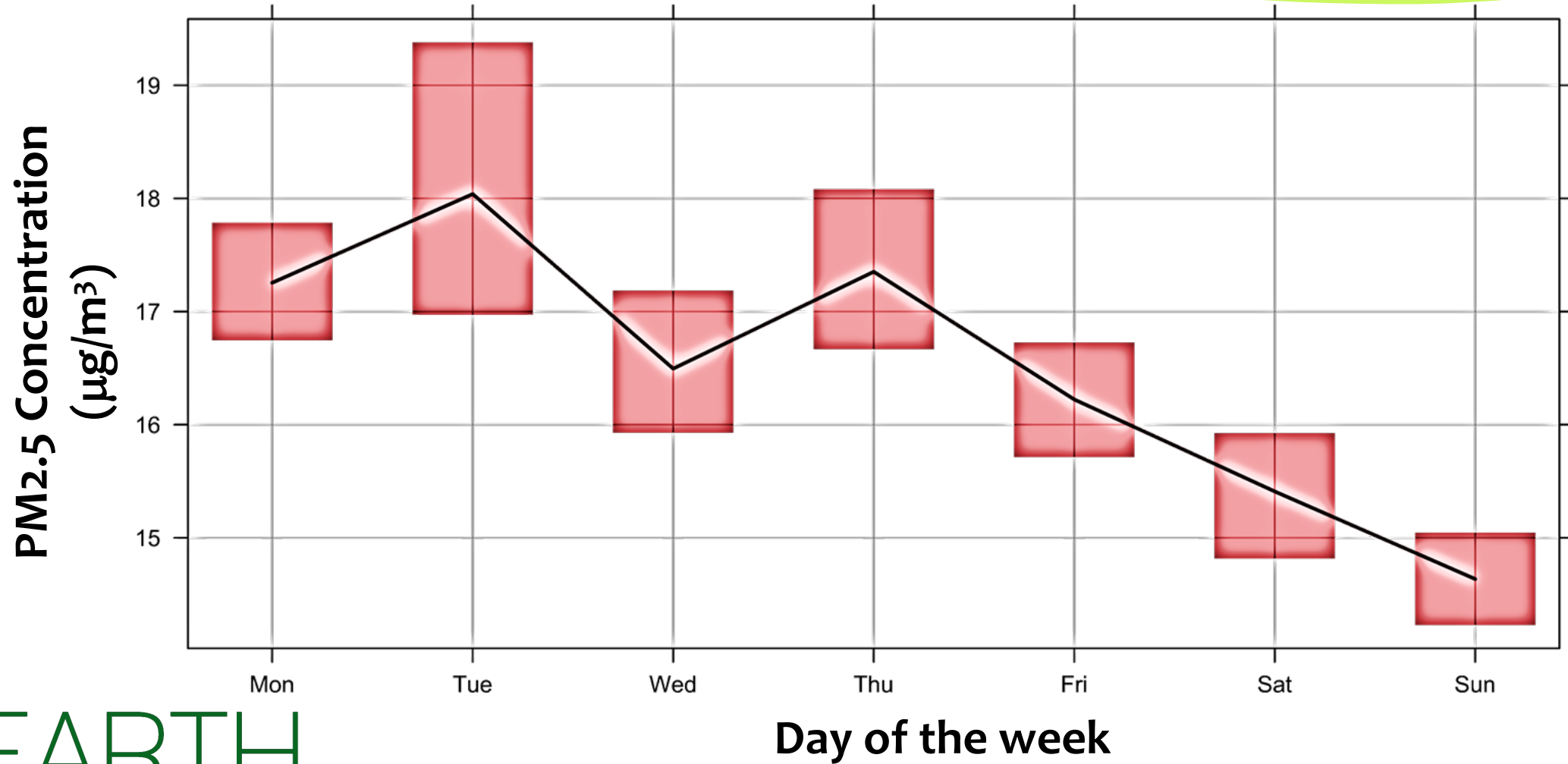
Diurnal Variation of PM_{2.5} (2018-2019)

For each day of the week



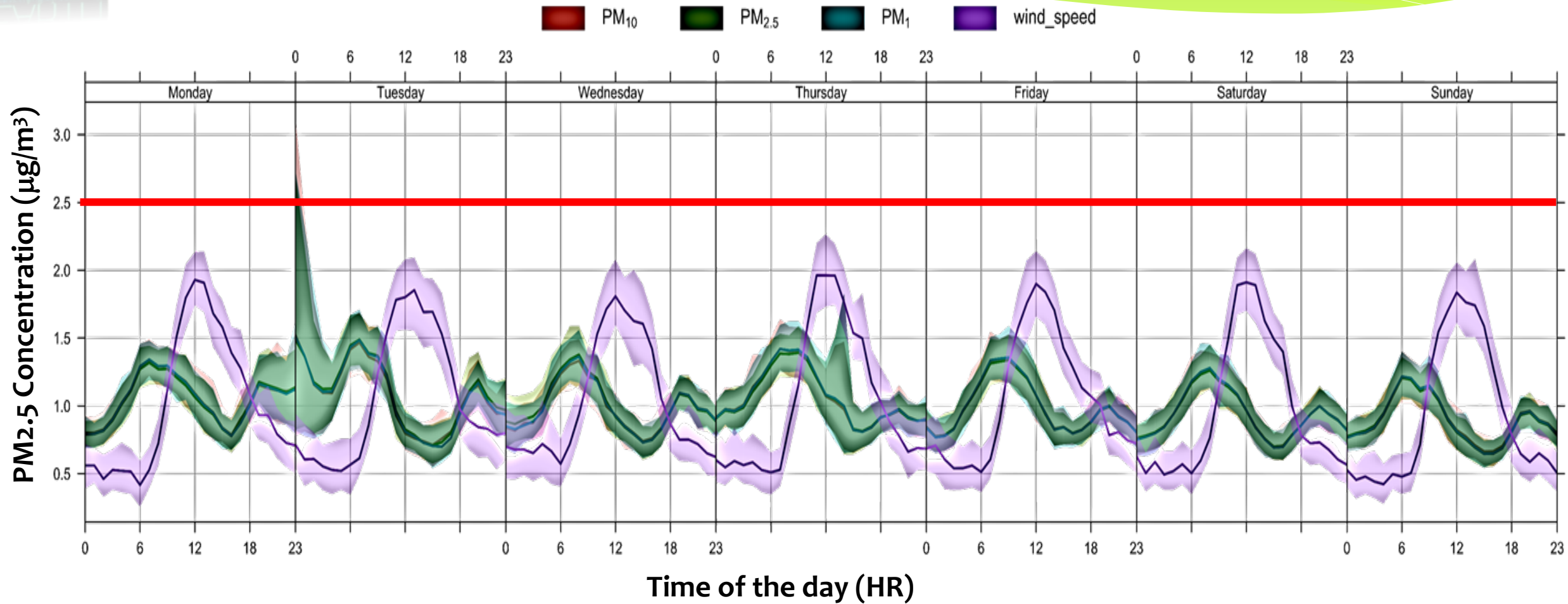
Average Daily Variation of PM_{2.5} (2018-2019)

PM_{2.5}





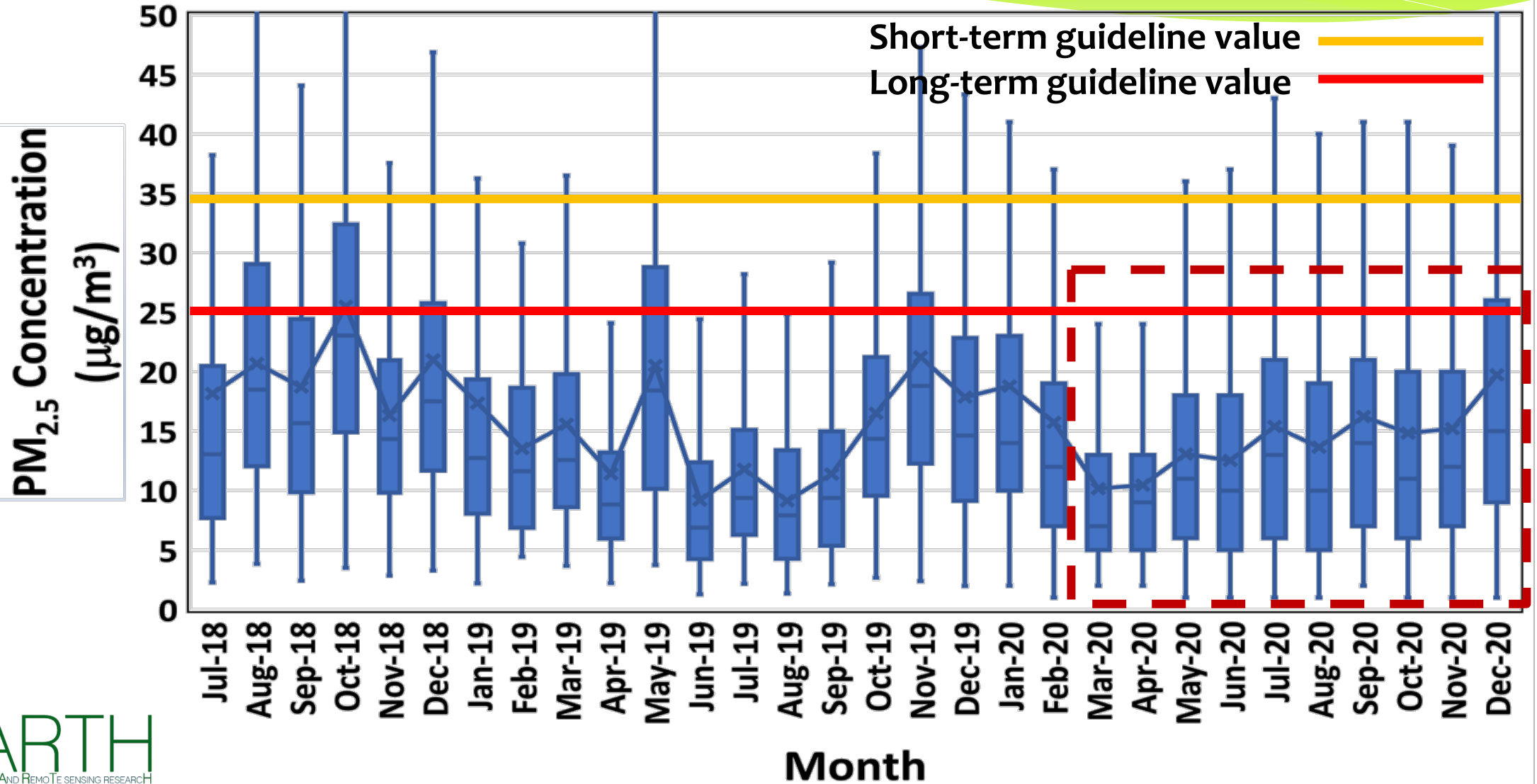
Diurnal Variation of PM_{2.5} and Wind Speed





Monthly Variation of PM_{2.5}

2018-2020





Diurnal Variation of O₃ (2018-2020)

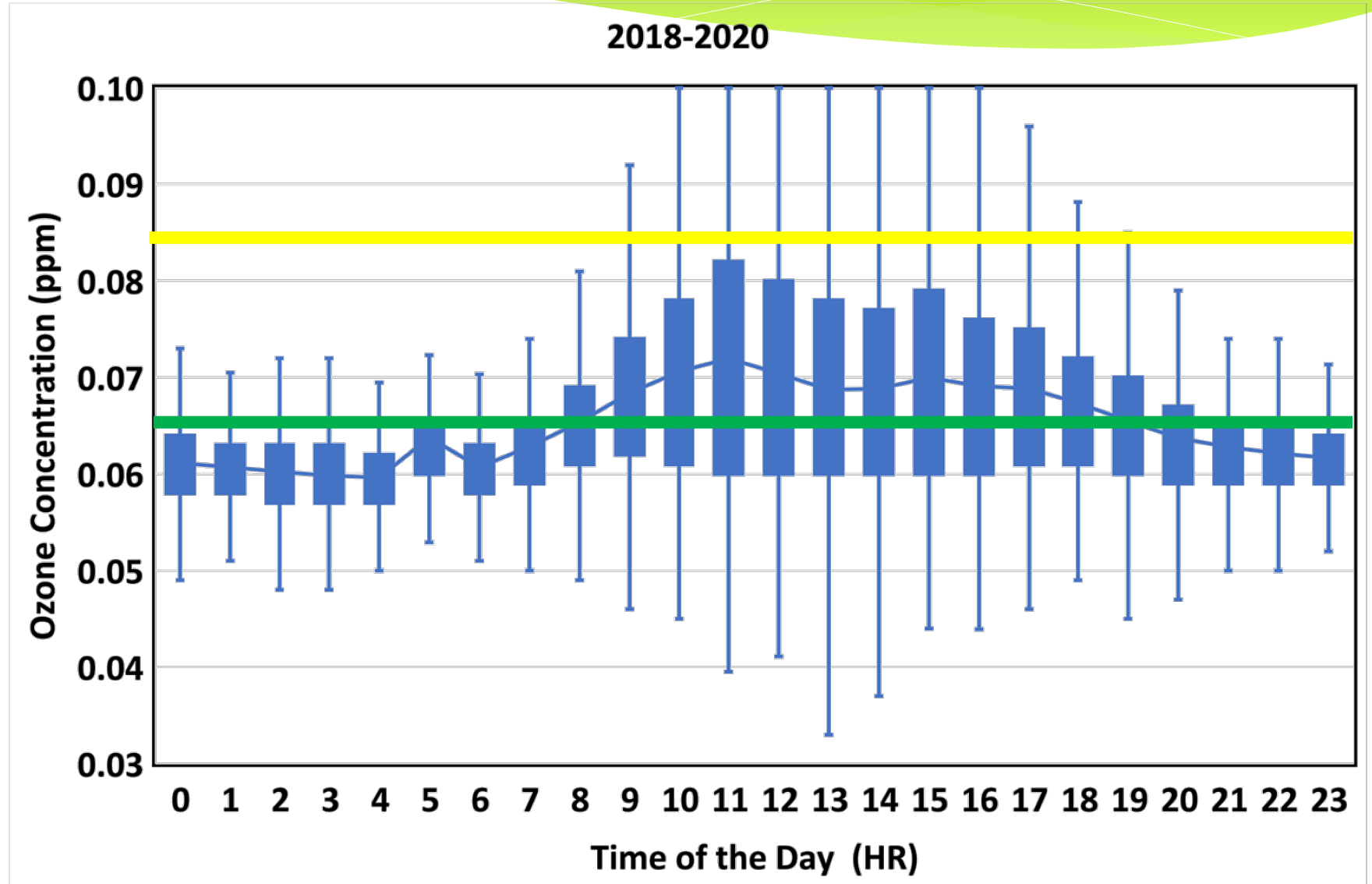
For 8-hour averaging

Good

< 0.065 ppm

Fair

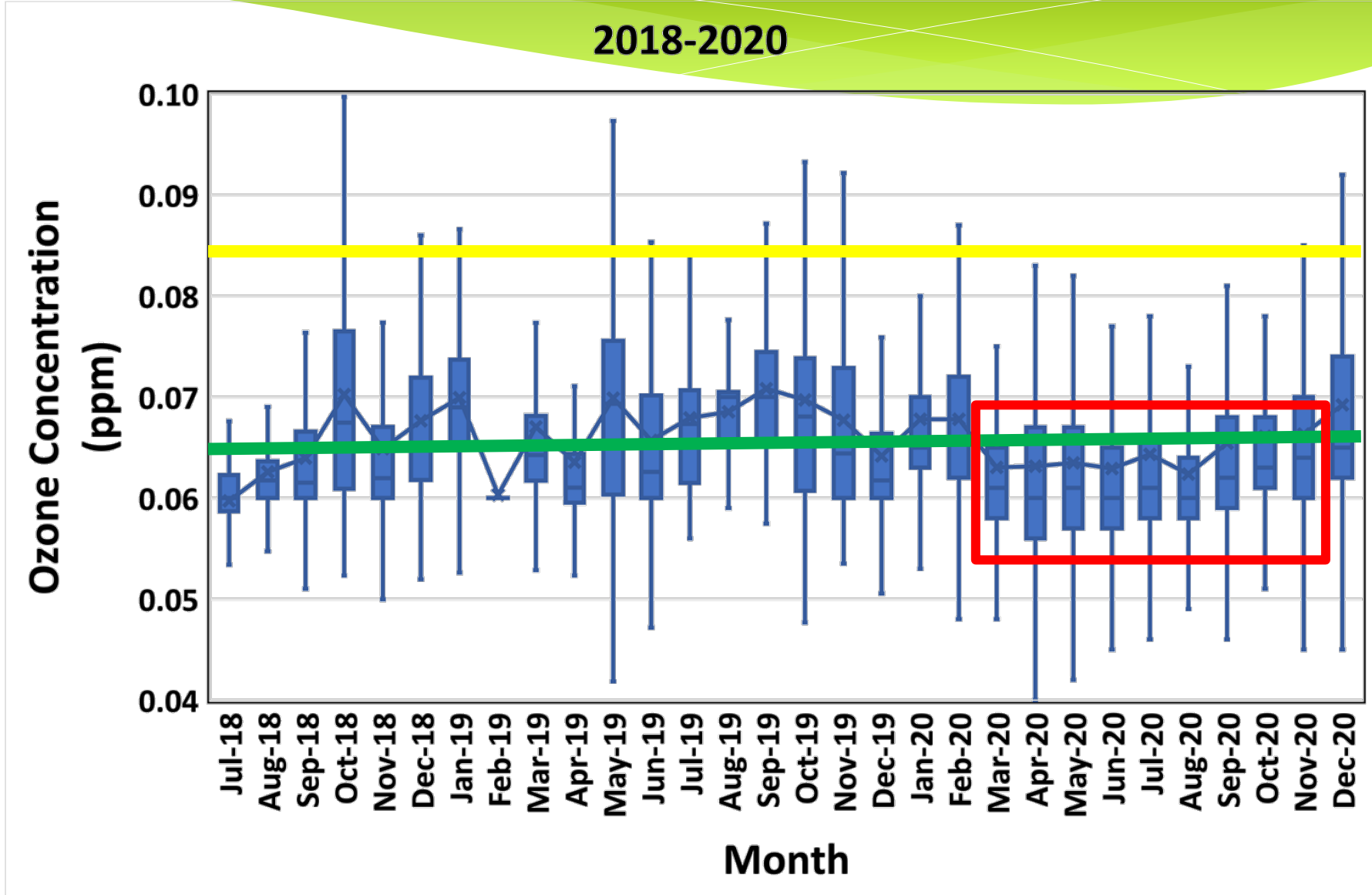
Between 0.065 to
0.085 ppm





Monthly Variation of O₃

For 8-hour averaging
Good
< 0.065 ppm
Fair
Between 0.065 to 0.085 ppm





Summary

- The EARTH-AQMS was able to provide measurements of two criteria pollutants, PM_{2.5} and Ozone for a period of two years and still ongoing.
- Human activities are the main source of air pollution along Taft Avenue.
- An affordable and portable EARTH AQMS can provide policymakers with immediate information if their policies in connection with air quality improvement are working or not.
- Because it is affordable and portable, this can be deployed to many areas and can provide higher spatial and temporal resolution about the air we breathe.
- With these, we can possibly have more detailed information on the health effects of air quality
- Forecasting, improvement of the system
- Our university is currently collaborating with the City of Manila
- DENR-EMB is now trying to come up with the Implementing Rules and Guidelines with the use of low-cost sensors.
- Engagement of people with the science of air quality monitoring is possible.



THANK YOU

FACEBOOK PAGE: www.dlsulidar-earth.org

WEBSITE: www.dlsu-earth.com