AiRBOX SENSE®

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Current Air Monitoring Technology

- Expensive
- High power consumption
- Heavy
- Bulky
- Poor mobility
- High maintenance

Example of gas analyzer

Outline

- What is AiRBOX Sense
- Applications
- Hardware
- How is the performance?
- Cloud-based post-processing of data

What is AiRBOX Sense

Atmosphere Investigation

We developed the entire system of AiRBOX and used Alphasense (UK) sensors.

- Real-time continuous monitoring small system of the 6 criteria air pollutants: particulate matter ($PM_{2.5}$ & PM_{10}), nitrogen dioxide (NO_2) and ozone (O_3) Sulphur dioxide (SO_2) and carbon monoxide (CO).
- Currently, AiRBOX is focus on common criteria air pollutants.
- Sensing device is well calibrated that delivers scientifically accurate data in a wide variety of environmental conditions.
- IoT communications platform that makes real-time data available wirelessly and gives access through an API value to the end users.
- Web interface accessed via browser on mobile Apps, tablet or PC, where you can see all your data in one place and set alerts on parameters of concern.
- Quick and easy to install, and relocate at different location in less than 10 minutes.

AiRBOX V3.0

Technical specification

Parameters	Sensors	Range	Detection limit	correlation	Resolution (alphasense)	Accuracy
$PM_{2.5}$ & PM_{10}	Alphasense OPC	0-1200 μgm^{-3}	1 μgm^{-3}	r^2=0.5-0.6	1 μgm^{-3}	~<± 7 μgm^{-3}
Nitrogen Dioxide	Alphasense EC	0- 5 ppb	2 ppb	r^2=0.71	1 ppb	~<± 5 ppb
Carbon Monoxide	Alphasense EC	0-30 ppm	0.02 ppm	r^2=0.88	0.02 ppm	~± 5 ppb
Sulphur Dioxide	Alphasense EC	0-200 ppb	0.2 ppb	r^2=0.71	1 ppb	~<± 5 ppb
Ozone	Alphasense EC	0-200 ppb	2 ppb	r^2=0.72	1 ppb	~<± 5 ppb

Note: Accuracy is determined by the bias of cross-comparison/validation with standard reference method

- Particulate matters (OPC) were compared and validated with GRIMM aerosol spectrometers provided by The National University of Malaysia.
- All electrochemicals (EC) were compared and validated with Thermo Scientific Gas analysers for CO, NO_2, SO_2 and O_3 provided by The Department of Environment Malaysia.

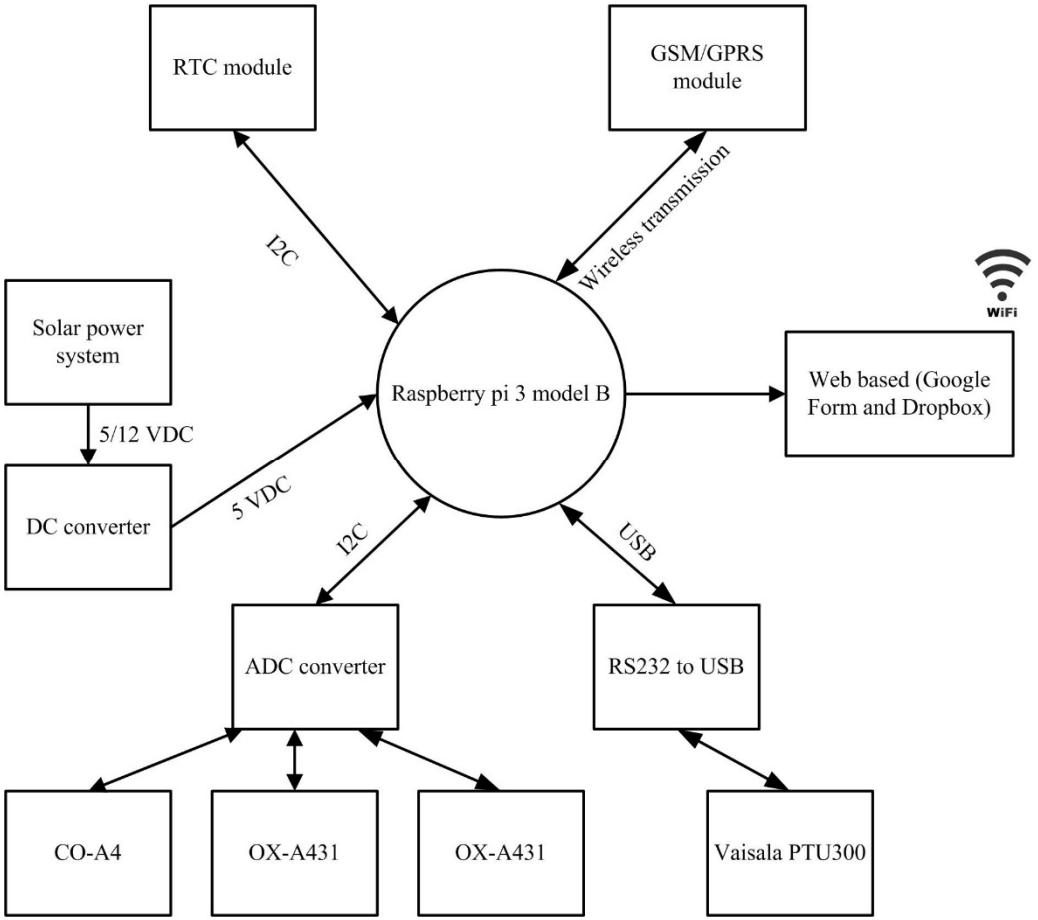
APPLICATIONS

- Smart city
- Early warning system for Air Pollution Disasters
- 3D Mapping pollution sources
- Roadside monitoring networks
- Assistance for the standard references monitoring stations
- Community exposure studies
- Protecting health and safety of students, workers and community

The Heart of AiRBOX

- The sensor element
- Sampling capability
- Power systems, including batteries and power supply.
- Sensor signal processing
- Data storage
- Data transmission capability (WiFi, GPRS)
- Server-side software for data treatment
- Housing and weatherproofing

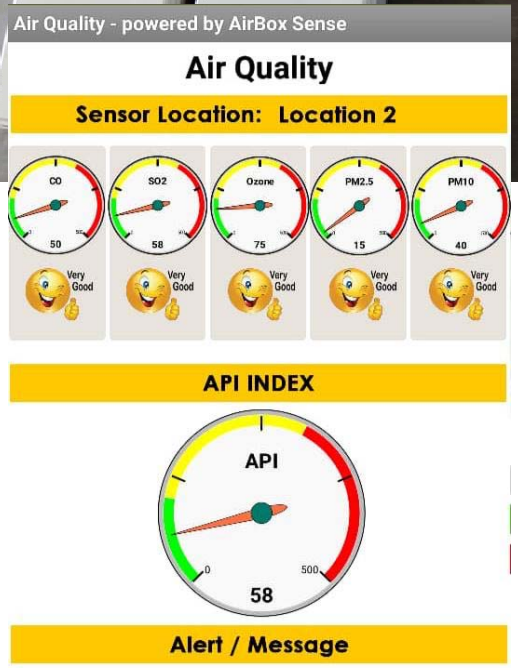
Hardware Development



Electrochemical sensor

Temp & Hum

AiRBOX for production



Sensors Status

Location	API	Status
Sensor Location 1	6	
Sensor Location 2	593	
Sensor Location 3	.	
Sensor Location 4	.	

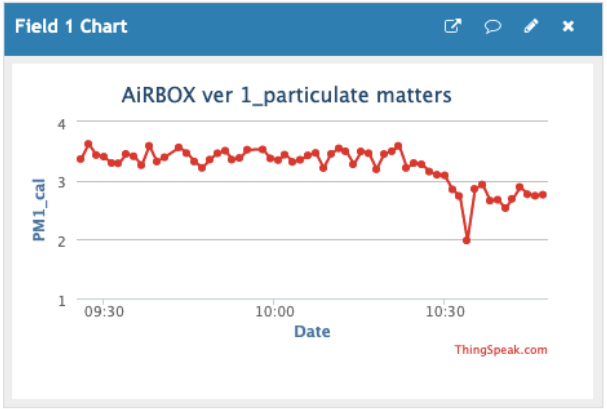
Mobile APPS and website

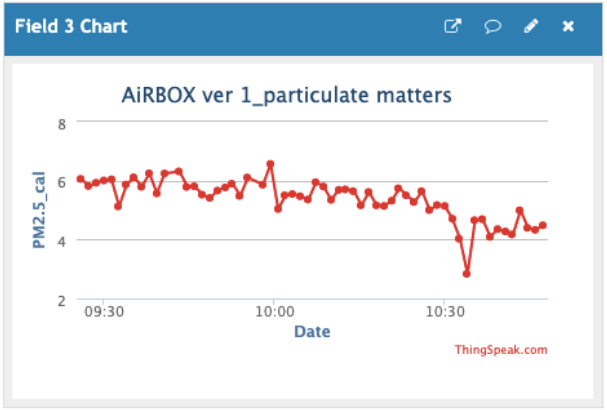
ThingSpeak™ Channels Apps Community Support

My Channels

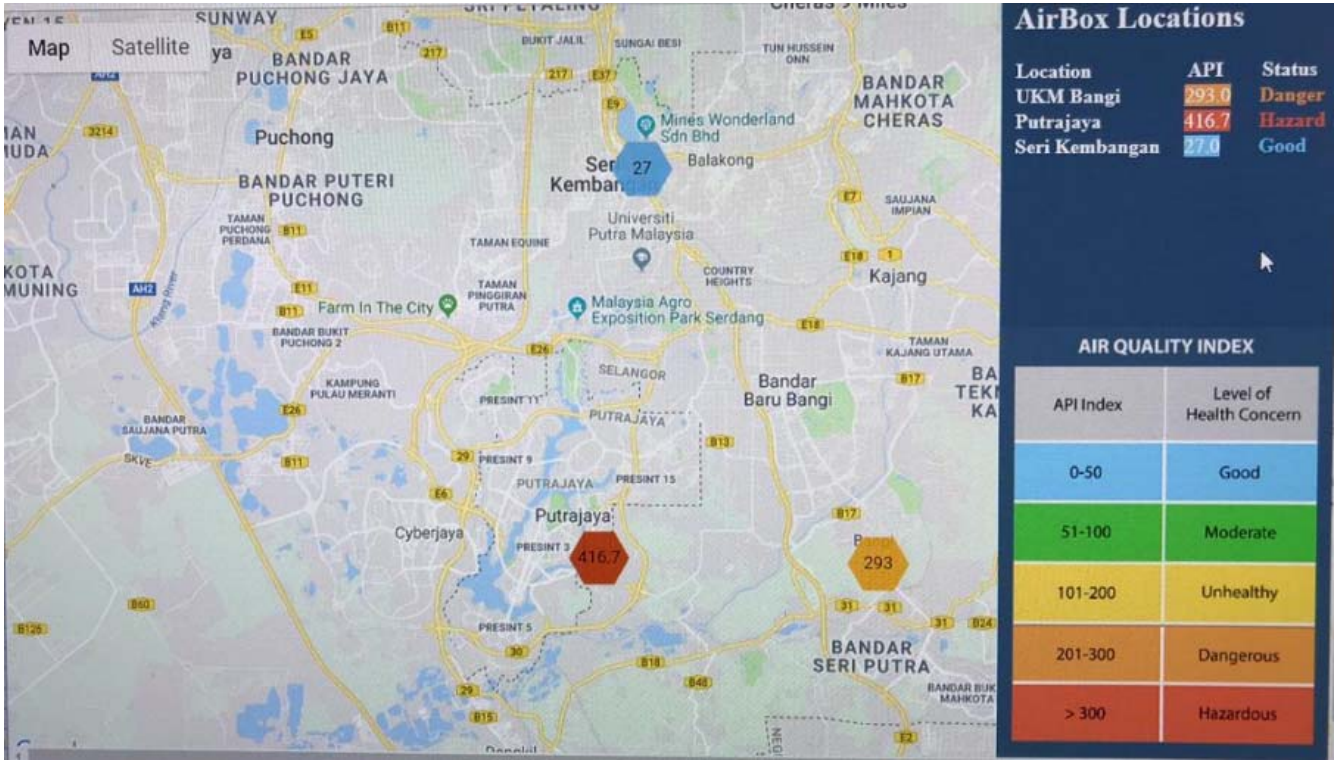
New Channel | Search by tag

Name	Created	Updated
Airbox ver 1.0 ghg sensor ndir co2 sensor, raspberry pi 3, low cost Private Public Settings Sharing API Keys Data Import / Export	2016-02-01	2019-03-22 07:05
AiRBOX Ver 1.0_Gases gas sensor, alphasense, low cost gas sensor Private Public Settings Sharing API Keys Data Import / Export	2018-10-22	2019-03-21 20:46
AiRBOX ver 1_particulate matters opc_n2 sensor, raspberry pi 3, low cost Private Public Settings Sharing API Keys Data Import / Export	2018-10-22	2019-03-21 21:32
Raw_data low_cost sensor Private Public Settings Sharing API Keys Data Import / Export	2018-10-29	2018-10-29 18:58
ProcessedData Private Public Settings Sharing API Keys Data Import / Export	2019-01-12	2019-02-27 14:47
UKM_AIRBox Sensor Private Public Settings Sharing API Keys Data Import / Export	2019-01-31	2019-05-03 12:00



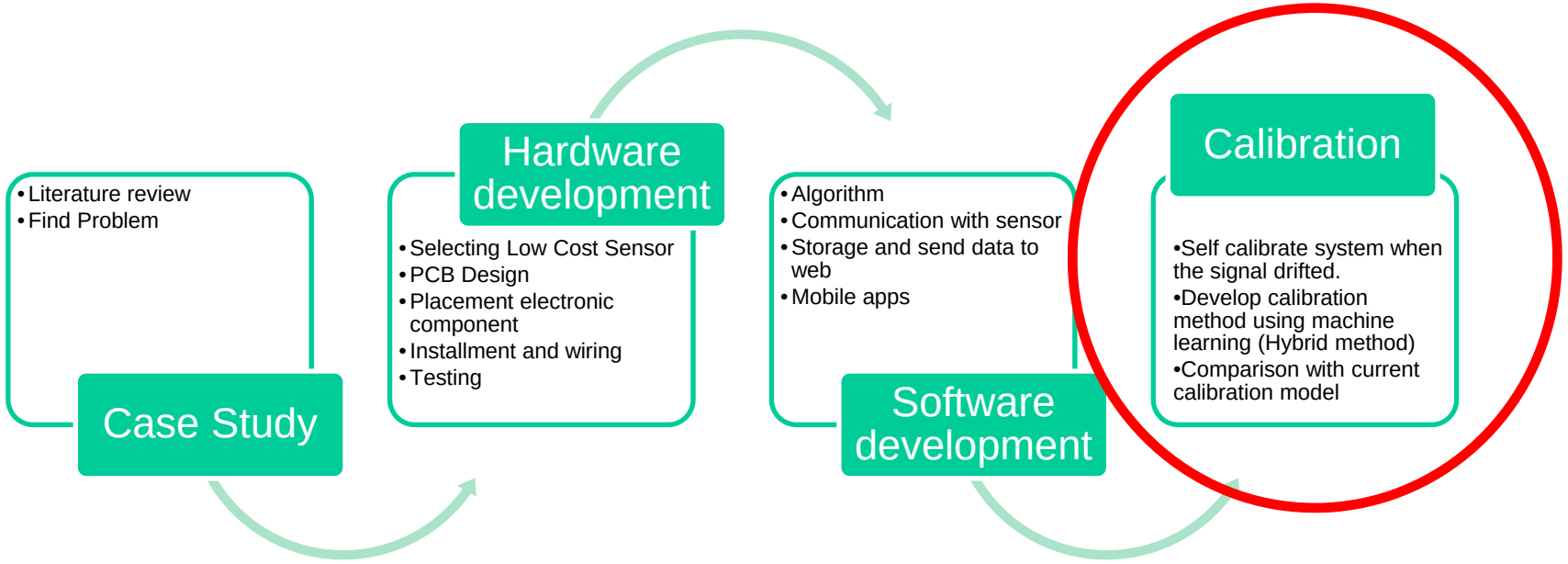


Dashboard



Note: this is a test experiment for AQI calculation, data from AiRBOX will generate in the website where formula AQI will applied and automatically calculate for end users. AQI calculation is referred to the USEPA formula.

We emphasize in Quality Control (calibration and cross-validation)



AiRBOX Sense for various gases (future development)

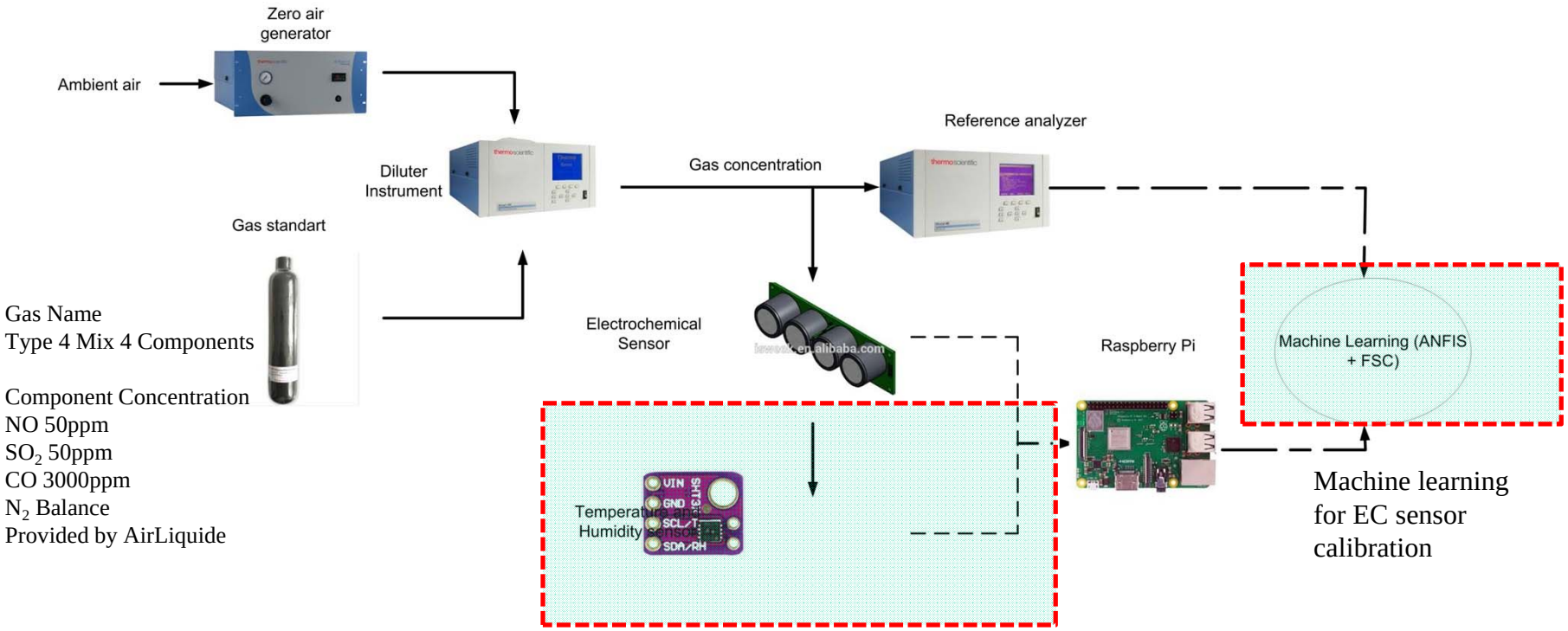
Alphasense
THE SENSOR TECHNOLOGY COMPANY

AiRBOX SENSE®

Type of Transducer	Air Pollutant	Prototype/Device
Electrochemical	NO_2, NO, O_3, CO, SO_2, H_2S	
Spectroscopic and NDIR	CO_2, CH_4, specific VOCs	
Photo-Ionisation Detector	total VOCs	
Optical Particulate Counter	PM_{10}, $PM_{2.5}$, $PM_{1.0}$, BC	
Metal Oxides	NO_2/NO, O_3, CO, SO_2, H_2S, VOCs	
Pellistors	CH_4, hydrocarbons	

ENEA

How we Calibrate and Cross-comparison for AiRBOX



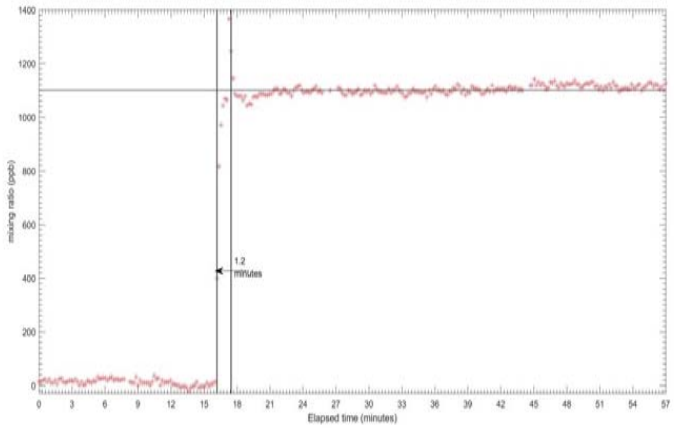
Gas Name
Type 4 Mix 4 Components

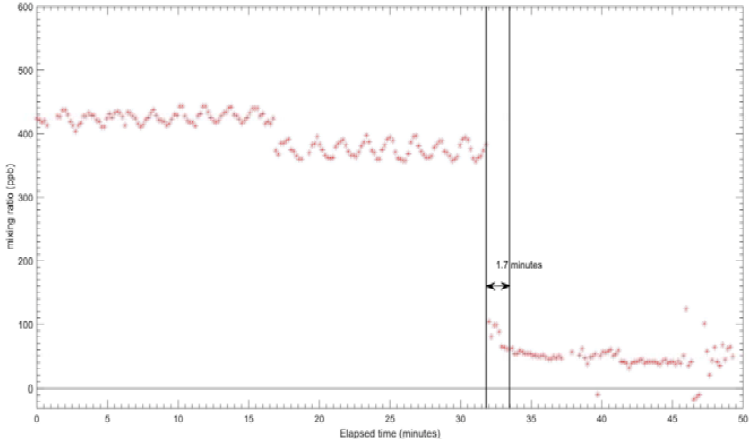
Component Concentration
NO 50ppm
SO_2 50ppm
CO 3000ppm
N_2 Balance
Provided by AirLiquide

Machine learning for EC sensor calibration

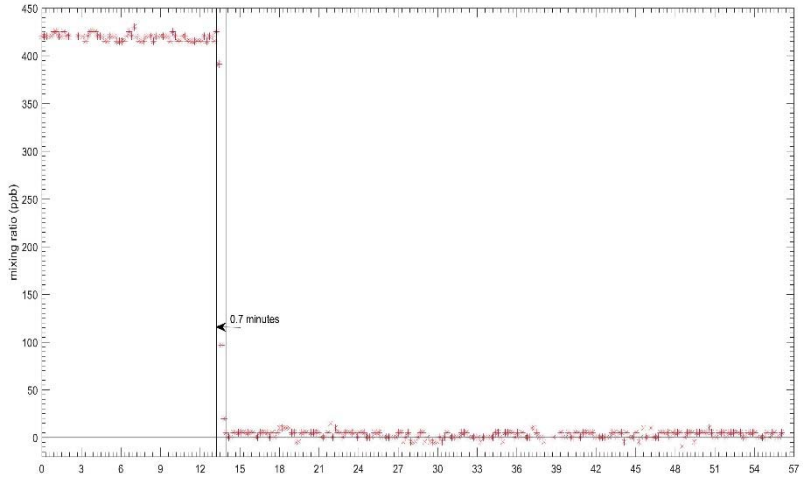
The effects of Temp & Hum is ongoing

Sensitivity experiment-University of Cambridge



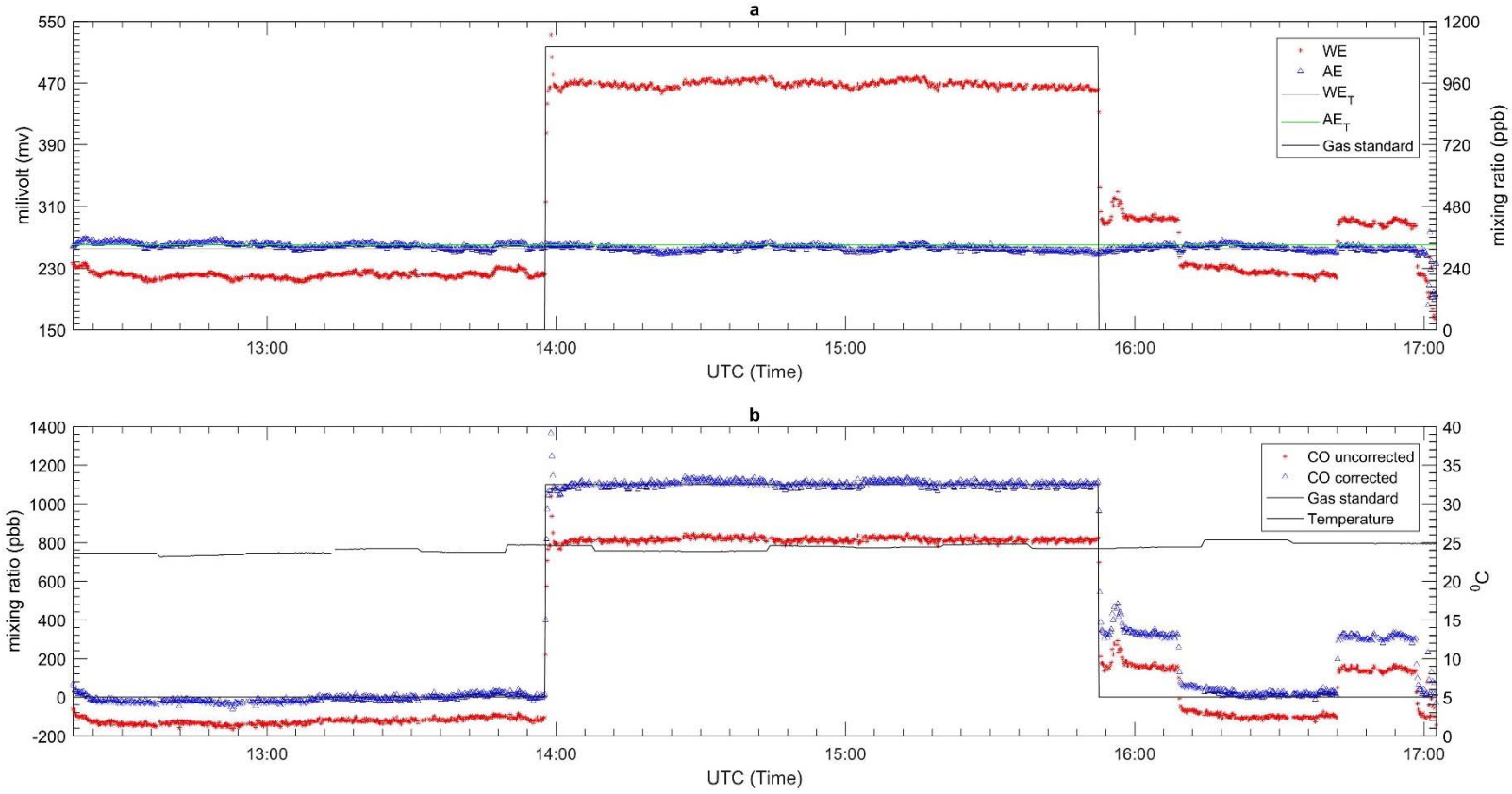


The response time



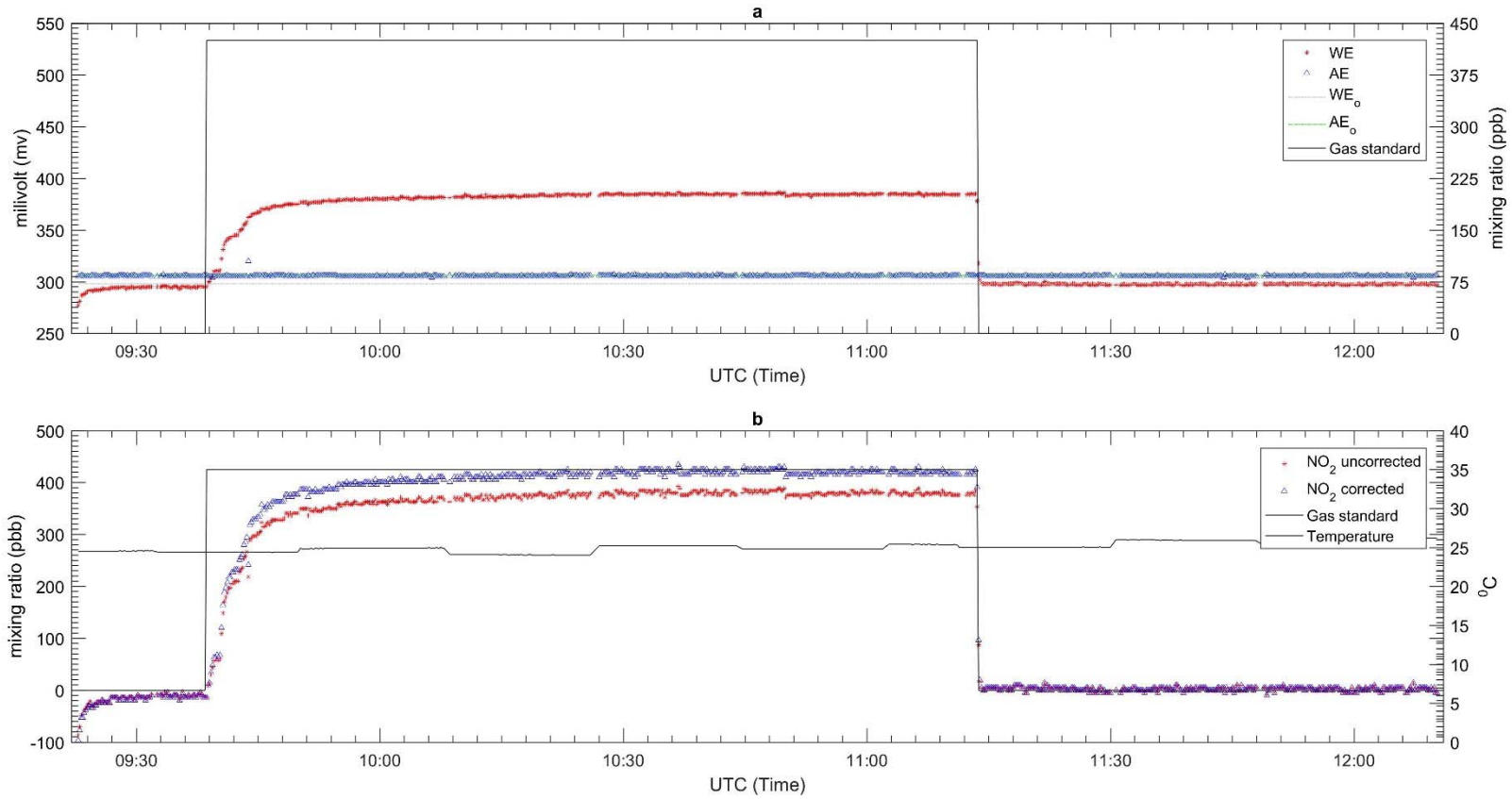
Ozone (O_3)

Carbon Monoxide (CO)



Carbon Monoxide (CO)

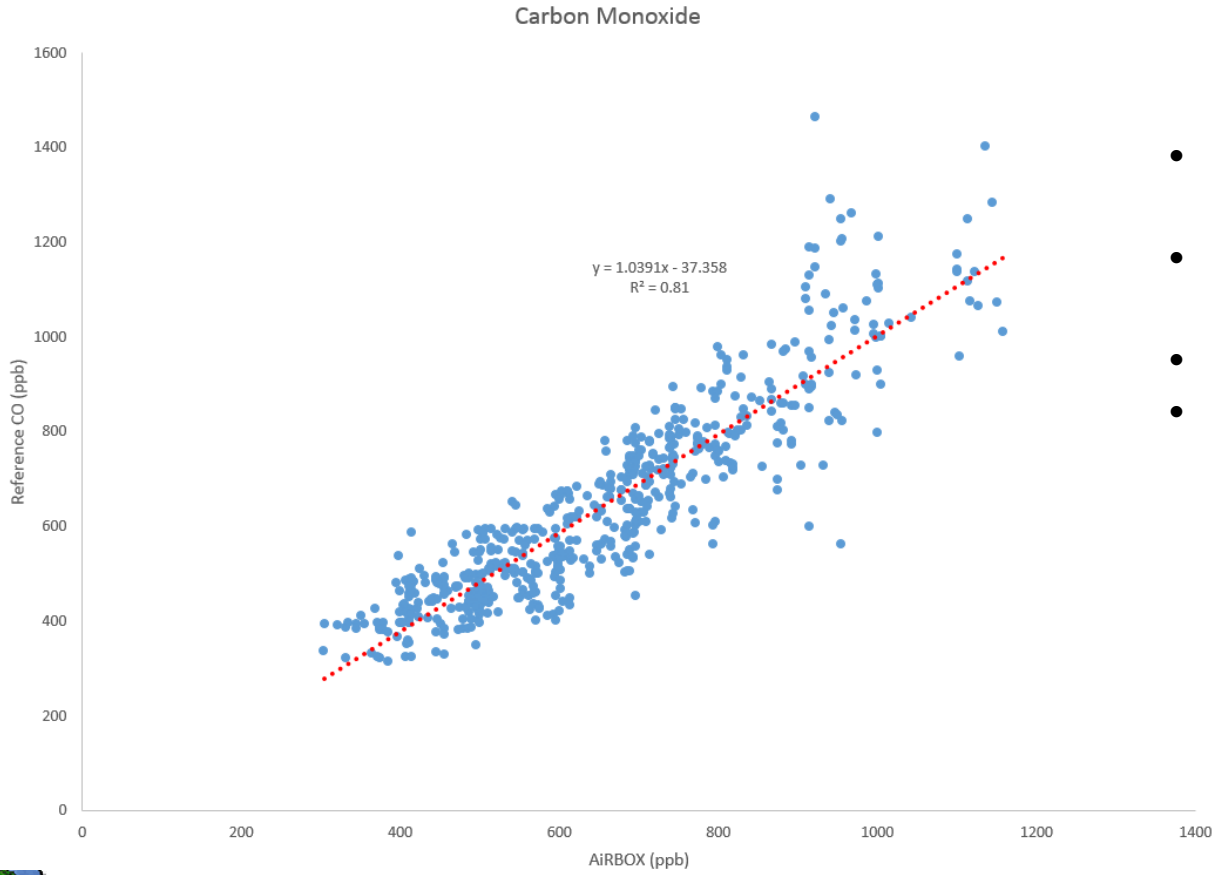
Nitrogen Dioxide (NO_2)



Nitrogen Oxide (NO)

VALIDATION CROSS-COMPARISON: PUTRAJAYA MONITORING

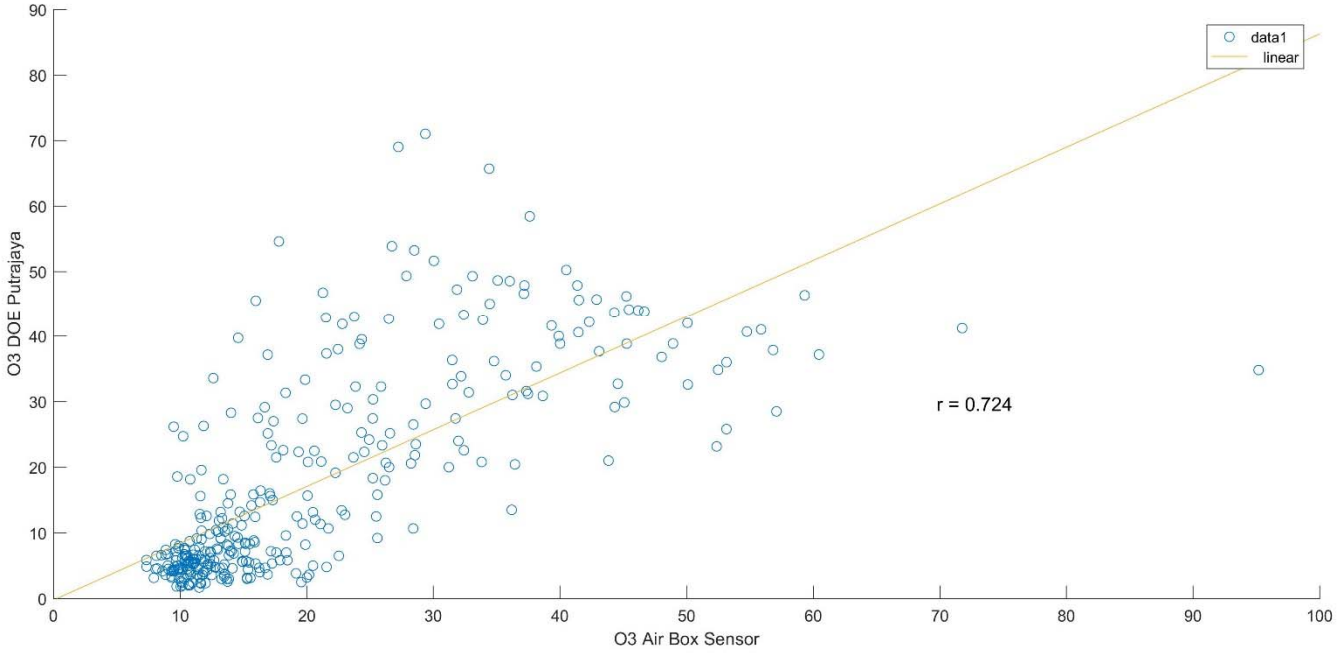
Correlation from validation with Reference CO



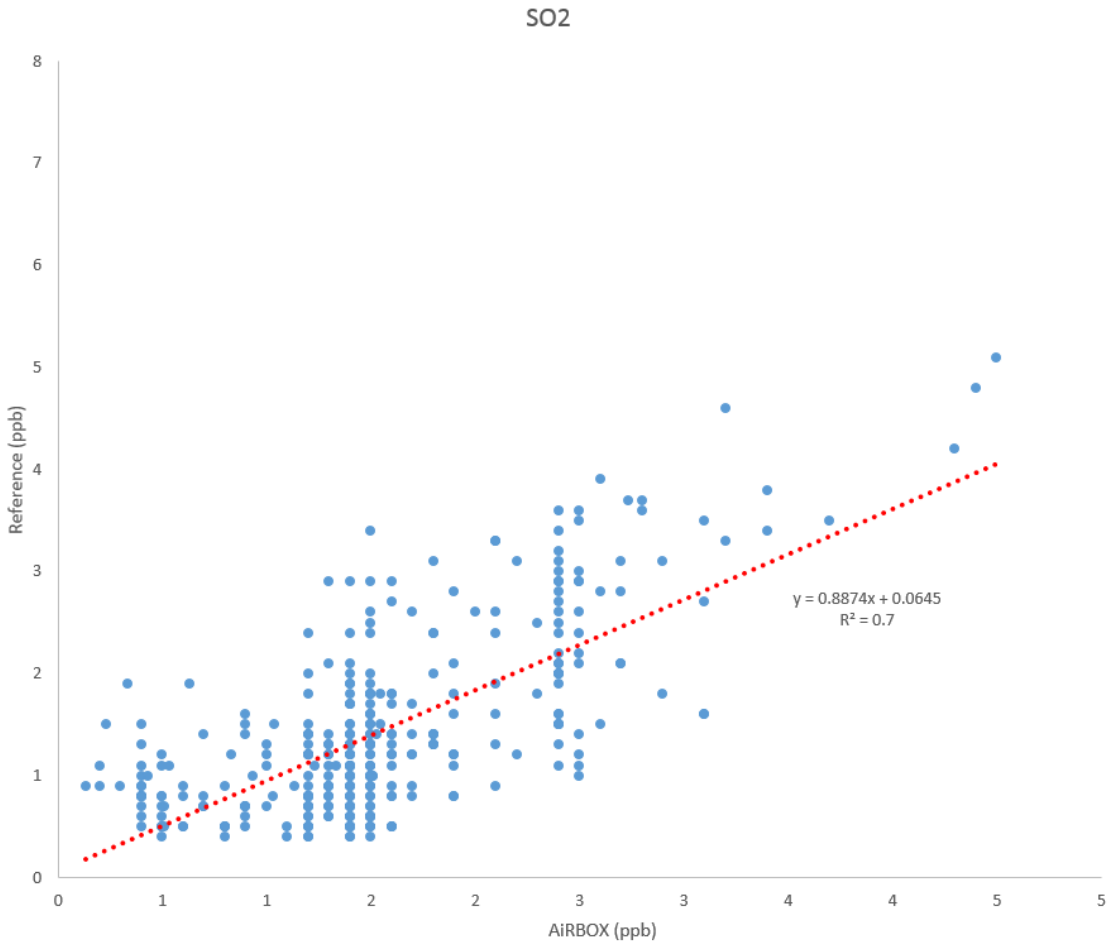
- The period of validations were conducted ~ 1 month.
- SO_2, NO_2 and PM Conducted at DOE, Putrajaya
- O_3 conducted at UKM Campus
- SO_2 was 3 weeks due to power problem at the DOE site.

Atmosphere
Investigation

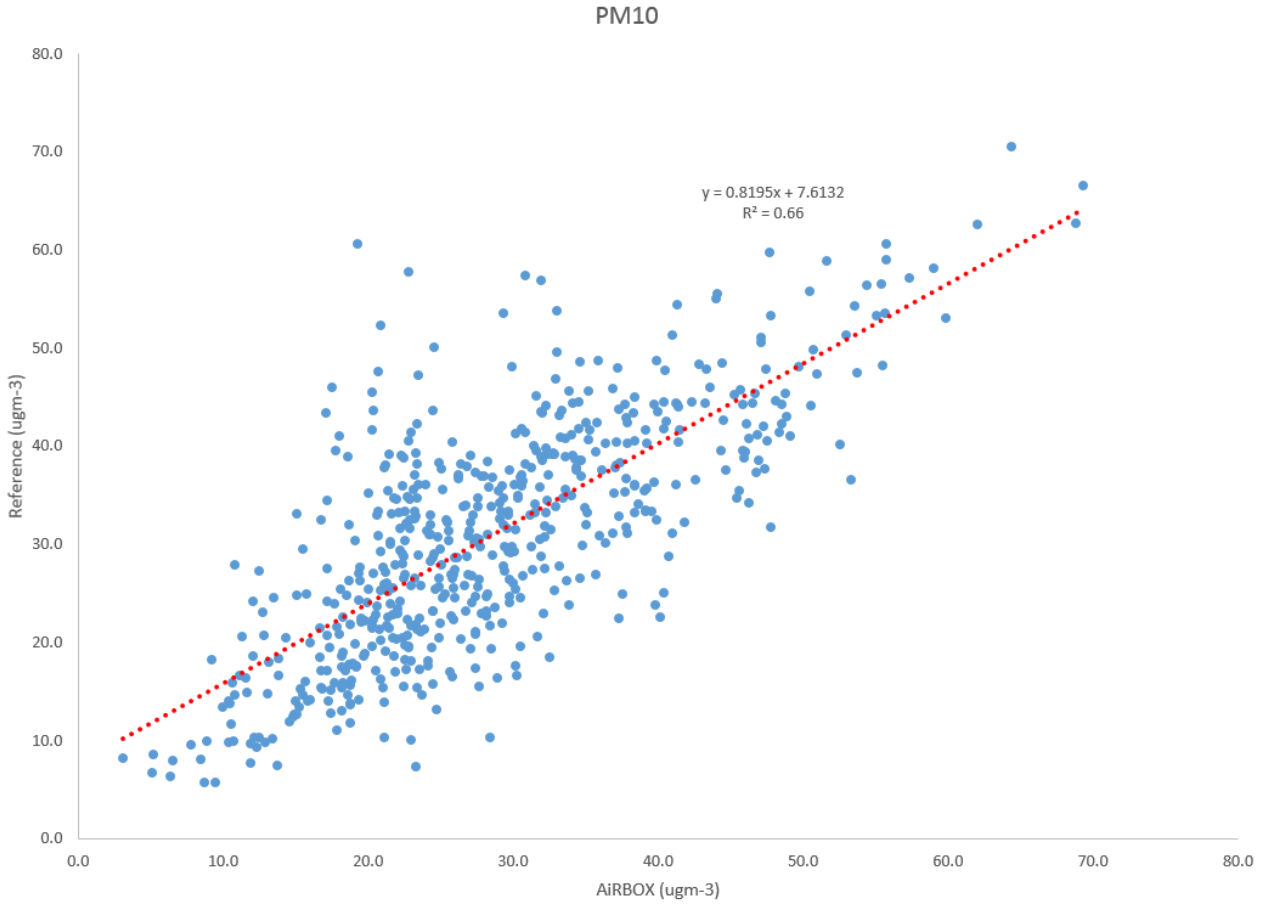
O_3


data1
linear
r = 0.724
O3 DOE Putrajaya
O3 Air Box Sensor
0
10
20
30
40
50
60
70
80
90
100

SO_2



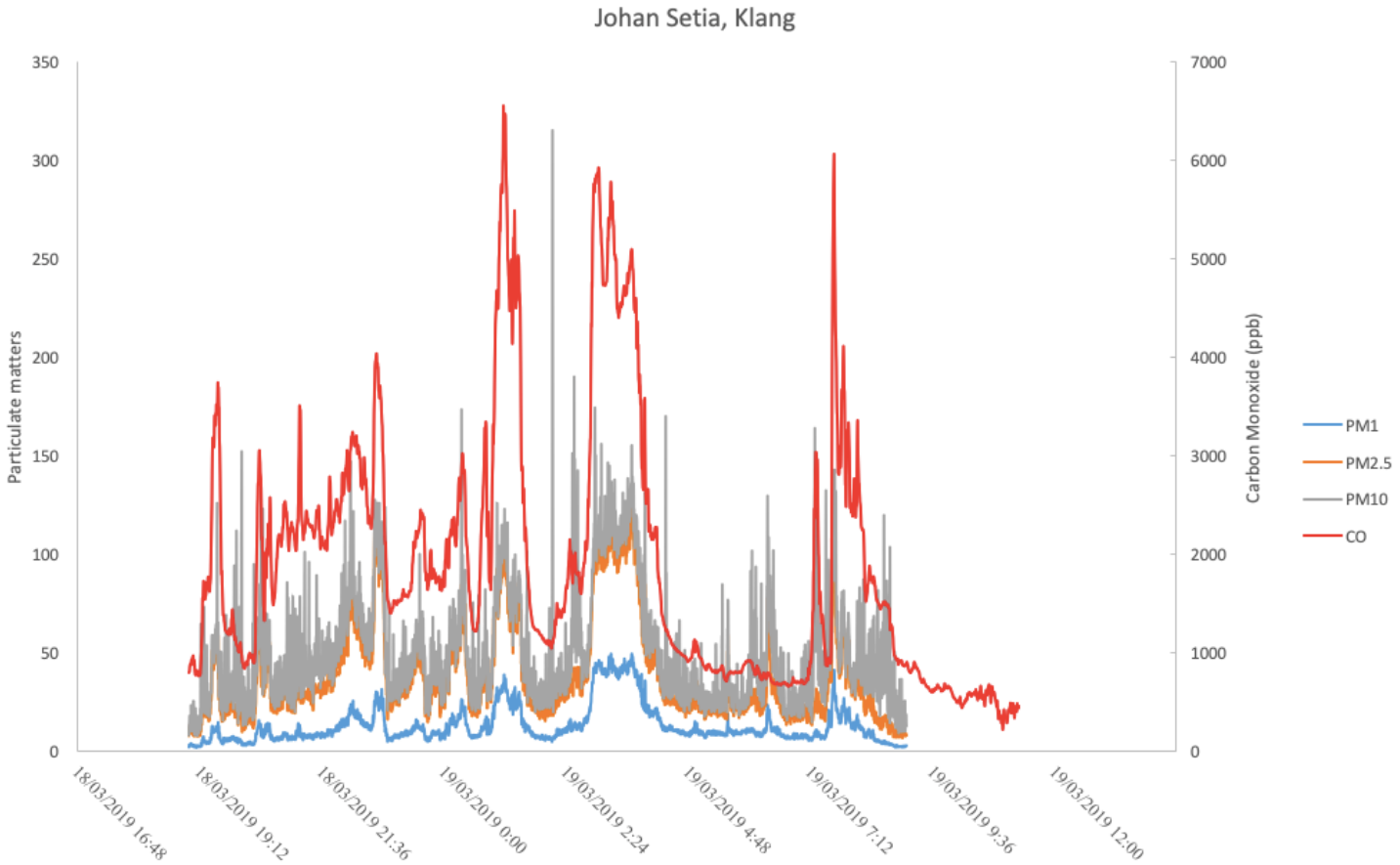
PM_{10}


PM10
y = 0.8195x + 7.6132
R² = 0.66
Reference (ugm-3)
AiRBOX (ugm-3)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0

$PM_{2.5}$

PM2.5
y = 0.9003x + 3.3928
R² = 0.5577
Reference (ugm-3)
AiRBOX (ugm-3)
0
10
20
30
40
50
60
0.00
10.00
20.00
30.00
40.00
50.00
60.00

HAZE EPISODE 2019



Conclusion

- The results showed that AiRBOX was in close agreement with the reference instrument by the Department of Environment in Putrajaya.
- Strong correlation between AiRBOX and standard reference instrument for O_3, CO,NO_2,SO_2 and PM (~r>0.6)- for OPC and EC.
- ‘AiRBOX should not substitute but supplement routine environmental monitoring equipment/devices.
- AiRBOX will be the Future Routine Environmental Networks.
- Green Routes through the city or access to information about air-pollution load at specific local address might be future goals for AiRBOX Sense
- THREE AiRBOX are still running since June 2018 at UKM Campus, Shah Alam and Putrajaya for monitoring 6 criteria air pollutants.
- Long-term validation between AiRBOX and Reference analysers is still on-going to investigate the stability and data accuracy-precisions.
- Cross-comparison with Cranfield University AQMESH and AMNodes for Newton Project
- Currently, FIVE AiRBOX will be commissioning for Petaling Jaya City Council (MBPJ) for SMART CITY program.
- We are still conducting experiments on the influences of humidity and temperature effects on those measured gases(6 criteria) and particulates.

Publication

sensors

MDPI

Article

Calibration Model of a Low-Cost Air Quality Sensor Using an Adaptive Neuro-Fuzzy Inference System

Kemal Maulana Alhasa [1], Mohd Shahrul Mohd Nadzir [2,3,*], Popoola Olalekan [4], Mohd Talib Latif [2], Yusri Yusup [5], Mohammad Rashed Iqbal Faruque [1], Fatimah Ahamad [3], Haris Hafizal Abd. Hamid [2,6], Kadaruddin Aiyub [7], Sawal Hamid Md Ali [8], Md Firoz Khan [3], Azizan Abu Samah [9], Imran Yusuff [10], Murnira Othman [2], Tengku Mohd Farid Tengku Hassim [11] and Nor Eliani Ezani [12]

1 Space Science Centre (ANGKASA), Institute of Climate Change, Level 5, Research Complex Building, Universiti Kebangsaan Malaysia, Bangi 43600, Selangor, Malaysia; kemalalhasa@gmail.com (K.M.A.); rashed@ukm.edu.my (M.R.I.F.)

2 School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, Bangi 43600, Selangor, Malaysia; talib@ukm.edu.my (M.T.L.); haris@ukm.edu.my (H.H.A.H.); murnira@ukm.edu.my (M.O.)

3 Centre for Tropical System and Climate Change (IKLIM), Institute of Climate Change, Universiti Kebangsaan Malaysia, Bangi 43600, Selangor, Malaysia; fatimah.a@ukm.edu.my (F.A.); mdfiroz.khan@ukm.edu.my (M.F.K.)

Atmosphere Investigation

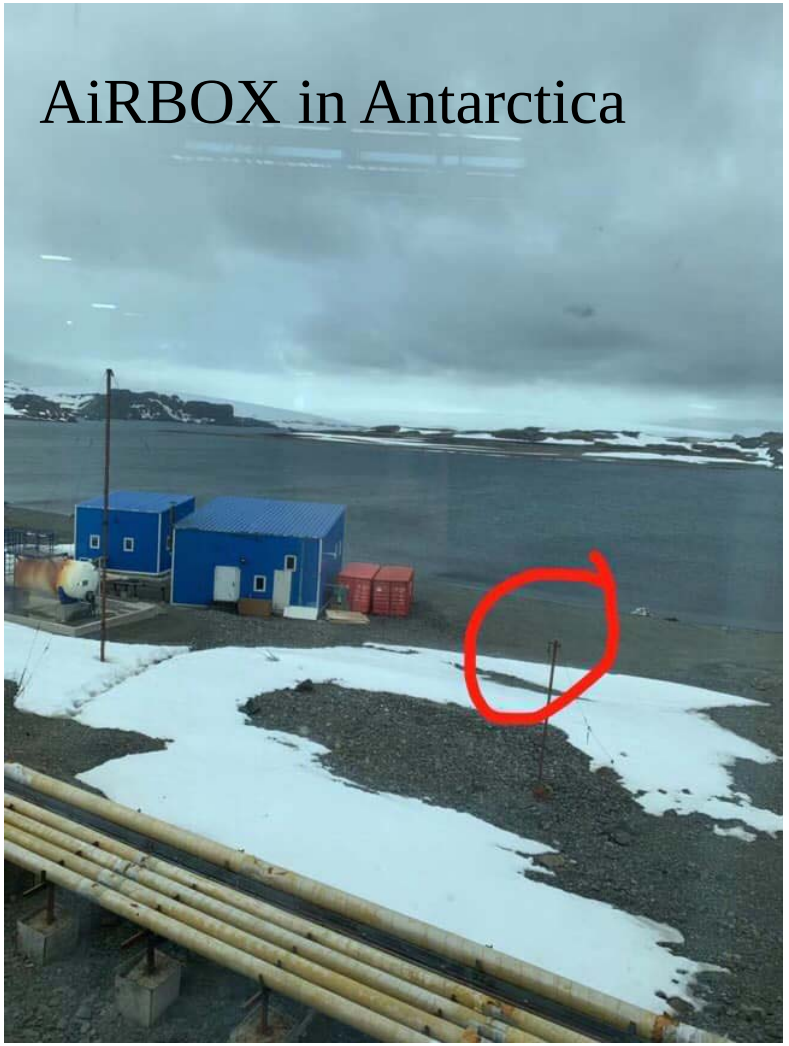
Atmosphere Investigation

malaysiakini

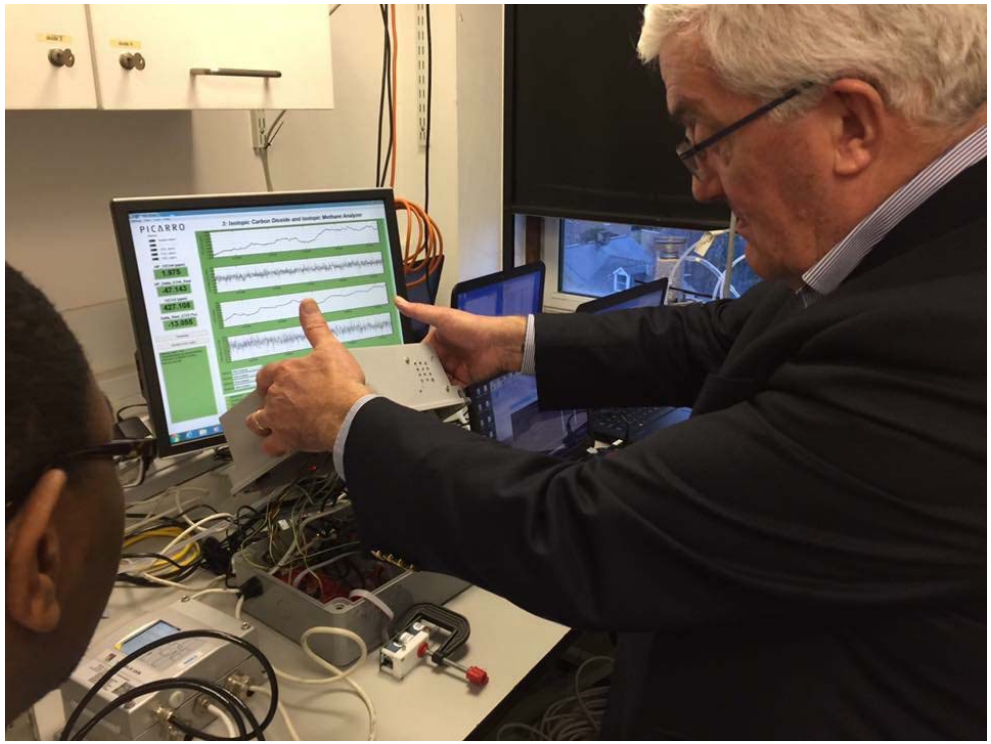
Utama | Terkini | Parlimen | Pilihan Editor | Su

UKM cipta alat lebih kecil, murah pantau kualiti udara

Rahmat Haron
11 Jan 2019, 12:03 tengahari (Dikemaskini 11 Jan 2019, 12:03 tengahari)



ACKNOWLEDGEMENT



Newton Fund

MOSTI
KEMENTERIAN SAINS, TEKNOLOGI DAN INOVASI
MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

UNIVERSITY of York

UNIVERSITY OF MALAYA

Cranfield University

MBPJ

UNIVERSITY OF CAMBRIDGE

PAKAR SCIENO TW
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(MyIPO)

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NOTIFICATION OF DELAY IN PROCESSING PATENT APPLICATIONS AND/OR REGISTRATIONS

PLEASE BE INFORMED that following a temporary interruption of the SPHI system, there will be some delay in processing patent applications and/or registrations from **6th December 2018.**

Registrar of Patent
Intellectual Property Corporation of Malaysia (MyIPO)
18 March 2019

Atmosphere Investigation

Find out more: AiRBOX Brochure

THANK YOU