Next generation sensors for urban air quality management and public health protection

———*Experience in Hong Kong*

Li Sun, City University of Hong Kong
Dr. Zhi Ning, City University of Hong Kong

Email: lisun4-c@my.cityu.edu.hk

Background

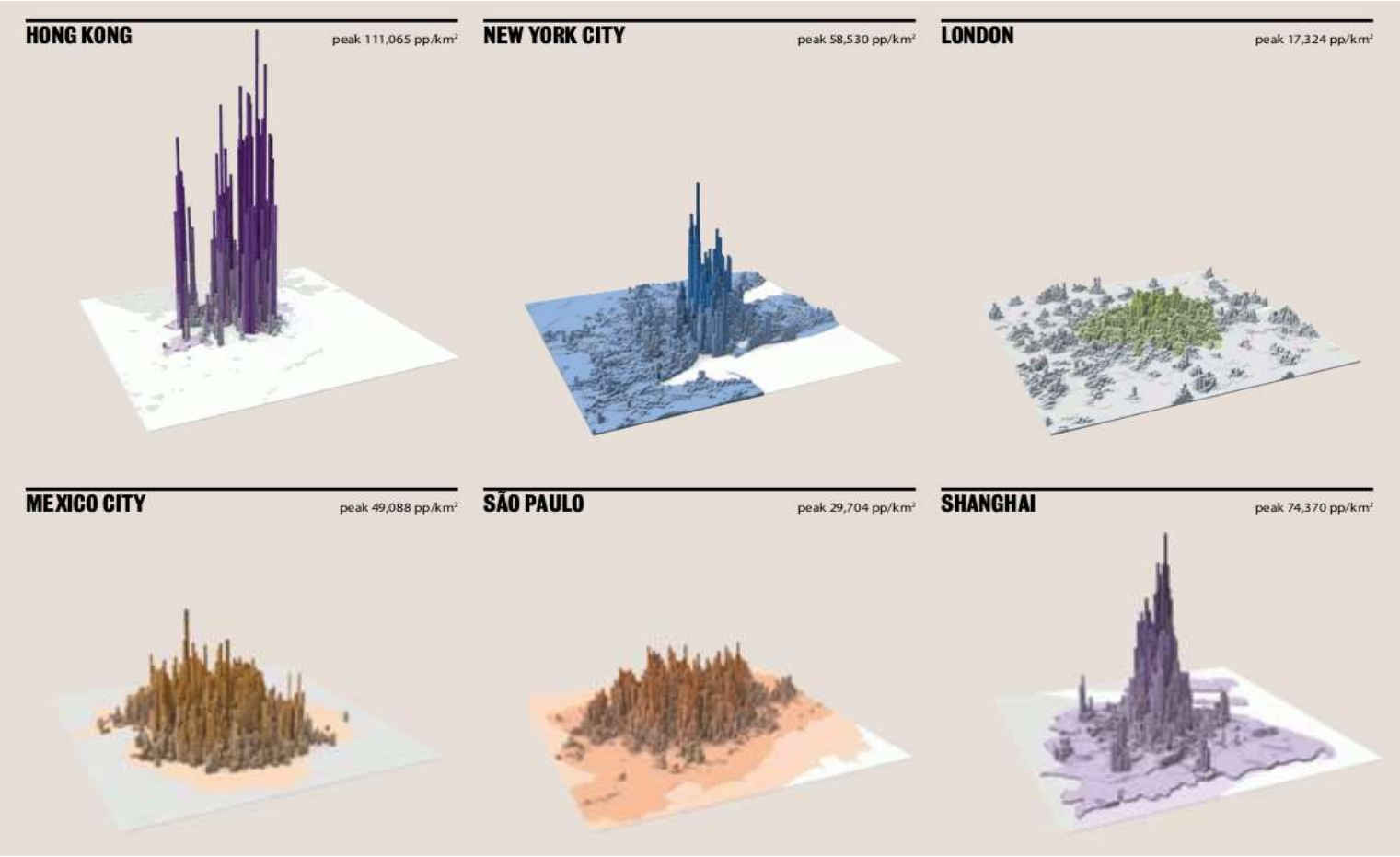
- **Why urban?**

Small fraction of the Earth's surface (0.5%) , yet with > 50% of the world population (3.42 b)

Background

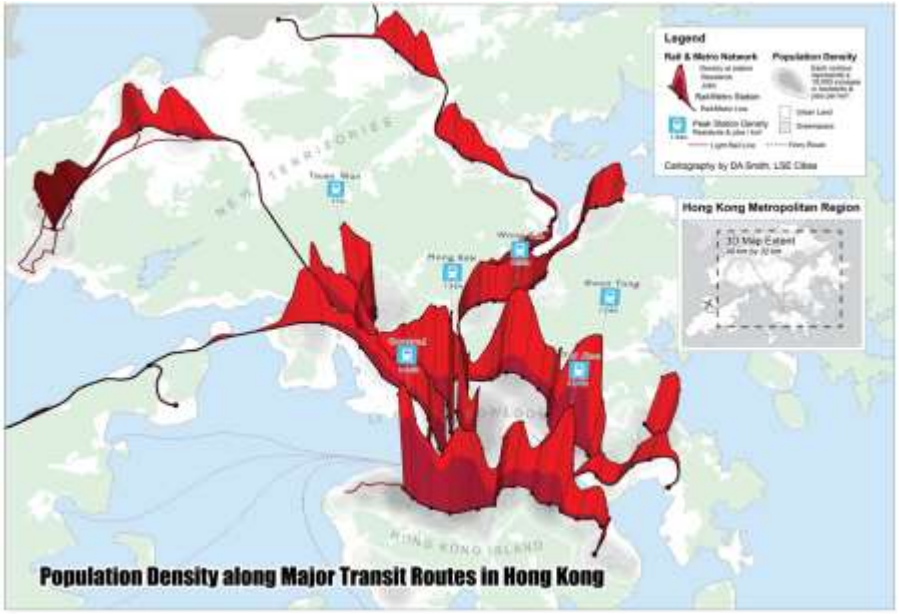
- **Why Hong Kong?**

Cities have different “genes”. Hong Kong being representative.



Issues with current practice

- 13 general air monitoring stations + 3 roadside air monitoring stations
- Regulatory monitoring data and Air Quality Health Index provide **only broad temporal and spatial scales**
- Need for more temporally and spatially resolved data



Issues with current practice

- **Why sensors?**

Traditional compliance monitor/equipment

- High price and maintenance cost;
- High precision but requires professionals;
- Regional/local air quality instead of personal info.

“Professional "sensors

- Lower cost and small, compact, easy to deploy;
- Good performance in certain applications with different data quality objectives.

Consumer grade sensors (low cost sensors)

- Cheap and small for personal and family usage;
- Indication purpose, not scientifically reliable.

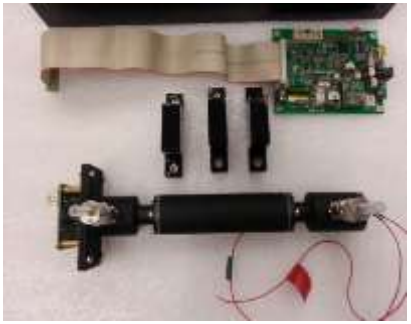
System development

- **Flow chart of system development**

Sensor selection → Sensor tests → System design / Circuit design → OEM → System integration → System tests






Sensor & system test

- Laboratory test
- Algorithm development
- Sensors have 3 dimension of factors **(Conc, Temp, RH)** while conventional monitors have only 1 dimension of factor **(Conc only)**

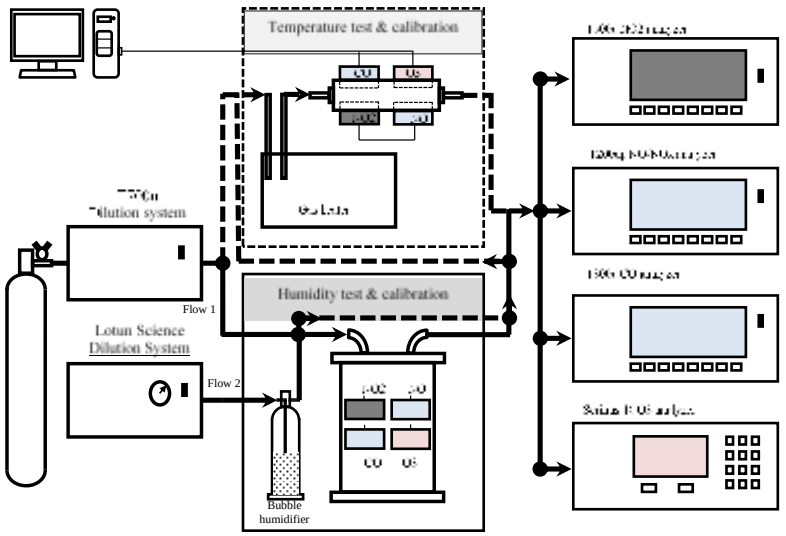
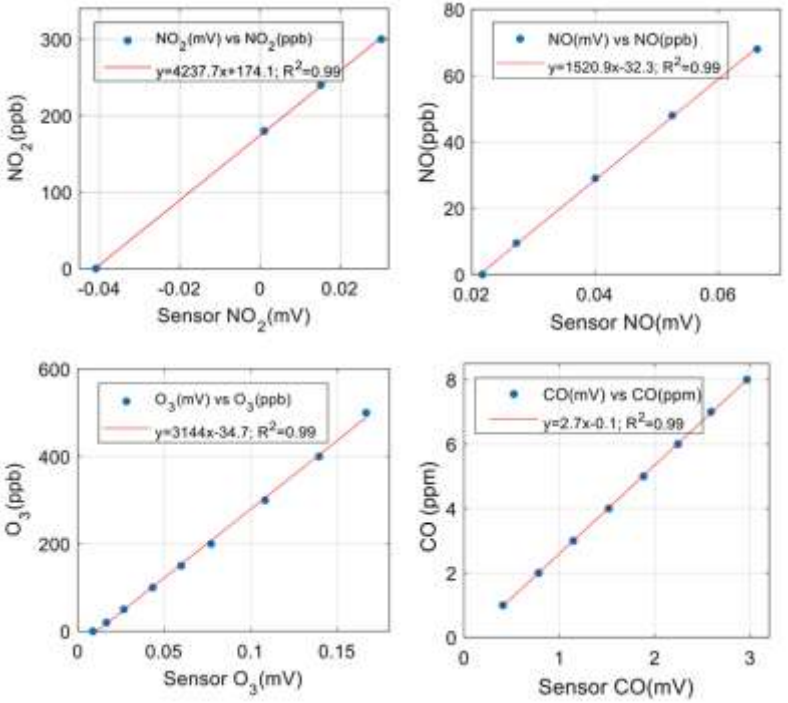
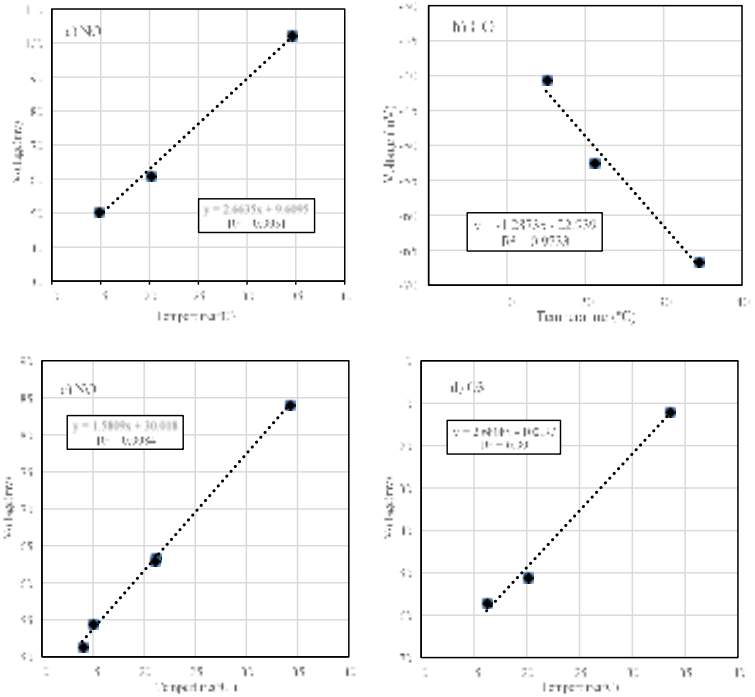


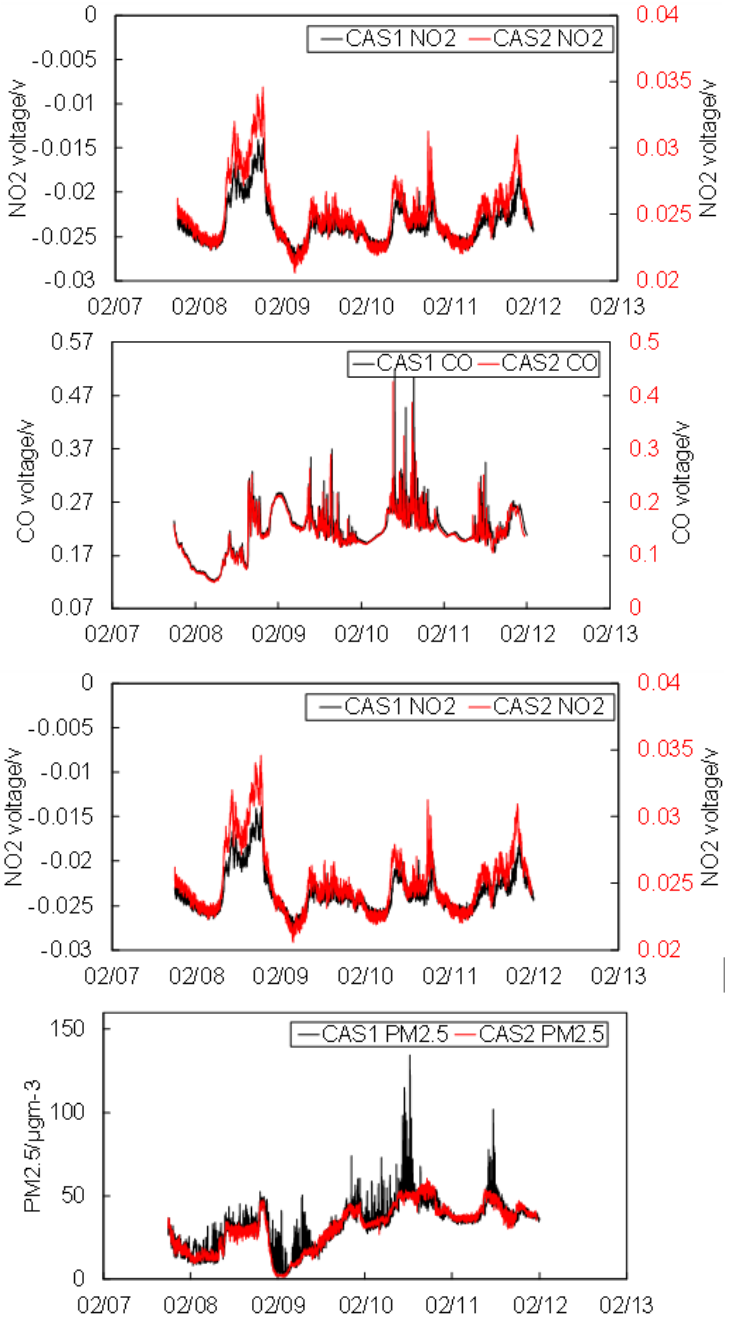
Figure 1 Evaluation system



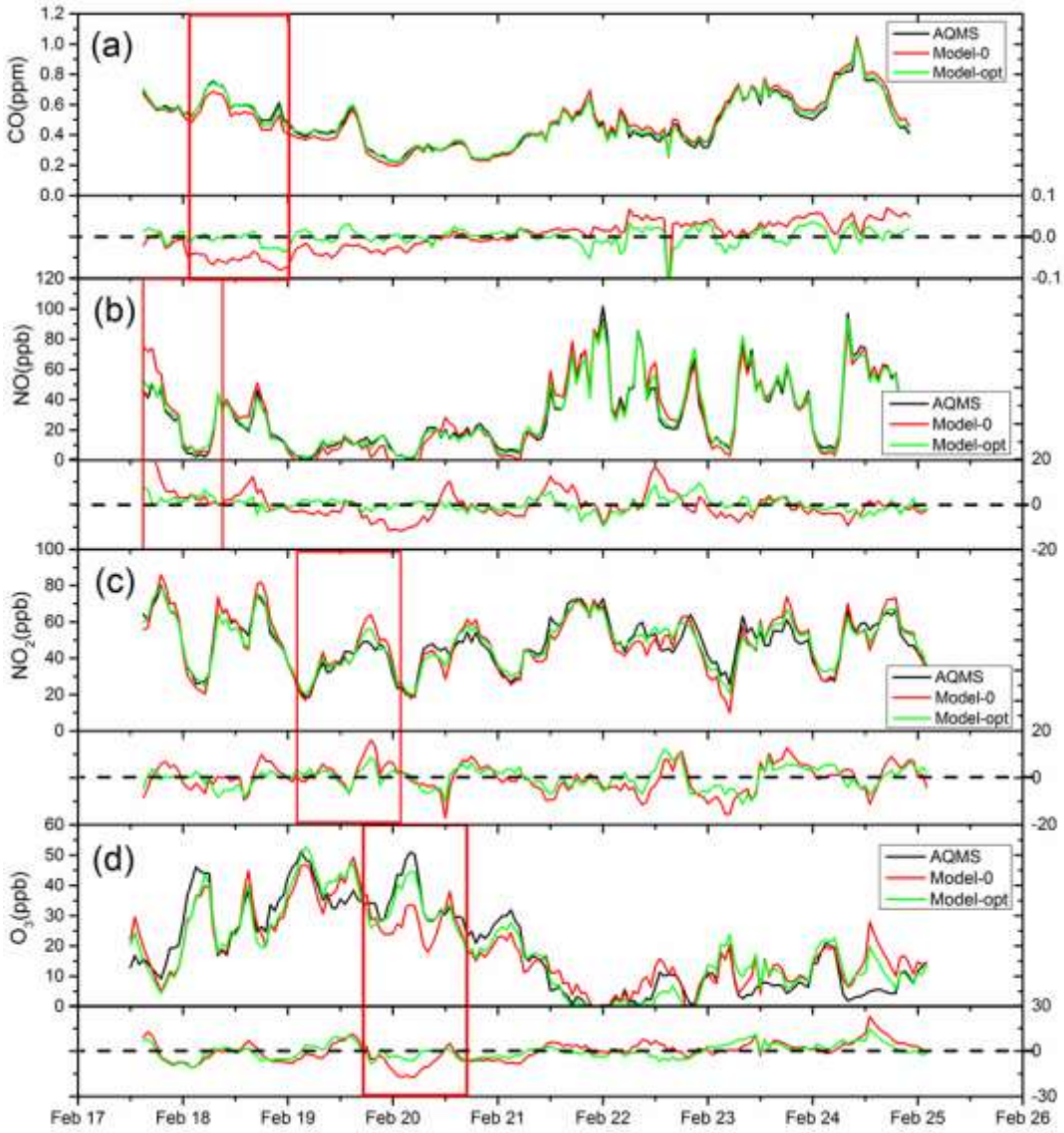


Sensor & system test

- **Laboratory test**
- **Inter-consistency check on multiple devices**
  - Cross check on the raw data output on the multiple sensor devices



Sensor & system test



- Field test
- Algorithm optimization
- QAQC is important!!

2015 Standard Chartered International Green Marathon -- our first sensor-based monitoring

In support of government initiative for "2015 Standard Chartered Green Marathon"

South China Morning Post EDITION: HONG KONG

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Pollution sensors to line Hong Kong marathon route

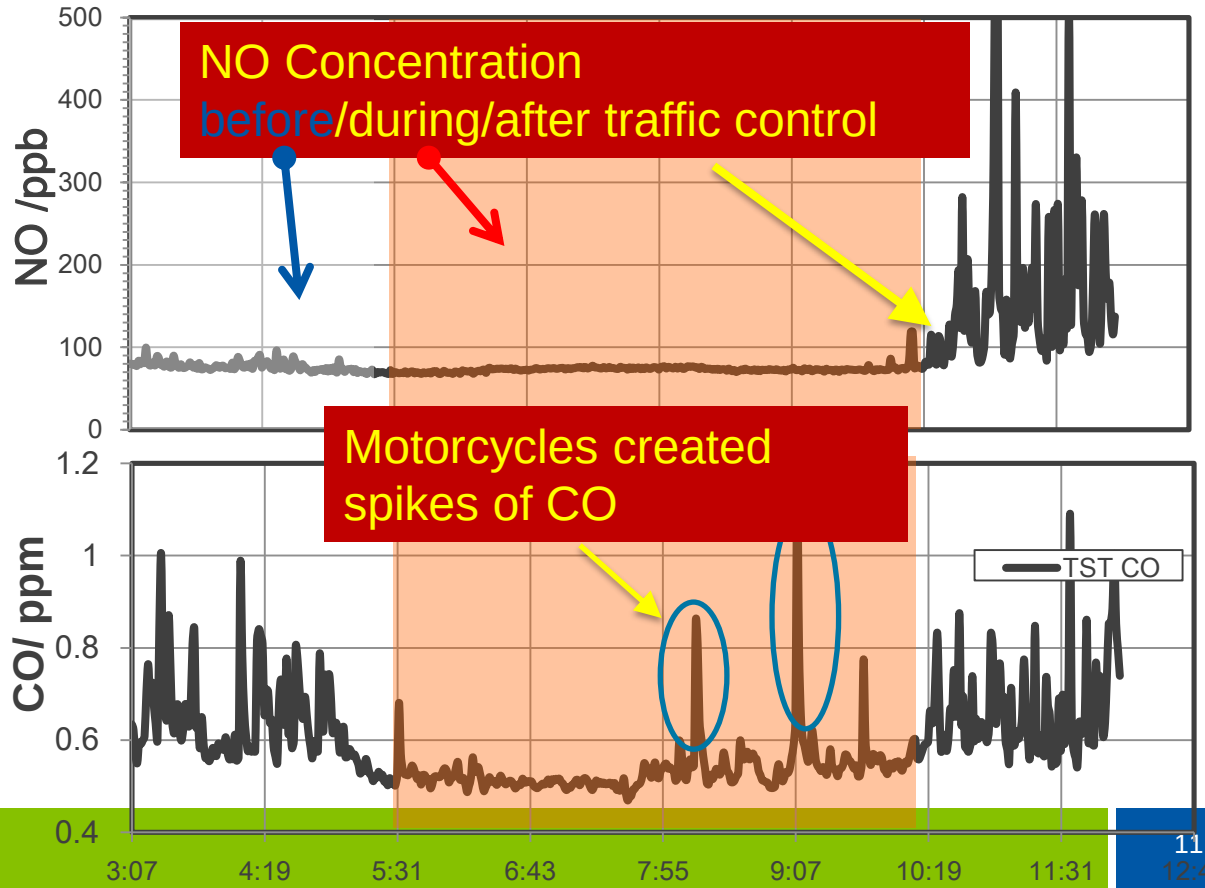
Government and universities team up to install monitors and give runners instant access to data

Danny Lee
danny.lee@scmp.com

PUBLISHED : Saturday, 24 January, 2015, 12:40am
UPDATED : Monday, 27 April, 2015, 3:29pm

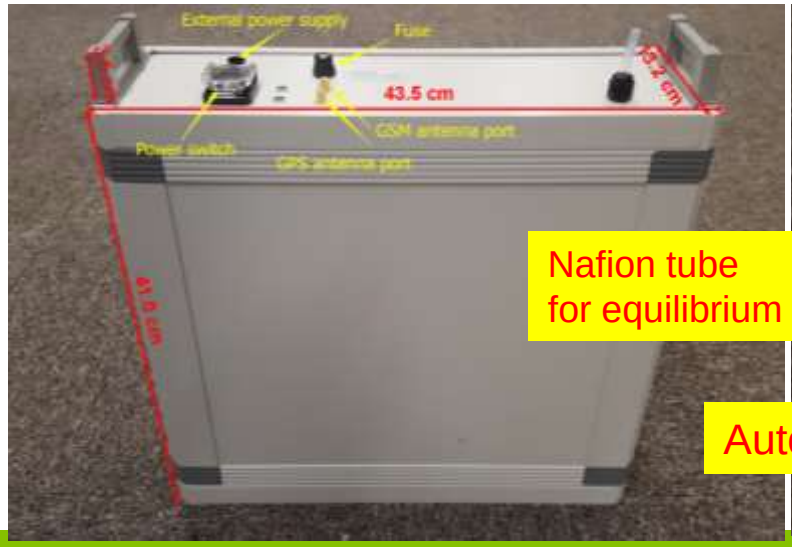
2015 SC Green Marathon network

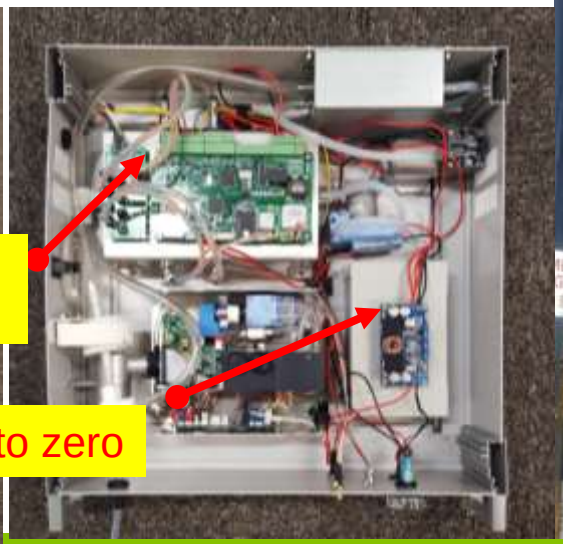
- Traffic control was effective to suppress pollution levels during the race
- Roadside traffic related pollutants quickly jumped once traffic control lifted



Mobile Air SEnsor Network (MASEN)

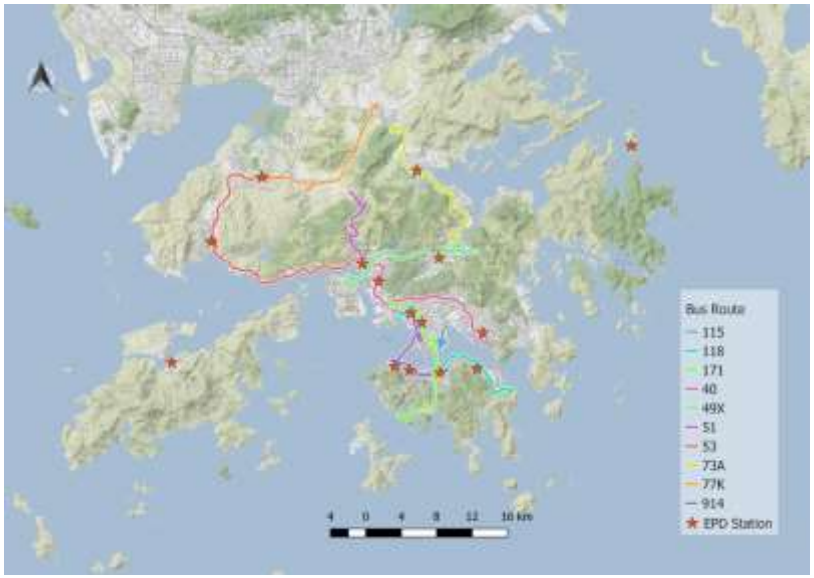
- Bus mobile sensor platform
- Compact and multipollutant solutions for $PM_{2.5}$,NO, NO_2,CO, CO_2 (traffic pollutants)
- GPS/ traffic speed data and real time transmission
- QAQC is very important for long term unattended operation!

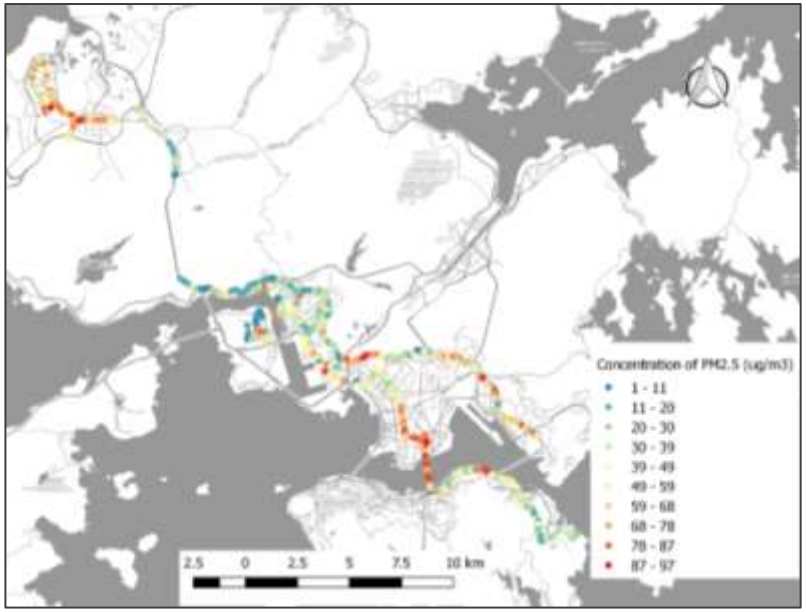


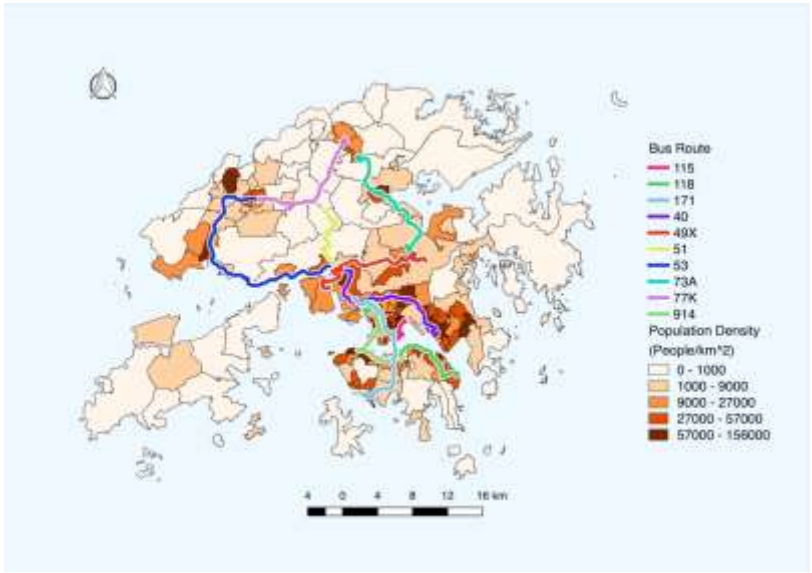


Mobile Air SEnsor Network (MASEN)

- Real time and real world pollution map;
- Roadway network emission and air quality modelling;
- Hotspot identification and evidence based policy making;
- Transport optimization.







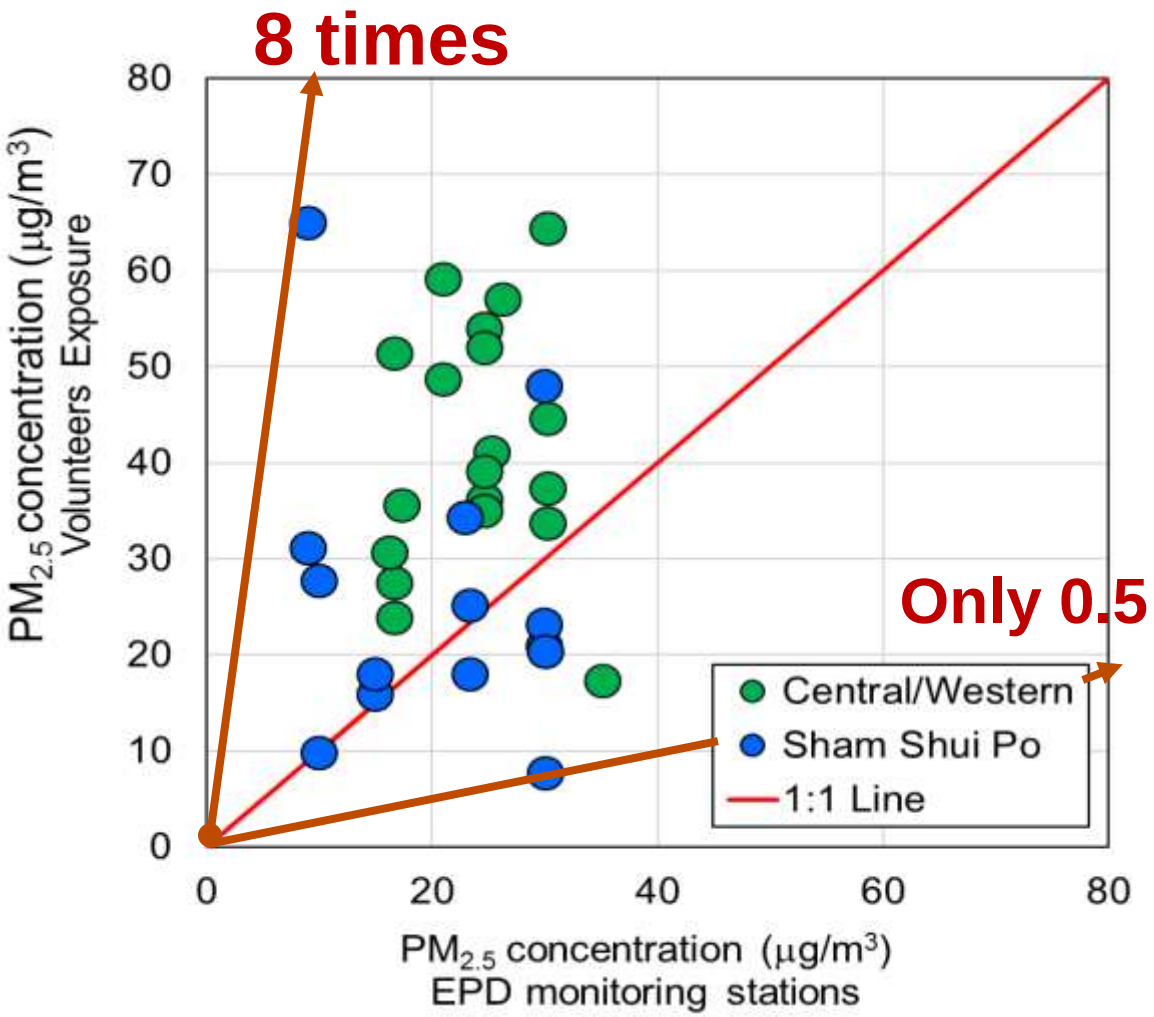
Personal Exposure Kit (PEK)

- **A portable device**
  - Can be carried and placed anywhere
  - Can measure, transmit + record real-time data
- **Several microenvironments studied**
  - Office, Home, Commuting, schools, indoor and outdoor
- **PM and 5 gases possible**
  - 3-axis accelerometer, noise sensor, light sensor
  - Temp/RH sensor
  - GPS
  - Encrypted Q-R code for online survey

Restaurant | Inside Subway | Park | Mini-Bus

Regulatory data representativeness?

- AQMS poorly represents individual exposure



The way forward…

- **“professional” sensors are here to stay and there are ample opportunities for sensor usage;**
- **They should not be viewed as substitution of regulatory/compliance monitoring;**
- **Awareness and understanding of potential and limitations of sensor based monitoring systems is the key to their successful use;**
- **Specific QAQC for sensor application is important.**