



Application of PM_{2.5} Low-cost-sensors to Assess Community Sources

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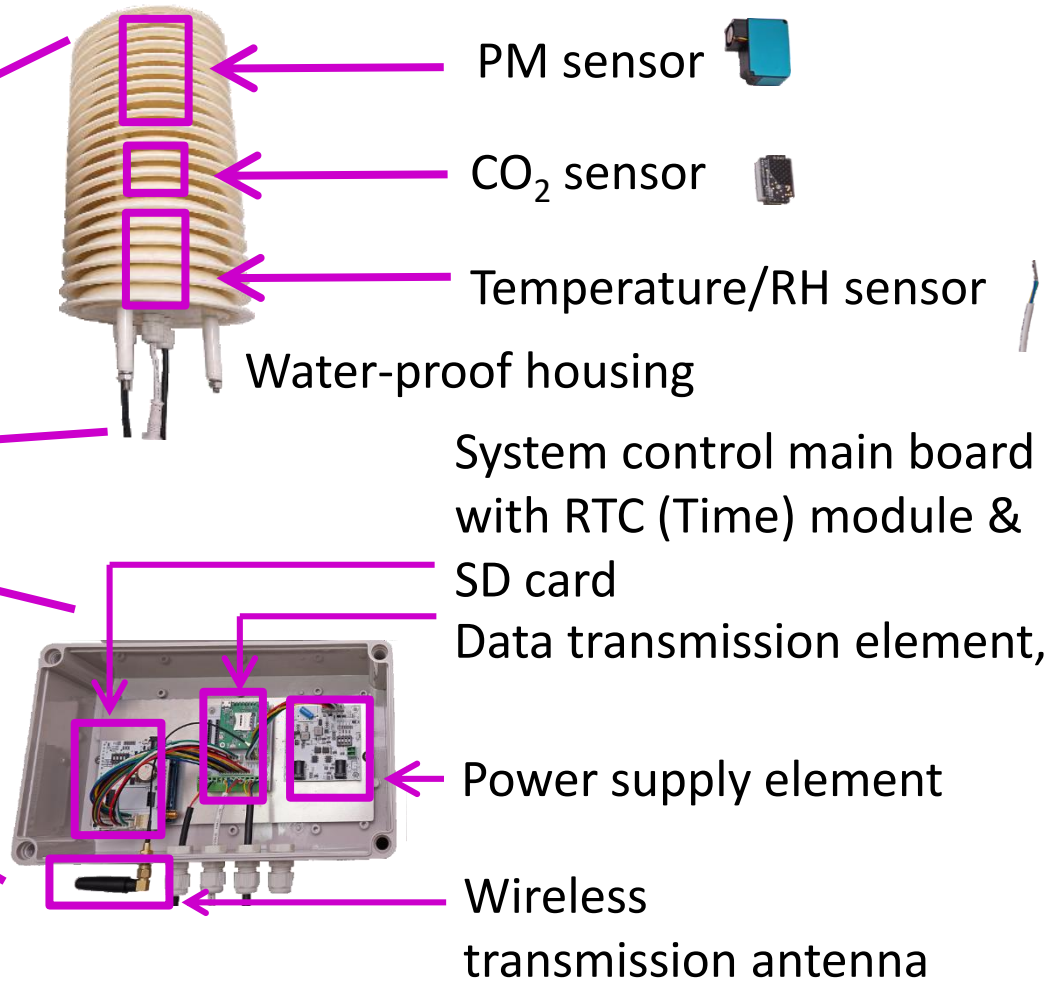
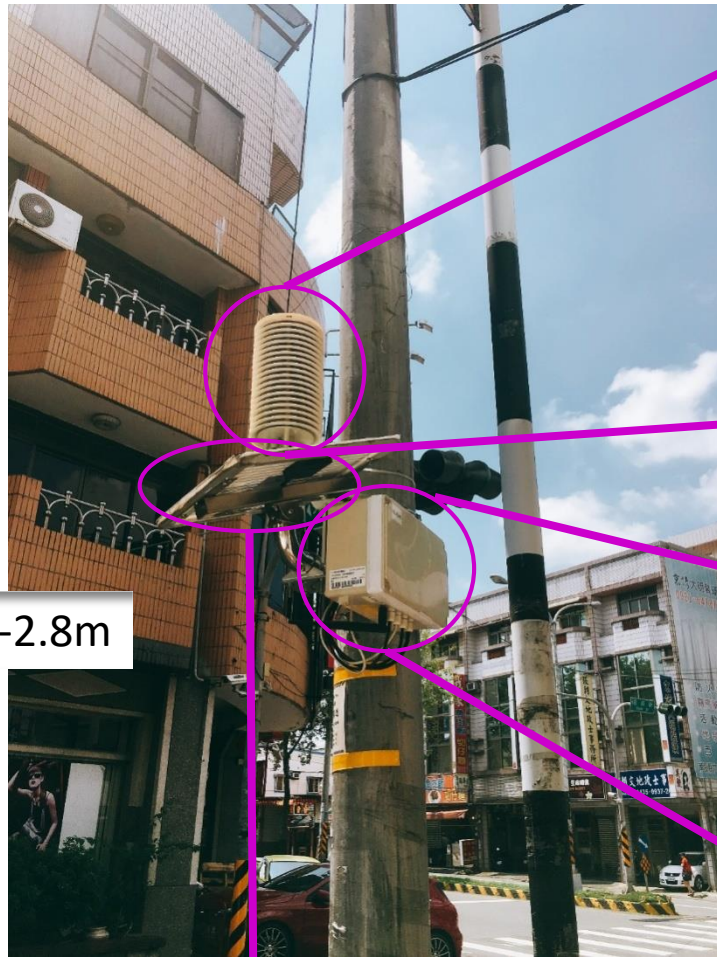
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Acknowledgements

This project was funded by the **Academia Sinica (AS)** under grant AS-104-SS-A02 and we also appreciate **Dr. Ling-Jyh Chen** in the Institute of Information Science of AS for the development of **AS-LUNG (Academia Sinica-LUNG)**

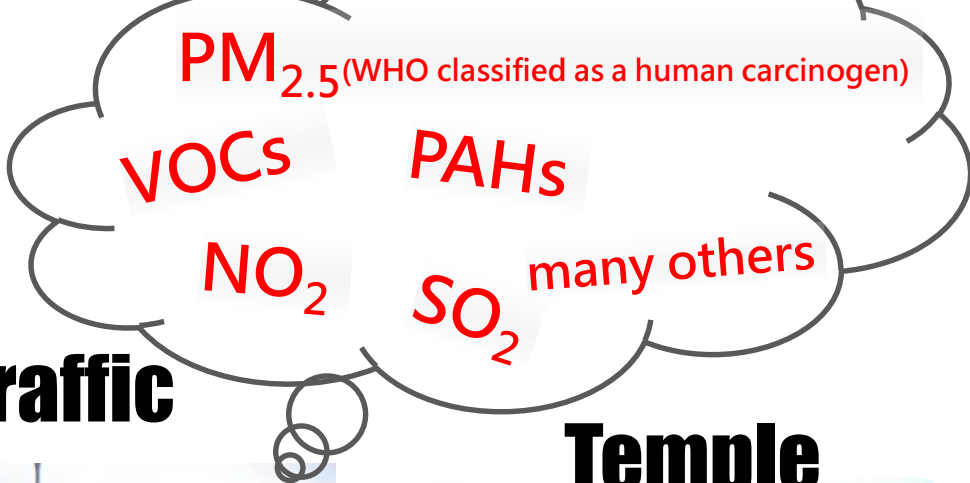
- AS-LUNG (Academia Sinica- LUNG)
 - Outdoor version (**AS-LUNG (O)**)
 - Portable version (AS-LUNG(P))

Set-up of AS-LUNG(O) in the community



Solar panel

Community Culture-related Air-Pollutant Sources in Asian Cities



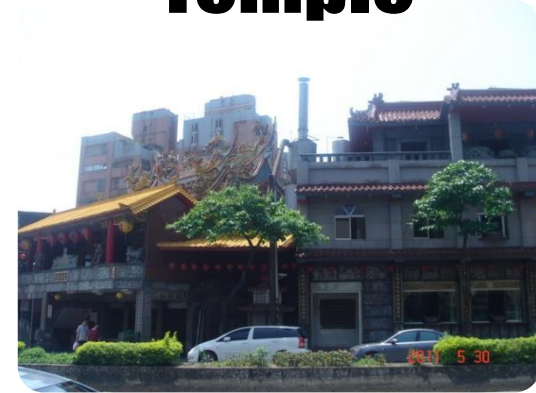
Asian style restaurant



Traffic



Temple



Night market



Hair salon



Car salon



Motivation

- Higher **intra-urban variability** in Asian residential communities than those in western countries
 - various PM_{2.5} sources, such as **restaurants and home factories**
- High **exposure** levels to residents due to **community sources**
- Objectives:
 - to evaluate the **applicability of AS-LUNG(O)**
 - to **quantify PM_{2.5} contributions** from those **community sources**

Comparison with GRIMM

Table 1 PM_{2.5} comparison in the laboratory and in the field
AS-LUNG(O)=slope*GRIMM+intercept

	PM _{2.5} -Slope	PM _{2.5} -Intercept	R ²
In lab (Sensor=40)			
Mean (STD)	2.33 (0.22)	-1.23 (1.65)	0.95 (0.04)
Max, Min	2.73, 1.86	2.92, -3.91	0.98, 0.80
In field (Sensor=11 for 3 days)			
Mean (STD)	2.01 (0.26)	3.66 (5.27)	0.88 (0.10)
Max, Min	2.39, 1.66	9.49, -2.01	0.97, 0.68

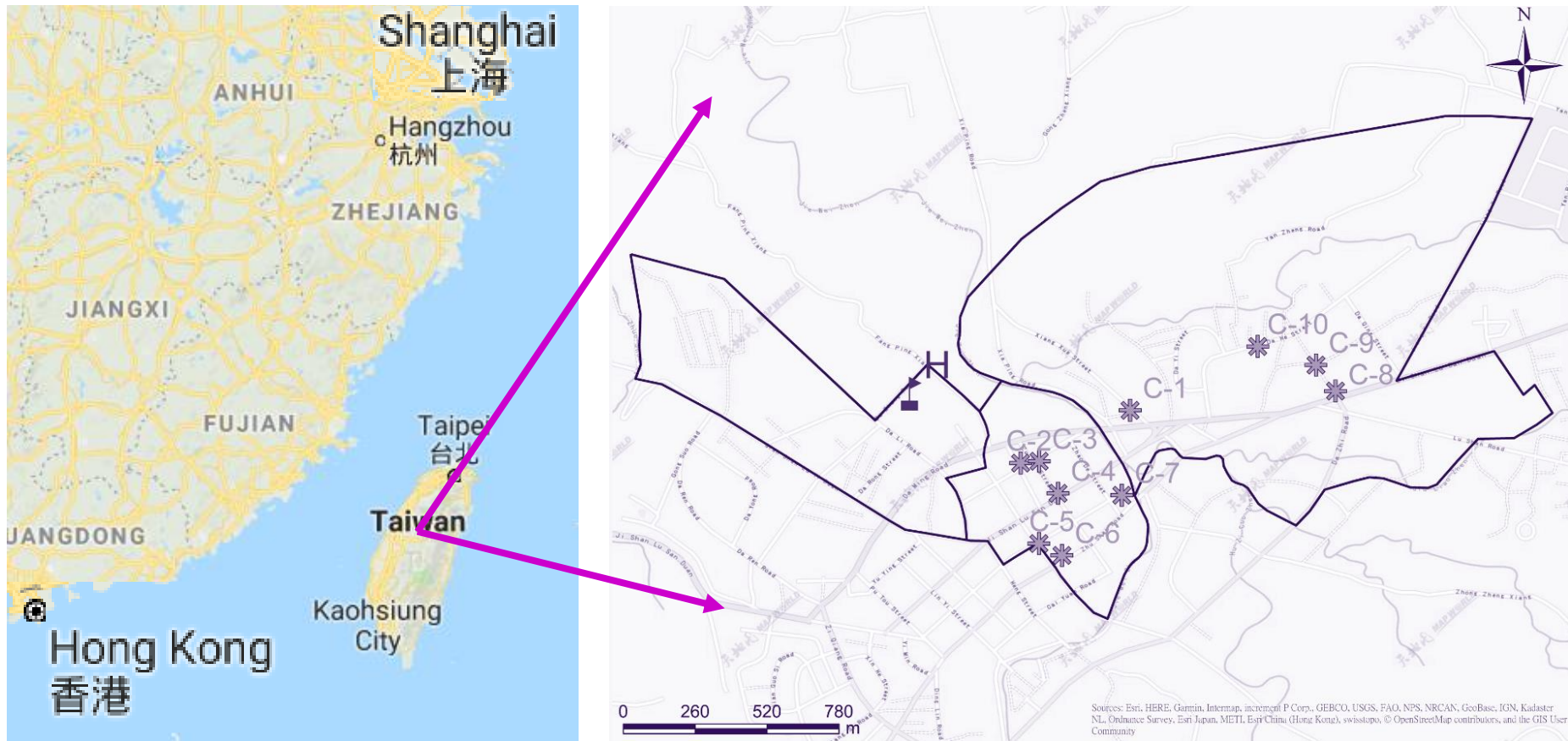
- Lab: T: 18.1-34.9C, RH: 56.3-97.4%, PM_{2.5}: 3-150ug/m³
- Field: T:25.9-40.9C, RH: 43.4-93.8%, PM_{2.5}: 3.9-30.1ug/m³

Monitoring Strategy

- **AS-LUNG-outdoor (AS-LUNG(O))**, a $PM_{2.5}$ sensor device with a solar panel and water-proof housing, was used for this work.
 - PM_{1} , $PM_{2.5}$, CO_2 , temperature, and relative humidity with **1-min resolution**
 - Wireless transmission plus SD-card to avoid data loss
- **10 AS-LUNG(O) devices were placed at 2.5 meters** above ground in Taiwanese communities to assess source contribution
- **one AS-LUNG(O) at 10 meters** above ground to assess ambient levels (high-level site)
- **July 1-28 and December 1-31, 2017**
- evaluated against **GRIMM in the laboratory and fields**; the measurements were converted accordingly

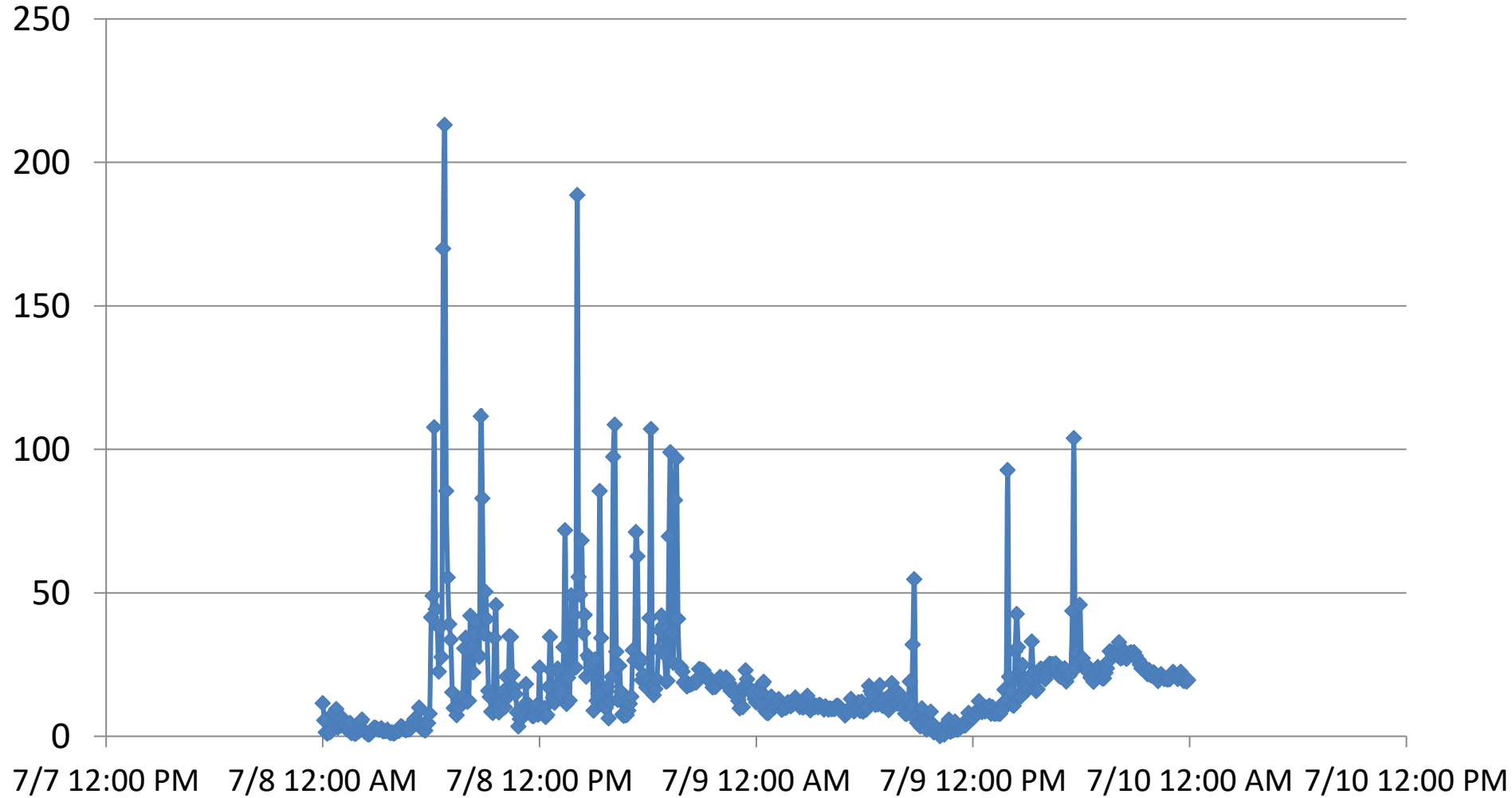


Locations of ten community sites and the high-level site

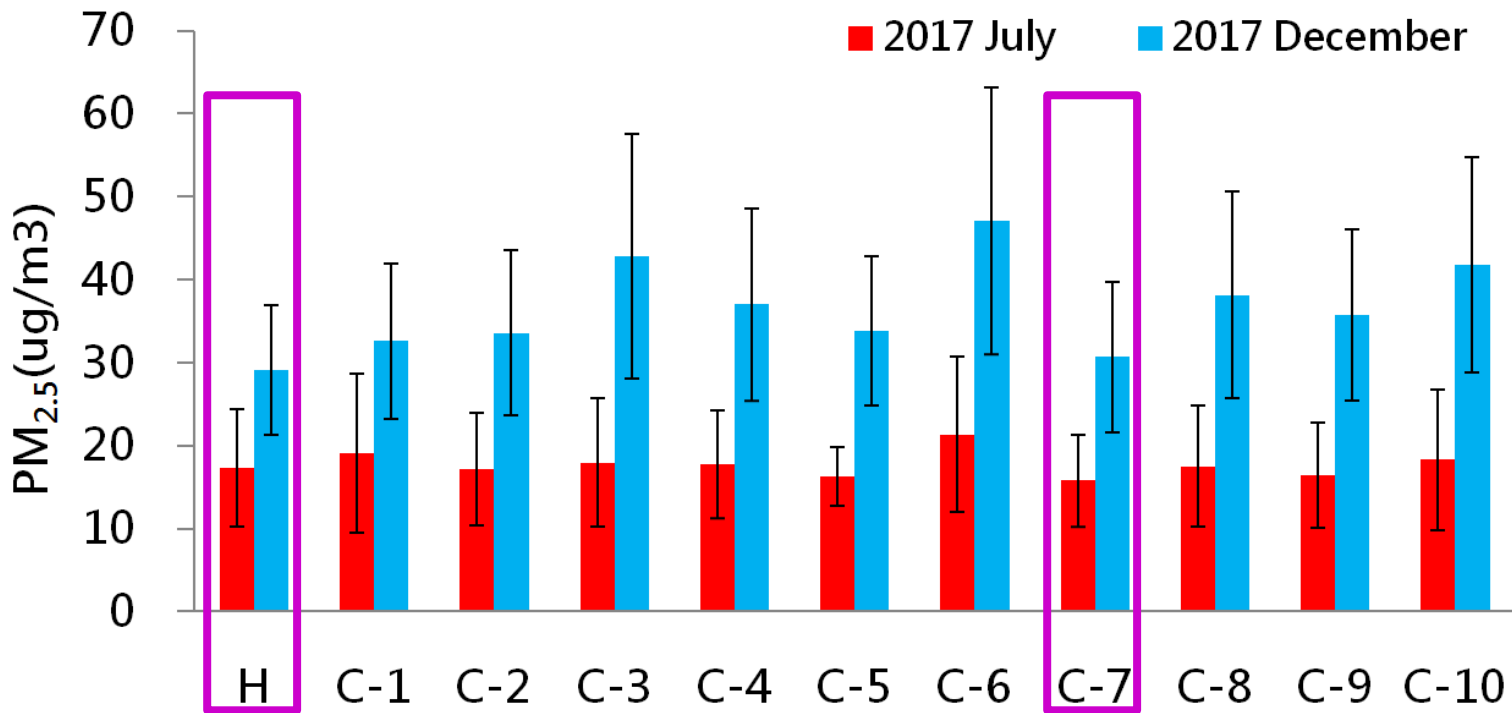


- This community is in the center of Taiwan island. **Within 1 km²**
- Site C-1 to C-10 (**street side**) and H (**high-level**) are community sites where AS-LUNG(O) sensors set-up
- AS-LUNG(O) usually **3-5 meters** from one or two community sources (**traffic, vendor, temple, store, etc**)

Temporal variation of PM_{2.5} in one community site (5-min averages)

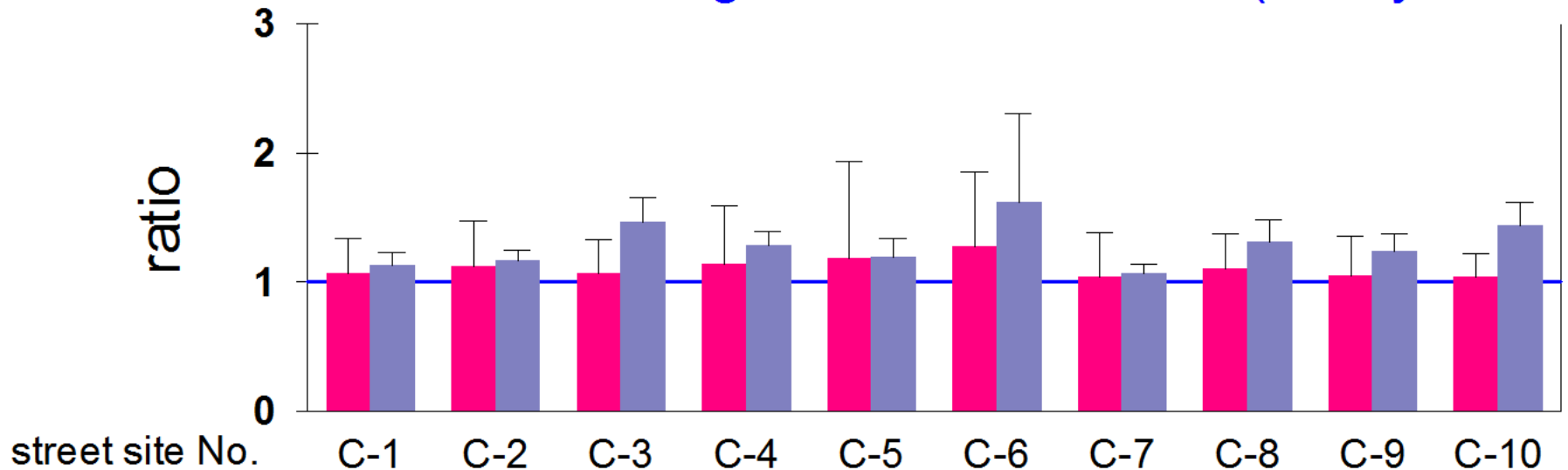


Date	High-level	C1 – C10
July	17.5±8.6	18.0±9.3
December	29.3±10.8	37.4±17.3



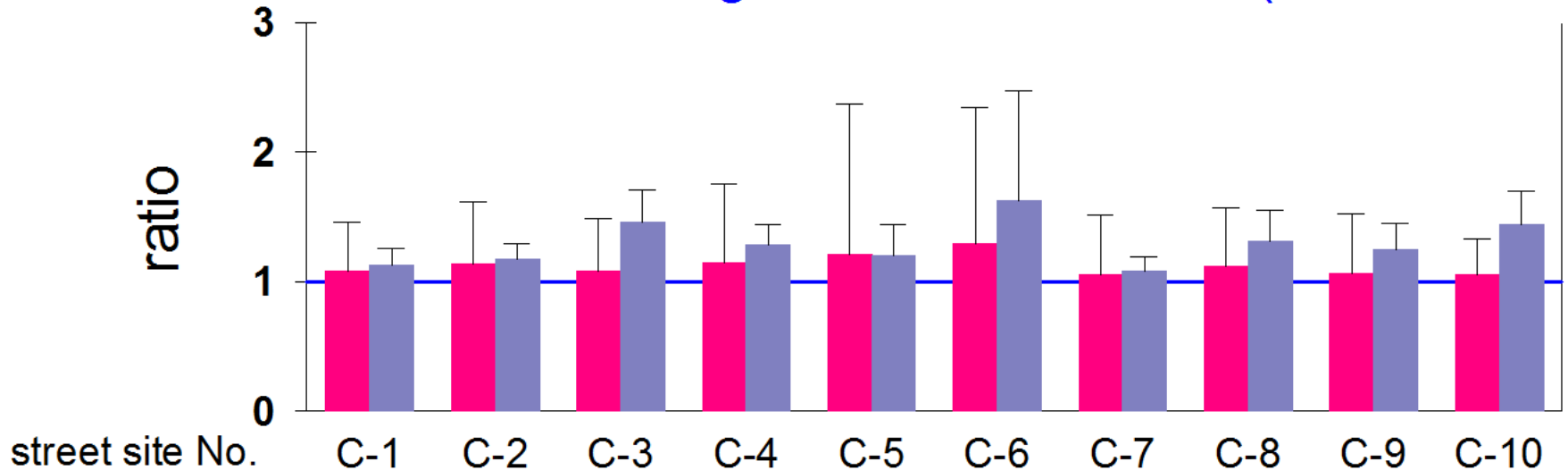
Note: data were 5-min means

Street side conc. / High level station conc. (hourly mean)



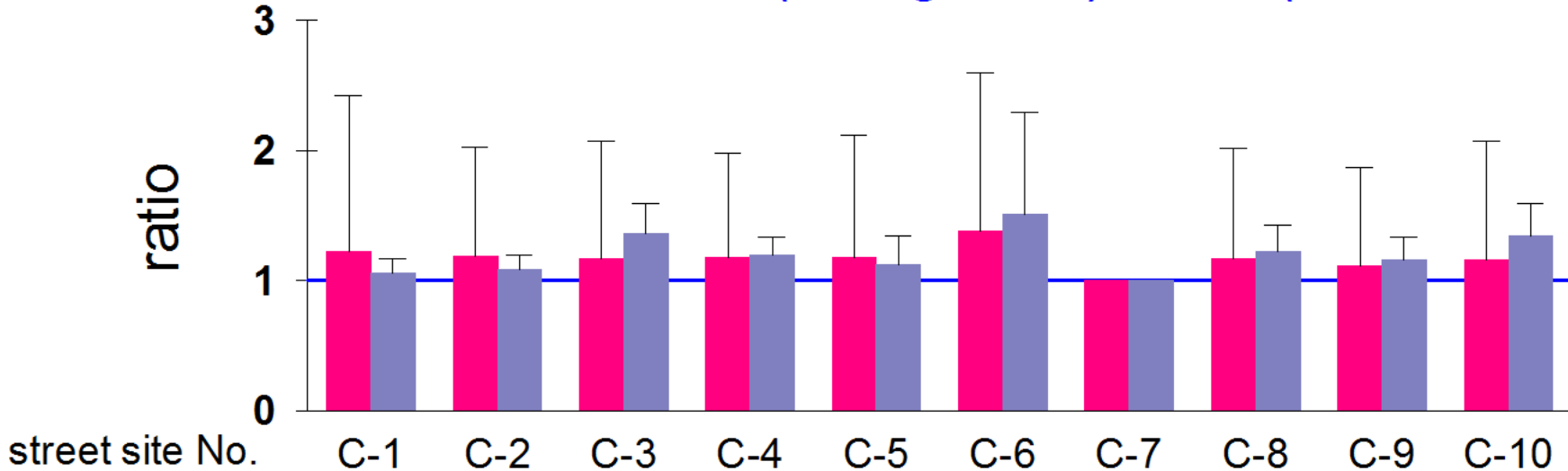
- hourly $PM_{2.5}$ levels at street sites compared to those at high-level site
 - Summer: ratio means among different sites were 1.04-1.27
 - Winter: ratio means among different sites were 1.07-1.62

Street side conc. / High level station conc. (5-min mean)



- 5-min $PM_{2.5}$ at street sites compared to the 5-min at high-level site
 - Summer: ratio means among different sites were 1.05-1.29, with a 5-min maximum of 35.5
 - Winter: ratio means among different sites were 1.08-1.63 with a 5-min maximum of 21.6
- Moreover, the highest 1-min level at a site near vendors and traffic was 100 times of that at the high-level site

Street side conc. / C-7 (background) conc. (5-min mean)



- 5-min $PM_{2.5}$ at street sites compared to those at background street site
 - Summer: ratio means among different sites were 1.10-1.38 with a 5-min maximum of 44.6
 - Winter: ratio means among different sites were 1.06-1.51 with a 5-min maximum of 19.5

PM_{2.5} Increments from Community Sources

(regression with dummy variables, **adj. R²=0.75**)

Variable	Estimate (ug/m ³)	Std. Error	Pr(> t)
Intercept	12.8	0.333	<2e-16
H_PM _{2.5} (high-level)	1.22	0.003	<2e-16
Wind Speed	0.13	0.073	0.0757
temperature	-0.41	0.006	<2e-16
RH	-0.09	0.003	<2e-16
School	1.83	0.132	<2e-16
Vehicle (wide street)	1.72	0.119	<2e-16
Vehicle (narrow street)	3.98	0.135	<2e-16
Store	4.49	0.124	<2e-16
Gas Station	2.12	0.121	<2e-16
Temple	2.67	0.111	<2e-16
Vendor (Fried Chicken)	1.64	0.175	<2e-16

Take Home Messages

- Our results showed the **applicability of AS-LUNG (O)** in the field and **significant contribution from community PM_{2.5} sources**
- **Potential applications** of low-cost PM sensors:
 - For residents to take actions to **prevent exposure and health risks**
 - For government agencies to **formulate control strategies** to reduce personal exposure levels