Climate and Atmosphere Research & Innovation in the Eastern Mediterranean & Middle East Virtual Workshop

Performance Evaluation of Air Quality Low-Cost Sensors

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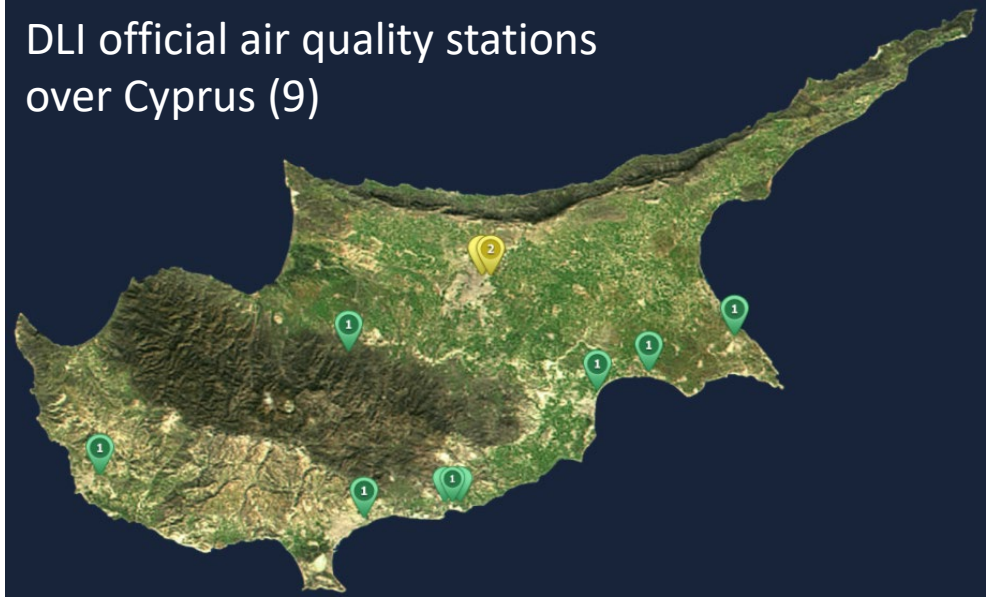
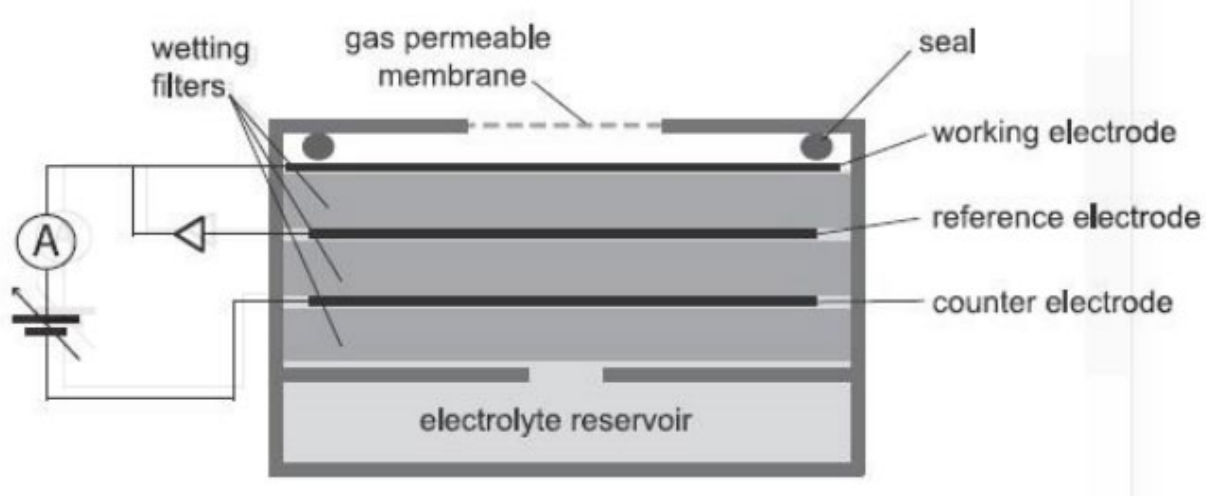
Motivation



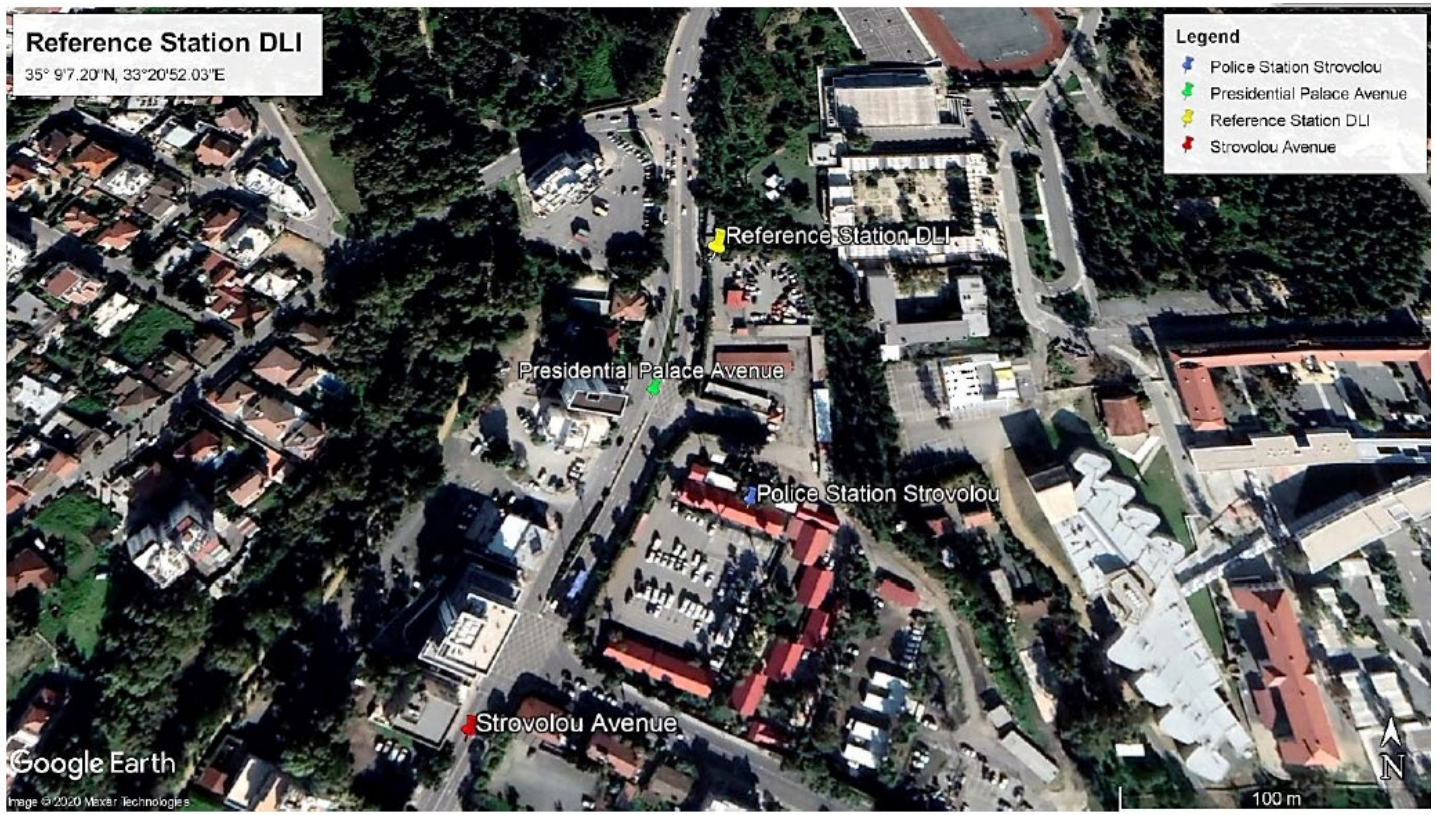
- High cost of scientific instrumentation
- Regular maintenance and calibration
- Low spatiotemporal resolution of air-quality (AQ) observations
- Need for monitoring AQ due to the increase in pollution and awareness of the harmful effects on health
- Need for inexpensive and compact methods

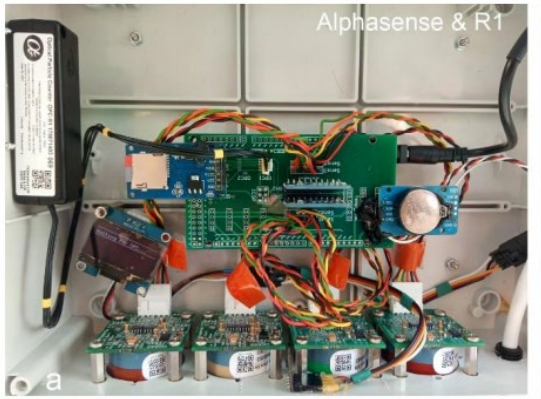
Electrochemical sensors

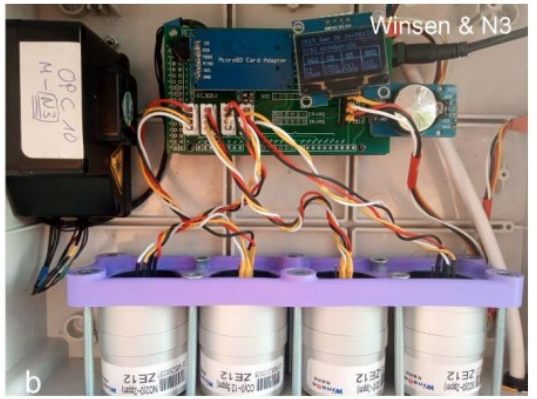


- Three-electrode configuration:
  - Working electrode,
  - Counter electrode and
  - Reference electrode
- Based on the redox reaction of the diffused air molecules with the electrolyte within a cell
- Electric current generated is proportional to the concentration of the target gas diffused in the sensor

Location – Configuration of the low-cost AQMS

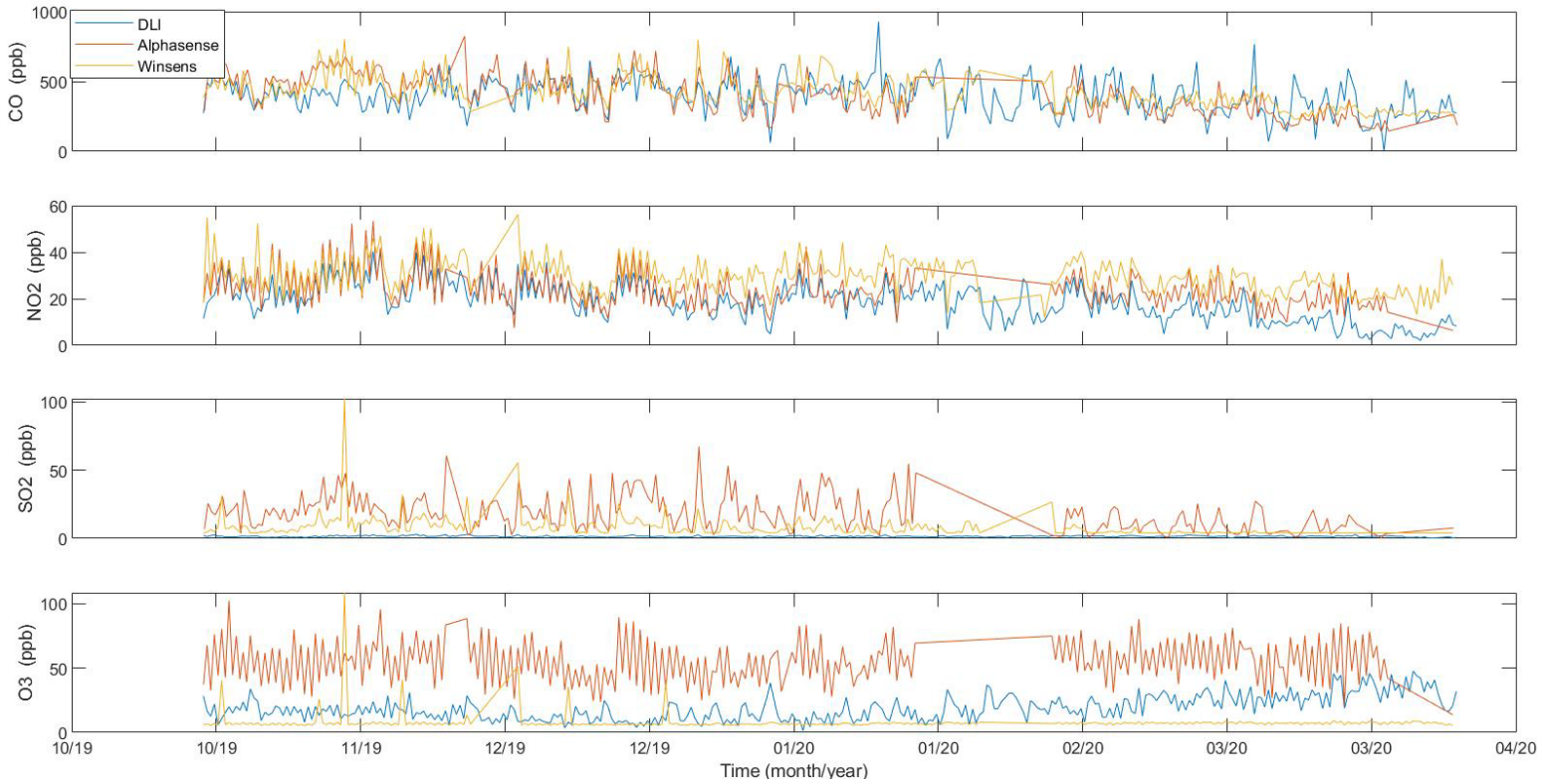






Use of Alphasense and Winsen commercial gas sensors for almost **2-year data collection** of:

- Air pollutants (CO, NO_2, SO_2 and O_3)



	Alphasense		Winsens	
	R^2	Efficiency(%)	R^2	Efficiency(%)
CO	0.43	10.4	0.54	73.1
NO_2	0.53	-64.5	0.55	-119.0
SO_2	0.35	-914.8	0.19	-448.3
O_3	0.21	-926.8	0.09	-7.2

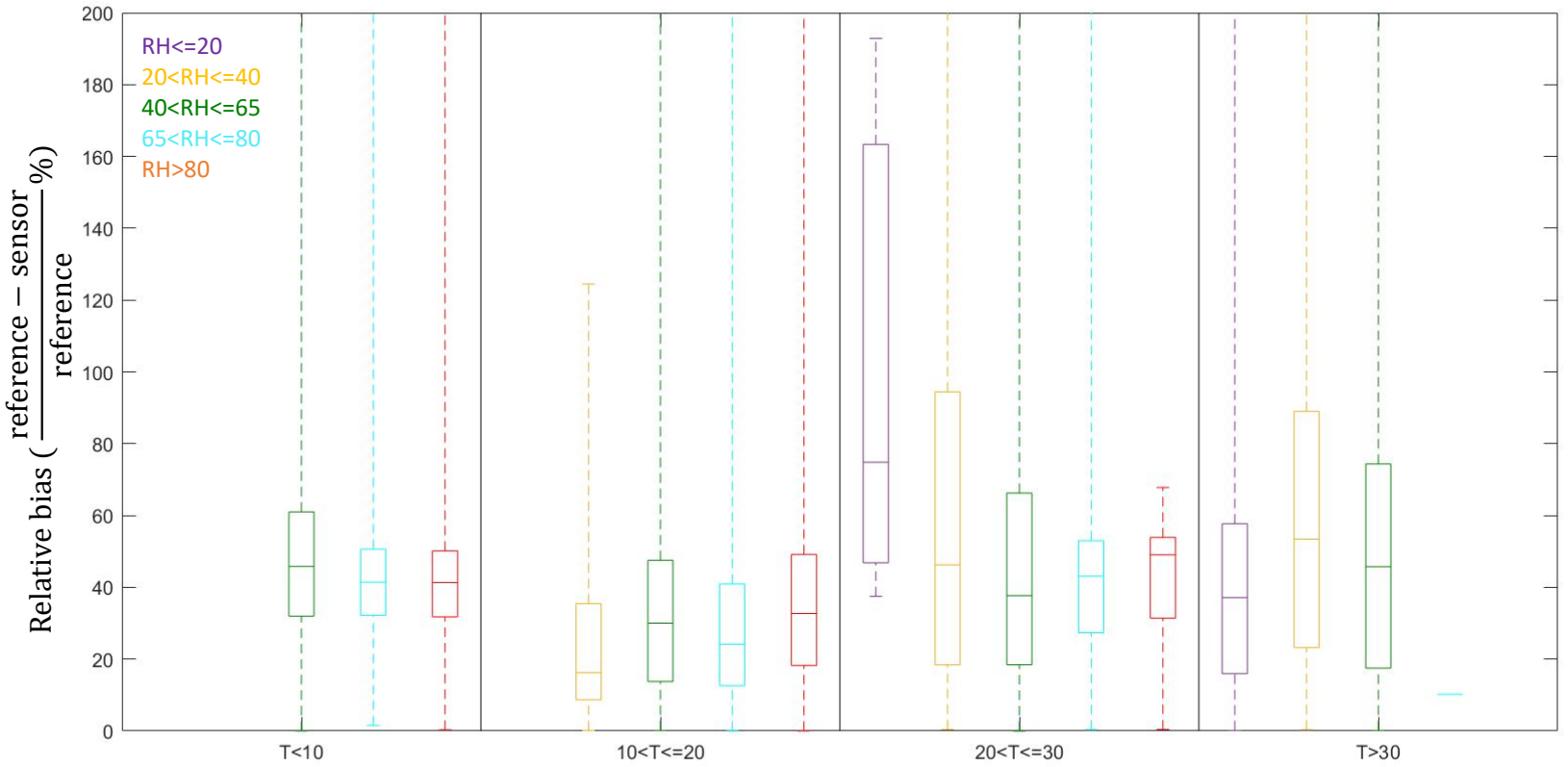
Seasonality Evaluation

Warm periods: 01/09 – 31/10

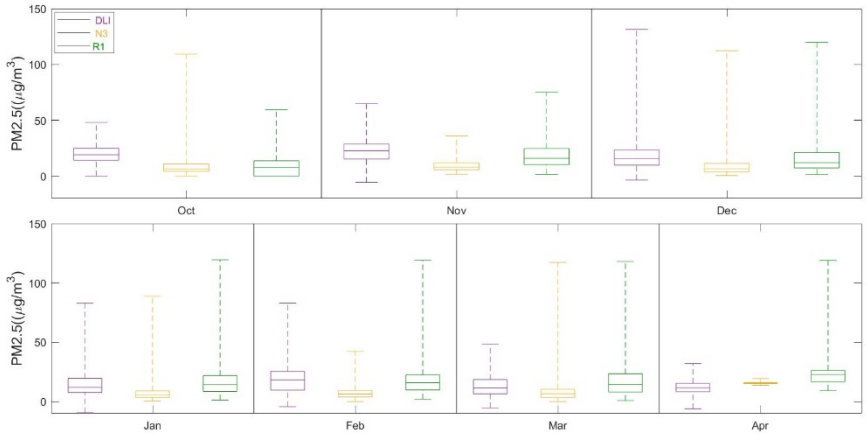
Cold periods: 01/12 – 31/12

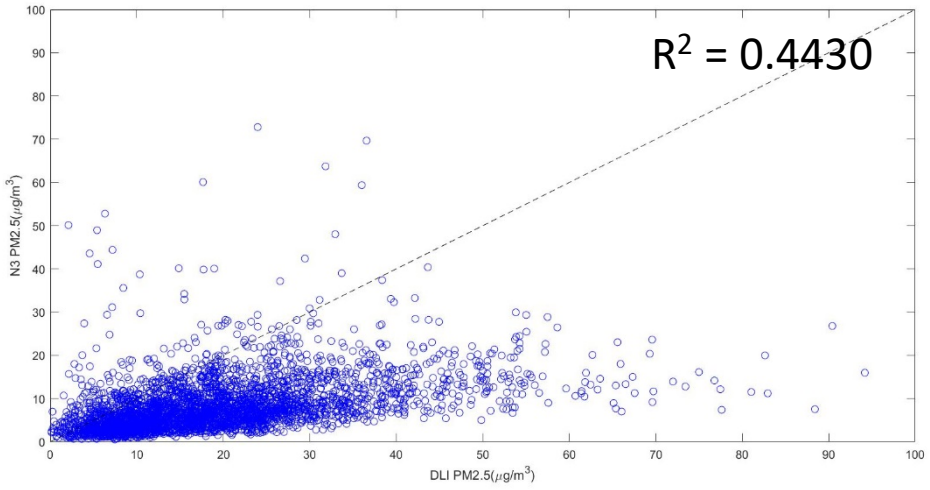
	Alphasense CO	Mean concentration (ppb)	Mean relative bias (%) (sensor-reference)/(reference)%	R^2
Warm 2019	DLI	375.92		
	Alphasense	465.95	38.07	0.58
Cold 2019	DLI	432.44		
	Alphasense	442.82	12.80	0.53
Warm 2020	DLI	330.50		
	Alphasense	379.93	18.32	0.45
Cold 2020	DLI	420.72		
	Alphasense	450.15	9.94	0.51

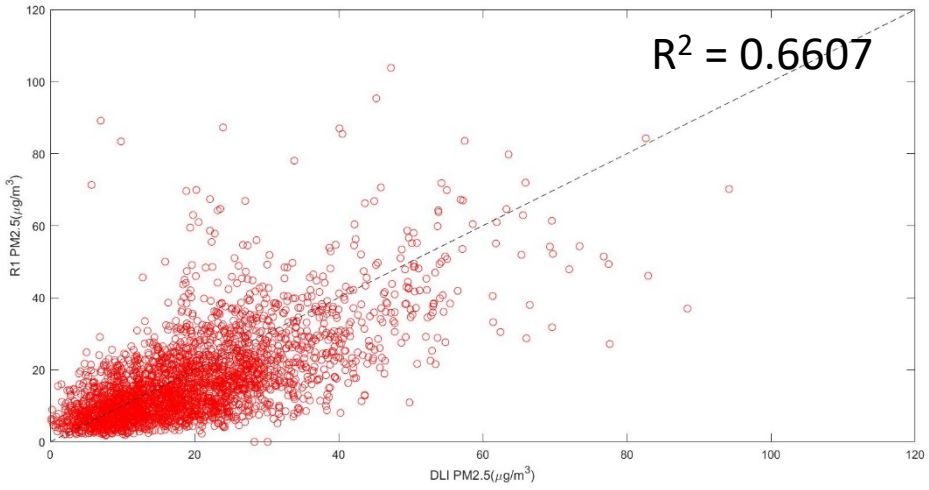
Impact of RH on sensor response



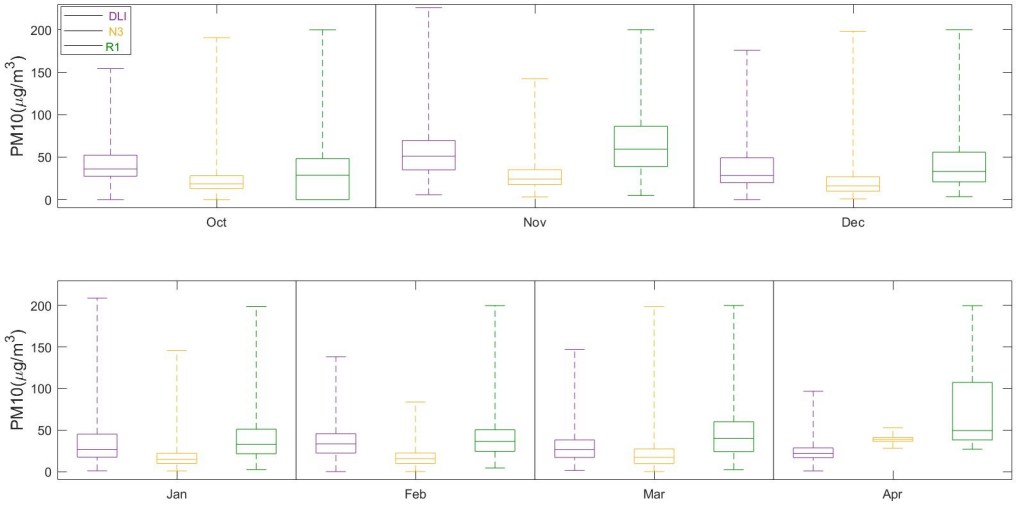
Alphasense OPCs – PM2.5

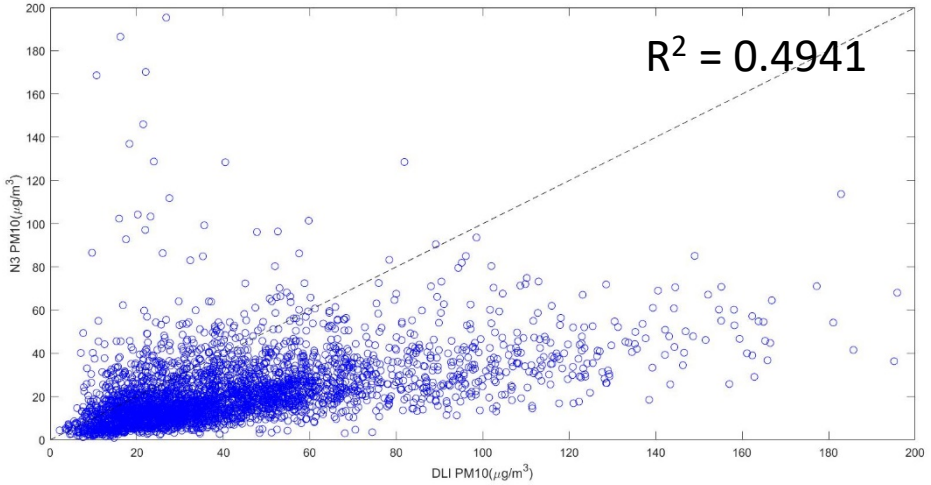


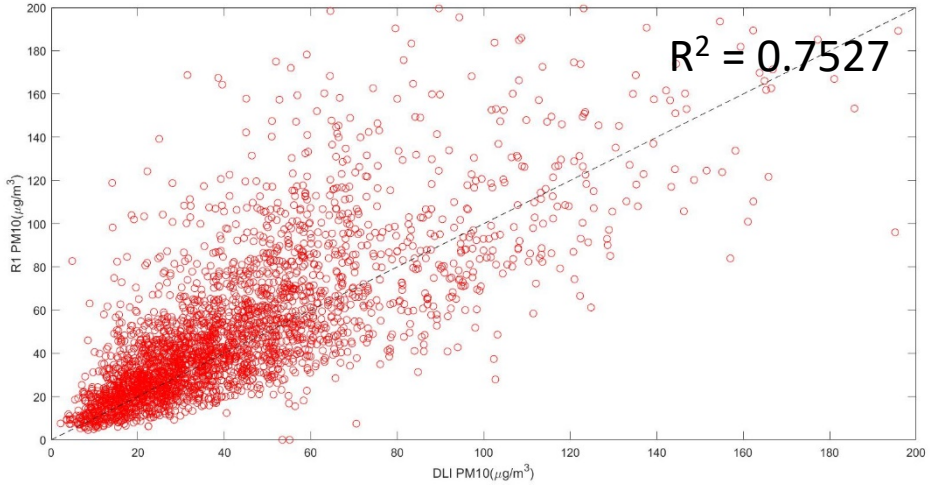




Alphasense OPCs – PM10







Conclusions

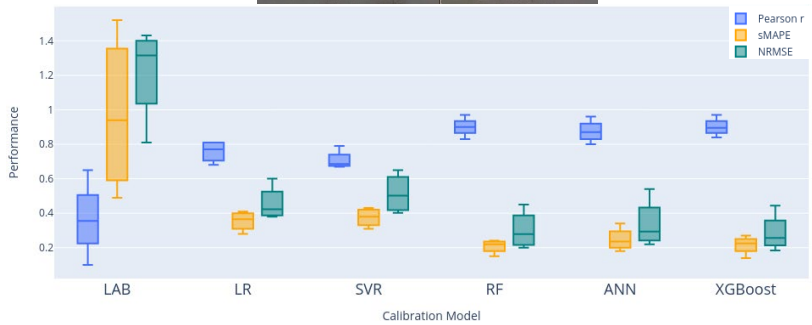
LCS:

- Provide better spatial resolution of AQ
- Can capture variability of the AQ, however not under all conditions and with lower accuracy than the reference instruments
- Discrepancies between the LCS AQ sensors and the reference instruments due to the effect of the meteorological conditions (i.e. temperature)
- High potential to be used for air quality networks by further post-processing through algorithms or calibration models
- R1 OPC resembles the reference data well in terms of mass concentration
- N3 underestimates both PM2.5 and PM10

Future work

Examine:

- Response / recovery time of sensors in the lab using reference gases
- Dependence on temperature / RH (environmental chamber)
- Performance evaluation of sensors during UAV flights
- Improvement using hybrid calibration algorithms



<u>Vaisala Boost project</u>

Aim: Create a high-resolution air quality network of low-cost sensors in Nicosia, Cyprus

AQT530, WXT530, CL51:

- Particulates: PM10, PM2.5
- Gases: NO2, NO, O3, CO and
- Environmental conditions: temperature, humidity, wind direction
- Cloud height and vertical visibility.

THANK YOU FOR YOUR ATTENTION

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- **The AQ-SERVE Project INTEGRATED/0916/0016 (AQ-SERVE) is co-financed by the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation.**

Thank you