

Field test results of a compact air quality sensor in urban environment

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Jarkko Niemi, Helsinki Region Environmental Services Authority

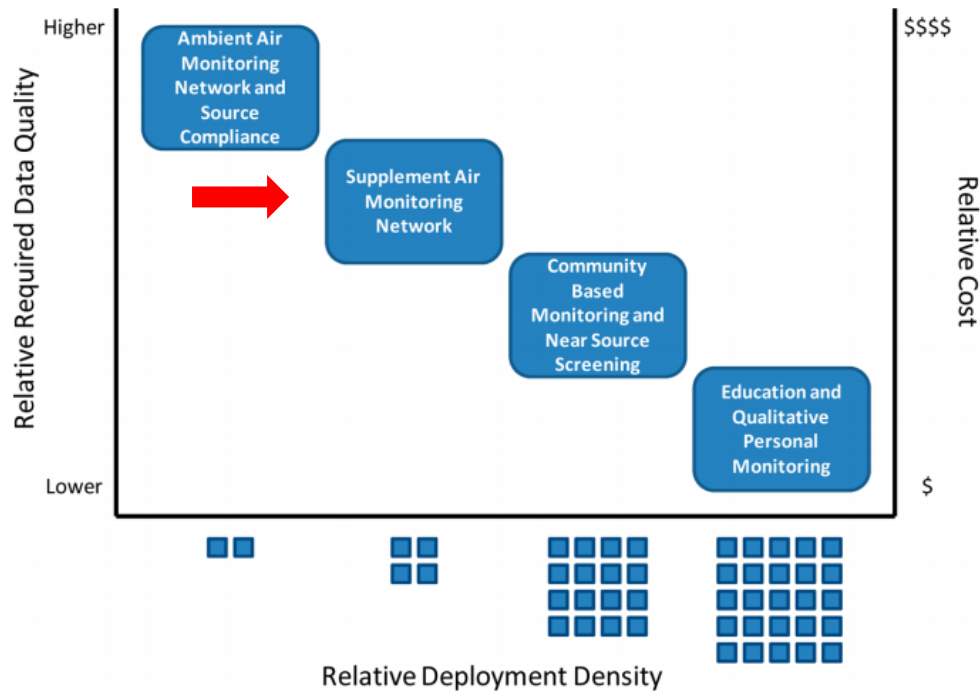
Joel Kuula, Hilikka Timonen, Finnish Meteorological Institute

Riina Hietikko, Topi Rönkkö, Tampere University of Technology

10.10.2017 Atmosfair conference, Lyon, France

VAISALA

Supplementary sensor networks are a new paradigm in air monitoring



Snyder et. al.: "The Changing Paradigm of Air Pollution Monitoring", Env. Science & Technology 47(20), August 2013.

Compact multiparameter air quality transmitters



Vaisala AQT420
4 gases + PM2.5/10

NO₂, CO, SO₂, O₃



Vaisala AQT410
4 gases

NO₂, CO, SO₂, O₃

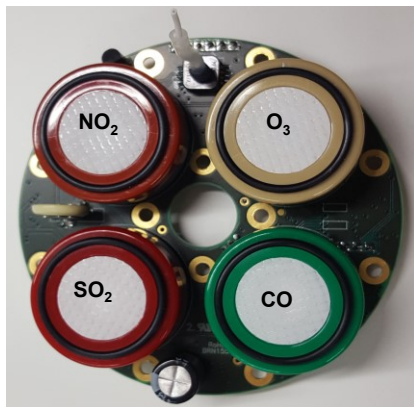
Summary

Name	$R^2 \text{ NO}_2$	$R^2 \text{ CO}$	$R^2 \text{ O}_3$	$R^2 \text{ PM}_{10}$
AQT1	0.82	0.70	0.71	0.48
AQT2	0.79	0.78	0.73	0.48
AQT3	0.87	0.64	0.78	0.49
AQT4	0.87	0.57	0.78	0.48
AQT5	0.84	0.79	0.72	0.50

Measurement technologies

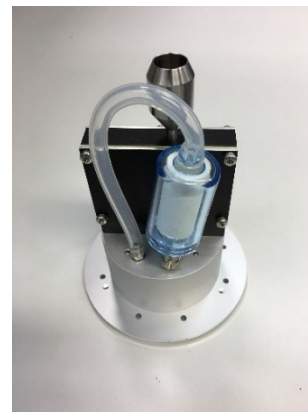
Gas measurement with EC cells

- %RH, T compensation
- aging compensation



PM measurement by laser scattering

- 90° scattering from a laser beam
- 16 size bins summed up
- humidity compensation



Test site and reference analyzers



Helsinki Region Environmental Services Authority
Urban traffic supersite, 28 000 vehicles/day

Analyzers relevant for this study

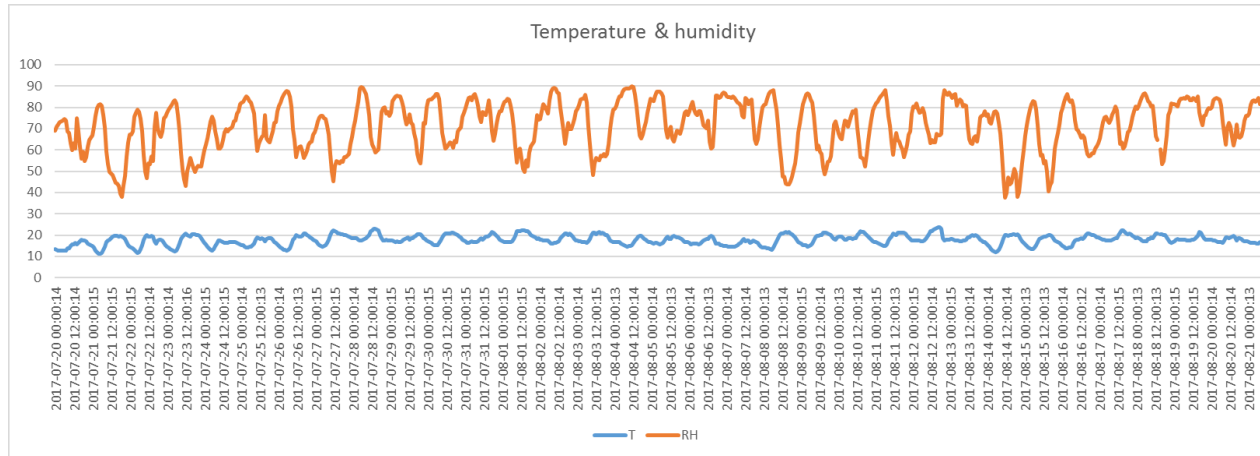
NO ₂	Horiba APNA-370
CO	Horiba APMA-360
O ₃	Thermo 49i
PM _{2.5/10}	TEOM 1405

PM sizing:	Aerodynamic Particle Sizer (APS)
	Differential Mobility Particle Sizer (DMPS)



Test period

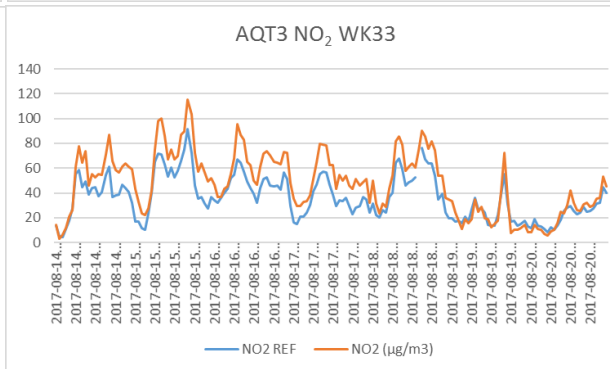
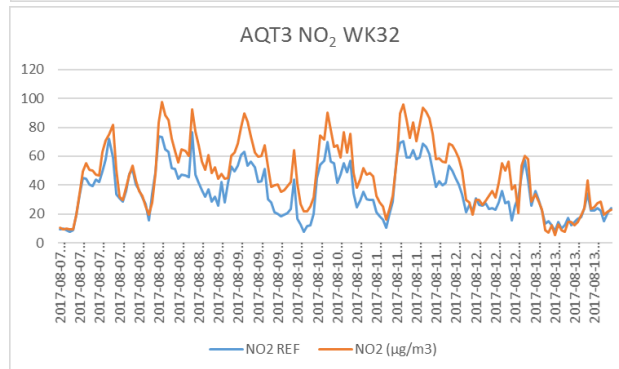
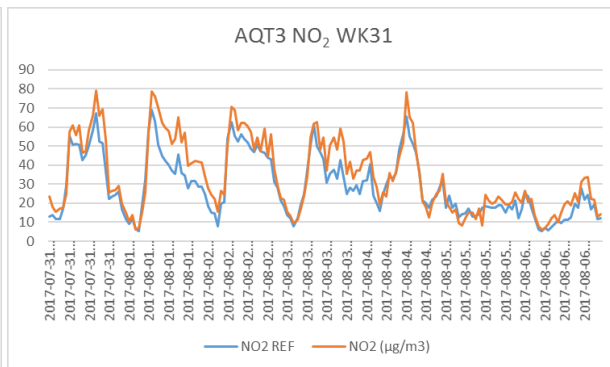
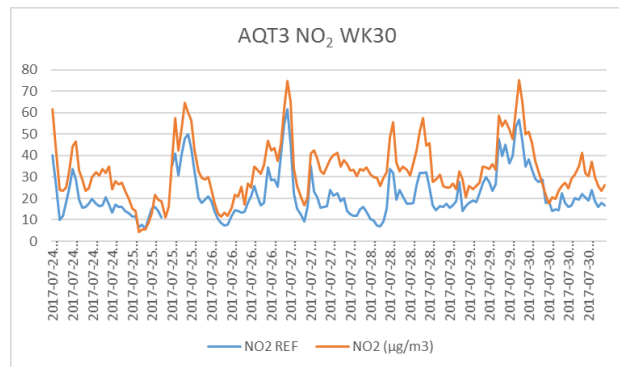
- 5 similar AQT420 instruments co-located with reference analyzers
- 7.4. – 31.8.1017 – Nordic spring / summer period
- moderate variations in temperature & humidity:



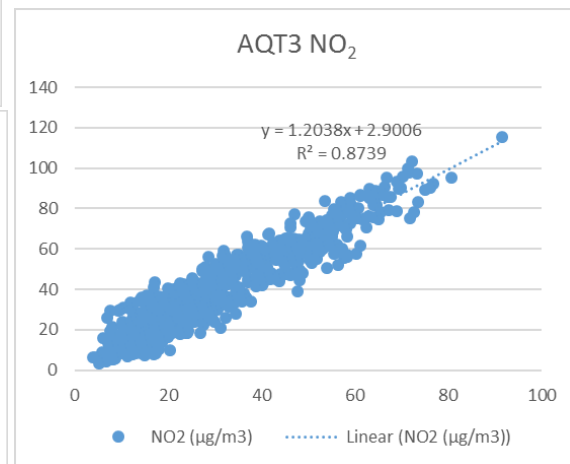
Gas measurement results

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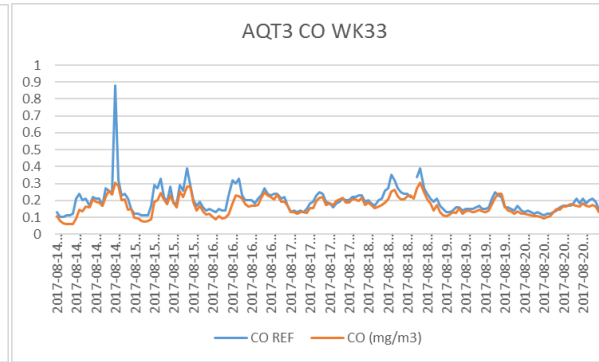
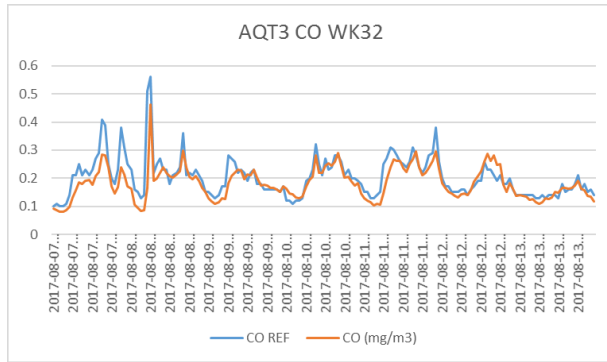
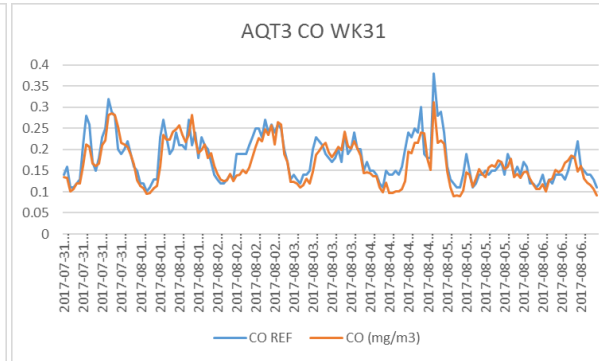
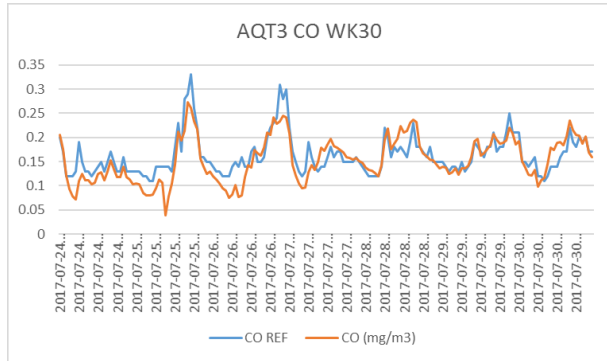
NO₂ response 5 weeks



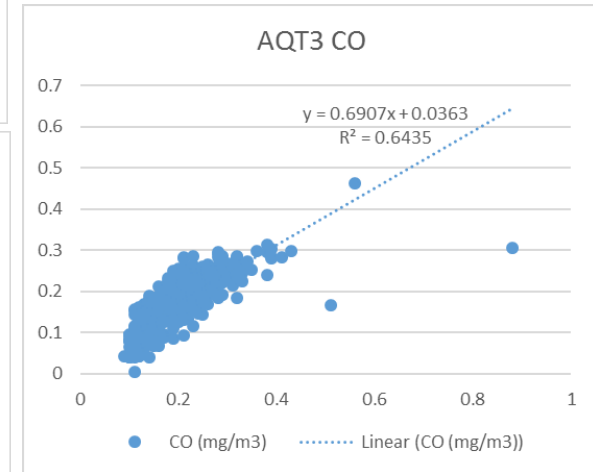
Hourly data
01.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m³



CO response 5 weeks

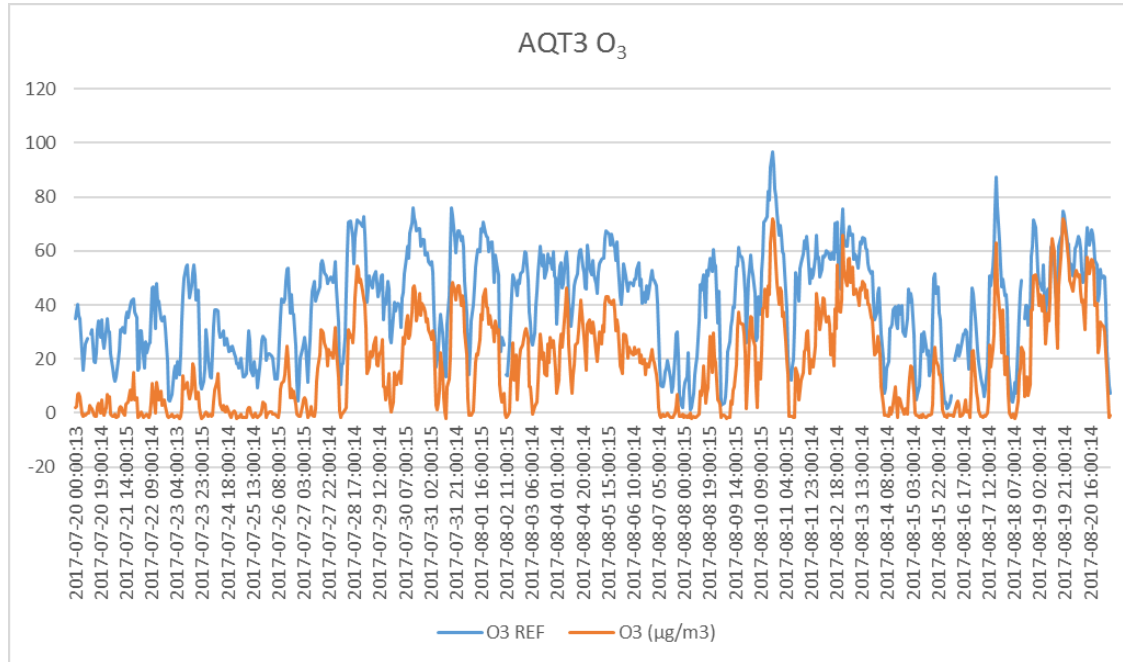


Hourly data
01.07. – 20.08.2017
Mäkeläncatu traffic site
Unit: mg/m³

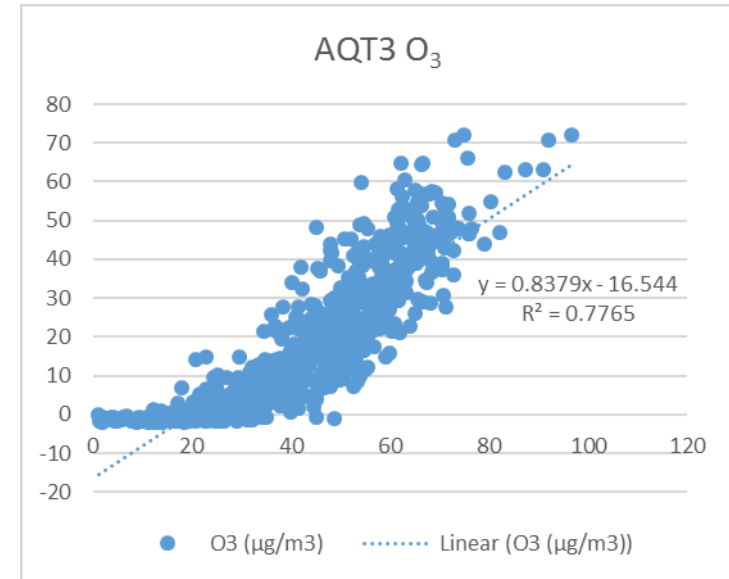


Note: low concentrations, little variation

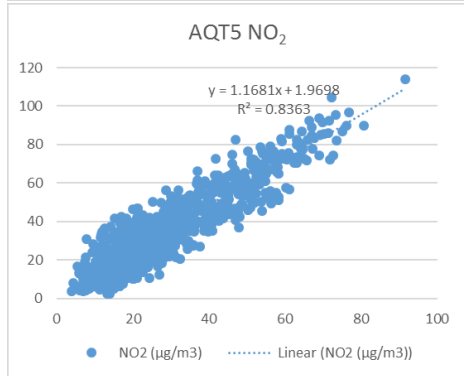
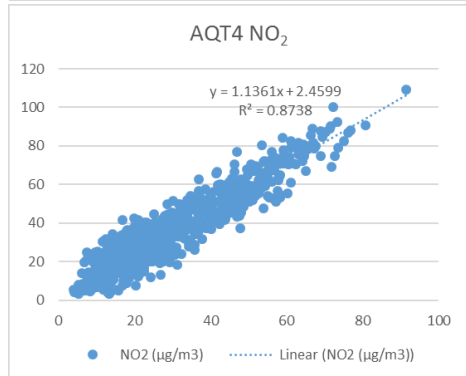
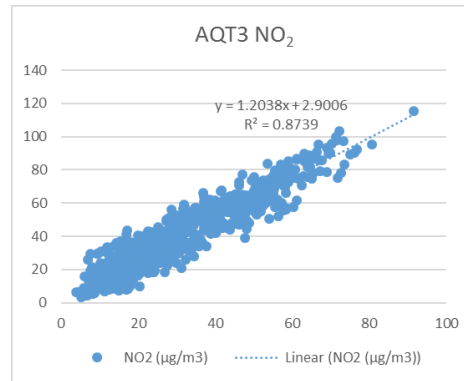
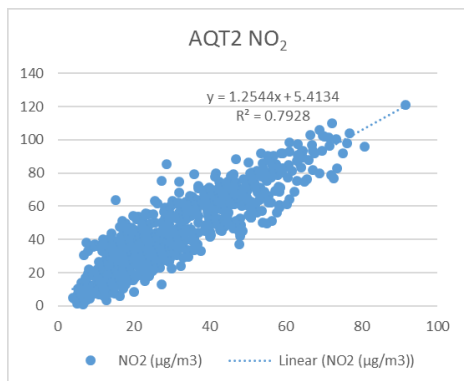
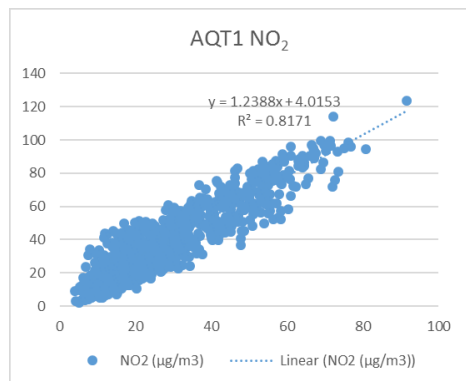
O₃ response 5 weeks



Hourly data
01.07. – 20.08.2017
Mäkeläncatu traffic site
Unit: µg/m³

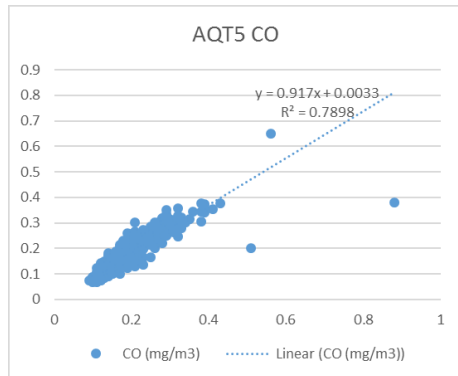
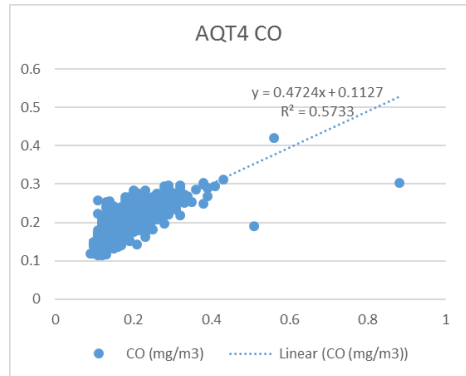
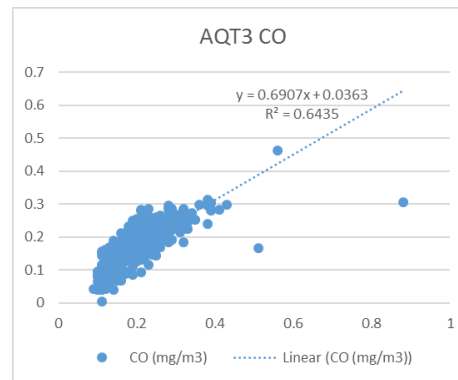
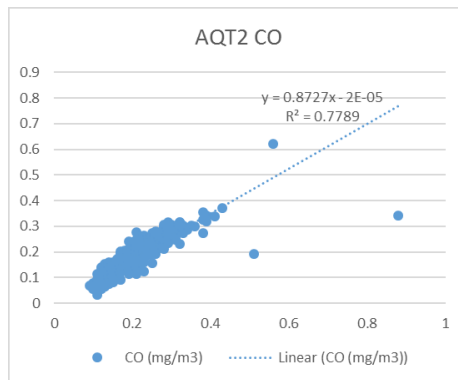
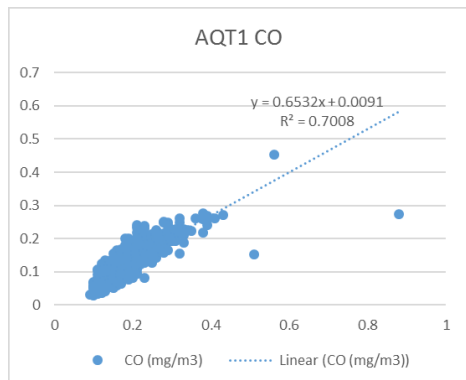


NO₂ correlations; R² = 0.79-0.87



Hourly data
01.07. – 20.08.2017
Mäkeläncatu traffic site
Unit: µg/m³

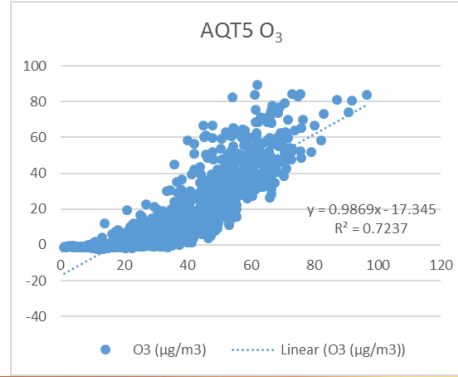
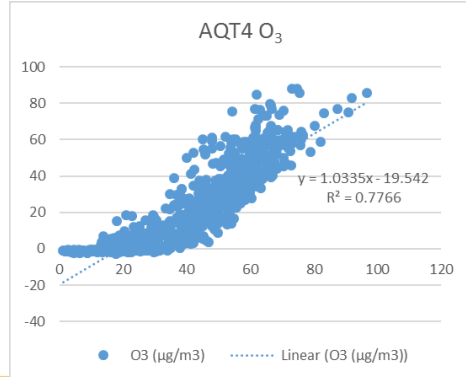
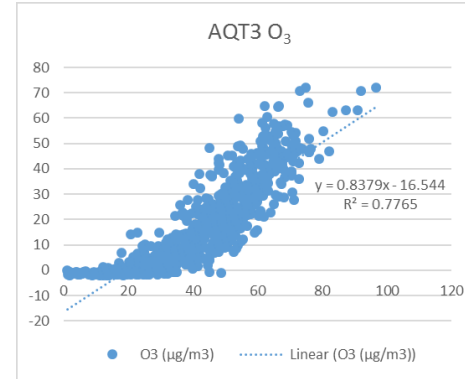
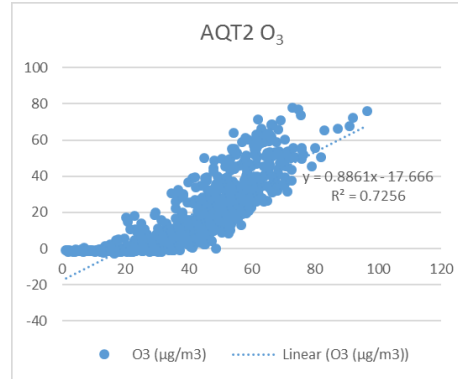
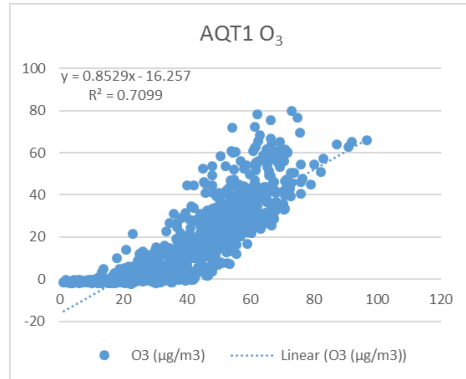
CO correlations / $R^2 = 0.57-0.78$



Hourly data
01.07. – 20.08.2017
Mäkeläncatu traffic site
Unit: mg/m^3

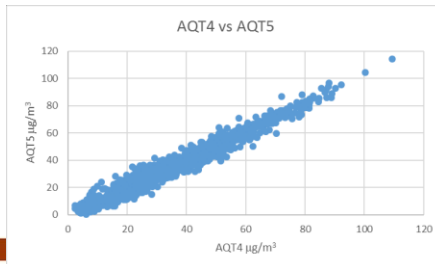
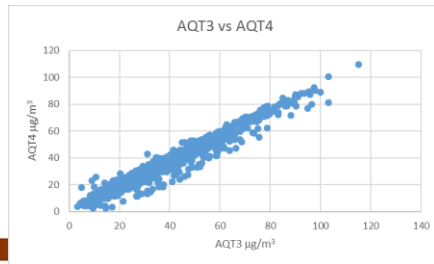
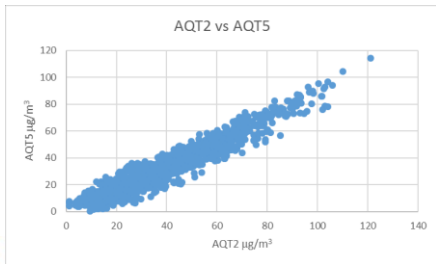
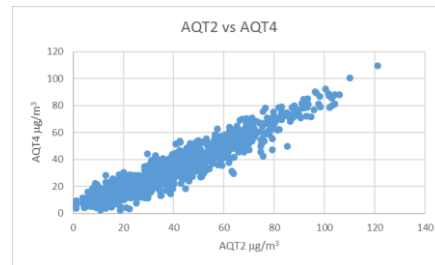
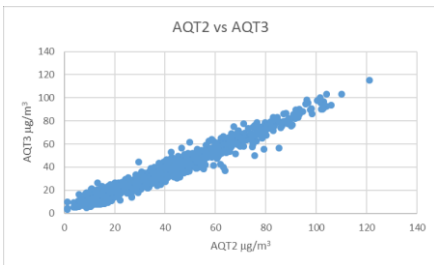
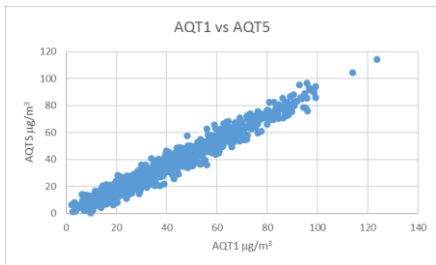
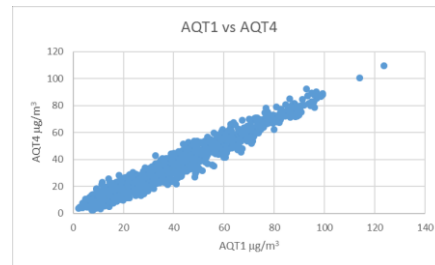
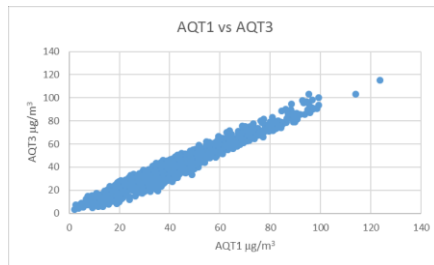
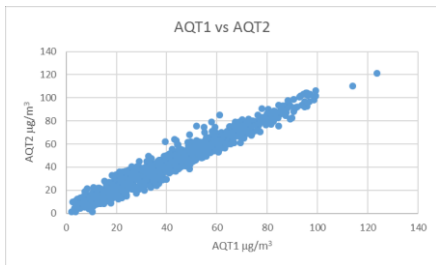
Note: low concentrations, little variation

O₃ correlations; R² = 0.71-0.78



Hourly data
01.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m³

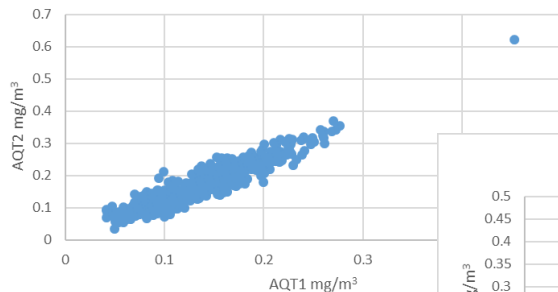
NO₂ consistency between units is $\pm 10 \mu\text{g}/\text{m}^3$ or 5 ppb



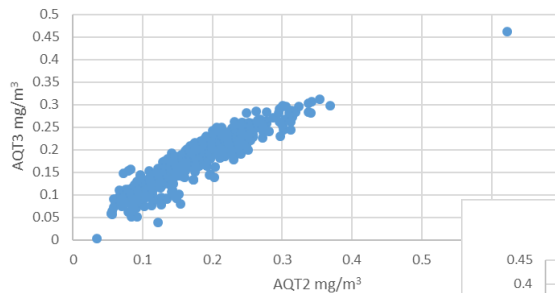
Hourly data
01.07. – 20.08.2017
Mäkeläncatu traffic site
Unit: $\mu\text{g}/\text{m}^3$

CO consistency between units is $\pm 0.05 \text{ mg/m}^3$ or 0.04 ppm

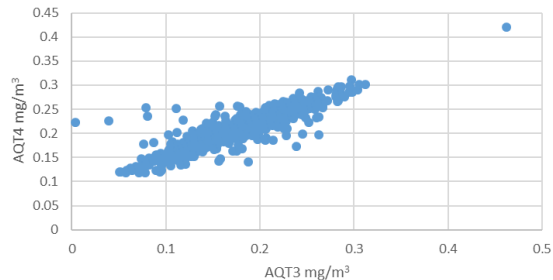
AQT1 vs AQT2



AQT2 vs AQT3



AQT3 vs AQT4



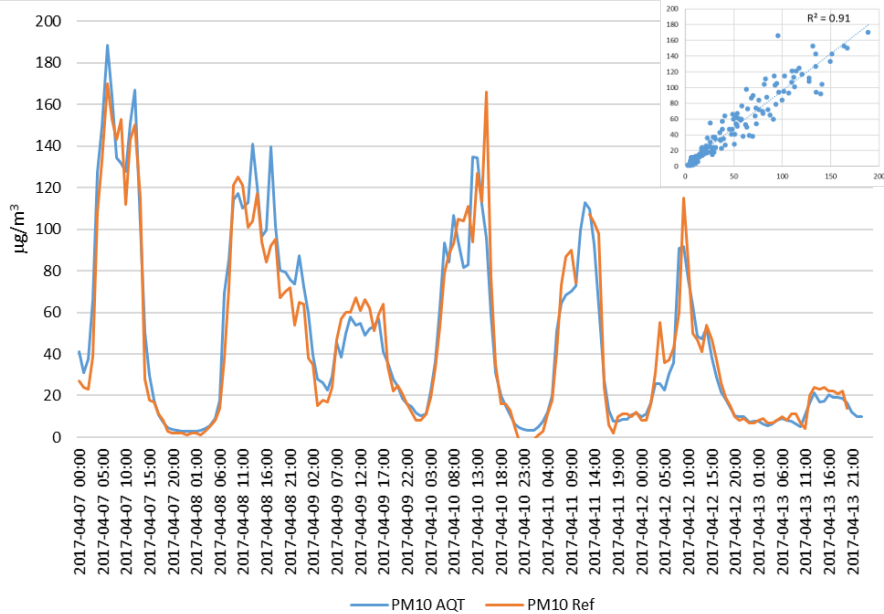
Hourly data
01.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: mg/m^3

Note: very small variation of CO level makes correlation analysis difficult

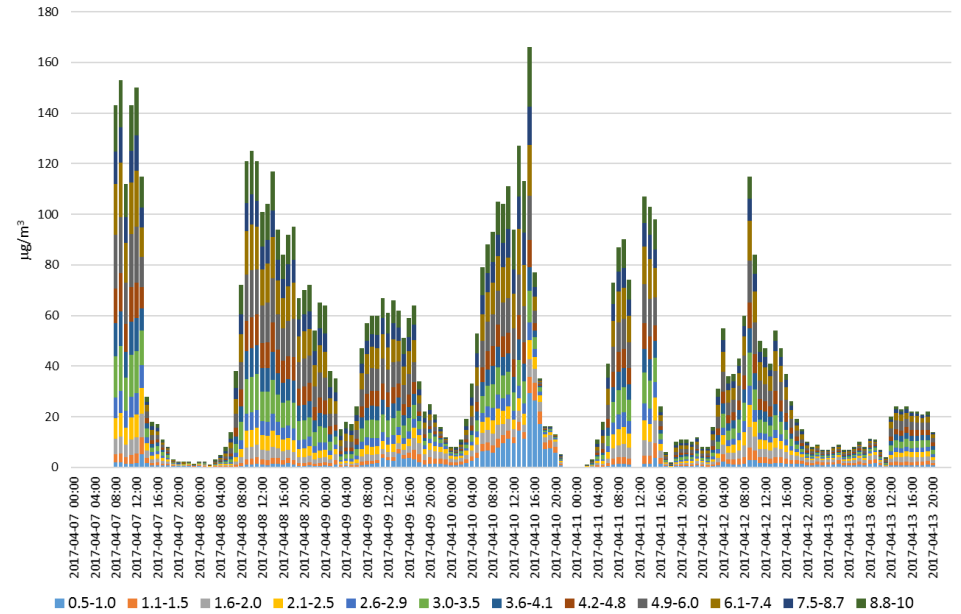
Particle measurement results

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Excellent PM10 response in a traffic dust event 7.-13.4.2017

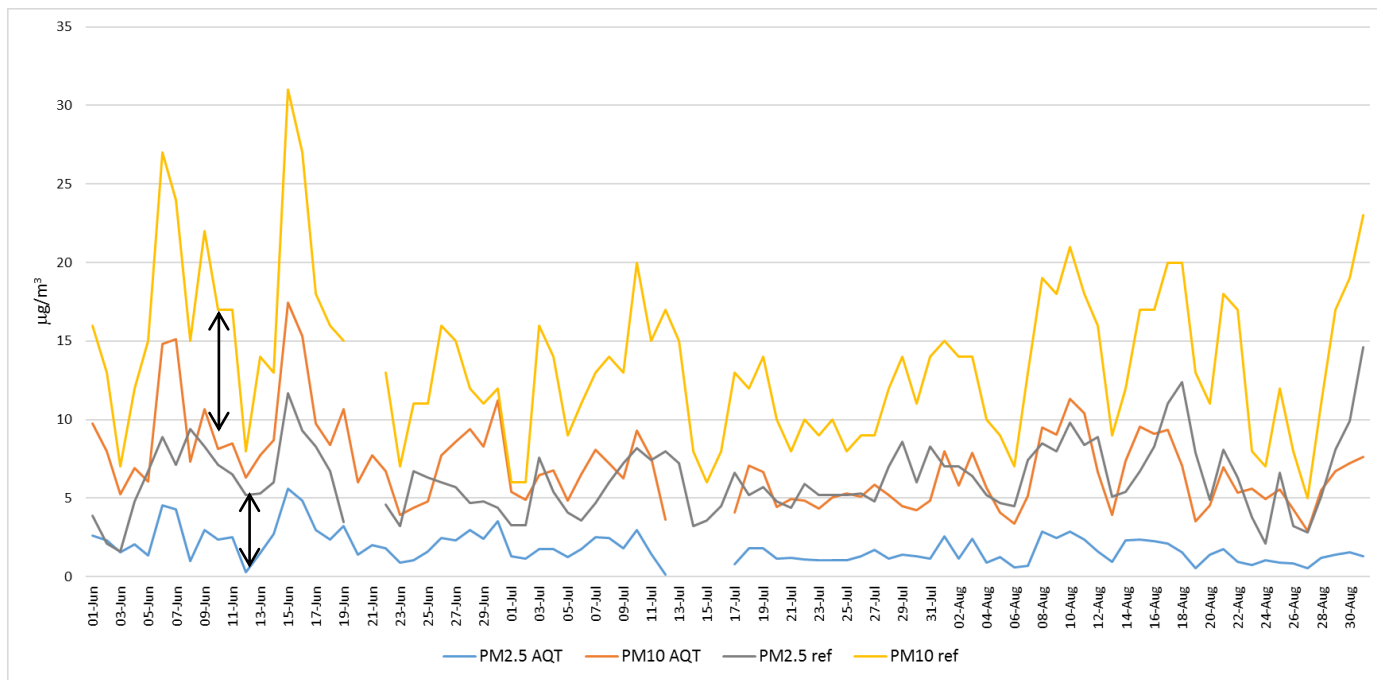


Time series with reference
1 week – hourly data



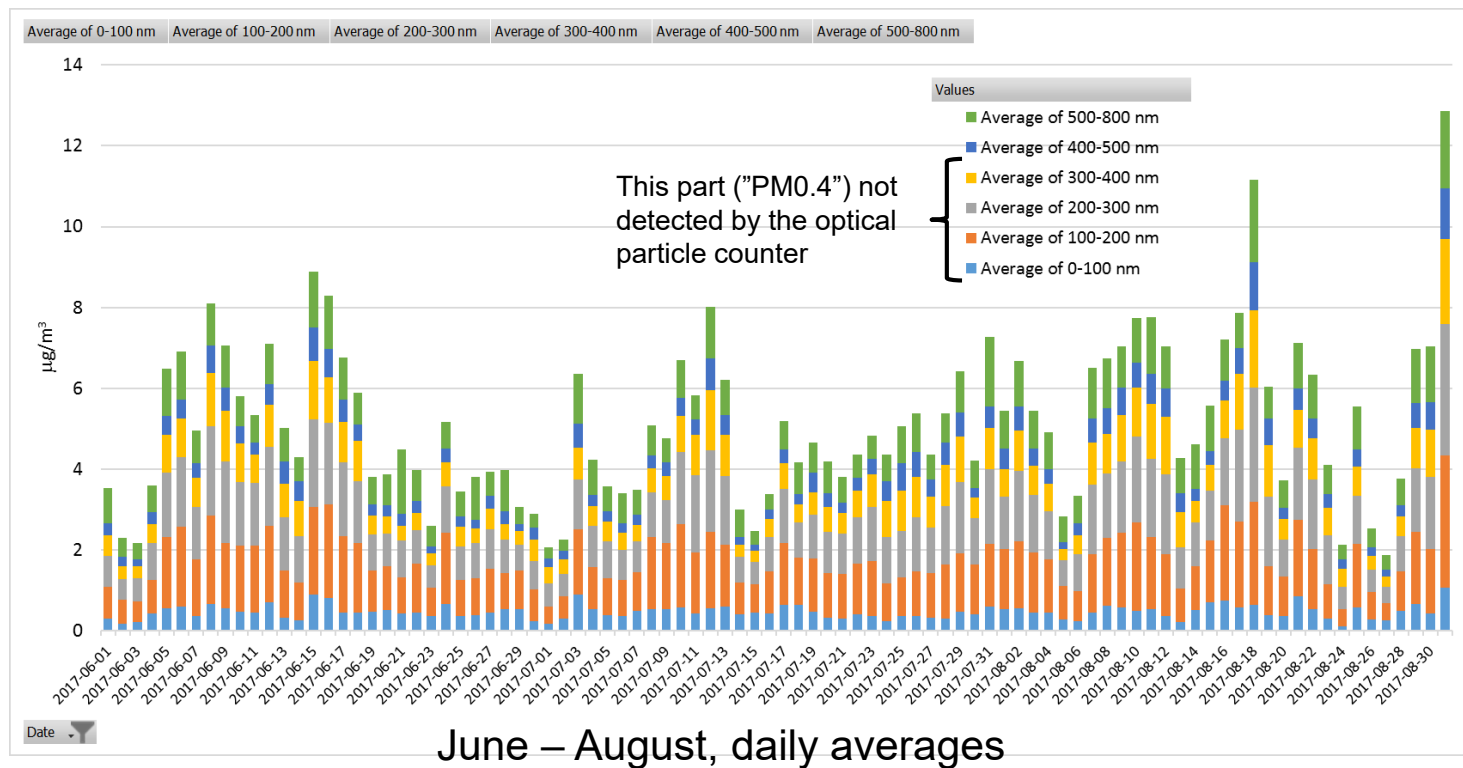
Particle size distribution from APS

PM data over summer shows deviations from reference

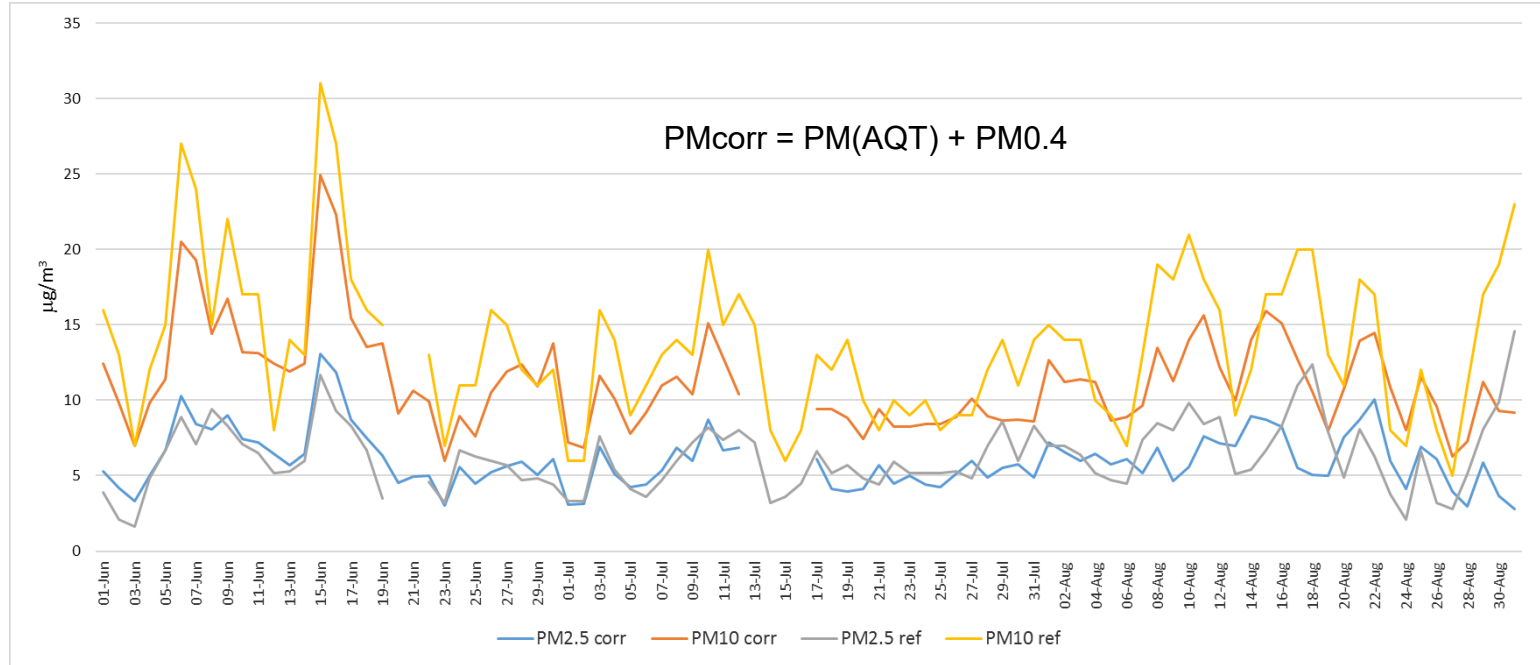


June – August, daily averages

DMPS data yields particle mass below 0.4 μm diameter



Missing PM0.4 accounts for the deviation from reference

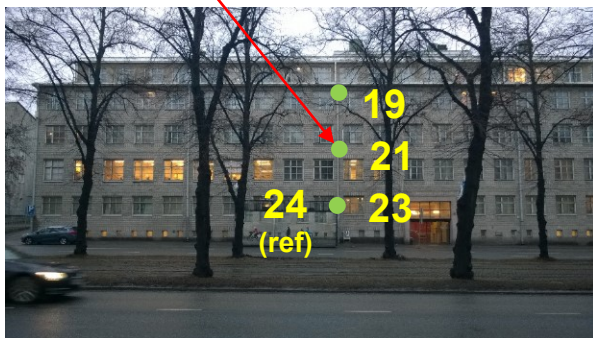


June – August, daily averages

Conclusions

- A state-of-the art performance for a compact air quality instrument has been verified in a co-location test
- Based on the performance, the instruments may find use in
 - Urban applications for traffic and street dust monitoring
 - Monitoring of CO from combustion sources
 - Dust monitoring in arid regions
 - Research projects where easy deployment is essential
- Evaluation for long term

NO₂-keskiarvot AQT 420 sensoreista 1.-27.9.2017



Sensorien sijoituspaikat
osoitettu vihreillä palloilla