New Tools for Air Quality Modelling and Forecasting: Compact Sensors Combined with a Data Fusion Model with Forecasting Capabilities

Mikko Laakso, Vaisala Oyj

Lasse Johansson, Ari Karppinen, (Finnish Meteorological Institute)

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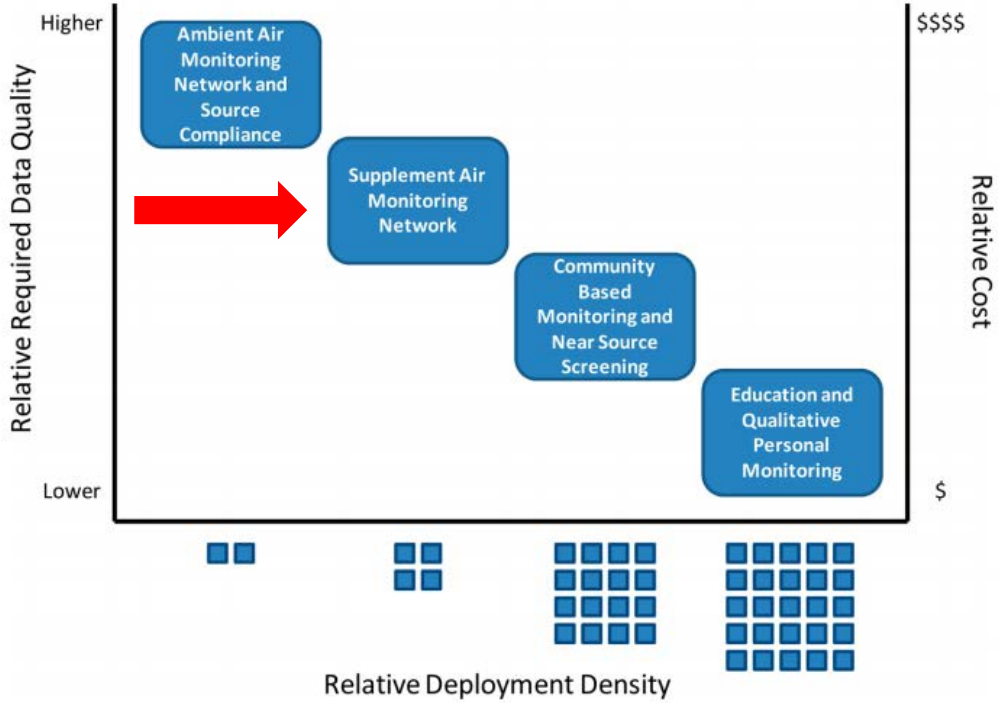
FINNISH METEOROLOGICAL INSTITUTE

The new paradigm of air monitoring



The rise of low-cost sensing for managing air pollution in cities

Prashant Kumar[1, 2, *], Lidia Morawska[3], Claudio Martani[4], George Biskos[5, 6, 7], Marina Neophytou[8], Silvana Di Sabatino[9], Margaret Bell[10], Leslie Norford[11], Rex Britter[12]

[1] *Department of Civil and Environmental Engineering, Faculty of Engineering and Physical Sciences (FEPS), University of Surrey Guildford GU2 7XH, Surrey, United Kingdom*

Environmental Science & Technology

Feature

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The Changing Paradigm of Air Pollution Monitoring

Emily G. Snyder,*[,†] Timothy H. Watkins,[†] Paul A. Solomon,[‡] Eben D. Thoma,[†] Ronald W. Williams,[†] Gayle S. W. Hagler,[†] David Shelow,[§] David A. Hindin,[∥] Vasu J. Kilaru,[†] and Peter W. Preuss[⊥]

[†]U.S. Environmental Protection Agency, Office of Research and Development, Research Triangle Park, North Carolina, 27711, United States

[‡]U.S. Environmental Protection Agency, Office of Research and Development, Las Vegas, Nevada, 89119, United States

[§]U.S. Environmental Protection Agency, Office of Air and Radiation, Research Triangle Park, North Carolina, 27711, United States

[∥]U.S. Environmental Protection Agency, Office of Enforcement and Compliance Assurance, Washington, District of Columbia, 20460, United States

[⊥]U.S. Environmental Protection Agency, Office of Research and Development, Washington, District of Columbia, 20460, United States

Compact air quality sensors: opportunities and challenges

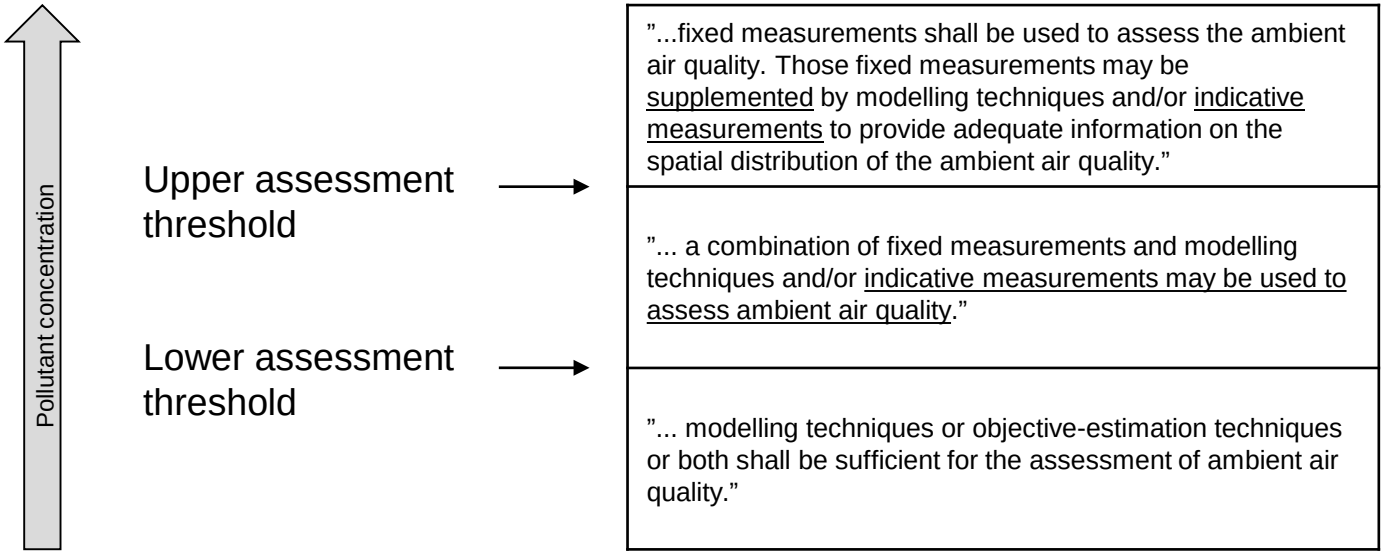
Opportunities

- Monitoring with lower cost and higher spatial density than with conventional methods
- Potential for game changer in
  - Traffic management (low emission zones)
  - Modelling and forecasting
  - Personal exposure, health assessment
  - Hot spot and perimeter monitoring
  - Developing countries

Challenges

- Coping with lower accuracy data than with reference analyzers
- Validation and suitable uses for new types of products and data
- Lagging regulations

EU legislation on indicative measurements



Source: Directive 2008/50/EC on ambient air quality and cleaner air for Europe

Vaisala new air quality transmitters for supplementary air quality networks

AQT410

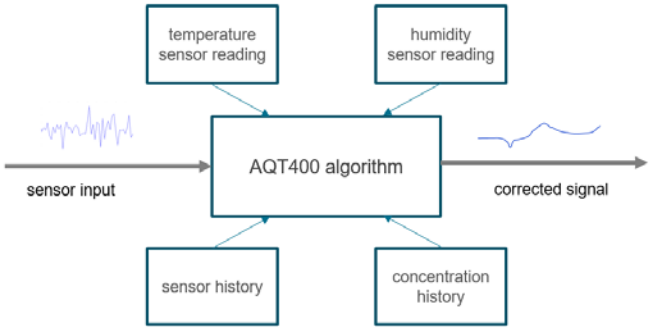
Measures NO_2, SO_2, CO and O_3

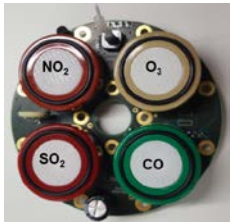
AQT420

Measures NO_2, SO_2, CO and O_3 and also $PM_{2.5}$ and PM_{10} Particulate Matter

Measurement technology

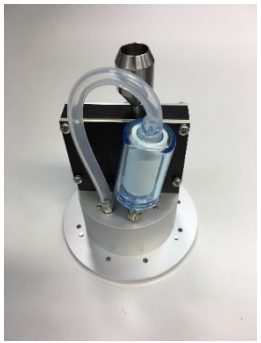
Electrochemical cells using advanced adaptive compensation algorithms

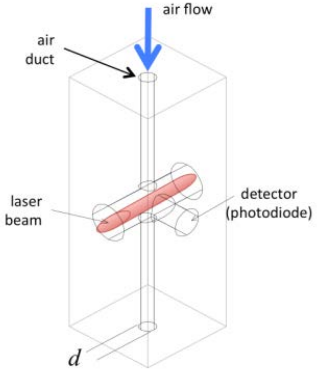




Optical laser particle counter

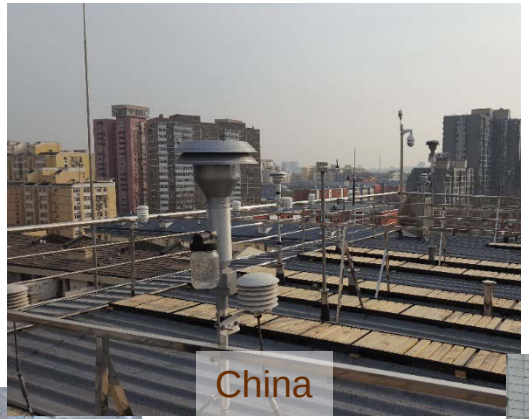
- 90º scattering
- 10 size bins
- $PM_{2.5}$ and PM_{10} µg/m^3



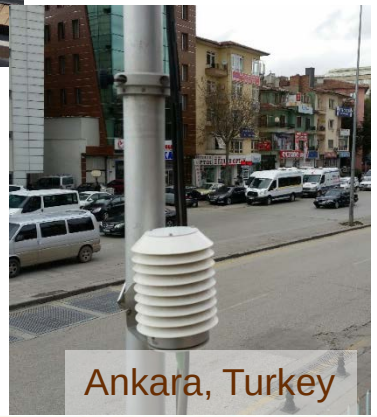


Some co-location test sites


Paris, France


China


Helsinki, Finland


Ankara, Turkey

5 x AQT420, 5 weeks test, Jul-Aug 2017

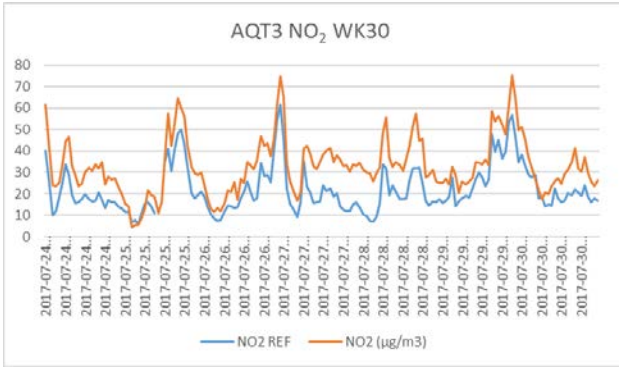
Helsinki Region Environmental

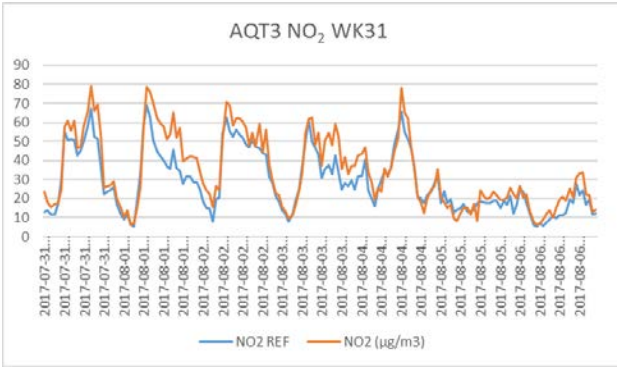
Services Authority

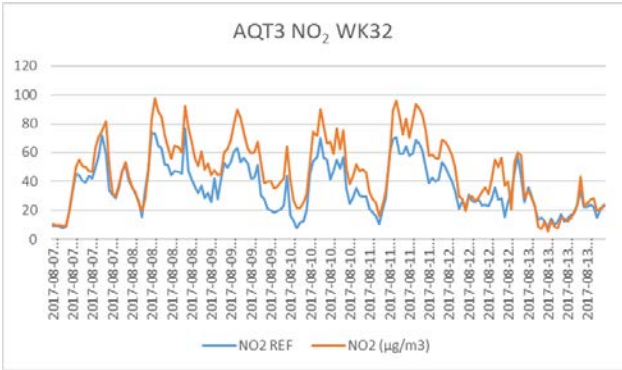
Urban supersite

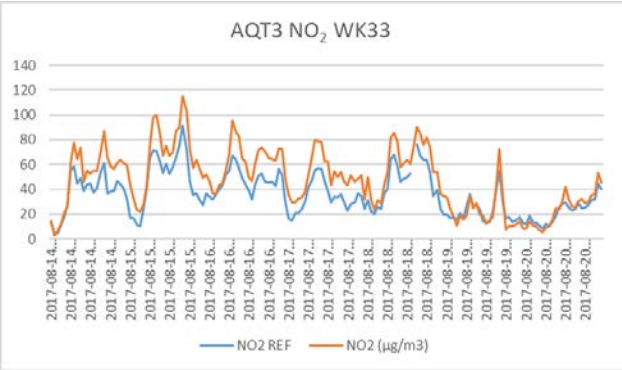
VAISALA

NO_2 response / AQT3

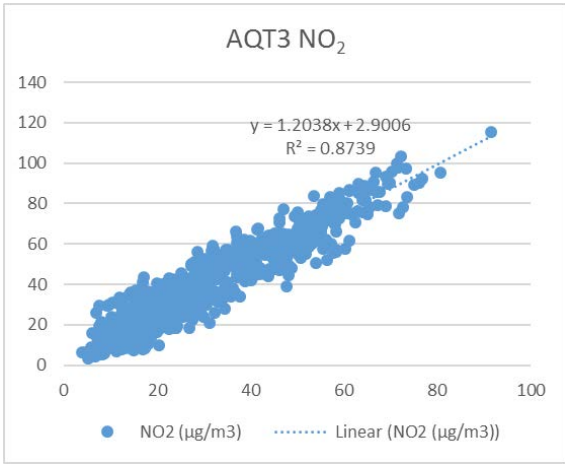




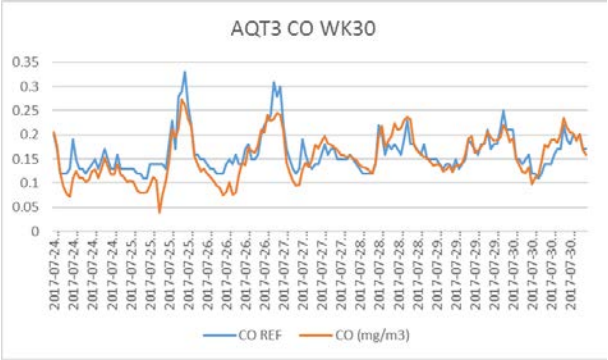


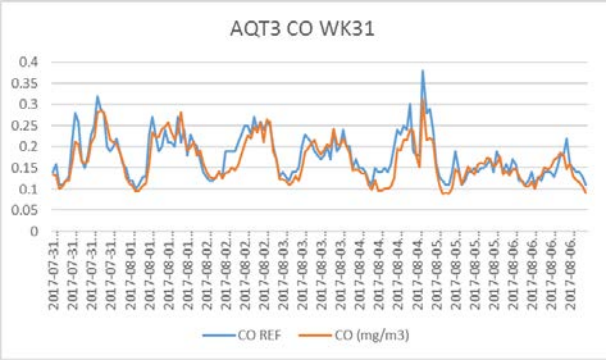


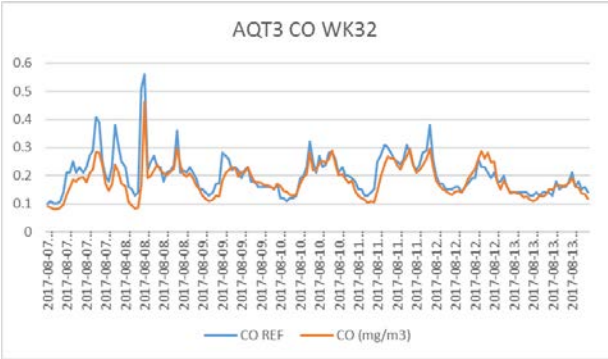
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m³

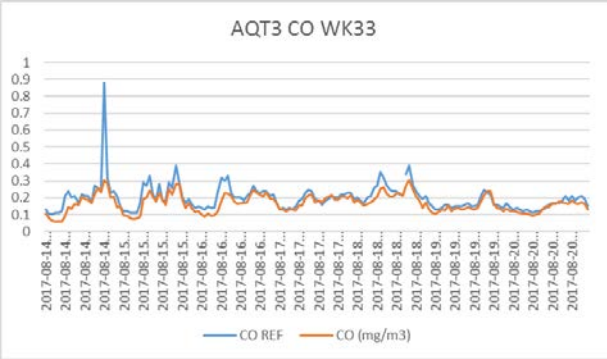


CO response / AQT3

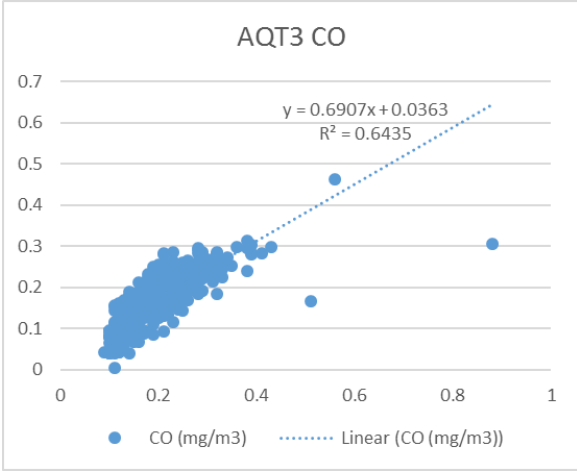








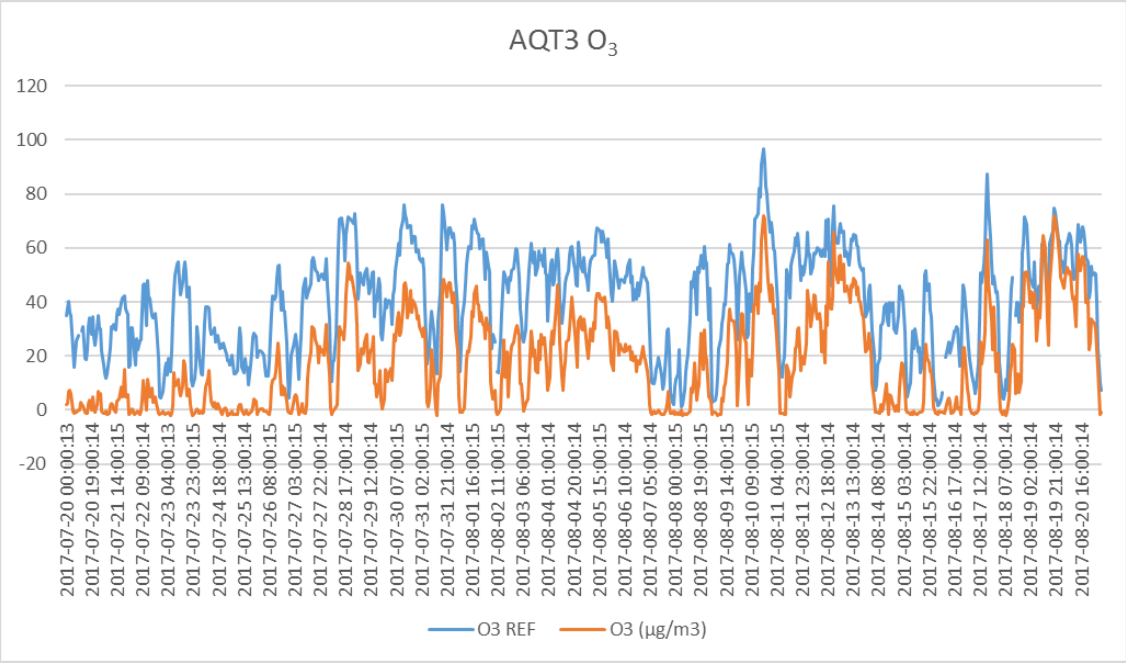
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: mg/m^3

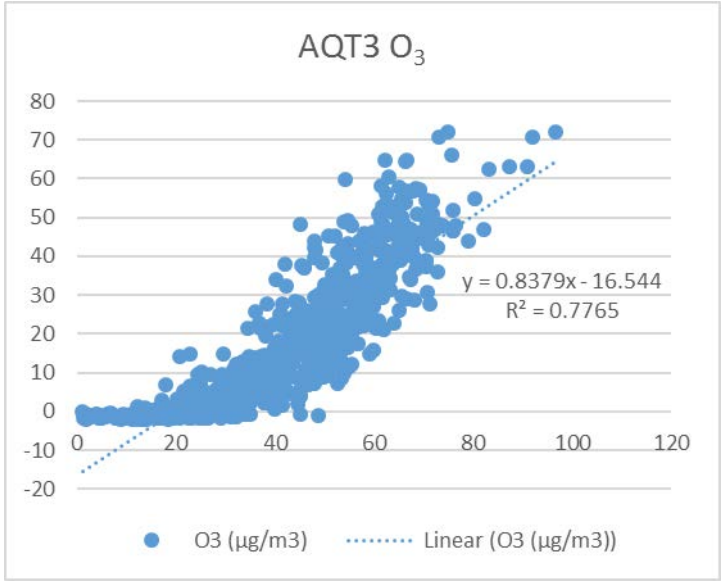


Note: low concentrations, little variation

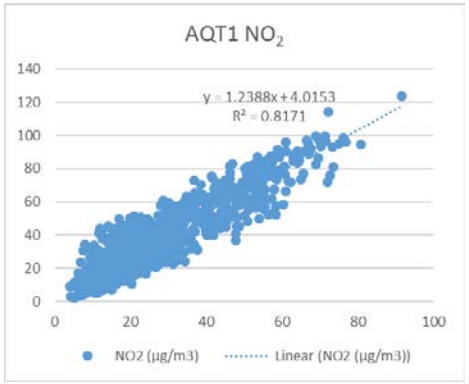
O_3 response / AQT3

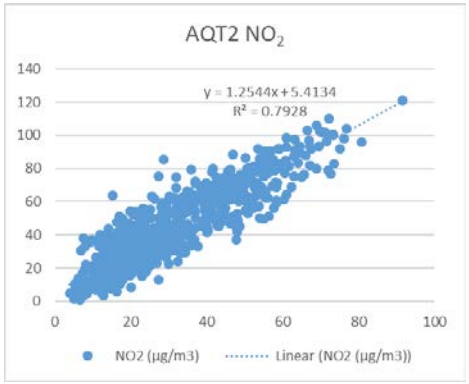
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m^3

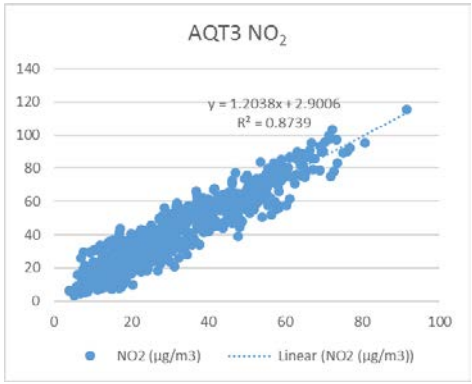


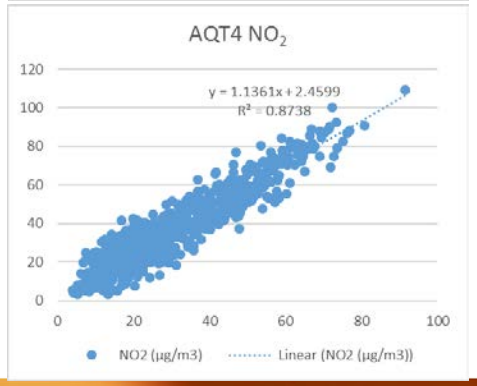


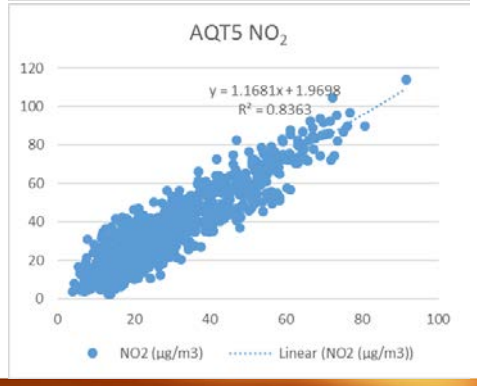
NO_2 correlations; R^2 = 0.79-0.87





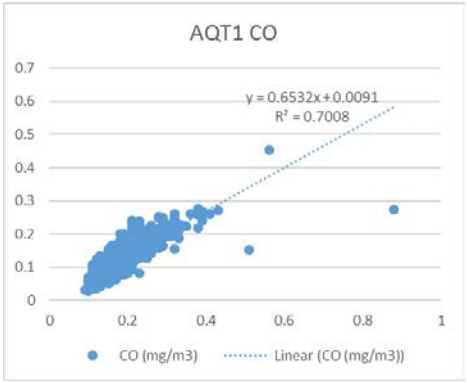


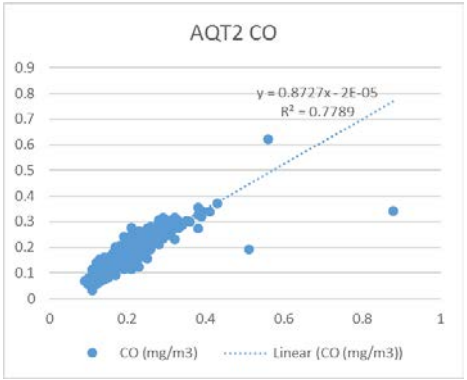


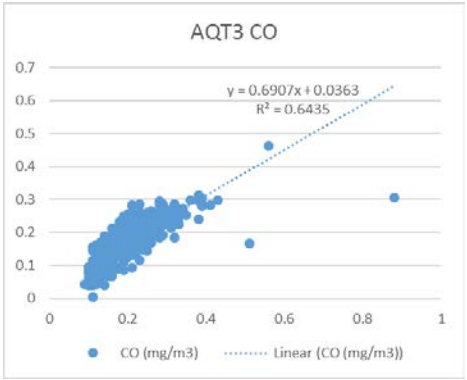


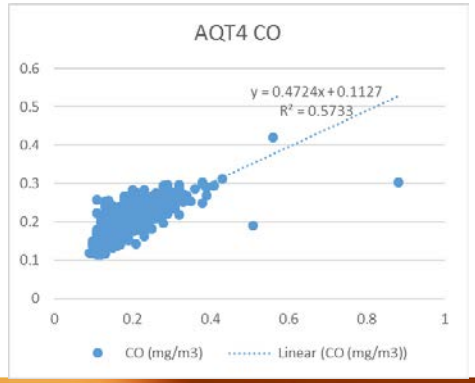
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m^3

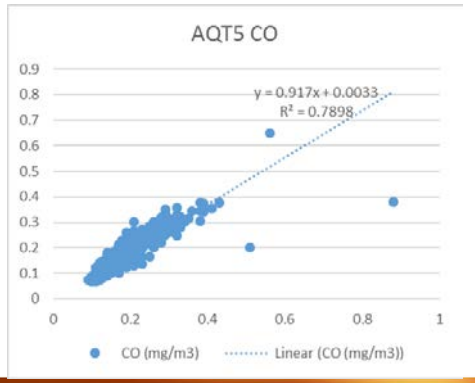
CO correlations / R^2 = 0.57-0.78







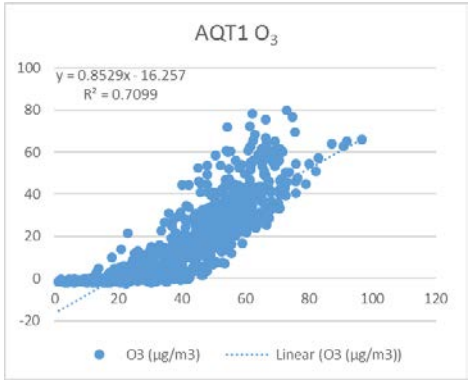


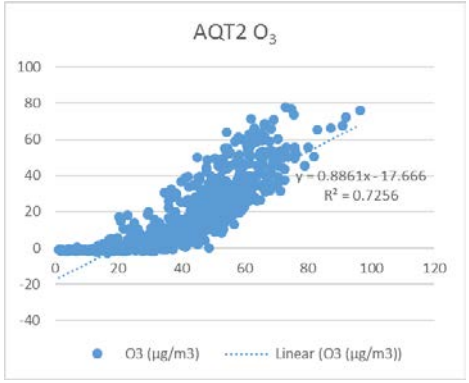


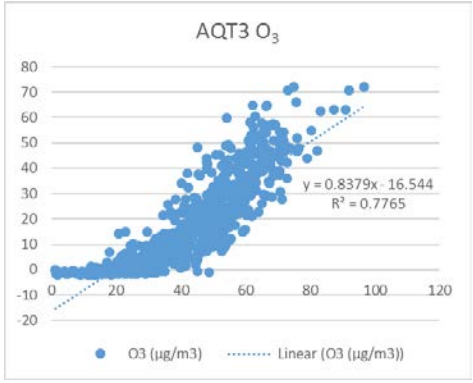
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: mg/m^3

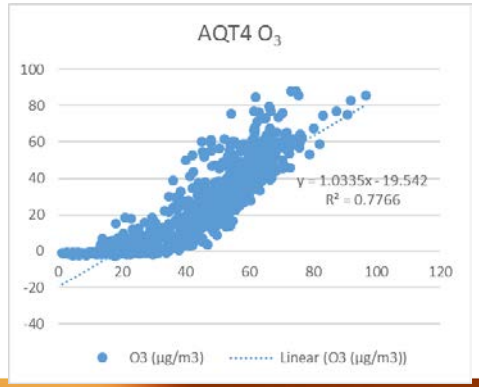
Note: low concentrations, little variation

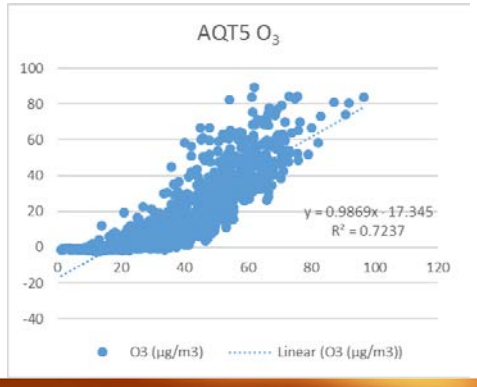
O_3 correlations; R^2 = 0.71-0.78











Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m^3

Test results from different environments

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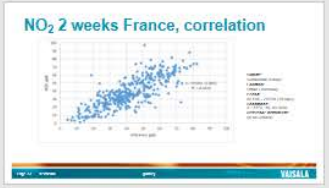

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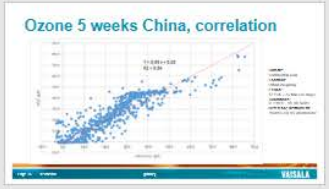

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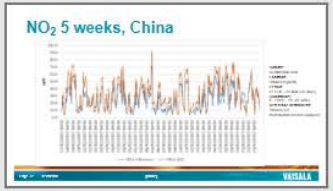

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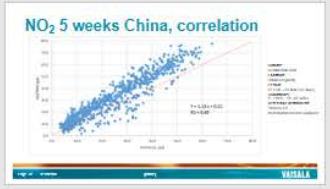

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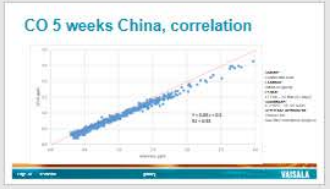

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Helsinki Metropolitan Air Quality Testbed

New air quality monitoring infrastructure to Helsinki Metropolitan area:

- Network of 15 air quality sensors to complement regulatory network
- Real time air quality model and forecast based on the improved resolution data
- Dissemination to citizens through internet, public displays etc.
- Open interface to data for application development

- Services for air quality forecasting, alerting, traffic, urban planning – local IT startups encouraged to utilize open data

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HELSINGIN YLIOPISTO
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HSY

FINNISH METEOROLOGICAL INSTITUTE

Network operational since Jan 2018

15 AQT420 sensors installed

Vaisala NM10 collects data

High resolution air quality model