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

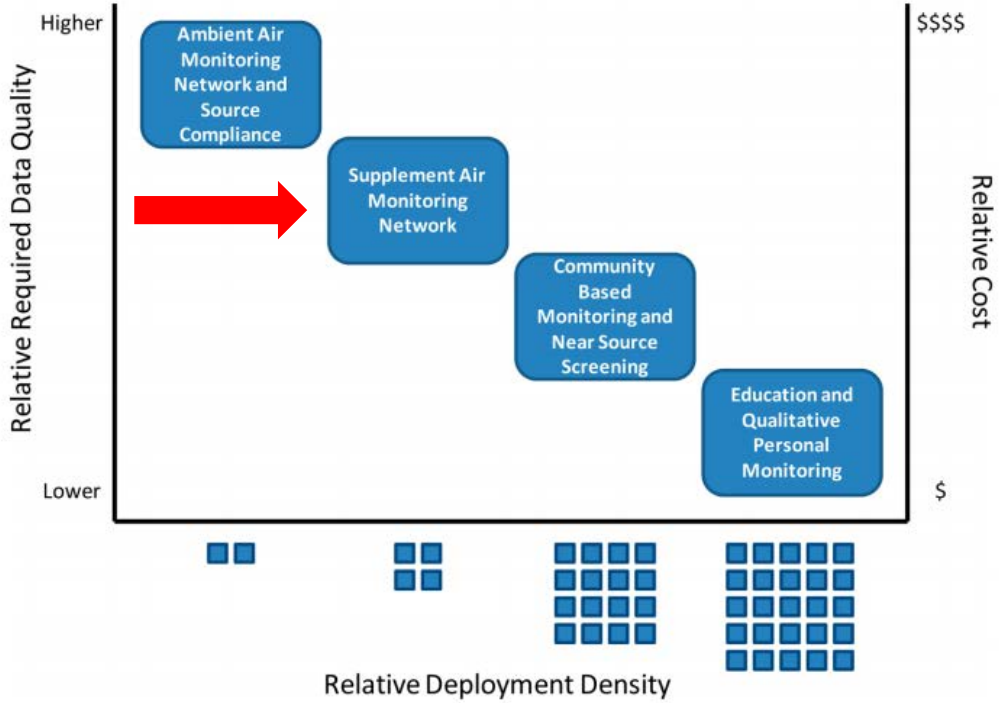
Mikko Laakso, Vaisala Oyj

Lasse Johansson, Ari Karppinen, (Finnish Meteorological Institute)

VAISALA

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

pubs.acs.org/est

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

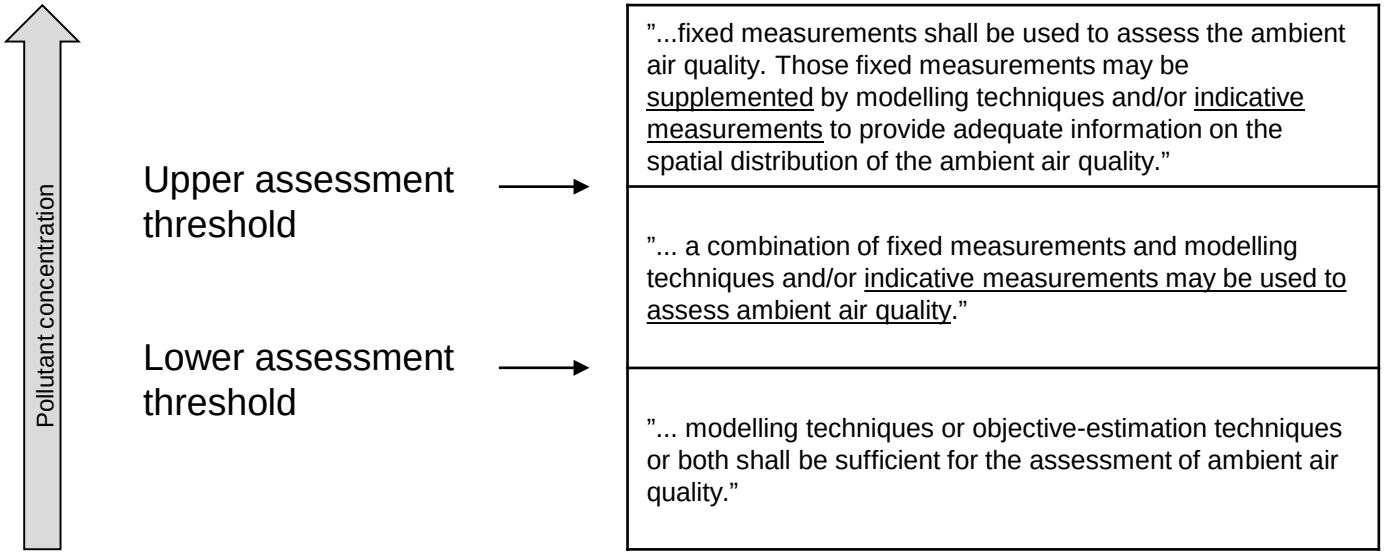
Opportunities

- 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

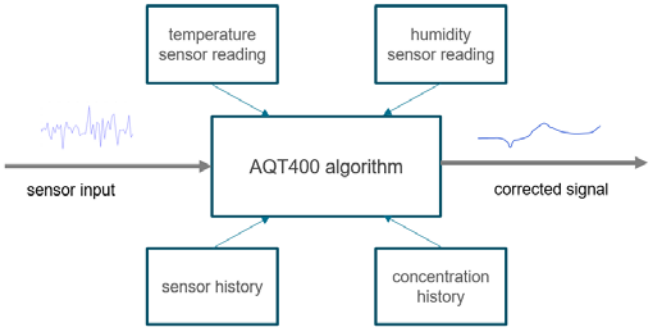
Measures NO_2, SO_2, CO and O_3

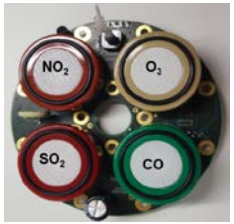
AQT420

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

Measurement technology

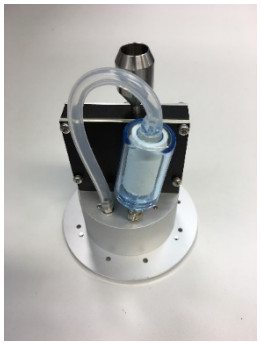
Electrochemical cells using advanced adaptive compensation algorithms

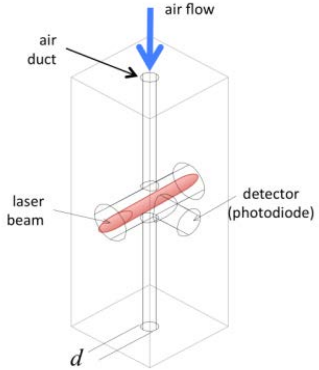




Optical laser particle counter

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

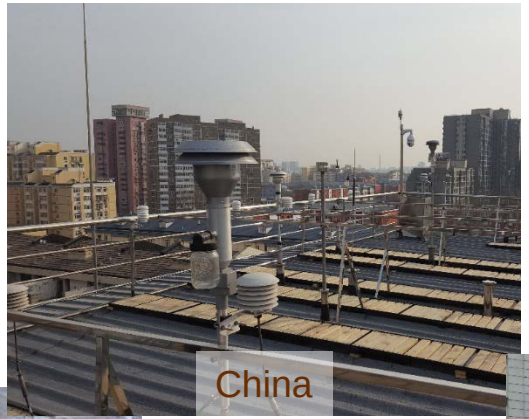




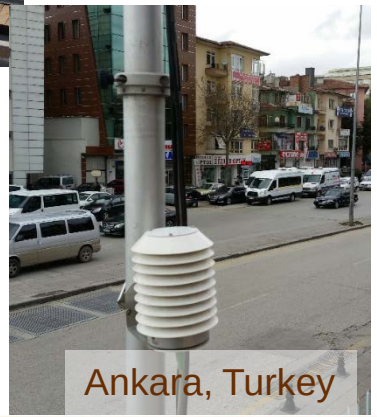
© Vaisala

Some co-location test sites


Paris, France


China


Helsinki, Finland


Ankara, Turkey

© Vaisala

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

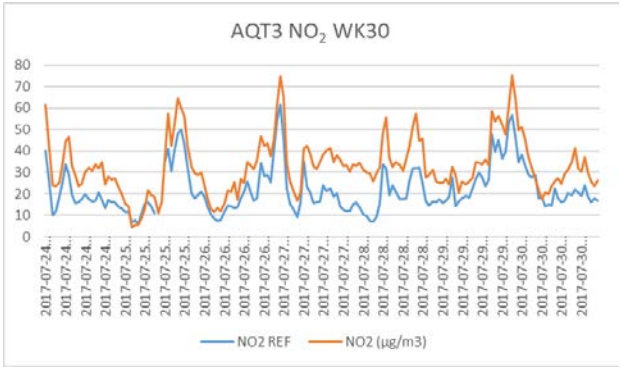
Helsinki Region Environmental

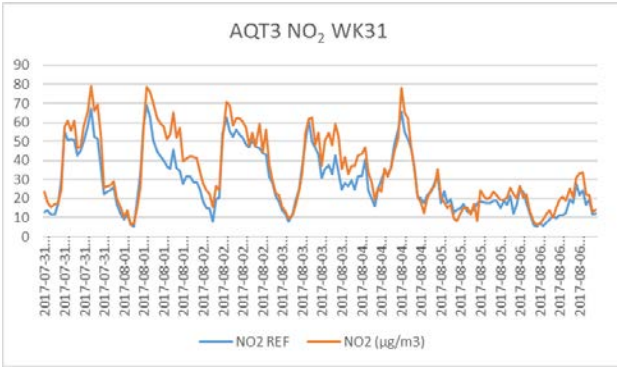
Services Authority

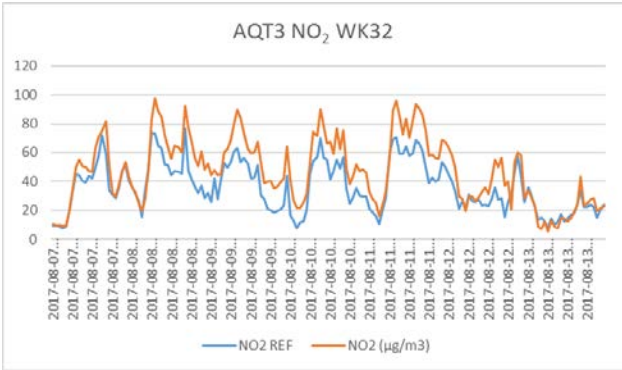
Urban supersite

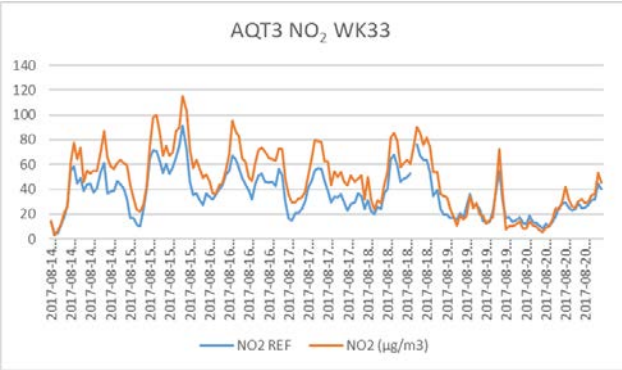
VAISALA

NO_2 response / AQT3

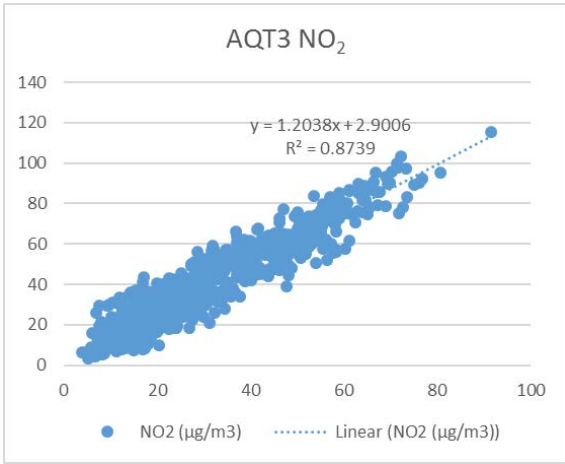




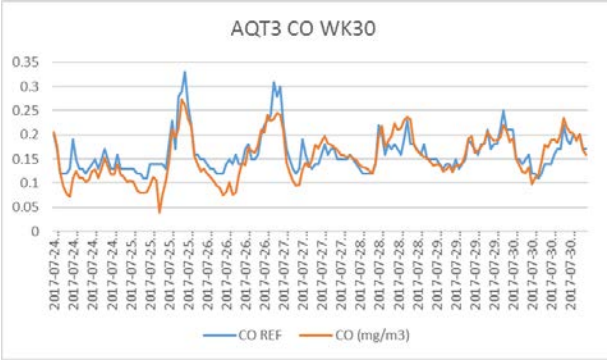


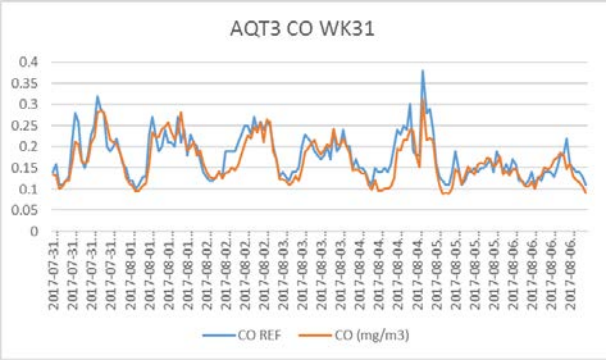


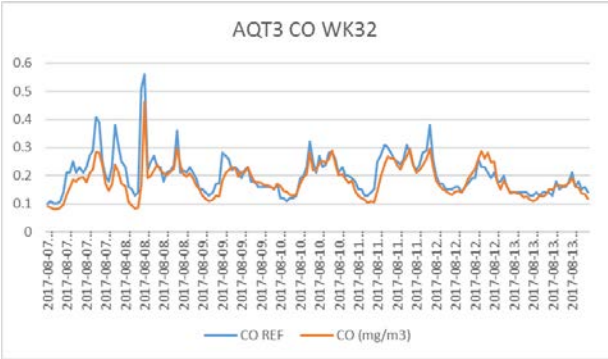
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m³

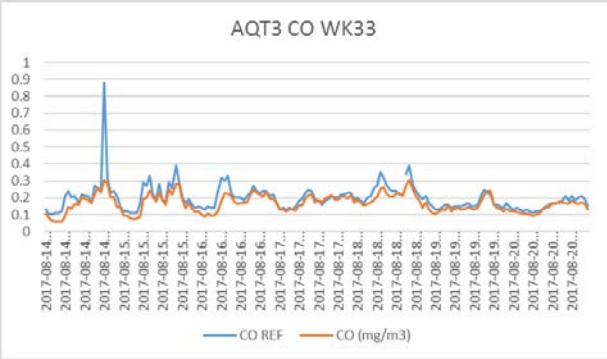


CO response / AQT3

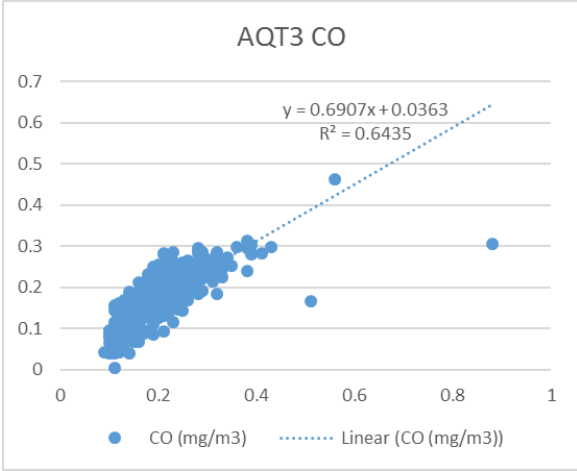








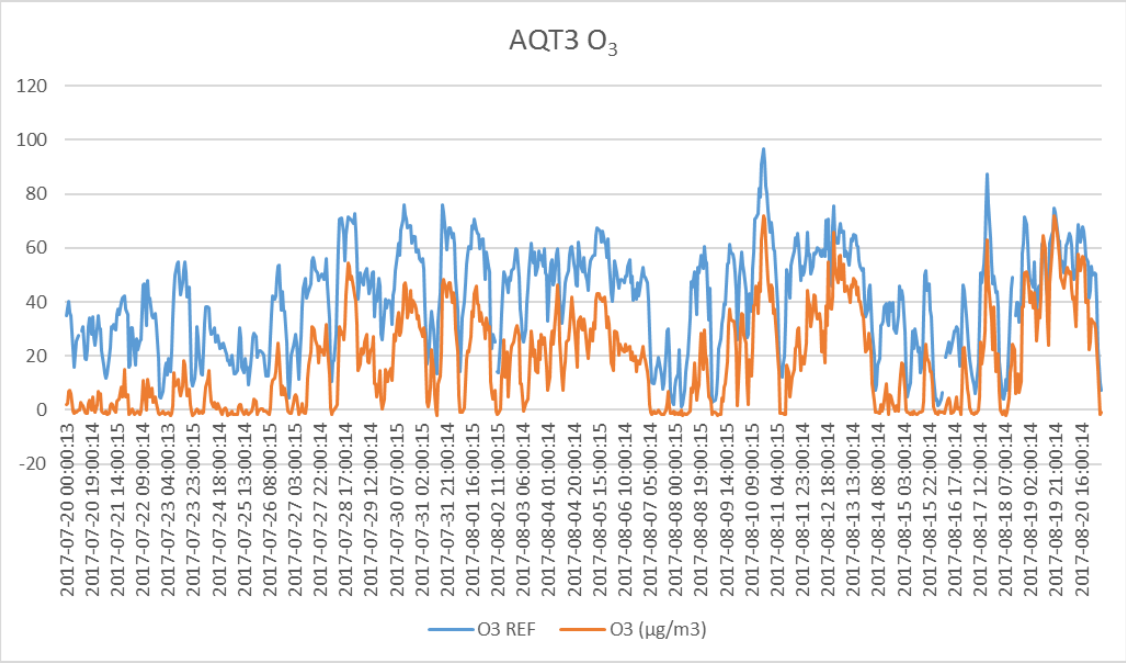
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: mg/m^3

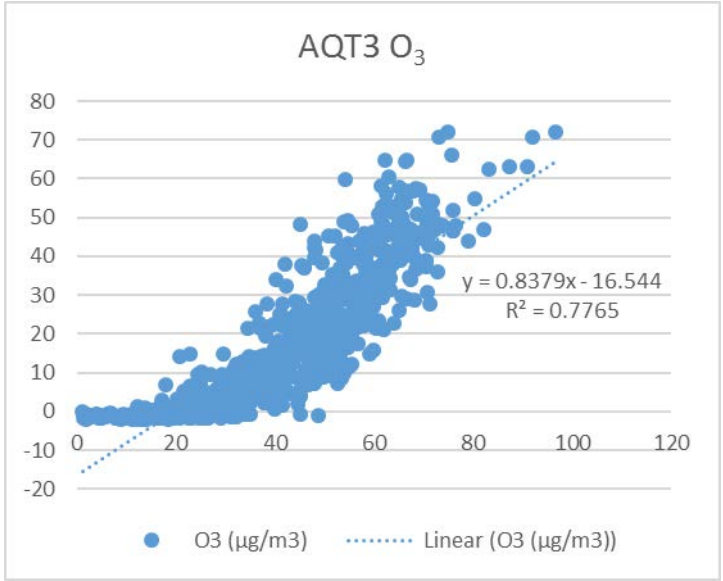


Note: low concentrations, little variation

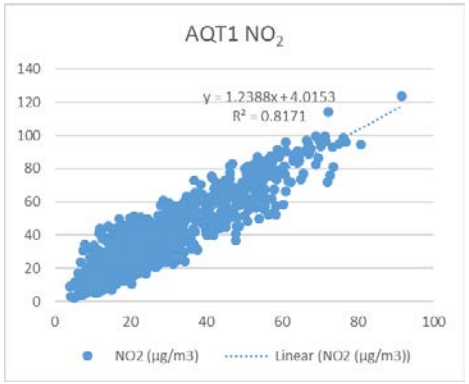
O_3 response / AQT3

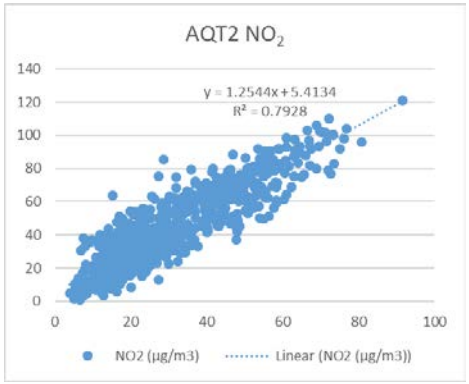
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m^3

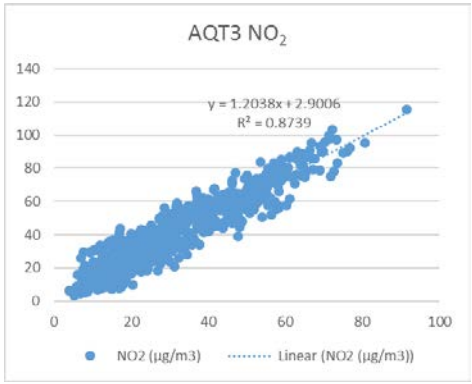


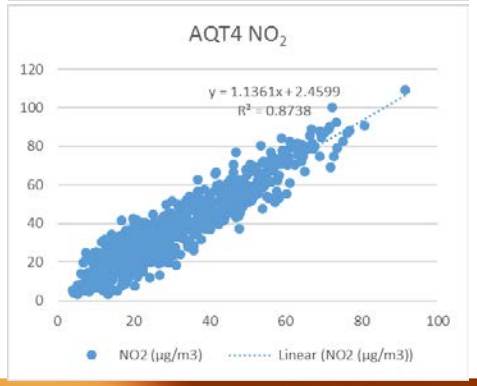


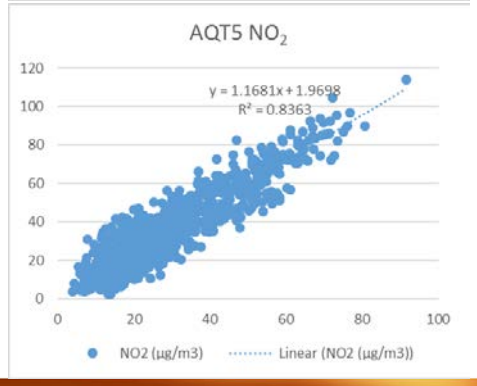
NO_2 correlations; R^2 = 0.79-0.87





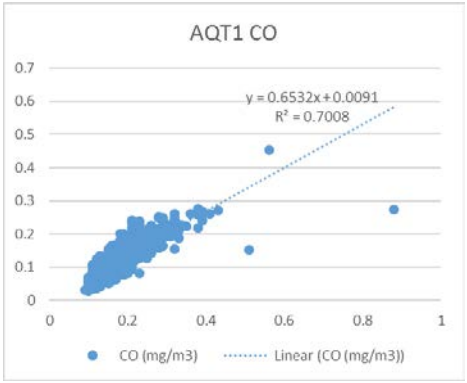


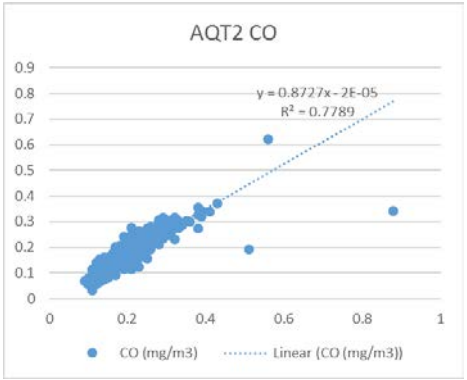


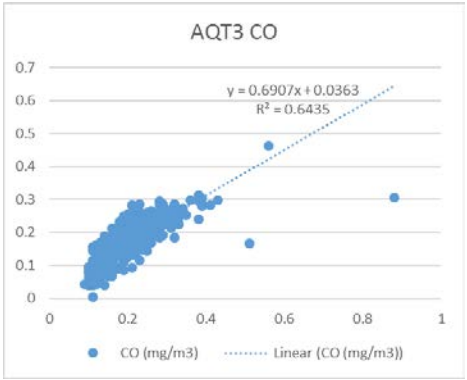


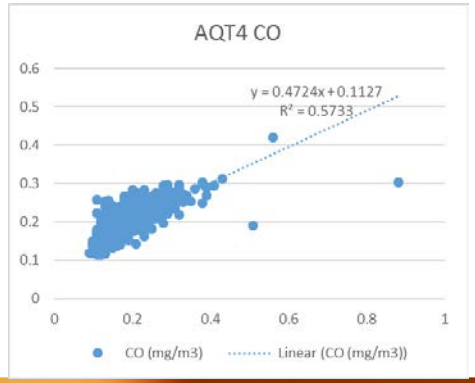
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m^3

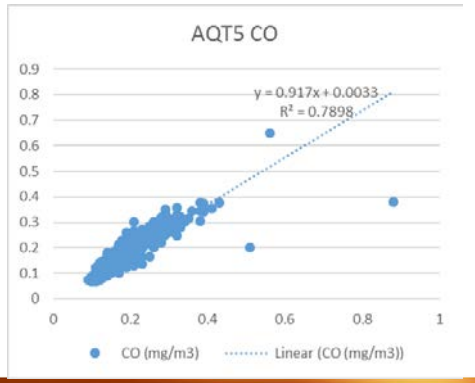
CO correlations / R^2 = 0.57-0.78







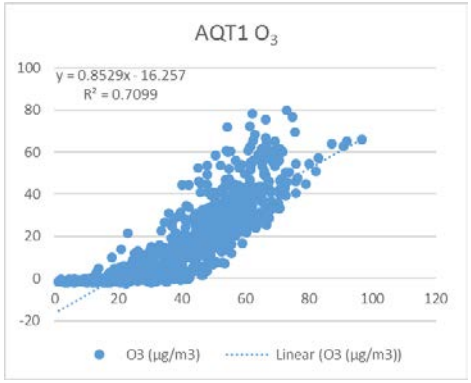


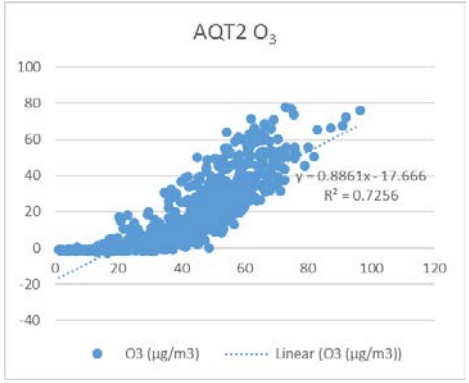


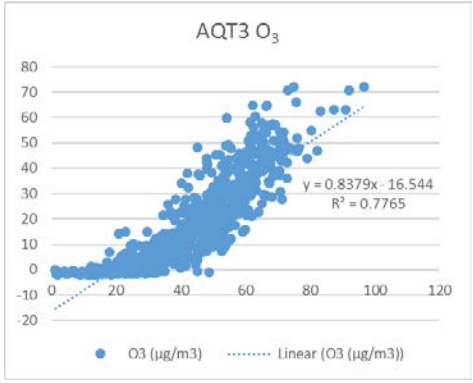
Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: mg/m^3

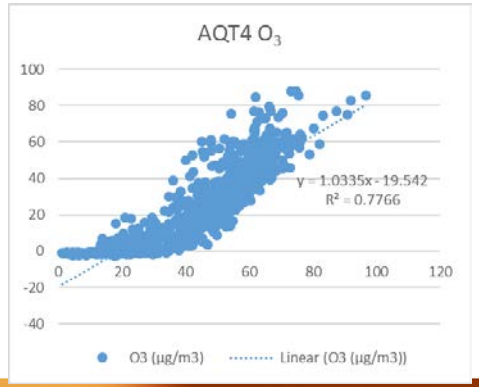
Note: low concentrations, little variation

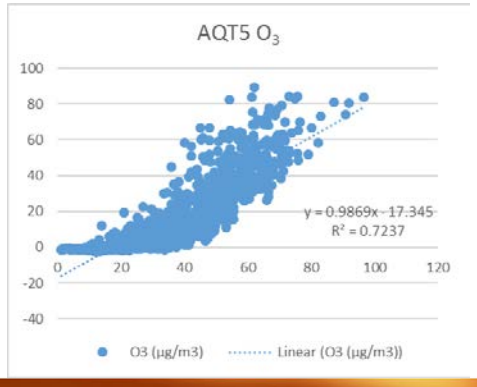
O_3 correlations; R^2 = 0.71-0.78









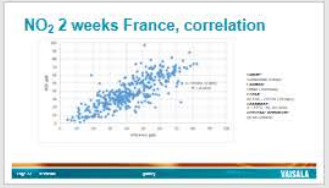


Hourly data
20.07. – 20.08.2017
Mäkelänkatu traffic site
Unit: µg/m^3

Test results from different environments

21

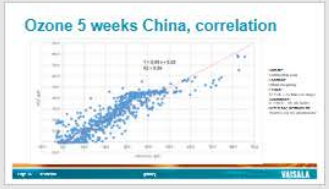
22



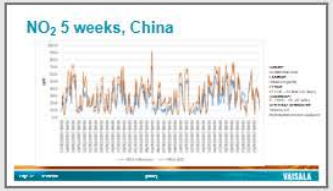
23

24

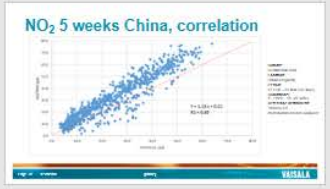
25



26

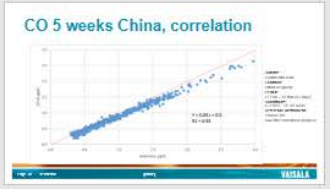


27



28

29



30

31

32

33

34

35

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

VAISALA

pegasor

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

HSY

FINNISH METEOROLOGICAL INSTITUTE

Network operational since Jan 2018

15 AQT420 sensors installed

Vaisala NM10 collects data

High resolution air quality model