

Near reference sensors and their application

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VAISALA

Observations for a Better World

Weather

Growth through industry leading offering and information services expansion

METEOROLOGY



ENERGY



TRANSPORTATION



Reliable
environmental observations
for better decision making,
safety and efficiency



Controlled Environment

Growth through product leadership



Leadership Built on

Reliability
Expertise in applications, science and technologies
Excellence in high mix — low volume businesses

Vaisala Meteorology Offering



Sensors /
Instruments

Humidity and
temperature sensors



Barometric
sensors



Carbon dioxide
sensors



Moisture in oil sensors



Wind sensors



Weather multi-sensors



Visibility and present
weather sensors



Surface
Observation
Systems



Remote
Observation
Systems

Weather radars



Lightning networks



Cloud heigh and boundary layer height measurement



Upper Air
Observation
Systems

Radiosondes



Automatic sounding stations

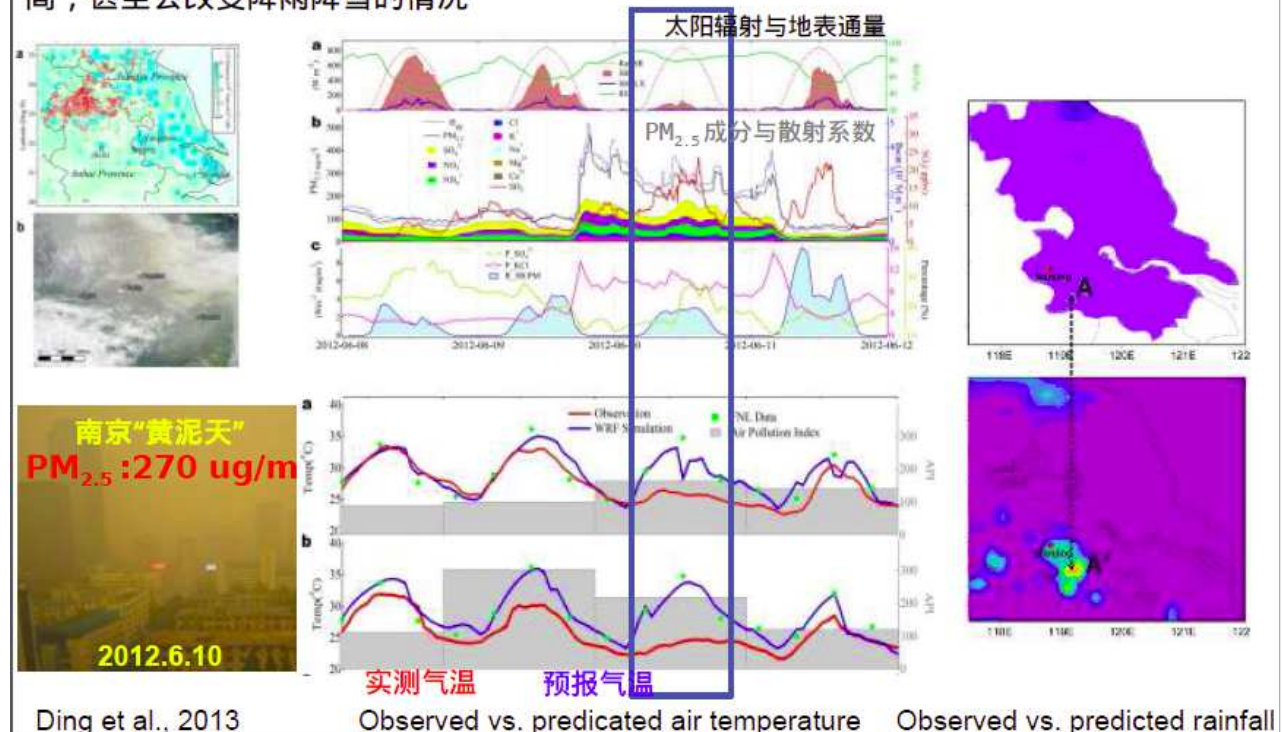


Helsinki University and
Nanjing NJU University
joint studies:

Poor Air Quality Impacts
Weather

China (Nanjing) Air Pollution - Weather/Climate Interactions

雾霾会影响天气预报的预测。比如，雾霾减少时，太阳光射入会增加，就会导致气温升高，甚至会改变降雨降雪的情况



Ding et al., 2013

Observed vs. predicted air temperature

Observed vs. predicted rainfall

Joint-International Research Laboratory of Atmospheric and Earth System Sciences
(JirLATEST) 南京大学 - 赫尔辛基大学大气与地球系统科学国际科学联合实验室

Beijing in September 2016

View from the hotel opposite to Vaisala office

September 19th, 2016 PM2.5 \approx 17 $\mu\text{g}/\text{m}^3$

September 23rd, 2016 PM2.5 \approx 225 $\mu\text{g}/\text{m}^3$



Air Pollution: Single Biggest Environmental Health Risk

- Inhaling air pollution takes away at least 1-2 years of a typical human life
- More than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the World Health Organization (WHO) limits
- More than 5 million people die prematurely each year from outdoor pollution.
 - Without action deaths will double by 2050
- Toxic air pollution poses a greater threat to children, due to their smaller physical size and lung capacity.
- We do not yet even fully understand, what impact nanoparticles will ultimately have...

Vaisala Expands its Business on the Air Quality Monitoring Market

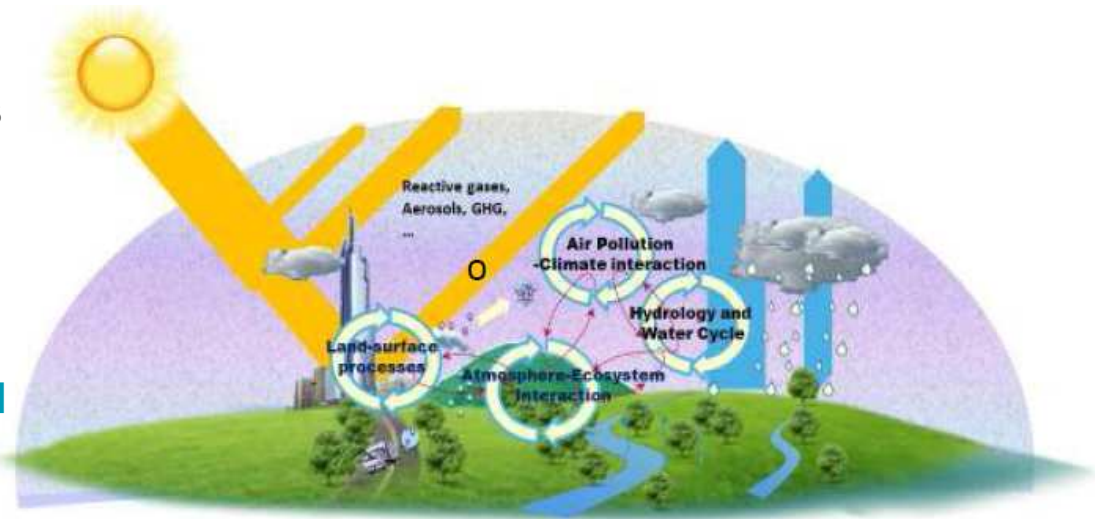
Vaisala has acquired new products and technology to expand its offering in the growing air quality monitoring market. The products and novel services are perfectly aligned with Vaisala's goal of making observations for a better world.

"Air quality is an area where observations can truly improve the lives of all people. Latest research shows that air pollution is a significant health risk leading to millions of premature deaths every year. Without reliable, affordable, accurate and extensive measurement networks it is difficult to improve the situation," says Jarkko Sairanen, Vaisala EVP for the Weather Business Area



Trends in Air Quality Monitoring

- Building deeper understanding on
 - how the ecosystem and human actions effects on formulation of pollution
 - the chains of chemical reactions and physical processes that pollutants undergo
- It's well known that weather effects air quality. Poor air quality however effects also weather, research on-going
- **Air quality advanced modelling and forecasting is coming increasingly important**
- **To improve air quality modelling and forecasting denser air quality measurements are required**



Natural Earth System → Human-Influenced Earth System

Supplementary air quality networks

Conventional network



- Air quality measurements are typically made with fixed ground-based monitoring stations, which cost several 100 k€
- These stations can only represent a very local area

Supplementary dense network



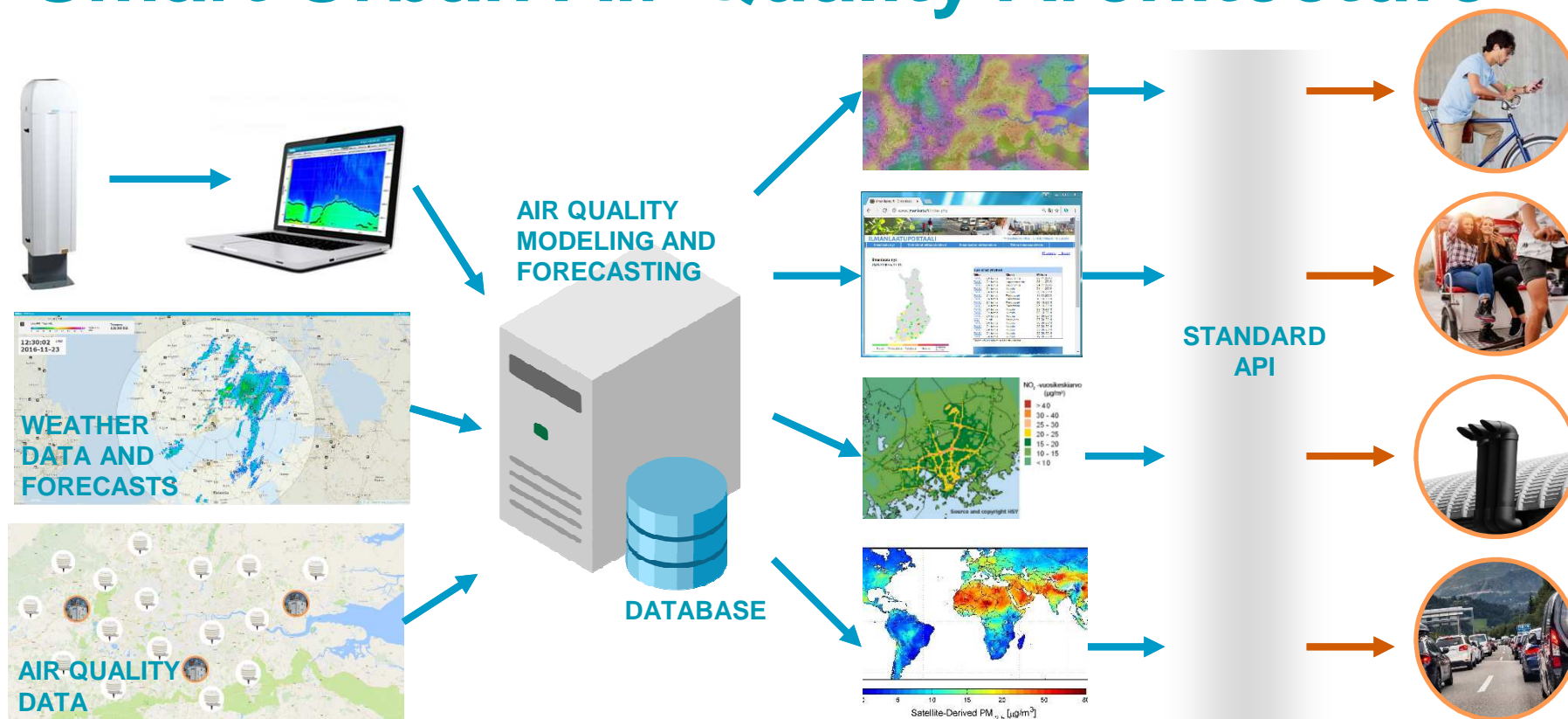
- The AQT410/420 concept enables dense but cost efficient measurement networks
- Improving air quality monitoring improves also air quality modelling and forecasting
- It can also be used to alert people about potential health risks

Weather + air quality



- Weather effects the air quality and air quality affects the weather.
- AQT transmitters can be connected with WXT to get a more complete picture
- This improves air quality forecasting

Smart Urban Air Quality Architecture



Air quality information needed by various users

- General public outdoors and indoors
- Industrial sites
- Maritime operators and harbours
- On roads, tunnels and parking garages
- Mines
- Airports



Vaisala AQT400

- from Sensors to Solutions

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Vaisala new air quality transmitters for supplementary air quality networks

AQT410



Measures NO₂, SO₂, CO and O₃

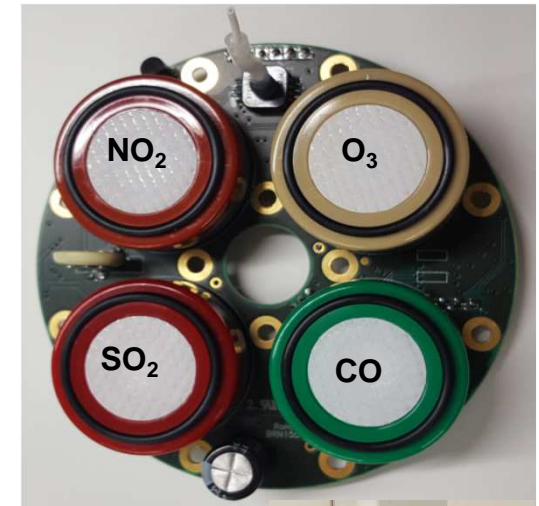
AQT420



Measures NO₂, SO₂, CO and O₃ and also PM_{2.5} and PM₁₀ Particulate Matter

Pollutant gas measurement

- One AQT400 device has 4 electrochemical sensors for pollution gases:
 - NO₂, SO₂, CO and O₃
 - H₂S to be configurable for larger quantities of sensors
- Electrochemical sensors are sensitive to ambient conditions around the sensor: temperature, humidity and aging
 - **The effects of ambient conditions are compensated by advanced algorithms**
 - This is where Vaisala's strong knowledge and scientific background makes the difference
 - **Also multi-step factory calibration is the key for the accuracy**



Pollutant gas measurement with advanced algorithms

- Compensation of effects of ambient conditions allows the use a compact and light-weight sensor structure, without heavy covering box
- The sensor can be placed in open air and it can be easily mounted to various locations:
 - on streets on pillars and walls of buildings
 - industrial sites
 - indoors
 - on moving vehicles



Particulate Matter Measurement

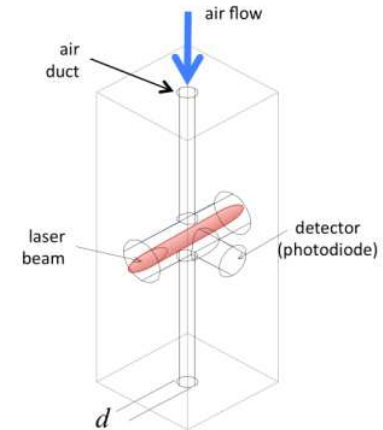
Laser Particle Counter

- Size distribution with optical granulometric measurement
- Measures 1 minute sample between 5-10 minutes



Optical Particulate Counter for PM2.5 and PM10

- Measures concentration and size distribution of PM2.5 and PM10 particulates
- Measurement principle is optical scattering
- Each particle scatters light, generating signal peak and the amount of scattered light is proportional to the size of the particle

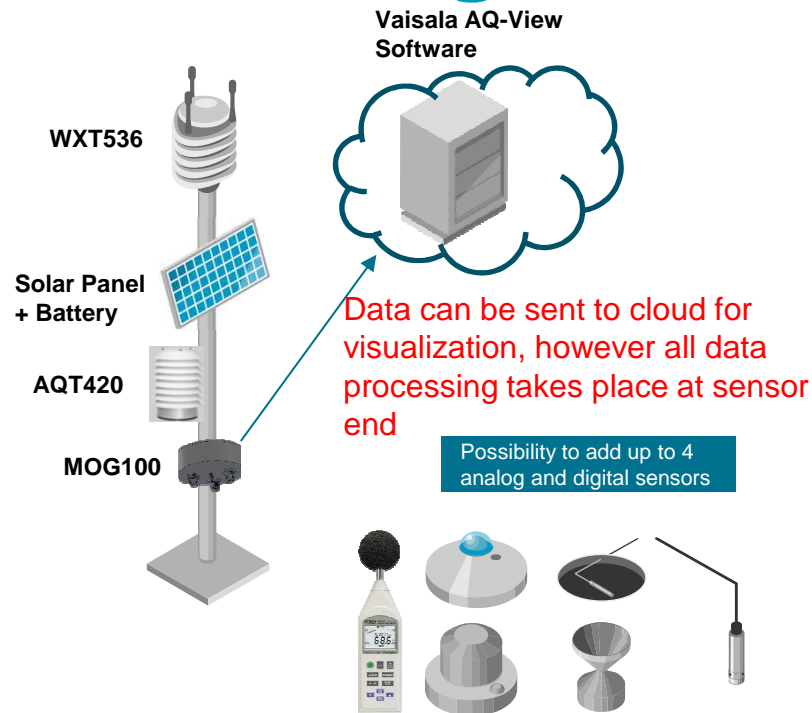


Weather parameters through WXT530 Multi-Weather sensor

- Possibility to connect Vaisala WXT530 Multi-Weather sensor straight to the AQT400 series
- WXT530 Multi-Weather sensor provides up to 6 different weather parameters: temperature, humidity, pressure, wind speed, wind direction and rain
- Weather data can be visualised through AQ-VIEW with the Air Quality data



Vaisala Sphere - Environmental Monitoring Station



- Air quality measurements
- Weather measurements
- Additional measurements for e.g. solar radiation
- Data logging capability
- Totally wireless with
 - solar panel and battery powering
 - GSM connection via MOG100 gateway

Vaisala Sphere Mobile Version



Test results for AQT400

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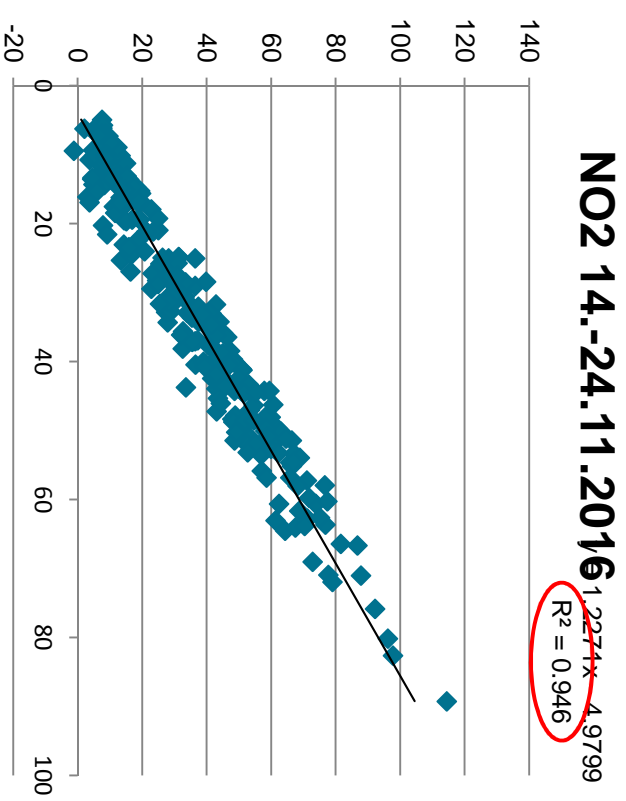
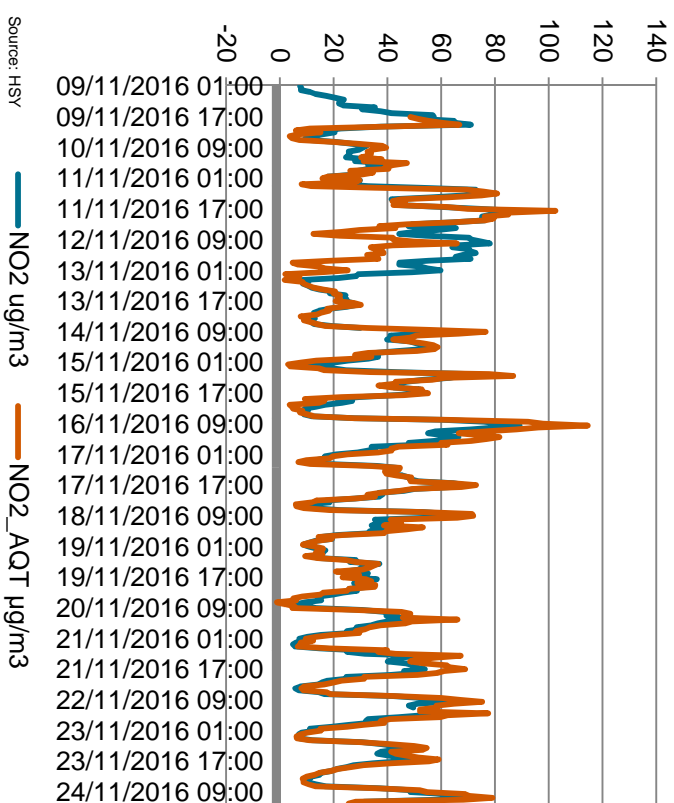
AQT400 testing against reference

- Tests in co-operation with Helsinki Region Environmental Services authority, HSY, in urban city canyon (Mäkeläncatu street) in Helsinki
 - NO₂: AQT410 vs Horiba APNA-370 chemiluminescence analyzer
 - O₃: AQT410 vs Thermo 49i UV photometric analyzer
- Tests for CO against FMI reference in Kumpula
- Vaisala tests for PM_{2.5} and PM₁₀ in Helsinki city center (Bulevardi street)
 - AQT410 vs TSI DustTrak Aerosol Monitor
- Test in co-operation with Beijing EPA
 - NO₂, O₃, SO₂ and O₃ against Thermo i Series



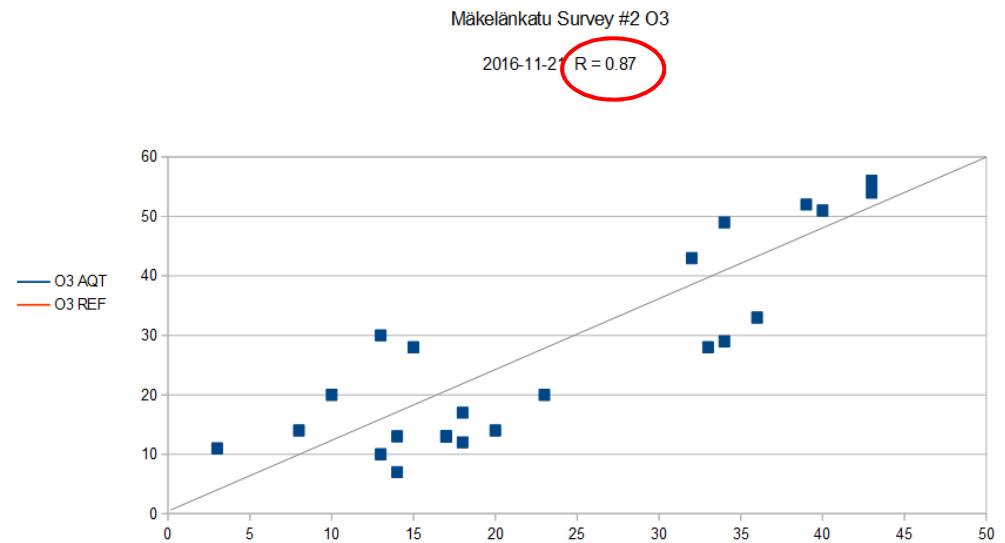
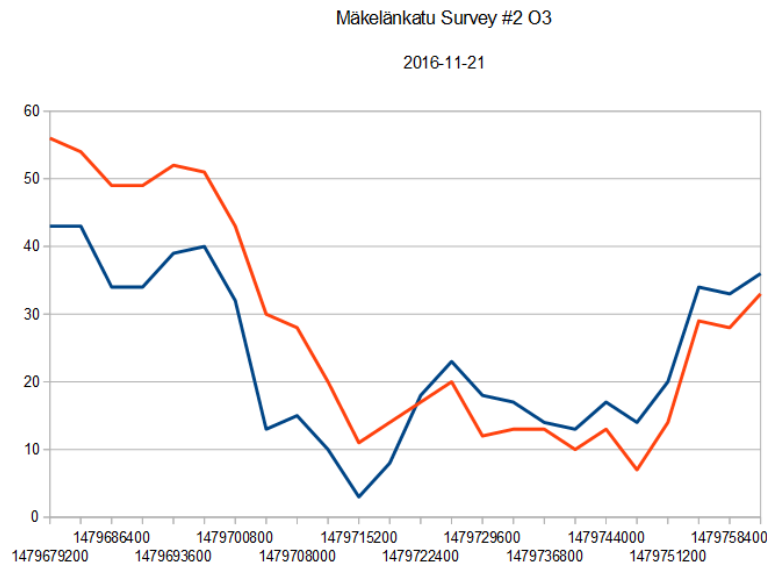
AQT410 NO2 vs. Horiba APNA-370

Helsinki City, Mäkelänkatu



AQT410 O3 vs. Thermo 49i

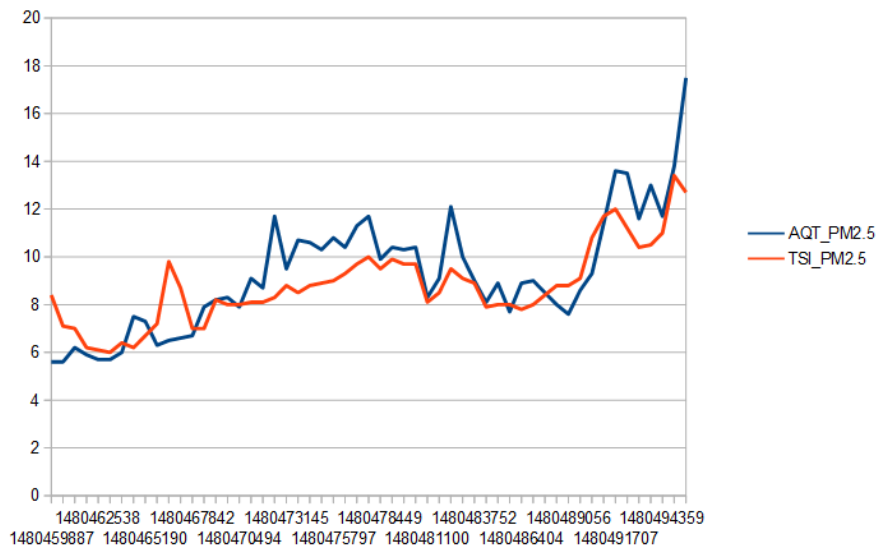
Helsinki City, Mäkelänkatu



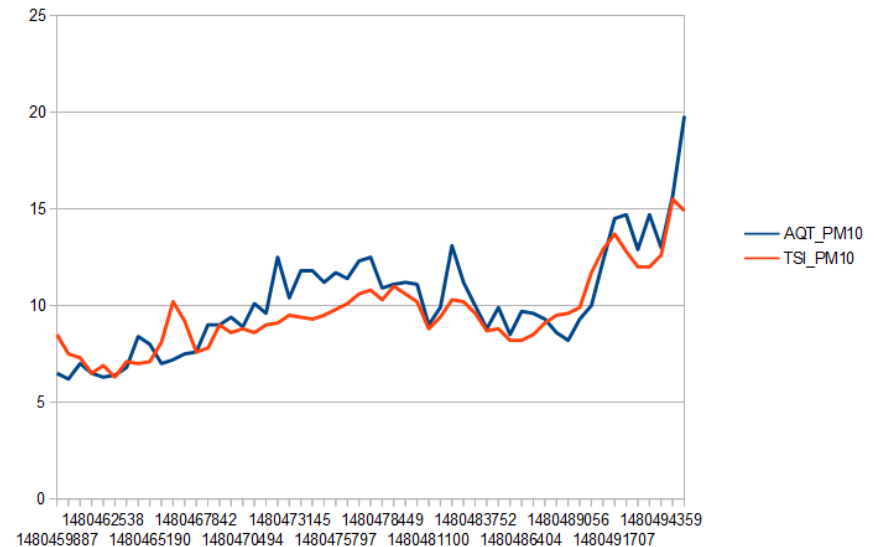
AQT420 LPC vs. TSI DustTrak PM2.5/PM10

Vaisala R&D, Bulevardi, Helsinki

AQT/TSI PM2.5 Bulevardi, Hki 29.11.2016



AQT/TSI PM10 Bulevardi, Hki 29.11.2016

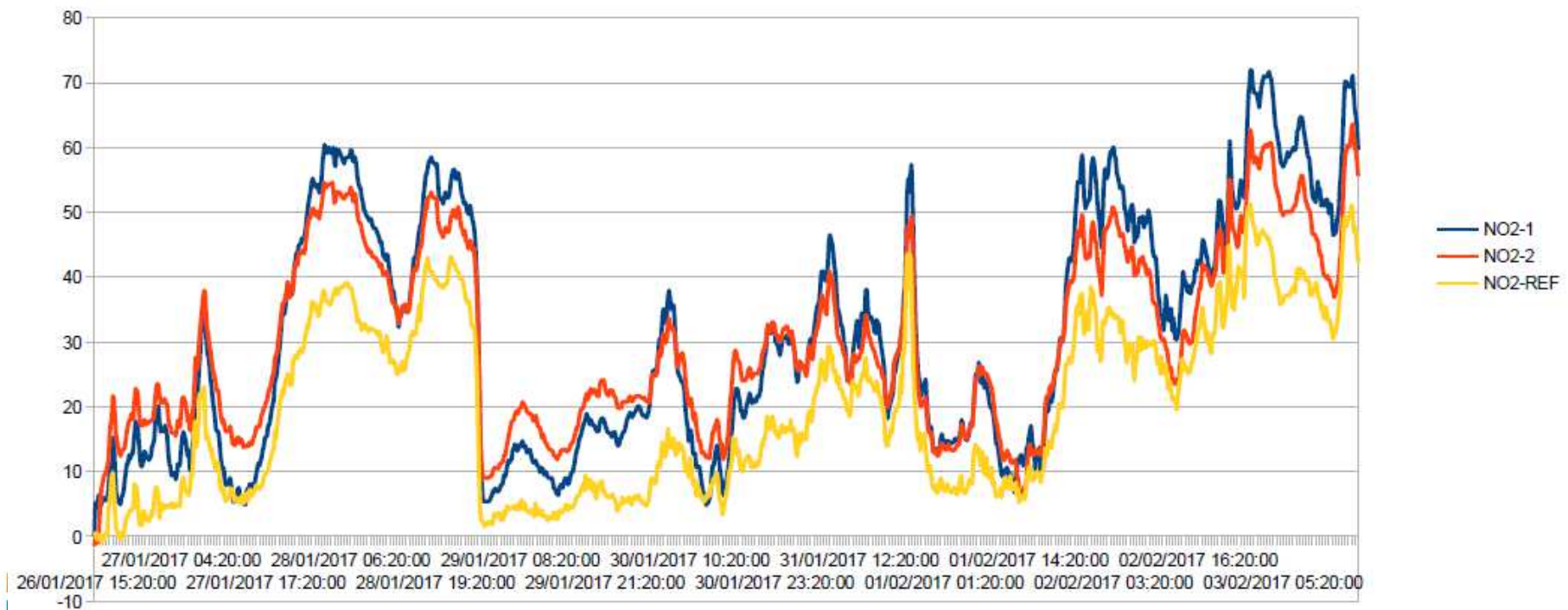


AQT410 NO₂ vs. Thermo 42i chemiluminescence technology

Beijing EPA

NO₂ Beijing, China

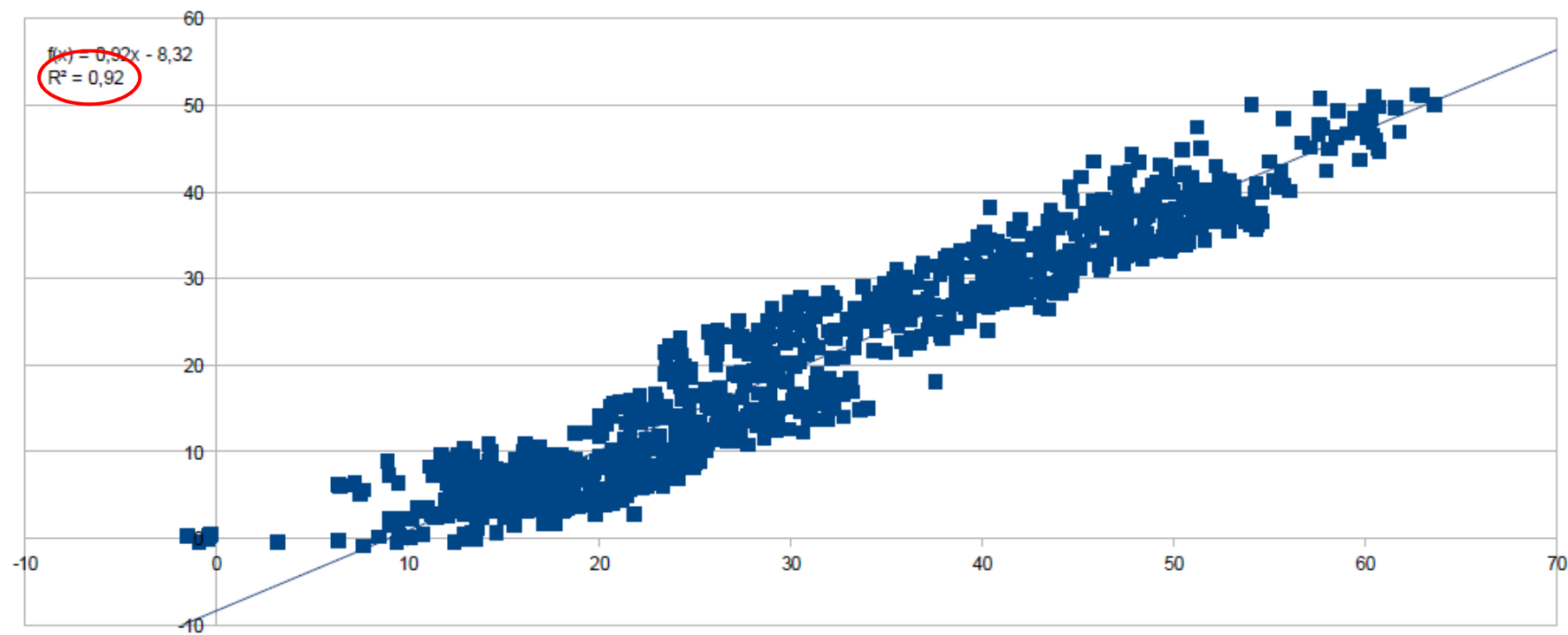
7 days, 10 min avg, in ppb



Beijing EPA

NO2 Beijing, China

7 days, 10 min avg, correlation

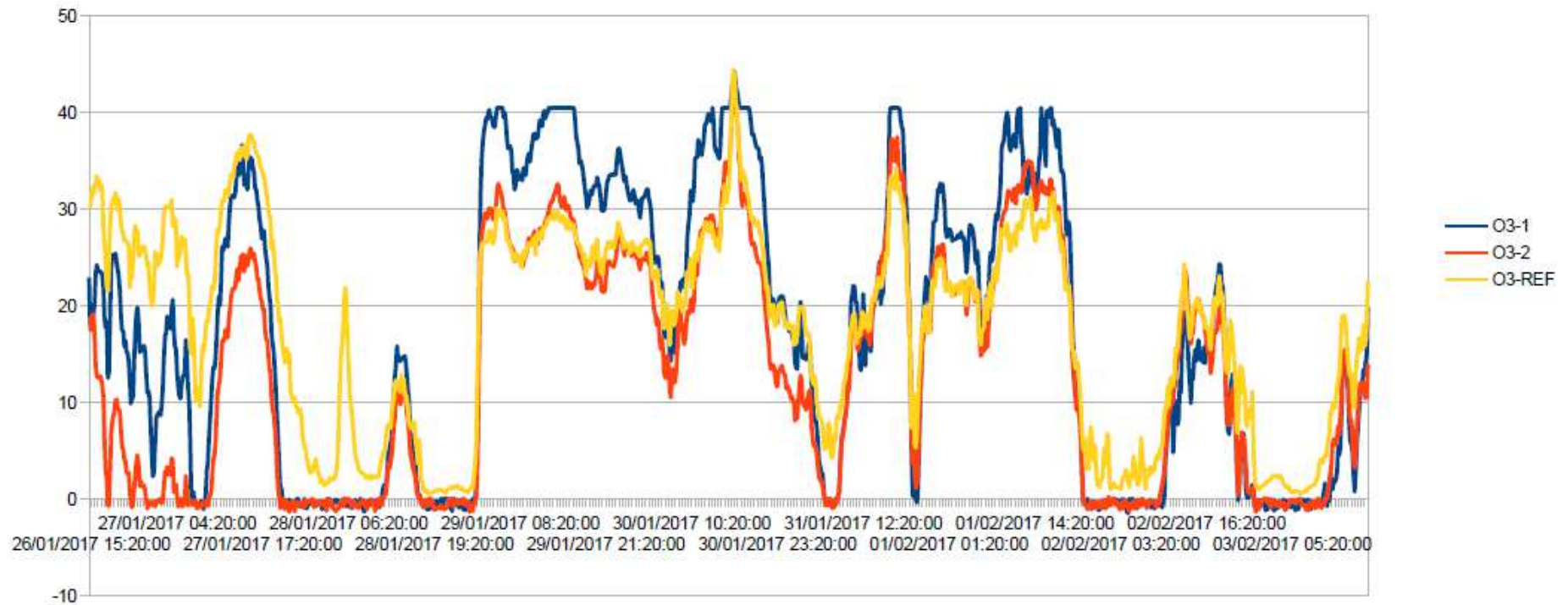


AQT410 O₃ vs. Thermo 49i UV photometric technology

O₃, Beijing China

Beijing EPA

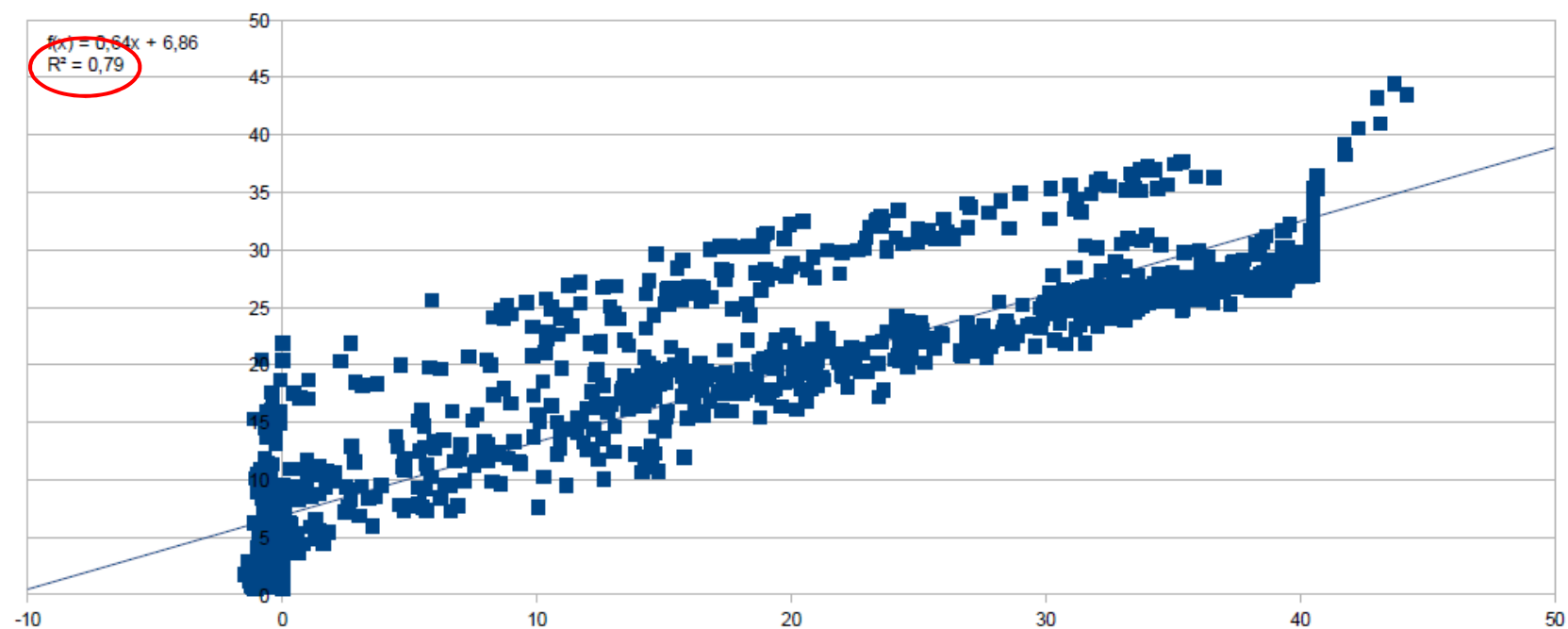
7 days, 10 min avg, in ppb



Beijing EPA

O3 Beijing, China

7 days, 10 min avg, correlation

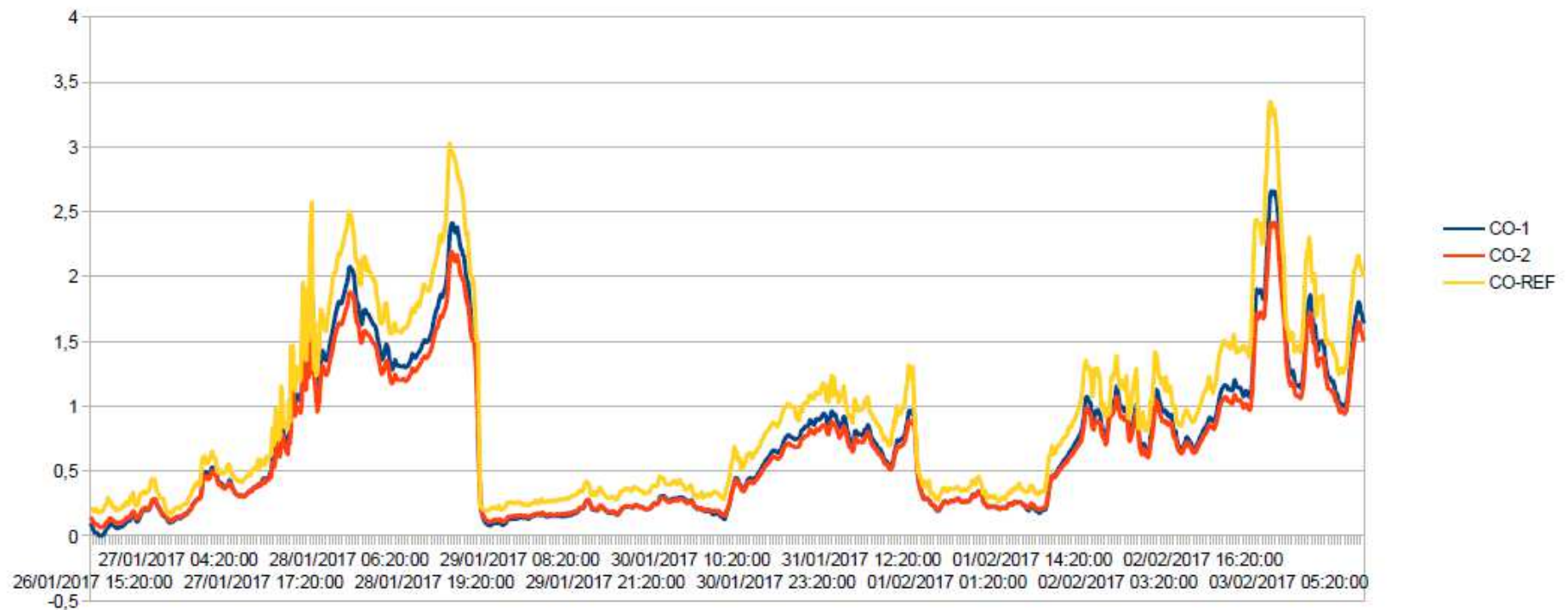


AQT410 CO vs. Thermo 48i gas filter correlation technology

CO, Beijing China

Beijing EPA

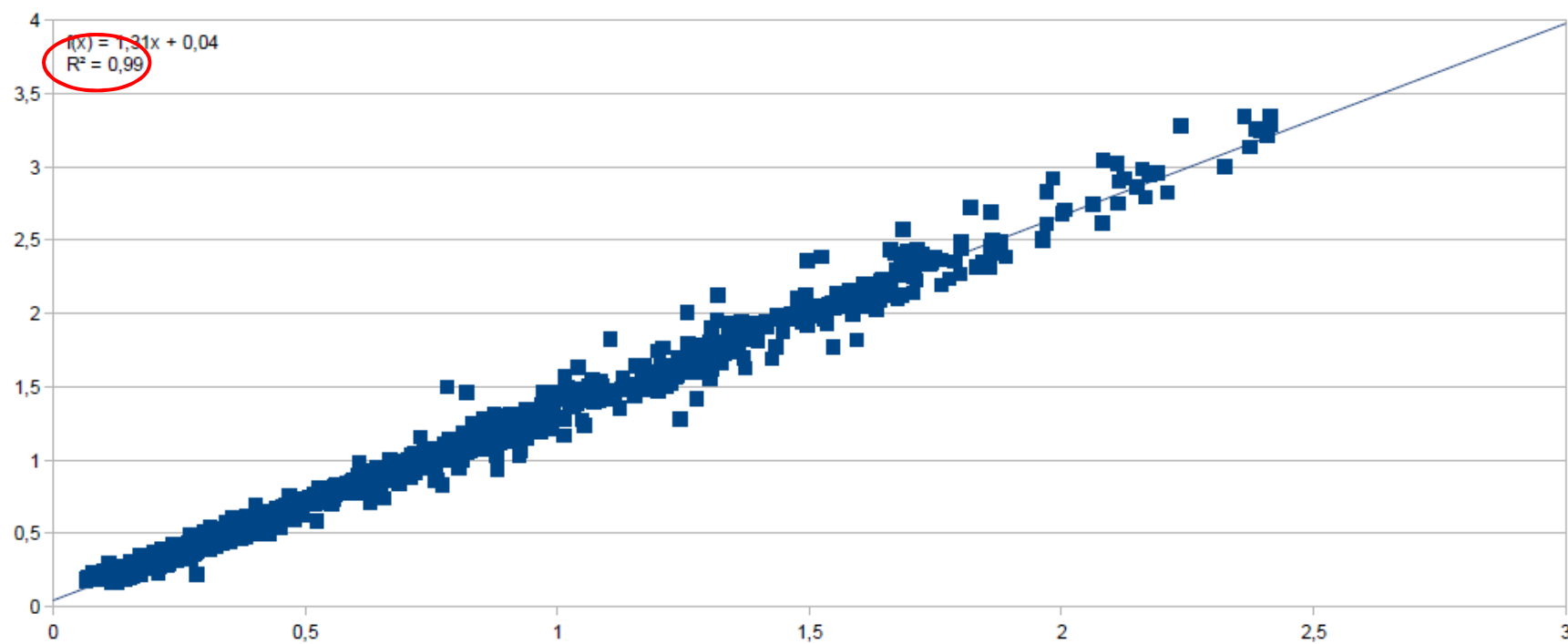
7 days, 10 min avg, in ppm



Beijing EPA

CO Beijing, China

7 days, 10 min avg, correlation

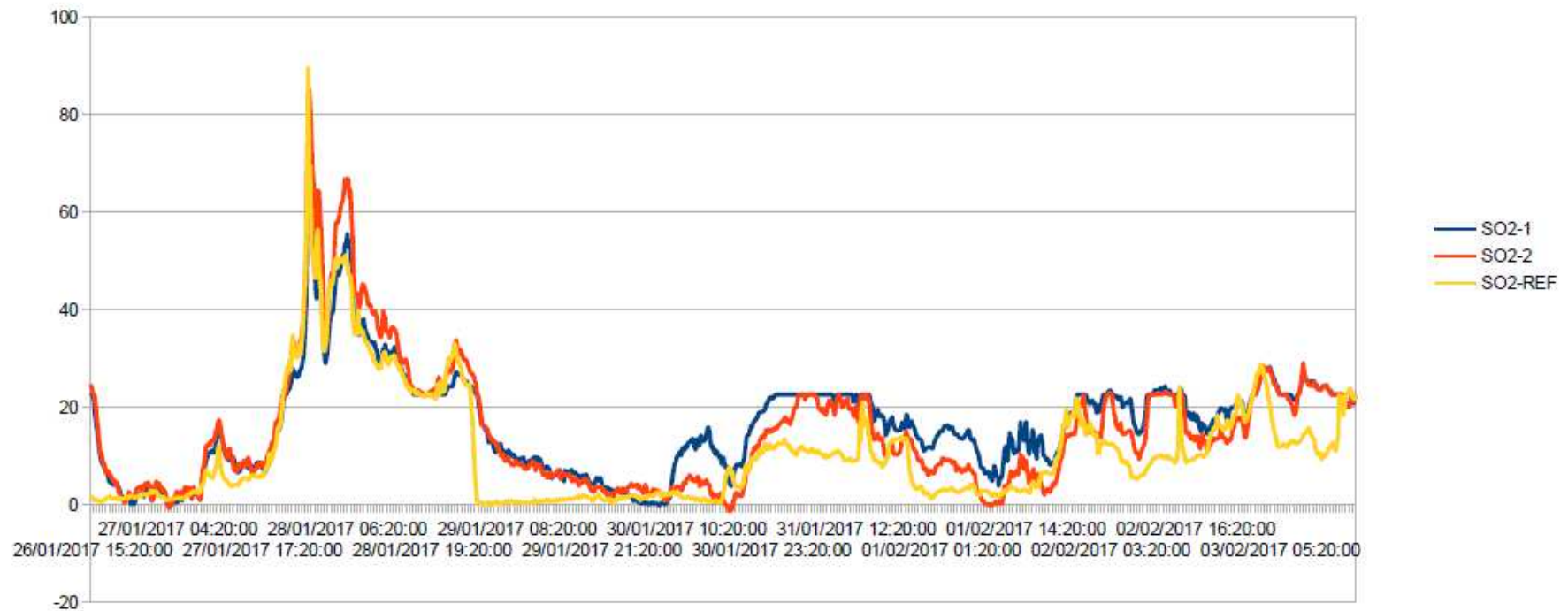


AQT410 SO₂ vs. Thermo 43i fluorescence technology

Beijing EPA

SO₂, Beijing China

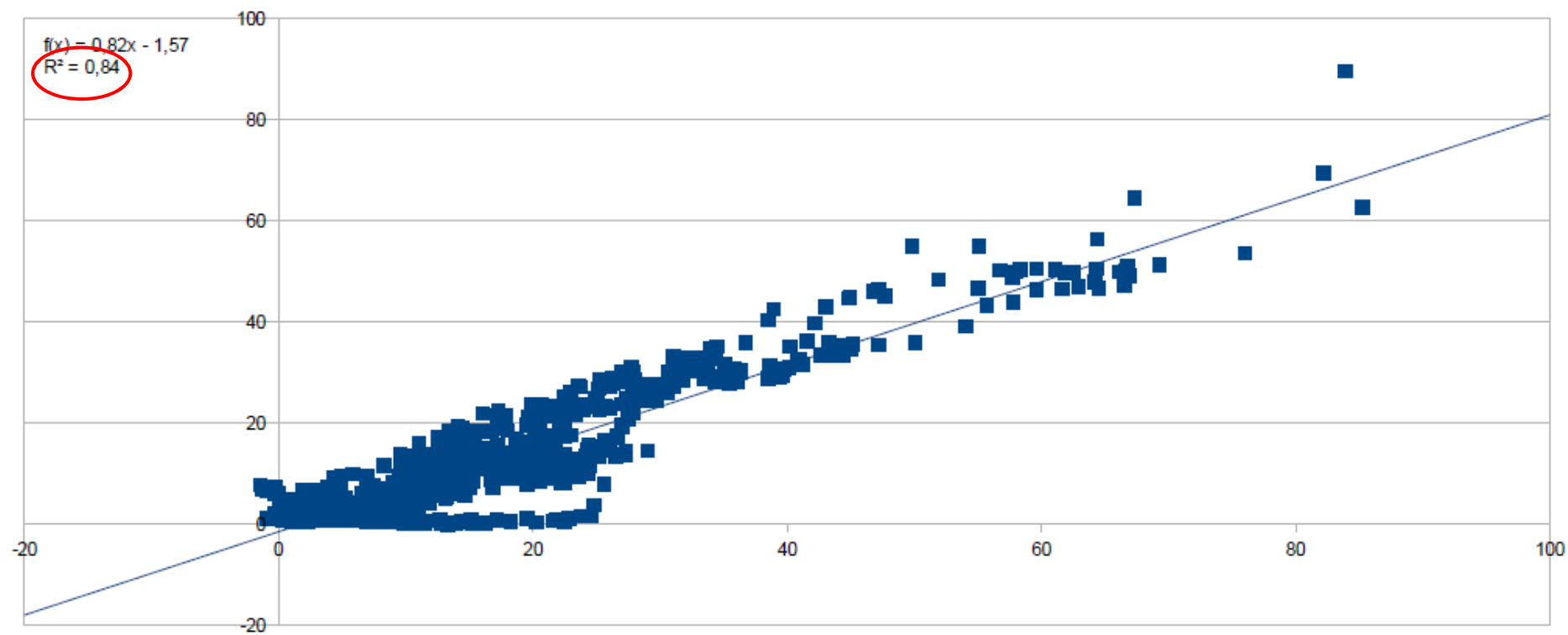
7 days, 10 min avg, in ppb



Beijing EPA

SO2 Beijing, China

7 days, 10 min avg, correlation





Supplementary air quality networks are needed to increase air quality measurement accuracy. This improves air quality modelling and forecasting and gives us tools to effect on air quality.

Thank You!