ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Vertailulaboratorion kuulumiset

Jari Waldén
Ilmatieteen laitos
Ilmakrhän koostumuksen tutkimus
Ilmanlaatu
Jari.walden@fmi.fi

Sisällys

Vertailulaboratorio
- Hlöstö, akkreditointi, suunnitelmat

Standardit etc
- PrEN16450
- PrTSWG42

Edustavuus
- FAIRMODE comparison

AQUILA
- Uutiset
- Subgroup for TA & DoE
- Laitteet

PM-vertailun tulokset

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Vertailulaboratorio

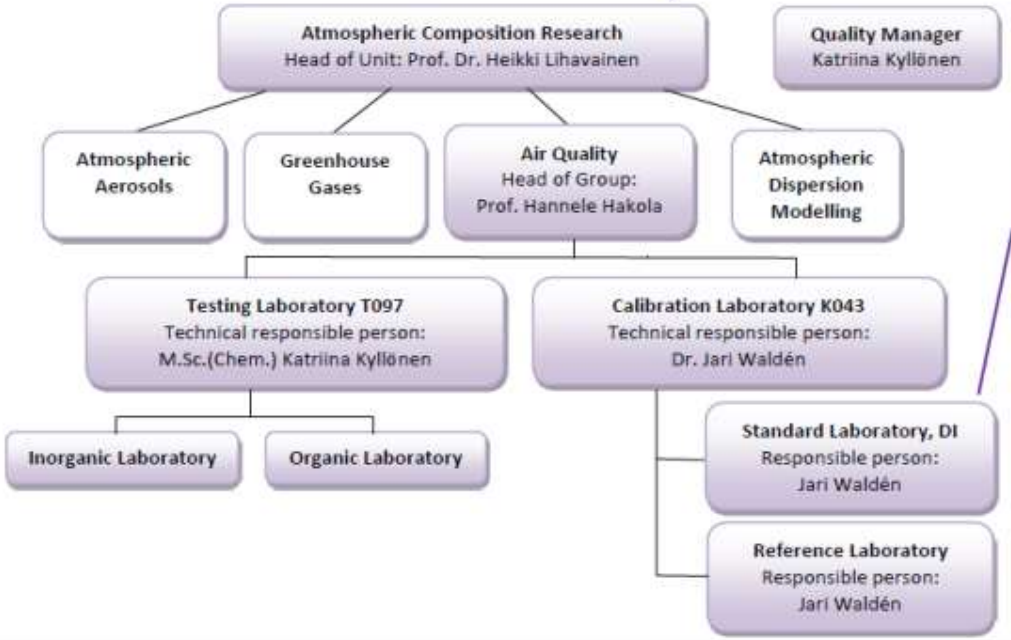
Standard Laboratory, DI

Jari Waldén, Dr., Technical Manager of the Laboratory, ozone calibrations, Gravimetric Reference Method for Particulate Matter

Kaisa Lusa, M.Sc.(Eng), Dilution methods, gas and flow calibrations

Sisko Laurila, Assistant Researcher, Permeation method, Calculation of the results, register

Quality Manager
Katriina Kyllönen, M.Sc. (Chem.)



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Akkreditointi

Laajennus virtausmittauksiin

- Alue 0 – 50 000 ml/min
- Useita eri mittausalueita: laimentimet, yksittäiset massavirtausmittarit ja säätimet eri käyttötarkoituksiin (kaasut, hiukkasmittausket)
- Kaasut: ilma, typpi

PÄTEVYYSALUE *SCOPE OF ACCREDITATION*		
Suure / menetelmä / kohde ***Quantity / method / object***	**Mittausalue** ***Measurement range***	**Mittauskyky, laajennettu mittausepävarmuus (*k*=2)** ***CMC, Expressed as Expanded Uncertainty (k=2)***
Kemialliset analyysit; referenssiaineet: kaasuseokset ***Chemical analyses; reference materials: gas mixtures***		
SO_2 ilmassa *SO_2 in air*	5 - 100 nmol/mol 100 - 1000 nmol/mol	0,7 - 1,8 nmol/mol 1,8 - 1,6 % (rel.)
NO ilmassa *NO in air*	5 - 100 nmol/mol 100 - 1000 nmol/mol	0,7 - 1,6 nmol/mol 1,6 - 1,4 % (rel.)
NO_2 ilmassa *NO_2 in air*	5 - 100 nmol/mol 100 - 1000 nmol/mol	0,7 - 3 nmol/mol 3,0 % (rel.)
CO ilmassa ja typessä *CO in air and nitrogen*	0,2 - 1 µmol/mol 1 - 100 µmol/mol	0,03 - 0,012 µmol/mol 1,2 % (rel.)
O_3 ilmassa *O_3 in air*	0 - 1000 nmol/mol	Q[1.3; 0.022 x (O_3)] [1)]
		1) Merkintä Q[a,b] tarkoittaa neliöllistä keskiarvoa hakasulkeiden sisällä olevista termeistä: $Q[a, b] = [a^2 + b^2]^{1/2}$. *1) The notation Q[a, b] stands for the root-sum-square of the terms between brackets: $Q[a, b] = [a^2 + b^2]^{1/2}$.*
Hiukkasmassan määritysmenetelmä *Determination* of particulate mass	0,055 - 11 mg	0,034 – 0,2 mg

Suunnitelmat

- EC/JRC Vertailu SO2, NO, NO2, CO ja O3 13. – 16.6. 2016

- Vertailu PM-referenssimeentelmä vs jatkuvatoiminen menetelmä vrt. FprEN 16450 Ch 8.6.2 Table 5.
  - Syksyllä 2016: 2 x 40 vrk vertailu
  - Keväällä 2017 : 4 x 40 vrk vertailu
  - Syksyllä 2017: 2 x 40 vrk vertailu

- Kaasumaisten yhdisteiden vertailu kunnissa 2017 touko-syyskuu

- Mittausohjeen päivitys

- Mittausjärjestelmien tarkastaminen

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Standardit

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

CEN Standardit

FprEN 16450:2015
Ambient air — Automated measuring systems for the measurement of the concentration of particulate matter PM10; PM2,5 (TS EN 1645 jatkotyö standardiksi).

Sisältää:

- **Demonstration of equivalence osion**
- **Type testing osion (Lab/Field), kuten kaasuanalysaattorit**
- **Jatkuvat laadunvalvonnan tehtävät kentällä (QA/QC)**
- **Ongoing verification of suitability**
- **Valmis 2016 (?)**

EN 14662-3:2015
Ambient air. Standard method for the measurement of benzene concentrations. Automated pumped sampling with in situ gas chromatography

EN 12341:2014
AMBIENT AIR. STANDARD GRAVIMETRIC MEASUREMENT METHOD FOR THE DETERMINATION OF THE PM10 OR PM2,5 MASS CONCENTRATION OF SUSPENDED PARTICULATE MATTER

- **Review prosessi alkaa 2016**
- **Sisältää Type testing osion kuten kaasuanalysaattorit**
- **Päivitetään tarpeelliset vaatimukset suodatinmateriaalien osalta**
- **Aloitus lokakuu 2016**

CEN Standardit, FprEN 16450

Table 4 — Required frequency of calibration, checks and maintenance

Calibration, checks and maintenance	Clause	Minimum Frequency[a]	Lab/ field	Action criteria[b]	Uncertainty requirements for transfer standards
Checks of status values of operational parameters (see 7.5.4)	8.4.3	Daily (on working days)	L / F	See below	
Checks of sensors for temperatures, pressure and/or humidity[c]	8.4.4	Every 3 months	F	± 2 °C ± 1 kPa ± 5 % RH	
Calibration of sensors for temperatures, pressure and/or humidity[c]	8.4.5	Every year	L / F		1,5 °C 0,5 kPa 3 % RH
Check of the AMS flow rate(s)	8.4.6	Every 3 months	F	± 5 %	2 %
Calibration of the AMS flow rate(s)	8.4.7	Every year	L / F		1 %
Leak check of the sampling system	8.4.8	Every year	F	± 2 %	
Zero check of the AMS reading	8.4.9	Every year	L / F	± 3 µg/m³	
Check of the AMS mass measuring system	8.4.10	As recommended by the manufacturer and after repair, but at least every year	L / F	as set out by manufacturer, or ± 3% if necessary	
Regular maintenance of components of the AMS	8.5	As required by the manufacturer	L / F	as set out by manufacturer	

[a] Frequencies of checks and calibrations may be relaxed when sufficient history exists demonstrating that drifts of sensor readings and flow rates remain within the specified requirements.

[b] With reference to nominal values.

[c] For some instruments such checks and calibrations are not possible in situ because of the positioning of the sensors within the AMS. Therefore, these checks and calibrations are restricted to sensors that are accessible in the field (typically in the sampling head). As a part of the annual checks, the checks may be performed in a laboratory room with constant temperature and relative humidity by comparing sensor readings (after stabilization) with those of reference standards.

CEN Standardit, FprEN 16450

Table 5 — Requirements for ongoing comparisons with the reference method

W_{AMS}, in %	≤10	>10 to ≤15	>15 to ≤20	>20 to ≤ 25
% of sites for on-going equivalence[a]	10	10	15	20
Number of sites for on-going equivalence[a]	2	3	4	5
[a] The smaller of the two resulting numbers may be applied. The minimum number of on-going equivalence test sites is 2 for each type of AMS.				

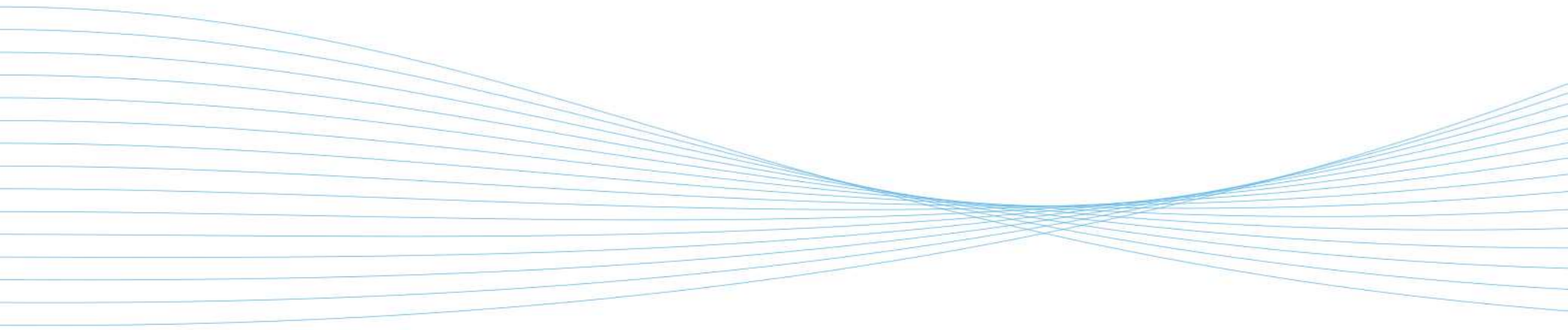
Esim:

W_{AMS}(%) 10 – 15 %

- Vähintään 2 - 3 mittausasemaa
- Testaus tasaisesti vuoden aikana
- Vähintään 80 onnistunutta vrk-näytettä
- 1 kpl AMS vs 1 kpl REF

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Representativeness
FAIRMODE



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Spatial Representativeness of Air Quality Monitoring Stations: Status of the Intercomparison Exercise

Oliver Kracht and Michel Gerboles, EC/JRC/Ispra

Objectives:

The **intercomparison exercise** on spatial representativeness (SR) methods shall:

- Be **executed by different groups**, but on the same **shared dataset**.

- Cover as much as possible the total **variety and diversity of procedures which are in use today** - ranging from methods with moderate complexity, used for pragmatic purposes, to those which involve higher levels of data requirements and computational efforts.

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Spatial Representativeness of Air Quality Monitoring Stations: Status of the Intercomparison Exercise

Oliver Kracht and Michel Gerboles, EC/JRC/Ispra

Objectives:

The **intercomparison exercise** on spatial representativeness (SR) methods shall:

- Be **executed by different groups**, but on the same **shared dataset**.

- Cover as much as possible the total **variety and diversity of procedures which are in use today** - ranging from methods with moderate complexity, used for pragmatic purposes, to those which involve higher levels of data requirements and computational efforts.

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Spatial Representativene

Suomi: Katja Lovén (IL) koordinoi:
IL, HSY, Kuopio, Turku, …

B) Future Dates

Feb. 2016

- Simulations based on the RIO-IFDM-OSPM model chain
  - Done by VITO (W. Lefebvre, H. Hooyberghs, S. Janssen, B. Maiheu)

April 2016

- Inspection of datasets by JRC

May 2016 (tentative)

- Official distribution of datasets
  - Datasets to be made available to participants for download from the FAIRMODE homepage

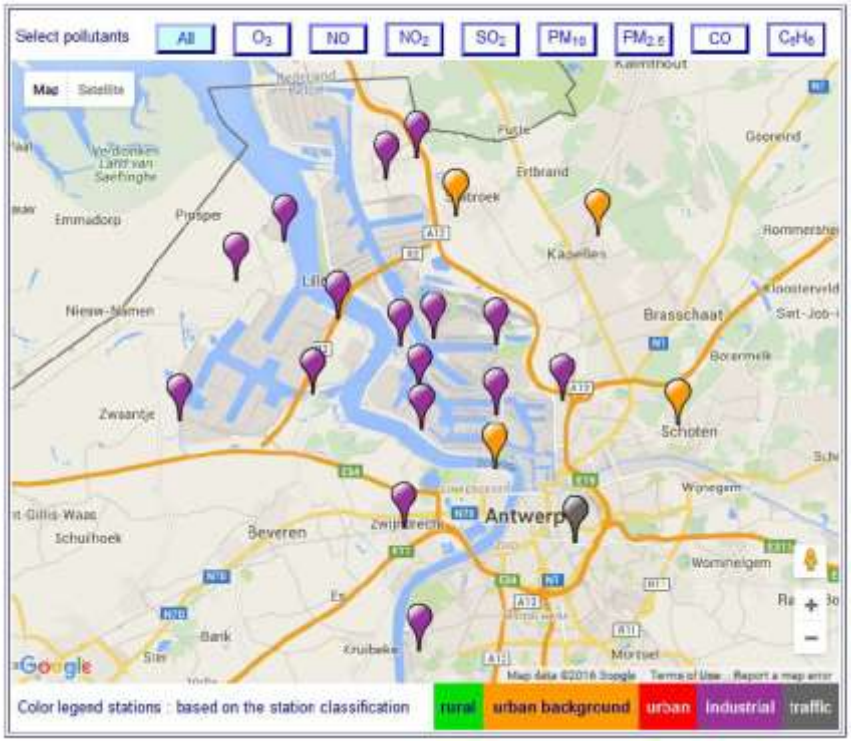
Summer 2016

- FAIRMODE Technical Meeting
  - Possibility to discuss and answer questions on technical details, means and operation (datasets, timeframe …)

Sept. 2016 (tentative)

- Return of the SR results provided by participants
  - Uploading facility made available on FAIRMODE homepage

Country	Institution
Austria	Umweltbundesamt Austria
Belgium	Flemish Environment Agency (VMM)
Belgium	VITO
Finland	Finnish Meteorological Institute
Finland	Helsinki Region Environmental Services Authority
Finland	City of Kuopio / Regional Environmental Protection Services
Finland	City of Turku / Environmental Division
France	INERIS
Germany	LANUV, FB 42
Germany	IVU Umwelt GmbH
Ireland	Irish EPA
Italy	ENEA
Netherland	TNO
Netherland	National Institute for Public Health and the Environment
Spain	Barcelona Supercomputing Center
Spain	CIEMAT
Spain	Technical University of Madrid (UPM)
Sweden	Swedish Meteorological and Hydrological Institute
UK	Ricardo-AEA
	JRC
total =	20



Spatial Representativeness

Datasets to be made available (1)

Measurements of the Antwerp monitoring stations

- Automatic network for the city of Antwerp and its regional area sites).
- All available compounds shall be included.
  - $PM_{2.5}$, PM_{10}, O_3, $NO/NO_2/NO_x$, CO, SO_2
  - BTX and available VOCs
  - Two averaging times (hourly and yearly)
- The official classification of these stations should also be supplied

(3) Modelled concentration obtained from the RIO-IFDM-OSPM simulations

- Gridded model data
  - $PM_{2.5}$, PM_{10}, O_3 and NO_2
  - Annual averages on a regular grid (probably at 10m resolution)
- Virtual monitoring points
  - Ca 340 points at traffic sites and at urban background locations
  - $PM_{2.5}$, PM_{10}: daily and annual averages
  - O_3 and NO_2: hourly and annual averages
  - Daily and hourly data **not** visible to participants? **(to be discussed)**
- Virtual diffusive samplers
  - Ca 340 synthetic series generated from the virtual monitoring points
  - Integration time of 2 weeks (1 week or 4 weeks if this would be required)
  - Added random noise corresponding to the data quality objectives for indicative measurements

Auxiliary measurements from sampling campaigns (passive samplers and mobile stations)

- PM_{10} and chemical speciation
  - daily averages of taken every 4th day at 3 sites
- NO_2
  - 2-week averages taken at 6 sites

Datasets to be made available (4)

Emission datasets

- Gridded emissions at 1x1km²
  - $PM_{2.5}$, PM_{10}, NO_x, NH_3, NMVOCs, CO, SO_2
  - Split up into different SNAP-sectors + total of all sectors

Additionally downscaled emission information:

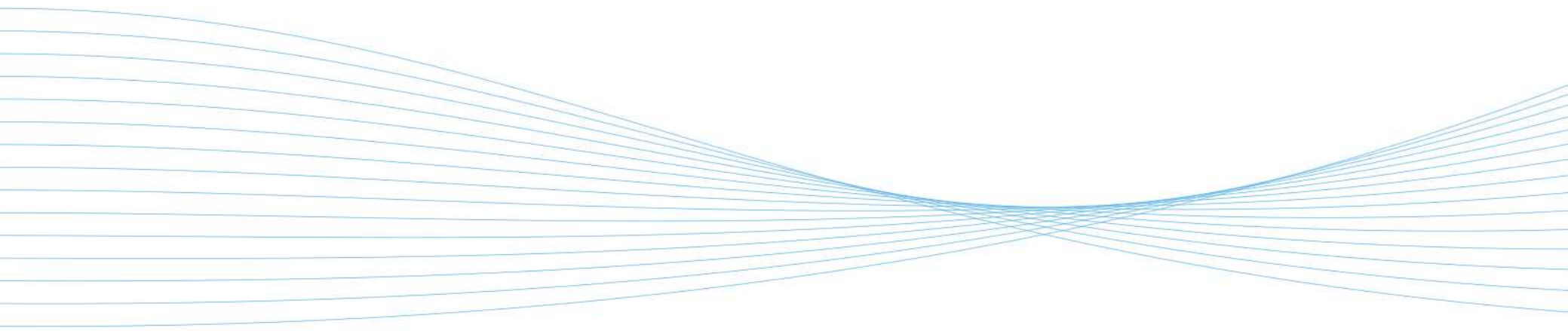
- Traffic emissions at 1x1km²
  - Annual average emissions per line segment of roads
  - Annual average traffic per line segment
- Point sources
  - Point sources reported by Belgian authorities in the scope of the CLRTAP Convention on Long-range Transboundary Air Pollution
  - Annual totals for 2010

Auxiliary datasets

- Population density for the great Antwerp area
  - gridded on a 100x100 m² grid
- Cadaster of building height
  - gridded on a 100x100 m² grid
- CORINE land use data
  - CORINE land cover classification (CLC2012)
  - gridded on a 100x100 m² grid

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

AQUILA



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

AQUILA Structure

AQUILA

- Members: 37 National Reference Laboratories from 28 Member States & EFTA
- Associate members:
  - World Health Organisation Collaborating Centre (Berlin, Hans-Guido Mücke
  - European Environment Agency (Michel Houssiau)
  - European Topic Centre on Air and Climate Change (Frank De Leeuw)
- Observers:
  - Institute of Public Health, Belgrade, Republic of Serbia
  - Ministry of Environment and Physical Planning, Skopje, Republic of Macedonia
  - Ministry of Environment and Forestry, Ankara, Turkey

- Steering committee: chair, vice chair and co-chairs
- Election of vice chair (4 years)
- Co-chair: DG-ENV, JRC-IES (4 years)
- Secretariat: JRC-IES

Chair
Jari Waldén
FMI, FI

Vice-chair
Brian Stacey
Ricardo-AEA, UK

Senior Advicer
Peter Woods,
NPL, UK

Co-chair
Marta Munoz
DG ENV

Co-Chair
Annette Borowiak
JRC IES

Objectives and Main Aims of AQUILA

Established with support of EC Directorate General Environment and the Joint Research Centre, Ispra.

- Provide a forum for the regular exchange of scientific and technical information between NRL's to improve knowledge, accuracy of results, enhance monitoring methods and harmonise QA.QC practises across Europe

- Provide coherent, expert, internationally agreed judgements and advice, on issues related to measurements and their strategy at EU level

- To provide scientific and technical advice,
  - To other NRL and to other organizations (EEA, WHO,)
  - To EC to support current EU legislation and development of future policy
  - To Competent Authorities in the MS: assist with dissemination of EU policies, monitoring requirements, ensure their up-to-date implementation and interpretation

- To raise the profile of the roles, responsibilities and activities of AQUILA and NRLs

- **Coordinate international and national interlaboratory comparison exercises carried out for the purposes of demonstrating the harmonisation of ambient air quality measurements across Euro**pe

- Participate in European standardization activities in the field of relevant ambient air measurements

- Act as a forum for the collation of practical experiences on published standards

1480/2015/EU: Annex II: Quality assurance for ambient air qualty assessment

To ensure accuracy of measurements and compliance with the DQO, MS shall ensure:

- All measurements are traceable in accordance with the requirements by harmonized standards for testing and calibration laboratories
- Established QA &QC system to assure continuous accuracy of measuring devices. Reviewed by NRL at least every 5 years
- QA/QC process is established for process of data collection and reporting. Participation in the related Union-wide quality assurance programmes
- National Reference Laboratories
  - Are appointed by appropriate competent authority or body at MS
  - Are accredited for the reference methods defined by the 1480/2015/EU
  - Coordination in MS the Union-wide QA programmes
  - Coordinating in the MS the use of reference methods and the demonstration of equivalence of non-reference methods
  - Organizing intercomparison at MS where applicable. Accreditation should cover the activity
  - NRL takes part at least every 3 years in the Union-wide QA programmes (Interlaboratory comparison, IE) organized by JRC. If NRL fails: Report of the cause and demonstration of remediation in the next IE
  - NRL support the work done by the European network od National Reference Laboratories set up by the Commission **(=AQUILA**)

TA reports ENXXXx:2012-

NOx: EN14211:2012

Manufacturer	Product	Components
Ecotech Pty Ltd	Serinus 40	NOx,
Environnement S. A	AC32M	NO, NO_2, NOx,
HORIBA Europe GmbH	APNA 370	NO, NO_2, NOx,
Teledyne Advanced Pollution Instrumentation	M200E T200	NOx,
Thermo Fisher Scientific	Model 42i	NO, NO_2, NOx,

SO2:EN14212:2012

Manufacturer	Product	Components
Ecotech Pty Ltd	Serinus 50	SO_2,
Environnement S. A	AF22M	SO_2,
HORIBA Europe GmbH	APSA 370	SO_2,
Opsis AB	AR 500 mit ER 120	NO_2, SO_2, Ozon (O_3),
Teledyne Advanced Pollution Instrumentation	M100E T100	SO_2,
Thermo Fisher Scientific	Model 43i	SO_2,

O3: EN14625:2012

Manufacturer	Product	Components
Ecotech Pty Ltd	Serinus 10	Ozon (O_3),
Environnement S. A	O342M	Ozon (O_3),
Environnement S. A	O342e	Ozon (O_3),
HORIBA Europe GmbH	APOA 370	Ozon (O_3),
Opsis AB	AR 500 mit ER 120	NO_2, SO_2, Ozon (O_3),
Teledyne Advanced Pollution Instrumentation	M400E T400	Ozon (O_3),
Thermo Fisher Scientific	Model 49i	Ozon (O_3),

CO: EN14626:2012

Manufacturer	Product	Components
Ecotech Pty Ltd	Serinus 30	CO,
Environnement S. A	CO12M	CO,
HORIBA Europe GmbH	APMA 370	CO,
Teledyne Advanced Pollution Instrumentation	M300E T300	CO,
Thermo Fisher Scientific	Model 48i	CO,

Benzene: DIN EN 14662-3:Version 2015?

Manufacturer	Product	Components
AMA Instruments GmbH	GC 5000 BTX Ausführung FID	benzene,
AMA Instruments GmbH	GC 5000 BTX Ausführung PID	benzene,
Environnement S. A	VOC 72M	benzene,
Synspec B. v.	GC 955 Modell 601 PID	benzene,

Equivalence reports

Manufacturer	Product	Components	Test laboratory/MS	Standard	DoE checked	Notes
Comde-Derenda GmbH	Air Pollution Monitor 2 (APM-2)	PM 10, PM 2.5,	TYV	EN12341:1998 EN14907:2005	No check No check	not in line with EN12341
DURAG GmbH	F 701-20	PM 2.5,	TYV	EN14907:2005	No check	Pass
DURAG GmbH	F 701-20	PM10	TYV	EN12341:1998	No check	Pass
Ecotech Pty Ltd	Spirant BAM 1000 PM10	PM 10,	TYV	EN12341:1998	No check	Pass
Ecotech Pty Ltd	Spirant BAM 1100 PM25	PM 2.5,	TYV	EN14907:2005	No check	Pass
FAI Instruments s.r.l.	SWAM 5a Dual Channel Monitor für PM10 und PM2,5	PM 10, PM 2.5,	TYV	EN12341:1998 EN14907:2005	Yes/MCERT Daily & hourly mode	Approved
HORIBA Europe GmbH	APDA-371 mit PM2,5-Vorabscheider	PM 2.5,	TYV	EN14907:2005	No check	Pass
HORIBA Europe GmbH	APDA-371 mit PM10-Vorabscheider	PM 10,	TYV	EN12341:1998	No check	Pass
HORIBA Europe GmbH	APDA-372 PM 2.5 / PM10	PM 10,	TYV Austria	EN12341:1998 EN14907:2005	No check	Pass
Met One Instruments Inc.	BAM 1020 mit PM2,5-Vorabscheider	PM 2.5,	TYV Finland France	EN14907:2005 EN12341:2014 EN12341:2014	Yes/MCERT Smart heater EPA inlet	Approved
Met One Instruments Inc.	BAM 1020 mit PM10-Vorabscheider	PM 10,	TYV Finland France		Yes/MCERT With and without smart heater, EPA inlet	Approved

Equivalence reports

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Manufacturer	Product	Components	Test laboratory/MS	Standard	DoE checked	Notes
Opsis AB	SM 200 PM2,5	PM 2.5,	UK	EN14907:2005		
PALAS GmbH	Fidas 200 S	PM 10, PM 2.5,	TYV France Belgiun	EN12341:1998 EN12341:2014 EN14907:2005	Ongoing evaluation according MCERT	Pass Pass
Thermo Fisher Scientific	Model 5014i PM 2.5	PM 2.5,	TYV	EN14907:2005 EN12341:2014	No check	Pass
Thermo Fisher Scientific	Model 5014i PM 10	PM 10,	TYV	EN12341:1998 EN12341:2014	No check	Pass
Thermo Fisher Scientific	Model 5030i PM 2.5	PM 2.5,	TYV	EN14907:2005 EN12341:2014	AQUILA check list	Approved
Thermo Fisher Scientific	Model 5030i PM 10	PM 10,	TYV	EN12341:1998 EN12341:2014	AQUILA check list	Approved
Thermo Fisher Scientific	TEOM 1405-F Ambient Particulate Monitor mit PM10- Vorabscheider	PM 10,	TYV France	EN12341:1998	MCERT	Approved
Thermo Fisher Scientific	TEOM 1405-F Ambient Particulate Monitor mit PM2.5- Vorabscheider	PM 2.5,	TYV France	EN14907:2005	MCERT	Approved
Thermo Fisher Scientific	TEOM 1405-DF Ambient Particulate Monitor mit PM10 und PM2.5- Vorabscheider	PM 10, PM 2.5,	TYV France	EN12341:1998 EN14907:2005	MCERT	Approved

Equivalence reports

Manufacturer	Product	Components	Test laboratory/MS	Standard	DoE checked	Notes
	Grimm 180	PM2.5/PM10	Austrian Finland	EN12341:2014 EN12341:2014		
Environnement S.A	MP101	PM2.5/PM10	Finland France	EN12341:2014 EN12341:2014		

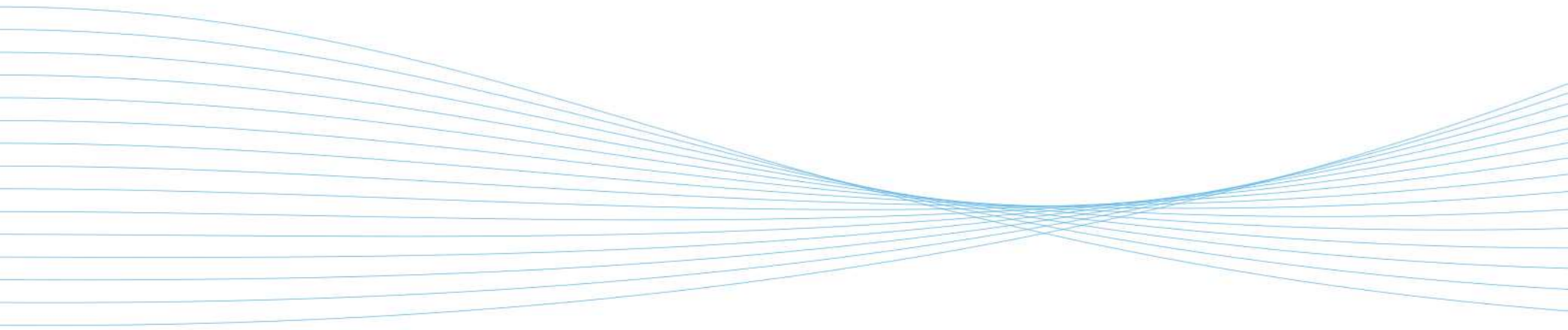
SUMMARY

- **TA reports checked by Theo Hafkencheid does not give evidence on improved consistency with the relevant EN-standards**
  - Findings are similar discovered by Spanish NRL years ago
  - Final acceptance of TA by MS competent authority

- **DoE check list by AQUILA ready to distribute to MS**
- **MCERT check list in line with the AQUILA check list**
  - Summary reports by MCERT procedure complete and informative
- **Most of the DoE reports available at www.qal1.de have been conducted according to standards EN12341:1998 and EN14907:2005:**
- **Analysis of the test report according to AQUILA and / or MCERT check list follows the EN 12341:2014, GDE: 2010 and TS 16450**

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Measurement methods in AirBase



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Meta-data on measurement methods in AirBase

Frank de Leeuw

AQUILA meeting, Boveno 15-16 February

- More insight in data quality:
- AQ Directive requires “demonstration of equivalence”
- Coordinating role NRL

- e-reporting (2011/850/EC):

(8) Measurement type

(9) Measurement/sampling/analytical method

(10) Measurement/sampling equipment (where available)

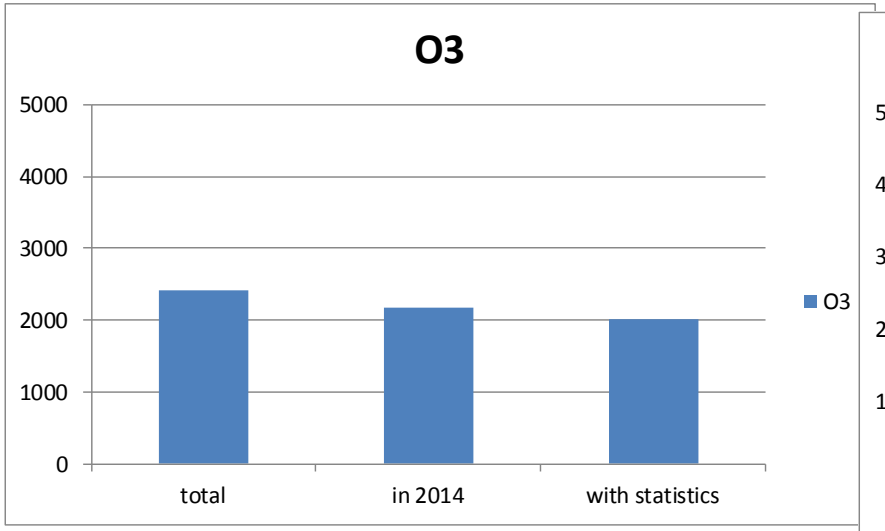
(11) Detection limit (where available)

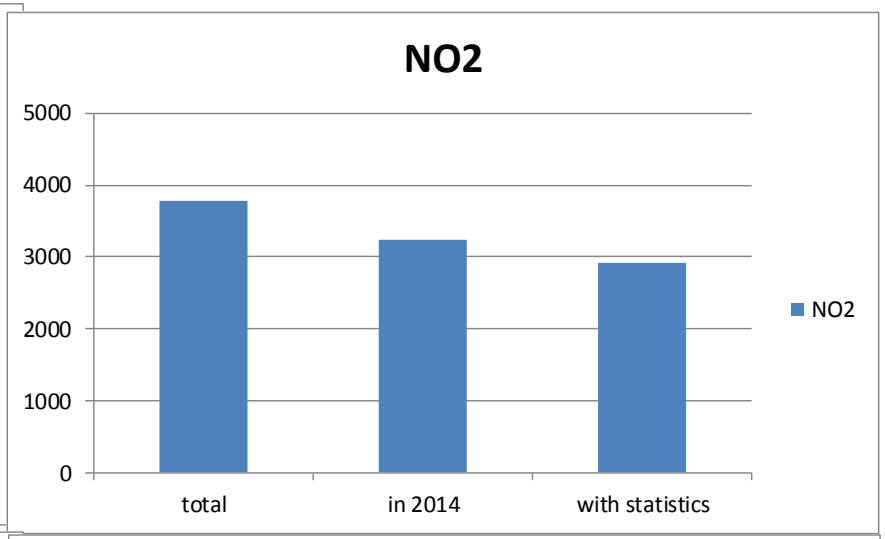
(12) Demonstration of equivalence

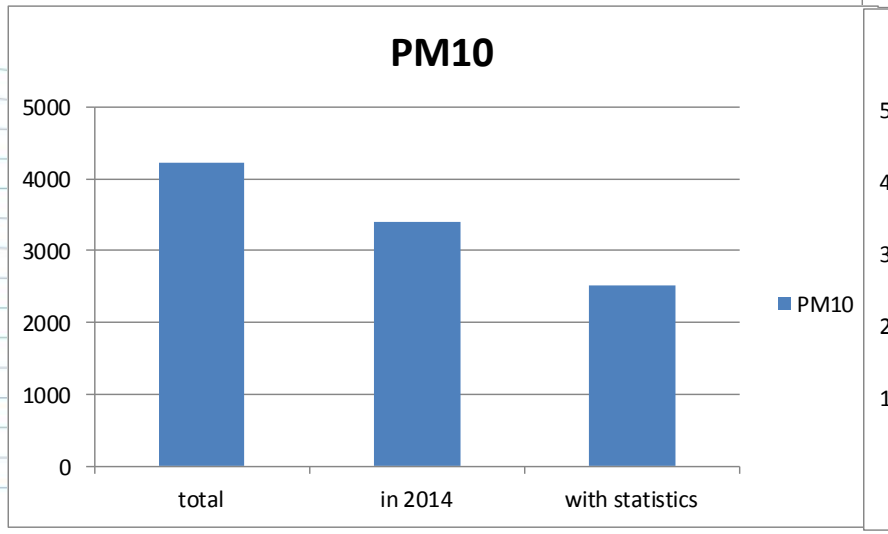
(13) Demonstration of equivalence: Documentation (web link)

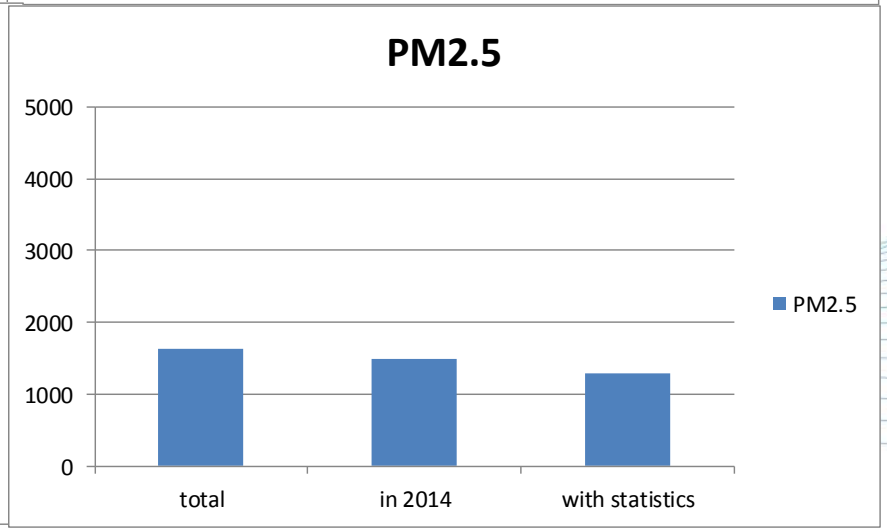
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Air Quality measurement sites/compound









ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

PM10 mittausmenetelmät

automatic	Counts
Beta ray attenuation	1326
TEOM-FDMS	349
TEOM	333
Nephelometry + BETA	205
Other, please specify	170
Light scattering	155
Nephelometry	21
<not reported>	6
Chemiluminescence	1
UV fluorescence	1
Grand Total	2567

non-automatic	Counts
Gravimetric analysis	820
Atomic absorption spectrometry (AAS)	3
High performance liquid chromatography - fluorescence detection (HPLC-FLD)	2
Graphite furnace atomic absorption spectrometry (GF-AAS)	1
Grand Total	826

Beta ray attenuation	**1326**
Unknown	214
Other	151
Thermo Andersen ESM FH 62 I-R	150
not reported	146
Environnement S.A. Model MP101M PM10 Monitor	117
SWAM 5a Dual channel monitor	110
too generic	99
MetOne BAM-1020	97
Thermo model 5030 SHARP Particular Monitor with PM10 & PM2.5 heads	51
Andersen/GMW Model FH621-N Beta Monitor	31
Teledyne API 200A chemiluminescent NOx analyser	31
Horiba model APNA 360 NOx analyser	2
GRIMM model EDM 365 for PM10, PM2.5, PM1 and TC	1
ONLY USED IN ONE STATION IN RS	1
SYNTECH SPECTRAS GC 955 series undetermined	1
TEOM 1400AB with FDMS module (8500)	1
Thermo model 42 NO/Nox analyser	1
Thermo model 42c NO/Nox analyser	1
Thermo model 43i SO2 analyser	1

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

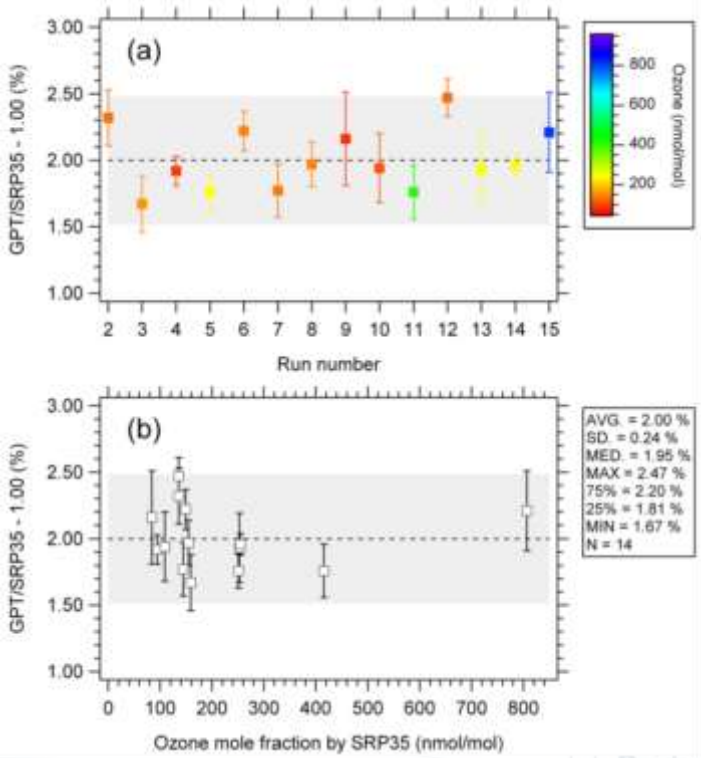
Otsoni

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INST

Towards the adoption of a new O_3 cross-section value in Ozone Photometers

GAW Scientific Advisory Group on Reactive Gases
meeting KRISS Oct. 2014

$$\frac{I}{I_0} = e^{-\alpha L C} \longrightarrow c = \frac{-1}{\sigma \cdot L} \cdot \frac{k \cdot T}{P} \cdot \ln(I / I_o)$$



Absorption Cross Section of Ozone committee – recommend new values for stratospheric ozone?

2018 Implementation plan for new recommended value and uncertainty

Stakeholder consultation **2017**

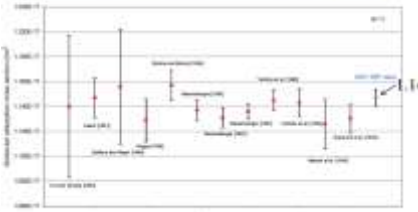
Published OXS-TG value and uncertainty **2016**

2015 GAWG Establish GAWG-OXS-TG

Environmental Protection Agencies
Via NMIs and DIs?

Air Quality Reference Laboratories Monitoring Networks
AQUILA meeting, etc...

Value of the absorption cross-section at 253.7nm



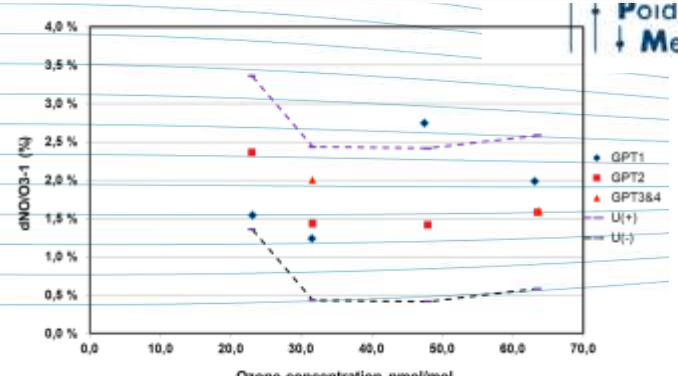
Slide borrowed from Robert Wielgosz

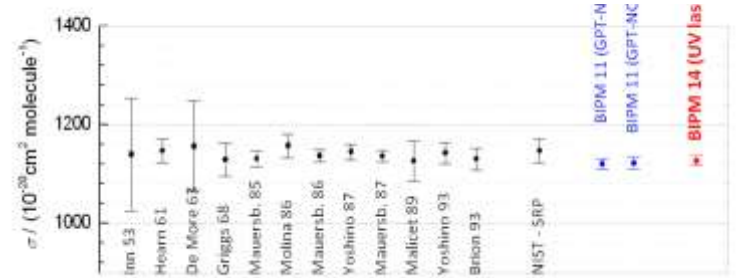
ISO ISO 13964 (Ozone by UV photometry)
Next revision ***2015***

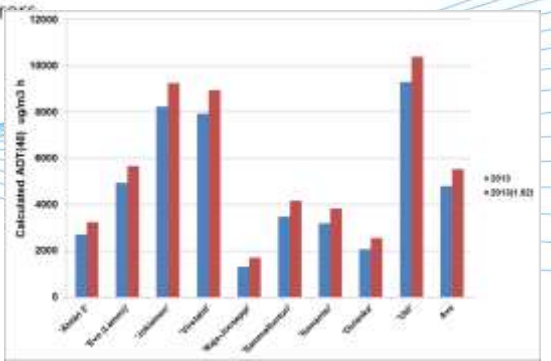
Ozone photometers manufactur

Slide by Robert Wielgosz/BIPM

onal des
Poids et Mesures







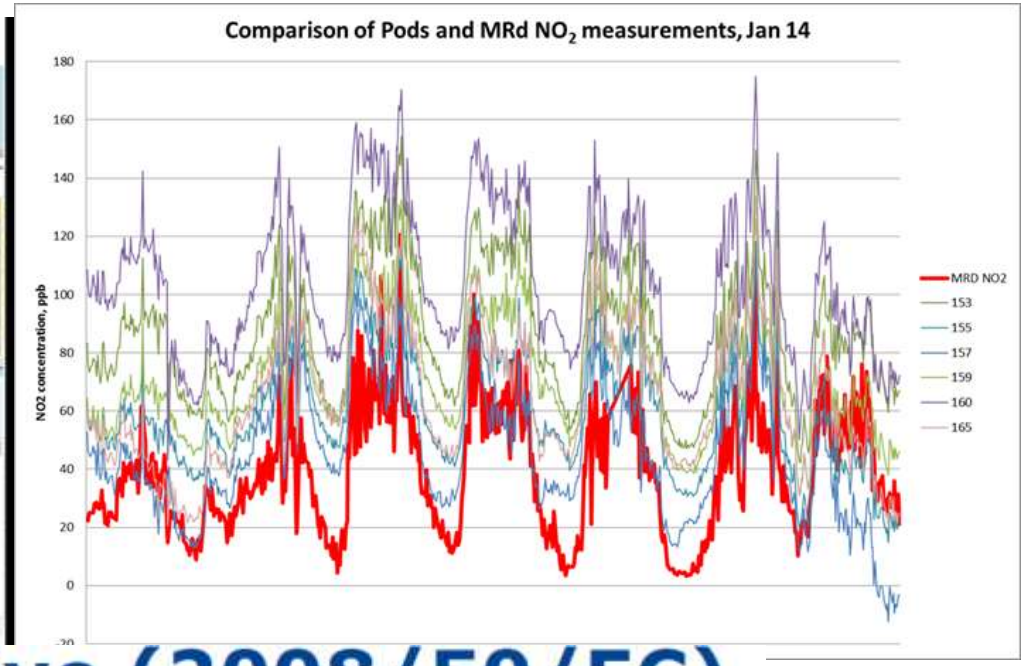
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Sensors for Air Quality Measurements

With contribution by
- Michele Gerboles/EC/JRC
- Brian Stacey, Ricardo, UK
- Sergey Novikov/Aalto University, Espoo

Use of Sensors for Air Quality Measurements

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE



Data Quality Objective (2008/50/EC)

	Fixed	Indicative	Modelling	Objective estimation
SO_2, NO_2/NOx, CO	15 %	25 %	50 % (30 % yearly)	75 %
Benzene	25 %	30 %	50 %	100 %
PM_{10}/$PM_{2.5}$	25 %	50 %	50 %	100 %
O3	15 %	30 %	50 %	100 %
CO2, N2O, CH4(not in Directive GAW)	r = 1 % ?			
	> UAT	UAT<[]<LAT	<LAT	<LAT

Sensors for Air Quality Measurements

Commission

MACPOll: evalaution of single sensors, rural site

Ozone:

- Amperometric: Good: precise, linear, long term stability, little matrix effect, hysteresis and temperature effect

  Less good: interference NO_2, humidity effect

- MOx: Good: low gaseous interference, precise, sensitive, humidity and temperature effect can be corrected

  Less good: calibration, lack of linearity, long term stability, matrix effect, response time

- DQO: Found Ok for one chemical sensor (NO2 interference and humidity effect solved)

- Calibration: field calibration better as lab calibration is not reproducible

Nitrogen dioxide: O_3 interference for amperometric sensors, matrix effect and humidity, gaseous interference on res. sensors – no good field results with chemical sensors (sensitive to O_3)

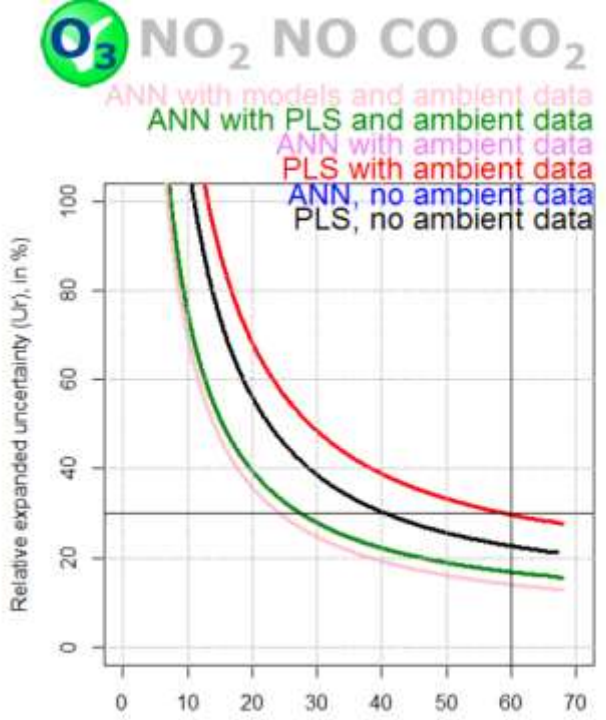
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

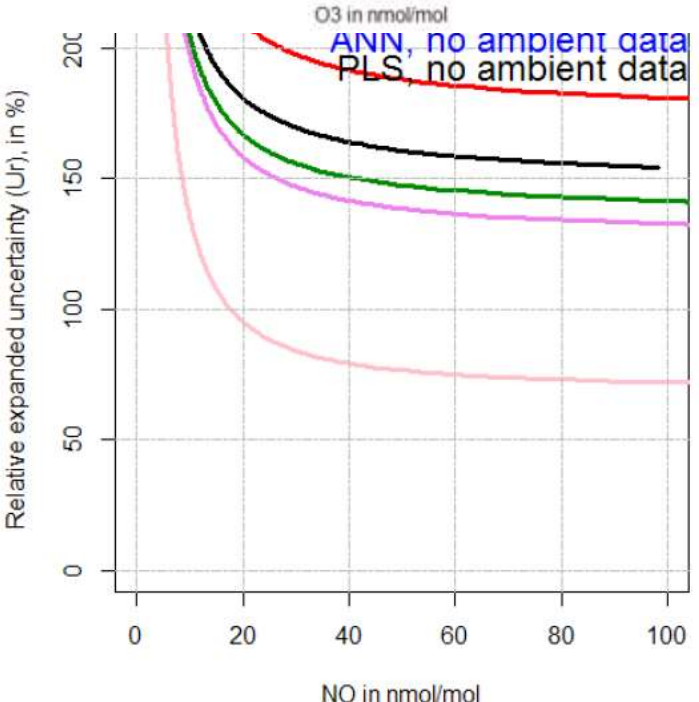
European Commission

Independent evaluation of sensors

Manufacturer (Model)	Type	Pollutant(s)	Approximate Cost	Time Resolution	Sensor vs FRM/FEM Method[1]
Dylos (DC1100)	Optical	$PM_{(0.5-2.5)}$	~$300	1 min	R^2 ~ 0.65 to 0.85
Shinyei (PM Evaluation Kit)	Optical	$PM_{2.5}$	~$1,000	1 min	R^2 ~ 0.80 to 0.90
RTI (MicroPEM)	Optical	$PM_{2.5}$	~$2,000	10 sec	R^2 ~ 0.65 to 0.90
HabitatMap (AirBeam)	Optical	$PM_{2.5}$	~$200	1 min	R^2 ~ 0.65 to 0.70
Met One (Neighborhood Monitor)	Optical	$PM_{2.5}$	~$1,900	15 min	R^2 ~ 0.53 to 0.67
Speck	Optical	$PM_{2.5}$	~$200	1 min	R^2 ~ 0
Naneos (Partector)	Electrical	PM (LDSA: Lung-Deposited Surface Area)	~$7,000	1 min	$PM_{1.0}$: R^2 ~ 0.1 $PM_{2.5}$: R^2 ~ 0.2
AethLabs (microAeth)	Optical	BC (Black Carbon)	~$6,500	1-300 sec	R^2 ~ 0.79 to 0.94
Air Quality Egg (Version 1)	Optical, Metal oxide	PM, CO, NO_2 and O_3	~$200	1 min	PM: R^2 ~ 0 CO: R^2 ~ 0 NO_2: R^2 ~ 0.40 O_3: R^2 ~ 0.85
Perkin Elmer (ELM)	Optical, Metal oxide	PM, NO, NO_2 and O_3	~$5,200	1 min	PM: R^2 ~ 0 NO: n/a NO_2: R^2 ~ 0 O_3: R^2 ~ 0.89 to 0.96
2B Technologies (PO_2M)	UV absorption (FEM Method)	O_3	~$4,500	10 sec	R^2 ~ 1.00
Aeroqual (S-500)	Metal oxide	O_3	~$500	1 min	R^2 ~ 0.85
Smart Citizen Kit	Metal oxide	CO, NO_2	~$200	1 min	CO: R^2 ~ 0.50 to 0.85 NO_2: R^2 ~ 0
AQMesh (v.3.0)	Electrochem	CO, NO, NO_2, SO_2, and O_3	~$10,000	1-15 min	CO: R^2 ~ 0.75 to 0.90 NO: R^2 ~ 0.75 to 0.90 NO_2: R^2 ~ 0 SO_2: R^2 ~ 0 O_3: R^2 ~ 0.25 to 0.55
AQMesh (v.4.0)	Electrochem	CO, NO, NO_2, and O_3	~$10,000	1-15 min	CO: R^2 ~ 0.42 to 0.80 NO: R^2 ~ 0.0 to 0.44 NO_2: R^2 ~ 0.0 to 0.46 O_3: R^2 ~ 0.46 to 0.83
UNI-TEC (SENS-IT)	Metal oxide	CO, NO_2 and O_3	~$2,200	1 min	CO: R^2 ~ 0.33 to 0.43 NO_2: R^2 ~ 0.60 to 0.65 O_3: R^2 ~ 0.72 to 0.83

http://www.aqmd.gov/aq-spec/evaluations#&MainContent_C001_Col00=2





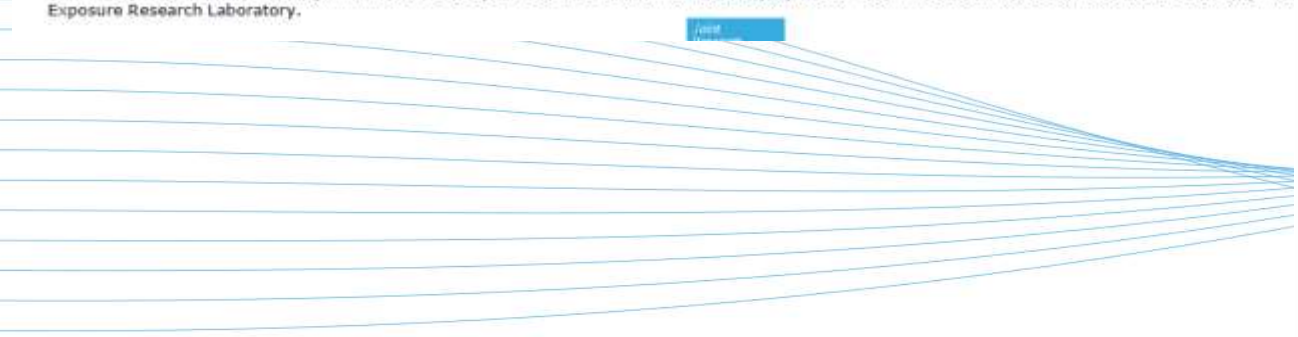
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

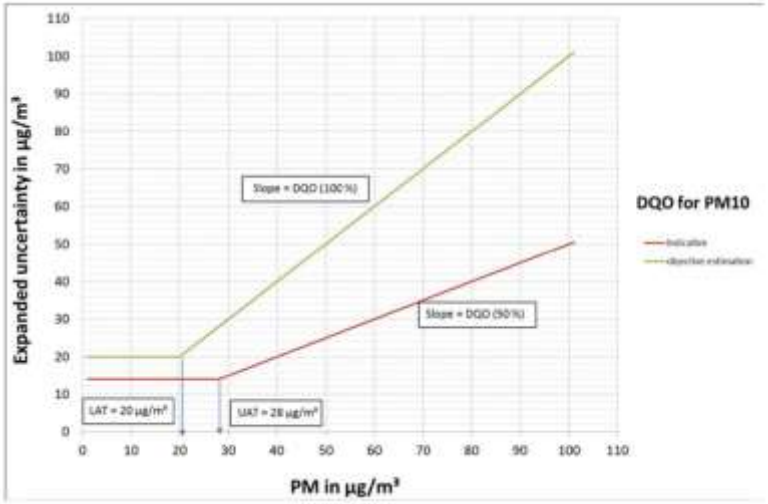
Sensors for Air Quality Measurements

Optical sensors for PM monitoring

Sensor	Method	Size Fraction	Measurement Unit	Weight (kg)	Shortest Time Resolution	Base Power Accessory	Data Retrieval Method
AirBase CanarIT	Optical	Undefined	ug/m^3	~2.5	20 sec	AC/DC Adapter	Proprietary Web Server
CairClip PM	Optical	$PM_{2.5}$	ug/m^3	~0.2	1 min	Battery	Proprietary Software
Carnegie Mellon Speck	Optical	Undefined	Particle counts	~0.25	1 sec	USB	Proprietary Software
Dylos DC1100	Optical	Undefined	Particle counts	~2	1 min	AC/DC Adaptor	Proprietary Software
Met One 831	Optical	<10µm	ug/m^3	~2	1 min	Battery	Proprietary Software
RTI MicroPEM	Optical	$PM_{2.5}$	ug/m^3	~0.5	10 sec	Battery	Proprietary Software
Sensaris Eco PM	Optical	$PM_{2.5}$	ug/m^3	~0.25	<1 min	USB	Proprietary Web Server
Shinyei PMS-SYS-1	Optical	$PM_{2.5}$	ug/m^3	~0.25	1 sec	Power Circuit Board	Proprietary Software

Williams, R., Kaufman, A., Hanley, T., Rice, J., Garvey, S., 2014. Evaluation of Field-deployed Low Cost PM Sensors, Office of Research and Developmen Exposure Research Laboratory.





Sensors for Air Quality Measurements

ILMATIETEEN LAITOS
METEOROLOGISK INSTITUT
FINNISH METEOROLOGICAL INSTITUTE

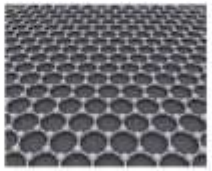
INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA

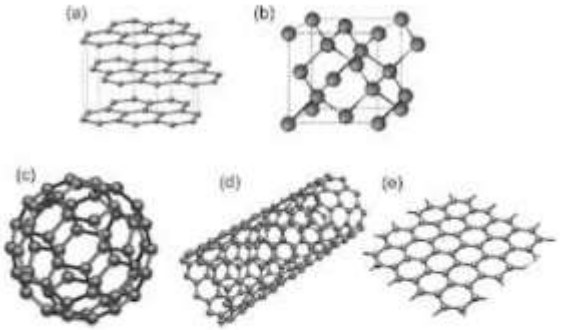
MACPoll

EMRP
European Metrology Research Programme
Programme of EURAMET
The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

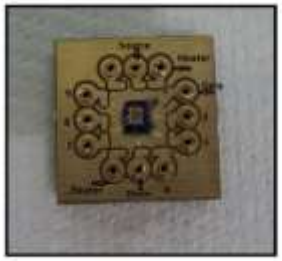
What is graphene?

- Graphene is pure carbon in the form of a very thin, nearly transparent sheet, basically one atom thick and can be described as a one-atom thick layer of graphite.
- Technically, graphene is a crystalline allotrope of carbon with two-dimensional properties.
- Carbon atoms are densely packed in a regular sp^2-bonded atomic scale hexagonal pattern.
- Graphene can also be considered as an indefinitely large aromatic molecule (the limiting case of the family of PAHs).
- It is remarkably strong for its very low weight, and it conducts heat and electricity with great efficiency.



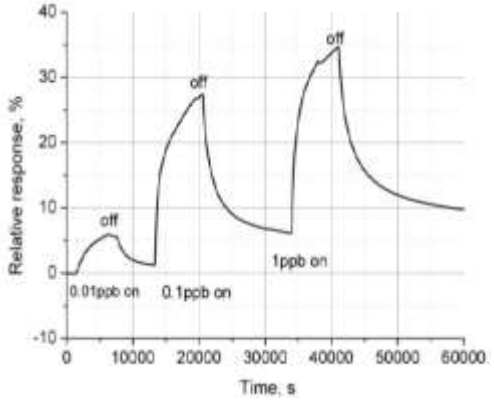


a) graphite
b) diamond
c) fullerene
d) carbon nanotubes
e) **graphene**



Graphene-based sensor in its final form with the indication of the various contacts.

The sensor is the central part. It is equipped with two **protection parts** (on the top and on the bottom) during its handling and storage.



- Increasing of resistivity indicates n-type of conductivity.
- The response of sensor is 5% at NO_2 concentration as low as 0.01 ppb.

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Sensors for Air Quality Measurements

CEN TC 264/WG42:

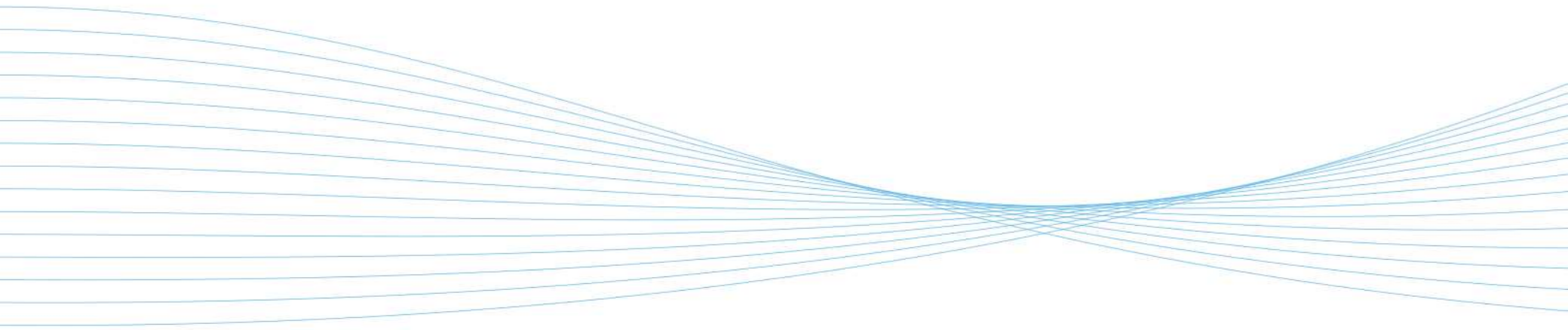
Air quality — Performance evaluation of sensors for the determination of concentrations of gaseous pollutants and particulate matter in ambient air

Commission

Parameters to be evaluated (E), corrected (C)

Parameters to be tested (significant ones: in bold)	Indicative method	Objective estimation	Informative method
Response time (at controlled conditions)	E (in lab.)	E (lab.)	E (in lab.)
Calibration at constant Temp. and RH	E/C (in lab.)	E/C (lab.)	E/C (in lab.)
Repeatability for 0 and span at constant Temp. and RH	E (in lab.)	E (lab.)	E (in lab.)
Short and **long term** drifts	E/C (in lab. or field)	E (lab or field)	E (only long term drift) (in field)
Cross sensitivities	E/C (in lab.)	E (in lab.)	E (in field)
Temperature (Temp.) and humidity (RH)	E/C (in lab.)	E (in lab.)	E (in field)
Hysteresis (concentration levels, Temp., RH), transient effects of humidity	E/C (in lab.)	E (in lab) (temp., RH), not transient	E (in field)
Wind velocity	E/C (in lab.)	E (in lab.)	E (in field)
Power supply	E/C (in lab.)	E (in lab.)	
Active sampling, loses … only for some sensors	E/C (in lab.)	E (in lab.)	
Electromagnetic fields …	E/C (in lab.)	E (in lab.)	
Pressure effect	E/C (in lab.)	E (in lab.)	E (in field)
Solar heating	E (in field)	E (in field)	

Demonstration of equivalency



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Demonstration of the equivalence of $PM_{2.5}$ and PM_{10} measurement methods in Kuopio 2014–2015

Jari Waldén
Tuomas Waldén
Sisko Laurila
Hannele Hakola

Ilmatieteen laitos
Meteorologiska Institutet
Finnish Meteorological Institute

Helsinki 2016

Referenssimenetelmä ja kandidaattimenetelmät

INSTRUMENTS	REPRESENTATIVE / MANUFACTURER	Method	PM10/PM2.5 inlet	Sample tube	Field campaign
REFERENCE SAMPLER	Leckel SEQ 47/50	Sequential sampler	Leckel	Ambient	T/S
Environnement MP-101+CPM	ENVIRONNEMENT SA (France)	β-attenuation + optical	Environment EN	Shield tube, ambient temp	T/S
GRIMM-180	FMI, Estonian Environmental Research Centre (Estonia)	Optical (light scattering)	Grimm	Shield tube,	T/S
SHARP 5030	FMI / THERMO Electron Co, (USA)	Light scattering +β-attenuation	Digitel /EN	Heated 35 ºC	T/S
FH-62-IR	FMI / THERMO Electron Co, (USA)	β-attenuation	Digitel /EN	Heated 35 ºC	T/S
BAM 1020	Estonian Environmental Research Centre (Estonia)	β-attenuation	US-EPA	Heated 40 ºC	T/S
TEOM-1405	JPP-kalibrointi ky, FMI	Tapered Element Oscillating Microbalance	US-EPA	Heated 50 ºC	T/S
OSIRIS	Hnu-Nordion (Finland) / Turnkey Instruments	Optical (nephelometer)	Osiris	Heated 35 ºC	T/S
DUST TRAK DRX 8533	TSI Inc (USA)	Optical (light scattering)	TSI	Ambient	S

Huom:

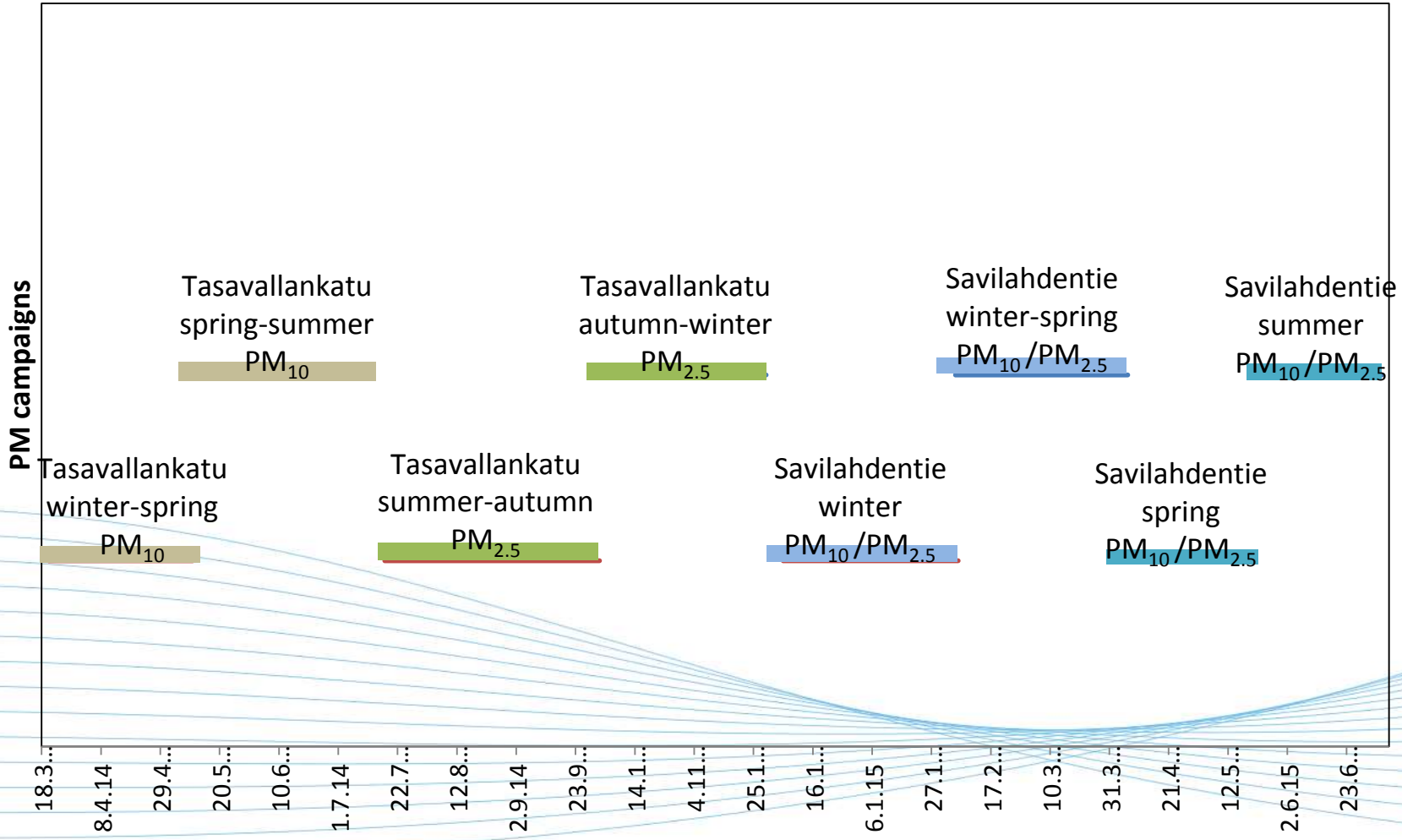
- Dust Trak liittyi vertailuun Savilahdentiella PM10 & PM2.5
- TEOM 1405 D:n osallistuminen peruttiin
- Dekati:n osallistuminen peruttiin

Referenssimenetelmä: Leckel SEQ47/50



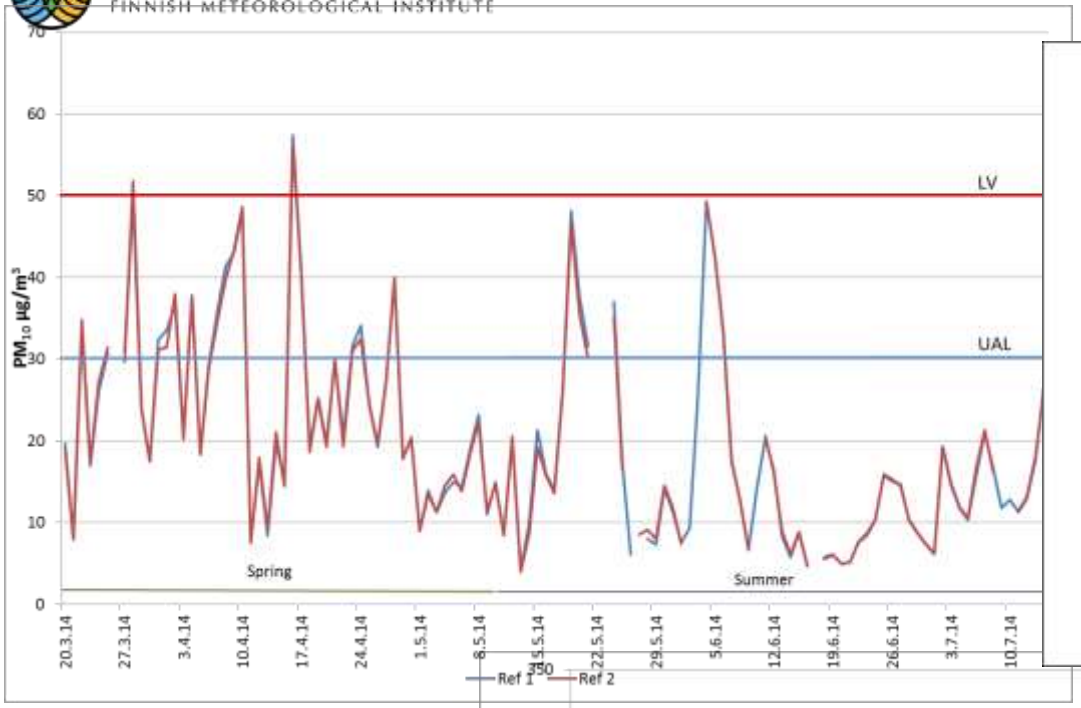


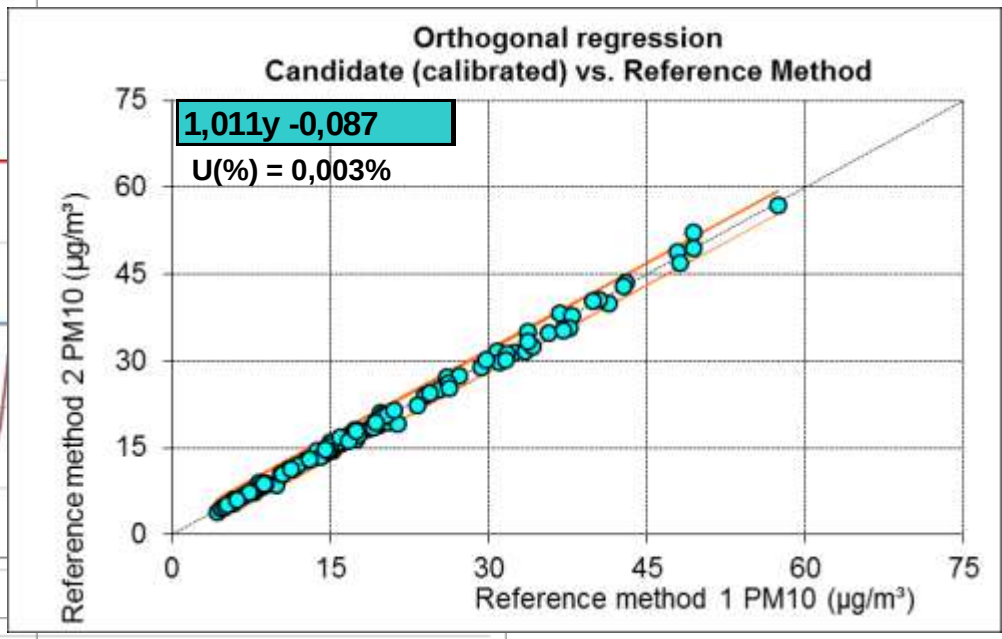

Mittausjaksot Kuopiossa (17.3.2014 – 7.7.2015)

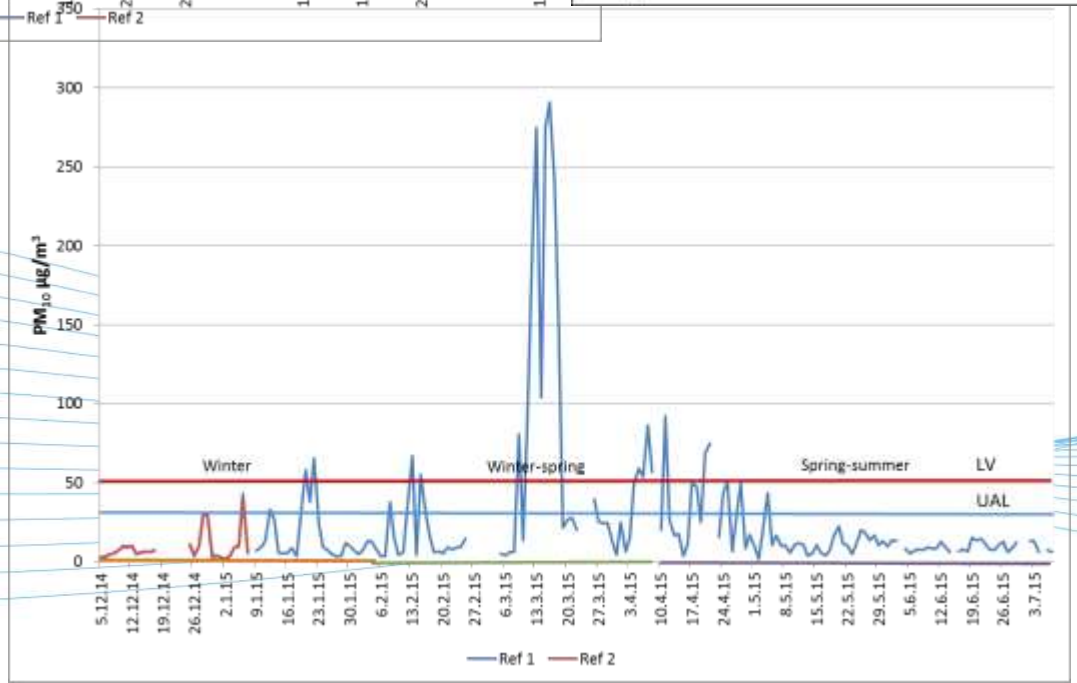

PM campaigns
Tasavallankatu spring-summer PM10
Tasavallankatu autumn-winter PM2.5
Savilahdentie winter-spring PM10/PM2.5
Savilahdentie summer PM10/PM2.5
Tasavallankatu winter-spring PM10
Tasavallankatu summer-autumn PM2.5
Savilahdentie winter PM10/PM2.5
Savilahdentie spring PM10/PM2.5
18.3...
8.4.14
29.4...
20.5...
10.6...
1.7.14
22.7...
12.8...
2.9.14
23.9...
14.1...
4.11...
25.1...
16.1...
6.1.15
27.1...
17.2...
10.3...
31.3...
21.4...
12.5...
2.6.15
23.6...

PM10 Referenssimenetelmä

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

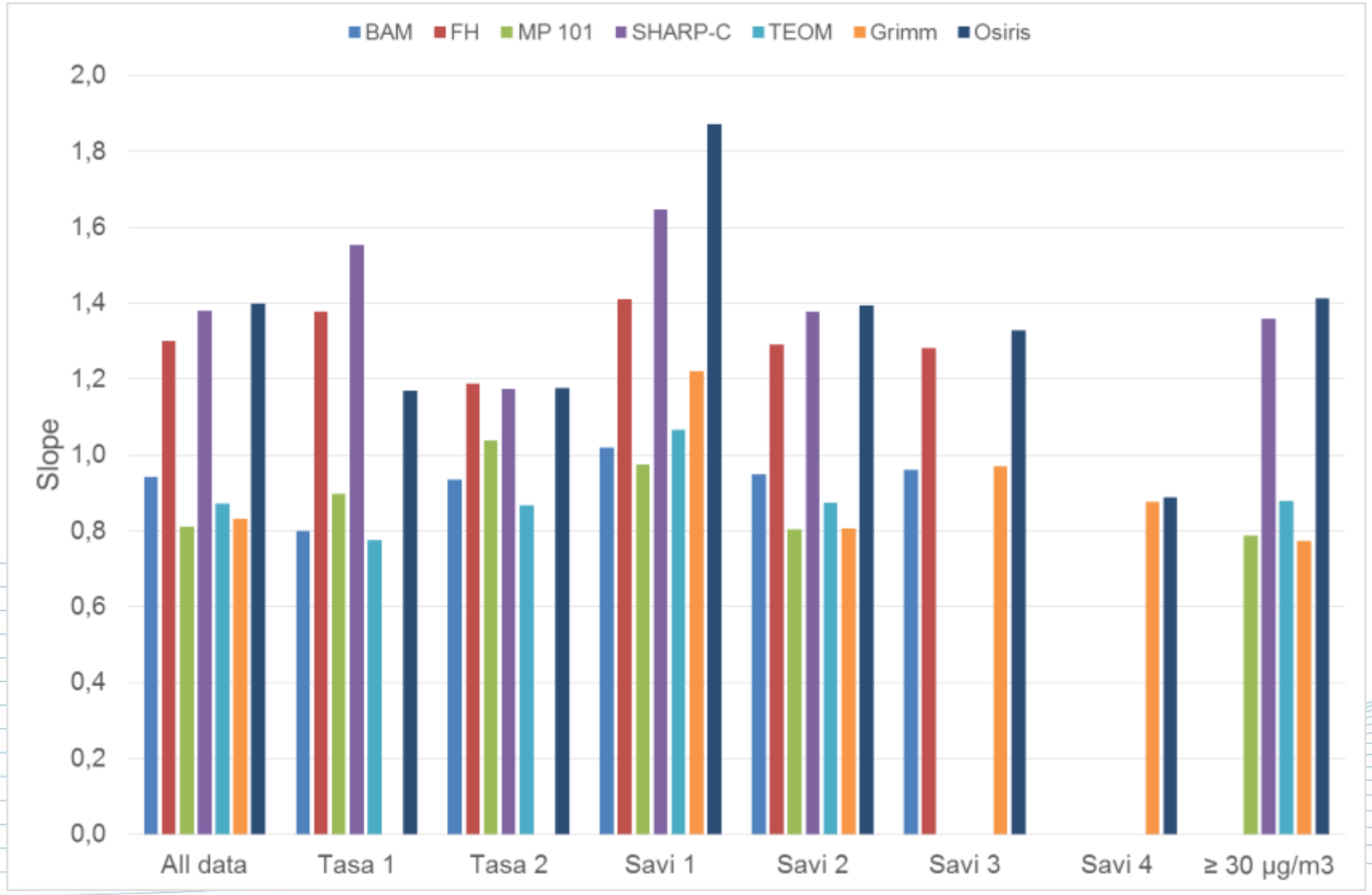






ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

PM10 Calibration slopes by CM



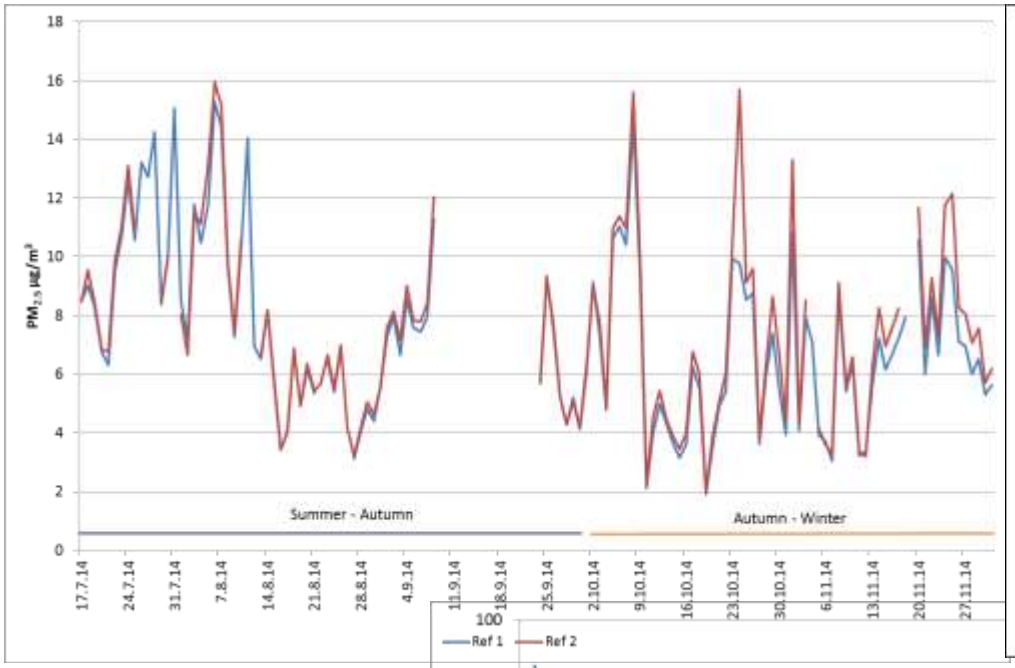
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

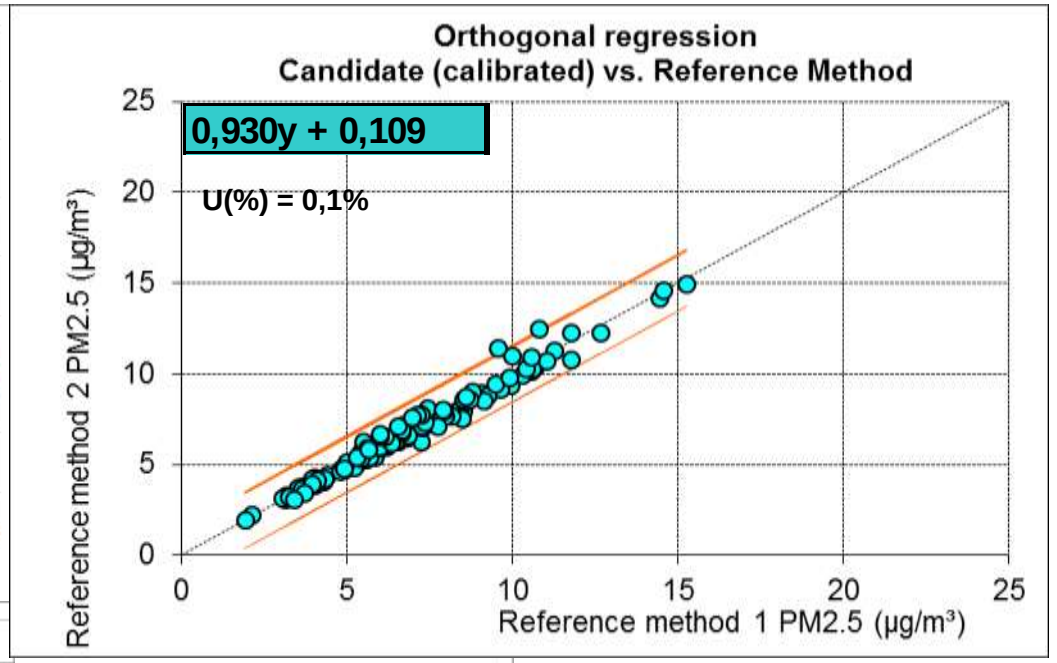
PM10 Calibration intercepts by CM

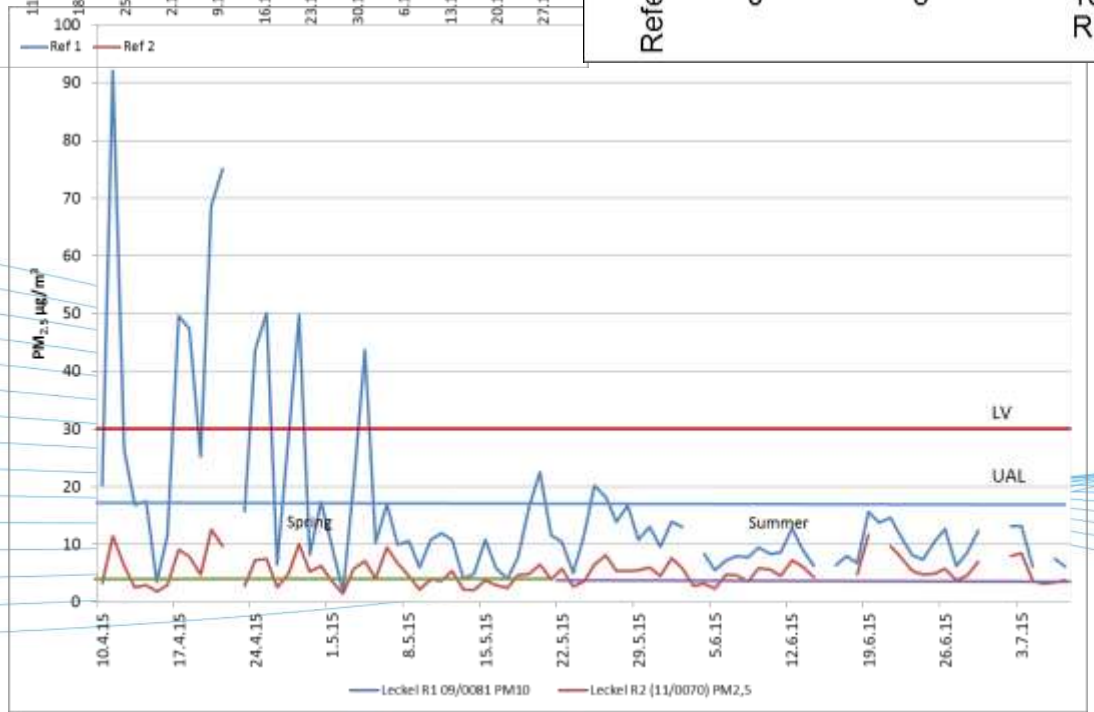
PM2.5

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

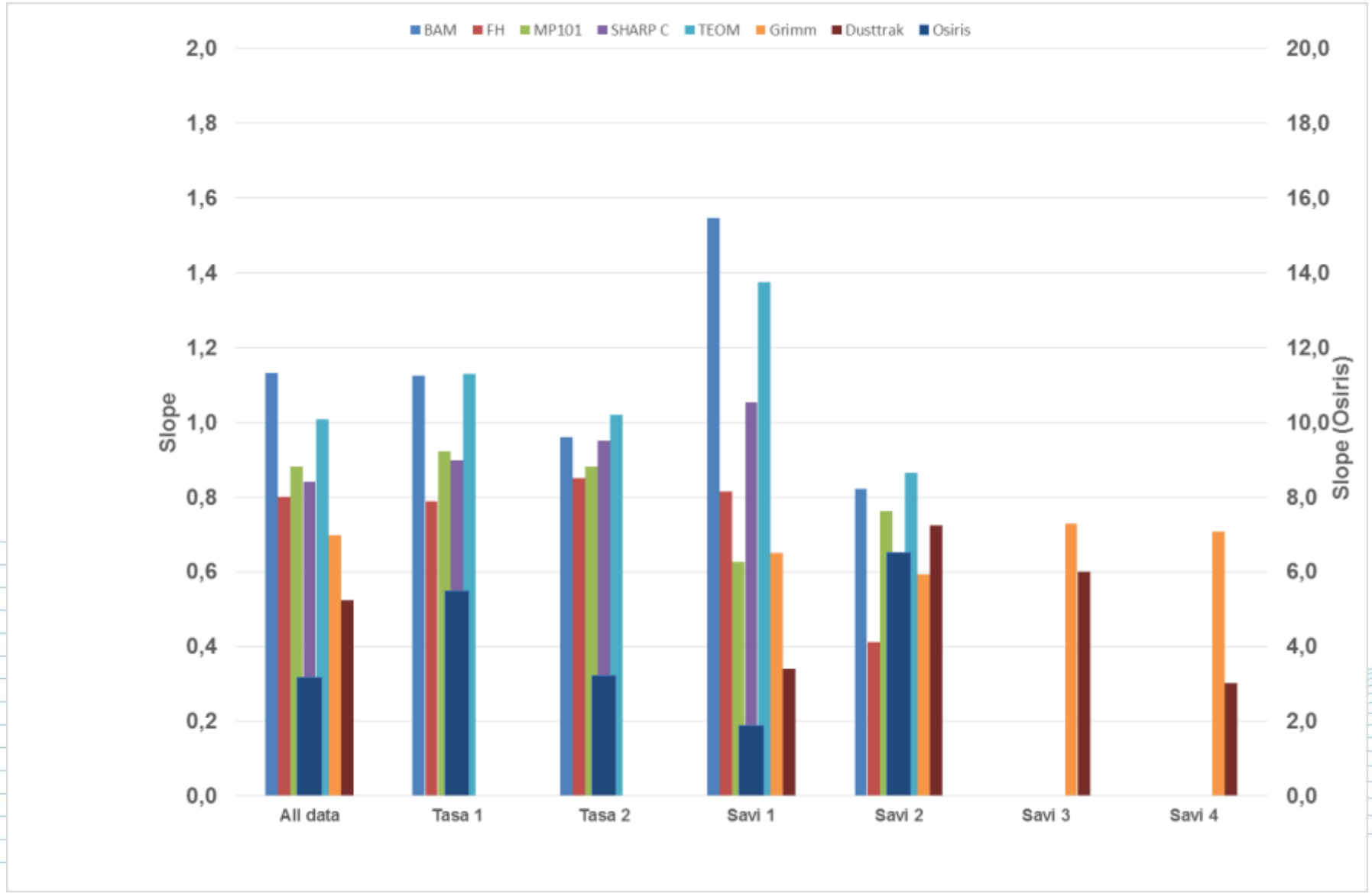
PM2.5 Referenssimenetelmä





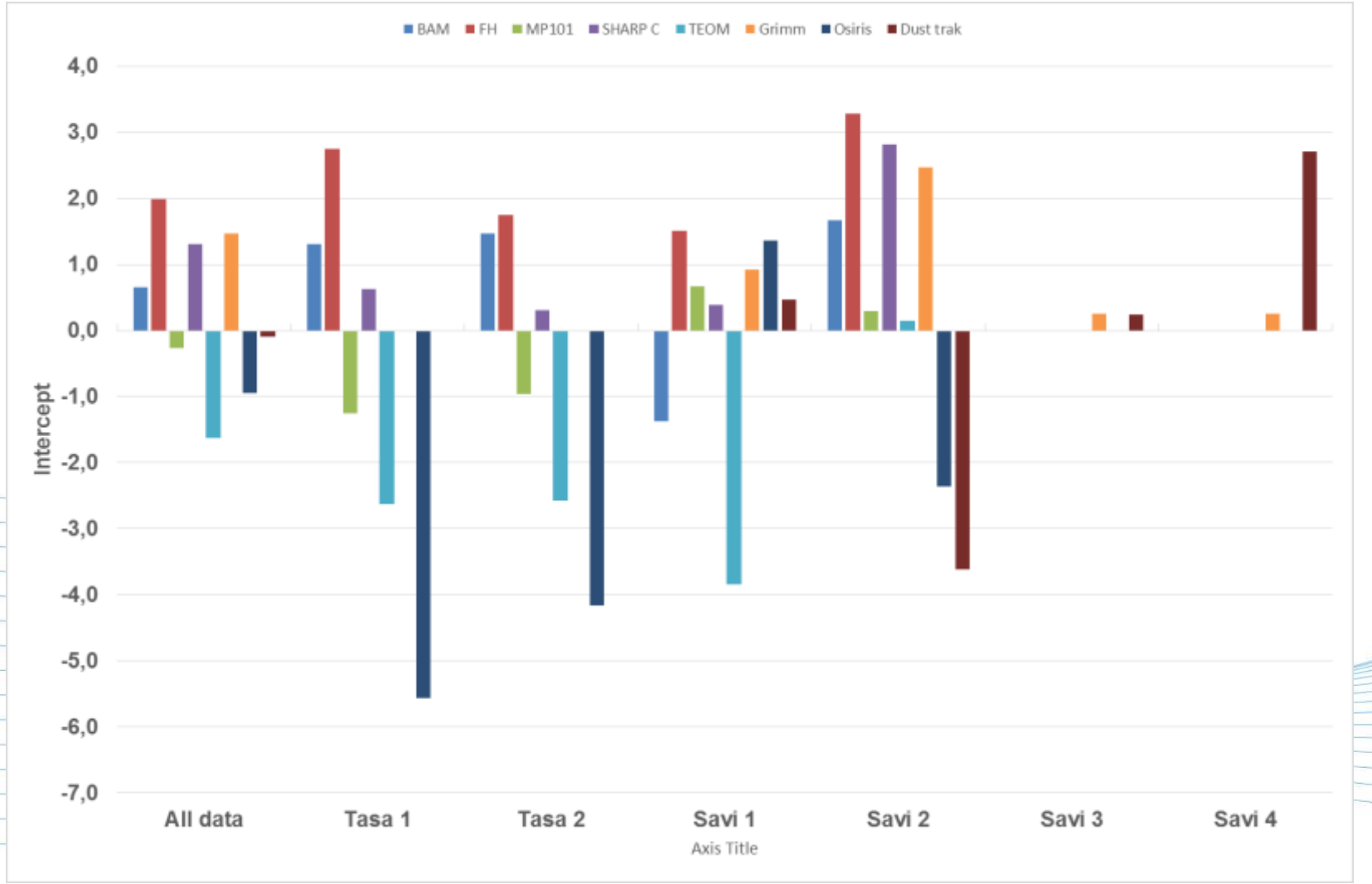


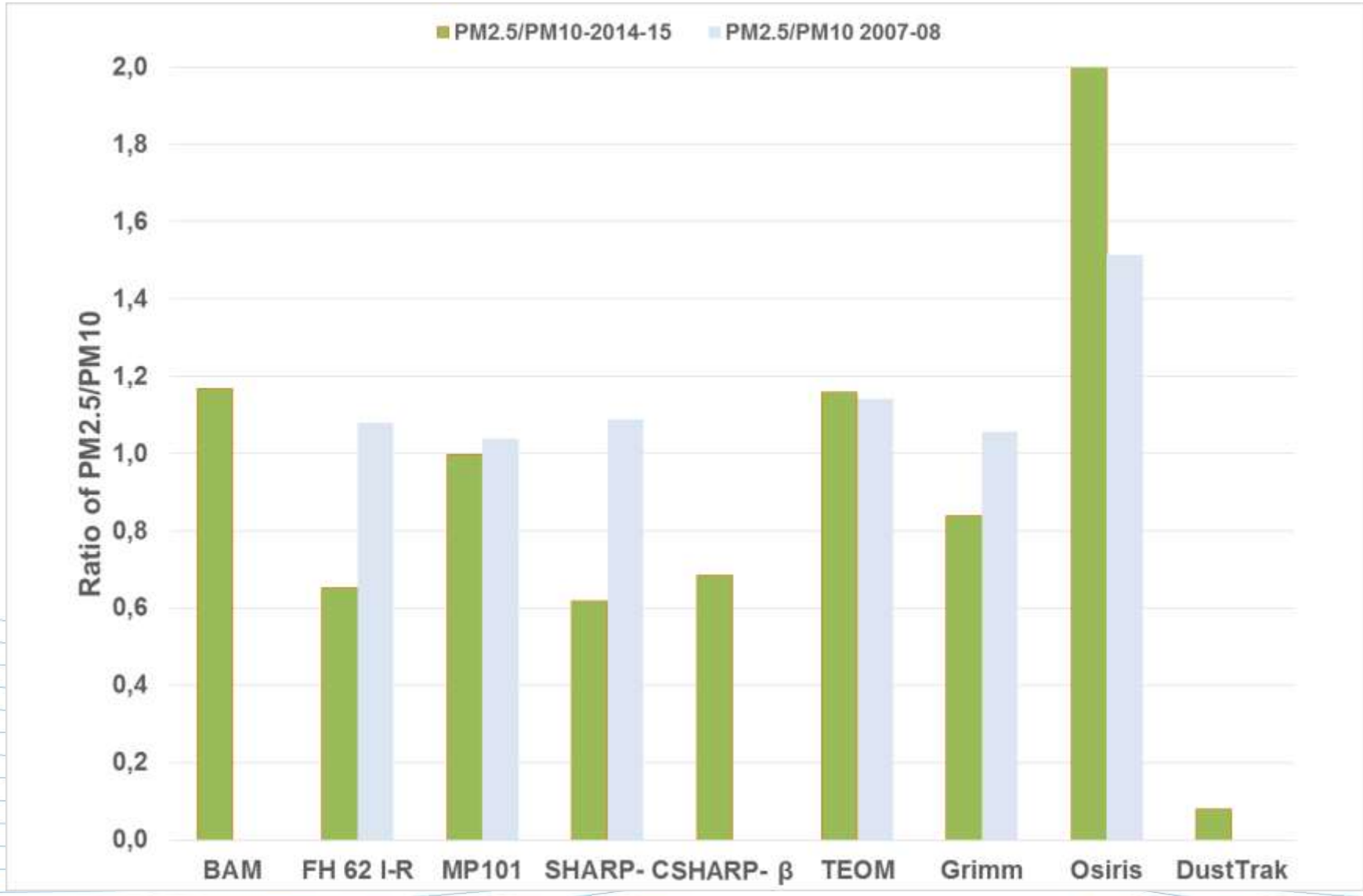
PM2.5 Calibration slopes by CM



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

PM2.5 Calibration intercepts by CM




PM2.5/PM10-2014-15
PM2.5/PM10 2007-08
Ratio of PM2.5/PM10
2,0
1,8
1,6
1,4
1,2
1,0
0,8
0,6
0,4
0,2
0,0
BAM
FH 62 I-R
MP101
SHARP-
CSHARP- β
TEOM
Grimm
Osiris
DustTrak

Yhteenveto

- Loppuraportti valmistuu tämän kevään kuluessa
- Yhtenäinen käytäntö kalibrointikertoimien suhteen
- DoE:n mukainen raportti
  - AQUILA:n sub group for TA & DoE tarkastus?
- Jatkuva vertailu referenssimenetelmän kanssa järjestettävä hiukkasmittauksille: EN 16450
-

Kiitokset

- Rahoitus: Ympäristöministeriö, Liikenne- ja viestintäministeriö, Ilmatieteen laitos
- Erkki Pärjälä & Mikko Sokura, Kuopion kaupunki
- Laitetoimittajat ja edustajat: EERC Estonia, Ekonia, HNU-Nordion, Ilmatieteen laitos, JPP kalibrointi, Kontram Oy, Sintrol Oy, Teknocalor Oy.

KYSYMYKSIÄ