

# **Monitoring air pollution in Denmark**

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# **DIRECTIVES**

OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

DIRECTIVE 2008/50/EC of 21 May 2008 on:

**Ambient air quality and cleaner air for Europe**

DIRECTIVE 2004/107/EC of 15 December 2004:

**Relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air**

# Reference methods for assessment of concentrations of SO<sub>2</sub>, NO<sub>2</sub> and NO, PM10 and PM2,5, lead, benzene, CO, and O<sub>3</sub>

**Sulphur dioxide:** EN 14212:2005 'Ambient air quality — Standard method for the measurement of the concentration of sulphur dioxide by ultraviolet fluorescence';

**Nitrogen dioxide and oxides of nitrogen:** EN 14211:2005 'Ambient air quality — Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence'.

**Lead:** EN 14902:2005 'Standard method for measurement of Pb/Cd/As/Ni in the PM10 fraction of suspended particulate matter'.

**PM10:** EN 12341:1999 'Air Quality — Determination of the PM10 fraction of suspended particulate matter — Reference method and field test procedure to demonstrate reference equivalence of measurement methods'.

**PM2,5:** EN 14907:2005 'Standard gravimetric measurement method for the determination of the PM2,5 mass fraction of suspended particulate matter'.

**Benzene:** EN 14662:2005, parts 1, 2 and 3 'Ambient air quality — Standard method for measurement of benzene concentrations'.

**Carbon monoxide:** EN 14626:2005 'Ambient air quality— Standard method for the measurement of the concentration of carbon monoxide by non-dispersive infrared spectroscopy'.

**Ozone:** EN 14625:2005 'Ambient air quality — Standard method for the measurement of the concentration of ozone by ultraviolet photometry'.

## Demonstration of equivalence

**Reference laboratory**  
**Accredited according to ISO 17025**  
**Scientific personnel involved in accreditation: ~10**

**In-organic**

Clorat, Nitrat, Sulfat (An-ion IC)  
NH<sub>3</sub>, NH<sub>4</sub>, NO<sub>2</sub>, Fosfat (auto-analyzer)  
pH and conduction (in precipitation)  
Cations K, Ca, Mg, Mn (atom abso. flame)  
ICPMS  
(6-7 lab. technicians)

**Organic**

EC/OC in PM<sub>2,5</sub>  
Pesticides (in precipitation)  
PAH (on particles)  
VOC  
Levoglucosol, dioxin in air, WHO-pcb  
(4 lab. technicians)

**Field monitors & stations**

Particles: PM<sub>10</sub>, PM<sub>2,5</sub>  
Gasses: NO<sub>2</sub>, NO, O<sub>3</sub>, CO, SO<sub>2</sub>  
  
(6-7 technicians)

**Data**

On-line control  
Final data control  
  
(3 on full time and 2-3 part time)

# Automatic and semi-automatic measurements

Gasses:

**SO<sub>2</sub>, NO<sub>2</sub> and NO, CO, and O<sub>3</sub>**

**(Hg GEM)**

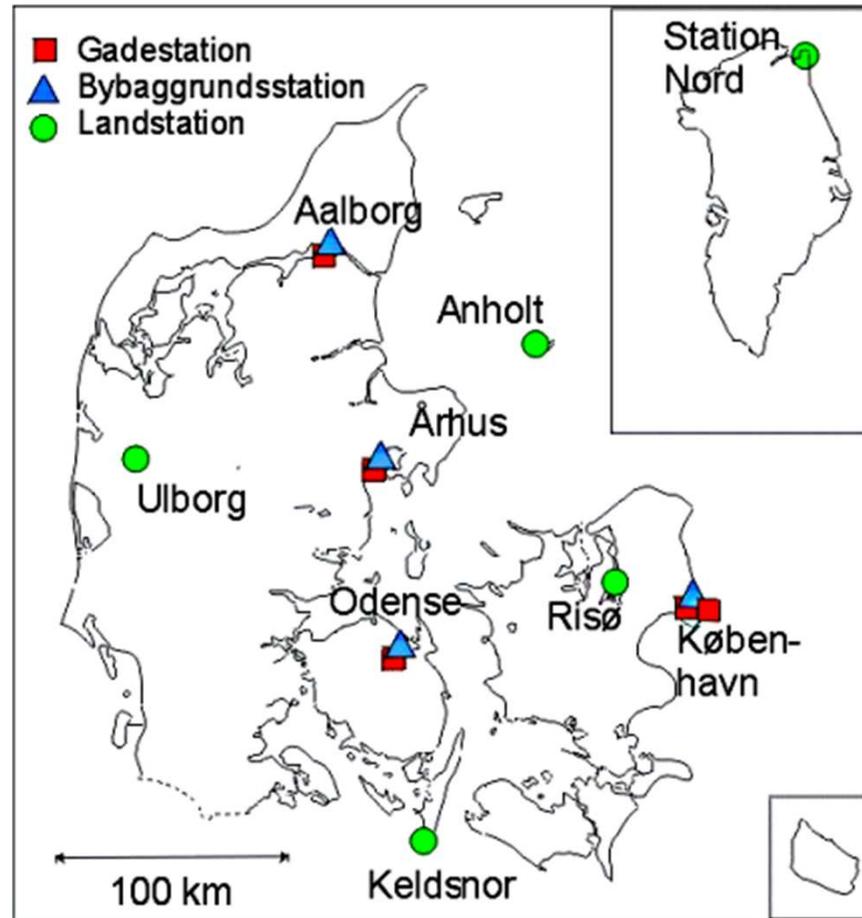
Particles:

**PM10 and PM2,5 , EC/OC in PM2,5**

**Particle number**

**Filter sampler**

# Main measuring network: automatic measurements



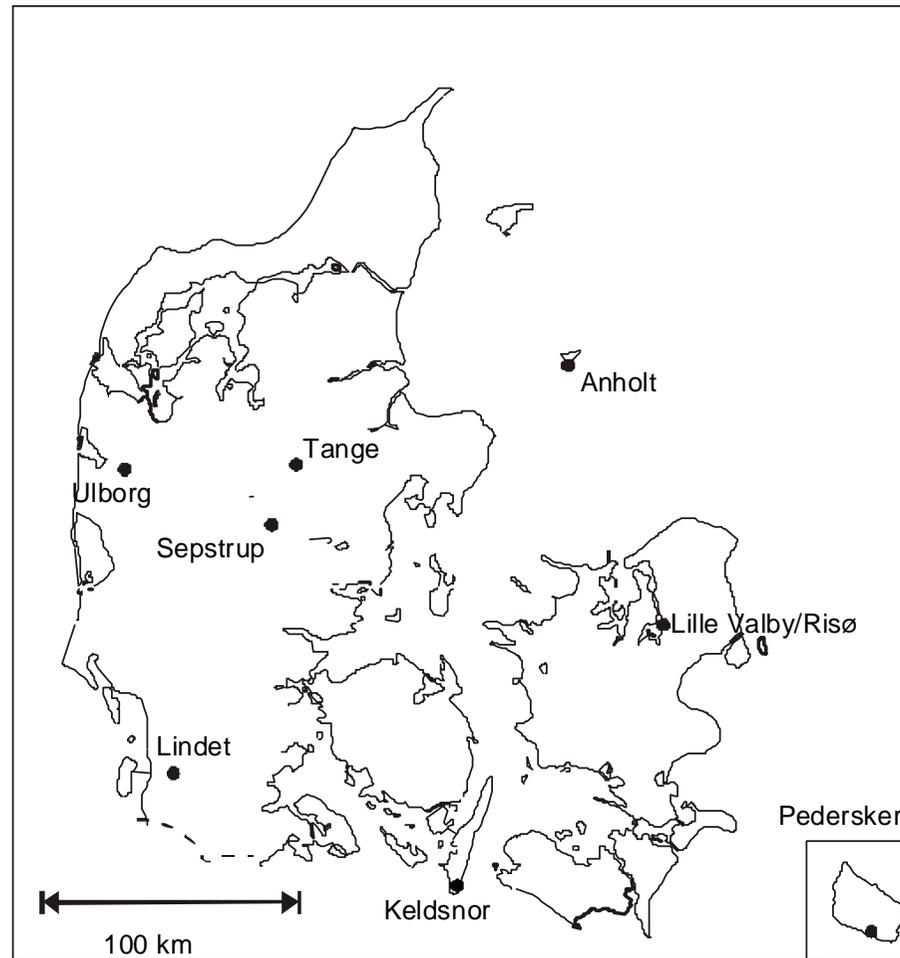
# Measurement of atmospheric deposition

Målestation	Våddeposition*	Gas og partikler**
Anholt	Uorganisk, Tungmetaller	Filterpack, NO <sub>2</sub> , Denuder
Keldsnor	Uorganisk, Tungmetaller	Denuder NO <sub>2</sub> , O <sub>2</sub> NH <sub>3</sub> -kortidsmålinger
Lille Valby/Risø***	Uorganisk, Tungmetaller MFS	Filterpack Denuder NO <sub>2</sub> , O <sub>2</sub>
Lindet	Uorganisk, Tungmetaller	
Pedersker	Uorganisk, Tungmetaller	
Sepstrup Sande	Uorganisk, Tungmetaller, MFS	
Tange		Filterpack
Ulborg	Uorganisk, Tungmetaller	Filterpack, Denuder, NO <sub>2</sub> , O <sub>2</sub>

- \* Uorganisk: N, P, S, Na, Cl, K, Mg, K og Ca. Tungmetaller: Cr, Ni, Cu, Zn, As, Cd, Pb og Fe. MFS: Pesticider, PAH og nitrophenoler.
- \*\* Filterpack: NH<sub>3</sub>, SO<sub>2</sub> og partikulært N, P, S, Ni, As, Cd, og Pb. Tungmetallerne er kun bestemt ved Anholt og Risø. Naturstation: Denuder: måling af NH<sub>3</sub>, HNO<sub>3</sub>, NH<sub>4</sub> og NO<sub>2</sub>. Passiv opsamler: NH<sub>3</sub>.
- \*\*\* Målestationen ved Lille Valby blev juli 2010 flyttet 2 km vestover til Risø, hvor den blev udvidet med ekstra målinger

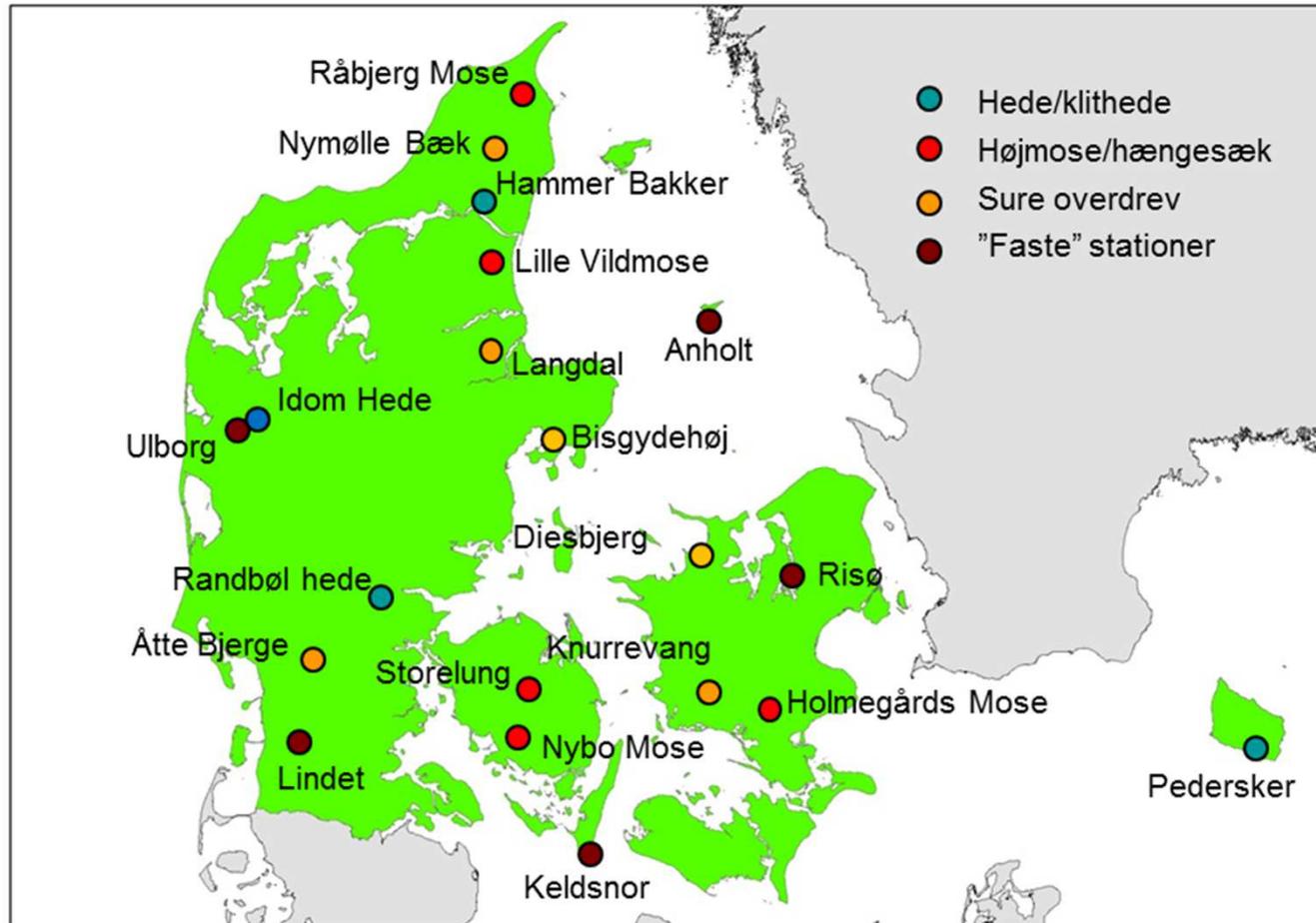
(MFS: pesticider, PAH og nitrophenoler)

# Semi-automatic and passive samplers



# Ammonia measurements

## semiautomatic and passive samplers



## Collection of nitric acid samples (denuder)

A denuder is an instrument for picking up and analysing nitric acid. These measurements are used for special studies.

## Measurement of NO<sub>2</sub>

At the roof of the measuring house there is an air intake where the air is sucked into an instrument which measures the concentration of NO<sub>2</sub> in the air directly.



## Collection of air samples (filter sampler)

At the end of each of the eight arms there is a filter pack that contains 3 filters mounted in succession:  
1 – Particles;  
2 – Potassium hydroxide for sulphate and nitric acid;  
3 – Oxalic acid for ammonia .  
During a 24 hour sampling period the air intake is approx. 60m<sup>3</sup>. After 24 hours the air intake automatic shifts to the next arm.

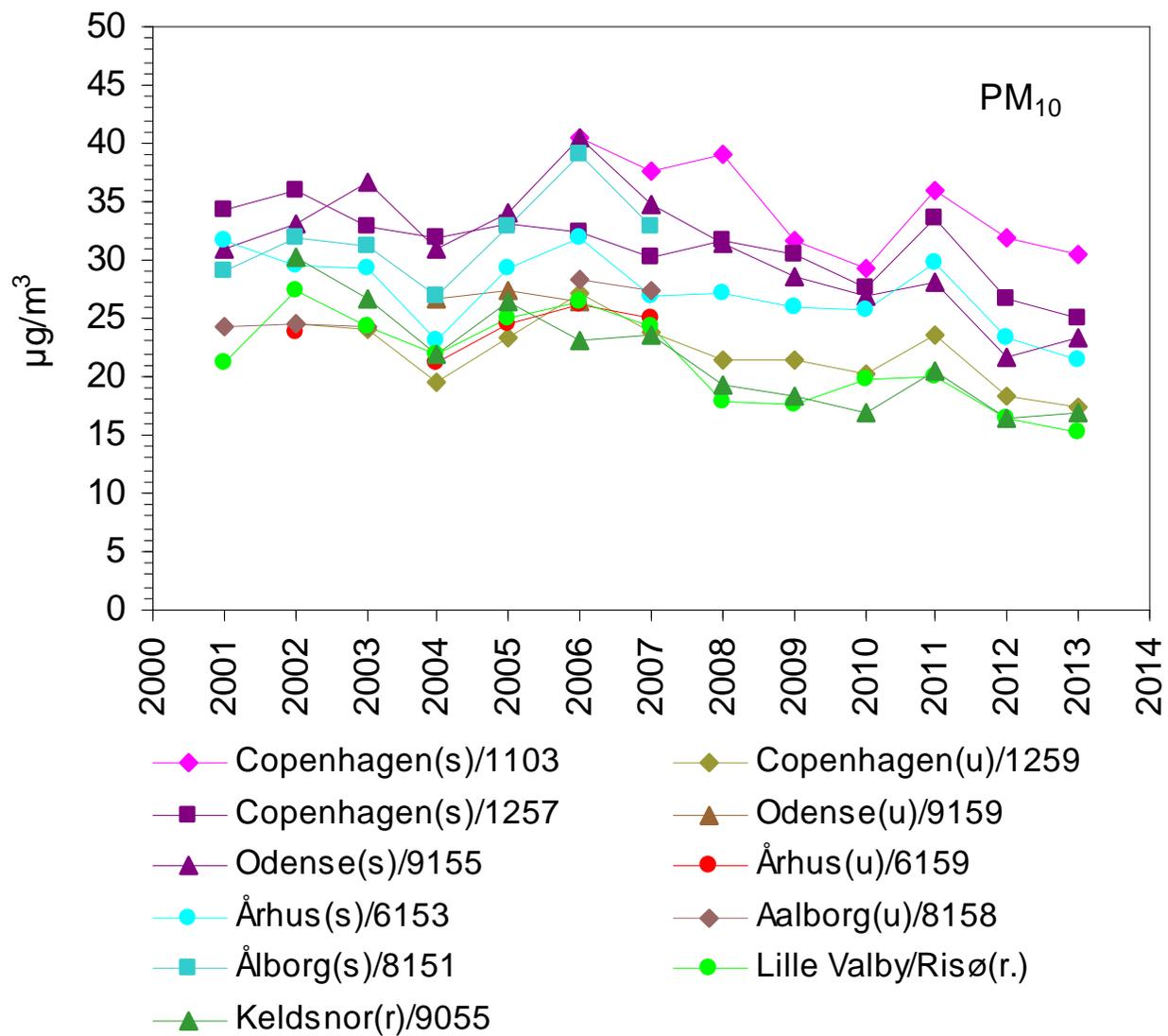
## Collection of precipitation samples

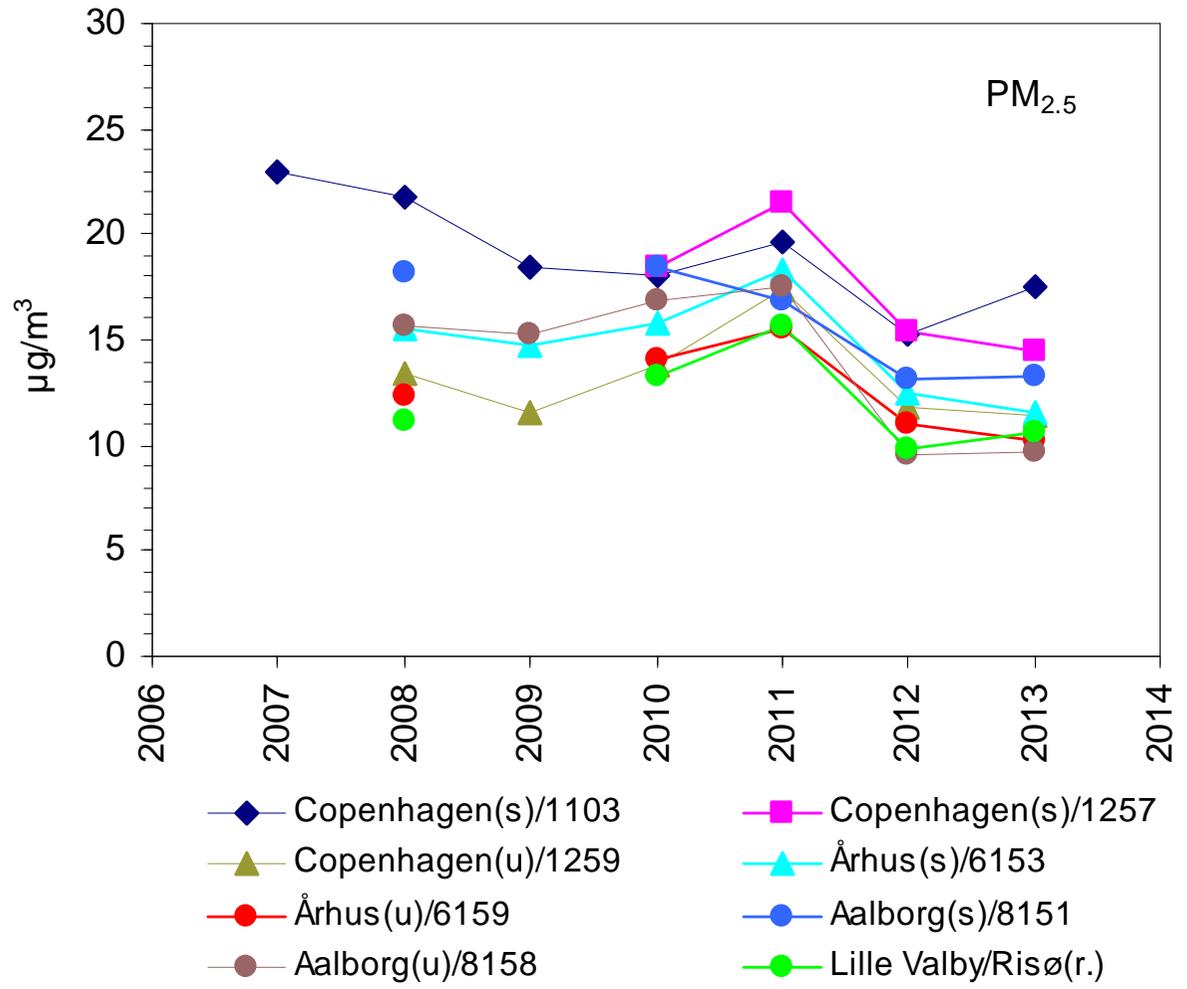
Collectors for collecting precipitation: the funnels (both the black and the white) are placed onto a sample bottle which is hidden by the grey tube.

## Passive diffusion samplers for ammonia

## Collection of precipitation samples

Wet-only collectors for collecting precipitation only during the periods in which it rains. The tube, which is covered by the lid, is connected with a funnel and a sample bottle. The "pyramid" in the background is a sensor that registers when it rains. As soon as it starts to rain the lid tips over and the funnel is opened for the precipitation.





# **Calibration and check 1: PM-samplers**

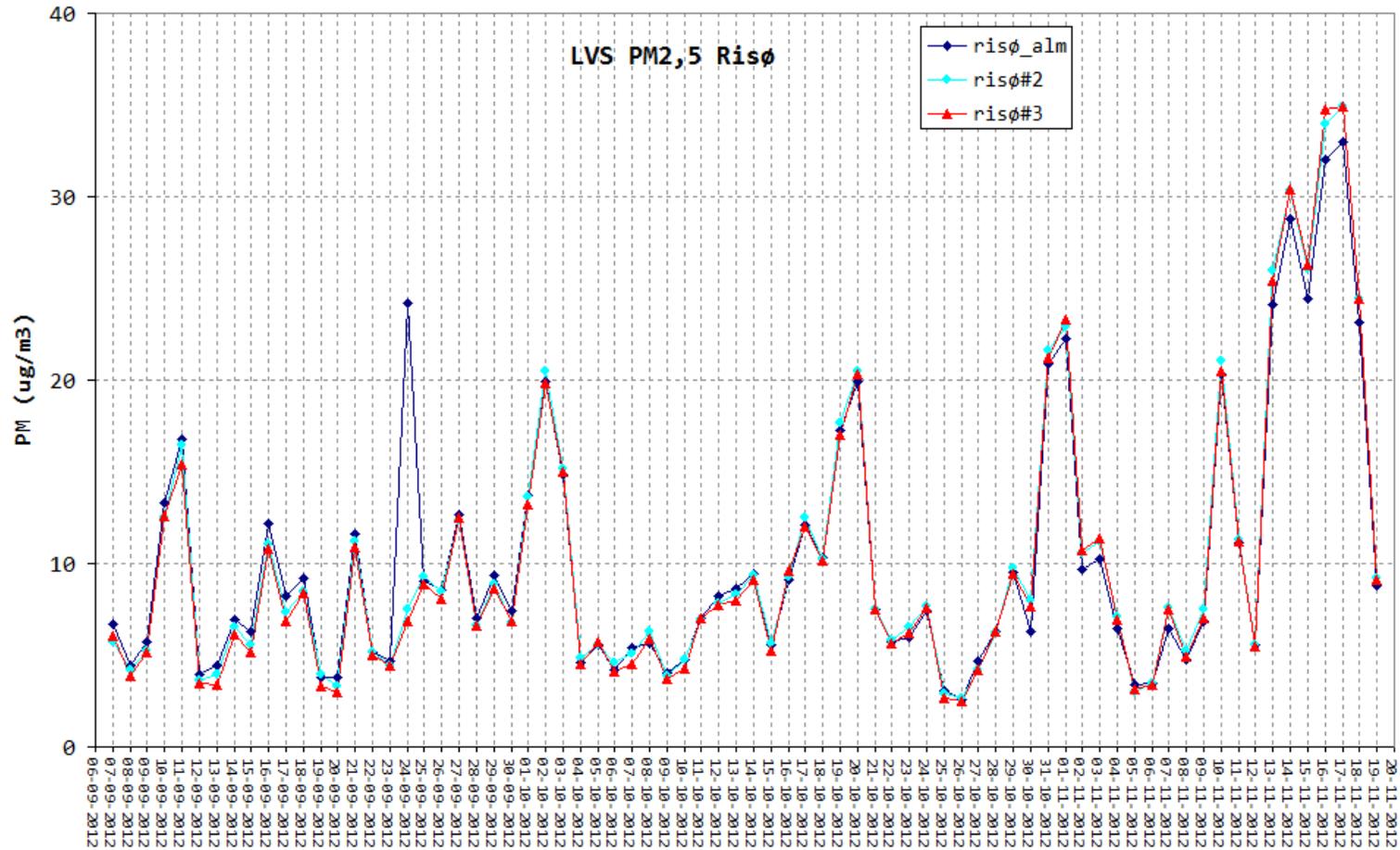
Flow, temperature and pressure:

**Every 3. month**

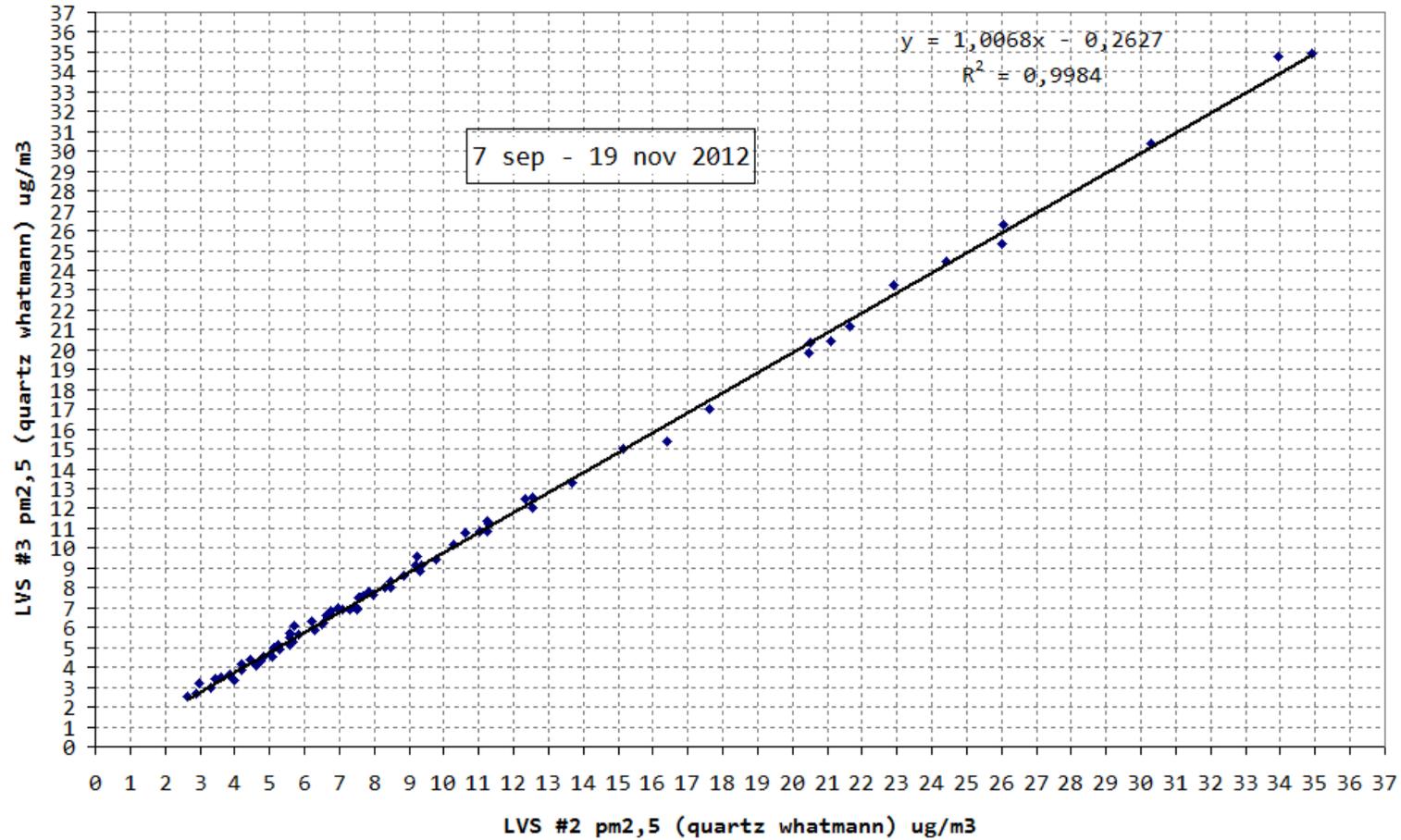
# Intercalibration of LVS PM2,5



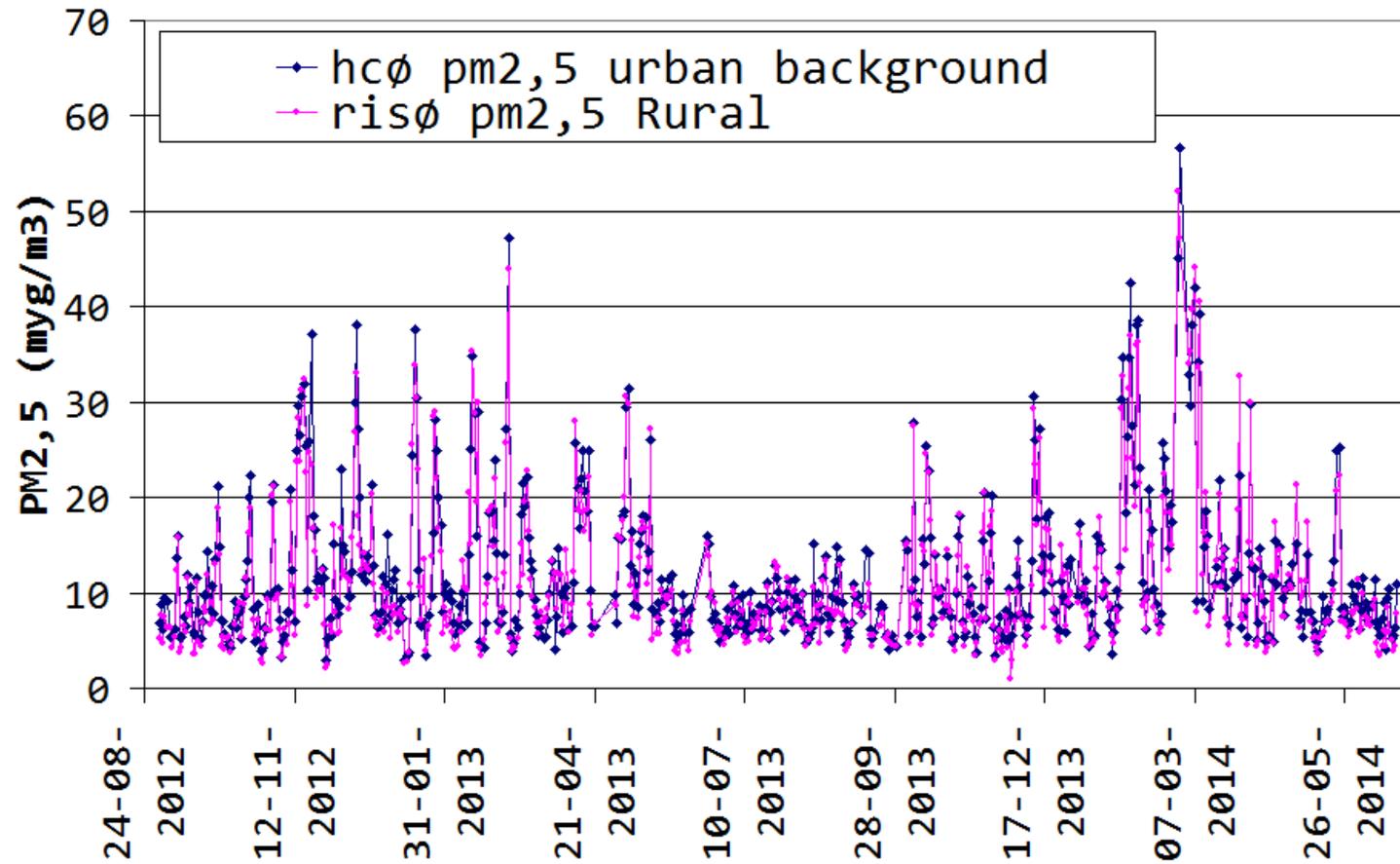
# Intercalibration of LVS PM2,5



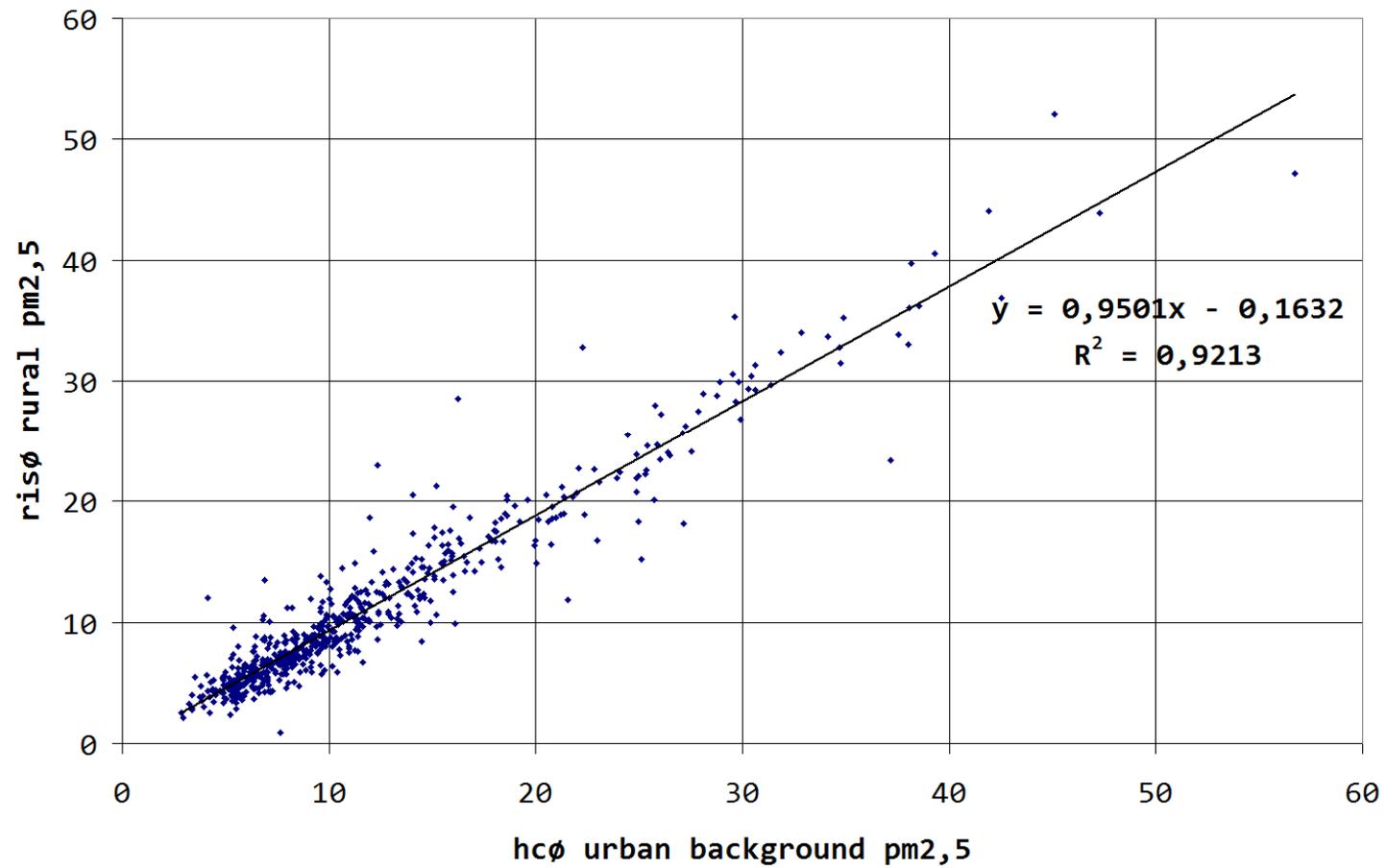
# Intercalibration of LVS PM2,5



# PM2,5 urban back ground vs. rural



# PM2,5 urban back ground vs. rural



# **Calibration and check 2: gas monitors**

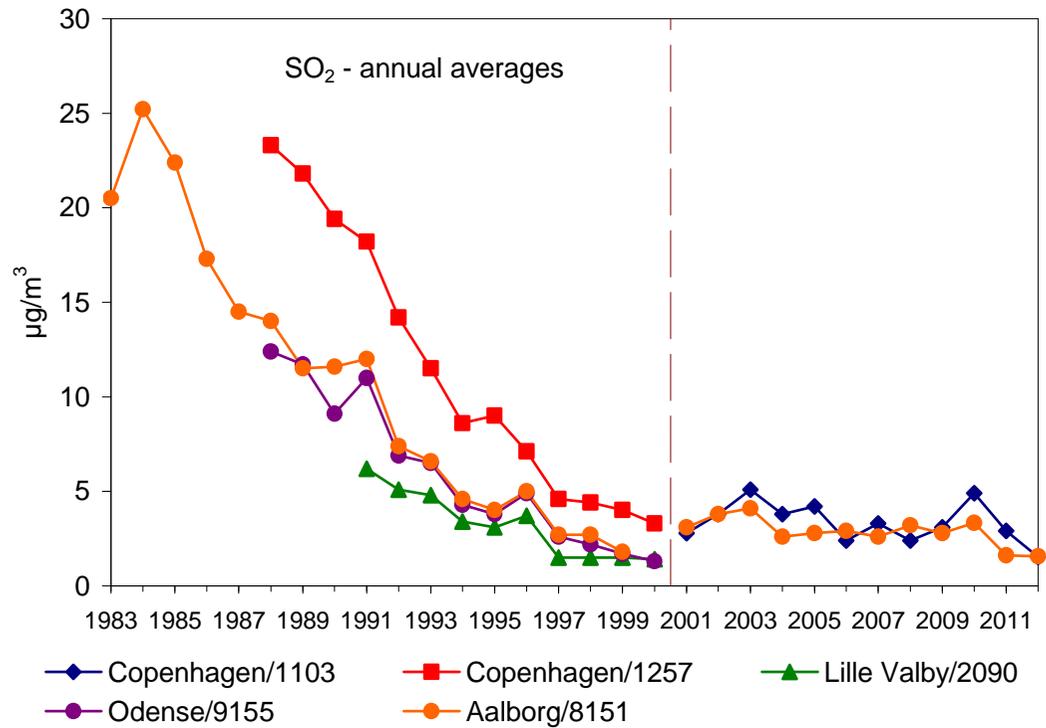
Zero calibration:

**Every 24 hours**

Span calibration:

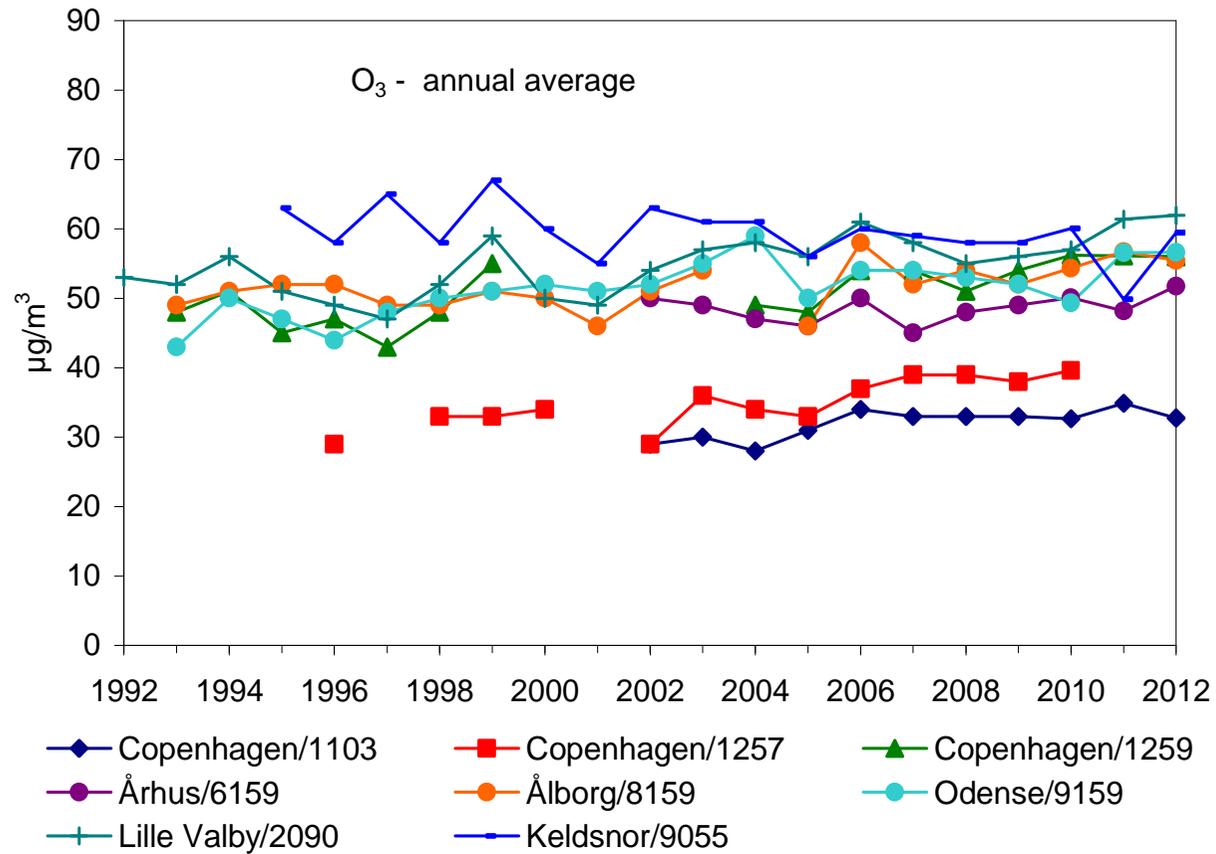
**Every 7<sup>th</sup> day**

# SO<sub>2</sub>

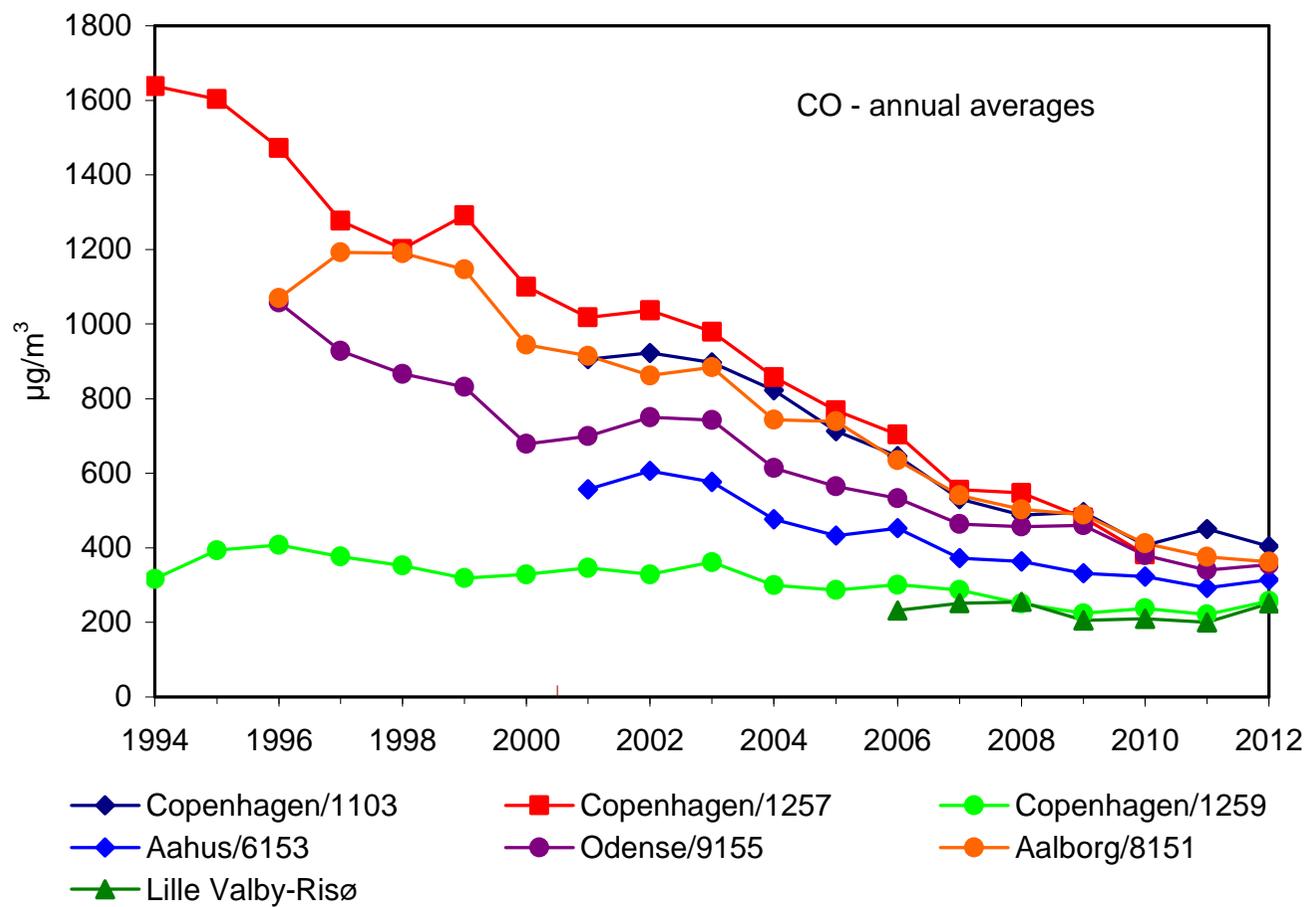


Annual averages for SO<sub>2</sub>. Until 2001 the results were obtained using KOH impregnated filters for collection of SO<sub>2</sub>. These measurements ceased in 2000. After 2000 the SO<sub>2</sub> measurements have been carried out using SO<sub>2</sub>-monitors in order to monitor episodic results. The detection limit for the monitors is a few µg/m<sup>3</sup>, which makes the average and median values encumbered with high relative uncertainties. The shift in level from 2000 to 2001 is due to shift of the methods.

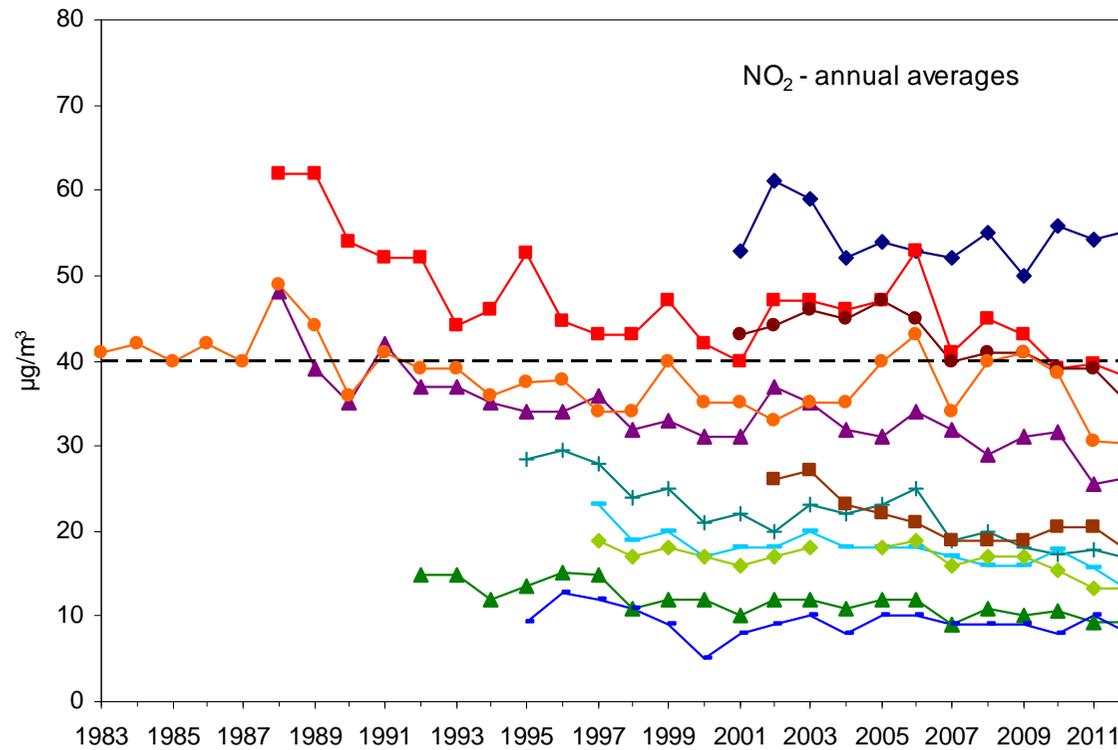
# O<sub>3</sub>



# CO



# NO<sub>2</sub>



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|----------------------|---------------------|---------------------|
| —◆— Copenhagen/1103  | —■— Copenhagen/1257 | —●— Århus/6153      |
| —▲— Odense/9155      | —○— Aalborg/8151    | —+— Copenhagen/1259 |
| —■— Århus/6159       | —□— Odense/9159     | —◇— Ålborg/8159     |
| —▲— Lille Valby/Risø | —■— Keldsnor/9055   |                     |

