Air quality dispersion modelling of wood smoke emissions in residential areas in Sweden

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- Introduction
- Experimental sites
- Measurements
- Models
- Results
- Conclusions

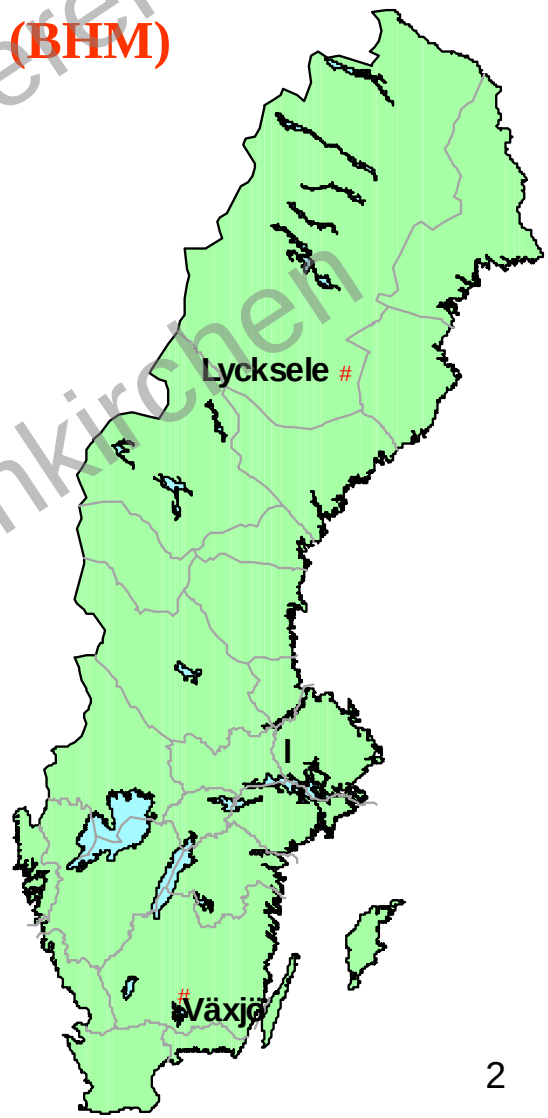
Introduction

Bio-mass-Health-Environment (BHM)

The goal is to describe how the use of bio-mass for energy production effects:

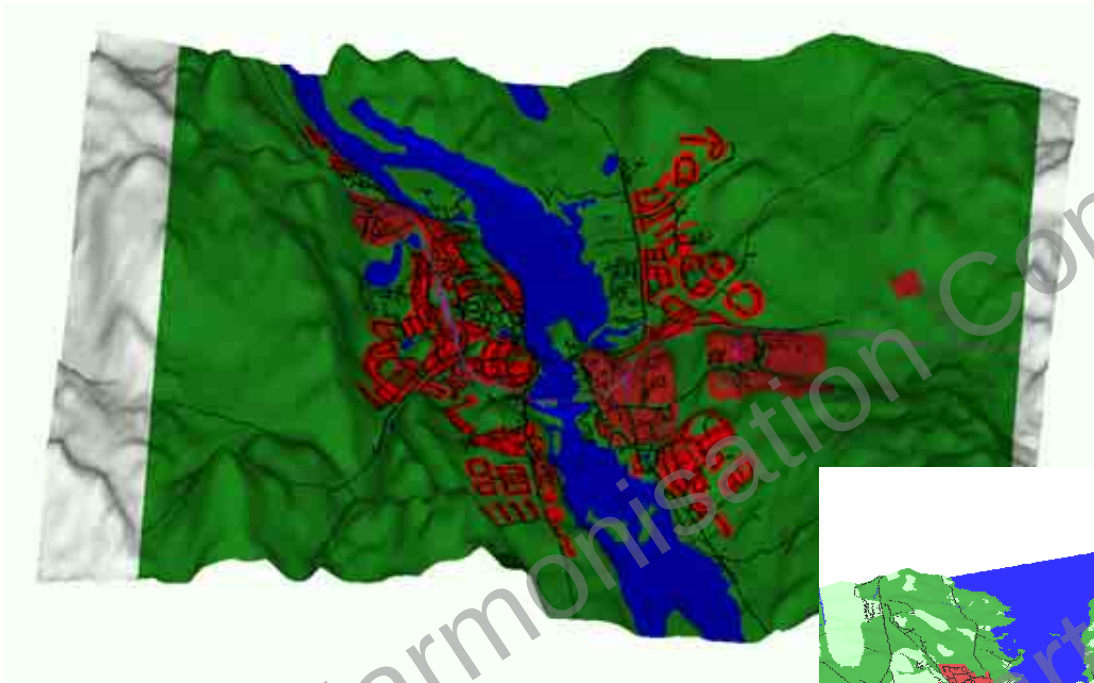
- **Emission (from units<10 MW)**
- **Air Quality**
- **Health**
- **To describe the effects the use and development of new technology will have on emissions in the future**

Focus on airborne particles

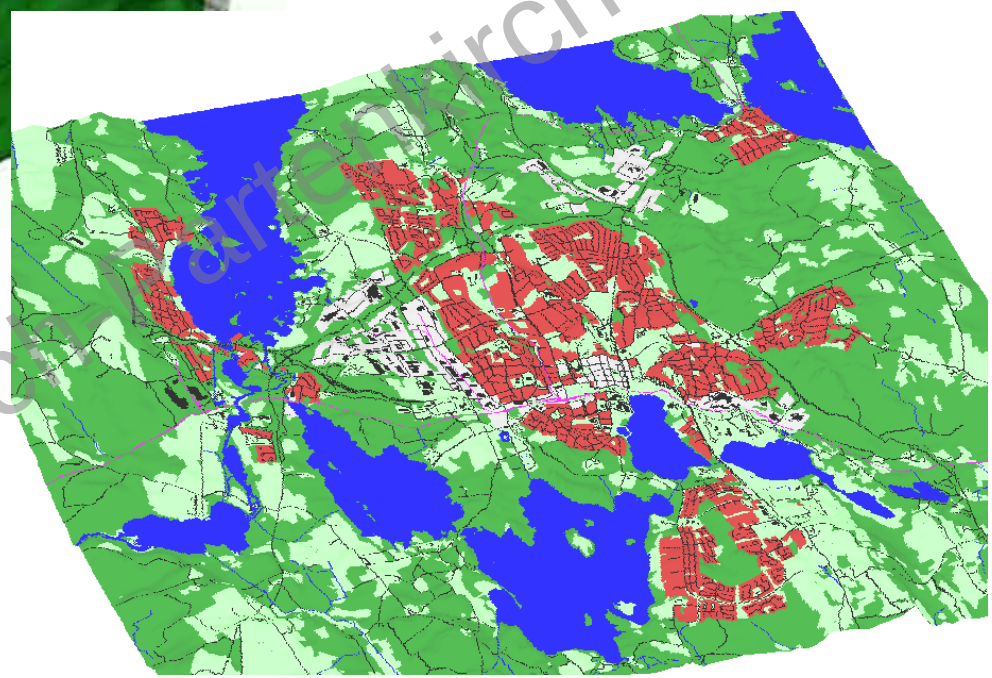


Experimental sites

Lycksele

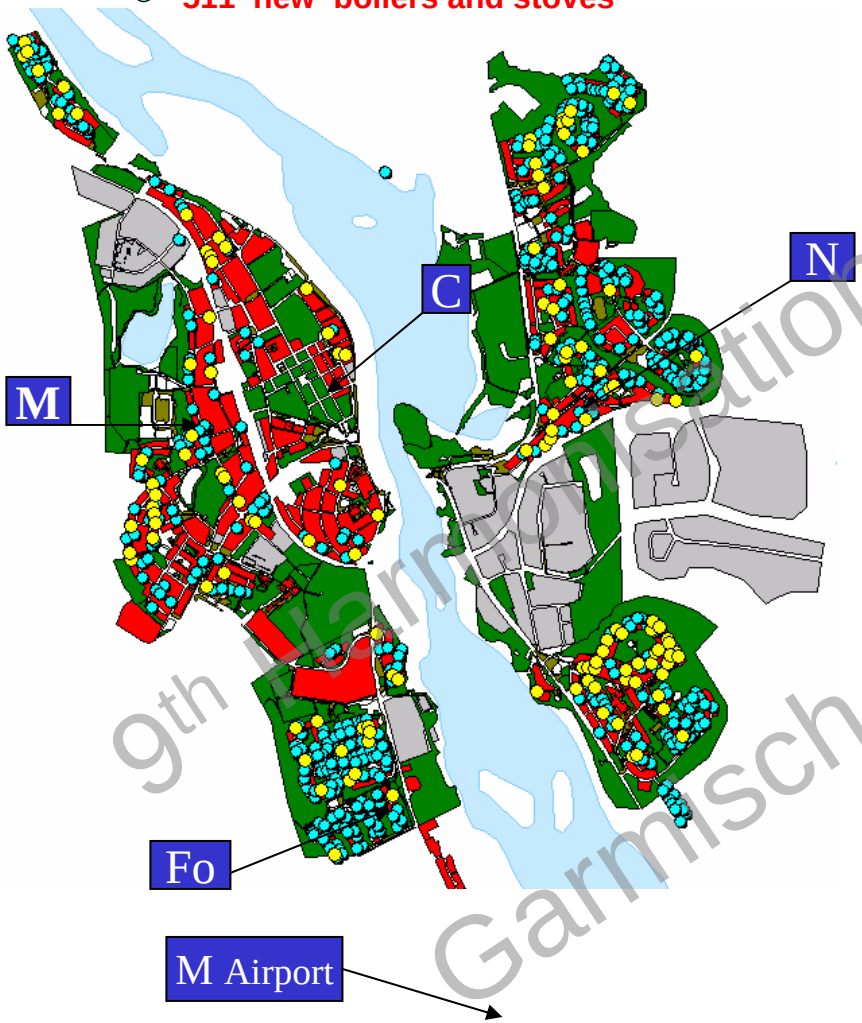


Växjö



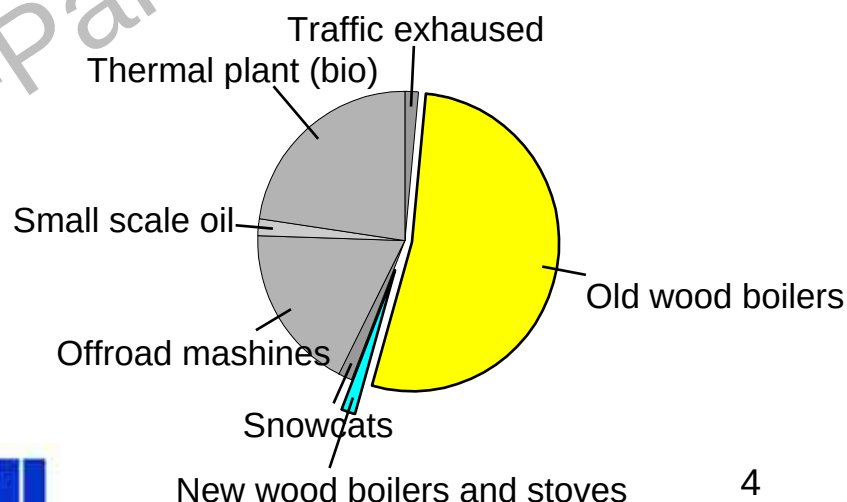
Residential wood boilers and stoves and monitoring stations in Lycksele/Sweden

- 136 old boilers
- 511 new boilers and stoves

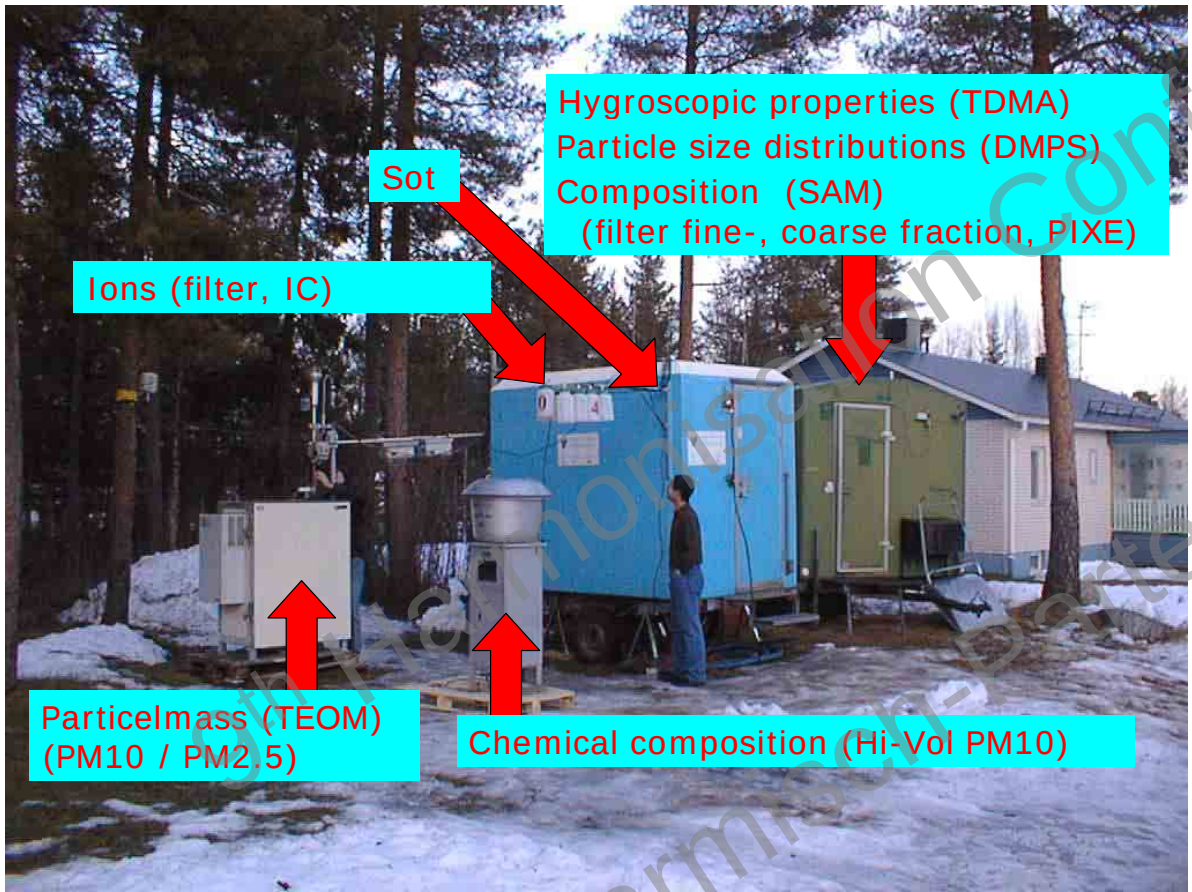


Emission factors	Particles mg/MJ
Modern boilers with heat storage tank	0.022
Old-type boilers with heat storage tank	0.089
Old-type boilers without heat storage tank	2.19
Stoves	0.11
Fireplace	0.11

Yearly PM emission in Lycksele: 66 ton/year



Measurments



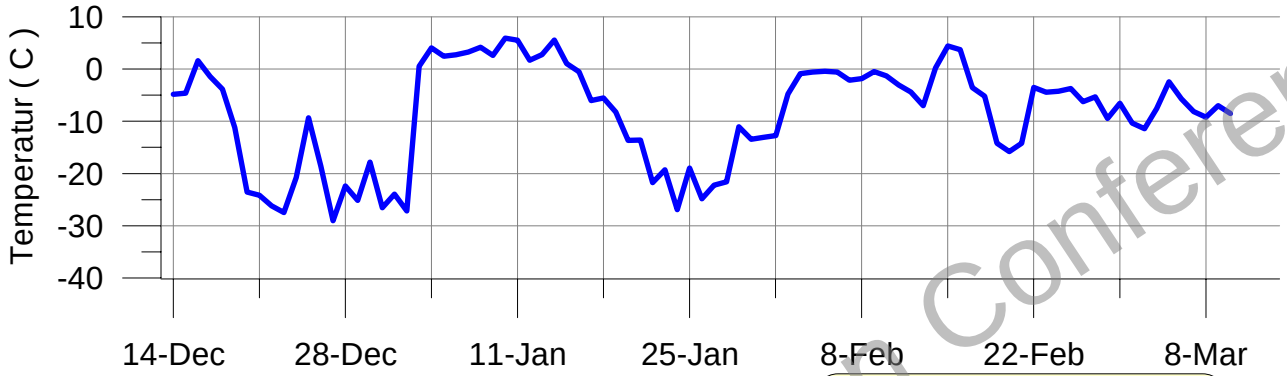
Particles

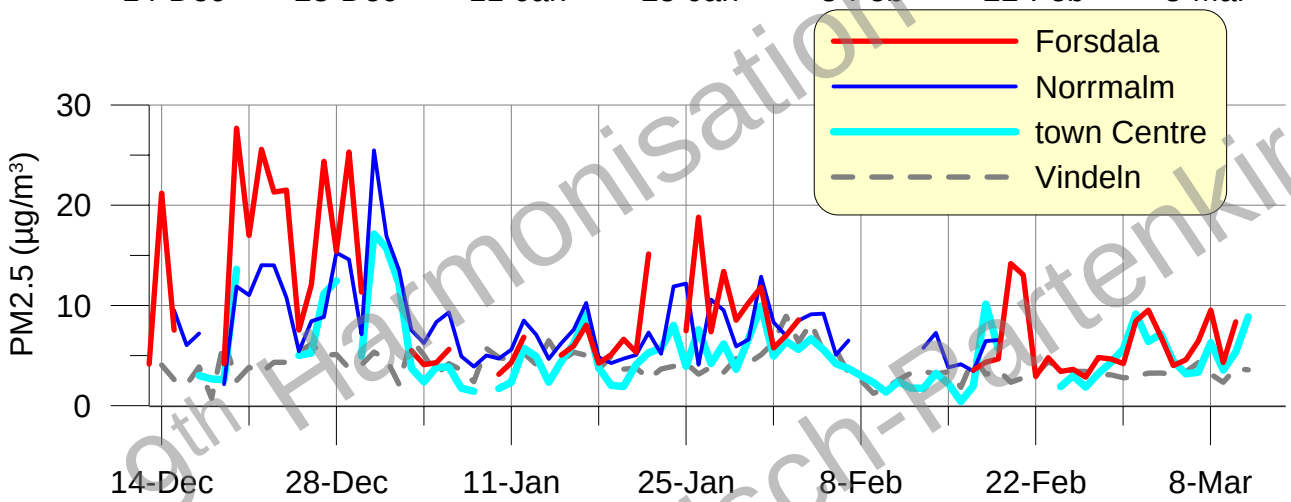
mass, number,size distribution and chemical composition

Gases

NOx, CO, SO2, VOC

Measurments



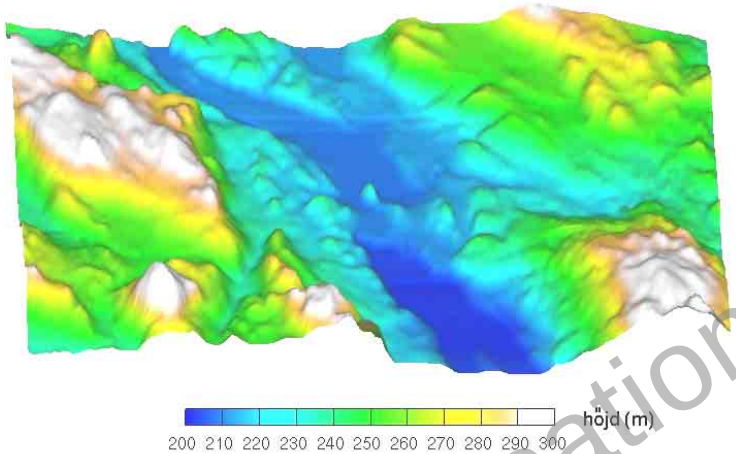


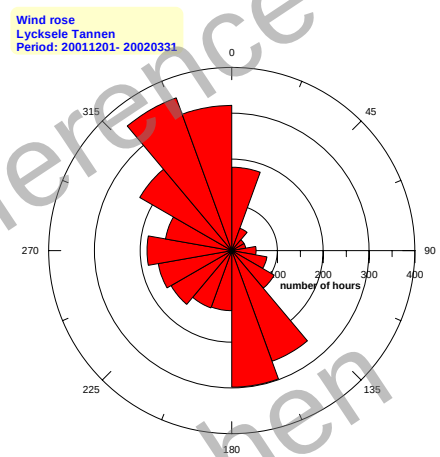
	FORSDALA	NORRMALM	TOWN CENTRE	VINDELN
Group 1	15.5	10.2	6.8	4.0
Group 2	5.5	6.4	3.8	3.9

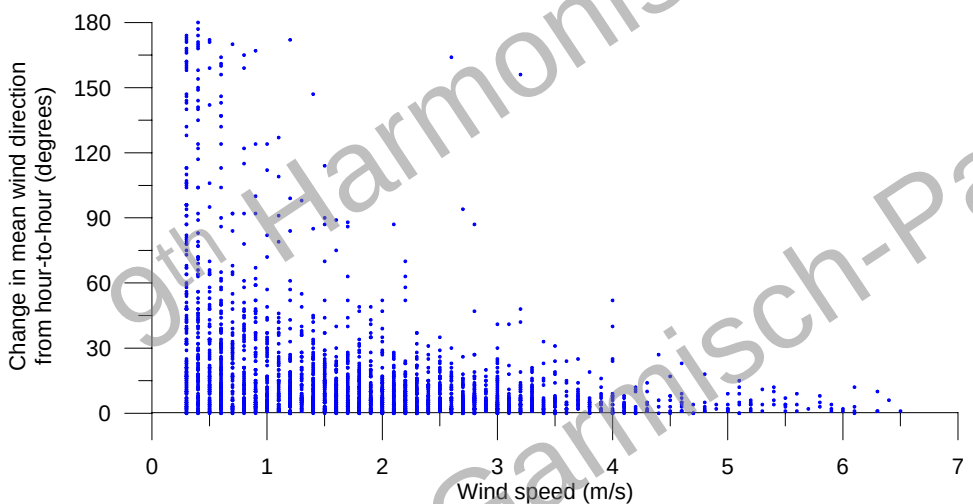
Temp < -10 °C

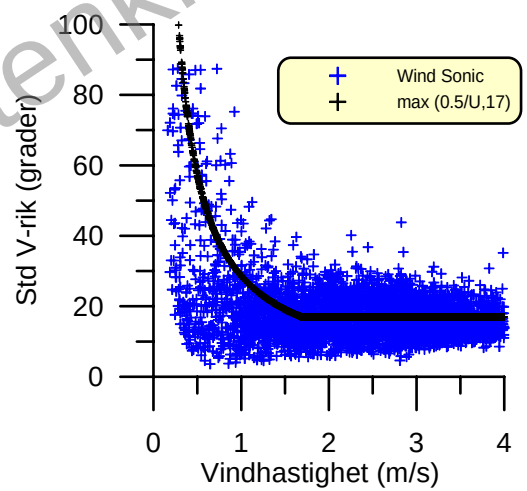
Temp > -10 °C

Meteorological measurements









Stable conditions, define as L<200, for about 60%

Models

Gaussian models: ***Airviro*** and
Dispersion ***(partly based on the Danish OML model)***

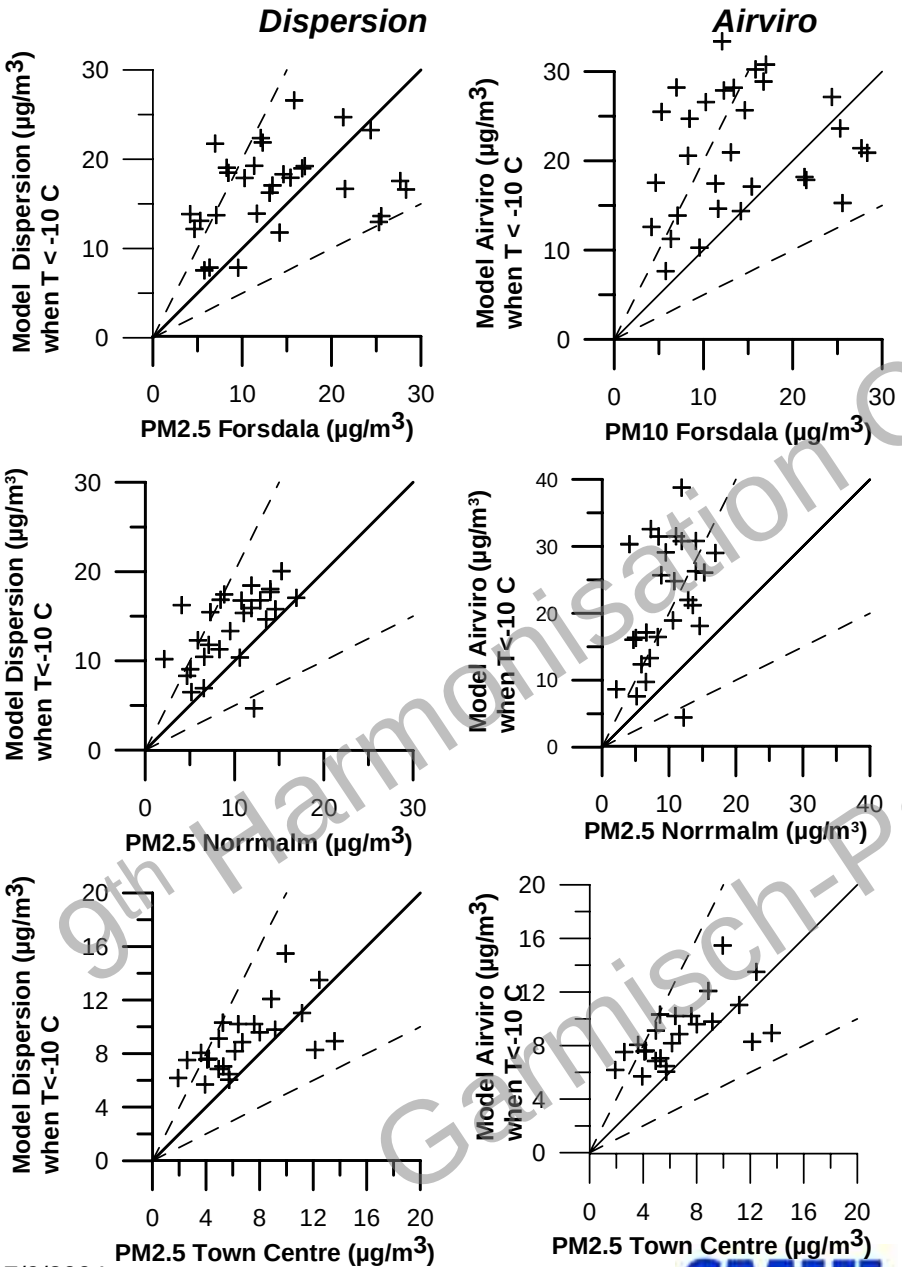
Meteorological inputs: local measurements

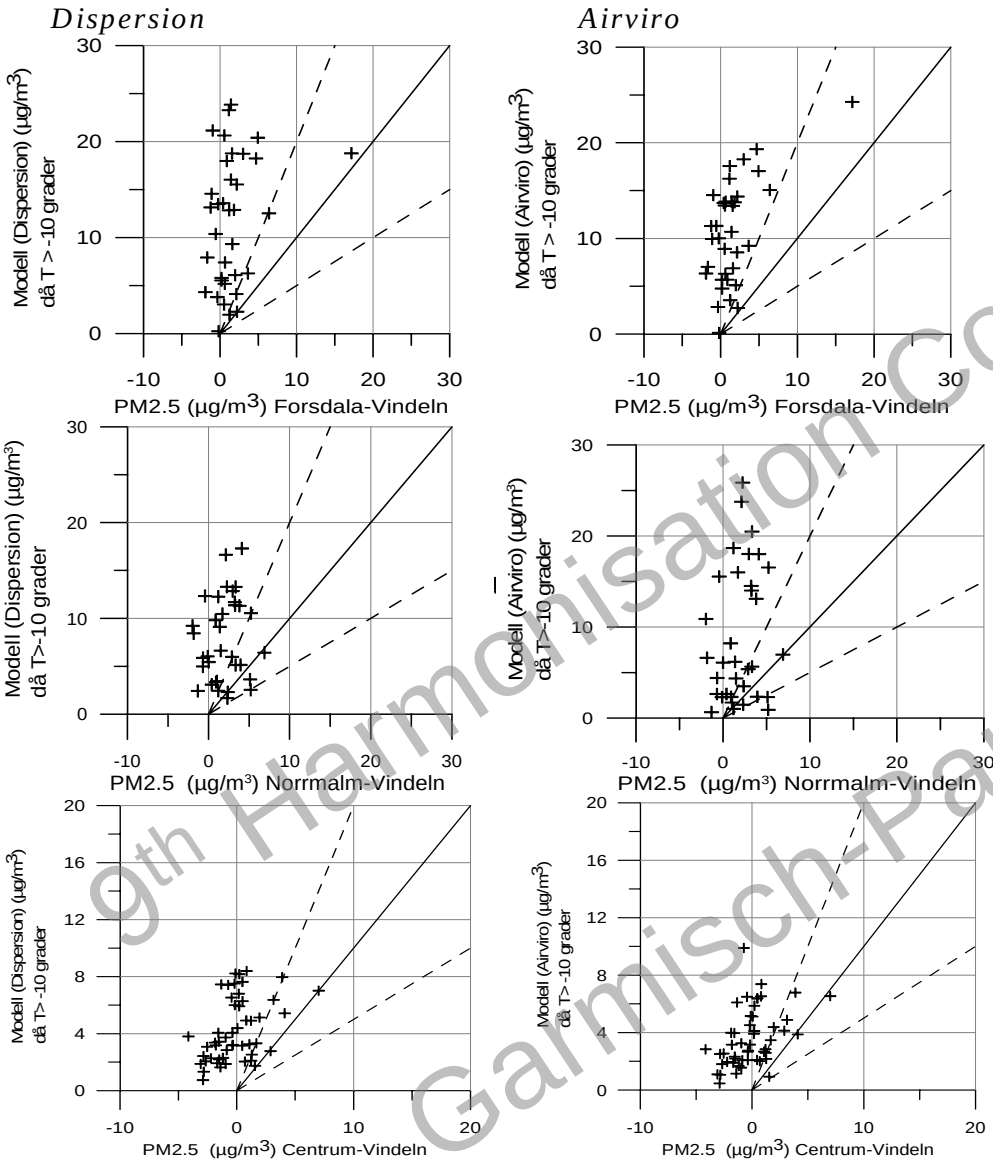
Computational Fluid Dynamic model: ***StarCD***

Meteorological inputs: from meteorological model (HIRLAM)

Results

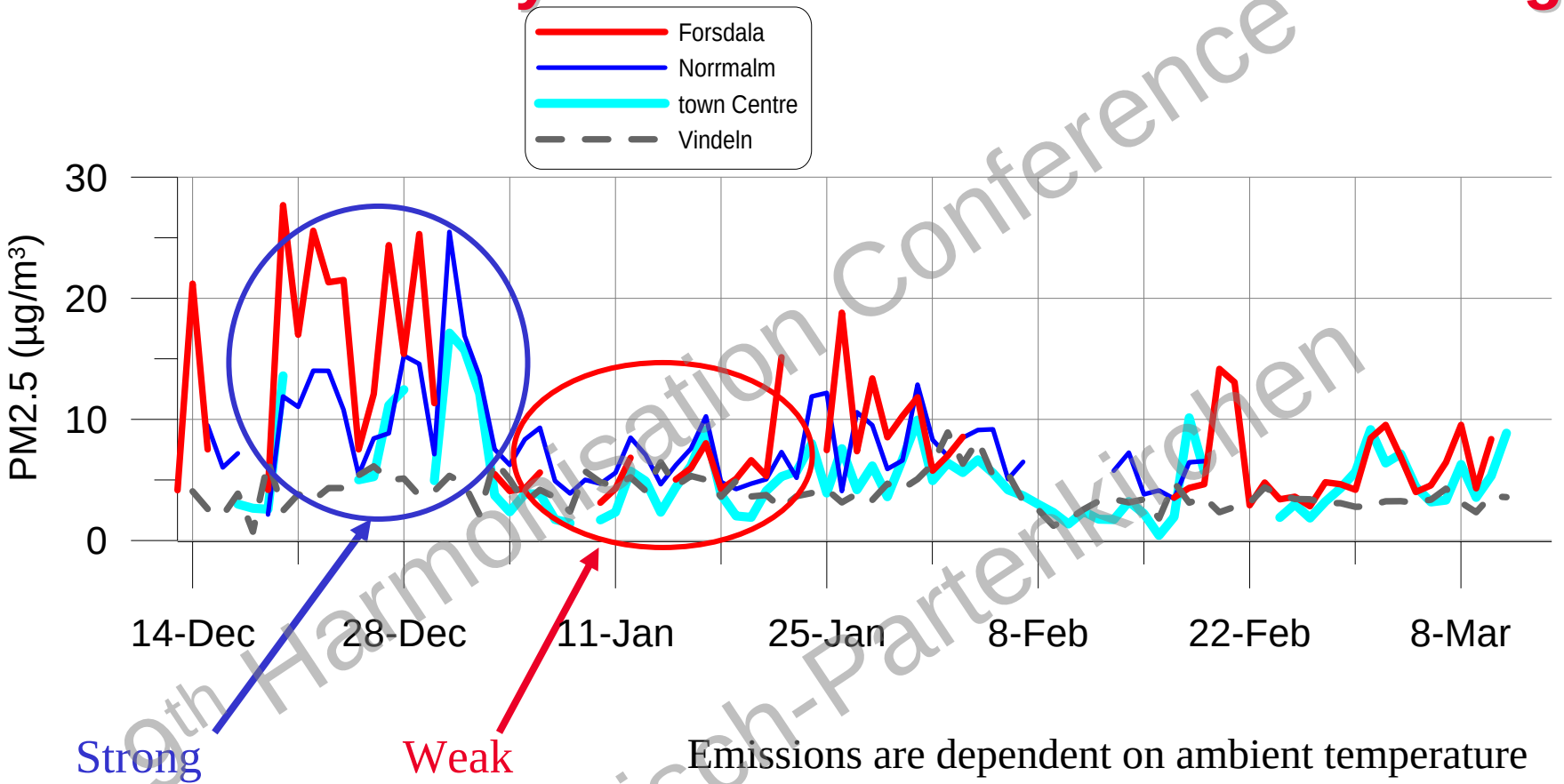
when T< -10 C





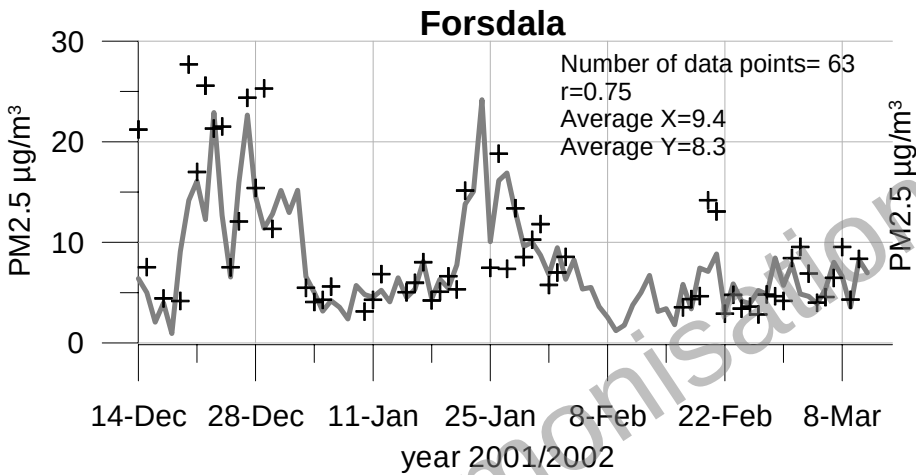
when T> -10C

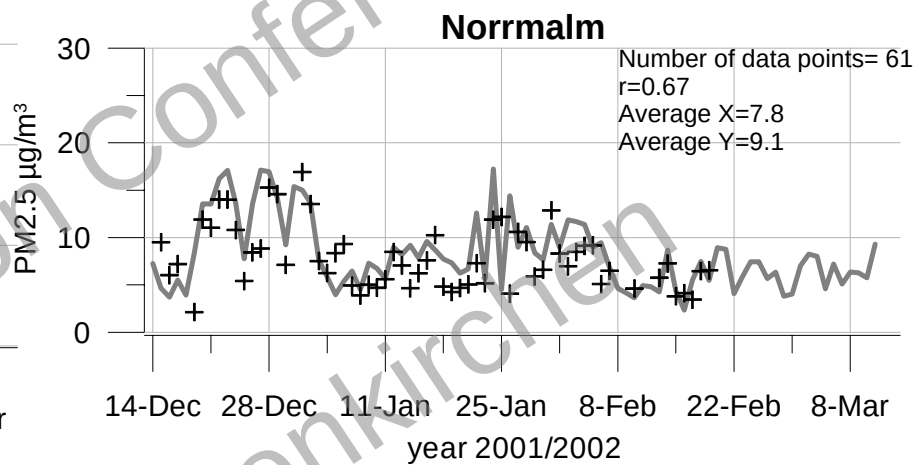
Activity data for domestic woodburning

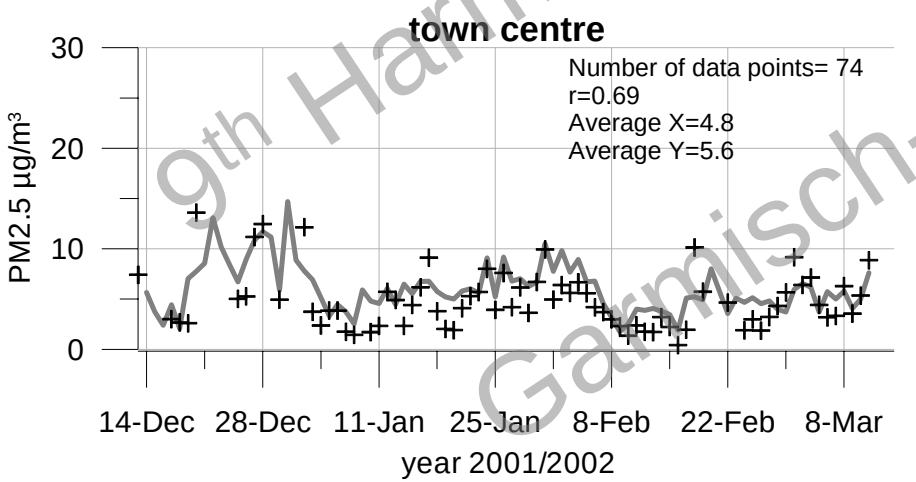


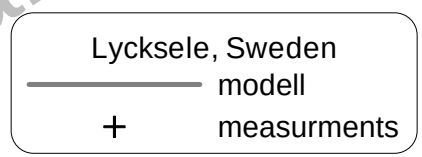
Emissions are dependent on ambient temperature and this relationship must be considered in order not to overestimate the emissions

Results





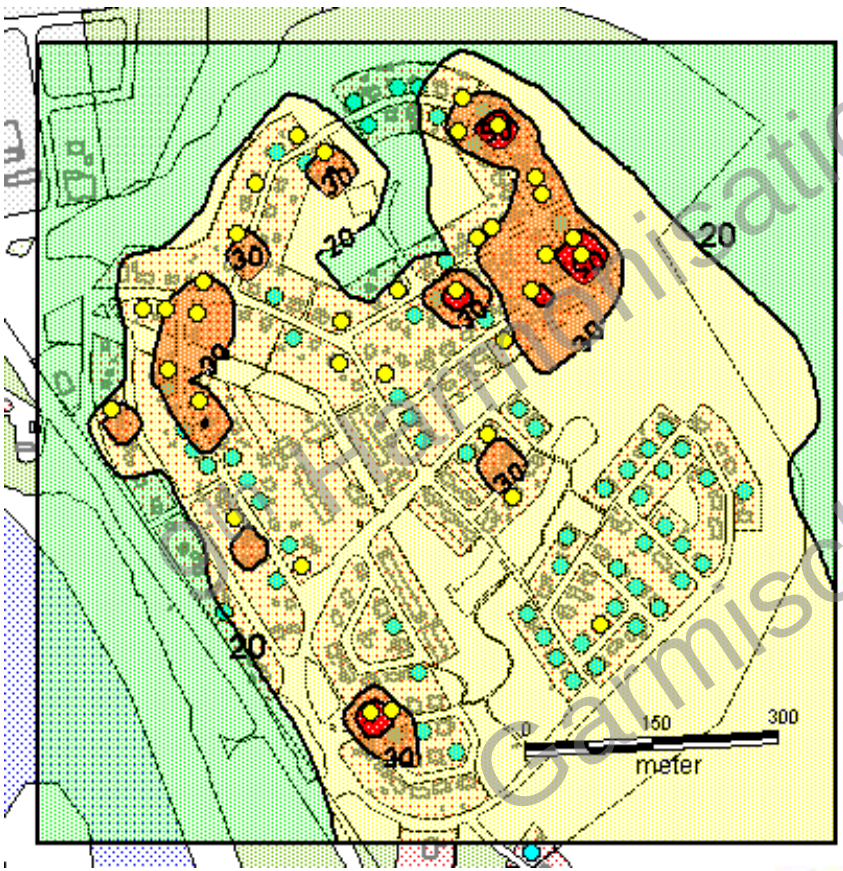




Example of model calculations

Furuvik/ Lycksele

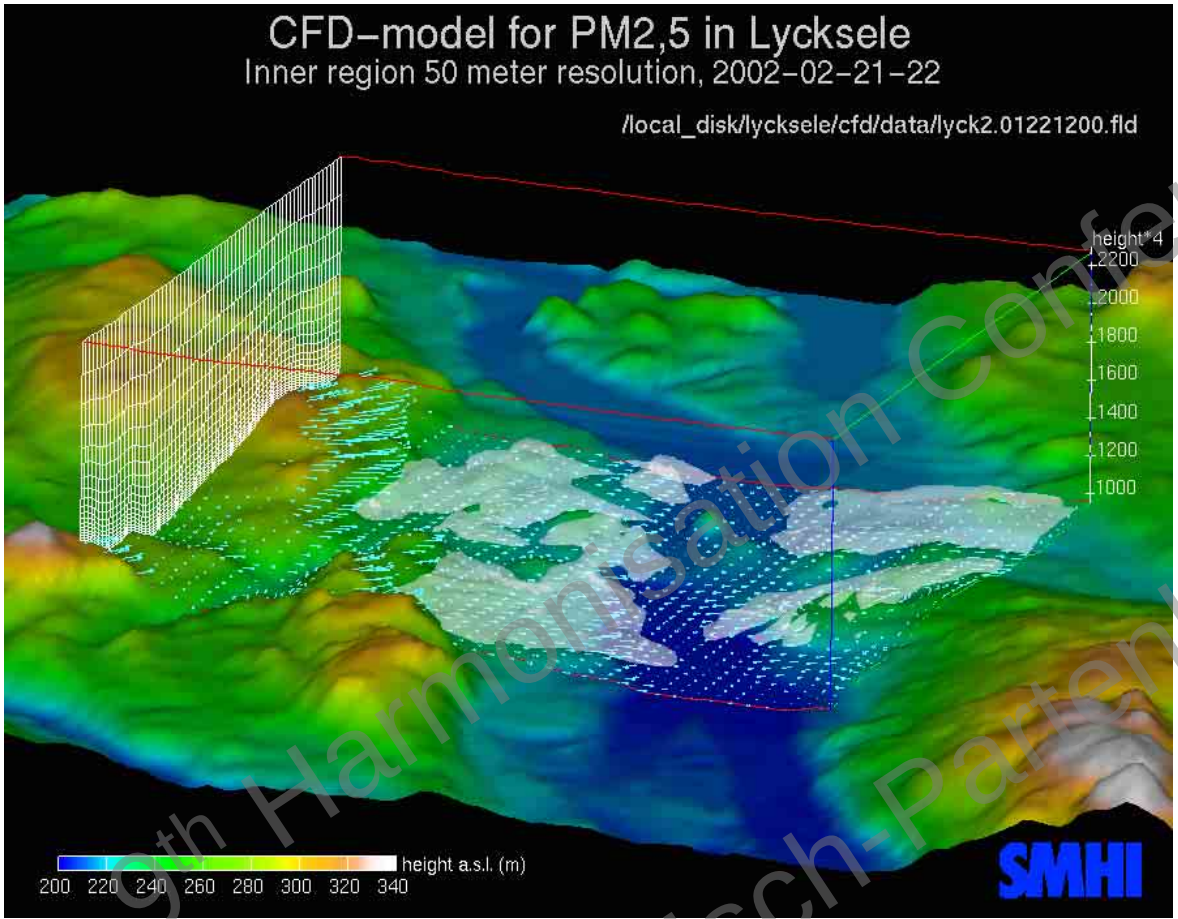
PM10 µg/m^3
90-percentiles of daily mean



Forsdala/ Lycksele

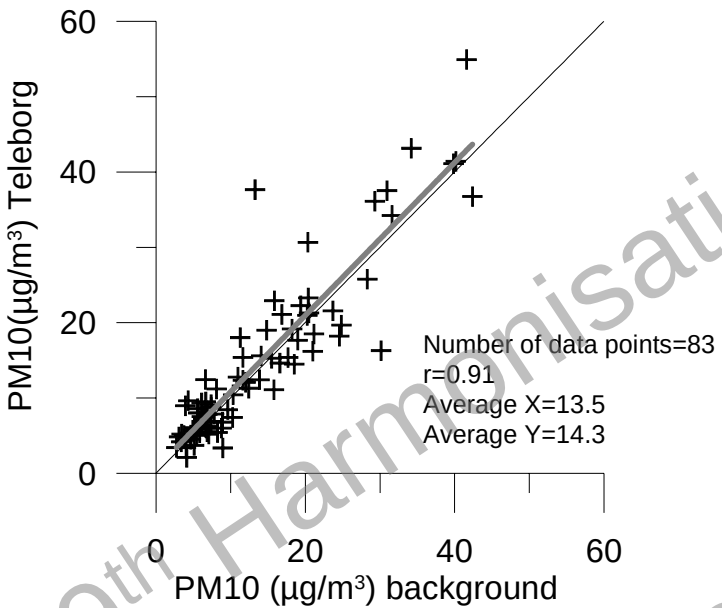
PM10 µg/m^3
98-percentiles of daily mean

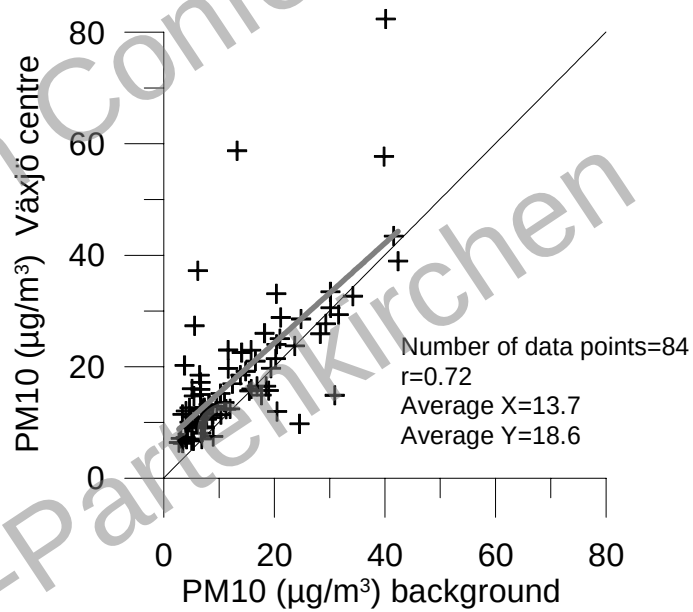
CFD model



High resolution, horizontal 50*50 m, vertical 20 layers below 600 m (156 980 grid cells)
Meteorolog inputs by the meteorological model ***HIRLAM22***

Results- Växjö





Strong correlation between measured PM10 in the town and in background air

Conclusions

- **The emission factors and their time variability are very critical parameters for the model assessment of the air quality and its relation to standards in areas with massive use of wood stoves.**

- **Environmental air quality standards for PM10 and evaluation thresholds (according to EU directives) were exceeded in rather different meteorological conditions in the two towns. For the northern town the main contribution was from local sources, mainly from biomass burning in old wood stoves, during strongly stable, light wind conditions. For the southern town the main contribution was long-range transport of air pollutants.**

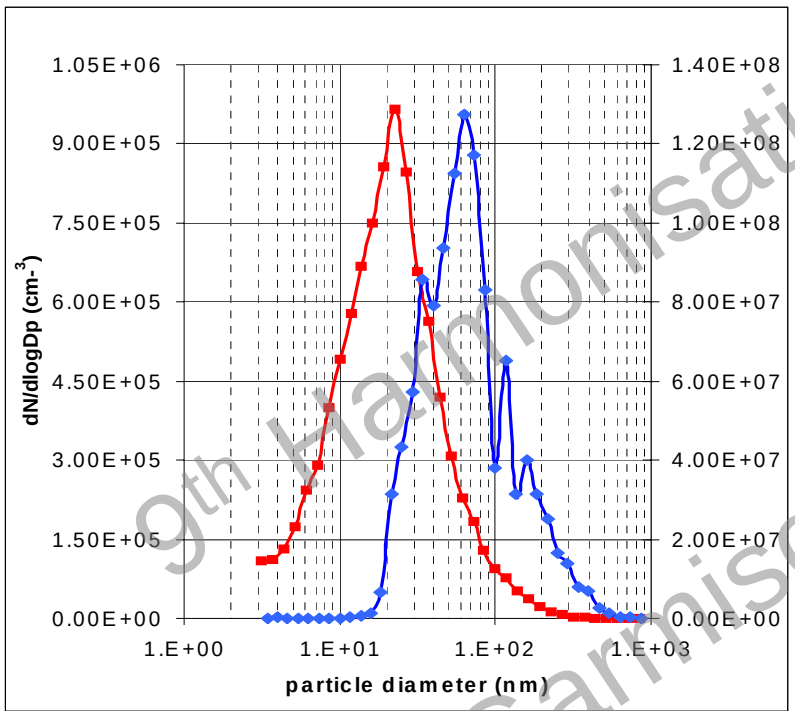
- **Domestic wood burning is the main contributor to the particle emissions from bio-mass use, due to use of old technology.**

- **The major abatement strategy to reduce emissions in the future is the application of new technology.**

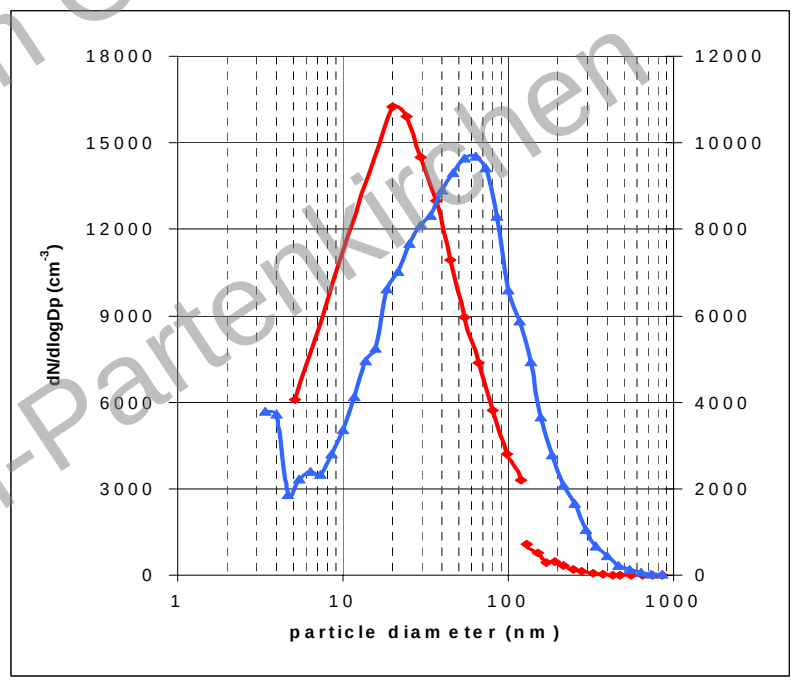
Typical traffic and wood burning distributions

Results from Lycksele (cold < -10 °C)

Traffic (car tunnel) Wood stove (laboratory exp.)



Central site Residential (Forsdala)



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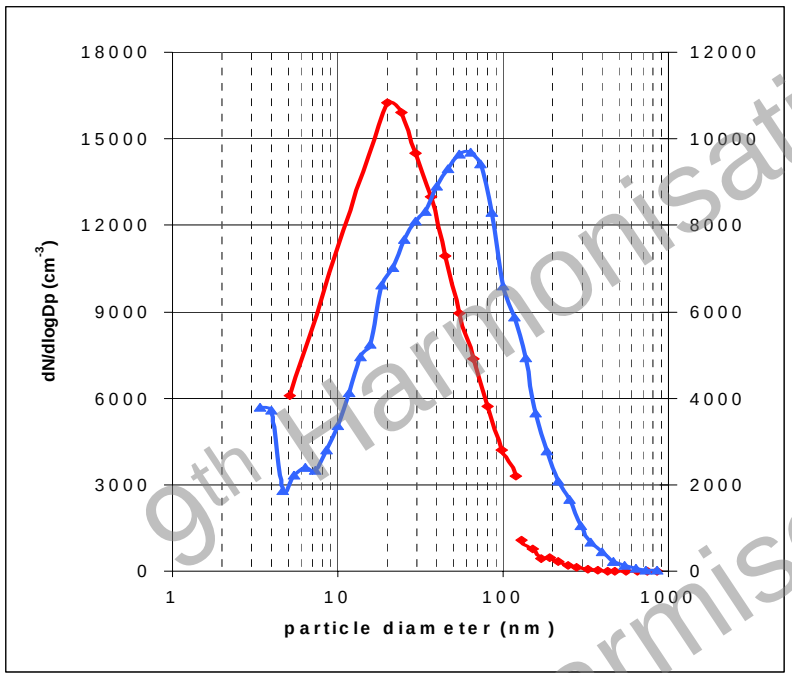

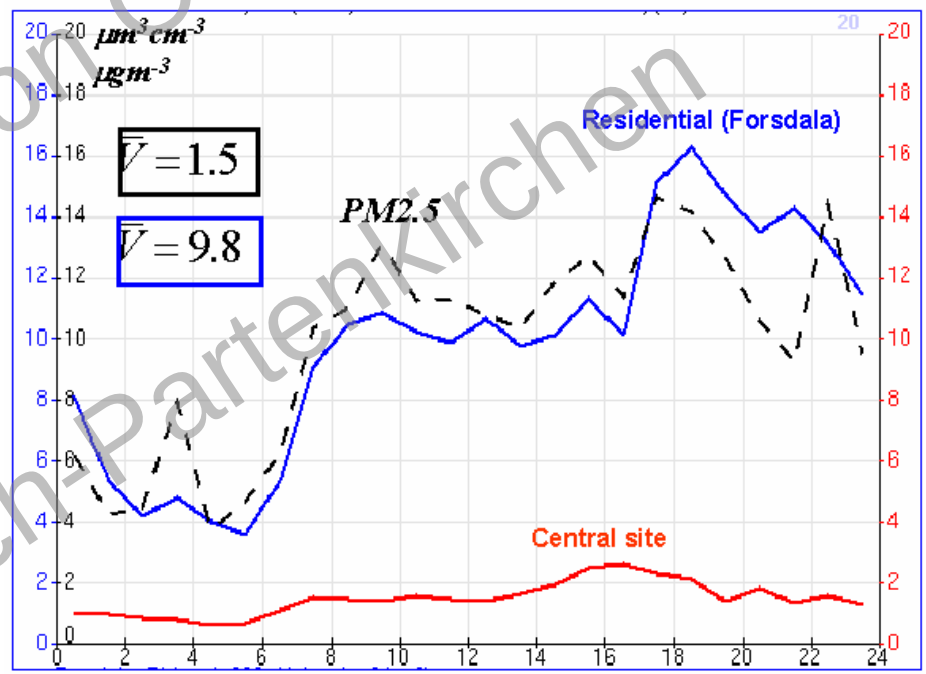

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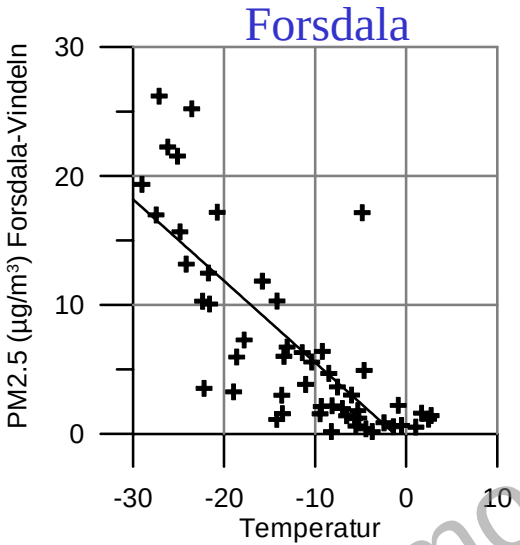

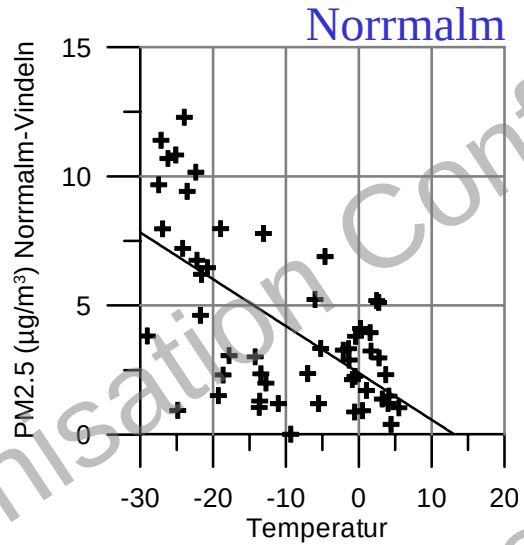

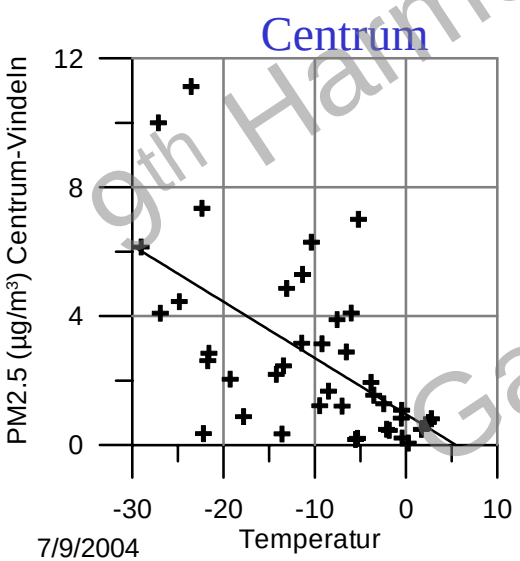

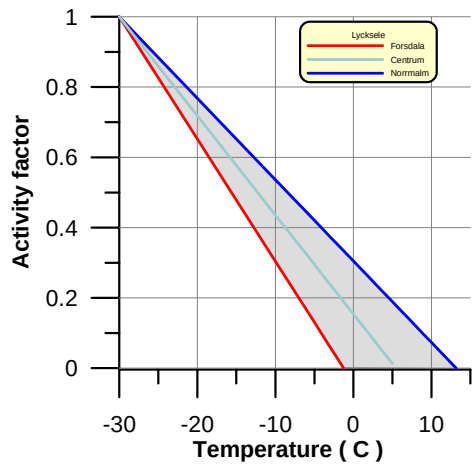

SMHI