NORPAC – A Nordic Project on PM Measurements and Modelling – Overview and First Results

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INTRODUCTION

This presentation gives an overview on the working plan and first results of a Nordic project launched in March 2004 under the support of the Nordic Council of Ministers (NMR). The project "Validated models describing Nordic urban and regional concentrations of particles and organic/ elemental carbon (**NORPAC**)" aims at enhancing and co-ordinating the Nordic research on measurements and modelling of ultrafine particles (UFP) and particles mass (PM). NORPAC connects 10 research groups from Denmark, Finland, Norway and Sweden.

The first phase (2004-2005) of the project covers the following activities:
1) Compilation, evaluation and synthesis of existing particle data and ongoing measurements in the Nordic urban and suburban areas, 2) Intercomparison of SMPS instruments and 3) Comparison and improvement of Nordic dispersion models for particles, including re-suspension of road dust.
The emphasis lies here on urban sources and models to get a good understanding on emission factors and processes on short time scale to provide a good description of concentration fields in the urban areas. The emission factors will be based on kerbside measurements and the urban background station will be used for validating the urban model.

The second phase (2005-2006) of the project will focus on the further development of the EMEP 3D Unified Eulerian model by implementing a better description of Elemental Carbon (EC) and Organic Carbon (OC), improving its capability to address sources, concentrations in the atmosphere, transformation and deposition.

The assessment of sources for local and regional PM levels has high priority in the political and scientific discussions due to stringent EU limit values that have to be met and the relation of PM to health effects and climate effects.

METHODS

At the activities in NORPAC are divided in 7 working groups. The meeting protocols, working reports and publications of the project are available on a designated web page (http://NORPAC.dmu.dk). For our data exchange and analysis we use the web based databank "NORDIC" (www.luftkvalitet.se) developed by Swedish Meteorological and Hydrological Institute (SMHI) and Slb (Environmental and Health Administration of Stockholm) for the Swedish Environmental Agency. For the SMPS intercomparison exercise an aerosol generator is under construction and will be calibrated by Lund University and circulated among the measuring groups. At the moment Stockholm University builds 6 soot photometer instruments that will be installed in Stockholm and Copenhagen covering kerbside, urban background and rural locations.

FIRST RESULTS

Emissions of **particle number** from traffic are totally dominated by tail-pipe emissions in the ultrafine size range. Figure 1 shows a comparison between emission factors (number of particles · vehicle^{-1} · km^{-1})

from a tunnel study in Stockholm (Gidhagen *et al.*, 2003; Kristensson *et al.*, 2003) and kerbside measurements on Jagtvej and H.C. Andersens Boulevard (HCAB) in Copenhagen (Ketzel *et al.*, 2003). For all measurements the particle number size distributions peak at ~15-20 nm in diameter, with an additional mode centred around ~75-80 nm. Total particle emission factors for an average car fleet (5% heavy-duty diesel vehicles, HDV) are typically $\sim 3 \cdot 10^{14}$ km^{-1} and $\sim 4 \cdot 10^{14}$ km^{-1} on Jagtvej and HCAB (speed limit 50 $km \cdot h^{-1}$), and increased with increasing speed from $\sim 3 \cdot 10^{14}$ km^{-1} to $\sim 11 \cdot 10^{14}$ km^{-1} in the speed interval 70 to 85 $km \cdot h^{-1}$. HDV emit typically ten times more particles (number) than the mix of light-duty vehicles, LDV.

Particle mass emissions from traffic can be divided into three main groups: **A)** Direct exhaust emissions that are predominantly found in the fine fraction (PM2.5) and are documented in different emission databases (e.g. COPERT, HbEfa). **B)** Emissions from brakes wear that are to about equal amount present in the fine and coarse (PM10-PM2.5) fraction and correlate well with the direct emissions and other vehicle emissions e.g. NOx. Most difficulties are connected with **C)** emissions from road abrasion, tyre wear and road dust re-suspension that are mostly found in the coarse fraction and are often less correlated with the exhaust emission due to an influence from 'external factors' as road condition (wetness, salting, sanding, road material) and use of studded tyres. A comparative analysis of PM measurements in Sweden and Denmark reveal a fair agreement for the average urban emission factors for PM2.5 and also for PM10 emissions during summer time. For these cases a harmonised Nordic emission methodology seems to be possible. Under winter/early spring conditions the use of studded tyres and salting leads to a dramatic increase of coarse emissions, that are very depending on the local conditions at the measuring site and are more difficult to predict. During rain events the coarse emissions seem to reduce while in the process of drying of the road surface elevated emissions are observed. Empirical models accounting for these effects are under development.

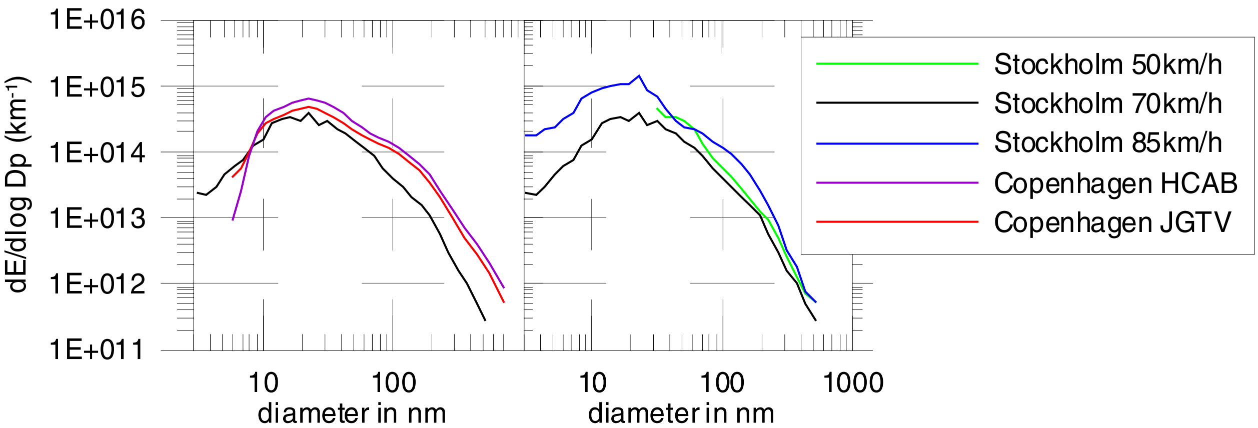

Figure 1. Left: Comparison of the emission factor size distribution for the average fleet from Stockholm (vehicle speed ca. 70 $km \cdot h^{-1}$) with the size distribution measured at two streets in Copenhagen (ca. 50 $km \cdot h^{-1}$). Right: Speed dependence of the emission factors in Stockholm. For the speed 50 $km \cdot h^{-1}$ and particle sizes below 30 nm, the emission factor could not be estimated due to particle losses in the tunnel.

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