CONTRIBUTIONS OF STREET TRANSPORT, RESIDENTIAL HEATING AND LOCAL INDUSTRIAL SOURCES TO AIR POLLUTION IN A SMALL TOWN IN ESTONIA

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INTRODUCTION

- This is the first air quality model-measurement intercomparison study in a small town (2200 inhabitants) in Estonia and to our knowledge, in the Baltic countries as well.
- This study is based on *in-situ* air quality measurement with diffusive samplers, dispersion modelling, and a questionnaire study of residents.

Research questions:

- Are there any signs of elevated concentrations of SO_2 and NO_2 in certain places?
- Does burning of fuels in private houses affect the local air quality?
- How much contribute the street transport and industrial sources to the concentrations beyond the rural background?

MEASURING WITH PASSIVE SAMPLERS

Measurements with passive (diffusive) samplers (Figure 1) were carried out at four sites in the town of Otepää during one month in summer and winter.

- Three measuring points were located in the most polluted area of the town of Otepää.
- one measuring point was slightly away from the town (site nr 4).

Figure 1. Passive samplers (under the white cover) at measurement site.

Measurement-based annual average concentrations up to 1.9 ngm^{-3}, with clear indication of higher concentrations in heating season.

MODELLING WITH AEROPOL MODEL

The Gaussian plume model AEROPOL is described by Kaasik & Kimmel (2003) and Geertsema & Kaasik (2018).

- The single-point meteorological data
- The street emission data (TU Graz (2009).
- The emission data on boiler houses and small local industrial enterprises
- Regional background concentrtions
- The emission factors from firewood (Teinemaa, 2013).

QUESTIONNAIRE STUDY

For residential heating emissions (incl. saunas) a questionnaire on heating habits (35 respondents from 638 houses in total) was performed.

It was found that by energetic value, 92% of used fuel is firewood, rest 8% consisting of peat and liquid fossil fuel.

The questionnaire study revealed that on very cold winter days (when outdoor temperature reaches nearly -20 °C), the wood-heated dwelling houses are usually heated twice a day (morning and evening) and in days with more usual temperature, once a day (predominantly in the evening). Daily course of emissions of NO_x and SO_2 is given in Figure 2.

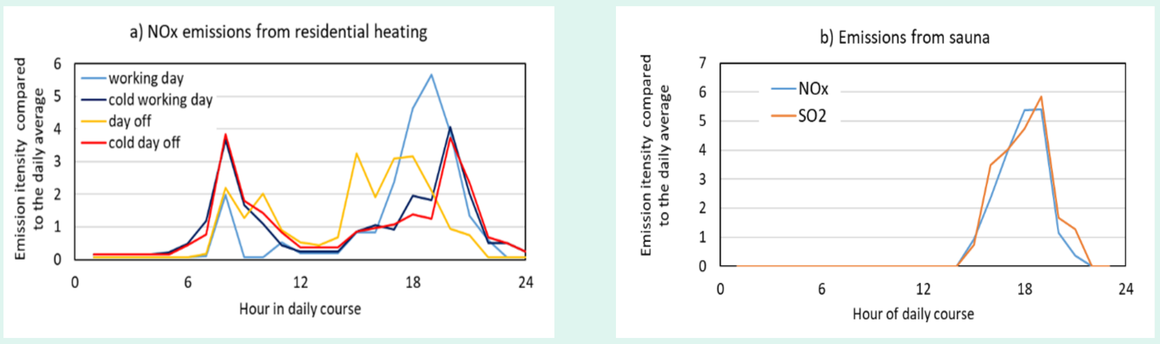

Figure 2. Daily course of emission intensity of NOx from residential heating (a) and daily courses of NOx and SO_2 from saunas (b)

RESULTS

In Figure 3 are presented the maps of modelled average concentrations of NOx and SO_2 from all sources in summer and winter episodes of passive sampling. For comparison with measured NO_2, it was assumed that 75% of locally emitted NOx is in form of NO_2 as average during the sampling time.

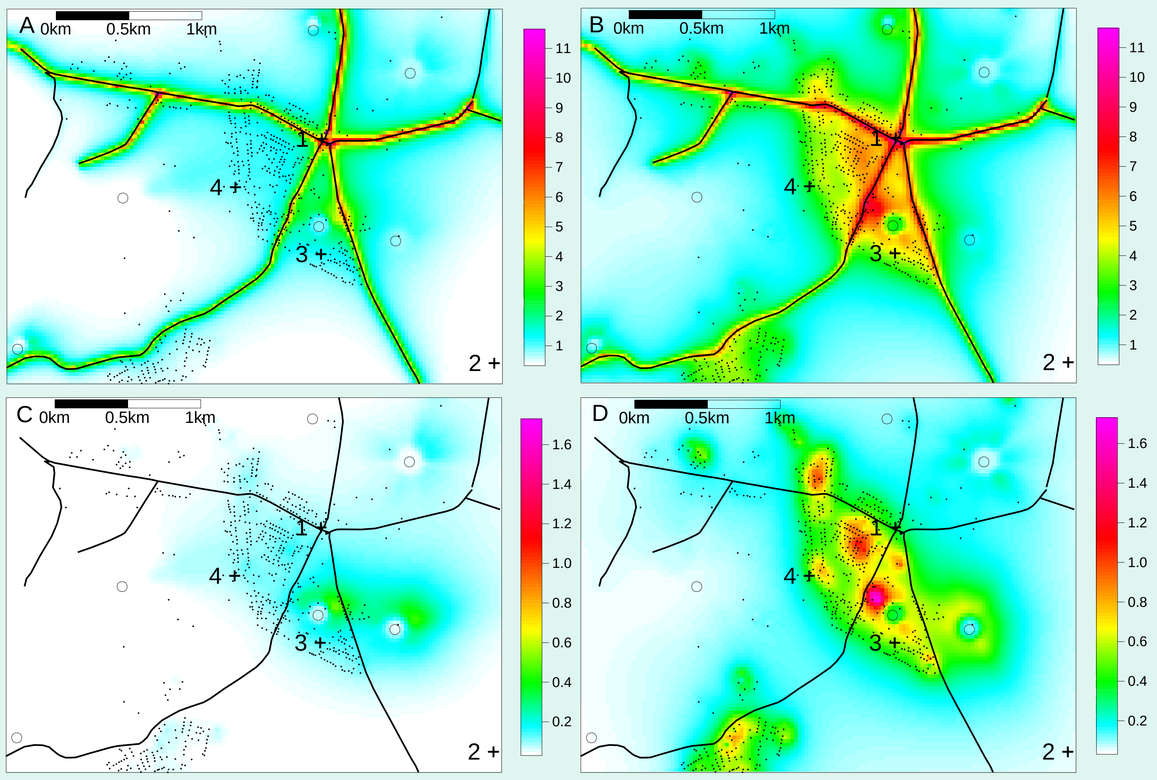

Figure 3. Modelled maps of concentrations of NO_2 in summer (A) and winter (B) and SO_2 in summer (C) and winter (D). Industrial sources are marked with black circles, Dwelling houses with small black dots and main streets with black lines. The crosses with numbers indicate the sampling sites.

Comparison of modelled (incl. added background) and measured concentrations is given in Figure 4.

- It is evident that the concentrations of both NO_2 and SO_2 are higher in winter due to heating, which is partially visible in regional background as well.
- However, the highest NO_2 levels at busy crossing (1) and lowest levels of both NO_2 and SO_2 in the forest site (4) are reproduced by the model, as well as relatively uniform distribution of SO_2, which originates mainly from residential and district heating.
- In wintertime the concentration of NO_2 in the traffic site (number 1) is underestimated by 34%, which may occur due to underestimated traffic flow, as the generalized governmental statistics may not catch the specific features of a winter resort.
- In general, the model performs rather reliably, the measured and modelled concentrations are relatively similar, well below the European annual average limit values for NO_2 (40 $\mu g/m^3$) and SO_2 (20 $\mu g/m^3$).

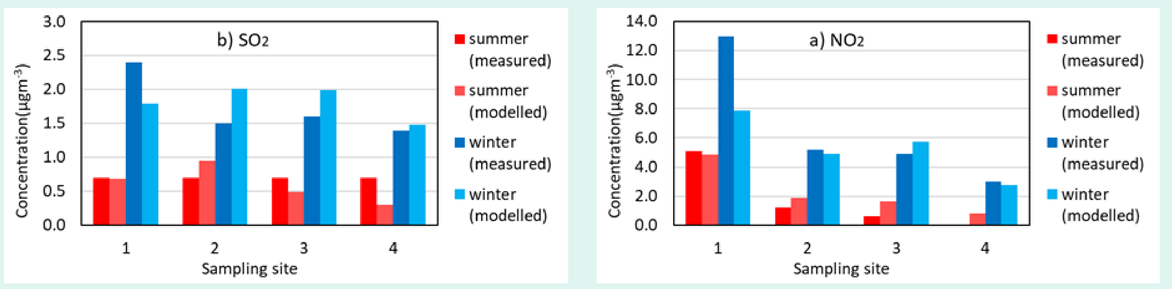

Figure 4. Measured winter- and summertime concentrations of NO_2 and SO_2 in sampling sites compared to model results

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