PM10 SOURCE APPORTIONMENTS WITHIN THE CITY OF KLAGENFURT, AUSTRIA

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ABSTRACT

Within the framework of the European funded LIFE Project KAPA GS, launched in summer 2004, it is intended to perform PM10 source apportionments within the city Klagenfurt (Austria). From November 2004 to November 2005 a dense network of twelve monitoring stations for PM10, PM2.5 and PM1 was installed in Klagenfurt. The GRAMM/GRAL model system is used for the calculation of the wind fields and the dispersion. A model validation was performed on basis of monitored PM10, PM2.5, PM1 and NOx concentrations. The results are used to evaluate the effects of action plans before they are set into force.

1. INTRODUCTION

In many regions in Austria the topographical situation and the meteorological conditions result in high PM10 concentration values. Permanent violations of PM10 air quality (AQ) standards call for action plans to reduce the PM10 emissions. In order to evaluate the effects of action plans before they are set into force a combined emission-dispersion tool has been developed within the framework of the Project KAPA GS. This approach has been applied to the city of Klagenfurt, which is a city of 90.000 inhabitants and approximately 150.000 including suburbs and commuters. Its location in a basin on the south side of the Alps results in wintertime in long periods with strong inversions combined with calm winds. These unfavourable dispersion conditions lead to a relatively high PM10 burden. The annual mean values are met on all air quality monitoring locations, but the threshold value for PM10 as daily mean value is exceeded frequently. In 2005 84 violations were registered at one of the monitoring stations (see Table 1).

Table 1: PM10 concentrations during the years 2002 to 2005

Air quality monitoring station	year	max. daily mean value [µg/m³]	No. of days > 50 µg/m³ [ ]	annual mean value [µg/m³]
Koschatstraße	2005	86	31	26
	2004	84	34	27
Völkermarkter Straße	2005	123	84	39
	2004	116	80	38
	2003	99	74	38
	2002	127	58	37

2. METHODOLOGY

Based on a new traffic model for Klagenfurt, traffic emissions were calculated with the program NEMO (Network Emission Model), which combines a detailed simulation of the fleet composition and of the emission factors and applies it to a road network (Rexeis et al. 2005). In NEMO the emission factors of the HBEFA 2.1 (Umweltbundesamt 2004) are used and can be applied to a road network considering also different road types and varying slopes.

The revised emission inventories of domestic heating and industry were implemented in the simulations for the spatial distribution of PM10. Therefore the prognostic wind field model GRAMM (Öttl 2000) and the Lagrangian particle model GRAL (Öttl et al. 2003) were applied. This model system was developed especially for the application to dispersion situations with low wind speeds in complex terrain.

The input data consists of different source types with different release characteristics. As a consequence it is necessary to simulate these different kinds of sources like line sources, point sources and tunnel portals, simultaneously. GRAL fulfils these requirements and the following parameters are taken into account for the individual source types:

- Point sources: location (3D): Source strengths, exit velocity, temperature differences, diameter.
- Line sources: location (3D, also bridges): Widths, source strengths, heights of noise barriers.
- Area sources: Same as line sources.
- Tunnel portals: Location (3D), source strengths, exit velocity, temperature differences, traffic influence on tunnel jet.

Quality assurance of the modelling system GRAL is guaranteed by permanent validation activities using data from field experiments. Currently 18 different data sets for tunnel portals, point sources, line sources and built-up area are used for the model evaluation, such as Prairie Grass, Indianapolis, INEL, Elimaeki, Goettingerstrasse, Hornsgatan, etc. Many of the modelling results have been published in peer-reviewed journals (e.g. Oettl et al. 2001, Oettl et al. 2003).

3. RESULTS AND DISCUSSION

A model validation was performed on basis of monitored and calculated (Figure 7) NOx concentrations and showed a good correlation. Figure 1 shows the contributions of the different source categories in Klagenfurt for the annual mean values at two different PM10 monitoring stations. Primary traffic exhaust emissions contribute roughly 10% to the total observed PM10 concentrations at the kerbside station, and approximately 5% at the urban background site. The calculated PM10 concentrations are shown in Figure 2. Outside the city centre the contribution is less than 1µg/m³ except near major roads. The non-exhaust traffic emissions contribute approximately 25% to the total observed PM10 concentrations at the kerbside station, and 15% at the urban background site (Figure 3) and have broader dispersion band due to higher emission factors. Domestic heating seems to be the second largest source for primary PM10 with a contribution of roughly 10% (Figure 4) and has the biggest extension in terms of covered area. Industry contributes only approximately 6-7% to the total observed concentrations in Klagenfurt (Figure 5). The results are also available for the winter mean value, the number of exceeding days and the maximum daily mean value. Interestingly, the city seems to contribute only approximately 50% to the total observed concentrations even at kerbside stations, which calls for measures to reduce PM10 emissions not only within cities but also at regional scales. Short and long term measures are taken into account. The short term measures are based on traffic restrictions which shall be implied as soon as 50 µg/m³ (daily mean value for PM10) are exceeded for more than 5 consequent days. In this case one of the main streets (Völkermarkter Straße) willl be closed for traffic. Figure 8 shows the result of the simulation. Long term measures are based on actions which should result in long term changes of the emission situations. As an example the effects of upgrading of old heating facilities on the PM10 concentrations are shown. In the near future approximately 600 households which use currently wood, coal and oil shall be connected to the district heating system. Figure 9 shows the result of the simulation. Further investigations within this project include analysis of non-exhaust emissions from vehicles by two-point PM10 observations at a major road. The main focus here is to identify possible reduction potentials concerning different winter sanding policies.

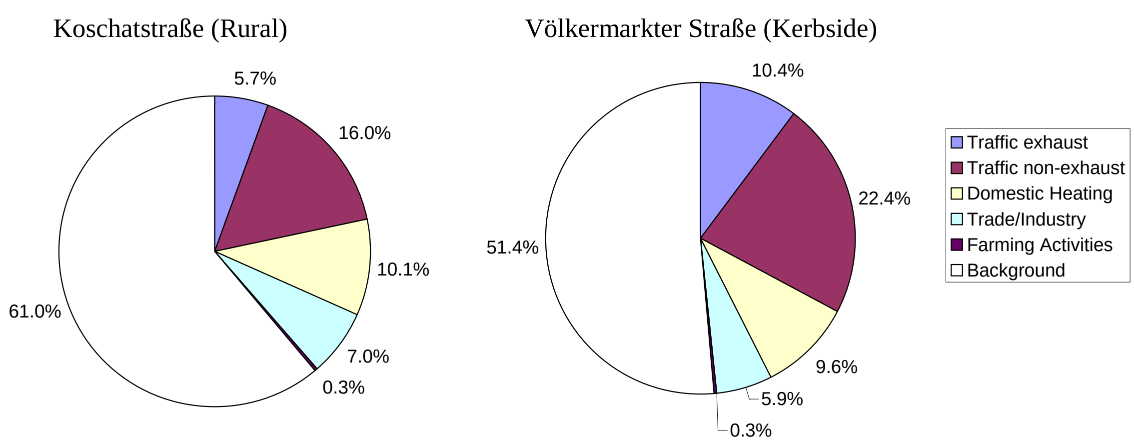

Figure 1: Contribution of the different sources to the PM10 concentrations in Klagenfurt

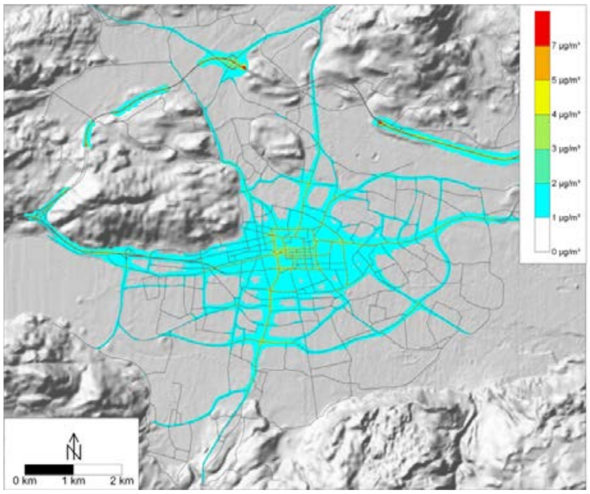

Figure 2: annual mean PM10 concentrations - traffic exhaust

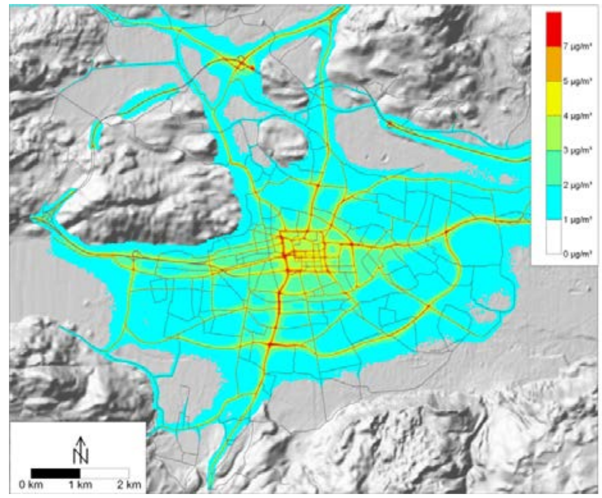

Figure 3: annual mean PM10 concentrations - traffic non-exhaust

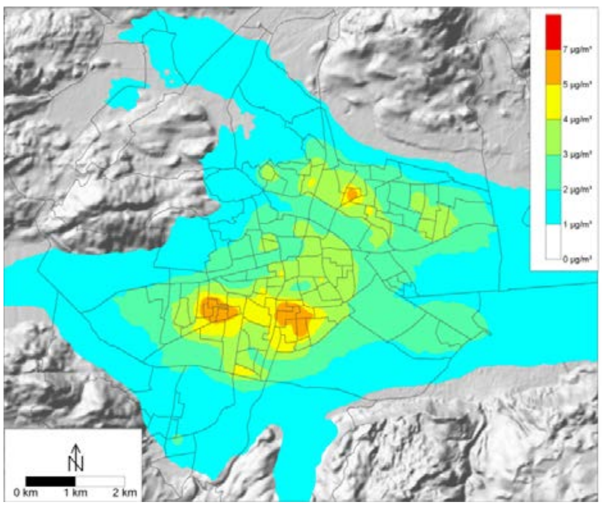

Figure 4: annual mean PM10 concentrations – domestic heating

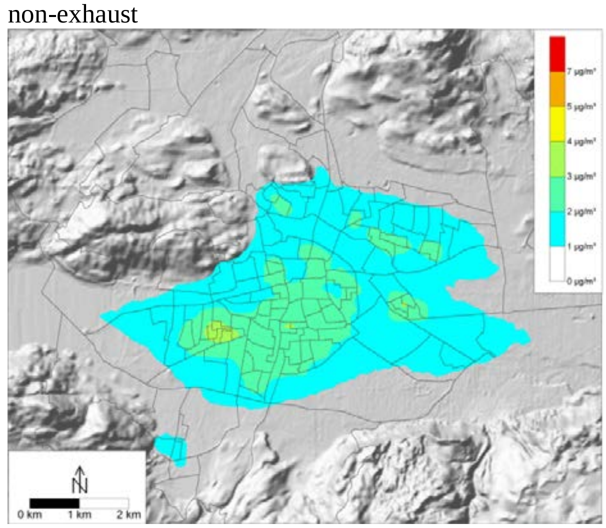

Figure 5: annual mean PM10 concentrations – trade and industry

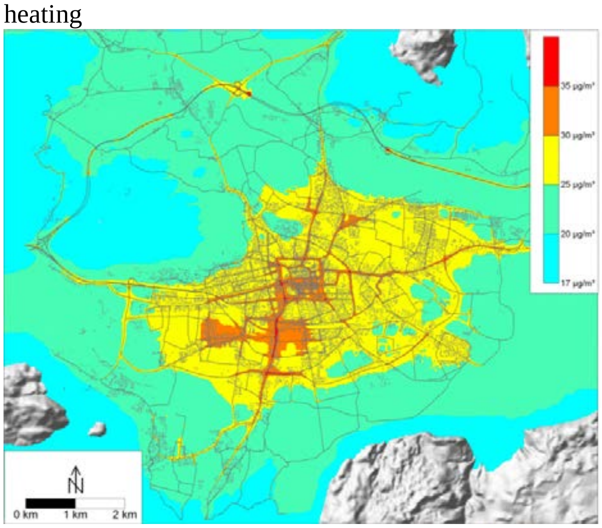

Figure 6: annual mean PM10 concentrations – all sources

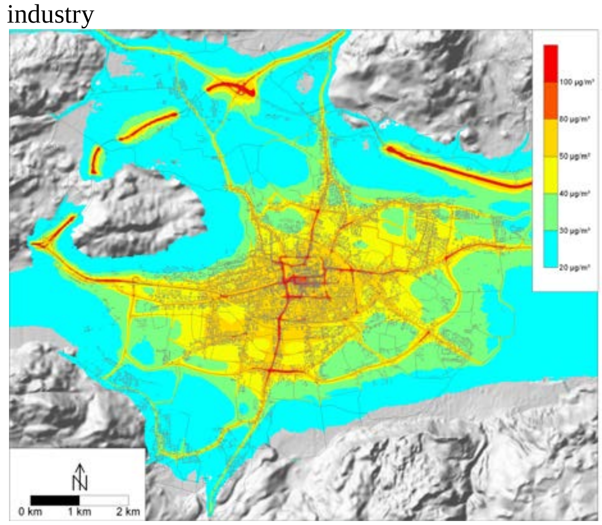

Figure 7: annual mean NOx concentrations – all sources

Figure 8: Impact of the closure of one main street on the PM10 concentration (daily mean value)

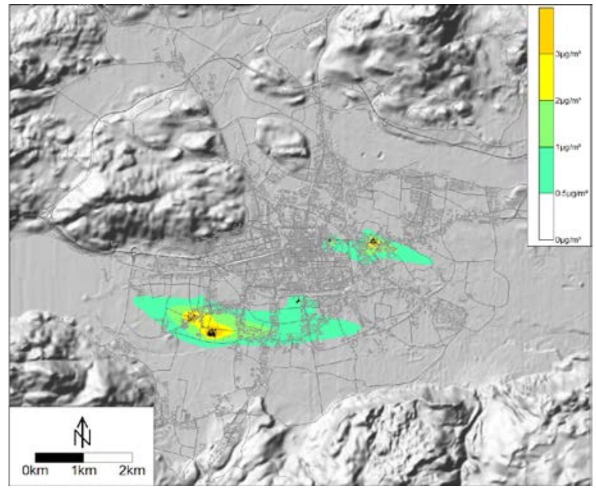

Figure 9: Impact of local upgrading of domestic heating systems on PM10 wintertime mean value [µg/m³]

4. CONCLUSIONS

The results of the emission and dispersion modeling agree well with the measured concentrations and the chemical analysis. The model chain offers the possibility to calculate air quality inventories on basis of different source types with different emission characteristics with a very high resolution. The results can be used to evaluate the effects of action plans before they are set into force. The analysis in Klagenfurt showed that emissions from traffic and domestic heating are dominating, but the background concentration accounts for at least 50 % of the measured concentrations. The main reasons are the formation of secondary particles and the transport of particles from outside the calculation domain. In the near future calculations with a chemical-transport-model will be performed to get more knowledge about the regional background.

5. ACKNOWLEDGEMENTS

Parts of this work were performed under the framework of the project KAPA-GS funded by the European Union.

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