

Chapter 111

Combining Models for Assessment of Local Air Quality

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Abstract Assessing local air quality can be a challenging task. Indeed, local air quality is strongly dependent on local factors but also regional and in some cases even global effects have to be taken into account when assessing local air pollution concentrations. Furthermore, large gradients in pollutant concentrations can be present in the urban environment. In order to assess the local air quality for the city of Antwerp, a combination of an Eulerian dispersion model, a measurement interpolation tool, a Gaussian plume model and a simplified version of the OSPM street canyon model have been coupled to each other, taking into account double counting effects of local emissions. The coupled model which combines the regional, urban and street canyon scale has been applied for the city centre of Antwerp and its harbour. This results in detailed maps with a resolution up to 30 m for four pollutants: PM₁₀, PM_{2.5}, EC (elementary carbon) and NO₂. Furthermore, several abatement measures have been assessed in order to improve the urban air quality. It has been shown that local (traffic) measures only have a small effect on total mass PM₁₀ and PM_{2.5} concentrations, but exhibit a larger effect on EC and NO₂-concentrations.

Keywords Local air quality • Coupled models

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111.1 Introduction

Modelling of air quality leads to a better understanding of the spatial distribution of air pollution. Furthermore, it is necessary to set up a modelling study if the air quality needs to be assessed in a complete region. However, local air quality is strongly dependent on local factors but also regional and in some cases even global factors have to be taken into account when assessing local air pollution concentrations. Therefore, a chain of different models (ranging from the regional scale to the local and the street canyon scale) has been applied in order to model the air quality for the city of Antwerp, one of the major hotspots in the polluted area of Flanders, Northern Belgium.

111.2 Model Chain and Coupling

An integrated model chain has been setup to assess the air quality, including both regional changes as well as local variation of air pollution. Hereafter the model chain is discussed. The road traffic loads are the input for the MIMOSA4 emission model [7, 9]. The resulting spatially and temporally distributed emissions are used in the bi-gaussian model IFDM [5]. These results are coupled to output of the Eulerian dispersion model AURORA [2, 7, 8] calibrated with the land-use regression model RIO [3, 4]. A mechanism to avoid double counting of the emissions by the different models is applied [6]. The IFDM concentrations related to the local emission sources are first averaged over the grid cells of the regional AURORA model. This local contribution is subtracted from the regional contribution before the concentration pattern of the bi-gaussian plume model is added at high resolution. Finally the output are coupled to results of the OSPM-model [1]. For every receptor point in a street canyon, the concentration due to the road lying in the street canyon is subtracted before adding the OSPM-calculation in order to avoid double counting of emissions. The double counting corrections described above are applied on an hourly basis and result in reliable maps for annual statistics which can be used for compliance checking in the framework of the EU Directive.

111.3 Results and Discussion

The complex model chain briefly presented in Sect. 111.2 is applied for the city of Antwerp. Figure 111.1 shows the NO₂-concentrations as estimated for the year 2015 over the city and its harbor. As an emission projection, a current legislation emission inventory is used. The major roads, the important industries (in the northern part) and the major street canyons are revealed in the NO₂ map. Furthermore, exceedances of the European limit value of 40 µg/m³ can be found at several places.

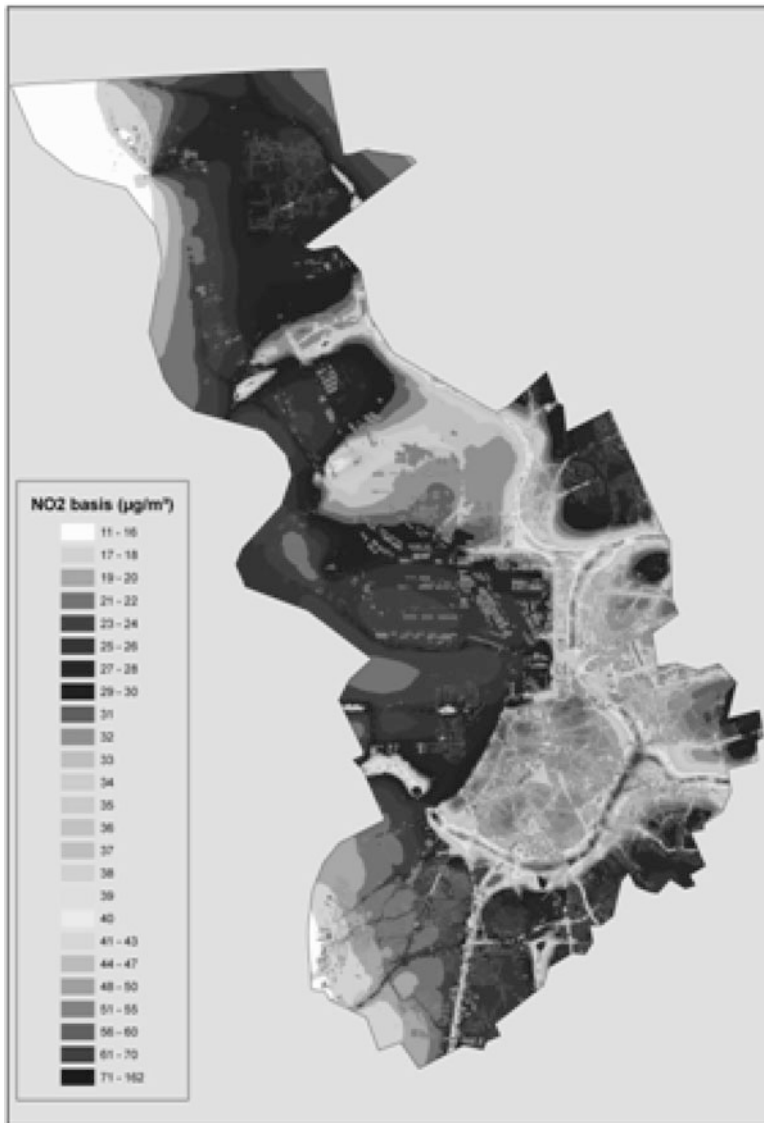


Fig. 111.1 NO₂-concentration for Antwerp (city and harbour) for the year 2015 under a current legislation emission projection

Therefore, it is necessary to take additional measures beyond the current legislation, in order to obtain acceptable air quality levels in the year 2015.

Making use of this air quality map, an number of abatement measures were defined by a local policy makers. The measures were combined in a number of scenarios which were evaluated within the same modeling framework. It has been

shown that local (traffic) measures only have a small effect on total mass PM₁₀ and PM_{2.5} concentrations, but exhibit a larger effect on EC and NO₂-concentrations. Based on those results, the most effective and cost efficient action plan was developed for the city of Antwerp.

111.4 Conclusion

A methodology is presented to deal with the multi scale problem in urban air quality. A coupled model chain accounts for the regional, local and street canyon scales and avoids double counting of emissions at the different modeling scales. The framework can be used to assess local air quality up to the street canyon level and can also be used to assess the impact of a set of abatement measures and to define the most effective and cost efficient action plan.

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