19th International Conference on
Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes
3-6 June 2019, Bruges, Belgium

WHEN A JUDGE CONVICTS YOU TO MODEL 2030 AIR QUALITY MAPS UP TO STREET CANYON LEVEL

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Abstract: On October 10, 2018 the Flanders region was convicted by the Belgian court (Rechtbank eerste aanleg, 2018) for exceeding European air quality limit values of NO_2 in all its air quality zones. The argument used for this legal decision was not based on measurements but on modelled high resolution air quality maps. The NO_2 maps were obtained by the ATMO-Street model (combined model chain of RIO, IFDM and OSPM, Lefebvre et al., 2013) which predicts concentration levels for the whole Flanders region down to every single street (canyon). In its conclusion, the Belgian court convicted Flanders to setup an air quality plan for the whole region at the same level of detail (street canyon level) in which it should be investigated how air quality limit values can be attained as soon as possible for every zone.

This court case poses some clear challenges with respect to the modelling setup of this air quality plan. How can pollution levels up to the spatial resolution of a few meters be estimated under future conditions of 2020, 2025 or 2030, taking into account both local measures at urban level as well as regional, national and European policies? To tackle this problem, a model chain is setup combining the results of a calibrated CTM with the IFDM Gaussian plume modelling for the urban scale and OSPM for the street canyon increments. The objective of this coupled approach is to capture regional as well as local effects of various policies in a single modelling application. Within this paper, the methodology and its validation is described in detail, strengths and weaknesses are discussed and results up to the year 2030 are presented. Furthermore, the (political) consequences of this court case and in particular the role of the modelling exercise will be discussed.

Key words: *Air quality limit values exceedances, Air quality modelling.*

INTRODUCTION

During the last couple of decennia, model results have been used for policy support in Flanders (northern Belgium). However, official air quality reporting towards the European Commission is done on the basis of the fixed telemetric measurement stations. These show only a small number of exceedances of the European limit values. In October 2018 a court decided that this approach is not sufficient. The court decision itself is unfortunately only available in Dutch. Nevertheless, if this decision would be applied European-wide, it would lead to an important change in the use of model data for policy support.

THE DECISION OF THE COURT

Several aspects were made clear by the court (translated from, Rechtbank van Eerste Aanleg, 2018) which are elaborated in a lengthy and well-motivated text. A few remarkable paragraphs with respect to modelling are:

- *The Air Quality Directive stipulates that the measuring method must in principle be fixed measurements, but that it is not necessary to limit this: the fixed measurements can be supplemented with modeling techniques and/or indicative measurements to provide adequate information about the spatial distribution of the air quality.*
- *In the light of the objectives of the Air Quality Directive it is self-evident that if data is collected via other (reliable and within the requirements of the Air Quality Directive) techniques than fixed measurements, this data must be included in the design of a policy, the implementation of the Air Quality Directive and for assessing air quality levels.*
- *If information from indicative measurements and modeling is available, it must also be used. It would go against the intention of the Air Quality Directive and the general duty of the government, to not make use of relevant - authorized and regulated - information that gives additional understanding of the air quality situation.*
- *The information obtained by the modeling techniques and indicative measurements must therefore be taken into account in the assessment regarding the exceedances of the limit values. If these two methods show that there are exceedances that meet the criteria of point B of Annex III (in particular: representativeness and a non-negligible exposure of the population to pollution), then it may be decided that the Air Quality Directive was not respected.*
- *Otherwise, assessments would have the strange consequence that there is no problem when the fixed monitoring network does not detect a problem, while on the basis of available information from modeling and/or indicative measurements it is known that there are limit value exceedances that have an impact on public health.*

TWO DIFFERENT REACTIONS

When the court decision was made public, two different type of reactions were observed. Obviously, this decision creates extra burden for policy makers and environment agencies as the model flags a lot of new exceedances compared to an assessment based on measurements. Instead of 1 air quality zone, all air quality zones in the Flanders region are now in exceedance of the EU limit values. This results in a large number of air quality plans that have to be drawn up and measures that have to be implemented in the near future. On the other hand policy makers, citizens and NGO's acknowledged that, thanks to the model, there is a better understating of the amount of exceedances in the region and as a society we have to make sure that proper action is taken to reduce these exceedances and improve impact on public health everywhere.

RESPONDING AS AN AIR QUALITY MODELLER TO THE COURT DECISION

As air quality modeller, this decision is very interesting. On the one hand, it creates value for the work that is performed. On the other hand, the results of the model that is applied will have much larger policy consequences than before. It will be up to us to ensure that the models are fit-for-purpose and meet AQ/AC criteria as put forward by FAIRMODE in order to support air quality policy.

Therefore, we must apply a modelling framework that is both capable of modelling the spatial heterogeneity of the air pollution fields, while staying well validated at all important spatial (and temporal) scales.

Over the last decade VITO has developed the ATMO-Street model (Lefebvre et al., 2013). This model is a combination of several core models:

- RIO, for the hourly calculation of background concentrations using a combination of land use data and measurements from the official measurement locations (Janssen et al., 2008);
- FASTRACE, for the estimation of the road traffic emissions;
- IFDM, for the local air quality calculations (Lefebvre et al., 2011);
- OSPM (licensed by Aarhus University), for the calculation of the effect of buildings on the concentrations near the roads (Berkowicz et al., 1997; 2008).

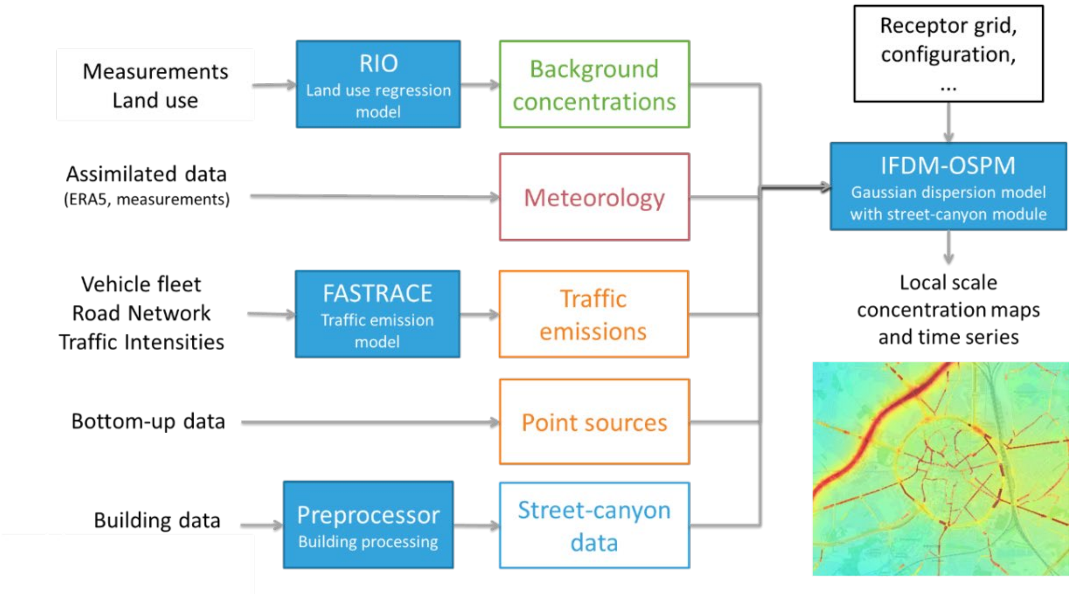

Figure 1. Flow chart of the main aspects of the ATMO-Street model.

The model has been well validated in the past (e.g. Lefebvre et al., 2013). Thanks to the CurieuzeNeuzen-campaign (De Craemer et al., 2019), the model has recently been validated by an enormous dataset of almost 20.000 sampling locations in the Flanders region (Lefebvre et al., 2019). Next to this, the model is every year validated to the passive sampler campaigns that the Flanders Environmental Agency performs in several cities (IRCEL, several years).

It was shown in these validations that the bias of the model is small (in general slightly negative, thus probably slightly underestimating the number of locations where exceedances were found), the scatter is reasonable, the correlations good and the representation of the spatial variation of the pollutant levels is excellent.

There is, however, one part of the model that does not lead easily to a validation exercise. When air quality plans have to be developed, one has to state the expected date of compliance. However, when applying the model for situations in the future, we cannot use the model chain as shown in Figure 1. As the future air quality measurements are not available, RIO cannot be applied and background concentrations are missing.

In order to alleviate this problem, an Eulerian model (AURORA, Mensink et al., 2001) is applied for both the reference and future years. The differences between the AURORA calculations for the reference and future year are applied on the RIO-results in order to get the best estimate for the concentrations in the future. This can be done in several ways, such as absolute or relative calibration or a mixture of both. An analysis was performed on which method works best, based on applying different methodologies for the period 2000-2010, but only using data up to the year 2000. The different projections for 2010 were then compared to the measurements and the best method was selected. An example of the model results is shown in Figure 2.

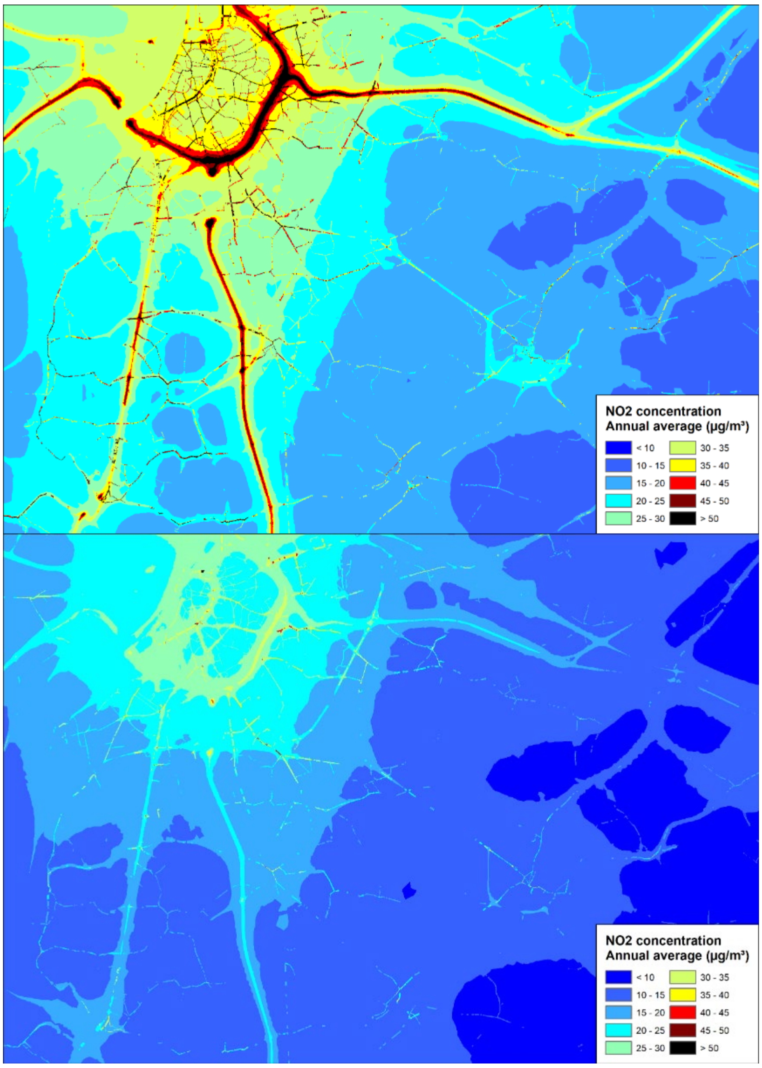

Figure 2. Current (2016 – upper panel) and future (2030 – lower panel) annual average NO_2-concentrations in a part of Flanders.

LIMITATIONS OF THE METHODOLOGY

The current modelling chain for future concentrations at such a high resolution presents of course several limitations. These include:

- Uncertainties in the emission modelling. For instance, what will be the number of "zero-emission" vehicles in 2030, …
- An important uncertainty both in the modelling of the reference year as for the future is the limited knowledge on the traffic data. It was shown to be a large contributor to the scatter in the model validation (Lefebvre et al., 2019).
- We use the meteorology of a past year (the reference year) for all future years. This is required as we cannot forecast the weather for the future years. However, one can discuss which year should be taken: an average year, a year with adverse weather conditions, multiple years to compare (but at a computational cost), …
- The calibration methodology as described in the previous chapter has been tested. However, quantifying the uncertainty of this methodology at every location remains difficult.

CONCLUSIONS

In October 2018, a court of justice determined that the available air quality modelling data in Flanders should be used for the reporting of the exceedances of the air quality standards. This results in a multiplication of the locations where exceedances are reported. For the modelling community, this also increases the importance of 'getting it right'. Therefore, we developed and validated the ATMO-Street model which can be used to assess historic air pollution levels as well as future concentrations up to 2030. The different aspects and limitations of the model approach were discussed in this paper. Despite the limitations, we are convinced that the model approach is a good way to tackle the increased policy reliance on air quality models.

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