Estimation of the exceedance of the European NO_2 annual limit value in Belgian cities and streets during the period 2005 - 2010 - 2015

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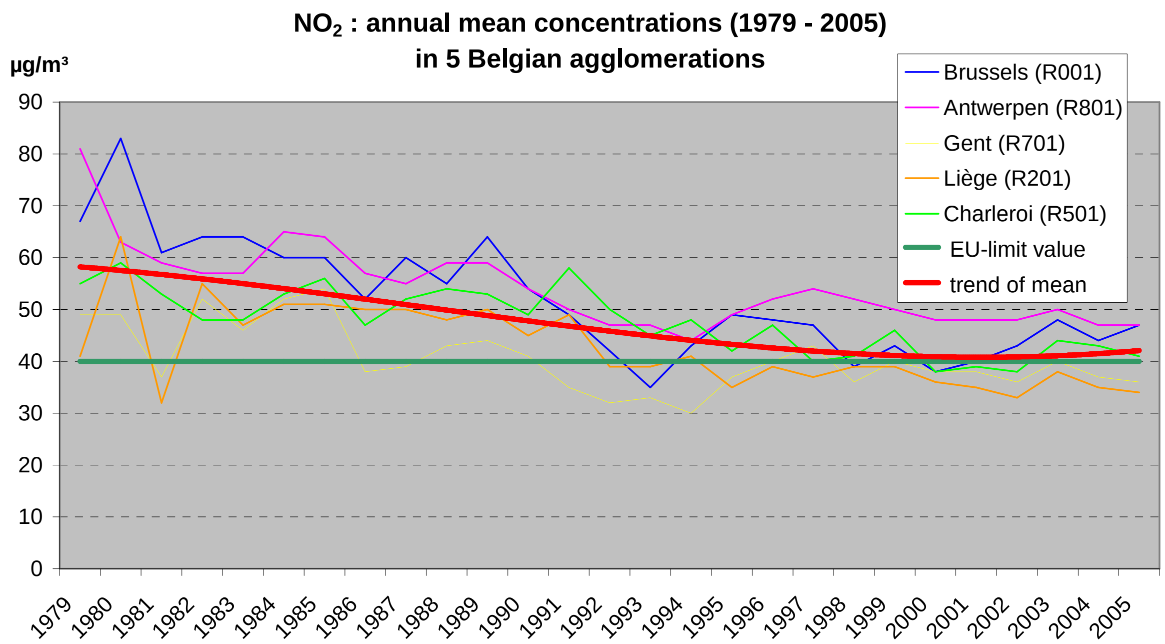
1 November 2006

1/ Context

Current EU legislation (1999/30/EC, the so-called 1st daughter directive) regulates the NO_2 concentrations in ambient air. It states that for NO_2 a limit value for the annual mean concentration of 40 µg/m³ has to be attained as from 1 january 2010. An hourly limit value is set at 200 µg/m³ not to be exceeded more than 18 hours within a calendar year.

The long term evolution of annual mean NO_2 values in the 5 Belgian agglomerations shows a decrease till 2000. From 2000 on, the decrease leveled out and even turned over in a slight increase, bringing it again above the EU limit value of 40 µg/m³..



Source : IRCEL - CELINE, 2006

It looks like as if the NO_2 fraction of the NO_x (= NO_2 + NO) emissions from traffic in inner cities is rising The reasons for supporting this assumption are, ao.:

1. Although the total emission of NOx is decreasing in general, there seems not to be a significant decrease of the NO_2 concentrations in urban locations, even a slight increase is observed since a few years.

2. Measurements in a road tunnel in Brussels over the last four years show the decreasing trend of NOx and the increasing trend of the ratio of NO_2/NOx. These measurements can almost be considered as exhaust measurements of the direct emissions by vehicles

3. The increasing ratio of NO_2/NOx has been observed in inner cities in Germany, the Netherlands and in London ("Evidence of an increasing NO_2/NOx emissions ratio from road traffic emissions", David C. Carslaw, *Atm. Env*. **39** (2005) 4793-4802). Reports of these observations were made at the CAFE steering group meetings.

This increasing ratio of NO_2/NOx in the emission from traffic can be attributed to:

- The increasing share of diesel vehicles in the total vehicle fleet. Diesel vehicles do have a relative higher NO_2/NOx emission ratio. Belgium is one of the countries with the highest share of diesel vehicles.
- The oxidation catalysts since the euro 3 standard enhances the NO_2 fraction in the exhaust gases
- The fitting of diesel particulate filters to heavy-duty trucks and buses causes a greater part of NO_2 emissions. This was clearly demonstrated by the study dealing with the London buses (see : www.defra.gov.uk/environment/airquality/aqeg/index.htm).

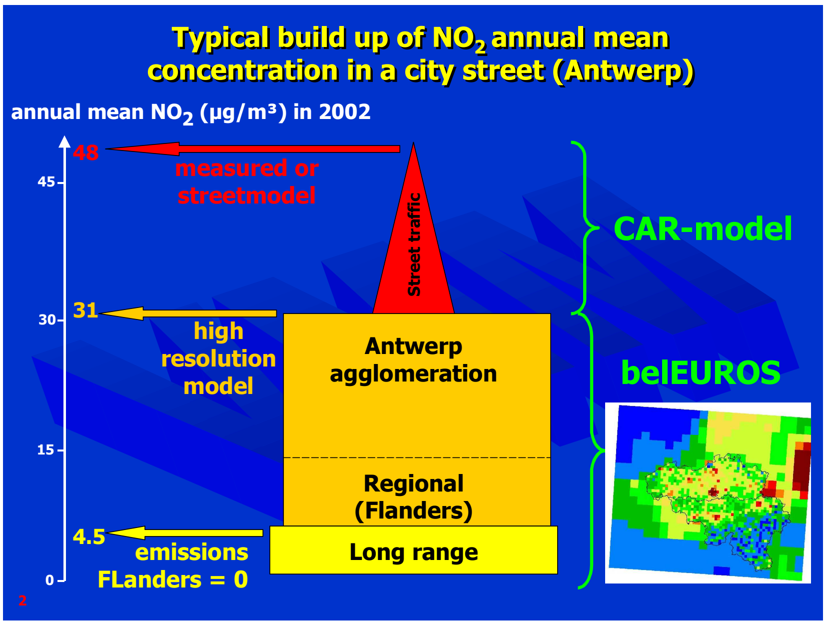
This increase of the fraction of NO_2 in the total NOx emissions is a side-effect of the abatement of the more health damaging PM10 and PM2,5 in ambient air. It was not foreseen when the 1st daughter directive stated the NO_2 limit values in 1999. This increase of NO_2 concentrations, although being a side effect, can however form an increased threat for attainment of the NO_2 annual limit value in inner cities and along major roads.

2/ Analysis of the origin of the NO_2 concentration levels in Belgian cities

The BelEUROS model accounts for the long range transport, for the regional and urban background contributions to the NO_2 concentrations.

The model can estimate the long range contribution to the background by setting all Belgian emissions to zero. Up till now the model cannot distinguish between the regional and urban background but the outcome of the model accounts for both of them in addition to the long range contribution. The BelEUROS model result is then called the "background" concentration upon which the "street increment" should be added to obtain the simulation of the real (measured) NO_2 concentration in the streets.

On top of these contributions there is a "street increment" which is due to specific local emissions by traffic in the streets. According to street characteristics (height, width, building size, ..) and the traffic characteristics (number of cars per day, speed, flux regime, …) it can vary considerably from one street to another. This contribution is not accounted for by the BelEUROS model but can be modelled by street canyons models (e.g. the CAR street model which will be implemented at community level in the Flemish Region).



source: IRCEL-CELINE, 2006

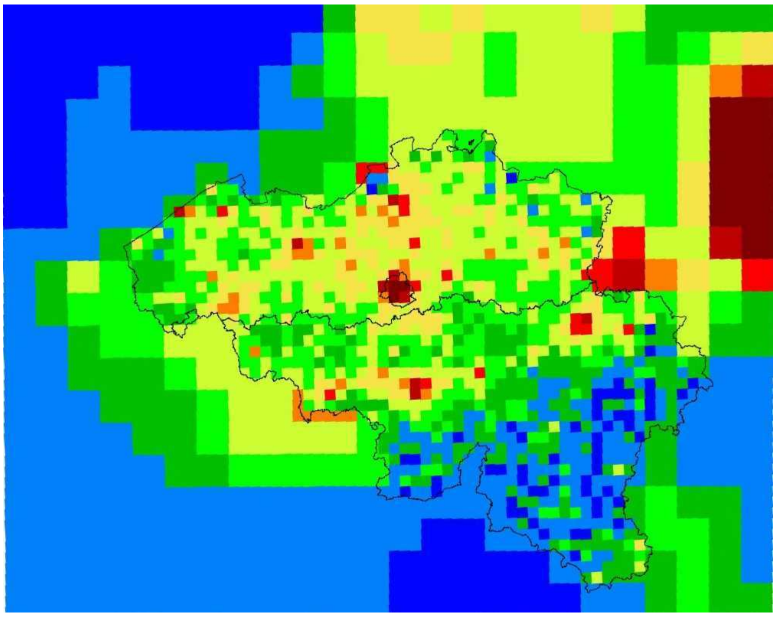
The schematic representation above gives an idea of the origin distribution of NO_2 annual mean concentrations in Antwerpen (Borgerhout). Model areas are indicated to the right.

The amount of NO_2 concentration that is due to local street traffic (street increment) can also be estimated from the study "Air Pollution at street level in European cities", EEA Technical report No 1/2005 which can be downloaded at
From this report (which includes data for Antwerp and Brussels) we see from fig 4.6 that street increment of the NO_2 annual values in 2000 for those 2 cities are about 25 µg/m³ for the narrow street canyon case. From figure 4.15 we conclude that mean street increments of the annual value of NO_2 in the future (in 2030 according to the CLE scenario) will be about 20 µg/m³. These data suggest that the street increment of the annual NO_2 value for mean streets in 2005 and 2010 in Belgium can be estimated at 25 µg/m³ and the increment for narrow street canyons in 2015 at about 20 µg/m³.

3/ Estimation by BelEUROS of the long range, regional and urban background levels of NO_2

Emission input data for 2005, 2010 and 2015 are the data from the IIASA CLE scenario (Current Legislation) as presented in IIASA report nr. 6, June 2005.
Meteorological data for pollution transfer, chemical transformation and dispersion over the model area were chosen from the year 2002 (source : ECMWF) which can be classified as a “normal” meteorological year.

The standard graphical output of the model (grid size 15 x 15 km) has been treated by an algorithm based on population density, land cover and land use data to deliver a much higher resolution of a 5 x 5 km grid for the Belgian region which is fine enough to distinguish clearly cities and agglomerations in Belgium

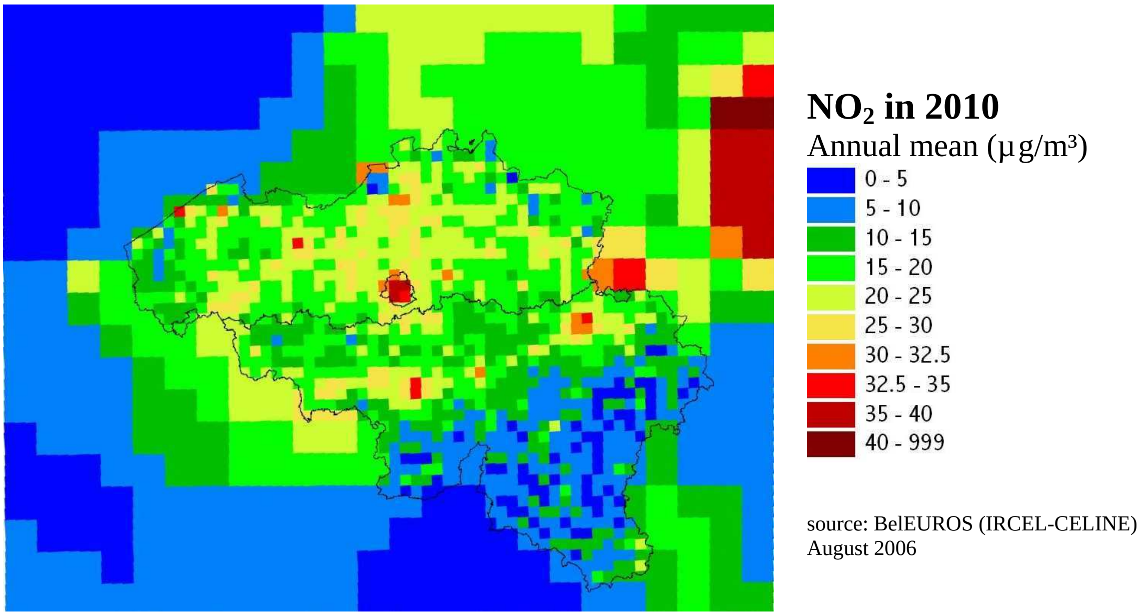


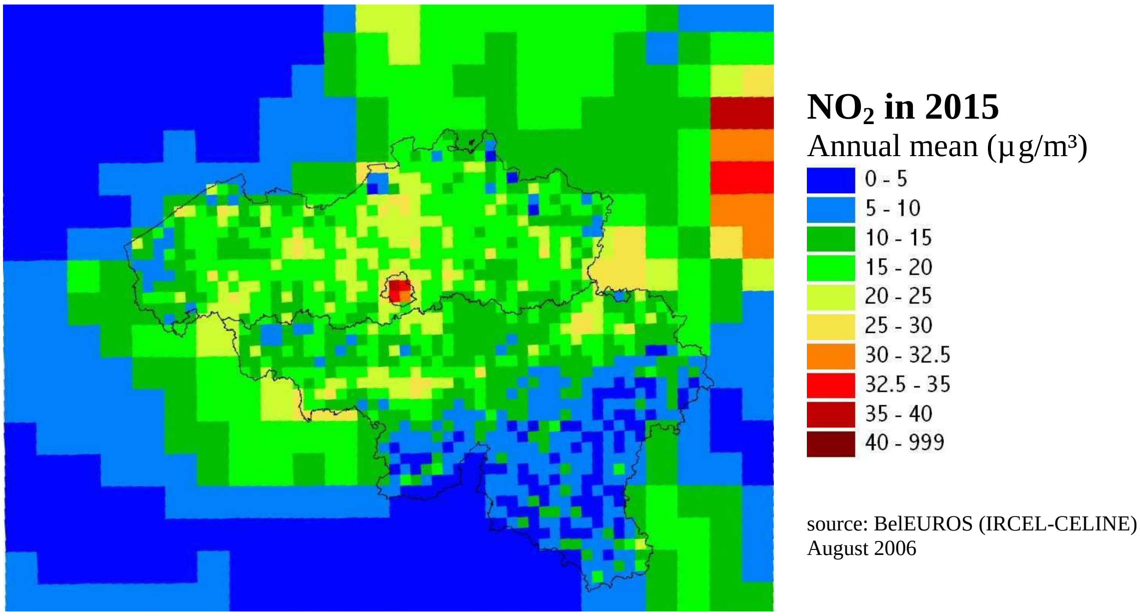
NO_2 in 2005

Annual mean (µg/m³)

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 32.5
- 32.5 - 35
- 35 - 40
- 40 - 999

source: BelEUROS (IRCEL-CELINE)
August 2006





BelEUROS simulation of the NO_2 background concentrations in Belgium assuming the EU-Commission baseline scenario (CLE: current legislation). Source: IRCEL-CELINE, 2006.

In the model simulation of the NO_2 background concentrations for the years 2005, 2010 and 2015, (see maps above) it is seen that the major cities in Belgium belong almost all to the same annual mean concentration class. Only the inner city of Brussels belongs to a single higher class. Covering the whole range in Belgian cities the figures can be summarised in the following table:

year	background NO_2 annual mean in major cities (*see maps above*)	*street increment* in some narrow busy streets	annual mean in narrow busy streets
2005	**30 - 40** $\mu g/m^3$	25 $\mu g/m^3$	**55 - 65** $\mu g/m^3$
2010	**25 - 35** $\mu g/m^3$	25 $\mu g/m^3$	**50 - 60** $\mu g/m^3$
2015	**22.5 - 32.5** $\mu g/m^3$	20 $\mu g/m^3$	**42.5 - 52.5** $\mu g/m^3$

***This estimates show that in Belgian cities - under CLE measures - the EU annual mean limit value for NO2 (40 µg/m³) might be attained in urban background locations but not in busy streets, even not in 2015*.**