CityZen

megaCITY - Zoom for the Environment

Collaborative Project

7th Framework Programme for Research and Technological Development
Cooperation, Theme 6:
Environment (including Climate Change)

Grant Agreement No.: 212095

Deliverable D1.5.3, type R

Report on import/export budgets from the BeNeLux at the regional and global scales

Due date of deliverable: project month 24
Actual submission date: project month 30

Start date of project: 1 September 2008 Duration: 36 months
Name of lead beneficiary for this deliverable: FRIUUK
Scientist(s) responsible for this deliverable: H. Jakobs, M. Memmesheimer

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Overview

During the first phase of the project a standard model configuration has been applied to perform and analyse decadal variations in the Central Europe/BeNeLux-Ruhr area for the period 2000 – 2009 (see also deliverable 1.5.2). The data calculated by the model have been used to perform budget calculations for deliverable 1.5.3 as well as model input for a model comparison study with the aim to evaluate the current state of modelled ozone, PM and deposition fields together with other modelling groups. A first evaluation of the results has been presented in deliverable 1.5.2. Within the deliverable 1.5.3 import/export budgets from the BeNeLux are presented based on the model calculations mentioned above.

Model Design

The model design is shown in Figure 1 and is the same as used for deliverable 1.5.2. Grid resolutions are 125 km, 25 km and 5 km for North-Rhine-Westphalia, and 1 km for the Ruhr area. Development and testing of methods to perform the numerical simulations and their analysis has been done with this model configuration, which has been used successfully for daily forecasts before (www.riu.uni-koeln.de). The decadal simulations also give the basis for the analysis of chemical and physical processes which will be investigated with respect to deliverables and milestones as planed in CityZen (e.g. the extreme summer episode in August 2003 is part of the decadal simulation). In the second period the modelling region will be extended to larger domain with the aim to improve the applicability and performance of the whole system leading to a more sophisticated model design which will be investigated in the second phase of CityZen (see Figure 5). Grid sizes in that case are selected to 45, 15, 5 and 1 km. Calculations already have been started and are currently underway, partly delivered for the model intercomparison study (Collete et al., 2011). Vertical resolution in both cases is done by 23 layers from the surface up to about 16 km. 16 layers are within the convective boundary layer (3 km), the thickness of the lowest layer is about 40 m. All data have a temporal resolution of 1 h and are stored permanently.

Results

Figure 2 gives an overview on the results of the model calculation showing the annual average for each of the years 2000 – 2009. In particular in Belgium, the Netherlands, Paris, Northern Italy and parts of England an annual value of 40 µg/m^3 has been exceeded. The figures, however, also show a slight decrease of the annual average of NO_2 approaching the year 2009. An exception are the areas with ship traffic emissions, which are assumed to have increasing emissions and therefore also show a tendency for increasing NO_2 concentrations. A similar effect can be seen for the annual average of PM_{10}, which also in general show a decrease going from 2000 to 2009. For ozone no clear tendency can be seen. The number of exceedances of the 24-hour-value of 50 µg/m^3 show a clear decrease during the years, it also can clearly be seen, that the year 2003 was an extraordinary year not only with respect to Ozone but also concerning PM_{10}. Also the 8-h-values for ozone show a decrease over the years and again 2003 show up as an extraordinary year. Overall 2009

seems to be the year with the lowest values of air pollutant concentrations, 2003 show the highest values.

Budget calculations as requested for D1.5.3 have been performed for the years 2000 – 2009 on the basis of simulations for N1-domain (see Figure 3). Two domains have been selected for the budget calculations:

1) BeNeLux small (BNL_S) covering Belgium, the Netherlands and most of North-Rhine-Westphalia, see Fig. 3a – 3c.

and

2) BeNeLux large (BNL_L) covering in addition Paris and London, see for example Fig. 3d.

The calculations have been perform in a diagnostic mode using the hourly output of the model (wind velocities and concentrations). The computations have been extended up to a height of about 2500 m.

Figures 4 and 5 show the horizontal inflow and outflow and the net effect for each year for both domains. The large domain, which includes Paris and London, acts as a net source of PM_{10} and NO_2 in all years, for ozone only 2002 is an exception, acting as a sink of ozone. The small domain (BNL_S) in general also act as source but with more exceptions for PM_{10} (for the years 2002 and 2005 net effect is negative), and even for NO_2 the net effect is near zero for 2002.

Summary and preliminary conclusions

The complete decade from 2000 – 2009 has been calculated with the EURAD model. A preliminary comparison with observation is presented in D1.5.2, horizontal flux calculations has been undertaken in deliverable 1.5.3 as shown here. Two regions has been selected for the computations, one (BNL_S) covers the standard BeNeLux area together with the large parts of North-Rhine-Westphalia including the megacity-type Ruhr area, the other (BNL_L) considers in addition London and Paris. It was found for net horizontal fluxes (integrated up to about 2500 m) both areas (BNL_S and BNL_L) for PM_{10}, NO_2 and O_3 act as source region in most of the years, the only clear exception is 2002. The horizontal net fluxes are higher for BNL_L as far as NO_2 and PM_{10} are concerned, which is reasonable, because Paris and London are included and the concentrations of both compounds are partially controlled by primary emissions. For O_3, which is not primarily emitted, no clear effect is seen in the difference between BNL_S and BNL_L. Also, there is no clear trend in the net horizontal fluxes during the decade. However quite high values occur for PM_{10} and ozone at the end of the decade whereas for NO_2 the highest values are in the beginning and the middle of the decade. It is planned to repeat the calculations with the more sophisticated modelling design as shown in figure 5.

References

Colette, A. and the CityZen Modeling team: A first multi-model assessment of Air Quality trends in Europe. Geophysical research Abstracts, Vol. 13, EGU2011-11625, 2011. Contribution the the EGU General Assembly, Vienna, April 2011.

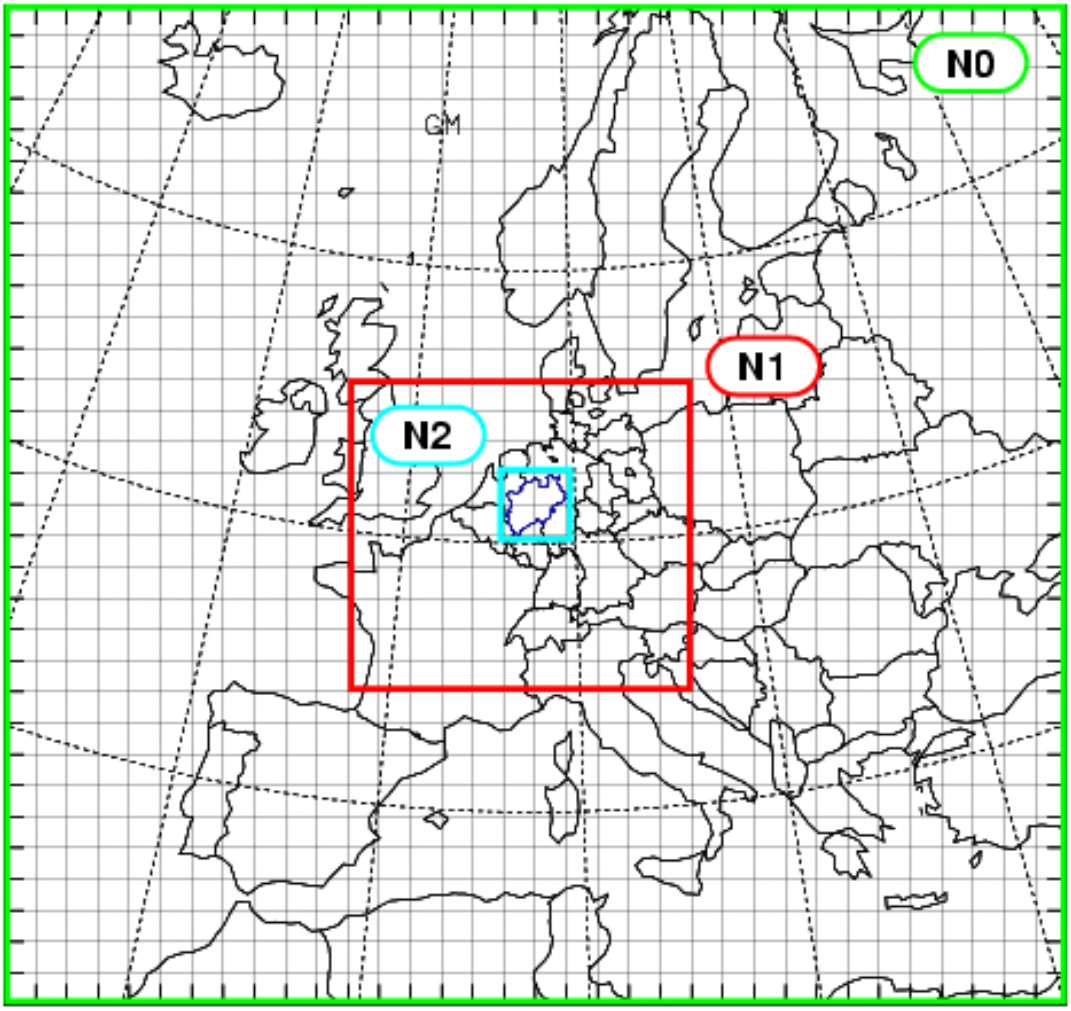


Figure 1: Model configuration from the European scale to the local scale, grid sizes 125, 25, 5, and 1 km. The N1-domain with a grid size for 25 km has been selected für the budget studies in the BeNeLux area.

ANNUAL AVERAGE 2000 – 2009: NO_2

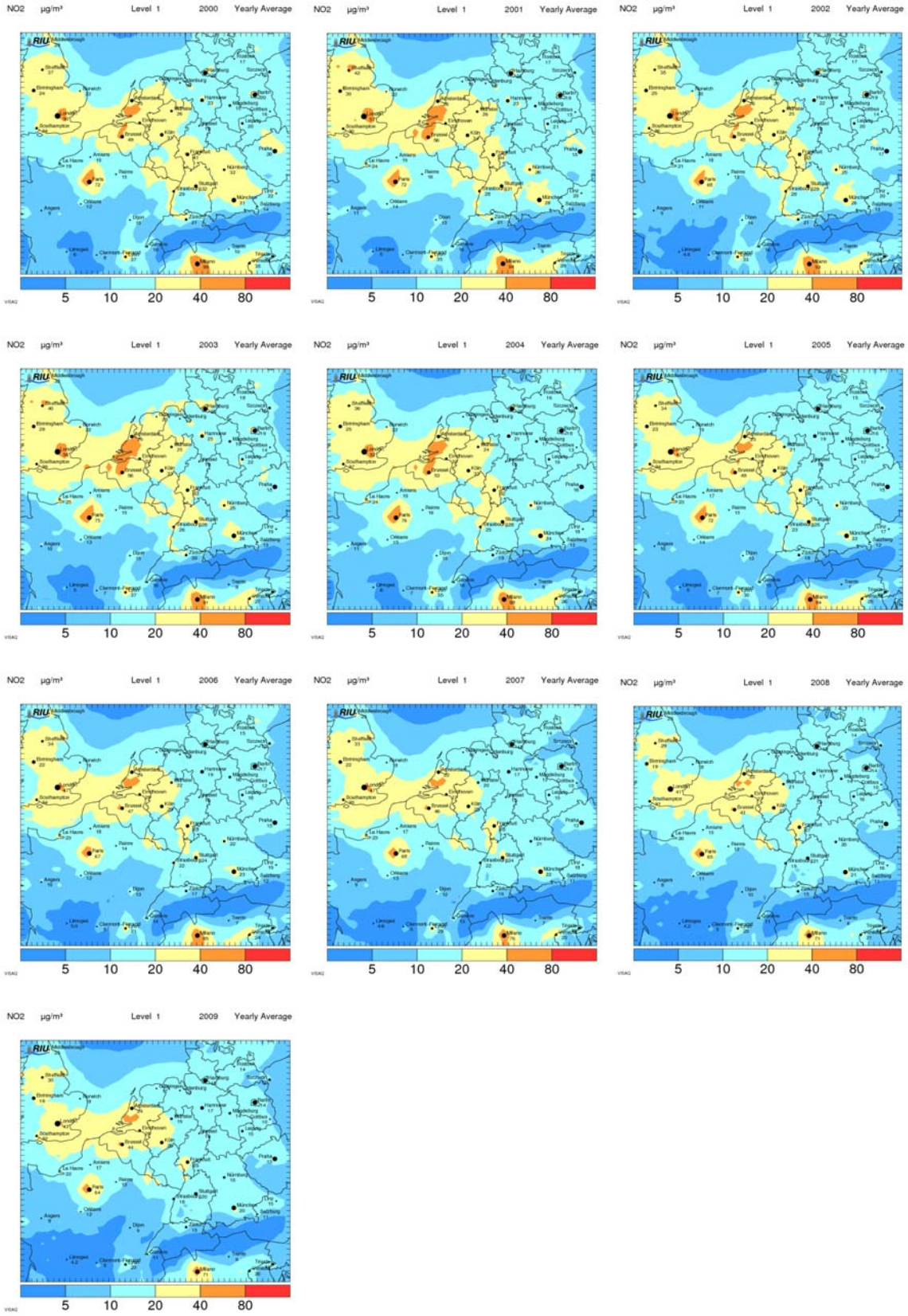


Figure 2a: Annual average of NO_2 for the N1-domain (25 km grid size, see Figure 1) for the year 2000 till 2009. Data are calculated on the basis of hourly values.

ANNUAL AVERAGE 2000 – 2009: PM_{10}

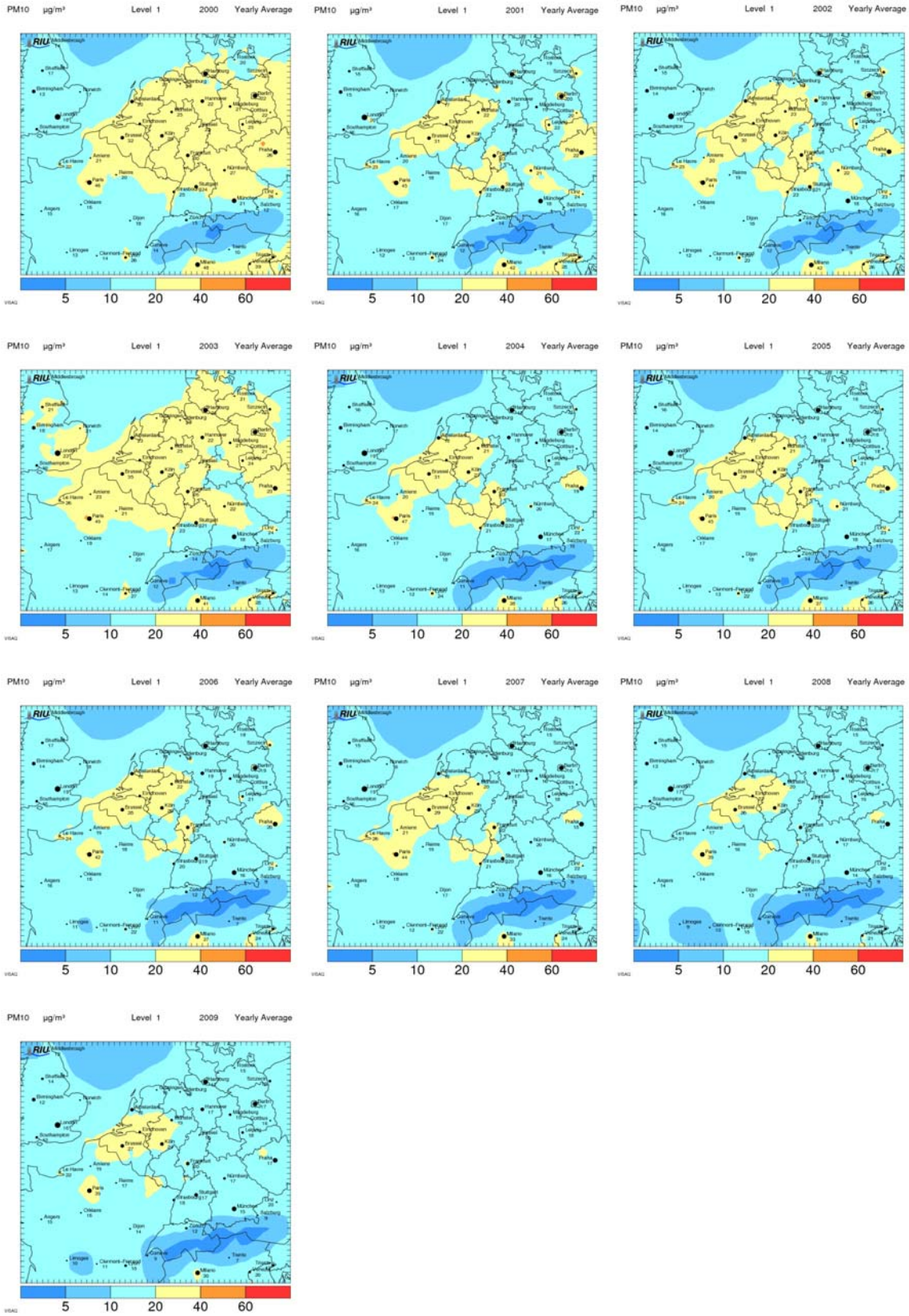


Figure 2b: Annual average of PM_{10} for the N1-domain (25 km grid size, see Figure 1) for the year 2000 till 2009. Data are calculated on the basis of hourly values.

ANNUAL AVERAGE 2000 – 2009: O_3

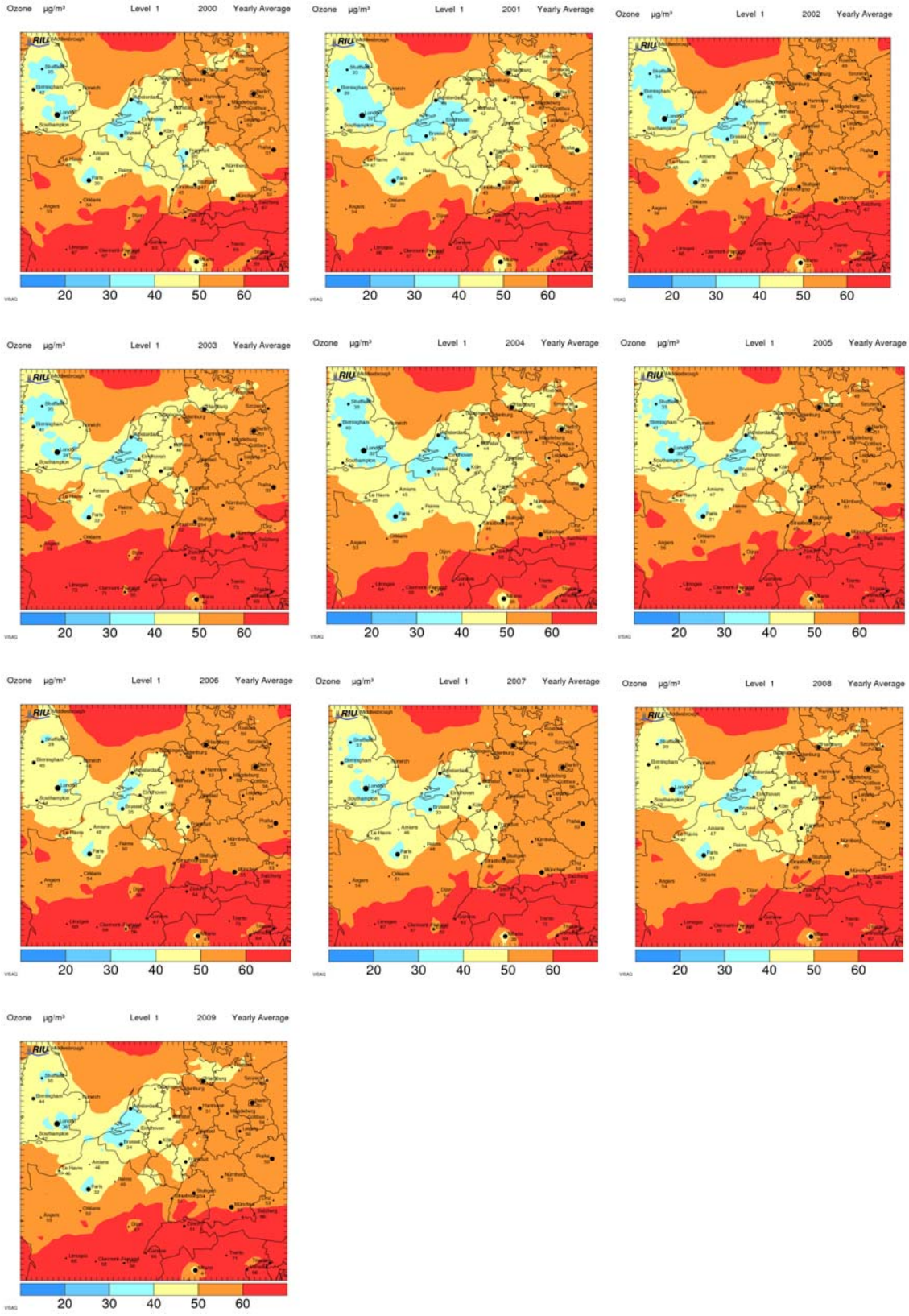


Figure 2c: Annual average of O_3 for the N1-domain (25 km grid size, see Figure 1) for the year 2000 till 2009. Data are calculated on the basis of hourly values.

PM_{10}, Number of days exceeding the 24h-average limit value of 50 µg/m^3

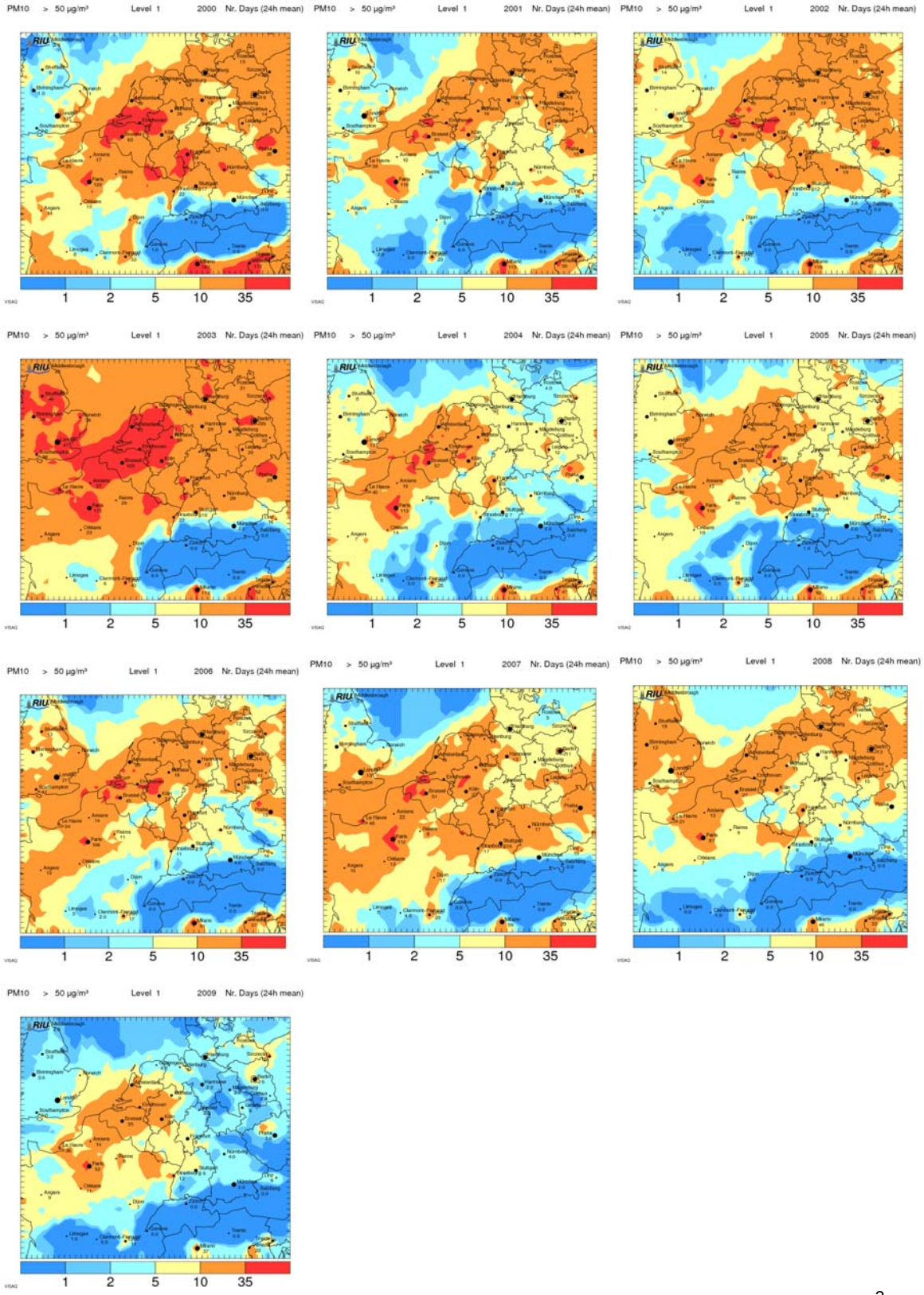


Figure 2d: Number of days exceeding the 24 h-average limit value of 50 µg/m^3 for the N1-domain (25 km grid size, see Figure 1) for the year 2000 till 2009. Data are calculated on the basis of hourly values.

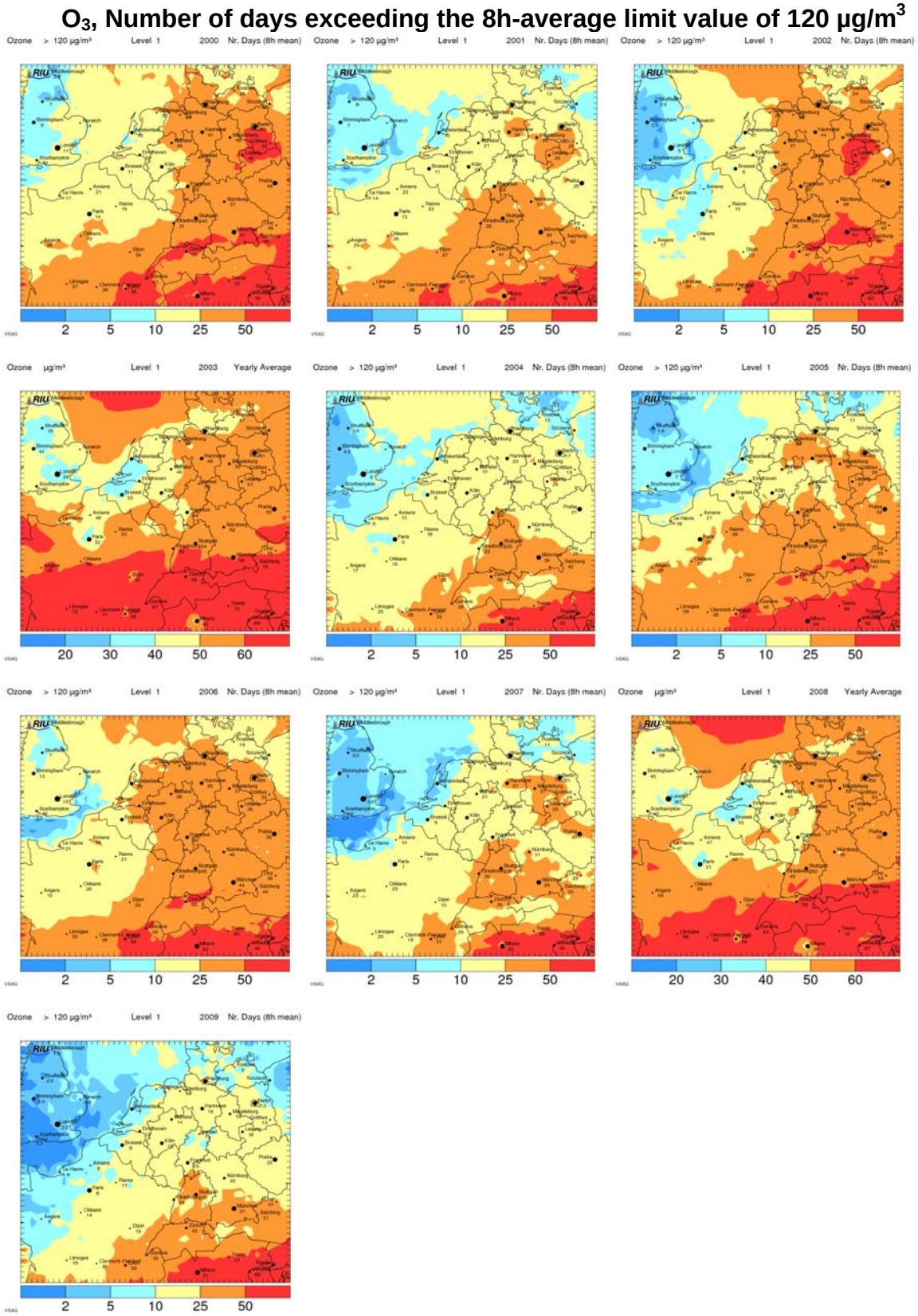


Figure 2e: Ozone, number of days exceeding the 8h-average limit value of 120 µg/m^3 for the N1-domain (25 km grid size, see Figure 1) for the year 2000 till 2009. Data are calculated on the basis of hourly values.

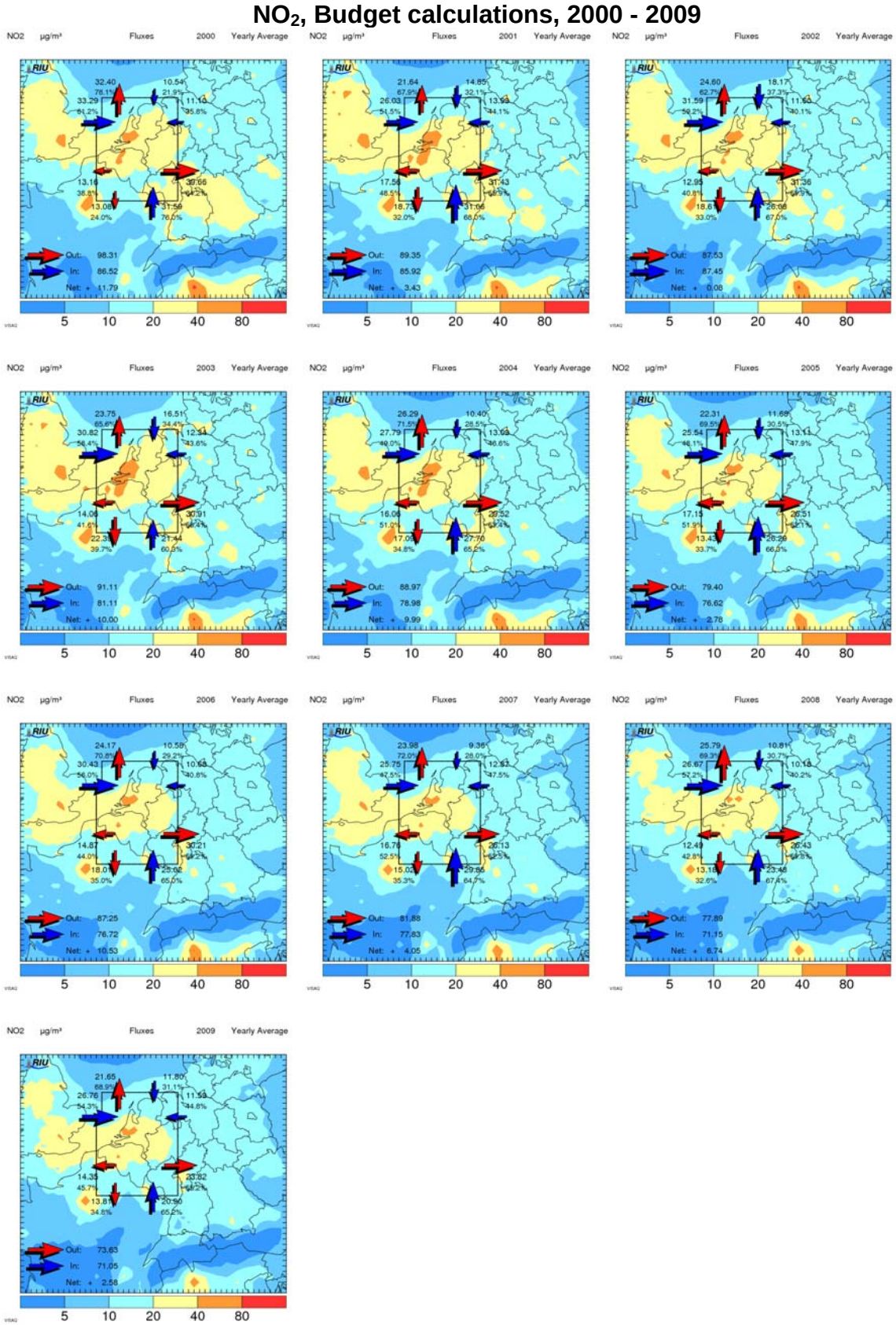


Figure 3a: NO_2, Budget calculations for the Benelux-Rhine-Ruhr area as indicated in the figure for 2000 – 2009. The calculations are performed up to a height of 2500 m. Fluxes are given in µg/m^{2}s.

PM_{10}, Budget calculations, 2000 - 2009

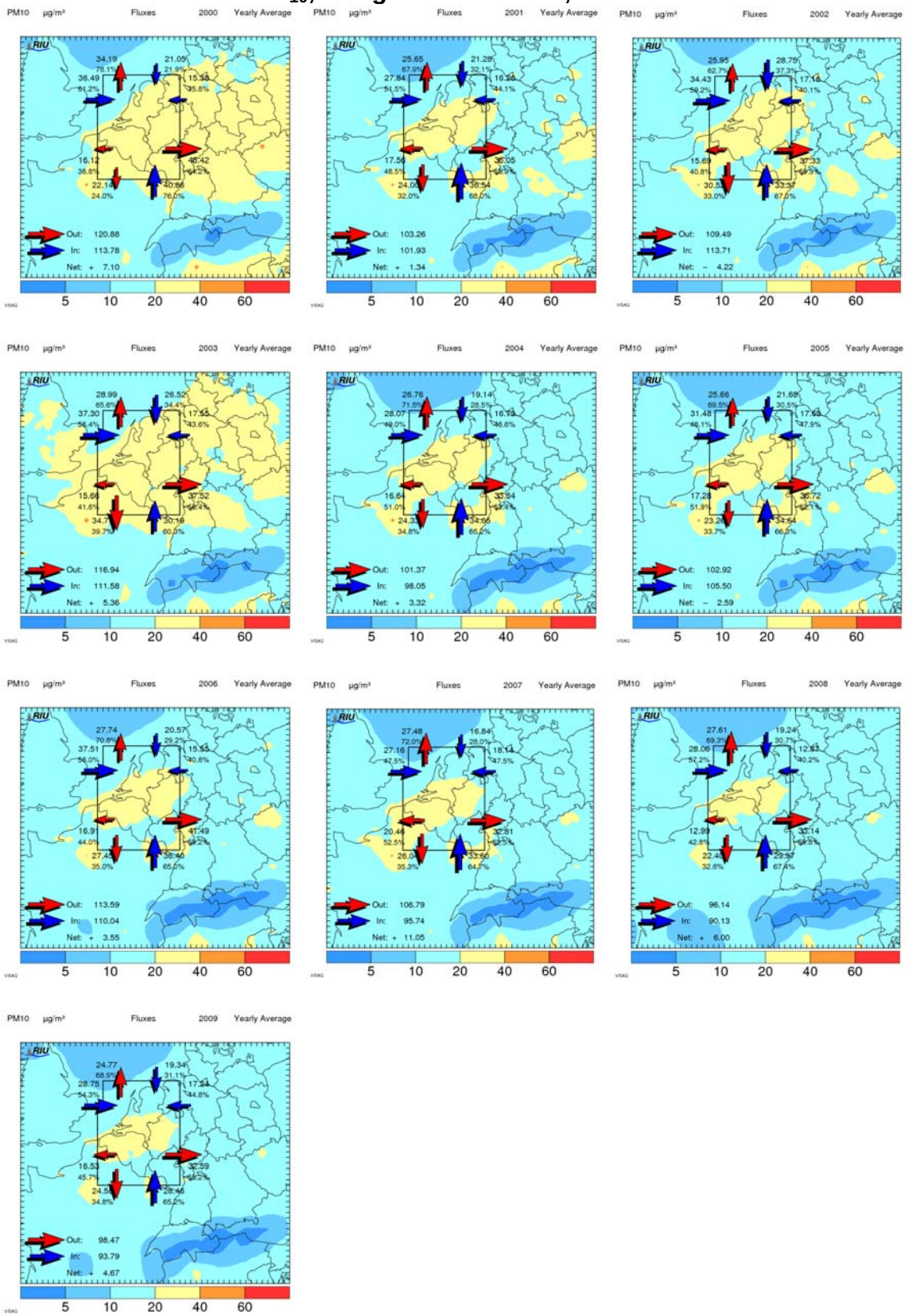


Figure 3b: PM_{10}, Budget calculations for the Benelux-Rhine-Ruhr area as indicated in the figure for 2000 – 2009. The calculations are performed up to a height of 2500 m. Fluxes are given in $\mu g/m^2 s$

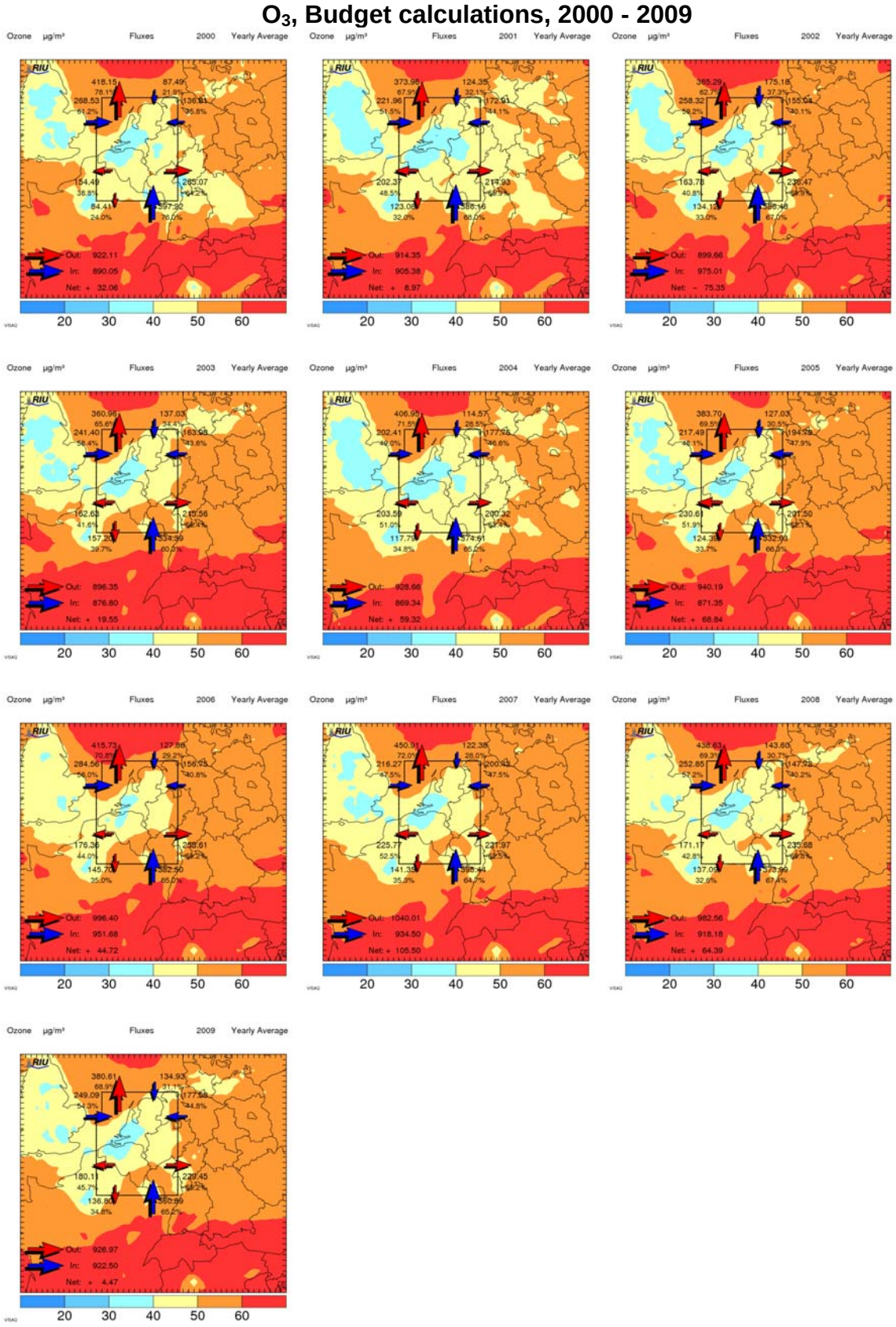


Figure 3c: O_3, Budget calculations for the Benelux-Rhine-Ruhr area as indicated in the figure for 2000 – 2009. The calculations are performed up to a height of 2500 m. Fluxes are given in µg/m^{2}s.

Budget calculations for NO_2, PM_{10} and O_3 (enlarged Benelux)

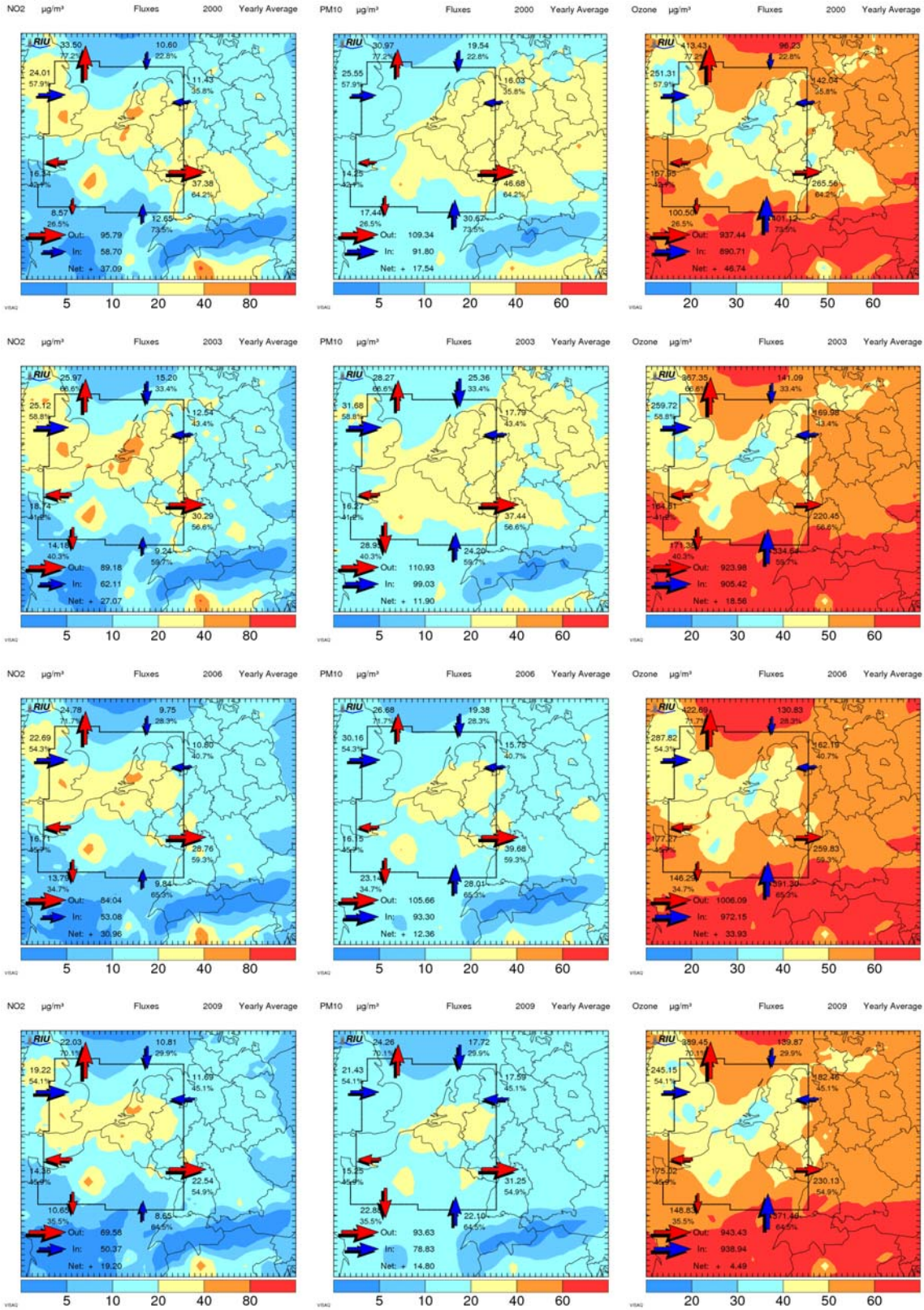
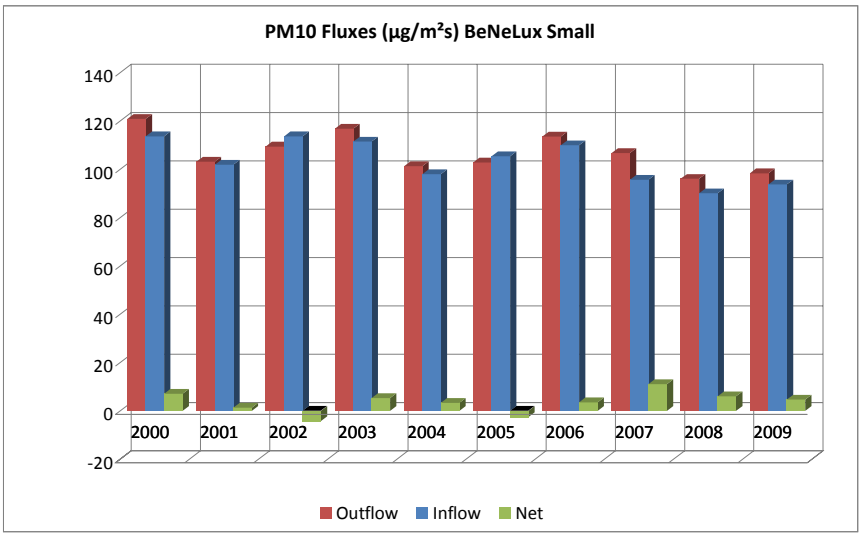
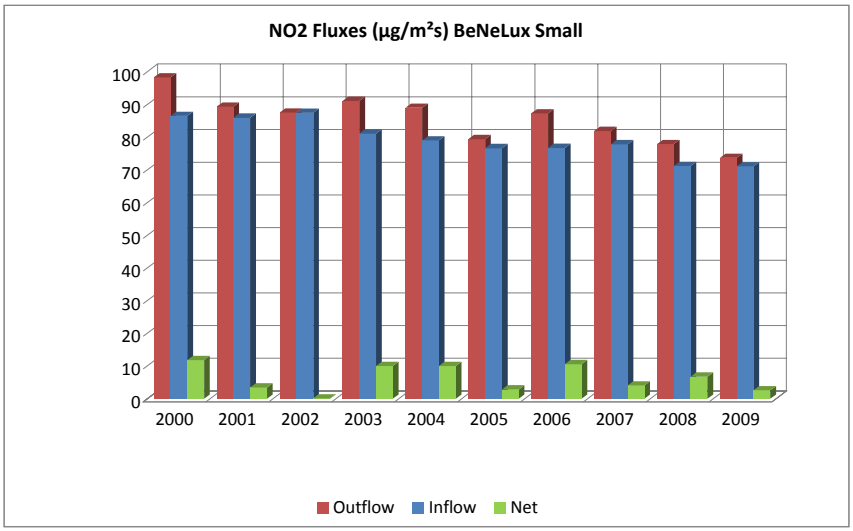


Figure 3d: Budget calculations for NO_2, PM_{10} and O_3 for the enlarged Benelux-Rhine-Ruhr area as indicated in the figure for 2000 – 2009. The calculations are performed up to a height of 2500 m. Fluxes are given in $\mu g/m^2 s$.





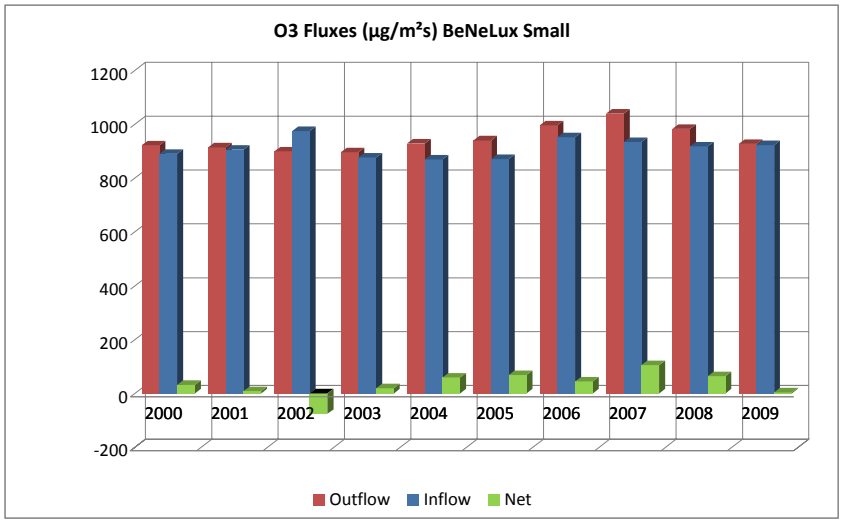
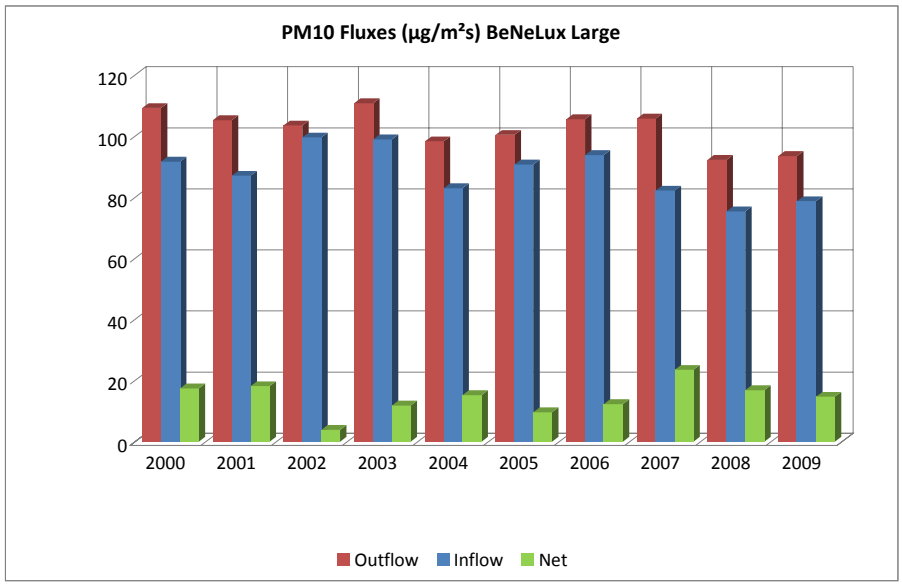
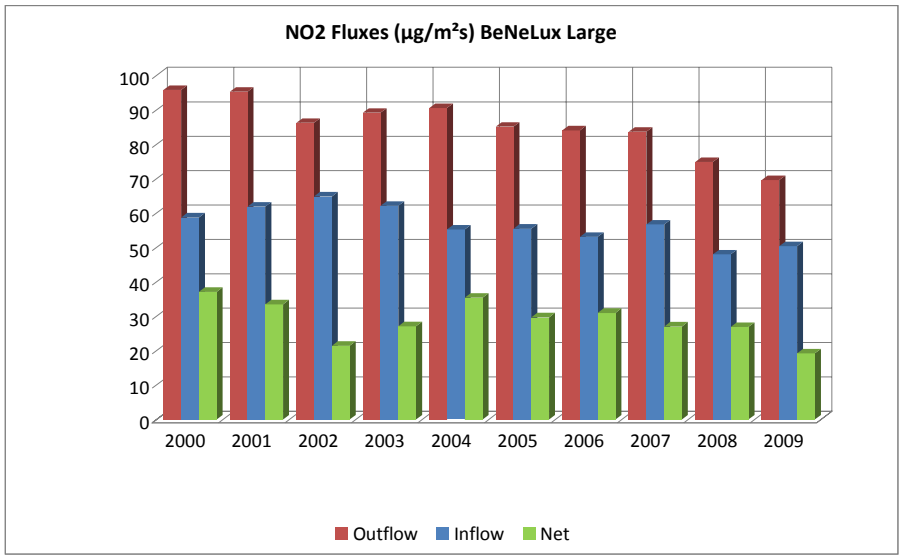


Figure 4: Budget for Benelux (small) for 2000 – 2009





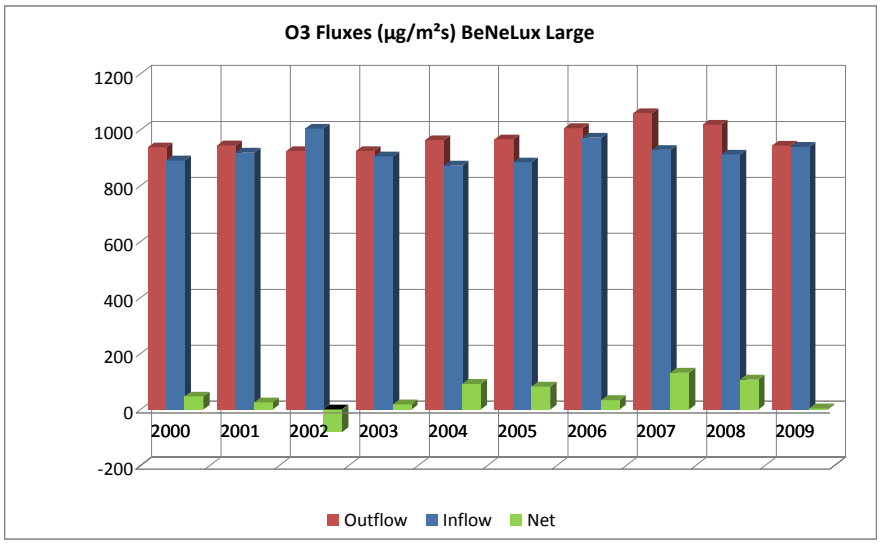


Figure 4d: Budget for Benelux (large) for 2000 – 2009

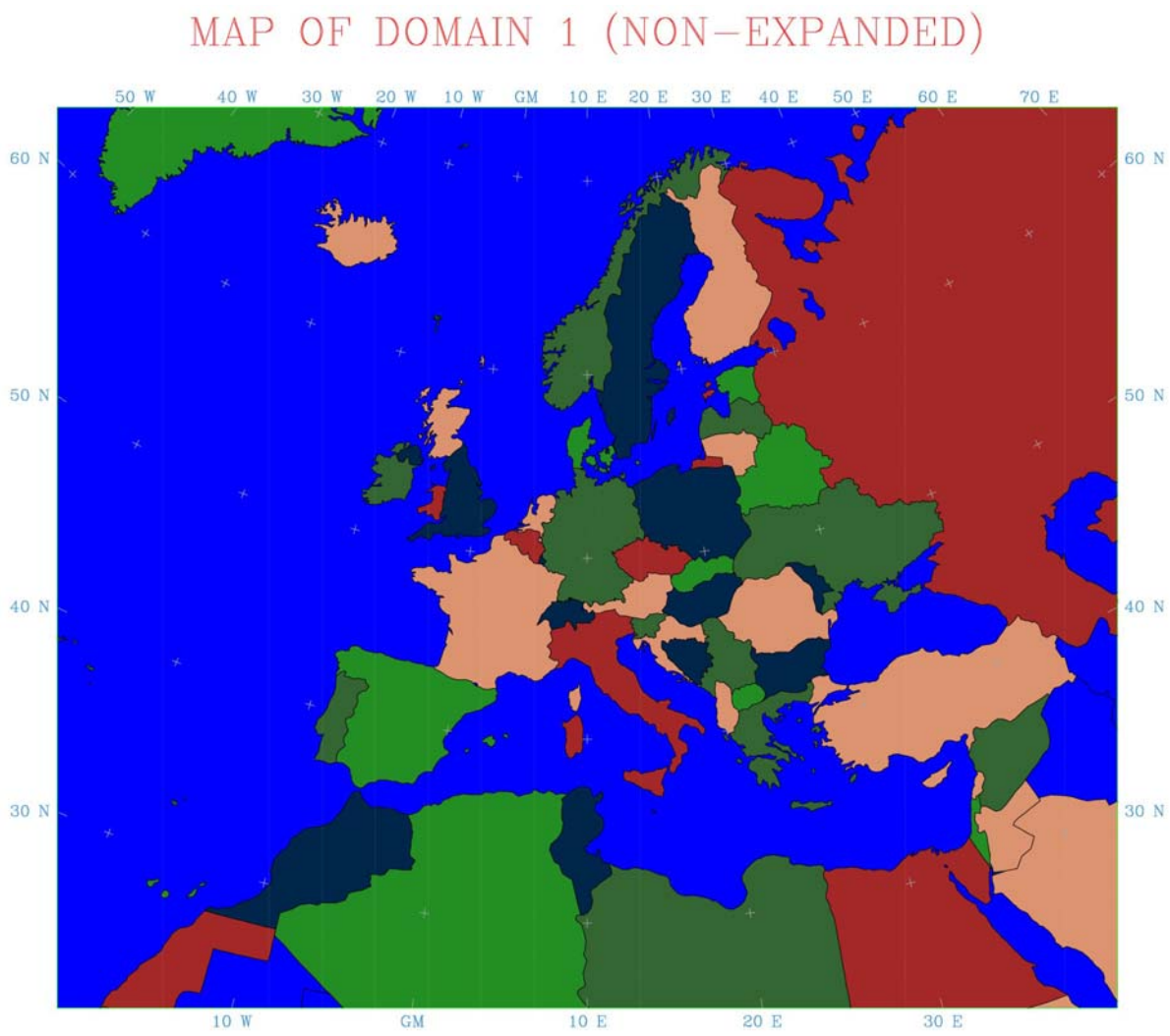


Figure 5: Extended modelling domain for future calculations, grid sizes 45, 15, 5 and 1 km.