Report on policy implications and emissions scenarios (D-5.4)

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REanalysis of the TROpospheric chemical composition
over the past 40 years
A long-term global modeling study of tropospheric chemistry
funded under the 5th EU framework programme
EU-Contract No. EVK2-CT-2002-00170

Document prepared on July 28, 2004

Introduction

In RETRO we seek to understand the chemical evolution over Europe during the last decades with the aid of atmospheric models. Clearly, one part of the changes observed in the last 40 years is of natural origin, but as evident are the influences by man. It is very important to understand what changes can be attributed to human activities, as well as the interaction between manmade changes and natural changes. The RETRO project will help identify how important emissions of primary gases and aerosols over Europe in the last 40 years have been: by using climate models, coupled climate chemistry models and chemical transport models. This deliverable aims to give recommendations on what emission scenarios should be undertaken to elucidate one specific aspect of the emission changes: how knowledge of human-caused changes in the chemical system has given grounds for policy makers to impose restrictions on emissions for specific gases and aerosols.

Work package 5 has the role of conveying information between the public, policy makers and scientists, a necessity but none the less difficult. How can we give general information with certified scientific validity? How can one give information about the certainty of the model results? Information will be given as model output statistics of tracer distributions, emission and deposition fluxes variability, radative forcing calculations, and evaluation of past and future calculations of selected chemical species.

The background of the challenges in Work Package 5 is given first, followed by a detailed description of the deliverable 5.4 with recommendations to what emission scenarios the participants in RETRO should use.

Background

The goal of this work package is to assess the policy response to recommendations from scientists on environmental issues in the past. A range of different environmental problems have been addressed by scientists and a number of recommendations have been posted to policy makers but often without, from the scientists' point of view, appropriate response. Also, there is an apparent under-representation of atmospheric scientists' reporting in newspapers and printed periodicals, and the popular knowledge of current problems in atmospheric sciences is lacking and possibly pressure on politicians from this important group is virtually absent. We will have a closer look at these interactions, primarily on the science-policy interaction, and will point at possible problems in conveying information to the decision makers. And, if the information reaches the policy makers, understand why action was not taken on the grounds of the recommendations given. If possible, we will suggest ways to better inform and make this particular user group (politicians and decision makers) aware of the "why and what" in the recommendations.

Acidifications, excess ozone concentrations, aerosol pollution or emission of radiative active gases are examples of environmental problems being addressed in an European context. Even with mitigations we can see an increase in total energy consumption, the most important source for emission of primary pollutants (figure 1). In the past, several legislations have been implemented, e.g. the long transport treaty (ECE-convention, Geneva, Nov. 1979) and the treaty on the effect of long transported agents (Finland, Feb. 1991). Further, a number of protocols were posted: on sulphur emissions (Helsinki, Jun. 1985); on nitrogen emissions (Sofia, Nov. 1988); the Sulphur protocol (Norway, 1994); the Gothenburg protocol on acidification, nitrification, and ground level ozone (revised several times, latest in 1999) and others. These protocols limit emissions based on recommendations from scientific studies set up in the EU and internationally. It is recognised in Europe that one must take into account emissions contributions from other regions to Europe, in particular from the US and from Asia. But there are large regional differences in the temporal evolution of emissions and one has to understand these to be able to make meaningful statements about this lateral

influence. In RETRO, we have the possibility to look at these temporal evolutions and are therefore in a better position than before to make fair judgements of lateral and local influences of emissions, for the last four decades. Thus we are in a position to evaluate changes in emissions and their effects with appropriate modelling and inventory tools.

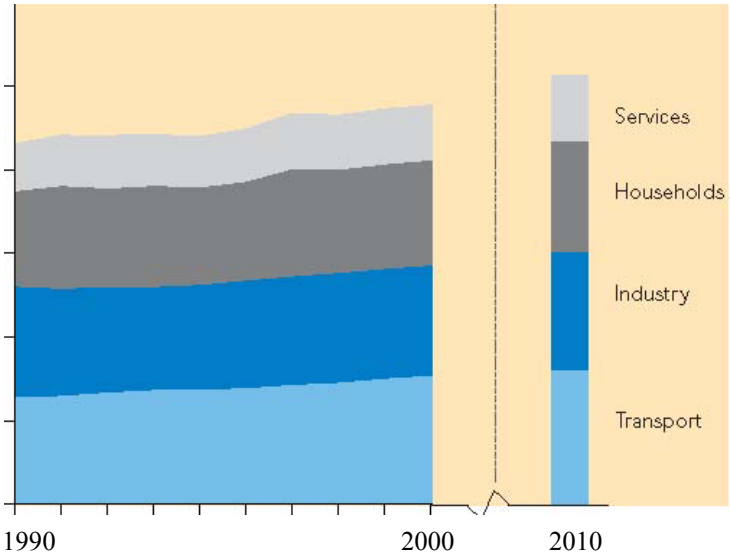

Figure 1: Energy use in Europe from 1990 with projection for 2010.

In this work package (WP5) we have selected two areas of public and political interest. Instead of focusing directly on emission inventories for a particular molecule, we will look at all molecules that are affected when changes to a source sector are implemented. This will be of broader interest and is also easier to conceptualize, when effects of mitigations are analyzed instead of the more artificial view where emissions of one and one molecule are changed. Although artificial, the focus on a single molecule gives scientists a better possibility to explain effects on other gases and aerosols, and is easier to approach than the integrated view. It is more complicated to assess the cause and effect in this kind of studies, but foremost we are interested in the total effect on gases and aerosols caused by changes in one sector. Setting up selected scenarios for several sectors is possible since we have tools to make consistent emission scenarios with built-in response in emission changes to selected industrial relocations.

Deliverable 5.4 - Recommendations for specific sensitivity and scenario experiments

One goal of the following recommendations is to acquire a broader knowledge of the success of the legislation in contrast to an optimal strategy (to be defined later) and to a no-legislation strategy. Thus we can relate the effect of current emission controls to other potential strategies, and also if the current controls are cost-effective and whether they have reached the intended goal. This gives us a range of emission responses which is both realistic and covers most of the possible range in the emissions for the selected sector. Thus we will be able to submit a conceptual model of how successful the legislations are, in terms of how “far from” or how “close to” we are to projected levels of pollutants. One other useful way to use this information is to analyse how close the emissions and gas levels are to an optimal strategy, and thus, one can have a qualified guess on the potential for further reductions and on the effect of these on future gas and aerosol levels. This can in the next instance be evaluated on the grounds of a cost-benefit analysis.

Our line of attack for work package 5 is to estimate how political legislation has affected emissions and thereby to assume its environmental effect in light of alternative scenarios, which generally can be worded as:

- What could happen (if tougher legislations were implemented)
- What would have happened (if no legislations had been implemented)

The consequential environmental response will be analysed with these emission scenarios, where a range of gases and aerosol emissions are changed according to legislation, national and international. Several aspects will be studied where the effect in Europe is the focus, e.g. changes in pollution levels (both gas and particles, and responses in solar radiation to this), changes in acidification (both SO_x and NO_x), and if appropriate, the changes in radiative forcing will be estimated. Most of these aspects will be discussed in other deliverables of WP5 and are due at a later stage, since this paper only concerns recommendations for scenarios.

Apart from local emission control, Europe is also under the pressure of long range transport emissions, thus it can also be of interest to understand to what degree lateral boundary conditions affect environmental conditions over Europe. Of particular interest are regional pollution and aerosol loading. Since the chemistry is non-linear it is likely that this lateral influence will not be just a scaling when the sensitivity is evaluated. Later in the RETRO project it will be of interest to study selected scenarios of the same sectors, and for US and Asia, to analyse the importance of these changes compared to the local European changes of the same sector. Both the local emissions changes as well as the effect on Europe will be studied.

Selected sector studies (The transport sector and power plants)

(A) The transport sector, car traffic emissions, and the use of catalysators
Temporal evolution of traffic in Europe has undergone different phases, and in this study we are particularly interested in understanding the effects legislation has had demanding the use of catalysators with cars since the introduction of catalysators. This study will evaluate the tendency of several components that are emitted from car traffic, NO_x, VOCs, aerosols (Black Carbon, and Organic Carbon, PM) and possibly heavy metals. The evolution of energy consumption in the traffic sector since 1990 to present is depicted in figure 2.

Already, there exists an emission inventory with detailed information about different categories of traffic in the TNO data base from 1970 until present. The categories used in the TNO data base will be reduced to a more manageable level using a similar granulation as LOTOS categories (nine main sectors). In addition to the existing data base, TNO will produce two more inventories, one based upon optimal technology (all use best catalysator technology instantly), and one based on the worst case possible (none use the catalysator).

Experimental set-up and the progress of selected integrations
At least two models should run the selected perturbation experiments to get a higher confidence in the results (i.e. results are less dependent upon one model). First take the base line case, which is the standard inventory. Appropriate statistics should be made in each model, similar to what was decided in work package 4. The base line case will be started late summer 2004 and will run until the beginning of 2005. The two perturbation runs should then be done, and the monthly averaged statistic of the selected tracers should be analysed. These should be started when the base line case is run, around January 2005.

Obvious questions to answer are: has the introduction of catalysators had any effect on the surface ozone over Europe? Is the pollutant level different with and without introduction of catalysators? What health effect has the introduction of catalysators had over Europe in the last two decades? Apart from the regional pollutant issue, it might be of interest to study the effect on regional climate from car traffic. This could be done with radiative forcing calculations.

When the European study is done, at least one model should analyse how car traffic affects the pollutant level over other regions of the world with heavy traffic. North America, India, South East China are candidates for investigation, and the focus should be on how to interpret the results found for the changes detected over Europe. As mentioned above, the temporal changes of traffic and implementation of catalysators in the regions have been very different, and these kin studies will help understand the resulting changes found over Europe.

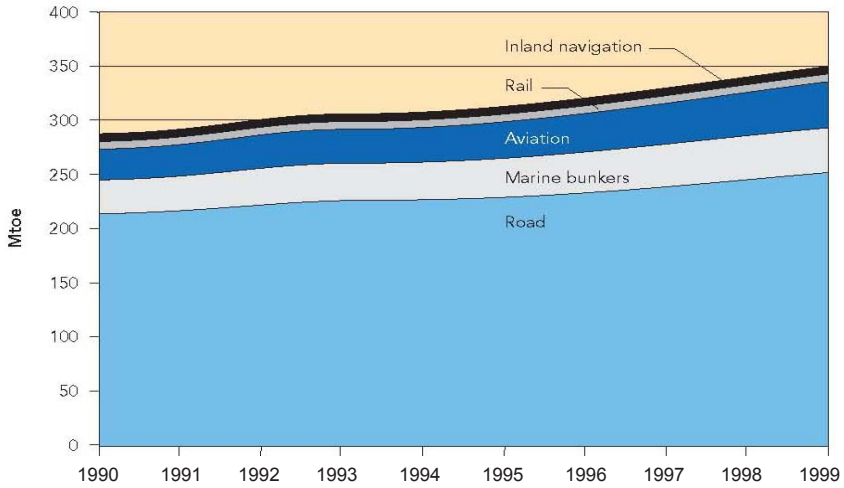

Figure 2: Overview of the transport categories from 1990 until 2000 in Europe.
Note: Transport by oil pipelines is responsible for between 1 and 1.5 % of total energy consumption by transport and is therefore omitted

(B) Emissions over Europe from energy production by power plants

The impact of energy generation upon the environment is an important topic that has been addressed in several studies. In work package 5 we are concerned with understanding how earlier legislation has affected the emissions from power plants over the last decades. Following the set-up under part A, we first run a base line run with the current emissions with at least two atmospheric models. TNO will again produce two selected inventories that pertain power generation by power plants. One scenario is based on an optimal assumption for cleaning technologies, with very little emissions of trace gases and aerosols. The second scenario that will be calculated is the non-regulated option with no cleaning technology imposed. Here again we focus foremost on Europe, and the scenarios should be calculated only for changes over Europe. We can see from figure 2 that the power consumption has been relatively stable in the last decade.

When the regional study for Europe is done, at least one model should look at similar studies for other regions, specifically North America and South East Asia, and if time permits one can look at e.g. India or other regions. The temporal evolution of emission has been different for the different regions and this will probably give more information on how to interpret the scenario results over Europe.

Of interest is how efficient the pollution control has been for power generation over Europe, and the results form these scenarios will give us data to make a meaningful evaluation. How far are imposed regulations from original goals?

Time table and action list

First run the base line runs (the standard ERA-40 runs) with appropriate diagnostics as suggested in work package 4 (to be finished by end of 2004).

Then at least two models should run the scenarios for changed emissions over Europe for both types of studies, (A) introduction of catalysators in cars, (B) power generation in power plants (first quarter of 2005).

Then at least one model should look at how the differences in the temporal evolution of emissions affect the perturbations. Specifically North America and South East Asia should be studied.

A report discussing the findings must then be written for policy makers/the public (second quarter of 2005).