Particulates and policy—the role of models

Much work on the development of reliable models still needs to be done to address concerns over particulate emissions.

INTRODUCTION

In the companion article in this *Review* (pp. 6–9) we examine the current state of understanding on the sources of particulate matter (emission inventories) and their contribution to ambient levels in the air we breathe (source apportionment). This serves to highlight the high degree of uncertainty in both areas. When it comes to the development and use of models that attempt to link emissions with air quality and to evaluate the efficacy of various emission reduction measures on current air quality, reliable emission inventories and source attribution are vital. In this article we will review the implications of these current uncertainties on particulate modelling with a particular focus on their implications for robust policy making. The purpose is not to focus on any particular models but rather to address the key question 'what policy questions can/can't current 'state of art' models help to us to answer?'.

EMISSIONS/EMISSIONS TRENDS

The two figures below help to illustrate that our understanding of emissions and emission trends is subject to change and also to highlight something of the uncertainty in current understanding. Figure 1 provides a forecast of anthropogenic primary PM_{10} emissions in EU-15 as developed by the Commission's Consultants for Auto/Oil-II early in 1999; Figure 2 shows the updated figure provided in June 1999. These data are largely based on the TNO inventory and forecast, but with road transport adjusted to reflect the Commission's Auto/Oil-II.

While it is obvious that both the absolute levels and trends for some sources have changed significantly, there are at least two clear policy messages which are unaffected by such changes.

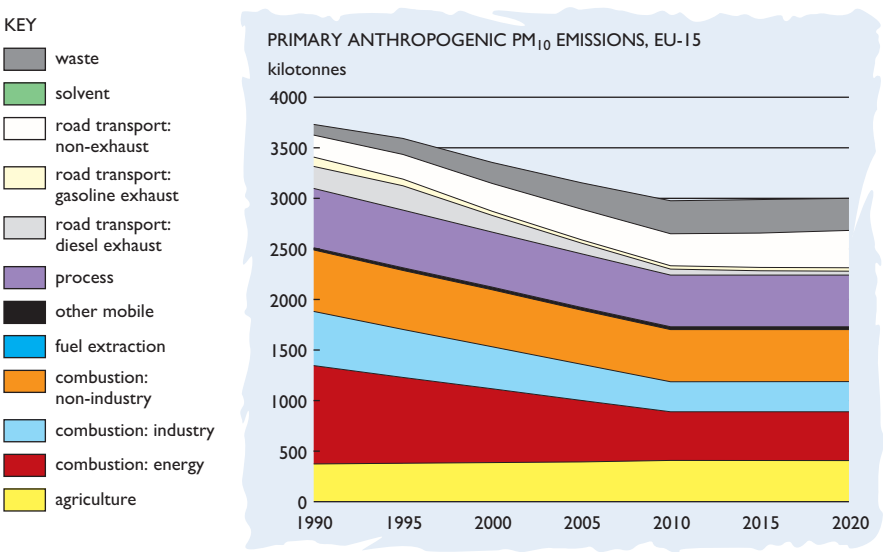

Figure 1
Predicted trends in PM_{10} emissions (EU-15) provided early in 1999.
(Source: European Commission Version 4)

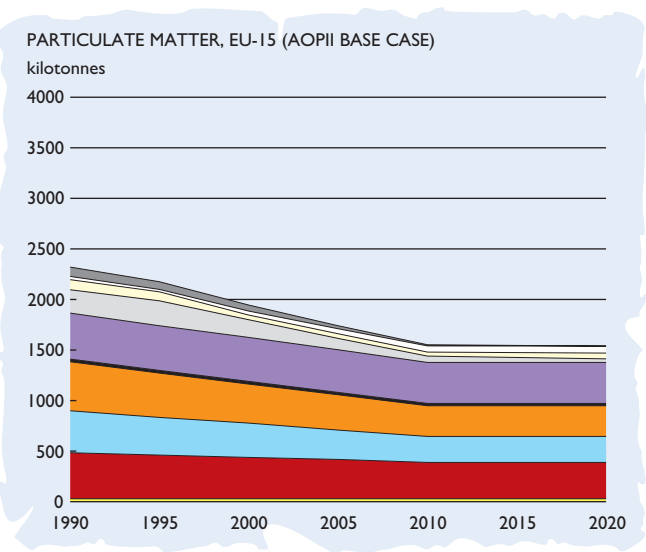

Figure 2
Revised prediction of PM_{10} emissions (EU-15), provided in June 1999.
(Source: European Commission Version 5)

The first message is the large predicted decline in the contribution from the tailpipe of road transport. This stands in contrast to the much more modest decreases (or in some cases increases) anticipated from other sources and reflects the impact of the policy priority that has been given to controlling tailpipe emissions over the last decade. Despite an anticipated growth of some 40 per cent in total vehicle kilometres from 1995 to 2015, the contribution of tailpipe emissions is seen to decline from about 14 per cent to 5 per cent. This clearly has implications for policy priorities not just for the current Auto/Oil-II programme but for broader based follow-up programmes such as the Commission's recently announced 'Cleaner Air for Europe.'

The second message is closely related. This is the need for comprehensive data to be developed and made available on the magnitude and nature of particulate emissions from sources other than road transport. Much research has been, and continues to be, undertaken to characterize the nature and fate of particulate emissions from road transport. However this is not currently matched by research programmes aimed at generating similar data from other sources. For policy makers to be in a position to respond to concerns over meeting air quality targets for particulates in the coming decade, such an imbalance needs urgently to be corrected.

AIR QUALITY/AIR QUALITY MODELLING

Understanding the relationship between air quality and emissions is the key to sound policy development aimed at delivering a given air quality target. A whole range of robust models are available for this purpose in the case of gaseous pollutants. However, in the case of particulate modelling, we encounter a serious problem since this requires the availability of air quality models that are able to represent adequately the physical and chemical processes involved, as well as the availability of reliable emission inventories. To date no such model is available. As discussed in the companion article in this *Review*, physical transformation processes, e.g. agglomeration of particles, and chemical transformation processes, e.g. secondary particulate formation, are to date poorly defined, at least in terms of what would be required to represent such processes adequately in a model. Both are very important, particularly if in future the focus of concern moves to $PM_{2.5}$ or $PM_{1.0}$. Furthermore, the lack of comprehensive data on what sources constitute current measured concentrations (source attribution) makes model validation very difficult.

Helsinki, one of the Auto/Oil-II cities in the EEA c-Q air quality model.

So where does this leave us in terms of policy guidance? The EEA with their semi-empirical 'c-Q model' have attempted to provide some understanding of particulate air quality trends. Their approach utilizes measured air quality data, empirically-derived relationships for the relative contribution from low and elevated emission sources and emissions forecasts. Such an approach is limited by the specific locations of the measuring stations on which future forecasts are based, by the robustness of the empirical relationship and, of course, by the robustness of the forecast on how individual emission sources change over time. The EEA have recently posted the results of their c-Q model for some 200 European cities which provided input to their recently published report 'Environment in the European Union at the turn of the century'.

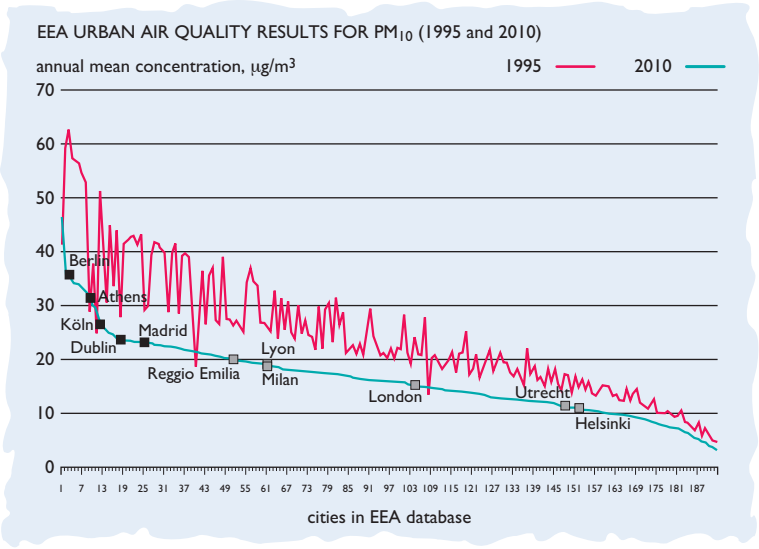

Figure 3
Currently mandated measures are expected to deliver a significant improvement in PM_{10} air quality over the next decade.
(Source: EEA c-Q Modelling June 1999)

The emissions inventory and emissions forecast for this analysis is consistent with the data shown in Figure 2 for EU-15. The results are shown in Figure 3.

The Auto/Oil-II cities have been identified on this figure given the importance of this current programme. Unlike the EEA, no accounting has been given here to the varying population in each of the cities. To provide a clear perspective, the cities have been ranked from highest to lowest predicted 2010 concentration. The 1995 plot has not been similarly ranked since it would not enable the change from 1995 to 2010 to be visible for a given city.

Although subject to all the uncertainties discussed above, what is clear from this chart is that currently mandated measures are expected to deliver a significant improvement in PM_{10} air quality in Europe over the next decade. However, the chart also shows that a significant number of cities are not expected to attain the annual mean target of 20 µg/m^3.* When weighted for population, the EEA quotes some 60 per cent of EU-15 population being exposed to levels above 20 even in 2010.

When it comes to addressing the key question of what further cost-effective measures can be introduced to deliver the objective in the non-compliance cities, these data from the EEA present a problem. This is the lack of detailed spatial coverage and the lack of source attribution data inherent in the c-Q modelling approach. The need to generate such data was recognized in Auto/Oil-II and formed part of the detailed Eularian modelling of the ten cities. However, the detailed results of this work were not available at the time of writing.

Despite the limitations of the c-Q model, the emissions projection given in Figure 2 would suggest that one interesting 'what if' scenario would be to run the model assuming zero road transport tailpipe emissions in 2010. Such a scenario would, potentially, provide an important perspective for developing any proposals within the context of the second Auto/Oil programme. For example, is continued emphasis on policy aimed at reducing tailpipe emissions from road transport appropriate in seeking to deliver the particulate air quality objective?

CONCAWE, along with others, recognizes the need for much more work to be done in developing the necessary understanding as a basis for building reliable models to guide further policy on dealing with the concerns over particulate emissions. This is especially true as the emphasis shifts to finer and finer particles. However, such work will require significant commitment to appropriate research programmes which recognize the need to balance the current high activity on emissions from road transport with similar activity on other sources. However, such work cannot be completed overnight and, in the meantime, work like that of the EEA and the city modelling within Auto/Oil-II should be used in the most effective way to inform policy makers and avoid the mandating of ineffective and high-cost measures.

* *Indicative limit value to be reviewed before 31.12.2003.*