The City Delta project

Assessing urban air pollutant effects

As part of the Clean Air For Europe (CAFE) programme, the so-called 'City Delta project' commenced in early 2002. The programme, as the name suggests, is designed to develop relationships between regional scale air quality levels and the levels found in cities using state-of-the-art models. These relationships will be incorporated into 'RAINS', the Integrated Assessment Model (IAM), which is being used in the CAFE Programme to examine various emission reduction scenarios as input to policy development. For the first time this will enable the IAM to be used to develop optimum control strategies which simultaneously address both urban and regional scale residual air quality problems in the EU.

The programme is coordinated by the Commission's Joint Research Centre (JRC) in Ispra and guided by a Steering Group of which CONCAWE is a member. Ten modelling teams were involved in the first phase of the programme (City Delta I) which was completed in December 2003 and focused largely on ozone. A smaller number of modelling teams are involved in the second phase which commenced in October 2003, is due to be completed in June 2004, and will focus on fine particulates (PM_{10}/$PM_{2.5}$).

In this brief article we will look at some of the important results that have emerged from the first phase, in particular the relationship between urban scale and regional scale ozone response to NO_x emission reductions.

It has long been recognised that in cities which are characterised by high levels of NO_x emissions, particularly from road transport, incoming ozone levels are reduced over the city due to the reaction of ozone with NO to form NO_2 and molecular oxygen. This is a simple, local scale phenomenon unlike the larger scale, complex photochemical reactions that form ozone downwind of a city. As such it is largely 'invisible' in the larger scale regional modelling which has, to date, underpinned the development of ozone response strategies in Europe.

Given that a major focus for CAFE is population exposure to pollutants of concern (including ozone), the fact that ozone levels drop over cities due to this titration effect is an important phenomenon to capture if the impact is to be reliably represented in the Integrated Assessment Modelling. Perhaps more importantly, the response to emission changes needs to account properly for such a phenomenon to avoid 'regret' policies being developed.

The following series of charts for London, Milan and Paris are reproduced from the modelling assessment toolkit developed by the JRC specifically for City Delta. This has been a key component of the whole City Delta exercise and CONCAWE acknowledges the important contribution that the JRC team has made by developing this tool. It enables a ready assessment/comparison of all the modelling results and provides a powerful means of viewing the impact of the control scenarios examined.

The charts are arranged in pairs; the 'a' figure showing the results of fine scale modelling (5x5 km); the 'b' figure showing the large scale model results (50x50 km). In each case the modelling domain is 300x300 km. The main highways, coastal outlines and country borders are drawn in white. The series of three pairs (London, Milan and Paris) all depict the model responses to a change in NO_x emissions from a '2010 Base Case' (assuming already legislated measures are implemented) to 'Maximum Feasible Reductions' in 2010 (assuming all available further NO_x control measures are applied).

The metric that is plotted here is population weighted AOT30[1] in ppm hours x thousands of people per square kilometre, i.e. a measure of the population exposure to ozone.

[1] *Accumulated exceedances Over Threshold where the threshold is 30 ppb*

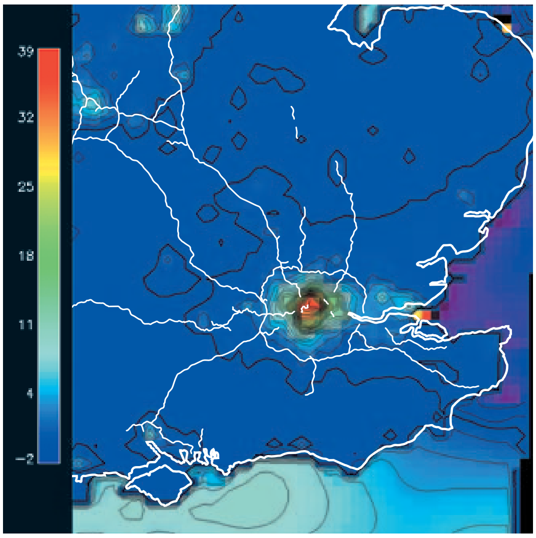


Figure 1a

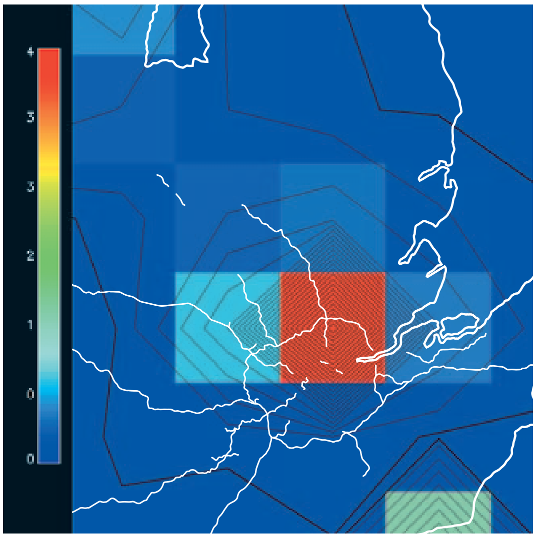


Figure 1b

London Area 2010: Change in AOT30 for NO_x from Base Case to Maximum Feasible Reduction Case at fine scale (Figure 1a) and coarse scale (Figure 1b).

In all three cities the fine scale models show significant increases in the population weighted levels of AOT30 with reduction in NO_x levels beyond the Base Case in 2010. This is to be expected given that the reduction in NO_x removes the NO that titrates the ozone in the city. Hence ozone levels are not reduced as much over the city as in the Base Case, so population exposure to ozone rises.

This has important implications for any cost-benefit assessment based on human population exposure: although further NO_x control (beyond that already legislated) may be beneficial for reducing regional scale ozone, it would increase population exposure to ozone in cities, implying negative human health benefits.

It is important to note that the regional scale modelling results not only miss the significance of this increase in exposure (see Figures 1b, 2b and 3b) but, in the case of Milan and Paris, indicate a reduction rather than an increase in exposure! In other words, it potentially misleads policy makers as to the benefits of such control measures from a human health point of view.

The City Delta project is specifically designed to look at the effects of air pollutants in the urban environment.

Figure 2a

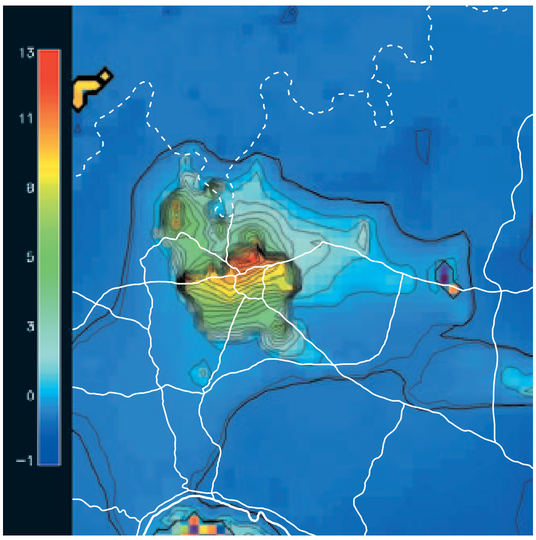
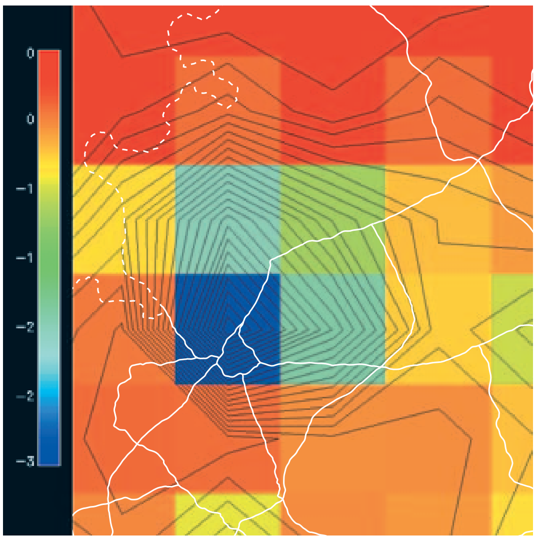


Figure 2b



Milan Area 2010: Change in AOT30 for NO_x from Base Case to Maximum Feasible Reduction Case at fine scale (Figure 2a) and coarse scale (Figure 2b).

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Paris Area 2010: Change in AOT30 for NO_x from Base Case to Maximum Feasible Reduction Case at fine scale (Figure 3a) and coarse scale (Figure 3b).

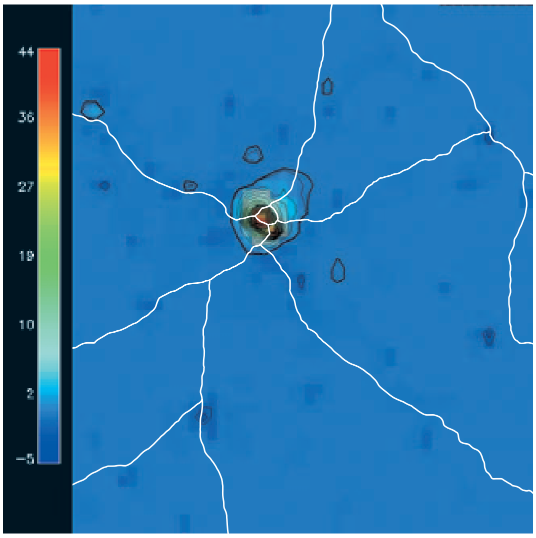

Figure 3a

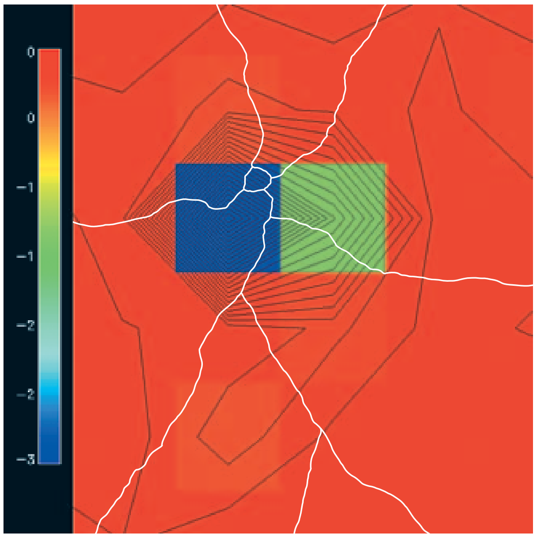

Figure 3b

The information that it generates will constitute a major enhancement to the Integrated Assessment Modelling. CONCAWE welcomes this improvement, which will help to ensure that synergistic solutions are developed for both regional and urban scale problems. In particular, such solutions must take into account potential 'environmental tensions' e.g. between urban and regional ozone abatement strategies. This can only enhance the role that IAM will play in designing robust policies.