Integration of air quality modelling and monitoring: review and applications

Science Summary SC060037

The Environment Agency has reviewed how ambient air quality modelling and monitoring can be integrated in order to improve the design of monitoring networks and to reduce uncertainties in air quality impact assessments around industrial sites.

The study covered two broad areas: 1) a review of the availability and application of monitoring data and modelling methods for assessing the impacts of industrial sites; 2) a review of existing methods for integrating monitoring and modelling data.

The key conclusions from the review of monitoring data in the first part of the report were:

- To achieve effective integration, it may be necessary to increase investment in monitoring resources and ensure the optimal placement of monitoring sites. Existing monitoring networks such as the Automatic Urban and Rural Network (AURN) are of limited use for industrial air quality assessments as they are often located far from industrial sources, and pollution from roads and urban areas can complicate attempts to identify industrial source impacts.
- It is essential that any monitoring resource be optimised in terms of the number and placement of monitors, both to ensure cost-effectiveness and to maximise the potential for effective integration of monitoring and modelling data.
- Decision-support tools, which are able to prioritise multiple monitoring objectives such as population protection, ecosystem protection or targeting specific air quality metrics, are invaluable in designing an effective monitoring network.

The key conclusion from the review of modelling methods in the first part of the report was:

- Improving the accuracy of modelled data is crucial to the effective integration of modelling and monitoring data. This may be achieved through the use of more representative meteorological data and the application of more appropriate background correction factors.

In the second part of the report, the following applications of the integration of modelling and monitoring data were reviewed, giving examples of current practice:

- **Model validation** - the independent testing of dispersion models using monitored data;
- **Data assimilation (model calibration)** - a procedure that combines model and observation data to improve a prediction;
- **Inverse modelling** - ambient concentrations predicted by dispersion models using varying emission rates can be compared to monitored concentrations to try to estimate source strength;
- **Optimisation of monitoring network design** - spatial patterns of ambient concentrations predicted by dispersion models can be used to identify the location of peak long-term and short-term concentrations and can therefore be used in the optimum placement of monitors for short and long-term monitoring campaigns. Modelled concentrations may also be used to locate monitors in order to discriminate between the impacts of two or more sources.
- **Data extrapolation** – air quality statistics determined during short-term monitoring campaigns may be extrapolated to give estimates of longer-term values for comparison with annual standards.

Various data assimilation and data extrapolation techniques were tested to assess their potential for use in regulatory decision-making.

Data assimilation methods were applied to a SO_2 validation data set from Kincaid, and it was found that the optimum number of monitoring sites needed to maximise the accuracy of data assimilation methods was between 10 and 15. Practical considerations would prohibit the use of so many monitors in current regulation. However developments in low-cost, high-resolution sensors may make this more achievable in the future.

Of the simple assimilation techniques tested, a simple ratio method provided the best calibration using both the Kincaid data set and another SO_2 data set from the Aire Valley. A linear regression method performed similarly to the simple ratio method when using a large number of data points, but its performance decreased markedly when fewer than three monitoring points were used to calibrate the modelled data. The success of more complex integration techniques, e.g. kriging, was limited.

Data extrapolation methods applied to data from short-term monitoring campaigns carried out by the Environment Agency proved of limited value compared to the currently used pro-rata extrapolation method. An Integration Scaling Method improved the consistency of measured and predicted air quality exceedences compared to the pro-rata method, although overall uncertainty was still high.

This summary relates to information from Science Project SC060037, reported in detail in the following output:

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