IAQM Meeting on Model Verification, 23 April 2009, held at Arup's office, London

On Thursday 23 April the Institute of Air Quality Management (IAQM) hosted a 'head to head' debate on model verification within the context of air quality management assessments. The argument *for* model verification was presented by Professor Duncan Laxen of Air Quality Consultants and the argument *against* by Dr Michael Bull of Arup. The session was chaired by Roger Barrowcliffe of ERM and attended by some 60 IAQM members.

Duncan started his talk by first making the important distinction between model validation (or evaluation) and model verification, the former being detailed, peer-reviewed studies that have been carried out by the model supplier or a regulatory agency and the latter being the subject of the day's debate. Duncan defined model verification as *checks carried out on model performance at a local level. This basically involves comparison of predicted versus measured concentrations. Where there is a disparity between predicted and measured concentrations, the first step should always be to check the input data and model parameters in order to minimise the errors. If required, the second step will be to determine an appropriate adjustment factor that can be applied*. In his presentation, Michael agreed with Duncan's definitions and highlighted the need for checking both the input data used and that the model is appropriate for the situation being assessed. Michael made the point that the usual modelling approach uses best estimate values for input data, whereas in reality many variables are uncertain and inputs could be better represented as probability distributions. A probabilistic approach would actually give a more representative estimate of the concentrations likely to arise.

Duncan then went on to describe in detail the process of model verification as recommended in the recently published Local Air Quality Management Technical Guidance TG(09). Duncan highlighted the need to consider separately the three principal components of a modelled concentration value (the regional background, the local background and the local road component), particularly when modelling future year scenarios. Background data are derived from national models, which have been calibrated against measurements, and hence Duncan argued that model verification and subsequent adjustment of model predictions, if required, should be undertaken for the road component only and, in the case of nitrogen dioxide, for the road component of NO_x and not NO_2. Duncan cited the results of national modelling studies (see for example The DMRB Air Quality Screening Method (Version 1.02) Calibration Report. TRL Report PA/SE/4029/03, 2003.) associated with validation of the DMRB model that have led to the common conclusion that the road NO_x component is generally underpredicted in circumstances of slow moving, congested traffic with local buildings present.

Discussion from the floor highlighted the lack of understanding of why road models appeared to underpredict air pollutant concentrations in circumstances of slow moving, congested traffic and local buildings. The audience and the speakers agreed that research is required in this area with the important point made that simple adjustment of models suppressed model development and validation.

Duncan went on to describe a typical verification procedure undertaken by Air Quality Consultants, highlighting the need for adjustment to ensure that monitoring and modelling results are consistent and reliable, particularly when close to the air quality objective. From a survey of forty modelling studies recently undertaken by Air Quality Consultants, adjustment factors of the order two to six were not uncommon.

Having agreed that model validation and checking of model input data are imperative, Dr Bull's argument against model verification centred on the adjustment of modelled data based on the method for adjustment described in the Technical Guidance TG(09). This assumes a linear

relationship between monitored and modelled concentrations and an intercept of zero, in other words that there is a known, systematic error. Michael argued there is no evidence to suggest that this is the case and that many factors contributing to the observed differences e.g. vehicle speeds, local buildings or micro climates, could have different effects in different situations. He pointed out that there are rarely sufficient monitoring data points available to have confidence in the correction factors produced, demonstrating this point by comparing the 95% confidence limits of a regression line passing through and not passing through zero.

Michael observed that the model adjustment process generally relies on monitoring data that is limited to only a few data points and is itself uncertain. This is particularly likely when data from NO_2 diffusion tubes are used to derive NO_x concentrations. Data sets from diffusion tubes are not accurate (they are generally considered to be within ±20-25% of the true value) and when combined with the range in possible (i.e. observed) associated NO_x values, estimates made using the current conversion method would be in the range ±35% NO_x.

Michael's main point was that the model adjustment process hides poor modelling and makes acceptable results that may otherwise be discarded or investigated further. This was demonstrated by a number of examples taken from local authority reports reviewed and accepted by Defra. He argued that high correction factors suggest that either the model was unsuitable for the area, or the model was not set up correctly, citing an example where a factor of 12 underprediction was removed when a detailed investigation was made of the model inputs and set-up.

In conclusion, there appeared to be much in common between the arguments for and against model verification. The need to use only models validated for the circumstances being assessed was clearly stated. Both speakers agreed that more checking and justification of model input data is required. The underprediction of models in situations where traffic is not fast flowing and where buildings may be present was identified as a situation requiring further research and that the simple use of an adjustment factor should be considered an interim measure only. The key difference between the two speakers was in the use of monitoring data to adjustment model results. The argument in favour is that it provides reliability to the overall assessment, the argument against is that it hides poor modelling practice.

Discussion from the floor followed the presentations and led to the preparation of a set of IAQM Recommendations on Model Use within Air Quality Management Assessments. The four recommendations by the IAQM address concerns about the current situation, from both sides of the argument, and includes a recommendation for a on-going survey of how model adjustment is generally carried out.

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