TOWARDS A MODELLING NETWORK IN SUPPORT OF THE NEW AIR QUALITY DIRECTIVE

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INTRODUCTION

Numerical modelling is increasingly being recognised as a valuable tool for conducting urban Air Quality Assessment (AQA). Although air pollution monitoring is still the basis of AQA, most air quality measurements are usually limited by low spatial and temporal resolutions or confined to only a small number of selected pollutants. Thus, in several cases they are not sufficient to realistically describe air pollution patterns in urban areas. This can be successfully achieved by using mathematical models to simulate pollutant dispersion and transformation over a given area and thus create exposure and concentration maps. However, a detailed and comprehensive understanding of physical and meteorological processes contributing to urban air pollution (*Pielke, R.A. and Uliasz, M.*, 1998) is required in order to realistically assess air pollution concentrations and the relative contribution from different emission sources. Numerical models are the most powerful and scientifically relevant tools, as they are capable of describing the time and space evolution of pollutants in the atmosphere (*Sportisse, B.*, 2001) and can be used to predict and prevent future air pollution episodes and design abatement strategies.

The current European Directive on ambient air quality emphasises the importance of modelling as a tool in the definition of high pollutant concentration areas that are not in compliance with standard values. Therefore, atmospheric modelling has lately received increasing attention from local authorities and decision-makers (*Borrego, C. et al.*, 2003). In response to this direction, several initiatives and networks have been developed aiming to facilitate the use of modelling in urban air quality assessment. The "Initiative on Harmonisation" was launched in 1991, in order to promote increased cooperation and standardisation of atmospheric dispersion models for regulatory purposes. The Initiative responded to the need for new models to be developed in a well-organized manner and turn into practical, generally accepted tools fit for the various needs of decision-makers. The intergovernmental network COST Actions 728 (*URL 1*) and 732 (*URL 2*) are respectively focused on the development and evaluation of modelling tools for air quality assessment. The large modelling intercomparison exercises Eurodelta and Citydelta (*URL 3, Cuvelier, C. et al.*, 2007) have also been launched by the Joint Research Centre JRC-IES in collaboration with EMEP, IIASA and EUROTRAC, in support to the modelling activities of the CAFE programme. The reports produced under the EU funded "Air Quality assessment by monitoring and modelling for regulated pollutants in Europe" (AIR4EU) project (*URL 4*) have also provided guidelines for authorities to establish best AQA practices, where the use of modelling is particularly encouraged. AIR4EU recommended various methodologies for improved spatial assessment of PM, NO_2 and O_3, with emphasis on the combined use of monitoring and modelling.AIR4EU emphasised the fact that although measurements provide the most direct information on pollution conditions at the measurement sites, they cannot be used to fully understand nor explain the relationships between sources and ambient pollution.

Proper interpretation of the measurements can only be done using reliable urban and local dispersion models. Furthermore, combining model results with measurements reduces uncertainties inherent in both, and is strongly recommended in order to achieve a better depiction of the real situation in the area of interest. AIR4EU underlined the need for modelling in order to conduct scenario calculations for the assessment of emission abatement strategies as well as integrated source apportionment studies. It is true that source apportionment can be carried out to some extent using only monitoring data in order to identify urban and regional contributions for PM as well as contributions to NO_2 that come from its reaction with O_3. However, this methodology is limited as it provides the contributions at the measurement site but cannot give information on the actual emissions. By combining dispersion models with receptor models it is possible to estimate emission strengths, providing verification of emission rates and identifying the absolute contributions of the various sources to ambient air quality. The project also provided a short description of "Best practice examples" from several European cities, where the use of modelling was successfully incorporated in AQA and Air Quality Management (AQM), providing useful information and results.

Despite all these efforts and suggested courses of actions, modelling tools are not regularly or sufficiently used for AQA purposes in most European cities. Therefore, the new Air Quality Directive (AQD) proposed by the European Parliament and the Council on ambient air quality and cleaner air for Europe (*URL 5*), particularly focuses on the introduction of modelling as a necessary tool for local authorities in several areas of AQA and AQM. The need for increased use of models in AQA by the member states is explicitly stated in the proposal for the new AQD (COM(2005)447 final). In the proposal, it is explicitly stated that a greater use of modelling to assess air quality should be permitted, in particular if fewer than five years' monitoring data are available. Similarly, the amendments of the new AQD proposal (P6_TA-PROV(2006)0362 - Amendment 16) requires that fixed measurements shall be supplemented by modelling techniques. The new EU Directive recognises the benefits resulting from the use of modelling in AQM and Assessment, as they are summarised in table 1.

Table 1: The use and limitations of modelling in Air Quality Management and Assessment

AQ Modelling	
Use	**Limitations**
• Assessing potential environmental impacts of development plans • Evaluate potential future policies • Examine compliance with long-term standards • Mapping • Identify pollution sources • Quantify air pollution patterns in space and time	• Inaccurate/unrealistic predictions • Not always easy to use • Input data not always available

This effort for the increased use of modelling in AQA, needs to be carried out on the basis of cooperation and information exchange between member states in a systematic and standardised manner. This need is explicitly mentioned at several places in the proposal for the new AQD, by requiring that Member States should consult with one another to develop a common approach to the assessment of AQ. It is also stated that member states should collect, exchange and disseminate AQ information, and should adapt procedures for data provision, assessment and reporting of AQ to enable electronic means and the internet to be used as the main tools to make information available.

AIM AND OBJECTIVES OF THE MODELLING NETWORK

In view of the requirement for increased modelling use by member states in AQA, several bodies such as the European Environment Agency (EEA) (*URL 6)* and the JRC were activated towards setting up a modelling network to promote synergy, collaboration between the users – at a local and national level – as well as exchange of relevant information. The EEA via the European Topic Centre on Air and Climate Change (ETC-ACC) has formulated a task, in direct response to these new AQD needs, having as a main aim the development of an EIONET (*URL 7*) modelling network. The exchange of scientific knowledge and experience through this network is expected to enhance awareness of model usefulness, reliability and accuracy, establishing the important role of modelling in the preparation of plans and strategies to improve urban air quality and finally prevent or reduce exceedances of the statutory limits. Concerted interactions between modellers and AQ managers from the various member states will be necessary to ensure maximum impact of the planned network. The network should be extended to include Candidate and Accession countries to ensure their preparation in complying with EU AQ legislation. Several stakeholders ought to be represented in the network, both from the scientific community as well as the related authorities and legislative bodies. End users and modellers should also be actively involved. Most of the network activities will directly address particular modelling needs and refer to exchanging scientific knowledge and experience, as well as user experiences, modelling examples, case studies and practical guidance on preparation of input to modelling cases. These network activities will provide valuable information on the usefulness, reliability and accuracy of different modelling tools and will reveal potential roles of modelling in air quality assessment, such as in the assessment of future pollutant concentrations if a particular mitigation policy is followed. The results of any modelling exercises performed within the network activities will be made available to the public and the wider scientific and environmental community and authorities through activities (workshops etc.) and tools established by the modelling network. This is in accordance with the requirement of the new AQD for sharing of AQ information between the member states. Further objectives include:

- The exchange of modelling results and maps through suitable interfaces and electronic tools, as well as in a more conventional manner (through seminars and workshops).
- The establishment and promotion of a common infrastructure based on best practice for reporting and storing the information, results and maps in a standardised and harmonised manner to create an archive for reference where tools, data and information will be readily available to authorities and scientists of the member states.
- The assessment of AQ in urban hot-spot areas, focusing on local vs. regional/global contributions.
- The promotion of model validation and quality assurance of model results to identify limitations and remove error factors, which implies the organisation of and participation in model validation and intercomparison exercises at national or European level. Such exercises will be complementary to other parallel activities. For this purpose, needs in terms of AQ assessment and model evaluation criteria will be defined at different scales (for example through benchmark tests following the relevant ACCENT activity on Model Benchmarking).
- The combination of modelling and monitoring through data assimilation methods, a technique often used to improve model accuracy and representativity at the urban scale.

SUGGESTED METHODOLOGY

A consistent methodology for the establishment of the modellers' network and its related actions should be followed. The network will be established by invitation according to a pre-selected list. In order for this action to bring maximum benefits, the network composition

must be carefully considered, in order for all important stakeholders to be adequately represented. The network should include national and selected city/urban agglomeration representatives with modelling experience as well as modellers groups and even industry representatives. The established network will be responsible for the preparation and organisation of theme specific workshops, seminars and information days. Relevant stakeholders from different member states will be invited, under the chairing of the network coordinators, to participate in hands-on events focused on the exchange of ideas, problems, information and practical/technical knowledge on air quality modelling. These events will thematically address aspects of modelling that will promote the ideals of good modelling practices. Such themes could include, for example, model assessment, validation and uncertainty, process descriptions in models, data assimilation and the use of monitoring. The underlying principle will be to communicate experience from expert to non-expert users, providing first hand practical experience.

The established network will examine the role of modelling and its application relative to EU Directives and guidelines. A detailed review of past examples on the use of modelling in AQA, case studies, model description and validation will be undertaken in order to define current needs and difficulties and plan the required actions. Following this review, in terms of more practical activities and depending on the users' and stakeholders' needs, modelling assessment exercises will be carried out. The JRC may take on a leading role in the coordination of such an action, gaining from its experience in leading the "Eurodelta" and "CityDelta" intercomparison exercises. In the exercises, suitable operational tools – either already existing or especially developed for this purpose within the network activities - will be utilised to ensure the meaningful and accurate review of the modelling results. As an essential part of the network activities, the results and findings from these exercises will be produced and stored in a standardised and harmonised manner and disseminated through suitable interfaces to member states. Existing databases and interfaces such as the EEA's data centre will play a crucial role for collecting, storing and making the results readily available.

Model validation will be a crucial outcome of the review analysis and modelling exercises. Several common infrastructures will be combined and established to serve the model validation purpose, including comprehensive model databases, validation meta-data databases, mapping tools and archives of model applications. Existing databases such as the Model Documentation System (MDS *(URL 8*), will contribute towards model validation, by providing information on model performance based on previous applications and by facilitating model application through its comprehensive and detailed description of a significant number of models. Information on model features, limitations and best use, as well as availability and other related resources, will further encourage model application. In addition, the validation meta-database developed within the COST728 framework (*URL 9*) will provide a flexible system both for submitting as well as for searching information on available validation datasets. The network will be established through regular exchange of information and expertise between member states through the scientists, regulators and model users involved in the modelling network. This interaction and information exchange will be carried out in a harmonised, standardised and electronic manner, with the use of suitable interfaces and electronic tools mentioned above, including MDS, COST728 meta-database, COST728/732 Model inventory (*URL 10*) and EEA's AirBase (*URL 11*). The overall activity will be closely connected to JRC actions related to air pollution modelling.

CONCLUSIONS

The proposed new Air Quality Directive (AQD) - the Directive of the European Parliament and of the Council on ambient air quality and cleaner air for Europe - recognises the benefits resulting from the use of modelling practises in AQA and particularly focuses on the introduction of modelling as a necessary tool for local authorities in several areas of AQA and AQM. This need for increased use of models in AQA, which is supplemented by recommendations for increased exchange of information and collaboration by the member states, is explicitly stated both in the proposal as well as in the corresponding amendments for the new AQD. In direct response to these needs, the EEA via the European Topic Centre on Air and Climate Change has formulated a specific task for the development of an EIONET modelling network. The synthesis of the network will be carefully considered to include all relevant stakeholders and the aim of the network will be achieved through coordination and collaboration actions between member states, involving events such as workshops, as well as through the use of electronic systems in the form of newsletters, web portals and databases.

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