COST Office

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Proposal for a new COST Action

COST 732

"QUALITY ASSURANCE AND IMPROVEMENT OF MICRO-SCALE METEOROLOGICAL MODELS"

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DRAFT
Memorandum of Understanding

For the implementation of a European Concerted Research Action
designated as

COST 732

"QUALITY ASSURANCE AND IMPROVEMENT OF MICRO-SCALE METEOROLOGICAL MODELS"

The signatories to this Memorandum of Understanding declaring their common intention to participate in the concerted Action referred to above and described in the Technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of the document COST 400/01 "Rules and Procedures for Implementing COST Actions", the contents of which the Signatories are fully aware of.

2. The main objective of the Action is to improve and assure the quality of micro-scale meteorological models that are applied for predicting flow and transport processes in urban or industrial environments.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action at Euro 16 million in 2004 prices.

4. The Memorandum of Understanding will take effect by being signed by at least five Signatories.

5. The Memorandum of Understanding will remain in force for a period of four years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter 6 of the document referred to in Point 1 above.

Technical Annex

COST 732

"QUALITY ASSURANCE AND IMPROVEMENT OF MICRO-SCALE METEOROLOGICAL MODELS"

A. Background

The Framework Directive on Air Quality Assessment and Management together with its 'daughter' directives is a key element of present-day European environmental legislation. It addresses air quality within conurbations and near to major sources. It is the first time that a European directive explicitly requires the use of models as tools for the execution of air quality policy. Though the directive does not require the harmonisation of models across Europe, the performance, representativeness and accuracy of results should be based on quality assured models that can be inter-compared across national borders in order to ensure sound, equitable and effective protection and/or mitigation measures.

For the short-range local problems (0 km to 5 km) at stake here, simple Gaussian type models have generally been used. These models are applicable for pollutant emissions into uniform atmospheric flows (for example tall stack releases in flat, unobstructed terrain and averaged over a large number of atmospheric conditions). It is accepted that these models are not appropriate for predicting flow and concentration in complex structured urban or industrial areas, which is unfortunately where pollutants that are of major concern at present (NOx, PM10, VOC) are emitted. They result from traffic and low elevation domestic or industrial sources. Additionally, hazardous and critical situations generally occur under certain specific flow conditions embedding meteorological and dynamical disturbances that make the flow conditions far from uniform or stationary, for which these models have been developed.

Other types of substances that deserve attention are toxic or flammable gases that escape during accidents or that are deliberately released in the context of terrorist attacks. It is common in all these cases that the dispersion takes place near to the ground within or slightly above the urban or industrial canopy layer. In this layer, the flow is significantly disturbed by buildings and other obstacles. The meteorological and concentration fields are very inhomogeneous and vary rapidly with time.

The emergence of increasingly powerful computers enabled the development of more powerful tools that have the potential to meet the new demand for predictions from models. These new tools are micro-scale meteorological models of prognostic or diagnostic type. Prognostic models are based on the Reynolds-averaged Navier-Stokes (RANS) equations, whereas diagnostic models are less sophisticated and only ensure the conservation of mass. These two model types are presently supplemented by even simpler engineering tools. It is to be expected, however, that the latter will sooner or later be replaced by RANS codes or the even more complex Large Eddy Simulation (LES) models. The RANS codes belong to the family of

Computational Fluid Dynamics (CFD) tools as they are used in various engineering contexts. Micro-scale meteorological models are special in so far as they are tailored to the needs of meteorologists. They are adjusted to domain sizes of the order of several decametres to a few kilometres (street canyons, city quarters). They usually use boundary conditions based on surface characteristics like land use, roughness and displacement thickness and they may contain modules that have the potential to simulate chemical transformations, aerosol formation or other important atmospheric physico-chemical processes. Typically these models contain a substantial amount of empirical knowledge, not only in the turbulent closure schemes but also in the use of wall functions and in other parameterisation schemes.

Models have begun to play an important and often dominant role in environmental assessment and urban climate studies that are undertaken to investigate and to quantify the effects of human activity on air quality and the local climate. Several of the conclusions that will be drawn from research activities carried out under the Sixth Framework Programme (FP6) of the European Community (EC) will be based on the output from such tools.

The increasing use of micro-scale meteorological models is paralleled by a growing awareness that the majority of these models have never been the subject of rigorous evaluation. Consequently, to a certain degree, there is a lack of confidence in the modelled results.

To cast doubt on the results is perfectly justified, as was shown by systematic studies in which applications of the same model by different modellers to a given problem (Hall et al., 1997) and applications of different models by either the same or different modellers to the same problem (Ketzel et al., 2001) revealed significant differences. Nevertheless, these models are used in the preparation of decisions with profound economic and political consequences.

The reason that most of the models lack quality assurance is not due to insufficient efforts made by the model developers, it is mainly caused by:
- the lack of a commonly accepted quality assurance procedures for such models, and
- the lack of data sets that are quality checked and commonly accepted as a standard for model validation purposes.

It is timely that this Action is introduced now, because of the wide range of associated collaborative activities under way within the European research community. Some of these associated activities include:
- The Clean Air for Europe project (CAFÉ) under the 6th Environment Action Programme that strives to develop a thematic strategy on air pollution the main elements of which are: (i) identify gaps and priorities for further action (e.g. particulate matter, smog, NOx) taking account of risks to vulnerable groups; (ii) review and, if necessary, update existing air quality standards and national emission ceilings (with attention to vulnerable groups); and (iii) better systems of gathering information, modelling and forecasting. Additionally, it looks at the implications of international policy such as the national emissions ceiling directives and the Gothenburg Protocol on ambient air quality.
- The City-Delta project organised by the Joint Research Centre of the EC which focuses on urban background concentrations in several European cities.
- The recently approved FP6 NoE ACCENT on atmospheric composition change that includes

a group on transport and transformation of air pollutants on a range of scales including the local scale.
- The ENV-e-City project which aims to improve access to environmental data, whereby meteorology for air pollution assessments is a pilot application area.
- The FUMAPEX project (Integrated systems for Forecasting Urban Meteorology, Air Pollution and Population Exposure) that is about to improve meteorological forecasts for urban pollution, coupling weather prediction models to urban air pollution and exposure models in cities subject to various European climates. It aims to improve urban air quality information forecasting systems.
- Other FP5 or FP6 projects which would benefit from this Action are INTEGAIRE (Integrated Urban Governance and Air Quality Management in Europe), SAPPHIRE (Source Apportionment of Airborne Particulate Matter and Polycyclic Aromatic Hydrocarbons in Urban Regions of Europe), OSCAR which focuses on the street level - measurement and modelling of NO2, PM10 and PM2.5, and finally the Cluster of European Air Quality Research (CLEAR) that spans scales from local to regional.
- National funded projects as, e.g., DAPPLE (UK), BUBBLE (Switzerland) and VALIUM (Germany) that carried out intensive measurements within or closely above city quarters in London, Basel and Hanover, respectively.
- The recently accepted Action COST-728 (Enhancing Meso-scale Meteorological Modelling Capabilities for Air Pollution and Dispersion Applications) will consider on the other hand the scale range immediately above the micro-scale, but can provide boundary conditions for the models treated under this Action.

However, none of these activities address the focus of this Action: quality assurance of micro-scale meteorological models in a standardised European-wide accepted form and the subsequent improvement of such models. The aim of the COST Action would be to involve and to support, but not to duplicate these other activities. Additionally, COST provides a suitable forum for the above mentioned activities as these have been performed so far at national level in a not concerted and scattered way.

B. Objectives and Benefits

The main objective of the Action is to improve and assure the quality of micro-scale meteorological models that are applied for predicting flow and transport processes in urban or industrial environments. In particular it is intended

- to develop a coherent and structured quality assurance procedure for these type of models which gives clear guidance to developers and users of such models as to how to properly assure their quality and their proper application,

- to provide a systematically compiled set of appropriate and sufficiently detailed data for model validation work in a documented, convenient and generally accessible form (www data bank),

- to invite scientists and users from all participating states to apply and test the procedure and to prove its serviceability,

- to develop a tool kit that implements the model evaluation methodology,

- to contribute to the development of an algorithm for uncertainty determination,

- to build a consensus within the community of micro-scale model developers and users regarding the usefulness of the procedure,

- to establish the minimum requirements as to input data (incl. meteorological, emission and concentration data) for a range of models

- to stimulate a widespread application of the procedure and the preparation of quality assurance protocols which prove the ‘fitness for purpose’ of all micro-scale meteorological models participating in this activity,

- to contribute to the proper use of models by disseminating information on the range of applicability, the potential and the limitations of such models,

- to identify the current weaknesses of the models and data bases,

- to give recommendations for focussed experimental programmes in order to improve the data base, and

- to give recommendations for the improvement of present models and, if necessary, for new model parameterisations or even new model developments.

It is to be expected that the very existence of a widely accepted European standard for quality assurance in the field of micro-scale meteorological models in combination with the provision of suitable validation data will significantly improve “the culture” within which such models are developed and applied. The Action will aim at establishing the basis for implementing measures to assure that environmental assessments based on modelling are considered sound, reliable and accurate.

Model developers from all over Europe will find step-by-step guidance on how to demonstrate that their models are fit for a particular purpose. Data sets (both flow and concentration data) obtained from extensive experiments will be made accessible and more widely exploited.

Relevant expertise available within the member states will be brought together and combined to develop a consensus for appropriate model use and model improvement. Very often these models were developed outside academic circles, so that simple schemes were often preferred to more state-of-the-art components but more complicated to use or involving extra data inputs. One benefit of this Action would also be to close the gap between the various models and the two communities.

C. Scientific Programme

Strategies for assuring the quality of a numerical model can only be based on very generic scientific principles such as the principle of falsification (K. R. Popper, 1959). The decision which particular tests should be performed and which particular data sets should be used for comparisons between model results and observations can ultimately only be based on a consensus built up within and by the scientific community. This need for a broad, trans-national consensus will give a real European dimension to the Action. The activities need to be carried out in a well-coordinated multi-national and multidisciplinary effort in which model developers, experimentalists and users combine their specific skills for the sake of a harmonised, European-wide accepted quality assurance procedure for micro-scale flow and transport models.

Although the details of the quality assurance procedure and the limits of its applicability are not yet determined since they will be the outcome of this COST Action, it is clear that already existing approaches will be carefully taken into account. These approaches comprise the 'General Requirements for a Quality Assurance Project Plan' by Borrego and Tchepel (1999), the 'Guidelines for Model Developers' and the 'Model Evaluation Protocol' which were worked out by the Model Evaluation Group (MEG, 1994) under the CECs Major Industrial Hazards Programme, the US-Environmental Protection Agency's requirements for quality assurance of atmospheric dispersion models (Irwin, 1998 and 1999) and the experiences made by the initiative for harmonisation of atmospheric dispersion modelling for regulatory purposes (Olesen, 1999 and subsequent papers). Results from similar initiatives in related fields will be taken into account, for example from the investigations carried out within the 'Podbi'-model inter-comparison exercise (Lohmeyer et al., 2002), from the FP5 thematic network QNET-CFD or from the COST Action C14 which dealt with the industrial application of CFD codes for engineering applications. Finally, the recommendations given by national bodies, e.g., the Quality Assurance Guidelines released by a task force of UKs 'Royal Meteorological Society' (1995) or Germanys 'VDI Commission on Clean Air' (2002), will be carefully considered.

Deliverable: A state of the art report, which collects and synthesises the available expertise on quality assurance initiatives in the field of micro-scale meteorological modelling. Preparation of a glossary with a clear definition of terms that are used in the context of quality assurance work.

In the next step a quality assurance plan needs to be developed that is adjusted to the needs of developers and users of such models. The most important part of the quality assurance plan will be a guideline for model developers. This guideline describes, step by step, what a developer of micro-scale flow and transport models should do in order to assure the quality of model output, and how he should document the results of his effort in the form of an evaluation protocol.

Deliverable: A Quality Assurance Plan for micro-scale meteorological models including a guideline for model developers on how to perform a structured model evaluation procedure for such models.

Of utmost importance for any evaluation work is the availability of appropriate data. Therefore, one of the main tasks of the Action will be to assess the existing database. The data will be classified with respect to how complete it is and it's usefulness for the present purpose. Special efforts will be made to assess the uncertainty in the data. Data sets that prove to be useful for quality assurance work in the field of micro-scale meteorological modelling will be documented and brought into a form that they can easily be accessed and used.

The likely finding of this work package is that most of the existing field and laboratory data sets are poorly documented, were taken with insufficient instrumentation, lack completeness or are, for other reasons, of questionable quality.

Consequently, suggestions for a focussed experimental programme to close the gaps in the existing database requires formulation. The gaps will be reported to scientists engaged in ongoing experiments in order to redirect funds and to influence pertinent experimental programmes, respectively.

Deliverable: A collection of quality checked data made accessible in convenient electronic form. Suggestions for focussed experimental programmes based on a thorough analysis of the existing database.

A structured model evaluation procedure is composed of many parts. These include model verification, i.e. assessments on whether the scientific foundation of the model is adequate for the purpose, and whether the computer code is producing output in accordance with the model specifications. Model validation is of similar importance, i.e. the comparison of model outputs with observed data. Model validation is not at all an easy task when undertaken in an objective and meaningful way. Data sampled within the urban canopy exhibit a large inherent variability, whereas micro-scale models are usually run with constant boundary conditions and produce steady-state results. Therefore, special emphasis must be given to the problem of what is really compared with each other. It can be shown that data from many short-term urban dispersion experiments have the character of snapshots that lack representativeness. (Schatzmann et al. 2003).Repeats carried out under identical conditions would not lead to identical results. Only averages over large ensembles of measurements taken under similar weather conditions provide mean values and standard deviations that are statistically meaningful.

The uncertainty resulting from systematic differences between numerical model simulations and data from the real world can also be quantified by repeating the field measurements under controlled conditions in a boundary layer wind tunnel (Schatzmann and Leitl, 2002). All major urban measurement campaigns that were carried out recently (DAPPLE,UK, BUBBLE, Switzerland, VALIUM , Germany, and the Joint Urban 2003 Tracer Experiment (USA)) had a substantial wind tunnel component. Here, the field experiments were repeated under carefully controlled inflow and boundary conditions in order to investigate the uncertainty contained in the field data and, when necessary, to complete the data by measuring the missing quantities. This new experimental strategy which combines the advantages of both field and laboratory experiments is particularly useful for the micro-scale and provides unique opportunities. Additional experimental effort will be devoted to the generation of laboratory

data that supports the development and/or justification of parameterisations used in micro-scale meteorological models.
Deliverable: Quality-checked validation data sets for micro-scale flow and transport models as complete as practically possible with known uncertainty ranges for the key parameters.

The Action focuses on micro-meteorological flow and transport models. This means that both the fluid flow and the substances which are transported and dispersed by the flow are of interest here. These models have a modular structure most of the time. They may predict meteorological and air quality parameters either within the same or in subsequent model runs. They may be restricted to only passive tracers or they may have sub-modules simulating chemical reactions, aerosol formation or other processes. At present it cannot be foreseen which particular models will participate in the quality assurance initiative of the Action and which characteristics the participating models will have.

It is however clear that the Action cannot restrict itself to the assessment of the performance of a model as such. In cooperation with the model developers and users, the Action will make every effort to find out what particular module or parameterisation caused a specific weakness in the results of the model. It can be expected that know-how will be generated about which particular parameterisation performs best or how a certain module should be made up. Common views on the best way to enhance the quality of micro-scale meteorological models will be formed and disseminated within the community of micro-scale modellers.

Deliverable: Recommendations for the improvement of model parameterisations, of sub-modules for specific processes or for micro-scale meteorological flow and transport models such as models based on the results of the structured quality assurance work.

All results of the Action will be made available to the public as soon as they have been attained. A web page will be created which will contain all the information in a suitable and easily accessible electronic form. Special workshops will be organised in order to disseminate the findings and to promote the widespread use of the recommendations for the quality assurance of models.

Deliverable: A home page to widely promote the activities of the Action among the community of micro-scale modellers and the various stake holders. It will contain the results of the Actions activities including the recommended step-by-step quality assurance procedure, the validation data sets and recommendations for the improvement of micro-scale flow and transport models. It will promote the organisation of workshops in order to disseminate the results of the Action.

D. Organisation

The overall duration of the Action is 4 years. During the first year the Management Committee will discuss, possibly modify and finally agree on the implementation of tasks described in the Memorandum of Understanding. During the first year, the Management Committee (MC) will supervise the establishment of WGs based on a survey of models, processes and activities to be considered within the Action. The participants would specify their contribution and goals through the Expression of Commitment scheme developed by the Technical Committee for Meteorology.

Broadly, the Action activities will have 3 phases, namely:
Phase 1 Planning, operational arrangements, establishment of WGs and inventory (year 1);
Phase 2 Main scientific work to be conducted by each WG (Years 2, 3 and parts of year 4);
Phase 3 WGs to conclude work with emphasis on reports and final publications (parts of year 4).

A dedicated preparatory phase will be implemented during the first year and will help to identify and compile the various models, datasets, applications and needs. Much of the compilation work will be conducted using the national networks of the Action's participants, internet, e-mail and questionnaires. It is envisaged that, at the beginning of the Action, two WGs would be established broadly developing the research areas described in section C, on the basis of previous and ongoing work, to provide:

- a state of the art report on former quality assurance initiatives in the field of micro-scale meteorological models, including a glossary of terms, and a first draft of the quality assurance plan for such models including a guideline for model developers with step-by-step advice on how to prepare a model evaluation protocol (WG 1), and

- a report that contains a selection of pertinent data with a clear description of the advantages and limitations of each data set for micro-scale model validation purposes, and with suggestions regarding the improvement of the existing data base in future experiments (WG 2).

When the tasks of Working Groups 1 and 2 are near the completion (expected by the end of year 1) it is anticipated that the Management Committee will establish Working Groups 3 and 4. The members of these new working groups comprise the MC-members that were already active in WGs 1 and 2 (but most likely in other individual combinations) plus additional external experts.

It has already been mentioned that different strategies for evaluating the quality of models can be regarded to be more or less suitable but not right or wrong in a scientific sense. Which particular tests and model/data set comparisons that should be made for a given model type can ultimately only be based on consensus built-up within and by the scientific and operational community. The success of the Action is therefore completely dependent on whether the quality assurance procedures suggested by the Action are accepted by the community of model developers and users or not.

Therefore, it will be essential to discuss the suggested quality assurance procedure and the use of specific data sets etc. with the developers and users of the numerical models. As a consequence there will be a modification of the documents according to their suggestions as far as possible. This will be done on a European level in order to produce a harmonised European wide accepted approach. WG3 would be tasked to disseminate the results the Action has produced so far and to organise 'Quality Assurance Workshops', either separately or (preferably) in combination with major conferences dealing with micro-scale flow and transport processes. The objective of WG 3 would be to develop common European views on the best way to enhance the quality of micro-scale meteorological models, and to combine the two drafts into a final quality assurance plan that also contains the suggested validation data base (second to the middle of fourth year).

The next logical step would be to demonstrate the applicability of the procedure. A quality assurance activity will be launched (WG4) within which the community of model developers and users would be invited to apply the procedure to their models and to prepare model evaluation protocols based on selected data sets (second to the middle of fourth year). This should be combined with a model inter-comparison exercise within which several model developers and users would simulate identical cases. Ideally this exercise should also comprise test cases for which the solution is not known (blind tests). The Actions intent is not to pillory models that perform badly or to rank the models in one way or the other. That would only block the flow of information and obstruct the scientific exchange. The differences in model results should be freely discussed and the reasons for deviant model results should be investigated. The strengths and weaknesses of particular modules, parameterisations or closure schemes should be determined. It is to be expected that the modellers will take the opportunity to test the various modules, that they will develop common views about the most appropriate set-up of micro-scale meteorological models and that, thereby, the quality standard of micro-scale meteorological models and their application will significantly improve.

In the last stage (fourth year), the documents will be brought into a final form, peer-reviewed and published. As soon as a widely accepted European standard to assure the quality of micro-scale meteorological models exists, it would be the task of the Management Committee to use its grass-root capabilities within the member states to convince not only the national agencies but also the European Commission, the European Environment Agency and the relevant Topic Centres that they should require evaluation protocols prepared according to the procedure advocated by this COST Action whenever the development, application or acceptance of such modelling tools is concerned. This would have the benefit that the majority of models would be subject to a thorough quality check accomplished in line with a harmonised European standard and undertaken by the developers or users themselves. There would be sufficient pressure on the model developers to carry out the quality assurance procedure themselves since both the sponsors of the model development work as well as the users of the models or of their results would force them to prepare an evaluation protocol. This leads to the expectation that the 'culture' within which urban air pollution models are developed and applied will be significantly improved.

E. Timetable

The three phases of the Action with their main milestones and the envisaged Working Groups activities are listed below.

Phase 1: Inventory (year 1, 12 months)

- MC: Establish initial WGs and membership and define initial work. Identification of users,
  and planning and organisation of 1st workshop.
- WG1: WG1 will jointly prepare an inventory of existing relevant models with detailed description (key components of models' infrastructure) as well as an inventory of validation approaches and a glossary of terms.
- WG2: WG2 will jointly prepare an inventory of datasets with indication of strengths, weaknesses and uncertainties. The group will identify gaps in the data and will give recommendations on how to close them.
- WG1/2 Report to the MC

Phase 2: Development, Assessment, Applications and Evaluation (years 2-4, 30 months)

- 1st workshop with proceedings and conclusions of the work for the Action.
- Establish final WGs and preparation of detailed plan of work based on outcomes of phase 1.
- WGs: Regular WG-meetings for planning, implementing, reviewing and synthesising the work.
- Report to the MC at least every 12 months on the progress of work
- MC: Short Term Scientific Missions as appropriate.
  Preparation of 2nd Workshop
  Monitoring of WG activities and advances in the field outside the Action

At the end of Phase 2 the following key achievements are expected (other deliverables are listed in section C):

- Homepage with data sets recommended for micro-scale model validation work and with suggestions for additional experiments needed to close gaps in the data base,,
- Report on the results of the model inter-comparison exercise that also documents the present state of the art in the field of micro-scale meteorological modelling.
- Critical examination of the capabilities and the limitations of micro-scale models concerning their suitability to serve as tools for environmental assessment studies,
- Consensus on ranges of applicability, strengths and weaknesses of existing models based on documented and reviewed experience.
- Identification of necessary improvements of models for specific applications.
- Recommendations for the set-up of model runs and other practical hints concerning micro-scale model applications,
- Documented guidelines for micro-scale model evaluation and evaluation protocols for those models that participated in the Actions activities,
- Recommendations for the training of model users and guidance for evaluating model results for end users and non-experts.

Phase 3: Synthesis and Dissemination of Action results (year 4, 12 months, overlapping with Phase 2)

- WGs: Finalisation of the expected outputs
- WGs: Contributions to the final report
- MC: Organisation of the Final Workshop
- MC: Completion of the final report
- MC: Dissemination of results through publications and participation in International Conferences

The following Table displays the overall time schedule for the proposed Action.

Table 1: Overall timetable of the Action

	Year 1				**Year 2**				**Year 3**				**Year 4**				
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
Phases	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	
MC-meetings	X		X		X		X		X		X			X		X	
WG-meetings			X		X		X		X		X			X		X	
Workshops							W							W			
WG reports					R		R			R		R	R	R			
Reports to TC	X				X				X				X				
Final report																	X
WWW-info pages	←			——	——			——	——			——	——			——	→
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	

F. Economic Dimension

The following countries are aware of the Action and either actively participated in the drafting of the MoU or expressed the wish to participate to the Action: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Norway, Poland, Portugal, Sweden, Switzerland, Spain, The Netherlands and the United Kingdom.

On the basis of national estimates provided by the representatives of above mentioned countries the economic dimension of the activities to be carried out under the Action has been estimated, in 2004 prices, at roughly Euro 16 million.

This estimate is valid under the assumption that all the countries mentioned above, but no other countries, will participate in the Action. Any departure from this will change the total cost accordingly.

F. Dissemination Plan

The results of the Action will be disseminated to the scientific community through the usual methods for scientific research. These will include a web site, reports, workshops and peer-reviewed publications. Particular attention will be paid to informing policy makers, i.e. to transmit the results to National and European environmental agencies, city authorities etc.

The management committee would invite a large number of developers and users of micro-scale meteorological models. All the tasks that were listed in section C would be carried out in close cooperation with them.

It can be expected that the proposed development of a well thought-out, structured and widely accepted QA-procedure for micro-scale models will greatly benefit from the combination of the different expertise of the participants and from the collaboration within the project. Teams experienced in advanced computational methods will share their skills with teams working in the field of flow and dispersion experiments and vice versa. The experimental groups will get first hand information on specific problems concerning the mathematical formulation of parameterisations. The numerical groups will profit from the fact that they will take part in selected measurement programmes that will give them a clear understanding of the reliability of the data and its inherent uncertainty. Another important aspect of the collaboration will be the exchange of experience and working contacts between the groups operating mainly in the field of research (universities) and the teams having their experience in practical applications of models (consultancies and governmental agencies).

The models under discussion here are sophisticated tools that are often developed and applied by young scientists who come into contact with them during their PhD work. The training aspect of the project will involve these young academics and bring them into contact with quality assurance philosophies. This will make them more self-critical concerning the results they achieve with their model simulations and will give them structured and helpful step-by-step guidance on how to test the quality of their models in a systematic way.

The final workshop of this Action will be used for disseminating the results especially among potential users and for promoting COST-activities in Europe and worldwide. Special efforts will be made to invite external keynote speakers and to publicise the Workshop outside the Action.

Wherever possible the Action will host workshops jointly with other international meetings. These will include:

- Urban Air Quality Conferences
- European Meteorological Society annual meetings
- Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes
- NATO/ITM Conference on Air pollution Modelling and its Application.

Particular links will be formed and pursued with all the projects and initiatives mentioned in Section A. A special effort will be made to involve a representative from the CAFÉ Programme from DG-ENV at the EC, in order that the outputs of the Action will support its objectives especially:

1. to develop, collect and validate scientific information relating to the effects of outdoor air pollution, emission inventories, air quality assessment, emission and air quality projections, cost-effectiveness studies and integrated assessment modelling, leading to the development and updating of air quality and deposition objectives and indicators and identification of the measures required to reduce emissions;

2. to support the implementation and review the effectiveness of existing legislation, in particular the air quality daughter directives, the decision on exchange of information, and national emission ceilings as set out in recent legislation, to contribute to the review of international protocols, and to develop new proposals as and when necessary;

3. to ensure that the sectoral measures that will be needed to achieve air quality and deposition objectives cost-effectively are taken at the relevant level through the development of effective structural links with sectoral policies;

4. to determine an overall, integrated strategy at regular intervals which defines appropriate air quality objectives for the future and cost-effective measures for meeting those objectives;

5. to widely disseminate the technical and policy information arising from implementation of the programme.

Additionally, the European Environment Agency (EEA), its Topic Centre on Air Quality and Climate and bodies on national level with corresponding tasks will be asked to require evaluation protocols according to the recommendations of this COST Action whenever they hand out contracts that require the use of micro-scale meteorological models.

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“QUALITY ASSURANCE AND IMPROVEMENT OF MICRO-SCALE METEOROLOGICAL MODELS”

ADDITIONAL INFORMATION
NOT PART OF THE MOU

PART II: ADDITIONAL INFORMATION

The idea for an activity on quality assurance and improvement of micro-scale meteorological models originates from discussions within EUROTRAC SATURN "Studying Atmospheric Pollution in Urban Areas", COST Actions 615 to 618 "Better Air for European Cities" and COST Action 715 "Meteorology Applied to Urban Air Pollution Problems". It was felt that the use of increasingly complex models should be paralleled by a quality assurance initiative that would provide standards for a structured model evaluation procedure and would promote common views for further model improvements. There was the unanimous belief that such an initiative should be established at least at European level in order to protect it from too narrow views or specific national or economic interests. On the other hand it appeared to be necessary to focus on a narrow range of models in order to be sufficiently specific and thus of real help to the community of model developers and users. The micro-scale meteorological models appeared to be a suitable choice since this type of model is relatively new and is just emerging from research laboratories for operational use, also because European legislation provides the ground for the wide-spread application of these models, and last but by no means least because the data availability at the micro-scale is excellent in comparison to other scales. These favourable conditions should be utilised to demonstrate that such an initiative can be successful and that a substantial step forward towards better models and their proper application can be made.

Once the initiative proves to be successful, it can be expected that parts of the methodology developed by the Action can, with some adjustment and the provision of other data, be applied to other model types and areas of application as well.

The following scientists have participated in the drafting of the Technical Annex of the MoU or expressed their interest in participating in this COST Action:

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These scientists are well-known in the community and have gained substantial experience in managing large multidisciplinary national and European projects. They would be prepared to form the core group of this COST Action. None of them have a financial interest in the promotion of a particular micro-scale meteorological model, so they can act as unbiased referees.

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