2.03 MODELLING TECHNIQUES FOR AIR QUALITY ASSESSMENT AND MANAGEMENT IN ITALY: THE WORK OF THE NATIONAL TOPIC CENTER

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INTRODUCTION

The Italian National Topic Centre on Atmosphere Climate and Emissions in air (CTN-ACE) was founded in 1999 by the Italian National Environmental Agency (APAT, formerly ANPA), the Italian Regional Environmental Agencies (ARPA) and several research institutions participate to the activities. CTN-ACE, since its foundation, has been working to produce and review guidelines for several topics related to air quality, one of these topics is air quality modelling.

Modelling is one of the main tools to evaluate air quality and to prepare plans and programmes, as requested by the framework EU Directive on air quality assessment and management (96/62/EC) and related "daughter" directives. Therefore the main task of the CTN-ACE working group on air quality modelling is to prepare the national guidelines for models application.

PRESENT GUIDELINES IN ITALY

A review on model applications in Italy, performed by the Italian working group during 1999-2000, put into evidence that modelling techniques are scarcely applied in the daily working routine by environmental agencies and local authorities; modelling received poor founding and was scarcely supported. Most models users indicated that it was often difficult to prepare the input data. Therefore the first stage of the work of the CTN-ACE was focused to produce reports and a web site to support the models users to choose the models to apply, to prepare the input data, correctly run the model and to evaluate the results. The four reports and the web pages are briefly described in the following. The guidelines are downloadable from the web and are available from the Italian national agency APAT as printed reports in Italian language. The Italian law concerning guidelines about air quality assessment (DM 1 October 2002 n. 261 Annex I) include the web site, prepared by the CTN-ACE as a technical reference.

The report contents

The first two reports released by CTN-ACE in 2000 and 2001 described the main features of air quality models to be applied in the preliminary assessment of the air quality (*Desiato F., Brusasca, G., et al.,* 2000) and presented a review of photochemical models for simulating tropospheric ozone, with special regards to the Italian experiences (*Deserti, M., Spagli, L., et al.,* 2001). They are addressed to users who approach air quality modelling for the first time. The next report (*Lollobrigida, F., Brusasca,G., et. al.,* 2001) is a methodological guideline which describes in detail the models applicable for each air quality scenario, the input data required, the computational needs, the kind of output data and their post-processing. The last report about the preparation of input data for modelling (*Deserti, M., Angelino, E., et. al.*,

2001) deals in depth with the input data pre-processing for 3D numerical models and is aimed to provide useful information to overcame the main difficulties that model users runs.

The web contents

During year 2000 CTN-ACE issued the first release of a hyper textual guide to air quality models selection. This guide, available at the address: http://www.sinanet.anpa.it/aree/atmosfera/, is included into SINAnet, the website of the National Environmental Information System (SINA). SINAnet is coordinated by APAT and aimed at harmonizing and integrating the environmental information. The hyper textual guide was updated in 2001 and 2003. The last release includes :

- an introduction to air quality modelling, which describes basic concepts;
- a list of air quality models, which were selected on the basis of main Italian experiences;
- a description of the meteorological input data pre-processing, containing basic concepts and including links to the COST actions 710 and 715;
- a part describing the emissive input data pre-processing;
- didactic documents, referred to training courses organized by CTN-ACE and to all the technical reports named above.

For each model the guide provides some basic information, a link to the international databases (such as MDS and EPA-SCRAM) and/or to the web site containing more detailed information, and a description of the model availability (open source or commercial). Some examples describing the models application in Italy are included.

PREPARING THE NEW GUIDELINES

In the most recent period the activities carried out by the working group on modelling have been undertaken with the final goal to provide all the information on modelling techniques required by the EC directives. The framework Council Directive 96/62/EC prescribe (art.4) that when limit values and alert threshold are set, the reference techniques and the spatial resolution for modelling should be established. The daughter directive 1999/30/EC annex VIII and the ozone Directive 2002/3/EC annex VII, define the data-quality objectives for the required accuracy of modelling. The 1999/30/EC was received in Italy by DM 2 aprile 2002 n. 60, while the ozone directive is not received at present time. Therefore the ongoing work is now focused to produce more detailed guidelines on models applications, indicating the reference techniques and the spatial resolution for modelling and, above all, evaluating the uncertainty of models to be applied.

The reference techniques and the spatial resolution for modelling

To meet the law request it is then necessary to define the models that can be employed, with regards to the air quality assessment and management and to the environmental impact assessment, and to quantify the uncertainties in their application. Concerning the spatial resolution, the approach was to consider two different spatial scales for models application: the local scale and the regional scale.

- the local scale models, are mainly considered to simulate generic passive pollutants for AQ evaluation and impact assessment in the urban areas and industrial agglomerates;
- the large regional scale models are mainly considered for simulating chemically reactive pollutants and particulate matter and are used for AQ evaluation in large urban areas and in the whole country.

Then, as described above about the web site, a first list of models applicable to each spatial scale was compiled. Among the models that are well documented and distributed, the models

applicable for long term simulations (6/12 months) of all the pollutants for which a reference level was fixed by law, were considered. Long term runs are requested because the AQ reference levels in most cases are expressed as annual or seasonal mean or exedeences. A maximum 1h/24h time step is recommended because this is the standard averaging period respectively for gaseous and particulate pollutants. A further criterion adopted in the compilation of the model list was to consider the models for which some successful and well documented application was available for Italy. This criterion arise from the consideration that, to be useful for practical purposes, the technical guidelines should contain operational procedure that can be derived only from practical experiences, analyzed in detail.

Evaluating the uncertainty of models

The main method to quantify the uncertainty of modelling techniques is to realize a well designed and documented model inter comparison exercise. Several exercises are been realized in the last years, but only few were specifically focused on evaluating the uncertainty in model application for the air quality evaluation purposes. Among these, recent exercise are the EUROTRAC (http://www.gsf.de/eurotrac) and CityDelta (http://rea.ei.jrc.it/netshare/thunis/citydelta). In an inter comparison exercises, to insure the results comparability, all the models should be applied in the same conditions and evaluated on the same criteria. The first step of the work is therefore to prepare a common data set containing the input data needed to run the models and evaluate the results. Because the results of a model application can differ depending from the set up and control parameters chosen, it is recommended that the same model is applied by different users. Then the data set should be distributed to the largest possible group of modellers and left open for a certain time, in order to increase the number of application that can be used to evaluate the range of results.

During 2003, CTN-ACE prepared a first data set to evaluate the local scale models outputs with regards to data-quality targets values established by the Italian law and EU directives, as concerns modelling techniques aimed at air quality assessment. A middle-sized urbanised area of 200.000 inhabitants situated in Northern Italy has been chosen. Most of the 12 x 12 km^2 domain is located in the flat land, even if the foothills of the Alps cover a little portion of the area to the north and north-east. Emission sources include some point and linear sources. The linear sources are related to a road network that has a total extension of about 650 km, divided into about a thousand road links. Emissions has been computed by COPERT III-CORINAR methodology as described in *Nava E. and Angius S.P.* (2001). Respectively 6 and 2 point sources have been included for NOx and CO simulation. Meteorological data have been obtained by means of the diagnostic meteorological model CALMET simulation. CALMET, as described in *Deserti, M., Cacciamani, C., et. al.* (2001), was applied to a set of surface data from the air quality monitoring network and upper data from synop and Linate airport sounding, while ECMWF data for initial wind field have been used. Meteorological single point data have been extracted from the three-dimensional wind field and the two-dimensional micrometeorological variables fields. The simulation period is 1999. The exercise dataset comprises hourly NOX and CO concentrations collected during the simulation period at the monitoring station located in the core of the domain, but not strongly influenced by vehicular traffic induced emissions.

In 2003 a preliminary test was performed by CTN-ACE workgroup applying two air quality models to the data set. The models used are available for routine applications among the institutions belonging to CTN-ACE and are ARIA Impact (developed by ARIA Technologies) and ADMS-urban (developed by Cambridge Environmental Research

Consultants Ltd). Both of them allow to process a one-hour resolution meteorological input dataset and a wide number of emissive sources, in order to compute yearly averaged atmospheric concentrations. The performed simulations assumed that pollutants are not reactive. Table 1 shows the main results with regards to NOx. In table 1 C.Y.A. indicate the computed NOx yearly average expressed as NO_2. M.Y.A. indicate the measured NOx (as NO_2) yearly average; Diff. % indicate ((M.Y.A. - C.Y.A)/M.Y.A.)*100 and Max Diff % indicate the maximum value of Diff%, according to Directive 1999/30/EU.

Table 1: some results of local scale models comparison.

Model	***C.Y.A*** ($\mu g/m^3$)	***M.Y.A*** ($\mu g/m^3$)	***Diff. %***	***Max Diff %***
ADMS Urban	107	138	23	30
ARIA Impact	102	138	26	30

From the table one can see that both models underestimates the measured concentrations, but in both cases the uncertainty satisfy the data-quality objectives set by the EU Directive, that require a 30 % accuracy for the annual averages.

A further data set to evaluate the large scale Chemical Transport Models (CTMs) will be prepared during 2004. The data set will contain all the data needed to apply CTMs to two Italian domains: the Po Valley (BPA) and a southern Mediterranean area (Med). Po valley was chose as models application domain because in the past most of the modelling experiences in Italy were performed on that heavy polluted and densely populated area. Therefore a large amount of data is available. Nevertheless strong ozone pollution has been often observed in the Mediterranean areas where the features of meteorology and pollution dynamics require a special attempt. At present time few modelling exercise included any target area in the south Mediterranean Europe, therefore a modelling exercise on a Mediterranean area will be promoted, in order to stimulate the growing of models applications in southern Italy. At present time the work is focused on checking and collecting the data, in order to define the better model's application domains.

The two data sets, to evaluate local scale and large scale models, will be open in the next future to developers and users interested to test their models. The participants to the exercise will be asked to provide their results to the CTN-ACE workgroup, according to a common protocol. CTN-ACE workgroup will review all the results and prepare the guideline report. The report will include a detailed description of input dataset, specifications of air quality models, a description of results with regards to law requirements and recommendations about air quality modelling at local scale and large scale.

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