SMEDIS: Scientific model evaluation of dense gas dispersion models

Introduction

SMEDIS is an ongoing EU research project funded under the Environment and Climate RTD Programme for the period 1996-1999. Its main objective is to develop a methodology for the scientific evaluation of dense gas dispersion (DGD) models, and to test this methodology by actually carrying out the scientific evaluation of a large number of DGD models currently available in Europe. The project is focusing on situations in which complex effects such as aerosols, topography and obstacles are important as well as "simple" situations.

The project is coordinated by the Health and Safety Executive (HSE, UK) with two other main partners, Cambridge Environmental Research Consultants (CERC, UK) and Electricité de France (EDF, F). There are also ten associated partners participating in the project : BG, DNV Research, Finnish Meteorological Institute, Gaz de France, JRC Ispra, NCSR "Demokritos", Riso National Laboratory, TNO, University of Hamburg and WS Atkins. Additionally, a number of external sponsors contribute both financially and technically to the project.

The origin of this project dates back to previous model intercomparison work carried out in the framework of the cooperation agreement between UK AEA and France CEA (Brighton *et al.*, 1994) and from more recent activities offrom a subgroup of the MEG, the Heavy Gas Dispersion Expert Group (HGDEG). This group has adapted the general guidelines of the MEG by drawing up a list of heavy gas dispersion models, identifying data sets, makingfurther developing the protocol more specific to the type of model and conducting an informal open exercise to test this protocol. This open exercise comprised the distribution of a limited number of data sets to interested participants followed by an attempt to carry out a statistical analysis of returned model predictions. Details and experience of this limited exercise are given by Cole & Wicks (1995) and the work of the HGDEG is described by Duijm *et al.* (1996).

The SMEDIS project is considering approximately 30 models for evaluation (some of which were included during the course of the project). The project differs from previous work in this area in that each model will be the subject of a two-stage evaluation process concentrating on complex dispersion effects such as the influence of aerosols and the presence of buildings or complex terrain. The first stage of the evaluation will comprise a validation exercise in which the predictions of each model,

initially assigned to one of the partners, will be compared with experimental data for up to 30 different cases. The second stage of the evaluation will consist of a scientific assessment in which both the physical basis and solution procedure of each model will be examined and tabulated.

Brief Description of the Project

The main milestones of the project are as follows :

- establish a protocol for the evaluation
- collect information on models
- carry out the scientific assessment of each model
- select data sets for the validation and process the selected data
- define procedures to conduct models runs and perform statistical analysis of results
- carry out the validation of each model
- revise the protocol (feedback)
- produce final report and disseminate results

It should be emphasized that these milestones and indeed the entire evaluation procedure is based on a consensus arrived at by all parties.

The protocol developed for SMEDIS has been based on the protocol proposed by the HGDEG, which is itself consistent with the MEG protocol. Comments from participants in the project have been included and as a consequence it goes into more specific details, particularly in the scientific assessment of each model. The "working version" is being used in the conduct the rest of the project.

The collection of information on each model has been obtained by means of two questionnaires. The first of these seeks preliminary information on each model, providing a summary of the capabilities of the model and the main characteristics of its (computer) implementation. This was useful in choosing data sets and developing the validation procedures. The second questionnaire requests the detailed information required for the scientific assessments. This latter information is handled by means of documents describing the different aspects of the model; the information suppliers provide copies of the documents and cross-reference them with the required aspects. All information is supplied by the responsible partner.

The scientific assessment is carried for each model by CERC, based on the information collected from the relevant partner. The headings and content of the

evaluation report have been defined in the protocol. Each report is agreed with the model developer. Currently one complete report has been circulated and commented on by all partners and the reports for approximately one-third of the remaining models are in preparation.

Identification of suitable data sets for the model validation was carried out with input from all participants. First a preliminary list of over 40 data sets and corresponding references was prepared by collecting information from partners. Based on this preliminary list, a detailed questionnaire was sent to all partners to obtain information about the data sets, including previous use of the data for model validation, availability of data and an opinion of the user on the data set quality in several areas, e.g. source specification and concentration measurements. The replies were then analysed to produce a priority list of data sets which had been previously used for the validation of a range of models, including integral and CFD models, and were judged of sufficient quality by the participantsThere turned out to be relatively few high quality data sets available for validation in these complex situations. A provision was made to include more recent data sets, which had not already used for validation, as the project progressed, including data sets for which near-field effects are important.

Before starting the model runs it was necessary to agree on the procedure to conduct the model runs and the parameters to be used in the statistical analysis. As far as the physical parameters are concerned, two different approaches have been adopted:

(a) pointwise comparisons - a comparison based on values at individual sensors (time-average concentration for continuous releases, dose and arrival/departure times for instantaneous releases);

(b) arcwise comparisons - a comparison of values based on sensor arcs (maximum centreline concentration and plume width for continuous releases, maximum concentration and corresponding time for instantaneous releases).

These choices were made taking into account a number of factors, including the cloud properties, the range of models and their capabilities and the limitations of the selected data sets.

Statistical comparison techniques are then applied to these physical parameters for each case being simulated by means of selected statistical measures to compare the model results and experimental values. These measures have been carefully selected and extensively discussed within the project.

The data sets were then prepared and distributed to participants as spreadsheets containing the input necessary for the models (geometry, release conditions, etc.), together with the measured experimental values, such as concentration and temperature.

Empty templates were also provided to return model results. This procedure allows automatic treatment of model results. Although all data sets are circulated to all participants, the minimum number of cases which each model is expected to simulate depends on the type of model: for screening tools/integral models, shallow layer models and CFD models, the expected number of runs is approximately in the ratio 10:5:2, due to the different resource requirements of the models. Two-thirds of the data sets have been prepared and distributed.

After the completion of the scientific assessment of all models and the validation with all data sets in SMEDIS, two important tasks remain. The first is to revise the protocol in the light of the experience gained in the project. The second is the dissemination of the project results : this will be achieved through an open workshop towards the end of 1999 and a Web site early in 1999.

REFERENCES

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