Atmospheric Dispersion Modeling System (ADMS)

Reference

Carruthers, D.J., R.J. Holroyd, J.C.R.Hunt., W.-S. Weng, A.G. Robins, D.D. Apsley, D.J. Thompson and F.B. Smith, 1994. UK-ADMS: A new approach to modelling dispersion in the earth's atmospheric boundary layer. *Journal of Wind Engineering and Industrial Aerodynamics*, 52: 139-153. Elsevier Science B.V.

ADMS 3 – User Guide

Availability

The model code is available on diskette or CD from Cambridge Environmental Research Consultants (CERC), 3 King's Parade, Cambridge, CB2 1SJ. UK. Tel: 00 44 1223 357773, Fax: 00 44 1223 357492, *e-mail*: adms@cerc.co.uk

Abstract

ADMS is an advanced model for calculating concentrations of pollutants emitted both continuously from point, line, volume and area sources, or discretely from point sources. The model includes algorithms which take account of the following: effects of main site building; complex terrain; wet deposition, gravitational settling and dry deposition; short term fluctuations in concentration; chemical reactions; radioactive decay and γ-dose; plume rise as a function of distance; jets and directional releases; averaging time ranging from very short to annual; condensed plume visibility; meteorological preprocessor.

a. Recommendations for Regulatory Use

The model can be used for the following regulatory purposes:

- multiple buoyant or passive industrial emissions
- urban or rural areas
- flat or complex terrain
- transport distances less than 50km
- short term (seconds) to annual averaging times

b. Input Requirements

Source data: location, emission rate, physical stack height, stack gas exit velocity, stack inside diameter, and stack gas temperature. Operational inputs include source elevation, building dimensions, particle size distribution with corresponding settling velocities, and surface reflection coefficients.

Meteorological data: hourly surface observations for input into the meteorological preprocessor and/or boundary layer parameters (boundary layer height, Monin-Obukhov length, surface heat flux, etc).

c. Output

Concentration for specified averaging times at receptor points or on an output grid: averages of concentration over a specified period and percentiles of these averages. Short and long term averages of wet, dry and total deposition and radioactive activity. Number of exceedences of specified standard by ensemble mean concentration and by concentration calculated taking account of short term fluctuations. Output for short term fluctuations, percentiles, PDF, toxic dose.

Advanced graphical output: line plotting of centreline variables and link to a contour plotting package.

d. Type of Model

The model is an advanced Gaussian type model using a Gaussian distribution for the concentration except for the case of the vertical distribution in unstable conditions when a skewed Gaussian is employed (Carruthers *et al.*, 1991). Plume spread is calculated using local boundary layer variables.

e. Pollutants Types

May be used to model primary pollutants and continuous releases of toxic and hazardous waste products. Settling and wet and dry deposition are treated. Radioactive decay is calculated.

f. Source Receptor Relationship

Up to 50 receptors may be specified in addition to an output grid with regular or variable spacing (up to 2048 gridded points).

g. Plume Behavior

ADMS uses a Lagrangian plume rise model, a buildings effect model based on a two plume approach, using wake averaged flow values to calculate plume spread (Robins *et al.*, 1997) and a complex terrain module based on the linearised airflow model FLOWSTAR (Carruthers *et al.*, 1988).

h. Horizontal Winds

A steady state wind is assumed for each hour; this varies in the vertical according to specified boundary layer profiles and in the horizontal plane when the boundary or complex terrain algorithm is employed.

i. Vertical Wind Speed

Vertical wind speed is zero except when the buildings or complex terrain algorithms are employed.

j. Horizontal Dispersion

Horizontal dispersion parameters are locally (at mean plume height) derived from the calculated horizontal components of turbulence.

k. Vertical Dispersion

Vertical dispersion parameters are locally derived from the calculated vertical component of turbulence and the buoyancy frequency.

l. Chemical Transformation

A generic reaction set is employed to calculate the interaction of NO, NO_2, and O_3 (McHugh *et al.*, 1997).

m. Physical Removal

Dry deposition effects for particles are treated using a resistance formulation in which the deposition velocity is the sum of the resistances to pollutant transfer within the surface layer of the atmosphere, across the laminar sublayer and onto the surface, plus a gravitational settling term. For gases the surface layer resistance is calculated as a function of the nature of the gas: reactive, unreactive or inert. Wet deposition is calculated making use of a specified washout coefficient which may be rainfall rate dependent.

n. Evaluation Studies

Carruthers, D.J., C.A. McHugh, A.G. Robins, B.M. Davies, D.J. Thomson and M.R. Montgomery, 1994. The UK Atmospheric Dispersion Modelling System: Comparisons with data from Kincaid, Lillestrøm and Copenhagen. *Proceedings of the Workshop Intercomparison of Advanced Practical Short-Range Atmospheric Dispersion Models,* 1993. Manno, Switzerland. C. Cuvelier, Ed.

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Carruthers, D.J., H.A. Edmunds, A.E. Lester, C.A. McHugh and R.J. Singles, 1998. Use and Validation of ADMS-Urban in Contrasting Urban and Industrial Locations. *Proc. 5th Int. Conf. on Harmonisation Within Dispersion Modelling for Regulatory Purposes*. pp. 360-367

Carruthers, D.J., A.M. McKeown, D.J. Hall and S. Porter, 1999. Validation of ADMS against Wind Tunnel Data of Dispersion from Chemical Warehouse Fires. *Atmos. Env.*, **33**: 1937 - 1953.

o. Literature Cited

Carruthers, D.J., J.C.R. Hunt and W.-S. Weng, 1988. A computational model of stratified turbulent airflow over hills - FLOWSTAR I. *Proceedings of Envirosoft*. In: Computer Techniques in Environmental Studies. P. Zanetti (Ed.), pp. 481-492. Springer-Verlag.

Carruthers, D.J., R.J. Holroyd, J.C.R. Hunt, W.-S. Weng, A.G. Robins, D.D. Apsley, F.B. Smith, D.J. Thomson and B. Hudson, 1991. UK Atmospheric Dispersion Modelling System. *Proceedings of the 19th NATO/CCMS International Technical Meeting on Air Pollution Modelling and its Application*. September 1991, Crete, Greece. Han van Dop and George Kallos, Eds. Plenum Publishing Corporation, New York.

McHugh, C.A., D.J. Carruthers and H.A. Edmunds, 1997. ADMS and ADMS-Urban *Workshop on Operational Short-range Atmospheric Dispersion Models for Environmental Impact Assessment in Europe*, Mol, Nov. 1994. *Int. J. Environment and Pollution*, 8(306): 437-440.

Robins, A.G., D.J. Carruthers and C.A. McHugh, 1997. The ADMS Building Effects Module. *Int. J. Environment and Pollution*, Vol 8, Nos. 3-6.