Compendium
of
Air Quality Related Models 1991

Ozone Research Center Report ORC910101

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Notation:
- indicates ‘‘comprehensive’’ Air Quality Models
- indicates ‘‘component’’ and/or auxiliary models
   ○ indicates special category of models
   * indicates model developers
* refers to separate entry in the list

Note:
The list of models that follows, although quite extensive, is neither complete nor final. This list will be extended, updated and improved in upcoming versions of the Compendium of Air Quality and Related Models that will be available through the Ozone Research Center at EOHSI. In the present draft the descriptions provided for some of the models are not complete due to time limitations in the preparation of this compendium. Furthermore, instead of a primary reference for some models a “secondary” reference such as a models catalog, a guidelines document, or a review report or article, is given, that, in addition to basic information, will also contain primary references for the model under consideration. Future revisions of this compendium should be expected to contain descriptions of all listed models and a complete list of primary references.
- **ACID** (U. of Michigan) (ARB-1989 “alternative”)

  *Atmospheric Contributions to Interregional Deposition*
  2D forward and backward trajectory sequentially long term, regional scale model with linear sulfur chemistry (see also the California ARB 1989 Guidelines for additional information)


- **ACS-ESC** (Acres Consulting Services, Ltd.)

  grid-based regional scale model for inert (or linearly reactive) pollutants


- **ADEPT** (EPRI)

  *Acid DEPosiTion decision framework*

  a control strategy model: decision tree framework for comparison of acid deposition control and mitigation strategies

• **ADOM, ADOM/TADAP**
  *(ARB-1989 “emergent”)*
  *(ERT, Inc.)*
  Acid Deposition and Oxidant Model
  2D or 3D grid based, episodic, continental scale model with HC, NO$_x$, SO$_x$ chemistry (including sulfate and nitrate aerosol formation); handles aqueous phase photochemistry (see also the California ARB 1989 Guidelines for additional information)

  ERT (1984, 1985) ADOM/TADAP Model Development Program, Vols. 1 to 8, Environmental Research and Technology, Inc., Concord, MA, and Camarillo, CA

• **ADPIC, MATHEW/ADPIC**
  *(Lawrence Livermore N.L. for U.S. D.O.E.)*
  Atmospheric Diffusion Particle In Cell
  3D hybrid (grid/trajectory – particle-in-cell method), short term, mesoscale model for inert (or linearly reactive) pollutants;
  Notes: ADPIC is an improved extension of PICK/NEXUS*; MATHEW* is a wind field preprocessor


• **AERAD**
  *(WNRE, Canada)*
  Atmospheric Environment, Radioactivity and Dose
  analytical (Gaussian plume) micro- to mesoscale model for radioactive (linearly decaying) pollutants


• **AERAM**
  *(EPRI)*
  Air Emission Risk Assessment Model
  analytical (Gaussian plume) micro- to mesoscale, long term model for inert (or linearly reactive) pollutants; intended for emission risk assessment calculations; uses dispersion formulation of ISCLT*

  Kowalczyk G.S., Gratt L.B., Ricci P.F. (1987) An air emission risk assessment for Benzo(a)pyrene and Arsenic from the Mt. Tom power plant,” JAPCA, 37, 361-369
**Aerosol Coagulation Model**

(Lawrence Livermore N.I.)

accounts for aerosol coagulation because of collisions due to Brownian motion, turbulent motion, laminar shear flow, and sedimentation; has been applied as a 1D trajectory model


**Aerosol Dynamics Models**

see Aerosol Coagulation Model, AGRO, COAGUL, CONFEMM, ESMAP, MAEROS

**Aerosol Thermodynamics Models**

see EQUIL, KEQUIL, SEQUIL, MARS

**AeroVironment Models**

see AVACTA, AVACTA II, AVCCM, AVKERN, AVPLUM, AVQUAL, AVMSTM, KAPPA-G, K-GAUSS, LAGPAR

**AES (Atmospheric Environment Service, Ontario, Canada) Models**

see AES-LRT (routine), AES-LRT (research)

**AES-LRT (routine)**

(AES, Canada)

AES-Long Range Transport

1D forward trajectory (horizontally resolved), sequentially long term, regional to synoptic scale model with linear SO$_2$, SO$_4^{2-}$ chemistry


**AES-LRT (research)**

(AES, Canada)

AES-Long Range Transport

as in AES-LRT (routine) but with linearized sulfur and nitrogen chemistry and PAN chemistry

AGRO (Aerosol Module)

*Aerosol GROWth*
simulates evolution (by coagulation and condensation) of a continuous, parameterized, bimodal aerosol size distribution


**AIRDOS II**
(U.S. Environmental Protection Agency)
superseded by AIRDOS-EPA*


**AIRDOS - EPA**
(U.S. Environmental Protection Agency)
analytical (Gaussian plume) statistical (climatological) long term model for radioactive (linearly decaying) pollutants


**AIRPOL-4**
(Virginia Highway and Transport Council)

*AIR POLLution model*
analytical (Gaussian plume) micro- to mesoscale short term model for inert (or linearly reactive) pollutants from line (traffic) sources


**AIRPOL-4A**
(Virginia Highway and Transport Council)

*AIR POLLution model*
enhanced version of AIRPOL-4

• **AIRSHED**
  
  predecessor versions of the Caltech (CIT-GRID*) and Systems Applications, Inc. (current version: UAM*, EPA-1986 “preferred”) grid-based models (see refs. to UAM*, CIT-GRID*)
  

• **AIRSOX**
  
  (Brookhaven N.L.)
  
  Atmospheric Input of Residual SOx
  
  quasi 3D (multilayer, Gaussian profile horizontally) forward trajectory, short term or sequentially long term, regional to synoptic scale model with linear SO₂, SO₄²⁻ chemistry
  

• **AIRTOX**
  
  (Paine et al.)
  
  heavy gas dispersion model
  

• **Air Weather Service Vaporization Model**
  
  (Air Weather S.)
  
  see AWS Vaporization Model*
  
  see ref. in AWS Vaporization Model*

• **Alabama Dept. of Environment Models**
  
  see COMPTER

• **Alberta Environment (Edmonton) Models**
  
  see SULDEP2, WILSON

• **ALOHA**
  
  (N00A)
  
  Areal LOCations of Hazardous Atmospheres
  
  Gaussian plume model for chemical spills with graphics interface (Macintosh-based)
  
  JAPCA (1987) Microcomputer Software Reviews, p. 946
o ALW (Chemical Mechanism) (ERT, Inc.) Atkinson, Lloyd and Winges mechanism
see ERT and SAPRC Chemical Mechanisms*
■ see ref. in ERT Chemical Mechanism*

• ANDEP (Pacific Northwest Lab.)
analytical statistical (climatological) long term trajectory model for inert (or linearly reactive) pollutants

o Anderson’s (Wind Field Module) (Center for Environment and Man)
diagnostic mesoscale wind field model

• Andresen’s model (Purdue U.)
analytical (solution of the Atmospheric Diffusion Equation) steady state mesoscale model with linear sulfur chemistry; for point sources

o AP-42 Emissions Estimation Procedures (U.S. Environmental Protection Agency)
documents providing emissions rates estimates from stationary point and area sources as well as from motor vehicles; the calculation procedures and emission factors contained in volume II (Mobile Sources) are incorporated in MOBILE4*

• APAMAX (Lukey & Allison)
analytical (Gaussian plume) micro- to mesoscale model for inert (or linearly reactive) pollutants from point sources
* Applied Modeling Inc. Models
  see CDMOCS, PTMOCS, TRACE

• APRAC-3
  (U.S. Environmental Protection Agency, Region IX)
  (EPA-1986 “alternative”, was part of UNAMAP-6)
  Air Pollution Research Advisory Committee model
  analytical (straight line, hourly steady state) Gaussian, short term (1 hr), micro- to mesoscale plume model for inert pollutants from traffic systems (line sources)
  - U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

• APRAC - other versions (1A, 2)
  (SRI, U.S. EPA - Region IX)
  Air Pollution Research Advisory Committee model
  superseded by current version of the guidelines model APRAC-3

• AQAT
  (CARB)
  Air Quality Analysis Tools
  software package for MS-DOS compatible PCs; includes EMFAC7PC (for calculation of emission factors), URBEMIS (for calculation of total emissions from motor vehicle traffic), CALINE4 (for dispersion calculations - with CALINPUT as input preprocessor) and PIVOT POINT (for study of mitigation strategies)
  - JAPCA (1986) Microcomputer Software Reviews, p. 1042

• AQDM
  (TRW)
  (EPA-1986 “alternative”)
  Air Quality Display Model
  analytical statistical (“climatological”), long term, micro- to mesoscale, Gaussian plume model for inert (or linearly reactive) pollutants; appropriate for urban areas
  - U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R
• AQSTM  
(Illinois E.P.A.)
analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model


○ ARAP  
(Aero. Research Assoc. of Princeton, Inc.)
Aeronautical Research Associates of Princeton
2nd order closure, grid-based microscale model that simulates plume rise (either buoyancy or momentum dominated) for inert pollutants; rather complex for routine regulatory use


★ Argonne National Laboratories Models
see ARGONNE, ASTRAP, STRAP

○ ARGONNE  
(Argonne N.L.)
2nd order closure, grid based, mesoscale model that simulates rise of buoyant plumes from large cooling ponds; rather complex for routine regulatory use


• ARIAM  
(ERT, Inc.)
Acid Rain Impact Assessment Model
quasi 2D (Gaussian profile horizontally) regional scale, long term forward trajectory model with linearized sulfur and nitrogen chemistry


★ ARL (Air Resources Laboratories, NOOA) Models
see ARL/ATAD, ARL/BAT, ARL/MLATAD, ARL/MS, MTDF, MTDM
• ARL/ATAD  
**ARL/Atmospheric Transport and Dispersion**  
quasi 2D forward trajectory, (Gaussian horizontal profile) short term, regional to synoptic scale model for inert (or linearly reactive) pollutants; extensively used as a trajectory generator for long range transport modeling  


• ARL/BAT  
**ARL/Branching Atmospheric Trajectories**  
quasi 3D forward trajectory (3 layers, Gaussian profile horizontally), short term, regional scale model for inert (or linearly reactive) pollutants  


• ARL/MLATAD  
**ARL/Multilayer ATAD**  
2D (multilayer, expanding control volume) short term, regional scale forward trajectory model for inert (or linearly reactive) pollutants  


• ARL/MS  
**ARL/MesoScale**  
2D trajectory (vertically resolved), short term, mesoscale model for inert (or linearly reactive) pollutants  


• ARRP/A  
**(EPA-1986 “alternative”)**  
**Air Resources Regional Pollution Assessment Model**  
segmented (horizontally uniform sectors/ vertically Gaussian analytical expressions) short term, mesoscale plume model for inert (or linearly reactive) pollutants; incorporates BLM*  

- U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R
- ASM (Cloud Physics Module) (EPRI)
calculates cloud and precipitation distributions and interconversion rates; incorporated in STEM-2*; same as PLUVIUS*
- ASTRAP (Argonne N.I.)
quasi 3D (multilayer, Gaussian profile horizontally) statistical trajectory; long term, mesoscale to regional scale model with linearized sulfur and nitrogen chemistry
- ATDL NOOA Models
  - see ATDL, ATM
- ATDL (-1, -2, -3) (ATDL, NOOA)
  Atmospheric Turbulence and Diffusion Laboratory model
  various versions of a grid-based, “multibox” model; (early versions based on a “simple box” trajectory concept); superseded by more realistic formulations
- Atkins Research Models
  - see HEAVYGAS
- ATM (ERT, Inc.)
  Atmospheric Transport Model
  trajectory model with linearized sulfur chemistry
• **ATMOS** (Los Alamos N.L.)
  superseded by ATMOS2

  • **ATMOS (Chemical Mechanism)** (Brookhaven N.L. Lawrence Livermore N.L.)
    ATMOSpheric model for Sulfur
    30 step gas phase chemistry mechanism for SO\textsubscript{2} oxidation; includes NO\textsubscript{x}/RHC kinetics

  • **ATMOS1 (Wind Field Module)** (Los Alamos N.L.)
    3D (with terrain-following, normalized, vertical coordinate) diagnostic mesoscale wind field model; it uses the continuity equation/variational relations (adiabatic) and considers topography

• **ATMOS2** (Los Alamos N.L.)
  meso- to regional scale trajectory model for inert (or linearly reactive) pollutants

• **AUSM** (U.S. Environmental Protection Agency)
  Advanced Utility Simulation Model
  utility sector analysis model for use in studies of alternative emissions reduction strategies

• **AVACTA** (AeroVironment)
  AV–Air pollution model for Complex Terrain Applications
  superseded by AVACTA-II
• AVACTA II  
(EPA-1986 “alternative” [Supplement A, 1987])

AV – Air pollution model for Complex Terrain Applications II
analytical (Gaussian puff), episodic, meso- to regional scale model for inert (or linearly reactive) pollutants


• AVAP  
(Argonne N.L./FAA)

Airport Vicinity Air Pollution model
analytical (Gaussian puff/plume) short term, micro- to mesoscale model for line sources (accelerating airplanes)


• AVCCM  
(AeroVironment)
superseded by improved schemes


• AVGTIME  
(U.S. Environmental Protection Agency)

empirical/statistical model for estimation of expected maxima and quantiles of pollutant concentrations


• AVKERN  
(AeroVironment)
proprietary model

  AeroVironment (1985) User’s guide to AVKERN, prepared for Western Oil and Gas Association. AV-R-85/601

• AVMSTM  
(AeroVironment)

AV – Multi-Source Terrain Model
analytical (Gaussian plume) model for dispersion over complex terrain

• **AVPLUM**

  *(AeroVironment)*
  
  **AV-PLUme Model**

  superseded by improved schemes


• **AVQUAL**

  *(AeroVironment)*

  superseded by improved schemes


• **AWS Vaporization Model**

  *(Air Weather Service/U.S.A.F.)*

  vaporization model for emergency response calculations

• BAP  
  (U. of Stockholm, Sweden)
  long term, regional scale model with linear sulfur chemistry
  - Bolin, B. and C. Persson, 1975: “Regional Dispersion and Deposition of
    Atmospheric Pollutants with Particular Application to Sulfur Pollution

• BAT  
  (ARL)
  *Branching Atmospheric Trajectories*
  
  see ARL-BAT
  - see ref in ARL-BAT

○ BLM (Wind Field Module)  
  (National Weather Service)
  *Boundary Layer Model*
  
  prognostic mesoscale wind field model; employed by the guidelines
  model ARRPA*
  - see ref. in ARRPA*
• BLP  
(EPA-1986 “preferred”, was part of UNAMAP-6; ARB-1989 “alternative”)
Buoyant Line and Point source dispersion model
analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model designed for estimating dispersion from aluminum reduction plants (see also the EPA 1986/87 and the California ARB 1989 Guideline documents for additional information)


• BNL-AIRSOX  
(Brookhaven N.I.)
see AIRSOX*
■ see ref. in AIRSOX*

• BPM  
(Systems Applications, Inc., for California ARB)
2D hybrid (grid/trajectory) steady state model


• Briere’s (Wind Field Module)  
(CNRM, France)
2D higher order closure planetary boundary layer model


• Briggs’ Plume Rise Formulas  
(Briggs, ATDL NOAA)
mmost common parameterizations of plume rise


• Britter’s model  
(Bitter)
heavy gas dispersion model

★ Brookhaven N.L. (BNL) Models
   see AIRSOX

- BULKABL (Atmospheric Dynamics Corp.)
  BULK Atmospheric Boundary Layer
  prognostic mesoscale wind field model

○ CALL Chemical Mechanism (SAPRC/ERT, Inc.)

(CARB-1989 “preferred”)

Carter-Atkinson-Lloyd-Lurmann mechanism

see ERT and SAPRC (Chemical Mechanism)


○ CALINE2 (Federal Highway Administration)

California LINE source model

superseded by current version of the guidelines model CALINE3


○ CALINE3 (Federal Highway Administration)

(EPA-1986 “preferred”; CARB-1989 “preferred”)

California LINE source model

analytical (straight line, hourly steady state) Gaussian, short term, micro- to mesoscale plume model (sources are highway links) (see also the California ARB 1989 Guidelines for additional information)

- **CALINE4**
  (California Dept. of Transportation)
  California LINE source model
  - enhanced version of CALINE3

- **CALINE4/URBEMIS2**
  (CARB)
  MS-DOS based version of CALINE4; includes source emissions model
  - see ref. in AQAT*

- **California Institute of Technology (Caltech, CIT) Models**
  see EQUIL, KEQUIL, Caltech Wind Field model, CITGRID, CIT-TRJ, LPFM, MAEROS, SEQUIL, TRPM

- **CALPUFF**
  (Sigma Research Corporation)
  Short term, micro- to mesoscale forward trajectory model for reactive pollutants in complex terrain
  - currently under continuing development

- **CAMEO**
  (NOAA)
  "emergency response model" (Macintosh/FileVision based)

- **CAPITA (Center for Air Pollution Impact and Trend Analysis) Models**
  see MCARLO

- **CAPITA-MCARLO**
  (CAPITA)
  CAPITA-Monte CARLO
  - see MCARLO
  - see ref. in MCARLO

- **CARB 1988 Alternative Models**
  see ACID, BLP, ENAMAP-2N and 2S, FISHER, LONGZ, RAM, SHORTZ, STADMOD, STEM-1, VALLEY

- **CARB 1988 Emergent Models**
  see ADOM, CIT-GRID, RADM(NCAR), ROM, RTM-III, STEM-2, TRPM
**CARB 1988 Preferred Models**

see CALINE3, CDM 2.0, COMPLEX I, CRSTER, ISCST, MESOPUFF II, MPTER, OCD III, PLMSTAR, RPM II, RTDM, RTM II, UAM

**CARB (Air Quality Modeling Section) Models**

see GEMGAR, SMOG, PTFUM, PTFUMOW

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- **CARBON BOND (Chemical Mechanism)** *(Systems Applications, Inc.)*

  (ARB-1989 “preferred”)

  a “lumped structure” gas phase mechanism for photochemical smog formation; successive versions are referred to as CB-I, CB-II, CB-III, CARB-IV, etc.; CB-X is the comprehensive (full reaction set) version of the mechanism; also referred to as the Killus - Whitten - Hogo (or KW, KWH) mechanism or SAI Chemical Mechanism; a simplified version of CB-II (with various equilibrium assumptions) is included in the pre-1990 regulatory version of UAM* (EPA-1986 “preferred”); current version (1990) of UAM incorporates CB-IV; currently under continuing development


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- **CARE** *(ESC, Inc.)*

  “emergency response system” (proprietary model); analytical (Gaussian puff/plume), micro- to mesoscale; includes source emissions model and handles dense (heavy) emissions


- **CBM or CB (Chemical Mechanism)** *(Systems Applications, Inc.)*

  (ARB-1989 “preferred”)

  see CARBON BOND* (Chemical Mechanism)

  ■ see ref to CARBON BOND* (Chemical Mechanism)
• **CCADM**  
  (Systems Applications, Inc.)  
  3D trajectory model with gas and aqueous phase photochemistry and cloud dynamics  
  - currently under continuing development

• **CDM 2.0**  
  (U.S. Environmental Protection Agency)  
  (EPA-1986 “preferred”, ARB-1989 “preferred”)  
  *Climatological Dispersion Model*  
  analytical statistical (“climatological”), long term, micro- to mesoscale,  
  Gaussian plume model for inert (or linearly reactive) pollutants (see also the California ARB 1989 Guidelines for additional information)  

• **CDMCW**  
  (Science Applications, Inc./Form and Substance)  
  *CDM/Curved Winds*  
  variation of CDM; incorporates effects of curved wind fields  

• **CDMQC**  
  (U.S. Environmental Protection Agency)  
  *CDM/Quality Control*  
  variation of CDM  

• **CDMOCS**  
  (Applied Modeling, Inc.)  
  long term version of PTMOCs*  

* **CEGB (Central Electricity Generating Board, U.K.) Models**  
  see CEGB-SS, CEGB-TD, FISHER
• **CEGB-SS**

*(CEGB)*

**CEGB-Steady State**

3D analytical, steady state, short term, mesoscale model with linear sulfur chemistry


• **CEGB-TD**

*(CEGB)*

**CEGB-Time Dependent**

quasi 2D (Gaussian profile vertically (initially)) regional scale, short term, model with linearized sulfur chemistry


• **CEUM**

*(ICF for U.S. EPA)*

**Coal and Electric Utility Model**

utility sector analysis model for use in studies of alternative emissions reduction strategies

- General Accounting Office (1986) Air Pollution: Improvements Needed in Developing and Managing EPA’s Air Quality Models. GAO/RCED-86-94; see also ref. in OMEGA*

• **CHAPEAU**

*(Savannah River Lab.)*

meso- to regional scale grid-based model


• **CHARM**

*(Radian Corporation)*

“emergency response system” (proprietary model); episodic, micro- to mesoscale; includes source emissions model and handles dense (heavy) emissions

• Chatwin's model
  
  heavy gas dispersion model
  

• CIGALE 2
  
  heavy gas dispersion model
  

○ CIT - Aerosol Models
  
  (Caltech)
  
  see EQUIL, KEQUIL, MAEROS, SEQUIL
  
  see refs. in EQUIL, KEQUIL, MAEROS, SEQUIL

○ CIT - Chemical Mechanism
  
  (Caltech)
  
  a “lumped molecule” gas phase mechanism for photochemical smog; the McRae-Seinfeld 1983 version is a slight revision of the earlier Falls-Seinfeld mechanism; also referred to as FS or FSM mechanism; superseded by current versions of the CBM, SAPRC, and RADM chemical mechanisms
  

• CIT - GRID
  
  (ARB-1989 “emergent”)
  
  CIT GRID model
  
  3D grid based, short term, mesoscale model with complex multiphase photochemistry; currently under continuing development (see also the California ARB 1989 Guidelines for additional information)
  
• **CIT-TRJ**
  
  *Caltech*

  CIT TRaJectory model

  2D backward trajectory episodic, mesoscale model with complex multi-phase photochemistry; currently under continuing development


• **CIT - Wind Field Model**
  
  *Caltech*

  3D (with terrain-following, normalized, vertical coordinate) diagnostic mesoscale wind field model; it uses the continuity equation; considers topography


• **COAGUL (Aerosol Module)**
  
  *(U. of Texas, Austin)*

  simulates evolution by coagulation of a continuous aerosol number size distribution (see also CONFEMM*)


• **COBRA**
  
  *(Alp et al.)*

  LNG vaporization model


• **COBRA III**
  
  *(CSC, Canada)*

  single box, episodic, micro- to mesoscale heavy gas dispersion model


• **Colorado State University (CSU) Models**
  
  see CSU-3D Cloud, Mesoscale, RAMS, RAMS/LES, HOOT
• COMPLEX I  
(ARB-1989 “preferred”)  
(U.S. Environmental Protection Agency)  

**COMPLEX terrain model, version I**  
analytical (Gaussian plume) model for point sources in complex terrain,  
urban or rural, sector averaged in the horizontal (see also the California  
ARB 1989 Guidelines for additional information)  


• COMPLEX II  
(U.S. Environmental Protection Agency)  

**COMPLEX terrain model, version II**  
analytical (Gaussian) plume model for point sources in complex terrain,  
urban or rural; it adopts a Gaussian profile in the horizontal direction


• COMPLEX II, Overwater Version  
(U.S. Environmental Protection Agency)  
version of COMPLEX II for overwater dispersion  

- Santa Barbara county APCD (1985) District Permit Processing Manual, April 8

  ○ COMPLEX (Wind Field Module)  
  (SRI International)  
  see SRI-COMPLEX  
  ■ see ref. in SRI-COMPLEX

  ○ COMPLEX/PFM (Wind Field Module)  
  (SRI International)  
  **COMPLEX/Potential Flow Model**  
  variation of SRI-COMPLEX (Wind Field Module)  
  ■ see ref. in SRI-COMPLEX
• **COMPTER**  
(Alabama Dept. of Environment)  
(EPA-1986 “alternative”)  
analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model  
- U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R  

• **CONDOR (Wind Field Module)**  
(Universität Karlsruhe, FRG)  
diagnostic mesoscale wind field model; it uses variational relations; employs a fast elliptic solver base on Fourier analysis (an alternative code – REDBL – utilizes the “red-black” SOR method)  

• **CONFEMM**  
(U. of Texas, Austin)  
simulates evolution by condensation/evaporation of a continuous aerosol number distribution (combination with COAGUL* gives the effect of simultaneous coagulation)  

• **CPS**  
(Lawrence Livermore N.L.)  
*Continuous Point Source model*  
analytical (Gaussian plume) micro- to mesoscale model for inert (or linearly reactive) pollutants  

• **CRSTER**  
(U.S. Environmental Protection Agency)  
(EPA-1986 “preferred”, was part of UNAMAP-6; ARB-1989 “preferred”)  
analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model for single point sources (see also the California ARB 1989 Guidelines for additional information)  
• **CRSTER-2**  
  (U.S. Environmental Protection Agency) 
  enhanced version of CRSTER* 
  ■ U.S. Environmental Protection Agency (1982) Environmental Modeling 
    Architects, Inc., Randolph, MA. NTIS PB84-207554 

• **CRUNCH**  
  (SRD, U.K.) 
  quasi 2D, episodic, micro- to mesoscale heavy gas dispersion model 
    Dispersion Models. Center for Chemical Process Safety of the American 
    Institute of Chemical Engineers 

• **CSFM, MSFM**  
  (U.S. Environmental Protection Agency) 
  CRSTER Shoreline Fumigation Model 
  specialized modification of guidelines model: interactive version of 
  EPA’s single source CRSTER* model modified to handle shoreline dis- 
  persion conditions (fumigation) (see also SLDM*) 
    CRSTER models, U.S. Environmental Protection Agency, June 

○ **CSU 3-D Cloud/Mesoscale Model**  
  (CSU) 
  3D (with terrain-following, normalized, vertical coordinate) prognostic 
  mesoscale wind field model; it uses the primitive equations (nonhydro- 
  static/compressible); considers radiative heating, topography, surface 
  effects, latent heating 
    185-219 

○ **CSU Mesoscale Model (Wind Field Module)**  
  (CSU) 
  3D (with terrain-following, normalized, vertical coordinate) prognostic 
  mesoscale wind field model; it uses the primitive equations (hydro- 
  static); considers radiative heating, topography, surface effects, latent 
  heating 
    over sloping terrain,” J. Atm. Sci., 31, 2198-2212
○ CSU-RAMS, RAMS/LES (Wind Field Module) (CSU)
Pielke’s 3D CSU Mesoscale Model* merged with Tripoli and Cotton’s CSU 3D Cloud/Mesoscale Model; it is a 3D (with terrain-following, normalized, vertical coordinate) prognostic mesoscale wind field model; it uses the primitive equations (hydrostatic or nonhydrostatic) and considers radiative heating, surface effects, topography, latent heating

- currently under continuing development

- CTDM (U.S. Environmental Protection Agency) (ARB-1989 “preferred”)

Complex Terrain Development program Model model for dispersion in complex terrain under stable conditions; (see also the California ARB 1989 Guidelines for additional information)


- CTSG (Sigma Research Corporation)

Complex Terrain algorithm for Sub-Grid scale features CTDM*-based module for treatment of (subgrid) complex terrain features in CALPUFF*

- currently under continuing development

○ CTWM (Wind Field Module) (Systems Applications, Inc.)

Complex Terrain Wind Model

3D diagnostic mesoscale wind field model; it uses the continuity equation (hydrostatic/adiabatic) and considers topography and surface effects


○ CUMSCAV (Cloud Physics Module) (Lawrence Livermore N.I.)

CUMulus cloud SCAVenging estimates removal of pollutants because of scavenging by convective clouds

* Dames & Moore Models
  see DM-RADM

○ Danard's (Wind Field Module)  (Danard, M.)
  prognostic mesoscale wind field model; it uses the primitive equations
  (simplified physics)
  on Surface Winds,” Mon. Wea. Rev., 105, 572-581

○ Danard's  (Danard, M.)
  2D numerical grid-based model for line (traffic) sources
  dispersion near highways” Atmospheric Environment, 13, 669-685

○ DEGADIS  (U.S. Coast Guard)
  DEnse GAs DISpersion model
  heavy gas dispersion model (numerical, episodic, micro- to mesoscale)
  dispersion model for heavier than air gas mixtures,” Final report prepared
  for Commandant G-FCP-22F/TP64, U.S. Coast Guard, Washington
  D.C.

○ DOT Photochemical Model  (Department of Transportation)
  version of UAM* employing CARBON BOND I; superseded by current
  version of the guidelines model UAM
  ical models for regulatory use,” Atmospheric Environment, 18, 2055-
  2069
- **DRAGONGP**
  **(ATDL)**
  analytical (Gaussian plume) short term, mesoscale model for inert (or linearly reactive) pollutants
  

- **DRAGONHP**
  **(ATDL)**
  same as DRAGONGP* but with different dispersion coefficients
  
  - see ref. in DRAGONGP*

- **DRAGONTH**
  **(ATDL)**
  same as DRAGONGP* but with top hat concentration profile
  
  - see ref. in DRAGONGP*

- **DRAx1**
  **(Air Resources Lab., NOOA)**
  **DRAXler’s model 1**
  analytical statistical (climatological) long term model for inert (or linearly reactive) pollutants
  

- **DRAx2**
  **(Air Resources Lab., NOOA)**
  **DRAXler’s model 2**
  analytical (Gaussian plume) short term model for inert (or linearly reactive) pollutants
  
  - see ref in DRAx1*

- **Draxler & Taylor’s model**
  **(Air Resources Lab., NOOA)**
  **Draxler and Taylor model**
  see ARL-MLATAD
  

- **Drexel University Models**
  see DREXEL/NCAR, LAMPS
- **DREXEL/NCAR Wind Model** *(Drexel University)*
  3D (with terrain-following, normalized, vertical coordinate) prognostic mesoscale wind field model; it uses the primitive equations (hydrostatic/diabatic) and considers surface effects, radiative heating, topography, latent heating

- **DRI CLOUD CHEMISTRY MODEL** *(Desert Research Institute)*
  numerical model for cloud chemistry and physics

- **D2PC** *(U.S. Army CRDC, MD)*
  analytical (Gaussian puff/plume) episodic, micro- to mesoscale model; includes source emissions model

- **DWNWND** *(Oak Ridge N.I.)*
  analytical (Gaussian plume) short term, micro- to mesoscale, model for inert (or linearly reactive) pollutants
- **EAHAP** (EAI, OK)
  quasi 2D, episodic, micro- to mesoscale heavy gas dispersion model; includes source emissions model

- **EDFrance Models**
  see MERCURE, PARADE

- **EDRAB** (Environplan, Inc.)
  *Environplan Dual-Mode Regional Air-Back trajectory model*
  quasi 2D (Gaussian profile horizontally) short term, regional scale, forward and backward trajectory model for inert (or linearly reactive) pollutants

- **Eidsvik's model** (NIAR)
  quasi 2D, episodic, micro- to mesoscale heavy gas dispersion model
- **EKMA** (U.S. Environmental Protection Agency)

  (standard EPA procedure)

  **Empirical Kinetic Modeling Approach**

  estimates O$_3$ levels for various NO$_x$ and RHC initial conditions based on the EPA CHEMICAL MECHANISM*; see also OZIPP/EKMA*

  - Meyer E.L., Summerhayes J.E. and Freas W.P. (1977) Uses, limitations and technical basis of procedures for quantifying relationships between photochemical oxidants and precursors. EPA-450/2-77-021a, U.S. Environmental Protection Agency

- **Eliassen & Saltbones’ model** (Norwegian Met. Inst.)

  1D regional scale, long term, forward trajectory model with linear sulfur chemistry; “routine” and “research” versions are available


- **Eliassen’s Photochemical Trajectory Model** (NMI)

  1D regional scale, long term, forward trajectory model incorporating SO$_x$/NO$_x$/RHC photochemistry


- **ELSTAR** (ERT, Inc.)

  photochemical trajectory model; superseded by LPM* and more recently by PLMSTAR*


  - **ELSTAR (Chemical Mechanism)** (ERT, Inc.)

    a “lumped molecule” gas phase mechanism for photochemical smog formation incorporated in the ELSTAR* trajectory model (superseded by ALW* or ERT Chemical Mechanism*)

    - see ref in ELSTAR (trajectory model)
• **EMEP-MSCW**
  
  (Norwegian Met. Inst.)
  
  see ELIASSEN/SALTBONES
  
  ■ see ref. in ELIASSEN/SALTBONES

  ○ **EMFC7PC (Emissions Module)**
    
    (CARB)
    
    *EMissions Factors C7PC*
    
    estimates emission factors for traffic sources
    
    ■ see ref. in AQAT

  ○ **EMISSIONS**
    
    (Monsanto)
    
    see MONSANTO Vaporization Model
    

  ○ **EMOD (Emissions Module)**
    
    (SRI, U.S. EPA)
    
    emissions module for APRAC
    
    ■ see ref. in APRAC-2

  ○ **ENAMAP-1**
    
    (SRI International)
    
    *Eastern North American Model for Air Pollution*
    
    2D trajectory (horizontally resolved), sequentially long term, regional to synoptic scale model with SO₂, SO₄²⁻ chemistry
    

  ○ **ENAMAP-2S, 2N**
    
    (SRI International)
    
    (ARB-1989 “alternative”)
    
    *Eastern North American Model for Air Pollution*
    
    2D (vertically resolved) regional forward trajectory (“puff”) model for both short and long term calculations of linearized sulfur (oxide/sulfates) (ENAMAP-2S) or nitrogen (ENAMAP-2N) chemistry (see also the California ARB 1989 Guidelines for additional information)
    
**Enger's model**

(U. of Uppsala)

2D grid-based higher order closure dispersion model


**ENSR models**

see ERT, Inc. models

**Environment Canada Models**

see HRS

**Environment Quebec Models**

see TGD-EQ

**Environmental Applications Inc. Models**

see SIGMET2

**Environmental Science Resources Lab. (EPA) Models**

see ROM

**Environplan Inc. Models**

see EDRAB, MODELS 3141 and 4141

**EPA1, EPA2**

(U.S. Environmental Protection Agency)

versions of UAM* employing CARBON BOND II


**EPA-1986 Alternative Models**

see AQFM, ARPPA, ARPAC3, COMPTER, ERTAQ, ERTVM, HIWAY 2, IMPACT, LONGZ, MARYLAND PPSP, MESOPUFF II, MTDDIS, MODELS 3141 and 4141, MULTIMAX, MPSDM, MULTI-SOURCE SCSTER, PACIFIC GAS AND ELECTRIC PLUME5 MODEL, PLMSTAR, PLUVUE II, POINT - AREA - LINE (PAL), RADM (DM), RPM II, RTM II, SHORTZ, SIMPLE LINE SOURCE MODEL (GMLINE), TCM, TEM
* EPA-1986 Preferred Models
  see BLP, CALINE 3, CDM 2.0, CRSTER, ISC, MPTER, RAM, UAM

* EPA-1987 (Supplement) Alternative Models
  see AVACTA

* EPA-1987 (Supplement) Preferred Models
  see OCD

  ▪ EPA Chemical Mechanism (U.S. Environmental Protection Agency)
    an “explicit” gas phase mechanism for photochemical smog (detailed
    reactions for butane, propene, formaldehyde and acetaldehyde); it is
    the mechanism used in early versions of OZIPP/EKMA*
    ■ see ref. in OZIPP/EKMA*

  ▪ EPA-Henmi & Reiter (U.S. Environmental Protection Agency)
    2D (day) or 3D (night - two layers) trajectory, short term, mesoscale
    model with SO$_2$, SO$_4$$^2$ chemistry
    ■ Henmi, T. and E.R. Reiter, 1979: "Long-Range Transport and Transfor-
    mation of SO$_2$ and Sulphate Refinement, Application, and Verification
    of Models," EPA- 600-4-81-070, 72 pp.

  ▪ EPA-PUFF (U.S. Environmental Protection Agency)
    instantaneous puff dispersion model
    taneous puff release,” EPA 600/3-82-078

  ▪ EPIDIS (FSI)
    numerical, episodic, micro- to mesoscale heavy gas dispersion model;
    includes source emissions model
    Dispersion Models. Center for Chemical Process Safety of the American
    Institute of Chemical Engineers

* EPRI Models
  see ADEPT, ASM, EPRIPUFF, FAST, SMICK, SURADS
• **EPRI/ERT**  
  (EPRI/ERT, Inc.)  
  3D grid based, short term, regional to synoptic scale model with complex SO\textsubscript{2} chemistry (involving 20 reactions)  
  Lavery T.F. et al. (1979) “Regional transport and photochemical model of atmospheric sulfates” Procs. of the 9th ITM, NATO/CCMS, Toronto. p. 353-362

• **EPRIPUFF**  
  (SUC, Oneonta N.Y.)  
  EPRI (Kincaid) data PUFF model  
  analytical (Gaussian puff) short term, micro- to mesoscale, model for inert (or linearly reactive) pollutants  

○ **EQUIL, KEQUIL (Aerosol Module)**  
  (Caltech)  
  aerosol (Kelvin effect) EQUILibrium model  
  thermodynamic equilibrium model for the prediction of mass and chemical composition of atmospheric aerosols containing sulfate, nitrate, ammonia, and water (17 species, 13 equilibrium reactions); KEQUIL is identical to EQUIL but in addition it takes into account the Kelvin effect  

• **ERT, Inc. Models**  
  see ALW, ADOM/TADAP, ARIAM, BLP, CAL, DIFKIN, DISCDEP, ELSTAR, EPRI/ERT, ERT Chemical Mechanism, ERTAQ, ERT Sulfate Model, ERTVM, HASTE, LPM, MESOGRID, MESOPLUME, MESOPUFF-I and II, MPSDM, OCD, OCDCPM, PLMSTAR, SULFA3D
ERT Chemical Mechanism (ERT, Inc.) (ARB-1989 “preferred”)
a “lumped molecule” gas phase mechanism for photochemical smog forma-
tion (also referred to as ALW* or Atkinson-Lloyd-Winges mechanism
and as CALL* or Carter-Atkinson-Lloyd-Lurmann mechanism); superseded
by current version of the SAPRC Chemical Mechanism*
mechanism for hydrocarbons/NOx/SO2/photoxidants suitable for in-
clusion in atmospheric simulation,” Atmos. Environ., 16, 1341-1355; see
also ref in CALL*

ERTAQ (ERT, Inc.)
(EPA-1986 “alternative”)
ERT Air Quality model
analytical statistical (“climatological”), long term, micro- to mesoscale,
Gaussian plume model for inert (or linearly reactive) pollutants from
point, line, and area sources
■ U.S. Environmental Protection Agency (1986) Guideline for Air Quality
Models (Revised) EPA-450/2-78-027R

ERTVM (ERT, Inc.)
(EPA-1986 “alternative”)
ERT Visibility Model
Gaussian plume dispersion model designed to estimate visibility impair-
ment for arbitrary lines of sight due to isolated point source emissions
by simulating gas-to-particle conversion, dry deposition, NO to NO2
conversion and linear radiative transfer
■ U.S. Environmental Protection Agency (1986) Guideline for Air Quality
Models (Revised) EPA-450/2-78-027R

ESL (U.S. Air Force)
vaporization model for emergency response calculations
spills of toxic liquids,” U.S.A.F. AFESC/ESL-TR-83-03

ESMAP (Aerosol Module) (Caltech)
simulates evolution of a sectional (discrete) aerosol size distribution af-
fected by simultaneous nucleation, coagulation and condensation (exten-
tion of MAEROS*)
■ Warren D.R. and Seinfeld J.H. (1985) “Simulation of aerosol size distri-
bution evolution in systems with simultaneous nucleation, condensation,
and coagulation,” Aerosol Sci. Technol., 4, 31-43
• EURMAP-1  
(SRI International)  
*European Regional Model for Air Pollution*  
1D trajectory (expanding control volume), sequentially long term, regional to synoptic scale model with SO\textsubscript{2}, SO\textsubscript{4}\textsuperscript{2-} chemistry  

• EURMAP-2A, 2B  
(SRI International)  
*European Regional Model for Air Pollution*  
extensions of EURMAP-1* principally for short term calculations; 2B is a multilayer version; superseded by ENAMAP-2N,S  
• FAST

   (EPRI)

   Decision Framework for Ambient Air Quality Standards
summarizes the relationship between regulatory standards, emissions, ambient concentration levels, population exposure, and adverse health impacts; allows assessment of the uncertainty on the overall extent of health impacts under a proposed primary or secondary air quality standard


• Fay & Zemba’s model

   (U.S. DOE)

   integral type (similarity) heavy gas dispersion model


• Federal Aviation Administration (FAA) Models

   see AVAP, GIMM, SIMPLEX ‘A’

• Federal Highway Administration (FHWA) Models

   see CALINE (various versions), CALINE3, PROBAQM, PROBCO-1, SIMCO-L
- **FEM A-D**  
  *(Lawrence Livermore N.L.)*  
  *Finite Elements Model for Advection-Diffusion*  
  finite element solver for the advection-diffusion equation  

- **FEM, FEM3**  
  *(Lawrence Livermore N.L.)*  
  3D numerical heavy gas dispersion model; FEM3 uses a Galerkin finite element code to solve for velocity, temperature, pressure, species concentrations, and densities in two or three dimensions using either the generalized anelastic equations or the Boussinesq equations; includes source emissions model  

- **FEM/PBLM**  
  *(Lawrence Livermore N.L.)*  
  *FEM/Planetary Boundary Layer Model*  
  derived from FEM3*; based on the Boussinesq equations  
  - Knox J.B., MacCracken M.C., Dickerson M.H., Gresho P.M. and Luther F.M. (1986) Program report for FY 1984 and 1985 Atmospheric and Geophysical Sciences Division of the Physics Department, Lawrence Livermore N.L.

- **Fisher’s model**  
  *(CEGB)*  
  *(ARB-1989 “alternative”)*  
  *model of B.E.A. Fisher (of CEGB)*  
  analytical statistical (climatological) regional model with wet and dry deposition that focuses on the long term deposition of SO2 and sulfates through analytical expressions based on statistics of wind, stability, and precipitation; more recent versions incorporate linearized NOx/nitrate chemistry (see also the California ARB 1989 Guidelines for additional information)  

- **Form & Substance Models**  
  see MADCAP (also Science Applications Inc. Models)
○ Fosberg’s *(Wind Field Module)*
  see KRISSY*
  ■ see ref. in KRISSY

- **Foussat’s model**

  3D numerical heavy gas dispersion model

- **FREDIS**

  long term, regional scale, trajectory model for inert (or linearly reactive) pollutants
G

○ **GASP (Emissions Module)**  
  source emissions/evaporation model

● **GEM**  
  (Science Applications, Inc./CARB)  
  *Gaussian Evaluation Model*
  analytical (Gaussian plume) short term, micro- to mesoscale, model for point sources and inert (or linearly reactive) pollutants with various options for calculating trajectory and dispersion parameters for different terrain and atmospheric conditions

● **GEMGAR**  
  (Science Applications, Inc./CARB)  
  *GEM with Gridded Array of Receptors*
  enhanced version of GEM*
  ■ see first ref. in GEM

* **General Motors Models**  
  see GMLINE
**Geomet Inc. Models**

see SCAM, SCIM

- **Gifford’s Meandering Plume Model**  
  (F. Gifford)  
  "generic" analytical model for a Gaussian (point source) meandering plume; provides standard formulas for meandering plume properties and the variance and probability of concentration fluctuations due exclusively to meandering  

- **Gillani’s model**  
  (Washington U., St. Louis)  
  *N.V. Gillani of Washington U.*  
  mesoscale trajectory model with linearized sulfur chemistry  

- **GIMM**  
  (FAA)  
  *Graphical Input Microcomputer Model*  
  analytical (Gaussian puff) episodic, micro- to mesoscale model based on the earlier scheme SIMPLEX ‘A’; with interactive graphics interface  

- **GMLINE**  
  (Env. Sci. Dept., General Motors)  
  (EPA-1986 “alternative”)  
  *General Motors simple LINE source model*  
  analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model for inert (or linearly reactive pollutants) from line (traffic) sources  
  ▼ U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

- **Goodin’s (Wind Field Module)**  
  (Caltech)  
  see CIT Wind Field Model*  
  ▼ see ref. in CIT Wind Field Model*
- **Graedel's (Chemical Mechanism)**  
  (T. Graedel)  
  comprehensive photochemical mechanism; superseded by improved schemes  

- **GRANTOUR**  
  (Lawrence Livermore N.L.)  
  regional to synoptic scale trajectory model for inert (or linearly reactive) pollutants  

- **GRID/NIPH**  
  (NIPH, Bilthoven, The Netherlands)  
  3D (3 layers) mesoscale, short term, grid-based (pseudospectral/leapfrog integration for transport) with linear sulfur chemistry  

- **GRID/MRI**  
  (Meteorology Research, Inc.)  
  3D numerical heavy gas dispersion model  
• **Hanna & Gifford’s model**
  (S.R. Hanna and Gifford)
  analytical (Gaussian plume) model for inert (or linearly reactive) pollutants from area sources (assumes Gaussian profile vertically (initially), uniform concentration horizontally)
  ■ U.S. Environmental Protection Agency (1978) Workbook for Comparison of Air Quality Models. OAQPS Guideline Series. EPA-450/2-78-028ab, OQAPS No. 1.2-097A

• **HASTE**
  (ERT, Inc.)
  “emergency response system” (proprietary model); quasi 2D, episodic, micro- to mesoscale heavy gas dispersion model; includes source emissions model

• **HAZARD**
  heavy gas dispersion model

• **HEAVYGAS**
  (Atkins Research)
  3D numerical heavy gas dispersion model
• HEAVY PU FF
  (Risø N.L., Denmark)
  single box, episodic, micro- to mesoscale heavy gas dispersion model;
  includes source emissions model
  Dispersion Models. Center for Chemical Process Safety of the American
  Institute of Chemical Engineers

• HEGADAS
  (Shell, Holland)
  quasi 2D, episodic, micro- to mesoscale heavy gas dispersion model
  Dispersion Models. Center for Chemical Process Safety of the American
  Institute of Chemical Engineers

• HEGDAS
  (Morrow)
  heavy gas dispersion model
  Dispersion Models. Center for Chemical Process Safety of the American
  Institute of Chemical Engineers

○ HEM II
  (U.S. Environmental Protection Agency)
  Human Exposure Model, version II
  Human exposure assessment modeling system incorporating the regulatory
  mode of ISCLT* and a simple area source model; contains 1980
  census data, 390 airports STAR meteorology data; menu driven; cur-
  rently under continuing development
  ■ User’s guidance to be available in the near future

• Henmi & Reiter’s model
  (CSU/U.S. Environmental Protection Agency)
  see EPA-HENMI/REITER
  ■ see ref. in EPA- Henmi & Reiter

• Hoot’s model
  (Hoot et al., CSU)
  heavy gas dispersion model
  Dispersion Models. Center for Chemical Process Safety of the American
  Institute of Chemical Engineers

• Hov’s model
  (Norwegian Inst. for Air Research)
  model of Hov et al. (of N.I.A.R.)
  see NLLRT-ABLC*
  ■ see ref. in NLLRT-ABLC
• HIWAY-2  
(U.S. Environmental Protection Agency)  
(EPA-1986 “alternative”, was part of UNAMAP-6)  
analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model for inert (or linearly reactive) pollutants from traffic sources

- U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

• HIWAY (other versions)  
(U.S. Environmental Protection Agency)  
early versions and variations of HIWAY-2


• HRS  
(Environment Canada)  
Hazard Ranking System  
vaporization model for emergency response calculations


• HYBRID  
(Systems Applications, Inc.)  
3D hybrid (grid/trajectory) micro- to mesoscale, short term model for dispersion of inert (or linearly reactive) pollutants in complex terrain (PDM* plus modules for plume rise and advection)

• **IAP-LRT**
  
  
  *IAP- Long range Transport*
  
  regional to synoptic scale trajectory model with linear sulfur chemistry
  

* IBM Models
  
  see SHIR/SHIEH

  • **Ille & Springer’s Vaporization Model**
    
    (USAF/CEEDO)
    
    vaporization model for emergency response calculations
    

  * Illinois EPA Models
    
    see AQSTM, Illinois EPA Emergency Response

• **Illinois EPA Emergency Response**
  
  (Illinois EPA)
  
  emergency response nomograms
  
  • Kelty J. (1983) “Calculation of evacuation distances during toxic air pollution incidents,” in “Atmospheric emergencies: existing capabilities and future needs,” Transportation research record 902, NAS
• **IMM**

(U.S. Environmental Protection Agency)

*Intersection Midblock Model*

uses the MODAL ANALYSIS MODEL* and the MOBILE1* to predict emissions from vehicles and models dispersion with the HIWAY-2* guidelines model


• **IMPACT (Radian)**

(Radian Corporation)

(EPA-1986 “alternative”)

*Integrated Model of Plume and Atmospherics in Complex Terrain*

3D short term, mesoscale, grid-based model for inert or reactive pollutants from point and area sources in simple or complex terrain


• **IMPACT (ScAI)**

(Science Applications, Inc.)

*Integrated Model of Plume and Atmospherics in Complex Terrain*

see IMPACT (Radian)


• **INPUFF**

(U.S. Environmental Protection Agency)

analytical (Gaussian puff) episodic, micro- to mesoscale model for inert (or linearly reactive) pollutants


• **INPUFF 2**

(U.S. Environmental Protection Agency)

enhanced version of INPUFF*

**Intera Technologies Ltd. (Calgary) Models**

see FREDIS, INTERA, MODTRAC

- **INTERA**
  
  (Intera Technologies Ltd.)
  
  numerical short term mesoscale grid-based model for inert (or linearly reactive) pollutants
  

- **IPS**
  
  (Lawrence Livermore N.L.)
  
  Instantaneous Point Source
  
  analytical (Gaussian puff) micro- to mesoscale, short term model for inert (or linearly reactive) pollutants
  

- **ISC**
  
  (U.S. Environmental Protection Agency)
  
  (EPA-1986 “preferred”, was part of UNAMAP-6)
  
  Industrial Source Complex model
  
  analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model for inert (or linearly reactive) pollutants (see also the EPA 1986/87 and the California ARB 1989 Guideline documents for additional information)
  

- **ISCLT**
  
  (U.S. Environmental Protection Agency)
  
  ISC/Long Term
  
  long term version of ISC
  
  - see ref. in ISC*
• **ISCST**
  (ARB-1989 "preferred")
  (U.S. Environmental Protection Agency)
  *ISC/Short Term*

  short term version of ISC

  ■ see ref. in ISC*
**Kappa-G**  
(AeroVironment)  
analytical non-Gaussian (solution of the Atmospheric Diffusion Equation) episodic, micro- to mesoscale, point source plume model for inert (or linearly reactive) pollutants  

- **KEQUIL (Aerosol Module)**  
(Caltech)  
*Kelvin effect - EQUilibrium*  
same as EQUIL* but including the Kelvin effect  
- see ref in EQUIL*

**KGAUSS**  
(AeroVironment)  
analytical non-Gaussian (solution of the Atmospheric Diffusion Equation) episodic, micro- to mesoscale, point source plume model for inert (or linearly reactive) pollutants  

**KNMI (Royal Netherlands Meteorological Institute) Models**

See KNMI GRID MODEL, LUVOLONG
**KNMI GRID MODEL** *(KNMI, The Netherlands)*
3D grid based (pseudospectral treatment of advection/ Crank-Nicholson scheme for dispersion) short term, meso- to regional scale model with linear SO₂, SO₄⁻² chemistry


**KRISSY (Wind Field Module)** *(Pacific SW Forest and Range Exp. St.)*
3D (with terrain-following, normalized, vertical coordinate) diagnostic mesoscale wind field model; it uses the continuity equation (anelastic/adiabatic) with momentum constraint


**Kunkel’s (Emissions Module)** *(AFGL)*
jet and evaporation emissions model


**KW Chemical Mechanism** *(Systems Applications, Inc.)*
*(ARB-1989 “preferred”)*

- Killus-Whitten mechanism

see CARBON BOND* Chemical Mechanism

- see ref. to CARBON BOND*
- **LAMPS**  
  (Drexel University, PA/NCAR/PNL)  
  numerical grid-based model for inert (or linearly reactive) pollutants; includes cloud submodel  

- **LAPS**  
  (U.S. Environmental Protection Agency)  
  Local Air Pollution Simulator  
  2D photochemical trajectory model, modification of DIFKIN*; superseded by improved schemes  

* **Lawrence Livermore N.L. (LLNL) Models**  
  see ADPIC, MATHEW, Aerosol Coagulation Model, CPS, FEM, FEM3, a-d FEM, FEM/PBLM, IPS, LIRAN-1 and 2, LLNL Chemical Mechanism, MSDM, Multilayer Air Quality Model (MAQ), PATRICE, SEAC-PATRICE, PHOKIN, PHOTO2, Tracer Trajectory Model (TTM)

- **Lewellen & Sykes’ Fluctuations Model**  
  (ARAP)  
  see SCIMP*  
  ■ see ref. in SCIMP; also American Meteorological Society (1983) Sixth Symposium on Turbulence and Diffusion, March 22-25, Boston, Massachusetts (paper 1.2)
• **LIRAQ-1, -2**
  
  **Livermore Regional Air Quality**
  
  quasi 3D (analytical expressions in the vertical) grid based, short term, mesoscale model with potential of including chemical mechanism for 20 species
  

• **LLNL Chemical Mechanism**
  
  **Livermore N.L.**
  
  a “lumped molecule” gas phase mechanism for photochemical smog formation (also referred to as the PW* mechanism)
  

• **LMLTDD**
  
  **Akademie der Wissenschaften, Leipzig**
  
  *Lagrangian MultiLevel model for Transport, Transfer, Deposition*
  
  2D regional scale trajectory model with linear sulfur chemistry
  

• **LONGZ**
  
  **U.S. Environmental Protection Agency, Region III**
  
  (EPA-1986 “alternative”; ARB-1989 “alternative”)

  analytical statistical (“climatological”), long term, micro- to mesoscale, Gaussian plume model for inert (or linearly reactive) pollutants
  

• **Los Alamos N.L. Models**

  see ATMOS1, ATMOS2, YAMADA

• **LPAQSM**

  **ERT/EPA**

  *Lagrangian Photochemical Air Quality Simulation Model*

  photochemical mesoscale trajectory model
  
• **LPFM** (Caltech)
  
  *Localized Production of Fluctuations Model*
  
  model for the variance (and probability distribution) of fine scale concentration fluctuations inside a (Gaussian) point source plume; analytical and numerical versions


• **LPM/ERT** (ERT, Inc.)
  
  *Lagrangian Photochemical Model*
  
  photochemical trajectory model; superseded by PLMSTAR*


• **LPM/SAI** (Systems Applications, Inc.)
  
  *Lagrangian Photochemical Model*
  
  variation of the LPM/ERT (different chemical mechanism)

  *see ref. in LPM/ERT*

• **LRTM** (ARL)
  
  *Long Range Transport Model*
  
  evolved from DRAXLER/TAYLOR* and ARL/MLATAD*; incorporates effects of wind shear

  *American Meteorological Society (1983) *Sixth Symposium on Turbulence and Diffusion*, March 22-25, Boston, Massachusetts (paper 3.2)*

• **LUVOLOONG** (KNMI)
  
  variation of CDM*; superseded by current version of the guidelines model

**Machta's model**
(U. of London, UK)
*Model of L. Machta*
long term, regional scale trajectory model for single sources and inert (or linearly reactive) pollutants


**MADCAP**
(Science Applications, Inc./ Form & Substance)
*Model of Advection Diffusion and Chemistry of Air Pollution*
3D numerical mesoscale, short term, grid-based, photochemistry model


**MADICT**
(SRI/U.S. Army Research office)
forward trajectory (puff) model for inert (or linearly reactive) pollutants

- **MAM (Emissions Module)**
  (U.S. Environmental Protection Agency)
  Modal Analysis Model
  see Modal Analysis Model
  - see ref. in Modal Analysis Model

- **MAEROS (Aerosol Module)**
  (Caltech)
  Model for an AEROSol system
  simulates evolution of a sectional (discrete) aerosol size distribution affected by coagulation and condensation

- **MARIAH**
  (Deygon-Ra Inc.)
  3D numerical heavy gas dispersion model

- **MARS (Aerosol Module)**
  (Systems Applications, Inc./Caltech)
  Model for an Aerosol Reacting System
  thermodynamic equilibrium model for prediction of the mass, chemical composition, and distribution of species among particles of different sizes of atmospheric aerosols containing sulfate, nitrate, ammonium, and water

- **MASCON (Wind Field Module)**
  (Lawrence Livermore N.I.)
  *MASs CONsistent*
  same as MATHEW but 2D (vertically averaged)

- **MASS 2.0 (Wind Field Module)**
  (Meso)
  Mesoscale Atmospheric simulation System
  3D (with surface pressure-following, normalized, vertical coordinate) prognostic mesoscale wind field model; it uses the primitive equations (hydrostatic) and considers topography, surface effects, radiative heating, latent heating
Mass & Dempsey’s (Wind Field Module)
(U. of Washington)
see U. of Washington One-Level Mesoscale Model

MATHEW (Wind Field Module)
(Lawrence Livermore N.I.
3D, diagnostic mesoscale wind field model; it uses the continuity equation/variational relations (adiabatic) and considers topography

MCARLO
(Washington U., St. Louis/CAPITA)
Monte-CARLO dispersion model
1D regional scale, long term, forward trajectory model (horizontal dispersion determined by random perturbations of individual trajectories) with linear sulfur chemistry

MC-LAGPAR (I, II)
(AeroVironment)
Monte Carlo - LAgrangian PARticle model
simulates turbulent dispersion of fluid particles via Monte Carlo methods

MELSAR
(Pacific Northwest Lab./DOE/U.S. EPA)
short term, mesoscale, forward trajectory model for multiple sources in complex terrain
• MELSAR (Wind Field Module) (Pacific Northwest Lab.)
  3D (with terrain-following, normalized, vertical coordinate) diagnostic mesoscale wind field model; it uses the continuity equation (anelastic/adiabatic) and considers topography

• MEP-IOM (Meteor. and Env. Planning, Ltd., Toronto)
  grid-based regional scale photochemical model; currently under continuing development

• MEP-TRANS/LRT (Meteor. and Env. Planning, Ltd., Toronto)
  long term, regional scale trajectory model with linear sulfur chemistry

• MERCURE (EDF, France)
  heavy gas dispersion model for complex terrain

• MSFM (U.S. Environmental Protection Agency)
  see CSFM*
  ■ see ref. in CSFM*

• MESOGRID (ERT, Inc.)
  3D numerical grid-based (employs method of moments to calculate advection) short term, mesoscale model for inert or reactive pollutants
• **MESOI**
  
  (Pacific Northwest Lab.)

  short term, meso- to regional scale forward trajectory model for inert (or linearly reactive) pollutants


  ○ **MESOPAC**
  
  (ERT, Inc.)

  preprocessor for MESOPUFF-II*

  - see ref. in MESOPUFF-II

  • **MESOPLUME**
  
  (ERT, Inc.)

  *MESOscale PLUME model*

  forward trajectory (segmented plume) model; included in EPA 1984 Draft version of Guideline on Air Quality Models; intended as a screening tool for MESOPUFF-II


  • **MESOPUFF-I**
  
  (ERT, Inc. for U.S. EPA)

  *MESOscale PUFF model*

  superseded by current version of the guidelines model MESOPUFF-II


  • **MESOPUFF-II**
  
  (U.S. Environmental Protection Agency)

  (EPA-1986 “preferred”, was part of UNAMAP-6; ARB-1989 “preferred”)

  *MESOscale PUFF model*

  quasi 2D (box with Gaussian horizontal profile) or quasi 3D (3 layers, Gaussian profile horizontally) trajectory model with simplified photochemistry (linearized sulfur chemistry) (see also the California ARB 1989 Guidelines for additional information)

- **MESOS** (Imperial College, UK)
  2D (+ analytical expression for the vertical) trajectory (horizontally resolved), short or sequentially long term, regional to synoptic scale model for radioactively decaying species

- **Meteorology and Environment Planning, Ltd. (Toronto) Models**
  see MEP-IOM, MEP-TRANS/LRT

- **MGM** (Minnesota State Planning Agency)
  mesoscale, short term trajectory model with linear sulfur chemistry

- **MICRO** (Colorado Dept. of Highways)
  model for the calculation of traffic parameters, estimation of emission rates, and estimation of dispersion of pollutants from highways (employs dispersion scheme of HIWAY-2*)

- **MIDAS** (PL & G)
  numerical episodic micro- to mesoscale heavy gas dispersion model; includes source emissions model

- **MINERVE I (Wind Field Module)** (CEC)
  mesoscale wind field model based on objective analysis with terrain-following, normalized, vertical coordinate; it uses interpolation formulas and considers surface effects and topography
  - see ref. in MINERVE II
• MINERVE II (Wind Field Module) (CEC)
as in MINERVE I but adopts a finite element method to describe irregular boundaries

• MIT (MIT)
  2D analytical (solution of the Atmospheric Diffusion Equation) meso-regional scale long term model with linearized sulfur chemistry

• MLRAPT (Pacific Northwest Lab.)
  Multilayer Regional Air Pollution Transport
  2D (vertically resolved) version of RAPT*

• MM4 (Wind Field Module) (NCAR/Penn State)
  3D (with surface pressure-following, normalized, vertical coordinate) prognostic mesoscale wind field model; it uses the primitive equations (hydrostatic) and considers radiative heating, topography, surface effects, latent heating

• MOBILE1,2 (Emissions Module) (U.S. Environmental Protection Agency)
  MOBILE sources emissions model
  emissions rate model for traffic sources
  ■ EPA (1981) User’s Guide to MOBILE2 (Mobile source emission model) EPA Publication No. EPA-460/13-81-006, Office of Mobile Sources Air Pollution Control, U.S. Environmental Protection Agency (NTIS ref. PB 81 205619)
- MOBILE3 (Emissions Module) (U.S. Environmental Protection Agency)
  MOBILE sources emissions model
  emissions rate model for traffic sources; superseded by MOBILE4*
    EPA Publication No. EPA-460/3-84-002, Office of Mobile Sources Air
    Pollution Control, U.S. Environmental Protection Agency (NTIS ref. PB
    84 213974)

- MOBILE4 (Emissions Module) (available from NTIS) (U.S. Environmental Protection Agency)
  MOBILE sources emissions model
  emissions rate model for traffic sources; uses the calculation procedures
  and emission factors of AP-42*, volume II; personal computer (DOS
  and Macintosh) versions available
    model) EPA Publication No. EPA-AA-TEB-89-01, U.S. Environmental
    Protection Agency, Office of Air and Radiation, Office of Mobile
    Sources, Emission Control Technology Division, Test and Evaluation
    Branch, 2565 Plymouth Road, Ann Arbor, MI 48105

- MOCAPD (FNG Associates)
  MOnte CArlo Particle Dispersion
  mesoscale model for inert (or linearly reactive) pollutants
  - American Meteorological Society (1983) Sixth Symposium on Turbulence
    and Diffusion, March 22-25, Boston, Massachusetts (paper 1.12)

- Modal Analysis Model (Emissions Module) (U.S. EPA)
  emissions rate model for traffic sources
    quality at street intersections,” JAPCA, 33, 760-764

- MODEL-E (API)
  analytical (Gaussian plume) micro- to mesoscale, short term or sequen-
  tially long term model for inert (or linearly reactive) pollutants
    Laboratories for the American Petroleum Institute (p.3-54)
• **MODEL-P** (API)
  enhanced version of MODEL-E

• **MODELS 3141, 4141** (Environplan, Inc.)
  (EPA-1986 “alternative”)
  modifications of CRSTER* for complex terrain
  ■ U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

• **MODSYS** (CSC, Canada)
  numerical heavy gas dispersion model; includes source emissions model

  ◦ **MODTRAC (Wind Field Module)** (Intera Technologies Ltd.)
    diagnostic mesoscale wind field model (layered modified potential flow)

• **MOE (Ministry of Environment, Ontario CANADA)**
  *see OME*

• **MOE-PUFF** (MOE)
  *see OME-PUFF*
  ■ see ref. in OME-PUFF*

• **MOMENTS** (SRL)
  mesoscale dispersion model employing the method of moments

  ◦ **MONSANTO Vaporization Model** (Monsanto)
    vaporization model for emergency response calculations
• **MPDA-1** (Meteorological Processor) (U.S. Environmental Protection Agency)  
  *Meteorological Processor for Diffusion Analysis*  
  set of subroutines for the estimation of wind, temperature, and turbulence profiles from hourly meteorological data  

• **MPSDM** (ERT, Inc.)  
  (EPA-1986 “alternative”, was part of UNAMAP-6)  
  *Multiple Point Source Diffusion Model*  
  analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model for inert (or linearly reactive) pollutants in simple or complex terrain  
  ■ U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

• **MPTER** (U.S. Environmental Protection Agency)  
  (EPA-1986 “preferred”, was part of UNAMAP-6; ARB-1989 “preferred”)  
  *Multiple Point Gaussian dispersion with TERain adjustment*  
  analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model for inert (or linearly reactive) pollutants (see also the California ARB 1989 Guidelines for additional information)  

• **MPTER-DS** (U.S. Environmental Protection Agency)  
  *MPTER/Deposition, Sedimentation*  
  version of MPTER* including simple description of sedimentation and deposition  
MRI (Meteorology Research Inc.) Models
see GRID/MRI

- MROAD2
  (Systems, Science and Software)
  2D numerical grid-based model for inert (or linearly reactive) pollutants from line (traffic) sources

- MSDM
  (Lawrence Livermore N.I. for US DOE)
  Multiple Source Dispersion Model
  analytical (Gaussian plume) micro- to mesoscale, short term or sequentially long term model for inert (or linearly reactive) pollutants

- MTDDIS
  (EPA-1986 “alternative”)
  (Combustion Engineering/Rockwell Int.)
  Mesoscale Transport, Diffusion and Deposition for Industrial Sources
  short term, mesoscale, forward trajectory model for inert (or linearly reactive) pollutants over rolling terrain

- MULTILAYER AIR QUALITY MODEL
  (Lawrence Livermore N.I.)
  3D episodic, regional scale, grid-based model for reactive pollutants

- MULTIMAX
  (Shell Development Co.)
  (EPA-1986 “alternative”)
  a multiple source version of CRSTER*
  ■ U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R
• MVM (Shell Development Co.)

modified version of MULTIMAX* using on-site meteorological data and variable height terrain

National Center for Atmospheric Research (NCAR) Models
see MM4, NGM, RADM/NCAR

○ NCM (ICF for EIA)
  National Coal Model
  utility sector analysis model for use in studies of alternative emissions reduction strategies

○ NCAR Wind Field Model (NCAR)
  see MM4
  □ see ref. in MM4

○ NEWEST (Wind Field Module) (Form and Substance)
  enhanced version of WEST*
● NEXUS L,P *(Systems, Science, and Software)*

_Numerical EXamination of Urban Smog_

see PICK/NEXUS-L,P*


○ NGM (Wind Field Module) *(NCAR)*

_Nested Grid Model_

3D (with terrain-following, normalized, vertical coordinate) prognostic mesoscale wind field model; it uses the primitive equations (nonhydrostatic or hydrostatic/anelastic) and considers surface effects, topography, latent heating


● NILU *(Eidsvåg/NIAR)*

heavy gas dispersion model


* NIPH (National Institute for Public Health, Netherlands) Models

see GRID/NIPH, PUFF/NIPH, RIV


2D trajectory (horizontally resolved), short term, synoptic scale model with complex HC, NOx, SO2 chemistry (100 reactions, 40 species including O3)

NOAA/ERL, LAMP/FRANCE (Wind Field Module) (NOAA)
3D (with surface pressure-following, normalized, vertical coordinate) prognostic mesoscale wind field model; it uses the primitive equations (hydrostatic) and considers surface effects, topography, latent heating


- NONLINEAR ROLLBACK/ROLLFORWARD (U.S. EPA)
  see ROLLBACK/ROLLFORWARD (NONLINEAR)
  • see ref. in ROLLBACK/ROLLFORWARD (NONLINEAR)*

- Norwegian Institute for Air Research (NIAR) Models
  see EMEP-MSCW, HOV, NLLRT-ABLC

- Norwegian Meteorological Institute (NMI) Models
  see NLLRT-ABLC, OECD(ECE)

- NTIS (National Technical Information Service Models)
  Various air quality related models are currently available (on MS-DOS compatible diskettes) from NTIS. These include EPA Regulatory Models (BLP, CALINE3, CDM2, COMPLEXI, CRSTER, ISCLT, ISCST, LONGZ-SHORTZ, MPRM 1.1, MPTER, PTPLU, RAM, RTDM, VALLEY), Air Quality Simulation Models from the Office of Research and Development (APRAC-3, HIWAY-ROADWAY, INPUFF, MESOPUFF, MPTDS, PAL, PBM, PEM, PLUVUE, TUPOS), and Utility Programs (the UTIL-1 disk, containing CALMPRO, RUNAVG, UTMCON, and CHAVG). Information and pricing for these models can be obtained from the Federal Computer Products Center on (703) 487-4763 and orders can be placed at the NTIS Sales Desk on (703) 487-4650
• **OCD III**
  *Offshore and Coastal Dispersion model*
  analytical (Gaussian) sequential (hourly steady state) plume model appropriate for offshore (typically, emissions from oil and gas operations on the outer continental shelf) and near-shore point sources, that incorporates overwater plume dispersion and changes that occur as the plume crosses the shoreline; it is an extension of MPTER* modified to handle coastal micrometeorology (see also the California ARB 1989 Guidelines for additional information)

• **OCD IV**
  (Sigma Research Corporation for MMS)
  *Offshore and Coastal Dispersion model*
  enhanced version of OCD-III
  - currently under development

• **OCDCPM**
  (ERT, Inc./EPA Region IX)
  variation of OCD
• **OECD (ECE), OECD-NILU**
  **(Norwegian Meteorological Institute, Oslo)**
  2D trajectory (horizontally resolved), long term, regional to synoptic scale model with SO$_2$, SO$_4^{2-}$ chemistry

• **OMEGA**
  **(Center for Energy and Env. Studies, Carnegie Mellon)**
  Optimization Model for Emissions Generating Alternatives
cost minimizing linear program for examining alternative emissions reduction schemes

* **OME (Ontario Ministry of the Environment, Canada) Models**
  see OME-LTP, OME-PUFF, OME-STATMOD PORT COMP SYSTEM

• **OME-LTP**
  **(OME, Ontario)**
  Lagrangian Trajectory Puff model
  see OME-PUFF*

• **OME - PUFF**
  **(OME, Ontario)**
  quasi 2D (Gaussian profile horizontally) trajectory (horizontally resolved), sequentially long term, regional to synoptic scale model with linear SO$_2$, SO$_4^{2-}$ chemistry

• **OME-STATMOD**
  **(OME, Ontario)**
  **OME-STATistical Acid Deposition MODEl**
  see STADMOD*
• OML  
(Danish Natl. Agency of Environ. Protection)  
*Operationelle Meyerologiske Luftkvalitetsmodeller*  
analytical (Gaussian plume) micro- to mesoscale, short term, model for  
inert (or linearly reactive) pollutants from point sources

paper no.4-9 in Proceedings of the DOE/AMS Air Pollution Model  
DP-1701-1, DE-AC09-76SR00001 (edited by A.H. Weber and A.J. Gar-  
rett)

• OOMS  
(Ooms et al.)  
heavy gas dispersion model

Dispersion Models. Center for Chemical Process Safety of the American  
Institute of Chemical Engineers

* ORNL (Oak Ridge National Lab.) Models  
see ATM, ORNL-ATM, PHENIX, RETADD

• ORNL-ATM  
(Oak Ridge N.L.)  
*ORNL- Atmospheric Transport Model*  
statistical (climatological) regional scale trajectory model for inert (or  
linearly reactive) pollutants

- Culkowski, W.M. and M.R. Patterson, 1976: “Comprehensive Atmospheric  
ORNL/NSF/EATC-17, Oak Ridge National Laboratory, 128 pp.

• OZIPP/EKMA  
(U.S. Environmental Protection Agency)  
(regulatory EPA modeling procedure)  
*OZone Isopleth Plotting Package/EKMA*  
employs EPA's EKMA to calculate isopleths of daily maximum hourly  
average concentrations as a function of morning concentrations of  
NMOC and NO<x>2; it uses the EPA chemical mechanism

ozone isopleth plotting package. EPA-600/3-77-011 U.S. Environmen-  
tal Protection Agency

• OZONE LIMITING METHOD  
(U.S. Environmental Protection Agency)  
(screening EPA procedure)  
screening method for calculating bounds for NO to NO<x>2 conversion in  
point source plumes (see for example the reference below)

for estimating short-term NO<x>2 concentrations,” *JAPCA*, 29, 812-817
*Pacific Environment Services Models*

see REM-1, REM-2

*Pacific Southwest FRES Models*

see KRISSY

- **PAL**
  
  *(U.S. Environmental Protection Agency)*

  Point, Area, Line source model

  various versions of the guidelines Gaussian plume model PAL; see PAL-DS*

  ■ see ref. in PAL-DS

- **PAL-DS**
  
  *(U.S. Environmental Protection Agency)*

  (EPA-1986 “alternative”, was part of UNAMAP-6)

  PAL/Deposition, Sedimentation

  analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model for inert (or linearly reactive) pollutants

  ■ U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R
• PARADE

(PARADIGM/Systems Applications, Inc.)

Panache Reactif en Atmosphere avec DEpots

version of RPM* (with CARBON BOND IV) incorporating treatment of aerosols by MARS* and cloud chemistry and microphysics


• PARIS

(Systems Applications, Inc.)

Plume-Airshed Reactive Interacting System

extension of UAM* that incorporates separate (subgrid) treatment of large point sources via an RPM* type reactive plume model


• PATRIC, SEAC-PATRIC

(Lawrence Livermore N.I.)

3D particle-in-cell sequential puff code; developed as a simplified and accelerated version of ADPIC*


• PBM

(U.S. EPA)

Photochemical Box Model

single box model with photochemistry


• PBM/SAI

(Systems Applications, Inc.)

Photochemical Box Model

single box model with photochemistry; for various (early) versions of CARBON BOND*

see ref. in CARBON BOND
• PDM (Systems Applications, Inc. for CARB)

*Plume Dispersion Model*

3D hybrid (grid/trajectory) short term, mesoscale model with SO₂, SO₄²⁻ chemistry; evolved to HYBRID


• PFPL (Savannah River Lab.)

*Puff-PLume model*

analytical (Gaussian puff/plume) model for inert (or linearly reactive) pollutants


• PHENIX (Oak Ridge N.L.)

2D grid-based short term, regional scale model with pseudospectral treatment of transport and linearized sulfur chemistry (similar to PSM*)


• PHOTO2 Chemical Rates Estimator (Lawrence Livermore N.L.)

estimates photodissociation constants given vertical concentration profiles of atmospheric constituents


• PIC or PICK/NEXUS/L,P (Systems, Science, and Software)

two versions of a particle-in-cell/K-theory dispersion model incorporating the chemistry of DIFKIN*

• PLMSTAR (ERT, Inc.)
  (EPA-1986 “alternative”; ARB-1989 “preferred”)
  3D (multilayer/multicolumn, constant control volume) episodic forward and backward trajectory model with complex gas phase photochemistry (see also the California ARB 1989 Guidelines for additional information)

• PLMSTAR/SAI (Systems Applications, Inc.)
  as in the ERT PLMSTAR but with modified gas phase chemistry and with modules for aerosol, cloud, and fog chemistry

• PLUME-5 (PGE) (Pacific Gas and Electric Co.)
  (EPA-1986 “alternative”)
  analytical steady state (Gaussian plume) micro- to mesoscale, short term, model for inert (or linearly reactive) pollutants
  ■ U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

• PLUMEPATH (Shell, Holland)
  analytical (Gaussian plume) episodic, micro- to mesoscale, heavy gas dispersion model

• PLUVUE (U.S. Environmental Protection Agency)
  simulates visual effects of particulate plumes; superseded by current version of the guidelines model PLUVUE-II*
• PLUVUE-II  
(U.S. Environmental Protection Agency)  
(EPA-1986 "alternative", was part of UNAMAP-6)  
estimates visual range reduction and atmospheric discoloration by  
plumes resulting from the emissions of particles, nitrogen oxides, and  
sulfur oxides from a single (point or area) source  
- U.S. Environmental Protection Agency (1986) Guideline for Air Quality  
Models (Revised) EPA-450/2-78-027R

○ PLUVIUS  
(Pacific Northwest Lab.)  
precipitation and wet and dry deposition model  
dimensional model of reactive pollutant behavior, including dry deposi-  
tion, precipitation formation, and wet removal. PNL-4046 ED 2, UC-11.  
Prepared for the U.S. Environmental Protection Agency. Pacific North-  
west Lab., operated for the U.S. DOE by Battelle Memorial Institute.

* PNL (Pacific Northwest Lab./Battelle) Models  
see ANDEP, MELSAR, MESOI, MLRAPT, PLUVIUS,  
PNL TRAJECTORY, PROTEUS, RAPT, STRAM,  
WP

• PNL TRAJECTORY  
(Pacific Northwest Lab.)  
superseded by RAPT, MLRAPT  
Laboratories for the American Petroleum Institute, p.3-75

• PORT COMP SYSTEM  
(OME)  
heavy gas dispersion model  
Dispersion Models. Center for Chemical Process Safety of the American  
Institute of Chemical Engineers

• PPFL  
(SRL)  
same as PFPL*  
- see ref. in PFPL; also paper no.4-8 in Proceedings of the DOE/AMS Air  
Pollution Model Evaluation Workshop, Kiawah, South Carolina, October  
and A.J. Garrett)
• PROBAQM (INCO, Inc. for Federal Highway Administration)
  Probabilistic Air Quality Model for highways
  analytical (Gaussian plume) short term, micro- to mesoscale model for pollutants from line (traffic) sources designed to calculate probabilities of violation of air quality standards; supersedes and replaces the PROBCO, PROBCO1, and SIMCO, SIMCO1 models

• PROBCO, PROBCO11 (Federal Highway Administration)
  superseded by PROBAQM

• PPSP (Maryland Dept. for Natural Resources)
  (EPA-1986 “alternative”)
  Maryland Power Plant Siting Program
  enhanced multisource version of CRSTER* applicable to tall stacks in flat terrain, urban or rural
  - U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

• PROTEUS (Pacific Northwest Lab.)
  3D short term micro- to mesoscale forward trajectory model with simplified photochemistry

• Pseudospectral Grid Model (Risø N.L., Denmark)
  see PSM
  - see ref. in PSM

• PSM (Risø N.L., Denmark)
  Pseudo Spectral Model
  2D grid based (horizontally resolved), short term, synoptic scale model with SO2, SO4^2^- chemistry
- **PTDIS**
  
  *(U.S. Environmental Protection Agency)*
  
  *Point-DISTance Model*
  
  analytical (Gaussian plume) short term, micro- to mesoscale model for point sources; performs calculations only directly downwind from the source; one of the original UNAMAP models
  

- **PTFUM, PTFUMOW**
  
  *(CARB AQMS)*
  
  *Point FUMigation, Point FUMigation Over Water*
  
  analytical models applying Turner’s fumigation procedure for overland use (with PTDIS dispersion parameters) and for offshore sources in coastal areas
  

- **PTMAX**
  
  *(U.S. Environmental Protection Agency)*
  
  *Point MAXimum model*
  
  analytical (Gaussian plume) short term, micro- to mesoscale model for point sources; one of the original UNAMAP models
  

- **PTMOCs**
  
  *(Applied Modeling, Inc.)*
  
  *Point source model for Overwater-Complex Terrain Setting*
  
  analytical (Gaussian plume) model incorporating shoreline fumigation from onshore and offshore point sources with dispersion treated as in PTMTP* (the long term version is CDMOCS*)
  
• PTMTP  
(U.S. Environmental Protection Agency)  
PoinT-MultIple PoinT model  
analytical (Gaussian plume) short term, micro- to mesoscale model for point sources; one of the original UNAMAP models


• PTPLU  
(U.S. Environmental Protection Agency)  
PoinT PLUme model  
analytical (Gaussian plume) model


• PUFF/NIPH  
(NIPH, The Netherlands)  
quasi 3D (multilayer, Gaussian profile horizontally) short term, mesoscale forward trajectory model with linearized sulfur chemistry


• PUFF/PLUME  
(SRL)  
see PFPL*


• PW Chemical Mechanism  
(Lawrence Livermore N.L.)  
Penner and Walton mechanism  
see LLNL Chemical Mechanism*

- see ref. in LLNL Chemical Mechanism*
• QSM  
(Air Quality Branch, Tennessee Valley Authority)  
Quasi Steady Model

time dependent (quasi-steady) segmented Gaussian plume model for ground level concentrations from multiple sources and variable height terrain

- **RAD1 (Solar Radiation Model)**  
  (Lawrence Livermore N.L.) 
  solves the radiative transfer equation for various atmospheric conditions


- **Radian Corporation Models**  
  see CHARM, IMPACT

- **RADM**  
  (Dames & Moore)  
  (EPA-1986 “alternative”)  
  Random Walk Advection and Dispersion Model

  see DM-RADM

  - U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R
• RADM (grid)  
  (ARB-1989 “emergent”)
  
  Regional Acid Deposition Model
  3D grid based, episodic to long term, regional to synoptic scale model with homogeneous gas phase \( \text{SO}_x / \text{NO}_x / \text{RHC} \) chemistry, and cloud physics module coupled with aqueous phase equilibrium chemistry; focuses on acidic deposition (see also the California ARB 1989 Guidelines for additional information)

  NCAR (1985) The Regional Acid Deposition Model, NCAR/TN-256+STR, National Center for Atmospheric Research, Boulder, CO

• RADM (trajectory)  
  (NCAR)
  
  Regional Acid Deposition Model
  2D trajectory (horizontally resolved), long term, regional to synoptic scale model with \( \text{SO}_2, \text{SO}_4^{2-} \) chemistry

  see ref. in RADM (grid)*

• Ragland & Pierce’s model  
  (K.W. Ragland and J.J. Pierce)
  
  2D numerical grid-based short term model for line (traffic) sources


• RAM  
  (U.S. Environmental Protection Agency)
  (EPA-1986 “preferred”, was part of UNAMAP-6; ARB-1989 “preferred”)
  
  analytical (straight line, hourly steady state) Gaussian, short term (or sequentially long term), micro- to mesoscale plume model for inert (or linearly reactive) pollutants (see also the California ARB 1989 Guidelines for additional information)

- **RAMF, RAMFR**  
  (U.S. Environmental Protection Agency)  
  **RAM/Frequency/Frequency Rural**  
  frequency/long term version of RAM*  

- **RAMMET**  
  (U.S. Environmental Protection Agency)  
  **RAM/METeorology**  
  meteorological data preprocessor program for RAM and other UNAMAP models  
  ■ see ref. in RAM*, RAMF*

- **RAMR**  
  (U.S. Environmental Protection Agency)  
  **RAM/Rural**  
  rural conditions version of RAM*  
  ■ see ref. in RAM*, RAMF*

- **RAPT**  
  (Pacific Northwest Lab.)  
  **Regional Air Pollution Transport**  
  2D trajectory (horizontally resolved), long term, regional to synoptic scale model with SO$_2$, SO$_4^{2-}$ chemistry  

- **RAQSM/ROM**  
  (Env. Sci. Res. Lab.)  
  **Regional Air Quality Simulation Model/ROM**  
  see ROM*  
  ■ see ref. in ROM*

- **RCDM**  
  (Teknetron Research, Inc.)  
  **Regional Climatological Dispersion Model**  
  analytical (solution of the Atmospheric Diffusion Equation) long term (based on statistics of trajectories) synoptic scale model with linear sulfur chemistry  
• **RCDM-2**

  *Regional Climatological Dispersion Model-2*

  enhanced version of RCDM-1

  Niemann, B.L. and E.H. Pechan, 1981: “Model Profile-Documentation of the Regional Climatological Dispersion Model (RCDM),” Work Group 2, Report No. 2-9, Atmospheric Sciences and Analysis Work Group, established under the Memorandum of Intent on Transboundary Air Pollution signed by the U.S. and Canada on August 5, 1981.

• **RCDM-3**

  *Regional Climatological Dispersion Model-3*

  extension of RCDM-2

  see ref. in RCDM-2

• **REGMOD**

  *Regional Climatological Dispersion Model*

  short term, regional scale grid-based model (pseudospectral treatment of advection) with linearized sulfur chemistry


• **REM-1, REM-2**

  *Regional Emissions Projection System*

  2D (horizontally resolved) trajectory mesoscale, short term model incorporating photochemistry (31 and 34 reactions in REM-1 and REM-2 respectively); evolved to TRACE(PES)*


• **REPS**

  *Regional Emissions Projection System*

  estimates emissions for five criteria pollutants from data on existing sources for the 243 Air Quality Control Regions in the U.S.

• **RETADD**  
  (Oak Ridge N.I.)  
  mesoscale, sequentially long term, trajectory model for single sources  

• **RIMPUFF**  
  (Risø N.I., Denmark)  
  analytical (Gaussian puff) episodic, micro- to mesoscale, model for inert (or linearly reactive) pollutants (a modified version is being used to estimate concentrations of pollutants released during shuttle launches at Vandenberg AFB)


• **Risø National Lab. (Denmark) Models**  
  see HEAVUPUFF, RIMPUFF, VAPID

  ◦ **Ritter’s (Cloud Physics Model)**  
  (NCAR)  
  cloud flux model; incorporated in NCAR/RADM*  

• **RIV**  
  (NIPH, the Netherlands)  
  3D hybrid (grid/trajectory) short term, mesoscale to regional model with SO₂, SO₄²⁻ chemistry


• **RIVAD**  
  (Systems Applications, Inc.)  
  *Regional Impact on Visibility and Acid Deposition*  
  1D expanding control volume forward trajectory regional scale short term or sequentially long term model with linearized sulfur and nitrogen chemistry; includes calculation scheme for visibility effects

\* **RNMI Models**

see KNMI Models

\* **Rockwell Models**

see MTDDIS

- **ROLLBACK**

  (U.S. EPA)

  diagnostic (statistical) model for air quality projections from past data


- **ROLLBACK/ROLLFORWARD (NONLINEAR)**

  (U.S. EPA)

  extension of ROLLBACK*


- **ROM/SAI**

  (Systems Applications, Inc.)

  superseded by RTM-II*


- **ROM**

  (U.S. Environmental Protection Agency)

  (ARB-1989 "emergent")

  Regional Oxidant Model

  currently under continuing development (see also the California ARB 1989 Guidelines for additional information)

- **RPM-II**
  
  (EPA-1986 “alternative”; ARB-1989 “preferred”)

  *Reactive Plume Model*

  2D (multicolumn, expanding control volume) episodic forward trajectory model with complex photochemistry (gas phase) (see also the California ARB 1989 Guidelines for additional information)


- **RPM-IISS and other versions**
  
  *Reactive Plume Model*

  variations and simplifications of RPM-II


- **RPM-IV**
  
  (EPA-1986 “alternative”; ARB-1989 “preferred”)

  *Reactive Plume Model*

  2D (multicolumn, expanding control volume) episodic forward trajectory model with complex photochemistry (gas phase) (see also the California ARB 1989 Guidelines for additional information)

Compendium of Air Quality Related Models 1991

- **RTDM** (ERT, Inc.)
  
  (ARB-1989 “preferred”)
  
  *Rough Terrain Dispersion Model*
  
  analytical (Gaussian plume) short term, local scale model for dispersion of inert (or linearly reactive) pollutants over complex terrain; (see also the California ARB 1989 Guidelines for additional information)
  

- **RTM-II** (Systems Applications, Inc.)
  
  (EPA-1986 “alternative”, ARB-1989 “preferred”)
  
  *Regional Transport Model-version 2*
  
  quasi 3D (2 layer) hybrid (grid/puff) short term, regional scale model with linearized SO₂, SO₄²⁻ chemistry (see also the California ARB 1989 Guidelines for additional information)
  

- **RTM-III** (Systems Applications, Inc.)
  
  (ARB-1989 “emergent”)
  
  *RTM-version 3*
  
  extension of RTM-II with gas phase photochemistry and cloud physics and chemistry; currently under continuing development
  

- **RTM-LT** (Systems Applications, Inc.)
  
  *RTM/Long Term*
  
  3D long term, regional scale, grid-based model with linearized sulfur chemistry
  
• **SACTI**  
  (EPRI)  
  cooling tower plume dispersion model; describes plume rise, atmospheric transport, drop evaporation, fog development, plume shadowing, and ground level icing  

• **SAFE**  
  (AOSTRA, Edmonton/Alberta)  
  numerical, episodic, micro- to mesoscale model for emergency response calculations  

• **SAFEMODS**  
  (TMS)  
  quasi 2D episodic, micro- to mesoscale heavy gas dispersion model; includes source emissions model  

• **SAFER**  
  (Safer, CA)  
  quasi 2D episodic, micro- to mesoscale model; includes source emissions model  
- **SAFETI**
  (Technica, London)
  quasi 2D episodic, micro- to mesoscale heavy gas dispersion model; includes source emissions model

- **SAI (Systems Applications, Inc.) Models**
  see BPM, Carbon Bond Chemical Mechanism, CCADM, CTWM, HYBRID, KW Chemical Mechanism, LPM, MARS, PARIS, RDM, RIVAD, ROM/SAI, RPM II, RTM-II, RTM-LT, UAM

- **SAI, SAI/EPA**
  (Systems Applications, Inc./ U.S. EPA)
  versions of UAM*

- **SAIASP**
  (Systems Applications, Inc.)
  SAI AirShed Pollution model
  version of UAM*

- **Savannah River Lab. Models**
  see CHAPEAU, MOMENTS, PFPL, SHEAR-ROSE, SPM, SRL-2DFLOW, XOQDOQ

- **SAPRC Chemical Mechanism**
  (Statewide Air Pollution Research Center)
  (state-of-the-art atmospheric photochemistry)
  a “lumped molecule” gas phase mechanism for photochemical smog formation (earlier versions are also referred to as ALW* or Atkinson-Lloyd-Winges mechanism, as CALL* or Carter-Atkinson-Lloyd-Lurmann mechanism, and as the ERT Chemical Mechanism*)
• SCAM (Geomet, Inc.)

_Sampled Chronological Air Quality Model_

see SCIM*


• SCAR/LRTM (Scandinavian Council Appl. Res., Finland)

_SCAR/Long Range Transport Model_

regional scale trajectory model


○ SCHEME (Chemical Mechanism) (Brookhaven N.I.)

_Surrogate CHEmical MEchanism_

surrogate species chemical mechanism incorporating gas phase SO\textsubscript{2} oxidation; superseded by improved schemes


○ Schatzmann’s Plume Rise Model (Schatzmann)

numerical (similarity) models for (dry or “wet”) plume rise (or descent) in arbitrarily stratified atmospheres


*Science Applications Inc. Models*

see DEPICT, SIGMET, SIGMET-N, WEST

• SCIM (Geomet, Inc.)

_Sampled Chronological Input Model_

analytical (Gaussian plume) model for inert (or linearly reactive) pollutants

• SCIMP (EPRI)

*Second order Closure Integrated Model Plume*

numerical model for the variance (and mean) of plume concentrations


• SCSTER (Southern Company Services, Inc.)

(EPA-1986 “alternative”) enhanced, multisource version of CRSTER*

U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

• SEAC-PATRIC (Lawrence Livermore N.I.L.)

see PATRIC*


• SEQUILIB (Caltech)

thermodynamic equilibrium model for the prediction of mass and chemical composition of atmospheric aerosols containing sulfate, nitrate, ammonia, water, and organics

currently under continuing development

• SHAPE (Stanford University)

*Simulation of Human Air Pollution Exposures*

uses Monte Carlo techniques to simulate carbon monoxide exposure of populations


• SHEAR-ROSE (Savannah River Lab.)

meso- to regional scale trajectory model for inert (or linearly reactive) pollutants

* Shell Development Co. (Houston, TX) Models
  see MULTIMAX, MVM, SPILLS

* Shell (Holland) Models
  see HEGADAS, PLUMEPATH

* Shir & Shieh's model (IBM)
  3D or 2D grid-based model for the numerical solution of the advection-diffusion equation for inert pollutants (employs various schemes to minimize numerical diffusion)

* SHORTZ (U.S. Environmental Protection Agency, Region III)
  (EPA-1986 "alternative"; ARB-1989 "alternative")
  analytical (Gaussian) plume model for a variety of sources in flat or complex terrain, urban or rural and for inert (or linearly reactive) pollutants (see also the California ARB 1989 Guidelines for additional information)

* Sigma Research Corporation Models
  see CALPUFF, CTSG

* SIGMET (Science Applications, Inc.)
  3D numerical heavy gas dispersion model for LNG vapor clouds

* SIGMET2 (Environmental Applications, Inc.)
  3D numerical heavy gas dispersion model
• SIGMETN  
  (Science Applications, Inc.)
  3D numerical heavy gas dispersion model

• SIMCO, SIMCO1, SIMNO2  
  (Federal Highway Administration)
  superseded by PROBAQM*

• SIMPLEX ‘A’  
  (FAA)
  superseded by GIMM*
  ■ see ref. in GIMM*

• SLAB  
  (Lawrence Livermore N.I.)
  single box, episodic, micro- to mesoscale heavy gas dispersion model; includes source emissions model

• SLDM  
  (Stunder and SethuRaman)
  ShoreLine Dispersion Model
  analytical (Gaussian puff/plume) model incorporating scheme for shoreline fumigation calculations

• SLSM  
  (EPA-1986 “alternative”)
  (General Motors)
  Simple Line Source Model
  see GMLINE*
  ■ see ref. in GMLINE*
○ **SMICK (Wet Removal Model)**  
*Scavenging Model Incorporating Chemical Kinetics*  
simulates precipitation scavenging and aqueous phase kinetics  

- **SMOG**  
*Simulation Model of Ozone Generation*  
3D short term, mesoscale, grid-based model incorporating photochemistry  

- **SPECTRA**  
*mesoscale trajectory (segmented Gaussian plume) model*  

- **SPILLS**  
*analytical (Gaussian puff/plume) “emergency response model”; simulates evaporation/atmospheric dispersion from accidental spills*  

- **SPM**  
*Sequential Plume Model*  
mesoscale trajectory model intended primarily for radioactive (linearly decaying) pollutants  

* **SRI International Models**  
see APRAC, COMPLEX/PFM, ENAMAP-1, ENAMAP-2s and 2N, EURMAP-1, EURMAP-2A and 2B, SRI-COMPLEX, SRI-PUFF
- **SRI-COMPLEX (Wind Field Module)** (SRI International)
  3D (with terrain-following, normalized, vertical coordinate) diagnostic mesoscale wind field model; it uses the continuity equation (adiabatic); considers topography

- **SRI-PUFF** (SRI International)
  analytical (Gaussian puff/plume) episodic, micro- to mesoscale dispersion model

- **SRL Models**
  see Savannah River Lab. Models

- **SRL-2DFLOW (Wind Field Module)** (Savannah River Lab.)
  2D prognostic mesoscale wind field model; it uses the primitive equations (hydrostatic/diabatic) and considers topography and surface effects

- **Stanford Research Institute Models**
  see SRI International Models

- **STACMAP** (KII, Haag)
  variation of CDM* providing wide choice of input parameters

- **STADMOD** (OME, Ontario)
  *Statistical Acid Deposition Model*
  2D statistical (climatological) regional scale, long term, trajectory model with linearized sulfur and nitrogen chemistry
• STEM-1
ARB-1989 “alternative”
Sulfur Transport Eulerian Model-1
3D (grid based) regional model with linearized sulfur chemistry (see also the California ARB 1989 Guidelines for additional information)

• STEM-2
ARB-1989 “emergent”
Sulfur Transport Eulerian Model-2
3D (grid based) regional model with SOx/NOx/RHC multiphase chemistry (chemical equilibrium for aerosol and aqueous phase) and acidic deposition (see also the California ARB 1989 Guidelines for additional information)

• STOCHACID
(U. of Michigan)
long term, regional scale trajectory model (variation of ACID*)

• STRAM
(Pacific Northwest Lab. for U.S. EPA)
Source-Transport-Receptor Analysis Model
trajectory model with non-linear sulfur chemistry

• STRAP
(Argonne N.I.)
long term (climatological) trajectory model with linearized sulfur chemistry
- **STRATSCAV** (Wet Removal Model)  
  Lawrence Livermore N.L.)  
  estimates scavenging and deposition by stratified precipitation  

- **SULDEP1**  
  (Western Research, Calgary)  
  *SULfur DEPosition, version 1*  
  superseded by SULDEP2  
  Western Research, 1978: “First Order Estimates of Sulphur Deposition in the Region of Representative Point Sources,” Alberta Environment, Pollution Control Division, Edmonton, Alberta.

- **SULDEP2**  
  (Alberta Environment, Edmonton)  
  *SULfur DEPosition, version 2*  
  regional scale trajectory model with sulfur chemistry and deposition  

- **SULFA3D**  
  (ERT, Inc.)  
  3D meso- to regional scale grid-based model (employs moment method for advection calculations); superseded by MESOGRID*  

- **SURAD**  
  (ERT, Inc.)  
  3D meso- to regional scale grid-based model (employs moment method for advection calculations)  

- **Systems Applications, Inc., Models**  
  see SAI Models

- **Systems, Science and Software Models**  
  see PICK/NEXUS/LP
- **TALD** (*Dept. de Protection, France*)
  regional scale trajectory model for single sources and radioactive (linearly decaying) pollutants

- **TCM-2** (*Texas Air Control Board*)
  (EPA-1986 “alternative”)
  Texas Climatological Model
  analytical climatological (Gaussian plume) mesoscale model; based on CDM*
  - U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

- **TCM (other versions)** (*Texas Air Control Board*)
  supersedes TCM-2*

- **TDMB (THD)** (*Technische Hochschule, Darmstadt, FRG*)
  grid-based mesoscale model for inert (or linearly reactive) pollutants
• TECJET
   (Technica, London)
   heavy gas dispersion model; includes source emissions model

• Technica (London, U.K.) Models
   see SAFETI, TECJET

• Teknetron Research Inc. Models
   see RCDM, RCDM-1, RCDM-2, TEKNETRON GRID

• TEKNETRON GRID
   (Teknetron Research, Inc.)
   2D grid based (horizontally resolved), short term, synoptic scale model with SO₂, SO₄²⁻ chemistry (version of REGMOD*)

• TEM-8
   (EPA-1986 “alternative”)
   Texas Episodic Model
   episodic, micro- to mesoscale, analytical (Gaussian plume) model for inert (or linearly reactive) pollutants
   ■ U.S. Environmental Protection Agency (1986) Guideline for Air Quality Models (Revised) EPA-450/2-78-027R

• TEM (other versions)
   (Texas Air Control Board)
   Texas Episodic Model
   superseded by current version of the guidelines model TEM-8*

• Texas Air Control Board Models
   see TCM, TEM
- **TEXIN**
  (Texas A&M/Texas Transportation Inst.)
  model for estimation of traffic parameters; estimation of vehicle emissions; estimation of dispersion from road intersections (incorporates MOBILE-2* and CALINE3*)

- **TGD-EQ**
  (Environment Quebec)
  statistical trajectory model with simplified sulfur chemistry

- **THD Models**
  see TDDB(THD)

- **TNO**
  (TNO, the Netherlands)
  analytical mesoscale model for inert (or linearly reactive) pollutants

- **TNO/SAI Airshed Model**
  (TNO, the Netherlands)
  adaptation of UAM*

- **TOXCOP**
  (NAS)
  simplified “emergency response model”

- **TOXGAS**
  (McCready et al.)
  “hazardous gas release” model
• **TRACE (PES)** (Pacific Environmental Services, Inc.)

*Trajectory Atmospheric Chemistry and Emissions*

3D trajectory, short term, mesoscale model with photochemistry


• **TRACE (AMI)** (Applied Modeling, Inc.)

*Trajectory Atmospheric Chemistry and Emissions*

3D trajectory, short term, mesoscale model with complex photochemistry (Falls-Seinfeld-McRae mechanism)


• **TRACER Trajectory Model** (Lawrence Livermore N.I.)

Models trajectories of emissions (no dispersion) on a continental scale for periods of days to several weeks


• **TRANS** (Canada)

*Transport of Anthropogenic Nitrogen and Sulfur*

Quasi 3D (multilayer, Gaussian profile horizontally) meso- to regional scale short term or sequentially long term forward trajectory model with linearized sulfur and nitrogen chemistry


• **TRANSLOG** (Battelle Inst., Frankfurt)

3D numerical heavy gas dispersion model


• **TRAPS (various versions)** (Texas A & M)

*Texas Roadway Air Pollution Simulator*

Analytical (Gaussian plume) model for line (traffic) sources

• TRAUMA
  (SRD, U.K.)
  single box, episodic, micro- to mesoscale model; includes source emissions model

• TRPM
  (Caitech)
  (ARB-1989 “emergent”)
  Turbulent Reacting Plume Model
  3D (multilayer, multicolumn) micro- to mesoscale, episodic to short term, forward trajectory model focusing on nonlinear NOx/O3 chemistry; incorporates explicitly effects of micromixing (fine scale fluctuations) and macromixing on chemical conversions; employs the LPFM* to calculate plume concentration fluctuations and a concentration field splitting method to obtain closure for turbulent chemical kinetics terms; currently under continuing development (see also the California ARB 1989 Guidelines for additional information)

* TRW Models
  see AQDM

* TVA (Tennessee Valley Authority) Models
  see ARRP, BLM, QSM

• 2BPUFF
  (Lawrence Livermore N.L.)
  2D axially symmetric mesoscale trajectory model for inert (or linearly reactive) pollutants

○ 2DFLOW
  (Savannah River lab.)
  see SRL-2DFLOW
  ■ see ref. in SRL-2DFLOW
UAM (Systems Applications, Inc./U.S. EPA)  
(EPA-1986 “preferred”; ARB-1989 “preferred”; available through the SCRAM BBS)

*Urban Airshed Model*

3D, urban scale, grid-based model with complex multiphase (gas and aerosol) photochemistry; the gas-phase chemistry version is recommended by EPA for regulatory applications (see also the EPA 1986/87 and the California ARB 1989 Guideline documents for additional information); the 1990 version incorporates the Carbon Bond IV Chemical Mechanism and various other improvements

**UMACID/ANTACID**  (U. of Michigan)

variations of ACID*


**UNAMAP models**

The User’s Network for Applied Modeling of Air Pollution (UNAMAP) compilation of computer programs, which in the past was offered on magnetic tape from NTIS, is no longer available (last version: UNAMAP-6). However most of the models previously included in UNAMAP have been updated and are available individually from NTIS on diskettes and/or from the SCRAM BBS (see also model listings under NTIS* and SCRAM*).

**UNAMAP Original Models**

APRAC, CDM, HIWAY, PTDIS, PTMAX (May 1973); CDMQC, CRSTER, PAL, VALLEY, RAM (added March 1978)

**University of Iowa Models**

see STEM-1, STEM-2

**University of London Models**

see MACHTA

**University of Michigan Models**

see ACID, STOCHACID, UMACID/ANTACID

**University of Oslo Models**

see NLLRT-ABLC

**University of Stockholm Models**

see BAP

**University of Texas (Austin) Models**

see COAGUL, CONFEMM

**University of Uppsala Models**

see ENGER
University of Virginia Models
see UVMM

- U. of Washington (One-Level) Wind Model (U. of Washington)
  2D ("one level") prognostic mesoscale wind field model; it uses the primitive equations (hydrostatic/diabatic); considers topography, surface effects

- URBMET (Wind Field Module) (San Jose S.U./Stanford/EPRI)
  \textit{URBAN METeorology}
  prognostic mesoscale wind field model (appropriate for the coastal planetary boundary layer)

U.S. Air Force Models
see ESL, ILLE/SPRINGER

- USAF ESL Model (U.S. Air Force)
  see ESL*
  \[\text{see ref. in ESL*}\]

- U.S. Army Vaporization Model (U.S. Army)
  vaporization model for emergency response calculations

U.S. Coast Guard Models
see DEGADIS

- USPR (U. of Salford, UK)
  \textit{U. of Salford Plume Rise model}
  integral plume rise/analytical dispersion model
o **UVMM (Wind Field Module)**

(U. of Virginia)

*U. of Virginia Mesoscale Model*

prognostic mesoscale wind field model


- **UWATM-SOX**

(U. of Wisconsin)

*U. of Wisconsin Atmospheric Model for SOx*

grid-based regional scale model for SO2, SO4- dispersion

• VALLEY (U.S. Environmental Protection Agency)
  (ARB-1989 “alternative”)
  (see also the EPA 1986/87 and the California ARB 1989 Guideline documents for additional information)

• VALMET (Pacific Northwest Lab. for EPA)
  model for predicting concentrations in deep mountain valleys arising from nocturnal down-valley transport of an elevated plume, and the fumigation of the plume on the valley floor and sidewalls after sunrise (the VALMET code is available from NTIS)

• van Ulden's model (van Ulden)
  heavy gas dispersion model
• **VAPID**
  (RisøN.L., Denmark)
  heavy gas dispersion model; includes source emissions model
    Dispersion Models. Center for Chemical Process Safety of the American
    Institute of Chemical Engineers

  ○ **VARMET (Wind Field Module)**
    (Science Applications, Inc.)
    3D (with terrain-following, normalized, vertical coordinate) diagnostic
    mesoscale wind field model; it uses the continuity equation/variational
    relations (adiabatic) and considers topography
      proved Simulations of Mesoscale Meteorology. SAI-093-82-005LI, Sci-
      ence Applications, Inc., La Jolla, CA

  • **VARMINT**
    (JRB Associates)
    3D numerical grid-based model for the simultaneous calculation of flow
    and concentration fields
      Laboratories for the American Petroleum Institute, p.3-90

  • **Veltischeva’s model**
    (Hydrometeorological Research Center USSR)
    3D regional to synoptic scale, short term, grid-based model for SO₂
    dispersion
    ■ Veltischeva, N., 1979: “A Model for Evaluation of Trans-Boundary Sul-
      fur Dioxide Flux with the Inclusion of Vertical Motion,” in Proc. 10th
      NATO CCMS Int. Technical Meeting on Air Pollution Modelling and
      Its Applications, Rome, Italy.

  * **Virginia Highway and Transport Council Models**
    see AIRPOL-4 and 4A

  ○ **Visibility Models**
    see ERTVM, PLUVUE, RIVAD

  * **von Karman Institute Models**
    see Foussat’s model
• **Washington University (St. Louis) Models**
  see Gillani’s model, MCARLO

• **Webber’s model**
  heavy gas dispersion model

○ **WEST (Wind Field Module)**
  (Form & Substance/Science Applications, Inc.)
  *Wind Extrapolation from Stability and Terrain*
  diagnostic mesoscale wind field model (it uses interpolation formulas); wind field module of DEPICT*

• **Western Research (Calgary) Models**
  see SULDEP1

• **WHAZAN**
  (Technica, London)
  quasi 2D heavy gas dispersion model; includes source emissions model
• Wilson's model
  (Alberta Environment)
  model for dispersion from temporally varying sources

• WIND
  (SRL)
  emergency response system incorporating the PFPL* model; includes data gathering and archiving procedures

○ WINDS (Wind Field Module)
  (ERT, Inc.)
  diagnostic mesoscale wind field model

• WPD
  (Pacific Northwest Lab.)
  Wendell-Powell-Drake
  regional scale trajectory model with linear sulfur chemistry
- **XOQDOQ** *(Savannah River Lab.)*

analytical statistical (climatological) long term trajectory model for inert (or linearly reactive) pollutants

Yamada’s (Wind Field Model)


- **Zeman's model** (Zeman)
  
  heavy gas dispersion model
  

- **ZEPHYR** (ERCO Inc.)
  
  3D numerical heavy gas dispersion model
  