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DEVELOPMENT OF MESOSCALE AIR QUALITY SIMULATION MODELS
VOLUME 2. USER'S GUIDE TO MESOPLUME (MESOSCALE PLUME SEGMENT) MODEL

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1. INTRODUCTION

1.1 Background

In response to a growing national commitment to the use of indigenous coal reserves to meet energy generation demands, several regions of the country will see greatly expanded use of coal and oil shale resources for steam electric power plants and other coal-based energy resource development. But, as mandated by federal National Ambient Air Quality Standards, and by the PSD major source review procedures, additional coal-based energy resource development (ERD) will only be permitted where consistent with the maintenance of human health, welfare, and environmental quality. Accordingly, the siting and generation capacity of such ERD facilities may be constrained by their potential impacts on regional ambient air quality.

Various plans have been proposed for regional development of multiple major new facilities, and suitable air quality simulation tools are needed to assess the impacts of different energy development scenarios on regional-scale air quality.

To meet this need in the public interest, the National Oceanic and Atmospheric Administration (NOAA) has sponsored a study by Environmental Research & Technology, Inc. (ERT) to develop, evaluate and exercise a number of alternative approaches to regional-scale ambient air quality modeling. A major objective of this study is to provide a suite of air quality simulation models that are both technically sound and computationally practical for assessing regional-scale impacts of energy development scenarios.

As described in the companion report, Volume 1 (Bass et al. 1979), three different air quality transport-diffusion models have been developed, implemented and compared for simulation of point-source plume dispersion on the mesoscale [e.g., dispersion at ranges of 100 to 1,000 kilometers (km)]. The models are optimized for regional-scale impacts; in Volume 1, the ambient air concentrations calculated by MESOPLUME in the near field of sources, that is, less than 100 km, are not realistic.* Both worst-case and average dispersion situations are treated, with meteorological inputs constructed from rawinsonde data that is readily available for the region. The models are computationally practical for simulating the impact of multiple point sources over periods of several days to several weeks and are easy to use for a variety of decision-making and regulatory applications. Finally, these models are intended to serve as flexible testbeds for further research, development, and simulation tasks.

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*Subsequently, the MESOPUFF model has been augmented to provide realistic near-field impacts (see the companion report, Volume 3).

The three new models are, respectively:

- MESOPLUME, a mesoscale variable-trajectory Gaussian "plume-segment" model, adapted by ERT from the plume segment approach taken in the STRAM model (Hales et al. 1977),
- MESOPUFF, a mesoscale variable-trajectory Gaussian "puff" superposition model (Benkley and Bass 1979a), adapted by ERT from the puff approach taken in the MESODIF model (Start and Wendell 1974); and
- MESOGRID, a mesoscale numerical grid model (Morris et al. 1979), adapted from the method of moments approach taken in the SULFA3D model (Egan et al. 1976).

This report, the second in a series entitled "Development of Mesoscale Air Quality Simulation Models", describes the MESOPLUME model in technical detail; illustrates its application; and provides a User's Guide to the model. However, to obtain a fuller understanding of the model's capabilities, limitations and recommended usage, the user should be familiar with the relevant materials contained in the following related reports:

- the companion report (Volume 1) describing the extensive series of comparison and model sensitivity analyses performed with these models (Bass et al. 1979);
- the companion report (Volume 6) describing the specially designed MESOSCALE meteorological preprocessor program, MESOPAC (Benkley and Bass 1979b);
- the companion report (Volume 5) describing the specially designed postprocessing and analysis system, MESOFILE (Scire et al. 1979).

1.2 The Mesoscale Plume Segment Model (MESOPLUME)

MESOPLUME is a regional-scale variable-trajectory Gaussian plume segment model. The modeling method used in MESOPLUME, adapted from that proposed by Hales et al. (1977), differs from the conventional Gaussian plume approach in that MESOPLUME allows for deformation of the continuous plume by a temporally-varying vertically-uniform, horizontal wind field. The plume is treated as divided into contiguous segments; each segment describes a portion of plume behavior between successive time periods; and the end points of each segment are advected in a Lagrangian sense. The representation of a continuous plume by the segmented-plume approach is depicted schematically in Figure 1-1.

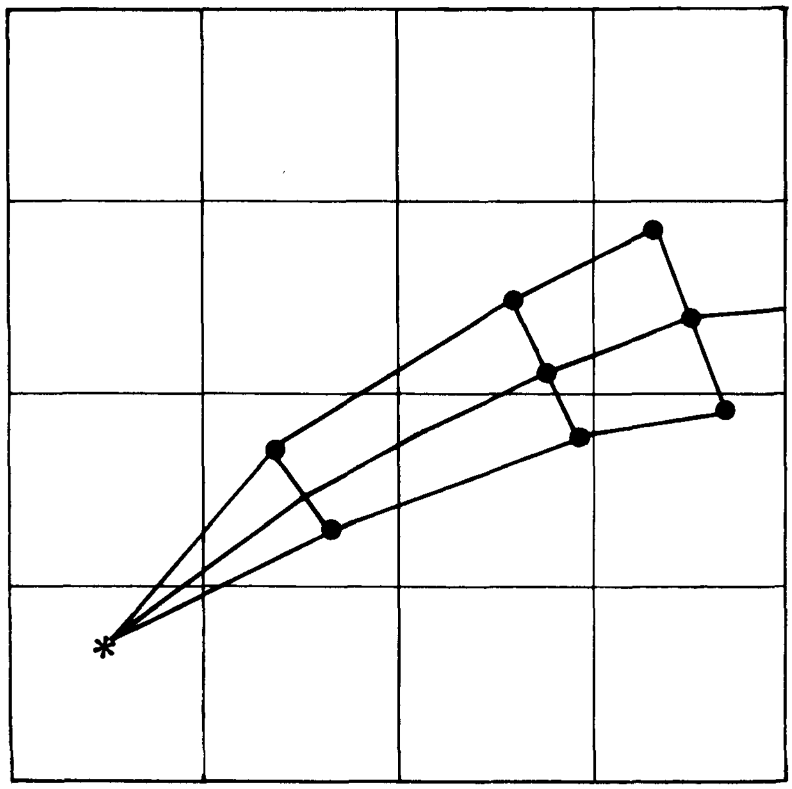

Figure 1-1 Schematic Representation of Segmented Plume Approach

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MESOPLUME accommodates multiple point sources, and includes modules for plume rise, plume growth, fumigation, linear conversion of sulfur dioxide (SO_2) to sulfate ($SO_4^=$), and dry deposition of SO_2 and $SO_4^=$.

1.3 Integrated Mesoscale Modeling System

The MESOPLUME model has been incorporated as an independent model element within an efficient, easy to use integrated mesoscale modeling system. This integrated system depicted in Figure 1-2, comprises components for meteorological preprocessing, mesoscale transport-diffusion, and post-processing. Standardizing model input/output functions in this system permits easy combination of results from two or more model runs, or direct and cost-effective comparison of simulations performed with two or more different models (see, for example, Bass et al. 1979). The meteorology preprocessor MESOPAC drives identically any of the three mesoscale transport-diffusion models. In turn, each of these models identically communicates its results to the MESOFILE post-processing system - responsible for file management, display, and statistical analysis of all model output fields.

1.4 Organization of the Report

Section 2 of this report contains detailed technical description of the MESOPLUME model; specific user instructions are described in Section 3; a test case for the MESOPLUME model is presented in Section 4.

A Fortran microfiche listing of the MESOPLUME model is appended.

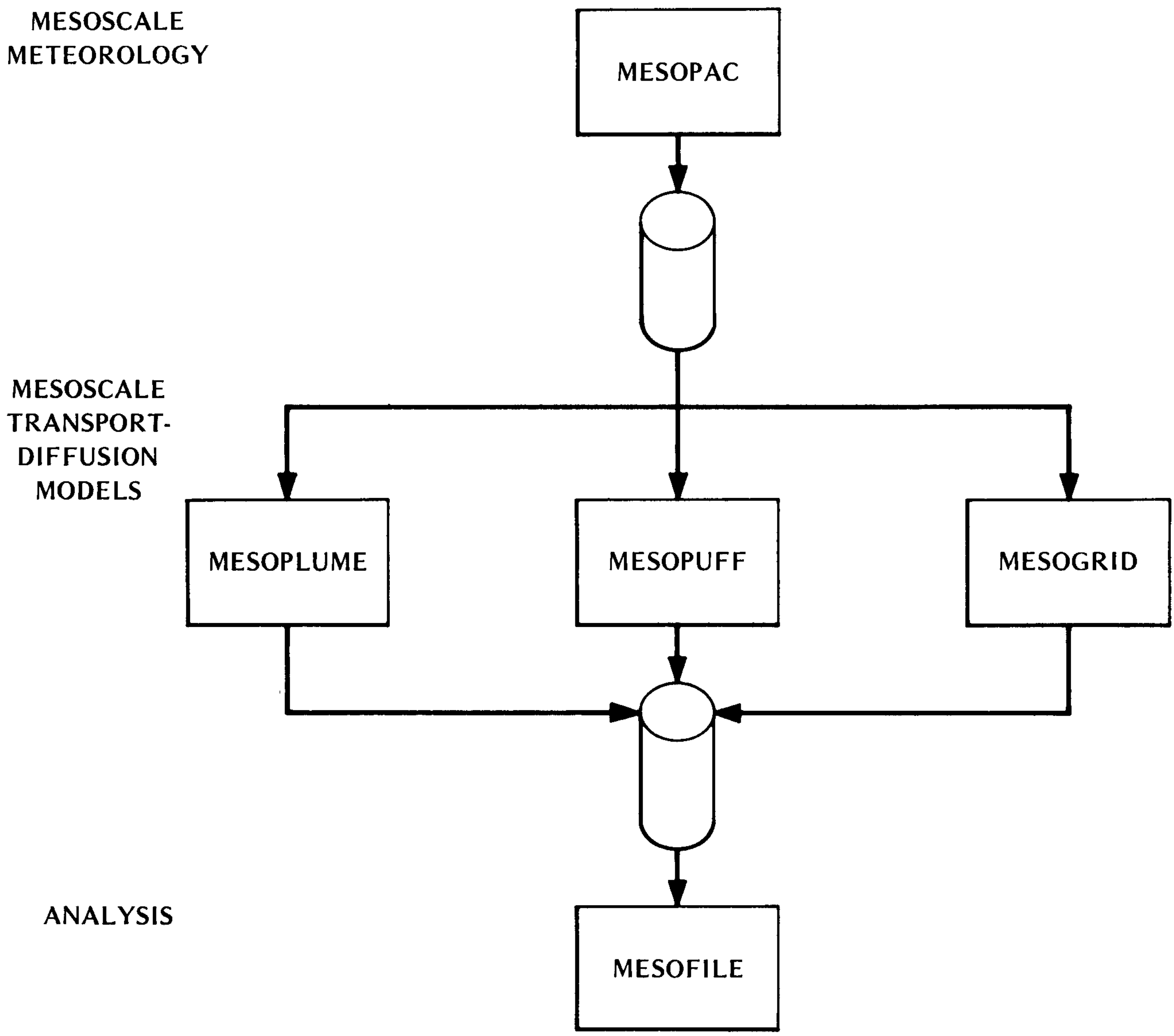

Figure 1-2 Integrated Modeling System

2. MESOPLUME TECHNICAL DISCUSSION

2.1 Basic Mass Conservation Equations

MESOPLUME, a variable-trajectory version of the conventional straight-line Gaussian plume model, is designed to take into account the spatial and temporal variations in the horizontal advection, diffusion, transformation, and removal mechanisms governing the dispersion of a plume on regional transport scales. In MESOPLUME, a continuous plume is modeled by subdividing the plume into a number of contiguous 'plume segment' elements. The conservation of pollutant mass over a plume segment of length Δs is expressed by the mass balance equation:

$$\Delta Q = \int_{o}^{\infty} \int_{-\infty}^{\infty} G(s,r,z)\, dr\, dz \quad \Delta s \tag{2-1}$$

$$+ \int_{o}^{\infty} \int_{-\infty}^{\infty} u\, C\, dr\, dz \Bigg|_{s+\Delta s} - \int_{o}^{\infty} \int_{-\infty}^{\infty} u\, C\, dr\, dz \Bigg|_{s}$$

where s, r, and z are the longitudinal, lateral, and vertical plume directions, $G(s,r,z)$ ($g\ m^{-3}s^{-1}$) is the rate of change (gain-loss) of pollutant concentration $C(s,r,z)$ ($g\ m^{-3}$) by conversion and removal processes, ΔQ ($g\ s^{-1}$) is the rate of change of pollutant mass flux from s to s + Δs, and u ($m\ s^{-1}$) is the wind speed. In MESOPLUME, $G(s,r,z)$ and u are constant over the plume segment, and s is the current distance of a plume segment endpoint from the emitting source, measured along the plume axis.

MESOPLUME permits the user to specify two possible vertical distribution functions; (1) a vertical Gaussian profile, ignoring any effects of the mixing lid H; or (2) a uniform vertical distribution below the mixing lid.

For Case 1, the ground-level axial plume concentration $C(s,r,0)$ is defined at the upwind edge of a plume segment by the expression:

$$C(s,r,0) = \frac{Q(s)}{\pi\, u\, \sigma_z(s)\, \sigma_y(s)} \exp\left(\frac{-r^2}{2\sigma_y^2}\right) \exp\left(\frac{-z^2}{2\sigma_z^2}\right) \tag{2-2}$$

where Q(s) is the pollutant mass flux and $\sigma_y(s)$, $\sigma_z(s)$ are the lateral and vertical Gaussian plume dispersion coefficient distributions at downwind distance s. Full reflection from the ground is assumed.

For Case 2, if the plume altitude (z) lies below the mixed lid H, the ground-level axial concentration is expressed at the upwind edge of the plume segment by the expression for uniform vertical mixing:

$$C(s,r,0) = \frac{Q(s)}{\sqrt{2\pi}\, u\, H_m\, \sigma_y(s)} \exp\left(\frac{-r^2}{2\sigma_y^2}\right) \tag{2-3}$$

where H_m is the maximum mixing depth encountered by the plume segment (see Section 2.8). If, rather, the plume centerline lies above the mixing lid, no ground-level concentrations are calculated. At the downwind edge ($s+\Delta s$) of the plume segment, the ground-level axial concentration ($s+\Delta s,r,0$) is expressed as:

$$C(s+ds,r,0) = \frac{\{Q(s)+(dQ/dt)\}\Delta t}{\sqrt{2\pi}\, u\, H_m\, \sigma_y(s+\Delta s)} \exp\left(\frac{-r^2}{2\sigma_y^2}\right) \tag{2-4}$$

The MESOPLUME model solves the mass conservation Equation 2-1 independently for both sulfur dioxide (SO_2) and sulfate ($SO_4^=$). The gain functions include terms for the loss (gain) of SO_2 ($SO_4^=$) by linear decay of SO_2 to $SO_4^=$ and terms for dry deposition of either species (see Sections 2.5 and 2.6).

2.2 The Grid System

The coordinate system used in the STRAM model has been replaced in MESOPLUME by a simple Cartesian coordinate system. All spatial model input data (emission source inventories and meteorological fields) are referenced to the same grid, called the "basic computational" grid. To improve the resolution of the plume sampling function (see Section 2.4.3), MESOPLUME uses a sampling grid that is a subset of the basic computational grid. The origin of the sampling grid may be placed anywhere on the basic computational grid (but not on the northern or eastern grid boundaries). The resolution of the sampling grid is a multiple of the resolution of the basic computational grid. Currently, the maximum allowable size of both the basic computational and sampling grids is 40 by 40 horizontal grid points. Figure 2-1 illustrates one possible arrangement of basic computational and sampling grids. [More detailed instructions for defining the dimensions and resolutions of the two grids are contained in Section 3.2.] Note that the grid index of the

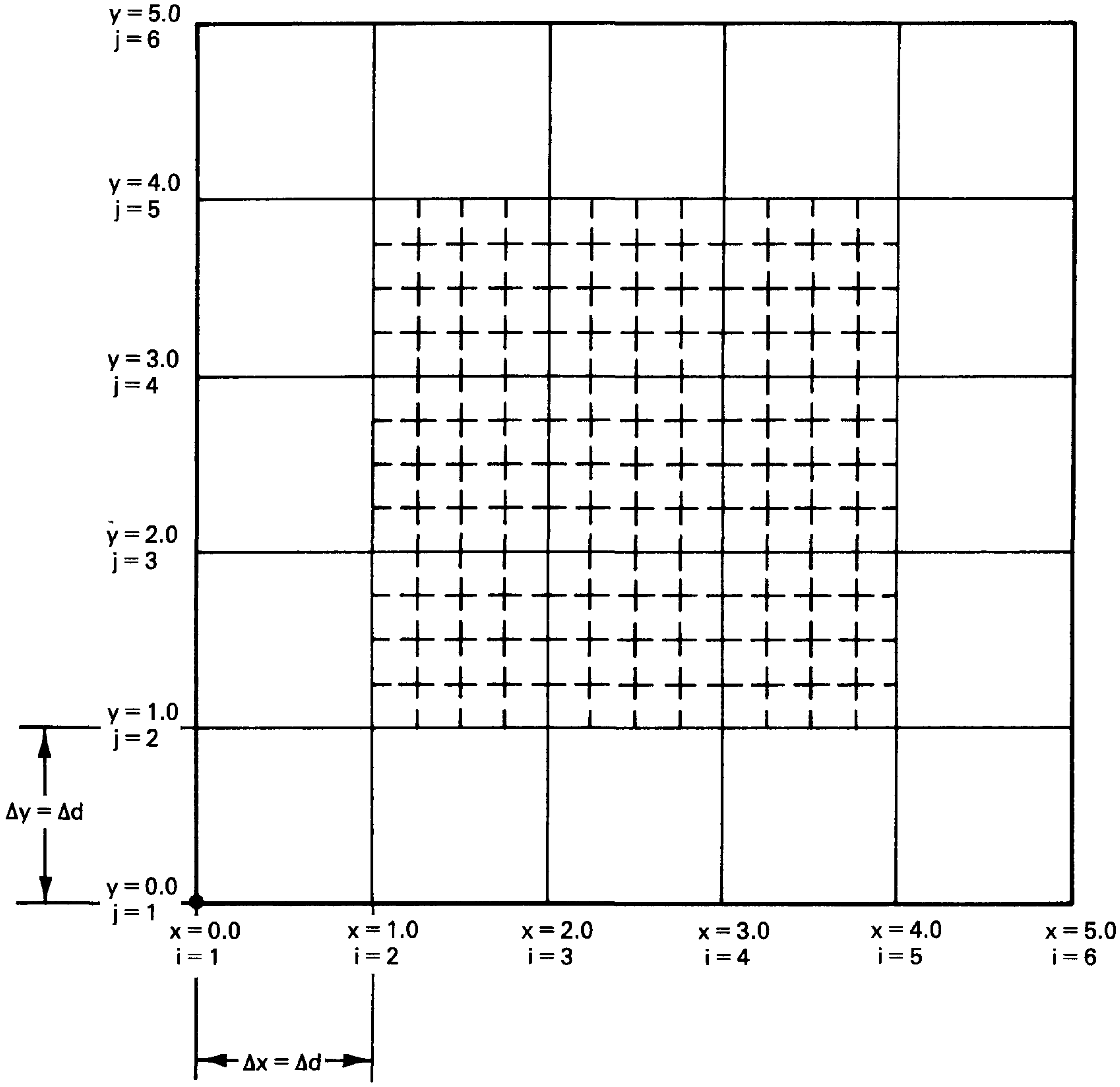

Figure 2-1 One Possible Arrangement of Sampling and Basic Computational Grids

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origin (1,1) is assigned Cartesian coordinates x = 0, y = 0. The sampling grid in this example originates at (i = 2, j = 2) or (x = 1, y = 1) on the basic computational grid, and has a spatial resolution four times finer than the basic computational grid.

2.3 Specification of Model Inputs

MESOPLUME is, at present, driven by the meteorological fields produced by MESOPAC, a MESOscale meteorology PACkage (Benkley and Bass 1979b), but an alternative meteorological preprocessing system with appropriate grid resolution could be substituted by the user. MESOPLUME requires the following fields (usually at hourly intervals) interpolated to each model grid point:

- horizontal (u,v) wind components,
- mixing depth, and
- Pasquill-Gifford-Turner (PGT) stability class.

Examples of the MESOPAC meteorological input used by MESOPLUME are shown in Appendix A. Use of MESOPAC model output by the MESOPLUME model is straightforward - the Cartesian coordinate system is identical in both models. Note that the horizontal (u,v) wind components are considered invariant with height. Vertical wind components are not used. The fields of PGT stability class are used by MESOPLUME in doing plume rise and plume growth calculations.

2.4 Plume Trajectory, Dispersion and Sampling Algorithms

The computational scheme of the MESOPLUME model has three distinct functional elements: (1) a Lagrangian plume trajectory function, (2) a plume dispersion function, and (3) a plume sampling function. The Lagrangian trajectory function is used to advect the endpoints of each plume segment during a basic time step; the resultant distance between consecutive endpoints defines the length of each plume segment. The widths at the upwind and downwind ends of each plume segment are determined by the plume dispersion function. Given the size and location of each plume segment, the plume sampling function computes the concentration exposure received during the time interval at each grid point that lies within the plume segment.

2.4.1 Lagrangian Trajectory Function

This section describes how the endpoints of a plume segment are advected during a time step; it has been adapted (but largely verbatim) from Hales et al. (1977, pages 15-18).

Let the components of the wind in the x and y grid directions along the trajectory be designated by $u[t;x(t),y(t)]$ and $v[t;x(t),y(t)]$, respectively,

where

$$x(t) = \frac{1}{\Delta d} \int_{o}^{t} u[t';x(t'),y(t')]dt'$$

$$y(t) = \frac{1}{\Delta d} \int_{o}^{t} v[t';x(t'),y(t')]dt'$$

$$x(0) = x_0 \; ; \; y(0) = y_0$$

$$u(0;x(0),y(0)) = u(x_0,y_0)$$

$$v(0;x(0),y(0)) = v(x_0,y_0)$$

and x_0,y_0 are the initial coordinates (origin) of a trajectory of total length s*. (The grid space unit Δd is used in the program to convert to nondimensional spatial units on the computational grid.) The vectors $u(t;...)$ and $v(t;...)$ provide a Lagrangian description of the velocity field. Increments of advection over a further time interval Δt are therefore given by

$$\Delta x = \frac{1}{\Delta d} \int_{t}^{t+\Delta t} u[t';x(t'),y(t')] \, dt' \; ; \qquad (2\text{-}5a)$$

$$\Delta y = \frac{1}{\Delta d} \int_{t}^{t+\Delta t} v[t';x(t'),y(t')] \, dt' \; . \qquad (2\text{-}5b)$$

After the new coordinates $x(t+\Delta t)$ and $y(t+\Delta t)$ are calculated for each incremented endpoint of a given plume, a check is made to see if any of these values are off the grid. If so, both the affected plume increment and all plume increments emitted from the same source previously are deleted from further consideration.

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*In practice, however, the exact definition of s in MESOPLUME is the current along-the-variable-plume-axis distance of a segment endpoint from a source. In time-varying flows, it may be somewhat different from the actual segment endpoint trajectory length.

The integration of the wind components over the trajectory is approximated by a two-step iteration method involving bilinear interpolation in space and in time (see Figure 2-2).

The various positions in Figure 2-2 are best defined by equations:

$$x_1 = x(t) + u[t;x(t),y(t)]\ \Delta t\ ; \tag{2-6a}$$

$$y_1 = y(t) + v[t;x(t),y(t)]\ \Delta t\ ; \tag{2-6b}$$

$$x_2 = x_1 + u[t+\Delta t;x_1,y_1]\ \Delta t\ ; \tag{2-6c}$$

$$y_2 = y_1 + v[t+\Delta t;x_1,y_1]\ \Delta t\ ; \tag{2-6d}$$

$$x(t+\Delta t) = 0.5[x(t) + x_2]\ ; \tag{2-6e}$$

$$y(t+\Delta t) = 0.5[y(t) + y_2]\ . \tag{2-6f}$$

Thus, the new position $(x(t+\Delta t),y(t+\Delta t))$ is found by adding the vector average of two advection increments to the former position $(x(t),y(t))$. The first advection increment is calculated by advecting the plume increment for the entire interval Δt using the wind effective at $[x(t),y(t)]$ at time t. The addition of this increment to the position $[x(t),y(t)]$ yields the position (x_1,y_1). However, (x_1,y_1) is not assumed to be the actual end of the advection increment because the wind may change along the trajectory. A second advection increment is calculated using (x_1,y_1) as the starting point and the wind at that point effective at the end of the time increment. The addition of this advection increment to position (x_1,y_1) yields position (x_2,y_2). Then the new plume increment position $(x(t+\Delta t),y(t+\Delta t))$ is taken to be the point halfway along the line from $(x(t),y(t))$ to (x_2,y_2).

The bilinear interpolation by which the effective wind components u(t), and v(t) are calculated works as follows. Let t_n and t_{n+1} be the effective times of the two gridded wind fields closest to time t. Time interpolation weights t_1 and t_2 are defined by:

$$t_2 = \frac{t - t_n}{t_{n+1} - t_n} \qquad t_n \leq t < t_{n+1}\ ; \tag{2-7a}$$

$$t_1 = 1 - t_2. \tag{2-7b}$$

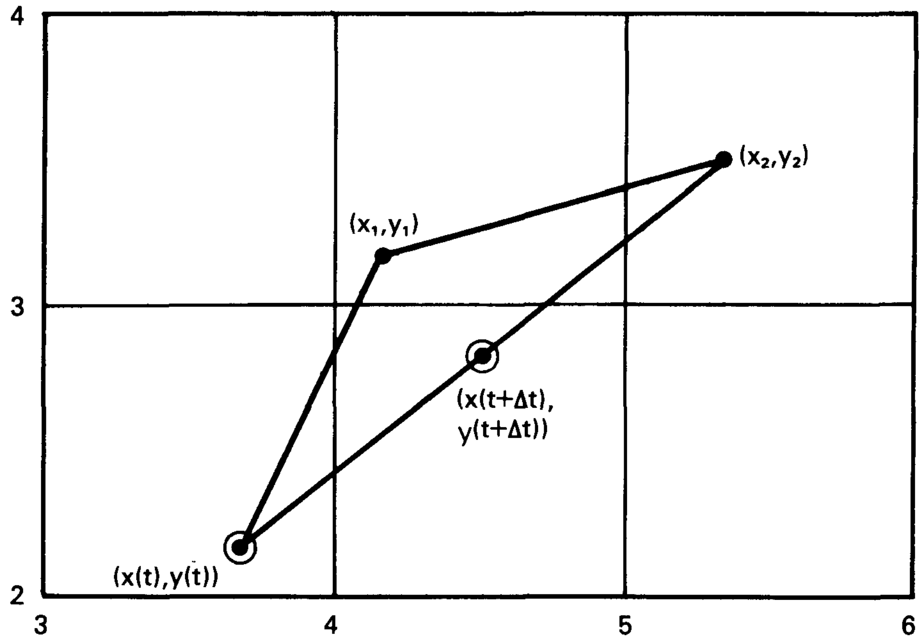

Figure 2-2 Calculation of the Trajectory of a Plume Segment Endpoint

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Next, the location of $(x(t),y(t))$ is noted on Figure 2-2. The coordinate values are between 3 and 4 for $x(t)$ and between 2 and 3 for $y(t)$. Accordingly:

$$X_q = x(t) - 3 ; \tag{2-8a}$$

$$X_p = 1 - X_q ; \tag{2-8b}$$

$$Y_q = y(t) - 2 ; \tag{2-8c}$$

$$Y_p = 1 - Y_q . \tag{2-8d}$$

This yields

$$\begin{aligned} u(t) = {} & t_1 X_p Y_p u(t_n;3,2) + t_2 X_p Y_p u(t_{n+1};3,2) \\ & + t_1 X_q Y_p u(t_n;4,2) + t_2 X_q Y_p u(t_{n+1};4,2) \\ & + t_1 X_p Y_q u(t_n;3,3) + t_2 X_p Y_q u(t_{n+1};3,3) \\ & + t_1 X_q Y_q u(t_n;4,3) + t_2 X_q Y_q u(t_{n+1};4,3) . \end{aligned} \tag{2-9}$$

Similar equations hold for $v(t)$, $u(t+\Delta t)$, and $v(t+\Delta t)$. Therefore, the advection equation 2.5 is calculated from

$$\Delta x = \frac{1}{2\Delta d} \{u(t) + u(t+\Delta t)\}\Delta t; \tag{2-10a}$$

$$\Delta y = \frac{1}{2\Delta d} \{v(t) + v(t+\Delta t)\}\Delta t. \tag{2-10b}$$

The subsequent positions are given by

$$x(t+\Delta t) = x(t) + \Delta x ; \tag{2-11a}$$

$$y(t+\Delta t) = y(t) + \Delta y . \tag{2-11b}$$

2.4.2 The Plume Dispersion Function

This section, describing the evaluation of the plume dispersion parameters, has been taken largely verbatim, with modifications, from Hales et al. (1977, pp. 23-24). The plume dispersion parameters σ_y and σ_z are calculated for distances out to 100 km using plume growth formulas fitted to the curves of Turner (1970). For distances greater than 100 km the plume growth rates given by Heffter (1965) are used. The growth of a plume with travel time t or along the plume trajectory distance s from the source is represented by

$$\sigma_y(s+\Delta s) = \sigma_y(s) + \Delta s \left.\frac{d\sigma_y}{ds}\right|_{s+\Delta s/2} ; \tag{2-12}$$

$$\sigma_y(t+\Delta t) = \sigma_y(t) + \Delta t \left.\frac{d\sigma_y}{dt}\right|_{t+\Delta t/2} . \tag{2-13}$$

Similar equations for σ_z are used. These terms allow for spatial and temporal changes in stability class to be included, without violating the entropy principle (centerline concentrations cannot increase with downwind distance).

The integral formulas for σ_y and σ_z for travel distances less than 100 km are of the following forms

$$\sigma_y(s,\alpha) = Y_\alpha \, s^{0.9} \text{ (meters)}; \tag{2-14}$$

$$\sigma_z(s,\alpha) = Z_\alpha \, s^{b_\alpha} \text{ (meters)}. \tag{2-15}$$

Here α is a stability index designated as A, B, C, D, E, or F for the PGT stability categories. The coefficients Y_α, Z_α, and b_α are given in Table 2-1 as a function of stability index α, and yield values of σ_y and σ_z in meters when s is specified in meters. Because the integral formulas are not valid if the stability class changes over the travel distance s, the derivative forms are actually used to carry out the computations:

$$\frac{d\sigma_y}{ds} = 0.9 \; Y_\alpha \, s^{-0.1} ; \tag{2-16}$$

TABLE 2-1

COEFFICIENTS FOR DISPERSION PARAMETER FORMULAS

Stability Index α	Plume Growth Coefficients		
	Y_α	Z_α	b_α
A	0.36	0.00023	2.10
B	0.25	0.058	1.09
C	0.19	0.11	0.91
D	0.13	0.57	0.58
E	0.096	0.85	0.47
F	0.063	0.77	0.42

$$\frac{d\sigma_z}{ds} = b_\alpha Z_\alpha s^{(b_\alpha - 1)} . \qquad (2\text{-}17)$$

MESOPLUME assumes that σ_y, $\sigma_z = 0$ at the origin ($s = 0$).

The derivative formulas used to grow σ_y and σ_z for travel distances greater than 100 km are those given by Heffter (1965):

$$\frac{d\sigma_y}{dt} (m\ s^{-1}) = 0.5 \qquad (2\text{-}18)$$

$$\frac{d\sigma_z}{dt} (m\ s^{-1}) = 0.5(2K_z)^{1/2}\ t^{-1/2} \qquad (2\text{-}19)$$

2.4.3 The Plume Sampling Function

Each plume segment resident on the grid (at the end of every time step Δt) is sampled, using the plume sampling function, to evaluate the average concentration experienced at each sampling and intersection during the previous time step. For example, consider the hypothetical plume segment depicted in Figure 2-3. The plume segment centerline at time $t+\Delta t$ extends from (x,y) to $(x+\Delta x,y+\Delta y)$, the positions of the two consecutive plume segment endpoints at $t+\Delta t$. The plume segment length is $\Delta s = (\Delta x^2 + \Delta y^2)^{1/2}$. The lateral extent of a plume segment is considered to be truncated at $\pm 3\sigma_y$. This is a reasonable simplification - much less than 1% of the area under the Gaussian distribution function lies beyond $\pm 3\sigma_y$ from its center. In this example, plume segment radii of size $3\sigma_y(s)$ at the upwind edge (x,y) of the segment and of size $3\sigma_y(s+\Delta s)$ at the downwind edge $(x+\Delta x,y+\Delta y)$ are indicated. At time $t+\Delta t$, the grid point intersections (21,12), (22,12), (22,13), (23,13), and (22,14) are each impacted by the hypothetical plume segment; each grid point is assigned a certain average concentration $C(i,j)$ resulting from the presence of the plume segment over Δt. This evaluation is illustrated as follows: Suppose the grid point concentration $C(i,j)$ is to be calculated at (22,12). First, the ground-level concentrations $C(x,y)$ and $C(x+\Delta x, y+\Delta y)$ are computed using Equations 2-3 and 2-4 for the case of uniform vertical distribution. Next, a point (x',y') is found such that the line segment of length r constructed from (x',y') to the grid point (i,j) is perpendicular to the plume segment centerline. The effective source strength $C(x',y')$ is then computed by linear interpolation:

$$C(x',y') = \frac{C(x,y)\ \Delta s_2 + C(x+\Delta x,\ y+\Delta y)\ \Delta s_1}{\Delta s_1 + \Delta s_2} \qquad (2\text{-}20)$$

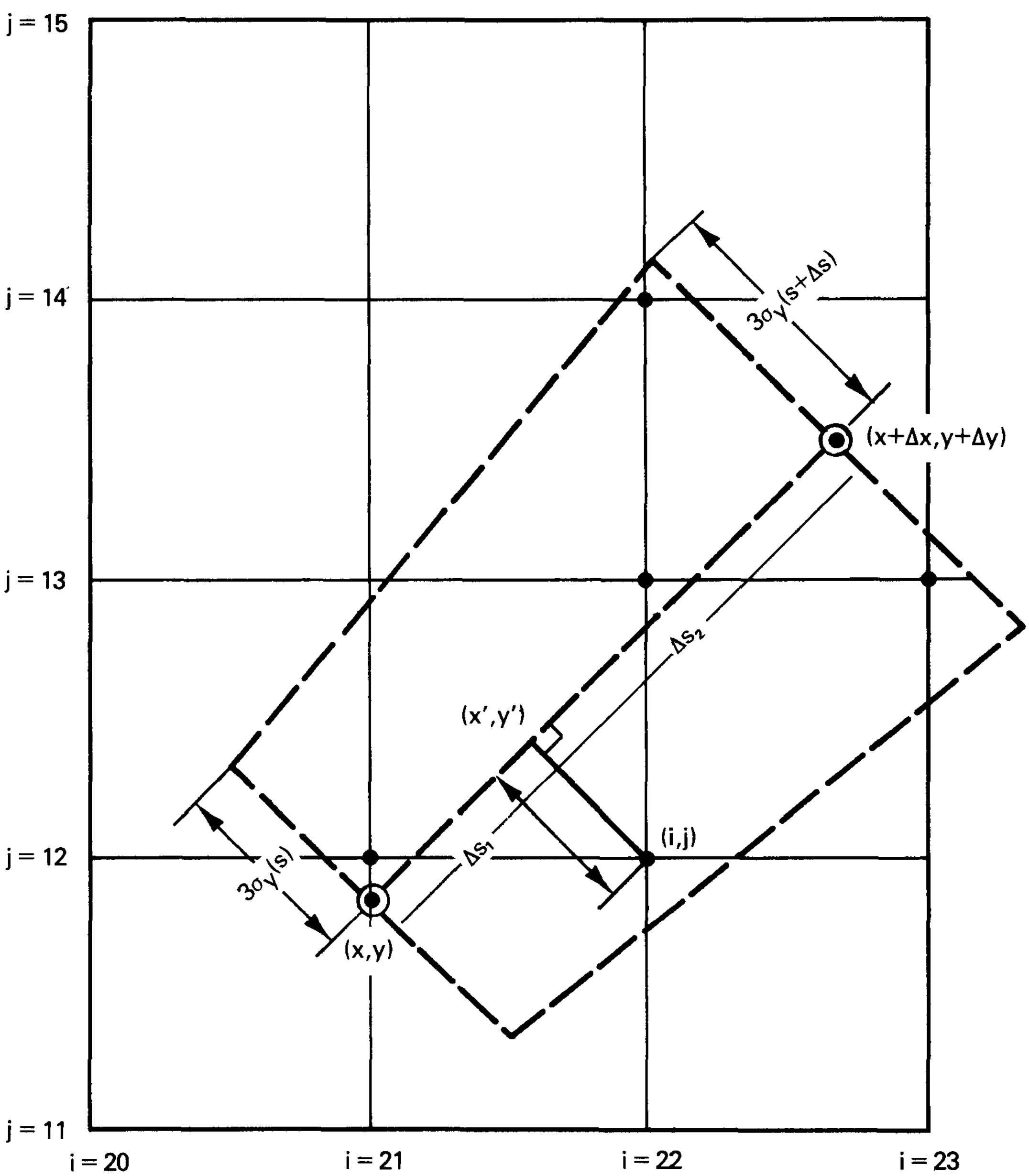

Figure 2-3 Calculation of the Concentration C(i,j) by the Sampling Function

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The lateral plume dispersion coefficient $\sigma_y(x,y)$ is similarly interpolated from:

$$\sigma_y(x',y') = \frac{\sigma_y(x,y)\ \Delta s_2 + \sigma_y(x+\Delta x,\ y+\Delta y)\ \Delta s_1}{\Delta s_1 + \Delta s_2} \tag{2-21}$$

Finally, the grid point concentration C(22,12) is computed as:

$$C(22,12) = C(x',y')\ \exp\left[\frac{-r^2}{2\sigma_y^2(x',y')}\right] \tag{2-22}$$

If a grid point lies within more than one plume segment at the end of a time step (for example, because plumes of multiple sources overlap), the total concentration at the grid point $C_T(i,j)$ is computed as the sum of the individual contributions:

$$C_T(i,j) = \sum_{m=1}^{m_T} C_m(i,j) \tag{2-23}$$

where m_T is the total number of segments impacting the grid intersection (i,j) during the time step of interest. Note that a plume segment is only sampled beginning with the second time step of its history and at every time step thereafter.

The MESOPLUME model has two peculiarities intrinsic to the basic advective-diffusive scheme of the model, which can present problems when the sampling function is applied. These problems arise from (1) the inverse-wind speed dependence of the concentration algorithm (Equation 2-2) and (2) the way in which adjacent plume segments are actually juxtaposed in a curvilinear flow. As an example of the inverse-wind speed dependence problem, consider the case illustrated in Figure 2-4, for which the wind flow along the plume axis rapidly decelerates, and suppose u_A, the average wind speed over segment A, is twice u_B, the average wind speed over segment B.* Neglecting removal processes, MESOPLUME evaluates the concentration $C(x_1,y_1)$ at the downwind edge of segment A according to Equation 2-4:

*This does not imply that the two-dimensional wind field is significantly divergent--the local flow about segments A and B may be exactly non-divergent if the mass fluxes through the lateral boundaries are "correct."

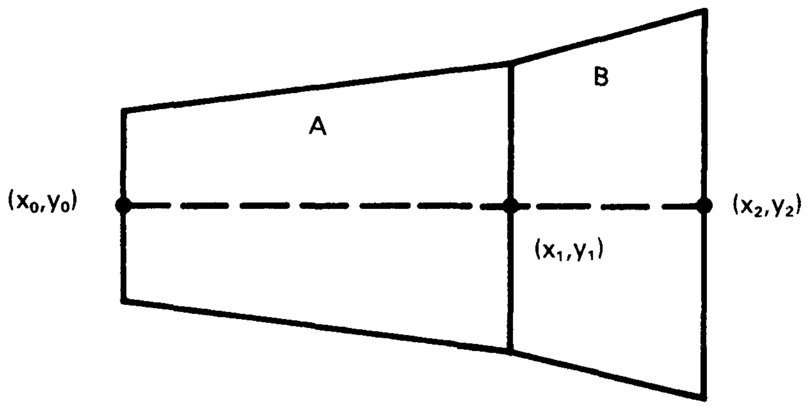

Figure 2-4 A Schematic Representation of Adjacent Plume Segments in Rapidly Decelerating Flow

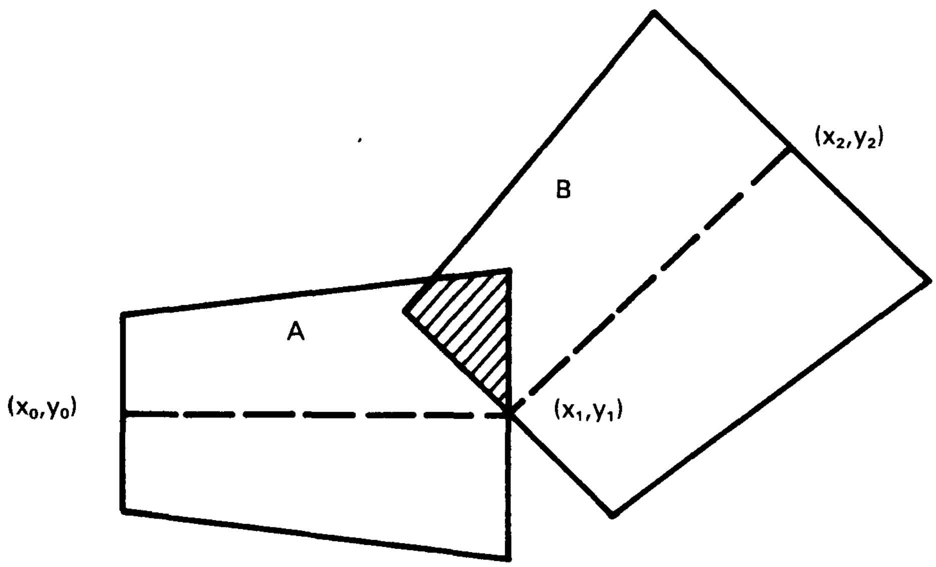

Figure 2-5 A Schematic Representation of Adjacent Plume Segments in Highly Curvilinear Flow

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$$C(x_1,y_1)\Big|_A = \frac{Q}{\sqrt{2\pi}\ u_A\ \sigma_y(x_1,y_1)\ H_m} \qquad (2\text{-}24)$$

but can also evaluate the concentration $C(x_1,y_1)|_B$ at the same point using Equation 2-3 as appropriate to the upwind edge of segment B using u_B instead. Since $u_A = 2u_B$,

$$C(x_1,y_1)\Big|_B = 2C(x_1,y_1)\Big|_A \qquad (2\text{-}25)$$

If the grid resolution is such that severe discontinuities in the wind field occur, the MESOPLUME model will indeed predict plume centerline concentrations increasing with downwind distance. This prediction, a violation of the second law of thermodynamics, represents a major shortcoming of the plume segment model - it cannot treat stagnation flows correctly.

To address the second problem, that of juxtaposing adjacent plume segments, consider the situation illustrated in Figure 2-5. In this figure two adjacent plume segments are advected in a highly curvilinear flow. In this case, for each plume segment, the lateral lines that define the plume segment widths (at the upwind and downwind end points) are constructed to be perpendicular to the local plume segment axes. Therefore, if the average wind direction used to advect segment B is very different from the average wind direction used to advect segment A, the plume segments will not be perfectly contiguous, as shown. In the example, there is a shaded region in which grid points will receive two concentration doses during one time step and also a region where the plume may actually "pass over" a grid point without impacting it at all. This illustrates a second potentially serious shortcoming of the model - it cannot treat strongly sheared flows (e.g., recirculating flows) correctly.

Both of the limitations identified here are intrinsic to the basic plume-segment approach, rather than to its present implementation. The effects of these limitations on MESOPLUME model performance are discussed in greater detail in the companion model sensitivity document (Bass et al. 1979).

2.5 Conversion of Sulfur Dioxide to Sulfate

MESOPLUME represents the conversion of SO_2 to $SO_4^=$ as a simple linear rate function--the changes in mass of each pollutant in one time step Δt are given by the time-discretized equations:

$$\Delta Q^n(SO_2) = k_1\ Q^n(SO_2)\ \Delta t \qquad (2\text{-}26a)$$

$$\Delta Q^n(SO_4^=) = -1.5\ k_1\ Q^n(SO_2)\ \Delta t \qquad (2\text{-}26b)$$

where $Q^n(SO_2)$ is the mass of SO_2 at the beginning of the nth time step and $k_1(s^{-1})$ is the conversion rate constant. MESOPLUME uses the nominal value $k_1 = -5.56 \times 10^{-6}$, suggested by Hales et al. (1977), unless otherwise specified by the user.

Note that the conversion of SO_2 to $SO_4^=$ represented by Equation 2-26 is (1) independent of the vertical or horizontal distribution of SO_2 within a plume and (2) independent of whether a plume lies above or below the mixing height.

For the solutions to be adequate representations of the continuous exponential equations (e.g., $\dot{Q}(SO_2) = k_1 Q(SO_2)$), Q should not change appreciably over the time interval Δt. Since this is frequently not the case, the time interval Δt is automatically subdivided into as many subintervals $\Delta t'$ as are required to ensure that no more than a specified fraction ΔQ_f of the mass Q is removed by decay during a subinterval $\Delta t'$. This process is described further in the next section.

2.6 Dry Deposition of Sulfur Dioxide and Sulfate

The changes of mass $\Delta Q^n(g)$ of each pollutant resulting from dry deposition are given by:

$$\Delta Q^n(SO_2) = -(v_d(SO_2)\ Q^n(SO_2)\ \Delta t)\ /\ H_m \qquad (2\text{-}27a)$$

$$\Delta Q^n(SO_4^=) = -(v_d(SO_4^=)\ Q^n(SO_4^=)\ \Delta t)\ /\ H_m \qquad (2\text{-}27b)$$

where $Q^n(SO_2)$ and $Q^n(SO_4^=)$ are the masses of SO_2 and $SO_4^=$, respectively, in the plume segment at the beginning of the time step, $v_d(SO_2)$ and $v_d(SO_4^=)$ are the deposition velocities of each pollutant, and H_m is the vertical depth of the plume segment (see Section 2.8). MESOPLUME uses the nominal values $v_d(SO_2) = 0.01$ (m/s) and $v_d(SO_4^=) = 0.001$ (m/s), as suggested by Hales et al. (1977), unless otherwise specified by the user.

As described before, MESOPLUME automatically ensures that the mass Q does not change within one subinterval $\Delta t'$ by more than a user-specified fraction ΔQ_f. Taking into account both SO_2 removal mechanisms (decay and deposition), the expression used by MESOPLUME to specify the subinterval $\Delta t'$ is

$$\Delta t' = \mathrm{MIN} \left\{ \frac{\Delta Q_f(SO_2)}{-k_1} \quad , \quad \frac{\Delta Q_f(SO_2)\ H_m}{v_d(SO_2)} \right\} \qquad (2\text{-}28)$$

In other words, the subinterval size $\Delta t'$ is chosen automatically by MESOPLUME at the beginning of each basic interval Δt such that no more than a specified fraction ΔQ_f of SO_2 mass is removed by either mechanism (or, no more than $2\Delta Q_f$ by both mechanisms combined) within $\Delta t'$. It should be emphasized that the conversion and removal rates are not affected by this restriction. Also, individual puff trajectories are not updated at each subinterval $\Delta t'$; they remain unchanged over the basic interval Δt.

2.7 Plume Rise

The effective emission height h_e of each plume segment is computed as $h_e = h_s + h_p$, where h_s is the stack height (m) and h_p is the plume rise (m). The plume rise equations used by the MESOPLUME model are those described by Briggs (1975) for equilibrium (final) plume rise. For unstable and neutral conditions with $h' \leq H$ (i.e., the plume does not rise into an elevated stable layer)

$$h_p = h' = 1.6\ F^{1/3}\ (3.5\ x^*)^{2/3}\ u^{-1}\ ; \qquad (2\text{-}29a)$$

For unstable and neutral conditions with $h' > H$ (i.e., the plume penetrates into an elevated stable layer)

$$h_p = \mathrm{MIN}\ \{h'\ ,\ (1.8\ z_b^3 + 18.75\ F\ u_m^{-1}\ S^{-1})^{1/3}\ \}; \qquad (2\text{-}29b)$$

For stable conditions when $u \geq 1.37$ m/s

$$h_p = 2.6\ F^{1/3}\ S^{-1/3}\ u^{-1/3}\ ; \qquad (2\text{-}29c)$$

For stable conditions when $u < 1.37$ m/s

$$h_p = 5.0\ F^{1/4}\ S^{-3/8}\ . \qquad (2\text{-}29d)$$

where:

F = buoyancy flux (m^4/s^3)

x^* = $34.49\ F^{0.4}$ for $F > 55$

= $14.0\ F^{0.625}$ for $F \leq 55$

$S = (g/T)(\partial\theta/\partial z)$

$g = 9.8 \text{ m s}^{-2}$

$T = 290°K$

$\partial\theta/\partial z = 0.0137°K \text{ m}^{-1}$

H = mixing depth (m)

$z_b = H - h_s$ (m)

u = wind speed (m s^{-1})

u_m = MAX {u, 1.37}

2.8 Treatment of Plume Fumigation

When the "uniform vertical distribution" option is elected, MESOPLUME takes the spatial and temporal variations in the mixing height into consideration to determine the extent of ground level pollutant impact:

(a) For a plume element centerline less than the mixing height, MESOPLUME arbitrarily assigns the element a height of zero and immediately mixes the mass of the plume element uniformly through the mixing depth with the mixing lid acting as a perfect reflector. Equations 2-3 and 2-4 are then applied to compute ground level concentrations.

(b) For a plume element centerline greater than the mixing height, no impact of the element is felt at the ground. However, if subsequently the mixing height becomes greater than the height of the plume element centerline, the entire plume element is immediately mixed uniformly through the mixing depth, and Equations 2-3 and 2-4 again apply.

The mixing depth encountered by a plume element is likely to change over time and space. MESOPLUME assumes that a plume element residing in the mixed layer is always uniformly mixed throughout the maximum mixing depth H_m encountered by the element in its progression through the computational space-time grid.

The restriction of a uniform plume element through a characterizable depth such as H_m is imperative for a one-layer model such as MESOPLUME to ensure that parcels of material, once entrained, are not bifurcated in the vertical when the height of the mixing lid changes. Therefore, in the MESOPLUME model a plume segment, once entrained, is uniformly mixed through a realistic height, consistent with the following assumptions:

(a) When convection ceases in the late afternoon, turbulent energy in the afternoon mixed layer dissipates. Once the energy of the large convective cells is completely damped, the remaining small scale energy is not sufficient to yield a vertical entrainment rate comparable to the daytime entrainment rate produced by large convective eddies.

(b) The stable lid capping the convective layer most likely maintains some integrity after convection ceases, and acts to prohibit any additional vertical entrainment of plume material.

(c) A modeling approach that redistributes mass into a shallower layer when the mixing depth decreases will violate the second law of thermodynamics.

Since no mechanism remains for turbulent transfer of pollutant material either upwards or downwards once the mixing depth decreases, it is asserted that the height most appropriate to define the extent of vertical mixing of a segment is the maximum mixing height H_m that the segment encounters during any portion of its travel.

A hypothetical example is given in Figure 2-6 to schematically illustrate the interaction of the MESOPLUME vertical distribution algorithm and the mixing depth progression algorithm used by MESOPAC [Benkley and Bass (1979b), Benkley and Schulman (1979)]. Here, consider two instantaneous parcels of material released at different times from a source with an effective stack height of 250 m; the first release is made at 0300 GMT on the first day; the second release is made at 0300 GMT on the second day. Assume that the hypothetical source is located in the western United States - so that 0000 GMT corresponds to late afternoon - the usual time of maximum mixing depth.

The first parcel is entrained at 0600 GMT on Day 1 as the nocturnal boundary layer oscillates slightly upward in height. MESOPLUME immediately mixes the parcel uniformly throughout this mixing depth. This parcel is mixed uniformly through 900 m by 0000 GMT on Day 2, and remains mixed through 900 m subsequent to that time, even though the height of the mixed layer collapses. The second parcel, emitted at 0300 GMT on Day 2 is fumigated at 1500 GMT and is mixed uniformly through 700 m by the end of the afternoon. Therefore, the first parcel, emitted at 0300 GMT on Day 1, remains uniformly mixed through a deeper vertical layer than the second parcel; this is consistent with the greater extent of mixing on the first day as compared to the second day.

This mixing depth/fumigation scheme exhibits at least two shortcomings:

- When a plume segment becomes bifurcated in the vertical by collapse of the mixing lid, how should the plume segment lateral dispersion rate be characterized? Because MESOPLUME is a one-layer model, the same set of horizontal dispersion

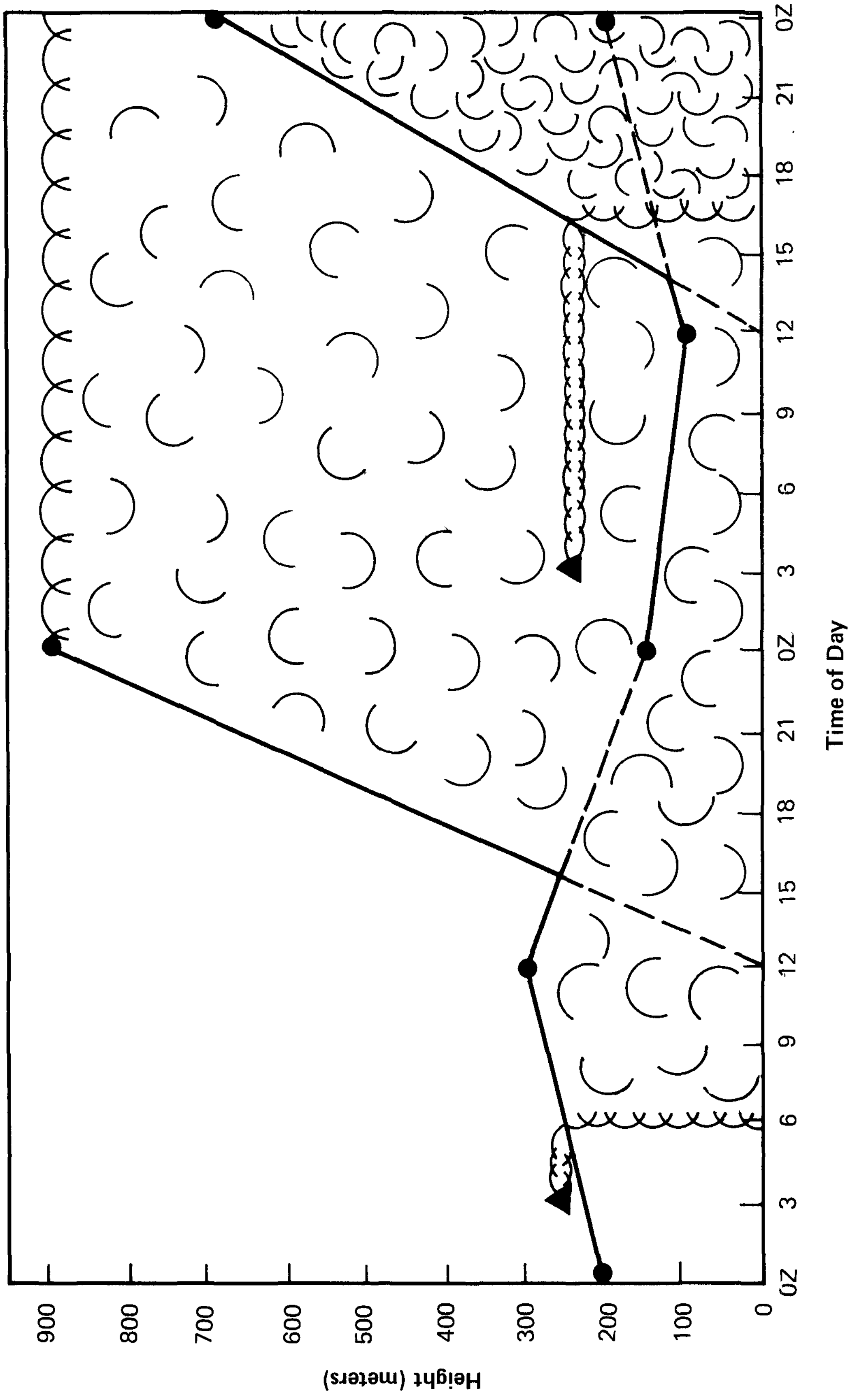

Figure 2-6 Response of Two Plume Elements to Changes in Mixing Depth

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coefficients must be applied to both the above-mixing-lid and the below-mixing-lid portions of the bifurcated segment.

- The dry deposition algorithm (see Section 2.6) removes SO_2 and $SO_4^=$ at a rate proportional to the surface concentration--this loss is then redistributed throughout the entire vertical extent of the plume. It would be more realistic to distribute the loss only through the current mixing depth, but this is not possible in a one-layer plume segment model.

It is felt that these limitations of the scheme are necessary to a method that is both computationally practical and yet realistic for use with a one-layer model. The inclusion of a fumigation cycle is very important; the marked effects of plume fumigation on the distribution of regional scale ground level concentration patterns are illustrated in Bass et al. (1979).

2.9 Comparison to the Conventional Gaussian Plume Model

From the point of view of possible regulatory applications, one of the most attractive features of MESOPLUME is its ability to recreate the results of the conventional Turner Workbook plume model (using PGT coefficients). When MESOPLUME is run with appropriate uniform, steady-state meteorology and fine spatial resolution, it can reproduce the Turner Workbook results to a high degree. This can be demonstrated, for example, under the following test conditions:

- The horizontal grid spacing of the model is reduced, e.g., to 5 km.
- The meteorological fields (wind direction, wind speed, mixing height and PGT stability class) used to drive MESOPLUME are taken to be spatially uniform and constant in time.
- MESOPLUME is run with one source until quasi-steady-state conditions are well established; that is, plume segments are created at the same uniform rate at which they disappear off the edge of the grid.

Under these special test conditions, MESOPLUME simulates very well the Turner Workbook plume concentrations out to distances of 100 km from an emission source. (The PGT σ_y and σ_z curves, represented in the model by piecewise linear power law fits, are only defined to 100 km.) Table 2-2 and Figure 2-7 provide a representative illustration of how closely MESOPLUME results compare to those obtained for the conventional Gaussian plume model using the PGT "D" curve for σ_y, and a uniform vertical distribution. Overall, the comparison is excellent--the very small fractional differences (typically less than 2%) are attributable mostly to inexact fitting of the PGT σ_y curve by the power law function

TABLE 2-2

COMPARISON OF Cu/Q VALUES FOR MESOPLUME AND TURNER WORKBOOK-COMPUTED VALUES

($u = 2.78$ m s^{-1}, PGT Class = D, H = 1000 m, uniform vertical distribution)

Distance (km)	PGT σ_y (m)	Turner Workbook ($C\ u\ Q^{-1}$)	MESOPLUME ($C\ u\ Q^{-1}$)	Fractional Deviation
10	550	$7.25\text{x}10^{-7}$	$7.77\text{x}10^{-7}$	0.07
15	780	5.11	5.94	0.16
20	1,000	3.99	4.11	0.03
25	1,220	3.27	3.47	0.06
30	1,420	2.80	2.83	0.01
35	1,620	2.46	2.50	0.02
40	1,820	2.19	2.19	0.00
45	2,020	1.97	1.97	0.00
50	2,200	1.81	1.78	-0.02
55	2,400	1.66	1.64	-0.01
60	2,600	1.53	1.50	-0.02
65	2,775	1.44	1.42	-0.01
70	2,975	1.34	1.31	-0.02
75	3,200	1.25	1.25	0.00
80	3,375	1.18	1.17	-0.01
85	3,550	1.12	1.11	-0.01
90	3,700	1.08	1.06	-0.02
95	3,850	1.04	1.00	-0.04
100	4,000	1.00	0.95	-0.05

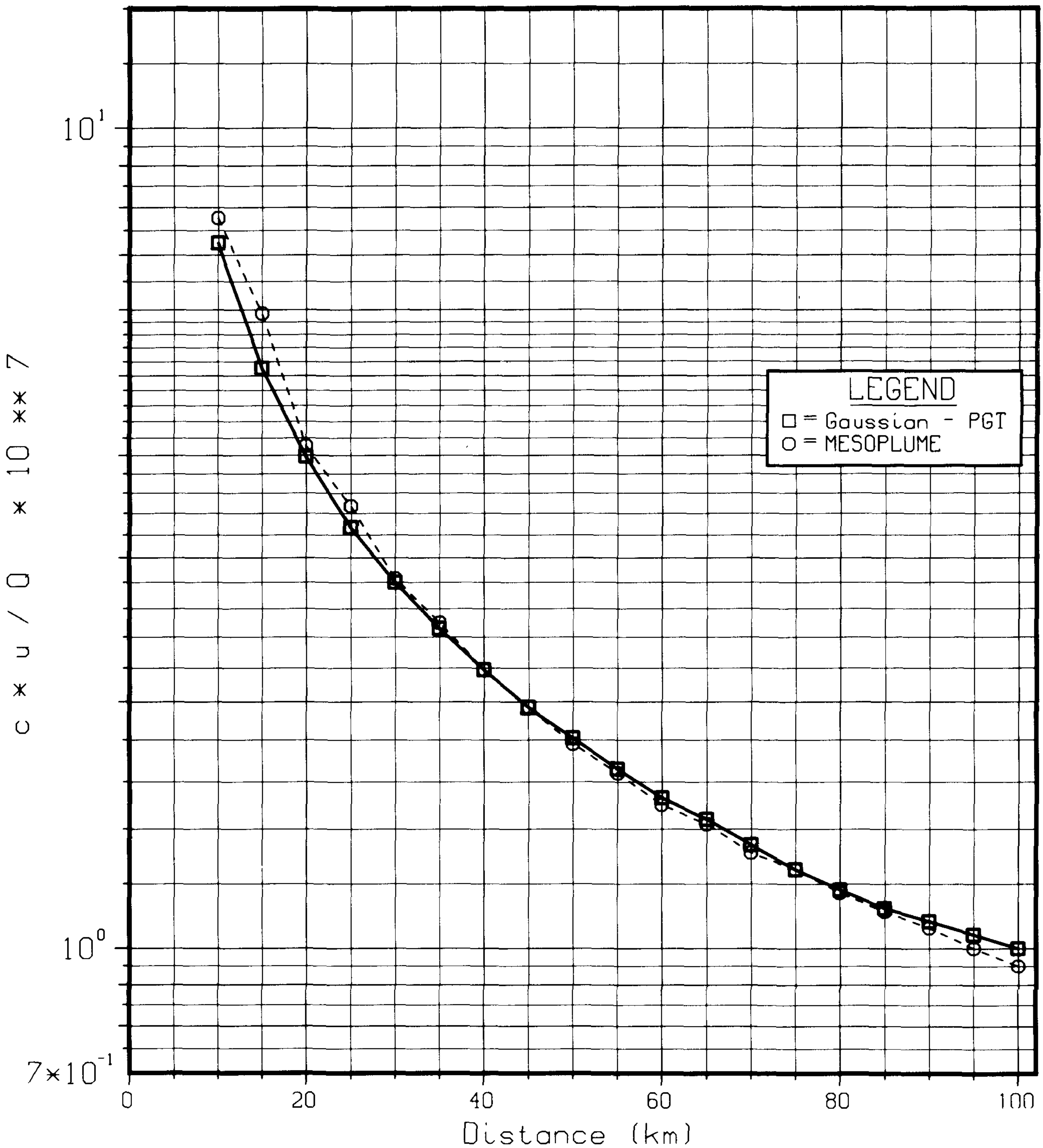

Figure 2-7 MESOPLUME vs. the Conventional Gaussian Plume

used in MESOPLUME. The somewhat larger deviations near the source are expected - the results shown here were obtained with a wind velocity and time step corresponding to plume segments about 5 km in length - so, near the source, the linear averaging done by the sampling function does not approximate accurately the power law behavior of the plume centerline concentrations. It is expected that with use of smaller time steps and correspondingly shorter plume segments, the comparison of MESOPLUME to the Turner Workbook plume in the very near field would be even closer.

In its present version MESOPLUME does not include an option for a reflected Gaussian vertical distribution, so that at distances where the plume does not yet approach a uniform vertical distribution, MESOPLUME will not give correct results. Under stable flow conditions, for example, plumes may not approach a uniform vertical distribution for many kilometers downwind. This version of MESOPLUME should therefore only be used at and beyond distances for which the assumption of uniform vertical mixing is appropriate - often only at distances of 100 km or more. [It would be very simple to modify the present version, however, to incorporate an optional Gaussian reflected vertical distribution so as to make MESOPLUME suitable also for near-field computations.]

2.10 The Computer Program

MESOPLUME is a highly modular computer program which shares with MESOPUFF and MESOGRID standardized input/output features and, where possible, identical program modules. The computer program flow chart (Figure 2-8) outlines the order of execution of the individual modules described at length in the 'MESOPLUME Technical Discussion'.

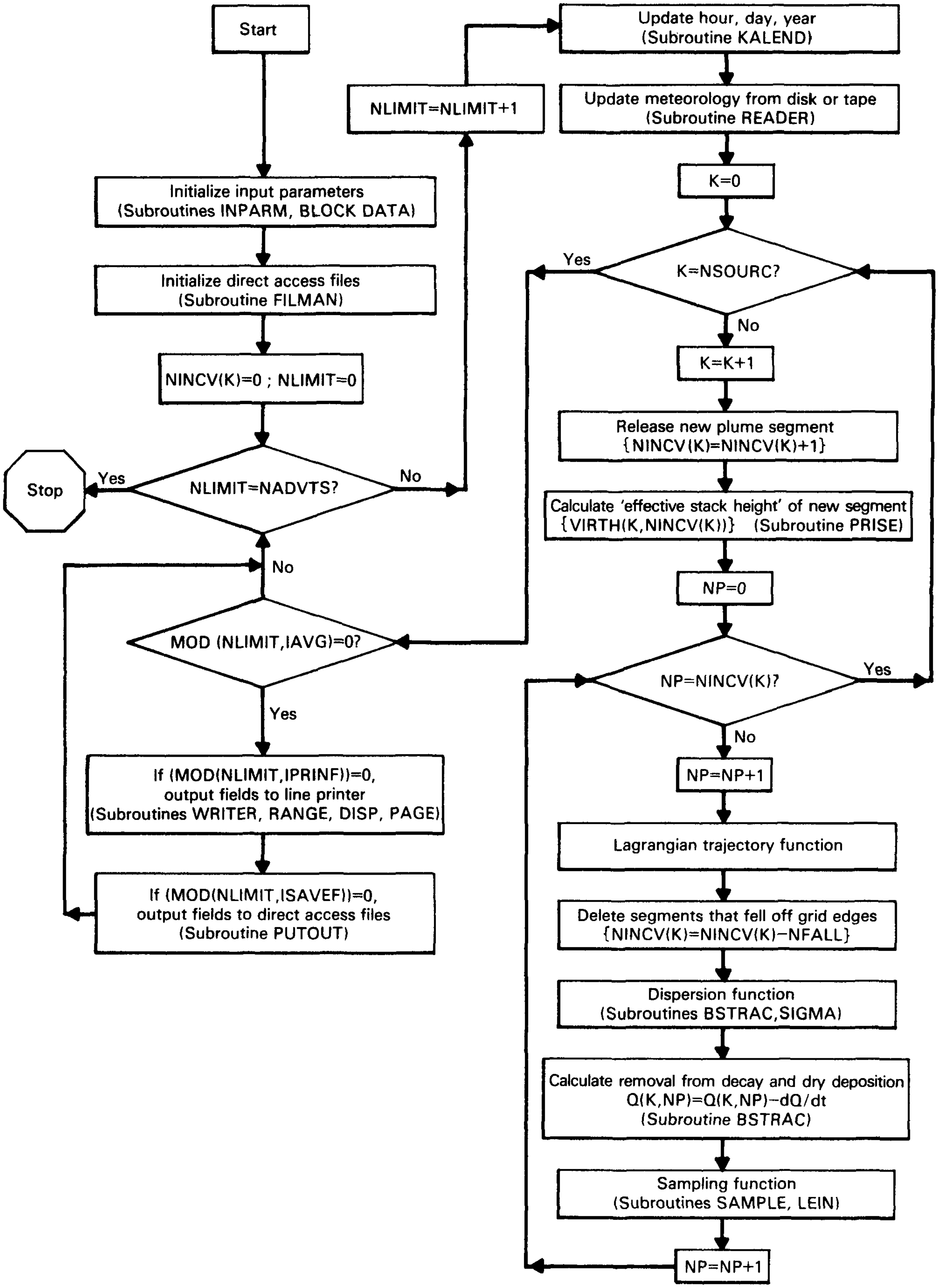

Figure 2-8 MESOPLUME Computer Program Flow Chart

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3. MESOPLUME USER INSTRUCTIONS

3.1 General

A MESOPLUME model simulation requires the following two input data sets:

- meteorological fields from MESOPAC (unformatted disk or tape input via logical unit 2) and
- model simulation control parameters and emission source inventory (cards or card-image disk input via logical unit 5)

A complete description of model simulation control parameter and emission source inventory input is contained in Section 3.2.

For most convenient operation, MESOPLUME should interface with the output of the MESOPAC meteorological preprocessor (see Section 3.3). Output of a MESOPLUME simulation can be routed to either (or both) of the following:

- line printer (logical unit 6) and
- direct-access disk storage system (logical units 13, 15, 21, 22, 23, and 24).

The direct access storage system allows for automatic storage, cataloging, and easy retrieval of all output data files from MESOPLUME. Availability of on-line direct-access disk storage enables the user to invoke the powerful MESOFILE file-management system, designed especially for interface with the regional-scale models. The MESOFILE system has file management components that can produce a record of the date of the run, the run characteristics, the disk file locations of all the concentration data output, and the values of all the input parameters for the run. The MESOFILE program allows this information to be retrieved for all the previous runs made on a particular set of disk files. The MESOPLUME program contains a file management subroutine (FILMAN) which determines without further user input the proper locations for all of the various MESOPLUME disk output files. MESOFILE can then be used for flexible time averaging of any set of fields, summation of different model simulations (particularly useful when more than 10 sources are to be simulated), statistical comparison of model results, and graphical contour display.

3.2 Description of Card-Image Input

This section provides a detailed description of all the card-image input requirements of the MESOPLUME model, model simulation control parameters, and emission inventory. The input package has been designed for use in common by all three mesoscale models (MESOPLUME, MESOPUFF, and MESOGRID) especially to facilitate intermodel comparison tests. The common input subroutine (INPARM) reads in all model simulation control parameters in Fortran NAMELIST format so that input parameters common to all three models can be included in standardized NAMELIST blocks. A few model-specific NAMELIST sets, however, are required because of certain features peculiar to each model algorithm. There are thirteen NAMELIST blocks included within the INPARM subroutine package, as follows: (1) MODEL, (2) CONTR, (3) GRID, (4) SIGMA, (5) METD, (6) PUFF1, (7) PUFF2, (8) PLUM1, (9) PLUM2, (10) GRIDY, (11) REMOV, (12) OUTPT, and (13) SOURC. NAMELIST blocks PUFF1, PUFF2, and GRIDY are not used by MESOPLUME and must be omitted from the input data runstream.

The remainder of this section provides detailed descriptions of the parameters in each NAMELIST set.* These NAMELIST sets are to be included in the input run stream in the identical sequence described above.

NAMELIST TITLE--MODEL

MODEL defines which model is to be run. Initialize LPLUME = .TRUE. for a MESOPLUME run.

Parameter	Type	Definition	Default
LPLUME	LOGICAL	If .TRUE., MESOPLUME is to be run	.FALSE.
LPUFF	LOGICAL	If .TRUE., MESOPUFF is to be run	.FALSE.
LGRID	LOGICAL	If .TRUE., MESOGRID is to be run	.FALSE.

NAMELIST TITLE--CONTR

CONTR initializes computational control variables.

Parameter	Type	Definition	Default
DTIME	REAL	Length of the basic time step (hours)	1.0
NADVTS	INTEGER	Length of the simulation in terms of basic time steps	24

*The description of certain parameters that were retained from the STRAM model but not otherwise used or that were included only to perform various model sensitivity tests, are omitted from this discussion--these parameters would not be activated by the average user. However, for a complete list of possible input parameters, the interested reader should consult the documentation included as comment cards directly in subroutine INPARM.

Parameter	Type	Definition	Default
MTFREQ	INTEGER	Rate (in terms of 'DTIME') with which wind, mixing depth, and stability fields are updated, in terms of the basic time step. 'MTFREQ'*'DTIME' must be equal to or an even multiple of the MESOPAC time step 'ISTEP' (hours)	1
IAVG	INTEGER	Number of basic time steps over which output concentration arrays are to be averaged	24

NAMELIST TITLE--GRID

GRID initializes parameters defining the three major grids: meteorological, basic computational, and sampling. The basic computational grid must be a subset of the meteorological grid and also must have the same grid spacing. The sampling grid must be a subset of the basic computational grid; it may be the same as the basic computation grid; or denser by an integer multiple. Currently, the maximum allowable size of both the basic computational and sampling grids is 40 by 40 horizontal grid elements.

Parameter	Type	Definition	Default
IELMET	INTEGER	Number of elements in the x-direction of the meteorological grid--must be the same as 'IMAX' used by MESOPAC (must be $\leq$ 40).	26
JELMET	INTEGER	Number of elements in the y-direction of the meteorological grid--must be the same as 'JMAX' used by MESOPAC (must be $\leq$ 40).	26
DELTMT	REAL	Basic computational grid spacing (meters)--must be equal to the grid spacing, DX, used by the MESOPAC meteorological grid.	40,000.
IASTAR	INTEGER	Element number of the meteorological grid where the basic computational grid starts (x-direction).	1
IASTOP	INTEGER	Element number of the meteorological grid where the basic computational grid stops (x-direction).	26

Parameter	Type	Definition	Default
JASTAR	INTEGER	Element number of the meteorological grid where the basic computational grid starts (y-direction).	1
JASTOP	INTEGER	Element number of the meteorological grid where the basic computational grid stops (y-direction).	26
ISASTR	INTEGER	Element number of the meteorological grid where the sampling grid starts (x-direction)--make sure that 'ISASTR' $\geq$ 'IASTAR'.	1
ISASTP	INTEGER	Element number of the meteorological grid where the sampling grid stops (x-direction)--make sure that 'ISASTP' $\leq$ 'IASTOP'.	26
JSASTR	INTEGER	Element number of the meteorological grid where the sampling grid starts (y-direction)--make sure that 'JSASTR' $\geq$ 'JASTAR'.	1
JSASTP	INTEGER	Element number of the meteorological grid where the sampling grid stops (y-direction)--make sure that 'JSASTP' $\leq$ 'JASTOP'.	26
MESHDN	INTEGER	A factor by which the basic computational grid spacing 'DELTMT' is divided to produce the sampling grid spacing.	1

NAMELIST TITLE--SIGMA

SIGMA initializes PGT stability-class-dependent coefficients that describe the differential forms of σ_y and σ_z. (σ_z is not applicable when 'LLID' = .TRUE.)

$$\sigma_y(s + \Delta s) = \sigma_y(s) + \frac{\partial \sigma_y}{\partial s} \Delta s$$

$$\text{where} \quad \frac{\partial \sigma_y}{\partial s} = a_y (s + \Delta s/2)^{b_y}$$

$$\sigma_z(s + \Delta s) = \sigma_z(s) + \frac{\partial \sigma_z}{\partial s} \Delta s$$

$$\text{where} \quad \frac{\partial \sigma_z}{\partial s} = a_z(s + \Delta s/2)^{b_z}$$

Parameter	Type	Definition	Defaults
AY(6)	REAL ARRAY	a_y for PGT classes A-F, respectively	(.33, .22, .17, .12, .086, .057)
BY(6)	REAL ARRAY	b_y for PGT classes A-F, respectively	(-.1, -.1, -.1, -.1, -.1, -.1)
AZ(6)	REAL ARRAY	a_z for PGT classes A-F, respectively	(.00048, .063, .1, .33, .41, .32)
BZ(6)	REAL ARRAY	b_z for PGT classes A-F, respectively	(1.10, .09, -.09, -.42, -.53, -.58)

NAMELIST TITLE--METD

METD initializes parameters that identify the input meteorological data base.

Parameter	Type	Definition	Default
METSRT	INTEGER	Year (2 digits), Julian day (3 digits), and hour (2 digits) in the MESOPAC output data file at which the MESOPLUME run begins.	7700101
METCOD	INTEGER	4-digit serial number to identify the meteorological data used (previously assigned by the user to the MESOPAC simulation run that generated the input meteorology fields).	1001

NAMELIST TITLE--PLUM1

For MESOPLUME only, PLUM1 initializes computational parameters.

Parameter	Type	Definition	Default
MAXSEG	INTEGER	Maximum number of plume segments per source allowed on the grid at any time (must be $\leq$ 100).	100

Parameter	Type	Definition	Default
LLID	LOGICAL	If .TRUE., plumes below the mixing lid are assumed to be uniformly vertically distributed. If .FALSE., plumes are assumed to have a Gaussian distribution in the vertical, with no constraining lid.	.TRUE.

NAMELIST TITLE--PLUM2

For MESOPLUME only, PLUM2 initializes parameters allowing the use of nongridded receptors.

Parameter	Type	Definition	Default
NRE	INTEGER	Number of nongridded receptors (must be $\leq$ 10).	0
XRES(10)	REAL ARRAY	x-coordinates of the nongridded receptors (meteorological grid units).	10 * 0.
YRES(10)	REAL ARRAY	y-coordinates of the nongridded receptors (meteorological grid units).	10 * 0.

NAMELIST TITLE--REMOV

REMOV assigns values to the removal rate parameters.

Parameter	Type	Definition	Default
CONVFR	REAL	Maximum fractional amount of conversion or removal of SO_2 by either decay or dry deposition in any one sampling step (limits the sampling step size, not the conversion rate).	.02
LDCAY	LOGICAL	If .TRUE., exponential decay of SO_2 to $SO_4^=$ is simulated; If .FALSE., no decay is simulated.	.TRUE.
EXTNCT	REAL	If 'LDCAY' is .TRUE., conversion rate of SO_2 to $SO_4^=$ (negative, for loss of SO_2).	-5.56×10^{-6}
LDEPOT	LOGICAL	If .TRUE. dry deposition is simulated for both species. If .FALSE., dry deposition is not simulated for either specie.	.TRUE.
DEPVEL(2)	REAL ARRAY	If 'LDEPOT' is .TRUE., 'DEPVEL(1)' and, 'DEPVEL(2)' are deposition velocities (m s^{-1}) for SO_2 and $SO_4^=$, respectively.	(.01,.001)

NAMELIST TITLE--OUTPT

OUTPT initializes the output control parameters.

Parameter	Type	Definition	Default
LPRINT	LOGICAL	Is .TRUE. if line printer output of gridded concentration arrays is desired.	.TRUE.
IPRINF	INTEGER	If 'LPRINT' is .TRUE., specifies the rate (in terms of 'DTIME') of gridded concentration array output (to line printer) in terms of the basic time step. Must be equal to or an even multiple of 'IAVG' (see NAMELIST CONTR).	24
LSAVE	LOGICAL	If .TRUE., concentration arrays are to be saved on disk or tape.	.FALSE.
ISAVEF	INTEGER	If 'LSAVE' is .TRUE., rate (in terms of 'DTIME') of concentration array output to tape or disk. Must be an even multiple of 'IAVG' (see NAMELIST CONTR).	24

NAMELIST TITLE--SOURC

SOURC assigns values to the parameters associated with source characteristics.

Parameter	Type	Definition	Default
NSOURC	INTEGER	Number of sources (up to 10).	1
LMISS	LOGICAL	If .TRUE., a 24 hour cycle of emission rate multipliers is to be read in. If .FALSE., temporally constant emission rates are assumed.	.FALSE.
LFLUX	LOGICAL	If .TRUE., a 24 hour cycle of buoyancy flux multipliers is to be read in. If .FALSE., temporally constant buoyancy fluxes are assumed.	.FALSE.

The following formatted (non-NAMELISTED) input follows the NAMELISTED input described above: For each source (there are a total of 'NSOURC' sources) the formatted input consists of the following sequence of cards.

STACK PARAMETERS (1 card per source)

Columns	Format	Parameter	Definition
1-10	F10.2	STAKHT	Stack height (m) above ground
11-20	F10.2	XXSTAK	x-coordinate of source (meteorological grid units)
21-30	F10.2	YYSTAK	y-coordinate of source (meteorological grid units)
31-40	F10.2	EMISS(1)	Emission rate (g s^{-1}) for SO_2
41-50	F10.2	EMISS(2)	Emission rate (g s^{-1}) for $SO_4^=$
51-60	F10.2	BFLUX	Buoyancy flux (m^4 s^{-3}) for plume rise

EMISSION CYCLE (2 cards per source; needed only if LMISS = .TRUE.)

The emission rate $Q_h(P,I)$ for hour h, source I, and pollutant P (1 = SO_2, 2 = $SO_4^=$) is computed as $Q_h(P,I)$ = 'ECYCLE(h,I)' * 'EMISS(P,I)'. Two emission cycle input cards are required for each source; the multipliers for hours 1-12 are specified on Card #1 and hours 13-24 are on Card #2. Card #1 is for each source set up as follows.

Columns	Format	Parameter	Definition
1-6	F6.2	ECYCLE (1,N)	Emission multiplier for hour 1, source N
7-12	F6.2	ECYCLE (2,N)	Emission multiplier for hour 2, source N
13-18	F6.2	ECYCLE (3,N)	Emission multiplier for hour 3, source N
19-24	F6.2	ECYCLE (4,N)	Emission multiplier for hour 4, source N
25-30	F6.2	ECYCLE (5,N)	Emission multiplier for hour 5, source N
31-36	F6.2	ECYCLE (6,N)	Emission multiplier for hour 6, source N
37-42	F6.2	ECYCLE (7,N)	Emission multiplier for hour 7, source N
43-48	F6.2	ECYCLE (8,N)	Emission multiplier for hour 8, source N
49-54	F6.2	ECYCLE (9,N)	Emission multiplier for hour 9, source N
55-60	F6.2	ECYCLE (10,N)	Emission multiplier for hour 10, source N
61-66	F6.2	ECYCLE (11,N)	Emission multiplier for hour 11, source N
67-72	F6.2	ECYCLE (12,N)	Emission multiplier for hour 12, source N

The format for Card #2 (hours 13-24) is identical.

BUOYANCY FLUX CYCLE (2 cards per source, needed only if LFLUX = .TRUE.).

The buoyancy flux $F_h(P,I)$ for hour h, source I, and pollutant P ($1 = SO_2$, $2 = SO_4^=$) is computed as $F_h(P,I)$ = 'BCYCLE(h,I)' * 'BFLUX(P,I)'. Two emission cycle input cards are required for each source; the multipliers for hours 1-12 are on Card #1, and hours 13-24 are on Card #2. Card #1 is for each source is set up as follows.

Columns	Format	Parameter	Definition
1-6	F6.2	BCYCLE (1,N)	Buoyancy flux multiplier for hour 1, source N
7-12	F6.2	BCYCLE (2,N)	Buoyancy flux multiplier for hour 2, source N
13-18	F6.2	BCYCLE (3,N)	Buoyancy flux multiplier for hour 3, source N
19-24	F6.2	BCYCLE (4,N)	Buoyancy flux multiplier for hour 4, source N
25-30	F6.2	BCYCLE (5,N)	Buoyancy flux multiplier for hour 5, source N
31-36	F6.2	BCYCLE (6,N)	Buoyancy flux multiplier for hour 6, source N
37-42	F6.2	BCYCLE (7,N)	Buoyancy flux multiplier for hour 7, source N
43-48	F6.2	BCYCLE (8,N)	Buoyancy flux multiplier for hour 8, source N
49-54	F6.2	BCYCLE (9,N)	Buoyancy flux multiplier for hour 9, source N
55-60	F6.2	BCYCLE (10,N)	Buoyancy flux multiplier for hour 10, source N
61-66	F6.2	BCYCLE (11,N)	Buoyancy flux multiplier for hour 11, source N
67-72	F6.2	BCYCLE (12,N)	Buoyancy flux multiplier for hour 12, source N

The format for Card #2 (hours 13-24) is identical.

3.3 Other Considerations

3.3.1 *Meteorological Considerations and MESOPAC Input*

The meteorological input for the MESOPLUME model is specified as a time sequence of spatially variable, gridded fields of horizontal (u,v) wind components, mixing depth, and PGT stability class. These fields are generated and written to off-line storage (disk or tape) by the MESOPAC* Meteorological Preprocessing Program (see Benkley and Bass 1979b). As mentioned in Section 3.1, MESOPLUME retrieves the meteorological data set from logical unit 2.

Direct compatibility of MESOPLUME input with MESOPAC output is ensured if the successive runs of MESOPAC and MESOPLUME jointly satisfy the following constraints on respective run parameters.

- The four-digit serial number 'METCOD' used to identify the meteorological data sets requested by MESOPLUME must match the 'METCOD' assigned when MESOPAC created and tagged its output meteorological data set.

*If desired, another meteorological preprocessing routine can be substituted to drive the MESOPLUME model.

- The grid spacing 'DELTMT' used by MESOPLUME must be identical to the grid spacing 'DX' used by MESOPAC; of course, the number of horizontal grid elements 'IELMET' and 'JELMET' used to specify the met data array sizes in both models must be identical.

- The geographical area covered by the MESOPLUME basic computational grid must be identical to, or a subset of the area covered by the MESOPAC meteorological grid.

- The chronological time period over which the MESOPLUME simulation run is performed must be a subset of the time period used by MESOPAC to define the meteorological fields.

- The interval at which the meteorological fields are updated by MESOPLUME is specified by the product 'DTIME' * 'MTFREQ' (hours). This time interval must be equal to or an even multiple of the time interval 'ISTEP' (hours) used by MESOPAC to generate and output successive sets of meteorological fields.

3.3.2 Array Size Considerations

Currently, MESOPLUME allows for the basic computational grid to be as large as 40 elements in each horizontal direction. However, since most of the large arrays in MESOPLUME are related to numbers of emission sources and plume increments, the size of the grid could be increased without a substantial increase in the core required by MESOPLUME. The user can specify up to 10 sources; if a larger source inventory is needed, the user will run MESOPLUME with up to 10 sources at a time and then aggregate results with MESOFILE. MESOPLUME allows for up to 100 plume segments per source to be resident on the grid at any time; thus, for example, for a 1-hour basic time step, the MESOPLUME simulation is prematurely terminated if any segment from any source remains on the grid for longer than 100 hours.

3.4 MESOPLUME Model Output

MESOPLUME output can be specified in either (or both) of two media depending on further user needs. The results can be output directly to the line printer, and/or routed for storage on the direct-access disk storage system for subsequent postprocessing. This section describes the types of output data that can be routed through each system. In most cases, the user may specify whether a certain type of output data will be received.

3.4.1 Line Printer Output

The following is a complete list of the line printer output options available from a MESOPLUME simulation:

- a table that lists the values of all input parameters used in the run (this output is always generated);

- a brief description of the model run time, concentration averaging time, source data, and grid characteristics of the model run (this output is always generated);

- arrays of ground-level concentrations for SO_2 and $SO_4^=$ block averaged over time intervals of 'IAVG' * 'DTIME' hours and output at intervals of 'IPRINF' * 'DTIME' hours during the run (these fields are printed only if 'LPRINT' = .TRUE.);

- tables of SO_2 and $SO_4^=$ ground level concentrations averaged and output as above, for a small number of receptor locations specified arbitrarily within the computational area (these tables are printed only if 'NRE' > 0 and 'LPRINT' = .TRUE.);

- for each pollutant, arrays of the <u>maximum</u> grid point concentration values (averaged as above) during the run span (these are printed only if 'LPRINT' = .TRUE.);

- for each pollutant, arrays of the grid point concentration values for SO_2 and $SO_4^=$ averaged over the entire run span (these are printed only if 'LPRINT' = .TRUE.); and

- a table listing the time when the initial plume segment from each source first reached the edge of the basic computational grid. This table is a useful adjunct to choosing an "initialization time" for the simulation; that is, the period of time during which the model concentration results are influenced by source "startup," and so are not to be considered representative of average concentrations for a continuously emitting source (or sources) (this table is always generated).

3.4.2 Direct Access Disk Output

Table 3-1 describes the logical unit file structure of the direct access disk storage system expected by MESOPLUME. (Model outputs are only directed to direct access disk storage when 'LSAVE' = .TRUE.) As indicated, six distinct direct access files are used, each with independent size characteristics; these file characteristics are currently frozen within the MESOPLUME code itself via Fortran "Define File" statements <u>and may require specific modification for adaptation to the user's host system</u>.

Concentration Files 21 and 22 contain the SO_2 and $SO_4^=$ concentration fields for each output time step. An identifying header record identical to the format used for File 15 (see File 15 description below) precedes the concentration fields. Files 21 and 22 can accommodate a maximum of 1,800 records each; therefore, for example, the results of 10 independent model simulations, each of 179 hours duration with hourly output, will fit exactly within the 1,800 records allotted.

TABLE 3-1

LOGICAL UNIT FILE STRUCTURE

Device Logical Unit Number	File Name	Record Structure
13	Library	25 records, 14 words/record
15	NAMELIST	25 records, 800 words/record
21	SO_2 Concentration	1,800 records, 1,610 words/record
22	$SO_4^=$ Concentration	1,800 records, 1,610 words/record
23	Run Number	1 record, 2 words
24	Pointer	1 record, 4 words

The library file (13) contains a single-record descriptor for each model run; File 13 can accommodate a maximum of 25 independent model runs. A hard copy printout of the library file produced by MESOFILE is shown in Figure 4-2 in the next section.

The parameters defining each model simulation run are as follows:

INUMB	-	a model run number which is automatically assigned by the direct access disk output subroutine.
DATFLD	-	The date of execution (day, month, and year) of the model run [not the day (or days) simulated].
MODEL	-	The particular mesoscale dispersion model chosen from the integrated modeling mesoscale system--in this case, MESOPLUME.
YR/DAY/HR	-	The year, Julian day, and hour on which the model simulation begins (Note that the first gridded concentration field is not output until 'ISAVEF'*'DTIME' hours subsequently, where 'DTIME' is the basic MESOPLUME time step (hours) and 'ISAVEF' is defined below).
NGRIDS	-	The total number of concentration arrays output for each pollutant during the model simulation ('NGRIDS' = 'NADVTS'/'ISAVEF' where 'NADVTS' is the total number of time steps in the model simulation.)
IAVG	-	The concentration array averaging frequency in terms of the basic time step, 'DTIME'.
ISAVEF	-	The concentration array direct-access disk output frequency in terms of the basic model time step, 'DTIME'.
ISAFE	-	The direct access address of the duplicate File 15 record.
IBEGIN	-	The direct access address of the first of the 'NGRIDS' number of arrays output to File 21 for SO_2 and File 22 for $SO_4^=$.
ISTOP	-	The direct access address of the last of the 'NGRIDS' number of arrays to File 21 for SO_2 and File 22 for $SO_4^=$.

ICHECK - The run termination status indicator 'ICHECK' = 1 indicates the model simulation terminated normally; 'ICHECK' = 0 indicates it terminated abnormally. In the latter case, the results of this run must be deleted from the file management system using the program BACKUPØ1 (see Scire et al. 1979) before another run is made.

NAMELIST File 15 contains a one-record detailed description of the parameters used for each model run. Each record in File 15 contains: (1) a duplicate of the corresponding FILE 13 record for the run and (2) the NAMELIST parameters used to make the run (also output to the line printer).

Finally, the Run Number and Pointer Files (23 and 24) preserve information between runs necessary to maintain proper archival sequencing of run outputs--they are invisible to the user.

3.5 Execution Time and Core Requirements

The time required for a MESOPLUME simulation is directly proportional to the number of time steps N and varies linearly with the number of sources S. Various meteorological factors--for example, lower transport wind speeds--cause an increase in the average number of plume segments resident on the grid and therefore an increase in running costs. For typical meteorological conditions within the Four Corners grid, and for the spatial extent and grid resolution used for these experiments, MESOPLUME model run times on an IBM 370/158 can be estimated by:

$$t(\text{sec}) = 0.17(S)(N) + 0.40\ (N) \tag{3-1}$$

On the same installation, MESOPLUME required 230k bytes of core during execution.

4. TEST CASE FOR MESOPLUME

A test case is provided in this section to familiarize the user with the operation of the MESOPLUME model and to verify that the model is running properly on the host system. The test case included here is a 3-day sequence of MESOPLUME model output for the time period 0000 Greenwich Mean Time (GMT) June 14, 1978 through 0000 GMT June 17, 1978 in the Four Corners area of the southwestern United States [see Bass et al. (1979)]. A 10-source partial emission inventory was selected from the full set of energy-related major point sources of SO_2 in the Four Corners area.

Figure 4-1 contains the run control parameters and emission source inventory (input on logical unit 5) for this test case. Note that most of the model input variables assume their default values. Appendix A contains the entire input data set used by the MESOPAC preprocessor to generate the meteorological fields that were subsequently read in by MESOPLUME (on logical unit 2). Appendix A also contains a very small portion of the MESOPAC model output--included to aid the user in verifying the full test case.

The full set of line printer output for this MESOPLUME test case is included in Appendix B. Descriptions of the model output fields assigned to the direct access disk storage system (as echoed in hard copy form by the MESOFILE system) are shown in Figure 4-2 (the library file) and in Appendix C (the NAMELIST file). In this example, the results from the MESOPLUME test case are stored together with the results from the MESOPUFF and MESOGRID test cases as discussed in the MESOPUFF user's manual (Benkley and Bass 1979) and the MESOGRID user's manual (Morris et al. 1979). Appendix C also shows the NAMELIST file; there, the library record NAMELIST input parameters and emission source data are stored for future reference.

The MESOFILE postprocessing system (Scire et al. 1979) operates on the direct access disk output files produced by MESOPLUME, to produce various forms of result analyses. Figure 4-3 illustrates one such option--a Calcomp contour plot of the 24-hour average ground-level SO_2 concentration field for June 16, 1978 as obtained from the test case. (Concentration isopleth values are not printed directly on the contour plot, but the user can generate an equivalent line printer plot, as illustrated in Figure 4-4, which does include the actual isopleth values.) Figure 4-5 illustrates the bulk statistical descriptors (described by Bass et al. 1979) used to compare, for example, two time sequences of model result fields. In this example, the base case 24-hour average ground-level SO_2 concentration fields for June 16 computed by the MESOPUFF model are compared to those computed by the MESOPLUME model.

```
&MODEL LPLUME=.TRUE. &END
&CONTR NADVTS=72 &END
&GRID &END
&SIGMA &END
&METD METSRT=7816500,METCOD=1003 &END
&PLUM1 &END
&PLUM2 &END
&REMOV &END
&OUTPT LSAVE=.TRUE. &END
&SOURC NSOURC=10 &END
236.     8.8     6.8     2560.    0.    6397.
152.     23.4    14.0    343.8    0.    1503.
152.     17.2    18.9    633.4    0.    2847.
152.     23.7    13.0    488.     0.    3353.
183.     13.5    1.2     53.7     0.    5016.
229.     10.0    13.1    320.     0.    6222.
76.2     8.0     19.5    146.9    0.    240.
183.     9.7     15.2    1310.8   0.    3016.
175.     0.9     8.0     268.8    0.    1047.
152.     1.5     4.1     1011.    0.    11144.
```

Figure 4-1 MESOPLUME Test Case Parameter and Emission Source Inventory Input

INUMB	DATFLD	MODEL	YR/DAY/HR	NGRIDS	IAVG	ISAVEF	ISAFE	IBEGIN	ISTOP	ICHECK
1	12 FEB 1979	MESOPLUM	78/165/ 0	3	24	24	1	2	4	1
2	12 FEB 1979	MESOPUFF	78/165/ 0	3	24	24	5	6	8	1
3	12 FEB 1979	MESOGRID	78/165/ 0	3	24	24	9	10	12	1

Figure 4-2 Test Case Library File (MESOFILE)

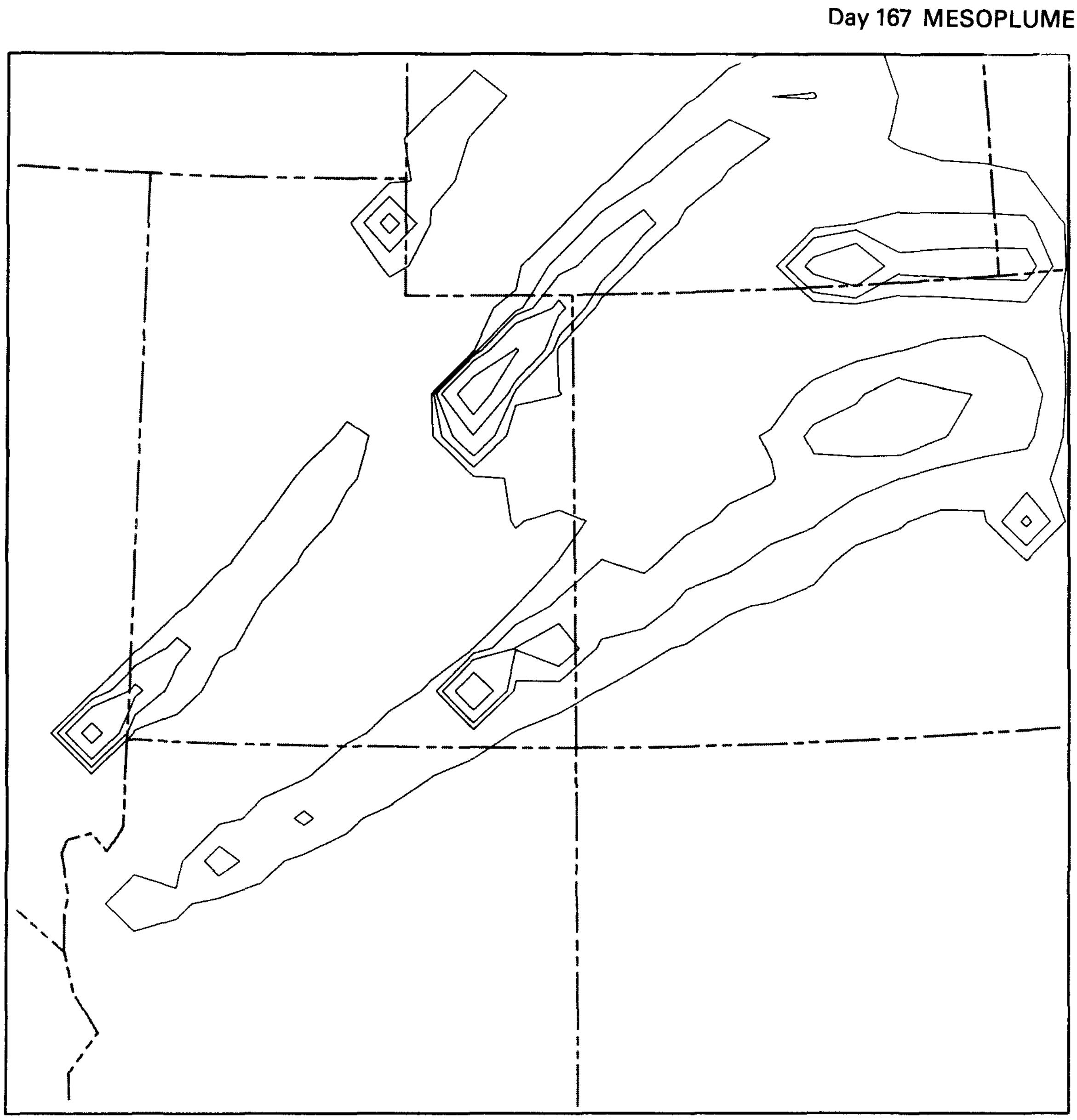
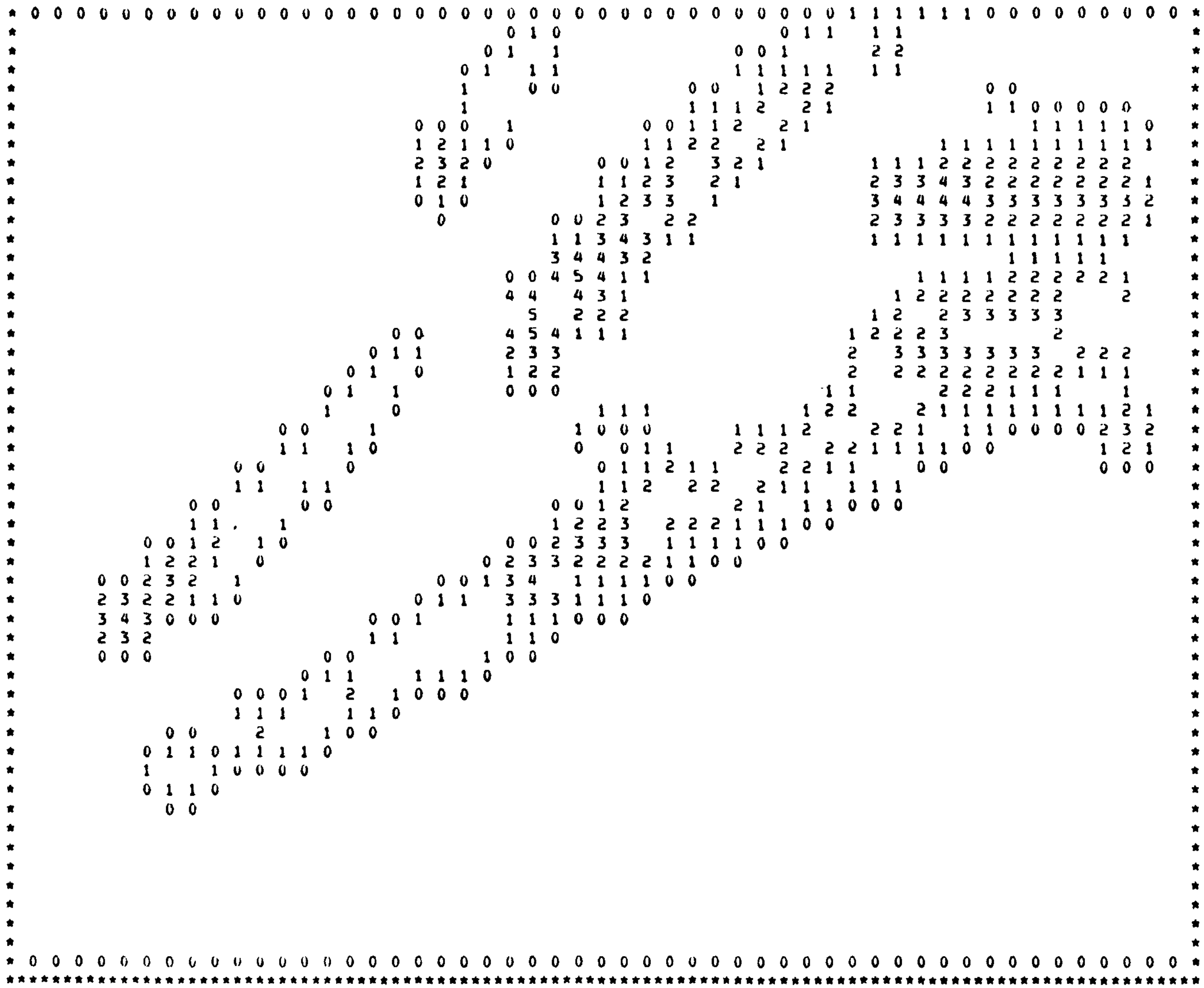


Figure 4-3 MESOPLUME 24-Hour Average SO_2 Concentration Calcomp Plot, 16 June, 1978 (from MESOFILE)

7901346



PLOT NUMBER: 3

VALUE	THRESHOLD (MICROGRAMS)
0	-0.00 LE X LT 0.10
1	0.10 LE X LT 0.50
2	0.50 LE X LT 1.00
3	1.00 LE X LT 2.00
4	2.00 LE X LT 5.00
5	5.00 LE X LT 10.00
6	10.00 LE X LT 25.00
7	25.00 LE X LT 50.00
8	50.00 LE X

Figure 4-4 MESOPLUME 24-Hour Average SO_2 Concentration Line Printer Plot, 16 June, 1978 (from MESOFILE)

```
THE FOLLOWING RECORDS WERE USED AS THE BASE FIELD:
FIRST RECORD =     28      LAST RECORD =     28

THE FOLLOWING RECORDS WERE USED AS THE PERTURBED FIELD:
FIRST RECORD =     31      LAST RECORD =     31

STATISTICS FOR THE SET OF ALL GRID POINTS:

AVERAGE BASE FIELD VALUE (AVEB) =  0.15684E-06
AVERAGE PERTURBED FIELD VALUE (AVEP) =  0.16300E-06
AVERAGE DEVIATION (AD) = -0.61647E-08
AVERAGE ABSOLUTE DEVIATION (AAD) =  0.52787E-07
MAXIMUM LOCAL DEVIATION (XMLD) =  0.91118E-05
DIFFERENCE OF MAXIMA (DLM) B-P = -0.21656E-05
FRACTIONAL DIFFERENCE OF MAXIMA (FDLM) B-P = -0.26802E+00
MAXIMUM BASE FIELD VALUE (XMBF) =  0.80800E-05
MAXIMUM PERTURBED FIELD VALUE (XMPF) =  0.10246E-04

STATISTICS FOR THE SET OF POINTS WITHIN THE UNION OF THE TWO PLUMES:

AVERAGE DEVIATION (AD1) = -0.11512E-07
AVERAGE ABSOLUTE DEVIATION (AAD1) =  0.98574E-07
CORRELATION COEFFICIENT (RBA) =  0.79

STATISTICS FOR THE SET OF POINTS WITHIN THE INTERSECTION OF THE TWO PLUMES:

AVERAGE DEVIATION (AD0) = -0.54887E-08
AVERAGE ABSOLUTE DEVIATION (AAD0) =  0.97060E-07
AVERAGE FRACTIONAL DEVIATION (AFD0) = -0.33695E+00
AVERAGE ABSOLUTE FRACTIONAL DEVIATION (AAFD0) =  0.61030E+00
MAXIMUM ABSOLUTE FRACTIONAL DEVIATION (XMLFD0) =  0.25661E+02

PLUME CHARACTERISTICS

TOTAL NUMBER OF GRID POINTS =       676
NUMBER OF GRID POINTS CONTAINED IN THE INTERSECTION OF THE BASE AND PERTURBED PLUMES =       344
NUMBER OF NON-ZERO CONCENTRATIONS (BASE OR PERTURBED) =       362
NUMBER OF GRID POINTS IN THE BASE PLUME =       350
NUMBER OF GRID POINTS IN THE PERTURBED PLUME =       356
AVERAGE BASE PLUME VALUE (AVEB0) =  0.30292E-06
AVERAGE PERTURBED PLUME VALUE (AVEP0) =  0.30952E-06
FRACTIONAL DEVIATION OF THE MEANS (FDM) = -0.21788E-01
```

Figure 4-5 Bulk Statistical Comparison of MESOPUFF to MESOPLUME, 16 June, 1978 (from MESOFILE)

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APPENDIX A

TEST CASE MESOPAC INPUT AND OUTPUT

```
MESOPAC TEST CASE -- DAYS 165 THROUGH 167, 1978
   26   26   18    1    1
0016578   0016878
40000.    0.0001              1.0                50
.TRUE.      .TRUE.     .TRUE.
.TRUE.      .TRUE.       12    0
 INW 10.0 3.7
 UCC -0.7 8.3
 ABQ 19.1 3.7
 GJT 14.5 14.7
 TUS 9.6  -4.0
 DEN 22.9 16.9
 LND 15.1 25.9
 SLC 7.8  19.8
 ELY 1.5  15.7
 BOI -0.4 27.7
 WMC -4.2 20.8
 RAP 26.0 28.8
 LBF 31.4 21.3
 DDC 34.8 12.3
 AMA 30.8 5.0
 MAF 29.2 -4.3
 ELP 19.6 -5.2
 SAN -5.2 -2.8
 016578      18
 BOI              26.0                   6.5  3.0
 RAP              32.2                   5.8  5.8
 WMC              27.8                   3.9  6.7
 LND              30.2                   6.3  5.3
 SLC              32.8                   5.0 10.7
 LBF              28.2                   5.0 -1.3
 ELY              28.2                   2.8  4.9
 GJT              33.2                   5.1  3.5
 DEN              29.4                   0.2  2.0
 DDC              29.4                   5.3  1.9
 UCC             999.0                 999.0999.0
 INW              34.4                   6.7  4.7
 ABQ              28.2                   5.6  1.0
 AMA              27.8                   8.0  4.6
 SAN              30.0                   9.9  8.3
 TUS              39.4                   3.6  0.3
 ELP              35.0                   2.3  1.1
 MAF              31.6                   0.4  4.6
1216578      18
 BOI        914. 10.6 12.8  3.2-14.1  6.9  8.3
 RAP        903. 18.8 21.8 10.4-11.9 14.7-10.3
 WMC        869.  8.2 13.4  3.8-12.3 12.6  8.9
 LND        830. 11.6999.0 11.0-11.5  7.1  4.1
 SLC        896. 21.6 23.6 11.4 -9.5  9.9  8.3
 LBF        916. 18.2 26.2 13.0-10.9  7.5  6.3
 ELY        809. 10.2999.0 10.0 -9.5  7.2 12.5
 GJT        853. 18.2 19.4 12.4 -7.7  7.5  3.5
 DEN        839. 13.2999.0 12.8 -8.3  9.4 -2.5
 DDC        927. 18.2 22.0 10.0-10.3  4.6  8.0
 UCC       9999.999.0999.0999.0999.0999.0999.0
```

```
INW       855. 16.0 17.4 11.6 -7.1  5.9  5.0
ABQ       842. 18.8999.0 13.8-11.1  6.5 -3.0
AMA       895. 18.2 19.8 11.0 -8.1  7.1 -1.3
SAN      1000. 17.0 15.8 11.2 -7.3 14.0  6.5
TUS       924. 23.0 27.2 14.2 -6.5  5.5  5.5
ELP       884. 21.2 22.2 13.2 -9.7999.0999.0
MAF       918. 18.8 21.4 12.4 -8.5  2.6 -0.2
016678      18
BOI            23.8                10.4  2.8
RAP            29.4                 4.8 10.3
WMC            25.0                 8.3  6.9
LND           999.0               999.0999.0
SLC            30.6                 2.4 13.7
LBF            33.2                 3.3  5.8
ELY            28.0                 4.6  9.8
GJT            31.0                 3.3  5.8
DEN            32.2                -2.9  2.9
DDC            33.8                 6.6 -1.2
UCC           999.0               999.0999.0
INW            35.0                 7.3  7.3
ABQ            35.0                 3.2  2.6
AMA            31.0                 7.6  4.4
SAN            23.8                19.3  7.0
TUS            40.0                 8.6  1.5
ELP            36.6                -1.1  2.9
MAF           999.0               999.0999.0
1216678     18
BOI       917.  8.2  9.0  3.5-19.1  8.2 -0.7
RAP      9999.999.0999.0999.0999.0999.0999.0
WMC       870.  6.6  7.6  2.3-17.1  5.1  0.9
LND       825. 10.6999.0 11.4-10.1  8.7  3.2
SLC       868. 15.6 17.4  8.2-12.1  4.6 12.6
LBF       911. 17.8 23.2 15.6 -9.9  1.9  7.0
ELY       807.  8.4999.0  8.4-12.3  3.5  5.1
GJT       851. 20.6 22.4 10.8 -9.9  7.6  5.3
DEN       836. 18.8999.0 13.2 -9.1  9.9  2.7
DDC       921. 21.6 25.8 14.2 -7.1 14.7  7.5
UCC      9999.999.0999.0999.0999.0999.0999.0
INW       853. 20.0 19.8 13.0 -8.3 12.6 10.6
ABQ       840. 17.2999.0 13.4 -5.9999.0999.0
AMA       891. 20.0 22.8 14.6 -7.3  6.1  0.5
SAN      1002. 16.0 17.6 11.6 -7.7 13.4  7.7
TUS       924. 23.2 24.4 13.6 -7.5  9.8  5.7
ELP       882. 24.8 27.0 15.4 -5.9  6.7  0.6
MAF       917. 20.6 22.0 13.8 -7.1 -2.5  0.7
016778      18
BOI            19.4                11.4  3.1
RAP            29.4                10.6  3.9
WMC            22.8                 5.0  7.2
LND            27.2                 7.3  7.3
SLC            26.6                 4.7  6.7
LBF           999.0                 9.2  0.8
ELY            23.8                 8.6 10.2
GJT            33.2                 6.5  6.5
DEN            34.0                 9.7 -0.9
```

```
 DDC          36.0                    12.9  7.5
 UCC         999.0                   999.0999.0
 INW          33.2                    10.3  4.8
 ABQ          35.6                    10.6  1.9
 AMA          35.0                     9.7  6.8
 SAN          22.0                    15.2  2.7
 TUS         999.0                   999.0999.0
 ELP         999.0                   999.0999.0
 MAF          33.2                     2.3 -4.0
1216778    18
 BOI       918.  6.6 10.8  3.5-20.5  7.6 -5.3
 RAP       904. 13.8 13.4  6.8-11.9  5.5 -1.5
 WMC       870.  6.6  8.0 -0.9-23.5  1.4  3.9
 LND      9999.999.0999.0999.0999.0999.0999.0
 SLC       870. 13.8 13.8  5.4-12.7  2.6  7.3
 LBF       910. 18.8 21.8 15.0 -9.1  4.7 -4.0
 ELY      9999.999.0999.0999.0999.0999.0999.0
 GJT      9999.999.0999.0999.0999.0999.0999.0
 DEN      9999.999.0999.0999.0999.0999.0999.0
 DDC       920. 23.2 26.6 15.6 -6.9 11.6  4.2
 UCC      9999.999.0999.0999.0999.0999.0999.0
 INW      9999.999.0999.0999.0999.0999.0999.0
 ABQ      9999.999.0999.0999.0999.0999.0999.0
 AMA       890. 21.6 27.4 16.2 -7.7  8.5  4.9
 SAN      9999.999.0999.0999.0999.0999.0999.0
 TUS      9999.999.0999.0999.0999.0999.0999.0
 ELP      9999.999.0999.0999.0999.0999.0999.0
 MAF       916. 21.0 25.2 14.6 -6.3 -1.5 -0.3
 016878    18
 BOI          20.6                     9.1 -1.6
 RAP          22.2                     4.3  5.1
 WMC          21.6                     3.6 -0.3
 LND         999.0                   999.0999.0
 SLC          25.6                    10.8  0.9
 LBF          28.8                     6.2  3.6
 ELY          21.6                     8.0  5.6
 GJT          31.6                    12.5  7.2
 DEN          31.6                     0.2 -1.0
 DDC          36.6                    10.5 10.5
 UCC         999.0                   999.0999.0
 INW          32.8                     9.8  5.7
 ABQ          34.4                    11.8 -0.0
 AMA          34.4                     5.5  3.8
 SAN          23.4                    18.4  1.6
 TUS          38.4                     3.8 -2.7
 ELP          38.0                     4.5 -1.2
 MAF          34.4                     2.9 -2.1
```

*** MESOPAC ***

STATION DATA FOR 0 166 78 (HOUR,DAY,YEAR)

STATION	U	V	DEPTH	STAB
INW	7.3	7.3	4130.	3
UCC	999.0	999.0	9999.	9
ABQ	3.2	2.6	4265.	1
GJT	3.3	5.8	2656.	2
TUS	8.6	1.5	3534.	2
DEN	-2.9	2.9	3861.	1
LND	7.1	4.1	9999.	9
SLC	2.4	13.7	1578.	3
ELY	4.6	9.8	3743.	3
BOI	10.4	2.8	1982.	3
WMC	8.3	6.9	2815.	3
RAP	4.8	10.3	1442.	3
LBF	3.3	5.8	1019.	2
DDC	6.6	-1.2	2612.	2
AMA	7.6	4.4	2029.	2
MAF	2.6	-0.2	9999.	9
ELP	-1.1	2.9	5264.	1
SAN	19.3	7.0	1088.	4

ONLY NON-MISSING DATA IS USED TO CONSTRUCT ALL FIELDS AT EACH TIME STEP

** MESOPAC **

U-FIELD FOR 0 166 78 (HOUR,DAY,YEAR) 2 ITERATIONS SCAN RADIUS= 9.8 GRID SPACES FIELD IN UNITS OF 10** -1

78	85	82	78	71	65	59	56	53	55	53	58	61	66	68	70	68	65	62	55	49	44
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
64	71	69	70	64	59	54	51	49	51	50	52	56	60	63	64	62	59	55	51	46	42
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
51	62	64	63	57	52	47	43	42	40	43	44	50	54	57	55	55	52	47	41	39	34
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
48	57	59	58	53	45	42	38	37	35	37	39	42	46	45	45	44	41	39	35	29	26
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
47	55	56	54	48	41	37	33	31	32	32	33	36	40	38	37	35	30	28	25	19	14
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
45	53	53	52	47	40	35	31	29	28	29	31	33	34	31	31	26	23	18	14	8	5
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
43	51	51	50	46	41	34	32	29	28	28	29	30	28	27	26	21	17	11	3	1	6
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
40	48	48	49	45	42	36	32	29	29	29	29	29	26	27	24	19	15	7	1	6	13
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-
38	45	45	47	45	42	39	34	31	29	29	29	29	28	28	24	20	14	7	1	9	16
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-
39	44	45	46	45	43	40	36	33	29	27	28	28	29	29	27	22	15	4	4	12	17
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-
39	44	44	46	46	43	40	37	33	31	29	28	29	29	31	29	25	17	8	1	10	14
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-
40	43	44	46	45	44	41	37	34	31	31	29	30	31	32	31	25	19	11	3	6	10
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
42	44	44	46	45	43	43	40	39	36	35	35	34	34	32	31	26	20	14	8	1	3
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-
42	48	45	46	46	45	44	42	41	40	38	38	36	36	33	29	26	21	16	10	7	3
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
40	48	47	47	45	44	47	45	44	43	43	43	40	37	35	31	28	24	18	15	11	11
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
44	49	52	54	53	51	50	49	48	46	47	43	43	41	39	38	32	28	25	20	18	17
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
48	49	51	56	59	59	57	57	56	56	54	48	49	48	45	42	39	31	29	23	24	22
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
49	59	55	58	59	60	61	61	61	60	57	56	55	53	49	46	42	39	32	32	28	32
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
50	54	61	63	62	64	64	66	65	63	61	61	59	56	52	48	44	41	38	36	35	35
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
87	69	68	69	69	65	67	67	68	67	67	66	65	60	53	48	45	41	38	36	37	39
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPAC **

119	117	86	89	78	74	69	68	69	69	69	69	68	64	57	49	44	39	36	34	34	36
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
120	122	119	94	87	74	73	70	71	71	71	70	69	65	58	49	43	37	36	34	34	35
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
121	130	129	110	89	85	76	73	72	71	71	69	67	63	52	47	42	38	35	35	34	36
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
127	136	115	112	93	88	80	76	74	72	71	68	65	57	51	46	41	38	34	34	34	34
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
157	138	123	115	109	90	86	81	77	75	71	67	60	55	50	45	40	36	34	31	29	27
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
168	140	127	113	107	87	84	80	80	78	74	67	62	57	51	45	39	34	30	27	21	20
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPAC **

40 +	39 +	38 +	37 +
37 +	36 +	31 +	27 +
30 +	29 +	23 +	20 +
21 +	20 +	15 +	11 +
12 +	10 +	6 +	3 +
0 -	1 -	7 -	7 -
11 -	12 -	15 -	15 -
18 -	18 -	20 -	19 -
20 -	20 -	21 -	19 -
20 -	19 -	20 -	18 -
18 -	17 -	15 -	13 -
14 -	13 -	14 -	10 -
7 -	6 -	8 -	0 +
1 +	3 +	9 +	14 +
8 +	18 +	18 +	23 +
20 +	25 +	22 +	31 +
26 +	28 +	27 +	34 +
30 +	33 +	33 +	37 +
32 +	36 +	36 +	42 +
40 +	47 +	49 +	52 +

```
********************************************************* MESOPAC *********************************************************
  40   46   47   49
   +    +    +    +

  36   41   39   44
   +    +    +    +

  35   37   36   39
   +    +    +    +

  32   36   35   37
   +    +    +    +

  28   31   31   31
   +    +    +    +

  23   26   28   31
   +    +    +    +
```

** MESOPAC **

V-FIELD FOR 0 166 78 (HOUR,DAY,YEAR) 2 ITERATIONS SCAN RADIUS= 9.8 GRID SPACES FIELD IN UNITS OF 10** -1

59	70	86	97	105	111	115	116	113	108	101	84	70	62	58	57	60	62	63	67	69	71
60	69	77	87	96	101	107	110	109	104	99	84	71	60	55	53	53	55	53	56	59	61
67	73	77	84	94	102	109	112	113	110	102	90	77	67	60	53	52	53	52	52	55	56
71	74	78	85	95	103	110	116	115	112	108	95	82	72	60	54	54	52	45	47	49	50
77	78	82	88	97	108	117	121	122	119	111	100	87	76	65	58	55	54	52	44	46	46
81	83	87	92	101	111	119	125	127	123	115	103	91	78	65	61	56	56	50	44	42	44
86	87	90	95	102	112	122	126	128	124	115	103	91	75	66	62	58	56	52	42	41	39
90	91	92	96	104	111	119	126	127	122	113	101	87	73	65	62	60	57	47	42	39	36
94	94	96	98	104	109	117	122	123	119	108	96	81	69	64	61	60	57	49	41	37	32
96	96	97	99	104	107	113	117	116	112	103	91	77	65	62	60	59	56	46	40	34	31
97	98	99	100	103	104	108	110	109	104	96	86	73	64	61	59	58	52	44	40	35	32
98	98	99	100	103	102	103	105	104	99	91	82	71	64	61	58	56	51	44	37	33	32
96	99	99	99	102	100	98	98	96	93	86	78	69	64	60	57	54	49	43	37	33	31
93	93	97	99	97	96	95	94	91	87	82	76	67	62	59	56	54	50	46	40	36	34
96	93	91	97	97	93	90	88	85	82	79	72	65	62	56	55	53	48	45	39	35	32
97	91	90	89	89	93	89	84	83	80	79	71	61	60	57	53	52	47	43	38	34	31
97	94	89	87	87	84	81	81	78	78	73	67	64	61	56	53	47	46	39	35	32	31
92	93	89	85	84	83	80	79	77	75	70	66	63	60	56	52	45	40	36	33	31	32
106	97	88	85	79	76	75	74	73	73	69	67	65	61	56	51	45	38	33	30	28	30
88	100	96	85	80	75	73	73	72	71	69	67	64	61	56	49	42	36	32	29	28	27

** MESOPAC **

72	78	92	87	76	68	66	69	70	69	69	68	64	59	54	48	41	34	30	28	28	29
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
76	75	73	85	70	66	65	65	67	68	68	67	63	59	51	42	37	33	30	29	29	29
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
71	75	68	63	68	59	61	61	64	66	67	65	62	56	46	40	35	32	30	29	29	28
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
84	68	57	54	52	58	54	57	57	60	60	59	55	48	41	35	31	28	27	27	26	24
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
72	54	47	43	48	50	50	53	54	56	57	54	48	43	37	32	28	26	25	26	24	22
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
37	30	29	30	30	34	44	46	49	49	46	43	38	32	26	22	19	18	18	17	15	19
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPAC **

71	73	72	80
+	+	+	+
63	66	68	73
+	+	+	+
59	61	63	67
+	+	+	+
51	53	54	57
+	+	+	+
46	48	48	49
+	+	+	+
43	42	42	43
+	+	+	+
38	37	37	40
+	+	+	+
34	33	34	34
+	+	+	+
31	31	32	32
+	+	+	+
30	30	31	29
+	+	+	+
30	30	30	27
+	+	+	+
30	32	31	25
+	+	+	+
31	30	31	26
+	+	+	+
30	29	32	28
+	+	+	+
30	35	34	26
+	+	+	+
33	35	32	29
+	+	+	+
34	32	33	33
+	+	+	+
34	30	32	33
+	+	+	+
29	29	31	33
+	+	+	+
28	29	31	35
+	+	+	+

**** MESOPAC ****

28	31	31	30
+	+	+	+
30	30	29	29
+	+	+	+
28	28	30	29
+	+	+	+
24	25	25	25
+	+	+	+
24	24	26	23
+	+	+	+
22	21	25	20
+	+	+	+

** MESOPAC **

MIXING DEPTH FIELD FOR 0 166 78 (HOUR,DAY,YEAR) FIELD IN UNITS OF 10** 0

2192	2197	2215	2223	2209	2172	1734	1703	1683	1671	1578	1578	1578	1578	1989	2037	1578	2621	2571	2506	2422	2320
2349	2325	2310	2281	2229	2153	1988	1928	1648	1642	1578	1816	1875	1939	2001	2057	2644	2463	2720	2708	2654	2581
2501	2457	2409	2341	2242	2119	1924	1845	1806	1692	1734	1795	1870	1949	2023	2526	2664	2798	2842	2852	2850	2868
2633	2584	2515	2409	2257	2075	1905	1749	1754	1774	1704	1780	1874	1971	2394	2543	2687	2831	3339	2997	3037	3062
2754	2719	2642	2502	2294	2045	1818	1679	1641	1688	1791	1776	1894	2014	2417	2567	2712	2861	3019	3441	3204	3272
2892	2887	2815	2650	2388	2069	1807	1616	1578	1646	1773	1797	1944	2086	2457	2597	2733	2883	3053	3452	3577	3452
3073	3109	3054	2875	2570	2191	1849	1660	1617	1684	1823	1999	2036	2367	2511	2627	2744	2889	3071	3456	3610	3720
3295	3373	3340	3161	2882	2456	2054	1834	1769	1820	1949	2120	2170	2459	2570	2651	2740	2873	3232	3445	3633	3761
3542	3632	3618	3464	3150	2726	2335	2094	2000	2020	2122	2268	2320	2547	2618	2661	2721	2838	3164	3411	3630	3776
3632	3743	3743	3593	3324	2947	2593	2350	2234	2222	2289	2399	2442	2608	2646	2661	2696	2795	3089	3352	3591	3751
3633	3710	3706	3598	3381	3070	2770	2546	2421	2384	2416	2489	2510	2634	2656	2656	2681	2826	3028	3282	3519	3685
3574	3628	3618	3529	3398	3109	2867	2674	2551	2498	2659	2541	2530	2609	2655	2659	2683	2818	2996	3318	3435	3596
3643	3524	3509	3481	3348	3100	3059	2940	2855	2801	2766	2740	2651	2659	2697	2713	2818	2953	3132	3320	3483	3604
3610	3634	3465	3398	3400	3222	3125	3043	2978	2927	2883	2839	2720	2813	2857	2946	3020	3062	3213	3364	3495	3594
3743	3743	3743	3451	3408	3254	3197	3148	3106	3067	3023	2873	2996	2969	3076	3152	3212	3306	3332	3451	3551	3626
3743	3743	3836	3852	3874	3430	3285	3268	3252	3230	3195	3225	3400	3342	3309	3313	3417	3488	3568	3578	3649	3699
3743	3743	3870	3890	3915	3944	3709	3708	3698	3676	3617	3662	3608	3562	3537	3543	3582	3670	3731	3735	3780	3804
3743	3888	3905	3928	3954	3984	4013	3801	3815	3826	3861	3830	3788	3748	3727	3737	3777	3836	3890	3928	3925	3695
3743	3918	3938	3962	3989	4018	4045	4069	3941	3957	3981	3960	3924	3887	3869	3883	3928	3989	4044	4076	4079	3837
2899	3945	3966	3990	4017	4044	4130	4130	4080	4018	4040	4023	3986	3982	3966	3984	4035	4099	4152	4178	4175	4077

```
****************************************************************** MESOPAC ************************************************************************
2324  2600  4130  4130  4130  4006  4035  4065  4092  4114  4120  4083  4042  4000  3982  4048  4103  4168  4218  4278  4284  4198
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

2186  2483  2799  4130  3966  3994  4027  4062  4095  4121  4130  4122  4109  4101  4112  4233  4262  4297  4276  4265  4274  4225
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

2031  2343  2682  3157  3944  3971  4004  4043  4082  4114  4130  4116  4098  4087  4194  4237  4269  4280  4284  4271  4282  4235
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

1865  2187  2813  3086  3912  3934  3964  4000  4039  4078  4091  4084  4067  4149  4194  4244  4283  4299  4324  4311  4324  4250
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

 917  2402  2722  3011  3255  3885  3903  3928  3957  3983  4012  4012  4094  4134  4192  4256  4309  4341  4354  4404  4438  4477
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

 914  2296  2636  2939  3189  3826  3828  3832  3839  3848  3886  3991  4038  4104  4187  4275  4354  4413  4453  4481  4612  4638
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
```

MESOPAC

2001	1898	1800	1717
2212	2108	1994	1881
2469	2368	2237	2082
2764	2674	2528	2329
3028	3010	2861	2625
3308	3292	3207	2954
3646	3577	3512	3267
3772	3803	3735	3583
3845	3861	3800	3664
3828	3825	3770	3661
3773	3804	3672	3539
3693	3736	3746	3428
3682	3725	3680	3418
3662	3704	3478	3397
3678	3447	3402	3299
3472	3426	3475	3221
3522	3439	3436	3263
3606	3609	3423	3208
3840	3661	3436	3177
3932	3708	3409	3065

```
*********************************************************** MESOPAC ****************************************************************
 4007  3779  3466  3101
    +     +     +     +

 4141  3984  3743  3143
    +     +     +     +

 4165  4027  3809  3513
    +     +     +     +

 4192  4074  3883  3621
    +     +     +     +

 4251  4147  3979  3749
    +     +     +     +

 4366  4262  4106  3898
    +     +     +     +
```

** MESOPAC **

STABILITY FIELD FOR 0 166 78 (HOUR,DAY,YEAR) FIELD IN UNITS OF 10** 0

3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
2	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
2	2	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
2	2	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
2	2	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1
2	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1	1
2	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	1	1	1	1	1
3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1	1
3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1
3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	1	1	1
3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	1	1	1	1

```
****************************************************************** MESOPAC ************************************************************************
     3   3   3   3   3   3   2   2   3   3   3   2   2   2   2   2   2   1   1   1   1   1
     +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +

     3   3   3   3   3   3   2   2   2   3   3   2   2   2   2   2   2   1   1   1   1   1
     +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +

     3   3   3   3   3   3   2   2   2   2   2   2   2   2   2   2   2   1   1   1   1   1
     +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +

     3   3   3   3   3   3   2   2   2   2   2   2   2   2   2   2   1   1   1   1   1   1
     +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +

     4   3   3   3   3   3   3   2   2   2   2   2   2   2   2   2   1   1   1   1   1   1
     +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +

     4   3   3   3   3   2   2   2   2   2   2   2   2   2   2   1   1   1   1   1   1   1
     +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
```

```
************************************************************ MESOPAC ************************************************************
2    2    2    2
+    +    +    +

2    2    2    2
+    +    +    +

2    2    2    2
+    +    +    +

2    2    2    2
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    1    1    1
+    +    +    +

1    2    2    2
+    +    +    +
```

```
****************************************************************** MESOPAC ******************************************************************
     1     2     2     2
     +     +     +     +

     1     1     1     1
     +     +     +     +

     1     1     1     1
     +     +     +     +

     1     1     1     1
     +     +     +     +

     1     1     1     1
     +     +     +     +

     1     1     1     1
     +     +     +     +
```

APPENDIX B

TEST CASE MESOPLUME OUTPUT

```
&MODEL
LPLUME=T,LPUFF=F,LGRID=F,LPAC=F,LFILE=F
&END
&CONTR
DTIME=  1.00000000    ,MTFREQ=           1,IAVG=          24,NADVTS=          72
&END
&GRID
IELMET=           26,JELMET=           26,DELTMT=  40000.0000    ,IASTAR=           1,IASTOP=          26,JASTAR=           1,JASTOP=
         26,ISASTR=           1,JSASTR=           1,ISASTP=          26,JSASTP=          26,MESHDN=           1
&END
&SIGMA
AY=  .329999983    ,  .220000029    ,  .170000017    ,  .120000005    ,  .860000253E-01,  .570000000E-01,BY= -.100000024    ,
  -.100000024    , -.100000024    , -.100000024    , -.100000024    , -.100000024    ,AZ=  .479999930E-03,  .630000234E-01,
  .100000024    ,  .329999983    ,  .410000026    ,  .319999993    ,BZ=  1.10000038    ,  .899999738E-01, -.899999738E-01,
  -.420000017    , -.529999971    , -.579999983
&END
&METD
METSRT=     7816500,METCOD=        1003,LSENSE=F
&END
&PLUM1
MAXSEG=         100,LLID=T,LSTAB=T,LDEPTH=T,MSTABV=           4,           4,           4,           4,           4,           4,
           4,           4,           4,           4,           4,           4,           4,           4,           4,           4,           4,
           4,           4,           4,           4,           4,           4,           4,HHMV=  1000.00000    ,  1000.00000    ,
  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,
  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,
  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,
  1000.00000
&END
&PLUM2
NRE=           0,XRES=  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,
  .0            ,  .0            ,  .0            ,  .0            ,YRES=  .0            ,  .0            ,  .0            ,
  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0
&END
&REMOV
CONVFR=  .199999996E-01,LDCAY=T,EXTNCT= -.556000032E-05,LDEPOT=T,DEPVEL=  .100000016E-01,  .999999931E-03,LWASH=F,WASHOT=
  .0            ,  .0
&END
&OUTPT
LECHO=T,LPRINT=T,IPRINF=          24,LEXACT=F,LSAVE=T,ISAVEF=          24
&END
&SOURC
NSOURC=          10,LMISS=F,LFLUX=F,STAKHT=  236.000000    ,  152.000000    ,  152.000000    ,  152.000000    ,  183.000000    ,
  229.000000    ,  76.1999969    ,  183.000000    ,  175.000000    ,  152.000000    ,XXSTAK=  8.80000019    ,  23.3999939    ,
  17.1999969    ,  23.6999969    ,  13.5000000    ,  10.0000000    ,  8.00000000    ,  9.69999981    ,  .899999976    ,
  1.50000000    ,YYSTAK=  8.80000019    ,  14.0000000    ,  18.8999939    ,  13.0000000    ,  1.19999981    ,  13.1000004    ,
  19.5000000    ,  15.1999998    ,  8.00000000    ,  4.10000038    ,EMISS=  2560.00000    ,  .0            ,  343.800049    ,
  .0            ,  633.399902    ,  .0            ,  488.000000    ,  .0            ,  53.6999969    ,  .0            ,
  320.000000    ,  .0            ,  146.899994    ,  .0            ,  1310.80005    ,  .0            ,  268.800049    ,
  .0            ,  1011.00000    ,  .0            ,ECYCLE=  1.00000000    ,  1.00000000    ,  1.00000000    ,  1.00000000    ,
  1.00000000    ,  1.00000000    ,  1.00000000    ,  1.00000000    ,  1.00000000    ,  1.00000000    ,  1.00000000    ,
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2847.00000   , 3353.00000   , 3016.00000   , 6222.00000   , 240.000000   , 3016.00000   , 1047.00000    ,
11144.0000   ,BCYCLE= 1.00000000    , 1.00000000    , 1.00000000    , 1.00000000    , 1.00000000    , 1.00000000    ,
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1.00000000   , 1.00000000   , 1.00000000   , 1.00000000   , 1.00000000   , 1.00000000   , 1.00000000    ,
1.00000000   , 1.00000000   , 1.00000000
&END
```

```
************************************************************ MESOPLUME ******************************************************************

TOTAL TIME FOR RUN IS     72 HOURS.
BASIC TIME INCREMENT IS     1. HOURS.  MAP INTERVAL IS      1 HOURS.
AVERAGING INTERVAL BETWEEN PRINTED MATRIX SERIES IS    24 HRS

THERE ARE 10 SOURCE LOCATIONS.
 X AND Y COORDINATES ON THE ADVECTION GRID, AND ACTUAL STACK HEIGHTS ARE
                8.80       8.80        236. M.
               23.40      14.00        152. M.
               17.20      18.90        152. M.
               23.70      13.00        152. M.
               13.50       1.20        183. M.
               10.00      13.10        229. M.
                8.00      19.50         76. M.
                9.70      15.20        183. M.
                0.90       8.00        175. M.
                1.50       4.10        152. M.
THE COORDINATES ON THE MET GRID OF THE LOWERLEFT AND UPPER RIGHT CORNERS OF THE ADVECTION GRID ARE
   0.0   0.0 AND  25.0  25.0 RESPECTIVELY.
THE COORDINATES ON THE MET GRID OF THE LOWERLEFT AND UPPER RIGHT CORNERS OF THE SAMPLING GRID ARE
   0.0   0.0 AND  25.0  25.0 RESPECTIVELY.
THE SAMPLING GRID IS DIVIDED INTO  25.0 BY  25.0 SQUARES
SINCE SAMPLING IS AT INTERSECTIONS THE SAMPLING MATRIX IS 26 BY 26.

THE BASIC SQUARE LENGTH IN THE ADVECTION GRID IS  40.00 KM.
THE BASIC SQUARE LENGTH IN THE SAMPLING GRID IS  40.00 KM.

THE INITIAL TIME IS    0  165   78 (HOUR,DAY,YEAR)
```

```
************************************************************ MESOPLUME ************************************************************
        24.0-HOUR CONCENTRATION (GRAMS/CUBIC METER) ENDING    0  166   78 (HOUR,DAY,YEAR) FOR
       POLLUTANT 1: SULFUR DIOXIDE


      THERE FOLLOWS 1 TABLE(S):

        1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
           PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER
```

** MESOPLUME **

TABLE 1 POLLUTANT 1 24.0 HOUR AVERAGE ENDING 0 166 78 (HOUR,DAY,YEAR) FIELD IN UNITS OF 10** -8

0	0	0	0	0	0	0	0	0	0	0	0	1	1	5	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	1	7	11	13	6	0	0	0	0	0	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	1	6	16	17	2	0	0	0	1	2	3	5	4
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	6	23	17	1	0	0	1	3	10	15	14	13	7
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	1	49	6	1	1	3	7	13	28	43	33	24	17	12
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	2	2	2	1	7	18	33	66	77	44	41	33	34	45
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	2	3	3	2	3	21	80	114	112	33	8	6	11	17	20
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	1	3	5	3	1	30	177	172	50	8	6	11	13	8	5	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	3	6	4	1	1	331	77	8	8	10	15	10	5	7	6	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	1	7	7	1	0	1	3	12	14	20	14	7	9	15	20	14	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	7	11	1	0	2	4	19	25	20	7	10	20	39	44	42	22	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	2	18	2	0	1	6	11	25	9	17	25	38	66	79	67	32	11	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	21	5	0	1	6	12	14	11	30	44	67	100	95	57	30	10	3	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	5	20	0	0	4	15	15	11	36	76	119	108	47	15	5	1	1	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	77	0	0	1	16	18	6	13	126	135	22	3	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	20	0	0	0	12	25	5	0	239	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	4	35	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	43	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	36	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

```
************************************************************ MESOPLUME ************************************************************
   0    0    0    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +

   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +

   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1    1    1    1    0    0
   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +

   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0   10    6    5    4    3    2    2
   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +

   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1    2    1
   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +

   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
```

** MESOPLUME **

1 +	0 +	0 +	0 +
2 +	1 +	0 +	0 +
3 +	1 +	0 +	0 +
3 +	1 +	1 +	0 +
11 +	9 +	8 +	0 +
52 +	42 +	33 +	0 +
22 +	21 +	19 +	1 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	4 +	0 +
0 +	0 +	86 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +
0 +	0 +	0 +	0 +

```
************************************************************ MESOPLUME ******************************************************************
     0      0      0      0
     +      +      +      +

     0      0      0      0
     +      +      +      +

     0      0      0      0
     +      +      +      +

     1      0      0      0
     +      +      +      +

     1      0      0      0
     +      +      +      +

     0      0      0      0
     +      +      +      +
```

```
************************************************************ MESOPLUME ************************************************************
 24.0-HOUR CONCENTRATION (GRAMS/CUBIC METER) ENDING    0  166   78 (HOUR,DAY,YEAR) FOR
POLLUTANT 2: SULFATES


THERE FOLLOWS 1 TABLE(S):

   1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
      PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER
```

** MESOPLUME **

TABLE 1 POLLUTANT 2 24.0 HOUR AVERAGE ENDING 0 166 78 (HOUR,DAY,YEAR) FIELD IN UNITS OF 10** -9

0	0	0	0	0	0	0	0	0	0	0	1	3	5	19	0	0	0	0	0	1	4
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	2	15	28	38	21	1	0	0	0	3	10	17
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	2	12	33	42	10	3	0	0	3	14	29	52	48
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	1	9	30	32	8	4	2	5	15	56	103	117	123	65
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	1	5	34	15	12	7	9	23	53	139	242	218	136	86	57
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	2	10	16	15	7	16	43	109	255	336	220	105	71	80	113
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	1	7	15	18	18	7	36	195	318	351	124	38	36	49	61	57
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	3	13	24	16	4	33	284	325	116	24	25	50	65	52	38	8
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	1	10	25	19	7	4	308	98	34	34	31	55	42	26	52	61	2
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	4	25	30	6	0	9	14	46	60	61	40	30	59	111	168	137	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	18	38	5	2	11	28	60	87	62	31	48	110	231	303	333	212	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	5	47	9	0	7	32	62	75	59	70	98	165	317	429	419	239	107	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	44	15	0	2	26	62	73	64	92	128	221	383	416	283	174	71	31	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	8	38	0	0	14	63	70	55	72	156	293	317	162	62	21	8	4	1	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	104	0	0	3	55	68	26	17	160	229	47	7	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	13	0	0	0	34	78	17	1	153	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	9	87	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	82	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	46	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPLUME **

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3	3	2	2
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	11	11	12	11	11	9
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	9	8
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPLUME **

12	0	0	0
+	+	+	+
24	9	0	0
+	+	+	+
41	14	4	0
+	+	+	+
28	10	5	0
+	+	+	+
46	40	42	0
+	+	+	+
155	159	153	0
+	+	+	+
61	75	85	4
+	+	+	+
1	0	1	1
+	+	+	+
1	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	7	0
+	+	+	+
0	0	32	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+

```
*************************************************************** MESOPLUME ******************************************************************
      0      0      0      0
      +      +      +      +

      0      0      0      0
      +      +      +      +

      1      2      0      0
      +      +      +      +

      6      3      1      0
      +      +      +      +

      5      3      0      0
      +      +      +      +

      1      0      0      0
      +      +      +      +
```

*** MESOPLUME ***

24.0-HOUR CONCENTRATION (GRAMS/CUBIC METER) ENDING 0 167 78 (HOUR,DAY,YEAR) FOR
POLLUTANT 1: SULFUR DIOXIDE

THERE FOLLOWS 1 TABLE(S):

1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER

** MESOPLUME **

TABLE 1 POLLUTANT 1 24.0 HOUR AVERAGE ENDING 0 167 78 (HOUR,DAY,YEAR) FIELD IN UNITS OF 10** -8

0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	5	14	29	17	16	8	6
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	1	3	4	27	10	1	2	8	24	45	57	47	27	15	14
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	2	5	18	18	2	4	15	31	49	63	46	31	21	17	30
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	3	5	46	3	1	13	32	45	66	46	24	19	15	30	31
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	1	5	4	15	2	5	34	34	72	37	20	16	15	17	85	57
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	3	6	3	2	3	16	20	78	34	16	19	20	20	215	81	33
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	5	6	3	2	6	39	53	48	14	22	26	30	33	34	32	23
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	1	8	5	2	3	8	12	85	12	17	31	43	51	45	44	39	21
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	4	10	4	2	5	11	193	13	14	41	43	49	57	56	41	34	10
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	11	9	3	2	9	11	15	13	38	50	46	61	57	41	22	19	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	2	18	7	3	4	11	11	14	36	58	38	65	64	21	10	8	3	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	15	16	6	1	8	12	10	42	50	31	62	66	11	1	0	1	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	34	9	2	2	13	9	15	31	33	67	70	5	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	18	28	5	0	6	12	14	22	61	76	69	1	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	70	11	0	1	13	9	24	24	92	47	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	39	25	0	0	7	11	21	16	132	4	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	56	0	0	1	14	31	24	4	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	13	53	24	3	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	4	98	21	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	160	9	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPLUME **

0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	1	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	2	2	2	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	2	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPLUME **

7	5	1	0
+	+	+	+
23	24	14	3
+	+	+	+
43	24	15	2
+	+	+	+
38	26	21	2
+	+	+	+
43	35	26	4
+	+	+	+
22	17	12	5
+	+	+	+
18	11	8	2
+	+	+	+
11	6	3	1
+	+	+	+
5	1	1	0
+	+	+	+
1	0	16	0
+	+	+	+
0	0	3	0
+	+	+	+
0	0	35	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
1	1	0	0
+	+	+	+

```
********************************************************** MESOPLUME **********************************************************
     1      1      1      0
     +      +      +      +

     1      1      1      0
     +      +      +      +

     0      1      0      0
     +      +      +      +

     0      0      0      0
     +      +      +      +

     0      0      0      0
     +      +      +      +

     0      0      0      0
     +      +      +      +
```

```
************************************************************ MESOPLUME *****************************************************************

  24.0-HOUR CONCENTRATION (GRAMS/CUBIC METER) ENDING    0  167   78 (HOUR,DAY,YEAR) FOR
 POLLUTANT 2: SULFATES


THERE FOLLOWS 1 TABLE(S):

   1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
      PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER
```

** MESOPLUME **

TABLE 1 POLLUTANT 2 24.0 HOUR AVERAGE ENDING 0 167 78 (HOUR,DAY,YEAR) FIELD IN UNITS OF 10** -9

0	0	0	0	0	0	0	1	6	6	5	5	7	14	26	50	105	181	120	128	79	65
0	0	0	0	0	0	0	3	21	29	57	30	7	19	55	148	267	347	312	214	147	134
0	0	0	0	0	0	1	11	31	43	39	21	38	85	166	252	336	284	229	183	144	184
0	0	0	0	0	0	2	20	31	54	18	7	64	154	209	306	264	173	149	119	162	167
0	0	0	0	0	0	6	31	29	25	21	47	133	161	275	198	143	127	123	126	290	267
0	0	0	0	0	0	14	37	25	17	23	76	99	238	151	114	134	140	161	351	292	250
0	0	0	0	0	1	27	36	20	18	45	119	146	157	109	133	167	212	256	294	302	243
0	0	0	0	0	5	42	31	16	24	59	77	184	86	108	172	271	340	328	370	380	206
0	0	0	0	0	18	51	25	14	33	70	205	73	77	192	236	279	332	372	330	351	100
0	0	0	0	1	47	44	17	13	51	70	73	69	141	235	224	292	286	256	197	223	12
0	0	0	0	8	75	31	12	20	62	61	75	109	220	158	245	257	101	71	86	33	1
0	0	0	0	45	60	20	4	37	59	50	96	162	107	171	197	38	3	3	14	0	0
0	0	0	1	93	25	6	7	55	37	62	104	93	137	162	13	0	0	0	0	0	0
0	0	0	31	65	11	0	21	48	50	82	123	114	120	2	0	0	0	0	0	0	0
0	0	0	106	18	0	3	41	27	75	61	93	59	0	0	0	0	0	0	0	0	0
0	0	29	26	0	0	18	31	55	47	68	4	0	0	0	0	0	0	0	0	0	0
0	0	26	0	0	1	32	66	55	11	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	22	85	45	6	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	4	111	30	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2
0	0	0	0	116	9	0	0	0	0	0	0	0	0	0	0	0	0	1	3	5	5

** MESOPLUME **

0	0	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	10	7	6
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	7	5	5	5
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	3	3	4	3	3
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

MESOPLUME

70	46	12	0
+	+	+	+
161	158	101	18
+	+	+	+
229	155	116	18
+	+	+	+
217	197	177	32
+	+	+	+
246	251	236	54
+	+	+	+
235	202	163	66
+	+	+	+
202	131	107	26
+	+	+	+
110	68	41	10
+	+	+	+
49	11	4	0
+	+	+	+
6	3	51	2
+	+	+	+
0	0	6	1
+	+	+	+
0	0	57	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
1	1	1	0
+	+	+	+
3	3	3	1
+	+	+	+
5	5	4	2
+	+	+	+

*** MESOPLUME ***

5 +	6 +	6 +	3 +
6 +	6 +	7 +	1 +
4 +	6 +	5 +	0 +
1 +	2 +	2 +	0 +
0 +	0 +	1 +	0 +
0 +	0 +	0 +	0 +

```
************************************************************ MESOPLUME ***********************************************************************

     24.0-HOUR CONCENTRATION (GRAMS/CUBIC METER) ENDING    0  168   78 (HOUR,DAY,YEAR) FOR
    POLLUTANT 1: SULFUR DIOXIDE


   THERE FOLLOWS 1 TABLE(S):

     1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
        PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER
```

** MESOPLUME **

TABLE 1 POLLUTANT 1 24.0 HOUR AVERAGE ENDING 0 168 78 (HOUR,DAY,YEAR) FIELD IN UNITS OF 10** -8

0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	2	13	33	23	3
0	0	0	0	0	0	0	0	0	0	1	24	6	3	3	2	4	24	50	52	28	10
0	0	0	0	0	0	0	0	0	0	29	7	4	3	3	5	38	71	49	24	13	9
0	0	0	0	0	0	0	0	0	3	16	5	5	3	3	44	85	43	21	16	15	15
0	0	0	0	0	0	0	0	0	129	7	6	4	2	67	127	31	19	24	23	50	63
0	0	0	0	0	0	0	0	0	13	7	4	2	66	147	22	19	29	23	246	372	118
0	0	0	0	0	0	0	0	0	3	6	5	16	234	20	28	41	20	12	12	12	19
0	0	0	0	0	0	0	0	1	6	6	3	530	28	42	43	14	13	14	19	36	50
0	0	0	0	0	0	0	0	5	10	4	808	65	52	26	11	14	16	30	64	92	130
0	0	0	0	0	0	0	2	13	7	2	192	11	16	13	16	16	39	54	113	124	142
0	0	0	0	0	0	0	13	12	3	2	1	13	22	10	13	45	37	47	82	74	50
0	0	0	0	0	0	10	19	5	2	2	2	11	6	12	48	36	58	73	56	19	12
0	0	0	0	0	4	29	6	3	3	1	1	5	10	54	39	79	61	30	16	3	2
0	0	0	0	0	44	8	5	2	0	0	4	10	61	96	89	31	12	8	4	2	0
0	0	0	0	68	12	6	1	0	0	2	10	102	158	37	15	7	3	1	0	0	0
0	0	0	117	22	1	0	0	0	2	13	345	33	18	9	3	1	0	0	0	0	0
0	0	265	2	0	0	0	0	2	19	35	23	9	2	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	5	37	33	11	2	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	18	60	15	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	77	21	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

```
************************************************************ MESOPLUME ****************************************************************
   0     0     0    30    16     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     1     1
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     1     2     2     3     3     3
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
```

** MESOPLUME **

1	1	1	0
+	+	+	+
2	2	2	2
+	+	+	+
6	6	5	2
+	+	+	+
14	13	11	2
+	+	+	+
63	63	60	4
+	+	+	+
126	131	130	1
+	+	+	+
20	27	34	4
+	+	+	+
62	64	45	6
+	+	+	+
106	98	78	4
+	+	+	+
105	72	61	2
+	+	+	+
28	26	22	0
+	+	+	+
3	4	113	0
+	+	+	+
0	1	1	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+

******************** MESOPLUME ********************

```
0   0   0   0
+   +   +   +

0   1   1   0
+   +   +   +

1   1   1   0
+   +   +   +

2   2   1   0
+   +   +   +

0   0   0   0
+   +   +   +

0   0   0   0
+   +   +   +
```

*** MESOPLUME ***

24.0-HOUR CONCENTRATION (GRAMS/CUBIC METER) ENDING   0 168   78 (HOUR,DAY,YEAR) FOR
POLLUTANT 2: SULFATES

THERE FOLLOWS 1 TABLE(S):

1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
   PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER

** MESOPLUME **

TABLE 1 POLLUTANT 2 24.0 HOUR AVERAGE ENDING 0 168 78 (HOUR,DAY,YEAR) FIELD IN UNITS OF 10** -8

0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	2	11	28	20	3
0	0	0	0	0	0	0	0	0	0	1	8	3	2	2	1	3	18	38	43	26	10
0	0	0	0	0	0	0	0	0	0	6	3	3	3	2	3	24	47	37	21	13	9
0	0	0	0	0	0	0	0	0	1	3	3	3	2	2	22	45	26	15	13	13	14
0	0	0	0	0	0	0	0	0	10	2	3	3	2	27	54	15	10	15	17	24	32
0	0	0	0	0	0	0	0	0	1	3	3	2	20	48	8	8	13	14	37	64	42
0	0	0	0	0	0	0	0	0	2	4	3	4	55	5	8	15	10	9	10	14	23
0	0	0	0	0	0	0	0	1	4	4	2	82	5	8	12	7	8	10	16	31	47
0	0	0	0	0	0	0	0	2	5	3	72	7	7	6	5	7	9	19	44	70	112
0	0	0	0	0	0	0	1	6	4	1	9	1	3	4	6	9	20	30	67	85	114
0	0	0	0	0	0	0	5	5	2	1	1	2	4	5	7	19	17	23	45	45	40
0	0	0	0	0	0	3	6	2	1	1	0	1	3	6	18	14	22	32	29	16	10
0	0	0	0	0	1	7	2	1	1	0	0	2	5	17	13	25	24	16	11	3	2
0	0	0	0	0	8	2	1	1	0	0	2	4	15	23	24	13	7	6	3	2	0
0	0	0	0	9	2	1	0	0	0	1	4	17	28	13	8	4	2	1	0	0	0
0	0	0	9	3	0	0	0	0	0	4	31	11	8	4	1	0	0	0	0	0	0
0	0	10	0	0	0	0	0	0	6	11	8	3	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	9	9	3	1	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	3	12	3	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

** MESOPLUME **

0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPLUME **

1	2	1	0
+	+	+	+
3	4	4	2
+	+	+	+
7	8	7	2
+	+	+	+
14	15	14	3
+	+	+	+
36	40	44	4
+	+	+	+
59	74	92	2
+	+	+	+
26	32	40	6
+	+	+	+
64	69	50	10
+	+	+	+
101	102	84	6
+	+	+	+
99	75	66	3
+	+	+	+
28	29	25	0
+	+	+	+
4	5	15	0
+	+	+	+
0	1	1	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+

```
******************************************************* MESOPLUME *******************************************************
    0     0     0     0
    +     +     +     +

    0     0     0     0
    +     +     +     +

    0     0     1     0
    +     +     +     +

    1     1     1     0
    +     +     +     +

    0     0     0     0
    +     +     +     +

    0     0     0     0
    +     +     +     +
```

*** MESOPLUME **

MAXIMUM 24.-HOUR CONCENTRATION OCCURING ANYTIME DURING THE ENTIRE RUN SPAN FOR
POLLUTANT 1: SULFUR DIOXIDE

THERE FOLLOWS 1 TABLE(S):

1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER

MESOPLUME

TABLE 1 POLLUTANT 1 MAXIMUM 24.0-HOUR AVERAGE OCCURING ANY TIME DURING RUN FIELD IN UNITS OF 10** -8

0	0	0	0	0	0	0	0	1	1	1	1	1	1	5	5	14	29	17	33	23	6
0	0	0	0	0	0	0	1	3	4	27	24	11	13	8	24	45	57	50	52	28	14
0	0	0	0	0	0	0	2	5	18	29	16	17	15	31	49	63	71	49	24	17	30
0	0	0	0	0	0	0	3	5	46	23	17	13	32	45	66	85	43	21	16	30	31
0	0	0	0	0	0	1	5	4	129	7	6	34	34	72	127	31	43	33	24	85	63
0	0	0	0	0	0	3	6	3	13	7	16	20	78	147	66	77	44	41	246	372	118
0	0	0	0	0	0	5	6	3	3	6	39	53	234	114	112	41	30	33	34	32	23
0	0	0	0	0	1	8	5	5	6	8	30	530	172	50	43	43	51	45	44	39	50
0	0	0	0	0	4	10	6	5	10	11	808	77	52	41	43	49	57	56	64	92	130
0	0	0	0	0	11	9	7	13	9	11	192	13	38	50	46	61	57	54	113	124	142
0	0	0	0	2	18	11	13	12	11	11	19	36	58	38	65	64	39	47	82	74	50
0	0	0	0	15	18	10	19	8	12	11	42	50	31	62	66	66	79	73	56	19	12
0	0	0	0	34	9	29	6	13	12	15	31	33	67	70	100	95	61	30	16	3	2
0	0	0	18	28	44	8	6	15	15	22	61	76	119	108	89	31	12	8	4	2	0
0	0	0	77	68	12	6	16	18	24	24	126	135	158	37	15	7	3	1	0	0	0
0	0	39	117	22	1	12	25	21	16	239	345	33	18	9	3	1	0	0	0	0	0
0	0	265	2	0	4	35	31	24	19	35	23	9	2	0	0	0	0	0	0	0	0
0	0	0	0	0	43	53	24	37	33	11	2	0	0	0	0	0	0	0	0	0	0
0	0	0	0	36	98	21	60	15	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	4	160	77	21	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1

** MESOPLUME **

0	0	0	120	16	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	1	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	2	2	2	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	6	5	4	3	3	3
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

MESOPLUME

7	5	1	0
+	+	+	+
23	24	14	3
+	+	+	+
43	24	15	2
+	+	+	+
38	26	21	2
+	+	+	+
63	63	60	4
+	+	+	+
126	131	130	5
+	+	+	+
22	27	34	4
+	+	+	+
62	64	45	6
+	+	+	+
106	98	78	4
+	+	+	+
105	72	61	2
+	+	+	+
28	26	22	0
+	+	+	+
3	4	113	0
+	+	+	+
0	1	1	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
1	1	0	0
+	+	+	+

```
******************************************************************* MESOPLUME *************************************************************************
     1      1      1      0
     +      +      +      +

     1      1      1      0
     +      +      +      +

     1      1      1      0
     +      +      +      +

     2      2      1      0
     +      +      +      +

     1      0      0      0
     +      +      +      +

     0      0      0      0
     +      +      +      +
```

** MESOPLUME **

MAXIMUM 24.-HOUR CONCENTRATION OCCURING ANYTIME DURING THE ENTIRE RUN SPAN FOR
POLLUTANT 2: SULFATES

THERE FOLLOWS 1 TABLE(S):

1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER

** MESOPLUME **

TABLE 1 POLLUTANT 2 MAXIMUM 24.0-HOUR AVERAGE OCCURING ANY TIME DURING RUN FIELD IN UNITS OF 10** -8

0	0	0	0	0	0	0	0	1	1	0	1	1	1	3	5	10	18	12	28	20	7
0	0	0	0	0	0	0	0	2	3	6	8	3	4	6	15	27	35	38	43	26	13
0	0	0	0	0	0	0	1	3	4	6	3	4	9	17	25	34	47	37	21	14	18
0	0	0	0	0	0	0	2	3	5	3	3	6	15	21	31	45	26	15	13	16	17
0	0	0	0	0	0	1	3	3	10	2	5	13	16	28	54	15	24	22	17	29	32
0	0	0	0	0	0	1	4	2	2	3	8	10	24	48	25	34	22	16	37	64	42
0	0	0	0	0	0	3	4	2	2	4	12	15	55	32	35	17	21	26	29	30	24
0	0	0	0	0	0	4	3	2	4	6	8	82	32	12	17	27	34	33	37	38	47
0	0	0	0	0	2	5	3	2	5	7	72	10	8	19	24	28	33	37	44	70	112
0	0	0	0	0	5	4	3	6	5	7	9	7	14	24	22	29	29	30	67	85	114
0	0	0	0	1	7	4	5	5	6	6	7	11	22	16	25	26	23	30	45	45	40
0	0	0	0	5	6	3	6	4	6	6	10	16	11	17	20	32	43	42	29	16	10
0	0	0	0	9	3	7	2	6	6	7	10	9	14	22	38	42	28	17	11	3	2
0	0	0	3	7	8	2	2	6	7	8	12	16	29	32	24	13	7	6	3	2	0
0	0	0	11	9	2	1	5	7	8	6	16	23	28	13	8	4	2	1	0	0	0
0	0	3	9	3	0	3	8	6	5	15	31	11	8	4	1	0	0	0	0	0	0
0	0	10	0	0	1	9	7	6	6	11	8	3	1	0	0	0	0	0	0	0	0
0	0	0	0	0	8	9	4	9	9	3	1	0	0	0	0	0	0	0	0	0	0
0	0	0	0	5	11	3	12	3	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	12	9	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

```
****************************************************************** MESOPLUME ***********************************************************************
   0      0      0      4      1      0      0      0      0      0      0      0      0      0      0      0      0      0      1      1      1      1
   +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +

   0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      2      1      1      0      0
   +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +

   0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      3      0      0      0      0      0
   +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +

   0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      1      1      1      1      1      1      1
   +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +

   0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      1      1      1
   +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +

   0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0      0
   +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +      +
```

```
************************************************************ MESOPLUME ************************************************************
     1     1     1     0
     +     +     +     +

     1     1     1     0
     +     +     +     +

     0     1     1     0
     +     +     +     +

     1     1     1     0
     +     +     +     +

     0     0     0     0
     +     +     +     +

     0     0     0     0
     +     +     +     +
```

```
****************************************************************** MESOPLUME ******************************************************************

                    CONCENTRATIONS AVERAGED OVER TOTAL RUN SPAN FOR
                    POLLUTANT 1: SULFUR DIOXIDE



                   THERE FOLLOWS 1 TABLE(S):

                      1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
                         PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER
```

*** MESOPLUME ***

TABLE 1 POLLUTANT 1 AVERAGE CONCENTRATIONS OVER ENTIRE RUN SPAN FIELD IN UNITS OF 10** -8

0	0	0	0	0	0	0	0	0	0	0	1	1	1	3	2	5	10	10	16	10	3
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	1	1	10	14	6	6	6	9	16	27	32	26	15	8
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	1	2	6	17	9	8	7	11	18	34	39	27	16	12	15
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	1	2	18	14	7	6	12	16	37	45	25	18	15	19	18
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	2	2	64	5	4	13	13	49	59	27	26	24	21	51	44
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	1	2	2	6	4	7	10	54	71	35	39	31	28	165	162	65
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	2	2	2	3	5	16	30	121	49	54	33	20	17	19	20	21
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	3	3	3	4	5	15	264	70	37	27	21	25	24	24	26	24
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	1	4	3	4	5	5	444	52	24	25	21	26	28	30	37	44	47
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	4	5	4	5	5	5	70	12	23	27	26	28	35	37	52	52	48
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	1	8	6	6	5	6	6	11	25	33	18	30	43	32	34	44	33	17
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	6	11	6	7	5	7	8	23	24	18	33	51	38	46	47	30	10	4
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	18	6	10	3	7	8	10	14	23	40	64	48	58	39	20	9	2	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	8	16	16	3	5	10	10	11	33	54	83	68	45	16	6	3	2	1	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	49	26	4	3	10	9	10	13	76	95	60	13	5	2	1	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	20	47	7	0	6	12	9	6	128	117	11	6	3	1	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	107	1	0	2	16	12	9	8	12	8	3	1	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	19	19	10	13	11	4	1	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	13	35	13	20	5	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	1	55	29	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPLUME **

0	0	0	50	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	1	1	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	3	2	2	2	2	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

** MESOPLUME **

3	2	1	0
+	+	+	+
9	9	6	1
+	+	+	+
17	10	7	1
+	+	+	+
18	13	11	2
+	+	+	+
39	35	31	3
+	+	+	+
67	63	58	2
+	+	+	+
20	20	20	2
+	+	+	+
24	23	16	2
+	+	+	+
37	33	26	1
+	+	+	+
35	24	26	1
+	+	+	+
9	9	10	0
+	+	+	+
1	1	78	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+

```
************************************************************ MESOPLUME ************************************************************
   0      0      0      0
   +      +      +      +

   0      1      1      0
   +      +      +      +

   1      1      1      0
   +      +      +      +

   1      1      1      0
   +      +      +      +

   0      0      0      0
   +      +      +      +

   0      0      0      0
   +      +      +      +
```

** MESOPLUME **

CONCENTRATIONS AVERAGED OVER TOTAL RUN SPAN FOR
POLLUTANT 2: SULFATES

THERE FOLLOWS 1 TABLE(S):

1) A 4 PAGE GRID OF CONCENTRATIONS, EXPRESSED IN INTEGER UNITS OF AN APPROPRIATE EXPONENT
PAGE 1: NW CORNER, PAGE 2: SW CORNER, PAGE 3: NE CORNER, PAGE 4: SE CORNER

** MESOPLUME **

TABLE 1 POLLUTANT 2 AVERAGE CONCENTRATIONS OVER ENTIRE RUN SPAN FIELD IN UNITS OF 10** -9

0	0	0	0	0	0	0	0	2	2	2	4	5	8	17	18	36	68	78	136	94	33
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	1	7	10	21	41	22	26	33	55	100	176	232	214	140	83
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	0	4	10	15	39	27	36	40	64	95	191	252	206	141	108	108
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	1	7	11	23	27	22	34	60	78	176	244	164	135	122	139	124
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	2	11	11	54	19	30	55	63	188	265	145	157	162	143	205	216
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	5	13	12	15	22	38	45	160	247	150	183	164	135	265	338	261
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	0	9	14	12	18	34	53	75	301	159	188	146	118	126	149	168	178
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	2	15	15	16	25	35	43	431	153	102	105	121	155	164	195	244	227
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	6	20	17	19	31	33	410	80	59	96	104	133	154	195	274	370	409
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	17	23	19	25	29	30	58	43	78	112	108	136	181	221	344	403	384
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	3	31	23	21	23	30	32	47	71	106	78	121	186	168	202	289	232	135
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	17	36	19	22	20	34	40	58	78	70	111	180	166	219	246	182	88	35
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	46	16	26	9	31	36	46	57	70	105	184	176	221	173	112	61	19	6
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	13	35	31	6	17	39	41	46	70	105	189	183	133	65	32	21	12	6	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	70	36	7	6	32	32	34	28	98	153	111	46	26	14	6	2	1	1	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	14	40	9	1	18	36	24	18	88	104	38	27	14	5	1	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	41	1	0	4	40	27	20	22	37	27	11	3	1	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	0	35	32	18	32	30	11	2	0	0	0	0	0	0	0	0	0	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	0	17	40	20	39	12	1	0	0	0	0	0	0	0	0	0	0	0	1
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0	0	0	1	41	33	10	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

```
**************************************************************** MESOPLUME *****************************************************************
   0     0     0    19     4     0     0     0     0     0     0     0     0     0     0     0     0     0     3     3     2     2
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     5     2     2     2     2
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     9     2     2     2     2     2
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     5     4     5     5     6     6     6
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     1     2     3     3
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +

   0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0
   +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
```

******************** MESOPLUME ********************

30	20	7	0
+	+	+	+
72	68	45	14
+	+	+	+
112	82	62	14
+	+	+	+
127	119	109	19
+	+	+	+
218	231	240	33
+	+	+	+
326	366	413	29
+	+	+	+
173	176	197	30
+	+	+	+
250	254	180	36
+	+	+	+
354	342	282	20
+	+	+	+
333	250	238	9
+	+	+	+
92	96	89	2
+	+	+	+
12	18	79	0
+	+	+	+
0	2	3	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
0	0	0	0
+	+	+	+
1	1	1	0
+	+	+	+
2	2	1	1
+	+	+	+

```
************************************************************** MESOPLUME ********************************************************************
    2      2      2      1
    +      +      +      +

    2      3      4      0
    +      +      +      +

    3      4      4      0
    +      +      +      +

    5      4      3      0
    +      +      +      +

    2      1      1      0
    +      +      +      +

    0      0      0      0
    +      +      +      +
```

WHEN THE FIRST SEGMENT FOR EACH SOURCE FELL OFF GRID

SOURCE	HR/DAY/YR
1	20/166/78
2	10/165/78
3	15/165/78
4	9/165/78
5	4/166/78
6	14/166/78
7	8/165/78
8	5/166/78
9	5/166/78
10	18/166/78

APPENDIX C

TEST CASE NAMELIST FILE

INUMB	DATFLD	MODEL	YR/DAY/HR	NGRIDS	IAVG	ISAVEF	ISAFE	IBEGIN	ISTUP	ICHECK
1	12 FEB 1979	MESOPLUM	78/165/ 0	3	24	24	1	2	4	1

```
*********************************************************************************************************

&MODEL
LPLUME=T,LPUFF=F,LGRID=F,LPAC=F
&END
&CONTR
DTIME=  1.00000000    ,MTFREQ=           1,IAVG=          24,NADVTS=          72
&END
&GRID
IELMET=           26,JELMET=          26,DELTMT=  40000.0000    ,IASTAR=          1,IASTOP=          26,JASTAR=           1,JASTOP=
        26,ISASTR=           1,JSASTR=           1,ISASTP=          26,JSASTP=          26,MESHDN=           1
&END
&SIGMA
AY=  .329999983    ,  .220000029    ,  .170000017    ,  .120000005    ,  .860000253E-01,  .570000000E-01,BY= -.100000024    ,
 -.100000024    , -.100000024    , -.100000024    , -.100000024    , -.100000024    ,AZ=  .479999930E-03,  .630000234E-01,
  .100000024    ,  .329999983    ,  .410000026    ,  .319999993    ,BZ=  1.10000038    ,  .899999738E-01, -.899999738E-01,
 -.420000017    , -.529999971    , -.579999983
&END
&METD
METSRT=     7816500,METCOD=        1003,LSENSE=F
&END
&PLUM1
MAXSEG=          100,LLID=T,LSTAB=T,LDEPTH=T,MSTABV=           4,           4,           4,           4,           4,           4,
          4,           4,           4,           4,           4,           4,           4,           4,           4,           4,           4,
          4,           4,           4,           4,           4,           4,HHMV=  1000.00000    ,  1000.00000    ,
  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,
  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,
  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,  1000.00000    ,
  1000.00000
&END
&PLUM2
NRE=           0,XRES=  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,
  .0            ,  .0            ,  .0            ,  .0            ,YRES=  .0            ,  .0            ,  .0            ,
  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0            ,  .0
&END
&REMOV
CONVFR=  .199999996E-01,LDCAY=T,EXTINCT= -.556000032E-05,LDEPOT=T,DEPVEL=  .100000016E-01,  .999999931E-03,LWASH=F,WASHOT=
  .0            ,  .0
&END
&OUTPT
LECHO=T,LPRINT=T,IPRINF=          24,LEXACT=F,LSAVE=T,ISAVEF=          24
&END
&SOURC
NSOURC=          10,STAKHT=  236.000000    ,  152.000000    ,  152.000000    ,  152.000000    ,  183.000000    ,  229.000000    ,
  76.1999969    ,  183.000000    ,  175.000000    ,  152.000000    ,XXSTAK=  8.80000019    ,  23.3999939    ,  17.1999969    ,
  23.6999969    ,  13.5000000    ,  10.0000000    ,  8.00000000    ,  9.69999981    ,  .899999976    ,  1.50000000    ,YYSTAK=
  8.80000019    ,  14.0000000    ,  18.8999939    ,  13.0000000    ,  1.19999981    ,  13.1000004    ,  19.5000000    ,
  15.1999998    ,  8.00000000    ,  4.10000038    ,EMISS=  2560.00000    ,  .0            ,  343.800049    ,  .0            ,
  633.399902    ,  .0            ,  488.000000    ,  .0            ,  53.6999969    ,  .0            ,  320.000000    ,
  .0            ,  146.899994    ,  .0            ,  1310.80005    ,  .0            ,  268.800049    ,  .0            ,
  1011.00000    ,  .0            ,LMISS=F,ECYCLE=  1.00000000    ,  1.00000000    ,  1.00000000    ,  1.00000000    ,
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1.00000000  , 1.00000000  , 1.00000000  , 1.00000000  , 1.00000000  ,BFLUX=  6397.00000    ,  1503.00000    ,
2647.00000  , 3353.00000  , 3016.00000  , 6222.00000  , 240.000000  , 3016.00000  , 1047.00000  ,
11144.0000  ,LFLUX=F,HCYCLE=  1.00000000  , 1.00000000  , 1.00000000  , 1.00000000  , 1.00000000  ,
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  1.00000000    ,  1.00000000    ,  1.00000000    ,  1.00000000
&END

*****************************************************************************************************************************************
```

INUMB	DATFLD	MODEL	YR/DAY/HR	NGRIDS	IAVG	ISAVEF	ISAFE	IBEGIN	ISTOP	ICHECK
2	12 FEB 1979	MESOPUFF	78/165/ 0	3	24	24	5	6	8	1

```
**************************************************************************************************

&MODEL
LPLUME=F,LPUFF=T,LGRID=F,LPAC=F
&END
&CONTR
DTIME=  1.00000000    ,MTFREQ=          1,IAVG=          24,NADVTS=          72
&END
&GRID
IELMET=        26,JELMET=        26,DELTMT=  40000.0000    ,IASTAR=          1,IASTOP=        26,JASTAR=          1,JASTOP=
        26,ISASTR=          1,JSASTR=          1,ISASTP=          26,JSASTP=          26,MESHDN=          1
&END
&SIGMA
AY=  .329999983    ,  .220000029    ,  .170000017    ,  .120000005    ,  .860000253E-01,  .570000000E-01,BY= -.100000024    ,
 -.100000024    , -.100000024    , -.100000024    , -.100000024    , -.100000024    ,AZ=  .479999930E-03,  .630000234E-01,
  .100000024    ,  .329999983    ,  .410000026    ,  .319999993    ,BZ=  1.10000038    ,  .899999738E-01, -.899999738E-01,
 -.420000017    , -.529999971    , -.579999983
&END
&METD
METSRF=    7816500,METCOD=        1003,LSENSE=F
&END
&PUFF1
NPUFTS=          0,NSAMAD=          1,LVARSA=T,MAXSAM=          100
&END
&PUFF2
IPFLIM=        400,CHIMIN=  .0            ,  .0            ,NSIGMA=          3,LANUAL=F,LUFORM=T
&END
&REMOV
CONVFR=  .199999996E-01,LDCAY=T,EXTNCT= -.556000032E-05,LDEPOT=T,DEPVEL=  .100000016E-01,  .999999931E-03,LWASH=F,WASHUT=
  .0            ,  .0
&END
&OUTPT
LECHO=T,LPRINT=1,IPRINF=          24,LEXACT=F,LSAVE=T,ISAVEF=          24
&END
&SOURC
NSOURC=          10,STAKHT=  236.000000    ,  152.000000    ,  152.000000    ,  152.000000    ,  183.000000    ,  229.000000    ,
  76.1999969    ,  183.000000    ,  175.000000    ,  152.000000    ,XXSTAK=  8.80000019    ,  23.3999939    ,  17.1999969    ,
  23.6999969    ,  13.5000000    ,  10.0000000    ,  8.00000000    ,  9.69999981    ,  .899999976    ,  1.50000000    ,YYSTAK=
  8.80000019    ,  14.0000000    ,  18.8999939    ,  13.0000000    ,  1.19999981    ,  13.1000004    ,  19.5000000    ,
  15.1999998    ,  8.00000000    ,  4.10000038    ,EMISS=  2560.00000    ,  .0            ,  343.800049    ,  .0            ,
  633.399902    ,  .0            ,  488.000000    ,  .0            ,  53.6999969    ,  .0            ,  320.000000    ,
  .0            ,  146.899994    ,  .0            ,  1310.80005    ,  .0            ,  268.800049    ,  .0            ,
  1011.00000    ,  .0            ,LMISS=F,ECYCLE=  1.00000000    ,  1.00000000    ,  1.00000000    ,  1.00000000    ,
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2847.00000   , 3353.00000   , 3016.00000   , 6222.00000   , 240.000000   , 3016.00000   , 1047.00000   ,
11144.0000   ,LFLUX=F,HCYCLE=  1.00000000   , 1.00000000   , 1.00000000   , 1.00000000   , 1.00000000   ,
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INUMB    DATFLD        MODEL      YR/DAY/HR     NGRIDS      IAVG     ISAVEF     ISAFE    IBEGIN     ISTOP     ICHECK
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  3   12 FEB 1979    MESOGRID    78/165/ 0        3          24        24         9         10        12         1

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&END
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7. AUTHOR(S) Carl W. Benkley Arthur Bass		8. PERFORMING ORGANIZATION REPORT NO.
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		11. CONTRACT/GRANT NO. 03-6-022-35254/NOAA Contract
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		14. SPONSORING AGENCY CODE EPA-600/7

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16. ABSTRACT

MESOPLUME is a variable-trajectory regional-scale Gaussian segmented plume model especially designed to simulate the air quality impacts of multiple point sources at long transport distances. It has been developed to answer the need for a simple, computationally practical, easy to use and flexible mesoscale point source model - suitable for decision-making and regulatory applications - particularly at transport distances beyond the range of applicability of the conventional (Turner Workbook) straight-line Gaussian plume model. MESOPLUME is a natural generalization of the conventional Gaussian plume model to situations in which plume transport and diffusion may be dominated by spatial and temporal variations in mesoscale meteorology

Highly user-oriented, MESOPLUME provides a range of flexible options, and its clean, modular structure permits further modifications with ease. It is designed to be driven by user-specified meteorological scenarios, of arbitrary duration, constructed by a suitable meteorological preprocessor model (e.g., MESOPAC). It outputs spatially-gridded concentration arrays averaged over arbitrary time intervals of one hour or more and is designed to be coupled to a postprocessor model (e.g., MESOFILE) to provide additional graphical and statistical analyses. Routines are provided for: plume rise; plume growth; fumigation; linear conversion of SO_2 to $SO_4^=$; and dry deposition of SO_2 and $SO_4^=$.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
* Air Pollution		13B
* Algorithms		12A
* Atmospheric Models		04A
* Atmospheric Diffusion		07D
* Transport Properties		14B

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