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MODELING WINTER STORMS OVER ARIZONA

Final Report
Volume II

APPENDIX A:

Users Guide for the Arizona Airflow and Microphysics Model

Prepared for
Arizona Department of Water Resources
Under IGA-0-AG-30-08290

September 1995

U.S. DEPARTMENT OF THE INTERIOR
Bureau of Reclamation
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The Bureau of Reclamation has adapted an orographic precipitation model to produce useful estimates of daily precipitation at grid points spaced at 5 or 10 km over the Mogollon Rim in Arizona. The model will also develop volume precipitation for the Salt and Verde watersheds. The model should be useful in planning future cloud seeding experiments, developing seeding suspension criteria, constructing daily weather forecasts necessary for seeding operations, and designing and performing the evaluation of cloud seeding effects on precipitation and streamflow. Additionally, model generated grid point precipitation can be employed as input to a physical hydrologic model that estimates daily runoff.

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D.A. Matthews

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Collaboration with Drs. William Hall and Terry Clark in the Mesoscale and Microphysical Meteorology Division of the NCAR (National Center for Atmospheric Research) provided insights into the three-dimensional modeling aspects of airflow and cloud development over the complex terrain of the Mogollon Rim.

Mr. Roelof Bruintjes and Dr. Robert Gall from the Institute of Atmospheric Physics, University of Arizona, provided initial results from their modeling studies of selected 1987 cases. Drs. Arlin Super and Ed Holroyd provided useful insight regarding conditions over the Mogollon Rim and access to data they collected during the 1987 field program. Mr. Ra Aman provided valuable programming support. Mses. Renate Colloton and Barbara Prokop provided manuscript preparation and editing.

U.S. Department of the Interior
Mission Statement

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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1. INTRODUCTION

1.1 Purpose: To Summarize Model FORTRAN Structure and Usage

This User's Guide provides a brief summary of the AAIM (Arizona Airflow and Microphysics) model FORTRAN code and describes the procedures to operate the model and its graphics analysis processor. Examples of interactive responses and input files show how to run various simulations.

The AAIM model is a diagnostic airflow/cloud physics particle trajectory model designed to guide seeding operations and provide analyses for future seeding experiments. Direction of field experiments and seeding operations requires simple, fast models that provide objective information for decision making during daily operations. The SCPP (Sierra Cooperative Pilot Project) model was developed to provide this information for California seeding experiments. This model was selected for use in Arizona, adapted to the Mogollon Rim, and renamed the AAIM model. It provides objective information regarding the targeting of seeding materials and the positioning of research aircraft and ground equipment for measurement of seeding effects on clouds and precipitation. Details of the model physics and the adaptation process for Arizona are discussed in volume I of this report (Matthews and Medina, 1993).

This appendix is designed to serve independently as a users guide and as model documentation for the scientist or programmer who requires detailed software information. Section 2 describes the model structure, subroutines, and functions. Model operation is discussed in section 3. Examples of different types of runs and input controls show how to operate the model for various purposes. Graphical plots to visualize model results are produced by the CRYSPLTS program. This program is also described. The model code is available from Reclamation on diskette upon request. The program has extensive comments to assist the programmer and user.

1.2 Modeled Region and Grid

Figure 1 provides a visual perspective of the region of Arizona included in the model simulations. It shows a three-dimensional view of the topography in central Arizona region (fig. 1.1a) and a map of the region with major sites located and 5000- and 7000-ft m.s.l. contours, and the Verde and Salt Rivers (fig. 1.1b). Figure 1.1b shows a map of the region from Phoenix to Flagstaff with the AAIM model's grid oriented at 225° from north. The 225° grid orientation is nearly perpendicular to the NW-SE axis of the mean barrier crestline. Interestingly, Super et al. (1989) found that the prevailing flow during most heavy precipitation events was from the southwest. This grid orientation provides maximum lifting effects under these conditions. The local terrain is somewhat homogeneous, permitting the assumption of a uniform terrain slope along the length of the crest (y-axis). Line AB shows the location of the transect used for the model terrain. The y-axis (NW-SE direction) is parallel to the crest. The grid domain is divided into seventeen 10-km grid spaces along the x- and y-axes. Figure 1.1a shows the terrain topography in three dimensions. The smoothed topography used in Clark model (Clark, 1977; Bruintjes et al., 1993) boundary conditions illustrates the complex terrain. Line AB shows the position of the simplified 225° x-axis transect for AAIM model through HJK (Happy Jack). Sites of the rawinsonde at CVR (Camp Verde) and PRE (Prescott Airport) are also marked. ALT (Allen Lake Tank) is located 7.4 km north of HJK falling within the same grid box in the coarse 10-km resolution of the model. The ALT location is plotted in cross sections for purposes of model presentations and future model applications during operations from the ALT area.

Table 1.1 shows the locations and map symbols used for field facilities, soundings, and SF_6 (sulfur hexafluoride) release points used in the 1987 experiment, potential seeding generator sites, and ground facilities at ALT (Allen Lake Tank) and Mormon Lake planned for future field experiments. Sites A1-A4 and B4 were used to evaluate the model predictions of plume location and depth based on the SF_6 transport and diffusion experiments in 1987. Seeding generator sites are set at these locations. They serve as an initial group of test locations for experimental seeding and may be modified as field experiments evolve.

Table 1.1. – Locations of field facilities, soundings, SF_6 sites, and seeding generator test sites.

Facility type	Site name	Symbol	Location Latitude (°)	Latitude (')	Longitude (°)	Longitude (')	Elevation (m m.s.l.)
Intense ground observations	Happy Jack	HJK	34	44.78	111	24.50	2286
Future field observations	Allen Lake Tank	ALT	34	49.45	111	26.40	2270
Future radar site	Mormon Lake	ML	34	54.05	111	26.43	2213
Prescott Airport VOR	Prescott	PRE	34	42.	112	28.5	1534
SF_6 release site	Cherry Road	A1	34	34.25	112	4.27	1524
SF_6 release site	Yavapi Road	A2	34	29.10	111	36.98	1844
SF_6 release site	Forest Road	A3	34	21.87	112	23.02	1650
SF_6 release site	Mingus Mountain	A4	34	42.52	112	8.85	2142
Western line of generators	Squaw Peak	B1	34	28.	111	54.5	1524
Western (future option)	Tule Mesa	B2	34	22.	111	50.	1989
Western (future option)	S. Tule Mesa	B3	34	20.5	111	47.5	1951
Western (future option)	Payson Airport	B4	34	15.40	111	20.33	1572
Aircraft sounding	Prescott Ascent	PRA	(exact locations vary with aircraft flight tracks)				
		PRZ	(Prescott aircraft composite sounding)				
Aircraft sounding	Prescott Descent	PRD					
Aircraft sounding	Happy Jack West	HJW					
Aircraft sounding	Happy Jack	HJK					
Aircraft sounding	Happy Jack East	HJE					
Aircraft sounding	Payson	PAY					
Aircraft sounding	Payson West	PAW					
Aircraft sounding	Camp Verde	CVA					
Rawinsonde site	Camp Verde	CVR	34	0.5	111	46.	1027
Rawinsonde site	Winslow	INV	35	2.	110	43.5	1505
Rawinsonde site	Tucson	TUS	32	10.	110	54.	862
Composite soundings	Clark model[1]	CMZ	34	0.5	111	46.	1027

[1] Soundings composited from all available information on case study days by Bruintjes et al. (1993).

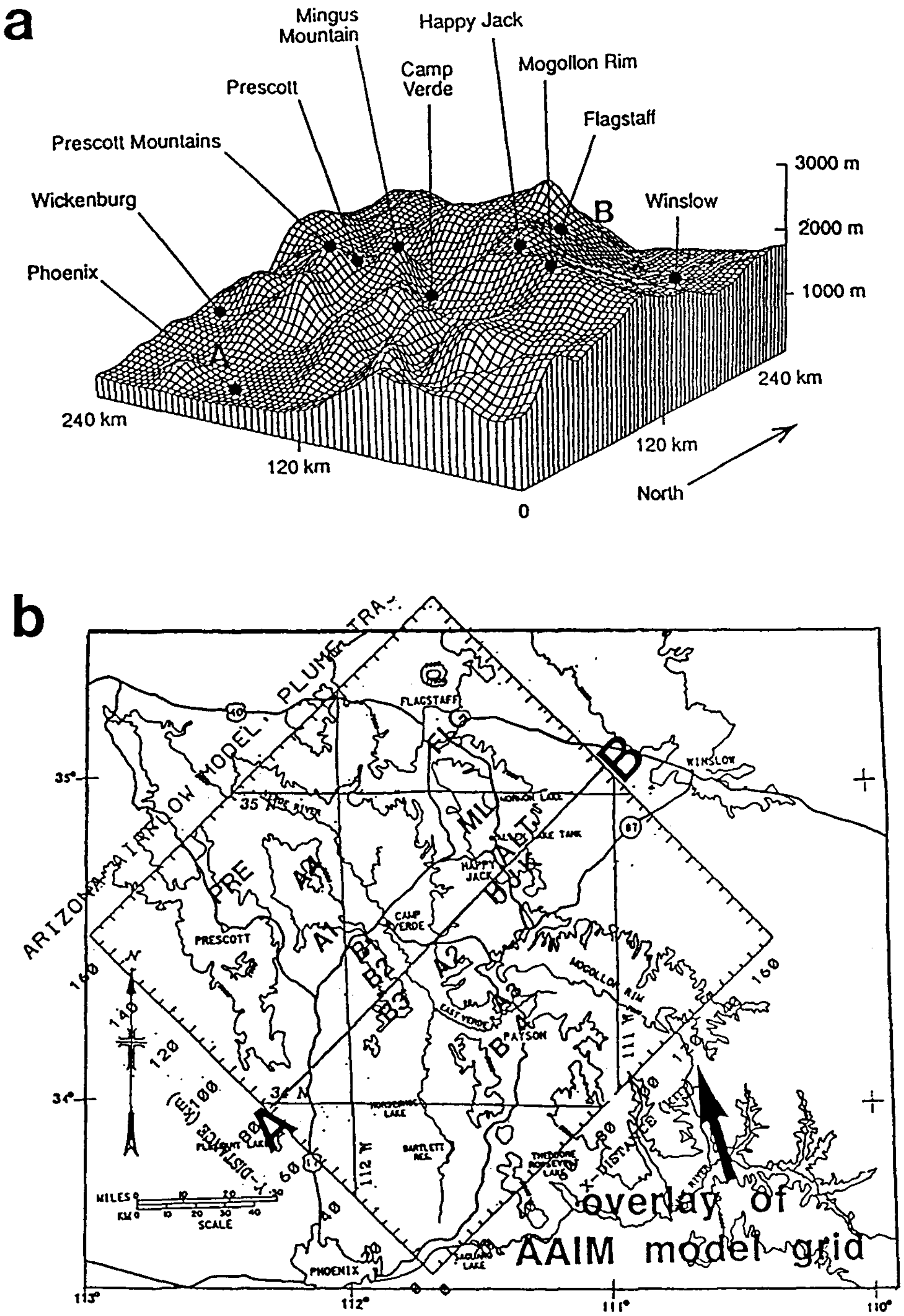

Figure 1.1. – The Mogollon Rim region showing the three-dimensional topography used in the Clark model (a) and a contour map of the area from Phoenix (PHX) to Flagstaff (FLG) showing the AAIM model's 225° grid overlay (b). Key points used in the model simulations are identified by bold letters on the map; numbers indicate locations of simulated seeding generators as defined in table 1.1. Line AB shows the AAIM model cross section through Happy Jack (HJK). Three-dimensional topography from the Clark model illustrates the limitations of simplifying assumptions used in the two-dimensional AAIM model, which performs remarkably well in this complex terrain (Figure 1.1a from Bruintjes et al., 1993).

2. DESCRIPTION OF THE FORTRAN PROGRAM

2.1 Overview

The AAIM model is a FORTRAN program that was adapted from the generic version of the SCPP targeting model modified by Dr. Terry Deshler and described by Rauber et al. (1988). The SCPP model was recently developed and tested in Reclamation's SCPP field experiments in the Sierra Nevada of California described by Reynolds and Dennis (1986). Details regarding the physics of the model with references are described previously in Volume I, Section 2, of this report (Matthews and Medina, 1993). Software routines and functions are described in this Guide. All program routines and functions are printed in ***bold italics*** for easy identification; file names are printed in quotation marks. Specific variables are denoted in UPPERCASE letters.

2.2 AAIM Model Structure

Figure 2.1 shows a general schematic of the flow of computations in the model. The model is initialized with an observed sounding of temperature, dewpoint, and wind direction and speed as a function of height from the surface to the 300-mb pressure level (about 9200 m m.s.l.). It may use one or two soundings to represent conditions over the barrier. Results are generally better when two soundings adjust the flow as described in section 2.3.1. Sounding data are interpolated to uniform pressure intervals and used to define flow-channel characteristics of temperature, relative humidity, and winds over the barrier. The scientist selects the type of seeding method used in the simulation: airborne or ground based. Then the model computes the appropriate dispersion rate of seeding material, the point where nucleation begins, and the growth and fallout trajectory of an ice crystal. Finally, a summary tabulation is provided in an output data file. A graphical processing program may be used to further analyze and display plots of the data to help interpret model results. This CRYSPLTS program was developed separately to visualize model simulations originally presented in tabular form. This visualization tool is discussed in section 2.5.

The model, which is coded in FORTRAN 77, consists of a main Program, AAIM, and two subroutine libraries, AGMLIB and SNDGLIB. Program AAIM sets the initial conditions for selected options in the model and calls principal subroutines that perform specific functions of retrieving sounding data, establishing flow channel grids, interpolating data to grids, computing plume motion, ice crystal growth, and fallout. The detailed flowchart on figure 2.2 shows the flow of computations among subroutines. The AGMLIB library has 25 subroutines and functions that establish the model grid domain, interpolate wind and thermodynamic data to the grid, perform the dynamic and microphysical computations, and tabulate results in output files for statistical and graphical analyses. Table 2.1 lists the main subroutines and their function. The SNDLIB library has 42 subroutines and functions that perform data retrieval, decoding, and thermodynamic computations, and prepare input for model initialization and verification of correct sounding information listed in table 2.2. Tables 2.2.1 and 2.2.2 list the main sounding variables and model derived fields with their variable names and units. The programmer should consult the program listing for further information regarding the SNDLIB routines. Figure 2.2 shows a detailed flowchart of the model with subroutine names that correspond to those described in tables 2.1 and 2.2.

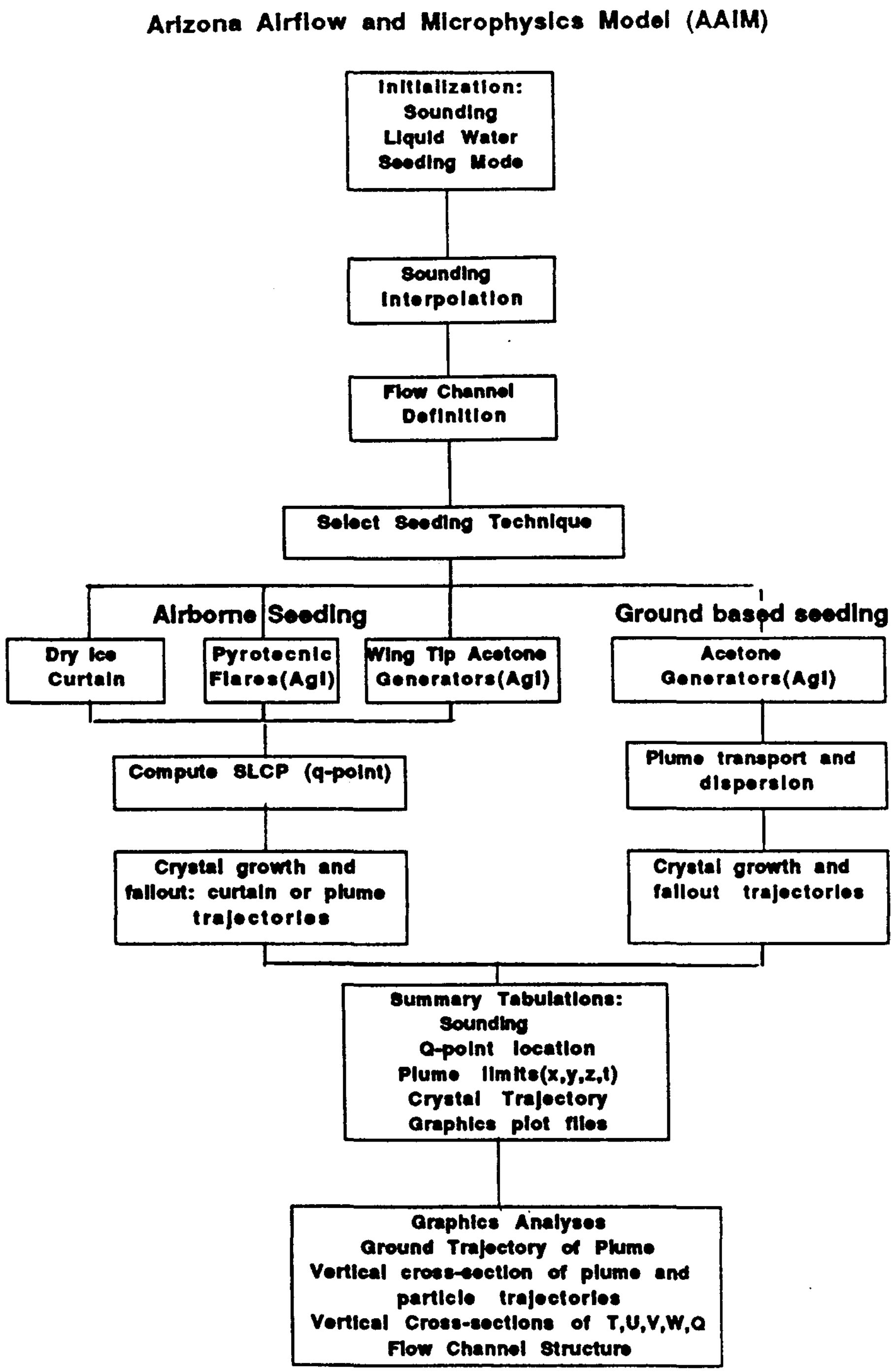

Figure 2.1. – Schematic chart showing the flow of computations in the AAIM model.

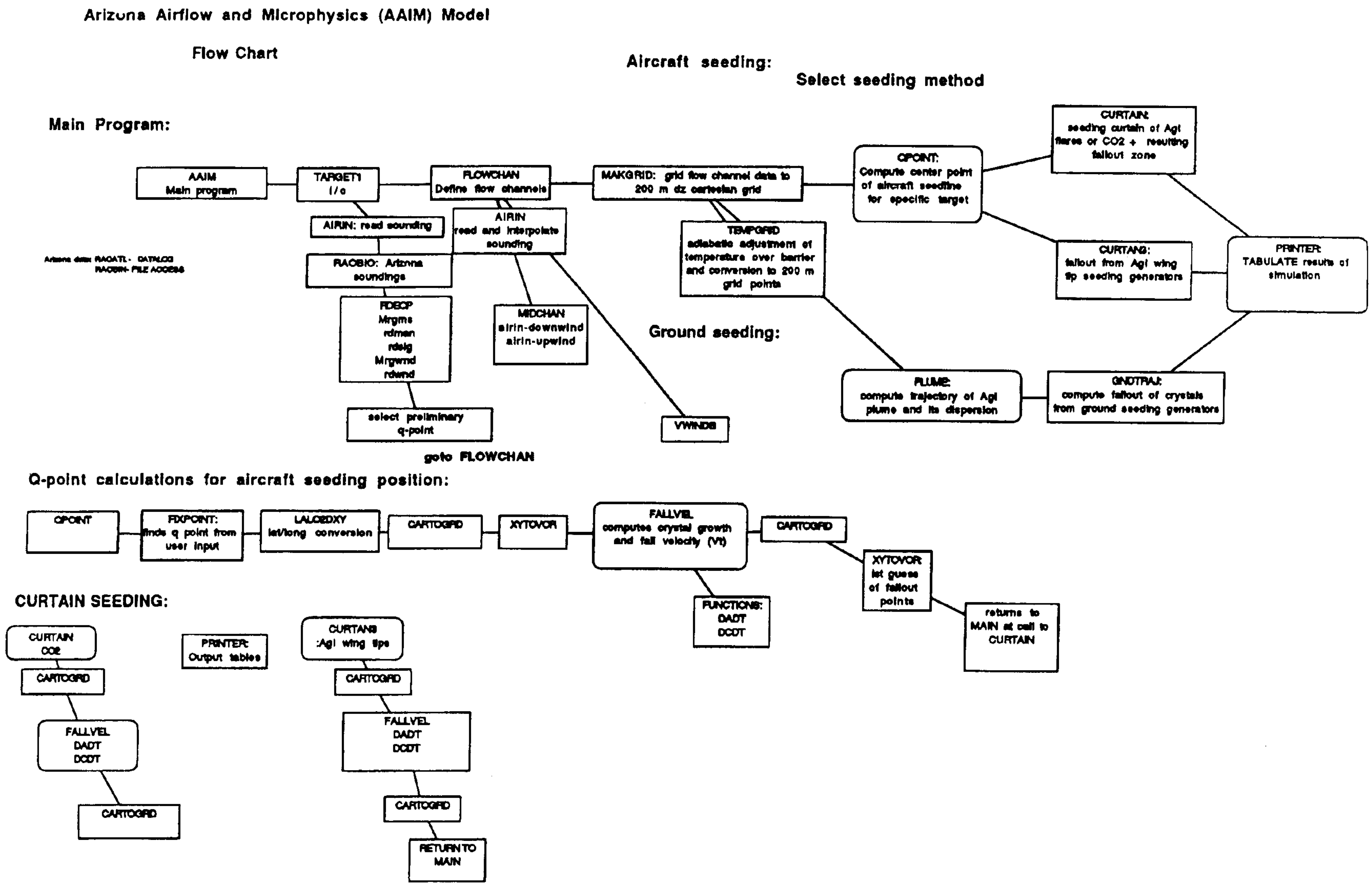

Figure 2.2. – Detailed schematic chart of primary subroutines used in the AAIM model.

Table 2.1. – Primary airflow and microphysics subroutines: AGMLIB.

Routine Name	Primary function
Model Airflow and Thermodynamics Routines,	
TARGET1	Retrieves sounding, computes the dead layer and initial guess of Q-point location
FLOWCHAN	Calculates wind fields used in the model in flow channel coordinates, calculates flow channel temperature and moisture cross section information
MIDCHAN	Calculates height of the center flow channel if a downwind sounding is used
VWINDS	Calculates v-component of the wind in flow channel coordinates
MAKGRID	Converts data from flow channel coordinates to cartesian coordinates
LALO2DXY	Converts latitude and longitude to cartesian grid coordinates (x,y) and vice versa for a coordinate system oriented at angle ANGLB to the west of true north
CARTOGRD	Converts x,z coordinates to model grid coordinates: j,i
XYTOVOR	Converts x,y coordinates to VOR/DME coordinate information
TEMPGRID	Calculates model temperature field in cartesian coordinates
Seeding Delivery Routines,	
QPOINT	Calculates Q-point orientation and length of seedline
FIXPOINT	Locates the x,y position of the Q-point, seedline end points and returns information to subroutine Q-point
CURTAIN	Calculates the fallout trajectories and fallout locations of particles originating in a curtain produced by dropping AgI flares or CO_2 pellets from an aircraft
CURTAN3	Calculates the fallout trajectories and fallout locations of particles originating in a curtain produced by burning wingtip acetone seeding generators on an aircraft
PLUME	Calculates the trajectory and spread of an aerosol plume released from ground generators
GNDTRAJ	Calculates the fallout trajectory of an ice crystal nucleated at the intersection of the plume and the -6 °C isotherm and the 2-σ concentration line of an AgI plume from a ground generator
GNDRD	Reads the GENLOC ground-based seeding generator location file to locate ground plumes
Microphysics Routines	
FALLVEL	Determines the fall velocity of particles using empirical growth rates and terminal velocities for four types of crystals with and without riming

Table 2.2. – Sounding processing routines for model initialization: SNDGLIB.

Routine Name	Primary Function
AIRIN	Primary sounding input processing routine for Airsonde formatted data and 1987 Arizona data, calls RAOBIO
RAOBIO	Reads soundings from Arizona data base and produces initial condition array of *P*, *T*, $T_{d,}$ *dd*, *ff*, *H* data
READARZ	Reads soundings from 1987 data base and transfers array to RAOBIO for mandatory and significant level processing
RDMAN	Extracts the mandatory level information *P*, *T*, *TD*, *DD*, *FF*, *H* from RDRAOB output
RDSIG	Extracts the significant level *P*, *T*, T_d, *H* information from RDRAOB data
RDWND	Extracts the wind data from the RDRAOB output file
RDFLP	Opens input data file for station and puts sounding data into array for processing
RDMOR	Reads type 2 Moroccan data for RDRAOB processing
GETRECP	Reads header from input file to determine type of processing
GETREC	Reads input sounding file records and forms total record
CTOIP	Converts character variables to integer and stores in array for processing
CTOI	Converts character string into integer
RDFL	Opens input file and decodes sounding
RDEQP	Creates a table of sounding variables based on equal pressure using merged mandatory-significant data
MRGMS	Merges mandatory and significant level data according to decreasing pressure
MRGWND	Merges wind data with mandatory and significant level data
Thermodynamic Routines	
THETAE	Computes Theta-*E* (equivalent potential temperature) from state parameters
ESW	Computes saturation vapor pressure over water
PSEUDO	Computes pseudo-adiabatic temperatures
THETAEQ	Computes equivalent potential temperature for points on a pseudo-adiabat
TMOIST	Computes wet-bulb potential temperature

Table 2.2.1. – Sounding variable names and units.

Name	Variable	Units
P	Pressure	mb
T	Temperature	°C
T_d	Dew point temperature	°C
DD	Wind direction	°
ff	Wind speed	knots
H	Height	m

Table 2.2.2. – Model derived fields.

Name	Variable	Units
u	x-wind component	m s^{-1}
v	y-wind component	m s^{-1}
w	z-wind component	m s^{-1}
Theta	Potential temperature	°K

A special graphics processor was developed to analyze and visualize model results. This program CRYSPLTS reads the output file from AAIM and provides selected analyses of model results. This processor is designed to assist the model user in a semi-interactive mode, so that the user may examine plots of interest to operational decision making or perform research on various aspects of model simulations. The program uses the NCAR Graphics software to provide graphics metacode files that may be plotted on the screen, on laser printers, or saved for film output. Details of the various NCAR Graphics processors and options are provided in its documentation. Table 2.3 lists the principal routines used by the CRYSPLTS program.

Table 2.3. – Graphic analysis routines: CRYSPLTS.

Routine Name	Primary Function
CRYSPLTS	Main program
AIROUTRD	Reads AAIM output file and calls plotting routines
PLTPLUME	Plots vertical cross sections of ground-based plumes
PLTPLM1	Plots horizontal position of plumes from generators
XSECTNS	Plots vertical cross sections of model wind and temperature fields
PLTMODL	Plots vertical cross sections of flow channel variables
MODLREA	Reads flow channel data and calls plotting routines
CURTREA	Reads the output from seeding aircraft simulations and calls plotting routines
PLTCURT	Plots crystal trajectories from aircraft seeding
READSTAR	Reads special *** fields for cross section analyses

2.2.1 ***Initialization: Main Program. – Program AAIM*** sets the initial conditions and calls key subroutines to perform various computations and arrange an output file for graphical post-processing. Figure 2.2 shows the sequence of calls from the main program. The model takes initial sounding data and interpolates these data within the flow channel structure to determine the components of the wind that affect lifting over the barrier. Subroutines ***FLOWCHN, MIDCHAN,*** and ***MAKGRD*** are the primary routines that determine the vertical structure and produce a grid within which the plume computations are performed. Section 2.1.3 of the main report describes the kinematic structure of the model.

A block data statement and interactive questions set the initial conditions. Block data set parameters for a particular geographic analysis area that do not change. Interactive questions prompt the user to select the date and time of initial sounding data, the seeding method, seeding generator sites, and other specific information for a simulation. The program listing documents all variables in detail. Users who are interested in that level of detail should refer to the comments in the program code, which is available on diskette upon request. The user does not need to know names of specific variables to operate the model, because all questions are automatically prompted by the program and appropriate variables are initialized. Section 3 documents this procedure and describes model execution with examples of various input soundings and user responses.

The main program calls ***TARGET1*** to retrieve initial conditions, then ***FLOWCHAN*** and ***MAKGRID*** to grid the data for model computations. It then simulates one of two methods to deliver seeding materials: ground seeding generators in the ***PLUME*** subroutine and aircraft seeding in the ***QPOINT*** subroutine. Three types of seeding materials are parameterized to simulate the effect of dry ice (CO_2), droppable pyrotechnics (AgI), or airborne or ground acetone generators (AgI). ***PLUME*** and ***QPOINT*** call the microphysics subroutine ***FALLVEL*** that calculates the growth of ice crystals and their fall velocity. Finally, model results are tabulated in the ***PRINTER*** subroutine, which completes the model run.

2.2.2 ***Subroutine TARGET1.*** – This routine finds the top of the dead layer, and for aircraft seeding, calculates a first guess at the targeting trajectory direction and length using only the upwind sounding winds (no model winds yet). Data from the sounding is transferred to a vertical coordinate system with grid spacing of 200 m. Parameters needed for the model run are calculated. ***TARGET1*** computes a first guess of the distance and direction a crystal would move downwind if it fell with a fall velocity typical of a rimed plate. Upwind sounding winds are used in this calculation. The calculated distance and direction provide a first estimate of the Q-point location for the seeding aircraft's seedline centerpoint.

2.3 Airflow Routines

2.3.1 ***Subroutine FLOWCHAN.*** – ***FLOWCHAN*** determines the values of the state parameters and wind field in flow channel space. Options are available to use aircraft observed winds and the downwind sounding. The model uses up to 12 flow channels. If a low-level dead layer with wind speeds less than 2.5 m s^{-1} is present, then the number of channels is reduced. The values of the v-component (parallel to the barrier) are determined by a parameterization, if the upwind sounding or aircraft is used alone. If the downwind sounding is used, the v-component is interpolated directly.

FLOWCHAN calculates the component of the wind perpendicular to the axis of the barrier from the surface to 600 mb above the ground (approximately the 300-mb level for Arizona topography). This barrier-perpendicular u-component is determined by assuming conservation of mass flux throughout the domain. The midpoint of the domain is defined as the level 350 mb above the ground (approximately the 550-mb level at the upwind boundary, where $x = 0.0$). The area below the midpoint is divided into seven channels that are 50-mb deep at their inflow location (see fig. 2.3). Above the midflow channel (from 550 to 300 mb), winds are estimated by assuming mass conservation between the midflow channel and the 300-mb level, which is assumed to be horizontal. This assumption artificially accelerates the winds in the upper channels over the crest, but these calculations have little effect on the trajectory calculations at 800- to 550-mb levels. Wind components above the midflow channel indicated by level 7 on figure 2.3 are estimated by dividing this region into five channels of equal pressure depth, and then computing the u-, v-, and w-wind components in a manner similar to that below the midflow channel described previously. Figure 2.3 shows the vertical cross section through the Mogollon Rim at ALT (Allen Lake Tank) along the 225° axis. The heights of each flow channel are plotted. Note the gravity wave effect of the ridge southwest of the Verde River Valley shown by the wave 10 km southwest of CVR.

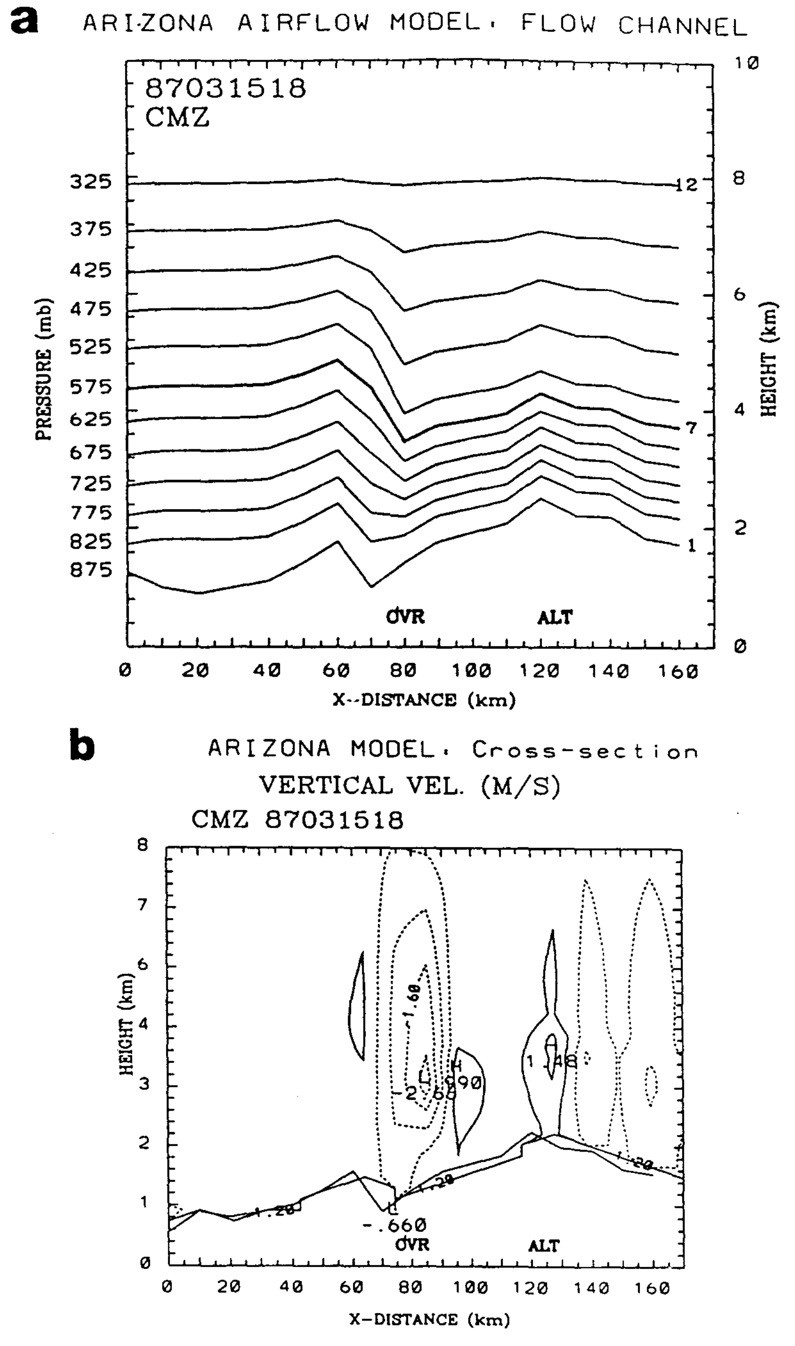

Figure 2.3. – Vertical cross section through the Mogollon Rim at ALT along the 225° southwest flow axis on March 15, 1987, showing the stable flow channel structure (a) and vertical motion field (b). Contours are shown in increments of 0.7 m s-1. Arrows indicate airflow through the flow channels. Numbers indicate the flow channel from 1 in the lowest 50 mb a.g.l. to 12 at the top of the flow channel domain. The midflow channel is shown by level 7.

Vertical motion is computed from the slope of the terrain and the *u*-component of the wind. The slope of the terrain to the lee of the crest produces downward flow that parallels the terrain. Lifting associated with the barrier is generally 0.2 to 1.5 m s^{-1} within 20 km of the ridgeline. Figure 2.3a shows an example of the flow channels under stable conditions and the resulting vertical motion field (fig. 2.3b) for the Clark model initial conditions on March 15, 1987, at 1800 UTC. Note that the channels parallel the surface terrain, forming a standing wave pattern. The first channel marked by "1" on figure 2.3a represents the flow in the bottom channel at 50 mb a.g.l. The channels below midflow channel (7) are compressed, resulting in a flow acceleration over the barrier.

Unstable-neutral conditions produce amplified waves with deeper regions of lifting and increased intensity of vertical motion fields. Figure 2.4 shows the flow channels for the unstable-neutral conditions and the resulting vertical motion field on March 15, 1987. Vertical motion is amplified by - 0.7 m s^{-1} in the lee of ridges and +0.2 to 0.5 m s^{-1} over the ridges, producing a more distinct standing wave pattern. This pattern effectively increases the upward momentum transfer and reduces the acceleration created by the restricted stable flow over the crest. Here, the maximum value of the *u*-component over the crest is 9 m s^{-1} less than in the stable case. Huggins et al. (1985) provided more detailed descriptions of the design of flow channels used in the SCPP model.

2.3.2 ***Subroutine MIDCHAN.*** – This routine computes the pressure height of the midflow channel, which determines the relative acceleration over the barrier. This information is used in association with mass flux to determine the acceleration of the *u*-component of the wind across the barrier. If upwind or aircraft winds are used without a downwind sounding, the midflow channel is established using the original FLOMID values in the data statement in subroutine ***FLOWCHAN***. If the downwind sounding is used, the FLOMID values are adjusted uniformly to satisfy mass balance at downwind and upwind soundings.

2.3.3 ***Subroutine MAKEGRID.*** – This routine takes variables computed in the irregular flow channel space and converts them into a regular 200-m vertical resolution grid with corrections for thickness changes applied in subroutine ***TEMPGRID***. ***TEMPGRID*** adjusts isotherms to account for adiabatic cooling that lowers them near the crest. This lowering is based on a climatological study of all upwind/downwind soundings during Sierra storms.

2.4 Microphysical Routines and Seeding Methods

2.4.1 ***Subroutine FALLVEL.*** – The model uses parameterized microphysical processes to compute particle growth in ***FALLVEL***. These computations provide a realistic empirical framework that describes the particle shape, mass, and degree of rime, which determine fall velocities. Fall velocities of particles are computed using empirical relationships for various types of ice particles, densities, and mass. Ice crystal growth rates are determined from empirical relationships that depend on temperature and supersaturation as described by Hallett and Mason (1958), Kobayashi (1961), Magono and Lee (1966), and Ryan et al. (1976). Seeding is conducted under a variety of cloud temperatures and supersaturations; therefore, a critical feature of targeting is proper determination of crystal fall velocity as a function of particle habit and size. A parameterized routine was developed for SCPP to compute the linear growth rates for basal (*c*) and planar (*a*) crystal axes specified by measurements of Ryan et al. (1976). These processes are described by Rauber et al.(1988) and are used in the AAIM model.

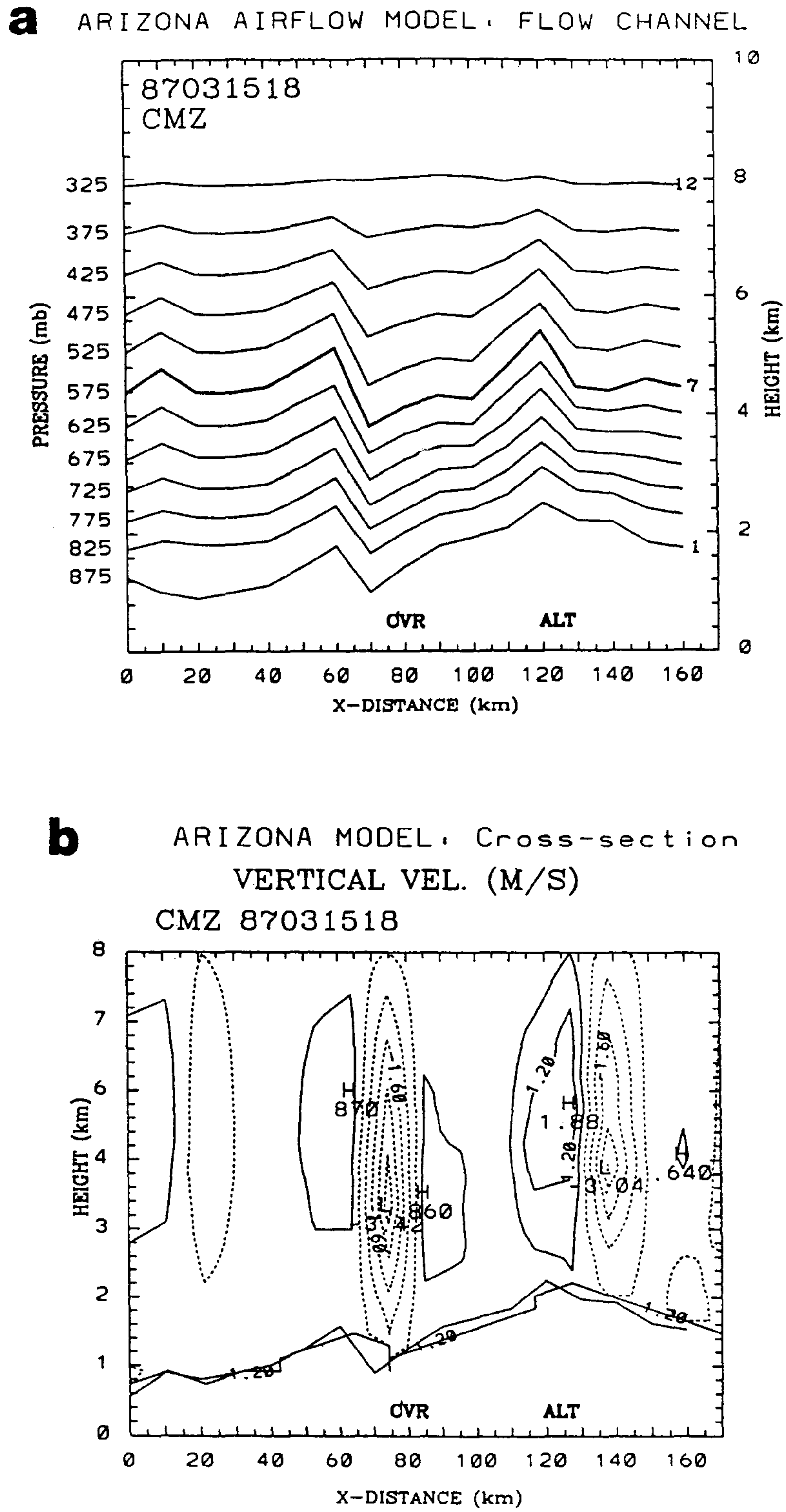

Figure 2.4. — Same as figure 2.3 for neutral-unstable flow channels, showing sensitivity to the type of stability conditions.

Cloud liquid water and riming processes are important factors in crystal mass growth and subsequent fallout. Several studies have examined the riming process in the Sierra Nevada (Reinking, 1974, 1979; Rodi et al. 1985; Prasad 1986). Results from their studies and those of Heymsfield (1982) and Heymsfield and Pflaum (1985) were used to estimate the onset time of riming under various LWC (liquid water content) conditions. Rodi et al. (1985) developed a relationship that is used in the SCPP and AAIM models today. Their method accounts for the onset of riming on different types of crystals as a function of liquid water content and determines the time required for a particle to become heavily rimed. The user specifies an estimate of LWC when running the model. This LWC estimate should be based on aircraft observations, radiometer measurements of LWC, or other evidence of liquid water droplets such as rimed ice crystals. Fall velocity of ice crystals can then be determined as a function of the crystal habit, its axis size, and degree of riming. Rauber et al. (1988) used direct measurements of Brown (1970), Davis (1974), and Locatelli and Hobbs (1974) to develop a set of parameterizations for the particle fall velocity used in the SCPP model targeting calculations. Table 2.4 shows the fall velocity equations used in the model and the references for each relationship. Table 2.5 indicates the temperature and particle axis dimension criteria used to select the appropriate fall velocity equation for the four different ice crystal types simulated in the model. These procedures are discussed in greater detail by Matthews and Medina (1993) in Volume 1 of this report.

Table 2.4. – Fall velocity (V_t m s^{-1}) equations as a function of crystal major axis (centimeters).

Type	Equation	Reference
1. Dendrite, unrimed	$V_t = 0.6197a^{0.217}$	Brown (1970)
Dendrite, rimed	$V_t = 1.32a^{0.330}$	Locatelli and Hobbs (1974)
2. Plate, unrimed	$V_t = 2.96a^{0.824}$	Davis (1974)
Graupel	$V_t = 3.34a^{0.460}$	Locatelli and Hobbs (1974)
3. Column unrimed (c<0.09cm)	$V_t = 24.3c^{1.309}$	Davis (1974)
Column unrimed (c>0.09 cm)	$V_t = 3.99c^{0.56}$	Locatelli and Hobbs (1974)
Column rimed	$V_t = 3.99c^{0.56}$	Locatelli and Hobbs (1974)
Column rimed (c<0.2 cm)	$V_t = 1.62$	Locatelli and Hobbs (1974)
4. Needles unrimed (0<c<0.1 cm)	$V_t = 5c$	Brown (1970), Nakaya (1954)
Needles unrimed (0.1<c<0.2 cm)	$V_t = 2.1c + 0.29$	Brown (1970), Nakaya (1954)
Needles unrimed (0.2<c<0.35 cm)	$V_t = 1.2c + 0.47$	Brown (1970), Nakaya (1954)
Needles unrimed (c>0.35 cm)	$V_t = 0.89$	Brown (1970), Nakaya (1954)
Needles (rimed or aggregated)	$V_t = 1.5V_t$ (unrimed)	Brown (1970), Nakaya (1954)

Table 2.5. – Temperature and axis size criteria are used to determine crystal type.

Temperature (°C)	Axis	Crystal type
≤-13	*a*-axis ≥ *c*-axis	dendrite
>-13	*a*-axis ≥ *c*-axis	plate
<-6	*c*-axis > *a*-axis	column
≥-6	*c*-axis > *a*-axis	needle

2.4.2 *Subroutine PLUME*. – This routine calculates the trajectory of a plume of silver iodide (AgI) aerosol particles from the generator to the nucleation point and onward to the AAIM model boundary. Plume transport and diffusion are simulated using the Pasquill-Gifford model for neutral stability (Turner, 1969). This model assumes a gaussian distribution of nuclei across a three-dimensional plume. This distribution is empirically described as a function of turbulence and mean horizontal wind speed. The horizontal width of the plume is calculated at the altitude of the two-standard deviations (2-σ) concentration line. The actual plume would likely be narrower at the seeding level. The top height of the plume is assumed to be the surface at which the concentration is two standard deviations (2-σ) lower than that on the centerline, accounting for horizontal displacement caused by wind shear.

2.4.3 *Subroutine GNDTRAJ*. – This routine calculates the trajectory of ice crystals originating from ground seeding. The growth and fallout of one crystal is calculated for a plume from each generator. This crystal originates at the intersection of the -6 °C isotherm and the 2-σ concentration surface of the seeding nuclei plume.

2.4.4 *Subroutine QPOINT*. – This routine calculates the location of the aircraft seed-line center-point (Q-point) and the headings left and right from the Q-point. The Q-point's altitude is specified by the model user as an input variable. Specification of this altitude is discussed in the model execution and operations chapter 3. The seed-line is assumed to be of variable length established by the distance from the Q-point to the target. Coordinates of the Q-point and the ends of the seedlines are computed. These latter points are used in subroutines ***CURTAIN*** and **CURTAN3** to obtain the "footprint" signature of the seeding curtain. The model calculates the shear vector in the layer extending from 200 m to 2 km below the Q-point. It calculates the Q-point from three adjustments of the initial guess of the Q-point in subroutine ***TARGET1***. The number of adjustments is variable and can be changed by altering the value of the variable IGUESS. The number of adjustments is equal to IGUESS-1. Each adjustment is accomplished within the first "DO 1, I=1,N" do-loop. The last run through the loop produces the same results as the previous run, but prints out all parameters.

2.4.5 *Subroutine CURTAIN*. – This routine calculates the fallout trajectories of a curtain of crystals initiated by aircraft release of dry ice or droppable flares. For CO_2 and pyrotechnic flares, the program calculates: 1) the location of the seeding line, 2) trajectory information concerning the targeting crystal (assumed to be the crystal originating 300 m below the aircraft release altitude), and 3) the fallout positions of five additional crystals originating at 200-m altitude intervals at five levels below the first crystal within the curtain. At each level, 5 crystals are released, each having slightly different fall velocity. Time-height "passage tables" are also calculated for the curtain. Particle position information at 10-min increments is also tabulated for each particle in the curtain.

Seeding is assumed to occur along a line centered on the Q-point and perpendicular to the mean direction of motion for the target crystal that was used to determine the Q-point. The temperature at the level of the crystal determines the type of growth curves according to criteria listed in table 2.4. The curtain spreads because of vertical wind shear and variable crystal terminal velocities. The depth of the curtain is a function of the cloud-top temperature, i.e., warm, shallow clouds may have shallower curtains than deep, cold clouds. The terminal velocity spectra is arbitrary. In this version, the terminal velocity spectra chosen depends on the curtain depth and the level from which the particle falls.

Computations of CO_2 and pyrotechnic seeding effects on crystal fallout include the effects of vertical dispersion of seeding material, vertical wind shear within that depth, variations in saturation vapor pressure, and changes in liquid water content as crystals fall along their trajectories. Variations in the AgI activation rates are not considered. Variations in the particle fall velocities caused by different growth rates are accounted for by a series of 5 particles with different fall velocities determined by the following parameterization:

$$V_{tn} = 0.1\ (n + 6)\ V_t, \quad n = 1, 2, 3, 4, 5$$

where:

V_{tn} = the fall velocity of particle n
V_t = the standard terminal velocity calculated from the equations in table 2.4

To estimate the nucleation effects through the depth of a seeding curtain of CO_2 or AgI, calculations for 6 depths were simulated from top to bottom of the curtain that would range from 200 to 1200 m deep. These depths are labeled 1 from the top to 6 at the bottom of the curtain as shown on figure 2.5. Trajectories are typically computed from the center and end points of the seedline. The end points were based on a 20-percent error in wind direction. As the trajectories of particles become longer with increased wind speed, the length of the seedline is proportionally increased according to table 2.6. Maximum seedline length was 37 km (20 n mi), equivalent to about 10 min of flight time at 120 kts. The seedline length must be determined to maximize the effects of seeding over a target of specific size. It is a function of target surface area and aircraft performance.

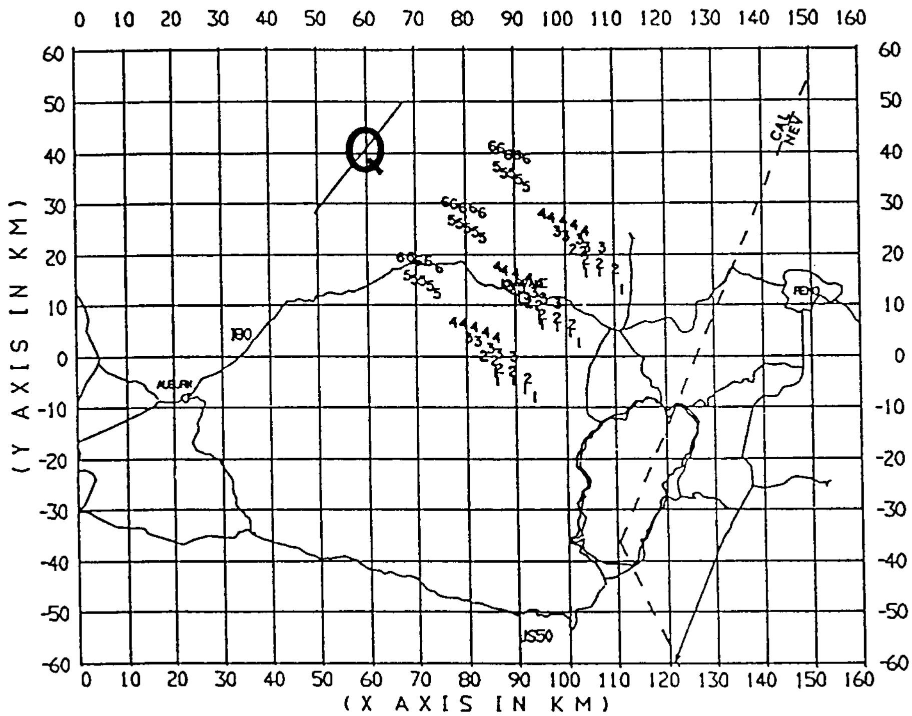

Figure 2.5. - Example of crystal trajectories from an aircraft seedline. Crystals were labeled 1 from the top to 6 at the bottom of the curtain at the center and endpoints of the seedline. The seedline is located along the line marked by Q. Five different release times are indicated for each set of crystals to block the area in which seeding is likely to have an effect (from Rauber, et al. 1988).

Table 2.6. – Seedline length versus trajectory length (*T*) used in SCPP fixed target experiments.

Trajectory length (*T*) (km)	Seedline length [km (n mi)]
T< 10	10(5)
30 < T ≥ 10	19(10)
45 > T ≥ 30	28(15)
T≥ 45	37(20)

2.4.6 *Subroutine CURTAN3.* – This routine calculates the fallout trajectories of a curtain of crystals nucleated by aircraft wingtip acetone generators. It calculates the location of the seedline, crystal's trajectory information, and the fallout position of crystals nucleated 0, 5, 10, 15, and 20 min downwind of the release point. As with the CO_2 and flares, 5 fall velocities are used. Seeding is assumed to occur at the selected flight altitude and along a line centered on the Q-point and perpendicular to the mean trajectory of the target crystal used to determine the Q-point. The curtain spreads because of a time lag in the rate of nucleation and variable terminal velocities.

Acetone seeding generators may be used when aircraft fly through or near the supercooled region of the target cloud and vertical mixing within the cloud is expected to disperse the seeding material throughout the region of supercooled liquid water. Temperatures in the target cloud generally must be from -6 to -15 °C. Targeting computations of the narrow continuous plume of AgI from the acetone generator differ from the curtain calculations for particle fall velocity. The crystal growth is initiated at the flight altitude 5 min after release of nuclei to account for laboratory measurements of nucleation rates by Demott et al. (1983). Deshler and Reynolds (1987) found that this procedure appeared adequate for the Sierra Nevada.

2.4.7 *Subroutine GENRD*. – Ground seeding generator locations are selected by this routine from an input file. The user may chose the generators simulated in each run of the model from the GENerator LOCations file (GENLOC).

The GENLOC file for Arizona:

Name	*X* (km)	*Y* (km)	*Z* (M)	Location
A1	64.0	110.0	1524.	Cherry Road SF_6 release point
A2	86.5	73.5	1844.	Yavapai Road SF_6 release point
A3	93.0	50.0	1650.	Forest Road SF_6 release point
A4	74.0	129.0	2142.	Mingus Mountain SF_6 release point
B1	68.0	97.5	1524.	Mingus Mountain ridge B1
B2	67.0	88.0	1989.	Mingus Mountain ridge B2
B3	62.5	76.0	1951.	Mingus Mountain ridge B3
B4	85.0	38.5	1890.	Payson Airport SF_6 release point

2.5 Graphic Analysis Processor

The ***CRYSPLTS*** program analyzes and plots model results. This is a separate program that was written to help the user visualize AAIM model results. It uses the NCAR Graphics routines to create a metafile with instructions for various plotting devices. ***CRYSPLTS*** reads the "AFL87xxx.yy" output file from AAIM, stores required information, then plots various data depending on the user's needs. It is composed of one main program, ***CRYSPLTS***, and nine subroutines. The main program prompts the user for the desired data file and plots. Subroutines then read the data and plot horizontal maps of the plume locations from ground seeding generators, vertical cross sections of plumes and ice crystal trajectories, and cross sections of modeled fields of temperature, winds, vertical motion, and flow channels.

Subroutine *AIROUTRD* reads the AAIM output file and calls the appropriate plotting routines for desired analyses. It is designed to step through the "AFL87xxx.yy" output file, search for key phrases, and either store or call plot plotting subroutines. It calls subroutine ***PLTPLUME*** to plot vertical cross sections of ground generator plumes. These sections show the domain from Phoenix across the Mogollon Rim through HJK to a point 40 km downwind of the crest along the x-axis. Plume centerpoints are plotted for each generator and marked every 60 minutes. If ice crystals develop, they are plotted for plumes from generator A2 and A4 in the default plot. If desired, ice crystal trajectories for all generators are plotted alone.

Horizontal positions of plumes are plotted by subroutine ***PLTPLM1***. This subroutine maps the plume position in model coordinates with key geographic features and latitude and longitude lines plotted for reference. Plumes for all generators are plotted by marking the horizontal boundary of the plume. The plotted points mark the plume edge where the AgI concentration has dropped one standard deviation below the theoretical center line concentration of the plume. It is calculated at the altitude where the plume's concentration has dropped 2 standard deviations below the theoretical center line concentration.

Next, if vertical cross sections are requested, ***AIROUTRD*** calls the ***XSECTNS*** subroutine. This routine plots vertical cross sections of the winds, temperature, and vertical motion fields. These fields are interpolated to 200-m vertical grid spacing and 10-km horizontal spaces over a domain of 40 vertical by 17 horizontal grid points. Contour analyses of the data are provided for scalar fields (*T*, *U*, *V*, *Theta*, and *W*) and vectors are plotted for horizontal and vertical winds. Tables 2.2.1 and 2.2.2 contain descriptions of variable names and units for sounding variables and model derived fields.

If a detailed analysis of modeled flow channel variables is desired, subroutine ***MODLREA*** is called. This routine reads the dynamic and thermodynamic variables interpolated to flow channel coordinates. These variables are used in trajectory calculations. Subroutine ***PLTMODL*** plots vertical cross sections of the flow channels.

Subroutine ***CURTREA*** reads the seeding aircraft curtain output and calls the ***PLTCURT*** subroutine to plot information. The aircraft Q-point position and seedline are plotted. Curtain information is plotted to show the endpoints of ice crystal fallout curtains from droppable pyrotechnic AgI flares or dry ice. Curtains are plotted for crystals that originate at six different levels below the seeding altitude, or for five time delays in the case of AgI acetone generator seeding. The set of fallout points from a spectra of terminal velocities is plotted to show the likely fallout zone from a selected seedline. Procedures to operate ***CRYSPLTS*** and examples of the various plots are discussed in chapter 3.

2.6 History of Model Code Evolution

For those interested in the complex evolution of the model code, this section provides a brief summary of key points in the history of the software development and people involved. These points were extracted from comments in the model code for the convenience of the reader.

Brief highlights of GUIDE and SCPPM87 model evolution:

- ~1970 Concept of GUIDE model developed by Elliott in BASIC.
- ~1980 Model adapted by Rhea and converted to FORTRAN on the Bureau Cyber.
- 84-85 Elliott conducts a literature survey to deduce an appropriate midflow channel. This channel is adjusted by comparisons with Waight's 1984 model and by comparisons with midflow channel measurements by soundings at Sheridan, Blue Canyon, and Kingvale.
- 85-86 Model adapted by Rauber. Microphysical growth rates and fall velocities from the literature were added to the trajectory calculations. A method was added to use the

downwind sounding to modify the midflow channel. Comparisons were made with aircraft measured winds.

- 86-87 The model was rewritten to run on the Perkin Elmer computer. Height coordinates were changed from temperature levels to meters and the temperature field was now obtained by interpolations between the upwind and downwind sounding. Options to handle ground seeding and acetone generator seeding from aircraft were added. Enhanced graphics capabilities were included.

- 9/87 A version of the code was modified for use in the Atlas Mountains of Morocco.

- 11/87 The code was rewritten by T. Deshler to be as generic as possible, while carefully checking that the output from the model was preserved.

- 12/87 The generic model was adapted for use in the Feather River Basin, and the graphics code was modified to be generic, so that it could also be used in the Feather River Basin.

- 3/90 Modifications to code for the Arizona Project and more generalized processing on the P.C. and Microvax by D. A. Matthews, and Ra Aman, Water Augmentation Group, Denver: AAIM/AGM model was created.

- 8/90 Automation of sounding processor and I/O between subroutines.

- 9/90 Flow channel and cross section analysis output added.

- 12/90 Surface terrain check and elevations in meters added zelev (m).

- 3/91 Ra modified user input and log files and kept the code compatible with Microsoft for P.C.s. AGM code was completed.

The model uses an algorithm for calculating winds that was originally developed by R. D. Elliott of North American Weather Consultants. R. M. Rauber modified this algorithm to incorporate the downwind sounding to produce more accurate winds. The original program, which is now contained in subroutines ***TARGET1, FLOWCHAN, MAKGRID, QPOINT, CURTAIN*** and ***PRINTER***, was originally developed by J. O. Rhea from 1983-85. The code from this original version was modularized by R. M. Rauber in late 1985. During 1985-86, Rauber made significant modifications, particularly in the aircraft acetone generator, the ground seeding routines, and the user interaction code. This code was developed on the Bureau of Reclamation Cyber. In June 1986, the code was rewritten as required to run on Reclamation's PE. This work was done by C. J. Bernhard in Denver.

Plot routines have been developed by K. Dreher and A. Kuciauska of ETI. The model ran on the PE using a CSS file (Command Substitution System, i.e., command procedure file, or under DOS called a batchfile) called GUIDE that resided on ETI'S PE account. In the fall of 1987, there was a need to apply the GUIDE model to several other mountain ranges, notably the Atlas Mountains in Morocco, and the Feather River Basin in California. Therefore, Terry Deshler made the code as generic as possible, by isolating those variables particular to an application.

Dr. Deshler made all code modifications in lower case to set them off from the SCPP model. Ten new common blocks were added to allow all variables particular to each application to be isolated into the block data subroutine at the end of TARG87. This modification also considerably reduced the number of arguments passed in subroutine calls. Three short subroutines and five new functions were added at the end of ***TARGET1*** or ***QPOINT***. Two of these routines standardize the calculation of u and v. In the SCPP model the calculation of u and v winds were done slightly different each time and some of these calculations were particular to the Sierra barrier orientation. Also, the value of the number converting radians to degrees varied from 3 to 5 significant digits. With the new functions the value of this number is now constant. Many block if's were added to eliminate, where possible, goto statements. The structure of ***QPOINT*** and ***TARG87*** were changed considerably to make them more readable. All plotting instructions were written to one file, "GUIDCD.PLT", which is used by the plotting program. This file now collects all the information that was scattered in five files: "CURT.PLT", "DELAY.PLT", "GPLUME.PLT", "SEEDMET.PLT", and "CRYSTAL.PLT". Finally and most importantly, Terry Deshler added a number of new variables to replace the numerical constants that appeared everywhere and made simple changes complex.

In 1990, Dave Matthews adapted a generic version of the SCPP model to Arizona's Mogollon Rim, naming the modified code the AAIM model. He automated the model's sounding retrieval to accept data stored in ***RAOB*** format from the Arizona 1987-88 field operations. He made several changes to the program to facilitate validation of the model's flow channel structure and examined vertical cross sections of modeled fields. He also developed software to process tabulations of fields and graphically represent horizontal and vertical trajectories of particles, and contour selected fields using NCAR Graphics routines.

In 1991, Ra Aman modified this AAIM code for the P.C., such that wherever making modifications, he often restored case to upper, while changing most upper case comments to lower case, and fill justified sections to fit into 72 columns, (leaving seq. # cols. 73-80 for only special uses, like marking start, entry point, and end of each routine, and marking "P.C." for lines to be used only on a "P.C"., or "DEC" for alternate versions of the lines to be used only on a DEC MicroVax computer). This modification will help programmers distinguish, at a glance, FORTRAN code from comment.

2.7 Specific PC and Microvax Differences

The program is written in FORTRAN 77; therefore, it is compatible with most machines. Machine specific routines such as GETTIM require adjustment of the code. This date time routine for DEC (Digital Equipment Corporation Microvax), PC(personal computer), and PE (Perkin-Elmer) is called, with the lines for other computers commented out, so that the user can change the executed lines and ignored comments. "DEC", "PC", or "PE" are listed in the sequence number field (col. 73-80) to indicate the machine for the respective calls.

The original model version was SCPPM87.FOR (main program), blockdata, main subroutines, and versions of SCTRJCR.FOR, and SCREADA.FOR. Subroutines were moved into a new library called AGMLIB.FOR to be compiled and updated into an object file for relinking (AGMLIB.OLB on DEC, AGMLIB.LIB on PC). The main program and the block data were named AGM.FOR from Aircraft/Airflow Guide/Generic Microphysics/Model initials. All new items were denoted by UPPER case letters and most modifications were also UPPER case, except comments.

The log file AGMINP.LOG is opened to logical unit LULOG in the append mode, so that lines may be copied to a file. This file has answers for a model rerun, which lets the user make a slight change by editing the log file and saving it under a new name. Then the user can name it in the first response for another run of the model, thereby entering all responses automatically. At the end of an execution, file "MODLFLO.DAT" is appended to the end of "AFLyrmdh.mg?", then deleted. If aircraft rather than ground seeding is simulated, files "ZZ.PLT" and "GUIDCD.PLT" are also appended to "AFLyrmdh.mg". This file, "AFLyrmdh.mg" now contains all of the model run information for graphical display and other analyses. The "ZZ.PLT" and "GUIDCD.PLT" files are then deleted from the directory, whether or not ground seeding was used.

3. MODEL EXECUTION AND ANALYSIS – VISUALIZATION PROCESSING

The model may be used as a real-time tool to assist in field program operations or as a research tool to evaluate a number of events. The mode of execution will depend on specific objectives and data available for its initialization. This chapter provides several examples of typical model runs and graphical post processing analyses. The model user should attempt to initialize the model with the sounding or soundings that are most representative of the conditions to be simulated. This initialization requires a sounding close in time and space to the target area. The scientist operating the model should first evaluate the airflow, stability, temperature, and cloud base height conditions from sounding, aircraft, and mesosynoptic data at the time of seeding to determine the best seeding techniques to be simulated by the model. For interactive model runs, the model will prompt the user to provide specific input by responding to questions that set initial conditions. These questions determine:

1. Type of model simulation
2. Type of analyses desired
3. Seeding method
4. Date, time and identification of sounding/s; the seeding altitude; LWC; request for additional options such as a change from the stable default value to unstable, etc.
5. A special output file identifier

Upon completion of the run the user should examine the output tabulation file, and then run the graphical analysis program CRYSPLTS. He/she then may examine plots of modeled plume trajectories and particle fallout patterns to help in selecting the optimum seeding technique and the location and time of seeding experiments for the day. This chapter gives examples of different types of model simulations, showing the step-by-step responses to model questions.

The initialization soundings are automatically processed by the SNDLIB routines. The user specifies the sounding station identifier, either 2 or 3 characters, and its date and time. The station identifier may be either the NWS rawinsonde station identifier such as TUS for Tucson, AZ, or a special project identifier such as CVR for Camp Verde or HJW for the Happy Jack west aircraft sounding. The model and processing routines then search the computer's database for the sounding, retrieve and decode it from one of the standard formats, and interpolate to the model grid. Examples of the standard input sounding formats are provided in chapter 4.

3.1 Ground-based Seeding Simulations

The following text shows the AAIM model run and the appropriate interactive input responses for a ground seeding simulation. Model responses are shown in Geneva text, the user's input to the program is given in **bold**. Comments regarding the operation are noted in *italics. Note the commands are case insensitive.*

This simulation runs the model in a ground-based seeding simulation that used one upwind CVR sounding observed on February 15, 1987, at 1200 UTC. Two groups of seeding generators were selected for group A and B. The sounding was considered stable, thus no special options were selected and the default stable option was used in this run. LWC was not observed and was set to 0.0. A special character of "x" was added to the output file name.

To execute the model the user types:

run AAIM

The model then responds with:

Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/3
AAIM/AGM run 91/ 6/26 21:41:39
Name file from which prepared user responses are to be read, or if interactive start by choosing how much you want in the print file by entering:
0 = Q-point parameters, model wind dir. and speed, or
1 = default = all of 0, + target crystal trajectory information, or
2 = all of 1, + U,V,W model wind fields, or
3 = all of 2, + curtain trajectory parameters.

User responds with:

3

Model:

Select the desired seeding method:
1=g=G= Ground seeding
2=a=A= aircraft seeding, wingtip Acetone generators
3=f=F= aircraft seeding, pyrotechnic Flares
4=d=D= aircraft seeding, Dry ice

User: may select either 1 or g or G options etc.

1

Model:

Under the generator group letters type any character under those you want, or any pair of nonblank characters to request all groups. To see what stations a group has, put a ? under it, (then you'll also be asked if you wanted it).
A B A B A B a b c

User:

a b

Model:

Under the values shown, please enter (No commas!) any changes to the following:
(To remove and Not replace a used sounding, put a . in the ID field.)
(1 and 2) Upwind sounding YrMoDaHr and sounding site ID,
(3 and 4) Downwind Sounding YrMoDaHr and sounding site ID,
(5th) Altitude of seeder aircraft (ft) (if not ground),
(6th) Radiometric liquid water content (mm), then

(last) 1 to select or 0 to skip other options
[--Upwind--] [-Downwind-] (blank implies none or 0)
YrMoDaHr Sit YrMoDaHr Sit Alt.Ft. LqWmm o
87031512 cvr 87031514 hjw 10000. 0.0 0=retained values if not changed

User:

87021512 cvr 0. 0

Model:

tentative output file name is AFL872FC.03 Enter any distinctive
final character if wanted to distinguish similar versions

User:

x

The model then executes and responds with the following informative statements:

output file is named AFL872FC.03X
0=KEYWIND, and 0=KEYSTAB=stability parameterization=stable
KEYWIND = 0
TARGET1 to make initial call to AIRIN
RDNCDC CVR 87 21612 line 1 BuRec RAWIN style proj. sounding
FLOWCHAN(751.96=PDEAD, 1=KEYPRMDL) just entered
FLOWCHN making initial call to AIRIN
MIDCHAN just entered
MAKGRID(751.96=PDEAD) just entered
TEMPGRD just entered
PLUME: just entered
plume trajectory time limit X,Y,Z=10860. 97. 94. 2059. gen=A1
plume trajectory time limit X,Y,Z=10860. 125. 38. 2533. gen=A2
plume trajectory time limit X,Y,Z=10860. 127. 16. 2549. gen=A3
plume trajectory time limit X,Y,Z=10860. 115. 90. 2916. gen=A4
plume trajectory time limit X,Y,Z=10860. 102. 80. 2072. gen=B1
plume trajectory time limit X,Y,Z=10860. 108. 58. 2636. gen=B2
plume trajectory time limit X,Y,Z=10860. 100. 50. 2526. gen=B3
plume trajectory time limit X,Y,Z=10860. 126. 1. 2576. gen=B4
GNDTRAJ just ENTERED: 0.000=AAXIS0 8=NOGEN
FALLVEL(-6.0=TNOW, 0.0=TTIME, 0=IHABIT,...) entered
GNDTRAJ grid lim 1800.=TTIME 107. 105. 1980.340=X,Y,Z -3.2=TNOW 0.0=PCAXIX

GNDTRAJ grid lim 1740.=TTIME 114. 52. 1995.431=X,Y,Z -3.2=TNOW 0.0=PCAXIX

PRINTER just entered
AGM run files were the following:
3= LUGENR = seeding generator locations: GENSTA.LOC
11= LU LOG = model runtime specifications: AGMINP.LOG
12=LU STATS= 1st, min Temp, last lines: AGMSTATS.GEN
4= LUWARN =model run diagnostic debug info: ADIAG.DAT
2= LUOUTP = standard output tables: AFL872FC.03X plus appended and deleted
10= LUMODL = model flow channel structure: MODLFLO.DAT
7= LU ZZ = crystal trajectory info. : ZZ.PLT
9= LU PLT = graphics plotting files: GUIDCD.PLT
Since you used ground seeding, the last two files were deleted without appending.
Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/3 run done

This completes the model simulation. The model results are written to the above files as noted in the final table showing unit numbers and file names. The standard set of tables that present results to the user are in the "AFL872FC.03X" file. The user should list this file to examine results. Graphical plots that summarize important features of the simulation may be viewed by running the CRYSPLTS graphics processor. In this example the winds were very weak leading to a time limit note in the output file.

3.1.1 *Model Output from Ground Seeding*. – Table 3.1 provides a description of model output tabulations for the ground seeding simulation on February 25, 1987, using the CVR 1200 UTC sounding. The table is arranged with comments in *italics* using larger 10 point characters. Model output is printed in 9 point courier font characters. Special notes are labeled in bold italic characters.

Table 3.1. - Example of model tabulations from ground seeding simulation.

First the model is identified with the specific output file and run date and time:

Table 3.1a. - Initial model design parameters.

```
Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/7
           AFL872PC.03Q              AAIM/AGM run 91/10/31 11:38:07
```

Next, the ground seeding generators used in the simulation are listed with their model coordinates (x, y km) and their elevations (m msl):

GenrLocs for Arizona SF6 airflow

1	64.0	110.0	1524.	Cherry Road	starts group 1=A with 4 stations
2	86.5	73.5	1844.	Yavapi Road	
3	93.0	50.0	1650.	Forest Road	
4	74.0	129.0	2142.	Mingus Mtn	
1	68.0	97.5	1524.	Ridge sw of CVR	starts group 2=B with 4 stations
2	67.0	88.0	1989.		
3	62.5	76.0	1951.		
4	85.0	38.5	1890.	Payson Airport	

Next, a list of initial conditions for the model run showing the grid orientation at 225°, grid spacing at 10 km, crest location at grid index 13, downwind sounding location at 12, and domain for the grid at 17 by 17 elements. The vertical cross section of the terrain used in the model is listed in the next line from 620 m on the southwest boundary to 1700 m msl on the northeast boundary. The next two lines show the values of FLOMID for stable and neutral-unstable conditions respectively. The user determines which type of stability is appropriate. FLOMID determines the height of the midflow channel above the surface at the upwind sounding. ZVALF, the mean pressure of the terrain above the valley floor, is defined in the next line.

```
225 deg section 10. km steps 13=crest 12=DwnWndSta 17 el(m),flomid,zvalv
 620 1000 900 1000 1120  1400 1750 1000 1400 1750  1900 2050 2500 2200 2150 1800 1700
 350 389 369 377 383   400 423 375 430 361   336 351 395 381 361 326 336 (flow mid-stable)
 325 355 326 325 332   355 380 275 300 316   311 356 400 331 326 341 331 (flow mid-unstable)
   0  10  10  10  16    44  80   5  44  80    95 110 154 125 120  85  75
```

Next, the generators that were used in the simulation are identified and initialization options are listed. The option and the selected values are listed. Options determine the method of seeding, amount of information printed, type of soundings used, specific date time and location of the sounding or a sounding file name, which is retrieved from the data base. Modifications to the sounding or model parameters for nucleation temperature are also set through proper selection of options.

wanted A B
groups 1 2 3 4 5 6 7 8 9
Seeding method 1 - Ground generator 8 used
1=KEYPRNT: output Qpt params, WDir&Spd; &if>0 CrysTraj info;
&if>1 U,W,V wind fields; &if>2 curtain traj. params.
0=KEYFALL: 0=default=dont (1=do) print trajectory information
1=KEYPRMDL: 1=default=do (0=dont) output model flowchanel structure to MODLFLO.D
AT (appended at end of file)
0=KEYCURT: 1=default=do (0=do no) curtain calculations
0=KEYFIX: 0=fixed target, find Q point; 1=the reverse
0=KEYSTAB: midflow channel stability param.=stable
1=KEYTARG: 0=fixed target center, 1=(default) downwind target
0=KEYWIND: 0=Upwind only, 1=upwind+acft winds, 2=Up+Dwnwind, 3=all
-6.0 -2.0=TEMPNUC,AIRNUCD nucleation temps from ground or CO2/Acetone
0. 0.=DEGMAG,RLTADME mag.dir.(deg), dist (nm) from LTA vortac to Qpt
0. 0.=HEADL,SEEDLIN heading to left (N. in deg.mag.), seedline length (NMi)

nTime	USndID	nkTime	DSndID	AltFt	RadLWC	JDWS	MtnCrst	dSndSp	ZVALF(JDWS & MTNCRST)
87022512	CVR	0		0.0	0.0	12	13	900.0	110.0 154.0

GRID ORIENTATION: ANGLB, ANGLU, ANGLV, DECL= 45.0 225.0 135.0 -13.0 250.0=TOP

Results from model computations begin at this point in the output file. Sounding name and date are listed first. This list should be carefully examined to verify that the correct sounding data are used for model analyses.

Table 3.1b. - Initial sounding.

TARGET1 sounding initiation
CVR 870225 12

MANDATORY AND SIGNIFICANT LEVELS — WINDS

	PRES (MBAR)	HGT (M)	T (C)	TD (C)	DIR	SPD (M/S)	HEIGHT (M)	HEIGHT (FT)	DIR	SPEED (M/S)	SPEED (KN)
1	892.	1027.	-0.9	-1.7	160.	1.	1027.	3369.	160.	1.	1.
2	882.	1117.	-0.1	-0.9			1219.	4000.	160.	3.	6.
3	851.	1404.	0.0	-1.4			1829.	6000.	190.	6.	12.
4	850.	1413.	-0.1	-1.5	160.	5.	2134.	7000.	210.	9.	17.
5	811.	1787.	-3.1	-3.5			2438.	8000.	210.	11.	21.
6	700.	2935.	-11.5	-12.4	210.	10.	2743.	9000.	210.	10.	20.
7	659.	3395.	-15.1	-16.0			3658.	12000.	220.	17.	33.
8	647.	3534.	-16.3	-17.3			4267.	14000.	220.	22.	42.
9	606.	4024.	-18.9	-27.9			4877.	16000.	215.	23.	44.
10	595.	4160.	-19.7	-31.7			6096.	20000.	220.	22.	43.
11	546.	4793.	-24.3	-37.3			7620.	25000.	220.	50.	98.
12	500.	5430.	-29.9	-39.9	220.	23.	9144.	30000.	255.	61.	119.
13	490.	5574.	-31.1	-41.1			10668.	35000.	240.	19.	36.
14	436.	6390.	-37.7	-42.0							
15	418.	6680.	-40.1	-48.1							
16	407.	6861.	-40.9	-52.9							
17	405.	6895.	-38.9	-52.9							
18	400.	6980.	-38.9	-58.9	220.	42.					
19	393.	7101.	-38.9	-68.9							
20	338.	8120.	-45.9	-75.9							
21	300.	8900.	-49.5	-79.5	245.	60.					
22	299.	8922.	-49.5	-79.5							
23	250.	10090.	-53.5	-83.5	200.	62.					
24	237.	10433.	-54.7	-84.7							
25	200.	11520.	-52.7	-82.7	235.	42.					
26	191.	11818.	-52.1	-82.1							

Next the upwind sounding date and time are listed in the form of year, month, day, hour (yy mm dd hh) and deadlayer height are noted.

Upwind sounding time = 87022512
The height of the dead layer is 1400. m
the pressure at the top of the dead layer is 851. mb
Wind field in this model run is from
Upwind sounding only

The following table summarizes the ground seeding plume information. The plume locations every 10 minutes are listed indicating the left, right boundaries of the plume for the 2-sigma concentration level and indicating the center coordinates (x,y in km) of the plume, its altitude and temperature. Tables for each generator are presented with data listed until the plume exits the grid, intersects the ground, or the time reaches 180 minutes.

Table 3.1c. - Plume trajectories.

Ground Seeding Plume Data
8 wanted seeding generators

GENERATOR NUMBER A1 **Plume 1**

Time	X-Rgt	Y-Rgt	X-Left	Y-Left	X-Cen	Y-Cen	Altitude	Temp
0	64.0	110.0	64.0	110.0	64.0	110.0	1604.0	-4.1
10	65.9	112.1	65.2	112.8	65.5	112.5	1639.4	-3.1
20	68.4	114.0	67.1	115.4	67.8	114.7	1645.8	-3.1
30	71.0	115.9	69.0	117.9	70.0	116.9	1638.8	-3.1
40	73.5	117.8	70.9	120.4	72.2	119.1	1637.2	-3.1
50	75.9	119.8	72.7	122.9	74.3	121.4	1631.3	-3.0
60	78.8	121.0	76.3	125.9	77.5	123.5	1631.6	-3.2
70	83.0	122.5	80.0	128.4	81.5	125.5	1632.3	-3.2
80	87.8	124.7	82.7	130.4	85.3	127.5	1640.1	-4.6
90	90.6	126.6	85.0	132.9	87.8	129.7	1741.9	-4.6
100	93.0	128.1	87.7	135.8	90.4	131.9	1845.2	-4.9
110	96.0	129.1	92.4	138.8	94.2	133.9	1988.7	-6.0
120	100.5	130.6	96.1	141.1	98.3	135.9	2083.8	-6.9
130	105.1	131.6	101.4	143.7	103.3	137.7	2174.1	-7.5
140	110.6	132.8	106.2	146.0	108.4	139.4	2270.7	-8.4
150	115.9	133.6	112.5	148.5	114.2	141.0	2389.5	-9.3
160	121.5	134.8	115.9	150.2	118.7	142.5	2568.9	-10.0
170	125.8	135.8	119.9	152.0	122.8	143.9	2522.2	-10.0
180	129.9	136.6	124.2	154.0	127.1	145.3	2351.6	-7.7

GENERATOR NUMBER A2 **Plume 2**

Time	X-Rgt	Y-Rgt	X-Left	Y-Left	X-Cen	Y-Cen	Altitude	Temp
0	86.5	73.5	86.5	73.5	86.5	73.5	1844.0	-4.9
10	91.6	74.5	91.2	76.2	91.4	75.3	2145.5	-7.2
20	99.0	75.0	98.3	78.7	98.6	76.8	2361.2	-8.9
30	107.3	75.4	106.3	81.2	106.8	78.3	2557.8	-10.5
40	116.4	75.8	114.9	83.7	115.7	79.7	2827.0	-11.7
50	125.4	76.1	123.8	86.2	124.6	81.2	2987.6	-12.4
60	135.1	76.4	133.3	88.8	134.2	82.6	2871.9	-11.4
70	145.0	76.7	142.7	91.3	143.8	84.0	2771.0	-10.3
80	154.5	77.1	151.8	93.8	153.1	85.4	2582.0	-8.9

GENERATOR NUMBER A3 **Plume 3**

Time	X-Rgt	Y-Rgt	X-Left	Y-Left	X-Cen	Y-Cen	Altitude	Temp
0	93.0	50.0	93.0	50.0	93.0	50.0	1650.0	-4.6
10	96.0	51.7	95.4	52.7	95.7	52.2	1859.6	-6.3
20	99.6	53.2	98.4	55.2	99.0	54.2	1992.6	-6.3
30	103.5	54.5	102.3	57.8	102.9	56.1	2105.5	-7.0
40	108.2	55.8	106.4	60.2	107.3	58.0	2213.8	-8.0
50	113.2	56.7	111.7	62.7	112.4	59.7	2341.5	-8.9
60	118.6	57.7	116.1	64.7	117.4	61.2	2524.3	-10.0
70	123.0	58.6	120.3	66.6	121.7	62.6	2611.9	-10.1
80	127.0	59.4	124.5	68.6	125.8	64.0	2422.1	-8.2
90	132.2	60.4	128.6	70.5	130.4	65.5	2328.5	-7.5
100	136.4	61.3	132.6	72.4	134.5	66.9	2335.2	-7.6
110	141.0	62.1	137.4	74.5	139.2	68.3	2344.0	-7.1
120	146.3	63.5	140.1	75.9	143.2	69.7	2163.0	-6.1
130	148.9	64.2	144.1	78.1	146.5	71.1	1969.8	-4.4
140	153.5	65.6	146.5	79.5	150.0	72.6	1869.8	-3.6
150	156.6	67.0	148.6	81.0	152.6	74.0	1844.7	-3.4
160	159.5	68.3	150.5	82.5	155.0	75.4	1826.4	-3.3
170	161.7	68.8	154.6	84.9	158.2	76.8	1813.7	-3.2

GENERATOR NUMBER A4 **Plume 4**

Time	X-Rgt	Y-Rgt	X-Left	Y-Left	X-Cen	Y-Cen	Altitude	Temp
0	74.0	129.0	74.0	129.0	74.0	129.0	2142.0	-6.8
10	81.4	129.4	81.0	131.6	81.2	130.5	2166.8	-7.2
20	90.1	129.7	89.4	134.3	89.8	132.0	2519.8	-9.9
30	99.6	130.0	98.6	137.0	99.1	133.5	2747.8	-11.8
40	109.8	130.3	108.5	139.7	109.2	135.0	2962.3	-12.9
50	121.1	130.3	119.6	142.4	120.3	136.4	3419.3	-15.1
60	133.2	130.4	131.3	145.2	132.3	137.8	3184.1	-13.5
70	144.9	130.5	142.7	147.9	143.8	139.2	3086.3	-12.7
80	156.3	130.7	153.9	150.6	155.1	140.7	2882.0	-11.2

GENERATOR NUMBER B1 **Plume 5**

Time	X-Rgt	Y-Rgt	X-Left	Y-Left	X-Cen	Y-Cen	Altitude	Temp
0	68.0	97.5	68.0	97.5	68.0	97.5	1524.0	-2.3
10	70.3	99.4	69.5	100.0	69.9	99.7	1599.1	-2.8
20	72.6	101.3	71.3	102.6	71.9	102.0	1632.5	-3.0
30	75.1	103.2	73.2	105.2	74.1	104.2	1647.8	-3.1
40	78.4	104.5	76.7	108.0	77.5	106.3	1655.9	-3.4
50	82.9	105.9	80.7	110.5	81.8	108.2	1657.9	-3.4
60	87.7	107.9	83.6	112.6	85.7	110.2	1676.1	-4.6
70	90.5	109.8	85.8	115.1	88.2	112.5	1781.0	-4.6
80	93.0	111.1	89.2	118.1	91.1	114.6	1898.2	-5.3
90	97.6	112.5	93.5	120.6	95.6	116.5	2040.3	-6.6
100	101.6	113.5	98.3	123.2	99.9	118.4	2138.0	-7.3
110	107.5	114.7	103.4	125.5	105.5	120.1	2237.0	-8.2
120	112.4	115.5	109.2	128.1	110.8	121.8	2349.4	-9.0
130	119.2	116.6	114.3	130.0	116.7	123.3	2503.4	-10.0
140	123.1	117.4	118.8	132.1	121.0	124.7	2662.6	-10.5
150	127.0	118.2	123.2	134.1	125.1	126.2	2455.6	-8.5
160	133.0	119.3	127.2	135.8	130.1	127.6	2335.4	-7.6
170	137.2	120.3	131.2	137.7	134.2	129.0	2335.4	-7.6
180	141.6	121.1	136.1	139.8	138.9	130.4	2337.3	-7.1

GENERATOR NUMBER B2 ***Plume 6***

Time	X-Rgt	Y-Rgt	X-Left	Y-Left	X-Cen	Y-Cen	Altitude	Temp
0	67.0	88.0	67.0	88.0	67.0	88.0	1989.0	-5.7
10	71.6	88.9	71.0	90.3	71.3	89.6	2004.3	-5.8
20	75.7	89.9	75.1	92.6	75.4	91.3	1924.4	-5.4
30	82.7	90.5	81.8	95.1	82.2	92.8	1949.0	-5.5
40	89.6	91.2	88.4	97.5	89.0	94.4	2181.7	-7.4
50	97.5	91.7	96.0	99.9	96.7	95.8	2369.8	-9.0
60	105.9	92.1	104.1	102.3	105.0	97.2	2542.6	-10.3
70	114.7	92.6	112.8	104.8	113.7	98.7	2762.7	-12.1
80	123.8	93.0	121.6	107.3	122.7	100.1	3023.2	-12.6
90	133.5	93.3	131.0	109.8	132.2	101.6	2849.8	-11.3
100	143.2	93.7	140.4	112.3	141.8	103.0	2828.0	-10.7
110	152.7	94.1	149.5	114.8	151.1	104.4	2583.5	-8.9

GENERATOR NUMBER B3 ***Plume 7***

Time	X-Rgt	Y-Rgt	X-Left	Y-Left	X-Cen	Y-Cen	Altitude	Temp
0	62.5	76.0	62.5	76.0	62.5	76.0	1951.0	-5.2
10	65.2	77.9	64.4	78.6	64.8	78.2	1956.8	-5.3
20	69.0	79.0	68.1	81.1	68.6	80.0	1925.7	-5.2
30	73.0	80.3	71.4	83.3	72.2	81.8	1863.1	-4.7
40	76.4	81.5	75.2	85.8	75.8	83.7	1797.4	-4.4
50	82.4	82.5	80.6	88.2	81.5	85.4	1763.4	-4.2
60	88.4	84.5	83.6	90.0	86.0	87.2	1771.1	-4.6
70	90.9	85.9	86.8	92.9	88.8	89.4	1884.2	-5.2
80	94.7	86.9	91.9	95.8	93.3	91.3	2030.7	-6.3
90	100.0	88.1	96.5	98.1	98.3	93.1	2130.6	-7.2
100	105.4	89.0	102.5	100.6	103.9	94.8	2236.4	-8.0
110	111.3	90.0	108.0	102.9	109.6	96.5	2350.4	-9.0
120	118.4	91.1	113.3	105.0	115.9	98.0	2499.5	-10.0
130	122.0	91.8	118.1	107.1	120.1	99.4	2703.0	-10.8
140	127.4	92.9	121.6	108.8	124.5	100.9	2494.6	-10.0
150	132.2	93.7	126.6	110.8	129.4	102.3	2354.1	-7.7
160	136.6	94.8	130.4	112.7	133.5	103.7	2332.7	-7.6
170	140.9	95.5	135.1	114.7	138.0	105.1	2333.6	-7.1
180	146.8	97.0	138.0	116.1	142.4	106.6	2216.4	-6.2

GENERATOR NUMBER B4 ***Plume 8***

Time	X-Rgt	Y-Rgt	X-Left	Y-Left	X-Cen	Y-Cen	Altitude	Temp
0	85.0	38.5	85.0	38.5	85.0	38.5	1890.0	-5.3
10	90.9	39.3	90.5	41.1	90.7	40.2	2252.5	-7.9
20	99.2	39.6	98.5	43.7	98.9	41.6	2487.8	-9.8
30	108.2	39.9	107.2	46.3	107.7	43.1	2698.4	-11.6
40	117.8	40.2	116.5	48.9	117.1	44.6	3043.1	-12.8
50	128.0	40.5	126.5	51.6	127.2	46.0	3025.8	-12.2
60	138.3	40.7	136.4	54.2	137.3	47.4	2975.6	-11.9
70	148.6	41.0	146.4	56.8	147.5	48.9	2780.1	-10.4
80	158.7	41.3	156.1	59.3	157.4	50.3	2677.6	-9.6

Next the Q-point location for seeding plume nucleation grid-coordinate location(km), altitude(m msl) and temperature (°C) are listed for each seeding generator. This shows the location for research aircraft sampling downwind of each generator.

GEN	XQPOINT	YQPOINT	ZQPOINT	TQPOINT
A1	94.2	133.9	1988.7	-6.01
A2	88.5	74.5	2006.7	-6.14
A3	95.0	51.8	1829.3	-6.26
A4	74.0	129.0	2142.0	-6.81
B1	93.6	115.8	1994.4	-6.05
B2	84.5	93.2	2013.7	-6.03
B3	91.7	90.8	1993.7	-6.05
B4	86.2	39.1	2004.5	-6.13

The following tables describe the ice crystal particle evolution and trajectories for each plume. The seeding generator is identified then the crystal's horizontal position (x, y km) and altitude (z m msl) and temperature (°C). Crystal properties of size for the c- and a-axis (microns), terminal velocity (m s^{-1}) and crystal habit are listed next. The crystal numbers (1-8) shown below are used in the graphics routines to label the crystal trajectories. The final fallout point time (s), location(x,y km), elevation (m msl), temperature (°C), and crystal c-axis length (microns) are indicated at the end of each crystal trajectory. If the crystal is too small to identify, then "too small" is printed under IHabit.

Table 3.1d. - Ice crystal trajectories.

GEN	X	Y	Z	Temp	CAxis	AAxis	VT	IHabit **Crystal 1**
A1	94.2	133.9	1988.7	-6.01	0.	0.	0.00	0 = too small?
A1	94.7	134.1	2001.0	-6.01	60.	10.	0.03	0
A1	95.2	134.3	2011.0	-6.10	120.	20.	0.07	0
A1	95.5	134.5	2008.3	-6.34	180.	31.	0.13	0
A1	95.9	134.7	2002.1	-6.32	240.	41.	0.18	0
A1	96.2	134.9	1992.1	-6.27	300.	51.	0.25	0
A1	96.5	135.1	1978.0	-6.26	360.	61.	0.31	2 = column
A1	96.9	135.3	1959.7	-6.26	420.	71.	0.38	2
A1	97.2	135.5	1937.1	-6.26	480.	82.	0.46	2
A1	97.5	135.7	1909.8	-6.26	540.	92.	0.53	2
A1	97.8	135.9	1877.9	-6.26	600.	102.	0.61	2
A1	98.2	136.1	1841.1	-6.26	660.	112.	0.69	2
A1	98.5	136.3	1799.2	-6.26	720.	122.	0.78	2

GNDTRAJ grid lim 720.=TTIME 99. 136. 1799.217=X,Y,Z -6.3=TNOW 720.0=PCAXIS

GEN	X	Y	Z	Temp	CAxis	AAxis	VT	IHabit **Crystal 2**
A2	88.5	74.5	2006.7	-6.14	0.	0.	0.00	0 = too small?
A2	89.0	74.7	2019.6	-6.14	60.	10.	0.03	0
A2	89.5	74.9	2030.3	-6.24	120.	20.	0.07	0
A2	90.0	75.0	2038.3	-6.31	180.	31.	0.13	0
A2	90.6	75.2	2043.0	-6.37	240.	41.	0.18	0
A2	91.2	75.4	2044.2	-6.41	300.	51.	0.25	0
A2	91.7	75.5	2041.4	-6.42	360.	61.	0.31	2 = column
A2	92.3	75.7	2034.3	-6.40	420.	71.	0.38	2
A2	92.8	75.9	2022.6	-6.34	480.	82.	0.46	2
A2	93.4	76.1	2005.9	-6.26	540.	92.	0.53	2
A2	93.9	76.2	1983.9	-6.14	600.	102.	0.61	2
A2	94.4	76.4	1955.8	-5.97	665.	112.	0.70	2
A2	94.8	76.6	1921.3	-5.76	730.	122.	0.79	2
A2	95.2	76.8	1880.0	-5.51	794.	133.	0.88	2
A2	95.5	77.0	1826.5	-6.26	854.	143.	0.97	2
A2	95.9	77.2	1768.5	-6.26	914.	153.	1.05	2

GNDTRAJ grid lim 900.=TTIME 96. 77. 1768.492=X,Y,Z -6.3=TNOW 914.4=PCAXIS

GEN	X	Y	Z	Temp	CAxis	AAxis	VT	IHabit **Crystal 3**
A3	95.0	51.8	1829.3	-6.26	0.	0.	0.00	0 = too small?
A3	95.3	52.0	1832.2	-6.26	60.	10.	0.03	0
A3	95.7	52.2	1832.5	-6.26	120.	20.	0.07	0
A3	96.0	52.4	1829.6	-6.26	180.	31.	0.13	0
A3	96.3	52.6	1823.3	-6.26	240.	41.	0.18	0
A3	96.7	52.8	1813.2	-6.26	300.	51.	0.25	0
A3	97.0	53.0	1799.1	-6.26	360.	61.	0.31	2 = column

GNDTRAJ grid lim 360.=TTIME 97. 53. 1799.109=X,Y,Z -6.3=TNOW 360.0=PCAXIS

GEN	X	Y	Z	Temp	CAxis	AAxis	VT	IHabit **Crystal 4**
A4	74.0	129.0	2142.0	-6.81	0.	0.	0.00	0 = too small?
A4	74.5	129.1	2124.5	-6.81	60.	10.	0.03	0
A4	75.0	129.3	2104.5	-6.68	120.	20.	0.07	0
A4	75.4	129.4	2081.8	-6.53	180.	31.	0.13	0
A4	76.2	129.6	2049.1	-6.53	240.	41.	0.18	0
A4	77.0	129.7	2014.0	-6.29	300.	51.	0.25	0
A4	77.8	129.9	1976.4	-6.03	360.	61.	0.31	2 = column
A4	78.5	130.0	1935.8	-5.75	425.	71.	0.39	2
A4	79.2	130.2	1892.1	-5.45	490.	82.	0.47	2
A4	79.9	130.3	1845.1	-5.13	554.	92.	0.55	2
A4	80.5	130.5	1796.8	-4.78	595.	102.	0.60	2
A4	81.1	130.7	1747.1	-4.42	635.	112.	0.66	2
A4	81.7	130.8	1695.9	-4.05	675.	122.	0.71	2
A4	82.1	131.0	1645.3	-3.66	690.	133.	0.73	2
A4	82.5	131.2	1595.2	-3.29	705.	143.	0.75	2
A4	82.9	131.4	1546.5	-2.92	711.	153.	0.76	2
A4	83.2	131.6	1499.1	-2.58	717.	163.	0.77	2
A4	83.4	131.9	1452.8	-2.24	723.	173.	0.78	2
A4	83.6	132.1	1407.7	-1.92	729.	184.	0.79	2
A4	83.7	132.4	1363.7	-1.60	735.	194.	0.80	2
A4	83.9	132.6	1319.5	-1.55	741.	204.	0.81	2
A4	84.0	132.9	1274.8	-1.55	747.	214.	0.81	2
A4	84.1	133.1	1229.6	-1.55	753.	224.	0.82	2
A4	84.2	133.4	1183.8	-1.55	759.	235.	0.83	2

GNDTRAJ grid lim 1380.=TTIME 84. 133. 1183.842=X,Y,Z -1.6=TNOW 759.0=PCAXIS

GEN	X	Y	Z	Temp	CAxis	AAxis	VT	IHabit **Crystal 5**
B1	93.6	115.8	1994.4	-6.05	0.	0.	0.00	0 = too small?
B1	94.1	116.0	2006.8	-6.05	60.	10.	0.03	0
B1	94.6	116.1	2017.0	-6.14	120.	20.	0.07	0
B1	95.2	116.3	2024.5	-6.22	180.	31.	0.13	0
B1	95.5	116.5	2018.6	-6.44	240.	41.	0.18	0
B1	95.9	116.7	2008.8	-6.39	300.	51.	0.25	0
B1	96.2	116.9	1994.9	-6.32	360.	61.	0.31	2 = column
B1	96.6	117.1	1976.7	-6.26	420.	71.	0.38	2
B1	96.9	117.3	1954.0	-6.26	480.	82.	0.46	2
B1	97.2	117.5	1926.8	-6.26	540.	92.	0.53	2
B1	97.5	117.7	1894.8	-6.26	600.	102.	0.61	2
B1	97.9	117.9	1858.0	-6.26	660.	112.	0.69	2
B1	98.2	118.1	1816.1	-6.26	720.	122.	0.78	2
B1	98.5	118.3	1769.1	-6.26	780.	133.	0.86	2

GNDTRAJ grid lim 780.=TTIME 99. 118. 1769.140=X,Y,Z -6.3=TNOW 780.0=PCAXIS

GEN	X	Y	Z	Temp	CAxis	AAxis	VT	IHabit	**Crystal 6**
B2	84.5	93.2	2013.7	-6.03	0.	0.	0.00	0 = too small?	
B2	85.2	93.4	1993.2	-6.03	60.	10.	0.03	0	
B2	85.7	93.6	2002.9	-6.04	120.	20.	0.07	0	
B2	86.2	93.8	2009.9	-6.11	180.	31.	0.13	0	
B2	86.7	93.9	2013.6	-6.17	240.	41.	0.18	0	
B2	87.3	94.1	2013.8	-6.19	300.	51.	0.25	0	
B2	87.8	94.3	2009.9	-6.19	360.	61.	0.31	2 = column	
B2	88.3	94.5	2001.7	-6.17	420.	71.	0.38	2	
B2	88.8	94.7	1988.8	-6.11	480.	82.	0.46	2	
B2	89.3	94.8	1970.9	-6.01	540.	92.	0.53	2	
B2	89.8	95.0	1947.3	-5.88	605.	102.	0.62	2	
B2	90.2	95.2	1917.6	-5.70	670.	112.	0.71	2	
B2	90.6	95.4	1881.3	-5.48	734.	122.	0.80	2	
B2	91.0	95.6	1838.2	-5.21	799.	133.	0.89	2	
B2	91.3	95.8	1790.0	-4.89	839.	143.	0.95	2	
B2	91.5	96.1	1736.9	-4.61	880.	153.	1.01	2	
B2	91.8	96.3	1681.4	-4.61	920.	163.	1.05	2	
B2	92.0	96.5	1624.3	-4.61	960.	173.	1.07	2	
B2	92.3	96.7	1565.7	-4.61	1000.	184.	1.10	2	

GNDTRAJ grid lim 1080.=TTIME 92. 97. 1565.743=X,Y,Z -4.6=TNOW1000.2=PCAXIS

GEN	X	Y	Z	Temp	CAxis	AAxis	VT	IHabit	**Crystal 7**
B3	91.7	90.8	1993.7	-6.05	0.	0.	0.00	0 = too small?	
B3	92.2	91.0	2006.1	-6.05	60.	10.	0.03	0	
B3	92.7	91.2	2016.3	-6.14	120.	20.	0.07	0	
B3	93.3	91.3	2023.7	-6.21	180.	31.	0.13	0	
B3	93.8	91.5	2028.0	-6.27	240.	41.	0.18	0	
B3	94.3	91.7	2028.6	-6.30	300.	51.	0.25	0	
B3	94.9	91.9	2025.3	-6.30	360.	61.	0.31	2 = column	
B3	95.4	92.0	2017.6	-6.28	420.	71.	0.38	2	
B3	95.8	92.2	1995.3	-6.39	480.	82.	0.46	2	
B3	96.1	92.4	1968.0	-6.26	540.	92.	0.53	2	
B3	96.8	92.8	1899.2	-6.26	660.	112.	0.69	2	
B3	97.1	93.0	1857.4	-6.26	720.	122.	0.78	2	
B3	97.4	93.2	1810.4	-6.26	780.	133.	0.86	2	
B3	97.8	93.4	1758.2	-6.26	840.	143.	0.95	2	

GNDTRAJ grid lim 840.=TTIME 98. 93. 1758.167=X,Y,Z -6.3=TNOW 840.0=PCAXIS

GEN	X	Y	Z	Temp	CAxis	AAxis	VT	IHabit	**Crystal 8**
B4	86.2	39.1	2004.5	-6.13	0.	0.	0.00	0 = too small?	
B4	86.8	39.3	2017.3	-6.13	60.	10.	0.03	0	
B4	87.3	39.4	2027.9	-6.22	120.	20.	0.07	0	
B4	87.8	39.6	2035.7	-6.30	180.	31.	0.13	0	
B4	88.4	39.8	2040.4	-6.35	240.	41.	0.18	0	
B4	88.9	40.0	2041.4	-6.39	300.	51.	0.25	0	
B4	89.5	40.1	2038.6	-6.40	360.	61.	0.31	2 = column	
B4	90.0	40.3	2031.4	-6.38	420.	71.	0.38	2	
B4	90.6	40.5	2019.5	-6.32	480.	82.	0.46	2	
B4	91.1	40.7	2002.7	-6.24	540.	92.	0.53	2	
B4	91.6	40.8	1980.6	-6.11	600.	102.	0.61	2	
B4	92.1	41.0	1952.4	-5.95	665.	112.	0.70	2	
B4	92.5	41.2	1917.8	-5.74	730.	122.	0.79	2	
B4	92.9	41.4	1876.4	-5.48	794.	133.	0.88	2	
B4	93.3	41.6	1827.8	-5.18	859.	143.	0.98	2	
B4	93.6	41.8	1774.1	-4.81	899.	153.	1.04	2	
B4	93.8	42.1	1717.8	-4.61	940.	163.	1.06	2	
B4	94.1	42.3	1660.0	-4.61	980.	173.	1.09	2	
B4	94.3	42.5	1600.7	-4.61	1020.	184.	1.11	2	
B4	94.6	42.7	1539.9	-4.61	1060.	194.	1.14	2	

GNDTRAJ grid lim 1140.=TTIME 95. 43. 1539.944=X,Y,Z -4.6=TNOW1060.2=PCAXIS

*Tables of vertical z-x cross sections and flow channels may follow depending on the options selected. They show the values used in model calculations interpolated to a standard grid with 200 m vertical spacing and 10 km horizontal spacing. Forty vertical levels and 17 horizontal grid points are printed. Ground locations are marked by * or 999.0 values. The first column shows the vertical axis of height (m msl). Grid point values are printed in the remaining columns. These tables require a full 132 character line for proper display of information. Samples from a laser printer are listed below for this example.*

Wind direction (ddd) and speed (ff) at each grid point are printed in the form ddd.ff, where direction is expressed in degrees from north at 0° and speed is in m s^{-1}. Other tables are labeled for fields of temperature(°C), potential temperature(°K), u- and v-components of the wind (m s^{-1}) in terms of the 225° grid where u is the wind component along the x-axis perpendicular to the crest; and vertical motion (m s^{-1}).

Table 3.1e. - TARGETING MODEL Upwind sounding YrMoDaHr=87022512
model wind dir.speed(m/s). Hgt(m),X-dist 10km inc.

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8000.229.52229.52229.52229.52229.53228.55227.58229.52236.39235.41234.42233.43231.47232.44233.44234.41235.41
7800.226.50225.51225.51225.51225.51224.53223.56226.50233.38231.40230.41230.42228.46229.43229.43231.40231.40
7600.222.49222.49222.49222.49222.50221.52220.54222.49229.37228.39227.40226.41224.44226.42226.42228.39228.39
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2200.210.08209.08209.08209.08209.08209.08194.06209.08214.14214.12206.10199.07******200.04201.05212.12214.13
2000.200.07200.07200.07200.07199.07198.07182.05201.07214.12201.09194.06188.03******************205.07208.09
1800.188.06187.06187.06187.06187.06186.06171.04189.06206.10189.05******************************198.03201.05
1600.175.05175.05175.05175.05175.05174.04******177.04193.06************************************************
1400.168.03168.03168.03168.03168.03168.03******169.03180.03************************************************
1200.160.02160.02160.02160.02160.02************160.02******************************************************
1000.152.01************************************************************************************************
 800.******************************************************************************************************
 600.******************************************************************************************************
 400.******************************************************************************************************
 200.******************************************************************************************************
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Table 3.1f. - TARGETING MODEL Upwind sounding YrMoDaHr=87022512

Model Temperature (C).

8000.	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7	-44.7
7800.	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4	-43.4
7600.	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2	-42.2
7400.	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0	-41.0
7200.	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6	-40.6
7000.	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1	-40.1
6800.	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7	-39.7
6600.	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2	-39.2
6400.	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8	-37.8
6200.	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2	-36.2
6000.	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5	-34.5
5800.	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9	-32.9
5600.	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2	-31.2
5400.	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5	-29.5
5200.	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8	-27.8
5000.	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2	-26.2
4800.	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6	-24.6
4600.	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0	-23.0
4400.	-21.4	-21.6	-21.7	-21.8	-22.0	-22.1	-22.2	-22.4	-22.5	-22.0	-21.7	-21.4	-21.4	-21.4	-21.4	-21.4	-21.4
4200.	-20.2	-20.3	-20.4	-20.5	-20.6	-20.7	-20.8	-20.9	-21.0	-20.6	-20.4	-20.2	-20.2	-20.2	-20.2	-20.2	-20.2
4000.	-19.0	-19.1	-19.2	-19.3	-19.4	-19.5	-19.6	-19.7	-19.8	-19.4	-19.2	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0
3800.	-17.7	-17.8	-18.0	-18.1	-18.2	-18.4	-18.5	-18.6	-18.8	-18.9	-18.4	-18.0	-17.7	-17.7	-17.7	-17.7	-17.7
3600.	-16.3	-16.5	-16.6	-16.8	-16.9	-17.1	-17.2	-17.4	-17.5	-17.7	-17.1	-16.6	-16.3	-16.3	-16.3	-16.3	-16.3
3400.	-15.0	-15.1	-15.3	-15.4	-15.6	-15.7	-15.8	-16.0	-16.1	-16.3	-15.7	-15.3	-15.0	-15.0	-15.0	-15.0	-15.0
3200.	-13.6	-13.7	-13.9	-14.1	-14.3	-14.4	-14.6	-14.8	-15.0	-15.1	-15.3	-14.4	-13.9	-13.6	-13.6	-13.6	-13.6
3000.	-12.0	-12.2	-12.4	-12.6	-12.8	-13.0	-13.2	-13.4	-13.6	-13.8	-14.0	-13.0	-12.4	-12.0	-12.0	-12.0	-12.0
2800.	-10.5	-10.7	-10.9	-11.0	-11.2	-11.4	-11.5	-11.7	-11.9	-12.0	-12.2	-12.4	-11.5	-11.0	-10.5	-10.5	-10.5
2600.	-9.0	-9.2	-9.4	-9.5	-9.7	-9.9	-10.0	-10.2	-10.4	-10.5	-10.7	-10.9	-10.0	-9.5	-9.0	-9.0	-9.0
2400.	-7.6	-7.7	-7.9	-8.0	-8.2	-8.4	-8.5	-8.7	-8.9	-9.0	-9.2	-9.3	******	-8.0	-7.6	-7.6	-7.6
2200.	-6.1	-6.3	-6.4	-6.6	-6.7	-6.9	-7.1	-7.2	-7.4	-7.6	-7.7	-7.9	******	-6.6	-6.1	-6.1	-6.1
2000.	-4.6	-4.8	-4.9	-5.1	-5.3	-5.4	-5.6	-5.8	-5.9	-6.1	-6.3	-6.4	******	******	******	-4.6	-4.6
1800.	-3.1	-3.3	-3.4	-3.6	-3.8	-3.9	-4.1	-4.3	-4.4	-4.6	******	******	******	******	******	-3.1	-3.1
1600.	-1.6	-1.8	-2.0	-2.1	-2.3	-2.5	******	-2.8	-2.9	******	******	******	******	******	******	******	******
1400.	-1.0	-1.0	-1.1	-1.2	-1.3	-1.3	******	-1.5	-1.6	******	******	******	******	******	******	******	******
1200.	-0.2	-0.2	-0.3	-0.4	-0.5	******	******	-0.8	******	******	******	******	******	******	******	******	******
1000.	0.7	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
800.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
600.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
400.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
200.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******

Table 3.1g. - TARGETING MODEL Upwind sounding YrMoDaHr=87022512
Potential Temperature (K).

8000.	310.1	310.1	310.1	310.1	310.1	310.0	310.0	310.1	309.9	309.9	309.9	309.9	309.9	309.9	309.9	309.9	309.9
7800.	309.1	309.1	309.1	309.1	309.1	309.1	309.1	309.1	309.0	309.0	309.0	309.0	309.0	309.0	309.0	309.0	309.0
7600.	308.1	308.1	308.1	308.1	308.1	308.1	308.1	308.1	308.1	308.0	308.0	308.0	308.0	308.0	308.0	308.0	308.0
7400.	307.1	307.1	307.1	307.1	307.1	307.1	307.1	307.1	307.0	307.0	307.0	307.0	306.9	306.9	307.0	307.0	307.0
7200.	305.1	305.1	305.1	305.1	305.1	305.1	305.1	305.1	305.0	305.0	305.0	304.9	305.1	304.9	304.9	305.0	305.0
7000.	303.1	303.1	303.1	303.1	303.1	303.1	303.1	303.1	303.0	303.1	303.1	303.1	303.1	303.1	303.1	303.1	303.1
6800.	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2	301.2
6600.	299.2	299.2	299.2	299.2	299.3	299.3	299.3	299.2	299.3	299.3	299.3	299.3	299.3	299.3	299.3	299.3	299.3
6400.	298.6	298.6	298.6	298.6	298.6	298.6	298.6	298.6	298.7	298.6	298.6	298.6	298.6	298.6	298.6	298.6	298.6
6200.	298.2	298.2	298.2	298.2	298.2	298.2	298.2	298.2	298.2	298.2	298.2	298.2	298.1	298.2	298.2	298.2	298.2
6000.	297.8	297.8	297.8	297.8	297.8	297.8	297.8	297.8	297.8	297.8	297.8	297.8	297.7	297.8	297.8	297.8	297.8
5800.	297.4	297.4	297.4	297.4	297.4	297.4	297.4	297.4	297.4	297.4	297.4	297.4	297.3	297.4	297.4	297.4	297.4
5600.	297.1	297.1	297.1	297.1	297.1	297.1	297.0	297.1	297.1	297.1	297.1	297.1	297.0	297.0	297.0	297.1	297.1
5400.	296.7	296.7	296.7	296.7	296.7	296.7	296.7	296.7	296.8	296.8	296.7	296.7	296.7	296.7	296.7	296.7	296.8
5200.	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4
5000.	296.1	296.1	296.1	296.1	296.1	296.1	296.1	296.1	296.1	296.0	296.1	296.1	296.1	296.1	296.1	296.0	296.0
4800.	295.6	295.6	295.6	295.6	295.6	295.6	295.6	295.6	295.6	295.6	295.7	295.7	295.6	295.6	295.6	295.6	295.6
4600.	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2
4400.	294.7	294.6	294.4	294.3	294.1	294.0	293.8	293.7	293.5	294.1	294.4	294.7	294.7	294.7	294.7	294.7	294.7
4200.	293.9	293.8	293.7	293.6	293.4	293.3	293.2	293.1	292.9	293.4	293.7	293.9	293.9	293.9	293.9	293.9	293.8
4000.	293.1	293.0	292.9	292.7	292.6	292.5	292.4	292.3	292.1	292.6	292.8	293.1	293.1	293.1	293.1	293.1	293.1
3800.	292.3	292.1	292.0	291.8	291.7	291.5	291.4	291.2	291.1	290.9	291.5	292.0	292.3	292.3	292.3	292.3	292.3
3600.	291.6	291.5	291.3	291.1	291.0	290.8	290.6	290.5	290.3	290.1	290.8	291.3	291.6	291.6	291.6	291.6	291.6
3400.	291.0	290.8	290.6	290.5	290.3	290.1	290.0	289.8	289.6	289.5	290.1	290.6	291.0	291.0	291.0	290.9	291.0
3200.	290.3	290.1	290.0	289.8	289.6	289.4	289.2	289.0	288.8	288.6	288.4	289.4	290.0	290.3	290.3	290.3	290.3
3000.	289.9	289.7	289.4	289.2	289.0	288.8	288.6	288.4	288.2	288.0	287.7	288.8	289.4	289.9	289.9	289.9	289.9
2800.	289.4	289.2	289.0	288.8	288.6	288.4	288.3	288.1	287.9	287.7	287.5	287.3	288.3	288.8	289.4	289.4	289.4
2600.	288.9	288.7	288.5	288.3	288.2	288.0	287.8	287.6	287.4	287.2	287.1	286.9	287.8	288.3	288.9	288.9	288.9
2400.	288.4	288.2	288.0	287.8	287.7	287.5	287.3	287.1	286.9	286.8	286.6	286.4	999.0	287.8	288.3	288.3	288.4
2200.	287.8	287.7	287.5	287.3	287.1	286.9	286.8	286.6	286.4	286.3	286.1	285.9	999.0	288.5	288.5	287.8	287.8
2000.	287.3	287.2	287.0	286.8	286.6	286.5	286.3	286.1	285.9	285.8	285.7	287.1	999.0	999.0	999.0	287.3	287.3
1800.	286.8	286.7	286.5	286.3	286.1	286.0	287.4	285.6	285.4	286.0	999.0	999.0	999.0	999.0	999.0	288.1	287.1
1600.	286.9	286.8	286.6	286.4	286.2	286.2	999.0	285.7	285.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0
1400.	285.0	284.9	284.8	284.8	284.7	284.6	999.0	284.5	286.2	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0
1200.	283.8	283.7	283.6	283.5	283.4	999.0	999.0	283.1	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0
1000.	282.6	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0
800.	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0
600.	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0
400.	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0
200.	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0

Table 3.1h. - TARGETING MODEL Upwind sounding YrMoDaHr=87022512
Model U-comp(225.0 deg) m/s.

8000.	51.4	52.2	52.2	52.2	52.7	55.0	58.3	51.8	38.1	40.5	41.6	42.8	46.6	44.0	43.6	40.9	40.2
7800.	50.1	50.8	50.8	50.8	51.3	53.5	56.6	50.5	37.4	39.7	40.8	41.9	45.5	43.1	42.7	40.1	39.4
7600.	48.8	49.5	49.5	49.5	49.9	52.0	54.8	49.1	36.7	38.9	39.9	41.0	44.5	42.1	41.7	39.2	38.6
7400.	47.2	47.6	47.6	47.6	47.9	48.9	50.3	47.4	36.0	38.1	39.1	40.1	43.4	41.2	40.8	38.4	37.8
7200.	43.7	44.0	44.0	44.0	44.2	44.9	45.8	43.9	35.3	37.3	38.3	39.2	41.7	40.2	39.9	37.6	37.0
7000.	40.2	40.4	40.4	40.4	40.5	40.9	41.2	40.3	34.6	36.4	36.9	37.4	38.8	37.9	37.7	36.5	36.2
6800.	36.7	36.7	36.7	36.7	36.8	36.8	36.9	36.7	33.2	34.1	34.5	34.9	35.9	35.3	35.2	34.3	34.0
6600.	33.2	33.1	33.1	33.1	33.2	33.4	33.5	33.1	31.2	31.9	32.2	32.4	33.0	32.7	32.6	32.0	31.8
6400.	30.4	30.4	30.4	30.4	30.4	30.4	30.1	30.4	29.2	29.7	29.9	30.0	30.1	30.1	30.0	29.8	29.6
6200.	27.8	27.7	27.7	27.7	27.7	27.4	26.8	27.7	27.3	27.5	27.5	27.5	27.7	27.4	27.5	27.5	27.5
6000.	25.1	25.0	25.0	25.0	24.9	24.4	25.9	25.1	25.3	25.3	25.3	25.4	25.5	25.5	25.5	25.2	25.3
5800.	22.5	22.8	22.8	22.8	23.1	24.2	25.9	22.6	23.3	23.5	23.6	23.6	23.4	23.6	23.6	23.5	23.5
5600.	22.5	22.8	22.8	22.8	23.1	24.3	26.0	22.6	21.8	21.9	21.8	21.8	21.2	21.6	21.7	21.9	21.9
5400.	22.5	22.9	22.9	22.9	23.1	24.3	25.3	22.7	20.4	20.2	20.1	19.9	20.1	19.7	19.8	20.2	20.2
5200.	22.5	22.9	22.9	22.9	23.1	23.7	24.0	22.7	18.9	18.5	18.4	18.3	20.1	18.9	18.7	18.5	18.6
5000.	22.4	22.6	22.6	22.6	22.7	22.6	22.7	22.5	17.4	17.3	17.8	18.3	20.2	18.9	18.7	17.4	17.1
4800.	22.2	22.2	22.2	22.2	22.1	21.5	21.5	22.2	16.1	17.3	17.8	18.3	20.2	18.9	18.7	17.4	17.1
4600.	21.9	21.7	21.7	21.7	21.6	20.5	20.3	21.8	16.2	17.3	17.8	18.4	25.0	19.0	18.8	17.5	17.1
4400.	21.6	21.1	21.1	21.1	20.8	19.4	19.2	21.4	16.2	17.3	17.8	18.7	32.5	22.8	21.3	17.5	17.1
4200.	20.4	19.9	19.9	19.9	19.6	18.3	18.0	20.2	16.2	17.3	20.9	25.0	36.9	29.5	27.9	18.3	17.2
4000.	19.2	18.7	18.7	18.7	18.5	17.3	16.2	19.0	16.2	22.9	27.0	31.4	33.2	35.2	34.6	24.3	21.7
3800.	18.0	17.5	17.5	17.5	17.1	15.7	14.4	17.7	20.1	28.8	33.1	32.9	28.5	31.9	32.2	30.2	27.4
3600.	16.1	15.6	15.6	15.6	15.3	14.1	12.6	15.9	25.7	31.5	30.6	29.6	22.9	28.0	28.8	31.2	31.7
3400.	14.2	13.8	13.8	13.8	13.5	12.4	11.7	14.0	31.0	28.6	27.5	25.4	19.7	23.0	23.8	28.2	28.8
3200.	12.4	12.1	12.1	12.1	12.0	11.3	10.8	12.3	28.2	25.0	22.9	20.5	17.3	19.3	19.6	24.3	25.7
3000.	11.5	11.3	11.3	11.3	11.1	10.5	10.0	11.4	25.4	20.6	18.8	17.9	15.6	17.0	17.3	19.8	21.3
2800.	10.7	10.4	10.4	10.4	10.3	9.8	9.4	10.5	21.2	17.5	16.7	15.8	11.9	15.3	15.5	17.3	17.8
2600.	9.9	9.7	9.7	9.7	9.6	9.2	8.9	9.8	17.5	15.5	14.9	14.4	6.5	13.2	14.0	15.2	15.8
2400.	9.3	9.1	9.1	9.1	9.0	8.6	7.9	9.2	15.6	14.0	13.5	11.5	******	8.4	9.5	13.9	14.2
2200.	8.7	8.5	8.5	8.5	8.5	8.1	6.0	8.6	14.0	12.6	9.9	6.9	******	3.6	4.7	11.8	12.9
2000.	7.1	7.0	7.0	7.0	6.9	6.5	4.2	7.1	12.7	8.4	5.5	2.3	******	******	******	7.5	9.3
1800.	5.2	5.1	5.1	5.1	5.0	4.7	2.3	5.2	9.9	4.2	******	******	******	******	******	3.2	5.1
1600.	3.3	3.2	3.2	3.2	3.2	3.0	******	3.3	5.9	******	******	******	******	******	******	******	******
1400.	2.4	2.3	2.3	2.3	2.3	2.2	******	2.4	2.0	******	******	******	******	******	******	******	******
1200.	1.2	1.2	1.2	1.2	1.2	******	******	1.2	******	******	******	******	******	******	******	******	******
1000.	0.1	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
800.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
600.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
400.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
200.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******

Table 3.1i. - TARGETING MODEL Upwind sounding YrMoDaHr=87022512
Model V-comp(135.0 deg) m/s.

8000.	-4.6	-4.4	-4.4	-4.4	-4.3	-3.6	-2.7	-4.5	-8.2	-7.6	-7.2	-6.9	-5.9	-6.6	-6.7	-7.5	-7.7
7800.	-1.6	-1.3	-1.3	-1.3	-1.2	-0.4	0.8	-1.5	-6.0	-5.2	-4.8	-4.4	-3.1	-4.0	-4.1	-5.0	-5.3
7600.	1.4	1.8	1.8	1.8	1.9	2.9	4.2	1.6	-3.7	-2.8	-2.3	-1.9	-0.4	-1.4	-1.6	-2.6	-2.9
7400.	4.1	4.1	4.1	4.1	4.1	4.0	3.8	4.1	-1.4	-0.4	0.1	0.6	2.3	1.2	1.0	-0.2	-0.5
7200.	3.8	3.8	3.8	3.8	3.8	3.6	3.5	3.8	0.9	2.0	2.6	3.2	4.1	3.8	3.6	2.2	1.9
7000.	3.5	3.5	3.5	3.5	3.4	3.3	3.1	3.5	3.1	4.1	4.1	4.0	3.8	3.9	4.0	4.1	4.2
6800.	3.2	3.2	3.2	3.2	3.1	3.0	2.8	3.2	4.0	3.9	3.8	3.7	3.5	3.7	3.7	3.9	3.9
6600.	2.9	2.8	2.8	2.8	2.8	2.7	2.5	2.9	3.8	3.6	3.6	3.5	3.2	3.4	3.4	3.6	3.7
6400.	2.7	2.6	2.6	2.6	2.6	2.5	2.3	2.6	3.6	3.4	3.3	3.2	2.9	3.1	3.2	3.4	3.4
6200.	2.4	2.4	2.4	2.4	2.4	2.2	2.0	2.4	3.3	3.1	3.0	2.9	2.7	2.9	2.9	3.1	3.2
6000.	2.2	2.2	2.2	2.2	2.1	2.0	2.3	2.2	3.1	2.9	2.8	2.7	2.5	2.6	2.7	2.8	2.9
5800.	2.0	2.0	2.0	2.0	2.1	2.3	2.6	2.0	2.8	2.7	2.6	2.5	2.3	2.4	2.5	2.7	2.7
5600.	2.3	2.4	2.4	2.4	2.4	2.7	3.0	2.3	2.7	2.5	2.4	2.3	2.1	2.2	2.3	2.5	2.5
5400.	2.7	2.7	2.7	2.7	2.8	3.1	3.1	2.7	2.5	2.3	2.2	2.1	2.1	2.0	2.1	2.3	2.3
5200.	3.0	3.1	3.1	3.1	3.2	3.1	2.8	3.1	2.3	2.1	2.0	2.0	2.5	2.1	2.1	2.1	2.1
5000.	3.1	3.1	3.1	3.1	3.0	2.8	2.6	3.1	2.1	2.0	2.2	2.3	2.8	2.5	2.4	2.1	2.0
4800.	2.9	2.8	2.8	2.8	2.8	2.6	2.3	2.8	2.0	2.3	2.5	2.6	3.1	2.8	2.7	2.4	2.3
4600.	2.6	2.6	2.6	2.6	2.5	2.4	2.1	2.6	2.3	2.6	2.8	2.9	3.0	3.1	3.0	2.7	2.6
4400.	2.4	2.3	2.3	2.3	2.3	2.1	1.9	2.3	2.6	2.9	3.1	3.2	2.6	3.0	3.1	3.0	2.9
4200.	2.1	2.0	2.0	2.1	2.0	1.9	1.7	2.1	2.9	3.2	3.1	2.9	2.4	2.7	2.8	3.2	3.2
4000.	1.8	1.8	1.8	1.8	1.8	1.7	1.8	1.9	3.1	2.9	2.7	2.5	2.4	2.4	2.4	2.9	3.0
3800.	1.6	1.6	1.6	1.6	1.7	1.8	2.0	1.7	3.0	2.6	2.4	2.3	2.4	2.4	2.4	2.5	2.6
3600.	1.8	1.8	1.8	1.8	1.9	1.9	2.2	1.9	2.7	2.3	2.1	2.1	2.4	2.4	2.4	2.4	2.4
3400.	2.0	2.0	2.0	2.0	2.0	2.1	2.3	2.1	2.4	2.0	1.9	2.1	2.4	2.4	2.4	2.4	2.4
3200.	2.2	2.2	2.2	2.2	2.2	2.3	2.5	2.2	2.1	1.9	2.1	2.2	2.4	2.4	2.4	2.4	2.4
3000.	2.4	2.4	2.4	2.4	2.4	2.5	2.6	2.4	1.8	2.1	2.3	2.4	2.4	2.4	2.4	2.4	2.4
2800.	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.0	2.3	2.5	2.5	2.4	2.4	2.4	2.4	2.4
2600.	2.6	2.6	2.6	2.6	2.6	2.6	2.4	2.6	2.3	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4
2400.	2.5	2.5	2.5	2.5	2.5	2.4	2.5	2.5	2.5	2.5	2.4	2.5	******	2.4	2.4	2.4	2.4
2200.	2.3	2.3	2.3	2.3	2.3	2.3	3.1	2.3	2.6	2.3	2.8	3.1	******	2.4	2.4	2.4	2.4
2000.	2.8	2.8	2.8	2.8	2.8	2.8	3.6	2.7	2.4	3.0	3.4	3.6	******	******	******	2.4	2.4
1800.	3.5	3.5	3.5	3.4	3.4	3.4	4.2	3.3	2.7	3.7	******	******	******	******	******	2.4	2.4
1600.	4.1	4.1	4.1	4.1	4.0	4.0	******	3.8	3.5	******	******	******	******	******	******	******	******
1400.	3.1	3.1	3.1	3.1	3.1	3.1	******	3.0	4.2	******	******	******	******	******	******	******	******
1200.	2.5	2.5	2.5	2.5	2.5	******	******	2.5	******	******	******	******	******	******	******	******	******
1000.	1.8	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
800.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
600.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
400.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******
200.	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******	******

Table 3.1j. - TARGETING MODEL Upwind sounding YrMoDaHr=87022512
Model Orog Vert. Vel. (m/s) printed at downwind end
of 10 km increment over which it applies.

```
8000. 0.07 0.07 0.00 0.00 0.04 0.22 0.32 -0.58 -1.08 0.23 0.10 0.11 0.37 -0.23 -0.04 -0.24 -0.07
7800. 0.08 0.09 0.00 0.00 0.05 0.26 0.38 -0.69 -1.28 0.26 0.12 0.13 0.43 -0.27 -0.04 -0.28 -0.08
7600. 0.10 0.10 0.00 0.00 0.06 0.30 0.44 -0.80 -1.48 0.30 0.14 0.14 0.49 -0.31 -0.05 -0.32 -0.09
7400. 0.11 0.11 0.00 0.00 0.07 0.32 0.45 -0.89 -1.67 0.34 0.15 0.16 0.55 -0.35 -0.06 -0.37 -0.10
7200. 0.11 0.11 0.00 0.00 0.07 0.32 0.45 -0.89 -1.87 0.38 0.17 0.18 0.59 -0.39 -0.06 -0.41 -0.11
7000. 0.11 0.11 0.00 0.00 0.07 0.32 0.45 -0.90 -2.07 0.41 0.18 0.19 0.60 -0.40 -0.07 -0.44 -0.12
6800. 0.11 0.11 0.00 0.00 0.07 0.33 0.45 -0.90 -2.16 0.41 0.18 0.19 0.60 -0.40 -0.07 -0.44 -0.12
6600. 0.11 0.11 0.00 0.00 0.07 0.32 0.44 -0.90 -2.16 0.41 0.18 0.19 0.60 -0.40 -0.07 -0.44 -0.12
6400. 0.11 0.11 0.00 0.00 0.07 0.31 0.42 -0.88 -2.16 0.41 0.18 0.19 0.60 -0.40 -0.07 -0.44 -0.12
6200. 0.10 0.10 0.00 0.00 0.06 0.30 0.41 -0.86 -2.16 0.41 0.18 0.19 0.59 -0.41 -0.07 -0.44 -0.12
6000. 0.10 0.10 0.00 0.00 0.06 0.29 0.42 -0.83 -2.16 0.41 0.18 0.19 0.57 -0.39 -0.07 -0.44 -0.12
5800. 0.10 0.10 0.00 0.00 0.06 0.31 0.45 -0.81 -2.16 0.40 0.17 0.18 0.56 -0.38 -0.06 -0.43 -0.12
5600. 0.10 0.10 0.00 0.00 0.06 0.32 0.47 -0.86 -2.11 0.39 0.17 0.18 0.54 -0.37 -0.06 -0.41 -0.11
5400. 0.11 0.11 0.00 0.00 0.07 0.34 0.48 -0.90 -2.06 0.38 0.16 0.17 0.54 -0.36 -0.06 -0.40 -0.11
5200. 0.11 0.12 0.00 0.00 0.07 0.34 0.47 -0.95 -2.00 0.37 0.15 0.17 0.56 -0.37 -0.06 -0.38 -0.11
5000. 0.11 0.11 0.00 0.00 0.07 0.31 0.47 -0.95 -1.95 0.36 0.16 0.17 0.59 -0.38 -0.06 -0.38 -0.11
4800. 0.11 0.11 0.00 0.00 0.06 0.29 0.46 -0.92 -1.92 0.38 0.17 0.18 0.61 -0.40 -0.06 -0.40 -0.11
4600. 0.10 0.10 0.00 0.00 0.06 0.27 0.44 -0.89 -2.00 0.39 0.17 0.19 0.80 -0.41 -0.07 -0.42 -0.11
4400. 0.10 0.09 0.00 0.00 0.06 0.24 0.43 -0.85 -2.08 0.41 0.18 0.20 1.07 -0.52 -0.08 -0.44 -0.12
4200. 0.09 0.08 0.00 0.00 0.05 0.21 0.41 -0.79 -2.16 0.42 0.23 0.27 1.25 -0.70 -0.11 -0.48 -0.12
4000. 0.07 0.07 0.00 0.00 0.04 0.18 0.38 -0.73 -2.24 0.58 0.30 0.35 1.15 -0.85 -0.14 -0.66 -0.16
3800. 0.06 0.06 0.00 0.00 0.04 0.15 0.34 -0.66 -2.38 0.74 0.38 0.37 1.02 -0.79 -0.13 -0.84 -0.21
3600. 0.05 0.05 0.00 0.00 0.03 0.12 0.31 -0.58 -2.55 0.82 0.36 0.35 0.84 -0.71 -0.12 -0.89 -0.25
3400. 0.04 0.04 0.00 0.00 0.02 0.10 0.29 -0.51 -2.70 0.75 0.33 0.31 0.75 -0.60 -0.10 -0.83 -0.23
3200. 0.03 0.03 0.00 0.00 0.02 0.08 0.28 -0.43 -2.20 0.66 0.28 0.26 0.68 -0.52 -0.09 -0.74 -0.21
3000. 0.03 0.03 0.00 0.00 0.01 0.06 0.26 -0.40 -1.71 0.55 0.24 0.23 0.63 -0.47 -0.08 -0.62 -0.18
2800. 0.02 0.02 0.00 0.00 0.01 0.05 0.25 -0.36 -1.26 0.48 0.22 0.21 0.49 -0.43 -0.07 -0.55 -0.15
2600. 0.02 0.02 0.00 0.00 0.01 0.04 0.24 -0.33 -0.85 0.43 0.20 0.20 0.28 -0.38 -0.07 -0.50 -0.14
2400. 0.01 0.01 0.00 0.00 0.01 0.03 0.22 -0.30 -0.64 0.40 0.18 0.16****** -0.25 -0.05 -0.46 -0.13
2200. 0.01 0.01 0.00 0.00 0.01 0.02 0.17 -0.28 -0.45 0.36 0.14 0.10****** -0.12 -0.02 -0.40 -0.12
2000. 0.01 0.01 0.00 0.00 0.00 0.02 0.12 -0.22 -0.30 0.24 0.08 0.04******************-0.26 -0.09
1800. 0.00 0.00 0.00 0.00 0.00 0.01 0.07 -0.16 -0.17 0.12******************************-0.12 -0.05
1600. 0.00 0.00 0.00 0.00 0.00 0.00****** -0.10 -0.05************************************************
1400. 0.00 0.00 0.00 0.00 0.00 0.00****** 0.00 0.07************************************************
1200. 0.00 0.00 0.00 0.00 0.00************ 0.00******************************************************
1000. 0.00************************************************************************************************
 800.*****************************************************************************************************
 600.*****************************************************************************************************
 400.*****************************************************************************************************
 200.*****************************************************************************************************
```

```
Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/N
            MODLFLO.DAT                  AAIM/AGM run 92/ 5/11 13:01:30
1=Seeding method
          MODEL FLOW CHANNEL DATA
      model boundary conditions:
        JHMAX  JDWS  JDWUNS  MTNCRST,MAXFLCHN,IBASE DELXKM
          17     12     0      13      12     2   10.0
ZELEV=  620. 1000.  900. 1000. 1120. 1400. 1750. 1000. 1400. 1750. 1900. 2050. 2500.
2200. 2150. 1800. 1700.
```

Table 3.1k. - Pressure (mb).

level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
12	325.	325.	325.	325.	324.	323.	322.	325.	335.	333.	332.	331.	328.	330.	330.	332.	333.
11	375.	374.	374.	374.	373.	370.	365.	374.	404.	398.	395.	392.	384.	389.	390.	397.	398.
10	425.	423.	423.	423.	422.	416.	408.	424.	474.	463.	458.	453.	439.	448.	450.	461.	464.
9	475.	472.	472.	472.	470.	462.	452.	474.	543.	528.	521.	514.	495.	508.	510.	525.	530.
8	525.	521.	521.	521.	519.	509.	495.	523.	613.	593.	584.	576.	551.	567.	570.	590.	595.
7	575.	571.	571.	571.	569.	559.	543.	573.	658.	635.	626.	616.	588.	606.	610.	632.	639.
6	625.	622.	622.	622.	620.	612.	593.	624.	693.	669.	658.	648.	616.	637.	640.	665.	672.
5	675.	673.	673.	673.	671.	665.	643.	674.	728.	702.	691.	679.	645.	667.	671.	698.	706.
4	725.	723.	723.	723.	722.	718.	693.	724.	763.	736.	723.	710.	674.	698.	702.	731.	740.
3	775.	774.	774.	774.	773.	771.	743.	775.	798.	769.	755.	742.	702.	728.	733.	764.	773.
2	825.	825.	825.	825.	824.	824.	794.	825.	833.	802.	788.	773.	731.	759.	764.	798.	807.

Table 3.1l. - HEIGHT (KM).

12	8380.	8389.	8389.	8389.	8394.	8418.	8449.	8385.	8192.	8238.	8257.	8276.	8333.	8296.	8289.	8244.	8232.
11	7421.	7444.	7444.	7444.	7458.	7522.	7605.	7433.	6908.	7024.	7072.	7121.	7267.	7171.	7154.	7040.	7008.
10	6566.	6599.	6599.	6599.	6620.	6715.	6840.	6583.	5812.	5981.	6053.	6125.	6342.	6198.	6174.	6005.	5957.
9	5794.	5837.	5837.	5837.	5863.	5986.	6148.	5815.	4831.	5048.	5133.	5225.	5500.	5317.	5286.	5078.	5017.
8	5078.	5129.	5129.	5129.	5160.	5308.	5502.	5103.	3942.	4193.	4300.	4409.	4729.	4514.	4477.	4228.	4158.
7	4413.	4459.	4459.	4459.	4486.	4616.	4834.	4436.	3406.	3672.	3789.	3902.	4254.	4020.	3980.	3711.	3634.
6	3794.	3829.	3829.	3829.	3850.	3948.	4184.	3811.	3012.	3283.	3405.	3529.	3899.	3654.	3612.	3324.	3243.
5	3213.	3238.	3238.	3238.	3254.	3326.	3578.	3226.	2634.	2912.	3040.	3171.	3559.	3299.	3255.	2954.	2869.
4	2665.	2682.	2682.	2682.	2693.	2741.	3009.	2673.	2267.	2554.	2686.	2821.	3229.	2959.	2913.	2598.	2509.
3	2145.	2155.	2155.	2155.	2161.	2189.	2470.	2150.	1916.	2206.	2345.	2487.	2911.	2631.	2582.	2252.	2160.
2	1651.	1655.	1655.	1655.	1657.	1666.	1960.	1653.	1575.	1872.	2017.	2161.	2604.	2309.	2260.	1920.	1824.

Table 3.1m. - TEMPERATURE (C).

12	-47.	-47.	-47.	-47.	-47.	-47.	-48.	-47.	-46.	-46.	-46.	-46.	-47.	-47.	-47.	-46.	-46.
11	-41.	-41.	-41.	-41.	-41.	-42.	-42.	-41.	-40.	-40.	-40.	-40.	-41.	-41.	-40.	-40.	-40.
10	-39.	-39.	-39.	-39.	-39.	-39.	-40.	-39.	-33.	-34.	-35.	-36.	-37.	-36.	-36.	-35.	-34.
9	-33.	-33.	-33.	-33.	-33.	-34.	-36.	-33.	-25.	-27.	-27.	-28.	-30.	-29.	-29.	-27.	-26.
8	-27.	-27.	-27.	-27.	-27.	-29.	-30.	-27.	-19.	-20.	-21.	-22.	-24.	-22.	-22.	-20.	-20.
7	-22.	-22.	-22.	-22.	-22.	-23.	-25.	-22.	-15.	-17.	-18.	-18.	-21.	-19.	-19.	-17.	-17.
6	-18.	-18.	-18.	-18.	-18.	-19.	-20.	-18.	-12.	-14.	-15.	-16.	-18.	-17.	-16.	-14.	-14.
5	-14.	-14.	-14.	-14.	-14.	-14.	-16.	-14.	-9.	-11.	-12.	-13.	-16.	-14.	-14.	-12.	-11.
4	-9.	-10.	-10.	-10.	-10.	-10.	-12.	-10.	-7.	-9.	-10.	-11.	-14.	-12.	-11.	-9.	-8.
3	-6.	-6.	-6.	-6.	-6.	-6.	-8.	-6.	-4.	-6.	-7.	-8.	-11.	-9.	-9.	-6.	-6.
2	-2.	-2.	-2.	-2.	-2.	-2.	-4.	-2.	-2.	-4.	-5.	-6.	-9.	-7.	-7.	-4.	-3.

Table 3.1n. - DEWPOINT (C).

12	-77.	-77.	-77.	-77.	-77.	-77.	-78.	-77.	-76.	-76.	-76.	-76.	-77.	-77.	-77.	-76.	-76.
11	-71.	-71.	-71.	-71.	-71.	-72.	-72.	-71.	-56.	-59.	-61.	-62.	-66.	-64.	-63.	-60.	-59.
10	-46.	-47.	-47.	-47.	-47.	-50.	-54.	-46.	-41.	-42.	-43.	-43.	-44.	-44.	-43.	-43.	-42.
9	-41.	-42.	-42.	-42.	-42.	-42.	-43.	-41.	-37.	-38.	-39.	-39.	-40.	-39.	-39.	-38.	-38.
8	-38.	-39.	-39.	-39.	-39.	-39.	-40.	-39.	-26.	-30.	-32.	-34.	-36.	-35.	-34.	-31.	-29.
7	-34.	-34.	-34.	-34.	-34.	-35.	-37.	-34.	-17.	-21.	-23.	-25.	-31.	-27.	-26.	-22.	-21.
6	-23.	-24.	-24.	-24.	-24.	-26.	-30.	-23.	-13.	-16.	-17.	-19.	-25.	-21.	-20.	-16.	-15.
5	-15.	-15.	-15.	-15.	-15.	-16.	-20.	-15.	-10.	-12.	-13.	-14.	-20.	-16.	-15.	-13.	-12.
4	-10.	-10.	-10.	-10.	-10.	-11.	-13.	-10.	-7.	-9.	-10.	-12.	-15.	-13.	-12.	-10.	-9.
3	-6.	-6.	-6.	-6.	-6.	-7.	-9.	-6.	-5.	-7.	-8.	-9.	-12.	-10.	-10.	-7.	-6.
2	-3.	-3.	-3.	-3.	-3.	-3.	-5.	-3.	-2.	-4.	-5.	-6.	-10.	-8.	-7.	-5.	-4.

Table 3.1o. - THETA (K).

12	312.	312.	312.	312.	312.	312.	312.	312.	311.	311.	311.	311.	311.	311.	311.	311.	311.
11	307.	307.	307.	307.	307.	308.	308.	307.	302.	303.	304.	304.	306.	305.	305.	304.	303.
10	299.	299.	299.	299.	299.	300.	302.	299.	297.	298.	298.	298.	298.	298.	298.	298.	298.
9	297.	297.	297.	297.	297.	298.	298.	297.	296.	296.	296.	296.	297.	297.	297.	296.	296.
8	296.	296.	296.	296.	296.	297.	297.	296.	293.	294.	294.	295.	295.	295.	295.	294.	294.
7	295.	295.	295.	295.	295.	295.	296.	295.	291.	292.	292.	293.	294.	293.	293.	292.	292.
6	292.	292.	292.	292.	292.	293.	294.	292.	290.	291.	291.	291.	293.	292.	292.	291.	290.
5	290.	290.	290.	290.	291.	291.	292.	290.	289.	290.	290.	290.	291.	291.	291.	290.	290.
4	289.	289.	289.	289.	289.	289.	290.	289.	288.	289.	289.	289.	290.	290.	290.	289.	289.
3	288.	288.	288.	288.	288.	288.	289.	288.	287.	288.	288.	289.	290.	289.	289.	288.	288.
2	286.	286.	286.	286.	287.	287.	287.	286.	286.	287.	287.	288.	289.	288.	288.	287.	287.

Table 3.1p. - THETA E (K).

12	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.
11	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	302.	303.	304.	304.	306.	305.	305.	304.	303.
10	299.	300.	300.	300.	300.	301.	302.	300.	298.	298.	299.	299.	299.	299.	299.	298.	298.
9	298.	298.	298.	298.	298.	298.	299.	298.	297.	297.	297.	297.	298.	297.	297.	297.	297.
8	297.	297.	297.	297.	297.	297.	298.	297.	295.	296.	296.	296.	297.	296.	296.	296.	296.
7	296.	296.	296.	296.	296.	296.	297.	296.	296.	295.	295.	295.	296.	295.	295.	295.	295.
6	295.	295.	295.	295.	295.	295.	296.	295.	296.	296.	296.	295.	295.	295.	295.	296.	296.
5	296.	296.	296.	296.	296.	296.	295.	296.	296.	296.	296.	296.	295.	296.	296.	296.	296.
4	296.	296.	296.	296.	296.	296.	296.	296.	296.	296.	296.	296.	296.	296.	296.	296.	296.
3	297.	297.	297.	297.	297.	297.	296.	297.	297.	297.	296.	296.	296.	296.	296.	296.	297.
2	297.	297.	297.	297.	297.	297.	297.	297.	297.	297.	297.	297.	296.	296.	296.	297.	297.

Table 3.1q. - MIXING RATIO (G/KG).

12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.3
8	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.8	0.5	0.5	0.4	0.3	0.4	0.4	0.5	0.6
7	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.4	1.5	1.1	1.0	0.8	0.5	0.7	0.7	1.1	1.2
6	1.0	0.9	0.9	0.9	0.9	0.8	0.5	0.9	2.0	1.7	1.5	1.3	0.8	1.1	1.2	1.6	1.8
5	1.8	1.8	1.8	1.8	1.8	1.6	1.2	1.8	2.4	2.1	2.0	1.9	1.3	1.7	1.8	2.1	2.2
4	2.4	2.4	2.4	2.4	2.4	2.3	2.0	2.4	2.9	2.5	2.4	2.2	1.8	2.1	2.1	2.5	2.6
3	3.1	3.1	3.1	3.1	3.1	3.0	2.6	3.1	3.4	3.0	2.8	2.6	2.1	2.5	2.5	2.9	3.1
2	3.8	3.8	3.8	3.8	3.8	3.8	3.3	3.8	3.8	3.5	3.3	3.1	2.5	2.9	2.9	3.4	3.5

Table 3.1r. - HUMIDITY (PERCENT).

12	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
11	3.	2.	2.	2.	2.	2.	2.	2.	17.	11.	9.	8.	5.	7.	7.	11.	12.
10	50.	45.	45.	45.	42.	31.	21.	47.	43.	44.	45.	45.	48.	46.	46.	44.	44.
9	42.	43.	43.	43.	43.	44.	46.	43.	32.	32.	33.	34.	38.	35.	35.	32.	32.
8	32.	33.	33.	33.	33.	35.	38.	33.	54.	41.	36.	32.	32.	32.	32.	39.	43.
7	32.	32.	32.	32.	32.	32.	32.	32.	82.	69.	64.	57.	38.	50.	52.	67.	71.
6	64.	61.	61.	61.	60.	54.	41.	62.	93.	89.	82.	76.	57.	70.	72.	87.	91.
5	93.	91.	91.	91.	91.	87.	74.	92.	94.	94.	93.	93.	75.	88.	90.	93.	94.
4	94.	94.	94.	94.	94.	94.	93.	94.	95.	94.	94.	94.	92.	93.	94.	94.	95.
3	96.	96.	96.	96.	96.	96.	95.	96.	95.	96.	95.	95.	94.	94.	94.	95.	96.
2	94.	95.	95.	95.	95.	95.	95.	94.	94.	95.	95.	96.	94.	95.	95.	95.	95.

FLOMID	360.	364.	364.	364.	366.	378.	392.	362.	266.	288.	297.	306.	332.	315.	312.	291.	285.
FLOMIDN	360.	364.	364.	364.	366.	378.	392.	362.	266.	288.	297.	306.	332.	315.	312.	291.	285.
ZVALF	0.	10.	10.	10.	16.	44.	80.	5.	44.	80.	95.	110.	154.	125.	120.	85.	75.

3.2 Airborne Seeding Simulations

Sections 3.2.1-3.2.4 give examples of airborne seeding simulations for wingtip AgI-Acetone generators, AgI flares, and dry ice respectively. In these runs the seeding aircraft flight level was specified at 10,000 ft m.s.l., LWC was specified at 0.5 mm, and the default option for stable flow channels was selected. Note that model inputs and outputs that deal with aircraft flight levels use altitudes in feet m.s.l. and distances in nautical miles (n. mi.) because these are the standard aviation units of measure. Normally the model user will specify the seeding flight level that he/she thinks best suits a particular set of observations. He/she would either specify aircraft flight levels in the region of SLW at the -6 °C to -12 °C level for wingtip seeding or at least 1200 m above the -6 °C level for droppable AgI flares. Dry ice seeding may be performed at lower levels depending on the cloud top temperatures and depth of clouds. The model user may run several iterative simulations to determine the best altitude for seeding. Similarly, the LWC should be specified based on observations from radiometer, aircraft, or surface observations of ice crystals. If riming is occurring, then LWC should be specified. The model is not very sensitive to the quantity of LWC, but whether or not it is specified determines the riming growth factor.

3.2.1 *Aircraft seeding with wingtip acetone (AgI) generators.* –

User:

run AAIM

Model:

Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/3

AAIM/AGM run 91/ 6/26 21:44:07

Name file from which prepared user responses are to be read, or if interactive start by choosing how much you want in the print file by entering:
0 = Q-point parameters, model wind dir. and speed, or
1 = default = all of 0, + target crystal trajectory information, or
2 = all of 1, + U,V,W model wind fields, or
3 = all of 2, + curtain trajectory parameters.

3

Select the desired seeding method:
1=g=G= Ground seeding
2=a=A= aircraft seeding, wingtip Acetone generators
3=f=F= aircraft seeding, pyrotechnic Flares
4=d=D= aircraft seeding, Dry ice

a (or 2, or A)

Under the values shown, please enter (No commas!) any changes to the following:
(To remove and Not replace an used sounding, put a . in the ID field.)
(1 and 2) Upwind sounding YrMoDaHr and sounding site ID,
(3 and 4) Downwind Sounding YrMoDaHr and sounding site ID,
(5th) Altitude of seeder aircraft (ft) (if not ground),
(6th) Radiometric liquid water content (mm), then

(last) 1 to select or 0 to skip other options
[--Upwind--] [-Downwind-]   (blank implies none or 0)
YrMoDaHr Sit YrMoDaHr Sit Alt.Ft. LqWmm o
     0   0   0.0   0.0 0=retained values if not changed

87021512 CVR   10000.   0.5 0

tentative output file name is AFL872FC.10   Enter any distinctive final character if wanted to distinguish similar versions

a

output file is named AFL872FC.10A
0=KEYWIND, and 0=KEYSTAB=stability parameterization=stable
KEYWIND =   0
TARGET1 to make initial call to AIRIN
RDNCDC CVR 87 21612 line   1 BuRec RAWIN style proj. sounding
FLOWCHAN(751.96=PDEAD,   1=KEYPRMDL) just entered
FLOWCHN making initial call to AIRIN
MIDCHAN just entered
MAKGRID(751.96=PDEAD) just entered
TEMPGRD just entered
QPOINT just entered
QPOINT: 135.000=XTARG 100.000=YTARG
FALLVEL(-7.4=TNOW,   60.0=TTIME, 0=IHABIT,...) entered
CURTAN3 just entered: 0.50=RADLWC   0.00   0.00=XQPT,YQPT
PRINTER just entered
AGM run files were the following:
3= LUGENR = seeding generator locations: GENSTA.LOC
11= LU LOG = model runtime specifications: AGMINP.LOG
12=LU STATS= 1st, min Temp, last lines: AGMSTATS.GEN
4= LUWARN =model run diagnostic debug info: ADIAG.DAT
2= LUOUTP = standard output tables: AFL872FC.10A plus appended and deleted
10= LUMODL = model flow channel structure: MODLFLO.DAT
7= LU ZZ = crystal trajectory info.   :   ZZ.PLT
9= LU PLT = graphics plotting files: GUIDCD.PLT
Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/3 run done

This completes the model simulation. The model results are written to the above files as noted in the final table showing unit numbers and file names. The standard set of tables that present results to the user are in the "AFL872FC.10A" file. The user should list this file to examine results. Graphical plots that summarize important features of the simulation may be viewed by running the CRYSPLTS graphics package.

3.2.2 *Aircraft Seeding with Pyrotechnic Flares.* –

User:

run AAIM

Model:

Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/3
AAIM/AGM run 91/ 6/26 21:46:14
Name file from which prepared user responses are to be read, or if interactive
start by choosing how much you want in the print file by entering:

0 = Q-point parameters, model wind dir. and speed, or
1 = default = all of 0, + target crystal trajectory information, or
2 = all of 1, + U,V,W model wind fields, or
3 = all of 2, + curtain trajectory parameters.

1

Select the desired seeding method:
1=g=G= Ground seeding
2=a=A= aircraft seeding, wingtip Acetone generators
3=f=F= aircraft seeding, pyrotechnic Flares
4=d=D= aircraft seeding, Dry ice

3 (or f, or F)

Under the values shown, please enter (No commas!) any changes to the following:
(To remove and Not replace an used sounding, put a . in the ID field.)
(1 and 2) Upwind sounding YrMoDaHr and sounding site ID,
(3 and 4) Downwind Sounding YrMoDaHr and sounding site ID,
(5th) Altitude of seeder aircraft (ft) (if not ground),
(6th) Radiometric liquid water content (mm), then
(last) 1 to select or 0 to skip other options
[--Upwind--] [-Downwind-] (blank implies none or 0)
YrMoDaHr Sit YrMoDaHr Sit Alt.Ft. LqWmm o
0 0 0.0 0.0 0=retained values if not changed

87021512 cvr 0 10000.0 0.5 0

In this case the seeding altitude was set at 10,000 ft msl and the user estimated 0.5 g/m^3 of liquid water.

tentative output file name is "AFL872FC.20" Enter any distinctive
final character if wanted to distinguish similar versions

b

output file is named AFL872FC.20B
0=KEYWIND, and 0=KEYSTAB=stability parameterization=stable
KEYWIND = 0
TARGET1 to make initial call to AIRIN
RDNCDC CVR 87 21612 line 1 BuRec RAWIN style proj. sounding
FLOWCHAN(751.96=PDEAD, 1=KEYPRMDL) just entered
FLOWCHN making initial call to AIRIN
MIDCHAN just entered
MAKGRID(751.96=PDEAD) just entered
TEMPGRD just entered
QPOINT just entered
QPOINT: 135.000=XTARG 100.000=YTARG
FALLVEL(-5.5=TNOW, 60.0=TTIME, 0=IHABIT,...) entered

CURTAIN just entered: 0.50=RADLWC 0.00 0.00=XQPT,YQPT
PRINTER just entered
AGM run files were the following:
3= LUGENR = seeding generator locations: GENSTA.LOC
11= LU LOG = model runtime specifications: AGMINP.LOG
12=LU STATS= 1st, min Temp, last lines: AGMSTATS.GEN
4= LUWARN =model run diagnostic debug info: ADIAG.DAT
2= LUOUTP = standard output tables: AFL872FC.20B plus appended and deleted
10= LUMODL = model flow channel structure: MODLFLO.DAT
7= LU ZZ = crystal trajectory info. : ZZ.PLT

9= LU PLT = graphics plotting files: GUIDCD.PLT
Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/3 run done

3.2.3 *Aircraft Seeding with Dry Ice* (CO_2). –

User:

run AAIM

Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/3
AAIM/AGM run 91/ 6/26 21:48:43
Name file from which prepared user responses are to be read, or if interactive start by choosing how much you want in the print file by entering:
0 = Q-point parameters, model wind dir. and speed, or
1 = default = all of 0, + target crystal trajectory information, or
2 = all of 1, + U,V,W model wind fields, or
3 = all of 2, + curtain trajectory parameters.

Select the desired seeding method:
1=g=G= Ground seeding
2=a=A= aircraft seeding, wingtip Acetone generators
3=f=F= aircraft seeding, pyrotechnic Flares
4=d=D= aircraft seeding, Dry ice

4 (or d, or D)

Under the values shown, please enter (No commas!) any changes to the following:
(To remove and Not replace an used sounding, put a . in the ID field.)
(1 and 2) Upwind sounding YrMoDaHr and sounding site ID,
(3 and 4) Downwind Sounding YrMoDaHr and sounding site ID,
(5th) Altitude of seeder aircraft (ft) (if not ground),
(6th) Radiometric liquid water content (mm), then
(last) 1 to select or 0 to skip other options
[--Upwind--] [-Downwind-] (blank implies none or 0)
YrMoDaHr Sit YrMoDaHr Sit Alt.Ft. LqWmm o
0 0 0.0 0.0 0=retained values if not changed

87021512 CVR 0 10000.0 0.5 0

tentative output file name is AFL872FC.30 Enter any distinctive final character if wanted to distinguish similar versions

c

output file is named AFL872FC.30C
0=KEYWIND, and 0=KEYSTAB=stability parameterization=stable
KEYWIND = 0
TARGET1 to make initial call to AIRIN
RDNCDC CVR 87 21612 line 1 BuRec RAWIN style proj. sounding
FLOWCHAN(751.96=PDEAD, 1=KEYPRMDL) just entered
FLOWCHN making initial call to AIRIN
MIDCHAN just entered
MAKGRID(751.96=PDEAD) just entered
TEMPGRD just entered
QPOINT just entered
QPOINT: 135.000=XTARG 100.000=YTARG

```
FALLVEL( -5.5=TNOW,   60.0=TTIME, 0=IHABIT,...) entered
CURTAIN just entered: 0.50=RADLWC    0.00    0.00=XQPT,YQPT
  PRINTER just entered
AGM run files were the following:
  3= LUGENR = seeding generator locations: GENSTA.LOC
 11= LU LOG = model runtime specifications: AGMINP.LOG
 12=LU STATS= 1st, min Temp, last lines:  AGMSTATS.GEN
  4= LUWARN =model run diagnostic debug info: ADIAG.DAT
  2= LUOUTP = standard output tables: AFL872FC.30C plus appended and deleted
 10= LUMODL = model flow channel structure: MODLFLO.DAT
  7= LU ZZ  = crystal trajectory info.   :   ZZ.PLT
  9= LU PLT = graphics plotting files:    GUIDCD.PLT
Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/3 run done
```

This concludes the set of examples. The user is encouraged to execute a variety of model simulations and develop a set of specific examples for his/her own applications.

3.2.4 ***Model Output Tabulations for Aircraft Seeding***. – The following table describes output from an aircraft seeding simulation. As in Table 3.1 comments are indicated in *italics and special information is marked by* **bold** *type.*

Table 3.2. - Model output for a simulation of aircraft seeding with Pyrotechnic (AgI) flares.

First, the label for the run indicating the file name "AFL872PC.20" and date and time of the run are printed.

```
Aircraft/Airflow Guide/Generic Microphysics/Model ver. 91/7
        AFL872PC.20          AAIM/AGM run 91/10/31 09:47:24
```

Next, a list of initial conditions for the model run showing the grid orientation at 225°, grid spacing at 10 km, crest location at grid index 13, downwind sounding location at 12, and domain for the grid at 17 by 17 elements. The vertical cross section of the terrain used in the model is listed in the next line from 620 m on the southwest boundary to 1700 m msl on the northeast boundary. The next two lines show the values of FLOMID for stable and neutral-unstable conditions respectively. FLOMID determines the height of the midflow channel above the surface at the upwind sounding. ZVALF, the mean pressure of the terrain above the valley floor, is defined in the next line.

Table 3.2a. - Model design criteria.

```
 GenrLocs for Arizona SF6 airflow
 225  deg section  10. km steps  13=crest  12=DwnWndSta 17 el(m),flomid,zvalv
620 1000 900 1000 1120 1400 1750 1000 1400 1750 1900 2050 2500 2200 2150 1800 1700
350  389 369  377  383  400  423  375  430  361  336  351  395  381  361  326  336
325  355 326  325  332  355  380  275  300  316  311  356  400  331  326  341  331
  0   10  10   10   16   44   80    5   44   80   95  110  154  125  120   85   75
```

This section gives a list of the options selected for the run. It describes the option and the selected value. Options determine the method of seeding, amount of information printed, type of soundings used, specific date time and location of the sounding or a sounding file name, which is retrieved from the data base. Modifications to the sounding or model parameters for nucleation temperature are also set through proper selection of options.

Seeding method 3 - Pyrotechnic flares

3=KEYPRNT: output Qpt params, WDir&Spd; &if>0 CrysTraj info;
&if>1 U,W,V wind fields; &if>2 curtain traj. params.

1=KEYFALL: 0=default=dont (1=do) print trajectory information

1=KEYPRMDL: 1=default=do (0=dont) output model flowchanel structure to MODLFLO.D
AT (appended at end of file)

1=KEYCURT: 1=default=do (0=do no) curtain calculations

0=KEYFIX: 0=fixed target, find Q point; 1=the reverse

0=KEYSTAB: midflow channel stability param.=stable

1=KEYTARG: 0=fixed target center, 1=(default) downwind target

0=KEYWIND: 0=Upwind only, 1=upwind+acft winds, 2=Up+Dwnwind, 3=all

-6.0 -2.0=TEMPNUC,AIRNUCD nucleation temps from ground or CO2/Acetone

0. 0.=DEGMAG,RLTADME mag.dir.(deg), dist (nm) from LTA vortac to Qpt

0. 0.=HEADL,SEEDLIN heading to left (N. in deg.mag.), seedline length (NMi)

nTime USndID nkTime DSndID AltFt RadLWC JDWS MtnCrst dSndSp ZVALF(JDWS & MTN CRST)

87022512 CVR 0 10000.0 0.0 12 13 900.0 110.0 154.0

GRID ORIENTATION: ANGLB, ANGLU, ANGLV, DECL= 45.0 225.0 135.0 -13.0 250.0=TOP

Results from model computations begin at this point in the output file. First the sounding is listed showing information used to initialize the model. This list should be carefully examined to verify that the correct sounding data are used for model analyses.

Table 3.2b. - Initial Sounding.

TARGET1 sounding initiation

CVR 870225 12

MANDATORY AND SIGNIFICANT LEVELS WINDS

	PRES (MBAR)	HGT (M)	T (C)	TD (C)	DIR	SPD (M/S)	HEIGHT (M)	HEIGHT (FT)	DIR	SPEED (M/S)	SPEED (KN)
1	892.	1027.	-0.9	-1.7	160.	1.	1027.	3369.	160.	1.	1.
2	882.	1117.	-0.1	-0.9			1219.	4000.	160.	3.	6.
3	851.	1404.	0.0	-1.4			1829.	6000.	190.	6.	12.
4	850.	1413.	-0.1	-1.5	160.	5.	2134.	7000.	210.	9.	17.
5	811.	1787.	-3.1	-3.5			2438.	8000.	210.	11.	21.
6	700.	2935.	-11.5	-12.4	210.	10.	2743.	9000.	210.	10.	20.
7	659.	3395.	-15.1	-16.0			3658.	12000.	220.	17.	33.
8	647.	3534.	-16.3	-17.3			4267.	14000.	220.	22.	42.
9	606.	4024.	-18.9	-27.9			4877.	16000.	215.	23.	44.
10	595.	4160.	-19.7	-31.7			6096.	20000.	220.	22.	43.
11	546.	4793.	-24.3	-37.3			7620.	25000.	220.	50.	98.
12	500.	5430.	-29.9	-39.9	220.	23.	9144.	30000.	255.	61.	119.
13	490.	5574.	-31.1	-41.1			10668.	35000.	240.	19.	36.
14	436.	6390.	-37.7	-42.0							
15	418.	6680.	-40.1	-48.1							
16	407.	6861.	-40.9	-52.9							
17	405.	6895.	-38.9	-52.9							
18	400.	6980.	-38.9	-58.9	220.	42.					
19	393.	7101.	-38.9	-68.9							
20	338.	8120.	-45.9	-75.9							
21	300.	8900.	-49.5	-79.5	245.	60.					
22	299.	8922.	-49.5	-79.5							
23	250.	10090.	-53.5	-83.5	200.	62.					
24	237.	10433.	-54.7	-84.7							
25	200.	11520.	-52.7	-82.7	235.	42.					
26	191.	11818.	-52.1	-82.1							

This section summarizes model analyses and provides specific information for aircraft operations. The deadlayer, seeding, and research aircraft heights are listed with the Q-point information for pilot navigation using the Prescott VOR.

Table 3.2c. - Aircraft Q-point position information.

Upwind sounding time = 87022512
The height of the dead layer is 1400. m
The pressure at the top of the dead layer is 851. mb
The seeder aircraft height is 3048. m
The height of the research aircraft and Q point was 2748. m

Wind field in this model run is from
Upwind sounding only
Q-pnt PRE mag direction 85. and dist naut mi 43.3
Bearing to Left 292. Bearing to Right 112.
The length of the seeding line is 20. naut. miles

The model coordinates of the seeding line are:

Q point	X = 96. km	Y = 93. km	Z = 2748. m	
right end of seedline	X = 99. km	Y = 75. km	Z = 2748. m	
left end of seedline	X = 92. km	Y = 112. km	Z = 2748. m,	Temp (C) = - 12.2 =TH(14, 11)

This section summarizes the ice crystal information used to determine the Q-point.

The particle fall time was 52. minutes
It fell out 40. km downwind of the Q point at 215. deg from true north
The radiometric liquid water depth was 0.00
The target crystal was an unrimed plate with major axis = 1147. microns
Shear vector TARGTMP level +200m to 2km below 46.deg. 5.m/s

HABITS: 0 = small plate
1 = large plate
3 = dendrite

This table shows the ice crystal development at 1-minute intervals from nucleation to fallout. Strt is the onset time of riming in seconds. End is the time from onset of riming to complete rime coverage.

Table 3.2d. - Ice crystal growth information and aircraft way-points.

Time	Strt	End	Habit	Aaxis	Temp	VT
1.	1000.	1000.	0	20.	-11.8	0.02
2.	1000.	1000.	0	40.	-11.9	0.03
3.	1000.	1000.	0	59.	-12.0	0.04
4.	1000.	1000.	0	92.	-12.1	0.06
5.	1000.	1000.	1	124.	-12.1	0.08
6.	1000.	2000.	1	157.	-12.2	0.10
7.	1000.	2000.	1	189.	-12.3	0.11
8.	1000.	2000.	1	221.	-12.3	0.13
9.	1000.	2000.	1	254.	-12.4	0.14
10.	1000.	2000.	1	286.	-12.4	0.16

Way-points for pilots and flight scientists are listed for every 10 minutes of crystal growth. This information is used for the research aircraft guidance.

106.X km 95.Y km 9282.Z ft way-pt VOR/LTA 79. Mag dir(deg) & 46.4 dist(n mi)

11.	1000.	2000.	1	319.	-12.5	0.17
12.	1000.	2000.	1	351.	-12.5	0.19
13.	1000.	2000.	1	383.	-12.5	0.20
14.	1000.	2000.	1	416.	-12.5	0.22
15.	1000.	2000.	1	448.	-12.5	0.23
16.	1000.	2000.	1	481.	-12.6	0.24
17.	1000.	2000.	1	513.	-12.6	0.26
18.	1000.	2000.	1	545.	-12.7	0.27
19.	1000.	2000.	1	578.	-12.8	0.28
20.	1000.	2000.	1	610.	-12.2	0.30

117.X km 96.Y km 9743.Z ft way-pt VOR/LTA 74. Mag dir(deg) & 50.0 dist(n mi)

21.	1000.	2000.	1	643.	-12.3	0.31
22.	1000.	2000.	1	675.	-12.4	0.32
23.	1000.	2000.	1	707.	-12.5	0.33
24.	1000.	2000.	1	740.	-12.6	0.35
25.	1000.	2000.	1	772.	-12.8	0.36
26.	1000.	2000.	1	805.	-12.4	0.37
27.	1000.	2000.	1	837.	-12.2	0.38
28.	1000.	2000.	1	857.	-12.0	0.39
29.	1000.	2000.	1	877.	-11.7	0.40
30.	1000.	2000.	1	894.	-11.0	0.40

126.X km 98.Y km 8985.Z ft way-pt VOR/LTA 69. Mag dir(deg) & 53.6 dist(n mi)

31.	1000.	2000.	1	911.	-10.6	0.41
32.	1000.	2000.	1	929.	-10.2	0.42
33.	1000.	2000.	1	944.	-9.8	0.42
34.	1000.	2000.	1	959.	-9.4	0.43
35.	1000.	2000.	1	974.	-9.1	0.43
36.	1000.	2000.	1	984.	-8.7	0.44
37.	1000.	2000.	1	994.	-8.5	0.44
38.	1000.	2000.	1	1004.	-8.2	0.45
39.	1000.	2000.	1	1015.	-8.0	0.45
40.	1000.	2000.	1	1025.	-7.8	0.45

134.X km 99.Y km 7665.Z ft way-pt VOR/LTA 66. Mag dir(deg) & 56.6 dist(n mi)

41.	1000.	2000.	1	1035.	-7.6	0.46
42.	1000.	2000.	1	1045.	-7.4	0.46
43.	1000.	2000.	1	1055.	-6.6	0.46
44.	1000.	2000.	1	1066.	-6.4	0.47
45.	1000.	2000.	1	1076.	-6.2	0.47
46.	1000.	2000.	1	1086.	-6.1	0.48
47.	1000.	2000.	1	1096.	-6.1	0.48
48.	1000.	2000.	1	1106.	-6.1	0.48
49.	1000.	2000.	1	1117.	-6.1	0.49
50.	1000.	2000.	1	1127.	-6.1	0.49

138.X km 100.Y km 6664.Z ft way-pt VOR/LTA 64. Mag dir(deg) & 58.0 dist(n mi)

51.	1000.	2000.	1	1137.	-6.1	0.49
52.	1000.	2000.	1	1147.	-6.1	0.50

This lists the end points of the final seedline position with respect to the VOR.

Rgt end seed ln Mag 90. and dist from VOR/LTA n mi 52.5
Lft end seed ln Mag 78. and dist from VOR/LTA n mi 34.6

This table provides information regarding the characteristics of the crystal fallout curtain. Calculations are performed at up to 6 levels (INIT LVL) depending on the cloud depth and top temperatures. The table shows the spread of fallout points (CRYSTL TYP) for a spectra of up to 6 different terminal velocities. The fallout points are determined by either impact at the ground within the model domain, or the exit of crystals from the model domain. The horizontal positions x, y (km) and z(m msl) are listed with the total fallout time (min).

Table 3.2e. - Crystal fallout locations.

INIT LVL	CRYSTL TYP	XFALLOUT	YFALLOUT	ZFALLOUT	FALL TIME	
1	1**					
1	2**					
1	3	156.6	102.6	1584.	72.0	
1	4	149.8	101.6	1595.	65.0	*1st velocity spectra*
1	5	144.5	99.7	1997.	52.0	
1	6	142.7	99.6	1996.	51.0	
1	7	140.5	99.6	1992.	51.0	
1	8**					
2	1**					
2	2**					
2	3	149.4	102.7	1584.	72.0	
2	4	142.3	100.5	1998.	56.0	
2	5	140.0	100.8	1977.	58.0	*2nd velocity spectra*
2	6	138.8	100.5	1985.	56.0	
2	7	136.6	100.0	1980.	53.0	
2	8**					
3	1**					
3	2**					
3	3	142.7	101.1	1985.	59.0	
3	4	140.6	101.1	1977.	59.0	
3	5	137.8	100.8	1992.	57.0	
3	6	134.8	100.4	1988.	54.0	
3	7	133.4	100.1	1994.	52.0	
3	8**					
4	1**					
4	2**					
4	3	138.0	102.0	2000.	65.0	
4	4	131.0	101.0	1980.	58.0	
4	5	124.6	98.6	2398.	41.0	
4	6	122.3	99.0	2372.	44.0	
4	7	122.0	98.8	2367.	43.0	
4	8**					
5	1**					
5	2**					
5	3	114.0	98.2	1776.	35.0	
5	4	112.2	97.7	1786.	32.0	
5	5	110.8	97.4	1768.	30.0	
5	6	109.7	97.1	1775.	28.0	
5	7	108.6	96.7	1790.	26.0	
5	8**					
6	1**					
6	2**					
6	3	101.1	95.5	1762.	17.0	
6	4	100.5	95.3	1755.	16.0	*6th velocity spectra*
6	5	99.9	95.1	1758.	15.0	
6	6	99.6	94.9	1771.	14.0	
6	7	99.0	94.8	1788.	13.0	
6	8**					

This section lists the coordinates of fallout curtain end points for each of the above velocity spectra. The x- and y-coordinates (km) for the left and right ends of the curtain are listed in terms of model grid positions.

Table 3.2f. - Curtain endpoint locations.

INIT LVL	,CRYSTAL T	,XFLEFT	,YFLEFT	,XFRITE	,YFRITE	
1	1***************************************					
1	2***************************************					
1	3	153.5	120.8	159.7	84.3	*1st level*
1	4	146.7	119.8	152.9	83.3	
1	5	141.4	118.0	147.7	81.5	
1	6	139.5	117.8	145.8	81.3	
1	7	137.4	117.8	143.6	81.3	
1	8***************************************					
2	1***************************************					
2	2***************************************					
2	3	146.3	121.0	152.5	84.5	
2	4	139.2	118.7	145.5	82.2	
2	5	136.8	119.0	143.1	82.5	
2	6	135.7	118.7	142.0	82.2	
2	7	133.5	118.3	139.7	81.8	
2	8***************************************					
3	1***************************************					
3	2***************************************					
3	3	139.5	119.3	145.8	82.8	
3	4	137.5	119.3	143.7	82.8	
3	5	134.7	119.1	141.0	82.5	
3	6	131.7	118.6	137.9	82.1	
3	7	130.3	118.4	136.5	81.8	
3	8***************************************					
4	1***************************************					
4	2***************************************					
4	3	134.9	120.3	141.1	83.8	
4	4	127.9	119.3	134.1	82.7	
4	5	121.4	116.8	127.7	80.3	
4	6	119.2	117.2	125.5	80.7	
4	7	118.8	117.1	125.1	80.6	
4	8***************************************					
5	1***************************************					
5	2***************************************					
5	3	110.9	116.5	117.1	80.0	
5	4	109.1	116.0	115.3	79.5	
5	5	107.7	115.7	113.9	79.2	
5	6	106.6	115.3	112.8	78.8	
5	7	105.5	115.0	111.7	78.5	
5	8***************************************					
6	1***************************************					
6	2***************************************					
6	3	98.0	113.7	104.2	77.2	
6	4	97.4	113.6	103.6	77.1	*6th level*
6	5	96.8	113.4	103.0	76.9	
6	6	96.5	113.2	102.7	76.7	
6	7	95.9	113.0	102.1	76.5	
6	8***************************************					

This table lists crystal height Z (m msl) and time T (minutes) for 5 release levels simulated for each 10 km interval downwind from the seedline.

Table 3.2g. - Time-height passage tables for ice crystals.

Printout of Z,T (minutes) pairs for each VT(L to R) and Lvl(Top-Bot) when passing, points at 10km increments from seedline for IP 1 (ice particle number 1)

	Z_1	t_1	Z_2	t_2	Z_3	t_3	Z_4	t_4	Z_5	t_5	
*****	3110.	9.8	3097.	9.8	3084.	9.8	3071.	9.8	3058.	9.8	*****
*****	2914.	11.9	2901.	11.9	2888.	11.9	2876.	11.9	2865.	11.9	*****
*****	2773.	13.5	2766.	13.5	2760.	13.5	2753.	13.5	2746.	13.5	*****
*****	2581.	15.1	2573.	15.1	2565.	15.1	1557.	15.1	2550.	15.1	*****
*****	2286.	16.6	2267.	16.6	2247.	16.6	2228.	16.6.	2207.	16.6	*****

****

Printout of Z,T (minutes) pairs for each VT(L to R) and Lvl(Top-Bot) when passing, points at 10km increments from seedline for IP 2 (ice particle number 2)

	Z_1	t_1	Z_2	t_2	Z_3	t_3	Z_4	t_4	Z_5	t_5	
*****	3186.	17.9	3155.	17.9	3124.	17.9	3093.	17.9	3062.	17.9	*****
*****	3024.	21.1	2985.	21.1	2951.	21.1	2919.	21.1	2890.	21.1	*****
*****	2913.	23.4	2892.	23.4	2861.	23.5	2830.	23.6	2807.	23.7	*****
*****	2724.	26.0	2676.	26.2	2628.	26.4	2587.	26.5	2567.	26.5	*****

****

3.3 Graphics Processing

Graphical plots of the 2 AAIM model examples presented in section 3.1 and 3.2 are shown in this section. The appropriate responses for graphical processing software are shown in **bold** as in the previous section.

To produce graphical analyses using the NCAR Graphics package, several steps are required. First, the graphcaps fonts must be initialized and access to the graphics package must be established. The CRYSPLTS command procedure file establishes these links on the DEC Microvax. Next, the plotting program CRYSPLTS is run to create a graphics metafile for the model run of interest. Upon creation of the graphics plot file named "GMETA.CGM", a device, either a graphics monitor or hardcopy printer, must be selected, and plots sent to that device. To plot on the screen a system plot command called PLT is executed. Plots on the hardcopy device use POSTGMETA command procedure file. The specific output devices and procedures used by various users will depend on their equipment. To use the CRYSPLTS processor, a version of the NCAR graphics package must reside on the user's computer. This package was purchased for ADWR as part of this research effort and was provided to ADWR upon completion of this research. Instructions to plot on various devices are provided in the graphics software documentation manuals.

To initialize graphcap fonts execute the crysplts procedure file as follows:

WAG2 > **@ crysplts v**

arguments may be UPPER OR lower case or mIxEd
@CRYSPLTS L T = link & 1st run on Tektronics, @CRYSPLTS L V = same on VT340
@CRYSPLTS L = link & rerun on either;
@CRYSPLTS F T = compile & 1st run on Tektronics, @CRYSPLTS F V = same on VT340,

@CRYSPLTS F = compile & rerun on either;
@CRYSPLTS T = 1st run on Tektronics, @CRYSPLTS V = same on VT340;

@CRYSPLTS = just rerun on either

This concludes the crysplts setup for plotting.

Next, to run the plotting program crysplt2 enter the following commands:

WAG2 > **run crysplt2**

Enter filename of prepared user responses, or give as your first interactive response a string of any of the digits (e.g., 13, or blank=ALL!) to request
1 = plume tracks if ground seeded, else
curtains if aircraft seeded,
2 = Model structure-flow channels,
3 = Cross section contour analyses and vectors.

enter:

13

the program prompts with:

To select which cross sections 1-10, type a nonblank character as Ith character
for X-sect. I, e.g. " x x " (without the " marks!) says do X-sects. 3 & 5
1=Q-points & crystal trajectories 2=Temperature 3=potential temp. Theta
| | | 4=U component of winds 5=V component of winds 6=wind vectors (m/s)
| | | | | | 7=orographic vertical motion 8=orographic winds vectors
12345678 (9 & 10 unused)

you enter a character beneath the desired plot numbers to select plots:

x xx x

A version of file AFLyrmdh.mg? will be needed. Please give its AFLyrmdh.mg?
file name, or else give as many characters as you know of your desired file
version's upwind sounding YrMoDaHrSit like 87030218CVR
AFL872PC.03

opening AFL872PC.03 to fit your request

This concludes the plotting run. Your plot file is created with the name "GMETA.CGM". This may be plotted on the screen using a command procedure file called ***plt****. To* **plot you type:** *plt gmeta.cgm. The plot file is then plotted on the screen. At the end of each plot you enter "return" to continue to the next plot. Upon completion of all plots, enter: control key and c. This terminates the run.*

Next example shows aircraft seeding with no additional plots:

WAG2 >RUN CRYSPLT2

```
Enter filename of prepared user responses, or give as your first interactive
response a string of any of the digits (e.g., 13, or blank=ALL!) to request
1 = plume tracks if ground seeded, else
    curtains if aircraft seeded,
2 = Model structure-flow channels,
3 = Cross section contour analyses and vectors.

1

A version of file AFLyrmdh.mg? will be needed. Please give its AFLyrmdh.mg?
file name, or else give as many characters as you know of your desired file
version's upwind sounding YrMoDaHrSit like 87030218CVR
AFL872PC.10

WAG2>
```

This concludes the plot. You may proceed with screen plots using the PLT GMETA.CGM command as discussed above. The command procedure file POSTGMETA makes laser printer plots of the last GMETA.CGM plot file. This is executed by typing: Submit Postgmeta. Plots are processed on the VAX and printed on the HP Laser Printer using the interactive postscript font processor.

3.3.1 *Example of Ground-based Seeding Generator Plots.* – The February 25, 1987, case study provides an excellent example of the types of graphical analyses available for the model user. These plots are designed to provide planning information for real-time operations and assist the user in the interpretation of model results. The sounding identifier CVR and the observation date and time are shown on each plot. Table 1.1 lists the code and locations of the seeding generators, rawinsondes, and other key field sites. Two initial plots show horizontal positions and vertical cross sections of seeding plume and ice crystal trajectories from ground generator sites. The seeding generators are labeled A1 to B4. Figure 3.1 shows the horizontal position of plumes from eight generators. Distance from the origin of the model grid domain along the 225° azimuth (x-axis) and y-axis, parallel to the crest is shown. Latitude and longitude lines show the relative geographic positions of the plume. The plume boundaries are plotted from each generator based on the Pasquill-Gifford dispersion rates for neutral stability. The position of the plume every 1/2 hour is marked by the number (1 to 3) on the left boundary of the plume.

Vertical cross sections of the plumes and ice crystal trajectories show the vertical transport of seeding material with respect to the barrier and the fallout positions of ice crystals. Figure 3.2 shows the plume and crystal trajectories for this case. The mean profile of the surface terrain along the 225° azimuth is drawn at the bottom of the figure. Plume trajectory center points are plotted along the solid lines from their x-axis positions showing the relative position of seeding material as it is transported across the barrier. Locations every 30 min are marked by the generator number (1 to 8). Positions of ice crystals are shown by the dashed lines for two seeding plumes and labeled for each generator. Note that the plumes may pass over the barrier; however, ice crystals grow and fall out at different locations depending upon their size and the airflow in their vicinity. These crystals fell at points ~20 and 30 km upwind of the crest.

Vertical cross sections of temperature and moisture fields and wind fields provide a close look at the vertical structure of conditions simulated in the model. These plots display information

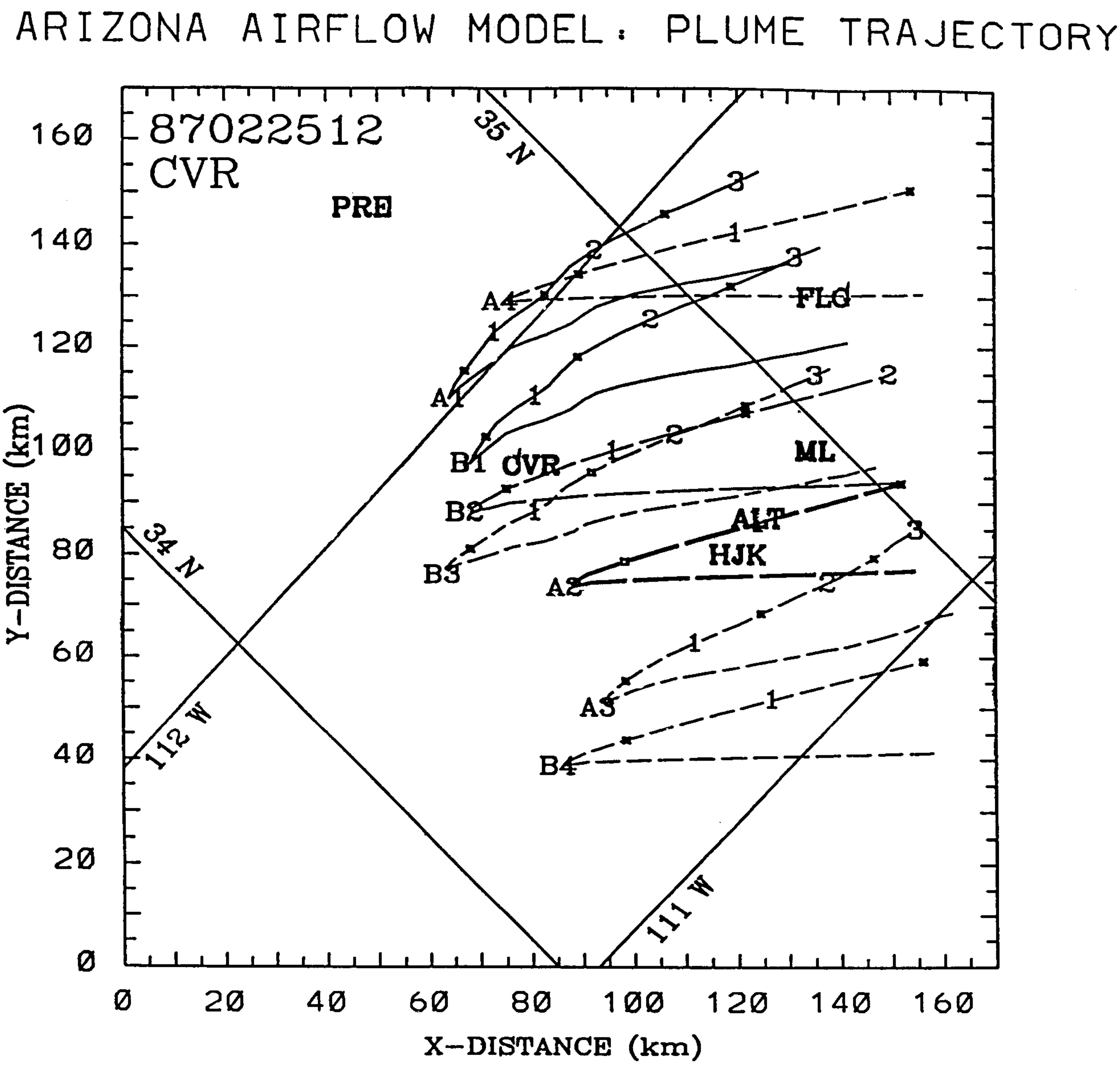


Figure 3.1. – Horizontal seeding plume trajectories simulated for seeding plumes from ground generators on February 25, 1987, at 1200 UTC using the CVR (Camp Verde) rawinsonde. Distances are measured in kilometers. Positions of the plume's left edge are marked every hour. Latitude and longitude reference lines are drawn with positions of major towns and sites shown for geographic positioning. Exact coordinates for sites are shown in table 1.1.

from the data fields that were interpolated to 200 m vertical and 10 km horizontal resolution across the barrier as tabulated in the standard output file shown in tables 3.1e-j. These tables may be used to examine model initial conditions to verify data quality and better understand the airflow structure. Figure 3.3a shows the temperature (°C) and potential temperature (°K) (fig. 3.3b) fields. The fields terminate at the ground level. Figure 3.4 shows the cross section of *u- and v*-components of the wind (m s^{-1}). The *u*-component along the *x*-axis indicates the flow perpendicular to the barrier at 225° azimuth; whereas, the *v*-component is parallel to the barrier.

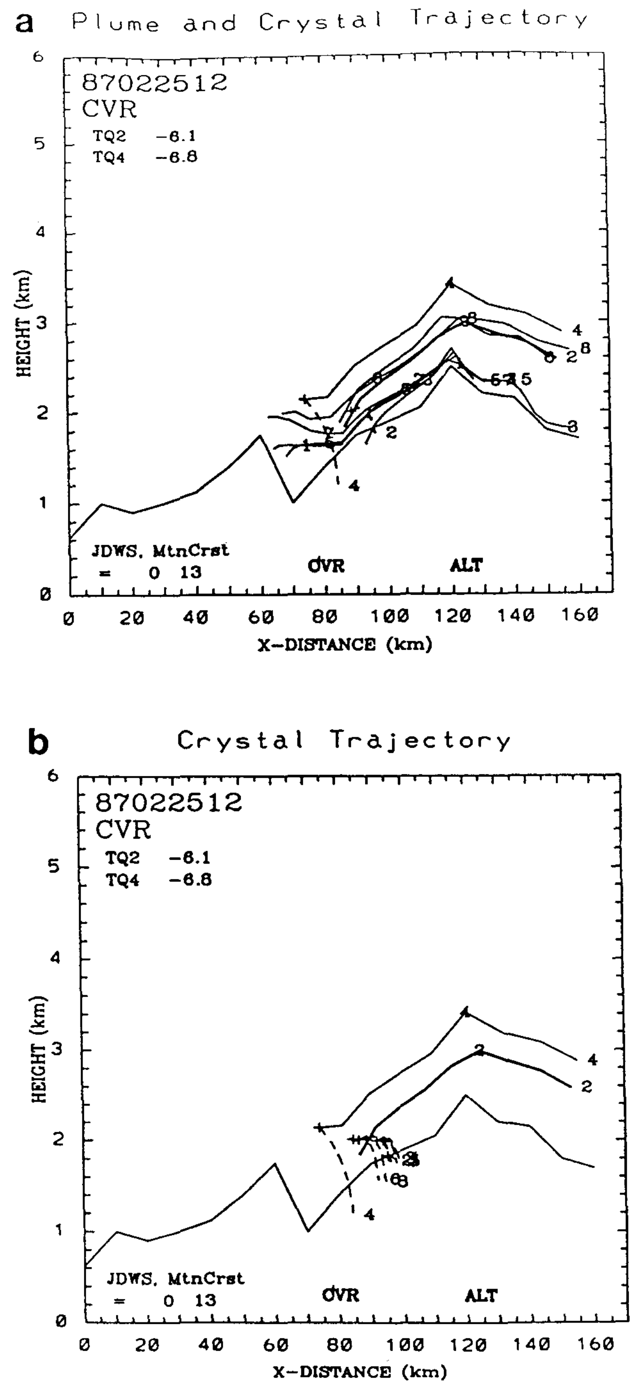
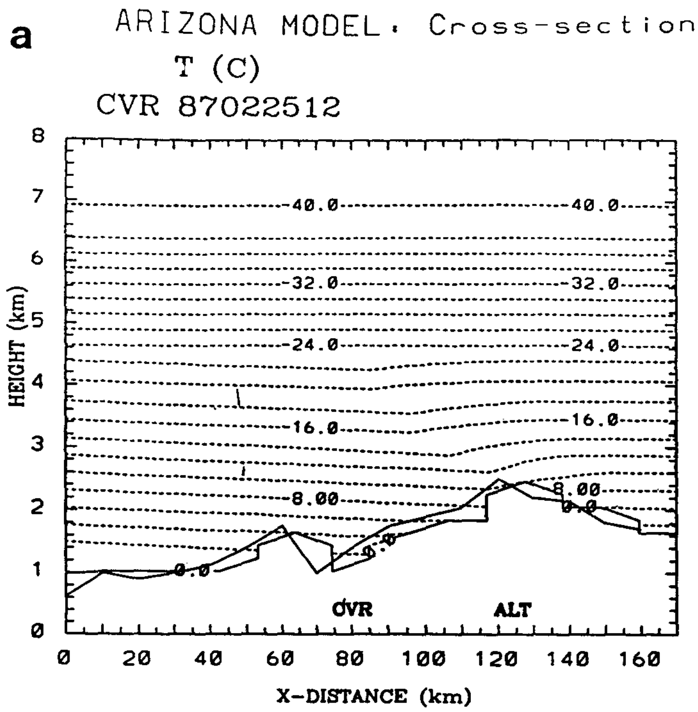


Figure 3.2. – Vertical cross section of plumes (a) and ice crystal trajectories (b). The vertical cross section of terrain along the 225° azimuth shows the barrier with plume centerpoint height cross sections shown by solid lines for generators labeled 1 to 8 as listed in table 1.1. Ice crystal trajectories are shown by dashed curves for generators 2 and 4 in figure 3.2a for generators A2 and A4, respectively. All crystal trajectories (2 through 8, for generators A2 through B4) are shown in figure 3.2b. Note that the precipitation from these ground generator sites is occurring about 20 km upwind from the crest in this wet storm with relatively light winds.

a



b

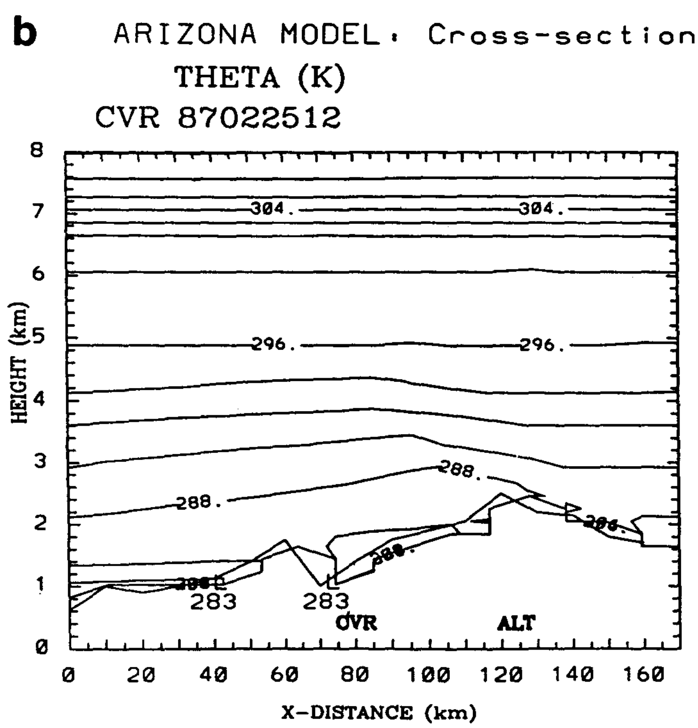


Figure 3.3. – Vertical cross section of (a) temperature (°C) and (b) potential temperature (°K). Cross sections are scaled from the surface to the top of the model domain. Negative values are shown by dashed lines, positive values have solid contours.

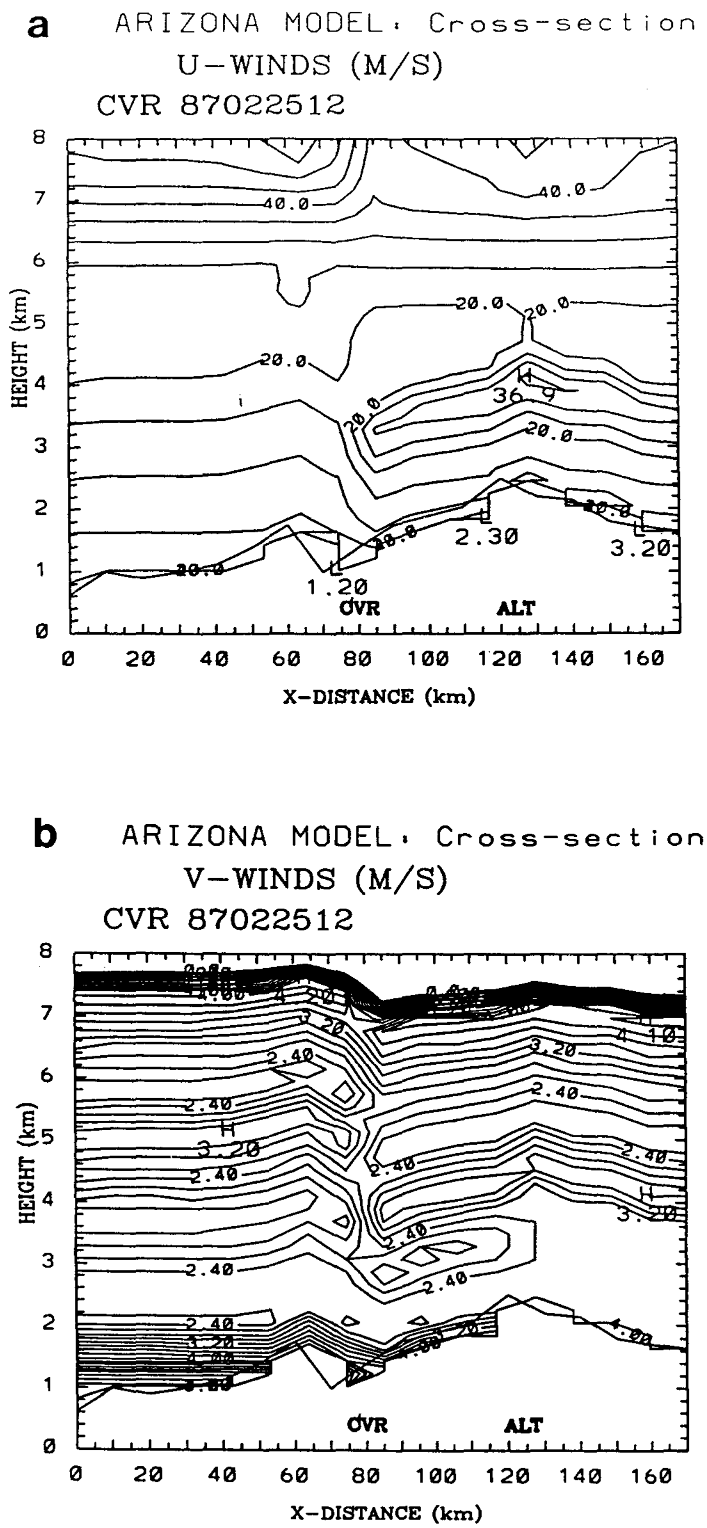


Figure 3.4. – Vertical cross section of wind components normal (a) and parallel (b) to the barrier. Contours show positive flow toward the barrier as solid contours in 5 m s^{-1} intervals.

The total wind vector and vertical wind (w-component) analyses are shown on figure 3.5. The total wind vectors are plotted at the grid points to show the variation of flow in the vertical across the barrier. Each vector indicates the wind direction plotted on a 360° azimuth circle pointing in the direction of flow. The vector length is proportional to the wind speed. Vectors are plotted for all points above the terrain and show the Bernoulli acceleration over the crest marked by ALT (Allen Lake Tank). The Verde River Valley is marked by CVR (Camp Verde). Vertical motion w-winds (m s^{-1}) show the gravity wave pattern generated by flow over the barrier (fig. 3.5b). The relative intensity of lifting depends on the magnitude of the horizontal component of the wind normal to the barrier and the thermodynamic stability of the airmass. The vertical motion field affects the lifting of seeding materials over the barrier and the net fall velocity of ice crystals, hence the amount of time available for growth before precipitation reaches ground level.

Five plots are available to describe the vertical structure of flow channels. These plots are not generally required for operational application of the model; however, they assist in understanding internal model characteristics and their effects on model computations. These plots analyze the data in tables 3.1k-q. Figure 3.6 shows a vertical cross section of the flow channel heights. Up to 12 flow channels are plotted from the surface labeled 1, or in the case of calm boundary layer conditions (e.g. figure 3.6b), the first level above the dead layer to model top at 12. The model top height is 600 mb above the ground, approximately at the 300-mb level, about 9 km m.s.l. for the Mogollon Rim. The center-point heights of each flow channel are plotted. The flow channel heights show the effect of the lifting upwind from the barrier, the sinking in the lee of the Mingus Mountain ridge west of the Verde River Valley (CVR), then lifting to the crest at ALT followed by sinking in the lee of the Mogollon crest. The midflow channel (labeled 7) shows the top of the compressed layer over the barrier.

3.3.2 *Example of Aircraft Seeding*. – The model estimates the best location for aircraft seeding upwind of the target for user selected flight levels. Figure 3.7 shows two examples of crystal fallout zones for simulations of seeding with AgI acetone generators (fig. 3.7a) and AgI flares (fig. 3.7b). These examples show sensitivity to selections for the altitude and type of seeding simulated. The user selected the seeding flight level and the model determined the Q-point location indicated by Q and the seeding line centered on Q that produced the "best" targeting of precipitation over the Rim. A curtain of ice crystals was simulated in which five crystals with different terminal velocities were followed from six different levels at 200-m intervals below the aircraft. The plot shows the crystal fallout locations for crystals nucleated at the end points of the seedline. A line is drawn between these points and labeled 1 to 6 corresponding to each altitude below the aircraft. Lines for the first and fifth crystals are drawn for each altitude to indicate the fallout footprint for that altitude. The fallout footprint for the first altitude is indicated by the shaded area on figure 3.7a. The second example shows that using AgI droppable flares improved targeting on ML. Crystals from the fourth level were properly targeted on ML. Note that this footprint overshot the ML target. Similar fallout footprints may be constructed for each level by shading the appropriate areas between lines with the same labels. Tabulations for aircraft simulations give exact locations of the Q-point with references to the Prescott (PRE) VOR/DME. Plots of the seeding line help interpret this information and assist the user in validating the model results.

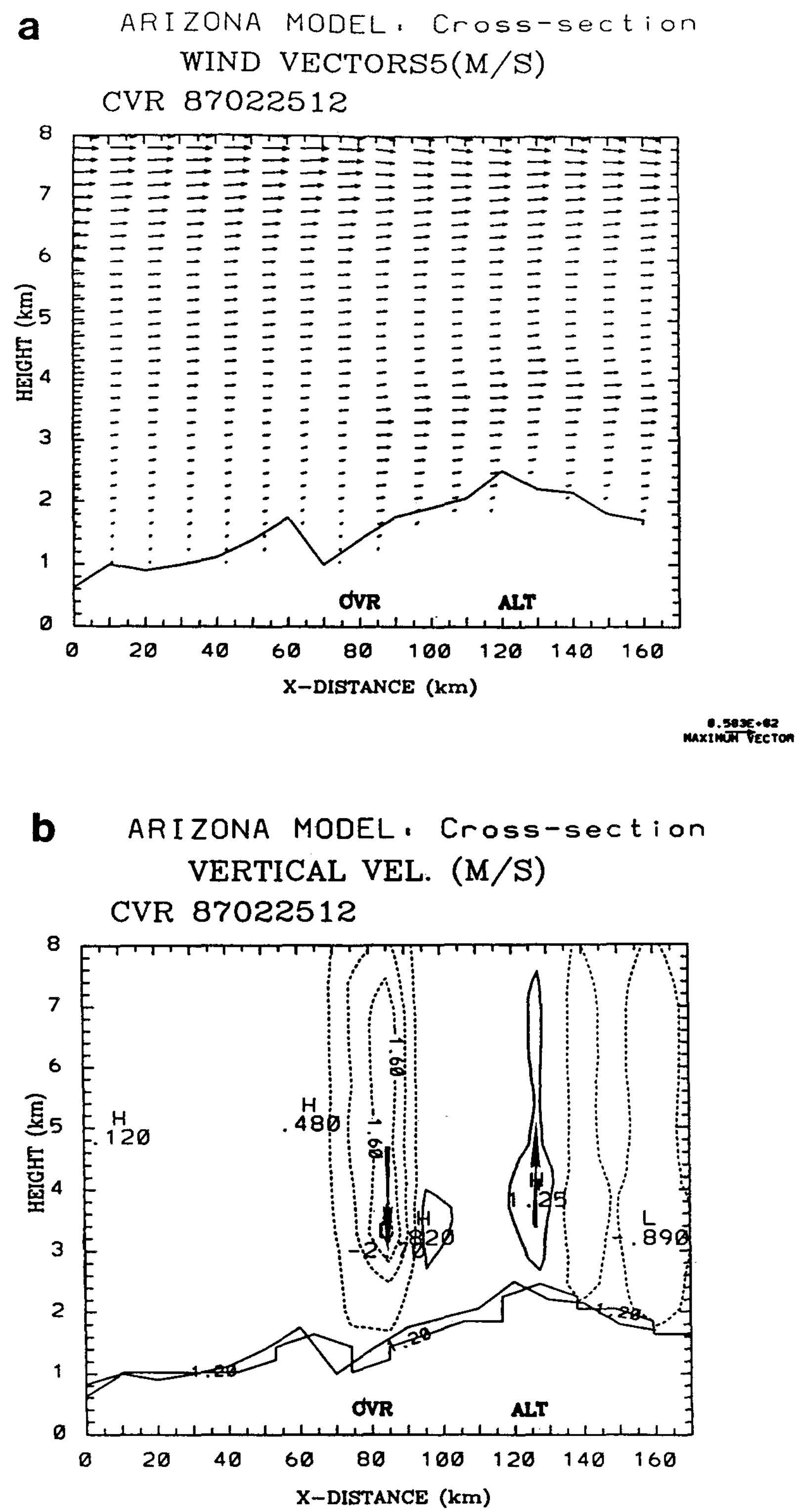


Figure 3.5. – Vertical cross section of wind vectors (a) showing relative changes in wind direction and speed across the barrier. Wind direction uses a 360° azimuth reference circle with north at 0°. Contours of the vertical motion field (b) show the sinking over the Verde Valley (CVR) and lifting along the Rim (ALT).

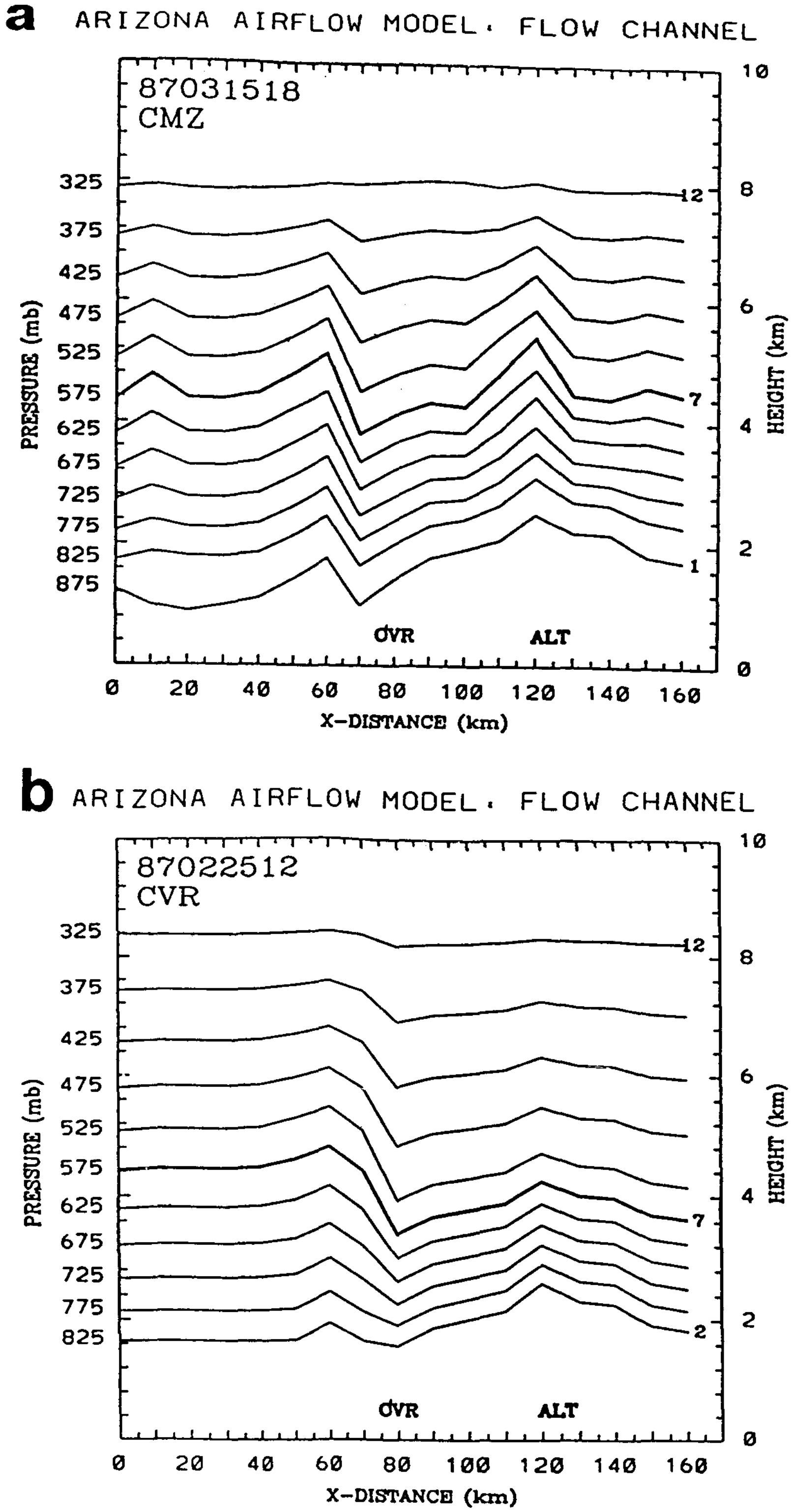


Figure 3.6. – Cross sections of the flow channel heights that show the vertical structure of airflow. The model simulates two-dimensional airflow across the barrier through these channels. The center heights of each 50-mb deep channel are labeled from 1 to 12 (fig. 3.6a). When a dead layer (winds less than 2.5 m s^{-1}) exists the flow channels are labeled from the top of the dead layer (level 2) in figure 3.6b. The midflow channel is labeled 7 and model's top channel is 12. The model domain top is assumed to be horizontal at a pressure height that is 600 mb above the ground at the left model boundary.

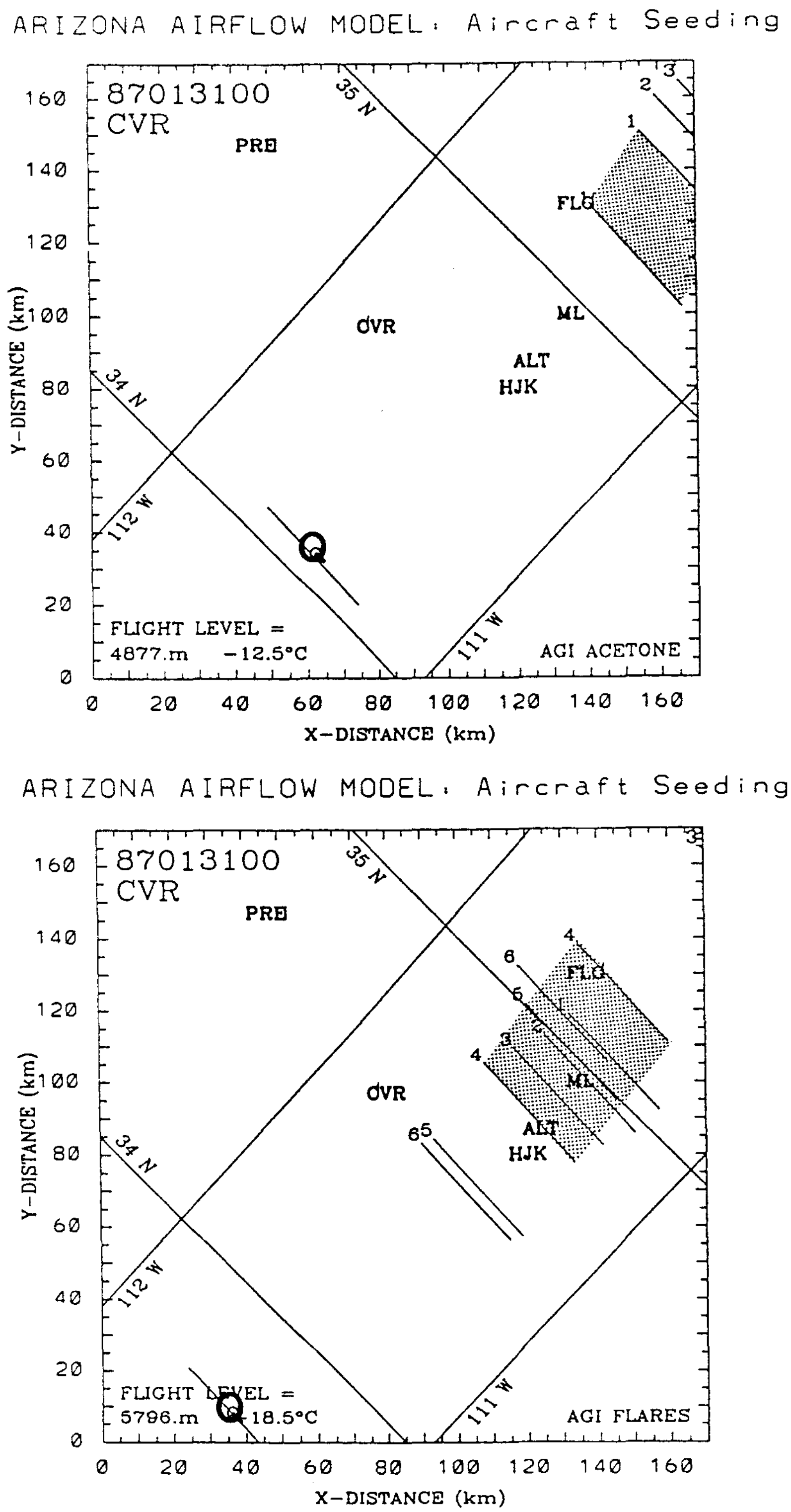


Figure 3.7. – Horizontal positions of the aircraft seeding flight track and ice crystal fallout zones. The center (Q-point) of the 20 n. mi seeding flight track is marked by Q. Positions of the fallout zone are outlined by the line sements labeled 1 to 6 for six seeding levels below the aircraft flight level. The fallout zone for each level is located between each pair of line segments that bracket a range of crystal fall velocities simulated. For example, the fallout zone from the first level (labeled 1) is stippled in figure 3.7a. Geographic locations are as decribed in figure 3.1.

4. MODEL INITIALIZATION – SOUNDING FORMATS

This chapter provides a set of examples of the standard input sounding formats that the AAIM model's SNDLIB routines will accept. These sounding formats are automatically decoded by the processing subroutines and then interpolated to the model grid. The model user simply enters the date and station identifier as prompted by AAIM. The SNDLIB routines then search the data base for appropriate file, check the file format, and then decode the input data. If no files with the requested sounding date or station identifier are found, the model notifies the user. Tables in this chapter have two consecutive input soundings for each format type. This shows the appropriate spacing and syntax between soundings.

4.1 Reclamation Field Project Soundings: PRJ80104.sh

	SH				800104		0			
	MANDATORY AND SIGNIFICANT LEVELS								WINDS	
	PRES	HGT	T	TD	DIR	SPD	HEIGHT		DIR	SPEED
	(MBAR)	(M)	(C)	(C)		(M/S)	(M)	(FT)		(M/S)
1	1013.	60.	7.4	7.2	120.	1.0	60.	197.	120.	1.0
2	1000.	164.	6.6	6.5	135.	1.5	305.	1000.	160.	2.1
3	974.		5.0	4.9			610.	2000.	175.	4.6
4	966.		4.6	1.3			914.	3000.	165.	7.2
5	956.		9.6	-5.4			1219.	4000.	160.	8.2
6	942.		11.4	-18.6			1829.	6000.	175.	5.1
7	913.		12.0	-18.0			2134.	7000.	185.	5.1
8	882.		10.4	-19.6			2438.	8000.	195.	6.2
9	850.	1512.	11.0	-19.0	160.	6.7	2743.	9000.	200.	7.7
10	830.		11.4	-18.6			3658.	12000.	220.	9.8
11	714.		2.0	-28.0			4267.	14000.	245.	8.2
12	700.	3105.	0.6	-29.4	205.	9.3	4877.	16000.	260.	8.7
13	649.		-4.1	-34.1			6096.	20000.	295.	10.3
14	631.		-4.9	-34.9			7620.	25000.	305.	10.3
15	604.		-7.9	-37.9			9144.	30000.	290.	17.0
16	570.		-10.5	-40.5			10668.	35000.	285.	18.5
17	562.		-10.7	-27.7			12192.	40000.	275.	15.4
18	551.		-11.7	-41.7			13716.	45000.	290.	17.5
19	529.		-13.7	-17.3			15240.	50000.	315.	9.3
20	505.		-14.3	-23.3						
21	500.	5720.	-14.9	-23.9	290.	9.3				
22	479.		-17.7	-23.7						
23	466.		-19.1	-30.1						
24	451.		-20.5	-29.5						
25	444.		-20.7	-36.7						
26	400.	7370.	-25.9	-55.9	305.	10.3				
27	300.	9380.	-42.5	-72.5	290.	17.5				
28	295.		-43.5	-73.5						
29	250.	10580.	-54.1	-84.1	285.	19.0				
30	245.		-55.5	-85.5						
31	200.	11970.	-65.5	-95.5	275.	16.5				
32	199.		-65.7	-95.7						
33	185.		-66.3	-96.3						
34	150.	13730.	-62.3	-92.3	290.	17.5				
35	135.		-60.5	-90.5						
36	100.	16250.	-60.7	-90.7	315.	11.3				
37	97.		-60.7	-90.7						

SH 800104 3

	MANDATORY AND SIGNIFICANT LEVELS						WINDS			
	PRES (MBAR)	HGT (M)	T (C)	TD (C)	DIR	SPD (M/S)	HEIGHT (M)	HEIGHT (FT)	DIR	SPEED (M/S)
1	1013.	60.	7.0	7.0	110.	1.0	60.	197.	110.	1.0
2	1000.	165.	6.4	6.3	130.	2.1	305.	1000.	155.	3.1
3	986.		5.8	5.8			610.	2000.	185.	4.6
4	971.		8.6	8.4			914.	3000.	200.	5.7
5	954.		9.0	7.0			1219.	4000.	205.	5.7
6	932.		10.0	-20.0			1829.	6000.	175.	4.6
7	898.		12.0	-18.0			2134.	7000.	180.	5.1
8	850.	1514.	10.0	-20.0	185.	5.1	2438.	8000.	195.	6.7
9	790.		7.6	-22.4			2743.	9000.	205.	8.7
10	700.	3102.	1.0	-29.0	215.	9.8	3658.	12000.	230.	8.7
11	649.		-3.1	-33.1			4267.	14000.	240.	8.7
12	628.		-5.3	-23.3			4877.	16000.	250.	9.3
13	602.		-6.1	-36.1			6096.	20000.	275.	10.3
14	529.		-13.3	-13.3			7620.	25000.	275.	8.2
15	505.		-14.7	-19.5			9144.	30000.	280.	14.4
16	500.	5720.	-15.3	-19.7	265.	10.8	10668.	35000.	280.	15.4
17	487.		-16.9	-20.1			12192.	40000.	270.	18.0
18	480.		-17.9	-24.9			13716.	45000.	300.	13.4
19	474.		-17.9	-23.9						
20	451.		-19.5	-30.5						
21	427.		-23.1	-32.1						
22	400.	7370.	-26.7	-37.7	275.	7.2				
23	391.		-27.9	-39.9						
24	359.		-32.9	-40.9						
25	325.		-39.1	-41.9						
26	308.		-41.9	-47.9						
27	300.	9380.	-43.5	-48.3	280.	14.9				
28	284.		-46.7	-50.0						
29	250.	10580.	-53.7	-72.7	280.	15.9				
30	229.		-58.5	-88.5						
31	200.	11980.	-63.5	-93.5	265.	15.4				
32	180.		-67.5	-97.5						
33	155.		-59.7	-89.7						
34	150.	13740.	-59.5	-89.5	300.	13.4				
35	135.		-58.7	-88.7						
36	107.		-62.1	-92.1						

4.2 WMO (World Meteorological Organization) Coded Message Soundings

```
MFR
92020512 405
TTAA  55121 72597 99966 11223 10003 00094 ///// /////
92767 18865 17003 85494 19069 09504 70131 07480 17009 50578
14964 22013 40742 28164 19013 30943 441// 20516 25063 521//
36005 20205 593// 35515 15384 607// 27007 88164 633// 14502
77999 51515 10158 10164 00002 10194 14003 13007=
TTBB  55120 72597 00966 11223 11963 14457 22949 18262
33914 20067 44799 17073 55700 07480 66537 12159 77534 12357
88527 12363 99461 18966 11435 23159 22408 27159 33400 28164
44380 30959 55321 39963 66250 521// 77164 633// 88136 589//
99101 609// 31313 01102 81100 51515 10150 10158=
PPBB  55120 72597 90023 10003 14003 19502 90467 12502 10008
10506 9089/ 14007 16509 91246 18509 21013 22512 92025 21511
19013 19012 93012 20016 20016 21013 93578 36006 34013 34519
940// 00514 9503/ 29505 32004=
```

```
OAK
92020512    2
TTAA  55121 72493 99009 13210 34503 00085 12610 33504
92754 25480 33018 85489 20880 29509 70124 07280 09008 50578
14580 14510 40743 25764 15513 30944 431// 23006 25064 531//
16510 20206 593// 34524 15385 599// 35007 10637 619// 33507
88188 613// 34022 77999 51515 10164 00005 10194 32012 00505=
TTBB  55120 72493 00009 13210 11976 11007 22973 11856
33967 17669 44954 23480 55939 26080 66817 18280 77700 07280
88611 02562 99544 10920 11530 11957 22526 11780 33482 16580
44476 17362 55472 17766 66416 24161 77400 25764 88318 40180
99230 573// 11188 613// 22157 589// 33100 619// 31313 01102
81104=
PPBB  55120 72493 90012 34503 31008 32515 90346 32517 32013
31505 90789 34504 01003 06505 91234 13008 11511 11515 9167/
11522 12021 92015 15510 15011 15012 93058 20505 16510 33516
94023 35024 33520 35516 944// 00511 9504/ 31506 33507=
```

4.3 WMO Decoded Message Soundings

```
1
  USBR UPPER AIR ANALYSIS PROGRAM    RAWIN
  FILE wmo                      FAA ID: MFR     LOCATION:
  DATE:  2/ 5/92                                               TIME: 12 Z
```

	MANDATORY AND SIGNIFICANT LEVELS						WINDS				
	PRES	HGT	T	TD	DIR	SPD	HEIGHT		DIR	SPEED	
	(MBAR)	(M)	(C)	(C)		(M/S)	(M)	(FT)		(M/S)	(KN)
1	966.	405.	11.2	8.9	100.	1.5	405.	1329.	100.	1.5	3.
2	963.	431.	14.4	7.4	105.	1.5	610.	2000.	140.	1.5	3.
3	949.	554.	18.2	6.2	129.	1.5	914.	3000.	195.	1.0	2.
4	925.	767.	18.8	3.8	170.	1.5	1219.	4000.	125.	1.0	2.
5	914.	870.	20.0	3.0	185.	1.2	1829.	6000.	100.	4.1	8.
6	850.	1494.	19.0	.0	95.	2.1	2134.	7000.	105.	3.1	6.
7	799.	2021.	17.0	-6.0	103.	3.5	2438.	8000.	140.	3.6	7.
8	700.	3131.	7.4	-22.6	170.	4.6	2743.	9000.	165.	4.6	9.
9	537.	5243.	-12.0	-21.0	223.	6.4	3658.	12000.	185.	4.6	9.
10	534.	5286.	-12.2	-19.2	223.	6.4	4267.	14000.	210.	6.7	13.
11	527.	5387.	-12.2	-25.2	222.	6.5	4877.	16000.	225.	6.2	12.
12	500.	5780.	-14.8	-28.8	220.	6.7	6096.	20000.	215.	5.7	11.
13	461.	6389.	-18.8	-34.8	202.	6.0	6706.	22000.	190.	6.7	13.
14	435.	6817.	-23.0	-32.0	190.	6.7	7620.	25000.	190.	6.2	12.
15	408.	7283.	-27.0	-36.0	190.	6.7	9144.	30000.	200.	8.2	16.
16	400.	7420.	-28.0	-42.0	190.	6.7	9449.	31000.	200.	8.2	16.
17	380.	7792.	-30.8	-39.8	191.	6.4	9754.	32000.	210.	6.7	13.
18	321.	8964.	-39.8	-52.8	199.	8.0	10668.	35000.	360.	3.1	6.
19	300.	9430.	-44.0	-58.0	205.	8.2	11278.	37000.	340.	6.7	13.
20	250.	10630.	-52.0	-72.1	360.	2.6	11582.	38000.	345.	9.8	19.
21	200.	12050.	-59.2	-89.3	355.	7.7	12192.	40000.	5.	7.2	14.
22	164.	13137.	-63.2	-104.5	330.	3.5	15240.	50000.	295.	2.6	5.
23	150.	13840.	-60.6	-111.4	270.	3.6	16154.	53000.	320.	2.1	4.
24	136.	14160.	-58.8	-119.0	274.	3.3					
25	101.	15660.	-60.8	-141.9	305.	2.3					

1

USBR UPPER AIR ANALYSIS PROGRAM RAWIN
FILE wmo FAA ID: OAK LOCATION:
DATE: 2/ 5/92 TIME: 12 Z

	MANDATORY AND SIGNIFICANT LEVELS						WINDS				
	PRES	HGT	T	TD	DIR	SPD	HEIGHT		DIR	SPEED	
	(MBAR)	(M)	(C)	(C)		(M/S)	(M)	(FT)		(M/S)	(KN)
1	1009.	10.	13.2	12.2	345.	1.5	0.	0.	345.	1.5	3.
2	1000.	85.	12.6	11.6	335.	2.1	305.	1000.	310.	4.1	8.
3	976.	291.	11.0	10.3	311.	4.0	610.	2000.	325.	7.7	15.
4	973.	317.	11.8	5.8	311.	4.2	914.	3000.	325.	8.7	17.
5	967.	370.	17.6	-1.4	315.	4.8	1219.	4000.	320.	6.7	13.
6	954.	486.	23.4	-6.6	321.	6.2	1829.	6000.	315.	2.6	5.
7	939.	623.	26.0	-4.0	326.	7.9	2134.	7000.	345.	2.1	4.
8	925.	754.	25.4	-4.6	330.	9.3	2438.	8000.	10.	1.5	3.
9	850.	1489.	20.8	-9.2	295.	4.6	2743.	9000.	65.	2.6	5.
10	817.	1829.	18.2	-11.8	315.	2.6	3658.	12000.	130.	4.1	8.
11	700.	3124.	7.2	-22.8	90.	4.1	3962.	13000.	115.	5.7	11.
12	611.	4224.	-2.4	-14.4	115.	7.4	4267.	14000.	115.	7.7	15.
13	544.	5135.	-10.8	-12.8	119.	10.9	4877.	16000.	115.	11.3	22.
14	530.	5337.	-11.8	-18.8	123.	9.2	5182.	17000.	120.	10.8	21.
15	526.	5395.	-11.6	-41.6	125.	8.6	6096.	20000.	155.	5.1	10.
16	500.	5780.	-14.4	-44.4	145.	5.1	6401.	21000.	150.	5.7	11.
17	482.	6057.	-16.4	-46.4	154.	5.1	7620.	25000.	150.	6.2	12.
18	476.	6151.	-17.2	-29.2	154.	5.2	9144.	30000.	205.	2.6	5.
19	472.	6214.	-17.6	-33.6	153.	5.3	10668.	35000.	165.	5.1	10.
20	416.	7149.	-24.0	-35.0	154.	6.4	11582.	38000.	335.	8.2	16.
21	400.	7430.	-25.6	-39.6	155.	6.7	12192.	40000.	350.	12.3	24.
22	318.	9060.	-40.0	-70.0	199.	2.6	12802.	42000.	335.	10.3	20.
23	300.	9440.	-43.0	-77.7	230.	3.1	13106.	43000.	355.	8.2	16.
24	250.	10640.	-53.0	-101.9	165.	5.1	13411.	44000.	5.	5.7	11.
25	230.	11224.	-57.2	-112.9	328.	3.0	15240.	50000.	315.	3.1	6.
26	200.	12060.	-59.2	-131.5	345.	12.3	16459.	54000.	335.	3.6	7.
27	188.	12493.	-61.2	-139.6	343.	11.2					
28	157.	13576.	-58.8	-163.5	1.	4.9					
29	150.	13850.	-59.8	-169.6	350.	3.6					
30	100.	16370.	-61.8	-223.3	335.	3.6					

4.4 MM4 (Mesoscale Model version 4 – Penn State University/NCAR) Model Derived Soundings

UPPER AIR SOUNDING FROM MM4 FOR GUCE 108 38
LAT= 38.26 LONG=-107.51 82 1 1 0=YEAR MODAHR

12 LEVELS

TYPE	PRESS (MB)	HT (M)	TEMP (C)	DEWP (C)	RHUM (%)	WDIR (DEG)	WSPD (M/S)	DIV (10**-4/S)
0	726.0	2710	-4.7	-6.6	86	233	10	1.8
2	716.0	2828	-5.4	-7.3	86	234	10	1.8
2	697.0	3070	-6.7	-8.0	90	237	11	2.1
2	661.0	3531	-9.0	-10.0	92	246	13	2.7
2	609.0	4245	-12.5	-13.1	95	255	17	2.7
2	547.0	5174	-17.0	-17.3	97	261	21	2.6
2	479.0	6330	-23.1	-24.5	88	266	26	2.0
2	411.0	7659	-31.3	-34.5	73	269	30	1.3
2	343.0	9229	-40.9	-45.1	64	271	34	0.6
2	275.0	11175	-49.4	-73.0	5	273	39	0.5
2	216.0	13390	-53.1	-75.9	5	273	45	0.1
2	168.0	16030	-55.9	-78.1	5	276	43	-1.1

UPPER AIR SOUNDING FROM MM4 FOR GUCE 108 38
LAT= 38.26 LONG=-107.51 82 1 1 6=YEAR MODAHR

12 LEVELS

TYPE	PRESS (MB)	HT (M)	TEMP (C)	DEWP (C)	RHUM (%)	WDIR (DEG)	WSPD (M/S)	DIV (10**-4/S)
0	725.0	2709	-4.7	-6.3	88	221	8	4.3
2	715.0	2828	-5.6	-6.5	93	221	9	4.6
2	695.0	3069	-7.2	-7.3	99	223	13	5.8
2	660.0	3529	-9.4	-9.6	98	236	19	7.1
2	608.0	4242	-13.4	-13.4	100	245	21	6.5
2	546.0	5168	-17.9	-18.0	99	253	24	5.5
2	478.0	6320	-23.1	-24.5	88	256	29	4.0
2	410.0	7649	-30.7	-36.8	55	259	34	2.3
2	342.0	9223	-39.5	-51.5	27	262	41	0.1
2	274.0	11178	-48.1	-72.0	5	262	49	-1.3
2	216.0	13403	-52.1	-75.2	5	262	53	-3.2
2	167.0	16055	-54.4	-77.0	5	265	44	-3.4

4.5 NCDC (National Climate Data Center) soundings using the Reclamation format

Upper air sounding for NCDC#=00023066 GJT 72476 GRAND JUNCTION
CO US .
Lat= 39.12 Long= 108.53 1982 1 1 0=Year MoDaHr

39 levels

Type of Levl	Min. since rel.	Pressure in mb	Height in meters	Temp Deg. C	Dew Point C	Rel Hum %	Wind dir deg	Wind sped m/s	Levl qual ind.	[quality flags] Mn	Pr	Ht	T	RH	W
0	0.0	845.9	1472	1.1	-3.6	71	100	3	0	0	0	0	0	0	0
2	0.2	841.0	1519	0.5	-3.1	77	112	3	0	0	0	0	0	0	0
2	0.8	821.0	1712	-1.1	-2.5	90	133	5	0	0	0	0	0	0	0
3	1.4	800.0	1918	-2.3	-3.6	91	143	7	0	0	0	0	0	0	0
2	3.1	750.0	2428	-5.6	-6.4	94	166	8	0	0	0	0	0	0	0
1	5.1	700.0	2968	-7.0	-7.8	94	236	11	0	0	0	0	0	0	0
2	6.8	655.0	3484	-10.0	-11.1	92	244	15	0	0	0	0	0	0	0
3	7.0	650.0	3543	-10.0	-11.1	92	243	15	0	0	0	0	0	0	0
2	7.2	646.0	3591	-10.0	-10.9	93	242	16	0	0	0	0	0	0	0
2	8.3	619.0	3919	-11.6	-12.9	90	242	18	0	0	0	0	0	0	0
3	9.0	600.0	4157	-13.5	-14.9	89	246	19	0	0	0	0	0	0	0
3	11.1	550.0	4813	-18.8	-20.6	86	258	22	0	0	0	0	0	0	0
2	12.0	531.0	5074	-21.0	-23.0	84	256	24	0	0	0	0	0	0	0
1	13.4	500.0	5517	-22.8	-24.9	83	261	27	0	0	0	0	0	0	0
3	16.0	450.0	6282	-27.6	-30.5	76	272	28	0	0	0	0	0	0	0
1	19.1	400.0	7120	-33.0	-37.1	67	265	27	0	0	0	0	0	0	0
2	20.5	377.0	7533	-37.0	-41.2	65	268	29	0	0	0	0	0	0	0
2	22.3	351.0	8024	-39.8	-43.3	69	266	31	0	0	0	0	0	0	0
3	22.3	350.0	8046	-39.9	-99.9	999	266	31	0	0	0	0	0	0	0
1	26.1	300.0	9075	-49.4	-99.9	999	268	34	0	0	0	0	0	0	0
2	27.4	280.0	9525	-51.4	-99.9	999	278	42	0	0	0	0	0	0	0
2	28.0	273.0	9690	-51.2	-99.9	999	282	47	0	0	0	0	0	0	0
1	30.0	250.0	10258	-54.2	-99.9	999	285	54	0	0	0	0	0	0	0
4	33.0	220.0	11073	-57.0	-99.9	999	284	45	0	0	0	0	0	0	0
1	35.2	200.0	11682	-53.1	-99.9	999	280	42	0	0	0	0	0	0	0
3	38.4	175.0	12546	-51.3	-99.9	999	280	46	0	0	0	0	0	0	0
2	38.6	174.0	12584	-51.2	-99.9	999	280	46	0	0	0	0	0	0	0
1	41.8	150.0	13546	-52.5	-99.9	999	999	999	0	0	0	0	0	0	0
3	46.0	125.0	14716	-55.9	-99.9	999	999	999	0	0	0	0	0	0	0
2	48.6	112.0	15411	-58.0	-99.9	999	999	999	0	0	0	0	0	0	0
2	49.1	109.0	15583	-56.1	-99.9	999	999	999	0	0	0	0	0	0	0
1	51.0	100.0	16127	-59.0	-99.9	999	999	999	0	0	0	0	0	0	0
3	55.5	80.0	17521	-60.8	-99.9	999	999	999	0	0	0	0	0	0	0
1	58.3	70.0	18349	-62.0	-99.9	999	999	999	0	0	0	0	0	0	0
2	60.6	63.0	18997	-64.6	-99.9	999	999	999	0	0	0	0	0	0	0
3	61.5	60.0	19296	-63.9	-99.9	999	999	999	0	0	0	0	0	0	0
1	64.9	50.0	20422	-60.9	-99.9	999	999	999	0	0	0	0	0	0	0
3	69.6	40.0	21801	-63.5	-99.9	999	287	14	0	0	0	0	0	0	0
2	71.9	36.0	22446	-64.8	-99.9	999	999	999	0	0	0	0	0	0	0

Upper air sounding for NCDC#=00023066 GJT 72476 GRAND JUNCTION CO US .
Lat= 39.12 Long= 108.53 1982 1 112=Year MoDaHr

51 levels

Type of Levl	Min. since rel.	Pressure in mb	Height in meters	Temp Deg. C	Dew Point C	Rel Hum %	Wind dir deg	Wind sped m/s	Levl qual ind.	[quality Mn	Pr	Ht	flags T	RH	] W
0	0.0	840.0	1472	-1.1	-3.0	87	120	2	0	0	0	0	0	0	0
2	0.2	836.0	1510	-1.1	-3.1	86	124	2	0	0	0	0	0	0	0
2	0.4	826.0	1606	-0.2	-0.9	95	127	2	0	0	0	0	0	0	0
2	1.2	804.0	1822	-1.1	-1.7	96	140	3	0	0	0	0	0	0	0
3	1.3	800.0	1862	-0.9	-1.5	96	143	3	0	0	0	0	0	0	0
2	2.2	778.0	2085	0.6	-0.5	92	179	3	0	0	0	0	0	0	0
2	3.0	750.0	2379	-1.0	-2.7	88	211	6	0	0	0	0	0	0	0
1	5.0	700.0	2926	-5.6	-6.3	95	235	15	0	0	0	0	0	0	0
3	6.5	650.0	3504	-9.3	-10.1	94	240	20	0	0	0	0	0	0	0
3	8.3	600.0	4118	-13.4	-14.3	93	243	21	0	0	0	0	0	0	0
2	8.7	589.0	4259	-14.4	-15.4	92	245	21	0	0	0	0	0	0	0
3	10.3	550.0	4776	-17.4	-26.5	45	256	22	0	0	0	0	0	0	0
2	10.5	547.0	4817	-17.7	-27.8	41	257	22	0	0	0	0	0	0	0
2	11.3	531.0	5039	-19.1	-35.6	22	261	24	0	0	0	0	0	0	0
1	12.8	500.0	5484	-21.8	-35.9	27	263	27	0	0	0	0	0	0	0
3	15.3	450.0	6251	-27.8	-41.2	27	262	26	0	0	0	0	0	0	0
2	15.6	446.0	6315	-28.4	-41.4	28	262	25	0	0	0	0	0	0	0
2	16.7	429.0	6592	-31.0	-39.3	44	262	27	0	0	0	0	0	0	0
1	18.6	400.0	7084	-35.4	-44.1	41	266	27	0	0	0	0	0	0	0
2	20.1	377.0	7493	-39.4	-48.2	39	266	28	0	0	0	0	0	0	0
3	21.8	350.0	8000	-43.7	-99.9	999	266	33	0	0	0	0	0	0	0
2	23.6	325.0	8490	-48.1	-99.9	999	263	38	0	0	0	0	0	0	0
1	25.0	300.0	9015	-50.3	-99.9	999	263	51	0	0	0	0	0	0	0
4	27.0	268.0	9745	-54.2	-99.9	999	264	59	0	0	0	0	0	0	0
2	27.8	260.0	9940	-52.9	-99.9	999	262	57	0	0	0	0	0	0	0
1	28.8	250.0	10192	-53.9	-99.9	999	262	57	0	0	0	0	0	0	0
2	29.8	241.0	10427	-54.2	-99.9	999	261	57	0	0	0	0	0	0	0
2	30.7	232.0	10674	-49.7	-99.9	999	261	58	0	0	0	0	0	0	0
1	34.6	200.0	11650	-47.7	-99.9	999	999	999	0	0	0	0	0	0	0
2	36.4	187.0	12093	-48.2	-99.9	999	999	999	0	0	0	0	0	0	0
3	37.7	175.0	12528	-50.0	-99.9	999	999	999	0	0	0	0	0	0	0
2	39.4	162.0	13030	-52.2	-99.9	999	999	999	0	0	0	0	0	0	0
2	40.2	158.0	13193	-49.9	-99.9	999	999	999	0	0	0	0	0	0	0
1	41.7	150.0	13532	-51.2	-99.9	999	999	999	0	0	0	0	0	0	0
3	46.2	125.0	14708	-54.8	-99.9	999	999	999	0	0	0	0	0	0	0
1	51.8	100.0	16120	-59.3	-99.9	999	999	999	0	0	0	0	0	0	0
2	53.9	89.0	16841	-64.5	-99.9	999	999	999	0	0	0	0	0	0	0
2	55.8	84.0	17196	-62.6	-99.9	999	999	999	0	0	0	0	0	0	0
3	56.8	80.0	17496	-63.1	-99.9	999	999	999	0	0	0	0	0	0	0
1	59.6	70.0	18315	-64.6	-99.9	999	999	999	0	0	0	0	0	0	0
2	60.3	67.0	18582	-66.0	-99.9	999	999	999	0	0	0	0	0	0	0
3	62.9	60.0	19255	-63.8	-99.9	999	999	999	0	0	0	0	0	0	0
2	64.6	56.0	19680	-62.4	-99.9	999	999	999	0	0	0	0	0	0	0
1	67.5	50.0	20380	-62.4	-99.9	999	999	999	0	0	0	0	0	0	0
2	72.5	40.0	21766	-59.9	-99.9	999	999	999	0	0	0	0	0	0	0
2	76.9	33.0	22957	-63.9	-99.9	999	999	999	0	0	0	0	0	0	0
2	78.0	31.0	23343	-60.9	-99.9	999	999	999	0	0	0	0	0	0	0
1	79.0	30.0	23546	-62.4	-99.9	999	999	999	0	0	0	0	0	0	0
2	81.2	28.0	23971	-63.1	-99.9	999	999	999	0	0	0	0	0	0	0
3	83.9	25.0	24672	-61.0	-99.9	999	999	999	0	0	0	0	0	0	0
2	85.9	23.0	25193	-59.3	-99.9	999	999	999	0	0	0	0	0	0	0

4.6 Reclamation's Special Array Format Soundings

The general form of these soundings is shown below; however, for specific decoding procedures the user should refer to the SNDGLIB FORTRAN code.

Station identifier date time station number
CM 890907 0 312 9999

VERTICAL COLUMNS CONTAIN THE FOLLOWING INFORMATION:
pressure height temperature dew point depression wind direction speed
(kPa) (m coded) (C coded) (C coded) (deg.) (m s-1)

These variables are listed for mandatory, then significant levels. Missing data is coded as 9999. Full documentation regarding the code and this unique data format is available from Ms. Reynolds of the Water Augmentation Group.

CM	890907	0	312		9999
99	969	238	8	0	0
0	33	9999	9999	9999	9999
85	451	188	18	130	4
70	101	106	16	230	6
50	583	43	7	100	10
40	756	143	17	100	23
30	968	289	56	100	21
25	9999	9999	9999	9999	9999
20	245	509	9999	90	41
15	427	645	9999	80	71
10	667	751	9999	80	55
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
999	9999	9999	9999	9999	9999
255	373	57	124	719	9999
93	761	9999	40	571	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
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9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999

9999	9999	9999	9999	9999	9999
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9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
CV	870126	12	1027		9999
99	910	3	25	165	2
0	9999	9999	9999	9999	9999
85	586	84	62	300	2
70	185	62	70	240	3
50	584	129	67	170	14
40	751	249	66	160	16
30	9999	9999	9999	9999	9999
25	9999	9999	9999	9999	9999
20	9999	9999	9999	9999	9999
15	9999	9999	9999	9999	9999
10	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
910	3	25	900	32	57
870	94	64	850	84	62
706	66	70	582	47	68
391	263	66	375	287	66
352	309	65	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999
9999	9999	9999	9999	9999	9999

The previous examples of input sounding files show a variety of possible formats. These input files are processed automatically by the SNDLIB routines. The user simply provides the station identifier and date-time code in the interactive response as outlined in chapter 3. The model calls the SNDLIB routines, which then search the local directory for the appropriate sounding file, read its initial set of records, determine its format, then decode the sounding. This decoded sounding is then passed to the model for interpolation into model coordinates and gridded fields. For further information regarding the model, contact Dr. Matthews or Mr. Aman; for information regarding data formats and available data contact Ms. Reynolds in the Water Augmentation Group, Bureau of Reclamation, Denver CO 80225-0007, or call: (303) 236-5262.

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Mission

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American Public.