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**SUMMIT: A Computer Code to
Interpolate and Sum Single
Release Atmospheric Model
Results onto a Master Grid**

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N. J. DeBlick
J. T. Holdeman, Jr.
A. L. Sjoreen
C. W. Miller

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Health and Safety Research Division

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for the
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MASTER

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HIGHLIGHTS

This report describes a computer code for the Systematic Unification of Multiple Input Tables of data (SUMIT). This code is designed to be an integral part of the Computerized Radiological Risk Investigation System (CRRIS) for assessing the health impacts of airborne releases of radioactive pollutants. SUMIT reads radionuclide air concentrations and ground deposition rates for different release points and combines them over a specified master grid. The resulting SUMIT grid may be circular, rectangular, or consist of irregularly spaced points. SUMIT can apply a different scaling factor to all data from each source. This program is designed to sum data written by the CRRIS code ANEMOS. Of course, SUMIT could read any data organized in the same manner as ANEMOS output. Descriptions of the necessary user input and data files are provided along with a complete listing of the SUMIT code.

1. INTRODUCTION

The funding for this research was provided by the U.S. Environmental Protection Agency (EPA) which, upon assuming regulatory authority of nuclear effluents covered by the Clean Air Act of 1977, launched an extensive review and revision of models that simulate transport of radionuclides through environmental pathways to man and calculate resulting health impacts. The results of the first phase of this work, undertaken by the Health and Safety Research Division (HASRD) of the Oak Ridge National Laboratory (ORNL), are published in two reports: AIRDOS-EPA (Moore et al., 1979) and DARTAB (Begovich et al., 1981). While the AIRDOS-EPA and DARTAB computer codes have provided EPA with an interim methodology for performing nuclear assessments, work has continued at ORNL on an integrated set of computer codes and data bases which serve as a state-of-the-art radiological risk assessment methodology. This Computerized Radiological Risk Investigation System, or CRRIS (Baes, Miller, and Murphy, in press) is based on a review and evaluation of the AIRDOS-EPA/DARTAB system. This report documents one code of the CRRIS - SUMIT, a computer code for the Systematic Unification of Multiple Input Tables of data.

1.1 THE CRRIS

The relationship of SUMIT to the other codes of the CRRIS is shown in Fig. 1. PRIMUS (Hermann et al., in press) accesses a data base of decay data (Kocher, 1981) and prepares all decay chains and decay matrices which must be used in transport, dose, and risk calculations by other codes of the CRRIS. RETADD-II (Murphy, Ohr, and Begovich, 1984)

Figure 1. The codes which make up the CRRIS and possible pathways of information flow among them in performing nuclear risk assessments. Note that multiple runs of ANEMOS are summed on a master grid by SUMIT.

is a long-range trajectory atmospheric dispersion model which calculates radionuclide air concentrations and deposition rates on a square grid on a regional or continental scale. ANEMOS (Miller et al., in press) is a short-range (≤ 80 km) Gaussian plume atmospheric dispersion model which calculates radionuclide air concentrations and deposition rates on a circular grid. TERRA (Baes et al., in press) is used to calculate concentrations of radionuclides in four vegetable and produce categories, four cattle feed categories, irrigated and nonirrigated soils, beef, and milk. MLSOIL (Sjoreen et al., in press) computes an effective soil concentration to be used in ANDROS (Begovich et al., in press) to compute external dose. MLSOIL implements a multi-layered soil transport model rather than the single layer model incorporated into TERRA. ANDROS receives environmental radionuclide concentrations and combines them with population estimates, food consumption and breathing rates, and dose and risk factors to calculate population and average individual doses and risks from the source term supplied to ANEMOS or RETADD-II.

As indicated by Fig. 1, various combinations of the CRRIS codes may be used to tailor the assessment to the user's needs. For example, if only inhalation and air immersion doses and risk are to be calculated, then the user may wish to eliminate TERRA and MLSOIL from the assessment strategy. If deposition rates or air concentrations are known for a given location, then the user may wish to make the assessment by using only PRIMUS, TERRA, MLSOIL, and ANDROS.

1.2 SUMIT

The ANEMOS code considers only one release point and does not account for contributions to the air concentration and deposition rate from nearby sources. The purpose of SUMIT is to combine the results of several ANEMOS runs onto a single grid. SUMIT can interpolate one or more ANEMOS grids, which are circular, onto a circular, rectangular, or irregular grid. SUMIT will also read the data for one source several times, repositioning the source and rescaling each source's air concentrations and deposition rates. SUMIT maintains the particle size and clearance class categories for each nuclide read from ANEMOS. No extrapolation is done in SUMIT. Therefore, any points which lie within the master grid but not within any source grid will be given zero concentration. A warning message will be issued when this happens. Note that SUMIT assumes that ANEMOS has been run with the option to write point values and not cell-averaged values (MAKEDS = TRUE in ANEMOS).

Input for SUMIT consists of the selected user options and the selected ANEMOS and PRIMUS files. The SUMIT user options are presented in Sect. 4.1. Within the CRRIS, each ANEMOS output file has a corresponding PRIMUS file which contains, among other things, an indexing system for all nuclides and all nuclide decay parameters. The PRIMUS file can be written by PRIMUS or by ANEMOS. SUMIT also reads a master PRIMUS file, which contains data for the nuclide chains from all the PRIMUS source files. This master PRIMUS file will be input to later CRRIS codes along with the SUMIT output file. The output from SUMIT has the same format as an ANEMOS file; therefore, the programs TERRA,

MLSOIL, and ANDROS will treat the SUMIT file as if it is an ANEMOS file. For example, a schematic of the files needed for SUMIT to combine three separate ANEMOS runs is shown in Fig. 2.

This document is a users' guide to SUMIT and presents the computational methods used in that code. The major portion of the SUMIT code is bookkeeping for matching nuclides, particle sizes, and clearance class fractions. The purpose of the computations done in SUMIT is to interpolate the input data from the input grid to the output grid. This computation is discussed in Sect. 2. A brief discussion of the program itself is presented in Sect. 3. The user input and input files are described in Sect. 4. The code listing, sample JCL, sample input, and sample output are presented in the appendices.

Figure 2. Schematic representation of SUMIT input and output files.

2. METHODOLOGY

The method for interpolating the data from the circular ANEMOS grid to the SUMIT master grid is very flexible. Any form of master grid is acceptable. Prior to performing each transformation, the master grid points are converted to the circular coordinates of that particular ANEMOS source. Note that the transformation to a particular master grid is only performed when there are nonzero data at each of the four surrounding source points. Figure 3 represents one master grid point surrounded by four source grid points. Given a value of a function F (air concentration or deposition rate) at four corners of a sector with radial distance r_{i-1} to r_i and angular direction θ_{i-1} to θ_i , a weighting function, P^* is selected by the user to control the smoothness of the interpolation across θ . This is one of six functions:

$$\text{Option 0 } P^* = P , \quad (1)$$

$$\text{Option 1 } P^* = -2P^3 + 3P^2 , \quad (2)$$

$$\text{Option 2 } P^* = 6P^5 - 15P^4 + 10P^3 , \quad (3)$$

$$\text{Option 3 } P^* = -20P^7 + 70P^6 - 84P^5 + 35P^4 , \quad (4)$$

$$\text{Option 4 } P^* = 70P^9 - 315P^8 + 540P^7 - 420P^6 + 126P^5 , \quad (5)$$

$$\begin{aligned} \text{Option 5 } P^* &= 0 \text{ if } P < 0.5 , \\ &1 \text{ if } P > 0.5 , \text{ and} \\ &0.5 \text{ if } P = 0.5 . \end{aligned} \quad (6)$$

with

$$P = \frac{\theta - \theta_{i-1}}{\theta_j - \theta_{j-1}} . \quad (7)$$

Figure 3. Relationship of a master grid point to a source grid.

For the 0 option, the interpolation is linear. When option 5 is used, the interpolation along θ is a step function. As the option increases from 1 to 4 the interpolation along the θ direction approaches the step function. P^* is plotted versus P in Fig. 4. The function P^* was derived for the first 5 options by setting

$$P^* = \frac{\int_0^P p^n (1-p)^n dp}{\int_0^1 p^n (1-p)^n dp} \text{ for } n = 0, 1, 2, 3 \text{ and } 4.$$

The values interpolated along the radius at θ_{j-1} and θ_j are:

$$F_i = (1-P^*) F(r_i, \theta_{j-1}) + P^* F(r_i, \theta_j) , \quad (8)$$

$$F_{i-1} = (1-P^*) F(r_{i-1}, \theta_{j-1}) + P^* F(r_{i-1}, \theta_j) . \quad (9)$$

The interpolation for $\bar{F}(r, \theta)$ for $r_{i-1} \leq r \leq r_i$ and $\theta_{i-1} \leq \theta \leq \theta_i$ is

$$\bar{F}(r, \theta) = F_i \left(\frac{r}{r_i} \right)^b , \quad (10)$$

where

$$b = \frac{\log\left(\frac{F_i}{F_{i-1}}\right)}{\log\left(\frac{r_i}{r_{i-1}}\right)} , \quad (11)$$

Note that r_i , which is set in ANEMOS, is never zero. Because there should be no zero or negative values of $F(r_i, \theta_j)$, F_i is never zero. Nonetheless, the code checks for zero values of F_i and does a simple linear interpolation if one is found. If $F_i = F_{i-1}$, then $\bar{F} = F_i$.

Figure 4. Optional interpolation functions. The function P^* is derived for options 0-4 by setting $P^* = \int_0^1 p^n (1-p)^n dp / \int_0^1 p^n (1-p)^n dp$ for $n = 0, 1, 2, 3$, and 4.

3. PROGRAM DESCRIPTION

Table 1 lists each SUMIT routine, the routines they call, the routines they are called by, and their COMMON blocks. SUMIT performs the following steps to produce its master grid. First SUMIT reads the master PRIMUS file which contains all the released nuclides for all of the sources to be combined on the master grid. From this information the required arrays are allocated in MAIN from one large work array. The master grid is then set up according to the selected user option. The grid can be circular, determined from the latitude and longitude at its center, the number of radial distances, and either specific distances or the maximum distance and the mesh spacing. If a maximum distance and mesh spacing (MESHTY) are entered, then radial distances are computed as $R(i-1)=R(i)/2^{**}X$, where X is 1 for MESHTY=1, 0.5 for MESHTY=2, and 0.25 for MESHTY=3. A rectangular grid is determined by the grid distance in meters for each direction and the number of grid points in each direction. The master grid can also be a series of unrelated points which are designated by the (x,y) distance in meters or in distance in meters and direction from the reference point.

After setting up the master file size and the master grid, the source files are read one at a time. The separation of the master grid from each source grid can be determined two ways, either (1) by comparing the locations of the reference points, or (2) by specifying in ANEMOS either the radial distance and direction that each source is from the master grid reference point or the (x,y) distance in meters that the source is from the reference point. SUMIT uses the second method unless the values passed from ANEMOS are zero.

Table 1. SUMIT subroutines, routines called, and COMMON blocks

Routine	Called from	Calls to	COMMONS
MAIN		PMAIN	
PMAIN	MAIN	BSERCH FIGRAD PRNTOT PTKEYS RADCFK TRNFMC TRNFMR	AS K M2 MY POS
BSERCH	PMAIN		POS
F4INTR	RADCHK		
FIGRAD	PMAIN		
PRNTOT	PMAIN	UNPACK	AS
PTKEYS	PMAIN		K
RADCHK	PMAIN	F4INTR	AS K M2 MY POS
TRNFMC	PMAIN		
TRNFMR	PMAIN		
UNPACK	PRNTOT		

The radionuclides of each source file are located in the master radionuclide list. Then, the source data are written to a random-access file in order to make the data more readily accessible. The records are keyed by location (radial distance and angle) and by the ANEMOS indicator which described the data as air concentrations (by the particle sizes) or deposition rates.

The master grid values are calculated node by node. First, the distance and direction of the master grid node from the ANEMOS reference point are calculated in TRNFMC or TRNFMR. If the master grid node is within the boundary of the ANEMOS computations, then the four ANEMOS grid points which surround the master node are found in BSERCH and their locations in the random access file are found in PTKEYS.

In subroutine RADCHK the interpolated grid value is computed, summed with the nuclide values at that node for previous sources, and written to a random access file for the master grid. All four source points are checked to make sure that not only the nuclides agree but also that particle size and clearance classes agree before the air concentrations can be interpolated.

After each ANEMOS source is interpolated onto the master grid as described, the entire master file is output in subroutine PRNTOT in the format of an ANEMOS file that can be read by TERRA, MLSOIL, and ANDROS.

4. INPUT

The input options and the input files needed to run SUMIT are described below. The logical unit numbers used for input, output, and scratch files are defined in Sect. 4.2. Appendix A and the documents for PRIMUS and ANEMOS give more details of the PRIMUS and ANEMOS files. A sample data set is shown in Appendix B. The printed output of these data is shown in Appendix D.

4.1 USER INPUT

The user options for SUMIT are entered in NAMELIST format. The NAMELIST names are presented below, in order, and with an explanation of each of the input variables. The default value for each variable is given in parentheses following the variable definition.

NAMELIST/OPTION/TITLE, NSOURC, INTERP, IOUT, CHGSRC, IOPT, YMLAT, XMLON

TITLE	= The title written on the SUMIT output file, up to 80 characters. (' ')
NSOURC	= The number of ANEMOS source files to be interpolated onto the master grid, a maximum of 10. (1)
INTERP	= The option for the interpolation formula, see Sect. 2. (0)
IOUT	= Option to print interpolated master grid; IOUT = 0 means do not print it. (0)
CHGSRC	= Option to multiply all air concentration and ground deposition rates by an input factor VNEW in NAMELIST/SRCID/, one VNEW is entered for each source; if FALSE, no multiplication is done. (FALSE)

IOPT = 1 for output master grid to be a regular circular grid.
 = 2 for output master grid to be a regular rectangular grid.
 = 3 for output on unrelated grid points using distance and direction.
 = 4 for output on unrelated grid points using x,y distance.
 (1)
YMLAT = latitude of reference point of master grid in decimal degrees.
 (0.)
YMLON = longitude of reference point of master grid in decimal degrees.
 (0.)

Note that YMLAT and YMLON above refer to the center of a circular grid or the southwest corner of a rectangular grid. Depending on the value of IOPT, one of CGRID, RGRID, or UPTS is read, as explained below.

If IOPT = 1

CGRID is read to set up circular grid. If you want SUMIT to compute the radial distances, then XMAX is entered and MESHTY is used to compute the radial distances. Otherwise, enter the distances you have selected in array DIST.

NAMelist/CGRID/MESHTY,XMAX,MNUMXC,DIST

MESHTY = 1, consecutive distances are increased by 2.
 = 2, consecutive distances are increased by $2^{0.5}$.
 = 3, consecutive distances are increased by $2^{0.25}$. (1)
XMAX = largest radial distance in meters. (0.)
MNUMXC = number of radial distances, a maximum of 20. (1)
DIST = user-selected radial distances in meters. (0.)

If IOPT = 2, RGRID is read to set up a rectangular grid.

NAMelist/RGRID/XMESH,YMESH,MNUMXR,MNUMYR

XMESH = distance in meters between 2 consecutive grid points in x direction. (1)

YMESH = distance in meters between 2 consecutive grid points in y direction. (1)

MNUMXR = number of grid cells in x direction. (1)

MNUMYR = number of grid cells in y direction. (1)

If IOPT=3 or 4, UPTS is read to set up the irregularly spaced points.

NAMLIST/UPTS/NPTS,ANGLE,MXDARY,MYDARY

NPTS = the number of points in the grid. (1)

ANGLE = if IOPT = 3, the units in which MYDARY is entered, enter 'DEG' or 'RAD'. 5.0('RAD')

MXDARY = distance in meters in x direction from the reference point. (1.)

MYDARY = direction from the reference point if IOPT = 3. (0. rad = east, 0. deg = north)

= distance in meters in y direction from the reference point if IOPT = 4. (0.)

If CHGSRC=.TRUE. then SRCID is read for each source (i.e., NSOURC times).

NAMLIST/SRCID/XNEW,YNEW,VNEW

XNEW = new longitude for the source. (0.)

YNEW = new latitude for the source. (0.)

VNEW = scaling factor for all air concentrations and ground deposition rates. (1.)

4.2 SUMIT FILES

The I/O units used by SUMIT are listed in Table 2. The units numbered 61 to 70 are the units for the ANEMOS output files which will be combined on the master grid. The units numbered 51 to 60 are the

Table 2. I/O units used in SUMIT

Unit Number	Use	Purpose
5	input	user options
6	output	printed data
20	input	master PRIMUS file
44	i/o	random access scratch file for summed master grid data
45	output	main SUMIT data files
51,...,60	input	source PRIMUS files
61,...,70	input	source ANEMOS files
77	i/o	random access scratch file, temporay storage of ANEMOS input files

units for the PRIMUS files which correspond to the ANEMOS files. Note that the same ANEMOS and PRIMUS files can be read from more than one unit number. Unit 20 is the master PRIMUS file which contains information on the complete list of radionuclides that will be output by SUMIT. This file also is required along with the SUMIT output file for execution of TERRA, MISOIL, and ANDROS. If a single list of radionuclides is used for all the ANEMOS files, then units 51-60 and 20 may be the same file. Unit 45 is the SUMIT output file. It is in the same format as an ANEMOS output file, and it contains all the data from the input ANEMOS files interpolated onto the master grid. Unit 44 is a temporary random access file which stores the master grid values. Each record represents a node on the master grid. Unit 77 is a temporary random access file which stores an ANEMOS output file for easy retrieval as the file is interpolated onto the master grid.

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5. SUMMARY

SUMIT uses air concentrations and ground deposition rates calculated for each radionuclide release point in a given area and combines them over a specified master grid area. The program is designed to work with ANEMOS output from the CRRIS, but it may also work independently with any data organized in the same manner.

SUMIT expands the usefulness of ANEMOS. A multiple source assessment can be reduced to one set of output. One ANEMOS run can be applied to different assessments by relocating and/or rescaling the data. SUMIT can reduce the number of runs you must do for an assessment and allows great flexibility in grid geometry.

6. REFERENCES

- [1] C. F. Baes, III, C. W. Miller, and B. D. Murphy, in press, An Introduction to CRRIS: A Computerized Radiological Risk Investigation System for Assessing Atmospheric Releases of Radionuclides. ORNL/TM-8573, Oak Ridge National Laboratory.
- [2] C. F. Baes, III, R. D. Sharp, A. L. Sjoeren, and O. W. Hermann, in press, TERRA: A Computer Code for Calculation of the Transport of Environmentally Released Radionuclides Through Agriculture. ORNL-5785, Oak Ridge National Laboratory.
- [3] C. L. Begovich, K. F. Eckerman, E. C. Schlatter, S. Y. Ohr, and R. O. Chester, 1981, DARTAB: A Program to Combine Airborne Radionuclide Environmental Exposure Data with Dosimetric and Health Effects Data to Generate Tabulations of Predicted Health Impacts. ORNL-5692, Oak Ridge National Laboratory.
- [4] C. L. Begovich, S. Y. Ohr, A. L. Sjoeren, and R. O. Chester, in press, ANDROS: A Code for Assessment of Nuclide Doses and Risks with Options Selection. ORNL-5889, Oak Ridge National Laboratory.
- [5] O. W. Hermann, C. F. Baes, III, C. W. Miller, C. L. Begovich, and A. L. Sjoeren, in press, PRIMUS: A Computer Code for the Preparation of Radionuclide Ingrowth Matrices from User-Specified Sources. ORNL-5912, Oak Ridge National Laboratory.
- [6] D. C. Kocher, 1981, Radioactive Decay Data Tables. U.S. Department of Energy DOE/TIC-11026.
- [7] C. W. Miller, C. L. Begovich, O. W. Hermann, and A. L. Sjoeren, in press, ANEMOS: A Computer Code to Estimate Air Concentrations and Ground Deposition Rates for Atmospheric Nuclides Emitted from Multiple Operating Sources. ORNL-5913, Oak Ridge National Laboratory.
- [8] R. E. Moore, C. F. Baes III, L. M. McDowell-Boyer, A. P. Watson, F. O. Hoffman, J. C. Pleasant, and C. W. Miller, 1979, AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides. ORNL-5532, Oak Ridge National Laboratory.
- [9] B. D. Murphy, S. Y. Ohr, and C. L. Begovich, 1984, RETADD-II: A Long Range Atmospheric Trajectory Model with Consistent Treatment of Deposition Loss and Species Growth and Decay. ORNL/CSD-99, Oak Ridge National Laboratory.
- [10] A. L. Sjoeren, D. C. Kocher, G. G. Killough, and C. W. Miller, in press, MLSOIL and DFSOIL - Computer Codes to Estimate Effective Ground Surface Concentrations for Dose Computations. ORNL-5974, Oak Ridge National Laboratory.

Appendix A

A.1 The PRIMUS File

A complete description of the PRIMUS file can be found in the code documentation (Hermann, et al., in press). Only the data in the file that are used in SUMIT is described here. The file is unformatted and can be written by either PRIMUS or ANEMOS.

The first record contains the total number of nuclides in the data file as the third word. The second record contains two arrays, IC and JC, each dimensioned by the total number of nuclides. The arrays IC and JC are indices for each radionuclide. The j^{th} position in JC contains the index of the released radionuclide which propagates nuclide j ; the j^{th} position in IC contains the position of nuclide j in the array of all nuclides present. The only other information which is used from the PRIMUS file is the fourth record which contains the number of released radionuclides and the total number of nuclides present.

A.2 The ANEMOS File

The ANEMOS file is an unformatted file which contains three header records and four or five records for each location.

Record 1 Variables: TITLE, GRDOPT, IPTOGR, YLAT, XLON,
RLOC, THLOC, XDIFF, YDIFF, UNIT, NLOC

TITLE: Title associated with the file (80 characters).

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GRDOPT: 1 for a circular grid (necessary for SUMIT), 2 for a rectangular grid.

IPTOGR: 1 implies that data were computed for each grid node (MAKEDS=TRUE in ANEMOS), 2 implies that data were averaged over each grid cell.

YLAT: Latitude of center of grid in decimal degrees.

XLON: Longitude of center of grid in decimal degrees.

RLOC: Distance (m) that this source is from master grid reference point.

THLOC: Angular direction that this source is from the reference point of the master grid in radians.

XDIFF: Distance (m) in the x direction that this source is from the reference point of the master grid.

YDIFF: Distance (m) in the y direction that this source is from the reference point of the master grid.

UNIT: Units of concentration (Bq or Ci).

NLOC: Number of locations in grid.

Record 2 Variables ICODE, OPTS

ICODE: Variable indicating which air model was used: 1 = ANEMOS, 2 = RETADD-II (must be 1 for SUMIT).

OPTS: List of 12 options used in ANEMOS; see Miller et al. (in press) for definitions.

Record 3 Variables NREL, [ZASREL(I), I = 1, NREL], NEXP, [ZASEXP(I), I = 1, NEXP]

NREL = Number of released radionuclides.

ZASREL = ZAS numbers of released radionuclides; see Hermann et al. (in press) for definition.

NEXP = Number of exposure nuclides.

ZASEXP = ZAS numbers of exposure nuclides.

Appendix B


```
βOPTION TITLE='SUMIT - ONE ANEMOS FILE TWICE',  
NSOURC=2, INTERP=3, IOUT=1, CHGSRG=.TRUE.,  
IOPT=1, XMLON=93.1, YMLAT=35.3, βEND  
βCGRID MNUMXC=4, DIST=100., 200., 300., 400., βEND  
βSRCID XNEW=93.1, YNEW=35.3, VNEW=1., βEND  
βSRCID XNEW=93.105, YNEW=35.305, VNEW=1.5, βEND
```

Appendix C

```

//ALSUMI2 JOB (22864,TAPE,I30),'XCSD/B212/ALS',TIME=(1)
/*ROUTE PRINT RMT59
//SCR EXEC PGM=IEFBR14
//DATASET DD UNIT=3330V,VOL=SER=VTATWO,DISP=(OLD,DELETE),
// DSN=X.ALS22864.SUMCIR
//STP1 EXEC SPDASCR
//SYSIN DD *
    T.ALS22864.SMTMP
// EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=A
//SYSIN DD DUMMY
//SYSUT2 DD UNIT=SPDA,DSN=T.ALS22864.SMTMP,DISP=(NEW,CATLG),
// DCB=(RECFM=VBS,BLKSIZE=2000),SPACE=(1000,4500,RLSE)
//SYSUT1 DD DSN=ANEMOS.INB,LABEL=(12,SL,,IN),DISP=(OLD,KEEP),
// UNIT=TAPE62,VOL=SER=X12227,DCB=(RECFM=VBS,BLKSIZE=2000,DEN=4)
// EXEC FORTHCLG,PARM.FORT='XREF',
// PARM.GO='EU=-1',REGION.GO=550K
//*FORT.SYSPRINT DD DUMMY
//FORT.SYSIN DD *
=SUMIT.FTN
//GO.FT20F001 DD DSN=T.ALS22864.PRIMU2,UNIT=SPDA,DISP=SHR
//GO.FT51F001 DD DSN=T.ALS22864.PRIMU2,UNIT=SPDA,DISP=SHR
//GO.FT52F001 DD DSN=T.ALS22864.PRIMU2,UNIT=SPDA,DISP=SHR
//GO.FT61F001 DD DSN=T.ALS22864.SMTMP,DISP=SHR,UNIT=SPDA
//GO.FT62F001 DD DSN=T.ALS22864.SMTMP,DISP=SHR,UNIT=SPDA
//GO.FT77F001 DD UNIT=SYSDA,DSN=ββTEMPA,DISP=(NEW,PASS),
// SPACE=(1000,4500,RLSE)
//GO.FT44F001 DD UNIT=SYSDA,DSN=ββTEMPB,DISP=(NEW,PASS),
// SPACE=(1000,9600,RLSE)
//GO.FT45F001 DD UNIT=3330V,DSN=X.ALS22864.SUMCIR,
// DISP=(NEW,CATLG),DCB=(RECFM=VBS,LRECL=X,BLKSIZE=2000),
// SPACE=(2000,(20,8),RLSE),VOL=SER=VTATWO
//GO.FT30F001 DD SYSOUT=A
//GO.FT05F001 DD *
=SUMIT.DAT
/*
//
ENDINPUT

```

Appendix D

*** SUNIT *** A PROGRAM TO COMBINE ANEMOS SOURCES ON A MASTER GRID
 TITLE OF THE OUTPUT FILE IS : SUNIT - ONE ANEMOS FILE TWICE

NSOURC = 2; NUMBER OF ANEMOS SOURCE FILES TO BE INTERPOLATED ONTO THE MASTER GRID

INTERP = 3; THE OPTION FOR THE INTERPOLATION FORMULA

YMLAT = 3.53D 01; LATITUDE OF REF. POINT OF MASTER GRID

YMLON = 0.0 ; LONGITUDE OF REFERENCE POINT OF MASTER GRID

IOPT = 1 MEANS THAT;
 THE OUTPUT MASTER GRID IS A REGULAR CIRCULAR GRID

NRUNXC = 4; NUMBER OF RADIAL DISTANCES

USER-SELECTED RADIAL DISTANCES IN METERS

1.00E 02

2.00E 02

3.00E 02

4.00E 02

CHGSRG IS TRUE; MULTIPLY ALL AIR CONCENTRATIONS AND GROUND DEPOSITION RATES BY
 INPUT FACTOR WHEN

FOR SOURCE 1: VNEW = 1.00E 00
XNEW = 9.31E 01; NEW LONGITUDE FOR THE SOURCE
YNEW = 3.53E 01; NEW LATITUDE FOR THE SOURCE

SOURCE 1
TITLE ON THE FILE IS TEST CASE, USING EVANSVILLE, IND. NET.DAT
REFERENCE LATITUDE(DEGREES) = 35.300
REFERENCE LONGITUDE(DEGREES)= 93.100

DISTANCE BETWEEN MASTER GRID REFERENCE POINT AND SOURCE GRID REFERENCE IS
ANGULAR DIRECTION (RAD) = -0.6448 00
RADIAL DISTANCE (M) = 0.1538-04

MASTER GRID		SOURCE GRID		SOURCE GRID POINTS			
DISTANCE	DIRECTION	DISTANCE	DIRECTION	DISTANCE		DIRECTION	
(M)	(RADIAN)	(M)	(RADIAN)				
100.00	1.7671	100.00	1.7671				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	1.7671	200.00	1.7671	1	2	1	2
300.00	1.7671	300.00	1.7671	1	2	1	2
400.00	1.7671	400.00	1.7671	2	3	1	2
100.00	1.3744	100.00	1.3744				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	1.3744	200.00	1.3744	1	2	2	3
300.00	1.3744	300.00	1.3744	1	2	2	3
400.00	1.3744	400.00	1.3744	2	3	2	3
100.00	0.9817	100.00	0.9817				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	0.9817	200.00	0.9817	1	2	3	4
300.00	0.9817	300.00	0.9817	1	2	3	4
400.00	0.9817	400.00	0.9817	2	3	3	4
100.00	0.5890	100.00	0.5890				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	0.5890	200.00	0.5890	1	2	4	5
300.00	0.5890	300.00	0.5890	1	2	4	5
400.00	0.5890	400.00	0.5890	2	3	4	5
100.00	0.1963	100.00	0.1963				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	0.1963	200.00	0.1963	1	2	5	6
300.00	0.1963	300.00	0.1963	1	2	5	6
400.00	0.1963	400.00	0.1963	2	3	5	6
100.00	6.0868	100.00	5.8905				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	6.0868	200.00	5.8905	1	2	6	7
300.00	6.0868	300.00	5.8905	1	2	6	7
400.00	6.0868	400.00	5.8905	2	3	6	7
100.00	5.6941	100.00	5.4978				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	5.6941	200.00	5.4978	1	2	7	8
300.00	5.6941	300.00	5.4978	1	2	7	8
400.00	5.6941	400.00	5.4978	2	3	7	8
100.00	5.3014	100.00	5.1051				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	5.3014	200.00	5.1051	1	2	8	9
300.00	5.3014	300.00	5.1051	1	2	8	9
400.00	5.3014	400.00	5.1051	2	3	8	9

100.00	4.9087	100.00	4.7124				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	4.9087	200.00	4.7124	1	2	9	10
300.00	4.9087	300.00	4.7124	1	2	9	10
400.00	4.9087	400.00	4.7124	2	3	9	10
100.00	4.5160	100.00	4.3197				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	4.5160	200.00	4.3197	1	2	10	11
300.00	4.5160	300.00	4.3197	1	2	10	11
400.00	4.5160	400.00	4.3197	2	3	10	11
100.00	4.1233	100.00	3.9270				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	4.1233	200.00	3.9270	1	2	11	12
300.00	4.1233	300.00	3.9270	1	2	11	12
400.00	4.1233	400.00	3.9270	2	3	11	12
100.00	3.7306	100.00	3.5343				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	3.7306	200.00	3.5343	1	2	12	13
300.00	3.7306	300.00	3.5343	1	2	12	13
400.00	3.7306	400.00	3.5343	2	3	12	13
100.00	3.3379	100.00	3.1416				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	3.3379	200.00	3.1416	1	2	13	14
300.00	3.3379	300.00	3.1416	1	2	13	14
400.00	3.3379	400.00	3.1416	2	3	13	14
100.00	2.9452	100.00	2.9452				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	2.9452	200.00	2.9452	1	2	14	15
300.00	2.9452	300.00	2.9452	1	2	14	15
400.00	2.9452	400.00	2.9452	2	3	14	15
100.00	2.5525	100.00	2.5525				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	2.5525	200.00	2.5525	1	2	15	16
300.00	2.5525	300.00	2.5525	1	2	15	16
400.00	2.5525	400.00	2.5525	2	3	15	16
100.00	2.1598	100.00	2.1598				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	2.1598	200.00	2.1598	1	2	16	1
300.00	2.1598	300.00	2.1598	1	2	16	1
400.00	2.1598	400.00	2.1598	2	3	16	1

FOR SOURCE 2: VNEW = 1.50E 00
 XNEW = 9.31E 01; NEW LONGITUDE FOR THE SOURCE
 YNEW = 3.53E 01; NEW LATITUDE FOR THE SOURCE

SOURCE 2
 TITLE ON THE FILE IS TEST CASE, USING EVANSVILLE, IND. NET.DAT
 REFERENCE LATITUDE(DEGREES) = 35.305
 REFERENCE LONGITUDE(DEGREES)= 93.105

DISTANCE BETWEEN MASTER GRID REFERENCE POINT AND SOURCE GRID REFERENCE IS
 ANGULAR DIRECTION (RAD) = 0.7860 00
 RADIAL DISTANCE (K) = 0.7060-02

MASTER GRID		SOURCE GRID		SOURCE GRID POINTS			
DISTANCE	DIRECTION	DISTANCE	DIRECTION	DISTANCE	DIRECTION		
(M)	(RADIAN)	(M)	(RADIAN)				
100.00	1.7671	100.00	1.7672				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	1.7671	200.00	1.7672	1	2	16	1
300.00	1.7671	300.00	1.7672	1	2	16	1
400.00	1.7671	400.00	1.7672	2	3	16	1
100.00	1.3744	99.99	1.3745				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	1.3744	199.99	1.3745	1	2	1	2
300.00	1.3744	299.99	1.3745	1	2	1	2
400.00	1.3744	399.99	1.3745	2	3	1	2
100.00	0.9817	99.99	0.9818				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	0.9817	199.99	0.9818	1	2	2	3
300.00	0.9817	299.99	0.9818	1	2	2	3
400.00	0.9817	399.99	0.9818	2	3	2	3
100.00	0.5890	99.99	0.5890				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	0.5890	199.99	0.5890	1	2	4	5
300.00	0.5890	299.99	0.5890	1	2	4	5
400.00	0.5890	399.99	0.5890	2	3	4	5
100.00	0.1963	99.99	0.1963				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	0.1963	199.99	0.1963	1	2	4	5
300.00	0.1963	299.99	0.1963	1	2	4	5
400.00	0.1963	399.99	0.1963	2	3	4	5
100.00	6.0868	100.00	5.8904				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	6.0868	200.00	5.8905	1	2	6	7
300.00	6.0868	300.00	5.8905	1	2	6	7
400.00	6.0868	400.00	5.8905	2	3	6	7
100.00	5.6941	100.00	5.4977				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	5.6941	200.00	5.4978	1	2	7	8
300.00	5.6941	300.00	5.4978	1	2	7	8
400.00	5.6941	400.00	5.4978	2	3	7	8
100.00	5.3014	100.00	5.1050				
POINTS OUT OF RANGE OF SOURCE GRID.							
200.00	5.3014	200.00	5.1051	1	2	8	9
300.00	5.3014	300.00	5.1051	1	2	8	9
400.00	5.3014	400.00	5.1051	2	3	8	9

100.00	4.9087	100.00	4.7123				
POINTS OUT OF RANGE OF		SOURCE GRID.					
200.00	4.9087	200.00	4.7124	1	2	9	10
300.00	4.9087	300.00	4.7124	1	2	9	10
400.00	4.9087	400.00	4.7124	2	3	9	10
100.00	4.5160	100.01	4.3196				
POINTS OUT OF RANGE OF		SOURCE GRID.					
200.00	4.5160	200.01	4.3197	1	2	10	11
300.00	4.5160	300.01	4.3197	1	2	10	11
400.00	4.5160	400.01	4.3197	2	3	10	11
100.00	4.1233	100.01	3.9270				
POINTS OUT OF RANGE OF		SOURCE GRID.					
200.00	4.1233	200.01	3.9270	1	2	11	12
300.00	4.1233	300.01	3.9270	1	2	11	12
400.00	4.1233	400.01	3.9270	2	3	11	12
100.00	3.7306	100.01	3.5343				
POINTS OUT OF RANGE OF		SOURCE GRID.					
200.00	3.7306	200.01	3.5343	1	2	12	13
300.00	3.7306	300.01	3.5343	1	2	12	13
400.00	3.7306	400.01	3.5343	2	3	12	13
100.00	3.3379	100.01	3.1416				
POINTS OUT OF RANGE OF		SOURCE GRID.					
200.00	3.3379	200.01	3.1416	1	2	13	14
300.00	3.3379	300.01	3.1416	1	2	13	14
400.00	3.3379	400.01	3.1416	2	3	13	14
100.00	2.9452	100.00	2.9453				
POINTS OUT OF RANGE OF		SOURCE GRID.					
200.00	2.9452	200.00	2.9453	1	2	13	14
300.00	2.9452	300.00	2.9453	1	2	13	14
400.00	2.9452	400.00	2.9453	2	3	13	14
100.00	2.5525	100.00	2.5526				
POINTS OUT OF RANGE OF		SOURCE GRID.					
200.00	2.5525	200.00	2.5526	1	2	14	15
300.00	2.5525	300.00	2.5526	1	2	14	15
400.00	2.5525	400.00	2.5526	2	3	14	15
100.00	2.1598	100.00	2.1599				
POINTS OUT OF RANGE OF		SOURCE GRID.					
200.00	2.1598	200.00	2.1599	1	2	15	16
300.00	2.1598	300.00	2.1599	1	2	15	16
400.00	2.1598	400.00	2.1599	2	3	15	16

LOCATION = 200.00 TO 300.00 348.75 TO 11.25

[illegible]

TEST CASE, USING EVANSVILLE, IND. NET. DATA

[illegible]

Appendix E

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C      THIS DRIVER PROGRAM START ALLOCATES STORAGE FROM ARRAY  $\pi A \pi$  TO
C      A NUMBER OF OTHER ARRAYS IN SUBROUTINE PMAIN.
C
C      INTEGER TNPACK, CONC1, CONC2, CONC3, CONC4, CLCLS1, CONC,
C      > PSIZE, CLCLS
C      *** MAXA MUST BE SET TO THE DIMENSION OF ARRAY A ***
C      DIMENSION A(20000)
C      DATA MAXA, MAXRNP / 20000 , 2000 /
C
C      READ TOTAL NUMBER OF RELEASED AND EXPOSURE NUCLIDES
C      FROM PRIMUS TO DETERMINE THE ARRAY LENGTHS
C
C      REWIND 20
C      READ(20) DUM, DUM, TNPACK
C
C      CONC1=1
C      CONC2=CONC1+TNPACK
C      CONC3=CONC2+TNPACK
C      CONC4=CONC3+TNPACK
C      CLCLS1=CONC4+TNPACK
C      ICT=CLCLS1+4*TNPACK
C      JCT=ICT+TNPACK
C      IC=JCT+TNPACK
C      JC=IC+MAXRNP
C      CONC=JC+MAXRNP
C      PSIZE=CONC+MAXRNP
C      CLCLS=PSIZE+MAXRNP
C      LAST=CLCLS+4*MAXRNP-1
C      IF (LAST.IE.MAXA) GO TO 10
C
C      WRITE(6,10000)
C      WRITE(6,10100) LAST
C      STOP
C
C      10 CALL PMAIN(TNPACK, MAXRNP, A(CONC1), A(CONC2), A(CONC3),
C      > A(CONC4), A(CLCLS1), A(ICT), A(JCT), A(IC), A(JC), A(CONC), A(PSIZE),
C      > A(CLCLS))
C
C      LEFT=MAXA-LAST
C      WRITE(6,10200) LEFT
C      STOP
C      10000 FORMAT(///' ***** INSUFFICIENT STORAGE TO CONTINUE *****')
C      10100 FORMAT(// ' ARRAY  $\pi A \pi$  IN PROGRAM START MUST BE DIMENSIONED'
C      > ' AT LEAST', I7///)
C      10200 FORMAT(///' UNUSED STORAGE IN THIS RUN WAS', I6, ' WORDS')
C      END
C
C

```

```

C*****
C      INTEGER*4
C  ASSVAR:  AN ASSOCIATED VARIABLE FOR FILE #77.  AT THE
C           CONCLUSION OF EACH READ OR WRITE OPERATION, ITS VALUE
C           POINTS TO THE KEY VALUE OF THE RECORD IMMEDIATELY
C           FOLLOWING THE LAST RECORD TRANSMITTED.
C  ASSVR2:  AN ASSOCIATED VARIABLE FOR FILE #44.  (SAME AS ASSVAR)
C  AZSEN:   A PACKED ARRAY CONTAINING THE AZS NUMBERS OF THE
C           EXPOSURE RADIONUCLIDES.
C  AZSRN:   A PACKED ARRAY CONTAINING THE AZS NUMBERS OF THE
C           RELEASED RADIONUCLIDES.
C  DUM1,DUM2,DUMMY1,DUMMY2:  DUMMY VARIABLES.
C  FINDEX:  FILE NUMBER OF THE SOURCE THAT IS BEING READ IN.
C  FINDX2:  FILE NUMBER OF THE FILE FROM PRIMUS THAT TELLS
C           HOW THE RADIONUCLIDES ARE PACKED FOR THE SOURCE
C           THAT IS BEING READ IN.
C  GRDOPT:  USER OPTION - '1' FOR A POLAR GRID,
C           '2' FOR A RECTANGULAR GRID.
C  IC:      TELLS HOW THE EXPOSURE RADIONUCLIDES ARE PACKED.
C  ICT:     TELLS HOW THE TOTAL NUMBER OF EXPOSURE RADIONUCLIDES
C           FROM ALL THE SOURCES ARE PACKED.
C  IND:     TELLS IF THE VALUES BEING READ IN TO THE CONC ARRAY
C           ARE AIR CONCENTRATION VALUES (IND = 1 OR 2) OR GROUND
C           DEPOSITION RATES (IND = 10).
C  IPTOGR:  USER OPTION - '1' FOR CONCENTRATION VALUES AT A POINT,
C           '2' FOR CONCENTRATION VALUES OVER A GRID CELL.
C  JC:      TELLS HOW THE RELEASED RADIONUCLIDES ARE PACKED.
C  JCT:     TELLS HOW THE TOTAL NUMBER OF RELEASED RADIONUCLIDES
C           FROM ALL THE SOURCES ARE PACKED.
C  KEY1:    KEY VALUE FOR LOWER LEFT POINT OF INTERPOLATION POLYGON.
C  KEY2:    KEY VALUE FOR LOWER RIGHT POINT.
C  KEY3:    KEY VALUE FOR UPPER RIGHT POINT.
C  KEY4:    KEY VALUE FOR UPPER LEFT POINT.
C  KNTSRC:  KEEPS COUNT OF THE NUMBER OF SOURCES THAT
C           HAVE BEEN READ IN.
C  MAPEXP:  AN ARRAY THAT MAPS THE LOCATION OF AN AZS
C           NUMBER OF AN EXPOSURE RADIONUCLIDE FROM THE AZSEN ARRAY
C           TO WHERE THE SAME EXPOSURE RADIONUCLIDE AZS NUMBER
C           IS LOCATED IN THE MTNEXP ARRAY.
C  MAPREL:  SAME AS MAPEXP EXCEPT WORKS FOR RELEASED RADIONUCLIDES.
C  MESHTY:  USER OPTION - MESH SIZE OF FINE, MEDIUM OR COURSE CAN
C           BE SPECIFIED FOR THE MASTER GRID.
C  MLCARY:  AN ARRAY IN WHICH EACH LOCATION CORRESPONDS TO A RADIAL,
C           ARC POSITION.  EACH LOCATION CONTAINS THE KEY VALUE FOR THE
C           FIRST DATA RECORD AT THAT PARTICULAR RADIAL,ARC POSITION.
C  MNUMX:   USER OPTION - NUMBER OF ARCS FOR MASTER GRID.
C  MRDARY:  AN ARRAY THAT CONTAINS THE VALUES FOR THE MASTER
C           GRIDS RADIAL DISTANCES.
C  MTNREL:  AN ARRAY OF ALL THE SOURCES RELEASED RADIONUCLIDES
C           AZS NUMBERS.

```



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C  MTNEXP:  AN ARRAY OF ALL THE SOURCES EXPOSURE RADIONUCLIDES
C  AZS NUMBERS.
C  NAMESR:  NAME OF SOURCE.
C  NIND:    TELLS THE NUMBER OF INDS THAT FOLLOW.
C  NLOC:    NUMBER OF CELLS OR POINTS IN THE SOURCE GRID.
C  NNE:     THE NUMBER OF RELEASED RADIONUCLIDES FOR A GIVEN SOURCE.
C  PASSED FROM PRIMUS TO COMPARE WITH THE VALUE OF NRNUCS (FROM
C  ANEMOS) FOR AGREEMENT.  AGREEMENT SHOWS THAT THE DATA FROM
C  PRIMUS AND FROM ANEMOS ARE FOR THE SAME SOURCE.
C  NNN:     THE NUMBER OF EXPOSED RADIONUCLIDES FOR A GIVEN SOURCE.
C  USED LIKE NNE IS USED.
C  NPACK:   THE TOTAL NUMBER OF RELEASED AND EXPOSURE
C  RADIONUCLIDE COMBINATIONS THAT EXIST.
C  NREXP:   THE NUMBER OF EXPOSURE RADIONUCLIDES IN A SOURCE.
C  NENUCS:  THE NUMBER OF RELEASED RADIONUCLIDES IN A SOURCE.
C  NSOURC:  THE NUMBER OF SOURCES THAT ARE TO BE SUMMED ONTO
C  THE MASTER GRID.
C  NUMX:    NUMBER OF RADIAL DISTANCES IN A SOURCE GRID.
C*****      REAL*4
      SUBROUTINE PMAIN(TNPACK,MAXRNP,CONC1,CONC2,CONC3,CONC4,
> CLCLS1,ICT,JCT,IC,JC,CONC,PSIZE,CLCLS)
      DOUBLE PRECISION XMLON,YMLAT,YLAT,XLON,DIFX,DIFY,CONV,THLOC,
A  RLOC,XMESH,YMESH,ZERO
      REAL MARRAY,MXDARY,MYDARY
      LOGICAL CHGSRC
      INTEGER ASSVAR,ASSVR2,FINDEX,FINDX2,TNPACK,TNREL,TNEXP,AZSRN,
> RNPACK,TITLE,GRDOPT,AZSEN,DUMMY1,DUMMY2,DUM1,DUM2,SLCARY
      LOGICAL OPTS(12)
      NAMELIST/OPTION/TITLE,NSOURC,INTERP,IOUT,CHGSRC,IOPT,YMLAT,XMLON
      NAMELIST/CGRID/MESHTY,XMAX,MNUMXC,DIST
      NAMELIST/RGRID/XMESH,YMESH,MNUMXR,MNUMYR
      NAMELIST/UPTS/NPTS,MXDARY,MYDARY,ANGLE
      NAMELIST/SRCID/XNEW,YNEW,VNEW
C
      DIMENSION CONC1(TNPACK),CONC2(TNPACK), CONC3(TNPACK)
> ,CONC4(TNPACK),CLCLS1(4,TNPACK), ICT(TNPACK),JCT(TNPACK),
> IC(MAXRNP),JC(MAXRNP),CONC(MAXRNP), PSIZE(MAXRNP),CLCLS(4,MAXRNP)
      DIMENSION MTNREL(100),MTNEXP(100),AZSRN(50),AZSEN(50), SRDARY(20),
> MXDARY(20),MYDARY(20),TITLE(20),SLCARY(20,16),
> DIST(20),THETAR(16)
      DATA THETAR/ 1.767146,1.374447, .981748, .589049, .196350,
> 6.086836,5.694137,5.301438, 4.908738,4.516039,4.123340,3.730641,
> 3.337942,2.945243,2.552544,2.159845/,ZERO/0.0D0/
C
      COMMON /POS/F(4),R1,R2,T1,T2,R,T
      COMMON /MY/MARRAY(7,60,100)
      COMMON /M2/MAPEXP(50),MAPREL(50),MLCARY(20,16),MIND
      COMMON /AS/ASSVAR,ASSVR2

```

C

```

DATA BQ/'BQ'/.TITLE/'SUMIT OUTPUT'/.ANGLE/'DEG'/.RAD/'RAD'/
DEFINE FILE 77(4500,250,U,ASSVAR)
DEFINE FILE 44(9500,250,U,ASSVR2)
CR=0.0
CT=0.0
MR1=0
MR2=0
MT1=0
MT2=0
NSOURC=1
YMLAT=0.
YMLON=0.
MESHTY=1
XMAX=0
DIST(1)=0.
XMESH=1.
YMESH=1.
MNUMXR=1
MNUMYR=1
NPTS=1
MXDARY(1)=1.
MYDARY(1)=0.
XNEW=0.
YNEW=0.
VNEW=1.
FINDEX = 60
FINDX2 = 50

```

C

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      READ IN THE MAPPING ARRAYS FOR THE TOTAL NUMBER OF
      RADIONUCLIDES THAT WILL BE ON THE MASTER GRID.
      READ(20)(ICT(N),N=1,TNPACK),(JCT(N),N=1,TNPACK)
      READ(20)
      READ(20)DUM,DUM
      REWIND 61
      READ(61)TITLE,GRDOPT,IPTOGR,YLAT,XLON,RLOC,THLOC,
> DIFX,DIFY,UNIT,NLOC
      READ(61)ICODE,OPTS
      READ(61)TNREL,(MTNREL(I),I=1,TNREL),TNEXP,(MTNEXP(I),I=1,TNEXP)

```

C

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C

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      READ IN GRID MESH SIZE AND MAX. RADIUS OF MASTER GRID,
      NUMBER OF SOURCES, AND INTERPOLATION OPTIONS.
      INTERP=0
      IOUT=0
      CHGSRC=.FALSE.
      IOPT=1
      READ(5,OPTION)
      WRITE(6,10100) TITLE
      WRITE(6,210)NSOURC
210 FORMAT('ONSOURC =',I2,'μ NUMBER OF ANEMOS',
#' SOURCE FILES TO BE INTERPOLATED ONTO THE MASTER GRID')
      WRITE(6,220)INTERP

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220 FORMAT('OINTERP =',I2,'μ THE OPTION FOR THE INTERPOLATION',
# ' FORMULA')
WRITE(6,280)YMLAT
280 FORMAT('OYMLAT =',1PE9.2,'μ LATITUDE OF REF. POINT',
# ' OF MASTER GRID')
WRITE(6,290)YMLON
290 FORMAT('OYMLON =',1PE9.2,'μ LONGITUDE OF REFERENCE',
# ' POINT OF MASTER GRID')
IF(IOPT.EQ.1)READ(5,CGRID)
IF(IOPT.EQ.2)READ(5,RGRID)
IF(IOPT.GE.3)READ(5,UPTS)
WRITE(6,270)IOPT
270 FORMAT('OIOPT =',I2,' MEANS THAT:')
GO TO (1000,2000,3000,3000),IOPT
1000 MNUMX=MNUMXC
WRITE(6,271)
271 FORMAT(' THE OUTPUT MASTER GRID IS A REGULAR CIRCULAR GRID')
WRITE(6,320)MNUMXC
320 FORMAT('OMNUMXC =',I2,'μ NUMBER OF RADIAL DISTANCES')
IF(XMAX.EQ.0) GO TO 1010
AMESH=2**(.5** (MESHTY-1))
WRITE(6,300)MESHTY,AMESH
300 FORMAT('OMESHTY =',I2,'μ CONSECUTIVE DISTANCES ARE',
# ' INCREASED BY ',F6.4)
WRITE(6,310)XMAX
310 FORMAT('OXMAX =',1PE9.2,'μ LARGEST RADIAL DISTANCE')
CALL FIGRAD(MNUMX,MESHTY,MXDARY,XMAX)
GO TO 1030
1010 DO 1020 IX=1,MNUMX
1020 MXDARY(IX)=DIST(IX)
1030 MNUMY=16
DO 1100 IY=1,MNUMY
1100 MYDARY(IY)=THETAR(IY)
WRITE(6,330)(DIST(I),I=1,MNUMXC)
330 FORMAT('OUSER-SELECTED RADIAL DISTANCES IN METERS'/
# (' ',1PE9.2))
GO TO 5000
2000 MNUMX=MNUMXR
WRITE(6,272)
272 FORMAT(' THE OUTPUT GRID IS A REGULAR RECTANGULAR GRID')
WRITE(6,340)XMESH
340 FORMAT('OXMESH =',1PE9.2,'μ DIST. IN METERS BETWEEN',
# ' 2 CONSECUTIVE GRID POINTS IN X DIR.')
WRITE(6,350)YMESH
350 FORMAT('OYMESH =',1PE9.2,'μ DIST. IN METERS BETWEEN 2',
# ' CONSECUTIVE GRID POINTS IN Y DIR.')
WRITE(6,360)MNUMXR
360 FORMAT('OMNUMXR =',I2,'μ NO. OF GRID CELLS IN X DIR.')
WRITE(6,370)MNUMYR
370 FORMAT('OMNUMYR =',I2,'μ NO. OF GRID CELLS IN Y DIR.')
MNUMY=MNUMYR
DO 2100 IX=1,MNUMX
MXDARY(IX)=IX*XMESH

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2100    CONTINUE
        DO 2200 IY=1,MNUMY
            MYDARY(IX)=IY*YMESS
2200    CONTINUE
        GO TO 5000
3000    MNUMX=NPTS
        IF(IOPT.EQ.3)WRITE(6,273)
273    FORMAT(' THE OUTPUT GRID POINTS ARE USER-DEFINED USING DIST.',
-      ' AND DIR.')
        IF(IOPT.EQ.4)WRITE(6,274)
274    FORMAT(' THE OUTPUT GRID POINTS ARE USER-DEFINED USING X,',
-      ' Y DIST.')
        WRITE(6,380)NPTS
380    FORMAT('ONPTS =',I2,'μ NO. OF POINTS IN THE GRID')
        IF(IOPT.EQ.3)WRITE(6,390)ANGLE
390    FORMAT('OANGLE =',A3,'μ THE UNITS IN',
-      #' WHICH MXDARY IS ENTERED')
        WRITE(6,410)(MXDARY(I),MYDARY(I),I=1,NPTS)
        WRITE(6,400)
410    FORMAT('O MXDARY      MYDARY'/((' ',1P2E10.2))
400    FORMAT('OMXDARYμ DIR. FROM THE REF. POINT',
-      #' IF IOPT = 3 (0=EAST)'/ ' ',8X,
-      #'THE DIST. IN METERS IN X DIR. FROM THE REF. POINT., IF IOPT = 4'
-      #'/' MYDARYμ DIST. IN METERS IN Y DIR. FROM THE REFERENCE POINT')
        MNUMY=1
        IF(ANGLE.EQ.RAD.OR.IOPT.EQ.4) GO TO 5000
        DO 3500 I=1,NPTS
            MYDARY(I)=90.+ABS(360.-MYDARY(I))
            IF(MYDARY(I).GE.360) MYDARY(I)=MYDARY(I)-360.
3500        MYDARY(I)=MYDARY(I)*3.1416/180.
5000    CONTINUE
        NNLOC=MNUMX*MNUMY
        WRITE(45)TITLE,IOPT,IPTOGR,YMLAT,XMLON,ZERO,ZERO,ZERO,ZERO,
-      > UNIT,NNLOC
        OPTS(7)=.TRUE.
        ICODE=2
        WRITE(45)ICODE,OPTS
        WRITE(45)TNREL,(MTNREL(I),I=1,TNREL),TNEXP,(MTNEXP(I),I=1,TNEXP)
C
C      PUTS A KEY CORRESPONDING TO EACH NODE OF MASTER GRID INTO AN
C      ARRAY LOCATION.
        KEY = 1
        MNIND = 0
        DO 20 JJ = 1,16
            DO 10 KK = 1,MNUMX
                MLCARY(KK,JJ) = KEY
                WRITE(44'KEY)MNIND
10        KEY = KEY + 30
20        CONTINUE
        IF(.NOT.CHGSRG)WRITE(6,250)
250    FORMAT('OCHGSRG IS FALSEμ NO MULTIPLICATION OF AIR',
-      #' CONCENTRATIONS AND GROUND DEPOSITION RATES BY AN INPUT FACTOR')
        IF(CHGSRG) WRITE(6,230)

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230 FORMAT('0CHGSRC IS TRUEμ MULTIPLY ALL',
# ' AIR CONCENTRATIONS AND GROUND DEPOSITION RATES BY' /
# ' INPUT FACTOR VNEW')
C
C*****
C      THIS OUTER LOOP EXECUTES FOR EACH SOURCE.
      DO 180 KNTSRC = 1, NSOURC
        IF(.NOT.CHGSRC) GO TO 27
        READ(5, SRCID)
        WRITE(6, 231) KNTSRC, VNEW
231  FORMAT('1FOR SOURCE', I3, ': VNEW =', 1PE9.2)
        WRITE(6, 225) XNEW
225  FORMAT(' ', 15X, 'XNEW =', 1PE9.2, 'μ NEW LONGITUDE FOR THE SOURCE')
        WRITE(6, 235) YNEW
235  FORMAT(' ', 15X, 'YNEW =', 1PE9.2, 'μ NEW LATITUDE FOR THE SOURCE')
27    FINDEX=FINDEX+1
        FINDX2=FINDX2+1
        REWIND FINDEX
        REWIND FINDX2
C      READ THE NUMBER OF PACKED RADIONUCLIDES AND THE INDEX
C      PARAMETERS FOR THE FOLLOWING SOURCE.
      READ(FINDX2) DUMMY1, DUMMY2, RNPACK
      READ(FINDX2) (IC(N), N=1, RNPACK), (JC(N), N=1, RNPACK)
      READ(FINDX2)
      READ(FINDX2) NNN, NNE
C
C      READ IN SOURCE INFORMATION.
      READ(FINDEX) TITLE, GRDOPT, IPTOGR, YLAT, XLON,
A   RLOC, THLOC, DIFX, DIFY, UNIT, NLOC
      IF(.NOT.CHGSRC) GO TO 161
      YLAT=YNEW
      XLON=XNEW
161  CONTINUE
      READ(FINDEX) ICODE, OPTS
      WRITE(6, 10500) KNTSRC, TITLE, YLAT, XLON
      IF(RLOC.NE.0.0D0 .OR. THLOC.NE.0.0D0) GO TO 25
      IF(DIFX.NE.0.0D0 .OR. DIFY.NE.0.0D0) GO TO 28
      DIFX=XLON-XMLON
      DIFY=YLAT-YMLAT
      GO TO 29
28    DIFY=DIFY*9.013E-4
      DIFX=DIFX*3.1416*6.357E6*DSIN(YMLAT*3.1416D0/180.D0)/180.
29    RLOC=DSQRT(DIFX*DIFX+DIFY*DIFY)
      THLOC=0.
      IF(RLOC.NE.0.) THLOC=DARSIN(DIFX/RLOC)
C      THE TYPE OF UNIT (BQ OR CI) THAT THE SUBSEQUENT
C      CALCULATIONS WILL USE, IS DEPENDENT UPON THE FIRST
C      SOURCE'S INPUT. EACH ENSUING SOURCE'S UNITS WILL BE
C      CONVERTED ACCORDINLY.
25    WRITE(6, 10900) THLOC, RLOC
10900 FORMAT('0DISTANCE BETWEEN MASTER GRID REFERENCE',
A   ' POINT AND SOURCE GRID REFERENCE IS '//
B   ' ANGULAR DIRECTION (RAD) = ', E10.3/
C   ' RADIAL DISTANCE (M)      = ', E10.3)
      IF (KNTSRC.EQ.1) REFUNT = UNIT

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C
C      READ IN AZS NUMBERS OF CURRENT SOURCE.
      READ(FINDEX)NRNUCS,(AZSRN(I),I=1,NRNUCS), NREXP,(AZSEN(I),I=1,
> NREXP)
      IF (NNN.EQ.NRNUCS.AND.NNE.EQ.NREXP) GO TO 30
      WRITE(6,10600)
      GO TO 180
C      CREATE MAPPING ARRAYS BETWEEN THE MASTER RADIONUCLIDE ARRAYS
C      AND THE CURRENT SOURCE RADIONUCLIDE ARRAYS.
C      ZERO OUT MAPPING ARRAYS.
30 DO 40 IZ = 1,50
40 MAPREL(IZ) = 0
      DO 50 IX = 1,50
50 MAPEXP(IX) = 0
C
      DO 60 M=1,NRNUCS
      DO 60 N=1,TNREL
60 IF (AZSRN(M).EQ.MTNREL(N)) MAPREL(M)=N
      DO 70 M=1,NREXP
      DO 70 N=1,TNEXP
70 IF (AZSEN(M).EQ.MTNEXP(N)) MAPEXP(M)=N
C
C      THIS SECTION PUTS A REPRESENTATIVE NUMBER FOR EACH NODE OF
C      THE SOURCE GRID INTO AN ARRAY LOCATION AND WRITES A KEY.
      NUMX = NLOC/16
      DO 80 NX = 1,NUMX
80 SRDARY(NX) = 0.0
      KEY = 1
C      THE NEXT 3 DO LOOPS WORK TOGETHER TO READ IN THE SOURCE
C      DATA AND STORE IT IN A KEYED FILE.
      DO 150 IA = 1,16
      DO 140 IB = 1,NUMX
      READ(FINDEX)XMIN,XMAX,YMIN,YMAX,NIND
      IF (SRDARY(IB).EQ.0.0) SRDARY(IB) = XMIN
      SLCARY(IB,IA) = KEY
      WRITE(77'KEY)NIND
      IRD=KEY
      DO 130 ND=1,NIND
      READ(FINDEX)IND,NPACK,(CONC(N),N=1,NPACK)
      IF(.NOT.CHGSRG) GO TO 163
      DO 162 N=1,NPACK
      CONC(N)=CONC(N)*VNEW
162 CONTINUE
163 CONTINUE
      IF (UNIT.EQ.REFUNT) GO TO 120
      IF (REFUNT.EQ.BQ) GO TO 100
C      CONVERT CONCENTRATIONS TO CURIE UNITS.
      DO 90 NO=1,NPACK
90 CONC(NO) = CONC(NO) * 3.7E10
      GO TO 120

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C          CONVERT CONCENTRATIONS TO BQ UNITS.
100 DO 110 NO = 1,NPACK
110 CONC(NO) = CONC(NO) * 2.7E-11
120 IRD=IRD+1
    WRITE(77'IRD)IND,NPACK,(CONC(N),N=1,NPACK)
    IF (IND.GE.2) GO TO 130
C          IF THE CONC ARRAY CONTAINS GROUND DEP. RATES
C          THE NEXT READ IS SKIPPED.
    READ(FINDEX)(PSIZE(N),N=1,NPACK),((CLCLS(I,N),I=1,4),N=1,NPACK)
    IRD=IRD+1
    WRITE(77'IRD)(PSIZE(N),N=1,NPACK),((CLCLS(I,N),I=1,4),N=1,NPACK)
130 CONTINUE
C          KEY VALUE IS INCREMENTED BY 14.
    KEY = KEY + 14
140 CONTINUE
150 CONTINUE
C
C          THE NEXT 2 DO LOOPS CALL THE FOLLOWING SUBROUTINES
C          TO PERFORM CALCULATIONS AT EACH NODE ON THE MASTER
C          GRID.
    WRITE(6,10550)
    DO 170 IA = 1,MNUMY
    DO 160 IB = 1,MNUMX
        IF(IOPT.EQ.1 .OR. IOPT.EQ.3)CALL TRNFMF
A (IA,IB,MXDARY,MYDARY,CR,CT,RLOC,THLOC)
        IF(IOPT.EQ.2 .OR. IOPT.EQ.4) CALL TRNFMF
A (IA,IB,MXDARY,MYDARY,CR,CT,RLOC,THLOC)
        IF (CR.GT.SRDARY(NUMX)) GO TO 165
        IF (CR.LT.SRDARY(1)) GO TO 165
        R = CR
        T = CT
        CALL BSERCH(SRDARY,THETAR,MR1,MR2,MT1,MT2,NUMX)
        CALL PIKEYS(SLCARY,MR1,MR2,MT1,MT2)
        CALL RADCHK(TNPACK,RNPACK,INTERP,IB,IA,CONC1, CONC2,CONC3,
> CONC4,CLCLS1, IC,JC,ICT,JCT,CONC,PSIZE,CLCLS)
160 CONTINUE
        GO TO 170
165    WRITE(6,10800)
        GO TO 160
170 CONTINUE
C
C
180 CONTINUE
    CALL PRNTOT(MNUMX,MNUMY,TNPACK,MXDARY,MYDARY,
> CONC1,CONC2,CLCLS1,IOUT,MTNREL,TNREL,MTNEXP,TNEXP,
> ICT,JCT,IOPT,REFUNT,TITLE)
    RETURN
10100 FORMAT('1*** SUMIT *** A PROGRAM TO COMBINE ANEMOS ',
- 'SOURCES ON A MASTER GRID'/
> ' TITLE OF THE OUTPUT FILE IS : ',20A4)
10200 FORMAT('0THE NUMBER OF SOURCE FILES ARE ',I5/
> ' OPTION FOR THETA INTERPOLATION IS : ',I1)

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10500 FORMAT('SOURCE ',I5/
>' TITLE ON THE FILE IS ',20A4/
>' REFERENCE LATITUDE(DEGREES) =',F12.3/
>' REFERENCE LONGITUDE(DEGREES)=',F12.3)
10550 FORMAT(
>'1      MASTER GRID      SOURCE GRID      SOURCE GRID POINTS'/
>'  DISTANCE DIRECTION  DISTANCE DIRECTION  DISTANCE DIRECTION'/
>'      (M)      (RADIAN)      (M)      (RADIAN) '/')
10600 FORMAT(' THE PRIMUS AND CONC DATA SET DO NOT AGREE.')
10800  FORMAT(' POINTS OUT OF RANGE OF SOURCE GRID.')
      END

C
C*****
      SUBROUTINE FIGRAD(NUMX,M,RADARY,XMAX)
C          THIS SUBROUTINE WAS ADAPTED FROM THE XCALC
C          SUBROUTINE IN ANEMOS.
C          SUBROUTINE CALCULATES RADII DISTANCES FOR MASTER GRID
      DIMENSION RADARY(NUMX)
      SQ2 = SQRT(2.0)
      SQ4 = SQRT(SQ2)
      RADARY(NUMX)=XMAX
      IF (NUMX.EQ.1) GO TO 90
      IF (M.GE.3) GO TO 50
      IF (M.EQ.2) GO TO 20

C
C          CALC. RADII FOR M = 1 (COURSE MESH)
      N1 = NUMX - 1
      DO 10 I = 1,N1
      N = NUMX - I
10  RADARY(N)=RADARY(N+1) / 2.0
      GO TO 90

C
C          CALC. RADII FOR M=2 (MEDIUM MESH)
20  N=2
      IF (NUMX.EQ.2) GO TO 40
      N1 = (NUMX - 1)/2
      DO 30 I = 1,N1
      N=NUMX - (2*I)
      RADARY(N) = RADARY(N+2)/ 2.0
30  RADARY(N+1) = RADARY(N) * SQ2
40  IF (N.EQ.2) RADARY(1) = RADARY(2) / SQ2
      GO TO 90

C
C          CALC. RADII FOR M=3 (FINE MESH)
50  N1 = (NUMX - 1) / 4
      N = NUMX
      IF (N.LE.4) GO TO 80
      DO 70 I=1,N1
      N = NUMX - (4*I)
      RADARY(N) = RADARY(N+4) / 2.0
      DO 60 K=1,3
60  RADARY(N+K) = RADARY(N+K-1) * SQ4

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70 CONTINUE
80 N=N-1
   IF (N.EQ.0) GO TO 90
   RADARY(N) = RADARY(N+1) / SQ4
   GO TO 80
C
90 RETURN
   END
C
C
C*****
      SUBROUTINE TRNFMC(IA, IB, MRDARY, THETAR, CR, CT, RLOC, THLOC)
      DOUBLE PRECISION RLOC, THLOC
C          THIS SUBROUTINE TRANSFORMS EACH MASTER NODE LOCATION
C          TO ITS LOCATION RELATIVE TO THE CENTER OF THE
C          CURRENT SOURCE.
C***      TWOPI IS MAXIMUM-IT IS 2*PI-PI/16
      DATA TWOPI/6.086836/
      REAL MRAD, MTHETA, MRDARY
      DIMENSION MRDARY(20), THETAR(16)
      MRAD = MRDARY(19)
      MTHETA = THETAR(IA)
      RX = MRAD * COS(MTHETA)
      RY = MRAD * SIN(MTHETA)
      CX = RLOC * DCOS(THLOC)
      CY = RLOC * DSIN(THLOC)
      RCX = RX - CX
      RCY = RY - CY
      CR = SQRT(RCX**2 + RCY**2)
      CT = ATAN2(RCY, RCX)
      IF(CT.LT.0.) CT=CT+TWOPI
      IF(CT.GE.TWOPI) CT=CT-TWOPI
      WRITE(6,10000) MRAD, MTHETA, CR, CT
      RETURN
10000 FORMAT(1X, F10.2, F9.4, F11.2, F9.4)
      END
      SUBROUTINE TRNFMR(IA, IB, MXDARY, MYDARY, CR, CT, RLOC, THLOC)
      DOUBLE PRECISION RLOC, THLOC
C          THIS SUBROUTINE TRANSFORMS EACH MASTER NODE LOCATION
C          TO ITS LOCATION RELATIVE TO THE CENTER OF THE
C          CURRENT SOURCE.
C***      TWOPI IS MAXIMUM-IT IS 2*PI-PI/16
      DATA TWOPI/6.086836/
      REAL MRAD, MTHETA, MXDARY, MYDARY
      DIMENSION MXDARY(20), MYDARY(20)
      RX=MXDARY(IB)
      RY=MYDARY(IA)
      CX = RLOC * DCOS(THLOC)
      CY = RLOC * DSIN(THLOC)
      RCX = RX - CX

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      RCY = RY - CY
      CR = SQRT(RCX**2 + RCY**2)
      CT = ATAN2(RCY,RCX)
      IF(CT.LT.0.) CT=CT+TWOPI
      IF(CT.GE.TWOPI)CT=CT-TWOPI
      WRITE(6,10000) RX,RY,CR,CT
      RETURN
10000 FORMAT(1X,F10.2,F9.4,F11.2,F9.4)
      END
C*****
      SUBROUTINE BSERCH(SRDARY,THETAR,MR1,MR2,MT1,MT2,NUMX)
C          THIS SUBROUTINE FINDS WHICH 2 RADII AND THETA VALUES
C          EACH MASTER GRID NODE LAY BETWEEN.
      COMMON /POS/F(4),R1,R2,T1,T2,R,T
      DIMENSION SRDARY(NUMX),THETAR(16)
C
      DO 10 JX=2,NUMX
      IF ((R-SRDARY(JX))*(R-SRDARY(JX-1)).GT.0.0) GO TO 10
      R1 = SRDARY(JX-1)
      R2 = SRDARY(JX)
      MR1 = JX-1
      MR2 = JX
      GO TO 20
10  CONTINUE
C
20  DIFFT=10.0
      IONEY=0
      DO 30 JY=1,16
      D=ABS(T-THETAR(JY))
      IF (D.GT.DIFFT) GO TO 30
      DIFFT=D
      IONEY=JY
30  CONTINUE
      IM1=IONEY-1
      IF(IM1.LE.0)IM1=16
      IP1=IONEY+1
      IF(IP1.GT.16)IP1=1
      IF(DIFFT.LT.1.E-6) GO TO 50
      IF (ABS(T-THETAR(IP1)).LT.ABS(T-THETAR(IM1))) GO TO 50
      T1 = THETAR(IM1)
      T2 = THETAR(IONEY)
      MT1 = IM1
      MT2 = IONEY
      GO TO 60
50  CONTINUE
      T1=THETAR(IONEY)
      T2=THETAR(IP1)
      MT1=IONEY
      MT2=IP1
60  CONTINUE
      WRITE(6,10000) MR1,MR2,MT1,MT2
      RETURN
10000 FORMAT(' ',40X,4I5)
      END
C

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```

C
C*****
      SUBROUTINE PTKEYS(SLCARY,MR1,MR2,MT1,MT2)
C          THIS SUBROUTINES LOCATES THE KEY VALUE OF THE FIRST
C          RECORD WHICH CONTAINS DATA PERTAINING TO EACH NODE.
      INTEGER SLCARY
      COMMON /K/KEY1,KEY2,KEY3,KEY4
      DIMENSION SLCARY(20,16)
      KEY1 = SLCARY(MR1,MT1)
      KEY2 = SLCARY(MR1,MT2)
      KEY3 = SLCARY(MR2,MT2)
      KEY4 = SLCARY(MR2,MT1)
      RETURN
      END
C
C
C*****
      SUBROUTINE RADCHK(TNPACK,RNPACK,INTERP,IB,IA,CONC1, CONC2,
> CONC3,CONC4,CLCLS2,IC,JC,ICT, JCT,CONC,PSIZE,CLCLS)
      COMMON/ST4/A1(6,20,50),A2(20,50),A3(20,50),A4(20,50)
C          THIS SUBROUTINE INTERPOLATES EACH GROUND DEP. RATE
C          AND AIR CONC AND THEN WRITES THE NEW VALUES TO
C          THE KEYED FILE FOR THE MASTER GRID.
C
      REAL MARRAY
      INTEGER ASSVAR,ASSVR2,TNPACK,RNPACK,EXPNO,RELNO
C
      COMMON /K/KEY1,KEY2,KEY3,KEY4
      COMMON /POS/F(4),R1,R2,T1,T2,R,T
      COMMON /MY/MARRAY(6,60,100),IM(60)
      COMMON /M2/MAPEXP(50),MAPREL(50),MLCARY(20,16),MNIND
      COMMON /AS/ASSVAR,ASSVR2
C
      DIMENSION CONC1(TNPACK),CONC2(TNPACK), CONC3(TNPACK)
> ,CONC4(TNPACK),CLCLS2(4,TNPACK), IC(RNPACK),JC(RNPACK),
> ICT(RNPACK), JCT(RNPACK),CONC(RNPACK),PSIZE(RNPACK),CLCLS(4,
> RNPACK)
C
      DO 10 II=1,TNPACK
      CONC1(II)=0.0
      CONC2(II)=0.0
      CONC3(II)=0.0
      CONC4(II)=0.0
10 CONTINUE
C          THIS FIRST SECTION READS IN EACH RECORD AT EACH NODE
C          AND IF IT CONTAINS GROUND DEP. RATES, STORES THE
C          RECORD.
      READ(77'KEY1)NIND1
      IRD=KEY1
      DO 50 JK=1,NIND1
      IRD=IRD+1
      READ(77'IRD)IND1,NPACK,(A1(1,JK,N),N=1,NPACK)
      IM(JK)=IND1

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      IF (IND1.NE.1) GO TO 50
      IRD=IRD+1
      READ(77'IRD) (A1(2,JK,N),N=1,NPACK), ((A1(2+II,JK,N),II=1,4),N=1,
> NPACK)
50  CONTINUE
      READ(77'KEY2)NIND2
      IF(NIND2.NE.NIND1) GO TO 9000
      IRD=KEY2
      DO 100 JK = 1,NIND2
      IRD=IRD+1
      READ(77'IRD)IND2,NPACK,(A2(JK,N),N=1,NPACK)
      IF(IND2.NE.1) GO TO 100
      IRD=IRD+1
      READ(77'IRD)DUM
100  CONTINUE
      READ(77'KEY3)NIND3
      IF(NIND3.NE.NIND1) GO TO 9000
      IRD=KEY3
      DO 150 JK = 1,NIND3
      IRD=IRD+1
      READ(77'IRD)IND3,NPACK,(A3(JK,N),N=1,NPACK)
      IF(IND3.NE.1) GO TO 150
      IRD=IRD+1
      READ(77'IRD)DUM
150  CONTINUE
      READ(77'KEY4)NIND4
      IF(NIND4.NE.NIND1) GO TO 9000
      IRD=KEY4
      DO 200 JK = 1,NIND4
      IRD=IRD+1
      READ(77'IRD)IND4,NPACK,(A4(JK,N),N=1,NPACK)
      IF(IND4.NE.1) GO TO 200
      IRD=IRD+1
      READ(77'IRD) DUM
200  CONTINUE
C
C      THIS NEXT SECTION FINDS THE PLACE IN THE MASTER CONC
C      ARRAY THAT THE PARTICULAR RADIONUCLIDE THAT IS
C      BEING INTERPOLATED WILL BE PLACED.
      DO 240 I = 1,RNPack
      EXPNO = IC(I)
      RELNO = JC(I)
      MEXP = MAEXP(EXPNO)
      MREL = MAPREL(RELNO)
C
C      THE VARIABLE MN TELLS WHERE IN PACKED MASTER
C      CONCENTRATION ARRAY THE SOURCE AZS NUMBER
C      IS TO BE MAPPED.
      DO 220 MN = 1,TNPack
      IF (ICT(MN).NE.MEXP) GO TO 220
      IEXP=MN
      IF (JCT(MN).EQ.MREL) GO TO 230

```

```

220 CONTINUE
  WRITE(6,10100)
  GO TO 380
C      THE INTERPOLATION FUNCTION IS BEING CALLED.
230 CONTINUE
  DO 235 IN=1,NIND1
    F(1)=A1(1,IN,I)
    F(2)=A2(IN,I)
    F(3)=A3(IN,I)
    F(4)=A4(IN,I)
    MARRAY(1,IN,IEXP)=F4INTR(F,R1,T1,R2,T2,INTERP,R,T)
    IF(IM(IN).NE.1) GO TO 235
    DO 234 IK=2,6
      MARRAY(IK,IN,IEXP)=A1(IK,IN,I)
234    CONTINUE
235    CONTINUE
240 CONTINUE
C
C
C
C*****
C*****
C
C
  KEY = MLCARY(IB,IA)
  READ(44'KEY)MNIND
  IRD=KEY
  IF (MN'ND.NE.0) GO TO 260
C      IF THESE ARE THE FIRST VALUES TO BE INPUT INTO THE
C      MASTER KEYED FILE THE NEXT SECTION IS EXECUTED.
C      IF NOT, IT IS SKIPPED.
  DO 250 LJ = 1,NIND1
    MNIND=MNIND+1
    IND = IM(LJ)
    IRD=IRD+1
    WRITE(44'IRD)IND,TNPACK,(MARRAY(1,LJ,N),N=1,TNPACK)
    IF (IND.NE.1) GO TO 250
    IRD=IRD+1
    WRITE(44'IRD)(MARRAY(2,LJ,N),N=1,TNPACK),((MARRAY(2+I,LJ,N),I=1,
    > 4),N=1,TNPACK)
250 CONTINUE
  WRITE(44'KEY) MNIND
  GO TO 380
C
C      THIS SECTION READS IN EACH RECORD
C      FROM THE MARRAY, SEARCHES FOR AN IDENTICAL
C      RADIONUCLIDE AND IF IT FINDS IT ADDS THE VALUE.
C      IF IT DOES NOT FIND ONE, THE NEW VALUE IS PLACED
C      IN EITHER AN UNOCCUPIED LOCATION CORRESPONDING TO
C      IT AZS NUMBER OR A NEW RECORD IS BUILT TO CONTAIN
C      IT.

```

```

260      READ(44'KEY) MNIND
      IRD=KEY
      DO 360 LP=1,MNIND
      IRD=IRD+1
      READ(44'IRD) LIND,TNPACK,(CONC3(N),N=1,TNPACK)
      IUP=IRD
      IF (LIND.GT.1) GO TO 310
      IRD=IRD+1
      READ(44'IRD)(CONC4(N),N=1,TNPACK),((CLCLS2(I,N),I=1,4),N=1,
> TNPACK)
C***      SEARCH MARRAY TO FIND IF HAVE A MATCH FOR THIS RECORD
310 DO 350 LM=1,NIND1
      IND=IM(LM)
      IF (IND.NE.LIND) GO TO 350
      DO 340 LQ=1,TNPACK
      IF(LIND.GT.2) GO TO 335
      IF (ABS(MARRAY(2,LM,LQ)-CONC4(LQ)).GT.1.E-6) GO TO 350
      DO 330 LR=1,4
      IF (ABS(MARRAY(2+LR,LM,LQ)-CLCLS2(LR,LQ)).GT.1.E-6) GO TO 350
330 CONTINUE
C***      THE PARTICLE SIZE AND CL CLASSES MATCH, SO ADD
335      CCNC3(LQ)=CONC3(LQ)+MARRAY(1,LM,LQ)
340 CONTINUE
      WRITE(44'IUP) LIND,TNPACK,(CONC3(I),I=1,TNPACK)
      IM(LM)=-IM(LM)
      GO TO 360
C***      THEY DONT MATCH
350 CONTINUE
360 CONTINUE
      NEWKEY=IRD
      DO 370 LM=1,NIND1
C***      IF A MATCH WAS NOT FOUND FOR AN MARRAY THEN IT IS STILL POSITIVE
      IF (IM(LM).LE.0.0) GO TO 370
      IF (IM(LM).EQ.10) GO TO 370
      IND=IM(LM)
      NEWKEY=NEWKEY+1
      MNIND=MNIND+1
      WRITE(44'NEWKEY) IND,TNPACK,(MARRAY(1,LM,LO),LO=1,TNPACK)
      IF (IND.GT.1) GO TO 370
      NEWKEY=NEWKEY+1
      WRITE(44'NEWKEY) (MARRAY(2,LM,LO),LO=1,TNPACK),((MARRAY(2+II,LM,
> LO),II=1,4),LO=1,TNPACK)
370 CONTINUE
      WRITE(44'KEY) MNIND
380 RETURN
9000      WRITE(6,10700)
      STOP
10100 FORMAT(' ERROR IN RADCHK,PROBLEM IN AZS ARRAY LOC. #')
10700      FORMAT(' THE NUMBER OF INDICATORS HAS CHANGED FOR A LOCATION.')
      END
      FUNCTION F4INTR(F,R1,T1,R2,T2,N,R,T)

```

C

```

C
C*****
C      INTERPOLATE F GIVEN AT CORNERS OF RECTANGLE
C      BY: JONAS HOLDEMAN
C
      DIMENSION F(4)
      RR1=ALOG(R2/R1)
      Y=(T-T1)/(T2-T1)
      M=N+1
      GO TO (60,10,20,30,40,50),M
10  Y=(-2.0*Y + 3.0) * (Y**2)
      GO TO 60
20  Y=((6.0*Y - 15.0)*Y + 10.0) * (Y**3)
      GO TO 60
30  Y=(((-20.0*Y + 70.0)*Y - 84.0)*Y + 35.0)*(Y**4)
      GO TO 60
40  Y((((70.0*Y - 315.0)*Y + 540.0)*Y-420.0) *Y + 126.0) * (Y**5)
      GO TO 60
50  Y=AIN(T(Y + .5)
60  G1=(1.-Y)*F(1)+Y*F(2)
      G2=(1.-Y)*F(4)+Y*F(3)
      IF(G1.NE.G2) GO TO 70
      F4INTR=G1
      GO TO 90
70  IF(G1.NE.0..AND.G2.NE.0.) GO TO 80
      F4INTR=G1+(G2-G1)*(R-R1)/(R2-R1)
      GO TO 90
80  ALPHA=ALOG(G2/G1)/RR1
      F4INTR=G1*((R/R1)**ALPHA)
90  RETURN
      END
C
C
C*****
      SUBROUTINE PRNTOT(MNUMX,MNUMY,TNPACK,MXDARY,MYDARY,CONC1,
> CONC2,CLCLS1,IOUT,MTNREL,TNREL,MTNEXP,TNEXP,IC,JC,IOPT,
> REFUNT,TITLE)
      REAL MXDARY,MYDARY
      REAL*8 NAMR,NAME,UNPACK
      DATA JND10/10/
      INTEGER ASSVR2,TNPACK,TNREL,TNEXP
      DIMENSION MXDARY(MNUMX),CONC1(1:TNPACK),CONC2(TNPACK), CLCLS1(4,
> TNPACK),MYDARY(MNUMY),MTNREL(TNREL),MTNEXP(TNEXP),IC(1),JC(1),
> TITLE(20)
      COMMON /AS/ASSVAR,ASSVR2
      COMMON/MY/NAMR(50),NAME(50)
C
      IF(IOUT.EQ.0) GO TO 5
      DO 10 I=1,TNREL
      NAMR(I)=UNPACK(MTNREL(I))

```

```

10    CONTINUE
      DO 15 I=1,TNEXP
        NAME(I)=UNPACK(MTNEXP(I))
15    CONTINUE
5     CONTINUE
      KEY = 1
      DO 90 IAA = 1,MNUMY
        YMIN=MYDARY(IAA)
        YMAX=MYDARY(1)
        IF(IAA.NE.MNUMY) YMAX=MYDARY(IAA+1)
        IF(IAA.EQ.MNUMY.AND. IOPT.EQ.2.OR. IOPT.EQ.4)YMAX=YMIN
      IF(IOPT.EQ.2.OR. IOPT.EQ.4) GO TO 40
        YMINP=YMIN*180./3.1416
        YMINP=ABS(360.-YMINP)+90.
        IF(YMINP.GE.360.) YMINP=YMINP-360.
        YMAXP=YMAX*180./3.1416
        YMAXP=ABS(360.-YMAXP)+90.
        IF(YMAXP.GE.360.) YMAXP=YMAXP-360.
40    DO 80 IBB = 1,MNUMX
      READ(44'KEY)NIND
        IF(NIND.EQ.0) GO TO 75
      IRD=KEY
      XMIN = MXDARY(IBB)
      XMAX = XMIN
        IF(IBB.LT.MNUMX)XMAX = MXDARY(IBB+1)
      WRITE(45)XMIN,XMAX,YMIN,YMAX,NIND
        IF(IOUT.NE.0) WRITE(6,10100) TITLE,XMIN,XMAX,YMINP,YMAXP,
> (NAMR(JC(IR)),IR=1,TNPACK)
        IF(IOUT.NE.0) WRITE(6,10200) (NAME(IC(IE)),IE=1,TNPACK)
      IND10=0
      DO 70 ICC=1,NIND
        IRD=IRD+1
        READ(44'IRD)IND,INPACK, (CONC1(N),N=1,TNPACK)
          IF(IOUT.NE.0.AND. IND.EQ.1) WRITE(6,10300) REFUNT,
> (CONC1(N),N=1,TNPACK)
          IF(IOUT.NE.0 .AND. IND.EQ.10) WRITE(6,10301)REFUNT,
> (CONC1(N),N=1,TNPACK)
          IF(IOUT.NE.0 .AND. IND.EQ.2) WRITE(6,10302)REFUNT,
> (CONC1(N),N=1,TNPACK)
          IF (IND.EQ.JND10) GO TO 50
        WRITE(45)IND,TNPACK, (CONC1(N),N=1,TNPACK)
        IF (IND.GT.1) GO TO 70
        IRD=IRD+1
        READ(44'IRD)(CONC1(N),N=1,TNPACK), ((CLCLS1(I,N),I=1,4),N=1,
> TNPACK)
          IF(IOUT.NE.0)WRITE(6,10400) (CONC1(N),N=1,TNPACK)
          IF(IOUT.NE.0)WRITE(6,10500) (CLCLS1(1,N),N=1,TNPACK)
          IF(IOUT.NE.0)WRITE(6,10501) (CLCLS1(2,N),N=1,TNPACK)
          IF(IOUT.NE.0)WRITE(6,10502) (CLCLS1(3,N),N=1,TNPACK)
          IF(IOUT.NE.0)WRITE(6,10503) (CLCLS1(4,N),N=1,TNPACK)
        WRITE(45)(CONC1(N),N=1,TNPACK), ((CLCLS1(I,N),I=1,4),N=1,TNPACK)
      GO TO 70

```



```

C***   MAKE SURE GROUND DEP RATES ARE LAST
50 IND10=1
   DO 60 N=1,TNPACK
   CONC2(N)=CONC1(N)
60 CONTINUE
70 CONTINUE
   IF (IND10.EQ.1) WRITE(45)JND10,TNPACK,(CONC2(N),N=1,TNPACK)
   GO TO 79
75   NIND=1
   JND10=10
   DO 76 N=1,TNPACK
76   CONC2(N)=0.0
   WRITE(45)XMIN,XMAX,YMIN,YMAX,NIND
   WRITE(45)JND10,TNPACK,(CONC2(I),I=1,TNPACK)
79   CONTINUE
   KEY = KEY + 30
80 CONTINUE
90 CONTINUE
   RETURN
10100 FORMAT('1',20A4/
- '0LOCATION = ',F10.2,' TO ',F10.2,
> F10.2,' TO ',F10.2//
> ' RELEASED NUCLIDES = ',10(1X,A8,1X)/(20X,10(1X,A8,1X)))
10200 FORMAT(' EXPOSURE NUCLIDES = ',10(1X,A8,1X)/(20X,10(1X,A8,1X)))
10300 FORMAT(' AIR CONC (' ,A2,'/Y)',4X,10(1PE10.2)/
> (20X,10(1PE10.2)))
10301 FORMAT(' DEP RATE(' ,A2,'/M**2/Y)',10(1PE10.2)/
> (20X,10(1PE10.2)))
10302 FORMAT(' EFF AIR CONC(' ,A2,'/Y) ',10(1PE10.2)/
> (20X,10(1PE10.2)))
10400 FORMAT(' PARTICLE SIZE(AMAD)',10(1PE10.3)/
> (20X,10(1PE10.2)))
10500 FORMAT(' FRACTION IN CCLS D ',10(F5.3,5X)/
> (20X,10(F5.3,5X)))
10501 FORMAT(' FRACTION IN CCLS W ',10(F5.3,5X)/
> (20X,10(F5.3,5X)))
10502 FORMAT(' FRACTION IN CCLS Y ',10(F5.3,5X)/
> (20X,10(F5.3,5X)))
10503 FORMAT(' FRACTION IN CCLS * ',10(F5.3,5X)/
> (20X,10(F5.3,5X)))
   END
FUNCTION UNPACK(ZAS)
C   THIS ROUTINE UNPACKS THE ZAS NUMBER TO FIND Z,A, AND S, WHERE
C   A=MASS NUMBER, Z=ATOMIC NUMBER, S=THE EXCITATION STATE
C   ZAS = 10000*Z + 10*A + S
C   WHERE S = 0 IF THE NUCLIDE IS IN THE NORMAL STATE
C   S >= 1 WHEN IN THE EXCITATION STATE
DOUBLE PR' JISION NAME,NAMEIN,BLANK,UNPACK
INTEGER ..ZAS,Z,EXCITE
INTEGER*2 NUCNAM(103),ELEMNT
LOGICAL*1 LNAME(4,103),HYPHEN,M,LBLANK,LONAME(8),DIGIT(10)
EQUIVALENCE (LNAME(1),NUCNAM(1)),(LONAME(1),NAME),
- (ELEMNT,NAME)

```

```

DATA HYPHEN/'-'/,M/'M'/,LBLANK/' '/,DIGIT/'0','1',
- '2','3','4','5','6','7','8','9'/
DATA BLANK/8H
/
DATA NUCNAM/2HH-, 2HHE, 2HLI, 2HBE, 2HB-, 2HC-, 2HN-,
- 2HO-, 2HF-, 2HNE, 2HNA, 2HMG, 2HAL, 2HSI, 2HP-,
- 2HS-, 2HCL, 2HAR, 2HK-, 2HCA, 2HSC, 2HTI, 2HV-, 2HCR,
- 2HMN, 2HFE, 2HCO, 2HNI, 2HCU, 2HZN, 2HGA, 2HGE, 2HAS,
- 2HSE, 2HBR, 2HKB, 2HRB, 2HSR, 2HY-, 2HZR, 2HNB, 2HMO,
- 2HTC, 2HRU, 2HRH, 2HPD, 2HAG, 2HCD, 2HIN, 2HSN, 2HSB,
- 2HTE, 2HI-, 2HXE, 2HCS, 2HBA, 2HLA, 2HCE, 2HPR, 2HND,
- 2HPM, 2HSM, 2HEU, 2HGD, 2HTB, 2HDY, 2HBO, 2HER, 2HTM,
- 2HYB, 2HLU, 2HHF, 2HTA, 2HW-, 2HRE, 2HOS, 2HIR, 2HPT,
- 2HAU, 2HNG, 2HTL, 2HPB, 2HBI, 2HPO, 2HAT, 2HRN, 2HFR,
- 2HRA, 2HAC, 2HTH, 2HPA, 2HU-, 2HNP, 2HPU, 2HAM, 2HCM,
- 2HBK, 2HCF, 2HES, 2HFM, 2HMD, 2HNO, 2HLW/
NAME=BLANK
Z=ZAS/10000
ITEMP=ZAS-Z*10000
A=ITEMP/10
EXCITE=ITEMP-A*10
IF(Z.GE.1.AND.Z.LE.103) GO TO 10
WRITE(6,10100) Z,ZAS
10100 FORMAT(' Z NUMBER NOT IN LIST = ',I5/' ZAS = ',I10)
RETURN
10 ELEMENT=NUCNAM(Z)
I=0
J=0
IP=3
IF(LONAME(2).EQ.HYPHEN) GO TO 20
LONAME(IP)=HYPHEN
IP=IP+1
20 IF(A.LT.100) GO TO 30
I=A/100
LONAME(IP)=DIGIT(I+1)
IP=IP+1
30 IF(A.LT.10) GO TO 40
J=A-100*I
J=J/10
LONAME(IP)=DIGIT(J+1)
IP=IP+1
40 K=A-100*I - 10*J
LONAME(IP)=DIGIT(K+1)
IP=IP+1
IF(EXCITE.NE.0) LONAME(IP)=M
IP=IP+1
IF(EXCITE.GT.1) LONAME(IP)=DIGIT(EXCITE+1)
UNPACK=NAME
RETURN
C
C THIS ENTRY PERFORMS THE REVERSE TRANSFORMATION,
C FROM THE ALPHANUMERIC NUCLIDE NAME TO THE ZAS NUMBER
C
ENTRY ID(NAMEIN)
NAME=NAMEIN
DO 100 I=1,103
IF(ELEMENT.EQ.NUCNAM(I)) GO TO 110

```

```

100   CONTINUE
      WRITE(6,10200)ELEMENT
10200 FORMAT(' ELEMENT NAME: ',A2,' NOT FOUND')
      ID=0
      RETURN
110   IS=0
      IA=0
      IZ=I
      IP=4
      IF(LONAME(2).EQ.HYPHEN) IP=3
120   DO 140 I=1,10
        IF(LONAME(IP).EQ.DIGIT(I)) GO TO 150
140     CONTINUE
150     IA=IA*10+I-1
        IP=IP+1
        IF(LONAME(IP).EQ.LBLANK) GO TO 210
        IF(LONAME(IP).EQ.M) GO TO 180
        GO TO 120
180   IS=1
        IP=IP+1
        IF(LONAME(IP).EQ.LBLANK) GO TO 210
        DO 190 I=1,10
          IF(LONAME(IP).EQ.DIGIT(I)) GO TO 200
190     CONTINUE
200     IS=I-1
210     ID=IZ*10000+IA*10+IS
      RETURN
      END

```

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