Using the NOABL Flow Model and Mathematical Optimization as a Micrositing Tool

**H. L. Wegley
J. C. Barnard**

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MATHEMATICAL OPTIMIZATION AS A
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SUMMARY

This report describes the use of an improved mass-consistent model that is intended for diagnosing wind fields in complex terrain. The model was developed by merging an existing mass-consistent model, the NOABL model, with an optimization procedure. The optimization allows objective calculation of important model input parameters that previously had been supplied through guesswork; in this manner, the accuracy of the calculated winds has been greatly increased.

The report covers such topics as the software structure of the model, assembling an input file, processing the model's output, and certain cautions about the model's operation. The use of the model is illustrated by a test case.

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1.0 INTRODUCTION

Over the past decade, the U.S. Wind Energy Program has sponsored the development and testing of several three-dimensional fluid flow models for wind energy applications. These models were, for the most part, developed to provide economical wind field predictors for wind resource assessments over large areas of complex terrain (Phillips 1979; Hiester and Pennell 1981). However, as the growth in wind farm development accelerated, a need arose for tools to predict flow variability over microscale ($\sim 10 \text{ km}^2$) areas in complex terrain. This report describes briefly the adaptation of an existing mass-consistent flow model to create such a tool and then explains the proper use of this tool for micrositeing applications.

This report is intended to serve as a user's guide for the micrositeing tool (which will be referred to as the 'model' in the remainder of this report). This model is based upon a combination of a mathematical optimization technique and the NOABL objective analysis model (Barnard et al. 1985). This user's guide should be used in conjunction with the NOABL objective analysis code user's guide (Phillips 1979). Phillips' report explains how the mass-consistent NOABL model simulates flow and describes the input parameters to the model.

It is recommended that users of this model have some background in the atmospheric sciences, particularly atmospheric stability and factors that affect flow in the boundary layer. Furthermore, users should have some knowledge of iterative methods for solving systems of partial differential equations. Users of the model will need access to at least a minicomputer that has scientific computing power roughly equivalent to that of a VAX 11/780 and that has a resident FORTRAN compiler (preferably FORTRAN 77).

At this time the model should be considered as a research model and not as a fully refined micrositeing tool. This is due to several reasons. The first of these is that the model has been verified using only a limited data set and although it performed well, further verification studies are necessary to establish its reliability under a variety of modeling situations. Second,

the model is somewhat cumbersome to use, and it requires a significant amount of computer resources. Despite these difficulties, it is essential that the model be made available to the wind energy community so that experience gained by its use can guide further model development.

2.0 MODEL DESCRIPTION

The NOABL flow model is the framework around which the current model was built. Since a NOABL user's guide has been published (Phillips 1979) and a mathematical description of the NOABL model is available in several publications (Traci et al. 1978; Heister and Pennell 1981), this section will briefly discuss the optimization procedure that has been integrated into the NOABL flow model. Further information about the optimization procedure and a description of the model verification studies are given by Barnard et al. (1985).

2.1 THE USE OF OPTIMIZATION IN THE MODEL

The NOABL model, without optimization, requires as input several parameters that describe the state of the atmosphere. Two of these parameters are of particular importance: the stability parameter, τ , which is used to simulate the effect of atmospheric stability, and the mean wind direction, θ , an estimate of the direction of the mean flow over the modeled area. Because a relationship between τ and any common measure of the atmospheric stability has not been discovered, it has not been possible to specify, as input to the model, a τ value that is appropriate for the wind flow conditions that are being simulated. Also, θ is often only approximately known because surface measurements of the wind direction, even if they are available, are influenced by the local terrain and do not represent the mean flow over the modeled area. This ignorance of appropriate τ and θ values is not a major problem, provided that the model-calculated winds are not very sensitive to these parameters. However, for many modeling situations, the calculated winds are quite sensitive to one or both of these parameters. Thus, without knowledge of appropriate values for them, confidence in the calculated wind fields is not justified.

The sensitivity of the calculated winds to τ and θ is a difficulty that can be turned to the modeler's advantage when a number of wind observations are available over the area to be modeled. In this case, the wind observations can be used to tune τ and θ ; this tuning process adjusts τ and θ so that the error between the observed winds and the model's simulation of these

winds, is minimized. When this error is a minimum, τ and θ have taken 'optimum' values, and the calculated winds at the observation sites are as close as possible to the observations. Then it is presumed that the calculated winds away from the observation sites are also a good estimate of the actual winds. A past study (Barnard et al. 1985) has shown that this is the case, provided that the error is sufficiently small.

In the parlance of optimization, the error to be minimized is called the objective function. The objective function (OF) is quantitatively expressed by a ratio root mean square error, given by

$$OF(\tau, \theta) = \left[\sum_{i=1}^N (r_i^C - r_i^O)^2 / N \right]^{1/2} \quad (1)$$

where r_i^O are the observed wind-speed ratios at N wind-observation sites, and r_i^C are the model-calculated ratios for these same sites. For each set of modeled or observed speeds, the ratios are formed by dividing the speeds at the sites by the speed at a reference site; i is chosen to be 1 for the reference site so that $r_1^O = r_1^C = 1$. As indicated above, the OF is a function of τ and θ because the calculated ratios depend upon these quantities.

An optimization procedure is merged with the NOABL model to minimize the objective function. In practice, two identical optimization routines similar to the Coggins algorithm (Kuester and Mize 1973) act on τ and θ until the objective function is minimized. Derivative-based optimization schemes, such as steepest descent, were avoided because of the extreme computational effort required to calculate objective function derivatives accurate enough to be useful in these schemes.

2.2 SOFTWARE STRUCTURE

The software structure of the model is depicted in Figure 2.1 using code-like structured English. This figure provides a basis for the following discussion of the optimization procedure employed in the model.

As shown in the figure, the model is configured to optimize up to two parameters per model run. The two input parameters, which are optimized, are

1. Stability parameter (TV)
2. Initial wind field direction (WDR).

(TV and WDR are the model variables that correspond to τ and θ , respectively.)

To run the model requires wind speed observations at several locations and preferably one observed wind direction within an area of interest. If a direction observation is not available, an estimate of the mean wind direction is adequate. The minimal data requirements as a function of grid size and terrain complexity have yet to be determined; however, good results have been obtained when as few as six simultaneous wind speed measurements were made within a 4 km² area of complex terrain (Barnard et al. 1985).

The model, in the form listed in Appendix B, is configured to optimize first on the variable WDR (using subroutine NEWMIN), and then inside of this optimization, the optimal stability parameter (TV) is calculated (by subroutine STABRMIN). A typical model run might, for example, do the following:

- STEP 1 NEWMIN starts optimizing on wind direction by initializing the wind field at the user-specified wind direction; it then passes control to an "inner loop" (by invoking function OF1, which in turn calls STABRMIN)
- STEP 2 STABRMIN, in the inner loop, optimizes on TV by invoking function OF to calculate the objective function as a function of the wind direction and the initial TV
- STEP 3 function OF causes the SOR algorithm in subroutine CNWAO to run for a user-specified^(a) number of iterations, removing most of

- (a) Determination of the proper number of iterations depends upon the number of iterations required for the objective function to converge within the SOR algorithm; methods of estimating the appropriate number of iterations are discussed in Section 3.2.1.

the divergence from the flow, then OF calculates the objective function from the resultant wind field

- STEP 4 STABRMIN then increments TV and step 3 is repeated until the optimal TV is obtained for the initial wind direction
- STEP 5 control passes from STABRMIN, through OF1, and then back to NEWMIN where the initial wind direction is incremented; at this point the flow of control passes back to step 1 and OF1 is invoked.

The above steps are repeated until the optimal initial wind direction for the model run is calculated. Note that at each step in the outermost loop (in this case the wind direction optimization) the model completely optimizes on TV. This means that several executions of the SOR algorithm (CNWAD) are required to calculate the optimal TV for one value of WDR, and numerous executions of CNWAD are required to complete one model run that optimally calculates two NOABL input parameters (WDR and TV). The methods of reducing the CNWAD executions are discussed in Sections 3.1 and 3.1.2. (It is not necessary to optimize on both WDR and TV. If desired, the model can be directed to optimize on one or the other of these variables.)

Once optimal model parameters have been calculated, the model saves the calculated flow field and all parameters. Special software, which is described later in this report, can process the calculated flow field to produce graphical displays of the wind field.


```

Program NOABL
  *** serving as a driver, this program reads in input parameters and
    initializes the finite difference mesh; it then calls NEWMIN to begin
    optimization

Subroutine NEWMIN
  *** optimizes on parameter 1, the wind direction, using a single-
    variable unconstrained procedure to minimize the objective function
    in OF1

Function OF1
  *** evaluates the objective function for the specified wind direc-
    tion, calls STABRMIN to begin optimization on the stability
    parameter (TV)

Subroutine STABRMIN
  *** optimizes on the stability parameter using a single-
    variable unconstrained procedure to minimize the objective
    function in OF

Function OF
  *** evaluates the objective function for the stability
    parameter, calls the successive overrelaxation (SOR)
    algorithm, CNWAD and an interpolation routine (LINTERP)
    to obtain calculated winds at specified points

Subroutine CNWAD (SOR Algorithm)
  *** iteratively removes divergence from the wind field
    providing the resultant 3-dimensional grid of
    model-calculated 3-dimensional wind components
    (u,v,w)
End CNWAD
End OF
End STABRMIN
End OF1
End NEWMIN
End NOABL

```

FIGURE 2.1. Software Structure of the Model. (The end statements denote logical containment of subprograms.)

3.0 USING THE MODEL

This section describes the steps necessary to assemble an input file, start a model run, and then process the model's output. Some familiarity with the NOABL user's guide (Phillips 1979) is necessary to understand the material presented here.

The application of the model will be illustrated by a test case. This case represents an actual flow simulation over a wind farm in the Altamont Pass area of California. Figure 3.1 shows the terrain of the test case. The black dots in this figure mark the locations of eight wind observation stations used for model tuning. The positions of these stations and of the gridded terrain elevations used to generate this figure are referenced from the origin of the modeling grid. This is located at the lower left-hand corner of this figure, at the point $x=0$, $y=0$.

3.1 ASSEMBLING AN INPUT FILE

The model requires as input: (1) parameters that specify the geometry of the finite-difference mesh; (2) gridded terrain elevations over the area to be modeled; (3) wind speed observations and the location of these observation sites; (4) initial guesses of τ and θ ; and (5) parameters that control the operation of the optimization and the overrelaxation process.

The model is comprised of parts of the NOABL code, which have been merged with an optimization scheme, and the dual nature of the model is reflected in the input file. One part of this file feeds the optimization software. The other part supplies input to a modified NOABL code, and these variables are put in exactly the same format as if they were to be used with the original NOABL model (i.e., an asterisk in column 1, followed by the variable name, its location in blank common, and finally, the value of the variable). Figure 3.2 is a summarized description of a typical input file, and Figure 3.3 shows the input file for the test case. Lines 2 through 21 contain the NOABL-related variables; the other lines are data associated with the optimization. (Note: Some of the variables are used by both the NOABL code and the

CONTOUR INTERVAL - 10 M

FIGURE 3.1. Terrain Contours of the Test Case. The contour interval is 10 meters. The black dots mark the locations of the 8 tuning sites.

- 1 TITLE (up to 70 characters)
- 2 *DX (grid point spacing (meters) - x direction)
- 3 *DY (grid point spacing (meters) - y direction)
- 4 *IMAX (number of grid points in the x direction)
- 5 *JMAX (number of grid points in the y direction)
- 6 *DZMIN (height (meters) of lowest conformal layer)
- 7 *KMAX (number of grid points in the z direction or number of conformal levels)
- 8 *ZDIST (distance (meters) from the origin to the top of the grid)
- 9 *XSTA (x coordinates (meters) of tuning stations)
- 10 *YSTA (y coordinates (meters) of tuning stations)
- 11 *NSTAT (number of tuning stations)
- 12 *X0 (x coordinate (meters) of reference site)
- 13 *Y0 (y coordinate (meters) of reference site)
- 14 *Z0 (anemometer height of reference site (meters AGL))
- 15 *WSPD (wind speed (meters/sec) at reference site)
- 16 *WDR (wind direction (degrees) at reference site)
- 17 *NPTS (number of reference sites - always 1)
- 18 *ITMAX (maximum number of iterations allowed in subroutine "CNWAD")
- 19 *ITERAN (always 1, directs the program to read terrain data from LU 8)
- 20 *ITYLOR (always 1, directs the program to invoke the routine "TAYLOR")
- 21 *END OF DATA \$ (informs input subroutine that there is no more NOABL input)
- 22 (wind speeds (meters/sec) at the tuning sites)
- 23 (anemometer heights (meters AGL) of the tuning sites)
- 24 (initial guesses of wind direction and stability)
- 25 (direction and stability switches, 1 = optimize, 0 = don't optimize)
- 26 (direction and stability optimization step sizes)
- 27 (direction and stability optimization convergence criteria)
- 28 (find objective function as a function of iteration ? 1=yes,0=no)

FIGURE 3.2. Summarized Description of Input File

```

1 TEST CASE OF NOABL WITH OPTIMIZATION ON 8 DATA LOCATIONS
2 *DX $6,50.0
3 *DY $7,50.0
4 *IMAX $14,40
5 *JMAX $24,40
6 *DZMIN $9,20.
7 *KMAX $27,10
8 *ZDIST $38,700.
9 *XSTA $292,1041.0,1135.73,1172.33,834.03,1013.83,1507.63,962.03,1562.43
10 *YSTA $317,598.0,533.64,811.04,1164.54,1350.54,1015.24,1682.74,1417.54
11 *NSTAT $291,8
12 *XO $141,1041.0
13 *YO $191,598.0
14 *ZO $241,14.02
15 *WSPD $91,18.3
16 *WDR $41,240.0
17 *NPTS $33,1
18 *ITMAX $40,25
19 *ITERAN $19,1
20 *ITYLOR $20,1
21 *END OF DATA $
22 18.3,17.4,13.4,13.4,11.6,11.6,12.5,12.1
23 14.02,14.02,14.02,14.02,14.02,14.02,14.02,14.02
24 240.0,1.0
25 1,1
26 5.0,0.2
27 0.5,0.05
28 0

```

FIGURE 3.3. Input File for the Test Case

optimization.) The NOABL-related section of the input file is not order-specific, and the variables can be shifted around without affecting the input process. Also, more variables may be added to this section, if necessary. Phillips' (1979) description of the NOABL-related input variables and the default values that they assume, if they are not explicitly included in the input file, comprises Appendix A of this report.

Each line of the input file contains a single input variable or array of related variables. A line-by-line description of the summarized input file follows, along with a parallel description of the specific test-case values that have been assigned to the input variables. Files for other runs may contain a different number of lines, depending upon the number of variables placed in the NOABL section.

Line 1 is a title, up to 70 characters long.

Lines 2 and 3 contain DX and DY, which are distances (in meters) between the horizontal grid points in the x and y directions, respectively. If h is the array that contains the terrain elevations, the elevation $h(i,j)$ has x and y coordinates of $x = DX/2 + (i-1) * DX$ and $y = DY/2 + (j-1) * DY$. With this definition of the terrain elevation locations, it is important to realize that $h(1,1)$ is the elevation at the position $x = DX/2$ m, $y = DY/2$ m; $h(1,1)$ is not located at the origin. For the test-case terrain depicted in Figure 3.1, DX and DY are both 50 meters.

Lines 4 and 5 contain the number of grid points in the x and y directions, which are given by the model variables IMAX and JMAX, respectively. For the test-case $IMAX = JMAX = 40$, so that the modeled area is a 2 km x 2 km square, over which there are 1600 terrain elevations. The terrain file is listed in Appendix C, and construction of this file is explained in the NOABL user's guide (Phillips 1979).

Vertical zoning in the model is controlled by the variables on lines 6, 7, and 8. DZMIN is the thickness of the lowest conformal level, KMAX, the number of vertical conformal levels, and ZDIST, the distance from the origin to the top of the modeling domain. These variables are assigned values 20 meters, 10, and 700 meters, respectively, for the test simulation. Further

description of these variables and an explanation of the terrain conformal coordinate system are found in the NOABL user's guide (Phillips 1979).

The model in its present form can accommodate up to 40 grid points in each horizontal direction and up to 10 points in the vertical. Therefore, IMAX and JMAX cannot exceed 40, and KMAX cannot exceed 10. However, the array dimensions of the model can be changed to allow more grid points; this procedure is described in Section 4.6.

Table 3.1 lists the x and y coordinates (in meters) of the 8 observation stations and hourly averaged wind speeds (m/s) for each of the 8 stations. These are the test-case wind speeds that the model uses during the tuning process to find the optimum values of τ and θ . The first station in this list is the reference site, and observed ratios are obtained by dividing the speeds listed in Table 3.1 by the reference site speed. These ratios are used as the observed ratios in Equation (1). The reference site is usually taken to be the observation site with the highest wind speed. The station coordinates are placed in the array variables XSTA (line 9) and YSTA (line 10); NSTAT (line 11) is assigned the total number of tuning stations; for the test-case this is 8. The first entry into both XSTA and YSTA must be the reference site coordinates. These same two coordinates are repeated in lines 12 and 13, which contain the variables XO,YO. These are the horizontal coordinates of the reference site (XO=1041 m, YO=598 m), and ZO (line 14) is the reference site anemometer height (14.01 m AGL). WSPD (line 15) and WDR (line 16) are the wind speed and direction at the reference site, which are 18.3 m/s and 240°, respectively. (If a wind direction measurement is not available at the reference site, an estimate of the direction will suffice.) NPTS on line 17 is set equal to 1. This informs this model that only one wind observation, the reference site, is to be used to build the initial guess of the wind field. For the present model configuration, NPTS should always be 1, and only one entry should be made on lines 15 and 16.

TABLE 3.1. Coordinates (m) and Wind Speeds (m/s) of the Eight Tuning Sites. x and y are measured from the model's origin; h is the anemometer in meters AGL.

<u>x (m)</u>	<u>y (m)</u>	<u>h (m)</u>	<u>Wind Speed (m/s)</u>
1041.0	598.0	14.02	18.3
1135.73	533.64	14.02	17.4
1172.33	811.04	14.02	13.4
834.03	1164.54	14.02	13.4
1013.83	1350.54	14.02	11.6
1507.63	1015.24	14.02	11.6
962.03	1682.74	14.02	12.5
1562.43	1417.54	14.02	12.1

ITMAX (on line 18) controls the maximum number of iterations within the subroutine CNWAD. The number of iterations that take place in one call to subrouting CNWAD is ITMAX + 1. This subroutine removes the divergence from the wind field, and the final mass-consistent wind field that results from this procedure is used to find the calculated ratios, which, in turn, are used to evaluate the objective function during one iteration of the optimization process. If ITMAX is too small, then inaccurate values of the objective function will be fed to the optimization routine; if ITMAX is too large, the CPU time required to evaluate the objective function will be unnecessarily large. Methods of estimating an acceptable value of ITMAX will be discussed in Section 3.2.1. For the test case, ITMAX was set to 25 iterations.

On line 19, the variable ITERAN must have a value of one. This directs the model to read the terrain data from a file that is assigned to logical unit 8.

Line 20 is the input for the variable ITYLOR, which is always set to 1 causing the subroutine TAYLOR to be invoked. This subroutine is used to find model-derived vertical wind speed profiles over the observation sites. From these profiles, model-calculated winds at the anemometer heights are determined; the ratios formed from these are used to evaluate the objective function. The model is informed that all the NOABL-related variables have been read by the "END OF NOABL DATA \$" on line 21.

The optimization software receives data from the next 6 lines. Line 22 contains the set of wind speeds (in m/s) used for model tuning. The speeds must be given in the same order as the station coordinates in the arrays XSTA and YSTA, and the number of speeds must equal NSTAT. The anemometer heights of the tuning sites are given in line 23, and these must be given in the same order as the station coordinates.

Line 24 contains the initial guesses of the mean flow direction, θ , and the stability parameter, τ . If a direction measurement is available within or near the modeled area, this direction can be used as the initial guess for θ ; otherwise, a crude estimate of θ is adequate. The value assigned to θ should be the same as the value given to WDR on line 16. A reasonable initial guess for τ is 1.

Switches that control the optimization are on line 25. These switches have either a value of 1 (on) or 0 (off); the first switch is for θ and the second is for τ . If the switch is set equal to 1, then the variable in question is optimized. If both switches are zero, the model operates without optimization.

Line 26 contains the optimization step sizes for θ and τ . For this case, θ is initially incremented by 5° during each optimization step; τ is incremented by 10^{-2} . (The actual step size for τ is 10^x , where x is the second value in line 26.)

Line 27 contains the convergence criteria for the optimization of θ and τ . When θ changes less than $.5^\circ$ between steps, and $\log_{10}(\tau)$ changes less than 0.05, the optimization is considered to have converged, and the routine stops. In general, the values on lines 26 and 27 can remain unchanged from run to run.

Finally, line 28 is a switch that has values of either 1 (on) or 0 (off). When this switch is equal to 1, the code will find the objective function as a function of the number of iterations within the CNWAD routine. This information is used to estimate ITMAX. When the switch is off, a normal optimization run occurs, using the value of ITMAX determined previously.

3.2 INITIATING A MODEL RUN

Several steps are involved in starting a model run. Most of these steps are very simple and are concerned with connecting the input and output to the appropriate files. However, before starting a model run that finds optimum values for τ and θ , it is necessary to have an estimate for ITMAX. This requires operation of the model in a special, non-optimizing mode. (This mode is invoked by setting the switch, on line 28 of the input file, equal to 1.)

The files associated with the model's use are the input file, which was described in Section 3.1, a terrain input file, which contains the gridded terrain data, and two output files. One output file is an ASCII file that logs the events that occur during the operation of the model. The other output file is a binary file that has as its contents the common block COMON and the final, computed wind components. The common block COMON stores the model variables and the terrain elevations. The binary file is not created if the model is being operated to find ITMAX. In that case, a special ASCII file is opened that receives information from which ITMAX can be determined.

Only a few job-control statements are needed to run the model. Figure 3.4 displays the command sequence that is used on a VAX/VMS operating system. Although this sequence is specific to the VAX/VMS operating system, the assignments of logical units to the input and output files are easily understood. Therefore, conversion of these commands to another system should pose little difficulty.

3.2.1 Finding ITMAX

A great deal of CPU time is sometimes required to operate the model. Therefore it is desirable to keep the total number of iterations per run as low as possible. One way of achieving this is to minimize the number of iterations in the subroutine CNWAD, which calculates, using an iterative overrelaxation technique, the nondivergent wind field. This routine stops when either a given number of iterations has occurred (specified by the variable ITMAX), or a given convergence criterion is met (specified by the variable EPSLN). The objective function is calculated from the nondivergent wind field, and if


```

$ ! ASSIGN THE TERRAIN FILE TO LOGICAL UNIT 8
$ ASSIGN TERRAIN.DAT FOR008
$ ! ASSIGN THE BINARY OUTPUT FILE TO LOGICAL UNIT 10
$ ! (THIS ASSIGNMENT IS NOT NECESSARY IF FINDING THE OBJECTIVE FUNCTION
$ ! AS A FUNCTION OF ITERATION)
$ ASSIGN OUTPUT.BIN FOR010
$ ! ASSIGN THE ASCII OUTPUT TO LOGICAL UNIT 6
$ ASSIGN OUTPUT.DAT FOR006
$ ! ASSIGN THE INPUT FILE TO LOGICAL UNIT 5
$ ASSIGN INPUT.DAT FOR005
$ ! RUN THE MODEL ("MODEL" IS THE EXECUTABLE CODE)
$ RUN MODEL
$ ! (THE ASSIGNMENT BELOW IS ONLY NECESSARY IF FINDING THE OBJECTIVE
$ ! FUNCTION AS A FUNCTION OF ITERATION)
$ ! ASCII FILE THAT CONTAINS THE OBJECTIVE FUNCTION AS A FUNCTION OF
$ ! ITERATION IS ASSIGNED TO LOGICAL UNIT 17
$ ASSIGN FILE.DAT FOR017

```

FIGURE 3.4. Command Stream Required to Operate the Model. This set of commands is appropriate for a VAX/VMS operating system. The statements that are preceded by a '!' are comments.

most of the divergence has not been removed from the field by the routine CNWAD, then erroneous values of the objective function will occur, and the optimization may produce results that are misleading.

One way of gauging the accuracy of the objective function is to observe its behavior as the iteration proceeds. This behavior is shown in Figure 3.5, which plots the objective function against iteration number for three different values of $\log_{10}(TV)$. (The test case terrain and model parameters were used to make this graph.) For all three values of $\log_{10}(TV)$, the objective function does not reach a steady state until about the 25th iteration. Further iterations past this point do not greatly alter the value of the objective function; therefore, the overrelaxation may stop at this point and, for this

case, ITMAX can be taken to be 25. Usually it is only necessary to find ITMAX for one value of TV, for a given modeled area.

The data used to create Figure 3.5, the value of the objective function at each iteration in CNWAD, are calculated by a special model run. To invoke this run, the switch on line 26 of the input file is set to 1, instead of 0. The iteration number and objective function are printed on a special ASCII file, which is assigned to logical unit 17. (Because of this, a command must be included in the command sequence that assigns a file to LU17.) For the test case data and a value of TV equal to 1, this special ASCII file is shown in Appendix D.

FIGURE 3.5. Objective Function as a Function of Iteration Number for Three Values of LOG(TV). The test case terrain and model parameters were used in developing this graph.

3.2.2 Model Run of Test Case

The file shown in Figure 3.2 was used as the input file for a model run. The printed output is displayed in Appendix E. At the end of this output, the optimum values for τ (TV) and θ (WDR) are given, and also the minimum value of the objective function. These values are 0.57296, 238.82, and 0.03393, respectively. The total number of iterations in the subroutine CNWAD was 624, which represent 25 calls to the subroutine CNWAD. The VAX 11/780 CPU time for this run was about 1 hour.

The bulk of the printed output consists of the calculated and observed ratios, and the calculated and observed speeds, at each of the NSTAT tuning sites. These quantities are printed for each time θ or τ is changed during the optimization.

3.3 PROCESSING THE MODEL'S OUTPUT

This section briefly describes the processing of the binary file, which contains the final, mass-consistent wind field calculated using the optimum values of θ and τ . Supplementary software (that is not part of the model code) takes this file and produces contours of the terrain and/or wind speeds (or ratios). These plots can be examined to locate areas where the wind speeds may be enhanced, which may therefore be suitable for wind turbine siting.

The supplementary software is listed in Appendix F. It uses plotting commands taken from the DISSPLA^(a) library. If this library is not available, then modifications must be made to incorporate other plotting software.

Figure 3.6 shows sample input for the plotting program. Only five pieces of input data are required, and they are entered in the following order:

- 1) the height (in m AGL) for which the wind speed (or ratio) contours are calculated
- 2) a switch that directs the program to compute wind ratios instead of wind speeds (Y = calculate ratios, N = calculate wind speeds only)

(a) DISSPLA is a proprietary software product of Integrated Software Systems Corporation.

14.02 (HEIGHT (M AGL) AT WHICH THE WIND FIELD WILL BE CALCULATED)
N (CALCULATE RATIOS? N = NO, Y = YES)
2.0 (WIND SPEED CONTOUR INTERVAL (M/S), OR RATIO CONTOUR INTERVAL)
10.0 (TERRAIN CONTOUR INTERVAL (M))
OUTPUT.BIN (NAME OF THE BINARY OUTPUT FILE)

FIGURE 3.6. Sample Input to Supplementary Software that Produces Wind Speed Contours (or Wind Speed Ratios). The parentheses enclose comments that describe the input.

- 3) the wind speed (or ratio) contour interval (in m/s if speed contours are calculated)
- 4) the terrain contour interval (meters)
- 5) the name of the NOABL binary file.

If item 3 (or 4) is assigned negative value, then the speed contours (or the terrain contours) are not calculated.

The graphical output of the plotting program using directives of Figure 3.6, is shown in Figure 3.7. This figure depicts the terrain contours as dotted lines at 10 m intervals, and the wind speeds are contoured at 2 m/s intervals. Appendix G is a listing of the printed output. This printed output includes the calculated and observed ratios at the tuning sites, and the calculated wind speeds at the specified height. The horizontal positions of the calculated wind speeds correspond to the horizontal positions of the terrain elevations. Therefore, the speed $S(i,j)$ is located at x and y positions of $DX/2 + (i-1) * DX$, $DY/2 + (j-1) * DY$, respectively, where these positions are measured relative to the origin.

CONTOUR INTERVAL - 10 M

AGL - 14.02 M

FIGURE 3.7. Wind Speed Contours, for the Test Case, Produced by the Supplementary Software and the Input File of Figure 3.6.

4.0 IMPORTANT POINTS ABOUT MODEL APPLICATION

This section discusses several problems that the user might encounter when running the model and interpreting the model output. Methods of avoiding or ameliorating these problems are provided for the user.

4.1 INTERPRETATION OF A MODEL RUN

This model is a diagnostic model that calculates a steady-state flow over the area of concern. To properly interpret the results of a model run, the user must know what, in the real world, equates most closely to 'steady-state' flow. The authors have examined analyses of various time averages of wind speed and direction at the Goodnoe Hills MDD-2 test site near Goldendale, Washington. The basic data collection rate for the period of study was 5 seconds. Running means were calculated for the wind data for averaging intervals of 2 minutes, 10 minutes, and 30 minutes. An examination of these means indicated that steady-state flow was usually observed for averaging times greater than 10 minutes.

It is reasonable to assume that a model run represents a 10- to 60-minute picture of the mean flow. To apply the modeled wind flow for micrositing, it is desirable to simulate the flow for an ensemble of cases that represent all the primary power-producing wind regimes for the area of interest. In this manner, the wind energy potential of a wind farm can be evaluated with the flow model, by running the model using optimally calculated input parameters for each of the important wind regimes.

4.2 TERRAIN SETUP

Evenly spaced gridded terrain elevations over an area of interest are required to run the model. The importance of having high quality terrain data cannot be overemphasized. To determine the resolution of the terrain grid, users should consider the size of the terrain features that influence the wind flow in the area of interest. To ensure the quality of the terrain data and accuracy of the model results, users should carefully edit the data to remove any erroneous terrain elevations. The terrain grid should not be

so coarse that such features become smoothed out. For the moderately complex terrain in the Altamont Pass area of California, it was found that the minimal grid distance above which significant loss of terrain resolution occurred was 50 meters. This can be used as a rough guideline for other areas of complex terrain until experience is gained using the model in the area of interest.

As noted by Phillips (1979), the grid cell aspect ratio (DX/DY) affects the convergence rate of the iterative scheme used to solve the system of equations in the model. The user should use a square mesh to minimize model run time. That is, DX and DY should be equal.

Terrain data is entered into the model from left to right, beginning at the lower left corner of the grid (the origin) and working upward, row by row, toward the top row. The units used for terrain by the model are heights above sea level in meters.

4.3 NUMERICAL STABILITY

The numerical method used to remove the divergence from the flow field is block overrelaxation. Occasionally this method becomes unstable and does not converge. This problem is most often associated with simulations of a stable atmosphere (i.e., $\log_{10}(TV) < 0.0$). However, terrain slope can also contribute to nonconvergence. As the terrain slope increases, the amount of adjustment required to make the wind field mass-consistent increases. If the slope becomes too great, the numerical technique can exhibit numerical instability.

One important parameter of the overrelaxation procedure is the overrelaxation parameter, ω . Figure 4.1 shows the number of iterations required for convergence as a function of ω for three different grid sizes imposed on the same terrain (not the same terrain as used in the test case). For a given grid size, one value of ω , called the optimum overrelaxation parameter, ω_{opt} , is associated with the minimum number of iterations. As indicated in Figure 4.1, values of ω much greater than ω_{opt} cause a rapid rise in the number of iterations required for convergence and may lead to nonconvergence. For values of ω less than ω_{opt} , convergence usually occurs, although at a slower rate.

FIGURE 4.1. Number of Iterations, Within the Subroutine "CNWAD", as a Function of the Overrelaxation Parameter

If ω is not explicitly specified in the input file, it is calculated by the model. Occasionally the model-calculated ω value is too large and the model fails to converge. If this occurs, the user can decrease the magnitude of ω , and often this reduction is sufficient to prevent numerical instability. If desired, the value of ω_{opt} may be determined by numerical experimentation. That is, the number of iterations for different values of ω can be noted and from this information, one can estimate ω_{opt} .

To specify a value for ω , a new line must be added to the input file before the *END OF NOABL DATA \$ and after the title (the first line). The format of this line is "OMEG \$34, x" where x is the value of ω .

4.4 PROPAGATION OF EDGE EFFECTS

Calculation of the wind speed near the horizontal boundary of the modeling grid may not be accurate because of the presence of the boundary. This 'edge effect' may be felt several grid cells in from the edge. To investigate the inward propagation of edge effects, several NOABL runs were made such that the terrain grids used partially overlapped one another. Differences in the calculated winds for the cases when a site was near the edge of the terrain grid and when the site was more near the center of the terrain grid were examined. These edge effects have been observed to cause changes in the calculated wind speed of up to 30% for sites within three grid cells of the horizontal grid boundaries. These effects are most significant when terrain features having high relief (peaks or valleys) are on, or near, the edge of the terrain grid. As a rough guideline, the user can expect edge effects to propagate inward for as many as five grid cells.

4.5 DIFFERENT OBJECTIVE FUNCTIONS

The objective function expressed in Equation (1) is based on wind speed ratios. Other formulations of the objective function, using wind speeds or wind velocity components in place of ratios, are also valid. However, when using speeds or velocity components, the quantities must be multiplied by a linear scale factor, f . (This scaling is necessary to counteract a tendency of the model to calculate wind speeds that are either too high or too low.) With a ratio-based objective function, implicit scaling is performed using a scale factor that is the reciprocal of the wind speed at the reference site. For other situations, f must be explicitly found during the calculation of the objective function.

Determination of f is quite simple. When f is included as part of the objective function, the expression for this quantity becomes

$$OF = \left[\sum_{i=1}^N \left(f \frac{s_i^c}{s_i^o} - 1 \right)^2 / N \right]^{1/2} \quad (2)$$

Once the speeds s_i^C are calculated, f is found so that the objective function assumes a minimum value. This is easily done by taking the derivative of the objective function with respect to f , setting the derivative equal to zero, and then solving for f . The expression for f is then

$$f = \frac{\sum_{i=1}^N s_i^O s_i^C}{\sum_{i=1}^N s_i^C s_i^C} \quad . \quad (3)$$

When the calculated speeds are scaled by f (i.e., the scaled speeds are $f s_i^C$, $i=1, N$), they are as close as possible to the actual speeds for the current values of τ and θ . Determining f and scaling the speeds should be done in subroutine OF. This scaling ability is not now in the code, but could be easily implemented by adding a few lines of new code. Then one would have the flexibility of using speeds or speed components in place of speed ratios.

4.6 CHANGING THE ARRAY DIMENSIONS OF THE MODEL CODE AND SUPPLEMENTARY SOFTWARE

The number of grid points that can be accommodated by the model is limited by the array dimensions within the model's code. The version of the model described in this report can handle up to 40 grid points in the x and y directions, and up to 10 grid points vertically (z or σ direction). If it is desired to increase these limits, then array dimensions must be changed. The user should note that changing the size of the array dimensions can greatly affect model execution time. With i , j , and k as the desired limits in the x , y , and z (or σ) directions respectively, Figure 4.2 shows the arrays that must be changed, the locations of these arrays within the code, and the correct array dimensions. (Also shown are a few lines of code, aside from array, that must also be changed.) The array locations are indicated by the file name and the line number within the file where the array resides. Because the common block in the file "COMMONJ.INC" is part of the main program and every subroutine of the code, all of these must be compiled and linked before the model can be operated.

When the array dimensions are changed within the model, it is also necessary to change array dimensions in the supplementary software. These changes are also shown in Figure 4.2. It is important that the array dimensions of

the model and supplementary software are the same; if they are not, the supplementary software will not work.

MODEL SOFTWARE

FILE NAME	LINE NUMBER	CODE
NOABL.FOR	18	DIMENSION UU((I+1)*J*K),VV(I*(J+1)*K),WW(I*J*(K+1))
	160	DO N=1,(I+1)*J*K
	167	DO N=1,I*J*(K+1)
COMMONJ.INC	38	DIMENSION X(I)
	39	DIMENSION Y(J)
	45	PI(I*J), TERAIR(I*J), DM1A(I*J)
	46	DMB(I*J)
	49	PHI(I+1,J+1,K+1)
	52	U(I+1,J,K), V(I,J+1,K), W(I,J,K+1)
	53	DIV(I,J,K), DZODX(I*J), DZODY(I*J)
ADJUSTUV.FOR	54	IFLAG(I*J), UTEN(I*J), VTEN(I*J)
	60	COMON(4*I*J+819),ICOMON(4*I*J+819)
	13	COMMON/UUVV/UU(I+1,J,K),VV(I,J+1,K)
	125	COMMON/UUVV/UU(I+1,J,K),VV(I,J+1,K)
	215	DIMENSION UAVG(I,J),VAVG(I,J)
MISC.FOR	216	COMMON/UUVV/UU(I+1,J,K),VV(I,J+1,K)
	667	NWORDS=4*I*J+819
	672	DO 30 N=1,I*J
	814	DIMENSION H(I,J)
	1913	DIMENSION UAVG(I,J),VAVG(I,J)

SUPPLEMENTARY SOFTWARE

FILE NAME	LINE NUMBER	CODE
HCONPLOT.FOR	8	COMMON/CNB/SPEED1(I*J),INPUTFILE
	9	COMMON/ARRAY/ZMAT(I,J),XCON(I*J),YCON(I*J),ZCON(I*J)
	131	COMMON/ARRAY/ZMAT(I,J),XCON(I*J),YCON(I*J),ZCON(I*J)
	132	COMMON/CNB/SPEED(I*J),INPUTFILE
COMMONJ.INC	38	DIMENSION X(I)
	39	DIMENSION Y(J)
	45	PI(I*J), TERAIR(I*J), DM1A(I*J)
	46	DMB(I*J)
	49	PHI(I+1,J+1,K+1)
	52	U(I+1,J,K), V(I,J+1,K), W(I,J,K+1)
	53	DIV(I,J,K), DZODX(I*J), DZODY(I*J)
GETSPEED.FOR	54	IFLAG(I*J), UTEN(I*J), VTEN(I*J)
	60	COMON(4*I*J+819),ICOMON(4*I*J+819)
	7	COMMON/OUT/A(I*J,K)
	8	COMMON/CNB/SPEED1(I*J),INPUTFILE
	9	DIMENSION UAVG(I*J,K),VAVG(I*J,K),SPEEDX(25)
	62	COMMON/OUT/A(I*J,K)
	63	DIMENSION UAVG(I*J,K),VAVG(I*J,K)
	99	DIMENSION UAVG(I,J),VAVG(I,J)

FIGURE 4.2. Array Dimensions and other code changes for the Model and Supplementary Software. The maximum number of grid points in the x, y, and z directions are I, J, and K, respectively.

5.0 RECOMMENDATIONS AND CONCLUSIONS

Limited testing of the optimizing version of the NOABL flow model has shown that the model can be a useful tool for microsimulating in complex terrain. The model in its present form still requires sufficient expertise and sufficient computing resources to discourage some potential users. For this reason, the possibility of developing a simplified version of the model suited for a broader audience should be examined. This work could entail developing a two-dimensional model that requires less knowledge of the mathematics and that could be run on a personal computer.

It is further recommended that limitations of the model be identified with respect to:

- 1) wind measurement and terrain elevation density required to obtain reliable results in complex terrain
- 2) the range of wind speeds over which the model performs reliably.

Several model enhancements should be examined that could significantly improve model performance:

- 1) incorporation of appropriate physics from other models
- 2) incorporation of the ability to optimize on wind components
- 3) improvement of the wind field initialization scheme to more intelligently interpolate/extrapolate the input winds over the grid.

6.0 REFERENCES

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- Phillips, G. T. 1979. A Preliminary User's Guide for the NOABL Objective Analysis Code. DOE/ET/20280-T1, National Technical Information Service, Springfield, Virginia.
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APPENDIX A

NOABL INPUT VARIABLES

APPENDIX A

NOABL INPUT VARIABLES

This appendix lists the input variables to the NOABL model. This listing is taken from the NOABL user's guide (Phillips 1979). Only a subset of the listed variables is required as user-specified input to the model described in this report.

<u>VARIABLE</u>	<u>LOCATION</u>	<u>TYPE</u>	<u>DEFAULT</u>	<u>DEFINITION</u>
ALFA1	1	Real	0.70710678	Defines horizontal transmissivity $\tau_h = 1.0/(2.0*ALFA1**2)$
ALFA2	2	Real	0.70710678	Defines vertical transmissivity $\tau_v = 1.0/(2.0*ALFA2**2)$
ATOP	343	Real		Wind direction at top of mesh (degrees)
BETA	3	Real	0.1429	Exponent of power law profile
DEBUG	5	Integer	0	Debug flag 0: no debug edit 1: turn on debug edits
DMP	39	Real	0.0	Damping factor for conformal simulations of highly stable flow; suggest: DMP $\sim .05 \rightarrow .1$ for $\tau_v < .01$
DX	6	Real	2000.0	Constant zone size in x-direction (east) (m)
DY	7	Real	2000.0	Constant zone size in y-direction (north) (m)
DZ	8	Real		Constant zone size in z-direction (vertical) (m). Set for real space runs only.
DZMIN	9	Real	30.0	Minimum vertical zone size (m). Specified when ISIG = 3.

<u>VARIABLE</u>	<u>LOCATION</u>	<u>TYPE</u>	<u>DEFAULT</u>	<u>DEFINITION</u>
EPSLN	10	Real	0.1	min $\Delta\phi_{ijk} \rightarrow$ conformal space min $\text{Div}_{ijk} \rightarrow$ real space
I2D	23	Integer	0	Space dimension flag 0: 3-D space (x,y,z or σ) 1: 2-D space (x,y or σ)
IDAY	11	Integer	1	Day of month being simulated
IEDIT	12	Integer	0	Edit flag 0: no edit of flow variables 1: edit flow variables 2: generate line printer contour plots 3: generate summary edit plus line printer contour plots on unit 9
IHOUR	13	Integer	1	Hour of day being simulated
IMAX	14	Integer	30	Maximum number of cells in x-direction (east)
IMN	15	Integer	1	Minimum column in I-direction to be edited
IMX	16	Integer	30	Maximum column in I-direction to be edited
IPATH	17	Integer	2	Geometry flag 1: real space 2: conformal space
ISIG	18	Integer	3	Vertical zoning flag (conformal space only) 1: log linear distribution 2: constant zoning 3: geometric progression

<u>VARIABLE</u>	<u>LOCATION</u>	<u>TYPE</u>	<u>DEFAULT</u>	<u>DEFINITION</u>
ITERAN	19	Integer	3	Terrain data source flag 1: read terrain data from tape (unit 8) [8F10.2 format] 2: initialize terrain data from data statement 3: read terrain data from cards [10F8.1 format]
ITMAX	40	Integer	100	Maximum allowable number of iterations
ITYLOR	20	Integer	0	Special edit flag 0: no special edit 1: interpolate adjusted field to define wind speed and direction at specified locations within the mesh
IWIND	21	Integer	1	Wind data type flag 1: surface wind data only, input wind speed and direction 2: surface wind data only, input wind components 3: surface wind data and one upper air station, input wind speed and direction 4: surface wind data and one upper air station, input wind components
IYEAR	22	Integer	1	Simulation year
JMAX	24	Integer	30	Maximum number of cells in y-direction (north)
JMN	25	Integer	1	Minimum column in J-direction to be edited
JMX	26	Integer	30	Maximum column in J-direction to be edited

<u>VARIABLE</u>	<u>LOCATION</u>	<u>TYPE</u>	<u>DEFAULT</u>	<u>DEFINITION</u>
KMAX	27	Integer	15	Maximum number of cells in vertical direction
KMN	28	Integer	1	Minimum row to be edited
KMX	29	Integer	15	Maximum row to be edited
MONTH	30	Integer	1	Month of simulation
MPS	31	Integer	1	Wind speed units flag 0: input is mph 1: input is m/sec 2: input is knots
NDAYS	32	Integer	1	Number of separate simulations to be performed
NPTS	33	Integer	1	Number of wind observation stations -1: initialization with upper air data only
NSTAT	291	Integer	0	Number of stations where wind speed and wind direction are to be computed for editing purposes. If NSTAT is negative, 4 character Hollerith station I.D.'s are to be entered via card input
NUA	345	Integer	2	Number of upper air reporting levels
OMEG	34	Real	-1.0	Over-relaxation parameter set to -1.0 in DEFINE, used initially as a flag -1.0: OMEG is calculated >0 : OMEG was entered through cards
ORIGNX ORIGNY	35,36	Real	0.0,0.0	Position of grid origin (m)

<u>VARIABLE</u>	<u>LOCATION</u>	<u>TYPE</u>	<u>DEFAULT</u>	<u>DEFINITION</u>
QTOP	342	Real	999.0	Wind speed at top of mesh, if QTOP=999.0 wind speed at top of mesh is assumed equal to that at top of boundary layer (m/sec, mph, knots)
ZBL	344	Real	200.0	Boundary layer height (AGL) (m)
ZDIST	38	Real	2*[Range of Terrain Heights]	Height of top boundary with respect to minimum terrain altitude (m)
UAMSL	396	Real Array		Array of upper level heights (MSL) corresponding to reported upper level winds (m)
WDR	41	Real Array		Array of observed surface wind direction or V-components (degrees, m/sec, mph, or knots)
WDRUA	371	Real Array		Array of observed upper air wind direction or V-components read from lowest level to highest level (degrees, m/sec, mph, or knots)
WSPD	91	Real Array		Array of observed surface wind speeds or U-components (m/sec, mph, or knots)
WSPDUA	346	Real Array		Array of observed upper air wind speeds or U-components read from lowest level to highest level (m/sec, mph, or knots)
XO	141	Real Array		Array of X-positions of observed wind velocities (m)
XSTA	292	Real Array		X-locations of each of NSTAT stations (m)

<u>VARIABLE</u>	<u>LOCATION</u>	<u>TYPE</u>	<u>DEFAULT</u>	<u>DEFINITION</u>
Y0	191	Real Array		Array of Y-positions of observed wind velocities (m)
YSTA	317	Real Array		Y-locations of each of NSTAT stations (m)
Z0	241	Real Array		Array of Z-positions (AGL) of observed wind velocities (m)

APPENDIX B

MODEL LISTING

APPENDIX B
MODEL LISTING

The model code is broken up into 9 files; this appendix lists these files. One of the files, COMMONJ.INC, contains a common block that is shared by most code modules. The files are listed in the following order:

- 1) NOABL.FOR
- 2) COMMONJ.INC
- 3) ADJUSTUV.FOR
- 4) LINTERP.FOR
- 5) MISC.FOR
- 6) NEWMIN.FOR
- 7) OF.FOR
- 8) OF1.FOR
- 9) STABR.FOR

To make executable code, all these files, except COMMONJ.INC, must be compiled and linked. A link command such as

```
LINK/EXE=MODEL.EXE NOABL,ADJUSTUV,LINTERP,MISC,NEWMIN,OF,OF1,STABR
```

produces the executable code MODEL.EXE.

FILE: NOABL.FOR

```

1:      PROGRAM NOABL
2:      C
3:      C
4:      C      ... NOABL- PRODUCES 3-D TERRAIN DEPENDENT
5:      C              DIVERGENCE FREE WIND FIELDS GIVEN
6:      C              OBSERVED WIND DATA AS INPUT. THIS
7:      C              MODEL IS FORMULATED IN BOTH REAL(X,Y,Z)
8:      C              AND CONFORMAL (X,Y,S) SPACE.
9:      C
10:     C UNIT 5 = NORMAL INPUT
11:     C UNIT 6 = NORMAL OUTPUT
12:     C UNIT 8 = INPUT FOR TERRAIN DATA
13:     C UNIT 9 = OUTPUT FOR CONTOUR PLOTS AND SUMMARY EDIT, IF IEDIT=3
14:     C UNIT 10 = OUTPUT FOR BLANK COMMON OR WIND DATA (AND STATION DATA)
15:     C UNIT 12 = SCRATCH FILE USED TO STORE U,V, AND W COMPONENTS
16:     C
17:     C      INCLUDE THE COMMON FILE DECLARING MOST OF THE VARIABLES USED IN NOABL
18:     C      DIMENSION UU(16400),VV(16400),WW(17800)
19:     C      INCLUDE 'COMMONJ.INC'
20:     C      EQUIVALENCE (U,UU),(V,VV),(W,WW)
21:     C
22:     C      DECLARE OTHER COMMON BLOCKS
23:     C      COMMON /OUT/ A(25,25), B(25,25)
24:     C      COMMON/SQUARE/V1(20),H0(20)
25:     C      COMMON/PARAMS/PARAM(3),IVAR(3),STEP(3)
26:     C      COMMON/JIM/ICOUNT,XVAR(2)
27:     C      COMMON/SLEAZ/ERROR(3)
28:     C      COMMON/GOOD/RMSE_MIN(100),TAU_MIN(100),DIR_MIN(100),SCALE(100),
29:     C      1JTER
30:     C
31:     C      DECLARE INTERNAL VARIABLES
32:     C      DIMENSION X1(2)
33:     C      CHARACTER*70 TITLE
34:     C
35:     C      OPEN SCRATCH FILE
36:     C      OPEN(12,FORM='UNFORMATTED',DISP='DELETE',STATUS='UNKNOWN')
37:     C
38:     C      READ(5,'(A)')TITLE
39:     C      WRITE(6,'(1X,A)')TITLE
40:     C
41:     C      ... READ NOABL INPUT DATA IN SUBROUTINE CARDS FORMAT ...
42:     C      CALL INPUT(1)
43:     C
44:     C      READ IN INPUT DATA USED FOR OPTIMIZATION FROM LOGICAL UNIT 5
45:     C      AND WRITE THEM TO UNIT 6 TO VERIFY THEIR CORRECTNESS
46:     C      READ(5,*)(V1(N),N=1,NSTAT)
47:     C      WRITE(6,1100)(V1(N),N=1,NSTAT)
48:     C      1100 FORMAT(' THE STATION WIND SPEEDS ARE :',/5(1X,F10.4))
49:     C      READ(5,*)(H0(N),N=1,NSTAT)
50:     C      WRITE(6,1040)(H0(N),N=1,NSTAT)
51:     C      1040 FORMAT(' THE HEIGHTS AGL (METERS) FOR EACH STATION ARE: '
52:     C      +,/,1H ,<NSTAT>F8.2)
53:     C      READ(5,*)PARAM(1),PARAM(3)
54:     C      WRITE(6,1070)PARAM(1),PARAM(3)
55:     C      1070 FORMAT(' THE INITIAL PARAMETERS FOR DIRECTION AND TV = '
56:     C      +,2(1X,E11.4))
57:     C      READ(5,*)IVAR(1),IVAR(3)
58:     C      WRITE(6,1090)IVAR(1),IVAR(3)
59:     C      1090 FORMAT(' IVAR (DIRECTION AND TV)= ',2I8)
60:     C      READ(5,*)STEP(1),STEP(3)
61:     C      WRITE(6,1080)STEP(1),STEP(3)
62:     C      1080 FORMAT(' THE STEP SIZES FOR DIRECTION AND LOG(TV) = '
63:     C      +,2(1X,E11.4))

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64:      READ(5,*)ERROR(1),ERROR(3)
65:      WRITE(6,1190)ERROR(1),ERROR(3)
66: 1190  FORMAT(' ABSOLUTE ERRORS FOR DIRECTION AND LOG(TV) =',
67:      +2(1X,E11.4))
68:      READ(5,*)IFLAG(1)
69:      IF(IFLAG(1).EQ.1)THEN
70:      WRITE(6,1120)
71: 1120  FORMAT(///,' FINDING OF AS A FUNCTION OF ITERATION',///)
72:      ENDIF
73: C
74: C      INITIALIZE ITERATION COUNTER, WIND DIRECTION, POWER LAW EXPONENT
75: C      AND ALFA2 (CONTROLLING STABILITY) BASED UPON TV (I.E. PARAM(3))
76:      ICOUNT=0
77:      JTER=0
78:      WDR(1)=PARAM(1)
79:      PARAM(2)=BETA
80:      ALFA2=1.0/SQRT(2.0*PARAM(3))
81: C
82: C      INITIALIZE THE INPUT WIND DIRECTION USED FOR OPTIMIZATION
83: C      NOTE: ONE INITIAL WIND DIRECTION IS ASSUMED BELOW; HOWEVER,
84: C      PARAM COULD BE MODIFIED TO ACCOMMODATE MULTIPLE WIND DIRECTIONS
85: C      ASSOCIATED WITH EACH OF 'NSTAT' SITES.
86:      DO 20 N=1,NPTS
87: 20    WDR(N)=PARAM(1)
88: C
89: C      ... SETUP FINITE DIFFERENCE MESH ...
90:      CALL SETUP
91: C      ... FINDING O.F. AS A FUNCTION OF ITERATION ?? ....
92:      IF(IFLAG(1).EQ.1)GOTO 1000
93: C      ... WRITE TERRAIN AND OBSERVATION DATA TO PLOT TAPE ...
94:      CALL WTAPE(1)
95: C
96: C      XVAR(1) REPLACES WDR(1) AS A NEW SCALED VARIABLE
97:      XVAR(1)=0.0
98: C
99:      IF(IVAR(1).EQ.1.OR.IVAR(3).EQ.1)WRITE(6,1210)
100: 1210  FORMAT(1H1,
101:  + ' ***** OUTPUT FROM OPTIMIZATION PROCEDURE *****')
102: C      IF OPTIMIZING ON THE WIND DIRECTION AND/OR STABILITY
103:      IF(IVAR(1).EQ.1)THEN
104:          IF(IVAR(1).EQ.1.AND.IVAR(3).EQ.0)WRITE(6,1240)
105: 1240  FORMAT(' OPTIMIZING ON WIND DIRECTION ALONE')
106:          IF(IVAR(1).EQ.1.AND.IVAR(3).EQ.1)WRITE(6,1250)
107: 1250  FORMAT(' OPTIMIZING ON WIND DIRECTION AND STABILITY')
108:          CALL NEWMIN(1,1.0,OFI,TVOPT)
109:          WDR(1)=XVAR(1)*STEP(1)+PARAM(1)
110: C      BACK CALCULATE TV FROM ALFA2 FOR FINAL OUTPUT
111:          TV=1.0/(2.0*ALFA2*ALFA2)
112:          GOTO 2000
113:      ENDIF
114: C
115: C      IF OPTIMIZING ON STABILITY ALONE
116:      IF(IVAR(3).EQ.1)THEN
117:          WRITE(6,1230)
118: 1230  FORMAT(' OPTIMIZING ON STABILITY ALONE')
119:          TV=1.0/(2.0*ALFA2*ALFA2)
120:          CALL OBSWND
121:          CALL STABRWIND(STEP(3),TV,OFI)
122:          ALFA2=SQRT(1.0/(2.0*TV))
123:          WDR(1)=PARAM(1)
124:          TVOPT=TV
125:      ENDIF
126: C
127: 2000  CONTINUE
128: C NO OPTIMIZATION
129:      IF(IVAR(1).EQ.0.AND.IVAR(3).EQ.0)THEN
130:          WRITE(6,'(1H1, ' ***** NOABL RUN WITHOUT OPTIMIZATION *****')')
131:          GOTO 3000

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132:      ENDIF
133: C FIND MINIMUM OBJECTIVE FUNCTION
134:      RMSEMIN=10000.
135:      DO J=1,JTER
136:      RMSEMIN=MIN(RMSEMIN,RMSE_MIN(J))
137:      IF(RMSEMIN.EQ.RMSE_MIN(J))JSAVE=J
138:      ENDDO
139:      WRITE(6,1010)TAU_MIN(JSAVE),ALOG10(TAU_MIN(JSAVE)),DIR_MIN(JSAVE),
140:      +RMSEMIN,ICOUNT
141: 1010 FORMAT(1H0,' OPTIMAL TV = ',F12.5,7X,' LOG(TV) = ',F12.6,
142:      +/' OPTIMAL WIND DIRECTION = ',F12.5,7X,/' MINIMUM OBJ. FUNCT.= ',
143:      +E11.4,7X,/' NUMBER OF NOABL ITERATIONS = ',I6)
144: C
145: C FIND OPTIMUM WIND FIELD
146:      EPSLN=.1
147:      ITMAX=200
148: 3000 CALL OBSWND
149:      CALL CNWAD
150: C FIND SCALE FACTOR
151:      ISTRT=1
152:      CALL TAYLOR(ISTRT)
153:      CALL LINTERP(1,H0(1),UC,VC)
154:      SPEED=SQRT(UC*UC+VC*VC)
155:      SCALE1=V1(1)/SPEED
156:      WRITE(6,1220)SCALE1
157: 1220 FORMAT(' SPEED SCALE FACTOR = ',F10.5)
158: C ADJUST SPEEDS
159:      IF(SCALE1.GT.0.0)THEN
160:      DO N=1,18400
161: C U-COMPONENT
162:      UU(N)=UU(N)*SCALE1
163: C V-COMPONENT
164:      VV(N)=VV(N)*SCALE1
165:      ENDDO
166: C W-COMPONENT
167:      DO N=1,17600
168:      WW(N)=WW(N)*SCALE1
169:      ENDDO
170: C
171:      ENDIF
172: C
173: C      ... WRITE ADJUSTED WIND FIELD DATA TO PLOT TAPE ...
174:      CALL WTAPE(2)
175: C
176: C      END OF THE RUN
177:      WRITE (6,10)
178: 10 FORMAT (/// 22H NORMAL EXIT - NOABL )
179:      CALL EXIT
180: C FINDING O.F. AS A FUNCTION OF ITERATION
181: 1000 CONTINUE
182:      ITMAX=100
183:      EPSLN=.001
184:      CALL OBSWND
185:      CALL CNWAD
186:      WRITE(6,11)
187: 11 FORMAT(//,' NORMAL EXIT -O.F. AS FUNCTION OF ITERATION')
188:      END

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FILE: COMMONJ.INC

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1: C          ... NOTE- CHANGING COMMON LENGTH REQUIRES REDEFINING
2: C          NWORD IN SUB. DEFINE - NWORD= NUMBER OF
3: C          WORDS IN BLANK COMMON
4: C
5: C          ... ALSO- THE DIMENSIONS OF DZDDX AND DZDDY MUST BE
6: C          EQUAL TO OR GREATER THAN IMAX*JMAX; THEREFORE
7: C          FOR A 40X40 GRID DIMENSION DZDDX(1600).
8: C
9: C          ... INPUT VARIABLES ...
10: C
11: C          COMMON
12: C          1      ALFA1,      ALFA2,      BETA,      CNVRSN,      DBUG,
13: C          2      DX,        DY,        DZ,        DZMIN,      EPSLN,
14: C          3      IDAY,      IEDIT,      IHOURL,      IMAX,      IMN,
15: C          4      IMX,        IPATH,      ISIG,      ITERAN,      ITYLOR,
16: C          5      IWIND,      IYEAR,      IZD,        JMAX,      JMN,
17: C          6      JMX,        KMAX,      KMN,        KMX,        MONTH,
18: C          7      MPS,        NDAYS,      NPTS,      OMEG,      ORIGNX,
19: C          8      ORIGNY,      ORIGNZ,      ZDIST,      OMP,        ITMAX
20: C
21: C          COMMON
22: C          1      WDR(50),   WSPD(50),   XO(50),   YO(50),   ZO(50)
23: C
24: C          COMMON
25: C          1      NSTAT,     XSTA(25),  YSTA(25)
26: C
27: C          COMMON
28: C          1      QTOP,      ATOP,      ZBL,        NUA,        WSPDUA(25),
29: C          2      WDRUA(25),UAMSL(25)
30: C
31: C          ... CALCULATED VARIABLES ...
32: C
33: C          COMMON
34: C          1      ALPHA,     DX2,        DY2,        DZ2,        I,
35: C          2      IJKMAX,    IJMAX,      IKMAX,      IMXP1,     J,
36: C          3      JMKXP1,    K,          KMKXP1,     NWORD,     RDX,
37: C          4      RDY,      RDZ,        DEG,        PII,        RDIAN
38: C
39: C          COMMON
40: C          1      DSIGC(28),DSIGF(28),SIGC(28), SIGF(28), X(50),
41: C          2      Y(50),     Z(25)
42: C
43: C          COMMON
44: C          1      UD(50),    VO(50),    WO(50)
45: C
46: C          COMMON
47: C          2      PI(1600),   TERA1N(1600),  DM1A(1600),
48: C          3      DMB(1600)
49: C
50: C          COMMON
51: C          1      PHI(41,41,11)
52: C
53: C          COMMON/LARGE/
54: C          1      U(41,40,10), V(40,41,10), W(40,40,11),
55: C          2      DIV(40,40,10), DZDDX(1600), DZDDY(1600),
56: C          3      IFLAG(1600), UTEN(41,40), VTEN(40,41)
57: C
58: C          COMMON /EDITT/
59: C          1      RESDUL(200), IHDS(25)
60: C
61: C          DIMENSION
62: C          1      COMON(7219),ICOMON(7219)
63: C          INTEGER
64: C          1      DBUG
65: C          EQUIVALENCE
66: C          1      (COMON(1),ALFA1),(ICOMON(1),ALFA1)

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FILE: ADJUSTUV.FOR

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1:  SUBROUTINE ADJUSTUV(JSTEP,WDR1,TY,ALF1SQ)
2:  C THIS SUBROUTINE ADJUSTS THE THE U AND V FIELDS SO THAT
3:  C THESE COMPONENTS ARE TRANSFERED FROM X,Y,S SPACE TO
4:  C X,Y,Z SPACE.  NORMALLY THIS SUBROUTINE IS
5:  C A PART OF CNWAD AND IS ONLY USED AFTER THE SOR ALGORITHM
6:  C HAS CONVERGED (OR OTHERWISE TERMINATED).  THIS VERSION
7:  C PRESERVES THE VALUES OF THE U AND V MATRICES BY ASSIGNING
8:  C THEIR VALUES TO UU AND VV TO PERFORM THE CALCULATIONS
9:  C BELOW.
10: C
11:
12:      INCLUDE 'COMMONJ.INC/LIST'
13:      COMMON/UUVV/UU(41,40,10),VV(40,41,10)
14: C-----
15: C          ... ADJUST THE VELOCITY FIELD ...
16: C-----
17: C
18: C          ... U-COMPONENTS ...
19:      RALFSQ= 1.0/ALF1SQ
20:      DO 200 I=1,IMXP1
21:          II= I
22:          II= MIN0(II,IMAX)
23:          DO 200 J=1,JMAX
24:              N= (J-1)*IMAX + II
25:              C1= 1.0
26:              NM1= N-1
27:              IF (I .NE. 1) GO TO 210
28:              C1= 0.0
29:              NM1= N
30: 210  CONTINUE
31:              PIWST= PI(N)+PI(NM1)
32:              SLPWST= (TERAIN(N)-TERAIN(NM1))*RDX
33:              DO 200 K=1,KMAX
34:                  KM1= K-1
35:                  KM1= MAX0(1,KM1)
36:                  TMP1= PIWST*(PHI(I,J,K)-C1*PHI(I-1,J,K))
37:                  TMP2= SIGC(K)*SLPWST*((PHI(I,J,K+1)-PHI(I,J,KM1)) +
38: 1              C1*(PHI(I-1,J,K+1)-PHI(I-1,J,KM1)))/(DSIGC(K)+DSIGC(K+1))
39:                  USTAR= 0.25*(RDX*TMP1 + TMP2)*RALFSQ
40:                  UU(I,J,K)= U(I,J,K) + USTAR
41: 200  CONTINUE
42: C
43: C
44: C          ... V-COMPONENTS ...
45:      DO 220 I=1,IMAX
46:          DO 220 J=1,JMAXP1
47:              JJ= J
48:              JJ= MIN0(JJ,JMAX)
49:              N= (JJ-1)*IMAX + I
50:              C2= 1.0
51:              NMIM= N-IMAX
52:              IF (J .NE. 1) GO TO 230
53:              C2= 0.0
54:              NMIM= N
55: 230  CONTINUE
56:              PISOTH= PI(N)+PI(NMIM)
57:              SLPSTH= (TERAIN(N)-TERAIN(NMIM))*RDY
58:              DO 220 K=1,KMAX
59:                  KM1= K-1
60:                  KM1= MAX0(1,KM1)
61:                  TMP1= PISOTH*(PHI(I,J,K) - C2*PHI(I,J-1,K))
62:                  TMP2= SIGC(K)*SLPSTH*((PHI(I,J,K+1)-PHI(I,J,KM1)) +
63: 1              C2*(PHI(I,J-1,K+1)-PHI(I,J-1,KM1)))/(DSIGC(K)+DSIGC(K+1))

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64:      VSTAR= 0.25*(RDY*TMP1 + TMP2)*RALFSQ
65:      VV(I,J,K)= V(I,J,K) + VSTAR
66: 220  CONTINUE
67: C
68: C      ... FORM U AND V FROM U AND V TIDLE ...
69: C      DO 300 I=1,IMXP1
70: C      II= MIN0(I,IMAX)
71: C      DO 300 J=1,JMXP1
72: C      JJ= MIN0(J,JMAX)
73: C      N= (JJ-1)*IMAX+II
74: C      NM1= N-1
75: C      IF (I .EQ. 1) NM1= N
76: C      NMIM= N-IMAX
77: C      IF (J .EQ. 1) NMIM= N
78: C      PIWST= 2.0/(PI(N)+PI(NM1))
79: C      PISOTH= 2.0/(PI(N)+PI(NMIM))
80: C      DO 300 K=1,KMAX
81: C      IF (J .NE. JMXP1) UU(I,J,K)= UU(I,J,K)+PIWST
82: C      IF (I .NE. IMXP1) VV(I,J,K)= VV(I,J,K)+PISOTH
83:
84:
85:
86: 300  CONTINUE
87:
88:      CALL OFAFOI(JSTEP,WDR1,TV)
89:
90:      RETURN
91:      END
92: C
93:      SUBROUTINE OFAFOI(JSTEP,WDR1,TV)
94: C      FILENAME: OFAFOI.FOR
95: C*****
96: C      I. HISTORY
97: C          AUTHOR - H. L. WEGLEY
98: C          DATE - JULY 23, 1985
99: C          INSPECTED -
100: C          DATE -
101: C          REVISED -
102: C          DATE -
103: C*****
104: C      II. FUNCTION PERFORMED
105: C      OUTPUTS THE VALUE OF THE OBJECTIVE FUNCTION (RMSE OF MODEL FITTED
106: C      VERSUS OBSERVED WINDS) EVERY "JSTEP" ITERATION IN THE SOR
107: C      ALGORITHM USED IN SUBROUTINE CNWAD. DATA IS WRITTEN TO LU 17.
108: C      THE ARRAYS UU AND VV ARE USED TO AVOID MODIFYING THE U AND V
109: C      ARRAYS WHILE OBTAINING THE CORRECTED U AND V COMPONENTS FROM
110: C      WITHIN SUBROUTINE CNWAD.
111: C*****
112: C      III. MODULE ENVIRONMENT
113: C          VAX 11/780 VMS 4.1
114: C          BATTELLE PACIFIC NORTHWEST LABORATORIES
115: C          RICHLAND, WA 99352
116: C
117: C      IMPLICIT NONE
118: C
119: C*****
120: C      IV. INCLUDES
121: C      INCLUDE 'COMMONJ.INC'
122: C      COMMON /SQUARE/V1(20),H0(20)
123: C      COMMON /PARAMS/PARAM(3),IVAR(3),STEP(3)
124: C      COMMON /JIM/ICOUNT,XVAR(2)
125: C      COMMON /UUVV/UU(41,40,10),VV(40,41,10)
126: C      COMMON /OUT/A(25,25),B(25,25)
127: C*****
128: C      V. SUBROUTINE FORMAL PARAMETERS
129: C      INTEGER JSTEP
130: C      REAL WDR1
131: C      REAL TV

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132: C*****
133: C VI. INTERNAL VARIABLES
134: REAL SPEED(20)
135: C*****
136: C VII. DATA STATEMENTS
137: DATA ITERATIONS/0/, ISTRT/1/
138: C*****
139: C VIII. PROGRAM STATEMENTS
140: C WRITE HEADER ON OBJ.FUNCT. OUTPUT FILE (LU=6)
141: IF(ITERATIONS.EQ.0)WRITE(6,901)
142: IF(ITERATIONS.EQ.0)WRITE(17,901)
143: ITERATIONS=ITERATIONS+JSTEP
144:
145: CALL TAYL(ISTRT)
146: ISTRT=2
147:
148: DO N=1,NSTAT
149:
150: C FIND THE 2 VERTICAL LAYERS TO INTERPOLATE BETWEEN
151: DO LEVEL=1,KMAX
152: KL=LEVEL
153: IF(A(N,LEVEL).LE.H0(N))GO TO 100
154: END DO
155:
156: WRITE(6,900)N,KL,A(N,KL)
157: STOP
158:
159: 100 KUP=KL-1
160: S1=(UTEN(N,KUP)-UTEN(N,KL))/(A(N,KUP)-
161: + A(N,KL))
162: S2=(VTEN(N,KUP)-VTEN(N,KL))/(A(N,KUP)-
163: + A(N,KL))
164: UC=S1*(H0(N)-A(N,KL))+UTEN(N,KL)
165: VC=S2*(H0(N)-A(N,KL))+VTEN(N,KL)
166:
167: SPEED(N)=SQRT(UC*UC+VC*VC)
168: END DO
169:
170: C EVALUATE THE RATIO OBJECTIVE FUNCTION
171: F=0.0
172: DO N=2,NSTAT
173: F=F+(SPEED(N)/SPEED(1)-V1(N)/V1(1))**2
174: END DO
175: F=SQRT(F/LOAT(NSTAT))
176:
177: C*****
178: C WRITE(17,1000)
179: C1000 FORMAT(' N R-CALC R-OBS SP-CALC',4X,'SP-OBS ')
180: C DO N=1,NSTAT
181: C write(17,1040)n,speed(n)/speed(1),v1(n)/v1(1),SPEED(N),
182: C + V1(N)
183: C1040 format(i0,4(1x,f10.4))
184: C END DO
185: C*****
186:
187: C WRITE OBJECTIVE FUNCTION DATA TO LU 17
188: WRITE(6,902)ITERATIONS,F,WDR1,TV
189: WRITE(17,902)ITERATIONS,F,WDR1,TV
190: IF(ITERATIONS.GE.100)STOP
191: RETURN
192: C*****
193: C IX. FORMAT STATEMENTS
194: 900 FORMAT(1X,'LEVEL IS OUT OF RANGE IN OFASFUNCTION ITERATION',
195: + '/' N=',I4,5X,'LEVEL=',I4,5X,'A(N,LEVEL)=' ,F10.4)
196: 901 FORMAT(1H1,'ITERATION',T20,'OBJECTIVE FUNCTION',T40,'DIRECTION',
197: + T60,'LOG10(TAU)')
198: 902 FORMAT(1X,T5,I5,T20,F15.6,T40,F7.1,T80,F8.4)
199: C*****

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200:      END
201:
202:      SUBROUTINE TAYL(ISTR)
203:  C
204:  C
205:  C          TAYL - INTERPOLATES A WIND SPEED AND WIND DIRECTION
206:  C          AT A SPECIFIED NUMBER OF POINTS IN THE MESH
207:  C          USING A SECOND ORDER TAYLOR EXPANSION ABOUT
208:  C          THE POINTS OF INTEREST
209:  C
210:      INCLUDE 'COMMONJ.INC/LIST'
211:  C
212:      COMMON /OUT/ A(25,25), B(25,25)
213:      DIMENSION VAVSTA(25), EATA(25), ISAV(25), JSAV(25),
214: 1      UAVSTA(25), XMSL(25), AGL(25), ZEATA(25)
215:      DIMENSION UAVG(40,40), VAVG(40,40)
216:      COMMON/UVV/UU(41,40,10),VV(40,41,10)
217:      ICOMP= 0
218:  C-----
219:  C          ... STORE WIND COMPONENTS FOR LEVEL K ...
220:  C-----
221:      DO 1000 KK=1,KMAX
222:      K= KMAX-KK+1
223:      IF (KK .GT. 1) ISTR= 2
224:      DO 10 J=1,JMAX
225:      DO 10 I=1,IMAX
226:      N= (J-1)*IMAX+I
227:      IF (IPATH .NE. 1) GO TO 5
228:  C
229:  C          ... REAL SPACE CALCULATIONS ...
230:      K= IFLAG(N)
231:      KW= K
232:      IF (I .NE. 1) KW= IFLAG(N-1)
233:      KE= K
234:      IF (I .NE. IMAX) KE= IFLAG(N+1)
235:      IF (KW .GT. K) GO TO 81
236:      KW= K
237: 81  CONTINUE
238:      IF (KE .GT. K) GO TO 82
239:      KE= K
240: 82  CONTINUE
241:      KS= K
242:      IF (J .NE. 1) KS= IFLAG(N-IMAX)
243:      KN= K
244:      IF (J .NE. JMAX) KN= IFLAG(N+IMAX)
245:      IF (KS .GT. K) GO TO 83
246:      KS= K
247: 83  CONTINUE
248:      IF (KN .GT. K) GO TO 84
249:      KN= K
250: 84  CONTINUE
251:      GO TO 7
252: 5   CONTINUE
253:  C
254:  C          ... CONFORMAL SPACE CALCULATIONS ...
255:      KE= K
256:      KW= K
257:      KS= K
258:      KN= K
259: 7   CONTINUE
260:      UAV= 0.5*(UU(I,J,KW)+UU(I+1,J,KE))
261:      VAV= 0.5*(VV(I,J,KS)+VV(I,J+1,KN))
262:      UAVG(I,J)= UAV
263:      VAVG(I,J)= VAV
264:
265: 10  CONTINUE
266:  C-----
267:  C          ... INTERPOLATE FOR STATION VALUES ...

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268: C-----
269:      DO 100 N=1,NSTAT
270: C
271: C          ... CHECK FOR STATIONS OUT OF BOUNDS ...
272:      IF ((XSTA(N) .LT. (X(1)-0.5*DX)) .OR.
273: 1      (XSTA(N) .GT. (X(IMAX)+0.5*DX))) GO TO 100
274:      IF ((YSTA(N) .LT. (Y(1)-0.5*DY)) .OR.
275: 1      (YSTA(N) .GT. (Y(JMAX)+0.5*DY))) GO TO 100
276:      GO TO (15,50), ISTRT
277: 15  CONTINUE
278: C
279: C          ... FIND STATION POSITIONS RELATIVE TO MESH ...
280:      DO 20 I=1,IMAX
281:      ISAV(N)= I
282:      IF (XSTA(N) .LE. X(I)) GO TO 25
283: 20  CONTINUE
284: 25  CONTINUE
285:      DO 30 J=1,JMAX
286:      JSAV(N)= J
287:      IF (YSTA(N) .LE. Y(J)) GO TO 35
288: 30  CONTINUE
289: 35  CONTINUE
290: C
291:      I= ISAV(N)
292:      J= JSAV(N)
293:      TEMP1= X(I)-XSTA(N)
294:      TEMP2= Y(J)-YSTA(N)
295:      TEMP3= X(I-1)-XSTA(N)
296:      TEMP4= Y(J-1)-YSTA(N)
297:      DIST1= SQRT(TEMP1*TEMP1 + TEMP2*TEMP2)
298:      DIST2= SQRT(TEMP3*TEMP3 + TEMP2*TEMP2)
299:      IF (DIST1 .LT. DIST2) GO TO 40
300:      ISAV(N)= ISAV(N)-1
301:      TEMP1= TEMP3
302: 40  CONTINUE
303:      DIST1= SQRT(TEMP1*TEMP1+TEMP2*TEMP2)
304:      DIST2= SQRT(TEMP1*TEMP1 + TEMP4*TEMP4)
305:      IF (DIST1 .GT. DIST2) JSAV(N)= JSAV(N)-1
306: C
307: C          ... COMPUTE DISPLACEMENT OF STATION WITHIN CELL (I,J)
308: C          FROM CELL CENTER ...
309:      I= ISAV(N)
310:      J= JSAV(N)
311:      EATA(N)= XSTA(N)-X(I)
312:      ZEATA(N)= YSTA(N)-Y(J)
313: 50  CONTINUE
314: C
315: C          ... DETERMINE WIND SPEED AT STATION N ...
316:      I= ISAV(N)
317:      J= JSAV(N)
318:      NN= (J-1)*IMAX + I
319:      AGL(N)= (1.0-SIGC(K))*PI(NN)
320:      IF (IPATH .EQ. 1) AGL(N)= Z(K) - TERAIN(NN)
321:      XMSL(N)= AGL(N) + TERAIN(NN)
322:      IE= I-1
323:      IW= I-1
324:      JN= J-1
325:      JS= J-1
326:      IF (I .EQ. IMAX) IE=IMAX
327:      IF (I .EQ. 1) IW= 1
328:      IF (J .EQ. JMAX) JN= JMAX
329:      IF (J .EQ. 1) JS= 1
330:      DWDX= 0.5*(UAVG(IE,J)-UAVG(IW,J))*RDX
331:      DWDY= 0.5*(UAVG(I,JN)-UAVG(I,JS))*RDY
332:      D2WDX2= RDX*((UAVG(IE,J)-UAVG(I,J))*RDX -
333: 1      (UAVG(I,J)-UAVG(IW,J))*RDX)
334:      D2WDY2= RDY*((UAVG(I,JN)-UAVG(I,JS))*RDY -
335: 1      (UAVG(I,J)-UAVG(I,JS))*RDY)

```

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336:      D2WDXY= 0.25*((UAVG(IE,JN)-UAVG(IW,JN)) -
337:      1      (UAVG(IE,JS)-UAVG(IW,JS)))*RDX*RDY
338: C
339: C      ... SECOND ORDER TAYLOR EXPANSION ...
340: C      ... FIND U- COMPONENT AT STATION N ...
341:
342:      UAVSTA(N)= UAVG(I,J) + EATA(N)*DWDX + ZEATA(N)*DWDY +
343:      1      0.5*(EATA(N)**2*D2WDX2 + 2.0*EATA(N)*ZEATA(N)*
344:      2      D2WDXY + ZEATA(N)**2*D2WDY2)
345:
346:      DDDX= 0.5*(VAVG(IE,J)-VAVG(IW,J))*RDX
347:      DDDY= 0.5*(VAVG(IE,JN)-VAVG(I,JS))*RDY
348:      D2DDX2= RDX*((VAVG(IE,J)-VAVG(I,J))*RDX -
349:      1      (VAVG(I,J)-VAVG(IW,J))*RDX)
350:      D2DDY2= RDY*((VAVG(IE,JN)-VAVG(I,J))*RDY -
351:      1      (VAVG(I,J)-VAVG(I,JS))*RDY)
352:      D2DDXY= 0.25*((VAVG(IE,JN)-VAVG(IW,JN)) -
353:      1      (VAVG(IE,JS)-VAVG(IW,JS)))*RDX*RDY
354: C
355: C      ... SECOND ORDER TAYLOR EXPANSION ...
356: C      ... FIND V- COMPONENT AT STATION N ...
357:      VAVSTA(N)= VAVG(I,J) + EATA(N)*DDDX + ZEATA(N)*DDDY +
358:      1      0.5*(EATA(N)**2*D2DDX2 + 2.0*EATA(N)*ZEATA(N)*
359:      2      D2DDXY + ZEATA(N)**2*D2DDY2)
360:      A(N,K)= AGL(N)
361:      B(N,K)= XMSL(N)
362:      UTEN(N,K)= UAVSTA(N)
363:      VTEN(N,K)= VAVSTA(N)
364: 100 CONTINUE
365: 1000 CONTINUE
366: 930 FORMAT (1H1)
367:      DO 9950 N=1,NSTAT
368:      IF ((XSTA(N) .GE. (X(1)-0.5*DX)) .AND.
369:      1      (XSTA(N) .LE. (X(IMAX)+0.5*DX)) .AND.
370:      2      (YSTA(N) .GE. (Y(1)-0.5*DY)) .AND.
371:      3      (YSTA(N) .LE. (Y(JMAX)+0.5*DY))) GO TO 9950
372:      WRITE (0,910) N,XSTA(N),YSTA(N)
373: 910 FORMAT (/11H STATION- ,I2,17H IS OUT OF BOUNDS ,
374:      1      5X,8HUTMX= ,1PE12.4,2X,8HVTMY= ,1PE12.4 ///)
375: 9950 CONTINUE
376:      RETURN
377:      END

```

FILE: LINTERP.FOR

```

1:      SUBROUTINE LINTERP(NSTA,H0,UC,VC)
2: C PERFORMS A LINEAR INTERPOLATION TO FIND THE WIND COMPONENTS UC,VC AT THE
3: C HEIGHT H0(NSTA) (HEIGHTS ARE IN METERS)
4: C NSTA IS THE STATION NUMBER
5:      INCLUDE 'COMMONJ.INC'
6:      COMMON /DUT/ A(25,25),B(25,25)
7: C A(N,K) IS THE HEIGHT (AGL) OF THE CONFORMAL LEVEL K ABOVE THE STATION N
8: C A(N,1) IS THE HIGHEST LEVEL, A(N,KMAX) IS THE LOWEST LEVEL
9: C
10: C FIND THE FIRST LEVEL BELOW Z0(NSTA)
11:      DO 100 KT=1,KMAX
12:          KBL=KT
13:          IF(A(NSTA,KT).LE.H0)GOTO 200
14: 100 CONTINUE
15:          STOP 'KBL IS GREATER THAN KMAX'
16: 200 CONTINUE
17: C PERFORM LINEAR INTERPOLATION BETWEEN THE TWO CONFORMAL LEVELS
18: C BRACKETING THE DESIRED HEIGHT AGL
19:          KUP=KBL-1
20:          S1=(UTEN(NSTA,KUP)-UTEN(NSTA,KBL))/(A(NSTA,KUP)-A(NSTA,KBL))
21:          S2=(VTEN(NSTA,KUP)-VTEN(NSTA,KBL))/(A(NSTA,KUP)-A(NSTA,KBL))
22:          UC=S1*(H0-A(NSTA,KBL))+UTEN(NSTA,KBL)
23:          VC=S2*(H0-A(NSTA,KBL))+VTEN(NSTA,KBL)
24:          RETURN
25:      END

```

FILE: MISC.FOR

```

1: SUBROUTINE CARDS
2: C
3: C
4: C CARDS- PROCESSES NON-FORMATED INPUT DATA. SEE
5: C NOABL USER'S MANUAL FOR INFORMATION REGARDIN
6: C CARD INPUT
7: C
8: COMMON ASTORE(410)
9: COMMON /EDSIN/ EIONIN(30)
10: C
11: DIMENSION IC(00), LC(10), IT(00), NSTORE(410)
12: C
13: DIMENSION LAZ (200), MAZ (200), NAZ (200)
14: DIMENSION LAZ1(100), MAZ1(100), NAZ1(100)
15: DIMENSION LAZ2(100), MAZ2(100), NAZ2(100)
16: C
17: EQUIVALENCE (ASTORE(1),NSTORE(1))
18: C
19: EQUIVALENCE (LAZ( 1),LAZ1), (MAZ( 1),MAZ1), (NAZ( 1),NAZ1)
20: EQUIVALENCE (LAZ(101),LAZ2), (MAZ(101),MAZ2), (NAZ(101),NAZ2)
21: C
22: DATA LC /1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,
23: 1 1H-,1H+,1H*,1H$,1H.,1H.,1HA,1HE/
24: DATA IH, IT /01*1H /, TEN /10./, ISLASH/1H//
25: C
26: C ... NOTE- HOLLERITH VARIABLE NAMES ARE USED FOR
27: C EDITING ONLY AND WORD LENGTH MAY BE
28: C SHORTENED WITHOUT EFFECTING CARDS PRO-
29: C CESSING ...
30: DATA LAZ1 /
31: 14HALF1 ,4HALF2 ,4HBETA ,4HCNVR ,4HDBGUG ,
32: 24HDX ,4HDY ,4HDZ ,4HDZMN ,4HEPSL ,
33: 34HIDAY ,4HIEDT ,4HIHQR ,4HIWAX ,4HIWM ,
34: 44HIMX ,4HIPTH ,4HISIG ,4HITRM ,4HITLR ,
35: 54HIWNO ,4HIYER ,4HI2D ,4HJMAX ,4HJMN ,
36: 64HJMX ,4HKMAX ,4HKMN ,4HKMX ,4HMNTH ,
37: 74HMPS ,4HNDAY ,4HNPTS ,4HOMEO ,4HORGX ,
38: 84HORGY ,4HORGZ ,4HZOST ,4HDWP ,4HITMX ,4HWDOR ,
39: 94HWSPO ,4HXO ,4HYO ,4HZO ,4HNSTA ,
40: *4HXSTA ,4HYSTA ,4HQTOP ,4HATOP ,4HZBL ,
41: *4HNUA ,4HWSUA ,4HWDUA ,4HUAMS ,45*4H /
42: DATA LAZ2 /100*4H /
43: DATA MAZ1 /
44: 1 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
45: 2 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
46: 350,50,50,50,50, 0,25,25, 0, 0, 0, 0,25,25,25,45*0/
47: DATA MAZ2 /100*0/
48: DATA NAZ1 /
49: 1 1, 2, 3, 4, 5, 6, 7, 8, 9,10,11,12,13,14,15,16,17,18,19,20,
50: 221,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,
51: 341,91,141,191,241,291,292,317,342,343,344,345,346,371,396,45*0/
52: DATA NAZ2 /100*0/
53: C
54: IPANIC=0
55: WRITE (0,41)
56: C
57: 1 READ (5,39) IC
58: WRITE (0,40) IC
59: MNUM=1
60: MULT=0
61: NDIV=0
62: NREP=1
63: NEION=0

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64:      JSW=2
65:      IK2=0
66:      K=0
67:      125 K=K+1
68:      IF (IC(K).EQ.IH) GO TO 25
69:      IF (JSW-2) 3,2,4
70:      2 IF (IC(K).NE.LC(13)) GO TO 4
71:      JSW=1
72:      3 IF (IC(K).EQ.LC(14)) GO TO 22
73:      GO TO 25
74:      4 K2=K
75:      IF (IC(K).EQ.ISLASH .AND. JSW.EQ.3) GO TO 17
76:      DO 5 J=1,18
77:      IF (IC(K).EQ.LC(J)) GO TO 6
78:      5 CONTINUE
79:      GO TO 24
80:      6 GO TO (7,7,7,7,7,7,7,7,7,7,11,12,15,21,16,23,9002,9001), J
81:      9001 IF (JSW - 7) 24,51,24
82:      51 KP1 = K + 1
83:      DO 54 KK = KP1, 80
84:      IF (IC(KK) - IH) 52, 54, 52
85:      52 IF (IC(KK) - LC(11)) 53, 25, 53
86:      53 IF (IC(KK) - LC(12)) 55, 25, 55
87:      54 CONTINUE
88:      GO TO 24
89:      55 JSW = 8
90:      GO TO 58
91:      9002 NEION=1
92:      9011 WRITE (8,9012)
93:      IF (JSW-2) 24,9,24
94:      7 MULT=MULT+10+J-1
95:      GO TO (24,9,25,8,9,25,10,8,9,25), JSW
96:      8 JSW=JSW+1
97:      9 JSW=JSW+1
98:      GO TO 25
99:      10 NDIV=NDIV+1
100:      GO TO 25
101:      11 IF (JSW.EQ.4) MNRM=-1
102:      IF (JSW.EQ.7) JSW = 8
103:      IF (JSW.EQ.8) MNRM=MNUM-MNRM
104:      12 JSW=JSW+1
105:      IF (JSW.EQ. 8) JSW = 9
106:      IF (JSW.NE.5) GO TO 14
107:      DO 13 K3=K,80
108:      IF (IC(K3).EQ.LC(14).OR.IC(K3).EQ.LC(15)) GO TO 25
109:      IF (IC(K3).EQ.LC(13)) GO TO 24
110:      13 CONTINUE
111:      GO TO 25
112:      14 IF (JSW.NE.9.OR.MULT.EQ.0) GO TO 24
113:      50 FACTOR=MULT
114:      GO TO 20
115:      15 IF (JSW.NE.8.OR.MULT.LE.1) GO TO 24
116:      NREP=MULT
117:      JSW=4
118:      GO TO 20
119:      16 GO TO (24,24,17,24,24,18,18,24,24,18), JSW
120:      17 IF (MULT.LE.0) GO TO 24
121:      LOC=MULT
122: C
123:      IF (LOC-410) 19,19,9120
124:      18 ASSIGN 19 TO IGO
125:      GO TO 30
126:      19 JSW=4
127:      20 MULT=0
128:      GO TO 25
129:      21 GO TO (24,38,24,24,24,50,50,24,24,50), JSW
130:      50 ASSIGN 22 TO IGO
131:      GO TO 30

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132: 22 JSW=2
133: GO TO 25
134: 23 IF (JSW.LT.4.OR.JSW.GT.6) GO TO 24
135: JSW=7
136: GO TO 25
137: 24 IK2=1
138: IT(K2)=IC(K2)
139: JSW=1
140: 25 IF(K.LT.80) GO TO 125
141: GO TO (27,27,28,57,28,27,27,28,28,27), JSW
142: 57 IF (IC(K2) .NE. LC(15)) GO TO 26
143: READ (5,39) IC
144: WRITE (8,40) IC
145: K = 0
146: GO TO 125
147: 26 IK2=1
148: IT(K2)=IC(K2)
149: 27 IF (IK2.EQ.0) GO TO 29
150: IPANIC=1
151: WRITE (8,44) IC
152: WRITE (8,45) IT
153: DO 28 I=1,80
154: 28 IT(I)=IH
155: 29 IF (JSW.EQ.2) GO TO 30
156: IF (JSW.EQ.1) GO TO 1
157: ASSIGN 1 TO IQ0
158: 30 IF (IPANIC.NE.0) GO TO 37
159: 310 IF (NEION) 330,330,320
160: 320 LST=4
161: GO TO 390
162: C
163: C
164: 330 DO 350 KAZ=1,200
165: IF (NAZ(KAZ)-LOC) 350,350,360
166: 350 CONTINUE
167: IF (LOC .EQ. 100) GO TO 380
168: LST=4
169: GO TO 390
170: 360 KAZ=KAZ-1
171: IF (MAZ(KAZ)) 380,380,370
172: 370 KAZD=LOC-NAZ(KAZ)+1
173: LST=2
174: GO TO 390
175: 380 LST=3
176: 390 IF (JSW.GT.6) GO TO 32
177: NVAL=ISIGN(MULT,MNUM)
178: IF (NREP.EQ.1) GO TO 550
179: GO TO (31,400,410,420), LST
180: 400 WRITE (8,405) NVAL,NREP,LAZ(KAZ),KAZD
181: GO TO 31
182: 410 WRITE (8,415) NVAL,NREP,LAZ(KAZ)
183: GO TO 31
184: 420 WRITE (8,42) NVAL,NREP,LOC
185: GO TO 31
186: 550 GO TO (31,580,570,580),LST
187: 580 WRITE (8,590) NVAL,LAZ(KAZ),KAZD
188: GO TO 31
189: 570 WRITE (8,800) NVAL,LAZ(KAZ)
190: GO TO 31
191: 580 WRITE (8,810) NVAL,LOC
192: 31 IF (NEION.NE.0) GO TO 9018
193: 9014 NSTORE(LOC)=NVAL
194: 9015 GO TO 30
195: 9016 WRITE (8,9017)
196: 9019 IPANIC=1
197: 9023 GO TO 37
198: 32 IF (JSW.NE.7) GO TO 33
199: ANUM=MULT

```

SECOND PARAMETER MUST EQUAL SIZE
OF LAZ(), ETC.

```

200: 100 IF(NDIV)34,34,101
201: 101 ANUM=ANUM/TEN
202: NDIV=NDIV-1
203: GO TO 100
204: 33 IF (IABS(MNUM).GT.1) MULT=-MULT
205: ANUM=FACTOR
206: NDIV=MULT-NDIV
207: 200 IF(NDIV)201,34,202
208: 201 ANUM=ANUM/TEN
209: NDIV=NDIV+1
210: GO TO 200
211: 202 ANUM=ANUM/TEN
212: NDIV=NDIV-1
213: GO TO 200
214: 34 IF (MNUM.LT.0) ANUM=-ANUM
215: IF (NREP.EQ.1) GO TO 400
216: GO TO (35,430,450,470), LST
217: 430 WRITE(8,440) ANUM,NREP,LAZ(KAZ),KAZD
218: GO TO 35
219: 450 WRITE (8,460) ANUM,NREP,LAZ(KAZ)
220: GO TO 35
221: 470 WRITE (8,43) ANUM,NREP,LOC
222: GO TO 35
223: 480 GO TO (35,490,500,510),LST
224: 490 WRITE (8,520) ANUM,LAZ(KAZ),KAZD
225: GO TO 35
226: 500 WRITE (8,530) ANUM,LAZ(KAZ)
227: GO TO 35
228: 510 WRITE (8,540) ANUM,LOC
229: 35 IF (NEION) 9022,9420,9022
230: 9420 ASTORE(LOC)=ANUM
231: GO TO 30
232: 9022 IF (LOC-30) 9122,9122,9120
233: 9120 WRITE (8,9220)
234: JSW=1
235: IPANIC=1
236: GO TO 25
237: 9122 EIONIN(LOC)=ANUM
238: 30 LOC=LOC+1
239: IF (NREP.LE.1) GO TO 37
240: NREP=NREP-1
241: C
242: IF(LOC.GT. 9905) GO TO 9120
243: IF (JSW-6) 31,31,35
244: 37 MNUM=1
245: MULT=0
246: GO TO IGO, (1,19,22)
247: 38 WRITE (8,46)
248: IF (IPANIC.EQ.0) RETURN
249: WRITE (8,47)
250: C
251: 39 FORMAT (80A1)
252: 40 FORMAT (3X,80A1)
253: 41 FORMAT (1H'//20X,37HINPUT VALUES TO PROGRAM BLANK COMMON '//)
254: 42 FORMAT (25X,I10,3H IN,I5,10H LOCS FROM,I6)
255: 43 FORMAT (24X,1PE11.3,3H IN,I5,10H LOCS FROM ,I6)
256: 44 FORMAT (// 3H ((,80A1,33H)) DATA CARD ERROR WITH FIRST BAD)
257: 45 FORMAT (3H ((,80A1,34H)) CHARACTER IN FILED ON THIS LINE '//)
258: 46 FORMAT (/10X,43H* BLANK FIELD INDICATES END OF DATA INPUT * //)
259: 47 FORMAT (/17X,46H CALLING EXIT BECAUSE OF ERROR IN DATA DECK //)
260: 405 FORMAT (25X,I10,3H IN,I5,10H LOCS FROM ,1X,A8,1H(,I3,1H) )
261: 415 FORMAT (25X,I10,3H IN,I5,10H LOCS FROM ,1X,A8)
262: 440 FORMAT (24X,1PE11.3,3H IN,I5,10H LOCS FROM ,1X,A8,1H(,I3,1H))
263: 480 FORMAT (24X,1PE11.3,3H IN,I5,10H LOCS FROM ,1X,A8 )
264: 520 FORMAT (24X,1PE11.3,8X,2HIN,9X,A8,1H(,I3,1H) )
265: 530 FORMAT (24X,1PE11.3,8X,2HIN,9X,A8)
266: 540 FORMAT (24X,1PE11.3,4X,11HIN LOCATION ,4X,I6)
267: 590 FORMAT (25X,I10,8X,2HIN,9X,A8,1H),I3,1H) )

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268: 600  FORMAT (25X,I10,8X,2HIN,9X,A6)
269: 610  FORMAT (25X,I10,4X,11HIN LOCATION ,4X, I6)
270: 9012 FORMAT (30X,20H STORE IN /E0SIN/EIONIN(LOC) )
271: 9017 FORMAT (27X,31H INTEGERS NOT ALLOWED IN EIONIN )
272: 9220 FORMAT (20H LOCATION TOO LARGE )
273:      END
274:      SUBROUTINE CNWAD
275:      INCLUDE 'COMMONJ.INC'
276:      COMMON/JIM/ICOUNT,XVAR(2)
277:      DIMENSION AA(20), BB(20), CC(20), DD(20), EE(20), FF(20),
278: 1      PP(20), RDSIGC(20), RDSIGF(20)
279:      DIMENSION PINRTH(100), SLPNTH(100)
280: C-----
281: C      ... INITIALIZE THE ITERATION ...
282: C-----
283: C
284: C      ... SET UP FLAGS AND REDUNDANT PARAMETERS ...
285: C      WRITE (0,11)
286: C 11  FORMAT (/1X,130(1H-)/57X,16HADJUSTMENT PHASE /1X,130(1H-)/)
287:      IF (I2D .EQ. 1) RDY= 0.0
288: C
289:      REWIND(12)
290:      READ(12)U,V,W
291: C      ... STABR> ATMOSPHERIC STABILITY COEFFICIENT ...
292:      STABR= (ALFA1/ALFA2)**2
293:      ALF1SQ= ALFA1*ALFA1
294:      RDXSQ= RDX*RDX
295:      RDYSQ= RDY*RDY
296:      DO 1 K=1,KMXP1
297:      RDSIGC(K)= 1.0/DSIGC(K)
298:      RDSIGF(K)= 1.0/DSIGF(K)
299: 1      CONTINUE
300: C
301: C      ... DAMP> NUMERICAL DAMPING COEFFICIENT ...
302:      DAMP= DMP*STABR*RDSIGF(KMAX)*RDSIGF(KMAX)
303: C
304: C      ... TRANSFORM VELOCITIES TO CONFORMAL COORDINATES ...
305:      DO 2 J=1,JMAX
306:      DO 2 I=1,IMAX
307:      N= (J-1)*IMAX + I
308:      DO 3 K=1,KMAX
309:      UCENT= 0.5*(U(I+1,J,K)+U(I,J,K))
310:      VCENT= 0.5*(V(I,J+1,K)+V(I,J,K))
311:      KM1= K-1
312:      KM1= MAX0(1,KM1)
313:      UCENB= 0.5*(U(I+1,J,KM1)+U(I,J,KM1))
314:      VCENB= 0.5*(V(I,J+1,KM1)+V(I,J,KM1))
315:      UCEN= 0.5*DZDDX(N)*(UCENT+UCENB)
316:      VCEN= 0.5*DZDDY(N)*(VCENT+VCENB)
317:      W(I,J,K)= SIGF(K)*(UCEN+VCEN) - W(I,J,K)
318: 3      CONTINUE
319:      W(I,J,KMXP1)= SIGF(KMXP1)*(DZDDX(N)*UCENT+DZDDY(N)*VCENT) -
320: 1      W(I,J,KMXP1)
321: 2      CONTINUE
322: C
323:      DO 4 J=1,JMAX
324:      DO 4 I=1,IMXP1
325:      II= I
326:      II= MIN0(IMAX,II)
327:      N= (J-1)*IMAX + II
328:      NM1= N-1
329:      IF (I .EQ. 1) NM1= N
330:      PIWST= 0.5*(PI(N)+PI(NM1))
331:      DO 5 K=1,KMAX
332:      U(I,J,K)= U(I,J,K)+PIWST
333: 5      CONTINUE
334: 4      CONTINUE
335: C

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336:      DO 6 J=1,JWXP1
337:      JJ= J
338:      JJ= MIN0(JMAX,JJ)
339:      DO 6 I=1,IMAX
340:      N= (JJ-1)*IMAX + I
341:      NM1= N-IMAX
342:      IF (J .EQ. 1) NM1= N
343:      PISO7H= 0.5*(PI(N)+PI(NM1))
344:      DO 7 K=1,KMAX
345:      V(I,J,K)= V(I,J,K)+PISO7H
346:      IF ((I2D .EQ. 1) .AND. (J .EQ. 1)) V(I,J,K)= 0.0
347:      IF ((I2D .EQ. 1) .AND. (J .EQ. JWXP1)) V(I,J,K)= 0.0
348: 7      CONTINUE
349: 6      CONTINUE
350: C
351: C      ... CALCULATE REDUNDANT TERMS USED IN COEFF. MATRIX ...
352:      DO 10 I=1,IMAX
353:      DO 10 J=1,JMAX
354:      N= (J-1)*IMAX + I
355:      NP1= N+1
356:      IF (I .EQ. IMAX) NP1= N
357:      NM1= N-1
358:      IF (I .EQ. 1) NM1= N
359:      NPIW= N+IMAX
360:      IF (J .EQ. JMAX) NPIW= N
361:      NM1W= N-IMAX
362:      IF (J .EQ. 1) NM1W= N
363:      DM1A(N)= DZODX(N)+DZODX(N) + DZODY(N)+DZODY(N)
364:      DUM= 2.0*PI(N)
365:      DM1B= (PI(NP1) + DUM + PI(NM1))*RDXSQ
366:      DM2B= (PI(NPIW) + DUM + PI(NM1W))*RDYSQ
367:      DMB(N)= 0.5*(DM1B+DM2B)
368: C
369: C      ... DAMPING
370:      DMB(N)= DMB(N) + DAMP/PI(N)
371: 10     CONTINUE
372: C
373: C      ... COMPUTE THE INITIAL DIVERGENCE ...
374:      DIMAX= 0.0
375:      DO 8 J=1,JMAX
376:      DO 8 I=1,IMAX
377:      N= (J-1)*IMAX + I
378:      DO 8 K=1,KMAX
379:      DUDX= (U(I+1,J,K)-U(I,J,K))*RDX
380:      DVDY= (V(I,J+1,K)-V(I,J,K))*RDY
381:      DWDS= (W(I,J,K+1)-W(I,J,K))*RDSIGF(K)
382: C THE EXPRESSION BELOW IS NOT THE INITIAL DIVERGENCE
383:      DIV(I,J,K)= -2.0*ALF1SQ*(DUDX+DVDY+DWDS)
384: C THIS IS THE TRUE INITIAL DIVERGENCE
385:      DIVMX=(DUDX+DVDY+DWDS)/PI(N)
386:      IF (DIMAX .GE. ABS(DIVMX)) GO TO 8
387:      DIMAX= DIVMX
388:      ISA= I
389:      JSA= J
390:      KSA= K
391: 8      CONTINUE
392: C
393: C-----
394: C      ... SOR ITERATION WITH COLUMN RELAXATION ...
395: C-----
396: C
397:      DIVMAX= 0.0
398:      IDIV= 0
399:      ITWXP1= ITMAX+1
400:      DO 100 ITER=1,ITWXP1
401:      IF (ITER .EQ. ITWXP1) IDIV= 1
402:      ICONT= 0
403:      IF (ITER .EQ. ITWXP1) ICONT= 1

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404:      RESID= 1.0E-20
405: C
406:      DO 59 I=1,IMAX
407:      PINRTH(I)= PI(I)
408:      SLPNTH(I)= 0.0
409: 59      CONTINUE
410: C
411:      DO 70 J=1,JMAX
412:      C2= 1.0
413:      IF (J .EQ. 1) C2= 0.0
414:      N= (J-1)*IMAX + 1
415:      PIEST= PI(N)
416:      SLPEST= 0.0
417:      DO 70 I=1,IMAX
418:      M= (J-1)*IMAX + I
419:      C1= 1.0
420:      IF (I .EQ. 1) C1= 0.0
421:      NP1= N+1
422:      IF (I .EQ. IMAX) NP1= N
423:      C2= 1.0
424:      IF (J .EQ. 1) C2= 0.0
425:      NPIM= N+IMAX
426:      IF (J .EQ. JMAX) NPIM= N
427: C
428:      PIWST= PIEST
429:      PIEST= 0.5*(PI(N)+PI(NP1))
430:      SLPWST= SLPEST
431:      SLPEST= (TERAIN(NP1)-TERAIN(N))*RDX
432:      PISOTH= PINRTH(I)
433:      PINRTH(I)= 0.5*(PI(NPIM)+PI(N))
434:      SLPSTH= SLPNTH(I)
435:      SLPNTH(I)= (TERAIN(NPIM)-TERAIN(N))*RDY
436: C
437:      TMP1XZ= 2.0*SIGF(1)*((PHI(I+1,J,1)-C1*PHI(I-1,J,1)))
438:      TMP1YZ= 2.0*SIGF(1)*((PHI(I,J+1,1)-C2*PHI(I,J-1,1)))
439:      RPI= 1.0/PI(N)
440:      DO 80 K=1,KMAX
441:      KM1= K-1
442:      KM1= MAX0(1,KM1)
443: C
444: C      ... DEFINE TRIDIAGONAL COEFFICIENTS ...
445:      DM2= RPI*RDSIGF(K)
446:      AA(K)= (STABR + SIGF(K)*SIGF(K)*DM1A(N))*RDSIGC(K)*DM2
447:      CC(K)= (STABR + SIGF(K+1)*SIGF(K+1)*DM1A(N))*RDSIGC(K+1)*DM2
448:      BB(K)= -(DMB(N) + AA(K) + CC(K))
449:      PHIWST= C1*PHI(I-1,J,K)
450:      PHITW= C1*PHI(I-1,J,K+1)
451:      PHISTH= C2*PHI(I,J-1,K)
452:      PHITS= C2*PHI(I,J-1,K+1)
453:      PHIBW= C1*PHI(I-1,J,KM1)
454:      PHIBS= C2*PHI(I,J-1,KM1)
455: C
456: C
457:      TMP1X= -(PIEST*PHI(I+1,J,K) + PIWST*PHITW)*RDXSQ
458:      TMP1Y= -(PINRTH(I)*PHI(I,J+1,K) + PISOTH*PHISTH)*RDYSQ
459:      TEMP1= TMP1X + TMP1Y
460: C
461:      TMP2X= SLPWST*((PHI(I,J,K+1)+PHITW) -
462: 1      (PHI(I,J,KM1)+PHIBW))
463:      TMP1X= SLPEST*((PHI(I+1,J,K+1)+PHI(I,J,K+1)) -
464: 1      (PHI(I+1,J,KM1)+PHI(I,J,KM1)))
465:      TMP2Y= SLPSTH*((PHI(I,J,K+1)+PHITS) -
466: 1      (PHI(I,J,KM1)+PHIBS))
467:      TMP1Y= SLPNTH(I)*((PHI(I,J+1,K+1)+PHI(I,J,K+1)) -
468: 1      (PHI(I,J+1,KM1)+PHI(I,J,KM1)))
469:      TEMP2= RDX*(TMP1X-TMP2X) + RDY*(TMP1Y-TMP2Y)
470:      TEMP2= -0.5*SIGC(K)*TEMP2/(DSIGC(K)+DSIGC(K+1))
471: C

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472:      TMP2XZ= TMP1XZ
473:      TMP1XZ= SIGF(K+1)*((PHI(I+1,J,K)+PHI(I+1,J,K+1)) -
474:      1      (PHI(I-1,J,K)+PHI(I-1,J,K+1)))
475:      TMP2YZ= TMP1YZ
476:      TMP1YZ= SIGF(K+1)*((PHI(I,J+1,K)+PHI(I,J+1,K+1)) -
477:      1      (PHI(I,J-1,K)+PHI(I,J-1,K+1)))
478:      TEMP3= DZODX(N)*(TMP1XZ-TMP2XZ)*RDX+DZODY(N)*(TMP1YZ-TMP2YZ)*RDY
479:      TEMP3= -0.25*TEMP3*RDSIGF(K)
480: C
481:      DD(K)= DIV(I,J,K) + (TEMP1+TEMP2+TEMP3)
482: C
483: C      ... DAMPING ...
484:      DD(K)= DD(K) - DAMP*PHI(I,J,K)*RPI
485: 60  CONTINUE
486: C
487: C      ... MODIFY END COEFFS. TO ACCOMODATE B.C. ...
488:      BB(1)= BB(1) + AA(1)
489:      AA(1)= 0.0
490: C
491:      K= KMAX
492:      TMPX= DZODX(N)*((PHI(I+1,J,K)+PHI(I+1,J,K+1)) -
493:      1      C1*(PHI(I-1,J,K)+PHI(I-1,J,K+1)))*RDX
494:      TMPY= DZODY(N)*((PHI(I,J+1,K)+PHI(I,J+1,K+1)) -
495:      1      C2*(PHI(I,J-1,K)+PHI(I,J-1,K+1)))*RDY
496:      TWPS= 8.0*ALFISQ*W(I,J,K+1)
497:      DENOM= STABR + DM1A(N)
498:      DIFF= -0.25*PI(N)*DSIGF(K+1)*(TMPX + TMPY + TWPS)/DENOM
499:      BB(K)= BB(K) + CC(K)
500:      DD(K)= DD(K) - CC(K)*DIFF
501:      CC(K)= 0.0
502: C
503: C      ... IF ITERATION CONVERGED OR ITMAX ITERATIONS
504: C      HAVE BEEN COMPUTED MAKE ONE MORE PASS TO
505: C      COMPUTE FINAL DIVERGENCE ...
506:      IF (IDIV .EQ. 1) GO TO 88
507: C
508: C      ... TRIDIAGONAL SOLVER ...
509:      CALL TRIDG(AA,BB,CC,DD,EE,FF,PP,1,KMAX)
510: C
511: C      ... FIND NEW PHI ALONG COLUMN IJ ...
512:      DO 86 K=1,KMAX
513:      TEMP= OMEG*(PP(K)-PHI(I,J,K))
514:      IF (RESID .GE. ABS(TEMP)) GO TO 84
515:      RESID= ABS(TEMP)
516:      ISAV= I
517:      JSAV= J
518:      KSAV= K
519: 84  CONTINUE
520:      IF (RESID .GT. EPSLN) ICONT= 1
521:      PHI(I,J,K)= PHI(I,J,K) + TEMP
522: 85  CONTINUE
523: C
524: C      ... SET BOTTOM B.C. ...
525:      PHI(I,J,KMAXP1)= PHI(I,J,KMAX) + DIFF
526:      GO TO 70
527: 86  CONTINUE
528: C
529: C      ... COMPUTE FINAL DIVERGENCE ...
530:      DO 87 K=1,KMAX
531:      KMI= K-1
532:      KMI= MAX0(1,KMI)
533:      DIV(I,J,K)= RPI*(AA(K)*PHI(I,J,KMI) + BB(K)*PHI(I,J,K) +
534:      1      CC(K)*PHI(I,J,K+1) - DD(K))
535:      IF (DIVMAX .GE. ABS(DIV(I,J,K))) GO TO 87
536:      DIVMAX= ABS(DIV(I,J,K))
537:      ISAV= I
538:      JSAV= J
539:      KSAV= K

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540: 87 CONTINUE
541: 70 CONTINUE
542: C*****
543: C FOR FINDING THE OBJECTIVE FUNCTION AS A NUMBER OF ITERATION
544: JSTEP=1
545: TV=ALOG10(STABR)
546: WDR1=WDR(1)
547: IF(IFLAG(1).EQ.1)CALL ADJUSTUV(JSTEP,WDR1,TV,ALF1SQ)
548: C*****
549: IF (IDIV .EQ. 1) GO TO 110
550: IF (ICONT .EQ. 0) IDIV= 1
551: C
552: RESDUL(ITER)= RESID
553: C IF (MOD(ITER,1) .EQ. 0) WRITE (6,90) ITER,ISAV,JSAB,KSAV,RESID
554: 90 FORMAT (5X,I3,4X,3(2X,I2),3X,1PE10.3)
555: C
556: 100 CONTINUE
557: 110 CONTINUE
558: IF (ICONT .NE. 0) GO TO 115
559: ITM1= ITER-1
560: ICOUNT=ITM1+ICOUNT
561: RESID= RESDUL(ITM1)
562: GO TO 110
563: 115 CONTINUE
564: ICOUNT=ICOUNT+ITER
565: WRITE (6,93)
566: 93 FORMAT (
567: 155H *** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED, /
568: 217X,58H CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES
569: 37H REMAIN )
570: 110 CONTINUE
571: C
572: C-----
573: C ... ADJUST THE VELOCITY FIELD ...
574: C-----
575: C
576: C ... U-COMPONENTS ...
577: RALFSQ= 1.0/ALF1SQ
578: DO 200 I=1,IMXP1
579: II= I
580: II= MIN0(II,IMAX)
581: DO 200 J=1,JMAX
582: N= (J-1)*IMAX + II
583: C1= 1.0
584: NM1= N-1
585: IF (I .NE. 1) GO TO 210
586: C1= 0.0
587: NM1= N
588: 210 CONTINUE
589: PIWST= PI(N)+PI(NM1)
590: SLPWST= (TERAIN(N)-TERAIN(NM1))*RDX
591: DO 200 K=1,KMAX
592: KM1= K-1
593: KM1= MAX0(1,KM1)
594: TMP1= PIWST*(PHI(I,J,K)-C1*PHI(I-1,J,K))
595: TMP2= SIGC(K)*SLPWST*((PHI(I,J,K+1)-PHI(I,J,KM1)) +
596: 1 C1*(PHI(I-1,J,K+1)-PHI(I-1,J,KM1)))/(DSIGC(K)+DSIGC(K+1))
597: USTAR= 0.25*(RDX*TMP1 + TMP2)*RALFSQ
598: U(I,J,K)= U(I,J,K) + USTAR
599: 200 CONTINUE
600: C
601: C ... V-COMPONENTS ...
602: DO 220 I=1,IMAX
603: DO 220 J=1,JMXP1
604: JJ= J
605: JJ= MIN0(JJ,JMAX)
606: N= (JJ-1)*IMAX + I
607: C2= 1.0

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808:      NMIM= N-IMAX
809:      IF (J .NE. 1) GO TO 230
810:      C2= 0.0
811:      NMIM= N
812: 230  CONTINUE
813:      PISOTH= PI(N)+PI(NMIM)
814:      SLPSTH= (TERAIN(N)-TERAIN(NMIM))*RDY
815:      DO 220 K=1,KMAX
816:      KM1= K-1
817:      KM1= MAX0(1,KM1)
818:      TMP1= PISOTH*(PHI(I,J,K) - C2*PHI(I,J-1,K))
819:      TMP2= SIGC(K)*SLPSTH*((PHI(I,J,K+1)-PHI(I,J,KM1)) +
820: 1      C2*(PHI(I,J-1,K+1)-PHI(I,J-1,KM1)))/(DSIGC(K)+DSIGC(K+1))
821:      VSTAR= 0.25*(RDY*TMP1 + TMP2)*RALFSQ
822:      V(I,J,K)= V(I,J,K) + VSTAR
823: 220  CONTINUE
824: C
825: C      ... FORM U AND V FROM U AND V TIDLE ...
826:      DO 300 I=1,IMXP1
827:      II= MIN0(I,IMAX)
828:      DO 300 J=1,JMXP1
829:      JJ= MIN0(J,JMAX)
830:      N= (JJ-1)*IMAX+II
831:      NM1= N-1
832:      IF (I .EQ. 1) NM1= N
833:      NMIM= N-IMAX
834:      IF (J .EQ. 1) NMIM= N
835:      PIWST= 2.0/(PI(N)+PI(NM1))
836:      PISOTH= 2.0/(PI(N)+PI(NMIM))
837:      DO 300 K=1,KMAX
838:      IF (J .NE. JMXP1) U(I,J,K)= U(I,J,K)*PIWST
839:      IF (I .NE. IMXP1) V(I,J,K)= V(I,J,K)*PISOTH
840: 300  CONTINUE
841: C
842: C      ... FORM W ASSUMING W0= 0 ...
843:      DO 250 J=1,JMAX
844:      DD 250 I=1,IMAX
845:      N= (J-1)*IMAX + I
846:      RPI= 1.0/PI(N)
847:      DO 250 K=1,KMXP1
848:      KM1= K-1
849:      KM1= MAX0(1,KM1)
850:      W(I,J,K)= -0.5*RALFSQ*STABR+RDSIGC(K)*RPI*
851: 1      (PHI(I,J,K) - PHI(I,J,KM1))
852: 250  CONTINUE
853: 1000 CONTINUE
854:      RETURN
855:      END
856:      SUBROUTINE DEFINE
857:      INCLUDE 'COMMONJ.INC'
858:      DATA IHDS /
859: 1 4H 1,4H 2,4H 3,4H 4,4H 5,4H 6,4H 7,4H 8,
860: 2 4H 9,4H 10,4H 11,4H 12,4H 13,4H 14,4H 15,4H 16,
861: 3 4H 17,4H 18,4H 19,4H 20,4H 21,4H 22,4H 23,4H 24,
862: 4 4H 25/
863: C
864: C-----
865: C      ... ZERO OUT CORE ...
866: C-----
867:      NWORDS=7219
868:      DO 10 N=1,NWORDS
869:      COMON(N)= 0.0
870: 10  CONTINUE
871:      NWORD= NWORDS
872:      DO 30 N=1,1000
873:      DZOOX(N)= 0.0
874:      DZODY(N)= 0.0
875:      IFLAG(N)= 0

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876: 30  CONTINUE
877: C-----
878: C          ... SET INPUT VARIABLE DEFAULT VALUES ...
879: C-----
880: C
881: C          ... STABILITY RATIO OF 1 (NEUTRAL ATMOSPHERE) ...
882:     ALFA1= 0.70710678
883:     ALFA2= 0.70710678
884: C
885: C          ... ONE SEVENTH POWER LAW ...
886:     BETA= 0.1429
887: C
888: C          ... CONVERSION FACTOR FROM MPH TO MPS ...
889:     CNVRSM= 0.44694
890: C
891: C          ... NO DEBUG EDITS ...
892:     DBUG= 0
893: C
894: C          ... ZONE SIZE IN X (EASTING) DIRECTION ...
895:     DX= 2000.0
896: C
897: C          ... ZONE SIZE IN Y (NORTHING) DIRECTION ...
898:     DY= 2000.0
899: C
900: C          ... MINIMUM VERTICAL ZONE SIZE ...
901:     DZMIN= 30.0
902: C
903: C          ... MAXIMUM RESIDUAL IN POTENTIAL ...
904:     EPSLN= 0.1
905: C
906: C          ... DUMMY DAY ...
907:     IDAY= 1
908: C
909: C          ... NO EDIT ...
910:     IEDIT= 0
911: C
912: C          ... HOUR OF SIMULATION ...
913:     I HOUR= 1
914: C
915: C          ... NUMBER OF ZONES IN X (EASTING) DIRECTION ...
916:     IMAX= 30
917: C
918: C          ... I-COLUMN TO INITIALIZE EDITING ...
919:     IIN= 1
920: C
921: C          ... I-COLUMN TO TERMINATE EDITING ...
922:     IMX= 30
923: C
924: C          ... CONFORMAL RUN ...
925:     IPATH= 2
926: C
927: C          ... GEOMETRIC VERTICAL ZONING ...
928:     ISIG= 3
929: C
930: C          ... READ TERRAIN DATA FROM CARDS ...
931:     ITERAN= 3
932: C
933: C          ... MAXIMUM ALLOWABLE ITERATIONS ...
934:     ITMAX= 100
935: C
936: C          ... NO OPTIONAL EDIT OF STATION DATA ...
937:     ITALOR= 0
938: C
939: C          ... NO U.A. DATA - INPUT WIND SPEED AND DIRECTION ...
940:     IWIND= 1
941: C
942: C          ... DUMMY YEAR ...
943:     IYEAR= 1

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744: C
745: C      ... 3-D PROBLEM ...
746: C      I2D= 0
747: C
748: C      ... NUMBER OF ZONES IN Y (NORTHING) DIRECTION ...
749: C      JMAX= 30
750: C
751: C      ... J-COLUMN TO INITIALIZE EDITING ...
752: C      JMN= 1
753: C
754: C      ... J-COLUMN TO TERMINATE EDITING ...
755: C      JMX= 30
756: C
757: C      ... NUMBER OF ZONES IN VERTICAL DIRECTION ...
758: C      KMAX= 15
759: C
760: C      ... K-ROW TO INITIALIZE EDITING ...
761: C      KMN= 1
762: C
763: C      ... K-ROW TO TERMINATE EDITING ...
764: C      KMX= 15
765: C
766: C      ... FLAG FOR OVER-RELAXATION PARAMETER ...
767: C      OMEG= -1.0
768: C
769: C      ... DUMMY MONTH ...
770: C      MONTH= 1
771: C
772: C      ... WINDS ARE IN MPS ...
773: C      MPS= 1
774: C
775: C      ... ONE SIMULATION ONLY ...
776: C      NDAYS= 1
777: C
778: C      ... ONE OBSERVATION ONLY ...
779: C      NPTS= 1
780: C
781: C      ... ORIGIN IS AT (0,0,0)
782: C      ORIGNX= 0.0
783: C      ORIGNY= 0.0
784: C      ORIGNZ= 0.0
785: C
786: C      ... NO DAMPING IN ITERATION ...
787: C      DMP= 0.0
788: C
789: C      ... DEGREE TO RADIAN CONVERSION ...
790: C      RADIAN= 0.01745329
791: C
792: C      ... RADIAN TO DEGREE CONVERSION ...
793: C      DEG= 57.2957795
794: C
795: C      ... PI ...
796: C      PII= 3.14159265
797: C
798: C      ... SPEED AT TOP BOUNDARY ...
799: C      QTOP= 999.0
800: C
801: C      ... BOUNDARY LAYER HEIGHT ...
802: C      ZBL= 200.0
803: C      RETURN
804: C      END
805: C      SUBROUTINE INPUT(NFLG)
806: C
807: C
808: C      INPUT- FUNCTIONS AS THE CARD INPUT MODULE FOR THE
809: C              PROGRAM. BOTH PROBLEM AND PROGRAM CONTROL
810: C              PARAMETERS ARE INITIALIZED IN THIS ROUTINE
811: C

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812:      INCLUDE 'COMMONJ.INC'
813: C
814:      DIMENSION H(40,40), HH(20)
815:      DATA HH/0.5,1.0,1.5,2.0,2.5,3.0,3.5,4.0,4.5,5.0,4.5,
816: 1      4.0,3.5,3.0,2.5,2.0,1.5,1.0,0.5,0.0/
817: C
818: C-----
819: C      ... INITIALIZE PROBLEM PARAMETERS AND ANY SURFACE
820: C      WIND DATA ...
821: C-----
822: C
823: C      ... SET DEFAULT VALUES OF INPUT PARAMETERS ...
824: C      IF (NFLG .EQ. 1) CALL DEFINE
825: C
826: C      ... READ INPUT DATA FROM CARDS ...
827: C      CALL CARDS
828: C      IF (IPATH .EQ. 2) GO TO 5
829: C      WRITE (6,4)
830: 4      FORMAT (1H1,///34X,32H*** CALCULATION TO BE PERFORMED
831: 1      32H IN CARTESIAN (X,Y,Z) SPACE ***      //)
832: C      GO TO 7
833: 5      CONTINUE
834: C      WRITE (6,6)
835: 6      FORMAT (1H1,///34X,32H*** CALCULATION TO BE PERFORMED
836: 1      32H IN CONFORMAL (X,Y,S) SPACE ***      //)
837: 7      CONTINUE
838: C      WRITE (6,3)
839: 3      FORMAT (///1X,130(1H-)/56X,18H I N P U T   D A T A   /
840: 1      1X,130(1H-)/)
841: C
842: C      ... CONVERT INPUT WIND DATA ...
843: C      IF (MPS .EQ. 1) CNVRSM= 1.0
844: C      IF (MPS .EQ. 2) CNVRSM= 0.51444444
845: C      IF (QTOP .NE. 999.0) QTOP= CNVRSM*QTOP
846: C
847: C      ... IWIND-
848: C      1 SURFACE DATA IS SPEED AND DIRECTION
849: C      2 SURFACE DATA IS WIND COMPONENTS
850: C      3 U.A. AND SURF. DATA IS SPEED AND DIRECTIO
851: C      4 U.A. AND SURF. DATA IS WIND COMPONENTS
852: C      IF ((IPATH .EQ. 1) .AND. (IWIND .GT. 2)) WRITE (6,70) IWIND
853: 70      FORMAT (///28H *** ERROR IN INPUT DECK ***/
854: 1      5X,51HONLY OBSERVED WIND DATA AT ONE LEVEL IS ALLOWED FOR
855: 2      38HREAL SPACE CALCULATIONS (IWIND .LE. 2) /5X,
856: 3      23HCARDS INPUT HAS IWIND= ,I2 ///)
857: C      IF ((IPATH .EQ. 1) .AND. (IWIND .GT. 2)) CALL EXIT
858: C      GO TO (12,8,12,8), IWIND
859: 8      CONTINUE
860: C      IF (NPTS .EQ. -1) GO TO 75
861: C
862: C      ... CONVERT SURFACE WIND COMPONENTS TO SPEED
863: C      AND DIRECTION ...
864: C      DO 10 N=1,NPTS
865: C      IF (WSPD(N) .EQ. 0.0) WSPD(N)= 1.0E-10
866: C      C1= 0.5
867: C      IF (WSPD(N) .GT. 0.0) C1= 1.5
868: C      AOB= C1*PII - ATAN(WDR(N)/WSPD(N))
869: C      WSPD(N)= SQRT(WDR(N)*WDR(N) + WSPD(N)*WSPD(N))
870: C      WDR(N)= DEG*AOB
871: 10      CONTINUE
872: 75      IF (IWIND .NE. 4) GO TO 12
873: C
874: C      ... CONVERT U.A. WIND COMPONENTS TO SPEED
875: C      AND DIRECTION ...
876: C      DO 11 N=1,NUA
877: C      IF (WSPDUA(N) .EQ. 0.0) WSPDUA(N)= 1.0E-10
878: C      C1= 0.5
879: C      IF (WSPDUA(N) .GT. 0.0) C1= 1.5

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880:      AOB= C1+PII - ATAN(WDRUA(N)/WSPDUA(N))
881:      WSPDUA(N)= SQRT(WDRUA(N)*WDRUA(N) + WSPDUA(N)*WSPDUA(N))
882:      WDRUA(N)= DEG*AOB
883: 11      CONTINUE
884: 12      CONTINUE
885: C
886: C      ... NCABL ASSUMES MKS ...
887:      IF (NPTS .EQ. -1) GO TO 71
888:      DO 18 N=1,NPTS
889:      WSPD(N)= CNVRSN*WSPD(N)
890: 18      CONTINUE
891: 71      IF (IWIND .LE. 2) GO TO 28
892:      DO 14 N=1,NUA
893:      WSPDUA(N)= CNVRSN*WSPDUA(N)
894: 14      CONTINUE
895: 28      CONTINUE
896: C
897: C      ... COMPUTE OVER-RELAXATION PARAMETER IF NOT
898: C      INPUT THROUGH CARDS ...
899:      IF (OMEG .GT. 0.0) GO TO 38
900:      XMX= IMAX
901:      YMX= JMAX
902:      TRM1= 9.8696044/(DX*DX + DY*DY)*(DY*DY/(XMX*XMX) +
903: 1      DX*DX/(YMX*YMX))
904:      TRM1= SQRT(TRM1)
905:      OMEG= 2.0/(1.0+TRM1)
906: 38      CONTINUE
907: C
908: C      ... PRINT CARD INPUT DATA ...
909:      WRITE(6,15) (COMMON(N),N=1,4),DEBUG,(COMMON(N),N=6,10),
910: 2(ICOMON(N),N=11,33),(COMMON(N),N=34,39),QTOP,ATOP,ZBL,NAU,ITMAX
911: 15      FORMAT (17H CARD INPUT DATA ///20H PROBLEM PARAMETERS//
912: 1 10X,8HALFA1= ,F10.4,3X,8HALFA2= ,F10.4,3X,8HBETA= ,F10.4,
913: 2 3X,8HCNVRSN= ,F10.4,3X,8HOBUG= , I10/
914: 3 10X,8HDX= ,F10.4,3X,8HDY= ,F10.4,3X,8HDZ= ,F10.4,
915: 4 3X,8HDZMIN= ,F10.4,3X,8HEPSLN= ,E10.4/
916: 5 10X,8HIDAY= , I10,3X,8HIEDIT= , I10,3X,8HIDUR= , I10,
917: 6 3X,8HIWAX= , I10,3X,8HIWY= , I10/
918: 7 10X,8HIWZ= , I10,3X,8HIPATH= , I10,3X,8HISIG= , I10,
919: 8 3X,8HITERAM= , I10,3X,8HITYLOR= , I10/
920: 9 10X,8HIWIND= , I10,3X,8HIYEAR= , I10,3X,8HI2D= , I10,
921: * 3X,8HJMAX= , I10,3X,8HJMN= , I10/
922: * 10X,8HJMX= , I10,3X,8HKMAX= , I10,3X,8HKMN= , I10,
923: * 3X,8HKMX= , I10,3X,8HMONTH= , I10/
924: * 10X,8HWPS= , I10,3X,8HNDAYS= , I10,3X,8HNPTS= , I10,
925: * 3X,8HOMEG= ,F10.4,3X,8HORIGNX= ,E10.4/
926: * 10X,8HORIGNY= ,E10.4,3X,8HORIGNZ= ,E10.4,3X,8HZDIST= ,E10.4,
927: * 3X,8HCMP= ,F10.4,3X,8HQTOP= ,F10.4/
928: * 10X,8HATOP= ,F10.4,3X,8HZBL= ,F10.4,3X,8HNUA= , I10,
929: * 3X,8HITMAX= , I10///)
930:      IF (NPTS .EQ. -1) GO TO 72
931:      WRITE (6,18) (N,WSPD(N),WDR(N),XO(N),YO(N),ZO(N), N=1,NPTS)
932: 18      FORMAT (26H SURFACE OBSERVATION DATA /7X,1HN,9X,2HWS,8X,2HWD,
933: 1 7X,2HXO,10X,2HYO,10X,2HZO/16X,5HW/SEC,4X,6HDEGREE,
934: 2 3X,6HMETERS,6X,6HMETERS,8X,6HMETERS/(4X,I4,2X,2(2X,F8.2)
935: 3, 3(2X,E10.3)))
936: 72      IF (IWIND .LE. 2) GO TO 37
937:      WRITE (6,19) (N,WSPDUA(N),WDRUA(N),UAMSL(N), N=1,NUA)
938: 19      FORMAT (/23H U.A. OBSERVATION DATA /7X,1HN,9X,2HWS,8X,2HWD,
939: 1 7X,2HZO/16X,5HW/SEC,4X,6HDEGREE,3X,6HMETERS//
940: 2 (4X,I4,2X,2(2X,F8.2),2X,E10.3))
941: 37      CONTINUE
942:      IF (NSTAT .EQ. 0) GO TO 42
943: C
944: C      ... READ AND PRINT STATION ID INFORMATION ...
945:      IF (NSTAT .GT. 0) GO TO 43
946:      NSTAT= ABS(NSTAT)
947:      READ(5,41) (IHDS(N), N=1,NSTAT)

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948: 41  FORMAT (20A4)
949: 43  CONTINUE
950:      WRITE(6,17) (IHDS(N),XSTA(N),YSTA(N), N=1,NSTAT)
951: 17  FORMAT (//38H SIMULATED OUTPUT STATION LOCATIONS /
952: 1    /4(3X,7HSTATION,5X,4HUTMX,7X,4HUTMY,2X)/4(14X,6HWETERS,5X,
953: 2    6HWETERS,1X)/(2X,4(3X,A4,2X,1PE11.4,1X,1PE11.4)))
954: 42  CONTINUE
955:      IF (NFLQ .NE. 1) GO TO 100
956: C-----
957: C          ... READ AND STORE TERRAIN DATA ...
958: C-----
959:      GO TO (32,33,35), ITERAN
960: 32  CONTINUE
961: C
962: C          ... READ TERRAIN DATA FROM LOGICAL UNIT 8 ...
963:      REWIND 8
964:      READ (8,99) ((H(I,J), I=1,IMAX), J=1,JMAX)
965: 99  FORMAT (8F10.2)
966:      GO TO 30
967: 33  CONTINUE
968: C
969: C          ... INITIALIZE TERRAIN DATA FROM DATA STATE. ...
970: C          FOR 2-D PROBLEMS
971:      FACTOR= 1.0
972:      DO 31 J=1,JMAX
973:      N= -1
974:      DO 31 I=1,IMAX
975:      H(I,J)= 0.0
976:      IF ((I .LT. 20) .OR. (I .GT. 40)) GO TO 31
977:      N= N+1
978:      H(I,J)= FACTOR*HH(N)
979: 31  CONTINUE
980:      GO TO 30
981: 35  CONTINUE
982: C
983: C          ... READ TERRAIN DATA FROM CARDS ...
984:      READ(5,36) ((H(I,J),I=1,IMAX),J=1,JMAX)
985: 36  FORMAT (10F8.1)
986: 39  CONTINUE
987: C
988: C          ... STORE TERRAIN DATA IN COMMON ...
989:      LL= -IMAX
990:      DO 40 J=1,JMAX
991:      LL= LL+IMAX
992:      DO 40 I=1,IMAX
993:      N= LL+I
994:      TERRAIN(N)= H(I,J)
995: 40  CONTINUE
996:      WRITE(6,51)
997: 51  FORMAT (///23H TERRAIN DATA (METERS) /8(4X,1HI,2X,1HJ,2X,
998: 1    6HHEIGHT)/)
999:      DO 60 JJ=1,2
1000:      J= JMAX-JJ+1
1001:      WRITE (6,50) (I,J,H(I,J), I=1,IMAX)
1002: 50  FORMAT (8(3X,I2,1X,I2,2X,F8.1))
1003:      WRITE(6,52)
1004: 52  FORMAT (/)
1005: 60  CONTINUE
1006: C
1007: C          ... GENERATE A TERRAIN PRINTER CONTOUR ...
1008:      IF(DEBUG.EQ.2)THEN
1009:      IWRT= 8
1010:      KLYL= -1
1011:      CALL MAP(IWRT,KLYL)
1012:      ENDIF
1013: 100 CONTINUE
1014: C
1015: C          ... NPTS= -1> U.A. DATA ONLY ...

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1016:      IF (NPTS .GT. 0) RETURN
1017:      NPTS= 1
1018:      XO(1)= ORIGNX
1019:      YO(1)= ORIGNY
1020:      ZO(1)= ZBL
1021:      ZBLMSL= ZBL + TERA(1)
1022:      IF (ZBLMSL .LT. UAMSL(1)) GO TO 147
1023:      IF (ZBLMSL .GE. UAMSL(NUA)) GO TO 148
1024:      DO 146 L=1,NUA
1025:      LBL= L
1026:      IF (ZBLMSL .LT. UAMSL(L)) GO TO 149
1027: 146 CONTINUE
1028: 147 LBL= 2
1029:      GO TO 149
1030: 148 LBL= NUA
1031: 149 LBLP1= LBL
1032:      LBL= LBL-1
1033:      FACT= (ZBLMSL - UAMSL(LBL))/(UAMSL(LBLP1)-UAMSL(LBL))
1034:      WSPD(1)= WSPDUA(LBL) + FACT*(WSPDUA(LBLP1)-WSPDUA(LBL))
1035:      WDR(1)= WDRUA(LBL) + FACT*(WDRUA(LBLP1)-WDRUA(LBL))
1036:      RETURN
1037:      END
1038:      SUBROUTINE INTERP
1039: C
1040: C
1041: C      ... INTERP- EXTRAPOLATES THE OBSERVED WIND FIELD
1042: C      DATA ON A HORIZONTAL CONFORMAL PLANE
1043: C      USING A 1/R**2 WEIGHTING FACTOR
1044: C
1045:      INCLUDE 'COMMONJ.INC'
1046: C
1047: C
1048: C      ... 1/R**2 INTERPOLATION ON HORIZONTAL PLANE ...
1049:      DO 70 J=1,JMXP1
1050:      DO 70 I=1,IMXP1
1051:      SUMD1= 0.0
1052:      SUMD2= 0.0
1053:      USUM= 0.0
1054:      VSUM= 0.0
1055:      DO 50 L=1,NPTS
1056:      IF (I .EQ. IMXP1) GO TO 10
1057:      X1= (X(I)-DX2) - XO(L)
1058:      X2= X(I) - XO(L)
1059:      GO TO 20
1060: 10 CONTINUE
1061:      X1= (X(I-1)+DX2) - XO(L)
1062:      X2= (X(I-1)+DX) - XO(L)
1063: 20 CONTINUE
1064:      IF (J .EQ. JMXP1) GO TO 30
1065:      Y1= Y(J) - YO(L)
1066:      Y2= (Y(J)-DY2) - YO(L)
1067:      GO TO 40
1068: 30 CONTINUE
1069:      Y1= (Y(J-1)+DY) - YO(L)
1070:      Y2= (Y(J-1)+DY2) - YO(L)
1071:
1072: 40 CONTINUE
1073:      DIST1= X1*X1 + Y1*Y1
1074:      DIST2= X2*X2 + Y2*Y2
1075: C
1076: C      ... PROTECT AGAINST /0 ...
1077:      DIST1= DIST1 + 1.0E-04*DX
1078:      DIST2= DIST2 + 1.0E-04*DY
1079:      DIST1= 1.0/DIST1
1080:      DIST2= 1.0/DIST2
1081:      SUMD1= SUMD1 + DIST1
1082:      USUM= USUM + UO(L)*DIST1
1083:      SUMD2= SUMD2 + DIST2

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1084:      VSUM= VSUM + VO(L)*DIST2
1085: 50 CONTINUE
1086:      IF (J.EQ. JMAXP1) GO TO 60
1087:      UTEN(I,J)= USUM/SUMD1
1088: 60 CONTINUE
1089:      IF (I.EQ. IMXP1) GO TO 70
1090:      VTEN(I,J)= VSUM/SUMD2
1091: 70 CONTINUE
1092: C
1093: C      ... PRINT RESULTS ...
1094:      IF (DEBUG.EQ.1) WRITE(6,80) ((I,J,UTEN(I,J), VTEN(I,J), I=1,IMAX),
1095: 1      J=1, JMAX)
1096: 80 FORMAT (16H UTEN-VTEN ARRAY / (2(2X,2I4,2X,1P2E12.4,2X)))
1097:      RETURN
1098:      END
1099:      SUBROUTINE MAP(IWRT,KLVL)
1100: C
1101: C
1102: C      ... MAP- GENERATE CONTOUR LINE PRINTER PLOTS OF U,V,PHI,
1103: C      DIV
1104:      INCLUDE 'COMMONJ.INC'
1105: C
1106:      DIMENSION PROP(100), PRMAX(7), VALUE(64), PR(64)
1107:      DIMENSION ALE(41), XUM(41), ZUM(25)
1108:      DATA ALE /2H .,2H -,2H A,2H B,2H C,2H D,2H E,2H F,2H G,2H H,2H I,
1109: 1      2H J,2H K,2H L,2H M,2H N,2H O,2H P,2H Q,2H R,2H S,2H T,
1110: 2      2H U,2H V,2H W,2H X,2H Y,2H Z,2H +,2H *,2H 1,2H 2,2H 3,
1111: 3      2H 4,2H 5,2H 6,2H 7,2H 8,2H 9,2H 0,2H /
1112:      DATA XUM /2H .,2H -,2H A,2H B,2H C,2H D,2H E,2H F,2H G,2H H,2H I,
1113: 1      2H J,2H K,2H L,2H M,2H N,2H O,2H P,2H Q,2H R,2H S,2H T,
1114: 2      2H U,2H V,2H W,2H X,2H Y,2H Z,2H +,2H *,2H 1,2H 2,2H 3,
1115: 3      2H 4,2H 5,2H 6,2H 7,2H 8,2H 9,2H 0,2H /
1116:      DATA ZUM /2H01,2H02,2H03,2H04,2H05,2H06,2H07,2H08,2H09,2H10,
1117: 1      2H11,2H12,2H13,2H14,2H15,2H16,2H17,2H18,2H19,2H20,
1118: 2      2H21,2H22,2H23,2H24,2H25/
1119:      KSYMBL= 28
1120:      K= KLVL
1121:      IDL= MIN0(IMAX,64)
1122:      JDL= JMAX
1123:      IF (K.LT. 0) GO TO 99
1124:      IF (I2D.EQ. 1) JDL= KMAX
1125: C
1126: C      ... SCALE PROPERTIES ...
1127:      DO 2 I=1,6
1128:      PRMAX(I)= 0.0
1129: 2 CONTINUE
1130:      DO 1 J=1,JDL
1131:      DO 1 I=1,IDL
1132:      IF (I2D.EQ. 1) GO TO 3
1133:      PRMAX(1)= AMAX1(PRMAX(1),ABS(U(I,J,K)))
1134:      PRMAX(2)= AMAX1(PRMAX(2),ABS(V(I,J,K)))
1135:      PRMAX(3)= AMAX1(PRMAX(3),ABS(PHI(I,J,K)))
1136:      PRMAX(4)= AMAX1(PRMAX(4),ABS(DIV(I,J,K)))
1137:      PRMAX(5)= AMAX1(PRMAX(5),ABS(W(I,J,K)))
1138:      UCEN= 0.5*(U(I,J,K)+U(I+1,J,K))
1139:      VCEN= 0.5*(V(I,J,K)+V(I+1,J,K))
1140:      SPD= SQRT(UCEN**2+VCEN**2)
1141:      PRMAX(6)= AMAX1(PRMAX(6),SPD)
1142:      GO TO 1
1143: 3 PRMAX(1)= AMAX1(PRMAX(1),U(I,2,J))
1144:      PRMAX(3)= AMAX1(PRMAX(3),PHI(I,2,J))
1145: 1 CONTINUE
1146: C
1147: C      ... STORE INFORMATION TO BE PLOTTED IN PROP ARRAY ...
1148:      NPROP= 1
1149: C
1150: C      ... U - VELOCITY ...
1151: 480 J= JDL

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1152:      MS= MSYMBL
1153:      IF (PRMAX(NPROP) .LE. 0.0) GO TO 1000
1154:      IF (I2D .EQ. 1) GO TO 401
1155:      WRITE(IWRT,11) K
1156: 11  FORMAT (1H1,4X,27HU-VELOCITY (M/SEC) LEVEL- ,I4//)
1157:      GO TO 402
1158: 401 WRITE(IWRT,10)
1159: 10  FORMAT (1H1,4X,18HU-VELOCITY (M/SEC) //)
1160: 402 CONTINUE
1161: 500 DO 40 I=1,IDL
1162:      IF (I2D .EQ. 1) GO TO 41
1163:      PROP(I)= U(I,J,K)
1164:      GO TO 40
1165: 41  PROP(I)= U(I,2,J)
1166: 40  CONTINUE
1167:      GO TO 100
1168: C
1169: C      ... V- VELOCITY ...
1170: 50  J= JDL
1171:      IF (PRMAX(NPROP) .LE. 0.0) GO TO 1000
1172:      WRITE(IWRT,51) K
1173: 51  FORMAT (1H1,4X,27HV-VELOCITY (M/SEC) LEVEL- ,I4//)
1174: 510 DO 60 I=1,IDL
1175: 60  PROP(I)= V(I,J,K)
1176:      GO TO 100
1177: C
1178: C      ... POTENTIAL ...
1179: 70  J= JDL
1180:      IF (PRMAX(NPROP) .LE. 0.0) GO TO 1000
1181:      IF (I2D .EQ. 1) GO TO 403
1182:      WRITE(IWRT,61) K
1183: 61  FORMAT (1H1,4X,29HPOTENTIAL (M**2/SEC) LEVEL- ,I4//)
1184:      GO TO 404
1185: 403 WRITE(IWRT,62)
1186: 62  FORMAT (1H1,4X,20HPOTENTIAL (M**2/SEC) //)
1187: 404 CONTINUE
1188: 520 DO 80 I=1,IDL
1189:      IF (I2D .EQ. 1) GO TO 81
1190:      PROP(I)= PHI(I,J,K)
1191:      GO TO 80
1192: 81  CONTINUE
1193:      PROP(I)= PHI(I,2,J)
1194: 80  CONTINUE
1195:      GO TO 100
1196: C
1197: C      ... DIVERGENCE ...
1198: 90  J= JDL
1199:      IF (PRMAX(NPROP) .LE. 0.0) GO TO 1000
1200:      WRITE(IWRT,91) K
1201: 91  FORMAT (1H1,4X,29HDIVERGENCE (1.0/SEC) LEVEL- ,I4//)
1202: 530 DO 92 I=1,IDL
1203: 92  PROP(I)= DIV(I,J,K)
1204:      GO TO 100
1205: C
1206: C      ... W-VELOCITY ...
1207: 700 J= JDL
1208:      IF (PRMAX(NPROP) .LE. 0.0) GO TO 1000
1209:      WRITE(IWRT,701) K
1210: 701 FORMAT (1H1,4X,27HW-VELOCITY (M/SEC) LEVEL- ,I4//)
1211: 540 DO 702 I=1,IDL
1212: 702 PROP(I)= W(I,J,K)
1213:      CONTINUE
1214:      GO TO 100
1215: C
1216: C      ... WIND SPEED ...
1217: 750 J= JDL
1218:      IF (PRMAX(NPROP) .LE. 0.0) GO TO 1000
1219:      WRITE(IWRT,751) K

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1220: 751 FORMAT (1H1,4X,27HWIND SPEED (M/SEC) LEVEL- ,I4//)
1221: 550 DO 752 I=1,IDL
1222:     UCEN= 0.5*(U(I,J,K)+U(I+1,J,K))
1223:     VCEN= 0.5*(V(I,J,K)+V(I+1,J,K))
1224:     SPD= SQRT(UCEN**2+VCEN**2)
1225:     PROP(I)= SPD
1226: 752 CONTINUE
1227: GO TO 100
1228: C
1229: C      ... TERRAIN ...
1230: 99 CONTINUE
1231: 760 NPROP= 7
1232:     MS= MSYMBL
1233:     PRMAX(NPROP)= 0.0
1234:     DO 761 J=1,JDL
1235:     DO 761 I=1,IDL
1236:     N= (J-1)*IMAX + I
1237:     PRMAX(NPROP)= AMAX1(PRMAX(NPROP),TERRAIN(N))
1238: 761 CONTINUE
1239: J= JDL
1240: IF (K .EQ. -1) WRITE (IWRT,762)
1241: 762 FORMAT (1H1,4X,21HTERRAIN (METERS) MSL //)
1242: 560 YSTH= Y(J) - DY2
1243:     YNTH= Y(J) + DY2
1244:     DO 763 I=1,IDL
1245:     N= (J-1)*IMAX + I
1246:     IF (K .EQ. -1) GO TO 765
1247:     XWST= X(I) - DX2
1248:     XEST= X(I) + DX2
1249:     DO 764 NN= 1,MSTAT
1250:     NSAV= NN
1251:     IF ((XSTA(NN) .GT. XWST) .AND. (XSTA(NN) .LE. XEST) .AND.
1252: 1      (YSTA(NN) .GT. YSTH) .AND. (YSTA(NN) .LE. YNTH)) GO TO 766
1253: 764 CONTINUE
1254: GO TO 765
1255: 766 PROP(I)= -(1000.0 + FLOAT(NSAV))
1256: GO TO 763
1257: 765 CONTINUE
1258: PROP(I)= TERRAIN(N)
1259: 763 CONTINUE
1260: 100 CONTINUE
1261: C
1262: C      ... WHEN PRINTING TOP ROW OF MAP, COMPUTE SCALE FACTOR ...
1263: C      AND PRINT KEY
1264: IF (J .LT. JDL) GO TO 300
1265: 180 SCALE= PRMAX(NPROP)/FLOAT(MS)
1266: IF (AINT(SCALE*1000.0) .LT. (SCALE*1000.0)) GO TO 190
1267: GO TO 200
1268: 190 SCALE= AINT(SCALE*1000.0 + 1.0)/1000.0
1269: 200 CONTINUE
1270: C
1271: VALUE(1)= 0.0
1272: VALUE(2)= SCALE/10.0
1273: VALUE2= VALUE(2)
1274: DO 210 I=1,MS
1275: 210 VALUE(I+2)= FLOAT(I)*SCALE
1276: C
1277: C      ... PRINT DEFINITIONS OF MAP SYMBOLS ...
1278: IF (K .EQ. -2) GO TO 290
1279: ILIM1= 1
1280: ILIM2= 10
1281: MSP= MSYMBL + 2
1282: 250 IF (MSP .LT. ILIM2) ILIM2= MSP
1283: WRITE(IWRT,570) (ALE(I), I=ILIM1,ILIM2)
1284: WRITE(IWRT,580) (VALUE(I), I=ILIM1,ILIM2)
1285: 570 FORMAT (16H SYMBOL ,10(3X,A2,5X))
1286: 580 FORMAT (16H MAXIMUM VALUE ,1P10E10.2)
1287: 270 IF (MSP .EQ. ILIM2) GO TO 280

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1288:      ILIM1= ILIM2 + 1
1289:      ILIM2= ILIM2 + 10
1290:      GO TO 250
1291: 280 WRITE(IWRT,590)
1292:      GO TO 300
1293: 290 CONTINUE
1294:      WRITE (IWRT,671) (ZUM(NN),IHDS(NN), NN=1,NSTAT)
1295: 671 FORMAT (//8(5X,2HID,2X,7HSTATION)/(8(5X,A2,3X,A4,2X)))
1296: 690 FORMAT (//)
1297: C
1298: C      ... ASSIGN APPROPRIATE SYMBOL TO EACH CELL IN ROW J ...
1299: 300 DO 370 I=1,IDL
1300:      IF ((K.EQ. -2) .AND. (PROP(I) .LT. -1000.0)) GO TO 381
1301:      IF (ABS(PROP(I)).GT. 0.0) GO TO 320
1302:      MA= 1
1303:      GO TO 360
1304: 320 IF (ABS(PROP(I)) .GT. VALUE2) GO TO 330
1305:      MA= 2
1306:      GO TO 360
1307: 330 FLOTMA= ABS(PROP(I))/SCALE + 2.0
1308:      MA= INT(FLOTMA)
1309:      IF (FLOTMA .GT. AINT(FLOTMA)) MA= MA + 1
1310:      MA= MAX0(MA,3)
1311: C
1312: C      ... STORE CHARACTER TO BE PLOTTED FOR CELL K ...
1313: 360 PR(I)= ALE(MA)
1314:      IF (PROP(I) .LT. 0.0) PR(I)= XUM(MA)
1315:      GO TO 370
1316: 381 CONTINUE
1317:      MA= ABS(PROP(I)) - 1000.0
1318:      PR(I)= ZUM(MA)
1319: C
1320: C      ... END OF LOOP ...
1321: 370 CONTINUE
1322: C
1323: C      ... PRINT J ROW OF MAP ...
1324:      IF (MOD(J,5) .NE. 0.0) GO TO 380
1325:      WRITE(IWRT,600) J,(PR(I), I=1,IDL)
1326:      GO TO 390
1327: 380 WRITE(IWRT,610) (PR(I), I=1,IDL)
1328: 390 J= J-1
1329: C
1330: C      ... HAVE WE REACHED THE BOTTOM ROW ...
1331:      IF (J .EQ. 0) GO TO 395
1332:      GO TO (500,510,520,530,540,550,560), NPROP
1333: C
1334: C      ... PRINT AND LABEL X-AXIS ...
1335: 395 PR(1)= ALE(29)
1336:      WRITE(IWRT,600) J,(PR(I), I=1,IDL)
1337:      WRITE(IWRT,620) (I, I=0,IDL,5)
1338: 1000 NPROP= NPROP + 1
1339: 600 FORMAT (I5,2H I,64A2)
1340: 610 FORMAT (5X,2H I,64A2)
1341: 620 FORMAT (I7,12I10///)
1342:      GO TO (470,50,70,90,700,750,470,470), NPROP
1343: 470 CONTINUE
1344:      RETURN
1345:      END
1346:      SUBROUTINE OBSWNO
1347: C
1348: C
1349: C      OBSWNO- SUBROUTINE OBSWNO INITIALIZES THE ESTIMATED
1350: C      WIND FIELD GIVEN SURFACE AND/OR UPPER AIR
1351: C      DATA AS INPUT.
1352:      INCLUDE 'COMMONJ.INC'
1353: C
1354:      DIMENSION ZMSL(25), Z08(25)
1355: C      WRITE(8,8)

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1358: C8   FORMAT (1H1)
1357: C     WRITE(6,7)
1358: C7   FORMAT (1X,130(1H-)/48X,25H WIND FIELD INITIALIZATION/
1359: C     1 1X,130(1H-))
1360:       DO 510 I=1,IMXP1
1361:       DO 510 J=1,JMXP1
1362:       IF (I.NE. IMXP1) VTEN(I,J)= 0.0
1363:       IF (J.NE. JMXP1) UTEN(I,J)= 0.0
1364:       DO 510 K=1,KMXP1
1365:       IF ((J.EQ. JMXP1).OR. (K.EQ. KMXP1)) GO TO 502
1366:       U(I,J,K)= 0.0
1367: 502    IF ((I.EQ. IMXP1).OR. (K.EQ. KMXP1)) GO TO 503
1368:       V(I,J,K)= 0.0
1369: 503    IF ((I.EQ. IMXP1).OR. (J.EQ. JMXP1)) GO TO 504
1370:       W(I,J,K)= 0.0
1371: 504    IF ((I.EQ. IMXP1).OR. (J.EQ. JMXP1).OR. (K.EQ. KMXP1))
1372:       1 GO TO 510
1373:       DIV(I,J,K)= 0.0
1374: 510    CONTINUE
1375:       IF (IPATH.EQ. 2) GO TO 1000
1376: C
1377: C-----
1378: C           ... DEFINE INITIAL WIND FIELD FOR REAL SPACE ...
1379: C-----
1380: C
1381: C           ... INPUT IS ASSUMED TO BE SURFACE DATA ONLY ...
1382: C
1383: C           ... CONVERT SPEED AND DIRECTION TO COMPONENTS ...
1384:       DO 5 N=1,NPTS
1385:       UO(N)= -WSPD(N)*SIN(RADIAN*WDR(N))
1386:       VO(N)= -WSPD(N)*COS(RADIAN*WDR(N))
1387: 5      CONTINUE
1388: C
1389: C           ... INITIALIZE SURFACE DATA TO 10 M AGL ...
1390:       DO 10 N=1,NPTS
1391:       HEIGHT= (10.0/ZD(N))*BETA
1392:       UO(N)= UO(N)*HEIGHT
1393:       VO(N)= VO(N)*HEIGHT
1394: 10     CONTINUE
1395: C
1396: C           ... INTERPOLATE WIND FIELD AT A CONFORMAL
1397: C           10 M AGL HEIGHT ...
1398:       CALL INTERP
1399: C
1400: C           ... EXTRAPOLATE WIND FIELD IN VERTICAL ASSUMING
1401: C           NO WIND TURNING ...
1402:       DO 20 J=1,JMXP1
1403:       JJ= J
1404:       JJ= MIN0(JJ,JMAX)
1405:       DO 20 I=1,IMXP1
1406:       II= I
1407:       II= MIN0(II,IMAX)
1408:       N= (JJ-1)*IMAX + II
1409:       KMIN= IFLAG(N)
1410:       DO 20 K=KMIN,KMAX
1411:       AGL= Z(K) - Z(KMIN) + DZ2
1412:       IF ((J.EQ. JMXP1).OR. ((IFLAG(N-1).GT. K).AND.
1413: 1      (I.NE. 1))) GO TO 15
1414:       IF (AGL.GT. ZBL) GO TO 12
1415:       U(I,J,K)= UTEN(I,J)*(0.1*AGL)**BETA
1416:       GO TO 15
1417: 12     CONTINUE
1418:       QBL= UTEN(I,J)*(0.1*ZBL)**BETA
1419:       IF (QTOP.EQ. 999.0) QTP= QBL
1420:       IF (QTOP.NE. 999.0) QTP= -QTOP*SIN(RADIAN*ATOP)
1421:       ZTPAGL= ZDIST + ORIGNZ - Z(KMIN) + DZ2
1422:       FACT= (AGL-ZBL)/(ZTPAGL-ZBL)
1423:       U(I,J,K)= QBL + (QTP-QBL)*FACT

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1424: 15  CONTINUE
1425:      IF ((I.EQ. IMXP1) .OR. ((IFLAG(N-IMAX) .GT. K) .AND.
1426: 1      (J.NE. 1))) GO TO 20
1427:      IF (AGL .GT. ZBL) GO TO 17
1428:      V(I,J,K)= VTEN(I,J)*(0.1*AGL)**BETA
1429:      GO TO 20
1430: 17  CONTINUE
1431:      QBL= VTEN(I,J)*(0.1*ZBL)**BETA
1432:      IF (QTOP.EQ. 999.0) QTP= QBL
1433:      IF (QTOP.NE. 999.0) QTP= -QTOP*COS(RADIAN*ATOP)
1434:      ZTPAGL= ZDIST + ORIGNZ - Z(KMIN) + DZ2
1435:      FACT= (AGL-ZBL)/(ZTPAGL-ZBL)
1436:      V(I,J,K)= QBL + (QTP-QBL)*FACT
1437: 20  CONTINUE
1438:      RETURN
1439: 1000 CONTINUE
1440: C
1441: C-----
1442: C      ... DEFINE INITIAL WIND FIELD FOR CONFORMAL SPACE ...
1443: C-----
1444: C
1445: C
1446: C      ... FIND MSL HEIGHT OF STATION POSITION ...
1447:      DO 100 N=1,NPTS
1448:      IX= IFIX((X0(N)-ORIGNX)/DX + 1.0)
1449:      JY= IFIX((Y0(N)-ORIGNY)/DY + 1.0)
1450:      NN= (JY-1)*IMAX + IX
1451:      ZMSL(N)= TERAIN(NN)
1452: 100  CONTINUE
1453:      DO 200 K=1,KMAX
1454:      GO TO (120,120,140,140), IWKD
1455: C
1456: C      ... SURFACE DATA ONLY ...
1457: 120  CONTINUE
1458:      DO 125 N=1,NPTS
1459:      ZKAGL= (1.0-SIGC(K))*(ZDIST+ORIGNZ-ZMSL(N))
1460:      ZKMSL= ZKAGL + ZMSL(N)
1461:      A0BS= WDR(N)
1462:      Q0BS= WSPD(N)
1463:      Z0BS= Z0(N)
1464: C
1465: C      ... POWER LAW IN BOUNDARY LAYER NO TURNING ...
1466: C
1467: C      ... ZBL- HEIGHT OF BOUNDARY LAYER ...
1468:      IF (ZKAGL .GT. ZBL) GO TO 121
1469:      QW= Q0BS*(ZKAGL/Z0BS)**BETA
1470:      AW= A0BS
1471:      GO TO 123
1472: C
1473: C      ... EXTRAPOLATE ABOVE BOUNDARY LAYER ...
1474: 121  CONTINUE
1475:      QBL= Q0BS*(ZBL/Z0BS)**BETA
1476: C
1477: C      ... IF NO U.A. VALUE - CONST. SPEED WITH HEIGHT
1478: C      NO TURNING ...
1479:      QSAV= QTOP
1480:      IF (QTOP.NE. 999.0) GO TO 122
1481:      QTOP= QBL
1482:      ATOP= A0BS
1483: 122  CONTINUE
1484:      ZTPAGL= ZDIST + ORIGNZ - ZMSL(N)
1485:      FACT= (ZKAGL-ZBL)/(ZTPAGL-ZBL)
1486:      QW= QBL + (QTOP-QBL)*FACT
1487: C
1488: C      ... TURN THROUGH SMALLEST ANGLE ...
1489:      DELA= ATOP - A0BS
1490:      DUM= 360.0-ABS(DELA)
1491:      IF (ABS(DELA) .GT. 180.0) DELA= -SIGN(DUM,DELA)

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1492:      AW= AOB5 + DELA*FACT
1493:      IF (AW .GT. 360.0) AW= AW - 360.0
1494:      IF (AW .LT. 0.0) AW= AW + 360.0
1495: 123  CONTINUE
1496: C
1497: C      ... SET VALUES FOR INTERPOLATION ROUTINE ...
1498:      UO(N)= -QW*SIN(RADIAN*AW)
1499:      VO(N)= -QW*COS(RADIAN*AW)
1500:      ZOB(N)= ZKMSL
1501:      QTOP= QSAV
1502: 125  CONTINUE
1503:      GO TO 160
1504: C
1505: C      ... U.A. DATA ...
1506: 140  CONTINUE
1507:      DO 155 N=1,NPTS
1508:      ZKAGL= (1.0-SIGC(K))*(ZDIST+ORIGNZ-ZMSL(N))
1509:      ZKMSL= ZKAGL + ZMSL(N)
1510:      ZBLMSL= ZBL + ZMSL(N)
1511:      AOB5= WDR(N)
1512:      QOB5= WSPD(N)
1513:      ZOB5= ZO(N)
1514:      IF (ZKAGL .GT. ZBL) GO TO 141
1515: C
1516: C      ... POWER LAW IN BOUNDARY LAYER NO TURNING ...
1517:      QW= QOB5*(ZKAGL/ZOB5)**BETA
1518:      AW= AOB5
1519:      GO TO 150
1520: 141  CONTINUE
1521:      IF (ZKMSL .LT. UAMSL(1)) GO TO 143
1522:      IF (ZKMSL .GE. UAMSL(NUA)) GO TO 144
1523: C
1524: C      ... FIT PROFILE ABOVE B.L. TO U.A. DATA ...
1525:      DO 142 L=1,NUA
1526:      LL= L
1527:      IF (ZKMSL .LT. UAMSL(L)) GO TO 145
1528: 142  CONTINUE
1529: 143  LL= 2
1530:      GO TO 145
1531: 144  LL= NUA
1532: 145  LLP1= LL
1533:      LL= LL-1
1534:      FACT= (ZKMSL-UAMSL(LL))/(UAMSL(LLP1)-UAMSL(LL))
1535:      QWUA= WSPDUA(LL) + FACT*(WSPDUA(LLP1)-WSPDUA(LL))
1536:      DELAUA= WDRUA(LLP1)-WDRUA(LL)
1537:      DUM= 360.0 - ABS(DELAUA)
1538:      IF (ABS(DELAUA) .GT. 180.0) DELAUA= -SIGN(DUM,DELAUA)
1539:      AWUA= WDRUA(LL) + DELAUA*FACT
1540:      IF (AWUA .GT. 360.0) AWUA= AWUA - 360.0
1541:      IF (AWUA .LT. 0.0) AWUA= AWUA + 360.0
1542:      QBL= QOB5*(ZBL/ZOB5)**BETA
1543:      ABL= AOB5
1544:      IF (ZBLMSL .LT. UAMSL(1)) GO TO 147
1545:      IF (ZBLMSL .GE. UAMSL(NUA)) GO TO 148
1546:      DO 148 L=1,NUA
1547:      LBL= L
1548:      IF (ZBLMSL .LT. UAMSL(L)) GO TO 149
1549: 148  CONTINUE
1550: 147  LBL= 2
1551:      GO TO 149
1552: 148  LBL= NUA
1553: 149  LBLP1= LBL
1554:      LBL= LBL-1
1555:      FACT= (ZBLMSL - UAMSL(LBL))/(UAMSL(LBLP1)-UAMSL(LBL))
1556:      QBLUA= WSPDUA(LBL) + FACT*(WSPDUA(LBLP1)-WSPDUA(LBL))
1557:      DLBLUA= WDRUA(LBLP1) - WDRUA(LBL)
1558:      DUM= 360.0 - ABS(DLBLUA)
1559:      IF (ABS(DLBLUA) .GT. 180.0) DLBLUA= -SIGN(DUM,DLBLUA)

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1580:      ABLUA= WDRUA(LBL) + DLBLUA*FACT
1581:      IF (ABLUA .GT. 360.0) ABLUA= ABLUA - 360.0
1582:      IF (ABLUA .LT. 0.0) ABLUA= ABLUA + 360.0
1583:      ZTPAGL= ZDIST + ORIGNZ - ZMSL(N)
1584:      FACT= (ZTPAGL-ZKAGL)/(ZTPAGL-ZBL)
1585:      QW= QWUA + (QBL-QBLUA)*FACT
1586:      DELABL= ABL - ABLUA
1587:      DUM= 360.0 - ABS(DELABL)
1588:      IF (ABS(DELABL) .GT. 180.0) DELABL= -SIGN(DUM,DELABL)
1589:      AW= AWUA + DELABL*FACT
1590:      IF (AW .GT. 360.0) AW= AW-360.0
1591:      IF (AW .LT. 0.0) AW= 360.0+AW
1592: 158 CONTINUE
1593:      IF (QW .LT. 0.0) QW= 1.0E-10
1594:      UO(N)= -QW*SIN(RADIAN*AW)
1595:      VO(N)= -QW*COS(RADIAN*AW)
1596:      ZOB(N)= ZKMSL
1597: 155 CONTINUE
1598: 180 CONTINUE
1599: C
1600: 220 CONTINUE
1601:      IF (DBUQ.EQ.2) THEN
1602:        WRITE (8,100) K
1603: 180 FORMAT (/19H CONFORMAL LEVEL- ,I3)
1604:        WRITE (8,101) (UO(N),VO(N),XO(N),YO(N),ZOB(N), N=1,NPTS)
1605: 181 FORMAT (7X,2HU0,10X,2HVO,10X,2HX0,10X,2HY0,10X,3HMSL/
1606: 1      6X,5HM/SEC,7X,5HM/SEC,6X,6HMETERS,6X,6HMETERS,6X,
1607: 2      6HMETERS/(2X,1P6E12.4))
1608:      ENDIF
1609: C
1610: C      ... INTERPOLATE IN CONFORMAL PLANE ...
1611: CALL INTERP
1612: C
1613: C      ... SET 3D WIND FIELD FOR LEVEL K ...
1614: DO 190 J=1,JMXP1
1615: DO 190 I=1,IMXP1
1616: IF (J .NE. JMXP1) U(I,J,K)= UTEN(I,J)
1617: IF (I .NE. IMXP1) V(I,J,K)= VTEN(I,J)
1618: W(I,J,K)=0.0
1619: 190 CONTINUE
1620: 200 CONTINUE
1621: REWIND(12)
1622: WRITE(12)U,V,W
1623: RETURN
1624: END
1625: SUBROUTINE PEDIT(IWRT)
1626: INCLUDE 'COMMONJ.INC'
1627: C
1628: C
1629: C
1630: IF (IWRT .EQ. 6) GO TO 145
1631: C      ... PRINT SUMMARY EDIT ...
1632: WRITE (9,10) ITITL
1633: 10 FORMAT (1H1///10X,10A6,///)
1634: WRITE (9,20) MONTH,IDAY,IYEAR,IHOUR
1635: 20 FORMAT (7H DATE ,I3,1H/,I2,1H/,I2,2X,3HHR=,I3/)
1636: WRITE (9,30) ORIGNX,ORIGNY,ORIGNZ
1637: 30 FORMAT (28H LOCATION OF ORIGIN (METERS) /9H ORIGNX= ,1PE12.4,
1638: 1      6X,9H ORIGNY= ,1PE12.4,9H ORIGNZ= ,1PE12.4)
1639: WRITE (9,40) ZDIST,ZMAX
1640: 40 FORMAT (34H HEIGHT OF TOP BOUNDARY (METERS)= ,1PE12.4,
1641: 1      37H MAXIMUM HEIGHT OF TERRAIN (METERS)= ,1PE12.4)
1642: WRITE(9,50) DX,DY
1643: 50 FORMAT (14H DX (METERS)= ,1PE12.4,14H DY (METERS)= ,1PE12.4)
1644: WRITE (9,60) (I,X(I), I=1,IMAX)
1645: 60 FORMAT (///17H X-ARRAY (METERS) /(4(1X,I4,2X,1PE11.4,2X)))
1646: WRITE (9,70) (J,Y(J), J=1,JMAX)
1647: 70 FORMAT (17H Y-ARRAY (METERS) /(4(1X,I4,2X,1PE11.4,2X)))

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1628:      IF (IPATH .EQ. 1) WRITE(9,88) (K,Z(K), K=1,KMAX)
1629: 80    FORMAT (17H Z-ARRAY (METERS) /(4(1X,I4,2X,1PE11.4,2X)))
1630:      IF (IPATH .NE. 2) GO TO 125
1631:      WRITE (9,90) (K,SIGF(K), K=1,KMXP1)
1632: 90    FORMAT (13H SIGMAF ARRAY /(4(1X,I4,2X,1PE11.4,2X)))
1633:      WRITE (9,100) (K,SIGC(K), K=1,KMXP1)
1634: 100   FORMAT (13H SIGMAC ARRAY /(4(1X,I4,2X,1PE11.4,2X)))
1635:      WRITE (9,110) (K,DSIGF(K), K=1,KMXP1)
1636: 110   FORMAT (14H DSIGMAF ARRAY /(4(1X,I4,2X,1PE11.4,2X)))
1637:      WRITE (9,120) (K,DSIGC(K), K=1,KMXP1)
1638: 120   FORMAT (14H DSIGMAC ARRAY /(4(1X,I4,2X,1PE11.4,2X)))
1639: 125   CONTINUE
1640:      WRITE (9,140) (I,RESUL(I), I=1,ITMAX)
1641: 140   FORMAT (///20H ITERATION RESIDUALS /(4(1X,I4,2X,1PE11.4,2X)))
1642: C
1643: C      ... PLOT APPROPRIATE DATA ...
1644: 145   CONTINUE
1645:      DO 150 K=KMN,KMX
1646:      KLV= K
1647:      CALL MAP(IWRT,KLV)
1648: 150   CONTINUE
1649:      RETURN
1650:      END
1651:      SUBROUTINE SETUP
1652: C
1653: C
1654: C      SETUP- GENERATES A CONSTANT HORIZONTAL MESH
1655: C             SPACING AND A VARIABLE OR CONSTANT
1656: C             VERTICAL MESH SPACING
1657: C
1658:      INCLUDE 'COMMON.J.INC'
1659: C
1660:      IMXP1= IMAX+1
1661:      JMXP1= JMAX+1
1662:      KMXP1= KMAX+1
1663:      IKMAX= IMAX*KMAX
1664:      IJMAX= IMAX*JMAX
1665:      IJKMAX= IJMAX*KMAX
1666: C-----
1667: C      ... GENERATE HORIZONTAL MESH SPACING ...
1668: C-----
1669:      DX2= 0.5*DX
1670:      DY2= 0.5*DY
1671:      RDX= 1.0/DX
1672:      RDY= 1.0/DY
1673:      X(1)= ORIGNX + DX2
1674:      DO 10 I=2,IMAX
1675:      X(I)= X(I-1) + DX
1676: 10    CONTINUE
1677:      Y(1)= ORIGNY + DY2
1678:      DO 20 J=2,JMAX
1679:      Y(J)= Y(J-1) + DY
1680: 20    CONTINUE
1681: C-----
1682: C      ... GENERATE VERTICAL MESH SPACING ...
1683: C-----
1684: C
1685: C      ... SEARCH FOR TERRAIN MINIMUM AND MAXIMUM ...
1686:      ZMIN= 1.0E10
1687:      ZMAX= 1.0E-10
1688:      DO 30 N=1,IJMAX
1689:      ZMAX= AMAX1(ZMAX,TERAIN(N))
1690:      ZMIN= AMIN1(ZMIN,TERAIN(N))
1691: 30    CONTINUE
1692:      ORIGNZ= ZMIN
1693:      IF (ZDIST .GT. 1.0E-05) GO TO 35
1694: C
1695: C      ... IF ZDIST WAS NOT SPECIFIED IN CARD INPUT SET

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1696: C          ZDIST EQUAL TO TWICE TERRAIN MAX. HEIGHT ...
1697:          ZDIST= ZMAX-ZMIN
1698:          ZDIST= 2.0*ZDIST
1699: 35 CONTINUE
1700: C
1701: C          ... GENERATE VERTICAL MESH SPACING ...
1702:          IF(IPATH .EQ. 2) GO TO 39
1703: C
1704: C          ... RUN TO BE EXECUTED IN REAL SPACE ...
1705:          DZ= ZDIST/FLOAT(KMAX)
1706:          RDZ= 1.0/DZ
1707:          DZ2= 0.5*DZ
1708:          Z(1)= DRIGNZ + DZ2
1709:          DO 40 K=2,KMAX
1710:          Z(K)= Z(K-1) + DZ
1711: 40 CONTINUE
1712:          GO TO 600
1713: 39 CONTINUE
1714: C
1715: C          ... RUN TO BE EXECUTED IN SIGMA SPACE ...
1716:          LL= -IMAX
1717:          DO 41 J=1,JMAX
1718:          LL= LL + IMAX
1719:          DO 41 I=1,IMAX
1720: C
1721: C          ... CALCULATE TERRAIN SLOPES AND PI ...
1722:          N= LL+I
1723:          PI(N)= (ZDIST+ZMIN) - TERRAIN(N)
1724:          IF (I .EQ. 1) GO TO 42
1725:          IF (I .EQ. IMAX) GO TO 43
1726:          DZODX(N)= 0.5*(TERRAIN(N+1)-TERRAIN(N-1))*RDZ
1727:          GO TO 44
1728: 42 CONTINUE
1729:          DZODX(N)= (TERRAIN(N+1)-TERRAIN(N))*RDZ
1730:          GO TO 44
1731: 43 CONTINUE
1732:          DZODX(N)= (TERRAIN(N)-TERRAIN(N-1))*RDZ
1733: 44 CONTINUE
1734:          IF (J .EQ. 1) GO TO 45
1735:          IF (J .EQ. JMAX) GO TO 46
1736:          DZODY(N)= 0.5*(TERRAIN(N+IMAX)-TERRAIN(N-IMAX))*RDY
1737:          GO TO 41
1738: 45 CONTINUE
1739:          DZODY(N)= (TERRAIN(N+IMAX)-TERRAIN(N))*RDY
1740:          GO TO 41
1741: 46 CONTINUE
1742:          DZODY(N)= (TERRAIN(N)-TERRAIN(N-IMAX))*RDY
1743: 41 CONTINUE
1744:          IF (DEBUG.EQ.1) WRITE (8,150) (N,DZODX(N), N=1,IJMAX)
1745: 150 FORMAT (//16H X-SURFACE SLOPE /(4(3X,I5,2X,F10.3)))
1746:          IF (DEBUG.EQ.1) WRITE (8,160) (N,DZODY(N), N=1,IJMAX)
1747: 160 FORMAT (//16H Y-SURFACE SLOPE /(4(3X,I5,2X,F10.3)))
1748:          IF (DEBUG.EQ.1) WRITE (8,170) (N,PI(N), N=1,IJMAX)
1749: 170 FORMAT (//9H PI ARRAY /(4(3X,I5,2X,F10.3)))
1750: C
1751: C          ... CALCULATE VERTICAL COORDINATE SPACING ...
1752:          GO TO (301,400,500), ISIG
1753: 301 CONTINUE
1754: C
1755: C          ... LOG-LINEAR DISTRIBUTION OF VERTICAL SPACING ...
1756:          SIGF(1)= 0.0
1757:          CX1= 0.001
1758:          CX2= 0.2
1759:          RANGE= 1.0 + CX2*ALOG((1.0+CX1)/CX1)
1760:          DRANGE= RANGE/FLOAT(KMAX)
1761:          TEMP= RANGE
1762:          DO 47 K=2,KMAX
1763:          TEMP= TEMP-DRANGE

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1784:     SIGF(K)= SIGF(K-1)
1785:     NN= 0
1786: 48  RRANGE= 1.0-SIGF(K) + CX2+ALOG((1.0-SIGF(K)+CX1)/CX1)
1787:     NN= NN+1
1788:     DRDQ= -1.0 - CX2/(1.0-SIGF(K)+CX1)
1789:     DELQ= (TEMP-RRANGE)/DRDQ
1790:     SIGF(K)= SIGF(K) +DELQ
1791:     IF (SIGF(K) .GT. 1.0) SIGF(K)= 1.0
1792:     IF (ABS(DELQ) .GT. 1.0E-05) GO TO 48
1793: 47  CONTINUE
1794:     SIGF(KMXP1)= 1.0
1795:     DO 51 K=1,KMAX
1796:     DSIGF(K)= SIGF(K+1)-SIGF(K)
1797:     SIGC(K)= 0.5*(SIGF(K+1)+SIGF(K))
1798:     IF (K .NE. 1) DSIGC(K)= SIGC(K)-SIGC(K-1)
1799: 51  CONTINUE
1800:     DSIGC(KMXP1)= DSIGC(KMAX)
1801:     DSIGC(1)= DSIGC(2)
1802:     DSIGF(KMXP1)= DSIGF(KMAX)
1803:     GO TO 800
1804: 400 CONTINUE
1805: C
1806: C     ... CONSTANT VERTICAL SPACING ...
1807:     DUM= 1.0/FLOAT(KMAX)
1808:     SIGF(1)= DUM
1809:     SIGC(1)= 0.5*DUM
1810:     DSIGF(1)= DUM
1811:     DSIGC(1)= DUM
1812:     DO 410 K=2,KMXP1
1813:     SIGF(K)= SIGF(K-1) + DUM
1814:     SIGC(K)= SIGC(K-1) + DUM
1815:     DSIGF(K)= DUM
1816:     DSIGC(K)= DUM
1817: 410 CONTINUE
1818:     GO TO 800
1819: 500 CONTINUE
1820: C
1821: C     ... VARIZBLE VERTICAL ZONING BY GEOMETRIC PROGRESSION ...
1822:     GAMMA= 1.2
1823:     DSM= DZMIN/ZDIST
1824:     NI= 0
1825: C
1826: C     ... FIND GAMMA BY NEWTON'S METHOD ...
1827: 805 CONTINUE
1828:     NI= NI+1
1829:     GAMSV= GAMMA
1830:     FRI= DSM*(1.0-GAMMA**KMAX)/(1.0-GAMMA) - 1.0
1831:     DUM= 1.01*GAMMA
1832:     FIRP1= DSM*(1.0-DUM**KMAX)/(1.0-DUM) - 1.0
1833:     DELTA= 1.0E-02*GAMMA
1834:     GAMMA= GAMMA - DELTA/((FIRP1/FRI)-1.0)
1835:     IF (NI .GT. 100) GO TO 806
1836:     IF (ABS(GAMMA-GAMSV) .GT. 1.0E-08) GO TO 806
1837:     GO TO 807
1838: 806 CONTINUE
1839:     WRITE (8,808) GAMMA
1840: 808 FORMAT (41H *** GAMMA ITERATION DID NOT CONVERGE *** ,4X,
1841: 1      7HGAMMA= ,F14.8)
1842:     CALL EXIT
1843: 807 CONTINUE
1844:     IF (GAMMA .GT. 1.3) WRITE (8,811) GAMMA
1845: 811 FORMAT (///2X,15H*** WARNING *** ,2X,7HGAMMA= ,F8.3,
1846: 1 2X,40H MAY RESULT IN EXCESSIVE TRUNCATION ERROR ///)
1847:     SIGF(KMXP1)= 1.0
1848:     DO 810 KK=1,KMAX
1849:     K= KMXP1-KK
1850:     DSIG= DSM*GAMMA**(KK-1)
1851:     SIGF(K)= SIGF(K+1) - DSIG

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1832: 810 CONTINUE
1833:     SIGF(1)= 0.0
1834:     DO 820 K=1,KMAX
1835:         DSIGF(K)= SIGF(K-1)-SIGF(K)
1836:         SIGC(K)= 0.5*(SIGF(K+1)+SIGF(K))
1837:         IF (K.NE. 1) DSIGC(K)= SIGC(K) - SIGC(K-1)
1838: 820 CONTINUE
1839:     DSIGF(KMXP1)= DSIGF(KMAX)
1840:     DSIGC(1)= DSIGC(2)
1841:     DSIGC(KMXP1)= DSIGC(KMAX)
1842:     SIGC(KMXP1)= 1.0
1843: 800 CONTINUE
1844: C
1845: C     ... PRINT TERRAIN MAXIMUM AND MINIMUM ...
1846:     WRITE (8,70) ZMAX,ZMIN
1847: 70  FORMAT (37H MAXIMUM HEIGHT OF TERRAIN (METERS)= ,F10.3/
1848: 1      37H MINIMUM HEIGHT OF TERRAIN (METERS)= ,F10.3/)
1849: C
1850: C     ... PRINT ZONING INFORMATION ...
1851:     WRITE (8,50)
1852: 50  FORMAT (1H1,31X,1SHMESH PARAMETERS ///)
1853:     WRITE (8,60) ORIGNX,ORIGNY,ORIGNZ
1854: 60  FORMAT (10X,27HLOCATION OF ORIGIN (METERS) //7X,6HORIGNX,
1855: 1      8X,6HORIGNY,8X,6HORIGNZ/2X,3(2X,1PE12.4))
1856:     GO TO (52,53), IPATH
1857: 52  CONTINUE
1858:     WRITE (8,54) DX,DY,DZ
1859: 54  FORMAT (///9X,21HMesh SPACING (METERS) //8X,2HDX,8X,2HDY,8X,
1860: 1      2HDZ/2X,3(2X,F8.2)///)
1861:     GO TO 55
1862: 53  CONTINUE
1863:     WRITE (8,38) DX,DY,DZMIN
1864: 38  FORMAT (/// 9X,21HMesh SPACING (METERS)//8X,2HDX,8X,2HDY,7X,
1865: 1      5HDZMIN/2X,3(2X,F8.2)///)
1866: 55  CONTINUE
1867:     IF ((IPATH.EQ. 2).AND. (ISIG.EQ. 3)) WRITE (8,809) GAMMA
1868: 809  FORMAT (26H EXPANSION FACTOR (GAMMA),
1869: 1      27HFOR GEOMETRIC PROGRESSION= ,F14.8//)
1870:     WRITE (8,80) (I,X(I),I=1,IMAX)
1871: 80  FORMAT (17H X-ARRAY (METERS) /(4(1X,I4,2X,1PE11.4,2X)))
1872:     WRITE (8,90) (J,Y(J), J=1,JMAX)
1873: 90  FORMAT (17H Y-ARRAY (METERS) /(4(1X,I4,2X,1PE11.4,2X)))
1874:     IF (IPATH.EQ. 1) WRITE (8,100) (K,Z(K), K=1,KMAX)
1875: 100  FORMAT (17H Z-ARRAY (METERS) /(4(1X,I4,2X,1PE11.4,2X)))
1876:     IF (IPATH.NE. 2) GO TO 199
1877:     WRITE (8,110) (K,SIGF(K), K=1,KMXP1)
1878: 110  FORMAT (13H SIGMAF ARRAY /(4(1X,I4,2X,1PE11.4,2X)))
1879:     WRITE (8,120) (K,DSIGF(K), K=1,KMXP1)
1880: 120  FORMAT (14H DSIGMAF ARRAY /(4(1X,I4,2X,1PE11.4,2X)))
1881:     WRITE (8,130) (K,SIGC(K), K=1,KMAX)
1882: 130  FORMAT (13H SIGMAC ARRAY /(4(1X,I4,2X,1PE11.4,2X)))
1883:     WRITE (8,140) (K,DSIGC(K), K=1,KMAX)
1884: 140  FORMAT (14H DSIGMAC ARRAY /(4(1X,I4,2X,1PE11.4,2X)))
1885:     RETURN
1886: 199  CONTINUE
1887: C
1888: C     ... MAP TERRAIN DATA ONTO GRID FOR REAL SPACE
1889: C     CALCULATIONS (ONLY) ...
1890:     DO 200 N=1,IJMAX
1891:     DO 200 K=1,KMAX
1892:         ZTOP= Z(K) + DZ2
1893:         ZBOT= Z(K) -DZ2
1894:         IF ((TERRAIN(N).LT. ZTOP).AND. (TERRAIN(N).GE. ZBOT)) IFLAG(N)=K
1895: 200  CONTINUE
1896:     IF (DEBUG.EQ.1) WRITE (8,210) (N,IFLAG(N), N=1,IJMAX)
1897: 210  FORMAT (//12H IFLAG ARRAY /(8(2X,I4,1X,I3)))
1898:     RETURN
1899:     END

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1900:      SUBROUTINE TAYLOR(ISTRT)
1901: C
1902: C
1903: C          TAYLOR- INTERPOLATES A WIND SPEED AND WIND DIRECTION
1904: C                  AT A SPECIFIED NUMBER OF POINTS IN THE MESH
1905: C                  USING A SECOND ORDER TAYLOR EXPANSION ABOUT
1906: C                  THE POINTS OF INTEREST
1907: C
1908: C          INCLUDE 'COMMONJ.INC'
1909: C
1910: C          COMMON /OUT/ A(25,25), B(25,25)
1911: C          DIMENSION VAVSTA(25), EATA(25), ISAV(25), JSAV(25),
1912: C          1      UAVSTA(25), XMSL(25), ACL(25), ZEATA(25)
1913: C          DIMENSION UAVG(40,40), VAVG(40,40)
1914: C          ICOMP= 0
1915: C-----
1916: C          ... STORE WIND COMPONENTS FOR LEVEL K ...
1917: C-----
1918: C          DO 1000 KK=1,KMAX
1919: C          K= KMAX-KK+1
1920: C          IF (KK .GT. 1) ISTRT= 2
1921: C          DO 10 J=1,JMAX
1922: C          DO 10 I=1,IMAX
1923: C          N= (J-1)*IMAX+I
1924: C          IF (IPATH .NE. 1) GO TO 5
1925: C
1926: C          ... REAL SPACE CALCULATIONS ...
1927: C          K= IFLAG(N)
1928: C          KW= K
1929: C          IF (I .NE. 1) KW= IFLAG(N-1)
1930: C          KE= K
1931: C          IF (I .NE. IMAX) KE= IFLAG(N+1)
1932: C          IF (KW .GT. K) GO TO 81
1933: C          KN= K
1934: C          81 CONTINUE
1935: C          IF (KE .GT. K) GO TO 82
1936: C          KE= K
1937: C          82 CONTINUE
1938: C          KS= K
1939: C          IF (J .NE. 1) KS= IFLAG(N-IMAX)
1940: C          KN= K
1941: C          IF (J .NE. JMAX) KN= IFLAG(N+IMAX)
1942: C          IF (KS .GT. K) GO TO 83
1943: C          KS= K
1944: C          83 CONTINUE
1945: C          IF (KN .GT. K) GO TO 84
1946: C          KN= K
1947: C          84 CONTINUE
1948: C          GO TO 7
1949: C          5 CONTINUE
1950: C
1951: C          ... CONFORMAL SPACE CALCULATIONS ...
1952: C          KE= K
1953: C          KW= K
1954: C          KS= K
1955: C          KN= K
1956: C          7 CONTINUE
1957: C          UAV= 0.5*(U(I,J,KW)+U(I+1,J,KE))
1958: C          VAV= 0.5*(V(I,J,KS)+V(I,J+1,KN))
1959: C          UAVG(I,J)= UAV
1960: C          VAVG(I,J)= VAV
1961: C          10 CONTINUE
1962: C-----
1963: C          ... INTERPOLATE FOR STATION VALUES ...
1964: C-----
1965: C          DO 100 N=1,NSTAT
1966: C
1967: C          ... CHECK FOR STATIONS OUT OF BOUNDS ...

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1968:      IF ((XSTA(N) .LT. (X(1)-0.5*DX)) .OR.
1969: 1      (XSTA(N) .GT. (X(IMAX)+0.5*DX))) GO TO 100
1970:      IF ((YSTA(N) .LT. (Y(1)-0.5*DY)) .OR.
1971: 1      (YSTA(N) .GT. (Y(JMAX)+0.5*DY))) GO TO 100
1972:      GO TO (15,50), ISTRT
1973: 15  CONTINUE
1974: C
1975: C      ... FIND STATION POSITIONS RELATIVE TO MESH ...
1976:      DO 20 I=1,IMAX
1977:      ISAV(N)= I
1978:      IF (XSTA(N) .LE. X(I)) GO TO 25
1979: 20  CONTINUE
1980: 25  CONTINUE
1981:      DO 30 J=1,JMAX
1982:      JSAV(N)= J
1983:      IF (YSTA(N) .LE. Y(J)) GO TO 35
1984: 30  CONTINUE
1985: 35  CONTINUE
1986: C
1987:      I= ISAV(N)
1988:      J= JSAV(N)
1989:      TEMP1= X(I)-XSTA(N)
1990:      TEMP2= Y(J)-YSTA(N)
1991:      TEMP3= X(I-1)-XSTA(N)
1992:      TEMP4= Y(J-1)-YSTA(N)
1993:      DIST1= SQRT(TEMP1*TEMP1 + TEMP2*TEMP2)
1994:      DIST2= SQRT(TEMP3*TEMP3 + TEMP2*TEMP2)
1995:      IF (DIST1 .LT. DIST2) GO TO 40
1996:      ISAV(N)= ISAV(N)-1
1997:      TEMP1= TEMP3
1998: 40  CONTINUE
1999:      DIST1= SQRT(TEMP1*TEMP1+TEMP2*TEMP2)
2000:      DIST2= SQRT(TEMP1*TEMP1 + TEMP4*TEMP4)
2001:      IF (DIST1 .GT. DIST2) JSAV(N)= JSAV(N)-1
2002: C
2003: C      ... COMPUTE DISPLACEMENT OF STATION WITHIN CELL (I,J)
2004: C      FROM CELL CENTER ...
2005:      I= ISAV(N)
2006:      J= JSAV(N)
2007:      EATA(N)= XSTA(N)-X(I)
2008:      ZEATA(N)= YSTA(N)-Y(J)
2009: 50  CONTINUE
2010: C
2011: C      ... DETERMINE WIND SPEED AT STATION N ...
2012:      I= ISAV(N)
2013:      J= JSAV(N)
2014:      NN= (J-1)*IMAX + I
2015:      AGL(N)= (1.0-SIGC(K))*PI(NN)
2016:      IF (IPATH .EQ. 1) AGL(N)= Z(K) - TERA(NN)
2017:      XMSL(N)= AGL(N) + TERA(NN)
2018:      IE= I+1
2019:      IW= I-1
2020:      JN= J+1
2021:      JS= J-1
2022:      IF (I .EQ. IMAX) IE=IMAX
2023:      IF (I .EQ. 1) IW= 1
2024:      IF (J .EQ. JMAX) JN= JMAX
2025:      IF (J .EQ. 1) JS= 1
2026:      DWDX= 0.5*(UAVG(IE,J)-UAVG(IW,J))*RDX
2027:      DWDY= 0.5*(UAVG(I,JN)-UAVG(I,JS))*RDY
2028:      D2WDX2= RDX*((UAVG(IE,J)-UAVG(I,J))*RDX -
2029: 1      (UAVG(I,J)-UAVG(IW,J))*RDX)
2030:      D2WDY2= RDY*((UAVG(I,JN)-UAVG(I,J))*RDY -
2031: 1      (UAVG(I,J)-UAVG(I,JS))*RDY)
2032:      D2WDXY= 0.25*((UAVG(IE,JN)-UAVG(IW,JN)) -
2033: 1      (UAVG(IE,JS)-UAVG(IW,JS)))*RDX*RDY
2034: C
2035: C      ... SECOND ORDER TAYLOR EXPANSION ...

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2036: C      ... FIND U- COMPONENT AT STATION N ...
2037:      UAVSTA(N)= UAVG(I,J) + EATA(N)*DWDX + ZEATA(N)*DWDY +
2038:      1      0.5*(EATA(N)**2*D2WOX2 + 2.0*EATA(N)*ZEATA(N)*
2039:      2      D2WDXY + ZEATA(N)**2*D2WDY2)
2040:      DDDX= 0.5*(VAVG(IE,J)-VAVG(IW,J))*RDX
2041:      DDDY= 0.5*(VAVG(IE,JN)-VAVG(I,JN))*RDY
2042:      D2DDX2= RDX*((VAVG(IE,J)-VAVG(I,J))*RDX -
2043:      1      (VAVG(I,J)-VAVG(IW,J))*RDX)
2044:      D2DDY2= RDY*((VAVG(IE,JN)-VAVG(I,JN))*RDY -
2045:      1      (VAVG(I,J)-VAVG(I,JN))*RDY)
2046:      D2DDXY= 0.25*((VAVG(IE,JN)-VAVG(IW,JN)) -
2047:      1      (VAVG(IE,J)-VAVG(IW,JN))*RDX+RDY)
2048: C
2049: C      ... SECOND ORDER TAYLOR EXPANSION ...
2050: C      ... FIND V- COMPONENT AT STATION N ...
2051:      VAVSTA(N)= VAVG(I,J) + EATA(N)*DDDX + ZEATA(N)*DDDY +
2052:      1      0.5*(EATA(N)**2*D2DDX2 + 2.0*EATA(N)*ZEATA(N)*
2053:      2      D2DDXY + ZEATA(N)**2*D2DDY2)
2054:      A(N,K)= AGL(N)
2055:      B(N,K)= XMSL(N)
2056:      UTEN(N,K)= UAVSTA(N)
2057:      VTEN(N,K)= VAVSTA(N)
2058: 100 CONTINUE
2059: 1000 CONTINUE
2060: C-----
2061: C      ... PRINT STATION RESULTS ...
2062: C-----
2063: C
2064: C      WRITE(6,900)
2065: 900 FORMAT (///39H SIMULATED OBSERVATION STATION RESULTS //)
2066: C
2067: C      ... PRINT MAP OF STATION LOCATIONS ...
2068:      IF(DEBUG.EQ.2) THEN
2069:      KLV= -2
2070:      IWRT= 8
2071:      CALL MAP(IWRT,KLV)
2072:      WRITE (6,930)
2073: 930 FORMAT (1H1)
2074:      ENDIF
2075:      DO 9950 N=1,NSTAT
2076:      IF ((XSTA(N) .GE. (X(1)-0.5*DX)) .AND.
2077:      1      (XSTA(N) .LE. (X(IMAX)+0.5*DX)) .AND.
2078:      2      (YSTA(N) .GE. (Y(1)-0.5*DY)) .AND.
2079:      3      (YSTA(N) .LE. (Y(JMAX)+0.5*DY))) GO TO 9950
2080:      WRITE (6,910) N,XSTA(N),YSTA(N)
2081: 910 FORMAT (/11H STATION- ,I2,17H IS OUT OF BOUNDS ,
2082:      1      5X,6HUTMX= ,1PE12.4,2X,6HUTMY= ,1PE12.4 ///)
2083:      GO TO 960
2084: 9950 CONTINUE
2085:      IF(DEBUG.EQ.2) THEN
2086:      DO 950 N=1,NSTAT
2087:      WRITE (6,901) IHDS(N),XSTA(N),YSTA(N)
2088: 901 FORMAT (/2X,9HSTATION- ,A4,5X,6HUTMX= ,1PE12.4,8H UTMY= ,1PE12.4
2089:      1      //8X,3HAGL,8X,3HMSL,8X,7HJ-COMP.,4X,7HY-COMP.,4X,
2090:      2      7HWND SPD,4X,7HWND DIR /8X,6HMETERS,5X,6HMETERS,3X,
2091:      3      7H M/SEC ,4X,7H M/SEC ,4X,7H M/SEC ,4X,7HDEGREES /)
2092:      DO 950 KK=1,KMAX
2093:      K= KMAX-KK+1
2094:      SPEED= SQRT(UTEN(N,K)**2+VTEN(N,K)**2)
2095:      C1= 0.5
2096:      IF (UTEN(N,K) .GT. 0.0) C1= 1.5
2097:      DIR= DEG*(C1*PII - ATAN(VTEN(N,K)/UTEN(N,K)))
2098:      WRITE (6,902) A(N,K), B(N,K), UTEN(N,K), VTEN(N,K), SPEED,DIR
2099: 902 FORMAT (5X,6(F8.2,3X))
2100: 950 CONTINUE
2101:      ENDIF
2102: 960 CONTINUE
2103:      RETURN

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2104:      END
2105:      SUBROUTINE TRIDG(A,B,C,D,E,F,P,NI,NF)
2106:      C
2107:      C      ... TRIDIAGONAL MATRIX SOLVER ...
2108:      DIMENSION A(NF), B(NF), C(NF), D(NF), E(NF), F(NF), P(NF)
2109:      NIP= NI-1
2110:      E(NI)= C(NI)/B(NI)
2111:      F(NI)= D(NI)/B(NI)
2112:      C
2113:      DO 100 I=NIP,NF
2114:      DENOM= 1.0/(B(I) - A(I)*E(I-1))
2115:      E(I)= C(I)*DENOM
2116:      F(I)= (D(I) - A(I)*F(I-1))*DENOM
2117: 100 CONTINUE
2118:      C
2119:      P(NF)= F(NF)
2120:      DO 200 II=NIP,NF
2121:      I= NF+NI-II
2122:      P(I)= F(I) - E(I)*P(I+1)
2123: 200 CONTINUE
2124:      RETURN
2125:      END
2126:      SUBROUTINE WTAPE(IDUMP)
2127:      C
2128:      C
2129:      C      WTAPE- SAVES BOTH COMMON BLOCKS AND LABELED COMMONS
2130:      C      ON TAPE
2131:      C
2132:      INCLUDE 'COMMONJ.INC'
2133:      C
2134:      COMMON /OUT/ A(25,25), B(25,25)
2135:      DIMENSION IWORD(2)
2136:      GO TO (10,20), IDUMP
2137: 10 CONTINUE
2138:      WRITE (10) (COMON(N), N=1,NWORD)
2139:      RETURN
2140: 20 CONTINUE
2141:      WRITE(10) U,V,W
2142:      IF (NSTAT .EQ. 0) GO TO 51
2143:      C
2144:      C      ... WRITE STATION DATA TO TAPE ...
2145:      DO 50 N=1,NSTAT
2146:      WRITE (10) IHDS(N), XSTA(N), YSTA(N)
2147:      WRITE (10) (A(N,K), B(N,K), UTEN(N,K), VTEN(N,K), K=1,KMAX)
2148: 50 CONTINUE
2149: 51 CONTINUE
2150:      IF (IDUMP .NE. 2) RETURN
2151:      WRITE(0,30)
2152: 30 FORMAT (20H PLOT TAPE DUMP FOR> )
2153:      WRITE(0,40) MONTH,IDAY,IYEAR,IHOUR
2154: 40 FORMAT (1X,I3,1H/,I2,1H/,I2,2X,3HHR=,I3//)
2155:      RETURN
2156:      END

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FILE: NEWMIN.FOR

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1:      SUBROUTINE NEWMIN(IVAR,STEP,OF1,TVSAVE)
2: C MINIMIZES THE OBJECTIVE FUNCTION AS A FUNCTION OF THE
3: C A SINGLE VARIABLE XVAR
4: C THE OBJECTIVE FUNCTION MINIMIZED IS OF1
5: C NOTE:: THIS IS A RELATIVELY UNSOPHISTICATED MINIMIZATION
6: C PROCEDURE INVOLVING REPETITIVE FITTING OF PARABOLAS UNTIL
7: C THE PARABOLIC FIT PROVIDES AN ESTIMATE OF THE MINIMUM OF
8: C THE OBJECTIVE FUNCTION THAT IS WITHIN THE TOLERANCE, ERROR(IVAR),
9: C SPECIFIED FOR THE PARAMETER BEING OPTIMALLY ADJUSTED.
10: C FOR IVAR=1, INITIAL WIND DIRECTION IS OPTIMALLY ADJUSTED
11: C FOR IVAR=2, THE POWER LAW EXPONENT IS OPTIMALLY ADJUSTED
12:      INCLUDE 'COMMONJ.INC'
13:      COMMON/PARAMS/PARAM(3),JVAR(3),SSTEP(3)
14:      COMMON/JIM/ICOUNT,XVAR(2)
15:      COMMON/SLEAZ/ERROR(3)
16:      DIMENSION OFTEMP(100),X1(100),A(3,3),B(3,1),WK(10)
17:      DIMENSION X2(3)
18: C
19: C      INITIALIZE X1(1), THE WIND DIRECTION
20:      X1(1)=XVAR(IVAR)
21: C
22: C MAKE TWO FUNCTION EVALUATIONS TO DETERMINE THE PROPER
23: C DIRECTION TO STEP IN THE OPTIMIZATION PROCESS
24:      XVAR(IVAR)=X1(1)
25:      OFTEMP(1)=OF1(X1(1),IVAR,TVSAVE)
26:      X1(2)=X1(1)+STEP
27:      XVAR(IVAR)=X1(2)
28:      OFTEMP(2)=OF1(X1(2),IVAR,TVSAVE)
29:      IF(OTEMP(2).GT.OTEMP(1))THEN
30:          IDIR=-1
31:          X1TEMP=X1(1)
32:          OFTEMP1=OTEMP(1)
33:          X1(1)=X1(2)
34:          OFTEMP(1)=OTEMP(2)
35:          X1(2)=X1TEMP
36:          OFTEMP(2)=OTEMP1
37:      ELSE
38:          IDIR=1
39:      ENDIF
40: C
41: C SAVE THE INDEX FOR THE SMALLEST FUNCTION EVALUATION
42:      JSAV=1
43:      OFMIN=AMIN1(OTEMP(1),OTEMP(2))
44:      IF(OFMIN.EQ.OTEMP(2))JSAV=2
45: C
46: C LOOP TO FIND APPROXIMATE MINIMUM
47:      DO 100 J1=3,100
48:          J2=J1+1
49:          X1(J1)=X1(J1-1)+IDIR*STEP
50:          XVAR(IVAR)=X1(J1)
51:          OFTEMP(J1)=OF1(X1(J1),IVAR,TVSAVE)
52:          OFMIN=AMIN1(OFMIN,OTEMP(J1))
53:          IF(OFMIN.EQ.OTEMP(J1))JSAV=J1
54: C REFINE INITIAL ESTIMATE USING A PARABOLIC FIT
55:      IF(OTEMP(J1).GT.OTEMP(J1-1))THEN
56: C FIND THE COEFFICIENTS OF THE PARABOLA
57: C FIRST SET UP THE "A" MATRIX DESCRIBED IN SOLVER
58: C THEN SET UP THE "B" VECTOR OF OBJECTIVE FUNCTION VALUES
59:          DO 10 N=1,3
60:              B(N,1)=OTEMP(J1-3+N)
61:          DO 10 M1=2,0,-1
62:              M2=3-M1
63:              IF(X1(J1-3+N).EQ.0.AND.M1.EQ.0)THEN
64:                  A(N,M2)=1.0

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85:      ELSE
86:        A(N,M2)=X1(J1-3+N)**M1
87:      ENDIF
88: 100  CONTINUE
89: C
90: C OBTAIN THE COEFFICIENTS OF THE PARABOLA USING SOLVER
91: CALL SOLVER(A,B,IER)
92: IF (IER.NE.0) THEN
93:   WRITE(8,1010) IER
94: 1010  FORMAT(' IER = ',I5,' MATRIX IS SINGULAR, STOP')
95: STOP
96: ENDIF
97: C EXIT THE 100 LDOP
98: GOTO 200
99: ENDIF
100: 100  CONTINUE
101: STOP
102: 200  CONTINUE
103: C MORE REFINEMENTS USING THE PARABOLA
104: DO 300 J1=J2,100
105:   IFLG=1
106:   JFLG=2
107: C ESTIMATE THE MINIMUM
108:   X1(J1)=-B(2,1)/(2.0*B(1,1))
109:   XVARMIN=X1(J1)+SSTEP(IVAR)+PARAM(IVAR)
110:   XVAR(IVAR)=X1(J1)
111:   OFTEMP(J1)=OF1(X1(J1),IVAR,TVSAVE)
112: C SAVE THE OLD MINIMUM
113:   B(1,1)=OFMIN
114:   X2(1)=X1(JSAY)
115: C IS THE ESTIMATED MINIMUM A NEW MINIMUM?
116:   OFMIN=AMIN1(OTEMP(J1),OFMIN)
117:   IF (OFMIN.EQ.OTEMP(J1)) THEN
118:     JSAY=J1
119:     IFLG=2
120:     JFLG=1
121:   TVOPT=TVSAVE
122: ENDIF
123: C DO WE STOP????
124: IF (ERROR(IVAR).LT.0.0.AND.J1.GT.J2) GOTO 600
125: IF (ABS((X2(1)-X1(J1))+SSTEP(IVAR)).LT.ERROR(IVAR)) THEN
126: 600  CONTINUE
127:   XVAR(IVAR)=X1(JSAY)
128:   OFI=OTEMP(JSAY)
129:   RETURN
130: ENDIF
131: C SAVE THE PREDICTED MINIMUM
132: B(2,1)=OTEMP(J1)
133: X2(2)=X1(J1)
134: C WHAT IS X2(3)????
135: C FIND CLOSEST VALUES OF X1 TO X2(IFLG)
136: DIF1=100000.
137: DIF2=100000.
138: DO 400 N=1,J1
139:   DIF=ABS(X1(N)-X2(IFLG))
140: C LEFT HAND SIDE
141: IF (X1(N).GE.X2(IFLG)) GOTO 410
142: DIF1=AMIN1(DIF1,DIF)
143: IF (DIF.EQ.DIF1) NLSAV=N
144: 410  CONTINUE
145: C RIGHT HAND SIDE
146: IF (X1(N).LE.X2(IFLG)) GOTO 400
147: DIF2=AMIN1(DIF2,DIF)
148: IF (DIF.EQ.DIF2) NRSAY=N
149: 400  CONTINUE
150: C FIND X2(3)
151: IF (X2(JFLG).EQ.X1(NLSAV)) THEN
152:   X2(3)=X1(NRSAY)

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133:      B(3,1)=0FTEMP(NRSAV)
134:      ELSE
135:      X2(3)=X1(NLSAV)
136:      B(3,1)=0FTEMP(NLSAV)
137:      ENDIF
138: C
139: C FIND THE COEFFICIENTS OF THE PARABOLA
140:      DO 500 N=1,3
141:      DO 500 M1=2,0,-1
142:      IF (M1.EQ.0.AND.X2(N).EQ.0.0) THEN
143:      A(N,3-M1)=1.0
144:      ELSE
145:      A(N,3-M1)=X2(N)**M1
146:      ENDIF
147: 500 CONTINUE
148:      CALL SOLVER(A,B,IER)
149:      IF (IER.NE.0) THEN
150:      WRITE(6,1010)IER
151:      STOP
152:      ENDIF
153: 300 CONTINUE
154:      STOP
155:      END
156:
157:      SUBROUTINE SOLVER(A,B,IER)
158: C FILENAME: SOLVER.FOR
159: C*****
160: C I. HISTORY
161: C      AUTHOR - H. L. WEGLEY
162: C      DATE - OCTOBER 29, 1985
163: C      INSPECTED -
164: C      DATE -
165: C      REVISED -
166: C      DATE -
167: C*****
168: C II. FUNCTION PERFORMED
169: C SOLVES THE FOLLOWING SYSTEM OF EQUATIONS:
170: C      A*X=B
171: C      WHERE:
172: C      A= 3 BY 3 MATRIX OF THE FORM
173: C      | X1**2 X1 1 |
174: C      | X2**2 X2 1 |
175: C      | X3**2 X3 1 |
176: C
177: C      X= 3 BY 1 VECTOR OF COEFFICIENTS (A,B,C) OF THE QUADRATIC
178: C      EQUATION OF THE FORM:
179: C      A*X**2+B*X+C=1=F(X)
180: C
181: C      B= 3 BY 1 VECTOR OF FUNCTION VALUES [F(X1),F(X2),F(X3)]
182: C
183: C INVERSION OF THE MATRIX IS PERFORMED USING CRAMER'S RULE.
184: C THE VALUES OF X ARE RETURNED IN THE B VECTOR.
185: C*****
186: C III. MODULE ENVIRONMENT
187: C      VAX 11/780 VMS 4.1
188: C      BATTELLE PACIFIC NORTHWEST LABORATORIES
189: C      RICHLAND, WA 99352
190: C
191: C
192: C*****
193: C IV. INCLUDES
194: C NONE
195: C*****
196: C V. SUBROUTINE FORMAL PARAMETERS
197: C      DIMENSION A(3,3) !INDEPENDENT VARIABLES OF QUADRATIC
198: C      DIMENSION B(3,1) !ON ENTRY CONTAINS THE DEPENDENT
199: C      ! VARIABLES (I.E. THE FUNCTION
200: C      !VALUES), ON RETURN CONTAINS THE

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281: C          !COEFFICIENTS OF A PARABOLA THROUGH THE
282: C          !POINTS A(1,2),B(1,1);A(2,2),B(2,1) AND
283: C          !A(3,2),B(3,1).
284: C          INTEGER IER !IER=1 IF MATRIX IS SINGULAR ELSE IER=0.
285: C*****
286: C VI. INTERNAL VARIABLES
287: C REAL DETA !DETERMINANT OF THE A MATRIX
288: C REAL EPSILON !MINIMUM ALLOWABLE VALUE FOR DETERMINANT
289: C REAL A1,A2,A3 !1ST COLUMN OF A INVERSE
290: C REAL B1,B2,B3 !2ND COLUMN OF A INVERSE
291: C REAL C1,C2,C3 !3RD COLUMN OF A INVERSE
292: C REAL AA,BB,CC !COEFFICIENTS OF THE PARABOLA OF THE
293: C          !FORM:
294: C          ! AA*X**2+BB*X+CC=F(X)
295: C          INTEGER I,J          !USED AS INDICES
296: C*****
297: C VII. DATA STATEMENTS
298: C DATA EPSILON /0.000001/
299: C*****
300: C VIII. PROGRAM STATEMENTS
301: C CALCULATE THE DETERMINANT OF MATRIX A
302: C DETA=A(1,1)*A(2,2)*A(3,3)+A(1,2)*A(2,3)*A(3,1)+
303: C      1 A(1,3)*A(2,2)*A(3,1)-A(1,3)*A(2,2)*A(3,1)
304: C      2 -A(2,3)*A(3,2)*A(1,1)-A(3,3)*A(2,1)*A(1,2)
305: C IF (ABS(DETA).LE.EPSILON) THEN
306: C   THE MATRIX IS SINGULAR
307: C   WRITE(12,901)DETA
308: C   IER=1
309: C   GO TO 999
310: C ELSE
311: C   CONTINUE
312: C END IF
313: C
314: C INVERT MATRIX "A" USING CRAMER'S RULE
315: C A1=(A(2,2)*A(3,3)-A(3,2)*A(2,3))/DETA
316: C A2=(A(3,1)*A(2,3)-A(2,1)*A(3,3))/DETA
317: C A3=(A(2,1)*A(3,2)-A(3,1)*A(2,2))/DETA
318: C B1=(A(3,2)*A(1,3)-A(1,2)*A(3,3))/DETA
319: C B2=(A(1,1)*A(3,3)-A(3,1)*A(1,3))/DETA
320: C B3=(A(3,1)*A(1,2)-A(1,1)*A(3,2))/DETA
321: C C1=(A(1,2)*A(2,3)-A(2,2)*A(1,3))/DETA
322: C C2=(A(2,1)*A(1,3)-A(1,1)*A(2,3))/DETA
323: C C3=(A(1,1)*A(2,2)-A(2,1)*A(1,2))/DETA
324: C
325: C MULTIPLY INVERTED MATRIX [WHOSE COLUMN ELEMENTS ARE CONTAINED
326: C IN A1,A2,A3 (COLUMN1), B1,B2,B3 (COLUMN2) AND C1,C2,C3 (COLUMN3)]
327: C BY B, THE VECTOR OF FUNCTION VALUES, TO OBTAIN THE COEFFICIENTS
328: C OF THE PARABOLA, AA BB & CC, THROUGH THE THREE POINTS.
329: C AA=A1*B(1,1)+B1*B(2,1)+C1*B(3,1)
330: C BB=A2*B(1,1)+B2*B(2,1)+C2*B(3,1)
331: C CC=A3*B(1,1)+B3*B(2,1)+C3*B(3,1)
332: C
333: C DEBUG PRINTOUT
334: C WRITE(12,900)((A(I,J),J=1,3),I=1,3)
335: C WRITE(12,901)DETA
336: C WRITE(12,902)A1,A2,A3,B1,B2,B3,C1,C2,C3
337: C WRITE(12,903)AA,BB,CC
338: C ASSIGN THE COEFFICIENTS OF THE PARABOLA TO THE VECTOR B BEFORE
339: C RETURNING.
340: C B(1,1)=AA
341: C B(2,1)=BB
342: C B(3,1)=CC
343: C
344: C FIND THE MINIMUM POINT OF THE PARABOLA
345: C XMIN=(-BB)/(2*AA)
346: C WRITE(12,904)XMIN
347: C
348: C*****

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269: C IX.  FORMAT STATEMENTS
270: C900  FORMAT(1X,' THE ORIGINAL A MATRIX IS:',3(/1X,3F10.4))
271: C901  FORMAT(1X,/' THE DETERMINANT OF A IS:'F15.6//)
272: C902  FORMAT(1X,' THE INVERTED A MATRIX IS:',3(/1X,3F15.5)//)
273: C903  FORMAT(1X,' THE COEFFICIENTS OF THE PARABOLA ARE:',/' AA=',
274: C      → F14.4,/' BB=',F14.4,/' CC=',F14.4)
275: C904  FORMAT(1X,'THE MINIMUM POINT OF THE PARABOLA = ',F14.4)
276: C*****
277: 999  RETURN
278:      END

```

FILE: OF.FOR

```

1:  FUNCTION OF(TV)
2:  C FINDS THE OBJECTIVE FUNCTION AS A FUNCTION OF THE
3:  C STABILITY 'TV'
4:      INCLUDE 'COMMONJ.INC'
5:      COMMON/SQUARE/V1(20),H0(20)
6:      COMMON/JIM/ICOUNT,XVAR(2)
7:      COMMON/PARAMS/PARAM(3),IVAR(3),STEP(3)
8:      COMMON/GOOD/RMSE_MIN(100),TAU_MIN(100),DIR_MIN(100),SCALE(100),
9:      1 JTER
10:  DIMENSION SPEED(20)
11:  DATA ISTRT/1/
12:  C INCRMENT JTER, THE ITERATION COUNTER
13:  JTER=JTER+1
14:  C INITIALIZE F, THE OBJECTIVE FUNCTION
15:  F=0.0
16:  C
17:  C CALCULATE ALFA2 BASED ON THE CURRENT TV
18:  ALFA2=1.0/SQRT(2.0+TV)
19:  C CALL CNWAD TO SOLVE THE SYSTEM OF EQUATIONS USING SOR
20:  CALL CNWAD
21:  IF(ITLDR.EQ.1)CALL TAYLOR(ISTRT)
22:  ISTRT=2
23:  C
24:      DO 100 N=1,NSTAT
25:          CALL LINTERP(N,H0(N),UC,VC)
26:  100  SPEED(N)=SQRT(UC*UC+VC*VC)
27:  C FIND THE RATIO OBJECTIVE FUNCTION
28:      DO 200 N=2,NSTAT
29:  200  F=F+(SPEED(N)/SPEED(1)-V1(N)/V1(1))**2
30:      F=SQRT(F/FLCAT(NSTAT))
31:  C FIND THE SCALE FACTOR
32:  SCALE(JTER)=V1(1)/SPEED(1)
33:  WRITE(6,1000)
34:  1000  FORMAT('      N,      R-CALC,      R-OBS,      SP-CALC, '
35:  +, '      SP-OBS,      HEIGHT AGL')
36:      DO 300 N=1,NSTAT
37:  300  WRITE(6,1040)N,SPEED(N)/SPEED(1),V1(N)/V1(1),
38:  +  SPEED(N)*SCALE(JTER),V1(N),H0(N)
39:  1040  FORMAT(I6,5(1X,F10.4))
40:  300  CONTINUE
41:  OF=F
42:  WDR1=PARAM(1)+XVAR(1)*STEP(1)
43:  WRITE(6,1070)WDR1,BETA,TV,OF,ICOUNT
44:  1070  FORMAT(' WDR = ',F8.2,' BETA = ',F8.4,' TV = ',F15.4,' OF = ',
45:  +  E12.5,' ICOUNT = ',I6)
46:  WRITE(6,1090)SCALE(JTER)
47:  1090  FORMAT(' LINEAR SCALE FACTOR = ',F10.5)
48:  C
49:  RMSE_MIN(JTER)=OF
50:  TAU_MIN(JTER)=TV
51:  DIR_MIN(JTER)=WDR1
52:  RETURN
53:  END

```

FILE: OF1.FOR

```

1:  FUNCTION OF1(X1,IVAR,TVSAVE)
2:  C THIS FUNCTION RETURNS THE OBJECTIVE FUNCTION FOR A GIVEN VALUE
3:  C THE WIND DIRECTION (IVAR=1)
4:      INCLUDE 'COMMONJ.INC'
5:      COMMON/PARAMS/PARAM(3),JVAR(3),STEP(3)
6:      COMMON/SQUARE/V1(20),H0(20)
7:  C INCREMENT THE WIND DIRECTION ONE STEP
8:      IF(IVAR.EQ.1)THEN
9:          DO 10 N=1,NPTS
10: 10      WDR(N)=PARAM(1)+X1*STEP(1)
11:          END IF
12:  C
13:  C INITIALIZE THE GRID WITH THE NEW WIND DIRECTION
14:      CALL OGSWIND
15:  C BACK CALCULATE TV
16:      TV=1./(2.*ALFA2+ALFA2)
17:  C IF OPTIMIZING ON THE STABILITY ALSO, THEN
18:      IF(JVAR(3).NE.0)THEN
19:  C ENTER THE "INNER" OPTIMIZATION LOOP, OPTIMALLY ADJUSTING TV, THE
20:  C STABILITY PARAMETER
21:          CALL STABRWIND(STEP(3),TV,OF1)
22:          OF1=OFI
23:      ELSE
24:          OF1=OF(TV)
25:      ENDIF
26:  C      TVSAVE=TV
27:      RETURN
28:      END

```

FILE: STABR.FOR

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1:      SUBROUTINE STABRMIN(STEP,TV,OFI)
2:      C MINIMIZES THE OBJECTIVE FUNCTION AS A FUNCTION OF THE
3:      C STABILITY 'TV'
4:      C NOTE:: THIS IS A RELATIVELY UNSOPHISTICATED MINIMIZATION
5:      C PROCEDURE INVOLVING REPETITIVE FITTING OF PARABOLAS UNTIL
6:      C THE PARABOLIC FIT PROVIDES AN ESTIMATE OF THE MINIMUM OF
7:      C THE OBJECTIVE FUNCTION THAT IS WITHIN THE TOLERANCE, ERROR(IVAR),
8:      C SPECIFIED FOR TV.
9:      INCLUDE 'COMMONJ.INC'
10:     COMMON/JIM/ICOUNT,XVAR(2)
11:     COMMON/SLEAZ/ERROR(3)
12:     DIMENSION OFTEMP(100),X1(100),A(3,3),B(3,1),WK(10)
13:     DIMENSION X2(3)
14:     C STATEMENT FUNCTION
15:     TVF(X)=10.0**X
16:     C
17:     X1(1)=ALOG10(TV)
18:     C MAKE TWO FUNCTION EVALUATIONS TO DETERMINE THE PROPER
19:     C DIRECTION TO STEP IN THE OPTIMIZATION PROCESS
20:     OFTEMP(1)=OF(TV)
21:     X1(2)=X1(1)+STEP
22:     OFTEMP(2)=OF(TVF(X1(2)))
23:     IF (OFTEMP(2).GT.OFTEMP(1)) THEN
24:         IDIR=-1
25:         X1TEMP=X1(1)
26:         OFTEMP1=OFTEMP(1)
27:         X1(1)=X1(2)
28:         OFTEMP(1)=OFTEMP(2)
29:         X1(2)=X1TEMP
30:         OFTEMP(2)=OFTEMP1
31:     ELSE
32:         IDIR=1
33:     ENDIF
34:     C
35:     C SAVE THE INDEX FOR THE SMALLEST FUNCTION EVALUATION
36:     JSAY=1
37:     OFMIN=AMIN1(OFTEMP(1),OFTEMP(2))
38:     IF (OFMIN.EQ.OFTEMP(2)) JSAY=2
39:     C
40:     C LOOP TO FIND APPROXIMATE MINIMUM
41:     DO 100 J1=3,100
42:         J2=J1+1
43:         X1(J1)=X1(J1-1)+IDIR*STEP
44:         OFTEMP(J1)=OF(TVF(X1(J1)))
45:         OFMIN=AMIN1(OFMIN,OFTEMP(J1))
46:         IF (OFMIN.EQ.OFTEMP(J1)) JSAY=J1
47:     C REFINE INITIAL ESTIMATE USING A PARABOLA
48:     IF (OFTEMP(J1).GT.OFTEMP(J1-1)) THEN
49:     C FIND THE COEFFICIENTS OF THE PARABOLA
50:     C SET UP THE 'A' MATRIX AND THE 'B' VECTOR DESCRIBED
51:     C IN SUBROUTINE SOLVER
52:     DO 10 N=1,3
53:         B(N,1)=OFTEMP(J1-3+N)
54:     DO 10 M1=2,0,-1
55:         M2=3-M1
56:         A(N,M2)=X1(J1-3+N)**M1
57:     C OBTAIN THE COEFFICIENTS OF THE PARABOLA USING SOLVER
58:     CALL SOLVER(A,B,IER)
59:     IF (IER.NE.0) THEN
60:         WRITE(6,1010) IER
61:     1010    FORMAT(' IER = ',I5,' MATRIX IS SINGULAR, STOP')
62:         STOP
63:     ENDIF

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64:      GOTO 200
65:      ENDIF
66: 100   CONTINUE
67:      STOP
68: 200   CONTINUE
69: C MORE REFINEMENTS USING THE PARABOLA
70:      DO 300 J1=J2,100
71:          IFLG=1
72:          JFLG=2
73: C ESTIMATE THE MINIMUM
74:          X1(J1)=-B(2,1)/(2.*B(1,1))
75:          TVMIN=10.*X1(J1)
76:          OFTEMP(J1)=OF(TVF(X1(J1)))
77: C SAVE THE OLD MINIMUM
78:          B(1,1)=OFMIN
79:          X2(1)=X1(JSAY)
80: C IS THE ESTIMATED MINIMUM A NEW MINIMUM?
81:          OFMIN=AMIN1(OTEMP(J1),OFMIN)
82:          IF(OFMIN.EQ.OTEMP(J1))THEN
83:              JSAY=J1
84:              IFLG=2
85:              JFLG=1
86:          ENDIF
87: C DO WE STOP????
88:          IF(ERROR(3).LT.0.0.AND.J1.GT.J2)GOTO 600
89: C ABSOLUTE ERROR
90:          IF(ABS(X2(1)-X1(J1)).LT.ERROR(3))THEN
91: 800   CONTINUE
92: C
93: C CALCULATE THE OPTIMAL TV AND SAVE THE OBJ. FUNCT. FOR OUTPUT
94:          TV=10.*X1(JSAY)
95:          OFI=OTEMP(JSAY)
96:          RETURN
97:      ENDIF
98: C SAVE THE PREDICTED MINIMUM
99:          B(2,1)=OTEMP(J1)
100:         X2(2)=X1(J1)
101: C FIND CLOSEST VALUES OF X1 TO X2(IFLG)
102:         DIF1=100000.
103:         DIF2=100000.
104:         DO 400 N=1,J1
105:             DIF=ABS(X1(N)-X2(IFLG))
106: C LEFT HAND SIDE
107:             IF(X1(N).GE.X2(IFLG))GOTO 410
108:             DIF1=AMIN1(DIF1,DIF)
109:             IF(DIF.EQ.DIF1)NLSAV=N
110: 410   CONTINUE
111: C RIGHT HAND SIDE
112:             IF(X1(N).LE.X2(IFLG))GOTO 400
113:             DIF2=AMIN1(DIF2,DIF)
114:             IF(DIF.EQ.DIF2)NRSAV=N
115: 400   CONTINUE
116: C FIND X2(3)
117:             IF(X2(JFLG).EQ.X1(NLSAV))THEN
118:                 X2(3)=X1(NRSAV)
119:                 B(3,1)=OTEMP(NRSAV)
120:             ELSE
121:                 X2(3)=X1(NLSAV)
122:                 B(3,1)=OTEMP(NLSAV)
123:             ENDIF
124: C
125: C FIND THE COEFFICIENTS OF THE PARABOLA
126:         DO 500 N=1,3
127:             DO 500 M1=2,0,-1
128:                 A(N,3-M1)=X2(N)**M1
129: 500   CONTINUE
130:         CALL SOLVER(A,B,IER)
131:         IF(IER.NE.0)THEN

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132:      WRITE(6,1010)IER
133:      STOP
134:      ENDIF
135: 300  CONTINUE
136:      STOP
137:      END
```


APPENDIX C

TERRAIN DATA FOR MODEL TEST CASE

APPENDIX C

TERRAIN DATA FOR MODEL TEST CASE

This appendix provides a listing of the terrain data used for the test case. These data are the heights above sea level (in meters) for each point of the 40 by 40 grid used for the test case. The first terrain elevation that is read by the code, in this case 181.30 m, corresponds to the lower left-hand corner of the modeling grid. The terrain data is in 8F10.2 format.

Figure 3.1 is a contour plot of these data.

181.30	195.07	190.84	176.78	174.68	183.45	185.19	181.00
168.80	160.09	150.82	149.92	180.88	164.59	161.06	160.83
170.69	170.89	192.22	200.35	218.04	214.05	200.20	197.51
192.59	182.88	172.03	162.84	158.81	155.82	154.14	153.17
146.30	138.56	128.91	142.49	152.90	150.81	150.88	153.38
178.78	184.57	186.83	173.21	183.65	175.77	177.78	171.70
167.18	180.88	149.87	155.45	164.01	159.51	152.40	160.32
167.33	188.67	179.83	198.12	210.44	207.26	198.81	190.33
178.38	171.44	168.25	165.12	157.11	147.95	138.88	140.21
138.22	128.02	121.92	135.64	144.59	147.78	143.43	141.16
165.78	170.69	178.13	173.21	161.34	166.79	170.69	167.10
164.59	165.42	158.50	145.42	163.58	151.45	148.09	158.50
183.23	182.29	165.75	179.31	199.58	199.90	189.89	181.00
168.86	162.96	170.69	169.53	160.32	149.63	138.32	129.34
124.97	124.25	121.38	121.09	124.45	136.80	135.54	128.75
149.81	152.40	164.59	168.00	160.02	155.45	163.32	159.82
159.98	168.55	164.59	152.48	143.31	142.10	143.41	150.20
150.29	168.88	161.74	163.80	182.88	181.42	176.78	179.89
174.14	162.64	160.09	164.59	156.92	144.42	127.22	128.02
129.74	131.08	126.23	121.92	118.19	121.92	128.06	120.16
158.80	146.18	151.08	158.81	155.16	149.85	153.99	151.29
155.70	161.91	159.72	155.13	147.83	140.88	139.92	143.81
148.30	153.51	155.82	157.39	183.59	183.59	169.67	175.07
172.21	161.54	146.64	155.38	146.30	134.11	129.34	138.31
136.88	137.28	132.45	127.17	124.49	117.97	115.82	113.30
183.32	149.87	144.01	142.82	143.26	143.70	143.38	143.24
147.65	147.77	146.30	145.30	143.55	140.02	137.86	138.63
141.33	145.72	147.04	149.98	149.40	146.30	156.16	161.08
158.98	149.00	138.88	141.40	132.52	130.86	140.21	143.28
143.21	139.79	134.11	134.11	134.11	128.02	125.53	125.20
168.40	157.48	145.70	142.87	140.21	139.71	139.17	138.63
138.10	137.55	137.16	137.16	137.16	137.16	137.29	137.16
137.79	137.99	138.46	140.21	136.10	134.11	141.67	141.67
140.21	132.59	131.30	131.02	131.23	134.11	138.39	138.92
142.78	142.73	137.56	137.47	135.90	134.47	134.58	131.06
168.77	158.39	144.93	145.25	145.69	146.30	141.67	139.94
139.61	142.09	139.94	137.98	139.17	137.92	137.50	137.16
137.21	136.72	137.84	139.27	140.21	140.21	139.06	139.25
139.38	143.43	148.84	147.85	147.32	150.84	150.54	145.08
137.47	139.00	138.98	137.84	137.28	136.19	135.18	134.32
160.24	150.20	146.13	155.24	155.05	160.09	158.36	148.19
146.30	153.27	148.02	141.93	144.46	144.84	144.97	148.30
146.30	144.10	146.30	157.17	163.13	168.08	166.06	164.59
183.40	162.02	160.12	157.59	159.41	161.90	158.50	149.35
140.21	136.05	136.00	138.64	138.88	134.75	131.67	128.78
155.79	149.75	158.50	165.20	182.23	165.93	160.90	151.37
163.95	155.76	146.30	149.10	153.91	153.91	158.50	163.40
163.00	154.43	150.98	172.57	185.41	187.23	186.98	184.57
175.87	167.17	161.38	181.06	182.94	184.59	157.38	149.85
142.53	135.75	134.11	137.46	140.21	137.28	133.16	128.02
150.75	161.26	172.01	173.49	170.02	167.24	162.05	154.08
158.77	154.43	151.73	158.58	168.06	169.50	176.78	180.52
175.77	169.13	182.07	161.42	197.92	201.17	199.70	188.98
176.78	168.18	158.50	155.19	159.88	157.73	153.08	148.51
144.13	137.53	132.43	133.07	135.14	136.62	132.45	129.83
155.81	168.48	178.87	179.60	173.74	168.85	160.02	159.60
161.29	159.98	183.88	170.69	181.16	187.51	193.96	199.28
195.07	184.22	172.15	188.98	201.17	201.17	198.76	183.99
173.54	162.56	158.30	152.40	150.98	151.84	149.49	145.97
141.54	137.85	133.48	130.38	133.41	135.30	133.29	130.88
165.78	168.00	180.30	182.88	173.74	164.59	163.94	164.02
164.59	189.77	176.74	187.51	199.84	207.26	214.36	214.23
202.17	185.93	183.67	193.73	201.17	198.81	187.36	177.62
168.51	160.25	156.88	152.81	148.99	145.32	144.65	143.44
139.98	136.63	133.17	129.66	127.72	130.83	131.29	130.90
175.99	166.51	177.54	181.23	173.74	170.89	172.21	171.09

172.57	184.76	201.17	207.26	217.88	226.57	227.88	217.99
206.00	195.90	193.11	197.10	195.76	188.98	179.83	171.56
165.57	160.89	156.64	152.40	148.87	144.93	140.74	138.57
137.10	136.67	135.18	131.36	126.44	127.25	127.67	127.56
181.61	170.59	175.48	176.82	174.26	176.78	177.22	177.65
179.31	199.14	214.18	226.47	233.20	236.89	235.71	225.55
214.38	203.78	201.57	199.51	196.23	188.98	180.82	174.54
170.89	164.59	159.34	153.25	147.49	143.82	141.52	137.44
133.47	134.11	132.60	131.03	128.47	125.43	125.79	128.04
183.64	176.78	160.04	160.47	179.66	182.88	184.63	187.09
190.17	202.39	218.59	232.41	243.10	243.84	240.18	229.56
220.05	208.48	204.68	201.50	195.07	188.98	184.33	179.96
175.84	168.97	161.54	154.84	149.01	143.90	139.34	136.79
134.93	130.86	128.93	129.95	126.88	125.03	123.92	128.18
184.91	184.09	186.84	187.83	188.08	188.98	192.93	203.20
211.37	209.79	220.72	232.26	239.00	241.70	238.26	229.39
219.46	207.92	202.99	196.98	190.13	184.15	182.30	179.18
174.00	168.44	161.98	154.81	149.24	143.74	139.19	135.13
134.11	131.06	127.12	126.89	125.65	123.06	122.20	124.74
192.83	195.93	197.52	200.21	201.17	201.17	207.26	219.46
222.89	215.69	217.93	224.54	227.24	229.78	228.68	222.26
213.36	202.08	193.98	186.88	181.73	177.34	171.52	171.28
165.94	163.25	159.20	153.10	147.81	142.10	138.59	136.34
134.11	129.26	126.10	123.61	122.41	121.07	120.59	123.31
204.90	209.26	209.15	216.93	221.17	221.01	227.14	231.65
221.31	211.58	210.02	212.15	213.36	218.49	216.21	212.62
208.50	198.43	186.25	178.78	171.90	169.48	163.08	160.38
158.50	154.49	152.90	149.50	145.11	139.30	136.76	134.63
133.76	130.15	126.33	123.14	119.69	118.67	121.92	121.55
218.44	217.87	219.48	230.46	236.55	240.11	237.74	226.88
214.82	205.81	199.04	200.41	204.25	205.55	203.74	204.23
205.31	201.17	192.02	181.02	170.07	161.69	157.64	152.40
150.35	148.52	147.36	144.94	142.08	137.85	134.72	131.90
129.94	128.97	126.15	123.83	119.09	117.14	121.92	120.51
232.99	233.11	236.42	245.72	248.67	237.74	227.88	218.30
209.47	199.29	193.68	190.63	193.85	195.07	192.32	199.70
207.26	204.54	194.31	181.14	170.18	162.05	154.57	149.63
145.79	142.37	140.63	142.06	141.08	138.22	135.68	132.23
129.10	125.87	124.41	121.92	117.65	115.82	121.92	118.78
243.84	249.94	254.61	247.75	242.82	233.47	222.56	213.38
208.31	203.20	199.55	195.07	187.57	181.62	182.88	191.01
204.62	203.09	194.20	182.09	173.61	166.52	159.17	153.27
147.91	143.26	138.63	135.54	135.74	136.76	134.96	131.30
128.02	125.84	123.07	119.79	117.57	114.12	117.71	120.22
241.81	247.60	245.18	240.51	235.71	228.64	219.48	216.19
213.84	210.14	206.04	199.90	189.85	180.54	173.33	161.69
195.99	198.27	193.87	185.93	177.80	169.38	161.82	154.69
149.59	145.36	140.78	135.47	130.75	129.54	131.91	130.45
125.72	124.45	121.92	121.74	121.39	115.82	118.35	121.92
228.11	233.64	234.22	231.65	229.46	228.88	224.88	222.38
219.70	213.77	204.59	196.34	184.91	176.78	170.13	172.72
187.09	190.94	189.40	185.02	177.86	167.53	159.11	153.26
147.22	142.62	138.99	136.47	133.07	128.02	125.56	125.14
122.38	123.15	119.58	121.92	121.92	116.23	112.60	121.92
217.90	218.58	220.29	226.57	236.40	235.03	229.00	222.25
219.46	206.56	197.79	188.22	179.68	171.88	163.73	165.71
175.67	178.25	176.78	178.28	173.06	163.88	155.89	150.79
147.32	141.02	136.79	132.78	131.29	128.37	124.04	120.38
118.80	118.83	115.56	116.92	117.89	118.37	112.17	112.78
215.76	205.88	212.50	226.34	235.24	232.74	227.44	216.93
207.26	198.81	188.96	180.79	174.40	168.09	161.54	156.29
156.86	159.96	162.87	171.29	166.79	158.50	151.64	145.45
143.86	140.65	136.18	131.79	127.21	125.73	123.20	120.10
118.29	116.36	114.11	112.06	112.06	112.37	116.47	109.73
210.11	202.91	201.17	220.46	229.19	224.60	224.36	217.28
208.59	196.79	188.98	180.98	177.25	170.69	166.53	162.58
157.74	148.89	153.32	162.34	161.38	153.92	149.04	143.05
137.57	137.61	135.07	130.60	126.40	121.62	119.28	123.02

123.42	122.55	120.38	117.15	113.94	109.73	109.45	109.07
199.14	202.60	193.23	209.60	218.13	215.96	215.09	216.18
210.75	199.82	193.01	186.42	178.98	172.78	168.67	162.23
158.50	150.37	141.90	152.40	155.74	149.76	143.20	140.21
133.51	131.02	129.86	126.83	121.92	118.87	122.94	127.34
125.51	124.26	122.42	119.24	116.75	113.03	109.43	106.91
186.62	196.55	184.75	196.66	207.26	204.74	202.38	208.92
207.79	200.34	194.60	186.27	178.78	168.47	160.87	154.79
148.46	147.07	139.10	138.86	144.27	143.58	136.04	134.11
132.15	128.38	124.15	120.97	117.45	120.88	127.28	128.74
128.03	123.33	121.57	118.81	115.29	110.60	108.99	108.48
185.68	182.88	177.61	181.72	187.79	188.98	193.35	198.78
191.34	192.71	191.58	184.47	174.46	168.21	157.88	149.77
142.32	139.32	136.37	131.87	133.68	135.20	130.91	126.28
127.84	125.77	121.92	116.34	114.55	122.36	128.44	128.02
124.58	121.35	118.57	116.18	113.42	112.11	108.41	107.38
201.17	193.48	185.93	176.78	170.89	174.42	177.97	185.45
178.67	182.88	183.97	175.67	171.21	162.20	154.60	147.38
141.58	136.25	132.53	128.02	126.68	127.31	123.36	120.65
119.51	116.82	115.59	113.68	113.72	121.92	126.40	125.38
122.79	120.03	117.98	115.49	110.41	108.04	105.65	104.22
222.50	215.72	205.67	193.96	182.88	168.16	182.80	184.59
186.48	188.18	171.35	166.55	165.09	158.50	150.15	144.75
139.06	135.52	130.58	126.54	123.58	121.12	119.00	117.95
115.25	114.23	111.88	110.68	112.49	119.70	124.92	123.68
120.18	118.08	115.82	116.84	115.82	113.22	110.84	108.51
237.74	226.74	211.00	199.43	185.41	177.90	173.68	164.59
154.73	152.40	154.97	154.93	154.88	150.88	145.21	141.05
138.40	131.85	128.36	126.11	126.97	126.57	125.53	123.50
120.07	116.98	114.01	111.19	108.50	116.89	123.54	124.79
120.21	118.40	113.92	114.45	117.83	121.01	119.35	112.76
234.89	219.46	207.26	201.17	198.81	192.02	185.04	174.83
166.02	157.58	151.02	148.32	146.78	145.08	140.00	137.71
133.77	130.77	132.39	136.99	141.07	140.21	138.88	131.50
127.02	122.98	117.58	115.38	109.73	109.73	120.73	123.20
121.92	118.59	111.98	113.96	120.61	126.58	124.97	118.67
239.46	232.52	224.03	214.80	204.42	193.72	183.99	176.22
168.13	161.43	155.77	151.06	145.54	140.06	137.68	135.67
133.20	136.45	144.58	149.87	150.94	147.26	139.83	134.11
129.96	125.12	120.59	118.42	110.18	106.92	110.55	120.38
120.77	114.12	109.61	115.62	124.13	128.67	127.28	122.24
235.94	231.65	224.52	215.65	203.88	193.19	184.54	176.22
168.08	161.81	156.44	151.65	146.30	140.57	137.90	136.64
139.66	143.18	150.52	152.40	151.29	144.90	137.75	132.05
127.77	125.08	122.38	118.12	114.25	109.06	108.14	114.13
115.36	110.18	108.24	117.18	125.40	129.54	126.87	120.70
225.55	221.34	216.61	212.21	203.89	193.54	184.71	174.96
167.26	161.16	155.18	149.86	144.37	142.13	145.64	149.31
148.02	145.04	147.28	148.61	144.84	139.05	134.50	129.37
125.33	122.98	122.28	119.19	115.82	108.42	103.63	106.93
108.97	106.18	112.05	121.09	128.11	128.71	125.22	120.32
216.88	208.91	203.34	199.31	194.06	188.98	182.88	174.01
168.82	160.85	154.85	148.87	144.97	148.11	153.49	154.88
147.20	139.75	140.21	141.99	138.74	133.84	130.81	126.97
124.47	120.80	119.88	117.62	115.82	110.99	104.39	101.87
103.33	103.63	114.47	123.09	128.02	126.51	123.55	119.48
214.35	206.57	196.80	188.98	182.88	180.35	178.93	172.71
165.90	159.85	154.38	149.63	140.18	154.33	158.50	153.51
143.14	135.68	135.28	135.97	134.75	132.03	128.58	124.90
122.38	119.94	116.99	119.12	118.28	116.97	111.08	101.73
101.18	104.42	115.82	123.02	122.71	124.06	120.11	115.82
207.98	204.08	196.50	189.41	181.19	171.45	170.08	168.54
163.13	158.50	154.28	151.79	154.49	158.50	158.50	149.18
140.21	133.23	130.31	129.38	130.03	128.78	126.69	123.70
120.60	117.81	115.82	115.82	117.05	118.50	113.39	105.10
98.73	103.63	117.97	123.77	117.47	120.66	118.14	113.98

APPENDIX D

LISTING OF THE OBJECTIVE FUNCTION AS
A FUNCTION OF ITERATION NUMBER

APPENDIX D

LISTING OF THE OBJECTIVE FUNCTION AS A FUNCTION OF ITERATION NUMBER

When the switch on the last line of the input file is set equal to "1", the model is operated in a special mode whose purpose is to find how the objective function varies with iteration number in the subroutine CNWAD. This appendix contains a listing of the objective function and iteration number obtained using the input data of Figure 3.2 (with the appropriate switch set to 1). The first 50 values of the objective function are plotted in Figure 3.5 as the curve associated with $\text{LOG}(\text{TV})=0.0$.

ITERATION	OBJECTIVE FUNCTION	DIRECTION	LOG10(TAU)
1	0.138502	240.0	0.0000
2	0.092432	240.0	0.0000
3	0.083393	240.0	0.0000
4	0.072410	240.0	0.0000
5	0.075418	240.0	0.0000
6	0.071931	240.0	0.0000
7	0.070429	240.0	0.0000
8	0.065585	240.0	0.0000
9	0.064254	240.0	0.0000
10	0.062065	240.0	0.0000
11	0.061593	240.0	0.0000
12	0.059904	240.0	0.0000
13	0.057842	240.0	0.0000
14	0.057404	240.0	0.0000
15	0.057985	240.0	0.0000
16	0.057529	240.0	0.0000
17	0.057854	240.0	0.0000
18	0.056548	240.0	0.0000
19	0.055999	240.0	0.0000
20	0.054954	240.0	0.0000
21	0.054801	240.0	0.0000
22	0.054388	240.0	0.0000
23	0.053328	240.0	0.0000
24	0.052788	240.0	0.0000
25	0.052293	240.0	0.0000
26	0.052289	240.0	0.0000
27	0.052920	240.0	0.0000
28	0.052908	240.0	0.0000
29	0.052604	240.0	0.0000
30	0.052391	240.0	0.0000
31	0.052108	240.0	0.0000
32	0.051779	240.0	0.0000
33	0.052044	240.0	0.0000
34	0.052213	240.0	0.0000
35	0.052045	240.0	0.0000
36	0.052062	240.0	0.0000
37	0.052099	240.0	0.0000
38	0.052172	240.0	0.0000
39	0.052243	240.0	0.0000
40	0.052290	240.0	0.0000
41	0.052274	240.0	0.0000
42	0.052207	240.0	0.0000
43	0.052173	240.0	0.0000
44	0.052200	240.0	0.0000
45	0.052232	240.0	0.0000
46	0.052260	240.0	0.0000
47	0.052285	240.0	0.0000
48	0.052210	240.0	0.0000
49	0.052199	240.0	0.0000
50	0.052212	240.0	0.0000
51	0.052210	240.0	0.0000
52	0.052204	240.0	0.0000
53	0.052184	240.0	0.0000
54	0.052180	240.0	0.0000
55	0.052178	240.0	0.0000
56	0.052180	240.0	0.0000
57	0.052189	240.0	0.0000
58	0.052183	240.0	0.0000
59	0.052182	240.0	0.0000
60	0.052180	240.0	0.0000
61	0.052180	240.0	0.0000
62	0.052183	240.0	0.0000
63	0.052182	240.0	0.0000
64	0.052183	240.0	0.0000
65	0.052182	240.0	0.0000
66	0.052181	240.0	0.0000

67	0.052181	240.0	0.0000
68	0.052180	240.0	0.0000
69	0.052180	240.0	0.0000
70	0.052180	240.0	0.0000
71	0.052181	240.0	0.0000
72	0.052181	240.0	0.0000
73	0.052181	240.0	0.0000
74	0.052182	240.0	0.0000
75	0.052181	240.0	0.0000
76	0.052181	240.0	0.0000
77	0.052181	240.0	0.0000
78	0.052181	240.0	0.0000
79	0.052181	240.0	0.0000
80	0.052181	240.0	0.0000
81	0.052181	240.0	0.0000
82	0.052181	240.0	0.0000
83	0.052181	240.0	0.0000
84	0.052181	240.0	0.0000
85	0.052181	240.0	0.0000
86	0.052181	240.0	0.0000
87	0.052181	240.0	0.0000
88	0.052181	240.0	0.0000
89	0.052181	240.0	0.0000
90	0.052181	240.0	0.0000
91	0.052181	240.0	0.0000
92	0.052181	240.0	0.0000
93	0.052181	240.0	0.0000
94	0.052181	240.0	0.0000
95	0.052181	240.0	0.0000
96	0.052181	240.0	0.0000
97	0.052181	240.0	0.0000
98	0.052181	240.0	0.0000
99	0.052181	240.0	0.0000
100	0.052181	240.0	0.0000

APPENDIX E

PRINTED OUTPUT FOR THE TEST CASE

APPENDIX E

PRINTED OUTPUT FOR THE TEST CASE

This appendix provides the information written to logical unit 6 during a model run. The input data for the test case (Figure 3.2) was used to generate this output. The last lines of the output contain optimal values for TV and WDR and the minimum objective function.

TEST CASE OF NOABL WITH OPTIMIZATION ON 8 DATA LOCATIONS

INPUT VALUES TO PROGRAM BLANK COMMON

*DX \$8,50.0			
	6.000E+01	IN	DX
*DY \$7,50.0			
	5.000E+01	IN	DY
*IMAX \$14,40			
	40	IN	IMAX
*JMAX \$24,40			
	40	IN	JMAX
*DZMIN \$9,20.			
	2.000E+01	IN	DZMIN
*KMAX \$27,10			
	10	IN	KMAX
*ZDIST \$38,700.			
	7.000E+02	IN	ZDIST
*NSTAT \$291,8			
	8	IN	NSTAT
*XSTA \$292,1041.0,1135.73,1172.33,834.03,1013.03,1507.63,962.03,1562.43			
	1.041E+03	IN	XSTA(1)
	1.136E+03	IN	XSTA(2)
	1.172E+03	IN	XSTA(3)
	8.340E+02	IN	XSTA(4)
	1.014E+03	IN	XSTA(5)
	1.508E+03	IN	XSTA(6)
	9.620E+02	IN	XSTA(7)
	1.562E+03	IN	XSTA(8)
*YSTA \$317,598.0,533.64,811.04,1164.54,1350.54,1016.24,1682.74,1417.64			
	5.980E+02	IN	YSTA(1)
	5.336E+02	IN	YSTA(2)
	8.110E+02	IN	YSTA(3)
	1.165E+03	IN	YSTA(4)
	1.351E+03	IN	YSTA(5)
	1.016E+03	IN	YSTA(6)
	1.683E+03	IN	YSTA(7)
	1.418E+03	IN	YSTA(8)
*NPTS \$33,1			
	1	IN	NPTS
*X0 \$141,1041.0			
	1.041E+03	IN	X0 (1)
*Y0 \$191,598.0			
	5.980E+02	IN	Y0 (1)
*Z0 \$241,14.02			
	1.402E+01	IN	Z0 (1)

*WSPD \$91,18.3	1.830E+01	IN	WSPD(1)
*WDR \$41,240.0	2.400E+02	IN	WDR (1)
*ITMAX \$40,25	25	IN	ITMX
*ITERAN \$19,1	1	IN	ITRN
*ITYLOR \$20,1	1	IN	ITLR
*END OF DATA \$			

* BLANK FIELD INDICATES END OF DATA INPUT *

*** CALCULATION TO BE PERFORMED IN CONFORMAL (X,Y,S) SPACE ***

INPUT DATA

CARD INPUT DATA

PROBLEM PARAMETERS

ALFA1=	0.7071	ALFA2=	0.7071	BETA=	0.1429	CMVRSN=	1.0000	DEBUG=	0
DX=	50.0000	DY=	50.0000	DZ=	0.0000	DZMIN=	20.0000	EPSLN=	0.1000E+00
IDAY=	1	IEDIT=	0	IHOURL=	1	IMAX=	40	IMN=	1
IMX=	30	IPATH=	2	ISIG=	3	ITERAN=	1	ITYLOR=	1
IWIND=	1	IYEAR=	1	I2D=	0	JMAX=	40	JMN=	1
JMX=	30	KMAX=	10	KMN=	1	KMX=	15	MONTH=	1
MPS=	1	NDAYS=	1	NPTS=	1	OMEG=	1.8544	ORIGNX=	0.0000E+00
ORIGNY=	0.0000E+00	ORIGNZ=	0.0000E+00	ZDIST=	0.7000E+03	DMP=	0.0000	QTOP=	999.0000
ATOP=	0.0000	ZBL=	200.0000	NUA=	0	ITMAX=	25		

SURFACE OBSERVATION DATA

N	WS M/SEC	WD DEGREE	X0 METERS	Y0 METERS	Z0 METERS
1	18.30	240.00	0.104E+04	0.590E+03	0.140E+02

SIMULATED OUTPUT STATION LOCATIONS

STATION	UTMX METERS	UTMY METERS	STATION	UTMX METERS	UTMY METERS	STATION	UTMX METERS	UTMY METERS	STATION	UTMX METERS	UTMY METERS
1	1.0410E+03	5.9800E+02	2	1.1357E+03	5.3364E+02	3	1.1723E+03	8.1104E+02	4	0.3403E+02	1.1645E+03
5	1.0130E+03	1.3505E+03	8	1.5076E+03	1.0152E+03	7	9.6203E+02	1.6027E+03	0	1.5024E+03	1.4175E+03

TERRAIN DATA (METERS)

I	J	HEIGHT	I	J	HEIGHT	I	J	HEIGHT	I	J	HEIGHT	I	J	HEIGHT	I	J	HEIGHT
1	40	208.0	2	40	204.1	3	40	198.5	4	40	189.4	5	40	181.2	6	40	171.4
9	40	163.1	10	40	158.5	11	40	154.3	12	40	151.8	13	40	154.6	14	40	158.5
17	40	140.2	18	40	133.2	19	40	130.3	20	40	129.4	21	40	130.0	22	40	120.0
25	40	120.6	26	40	117.8	27	40	115.8	28	40	115.0	29	40	117.1	30	40	118.5
33	40	98.7	34	40	103.6	35	40	118.0	36	40	123.0	37	40	117.5	38	40	120.7
39	40		40	40													

1	39	214.4	2	39	208.8	3	39	198.6	4	39	189.0	5	39	182.9	6	39	180.4
9	39	185.9	10	39	159.9	11	39	154.4	12	39	149.6	13	39	149.2	14	39	154.3
17	39	143.1	18	39	135.9	19	39	135.3	20	39	136.0	21	39	134.0	22	39	132.0
25	39	122.4	26	39	119.9	27	39	117.0	28	39	119.1	29	39	118.3	30	39	117.0
33	39	101.2	34	39	104.4	35	39	115.8	36	39	123.0	37	39	122.7	38	39	124.1
39	39		40	39													

THE STATION WIND SPEEDS ARE :

18.3000 17.4000 13.4000 13.4000 11.6000
11.0000 12.5000 12.1000

THE HEIGHTS AGL (METERS) FOR EACH STATION ARE:

14.02 14.02 14.02 14.02 14.02 14.02 14.02 14.02

THE INITIAL PARAMETERS FOR DIRECTION AND TV = 0.2400E+03 0.1000E+01

IVAR (DIRECTION AND TV)= 1 1

THE STEP SIZES FOR DIRECTION AND LOG(TV) = 0.5000E+01 0.2000E+00

ABSOLUTE ERRORS FOR DIRECTION AND LOG(TV) = 0.5000E+00 0.5000E-01

MAXIMUM HEIGHT OF TERRAIN (METERS)= 254.610

MINIMUM HEIGHT OF TERRAIN (METERS)= 98.730

MESH PARAMETERS

LOCATION OF ORIGIN (METERS)

DRIGNX	ORIGNY	DRIGNZ
0.0000E+00	0.0000E+00	9.8730E+01

MESH SPACING (METERS)

DX	DY	DZMIN
50.00	50.00	20.00

EXPANSION FACTOR (GAMMA), FOR GEOMETRIC PROGRESSION= 1.28031709

X-ARRAY (METERS)

1	2.5000E+01	2	7.5000E+01	3	1.2500E+02	4	1.7500E+02
5	2.2500E+02	6	2.7500E+02	7	3.2500E+02	8	3.7500E+02
9	4.2500E+02	10	4.7500E+02	11	5.2500E+02	12	5.7500E+02
13	6.2500E+02	14	6.7500E+02	15	7.2500E+02	16	7.7500E+02
17	8.2500E+02	18	8.7500E+02	19	9.2500E+02	20	9.7500E+02
21	1.0250E+03	22	1.0750E+03	23	1.1250E+03	24	1.1750E+03
25	1.2250E+03	26	1.2750E+03	27	1.3250E+03	28	1.3750E+03
29	1.4250E+03	30	1.4750E+03	31	1.5250E+03	32	1.5750E+03
33	1.6250E+03	34	1.6750E+03	35	1.7250E+03	36	1.7750E+03
37	1.8250E+03	38	1.8750E+03	39	1.9250E+03	40	1.9750E+03

Y-ARRAY (METERS)

1	2.5000E+01	2	7.5000E+01	3	1.2500E+02	4	1.7500E+02
5	2.2500E+02	6	2.7500E+02	7	3.2500E+02	8	3.7500E+02
9	4.2500E+02	10	4.7500E+02	11	5.2500E+02	12	5.7500E+02
13	6.2500E+02	14	6.7500E+02	15	7.2500E+02	16	7.7500E+02
17	8.2500E+02	18	8.7500E+02	19	9.2500E+02	20	9.7500E+02
21	1.0250E+03	22	1.0750E+03	23	1.1250E+03	24	1.1750E+03
25	1.2250E+03	26	1.2750E+03	27	1.3250E+03	28	1.3750E+03
29	1.4250E+03	30	1.4750E+03	31	1.5250E+03	32	1.5750E+03
33	1.6250E+03	34	1.6750E+03	35	1.7250E+03	36	1.7750E+03
37	1.8250E+03	38	1.8750E+03	39	1.9250E+03	40	1.9750E+03

SIGMAF ARRAY

1	0.0000E+00	2	2.2922E-01	3	4.1109E-01	4	5.5540E-01
5	6.6990E-01	6	7.8075E-01	7	8.3284E-01	8	8.9004E-01
9	9.3542E-01	10	9.7143E-01	11	1.0000E+00		

DSIGMAF ARRAY

1	2.2922E-01	2	1.8187E-01	3	1.4431E-01	4	1.1450E-01
5	9.0851E-02	6	7.2086E-02	7	5.7197E-02	8	4.5383E-02
9	3.6009E-02	10	2.8571E-02	11	2.8571E-02		

SIGMAC ARRAY

1	1.1401E-01	2	3.2018E-01	3	4.0326E-01	4	6.1265E-01
5	7.1533E-01	6	7.9680E-01	7	8.6144E-01	8	9.1273E-01
9	9.5342E-01	10	9.0571E-01				

DSIGMAC ARRAY

1	2.0555E-01	2	2.0555E-01	3	1.8309E-01	4	1.2940E-01
5	1.0268E-01	6	8.1409E-02	7	6.4641E-02	8	5.1290E-02
9	4.0696E-02	10	3.2290E-02				

***** OUTPUT FROM OPTIMIZATION PROCEDURE *****

OPTIMIZING ON WIND DIRECTION AND STABILITY

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N,	R-CALC,	R-OBS,	SP-CALC,	SP-OBS,	HEIGHT AGL
1	1.0000	1.0000	10.3000	10.3000	14.0200
2	0.9609	0.9508	17.5847	17.4000	14.0200
3	0.7668	0.7322	14.0205	13.4000	14.0200
4	0.8071	0.7322	14.7701	13.4000	14.0200
5	0.7341	0.6339	13.4335	11.6000	14.0200
6	0.6807	0.6339	12.4559	11.6000	14.0200
7	0.6667	0.6831	12.2005	12.5000	14.0200
8	0.7168	0.6612	13.1024	12.1000	14.0200

WDR = 240.00 BETA = 0.1429 TV = 1.0000 OF = 0.52892E-01 ICOUNT = 28

LINEAR SCALE FACTOR = 0.74988

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N,	R-CALC,	R-OBS,	SP-CALC,	SP-OBS,	HEIGHT AGL
1	1.0000	1.0000	10.3000	10.3000	14.0200
2	0.9671	0.9508	17.6960	17.4000	14.0200
3	0.7896	0.7322	14.4490	13.4000	14.0200
4	0.6206	0.7322	15.1630	13.4000	14.0200
5	0.7640	0.6339	13.9817	11.6000	14.0200
6	0.7137	0.6339	13.0810	11.6000	14.0200
7	0.7030	0.6831	12.8643	12.5000	14.0200
8	0.7473	0.6612	13.6759	12.1000	14.0200

WDR = 240.00 BETA = 0.1429 TV = 1.5849 OF = 0.74130E-01 ICOUNT = 52

LINEAR SCALE FACTOR = 0.78291

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N,	R-CALC,	R-OBS,	SP-CALC,	SP-OBS,	HEIGHT AGL
1	1.0000	1.0000	10.3000	10.3000	14.0200
2	0.9539	0.9508	17.4559	17.4000	14.0200
3	0.7303	0.7322	13.3642	13.4000	14.0200
4	0.7760	0.7322	14.2001	13.4000	14.0200
5	0.6994	0.6339	12.7996	11.6000	14.0200
6	0.6405	0.6339	11.7205	11.6000	14.0200
7	0.6268	0.6831	11.4704	12.5000	14.0200
8	0.6022	0.6612	12.4843	12.1000	14.0200

WDR = 240.00 BETA = 0.1429 TV = 0.6310 OF = 0.35127E-01 ICOUNT = 78

LINEAR SCALE FACTOR = 0.72081

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9457	0.9500	17.8068	17.4000	14.0200
3	0.6994	0.7322	12.7990	13.4000	14.0200
4	0.7476	0.7322	13.6810	13.4000	14.0200
5	0.6639	0.6339	12.1493	11.6000	14.0200
6	0.5996	0.6339	10.9761	11.6000	14.0200
7	0.5668	0.6631	10.7343	12.5000	14.0200
8	0.6447	0.6612	11.7989	12.1000	14.0200

WDR = 240.00 BETA = 0.1429 TV = 0.3901 OF = 0.40286E-01 ICOUNT = 104
LINEAR SCALE FACTOR = 0.68951

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9518	0.9500	17.4180	17.4000	14.0200
3	0.7223	0.7322	13.2170	13.4000	14.0200
4	0.7685	0.7322	14.0631	13.4000	14.0200
5	0.6904	0.6339	12.6341	11.6000	14.0200
6	0.6295	0.6339	11.5203	11.6000	14.0200
7	0.6160	0.6631	11.2725	12.5000	14.0200
8	0.6720	0.6612	12.2976	12.1000	14.0200

WDR = 240.00 BETA = 0.1429 TV = 0.5559 OF = 0.33988E-01 ICOUNT = 130
LINEAR SCALE FACTOR = 0.71210

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9518	0.9500	17.4143	17.4000	14.0200
3	0.7214	0.7322	13.2023	13.4000	14.0200
4	0.7678	0.7322	14.0503	13.4000	14.0200
5	0.6894	0.6339	12.6160	11.6000	14.0200
6	0.6285	0.6339	11.5017	11.6000	14.0200
7	0.6150	0.6631	11.2538	12.5000	14.0200
8	0.6713	0.6612	12.2840	12.1000	14.0200

WDR = 240.00 BETA = 0.1429 TV = 0.5498 OF = 0.33966E-01 ICOUNT = 150
LINEAR SCALE FACTOR = 0.71139

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9487	0.9500	17.3603	17.4000	14.0200
3	0.7199	0.7322	13.1747	13.4000	14.0200
4	0.7773	0.7322	14.2251	13.4000	14.0200
5	0.7113	0.6339	13.0174	11.6000	14.0200
6	0.6345	0.6339	11.6115	11.6000	14.0200
7	0.6370	0.6631	11.6576	12.5000	14.0200
8	0.6824	0.6612	12.4885	12.1000	14.0200

WDR = 245.00 BETA = 0.1429 TV = 0.5498 OF = 0.36670E-01 ICOUNT = 182
LINEAR SCALE FACTOR = 0.72047

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*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIYMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN
  N,   R-CALC,   R-OBS,   SP-CALC,   SP-OBS,   HEIGHT AGL
  1,   1.0000,   1.0000,   18.3000,   18.3000,   14.0200
  2,   0.9561,   0.9500,   17.4968,   17.4000,   14.0200
  3,   0.7511,   0.7322,   13.7444,   13.4000,   14.0200
  4,   0.8039,   0.7322,   14.7119,   13.4000,   14.0200
  5,   0.7433,   0.6339,   13.6020,   11.6000,   14.0200
  6,   0.6732,   0.6339,   12.3193,   11.6000,   14.0200
  7,   0.6744,   0.6831,   12.3423,   12.5000,   14.0200
  8,   0.7171,   0.6612,   13.1226,   12.1000,   14.0200
WDR = 245.00 BETA = 0.1429 TV = 0.0714 OF = 0.52715E-01 ICOUNT = 208
LINEAR SCALE FACTOR = 0.75153
*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIYMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN
  N,   R-CALC,   R-OBS,   SP-CALC,   SP-OBS,   HEIGHT AGL
  1,   1.0000,   1.0000,   18.3000,   18.3000,   14.0200
  2,   0.9404,   0.9500,   17.2090,   17.4000,   14.0200
  3,   0.6878,   0.7322,   12.5837,   13.4000,   14.0200
  4,   0.7492,   0.7322,   13.7111,   13.4000,   14.0200
  5,   0.6768,   0.6339,   12.3021,   11.6000,   14.0200
  6,   0.5930,   0.6339,   10.8523,   11.6000,   14.0200
  7,   0.5991,   0.6831,   10.9639,   12.5000,   14.0200
  8,   0.6451,   0.6612,   11.6045,   12.1000,   14.0200
WDR = 245.00 BETA = 0.1429 TV = 0.3469 OF = 0.40604E-01 ICOUNT = 234
LINEAR SCALE FACTOR = 0.68994
*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIYMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN
  N,   R-CALC,   R-OBS,   SP-CALC,   SP-OBS,   HEIGHT AGL
  1,   1.0000,   1.0000,   18.3000,   18.3000,   14.0200
  2,   0.9463,   0.9500,   17.3168,   17.4000,   14.0200
  3,   0.7105,   0.7322,   13.0025,   13.4000,   14.0200
  4,   0.7691,   0.7322,   14.0743,   13.4000,   14.0200
  5,   0.7014,   0.6339,   12.8351,   11.6000,   14.0200
  6,   0.6226,   0.6339,   11.3927,   11.6000,   14.0200
  7,   0.6256,   0.6831,   11.4522,   12.5000,   14.0200
  8,   0.6712,   0.6612,   12.2038,   12.1000,   14.0200
WDR = 245.00 BETA = 0.1429 TV = 0.4782 OF = 0.35201E-01 ICOUNT = 260
LINEAR SCALE FACTOR = 0.71111
*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIYMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN
  N,   R-CALC,   R-OBS,   SP-CALC,   SP-OBS,   HEIGHT AGL
  1,   1.0000,   1.0000,   18.3000,   18.3000,   14.0200
  2,   0.9460,   0.9500,   17.3109,   17.4000,   14.0200
  3,   0.7091,   0.7322,   12.9769,   13.4000,   14.0200
  4,   0.7679,   0.7322,   14.0527,   13.4000,   14.0200
  5,   0.6998,   0.6339,   12.8071,   11.6000,   14.0200
  6,   0.6208,   0.6339,   11.3602,   11.6000,   14.0200
  7,   0.6241,   0.6831,   11.4216,   12.5000,   14.0200
  8,   0.6699,   0.6612,   12.2590,   12.1000,   14.0200
WDR = 245.00 BETA = 0.1429 TV = 0.4693 OF = 0.35180E-01 ICOUNT = 266
LINEAR SCALE FACTOR = 0.70990

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*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9526	0.9508	17.4317	17.4000	14.0200
3	0.7167	0.7322	13.1161	13.4000	14.0200
4	0.7508	0.7322	13.7402	13.4000	14.0200
5	0.6584	0.6339	12.0482	11.6000	14.0200
6	0.6129	0.6339	11.2155	11.6000	14.0200
7	0.5822	0.6831	10.6540	12.6000	14.0200
8	0.6507	0.6612	11.9071	12.1000	14.0200

WDR = 235.00 BETA = 0.1429 TV = 0.4693 OF = 0.38598E-01 ICOUNT = 312
LINEAR SCALE FACTOR = 0.09433

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9804	0.9508	17.5753	17.4000	14.0200
3	0.7465	0.7322	13.8009	13.4000	14.0200
4	0.7794	0.7322	14.2622	13.4000	14.0200
5	0.6955	0.6339	12.7275	11.6000	14.0200
6	0.6520	0.6339	11.9323	11.6000	14.0200
7	0.6244	0.6831	11.4272	12.6000	14.0200
8	0.6880	0.6612	12.6897	12.1000	14.0200

WDR = 235.00 BETA = 0.1429 TV = 0.7430 OF = 0.36732E-01 ICOUNT = 338
LINEAR SCALE FACTOR = 0.72631

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9671	0.9508	17.6977	17.4000	14.0200
3	0.7752	0.7322	14.1857	13.4000	14.0200
4	0.8063	0.7322	14.7547	13.4000	14.0200
5	0.7299	0.6339	13.3569	11.6000	14.0200
6	0.6893	0.6339	12.6136	11.6000	14.0200
7	0.6648	0.6831	12.1662	12.6000	14.0200
8	0.7220	0.6612	13.2134	12.1000	14.0200

WDR = 235.00 BETA = 0.1429 TV = 1.1788 OF = 0.54668E-01 ICOUNT = 364
LINEAR SCALE FACTOR = 0.75816

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9572	0.9508	17.5173	17.4000	14.0200
3	0.7340	0.7322	13.4316	13.4000	14.0200
4	0.7678	0.7322	14.0502	13.4000	14.0200
5	0.6803	0.6339	12.4405	11.6000	14.0200
6	0.6364	0.6339	11.6456	11.6000	14.0200
7	0.6072	0.6831	11.1112	12.6000	14.0200
8	0.6731	0.6612	12.3181	12.1000	14.0200

WDR = 235.00 BETA = 0.1429 TV = 0.6170 OF = 0.34222E-01 ICOUNT = 390
LINEAR SCALE FACTOR = 0.71320

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9571	0.9500	17.5142	17.4000	14.0200
3	0.7335	0.7322	13.4233	13.4000	14.0200
4	0.7072	0.7322	14.0398	13.4000	14.0200
5	0.8797	0.6339	12.4385	11.6000	14.0200
6	0.6354	0.6339	11.6271	11.6000	14.0200
7	0.6062	0.6031	11.0930	12.5000	14.0200
8	0.8722	0.6012	12.3005	12.1000	14.0200

WDR = 235.00 BETA = 0.1429 TV = 0.6098 DF = 0.34261E-01 ICOUNT = 418
LINEAR SCALE FACTOR = 0.71243

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9545	0.9500	17.4687	17.4000	14.0200
3	0.7290	0.7322	13.3522	13.4000	14.0200
4	0.7710	0.7322	14.1200	13.4000	14.0200
5	0.6912	0.6339	12.6480	11.6000	14.0200
6	0.6363	0.6339	11.6442	11.6000	14.0200
7	0.6170	0.6031	11.3051	12.5000	14.0200
8	0.8767	0.6012	12.3045	12.1000	14.0200

WDR = 238.37 BETA = 0.1429 TV = 0.6098 DF = 0.34212E-01 ICOUNT = 442
LINEAR SCALE FACTOR = 0.71620

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9617	0.9500	17.5989	17.4000	14.0200
3	0.7596	0.7322	13.8999	13.4000	14.0200
4	0.7907	0.7322	14.6160	13.4000	14.0200
5	0.7255	0.6339	13.2760	11.6000	14.0200
6	0.6746	0.6339	12.3453	11.6000	14.0200
7	0.6570	0.6031	12.0377	12.5000	14.0200
8	0.7119	0.6012	13.0276	12.1000	14.0200

WDR = 236.37 BETA = 0.1429 TV = 0.9605 DF = 0.48142E-01 ICOUNT = 468
LINEAR SCALE FACTOR = 0.74798

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9462	0.9500	17.3149	17.4000	14.0200
3	0.6904	0.7322	12.7805	13.4000	14.0200
4	0.7425	0.7322	13.5875	13.4000	14.0200
5	0.8530	0.6339	11.9852	11.6000	14.0200
6	0.5953	0.6339	10.8941	11.6000	14.0200
7	0.5763	0.6031	10.5464	12.5000	14.0200
8	0.8388	0.6012	11.6900	12.1000	14.0200

WDR = 238.37 BETA = 0.1429 TV = 0.3840 DF = 0.43384E-01 ICOUNT = 494
LINEAR SCALE FACTOR = 0.68465

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIYMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9537	0.9500	17.4528	17.4000	14.0200
3	0.7266	0.7322	13.2971	13.4000	14.0200
4	0.7087	0.7322	14.0868	13.4000	14.0200
5	0.6677	0.6339	12.5841	11.6000	14.0200
6	0.6323	0.6339	11.5710	11.6000	14.0200
7	0.6136	0.6031	11.2293	12.5000	14.0200
8	0.6728	0.6612	12.3120	12.1000	14.0200

WDR = 238.37 BETA = 0.1429 TV = 0.5816 OF = 0.33943E-01 ICOUNT = 520
LINEAR SCALE FACTOR = 0.71288

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIYMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9534	0.9500	17.4468	17.4000	14.0200
3	0.7261	0.7322	13.2873	13.4000	14.0200
4	0.7093	0.7322	14.0784	13.4000	14.0200
5	0.6891	0.6339	12.6114	11.6000	14.0200
6	0.6325	0.6339	11.5749	11.6000	14.0200
7	0.6153	0.6031	11.2591	12.5000	14.0200
8	0.6737	0.6612	12.3281	12.1000	14.0200

WDR = 238.82 BETA = 0.1429 TV = 0.5816 OF = 0.33984E-01 ICOUNT = 546
LINEAR SCALE FACTOR = 0.71353

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIYMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9607	0.9500	17.5807	17.4000	14.0200
3	0.7582	0.7322	13.0388	13.4000	14.0200
4	0.7968	0.7322	14.5773	13.4000	14.0200
5	0.7238	0.6339	13.2413	11.6000	14.0200
6	0.6710	0.6339	12.2801	11.6000	14.0200
7	0.6553	0.6031	11.9918	12.5000	14.0200
8	0.7091	0.6612	12.9766	12.1000	14.0200

WDR = 238.82 BETA = 0.1429 TV = 0.9216 OF = 0.46505E-01 ICOUNT = 572
LINEAR SCALE FACTOR = 0.74529

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIYMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N	R-CALC	R-OBS	SP-CALC	SP-OBS	HEIGHT AGL
1	1.0000	1.0000	18.3000	18.3000	14.0200
2	0.9450	0.9500	17.2928	17.4000	14.0200
3	0.6948	0.7322	12.7144	13.4000	14.0200
4	0.7403	0.7322	13.5470	13.4000	14.0200
5	0.6610	0.6339	11.9282	11.6000	14.0200
6	0.5913	0.6339	10.8199	11.6000	14.0200
7	0.5741	0.6031	10.5053	12.5000	14.0200
8	0.6355	0.6612	11.6298	12.1000	14.0200

WDR = 238.82 BETA = 0.1429 TV = 0.3670 OF = 0.44976E-01 ICOUNT = 598
LINEAR SCALE FACTOR = 0.68214

*** WARNING *** MAXIMUM ITERATION LIMIT ENCOUNTERED,
CHECK DIVMAX TO DETERMINE IF EXCESSIVE LOCAL DIVERGENCES REMAIN

N,	R-CALC,	R-OBS,	SP-CALC,	SP-OBS,	HEIGHT AGL
1	1.0000	1.0000	10.3000	10.3000	14.0200
2	0.9531	0.9500	17.4422	17.4000	14.0200
3	0.7252	0.7322	13.2718	13.4000	14.0200
4	0.7684	0.7322	14.0624	13.4000	14.0200
5	0.6882	0.6339	12.5940	11.6000	14.0200
6	0.6313	0.6339	11.5525	11.6000	14.0200
7	0.6140	0.6831	11.2365	12.5000	14.0200
8	0.6723	0.6612	12.3032	12.1000	14.0200

WDR = 238.82 BETA = 0.1429 TV = 0.5730 OF = 0.33934E-01 ICOUNT = 824
LINEAR SCALE FACTOR = 0.71246

OPTIMAL TV = 0.57298 LOG(TV) = -0.241876
OPTIMAL WIND DIRECTION = 238.82281
MINIMUM OBJ. FUNCT. = 0.3393E-01
NUMBER OF NOABL ITERATIONS = 624
SPEED SCALE FACTOR = 0.71250
PLOT TAPE DUMP FOR
1/ 1/ 1 HR= 1

NORMAL EXIT - NOABL

APPENDIX F

SUPPLEMENTARY SOFTWARE

APPENDIX F

SUPPLEMENTARY SOFTWARE

The model produces a binary file that contains the terrain data and the final, calculated winds. The supplementary software listed here takes that binary file and makes a contour plot of the terrain and wind speed. In this way the output of a model run can be interpreted.

The software consists of three files, listed in this order:

- 1) HCONPLOT.FOR
- 2) COMMONJ.INC
- 3) GETSPEED.FOR

File 2, COMMONJ.INC, contains a common block that is shared both by the model and the supplementary software. After compilation, this software must be linked with the DISSPLA^(a) library, which contains the graphics subroutines used by this software. If this library is not available, other plotting commands must be substituted for the DISSPLA commands.

(a) DISSPLA is a proprietary software product of Integrated Software Systems Corporation.


```

1:      PROGRAM HCONPLOT
2: C PROGRAM TO CONTOUR THE WINDSPEED AT A SPECIFIC HEIGHT (AGL)
3: C CAN OPTIONALLY CONTOUR THE TERRAIN
4:      common work(10000)
5:      INCLUDE 'COMMONJ.INC/LIST'
6:      CHARACTER*40 INPUT FILE
7:      CHARACTER*1 ANS
8:      COMMON/CNB/SPEED1(1000),INPUT FILE
9:      COMMON/ARRAY/ zmat(40,40),xcon(1000),ycon(1000),zcon(1000)
10: C
11:      WRITE(*, '( " HEIGHT (AGL) FOR SPEED CONTOURS? " )')
12:      READ(*,*)H
13: C
14:      WRITE(*, '( " RATIOS??? (Y/N) " )')
15:      READ(*, '(A)')ANS
16: C
17:      WRITE(*,1011)
18: 1011  FORMAT(' ENTER SPEED CONTOUR INTERVAL (M/S) OR RATIO INTERVAL')
19:      READ(*,*)SPEED_INT
20: C
21:      WRITE(*, '( " ENTER TERRAIN CONTOUR INTERVAL (M) " )')
22:      READ(*,*)CONT_INT
23: C
24:      TYPE *, 'ENTER NOABL INPUT FILE:'
25:      ACCEPT 101, INPUT_FILE
26: 101  FORMAT(A)
27:      OPEN(UNIT=10, NAME=INPUT_FILE, TYPE='OLD', READONLY,
28:          + FORM='UNFORMATTED')
29: C THE VARIABLE "COMON" IS EQUIVALENCED TO THE LARGE COMMON BLOCK
30:      read(10)comon
31: C THIS READS IN THE VELOCITIES AT THE CELL FACES
32:      read(10)u,v,w
33:      CLOSE(10)
34:      call comprs
35:      call page(0.5,11.0)
36: C
37:      xaxis=0.25
38:      yaxis=0.25
39: C DIMENSIONS OF MODELING DOMAIN DOMAIN
40:      XLENGTH=(IMAX+DX)/1000.
41:      YLENGTH=(JMAX+DY)/1000.
42:      IF (XLENGTH.GT.YLENGTH) THEN
43:          YAXIS=XAXIS*YLENGTH/XLENGTH
44:      ELSE
45:          XAXIS=YAXIS*XLENGTH/YLENGTH
46:      ENDIF
47: C
48:      CALL MBBROR
49:      call area2d(xaxis,yaxis)
50:      CALL HEIGHT(.25)
51:      CALL INTAXS
52:      call xname('X (KM)',100)
53:      call yname('Y (KM)',100)
54:      call xticks(5)
55:      call yticks(5)
56:      call graf(0.,1.,XLENGTH,0.,1.,YLENGTH)
57:      call frame
58: C CONTOUR THE TERRAIN
59:      IF (CONT_INT.LE.0.0) GOTO 2000
60: C DISPLAY CALLS FOR CONTOURING THE TERRAIN
61:      call bcomon(10000)
62:      call bgmat(imax,jmax)
63: C EXTRACT THE TERRAIN DATA FROM THE COMMON BLOCK

```



```

64:         LL=-IMAX
65:         DO J=1,JMAX
66:             LL=LL+IMAX
67:             DO I=1,IMAX
68:                 K=LL+I
69: C DIVIDE BY 1000 TO CONVERT METERS TO KM
70:                 xcon(k)=(FLOAT(I-1)*DX+DX/2.)/1000.
71:                 ycon(k)=(FLOAT(J-1)*DY+DY/2.)/1000.
72:                 zcon(k)=TERRAIN(K)
73:             end do
74:         end do
75: C
76:         call getmat(xcon,ycon,zcon,k,0)
77:         call endmat(zmat,0)
78:         call conmak(zmat,imax,jmax,CONT_INT)
79:         CALL HEIGHT(.15)
80: c dotted contour lines
81:         if(speed int.gt.0.0)then
82:             CALL CONLIN(0,'DOT','NOLABELS',1,10)
83:             call contour(1,'NOLABELS','DRAW')
84:         else
85: c solid contour lines
86:             CALL CONANG(90.)
87:             CALL CONMIN(2.5)
88:             CALL CONLIN(0,'SOLID','LABELS',1,10)
89:             call contour(1,'LABELS','DRAW')
90:             CALL RESET('CONANG')
91:             CALL RESET('CONMIN')
92:         endif
93:         CALL MESSAG(' CONTOUR INTERVAL = ',100,0.,YAXIS+0.5)
94:         INUM=NINT(CONT_INT)
95:         CALL INTNO(INUM,'ABUT','ABUT')
96:         CALL MESSAG(' M',100,'ABUT','ABUT')
97: 2000      CONTINUE
98: C FOR CONTOURING THE SPEEDS
99: C CONTOUR THE SPEEDS
100:         IF(SPEED_INT.GT.0.0)THEN
101:             CALL HCONT(SPEED_INT,H,ANS)
102: C KLUDGE TO GET AGL MESSAGE TO PLOT IN THE RIGHT LOCATION IF
103: C THE TERRAIN CONTOUR MESSAGE IS NOT PLOTTED
104:             IF(CONT_INT.LE.0.0)CALL MESSAG(' ',1,0.,YAXIS+0.5)
105: C
106:             CALL MESSAG(' AGL = ',100,'ABUT','ABUT')
107:             CALL REALNO(H,2,'ABUT','ABUT')
108:             CALL MESSAG(' M',100,'ABUT','ABUT')
109:         ENDIF
110: C
111: C PLOT THE STATION LOCATIONS
112:         DO I=1,NSTAT
113:             XSTA(I)=XSTA(I)/1000.
114:             YSTA(I)=YSTA(I)/1000.
115:         ENDDO
116:         CALL SCLPIC(2.0)
117:         CALL MARKER(15)
118:         CALL CURVE(XSTA,YSTA,NSTAT,-1)
119:         call endpi(0)
120:         call donepi
121:     end
122: C
123: SUBROUTINE HCONT(SPEED_INT,H,ANS)
124: C CONTOURS HORIZONTAL SPEED USING THE NOABL OUTPUT COMMON
125: C BLOCK
126:     common work(10000)
127:     INTEGER ULEVEL
128:     INCLUDE 'COMMONJ.INC/LIST'
129:     CHARACTER*40 INPUT_FILE
130:     CHARACTER*1 ANS
131:     COMMON/ARRAY/ zmat(40,40),xcon(1600),ycon(1600),zcon(1600)

```

```

132:      COMMON/CNB/SPEED(1000),INPUT_FILE
133: C GET THE SPEEDS AT THE CELL CENTERS
134:      CALL GETSPEED(H)
135: C
136:      call BCOMMON(10000)
137: C
138:      SMAX=0.0
139:      SMIN=1000.0
140:      LL=-IMAX
141:      DO J=1,JMAX
142:      LL=LL+IMAX
143:      DO I=1,IMAX
144:      K=LL+I
145:      XCON(K)=(FLOAT(I-1)*DX+DX/2.0)/1000.
146:      YCON(K)=(FLOAT(J-1)*DY+DY/2.0)/1000.
147: C CONVERT SPEEDS TO RATIOS???
148:      IF(ANS.EQ.'Y'.OR.ANS.EQ.'y')SPEED(K)=SPEED(K)/WSPD(1)
149: C
150: C FIND THE MINIMUM AND MAXIMUM SPEEDS
151:      smax=max(speed(k),smax)
152:      if(smax.eq.speed(k))then
153:      imax=i
154:      jmax=j
155:      endif
156:      smin=min(speed(k),smin)
157:      if(smin.eq.speed(k))then
158:      imins=i
159:      jmins=j
160:      endif
161: C
162:      ENDDO
163:      ENDDO
164: C CODE FOR CONTOURING THE SPEEDS
165:      call bgmat(imax,jmax)
166:      call getmat(xcon,ycon,SPEED,k,0)
167:      call endmat(zmat,0)
168:      CALL HEIGHT(.15)
169: C MAKE THE SPEED CONTOURS TWICE AS THICK
170:      ITHICK=2
171:      CALL CONLIN(0,'SOLID','LABELS',ithick,10)
172:      call conmak(zmat,imax,jmax,SPEED_INT)
173:      CALL CONANG(180.)
174:      CALL CONWIN(2.)
175:      call contour(1,'LABELS','DRAW')
176: C
177:      WRITE(6,1031)SMIN,IMINS,JMINS
178: 1031  FORMAT(//,' MINIMUM SPEED = ',F10.2,' I = ',I5,' J = ',I5)
179:      WRITE(6,1032)SMAX,IMAXS,JMAXS
180: 1032  FORMAT(' MAXIMUM SPEED = ',F10.2,' I = ',I5,' J = ',I5)
181: C PRINT OUT THE SPEEDS
182:      WRITE(6,'(1H1,' ' SPEED')')
183:      DO J=JMAX,1,-1
184:      L=(J-1)*IMAX
185:      WRITE(6,'(1X)')
186:      WRITE(6,1038)(SPEED(I),I=L+1,L+IMAX)
187: 1038  FORMAT(20F5.1)
188:      ENDDO
189:      RETURN
190:      END

```

FILE: COMMONJ.INC

```

1: C      ... NOTE- CHANGING COMMON LENGTH REQUIRES REDEFINING
2: C      NWORD IN SUB. DEFINE - NWORD= NUMBER OF
3: C      WORDS IN BLANK COMMON
4: C
5: C      ... ALSO- THE DIMENSIONS OF DZODX AND DZODY MUST BE
6: C      EQUAL TO OR GREATER THAN IMAX*JMAX; THEREFORE
7: C      FOR A 40X40 GRID DIMENSION DZODX(1600).
8: C
9: C      ... INPUT VARIABLES ...
10: C
11: C      COMMON
12: C      1      ALFA1,      ALFA2,      BETA,      CNVRSN,      DEBUG,
13: C      2      DX,        DY,        DZ,        DZWIN,      EPSLN,
14: C      3      IDAY,      IEDIT,      IHOOR,      IMAX,      IMN,
15: C      4      IMX,      IPATH,      ISIG,      ITERAN,      ITYLR,
16: C      5      IWIND,      IYEAR,      IZD,      JMAX,      JMN,
17: C      6      JMX,      KMAX,      KMN,      KMX,      MONTH,
18: C      7      WPS,      NDAYS,      NPTS,      OMEG,      ORIGNX,
19: C      8      ORIGNY,      ORIGNZ,      ZOIST,      DMP,      ITMAX
20: C
21: C      COMMON
22: C      1      WDR(50), WSPD(50), XO(50), YO(50), ZO(50)
23: C
24: C      COMMON
25: C      1      NSTAT, XSTA(25), YSTA(25)
26: C
27: C      COMMON
28: C      1      QTOP,      ATOP,      ZBL,      NUA,      WSPDUA(25),
29: C      2      WDRUA(25),UAMSL(25)
30: C
31: C      ... CALCULATED VARIABLES ...
32: C
33: C      COMMON
34: C      1      ALPHA,      DX2,      DY2,      DZ2,      I,
35: C      2      IJMAX,      IJMAX,      IKMAX,      IMXP1,      J,
36: C      3      JMXPI,      K,      KMXPI,      NWORD,      RDX,
37: C      4      RDY,      RDZ,      DEG,      PII,      RADIAN
38: C
39: C      COMMON
40: C      1      DSIGC(20),DSIGF(20),SIGC(20), SIGF(20), X(50),
41: C      2      Y(50),      Z(25)
42: C
43: C      COMMON
44: C      1      UQ(50), VO(50), WO(50)
45: C
46: C      COMMON
47: C      2      PI(1600), TERA(1600), DM1A(1600),
48: C      3      DM1B(1600)
49: C
50: C      COMMON
51: C      1      PHI(41,41,11)
52: C
53: C      COMMON/LARGE/
54: C      1      U(41,40,10), V(40,41,10), W(40,40,11),
55: C      2      DIV(40,40,10), DZODX(1600), DZODY(1600),
56: C      3      IFLAG(1600), UTEN(41,40), VTEN(40,41)
57: C
58: C      COMMON /EDIT/
59: C      1      RESDUL(200), IHDS(25)
60: C
61: C      DIMENSION
62: C      1      COMMON(7219),ICOMON(7219)
63: C      INTEGER
64: C      1      DEBUG
65: C      EQUIVALENCE
66: C      1      (COMMON(1),ALFA1),(ICOMON(1),ALFA1)

```

FILE: GETSPEED.FOR

```

1:      SUBROUTINE GETSPEED(H)
2:      C PROGRAM TO COMPUTE THE WINDSPEED AT A SPECIFIC HEIGHT (AGL)
3:      C CAN OPTIONALLY CONTOUR THE TERRAIN
4:      CHARACTER*40 INPUT FILE
5:      COMMON WORK(10000)
6:      INCLUDE 'COMMONJ.INC/LIST'
7:      COMMON /OUT/ A(1000,10)
8:      COMMON/CNB/SPEED1(1000),INPUT FILE
9:      DIMENSION UAVG(1000,10),VAVG(1000,10),SPEEDX(25)
10:     C EQUIVALENCE TO SAVE STORAGE
11:     EQUIVALENCE (UAVG,W),(VAVG,DIV)
12:     C RETRIEVE THE SPEEDS AT THE TUNING SITES
13:     ISTRT=1
14:     CALL TAYLOR(ISTRT)
15:     C
16:     H0=Z0(1)
17:     C
18:     WRITE(6,1015)
19: 1015   FORMAT(///)
20:     WRITE(6,1016)
21: 1016   FORMAT(T4,'N',T16,'X0',T29,'Y0',T37,'SPEED',T47,'RATIO')
22:     C
23:     DO N=1,NSTAT
24:     CALL LINTERP(N,H0,UC,VC)
25:     SPEEDX(N)=SQRT(UC*UC+VC*VC)
26:     RATIO=SPEEDX(N)/SPEEDX(1)
27:     WRITE(6,1020)N,XSTA(N),YSTA(N),SPEEDX(N),RATIO
28: 1020   FORMAT(I5,2(1X,E12.5),2(1X,F10.5))
29:     ENDDO
30:     C FIND THE SCALE FACTOR
31:     SCALE=WSPD(1)/SPEEDX(1)
32:     WRITE(6,1030)SCALE
33: 1030   FORMAT(//,' SCALE FACTOR = ',F10.0)
34:     CALL HORZ
35:     NMAX=IWAX*JMAX
36:     DO N=1,NMAX
37:     C A(N,K) IS THE HEIGHT (AGL) OF THE CONFORMAL LEVEL K ABOVE THE STATION N
38:     C A(N,1) IS THE HIGHEST LEVEL, A(N,KMAX) IS THE LOWEST LEVEL
39:     C
40:     C FIND THE FIRST LEVEL BELOW H
41:     DO 100 KT=1,KMAX
42:     KBL=KT
43:     IF(A(N,KT).LE.H)GOTO 200
44: 100    CONTINUE
45:     STOP 'KBL IS GREATER THAN KMAX'
46: 200    CONTINUE
47:     C PERFORM LINEAR INTERPOLATION BETWEEN THE TWO CONFORMAL LEVELS
48:     C BRACKETING THE DESIRED HEIGHT AGL
49:     KUP=KBL+1
50:     S1=(UAVG(N,KUP)-UAVG(N,KBL))/(A(N,KUP)-A(N,KBL))
51:     S2=(VAVG(N,KUP)-VAVG(N,KBL))/(A(N,KUP)-A(N,KBL))
52:     UC=S1*(H-A(N,KBL))+UAVG(N,KBL)
53:     VC=S2*(H-A(N,KBL))+VAVG(N,KBL)
54:     SPEED1(N)=SQRT(UC*UC+VC*VC)*SCALE
55:     ENDDO
56:     RETURN
57:     END
58:     C
59:     SUBROUTINE HORZ
60:     COMMON WORK(10000)
61:     INCLUDE 'COMMONJ.INC/LIST'
62:     COMMON /OUT/ A(1000,10)
63:     DIMENSION UAVG(1000,10),VAVG(1000,10)

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64: C EQUIVALENCE TO SAVE STORAGE
65:     EQUIVALENCE (UAVG,W), (VAVG,DIV)
66: C-----
67: C                                     ... STORE WIND COMPONENTS FOR LEVEL K ...
68: C-----
69:     DO 1000 KK=1,KMAX
70:         K= KMAX-KK+1
71:         DO 10 J=1,JMAX
72:             DO 10 I=1,IMAX
73: C                 ... CONFORMAL SPACE CALCULATIONS ...
74: C                 ... DETERMINE WIND SPEED AT CELL CENTER ...
75:         NN= (J-1)*IMAX + I
76: C AGL
77:         A(NN,K)=(1.0-SIGC(K))*PI(NN)
78:         UAVG(NN,K)= 0.5*(U(I,J,K)+U(I+1,J,K))
79:         VAVG(NN,K)= 0.5*(V(I,J,K)+V(I+1,J,K))
80:     10 CONTINUE
81: 1000 CONTINUE
82:     RETURN
83:     END
84: C
85:     SUBROUTINE TAYLOR(ISTR)
86: C
87: C
88: C         TAYLOR- INTERPOLATES A WIND SPEED AND WIND DIRECTION
89: C                 AT A SPECIFIED NUMBER OF POINTS IN THE MESH
90: C                 USING A SECOND ORDER TAYLOR EXPANSION ABOUT
91: C                 THE POINTS OF INTEREST
92: C
93:     COMMON WORK(10000)
94:     INCLUDE 'COMMONJ.INC'
95: C
96:     COMMON /OUT1/ A(25,25), B(25,25)
97:     DIMENSION VAVSTA(25), EATA(25), ISAV(25), JSAY(25),
98: 1           UAVSTA(25), XMSL(25), AGL(25), ZEATA(25)
99:     DIMENSION UAVG(40,40), VAVG(40,40)
100:     ICOMP= 0
101: C-----
102: C                                     ... STORE WIND COMPONENTS FOR LEVEL K ...
103: C-----
104:     DO 1000 KK=1,KMAX
105:         K= KMAX-KK+1
106:         IF (KK .GT. 1) ISTR= 2
107:         DO 10 J=1,JMAX
108:             DO 10 I=1,IMAX
109:                 N= (J-1)*IMAX+I
110: C                 ... CONFORMAL SPACE CALCULATIONS ...
111:                 KE= K
112:                 KW= K
113:                 KS= K
114:                 KN= K
115:             7 CONTINUE
116:                 UAV= 0.5*(U(I,J,KW)+U(I+1,J,KE))
117:                 VAV= 0.5*(V(I,J,KS)+V(I+1,J,KN))
118:                 UAVG(I,J)= UAV
119:                 VAVG(I,J)= VAV
120:             10 CONTINUE
121: C-----
122: C                                     ... INTERPOLATE FOR STATION VALUES ...
123: C-----
124:     DO 100 N=1,NSTAT
125: C
126: C         ... CHECK FOR STATIONS OUT OF BOUNDS ...
127:         IF ((XSTA(N) .LT. (X(1)-0.5*DX)) .OR.
128: 1         (XSTA(N) .GT. (X(IMAX)+0.5*DX))) GO TO 100
129:         IF ((YSTA(N) .LT. (Y(1)-0.5*DY)) .OR.
130: 1         (YSTA(N) .GT. (Y(JMAX)+0.5*DY))) GO TO 100
131:         GO TO (15,50), ISTR

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132: 15  CONTINUE
133: C
134: C      ... FIND STATION POSITIONS RELATIVE TO MESH ...
135:      DO 20 I=1,IMAX
136:      ISAV(N)= I
137:      IF (XSTA(N) .LE. X(I)) GO TO 25
138: 20  CONTINUE
139: 25  CONTINUE
140:      DO 30 J=1,JMAX
141:      JSAV(N)= J
142:      IF (YSTA(N) .LE. Y(J)) GO TO 35
143: 30  CONTINUE
144: 35  CONTINUE
145: C
146:      I= ISAV(N)
147:      J= JSAV(N)
148:      TEMP1= X(I)-XSTA(N)
149:      TEMP2= Y(J)-YSTA(N)
150:      TEMP3= X(I-1)-XSTA(N)
151:      TEMP4= Y(J-1)-YSTA(N)
152:      DIST1= SQRT(TEMP1*TEMP1 + TEMP2*TEMP2)
153:      DIST2= SQRT(TEMP3*TEMP3 + TEMP2*TEMP2)
154:      IF (DIST1 .LT. DIST2) GO TO 40
155:      ISAV(N)= ISAV(N)-1
156:      TEMP1= TEMP3
157: 40  CONTINUE
158:      DIST1= SQRT(TEMP1*TEMP1+TEMP2*TEMP2)
159:      DIST2= SQRT(TEMP1*TEMP1 + TEMP4*TEMP4)
160:      IF (DIST1 .GT. DIST2) JSAV(N)= JSAV(N)-1
161: C
162: C      ... COMPUTE DISPLACEMENT OF STATION WITHIN CELL (I,J)
163: C      FROM CELL CENTER ...
164:      I= ISAV(N)
165:      J= JSAV(N)
166:      EATA(N)= XSTA(N)-X(I)
167:      ZEATA(N)= YSTA(N)-Y(J)
168: 50  CONTINUE
169: C
170: C      ... DETERMINE WIND SPEED AT STATION N ...
171:      I= ISAV(N)
172:      J= JSAV(N)
173:      NN= (J-1)*IMAX + I
174:      AGL(N)= (1.0-SIGC(K))*PI(NN)
175:      IF (IPATH .EQ. 1) AGL(N)= Z(K) - TERRAIN(NN)
176:      XMSL(N)= AGL(N) + TERRAIN(NN)
177:      IE= I-1
178:      IW= I-1
179:      JN= J-1
180:      JS= J-1
181:      IF (I .EQ. IMAX) IE=IMAX
182:      IF (I .EQ. 1) IW= 1
183:      IF (J .EQ. JMAX) JN= JMAX
184:      IF (J .EQ. 1) JS= 1
185:      DWDX= 0.5*(UAVG(IE,J)-UAVG(IW,J))*RDX
186:      DWDY= 0.5*(UAVG(I,JN)-UAVG(I,JS))*RDY
187:      D2WDX2= RDX*((UAVG(IE,J)-UAVG(I,J))*RDX -
188: 1      (UAVG(I,J)-UAVG(IW,J))*RDX)
189:      D2WDY2= RDY*((UAVG(I,JN)-UAVG(I,J))*RDY -
190: 1      (UAVG(I,J)-UAVG(I,JS))*RDY)
191:      D2WDXY= 0.25*((UAVG(IE,JN)-UAVG(IW,JN)) -
192: 1      (UAVG(IE,JS)-UAVG(IW,JS)))*RDX*RDY
193: C
194: C      ... SECOND ORDER TAYLOR EXPANSION ...
195: C      ... FIND U- COMPONENT AT STATION N ...
196:      UAVSTA(N)= UAVG(I,J) + EATA(N)*DWDX + ZEATA(N)*DWDY +
197: 1      0.5*(EATA(N)**2*D2WDX2 + 2.0*EATA(N)*ZEATA(N)*
198: 2      D2WDXY + ZEATA(N)**2*D2WDY2)
199:      DDX= 0.5*(VAVG(IE,J)-VAVG(IW,J))*RDX

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200:      DDDY= 0.5*(VAVG(I,JN)-VAVG(I,JS))*RDY
201:      D2DDX2= RDX*((VAVG(IE,J)-VAVG(I,J))*RDX -
202:      1      (VAVG(I,J)-VAVG(IW,J))*RDX)
203:      D2DDY2= RDY*((VAVG(I,JN)-VAVG(I,J))*RDY -
204:      1      (VAVG(I,J)-VAVG(I,JS))*RDY)
205:      D2DDXY= 0.25*((VAVG(IE,JN)-VAVG(IW,JN)) -
206:      1      (VAVG(IE,JS)-VAVG(IW,JS))*RDX*RDY
207: C
208: C      ... SECOND ORDER TAYLOR EXPANSION ...
209: C      ... FIND V- COMPONENT AT STATION N ...
210:      VAVSTA(N)= VAVG(I,J) + EATA(N)*DDDX + ZEATA(N)*DDDY +
211:      1      0.5*(EATA(N)**2*D2DDX2 + 2.0*EATA(N)*ZEATA(N)*
212:      2      D2DDXY + ZEATA(N)**2*D2DDY2)
213:      A(N,K)= AGL(N)
214:      B(N,K)= XMSL(N)
215:      UTEN(N,K)= UAVSTA(N)
216:      VTEN(N,K)= VAVSTA(N)
217: 100 CONTINUE
218: 1000 CONTINUE
219:      RETURN
220:      END
221: C
222:      SUBROUTINE LINTERP(NSTA,H0,UC,VC)
223: C PERFORMS A LINEAR INTERPOLATION TO FIND THE WIND COMPONENTS UC,VC AT THE
224: C HEIGHT H0(NSTA) (HEIGHTS ARE IN METERS)
225: C NSTA IS THE STATION NUMBER
226:      COMMON WORK(10000)
227:      INCLUDE 'COMMONJ.INC'
228:      COMMON /OUT1/ A(25,25),B(25,25)
229: C A(N,K) IS THE HEIGHT (AGL) OF THE CONFORMAL LEVEL K ABOVE THE STATION N
230: C A(N,1) IS THE HIGHEST LEVEL, A(N,KMAX) IS THE LOWEST LEVEL
231: C
232: C FIND THE FIRST LEVEL BELOW Z0(NSTA)
233:      DO 100 KT=1,KMAX
234:      KBL=KT
235:      IF(A(NSTA,KT).LE.H0)GOTO 200
236: 100 CONTINUE
237:      STOP 'KBL IS GREATER THAN KMAX'
238: 200 CONTINUE
239: C PERFORM LINEAR INTERPOLATION BETWEEN THE TWO CONFORMAL LEVELS
240: C BRACKETING THE DESIRED HEIGHT AGL
241:      KUP=KBL-1
242:      S1=(UTEN(NSTA,KUP)-UTEN(NSTA,KBL))/(A(NSTA,KUP)-A(NSTA,KBL))
243:      S2=(VTEN(NSTA,KUP)-VTEN(NSTA,KBL))/(A(NSTA,KUP)-A(NSTA,KBL))
244:      UC=S1*(H0-A(NSTA,KBL))+UTEN(NSTA,KBL)
245:      VC=S2*(H0-A(NSTA,KBL))+VTEN(NSTA,KBL)
246:      RETURN
247:      END

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APPENDIX G

PRINTED OUTPUT FROM THE SUPPLEMENTARY SOFTWARE

APPENDIX G

PRINTED OUTPUT FROM THE SUPPLEMENTARY SOFTWARE

The supplementary software produces both graphical and printed output. The printed output is shown here. The first page starts by listing the x and y coordinates of the tuning sites and the calculated speeds and ratios at these sites. This information is followed by the speed scale factor, which should be 1.0, and then the maximum and minimum speeds, and the horizontal grid point locations where these speeds occur.

The next pages list the final, calculated wind speeds at each horizontal grid point for the height specified in the input. These speeds are listed downwards, row by row, so that the first speed, 13.4 m/s, corresponds to the grid point I=1, J=40; the second speed, 12.2 m/s, corresponds to I=2, J=40, etc. This pattern continues until the lowest row of speeds has been printed; these are the speeds along the bottom edge of the modeled area.

The width of the paper does not allow all the speeds from one row of model grid points to be printed on one line. Because of this, the speeds from one row require two printed lines, one directly below the other. Speeds from different rows are separated by a blank line.

N	X0	Y0	SPEED	RATIO
1	0.10410E+04	0.59800E+03	18.30000	1.00000
2	0.11357E+04	0.53384E+03	17.44182	0.95309
3	0.11723E+04	0.81104E+03	13.26912	0.72509
4	0.83403E+03	0.11845E+04	14.06171	0.78840
5	0.10138E+04	0.13505E+04	12.59013	0.88799
6	0.15076E+04	0.10152E+04	11.55153	0.83123
7	0.98203E+03	0.16827E+04	11.23508	0.81394
8	0.15824E+04	0.14175E+04	12.30615	0.67247

SCALE FACTOR = 1.000000

MINIMUM SPEED = 9.38 I = 30 J = 5
 MAXIMUM SPEED = 19.27 I = 8 J = 19

SPEED

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13.4 12.2 11.8 11.3 10.9 10.7 10.8 11.0 10.9 10.7 10.6 10.7 11.4 12.5 12.8 11.8 10.9 10.9 11.2 11.4
11.5 11.5 11.4 11.3 11.3 11.3 11.4 11.8 11.8 11.9 11.7 11.3 11.1 11.7 13.1 13.7 12.9 12.5 12.2 11.7

14.8 13.0 12.1 11.5 11.2 11.2 11.2 11.1 10.9 10.7 10.4 10.1 10.5 11.9 13.2 12.9 11.7 11.2 11.8 11.8
11.7 11.6 11.4 11.3 11.3 11.3 11.3 11.5 11.8 11.9 11.7 11.2 10.8 10.9 12.3 13.7 13.8 13.8 12.4 11.8

15.5 13.8 12.8 12.2 11.7 11.4 11.3 11.1 11.0 10.9 10.8 10.2 10.0 10.8 12.5 13.3 12.8 11.9 12.1 12.4
12.1 11.8 11.4 11.3 11.3 11.4 11.4 11.5 11.6 11.6 11.6 11.4 10.7 10.3 11.5 13.2 13.9 13.4 12.6 11.8

15.8 14.3 13.4 12.8 12.2 11.8 11.6 11.4 11.2 11.1 11.0 10.6 10.1 10.1 11.1 12.3 12.8 12.7 12.9 13.1
12.7 12.0 11.6 11.4 11.3 11.4 11.6 11.6 11.6 11.4 11.5 11.7 11.0 10.1 10.6 12.3 13.7 13.7 12.8 11.8

15.8 14.7 14.0 13.4 12.8 12.3 12.1 11.8 11.5 11.4 11.3 11.1 10.7 10.2 10.3 10.8 11.3 12.0 12.9 13.8
13.5 12.7 11.9 11.8 11.5 11.5 11.6 11.6 11.6 11.6 11.7 12.0 11.5 10.3 10.0 11.4 13.0 13.7 13.1 11.9

15.6 14.5 14.1 14.1 13.8 13.2 12.7 12.3 11.9 11.7 11.8 11.5 11.2 10.6 10.4 10.2 10.1 10.4 11.6 12.9
13.6 13.4 12.6 12.1 11.8 11.7 11.8 11.6 11.4 11.8 11.8 12.2 12.0 10.8 10.0 10.7 12.3 13.3 13.1 12.2

16.1 13.9 13.1 13.2 13.7 13.9 13.5 12.8 12.3 12.1 11.8 11.7 11.5 11.1 10.6 10.4 10.0 9.8 10.2 11.3
12.5 13.0 12.8 12.3 12.0 11.8 11.8 11.5 11.4 11.8 12.0 12.2 12.0 11.3 10.4 10.4 11.8 12.7 12.9 12.2

16.4 15.3 14.0 13.2 12.8 13.0 13.6 13.3 12.4 12.2 12.2 12.0 11.7 11.2 10.8 10.6 10.4 10.2 10.1 10.5
11.3 11.9 12.1 12.0 11.8 11.8 11.4 11.2 11.2 11.7 12.2 12.3 11.9 11.4 10.8 10.6 11.1 12.0 12.5 12.1

15.6 16.0 15.8 14.8 14.0 13.1 13.2 13.3 12.8 12.7 12.5 12.1 11.8 11.4 10.9 10.7 10.7 10.7 10.6 10.7
11.1 11.3 11.3 11.4 11.4 11.2 10.9 10.7 10.9 11.7 12.3 12.3 11.9 11.5 11.1 11.0 11.1 11.4 11.9 11.9

14.8 15.1 15.3 15.1 14.4 13.9 14.0 13.8 12.8 12.9 12.9 12.3 11.9 11.6 11.2 10.9 10.9 10.9 11.0 11.1
11.4 11.5 11.2 11.1 11.2 11.1 10.8 10.2 10.4 11.5 12.4 12.4 12.0 11.8 11.4 11.2 11.1 11.2 11.4 11.5

15.0 14.7 14.4 15.3 14.8 13.8 14.0 14.2 13.1 12.8 13.1 12.7 12.2 11.9 11.8 11.3 11.1 11.1 11.2 11.4
11.7 11.7 11.3 11.0 11.2 11.2 10.8 10.1 9.9 11.0 12.3 12.5 12.1 11.8 11.8 11.5 11.3 11.3 11.2 11.2

14.8 14.7 14.0 15.1 15.5 14.3 13.6 14.1 13.7 13.0 13.0 13.0 12.8 12.3 12.1 11.9 11.8 11.4 11.5 11.9
12.1 11.8 11.3 11.0 11.1 11.2 11.0 10.4 9.8 10.3 11.7 12.5 12.3 12.1 11.9 11.8 11.6 11.3 11.3 11.1

14.4 14.0 13.8 15.1 15.7 14.9 14.1 13.9 13.8 13.0 12.8 12.9 12.8 12.7 12.8 12.8 12.3 11.7 11.7 12.3
12.5 11.9 11.4 11.1 11.1 11.2 11.2 10.8 10.1 9.9 10.8 12.0 12.2 12.1 12.0 11.9 11.8 11.6 11.4 11.1

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14.4 13.0 13.2 14.9 16.0 15.3 14.5 14.0 13.4 12.8 12.4 12.3 12.4 12.4 12.5 12.8 12.8 12.1 12.1 12.7
 12.6 11.9 11.5 11.2 11.2 11.3 11.3 11.1 10.8 10.3 10.3 11.1 11.7 11.8 11.9 11.9 11.8 11.7 11.4 11.0
 14.9 12.8 12.8 14.1 15.9 15.8 15.1 14.6 13.8 13.0 12.4 12.0 11.9 11.9 12.1 12.7 13.1 12.5 12.2 12.8
 12.6 11.8 11.4 11.3 11.3 11.3 11.4 11.3 11.1 10.9 10.7 10.8 11.2 11.4 11.5 11.8 11.5 11.5 11.8 11.1
 15.1 13.9 12.7 13.1 14.8 15.5 15.4 15.4 15.1 14.1 13.2 12.5 12.0 11.7 11.8 12.9 13.8 13.3 12.6 12.7
 12.6 11.9 11.4 11.4 11.4 11.4 11.4 11.4 11.3 11.3 11.1 10.9 11.1 11.2 11.3 11.6 11.5 11.3 11.5 11.6
 15.0 14.9 14.0 13.4 13.7 14.1 14.5 14.9 15.4 15.4 14.8 13.7 12.7 12.1 11.9 12.7 13.9 14.0 13.3 12.9
 12.6 12.1 11.7 11.6 11.5 11.5 11.5 11.5 11.5 11.5 11.4 11.2 11.1 11.2 11.2 11.5 11.6 11.3 11.2 11.7
 14.6 15.7 15.6 14.9 14.3 13.7 13.2 13.5 14.3 15.0 15.2 14.8 13.7 12.6 12.0 12.7 14.0 14.2 13.4 12.8
 12.6 12.4 12.1 11.8 11.8 11.7 11.8 11.5 11.5 11.5 11.6 11.5 11.2 11.2 11.1 11.2 11.4 11.3 11.2 11.5
 13.1 15.0 16.8 17.1 16.2 15.0 13.8 13.1 13.1 13.6 14.4 14.9 14.4 12.9 12.2 12.8 14.1 14.4 13.3 12.4
 12.2 12.2 12.1 11.9 11.8 11.7 11.7 11.6 11.5 11.6 11.8 11.8 11.4 11.3 11.2 11.0 11.0 11.1 11.1 11.3
 11.6 12.7 14.7 17.2 18.2 17.6 15.9 14.3 13.4 13.1 13.5 14.2 14.8 13.6 12.4 12.8 13.9 14.4 13.6 12.6
 12.6 11.9 11.8 11.7 11.7 11.8 11.5 11.6 11.5 11.5 11.6 11.6 11.5 11.4 11.4 11.1 10.8 11.0 11.4 11.2
 10.8 11.8 12.3 14.4 16.7 18.5 18.8 17.0 15.0 14.3 14.2 14.4 14.7 14.4 13.3 12.8 13.3 13.6 13.6 13.0
 12.4 12.0 11.9 11.7 11.6 11.6 11.8 11.5 11.4 11.4 11.5 11.6 11.8 11.5 11.4 11.3 10.9 10.9 11.4 11.4
 10.3 11.3 11.6 12.6 14.0 15.4 17.9 19.3 17.7 16.3 16.1 15.7 15.4 15.2 14.4 13.8 13.2 13.2 13.1 12.8
 12.7 12.5 12.2 12.0 11.9 11.7 11.7 11.6 11.5 11.3 11.4 11.6 11.6 11.5 11.5 11.3 11.0 10.8 11.2 11.5
 9.9 10.8 11.4 11.8 12.4 12.7 14.1 17.2 18.6 18.0 17.7 17.6 16.9 16.3 15.4 14.5 13.8 13.6 13.6 13.2
 12.9 12.8 12.7 12.6 12.3 12.1 12.0 11.8 11.7 11.5 11.5 11.7 11.8 11.6 11.5 11.4 11.2 10.9 11.0 11.4
 10.2 10.5 11.1 11.5 11.6 11.8 11.9 13.6 16.1 17.1 17.5 18.1 18.2 17.5 16.5 15.5 14.7 14.5 14.8 14.4
 13.7 13.3 13.2 13.2 12.9 12.6 12.4 12.1 12.0 11.8 11.6 11.8 11.8 11.7 11.6 11.5 11.3 11.1 11.0 11.3
 10.9 10.6 11.3 11.4 11.2 11.3 11.2 11.4 12.7 14.5 15.6 16.9 18.1 18.4 17.5 16.3 15.4 15.2 15.5 15.6
 14.8 13.8 13.3 13.3 13.3 13.1 12.8 12.4 12.2 12.1 11.8 11.7 11.8 11.8 11.6 11.6 11.4 11.2 11.1 11.2
 11.6 11.0 11.7 11.8 11.0 10.9 10.9 10.5 10.5 12.1 13.7 15.1 16.9 18.4 18.2 16.8 15.5 15.1 15.6 16.4
 15.8 14.3 13.1 12.8 12.9 13.0 12.9 12.7 12.4 12.2 12.1 11.8 11.7 11.8 11.7 11.6 11.5 11.4 11.2 11.2
 12.1 11.8 12.5 12.5 11.2 10.5 10.6 10.2 9.8 10.2 11.9 13.3 15.0 17.3 18.6 17.4 15.3 14.4 15.4 17.1
 17.1 15.3 13.4 12.4 12.2 12.4 12.7 12.7 12.6 12.3 12.1 11.9 11.7 11.7 11.8 11.6 11.5 11.5 11.4 11.2
 11.6 12.4 13.1 13.3 11.9 10.5 10.2 10.2 9.6 9.4 10.4 11.8 13.2 15.2 17.4 18.1 16.0 13.8 14.2 16.7
 16.1 17.0 14.7 13.0 12.2 12.0 12.3 12.7 12.7 12.5 12.3 12.1 11.8 11.6 11.7 11.7 11.7 11.6 11.5 11.3
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