N O T I C E

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FINAL REPORT

on

An Algorithm to Generate Input Data from Meteorological and

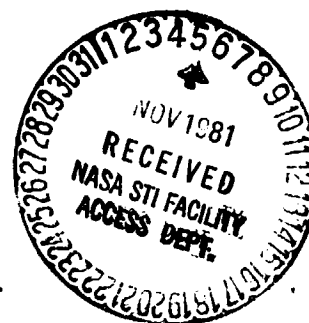Space Shuttle Observations to Validate a CH_4-CO Model

by

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AN ALGORITHM TO GENERATE INPUT DATA FROM METEOROLOGICAL AND SPACE SHUTTLE OBSERVATIONS TO VALIDATE A CH_4-CO MODEL

ABSTRACT

This research addressed objective procedures to analyze data from meteorological and Space Shuttle observations to validate a three-dimensional model which describes the transport and chemistry of carbon monoxide and methane in the troposphere. These efforts will ultimately provide the knowledge needed to understand the chemical dynamics of these species in the troposphere. There have been four aspects of this research: (1) Detailed evaluation of the variational calculus procedure, with the equation of continuity as a strong constraint, for adjustment of global tropospheric wind fields; (2) Reduction of the National Meteorological Center (NMC) Data Tapes for data input to the OSTA-1/MAPS Experiment; (3) Interpolation of the NMC Data for input to the CH_4-CO model; and (4) Temporal and spatial interpolation procedures of the CO measurements from the OSTA-1/MAPS Experiment to generate usable contours of the data. Each of these aspects is discussed in this report.

INTRODUCTION

Combined transport/chemistry models can be employed to analyze the circulation of pollutants from their sources to sinks. Depending on the time scale of the phenomena involved, these models can be broadly classified into urban, regional, or global scale. Sulfur dioxide and particulates are examples of pollutants that are important on urban scales, whereas the SO_2-sulfate conversion is representative of a problem of regional importance. Finally, carbon monoxide is a species that has significant sources and sinks on a global scale.

This report describes research to develop an algorithm to process

meteorological and CO observational data for model simulations that would be compared with CO concentrations obtained from measurements on Space Shuttle missions. In the future, data from National Meteorological Center tapes and CO observations from Space Shuttle experiments will be used to generate input and comparison data for model simulations based on the procedures discussed in this report.

OBJECTIVES OF RESEARCH

The overall objectives of this research can be summarized as follows:

a) Development of suitable spatial and temporal interpolation and extrapolation procedures to provide representative approximations of the discrete wind-field data which are necessary for the model simulations; and

b) Development of representative three-dimensional CO data from two-dimensional observations, and interpolation of meteorological data for use in tropospheric species transport models.

Most of the effort was expended on the first objective which, due to the size of the system, proved to be an unwieldy problem. Nevertheless, some suggestions relative to the second objective will be made.

DISCUSSION OF RESEARCH

The greatest emphasis during this research has dealt with the velocity field. This is most important since a mass-conservative wind field is essential to minimization of systematic numerical errors during integration of turbulent transport equations. The approaches which have been evaluated in the past to guarantee conservative wind fields will be briefly discussed. This actually involves two separate problems: (a) Establishing a conservative wind field from the observations generally available at 0:00 and 12:00 GMT; and

(b) Interpolating between these observation periods (wind fields are required at approximately 1/2-hour intervals for many models) to establish representative "best wind fields" at intermediate times that are also conservative. The thrust of our research in these areas will be discussed separately. The presentation has been divided into the following four sub-areas: (a) Spatial Adjustment of Data; (b) Temporal Interpolation of Meteorological Parameters; (c) Decoding the NMC Data Tape; and (d) Temporal and Spatial Interpolation of CO Data.

Spatial Adjustment of Data

A wind field that is free of errors and satisfies a particular set of general relations is a very important input parameter for all kinds of meteorological models, whether these models are for weather forecasting or for atmospheric transport studies. Unfortunately, such a wind field is not easily provided. The observed wind field data, as available mainly from rawinsonde measurements, contain observational errors and small scale effects, and as a result, do not satisfy general physical relations, say mass conservation or other diagnostic relations applicable to a particular atmospheric model. Such a wind field when input to model computations can lead to highly inaccurate results with initial errors multiplied many fold. In order to overcome this, it becomes an important and essential task to treat and adjust the observed wind field data in such a way that the observed data are minimally adjusted. But at the same time, the adjusted values should satisfy the physical relations applicable to a particular atmospheric model. For example, a mass consistent wind field is a must in the transport and diffusion atmospheric model. Thus, for such models the observed wind fields are adjusted so as to satisfy the mass conservation condition, i.e., the continuity equation.

Several methods of varying degrees of complexity have been investigated

to accomplish this mass conservation. The first and simplest is establishing a vertical velocity component by numerically differencing the equation of continuity*

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \tag{1}$$

Thus, from Equation (1) the vertical velocity is immediately calculated taking $w = 0$ at $z = 0$ to initiate the calculation. This procedure has been used with completed initial simulations (Peters and Jouvanis, 1979 and Carmichael and Peters, 1981).

This procedure is very simple to use. However, due to errors in the reported observed wind field, the calculated vertical velocity can be more representative of "noisy data" than of the actual vertical motions. As a result, representativeness of the wind field may be sacrificed and not attained by this simple method. The procedures discussed next recognize that there are observational errors and make allowance for such.

A technique employed in the past (Endlich, 1967 and Goodlin, 1976) uses a point iterative method to adjust the observed wind field data so as to satisfy the desired physical constraints. Goodin et al. (1980) recently used a hybrid of the point iterative procedure with numerical satisfaction of the continuity equation.

A seemingly more general and powerful technique is that based on variational calculus principles. This technique, which was first proposed by Sasaki (1958), allows the observed wind field data to be changed by a minimum amount in a least squares sense, while at the same time, adjusted values satisfy the imposed physical conditions within numerical approximation errors.

Subsidiary conditions that are to be satisfied exactly are termed strong

* All of the development presented in this section will assume constant density for simplicity. However, analysis using a varying density is an obvious and straightforward extension and is being included in the actual analysis.

constraints, while conditions being imposed approximately are weak constraints. This technique has been extended to a number of situations with various forms of constraints. Washington and Duquet (1963) used the technique with the geostrophic approximation while Sasaki (1958) and Stephens (1970) applied the balance equation as the dynamic constraint. Achtemeier (1975) extended the technique with a number of constraints such as the momentum, energy, continuity, and hydrostatic equations. Later work seems to lead to a more complex network of non-linear equations that must be linearized before solving them. Recently, Dickerson (1978) and Sherman (1978) used a variational technique to adjust the observed wind field in the San Francisco Bay area under the strong constraint of the continuity equation.

Generally, the mathematical formulations of the variational technique may be described as follows. Let u°, v°, and w° be the observed velocity components of a wind field, and u, v, and w be the corresponding modified adjusted values. The difference between the observed and adjusted field may be expressed in a least squares sense as

$$\alpha_1^2(u - u^\circ)^2 + \alpha_2^2(v - v^\circ)^2 + \alpha_3^2(w - w^\circ)^2 \qquad (2),$$

where α_1, α_2, and α_3 are weighting functions defined as the reciprocal of twice the variance of the errors of observations for the respective observed components. The simplification of $\alpha_1 = \alpha_2$ has been used in the past on the basis that the errors in the horizontal components should be comparable. In order to obtain the modified values, u, v, and w, it is required that the adjustment over space and time, subject to the satisfaction of the constraint equations, be a minimum. An adjustment functional, therefore, may be expressed as

$$I = \int_V \int_t [\alpha_1^2(u - u^\circ)^2 + \alpha_2^2(v - v^\circ)^2 + \alpha_3^2(w - w^\circ) + \gamma G_1 + \lambda G_2] \, dt dV \quad (3),$$

where G_1 is a weak constraint which is introduced into the functional through the constant γ. The strong constraint G_2 is introduced through the Lagrangian multiplier λ. Equation (3) defines a variational problem in which a minimum value of the integrand under the given constraints G_1 and G_2 is being sought; i.e, the first variation on I must vanish, $\delta I = 0$. As a result, the associated Euler-Lagrange equations along with the so-called natural boundary conditions being inherited from the variational formulation must be satisfied. For example, a functional such as given in Equation (3) with the continuity equation as the only strong constraint and no weak constraint yields the following associated Euler-Lagrange equations along with natural boundary conditions (Sasaki, 1958).

$$u = u^\circ + \frac{1}{2\,\alpha_1^2} \frac{\partial \lambda}{\partial x} \tag{4}$$

$$v = v^\circ + \frac{1}{2\,\alpha_1^2} \frac{\partial \lambda}{\partial y} \tag{5}*$$

$$w = w^\circ + \frac{1}{2\,\alpha_3^2} \frac{\partial \lambda}{\partial z} \tag{6}$$

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \tag{7}$$

The natural boundary conditions are

$$n_x \lambda \delta u = n_y \lambda \delta v = n_z \lambda \delta w = 0 \tag{8},$$

where δu, δv, and δw are the first variation of velocity components, and n_x, n_y, and n_z are the outward positive unit normals in the subscripted directions. From Equations (4) through (7), an expression for λ may be obtained as

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* Note that $\alpha_1 = \alpha_2$ has been assumed.

$$\frac{\partial^2 \lambda}{\partial x^2} + \frac{\partial^2 \lambda}{\partial y^2} + \left(\frac{\alpha_1^2}{\alpha_3^2}\right) \frac{\partial^2 \lambda}{\partial z^2} = -2\alpha_1^2 \left(\frac{\partial u^\circ}{\partial x} + \frac{\partial v^\circ}{\partial y} + \frac{\partial w^\circ}{\partial z}\right) \qquad (9).$$

Equation (9) along with boundary conditions as given in Equation (8) can now be solved for $\lambda(x,y,z)$, which in turn is used in Equations (4), (5), and (6) to estimate the adjusted values of the velocity components.

The adjustment procedures under the continuity condition as a strong constraint, as described above, lead to working equations which are in principle easy to apply. These procedures with Equations (3) through (8) have been evaluated for small regions, such as the San Francisco Bay area, by Dickerson (1978) and Sherman (1978). For the global wind field adjustment problem, the validity of these procedures has yet to be completely evaluated. On the global scale, it may be required that the wind field not only satisfy the continuity relation but also retain other observed kinematic properties. One of the important kinematic properties of the wind is its vorticity. In such cases another constraint defining vorticity of the wind may be introduced into Equation (3) through a second Lagrange multiplier λ_2. Consider that it is required to retain only the vertical component of vorticity, ζ_z°, estimated from the observed velocity components. Then the second constraint may be expressed as

$$\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} = \zeta_z^\circ = \frac{\partial v^\circ}{\partial x} - \frac{\partial u^\circ}{\partial y} \qquad \text{or} \qquad \frac{\partial(v-v^\circ)}{\partial x} - \frac{\partial(u-u^\circ)}{\partial y} = 0 \qquad (10).$$

The functional as defined by Equation (3) with the continuity equation and vorticity, Equation (10), as strong constraints leads to the following Euler-Lagrange equations

$$u = u^\circ + \frac{1}{2\alpha_1^2} \frac{\partial \lambda_1}{\partial x} - \frac{1}{2\alpha_1^2} \frac{\partial \lambda_2}{\partial y} \qquad (11),$$

$$v = v^\circ + \frac{1}{2\alpha_1^2} \frac{\partial \lambda_1}{\partial y} + \frac{1}{2\alpha_1^2} \frac{\partial \lambda_2}{\partial x} \qquad (12),$$

$$w = w^\circ + \frac{1}{2\,\alpha_3^2} \frac{\partial \lambda_1}{\partial z} \tag{13}$$

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \tag{14}$$

$$\frac{\partial(v-v^\circ)}{\partial x} - \frac{\partial(u-u^\circ)}{\partial y} = 0 \tag{15}$$

with natural boundary conditions

$$n_x \lambda_1 \delta u - n_y \lambda_2 \delta u = 0 \tag{16}$$

$$n_x \lambda_2 \delta v + n_y \lambda_1 \delta v = 0 \tag{17}$$

$$n_z \lambda_1 \delta w = 0 \tag{18}$$

λ_1 and λ_2 are the Lagrange multipliers for the continuity and vorticity constraints, respectively, and the following equations for λ_1 and λ_2 may be obtained from Equations (11) through (15).

$$\frac{\partial^2 \lambda_1}{\partial x^2} + \frac{\partial^2 \lambda_1}{\partial y^2} + \left(\frac{\alpha_1^2}{\alpha_3^2}\right) \frac{\partial^2 \lambda_1}{\partial z^2} = -2\alpha_1^2 \left(\frac{\partial u^\circ}{\partial x} + \frac{\partial v^\circ}{\partial y} + \frac{\partial w^\circ}{\partial z}\right) \tag{19}$$

$$\frac{\partial^2 \lambda_2}{\partial x^2} + \frac{\partial^2 \lambda_2}{\partial y^2} = 0 \tag{20}$$

Equations (19) and (20) along with the boundary conditions (Equations 16 - 18) can be solved for λ_1 and λ_2 which can in turn be substituted in Equations (11) to (13) to estimate the adjusted values of the velocity components.

This variational formulation is applicable to those cases in which only the observed vertical component of the vorticity is to be retained. Similarly, cases constraining all three components of vorticity may be formulated. Such a formulation not only leads to more complicated equations which are more difficult to solve, but it also involves vorticity terms which require observed values of the vertical velocity. In practive, the vertical velocities are

rarely measured at meteorological stations. Therefore, it leads to considerable uncertainty and difficulty in calculating the observed x- and y-direction vorticities.

Any or all of the fundamental equations describing the state of the atmosphere could be used as constraints in a variational sense. However, only Achtemeier (1972) has attempted to treat the observed data so they satisfy the complete set of equations comprising the mathematical model for the atmosphere, and he did that based on the variational method. This is probably the best approach in treating the limited experimental data obtained every twelve hours, and if applied, it would yield sets of "data" which, in terms of the mathematical model used, consistently describe the state of the atmosphere at discrete points in time.

To summarize, the four procedures represented by (a) Equation (1) alone; (b) Equations (4) through (9); (c) Equations (11) through (20); and (d) the completely constrained formulation represent a comprehensive analysis of global wind field adjustment procedures. Only Procedure (b) has been studied in this research. The computer program to solve that set of equations is presented in the Appendix. The program is written in SL/1 for use on the NASA LaRC STAR computer.

Temporal Interpolation of Meteorological Parameters

The preceding analyses deal with the meteorological configuration based on observations at a specific time. Generally, observations are only available every 12 hours while data describing the state of the atmosphere may be required at the intermediate time periods. As mentioned previously, transport modeling efforts frequently require such information at 30 minute intervals. In this section, a procedure to achieve this will be described. It is an extension of the mass-consistent wind field methodology presented in the previous

section. (These temporal interpolation studies may also be applicable to the data reduction procedure for the MAPS instrument which requires the temperature (to within 2°K) and water vapor profiles to determine the CO concentration. Again, since the data are only available at 12-hour intervals, the projection of these meteorological variables at the intermediate times at locations under the Space Shuttle track are required. The procedure that is suggested could also be applied to those requirements.)

The variational formulation for spatial adjustment is applicable to the observed data available at one time level. However, a similar formulation may be extended to any time level, and interpolation of data between two time levels may be obtained in such a way that the interpolated data satisfy the given constraint(s). Consider that observed values of wind field data are given for time levels t_n and t_{n+1}. It is required to estimate interpolated values at time t where $t_n < t < t_{n+1}$. If linear interpolation between time levels is assumed, then the functional in this case may be written as

$$I* = \int_V \int_{t_n}^{t_{n+1}} [\alpha_1^2(U - U*)^2 + \alpha_1^2(V - V*)^2 + \alpha_3^2(W - W*)^2$$
$$+ \lambda \left(\frac{\partial U}{\partial x} + \frac{\partial V}{\partial y} + \frac{\partial W}{\partial z}\right)]\, dt dV \tag{21}$$

where

$$U = \frac{u - u_n}{t - t_n} \qquad \text{and} \qquad U* = \frac{u_{n+1} - u_n}{t_{n+1} - t_n} \tag{22},$$

with similar definitions for V and W. It can be shown that a simple transformation on the velocity components can reduce Equation (21) to a functional similar to that of Equation (3) from which Euler-Lagrange equations and boundary conditions are obtained which adjust the interpolated wind field so that the continuity equation is automatically satisfied. Thus, the wind field proceeds smoothly from the configuration at t_n to that at t_{n+1}. Equation (21) and the

associated conditions apply to linear temporal interpolation, but non-linear interpolation schemes are readily handled. Finally, the additional constraint of vorticity can also be incorporated.

Decoding the NMC Data Tape

The National Meteorological Center Data tape includes considerable data that are not necessary for interpretation of the OSTA-1/MAPS experimental data. In addition, separate tapes are used for the Soutern and Northerm Hemispheres and these data must be merged. Finally, the data must be decoded for use by the MAPS Science Team. A substantial effort was expended in this phase of the project.

Weather data tapes produced by the National Meteorological Center have been coded in a binary format not easily utilized by most computer programming languages. For this reason, a preliminary procedure must be performed on the data, to transform it into a standard EBCDIC format. (See the Appendix for a description of the data on the NMC tape.) DECODE is a PL/1 program which converts the NMC binary data to their EBCDIC equivalents. The tape format is also modified so that only certain desired fields are processed and retained. A program listing of DECODE is also contained in the Appendix and has been designed for use on the IBM 370 at the University of Kentucky.

DECODE works by manipulating PL/1 data structures. Data are read into a structure of bit strings. Then, using a subroutine, the binary data are converted, first to fixed binary numbers, then to EBCDIC characters for output to tape. Conversions are done based on the equations given in Office Notes 84 and 184 from the National Meteorological Center (see the Appendix for copies of these). A selection is made so that only the desired data are processed. All included data are of type 8. Data are included for the following conditions:

1. Q = 1, height with respect to mean sea level geopotential

(at 12 levels),

2. Q = 16, atmospheric temperature in degrees Kelvin (12 levels),

3. Q = 48, u-component of wind (12 levels),

4. Q = 49, v-component of wind (12 levels), and

5. Q = 88, relative humidity (6 levels).

A sort is then done to sequence the data in the proper order for merging into longer records. The input records contain all the data for 5,365 points on a southern or northern hemispheric grid of 145 x 37. Two input records are required to store all 10,730 of the global values for each time period of a two time-period day, with 15 days making up a complete tape. Alternate data values have been omitted, leaving 2 grids of 73 x 19, which corresponds to a 5° x 5° gridding. The output records contain data for 2,774 global points in a west to east, south pole to north pole order, with the sort field values included for identification purposes. In this manner, selected data from a full time period can be contained in a single record. Data fields (and their formats) included in the output records are

DATA-TYPE	F(14)	type of surface;
CI	F(14)	value of surface levels;
Y	F(14)	year;
M	F(14)	month;
D	F(14)	day;
I	F(14)	time period;
DATA(1387)	F(9)	data values from the southern grid; and
DAT2(1387)	F(9)	data values from the northern grid.

The records are sorted by year, month, day, time period, type of surface, and value of surface levels in descending order. The type of data is sorted in the following order: 48, 49, 1, 16, 88.

DECODE has been designed for maximum ease of utility by the end-user. Only one modification must be made prior to submission of the job with a new tape. JCL cards describing the input and output datasets must be prepared for each run of the program. Input (the NMC tape) is defined as SYSUT1, illustrated by the following example:

```
//SYSUT1 DD UNIT = 3400-5, VOL = SER = tape-number, DISP = (OLD,PASS),
//        DSN = name.of.dataset.on.tape,LABEL = (file-number,SL)
```

Output records may be sent to either disk or tape. However, the JCL for tape is simpler to prepare since the output records are longer than a track and therefore would require VBS records on disk. Be sure to specify a large enough SPACE parameter when using disk. A sample JCL definition for output on tape follows.

```
//GO.TAPE DD UNIT = 3400-5, VOL = SER = tape-number, DISP = (,PASS),
//        DCB = (RECFM = F,LRECL = 25050,BLKSIZE = 25050),
//        DSN = name.of.dataset.on.tape,LABEL = (file-number,SL)
```

Based on partial tape runs done on the University of Kentucky Computing Center's IBM 370/165 Model II computer running OS/MVT, a projected cost estimate may be made with some degree of accuracy. Since a load module will be used for the production runs, compilation costs for this projection can be ignored. Processing only the 2 time periods of the first day took 55 CPU-seconds of which 3 seconds can be attributed to compile time. Using the remaining 52 seconds of execution time, the approximate cost is $7.52 for decoding the first day. This is based on a $525 per hour charge (the discounted rate for deferred priority). Multiplying by the 15 days on each tape makes each tape cost about $113 to decode. It should be understood that this is only an approximation, and the actual cost will depend on various circumstances at

the time the job is run. Other computer installations use different charging algorithms, so costs will vary even more if run on a different machine.

Interpolation of the NMC Data for OSTA-1/MAPS

The NMC data as decoded provide horizontal winds, temperature, and dew point, all at the pressure levels of 1000, 850, 700, 500, 400, 300, 250, 200, 150, 100, 70, and 50 mb. An interpolation scheme was developed to represent these data in an alternate form. This scheme provides interpolated values for a 5° Longitude x 5° Latitude grid and a non-dimensional vertical coordinate which has $\rho = 0$ at the surface and $\rho = 1$ at the tropopause. The data are provided at $\rho = 0$, 0.0333, 0.0666, 0.10, 0.20, 0.40, 0.60, 0.80, and 1.0. This gridding provides a finer structure within the planetary boundary layer.

With the data unpacked from the NMC tapes consistent with the requirements, the data can then be interpolated for a geometric gridding. The mixing layer depth will also be calculated at each grid point and will use the 1-dimensional planetary boundary layer model of Yamada and Mellor (1975). Those researchers have provided a version of their program which is being modified for the present purposes.

Temporal and Spatial Interpolation of CO Data

The CO measurements from the OSTA-1/MAPS experiment on board the second Space Shuttle flight will correspond to mid-troposphere concentrations below the orbit path. These data will be from 38°S Latitude to 38°N Latitude and represent variations in both space and time. Thus, it is necessary to interpolate the concentration-time-position data at the desired times. The following treatment would accomplish this.

1) Transform the individual 1-second signals to correspond to non-overlapping, discrete orbiter track lengths of 10.37

nautical miles.

2) The information from Item (1) represents a concentration at some time t_k, and some position r_j. The position is, of course, expressible in terms of latitude and longitude.

3) In order to construct an entire concentration field at some time t_n, interpolation in both space and time is required using as much of the data as seems reasonable. Define the following.

$c_i^n \equiv$ Concentration at time t_n and position r_i

$f_{ij}^k \equiv$ Weighting factor for temporal and spatial interpolation scheme

$r_{ij} \equiv$ Distance between positions r_i and r_j

$t_{kn} \equiv t_k - t_n$

$q \equiv$ Total number of locations which are considered to influence interpolated value

$s \equiv$ Total number of time intervals which are considered to influence the interpolated value.

For the present case, $s = q$.

Then, the interpolated concentration is simply

$$c_i^n = \sum_{k=1}^{s} \sum_{j=1}^{q} f_{ij}^k c_j^k \qquad (23).$$

If one considers all of the data, this could be simplified to

$$c_i^n = \sum_{j=1}^{q} f_{ij}^j c_j^j \qquad (24).$$

4) Now the crucial question is, What should be used for f_{ij}^k? There are a few papers on this topic for aerometric data, and one scheme used is an inverse square dependence for

spatial interpolation. Nobody has apparently reported both spatial and temporal interpolation. Nevertheless, one plan to start with is the inverse square dependence for both space and time; i.e.,

$$f_{ij}^{k} = \frac{r_{ij}^{-2} \; t_{kn}^{-2}}{\sum_{j=1}^{q} r_{ij}^{-2} \; \sum_{k=1}^{s} t_{kn}^{-2}} \tag{25}$$

In this manner, f_{ij}^{k} is of course normalized. Other weighting schemes could be tried.

5) The procedure in Items (1) - (4) provides interpolated values over a 10.37 nautical mile region. Since that is too much data to handle reasonably, these values could be averaged over 1° x 1°, 2.5° x 2.5°, or 5° x 5° longitude-latitude intervals. Then these data could be presented in digitized form as well as contours. Contours will be most helpful to see large scale plumes.

This procedure is easily coded, and the weighting function could be varied to evaluate its effect. Furthermore, several times could be done at once, and one may be able to take advantage of the data format, and calculate $\sum_{j=1}^{q} r_{ij}^{-2}$ just once.

CONCLUDING REMARKS

The procedures discussed in this final report will be used to assist in the analysis and interpretation of the CO observations obtained from the OSTA-1/MAPS Experiment which will be aboard the second Space Shuttle flight scheduled for November, 1981. Specifically, DECODE will be used to provide meteorological data from the NMC data tapes in a format useable by the MAPS Science Team. This will include u, v, T, and water vapor concentration data

for the flight period in either a pressure coordinate or a dimensionless terrain/tropopause following coordinate. In addition, an interpolation procedure for the OSTA-1/MAPS CO observation data has been proposed that includes a spatial and temporal weighting function.

A considerable effort has been expended on objective analysis procedures to establish global mass-conservative wind fields from the NMC data. The variational calculus procedure with the equation of continuity as a strong constraint has been coded and is in the final stages of evaluation. Novel adjustment procedures which incorporate vorticity preservation as an additional strong constraint and temporal interpolation during adjustment have also been presented. However, these procedures have not been evaluated. Research is continuing in this overall area of wind field adjustment techniques (Kitada et al., 1981).

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APPENDIX

FILE PAMLAN*

```
/set,pamlam
/copyshf(pamlam)
1       MODULE WINDADJIS(UNIT1=COEFMTRX,UNIT2=SOLMTRX,UNIT3=
        ADJMTRX,UNIT6=OUTPUT,UNIT5=INPUT) BEGIN MAIN;
    $XREF;
    $TITLE:WINDFIELD MODULE = PL/RARIG = SEPTEMBER 2,1981 4
    /*      SOURCE = PAMLAM                      */
    /*      DATA = LAMDATA                       */
    /*      JCL = PAMCTL                         */
    /*=========================================*/
        /* THIS PROGRAM ADJUSTS OBSERVED WIND FIELD TO MAKE
        IT MASS=CONSERVATIVE WIND FIELD. ADJUSTING TECHNIQUE
        IS BASED ON VARITIONAL FORMULATION. SIMULTANEOUS
        EQUATIONS FOR LAMDA TERMS ARE SOLVED USING SUCCESSIVE
        OVER RELAXATION (S-O-R) ITERATION METHOD. FILES NAMED AS
        COEFMTRX,SOLMTRX,AND ADJMTRX HAVE NESSASARY
        ESTIMATED COEFFICIENTS. THESE FILES WILL BE READ IN THIS
        PROGRAM. */
        /* THE FOLLOWING SECTION NEEDS TO BE CHANGED FOR DIFFERENT
        GRID SYSTEM. XTRA1 TO XTRA7 AND ISM1 TO ISM7 ARE
        PAGING PARAMETERS. AL1 IS WEIGHTING FACTOR FOR U VELOCITY
        COMPONENT.                               */
```

* Anyone interested in this program should contact L. K. Peters at the
  University of Kentucky.

```
/*      MODIFICATION HISTORY                              */
/*-----FEBRUARY-18,1981-----------------------------------*/
/*-----COMMENTING REGARDING F3 IMPLICIT I/O-----------*/
/*-----FILE-6 IS NOW OUTPUT!------------------------*/
/*------------------------------------------------*/
/*------------------------------------------------*/
        /*---BEGINING OF THE SECTION---------*/
        LITERALLY "5.0" DYY;
        LITERALLY "72" NUM_EW;
        LITERALLY "37" NUM_NS;
        LITERALLY "9" NUM_ALT;
        LITERALLY "10" NUM_ALTP1;  /*-- NUM_ALTP1= NUM_ALT+1 */
        LITERALLY "23976" EW_NS_ALT;
        LITERALLY "33576" XTRA1;
        LITERALLY "15992" XTRA2;
        LITERALLY "17584" XTRA3;
        LITERALLY "24512" XTRA4;
        LITERALLY "51152" XTRA5;
        LITERALLY "11192" XTRA7;
        LITERALLY "768" ISM1;
        LITERALLY "640" ISM2;
        LITERALLY "128" ISM3;
        LITERALLY "256" ISM4;
        LITERALLY "256" ISM5;
        LITERALLY "256" ISM7;
/*LFE LITERALLY "0.01" AL1; LFE*/
        LITERALLY "3.1415926535897933" PI;
        /* NUM_EW=NUMBER OF GRIDS IN EAST-WEST DIRECTION.
        NUM_NS=NUMBER OF GRIDS IN NORTH-SOUTH DIRECTION.
        NUM_ALT=NUMBER OF GRIDS IN ALTITUDE DIRECTION.
        EW_NS_ALT=TOTAL NUMBER OF GRIDS.
        TOLERANCE=TOLRANCE IN ITERATIONS.
        RLXFAC=RELAXATION FACTOR IN SUCCESIVE OVER RELAXTION
        METHOD. */
        /* END OF THE SECTION---*/
        REAL VECTOR [15] ARRAY(EW_NS_ALT) TX;
        COMMON CT(TX,TDUMP1);
        REAL VECTOR [XTRA1] TDUMP1;
        REAL VECTOR[2644] MYALT;
        REAL VECTOR [5] ARRAY(EW_NS_ALT) ADJX;
        COMMON CA(ADJX,TDUMP3);
        REAL VECTOR [XTRA7] TDUMP3;
        REAL VECTOR [EW_NS_ALT] ARRAY(13) SSX;
        COMMON CSS(SSX,TDUMP4);
        REAL VECTOR [XTRA2] TDUMP4;
        REAL VECTOR [15] ARRAY(EW_NS_ALT) TLAMDA;
        COMMON B1(TLAMDA,TDUMP11);
        REAL VECTOR [XTRA1] TDUMP11;
        REAL VECTOR [EW_NS_ALT] S_DIV;
        COMMON B2(S_DIV,TDUMP5);
        REAL VECTOR [XTRA3] TDUMP5;
```

```
..... ..... ....... ...... .
REAL VECTOR [5] ADJ;
REAL VECTOR [NUM_EW] ARRAY(NUM_NS, NUM_ALT) ALAMDA, BLAMDA;
COMMON B3(BLAMDA, ALAMDA, TDUMP6);
REAL VECTOR [XTRA3] TDUMP6;
REAL VECTOR [NUM_EW] ARRAY(NUM_NS, NUM_ALTP1)
     U, V, W, D, ADJUSTU, ADJUSTV,
ADJUSTW;
COMMON B4(U, V, W, D, TDUMP7);
REAL VECTOR [XTRA4] TDUMP7;
COMMON B5(ADJUSTU, ADJUSTV, ADJUSTW, TDUMP8);
REAL VECTOR [XTRA5] TDUMP8;
REAL VECTOR [EW_NS_ALT] ARRAY(13) VEL;
COMMON B6(VEL, TDUMP9);
REAL VECTOR [XTRA2] TDUMP9;
REAL VECTOR [NUM_ALTP1] Z;
INITIAL (7=\0.0, 0.0333334, 0.0333334, 0.0333334
      , 0.1, 0.2, 0.2, 0.2, 0.2, 0.2\);
REAL AL3, T, ERROR, 777, THETA, TH, CON, MAXDIV, MINDIV, TOLERANCE, RLXFAC;
INTEGER IMINDIV, IMAXDIV;
INTEGER NOT_CONV, I, J, K, NL, I1, I2, I3, I4, J1, J2, K2,
/*LEEK3, ITERATION, K1, IW, E1, E2, E3, E4, E5, NUM_ITER, LEE*/
K3, ITERATION, K1, IW, E1, E2, E3, E4, E5, NUM_ITER, MAX_ITER,
E6, E7, E8, E9, E10, MMMM, JJ, NS_INCR, ALT_INCR, EW_OUT;
REAL VECTOR [333] WLAMDA, WLAMDA1;
REAL VECTOR [9] KLAMDA;
REAL MAXLAMDA, MINLAMDA, AL1;
/**************************************************************************/
/**************************************************************************/
/**************************************************************************/
/**************************************************************************/
/**************************************************************************/
$PAGE;
PROCEDURE MAIN;
/*LEE*/
WRITE_UNIT(6)#'BEGIN MAIN PROCEDURE'#;
READ_UNIT (5)
   (RLXFAC, TOLERANCE, AL1, MAX_ITER, NS_INCR, ALT_INCR,
    EW_OUT)
   #3(F9.0/), 3(I9/), I9#;
/*LEE*/
/* === PLR JANUARY 23 1981 === */
IF EW_OUT > NUM_EW THEN
WRITE_UNIT(6) (EW_OUT) #5X 'USER WANTS' I5#;
EW_OUT := NUM_EW;
ENDI;
OPENMAP('F1', TLAMDA(1)[1], ISM1, F1, 'LARGE');
OPENMAP('F2', S[1], ISM3, E2, 'LARGE');
OPENMAP('F3', BLAMDA(1,1)[1], ISM3, E3, 'LARGE');
OPENMAP('F4', U(1,1)[1], ISM4, F4, 'LARGE');
OPENMAP('F5', ADJUSTU(1,1)[1], ISM5, E5, 'LARGE');
OPENMAP('F6', VEL(1)[1], ISM2, F6, 'LARGE');
```

```
      OPENMAP('COEMTRX',TX(1)[1],ISM1,F8,'LARGE')!
      OPENMAP('SOLMTRX',SSX(1)[1],ISM2,F9,'LARGE')!
      OPENMAP('ADJMTRX',ADJX(1)[1],ISM7,F10,'LARGE')!
/*LEE--WRITE UNIT(6)(E1,E2,E3,E4,E5,E6,E8,E9
      ,F10)#'OPEN', 9(3XI2)#!LEE*/
      WRITE UNIT(6)(E1,E2,E3,E4,E5,E6,E8,E9
      ,F10)#' OPEN',9(3XI2)#!
      NUM_ITER := 0!
/*LEE--WRITE UNIT(6)
      (DYY,NUM_EW,NUM_NS,NUM_ALT,AL1,TOLERANCE,RLXFAC)#'DYY = ',
      F5.2,
      'NUM_EW =',I3,'NUM_NS = ',I3,'NUM_ALT = ',I3,
      'AL1 = ',F7.3,'TOLERANCE = ',F8.4,
      'RLXFACTOR =',F6.3#!LEE*/
      WRITE UNIT(6)
      (DYY,NUM_EW,NUM_NS,NUM_ALT,AL1,TOLERANCE,RLXFAC,
      MAX_ITER)#' DYY = ',F5.2,
      ' NUM_EW =',I3,' NUM_NS = ',I3,' NUM_ALT = ',I3,
      ' AL1 = ',F7.3,' TOLERANCE = ',F8.4,
      ' RLXFACTOR = ',F6.3,' MAX_ITER =',I3#!
      CON := PI/180.0!
      K2 := NUM_ALT+1!
      /* INITIALIZING ALAMDA AND BLAMDA ARRAYS-GIVING
      FIRST GUESS VALUES */
/* LAMBDA VALUES ARE FOUND ON PAGE FILE F3    */
/* WHEN THE FOLLOWING IMPLICIT I/O IS         */
/* IS COMMENTED OUT, OLD VALUES FROM SAVED    */
/* FILE F3 ARE NOT OVER-WRITTEN               */
/*-------------------------------------------*/
      THETA:=90.0 + DYY!
      FOR J := 1 TO NUM_NS DO
      THETA := THETA-DYY!/*NOT NEEDED PLR-FEB 17,81 */
/* UP THE INITIAL VALUES BY 1.0E+06  */
      FOR K := 1 TO NUM_ALT DO
      BLAMDA(J,K)[1:NUM_EW] := 2.0E+06!
      ALAMDA(J,K)[1:NUM_EW] := 2.0E+06!
      ENDF!
      ENDF!
      FOR J := 1 TO NUM_NS DO
      FOR K := 1 TO NUM_ALT DO
      FOR I := 1 BY 2 TO NUM_EW DO
      BLAMDA(J,K)[I] := 1.0E+06!
      ALAMDA(J,K)[I] := 1.0E+06!
      ENDF!
      ENDF!
      ENDF!
/* === END OF I/O === INSERT COMMENT HERE ==*/
/* === FLOAT APRIL 7TH == */
/* BLAMDA(5,5)[36] := 1.5E+06!
      ALAMDA(5,5)[36] := 1.5E+06! */
      FOR J := 1 TO NUM_NS DO
```

```
        WLAMDA[J] := BLAMDA(J,5)[36];
      ENDF;
/*LEE*/WRITE UNIT(6)#'WLAMDA ARE;'#;/*LEE*/
      WRITE UNIT(6)(WLAMDA[1:NUM_NS])#5E14.7#;
      FOR K := 1 TO NUM_ALT DO
        KLAMDA[K] := BLAMDA(5,K)[36];
      ENDF;
/*LEE WRITE UNIT(6)(KLAMDA[1:NUM_ALT])#'KLAMDA = ',5E14.7#;
      WRITE UNIT(6)(BLAMDA(5,5)[30:40])#'LAMDA = ',5E14.7#;
      WRITE UNIT(6)(BLAMDA(5,5)[1],BLAMDA(5,5)[NUM_EW])
      #'LAMDA = ',2E14.7#;LEE*/
/*LEE*/WRITE UNIT(6)(KLAMDA[1:NUM_ALT])#' KLAMDA = ',5E14.7#;
      WRITE UNIT(6)(BLAMDA(5,5)[30:40])#'LAMDA = ',5E14.7#;
      WRITE UNIT(6)(BLAMDA(5,5)[1],BLAMDA(5,5)[NUM_EW])
      #' LAMDA = ',2E14.7#;/*LEE*/
      FOR I := 1 TO 13 DO
        VEL(I)[1:EW_NS_ALT] := 0.0;
      ENDF;
/*  INITIALIZING WIND FIELD U,V,W AND DENSITY D ARRAYS */
      THETA := -90.0-DYY;
      FOR J := 1 TO NUM_NS DO
        THETA := THETA+DYY;
        TH := THETA*CON;
        FOR K := 1 TO K2 DO
          U(J,K)[1:NUM_EW] := -10.0;
          V(J,K)[1:NUM_EW] := -3.0            ;
          W(J,K)[1:NUM_EW] := 0.0;
          D(J,K)[1:NUM_EW] := -1.0;
        ENDF;/*LOOP ON K  LEE*/
      ENDF;/*LOOP ON J  LEE*/
      CALL DIVRGNCE;
      CALL SOR;
/*  AUG 27TH,1981        */
/*  PRINT OUT 10  LARGEST AND */
/*  SMALLEST DIVS PER LAYER...SELEQ RETURNS */
/*  # OF UNSUCCESSFUL COMPARISONS;  */
/*                              */
      FOR K := 1 TO NUM_ALT DO
        NL := 0;
        WRITE UNIT(6)(K)#1H1,///,40X,'ALTITUDE = ',I3,///#;
        FOR J := 1 TO NUM_NS DO
          FOR I := 1 TO NUM_EW DO
            NL := NL+1;
            MYALT[NL]:=DIV[(K-1)*72+(J-1)*648+I];
          ENDF;
        ENDF;
      MYALT[1:2664]:=ABS(MYALT[1:2664]);
      FOR JJ := 1 TO 20 DO
        MAXDIV:=MAX(MYALT);
        MINDIV:=MIN(MYALT);    .
```

```
      IMAXDIV:=SELEQ(MYALT,MAXDIV)+1;
      IMINDIV:=SELEQ(MYALT,MINDIV)+1;
      J1:=IMAXDIV.DIV.72.+1;
      I1:=IMAXDIV-((J1-1)*72);
      J2:=IMINDIV.DIV.72+1;
      I2:=IMINDIV-((J2-1)*72);
      WRITE UNIT(6)(K,MAXDIV,IMAXDIV,I1,J1,MINDIV,IMINDIV,I2,J2)
      #5X,I5,E15.5,3I5,E15.5,3I5#;
      MYALT[IMAXDIV]:=0.0;
      MYALT[IMINDIV]:=0.0;
      END;
      ENDF;
      CLOSE('F1',E1);
      CLOSE('F2',E2);
      CLOSE('F3',E3);
      CLOSE('F4',E4);
      CLOSE('F5',E5);
      CLOSE('F6',E6);
      CLOSE('COEMTRX',E8);
      CLOSE('SOLMTRX',E9);
      CLOSE('ADJMTRX',E10);
/*LEE   WRITE UNIT(6)(E1,E2,E3,E4,E5,E6,E8
      ,E9,E10)#'CLOSE', 9(3XI2)#;LEE*/
      WRITE UNIT(6)(E1,E2,E3,E4,E5,E6,E8
      ,E9,E10)#' CLOSE', -9(3XI2)#;
/*LEE*/ WRITE UNIT(6)#'1LEAVE MAIN PROCEDURE'#;/*LEE*/;
      ENDP;/*MAIN  LEE*/
      /******************************************************************/
      /******************************************************************/
      /******************************************************************/
      /******************************************************************/
      /******************************************************************/
$PAGE;
      PROCEDURE DIVRGNCE;
/*   REVISIO  JUNE 8,1981  PL/RARIG           */
/*   TREAT EDGE NODES FOR VEL(4,8,10)         */
/*   K=1    GROUND EDGE                       */
/*   K=9    TROPOPAUSE EDGE                   */
/*------------------------------------------- */
/*LEE*/ WRITE UNIT(6)#'1BEGIN PROCEDURE DIVRGNCE'#;/*LEE*/
      /* THIS PROCEDURE ESTIMATES THE VALUE OF RIGHT HAND SIDE
      OF EQUATIONS. AT THE END IT CALCULATES THE DIVERGENCE
      OF OBSERVED OR ADJUSTED WIND FIELD. */
      NL := 0;
      FOR J := 1 TO NUM_NS DO
         FOR K := 1 TO NUM_ALT DO
            FOR I := 1 TO NUM_EW DO
               NL := NL+1;
               I1 := I+1;
               I2 := I-1;
               IF I1=NUM_EW+1 THEN I1 := 1;END;
```

```
        IF I2=0      THEN I2 := NUM_EW;ENDI;
            VEL(1)[NL] := U(J,K)[I]*D(J,K)[I];
            VEL(2)[NL]-:= U(J,K)[I2]*D(J,K)[I2];
            VEL(3)[NL]-:= U(J,K+1)[I]*D(J,K+1)[I];
            IF K=1 THEN
                VEL(4)[NL]-:= (2*U(J,1)[I]-U(J,2)[I])*(2*D(J,1)[I]
                -D(J,2)[I]);
            ENDI;
            IF K=9 THEN
                VEL(4)[NL]-:= (2*U(J,8)[I]-U(J,9)[I])*(2*D(J,8)[I]
                -D(J,9)[I]);
            ENDI;
            IF((K>1).AND.(K<9))THEN
                VEL(4)[NL]-:= U(J,K-1)[I]*D(J,K-1)[I];
            ENDI;
        ENDF;/*LOOP ON I   LEE*/
        ENDF;/*LOOP ON K   LEE*/
    ENDF;/*LOOP ON J   LEE*/
    NL := 0;
    FOR J := 1 TO NUM_NS DO
      FOR K := 1 TO NUM_ALT DO
        FOR I := 1 TO NUM_EW DO
            NL := NL+1;
            J1 := J+1;
            J2 := J-1;
            IF J1=NUM_NS+1 THEN J1 := NUM_NS-1;ENDI;
            IF J2=0      THEN J2 := 2;ENDI;
            VEL(5)[NL] := V(J1,K)[I]*D(J1,K)[I];
            VEL(6)[NL]-:= V(J2,K)[I]*D(J2,K)[I];
            VEL(7)[NL]-:= V(J,K+1)[I]*D(J,K+1)[I];
            IF K=1
            THEN VEL(8)[NL]-:= (2*V(J,1)[I]-V(J,2)[I])*(2*D(J,1)[I]
                -D(J,2)[I]);
            ENDI;
            IF K=9
            THEN VEL(8)[NL]-:= (2*V(J,8)[I]-V(J,9)[I])*(2*D(J,8)[I]
                -D(J,9)[I]);
            ENDI;
        IF((K>1).AND.(K<9)) THEN
                VEL(8)[NL]-:= V(J,K-1)[I]*D(J,K-1)[I];
            ENDI;
        ENDF;/*LOOP ON I   LEE*/
        ENDF;/*LOOP ON K   LEE*/
    ENDF;/*LOOP ON J   LEE*/
    NL := 0;
    FOR J := 1 TO NUM_NS DO
      FOR K := 1 TO NUM_ALT DO
        FOR I := 1 TO NUM_EW DO
            NL := NL+1;
            VEL(9)[NL] := W(J,K+1)[I]*D(J,K+1)[I];
        IF K=1 THEN
```

```
              VEL(10)[NL] := (2*W(J,1)[I]-W(J,2)[I])*(2*D(J,1)[I]
           -D(J,2)[I])+
              ENDI;
              IF K=9 THEN
              VEL(10)[NL] := (2*W(J,8)[I]-W(J,9)[I])*(2*D(J,8)[I]
              -D(J,9)[I])+
              ENDI;
              IF((K>1).AND.(K<9))THEN
                 VEL(10)[NL] := -W(J,K-1)[I]*D(J,K-1)[I];
              ENDI;
              VEL(11)[NL] := U(J,K)[I]*D(J,K)[I];
              VEL(12)[NL] := V(J,K)[I]*D(J,K)[I];
              VEL(13)[NL] := W(J,K)[I]*D(J,K)[I];
           ENDF;
           ENDF;
         ENDF;
         /*-CALCULATING RIGHT-HAND SIDE OF EQUATIONS -*/
         S[1:EW_NS_ALT] := 0.0;
/*-----BEGIN-COMMENT-HERE-----*/
              FOR I := 1 TO 13 DO
         S[1:EW_NS_ALT] := S[1:EW_NS_ALT]+
         SSX(I)[1:EW_NS_ALT]*VEL(I)[1:EW_NS_ALT]
         ENDF;
/*-----END-COMMENT HERE---*/
         /*-CALCULATING DIVERGENCE OF WIND FIELD-*/
         AL3 := -2.0*AL1*AL1;
         DIV[1:EW_NS_ALT] := S[1:EW_NS_ALT]/AL3;
         MAXDIV := MAX(DIV);
         MINDIV := MIN(DIV);
/*LEE    WRITE UNIT(6)(MAXDIV,MINDIV)#'MAXDIV = ',E14.7,
         'MINDIV = ',E14.7#;LEE*/
         WRITE UNIT(6)(MAXDIV,MINDIV)#'MAXDIV = ',E14.7,
         'MINDIV = ',E14.7#;
BBB: WRITE UNIT(6)#'LEAVE PROCEDURE DIVRGNCE'#
         ENDP;/*DIVRGNCE LEE*/
/*********************************************************************/
/*********************************************************************/
/*********************************************************************/
/*********************************************************************/
/*********************************************************************/
$PAGE;
         PROCEDURE SOR;
         INTEGER JMOD,KMOD,IMOD;
/*LEE*/.WRITE UNIT(6)#'BEGIN PROCEDURE SOR'#;/*LEE*/
         /* THIS PROCEDURE IS A PROGRAM FOR A SUCCESSIVE OVER
         RELAXATION (S-O-R) ITERATION METHOD TO SOLVE SIMULTANEOUS
         EQUATIONS.FIRST VELOCITIES AND LAMDA TERMS ARE ARRANGED
         IN VECTOR FORMS, AND THEN S-O-R EQUATION IN GENERAL
         FORM IS USED FOR ITERATIONS. */
    /*----------------------------------------------*/
```

```
          NUM_ITER := 0;
LC:       NL := 0;
          /* INITIALIZING TLAMDA ARRAYS */
          FOR I := 1 TO EW_NS_ALT DO
            TLAMDA(I)[1:15] := 0.0;
          ENDF;
/*LEE              NOT_CONV := 1;*/
          NOT_CONV := 0;
          FOR J := 1 TO NUM_NS DO
            FOR K := 1 TO NUM_ALT DO
              FOR I := 1 TO NUM_EW DO
                NL := NL+1;
                I1 := I+1;
                I2 := I-1;
                I3 := -I+2;
                I4 := I-2;
                J1 := J+1;
                J2 := J-1;
                K1 := K+1;
                K3 := K-1;
                IF I1=NUM_EW+1 THEN I1 := 1;ENDI;
                IF I2=0       THEN I2 := NUM_EW;ENDI;
                IF J1=NUM_NS+1 THEN J1 := NUM_NS-1;ENDI;
                IF J2=0       THEN J2 := 2;ENDI;
                IF K1=NUM_ALT+1 THEN K1 := NUM_ALT;ENDI;
                IF K3=0 THEN K3 := 1;ENDI;
                IF I3=NUM_EW+2 THEN I3 := 2;ENDI;
                IF I3=NUM_EW+1 THEN I3 := 1;ENDI;
                IF I4=0       THEN I4 := NUM_EW;ENDI;
                IF I4=-1       THEN I4 := NUM_EW-1;ENDI;
                TLAMDA(NL)[1] := BLAMDA(J,K)[I];
                TLAMDA(NL)[2] := BLAMDA(J,K)[I1];
                TLAMDA(NL)[3] := BLAMDA(J,K)[I2];
                TLAMDA(NL)[4] := BLAMDA(J1,K)[I];
                TLAMDA(NL)[5] := BLAMDA(J2,K)[I];
                TLAMDA(NL)[6] := BLAMDA(J,K1)[I];
                TLAMDA(NL)[7] := BLAMDA(J,K3)[I];
                TLAMDA(NL)[8] := BLAMDA(J,K1)[I1];
                TLAMDA(NL)[9] := BLAMDA(J,K3)[I1];
                TLAMDA(NL)[10] := BLAMDA(J,K1)[I2];
                TLAMDA(NL)[11] := BLAMDA(J,K3)[I2];
                TLAMDA(NL)[12] := BLAMDA(J1,K1)[I];
                TLAMDA(NL)[13] := BLAMDA(J1,K3)[I];
                TLAMDA(NL)[14] := BLAMDA(J2,K1)[I];
                TLAMDA(NL)[15] := BLAMDA(J2,K3)[I];
                /* ENDING OF VECTORIZATION */
                /* BEGINING OF S-O-R METHOD */
                T := TLAMDA(NL).DOT.TX(NL);
                BLAMDA(J,K)[I] := ALAMDA(J,K)[I]+(RLXFAC*(S[NL]-T)/
                TX(NL)[1]);
      /*   DIAGNOSTIC EVERY 10TH GUY    */
```

```
/*   MARCH 27,1981      PLR         */
            JMOD: =J.MOD.10;
            IMOD: =I.MOD.-10;
            KMOD: =K.MOD.10;
        IF((JMOD=1).AND.(KMOD=1).AND.(IMOD=1)) THEN
            WRITE UNIT(6)
            (I,J,K,ALAMDA(J,K)[I],BLAMDA(J,K)[I],S[NL],
            T,TX(NL)[I])#3I5,5E15.5#;
        ENDI;
                IF((J=1).OR.(J=NUM_NS)) THEN
                IF(J=1) THEN JJ := 2;ENDI;
                IF(J=NUM_NS) THEN JJ := NUM_NS-1;ENDI;
                BLAMDA(J,K)[I] := SUM(BLAMDA(JJ,K)[1:NUM_EW])/NUM_EW;
                ENDI;
    /*----BUMP UP BY 1.0E+06 MAR 31------*/
    /*--TRY A"FLOAT" -*/
    /*          BLAMDA(5,5)[36] := 1.5E+06; */
                IF(ALAMDA(J,K)[I]=0.0) THEN ALAMDA(J,K)[I] := 0.0001;ENDI;
                ERROR := 1.0-(BLAMDA(J,K)[I]/ALAMDA(J,K)[I]);
                IF ABS(ERROR)>TOLERANCE THEN NOT_CONV := NOT_CONV+1;ENDI;
            ENDF;
        ENDF;
    ENDF;
    /*---------TEMPORARY RHS PRINTOUT --------
    ----PLR MARCH 12 1981--------*/
    /*  FOR J FROM 1 BY 100 TO FW.NS.ALT DO
        WRITE UNIT(6)(J,S[J])#5X,I5,5X,E15.5#;
    ENDF; */
        FOR J := 1 TO NUM_NS DO
            WLAMDA[J] := BLAMDA(J,5)[36];
        ENDF;
    /*LEE*/WRITE UNIT(6)#"OWLAMDA ARE:"#;/*LEE*/
            WRITE UNIT(6)(WLAMDA[1:NUM_NS])#5E14.7#;
        FOR K := 1 TO NUM_ALT DO
            KLAMDA[K] := BLAMDA(5,K)[36];
        ENDF;
    /*LEE WRITE UNIT(6)(KLAMDA[1:NUM_ALT])#"KLAMDA = ",5E14.7#;
        WRITE UNIT(6)(BLAMDA(5,5)[30:40])#"LAMDA = ",5E14.7#;
        WRITE UNIT(6)(BLAMDA(5,5)[1],BLAMDA(5,5)[NUM_EW])
        #"LAMDA = ",2E14.7#;LEE*/
        WRITE UNIT(6)(KLAMDA[1:NUM_ALT])#" KLAMDA = ",5E14.7#;
        WRITE UNIT(6)(BLAMDA(5,5)[30:40])#" LAMDA = ",5E14.7#;
        WRITE UNIT(6)(BLAMDA(5,5)[1],BLAMDA(5,5)[NUM_EW])
        #" LAMDA = ",2E14.7#;
        MMMM := 0;
        NL := 0;
        FOR J := 1 TO NUM_NS DO
            FOR K := 1 TO NUM_ALT DO
                NL := NL+1;
                WLAMDA[NL] := MAX(BLAMDA(J,K));
            WLAMDA1[NL] := MIN(BLAMDA(J,K));
```

```
        IF (MMMM<3) THEN
            IF (WLAMDA1[NL]<0.0) THEN
/*LEE      WRITE UNIT(6)(J,K,WLAMDA1[NL])#'J = ',I3,'K = ',I3,
                'WLAMDA1 = ',F14.7#:LEE*/
                WRITE UNIT(6)(J,K,WLAMDA1[NL])#' J = ',I3,' K = ',I3,
                ' WLAMDA1 = ',E14.7#:
                MMMM := MMMM+1:
            ENDI:
            ENDI:
            IF((J=37).AND.(K=1)) THEN
/*LEE      WRITE UNIT(6)(J,K,WLAMDA1[NL])#'J = ',I3,'K = ',I3,
                'WLAMDA1 = ',F14.7#:LEE*/
                WRITE UNIT(6)(J,K,WLAMDA1[NL])#' J = ',I3,' K = ',I3,
                ' WLAMDA1 = ',E14.7#:
            ENDI:
            ALAMDA(J,K)[1:NUM_EW] := BLAMDA(J,K)[1:NUM_EW]:
        ENDF:
    ENDF:
    MAXLAMDA := MAX(WLAMDA):
    MINLAMDA := MIN(WLAMDA):
/*LEEWRITE UNIT(6)(MAXLAMDA,MINLAMDA)#'LAMDA = ','MAX = ',E14.7,
    'MIN = ',F14.7#:LEE*/
    WRITE UNIT(6)(MAXLAMDA,MINLAMDA)#'-LAMDA = ','-MAX = ',E14.7,
    ' MIN = ',F14.7#:
    NUM_ITER := NUM_ITER + 1:
/*LEE      WRITE UNIT(6)(NOT_CONV)#'NUMBER OF ELEMENTS NOT CONVED ='
    ,I8#:LEE*/
    WRITE UNIT(6)(NOT_CONV,NUM_ITER)
        #' ',I8,' ELEMENTS HAVE NOT CONVERGED AFTER',
        I8,' ITERATIONS.'#:
/*LEE   WRITE UNIT(6)(NUM_ITER)#'COUNTING OF ITERATIONS = ',I8#:LEE*/
/*LEE IF(NUM_ITER>MAX_ITER)THEN GO TO BBB:ENDI:LEE*/
    IF(NUM_ITER>MAX_ITER)THEN GO TO BBB:ENDI:
/*LEE      IF NOT_CONV>1 THEN GO TO LC:ENDI:*/
    IF NOT_CONV > 0 THEN GO TO LC: ENDI:
/*LEE      WRITE UNIT(6)(ITERATION)#1H0,'NUMBER OF ITERATIONS = '
    ,I3#:LEE*/
    WRITE UNIT(6)(NUM_ITER)#'0',I8,' ITERATIONS BEFORE TERMINATION',
    'OF S-O-R SOLUTION'#:
    /* ENDING OF S-O-R METHOD */
    /* PRINTING OF LAMDA TERMS */
    /*       FOR J := 1 TO NUM_NS DO    */
/*LEE*/WRITE UNIT(6)#'0FINAL LAMBDA ARE:'#:/*LEE*/
    FOR J := 1 BY NS_INCR TO NUM_NS DO
        FOR K := 1 BY ALT_INCR TO NUM_ALT DO
            WRITE UNIT(6)(J,K)#1H0,'J = ',I3,'K = ',I3#:
            WRITE UNIT(6)(BLAMDA(J,K)[1:10])#5E14.7#:
        ENDF:
    ENDF:
    /* ADJUSTMENT OF OBSERVED WIND FIELD TO MAKE IT MASS-
    CONSERVATIVE */
```

```
NL := 0;
FOR J := 1 TO NUM_NS DO
  FOR K := 1 TO NUM_ALT DO
    FOR I := 1 TO NUM_EW DO
      NL := NL+1;
      ADJ[1:5] := ADJX(NL)[1:5];
      I1 := I+1;
      I2 := I-1;
      J1 := J+1;
      J2 := J-1;
      K1 := K+1;
      K3 := K-1;
      IF (I1=NUM_EW+1) THEN I1 := 1;ENDI;
      IF (I2=0    ) THEN I2 := NUM_EW;ENDI;
      IF (J1=NUM_NS+1) THEN J1 := NUM_NS-1;J2 := NUM_NS;ENDI;
      IF (J2=0    ) THEN J2 := 1;ENDI;
      IF (K1=NUM_ALT+1) THEN K1 := NUM_ALT;ENDI;
      IF (K3=0    ) THEN K3 := 1;ENDI;
      ADJUSTU(J,K)[I] := U(J,K)[I]+ADJ[1]*(BLAMDA(J,K)[I1]
      -BLAMDA(J,K)[I2])-ADJ[2]*(BLAMDA(J,K1)[I]
      -BLAMDA(J,K3)[I]);
      ADJUSTV(J,K)[I] := V(J,K)[I]+ADJ[3]*(BLAMDA(J1,K)[I]
      -BLAMDA(J2,K)[I])-ADJ[4]*(BLAMDA(J,K1)[I]
      -BLAMDA(J,K3)[I]);
      ADJUSTW(J,K)[I] := W(J,K)[I]+ADJ[5]*(BLAMDA(J,K1)[I]
      -BLAMDA(J,K3)[I]);
    ENDF;
  ENDF;
ENDF;
/* PRINTING OF ADJUSTED WIND FIELD */
/*          FOR J := 1 NUM_NS DO  */
FOR J := 1 BY NS_INCR TO NUM_NS DO
  FOR K := 1 BY ALT_INCR TO NUM_ALTP1 DO
/*IFF      WRITE UNIT(6)(J,K)#1H0,'J = ',I3,'K = ',I3#;
      WRITE UNIT(6)(U(J,K)[1:10],ADJUSTU(J,K)[1:10],
      V(J,K)[1:10],ADJUSTV(J,K)[1:10],
      W(J,K)[1:10],ADJUSTW(J,K)[1:10]#5E14.7#;IFF*/
      WRITE UNIT(6)(J,K)#'0J = ',I3,'K = ',I3#;
    WRITE UNIT(6)(U(J,K)[1:EW_OUT])#' UNADJUSTED U ARE',5E14.7#;
    WRITE UNIT(6)(ADJUSTU(J,K)[1:EW_OUT])#' ADJUSTED U ARE',5E14.7#;
    WRITE UNIT(6)(V(J,K)[1:EW_OUT])#' UNADJUSTED V ARE',5E14.7#;
    WRITE UNIT(6)(ADJUSTV(J,K)[1:EW_OUT])#' ADJUSTED V ARE',5E14.7#;
    WRITE UNIT(6)(W(J,K)[1:EW_OUT])#' UNADJUSTED W ARE',5E14.7#;
    WRITE UNIT(6)(ADJUSTW(J,K)[1:EW_OUT])#' ADJUSTED W ARE',5E14.7#;
  ENDF;
ENDF;
/* CALCULATING DIVERGENCE OF ADJUSTED WIND FIELD */
FOR J := 1 TO NUM_NS DO
  FOR K := 1 TO NUM_ALT DO
    U(J,K)[1:NUM_EW] := ADJUSTU(J,K)[1:NUM_EW];
    V(J,K)[1:NUM_EW] := ADJUSTV(J,K)[1:NUM_EW];
```

```
          W(J,K)[1:NUM_EW] := ADJUSTW(J,K)[1:NUM_EW];
             ENDF;
             ENDF;
             CALL DIVRGNCE;
    /*LEE BBB;        ENDP;LEE*/
    /*LEE*/
    BBB:-WRITE UNIT(6)#'LEAVE PROCEDURE-SOR'#;
             ENDP;/*SOR LEE*/
    /*LEE*/
             ENDM;
    EOT ENCOUNTERED.
    /
```

FILE WINDP

```
ave.windp
awind.windp
EWIND.WINDP
apushf.windp
```

```
      MODULE WIND(UNIT1=GLBTROP,UNIT4=COEFMTRX,UNIT7=SOLMTRX
                 ,UNIT8=ADJMTRX,UNIT6=RESULT,UNIT9=SOLMTR)
                          BEGIN MAIN
/*CC----PROGRAMME WIND LEADS TO AN ADJUSTED MASS-CONSERVATIVE ------CCCC---0002
C-------WIND FIELD FROM REAL-TIME-OBSERVED WIND FIELD DATA.-THIS --------C---0003
C-------PROGRAMME INVOLVES NUMERICAL-SOLUTIONS OF THE PARTIAL------------C---0004
C-------DIFFERENTIAL EQUATIONS RESULTING FROM A CONSTRAINED -------------C---0005
C-------VARIATIONAL FORMULATION (EULER-LAGRANGE TYPE). THIS PROGRAMME----C---0006
CCCC----IS WRITTEN IN STAR LANGUAGE-1(SL1) OF CYBER COMPUTER.--------CCCC----0007
CCCC----DEFINITION OF TERMS --------------------------------------------CCCC---0008
C-------X:=EASTWARD DIRECTION ------------------------------------------C---0009
C-------Y:=NORTHWARD DIRECTION -----------------------------------------C---0010
C-------Z:=VERTICAL DIRECTION ------------------------------------------C---0011
C-------XX:=GRID SIZE IN X-DIRECTION,DEGREES & RADIANS RESPECTIVELY -----C---0012
C-------YY:=GRID SIZE IN Y-DIRECTION,DEGREES & RADIANS RESPECTIVELY -----C---0013
C-------ZZ:=GRID SIZE IN Z-DIRECTION -----------------------------------C---0014
C-------IL:=NUMBERS OF GRIDS IN X- DIRECTION ---------------------------C---0015
C-------JL:=NUMBERS OF GRIDS IN Y- DIRECTION ---------------------------C---0016
C-------KL:=NUMBERS OF GRIDS IN Z- DIRECTION ---------------------------C---0017
C-------THETA-&-TH :=ANGLE IN DEGREES & RADIANS RESPECTIVELY FROM SOUTH C---0018
C----------------POLE(-90.0)-TO-NORTH-POLE(+90.0)----------------------C---0019
C-------NLAMDA:=DUMMY LAGRANGE MULTIPLIER FORCOUNTING PURPOSE ----------C---0020
C-------TALPHA:=THREE DIMENSIONAL COEFFICIENT MATRIX -------------------
CCCC----SS:=ONE DIMENSIONAL SOLUTION MATRIX----------------------------CC*/---0023
/*-----THE FOLLOWING SECTION NEEDS TO BE CHANGED FOR -----------------------
       DIFFERENT-GRID SYSTEM.XTRA1 TO ISM3 ARE PAGING ------------------
       PARAMETRES.-THIER VALUES SHOULD BE ESTIMATED --------------------
       ACCORDINGLY. AL1,AL3 AND AL2 ARE WEIGHTING FACTORS -------------
       FOR U,V AND W VELOCITY COMPONENETS RESPECTIVELY. */
/*-----BEGINING OF THE SECTION---------------------------------------*/
LITERALLY "5.0" DXX;
LITERALLY "5.0" DYY;
LITERALLY "72" IL;
LITERALLY "37" JL;
LITERALLY "9" KL;
LITERALLY "10"KKLL;/*KKLL=KL+1*/
LITERALLY "23976" LJK;
LITERALLY "0.01" AL1;
LITERALLY "0.01" AL3;
LITERALLY "1.0" AL2;
LITERALLY "33576" XTRA1;
LITERALLY "15992" XTRA2;
LITERALLY "11192" XTRA3;
LITERALLY "768" ISM1;
LITERALLY "640" ISM2;
LITERALLY "256" ISM3;
/*-----END OF THE SECTION--------*/
REAL VECTOR [KKLL] Z;
       INITIAL Z=\0.0333334,0.0333334,0.0333334,0.0333334
              ,0.1,0.2,0.2,0.2,0.2,0.2\);
LITERALLY "ZVECTOR[K]" ZZ;
```

```
.ITERALLY "ZZ1[K]" 71;
-ITERALLY "ZZ2[K]" 72;
-ITERALLY "ZZ3[K]" 73;
REAL VECTOR [K] ZZ1,ZZ2,ZZ3,ZVECTOR;
ITERALLY "3.141592653589793" PI;
ITERALLY "WRITE" PRINT;
ITERALLY "RTRS(1)[1:IIL]" TS1;
ITERALLY "RTRS(2)[1:IIL]" TS2;
ITERALLY "RTRS(3)[1:IIL]" TS3;                                  00
ITERALLY "RTRS(4)[1:IIL]" TS4;                                  00
ITERALLY "RTRS(5)[1:IIL]" TS5;                                  39
ITERALLY "R(J,K)[1:IIL]" RO;                              0040
/* DEFINITIONS
   T1=LAMDA(J,K)[I],T2=LAMDA(J,K)[I+1],T3=LAMDA(J,K)[I-1]
   T4=LAMDA(J+1,K)[I],T5=LAMDA(J-1,K)[I],T6=LAMDA(J,K+1)[I]
   T7=LAMDA(J,K-1)[I],T8=LAMDA(J,K+1)[I+1],T9=LAMDA(J,K-1)[I+1]
   T10=LAMDA(J,K+1)[I-1],T11=LAMDA(J,K-1)[I-1]
   T12=LAMDA(J+1,K+1)[I],T13=LAMDA(J+1,K-1)[I],
   T14=LAMDA(J-1,K+1)[I],T15=LAMDA(J-1,K-1)[I]
   RTRS=DISTANCE BETWEEN SURFACE AND TROPOPAUSE AT ANY GRID.
   GAMAU,GAMAV AND GAMAW ARE COEFFICIENTS FOR THE
   ADJUSTING EQUATIONS.                              */
              LITERALLY "TALPHA[1]" T1;
              LITERALLY "TALPHA[2]" T2;
              LITERALLY "TALPHA[3]" T3;
              LITERALLY "TALPHA[4]" T4;
              LITERALLY "TALPHA[5]" T5;
              LITERALLY "TALPHA[6]" T6;
              LITERALLY "TALPHA[7]" T7;
              LITERALLY "TALPHA[8]" T8;
              LITERALLY "TALPHA[9]" T9;
              LITERALLY "TALPHA[10]" T10;
              LITERALLY "TALPHA[11]" T11;
              LITERALLY "TALPHA[12]" T12;
              LITERALLY "TALPHA[13]" T13;
              LITERALLY "TALPHA[14]" T14;
              LITERALLY "TALPHA[15]" T15;
              LITERALLY "GAMAU(1)[1:IIL]" GU1;
              LITERALLY "GAMAU(2)[1:IIL]" GU2;
              LITERALLY "GAMAV(1)[1:IIL]" GV1;
              LITERALLY "GAMAV(2)[1:IIL]" GV2;
              LITERALLY "GAMAW(1)[1:IIL]" GW1;
              LITERALLY "GAMAU(1)[I]" GGU1;
              LITERALLY "GAMAU(2)[I]" GGU2;
              LITERALLY "GAMAV(1)[I]" GGV1;
              LITERALLY "GAMAV(2)[I]" GGV2;
              LITERALLY "GAMAW(1)[I]" GGW1;
              EXTERNAL PROCEDURE(INTEGER,BIT-VECTOR[64],REAL,
                        INTEGER,INTEGER) Q3OPNMAP;
          EXTERNAL PROCEDURE(INTEGER,BIT_VECTOR[64]) Q3CLOSE;
          REAL VECTOR [15] ARRAY(IJK) TX;
```

```
COMMON CT(TX,TDUMP1);
REAL VECTOR [XTRA1] TDUMP1;
REAL VECTOR [13] ARRAY(IJK) SX;
COMMON CS(SX,TDUMP2);
REAL VECTOR [XTRA2] TDUMP2;
REAL VECTOR [5] ARRAY(IJK) ADJX;
COMMON CA(ADJX,TDUMP3);
REAL VECTOR [XTRA3] TDUMP3;
REAL VECTOR [IJK] ARRAY(13) SSX;
COMMON CSS(SSX,TDUMP4);
REAL VECTOR [XTRA2] TDUMP4;
REAL VECTOR [IL] ARRAY(2) GAMAU,GAMAV,GAMAW;
REAL VECTOR [5] ADJ;
INTEGER IER1,IER2,IER3,IER4;
INTEGER I,J,K,NL,I1,I2,I3,I4,J1,J2,K3,KK,JJ,K2,IIL,COUNT;
REAL VECTOR[6] RRO;
REAL AL,4,CON,ZZZ,XX, THETA,TH,YY ;
REAL VECTOR [IL] ARRAY(8) ALPHA,BETA;                                      0043
REAL VECTOR [IL] ARRAY(5)RTRS;
REAL VECTOR [15] TALPHA;
REAL VECTOR [13] SS;
REAL VECTOR [IL] A,B,C,E;
REAL VECTOR [IL] ARRAY(JL,KL)R;
REAL VECTOR [JL] TROP;
INITIAL (TROP=\9.2,9.3,9.4,9.5,9.7,9.9,10.1,10.3,10.5,10.7,
             10.9,11.1,11.8,16.8,17.8,18.0,18.0,18.0,18.0,
             18.0,18.0,18.0,17.8,16.8,11.8,11.1,10.9,10.7,10.5,
             10.3,10.1,9.9,9.7,9.5,9.4,9.3,9.2\);
REAL VECTOR[IL]RR1,RR2,RR3,RR4,RR5,RR6;
PROCEDURE MAIN;                                                           0051
WRITE UNIT(6)(DXX,DYY,KL,IJK,AL1,AL2,AL3)#'DXX=',F5.2,
             'DYY=',F5.2,'KL=',I2,'IJK=',I7,'AL1=',F7.3,
             'AL2=',F7.3,'AL3=',F7.3#;
ZVECTOR[1:KL]:=(Z[2:KKL]+Z[1:KL])/2.0;
ZZ1[1:KL]:=1.0/Z[2:KKL];
ZZ3[1:KL]:=1.0/Z[1:KL];
ZZ2[1:KL]:=ZZ1[1:KL]+ZZ3[1:KL];
CALL O30PNMAP(IER1,X\434F464D54525820\,TX(1)[1],ISM1,1);
CALL O30PNMAP(IER2,X\534F4C4D54522020\,SX(1)[1],ISM2,1);
CALL O30PNMAP(IER3,X\41444A4D54525820\,ADJX(1)[1],ISM3,1);
WRITE UNIT(6)(IER1,IER2,IER3)#'IER1=',Z16,4X,
             'IER2=',Z16,4X,'IER3=',Z16#;
COUNT:=0;
CON:=PI/180.0;
/* INITIALIZING TALPHA,ADJ,SS ARRAYS */
TALPHA[1:15]:=0.0;
ADJ[1:5]:=0.0;
SS[1:13]:=0.0;
XX:=DXX*CON;
YY:=DYY*CON;
K2:=KL +1;
```

```
      AL4:=(AL1/AL3)**2;
      TIL:=TL;
/*CC---INITIALIZING ELEMENTS OF R(JL,KL)[1:IL]              ---CC*/
   FOR J:=1 TO JL DO
      READ UNIT(1)-(R(J,1)[1:IL])-#6E13.6#;
      R(J,1)[1:IL]:=6371000.0+R(J,1)[1:IL];
      R(J,KL)[1:IL]:=6371000.0 +TROP[J]*1000.0;
      ZZZ:=0.0;
      FOR K:=2 TO KL-1 DO
      ZZZ:=ZZZ+Z[K];
      TS1:=R(J,KL)[1:IL]-R(J,1)[1:IL];
      RO:=R(J,1)[1:IL]+ZZZ*TS1;
   ENDF;
   ENDF;
/*CC---THE FOLLOWING DO-LOOP DEFINES THE ELEMENTS OF COEFFICIENT---CCCC--- 0069
C       MATRIX "TALPHA" AND SOLUTION MATRIX "SS". IT HAS FIVE          C    0070
C       PROCEDURES WHICH DEAL WITH EQUATIONS SUITABLE FOR PARTICULAR   C    0071
C       CONDITIONS.PROCEDURE "SNPOLS" STANDS FOR SOUTH NORTH POLAR     C    0072
C       SURFACE.SIMILIARLY "SNPOLI" STANDS FOR SOUTH NORTH POLAR       C    0073
C       INTERIOR; SNPOLT FOR SOUTH NORTH POLAR TROPOPAUSE;             C    0074
C       "INTEPS" FOR INTERIOR POINTS AND SURFACE AND "TROPOI" FOR      C    0075
CCCC---TROPOPAUSE INTERIOR.                                         ---CC*/  0076
      THETA:=-90.0-DYY;
   FOR J:=1 TO JL DO                                                         0078
         THETA:=THETA+DYY;                                                   0079
         TH:=THETA*CON;                                                      0080
      FOR K:=1 TO KL DO                                                      0081
   TS1:=R(J,KL)[1:IL]-R(J,1)[1:IL];
         IF ((J=1).OR.(J=JL)).AND.(K=1) THEN CALL SNPOLS; ENDI;
         IF ((J=1).OR.(J=JL)).AND.((K>1).AND.(K<KL)) THEN CALL SNPOLI;
         ENDI;
         IF ((J=1).OR.(J=JL)).AND.(K=KL) THEN CALL SNPOLT; ENDI;
         IF ((J>1).AND.(J<JL)).AND.(K<KL) THEN CALL INTEPS; ENDI;
         IF ((J>1).AND.(J<JL)).AND.(K=KL) THEN CALL TROPOI; ENDI;
      ENDF;                                                                  0092
      ENDF;                                                                  0093
      CALL Q3CLOSE (IER1,X\434F464D54525820\);
      CALL Q3CLOSE (IER3,X\41444A4D54525820\);
      CALL Q3OPNMAP(IER4,X\534F4C4D54525820\,SSX(1)[1],ISM2,1);
   WRITE UNIT(6)(IER4)#'IER4=',7I6#;
      FOR I:=1 TO 13 DO
         J:=1;
   LS: SSX(I)[J]:=SX(J)[I];
         J:=J+1;
      IF (J<=IJK) THEN GO TO LS; ENDI;
      ENDF;
      CALL Q3CLOSE(IER2,X\534F4C4D54522020\);
      CALL Q3CLOSE(IER4,X\534F4C4D54525820\);
   WRITE UNIT(6)#'CLOSE'#;
      WRITE UNIT(6)(IER1,IER2,IER3,IER4)#'IER1=',7I6,4X,
                'IER2=',7I6,4X,'IER3=',7I6,4X,'IER4=',7I6#;
```

```
                        ENDP;                                                          0143
                        PROCEDURE SNPOLS;                                              0144
/*CC    PROCEDURE "SNPOLS" DEALS WITH THOSE EQUATIONS WHICH ARE     CCCC      0145
C       SUITABLE FOR SOUTH AND NORTH POLES SURFACES. IT ESTIMATES       C     0146
C       COEFFICIENTS OF EACH CORRESPONDING "LAMDA" TERMS AND TRANSFERS  C     0147
CCCC    THEM TO THE WORKING MATRICES "TALPHA","SS".                    CC*/   0148
            IF J=1 THEN JJ:=1; ENDI;                                          0150
            IF J=JL THEN JJ:=JL-2; ENDI;                                      0151
        RR1[1:IL]:=R(JJ+1,1)[1:IL]-R(J,1)[1:IL];                             0152
        ALPHA(2)[1:IL]:=((AL1*AL1/(1.0*AL2*AL2*RTRS(1)[1:IL]))+(((RR1
        [1:IL])/(R(JJ,1)[1:IL]*YY))**2)*AL4/(1.0*RTRS(1)[1:IL]))*Z1;
        ALPHA(3)[1:IL]:=(AL4*RR1[1:IL])/(R(J,1)[1:IL]*R(J,1)[1:IL]*
                YY*YY);
        BETA(2)[1:IL]:=2.0*AL1*AL1*(RR1[1:IL])/(R(JJ,1)[1:IL]*YY);            0159
        BETA(3)[1:IL]:=2.0*AL1*AL1;                                          0160
        GV1:=1.0/(2.0*AL3*AL3*RO*YY);
        GV2:=RR1[1:IL]/(2.0*AL3*AL3*TS1*RO*YY*(1.0/Z1));
        GW1:=1.0/(2.0*AL2*AL2*TS1*(1.0/Z1));
    FOR I:=1 TO IL DO                                                        0163
        T1:=ALPHA(2)[I]+ABS(ALPHA(3)[I]);
        IF(J=1) THEN T4:=-ABS(ALPHA(3)[I]);ENDI;
        IF(J=JL) THEN T5:=-ABS(ALPHA(3)[I]);ENDI;
        T6:=-ALPHA(2)[I];
        SS[12]:=-BETA(2)[I];
        SS[13]:=BETA(3)[I];
        AD[3]:=GAMAV(1)[I];
        AD[4]:=GAMAV(2)[I];
        AD[5]:=GAMAW(1)[I];
        CALL TRANSFER;
    ENDF;                                                                    0170
    ENDP;                                                                    0171
    PROCEDURE SNPOLI;                                                        0172
/*CC    PROCEDURE "SNPOLI" DEALS WITH THOSE EQUATIONS WHICH ARE     CCCC      0173
C       SUITABLE FOR SOUTH AND NORTH POLES INTERIOR POINTS. IT         C      0174
C       ESTIMATES COEFFICIENTS OF EACH CORRESPONDING "LAMDA" TERMS AND C      0175
CCCC    TRANSFERS THEM TO THE WORKING MATRICES "TALPHA","SS".         CC*/    0176
            IF J=1 THEN JJ:=1 ENDI;                                          0178
            IF J=JL THEN JJ:=JL-2 ENDI;                                      0179
        RR2[1:IL]:=R(JJ+1,K)[1:IL]-R(J,K)[1:IL];                            0180
        ALPHA(1)[1:IL]:=(AL4*RR2[1:IL]*Z1)/(1.0*RTRS(1)[1:IL]*RO*RO*YY);
        ALPHA(2)[1:IL]:=AL4/(RO*RO*YY);
        ALPHA(3)[1:IL]:=ABS(ALPHA(1)[1:IL])+ALPHA(2)[1:IL];
        BETA(1)[1:IL]:=-2.0*AL1*AL1/RO;
        GV1:=1.0/(2.0*AL3*AL3*RO*YY);
        GV2:=RR2[1:IL]/(4.0*AL3*AL3*RO*TS1*YY*ZZ);
        GW1:=1.0/(4.0*AL2*AL2*TS1*ZZ);
    FOR I:=1 TO IL DO                                                       0182
        T1:=+ALPHA(3)[I];
        T6:=-ABS(ALPHA(1)[I]);
        IF(J=1) THEN T4:=-ALPHA(2)[I];ENDI;
```

```
      IF(J=IL) THEN T5:=-ALPHA(2)[I];ENDI;
      IF(R(J,I+1,K)[I]<R(J,K)[I]) THEN
        SS[12]:=-BETA(1)[I];
      ELSE
        SS[12]:=BETA(1)[I];
      ENDI;
        ADJ[3]:=GAMAV(1)[I];
        ADJ[4]:=GAMAV(2)[I];
        ADJ[5]:=GAMAW(1)[I];
        CALL TRANSFER;
      ENDF;                                              0192
      ENDP;                                              0193
    PROCEDURE SNPOLT;                                    0194
/*CC---PROCEDURE- "SNPOLT" DEALS WITH THOSE EQUATIONS WHICH ARE---CCCC---0195
C------SUITABLE FOR SOUTH AND NORTH POLES TROPOPAUSES.IT ESTIMATES----C--0196
C------COEFFICIENTS OF EACH CORRESPONDING "LAMDA"TERMS AND TRANSFERS--C--0197
CCCC---THEM TO THE WORKING MATRICES "TALPHA", "SS".--------------CC*/--0198
        IF J=1 THEN J,I:=1 ENDI;                         0199
        IF J=IL THEN J,I:=IL-2 ENDI;                     0200
        ALPHA(1)[1:IL]:=AL4/(RO*RO*YY);
        BETA(1)[1:IL]:=2.0*AL1*AL1/RO;
        GV:=1.0/(2.0*AL3*AL3*RO*YY);
    FOR I:=1 TO IL DO                                    0201
        T1:=+ALPHA(1)[I];
        IF(J=1) THEN T4:=-ALPHA(1)[I];ENDI;
        IF(J=IL) THEN T5:=-ALPHA(1)[I];ENDI;
        SS[12]:=+BETA(1)[I];
        ADJ[3]:=GAMAV(1)[I];
        CALL TRANSFER;
      ENDF;                                              0207
      ENDP;                                              0208
    PROCEDURE INTEPS;                                    0209
/*CC---PROCEDURE "INTEPS" DEALS WITH THOSE EQUATIONS WHICH ARE---CCCC---0210
C------SUITABLE FOR ALL INTERIOR POINTS AND SURFACE POINTS EXCEPT----C--0211
C------SOUTH AND NORTH POLES SURFACES. IT ESTIMATES COEFFICIENTS OF--C--0212
C------EACH CORRESPONDING "LAMDA" TERMS AND TRANSFERS THEM TO THE----C--0213
C------WORKING MATRICES="TALPHA","SS". IN CASE OF SURFACE POINTS,THE-C--0214
CCCC---FIRST "IF" STATEMENT ACCESS TO ANOTHER PROCEDURE "INSUR".---CC*/--0215
        TS2:=R(J+1,KL)[1:IL]-R(J+1,1)[1:IL];            0217
        RTRS(3)[1:IL]:=R(J-1,KL)[1:IL]-R(J-1,1)[1:IL];  0218
        RTRS(4)[1:IL-1]:=RTRS(1)[2:IL];                 0219
        RTRS(4)[IL]:=RTRS(1)[1];                        0220
        RTRS(5)[2:IL]:=RTRS(1)[1:IL-1];                 
        RTRS(5)[1]:=RTRS(1)[IL];                        0222
        RR3[1]:=R(J,K)[2]-R(J,K)[IL];                   0223
        RR3[IL]:=R(J,K)[1]-R(J,K)[IL-1];                0224
        RR3[2:IL-1]:=R(J,K)[3:IL]-R(J,K)[1:IL-2];       
        RR4[1:IL]:=R(J+1,K)[1:IL]-R(J-1,K)[1:IL];       0226
        RR5[1]:=R(J,K)[2]-2.0*R(J,K)[1]+R(J,K)[IL];     0227
        RR5[IL]:=R(J,K)[1]-2.0*R(J,K)[IL]+R(J,K)[IL-1]; 0228
        RR5[2:IL-1]:=R(J,K)[3:IL]-2.0*R(J,K)[2:IL-1]+R(J,K)[1:IL-2]; 0229
```

```
RR6[1:IL]:=R(J+1,K)[1:IL]-2.0*R(J,K)[1:IL]+R(J-1,K)[1:IL];
A[1:IL]:=((AL1/(AL2*TS1))**2)+(((RR3[1:IL])/(2.0*XX*            0231
R(J,K)[1:IL]*TS1*COS(TH)))**2)+((((RR4[1:IL])/(2.0*YY*
R(J,K)[1:IL]*TS1))**2)*AL4);
      IF (J<JL) AND (K=-1) THEN CALL INSUR; ENDI;
      IF (J<JL) AND (K=1) THEN GO TO LA; ENDI;
B[1:IL]:=((AL1/AL2)**2)*2.0/(R(J,K)[1:IL]*TS1)+((RR3[1:IL]
*(TS4-TS5))/(2.0*((R(J,K)[1:IL]*TS1                              0235
*COS(TH)*XX)**2)))-(RR5[1:IL]/(TS1*((RO*XX*COS(TH))**2          0236
))))+(((AL4*RR4[1:IL])*(TS2-TS3))/(2.0*((RO*TS1               0
*YY)**2)))-((AL4*RR6[1:IL])/(TS1*((                           0
RO*YY)**2)))+((TAN(TH)*(AL4*RR4[1:IL]))/(2.0*YY*TS1*RO*RO));  0
C[1:IL]:=-(RR3[1:IL])/(XX*TS1*((RO*COS(TH))**2));              0240
E[1:IL]:=-(AL4*RR4[1:IL])/(YY*TS1*RO*RO);                     0
ALPHA(1)[1:IL]:=2.0*((1.0/((RO*COS(TH)*XX)**2))+(AL4/((RO
*YY)**2))+(Z2*A[1:IL]/(2.0*ZZ)));
ALPHA(2)[1:IL]:=1.0/((RO*COS(TH)*XX)**2);                      0244
ALPHA(3)[1:IL]:=((1.0/(RO*RO*YY*YY))-(TAN(TH)/(2.0*RO*RO*YY))
)*AL4;
ALPHA(4)[1:IL]:=((1.0/(RO*RO*YY*YY))+(TAN(TH)/(2.0*RO*RO*YY))
)*AL4;
ALPHA(5)[1:IL]:=(Z2*A[1:IL]/(ZZ))+(B[1:IL]/(2.0*ZZ));
ALPHA(6)[1:IL]:=(Z3*A[1:IL]/(ZZ))-(B[1:IL]/(2.0*ZZ));
ALPHA(7)[1:IL]:=C[1:IL]/(4.0*ZZ*XX);                           0249
ALPHA(8)[1:IL]:=E[1:IL]/(4.0*ZZ*YY);                           0250
BETA(1)[1:IL]:=AL1*AL1/(RO*COS(TH)*XX);                        0251
BETA(2)[1:IL]:=AL1*AL1/(RO*YY);                               0252
BETA(3)[1:IL]:=AL1*AL1/(TS1*ZZ);                              0253
BETA(4)[1:IL]:=AL1*AL1*(RR3[1:IL])/(2.0*XX*ZZ*TS1*RO*COS(TH)); 0254
BETA(5)[1:IL]:=AL1*AL1*(RR4[1:IL])/(2.0*YY*ZZ*RO*TS1);         0255
BETA(6)[1:IL]:=2.0*AL1*AL1*TAN(TH)/RO;                         0256
BETA(7)[1:IL]:=4.0*AL1*AL1/RO;                                 0257
GU1:=1.0/(4.0*AL1*AL1*RO*COS(TH)*XX);
GU2:=RR3[1:IL]/(8.0*AL1*AL1*RO*TS1*COS(TH)*XX*ZZ);
GV1:=1.0/(4.0*AL3*AL3*RO*YY);
GV2:=RR4[1:IL]/(8.0*AL3*AL3*RO*TS1*YY*ZZ);
GW1:=1.0/(4.0*AL2*AL2*TS1*ZZ);
FOR I:=1 TO IL DO                                              0260
I1:=I+1;                                                       0261
I2:=I-1;                                                       0262
      IF I1=IL+1 THEN I1:=1;ENDI;                              026
      IF I2=0 THEN I2:=IL;ENDI;                                0264
T1:=+ALPHA(1)[I];                                              0266
T2:=-ALPHA(2)[I];
T3:=-ALPHA(2)[I];                                              0270
T4:=-ALPHA(3)[I];                                              0274
T5:=-ALPHA(4)[I];                                              0274
T6:=-ALPHA(5)[I];                                              0276
T7:=-ALPHA(6)[I];                                              0278
T8:=-ALPHA(7)[I];                                              0280
T9:=+ALPHA(7)[I1];                                             0282
```

```
     T10:=+ALPHA(7)[I];                                                    0284
     T11:=-ALPHA(7)[I];                                                    02
     T12:=-ALPHA(8)[I];                                                    02
     T13:=+ALPHA(8)[I];                                                    0290
     T14:=+ALPHA(8)[I];                                                    0292
     T15:=-ALPHA(8)[I];                                                    02
     SS[1]:=+BETA(1)[I];
     SS[2]:=-BETA(1)[I];
     SS[5]:=+BETA(2)[I];
     SS[6]:=-BETA(2)[I];
     SS[9]:=+BETA(3)[I];
     SS[10]:=-BETA(3)[I];
     SS[3]:=-BETA(4)[I];
     SS[4]:=+BETA(4)[I];
     SS[7]:=-BETA(5)[I];
     SS[8]:=+BETA(5)[I];
     SS[12]:=-BETA(6)[I];
     SS[13]:=+BETA(7)[I];
     ADJ[1]:=GAMAU(1)[I];
     ADJ[2]:=GAMAU(2)[I];
     ADJ[3]:=GAMAV(1)[I];
     ADJ[4]:=GAMAV(2)[I];
     ADJ[5]:=GAMAW(1)[I];
     CALL TRANSFER;
  ENDF;                                                                    0307
  LA: ENDP;                                                                0308
     PROCEDURE INSUR;                                                      0309
/*CC   PROCEDURE "INSUR" DEALS WITH THOSE EQUATIONS WHICH ARE     CCCC     0310
 C     SUITABLE FOR ALL SURFACE POINTS EXCLUDING SOUTH AND NORTH     C     0311
 C     POLES ONES. IT ESTIMATES COEFFICIENTS OF EACH CORRESPONDING    C    0312
 C     "LAMDA" TERMS AND TRANSFERS THEM TO THE WORKING MATRICES       C    0313
 C     ="TALPHA","SS".                                       */
     ALPHA(1)[1:IL]:=ABS(RR3[1:IL]/(2.0*XX*XX*RO*RO*
                          COS(TH)*COS(TH)));
     ALPHA(2)[1:IL]:=ABS(RR4[1:IL]*AL4/(2.0*RO*RO*YY*YY));
     ALPHA(3)[1:IL]:=A[1:IL]*TS1*Z1;
     BETA(1)[1:IL]:=AL1*AL1*RR3[1:IL]/(RO*COS(TH)*XX);
     BETA(2)[1:IL]:=AL1*AL1*RR4[1:IL]/(RO*YY);
     BETA(3)[1:IL]:=2.0*AL1*AL1;
     GU1:=1.0/(4.0*AL1*AL1*RO*TS1*COS(TH)*XX);
     GU2:=RR3[1:IL]*Z1/(4.0*AL1*AL1*RO*TS1*COS(TH)*XX);
     GV1:=1.0/(4.0*AL3*AL3*RO*YY);
     GV2:=RR4[1:IL]*Z1/(4.0*AL3*AL3*RO*TS1*YY);
     GW1:=Z1/(2.0*AL2*AL2*TS1);
  FOR I:=1 TO IL DO                                                        0319
     I1:=I+1;                                                              0320
     I2:=I-1;                                                              0321
        IF I1=IL+1 THEN I1:=1; ENDI;                                       0324
        IF I2=0 THEN I2:=IL; ENDI;                                         0325
     T1:=ALPHA(1)[I]+ALPHA(2)[I]+ALPHA(3)[I];
     T6:=-ALPHA(3)[I];
```

```
      SS[11]:=-BETA(1)[I];
      SS[12]:=-BETA(2)[I];
      SS[13]:=BETA(3)[I];
         IF((R(J-1)[I])>=R(J,1)[I2]).AND.(R(J+1,1)[I]
                              >R(J-1,1)[I])) THEN
         T3:=-ALPHA(1)[I];
         T5:=-ALPHA(2)[I];
         ENDI;
         IF((R(J,1)[I])<=R(J-1)[I2]).AND.(R(J+1,1)[I]
                              <R(J-1,1)[I])) THEN
         T2:=-ALPHA(1)[I];
         T4:=-ALPHA(2)[I];
         ENDI;
         IF((R(J,1)[I])<R(J,1)[I2]).AND.(R(J+1,1)[I]
                              >=R(J-1,1)[I])) THEN
         T2:=-ALPHA(1)[I];
         T5:=-ALPHA(2)[I];
         ENDI;
         IF((R(J,1)[I])>R(J,1)[I2]).AND.(R(J+1,1)[I]
                              <=R(J-1,1)[I])) THEN
         T3:=-ALPHA(1)[I];
         T4:=-ALPHA(2)[I];
         ENDI;
         ADJ[1]:=GAMAU(1)[I];
         ADJ[2]:=GAMAU(2)[I];
         ADJ[3]:=GAMAV(1)[I];
         ADJ[4]:=GAMAV(2)[I];
         ADJ[5]:=GAMAW(1)[I];
         CALL TRANSFER;
         ENDF;
         ENDP;
      PROCEDURE TROPOI;                                            0512
/*CC    PROCEDURE "TROPOI" DEALS WITH THOSE EQUATIONS WHICH ARE    CCCC  0513
C       SUITABLE FOR TROPOPAUSE INTERIOR POINTS.IT ESTIMATES       C    0514
C       COEFFICIENTS OF EACH CORRESPONDING "LAMDA" TERMS AND       C    0515
CCCC    TRANSFERS THEM TO THE WORKING MATRICES "TALPHA","SS".      CC*/ 0516
AUTOMATIC REAL VECTOR[I],RR10,RR11;                                    0517
      RR10[1]:=R(J,K)[2]-R(J,K)[I-1];                                  0518
      RR10[IL]:=R(J,K)[1]-R(J,K)[IL-1];                                0519
      RR10[2:IL-1]:=R(J,K)[3:IL]-R(J,K)[1:IL-2];                       0520
      RR11[1:IL]:=R(J+1,K)[1:IL]-R(J-1,K)[1:IL];                       0521
      ALPHA(1)[1:IL]:=1.0/((RO*COS(TH)*XX)**2);                        0522
      ALPHA(2)[1:IL]:=((1.0-(TAN(TH)*YY/2.0))/((RO*YY)**2))*AL4;
      ALPHA(3)[1:IL]:=((1.0+(TAN(TH)*YY/2.0))/((RO*YY)**2))*AL4;
      A[1:IL]:=((AL1/(AL2*TS1))**2)+(((RR10[1:IL])/(2.0*XX*RO        0525
   *TS1*COS(TH)))**2)+((((RR11[1:IL])/(2.0*YY*RO*TS1))**2)*AL4);
      ALPHA(4)[1:IL]:=+(2.0/((RO*COS(TH)*XX)**2))+(2.0*AL4/((RO*YY)    0
   **2))+(72*A[1:IL]/(ZZ));
      ALPHA(5)[1:IL]:=72*A[1:IL]/(ZZ);
      BETA(1)[1:IL]:=AL1*AL1/(RO*COS(TH)*XX);                          0530
      BETA(2)[1:IL]:=AL1*AL1/(RO*YY);                                  0531
```

```
     BETA(3)[1:IL]:=AL1*AL1/(TS1*ZZ);                                          0532
─────────BETA(4)[1:IL]:=AL1*AL1*(RR10[1:IL,1)/(2.0*XX*ZZ*TS1*RO*COS(TH));──── 0533
───────BETA(5)[1:IL]:=AL1*AL1*(RR11[1:IL])/(2.0*YY*ZZ*TS1*RO);─────────────── 0534
─────BETA(6)[1:IL]:=2.0*AL1*AL1*TAN(TH)/RO;────────────────────────────────── 0535
─────BETA(7)[1:IL]:=4.0*AL1*AL1/RO;─────────────────────────────────────────
──────GU1:=1.0/(4.0*AL1*AL1*RO*COS(TH)*XX);──────────────────────────────────
─────GV1:=1.0/(4.0*AL3*AL3*RO*YY);──────────────────────────────────────────
─── FOR I:=1 TO IL DO ────────────────────────────────────────────────────── 0536
────I1:=I+1;──────────────────────────────────────────────────────────────── 0537
────I2:=I-1;──────────────────────────────────────────────────────────────── 0538
──────────IF I=IL+1 THEN I1:=1;END;─────────────────────────────────────────── 0539
──────────IF I2=0 THEN I2:=IL;END;─────────────────────────────────────────── 0540
──────T1:=ALPHA(4)[I];──────────────────────────────────────────────────────── 0542
─────T2:=-ALPHA(1)[I];──────────────────────────────────────────────────────── 0544
─────T3:=-ALPHA(1)[I];──────────────────────────────────────────────────────── 0546
─────T4:=-ALPHA(2)[I];──────────────────────────────────────────────────────── 0548
─────T5:=-ALPHA(3)[I];──────────────────────────────────────────────────────── 0550
─────T7:=-ALPHA(5)[I];──────────────────────────────────────────────────────── 0552
─────SS[1]:=+BETA(1)[I];────────────────────────────────────────────────────────
─────SS[2]:=-BETA(1)[I];────────────────────────────────────────────────────────
─────SS[5]:=+BETA(2)[I];────────────────────────────────────────────────────────
─────SS[6]:=-BETA(2)[I];────────────────────────────────────────────────────────
─────SS[9]:=+BETA(3)[I];────────────────────────────────────────────────────────
─────SS[10]:=-BETA(3)[I];────────────────────────────────────────────────────────
─────SS[3]:=-BETA(4)[I];────────────────────────────────────────────────────────
─────SS[7]:=-BETA(5)[I];────────────────────────────────────────────────────────
─────SS[4]:=+BETA(4)[I];────────────────────────────────────────────────────────
─────SS[8]:=+BETA(5)[I];────────────────────────────────────────────────────────
─────SS[12]:=-BETA(6)[I];────────────────────────────────────────────────────────
─────SS[13]:=+BETA(7)[I];────────────────────────────────────────────────────────
─────ADJ[1]:=GAMAU(1)[I];────────────────────────────────────────────────────────
─────ADJ[3]:=GAMAV(1)[I];────────────────────────────────────────────────────────
─────CALL TRANSFER;─────────────────────────────────────────────────────────────
───ENDF;                                                                      0564
─────ENDP;                                                                    0565
──────── PROCEDURE TRANSFER;
──────────/* THIS PROCEDURE TRANSFER CALCULATED VALUES OF
──────────ELEMENTS OF COEFFICIENT MATRIX (COEMTRX), SOLUTION
──────────MATRIX (SOLMTRX), ADJUSTING MATRIX (ADJMTRX) TO
──────────THE CORESPONDING FILES NAMED AS COEMTRX,SOLMTRX
──────────ADJMTRX. THESE FILES WILL BE ACCESSED IN WINDADJUST
──────────MODULE. */
──────COUNT:=COUNT+1;
──────TX(COUNT)[1:15]:=TALPHA;
──────SX(COUNT)[1:13]:=SS;
──────ADJX(COUNT)[1:5]:=ADJ;
──────TALPHA[1:15]:=0.0;
──────ADJ[1:5]:=0.0;
──────SS[1:13]:=0.0;
──────ENDP;
──────ENDM;
```

FILE LAMDA

```
rewind,lamda
$REWIND,LAMDA.
/copysbf,lamda
1          MODULE WINDADJS(UNIT1=COEFMTRX,UNIT2=SOLMTRX,UNIT3=
                              ADJMTRX,UNIT6=RESULT) BEGIN MAIN;
           /* THIS PROGRAM ADJUSTS OBSERVED WIND FIELD TO MAKE
              IT MASS-CONSERVATIVE WIND FIELD. ADJUSTING TECHNIQUE
              IS BASED ON VARITIONAL FORMULATION. SIMULTANEOUS
              EQUATIONS FOR LAMDA TERMS ARE SOLVED USING SUCCESSIVE
              OVER RELAXATION (S-O-R) ITERATION METHOD. FILES NAMED AS
              COEFMTRX,SOLMTRX,AND ADJMTRX HAVE NESSASARY
              ESTIMATED COEFFICIENTS. THESE FILES WILL BE READ IN THIS
              PROGRAM. */
    /* THE FOLLOWING SECTION NEEDS TO BE CHANGED FOR DIFFERENT
       GRID SYSTEM. XTRA1 TO XTRA7 AND ISM1 TO ISM7 ARE
       PAGING PARAMETERS. AL1 IS WEIGHTING FACTOR FOR U VELOCITY
       COMPONENT.                                            */
    /* BEGINING OF THE SECTION        */
                    LITERALLY "5.0" DYY;
                    LITERALLY "72" IL;
                    LITERALLY "37" JL;
                    LITERALLY "9" KL;
                    LITERALLY "10" KLLL; /* KLLL= KL+1 */
                    LITERALLY "23976" IJK;
              LITERALLY "33576" XTRA1;
              LITERALLY "15992" XTRA2;
          LITERALLY "17584" XTRA3;
```

```
        LITERALLY "24512" XTRA4;
        LITERALLY "51152" XTRA5;
        LITERALLY "41192" XTRA7;
        LITERALLY "768" ISM1;
        LITERALLY "640" ISM2;
        LITERALLY "128" ISM3;
        LITERALLY "256" ISM4;
        LITERALLY "256" ISM5;
        LITERALLY "256" ISM7;
        LITERALLY "0.01" AL1;
        LITERALLY "0.001" TOLRNCE;
        LITERALLY "1.75" RLXFAC;
        LITERALLY "3.14159265358979" PI;
    /* IL=NUMBER OF GRIDS IN EAST-WEST DIRECTION.
       JL=NUMBER OF GRIDS IN NORTH-SOUTH DIRECTION.
       KL=NUMBER OF GRIDS IN ALTITUDE DIRECTION.
       IJK=TOTAL NUMBER OF GRIDS.
       TOLRNCE=TOLRANCE IN ITERATIONS.
       RLXFAC=RELAXATION FACTOR IN SUCCESIVE OVER RELAXTION
       METHOD. */
    /* END OF THE SECTION */
    REAL VECTOR [15] ARRAY(IJK) TX;
    COMMON CT(TX,TDUMP1);
    REAL VECTOR [XTRA1] TDUMP1;
    REAL VECTOR [5] ARRAY(IJK) ADJX;
    COMMON CA(ADJX,TDUMP3);
    REAL VECTOR [XTRA7] TDUMP3;
    REAL VECTOR [IJK] ARRAY(13) SSX;
    COMMON CSS(SSX,TDUMP4);
    REAL VECTOR [XTRA2] TDUMP4;
    REAL VECTOR [15] ARRAY(IJK) TLAMDA;
    COMMON B1(TLAMDA,TDUMP11);
    REAL VECTOR [XTRA1] TDUMP11;
    REAL VECTOR [IJK] S,DIV;
    COMMON B2(S,DIV,TDUMP5);
    REAL VECTOR [XTRA3] TDUMP5;
    REAL VECTOR [5] ADJ;
    REAL VECTOR [IL] ARRAY(JL,KL) ALAMDA,BLAMDA;
    COMMON B3(BLAMDA,ALAMDA,TDUMP6);
    REAL VECTOR [XTRA3] TDUMP6;
    REAL VECTOR [IL] ARRAY(JL,KLL) U,V,W,D,ADJUSTU,ADJUSTV,
                                   ADJUSTW;
    COMMON B4(U,V,W,D,TDUMP7);
    REAL VECTOR [XTRA4] TDUMP7;
    COMMON B5(ADJUSTU,ADJUSTV,ADJUSTW,TDUMP8);
    REAL VECTOR [XTRA5] TDUMP8;
    REAL VECTOR [IJK] ARRAY(13) VEL;
    COMMON B6(VEL,TDUMP9);
    REAL VECTOR [XTRA2] TDUMP9;
    REAL VECTOR [KLL] Z;
    INITIAL (Z=\0.0,0.0333334,0.0333334,0.0333334
```

```
                  ,0.1,0.2,0.2,0.2,0.2,0.2\);
        REAL AL3,T,ERROR,ZZZ,THETA,TH,CON,MAXDIV,MINDIV;
        INTEGER CHECK,I,J,K,NL,I1,I2,I3,I4,J1,J2,K2,
               K3,ITERATION,KI,IW,E1,E2,E3,E4,E5,COUNTING,
               E6,E7,E8,E9,E10,MMMM,JJ;
        REAL VECTOR [333] WLAMDA,WLAMDA1;
        REAL VECTOR [9] KLAMDA;
        REAL MAXLAMDA,MINLAMDA;
               PROCEDURE MAIN;
        OPENMAP('F1',TLAMDA(1)[1],ISM1,E1,'LARGE');
        OPENMAP('F2',SE[1],ISM3,E2,'LARGE');
        OPENMAP('F3',BLAMDA(1,1)[1],ISM3,E3,'LARGE');
        OPENMAP('F4',U(1,1)[1],ISM4,E4,'LARGE');
        OPENMAP('F5',ADJUSTU(1,1)[1],ISM5,E5,'LARGE');
        OPENMAP('F6',VEL(1)[1],ISM2,E6,'LARGE');
        OPENMAP('COEFMTRX',TX(1)[1],ISM1,E8,'LARGE');
        OPENMAP('SOLMTRX',SSX(1)[1],ISM2,E9,'LARGE');
        OPENMAP('ADJMTRX',ADJX(1)[1],ISM7,E10,'LARGE');
        WRITE UNIT(6)(E1,E2,E3,E4,E5,E6,E8,E9
               ,E10)#'OPEN',9(3XI2)#;
        COUNTING:=0;
        WRITE UNIT(6)(DYY,IL,JL,KL,AL1,TOLRNCE,RLXFAC)#'DYY=',F5.2,
               'IL=',I3,'JL=',I3,'KL=',I3,'AL1=',F7.3,'TOLRNCE=',F8.4,
               'RLXFACTOR=',F6.3#;
        CON:=PI/180.0;
        K2:=KL+1;
        /* INITIALIZING ALAMDA AND BLAMDA ARRAYS-GIVING
               FIRST GUESS VALUES */
/*        THETA:=+90.0+DYY;
        FOR J:=1 TO JL DO
        THETA:=THETA-DYY;
        FOR K:=1 TO KL DO
        BLAMDA(J,K)[1:IL]:=2.0;
        ALAMDA(J,K)[1:IL]:=2.0;
        ENDF;
        ENDF;
        FOR J:=1 TO JL DO
        FOR K:=1 TO KL DO
        FOR I:=1 BY 2 TO IL DO
        BLAMDA(J,K)[I]:=1.0;
        ALAMDA(J,K)[I]:=1.0;
        ENDF;ENDF;ENDF; */
        BLAMDA(5,5)[36]:=1.5;
        ALAMDA(5,5)[36]:=1.5;
        FOR J:=1 TO JL DO
        WLAMDA[J]:=BLAMDA(J,5)[36];
        ENDF;
        WRITE UNIT(6)(WLAMDA[1:JL])#5E14.7#;
        FOR K:=1 TO KL DO
        KLAMDA[K]:=BLAMDA(5,K)[36];
        ENDF;
```

```
                WRITE UNIT(6)(KLAMDA[1:KL])#'KLAMDA=',5E14.7#;
                WRITE UNIT(6)(BLAMDA(5,5)[30:40])#'LAMDA=',5E14.7#;
                WRITE UNIT(6)(BLAMDA(5,5)[1],BLAMDA(5,5)[IL])
                            #'LAMDA=',2E14.7#;
                FOR I:=1 TO 13 DO
                VEL(I)[1:IJK]:=0.0;
                ENDF;
            /* INITIALIZING WIND-FIELD U,V,W AND DENSITY-D ARRAYS-*/
                THETA:=-90.0-DYY;
                FOR J:=1 TO JL DO
                THETA:=THETA+DYY;
                TH:=THETA*CON;
                FOR K:=1 TO K2 DO
                U(J,K)[1:IL]:=10.0;
                V(J,K)[1:IL]:=3.0                      ;
                W(J,K)[1:IL]:=0.0;
                D(J,K)[1:IL]:=1.0;
                ENDF;
                ENDF;
                CALL DIVRGNCE;
                CALL SOR;
                CLOSE('F1',E1);
                CLOSE('F2',F2);
                CLOSE('F3',E3);
                CLOSE('F4',F4);
                CLOSE('F5',E5);
                CLOSE('F6',F6);
                CLOSE('COEMTRX',F8);
                CLOSE('SOLMTRX',E9);
                CLOSE('ADJMTRX',E10);
                WRITE UNIT(6)(F1,F2,F3,F4,F5,F6,F8
                            ,E9,E10)#'CLOSE',9(3XI2)#;
                ENDP;

        PROCEDURE DIVRGNCE;
        /* THIS PROCEDURE ESTIMATES THE VALUE OF RIGHT HAND SIDE
           OF EQUATIONS. AT THE END IT CALCULATES THE DIVERGENCE
           OF OBSERVED OR ADJUSTED WIND FIELD.   */
                NL:=0;
                FOR J:=1 TO JL DO
                FOR K:=1 TO KL DO
                FOR I:=1 TO IL DO
                NL:=NL+1;
                I1:=I+1;
                I2:=I-1;
                IF I1=IL+1 THEN I1:=1;ENDI;
                IF I2=0    THEN I2:=IL;ENDI;
                VEL(1)[NL]:=U(J,K)[I1]*D(J,K)[I1];
                VEL(2)[NL]:=U(J,K)[I2]*D(J,K)[I2];
                VEL(3)[NL]:=U(J,K+1)[J]*D(J,K+1)[J];
                IF K=1 THEN
```

```
VEL(4)[NL]:=(2*U(J,1)[I]-U(J,2)[I])*(2*D(J,1)[I]
                          -D(J,2)[I]);
        ELSE
              VEL(4)[NL]:=U(J,K-1)[I]*D(J,K-1)[I];
        ENDI;ENDF;ENDF;ENDF;
        NL:=0;
      FOR J:=1 TO JL DO
      FOR K:=1 TO KL DO
      FOR I:=1 TO IL DO
              NL:=NL+1;
              J1:=J+1;
              J2:=J-1;
        IF J1=JL+1 THEN J1:=JL-1; ENDI;
        IF J2=0    THEN J2:=2; ENDI;
              VEL(5)[NL]:=V(J1,K)[I]*D(J1,K)[I];
              VEL(6)[NL]:=V(J2,K)[I]*D(J2,K)[I];
              VEL(7)[NL]:=V(J,K+1)[I]*D(J,K+1)[I];
        IF K=1 THEN
              VEL(8)[NL]:=(2*V(J,1)[I]-V(J,2)[I])*(2*D(J,1)[I]
                          -D(J,2)[I]);
        ELSE
              VEL(8)[NL]:=V(J,K-1)[I]*D(J,K-1)[I];
        ENDI;ENDF;ENDF;ENDF;
        NL:=0;
      FOR J:=1 TO JL DO
      FOR K:=1 TO KL DO
      FOR I:=1 TO IL DO
              NL:=NL+1;
              VEL(9)[NL]:=W(J,K+1)[I]*D(J,K+1)[I];
        IF K=1 THEN
              VEL(10)[NL]:=(2*W(J,1)[I]-W(J,2)[I])*(2*D(J,1)[I]
                          -D(J,2)[I]);
        ELSE
              VEL(10)[NL]:=W(J,K-1)[I]*D(J,K-1)[I];
        ENDI;
              VEL(11)[NL]:=U(J,K)[I]*D(J,K)[I];
              VEL(12)[NL]:=V(J,K)[I]*D(J,K)[I];
              VEL(13)[NL]:=W(J,K)[I]*D(J,K)[I];
        ENDF;
        ENDF;
        ENDF;
/* CALCULATING RIGHT HAND SIDE OF EQUATIONS */
        S[1:IJK]:=0.0;
/*      FOR I:=1 TO 13 DO
          S[1:IJK]:=S[1:IJK]+SSX(I)[1:IJK]*VEL(I)[1:IJK];
        ENDF; */
/* CALCULATING DIVERGENCE OF WIND FIELD */
        AL3:=2.0*AL1*AL1;
        DIV[1:IJK]:=S[1:IJK]/AL3;
      MAXDIV:=MAX(DIV);
```

```
      MINDIV:=MIN(DIV);
      WRITE UNIT(6)(MAXDIV,MINDIV)#'MAXDIV=',E14.7,
                              'MINDIV=',E14.7#;
    ENDP;
        PROCEDURE SOR;
    /* THIS PROCEDURE IS A PROGRAM FOR A SUCCESSIVE OVER
       RELAXATION (S-O-R) ITERATION METHOD TO SOLVE SIMULTANEOUS
       EQUATIONS.FIRST VELOCITIES AND LAMDA TERMS ARE ARRANGED
       IN VECTOR FORMS, AND THEN S-O-R EQUATION IN GENERAL
       FORM IS USED FOR ITERATIONS. */
          ITERATION:=0;
  LC:      NL:=0;
      /* INITIALIZING TLAMDA ARRAYS */
      FOR I:=1 TO IJK DO
          TLAMDA(I)[1:15]:=0.0;
      ENDF;
          CHECK:=1;
      FOR J:=1 TO JL DO
      FOR K:=1 TO KL DO
      FOR I:=1 TO IL DO
          NL:=NL+1;
          I1:=I+1;
          I2:=I-1;
          I3:=I+2;
          I4:=I-2;
          J1:=J+1;
          J2:=J-1;
          K1:=K+1;
          K3:=K-1;
       IF I1=IL+1 THEN I1:=1;ENDI;
       IF I2=0     THEN I2:=IL;ENDI;
       IF J1=JL+1 THEN J1:=JL-1;ENDI;
       IF J2=0     THEN J2:=2;ENDI;
       IF K1=KL+1 THEN K1:=KL;ENDI;
       IF K3=0 THEN K3:=1;ENDI;
       IF I3=IL+2 THEN I3:=2;ENDI;
       IF I3=IL+1 THEN I3:=1;ENDI;
       IF I4=0     THEN I4:=IL;ENDI;
       IF I4=-1    THEN I4:=IL-1;ENDI;
          TLAMDA(NL)[1]:=BLAMDA(J,K)[I];
          TLAMDA(NL)[2]:=BLAMDA(J,K)[I1];
          TLAMDA(NL)[3]:=BLAMDA(J,K)[I2];
          TLAMDA(NL)[4]:=BLAMDA(J1,K)[I];
          TLAMDA(NL)[5]:=BLAMDA(J2,K)[I];
          TLAMDA(NL)[6]:=BLAMDA(J,K1)[I];
          TLAMDA(NL)[7]:=BLAMDA(J,K3)[I];
          TLAMDA(NL)[8]:=BLAMDA(J,K1)[I1];
          TLAMDA(NL)[9]:=BLAMDA(J,K3)[I1];
          TLAMDA(NL)[10]:=BLAMDA(J,K1)[I2];
          TLAMDA(NL)[11]:=BLAMDA(J,K3)[I2];
          TLAMDA(NL)[12]:=BLAMDA(J1,K1)[I];
```

```
                TLAMDA(NL)[13]:=BLAMDA(J1,K3)[I];
                TLAMDA(NL)[14]:=BLAMDA(J2,K1)[I];
                TLAMDA(NL)[15]:=BLAMDA(J2,K3)[I];
                /* ENDING OF VECTORIZATION */
                /* BEGINING OF S-O-R METHOD */
                T:=TLAMDA(NL).DOT.TX(NL);
                BLAMDA(J,K)[I]:=ALAMDA(J,K)[I]+(RLXFAC*(S[NL]-T)/
                                TX(NL)[I]);
        IF((J=1).OR.(J=JL)) THEN
        IF(J=1) THEN JJ:=2;ENDI;
        IF(J=JL) THEN JJ:=JL-1;ENDI;
        BLAMDA(J,K)[I]:=SUM(BLAMDA(JJ,K)[1:IL])/IL;
        ENDI;
        BLAMDA(5,5)[36]:=1.5;
        IF(ALAMDA(J,K)[I]=0.0) THEN ALAMDA(J,K)[I]:=0.0001;ENDI;
                ERROR:=1.0-(BLAMDA(J,K)[I]/ALAMDA(J,K)[I]);
                IF ABS(ERROR)>TOLRNCE THEN CHECK:=CHECK+1;ENDI;
        ENDF;
        ENDF;
        ENDF;
        FOR J:=1 TO JL DO
        WLAMDA[J]:=BLAMDA(J,5)[36];
        ENDF;
        WRITE UNIT(6)(WLAMDA[1:JL])#5E14.7#;
        FOR K:=1 TO KL DO
        KLAMDA[K]:=BLAMDA(5,K)[36];
        ENDF;
        WRITE UNIT(6)(KLAMDA[1:KL])#'KLAMDA=',5E14.7#;
        WRITE UNIT(6)(BLAMDA(5,5)[30:40])#'LAMDA=',5E14.7#;
        WRITE UNIT(6)(BLAMDA(5,5)[1],BLAMDA(5,5)[IL])
                #'LAMDA=',2E14.7#;
        MMMM:=0;
        NL:=0;
        FOR J:=1 TO JL DO
        FOR K:=1 TO KL DO
        NL:=NL+1;
        WLAMDA[NL]:=MAX(BLAMDA(J,K));
        WLAMDA1[NL]:=MIN(BLAMDA(J,K));
        IF (MMMM<3) THEN
        IF (WLAMDA1[NL]<0.0) THEN
        WRITE UNIT(6)(J,K,WLAMDA1[NL])#'J=',I3,'K=',I3,
                'WLAMDA1=',F14.7#;
        MMMM:=MMMM+1;
        ENDI;ENDI;
        IF((J=37).AND.(K=1)) THEN
        WRITE UNIT(6)(J,K,WLAMDA1[NL])#'J=',I3,'K=',I3,
                'WLAMDA1=',F14.7#;
        ENDI;
        ALAMDA(J,K)[1:IL]:=BLAMDA(J,K)[1:IL];
        ENDF;
        ENDF;
```

```
        MAXLAMDA: =MAX(WLAMDA):
        MINLAMDA:=MIN(WLAMDA):
  WRITE UNIT(6)(MAXLAMDA,MINLAMDA)#'LAMDA=','MAX=',E14.7,
                                   'MIN=',E14.7#:
          ITERATION:=ITERATION+1:
        WRITE UNIT(6)(CHECK)#'NUMBER OF ELEMENTS NOT CHECKED='
                            ,I8#:
          COUNTING:=COUNTING+1:
        WRITE UNIT(6)(COUNTING)#'COUNTING OF ITERATIONS=',I8#:
       IF(COUNTING>10)THEN GO TO BBB:ENDI:
          IF CHECK>1 THEN GO TO LC:ENDI:
        WRITE UNIT(6)(ITERATION)#1H0,'NUMBER OF ITERATIONS='
                            ,I3#:
        /* ENDING OF S-O-R METHOD */
        /* PRINTING OF LAMDA TERMS */
/*        FOR J:=1 TO JL DO     */
        FOR J:=1 BY 6 TO JL DO
        FOR K:=1 TO KL DO
        WRITE UNIT(6)(J,K)#1H0,'J=',I3,'K=',I3#:
        WRITE UNIT(6)(BLAMDA(J,K)[1:10])#5E14.7#:
        ENDF:
        ENDF:
        /* ADJUSTMENT OF OBSERVED WIND FIELD TO MAKE IT MASS
        CONSERVATIVE */
          NL:=0:
        FOR J:=1 TO JL DO
        FOR K:=1 TO KL DO
        FOR I:=1 TO IL DO
          NL:=NL+1:
        ADJ[1:5]:=ADJX(NL)[1:5]:
          I1:=I+1:
          I2:=I-1:
          J1:=J+1:
          J2:=J-1:
          K1:=K+1:
          K3:=K-1:
        IF (I1=IL+1) THEN I1:=1:ENDI:
        IF (I2=0   ) THEN I2:=IL:ENDI:
        IF (J1=JL+1) THEN J1:=JL-1:J2:=JL:ENDI:
        IF (J2=0   ) THEN J2:=1:ENDI:
        IF (K1=KL+1) THEN K1:=KL:ENDI:
        IF (K3=0   ) THEN K3:=1:ENDI:

        ADJUSTU(J,K)[I]:=U(J,K)[I]+ADJ[1]*(BLAMDA(J,K)[I1]
              -BLAMDA(J,K)[I2])-ADJ[2]*(BLAMDA(J,K1)[I]
              -BLAMDA(J,K3)[I]):
        ADJUSTV(J,K)[I]:=V(J,K)[I]+ADJ[3]*(BLAMDA(J1,K)[I]
              -BLAMDA(J2,K)[I])-ADJ[4]*(BLAMDA(J,K1)[I]
              -BLAMDA(J,K3)[I]):
        ADJUSTW(J,K)[I]:=W(J,K)[I]+ADJ[5]*(BLAMDA(J,K1)[I]
              -BLAMDA(J,K3)[I]):
```

```
                ENDF;
                ENDF;
                ENDF;

                /* PRINTING OF ADJUSTED WIND FIELD */
        /*      FOR J:=1 TO JL DO      */
                FOR J:=1 BY 6 TO JL DO
                FOR K:=1 TO KL DO
                WRITE UNIT(6)(J,K)#1H0,'J=',I3,'K=',I3#;
                WRITE UNIT(6)(U(J,K)[1:10],ADJUSTU(J,K)[1:10],
                        V(J,K)[1:10],ADJUSTV(J,K)[1:10],
                        W(J,K)[1:10],ADJUSTW(J,K)[1:10])#5E14.7#;
                ENDF;
                ENDF;
                /* CALCULATING DIVERGENCE OF ADJUSTED WIND FIELD */
                FOR J:=1 TO JL DO
                FOR K:=1 TO KL DO
                U(J,K)[1:IL]:=ADJUSTU(J,K)[1:IL];
                V(J,K)[1:IL]:=ADJUSTV(J,K)[1:IL];
                W(J,K)[1:IL]:=ADJUSTW(J,K)[1:IL];
                ENDF;
                ENDF;
                CALL DIVRGNCE;

        BBB:            ENDP;
                        ENDM;
        EOI ENCOUNTERED.
        /IDLE
```

FILE MASSC

```
save,massc,windc,mass
/rewind,massc
$REWIND,MASSC
/copyabf,massc
JSTR,IC,R,T100,CM120000,
ACCOUNT,689650E,
CHARGE,102258,LRC,
DELIVER,R2114VVWASEEM,AKHTAR
GET(MASS)
GET(GLBTROP)
ATTACH,SI,LUIN=LIBRARY,
REDUCE,-
```

```
   RFL,120000,
- -SL-1-MASS,DUMMY,SL1BIN,
   -REPLACE,DUMMY,
   -REWIND,SL1BIN,
   -TOSTAR(I=SL1BIN=RI//U,GLBTROP=//U)
   -DAYFILE,DAY2,
   -REPLACE(DAY2)
   -EXIT,
   -REPLACE(DUMMY)
   -DAYFILE,DAY2,
   -REPLACE(DAY2)
   -1STORE -689650 -102258 MASS            R              U
   -MASS,T70,
   -DELIVER(R2114)
   -LOAD(SL1BIN,I-I=SL1LIB,CN=GO,OU=LODFILE,#200,
   -GROL=*C1,GROL=*C2,GROL=*C3)
   -ATTACH,COFF,VELOCITY,
   -REQUEST,F1/128,
   -GO,
   -DAYFILE,DAY1,
   -TOAS(Z=689650E,RESULT,)
   -EXIT,
   -DAYFILE,DAY1,
   -TOAS(Z=689650E,RESULT,)
   -Q3MPDMP,
   -EOI ENCOUNTERED,
```

FILE WINDC

```
/rewind,windc.
$REWIND,WINDC.
/copyshf,windc.
1STRJOB,T100,CM120000.
ACCOUNT,689650F.
CHARGE,102258,I,RC.
DELIVER,R2114VVWASEEM,AKHTAR
GET(WINDP)
GET(GLBTROP)
ATTACH,SL1/UN=LIBRARY.
REDUCE,-.
RFL,120000.
SL1,WINDP,DUMMY,SL1BIN
REPLACE,DUMMY.
REWIND,SL1BIN.
TOSTAR(I,SL1BIN=BI//U,GLBTROP=//U)
DAYFILE,DAY2.
REPLACE(DAY2)
EXIT.
REPLACE(DUMMY)
DAYFILE,DAY2.
REPLACE(DAY2)
1STORE 689650 102258 WINDP         R             U                    2
WIND,T70.
DELIVER(R2114)
```

```
LOAD(SLIBIN,LI=SLILIB,CN=GO,OU=LODFILE,#200,
     GROL=*CT,GROL=*CS,GROL=*CA,GROL=*CSS)
ATTACH,COEFMTRX,
ATTACH,SOLMTRX,
ATTACH,ADJMTRX,
PURGE(COEFMTRX,SOLMTRX,ADJMTRX,SOLMTR)
REQUEST,COEFMTRX/768,
REQUEST,SOLMTRX/640,
REQUEST,ADJMTRX/256,
REQUEST,SOLMTR/640,
DEFINE,COEFMTRX,
DEFINE,SOLMTRX,
DEFINE,ADJMTRX,
GO,
DAYFILE,DAY1,
TDAS(Z=689650E,RESULT)
EXIT,
DAYFILE,DAY1,
TDAS(Z=689650E,RESULT)
Q3MPDMP,
EOI-ENCOUNTERED,
/
```

FILE WIND

```
-rewind,wind-------
 $REWIND,WIND.------
 /rewind,mass------
 $REWIND,MASS.------
 /copyshf,mass------
-1--------MODULE CONTINUITY(UNIT1=GLBTROP,UNIT2=COFF,UNIT6=RESULT------
                         -UNIT3=VELOCITY)-BEGIN MAIN;------
 /*CC--PROGRAM CONTINUITY LEADS TO AN ADJUSTED MASS --,        --C
         CONSERVATIVE WIND FIELD FROM REAL-TIME OBSERVED DATA.
         THE OBSERVED WIND COMPONENTS U AND V ARE SUBSITUTED
         IN THE CONTINUITY EQUATION TO ESTIMATE W COMPONENT.
         THE CONTINUITY EQUATION IS WRITTEN IN SPHERICAL
         COORDINATES WITH A VERTICAL COORDINATE SYSTEM WHICH TAKES
         INTO ACCOUNT THE VARIABLE TROPOGRAPHY OF THE EARTH'SURFACE
         AND VARIABLE TROPOPAUSE HEIGHT. THIS PROGRAMME IS
         WRITTEN IN STAR-LANGUAGE-1 (SL1) FOR CYBER MACHINE. ----CC*/
 /*CC--DEFINITIONS--------------
         X=EASTWAARD DIRECTION
         Y=NORTHWARD DIRECTION
         Z=VERTICAL DIRECTION
         XX=GRID SIZE IN X-DIRECTION
         YY=GRID SIZE IN Y-DIRECTION
         ZZ=GRID SIZE IN Z-DIRECTION
         IL=NUMBER OF GRID POINTS IN X-DIRECTION
         JL=NUMBER OF GRID POINTS IN Y-DIRECTION
         KL=NUMBER OF GRID POINTS IN Z-DIRECTION
         THETA & TH=ANGLE IN DEGREES & RADIANS RESPECTIVELY FROM
                   SOUTH POLE(-90) TO NORTH POLE(+90)
         R= DISTANCE FROM EARTH CENTER TO THE POINT OF INTEREST
           IN TROPOSPHERE
         TROP= TROPOPAUSE HEIGHT
         U,V & W=WIND COMPONENTS IN X,Y & Z DIRECTIONS RESPECTIVELY
         -----END OF DEFINITIONS----CC*/
```

```
/* THE FOLLOWING SECTION NEEDS TO BE CHANGED FOR A GIVEN
   GRID SYSTEM, FOR EXAMPLE: FOR A GRID SYSTEM 5 DEGREE LONGI-
   TUDE X 5 DEGREE LATITUDE X 9 VERTICAL LEVELS WE HAVE IL=72,
   JL=37, KL=9 AND TOTAL GRID POINTS IJK=23976. XTRA1 TO XTRA3 AND
   ISM1 TO ISM3 ARE PAGING PARAMETERS WHOSE VALUES SHOULD BE ESTIMATED
   FOR A GIVEN SYSTEM. IN THIS PROGRAMME VARIABLES R ,U,V,W AND
   AND ALPHA ARE PAGED SEPARETELY ON DIFFERENT LARGE PAGES.
   EXAMPLE: ALPHA VARIABLE HAS TOTAL 136080 BIT WORDS (6X315X72).
   THIS IS EQUIVALENT TO 6X(JL-2)X(KL-1)XIL.
   A SINGLE LARGE PAGE CAN HAVE 65536 BIT WORDS OR 128 SMALL PAGES.
   THEREFORE WE NEED THREE LARGE PAGES WHICH WILL BE FILLED PARTIALLY
   BY ALPHA VARIABLE. EXTRA PLACE IN THE SECOND PAGE WILL BE
   FILLED BY A DUMMY PARAMETER DUMP3. THE DIMENSION OF THIS PARAMETER
   CAN BE ESTIMATED AS XTRA3=3X65536-136080=60528 AND PARAMETER ISM3
   (IN OPEN MAP STATEMENT)=3X128=384.                        CC*/
                LITERALLY "5.0" DXX;
                LITERALLY "5.0" DYY;
                LITERALLY "72" IL;
                LITERALLY "37" JL;
                LITERALLY "9" KL;
                LITERALLY "10" KKLL; /*KKLL=KL+1 */
                LITERALLY "23976" IJK;
                LITERALLY "315" IJK1; /* IJK1=(JL-2)X KL */
                LITERALLY "41560" XTRA1;
                LITERALLY "51152" XTRA2;
                LITERALLY "60528" XTRA3;
                LITERALLY "128" ISM1;
                LITERALLY "256" ISM2;
                LITERALLY "384" ISM3;
/* END OF THE SECTION TO BE CHANGED                               */
                LITERALLY "ZVECTOR[K]" ZZ;
                LITERALLY "R(J,K)[1:IL]" RO;
                LITERALLY "RTRS[1:IL]" TS1;
                LITERALLY "ALPHA(1,NL)[1:IL]" A1;
                LITERALLY "ALPHA(2,NL)[1:IL]" A2;
                LITERALLY "ALPHA(3,NL)[1:IL]" A3;
                LITERALLY "ALPHA(4,NL)[1:IL]" A4;
                LITERALLY "ALPHA(5,NL)[1:IL]" A5;
                LITERALLY "ALPHA(6,NL)[1:IL]" A6;
                LITERALLY "3.1415926535897793" PI;
                REAL VECTOR [KKLL] Z;
                REAL VECTOR [KL] ZVECTOR;
                REAL VECTOR [JL] TROP;
                REAL VECTOR [IL] RTRS,RR1,RR2,SS;
                REAL VECTOR [IL] ARRAY(6) VEL;
                REAL VECTOR [IJK] WVEL;
/* PAGING OF VARIABLES R,U,V,W AND ALPHA */
                REAL VECTOR [IL] ARRAY(JL,KL) R;
                COMMON C1(R,DUMP1);
                REAL VECTOR [XTRA1] DUMP1;
                REAL VECTOR [IL] ARRAY(JL,KKLL) U,V,W;
```

```
        COMMON C2(U,V,W,DUMP2);
        REAL VECTOR [XTRA2] DUMP2;
        REAL VECTOR [IJK]-ARRAY(6,IJK1) ALPHA;
        COMMON C3(ALPHA,DUMP3);
        REAL VECTOR [XTRA3] DUMP3;
/* END OF PAGING */
        INTEGER I,J,K,NL,E1,E2,E3,KL,KK,IJL;
        REAL MAXW,MINW,ZZZ,THETA,TH,XX,YY,CON;
        INITIAL (Z=\0.0333334,0.0333334,0.0333334,0.0333334
                ,0.1,0.2,0.2,0.2,0.2,0.2\);
        INITIAL (TROP=\9.2,9.3,9.4,9.5,9.7,9.9,10.1,10.3,10.5,10.7,
                10.9,11.1,11.8,16.8,17.8,18.0,18.0,18.0,18.0,
                18.0,18.0,18.0,17.8,16.8,11.8,11.1,10.9,10.7,10.5,
                10.3,10.1,9.9,9.7,9.5,9.4,9.3,9.2\);
        PROCEDURE MAIN;
        OPENMAP('F1',R(1,1)[1],ISM1,E1,'LARGE');
        OPENMAP('VELOCITY',U(1,1)[1],ISM2,E2,'LARGE');
        OPENMAP('COEF',ALPHA(1,1)[1],ISM3,E3,'LARGE');
        WRITE UNIT(6)(E1,E2,E3)#'OPEN'→3(3XI2)#;
        IJL:=IL;
        CON:=PI/180.0;
/*      INITIALIZING U , V AND W VELOCITY VARIABLES      */
        THETA:=-90.0-DYY;
        TH:=THETA*CON;
        FOR J:=1 TO JL DO
        FOR K:=1 TO KKL1 DO
        U(J,K)[1:IL]:=-10.0;
        V(J,K)[1:IL]:=3.0*COS(TH);
        W(J,K)[1:IL]:=0.0;
        ENDF;ENDF;
/*CC    THE FOLLOWING STATEMENT "CALL COEFFICIENT" LEADS THE
        EXECUTION TO PROCEDURE COEFFICIENT. THIS PROCEDURE
        ESTIMATES THE NECESSARY COEFFICIENTS FOR THE CONTINUITY
        EQUATION FOR A GIVEN CONDITIONS SUCH
        AS GLOBAL TOPOGRAPHY OF EARTH'S SURFACE, TROPOPAUSE HEIGHT
        AND GRID SIZES. THEREFORE FOR A GIVEN CONDITIONS THIS
        PROCEDURE SHOULD BE ACCESSED ONLY ONCE. THE COEFFICIENTS
        THUS ESTIMATED WILL BE STORED PERMANENTLY IN A FILE
        CALLED "COEF". IN ORDER TO AVOID EXECUTION OF THIS
        STATEMENT TYPE /* AND */ ON LEFT AND RIGHT SIDE OF
        "CALL COEFFICIENT" STATEMENT.               CC*/

        CALL COEFFICIENT;

/*      THE FOLLOWING " DO LOOP " FIRST CONVERTS VELOCITY
        DATA IN THE VECTOR FORM AND THEN USING THE CORRESPONDING
        COEFFICIENTS FROM FILE "COEF" ESTIMATES VERTICAL VELOCITY
        COMPONENT "W" WHICH SATISFIES CONTINUITY EQUATION. --*/
        NL:=0;
        FOR J:=2 TO JL-1 DO
        FOR K:=1 TO KL DO
```

```
        NL:=NI +1;
        K1:=K-1;
        IF (K1=0) THEN K1:=1;ENDI;
        VEL(1)[1:IL]:=W(J,K)[1:IL];
        VEL(2)[1]:=U(J,K)[2]-U(J,K)[IL];
        VEL(2)[IL]:=U(J,K)[1]-U(J,K)[IL-1];
        VEL(2)[2:IL-1]:=U(J,K)[3:IL]-U(J,K)[1:IL-2];
        VEL(3)[1:IL]:=V(J+1,K)[1:IL]-V(J-1,K)[1:IL];
        VEL(4)[1:IL]:=V(J,K)[1:IL];
        VEL(5)[1:IL]:=U(J,K+1)[1:IL]-U(J,K1)[1:IL];
        VEL(6)[1:IL]:=V(J,K+1)[1:IL]-V(J,K1)[1:IL];
        SS[1:IL]:=0.0;
        FOR KK:=1 TO 6 DO
          SS[1:IL]:=SS[1:IL]+(VEL(KK)[1:IL]*ALPHA(KK,NL)[1:IL]);
        ENDF;
        IF(K=1) THEN W(J,K+1)[1:IL]:=SS[1:IL];ENDI;   ----\
        IF(K>1) THEN W(J,K+1)[1:IL]:=W(J,K1)[1:IL]+SS[1:IL];ENDI;
        ENDF;
        ENDF;

/* TO ESTIMATE MAXIMUM AND MINIMUM VALUE OF "W" VELOCITY */
        NL:=0;
        FOR J:=1 TO JL DO
        FOR K:=1 TO KL DO
        FOR I:=1 TO IL DO
        NL:=NL+1;
        WVEL[NL]:=W(J,K)[I];
        ENDF;ENDF;ENDF;
        MAXW:=MAX(WVEL);
        MINW:=MIN(WVEL);
        WRITE UNIT(6) (MAXW,MINW)#'MAXW=',E14.7,'MINW=',E14.7#;
        CLOSE ('F14',E1);
        CLOSE ('VELOCITY',E2);
        CLOSE ('COFF',E3);
        WRITE UNIT(6)(E1,E2,E3)#'CLOSE=',3(3X I2)#;
      ENDP;
      PROCEDURE COEFFICIENT;
/*    SEE DETAILED COMMENT ABOUT THIS PROCEDURE IN THE
      "PROCEDURE MAIN".                                  */
      ZVECTOR[1:KL]:=(Z[2:KKL]+Z[1:KL])/2.0;
      XX:=DXX*CON;
      YY:=DYY*CON;
/*CC  INITIALIZING ELEMENTS OF R(JL,KL)[IL]   CC*/
      FOR J:=1 TO JL DO
      READ UNIT(1) (R(J,1)[1:IL])#6E13.6#;
      R(J,1)[1:IL]:=6371000.0+R(J,1)[1:IL];
      R(J,KL)[1:IL]:=6371000.0+TROP[J]*1000.0;
      TS1:=R(J,KL)[1:IL]-R(J,1)[1:IL];
      ZZZ:=0.0;
      FOR K:=2 TO KL DO
      ZZZ:=ZZZ+Z[K];
```

```
      RO:=R(J,1)[1:IL]+ZZZ*TS1;
      ENDF; ENDF;
/*      ESTIMATING THE COEFFICIENTS OF CONITUINY EQUATION      */
                NL:=0;
                THETA:=-90.0;
                FOR J:=2 TO JL-1 DO
                THETA:=THETA+DYY;
                TH:=THETA*CON;
                FOR K:=1 TO KL DO
                NI:=NI+1;
                TS1:=R(J,KL)[1:IL]-R(J,1)[1:IL];
                RR1[1]:=R(J,K)[2]-R(J,K)[IL];
                RR1[IL]:=R(J,K)[1]-R(J,K)[IL-1];
                RR1[2:IL-1]:=R(J,K)[3:IL]-R(J,K)[1:IL-2];
                RR2[1:IL]:=R(J+1,K)[1:IL]-R(J-1,K)[1:IL];
                IF(K=1) THEN
                   A1:=(RO-2.0*TS1*ZZ)/RO;
                   A2:=-TS1*ZZ/(2.0*RO*COS(TH)*XX);
                   A3:=-TS1*ZZ/(2.0*RO*YY);
                   A4:=-2.0*YY*A3*TAN(TH);
                ENDI;
                IF(K>1) THEN
                   A1:=-4.0*TS1*ZZ/RO;
                   A2:=-TS1*ZZ/(RO*COS(TH)*XX);
                   A3:=-TS1*ZZ/(RO*YY);
                   A4:=-2.0*YY*A3*TAN(TH);
                ENDI;
                A5:=RR1[1:IL]/(2.0*RO*COS(TH)*XX);
                A6:=RR2[1:IL]/(2.0*RO*YY);
              ENDF; ENDF;
                ENDP;
                ENDM;
EOL ENCOUNTERED.
      /
```

TD-8004 + TD-9009

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
NATIONAL METEOROLOGICAL CENTER

OFFICE NOTE 84

Labels for NMC 360/195 Data Fields

Automation Division Staff

JULY 1973

Office Note No. 84

Each NWS data field is prefixed with a 384-bit label. The first 192 bits contain values which indicate the quantity, the surface or layer, and the time of the data being labeled. The next 64 bits contain the initial time, the number of data points, and generating code information. The remaining bits hold, among other things, scale factors partinent to packed data. Appendix C shows each entry and its location within the label.

All data fields can be thought of as some quantity, Q on a horizontal or quasi-horizontal surface S at some level of value L. If the quantity Q is by its nature, a layer-defined quantity, the limits of the layer are given by S_1 at L_1 and S_2 at L_2. Code figure for Q and S are both given in Table 1.

The numerical value of the level L for the corresponding surface S is composed of two numbers: an integer C and a power of ten with the exponent E such that

$$L = C \times 10^E,$$

Both C and E are signed integers (sign and magnitude). The space allocated for C in the identifier is 20 bits which is large enough to accomodate the binary equivalent of any 5-digit decimal integer. The convention which must be followed in order to provide a unique bit configuration for any given level is as follows:

(a) C must be a 5-digit decimal integer whose leading digit (the highest order digit) must be nonzero, unless L is zero,

Once C is determined, the value of the exponent E naturally follows such that the resulting L will have its true value in the standard units given in Table 1. For example, if L is 500 mb

$$C = 50000$$
$$E = -2$$
$$50000 \times 10^{-2} = 500.00$$

or if L is 0.7 mb

$$C = 70000$$
$$E = -5$$
$$70000 \times 10^{-5} = .70000$$

Appendix B contains the hexadecimal equivalents of commonly used values of C.

Table 1a gives the values for the marker N which is used for identifying different spectral quantities.

Table 2 gives the values for the marker t which is used for identifying fields involving time and explains how F_1 and F_2 are to be used for each value of t.

Table 3 gives the values for the marker m which is used for identif ng fields involving layers.

Table 4 gives value to be used for the marker X. In general, this marker will be non-zero only for fields in a guess file.

Table 4a gives the values for the markers CM and CD which identify climatological data.

Table 5 gives the values for the marker K which identifies the grid to which these data apply.

Table 5a gives the values for the markers KS which indicates if the grid was derived from spectral or other special methods.

The initial hour I of the forecast (or the observation time on which the analysis is based) is entered in accordance with the 24-hour clock GMT to the nearest hours. For example: I = CO for midnight GMT and I = 12 for noon GMT. Y is the year within the century. For example, for the year 1973, Y - 73. M is the month of the year, and D is the day of the month.

Table 6 gives the values for the marker R which identifies the run within the cycle.

Table 7 gives the values for the marker G assigned to the program which generated the field.

Each datum point value Q on a surface S (Qs) is scaled according to the equation .

$$\hat{Q}s = (Qs - A)/2^n.$$

Qs must be in the standard units given in Table 1.

The procedure followed for scaling is to scan the data to find the maximum and minimum values of Qs. The value of A is set equal to [(Qs) max. + (Qs) min.]/2. An integer n is then chosen such that 2^n is the smallest value which satisfies the condition $([(Qs) max-A]/2^n)<1$. This procedure allows maximum accuracy to be maintained in packing the data.

The mid-range value A is placed in the identifiers as a IBM 360 real number, i.e., 8-bit sign and exponent and 24-bit fraction. The scaling value n is inserted as an IBM 360 half-word integer, i.e., 16-bit integer, 2's complement if negative.

The scaled quantity $\hat{Q}s$, an unnormalized fraction, is packed into 16 bits using 2's complement if negative.

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TABLE 1 -- Q and S

Parameters and Surfaces

Number Hexadecimal	Decimal	Abbreviation	Parameter Name	Standard Unit
			Height w/r to mean sea level	
1	1	-HGT--	geopotential	geopotential meter
2	2	-P-ALT	pressure altitude	geopotential meter
			Distance w/r to earth's	
6	6	-DIST-	surface geometric distance	meter
			Pressure	
8	8	-PRES-	atmospheric pressure	mb
			Temperature	
10	16	-TMP--	atmospheric temperature	degree K
11	17	-DPT--	dewpoint temperature	degree K
12	18	-DEPR-	dewpoint depression	degree K
13	19	-POT--	potential temperature	degree K
14	20	-T-MAX	maximum temperature	degree K
15	21	-T-MIN	minimum temperature	degree K
			Vertical Motion	
28	40	-V-VEL	vertical velocity ($\frac{dp}{dt}$)	mb/sec
29	41	-NETVD	net vertical displacement	mb
2A	42	-DZDT-	vertical velocity ($\frac{dz}{dt}$)	meter/sec
2B	43	-OROW-	orographical component ($\frac{dz}{dt}$)	meter/sec
2C	44	-FRCVV	frictional component ($\frac{dz}{dt}$)	meter/sec
			Wind	
30	48	-U-GRD	u component of wind (with respect to grid)	meter/sec
31	49	-V-GRD	v component of wind (with respect to grid)	meter/sec
32	50	-WIND-	wind speed	meter/sec
33	51	-T-WND	thermal wind speed	meter/sec
34	52	-VW-SH	vertical speed shear	sec^{-1}
35	53	-U-DIV	divergent u component (with respect to grid)	meter/sec
36	54	-V-DIV	divergent v component (with respect to grid)	meter/sec
37	55	-WDIR-	direction from which wind is blowing w/r to north	degree
38	56	-WEND-	westerly component of wind	meter/sec
39	57	-SWND-	southerly component of wind	meter/sec
3A	58	-RATS-	ratio of speeds	dimensionless
3B	59	-VECW-	vector wind (spectral)	not applicable
3C	60	-STNS-	steadiness factor	percent

③

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Serial Hexadecimal	Decimal	Abbreviation	Parameter Name	Standard Units
			Fluid Flow Functions	
48	72	-ABS-V	absolute vorticity	sec^{-1}
49	73	-REL-V	relative vorticity	sec^{-1}
4A	74	-DIV--	divergence	sec^{-1}
50	80	-STRM-	stream function	$meter^2/sec$
51	81	-V-POT	velocity potential	$meter^2/sec$
			Moisture	
58	88	-R-H--	relative humidity	percent
59	89	-P-WAT	precipitable water	$kg/meter^2$
5A	90	-A-PCP	accumulated total precipitation	meter
5B	91	-P-O-P	probability of precipitation	percent
5C	92	-P-O-Z	probability of frozen precipitation	percent
5D	93	-SNO-D	snow depth	meter
5E	94	-ACPCP	accumulated convective precipitation	meter
5F	95	-SPF-H	specific humidity	dimensionless
60	96	-L-H2O	liquid water	dimensionless
			Stability	
70	112	-LFT-X	lifted index	degree K
71	113	-TOTOS	total totals	degree K
72	114	-K-X--	k-index	degree K
73	115	-C-INS	convective instability	degree K
			Wave Components	
78	120	-L-WAV	long wave component of geopotential	geopotential meter
79	121	-S-WAV	short wave component of geopotential	geopotential meter
			Miscellaneous Surfaces	
80	128	------	Mean Sea Level	dimensionless
81	129	------	Earth's Surface	dimensionless
82	130	------	Tropopause	dimensionless
			Sigma Domain	
90	144	------	boundary	dimensionless
91	145	------	troposphere	dimensionless
92	146	------	stratosphere	dimensionless
93	147	------	quiet cap	dimensionless

Number		Abbreviation*	Parameter Name	Standard Unit
Hexadecimal	Decimal			
			Miscellaneous Parameters	
A0	160	-DRAG-	drag coefficients	dimensionless
A1	161	-LAND-	land/sea	dimensionless
A2	162	-KFACT	k factors (700mb to 500mb normal ratio)	dimensionless
A3	163	-1CTST	conversion constants (1000mb to sea level pressure)	dimensionless
A4	164	-70SL-	sea level pressure specification from 700mb heights	mb/meter
A5	165	-RCPOP	regression coefficients for probability of precipitation	percent/meter
A6	166	-RCMT-	regression coefficients for mean temperature	degree K/meter
A7	167	-RCMP-	regression coefficients for mean precipitation	dimensionless
A8	168	-OPRSP	orthogonal pressure function	mb
A9	169	-ALBDO	albedo	dimensionless
AA	170	-ENFLX	energy flux	watt/m²
AB	171	-HTRAT	heating rate	degree K/sec
B0	176			
B1	177			
B2	178			
B3	179			
B4	180			
B5	181			
B6	182			
B7	183			
			Oceanographic Variables	
180	384	-WTMP-	water temperature	degree K
181	385	-WVHGT	height of wind driven waves	meter
182	386	-SWELL	height of sea swells	meter
183	387	-WVSWL	combined height of waves and swells	meter
184	388	-WVPER	period of wind driven waves	second
185	389	-WVDIR	direction from which waves are moving (w/r to north)	degree
186	390	-SWPER	period of sea swells	second
187	391	-SWDIR	direction from which sea swells are moving (w/r to north)	degree

* Abbreviations are 6 characters. A dash (-) is used to indicate a blank.

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TABLE 10.

II

Spectral Quantity Marker
(4 bits)

II	MEANING
0	Not to be assigned
1	Spectral specification
2	Zonal coefficient
3	Spectral amplitude
4	Spectral phase angle

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Table 2

Time Marker t (4 bits)

t	MEANING	F_1	F_2
0	Indicates the field is instantaneous; e.g., a 500 mb height forecast: Q_5	Forecast hour (tau)	0
1	Indicates the field is formed from two fields of the same type whose valid times are equal but whose forecast hours (taus) may or may not be equal; e.g., difference between two analyses (taus equal) of the same parameter; difference between a forecast and the verifying analysis of the same parameter (taus unequal): $(Q_5)_2 - (Q_5)_1$	Forecast hour (tau) of $(Q_5)_2$	Tau of $(Q_5)_2$ minus tau of $(Q_5)_1$
2	Indicates the field is formed from two fields of the same parameter whose forecast hours (taus) are equal and whose valid times are unequal; e.g., a tendency field formed by differencing two analyses of the same parameter which are 12 hours apart: $(Q_5)_2 - (Q_5)_1$.	Forecast hour (tau) of $(Q_5)_2$ and $(Q_5)_1$	Valid time of $(Q_5)_2$ minus valid time of $(Q_5)_1$
3	Indicates the field is formed from two fields of the same parameter whose forecast hours (taus) are unequal and whose initial times are equal; e.g., a forecast tendency field: $(Q_5)_2 - (Q_5)_1$.	Forecast hour (tau) of $(Q_5)_2$	Forecast hour (tau) of $(Q_5)_2$ minus forecast hour (tau) of $(Q_5)_1$
4	Indicates the field is formed from a number of fields of the same parameter to obtain average or normal values. If the average applies to a number of days, f_1 is used to indicate this number; and if the average applies to a number of years, f_2 is used to indicate that number.	Days used in average or 0	0 or years used in average

7

TABLE 2 - continued

| 5 | Indicates the field is non-instantaneous and applies during some time period; e.g., a field of forecast probability of precipitation during some time period. | Forecast hour (tau) at end of period. | Tau at ending of period minus tau at beginning of period. |

TABLE 3

n

LEVEL DIFFERENCE MARKER

(4 Bits)

n	MEANING
0	Indicates S_2 and L_2 are not applicable.
1	Indicates a field is formed by taking the value of Q at S_1 minus the value of Q at S_2.
2	Indicates a field of Q for the layer bounded by S_1 and S_2 not covered by category n = 1.

TABLE 4

X

EXCEPTION MARKER
(8 bits)

	MEANING
0	Indicates the initial time of the field is the same as the current date of the observation cycle.
1	Indicates the initial time of the field is six hours prior to the current date of the observation cycle.
2	Indicates the initial time of the field is twelve hours prior to the current date of the observation cycle.
3	Indicates the initial time of the field is eighteen hours prior to the current date of the observation cycle.
4	Indicates the initial time of the field is twenty-four hours prior to the current date of the observation cycle.
5	Indicates the initial time of the field is thirty hours prior to the current date of the observation cycle.
6	Indicates the initial time of the field is thirty-six hours prior to the current date of the observation cycle.
· · ·	
254	Indicates the initial time of the field is one thousand five hundred twenty-four hours prior to the current date of the observation cycle.
255	Not applicable. The exception marker (X) does not apply for this data or the value of X is greater than 254.

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CM and CD

CLIMATOLOGY NUMBERS

(8 bits each)

(MONTH-HOUR)

CM	MEANING
00	Not applicable.
01	JAN 0000 GMT
02	FEB 0000 GMT
.	.
.	.
.	.
12	DEC 0000 GMT
13	JAN 1200 GMT
14	FEB 1200 GMT
.	.
.	.
24	DEC 1200 GMT

(DAY OF MONTH)

CD	MEANING
00	Not applicable
01	First
02	Second
.	.
.	.
.	.
31	Thirty-First

11

TABLE 5

K

GRID TYPE MARKER
(6 bits)

K	MEANING
0	1977 - point octagonal grid (Northern Hemisphere) (Grid increment = 381 km)
1	1679 - point grid (73 x 23) Tropical (Grid increment = 5° longitude)
2	1752 - point grid (73 x 24) Tropical (Grid increment = 5° longitude)
3	3021 - point grid (53 x 57) Northern Hemisphere (Grid increment = 381 km)
4	510 - point FD (U,V,T) grid
5	3021 - point (53 x 57) fine mesh grid (North America) (Grid increment = 190.5 km)
6	1977 - point fine mesh octagon (North America) (Grid increment = 190.5 km)
7	2329 - point (53 x 53) octagon (North America)
8	5104 - point facsimile grid (116 x 44)
9	143 - U. S. cities for Max/Min Temp.
10	216 - U. S. cities for Probability of Precipitation
11	286 - U. S. cities for Precipitation Amount
12	1702 - point tropical grid (74 x 23) (Grid increment = 5° longitude)
13	576 - point longitude/latitude grid (Grid increment = 10°)
14	103 - U. S. station array
15	40 - U. S. station array
16	1560 - point grid (39 x 40) eastern half of U. S. (Grid increment = 95.2 km)
17	221 - point grid (13 x 17) centered over U. S. (Grid increment = 381 km)
18	Reserved
19	1977 - point octagon (Southern Hemisphere) (Grid increment = 381 km)
20	2555 - point Mercator grid (45 x 59) (Grid increment = 1½° longitude)
21	1387 - point (73 x 19) longitude/latitude Southern Hemisphere grid (Grid increment = 5°)
22	1387 - point (73 x 19) longitude/latitude Northern Hemisphere grid (Grid increment = 5°)
23	783 - point subset of grid 5 (fine mesh (29 x 27)) Planetary Boundary Layer (PBL) grid
24	651 - point (31 x 21) facsimile grid covering U.S. (Grid increment = 190.5 km)

TABLE 5 CONTINUED

25	3021 – point grid (53 x 57) Southern Hemisphere (Grid increment = 381 km)
26	2385 – point (53 x 45) fine mesh grid (North America) (Grid increment = 190.5 km)
27	4225 – point (65 x 65) Northern Hemisphere grid (Grid increment = 381 km at 60° N)
28	4225 – point (65 x 65) Southern Hemisphere grid (Grid increment = 381 km at 60° S)
29	5365 – point (145 x 37) longitude/latitude Northern Hemisphere grid (Grid increment = 2.5°)
30	5365 – point (145 x 37) longitude/latitude Southern Hemisphere grid (Grid increment = 2.5°)
31	327 – point-TDL field composed of a string of 4 grids: U.S. (255 points), Alaska (56 points), Hawaii (12 points), and Puerto Rico (4 points). See TDL Technical Memo 73-5
32	Not Assigned
33	8326 – point (181 x 46) longitude/latitude Northern Hemisphere grid (Grid increment = 2°)
34	8326 – point (181 x 46) longitude/latitude Southern Hemisphere grid (Grid increment = 2°)
255	Not Applicable

TABLE 5a

KS

Spectral Method Marker
(3 bits)

KS	MEANING
0	Not to be assigned
1	Hough spectral method

TABLE 6

R

RUN MARKER
(8 Bits)

R	MEANING
0	New operational run (LFM)
1	First operational run with an observation cycle (RADAT)
2	Second operational run (RAOB)
3	Third operational run (OPNL)
4	Fourth operational run
5	Fifth operational run (10 + 0 FINAL)

TABLE 7

G

CODE NUMBER OF PROGRAM GENERATING DATA
(8 Bits)

DEC	HEX	NAME OF GENERATING PROGRAM
00	0	Objective analysis
01	1	Barotropic Forecast model described in NMC Office Note 15
02	2	Mesh model 1958 described in NMC Office Note 15
03	3	Mesh model 1964 (with improved terrain) described in Office Note 24
04	4	Reed 1000 mb forecast model described in NMC Tech. Memo 25
05	5	3-level baroclinic forecast model described in NMC Tech. Memo 22
06	6	4-level baroclinic forecast model
07	7	4-layer Primitive Equation (PE) model
08	8	6-layer PE model
09	9	Maximum and minimum temperature forecast
10	A	Sea height and swell forecast
11	B	Tropical Analysis
12	C	Tropical Forecast
13	D	Bat Analysis
14	E	Tropical Forecast
15	F	Tropical Forecast with Satellite measurements
16	10	Sub-synoptic Advection Model
17	11	Compute long wave components
18	12	Trajectory Forecast
19	13	Limited-area Fine mesh model

TABLE 7 CONTINUED

20	14	Limited-area Fine Mesh Forecast
21	15	Perfect Prog Precipitation Forecast
22	16	Rough Analysis
23	17	MOFA - Eddy Analysis & Sanbar Forecast
24	18	NMRC/NCAR Climatology data
25	19	Snow cover
26	1A	Planetary boundary layer analysis and forecast
27	1B	Extended Forecast data processor
23	1C	PE and Trajectory Model Output Statistics
29	1D	8-layer spheral ("global") PE model (5° mesh)
30	1E	8-layer northern hemispheral ("hemiglobal") PE model (2.5° mesh)

APPENDIX B

Hexadecimal Equivalents for Commonly Used Values of C

Decimal	Hexadecimal
10000	02710
15000	03A98
15240	03B88
18290	04772
20000	04E20
21340	0535C
25000	061A8
27315	06AB3
27430	06B26
30000	07530
30480	07710
33333	08235
35000	088B8
36580	08EE4
40000	09C40
42570	0A64A
45000	0AFC8
50000	0C350
55000	0D6D8
60000	0EA60
65000	0FDE8
65657	10463
70000	11170
75000	124F8
80000	13880
85000	14C08
90000	15F90
91400	16508
95000	17318
99000	182B8

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
NATIONAL METEOROLOGICAL CENTER

OFFICE NOTE 184

Procedures for Creating or Unpacking FGGE Level III
Data Sets in International Exchange Formats

Armand J. Desmarais
Development Division

JULY 1978

Wanda,
See exceptions for
your tape.

Procedures for Creating or Unpacking FGGE Level III Data Sets

General

The documentation for FGGE Level III formats is described in Appendix 11, FGGE International Data Management Plan, "Format for the International Exchange of Level III Data Sets During the FGGE." *Ignore*

Purpose

This note describes the basic steps needed for creating or unpacking Level III data sets with the use of attached subroutine listings. These subroutines were written for use on IBM 360 machines that have 32-bit words. Some modifications may be necessary to utilize these routines on other machines.

Level III Tape Files

File 1	—	TEST file — *Ignore*
File 2	—	TAPE HEADER file "
File 3	—	GRID DESCRIPTOR file "
Files 4-n	—	LEVEL III DATA file(s)

the 1ST record in your files is a label record

To Create Level III Magnetic Tape

The basic sequence of events in a computer program should be as follows, assuming that the required analysis fields are available in an analysis file and are ready for processing:

A. Write the required TEST file on output tape (File 1).

B. Screen available analyses to determine first and last dates to be processed and written on the output tape. Prepare the documentation for the TAPE HEADER file with appropriate dates (File 2), and write it on the output tape (See example, Attachment 1).

not applicable

C. Describe the grid(s) used for the Level III data (See example, Attachment 1). Write GRID DESCRIPTOR file on output tape.

D. Select an analysis field from the analysis file, prepare the necessary unique identification words (see subroutine W3FI32, Attachment 2), scale and pack the data (see subroutine W3AI00, Attachment 3), and write the packed field in a LEVEL III DATA file on the output tape.

not applicable

E. Repeat D above for other fields for the given date/time.

F. Write an end-of-file tape mark on the output tape.

G. Repeat steps D, E, and F above for any remaining date/times.

H. Terminate the output tape with at least two (2) consecutive end-of-file tape marks.

To Unpack Level III Data

ignore

The format required to read FGGE Level III data sets is written in clear text in the second file (TAPE HEADER) of each tape. The third file of each tape will contain information concerning the arrangement of the data for the grid(s) used in the DATA file(s) that start with the fourth file.

ignore

A. Read a record from selected DATA file.

B. Determine if you desire to process and unpack the record. Subroutine W3FI33 (Attachment 4) could be used to convert the first 256 bits of the record identification to individual field identifiers.

C. If the field is desired, the packed data (beginning at bit 385) can be unpacked and rescaled with the use of subroutine W3AI01 (see Attachment 5). If not desired, repeat A and B above.

A sample FORTRAN program to locate and unpack N. Hemisphere 700 mb heights, and to print out some values over the United States, is given in Attachment 6. Descriptions of built-in and intrinsic functions used in the various subroutines are given in Attachment 7.

EXAMPLE -- TAPE HEADER FILE

FGGE3A00317801020078010812
10780   FIXED LENGTH RECORDS (BLOCKSIZE = RECORD SIZE)
20A4   USE (100(27A4)) FOR FULL RECORD
0123456789=:> /STUVWXYZ.(-JKLMNOPQR*);+ABCDEFGH.)(<
9-TRACK, 800 BPI
BINARY, ODD PARITY
IBM 360/195,   32 BITS/WORD, 8 BITS/BYTE.
NATIONAL METEOROLOGICAL CENTER, NWS, NOAA, WASHINGTON, D.C., USA
(100(27A4))
HOUGH FUNCTION ANALYSIS METHOD, GLOBAL   (FLATTERY)
FIRST GUESS COEFFICIENTS DERIVED FROM A 9-LAYER PRIMITIVE EQUATION
FORECAST MODEL ON A 2.5 X 2.5 LATITUDE/LONGITUDE GRID.
100. = (42640000) HEXADECIMAL   FLOATING POINT REPRESENTATION
-100. = (C2640000) HEXADECIMAL   FLOATING POINT REPRESENTATION

ANALYSIS FIELDS NORMALLY PROVIDED:
12 LEVELS OF U- and V-WIND COMPONENTS, TEMPERATURES, AND HEIGHTS
(AT 1000, 850, 700, 500, 400, 300, 250, 200, 150, 100, 70, AND 50 MB);
6 LEVELS OF RELATIVE HUMIDITIES (AT 1000, 850, 700, 500, 400, AND 300 MB);
TROPOPAUSE PRESSURE AND TEMPERATURE (MODELED); SNOW FIELD;
SEA SURFACE TEMPERATURE (FROM SATELLITE DATA); SEA LEVEL PRESSURE.

MISSING ANALYSES: NONE

... END OF TEXT ....

[handwritten: This info is ok for your case.]

[handwritten: Print data for one fito record]

EXAMPLE -- GRID DESCRIPTOR FILE

GRID 029   RECTANGLE
GEOGRAPHIC
RIGHT-HANDED
GRIDLINES = 037, DELTAJ = 2.50, FIRSTPT=(0.00N, 0.00E)
J=ALL, NI=145,   DELTAI = 2.50
... END OF TEXT ....

GRID 030   RECTANGLE
GEOGRAPHIC
RIGHT-HANDED
GRIDLINES = 037, DELTAJ = 2.50, FIRSTPT=(90.00S, 0.00E)
J=ALL, NI=145,   DELTAI = 2.50
... END OF TEXT ....

[handwritten: basic info ok, too]

W3FI32
Pack ID
(Modified for FGGE Level III)

FORTRAN H EXT +
IBM 360
NMC, DCA

PURPOSE:

To convert an array of the 27 data field identifiers into an array of the first 8 identification words. (See Appendix 11, FGGE International Data Management Plan, "Format for the International Exchange of Level III Data Sets During the FGGE."

USAGE:

Calling Statement

CALL W3FI32(KARRAY,PKDNT)

where,

KARRAY = array containing the 27 data field identifiers (INTEGER*4).

PKDNT = array to receive the 8 identification words.

NOTE 1

(a) If any number n in (KARRAY(I),I=1,27) is erroneously large, W3FI32 will print:
'VALUE IN KARRAY(I)=n ID TOO LARGE TO PACK'

(b) If any number n in KARRAY(I) is erroneously negative, W3FI32 will print:
'VALUE IN KARRAY(I)=n SHOULD NOT BE NEGATIVE'

(c) If either (a) or (b) occurs, that portion of the packed word corresponding to KARRAY(I) will be set to binary ones.

Examples

1. Suppose KARRAY(4)=30. Then W3FI32 will print 'VALUE IN KARRAY(4)=30 IS TOO LARGE TO PACK' and will place ones in the first 4 bits of PKDNT(2).

2. To form PKDNT from the 27 data field identifers for 500 mb height from FMANL (limited-area fine mesh analysis file) dated 00Z March 15, 1974, KARRAY should be initialized as follows:

KARRAY	IDENTIFIER	KARRAY	IDENTIFIER	KARRAY	IDENTIFIER
(1)=1	Q	(10)=0	F_2	(19)=0	Unused
(2)=8	S_1	(11)=0	N^2	(20)=1523	NW
(3)=0	F_1	(12)=0	C_2	(21)=74	JJ
(4)=0	t_1	(13)=0	E_2	(22)=3	MM
(5)=50000	C_1	(14)=0	CD	(23)=15	YY
(6)=-2	E_1	(15)=0	CM	(24)=0	GG
(7)=0	m	(16)=0	KS	(25)=0	R
(8)=0	X	(17)=5	K	(26)=19	G
(9)=0	S_2	(18)=0	Unused	(27)=3021	J

Then the resulting PKDNT array would be as follows (in hexadecimal):

PKDNT (1) 00100800   (5) 00000005
       (2) 00C35082   (6) 000005F3
       (3) 00000000   (7) 4A030F00
       (4) 00000000   (8) 00130BCD

```
W3FI32
          SUBROUTINE W3FI32 (IARRAY,KIDNT)
      C   SUBROUTINE W3FI32 PACKS DATA FIELD IDENTIFIERS.
          DIMENSION KIDNT(8),ITABLE(27),IARRAY(27)
          DATA ITABLE/Z00140C01,Z00080C01,Z00000801,Z001C0402,Z01081402,
         1Z01000802,Z001C0403,Z00140803,Z00080C03,Z00000803,Z001C0404,
         2Z01081404,Z01000804,Z00180805,Z00100805,Z00080805,Z00000805,
         3Z001C0406,Z00100C06,Z00001006,Z00180807,Z00100807,Z00080807,
         4Z00000807,Z00180808,Z00100808,Z00001008/
          DATA KX/ZFFFFFFFF/
          DATA MASK/Z000000FF/
      C   MAKE KIDENTS=0
          DO 20 I=1,8
          KIDNT(I)=0
       20 CONTINUE
          ISIGN=0
          DO 40 I=1,27
          ISC=ITABLE(I)
          I1=LAND(ISC,MASK)
          I2=LAND( SHFTR(ISC,8),MASK)
          I3=LAND( SHFTR(ISC,16),MASK)
          I4=LAND(SHFTR(ISC,24),MASK)
      C   SIGN TEST
          IV=IARRAY(I)
          IF(IV.GE.0)GO TO 12
          IF(I4.NE.0) GO TO 1
          WRITE (6,22) I,IV
       22 FORMAT(///,1X,' VALUE IN KARRAY(',I2,')=',I11,' SHOULD NOT BE NEGA
         /TIVE'///)
          GO TO 30
        1 IV=IABS(IV)
          MSIGN=1
          ISIGN=MSIGN
          K=I2/4
          DO 25 M=1,K
       25 ISIGN=SHFTL(ISIGN,4)
          ISIGN=SHFTR(ISIGN,1)
          IV=LOR(IV,ISIGN)
       12 CONTINUE
      C   MAG TEST
          IF( SHFTR(IV,I2).EQ.0)GO TO 100
          WRITE(6,21)I,IV
       21 FORMAT(///,1X,' VALUE IN KARRAY(',I2,')=',I11,' IS TOO LARGE TO PA
         /CK'///)
       30 IV=KX
          IA=32-I2
          IV=SHFTR(IV,IA)
      C   SHIFT
      100 KIDNT(I1)=LOR(KIDNT(I1), SHFTL(IV,I3))
       40 CONTINUE
          RETURN
          END
```

```
W3AI00
         SUBROUTINE W3AI00(REAL4,PACK,LABEL)
C
C   SCALE AND CONVERT A FIELD OF REAL*4 DATA TO HALF-WORD INTEGERS AND
C   PACK TOGETHER WITH LABEL DATA IN FGGE LEVEL III DATA FORMAT.
C
C      CALL W3AI00(REAL4,PACK,LABEL)
C
C   WHERE REAL4 = ARRAY OF REAL*4 DATA TO BE PACKED.
C         PACK  = OUTPUT ARRAY. WORDS 1-8 COPY LABEL WORDS 1-8. WORDS
C                 9-12 ARE GENERATED. WORDS 13,14,... ARE PACKED DATA.
C                 ALLOW 12+(J+1)/2 FULLWORDS, WHERE J IS NUMBER OF POINTS.
C         LABEL =INPUT LABEL DATA. WORD 8, BITS 16-31, MUST CONTAIN THE
C                 COUNT OF THE NUMBER OF POINTS IN ARRAY REAL4 FOR THIS
C                 ROUTINE TO WORK.
C
C   GENERATED DATA TO BE FOUND IN PACK.....
C   WORD 9   BITS  0-15: NUMBER OF BYTES IN WHOLE RECORD.
C            BITS 16-31: EXCLUSIVE-OR CHECKSUM OF WHOLE RECORD (EXCEPT
C                        CHECKSUM ITSELF), BY HALFWORDS.
C   WORD 10 BITS  0-31: REAL*4 CENTERING VALUE A = THE MEAN OF THE MAX
C                        AND MIN VALUES OF ARRAY REAL4.
C   WORD 11 BITS  0-23: ZERO
C            BITS 24-31: INTEGER*2 SHIFT VALUE N, THE LEAST INTEGER SUCH
C                        THAT ABS(X-A)/2**N IS LESS THAN 1 FOR ALL X IN
C                        ARRAY REAL4.  N IF NEGATIVE IS IN 2'S COMPLEMENT
C                        FORM.  VALUE OF N WILL NOT EXCEED 127.
C   WORD 12 BITS  0-31: ZERO
C   WORD 13 BITS  0-15: FIRST PACKED DATUM
C            BITS 16-31: SECOND PACKED DATUM
C   WORD 14 BITS  0-15: THIRD PACKED DATUM
C    . . .
C
C   THE BINARY POINT OF THE PACKED DATA IS CONSIDERED TO BE TO THE RIGHT
C   OF THE LEFTMOST, OR SIGN BIT.  DATA IS IN 2'S COMPLEMENT FORM IF
C   NEGATIVE.  IF PACK IS EQUIVALENCED TO AN INTEGER*2 ARRAY HLF, THE
C   DATA MAY BE RECONSTRUCTED AS FOLLOWS:
C        REAL4(J) = HLF(J+24)*2.**(N-15) + A
C   WHERE A AND N ARE TO BE FOUND IN WORDS 10 AND 11.
C
         REAL*4 REAL4(1)
         INTEGER*2 LABEL(1),PACK(1),IA(2)
         EQUIVALENCE (A,IA(1)),(X,IX)
C
C   TRANSFER LABEL DATA TO WORDS 1-8.  GET WORDCOUNT, COMPUTE BYTES.
C
         DO 10 I=1,16
         PACK(I) = LABEL(I),
   10    CONTINUE
         J = LABEL(16)
         M = J+24
         PACK(17) = M+M
         PACK(18) = 0
C
C   FIND MAX, MIN OF DATA, COMPUTE A AND N.
C
         RMAX = REAL4(1)
         RMIN = RMAX
         DO 20 I=2,J
```

```
W3AI00
          RMAX = AMAX1(RMAX,REAL4(I))
          RMIN = AMIN1(RMIN,REAL4(I))
   20     CONTINUE
          A = 0.5*(RMAX+RMIN)
          X = RMAX-A
          N = LAND(SHFTR(IX,24),127)
          N = 4*(N-64)
          IF (TBIT(IX,8)) GO TO 30
          N = N-1
          IF (TBIT(IX,9)) GO TO 30
          N = N-1
          IF (TBIT(IX,10)) GO TO 30
          N = N-1
   30     N = MAX0(-127,MIN0(127,N))
          PACK(19) = IA(1)
          PACK(20) = IA(2)
          PACK(21) = 0
          PACK(22) = N
          PACK (23) = 0
          PACK(24) = 0
C
C NOW PACK UP THE DATA
C
          TWON = 2.**(15-N)
          DO 60 I=1,J
          X = (REAL4(I)-A)*TWON
          K = X+SIGN(0.5,X)
          IF (K.LT.(-32767)) GO TO 40
          K = MIN0(32767,K)
          GO TO 50
   40     K = -32767
   50     PACK(I+24) = K
   60     CONTINUE
C
C COMPUTE CHECKSUM AND STORE
C
          IXOR = 0
          DO 70 I=1,M
          K = PACK(I)
          IXOR = LXOR(IXOR,K)
   70     CONTINUE
          PACK(18) = IXOR
          RETURN
          END
```

W3FI33
Unpack ID
(Modified for FGGE Level III)

FORTRAN H EXT +
IBM 360
NMC,DCA

PURPOSE:

To convert an array of the first 8 identification words into an array of 27 data field identifiers. (See Appendix 11, FGGE International Data Management Plan, "Format for the International Exchange of Level III Data Sets During the FGGE.")

Calling Statement

    CALL W3FI33(PKDNT,KARRAY)

where,

    PKDNT == array containing the 8 identification words.
    KARRAY = array to receive the 27 data field identifiers (INTEGER*4).

Example

Suppose the 8 identification words for 500 mb height from FMANL (limited-area fine mesh analysis file) dated 00Z March 15, 1974 are given (in hexadecimal)

PKDNT				
(1)	00100800	(5)	00000005
(2)	00C35082	(6)	000005F3
(3)	00000000	(7)	4A030F00
(4)	00000000	(8)	00130BCD

Then the resulting KARRAY array would be as follows:

KARRAY	IDENTIFIER	KARRAY	IDENTIFIER	KARRAY	IDENTIFIER
(1)=1	Q	(10)=0	F_2	(19)=0	Unused
(2)=8	S_1	(11)=0	N	(20)=1523	NW
(3)=0	F_1	(12)=0	C_2	(21)=74	JJ
(4)=0	t	(13)=0	E_2	(22)=3	MM
(5)=50000	C_1	(14)=0	CD	(23)=15	YY
(6)=-2	E_1	(15)=0	CM	(24)=0	GG
(7)=0	m	(16)=0	Ks	(25)=0	R
(8)=0	X	(17)=5	K	(26)=19	G
(9)=0	S_2	(18)=0	Unused	(27)=3021	J

W3FI33

```
      SUBROUTINE W3FI33 (IDNT,LARRAY)
      DIMENSION LARRAY(27),IDNT(8),ITABLE(27),J(6),JS(6)
C     SUBROUTINE W3FI33 UNPACKS THE 8 IDENTIFICATION WORDS INTO AN ARRAY
C     OF 27 DATA FIELD IDENTIFIERS.
      DATA J/Z0000000F,Z000000FF,Z00000FFF,Z0000EFFF,Z000FFFFF,
     /Z00FFFFFF/
      DATA JS/Z00000007,Z0000007F,Z000007FF,Z00007FFF,Z0007FFFF,
     /Z007FFFFF/
      DATA MASK/Z000000FF/
      DATA ITABLE/Z00140C01,Z00080C01,Z00000801,Z001C0402,Z01081402,
     1Z01000802,Z001C0403,Z00140803,Z00080C03,Z00000803,Z001C0404,
     2Z01081404,Z01000804,Z00180805,Z00100805,Z00080805,Z00000805,
     3Z001C0406,Z00100C06,Z00001006,Z00180807,Z00100807,Z00080807,
     4Z00000807,Z00180808,Z00100808,Z00001008/
      DO 50 I=1,27
      ISC=ITABLE(I)
      I1=LAND(ISC,MASK)
      I2=LAND(SHFTR(ISC,8),MASK)
      I3=LAND( SHFTR(ISC,16),MASK)
      I4=LAND(SHFTR(ISC,24),MASK)
      IX=I2/4
      LARRAY(I)=LAND(SHFTR(IDNT(I1),I3),J(IX))
C     TO SEE IS THE NUMBER IS MINUS
      IF(I4.EQ.0) GO TO 50
      IB=LARRAY(I)
      IC=SHFTL(IB,1)
      DO 30 M=1,IX
   30 IC=SHFTR(IC,4)
      IF(IC.EQ.0) GO TO 50
C     ABS. VALUE,THEN MINUS.
      LARRAY(I)=-(LAND(IB,JS(IX)))
   50 CONTINUE
      RETURN
      END
```

W3AI01

```
        SUBROUTINE W3AI01(PACK,REAL4,LABEL)
C
C  UNPACK AND FLOAT A FIELD OF PACKED DATA IN FGGE LEVEL III DATA
C    FORMAT ACCORDING TO SPECIFICATIONS IN THE ID WORDS OF THE
C  PACKED DATA.  ALSO MOVE THE ID WORDS TO A LABEL ARRAY.
C
C      CALL W3AI01(PACK,REAL4,LABEL)
C
C  WHERE PACK  = ARRAY OF ID WORDS AND PACKED DATA TO BE UNPACKED,
C        REAL4 = REAL*4 ARRAY TO RECEIVE THE UNPACKED DATA WHICH WILL
C                BE DE-SCALED ACCORDING TO ID SPECIFICATIONS.
C        LABEL = A 12-WORD ARRAY INTO WHICH THE ID WORDS WILL BE COPIED.
C
C  PACK MUST CONTAIN THE FOLLOWING FIELDS.....
C  WORD  8 BITS 16-31: NUMBER OF DATA POINTS J.
C  WORD  9 BITS 16-31: EXCLUSIVE-OR CHECKSUM OF REST OF ARRAY BY
C                      HALFWORDS.  THUS CHECKSUM OF ENTIRE ARRAY SHOULD
C                      BE ZERO.
C  WORD 10 BITS  0-31: REAL*4 DATA OFFSET VALUE A.
C  WORD 11 BITS 16-31: INTEGER*2 SHIFT VALUE N, IN 2'S COMPLEMENT FORM
C                      IF NEGATIVE.
C  WORD 13 BITS  0-15: DATUM 1
C          BITS 16-31: DATUM 2
C  WORD 14 BITS  0-15: DATUM 3
C      ----     ETC  ----
C
C  THERE WILL BE 12+(J+1)/2 FULLWORDS IN ARRAY PACK, AND J FULLWORDS IN
C  ARRAY REAL4.
C
       REAL*4 REAL4(1)
       INTEGER*2 LABEL(1),PACK(1),IA(2)
       EQUIVALENCE (A,IA(1))
C
C  TRANSFER ID WORDS TO LABEL.
C
       DO 10 I=1,24
       LABEL(I) = PACK(I)
 10    CONTINUE
C
C  GET WORD COUNT, A, N.
C
       J = PACK(16)
       IA(1) = PACK(19)
       IA(2) = PACK(20)
       N = PACK(22)
       TWON = 2.**(N-15)
C
C  UNPACK, CONVERT REAL*4 DATA
C
       DO 20 IM=1,J
       I = J+1-IM
       REAL4(I) = PACK(I+24)*TWON+A
 20    CONTINUE
       RETURN
       END
```

LEVEL 2.2 (SEPT 76)   OS/360 FORTRAN H EXTENDED PLUS   DATE 78.193/07.17.07   PAGE

REQUESTED OPTIONS: MAP,XREF,LC(80)

OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(80) SIZE(MAX) AUTODBL(NONE)
SOURCE EBCDIC NOLIST NODECK OBJECT MAP NOFORMAT NOGOSTMT XREF ALC NOANSF NOTERM FLAG(I)

FUNCTIONS INLINE ARE: NONE

```
C***   SAMPLE PROGRAM TO READ AND UNPACK FGGE LEVEL III 2.5 X 2.5
C***   LATITUDE/LONGITUDE ANALYSIS FIELDS, WRITTEN IN INTERNATIONAL
C***   EXCHANGE FORMAT.
C***   THIS SAMPLE SEARCHES FOR AND UNPACKS 700 MB HEIGHTS (NO. HEMIS.)
C***   AND DISPLAYS VALUES OVER THE UNITED STATES --- FROM 30N TO 50N,
C      AND FROM 235E(125W) TO 280E(80W).
C
ISN 0002       DIMENSION LABEL(12), IBUF(2695), RECT(145,37), IDS(6)
ISN 0003       LOGICAL*1 LABX(48)
ISN 0004       DATA IDS /Z0010800, Z0111708, 0, 0, Z11D /
ISN 0005       EQUIVALENCE (LABX(1),LABEL(1))
ISN 0006       NFILES =
C***   ASSUME THAT THE TAPE IS PRE-POSITIONED.........         <---- (Wonder,
ISN 0007       DO 500  KK = 1, NFILES
ISN 0008     7 N = N + 1
ISN 0010       READ (10,3030,ERR=307,END=320) IBUF
ISN 0011  3330 FORMAT ( 255 (33A4) )
ISN 0012       IF (IBUF(1) .NE. IDS(I))  GO TO 7
ISN 0013  C**12 CONTINUE
C***   FOUND DESIRED FIELD         (700 MB HEIGHTS)....
ISN 0016    13 PRINT 13, (IBUF(I), I=1,12)
ISN 0017    13 FORMAT (' FOUND FIELD WITH THE FOLLOWING IDENTS...'/ 1X,1229. -
C***   UNPACK FROM IBUF TO RECT
ISN 0018       CALL #3A101 (IBUF, RECT, LABEL)
C
C***       RECT(1,1)    AT 0 DEGREES N, 0 DEGREES EAST
C***       RECT(2,1)    AT 0 DEGREES N, 2.5 DEGREES E..
C***       RECT(3,1)    AT 0 DEGREES N, 5.0 DEGREES E..         ETC.
C***       RECT(145,1)  AT 0 DEGREES N, 2.5 DEGREES E..
C***       RECT(1,2)    AT 2.5 DEGREES N, 0 DEGREES E..         ETC
C       RECT(1,37) THRU RECT(145,37) AT NORTH POLE.
C
C***   FOR SOUTHERN HEMISPHERE GRIDS, (5TH IDENTIFICATION WORD = 1E.)
C***       RECT(1,1) THRU RECT(145,1) WOULD BE AT SOUTH POLE.
C***       RECT(1,37) AT 0 DEGREES N, 0 DEGREES E..             ETC
C       RECT(2,37) AT 0 DEGREES N, 2.5 DEGREES E.
C
C***   PRINT SELECTED 700 MB HEIGHTS (METERS)
ISN 0019    21 FORMAT (' SELECTED 700 MB HEIGHTS (METERS) OVER THE UNITED ST
ISN 0020       1ATES. (LOWER LEFT VALUE AT 30N, 125W)'.////)
               JJ = 40
               DO 22 J = 1, 9
ISN 0021    22 PRINT 22, (RECT(I,JJ), I=95, 113)
ISN 0022    22 FORMAT (1X,19F6.0,///)
               JJ = JJ -
ISN 0023    40 CONTINUE
ISN 0024    45 PRINT 45, LABX(4), (LABX(I),I=25,28)
ISN 0025    45 FORMAT (//,' VALID ',I2,' HOURS AFTER ',I2,'/',I2,'/',I2,
ISN 0026       1           I2,'00 GMT.')
ISN 0029   310 PRINT 310,/,' ..... RAN TO PLANNED EXIT ..........')
ISN 0032       STOP
ISN 0033   307 PRINT 308, KK.  READ ERROR ON UNIT 10, FILE NUMBER ',I2,' RECORD ',
ISN 0034   308 FORMAT (' WILL CONTINUE...')
               GO TO 7
ISN 0035   320 PRINT 321, KK.  HIT END-OF-FILE MARK NUMBER ',I2,' ON UNIT 10.')
ISN 0037   500 CONTINUE
               STOP
               END
```

FOUND FIELD WITH THE FOLLOWING IDENTS
00100BOG 0111708Z 00000000 00000000 00000087 4E010200 0A0014F5 2A1AC45C 4J829400 00000009 00000000
0010011D 00000000

SELECTED 700 MB HEIGHTS (METERS) OVER THE UNITED STATES. (LOWER LEFT VALUE AT 30N. 125W)

3049. 3057. 3062. 3056. 3041. 3018. 2985. 2943. 2898. 2856. 2822. 2801. 2789. 2783. 2779. 2775. 2773. 2777.

3033. 3041. 3049. 3056. 3059. 3054. 3039. 3014. 2982. 2945. 2909. 2877. 2853. 2835. 2820. 2808. 2796. 2786. 2786.

3028. 3035. 3043. 3053. 3060. 3061. 3052. 3035. 3011. 2984. 2953. 2922. 2893. 2868. 2848. 2830. 2813. 2800. 2795.

3036. 3042. 3049. 3056. 3063. 3065. 3060. 3050. 3033. 3011. 2984. 2953. 2924. 2896. 2875. 2854. 2836. 2822. 2819.

3052. 3059. 3062. 3065. 3069. 3069. 3066. 3060. 3048. 3030. 3007. 2982. 2956. 2933. 2911. 2891. 2874. 2865. 2868.

3069. 3075. 3077. 3077. 3075. 3071. 3066. 3058. 3047. 3033. 3016. 2998. 2978. 2959. 2943. 2932. 2929. 2932.

3083. 3088. 3090. 3089. 3085. 3078. 3070. 3066. 3064. 3061. 3054. 3042. 3027. 3014. 3005. 3000. 2998. 2998.

3096. 3098. 3098. 3100. 3100. 3096. 3088. 3081. 3080. 3084. 3080. 3073. 3068. 3065. 3062. 3058. 3054.

3106. 3102. 3104. 3106. 3108. 3108. 3104. 3099. 3096. 3095. 3098. 3103. 3107. 3110. 3111. 3110. 3108. 3105. 3102.

VALID 0 HOURS AFTER 78/ 1/ 2. 000 GMT.

**** RAN TO PLANNED EXIT **********

A6 - 2

Built-in Functions

IV = LAND (a, b)

where a,b may be a 1-, 2-, or 4-byte logical integer expression.
The value of LAND is obtained by AND-ing the individual bits of the
arguments. The resulting value, IV, will be considered to be logical*4,
but may be used as an integer.

IV = LOR (a, b)

where a, b may be a 1-, 2-, or 4-byte logical or integer expression.
The value of LOR is obtained by OR-ing the individual bits of the arguments.
The resulting value, IV, will be considered to be logical*4, but may be
used as an integer.

IV = LXOR (a, b)

where a, b may be a 1-, 2-, or 4-byte logical or integer expression.
The value of LXOR is obtained by exclusive OR-ing the individual bits of
the arguments. The resulting value, IV, will be considered to be logical*4,
but may be used as an integer.

IV = SHFTL (J, K)

IV = SHFTR (J, K)

where J is a 4-byte variable,

K is the actual number of bits to be shifted.

The values of SHFTL and SHFTR are obtained by shifting the first
argument, J, left or right, respectively, the number of bits specified
by the second argument, K. The resulting value, IV, will be considered
to be logical*4, but may be used as an integer.

IV = TBIT (A, K)

where A is a variable, 4-bytes or less,

K is the number assigned to the bit to be tested

The value of TBIT is .TRUE. or .FALSE. depending whether bit position K of the variable A is ON or OFF (ON=1, OFF=0). Bit 0 is the leftmost bit of variable A. The result, IV, will be declared as logical*4.

Intrinsic Functions

AMAX1 - Maximum, Real

$$A=AMAX1(X_1,X_2,\ldots,X_n)$$

where A and X are real *4

AMIN1 - Minimum, Real

$$A=AMIN1(X_1,X_2,\ldots,X_n)$$

where A and X are Real *4

MAX0 - Maximum, Integer

$$L=MAX0(M_1, M_2,\ldots,M_n)$$

where L and M are Integer *4

MIN0 - Minimum, Integer

$$L=MIN0(M_1,M_2,\ldots,M_n)$$

where L and M and Integer *4

IABS - Absolute Value, Integer

$$L = IABS(M)$$

where L and M are Integer *4

SIGN -

$$Y=SIGN(X_1,X_2)$$

where X and Y are Real *4

$$Y=(sign\ of\ X_2)\cdot|X_1|$$

C - 2

Wascom→ 7-2675?

for Dr. Peters

APPENDIX C

7-2675

7-1994

BIT

	0	3	4	7	8	11	12	15	16	23	24	31
1	Q	Data Type		S₁	Type of Surface 1	F₁ Time 1	
2	T	Marker C₁	Numerical Value of Surface 1 = C₁ × 10^E₁			E₁	
3	M	Marker X	Exception Marker	S₂	Type of Surface 2	F₂ Time 2	
4	N	Marker C₂	Numerical Value of Surface 2 = C₂ × 10^E₂			E₂	
5	CD		CM		KS	Gridding Method	K Grid Type
6	Unused	RN	Record Number on disk		NW	Number of words in record	
7	Y	Year 2	M Month		D	Day	I Initial Hour
8	R	Run Marker	G Generating Program		J	Number of Data Points	
9	B	Number of Bytes in Record			Z	Checksum	
10	A	Mid-Range Value, Real #4					
11	Unused				n	Scaling Value, Integer #2	
12			Unused				
13	Data Point 1				Data Point 2		
14	Data Point 3				Data Point 4		
	Point 5				Data Point 6		
					Data P...		

$$I_f = F_1 \qquad \text{Time 1}$$

12 8
20
12
20
8
8 15
12
8 8
8 16
15 16
32
16
32
16
16
16
16
15

D 1 I 0
I 12
D I
I

360 FORMAT FOR PACKED DATA FIELDS

*Rev. Dec. 1973

10780

National Oceanic and Atmospheric Admini...
ENVIRONMENTAL DATA SERVICE

National Climatic Center
Federal Building
Asheville, N. C. 28801

D5231(17136)/SD

September 18, 1978

TO: Mr. Beck
        NASA
        Langley Research Center
        Hampton, VA 23665

        (704)

FROM: Richard M. Davis, Chief   →   672-0203
        Computer Products Branch

SUBJECT: Tape Dumps (Your Telcon 9/8/78)

Enclosed are hex tape dumps of the first and last five records from the NMC global and N. Hemisphere tapes for April 1-15, 1978.

Enclosure

7-2675

DECODE Program Listing

```
/* (SUBRG,STRG,STRZ,SIZE,FOFL,OFL):*/
DECODE:                          /* TO UNPACK NASA WEATHER TAPE */
        PROCEDURE
        OPTIONS(MAIN);


/*

    This program requires no special control cards to decode
    all FGGE level III data packed on a National Meteorological
    Center weather tape. Proper JCL cards must be included,
    however. SYSUT1 and SYSUT2 are the DDnames for the input
    and output datasets respectively. If only a part of the
    data is desired, some program modification will be necessary.
    The basic conversion subroutines may remain unchanged.
    See the writeup, UNPACKING FGGE LEVEL III DATASETS IN
    INTERNATIONAL EXCHANGE FORMATS, for further information.
*/
```

```
DCL 01 RECIN ALIGNED,        /* STRUCTURE FOR INPUT RECORDS */
    05 PART1,                /* RECEIVES BINARY DIGITS FOR  */
    10 DATA_TYPE BIT(12),    /* CONVERSION TO DECIMAL       */
    10 TYPE_S1   BIT(12),
    10 TIME1     BIT(8),
    10 MARKER1   BIT(4),
    10 C1        BIT(20),
    10 BSIGN     BIT(1),
    10 E1        BIT(7),
    10 MARKER2   BIT(4),
    10 XMARKER   BIT(8),
    10 TYPE_S2   BIT(12),
    10 TIME2     BIT(8),
    10 MARKER3   BIT(4),
    10 C2        BIT(20),
    10 BSIGN2    BIT(1),
    10 E2        BIT(7),
    10 CD        BIT(8),
    10 CM        BIT(8),
    10 KS        BIT(8),
    10 K         BIT(8),
    10 UNUSED    BIT(4),
    10 RN        BIT(12),
    10 NW        BIT(16),
    10 Y         BIT(8),
    10 M         BIT(8),
    10 D         BIT(8),
    10 I         BIT(8),
    10 RMARKER   BIT(8),
    10 G         BIT(8),
    10 J         BIT(16),
    10 B         BIT(16),
    10 Z         BIT(16),
    10 A         BIT(32),
    10 UNUSED2   BIT(16),
    10 N         BIT(16),
    10 UNUSED3   BIT(32),
    05 DATA(5365) BIT(16),
    05 XX        BIT(16);
```

Using Decode

```
DCL 01 TEMPREC UNALIGNED,              /* STRUCTURE TO RECEIVE      */
    05 PART1,                          /* NUMBERS AFTER CONVERSION  */
    10 DATA_TYPE FIXED BINARY(31),
    10 TYPE_S1   FIXED BINARY(31),
    10 TIME1     FIXED BINARY(31),
    10 MARKER1   FIXED BINARY(31),
    10 C1        FIXED BINARY(31),
    10 BSIGN     FIXED BINARY(31),
    10 E1        FIXED BINARY(15),
    10 MARKER2   FIXED BINARY(31),
    10 XMARKER   FIXED BINARY(31),
    10 TYPE_S2   FIXED BINARY(31),
    10 TIME2     FIXED BINARY(31),
    10 MARKER3   FIXED BINARY(31),
    10 C2        FIXED BINARY(31),
    10 BSIGN2    FIXED BINARY(31),
    10 E2        FIXED BINARY(15),
    10 CD        FIXED BINARY(31),
    10 CM        FIXED BINARY(31),
    10 KS        FIXED BINARY(31),
    10 K         FIXED BINARY(31),
    10 UNUSED    FIXED BINARY(31),
    10 RN        FIXED BINARY(31),
    10 NW        FIXED BINARY(31),
    10 Y         FIXED BINARY(31),
    10 M         FIXED BINARY(31),
    10 D         FIXED BINARY(31),
    10 I         FIXED BINARY(31),
    10 RMARKER   FIXED BINARY(31),
    10 G         FIXED BINARY(31),
    10 J         FIXED BINARY(31),
    10 B         FIXED BINARY(31),
    10 Z         FIXED BINARY(15),
    10 A         FLOAT,
    10 UNUSED2   FIXED BINARY(31),
    10 N         FIXED BINARY(31),
    10 UNUSED3   FIXED BINARY(31),
    05 DATA(1387) FIXED BINARY(15),
    05 XX        FIXED BINARY(31);
```

Using Decode

```
DCL 01 OUTREC   UNALIGNED,          /* STRUCTURE RETURNED BY  */
    05 PART1,                       /*          SORT          */
    10 DATA_TYPE CHAR(14),
    10 C1        CHAR(14),
    10 K         CHAR(14),
    10 Y         CHAR(14),
    10 M         CHAR(14),
    10 D         CHAR(14),
    10 I         CHAR(14),
    05 DATA(1337)CHAR(9);
```

```
DCL 01 WRITEREC   UNALIGNED,        /* STRUCTURE TO WRITE OUT */
    05 PART1,                       /*    TO TAPE AFTER SORT   */
    10 DATA_TYPE CHAR(14),          /* WITH DATA CONSOLIDATED  */
    10 C1        CHAR(14),          /* FROM 2 RECORDS INTO 1   */
    10 Y         CHAR(14),
    10 M         CHAR(14),          /*   ONE OUTPUT RECORD IS  */
    10 D         CHAR(14),          /*   NOW TWO TIME PERIODS   */
    10 I         CHAR(14),          /*    (ONE DAY) OF DATA     */
    05 DATA(1387)CHAR(9),
    05 DAT2(1387)CHAR(9);
```

Using Decode

```
    DCL SYSUT1        FILE RECORD INPUT,       /*   INPUT TAPE FILE   */
        SYSUT2        FILE RECORD OUTPUT,      /* SORTED OUTPUT FILE  */
        SYSPRINT      FILE STREAM OUTPUT;      /*   PRINT  FILE       */


    DCL (EOF,BADQ) BIT(1),                     /*        FLAGS        */
        (II,JJ,JJJ,KK,
         LIMIT,
         REC_NUMBER) FIXED BIN(15) INIT(1),
         BLKS  FIXED BIN(31),                  /*   USED FOR COUNTERS  */
         RETCODE FIXED BIN(31,0):              /* RETURN CODE FROM PLISRT*/


    DCL (UNSPEC,
         PLIRETC,
         PLISRTD,
         STRING,
         FLOOR)    BUILTIN;                    /*     PLI FUNCTIONS */



    ON OVERFLOW BEGIN;
         PUT SKIP(4) EDIT('******  OVERFLOW ERROR ENCOUNTERED  ******')
                                                                (A);
         PUT SKIP(2) EDIT('******  RETURN OUTPUT TO BOB CROVO  ******')
                                                                (A);
         PUT SKIP(2) EDIT('******      FOR    DEBUGGING        ******')
                                                                (A);
         STOP;
         END;

    EOF = '0'B;
    ON ENDFILE(SYSUT1) EOF = '1'B;
    READ FILE(SYSUT1) INTO(RECIN): /* READ 1ST RECORD (HEADER LABEL) INTO
                                      STRUCTURE RECIN TO THROW AWAY     */
```

DECPROG-UKC332

Using Decode

```
BIG_LOOP:                               /* NUMBER OF TIME PERIODS TO TRANSLATE*/
DO BLKS=1 TO 100000 UNTIL(EOF);/* FOR ACTUAL PRODUCTION RUNS */
/* DO BLKS = 1 TO 2 */                  /* FOR DEBUGGING */


READ_LOOP:
/*
   Read remaining records into structure RECIN and do conversion from
   binary to decimal by making the assignment from the binary structure
   (RECIN) to the fixed binary(31) structure (TEMPREC) by name.
   Finally, convert structure to character representation for output
   to tape in character structure OUTREC.
*/

/* PLISRTD calls GETREC 116 times before starting to sort records.
   After sort, PUTREC is used to write to tape. Fields to be sorted
   are YEAR, MONTH, DAY, TIME PERIOD, Q, C Descending, and K (grid),
   also Descending.
*/
CALL PLISRTD(
     ' SORT FIELDS=(43,56,CH,A,1,14,CH,A,15,14,CH,D,29,14,CH,D)',
                    ' RECORD TYPE=F,LENGTH=(12581) ',
                    200000,RETCODE,GETREC,PUTREC,'','AP');

IF RETCODE¬=0 THEN DO; PUT DATA(RETCODE);      /*  BAD SORT  */
                       CALL PLIRETC(RETCODE);
                       STOP;
                       END;



   /*     <<<<<<< THE FOLLOWING STMT IS FOR DEBUGGING ONLY >>>>>>>    */
PUT SKIP EDIT(' HAVING RETURNED FROM PLISRTD WITH RETCODE = ',RETCODE,
   ' RETURN TO TOP OF LOOP AFTER READING DUMMY RECORD')(A,F(12,3),A);
   /*     <<<<<<< REMOVE THE PRECEDING STMT FOR ACTUAL RUNS>>>>>>>>   */



READ FILE(SYSUT1) INTO(RECIN); /* READ 1ST RECORD (HEADER LABEL) INTO
                                  STRUCTURE RECIN TO THROW AWAY       */
END; /* OF BIG_LOOP */

PUT SKIP(8) EDIT('******   NORMAL PROGRAM TERMINATION   ******')
                                                    (COL(10),A);
PUT SKIP(8) EDIT('******   ',BLKS, ' RECORDS PROCESSED ******')
                                                    (COL(10),A);
STOP;
```

Using Decode

```
GETREC:                             /* GETREC READS 116 RECORDS BEFORE */
                                    /* CALLING PLIRETC(8) FOR PLISRTD  */
    PROCEDURE RETURNS (CHAR(12581));
    DCL KNT FIXED BIN(15) STATIC INIT (1);
    READ:  IF KNT = 117 THEN DO; KNT = 1;
                                 REC_NUMBER = 1;
                                 CALL PLIRETC(8);/*LAST RECORD TO SORT*/
                                 RETURN(STRING(OUTREC));
                                 END;
           BADQ = CONVERT;
           KNT = KNT + 1;
           IF BADQ THEN GOTO READ;    /*       SKIP THIS RECORD      */
           CALL PLIRETC(12);          /* NEED MORE RECORDS FOR SORT */
           RETURN(STRING(OUTREC));
    END; /* OF GETREC */



PUTREC:
    PROCEDURE (STRUCT);            /* STRUCT DEF ON OUTREC MAY BE BETTER */
           DCL STRUCT CHAR(12581);
           DCL Q FIXED BIN(31); /*     USED AS TEMPORARY VARIABLE      */
           DCL NEWCALL BIT(1) STATIC INIT('1'B);
           STRING(OUTREC) = STRUCT;
           Q = OUTREC.DATA_TYPE;
           Q = 48 * (Q=1) + 49 * (Q=2) + 16 * (Q=3) + (Q=4) + 88 * (Q=5);
(NOSTRZ) :OUTREC.DATA_TYPE = Q;
           IF NEWCALL THEN DO; NEWCALL = '0'B;
                               REC_NUMBER = REC_NUMBER + 1;
                               WRITEREC = OUTREC, BY NAME;
                               END;
                   ELSE DO; NEWCALL = '1'B;
                            WRITEREC.DAT2 = OUTREC.DATA;
                            WRITE FILE(SYSUT2) FROM(WRITEREC);
                            END;
           CALL PRINT;     /* FOR DEBUGGING ONLY--BEST REMOVE ON RUN */
           CALL PLIRETC(4);
    END; /* OF PUTREC */
```

Using Decode

```
CONVERT:                        /* CONVERT TAPE DATA TO DECIMAL NUMBERS */
   PROCEDURE  RETURNS(BIT(1));   /* 1 FOR FAILURE, 0 FOR SUCCESS */
   DCL Q FIXED BIN(31);          /*  Q IS USED AS TEMPORARY VAR  */



   READ FILE(SYSUT1) INTO(RECIN);     /* READ RECORD INTO
                                                 STRUCTURE RECIN */
(NOSTRZ):
   TEMPREC.PART1=RECIN.PART1, BY NAME;/* CONVERT FROM BINARY TO  */
                                      /* DECIMAL BY ASSIGNMENT    */
   IF (TEMPREC.TYPE_S1 ¬= 8) THEN
      RETURN('1'B);                   /*    TEST FOR DESIRED  S   */

   Q = TEMPREC.DATA_TYPE;
   Q = (Q=48) + 2 * (Q=49) + 3 * (Q=16) + 4 * (Q=1) + 5 * (Q=88);
   IF (Q = 0) THEN RETURN('1'B);      /*   TEST FOR DESIRED  Q'S */
   TEMPREC.DATA_TYPE = Q;

   TEMPREC.XX = RECIN.XX;
   UNSPEC(TEMPREC.Z) = RECIN.Z;       /*  TRANSLATE DATA INTO   */
   UNSPEC(TEMPREC.A) = RECIN.A;       /*    THE CORRECT FORM.    */

   IF (RECIN.BSIGN = '1'B) THEN  /* GIVE EXPONENT E1 CORRECT SIGN */
                         TEMPREC.E1 = -(TEMPREC.E1);
   IF (RECIN.BSIGN2 = '1'B) THEN  /* GIVE EXPONENT E2 CORRECT SIGN */
                         TEMPREC.E2 = -(TEMPREC.E2);
   TEMPREC.C1 = FLOOR((TEMPREC.C1 * (10 ** TEMPREC.E1)) + .5);

   KK = 0;

   DO JJ = 1 TO  37 BY 2;             /* TRANSLATE ONLY ALTERNATE ARRAY */
    JJJ = (JJ - 1 ) * 145;
   DO II = 1 TO 145 BY 2;            /*   VALUES INTO DECIMAL VALUES    */
    KK = KK + 1;
    UNSPEC(TEMPREC.DATA(KK)) = RECIN.DATA(JJJ + II);
    TEMPREC.DATA(KK) =
            TEMPREC.A + (TEMPREC.DATA(KK)*(2**(TEMPREC.N-15)));
   END;
   END;
(NOSTRZ):
   OUTREC = TEMPREC, BY NAME;/*CONVERT TO CHARACTER FOR EBCDIC OUTPUT*/

   RETURN('0'B);

   END; /* OF CONVERT */
```

Using Decode

```
PRINT:                                       /* OUTPUT CONVERTED VALUES */
   PROCEDURE;

   /*
      OUTPUT THE RESULT OF THE CONVERSION, GIVING THE
      NECESSARY VARIABLES AND THE VALUES ASSOCIATED WITH THEM.
   */
   PUT PAGE;
   PUT SKIP EDIT ('RECORD NUMBER -- ')         (COL(1),A)
                 (REC_NUMBER)                   (F(7));
   PUT SKIP EDIT ('Q =',OUTREC.DATA_TYPE)       (A,F(6))
                 ('C1 =',OUTREC.C1)             (X(24),A,F(6))
                 ('K =',OUTREC.K)               (X(24),A,F(6));
   PUT SKIP EDIT ('Y =',OUTREC.Y)               (A,F(6))
                 ('M =',OUTREC.M)               (X(24),A,F(6))
                 ('D =',OUTREC.D)               (X(24),A,F(6))
                 ('I =',OUTREC.I)               (X(24),A,F(6));
   PUT SKIP(4) EDIT('---------->    DATA FROM RECORD    <----------')
                 (COL(38),A);
   PUT SKIP(2);
   /*
      Output data entries along with the array subscripts, for
      reference.  The following LIMIT may be from 1 to 1387.
      A multiple of 5 is preferred.
   */
   LIMIT = 225;
   DO KK = 1 TO LIMIT BY 5;
      PUT SKIP EDIT ('(',KK,' - ',KK+4,')',
                 OUTREC.DATA(KK),OUTREC.DATA(KK+1),
                 OUTREC.DATA(KK+2),OUTREC.DATA(KK+3),OUTREC.DATA(KK+4))
                 (COL(1),A,F(5),A,F(5),A,5 (A,X(2)));
   END;
   RETURN;
   END; /* OF PRINT */


END;    /* OF DECODE */
```