PARAMETERIZATION OF WEATHER RADAR DATA FOR USE IN THE PREDICTION OF STORM MOTION AND DEVELOPMENT

by

Robert K. Crane

Environmental Research & Technology, Inc.
696 Virginia Road
Concord, Massachusetts 01742

March 1977

Final Report of Period
6 August 1976 to 31 December 1976

Approved for Public Release; Distribution Unlimited

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AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731
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Algorithms were developed for the rapid and efficient representation of digital data from a single Doppler weather radar. The data are processed to obtain a number of attributes which describe small convective cells, larger echo areas, and isolated regions of high tangential shear. The data are also processed to provide estimates of the environmental wind velocity profile and the total reflectivity profile. The attributes are obtained to represent the essential information content of the radar data with the fewest possible number of parameters. The attributes were selected to describe the development and motion of severe storms.
of severe storms and, in particular, the small convective elements that are viewed as the building blocks of the storm. Attributes were also selected to describe isolated tangential shear maxima to obtain signatures of storm severity.
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1. INTRODUCTION

1.1 Program Objective

The ultimate goal of the work reported herein is to develop an objective method for the short range forecast of storm development and motion. The initial step in this program is to devise a set of parameters for the characterization of weather radar data to efficiently represent the essential information obtained by a radar without requiring extensive storage capacity to handle unprocessed data. In this report we consider techniques for the representation of the reflectivity and Doppler velocity fields generated by a single weather radar. The reflectivity data are considered both alone and in conjunction with simultaneously obtained Doppler data.

A computer program was developed to process Doppler weather radar data to obtain the required parameters. The program detects small convective cells and larger echo regions and computes a series of attributes for each. The program represents the first step in the development of an objective procedure for the automatic processing of weather radar data for use in the short range forecast of storm development and motion.

1.2 Summary

The recommended parameterization of radar data is based upon the use of small convective cells to represent the basic architecture of a storm system. Convective cells are readily apparent in isolated showers, clusters of showers, and squall lines. They are also evident as embedded structures in the rain bands associated with widespread rain. Crane (1976) found that small convective cells were stable entities which could be reliably identified on successive scans and tracked from scan to scan.

The small cells are characterized by a set of attributes: intensity, area, height, age, stage of development, associated low level convergence (radial shear), associated vorticity (tangential shear), and propagation velocity. Additional parameters are obtained to characterize the cells within a larger precipitation (echo) region. These parameters include cell spacings and relative orientation, number of cells within a precip-
itation region, relative cell motion, and the motion of the cells relative to the motion of the centroid of the encompassing echo region. The mean radial velocity data are also processed to estimate the mean wind profile (environmental) and to identify local maxima in tangential shear. The shear maxima may not be coincident with a single cell but may occur within a cell cluster. The location of the shear maxima relative to the location of neighboring cells is also used to characterize the Doppler velocity field.

A previous analysis of available aircraft observations of velocity fluctuations and of radar observations of tangential shear and Doppler velocity variance by Crane (1976) had shown that the velocity variance was primarily caused by shear within the radar sampling volume. The variance data therefore may not be useful for the estimation of the intensity of turbulence as described by an eddy dissipation rate. For this reason, the mean Doppler velocity estimates provide the principal data to be processed. These data are used to develop radial and tangential shear estimates for association with detected cells and to locate tangential shear maxima not associated with a cell. Variance data are used to mark regions with larger than normal velocity fluctuations that should not be included in estimates of the environmental wind. Local maxima in velocity variance are also detected for comparison with the attributes of local maxima in tangential shear to test the hypothesis that the major contribution to the observed variance is due to larger scale shear rather than turbulence.

The data parameterization reduces the amount of data required to represent the initial radar observations. Each volume scan is represented by detected cells, by larger echo regions, by tangential shear maxima, and by the attributes of the cells and larger echo regions. Additional information is provided to describe the spatial organization of the cells. These data will be used in the forecast of cell propagation as defined by their development and motion. The cells and their attributes are important for the identification of severe weather and aircraft hazards, however, they do not represent the total production of precipitation within the echo envelope surrounding the cells. Additional data will be provided to represent the equivalent precipitation depth (accumulation) within a larger echo region.
1.3 Software Development

The goal of this contract with the Air Force Geophysics Laboratory (AFGL) is to provide computer software to obtain the parameters required to represent weather radar data. The radar used to provide the data is the C-band weather radar operated by the Weather Radar Branch of AFGL at Sudbury, Massachusetts. The computer programs were prepared for the CDC-6600 at AFGL.

Table 1 provides a list of the cell and echo area attributes recommended as important for the efficient representation of the radar data. Due to the limited duration of this contract it was not possible to provide software to obtain all the attributes on the list. The attributes identified by asterisks are calculated by the first generation computer program developed under this contract. These attributes describe radar data obtained on a single azimuth scan. Algorithms exist to combine data from a series of azimuth scans within an elevation scan (Crane, 1976) but were not included in the first generation computer program.

Although cell tracking algorithms are also available (Crane, 1976) they were not included in the first generation program package. The development and fine tuning of the tracking algorithms require experience with the cell detection program under a number of different environmental conditions such as isolated showers, squall lines, and widespread rain. Neither the data nor the time were available to process the required data.

1.4 Organization of the Report

A review of radar data processing is given in Section 2. Reflectivity-based parameters are discussed in Section 3. The use of Doppler data is considered in Section 4. The computer algorithms, a description of the software package and sample results are given in Section 5. Section 6 summarizes the results obtained to date.
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*Attributes Provided by First Generation Computer Program
2. BACKGROUND

Although weather radar data have been operationally available for many years, they have not been used in routine objective forecast procedures. Weather radar data were initially displayed as echo-filled or echo-free regions on a plan position indicator (PPI) display. The data displays were useful in locating precipitation regions and providing forecast verification, but they were not useful for measuring storm intensity or displaying the structure of the storm. Next, reflectivity data were depicted using fixed level contours. These contours provided a graphic display of storm intensity and structure but unfortunately only a limited number of contours could be displayed and interpreted. Recently, the use of color displays has increased the number of contours that can be displayed. Operator interpretation is still difficult and the data require additional processing before they are available for quantitative objective analysis.

Digitized radar data are required for objective analysis. Most current research radars obtain and store the radar data in a digital form, and operational systems are being improved to provide digital data. Attempts have been made to use digitized fixed contour level data for the objective forecast of storm motion. Recently, Elvander (1976) reported on the performance evaluation of three different techniques to estimate and forecast echo motion. The first (oldest) technique used a linear least squares tracking procedure to follow the centroids of echos defined using a fixed reflectivity level contour (Barclay and Wilk, 1970; Wilk and Gray, 1970). The predicted location of an echo region was estimated by extrapolation along a least square curve fit to the previously observed echo locations. This procedure can not handle storm development, growth, or decay - only storm translation.

The other two tracking techniques used echo velocity estimates based upon correlation analysis. Correlation analyses have been used for years to study echo characteristics and their changes (see for example Kessler and Russo, 1963). Recently, two separate correlation procedures were tried to automatically derive storm motions: correlations involving only isolated echo regions (Duda and Blackmer, 1972; Blackmer et al. 1973) and correlations using the entire PPI display.
(Austin and Bellon, 1974). The first provides independent velocity estimates for each echo region; the latter uses a single velocity for all the depicted echo areas. Crane (1976) found that the echo areas propagate to encompass the growth and decay of small enclosed convective cells. The small cells have regular tracks but cells within a larger, isolated echo region may move in slightly different directions. The motions of the larger echo regions were erratic as they merged, separated, and changed to encompass the developing cells.

Elvander found that the objective procedures that forecast the motion of echo centroids defined using the lowest level reflectivity data worked best when based upon velocity estimates generated using correlation techniques. He reported that the least squares curve fit approach worked best when the echo centroids were defined using vertically integrated liquid water content (VIL) data. Since the VIL values are largest within the small active regions of convection, the VIL results should be similar to those reported by Crane (1976) when the echo regions are dominated by a single intense cell. The National Hurricane and Experimental Meteorology Laboratory has also been experimenting with objective echo identification and tracking procedures (Ostlund, 1974; Wiggert et al, 1976). They initially used the echo centroid tracking procedure but have recently abandoned that technique to use a procedure that tracks reflectivity maxima or peaks. The locations of the peaks (reflectivity maxima) are found by best fitting (correlating) the observed reflectivity values with a number of two-dimensional Gaussian distributions. The best fit Gaussian distributions are used to identify the peaks within an echo to be tracked. This procedure was devised to improve the operation of their program when splits or merges occur.

An alternative development in the representation of reflectivity maxima or peaks within a larger echo region is the use of small cells defined by contours a fixed level below local reflectivity maxima within larger echo regions (Crane, 1976). These cells are defined by small reflectivity changes and correspond to volumes that encompass updraft regions during the growth stage of cell development and encompass downdraft regions during the mature stage. They are defined on a single scan by local reflectivity maxima only a few dB above their surroundings. The local concentrations of liquid water are reliably detected throughout
the active stages of cell development. Single identifiable regions of locally increased liquid water content persist from scan to scan for durations of 5 to 50 minutes. The small cells are continuous in height and display smooth regular horizontal motion.

Doppler velocity observations show that the small active cells are important elements in organizing deviations in the flow field from that of the surrounding or environmental flow pattern. Reported Doppler velocity measurements show little deviation from the environmental or background winds over much of the volume enclosed within an echo region. Doppler velocity observations near the small cells reveal the convergence patterns required to feed the updrafts and respond to downdrafts. The data also reveal mesoscale cyclones (and anticyclones) associated with the updraft regions and with secondary flows caused by a number of closely spaced cells.

Currently, the analysis of single Doppler radar data is based upon comparison with simplified kinematic models for the flow fields of importance to severe weather: supercells, tornadoes and low level gust fronts (Donaldson, 1970; Browning and Foote, 1976; Burgess, 1976; Brown and Lemon, 1976; Zrnic et al, 1976). The identification of regions of severe weather is made by comparing the Doppler observations with signatures representative of each of the models. The Doppler data provide a measure of the severity of the weather associated with features of the reflectivity field. The reflectivity data in turn provide the means to forecast the motion of the active regions that are probable sites of severe weather.

Doppler data have been mainly used for the display of the flow fields within an echo region (especially multiple Doppler radar data) and for the identification of severe weather. They have not been used in an objective fashion to forecast the motion of severe weather. Initially, in the objective analysis algorithms developed under this contract, the reflectivity data are to be used to identify cells and, using observations on successive scans, their motion. The Doppler data will be used for the identification of regions of severe weather or possible hazard. The data will be processed in a manner to allow ready incorporation of additional features of either the Doppler or reflectivity fields that appear to be important after detailed analysis of a large set of data using the initial processing algorithms.
3. OBJECTIVE ANALYSIS OF REFLECTIVITY DATA

Objective analysis of reflectivity data must provide information for use in forecasting the location and development of severe weather and for use in measuring the production of precipitation and the resultant distribution of precipitation on the ground. The analysis algorithms developed under this contract include two types, (1) the small cell analysis using peak reflectivity reference contour levels, and (2) larger echo area analysis using fixed echo contours. The former is recommended because of the association between convectively active regions and severe weather and because of the utility of the small cells for the forecast of pattern development and motion. The latter is recommended to keep track of the precipitation produced by the active cells. No attempt will be made to partition the precipitation within an echo region by cell.

3.1 Small Cells

The use of objective techniques for the detection of small convective cells was developed and reported by Crane (1976). He found that a small cell can be readily detected using at most three azimuth scans; the detection probability for a single scan was above 0.6 for the reflectivities greater than 35 dBZ and for three scans in a volume scan sequence, the probability of detection increases to 0.93. The detection probability is still higher for a typical volume scan with a larger number of azimuth scans at different elevation angles.

The small cell detection procedure developed by Crane is illustrated in Figures 1 and 2. Figure 1 shows a hypothetical echo region (lowest level contour) including two cells. The cells are identified by smaller contours T* units below their enclosed relative maxima. The cell areas are the shaded regions within the peak referenced contours. Figure 2 shows the application of this detection process to actual radar data using a 2.5 dB value for T. The outer or lowest level contours on this figure have a value of 20 dBZ. The peak values are above 50 dBZ. The data reveal a wealth of detail not evident using a limited number of fixed level contours separated by large differences in reflectivity. The display as shown in Figure 2 is quite complex. It may be replaced by the

*T represents the cell detection threshold.
display in Figure 3 with little loss of information. On this figure the cell attribute, peak reflectivity, is listed for each cell. Other attributes such as cell area, cell height, height of maximum reflectivity, height of cell base for first echo, or any other measurable associated with the reflectivity of Doppler data fields may be calculated and displayed or recorded for each of the cells.

3.2 Larger Echo Areas

The small cells are generally contained in larger multicell echo regions. Warner (1976) reported that all the hailstorms he observed in Alberta, Canada occurred as small cells within larger echo areas. An analysis of his reported data shows that single isolated cells do not develop significantly either in height or intensity. Clusters of cells within a single envelope defined by a low level reflectivity contour (10-20 dBZ) usually exhibit more significant development growing both higher and more intense than the single isolated cells that appeared at the same time on the same day.

The apparent cooperation between small closely spaced cells has been reported by other investigators. Woodley and Simpson (1972) have reported that convective cells in the Florida area have a higher intensity and produce more precipitation after they merge than before. They declare mergers when echo regions defined by a fixed 25 dBZ contour combine to form a larger multicell echo region. Their data show that the environment surrounding each cell is important. The number, spacing, and relative orientation of the cells within a single echo region appear to affect the development of the small cells. These data must be recorded in addition to the attributes of each cell. They are attributes of the larger echo region.

The small cells are considered to be the active regions of convection within the larger echo region. The larger area encompasses precipitation resulting from the transport of liquid water (and ice or snow) and water vapor out from the updraft regions. The transport processes are mainly turbulent - eddy diffusion or advection depending upon the scale size of the motion. Microphysical processes continue to produce precipitation within the larger regions about each cell which results in precipitation that is measurable on the ground. The precipitation is
apparently carried out from the cells by the environmental or background winds as it settles to the ground. The larger echo area also contains the decaying cells that remain after their active stages have been completed. The total precipitation in this region is important and must be obtained from the radar data. The transport processes are complex and it does not appear reasonable to attempt to identify the resultant precipitation with particular active generating regions.

At midlatitudes the larger area of precipitation surrounding the active cells generally consists of ice and snow aloft melting to form rain below. Care must be taken in processing the data to exclude measurements made within the melting region or bright band. Data taken at the lowest elevation angle will be processed once per volume scan to provide an estimate of the rain rate integrated over the area of the larger echo region. Rain rate estimates made on a series of scans (lowest elevation from each volume scan) will be combined to estimate the averaged accumulation of precipitation at the surface.
4. OBJECTIVE ANALYSIS OF DOPPLER DATA

A single radar system can only measure the radial velocity of the scatterers relative to the radar. This component of the scatterer motion is not sufficient to characterize the three-dimensional motion of the scatterers within the sampling volume defined by a range resolution element times the antenna beam cross section. Models must be employed to extract useful data from the Doppler velocity estimates. If a radar were completely surrounded by scatterers all moving in the same direction, the particle velocity could be measured by making observations in three different directions (including vertical for three-dimensional motion). Unfortunately, the scatterers are not all moving in the same direction especially in the vicinity of the small active cells.

4.1 Velocity Information Associated with a Small Cell

The flow field about and within a small cell is too complex to be measured with a single Doppler radar. Shear values can be calculated for the area within the cell to characterize the variation of the flow field within that cell. For a simple axisymmetric flow pattern model with a vertical symmetry axis radial shear values can be identified with convergence and tangential shear values with vorticity if measurements are made at a low elevation angle. The success of the plan shear indicator (Donaldson, 1970) and the use of the mesocyclone signature (Burgess, 1976) and the tornado vortex signature (Brown and Lemon, 1976) are based upon this model for the flow field. In general, the flow pattern is not axisymmetric and larger scale shear deforms the simple model flow causing a more complex pattern. The deviations from the model appear to be small and the model seems to be useful for identifying potential regions for the development of tornadoes. For this application the average shear values within a cell are of interest.

Detailed reflectivity and Doppler velocity measurements in situations characterized by supercells and tornadoes reveal mesoscale circulation patterns not within the confines of a small cell. (See the Stillwater tornado data reported by Zrnic et al, 1976 and discussed in Section 6.1; see also Agee et al, 1976.) The circulation about a weak echo region
appears to be associated with a secondary circulation caused by the cells neighboring the weak echo or echo-free vault. The mechanism for triggering and maintaining the circulation is uncertain. It is evident that a tangential shear signature occurs that is not within a cell. This region can be separately identified using Doppler velocity data.

4.2 Mean Velocity Within a Larger Echo Region

The lower reflectivity regions surrounding the small, active cells generally follow the environmental wind. Velocity measurements made in the lower reflectivity regions may be used to estimate the environmental wind. Observations must be made at the same range and at least at two different azimuth angles. An estimate can be generated by assuming that the wind at a given height (range) is constant over the azimuth span of each echo region. The velocity is calculated using a least squares procedure on all data not included in detected cells and in regions with high velocity variance.

4.3 Turbulence Estimates

Analysis of aircraft observations of wind velocity fluctuations within thundershowers show that the turbulence is anisotropic at scale sizes in excess of 200 meters and suggest that velocity variance measurements at scale sizes larger than 200 m will not describe the turbulent dissipation process (Crane, 1976). The doppler velocity fluctuations are caused primarily by radial velocity fluctuations at scale sizes the order of the antenna beam cross section at the measurement range. For most radar systems, the scale sizes associated with Doppler measurements are in the 1 to 3 km range, significantly outside the range for isotropic turbulence. The variance estimates therefore correspond to larger scale processes such as organized up and downdrafts and their associated convergence and rotation patterns, for example, mesocyclones. The radial wind speed profile however does not vary linearly across the radar beam and simple models to estimate variance due to shear will lead to large measurement errors. Errors in a simple linear model or any other model for the variation of wind speed across the beam will cause insufficient estimation accuracy to remove the effect of shear and leave an accurately estimated residual component.
Pulse-volume to pulse-volume changes in the mean Doppler velocity will be used to estimate shear because the Doppler variance estimates should be identified with shear and because the variance estimates tend to be biased and severely affected by noise. The radial velocity variations within the beam that contribute to the observed variance may be associated with either vertical or horizontal variations in the wind field. Mean Doppler velocity observations may be used to estimate the horizontal variations evident after averaging by the antenna beam. Comparisons should be made between tangential shear and velocity variance data to determine the degree to which the larger scale horizontal shear contributes to the variance. If significant variance can occur in regions where the tangential shear is low, relative variance maxima attributes could also be used to characterize the radar data.
5. SOFTWARE DESCRIPTION

5.1 Program Structure

The object of this contract was to develop a set of algorithms for the processing of single Doppler radar data and to provide a computer program to accomplish the data processing. The cell detection procedure selected for this task is based upon a procedure previously developed by Crane (1976). The algorithms developed under this contract are significantly different from the earlier ones used by Crane or from the contouring algorithms generally used on large scale computers. The new algorithms were developed specifically for this contract to provide rapid computer processing requiring a minimum of computer storage. The algorithms were also generated to simultaneously process both reflectivity and Doppler data in a manner constant with ultimate employment in real-time programs on a mini-computer coupled to a weather radar.

The computer program processes the digital radar data and generates the cell and larger echo area attributes identified by asterisks in Table 1. The program was designed to read digital radar data tapes prepared by the Weather Radar Branch of AFGL at their Sudbury field station. The raw data consisted of received power, mean radial velocity, and velocity variance values together with radar operating and pointing parameters plus time as described by the input data format given in Appendix A. A series of subroutines were developed to read and reformat the radar data, find both fixed and peak referenced contours, and calculate the attributes associated with the contours. A schematic of the program is given in Figure 4. The program provides contour output data for input to a second program which generates plots for fixed level contours, and outputs attributes calculated for the small convective cells, tangential shear maxima, and fixed echo regions.

This program is configured to be the first in a series of programs that (1) detect the cells and generate the lists of attributes; (2) combine data from separate scans within a volume scan to provide the vertical development attributes for the detected cells, tangential shear maxima, and fixed contours; and (3) combine data from separate volume scans to generate cell tracks and to list the time histories of the cells. A schematic overview of the entire processing sequence is given in Figure 5.
The computer program listing is reproduced in Appendix B; the operating instructions are in Appendix A.

5.2 Contour Generation Algorithm

The contouring algorithm used to find both the fixed level contours and the peak referenced contours was designed to process the radar data a single radial (all data for a single pointing angle) at a time. The processing algorithm was tailored after the technique generally used to obtain isoecho contours for a weather radar display and is significantly different from the edge following algorithms generally used in computer processing. The edge following contouring algorithm requires the storage of the entire data field in the main computer memory at one time. For the radar data to be processed, the reflectivity data alone would require 184,320 storage locations which exceeds the available core storage if not packed into the CDC 6600 computer words. If the data were packed, considerable time would be expended unpacking the data for use with the contouring algorithm. This new approach was taken to minimize both the computer storage and time requirements. The processing is performed in the range, azimuth coordinates of the radar. The program searches the data in range along a radial defining regions or events where the data exceed the thresholds for contouring. For fixed level contouring, the thresholds are preselected; for peak reference contouring, the thresholds are computed from the data. This contouring algorithm differs from the usual application of isoecho contouring techniques by combining data for each event from one radial to the next to generate the attributes. The peak detection algorithm is unique since it stores sufficient data from radial-to-radial to obtain the required attributes even though the threshold level is not known apriori.

The contouring operation starts by searching the data along a single radial. The start and stop ranges for each event are defined by threshold crossings as illustrated in Figure 6. The data are quantized prior to contouring and the thresholds are applied just above the reported value. For example, a 20 dBZ threshold would include only data that exceeded 20 dBZ. Since a round-up operation is included in the generation of the quantized data, a 20 dBZ threshold would include all values above 20.5 dBZ. The data are searched by threshold at each range element reducing
the number of tests applied at each range element to a minimum. The event identification algorithm is depicted by the flow chart on Figure 7. In the remainder of the processing, only data within an event are tested or combined with other data to generate attributes.

The data for events from one radial are combined with data from events for the previous radial to calculate the attributes. This process is illustrated schematically on Figure 8. Events on both radials are searched to locate adjacent events. If more than one B event (previous radial) overlaps a single C-event (current or this radial) then the attributes for both B-events are combined into a single set. Each identifiable echo region is tagged by an identification number which is used to index the final set of attributes.

The attributes are processed separately for each threshold. Additional processing is performed for the lowest level threshold. Each separate identifiable peak along each radial is located and recorded for subsequent use in the peak reference contouring subroutine. The height of each range element within each lowest threshold event is calculated and then used to index arrays for accumulating reflectivity and velocity data as a function of height. These data are used for the generation of reflectivity and environmental wind profiles.

The peak reference contour algorithms are identical with those described above with the exception that the contouring thresholds are separately calculated for each radial. The peak detection algorithm uses a threshold a fixed number of quantization steps below the peak value. Since the peak value is not known apriori, attributes must be summed for each possible cell (segment of radial) within the fixed number of steps below each peak value. The data are processed one event (lowest fixed level threshold) at a time. Threshold levels are established for each peak within the event. The data at each threshold level are associated between the B- and C-radial segments. Cells are declared when cells have been detected which do not enclose other cells at a threshold level the required fixed number of steps below the peak value. When B- and C-radial data are associated, the highest peak from either B- or C- is taken as the new peak and the attributes are restored so only data for the required fixed number of steps below each peak are saved. This process is repeated from one radial to the next until a cell is not
updated and no higher level data are present on the next radial adjacent to the cell. At this point, a peak referenced cell has been detected. Only the attributes for the lowest saved threshold relative to the peak are then saved for subsequent processing. To ensure that a second cell immediately adjacent to a previously detected cell is not subsequently detected, the C-radial segments are also compared with B-radial data and attributes for a threshold are saved only when the C-radial data are of higher value or a B-radial cell is being activity processed. The peak detection process is illustrated schematically in Figure 9.

5.3 Attributes

The area, average reflectivity, and centroid location are calculated for each fixed contour echo region and for the contour a prescribed number of quantization units (CDB) below each peak value. The basic data were obtained in a polar coordinate system. The attributes are calculated as follows when the sums are taken over all i (range), and j (azimuth) enclosed within the contoured region:

\[
A = \sum_{i,j} (\theta_j - \theta_{j-1}) r_i \Delta r
\]

\[
\overline{Z} = \frac{1}{A} \sum_{i,j} (\theta_j - \theta_{j-1}) r_i Z_{ij} \Delta r
\]

\[
\overline{x} = \frac{1}{AZ} \sum_{i,j} (\theta_j - \theta_{j-1}) r_i^2 \sin \theta_j Z_{ij} \Delta r
\]

\[
\overline{y} = \frac{1}{AZ} \sum_{i,j} (\theta_j - \theta_{j-1}) r_i^2 \cos \theta_j Z_{ij} \Delta r
\]

where \(A\) is the area, \(\overline{Z}\) is the average of the logarithm of reflectivity, \(\overline{x}, \overline{y}\) are the rectangular coordinates of the centroid, \(\theta_j\) is the azimuth angle, \(r_i\) is range, \(\Delta r\) is the range interval, and \(Z_{ij}\) is the logarithm of the reflectivity value (in dBZ). For the detection of localized tangential shear maxima, the logarithm of the reflectivity value is replaced by

\[
VS_{ij} = (V_{ij} - V_{ij-1})/(r_i(\theta_j - \theta_{j-1}))
\]
where $V_{ij}$ is the tangential shear and $V_{ij}$ is the mean radial velocity.

Additional shear attributes are calculated for the peak reflectivity referenced attributes. These were the average radial shear

$$\overline{VR} = \frac{1}{A} \sum_{i,j} (\theta_j - \theta_{j-1}) r_i (V_{ij} - V_{ij-1})$$

the average tangential shear

$$\overline{VS} = \frac{1}{A} \sum_{i,j} (\theta_j - \theta_{j-1}) r_i V_{ij} \Delta r$$

and the average radial velocity

$$\overline{V} = \frac{1}{A} \sum_{i,j} (\theta_j - \theta_{j-1}) r_i V_{ij} \Delta r$$

The fixed contour profiles are calculated by summing the required attributes for height regions quantized in 1 kilometer steps. The height is computed using

$$H_i = r_i \sin \alpha + \frac{r_i^2 \cos^2 \alpha}{aR}$$

where $\alpha$ is the elevation angle, $R$ the radius of the earth and $a$ the effective earth's radius multiplier. A value of 1.21 was used for $a$. In addition the environmental wind velocity profile is statistically calculated using mean radial velocity data confined to a narrow reflectivity interval (typically 20 to 35 dBZ) and for sampling elements with velocity variance values below a preset threshold, TS. The mean easterly and northerly velocities $\bar{u}$, $\bar{v}$ are calculated as follows:

$$\bar{u}(H) = \left[ (\sum_i \cos^2 \theta_i)(\sum_j V_{ij} \sin \theta_j) - (\sum_i \sin \theta_i \cos \theta_i)(\sum_j V_{ij} \cos \theta_i) \right] / \text{DEL}$$

$$\bar{v}(H) = \left[ (\sum_i \sin^2 \theta_i)(\sum_j V_{ij} \cos \theta_j) - (\sum_i \sin \theta_i \cos \theta_i)(\sum_j V_{ij} \sin \theta_i) \right] / \text{DEL}$$

$$\text{DEL} = (\sum_i \sin^2 \theta_i)(\sum_j \cos^2 \theta_j) - (\sum_i \sin \theta_i \cos \theta_i)^2$$

where $V_{ij}$ is the mean radial velocity and the summations were again taken only over the area within an event (identifiable larger echo region).

5.4 Sample Results

Processing for the C-band Doppler radar at the AFGL Weather Radar Branch in Sudbury was accomplished using 512 range intervals of 300 m
each. The raw data were averaged to reduce the original 1024 range elements to the final 512 value. The processing program is flexible in adjusting to the angular increment between radials. For the data from Sudbury, the interval is roughly 1°. If the entire 360 by 512 data array were stored for both reflectivity and mean radial velocity, 368,764 words of core storage would be required, roughly four times the 106,000 words available on the CDC-6600 computer at AFGL. The computer program described above performs the required contouring and attribute generation operations within the core storage available on the computer and also provides computer generated plots of the fixed level contours and the centroid locations of the detected cells.

The operation of the fixed contour and peak detection algorithms can be summarized by the following synthetic example. The data to be contoured are given in Figure 10. For this example, the threshold for fixed contouring is a value of 0; all numbers shown are within the fixed contour. Table 2 depicts the values for the start and stop ranges (l), the event number and the echo area identifier that is determined after B-radial, C-radial association. In this example, all the data are for one echo area or region although as many as 3 events are detected on a single radial. The number of peaks and their locations within an event are also listed. Each column corresponds to an array in the program; their function is explained in the description of the contouring algorithm (Section 5.2).

The operation of the peak detection algorithm is summarized by the entries in Table 3. The azimuth and event values are the same as for Table 2. The thresholds generated for each of the peaks as well as the segment start and stop locations and associations as possible cells and detected cells are listed. Note that the start locations are of the range element preceding the threshold crossing as are the stop locations. The cells detected by the algorithm are indicated by the solid lines in Figure 10. In many cases, a zero is listed in the possible counter column. In these cases, no cell attribute updating takes place. A cell is detected when a cell is not updated on the current or C-radial and no higher adjacent values are present on the C-radial.

Program operation to date has been to debug and evaluate the operation of the new algorithms developed for the fixed contouring and peak detection.
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**TABLE 2**

(1 & Higher Included Within the Threshold)

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- Set Edge Indicator

2 included in 1

3 included in 1
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operations. The program has been exercised using both a complex ground clutter pattern that severely tests the multithreshold program logic required for peak detection and actual rain data. The Doppler measurements - shear values and average radial velocity values - are all zero for the ground clutter providing a reasonable technique for ground clutter suppression. Sample program outputs for rain are depicted in Figures 11 through 16. Figures 11 and 12 depict the B-Scan printout display available from the program as an option. The data are averaged in range and printed for each azimuth. The solid radial lines on Figure 13 depict the start and stop scan boundaries. Ground clutter is evident at short ranges at many azimuths and regions of rain are evident to the west and north of the radar. Figures 13 and 14 depict 20 dBZ reflectivity contours. The contours in Figure 14 were obtained from the second EXPAND program which allows variable plotting scales. It depicts an expanded view of the region to the south and west of the radar. The fixed contour identification numbers are shown together with dots to indicate centroid location. Finally, the attributes are listed in Figures 15 and 16.
6. SUMMARY OF RESULTS AND RECOMMENDATIONS

6.1 Use of Attributes

The parameters to be estimated using radar volume scans are listed in Table 1. The attributes can be objectively obtained from reflectivity and mean velocity estimates from a pulse-pair processor. The cell detection algorithm was tested by Crane (1976) using a threshold of 3 dB and a precision of 0.5 dB (128 independent samples). A cursory examination of the measurement precision problem suggests that adequate operation could be obtained using a precision of 1 dB (32 independent samples). This problem still must be considered in some detail using live data.

Sample results have been generated using pulse-pair velocity and reflectivity data provided by the National Severe Storms Laboratory (Doviak, 1976). These data were taken with a precision of 2 dB rms. Even though the data are not as precise as desired, the expected relationships between reflectivity and velocity attributes were evident. Figures 17 through 19 depict data from the Stillwater tornado (Zrnic et al., 1976). The reflectivity data on Figure 17 have been simplified by including only two fixed contours and identifying the locations of the small cells. The reflectivity data as provided by Doviak contained only 5 dB interval contours and the true number of cells could exceed the number displayed. The 40 dBZ contour displays a hooked echo although the hook pattern could not be discerned at any other contour level. The Stillwater tornado occurred within the hook. Figure 18 displays the important features of the mean velocity pattern. The cell locations are again displayed on this figure. The highest (positive) and lowest (negative) Doppler velocity contours together with the contour midway between the two are displayed for each shear maxima. The tangential shear values are listed on the figure. The two shear maxima between the 0 and 10 km differential X positions straddled the 20 dBZ contour and are caused by noise and calculations contaminated by using data from regions without scatterers. These shear values are not real and should be ignored. The highest shear value, 0.03 s⁻¹, corresponds to the Stillwater tornado. This value occurs in a weak echo region that does not coincide with a cell but appears between two cells 5 km apart. The other region of high
tangential shear is associated with a gust front near the surface. It is interesting that a new tornado subsequently formed in the rather weak echo region at the point of highest tangential shear along the gust front. Figure 19 displays the regions with rms Doppler velocity fluctuations in excess of 10 m s\(^{-1}\) together with the cells and high tangential shear regions. In this figure the data associated with the edge of the echo region has been suppressed.

The data displayed in Figures 17 to 19 show the important details of the reflectivity structure and the associated tangential shear field. Agee et al (1976) recently reported on multiple tornado occurrences within a single mesoscale cyclone which suggest that the tornadoes are more closely associated with the reflectivity maxima that move within the larger scale flow field surrounding the weak echo region than with the weak echo region. These results indicate that the spatial structure of highly localized tangential shear maxima and possibly associated small convective cells is an important characteristic of severe storms that spawn tornadoes. The computer program developed under this contract provides a means to obtain the significant information from the radar and display it in a form that is easy to interpret.

6.2 Use of Program

The object of this contract was to develop a computer program that would significantly reduce the amount of data required to characterize a set of weather radar observations. The computer program, although designed for use on the CDC-6600 computer was to be easily transferred to smaller, dedicated radar site computers. The program that was developed uses algorithms that minimize computer storage requirements. The initial program uses nearly the full 106,000 words available on the CDC-6600 computer and techniques have already been devised to significantly reduce this requirement without significantly increasing operation time. As currently configured, an operational version of the program can be generated that uses less than 64,000 16-bit words.

To date, program operation has only been to debug and check the program. The processing includes the generation of a considerable amount of intermediate output. Processing runs have taken less than one second of CDC-6600 time per radial. For real time operation with an onsite computer, operate times of less than one third to one sixth this value.
are required and should be achieved with available computers. Initial estimates for the time required just to read in, calibrate, and store the radar data for a single radial range between .1 and .2 seconds, a significant fraction of the computer time required for all the processing. Preprocessing of the data to provide range correction and scaling will also be important for reducing the program cycle time to provide a real time capability.

6.3 Recommendations

The program developed under this contract is a first step in the generation of an automatic data processing system for single station Doppler radar data. The program has been subjected only to preliminary analysis to ensure that the computer code is correct and the program operates as designed. Two tasks now remain: (1) evaluate the operation of the program with a large amount of weather radar data and (2) generate the next level programs to track the cells.
REFERENCES


REFERENCES


REFERENCES (continued)


ACKNOWLEDGEMENT

The author wishes to acknowledge the effort of Mr. J. Willand who prepared the computer program. The discussions with Mr. K. Glover, and staff members of the Air Force Geophysics Laboratory Weather Radar Branch were of great value in preparing the list of attributes given in Table 1.
Figure 1  Schematic Illustration of the Cell Detection Criterion (from Crane, 1976)
Figure 2: Radar Reflectivity Contours and Cells Detected Using a 2.5 dB Threshold (see Crane, 1976)
Figure 4  Computer Program Structure
Figure 5 Overall Processing Scheme
Figure 6  Event Definition
START

Loop on Range

Loop on Threshold

Above Threshold

Yes

Previous Range Above Threshold

No

New Event Increment Event Counter and Record Start Range

Yes

Increment Attribute Sums

Loop on this to Higher Thresholds

Previous Range Above Threshold

Yes

End of Event Record Stop Range

No

STOP

Figure 7  Event Identification
Figure 8  Event Association
Loop on Peaks within Event (Lowest Threshold)

Calculate Thresholds
Log Units Below Peak Value

Loop on Range within Event
Loop on Threshold

Contour to Identify Segments at Each Threshold

Loop on Threshold
Loop on Segment
Loop on Segment next Higher Threshold C-Radial

Associate Nested C-Radial Segments

Loop on Threshold B-Radial
Loop on Segments B-Radial

Associate B to C Radial

Detect Cell if not Updated this Radial and C Radial values are lower than Cell Threshold

STOP

Figure 9 Peak Detection
Figure 10 Example of Detected Peaks (see Tables 2 and 3)
Figure 11a  B SCAN for Radial Velocity (see Figure 12 for calibration)
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Figure 12  B SCAN Codes for Radial Velocity and Reflectivity
Figure 13  Plot of 20 dBZ Contour Generated Using the Computer Program - The Lines Denote Scan Boundaries
Figure 14  An Expanded Section of the Contour Map Presented in Figure 13 - The Centroid of Each Contour is Marked and Labeled
### Fixed Contour Attributes

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Figure 15  Fixed Contour Attributes for Contours Displayed on Figure 14

### Small Cell Attributes

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</tr>
<tr>
<td>3</td>
<td>20.0</td>
<td>1.3</td>
<td>-30.3</td>
<td>-46.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Figure 16  Small Cell Attributes for Contours Displayed on Figure 14
Figure 17 Reflectivity Structure for the Stillwater Tornado at 1.5 km Height
Figure 18  Mean Doppler Velocity Structure for the Stillwater Tornado at 1.5 km Height
Figure 19  RMS Doppler Velocity Fluctuation Structure for the Stillwater Tornado at 1.5 km Height
APPENDIX A
PROGRAM OPERATION

A.1 Description of Input and Output

Program input and output are depicted in Figure A1. The tape input format is given in Table A1. The control cards are discussed in section A2. The program produces (a) tapes of computed attributes for input to a second program for computing volume scans; (b) a plot tape is generated that can be stored for input to another program "EXPAND" which is a general purpose plotting package for plotting the fixed contours, centroids, cell identification and peak locations expanded over selected areas; (c) B-scan maps are also produced as an option; (d) full scan fixed contour plots of the lowest threshold level can be obtained on 35 mm film as the program is executing; (e) hard copy plots can also be obtained; and (f) at the completion of a scan the program will print out fixed contour attributes, peak detected cell attributes and tangential shear maxima attributes. All of the attributes printed have identifiers which can be associated with the identifiers displayed on the expanded plots.

A.2 Control Card Format

Control card input to the program is NAMELIST input which allows certain parameters in the program to default or to be set to different values. The variable names, type (LOGICAL L, INTEGER I, and REAL R), dimension, default value and their meanings are listed in Table A2.
Figure A1  EXTRAD Products
### Table A1

<table>
<thead>
<tr>
<th>Day</th>
<th>2^11</th>
<th>2^10</th>
<th>2^9</th>
<th>2^8</th>
<th>2^7</th>
<th>2^6</th>
<th>2^5</th>
<th>2^4</th>
<th>2^3</th>
<th>2^2</th>
<th>2^1</th>
<th>2^0</th>
<th>12 Bit Word Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>400</td>
<td>200</td>
<td>100</td>
<td>80</td>
<td>40</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hour</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>40</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sec</td>
<td>40</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Auxiliary Data

<table>
<thead>
<tr>
<th>PRF</th>
<th>PRF</th>
<th>PRF</th>
<th>PRF</th>
<th>PRF</th>
<th>PRF</th>
<th>PRF</th>
<th>PRF</th>
<th>PRF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Azimuth</th>
<th>AZ_1</th>
<th>AZ_2</th>
<th>AZ_3</th>
<th>AZ_4</th>
<th>AZ_5</th>
<th>AZ_6</th>
<th>AZ_7</th>
<th>AZ_8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elev.</td>
<td>EL_1</td>
<td>EL_2</td>
<td>EL_3</td>
<td>EL_4</td>
<td>EL_5</td>
<td>EL_6</td>
<td>EL_7</td>
<td>EL_8</td>
</tr>
<tr>
<td>Spare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Repeated 256 Times

**VAR**

<table>
<thead>
<tr>
<th>Mean</th>
<th>HEX</th>
<th>DEC</th>
<th>12 Bit Word Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Var**

<table>
<thead>
<tr>
<th>Power</th>
<th>HEX</th>
<th>DEC</th>
<th>12 Bit Word Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

1) **Number Range Cells**

<table>
<thead>
<tr>
<th>Number</th>
<th>Range Cells</th>
<th>NRC</th>
<th>NRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>256</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>512</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>768</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1024</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2) **Least Significant Bit**

3) **Not Included in Parity**

4) **Sign**

5) **Parity**

6) **Frequency of Dump Pulses**

<table>
<thead>
<tr>
<th>Subframe</th>
<th>SF</th>
<th>SF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

7) **Cell Width**

<table>
<thead>
<tr>
<th>T_p1</th>
<th>T_p0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>0</td>
</tr>
</tbody>
</table>

---

**Notes:**

* If any group A bit = 1 and any group B bit = 1: PRF = 394
* If A has 1 bit and B has 3 bits: PRF = 794
* If A has 3 or more and B has 1 or less: PRF = 1613
* If A has 3 or more and B has 3 or more: PRF = 3333
* If A has 2 bits or B has 2 bits: PRF = Previous PRF
* If all zero for A and B groups: use an input PRF

**First Cell is the 21st twelve bit data word.**

---

**TABLE A1**
### TABLE A2
CARD FORMAT FOR PROGRAM EXTRAD

Reads in program parameters via NAMELIST format.

**NAMELIST VARIABLES:** (Level 760916)

<table>
<thead>
<tr>
<th>NAME</th>
<th>TYPE</th>
<th>DIMENSION</th>
<th>DEFAULT</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRINT 1</td>
<td>L</td>
<td>1</td>
<td>FALSE</td>
<td>When. True. Program prints out unpacked raw digital data from the Doppler data tape.</td>
</tr>
<tr>
<td>PRINT 2</td>
<td>L</td>
<td>1</td>
<td>FALSE</td>
<td>Currently unused.</td>
</tr>
<tr>
<td>PRINT 3</td>
<td>L</td>
<td>1</td>
<td>FALSE</td>
<td>When. True. B-Scan maps are produced.</td>
</tr>
<tr>
<td>PRINT 4</td>
<td>L</td>
<td>1</td>
<td>FALSE</td>
<td>When. True. Full scan plots are generated.</td>
</tr>
<tr>
<td>ICODES</td>
<td>I</td>
<td>36</td>
<td></td>
<td>Codes for representing DBZ categories for B-Scan map output.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A thru Z then 1 thru 9 followed by a dot.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>R</td>
<td>1</td>
<td>.13779</td>
<td>In the linear equation ( y = mx + b ) For computing coded DBZ for B-scans, ( A1 = M ) and ( B1 = b ).</td>
</tr>
<tr>
<td>AZ</td>
<td>R</td>
<td>1</td>
<td>.017</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>BZ</td>
<td>R</td>
<td>1</td>
<td>18.6</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>CONTRZ</td>
<td>L</td>
<td>1</td>
<td>FALSE</td>
<td>When. True. Fixed contours are generated and their attributes. .False. will ignore fixed contouring.</td>
</tr>
<tr>
<td>CONTRV</td>
<td>L</td>
<td>1</td>
<td>FALSE</td>
<td>When. True. Peak detection and their attributes will be generated. .False. will ignore peak detection.</td>
</tr>
<tr>
<td>NFILE</td>
<td>I</td>
<td>1</td>
<td>1</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>NUMF</td>
<td>I</td>
<td>1</td>
<td>1</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>AC</td>
<td>R</td>
<td>4</td>
<td>-107.7, +1.97, -0.094, +0.0018</td>
<td>Calibration coefficients for computing DBM below a threshold XCU T. (See XCU T.)</td>
</tr>
<tr>
<td>NAME</td>
<td>TYPE</td>
<td>DIMENSION</td>
<td>DEFAULT</td>
<td>MEANING</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>CALM</td>
<td>R</td>
<td>1</td>
<td>.332</td>
<td>In the calibration equation $y = mx + b$, CALM $= M$ and CALB $= b$.</td>
</tr>
<tr>
<td>XCUT</td>
<td>R</td>
<td>1</td>
<td>10.0</td>
<td>Threshold value that determines which equation to use for calibration. (linear or non-linear)</td>
</tr>
<tr>
<td>CK</td>
<td>R</td>
<td>1</td>
<td>10.0</td>
<td>In the equation for computing DBZ, hence $K+P+\log_{10}(S(I-.5)) - CL+.5 (1) K = CK$.</td>
</tr>
<tr>
<td>ZMAX</td>
<td>R</td>
<td>1</td>
<td>0.0</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>VMAX</td>
<td>R</td>
<td>1</td>
<td>0.0</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>NREC</td>
<td>I</td>
<td>1</td>
<td>1</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>NUMR</td>
<td>I</td>
<td>1</td>
<td>999</td>
<td>Number of radials to be processed. Use default value when doing full scan.</td>
</tr>
<tr>
<td>IRUN</td>
<td>I</td>
<td>1</td>
<td>0</td>
<td>Run number chosen by user.</td>
</tr>
<tr>
<td>INC</td>
<td>I</td>
<td>1</td>
<td>0</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>TL</td>
<td>I</td>
<td>4</td>
<td>20,30,40,50</td>
<td>DBZ fixed contouring thresholds.</td>
</tr>
<tr>
<td>LT</td>
<td>I</td>
<td>1</td>
<td>4</td>
<td>Number of fixed contour thresholds to produce. (0&lt;LT&lt;4)</td>
</tr>
<tr>
<td>TDW</td>
<td>R</td>
<td>1</td>
<td>0.0</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>DN</td>
<td>R</td>
<td>1</td>
<td>0.0</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>STARTR</td>
<td>I</td>
<td>1</td>
<td>1</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>DELTR</td>
<td>R</td>
<td>1</td>
<td>1.0</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>INPRF</td>
<td>I</td>
<td>1</td>
<td>3333</td>
<td>Value of PRF (Pulse Repetition Frequency). To be used when PRF cannot be obtained from the data tape.</td>
</tr>
<tr>
<td>SCALE</td>
<td>R</td>
<td>1</td>
<td>1.0</td>
<td>Scale factor for drawing fixed contours.</td>
</tr>
<tr>
<td>AE</td>
<td>R</td>
<td>1</td>
<td>1.21</td>
<td>Constant for computing heights of cells.</td>
</tr>
<tr>
<td>AA</td>
<td>R</td>
<td>1</td>
<td>300</td>
<td>Constant for computing heights of cells.</td>
</tr>
<tr>
<td>NAME</td>
<td>TYPE</td>
<td>DIMENSION</td>
<td>DEFAULT</td>
<td>MEANING</td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>BB</td>
<td>R</td>
<td>1</td>
<td>1.5</td>
<td>Constant for computing heights of cells.</td>
</tr>
<tr>
<td>X1</td>
<td>R</td>
<td>1</td>
<td>0.0</td>
<td>Frame size coordinates for fixed contour plotting. Less than or equal to 8 inches.</td>
</tr>
<tr>
<td>X2</td>
<td>R</td>
<td>1</td>
<td>8.0</td>
<td>Same as above.</td>
</tr>
<tr>
<td>Y1</td>
<td>R</td>
<td>1</td>
<td>0.0</td>
<td>Same as above.</td>
</tr>
<tr>
<td>Y2</td>
<td>R</td>
<td>1</td>
<td>8.0</td>
<td>Same as above.</td>
</tr>
<tr>
<td>TV</td>
<td>I</td>
<td>1</td>
<td>35</td>
<td>Velocity attributes are not computed for DBZ greater than this value.</td>
</tr>
<tr>
<td>TSV</td>
<td>R</td>
<td>1</td>
<td>$10^6$</td>
<td>Not currently used.</td>
</tr>
<tr>
<td>LDV</td>
<td>I</td>
<td>1</td>
<td>3</td>
<td>Cell detection threshold for reflectance peaks.</td>
</tr>
<tr>
<td>LTV</td>
<td>I</td>
<td>1</td>
<td>2</td>
<td>Cell detection threshold for velocity peaks.</td>
</tr>
</tbody>
</table>
APPENDIX B

COMPUTER PROGRAM LISTING
PROGRAM EXTRAD(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE1=O,
* TAPE2,OPT=0,DEBUG=OUTPUT)

PROGRAM EXTRAD ERT NO. 162

VERSION 2.0 LEVEL 761119

MAIN PROGRAM SECTION.

JHN AfGL CDC 6600

*****************************************************************************

LOGICAL PRINT1,PRINT2,PRINT3,PRINT4,CONTRZ,CONTRV

INTEGER CRD(3)

COMMON /PARM/ PRINT1,PRINT2,PRINT3,PRINT4,ICODES(36),A1,B1,A2,B2,

CONTRZ,CONTRV,NFILE,NUMF,NREC,NUMR

DATA CRD/4MPARA,4HEXEC,4HCOMM/

*****************************************************************************

CALL DAY

1 READ (5,11) KEY

11 FORMAT (44)

IF (EOF(5)) 91,21,91

21 CALL PAGE

3 WRITE (6,31) KEY

31 FORMAT (*4)

DO 41 K=1,3

41 IF (KEY.EQ.CRD(K)) GO TO (61,71,81), K

CONTINUE

4 WRITE (6,51)

51 FORMAT (16M ILLEGAL KEYWORD)

GO TO 91

C

* PARAMETERS * PACKAGE.

C

61 CALL INPAREN

GO TO 1

C

* EXECUTION * PACKAGE.

C

71 CALL EXTRAT

GO TO 1

C

* COMMENTS CARD * PACKAGE.

C

81 CALL INE (5)

GO TO 1

C

END OF JOB.

91 WRITE (6,101)

101 FORMAT (/2X,7H ENDJOB)

IF (.NOT.*PRINT4) GO TO 111

CALL ENDPRT

111 STOP

END
SUBROUTINE INPARM

*****************************************************************************
VERSION 2.0 LEVEL 761119
JH AGFL CDC6600
CONTROL CARD INPUT PARAMETERS
*****************************************************************************
LOGICAL PRINT1,PRINT2,PRINT3,PRINT4,CONTRZ,CONTRV
INTEGER TL,STARTR,TV,TSV

DIMENSION PROGID(3)
COMMON /PARM/ PRINT1,PRINT2,PRINT3,PRINT4,ICODES(36),A1,B1,A2,B2
COMMON /CONTR/ CONTRZ,CONTRV,NFILE,UMF,NREC,NUMR
COMMON /VALMAX/ ZMAX,VMAX,AC(4),CALM,CALB,XCUT,CK,INC
COMMON /HEAD/ TITLE(6),ICODE,VERS,LEVEL,DATE,IRUN,NPAGE,NLOG
COMMON /INSUB/ TL(4),LT,TON,DN,STARTR,DELTR,INPRF,SCALE,LOV,LT,TV
COMMON /MORE/ INPRF,SCALE,LOV,LT,TV
COMMON /EXPAN/ X1,X2,Y1,Y2,XMIN,XMAX,YMIN,YMAX
COMMON /STORE/ AE,A,B,X1,X2,Y1,Y2

DATA PROGID/7WILLAND/1H,1H /
NAMELIST /INPUT/ PRINT1,PRINT2,PRINT3,PRINT4,ICODES,A1,B1,A2,B2,
1NTRZ,CONTRZ,NFILE,UMF,AC,CALM,CALB,XCUT,CK,ZMAX,VMAX,NREC,NUMR,
2NUM,INC,TL,LT,TON,DN,STARTR,DELTR,INPRF,SCALE,AE,A,B,X1,X2,Y1,Y2
3TV,TSV,LOV,LT

READ (5,INPUT)
IF (EOF(5)) 111,1,111
WRITE (6,INPUT)
IF (NOT,CONTRZ) GO TO 21
IF (NOT,PRINT4) GO TO 11
CALL CRTPLT (PROGID,1,0,17,0)
CALL PLOT (0,0,0,0,3)
CALL PLOT (8,8,8,2)
CALL PLOT (8,8,8,2)
CALL PLOT (0,0,0,2)
CALL PLOT (0,0,0,2)
X*SIN(0.0)+4.0
Y=COS(0.0)+8.0
CALL PLOT(X,Y,3)
Y= .25
CALL PLOT(X,Y,2)
SCALE=8.0/(Y2=Y1)
IF ((X2=X1), GT, (Y2=Y1)) SCALE=8.0/(X2-X1)
XMIN=SCALE*X1
XMAX=SCALE*X2
YMIN=SCALE*Y1
YMAX=SCALE*Y2
21 IF (NOT,PRINT2) GO TO 61
 CALL PAGE
 WRITE (6,31)
31 FORMAT (1HO,8X,13HCODE FOR MEAN,7X,SHVALUE,5X,12HCODE FOR VAR,7X;5000000148
1HVALUE/40X,7HAND PWR)
DO 41 I=1,36
  XA=(FLOAT(I)-B1)/A1
  IF (XA,LT,0.) XA=0.
  XB=(FLOAT(I)-B2)/A2
41 WRITE (6,51) ICODES(I),XB,ICODES(I),XA
   CONTINUE
   IF (.NOT.,PRINT3) GO TO 101
   CALL PAGE
   WRITE (6,71)
71 FORMAT (140,8X,13HCODE FOR DBZ,7X,5HVALUE)
   DO 81 I=1,36
     XA=(FLOAT(I)-B1)/A1
     IF (XA,LT,0.) XA=0.
81 WRITE (6,91) ICODES(I),XA
91 FORMAT (15X,A1,9X,F9.3)
101 CONTINUE
   RETURN
111 WRITE (6,121)
121 FORMAT (30H END OF FILE IN NAMELIST INPUT)
   STOP
   END
SUBROUTINE EXTRAT

C~********************************************************************************~
C JHP MODIFIED 4/27/77 MOD. 1.0
C VERSION 1.0 LEVEL#760916
C JHW AFGL CDC 6600
C UNPACKING ROUTINE.
C~********************************************************************************~
C LOGICAL PRINT1, PRINT2, PRINT3, PRINT4, CONTRZ, CONTRV
INTEGER V(514), UI(514), VSI(514)
INTEGER W(514), V(514), VS(514), VB(514), HB(514), HVB(514),
  1 T(50), TC(10,30), TB(10,30), KDD(4), IPTB(30), IPL0(10,10), IPB(10,
  210,30), IPB2(10,10,30), IPB3(10,10,30), IPC(10,10,30), IPC2(10,10,30),
  3, IPC3(10,10,30), IC1(4,30,4), IBN(10,30), IPC1(10,30), IB(4,30,4),
  400000182
  4C(4,30,4), IPTC(30), TC1(10,10,30), IPC1(30), IPC1T(10,10,30),
  5IPC2T(100000185
  50,10,30), IPC3T(10,10,30), IVCNT(4), IVCNT(4), IDC(30), IDVC(30),
  6IPRNG(10,30), IPCRT(10,30), IACT(100), IACV(100)
INTEGER TL, STARTT
REAL UP0(8,100), DI(30), MZ(2,15,30), V(3,15,30), CI(3,30,4), ATR(5,100000189
  1,4), ZH(12,15,100), B1I(100), TATR(33,100), CII(3,30,4), UV(5,100),
  2VATR(17,100), B1(3,30,4)
C~********************************************************************************~
C DIMENSION IN(158)
C DIMENSION DAYMSK(3), IDAYSF(3), HRS8K(2), THRSFT(2), HINMSK(2),
C CIMHSFT(2), SECMSK(2), SESCFT(2), VMPSK(5), IMVPSST(5)
COMMON/WORK/W,V, VS, SV, VB, VJ, UI, VSI, HB, HVB, NCL
COMMON/AZM/, AZMUTH(460), NA, ELEVAT, PRF, KEEP
COMMON/PARM/, PRINT1, PRINT2, PRINT3, PRINT4, ICODES(36), A1, B1, A2, B2,
  100000198
COMMON/PR, PRINT1, PRINT2, PRINT3, PRINT4, ICODES(36)
COMMON/A1024/, MVP(3,1024)
COMMON/VVALMAX/, VMAX, VMAX, AC(4), CALM, CALB, XCM, CK, INC
COMMON/ADATA/, IDAY, IMHR, IIN, ISEC, NTP, NSF, MOD, NRC
COMMON/HORED/, INPRF, SCALE, LDV, LTV
COMMON/INSUB/, TL(4), LT, TDW, DN, STARTR, DELTR, RN(4), SCON, CELWTH(3)
COMMON/A22/, SINA, COSA, DELTAT, ISCANF, NEL
C~********************************************************************************~
C DATA MVPSK/77770000000000000000B,
C 0000000777000000000000B,
C 0000000077770000000000B,
C 0000000000077700000000B,
C 00000000000000077700B,
C 0000000000000000007777B/ 000000000000000000000B,
C 000000000000000000000B,
C 0000000000077700000000B,
C 00000000000000007777B/ 000000000000000000000B,
C 000000000000000000000B,
C 000000000000000000000B,
C 000000000000000000000B,
C 000000000000000000000B,
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C 000000000000000000000B,
C 000000000000000000000B,
C 000000000000000000000B,
C 000000000000000000000B,
DATA MEANH1/00000000777700000000B/
DATA VARMSK1/0000000000000077770000B/
DATA PWKMSK1/000000000000000000777B/
DATA AZMSK/00000777700000000000B/
DATA NMSK/94000000000000000000B/
DATA NSFMSK/00000000000000000000B/
DATA NDDMSK/00000000000000000000B/
DATA STMSK/00000000000000000000B/
DATA NPSK/00360000000000000000B/
DATA IPARMS1/00000000000000000022B/
DATA IDAYSFT/12,8,4/
DATA IHRSKFT/21,17/
DATA IMINSFT/27,29/
DATA ISECSFT/12,16/
DATA JMAX/10/,KMAX/10/,JEMAX/30/,JAT/5/,NID/100/,NFC/4/,NZP/12/,NZD/00000243
1H/15/,NUPB/,NHZ/2/,NVI/3/,NPA/4/,NUMAX/33/,NTH/50/,NCL/51/
DATA DZT/2,0/,NPB/3/,NUV/5/,NVMAX/17/

IEOF U O C IS CANF.0 0000 00236
NFCs LI 0000 0251
NA Il 0000 0258
14EL1 1 0000 0259
BUFF ER I~ (1, 1) (I~4 C1 ) .PJ ( 15 * )) 00000260
IF (I~T T( t)) 1,18 1: 201 00000261
1 VS(1) l.999 0000 0263
11 SV(I) su99R 00000264
C 00000267
C UNRA CK D*V Wr UR '~!~d~~ E SECON D AND STATUS FLAGS, 00000266
C 00000269
21 IDAY=0
23 IDA Y=I4*(I=1)*SHIFT(IN(1) .AND. DAYSFT(I))
23 CONTINUE
23 IHR=0
25 IHR=0*
25 CONTINUE
27 IMI N=0
27 IMIN=I4*(I=1)*IFT(IN(1) .AND. MINSFT(I))
27 CONTINUE
ISER0
DO 29 I=1,2
ISER0=ISER0+10**(I-1)*SHIFT(IN(1),AND,SECMSK(I),ISECSFT(I))
CONTINUE
NTP=SHIFT(IN(1),AND,NTPMSK,=9)
NSF=SHIFT(IN(1),AND,NSMK,=7)
NDN=SHIFT(IN(1),AND,NDMSK,=5)
NRC=SHIFT(IN(1),AND,NRCMSK,=3)
C
UNPACK PRF AZIMUTH, AND ELEVATION.
N=SHIFT(IN(2),AND,NMSK,=8)
K=SHIFT(IN(2),AND,KMSK,=11)
IF (K.EQ.0,AND,N.EQ.0) GO TO 41
JA=0
JB=0
DO 31 I=1,4
IREG=2**(I-1)
IF ((IREG,AND,N),NE.0) JA=JA+1
IF ((IREG,AND,K),NE.0) JB=JB+1
CONTINUE
IF (JA.EQ.1,AND,JB.EQ.1) PRF=394.
IF (JA.EQ.1,AND,JB.EQ.3) PRF=794.
IF (JA.EQ.3,AND,JB.EQ.1) PRF=1613.
IF (JA.EQ.3,AND,JB.EQ.3) PRF=3333.
GO TO 51
41
PRF=INPRF
51
CONTINUE
IREG=SHIFT(IN(2),AND,AZMSK,=24)
AZMUTH(NA)=IREG*360.0/4096.
IREG=SHIFT(IN(2),AND,ELMSK,=0)
ELEVAT=IREG*360.0/4096.
IF (ELEVAT.GT.180.) ELEVAT=ELEVAT-360.
C
UNPACK THE DATA.
NSF IS SUBFRAME.
K=NSF*256+1
KEEPK
C
UNPACK FIRST DATA WORD.
MVP(1,K)=SHIFT(IN(3),AND,MEANM1,=24)
MVP(2,K)=SHIFT(IN(3),AND,VARMK1,=12)
MVP(3,K)=SHIFT(IN(3),AND,PRMSK1,=0)
N=3
C
UNPACK REMAINING DATA.
DO 65 I=1,3
N=N+1
DO 63 J=1,9
IF (J.EQ.1,AND,(J.EQ.1,OR,J.EQ.4)) K=K+1
IF (J.EQ.1,AND,(J.EQ.1,OR,J.EQ.4)) M=1
IF (J.EQ.2,AND,(J.EQ.2,OR,J.EQ.5)) K=K+1
67
IF(I .EQ. 2 .AND. (J .EQ. 2 .OR. J .EQ. 5)) M=1
IF(I .EQ. 3 .AND. (J .EQ. 3)) K=K+1
IF(I .EQ. 3 .AND. (J .EQ. 5)) M=1
MVP(M,K)=SHIFT(IN(N)) .AND. MVPMSK(J), IMPSFT(J)
M=1
63 CONTINUE
65 CONTINUE
IF(N .LT. 155) GO TO 61

CLEAN OFF EXTRA BITS.
DO 71 I=K,KEEP
IPAR1=SHIFT(MVP(1,I)) .AND. IPARMSK,=11
IPAR2=SHIFT(MVP(2,I)) .AND. IPARMSK,=11
MVP(1,I)=MVP(1,I) .AND. MEANH2
IF(IREG,GT,0) MVP(I,I)=MVP(1,I)
IPAR3=SHIFT(MVP(3,I)) .AND. IPARMSK,=11
MVP(3,I)=SHIFT(MVP(3,I)) .AND. VPMSK,=3
71 CONTINUE
IF(.NOT. PRINT1) GO TO 81
CALL PRN1
GET NEXT TAPE RECORD.
BUFFER IN (1,1) (IN(1),IN(158))
IF (UNIT(1)) 91,111,201
91 IN=SHIFT(IN(1)) .AND. NSMSK,=7
IREG=SHIFT(IN(2)) .AND. ISGNSK,=10
AZ=IREG=360.0/4096.
DAZ=AZ=AZHUTH(NA)
IF (ABS(DAZ),GT,DAZT) GO TO 101
DAZS=SIGN(1.,DAZ)
IF (NA .EQ. 1) DAZ=DZ
IF (DAZ, .LT. DAZ) GO TO 141
AZ=AZ=360.*DAZ
DAZ=AZ=AZHUTH(NA)
IF (ABS(DAZ),GT,DAZT) GO TO 121
DAZS=SIGN(1.,DAZ)
IF (DAZ, .LT. DAZ) GO TO 121
IF (ABS(AZ=360.,*DAZ=AZHUTH(1)),GT,DAZT) GO TO 141
FINISHED SCAN
ISCANF=1
AZ=AZ=360.*DAZ
GO TO 131
111 ISCANF=1
121 ISCANF=1
131 CALL CONTR2 (JMAX, KMAX, IEMAX, IAT, NID, NFC, NZP, NTH, SUP, NUMAX, NVH, NV1000000385
1, NPA, IPVRNG, IPVRG, IDC, IDCV, IPB1, IPB2, IP83, IPC1, IPC2, IPC3, IP87, T8, 1000000386
2IPNT, IPCNT, T, IPTC, UP, TC, TR, IC, HC, VI, ICVNT, IBVNT, DI, TC1, IPTC1, IPC1000000387
3, IPC2T, IPC3T, C1, AT, ZH, DSP, IPOP, TATR, KDO, NTT, CI1, IC1, NPB,
4IPCTT, IACT, IACV, NW, NWMAX, UV, VATT, NNE, BI)
IF (IEOF, .EQ. 1) GO TO 181
IF (NA, .GT. NUMR) RETURN
141 IF(NS .GT. NSF .OR. NS .GT. NRC) GO TO 21
      IF (.NOT. CONTZ) GO TO 161
      CALL COMPZ
      CALL CONTOR (JMAX, KMAX, IEMAX, IAT, NID, NFC, NZP, NZH, NUP, NUMAX, NHZ, NVI, NPI
      1, NPA, IPVRNG, IPRNG, IDC, IDVC, IPB1, IPB2, IPB3, IPC1, IPC2, IPC3, IPTB, TB, I
      00000394
      2PBNT, IPCNT, T, IRTC, TC, IB, IC, IC, VIT, VP, IBVNT, VIT, T, ITC1, ITC1, IPC1, T
      3, IPC2, IPC3, CI, ATR, ZH, OSI, IPLO, TATR, KDD, NTT, CI1, IC1, NPC
      4IPCNTT, IACT, IC, IACV, NU, NVMAX, UV, VTR, NNE, DI
      161 NA = NA + 1
      IF (NA .GT. NUM) GO TO 121
      GO TO 1
      181 WRITE (6,191)
      191 FORMAT (6,191)
      191 IF (.NOT. PRINT2) GO TO 221
      CALL PRN2(2)
      GO TO 221
      201 WRITE (6,211)
      211 FORMAT (6,211)
      221 RETURN
      END
SUBROUTINE COMPZ

C **************************************************************
C VERSION 2.0 LEVEL 761119
C JHW AFGL CDC6600
C Computes DBZ.
C **************************************************************
C
INTEGER W,V,VS,SV,VB,VJ,UI,VSI,HB,MB,TV$,
INTEGER TL,STARTR

COMMON / WORK/W(514),V(514),VS(514),SV(514),VB(514),VJ(514),UI(514),
VSI(514),HB(514),MB(514),TV$(514),NCL

COMMON /AZM/ AZMUTH(460),NA,ELEVAT,PRF,KEEP
COMMON /VALMAX/ VMAX,VMAX,AC(4),CALM,CALB,XCUT,CK,INC
COMMON /ADATA/ IDA,IVT,IP44,ISEC,NTP,NSF,NOO,NRC
COMMON /INOUT/ TL(4),LT,TDW,DT,STARTR,DELTR,RN(4),SCON,CELWTH(3)

FET~CH NUMBER OF RANGE CELLS (N).

VCON= (106/4)*PRF/2047
N=RN(NRC+1)+1
M=2
IF (NRC,LT,2) GO TO 11

COM~PRESS DATA DOWN TO AN NCL CELL RADIAL.

M=N=1
DO 1 K=2,M,2
J=K/2
DO 1 I=1,3
MVP(I,J) = (MVP(I,K=1)+MVP(I,K))/2.0
1 CONTINUE
N=NCL=4
M=2

COMPUTE DBZ

DO 41 J=M,N
P=MVP(3,J+2)
IF (P,LE,XCUT) GO TO 21

USE LINEAR CALIBRATION.

P=AC(1)+AC(2)*P+AC(3)*P**2+AC(4)*P**3

USE NON LINEAR CALIBRATION.

W(J) = CK+P**20.*ALOG10(SCON*(FLOAT(J=1,.5)+.5))+CELWTH(NTP+1)+.5
IF (W(J),LT,TL(1)) W(J)=0

COMPUTE V
IF (w(J) .LE. TL(1)) GO TO 41
V(J) = IFIX(VCON*FLOAT(MVP(1,J+2)))
SV(J) = IFIX(VCON*2*FLOAT(MVP(2,J+2)))
IF (VB(J) ,EQ ,999 ,OR ,NA ,EQ ,1) GO TO 41
RSCON *(FLOAT(J-1) = .5) * CELWTH(NYP+1)
VS(J) = (V(J) + VB(J)) / R*1000.

41 CONTINUE
DO 51 J=1 , NCL
51 VB(J) = V(J)
DO 61 J=1 , NCL
61 VJ(J) = V(J)
RETURN
END

71
SUBROUTINE PRANG

***************************************************************************

VERSION 2.0  LEVEL 761119

JHW  CDC6600

COMPUTES RANGES AND PRINTS THEM OUT FOR BSCAN MAPS.

***************************************************************************

DIMENSION R$AVE(B)

COMMON/INSUB/TL(04),LT,TDW,DN,STARTR,DELTR,RN(4),SCON,CELMTH(3)
COMMON/ADA ?A/IOAY, !HOUR,!MIN,NSEC,NT,NDF,NDD,NRC

SCRAMBLED

IF(NRC.EQ.3)SCRA=SCON/2

RMAX=SCRA*(RN(NRC+1)=5)*CELMTH(NTP+1)/1000.

D=RMAX/8.0

RSAVE(8)=RMAX

J#1

DO 10 I=1,7

RSAVE(J)=RSAVE(J+1)+0

J=J+1

10 CONTINUE

CALL PAGE

WRITE(6,99)RSAVE

99 FORMAT(100,3IX,20HRANGE SCALE ( KM )/

X4X,2HANG,4X,2HEL,1X,3MDAY,1X,4MMHMM,1X,2H8SS,6X,8BF,1,10H PRF)

RETURN

END
CONTINUE
IF (NA.EQ.1) GO TO 11
TEMP=AZMUTH(NA=1)
AZNOR=AZMUTH(NA)
DELTAZ=(AZMUTH(NA)-TEMP)*RPD
TEMP=TEMP*RPD
GO TO 61

INITIALIZE.

TEMP=0.0
DELTAZ=0.0
AZNOR=0.0
DO 21 K=1,NFC
KDD(K)=0
SL=SIN(ELEVAT*RPD)/1000.
CL=COS(ELEVAT*RPD)*2/AS/6.731E09
NCHEL=1
NVCEL=1
AR=ALOG10(AA)
BR=0.1/BB
AR=ALOG10(AA)
BR=0.1/BB
DO 31 K=1,NID
DSI(K)=0.0
DO 31 J=1,NNE
DO 31 L=1,NZP
31
ZH(L,J,K)=0.0
DO 41 K=1,NID
DO 41 J=1,NNE
DO 41 L=1,NFC
41
ATR(J,K,L)=0.0
DO 51 K=1,NFC
DO 51 J=1,NMAX
DO 51 L=1,NPA
51
IB(J,L,K)=0
61
CONTINUE

DO 71 K=1,NMAX
DO 71 J=1,NZH
DO 71 L=1,NHZ
71
HZ(L,J,K)=0.0
DO 81 K=1,NMAX
DO 81 J=1,NVI
DO 81 L=1,NZH
81
VI(J,L,K)=0.0
DO 91 K=1,NMAX
DO 91 J=1,NFC
DO 91 L=1,NPB
91
CI(L,K,J)=0.0
DO 101 K=1,NMAX
DI(K)=0.0
IDC(K)=0
IDVC(K)=0


```
DO 101 J=1,JMAX
IPVRNG(J,K)=0
IPVRNG(J,K)=0
101 CONTINUE
DO 111 K=1,NFC
ICVNT(K)=0
111 CONTINUE
IPV=0
IP=0
IPB=0
IPVB=0
C
FIND EVENTS
C
DO 281 I=2,NCL
DO 231 K=1,NFC
IF (W(I).GT.TL(K)) GO TO 131
GO TO 241
131 IF (W(I-1).LE.TL(K)) GO TO 141
GO TO 191
141 ICVNT(K)=ICVNT(K)+1
IEVENT=ICVNT(K)
IF (K.EQ.1) IE0=IEVENT
IC(1,IEVENT,K)=I=1
IC(3,IEVENT,K)=IE0
C
TALLY ATTRIBUTES.
C
151 R=SCOND*(FLOAT(I=1)=.5)*CELWTH(NTP+1)
EVENT=ICVNT(K)
CI(1,IEVENT,K)=CI(1,IEVENT,K)+R
CI(2,IEVENT,K)=CI(2,IEVENT,K)+R*W(I)
CI(3,IEVENT,K)=CI(3,IEVENT,K)+R*R*W(I)
IF (K.NE.1) GO TO 231
C
PEAK DETECTION, LOCATE AND COUNT PEAKS.
C
IF (W(I)=W(I-1)) 171,181,161
161 IPB=I-1
GO TO 181
171 IF (IPB.EQ.0) GO TO 181
IP=IP+1
IFVRNG(IP,IEVENT)=(I+IPB)/2
IPB=0
181 CONTINUE
IF (VS(I)=999) GO TO 191
IF (V8(I-1)=999) GO TO 201
IF (ABS(V8(I)-V8(I-1))=999) 191,211,201
191 IF (IPVB.EQ.0) GO TO 211
IPV=IPV+1
IPVRNG(IPV,IEVENT)=(I+IPVB)/2
IPVB=0
GO TO 211
201 IPVB=I-1
211 CONTINUE
```
IH=IFIX(R=SL+R*CL)*1
IF (IH.LE.0. OR. IH.GT.NZM) GO TO 221
IE1=IEVENT
H2(1, IH, IE1) = HZ(1, IH, IE1) + W(I) * R
H2(2, IH, IE1) = HZ(2, IH, IE1) + R
IF (W(I).GT.TV, OR. SV(I).GT.TSV) GO TO 221
IF (W(I).LT.TL(I), OR. V(I).EQ.999) GO TO 221
VI(1, IH, IE1) = VI(1, IH, IE1) + V(I)
VI(2, IH, IE1) = VI(2, IH, IE1) + V(I) * V(I)
VI(3, IH, IE1) = VI(3, IH, IE1) + 1.0
221 CONTINUE
IF (NEL.NE.I) GO TO 231
RA=NJO, (BR(W(I)=AR))
DI(IE1)=DI(IE1)*RA
231 CONTINUE
GO TO 281
241 DO 271 KL=K, NFC
IF (W(I)=1, LE.TL(KL)) GO TO 281
IEVENT=IEVENT(KL)
IC(2, IEVENT, KL)=I=1
C
C KEEP COUNT OF PEAKS WITH EVENT.
C
IF (KL.LE.1) GO TO 271
IF (IPB.EQ.0) GO TO 251
IP=IP+1
IPRNG(IP, IEVENT) = (IP+IPB)/2
IPB=0
251 IDC(IEVENT)=IP
IP=0
IF (IPV.EQ.0) GO TO 261
IPV=IPV+1
IPVRNG(IPV, IEVENT) = (IP+IPV)/2
IPV=0
261 IDVC(IEVENT)=IPV
IPV=0
271 CONTINUE
281 CONTINUE
IF (NA.NE.1) GO TO 321
DO 311 K=1, NFC
DO 311 KEVENT=1, IEMAX
DO 291 I=1, NPC
291 C11(I, KEVENT, K) = C1(I, KEVENT, K)
DO 301 I=1, NPA
301 IC1(I, KEVENT, K) = IC(I, KEVENT, K)
311 CONTINUE
321 COST=COS(TEMP)
SINT=SIN(TEMP)
COSA=COS(AZNOW*RPD)
COSA2=COSA*COSA
SINA=SIN(AZNOW*RPD)
SINA2=SINA*SINA
SINACNA=SINA*COSA
IMXRPN(NRC+1)/2=3
IF (NRC.EQ.1) IMXRNRC=3
PLOT FIXED CONTOURS.

DO 611 K=1,NFC
   IP∪=IP∪+K
   IPD=IPD+K
   IDO=IDO(K)
   KEVENT=1
   IEVENT=1
   331 IF (IB(2,IEVENT,K),EQ.0.AND.IC(2,KEVENT,K),EQ.0) GO TO 601
   IF (IB(1,IEVENT,K),GT.IC(2,KEVENT,K)) GO TO 471
   IF (IB(2,IEVENT,K),LT.IC(1,KEVENT,K)) GO TO 471
   AASSOCIATED
   LEFT SIDE PEN UP.
   IID=IB(NPA,IEVENT,K)
   IF (ISCNFIN.EQ.0) IC(NPA,KEVENT,K)=IID
   X=FLOAT(IB(1,IEVENT,K))=5
   R=SCON*X*CELTH(NTP+1)/(3,84*10E03)
   X=SCALE*(R*SINT+4,0)
   Y=SCALE*(R*COST+4,0)
   IF (PRINT4) CALL PLOT (X,Y,3)
      WRITE(2)X,Y,IPU
   LEFT SIDE PEN DOWN.
   X=FLOAT(IC(1,KEVENT,K))=5
   R=SCON*X*CELTH(NTP+1)/(3,84*10E03)
   X=SCALE*(R*SINA+4,0)
   Y=SCALE*(R*COSA+4,0)
   IF (PRINT4) CALL PLOT (X,Y,2)
      WRITE(2)X,Y,IPD
   ATR(1,IID,K)=ATR(1,IID,K)*DELTAZ*C(1,KEVENT,K)
   ATR(2,IID,K)=ATR(2,IID,K)*DELTAZ*C(2,KEVENT,K)
   ATR(3,IID,K)=ATR(3,IID,K)*SINA*DELTAZ*C(3,KEVENT,K)
   ATR(4,IID,K)=ATR(4,IID,K)*COSA*DELTAZ*C(3,KEVENT,K)
   IE=IC(3,KEVENT,K)
   IID1=IC(NPA,IE1,1)
   IF (ATR(IAT,IID,K),EQ.0) ATR(IAT,IID,K)=IID1
   IF (IC(1,KEVENT,K),EQ.1.OR.IC(2,KEVENT,K),EQ.IMX) ATR(IAT,IID,K)=0
   1AB8(ATR(IAT,IID,K))
   IF (K.NE.1) GO TO 371
   IE=NNE
   DO 361 IH=1,NZH
   IF (HZ(2,IH,KEVENT),LE.0) GO TO 361
   IF (VI(3,IH,KEVENT),LE.0) GO TO 351
   ZH(1,12,IID)=ZH(1,12,IID)+VI(1,IH,KEVENT)
   ZH(2,12,IID)=ZH(2,12,IID)+VI(2,IH,KEVENT)
   ZH(3,12,IID)=ZH(3,12,IID)+SINA*VI(1,IH,KEVENT)
   ZH(4,12,IID)=ZH(4,12,IID)+COSA*VI(1,IH,KEVENT)
   ZH(5,12,IID)=ZH(5,12,IID)+SINA*VI(3,IH,KEVENT)
   ZH(6,12,IID)=ZH(6,12,IID)+COSA*VI(3,IH,KEVENT)
   ZH(7,12,IID)=ZH(7,12,IID)*SNACNA*VI(3,IH,KEVENT)
   ZH(8,12,IID)=ZH(8,12,IID)+SINA*VI(3,IH,KEVENT)
ZH(9,12,IID)*ZH(9,12,IID)+COSA*VI(3,IM,KEVENT) 00000781
ZH(10,12,IID)*ZH(10,12,IID)+VI(3,IM,KEVENT) 00000782
351 ZH(11,12,IID)*ZH(11,12,IID)*H(1,IM,KEVENT)*DELTAZ 00000783
ZH(12,12,IID)*ZH(12,12,IID)*H(2,IM,KEVENT)*DELTAZ 00000784
361 CONTINUE 00000785
DBI(IID)=DBI(IID)+DI(KEVENT)*DELTAZ 00000786
371 IF (ISCANF,EQ.,AND.,IID,NE.,IC(MPI,KEVENT,K)) GO TO 571 00000787
381 IF (IB(1,IEVENT+1,K),GT,IC(2,KEVENT,K)) GO TO 441 00000788
IF (IB(1,IEVENT+1,K),EQ,0) GO TO 441 00000789
C DRAW DOWN TO PRESENT AZMUTH, 00000790
C X=FLOAT(IB(2,IEVENT,K))=.5 00000791
R=SCON*X*CELTH(NTP+1)/(3.84*10E03) 00000792
X=SCALE*(R*SINT+4,0) 00000793
Y=SCALE*(R*COST+4,0) 00000794
IF (PRINT4) CALL PLOT (X,Y,3) 00000795
WRITE(2)X,Y,IPU 00000796
X=SCALE*(R*SINT+4,0) 00000797
Y=SCALE*(R*COST+4,0) 00000798
IF (PRINT4) CALL PLOT (X,Y,2) 00000799
WRITE(2)X,Y,IPU 00000800
C DRAW OVER TO IEVENT+1 00000801
C X=FLOAT(IB(1,IEVENT+1,K))=.5 00000802
R=SCON*X*CELTH(NTP+1)/(3.84*10E03) 00000803
X=SCALE*(R*SINT+4,0) 00000804
Y=SCALE*(R*COST+4,0) 00000805
IF (PRINT4) CALL PLOT (X,Y,2) 00000806
WRITE(2)X,Y,IPU 00000807
C DRAW UP TO PREVIOUS AZMUTH, 00000808
C X=SCALE*(R*SINT+4,0) 00000809
Y=SCALE*(R*COST+4,0) 00000810
IF (PRINT4) CALL PLOT (X,Y,2) 00000811
WRITE(2)X,Y,IPU 00000812
IEVENT=IEVENT+1 00000813
IF (IEVENT,GT,IEMAX) GO TO 601 00000814
KID=IB(MPI,IEVENT,K) 00000815
401 IF (ATR(IAT,KID,K),EQ,0,0,0,Avm(1,IAT,IID,K),EQ,0,0) GO TO 381 00000816
IATT=IAT+1 00000817
DO 411 J=1,IATT 00000818
411 ATR(J,IID,K)=ATR(J,IID,K)*ATR(J,KID,K) 00000819
IF (ATR(IAT,KID,K),LT,0,0,0,Avm(1,IAT,IID,K),LT,0,0) ATR(IAT,IID,K) 00000820
1=ABS(ATR(IAT,IID,K)) 00000821
C A WILL FLAG USELESS ATTR'S, 00000822
ATR(IAT,KID,K)=0.0 00000823
IDSLT=KID 00000824
I2NNE 00000825
421 ZH(J,12,IID)*ZH(J,12,IID)+ZH(J,12,KID) 00000826
ZH(NZP,12,KID)=0.0 00000827
D$1(IID) = D$1(IID) + D$1(KID)

GO TO 351

451 IF (IC(1,KEVENT+1,K) .EQ. IB(2,IEVENT,K)) GO TO 451
IF (IC(1,KEVENT+1,K) .EQ. 0) GO TO 451

DRAW LINE CONNECTING IC(N) TO IC(N+1).

X = FLOAT(IC(2,KEVENT,K)) / 5
R = SCONX*CEILTH(NTP+1)/(3.84*10E03)
X = SCALE*(R*SINT+4.0)
Y = SCALE*(R*COST+4.0)
IF (PRINT4) CALL PLOT (X,Y,1)
WRITE(2),X,Y,IPU
X = FLOAT(IC(1,KEVENT+1,K)) / 5
R = SCONX*CEILTH(NTP+1)/(3.84*10E03)
X = SCALE*(R*SINT+4.0)
Y = SCALE*(R*COST+4.0)
IF (PRINT4) CALL PLOT (X,Y,2)
WRITE(2),X,Y,IPU
KEVENT = KEVENT+1
IC(NPA,KEVENT,K) = IID
IF (KEVENT LT IEMAX) GO TO 341
GO TO 601

RIGHT SIDE.

X = FLOAT(IC(2,KEVENT,K)) / 5
R = SCONX*CEILTH(NTP+1)/(3.84*10E03)
X = SCALE*(R*SINT+4.0)
Y = SCALE*(R*COST+4.0)
IF (PRINT4) CALL PLOT (X,Y,3)
WRITE(2),X,Y,IPU
X = FLOAT(IC(2,KEVENT,K)) / 5
R = SCONX*CEILTH(NTP+1)/(3.84*10E03)
X = SCALE*(R*SINT+4.0)
Y = SCALE*(R*COST+4.0)
IF (PRINT4) CALL PLOT (X,Y,2)
WRITE(2),X,Y,IPU
KEVENT = KEVENT+1
IF (IEVENT LT IEMAX) GO TO 601
KEVENT = KEVENT+1
GO TO 331

471 IF (IB(1,IEVENT,K) .EQ. 0) GO TO 521
IF (IC(1,KEVENT,K) .EQ. 0) GO TO 481

UNASSOCIATED.

ANGLE LINE ON IB

IF (IC(2,KEVENT,K) LT IB(1,IEVENT,K)) GO TO 511
X = FLOAT(IB(1,IEVENT,K)) / 5
R = SCONX*CEILTH(NTP+1)/(3.84*10E03)
X = SCALE*(R*SINT+4.0)
Y = SCALE*(R*COST+4.0)
IF (PRINT4) CALL PLOT (X,Y,3)
WRITE(2),X,Y,IPU
X = SCALE * (R * SIN(A + 4.0))
Y = SCALE * (R * COS(A + 4.0))
IF (PRINT4) CALL PLOT (X, Y, 2)
WRITE (2) X, Y, IPD
WRITE (2) X, Y, IPU
X = FLOAT (IB(2, IEVENT, K)) = 5
R = SCALE * CELTH(NTP+1) / (3.84 * 10E03)
SCALE = R * SCALE
Y = SCALE * (R * COST + 4.0)
IF (PRINT4) CALL PLOT (X, Y, 2)
WRITE (2) X, Y, IPD
IDD = (NP, IEVENT, K)
ATR(1, IID, K) = ATR(1, IID, K) + DELTA * BI(1, IEVENT, K)
ATR(2, IID, K) = ATR(2, IID, K) + DELTA * BI(2, IEVENT, K)
ATR(3, IID, K) = ATR(3, IID, K) + SINA * DELTA * BI(3, IEVENT, K)
ATR(4, IID, K) = ATR(4, IID, K) + COSA * DELTA * BI(3, IEVENT, K)
IE = IC(3, KEVENT, K)
IID = IC(NP, IE1, 1)
IF (ATR(IAT, IID, K) .EQ. 0) ATR(IAT, IID, K) = IID
IF (IC(1, KEVENT, K) .EQ. 1 OR. IC(2, KEVENT, K) .EQ. IMX) ATR(IAT, IID, K) = 0
LABS = ATR(IAT, IID, K)
IEVENT = IEVENT + 1
IF (IEVENT .GE. IEMAX) GO TO 601
IF (IC(1, KEVENT, K) .LE. IB(2, IEVENT, K)) GO TO 331
IF (IC(2, KEVENT, K) .NE. 0) GO TO 501
GO TO 331
501 IF (IB(1, IEVENT, K) .EQ. 0) GO TO 521
511 IF (IC(1, KEVENT, K) .GT. IB(2, IEVENT, K)) GO TO 331
C
C
C
C
521 IF (IC(1, KEVENT, K) .EQ. 0) GO TO 562
IF (ISCANF .EQ. 1) GO TO 581
IF (IDSLOT .EQ. 0) GO TO 523
IC(NP, KEVENT, K) = IDSLOT
GO TO 524
523 IC = IC + 1
IC(NP, KEVENT, K) = IID
524 X = FLOAT (IC(1, KEVENT, K)) = 5
R = SCALE * CELTH(NTP+1) / (3.84 * 10E03)
SCALE = R * SCALE
Y = SCALE * (R * COST + 4.0)
IF (PRINT4) CALL PLOT (X, Y, 3)
WRITE (2) X, Y, IPD
X = FLOAT (IC(2, KEVENT, K)) = 5
R = SCALE * CELTH(NTP+1) / (3.84 * 10E03)
SCALE = R * SCALE
Y = SCALE * (R * COST + 4.0)
IF (PRINT4) CALL PLOT (X, Y, 2)
WRITE (2) X, Y, IPD
IF (NA .EQ. 1) GO TO 531
IF (IDSLOT .EQ. 0) GO TO 527
IDTEMP = IID
ID=IDSLT

ATR(1,IDD,K)=DELTAZ*CI(1,KEVENT,K)
ATR(2,IDD,K)=DELTAZ*CI(2,KEVENT,K)
ATR(3,IDD,K)=SINA*DELTAZ*CI(3,KEVENT,K)
ATR(4,IDD,K)=COSA*DELTAZ*CI(3,KEVENT,K)

IE=IC(3,KEVENT,K)
ATR(IAT,IDD,K)=IC(NPA,KEVENT)
IF (NA,EQ.1) ATR(IAT,IDD,K)=ABS(ATR(IAT,IDD,K))
IF (IC(1,KEVENT,K),EQ.1.OR.,IC(2,KEVENT,K),EQ.IMX) ATR(IAT,IDD,K)=0.0
IF (K,NE.1) GO TO 561
IZ=NNE
DO 551 IH=1,NZ
IF (HZ(2,1H,KEVENT)<=0.) GO TO 551
IF (V1(3,1H,KEVENT)<=0.) GO TO 541
ZH(1,1H,IDD)=V1(1,1H,KEVENT)
ZH(2,1H,IDD)=V1(2,1H,KEVENT)
ZH(3,1H,IDD)=SINA*V1(1,1H,KEVENT)
ZH(4,1H,IDD)=COSA*V1(1,1H,KEVENT)
ZH(5,1H,IDD)=SINA2*V1(3,1H,KEVENT)
ZH(6,1H,IDD)=COSA2*V1(3,1H,KEVENT)
ZH(7,1H,IDD)=SINAC*V1(3,1H,KEVENT)
ZH(8,1H,IDD)=SINA2*V1(3,1H,KEVENT)
ZH(9,1H,IDD)=COSA*V1(3,1H,KEVENT)
ZH(10,1H,IDD)=V1(3,1H,KEVENT)
IF (NA,EQ.1) GO TO 561
ZH(11,1H,IDD)=HZ(1,1H,KEVENT)*DELTAZ
ZH(12,1H,IDD)=HZ(2,1H,KEVENT)*DELTAZ
CONTINUE
DSI(IDD)=DI(KEVENT)*DELTAZ
IF (IDSLT,NE.0) IDD=IDTEMP
IDSLT=0
DO 562 KEVENT=KEVENT+1
IF (KEVENT,GT.IEMAX) GO TO 601
GO TO 331
KD=IC(NPA,KEVENT,K)
IF (IC(1,KEVENT,K),EQ.1.OR.,IC(2,KEVENT,K),EQ.IMX) GO TO 401
ATR(IAT,KID,K)=ABS(ATR(IAT,KID,K))
GO TO 401
IF (IC(1,KEVENT,K).GT.1.AND.,IC(2,KEVENT,K).LT.IMX) ATR(IAT,KID,K)=-0.0
1ABB(ATR(IAT,KID,K))
IF (ATR(IAT,KID,K),NE.0.) GO TO 341
GO TO 591
CONTINUE
DO 601 KDD(K)=IDD
CONTINUE
DO 782 IF (.NOT.,CONTRV) GO TO 800
CALL PEAKO(W,LDV,TL(1),IPRNG,ICDC,1,TATR,IBP1,IPB2,IPB3,IBP4,IBP5,IBP6,IP00000943
1BNT,IPCNT,T,IPC1,IPC2,IPC3,IPCT,UP,TC,NTT,EIMAX,KMAX,JMAX,NC100000944
2L,ND,IB,IC,ICVNT,IVBNT,NPA,NFC,IPLO,NUMAX,NUP,IACT,H8)
CALL PEAKO(VS,LTX,0,IPVRNG,IVDC,0,VATR,IVP1,IVP2,IVP3
2IVP5,TVB,IPBNT,IPCVNT,T,IPC1,IPC2,IPC3,IPCT,UV,TC,NTT,EIMAX,KMAX,NC100000947
3JMAX,NVCN2,NI0,IB,IC,ICVNT,IVBNT,NPA,NFC,IPLO,NVMAX,NUV,IACT,IVHB)
CONTINUE
STORE PRESENT PARAMETERS IN PREVIOUS PARAMETERS.

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81
NAME=1
WRITE(6,9909)NAME,INDX
CONTINUE
GO TO 931

COMBINE NPCEL AND LPCEL, PEAK VALUES EQUAL

COMBINE WITH B RADIAL CELLS

421 IF(MPK.LT.0)GO TO 422
LPCEL= MK
IF(TATR(IDX,LPCEL).EQ.NA.AND.MPK.EQ.0)GO TO 485
INDX=TATR(1,LPCEL)=TC(KC,IE)=1
IF(IDX,LT.0)GO TO 481

COMBINE WITH B=RADIAL, C=LEVEL LOWER

512 ISP=IPC2(IPE,KC,IE)
NPCEL=LPCEL
DO 531 IDX=IST,ISP
R=SCON*(FLOAT(I=1)=.5)CELWTH(NTP+1)
TATR(2+IN,NPCEL)=TATR(2+IN,NPCEL)+DAZ*R
TATR(3+IN,NPCEL)=TATR(3+IN,NPCEL)+DAZ*R*U(I)
TATR(4+IN,NPCEL)=TATR(4+IN,NPCEL)+DAZ*SAZ*R*U(I)
TATR(5+IN,NPCEL)=TATR(5+IN,NPCEL)+DAZ*CAZ*R*U(I)
IF (ITY,NE,1) GO TO 531
IF (V(I).EQ.999,.OR.V(I=1).EQ.999) GO TO 521
TATR(6+IN,NPCEL)=TATR(6+IN,NPCEL)+DAZ*R*(V(I)=V(I=1))
521 IF (VS(I).EQ.999) GO TO 531
TATR(7+IN,NPCEL)=TATR(7+IN,NPCEL)+DAZ*R*VS(I)
TATR(8+IN,NPCEL)=AMAX1(TATR(8+IN,NPCEL),FLOAT(IABS(VS(I))))
CONTINUE
TATR(IDX+IN,NPCEL)=SIGN(FLOAT(NA),TATR(IDX+IN,NPCEL))
IF (IST,NE,2,.OR.ISP,NE,IMX)TATR(IDX+IN,NPCEL)=SIGN(TATR(IDX+IN,NPCEL))
GO TO 422

COMBINE WITH B=RADIAL, C=LEVEL HIGHER

481 INDEX=INDEX
IND=NUMP
INS=2
TATR(1,LPCEL)=TC(KC,IE)=1
TATR(NUMP,LPCEL)=TC(NPA,IE,1)
IF(IDX,GE,IM8)GO TO 482
C
800 DO 790 K=1,NFC
    DO 790 IEVENT=1,IEMAX
    DO 790 N=1,NPB
    790 BI(N,IEVENT,K)=CI(N,IEVENT,K)
    DO 801 K=1,NFC
    IBVNT(K)=ICVNT(K)
    DO 801 IEVENT=1,IEMAX
    DO 801 N=1,NPB
    IC(N,IEVENT,K)=0
    IF (ISCANF.EQ.1) GO TO 871
    RETURN

C
ENTRY CONTR2
IF (ISCANF.GT.0) GO TO 831
DO 821 K=1,NFC
    IE=IBVNT(K)
    DO 821 I=1,IE
    IDD=IB(NPA,I,IE)
    821 ATR(IAT,IDD,K)=ATR(IAT,IDD,K)

C
     PLOT FINAL RADIALS.
     X=4.0
     Y=4.0
     IF(PRINT4)CALL PLOT(X,Y,3)
     WRITE(2)X,Y,IPU
     SCRA=SCON
     IF(NRC.EQ.3)SCRA=SCON/2
     R=SCRA*(RN(NRC+1)-.5)*CELMUTH(NTP+1)/(3.84*10E03)
     X=SCALE*(R*SIN(AZMUTH(1)*RPD)+4.0)
     Y=SCALE*(R*COS(AZMUTH(1)*RPD)+4.0)
     IF(PRINT4)CALL PLOT(X,Y,2)
     WRITE(2)X,Y,IPD
     X=SCALE*(R*SIN(AZMUTH(NA)*RPD)+4.0)
     Y=SCALE*(R*COS(AZMUTH(NA)*RPD)+4.0)
     IF(PRINT4)CALL PLOT(X,Y,3)
     WRITE(2)X,Y,IPU
     X=4.0
     Y=4.0
     IF(PRINT4)CALL PLOT(X,Y,2)
     WRITE(2)X,Y,IPD
     GO TO 871

831 DO 861 K=1,NFC
    IE=ICVNT(K)
    DO 861 I=1,IE
    DO 841 L=1,NPA
    841 IC(L,I,K)=IC1(L,I,K)
    DO 851 L=1,NPB
    851 CI(L,I,K)=CI1(L,I,K)
    861 CONTINUE
    TEMP=AZMUTH(NA)*RPD
    DELTA=(AZMUTH(1)-TEMP)*RPD
    AZNOW=AZMUTH(1)
    GO TO 321
OUTER C EVENT LOOP

DO 951 IE=1,IEM
IPK=1
IPL=1
IP=IDC(IE)
IF (IP,NE,0) GO TO 951
JE1=0
JE2=0

FIND EVENTS ASSOCIATED WITH C EVENTS.
JEM IS NO. OF EVENTS IN PREVIOUS RADIAL.

JEM=IVNT(1)
IF(JEM,NE,0) GO TO 41
DO 31 JEM=JEM
IF (IC(4,IE,1),NE,IEB(4,JE,1)) GO TO 31
JE2=JE
IF (JE1,NE,0) JE1=JE
31 CONTINUE

FIND THRESHOLDS FOR IE EVENT

41 DO 51 J=1,IMXDB
51 IT(J)=0
DO 71 L=IPL,IP
IE=IPCRNG(L,IE)
DO 71 K=1,LDB
ITM=IAK(B(U(IR)),TM=K+1
IF(ITM,GE,1. AND, ITM,LE,IMXDB)TM=ITM+1
71 CONTINUE

IPT=1
DO 91 L=1,IMXDB
IF (T(L),NE,91,91,81
81 TC(IPT,IE)=L+TM=1
IPT=IPT+1
91 CONTINUE

IPT=IPT+1
IPTC(IE)=IPT

LOOP ON RANGE IN IE EVENT TO FIND CONTOUR

IBGN=IC(1,IE,1)+1
IND=IC(2,IE,1)+1
DO 161 I=IBGN,IND
IF (I,NE,IPCRNG(IPK,IE)) GO TO 101
IPK=IPK+1
101 CONTINUE

LOOP ON THRESHOLD

101 DO 131 K=1,IPT
IF (U(I),EQ,999) GO TO 141
IF (IAK(B(U(I))),GT,TC(K,IE)) GO TO 111
GO TO 141
111 IF (U(I),EQ,999) GO TO 121

84
SURROUTEINE PEAKD (U,LDR,TH,IPCRNG,IDX,ITY,TATR,IPB1,IPB2,IPB3,IPB000001163
1,TR,IPBNT,IPCNT,T,IPC1,IPC2,IPC3,IPCT,UP,TC,JMXDB,IEMAX,KMAX,JMAX,00001164
2NCCELL,NID,IB,IC,ICVNT,ICVNT,NPA,NFC,IPLO,NUMAX,NUP,IACT,HB) 00001165
C VERSION 1.0 LEVEL 770112
C ***************************************************************00001166
C JNW AFGL 6600
C DETERMINES PEAK VALUES AND THEIR ATTRIBUTES.
C ***************************************************************00001167
C INTEGER IPCRGNG(JMAX,IEMAX),IDX(IEMAX),IPB1(JMAX,KMAX,IEMAX),IPB2(000001171
1MAX,KMAX,IEMAX),IPB3(JMAX,KMAX,IEMAX),IPBT(IEMAX),TB(KMAX,IEMAX),00001172
2IPBNT(KMAX,IEMAX),T(JMXDB),IPC1(JMAX,KMAX,IEMAX),IPC2(JMAX,KMAX,IEMAX),00001173
3AX,IPC3(JMAX,KMAX,IEMAX),IPCT(IEMAX),TC(KMAX,IEMAX),IPLO(JMAX,KMAX,IEMAX),00001174
4X),IB(NPA,IEMAX,NFC),IC(NPA,IEMAX,NFC),ICVNT(NFC),ICVNT(NFC),IPCT00001175
5(KMAX,IEMAX),IACT(NID),KB(1),U(1)
C INTEGER W,V,VS,SV,VB,VJ,UI,VSI,H1,H2
C INTEGER TV,TSV,TM,TL,STARTR
C REAL TATR(NUMAX,NID),UP(NUP,NID)
C ***************************************************************00001177
C COMMON /STORE/ AE,AA,HB,SL,CL,Tv,TSV
C COMMON /STORE/ IMX
C COMMON /INSUB/ TL(4),MT,TDW,DT,STARTR,DELTR,RN(4),SCON,CW,PH,KEEP
C COMMON/AZM/ AZMTH(460),NA,ELEVAT,PRF,KF,KEEP
C COMMON/ADATA/ IDAV,IHOUR,IMIN,ISEC,TPF,KEE
C COMMON/WORK/WM(514),V(514),VB(514),SV(514),VJ(514),UI(514)
C IF (LDB,GT,LDMX) LDB=LDMX
C COMMON /AZA/SZ,CAZ,DAZ,ICAF,NCL
C ***************************************************************00001178
C INITI ALIZE AND GENERATE HC ARRAY
C***************************************************************00001179
C IEM IS NO. OF EVENTS IN C RADIAL.
C***************************************************************00001180
C
C***************************************************************00001181
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C***************************************************************00001217
CONTINUE

IF (UP(1,N) .LE. 0., OR. UV(2,N) .EQ. 0.) GO TO 943

UP(4,N) = UP(4,N) / UP(2,N) / 1002
UP(2,N) = UP(2,N) / UP(1,N)

UP(6,N) = UP(6,N) / UP(1,N)

WRITE(6,942) N, UP(2,N), UP(1,N), UP(4,N), UP(5,N), UP(6,N), XUP(7, N)

CONTINUE

WRITE(6,943) N, NVCEL

IF (NVCEL .LE. 1.) OR. UV(2,N) .EQ. 0.) GO TO 943

UV(4,N) = UV(4,N) / UV(2,N)

UV(2,N) = UV(2,N) / UV(1,N)

WRITE(6,945) N, UV(2,N), UV(1,N)

CONTINUE

WRITE(6,950) IDD

CONTINUE

WRITE(6,955) IDD

CONTINUE

READ(1,H0,10H TOTAL IDD=.16)

ISCANF=0

RETURN

END
871     DELR=SCON*CELWTH(NTP+1)
     IPU=999
     WRITE(2),X,Y,IPU
     CALL PAGE
     WRITE(6,872)
872     FORMAT(1H*,* FIXED CONTOUR ATTRIBUTES*)
     WRITE(6,712)
     712     FORMAT(28X,7HAVERAGE,5X,8LOCATION,4X,5HTOTAL,3X,7HAVERAGE/)
             X5X,9HTHRESHOLD,5X,4HAREA,2X,12HREFLECTIVITY,1X,4HEAST,2X,
             X5HNOSE,2X,6HPRECIP,4X,6HPRECIP/2,2MID,4X,
             X5H(DBZ),4X,7H(KM#2),4X,5H(DBZ),5X,4H(KM),3X,4H(KM),1X,9H(TONS/HR)
     DO 931 K=1,NFC
          JDO=NDD(K)
     DO 931 J=1,JDD
     IDEGEO=0
     IF (ATR(IAT,J,K).EQ.0.0) GO TO 931
     IF (ATR(IAT,J,K).LT.0.) 11051.1 00001004
     ID=J
     ABAR=DELR*ATR(I,J,K)
     IF (ABAR.LE.0.0) GO TO 931
     ZBAR=ABAR/(2,J,K)*DELR/ABAR
     XBAR=ATR(3,J,K)*DELR/ABAR/ZBAR
     YBAR=ATR(4,J,K)*DELR/ABAR/ZBAR
     ABAR=ABAR/1000*2
     IF (K.GT.1) WRITE(6,720)ID,TL(K),ABAR,ZBAR,XBAR,YBAR
     720     FORMAT(1X,5X,12,4X,9F9.2,4X,FS,1,4X,2F6,1)
     IF (K.GT.1) GO TO 931
     TPREC=81(J,K)*DELR
     AVPREC=TPREC/(ABAR*1000)
     TPREC=TPREC/10E05
     WRITE(6,716)ID,TL(K),ABAR,ZBAR,XBAR,YBAR,TPREC,AVPREC
     716     FORMAT(1X,5X,12,4X,9F9.2,4X,FS,1,4X,2F6,1)
     WRITE(2),XBAR,YBAR,ID1
     931     CONTINUE
     DO 921 I=1,NNE
          IF (ZH(NZP,I,J).EQ.0.0) GO TO 921
          T2=DELR*ZH(11,I,J)
          AV2=ZH(11,I,J)/ZH(12,I,J)
          COMPUTE AVG WIND SPEED AND DIRE.
          DEL=ZH(5,I,J)-ZH(7,I,J)-ZH(7,I,J)*ZH(7,I,J)
          IF (DEL.EQ.0.) GO TO 921
          VN=ZH(4,I,J)+ZH(5,I,J)-ZH(7,I,J)*ZH(7,I,J)/DEL
          VE=ZH(6,I,J)+ZH(3,I,J)-ZH(7,I,J)*ZH(4,I,J)/DEL
          VER=ZH(2,I,J)+VN*VE-ZH(6,I,J)+2.5*VN*VE-ZH(7,I,J)
          1=0.0*VN-ZH(4,I,J)+2.0*VE-ZH(3,I,J)/ZH(10,I,J)
          VF=ZH(5,I,J)+ZH(10,I,J)-ZM(8,I,J)/ZH(10,I,J)
          VC=ZM(6,I,J)/ZH(10,I,J)-ZM(9,I,J)/ZH(10,I,J)*2
          WRITE(6,713)
     713     FORMAT(1H*,10X,7HAVERAGE,6X,5HTOTAL,5X,7HAVERAGE,1X,7HAVERAGE,2X,
             X8MVELOCITY,1X,6MHEIGHT,1X,12HREFLECTIVITY,1X,12HREFLECTIVITY,4X,
             X1MU,7X,1KV,5X,8HVARIANCE,14X,3HDEL/
     000105_
NAME='12
WRITE(6,9909)NAME,NPCEL
C
C ASSOCIATE CELLS ON B RADIAL, TOP DOWN
C
193 MPK=0
NAME='11
WRITE(6,9909)NAME,NPK
9909 FORMAT(5X,I2,10X,I5)
IF(NA.EQ.1)GO TO 361
TATM=0,
IMB=IPC1(IPE,KC,IE)+1
IMD=IPC2(IPE,KC,IE)
DO 194 I=IMB,IMD
IF(ABS(HB(I)).EQ.999)GO TO 194
IF(IPB(HB(I)),GT,TC(KC,IE)+LDB)GO TO 934
194 CONTINUE
IF (JE.EQ.0) GO TO 361
DO 281 JE=JE1,JE2
IF (IB(JE,JE1),LT,IPC1(IPE,KC,IE)) GO TO 261
IF (IB(JE,JE1),GT,IPC2(IPE,KC,IE)) GO TO 361
C
C JE EVENT ON B RADIAL IS ASSOCIATED
C
271 IPB=IPB(JE)
DO 291 LB=1,IPB
KB=IPB-LB+1
NP1=IPN1(KB,JE)
DO 281 JPE=1,NP1
IF (IPB(JPE,KB,JE),LT,IPC1(IPE,KC,IE)) GO TO 281
IF (IPB(JPE,KB,JE),GT,IPC2(IPE,KC,IE)) GO TO 361
LPCEL=IPB(JPE,KB,JE)
WRITE(6,2729)JPE,IPE,KB,KC,JE,IE,LPCEL,MPK
2729 FORMAT(2X,8110)
IF(LPCEL.EQ.0)GO TO 281
TATM=MAX1(TATM,TATR(1,LPCEL))
IF(TATM.EQ.TATR(1,LPCEL))MPK=LPCEL
281 CONTINUE
291 CONTINUE
261 CONTINUE
IF(MPK.EQ.0)GO TO 361
IF(ABS(TATR(1,MPK)),GT,TC(KC,IE)+LDB)MPK=MPK
GO TO 361
934 MPK=(NID+1)
C
C HAVE B COMPARE WITHIN RANGE
C
361 CONTINUE
NAME='21
WRITE(6,9909)NAME,MPK
IF(MPK.EQ.0.AND.NPK.EQ.0)GO TO 631
C
C MPK=0.AND.NPK=0 = NO COMPARE
C MPK=0.AND.NPK.NE.0 = NO B COMPARE
C NPK=0.AND.NPK.NE.0 = B COMPARE
IF (IABS(U(I=1)).LE.TC(K,IE)) Go TO 121
GO TO 131

START RANGE FOR SEGMENT (CONTOUR)

121 IPCNT(K,IE)=IPCNT(K,IE)+1
IPE=IPCNT(K,IE)
IPC1(IPE,K,IE)=1
IPLO(IPE,K)=IPK=1
131 CONTINUE
GO TO 161

END RANGE FOR SEGMENT

141 DO 151 KL=K,IPT
IF (U(I=1).EQ.999) Go TO 161
IF (IABS(U(I=1)).LE.TC(KL,IE)) Go TO 161
IPE=IPCNT(KL,IE)
IPC2(IPE,KL,IE)=1
151 CONTINUE
161 CONTINUE
DO 181 K=1,IPT
IPE=IPCNT(K,IE)
DO 181 I=1,IPE
WRITE(6,171)IE,I,K,IPC1(I,K,IE),IPC2(I,K,IE),IPCNT(K,IE),IPLO(I,K)
WRITE(6,181)IE,I,K,IPC1(I,K,IE),IPC2(I,K,IE),IPCNT(K,IE),IPLO(I,K)
171 FORMAT(1H,3I3,SI10)
181 CONTINUE

ASSOCIATE CELLS LOOP ON THRESHOLD HIGHEST TO LOWEST

940 DO 941 LC=1,IPT
KC=IPT=LC+1
NPC=IPCNT(KC,IE)
DO 941 IPE=1,NPC
K=KC+1
NPC=K
IPE=K
DO 941 IF (K,GT.IPT) GO TO 193
LPE=IPCNT(K,IE)
192 DO 191 L=1,LPE
IF (IPC2(L,K,IE).LT.IPC1(IPE,KC,IE)) Go TO 191
IP(1PE,KC,IE).GT.IPC2(IPE,KC,IE)) Go TO 193
NPCE=IPC3(L,K,IE)
193 CONTINUE
IF (NPCE.EQ.0) Go TO 932
TATM=MAX1(TATM,TATR(1,NPCE))
IF (TATM.TEQ.TATR(1,NPCE))NPK=NPCE
NPCE IS FOR NEXT HIGHER (ENCLOSED) THRESHOLD ON C RADIAL
231 IF (ABS(TATR(1,NPCE)).GT.(TC(KC,IE)+LDB)) Go TO 932
191 CONTINUE
GO TO 193
932 NPK=1
C HIGHEST THIS RADIAL

IF(MPK.EQ.0.AND.NPK.LT.0)GO TO 931
IF(MPK.NE.0)GO TO 421

C NO PRIOR RADIAL FOR COMPARISON, INCREMENT NPCEL

381 NPCEL=NPK
IF(NA.EQ.1)GO TO 359
DO 352 I=1MB,IRD
IF(HB(I).EQ.999)GO TO 352
IF(IABS(HB(I)).GE.TC(KC,IE))GO TO 931
352 CONTINUE

359 INDEX=TATR(1,NPCEL)=TC(KC,IE)+1
391 IF (INDEX,GE,108) GO TO 931
IPC3(IPE,KC,IE)=NPCEL
IN=1+INDEX*LM
INDEX+INDEX+LM
IF(NA.EQ.1)GO TO 419
IST=IPC2(IPE,KC,IE)+1
ISP=IPC2(IPE,KC,IE)
DO 411 I=1,IST,ISP
R=SCON*(FLOAT(I+1)-5)*CELMTH(NTP+1)
TATR(IN+1,NPCEL)=TATR(IN+1,NPCEL)+DAZ*R
TATR(IN+2,NPCEL)=TATR(IN+2,NPCEL)+DAZ*R*(V(I)-V(I+1))
TATR(IN+3,NPCEL)=TATR(IN+3,NPCEL)+DAZ*SAZ*R*R*(V(I)-V(I+1))
TATR(IN+4,NPCEL)=TATR(IN+4,NPCEL)+DAZ*CAZ*R*R*(V(I)-V(I+1))
TATR(IN+5,NPCEL)=TATR(IN+5,NPCEL)+DAZ*U*(V(I)-V(I+1))
TATR(IN+6,NPCEL)=TATR(IN+6,NPCEL)+R*VS(I)
TATR(IN+7,NPCEL)=AMAX1(TATR(IN+7,NPCEL),FLOAT(IABS(VS(I))))
CONTINUE

419 TATR(INX,NPCEL)=SIGN(FLOAT(INX),TATR(INX,NPCEL))
IF (IST.EQ.2.OR.ISP.EQ.IMK)TATR(INX,NPCEL)=SIGN(TATR(INX,NPCEL),-1)
NAME=31
WRITE(6,9909)NAME,INDEX
WRITE(6,1071)INDEX,(TATR(KZ,NPCEL),KZ=1,NUMP)

C COMBINE LPCEL WITH NPCEL AT THIS LEVEL

366 DO 365 L=1,LPE
IF(IPC2(L,K,IE).LT.IPCT1(IPE,KC,IE))GO TO 365
IF(IPC1(L,K,IE).GT.IPC2(IPE,KC,IE))GO TO 931
LPCEL=IPC3(L,K,IE)
341 IF(LPCEL.EQ.0)GO TO 931
IF(TATR(INX,LPCel).EQ.0)GO TO 365
351 IF(NPCEL.EQ.LPCEL)GO TO 365
INDEX=TATR(1,NPCEL)=TC(KC,IE)+1
INDEX+INDEX+LM
IF(INX.GT.NUMP)GO TO 365
TATR(INX,NPCEL)=TATR(INX,LPCel)*0
TATR(2+INDEX+LM,LPCel)=NPCEL
INDX=IN
DO 483 I=1,IND
DO 483 J=1,LM
INDX=INDX+1
483 TATR(IN,LPCEL)=TATR(IM,LPCEL)
INDEX=INDEX+1
DO 484 INDEX=INDX+1
484 TATR(I,LPCEL)=0
INDEX=INDEX+1
IN=0
IPC3(IPE,KC,IE)=LPCEL
NAME=NAME+1
WRITE(6,9909)NAME,INDX
GO TO 512
485 DO 486 INDEX=INDEX+1
IF(IAC(I)=NID)GO TO 487
486 CONTINUE
WRITE(6,644)
GO TO 931
487 LPCEL=I
IAC(I)=1
TATR(I,LPCEL)=TC(KC,IE)+1
TATR(NUMP,LPCEL)=TC(NPA,IE,1)
GO TO 488
422 IF(LPCEL.LE.O)GO TO 441
DO 441 J1=1,J12
IF (12(J1,J12).LT.IPC1(IPE,KC,IE)) GO TO 441
IF (12(J1,J12).GT.IPC1(IPE,KC,IE)) GO TO 632
IPB(IPTB(J1))
DO 471 LB=1,LB
MPB=MPB+1
IF(IPB(JP,J1).LT.IPC1(IPE,KC,IE)) GO TO 461
GO TO 632
NPCEL=NPCEL+1
IF(LPCEL.LE.O)GO TO 461
IF (LPCEL.LE.O) GO TO 461
IF(TB(KB,J1).GT.TC(KC,IE))GO TO 661
GO TO 461
C
C COMBINE AT TB=TC LEVEL AND BELOW
C
502 INDEX=TATR(1,NPCEL)=TB(KB,KB)
NAME=NAME+1
WRITE(6,9909)NAME,INDEX
IF(INDEX.LE.IND)GO TO 461
INDEX=TATR(1,LPC)L=TB(KB,KB)
NAME=NAME+1
WRITE(6,9909)NAME,INDEX
IF(INDEX.LE.IND)GO TO 861
851 DO 852 J=1,NUMP
852 TATR(J,NPCEL)=0
IAC(NPCEL)=0
INDEX=INDEX+1
NAME=NAME+1
WRITE(6,9909) NAME, NPCEL
GO TO 461

861 INDX=INDX+LDB
DO 891 N=1,IND
LD=1+(LDB=N)*LM
ND=1+(INDX=N)*LM
DO 891 I=1,LM
IF (I.GE.LM) GO TO 861
IF (I.GE.8) GO TO 871
TATR(LD+I,LPCEL)=TATR(ND+I,NPCEL)+TATR(LD+I,LPCEL)
TATR(ND+I,NPCEL)=0.
GO TO 891

871 TATR(LD+I,LPCEL)=MAX1(TATR(ND+I,NPCEL),TATR(LD+I,LPCEL))
TATR(ND+I,NPCEL)=0.
GO TO 891

881 TATR(ND+I,LPCEL)
891 CONTINUE
461 CONTINUE
471 CONTINUE
441 CONTINUE

632 IF(NPK.LE.0) GO TO 931
NPCEL=LPCEL
GO TO 366

C UNASSOCIATED
C
631 IF(NA.EQ.1) GO TO 639
DO 641 I=IMB,IND
IF (H(I),EQ.,999) GO TO 641
IF (IABS(H(I)),GE.TC(KC,IE)) GO TO 931
641 CONTINUE

639 DO 642 J=1,NID
IF (IACT(J),EQ.0) GO TO 643
642 CONTINUE
WRITE(6,644)
644 FORMAT(5X,** TOO MANY CELLS**) GO TO 931

643 NPCEL=J
IACT(J)=1
661 IPC3(IPE,KC,IE)*NPCEL
IP*IPD(IPE,KC)
IR=IPCRNG(IPK,IE)
IN1=LM+1
IN=(LDB=1)+LM+IN1
DO 671 I=IN,IN
TATR(I,NPCEL)=0.0
671 CONTINUE
591 TATR(1,NPCEL)=IABS(U(IR))
TATR(NUMP,NPCEL)=IC(NPA,IE,1)
IF(NA.EQ.1) GO TO 939
IST=IPC1(IPE,KC,IE)+1
ISP=IPC2(IPE,KC,IE)
DO 621 I=IST,ISP
R=SQR((FLOAT(I)+1)*5.0)*CELWTH(NTP=1)
TATR(2,NPCEL)=DAZ+R*TATR(2,NPCEL)
TATR(3, NPCEL) = DAZ*R*U(I) + TATR(3, NPCEL)
TATR(4, NPCEL) = DAZ*R*RE(I) + TATR(4, NPCEL)
TATR(5, NPCEL) = DAZ*CAZ*R*U(I) + TATR(5, NPCEL)
IF (TY > NE) GO TO 621
IF (V(I), EQ. = 999, OR, V(I+1). EQ. = 999) GO TO 601
TATR(6, NPCEL) = DAZ*R*(V(I) = V(I+1)) + TATR(6, NPCEL)
IF (V(S(I), EQ. = 999) GO TO 621
TATR(7, NPCEL) = DAZ*RS(V(I) + TATR(7, NPCEL)
TATR(8, NPCEL) = AMAX1(TATR(8, NPCEL), FLOAT(IABS(VS(I))))
621 CONTINUE
939 TATR(IDX, NPCEL) = NA
IF (IST, EQ. = 0, OR, ISP, EQ. = IMX) TATR(IDX, NPCEL) = TATR(IDX, NPCEL)
WRITE(6, 1071) NPCEL, (TATR(KZ, NPCEL), KZ = 1, NUMP)
938 CONTINUE
941 CONTINUE
951 CONTINUE
IF (NA, EQ. = 1) GO TO 1031
C END OF ASSOCIATION LOOPS
C
IF (ACT(I), EQ. = 0) GO TO 991
IF (TATR(1, I), GT. = 0, AND, TATR(2, I), GT. = 0) GO TO 961
GO TO 991
961 IF (TATR(IDX, I), LE. = 0, OR, TATR(ID2+1, I), LE. = 0) GO TO 991
IF (TATR(IDX, I), LT. = NA, OR, ISCANF, EQ. = 1) GO TO 971
GO TO 991
971 DO 981 J = 1, LMM
UP(J, NCELL) = TATR(ID2+J, I)
981 CONTINUE
UP(LH, NCELL) = TATR(NUMP, I)
NAME = 101
WRITE(6, 9909) NAME, NAME
WRITE(6, 1071) I, (TATR(K, I), K = 1, NUMP)
WRITE(6, 9910) NCELL, (UP(K, NCELL), K = 1, LMM)
9910 FORMAT(1X, I2, 12X, 8F13.2)
NCELL = NCELL + 1
DO 982 J = 1, NUMP
982 TATR(J, I) = 0.
ACT(I) = 0
991 CONTINUE
1031 DO 1041 I = 1, IEMAX
IP2B(I) = IP2C(I)
DO 1041 K = 1, KMAX
TH(K, I) = TC(K, I)
IP3N(T, K, I) = IP3N(K, I)
DO 1041 J = 1, JMAX
IP3(J, K, I) = IP3C(J, K, I)
1041 CONTINUE
DO 1 I = 2, NCELL
MM = 999
93
93
IF (U(I+1).NE.,999) MH=MAX(MH,ABS(U(I+1)))
IF (U(I).NE.,999) MH=MAX(MH,IBA5(U(I)))

IF (U(I).NE.,999) MH=MAX(MH,IBA5(U(I)))

N=1
WRITE (6,1061) N

1061 FORMAT (I6)
DO 1081 I=1,NID
   IF (IACT(I),EQ,0)GO TO 1081
   WRITE (6,1071) I,(TATR(K,I),K=1,NUMP)
1071 FORMAT (1X,I2,3X,9F13.2,/19X,8F13.2))
1081 CONTINUE

N=2
WRITE (6,1061) N

1082 DO 1101 IE=1,IEM
   IPT=IPTB(IE)
   DO 1101 K=1,IE
   IPE=IPBTN(K,IE)
   DO 1101 I=1,IPE
      ITATR=0
      TATRX=0.
      IPX=IPB3(I,K,IE)
      IF (IPX,GT,0) TATRX=TATR(1,IPX)
      IF (IPX,GT,0) ITATR=TATR(IDX,IPX)
   WRITE (6,1091) I,K,IE,IPB1(I,K,IE),IPB2(I,K,IE),IPB3(I,K,IE),TB(K,IE),TATRX,ITATR
1091 FORMAT (1H,3I5,4I8,E15.3,18)
1101 CONTINUE
RETURN
END
SUBROUTINE PRNI

*************************************************************************************************

PRINTS OUT UNPACKED DATA (INTEGER FORMAT).

VERSION 1.0  LEVEL 760920

JHM  CDC 6600  AFGL  P2095

*************************************************************************************************

COMMON/A1024/MVP(3,1024)
COMMON/AZM/AZMUTH(460),NA,ELEVAT,PRF,KEEP
COMMON/ADATA/IDAY,IMIN,ISec,NTP,NSF,NDD,NRC

CALL PAGE
WRITE(6,100)IDAY,IMIN,ISec,NTP,NSF,NDD,NRC,PRF,AZMUTH(NA),X,ELEVAT

100 FORMAT(38H UNPACKED RADAR DATA (INTEGER VALUES)/2X,
X*DAY HR MN SC CELLWDTH SUBFRAME DUMP FREQ #CELLS PRF AZIMUTH/)
X ELEVATION/*15,313,9X,12,7X,I2,6X,I2,17,F6,0,F10,1,3X,F9.1//4X,
X*HI,2X,8(14H MEAN VAR PWR)/

K=KEEP
N=KEEP+7
DO 10 N=1,32
WRITE(6,101)K,(MVP(I,J),I=1,3),J=KK,NN)

101 FORMAT(15,2X,8(I6,2I4))
K=KK+8
N=NN+8
CONTINUE
RETURN
END
SUBROUTINE PRN3(MODE, W)

* Prints Bscan maps of computed and coded DBZ and Velocity.*

** Version 1.0 Level 761129 **

** John CDC 6600 AFGL **

* Integer TL, START, W *

** Logical PRINT1, PRINT2, PRINT3, PRINT4, CONTR, CONTRV **

* Dimension IC(64), W(1) *

** COMMON/PARM/PRINT1, PRINT2, PRINT3, PRINT4, ICODE(36), A1, B1, A2, B2, **

** CONTR, CONTRV, NFILE, NREC, NUMR **

** COMMON/A1024/ MVP(3, 1024) **

** COMMON/AZM/AZMUTH(460), NA, ELEVAT, PRF, KEEP **

** COMMON/ADATA/IDAY, IHOUR, IMIN, ISEC, NTP, NSF, NDD, NRC **

* COMMON/A1021/ MVP(3, 1024) *

** COMMON/A1021/ MVP(3, 1024) **

* NCOL=(NRC+1)*256 *

** IF(MODE.EQ.1) CALL COMPZ **

I=1

10 IF=IP+1

IY=IY+1

IF(IY.GT.36) IY=1

IC(IY)=ICODE(IY)

IY=IY/IP

IF(IY.GT.36) IY=36

IF(IY.LE.0) IY=1

WRITE(6, 100) AZMUTH(NA), ELEVAT, IDAY, IHOUR, IMIN, ISEC, IC, PRF

100 FORMAT(1X, F5.1, F6.1, 14.1X, 21Z, 13, 3X, 64A1, 3X, F7.1)

RETURN

END
SUBROUTINE PAGE

*** Prints page header and keeps track of line count ***

VERSION 1.0 LEVEL 711122

INTEGER ICODE,IRUN,NPAGE
REAL TITLE(6)
COMMON /HEAD/ TITLE,ICODE,VERS,LEVEL,DAT,IRUN,NPAGE,NLOG
COMMON/LINUM/LINE

LINE=4
NPAGE=NPAGE+1
WRITE (6,2030) ICODE,IRUN,TITLE,VERS,LEVEL,DAT,NPAGE

2030 FORMAT(*13,16,5X,6A8,* VERSION *F5.1,* 11X,X,A10,10X,#PAGE *,13/1X,127(***))
RETURN
END
SUBROUTINE LINES(N),RETURNS(A)

C ************************************************************************************************************
C VERSION 1.0   LEVEL 760921
C ************************************************************************************************************
REAL TITLE(6)
INTEGER ICODE, IRUN, NPAGE, LCT
COMMON /HEAD/ TITLE, ICODE, VERS, LEVEL, DATE, IRUN, NPAGE, NLOG
COMMON/LINUM/LINE
DATA LCT/61/

C
LINE=LINE+N
IF(LINE.LT.LCT) RETURN
LINE=N+4
30 NPAGE=NPAGE+1
WRITE(6,2030) ICODE, IRUN, TITLE, VERS, LEVEL, DATE, NPAGE
2030 FORMAT(*14,13,16,3X,6A8,* VERSION *,F5.1,*,(*,I6,*),11X,
K X A10,10X,*PAGE *,I3/1X,127(*=*))
RETURN
END
SUBROUTINE ERRX(N, NAME)

C *****************************************************
C IBM 360 E. REIFENSTEIN FORTRAN IV
C VERSION 2 LEVEL 720421
C *****************************************************
C INTEGER N
C REAL NAME

WRITE(6,6000) N, NAME

6000 FORMAT(*EXECUTION TERMINATED DUE TO ERROR NO. *,I4,* IN *,A6)
STOP
END
SUBROUTINE ERRM(N,NAME)

C
C VERSION 1.0 LEVEL 760921

C

INTEGER N
REAL NAME

WRITE(6,6100) N,NAME

6100 FORMAT(*ERROR NO. *,I4,* IN *,A8/)
RETURN
END
SUBROUTINE INECIC)

*************************************************************************

C IBM 360 E.REIFENSTEIN FORTRAN IV
C VERSION 1 LEVEL 720602
C READS AND PRINTS COMMENTS CARDS
C*************************************************************************

REAL NAME

INTEGER IFORM,IF(3),COM(13),BLANK
DATA IF/1H,1HO,1H1/,NAME/HLINE/,BLANK/1H/

10 READ(IC,5010) IFORM,COM,JP
5010 FORMAT(I4,A1,5X,12A4,A2,A2)
20 DO 20 I=1,3
20 IF(IF(IFORM,ER,IF(I)) GO TO (30,30,40),I
20 CONTINUE
30 CALL LINESCI),RETURNS(32)
32 WRITE(6,6032) IF(I),COM
6032 FORMAT(A1,T21,12A4,A2)
40 CALL PAGE
40 I=2
40 GO TO 30
50 IF(JF,NE,BLANK) GO TO 10
RETURN
END
SUBROUTINE DAY

C

VERSION 1.0  LEVEL 760921

C

REAL TITLE(6)

COMMON /HEAD/ TITLE,ICODE,VERS,LEVEL,DAT,IRUN,NPAGE,NLOG

C

DAT = DATE(0)

RETURN

END