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# RADAP II ARCHIVE DATA USER'S GUIDE

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## 1. INTRODUCTION

In 1971, the National Weather Service (NWS) began the Digitized RADar EXperiment (D/RADEX) to improve the operational use of radar data through computer processing (McGrew, 1972). The early stages of D/RADEX involved four sites: Kansas City, Mo. (August 1971); Oklahoma City, Okla. (October 1971); Fort Worth, Tex. (December 1971); and Monett, Mo. (February 1972), as shown in Fig. 1. Many useful meteorological and hydrological products were developed under D/RADEX including echo tops, vertically integrated liquid water content (Green, 1971), severe weather probability (Saffle, 1976), storm structure, and rainfall accumulation. In 1983, positive evaluation of the results of D/RADEX resulted in transfering the system to quasi-operational status and renaming it RAdar DAta Processor, version II (RADAP II). Currently, the RADAP II network consists of the twelve sites shown in Fig. 2. The sites are Amarillo, Tex. (AMA); Binghamton, N.Y. (BGM); Nashville, Tenn. (BNA); Charleston, W. Va. (CRW); Garden City, Kans. (GCK); Wichita, Kans. (ICT); Jackson, Ky. (JKL); Limon, Colo. (LIC); Oklahoma City, Okla. (OKC); Pittsburgh, Pa. (PIT); Tampa Bay, Fla. (TBW); and Monett, Mo. (UMN).

## 2. DATA QUALITY CONTROL

Based on the strength of the signal returned from a target, the current NWS weather radar receivers estimate the equivalent reflectivity factor (in $mm^6 m^{-3}$) that would be representative of such a signal. This reflectivity factor quantity is called "Z" and can range from about 50 to about $5 \times 10^5$ $mm^6 m^{-3}$. The receiver then calculates the logarithm of each estimated value of Z; the dynamic range of Log Z is about 1.7 to 5.7. To simplify further processing of the data, the Log Z values are scaled upwards by a factor of 10 (10 Log Z); these values are commonly referred to as dBZ values. The RADAP II system utilizes dBZ values for calculations and archiving.

The RADAP II system performs several quality control procedures on each scan of radar reflectivity data before that scan is passed to any other task, including archiving. The first of these procedures corrects the data for attenuation due to absorption by atmospheric gases. This correction is a linear function that increases with distance and reaches a maximum corrective value of +3 dBZ for data at a range of 126 n mi.

Next, in order to mitigate the effects of normal ground clutter, a hybrid base-level scan is generated by merging higher elevation angle scan data out to a given range with 0.5 degree elevation angle scan data from that range out to 126 n mi. Both the higher elevation angle and the range of its use are site-adaptable and vary from site to site. These values are included in the header data for each scan, as shown in Section 4.

Finally, each scan is processed to remove isolated point targets by requiring a given nonzero data value to be adjacent to at least two other nonzero data values. During this filtering procedure, a check is also made on whether a

given data value exceeds the maximum of its adjacent neighbors by more than about 16 dBZ. If so, the data value is changed to that of the neighborhood maximum.

## 3. DATA COLLECTION

Although two types of radars (WSR-57 or WSR-74S) are used in the RADAP II network, they share the common characteristics of a 2.2 deg beam width and a 10 cm wavelength. The RADAP II sites schedule base-level and tilt-sequence (volumetric) observations of reflectivity every 10 or 12 min. These observations are built from input scans of data consisting of 180 radials covering 360 deg of azimuth under the radar umbrella. The radials are centered on even azimuths, cover a range from 10 to 126 n mi, and contain a data value for each nautical mile of range (Fig. 3). The data values range from 0 to 15 with each nonzero value representing a RADAP II category of radar reflectivity. The nominal reflectivity thresholds for the categories are given in Table 1. As previously noted in Section 2, a base-level observation is a hybrid of a scan taken at an elevation angle of 0.5 deg for data at farther ranges and one taken at a site-adaptable higher elevation angle for data near the radar site. In contrast, a volumetric observation consists of a series of single elevation angle scans starting at 0.5 deg elevation and extending, in vertical steps of two degrees, to the top of the existing echoes or to 22.0 deg, whichever comes first.

In 1984, the NWS began archiving RADAP II data to support the development of reflectivity-based operational algorithms that could be tested at RADAP II sites and later implemented on future NWS radar systems. The data are first written to floppy diskettes at each RADAP II site and later transferred to a central location for final archiving to IBM compatible 9-track magnetic tapes. RADAP II data for the period April 1985 through March 1987 were archived to tape under contract. Since April 1987, the diskettes have been transferred to NWS Headquarters for final archiving to tape.

In order to increase the utility of the RADAP II archive for snowfall research, the cool season base-level data have been coded since 1986 according to category thresholds that cover, in 2-dBZ steps, the reflectivity range 18-46 dBZ (Table 1). Nominally, the cool season is November 1 through March 1, but individual sites will vary somewhat. Volumetric observations taken during the cool season are coded according to the warm season category thresholds in Table 1. Thus, the cool season archive will enable research both on frozen precipitation and on severe convective events that might occur during that season.

## 4. ARCHIVE DATA TAPES

The data tapes are 9-track, nonlabeled (NL), high density (6250 bpi) magnetic tapes. They are written in binary coded decimal (BCD) with an unformatted FORTRAN write statement using a variable spanned (VS) record format and a maximum record length of 32,756 bytes. Each tape contains one file of data for one RADAP II site. Each record has two logical parts representing one scan of data. Part 1 contains thirty-four 16-bit words of header parameters which describe the station and data characteristics for the scan (Table 2). Part 2 has a variable number of 16-bit words and contains the radial reflectivity category data for each scan in the form shown in Table 3.

The RADAP II archive tapes can be read with a FAST FORTRAN I/O (FFIO) package subroutine called FFGET(BUF,N,L,&END,&ERR), where FFGET reads a record from FORTRAN unit "N" into contiguous locations starting at "BUF." The length of the record in bytes is returned in "L." At end-of-file (EOF), transfer will be made to statement number "END" and errors to statement number "ERR." The FFIO package is available at the NOAA Computer Center to 360/195, 360/65, and NAS 9000 users and will automatically be included in programs executed under the NFOR, NPL1F, and XFORX procedures. For non-FFIO users, the data tapes can be read with basic FORTRAN unformatted read statements or with any other compatible utility.

## 5. DECODING ARCHIVED DATA

Table 4 represents a sample formatted display of the alphanumeric value of each byte of one record. Note that each record corresponds to one 360° observational scan of data. A graphical display of all of the scan data in this record is presented in Fig. 4. Table 2 contains the information that allows line 1 of this record to be decoded to reveal the following information:

| | |
|---|---|
| ISTAT | = OKC |
| IYR | = 87 |
| IJUL | = 123 |
| IMMDD | = May 3 |
| ITIME | = 1000 GMT |
| IELEV | = 0.5 deg |
| IRINT | = 1.00 n mi |
| IMERGR | = 60 km |
| IMERGA | = 2.9 deg |
| IALT | = 1300 ft above msl |
| IOBFLG | = 0 (base elevation observation) |
| IDRFLG | = 0 (clockwise rotation) |
| IAPFLG | = 0 (no AP present) |
| ISNFLG | = 0 (no snow) |
| NVAL | = 5248 |
| NONZIP | = 3222 |
| IMEAN | = 5 |
| ISTDEV | = 99 (standard deviation not calculated) |
| ITRESH(15) | = 18,25,30,36,39,41,43,44,46,48,49,51,53,55 & 57 (warm season threshold values) |

Lines 2 through the end-of-record (EOR) are coded reflectivity category values listed by azimuth. The coding method records (1) the azimuth of the radial with nonzero values, (2) the number of runs at that azimuth, and, for each run at the azimuth, (3) the number of range bins in the run and (4) the reflectivity category value of the run. Azimuths that contain only zeros as reflectivity category values are not coded in an observational record. The user should assume zeros for any noncoded azimuths. A run is defined as a group of range bins with identical reflectivity category values along an azimuth, i.e., a new run starts when the reflectivity category value changes. The total sum of all range bins per radial (10-126 n mi) will always be equal to 116. For example, if a series of 8 range bins along a radial contained the reflectivity values 22221144, there would be 3 runs detected with reflectivity category values of 2, 1, and 4, respectively. This series of 3 runs would then be coded as 42, 21, and 24; where the first number indicates the number of range bins in the run

(the run length) and the second the reflectivity category value of the run. As a further example, a portion of Table 4 has been decoded according to the format shown in Table 3 to reveal the following information:

| Azimuth | Number of runs | Run | Range Bins | Reflectivity Category value |
|---|---|---|---|---|
| 0 | 53 | 1 | 32 | 0 |
| | | 2 | 1 | 1 |
| | | 3 | 1 | 0 |
| | | 4 | 2 | 1 |
| | | 5 | 1 | 0 |
| | | 6 | 1 | 1 |
| | | 7 | 1 | 2 |
| | | 8 | 1 | 4 |
| | | 9 | 1 | 2 |
| | | 10 | 1 | 4 |
| | | 11 | 1 | 13 |
| | | 12 | 4 | 15 |
| | | 13 | 1 | 13 |
| | | . | . | . |
| | | . | . | . |
| | | . | . | . |
| | | 48 | 2 | 9 |
| | | 49 | 1 | 3 |
| | | 50 | 1 | 4 |
| | | 51 | 2 | 6 |
| | | 52 | 3 | 1 |
| | | 53 | 1 | 0 |

## 6. DATA AVAILABILITY

The National Climatic Data Center (NCDC) will maintain a RADAP II data archive. The initial shipment of data to NCDC was in January 1989 and covered the period 1985 through 1987, as shown in Table 5. Future updates to this archive will be shipped to NCDC twice a year. Each shipment will be timed to cover the preceding 6 month season (warm or cool). An inventory of the days available for each RADAP II site will be included with each data shipment. Interested parties should query NCDC about the availability of data for specific times and RADAP II sites. When requesting copies of archive RADAP II data tapes, address all correspondence to:

National Climatic Data Center (NCDC)
Attn: User Services Branch
Federal Building
Asheville, NC 28801-2696

or call the Customer Service Section on (704) 259-0682 (commercial) or 672-0682 (FTS).

## 7. ACKNOWLEDGEMENTS

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## 8. REFERENCES

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McGrew, R. G., 1972: Project D/RADEX (Digitized Radar Experiments). Preprints Fifteenth Radar Meteorology Conference, Champaign-Urbana, Amer. Meteor. Soc., 101-106.

Saffle, R. E., 1976: D/RADEX products and field operation. Preprints Seventeenth Radar Meteorology Conference, Seattle, Amer. Meteor. Soc., 555-559.

Table 1. Nominal values of reflectivity thresholds for archived RADAP II data for base-level scans for warm and cool seasons. The actual values used for a given archive scan are included in the header data for that scan. All tilt-sequence scans are archived with warm season category thresholds regardless of the season.

| RADAP II category | Warm Season threshold (dBZ) | Cool Season threshold (dBZ) |
|---|---|---|
| 1 | 18.5 | 18 |
| 2 | 24.5 | 20 |
| 3 | 30.0 | 22 |
| 4 | 35.5 | 24 |
| 5 | 38.5 | 26 |
| 6 | 41.0 | 28 |
| 7 | 43.0 | 30 |
| 8 | 44.0 | 32 |
| 9 | 46.0 | 34 |
| 10 | 47.5 | 36 |
| 11 | 49.0 | 38 |
| 12 | 51.0 | 40 |
| 13 | 53.0 | 42 |
| 14 | 55.0 | 44 |
| 15 | 57.0 | 46 |

Table 2. Header information (Part 1) of a RADAP II archive data record.

| Bytes | Parameter | Description |
|---|---|---|
| 1-4 | ISTAT | Station identifier. 3 characters + a blank. two 16-bit words (ISTAT(2)) (left-justified) |
| 5-6 | IYR | Last two digits of the year. |
| 7-8 | IJUL | Julian date. |
| 9-10 | IMMDD | Calendar date (MM=month & DD=day). |
| 11-12 | ITIME | Hour and minute (HHMM). GMT |
| 13-14 | IELEV | Elevation angle (scaled by 10). Deg |
| 15-16 | IRINT | Range interval (scaled by 100). n mi |
| 17-18 | IMERGR | Ending range for merging higher elevation data with base elevation data. Km |
| 19-20 | IMERGA | Elevation angle of the higher elevation data used for merging with base elevation data. (scaled by 10). Deg |
| 21-22 | IALT | Station elevation above msl. Ft |
| 23-24 | IOBFLG | Type of observation scan. 0=base Level 1=volumetric |
| 25-26 | IDRFLG | Rotational direction of antenna during data collection. 0=clockwise 1=counter clockwise |
| 27-28 | IAPFLG | Operator indication of Anomalous Propagation (AP). 0=None 1=Some |
| 29-30 | ISNFLG | Operator indication of snow. 0=none 1=some |
| 31-32 | NVAL | Number of 16-bit words in the input record. Contains the header information (1-34) + coded reflectivity values (35-NVAL). |
| 33-34 | NONZIP | Number of nonzero reflectivity values. |
| 35-36 | IMEAN | Mean of the nonzero reflectivity values. |
| 37-38 | | Reserved for future use. |
| 39-68 | ITRESH | Threshold reflectivity values. dBZ Fifteen 16-bit words (ITRESH(15)). |

Table 3. Specification of coded reflectivity data (Part 2) of a RADAP II archive data record.

| Element | Parameter | Description |
|---|---|---|
| 1 | IRADAZ(1) | Azimuth of first radial with nonzero data |
| 2 | NGROUP(1) | Number of groups (runs) at this azimuth |
| 3 | NBIN(1,1) | Number of bins (run length) in the first run |
| 4 | IDVIP(1,1) | RADAP II category value of the first run |
| 5 | NBIN(2,1) | Number of bins in the second run |
| 6 | IDVIP(2,1) | RADAP II category value of the second run |
| . | . | . |
| . | . | . |
| . | . | . |
| 1+(NGROUP(1)*2) | NBIN(NGROUP(1),1) | Number of bins in the last run |
| 2+(NGROUP(1)*2) | IDVIP(NGROUP(1),1) | RADAP II category value of the last run |
| 3+(NGROUP(1)*2) | IRADAZ(2) | Azimuth of the second nonzero azimuth |
| 4+(NGROUP(1)*2 | NGROUP(2) | Number of runs at this azimuth |
| 5+(NGROUP(1)*2) | NBIN(1,2) | Number of bins in the first run |
| 6+(NGROUP(1)*2) | IDVIP(1,2) | RADAP II category value of the first run |
| . | . | . |
| . | . | . |
| . | . | . |
| NVAL-1 | NBIN(NGROUP(n),n) | Run length of last run of last radial |
| NVAL | IDVIP(NGROUP(n),n) | Run value of the last run of last radial |

Table 4. A portion of a sample scan of coded reflectivity data for Oklahoma City, Okla.

| OKC | 87123 | 5031000 | 5100 | 60 | 29 | 13060000 | 5248 | 3222 | 599 | 18 | 25 | 30 | 36 | 39 | 41 | 43 | 44 | 46 | 48 | 49 | 51 | 53 | 55 | 57 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 053 | 32 0 | 1 1 | 1 0 | 2 1 | 1 0 | 1 1 | 1 2 | 1 4 | 1 2 | 1 4 | 113 | 415 | 113 | 111 | 515 |
| 1 6 | 1 5 | 1 8 | 515 | 111 | 1 5 | 1 6 | 1 5 | 111 | 114 | 815 | 113 | 114 | 115 | 111 | 113 |
| 214 | 1 6 | 1 5 | 2 3 | 1 4 | 1 9 | 1 6 | 110 | 1 6 | 2 3 | 1 7 | 4 9 | 311 | 113 | 111 | 3 6 |
| 2 9 | 1 3 | 1 4 | 2 6 | 3 1 | 1 0 | 243 | 41 0 | 1 1 | 1 2 | 1 6 | 3 9 | 2 3 | 1 9 | 1 6 | 215 |
| 1 8 | 2 3 | 1 5 | 214 | 515 | 113 | 114 | 715 | 112 | 115 | 213 | 114 | 113 | 111 | 113 | 112 |
| 1 9 | 2 1 | 1 3 | 1 1 | 5 3 | 1 2 | 1 4 | 2 6 | 2 5 | 3 6 | 1 4 | 1 3 | 3 2 | 2 3 | 2 2 | 2 4 |
| 1 1 | 3 0 | 447 | 40 0 | 2 1 | 2 0 | 3 1 | 2 0 | 1 1 | 1 0 | 1 3 | 1 4 | 2 0 | 2 1 | 1 4 | 1 9 |
| 315 | 1 8 | 815 | 110 | 112 | 1 9 | 115 | 112 | 115 | 110 | 1 8 | 1 6 | 1 5 | 1 4 | 1 3 | 2 1 |
| 1 5 | 1 3 | 1 5 | 1 2 | 1 3 | 2 1 | 1 2 | 2 3 | 2 9 | 1 3 | 1 2 | 3 1 | 1 4 | 1 3 | 1 4 | 1 2 |
| 3 1 | 7 0 | 633 | 40 0 | 2 3 | 1 1 | 8 0 | 2 1 | 4 0 | 2 2 | 3 4 | 2 2 | 111 | 115 | 114 | 1015 |
| 113 | 110 | 1 8 | 1 7 | 3 6 | 1 5 | 210 | 2 6 | 1 4 | 1 5 | 3 4 | 2 6 | 210 | 1 2 | 1 1 | 3 0 |
| 1 7 | 3 3 | 2 1 | 8 0 | 828 | 40 0 | 2 1 | 9 0 | 2 1 | 10 0 | 1 2 | 1 4 | 1 3 | 1 7 | 111 | 915 |
| 214 | 211 | 214 | 1 9 | 211 | 1 9 | 1 6 | 2 5 | 1 3 | 1 6 | 1 4 | 2 5 | 2 3 | 6 0 | 1 1 | 1 3 |
| 11 0 | 1031 | 44 0 | 3 1 | 4 0 | 1 1 | 1 3 | 15 0 | 1 2 | 1 4 | 1 6 | 2 8 | 1 6 | 1 8 | 112 | 110 |
| 1 5 | 111 | 1 5 | 210 | 1 9 | 1 6 | 3 3 | 1 2 | 1 3 | 1 2 | 1 3 | 1 4 | 1 5 | 2 1 | 9 0 | 1 1 |
| 11 0 | 1223 | 44 0 | 3 1 | 4 0 | 1 2 | 1 4 | 22 0 | 3 1 | 2 3 | 2 7 | 2 5 | 2 4 | 1 1 | 1 3 | 1 3 |
| 1 4 | 1 3 | 1 2 | 1 3 | 2 1 | 9 0 | 1 2 | 1 5 | 10 0 | 14 3 | 105 0 | 1 2 | 10 0 | 26 3 | 0 0 | 2 1 |
| 114 0 | 28 5 | 0 0 | 2 3 | 69 0 | 3 1 | 42 0 | 30 5 | 0 0 | 2 2 | 69 0 | 3 1 | 42 0 | 44 3 | 29 0 | 3 3 |
| 84 0 | 46 5 | 29 0 | 3 1 | 76 0 | 2 1 | 6 0 | 48 3 | 108 0 | 215 | 6 0 | 52 3 | 106 0 | 2 1 | 8 0 | 54 3 |
| 106 0 | 2 1 | 8 0 | 76 3 | 0 0 | 1 1 | 115 0 | 146 3 | 3 0 | 2 2 | 111 0 | 148 3 | 3 0 | 2 1 | 111 0 | 150 5 |
| 89 0 | 3 1 | 1 2 | 1 1 | 22 0 | 16216 | 85 0 | 2 1 | 1 3 | 1 4 | 1 6 | 1 7 | 111 | 110 | 1 9 | 1 5 |
| 1 4 | 1 2 | 2 1 | 6 0 | 1 1 | 10 0 | 16421 | 4 0 | 1 1 | 1 2 | 78 0 | 1 1 | 1 3 | 1 2 | 1 6 | 110 |
| 113 | 114 | 115 | 314 | 113 | 1 6 | 1 4 | 1 3 | 4 4 | 3 3 | 3 2 | 7 0 | 16629 | 4 0 | 2 1 | 73 0 |
| 1 1 | 1 2 | 1 1 | 1 3 | 1 4 | 1 6 | 1 9 | 1 7 | 1 8 | 1 9 | 1 8 | 2 6 | 1 5 | 110 | 113 | 112 |
| 114 | 115 | 110 | 2 9 | 1 5 | 2 3 | 1 1 | 2 0 | 3 1 | 1 0 | 16831 | 2 0 | 2 1 | 41 0 | 1 4 | 1 3 |
| 1 4 | 1 3 | 1 5 | 37 0 | 1 1 | 2 2 | 4 1 | 1 2 | 2 3 | 1 4 | 1 7 | 111 | 1 9 | 112 | 110 | 1 8 |
| 1 7 | 1 8 | 112 | 213 | 1 9 | 1 3 | 2 2 | 1 1 | 1 2 | 1 0 | 17020 | 2 0 | 2 1 | 41 0 | 1 2 | 1 1 |
| 1 2 | 1 1 | 1 2 | 42 0 | 5 1 | 4 3 | 2 4 | 2 6 | 110 | 314 | 312 | 110 | 1 9 | 1 7 | 1 0 | 17223 |
| 45 0 | 1 3 | 1 1 | 1 3 | 1 2 | 1 1 | 3 0 | 3 1 | 7 0 | 1 2 | 33 0 | 4 1 | 1 2 | 1 3 | 1 5 | 1 6 |
| 1 9 | 113 | 214 | 313 | 212 | 1 9 | 1 0 | 17428 | 1 0 | 2 2 | 41 0 | 1 1 | 3 2 | 1 4 | 1 1 | 2 0 |
| 1 1 | 2 4 | 1 3 | 1 1 | 4 0 | 1 2 | 1 1 | 1 3 | 2 1 | 35 0 | 1 1 | 1 2 | 2 3 | 1 4 | 1 5 | 1 7 |
| 2 9 | 210 | 3 8 | 1 0 | 17641 | 1 4 | 2 2 | 36 0 | 2 2 | 1 1 | 1 2 | 1 4 | 1 5 | 1 3 | 1 5 | 1 6 |
| 1 5 | 1 2 | 1 3 | 1 4 | 1 9 | 3 4 | 1 0 | 4 1 | 2 0 | 1 1 | 12 0 | 3 1 | 7 0 | 3 1 | 1 2 | 4 1 |
| 2 0 | 1 1 | 3 2 | 1 1 | 2 2 | 1 3 | 2 2 | 1 3 | 1 2 | 2 5 | 1 5 | 2 8 | 1 6 | 1 0 | 17838 | 0 0 |
| 3 2 | 35 0 | 1 2 | 1 1 | 2 3 | 1 9 | 2 1 | 1 6 | 1 2 | 113 | 21 5 | 112 | 113 | 2 5 | 2 4 | 1 1 |
| 1 0 | 3 3 | 2 0 | 1 2 | 1 1 | 12 0 | 2 1 | 1 2 | 7 0 | 1 1 | 1 2 | 4 3 | 1 2 | 1 2 | 2 0 | 7 1 |
| 1 2 | 2 3 | 5 1 | 3 2 | 1 0 | 18028 | 0 0 | 1 1 | 2 2 | 32 0 | 3 1 | 1 3 | 1 2 | 2 3 | 1 5 | 2 8 |
| 1 7 | 1 1 | 315 | 213 | 1 2 | 3 3 | 7 0 | 2 1 | 6 0 | 2 2 | 1 1 | 10 0 | 2 1 | 26 0 | 1 1 | 1 0 |
| 1 1 | 1 0 | 18232 | 0 0 | 2 1 | 32 0 | 1 3 | 2 1 | 1 2 | 2 5 | 1 8 | 1 6 | 2 8 | 1 1 | 1 2 | 2 15 |
| 113 | 1 9 | 1 2 | 1 0 | 2 2 | 14 0 | 5 1 | 5 0 | 2 2 | 2 1 | 3 3 | 1 2 | 2 3 | 2 1 | 1 0 | 6 1 |
| 1 0 | 2 1 | 15 0 | 18447 | 0 0 | 1 1 | 31 0 | 1 6 | 1 3 | 112 | 1 3 | 1 5 | 113 | 4 15 | 113 | 1 5 |
| 1 6 | 115 | 110 | 215 | 110 | 1 2 | 1 1 | 12 0 | 1 2 | 1 1 | 1 2 | 1 1 | 5 4 | 1 2 | 1 5 | 1 2 |
| 1 3 | 1 5 | 2 1 | 2 3 | 2 6 | 1 8 | 1 6 | 1 8 | 1 4 | 1 5 | 1 2 | 1 1 | 1 7 | 212 | 2 8 | 1 5 |
| 1 3 | 2 4 | 15 0 | 18653 | 31 0 | 1 2 | 1 4 | 1 8 | 114 | 1 9 | 114 | 115 | 114 | 4 15 | 1 9 | 1 6 |
| 311 | 115 | 1 5 | 1 3 | 2 1 | 1 0 | 5 1 | 1 3 | 1 1 | 1 3 | 1 1 | 1 4 | 1 7 | 1 2 | 2 3 | 1 4 |
| 1 6 | 1 8 | 212 | 111 | 1 5 | 1 3 | 1 6 | 1 8 | 110 | 3 3 | 1 4 | 3 7 | 1 5 | 1 6 | 2 5 | 1 6 |
| 1 2 | 1 3 | 211 | 110 | 1 9 | 1 5 | 3 4 | 1 2 | 14 0 | 19850 | 30 0 | 1 1 | 1 3 | 115 | 1 7 | 115 |
| 1 8 | 212 | 1 9 | 1 8 | 211 | 110 | 1 8 | 1 7 | 111 | 1 6 | 1 4 | 1 2 | 1 0 | 2 4 | 1 3 | 2 5 |
| 1 2 | 8 3 | 2 6 | 2 7 | 1 8 | 210 | 1 3 | 1 6 | 1 8 | 1 7 | 1 6 | 111 | 110 | 2 3 | 1 5 | 4 3 |
| 1 7 | 1 1 | 2 2 | 1 1 | 2 5 | 1 4 | 1 3 | 1 7 | 1 3 | 1 2 | 1 3 | 14 0 | 19054 | 28 0 | 1 3 | 2 4 |
| 114 | 515 | 110 | 1 3 | 2 6 | 1 4 | 4 6 | 1 5 | 1 1 | 1 8 | 1 6 | 1 5 | 1 3 | 1 2 | 2 5 | 2 4 |
| 2 5 | 1 6 | 1 5 | 1 6 | 1 5 | 1 3 | 1 2 | 1 5 | 1 6 | 1 5 | 2 6 | 210 | 2 6 | 1 4 | 1 6 | 2 5 |
| 1 7 | 113 | 111 | 110 | 211 | 110 | 211 | 1 8 | 112 | 1 6 | 2 1 | 1 0 | 1 1 | 3 5 | 2 1 | 1 2 |
| 1 1 | 1 2 | 14 0 | 19255 | 28 0 | 2 6 | 1 7 | 113 | 115 | 114 | 115 | 1 6 | 1 4 | 3 3 | 1 2 | 1 3 |
| 4 4 | 1 1 | 1 0 | 1 4 | 1 9 | 112 | 111 | 1 4 | 2 9 | 214 | 2 8 | 2 6 | 1 3 | 1 5 | 1 5 | 1 3 |
| 2 6 | 1 4 | 1 2 | 1 3 | 3 4 | 1 2 | 1 7 | 3 1 | 1 3 | 1 5 | 1 4 | 1 3 | 2 6 | 2 4 | 1 2 | 1 3 |
| 1 4 | 1 8 | 1 1 | 1 2 | 1 0 | 1 1 | 2 4 | 1 1 | 2 2 | 1 1 | 16 0 | 19439 | 28 0 | 3 3 | 5 4 | 2 3 |
| 1 5 | 2 4 | 1 5 | 2 7 | 212 | 1 9 | 1 1 | 1 8 | 115 | 113 | 110 | 1 5 | 2 8 | 2 7 | 3 4 | 4 3 |
| 1 1 | 1 2 | 1 4 | 1 3 | 1 1 | 3 3 | 2 1 | 4 0 | 1 3 | 6 0 | 4 1 | 1 2 | 2 1 | 1 0 | 1 2 | 1 1 |
| 1 0 | 2 1 | 18 0 | 19625 | 31 0 | 1 1 | 1 4 | 1 3 | 2 4 | 1 2 | 4 3 | 1 2 | 2 3 | 2 5 | 1 4 | 2 3 |
| 1 5 | 1 3 | 1 8 | 1 1 | 1 3 | 2 4 | 2 3 | 1 1 | 30 0 | 1 1 | 3 0 | 2 1 | 21 0 | 19811 | 31 0 | 1 3 |
| 1 6 | 1 4 | 2 7 | 3 1 | 1 3 | 2 5 | 6 3 | 4 2 | 64 0 | 2002 | 27 0 | 1 2 | 2 3 | 1 1 | 1 3 | 1 7 |
| 1 6 | 110 | 1 5 | 1 3 | 1 2 | 1 3 | 2 4 | 1 3 | 1 2 | 2 3 | 1 2 | 1 1 | 2 2 | 67 0 | 20218 | 26 0 |
| 1 1 | 1 3 | 2 5 | 1 0 | 1 1 | 1 2 | 1 1 | 1 2 | 1 1 | 1 0 | 1 1 | 1 2 | 1 1 | 3 3 | 3 2 | 3 1 |
| 67 0 | 20415 | 27 0 | 3 3 | 1 0 | 3 1 | 4 0 | 1 3 | 1 2 | 2 5 | 2 3 | 4 4 | 1 5 | 1 4 | 1 3 | 1 1 |
| 64 0 | 20618 | 26 0 | 1 1 | 2 3 | 3 2 | 1 3 | 7 0 | 3 3 | 1 0 | 3 0 | 3 3 | 1 4 | 1 3 | 1 2 | 1 1 |
| 2 0 | 3 3 | 1 2 | 58 0 | 20818 | 27 0 | 1 3 | 4 0 | 2 1 | 1 3 | 3 0 | 2 1 | 2 3 | 1 1 | 1 3 | 1 2 |
| 1 3 | 2 5 | 2 4 | 2 2 | 2 4 | 2 3 | 58 0 | 21022 | 29 0 | 2 2 | 1 3 | 1 3 | 1 9 | 1 6 | 1 3 | 1 3 |
| 1 1 | 5 0 | 1 1 | 1 3 | 112 | 1 3 | 1 3 | 114 | 1 7 | 2 5 | 3 3 | 1 2 | 2 1 | 58 0 | 21223 | 29 0 |
| 2 1 | 1 8 | 111 | 1 8 | 211 | 1 0 | 3 1 | 1 2 | 2 1 | 1 4 | 110 | 114 | 1 8 | 114 | 112 | 113 |
| 1 4 | 1 5 | 1 2 | 2 4 | 1 3 | 60 0 | 21424 | 26 0 | 2 2 | 3 0 | 1 3 | 111 | 1 9 | 21 1 | 2 0 | 1 1 |
| 1 0 | 3 1 | 1 3 | 1 7 | 1 8 | 1 7 | 1 8 | 1 6 | 1 4 | 1 1 | 1 2 | 4 1 | 2 2 | 1 1 | 55 0 | 21631 |
| 26 0 | 2 3 | 2 2 | 1 0 | 1 1 | 1 5 | 1 3 | 1 5 | 1 6 | 7 0 | 1 3 | 1 5 | 112 | 1 9 | 112 | 1 5 |
| 1 3 | 1 1 | 1 4 | 3 0 | 1 2 | 3 5 | 1 7 | 1 3 | 1 4 | 1 2 | 1 3 | 1 1 | 2 3 | 1 1 | 47 0 | 21321 |
| 26 0 | 1 2 | 4 3 | 3 0 | 1 2 | 1 3 | 9 0 | 1 2 | 1 1 | 2 1 | 1 2 | 5 0 | 2 2 | 2 6 | 3 3 | 110 |
| 2 1 | 1 2 | 2 5 | 3 1 | 45 0 | 22015 | 26 0 | 1 1 | 2 5 | 2 2 | 3 0 | 1 1 | 1 2 | 1 3 | 25 0 | 1 1 |
| 3 0 | 3 1 | 1 0 | 2 1 | 44 0 | 22212 | 28 0 | 1 2 | 2 7 | 1 1 | 5 0 | 1 1 | 1 4 | 29 0 | 3 1 | 2 0 |

Table 4. Continued.

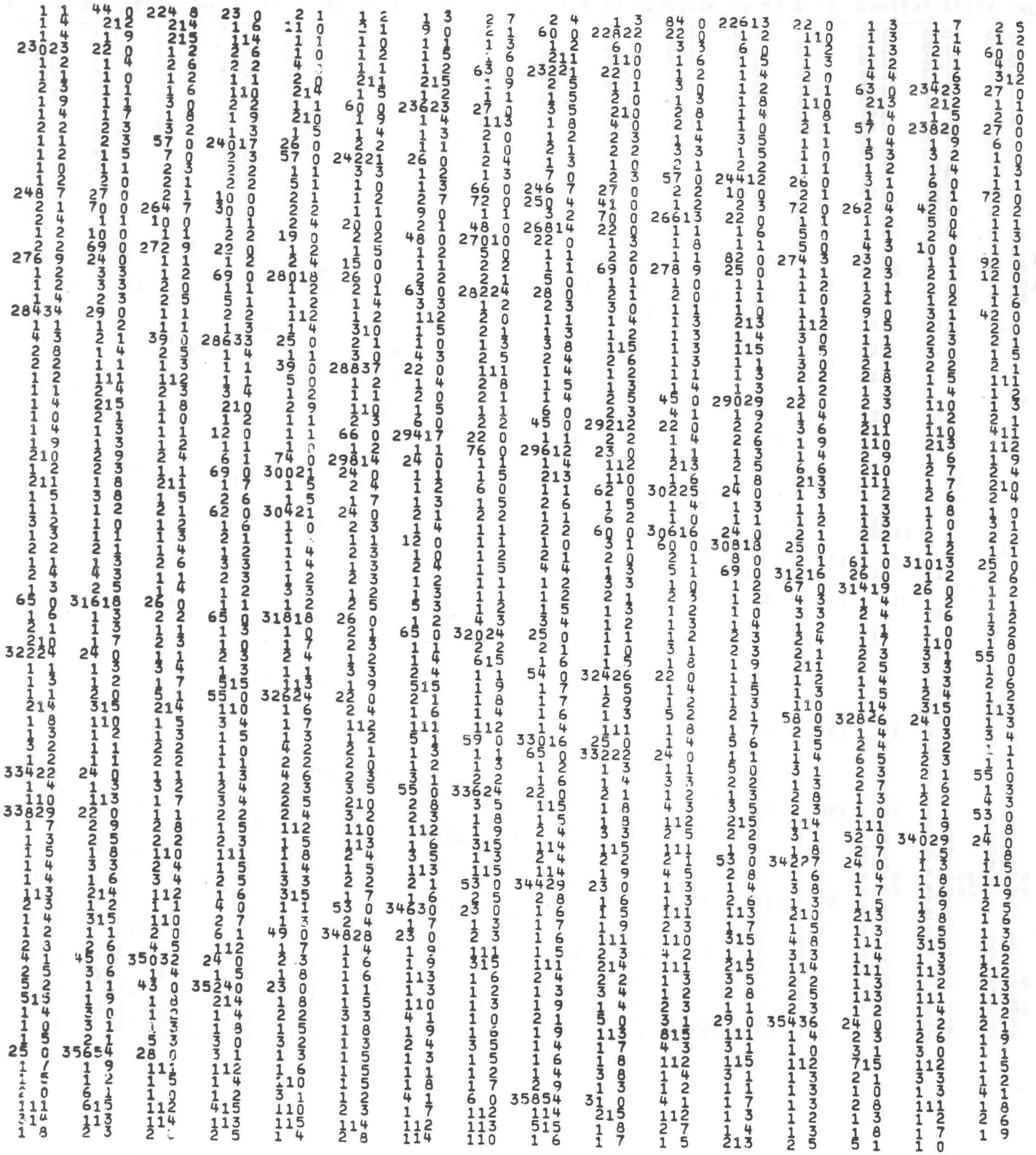

Table 5. Number of months of data available in the RADAP II seasonal archives as of October 25, 1988. The warm season is defined as March through August and the cool season as September through February.

| RADAP II sites | Start date Mo/Yr | 1985 | | 1986 | | 1987 | | 1988 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Warm | Cool | Warm | Cool | Warm | Cool | Warm | Cool |
| AMA | 4/85 | 4 | 4 | 3 | 0 | 6 | 6 | 6 | |
| BGM | 6/88 | | | | | | | 3 | |
| BNA | 4/86 | | | 5 | 5 | 6 | 6 | 6 | |
| CRW | 3/85 | 6 | 5 | 6 | 6 | 6 | 6 | 6 | |
| GCK | 4/85 | 4 | 0 | 4 | 5 | 6 | 6 | 6 | |
| ICT | 4/85 | 5 | 3 | 0 | 2 | 5 | 6 | 6 | |
| JKL | 5/86 | | | 4 | 6 | 5 | 6 | 6 | |
| LIC | 4/85 | 5 | 6 | 6 | 1 | 2 | 4 | 6 | |
| OKC | 4/85 | 5 | 4 | 5 | 5 | 6 | 6 | 6 | |
| PIT | 6/85 | 3 | 3 | 6 | 5 | 6 | 6 | 6 | |
| TBW | 4/85 | 3 | 5 | 4 | 2 | 5 | 6 | 6 | |
| UMN | 4/85 | 3 | 4 | 5 | 2 | 2 | 6 | 6 | |

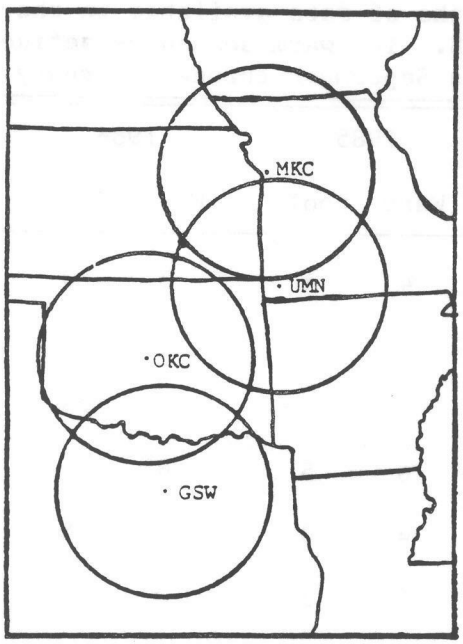


Fig. 1. D/RADEX Test Bed.

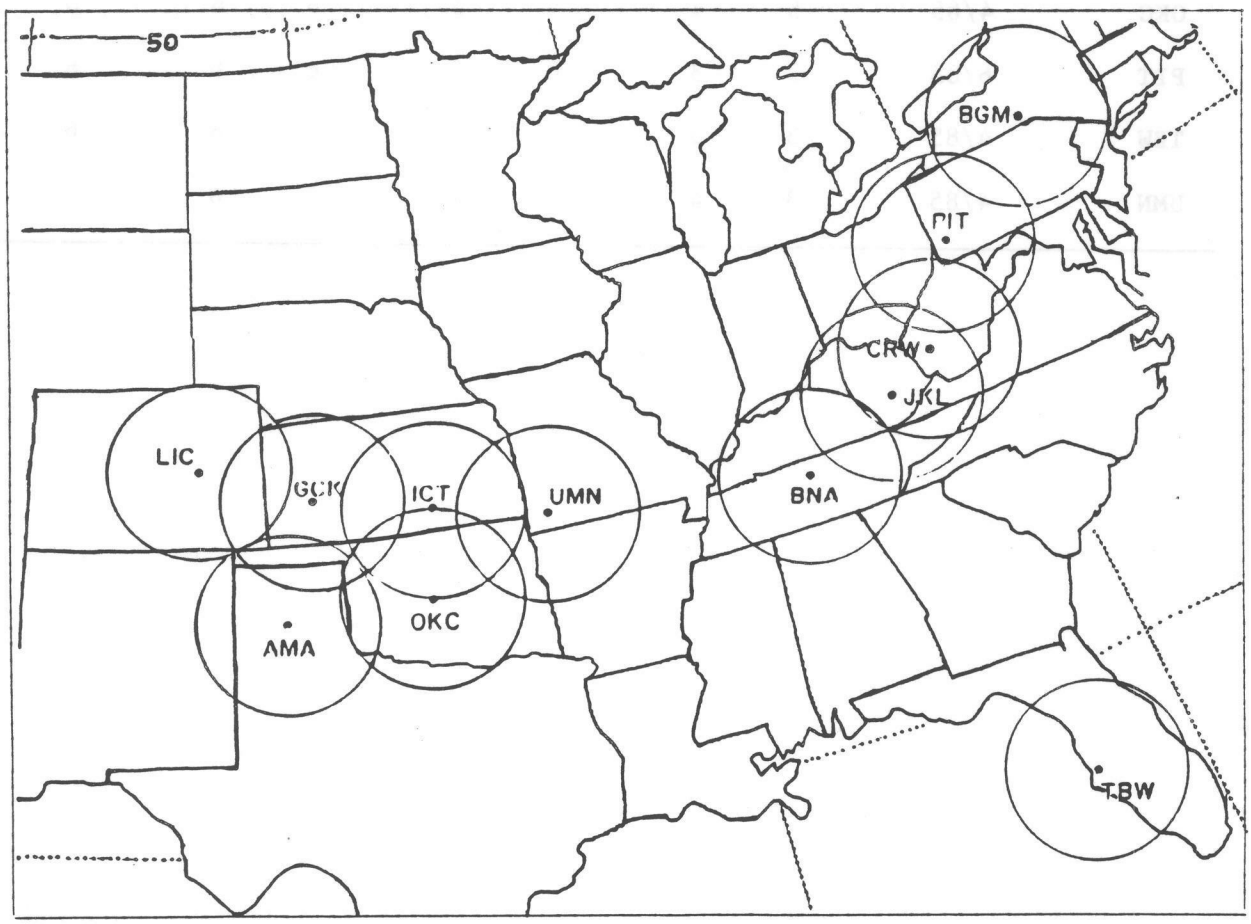


Fig. 2. RADAP II network. Circles represent 125 n.m. surveillance region.

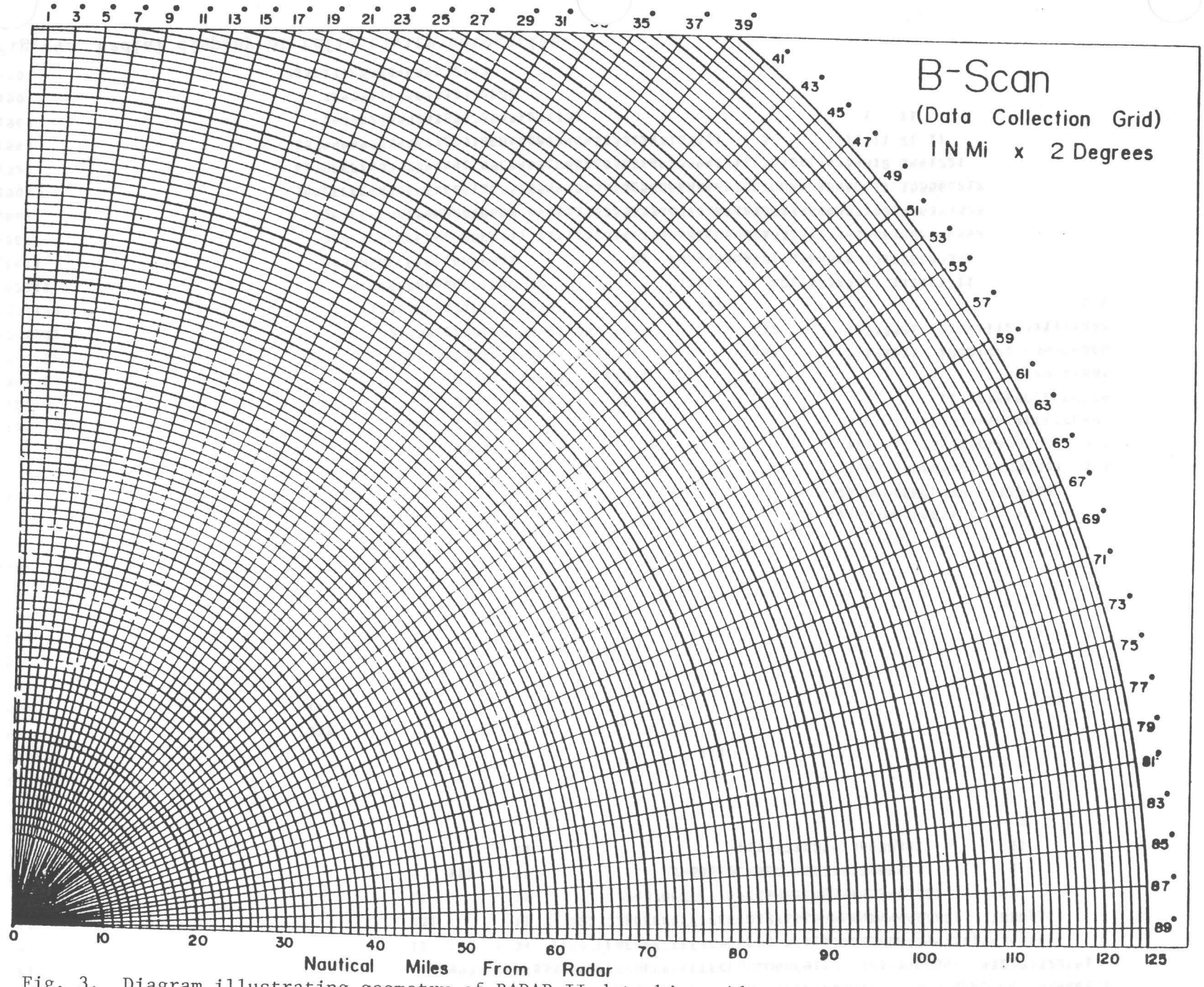


Fig. 3. Diagram illustrating geometry of RADAP II data bin grid.


Fig. 4. Radial display of reflectivity categories.

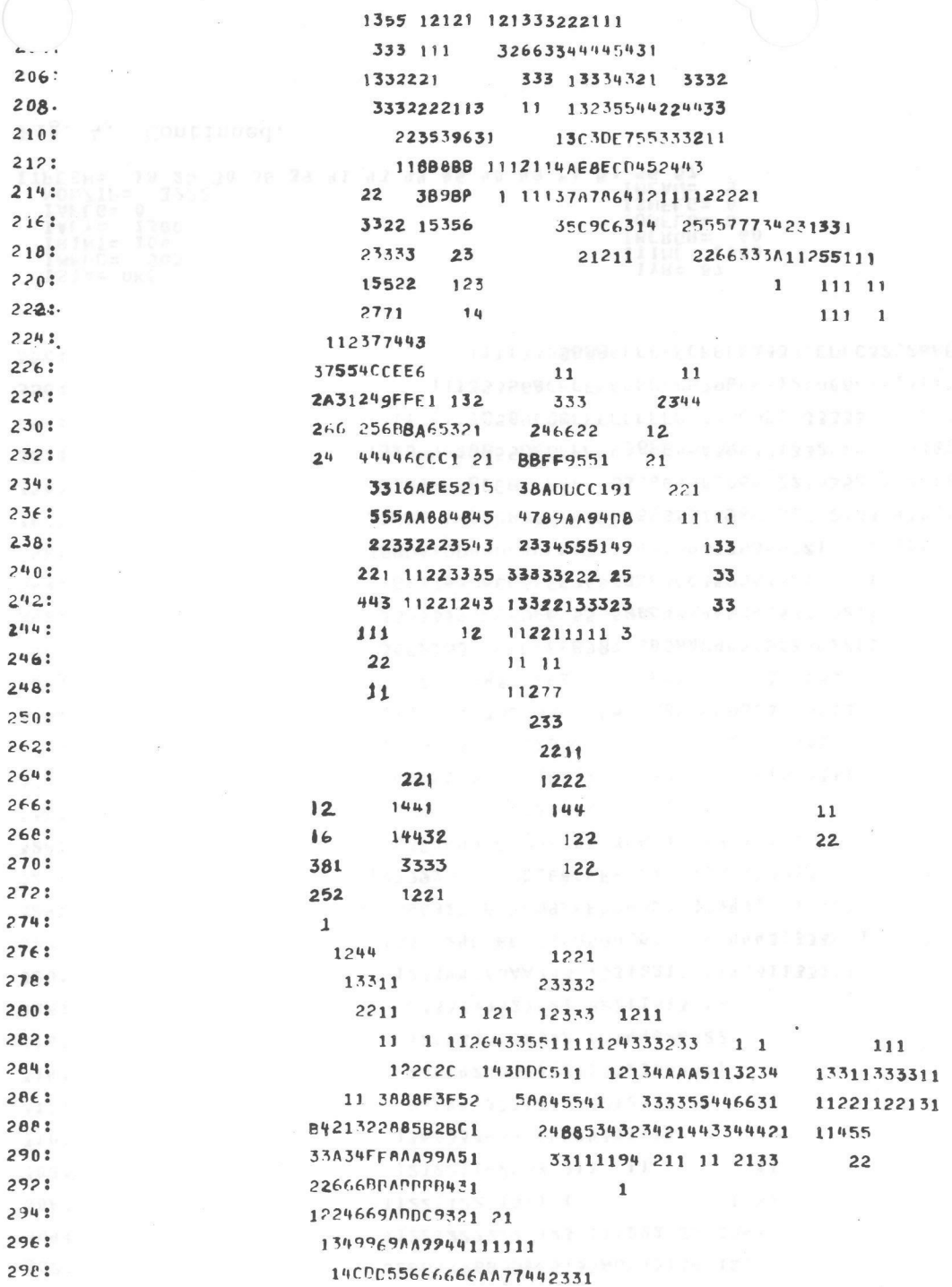

Fig. 4. Continued.


Fig. 4. Continued.

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National Oceanic and Atmospheric Administration
National Weather Service
Systems Development Office
Techniques Development Laboratory

TDL OFFICE NOTE 89-2

# RADAP II ARCHIVE DATA
# USER'S GUIDE

Melvina McDonald and Robert E. Saffle

January 1989

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## 1. INTRODUCTION

In 1971, the National Weather Service (NWS) began the Digitized RADar EXperiment (D/RADEX) to improve the operational use of radar data through computer processing (McGrew, 1972). The early stages of D/RADEX involved four sites: Kansas City, Mo. (August 1971); Oklahoma City, Okla. (October 1971); Fort Worth, Tex. (December 1971); and Monett, Mo. (February 1972), as shown in Fig. 1. Many useful meteorological and hydrological products were developed under D/RADEX including echo tops, vertically integrated liquid water content (Green, 1971), severe weather probability (Saffle, 1976), storm structure, and rainfall accumulation. In 1983, positive evaluation of the results of D/RADEX resulted in transfering the system to quasi-operational status and renaming it RAdar DAta Processor, version II (RADAP II). Currently, the RADAP II network consists of the twelve sites shown in Fig. 2. The sites are Amarillo, Tex. (AMA); Binghamton, N.Y. (BGM); Nashville, Tenn. (BNA); Charleston, W. Va. (CRW); Garden City, Kans. (GCK); Wichita, Kans. (ICT); Jackson, Ky. (JKL); Limon, Colo. (LIC); Oklahoma City, Okla. (OKC); Pittsburgh, Pa. (PIT); Tampa Bay, Fla. (TBW); and Monett, Mo. (UMN).

## 2. DATA QUALITY CONTROL

Based on the strength of the signal returned from a target, the current NWS weather radar receivers estimate the equivalent reflectivity factor (in $mm^6 m^{-3}$) that would be representative of such a signal. This reflectivity factor quantity is called "Z" and can range from about 50 to about $5 \times 10^5$ $mm^6 m^{-3}$. The receiver then calculates the logarithm of each estimated value of Z; the dynamic range of Log Z is about 1.7 to 5.7. To simplify further processing of the data, the Log Z values are scaled upwards by a factor of 10 (10 Log Z); these values are commonly referred to as dBZ values. The RADAP II system utilizes dBZ values for calculations and archiving.

The RADAP II system performs several quality control procedures on each scan of radar reflectivity data before that scan is passed to any other task, including archiving. The first of these procedures corrects the data for attenuation due to absorption by atmospheric gases. This correction is a linear function that increases with distance and reaches a maximum corrective value of +3 dBZ for data at a range of 126 n mi.

Next, in order to mitigate the effects of normal ground clutter, a hybrid base-level scan is generated by merging higher elevation angle scan data out to a given range with 0.5 degree elevation angle scan data from that range out to 126 n mi. Both the higher elevation angle and the range of its use are site-adaptable and vary from site to site. These values are included in the header data for each scan, as shown in Section 4.

Finally, each scan is processed to remove isolated point targets by requiring a given nonzero data value to be adjacent to at least two other nonzero data values. During this filtering procedure, a check is also made on whether a

given data value exceeds the maximum of its adjacent neighbors by more than about 16 dBZ. If so, the data value is changed to that of the neighborhood maximum.

## 3. DATA COLLECTION

Although two types of radars (WSR-57 or WSR-74S) are used in the RADAP II network, they share the common characteristics of a 2.2 deg beam width and a 10 cm wavelength. The RADAP II sites schedule base-level and tilt-sequence (volumetric) observations of reflectivity every 10 or 12 min. These observations are built from input scans of data consisting of 180 radials covering 360 deg of azimuth under the radar umbrella. The radials are centered on even azimuths, cover a range from 10 to 126 n mi, and contain a data value for each nautical mile of range (Fig. 3). The data values range from 0 to 15 with each nonzero value representing a RADAP II category of radar reflectivity. The nominal reflectivity thresholds for the categories are given in Table 1. As previously noted in Section 2, a base-level observation is a hybrid of a scan taken at an elevation angle of 0.5 deg for data at farther ranges and one taken at a site-adaptable higher elevation angle for data near the radar site. In contrast, a volumetric observation consists of a series of single elevation angle scans starting at 0.5 deg elevation and extending, in vertical steps of two degrees, to the top of the existing echoes or to 22.0 deg, whichever comes first.

In 1984, the NWS began archiving RADAP II data to support the development of reflectivity-based operational algorithms that could be tested at RADAP II sites and later implemented on future NWS radar systems. The data are first written to floppy diskettes at each RADAP II site and later transferred to a central location for final archiving to IBM compatible 9-track magnetic tapes. RADAP II data for the period April 1985 through March 1987 were archived to tape under contract. Since April 1987, the diskettes have been transferred to NWS Headquarters for final archiving to tape.

In order to increase the utility of the RADAP II archive for snowfall research, the cool season base-level data have been coded since 1986 according to category thresholds that cover, in 2-dBZ steps, the reflectivity range 18-46 dBZ (Table 1). Nominally, the cool season is November 1 through March 1, but individual sites will vary somewhat. Volumetric observations taken during the cool season are coded according to the warm season category thresholds in Table 1. Thus, the cool season archive will enable research both on frozen precipitation and on severe convective events that might occur during that season.

## 4. ARCHIVE DATA TAPES

The data tapes are 9-track, nonlabeled (NL), high density (6250 bpi) magnetic tapes. They are written in binary coded decimal (BCD) with an unformatted FORTRAN write statement using a variable spanned (VS) record format and a maximum record length of 32,756 bytes. Each tape contains one file of data for one RADAP II site. Each record has two logical parts representing one scan of data. Part 1 contains thirty-four 16-bit words of header parameters which describe the station and data characteristics for the scan (Table 2). Part 2 has a variable number of 16-bit words and contains the radial reflectivity category data for each scan in the form shown in Table 3.

The RADAP II archive tapes can be read with a FAST FORTRAN I/O (FFIO) package subroutine called FFGET(BUF,N,L,&END,&ERR), where FFGET reads a record from FORTRAN unit "N" into contiguous locations starting at "BUF." The length of the record in bytes is returned in "L." At end-of-file (EOF), transfer will be made to statement number "END" and errors to statement number "ERR." The FFIO package is available at the NOAA Computer Center to 360/195, 360/65, and NAS 9000 users and will automatically be included in programs executed under the NFOR, NPL1F, and XFORX procedures. For non-FFIO users, the data tapes can be read with basic FORTRAN unformatted read statements or with any other compatible utility.

## 5. DECODING ARCHIVED DATA

Table 4 represents a sample formatted display of the alphanumeric value of each byte of one record. Note that each record corresponds to one 360° observational scan of data. A graphical display of all of the scan data in this record is presented in Fig. 4. Table 2 contains the information that allows line 1 of this record to be decoded to reveal the following information:

| | |
|---|---|
| ISTAT | = OKC |
| IYR | = 87 |
| IJUL | = 123 |
| IMMDD | = May 3 |
| ITIME | = 1000 GMT |
| IELEV | = 0.5 deg |
| IRINT | = 1.00 n mi |
| IMERGR | = 60 km |
| IMERGA | = 2.9 deg |
| IALT | = 1300 ft above msl |
| IOBFLG | = 0 (base elevation observation) |
| IDRFLG | = 0 (clockwise rotation) |
| IAPFLG | = 0 (no AP present) |
| ISNFLG | = 0 (no snow) |
| NVAL | = 5248 |
| NONZIP | = 3222 |
| IMEAN | = 5 |
| ISTDEV | = 99 (standard deviation not calculated) |
| ITRESH(15) | = 18,25,30,36,39,41,43,44,46,48,49,51,53,55 & 57 (warm season threshold values) |

Lines 2 through the end-of-record (EOR) are coded reflectivity category values listed by azimuth. The coding method records (1) the azimuth of the radial with nonzero values, (2) the number of runs at that azimuth, and, for each run at the azimuth, (3) the number of range bins in the run and (4) the reflectivity category value of the run. Azimuths that contain only zeros as reflectivity category values are not coded in an observational record. The user should assume zeros for any noncoded azimuths. A run is defined as a group of range bins with identical reflectivity category values along an azimuth, i.e., a new run starts when the reflectivity category value changes. The total sum of all range bins per radial (10-126 n mi) will always be equal to 116. For example, if a series of 8 range bins along a radial contained the reflectivity values 22221144, there would be 3 runs detected with reflectivity category values of 2, 1, and 4, respectively. This series of 3 runs would then be coded as 42, 21, and 24; where the first number indicates the number of range bins in the run

(the run length) and the second the reflectivity category value of the run. As a further example, a portion of Table 4 has been decoded according to the format shown in Table 3 to reveal the following information:

| Azimuth | Number of runs | Run | Range Bins | Reflectivity Category value |
|---|---|---|---|---|
| 0 | 53 | 1 | 32 | 0 |
| | | 2 | 1 | 1 |
| | | 3 | 1 | 0 |
| | | 4 | 2 | 1 |
| | | 5 | 1 | 0 |
| | | 6 | 1 | 1 |
| | | 7 | 1 | 2 |
| | | 8 | 1 | 4 |
| | | 9 | 1 | 2 |
| | | 10 | 1 | 4 |
| | | 11 | 1 | 13 |
| | | 12 | 4 | 15 |
| | | 13 | 1 | 13 |
| | | . | . | . |
| | | . | . | . |
| | | . | . | . |
| | | 48 | 2 | 9 |
| | | 49 | 1 | 3 |
| | | 50 | 1 | 4 |
| | | 51 | 2 | 6 |
| | | 52 | 3 | 1 |
| | | 53 | 1 | 0 |

## 6. DATA AVAILABILITY

The National Climatic Data Center (NCDC) will maintain a RADAP II data archive. The initial shipment of data to NCDC was in January 1989 and covered the period 1985 through 1987, as shown in Table 5. Future updates to this archive will be shipped to NCDC twice a year. Each shipment will be timed to cover the preceding 6 month season (warm or cool). An inventory of the days available for each RADAP II site will be included with each data shipment. Interested parties should query NCDC about the availability of data for specific times and RADAP II sites. When requesting copies of archive RADAP II data tapes, address all correspondence to:

National Climatic Data Center (NCDC)
Attn: User Services Branch
Federal Building
Asheville, NC 28801-2696

or call the Customer Service Section on (704) 259-0682 (commercial) or 672-0682 (FTS).

## 7. ACKNOWLEDGEMENTS

The authors extend special thanks to all the RADAP II sites for their cooperation in providing the reflectivity data, to OSO personnel for administering the RADAP II program, and to Karen Yip for typing the manuscript.

## 8. REFERENCES

Green, D. R., 1971: Numerical techniques for the analysis of radar with applications to meteorology and hydrology. Ph.D. dissertation, Texas A & M University, College Station, Texas, 125 pp.

McGrew, R. G., 1972: Project D/RADEX (Digitized Radar Experiments). Preprints Fifteenth Radar Meteorology Conference, Champaign-Urbana, Amer. Meteor. Soc., 101-106.

Saffle, R. E., 1976: D/RADEX products and field operation. Preprints Seventeenth Radar Meteorology Conference, Seattle, Amer. Meteor. Soc., 555-559.

Table 1. Nominal values of reflectivity thresholds for archived RADAP II data for base-level scans for warm and cool seasons. The actual values used for a given archive scan are included in the header data for that scan. All tilt-sequence scans are archived with warm season category thresholds regardless of the season.

| RADAP II category | Warm Season threshold (dBZ) | Cool Season threshold (dBZ) |
|---|---|---|
| 1 | 18.5 | 18 |
| 2 | 24.5 | 20 |
| 3 | 30.0 | 22 |
| 4 | 35.5 | 24 |
| 5 | 38.5 | 26 |
| 6 | 41.0 | 28 |
| 7 | 43.0 | 30 |
| 8 | 44.0 | 32 |
| 9 | 46.0 | 34 |
| 10 | 47.5 | 36 |
| 11 | 49.0 | 38 |
| 12 | 51.0 | 40 |
| 13 | 53.0 | 42 |
| 14 | 55.0 | 44 |
| 15 | 57.0 | 46 |

Table 2. Header information (Part 1) of a RADAP II archive data record.

| Bytes | Parameter | Description |
|---|---|---|
| 1-4 | ISTAT | Station identifier. 3 characters + a blank. two 16-bit words (ISTAT(2)) (left-justified) |
| 5-6 | IYR | Last two digits of the year. |
| 7-8 | IJUL | Julian date. |
| 9-10 | IMMDD | Calendar date (MM=month & DD=day). |
| 11-12 | ITIME | Hour and minute (HHMM). GMT |
| 13-14 | IELEV | Elevation angle (scaled by 10). Deg |
| 15-16 | IRINT | Range interval (scaled by 100). n mi |
| 17-18 | IMERGR | Ending range for merging higher elevation data with base elevation data. Km |
| 19-20 | IMERGA | Elevation angle of the higher elevation data used for merging with base elevation data. (scaled by 10). Deg |
| 21-22 | IALT | Station elevation above msl. Ft |
| 23-24 | IOBFLG | Type of observation scan. 0=base Level 1=volumetric |
| 25-26 | IDRFLG | Rotational direction of antenna during data collection. 0=clockwise 1=counter clockwise |
| 27-28 | IAPFLG | Operator indication of Anomalous Propagation (AP). 0=None 1=Some |
| 29-30 | ISNFLG | Operator indication of snow. 0=none 1=some |
| 31-32 | NVAL | Number of 16-bit words in the input record. Contains the header information (1-34) + coded reflectivity values (35-NVAL). |
| 33-34 | NONZIP | Number of nonzero reflectivity values. |
| 35-36 | IMEAN | Mean of the nonzero reflectivity values. |
| 37-38 | | Reserved for future use. |
| 39-68 | ITRESH | Threshold reflectivity values. dBZ Fifteen 16-bit words (ITRESH(15)). |

Table 3. Specification of coded reflectivity data (Part 2) of a RADAP II archive data record.

| Element | Parameter | Description |
|---|---|---|
| 1 | IRADAZ(1) | Azimuth of first radial with nonzero data |
| 2 | NGROUP(1) | Number of groups (runs) at this azimuth |
| 3 | NBIN(1,1) | Number of bins (run length) in the first run |
| 4 | IDVIP(1,1) | RADAP II category value of the first run |
| 5 | NBIN(2,1) | Number of bins in the second run |
| 6 | IDVIP(2,1) | RADAP II category value of the second run |
| . | . | . |
| . | . | . |
| . | . | . |
| 1+(NGROUP(1)*2) | NBIN(NGROUP(1),1) | Number of bins in the last run |
| 2+(NGROUP(1)*2) | IDVIP(NGROUP(1),1) | RADAP II category value of the last run |
| 3+(NGROUP(1)*2) | IRADAZ(2) | Azimuth of the second nonzero azimuth |
| 4+(NGROUP(1)*2 | NGROUP(2) | Number of runs at this azimuth |
| 5+(NGROUP(1)*2) | NBIN(1,2) | Number of bins in the first run |
| 6+(NGROUP(1)*2) | IDVIP(1,2) | RADAP II category value of the first run |
| . | . | . |
| . | . | . |
| . | . | . |
| NVAL-1 | NBIN(NGROUP(n),n) | Run length of last run of last radial |
| NVAL | IDVIP(NGROUP(n),n) | Run value of the last run of last radial |

Table 4. A portion of a sample scan of coded reflectivity data for Oklahoma City, Okla.

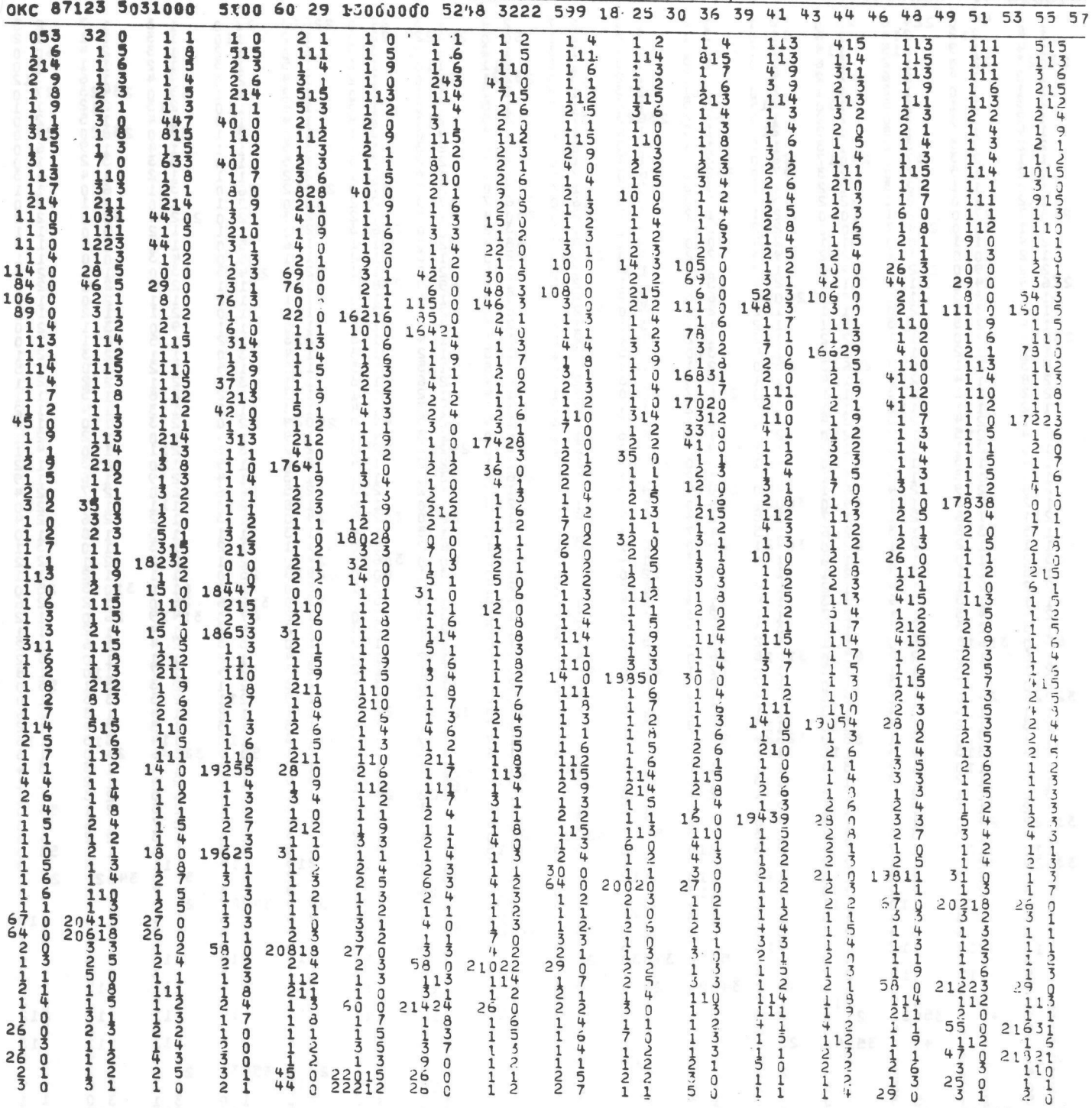
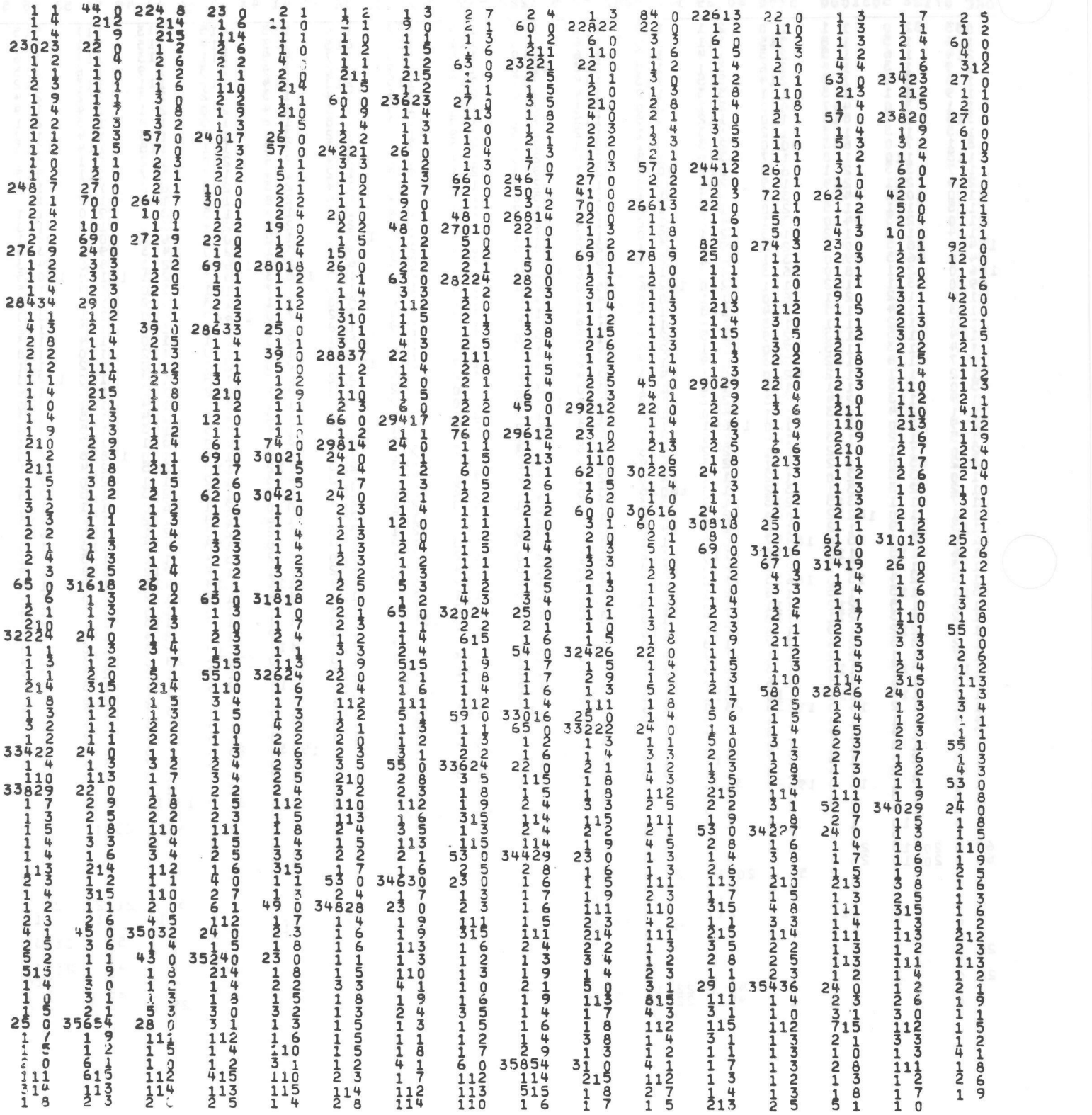


Table 4. Continued.



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| RADAP II sites | Start date Mo/Yr | 1985 | | 1986 | | 1987 | | 1988 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Warm | Cool | Warm | Cool | Warm | Cool | Warm | Cool |
| AMA | 4/85 | 4 | 4 | 3 | 0 | 6 | 6 | 6 | |
| BGM | 6/88 | | | | | | | 3 | |
| BNA | 4/86 | | | 5 | 5 | 6 | 6 | 6 | |
| CRW | 3/85 | 6 | 5 | 6 | 6 | 6 | 6 | 6 | |
| GCK | 4/85 | 4 | 0 | 4 | 5 | 6 | 6 | 6 | |
| ICT | 4/85 | 5 | 3 | 0 | 2 | 5 | 6 | 6 | |
| JKL | 5/86 | | | 4 | 6 | 5 | 6 | 6 | |
| LIC | 4/85 | 5 | 6 | 6 | 1 | 2 | 4 | 6 | |
| OKC | 4/85 | 5 | 4 | 5 | 5 | 6 | 6 | 6 | |
| PIT | 6/85 | 3 | 3 | 6 | 5 | 6 | 6 | 6 | |
| TBW | 4/85 | 3 | 5 | 4 | 2 | 5 | 6 | 6 | |
| UMN | 4/85 | 3 | 4 | 5 | 2 | 2 | 6 | 6 | |

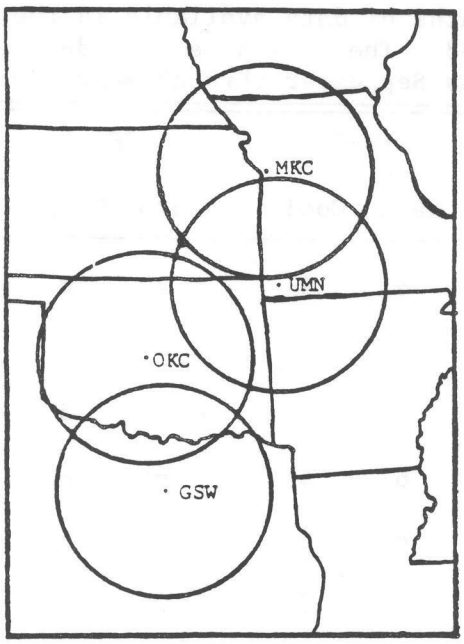


Fig. 1. D/RADEX Test Bed.

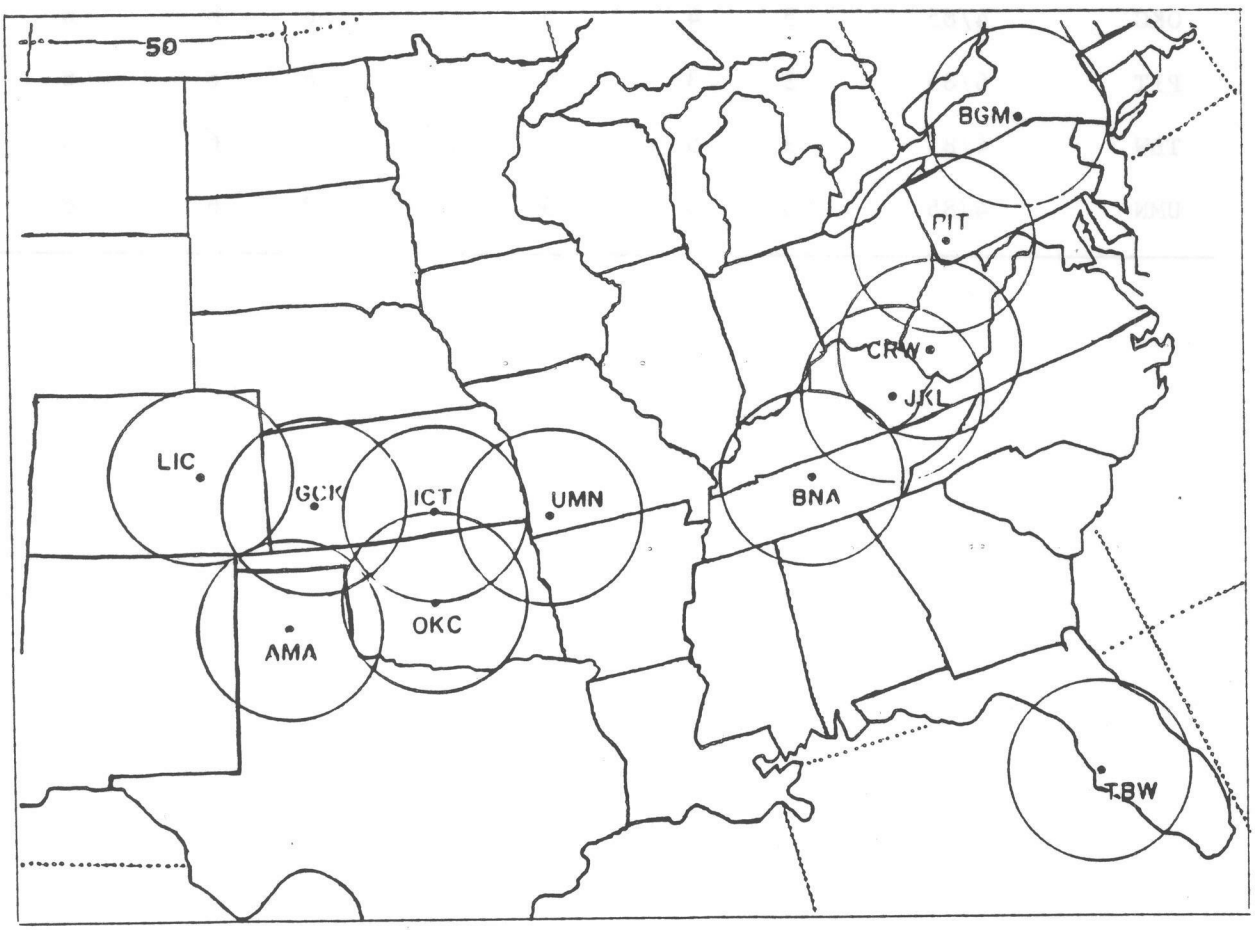


Fig. 2. RADAP II network. Circles represent 125 n.m. surveillance region.

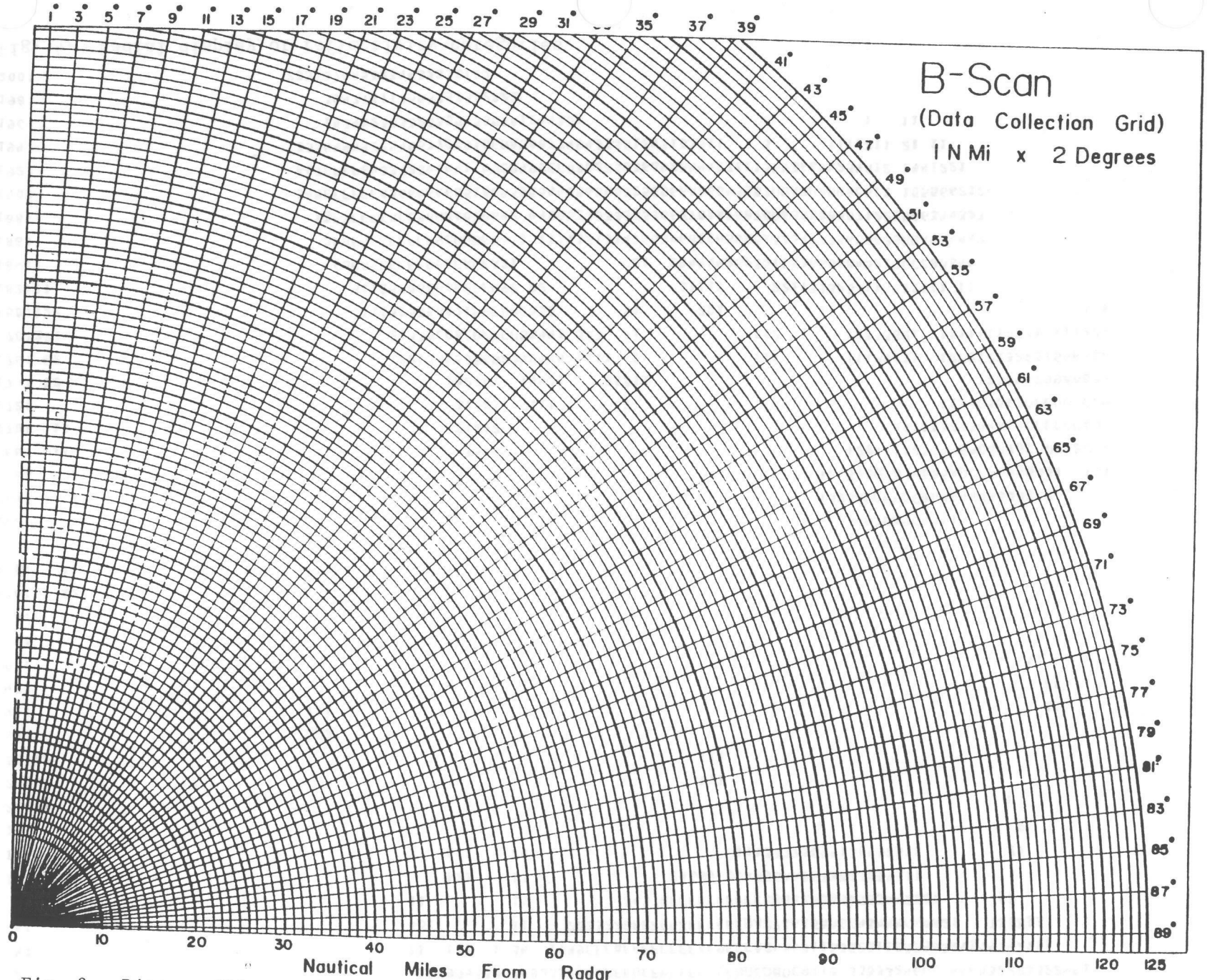


Fig. 3. Diagram illustrating geometry of RADAP II data bin grid.


Fig. 4. Radial display of reflectivity categories.

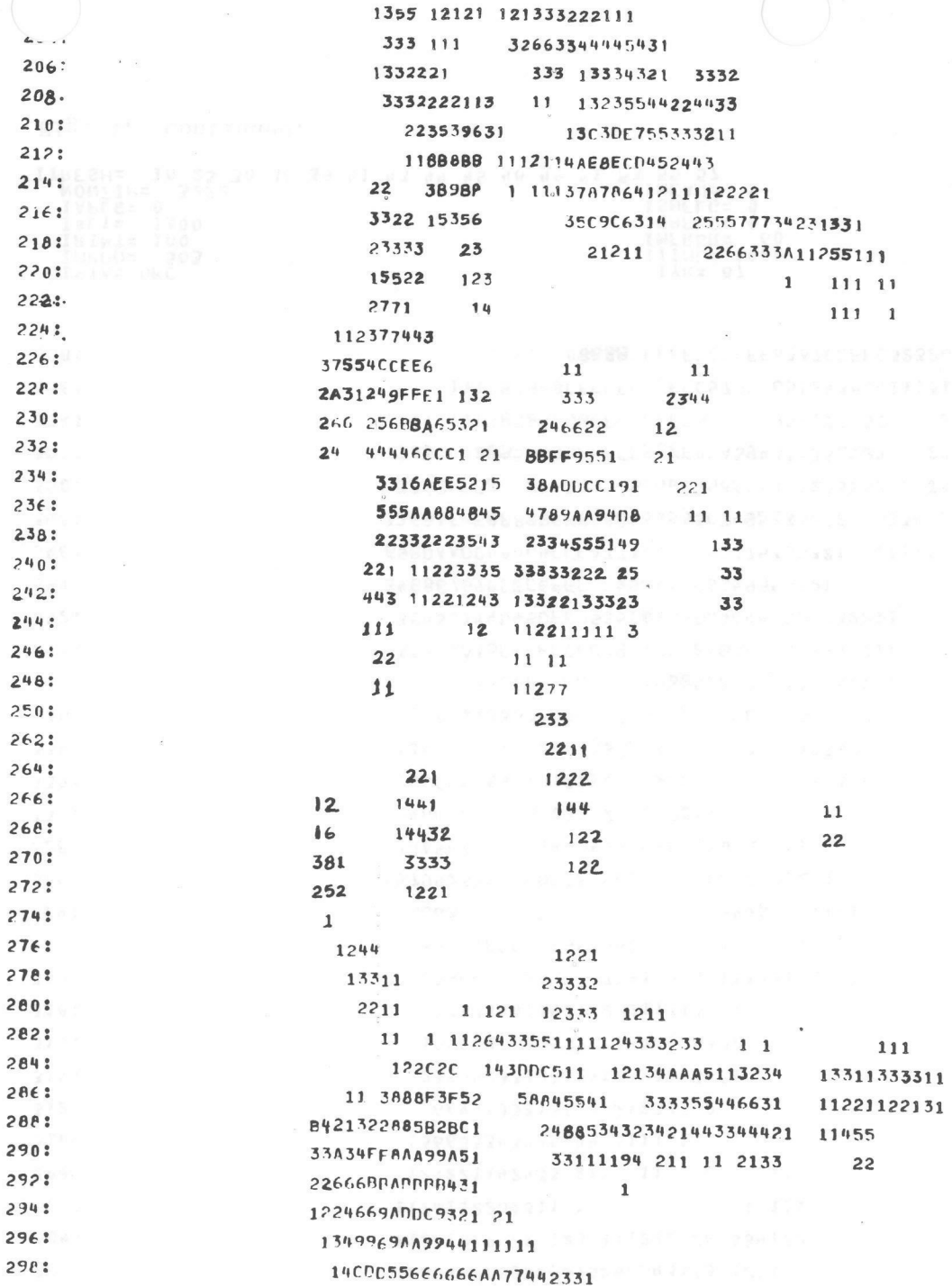


Fig. 4. Continued.


Fig. 4. Continued.