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ARCHIVING THE NEW MANUALLY DIGITIZED RADAR DATA

Donald S. Foster and Ronald M. Reap

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1. INTRODUCTION

Manually digitized radar (MDR) data have been collected from hourly teletype reports and archived in the MOS predictand tape format since November 1, 1973 (Foster and Reap, 1973). These data are used in both general and severe thunderstorm prediction that utilize Model Output Statistics (MOS) (Glahn and Lowry, 1972) which relate the radar data to large-scale predictors from operational numerical models. Other uses for the data include the development of improved probability of precipitation forecasts, propagation of radar echo studies, and verification of convective weather forecasts.

The whole archiving procedure became obsolete with the implementation of the new manually digitized radar reporting system at 1735 GMT February 28, 1978. In order to save over 4 years of archived data from also becoming obsolete, we have transposed the old data to a new MDR grid and to a new MOS predictand tape format that is also being used to archive the new MDR data.

Only the intensity codes from the new MDR data are being archived. They are being archived in two forms on two different sets of tapes. The first form includes a resolved set of intensity codes for a master U.S. MDR grid (see Fig. 1). The second form includes the highest intensity code of four small MDR blocks in Fig. 1 that make up one MDR block in Fig. 2. This last set of tapes is written in the MOS predictand data format (Glahn, 1974). The block size in Fig. 2 is the same as the old MDR block size shown in Fig. 3. This resolution meets TDL's present requirements and also permits the transposition of the old MDR data to the new grid. The finer resolution data archived in the first form above is being saved for probable future research, e.g., quantitative precipitation studies.

In addition to the MDR archive tapes, we have kept a set of tapes with the old MDR code plus the number and type of severe local storms that occurred in an MDR block between hour + 00 and hour + 59 minutes. These data were transposed to the new TDL MDR grid and written to tape in the MOS predictand tape format. These tapes are being continued with the new MDR intensity codes and severe storm data received periodically from the National Severe Storms Forecast Center at Kansas City, Mo.

2. THE MDR GRIDS

The old MDR grid (see Fig. 3) was oriented along the primitive equation (PE) model grid, with four MDR grid intervals for each PE grid interval. MDR grid intervals varied from about 75 to 85 km across the grid. The dots in Fig. 3 coincide with PE grid points. Each radar station was assigned a fixed set of MDR blocks for reporting purposes;

e.g., Oklahoma City's blocks are heavily outlined in Fig. 3. Several stations in the Eastern Region had overlapping blocks with their neighbors. Otherwise, the MDR report from one block always came from the same radar station.

In contrast, the new MDR grid (Fig. 1) is oriented along the limited area fine mesh (LFM) model grid. Grid intervals are one-fourth the LFM grid interval and are about 40 km in length. Dots around the edge of the grid coincide with LFM grid points. Each radar station reports echo intensity out to 230 km from the station. As a result, several radar stations may report for the same blocks. The row and column numbers in Fig. 1 are the same as the teletype overlay referenced in NWS Technical Procedures Bulletin No. 185 (National Weather Service, 1977b). The mapping array used to contour the automated radar summary chart (National Weather Service, 1977a) is an 89 x 113 block array. Block 89,2 of Fig. 1 coincides with block 1,1 of the mapping array. Similarly, block 1,114 coincides with block 89,113.

Data archived on the MOS predictand tapes are for the grid shown in Fig. 2. Each block contains four MDR reporting blocks shown in Fig. 1. The blocks in Fig. 2 are the same size as those in Fig. 3. However, the orientation is quite different. Again LFM grid points are shown around the edge of the grid.

3. TRANSPOSING THE OLD MDR DATA

In order to maintain continuity of the MDR predictand data with the changeover to the new code and grid, we decided to transpose the old data to the new grid. Data from an old block were placed in the closest new block. Distances were measured from block centers. The old MDR code was also changed to intensity and coverage code as follows:

Old MDR Code	Old Coverage Code	New Intensity Code	New Coverage Code
0	No echoes	0	0
1	Any weak echo	1	1
2	$\leq \frac{1}{2}$ block	2	2
3	$> \frac{1}{2}$ block	2	3
4	$\leq \frac{1}{2}$ block	3	2
5	$> \frac{1}{2}$ block	3	3
6	$\leq \frac{1}{2}$ block	4	2
7	$> \frac{1}{2}$ block	4	3
8	$\leq \frac{1}{2}$ block	5	2
9	$> \frac{1}{2}$ block	5	3

The coverage in the old code was indicated by the odd or even numbered codes. Odd numbers indicated that over $\frac{1}{2}$ the MDR block area was covered. Even numbers meant that one half or less of the MDR block area was covered. The coverage that we use in the new MDR archiving scheme indicates the number of the four small MDR blocks that make up the TDL archive block

that report the maximum intensity code. In the transposed data we coded equal to or less than one half covered as 2, and greater than one half covered as 3.

4. NEW MDR DATA

The procedure for coding and reporting the new MDR data is described in U.S. Department of Commerce and U.S. Department of Defense (1978). TDL was interested in archiving only the radar intensities. The raw teletype data are decoded and the intensities are placed in NMC's 89 x 113 mapping array by the same computer program that creates the radar summary chart. The data from that array are written on disc every hour after the chart is finished. There are two data sets, each containing twelve hours of data. The data are packed, eight digits per word, with the usual NMC 12-word identifier at the beginning of each hour (Automation Division Staff, 1975). The attached memorandum by P. Chase describes some exceptions for the MDR identifier. The computer program that puts the intensities in the 89 x 113 array resolves differing intensities reported for the same block by choosing the highest value reported. Code 9's are replaced by the highest code less than 9 reported by other radars, or left as 9's if no other radar reports for that block. Blocks completely out of range from any network radar are coded with a hexadecimal 15. Missing reports in blocks within radar range are coded with a hexidecimal 14. Blocks within radar range and the station reports PPINA or PPIOM are coded with a hexidecimal 13. Otherwise, blocks are coded 0 (for no echoes), 1, 2, 3, 4, 5, 6 to correspond to video integrator and processor (VIP) codes, and 8 or 9 for unknown intensity echoes. Code 8 indicates there may be a severe local storm associated with this echo. One of these two data sets is written to tape each 12-h cycle. If one hour or a whole 12-h cycle is missing, it will be missing on tape. This tape is cataloged under data set name NWS.SDO.TDL.PROD.MDRARC and will be saved indefinitely. The tape is a 9 track, standard labeled tape written with the following DCB parameters: DCB = (RECFM=VS, LRECL=5080, BLKSIZE=5084, DEN=3). The records are written with FORTRAN unformatted write. The record length for the 12-word identifier and packed data is 1269 words (see Attachment 2 for further details).

We received a request from the River Forecast Center at Ft. Worth, Texas to instruct them on how to access the two NMC operational data sets. It occurred to us that others may be interested in using these detailed data for operational forecasting assistance. A brief FORTRAN program is included in Attachment 3 that includes all the necessary information required to access these data sets. The forecaster programmer can expand on this basic program to suit his own requirements.

5. THE NEW MDR MOS PREDICTAND DATA

The general MOS predictand tape format is described by Glahn (1974). The new MDR MOS predictand tape (MDRMOS) format follows the general format with these further explanations:

1. Record 1:

   Word 1 - number of MDR blocks (number of rows in the DATA array) = 2565,

   Word 2 - number of types of data (number of columns in the DATA array) = 2,

   Word 3 - number of words in packed data array + 1 = 579,

   Words 4 to 20 - reserved for possible future use.

2. Record 2:

   List of MDR block identifiers. The block in the upper left hand corner of Fig. 2 is identified by its I and J coordinates, 4501. The list continues left to right, row after row until the last block 0157.

3. Record 3:

   Call letters of closest primary radar network station (usually one with a WSR-57) to the block identified in record 2.

4. Record 4:

   Used to complete call letters, if required.

5. Record 5:

   Distance in nautical miles from center of MDR block to nearest network reporting radar station. 250+ indicates over 250 nautical miles.

6. Record 6:

   Call letters of the nearest secondary network station, e.g., local WSR-74C's.

7. Record 7:

   Distance in nautical miles from center of MDR block to the nearest secondary radar station. 125+ indicates over 125 nautical miles.

8. Multiple records until end-of-file consisting of

   a. Word 1 = data/time in the form:

      YR*1000000 + MO*10000 + DA*100 + HR

e.g., MDR reports for 1735Z Feb. 28, 1978 are dated 78022817

b. 578 packed DATA array words.

The NWS.SDO.TDL.PROD.MDRARC tape is input to the program that generates the new MDRMOS predictand tape. Since four blocks of the 89 x 113 array make up one of the TDL 45 x 57 array, the highest intensity code of the four is placed in the TDL array, except that four 13's, four 14's or four 15's are entered as 9999., the standard MOS missing data indicator. A 9 is changed to an intensity code of 1, the assumption being that a 1 would do the least harm when selecting the highest of the four codes to archive. Intensity codes are placed in column 1 of the DATA array. Column 2 contains the number of small blocks reporting the intensity code recorded in column 1, except a 0 intensity in all four small blocks is carried over as 0 in the TDL archive block. Also, a missing indicator (9999.) in column 1 will always be accompanied by a missing indicator in column 2. The MDRMOS tape is a 9 track, standard labeled tape written with the following DCB parameters: DCB = (RECFM=VS, LRECL=10264, BLKSIZE=10268, DEN=3). The records are written with FORTRAN unformatted write.

6. THE MDR/SEVERE LOCAL STORM TAPES

Data from the old MDR/severe local storms tapes (MDRSLS) have been transposed to the new grid just as the MDR data alone were, i.e., data from the old MDR block going into the closest TDL grid block. Data were written to tape in the MOS predictand tape format described further as follows:

1. The first seven header records are the same as the MDRMOS tapes, except word 2 in record one = 4 and word 3 = 1825.

2. Elements from columns 1 and 2 of the DATA array are the same as the MDRMOS tapes, except that intensity of 8 was coded if the additive data of the old MDR block contained a plus sign.

3. Column 3 of the data array contains the number of tornadoes, number of windstorms and number of hailstorms packed into one word. Tornadoes are counted in the hundred's position, windstorms in the ten's position and hailstorms in the unit's position. A limit of nine events is imposed on each position.

4. Column 4 of the DATA array contains a code giving approximate values for the maximum windspeed and hail size as follows:

   0* = wind 50-69 knots or wind damage, no hail reported,
   1 = wind 70-129 knots, no hail,
   2 = wind over 129 knots, no hail,
   3 = no wind, 3/4" $\leq$ hail < 1 3/4",
   4 = no wind, 1 3/4" $\leq$ hail < 3 1/4",

5 = no wind, hail $\geq 3\frac{1}{4}$",
6 = code 0 wind, code 3 hail,
7 = code 0 wind, code 4 hail,
8 = code 0 wind, code 5 hail,
9 = code 1 wind, code 3 hail,
10 = code 1 wind, code 4 hail,
11 = code 1 wind, code 5 hail,
12 = code 2 wind, code 3 hail,
13 = code 2 wind, code 4 hail,
14 = code 2 wind, code 5 hail.

*For these codes to be meaningful, the number of windstorms and/or hailstorms packed in column 3 must be greater than zero.

The MDR/severe local storm tapes are called MDRSLS. They are 9 track, standard labeled tapes written with the following DCB parameters: DCB = (RECFM=VS, LRECL=10264, BLKSIZE=10268, DEN=3). The records are written with FORTRAN unformatted write.

Both the packer and unpacker for MDRMOS and MDRSLS tapes are on NWS.SDO.TDL.W4LIB.LOAD library, and the documentation for their use is contained in Glahn (1975). The unpacker for the MDRARC tapes is not a separate subroutine, but the data can be unpacked by removing four bits for one hexadecimal number from left to right from each word.

REFERENCES

Automation Division Staff, 1975: Labels for NMC 360/195 data fields. NMC Office Note 84, National Weather Service, NOAA, U.S. Department of Commerce, 18 pp.

Foster, D. S., and R. M. Reap, 1973: Archiving of manually-digitized radar data. TDL Office Note 73-6, National Weather Service, NOAA, U.S. Department of Commerce, 5 pp.

Glahn, H. R., 1974: The TDL MOS development system, IBM 360/195 version. TDL Office Note 74-14, National Weather Service, NOAA, U.S. Department of Commerce, 73 pp.

_____, and D. A. Lowry, 1972: The use of the model output statistics (MOS) in objective weather forecasting. J. Appl. Meteor., 11, 1203-1211.

_____, G. W. Hollenbaugh, and F. T. Globokar, 1975: Computer programs for the MOS development system, IBM 360/195 version. TDL Office Note 75-2, National Weather Service, NOAA, U.S. Department of Commerce, 224 pp.

National Weather Service, 1977a: The automated radar summary chart. NWS Technical Procedures Bulletin No. 167, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 5 pp.

National Weather Service, 1977b: The teletype radar intensity plot. NWS Technical Procedures Bulletin No. 185 (Revised), National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 4 pp.

U.S. Department of Commerce and U.S. Department of Defense, 1978: Weather radar observations, Part A. National Weather Radar Network Observing and Reporting Procedures. Federal Meteorological Handbook No. 7, Superintendent of Documents, U.S. Government Printing Office, 42 pp.

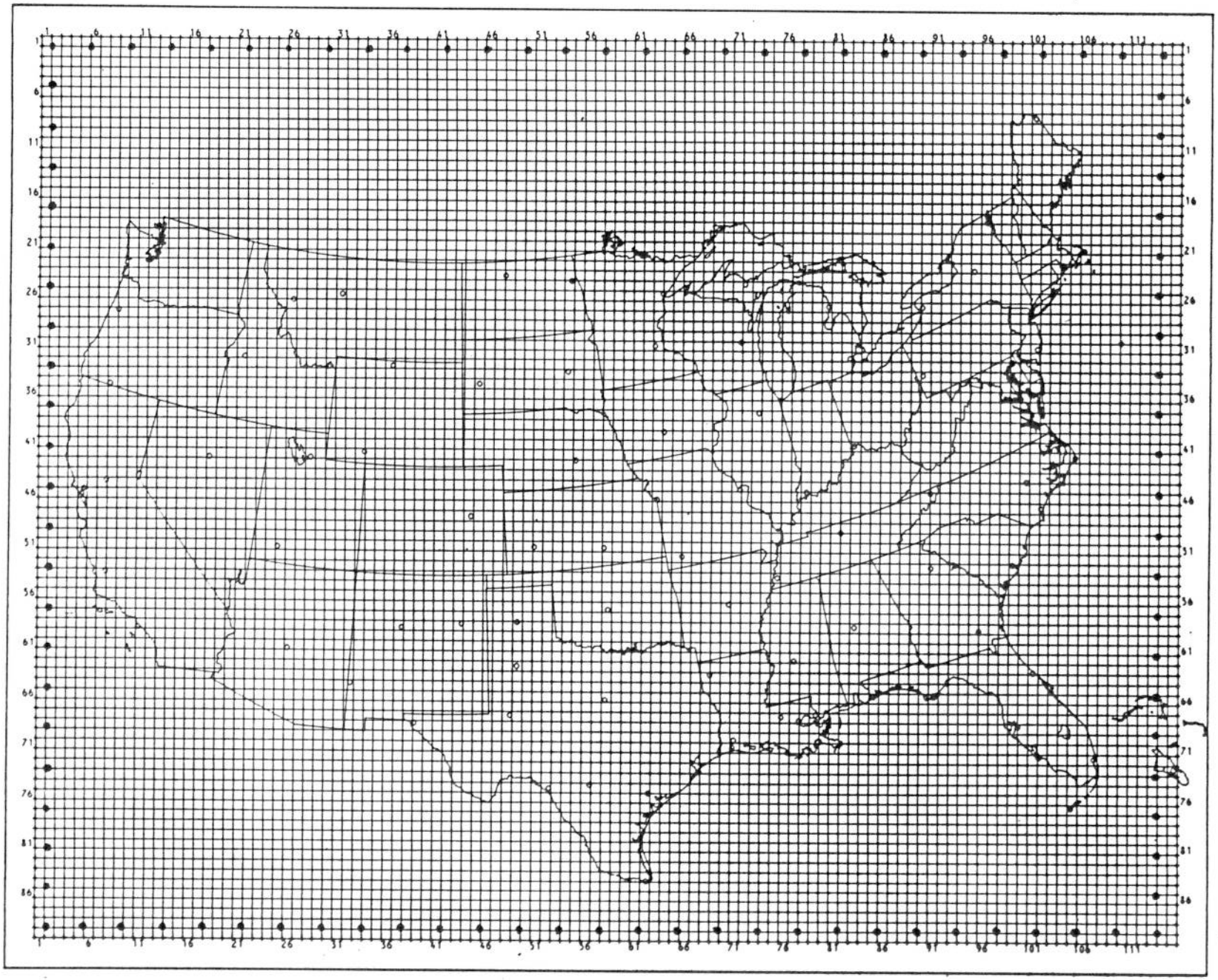

Figure 1. Grid showing the local MDR reporting blocks. Dots at grid intersections just inside the grid border are limited area fine mesh (LFM) grid points.

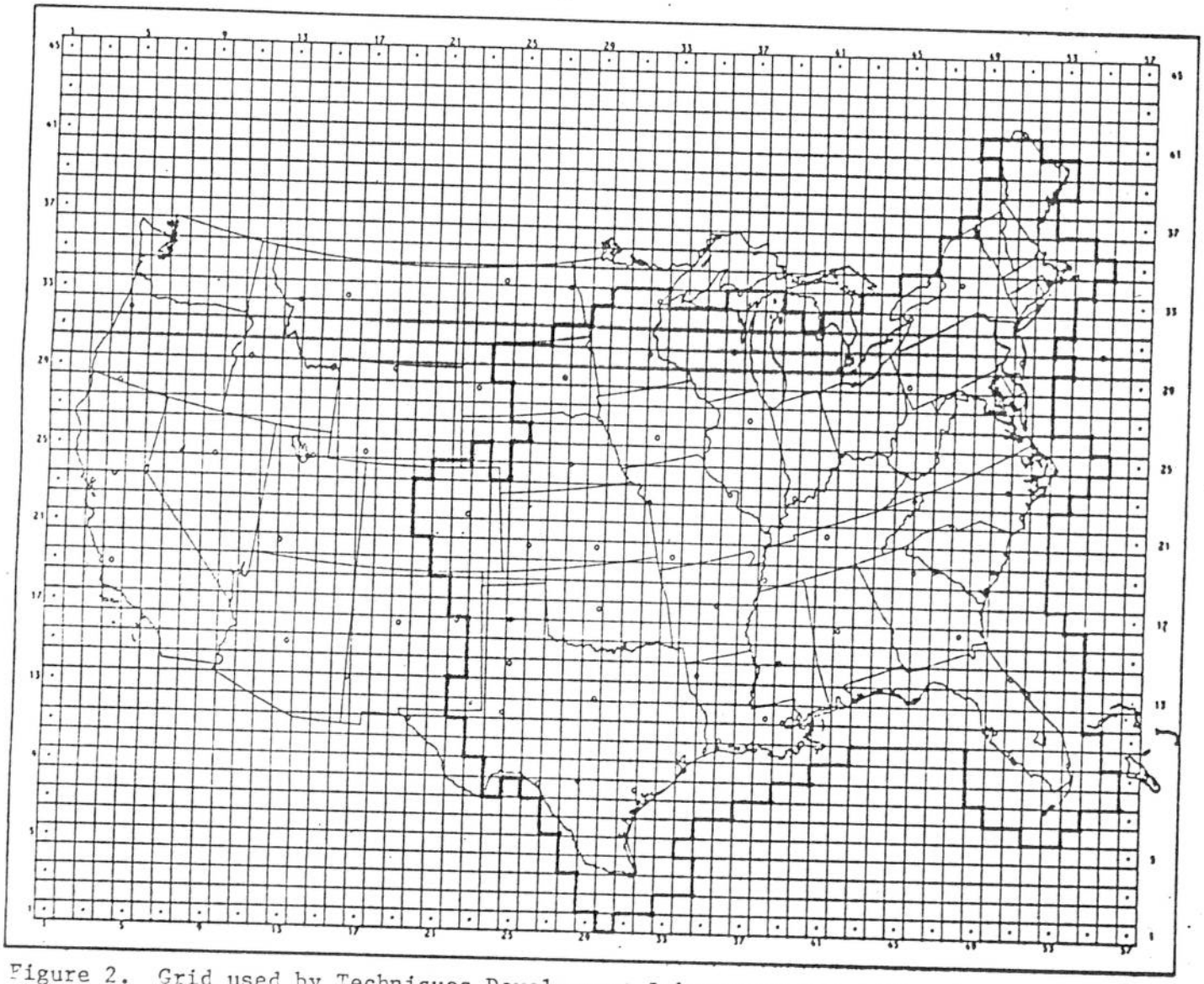

Figure 2. Grid used by Techniques Development Laboratory for collecting and archiving MDR intensity codes. Data from 869 MDR blocks in Fig. 3 have been transposed to the 869 blocks outlined above. Dots around the periphery are limited area fine mesh (LFM) grid points.

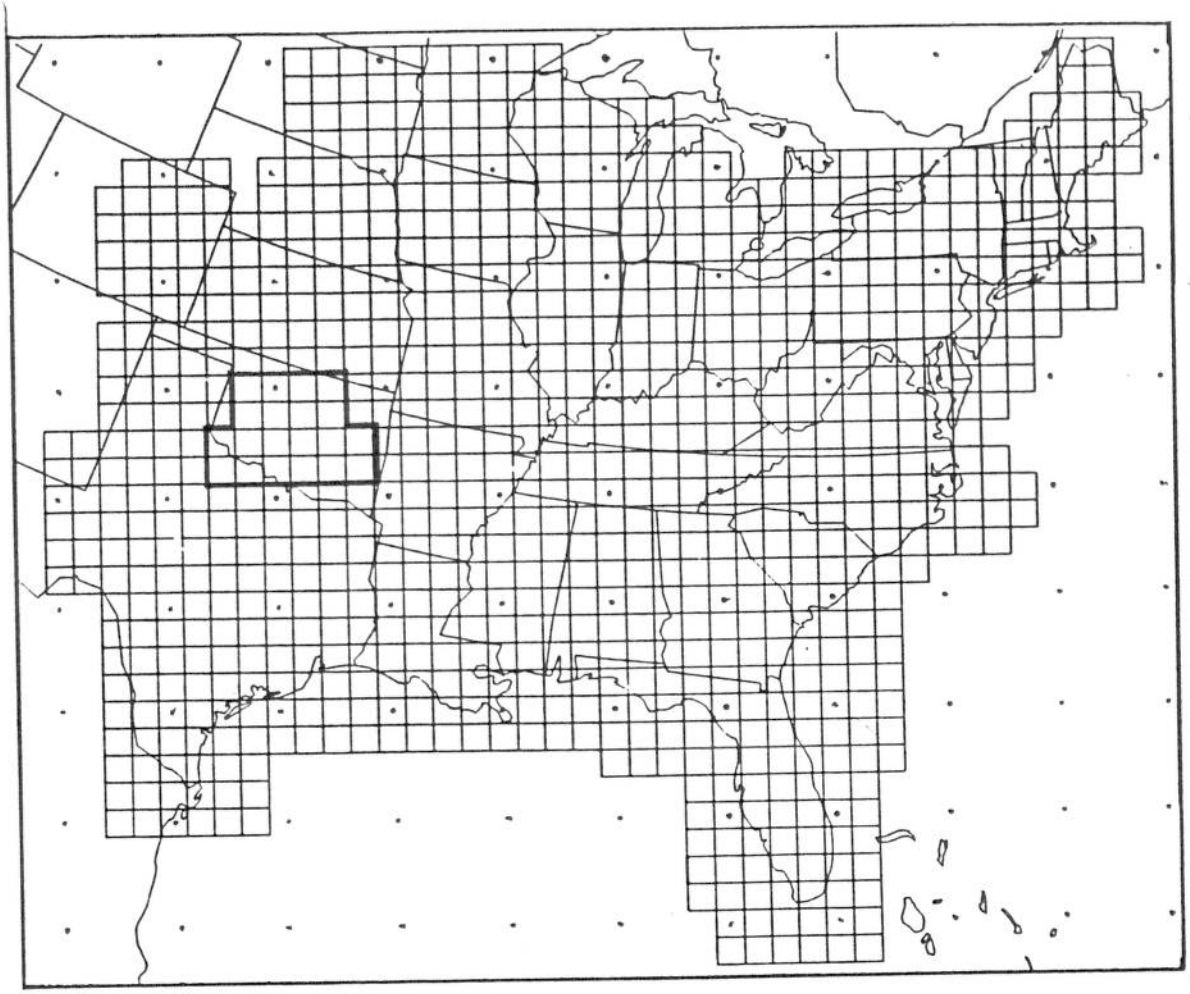

Figure 3. The old MDR reporting grid. Dots are primitive equation (PE) model grid points. Oklahoma City reported for the blocks heavily outlined above.

ATTACHMENT 1

TO: Jim Howcroft

FROM: P. Chase

SUBJECT: Archiving of radar intensity analyses

Could we arrange to begin archiving radar intensity analyses on March 1?

After the ØØZ LFM, archive NWS.NMC.PROD.RADAR.T12Z.AC1223
After the 12Z LFM, archive NWS.NMC.PROD.RADAR.TØØZ.ACØØ11
There will be 12 fields in each file at most.

Pecularities (known) of the fields

This will be a new quantity: radar intensity, $Q = B2_{16} = 178_{10}$

This will be a new grid type: K = 47 for 10057-point grid, 113 x 89, grid increment 47.625 km, oriented vertically at 105°W, covering the U.S.

This will be a new packing scheme: 1/8 packing, with 2 points per byte. Word 11, bits 0-3 will accordingly contain a binary quantity 2 to signify this, according to the table:

Word 11 Bits 0-3	Packing
0	16 bits/point
1	8
2	4
3	2
4	1

This will mean, among other things, that NW and J will no longer bear a simple relation to each other.

This will be a new use of field F_1 which normally shows tau. Initial hour II traditionally gives the cycle, ØØ or 12. Since radar intensities will be given hourly, and since II is not a part of the 6-word identifier field, F_1 will be used to give the displacement from II in hours. Thus hour will be computed by taking II + F_1.

For checksum purposes, it will be assumed that the packed array will be rounded out to the next larger halfword and that unused halfwords will be filled with zeroes. Eventually the packers and unpackers will be modified accordingly.

ATTACHMENT 2

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MDR ARCHIVING

INTRODUCTION

Twice daily the MDR operational files are archived on Tape. The DSN's for these saved operational files are:

(00Z) NWS.NMC.PROD.RADAR.T00Z.AC0011

(12Z) NWS.NMC.PROD.RADAR.T00Z.AC1223

AC0011 is copied to the archived tape after the 1135Z radar summary chart is finished. Similarly, AC1223 is written to the archive tape after the 2335Z radar summary chart is finished. (See Technical Procedures Bulletin No. 167).

Currently, this archiving is done in step "MDRARC" in operational job WW2133A8 (M8). The source pgm is located on W.NWS.SDO.TDL.RR.SOURCE1 (RRMDRARC).

The archived records are written to a catalogued tape of the following description:

```
DSN=NWS.SDO.TDL.PROD.MDRARC,UNIT=TAPE9,DISP=MOD,
DCB=(RECFM=VS,LRECL=5080,BLKSIZE=5084,DEN=3),
VOL=SER=EXXXXX   where EXXXXX is a NOAA 6-character tape no.
```

PREPARING CATALOGUED TAPE

In order to use DISP=MOD in operations the tape must be prepared with standard labels including the DCB and DSN. This is done using a PROC called 'TRLINT'. As shown in the JCL below, only the DSN and DCB must be supplied (in quotes). The UNIT=TAPE9 is assumed (default). As many as 11 tapes can be initialized at once (only two are shown in

the example on the SYSIN data card), by giving the 6-character tape numbers, separated by commas.

```
//STEP1 EXEC TRLINIT,DSN='NWS.SDO.TDL.PROD.MDRARC',
//  DCB='(RECFM=VS,LRECL=5080,BLKSIZE=5084,DEN=3)'
//SYSIN DD *
E03382, E03386
/*
```

When a tape has been prepared it is catalogued using IEHPROGM (JCL BELOW). NOTE that when changing tapes the old catalogue must be uncatalogued first.

```
//CATLOG EXEC PGM=IEHPROGM
//SYSPRINT DD SYSOUT=A
//DD1 DD UNIT=3330,VOL=SER=NWS250,DISP=SHR
//SYSIN DD *
    UNCATLG DSNAME=NWS.SDO.TDL.PROD.MDRARC
    CATLG   DSN=NWS.SDO.TDL.PROD.MDRARC,VOL=3400-3=(EXXXXX,1)
    where EXXXXX is the 6-character tape number
```

TAPE MANAGEMENT

Although the catalogued tape is capable of holding up to 6 months of data, a different tape is catalogued and prepared for operational use around the first of each month. This changing of tapes in short intervals is done to prevent loss of data if a tape "accident" occurs.

ATTACHMENT 3

```
//WEFDMDR JOB (WE26008C3781010,TDL-12),'D FOSTER',MSGLEVEL=(1,1),
// REGION=256K,CLASS=B,TIME=1
// EXEC PROC=NFORXCLG,FXPMAP=MAP,FXPL=XL,FXPXREF=XREF
//FORT.SYSIN DD *
C       PROGRAM NAME. NEW MDR INTENSITY CODES
C
C       AUTHOR. DONALD S. FOSTER
C
C       DATE. MARCH 1978
C
C       PURPOSE. TO RETRIEVE THE MANUALLY DIGITIZED RADAR INTENSITY
C       CODES FROM THE NMC CATALOGED DATA SETS, UNPACK THE DATA AND
C       WRITE THE CODES TO THE PRINTER SO THEY CAN BE READ UNDER
C       THE 8LPI PAPER DOLL OVERLAY.
C
C       CONTACT DON FOSTER AT TDL 301-427-7772 IF YOU DO NOT HAVE ONE.
C
C       THIS PROGRAM CAN BE SENT TO YOUR TERMINAL PUNCH FROM THE GRAMAX
C       TERMINAL BY REQUESTING SAME FROM DON FOSTER.
C
        DIMENSION MMP(1269),MM(89,113)
        INTEGER*4 LOCTBL(13),IDTBL(81),IDENT(6)
        REAL*8 MDRDA1,MDRDA2,MDRDAT
        DATA MDRDA1/'MDRDA1  '/
        DATA MDRDA2/'MDRDA2  '/
        DATA NFLD/12/,NPWDS/1269/,MASK/ZF0000000/
        DATA MSK/ZFFFFFF00/,MAK/Z000000FF/
        DATA IDENT/Z0B200600,Z00000000,Z00000000,Z00000000,Z00000002F,
       1Z000004F5/
C       READ BEGINNING HOUR (IHR) OF DATA TO BE RETRIEVED AND THE NUMBER
C       OF HOURS (NHRS) TO RETRIEVE. IHR WILL BE INCREMENTED IF NHRS IS
C       POSITIVE AND DECREMENTED IF NEGATIVE. FOR EXAMPLE,  17  04 PUNCHED
C       IN THE DATA CARD WILL RETRIEVE THE 1735Z, 1835Z, 1935Z, AND 2035Z
C       INTENSITY CODES.
        READ (5,10) IHR,NHRS
   10   FORMAT (2I4)
        IF(NHRS.GT.0) NHRS=NHRS-1
        IF(NHRS.LT.0) NHRS=NHRS+1
C       SELECT PROPER DATA SET AND DEFINE DISPLACEMENT
   80   IF(IHR.GT.11) GO TO 100
        MDRDAT=MDRDA1
        IDIS=IHR
        GO TO 120
  100   MDRDAT=MDRDA2
        IDIS=IHR-12
C       PUT DISPLACEMENT IN IDENT(1)
  120   IF1=LAND(IDENT(1),MSK)
        IDENT(1)=LOR(IF1,IDIS)
C       OPEN MDRDAT
        CALL W3FK00(MDRDAT,LOCTBL,NFLD)
C       READ IDTBL
        CALL W3FK01(MDRDAT,IDTBL,NFLD)
C       READ PACKED DATA FIELD INTO MMP
        CALL W3FK03(MDRDAT,IDTBL,IDENT,MMP,NFLD,NPWDS,IERR)
        IF(IERR.EQ.0) GO TO 180
        GO TO (130,140,160),IERR
  130   WRITE (6,131) IHR
  131   FORMAT (' DATA FIELD ENTRY NOT IN IDTBL FOR ',I4)
        GO TO 305
  140   WRITE (6,141) IHR
  141   FORMAT (' RETRIEVED DATA HAS WRONG ID FOR ',I4)
        GO TO 305
  160   WRITE (6,161) IHR
  161   FORMAT (' DATA FIELD ENTRY IS IN IDTBL BUT CORRESPONDING ENTRY IS
       1MISSING FROM MASTER INDEX TABLE FOR ',I4)
        GO TO 305
```

```
C       UNPACK ONE HOURS RECORD OF MDR INTENSITY CODES INTO MM ARRAY.
  180   II=1
        JJ=0
        DO 260 I=13,1269
        IWD=MMP(I)
        DO 240 J=1,8
        JJ=JJ+1
        IF(JJ.GT.113) GO TO 220
  200   IDIG=LAND(IWD,MASK)
        MM(II,JJ)=SHFTR(IDIG,28)
C       SEVENS ARE INSERTED IN BLOCKS OUT OF RADAR RANGE, IN BLOCKS WITH
C       PPINA OR PPIOM, AND IN BLOCKS WITH MISSING DATA
        IF(MM(II,JJ).GT.9) MM(II,JJ)=7
        IWD=SHFTL(IWD,4)
        GO TO 240
  220   II=II+1
        JJ=1
        GO TO 200
  240   CONTINUE
  260   CONTINUE
        MM(89,113)=7
C       UNPACK AND PRINT DATE OF DATA JUST UNPACKED
        IWD=MMP(7)
        IH=LAND(IWD,MAK)
        IWD=SHFTR(IWD,8)
        ID=LAND(IWD,MAK)
        IWD=SHFTR(IWD,8)
        IM=LAND(IWD,MAK)
        IWD=SHFTR(IWD,8)
        IY=LAND(IWD,MAK)
        IWD=MMP(1)
        JDIS=LAND(IWD,MAK)
        JDATE=IY*1000000+IM*10000+ID*100+IH+JDIS
        WRITE (6,280) JDATE
  280   FORMAT (1H1,1X,I8)
C       WRITE THE MM ARRAY TO THE PRINTER
        DO 300 II=1,89
        I=90-II
        WRITE (6,290) (MM(I,J),J=1,113)
  290   FORMAT (1X,113I1)
  300   CONTINUE
C       CLOSE MDRDAT
  305   CALL W3FK09(MDRDAT)
C       INCREMENT OR DECREMENT IHR BY 1 UNLESS NHRS EQUALS 0
        IF(NHRS)320,350,310
  310   IHR=IHR+1
        IF(IHR.EQ.24) IHR=0
        NHRS=NHRS-1
        GO TO 80
  320   IHR=IHR-1
        IF(IHR.EQ.-1) IHR=23
        NHRS=NHRS+1
        GO TO 80
  350   STOP
        END
/*
//LKED.NMCLIB DD DSN=NWS.NMC.W3LIB.LOAD,DISP=SHR
//LKED.SYSIN DD *
  INCLUDE NMCLIB(W3FK00,W3FK01,W3FK03,W3FK09)
  ENTRY MAIN
/*
//GO.MDRDA1 DD DSN=NWS.NMC.PROD.RADAR.T00Z.AC0011,DISP=SHR
//GO.MDRDA2 DD DSN=NWS.NMC.PROD.RADAR.T12Z.AC1223,DISP=SHR
//GO.SYSIN DD *
  03  -6
/*
//
```