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ARCHIVING OF MANUALLY-DIGITIZED RADAR DATA

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INTRODUCTION

Manually-digitized radar data have been collected from hourly teletype reports and archived in the MOS predictand tape format since November 1, 1973. These data are intended for both general and severe thunderstorm prediction using Model Output Statistics [1] which relate the radar data to large-scale predictors from operational numerical models. Other uses for the data include the development of improved initial moisture fields in TDL numerical models and verification of convective weather forecasts.

PROCEDURE

A master grid of radar reporting blocks was designed to include the 48 conterminous United States. A portion of that grid, covering the eastern two-thirds of the country, is shown in Fig. 1. The grid blocks are roughly 40-45 nautical miles on a side, i.e., one-fourth of the NMC coarse mesh. For convenience, the radar grid is referenced to a 26 x 33 grid, shown in Fig. 2, which is a subset of the standard NMC 1977 point octagon grid. The radar grid (Fig. 1) is shifted slightly so that the NMC grid points fall exactly in the center of every fourth radar grid block. For example, the first (left-most) column of blocks in Fig. 1 coincides with column 17 of the 26 x 33 grid, and the 53rd column of blocks in Fig. 1 coincides with column 26. The 2nd (next to bottom) row of blocks in Fig. 1 coincides with row 6 of the 26 x 33 grid and the 34th (top) row coincides with row 14.

Each block of the radar grid is identified by a 4 digit block number generated by multiplying the row number by 100 and adding the column number. For example, the grid block containing St. Louis, Mo. is block 2334. Block numbers identifying all 864 blocks in the digitized radar program for the Southern, Central, and Eastern Regions are stored as "Station Numbers" in the LWBANY array (see attachment 1). They are stored in the same order as the digitized data appear in the packed data matrix. The corresponding radar station call letters and its local grid row and column numbers are stored in the NAMEY (I,1) array. If another station also reports for any of the blocks, the call letters and block coordinates of the second station are stored in the NAMEY (I,2) array. The data matrix contains 3 columns and 864 rows, each row corresponding to a radar grid block. The first column contains the echo intensity and coverage code for each block and has possible values from 0 through 9, as described in attachment 2. The second column contains additive data, if any, as shown in Fig. 3. These data are represented by digits ranging

from 1-3, where

3 means a (+) was coded for the block, indicating that ROML criteria [2] for severe convective storms were satisfied,

2 means a (-) was coded for the block, indicating echoes requiring a special radar observation during the last hour,

1 means a (/) was coded for the block, indicating a line of echoes.

When reporting blocks from two stations overlap, intensity codes and additive groups from the secondary station are packed in column 3.

Search time, or table look-up, in the archiving program is held to a minimum by including an index array containing a row of data for each of the 48 radar reporting stations currently in the digitized program. Each row of index data includes the station call letters, the number of blocks in the local station grid, and the index to the LWBANY, NAMEY and data arrays for each block.

Input tapes to the archiving program consist of the 360/40 dump tapes containing intensity codes and additive data for each 24-hour period starting at 0000 GMT. Each dump begins with the heading, SD DIGITAL DATA DAHRMN. The dump tape is an "S" tape written at 556 bpi density in coded mode and may be read with the FORTRAN BUFFER IN statement. Each tape contains a single file of 192-character records in BCD mode. The first record begins with the 10 character data-time group SDUSYRMODA, with 182 blank characters saved for future use. Station reports begin with a three digit call-letter identifier, a four digit time group, a beginning delimiter (11-4-8 Hollerith punch), intensity codes, additive data, if any, and an ending delimiter (12-5-8 Hollerith punch). The 192-character record may end anywhere within a station report.

The data on the 360/40 dump tapes are identical to the raw teletype data (see Fig. 3), i.e., they are unedited and unchecked for possible errors. The archiving program does a limited amount of editing and error checking prior to storing data in the data matrix. These procedures are described below:

1. A report must start with a station call-letter identification matching one in the index array or it is discarded.
2. If a good report has been decoded, any succeeding duplicate reports for that station in the same hourly collection will be discarded. This is accomplished by flagging column 32 in the index array when a good report is decoded for the hour being processed.
3. All blanks are skipped over. Therefore, any numeric field or alphabetic field separated accidently by a blank or blanks will decode properly.

4. After a valid station identifier is found, a search is made for a time group. If a beginning delimiter is found before a complete time group is decoded, the time is assumed to be that of the hourly collection and decoding continues. Experience indicates that this procedure saves many reports when the time group is garbled, which occurs frequently, and introduces only a very small chance of including a report in the wrong hourly collection.
5. Column 33 of the index array is flagged when a station reports PPINE, i.e. no echoes on the scope. If echoes do not occur for an extended period, subsequent PPINE reports are required only at three-hour intervals, e.g. 0200-, 0500-, 0800-GMT, etc. The flag provides a means for coding zeroes in the data matrix for the intermediate hours when a station report is not transmitted due to an absence of echoes on the scope.
6. Data between the beginning delimiter and the additive data group or an ending delimiter should be intensity codes (see Fig. 3). Each character is checked to see if it is numeric. Any superfluous characters appearing in designated blank spaces are passed over.
7. A character count is made and checked against the station total block number assignment stored in the index array. That is, if the number of numeric characters in the message does not agree with the number of blocks assigned to the station, the report is printed-out for visual inspection and the missing indicator (9999.) is left undisturbed in the data matrix. (Initially, 9999.'s are placed in the data matrix and are gradually replaced in blocks where decoded data are available).
8. Additive data are decoded next, if included. A symbol indicator (+, -, /) should precede each pair of block coordinate digits (see Fig. 3). If the symbol indicator is followed by more than one pair of coordinates, the symbol code is stored in each block until a new symbol indicator or ending delimiter is encountered. We assume that it was the intent of the encoder to apply the same symbol to successive pairs of block coordinate digits. The information saved outweighs the chance for error. Occasionally, two symbols will be coded for the same block. In this case, the highest coded value is stored in the data matrix. Before a 3 is stored in the data matrix, a check is made to insure that the intensity code for the block is 4 or higher. Otherwise, the ROML code is discarded. Before a 1 is recorded in the data matrix, a check is made to insure that the intensity code for the block is non-zero. Otherwise, the line-echo code is discarded. A 2 is recorded for a block even in cases where the intensity code is zero. Because of the time difference, it is possible for the echo requiring the special observation during the past hour to move completely out of the grid box.

9. A primary and secondary station are designated for each overlapping block. Data from the primary station are stored in columns 1 and 2 of the packed data matrix. To prevent the loss of any data, intensity codes and additive groups from the secondary station are stored in column 3 of the packed data matrix.
10. Reports of DRZERO cause zeroes to be entered in the data matrix for that hour only. (A DRZERO report means that echoes were observed outside of the reporting blocks assigned to the station).
11. Any other reports such as PPIOM, PPINA, etc, or missing reports, except where a PPINE flag is set, result in the missing indicator 9999. in the data matrix.
12. At the end of each hour's processing, the proper locations in the data matrix are set to zero (no echoes) for all PPINE flags set, a packing subroutine is called, the packed array written on the archive tape, and the data matrix reinitialized to start a new hour. Missing indicators are written on the archive tape for all hourly or daily collections missing on the dump tapes.

It is possible in rare occasions to miss some data. Only experience will indicate if a more elaborate system is needed. A sample of the decoded and edited teletype data is shown in Fig. 4.

Printed output from the archiving program consists of reports that could not be decoded and off-time reports. Tape output is in the format of a MOS predictand tape (see attachment 1). This includes

Record 1: A header record (20 words)

Word 1 = 864
Word 2 = 3
Word 3 = 624
Word 4-20 = for future use

Record 2: LWBANY array (864 words)

Record 3: NAMEY (I,1) array (864 words)

Record 4: NAMEY (I,2) array (864 words)

Record 5 thru 28: packed data arrays with one record for each hour of the day. The first word of each record is NDATE, i.e., YRMODAHR

A double EOF indicates the end of information on a tape. The archive tape is a 7-track nonlabeled "L" tape written in binary mode with the FORTRAN WRITE statement at 800 bpi density.

REFERENCES

[1] Glahn, H. R. and D. A. Lowry, 1972: "The Use of Model Output Statistics (MOS) in Objective Weather Forecasting." J. Appl. Meteor., 11, 1203-1211.

[2] Regional Operations Manual Letter 71-8, 1971: "Guidelines for Issuing Tornado and Severe Thunderstorm Warnings and Statements Based on Radar Data." Southern Region, NWS, NOAA.

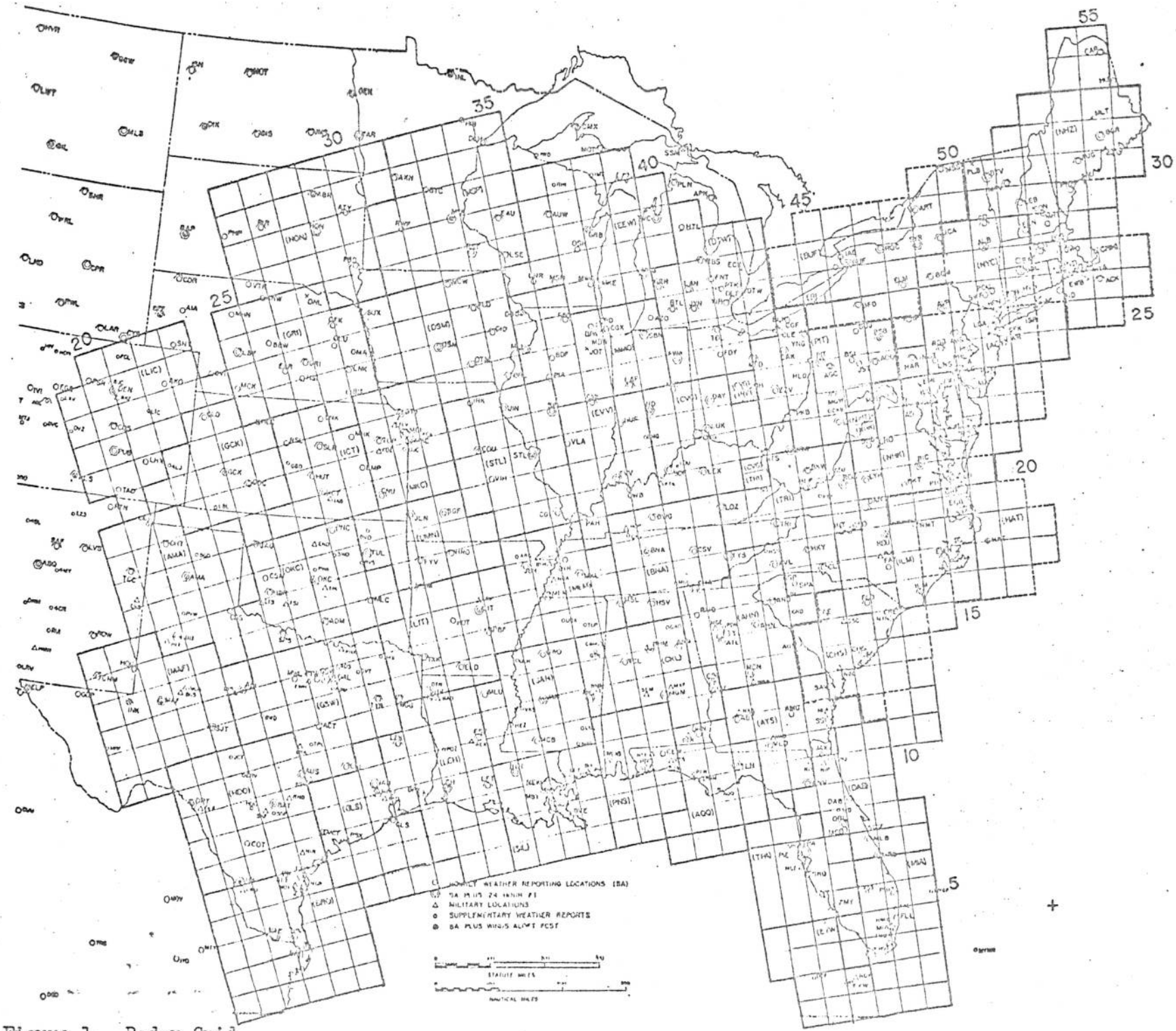


Figure 1. Radar Grid

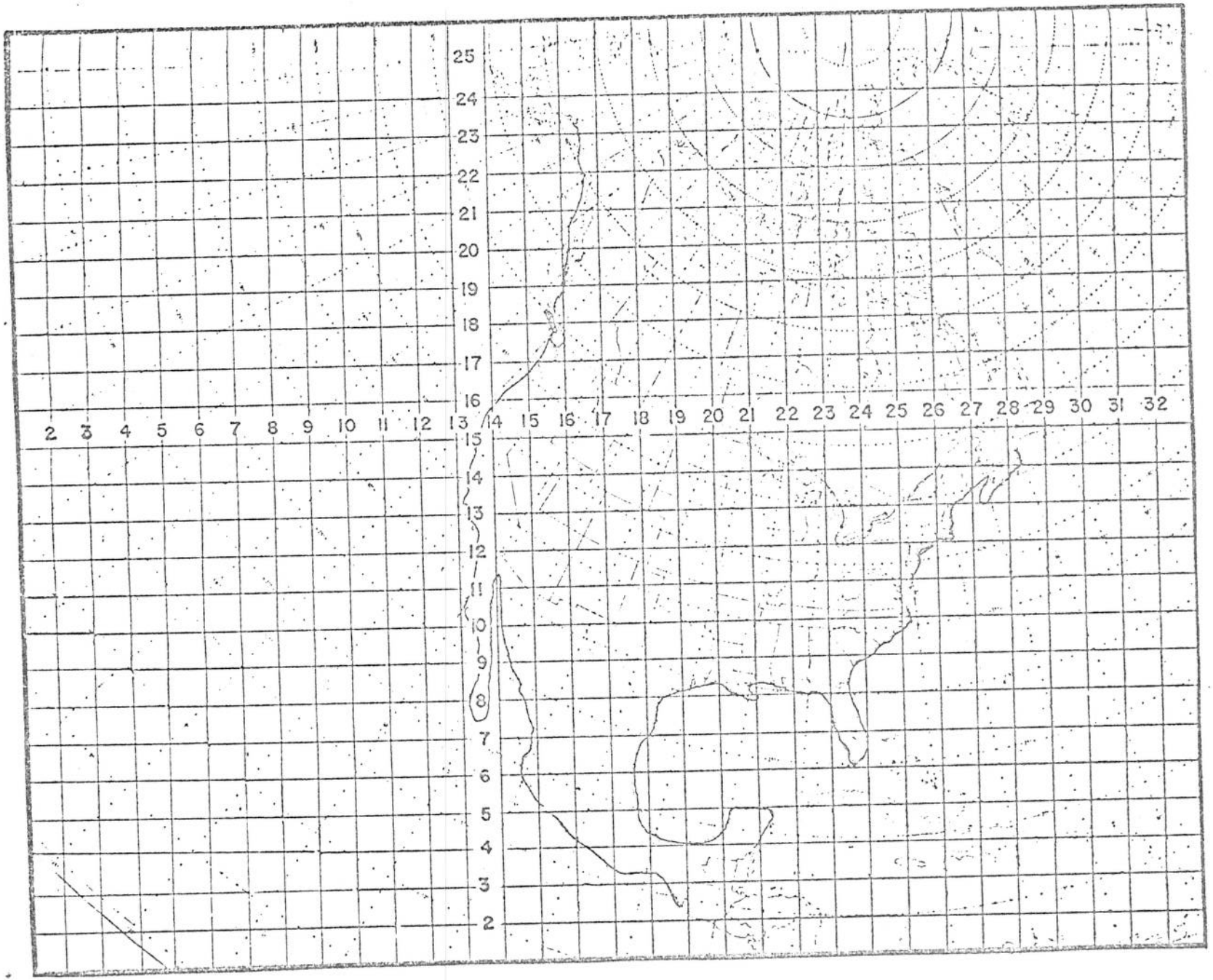
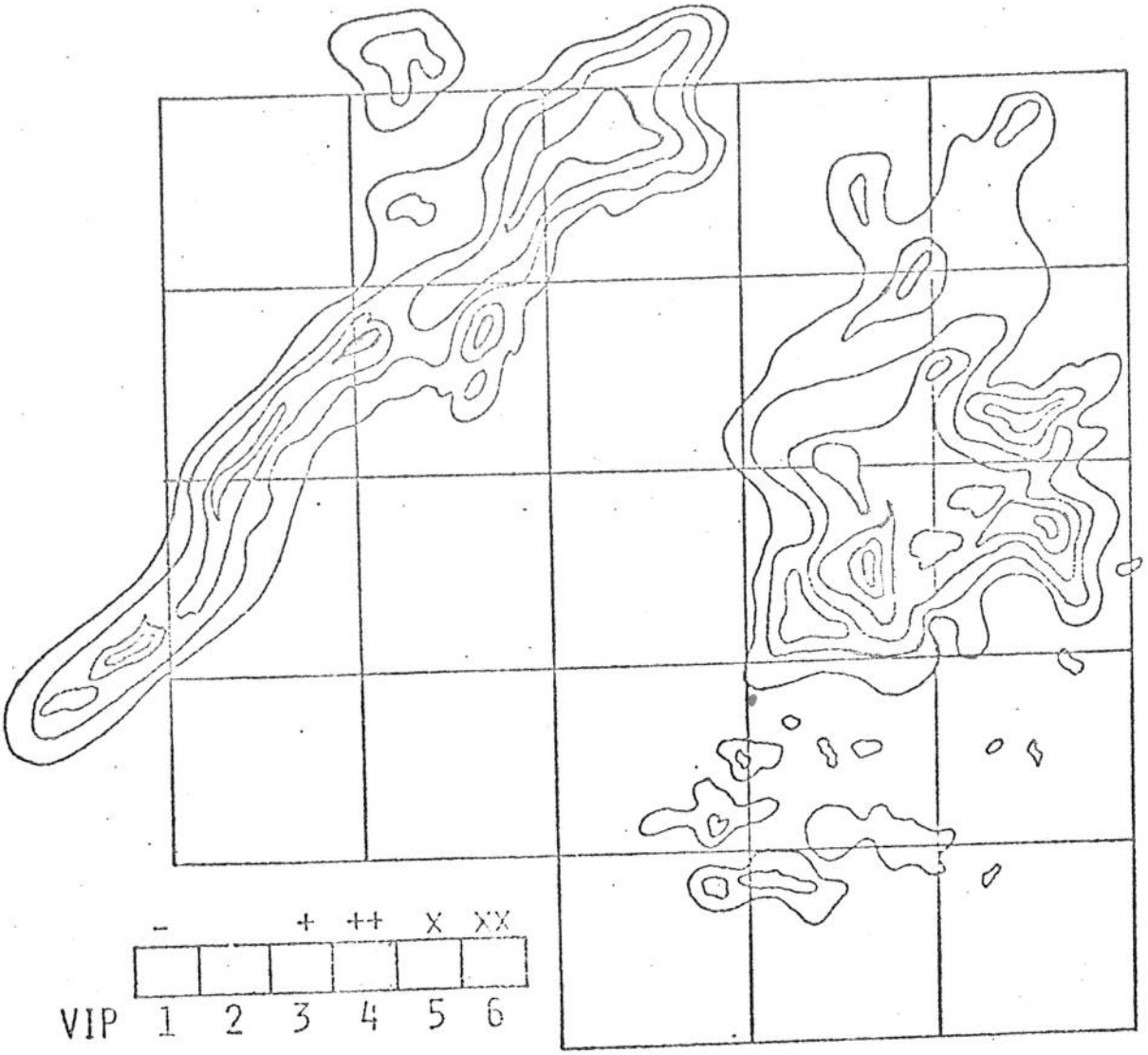


Figure 2. The 26 x 33 grid shown above is a subset of the NMC 1977 point octagon. The mesh length is 381 km at 60° north latitude.

EXAMPLE OF DR CODING



CODE ↑ 0 6 8 4 2 \\\ 6 6 1 6 6 \\\ 6 0 0 9 8 \\\ 0 0 2 1 1 \\\ 2 2 1

ADDED DATA /12/13/21/22/31+34-35←

DATA LINE ON TTY WILL APPEAR ON SINGLE SEPARATE LINE:

↑06842 66166 60098 00211 221 /12/13/21/22/31+34-35←

Figure 3. Sample teletype message.

Block No.	NAMEY(I,1)	NAMEY(I,2)	Intensity	Additive
2750	NYC22		0.	0.
2751	NYC23		1.	0.
2752	NYC24		2.	0.
2753	CHH31	NYC25	2.	0.
2754	CHH32		1.	0.
2755	CHH33		1.	0.
2756	CHH34		2.	0.
2619	LIC51		0.	0.
2620	LIC52		1.	0.
2621	LIC53		3.	3.
2622	GCK21		4.	1.
2623	GCK22		0.	0.
2624	GCK23		0.	0.
2625	GCK24		0.	0.
2626	ICT11		0.	0.
2627	ICT12		0.	0.
2628	GRI51		0.	0.
2629	MKC11		0.	0.
2630	MKC12		0.	0.
2631	MKC13		0.	0.
2632	DSM41		0.	0.
2633	DSM42		0.	0.
2634	DSM43		0.	0.
2635	MM031		0.	0.
2636	MM032		0.	0.
2637	MM033		0.	0.
2638	MM034		0.	0.
2639	MM035		0.	0.
2640	DTW51		0.	0.
2641	DTW52		0.	0.
2642	DTW53		0.	0.
2643	DTW54		0.	0.
2644	PTT11		0.	0.
2645	BUF51	PTT12	0.	0.
2646	BUF52	PTT13	0.	0.
2647	BUF53		0.	0.
2648	BUF54		0.	0.
2649	NYC31		0.	0.
2650	NYC32		0.	0.
2651	NYC33		0.	0.
2652	NYC34		2.	0.
2653	CHH41	NYC35	1.	0.
2654	CHH42		1.	0.
2655	CHH43		0.	0.
2656	CHH44		0.	0.
2520	LIC61		6.	1.
2521	GCK31		4.	1.
2522	GCK32		0.	0.
2523	GCK33		0.	0.
2524	GCK34		0.	0.
2525	GCK35		0.	0.
2526	ICT21		0.	0.
2527	ICT22		0.	0.
2528	ICT23		0.	0.
2529	MKC21		0.	0.
2530	MKC22		0.	0.
2531	MKC23		0.	0.
2532	STL11		9999.	9999.
2533	STL12		9999.	9999.
2534	STL13		9999.	9999.
2535	STL14		9999.	9999.
2536	MM041		0.	0.
2537	MM042		0.	0.
2538	MM043		0.	0.
2539	MM044		0.	0.

Figure 4. Sample of decoded and edited SD radar data.

Format of MOS Predictand Tapes

A - One or more files, each consisting of

1 - Header information, consisting of:

Record 1:

Word 1 - number of stations = number of rows in data matrix (NROWS)

Word 2 - number of types of data = number of columns in data matrix (NCOLS)

Word 3 - number of words in packed data matrix +1 = size of record (NWDS)

Words 4 to 20 - reserved for possible future use

Record 2:

NROWS words - list of station numbers (5 digit WBAN in order as data appear in matrix (LWBANY( ))

Record 3:

NROWS words - first 10 characters of station names (NAMEY(,1))

Record 4:

NROWS words - second 10 characters of station names (NAMEY(,2))

2 - Multiple records, consisting of:

a - Word 1 = date in YR*1000000 + MO*10000 + DA*100 + HR

b - NWDS-1 words = packed data matrix

B - End of data on tape signaled by a double EOF

Attachment 1.

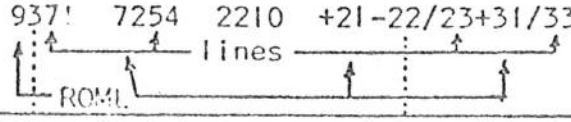
MANUALLY DIGITIZED RADAR DATA (DR) CODE

CODE NO.	MAXIMUM OBSERVED VIP LEVEL	COVERAGE IN BOX	RAINFALL RATE IN/HR	INTENSITY CATEGORY
0	NO ECHOES			
1	1	ANY VIP1	<.1	WEAK
2	2	≤ 1/2 OF VIP2	.1-.5	MODERATE
3	2	> 1/2 OF VIP2		
4	3	≤ 1/2 OF VIP3	.5-1	STRONG
5	3	> 1/2 OF VIP3		
6	4	≤ 1/2 OF VIP3 AND 4	1-2	VERY STRONG
7	4	> 1/2 OF VIP3 AND 4		
8	5 OR 6	≤ 1/2 OF VIP3 4,5 AND 6	>2	INTENSE OR EXTREME
9	5 OR 6	> 1/2 OF VIP3 4,5 AND 6	>2	INTENSE OR EXTREME

(IGNORE ADDITIONAL COVERAGE BY WEAK ECHOES FOR ALL DR CODE NUMBERS ABOVE 1. INTENSITY CATEGORIES AND RAINFALL RATES CORRESPOND TO MAXIMUM OBSERVED VIP LEVELS.)

Information on lines and ROML criteria will be handled by adding, when necessary, an additional data group at the end of the line of DR data in the teletype message. A plus (+) sign will precede row and column coordinates of boxes containing echoes which satisfy any of the guidelines for issuing tornado or severe thunderstorm warnings and statements as described in the current ROML on this subject. A minus (-) sign will precede coordinates of boxes which have had, during the immediate past hour, echoes requiring a special RAREP. A solidus(/) will precede coordinates of boxes containing echoes in clearly significant line configuration. Where more than one of these symbols is applicable to a box the order of priority will be: 1) +, 2) -, and 3) /. The coordinates of any box will appear in the added data group at most once and will be added in the order that they appear from left to right, top to bottom, in the station grid. For instance, the third box in the first row (coordinates: 13) would appear before, say, the first box in the third row (coordinates: 31), regardless of whether the coordinates are preceded by +, -, or /.

Sample message: 40001 9371 7254 2210 +21-22/23+31/33=



This indicates that box now coded as 3 had an echo in the past hour which required a special observation

Attachment 2