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CENTRAL REGION TECHNICAL ATTACHMENT 89-36

USING RADAR DATA TO ESTIMATE RAINFALL AMOUNTS A CASE STUDY AND DISCUSSION

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1. Introduction

Since the early days of weather radar, meteorologists have attempted to correlate radar reflectivities with rainfall amounts. Although many studies have found problems with this approach, it can yield a good first estimate of rainfall over an area.

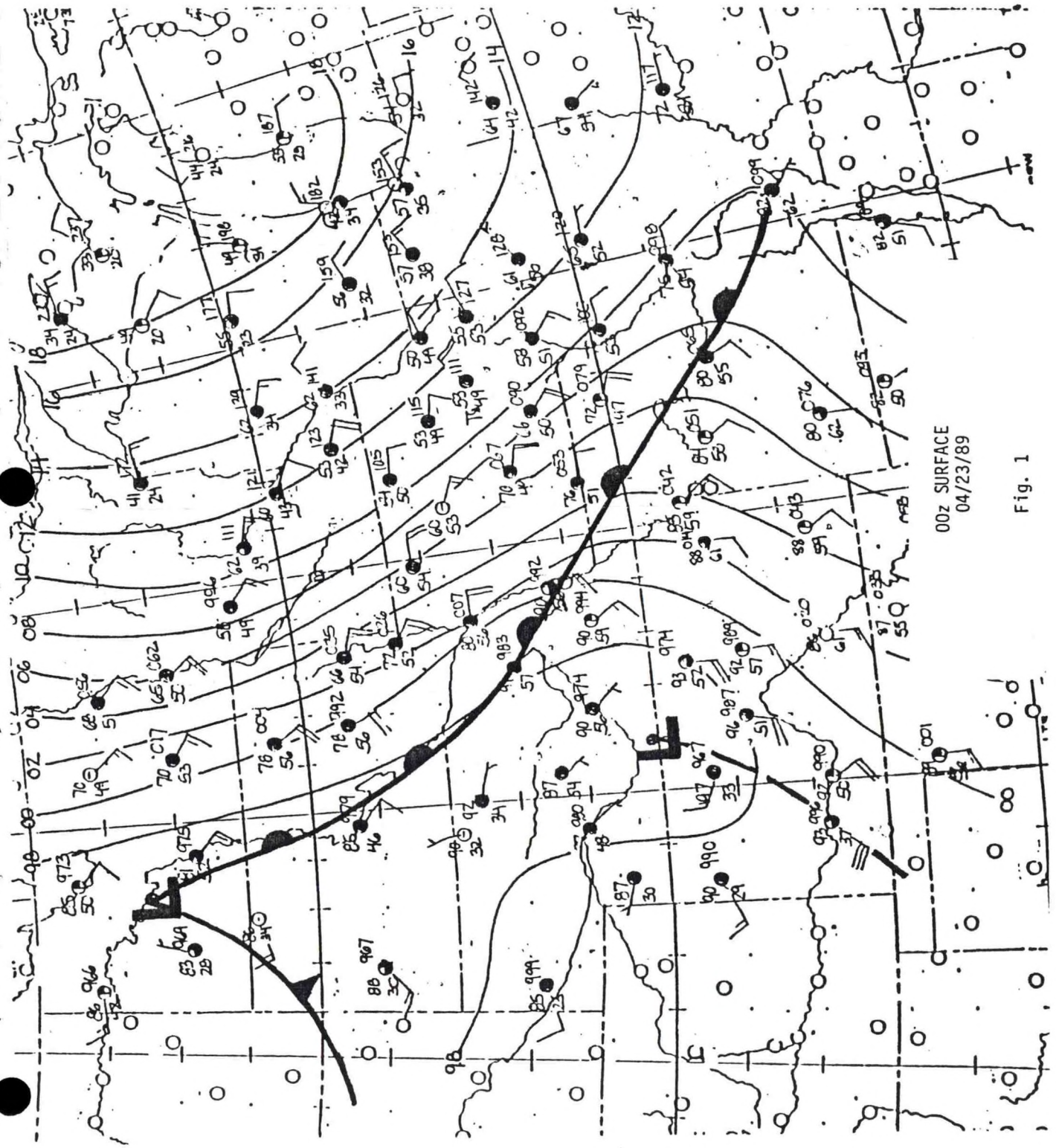
In particular, the MDR data appended to current radar observations can provide useful rainfall information via the AFOS application MDR (Peroutka, 1985). WSFO Des Moines has used this program (with good results) for a number of years for calculating rainfall amounts in convective situations. The following example is one case where the MDR program was used to keep track of rainfall over eastern Iowa.

Typically, the program is used to calculate rainfalls over a 1, 3, or 6 hour time span. In this example, the rainfall event occurred over a 12 hour period, so two 6-hour periods were summed to get rainfall totals for the entire event. Although this is a somewhat unique way to use the MDR program, it does demonstrate its usefulness.

2. The Rainfall Event of April 22-23, 1989

On April 22, 1989, a warm front extended from eastern Nebraska, through southwest Iowa, into central Missouri (Fig. 1). Showers and thunderstorms developed in the strong overrunning north of this front in a rather narrow band from near Mason City, through Cedar Rapids, to around Burlington. A strong upper level ridge was centered over the Plains, resulting in northwest flow over eastern Iowa. This flow supported a train echo effect, so that repeated cells with VIP levels of 4 and 5 were common. Almost all of the rain fell between 2100Z on the 22nd to 0830Z on the 23rd.

Under normal soil conditions, this pattern would have almost certainly produced flooding, especially since the repeat storms moved directly down the Wapsipinicon River drainage area. However, due to the drought and low water levels, no problems occurred.



00z SURFACE
04/23/89

Fig. 1

Using the MDR program, the WSFO staff kept track of 1, 3, and 6 hourly rainfall totals throughout the afternoon of the 22nd and into the early morning hours of the 23rd. Since the event spanned 12 hours, the MDR derived rainfall totals for two 6-hour periods (2030Z-0230Z and 0230Z-0830Z) were used to provide the 12 hour calculation.

The MDR program documentation stated that rainfall amounts were overestimated by a factor of two in the Northeast U.S. WSFO Des Moines has found this to also be the case in the Central U.S. Therefore, the MDR derived rainfall was cut in half to come up with the estimated rainfall for the event. (There are important exceptions to this, and they are discussed below.)

3. Results

The MDR rainfall estimate is shown in Figure 2. Note that it was very close to the observed rainfall (Fig. 3), especially in denoting the axis and amount of the heaviest precipitation. The MDR estimates were on the low side over far northeast and southeast counties, but this is probably due to missing MDR values for these areas and the fact that these areas are on the fringes of network radar coverage where the accuracy of MDR values decline rather rapidly.

Also of interest is a comparison of satellite derived rainfall estimates (as calculated by NESDIS and sent out over the AFOS network) for the same event, which are given in Figure 4. In this case, MDR rainfall values were of far more use than those produced by satellite imagery.

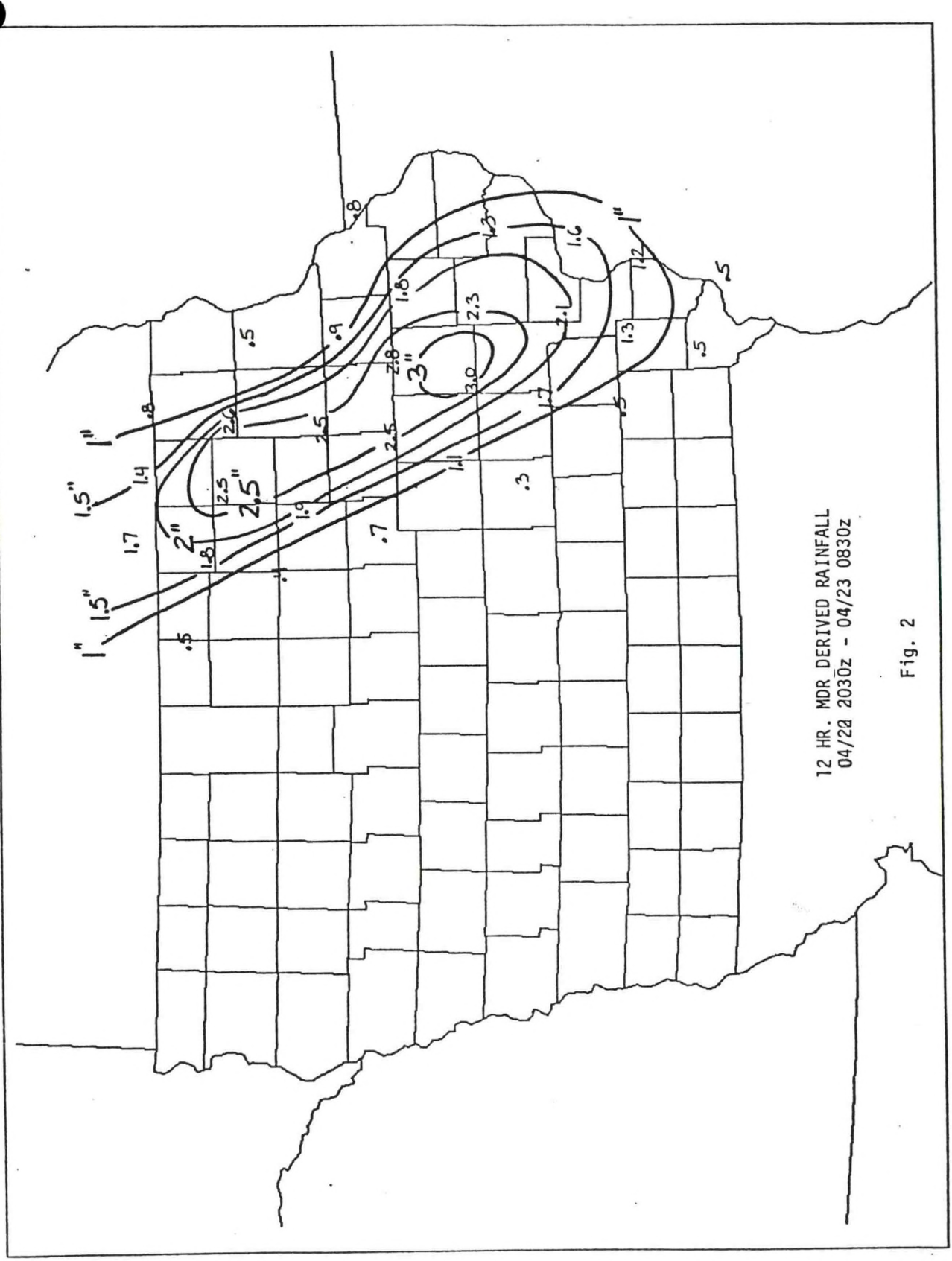
4. Discussion and Conclusion

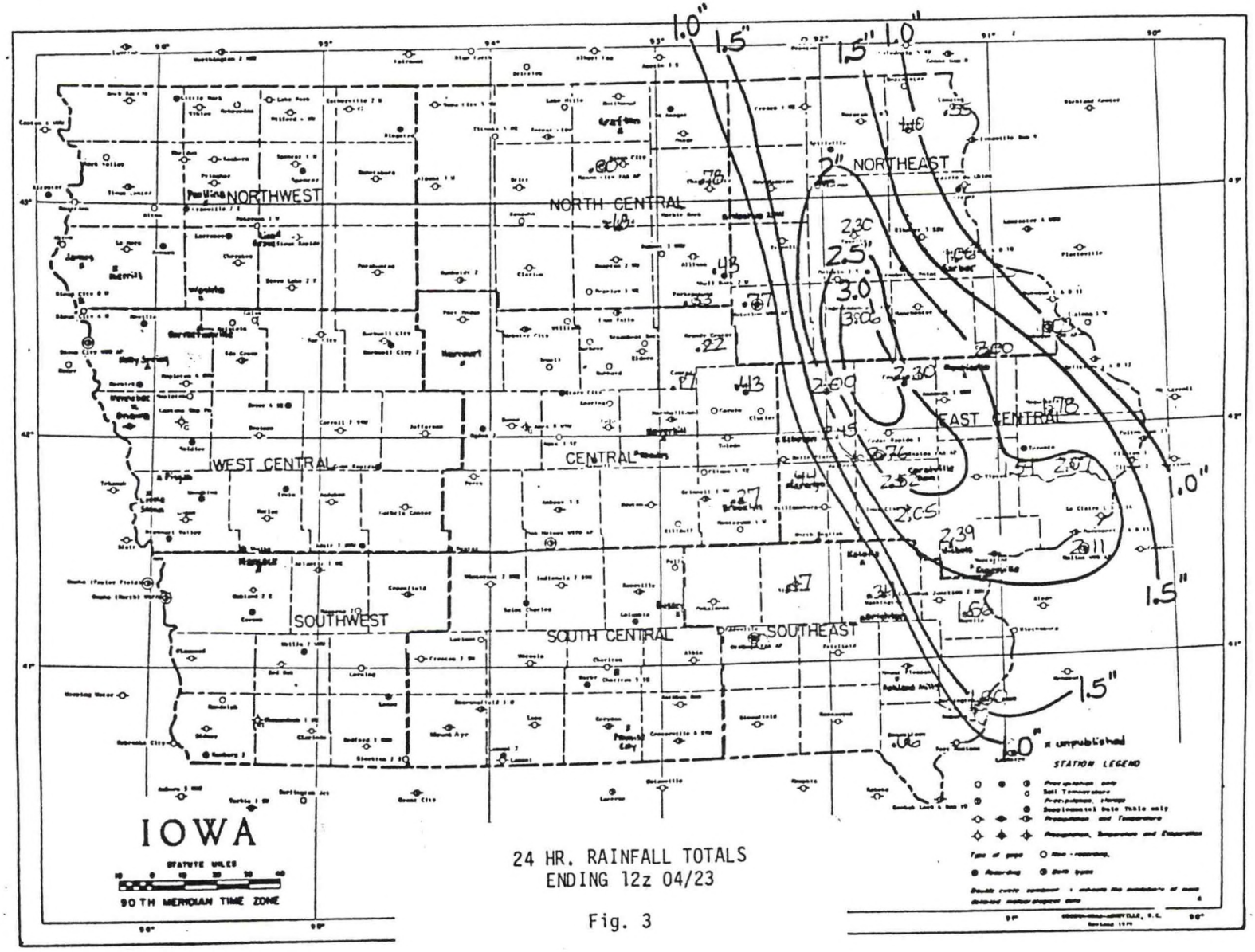
The staff at WSFO Des Moines has found that MDR derived estimates of rainfall amounts are very valuable when real time rainfall observations are not available, such as at night or in areas with no rainfall observers. It was also noted that, as stated in the documentation, the program does normally overestimate the rainfall over an entire MDR block by a factor of two.

However, it is important to remember that the heaviest rainfall in a convective situation can be very localized, and may only occur over a small fraction of a (approximately) 22 x 22 nmi MDR grid. The staff at Des Moines has found that the actual value given by the MDR program (not reduced by a factor of two) can provide a "worst case scenario" of maximum rainfall.

The MDR program also makes assumptions about the areal coverage of a VIP level. On most occasions, high VIP levels only cover a small area, and the program takes this into account when calculating rainfalls. If high VIP levels have a large areal coverage, the rainfalls may be closer to the actual value given by the program, rather than one-half of the value.

Also, caution must be used when using real-time rainfall reports to judge the accuracy of MDR derived rainfall values. Experience suggests that such caution will have to be used with the MDR program (or any rainfall estimate program) because in any given convective situation, the chances of a ground


12 HR. MDR DERIVED RAINFALL
04/22 2030z - 04/23 0830z
Fig. 2



24 HR. RAINFALL TOTALS
ENDING 12z 04/23

Fig. 3

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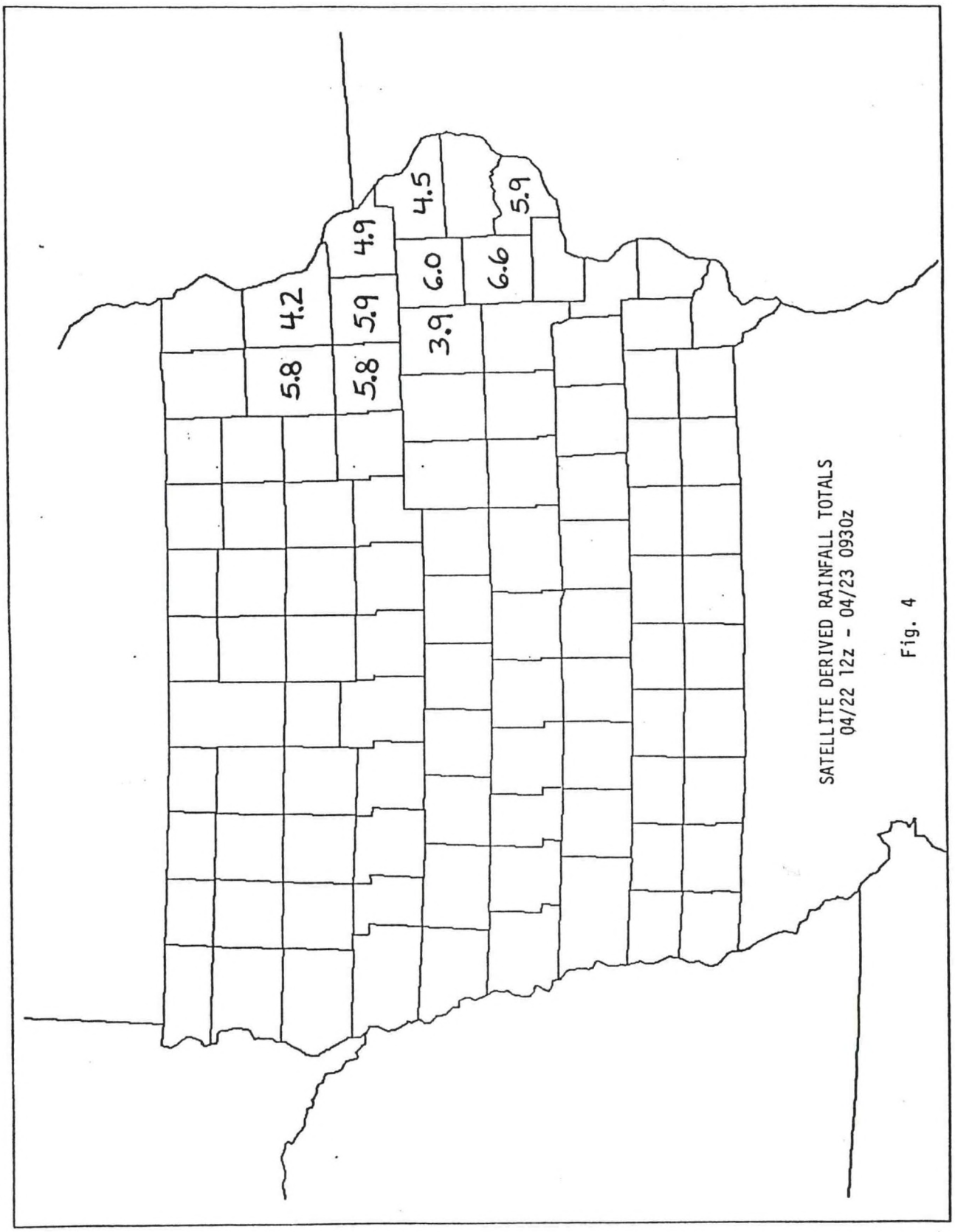

SATELLITE DERIVED RAINFALL TOTALS
04/22 12z - 04/23 0930z

Fig. 4

based rainfall report being under the area of heaviest rainfall is very slim, and therefore, MDR values may actually be more representative of the rainfall than one or two surface observations.

One study conducted by the Illinois State Water Survey suggested that a rain gauge network density of one gauge per 60 to 120 square km (approximately 17-34 square nmi) was necessary to accurately correlate rainfall with radar data over an urban area. But at times, even these very dense rainfall networks may not catch the heaviest rains.

As an example, during the Walnut Creek flood on the west side of Des Moines on May 9-10, 1986, real time rainfall reports from the basin (which has the greatest rain gauge density of any location in Iowa) indicated that two to three inches of rain fell over the basin. However, a later storm survey (May, 1986) found that five to seven inches of rain "fell between the cracks" of the rain gauge network. In addition, rainfall over the small town of Waukee (an area of about one-half square mile) varied from 4.75 to almost seven inches!

In conclusion, the MDR program can be used by field personnel to give a good estimate of rainfall over a given area. However, as with most products, it must be used with caution.

5. References

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