9.7 **RADAR-TO-GAUGE COMPARISON OF PRECIPITATION TOTALS: IMPLICATIONS FOR QUALITY CONTROL**

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1. INTRODUCTION

Comparisons of data values with independent sources are sometimes used to evaluate the plausibility of meteorological observations. Independent sources may be valuable to the quality control (QC) process when, for example, there is more confidence in the accuracy of the independent source than in the target observations. An independent data source may be especially useful when the observations are collocated in space and time. When spatio- temporal variability is large, the effectiveness of spatial and temporal consistency checks within a single data source is limited. Under these circumstances, collocated values are particularly appealing. Daily precipitation totals, for example, tend to be highly variable. Therefore, the evaluation of gauge totals could potentially benefit from comparison with an independent source such as radar-based precipitation estimates. In order for such a comparison to be valuable, the variability between gauge totals and radar estimates should be within reasonable bounds. The goal of this study was to evaluate the co-variability of gauge and radar-based totals for the purpose of assessing the potential utility of radar in the QC of gauge observations.

In the NOAA National Weather Service's Cooperative Observer Network (Coop) daily precipitation totals are recorded by volunteers according to a variety of observation schedules. Precipitation events in an area may, therefore, be differentially apportioned across more than one calendar day at various neighboring stations as an artifact of differences in the gauge reading schedule. The result is an additional dimension of complexity to the local precipitation field that complicates the application of spatial consistency checks to values from this network. Considering the spatial variability and timing issues inherent to Coop precipitation totals, this study focused on the potential use of hourly radar-based precipitation estimates for the QC of daily Coop totals. Specifically, two questions were addressed: 1) Are hourly rain gauge and radar estimates in close agreement? 2) Is it reasonable to apportion daily gauge totals across calendar days using the apportionment implied by the radar estimates?

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2. METHODS

Contingency tables and skill scores were used to quantify the agreement between gauge and radar data sources. Both the joint frequency of occurrence/non occurrence and amount were assessed. If sufficient agreement were to exist, direct quantitative comparison between observations and estimates could be used to QC gauge totals. Moreover, errors associated with incorrect reporting of the timing of precipitation could be identified. In addition, accurate reapportionment would allow gauge totals to be set to the most common 24-hour summary period, facilitating spatial comparison of gauge totals.

To address the above questions, hourly gauge and radar values were required. Gauge totals were extracted from the NOAA/NCDC Hourly Precipitation Data (HPD) archive (dataset 3240). Values from the approximately 300 synoptic stations with precision to the nearest hundredth of an inch were used. The radar-derived estimates used in the analysis included the digital precipitation array (DPA) gridded values (Fulton et al., 1998) from radars nearest to each station as well as the Stage IV DPA/gauge blended analysis (NWS, 1997; Young et al., 2000).

3. RESULTS

Figure 1 shows binned contingency tables comparing hourly gauge and radar estimates for two winter and two summer months. The dot size is proportional to the logarithm of the number of joint occurrences within each particular bin. If agreement were perfect, dots would appear only along the diagonal indicated in red. However, Fig. 1 shows that a wide range of radar-based estimates is possible for any given gauge amount and vice versa. In both seasons, the range of differences is somewhat less when gauge totals are compared to Stage IV estimates than for gauge/nearest-radar comparisons. On the other hand, the Stage IV estimates appear to have a low bias relative to the gauge totals at small precipitation amounts. The range of gauge/radar differences is larger in summer than in winter. Nevertheless, the hit rate, defined as the joint occurrence of any non-zero precipitation amount, is higher during summer with respect to both nearest radar (Fig. 2) and Stage IV (not shown) estimates. Fig. 2 also shows that there are regional differences in the agreement between the precipitation reported by the radar and gauge sources.

Comparisons of hourly fractions of 24-hour gauge sums with the hourly fractions of corresponding radar-based values are shown in the form of binned contingency tables in Fig 3. The hourly fraction for any particular hour refers to that hour's percent contribution to the corresponding 24-hour total. In other words, radar fractions are calculated using hourly radar estimates and 24-hour radar sums while gauge fractions are calculated from the corresponding hourly and 24-hour gauge totals. Dots along the diagonal represent cases in which the radar fractions lie within 5% of the gauge fractions. The plots in Fig. 3 indicate that gauge/radar differences vary considerably even within individual precipitation events. This implies that the use of radar to reapportion daily gauge totals to a different 24-hour summary period would likely lead to considerable error.

4. CONCLUSIONS

The results of this analysis suggest that for the QC of gauge totals, the quantitative comparison between radar and gauge precipitation amounts is not recommended. Moreover, radar appears to be of limited value in the identification of errors in the reported timing of precipitation. In addition, when performing spatial consistency checks on daily Coop precipitation measurements, differences in observation times should be resolved through methods other than comparisons with radar estimates.

5. REFERENCES

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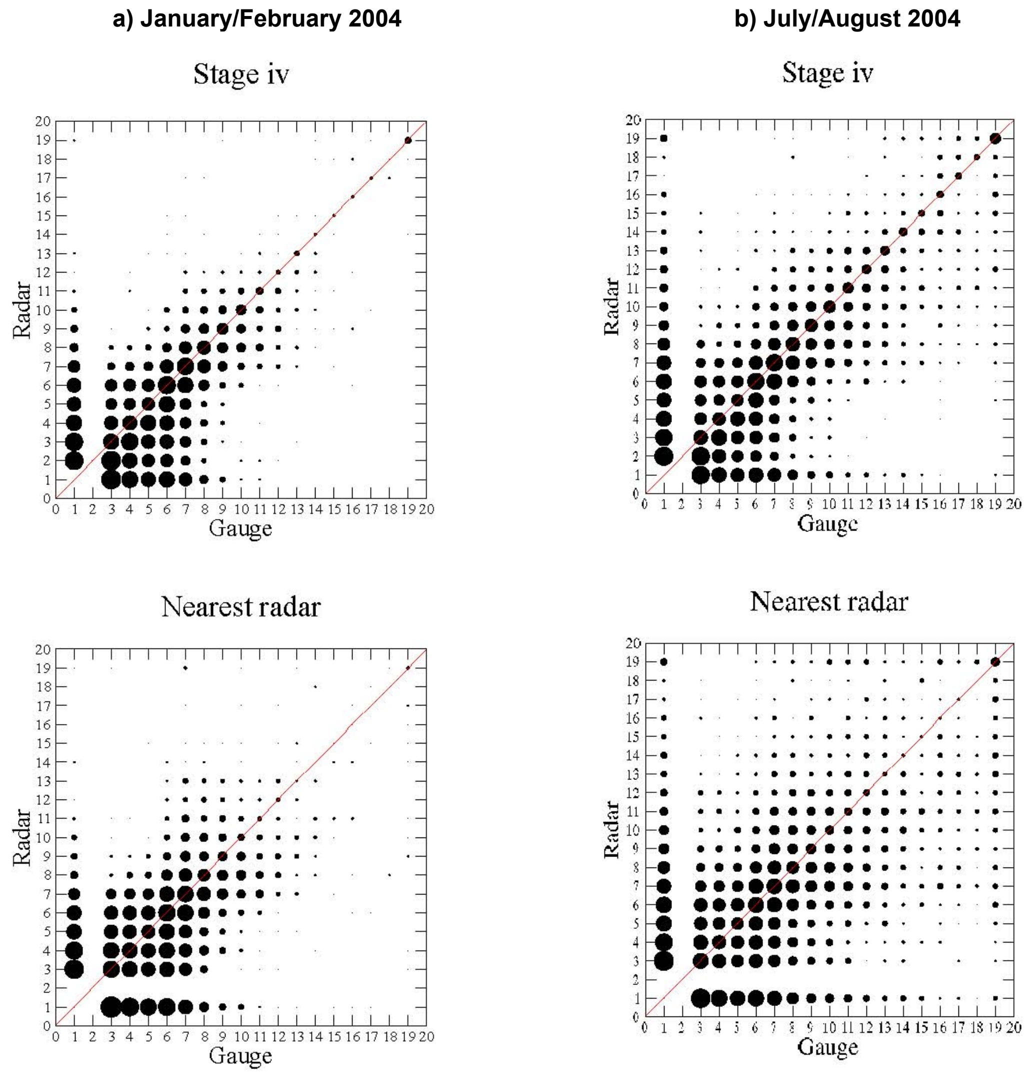

Figure 1. Binned contingency plots comparing hourly gauge totals to radar-based estimates. Dot size is proportional to the logarithm of the count of joint occurrences in each bin. The bins are numbered from 1 to 19 corresponding to the following amounts (in inches): 1--0.0 to 0.005; 2--0.005 to 0.01…6--0.04 to 0.08; 7--0.08 to 0.16...18--0.94 to 1.02; 19-- >1.02. Note that the precision of the Stage IV estimates is to the nearest 0.001 inch while gauge and nearest radar precision is 0.01 inch.

a) January/February 2004

b) January/February 2004

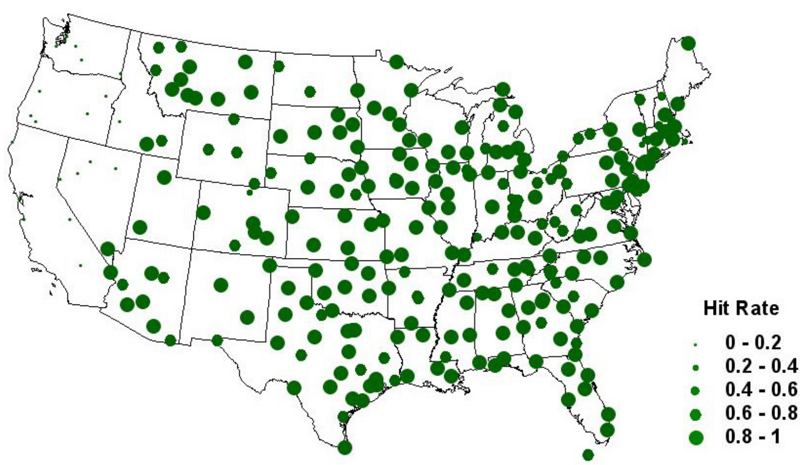

Figure 2. Frequency of joint occurrences of non-zero precipitation amounts for hourly gauge and radar reports (hit rate).

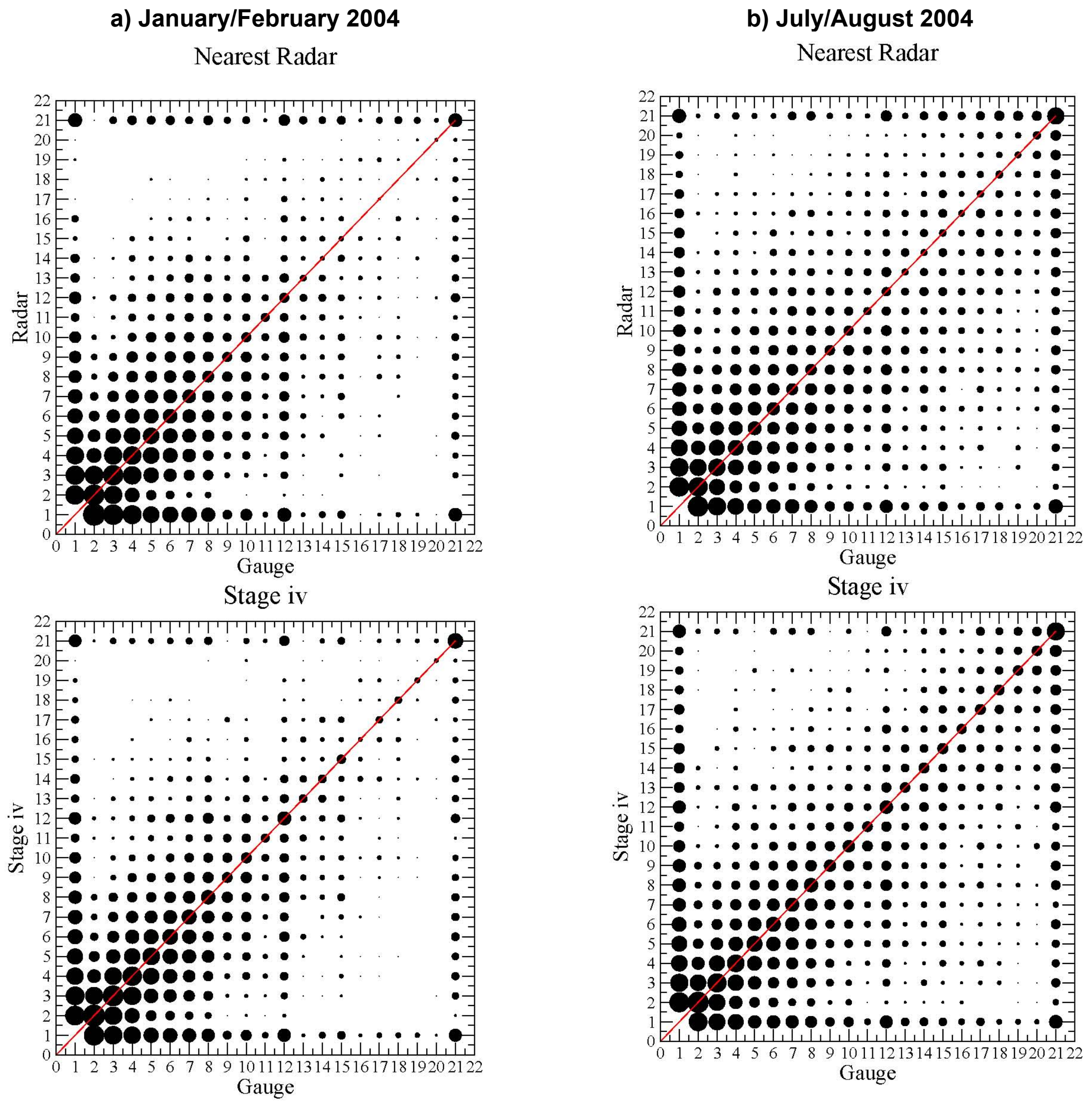

Figure 3. Binned contingency plots comparing hourly gauge and radar fractions of 24-hour sums. Dot size is proportional to the logarithm of the count of joint occurrences in each bin. The bins are numbered from 1 to 21 corresponding to 5% intervals. Bin 1: 0%, bin 2: >0 and >= 5%...bin 21 >95 and <= 100%.