Distances to MMA Calibrators Based on 90 GHz Source Counts

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Abstract

We use Monte Carlo simulations to estimate the typical distances to millimeter phase calibration sources based on 90 GHz source counts. We find that there is a 70% chance of finding a calibrator with a flux density of at least 100 mJy within 2° of a random point on the sky.

1 Introduction

Many of the phase calibration schemes proposed to date (Holdaway 1992a,b) depend directly or indirectly on the presence of suitable phase calibration sources. In an effort to estimate the number of potential phase calibrators, Holdaway, Owen and Rupen (1994) observed a large sample of flat spectrum quasars and steep spectrum quasars with bright cores at 90 GHz with the NRAO 12m. Using the resulting source count estimates, we have performed a large number of Monte Carlo simulations to estimate the typical distance to a calibrator as a function of the minimum flux density useful for phase calibration.

2 Simulations

In order to perform the simulations, we modified an existing SDE (Software Development Environment) program originally written by Tim Cornwell in 1992. The modified program read the differential source count data derived from the survey by Holdaway, Owen and Rupen (1994) and integrated the distribution to calculate the total number of sources which should be present in a 40° by 40° section of sky. For each source, the program then generated uniformly distributed random x and y offsets in the range of $-20°$ to $20°$ and a random source flux density with a probability density function determined by the differential source count data. The results were then analyzed to find the nearest source of a given minimum flux density, S_{min}, for several S_{min}.

3 Results

We performed a total of 1000 such simulations in order to obtain good statistics. Figure 1 shows the average distance in degrees to the nearest source which is at least as bright as S_{min}. The $1-\sigma$ error bars reflect the variation between simulations and are determined by calculating the distance range containing the 68% of the simulations centered on the mean.

Figure 2 is perhaps more useful for evaluating the potential success of any phase calibration scheme which requires a calibrator source. This figure shows the probability of finding a calibration source of a given minimum flux density within a given distance. We present curves for flux densities of 25, 50, 100, 200, 500, and 1000 mJy. We have tabulated some of this data in table 1, which shows the distance within which there is a 50%, 75%, and 90% chance of finding a calibrator.

Finally, the histograms in figures 3a-f show the derivative of each curve from figure 2.

flux (mJy)	50%	75%	90%
25	0.7	1.1	1.4
50	1.1	1.5	1.9
100	1.5	2.1	2.7
200	2.1	3.6	4.4
500	4.1	5.9	7.6
1000	6.6	9.1	12.1

Table 1: Distance in degrees within which there is a 50%, 75%, and 90% chance of finding a source of given flux.

4 Acknowledgements

We would like to thank Mark Holdaway for providing his source count data. We would also like to thank Frazer Owen and Peter Napier for their helpful suggestions.

5 References

Holdaway, M.A., 1992, "Possible Phase Calibration of the MMA", MMA Memo 84.

Holdaway, M.A., 1992, "Paired Antenna Phase Calibration: Residual Phase Errors and Configuration Study", MMA Memo 88.

Holdaway, M.A., Owen, F.N., and Rupen, M.P., 1994, "Source Counts at 90 GHz", MMA Memo 123.

Figure 1: Average distance to the nearest calibrator with minimum flux S_{min}. The $1-\sigma$ error bars reflect the variation between simulations and are determined by calculating the distance range containing the 68% of the simulations centered on the mean.

Figure 2: Probability of finding a calibrator with minimum flux of 25, 50, 100, 200, 500, 1000 mJy within a given distance of an observed source.

Figure 3: Number of cases in which the nearest calibrator of minimum flux S_{min} is found at various distances from the observed source.

Figure 1

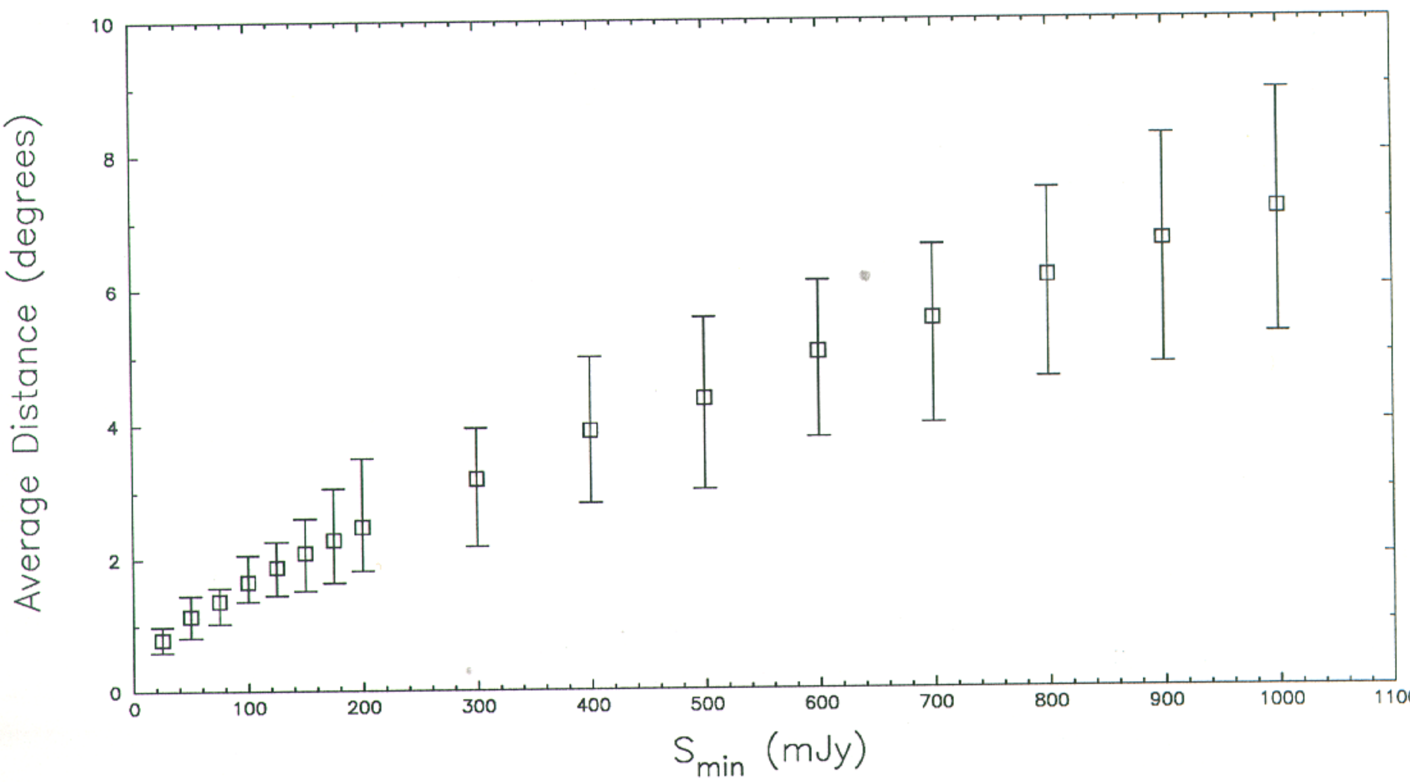
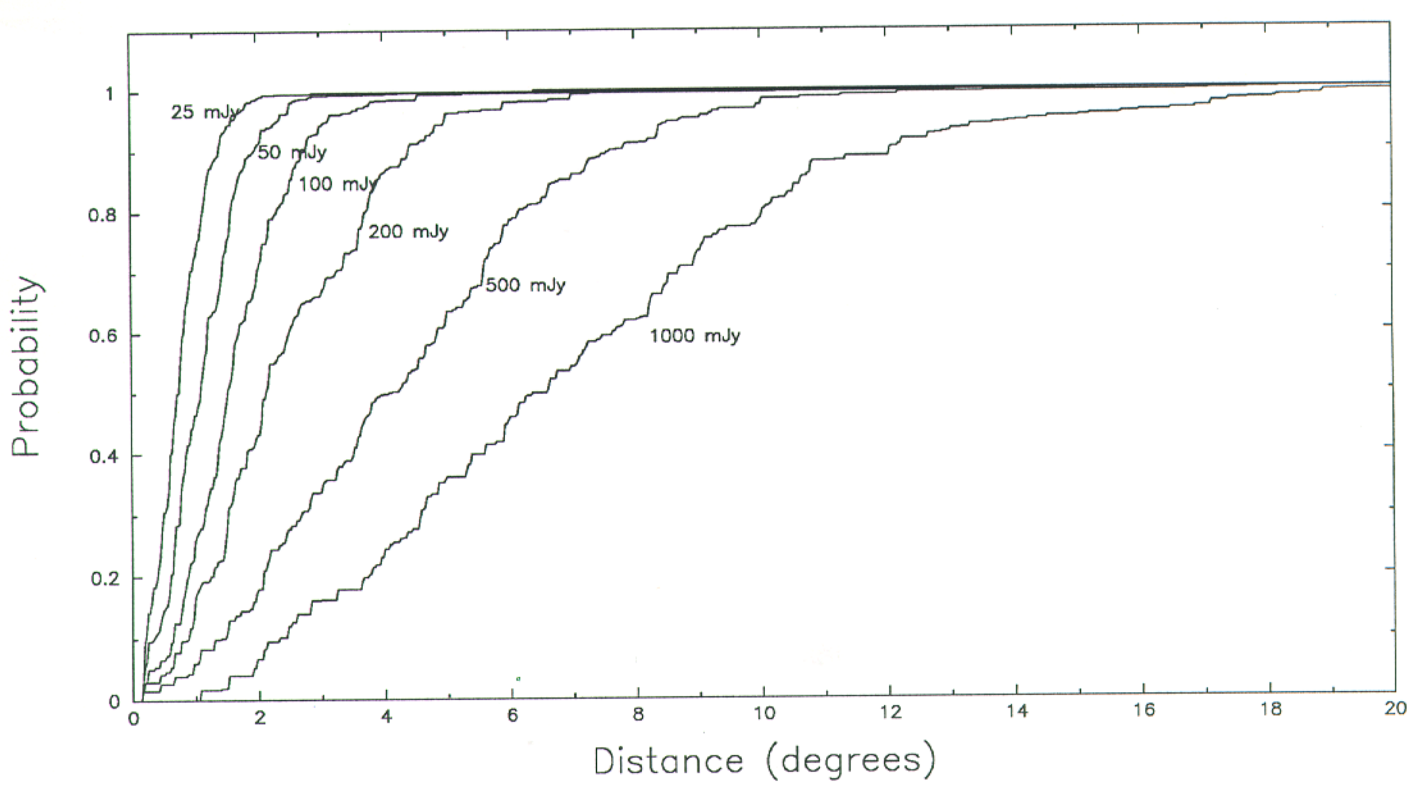


Figure 2



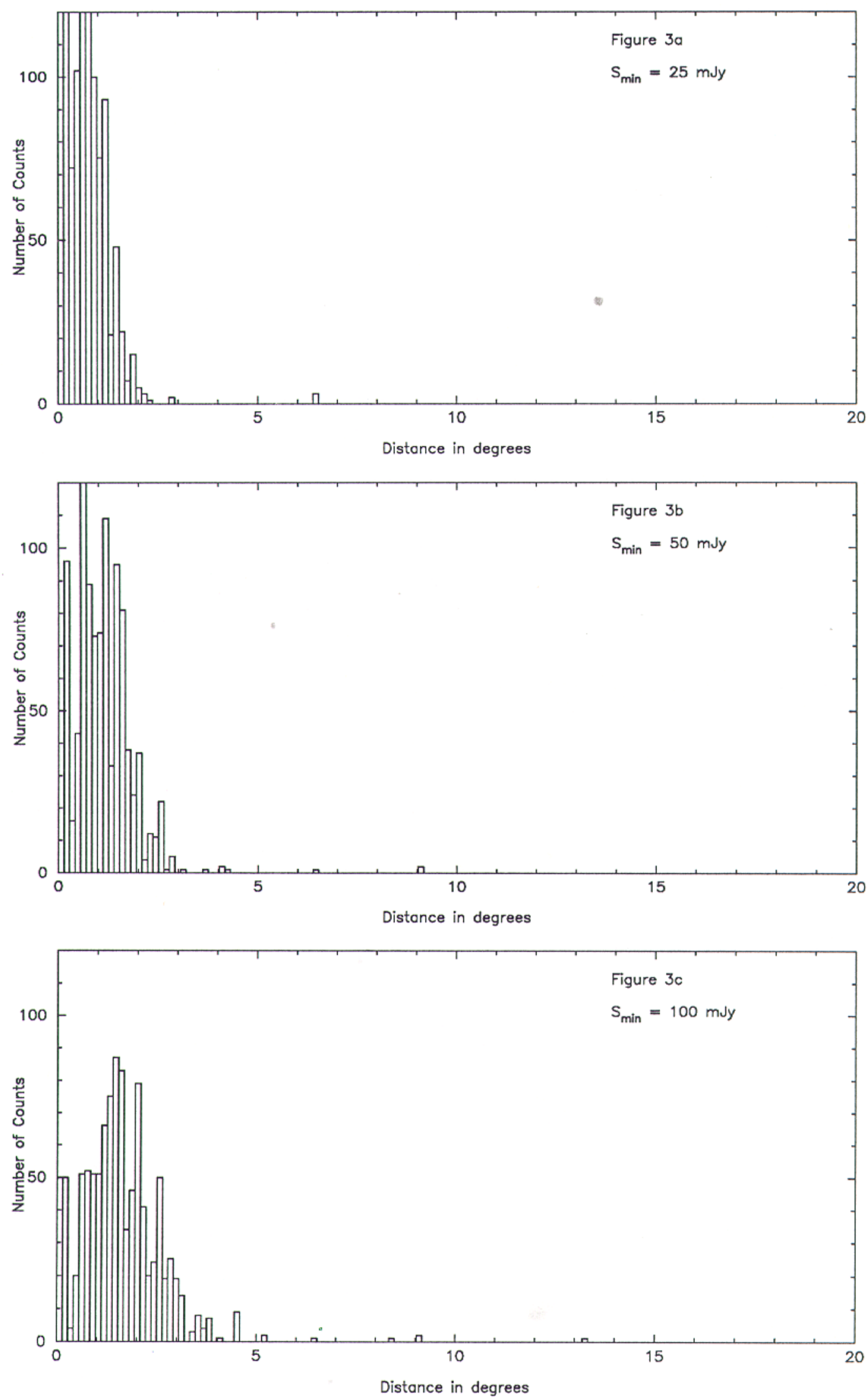


Figure 3a
S_{min} = 25 mJy
Number of Counts
Distance in degrees
Figure 3b
S_{min} = 50 mJy
Number of Counts
Distance in degrees
Figure 3c
S_{min} = 100 mJy
Number of Counts
Distance in degrees

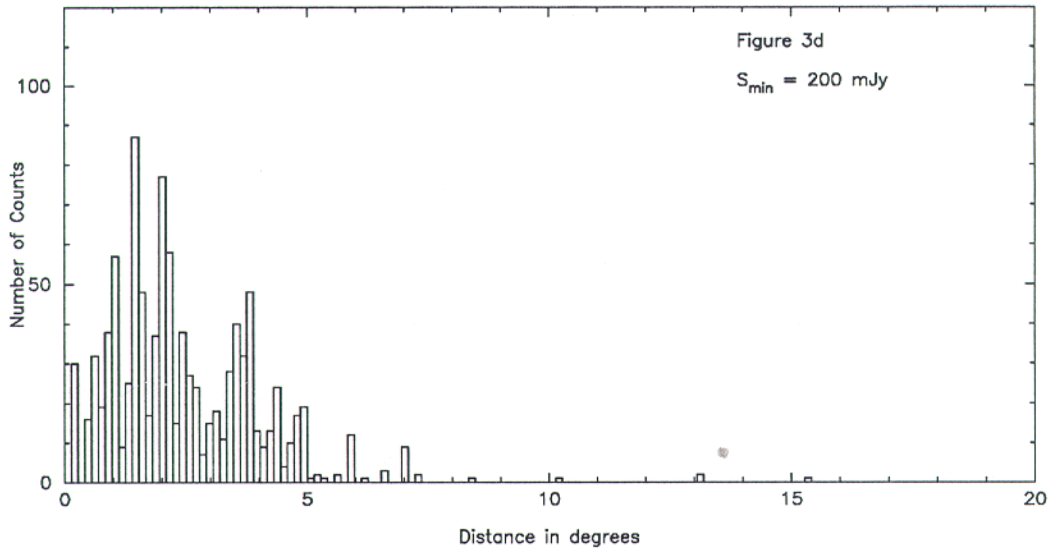


Figure 3d
S_{min} = 200 mJy
Number of Counts
Distance in degrees
0
50
100
0
5
10
15
20

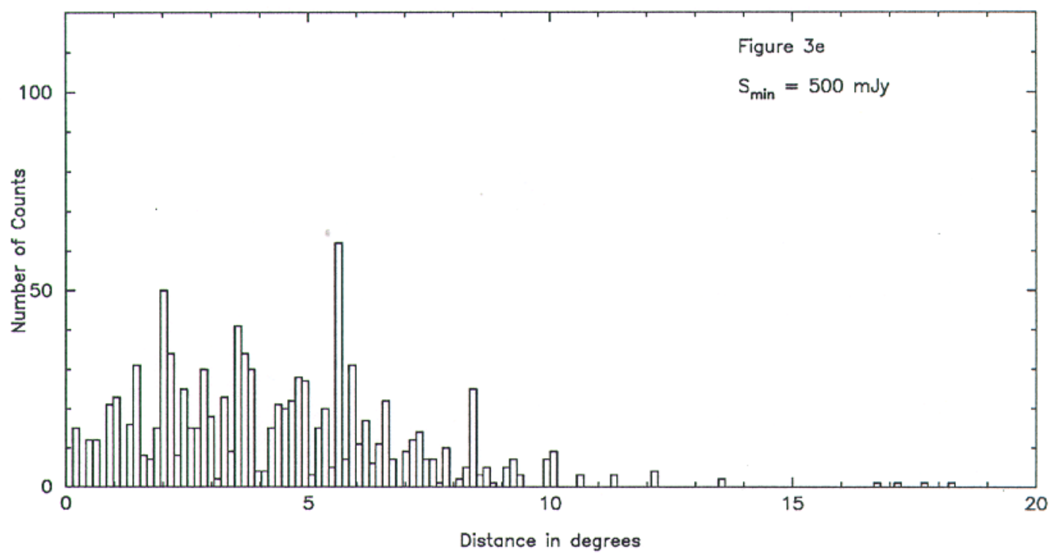


Figure 3e
S_{min} = 500 mJy
Number of Counts
Distance in degrees
0
50
100
0
5
10
15
20

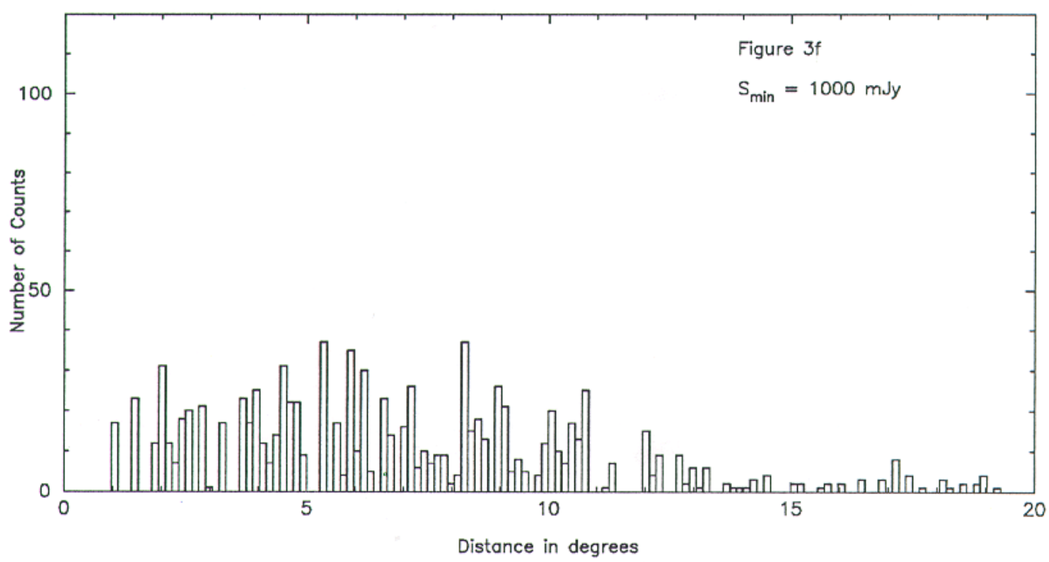


Figure 3f
S_{min} = 1000 mJy
Number of Counts
Distance in degrees
0
50
100
0
5
10
15
20