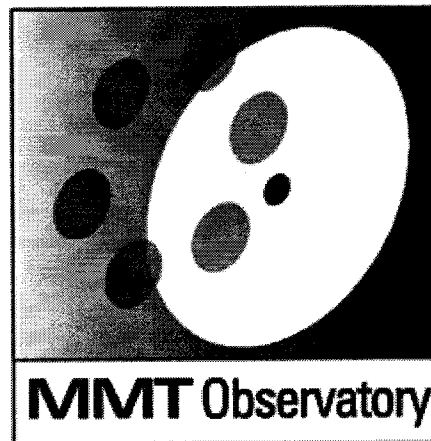


MMTO Technical Memorandum #99-1



**Smithsonian Institution &
The University of Arizona***

Meteorological Data for Mt. Hopkins

A. A. E. Milone, C. Heller, J. McAfee

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METEOROLOGICAL DATA FOR MT. HOPKINS

Alejandra A. E. Milone, Carol Heller, and John McAfee

1. Introduction

The six-primary MMT was in operation from mid 1979 through early 1998. Beginning late 1990 the telescope operator conducted a seeing test as close as possible to the end of the night. This seeing test was performed every night that the telescope was open, except for those nights when the instrument being used required the removal of some/all of the needed hardware.

Besides producing a consistent determination for the seeing at Mt. Hopkins' summit, an added bonus of this measurement was the recording of weather parameters; ambient temperature, relative humidity, wind speed and direction were typed in as part of the header for the seeing log. This set of data is then more uniform than the manual recordings in the nightly logs, and we are using it to determine average values for future reference. We also hope that the information presented here will be useful for the instruments currently in development for the converted 6.5-m MMT.

2. Data set

After retyping all the information into files suitable for analysis, we created the histograms in Figs. 1 to 9, one set per year.¹ The following important comments need to be made at this point.

(a) Not only there are very few points for 1990 and 1998, but together with 1995 these sets are biased towards colder months. As mentioned before, the seeing tests did not start until late in 1990; the 4.5-m MMT was shutdown in 1995 from May to October to enlarge the chamber for the new telescope, and in 1998, we only have data for January and February, before the old MMT was finally decommissioned on March 2nd.

¹ The convention for wind direction is that North has 0° azimuth, East 90°, etc.

For this reason, none of these three years will be included in the overall analysis.

(b) Wind speed measurements suffer from the strongest selection effect of the four variables we are dealing with. The telescope could not be open if the wind was 40 mph for five or more minutes. This creates a small-range sample with a sharp cutoff. In addition, the building shields the sensor when the wind is from the NE quadrant, producing erroneous readings for both velocity and direction. And although the operators tried to get the most accurate values in those circumstances by stepping outside with hand-held anemometers, wind azimuths in the 90° range should be taken more cautiously than the rest.² These two conditions preclude us from attempting an overall characterization of wind parameters at Mt. Hopkins at this time.

(c) There is also some selection for relative humidity, although not as significant as with the wind. The telescope could obviously not be operating when humidity was high enough for condensation to occur on the optical surfaces. Consequently we do not have humidity recordings above $\sim 95\%$, meaning that our results will be very slightly skewed towards drier air.

(d) The telescope was shutdown every August for its yearly maintenance and our temperature files could lack some of the hottest nights of the year. We do not expect any noticeable effect though: because of the monsoon rains the average number of workable nights during August is very low and, under the current methodology for gathering weather data, we are missing an insignificant number of seeing tests.

3. Data analysis

In Fig. 10 we represent the averages of the four variables for each year. Triangles are used to flag 1990, 1995, 1998, and 1993's wind azimuth because of the equipment problems. Standard deviations are plotted as well. The same information can also be found in Table 1 where we have added the number of nights we have data for.

Limiting our attention to temperature and relative humidity, we do not see any obvious trend from Fig. 10. Thus we decided to average the 865 individual readings for the six years without bias. We find

² The strong column around 0° azimuth in 1993 is due to equipment malfunction.

Temperature (F) : 46 ± 10
 Relative Humidity (%) : 45 ± 21 ,

and which are also plotted in Fig. 10. Fig. 11 is a representation of the histograms for these two latest samples with the averages and standard-deviation bands superimposed.

Table 1. Average values for the MMT site.

Year	N	T(F)	RH(%)	Wv(mph)	Waz(°)
1990*	10	53 ± 12	60 ± 20	8 ± 6	128 ± 162
1991	94	47 ± 10	45 ± 15	13 ± 8	185 ± 102
1992	121	46 ± 10	53 ± 16	14 ± 8	199 ± 96
1993	168	44 ± 10	54 ± 16	13 ± 9	$162 \pm 118^*$
1994	119	49 ± 9	44 ± 25	15 ± 9	177 ± 95
1995*	109	41 ± 10	43 ± 19	11 ± 5	200 ± 97
1996	176	47 ± 10	40 ± 21	12 ± 7	186 ± 110
1997	187	46 ± 11	39 ± 23	13 ± 7	200 ± 106
1998*	25	35 ± 7	34 ± 25	17 ± 6	227 ± 68

4. Conclusions

We have attempted to “characterize” the weather conditions at the Summit of Mt. Hopkins by obtaining mean values for temperature, relative humidity, and wind (speed and direction). Although we can determine reliable averages for temperature and relative humidity, we cannot do the same for the wind parameters because of strong selection effects. We need to find a way to obtain good information for wind independently of its azimuth. We may also want to consider the possibility of storing weather data automatically even when the telescope is not open; these two steps would greatly improve the quality of our database and, thus, the conclusions we obtain from it.

Our gratitude to Craig Foltz and J.T. Williams for suggesting this study. Thanks to Craig as well for proof-reading the original version of the manuscript.

FIGURE 1

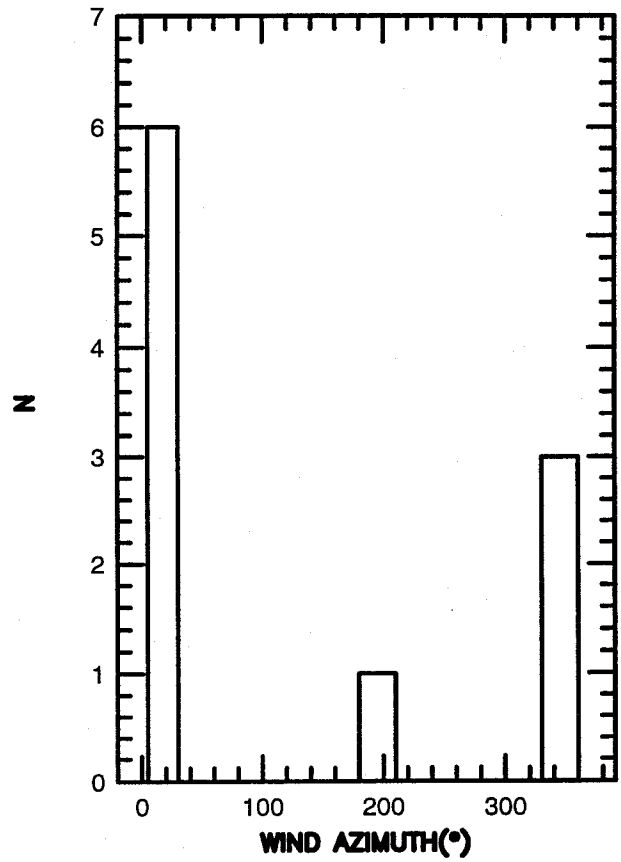
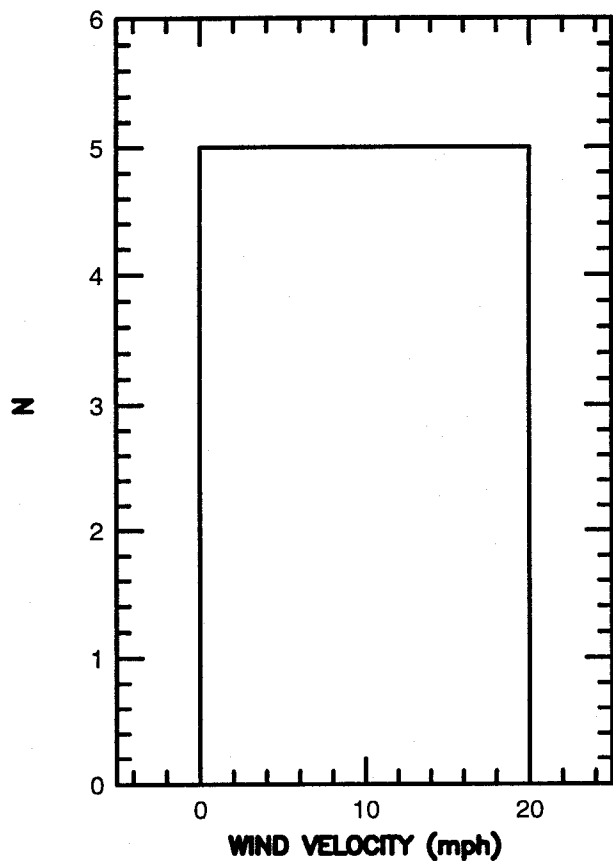
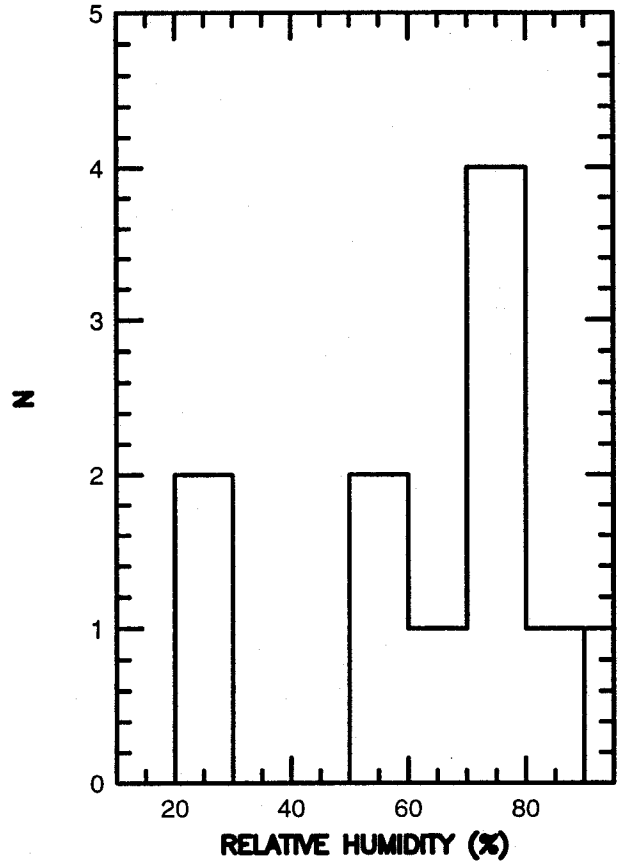
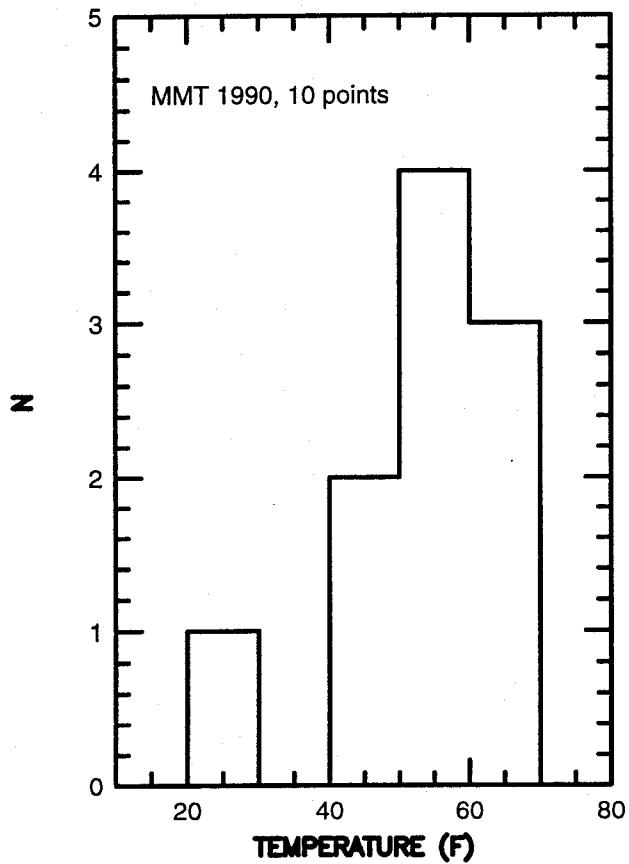


FIGURE 2

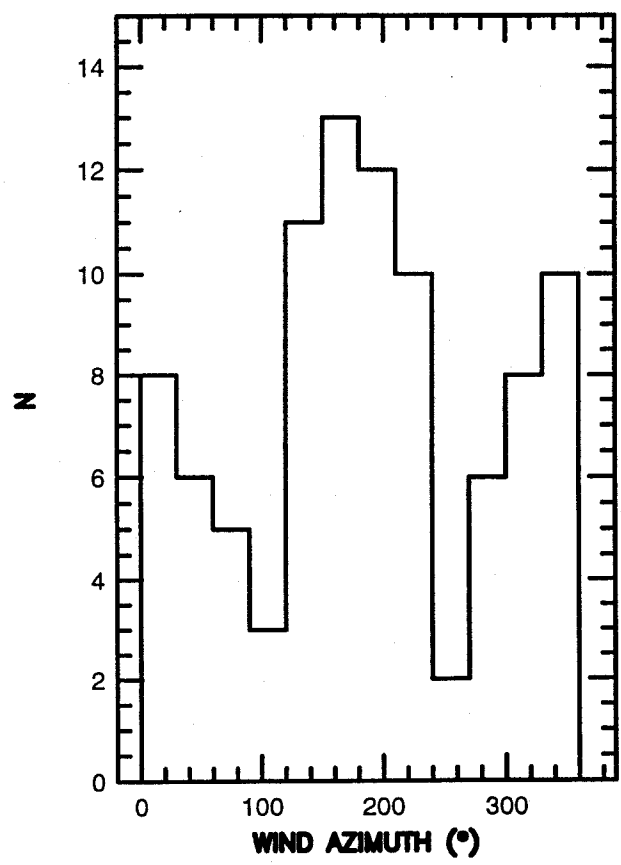
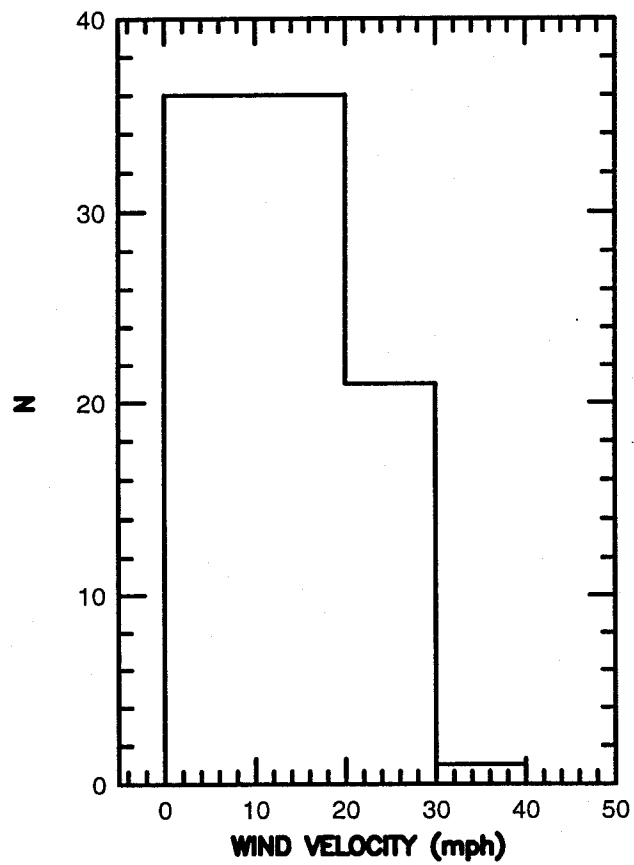
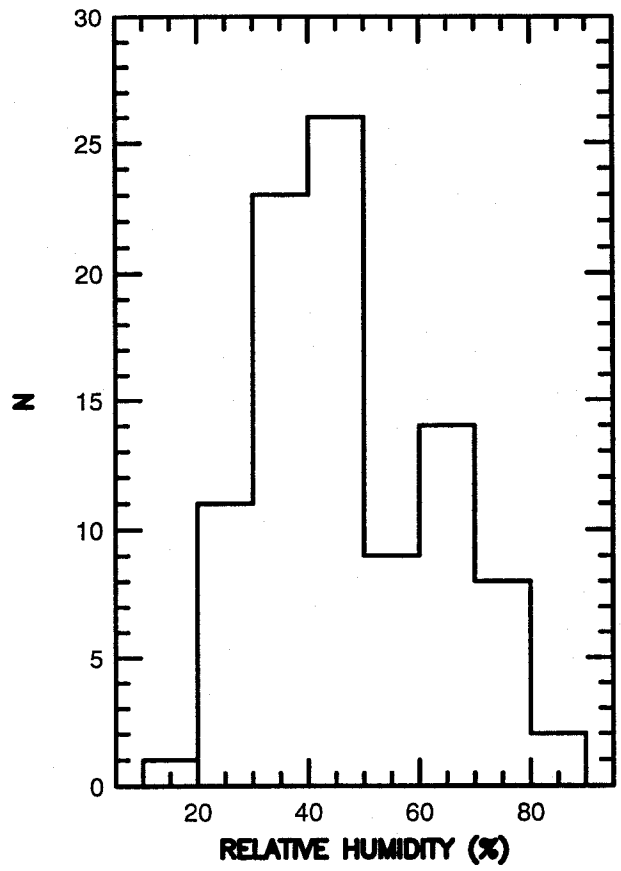
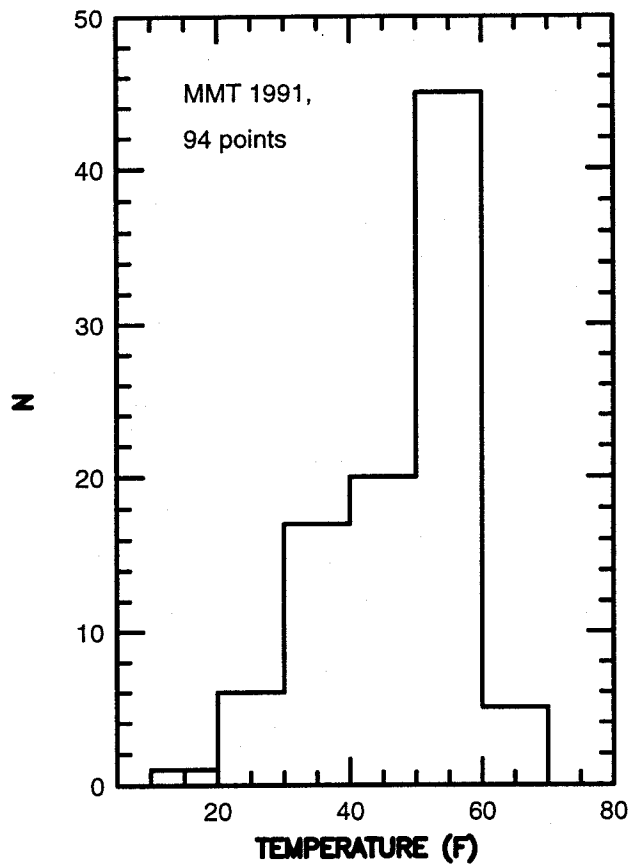


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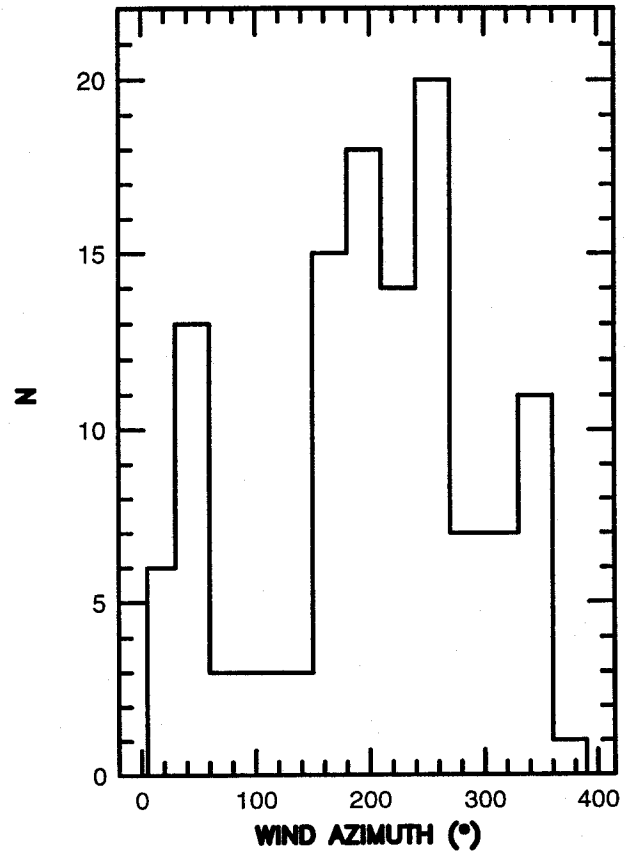
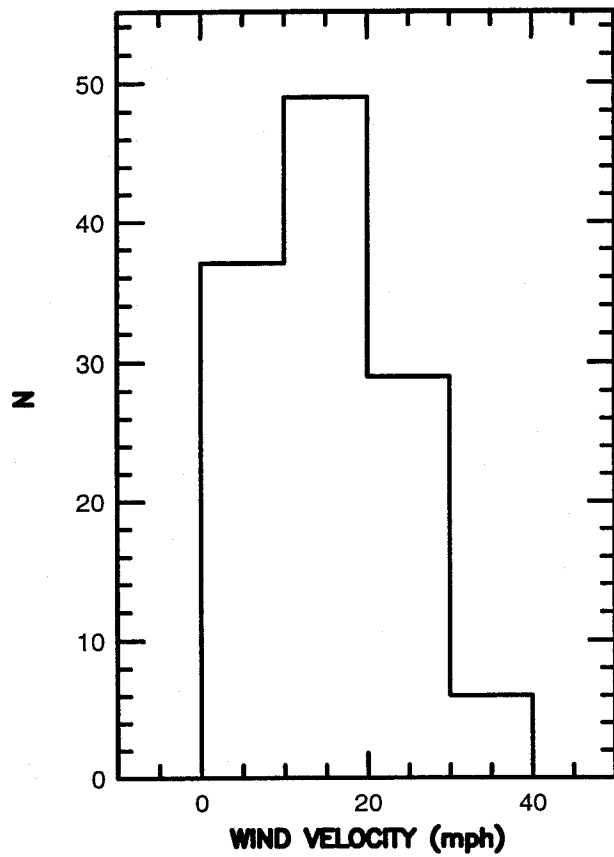
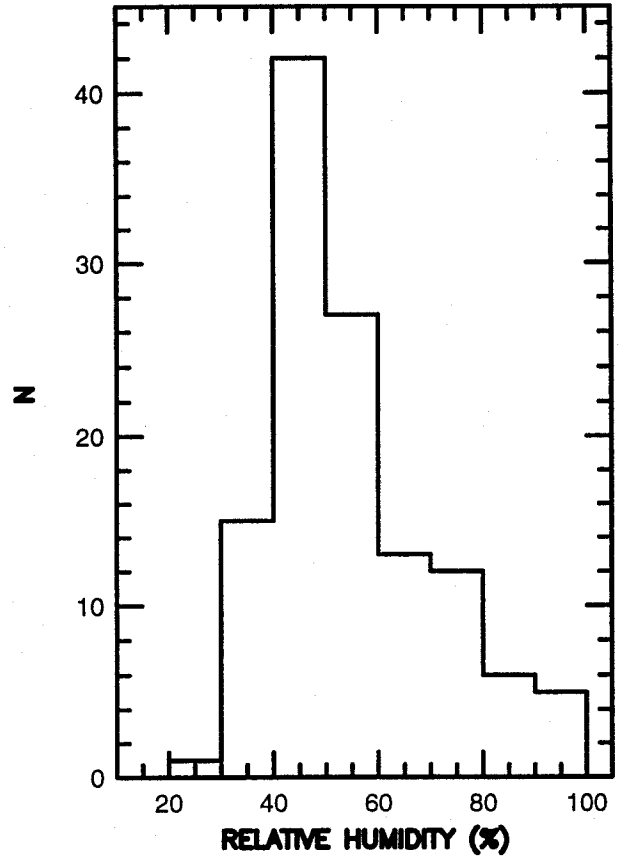
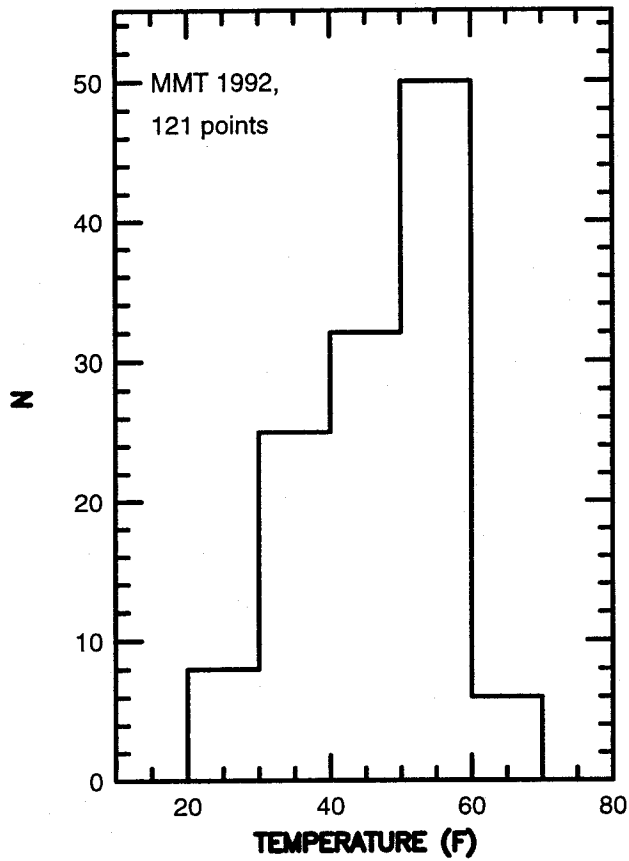


FIGURE 4

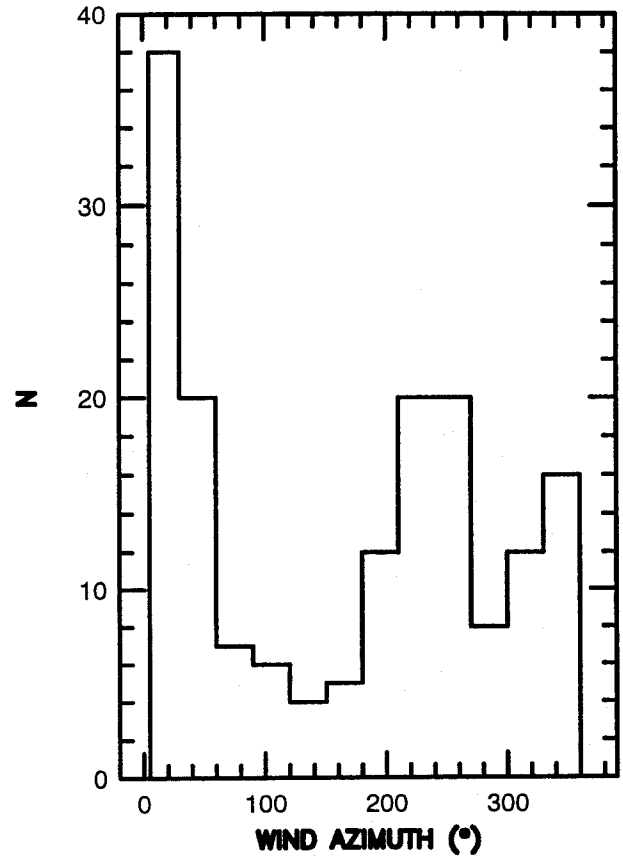
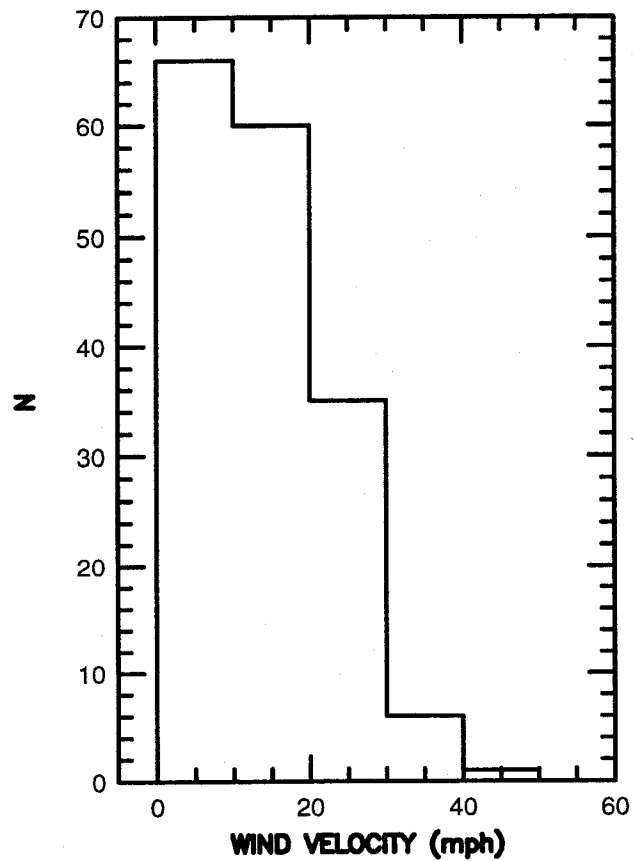
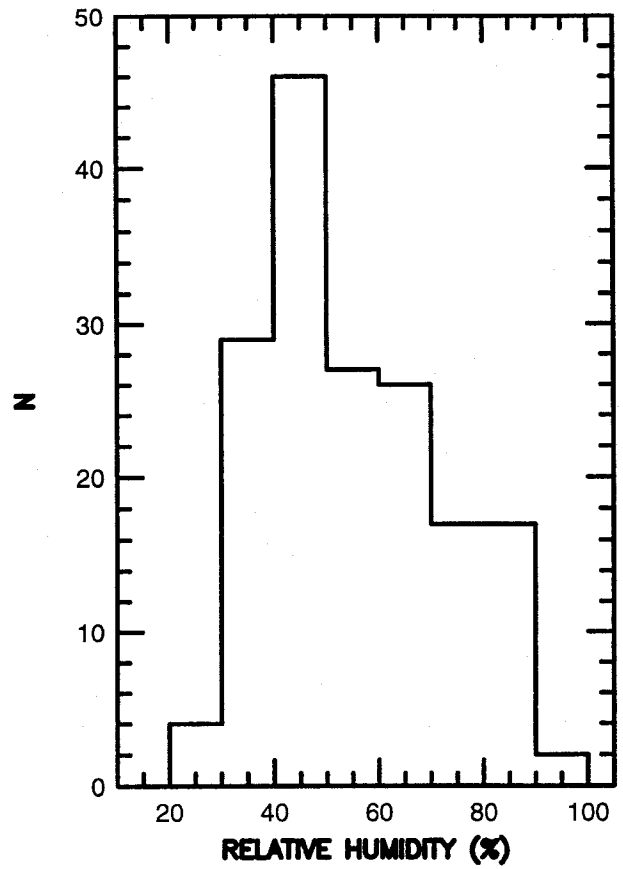
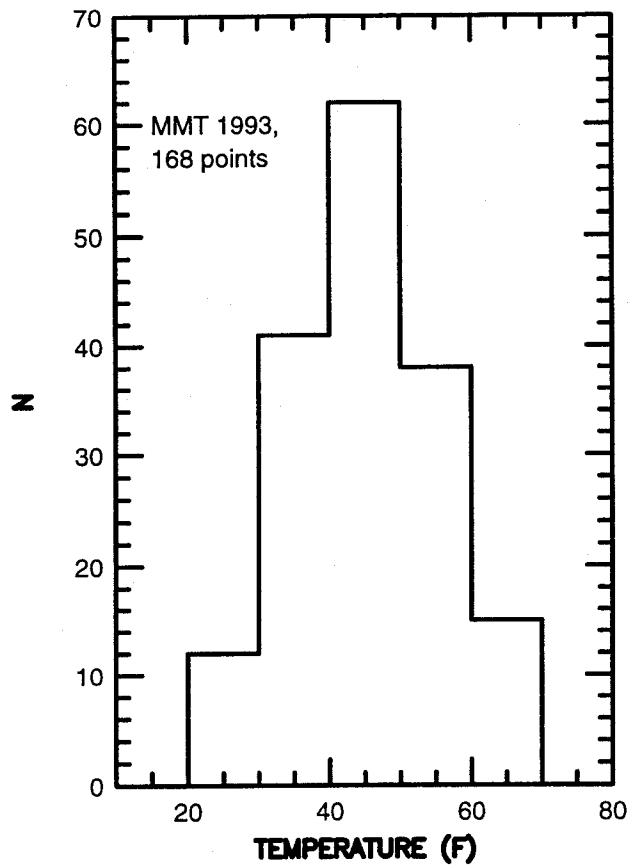


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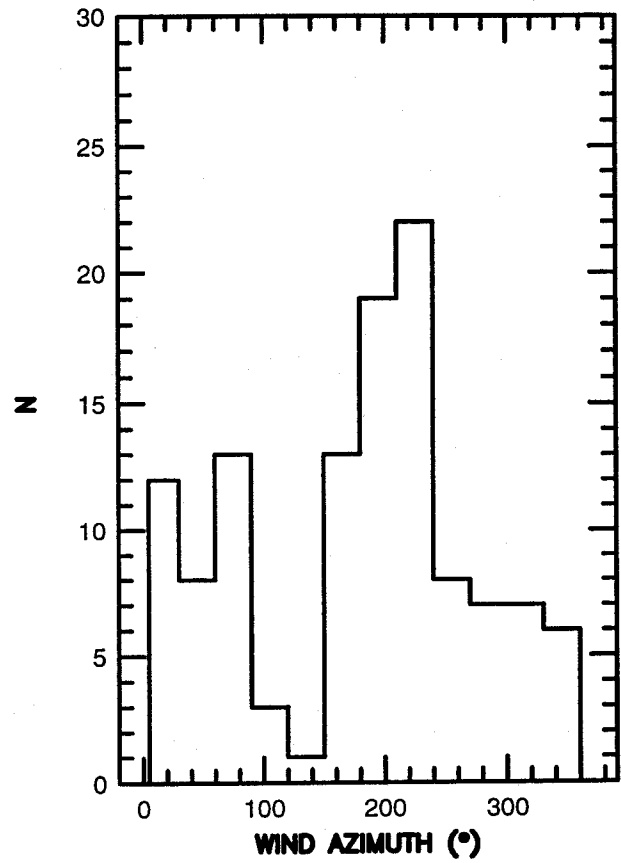
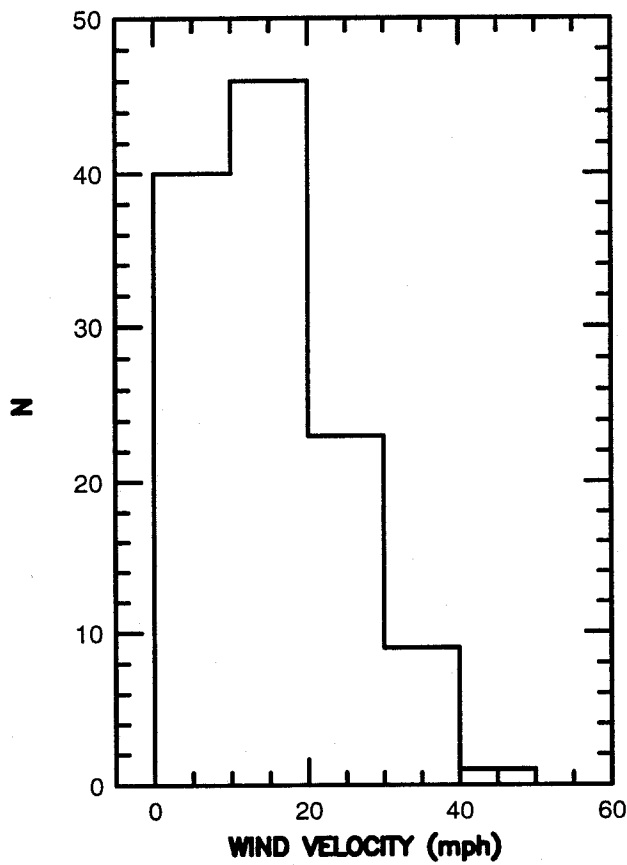
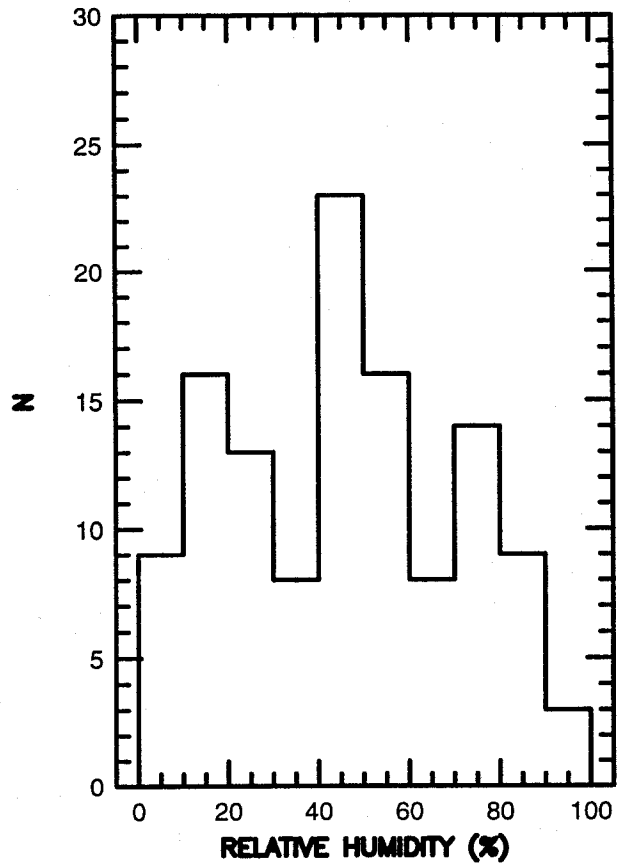
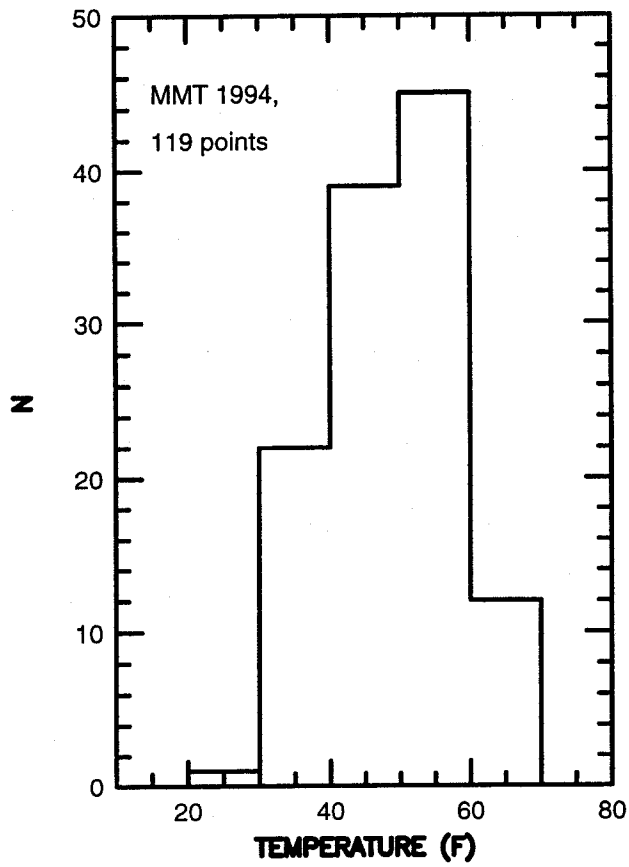


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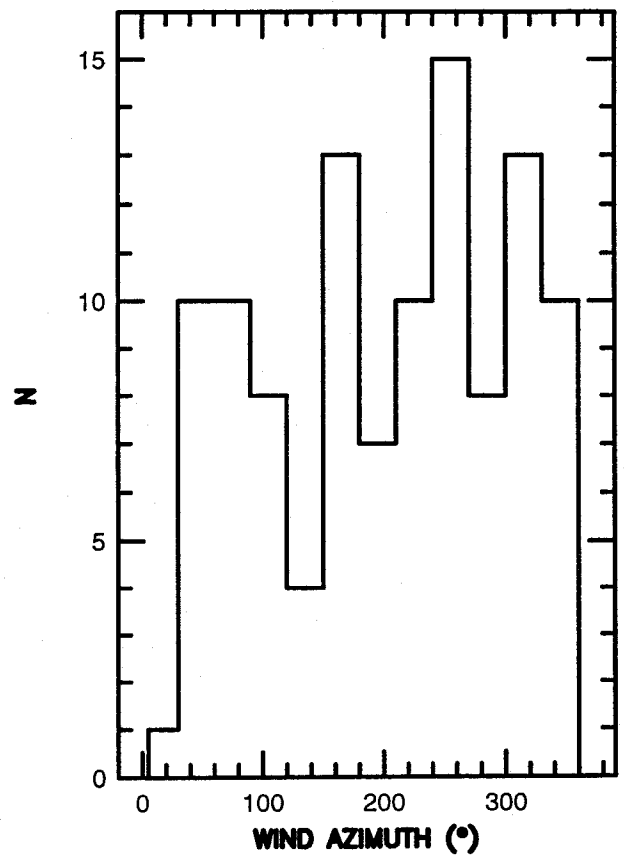
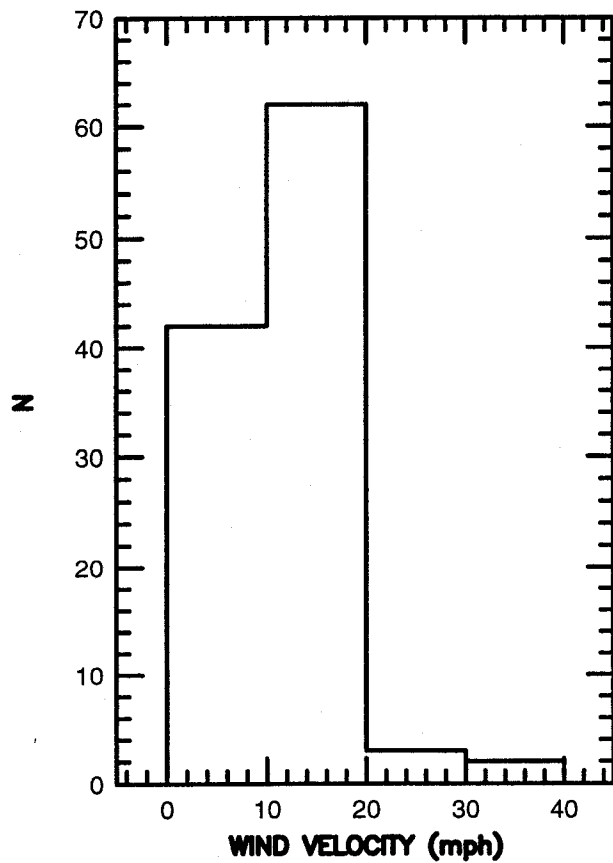
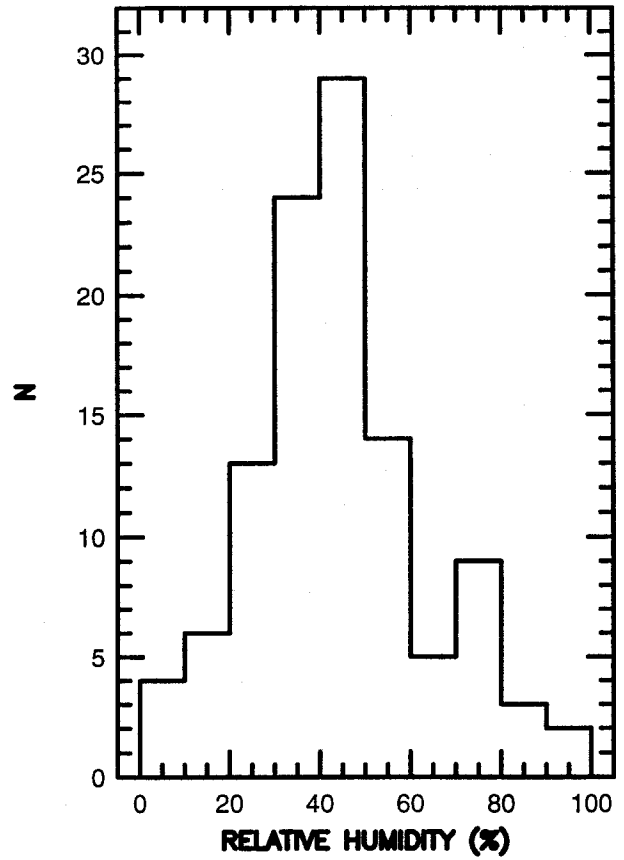
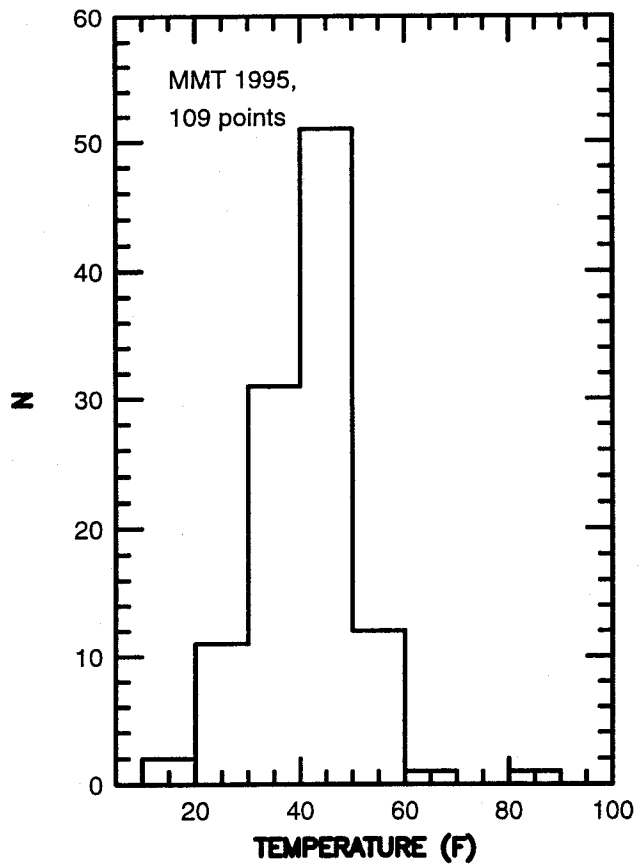


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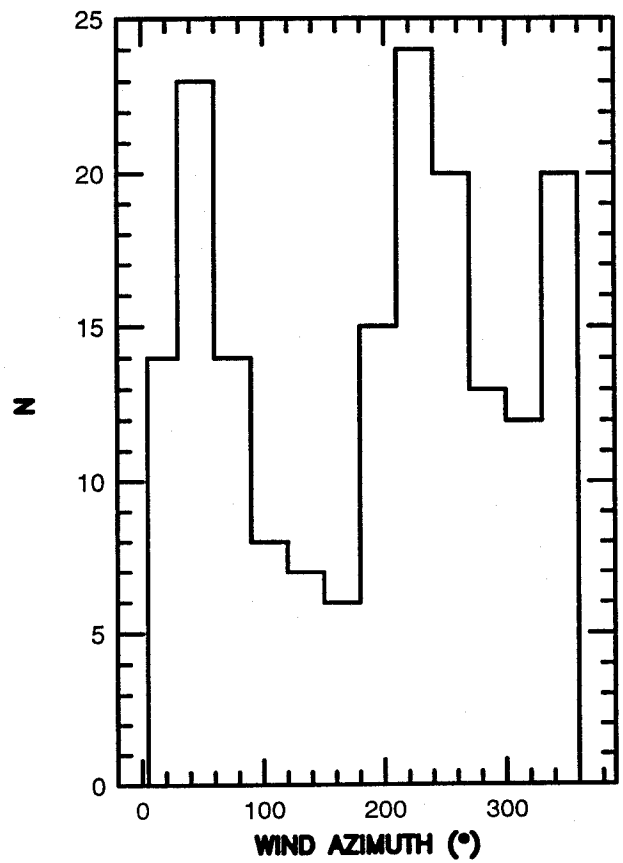
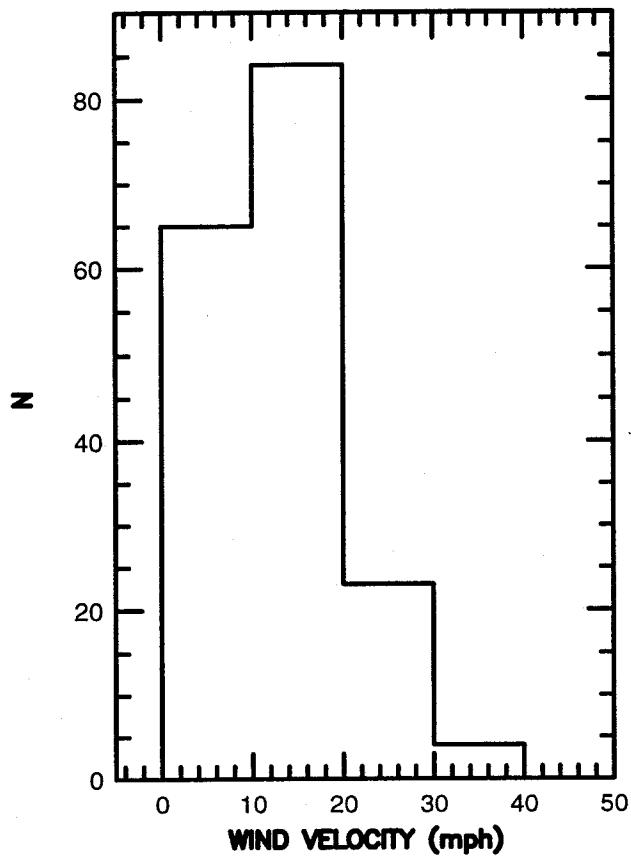
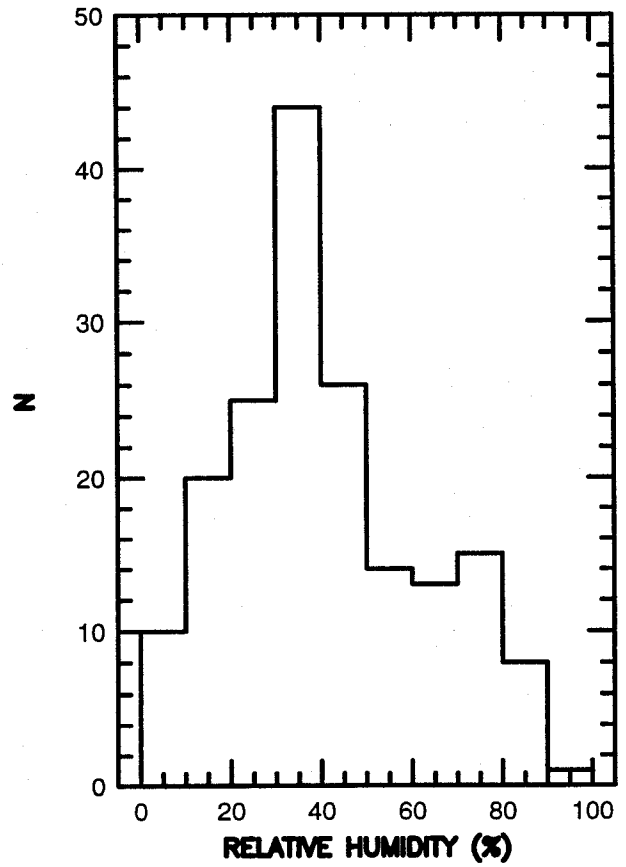
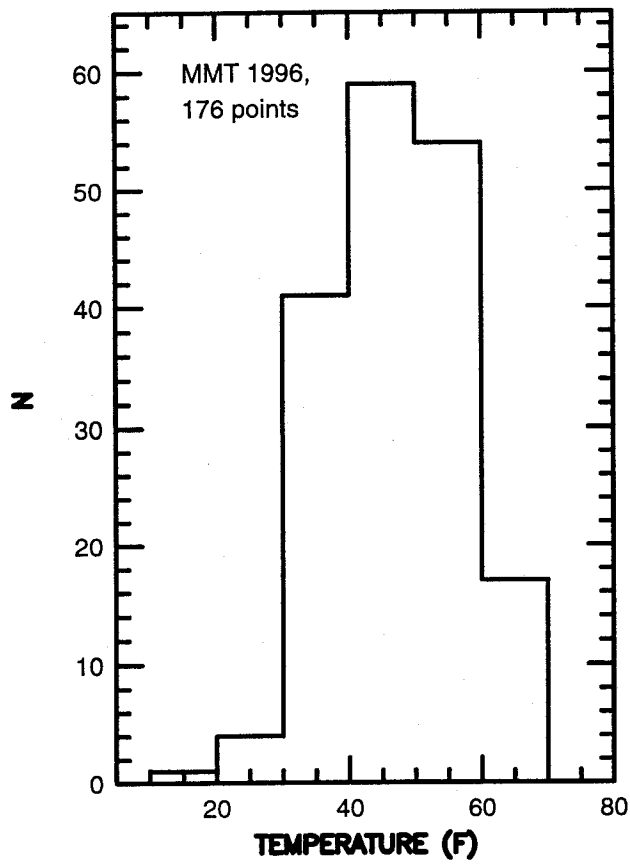


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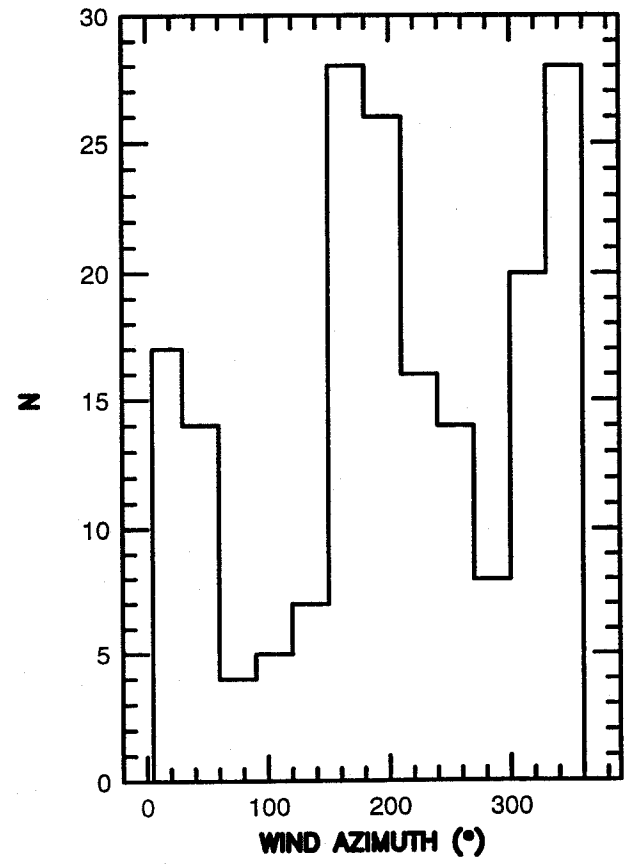
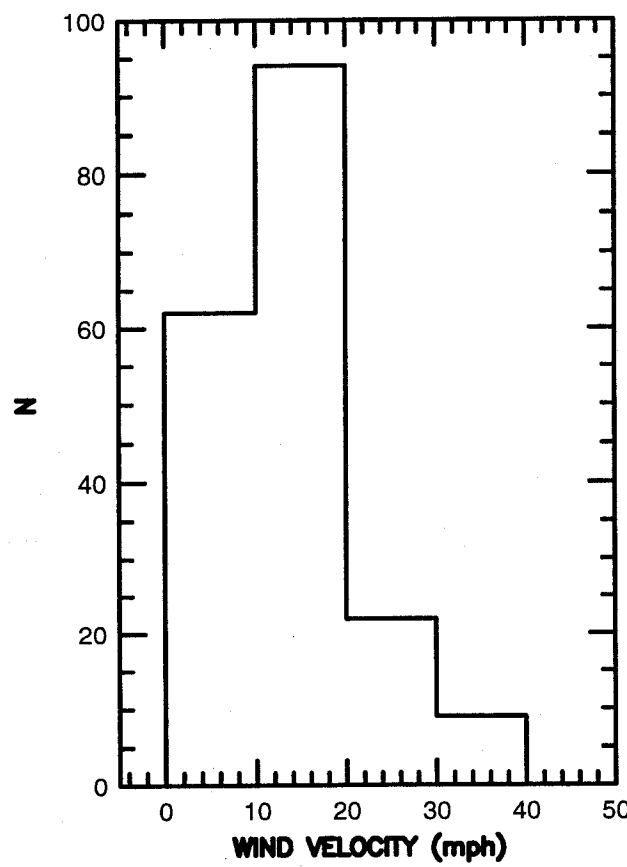
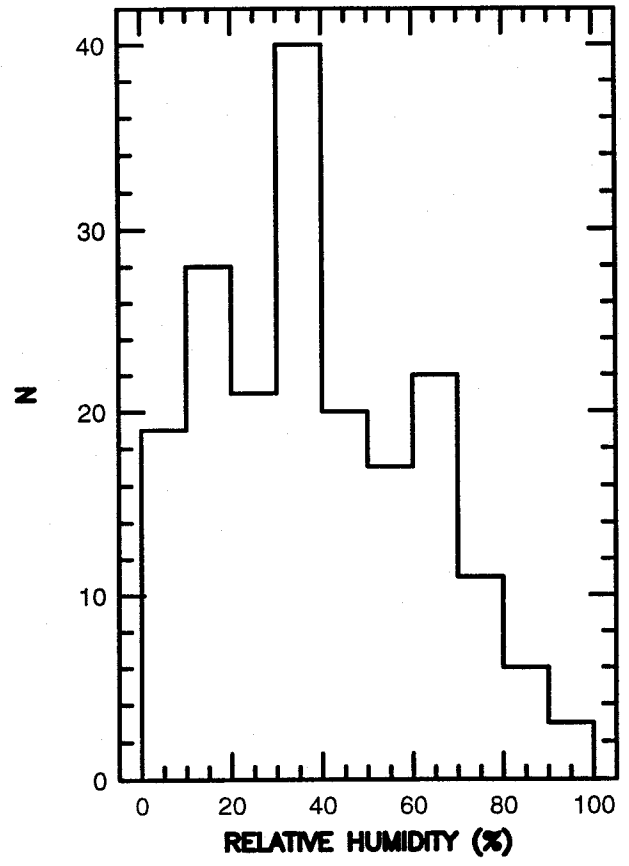
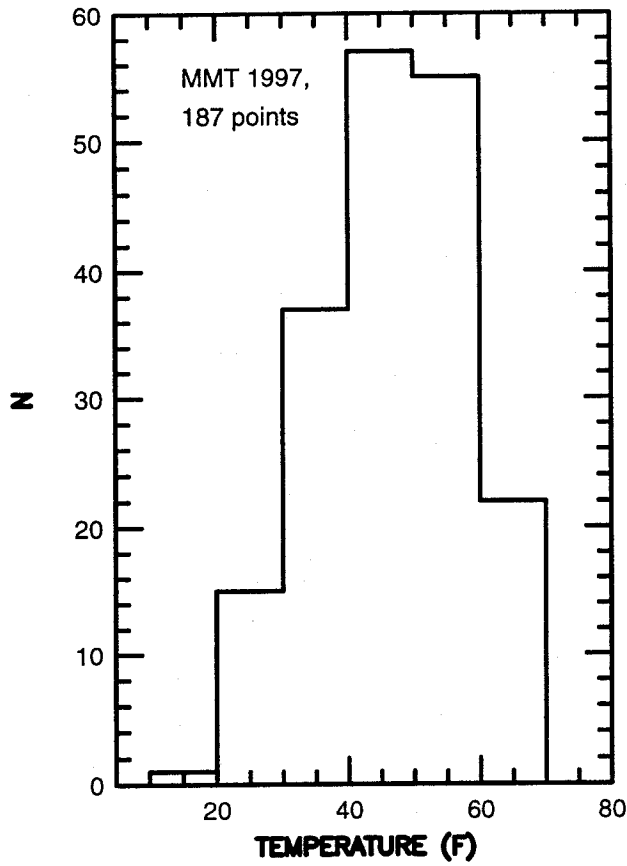


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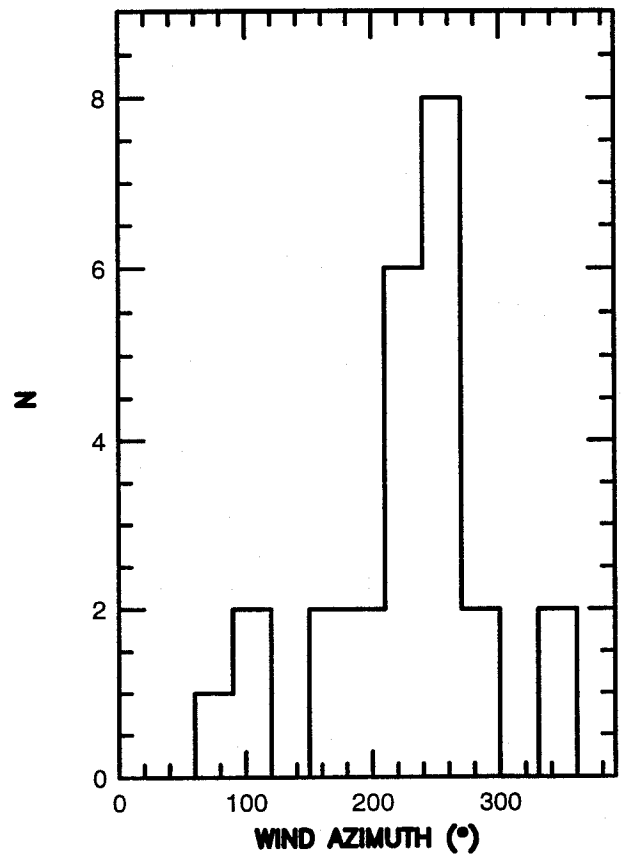
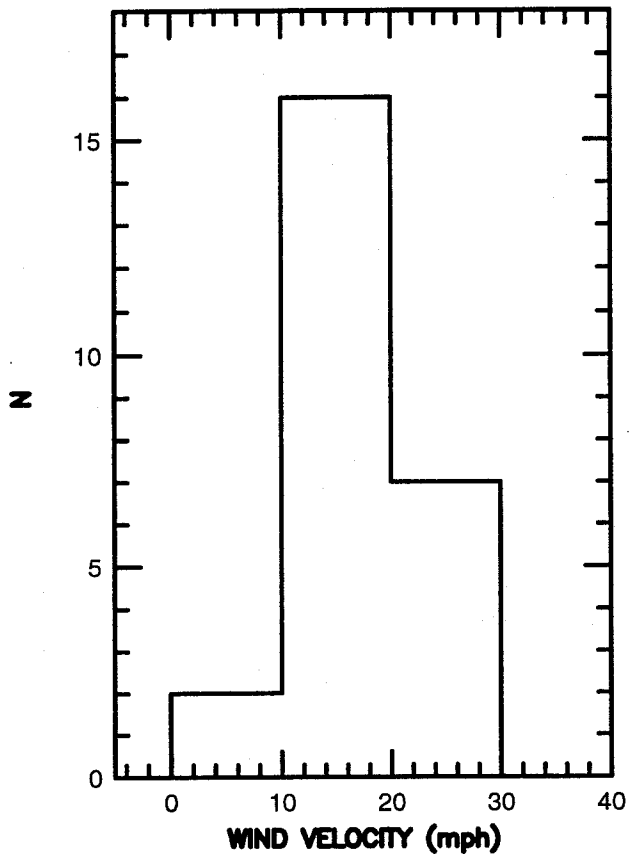
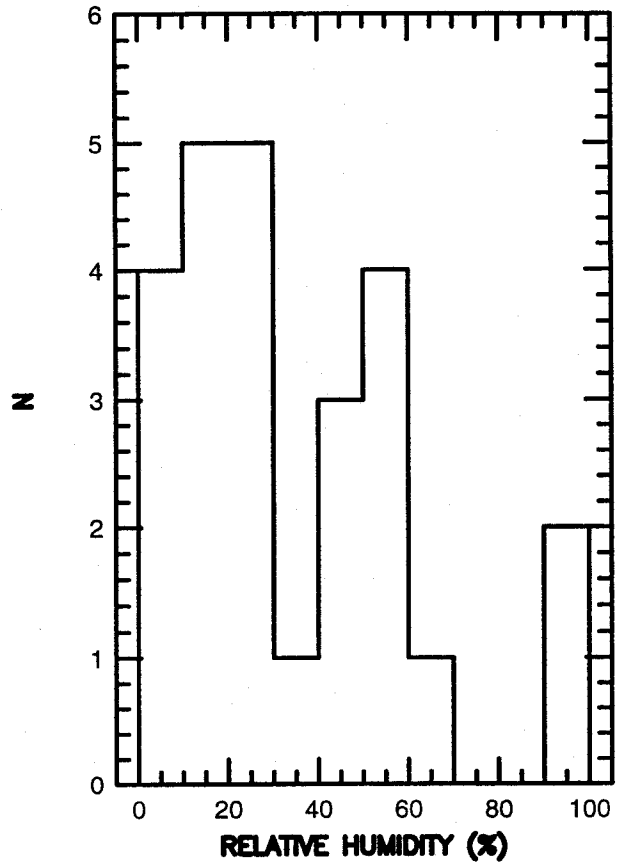
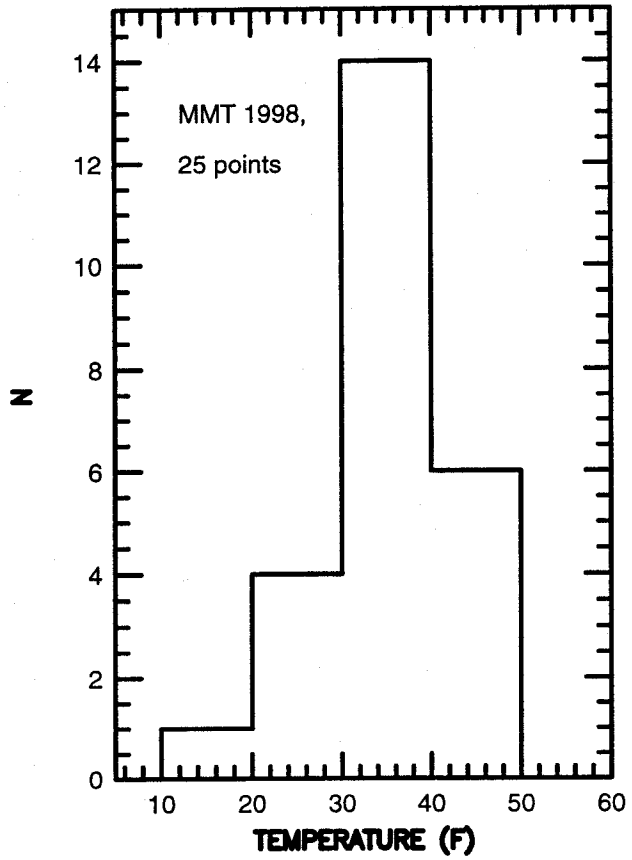


FIGURE 10

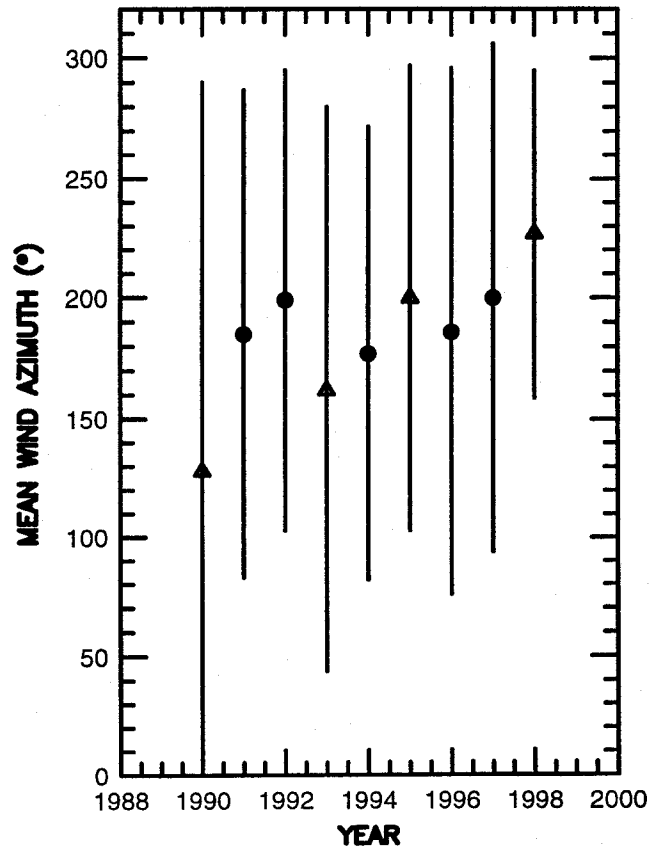
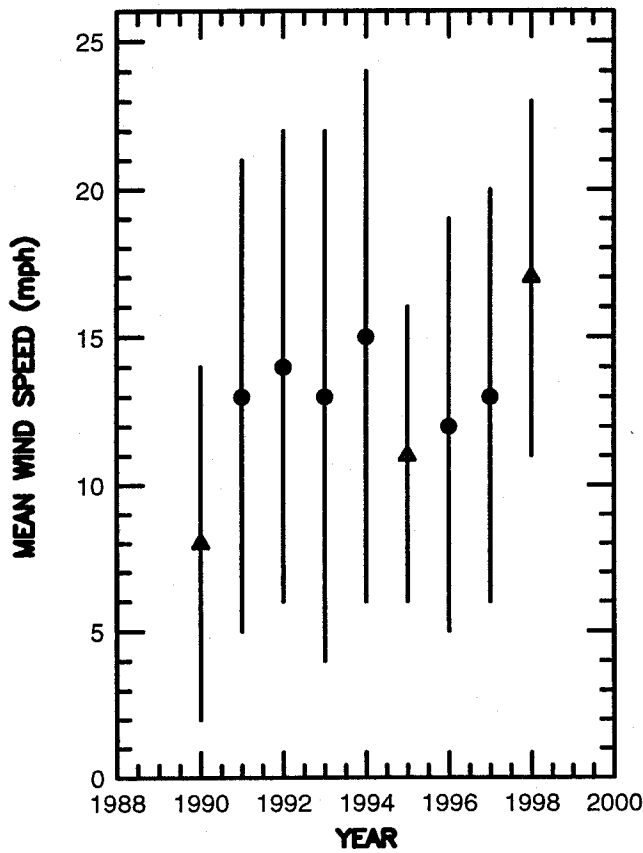
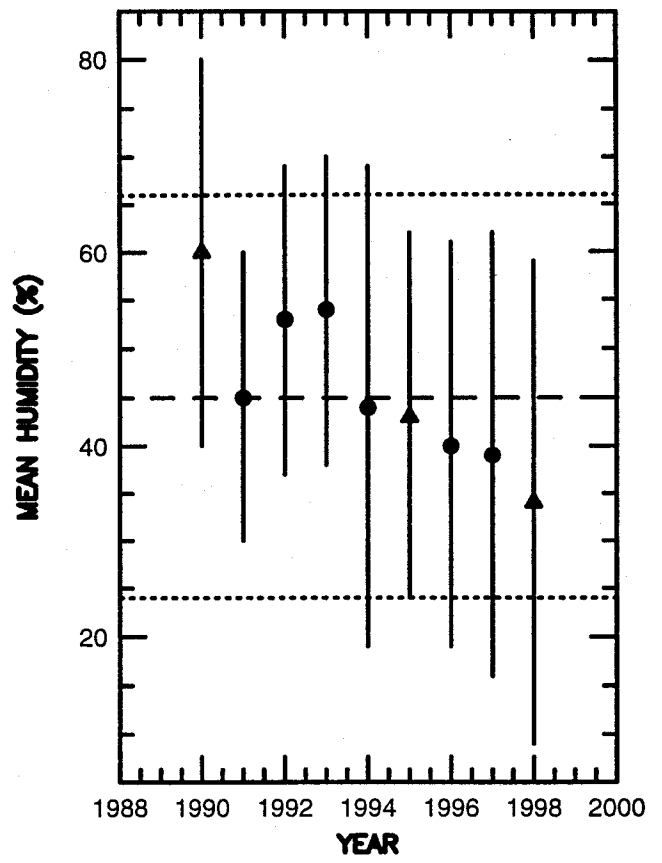
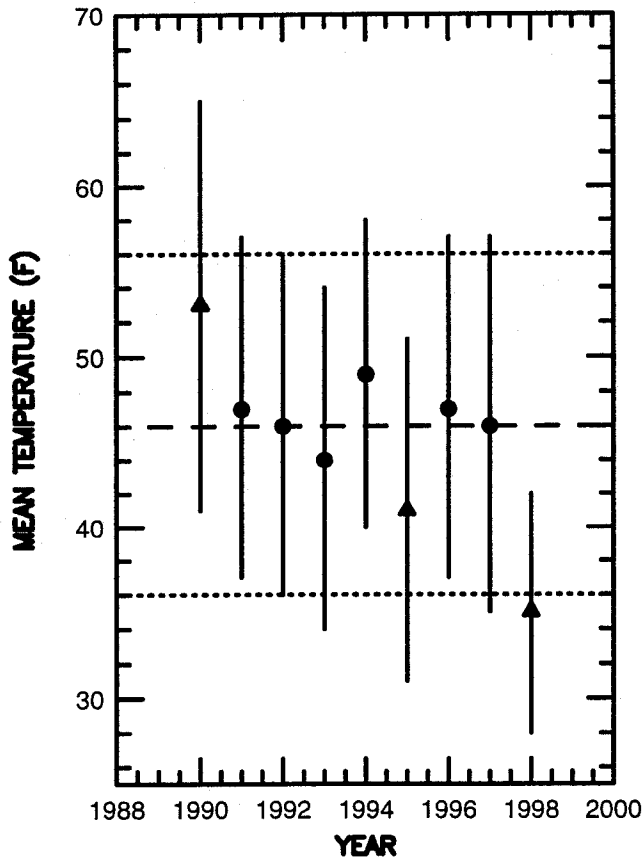


FIGURE 11

