Submillimeter Array Technical Memorandum

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Opacity Update

The 225 GHz radiometer on Mauna Kea has been running now for nearly 2 years. The reliability improved after the first 6 months, and the data from the start of operation in August 1989 to the end of July 1991 are 83% complete. The results are more optomistic the those from the first year of operation, with 15% of the measured times showing opacity < 0.05 (PWV = 1 mm).

Data Analysis

The opacity data were analyzed in a similar fashion to the previous study (Technical Memo 48). After retrieving the data from CSO, they were edited. If the tau derived from a tipping scan was less than 0.015, the less-accurate but more reliable tau derived from the zenith sky temperature was substituted. If the result was still discrepant with adjacent values, it was removed entirely. Almost all of the wild points occurred during the afternoon, or in bad weather, when the sky was non-uniform and the tipping scan did not yield a good fit for tau. At a few times, the radiometer appeared to be bad, and blocks of time were removed.

After editing, medians were calculated for 1.5 hour periods. This is long enough to ensure that there should be at least one data point in each period, despite the regular interruptions (every 5 hours) of tipping scans for fluctuation measurements lasting 4096 seconds (1.38 hours). The use of medians also minimizes the effect of occasional discrepant points not removed by editing. In the previous analysis 1 hour medians were used. All further analysis is based on the 1.5 hour medians.

Results

Figure 1 shows a histogram of the distribution of measurement times, which run from day number 232 in August 1989 to day number 941 in July 1991 (day 211 of 1991). The radiometer was replaced after the first six months with a more reliable unit. The overall coverage was 82.7%. Some of the missing points are associated with bad weather, but at other times the radiometer was down during good weather. Since the overall coverage was so high, any correlation between weather and missing data can cause only a small bias.

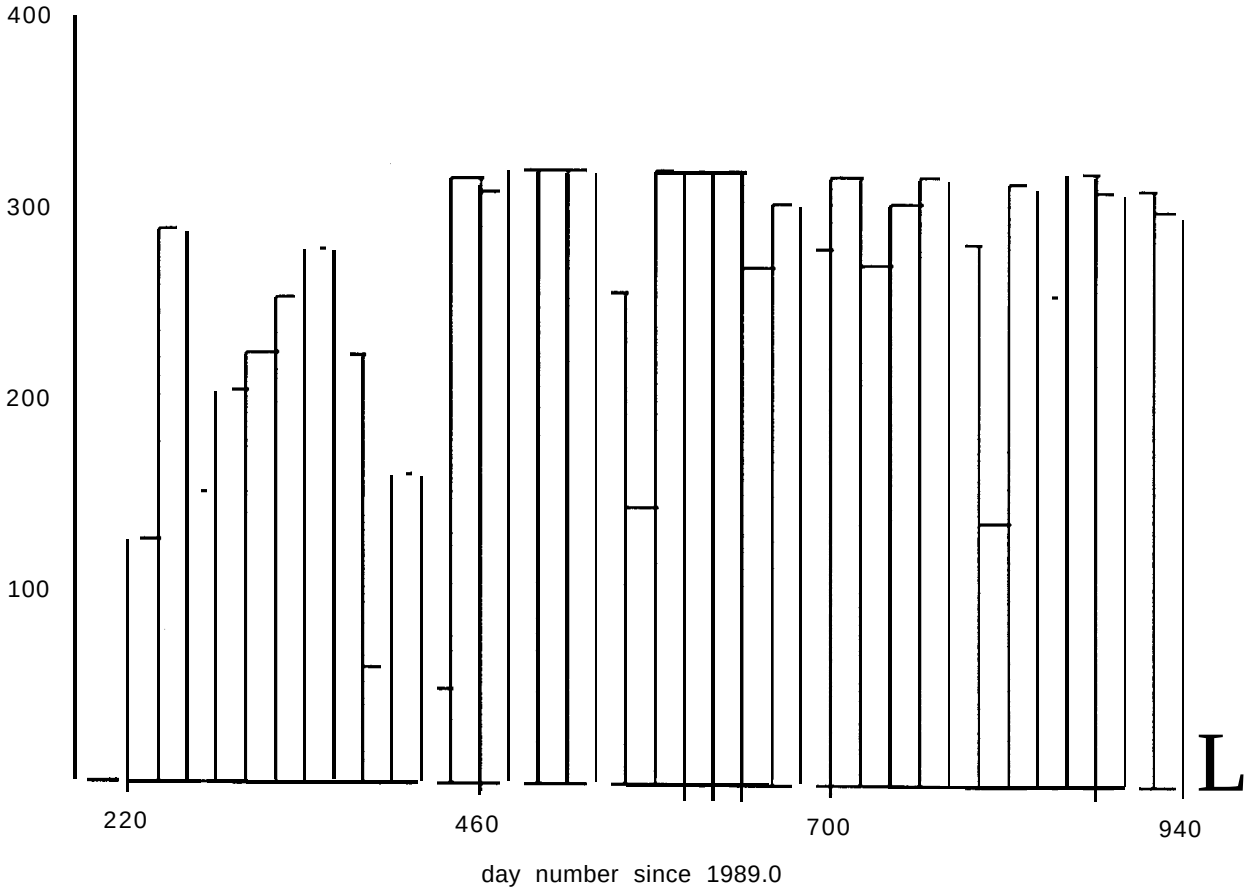

Figure 1. Histogram of times of 1.5 hour medians from 1989 August to 1991 July. The radiometer was replaced after 6 months by a more reliable unit.

Figure 2 is a plot of all the 9292 measured opacities, plotted against day number. The values have been truncated at an opacity of 0.5. There is a slight indication of a seasonal effect, or at least a tendency for weather to be good or bad for several months at a time.

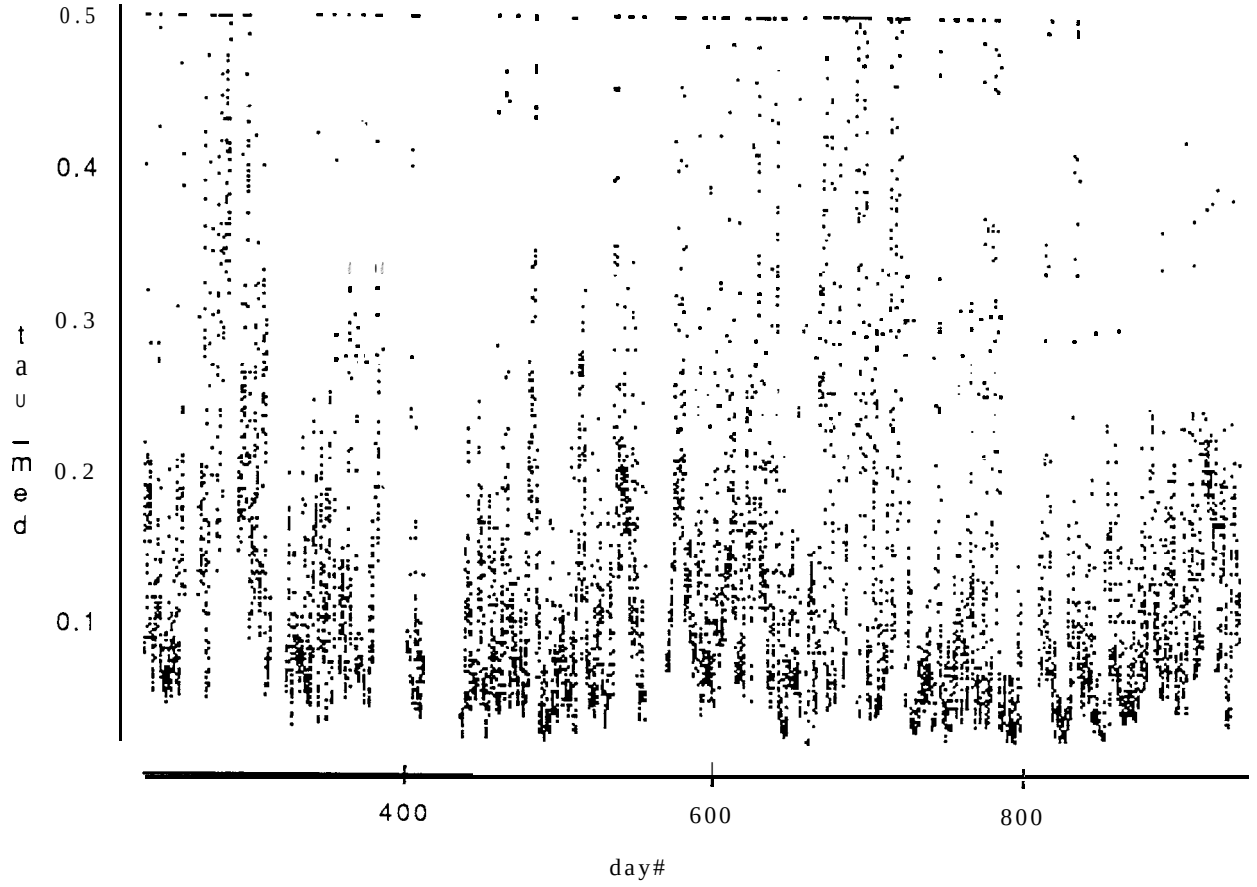

Figure 2. Distribution of all measured median opacities from 1989 August to 1991 July.

Figure 3 shows the cumulative distribution of measured opacities. The overall median opacity is 0.095, with quartiles of 0.062 and 0.171. The minimum recorded value was 0.023, and 14.8% of the points had an opacity less than or equal to 0.05. These statistics apply to the whole dataset, covering 24 hours per day. As shown in Technical Memo 44, there is a diurnal effect, which is especially pronounced at higher opacities, such that days are worse than nights. The possible incompleteness can have only a small effect. Even if all of the missing 17.3% of points were during bad weather, there would still be 12% of the time with opacity less than 0.05.

These results are more optomistic than those presented in Technical Memo 44, where roughly 10% of the points were below 0.05, and they are more in line with some previous measurements from the literature. The difference is probably attributable to statistical fluctuations, especially since the periods of good or bad weather seem to run for several months. For example, there are periods of several months where more than 25% of the points are below 0.05.

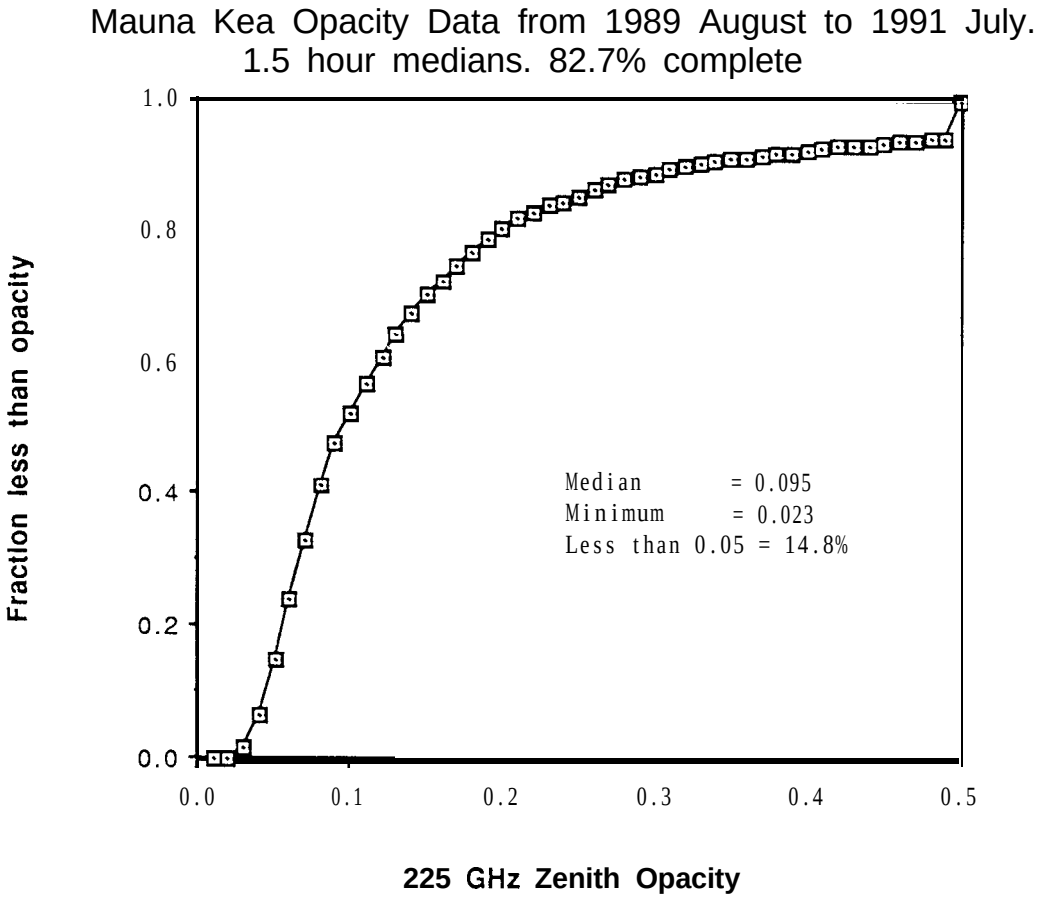

Figure 3. Cumulative Distribution of opacity