Interoffice

National Radio Astronomy Observatory

Charlottesville, Virginia

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To: D. S. Heeschen

25 Meter Millimeter Wave Telescope Memo #77

From: Lee J Rickard

Subject: Another indicator of the frequency of cloud cover on Mauna Kea

As has been discussed in previous memorandums, one of the major unknowns of the observing conditions on Mauna Kea is the frequency of cloud cover. While the summit is far above the normal local trade-wind inversion, the daytime heating of the mountain slopes draws moist air up from below the inversion. Thus, during the afternoons, the peak is often surmounted by cumulus clouds, with an associated increase in the relative humidity. As the mountain cools in the late afternoon, the moist air rapidly subsides, and the nights are usually clear. Apparently, our best estimate to date of the frequency of afternoon cloud cover has been that of Morrison et al. (1973, PASP, 85, 255): about two thirds of the afternoons are cloudy. Assuming that 90% of the remaining hours are clear (and a 365-day year), this implies 6570 hours of clear weather.

However, data obtained by Hansen et al. (1966, PASP, 78, 14) suggest even better conditions. Hansen et al. monitored the relative humidity at the summit of Mauna Loa over the period from 1957 to 1965. In a comparison with a daily log of direct observations of the state of the sky from August 1964 to June 1965, they found a correlation between the fraction of the time that the relative humidity exceeded 70% and the fraction of the time indicated as cloudy in the logs. The correlation was very good for the nights, but somewhat poorer for the days; however, Hansen et al. attribute the daytime discrepancy to the logging of cirrus clouds that were not associated with an increase in humidity. Thus, the Hansen et al. data ought to be very useful to us, assuming that we can extrapolate from the conditions on Mauna Loa to those on Mauna Kea. This last point is decidedly uncertain; still, if the dominant parameters are the warming rate of the mountain and the length of slope that the clouds must traverse to reach the summit, it seems that the afternoon cloud-cover statistics of the two mountains could be similar.

Hansen et al. give the average fraction of the time that the relative humidity lay below 70% (i.e., fraction of cloud-free time) for six four-hour periods. Rounded to the nearest 5%, these values are given in Table 1.

TABLE 1

Period	Fraction	Period	Fraction
6 AM- 10 AM	0.9	6 PM- 10 PM	0.75
10 AM- 2 PM	0.8	10 PM- 2 AM	0.85
2 PM- 6 PM	0.6	2 AM- 6 AM	0.9

~~Note that the afternoon figure is in fairly good agreement with that of Morrison et al. for the afternoons on Mauna Kea.~~ For a 365-day year, these values imply 7000 cloud-free hours.

By way of comparison, the absolute best estimate for Kitt Peak is 7140 clear hours (90% of all time clear except August). Thus the Hansen et al. data suggest that Mauna Kea is at least as good as Kitt Peak in terms of the frequency of cloud cover.