## Task 5: Haleakala Observatories--Rainfall

This task is the analysis of rainfall data for the summit of Haleakala, Maui. CAPS REMS do not measure rain, and therefore only IfA Mees station data was available. The time interval covered was 1998 through 2002, with several exceptions: data was not available for February 1998, March 1998, April 1998, September 1998 (3 days missing), and December 1999 (25 days missing).

First, all rainfall values were totaled for each year. The variation from year to year is shown in Figure 1.

Amount of Rain (by year)


Figure 1
The annual total rainfall during the last 5 -year period varies from less than 15 inches per year to more than 45 inches per year. As noted above, 3 months of data were missing from 1998 and nearly one month from 1999. For the 3 years of complete data (2000, 2001, and 2002), the contributions from these 3 months are 5, 8 , and 10 inches respectively. Although the missing data would change the trend observed in Figure 1, 1998 and 1999 would likely remain drier years than the later years.

Inter-annual variability is normal for Hawaiian weather. As discussed in our earlier Task 1 report, large-scale patterns (such as El Nino/Southern Oscillation, or ENSO) correlate with significant changes in the local weather. During 1998, a strong ENSO (also called a warm phase event) was ending and a La Nina (or cold phase event) was beginning. This study does not attempt to discover what relationship (if any) exists between Haleakala
weather and the larger Pacific patterns. However, interpretation of the present results should include awareness of these phenomena.

Another feature of the rainfall data that was explored was variability during the course of a year. All data was combined, by month, for the 5 years available here. This pattern is shown in Figure 2. Note that the rainfall has been annualized for an effective amount/year.

Amount of Rain (by month) 1998-2002


Figure 2
This pattern shows the normal rain distribution throughout the year with the summer months being the driest and the winter months, the wettest.

Another pattern that was explored is the diurnal variability by hour of the day. This data is presented in Universal Time (UT) ${ }^{2}$ since that is the standard time reference for all measurements herein. This hourly data is presented in two ways:

Figures $3-6$ show the hourly distribution by amount of rain,
Figures 7-10 show the hourly distribution by probability of occurrence.
The probability distribution was obtained by determining the number of data points indicating any rainfall during each hour and deriving its percentage of all points for that interval. For readability, 3 months are shown on each chart.

[^0]

Figure 3


Figure 4

Amount of Rain Q3 (by hour-UT) 1998-2002


Figure 5


Figure 6

Probability of Rain Q1 (by hour-UT) 1998-2002


Figure 7
Probability of Rain Q2 (by hour-UT) 1998-2002


Figure 8


Figure 9

Probability of Rain Q4 (by hour-UT) 1998-2002


Figure 10

## Comments

Five years of weather data is a quite small sample from which to elicit climatic patterns other than the grossest ones. Inter-annual variability may dominate the pattern on these short temporal scales. The ENSO alone has a period of from 2 to 10 years and produces significant changes in various atmospheric parameters, including rainfall.

Examples of the small sample effect can be seen in the monthly "amount of rain" charts (Figures 3 to 6). Apparently large excursions from a mean value occur at various times during the year: January @ 0400, January @ 2000-2200, April @ 1000, and October @ 1700. However, all of these peaks are related to single event rainfalls: January @ 0400 occurred on $1 / 6 / 98$ and amounted to $71 \%$ of the total for that monthly hour; similarly, January @ 2000-2200 was on 1/29/02 (40\%), April @ 1000 was on 4/2/00 (76\%), and October 1700 was on 10/15/02 (75\%). Thus, these peaks do not represent a general trend. However, the generally low rainfall during the summer months (June, July, August, and September) compared to that during winter months (November, December, January, and February) is consistent with other data.

Similar comments are applicable to the monthly "probability of rain" charts (Figures 7 to 10). The general pattern of low probability during summer months (often less than 5\%) versus a higher probability during winter months (around 10\%) matches the higher rainfall in winter.


[^0]:    ${ }^{1}$ Due to the missing data, some months only had data from 4 years; the other months had data from 5 years.
    ${ }^{2}$ UT $=$ Hawaii Standard Time (HST) +10 hours.

