

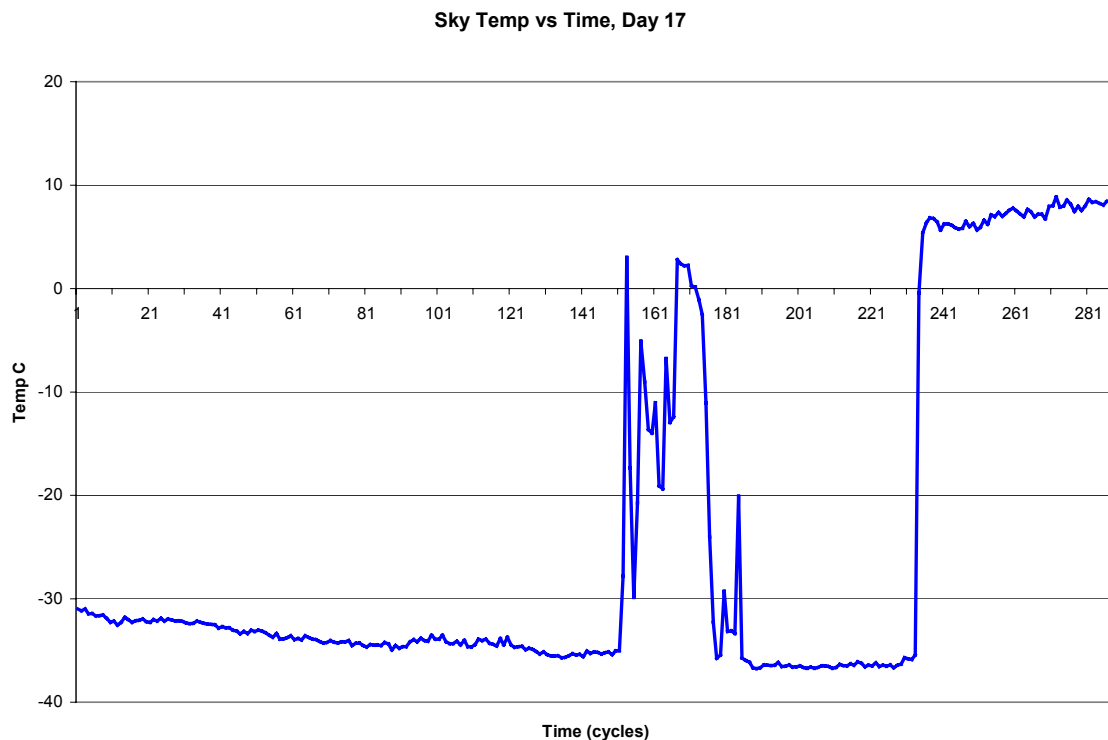
Task 3: CAPS IR Sky Temperature/Clouds

An infrared (IR) detector array to measure sky temperature was recently added to the CAPS sensor suite. Its present configuration consists of 5 sensors; one pointing straight up and the other 4 pointed east, west, north, and south. The sensors have a field-of-view of 60° and the side-pointing ones are aimed at about 40° elevation. The sensors are COTS IR thermocouples with a spectral response from 6.5 to 14 microns. The data is sampled once per 5 minutes and stored in an archive file. These IR sensors are not integrated with the rest of CAPS at present but are operated by a separate computer and data logger. This system has been operational from late 2001. Only the data from year 2002 and only data from the zenith detector will be presented.

The purpose of the CAPS IR sky temperature array is twofold:

- 1) to confirm the presence/absence of clouds over Haleakala summit on a continuous 24/7/365 basis as another input parameter to the prediction system;
- 2) to provide the archive data that is used in the verification of the CAPS performance on a routine basis. Figure 1 an example of one day's data.

Figure 1



When the sky is clear, the effective sky temperature is below minus 30° C, as seen from data point #1 to about #150. Between #150 and #190, the warmer temperatures indicate low-level intermittent clouds. And after #233, the warm sky temperature is close to that at the surface and coincides with an episode of fog/rain that was confirmed by the CAPS

video surveillance record. The clear sky temperatures vary from the winter season to summer and these variations have been incorporated here.

The characterization of the CAPS IR sky temperature array is still in a preliminary phase since it has only been operational since late 2001. Many clear sky episodes that been verified by the CAPS video surveillance system show no effect from changes in the ground temperature. This supports the conclusion that the sensor mainly sees a higher layer of the atmosphere over the site. However, on some occasions a small effect is observed that does correlates with the surface temperature. Although it has not yet been verified, there may be a small contribution from a near surface layer when the relative humidity at the surface is above some threshold. This would be explained by emission of water vapor in the 6.7-micron band, which is at the low end of the sensor's spectral sensitivity. This must be confirmed by further analysis

Weather extremes, clear sky or fog/rain, are clearly defined by sky temperatures that are very cold (-30 C) or near ground temperature, respectively. In the middle range, however, the temperature might be either a broad, thin high cloud layer or a broken, thick, lower layer. For this study, it is relatively unimportant which is the case, since the purpose here is to define the grosser categories of clear versus cloudiness for observational operations.

For the purpose of this task, the IR data was categorized into the same four threat level bins that are employed in the CAPS verification procedure.¹ These are:

Type 0=clear	No threat, clear skies
Type 1=part cldy	Small threat, partly cloudy at/above 10,000 feet
Type 2=most cldy	Moderate threat, mostly cloudy at/above 10,000 feet
Type 3=fog/rain	Severe threat, cloudy with rain or fog at 10,000 feet

Subsequent analyses, including the charts, use this threat classification. Based upon the observed sky temperature, a threat level was assigned to each hour of the day.

All data were segregated into daily one-hour bins and the daily bins for each month were counted for the number of occurrences of each threat/cloud condition. The data for the entire year (2002) was combined on an hourly basis and is shown in Figure 2. This figure indicates that throughout most of the day (0600 to 1800 approximately), the sky was clear up to 50% of the time decreasing to about 15% between 2200 and 0200 UT (1200 to 1600 HST). Up to 36% of the time, the sky was partly or mostly cloudy from about 0600 to 1800 UT.² Rain or fog conditions occurred up to 18% of the time.

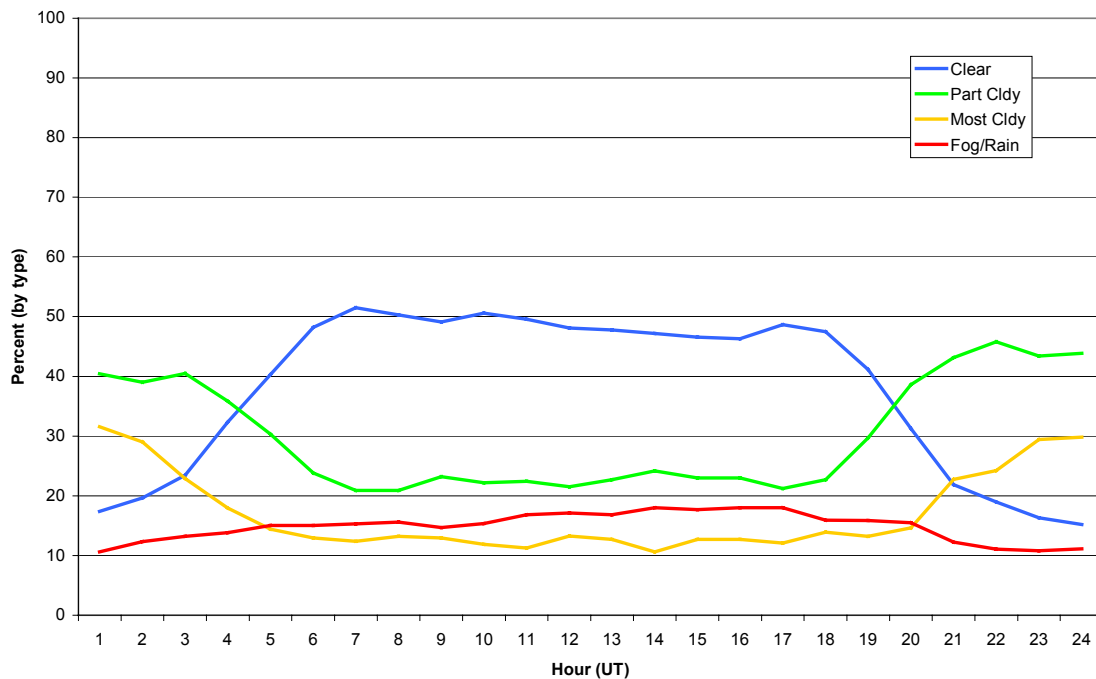
¹ The CAPS verification procedure refers to the routine analysis for comparing the CAPS predictions against the "real weather". This has been done every month since CAPS became operational. CAPS predictions are continuously saved in archive files and reviewed. They are compared to a determination of "real weather" that is assessed by analysis of a time-lapse video record (obtained by the CAPS video surveillance system on Haleakala). The CAPS video system currently records images from 5 cameras covering different zones at the summit of the mountain.

² This includes both Type 0 and Type 1.

The same data was segregated into monthly bins and similarly analyzed to reveal any seasonal effects. These monthly charts are shown in Figures 3 to 14. In the following discussion, the values quoted are for the middle of the day peak³ in the diurnal pattern.

Figure 2

Clouds (hourly) 2002



For the single year analyzed here (2002), the infrared sky temperature measurements show considerable variation throughout the year. For example, the clear sky pattern varies from a high around 80% in December to a low around 10% in August. The winter months (February, November, and December) had clear skies greater than 60% throughout most of the day. The summer months (June, July, and September) had clear skies around 50% of the time (August was an exception, as noted above).

Obviously, one year does not establish a climatological pattern. But, this study does show the significant variation in pattern throughout the day and throughout a single year. It also validates the CAPS IR sky temperature array as a useful sensor for defining the sky character over Haleakala for both the day and night regimes.

³ Note, this refers to the UT day; thus, this period corresponds to local nighttime (0600 UT = 2000 HST, and 1800 UT = 0800 HST).

Figure 3

Clouds (hourly) Jan. 2002

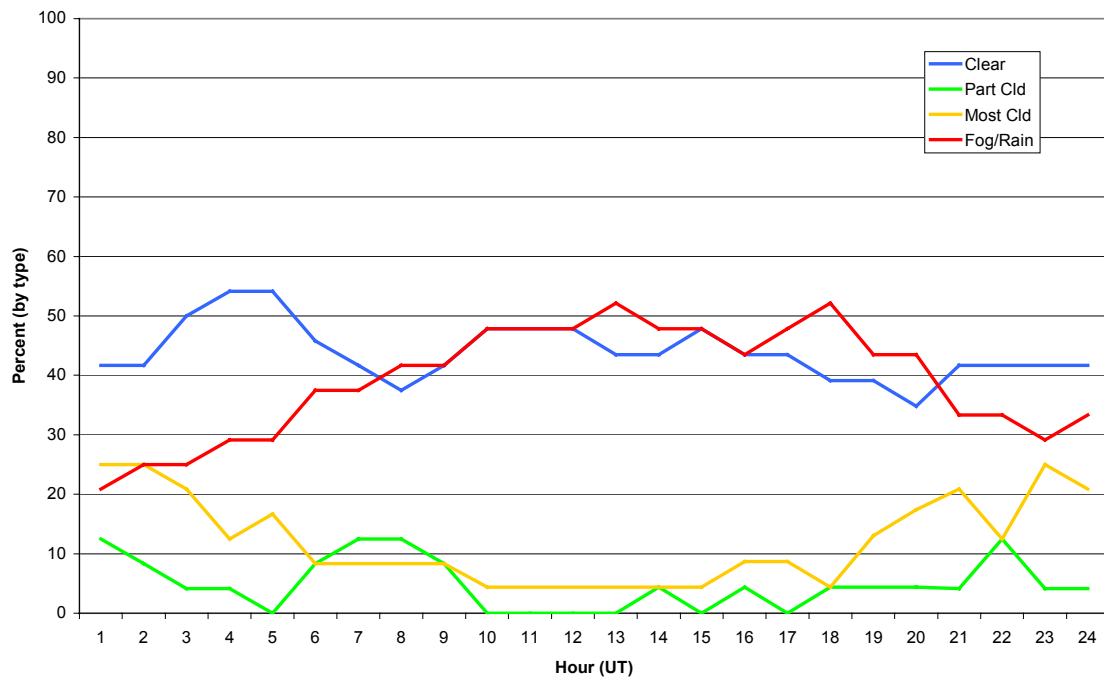


Figure 4

Clouds (hourly) Feb. 2002

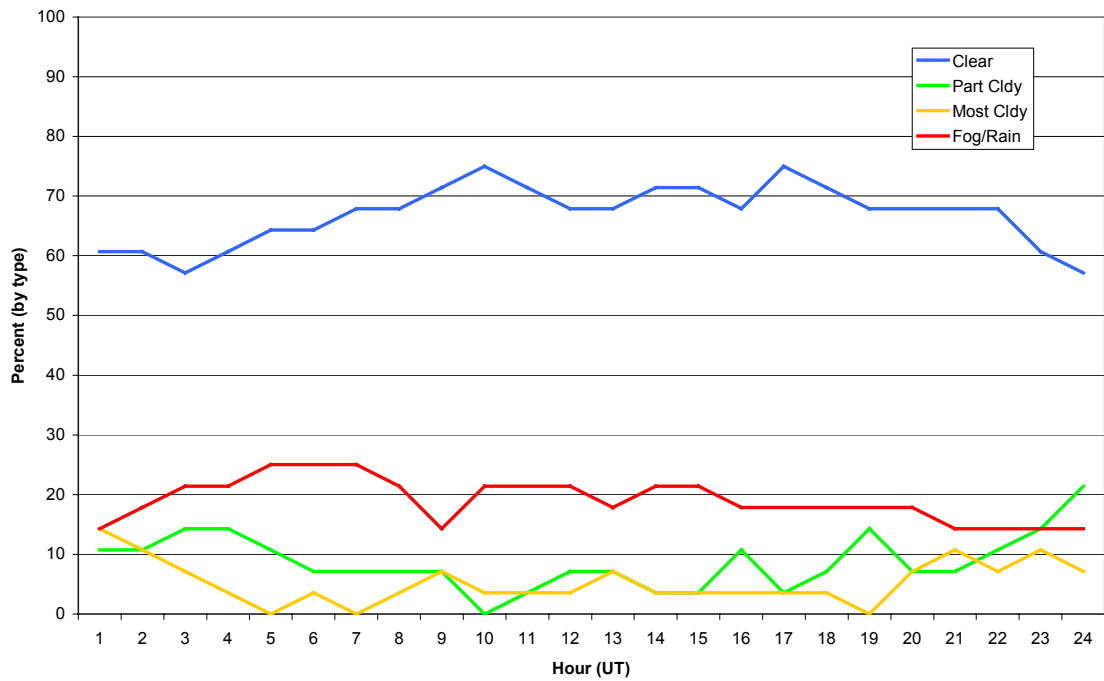


Figure 5

Clouds (hourly) Mar. 2002

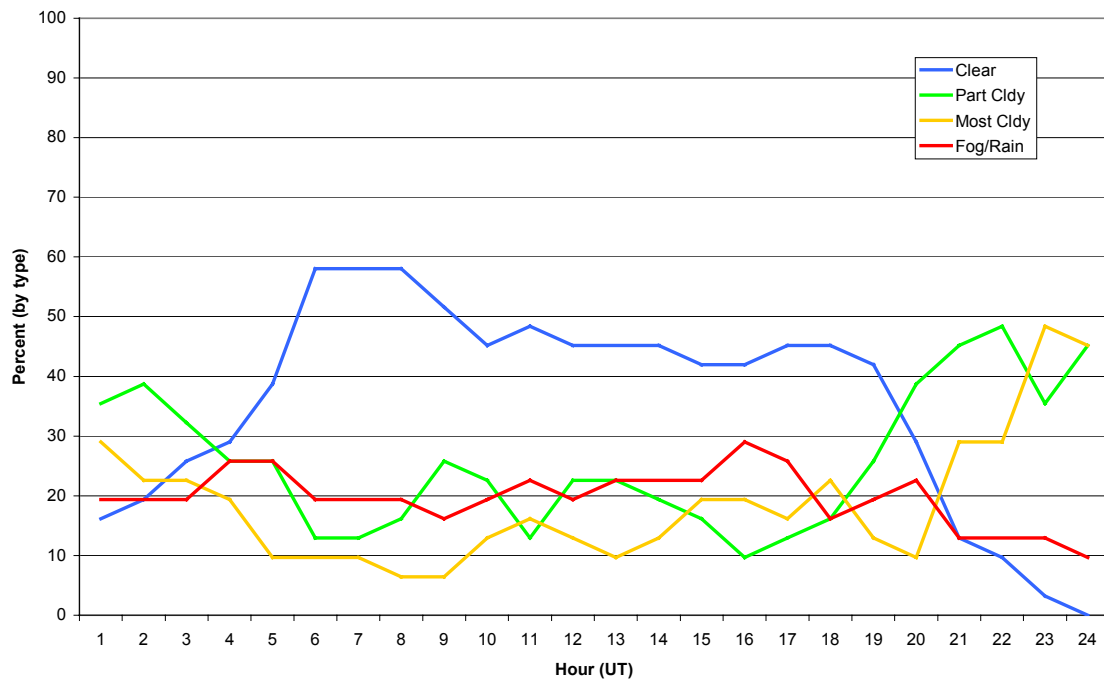


Figure 6

Clouds (hourly) Apr. 2002

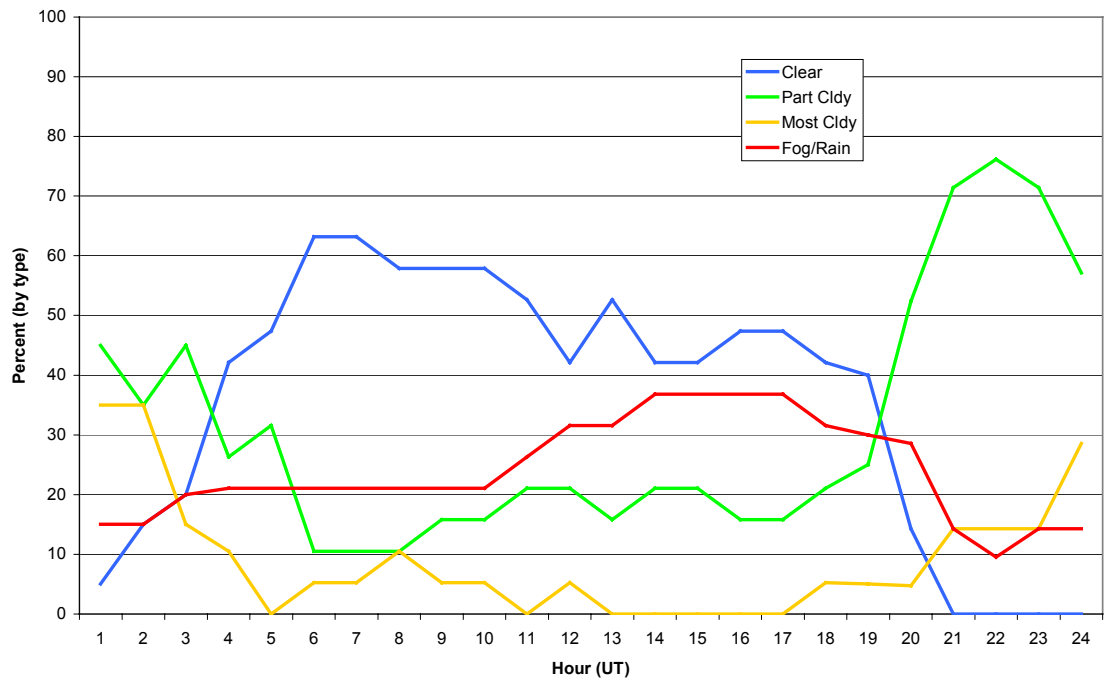


Figure 7

Clouds (hourly) May 2002

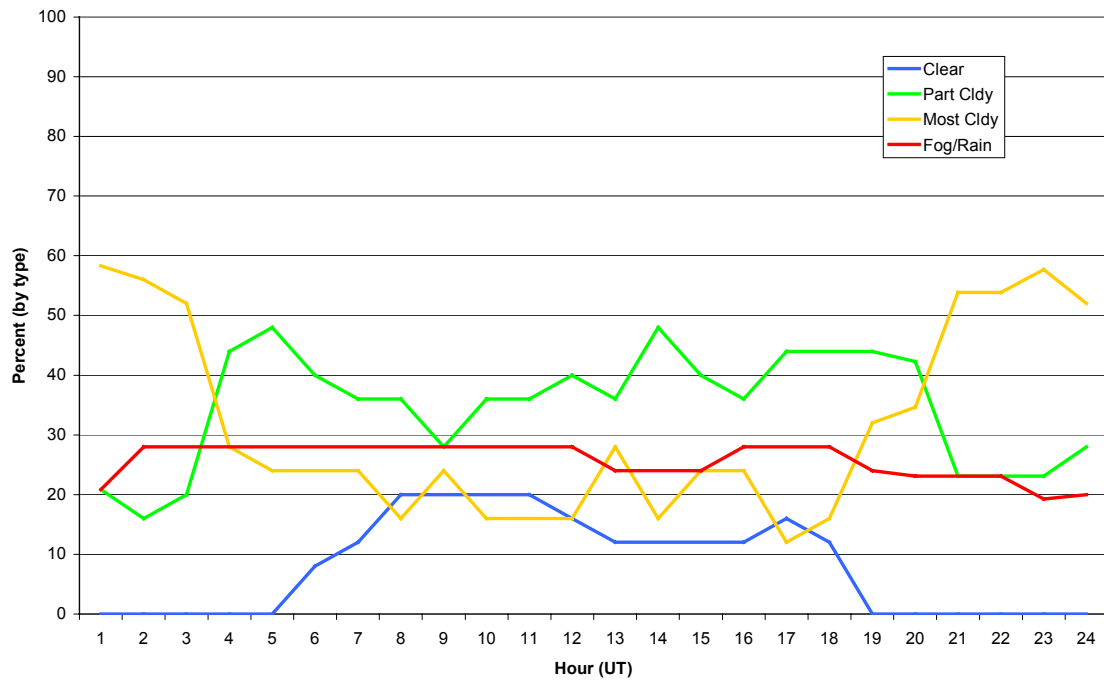


Figure 8

Clouds (hourly) Jun. 2002

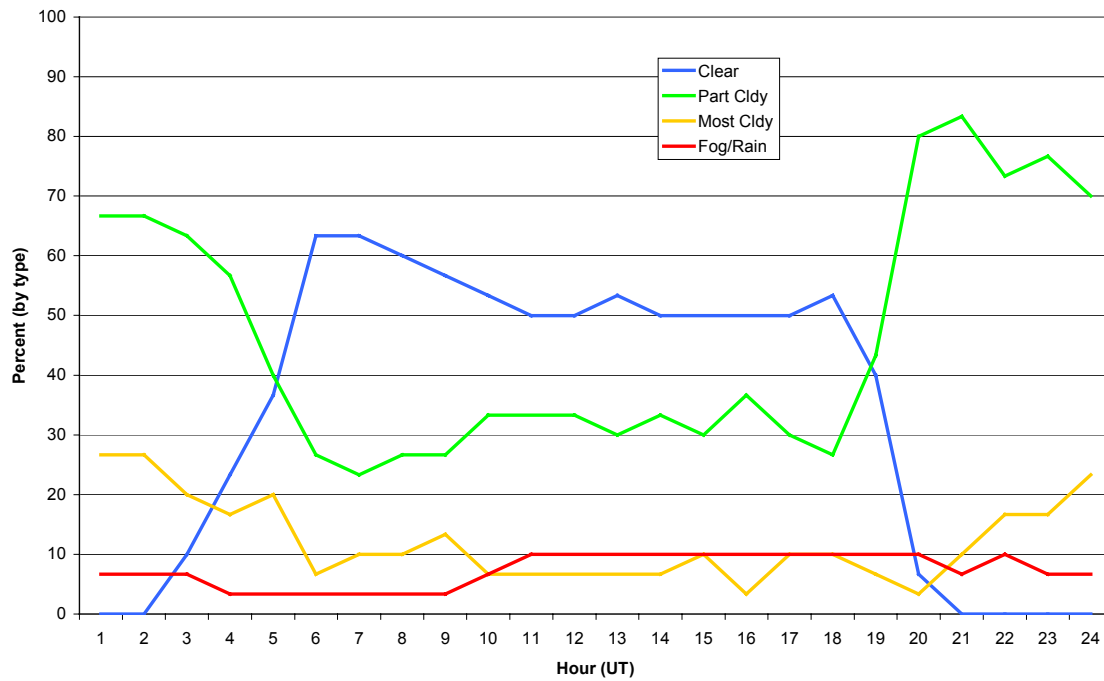


Figure 9

Clouds (hourly) Jul. 2002

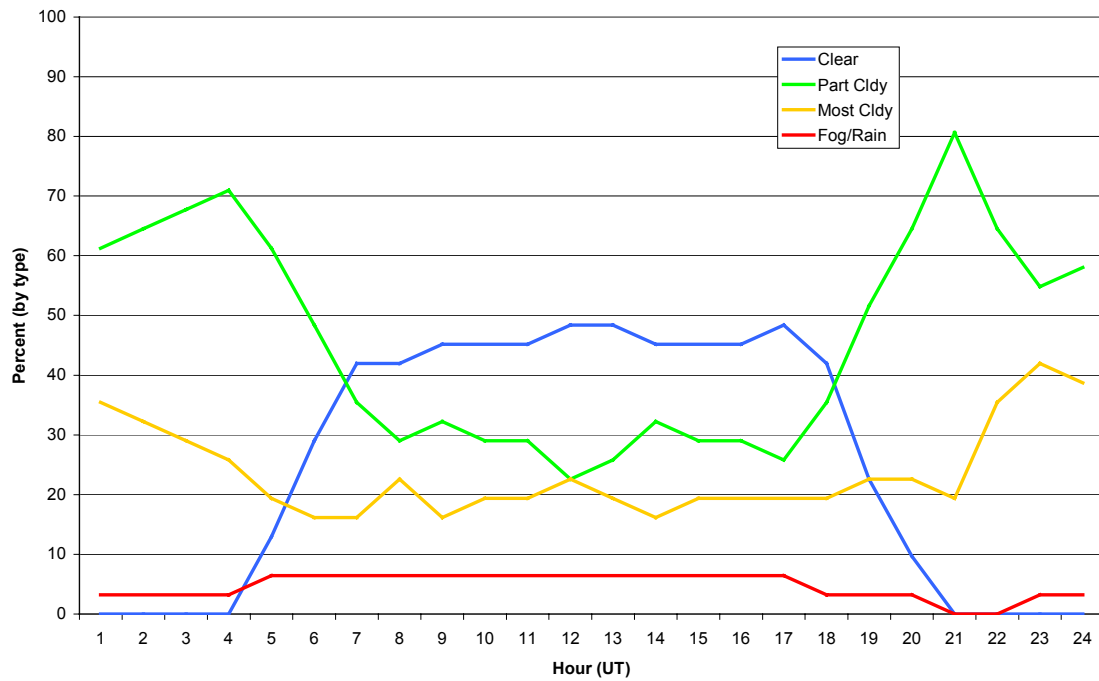


Figure 10

Clouds (hourly) Aug. 2002

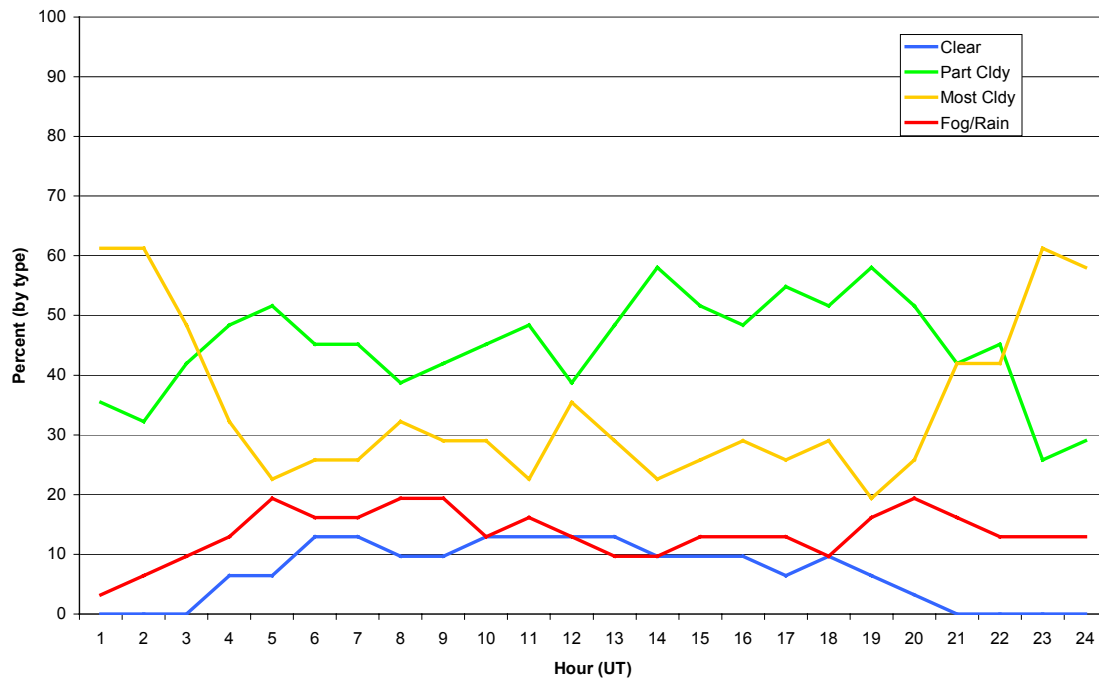


Figure 11

Clouds (hourly) Sep. 2002

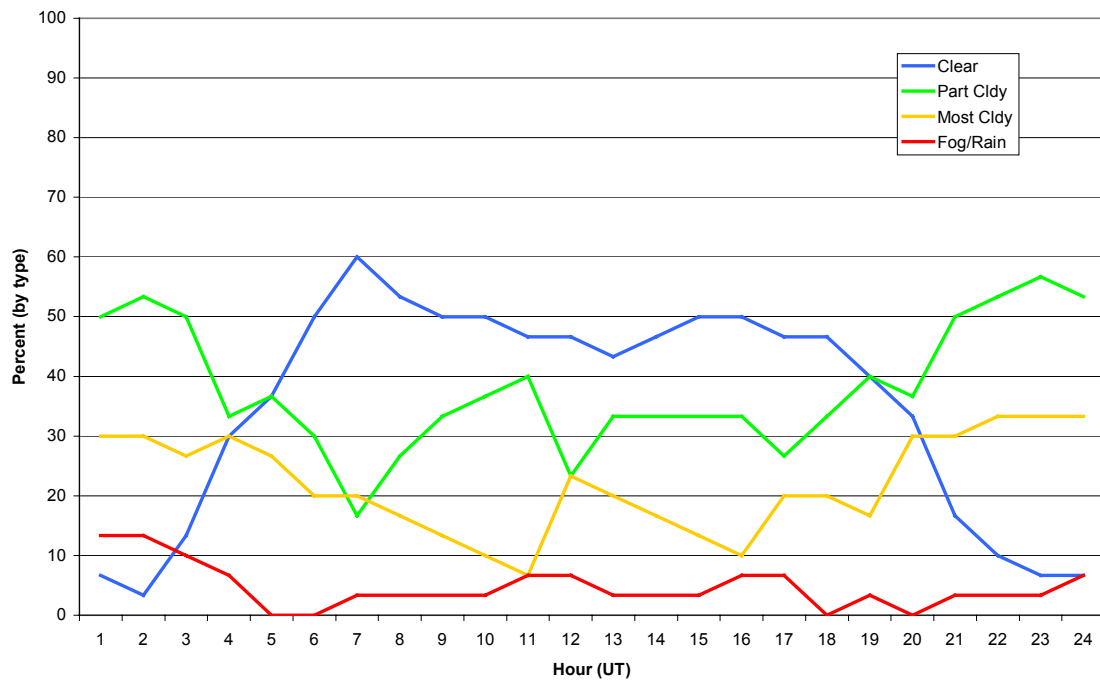


Figure 12

Clouds (hourly) Oct. 2002

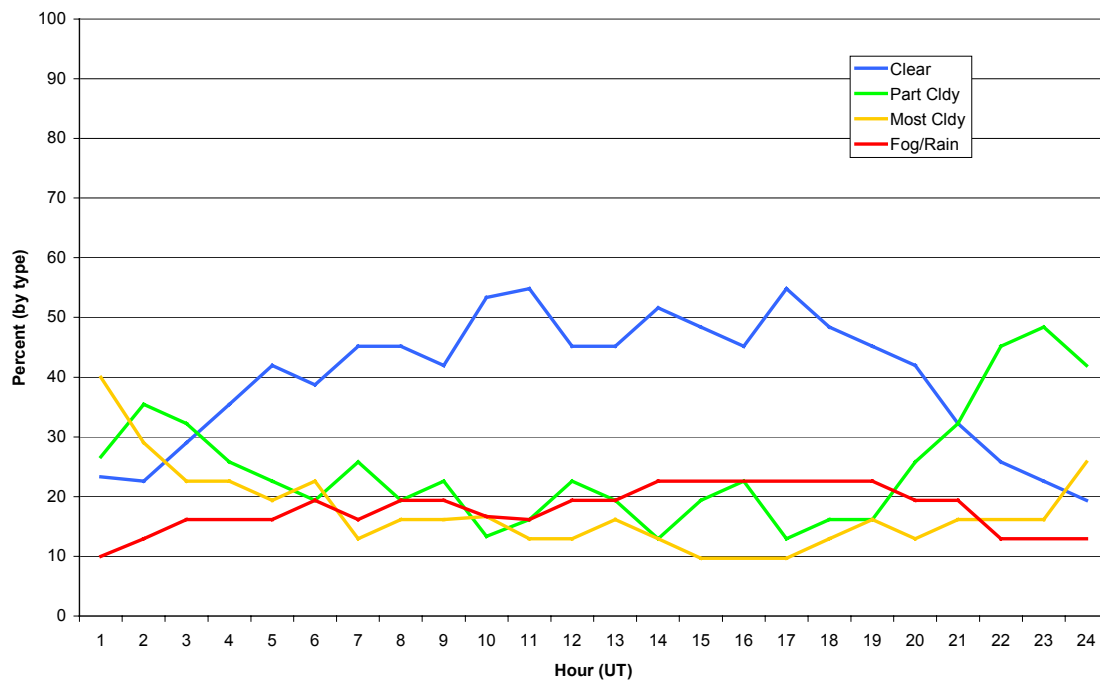


Figure 13

Clouds (hourly) Nov. 2002

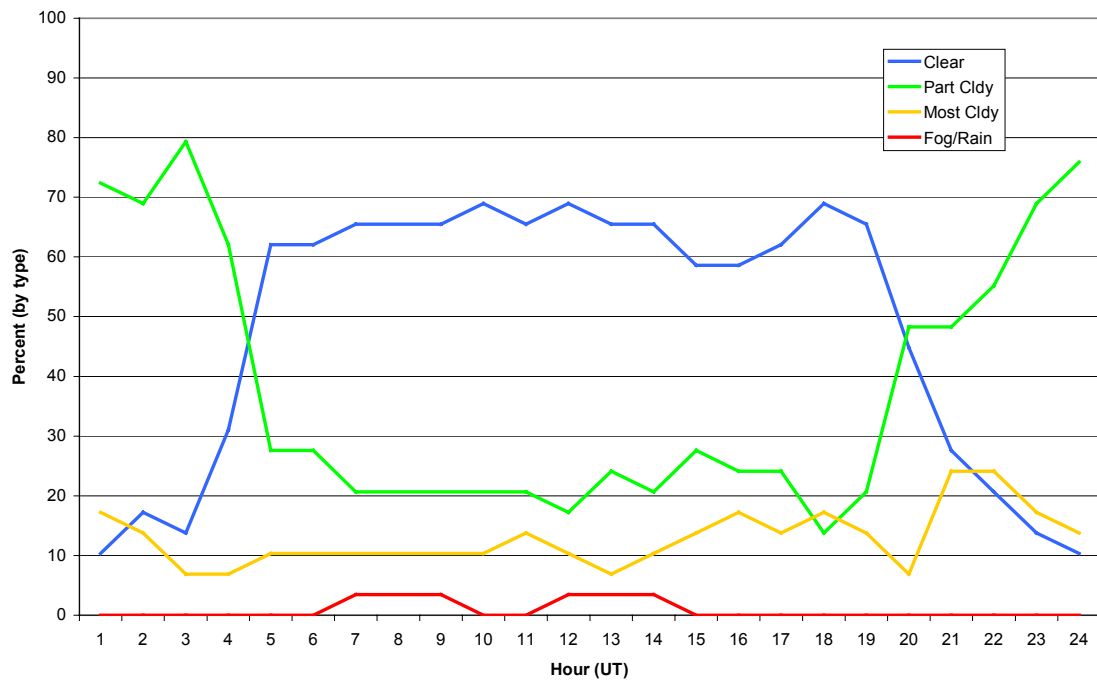


Figure 14

Clouds (hourly) Dec. 2002

