

## Task 2: CAPS Solar Flux/Cloud Cover at HO

A solar flux sensor is one component of the standard CAPS sensor suite. The specific device employed is a LI-COR LI200X pyranometer. It measures incoming solar radiation with a silicon photovoltaic detector mounted in a cosine-corrected head. It is a current-output device with an integrated shunt resistor to provide a voltage signal to the data logger. Solar flux data is collected from all CAPS remote stations but only the summit station is analyzed here as a means to determine the amount of cloud cover at Haleakala Observatories during daylight hours. The results presented here are only from the year 2002 and may be compared with the IR sky temperature data for the same time period and described in our Task 3 (CAPS IR Sensor Data) report.

Figure 1 is an example of one day's data--Day 17 (January 17). We chose it to coincide with the equivalent sky temperature example from Task 3.

Figure 1



With clear skies, the solar flux is a smooth curve rising from zero at sunrise to a peak at local noon and decreasing back to zero at sunset; this is the reference curve. Any significant deviation from this curve is interpreted as evidence of cloud cover. In the example above, partly cloudy conditions occur throughout the day from about data point 29 to 127. It is noted that clouds lie in the sun-sensor path throughout the day and can be different from the sky temperature measurement (which is a zenith pointing device). For

this analysis, the deviations (or lack thereof) are estimates based upon significant differences from the reference. The categories defined are the same as for Task 3.

Weather extremes, clear sky or cloudy, are relatively well defined by solar flux values that are near to or markedly different from, the reference curve. In the middle range, however, the flux data may be less well categorized. Again, for this study that is relatively unimportant, since the purpose here is to define the grosser categories of clear versus cloudiness for observational operations.

For the purpose of this task, the solar flux data was categorized into the same four threat level bins that are employed in the CAPS verification procedure.<sup>1</sup> These are:

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

Note: for this solar flux analysis, only the first part of the description is useful since the change in flux value tells nothing about where in the path the flux deviation occurs. The latter description for each type is that employed in the CAPS video analysis.

Subsequent analyses, including the charts, use this threat classification. Based upon the solar flux deviation a threat level was assigned to each hour during daylight. Also note that the solar flux data only exists for daylight hours (roughly 1700 to 0400 UT, or 0700 to 1800 HST), but is presented for the entire day to coincide with the sky temperature results (Task 3).

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 results are presented as percentages of the number of occurrences for each cloudiness type over the total number (except for a few minor gaps in the data, the total number per month equals the number of days per month). The data for the entire year 2002 was combined on an hourly basis and is shown in Figure 2. This figure indicates that throughout the daylight hours (2000 to 0200 UT approximately), the sky was less clear (<40% of the time) compared to early morning hours (1700 to 2000 UT) when it was greater than 50%. This agrees with the results for cloudiness derived from the sky temperature in Task 3.

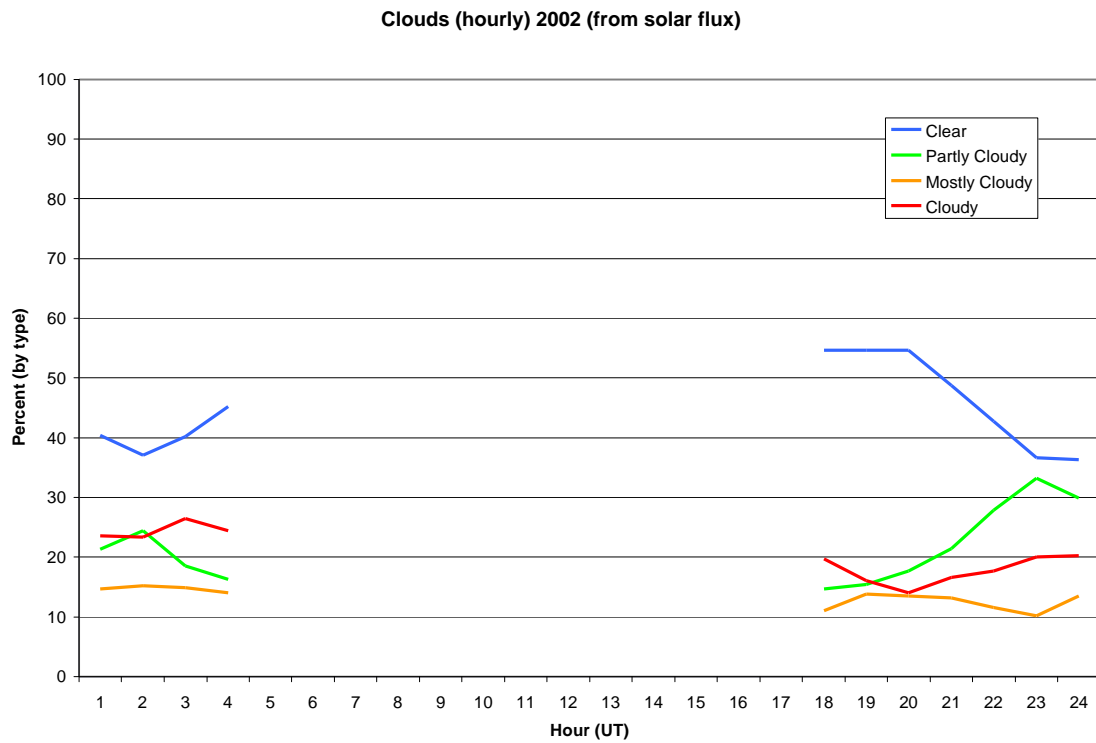
The same data were segregated into monthly bins and similarly analyzed to reveal any seasonal effects. These monthly charts are shown in Figures 3 to 14.

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<sup>1</sup> 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.

The clearest skies for daylight hours occurred during the winter months November to February with midday values ranging from about 50% to 80%. Cloudy skies dominate (about 80%) during summer months May through October for the same time of day. This annual variation in cloudiness also agrees in general with the results of Task 3.

Figure 2



Although these results (for cloudiness as derived from solar flux measurements) are, by definition, not applicable to nighttime observing conditions, they do support the infrared sky temperature data that are available 24 hours per day.

Figure 3

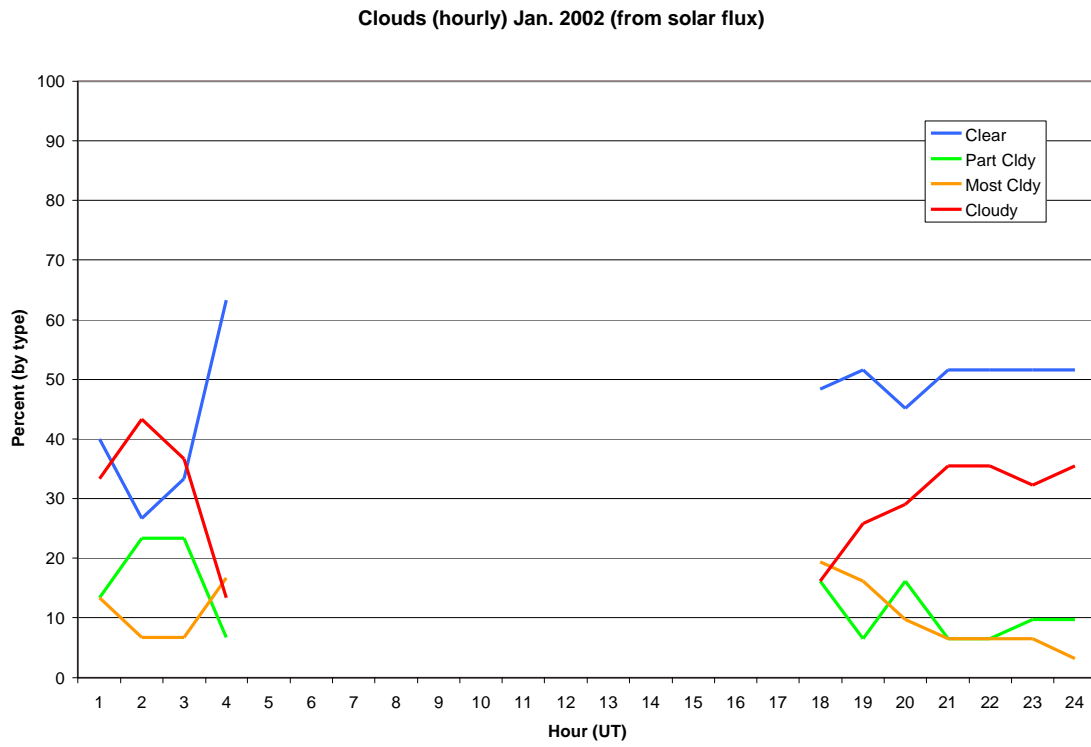


Figure 4

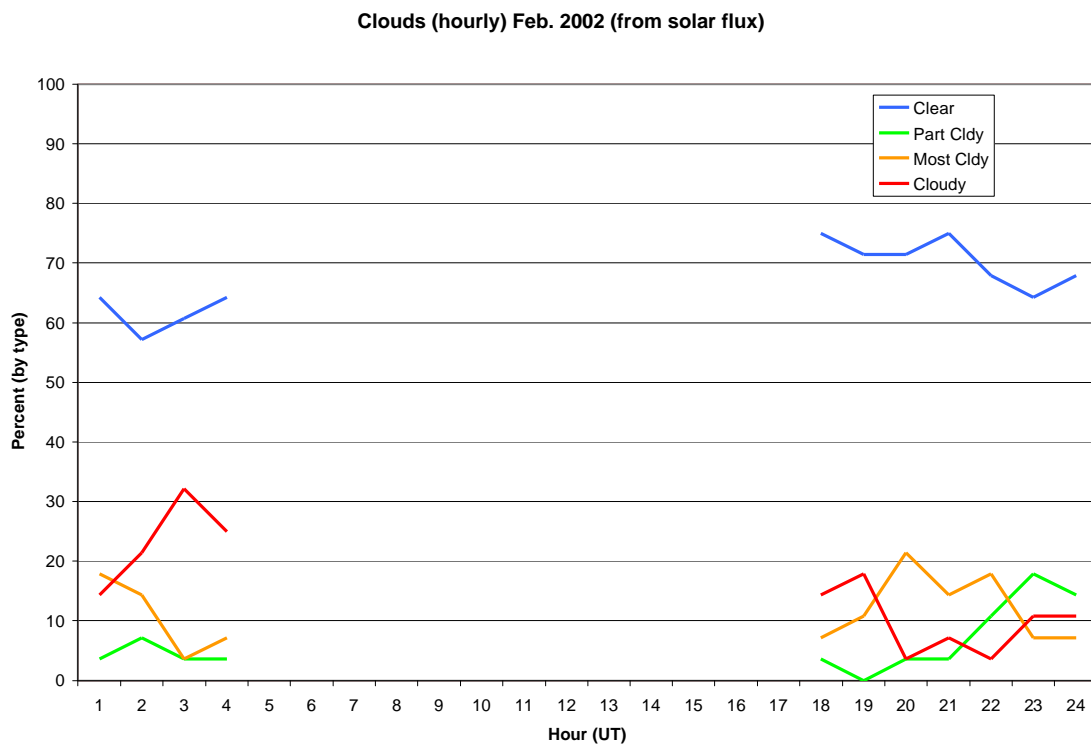


Figure 5

Clouds (hourly) March 2002 (from solar flux)

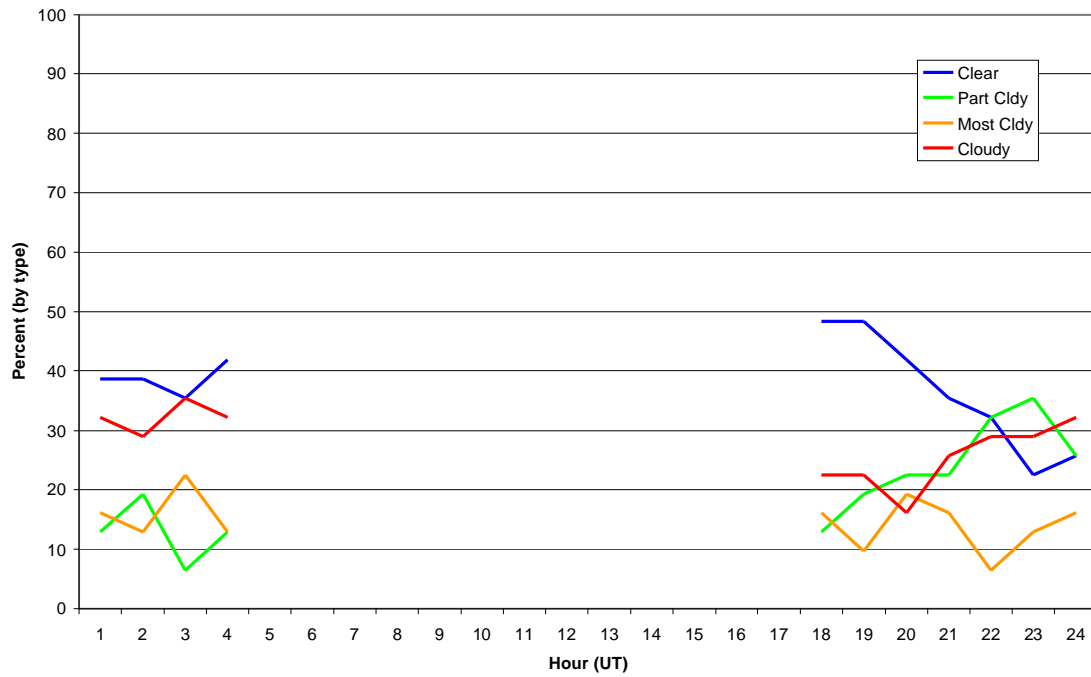


Figure 6

Clouds (hourly) April 2002 (from solar flux)

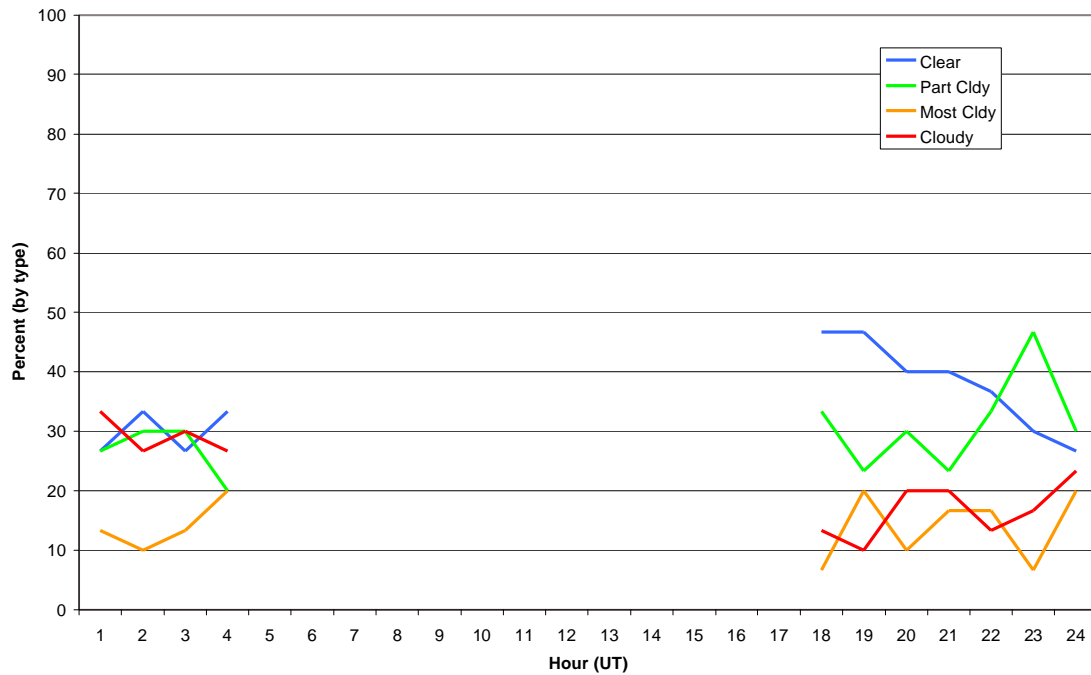


Figure 7

Clouds (hourly) May 2002 (from solar flux)

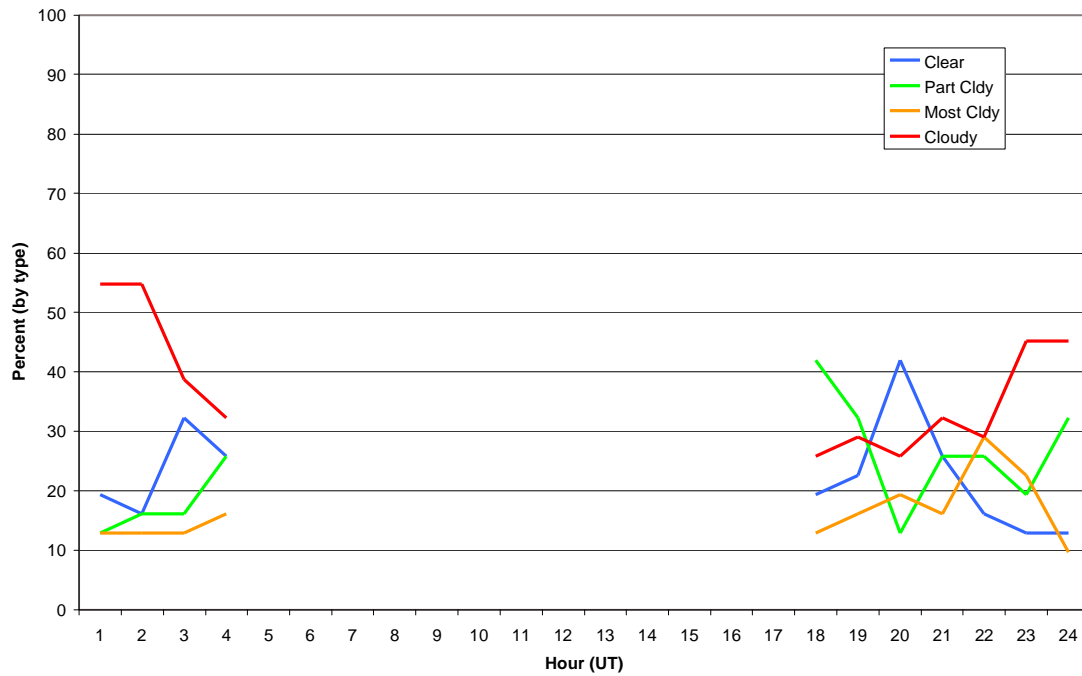


Figure 8

Clouds (hourly) June 2002 (from solar flux)

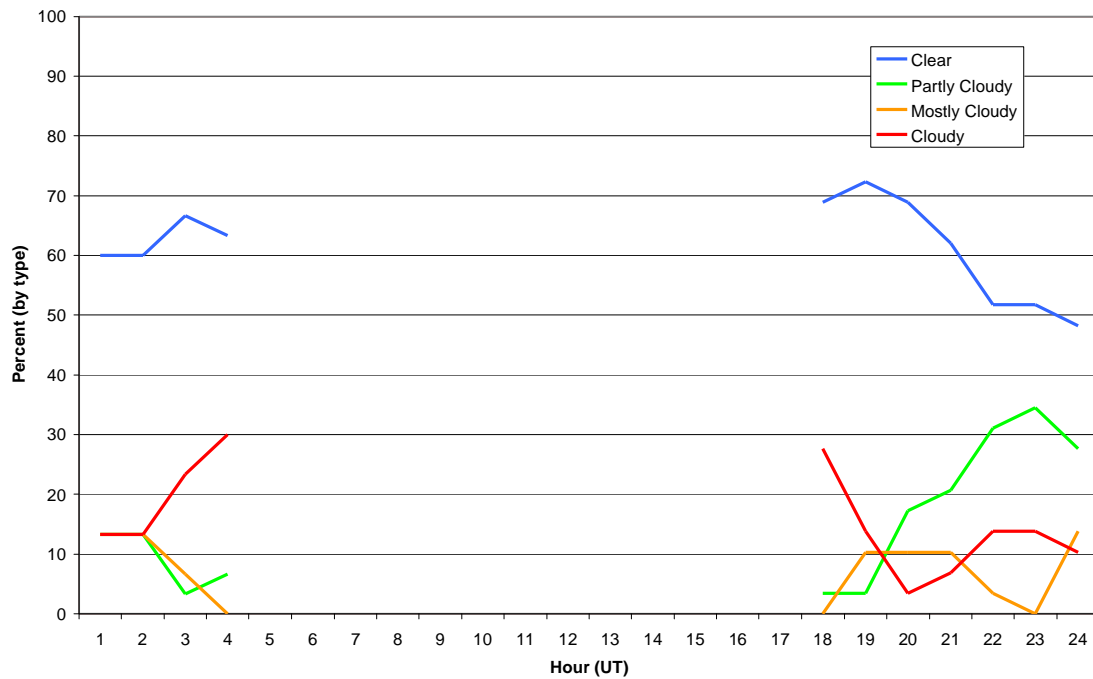


Figure 9

Clouds (hourly) July 2002 (from solar flux)

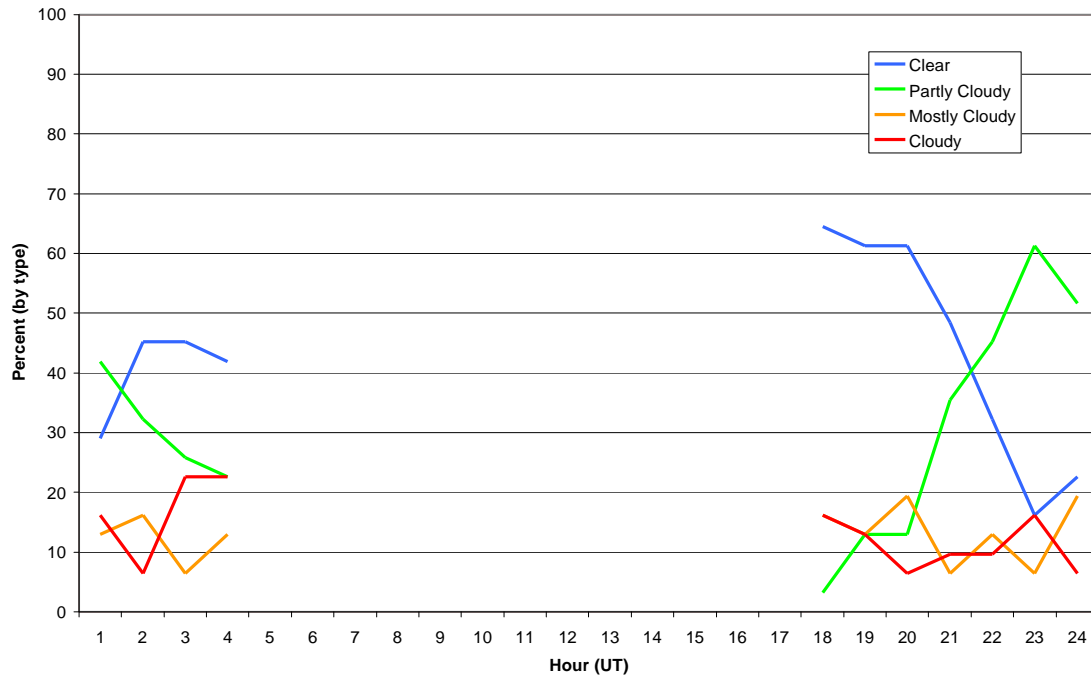


Figure 10

Clouds (hourly) August 2002 (from solar flux)

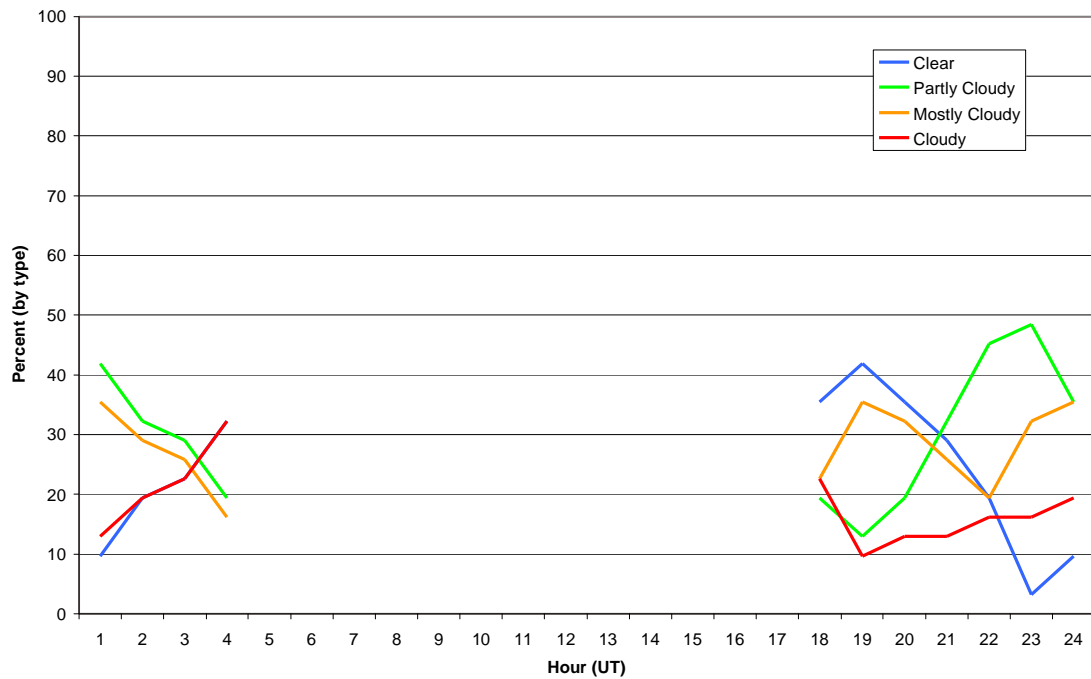


Figure 11

Clouds (hourly) Sept. 2002 (from solar flux)

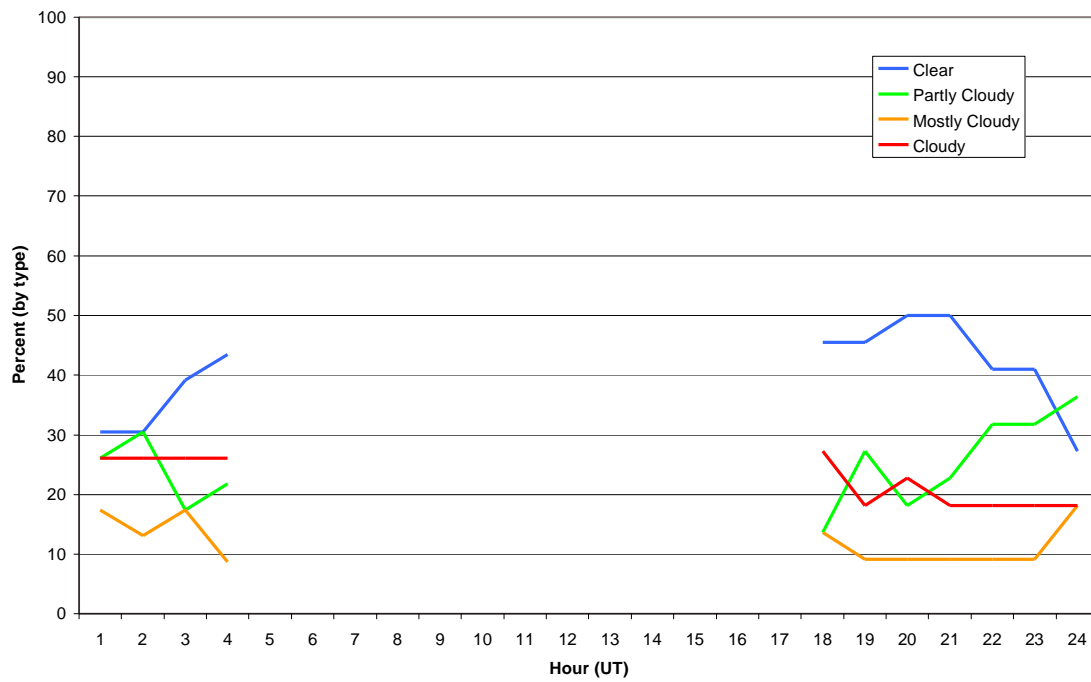


Figure 12

Clouds (hourly) Oct. 2002 (from solar flux)

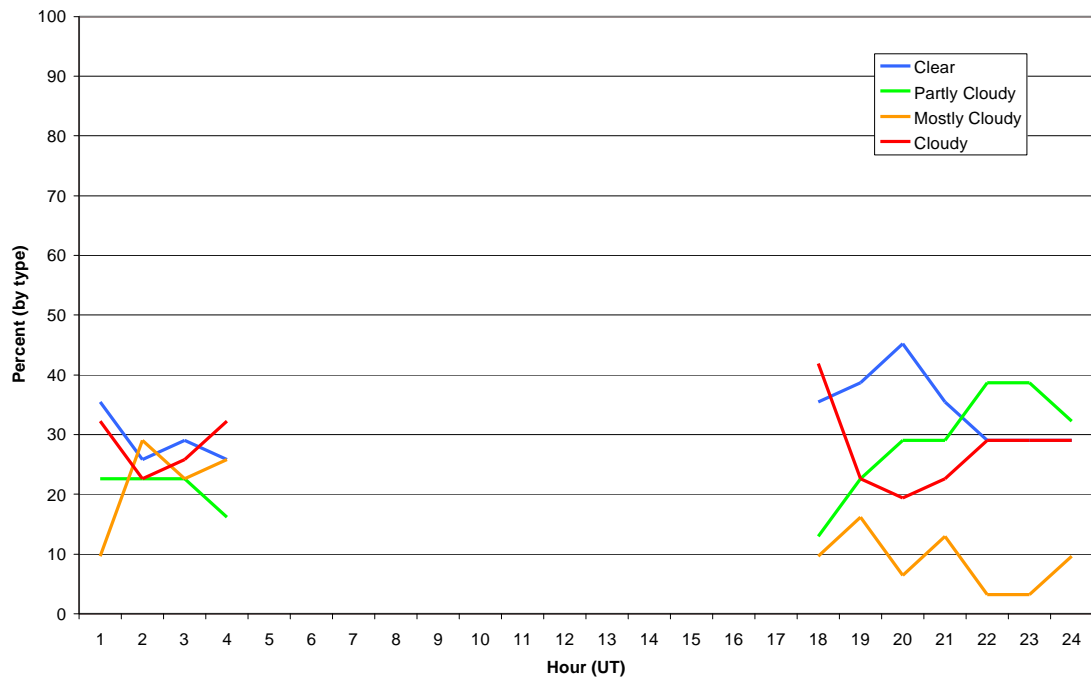




Figure 13

Clouds (hourly) Nov. 2002 (from solar flux)

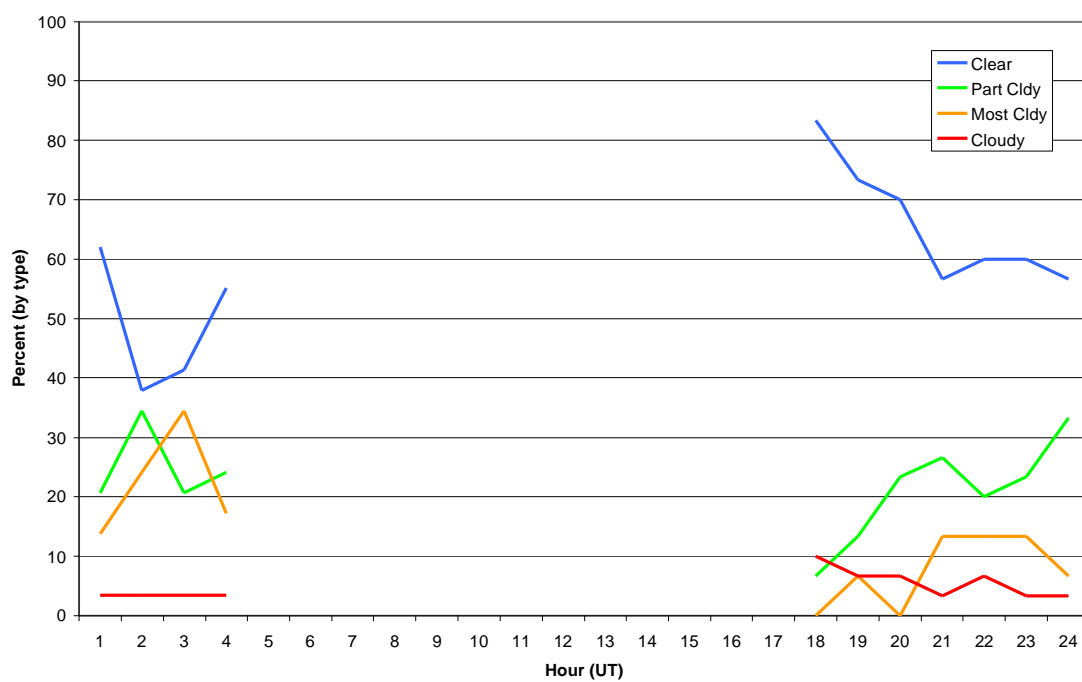


Figure 14

Clouds (hourly) Dec. 2002 (from solar flux)

