A One-Year Cloud Climatology Using Data from the Southern Great Plains (SGP) Site Micropulse Lidar

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Data Acquisition and Analysis

The micropulse lidar (MPL) has been operational at the Southern Great Plains site of the Atmospheric Radiation Measurement Program for the past 15 months. The compact MPL is unique among research lidar systems in that it is eyesafe and operates continuously, except during precipitation. Unlike commercial laser ceilometers, the MPL is capable of detecting cloud base throughout the entire depth of the troposphere. The MPL data set is an unprecedented time series of cloud base heights. It is a vital resource for understanding the frequency of cloud occurrence and the impact of clouds on the surface radiation budget, as well as for large-scale model validation and satellite retrieval verification.

The raw lidar data are processed for cloud base height at a temporal frequency of one minute and a vertical resolution of 270 m. The resultant time series of cloud base is used to generate histograms as a function of month and time of day. To create composite diurnal frequency plots, the cloud base data are sorted into three-hour bins with a vertical resolution of 2 km. For plots of the annual cycle, the data are sorted into monthly bins with the same vertical resolution. The counts are then converted to a frequency by dividing each set of vertical bins by the total number of counts in that vertical column.

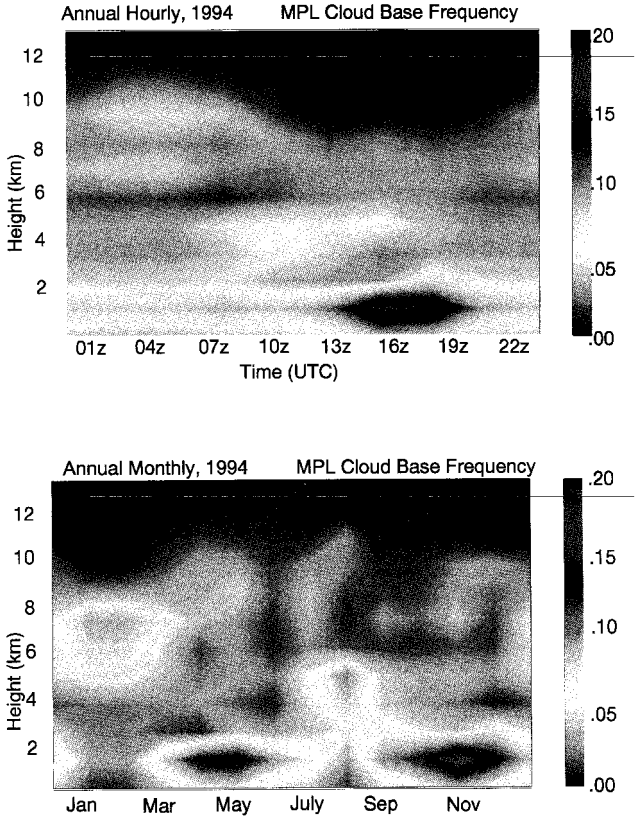

Figure 1. Micropulse lidar cloud base frequency.

Sample Results

Two plots are presented in Figure 1 to illustrate the type of information available from the MPL. The upper panel in the figure is the annual composite of the diurnal cycle. (The horizontal axis is UTC, which is approximately 6 hours ahead of local sun time.) The morning peak in boundary layer cloud occurrence is clearly evident as the most distinctive feature. Little diurnal variability in low cloud base height is observed, although the relatively coarse 2-km binning may obscure some variability. Middle tropospheric cloud base peaks during the late night and early morning hours. Cirrus bases tend to be observed throughout the day, but peak during the night.

The lower panel in Figure 1 depicts the annual cycle of cloud base occurrence. Well-defined maxima in boundary

layer cloud base occur during the spring and autumn months. Higher frequencies of occurrence of middle level clouds in late summer and cirrus clouds in winter may be due in part to the absence of low clouds. Note that since data for March were missing, data from February and April were used to fill the gap for display purposes.

Several general observations should be made about the two plots. First, since only the lowest cloud base can be detected by the MPL, frequencies of occurrence for middle and upper tropospheric clouds are certainly underestimates of their actual values. Second, because of solar background noise, thin cirrus are often undetected during daylight hours. Enhanced sensitivity may also account for the apparently higher cirrus bases detected at night (upper panel in Figure 1). Lastly, although these cloud occurrence statistics are an underestimate of total cloud occurrence, they do represent an accurate accounting of the clouds that are important to the surface radiation budget.