Five-Year Statistics of Shallow Clouds at the ACRF SGP Site

Contributors

Larry Berg, *Pacific Northwest National Laboratory*; Evgueni Kassianov, *Pacific Northwest National Laboratory*

Research Highlight

While fair-weather clouds (FWC) are small in size, they are ubiquitous, occurring over large areas of continents and in the trade wind regions over the oceans. These clouds play an important role in the Earth's climate by reflecting the sun's energy away from the planet. FWC are smaller than the grid spacing used in most numerical models of the atmosphere. For this reason, scientists use approximations, called parameterizations, to estimate the properties and effects of these clouds at a larger scale. To verify these parameterizations, researchers funded by the Atmospheric Radiation Measurement (ARM) Program studied five years worth of FWC data from the ARM Climate Research Facility (ACRF) Southern Great Plains (SGP) site. Their results showed cloud properties depend primarily on the time of day and the amount of low-altitude moisture. Findings such as these are important for evaluating FWC produced by parameterizations in climate models.

This study makes use of an ARM-developed algorithm, called the Active Remotely Sensed Clouds Locations (ARSCL), along with data from the 915-MHz radar wind profiler and total sky imager to determine the cloud cover, cloud-base height, cloud-top height, cloud-thickness, and cloud-chord length over the ACRF SGP site during a five-year period (2000-2004). The cloud-chord length is a horizontal length scale representative of the FWC. This length is equal to the length of time that an individual cloud is over the cloud radar, multiplied by the wind speed at cloud base. One additional cloud parameter, the cloud-cover hours, is also computed. The cloud-cover hours are defined as the cloud fraction multiplied by the number of hours with that cloud fraction. This variable was introduced to better account for the number of days and length of times with FWC.

A significant diurnal evolution of the clouds was found, with the average cloud-base height generally increasing and the average cloud thickness generally decreasing through the day (Figure 1a). The average cloud fraction was found to reach a maximum value near 14:00 CST, but the average cloud-chord length was nearly constant throughout the day. This suggests that the change in average cloud fraction is due to a change in the number of clouds, rather than a change in the size of the clouds. The cloud properties were also found to vary from year-to-year (Figure 1b), and often were a function of the low-altitude moisture (Figure 1c). Note that 2001 and 2003 were relatively dry years at the ACRF SGP site. For example, when the low-altitude moisture is large, the cloud fraction tends to be larger (Figure 1c). In contrast to the cloud fraction being largest for conditions with large low-altitude moisture, the cloud-cover hours are largest for moderate values of low-altitude moisture. This finding indicates that clouds are less likely to form when conditions are moist, but when they do form, there are many clouds leading to a large cloud fraction.

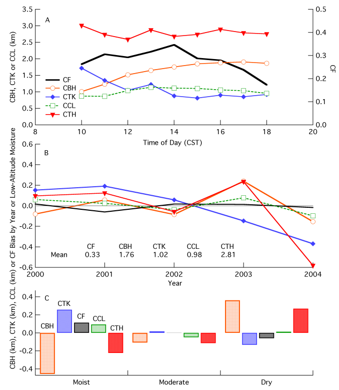

Figure 1. Five-year mean ARSCL VAP values of cloud fraction (black), cloud-base height (orange circles), cloud-top height (red), cloud thickness (blue), and cloud-chord length (green), and their average daily bias for each year (B) and low-altitude moisture (C).

Reference(s)

Berg, L. K., and E. I. Kassianov. 2008. Temporal variability of fair-weather cumulus statistics at the ARM SGP site. J. Climate, 21, 3344-3358.

Working Group(s)
Cloud Modeling