Mid-Level Cloud Formation at the ARM Darwin Site

Research Highlight

Department of Energy scientists at Pacific Northwest National Laboratory capitalized on the multiple sensors available at ARM's Tropical Western Pacific Darwin site to understand how and when mid-level clouds form in the tropics. Low and high clouds get most of the attention—because they are easier to detect. The researchers found that the timing and temperature of these thin clouds signal whether they form when the monsoon storms originate over the ocean, or primarily over land. The results show a more complete picture of how clouds influence the global climate.

The scientists observed cloud formation using the vertically pointing, or “soda-straw” view, lidar and radar together to get a complete picture of how these clouds in the middle occur. The research team combined this technique with data from radiosondes launched on weather balloons, which gather atmospheric measurements, and a scanning precipitation radar, which observes precipitation. Their results show that thin mid-level clouds more frequently follow stratiform precipitation during the active monsoon rather than the break monsoon period. Cloud layers are more likely to coincide with warmer, more stable layers during the break period. In the active monsoon phase, when storms come from the ocean, these mid-layer clouds are more often found after ice precipitation melts and cools the layer, causing more water vapor to condense into a cloud. In the break monsoon phase, the clouds come primarily from over land. A greater percentage of those mid-level clouds come from direct injection of cloud particles into the layer.

This study provides a unique climatology based on four years of observations at the ARM Facility's site in Darwin, Australia. How these clouds form influences the moisture and temperature at mid-levels, which is important to the region’s convection profile.

Hovering between the large anvils from storm-forming cumulonimbus clouds at the top and low boundary-layer clouds, mid-level clouds are more difficult to characterize. Finding the origin and characteristics of these clouds in the middle will help provide a better picture of the tropical circulation. Shown in the foreground are meteorological instruments and radiometers. Photo taken at the Tropical Western Pacific site of the ARM Climate Research Facility, located in Darwin, Australia.

Reference(s)

Riihimaki LD, SA McFarlane, and JM Comstock. 2012. "Climatology and formation of tropical midlevel clouds at the Darwin ARM site." Journal of Climate, 25(19), doi:10.1175/JCLI-D-11-00599.1.

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Cloud Life Cycle