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New Micropulse Lidars Improve Measurements of Cloud Properties

To understand how clouds and sunlight affect Earth's climate, the ARM Program studies these entities and their interactions. One of the many instruments used to gather information on clouds at ARM Climate Research Facility (ACRF) sites is the micropulse lidar (MPL).

An MPL is a ground-based remote sensing system that uses small laser pulses to detect and measure the altitude of overhead clouds. Six MPL units are currently installed and collecting data at ACRF sites worldwide; one is at the SGP Central Facility. Because the MPL uses an eye-safe laser, it is not a danger to pilots of planes flying overhead and can be run continuously. The availability of continuous data is a great benefit to researchers in their efforts to incorporate the interactions of clouds into climate models.

The MPL uses an eye-safe laser that directs a beam vertically. As short pulses of laser light travel upward, they may encounter water droplets or aerosol particles in the atmosphere. These particles intercept the laser light and scatter it in different directions. Some of the scattered light returns to Earth's surface. A receiver on the ground collects backscattered light that bounces off the atmospheric particles and

Figure 1. A representative of Sigma Space Corporation, the manufacturer of the new micropulse lidar instrument, leads a training session for ACRF instrument mentors and technicians (ARM photo).

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uses the information to determine the distance between the ground and the particles. The signals detected are collected and plotted using computer software. Greater signal strength implies that more scattering particles are present in the atmosphere.

A recent improvement in MPL technology allows the transmitted laser light to be polarized. This advancement increases the level of detail in measurements. For example, scientists can now decipher the makeup of thin clouds and determine whether they contain ice particles, because the structures of ice particles and water droplets interact differently with polarized light. The ice particle content of clouds is essential information for researchers developing more accurate computer models to describe solar radiation physics.

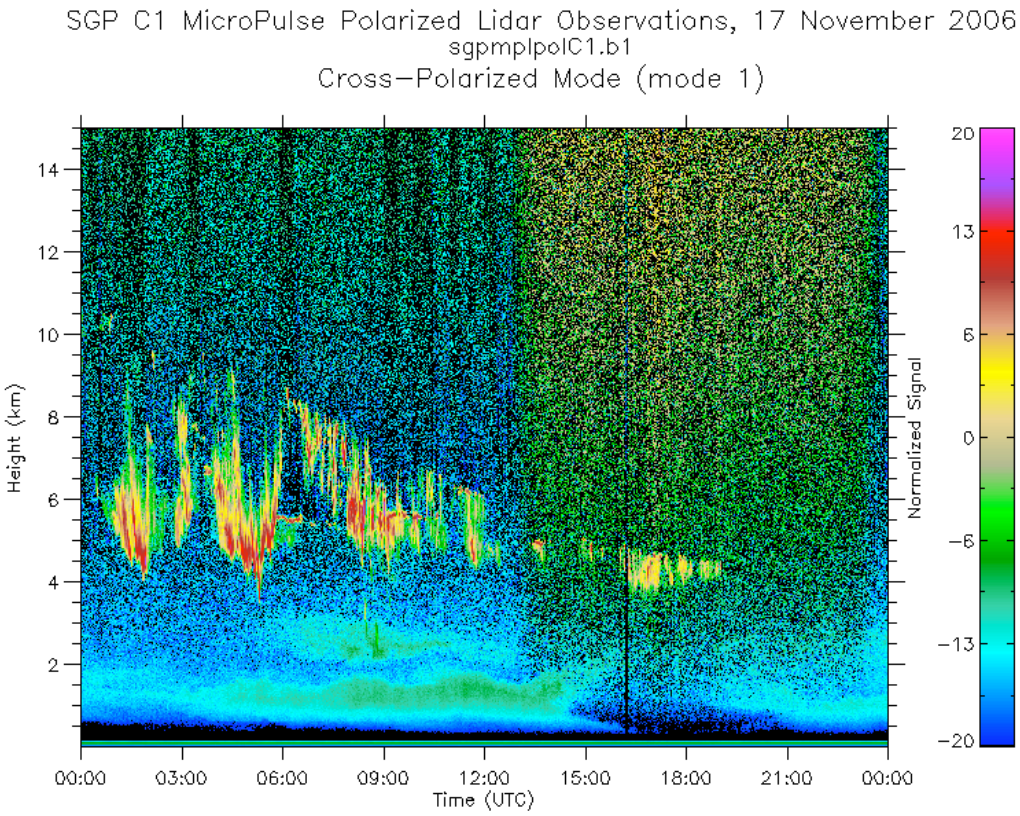

Figure 2. A plot of data collected by the micropulse lidar. This instrument can detect cloud base heights and aerosols directly above its location (ARM graphic).

The information gathered from the MPL can also be used to determine the height of the planetary boundary layer (PBL), which is the well-mixed layer of the atmosphere nearest Earth's surface. The PBL develops during daytime hours as the sun heats Earth's surface and creates vertical mixing. Small airborne particles like smoke and dust carried into the atmosphere are contained in the PBL. The PBL height determined by the MPL is additional valuable information for climate and weather researchers.

The polarization techniques available on the new MPLs generate increasingly valuable data for the research community, keeping ARM and its climate research facilities at the forefront of premier climate research.