Boundary Layer Aerosol Measurements Using a Bistatic CCD Camera Lidar

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A charged coupled device (CCD) camera-based bistatic lidar (CLidar) system was constructed to measure aerosol scattering in the atmospheric boundary layer. The system is based on a CCD camera, wide-angle optics, and a laser. Measuring near the ground with the standard monostatic lidar method is problematic because of the huge change in signal strength with altitude and the incomplete overlap between the laser and the telescope (high spatial (altitude) resolution is also desired near the ground for comparison with in situ aerosol instruments). Imaging a vertical laser beam from the side with a CCD camera and wide-angle field-of-view optics overcomes both of these problems. Whereas the molecular signal changes many orders of magnitude in the standard method, it changes only about one order with the CLidar method. In addition, the CLidar resolution near the ground is less than a meter. Other advantages of the CLidar method include low cost and simplicity. The signal is integrated on the CCD rather than with specialized electronics. With the bistatic CLidar method, the scattering angle changes with altitude. The variation of scattering intensity with the scattering angle (the aerosol phase function) will be influenced by the aerosol size distribution and must be assumed. Measurements made at Mauna Loa Observatory, during very low aerosol conditions, show agreement with a molecular scattering model. Preliminary measurements of aerosol scattering at 10-m elevation show agreement with an in situ nephelometer that measured total aerosol scattering. A comparison made on September 4, 2002, is shown in Figure 1. The humidity was decreasing rapidly that day as the cloud layer subsided below the observatory level.

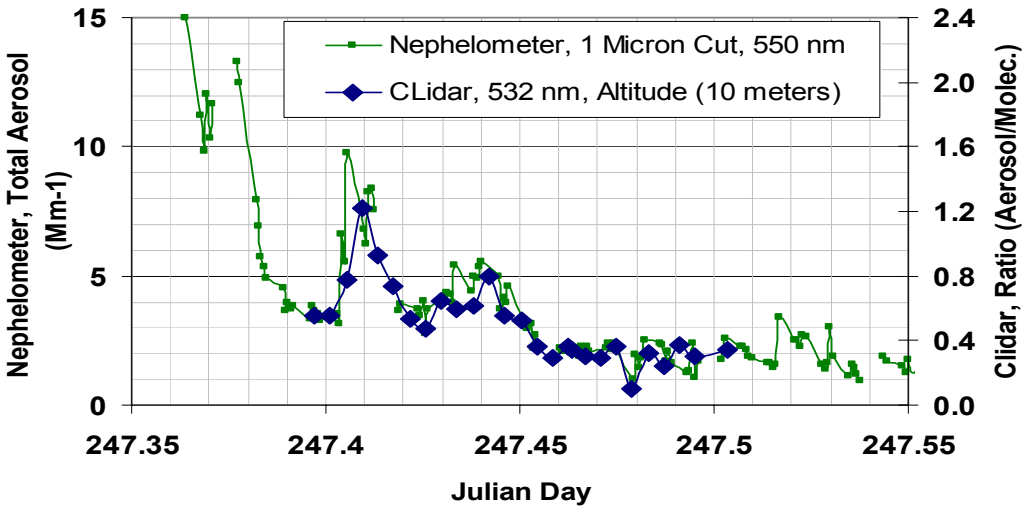

Figure 1. Comparison of the aerosol scattering coefficient (Mm^{-1}) from nephelometer measurements and the aerosol lidar ratio from CLidar measurements.