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Objective determination of convective boundary layer depth by application of a Haar wavelet algorithm to scanning atmospheric aerosol lidar images

James A. Schafer[1], Rex K. Belli[2], Shane D. Mayor[3]

The atmospheric boundary layer (ABL) is that part of the troposphere that is directly influenced by the presence of the earth's surface, and responds to surface forcings with a timescale of about an hour or less (Stull, 1988). During the day, the ABL typically takes the form of a "mixed layer" where vertical mixing may be generated mechanically by wind shear or by buoyancy from positive surface heat flux. When buoyancy dominates the production of mixing, it is called a convective boundary layer (CBL). The CBL begins growing at dawn and can reach to altitudes of hundreds of meters or kilometers by the afternoon. Knowledge of CBL depth is important for air quality, wind energy, weather forecasting, and even climate modeling. Traditionally, CBL depth is measured using radiosondes. However, an emerging alternate technique is through the use of active remote sensors such as elastic backscatter lidars. The top of the CBL appears in lidar imagery as a significant decrease in aerosol backscatter because the surface of the earth is a major source of particulate matter and the overlying free atmosphere usually has a much lower concentration of particulate matter. The process of identifying this step-like decrease in aerosol backscatter intensity can be automated in a computer by applying a Haar wavelet transform previously described by Davis et al. (2000). Their work demonstrates application to only vertically pointed lidars. We apply the technique to columns of data extracted from two-dimensional cross-sectional images made by the Raman-shifted Eye-safe Aerosol Lidar (REAL).

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[1]Department of Geological and Environmental Sciences
[2]Department of Physics
[3]Department of Geological and Environmental Sciences