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Determination of atmospheric boundary layer heights using statistical techniques

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Mixing layer height (MLH) is one of the most important factors in many atmospheric boundary layer (ABL) studies and processes. MLH is a key parameter in determining the diffusion volume of pollutants and the turbulence structure in the boundary layer in the air pollution model. Despite this importance, it is difficult to directly detect other than the radiosonde observations. As an alternative, many previous studies have attempted to detect MLH using surface-based remote sensing instruments, such as ceilometer and radiometer. In this study, MLH was determined by applying the four methodologies of the time-variance method, gradient method, wavelet covariance transform method, and clustering analysis method using the backscattering coefficient from ceilometer. In the real atmosphere, there is not only one MLH but a complex structure with several layers depending on time and atmospheric phenomena. Therefore, several MLH candidate groups were selected for each methodology, and k-means clustering techniques were used to identify the layers. The sorted clusters were ranked in descending order of the number of members and RMSE of the members. The final five clusters were selected and the average of each cluster member was determined as the final MLH. A post-treatment process was performed to remove unreasonable MLH. First, the SNR stop level was applied. Second, the near-range artifacts were removed. Third, the MLH was removed when the time continuity was very short. Finally, the MLH caused by small-scale fluctuation was removed in the quality control process. The MLH obtained was compared with radiosonde observations for verification. As a result, mean bias was -9.2 m, RMSE was 52.5 m, and R square was 0.988, indicating a very high correlation.