Boundary-layer aerosols observed in a polluted megacity (Seoul, Korea) from multiple lidar measurements: implications on particulate matter (PM) simulations

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The mixing layer height (MLH) is often defined as the height up to which turbulent mixing creates an environment favorable for the redistribution of temperature, mass, and humidity. The MLH has been widely investigated to understand its implications on the vertical distribution of pollutants, especially in regions suffering from high pollution levels. Ground-based remote sensing techniques have been commonly used to retrieve MLH since they can probe atmospheric characteristics at dense temporal resolutions. In this study, we estimate MLH from co-located elastic aerosol lidar, ceilometer, and wind Doppler lidar (WDL) measurements obtained in Seoul, Republic of Korea, and intercompare the results to discuss the advantages and limitations of each method. Secondly, MLH from elastic aerosol lidar and WDL are compared with atmospheric chemistry transport model simulations to evaluate the accuracy of the MLH simulation in the model and discuss how model-estimated MLH affects surface PM concentration simulation results. For two case studies during the KORUS-AQ campaign of 12 and 18 May 2016, implicating full mixing within the MLH defined by aerosol lidar measurements on WRF-Chem $PM_{2.5}$ vertical distribution simulations was shown to significantly reduce model $PM_{2.5}$ simulation errors from mean normalized bias (MNB) of 52% to 19%.

Furthermore, aerosol-type specific lidar ratio and mass extinction efficiency (MEE) values are determined from the two-year measurements of the University of Wisconsin-Madison High Spectral Resolution Lidar (HSRL) deployed in Seoul (2016-2018). Implications of the use of type-specific lidar ratios and MEE are examined in calculating extinction coefficient calculations from Mie-scattering lidar measurements and estimating PM_{10} profiles from lidar observations.