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Evaluation of the Boundary-layer structure from the Weather Research and Forecasting model against observation at Urban site on clear days during summer

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Accurate prediction of planetary boundary layer height (PBLH) is important in weather forecasting as well as air quality prediction. We evaluated Weather Research and Forecasting model performance to simulate planetary boundary structure against observation from ceilometer, wind lidar, microwave radiometer and flux tower at an urban site located in Seoul Metropolitan area on clear days during summer. Urban area is warmer than surrounding rural area and hence temperature advection plays an important role in thermal structure over urban area. PBLH was estimated from two different methods using observations: ceilometer based method (CBM) and bulk Richardson method using microwave radiometer and wind lidar (BRM). CBM detects maximum PBLH but detects aerosol layer during nighttime. BRM underestimates PBLH during daytime but it gives mixing height information during nighttime. Model shows different performance depending on day. To investigate the cause for the different performance of PBLH depending on day, we compared wind structure between model and observation. General features such as timing and vertical extent of sea breeze are well captured by model. However, some deficiencies are noted. Intensity of simulated sea breeze is much stronger in the model than observation. Stronger sea breeze results in stronger cold advection and hence cooling. Particularly, on the first day, vertical extent of sea breeze is confined in the lower part of PBL. Rapid decay of PBL in the model is due to enhanced cooling in the lower boundary layer in the late afternoon. On the other hand, on the last day stronger synoptic wind in the model leads to stronger cold advection within the boundary layer and hence prevents growth of PBL during daytime. This study suggests the importance of good simulation of both local and synoptic winds on accurate PBLH prediction on urban area.