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Optimization of vertical grid setting for air quality modeling in China considering the effect of aerosol-boundary layer interaction

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The feedback between ambient aerosols and planetary boundary layer (PBL) meteorology has been proven to play a critical role in the enhancement of haze pollution. Vertical distribution of aerosols as well as temperature stratification are vital to understand aerosol – boundary layer interaction (ABI) and its impact on air quality deterioration. In current regional chemical transport model (CTM), the default vertical grid setting is relatively coarse and decreases progressively with altitude. However, the ABI is sensitive to aerosol layer at specific altitudes, i.e. around the top of PBL. This work aims to explore optimized vertical grid setting for better characterizing ABI and its role in air quality degradation. A single column model (SCM) is used for sensitivity tests considering the balance between model performance and computational cost. This optimized grid setting is then applied in three-dimensional air quality modelling in eastern China. Compared with default configuration, the optimized one is demonstrated to perform much better in characterizing temperature stratification and extreme fine particle (PM2.5) concentration as well as its diurnal variation during haze episodes. Specifically, the averaged decrease in PBL height and increment in surface PM2.5 concentration are about 5% and 20% under polluted conditions while applying optimized setting, thereby reducing the mean bias from 30 to 5 μg/m3 in PM2.5 concentration. Such an optimization of vertical grid setting in CTM could help better predict extreme near-surface pollution episodes in environment with high concentration of absorption aerosols such as the eastern China.