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The impact of aerosols on the temperature inversion in the boundary layer over southwest China

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The Sichuan Basin, which is located in southwest China, has become one of the most polluted regions in China. The frequency of atmospheric boundary layer in the Sichuan Basin are analyzed based on radiosonde profile from 2014 to 2016. The occurrence probability of multi-layer temperature inversions is about 46.86% in winter over the Sichuan Basin. The radiosonde data are divided into four equal parts according to the previous 12-hour average visibility and $PM_{2.5}$ mass concentration. As the $PM_{2.5}$ mass concentration increases (visibility decreases), the surface-based inversion frequency increases more consistently in the morning, while the elevated inversion increases more consistently in the evening. The mechanisms of the aerosol radiative effect on the boundary layer temperature inversion are further investigated by using the radiometer, the Mie scattering lidar, and the microwave radiometer in Chengdu. 1D-SBDART simulation is performed to better clarify the mechanisms. The simulation results show that: from clean to heavy pollution conditions, in clear-sky the surface shortwave radiation reduces by 135.04 $w{\cdot}m^{-2}$ and the heating rate increases by 0.75 $k{\cdot}d^{-1}$; in cloudy sky the surface shortwave radiation reduces by 46.15 $w{\cdot}m^{-2}$ and the heating rate increases by 0.35 $k{\cdot}d^{-1}$. Aerosols can enhance the boundary layer temperature inversion at both daytime and nighttime due to the radiative effect, while clouds mitigate the enhancement by aerosol effects.