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Investigation of the atmospheric boundary layer during an unexpected summertime persistent severe haze pollution period in Beijing

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Persistent severe haze pollution (PSHP) seldom happen in summer in Beijing. In this study, a PSHP event, defined as daily PM2.5 concentration higher than 150 μg m-3 on five consecutive days, was observed in Beijing from 26–30 in July 2010. It was not caused by crop residue burning during the harvest period. Weak pressure systems dominated at surface and implicated weak advection. Regional weak southerly winds with speeds of 2–3 m s-1 consistently brought pollutants from southern large-emission regions to Beijing. Surface convergence condition resulted from northerly winds prevailing in northern regions induced pollutants remaining in Beijing, which contributed to the maximum daily PM2.5 concentration on 26 in July. A continental high-pressure system persisted in the northwest of Beijing at 500 hPa, which led to significant sinking motion. Elevated inversion was found in the form of subsidence inversion, this was confirmed by a skew T-logp diagram and vertical velocity analysis. The subsidence inversion was an extremely stable layer with an average depth of hundred meters and strength of 1.4°C. Its regional influence was from southwest of Beijing with a horizontal scale of approximately 300 km. The capping effect of the inversion layer at low altitude of average 720 meter limited vertical diffusion of pollutants and trapped them in a shallow layer, thus extremely high concentration of PM2.5 remained. WRF-Chem model simulation demonstrated that about 70% of PM2.5 was produced in Beijing with the combined effect of regional southerly winds and subsidence temperature inversion during this PSHP period.