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Vertical distribution of atmospheric pollutants based on tethered balloon in North China Plain: a winter haze case study

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The vertical distribution of SO_2, NO, NO_2, O_3, CO, $PM_{2.5}$, black carbon, particle size distribution, species of PM_1 within 0-1000m as well as meteorological parameters were measured simultaneously on tethered balloon at Wangdu County, Baoding City, North China Plain, as part of the winter field campaign which hold during December 2018.

During December 18 to 21, the ground monitoring data demonstrated sharp increase of NO, CO and $PM_{2.5}$ concentration during the nighttime and decrease in the daytime, while the diurnal variation of ozone concentration was the opposite. The increased concentrations of pollutants at night mostly due to the much lower boundary layer during nights, which could be as low as 100 meters. Except for the worse vertical diffusion at night, the low wind speed also contributed to the increase of pollutants concentrations.

The organic component accounted for up to 60% of $PM_{2.5}$ at night, which was the main contribution to the increased $PM_{2.5}$. The significant increase of NO, CO and organic may due to the emission from home heating at night.

The vertical detection demonstrated very low boundary layer and inversion layer during the observation period. The vertical distribution of pollutant in the boundary layer and upper the boundary layer are quite different at night. The concentrations of gaseous pollutants (CO, SO_2, NO and NO_2) and $PM_{2.5}$ were higher in the nocturnal boundary layer, and the proportion of organic component, black carbon and chloride were significantly higher than that upper the boundary layer. During the daytime, with the development of the boundary layer, the favorable horizontal and vertical diffusion condition lead to the decreased pollutants concentrations. In addition, pollutants with high concentrations were found at high altitudes, where the proportion of secondary components such as nitrates, sulfates and ammonium were higher than that of the ground. It may attributed to air mass from regional transport.