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Vertical structure of the transport fluxes of aerosol and its precursors on the southwest transport pathway in the Beijing-Tianjin-Hebei region

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Haze pollution caused by atmospheric aerosols has become one of the most severe environmental problems in China, especially in the Beijing-Tianjin-Hebei (BTH) region. Air pollution is not caused by local emission and secondary formation of air pollutants, but also affected by transport from its surrounding areas. A number of studies with respect to the regional transport of air pollutants in the BTH region have been conducted based on surface observation. However, owing to the inhomogeneous vertical distribution of air pollutants and meteorological conditions, the vertical profiles of transport fluxes should be considered for a comprehensive understanding of regional transport. In this study, the vertical profiles of aerosol and its precursor indicators HCHO, NO_2 and SO_2 were observed by ground-based multi-axis differential optical absorption spectroscopy (MAX-DOAS) at the Nancheng (NC) site in suburban Beijing on the southwest transport pathway. The profiles of the pollutants varied with seasons with more aerosols concentrated at the surface in the winter. Through potential source contribution function (PSCF) analysis, southwest transport pathway was determined as the main transport source region, particularly for air pollutants in the middle and upper boundary layer. The transport fluxes of air pollutants at each vertical layer on the southwest-northeast direction were estimated combining with wind field simulated by WRF-Chem modeling. The average fluxes of the measured pollutants from June 2018 to May 2019 during the southwest transport (from southwest to northeast) were all higher than those during the northeast transport (from northeast to southwest), indicating net input of pollutants to urban Beijing from southwest transport pathway. Except for northwest transport of aerosols, the other maximum transport fluxes occurred at high altitudes instead of at the surface. The proportions of surface flux in the column flux for all the species during southwest transport were higher than those during northeast transport. Surface observation would overestimate the relative contribution from urban Beijing to southwest pathway and underestimate the contribution from southwest pathway to urban Beijing. Southwest transport played an important role on the developing stage of aerosol pollution in urban Beijing in the autumn and winter, and this transport mainly occurred in the middle boundary layer.