Dust aerosol properties and radiative impacts at a suburban site on the North China Plain during 2004–2017

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Aerosols and their radiative effects are of primary interest in climate research because of their vital influence on climate change. Dust aerosols are an important aerosol type in the North China Plain (NCP), mainly as a result of long-range transport, showing substantial spatiotemporal variations. By using measurements from the Aerosol Robotic Network (AERONET) between September 2004 and May 2017, the space-borne Moderate Resolution Imaging Spectroradiometer (MODIS) and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) aerosol products, we investigated the properties of dust aerosols and their radiative effects at Xianghe (XH) – a suburban site in the NCP. Dust events occurred most frequently during spring (a total of 105 days) relative to the other three seasons (a total of 41 days) during the periods concerned. The dust aerosol optical depth (AOD) at 675 nm was at a maximum in spring (0.60 ± 0.44), followed (in decreasing order) by those in autumn (0.58 ± 0.39), summer (0.54 ± 0.15), and winter (0.53 ± 0.23). Cooling effects of dust aerosol radiative forcing (RF) at the bottom and top of the atmosphere tended to be strongest in spring (–96.72 ± 45.69 and –41.87 ± 19.66 Wm^{-2}) compared to that in summer (–57.08 ± 18.54 and –25.54 ± 4.45 Wm^{-2}), autumn (–72.01 ± 27.27 and –32.54 ± 15.18 Wm^{-2}), and winter (–79.57 ± 32.96 and –37.05 ± 17.06 Wm^{-2}). The back-trajectory analysis indicated that dust air mass at 500 m that arrived at XH generally originated from the Gobi and other deserts of northern China and Mongolia (59.8%), and followed by northwest China and Kazakhstan (37.2%); a few dust cases came from northeast China (3.0%). A single-peaked structure with the maximum occurred at ~2 km was illustrated by all dust events and those sorted by their sources in three directions . Three typical dust events were specifically discussed to better reveal how long-range transport impacted the dust properties and radiative effects over the NCP. The results presented here are expected to improve our understanding of the physical properties of dust aerosols over the NCP and their major transport path and significant impacts on the regional solar radiation budget.

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