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The pathway of aerosol direct effects impact on air quality: a case study by using process analysis

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In addition to direct deteriorate air quality, aerosol reduces solar radiation through light scattering and absorption (aerosol direct effects, ADE), influences regional meteorology and further impacts on air quality indirectly. Previous study shows that these process may increase 2.2% to 3.2 % of PM2.5 concentration on north hemispheric. The contribution may reach 140 ug/m3 during heavily polluted period in Beijing. But the detailed pathway is still unclear. In this study, two-way coupled WRF-CMAQ with integrated process analysis was applied to explore how aerosol direct effect impacts on air quality through atmospheric dynamic process. Meteorology and air quality in January and July, 2013 is simulated to represent winter and summer case, respectively. Two scenarios, i.e. with and without aerosol radiation feedback are used and the difference between them is treated as contribution of aerosol direct effect. Diurnal average and vertical distribution of each process are analyzed. The results show that modeling performance is increased by considering aerosol direct effects. The modifications of vertical diffusion (VDIF), dry deposition (DDEP) and secondary reactions (AERO) are the most important ways. Maximum impacts on AERO and DDEP occurred at noon, while the maximum impacts on VDIF occurred in the morning and evening. ADE decreases PM2.5 concentration through AERO in winter and increases in summer. The relative contributions of these processes vary under different pollution condition and season. Fully understanding the influence of aerosol and meteorology interaction on atmospheric composite pollution will provide important guidance for the analysis of the causes of atmospheric composite pollution and the development of effective control strategies.