Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31353

Atmospheric cadmium pollution and its impacts in China: emissions, concentrations and deposition

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As one of toxic heavy metals, cadmium (Cd) and its atmospheric emission and cross-media transmission have received continuous concerns due to their harmful damage to the ecosystem, food safety and human health. Anthropogenic atmospheric emission of Cd in China mainly comes from non-ferrous metals smelting and coal combustion. After discharged into the atmosphere, Cd is easily adheres to PM2.5 for transmission. Except for physical diffusion with air flow, a large part of Cd would deposit onto earth surface and migrates into the topsoil after a certain time. In this study, we developed a bottom-up atmospheric emission inventory of Cd from primary anthropogenic activities during the period of 2010−2019. Then, with the emission inventory as input, the nationwide atmospheric concentration and dry/wet deposition flux of atmospheric Cd were synergistically simulated by using the modified GEOS-Chem model. The evaluation results shows that the GEOS-Chem model can reasonably reproduce the spatiotemporal variations of atmospheric Cd pollution in China. The results indicate that the Cd pollution in central-southern China region is notably prominent which showing as both the serious local pollution and the main sink zone of atmospheric Cd from long-range regional transmissions, with the annual mean atmospheric concentration and deposition flux reaching 0.8 ng/m^3 and 0.3 $mg/m^2/yr$, respectively. Furthermore, we calculated the Cd flux mass deposited to the ground and present a hazard calendar of atmospheric Cd deposition. We found that about 236.6 tons of Cd cumulatively deposited to the ground of central-southern China in the past ten years, significantly higher than that in other regions. From 2010 to 2019, total deposition in central-southern China decreased by 52%, mainly attributed to the emission reduction from nonferrous metal smelting sector. Compared to summer and autumn, winter and spring exhibits higher atmospheric concentration and deposition flux, mainly attributed to elevated emission level correlated with space heating demand. We believe that our study provides important insights for the policy makers to implement more stringent control measures to reduce the emission, concentration and deposition of atmospheric Cd, and is conducive to the relevant research on the sources of heavy metals in soil.