

Response of BC emissions to clean air and clean energy policies in Asia

GAN ZHANG¹, XIAO WANG¹, BOJI LIN¹, JUN LI¹ AND
PAROMITA CHARKRABORTY²

¹Guangzhou Institute of Geochemistry, Chinese Academy of Sciences

²SRM Institute of Science and Technology, India

Since the implementation of clean air policies across Asia starting in 2013, concurrent with the adoption of global climate commitments under the Paris Agreement (2015), Asia has witnessed a substantial reduction in black carbon (BC) concentrations. Our study quantitatively evaluates BC emission responses to mitigation policies in three high-pollution regions: China, India, and the Indo-China Peninsula (ICP). Integrating year-round radiocarbon (¹⁴C) isotope measurements with a bottom-up emission inventory (EI) and chemical transport modeling, we reveal distinct spatiotemporal patterns in BC reduction during 2016-2017. The measured BC concentrations were 2.2 µgC/m³ in China, 2.4 µgC/m³ in India, and 2.1 µgC/m³ in ICP, with significant regional and seasonal heterogeneity. Direct source-segregated comparisons revealed that BC emission from fossil fuel combustion had been significantly abated in Chinese cities. While larger contributions from biomass burning were observed in ICP, India and rural China, and with a slow decline. The EI-coupled-model analysis reported a decline in BC emission consistent with observation, yet there was an overestimation of fossil-BC in cities of China (Bias, 40%), and an underestimation of biomass-BC in India, ICP and remote areas of China (Bias, -123%). In general, the policy driven transition highlights the effective fossil fuel regulation in developed urban systems, and informs critical gaps in controlling biomass burning. Our study also implies the necessity for region-specific inventory refinement through isotopic constraints.