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Underestimation and Transboundary Transport of Biomass Burning Black Carbon in Southern China: Insights from Combining Radiocarbon Measurements with Modeling

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Black carbon (BC) from biomass burning (BCbb) constitutes a major fraction of global BC's climate impact. Yet, its contributions estimated by emission inventory-based modeling remain highly uncertain due to the lack of source-diagnostic observational constraints. Here, we present year-round, Δ 14C-based measurements of BCbb from two regional and one background sites in southern China. By comparing with tailored simulations from an atmospheric transport model, we find that although the model reproduces the seasonal reasonably well, it captures only ~ 50% of observed BC concentrations on average and can underestimate individual cases by over 13-fold. The unmonitored biomass burning (BB) mainland China can result in the substantial model-observation discrepancy. Our results reveal that although residential BB across East Asia is the main contributor to BCbb in southern China, the transport of BCbb from Southeast Asia is important in summer. Notably, the transboundary BB pollution from Southeast Asia, facilitated by free tropospheric transport, cannot be ignored even in winter when continental air massesprevail. Our findings highlight a transboundary biomass burning effect that may exceed prior estimates and underscore the need to update emission inventories by incorporating previously overlooked BB sources to improve the assessment of BC's climate and air quality impacts.