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Observation-constrained estimates of the black carbon climate effect using high-resolution emission inventory and model

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Black carbon (BC) is an important short-lived climate forcer with significant impacts on climate and health. However, the direct radiative forcing (RF) of BC is subject to a large uncertainty, due to the limitations that models have to capture the observed light absorption. In this study, we investigated the effect of using highly disaggregated inventory and high-resolution model on modelling of BC radiation absorption. It's found that the low resolution in emission inventory and model is a significant and overlooked source of error in previous studies. Using a detailed 10-km emission inventory and a 50-km atmospheric model allows us to reduce the under-estimation of BC absorption by more than 50% over Asia. Downscaling the BC field to 10 km further reduces the bias to –5% in Asia. The underestimation of coarse-resolution models can be attributed to the fact that about half of the observational sites are located in locations within the top 90th percentile of BC AAOD. To reinforce these results, we applied a Bayesian method and obtain a best estimate of 0.37 Wm-2, with a 90% uncertainty range of 0.11-0.83 W m-2. Our best estimate is lower than previously thought and, importantly, the uncertainty is reduced by 40%. This lower RF of BC implies that reducing BC emissions might improve air quality but bring less co-benefit for climate than expected.