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Climate response to regional Black Carbon emissions: do location and magnitude matter?

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Aerosol radiative forcing can influence climate both locally and far outside the forcing region. Here we investigate the sensitivity of regional climate to Black Carbon aerosols emitted in four major emissions areas using a fully coupled climate model. We perform simulations where we increase Black Carbon emissions by a factor of 10 and 20 in South Asia, North America and Europe, respectively, and by a factor of 5 and 10 in East Asia (due to higher emissions here). Each perturbation has been run for 100 years with three ensemble members. We find strikingly similar regional surface temperature responses per unit Black Carbon emissions in Europe and North America, with similar but somewhat lower temperature sensitivities for Asian emissions. Choosing the highest emission factor (i.e. 20 instead of 10) results in lower surface temperature change per emission unit compared to the lowest factor, but the difference is generally not statistically significant. An advantage of high-perturbation simulations is the clearer emergence of regional signals. This shows that the linearity of normalized temperature effects of Black Carbon is fairly preserved, and that regional temperature coefficients calculated from high perturbations may be a conservative estimate.