4.179 Impact of particle size and mixing state diversity on estimates of black carbon mitigation.

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Abstract:

Post-industrial increases in atmospheric black carbon (BC) have a large but uncertain warming contribution to Earth's climate. Particle size and mixing state determine the solar absorption efficiency of BC and also strongly influence how effectively BC is removed, but they have large uncertainties. In this study, we use a multiple-mixing-state global aerosol microphysics model and show that the sensitivity (range) of present-day BC direct radiative effect, due to current uncertainties in emission size distributions, is amplified 5-13 times (0.18-0.42 W m^{-2}) when the diversity in BC mixing state is sufficiently resolved. This amplification is caused by the lifetime, core absorption, and absorption enhancement effects of BC, whose variability is underestimated by 45-70% in a single-mixing-state representation. We demonstrate that reducing uncertainties in emission size distributions and how they change in the future, while also resolving modeled BC mixing state diversity, is now essential for evaluating BC radiative effect and the effectiveness of BC mitigation on future temperature changes.