Large uncertainty in black carbon radiative effect with resolved mixing state diversity

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Atmospheric black carbon has a large but uncertain warming contribution to the Earth's climate. Particle size and mixing state determine the lifetime and solar absorption efficiency of black carbon. However, the mixing state of black carbon is not represented sufficiently in most global aerosol models. Here we show that the current uncertainty in aerosol size distributions in emissions introduces an unrecognized large uncertainty in black carbon direct radiative effect by using a state-of-the-art global aerosol model which resolves both particle size and mixing state. The range of the new uncertainty corresponds to 60% of the total uncertainty range of black carbon direct radiative effect in a recent black carbon assessment and is comparable to the inter-model variability of black carbon direct radiative effect simulated by global aerosol models. As the new uncertainty is 5-9 times larger than the uncertainty when mixing state is not resolved, we conclude a more realistic representation of mixing state which includes pure black carbon, thinly-coated black carbon, thickly-coated black carbon, and black carbon free particles, is necessary for accurate estimates of the heating effect of black carbon and its interactions with the climate system.

Keywords: black carbon, mixing state, size distribution, radiative effect, global aerosol model

