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New evidence of soot particles affecting past and future cloud formation and climate

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Clouds play a critical role in the hydrological cycle and modulating the Earth's climate via precipitation and radiative forcing. Aerosol particles acting as cloud condensation nuclei and ice nucleating particles aid in cloud formation, shaping their microphysical structure. Previously thought to be unimportant for cloud formation, soot particles that undergo oxidation by ozone and/or aging with aqueous sulfuric acid result in being both good centers for cloud droplets and ice crystals formation. However, the associated changes in cloud radiative properties and the consequences for Earth's climate remain uncertain, because these processes have not been considered in global climate models. Here we present both past and future global climate simulations, which for the first time consider the effect of such aged soot particles as cloud condensation nuclei and ice nucleating particles. Our results constitute the first evidence that aging of soot particles produce a 0.2 to 0.25 Wm^{-2} less negative shortwave indirect aerosol forcing compared to previous estimates. We also conducted equilibrium climate sensitivity simulations representing a future warmer climate in which the carbon dioxide concentration is doubled compared to pre-industrial levels. Accounting for these soot aging processes significantly exacerbates the global mean surface temperature increase by 0.4 to 0.5 K. Thus, reducing emissions of soot particles will be beneficial for many aspects including air pollution and future climate.