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Historical and future simulations of aerosol radiative forcing along the Representative Concentration Pathways (RCPs) with a global climate model

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Past, present, and future aerosol radiative forcing from the year 1850 to 2100 are estimated by a global aerosol climate model, SPRINTARS (Takemura et al. 2000, 2002, 2005, 2009), along the Representative Concentration Pathways (RCPs) in this study. All RCPs (RCP2.6, RCP4.5, RCP6.0, and RCP8.5) which are used in future climate simulations for the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) are applied to this study. SPRINTARS is coupled to a general circulation model, MIROC (Watanabe et al. 2010), developed by the Atmosphere and Ocean Research Institute (AORI)/University of Tokyo, National Institute for Environmental Studies (NIES), and Japan Agency for Marine-Earth Science and Technology (JAMSTEC). It includes the radiation, cloud, and precipitation processes related with the aerosol direct, semi-direct, and indirect effects of main tropospheric aerosols (black carbon (BC), organic matter, sulfate, soil dust, and sea salt) as well as the transport processes (emission, advection, diffusion, sulfur chemistry, and deposition). The model treats not only the aerosol mass mixing ratios but also the number and mass concentrations of cloud droplets and ice crystals as prognostic variables. Sulfate aerosols in the atmosphere are estimated to be already decreasing around the developed countries although they will continue to increase until the mid-21st century. On the other hand, BC aerosols are predicted to increase for next a few decades. Therefore the total aerosol effects on the climate system may be largely different between 20th and 21st centuries. While the negative radiative forcing by the total aerosol effect has increased since the Industrial Revolution, it is predicted to be close to zero toward the end of the 21st century due to decreases in atmospheric aerosols. Continuous increases in greenhouse gas concentrations and decreases in aerosol concentrations during the 21st century will cause an acceleration of the global warming.

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