The development of an atmospheric aerosol/chemistry–climate model, BCC_AGCM_CUACE2.0, and simulated effective radiative forcing of nitrate aerosols

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As important components of total anthropogenic aerosols, nitrate aerosols have large impacts on aerosol radiative forcing and climate at regional and seasonal scales, but few current climate models coupled nitrate chemical modules online. This study developed a next-generation atmospheric aerosol/chemistry–climate model, the BCC_AGCM_CUACE2.0. Then, the performance of the model for nitrate was evaluated, and the direct radiative forcing (DRF) and effective radiative forcing (ERF) due to nitrate were simulated for the present day (2010), near future (2030) and middle future (2050) under the Representative Concentration Pathway (RCP) 4.5, 6.0, and 8.5 scenarios relative to the pre-industrial era (1850). The model reproduced the distributions and seasonal changes in nitrate loading well and simulated surface concentrations matched observations in Europe and North America. Current global mean annual loading of nitrates was predicted to increase by 1.12 mg m^{-2} relative to 1850, with the largest increases occurring in East Asia (3.89 mg m^{-2}), Europe (3.6 mg m^{-2}), and South Asia (1.86 mg m^{-2}). The current global mean annual ERF of nitrates was −0.21 W m^{-2} relative to 1850. Due to global reductions in pollutant emissions, the nitrate ERF values were predicted to decrease to −0.17 and −0.20 W m^{-2} in 2030, −0.07 and −0.18 W m^{-2} in 2050 for RCP4.5 and 6.0 relative to 1850, respectively. Under RCP8.5, nitrate ERF values were −0.24 and −0.19 W m^{-2} in 2030 and 2050, respectively. Although global mean nitrate values showed a declining trend, future nitrate loading remained high in East Asia and South Asia.

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