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Effects of mineral dust on global atmospheric nitrate concentrations

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Inorganic particulate nitrate contributes significantly to the total aerosol mass. While nitrate is predominantly present in the submicron mode, coarse mode aerosol nitrate can also be produced by adsorption of nitric acid onto soil particles. Naturally emitted particles affect the phase partitioning of nitrate, especially in areas where dust comprises a significant portion of total particulate matter, and the simulation of these effects can considerably improve model predictions. However, most thermodynamic models used in global studies lack a realistic treatment of crustal species. This work aims to improve the representation of nitrate aerosols in the global chemistry climate model EMAC, and addresses the shortcomings of previous models. EMAC calculates the aerosol microphysics and gas/aerosol partitioning by using the GMXe aerosol module. The aerosol size distribution is described by 7 interacting lognormal modes (4 hydrophilic and 3 hydrophobic modes). An advanced dust emission module also accounts for the soil particle size distribution of different deserts worldwide. Gas/aerosol partitioning is simulated using the ISORROPIA-II thermodynamic equilibrium model which considers the interaction of K(+), Ca(+2), Mg(+2), NH4(+), Na(+), SO4(-2), NO_3(-), Cl(-), H_2O aerosol components. The EMAC model is tested in long-term simulations covering the years 2005-2008. Model predictions are compared with data from the European network EMEP, the IMPROVE network in North America, and the EANET Network in East Asia.