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Global evaluation of nitric acid effect on cloud droplet number concentrations

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Cloud droplet number concentration (CDNC) is a climatically important variable, since it affects both cloud albedo and lifetime. It has been shown with cloud model studies that nitric acid can increase CDNC significantly, especially when the aerosol number concentration is low. To study this effect in global scale, we implement a parameterization of the nitric acid effect in ECHAM5-HAM global aerosol-climate model. ECHAM5-HAM simulates the development of global aerosol size distributions, and a cloud droplet activation model is coupled to the aerosol model. The parametrization of the nitric acid effect is based on results from a numerical air parcel model. In addition to the aerosol particle size distribution and gas-phase HNO3 concentration, the parameterization requires temperature, total pressure, updraft velocity, and the number concentration of cloud droplets formed at zero nitric acid concentration, as input parameters. For the nitric acid we use monthly mean fields from RETRO-run (1960-2000) calculated with MOZART. Our simulations show that the nitric acid effect can increase CDNC by 5-10 % in large areas. Additionally, nitric acid can enhance CCN activation by 50 % in areas with low aerosol concentrations and considerable nitric acid concentration.