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Effect of humidity on nitric acid uptake to mineral dust aerosol particles

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Abstract. This study presents the first laboratory observation of HNO_3 uptake by airborne mineral dust particles. The model aerosols were generated by dry dispersion of Arizona Test Dust (ATD), SiO_2, and by nebulizing a saturated solution of calcium carbonate. The uptake of ^{13}N-labeled gaseous nitric acid was observed in a flow reactor on the 0.2–2 s reaction time scale at room temperature and atmospheric pressure. The amount of nitric acid appearing in the aerosol phase at the end of the flow tube was found to be a linear function of the aerosol surface area. SiO_2 particles did not show any significant uptake, while the $CaCO_3$ aerosol was found to be more reactive than ATD. Due to the smaller uncertainty associated with the reactive surface area in the case of suspended particles as compared to bulk powder samples, we believe that we provide an improved estimate of the rate of uptake of HNO_3 to mineral dust. The fact that the rate of uptake was smaller at a concentration of 10^{12} than at 10^{11} was indicative of a complex uptake mechanism. The uptake coefficient averaged over the first 2 s of reaction time at a concentration of 10^{12} molecules cm^{-3} was found to increase with increasing relative humidity, from 0.022±0.007 at 12% *RH* to 0.113±0.017 at 73% *RH* , which was attributed to an increasing degree of solvation of the more basic minerals. The extended processing of the dust by higher concentrations of HNO_3 at 85% *RH* led to a water soluble coating on the particles and enhanced their hygroscopicity.

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