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The impact of dust on sulfate aerosol, CN and CCN during an East Asian dust storm

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Abstract. A global model of aerosol microphysics is used to simulate a large East Asian dust storm during the ACE-Asia experiment. We use the model together with size resolved measurements of aerosol number concentration and composition to examine how dust modified the production of sulfate aerosol and the particle size distribution in East Asian outflow. Simulated size distributions and mass concentrations of dust, sub- and super-micron sulfate agree well with observations from the C-130 aircraft. Modeled mass concentrations of fine sulfate (D_p<1.3 μm) decrease by ~10% due to uptake of sulfur species onto super-micron dust. We estimate that dust enhanced the mass concentration of coarse sulfate (D_p>1.0 μm) by more than an order of magnitude, but total sulfate concentrations increase by less than 2% because decreases in fine sulfate have a compensating effect. Our analysis shows that the sulfate associated with dust can be explained largely by the uptake of H_2SO_4 rather than reaction of SO_2 on the dust surface, which we assume is suppressed once the particles are coated in sulfate. We suggest that many previous model investigations significantly overestimated SO_2 oxidation on East Asian dust, possibly due to the neglect of surface saturation effects. We extend previous model experiments by examining how dust modified existing particle concentrations in Asian outflow. Total particle concentrations (condensation nuclei, CN) modeled in the dust-pollution plume are reduced by up to 20%, but we predict that dust led to less than 10% depletion in particles large enough to act as cloud condensation nuclei (CCN). Our analysis suggests that E. Asian dust storms have only a minor impact on sulfate particles present at climate-relevant sizes.

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