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Aerosol and cloud chemistry of amines from CCS - reactivity experiments and numerical modeling

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Capturing CO_2 from the exhaust of power plants using amine scrubbing is a common technology. Therefore, amines can be released during the carbon capture process. To investigate the tropospheric chemical fate of amines from CO_2 capturing processes and their oxidation products, the impact of aqueous aerosol particles and cloud droplets on the amine chemistry has been considered. Aqueous phase reactivity experiments of NO_3 radicals and ozone with relevant amines and their corresponding nitrosamines were performed. Furthermore, nitrosamine formation and nitrosamine photolysis was investigated during laboratory experiments. These experiments implicated that aqueous phase photolysis can be an effective sink for nitrosamines and that ozone is unreactive towards amines and nitrosamines.

Multiphase phase oxidation schemes of amines, nitrosamines and amides were developed, coupled to the existing multiphase chemistry mechanism CAPRAM and built into the Lagrangian parcel model SPACCIM using published and newly measured data. As a result, both deliquescent particles and cloud droplets are important compartments for the multiphase processing of amines and their products. Amines can be readily oxidised by OH radicals in the gas and cloud phase during daytime summer conditions. However, amine oxidation is restricted during winter conditions with low photochemical activity leading to long lifetimes of amines. The importance of the gas and aqueous phase depends strongly on the partitioning of the different amines. Furthermore, the simulations revealed that the aqueous formation of nitrosamines in aerosol particles and could droplets is not a relevant process under tropospheric conditions.