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Influence of Ammonia Emissions on Aerosol Formation in Northern and Central Europe

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Abstract : High concentrations of particles pose a threat to human health. Thus, legal maximum concentrations of PM10 and PM2.5 in ambient air have been steadily decreased over the years. In central Europe, the inorganic species ammonium sulphate and ammonium nitrate make up a large fraction of fine particles. Many studies investigate the influence of emission reductions of sulfur- and nitrogen oxides on aerosol concentration. Here, we focus on the influence of ammonia (NH3) emissions. While emissions of sulphate and nitrogen oxides are quite well known, ammonia emissions are subject to high uncertainty. This is due to the uncertainty of location, amount, time of fertilizer application in agriculture, and the storage and treatment of manure from animal husbandry. For this study, we implemented a crop growth model into the SMOKE emission model. Depending on temperature, local legislation, and crop type individual temporal profiles for fertilizer and manure application are calculated for each model grid cell. Additionally, the diffusion from soils and plants and the direct release from open and closed barns are determined. The emission data was used as input for the Community Multiscale Air Quality (CMAQ) model. Comparisons to observations from the EMEP measurement network indicate that the new ammonia emission module leads to a better agreement of model and observation (for both ammonia and ammonium). Finally, the ammonia emission model was used to create emission scenarios. This includes emissions based on future European legislation, as well as a dynamic evaluation of the influence of different agricultural sectors on particle formation. It was found that a reduction of ammonia emissions by 50% lead to a 24% reduction of total PM2.5 concentrations during winter time in the model domain. The observed reduction was mainly driven by reduced formation of ammonium nitrate. Moreover, emission reductions during winter had a larger impact than during the rest of the year.

Keywords : ammonia, ammonia abatement strategies, ctm, seasonal impact, secondary aerosol formation
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