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Effects of changing gaseous precursor emissions on aerosol chemical composition in Europe

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In the last two decades, emissions of air pollutants and their gaseous precursors have changed dramatically in Europe. Besides the strong reductions in SO_2, also NO_x and VOC emission amounts were considerably reduced in a number of countries. Aerosols are intimately connected to the gas-phase for both its inorganic and organic components. The effects of changing emissions on sulfate aerosols as observed by long-term EMEP wet deposition measurements is clearly visibly, with strongly reduced concentrations at almost all stations. Reactions of nitrate aerosols on the changes in NO_x are less clear, where decreases, no change, and even increases are observed. Several hypotheses have been proposed to explain these findings, but no comprehensive study has been made to investigate the relative contributions of each hypothesis to the changes observed.

In our work we present a modeling study with the fully online-coupled regional chemistry-climate model COSMO-ART (Vogel et al., 2009), which considers both gas-phase and aerosol processes. We conducted simulations with emissions of 1990 and 2009 for the domain of Europe for selected periods, and additionally made sensitivity studies to assess the influence of the changes in selected precursors on the different aerosol components. We show that reactions to changes in precursor emissions are spatially variable and especially for strongly polluted regions quite unexpected.