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Impact of trace gas-aerosol interactions on the global aerosol distributions in the chemistry-aerosol-climate coupled ECHAM5-HAMMOZ model

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Atmospheric trace gases and aerosols interact in many ways. The gas phase chemistry drives the formation and growth of aerosols while aerosols alter the photolysis rates and act as sites for heterogeneous conversion of trace gases. In particular sulfur chemistry plays a central role in the gas-aerosol interactions. The trace gases, sulfur dioxide (SO_2) and dimethyl sulfide (DMS), are precursors of sulfuric acid (H_2SO_4) which can be converted to sulfate (SO_4^{2-}) on existing aerosol particles by condensation or can nucleate to form new fine sulfate particles. SO_2 can be also oxidized in the liquid phase by ozone (O_3) and hydrogen peroxide (H_2O_2) leading to in-cloud sulfate formation. Furthermore, heterogeneous reaction of SO_2 also takes place on aerosol surface, for example on sea salt and mineral dust, with formation of SO_4^{2-}. This process has potentially significant influences on the scavenging efficiency (and thus lifetime) of the aerosols. We used the ECHAM5-HAMMOZ chemistry-aerosol-climate model to quantify the influence of the trace gas-aerosol interactions on the global distributions and optical properties of aerosols. The TRACE-P aircraft campaign offered us the opportunity to compare a large data set of trace gas and aerosol measurements with the model results over a region, the Asian continental outflow, which is characterized by high aerosol loads and gaseous pollutants of different origins. The model includes on line calculation of the photolysis rates, coupled sulfur chemistry between the gas phase and the aerosols and heterogeneous reactions. As the ECHAM5-HAMMOZ model includes a prognostic representation of the mixing state of the aerosol compo-

nents (including sulfate, black carbon, organic carbon, sea salt and mineral dust) and is fully coupled with a comprehensive trace gas simulation (including sulfur chemistry), it is an appropriate tool to study the complex system of trace gas-aerosol interactions and their impacts on aerosol global distributions, composition and optical properties. We show the results from a series of sensitivity simulations to assess the impact of sulfur chemistry, but also of heterogeneous chemistry on the global aerosol distribution, composition and optical properties.