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Introducing GMXe: A new global aerosol dynamics and thermodynamics model for climate and air quality studies

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The treatment of aerosols in global atmospheric models has advanced significantly in the past decade, but the global aerosol distribution is very complex and simplifications must be made in order to treat aerosols in global models. One common simplification is in the treatment of the partitioning of semi-volatile species (e.g. NH3, HNO3 and H2O) between the gas and the aerosol phases, which is often neglected in models or treated in a simplified manner. The treatment of partitioning is, however, important as it controls the aerosol composition (including the aerosol water concentration) as well as affecting the concentration of both aerosol and gas phase pollutants.

This paper introduces the newly developed GMXe aerosol model, which has been developed to investigate gas / aerosol partitioning on a global scale. The model (implemented within the ECHAM5/MESSy Atmospheric Chemistry (EMAC) model) combines an extended version of an established aerosol microphysics model (the M7, Stier et al ACP 2005) with a thermodynamic equilibrium model (EQSAM3, Metzger et al ACP 2008). The resulting model is capable of calculating gas / aerosol partitioning with relatively little additional computational overhead.

In this paper we give an overview of the modelling approach used and show various model inter-comparisons, including a detailed comparison of the results of the GMXe and M7 models. We show the effect of including additional aerosol components - such as nitrate aerosol - on the global aerosol distribution and on the behaviour of other aerosol species (e.g. sulphate). The water uptake behaviour of the aerosol is examined, a factor that is important for the aerosol lifetime and also for the aerosol radiative forcing. We examine our results in the context of future emissions scenarios and air quality standards.