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The importance of aerosol water for air pollution effects on weather and climate - a new concept

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We present a new concept to study air pollution effects on weather and climate, which is based on thermodynamic principles that explain hydration and osmosis - including the required transformation of laboratory based concepts to atmospheric conditions (Metzger and Lelieveld, 2007). Under ambient conditions the equilibrium relative humidity (ERH) determines the saturation molality, solute and solvent activities (and activity coefficients), and the aerosol associated water mass, since the water content is fixed by ERH for a given aerosol concentration and type. As a consequence, aerosol water drives the gas/liquid/solid aerosol partitioning, ambient aerosol size-distributions and directly links aerosol hygroscopic growth into haze and cloud formation.

Various modeling results indicate that a) our new concept is not limited to dilute binary solutions, b) sensitive aerosol properties such as the pH of binary and mixed inorganic/organic salt solutions up to saturation can be computed accurately, and c) that anthropogenic emissions can be directly linked to visibility reduction, cloud formation and climate forcing, if we explicitly account for the aerosol water mass.

Our new concept is more explicit than the traditional CCN concept as it abandons the use of ambiguous terms such as “marine” and “continental” aerosols, and refines lumped categories such as mineral dust, biomass burning, sea salt, organic or sulfate aerosols currently used in atmospheric modeling.

Metzger, S., and J. Lelieveld, Reformulating Atmospheric Aerosol Thermodynamics and Hygroscopic Growth into Haze and Clouds, Atmos. Chem. Phys., Discus., in press, 2007.