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Hygroscopic growth and critical supersaturations for mixed aerosol particles of inorganic and organic compounds of atmospheric relevance

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Abstract. The organic fraction of atmospheric aerosols contains a multitude of compounds and usually only a small fraction can be identified and quantified. However, a limited number of representative organic compounds can be used to describe the water-soluble organic fraction. In this work, initiated within the EU 5FP project SMOCC, four mixtures containing various amounts of inorganic salts (ammonium sulfate, ammonium nitrate, and sodium chloride) and three model organic compounds (levoglucosan, succinic acid and fulvic acid) were studied. The interaction between water vapor and aerosol particles was studied at different relative humidities: at subsaturation using a hygroscopic tandem differential mobility analyzer (H-TDMA) and at supersaturation using a cloud condensation nuclei spectrometer (CCN spectrometer). Surface tensions as a function of carbon concentrations were measured using a bubble tensiometer. Parameterizations of water activity as a function of molality, based on hygroscopic growth, are given for the pure organic compounds and for the mixtures, indicating van't Hoff factors around 1 for the organics. The Zdanovskii-Stokes-Robinson (ZSR) mixing rule was tested on the hygroscopic growth of the mixtures and it was found to adequately explain the hygroscopic growth for 3 out of 4 mixtures, when the limited solubility of succinic acid is taken into account. One mixture containing sodium chloride was studied and showed a pronounced deviation from the ZSR mixing rule. Critical supersaturations calculated using the parameterizations of water activity and the measured surface tensions were compared with those determined experimentally.

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