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Closure study between chemical composition and hygroscopic growth of aerosol particles during TORCH2

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Abstract. Measurements of aerosol properties were made in aged polluted and clean background air masses encountered at the North Norfolk (UK) coastline as part of the TORCH2 field campaign in May 2004. Hygroscopic growth factors (GF) at 90% relative humidity (RH) for D_0=27–217 nm particles and size-resolved chemical composition were simultaneously measured using a Hygroscopicity Tandem Differential Mobility Analyser (HTDMA) and an Aerodyne aerosol mass spectrometer (Q-AMS), respectively. Both hygroscopic properties and chemical composition showed pronounced variability in time and with particles size. With this data set we could demonstrate that the Zdanovskii-Stokes-Robinson (ZSR) mixing rule combined with chemical composition data from the AMS makes accurate quantitative predictions of the mean GF of mixed atmospheric aerosol particles possible. In doing so it is crucial that chemical composition data are acquired with high resolution in both particle size and time, at least matching the actual variability of particle properties. The closure results indicate an ensemble GF of the organic fraction of ~1.20±0.10 at 90% water activity. Thus the organics contribute somewhat to hygroscopic growth, particularly at small sizes, however the inorganic salts still dominate.

Furthermore it has been found that most likely substantial evaporation losses of NH_4NO_3 occurred within the HTDMA instrument, exacerbated by a long residence time of ~1 min. Such an artefact is in agreement with our laboratory experiments and literature data for pure NH_4NO_3, both showing similar evaporation losses within HTDMAs with residence times of ~1 min. Short residence times and low temperatures are hence recommended for HTDMAs in order to minimise such evaporation artefacts.

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