Hygroscopicity and CCN activity of CaCO3 and Ca(HCO3)2 aerosols

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Calcium carbonate (CaCO3) is an important component of mineral dust. It also is one of its most reactive components. In the atmosphere it can react with acids (e.g. H2SO4 and HNO3) forming the corresponding salts.

First we investigated freshly produced CaCO3 and calcium bicarbonate (Ca(HCO3)2) aerosol. The chemical composition was characterized with a quadrupole aerosol mass spectrometer. Hygroscopic growth factors (GF) were measured with a humidity tandem differential mobility analyzer (HTDMA) for 150nm particles at RH = 2 - 97%. Cloud condensation nuclei (CCN) activation was studied with a continuous flow CCN counter (DMT).

Fresh Ca(HCO3)2 aerosol is more hygroscopic than CaCO3 although both of them do not exhibit high GF (GF(95%) = 1.02 and 1.01, respectively). The CCN activity of Ca(HCO3)2 aerosol is remarkably higher than that of CaCO3 aerosol and not much less than calcium nitrate (Ca(NO3)2) or ammonium sulfate (critical SS for 150nm particles: 0.175% for Ca(HCO3)2 and 0.85% for CaCO3).

Experiments in the Large Jülich Aerosol Chamber show that Ca(HCO3)2 can exist for longer time periods under dry atmospheric conditions which is in contrast to the current believe that Ca(HCO3)2 is generally unstable in the atmosphere. Under humid condition in the presence of NOy the fresh aerosol is converted into Ca(NO3)2 which has an even higher hygroscopicity (GF(95%) = 1.92) and is more CCN active than the bicarbonate (critical SS 0.2% for 92nm particles).