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

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Calcium carbonate ($CaCO_3$) 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. H_2SO_4 and HNO_3) forming the corresponding salts.

First we investigated freshly produced $CaCO_3$ and calcium bicarbonate ($Ca(HCO_3)_2$) 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 $Ca(HCO_3)_2$ aerosol is more hygroscopic than $CaCO_3$ although both of them do not exhibit high GF (GF(95%) = 1.02 and 1.01, respectively). The CCN activity of $Ca(HCO_3)_2$ aerosol is remarkably higher than that of $CaCO_3$ aerosol and not much less than calcium nitrate ($Ca(NO_3)_2$) or ammonium sulfate (critical SS for 150nm particles: 0.175% for $Ca(HCO_3)_2$ and 0.85% for $CaCO_3$).

Experiments in the Large Jülich Aerosol Chamber show that $Ca(HCO_3)_2$ can exist for longer time periods under dry atmospheric conditions which is in contrast to the current believe that $Ca(HCO_3)_2$ is generally unstable in the atmosphere. Under humid condition in the presence of NOy the fresh aerosol is converted into $Ca(NO_3)_2$ 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).