# Effect of organics and their hygroscopicity on cloud condensation nuclei (CCN) activity

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Aerosols play a significant role in the Earth climate system directly by absorbing and scattering sunlight, and indirectly by acting as cloud condensation nuclei (CCN). Higher concentration of CCN in the air parcel results in small cloud droplets, thereby affecting the cloud radiative properties. This leads to reflection of incoming shortwave and cooling the Earth's surface (Twomey, 1974).

Aerosols are the complex mixture of organics, inorganics, BC and dust. The water uptake capacity of inorganics, single organic component are well understood and while the properties of their mixtures need further studies (Petters and Kreidenweis, 2007). Understanding the activation properties of the ambient aerosols need the size and mixing state resolved chemical composition, which is not possible with the present level of instrumentation.

Several studies examined the contribution of aerosol parameters like, size distribution and chemical composition or hygroscopicity, to CCN activity using Köhler theory. It has been found that performance of CCN closure study depends on how well the chemical composition mainly organics and mixing state of aerosols is treated. Various studies have tested different assumptions regarding mixing state of aerosols using chemical composition from AMS (both size resolved and bulk) (Cubsion et al., 2008). It appears that the closure ratio improves as the distance from the source region increases because the particles become more internally mixed and less size dependent.

We conducted measurements of CCN, aerosol size distribution and chemical composition at SS = 0.2-1% at the Indian Institute of Technology Kanpur, India, in November, 2012. The main goal of this study is to investigate the effect of organics and their hygroscopicity on cloud condensation nuclei activity. CCN closure study was carried out on the basis of size distribution measured through Scanning Mobility Particle Sizer (SMPS) and chemical composition from Aerodyne HR-ToF-AMS, using simple Köhler theory at five different supersaturations (0.2, 0.4, 0.6, 0.8, 1%). The size dependence of the chemical composition and the mixing state (internal and external) are accounted in various ways. During the sampling period, CCN concentration ranged from 1500-5000 #/cc at lower SS (0.2%) while at medium SS (0.4-0.6%) it ranges from 3000-15000 and at higher SS (0.8-1%) varies from 5000-20000. The total aerosol (CN) concentration varied from 7000 to 34000 #/cc. Diurnal variation in the activation fraction (CCN/CN) is observed with maxima in day time (1200-1800 hrs). In addition, both CCN and CN concentration decreased during day time due to expansion of boundary layer due to solar heating. Due to higher CCN loading, SS depletion correction has been applied throughout the sampling period (Lathem and Nenes, 2011).

Preliminary results show that differences in the $CCN_{predicted}$ and $CCN_{measured}$ decreases with the increase in SS. For example, closure ratio improved from 180 % to 50% as the SS increases from 0.2% to 1.0%, when aerosols were assumed to be internally mixed and composed of inorganics and insoluble organics. This can be attributed to less sensitivity of smaller sized particles to chemical composition. This over-prediction can be reduced by considering day time and night time aerosols separately during closure study. It has also been observed that O:C ratio increases from 0.3-0.6 during the day time due to photochemical activity and oxidation of organics, thus increasing the activation fraction. The effect of organics on CCN activity is examined using an effective hygroscopicity parameter through "$\kappa$-Köhler theory" (Petters and Kreidenweis, 2007).

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