

## **Understanding the effects of chemical composition on hygroscopicity and cloud condensation nuclei activity**

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The main objective of this work is to address the need for atmospheric measurements that elucidate the processes governing aerosol-cloud-climate interactions. In the past year we have developed a suite of measurements that include aerosol hygroscopicity, Cloud Condensation Nuclei (CCN) concentrations, and particle chemical composition in order to provide a uniquely clear picture of the physicochemical properties of the aerosol that enable them to serve as CCN. Our Hygroscopicity Tandem Differential Mobility Analyzer (HTDMA), which was developed in-house with funds from an NCAR Instrument Fund grant, quantifies the uptake of water onto particles that are in equilibrium with air at a Relative Humidity (RH) that can be set from ambient to 90%. The response of a particle to changes in RH is determined by its size and composition: soluble particles such as that composed of inorganic salts uptake water and grow with increasing humidity, while particles composed of a hydrophobic material such as soot do not. Also, small particles grow less than larger ones of the same composition. The commonly reported measurement from an HTDMA is the ratio of the wet to dry diameter and is referred to as the particle's growth factor. In the past year we have also obtained a commercial CCN counter (Droplet Measurement Technologies), on loan from the Georgia Institute of Technology. A particle sizing instrument is placed upstream of the CCN counter to obtain the fraction of particles that act as CCN at a particular size and supersaturation, while the HTDMA scans over the same particle sizes to obtain the size-resolved hygroscopicity. Data acquisition software was written for both instruments to allow coordinated measurements that can be run continuously and autonomously. Figure 1 shows an example of aerosol hygroscopicity and CCN concentration over a range of water supersaturations (for 100nm particles), sampled from outside our lab on Oct .13, 2005. The measurements show that for much of the day the aerosol has the hygroscopicity of ubiquitous ammonium sulfate aerosol (growth factor  $\sim 1.5$ ). However, during the late morning, the HTMDA encounters a plume of higher aerosol concentration with very low affinity for water (growth factor = 1.0-1.2) at which time there appear to be two distinct aerosol populations. With the CCN measurements, we determine that the ammonium sulfate aerosol is internally mixed with other chemical compounds, since the observed critical supersaturation (which corresponds to an activated fraction of 0.5) is higher than for ammonium sulfate particles of the same size; thus, the aerosol requires a higher water vapor supersaturation to become a cloud droplet. During the plume events, the measured critical supersaturation increases even more, corresponding to the less hygroscopic nature of the aerosol in the plume.

Future plans for these instruments include field deployment to Mexico during MIRAGE-Mex (to be located at the T1 site), and to the Marshall Field Site sometime in 2006. In addition, laboratory measurements are planned using generated particles of varying size and composition to study the relationships between hygroscopicity, CCN activation, and composition under more controlled conditions.

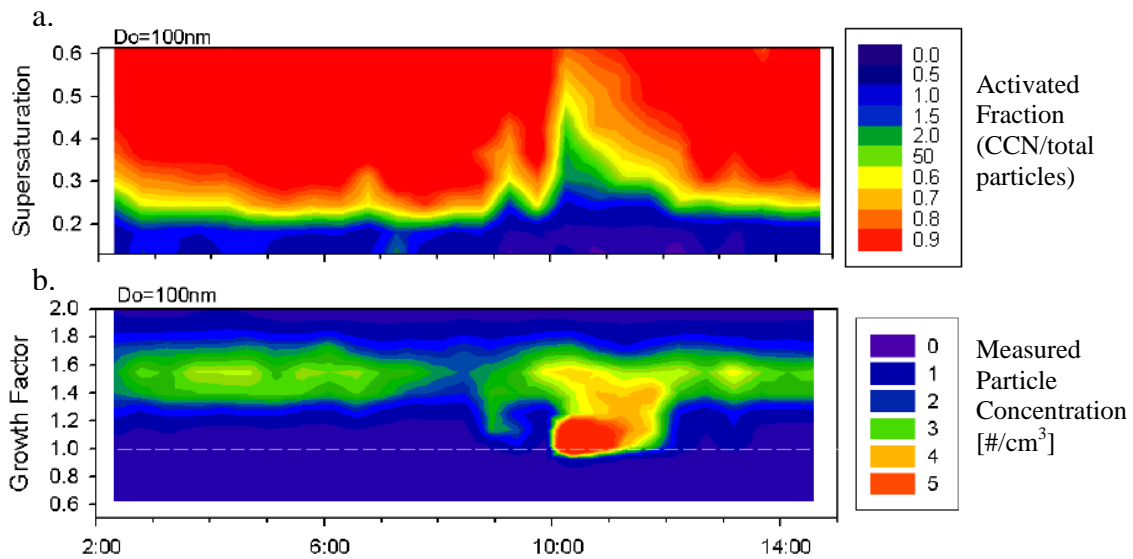


Figure: (a) CCN spectra and (b) growth factor at 90% RH (with dashed line indicating no particle growth) for ambient aerosol sampled in Boulder, CO, during 13 Oct 2005. This period is characterized by a plume of non-hygroscopic particles that impacted the site at 10:00-12:00.