Assessment of cloud maximum supersaturation by size-resolved CCN measurements

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Cloud condensation nuclei (CCN) measurements determine the fraction of aerosol particles that act as condensation nuclei when exposed to supersaturated conditions. During a cloud event, a certain fraction of the CCN has already been activated to droplets depending on the maximum supersaturation that was recently present in the cloud. Thus, CCN measurements during single cloud events are strongly affected by the maximum supersaturation in the cloud. The present work aims to assess the maximum supersaturation in single cloud events.

CCN measurements were conducted during the ACRIDICON-Zugspitze campaign (17.09.2012 - 04.10.2012) at the research station Schneefernerhaus (German Alps, 2650 m a.s.l.). Size-resolved CCN spectra of the non-activated aerosol particles of a cloud (separated by an interstitial inlet) were measured by a combination of a differential mobility analyzer (DMA), a condensation particle counter (CPC) and a CCN counter built by Droplet Measurement Technologies (DMT) (e.g., Rose et al., 2008; Rose et al., 2011).

During a cloud event, no CCN were detected by the instrument for small supersaturations. Only when the supersaturation in the CCN counter was increased above a certain level, these aerosol particles were activated and the activation curve was similar to the activation curve for aerosol particles without cloud (Fig.1). The aerosol particles sampled during no-cloud conditions activate at significantly lower defined supersaturations in the CCN counter than the interstitial aerosol particles during cloud.

The highest supersaturation level during a cloud event at which no interstitial particles were activated in the CCN counter can be regarded as a lower limit for the maximum supersaturation of the cloud ($S_{max,l}$). The lowest supersaturation level where activation could be observed in the CCN counter can be regarded as an upper limit for the maximum supersaturation of the cloud ($S_{max,u}$).

Figure 1 shows the activation curve of 170 nm particles for cloud and no-cloud conditions at different supersaturations in the CCN counter. It gives an impression of the specific maximum supersaturation of the measured cloud event which is between $S_{max,l}$ and $S_{max,u}$. The observed cloud events during the campaign show maximum supersaturations in the range of 0.07% to 0.39%.

This is in agreement with liquid water content (LWC) measurements showing higher cloud maximum supersaturations with higher LWC.

We will compare the CCN spectra with data from mass spectrometer measurements and STXM measurements to derive the chemical composition of the CCN. Especially the influence of organic compounds on the CCN activation is currently of interest (e.g., Topping and McFiggans, 2012).

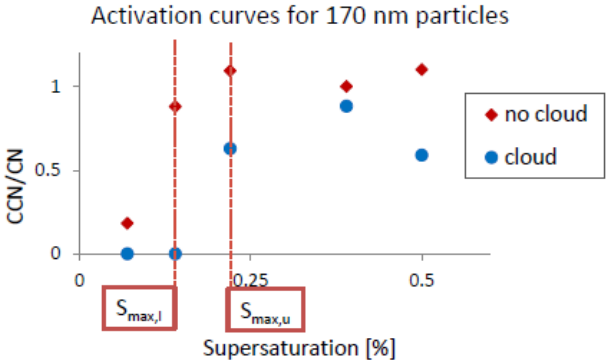

Fig. 1: Comparison of the activation curves for 170 nm aerosol particles at different supersaturations in the CCN counter, for cloud and no-cloud conditions during a single cloud event. In this case $S_{max,l}$ is 0.14% and $S_{max,u}$ is 0.22%.

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