CCN activity during new particle formation events: A case study on a basis of HCCT-2010 field campaign

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HCCT 2010

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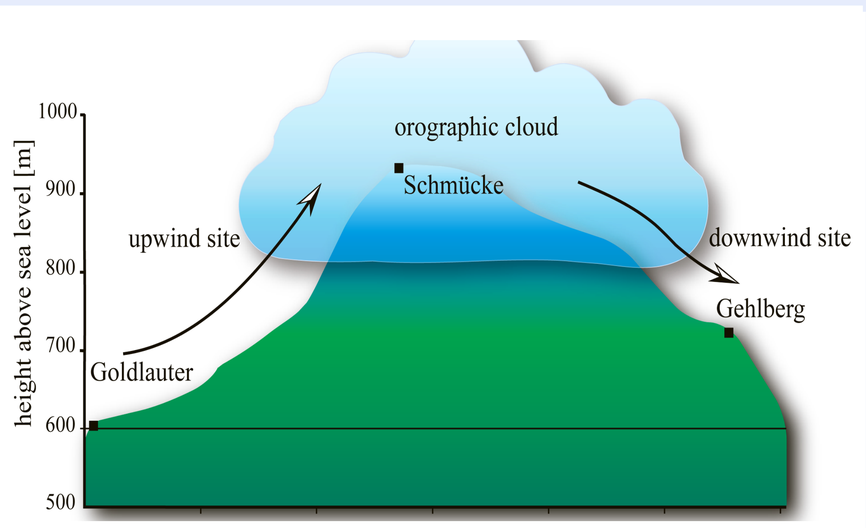
EXPERIMENT AND INSTRUMENTS

The main objective of the Hill Cap Cloud Thuringia 2010 (HCCT-2010) was to perform a ground-based Langrangian-type experiment for investigating the influences of clouds on aerosol chemistry. During the campaign, three research stations were employed, as shown in the figure at right side. Here, we will refer to measurements at Goldlauter (upwind site) only and focus on cloud condensation nuclei (CCN) activity during new particle formation (NPF) events. Two aspects including particle formation and growth and chemical ageing of pre-existing particles during NPF events will be investigated to understand the effects on CCN concentration of NPF events.

Parameters	Instrumentation
Particle number size distribution	Scanning Mobility Particle Sizer (SMPS)
Particle chemical composition	High Resolution Time-of-Flight Aerosol Mass Spectrometer (AMS)
Particle hygroscopic growth (RH=90%)	Hygroscopicity Tandem Differential Mobility Analyzer (HTDMA)
CCN	Cloud Condensation Nuclei counter (CCNc)
Black carbon	Multi-Angle Absorption Photometer (MAAP)



Scheme of the HCCT-2012 sampling sites

RESULTS

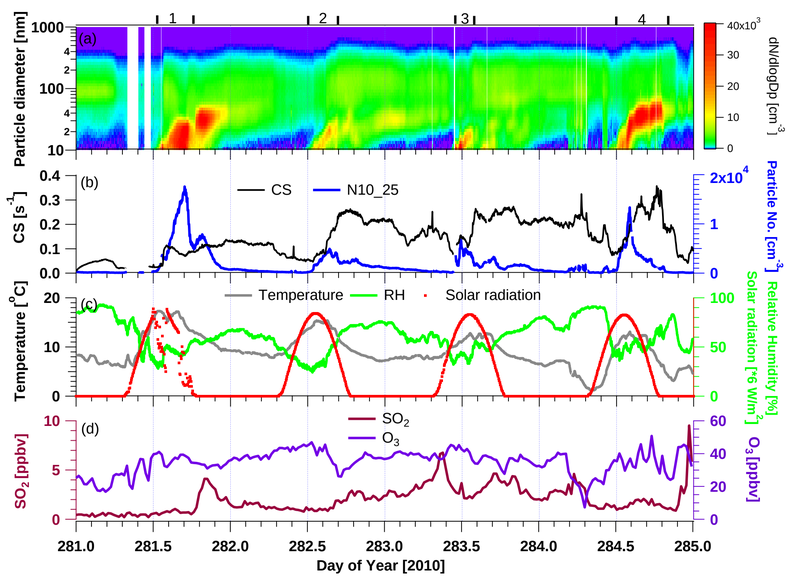


Fig. 1: Particle number size distribution, Condensation sink (CS), meteorological parameters, and trace gases concentrations during NPF events.

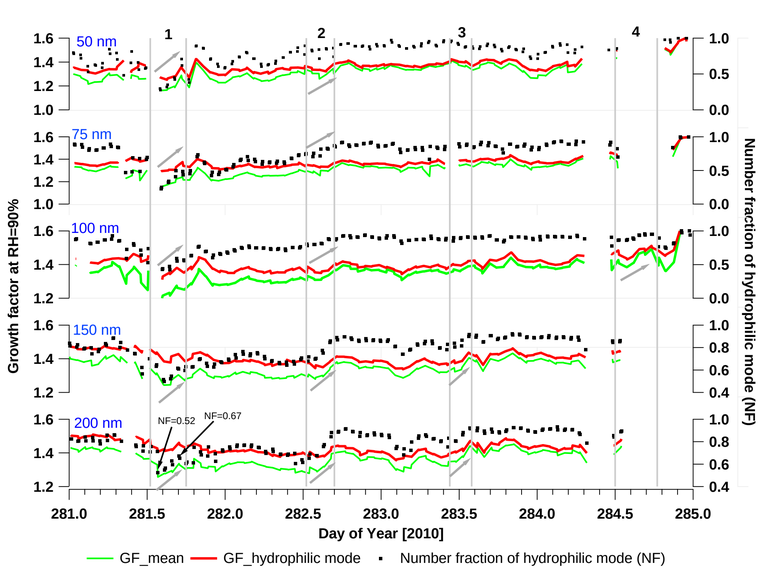


Fig. 2: Size-resolved particle hygroscopicity during NPF events. The hygroscopicity of pre-existing particles enhanced rapidly during the NPF events.

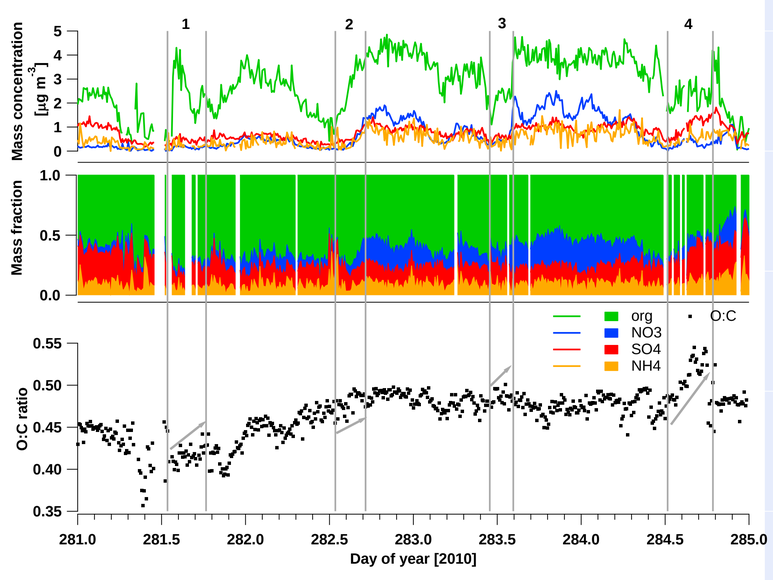


Fig. 3: Chemical composition of particles below 200 nm and O/C ratio (PM1). The oxidation level of organic fraction increased during NPF events.

DISCUSSIONS

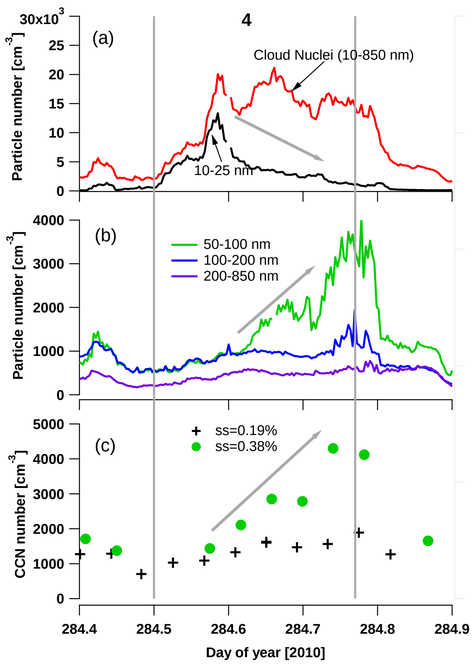


Fig. 4: Size-resolved particle number concentration and CCN number at different super-saturation during NPF4 event.

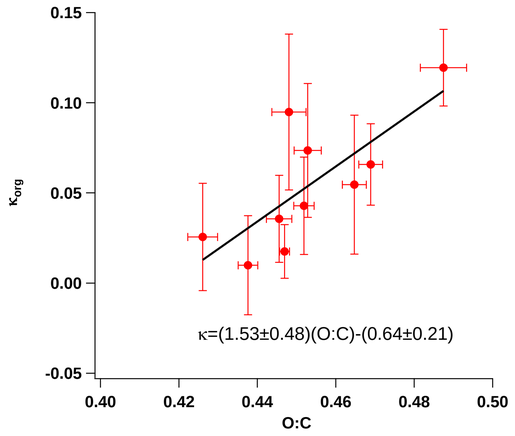


Fig. 5: Relationship between O/C and hygroscopicity parameter κ of organic fraction (κ_{org}) on NPF days. The relationship agrees with the previous studies (e.g., Ref1) and confirm that the increasing oxidation level leads to an increase in hygroscopicity of organic fraction during NPF events.

Ref1: Jimenez et al., 2009, 326, 1525-1529 Science

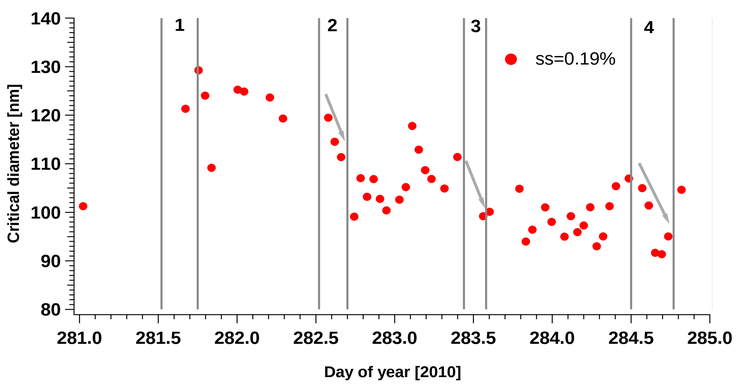


Fig. 6: Critical diameter at ss=0.19% during NPF events. The decreasing trend of critical diameter during NPF events is consistent with increase in particle hygroscopicity.

CONCLUSIONS

(1) The contribution of NPF via particle growth to enhancement of CCN number is obvious during the rapid-growth NPF events. Only two cases with rapid particle growth were observed in our measurements.

(2) The changes in oxidation level and mixing state of pre-existing particles during NPF events increase their ability to act as CCN. Therefore, the increase in CCN number during NPF event may not be explained by particle growth rate alone, and the enhancement in ageing level of pre-existing particles should also be considered.