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

Deepika Bhattu[1] and Sachchida Nand Tripathi[1,2]

[1]Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, India 208016

[2]Center for Environmental Science and Engineering, Indian Institute of Technology Kanpur, Kanpur, India 208016

Corresponding Author: snt@iitk.ac.in

Introduction

- Atmospheric particles play a significant role in the Earth climate system indirectly by acting as cloud condensation nuclei (CCN) depending on their size and chemical composition.
- Sensitivity of CCN closure to various parameters like, size distribution, chemical composition or hygroscopicity in CCN activity considering bulk/ size-resolved chemical composition from filters/AMS and different mixing states has been studied.
- Several closure studies have been performed in the past but a very few studies have predicted CCN concentration within uncertainty levels (± 20%).

Objectives

- **To examine the effect of organics and their hygroscopicity on CCN activity of ambient aerosols.**
- **To study the sensitivity of CCN closure to aerosol mixing state and AMS-PMF derived soluble organic fraction.**
- **To explore the effect of degree of oxygenation on hygroscopicity of organics.**

Methodology

- Measurements were conducted from Nov 7- 27, 2012 at the IIT Kanpur (80° 20'E, 26° 26'N), India using set of instruments given in Table 1.
- Chemical composition from AMS is used in Köhler theory to calculate critical diameter, Dc, assuming different mixing states (external/ internal). Soluble organic fraction (OOA, LVOOA, SVOOA, BBOA and their combinations) obtained from AMS-PMF analysis are used.
- CCN derived hygroscopicity parameter is calculated using κ-Köhler theory (Petters and Kreidenweis, 2007) and its correlation with O:C ratio is studied.

Table 1 : List of instruments used and the measured property

Instruments	Measured property
SMPS	Size distribution (14.6 <D< 685 nm)
CPC	Total particle number concentration (#/cc)
Aerodyne HR-ToF-AMS	Chemical composition (bulk & size-resolved)
CCNc	CCN concentration (#/cc) (SS=0.2-1%)

Results and Discussion

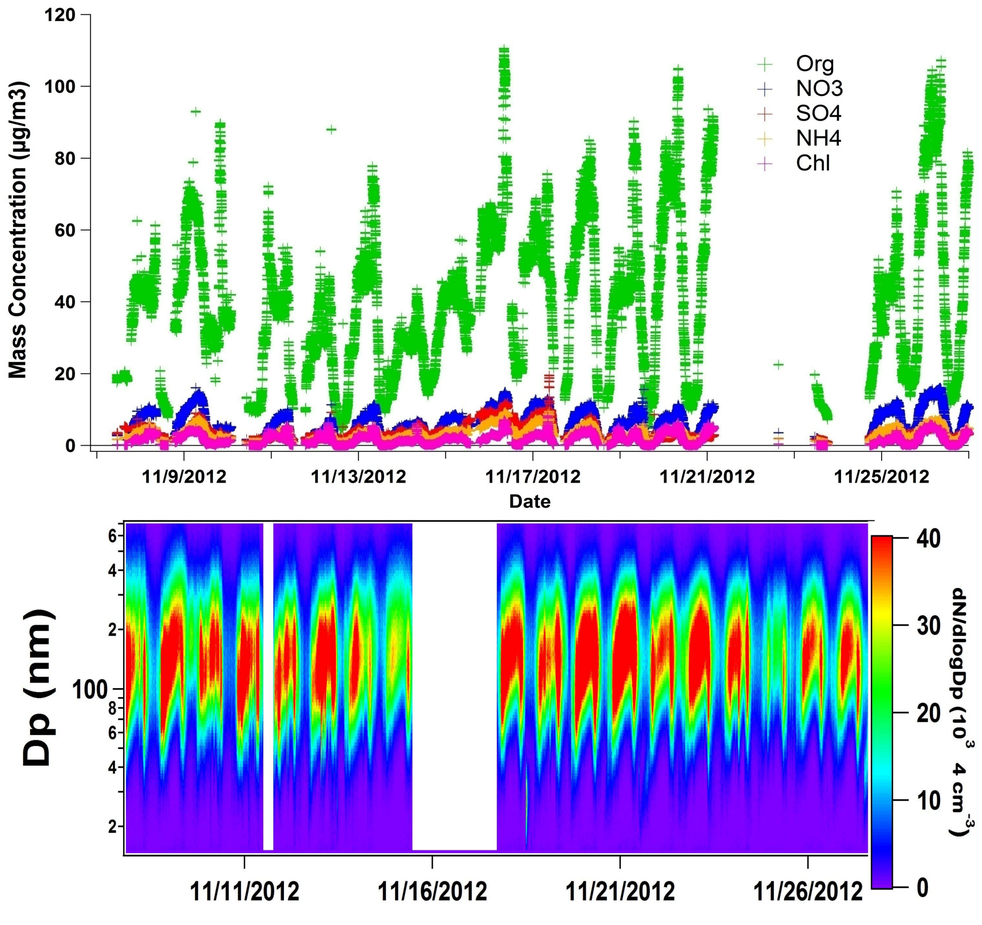

Figure1: Time series of bulk chemical composition from HR-ToF-AMS using CE as unity (Most of the time ε_{org} is greater than 50% with maxima at night time(b) SMPS size distribution during the measurement period.

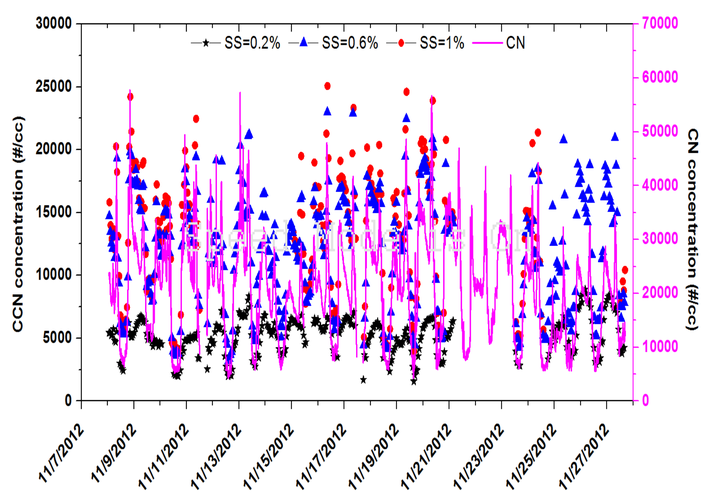

Figure2: Times series of CCN and CN concentration(#/cc). Maximum activation fraction (CCN/CN) observed at daytime due to enhanced photochemical activity is in accordance with O:C ratio. Few exceptions have been observed at the end of the sampling period when fraction of SVOOA is comparable to LVOOA.

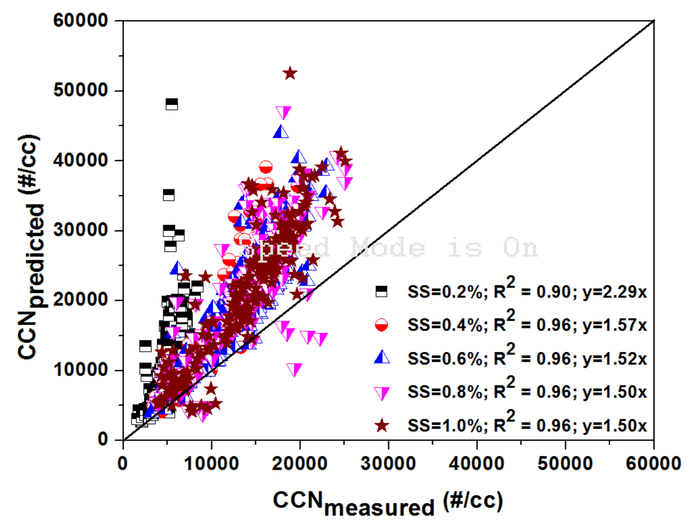

Figure3: Predicted Vs measured CCN concentration at SS=0.2-1%. Assumptions involved are: Internally mixed aerosols; bulk chemical composition; surface tension same as of pure water. Real-time volume fraction of soluble organics is taken as OOA (Nov 8 - 18) and LVOOA (Nov 18-27) conc.. Closure ratio improves as the SS increases showing less sensitivity to chemical composition.

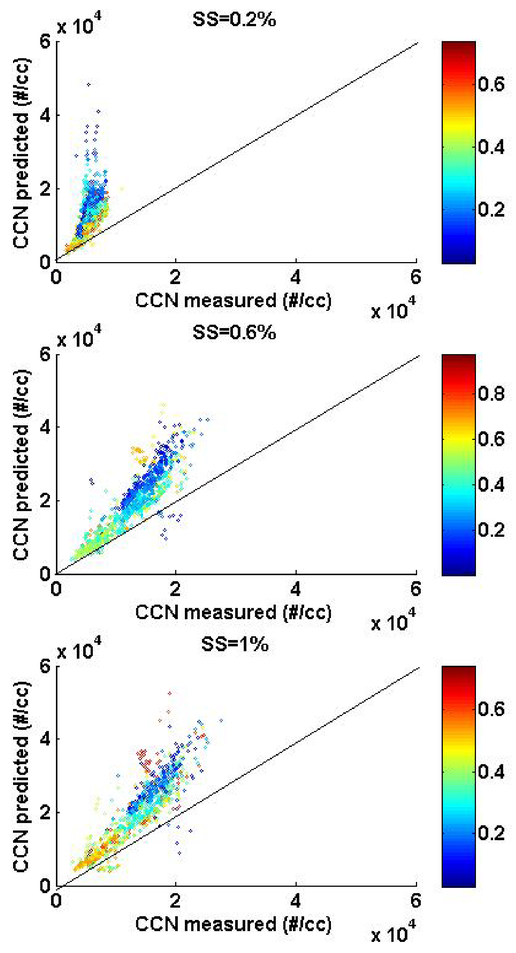

Figure4: Predicted Vs measured CCN concentration at SS=0.2-1%. Colorbar shows volume fraction of soluble organics. Closure is best achieved when volume fraction is ~ 0.4-0.5.

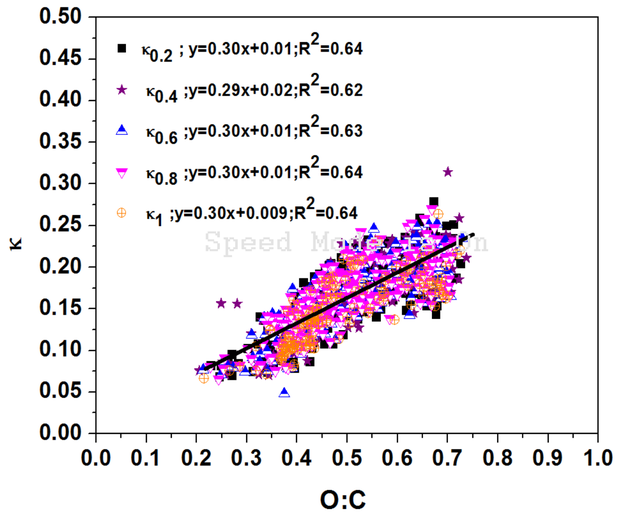

Figure5: Correlation between hygroscopicity parameter, κ (CCN derived) at different supersaturation (0.2%-1%) and O:C ratio (AMS) shows increase in hygroscopicity with the degree of oxygenation.

- O:C ratio ranges from 0.2-0.8 with maxima at noon while κ value varies from 0.07 - 0.37
- Further, sensitivity test to oxygenated factors is in progress.

References

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