Processing of ambient aerosols during fog events

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1. Introduction

- Fog is a major processing and removal agent of ambient aerosols
- Enhanced secondary organic aerosol (SOA) production has been reported during fog and there is a growing understanding that SOA formed via this aqueous processing can contribute significantly to ambient aerosol loading
- Very few smog chamber studies have been carried out to understand this aqueous processing but none of them represents the actual complexity of ambient system

2. Scope and Objectives

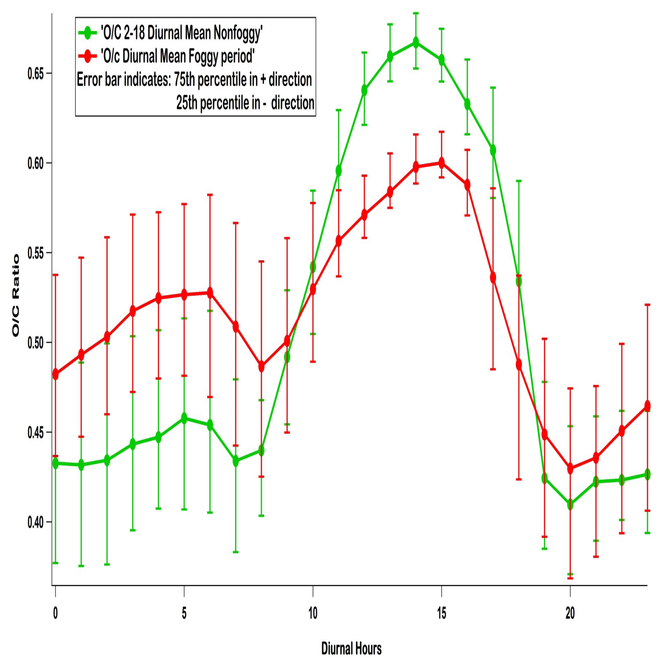
- Objective of this study was to investigate the effect fog and subsequent aqueous processing on the ambient aerosols
- Comparison between foggy and non foggy time period to understand the difference in mechanisms that operates during both the periods
- Evaluation of aerosol oxidation level during fog, hygroscopicity and interrelation between different parameters
- Effect of acidity on different aerosol processing mechanisms

3. Experimental Methods

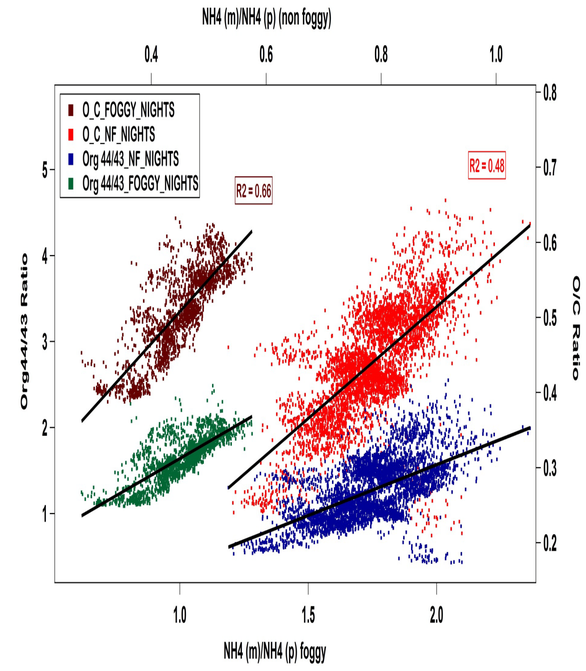
- Sampling was carried out in Kanpur, India from 02-18 Nov, 2012 (non-foggy period) and again from 22 Dec, 2012- 10 Jan, 2013 (foggy period), a total of 12 fog events were recorded form 22 Dec, 2012- 10 Jan, 2013
- Variety of instruments were deployed including – HR-ToF-AMS (High Resolution Time of Flight-Aerosol Mass Spectrometer), SMPS (Scanning Mobility Particle Sizer), CCP (Cloud Combination Probe), CCN (Cloud condensation nuclei counter)
- Submicron aerosol loadings, aerosol oxidation level (O:C ratio), aerosol acidity, size distribution was calculated from AMS data, while liquid water content (LWC) was derived form CCP to identify fog duration. CCN data was used to calculate organic hygroscopicity, SMPS data was used to quantify the collection efficiency of AMS

4. Results

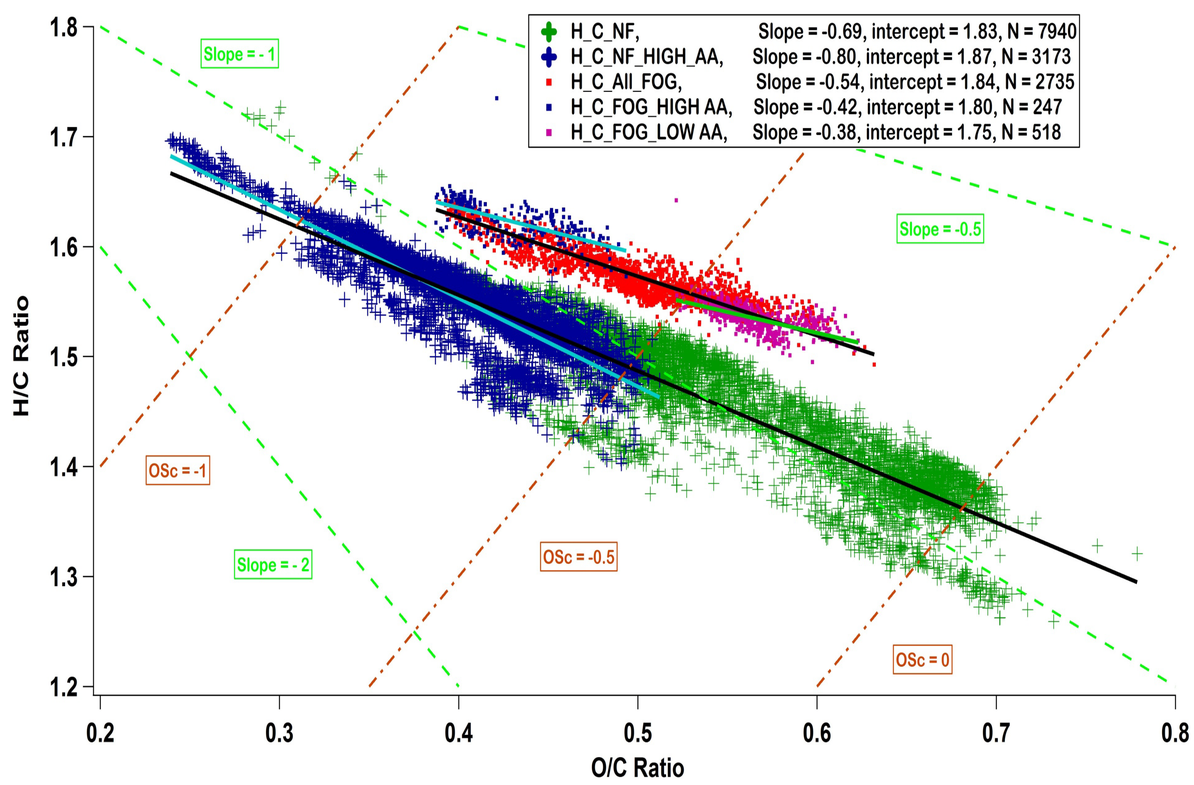
Diurnal O:C Ratio



Acidity vs. O:C vs. Org44/43 ratio



Van-Krevelen Diagram (H:C vs. O:C Plot)



- It appears that with decreasing acidity both O:C ratio and Org 44/43 ratio are increasing. Org 44 is associated with CO2+ fragment, its dominance typically indicates enhanced fragmentation process, while dominance of org 43 or C2H3O+ fragment indicates enhanced functionalization.
- H:C vs. O:C plot also become shallower during foggy and neutralized periods indicating fragmentation is the dominant mechanism.

5. Some Important Conclusions Derived from the Work

- Average O: C ratio of 0.54 0.05 during foggy nights was higher than average O:C ratio of 0.43 0.03 of non foggy nights , in spite of high loadings during foggy period, possibly due to enhanced aqueous processing
- For both the periods neutralized aerosols ($NH4^+(m)/NH4^+(p) > 1.1$) are more oxidized than acidic aerosols ($NH4^+(m)/NH4^+(p) < 0.8$)
- In neutralized aerosols dominant mechanism of aerosol oxidation is fragmentation while in acidic aerosols its functionalization as observed form Van-Krevelen diagram
- 60-70% mass of the total submicron aerosol was contributed by organics, followed by Nitrate , but Sulphate increased significantly during foggy period possibly due to aqueous phase production