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Yale-NUIST Center on Atmospheric Environment

Characteristics of the Carbonaceous components in $PM_{2.5}$ in Northern Suburbs of Nanjing in Autumn

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Outline

- Current work
- Introduction
- Experimental Methods
- Results and Discussion
- Conclusions
- Future Work

Current work

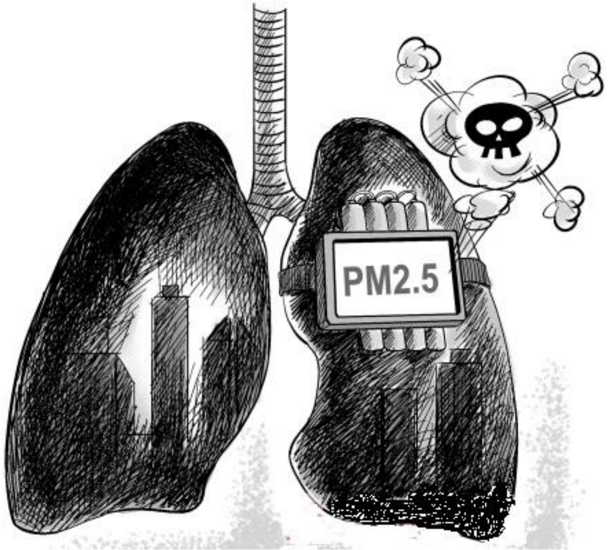
- My research direction is mainly about the Chemical composition in $PM_{2.5}$ in Northern Suburbs of Nanjing in four seasons , including organic carbon(OC)and element carbon(EC)、cation&anion and Carbohydrate compounds.

- I have already weighed and calculated the concentration of $PM_{2.5}$ samples, measured the OC,EC and cation&anion concentration in the samples which collected in four seasons in northern suburb of Nanjing in 2015 and used ion chromatography method to measure the levoglucosan in autumn.

- I will present my research in autumn in this report.

Introduction

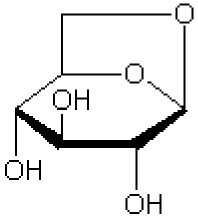
- Carbonaceous aerosols accounts for a high portion of aerosols, it includes organic carbon (OC) and element carbon (EC). Most of the EC derives from primary aerosol or incomplete combustion of fossil fuels or biomass; the origin of OC is relatively complex, it can exist in primary contaminant or it can developed from primary organic carbon (POC), which undergoes photochemical reaction and produces secondary organic carbon (SOC).OC and EC account for a high proportion in $PM_{2.5}$, and they have a great impact on environmental quality and human health. This topic is a hotspot in recent years at home or abroad.



Introduction

- In recent years, the reports of biomass burning increased a lot, which revealed many large-scale burning incidents in autumn. Although potassium may be useful as a biomass-burning tracer (Andreae,1983; Echalar et al.,1995), its application is limited by the fact that there are other important sources of this element such as soil and seawater. The monosaccharide levoglucosan released during the pyrolysis of cellulose at temperatures above 300℃, has been proposed as a specific tracer for biomass burning (Simoneit et al.,1999).

- This research took samples from $PM_{2.5}$ in northern suburbs of Nanjing in autumn, analyzed and compared the characteristics of OC and EC in day and night . For the first time we use IC to measure the levoglucosan concentration within $PM_{2.5}$ in northern suburbs of Nanjing. We also discussed the influence of biomss burning in northern suburbs of Nanjing in autumn and took a further research on incidents through creating a backward trajectory model.



Levoglucosan($C_6H_{10}O_5$)

Experimental Method

➢Experiment site

➢Observation data

Sampling time: 7-Oct to 5-Nov, 2015
Sampling place: Northern Suburbs of Nanjing
Samples: $PM_{2.5}$
Sampling frequency : 12 hours

OC and EC were analyzed by a Sunset Model 4 carbon analyzer with the Thermo optical transmission(TOT) method.

The levoglucosan were analyzed by ICS-5000^{+}.

➢Observation data

Meteorological data: The data comes from meteorological observational site in NUIST, the time interval is 1 h.

Fire point data: Through using Modis satellite fire point data provided by NASA to analyze the origin of biomass burning in northern suburb of Nanjing.

We used data from NOAA to create a HYSPLIT backward trajectory model, which can simulate the air trajectory of northern suburb of Nanjing during sampling period. Time is postponed for 72 hours, and we choose 100, 500, 1000 as the altitude(m-AGL).

➢Method

This work uses empirical formula proposed by Turpin et al,. to make a quantitative description of SOC:

$$SOC = OC - EC \times (OC/EC)_{min}$$

$(OC/EC)_{min}$ in the equation seclected the minimum value during sampling period.

Results and Discussion

➢Section 1 $PM_{2.5}$、OC、EC Feature Analysis

The average concentration of $PM_{2.5}$ in this work is 54.05μg/m³, far below to Wu's research in 2011(104.43μg/m³).

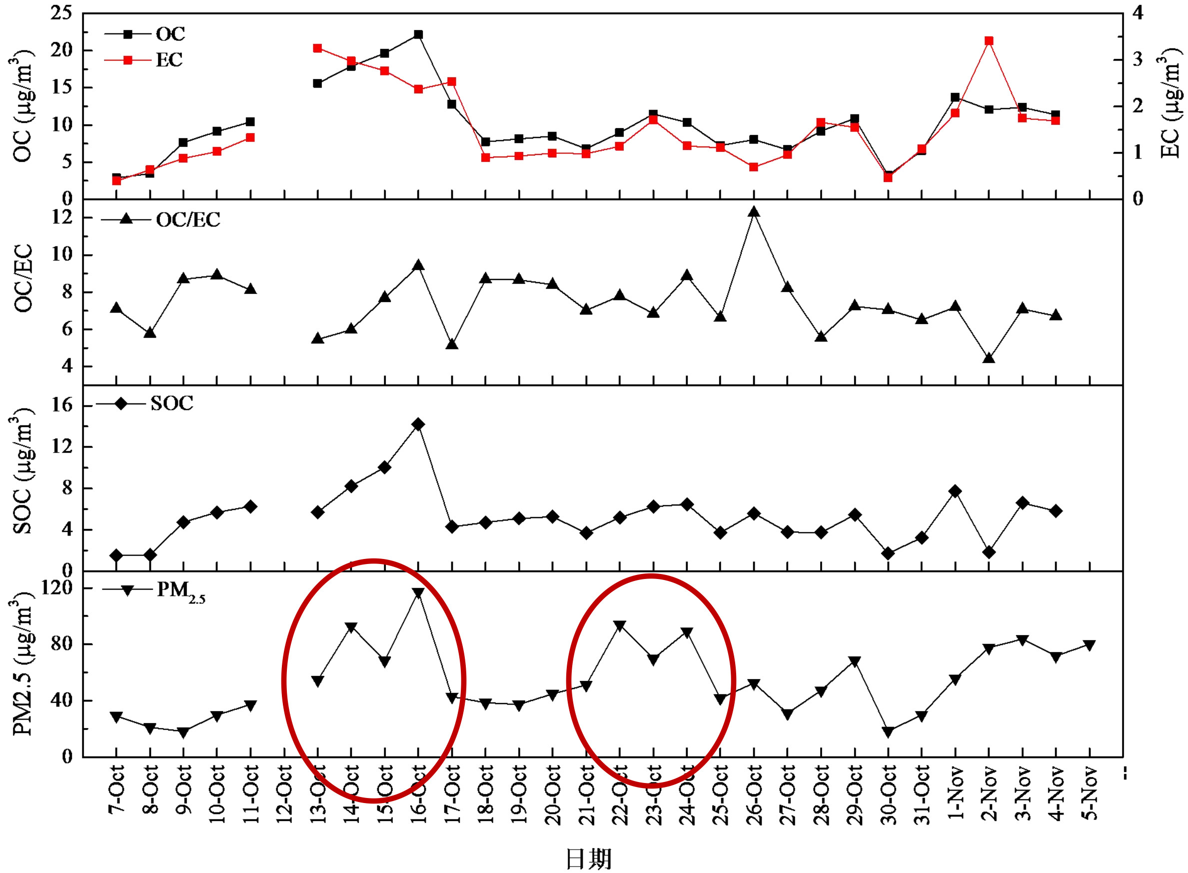


Fig 1. Time series of $PM_{2.5}$,OC,EC, OC/EC, SOC from7-Oct to 5-Nov, 2015, at Northern Suburbs of Nanjing.

Table 1. Comparison of OC, EC , OC/EC ratios and SOC with other studies

Location	Time	OC (μg/m³)	EC (μg/m³)	OC/EC	SOC (μg/m³)	SOC/OC (%)	Method	Reference
This research	2015Autumn	11.28	1.07	7.38	5.31	51.7	TOT	This paper
Nanjing Nanhua	2011Autumn	13.24	2.69	5.09	5.73	43.27	TOR	Wu et al., 2013
Xiamen	2011Winter	15.71	2.72	5.78	7.17	45.67	TOT	Chen et al., 2013
Xi'an	2013Autumn	29.77	8.4	3.54	—	—	TOT	Wang et al., 2015
Shanghai	2010-06 ～ 2011-05	8.6	2.4	3.58	3.9	38.9	TOR	Zhang et al., 2014
Wuxi	2013Winter	22.8	2.08	12.83	9.04	40.96	TOT	Yun et al., 2014
Trisaia, (Italy)	2010Summer	1.69	0.44	3.84	—	—	TOT	Antonella et al., 2013
Aragon, (Spain)	2011	3.6	1.1	4.7	—	—	—	M.Escudero et al., 2015

OC/EC 2.5~10.5 represent coal burning Chen et al., 2006

3.8~13.2 represent biomass burning Zhang et al., 2007

➢Section 2   Day&Night Comparison

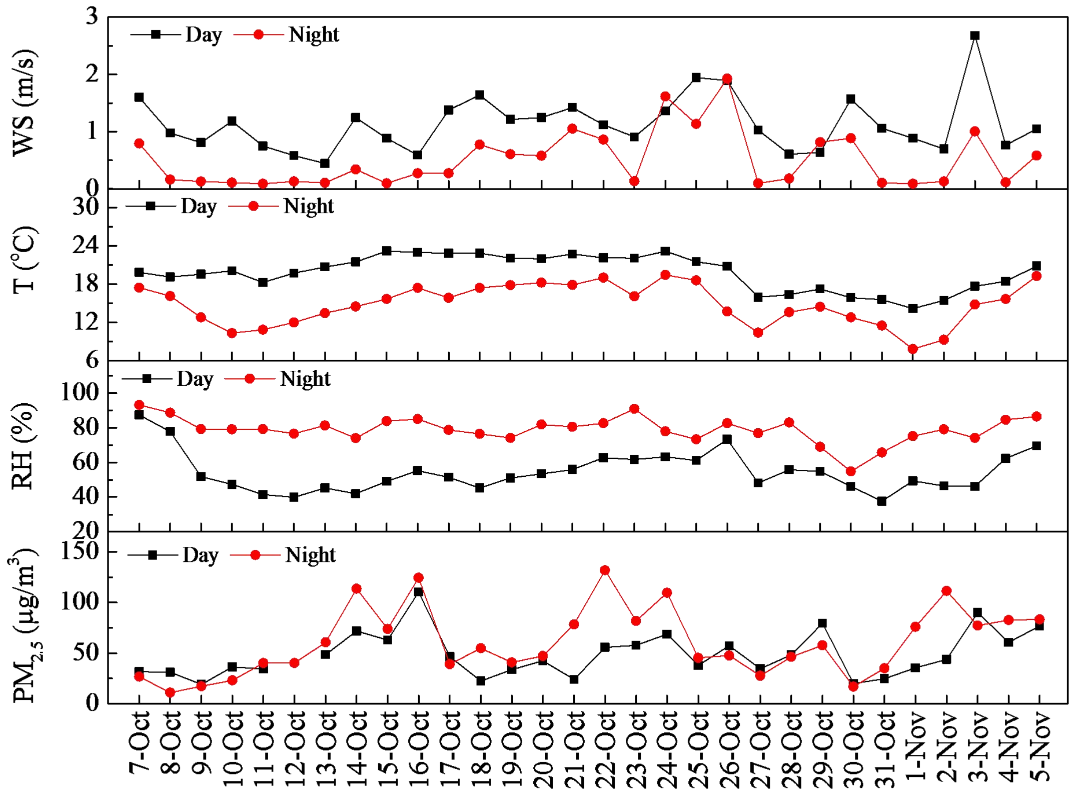
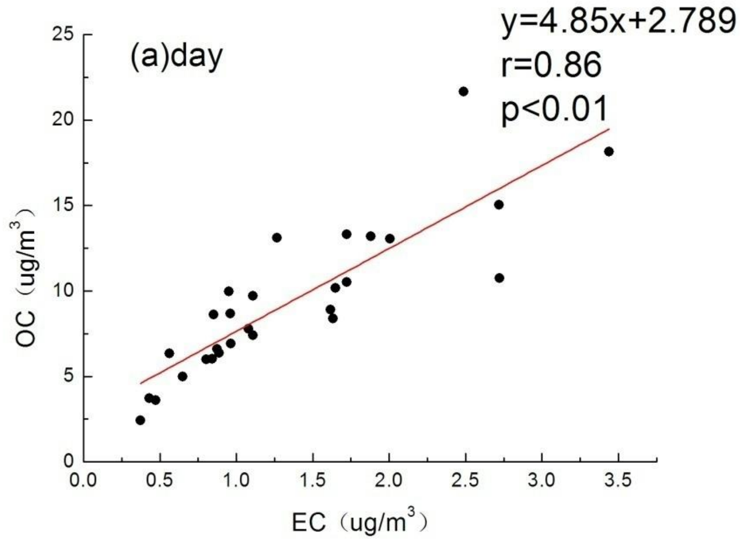
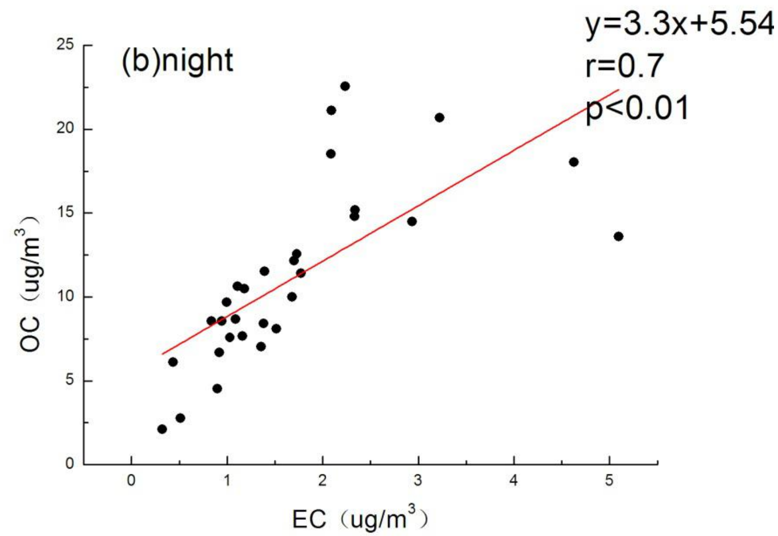


Fig 2 Time series of $PM_{2.5}$ and other meteorological parameters in Day and Night.





High relative humidity will increase SOC, and let EC play the role of cloud condensation nuclei, which is easily can be wet scavenged.

Fig 3 Scatter plots of OC and EC concentrations in day and night.

Table 2 Day&Night comparison of $PM_{2.5}$、OC、EC and SOC and other meteorological parameters

	Day	Night
$PM_{2.5}$(μg/m³)	48.48	59.49
OC(μg/m³)	9.34	11.15
EC(μg/m³)	1.35	1.7
SOC(μg/m³)	4.01	6.61
SOC/OC(%)	43.96	59.39
WS(m/s)	1.14	0.51
T(℃)	19.8	14.78
RH(%)	54.41	78.89

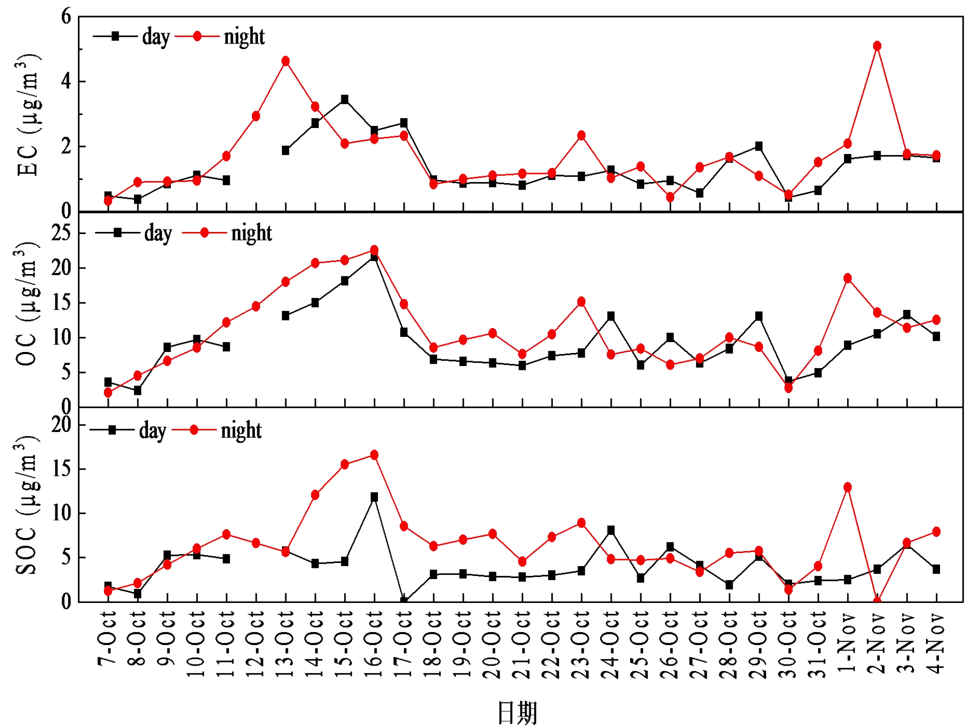


Fig 4 Time series of OC、EC and SOC in Day and Night.

➢Section 3 Analysis of Contamination Incidents

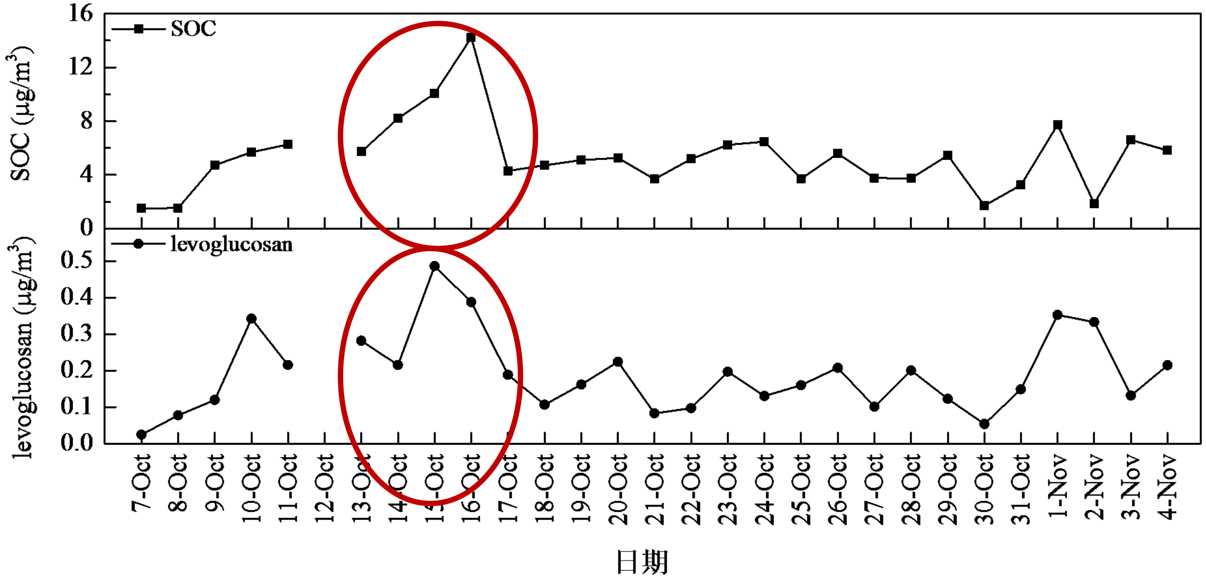
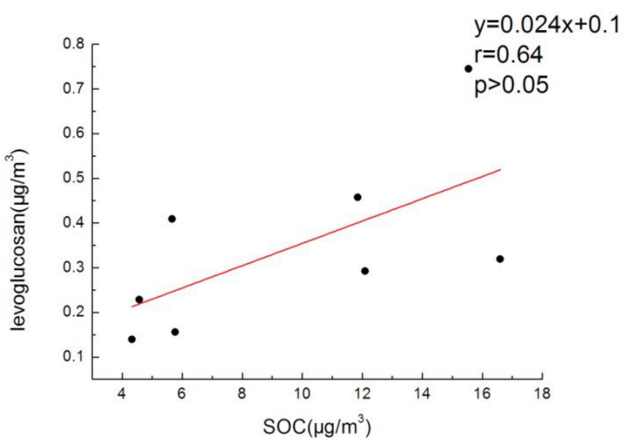
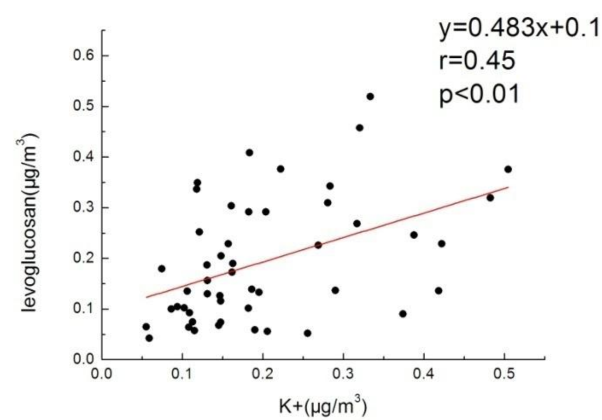
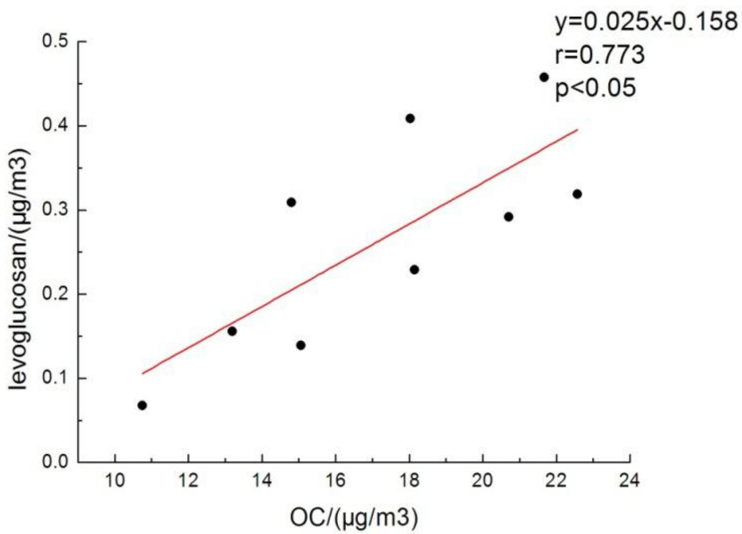


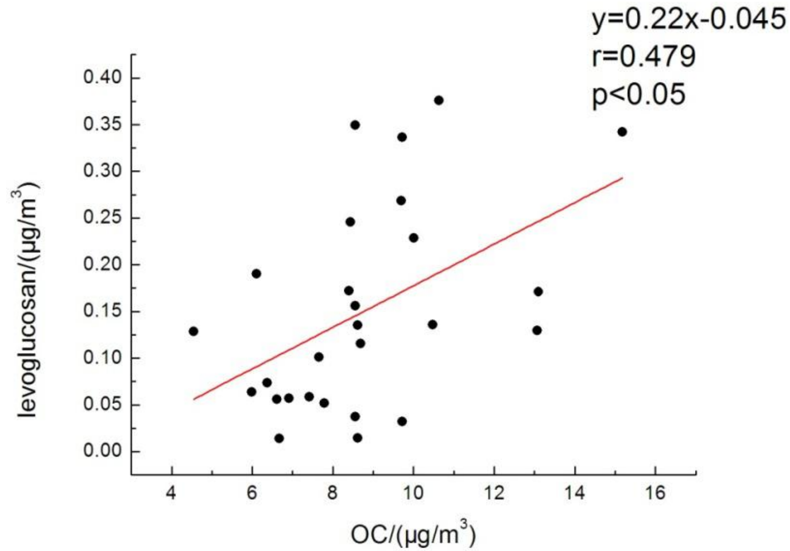
Fig 5 Time series of Levoglucosen and SOC.







13th -16th Oct



7th-12th Oct and 17th -31thOct

Fig 6 Scatter plots of Levoglucosen and OC concentrations.

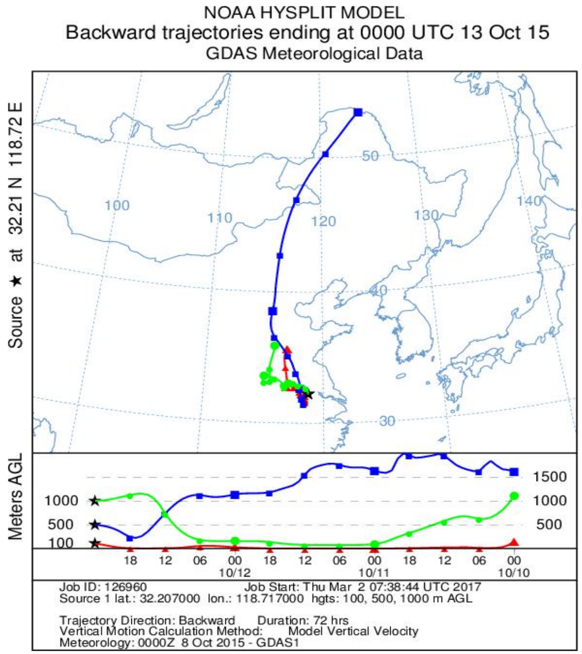
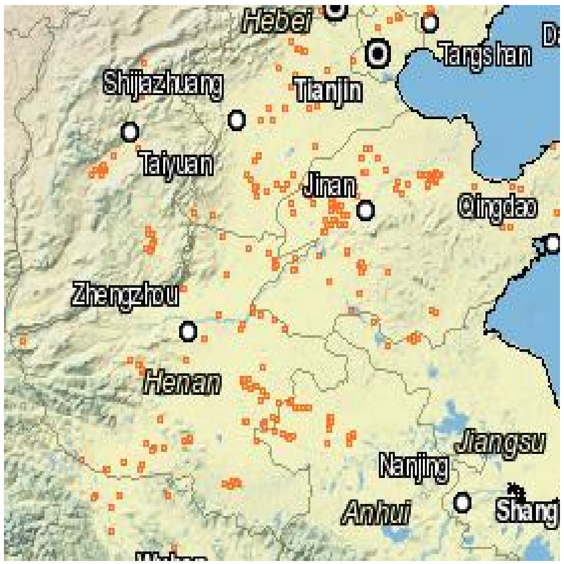
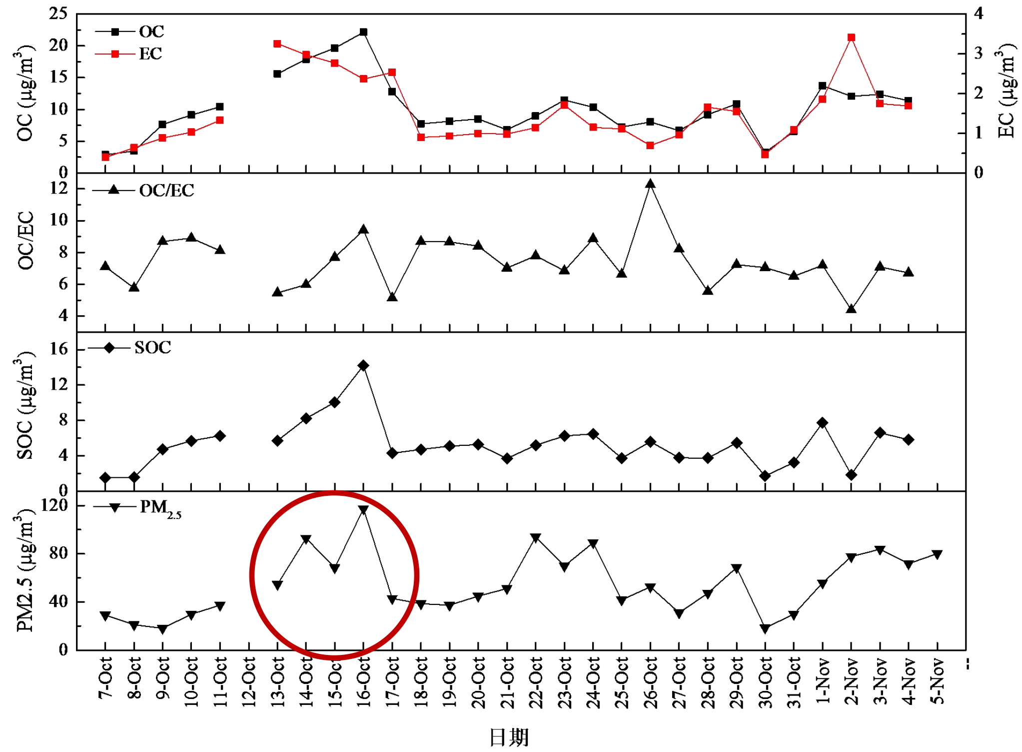
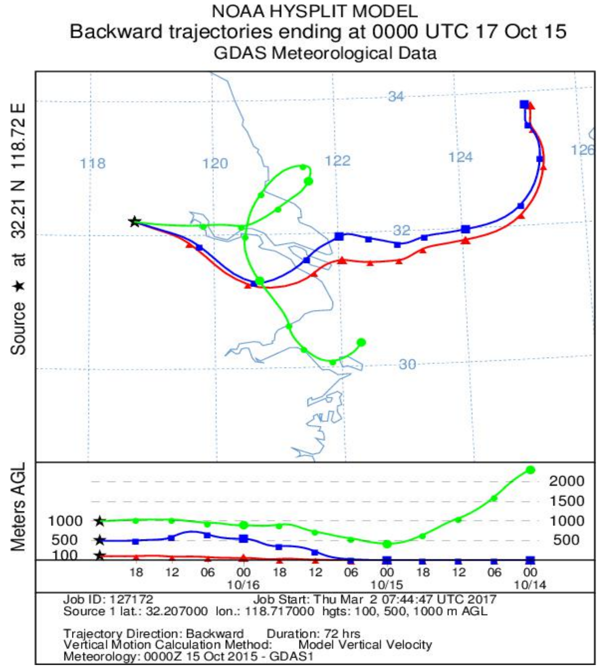


Fig 7 Backward trajectory in northern suburb in Nanjing(13th Oct.) and fire point data(8th-10th,Oct.)







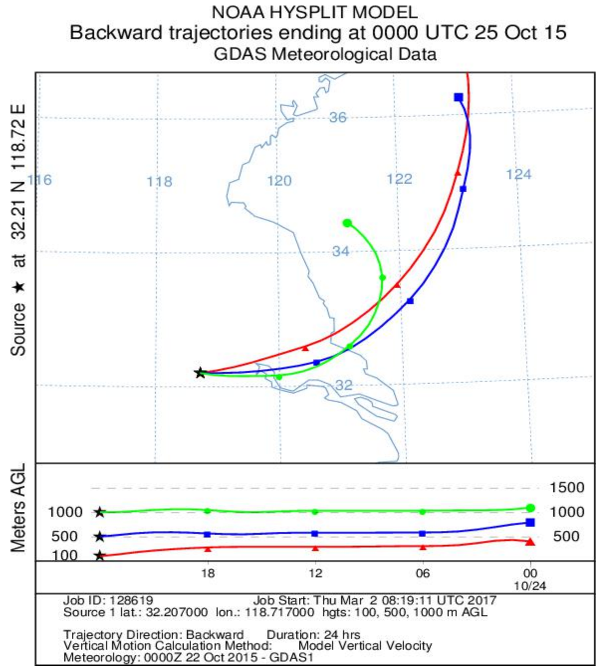
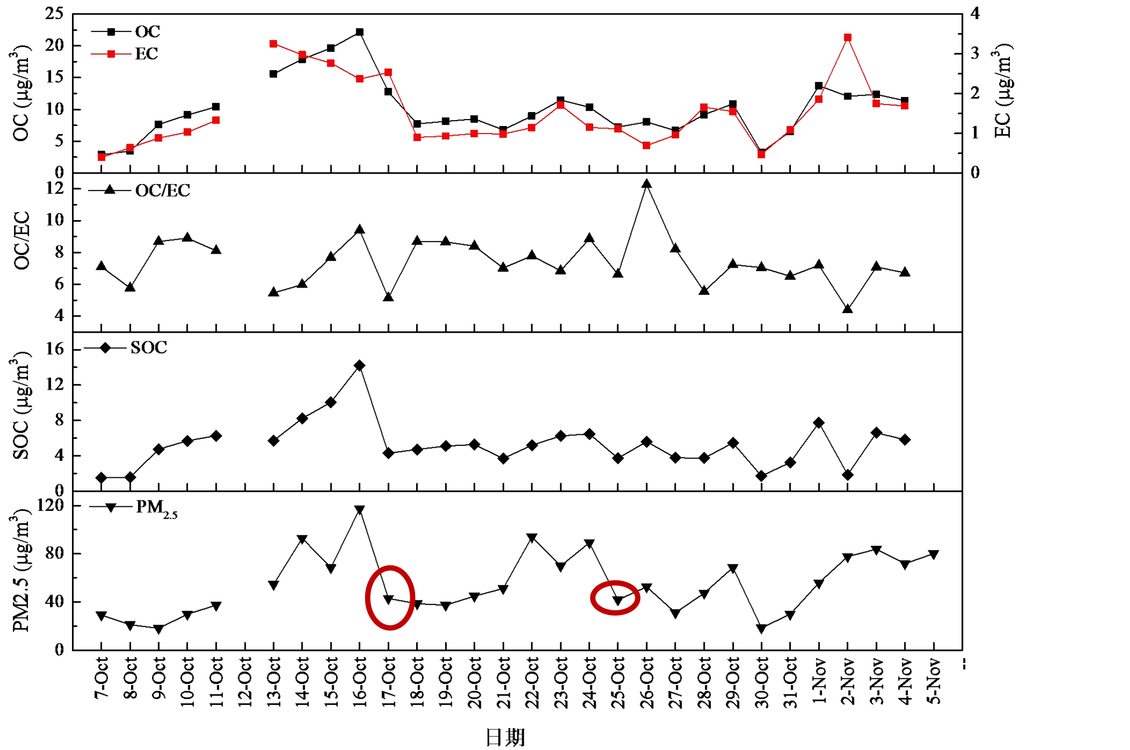


Fig 8 Backward trajectory in northern suburb in Nanjing(17th Oct and 25th Oct).



Conclusion

➢Average $PM_{2.5}$ concentration in northern suburb of Nanjing in 2015 is (54.05±28.90)μg/m^3,which is obvious lower than Nanjing Nanhua in the same period in 2011. The mean of OC/EC is 7.38, which indicated that the emission of coal burning in factories nearby and biomass burning are significant sources of pollution. Compared to the same period in 2011, SOC/OC increased, It shows that the secondary pollution in northern suburb of Nanjing still severe.

➢Both concentrations of $PM_{2.5}$, OC, EC and SOC in northern suburb of Nanjing represent a feature of Night ＞Day. The relativity of OC and EC in daytime is better than in night, mostly because the wind speed in daytime is higher than night, which can help the spread of contaminant. The relative humidity in autumn night is higher than daytime, which can create more SOC, and EC can easily be wet scavenged in a high humidity condition.

➢$PM_{2.5}$ and levoglucosan reached peak between 13th and 16th, through the analysis of backward trajectory data and fire point data we can know that northern suburb of Nanjing was effected by a long time trasportation of contaminant from Hebei Province. In 17th and 25th, clean air mass from the Huang ocean diluted the contaminations.

Future work

- Analyzing and comparing the changing features of chemical component in $PM_{2.5}$ in northern suburb of Nanjing in four seasons.

- Use ion chromatography method to measure Carbohydrate compounds in four seasons' samples and make a more detailed analysis of pollution sources.

Thank you