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Variation of OC, EC during a haze process in winter,suburban of Nanjing

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Introduction

- Atmospheric haze phenomenon in China is becoming more and more serious, especially in Beijing-Tianjin-Hebei region, Yangtze River Delta and Pearl River Delta.
- Yao's study showed that in the nearest 50years, hazy days in NJ has an obvious upward trend with a variation of winter > autumn > spring > summer.
- Fine particulate matter in the atmosphere is the main cause of hazy days. The final purpose of this research is to observe the change of chemical composition in haze, so as to deduce its formation mechanism and sources.

- Carbonaceous aerosol consititute one of most significant contribution of the atmospheric aerosols, are of worldwide concern due to their effects on environment, climate, atmospheric visbility, air quality and human health.
- According to their chemical composition, carbonaceous content of aerosols is mainly devided into Organic Carbon (OC) and Elemental Carbon (EC), their contribution of PM2.5 is 20%~60%.
- SOC(Secondary Organic Carbon) has obviously impacts on reduced visibility, haze formation and climate change due to its stronger polarity and hygroscopicity. SOC's average contribution rate of PM2.5 is 30%~77% during heavy hazy days in China(*Dr. Huang et al.,2014*).

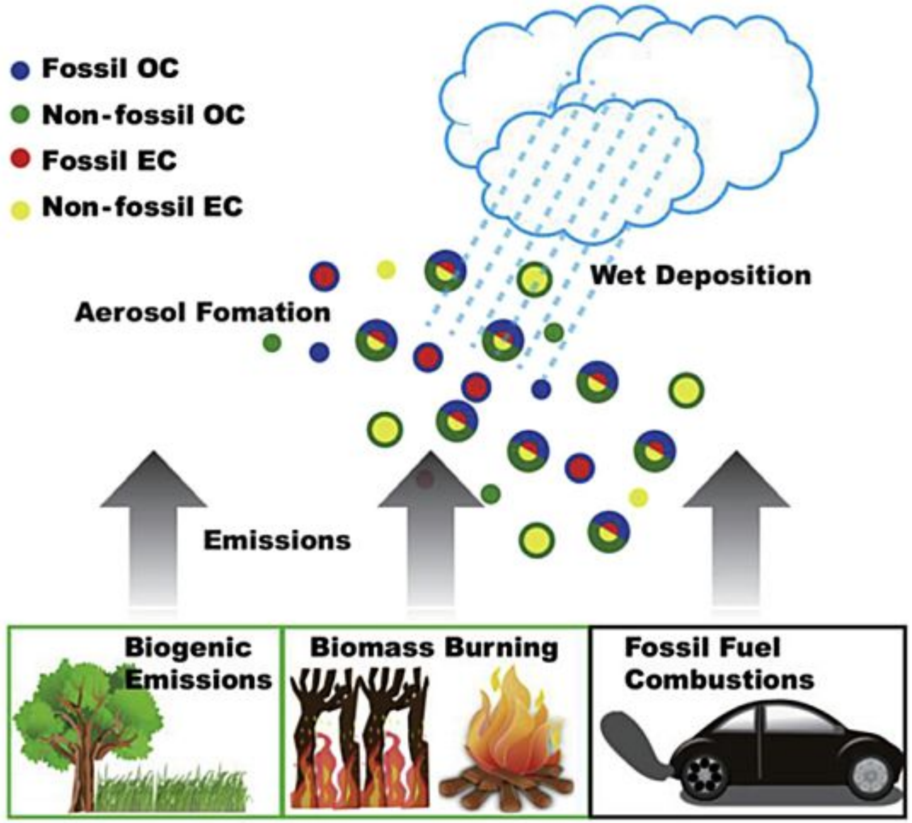


Fig1. A simplified sketch showing the sources and wet deposition of carbonaceous particles(OC and EC).*from Zhang et al.,2015*

Tab1. Concentration of PM2.5 in wet and dry days of different seasons in NJ,2007

污染物	春季		夏季		秋季		冬季	
	降水	非降水	降水	非降水	降水	非降水	降水	非降水
$PM_{2.5}$	0.081	0 110	0.079	0.104	0.062	0.096	0.085	0.109

from Wei et al.,2009

Experiment description

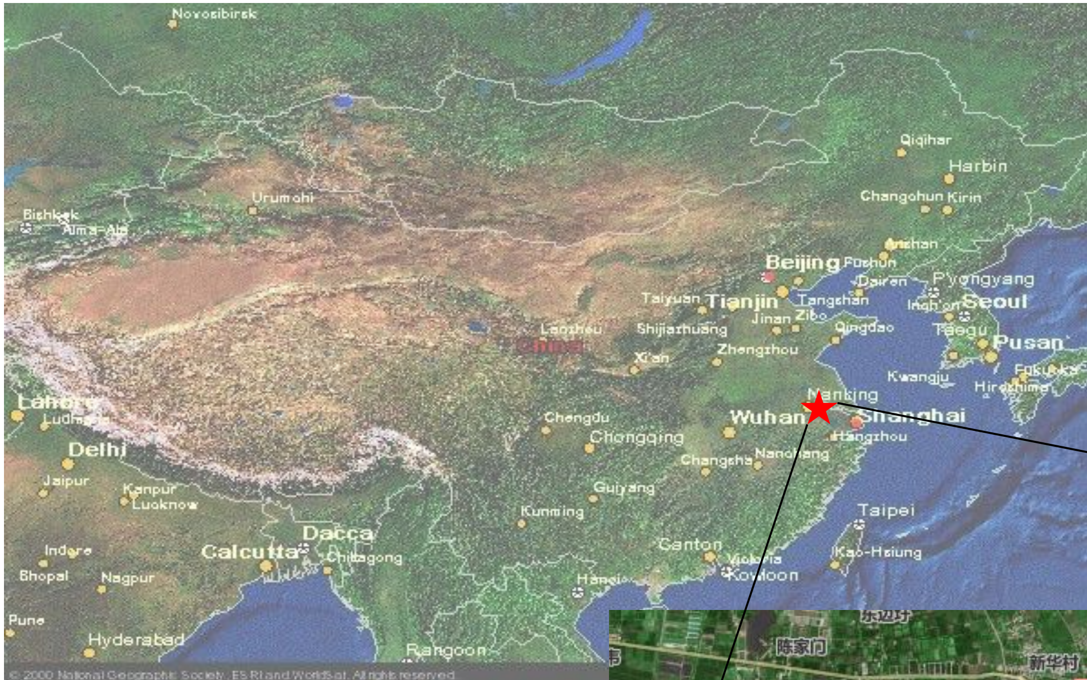
- Site:NUIST
- Sampler:KC-1000， $1.05m^3/min$
- Sampling filter： PALL, Tissuquartz, $S=(18*23)cm^2$
- Sampling frequency：
  2015.1.14~1.26，8/24h
  1.26 14:00~1.28,4/24h
- Data:

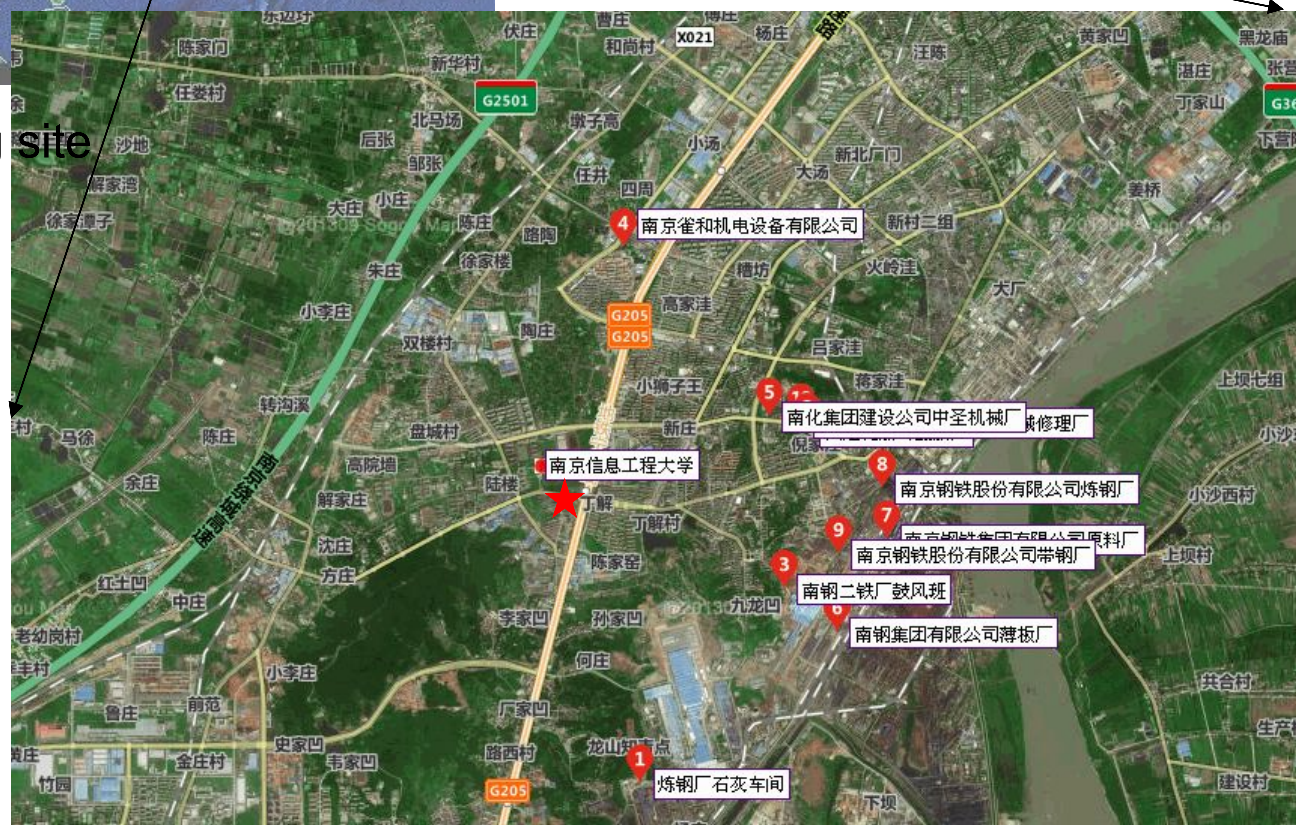
Visbility, precipitation

Meteorological elements

AQI

Fig2. Sampler used in the experiment





- Site: NUIST, 17km away from downtown

Fig 3. Location of sampling site

QAQC

- Prior to sampling, the filters were calcined at 540℃ for 6h to remove any organic compounds on them.
- Before and after sample collection, the filters were equilibrated in a desiccator at room temperature for 48h and then weighed.
- In order to minimize the deviation, standard filters were adopted, and the weighing was repeated once for every 10 filters under certain temperature and humidity conditions.
- Filters were then folded in half and stored at -24℃ in a freezer until extraction and analysis. Additionally, filter blanks were prepared and handled the same way as the samples.
- OC/EC analysis: blank filters, calib check, sucrose calibration/standard filter, repeated tests.

Methods

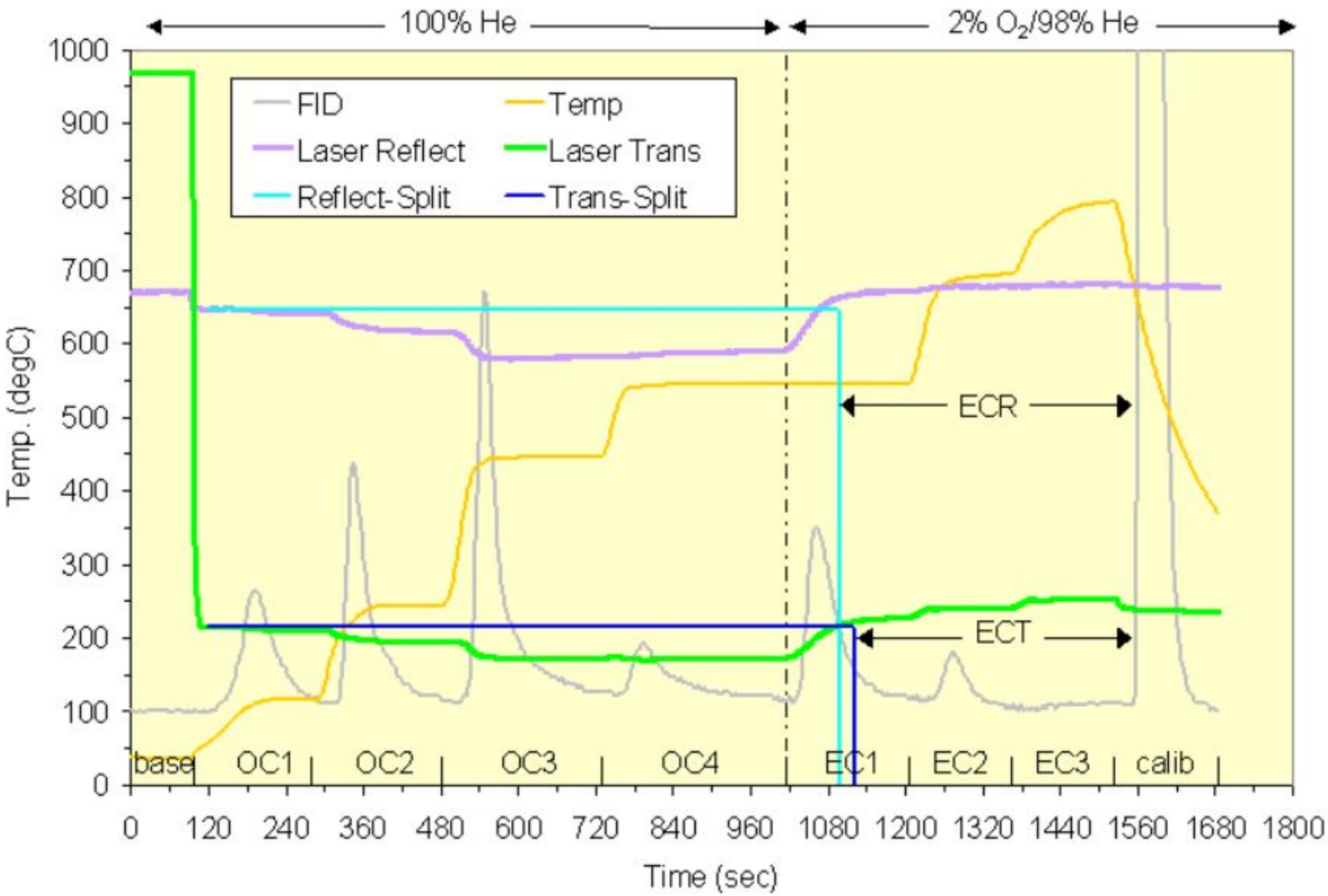


Fig4. Principle explaination of thermo optical analysis

from DRI 2001A Type /(OC/EC) analyser Manual

SOC estimation：EC-tracer method

EC-tracer method(*Turpin,2002*)：

a widely used method based on the EC-tracer.

$\begin{cases} \text{OC:POC(Primary Organic Cabon)+SOC} \\ \text{EC:tracer of POC} \end{cases}$

$$VOCs \xrightarrow[O_3\text{、}HO\bullet\text{、}NO_3]{\text{Light}} SVOCs \xrightarrow[\text{Gas-to-particle vonversation}]{\text{Condensation or}} SOC$$

$$SOC = OC_{tot} - EC \cdot (OC/EC)_{\min}$$

- $SVOCs$:Semivolatile Organic Compounds
- SOC:Secondary Organic Carbon
- OC_{tot}:total Organic Carbon
- EC:Elementary Carbon
- $(OC/EC)_{min}$:the minimum value of observed OC/EC

Results and discussion

- Weather condition during the experiment
- Fine particle pollution in NJ
- Variation of pollutant concentrations in different processes of the haze
- The precipitation scavenging of pollutants

Weather condition during the experiment

- T: -1.12~12.83℃
- RH: 19.2~83.96%
- WS: 0.04~3.99m/s

  ws<3m/s, 96%
- Vis:1.01~9.96km

  vis<5km, 71%
- AQI: 29.67~313.67

  AQI>100, 65%
- Precpitation: 1/14,1/25,1/26,1/27

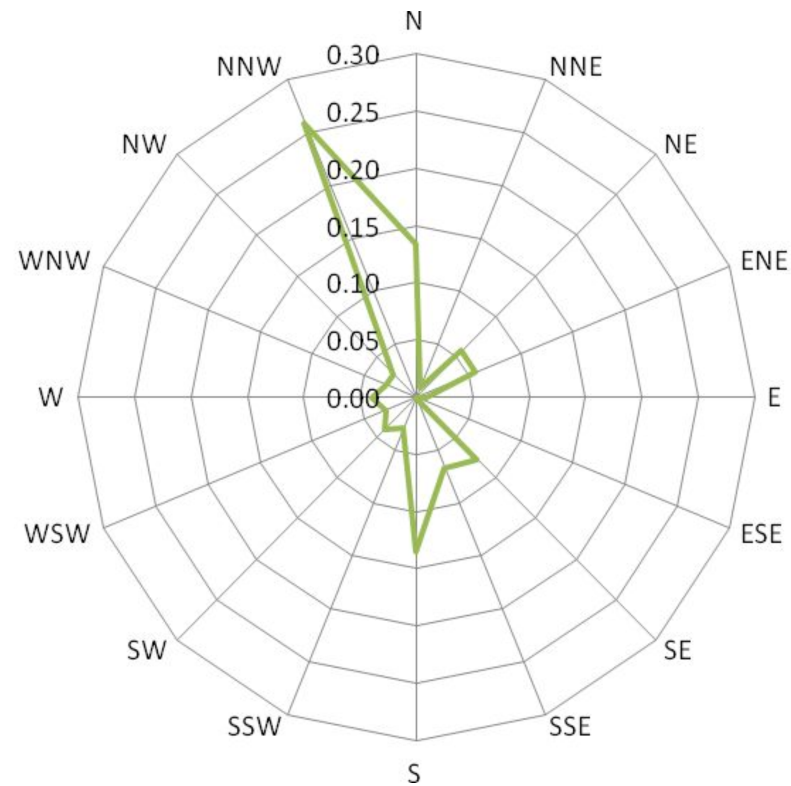


Fig 5. Wind-rose diagram during the experiment

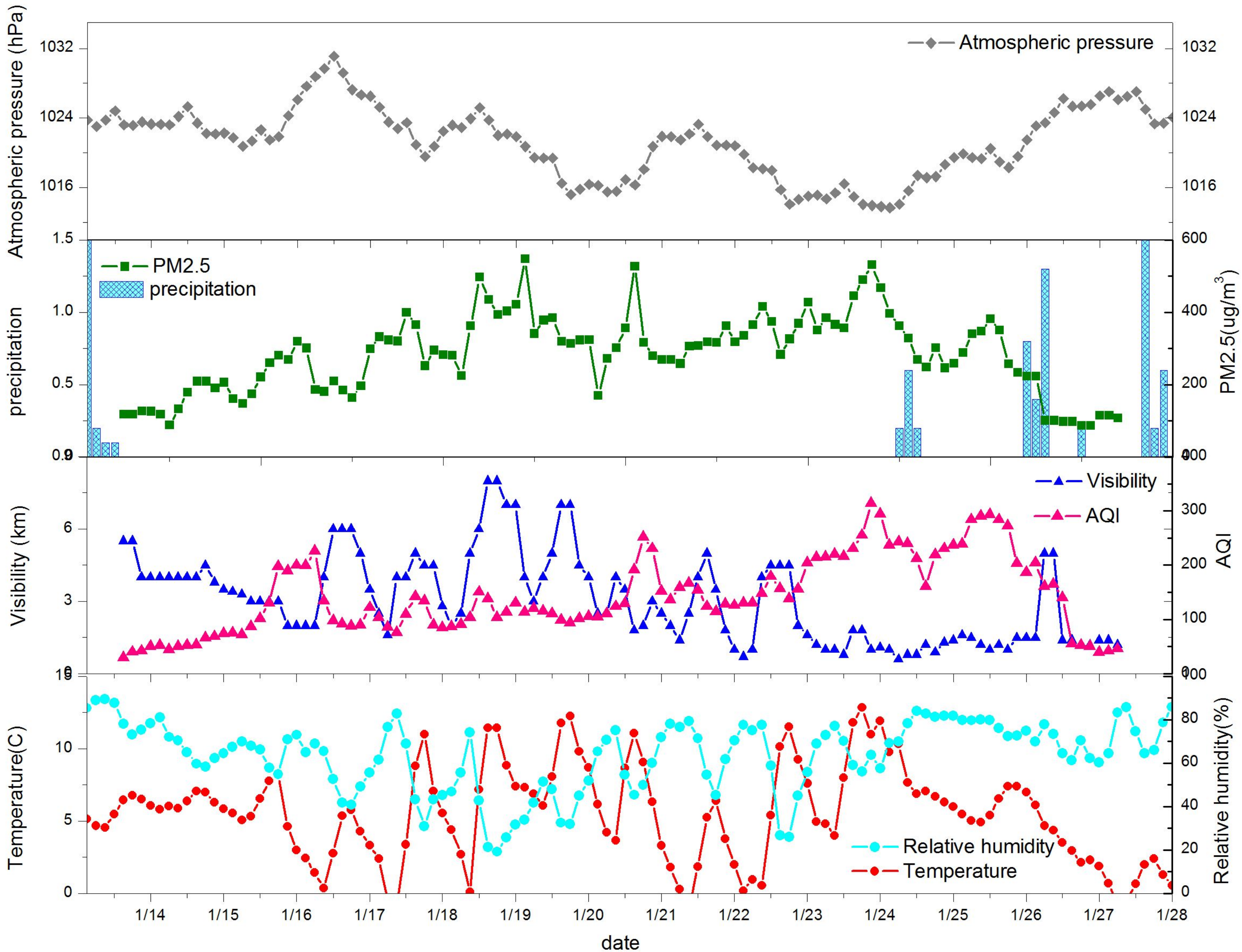


Fig 6. The time series of meteorological factors during the observation

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Fine particle pollution in NJ

Tab2. Level of 4 pollutins in fine particles in different locations in China

City	Particles	Experiment time	PM2.5	OC	EC	SOC	Quotation
NUIST	PM2.5	2015 winter	279.64	18.58	6.29	8.08	This research
Nanjing	PM2.5	2015 winter	228.85	19.54	1.56	5.73	This research
Dongshan	PM2.5	2015 winter	142.53	19.59	4.85	10.90	This research
Beijing	PM2.1	2011 winter	-	24.70	2.80	-	Fan et al.
Shanghai	PM2.5	2010 winter	-	13.30	3.80	-	Lee et al.
Guangzhou	PM2.5	2007 winter	-	8.50	4.80	2.70	Huang et al.
Xian	PM2.5	2009 winter	-	48.65	12.92	20.16	Wang et al.

OC/TC	EC/TC	OC/EC
75.30%	24.70%	7.51

1.0~4.2 vehicle 95.65%

2.5~10.5 fossil 92.17%

by Turpin et al. ,1990

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- ❖ Variation of pollutant concentrations in different processes of the haze
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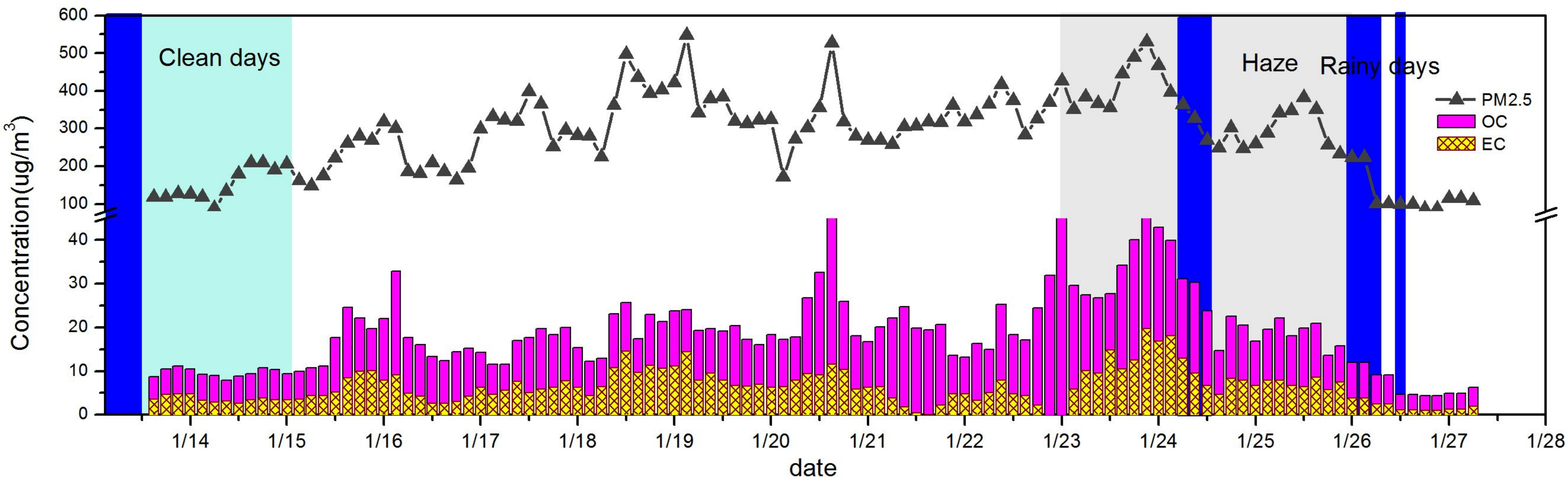

Fig 7. Description of the hazy days

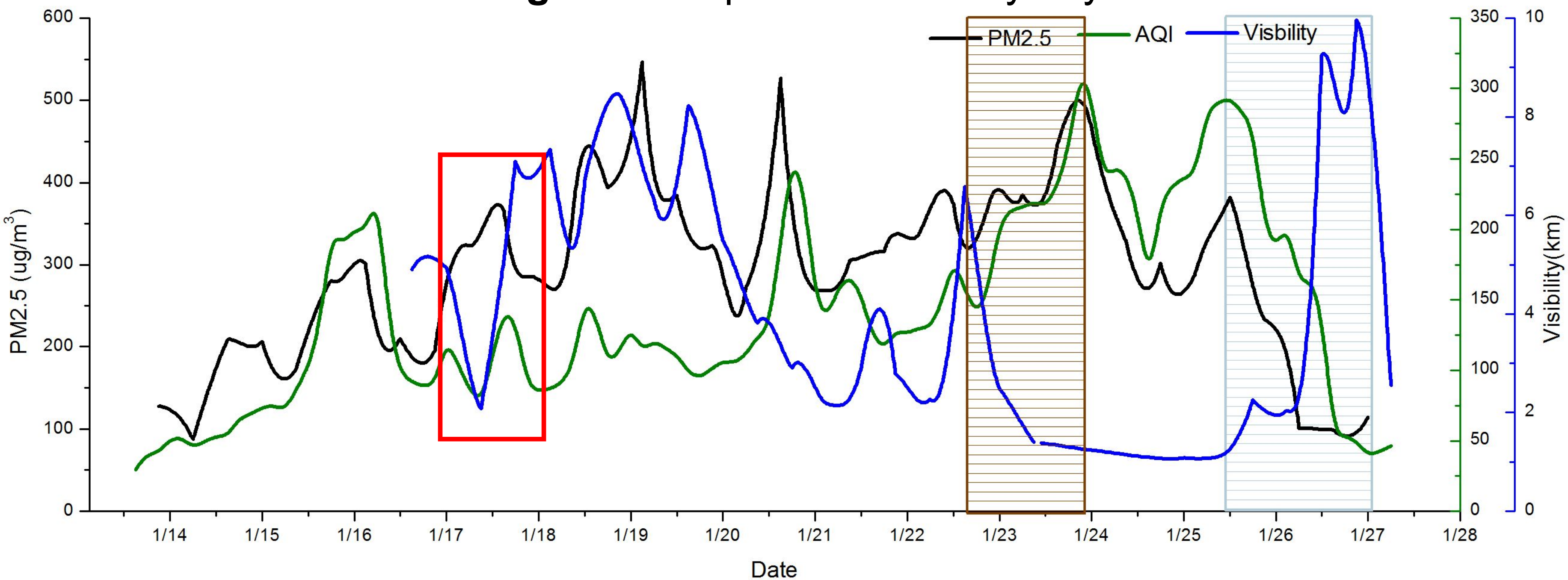

Fig 8. Time serieses of PM2.5, AQI and visibility

Hazy days and clean days

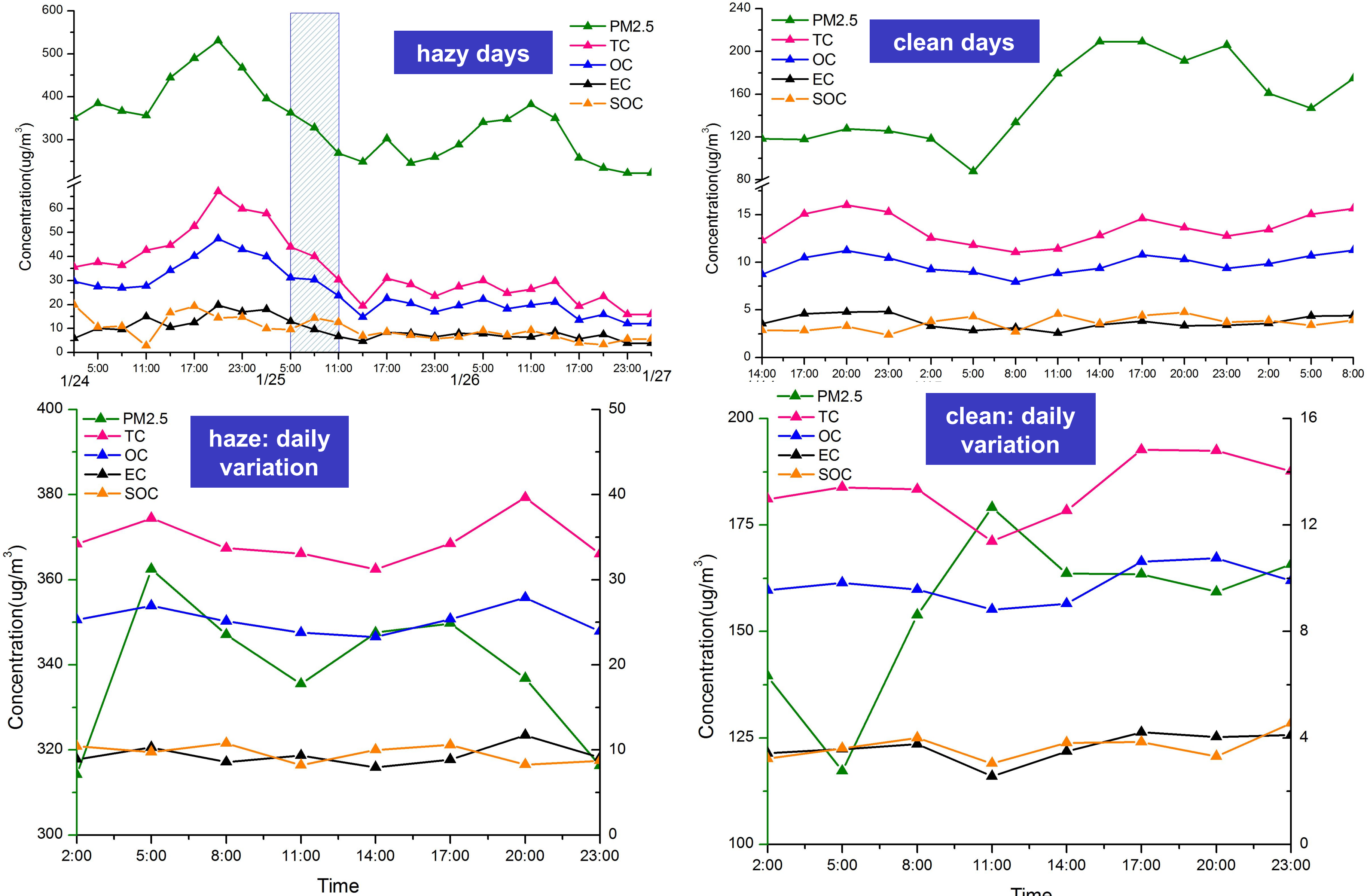

Fig9(a). Indexes comparison and their daily variation of hazy days and clean days

Hazy days and clean days

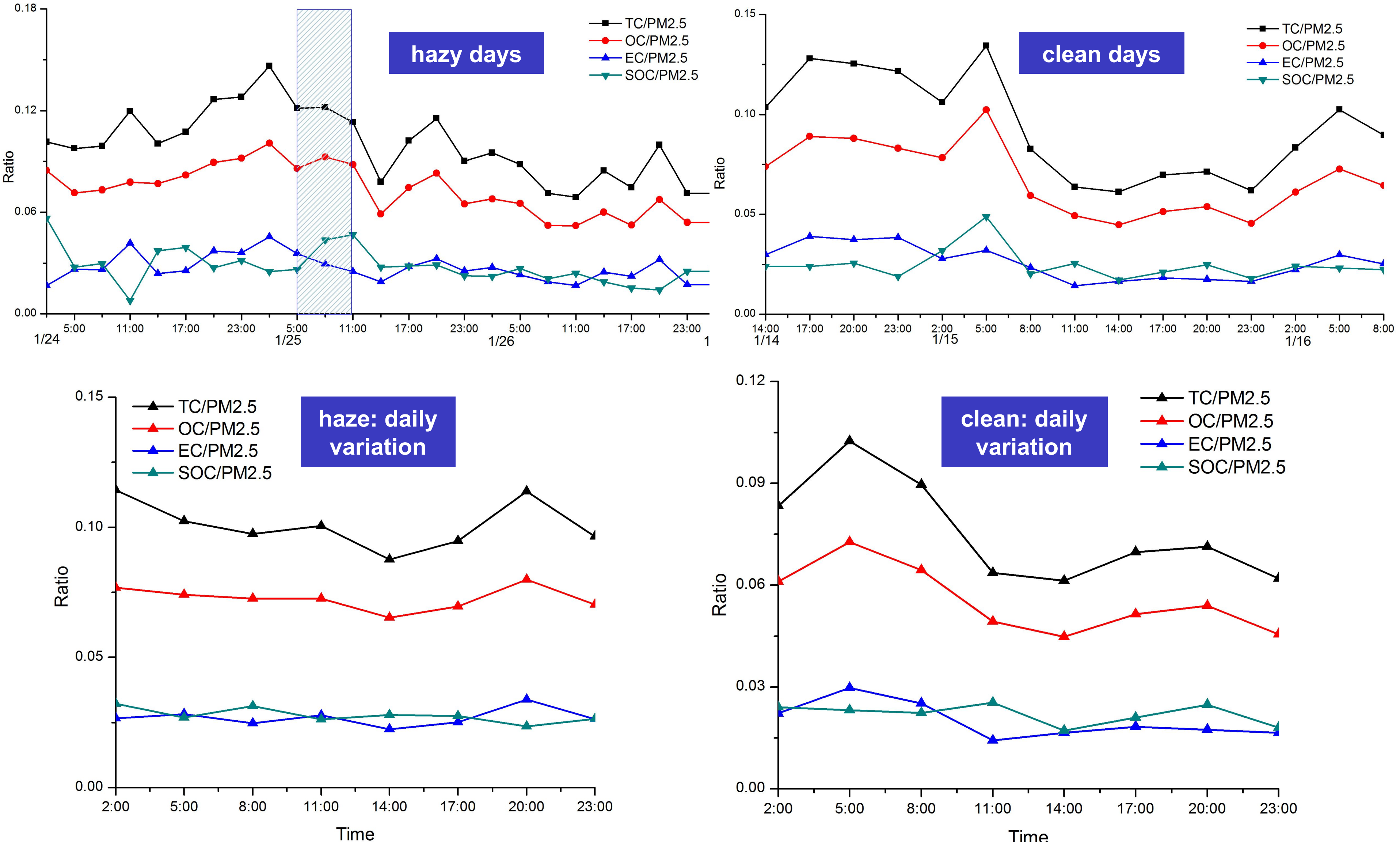

Fig9(b). Indexes comparison and their daily variation of hazy days and clean days

Accumulation and scavenging

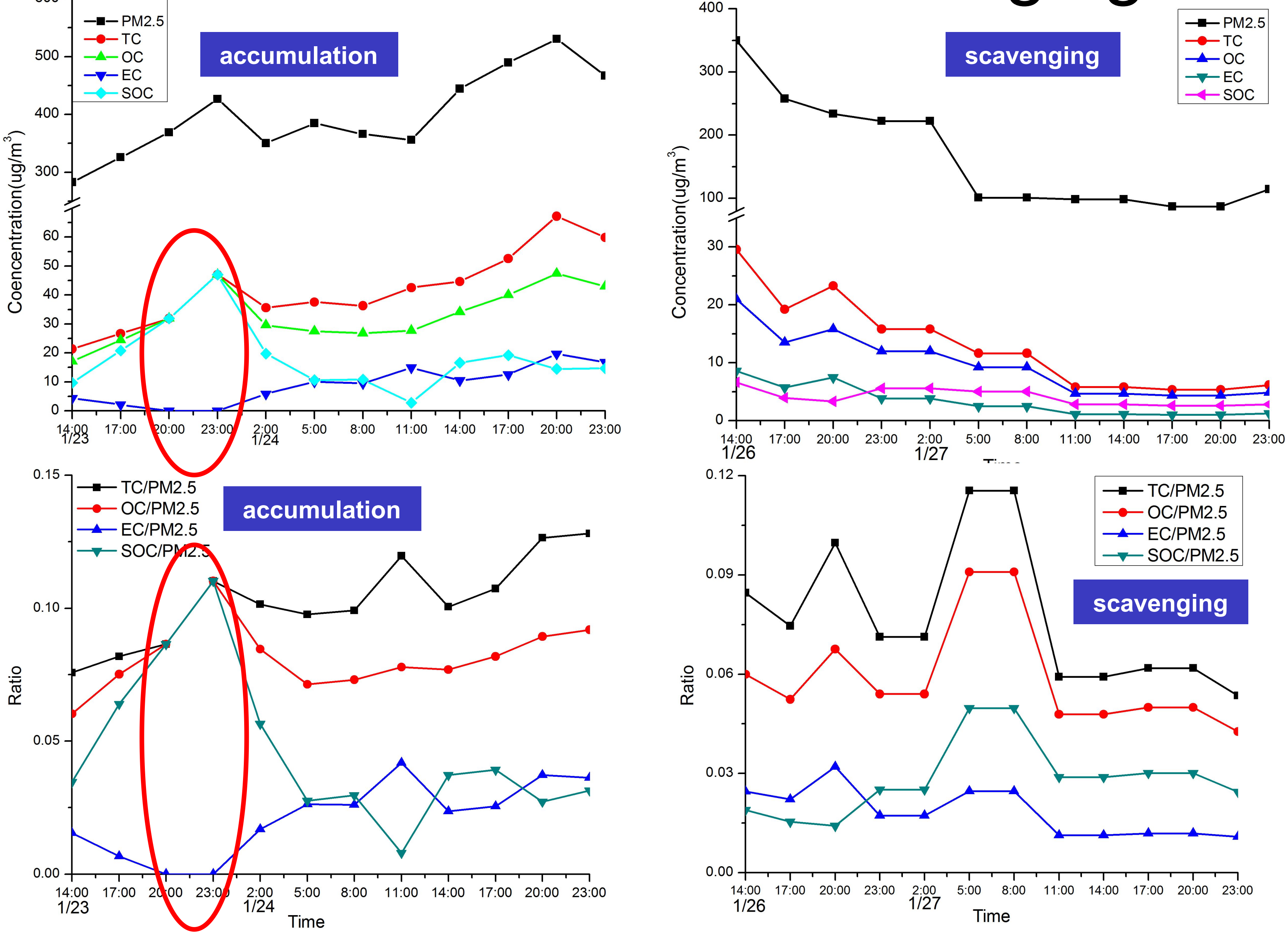

Fig10. Indexes comparison during accumulation and scavenging processes

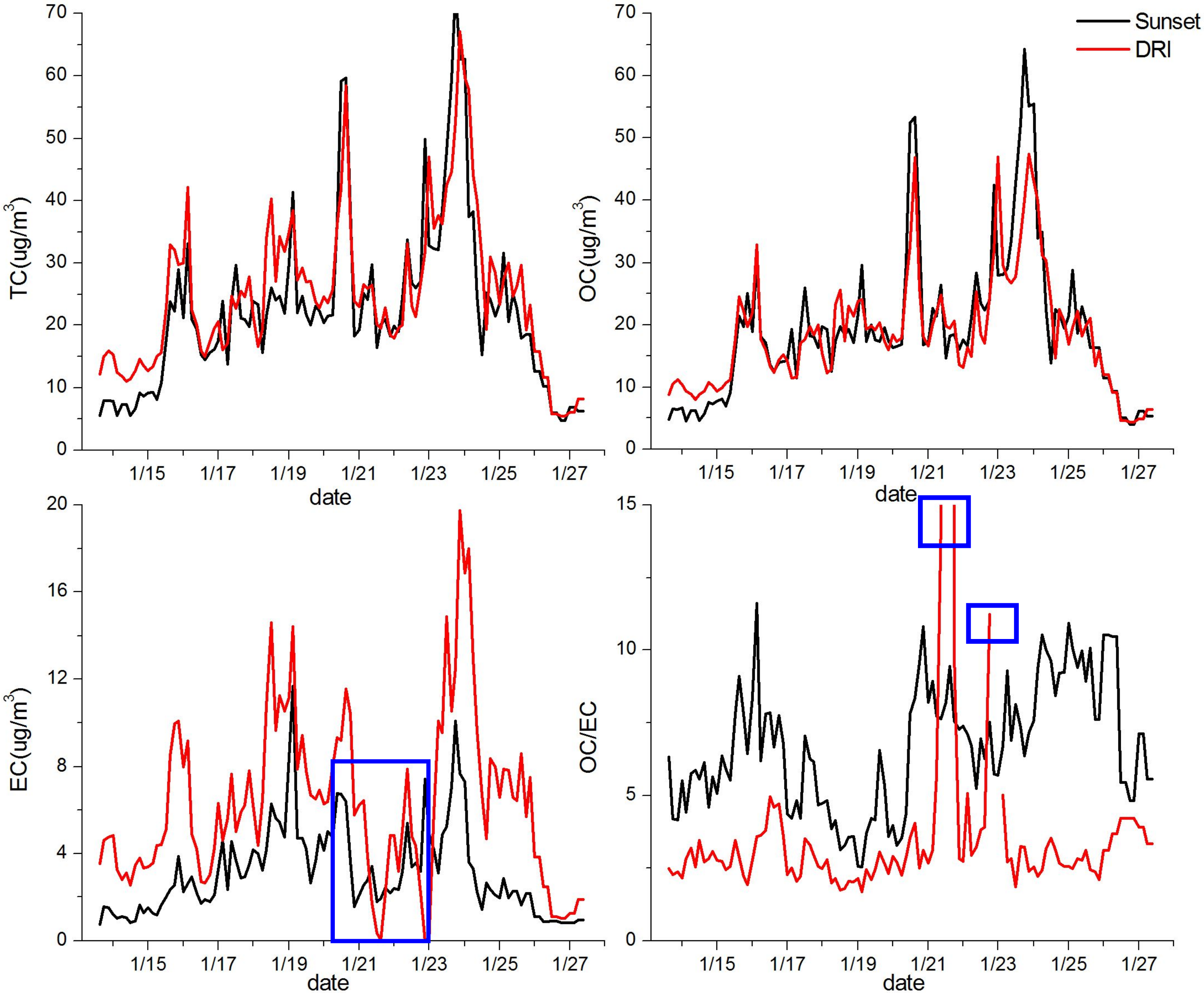

Fig11. Detecting results comparison of different carbon fractions by using Sunset RT4 and DRI Model 2001A

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Precipitation scavenging process

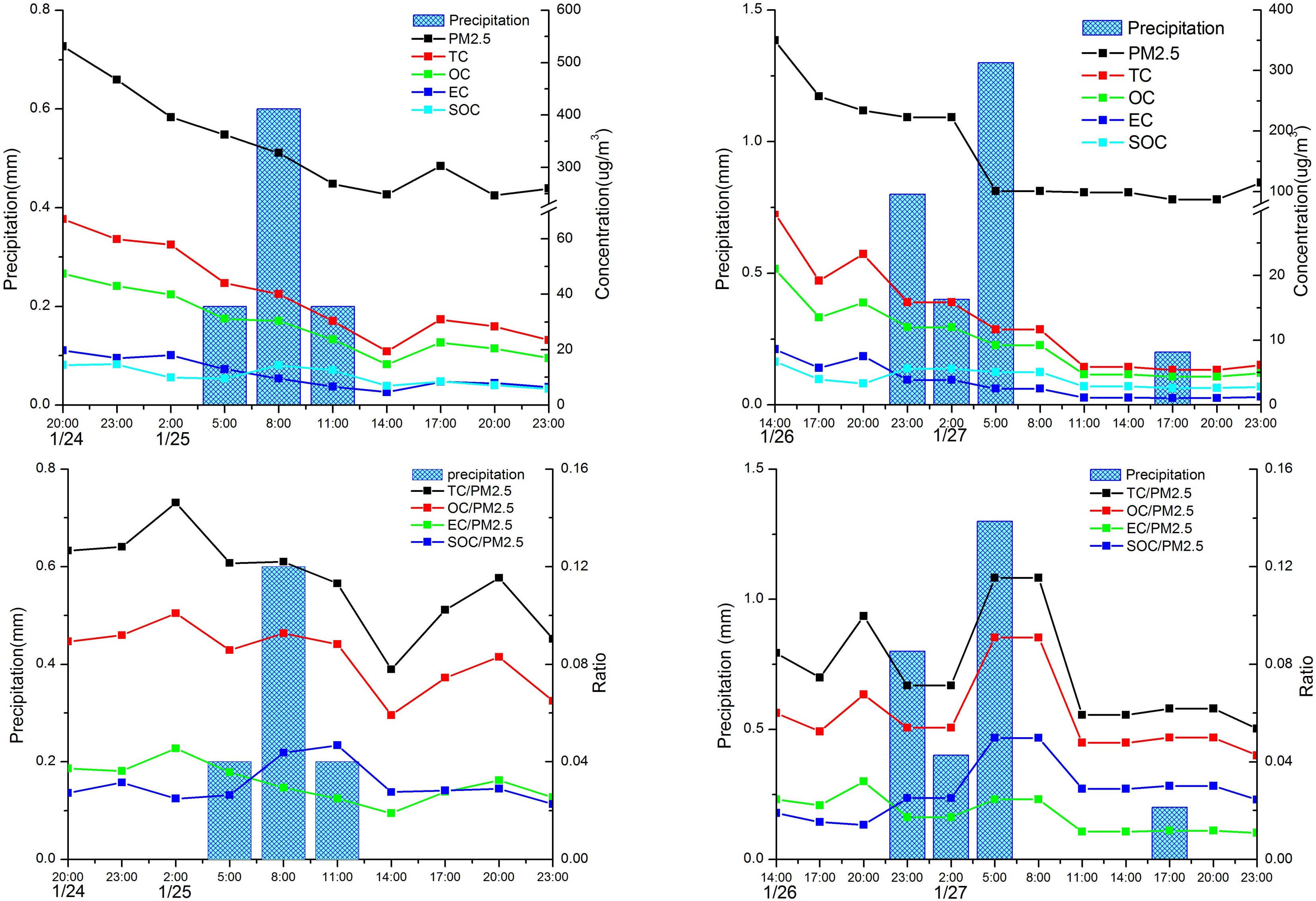

Fig12. Variation of pollutants during precipitation scavenging process

Conclusions

- The level of OC,EC concentration in NJ is high,compared with other major cities.
- OC and EC are majorly affcted by fossil and vehicle emissions during the experiment.
- There is an intenser variation of both concentrations and ratios of different carbon fractions in clean days than hazy days.
- Ratios of PM2.5 to TC, OC and EC (10.10%, 7.27%, 2.69%) in hazy days are higher than that (8.78%, 6.39%, 2.39%) in clean days.
- Precipitation has a strong scavenging effect of carbonaceous particulate matters and is worthy of futher study.

Future work

- Simply statistical analysis of OC,EC is far from enough to deduce the generation mechanism and sources of haze, so analysis of ion chromatography and organic compounds, will be adopted in the future work;
- Apparently, the precipitation scavenging process can not be ignored, we have been collecting the sample of precipitation for more than 5 months, analysis of ion chromatography, TOC, OC and EC are about to begin;
- These two experiments will eventually be combined together to discuss the process of haze.

Thank you,

have a nice day !