Yale 耶鲁大学-南京信息工程大学大气环境中心
Yale-NUIST Center on Atmospheric Environment

Research on a Continuous Air Pollution Event in January of 2015 in Downtown of Nanjing, China

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Outline

- Background
- Material and method
- Results and discussion
- Preliminary conclusion
- Next work

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Background

- Long duration air pollution in winter is always related with unfavorable weather, such as uniform pressure pattern, low PBL height; Well pollution dominated by biomass burning is reckoned that more frequently occurring in summer days.
- This study focuses on the meteorology condition during the pollution in January of 2015 which last half month, but also relation between PM and gaseous pollutants; at the meanwhile, it detects source of fine particle ($PM_{2.5}$) which is the primary pollutant by chemical composition analysis.
- All above will help understand mechanism of haze's formation, development and elimination during winter in Nanjing.

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Material and method

- Data:
- Synoptic chart from KMA
- Hourly PBL height from Wrf
- Hourly AQI and concentration six criteria pollutants at Shanxi Road station
- Concentration of OC, EC data from $PM_{2.5}$ sample per 3 or 6 hours
- $PM_{2.5}$ sampling method

$PM_{2.5}$ sampling site

▲ Sampling site

★ Shanxi Road station

Distance: 1.7 km

➢ $PM_{2.5}$ Sampling instrument

- Sampler: KC 1000
- Sample collector: quartz filter（8×10 inch）

➢ Sampling frequency and time :

Time	Frequency	Notes
14th Jan 16:30-26th Jan 18:00	Every 3 hrs	Afternoon of 14th : after light rain Morning of 25th : light rain 9 a.m. to 1 p.m. of 25th :power failure
26th Jan 18:00-29th Jan 00:00	Every 6 hrs	27th to 29th : rain and snow

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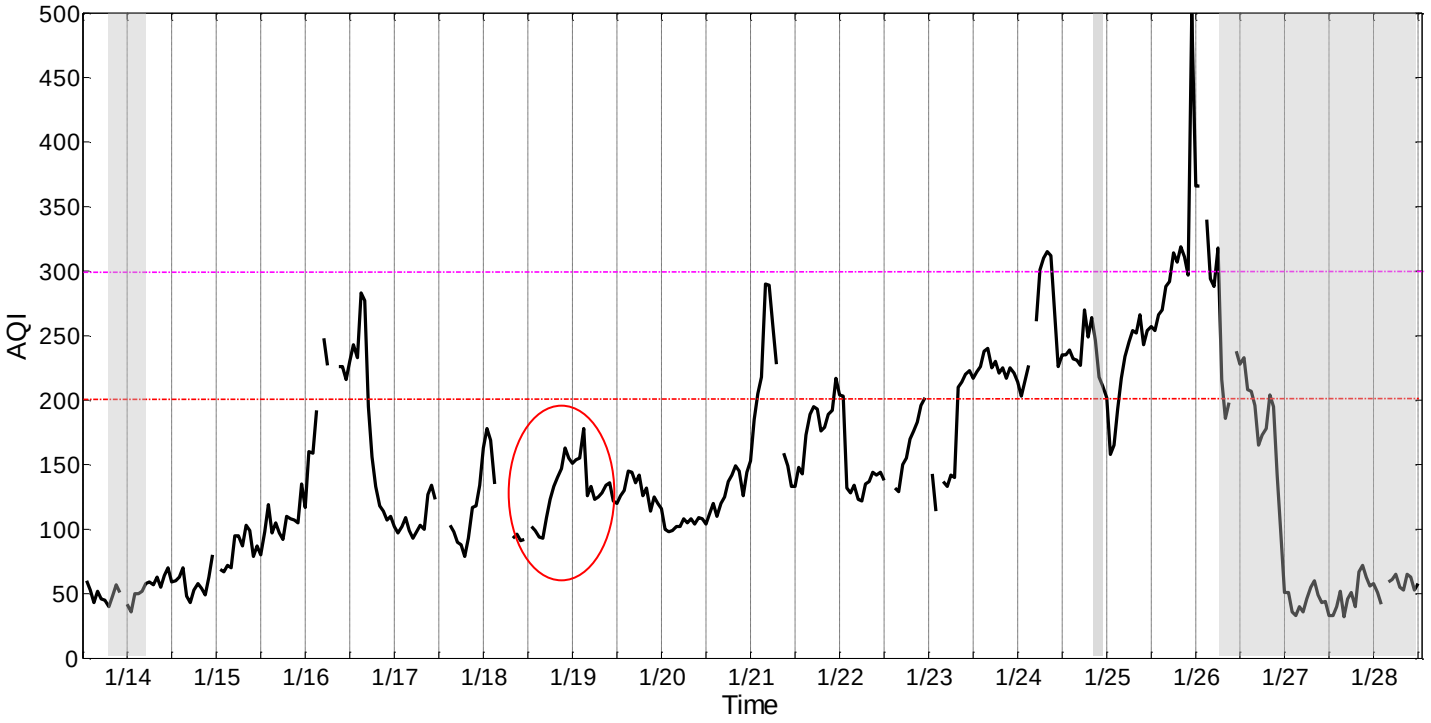
Results and discussion

Air Quality Index(AQI) implicates quantity of PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, O_3



rainfall
severe pollution
heavy pollution
middle level pollution
mild pollution
moderate
good

Figure 1. AQI per hour on Shanxi Road station from 14th to 29th in January in 2015

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Results and discussion

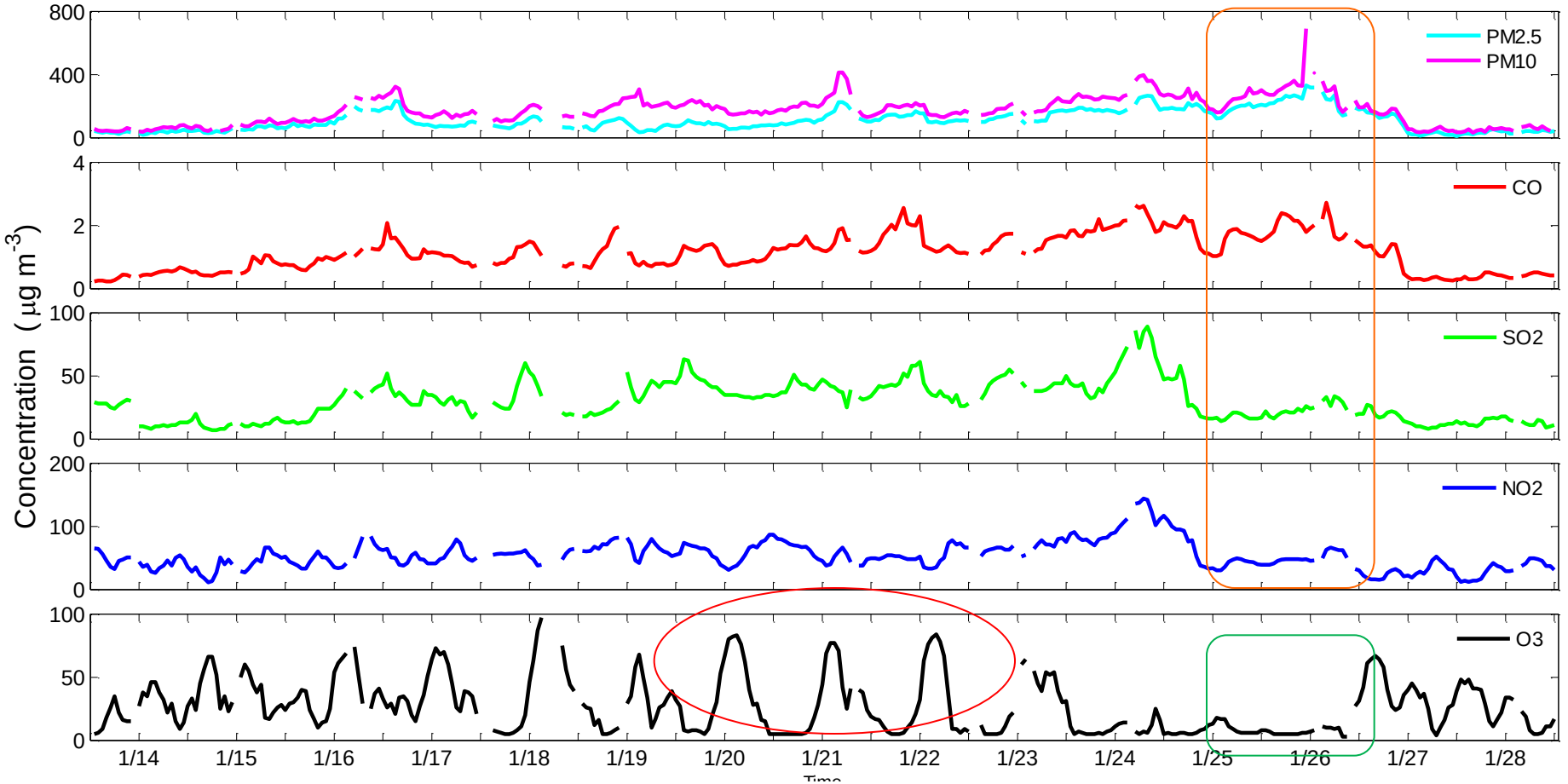


Figure 2. Temporal variation of per hour concentration of $PM_{2.5}$,PM_{10} , CO, SO_2 ,NO_2 ,O_3 on Shanxi Road station from 14th to 29th in January of 2015

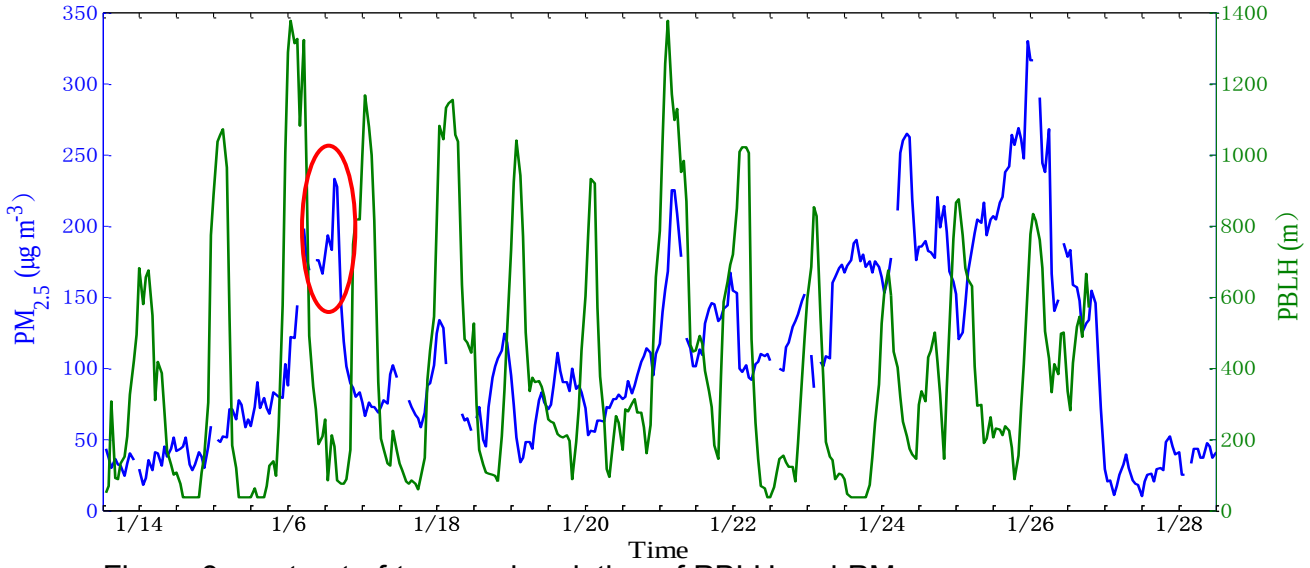


Figure 3. contrast of temporal variation of PBLH and $PM_{2.5}$

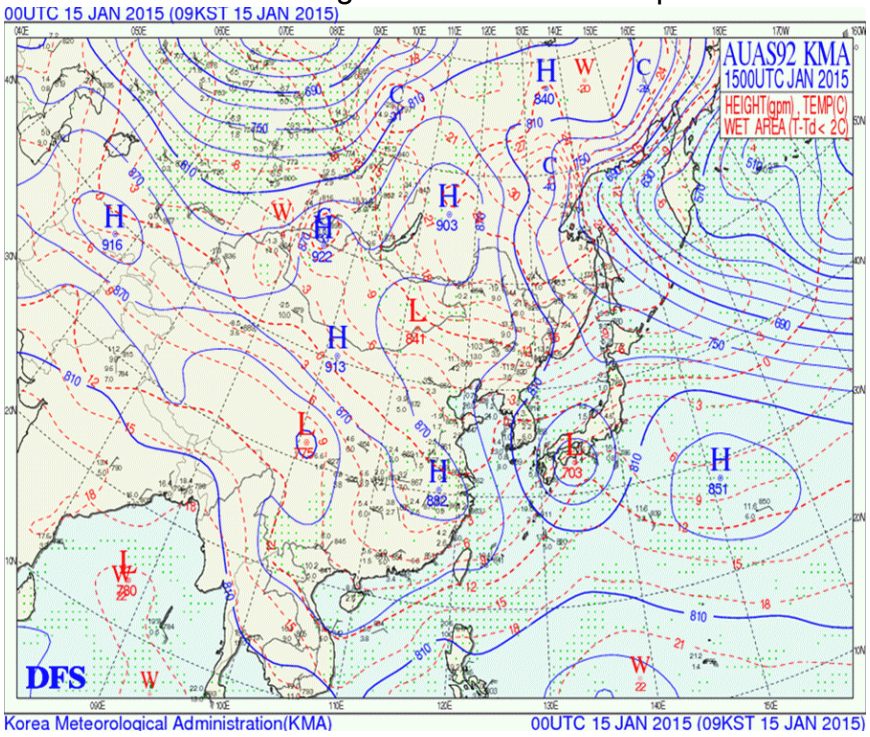


Figure 4.Near-surface pressure distribution from 8:00 on 15th to 8:00 on 17th Jan

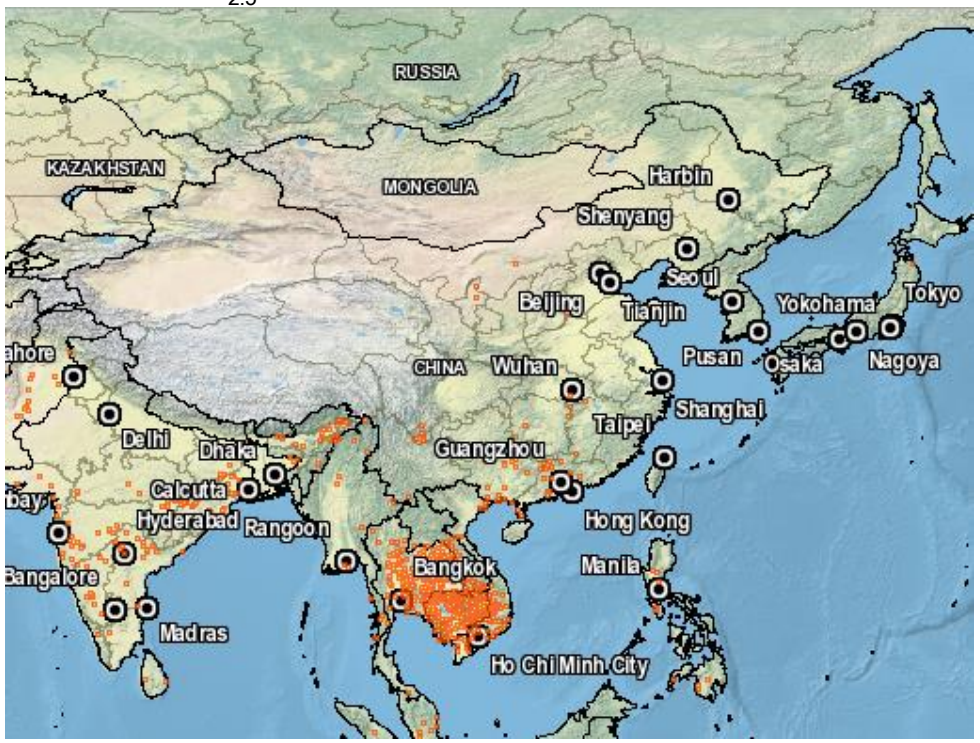


Figure 5. Fire spots distribution from 15th to 16th Jan

Results and discussion

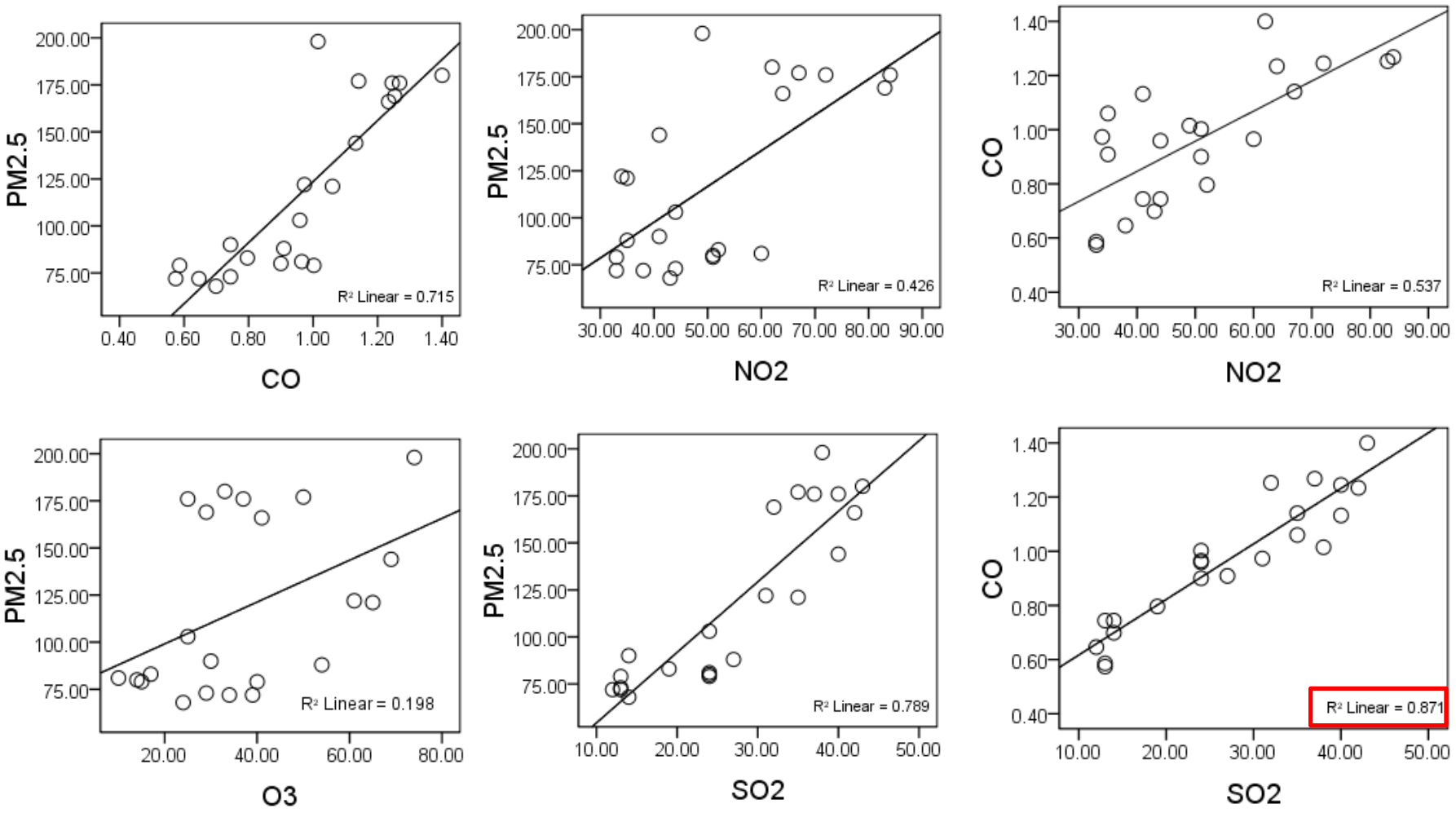


Figure 6. Correlation between different pollutants' concentration on 16th Jan in 2015

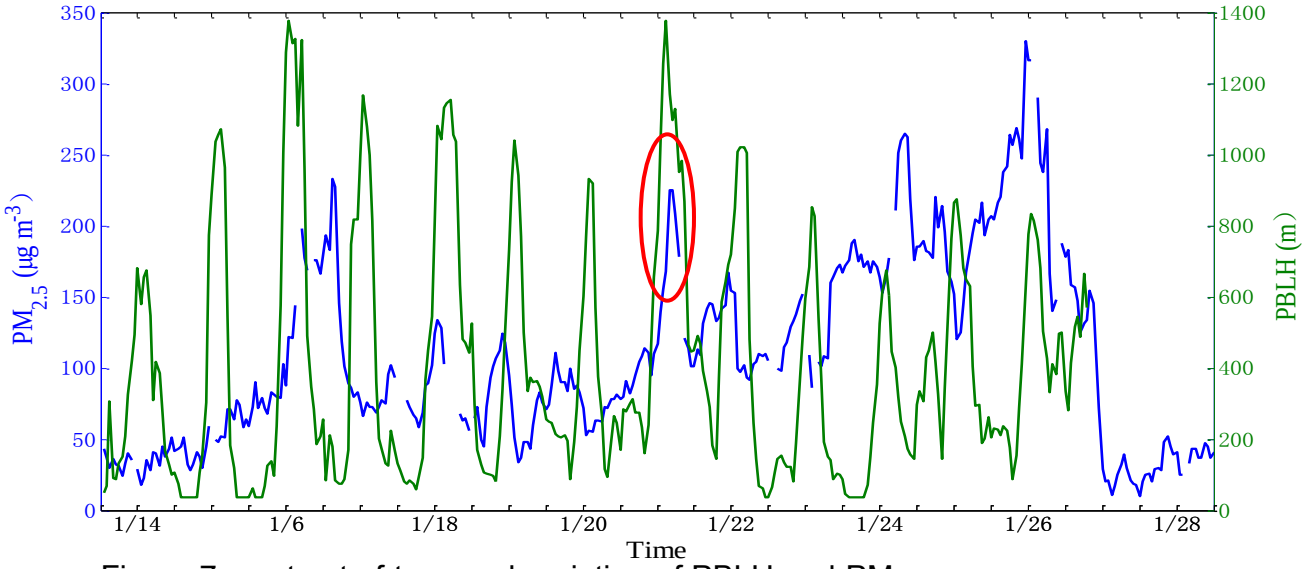


Figure 7. contrast of temporal variation of PBLH and $PM_{2.5}$

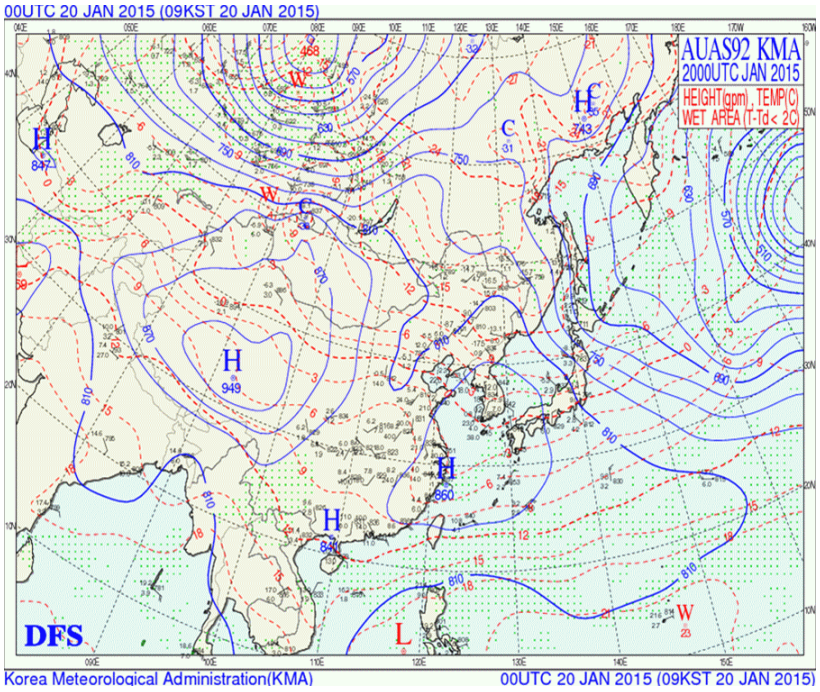


Figure 8.Near-surface pressure distribution from 8:00 on 20th to 20:00 on 21th Jan

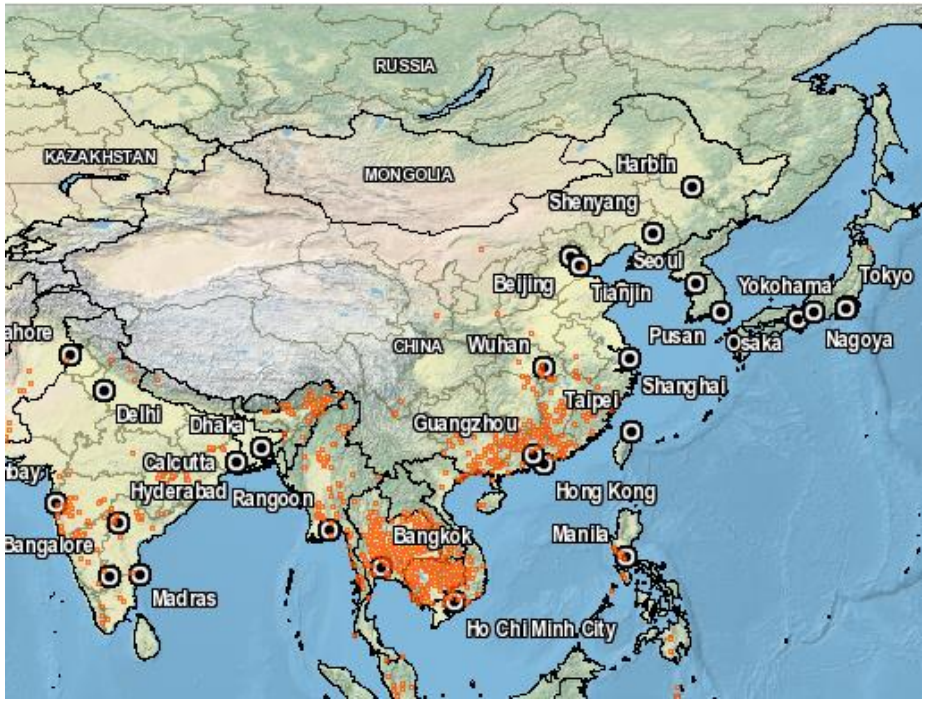


Figure 9. Fire spots distribution from 19th to 20th Jan

Results and discussion

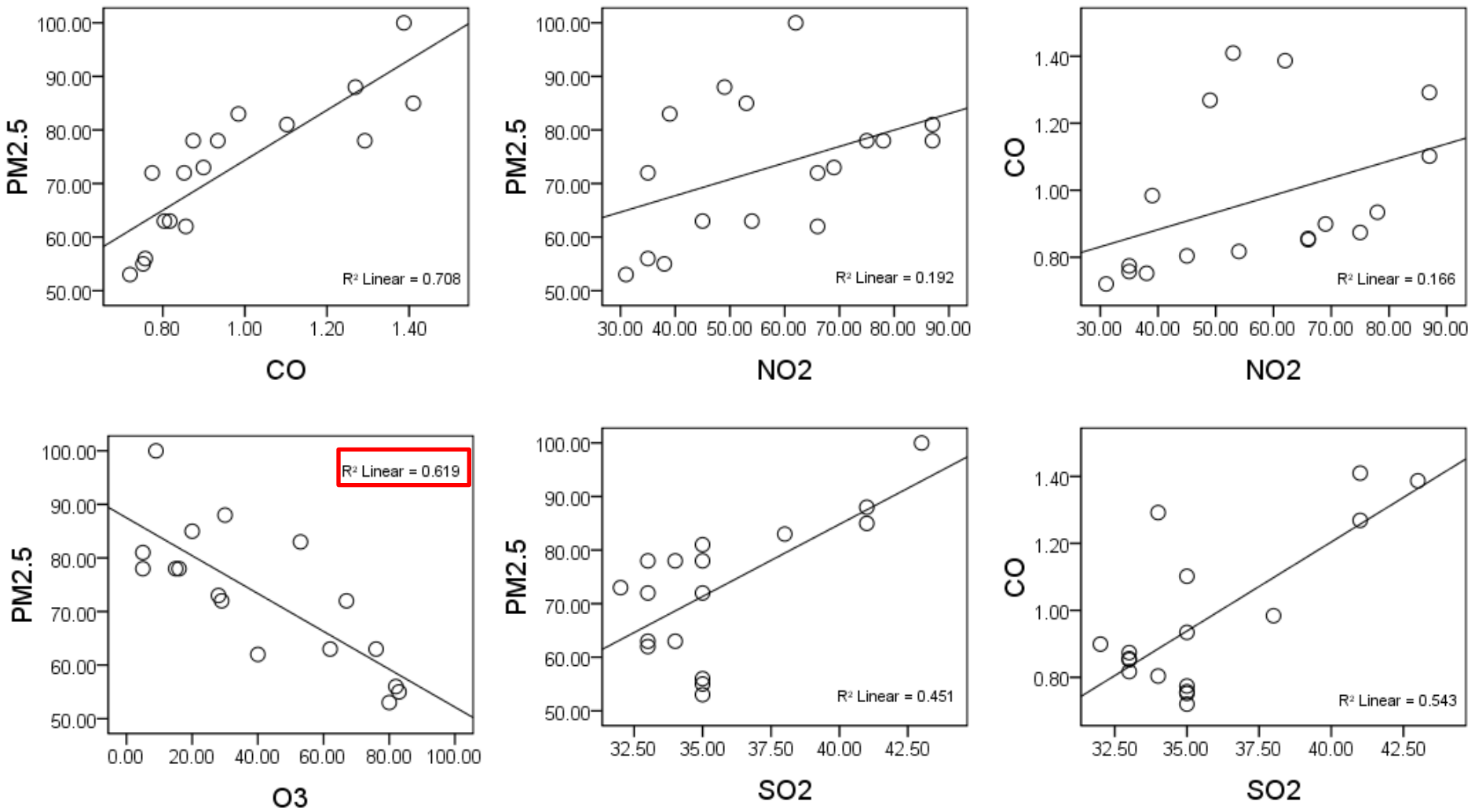


Figure 10. Correlation between pollutants concentration from 8:00 on 20th to 00:00 on 21th Jan

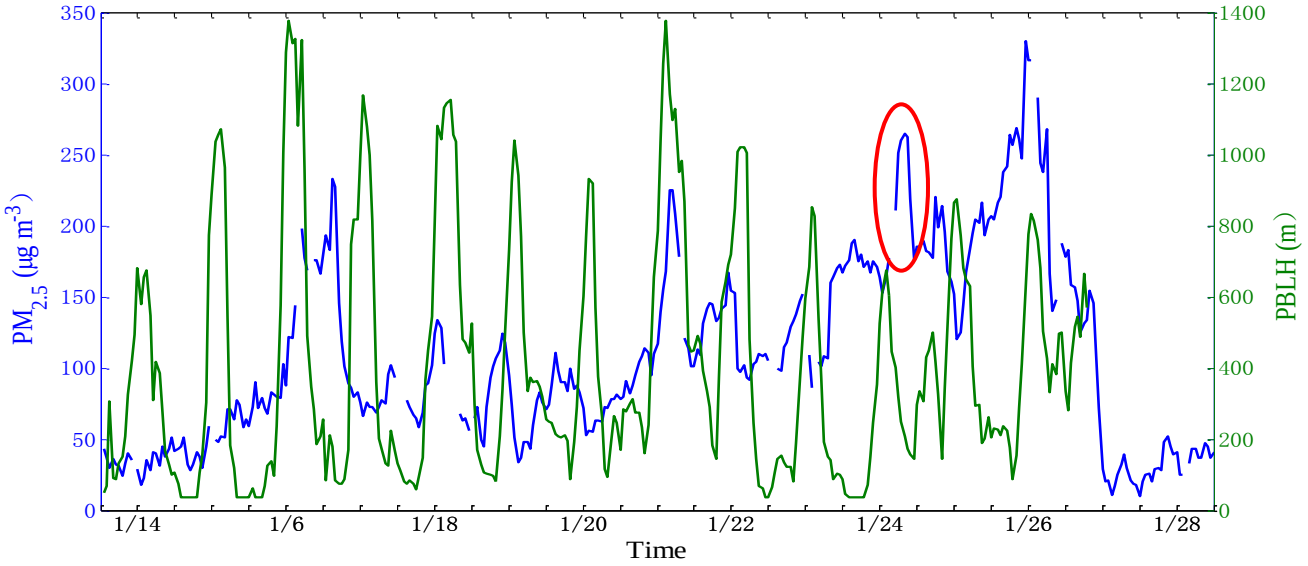


Figure 11. contrast of temporal variation of PBLH and $PM_{2.5}$

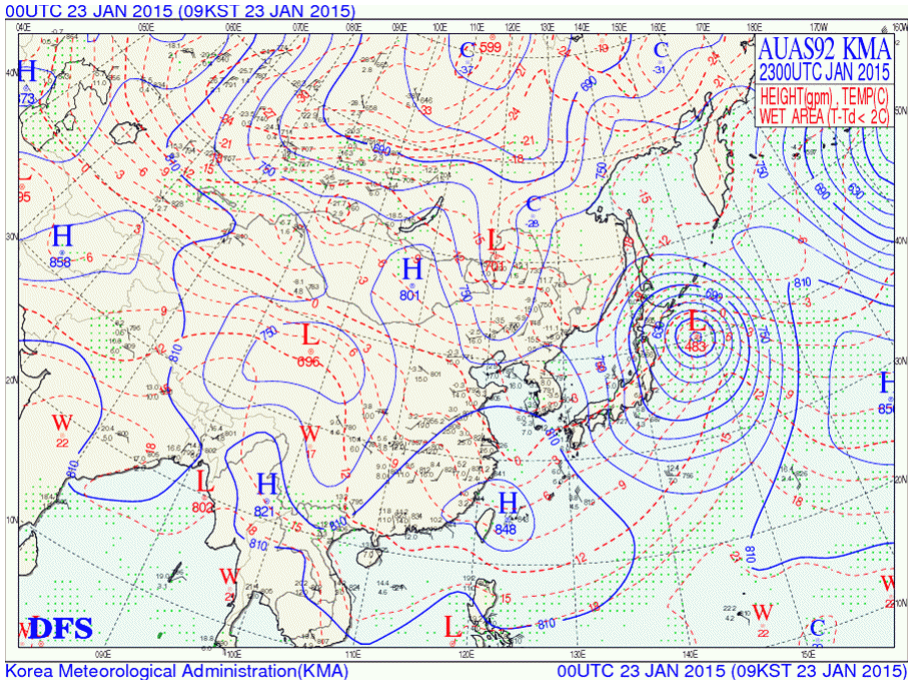


Figure 12.Near-surface pressure distribution from 8:00 on 23th to 8:00 on 25th Jan

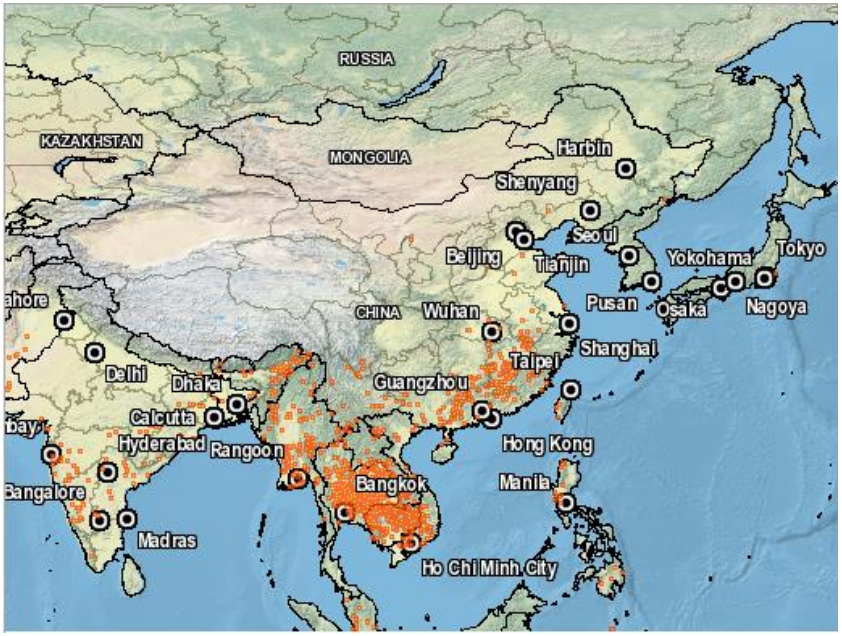


Figure 13. Fire spots distribution from 23h to 24th Jan

Results and discussion

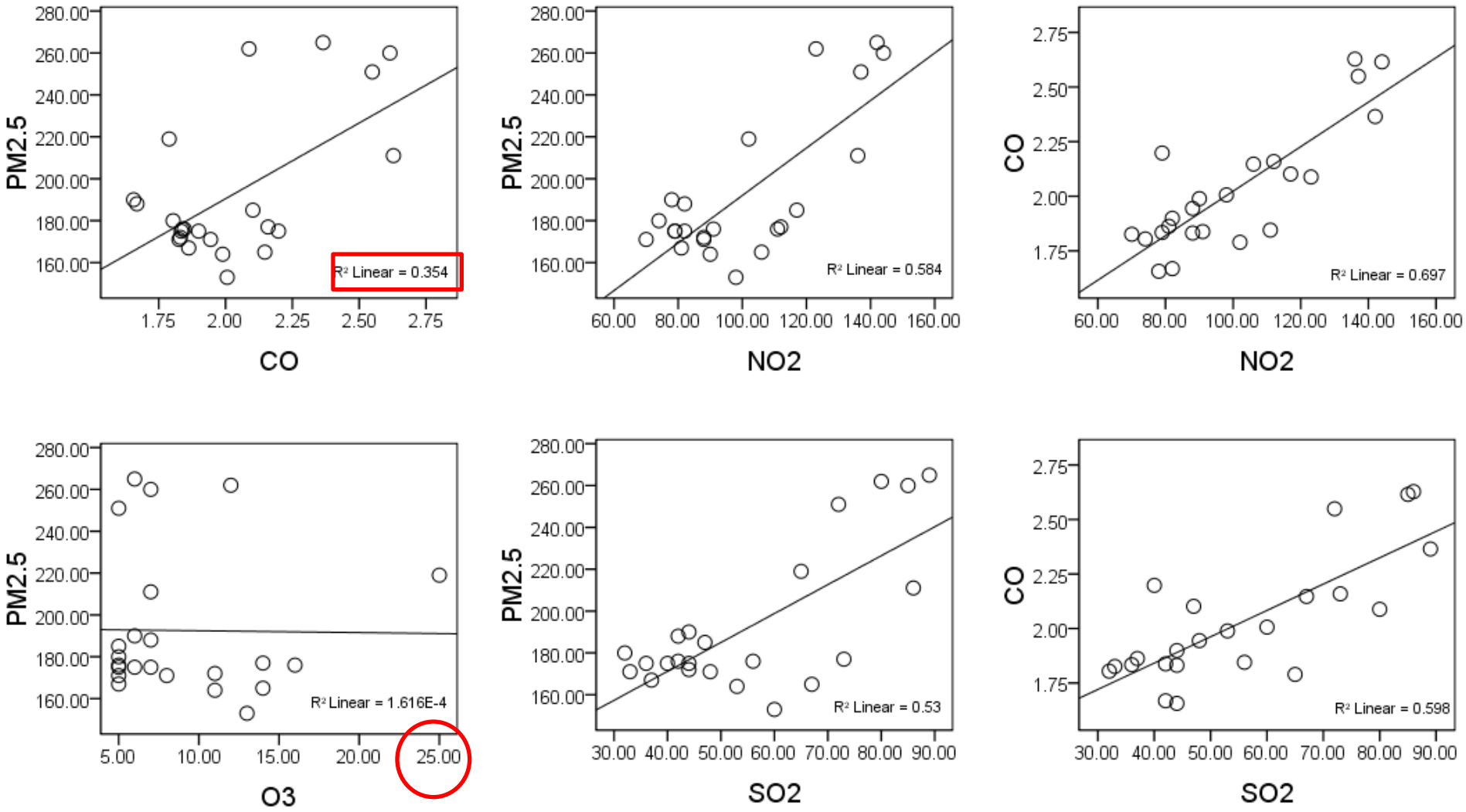


Figure 14. Correlation between pollutants concentration on 24th Jan

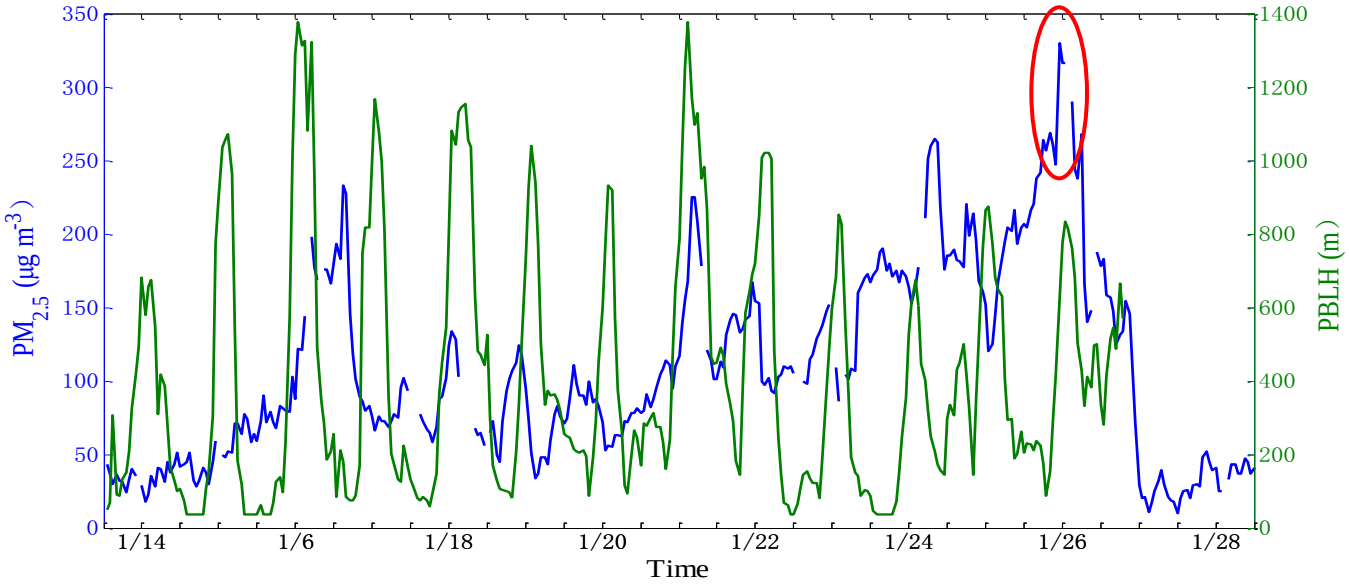


Figure 15. contrast of temporal variation of PBLH and $PM_{2.5}$

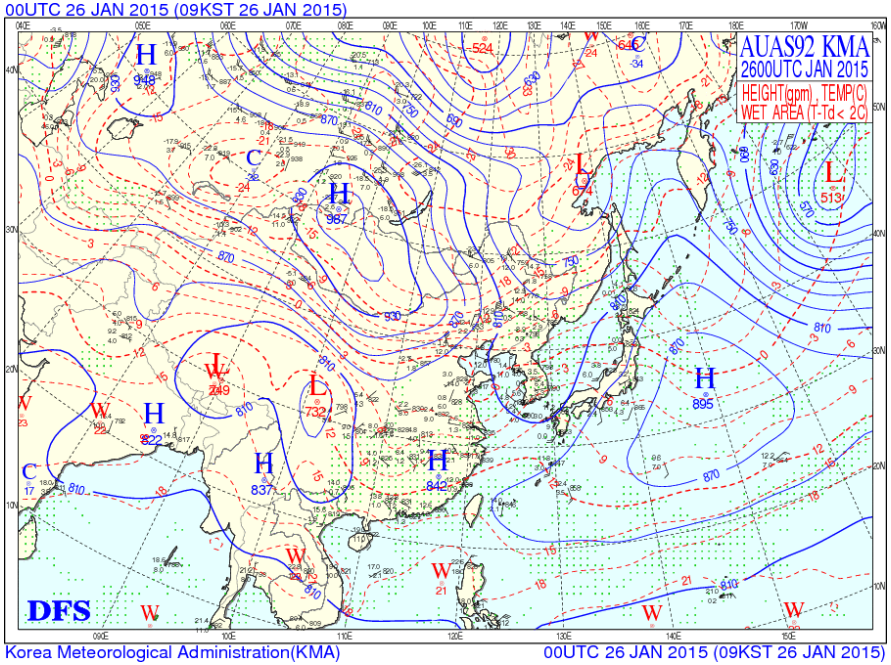


Figure 16.Near-surface pressure distribution from 8:00 on 26th Jan

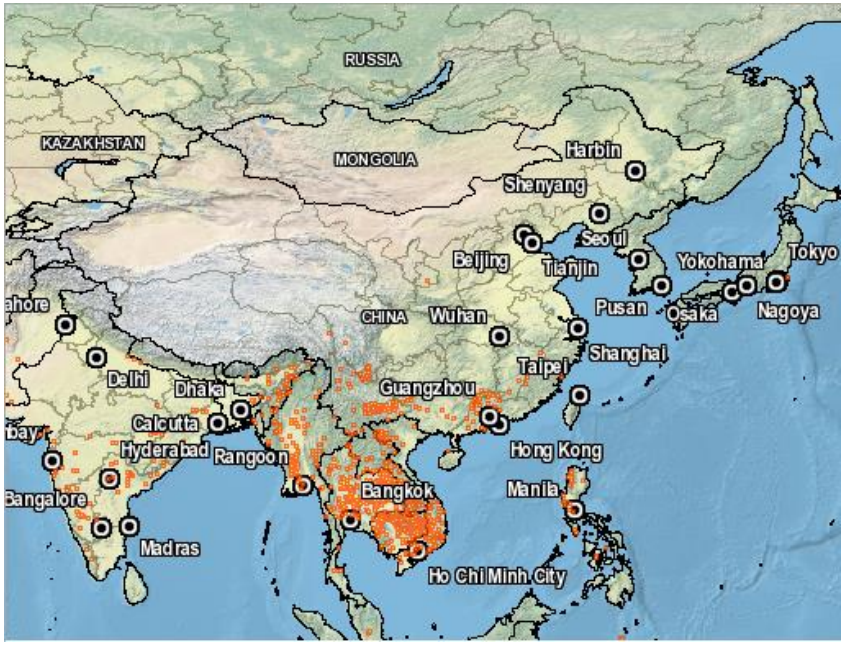


Figure 17. Fire spots distribution from 26th to 27th Jan

Results and discussion

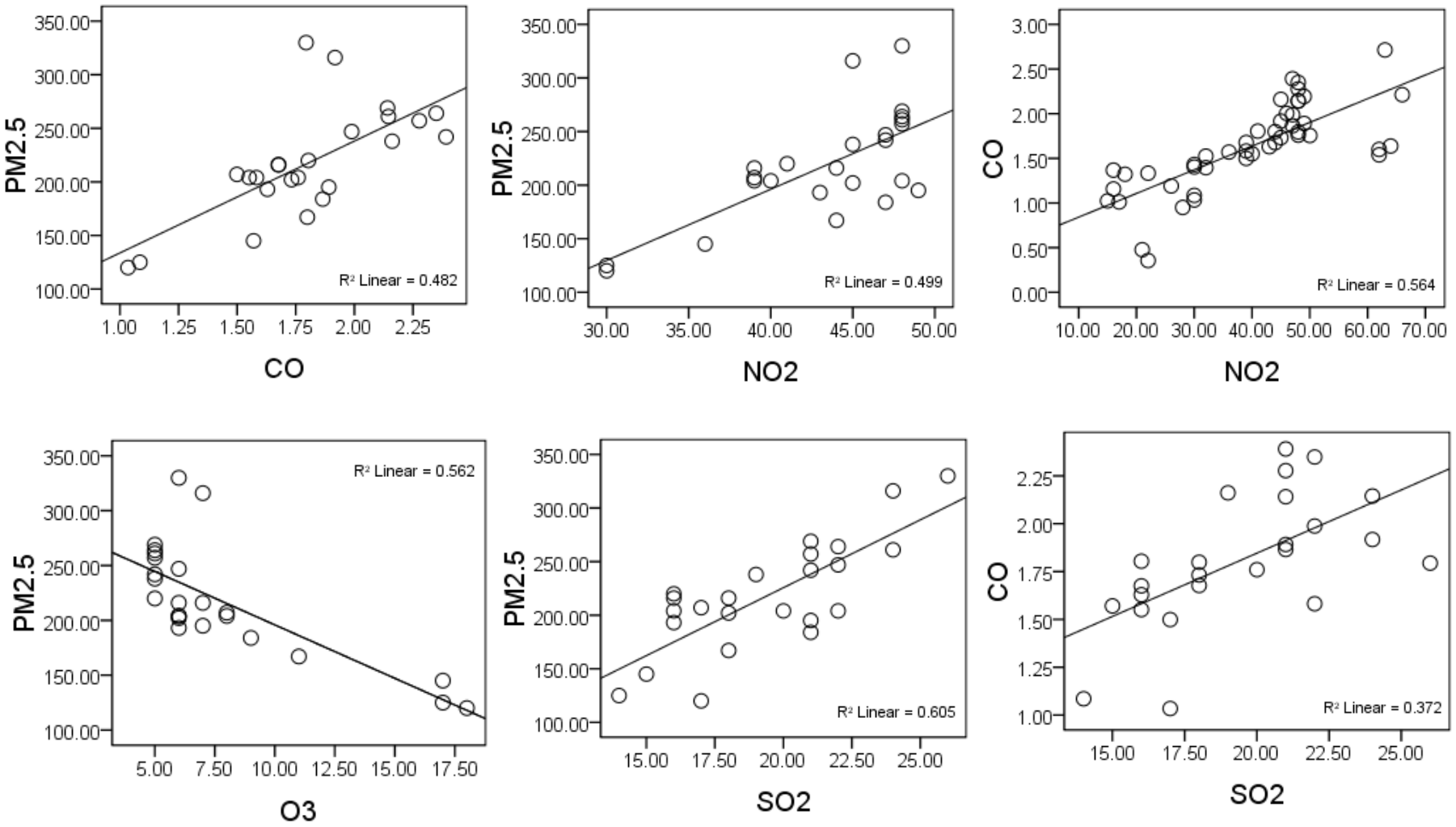


Figure 18. Correlation between pollutants concentration from 25:00 on 25th to 12:00 on 26th Jan

Results and discussion

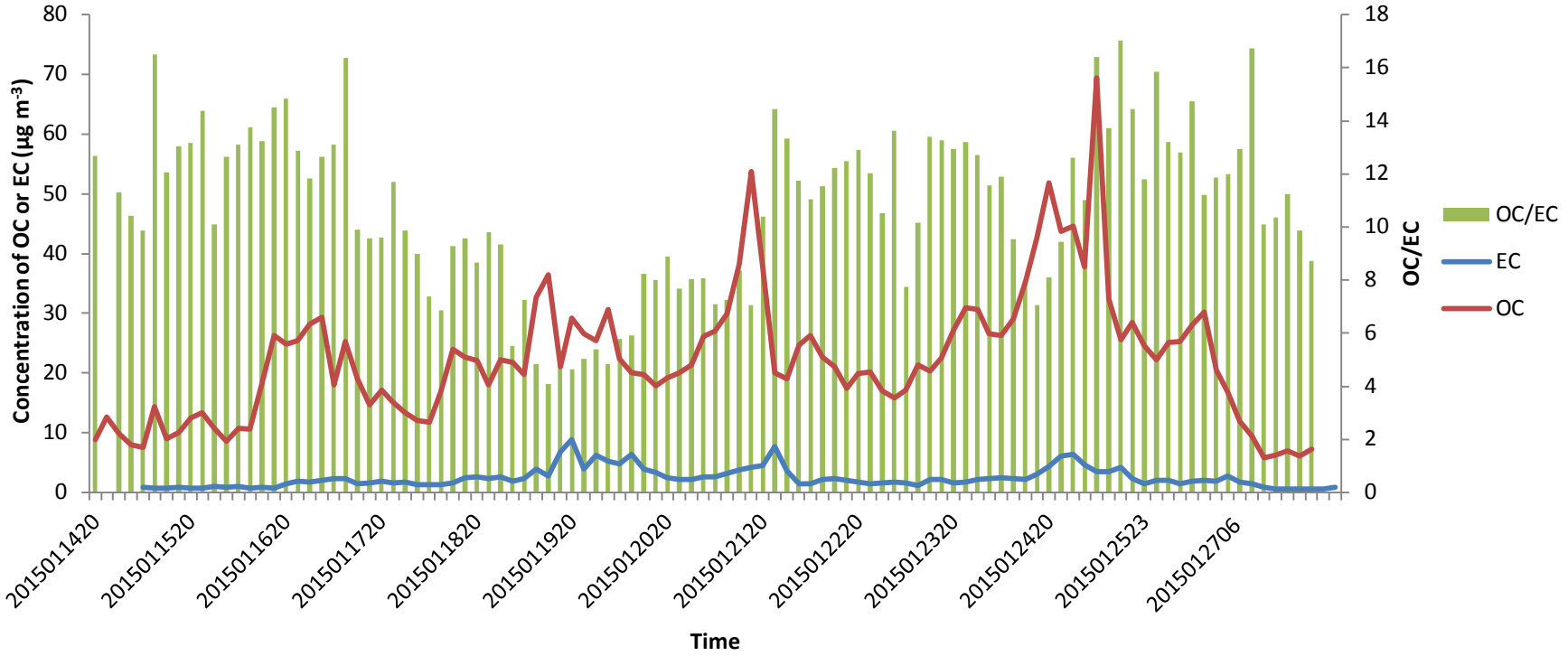


Figure 19. temporal variation of OC/EC and concentration of EC and OC

time	OC(μg m^{-3})	EC(μg m^{-3})	OC/EC
16th Jan 23:00	28.22664928	2.384515496	11.83747781
21st Jan 20:00	19.99900251	1.384567417	14.44422443
24th Jan 20:00	51.78782296	6.394006132	8.099432796
26th Jan 11:00	30.15940416	2.688310375	11.21872104

Fossil fuel dominated aerosols in Chinese urban cities： 2.6-3.6 This study： 10.72

Regions dominated by biomass burning： 4-12

Primary conclusion

- $PM_{2.5}$ peak on 16th Jan maybe the result of pollutant from coal combustion and biomass burning in Inner Mongolia transported by high wind from North-West.
- Biomass burning source from Guangdong during 19th, 20th and 21st are accumulated under the uniform pressure pattern on 21st Jan, and SOC is one of main chemical component
- In the evening of 24th Jan, $PM_{2.5}$ get very high mainly because of its low PBL height; and then it become lower because of the rainfall in the morning of 25th .
- The highest $PM_{2.5}$ concentration appears at the noon of 26th is the consequence of low PBLH and transport from Guangdong .And quite part of $PM_{2.5}$ transported is SOC considering OC/EC.
- According to OC/EC data, secondary aerosol contamination maybe severe in winter of Nanjing

Next work

- Investigate characteristics of OC, EC, OC to EC ratio, to find out main source of $PM_{2.5}$,whether local or not.
- Learn about further relation between gaseous pollutants and PM, especially its organic components, and understand their transformation mechanism to dig out more information from the correlation between them.
- Make comparison between data analysis of NUIST and downtown, to discover difference characteristics of fine particle's distribution, physical and chemical properties between urban and suburban area in winter of Nanjing city.

Thank you for your time

Table 1. Correlations between six pollutants during research period

		$PM_{2.5}$	PM_{10}	CO	NO_2	O_3	SO_2
$PM_{2.5}$	Pearson 相关性	1	.898**	.874**	.387**	-.267**	.436**
	显著性（双侧）		.000	.000	.000	.000	.000
	N	339	336	338	338	338	338
PM_{10}	Pearson 相关性		1	.830**	.502**	-.194**	.571**
	显著性（双侧）			.000	.000	.000	.000
	N		336	335	335	335	335
CO	Pearson 相关性			1	.567**	-.333**	.629**
	显著性（双侧）				.000	.000	.000
	N			338	338	338	338
NO_2	Pearson 相关性				1	-.444**	.707**
	显著性（双侧）					.000	.000
	N				338	338	338
O_3	Pearson 相关性					1	-.100
	显著性（双侧）						.066
	N						338
SO_2	Pearson 相关性						1
	显著性（双侧）						
	N						338

**. 在 .01 水平（双侧）上显著相关。

Results and discussion

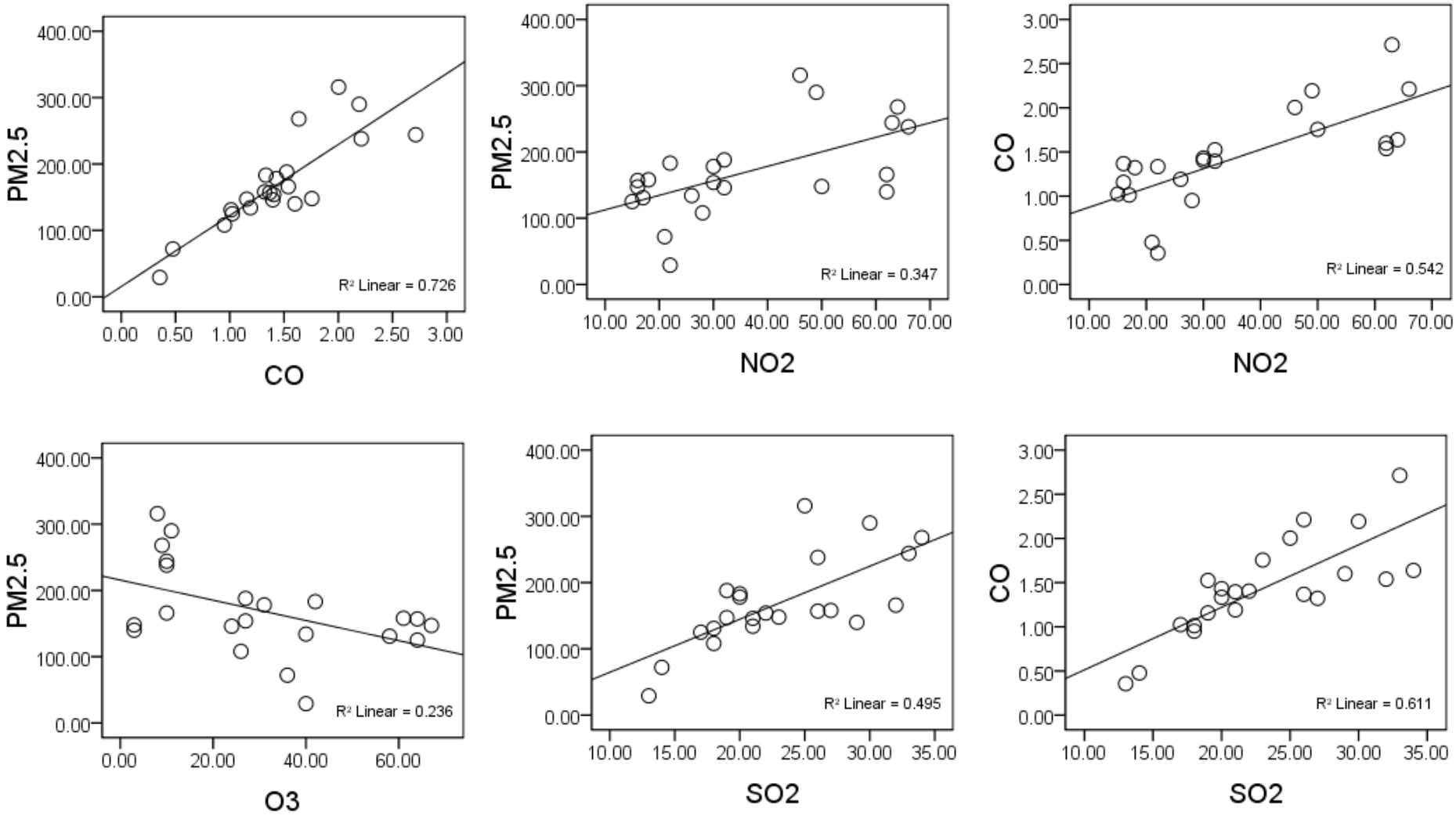
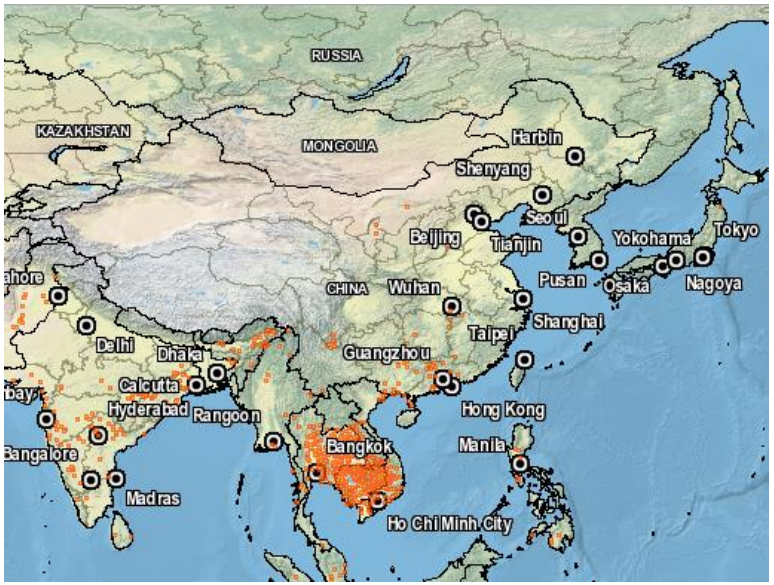
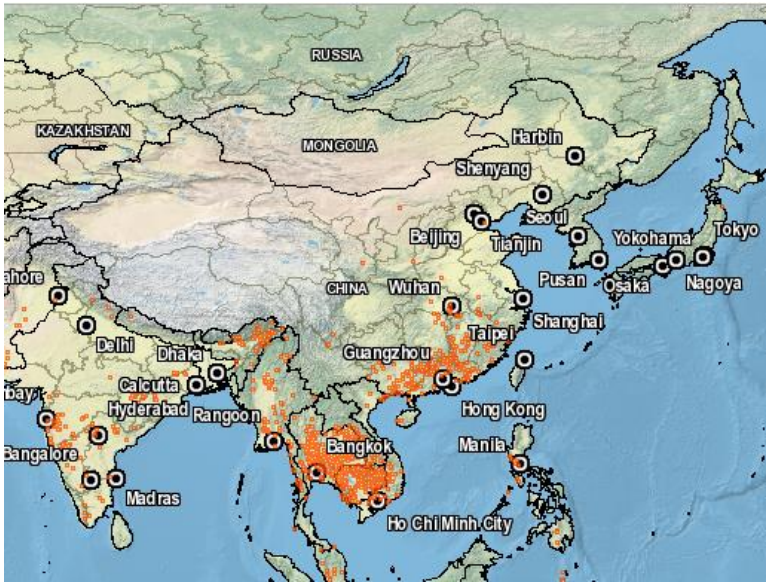


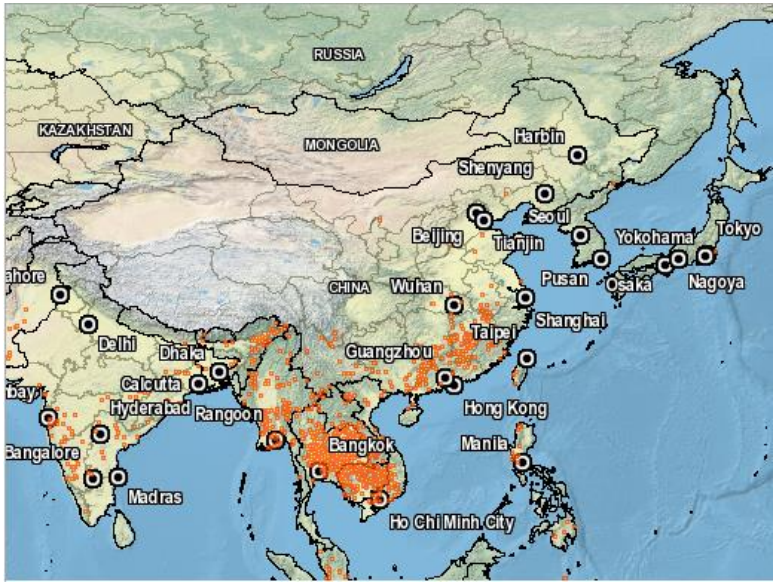
Figure 8. Correlation between pollutants concentration during the decrease of $PM_{2.5}$ from 12:00 on 26th to 12:00 on 27th Jan



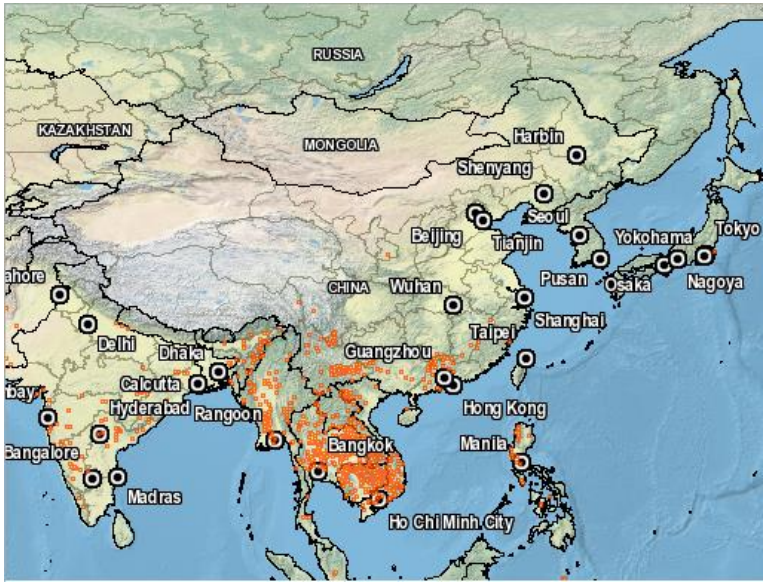
15th to 16th Jan



19th to 20th Jan

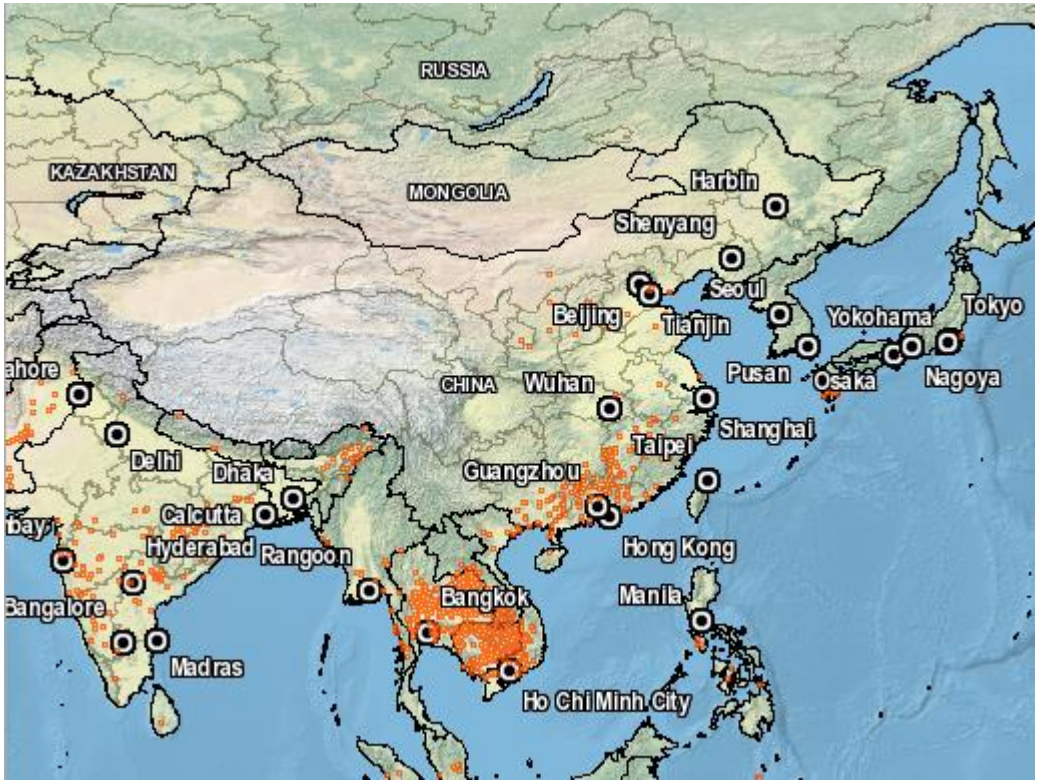


23th to 24th Jan



26th to 27th Jan

Figure 8. fire spot distribution during observed days


RUSSIA
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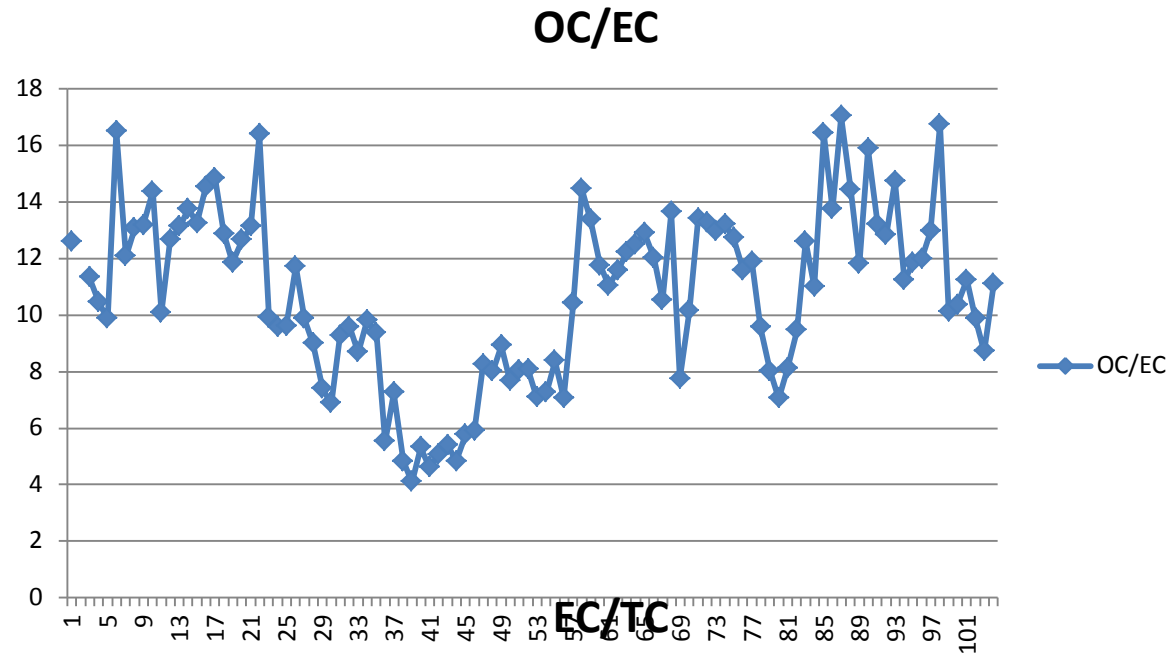
MONGOLIA
Harbin
Shenyang
Seoul
Beijing
Tianjin
Yokohama
Tokyo
Pusan
Osaka
Nagoya
CHINA
Wuhan
Shanghai
Taipei
Delhi
Dhaka
Guangzhou
Calcutta
Hyderabad
Rangoon
Hong Kong
Bangkok
Manila
Bangalore
Madras
Ho Chi Minh City

- Figure 19-20


OC/EC
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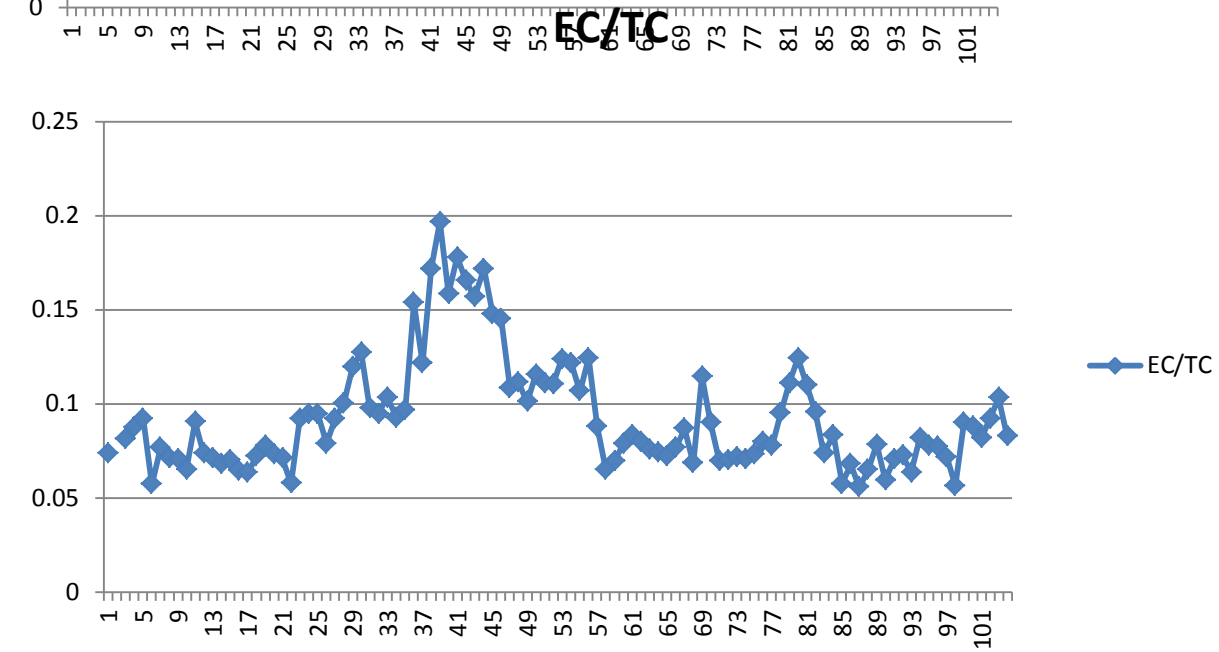
101
OC/EC


EC/TC
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EC/TC

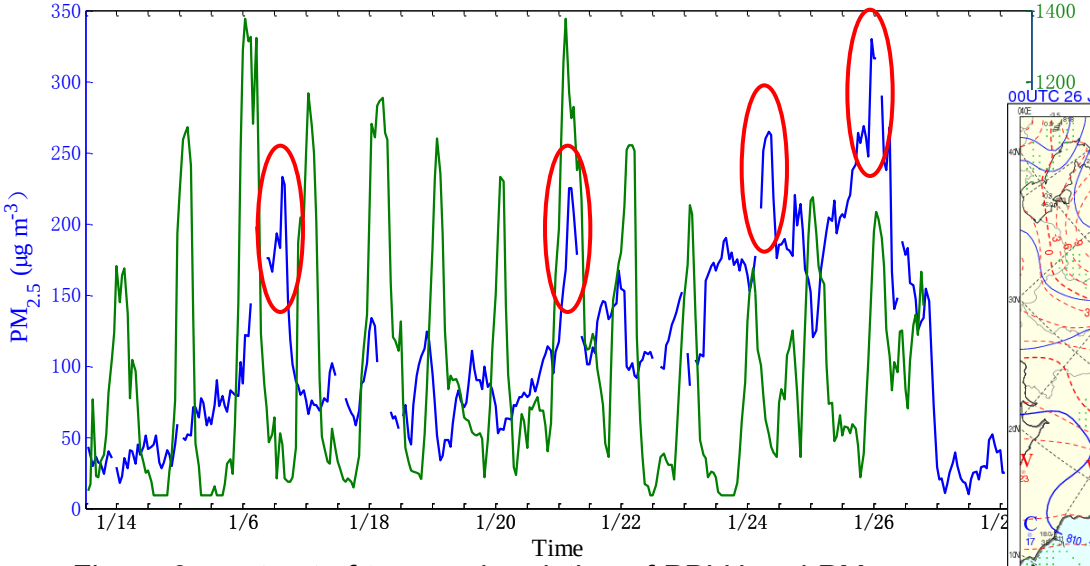
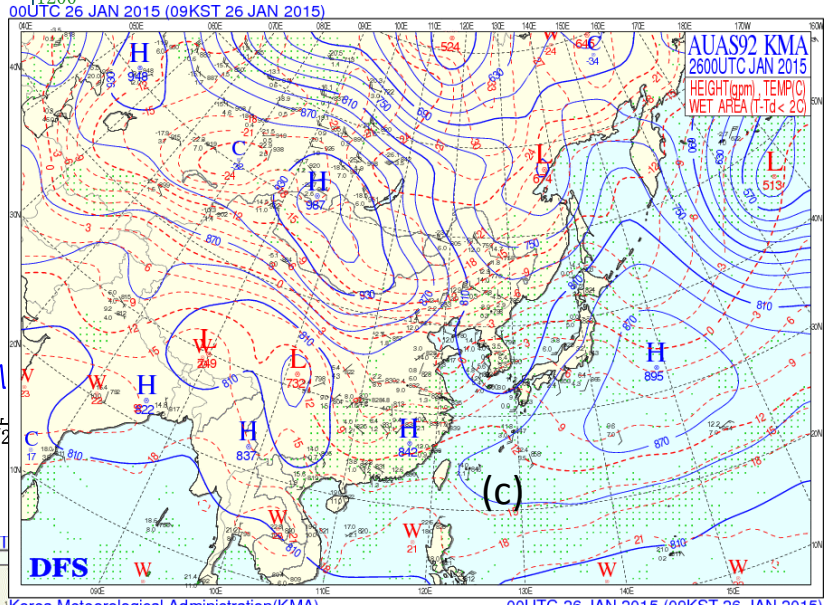
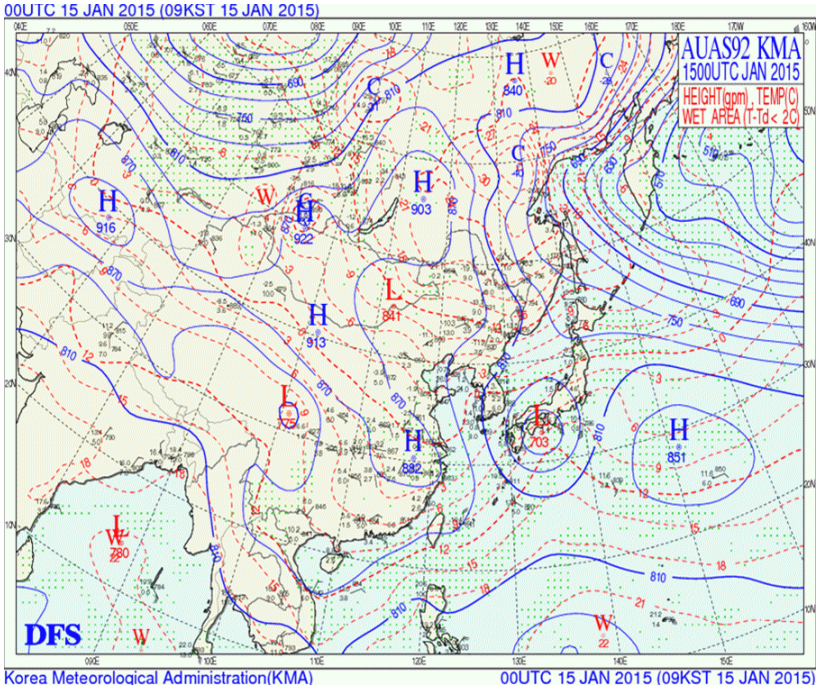


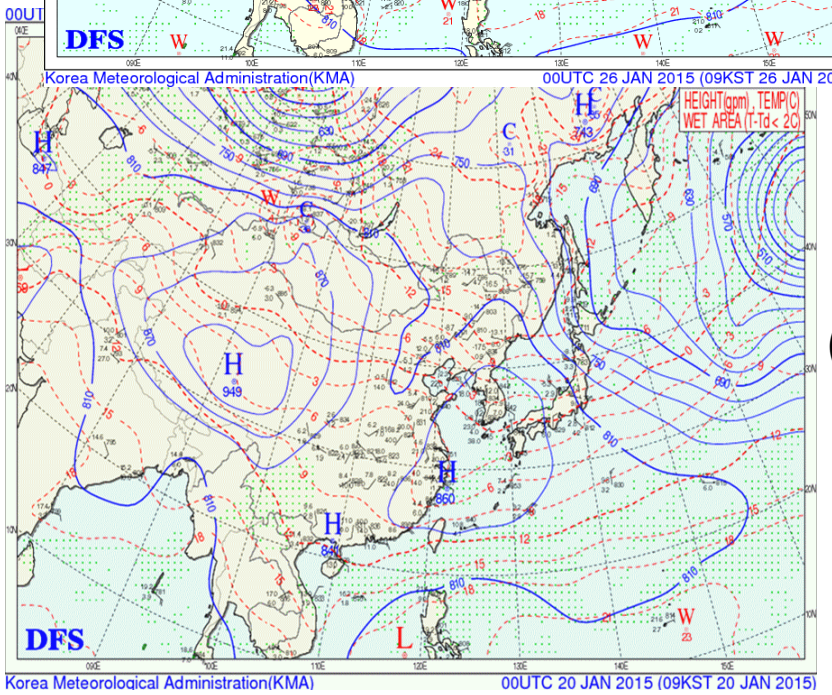
Figure 3. contrast of temporal variation of PBLH and $PM_{2.5}$



(c)

(a)





(b)

Fig.4. Near-surface pressure distribution (a) from 8:00 on 15th to 8:00 on 17th Jan, (b) from 8:00 on 20th to 20:00 on 21th Jan, (c) at 8:00 on 26th Jan