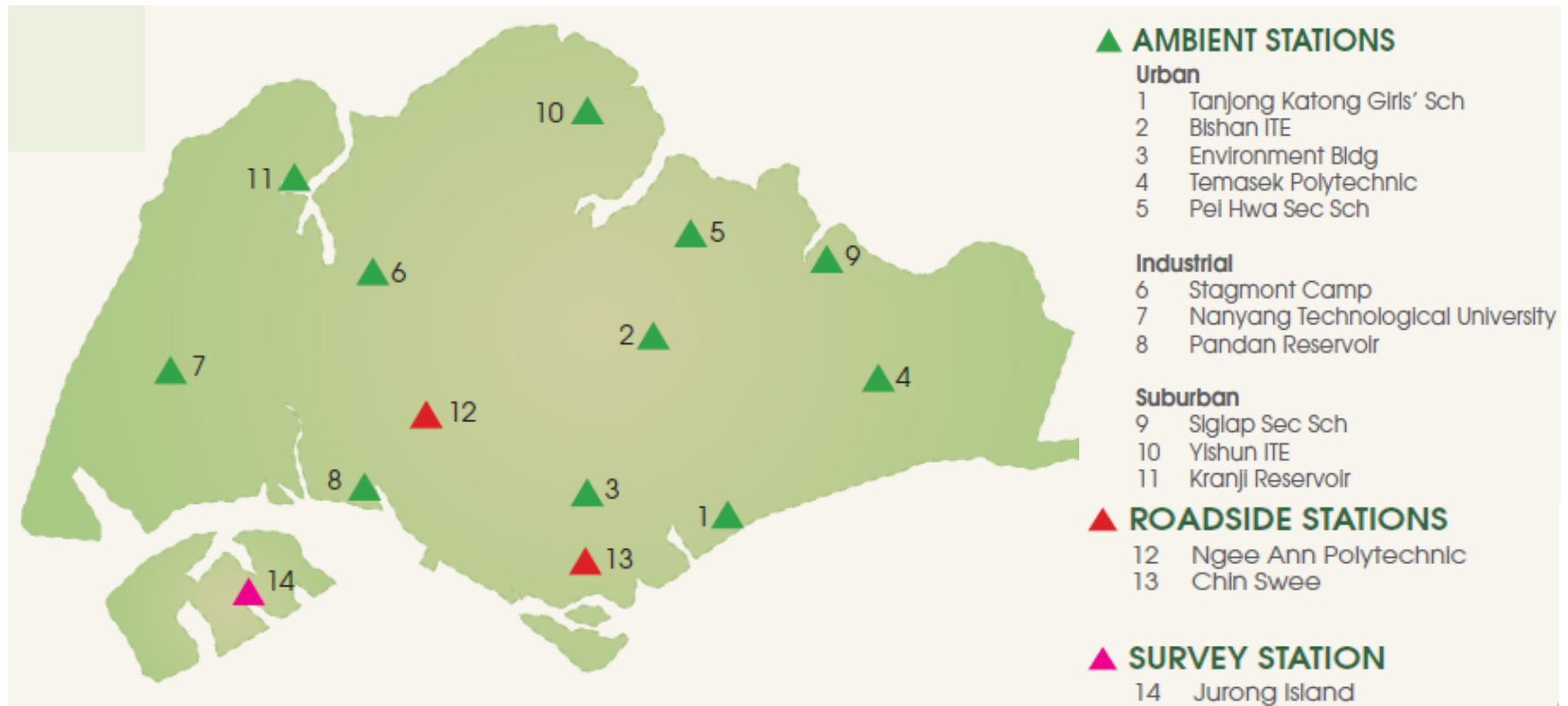


# **Overview of Ambient Air Quality Monitoring in Singapore: Current Status**

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# Network of Ambient Air Monitoring Sites in Singapore



The National Environment Agency (NEA) currently has a network of 11 air monitoring stations on the mainland of Singapore to measure ambient air quality and another 2 stations to measure roadside air quality. All the air monitoring stations are located at ground level except for the “station #3” which is located at the roof (above 25<sup>th</sup> Floor) of the Environment Building. The 11 air monitoring stations are operated in accordance with international guidelines.

# National Environmental Agency's Ambient Air Monitoring Site



The objectives of the monitoring program are to monitor ambient AQ trends so that timely policy decisions can be made to prevent air pollution problems and to assess the adequacy and effectiveness of pollution control programs. Singapore has an effective AQM program, which is due in part to regular monitoring, assessment, and effective interventions to improve the quality of ambient air.

# PSI: Pollution Standard Index

PSI- Pollution Standard Index provides accurately and easily understandable information about air quality



Note: Air quality based on PSI is as follows:

PSI Value	Air Quality Descriptor
0 - 50	Good
51 - 100	Moderate
101 - 200	Unhealthy
201 - 300	Very unhealthy
Above 300	Hazardous

# Computation of PSI

Using a network of air monitoring stations located in different parts of Singapore, concentrations of the following five pollutants (measured in micrograms per cubic meter): respirable particulate matter, sulphur dioxide, nitrogen dioxide, ozone and carbon monoxide are measured. These pollutants are used to determine the PSI Value. The concentration of each pollutant is converted to a PSI sub-index ranging from 0 to 500. The PSI reading is the highest of the five PSI sub-indices. The PSI is not a composite or an average of the five PSI sub-indices.

The breakpoints used in defining each of the five pollutant sub-indices are listed as follows:

PSI Value	24-h PM10 ( $\mu\text{g}/\text{m}^3$ )	24-h SO <sub>2</sub> ( $\mu\text{g}/\text{m}^3$ )	8-h CO ( $\text{mg}/\text{m}^3$ )	8-h Ozone ( $\mu\text{g}/\text{m}^3$ )	1-h NO <sub>2</sub> ( $\mu\text{g}/\text{m}^3$ )
50	50	80	5	118	*
100	150	365	10	157	*
200	350	800	17	235	1,130
300	420	1,600	34	785*	2,260
400	500	2,100	46	980*	3,000
500	600	2,620	57.5	1,180*	3,750

(Note: \*When 8-hour ozone concentration exceeds  $785\mu\text{g}/\text{m}^3$ , the PSI sub-index is calculated using the 1-hour ozone concentration)

# Health advisories based on PSI

24-hr PSI	Healthy persons	Elderly, children, pregnant women	Persons with chronic lung disease, heart disease
<b>≤ 100 (Good/Moderate)</b>	Normal activities	Normal activities	Normal activities
<b>101 - 200 (Unhealthy)</b>	Reduce <sup>^</sup> prolonged <sup>**</sup> or strenuous <sup>***</sup> outdoor physical exertion	Minimise <sup>^^</sup> prolonged <sup>**</sup> or strenuous <sup>***</sup> outdoor physical exertion	Avoid <sup>^^^</sup> prolonged <sup>**</sup> or strenuous <sup>***</sup> outdoor physical exertion
<b>201 - 300 (Very Unhealthy)</b>	Avoid <sup>^^^</sup> prolonged <sup>**</sup> or strenuous <sup>***</sup> outdoor physical exertion	Minimise <sup>^^</sup> outdoor activity	Avoid <sup>^^^</sup> outdoor activity
<b>&gt; 300 (Hazardous)</b>	Minimise <sup>^^</sup> outdoor activity	Avoid <sup>^^^</sup> outdoor activity	Avoid <sup>^^^</sup> outdoor activity

\*\* Prolonged = continuous exposure for several hours

\*\*\* Strenuous = involving a lot of energy or effort

^ Reduce = do less

^^ Minimise = do as little as possible

^^^ Avoid = do not do



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Time	24-hr PSI (22 Sep 2014)					
	North	South	East	West	Central	Overall Singapore
1am	72	71	74	68	72	68-74
2am	74	73	76	70	74	70-76
3am	76	75	77	72	76	72-77
4am	77	76	79	73	78	73-79
5am	79	77	80	75	80	75-80
6am	82	78	82	77	81	77-82
7am	85	80	84	80	84	80-85
8am	87	81	86	83	86	81-87
9am	90	81	87	85	88	81-90
10am	91	82	87	86	88	82-91
11am	92	83	88	87	89	83-92
12pm	92	84	88	87	89	84-92
1pm	92	85	89	87	89	85-92
2pm	91	85	89	88	89	85-91
3pm	91	85	89	87	88	85-91
4pm	91	85	89	87	88	85-91
5pm	91	85	89	87	88	85-91
6pm	91	84	87	87	87	84-91
7pm	89	81	84	86	85	81-89
8pm	85	76	79	84	81	76-85
9pm	82	74	76	82	78	74-82
10pm	80	72	75	80	77	72-80
11pm	79	71	73	79	75	71-79
12am	78	69	72	77	74	69-78

# Status of PM<sub>2.5</sub> Monitoring



The NEA used to publish the annual average PM<sub>2.5</sub> readings. Since 24 August 2012, the PM<sub>2.5</sub> readings of the 5 regions (North, South, East West, Central) have been reported on the NEA website 3 times a day at 8 am, 12 noon and 4 pm to help the public better plan their activities for the day.

Since June 2013, NEA has been reporting hourly PM<sub>2.5</sub> reading when Singapore was hit by worst haze in its history.

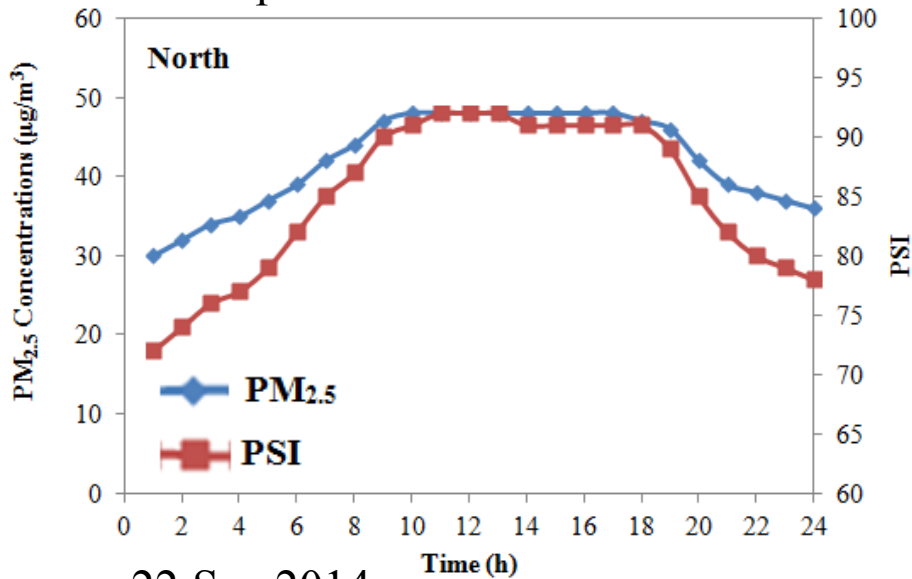
## Future goals of PM<sub>2.5</sub> Monitoring

Plans are in place here to more accurately monitor levels of PM<sub>2.5</sub>, the air pollutant associated with vehicle emissions and the seasonal haze that has blanketed Singapore in the past. NEA will add nine more monitoring stations nationwide to the existing 14 by early next year to give "a better picture" of PM<sub>2.5</sub> levels across a wider area

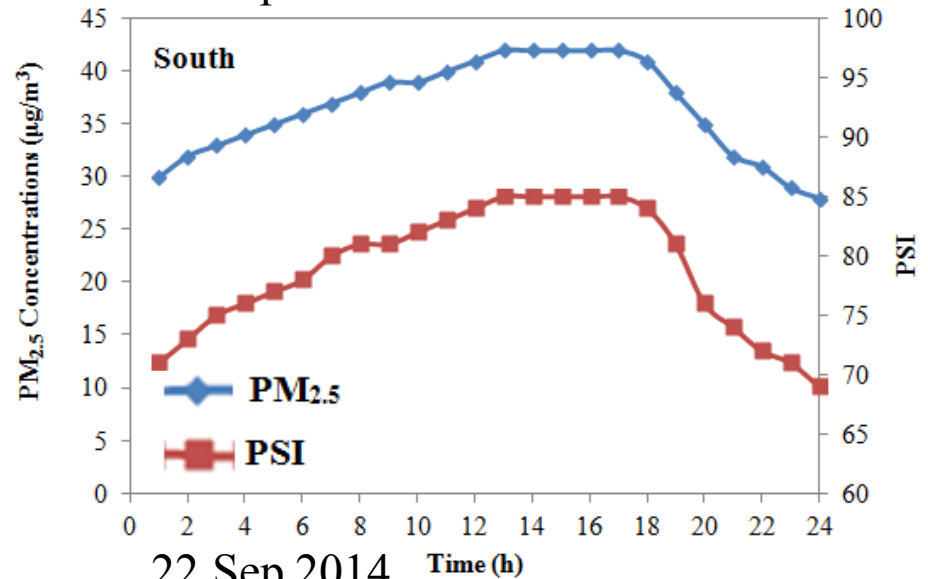


# Hourly PM<sub>2.5</sub> Concentrations – Reported by NEA

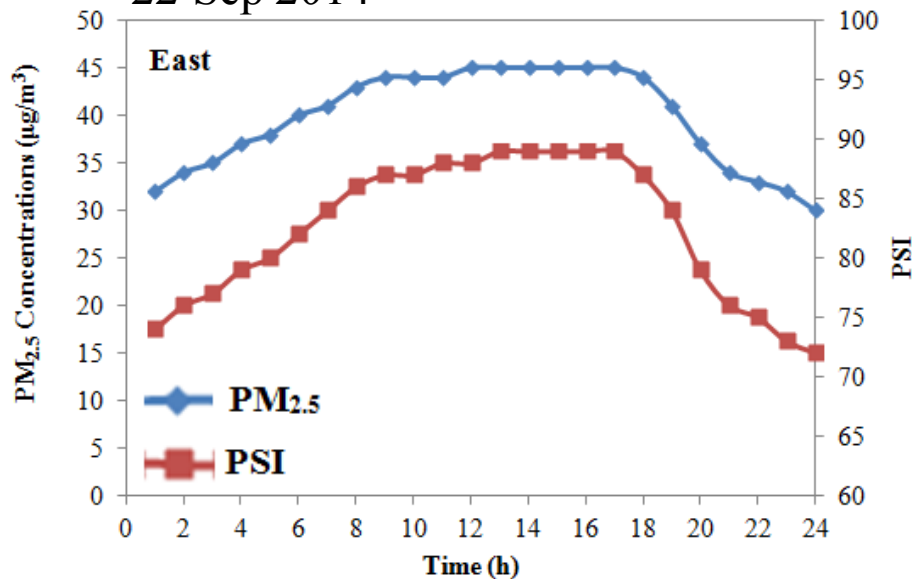
22 Sep 2014



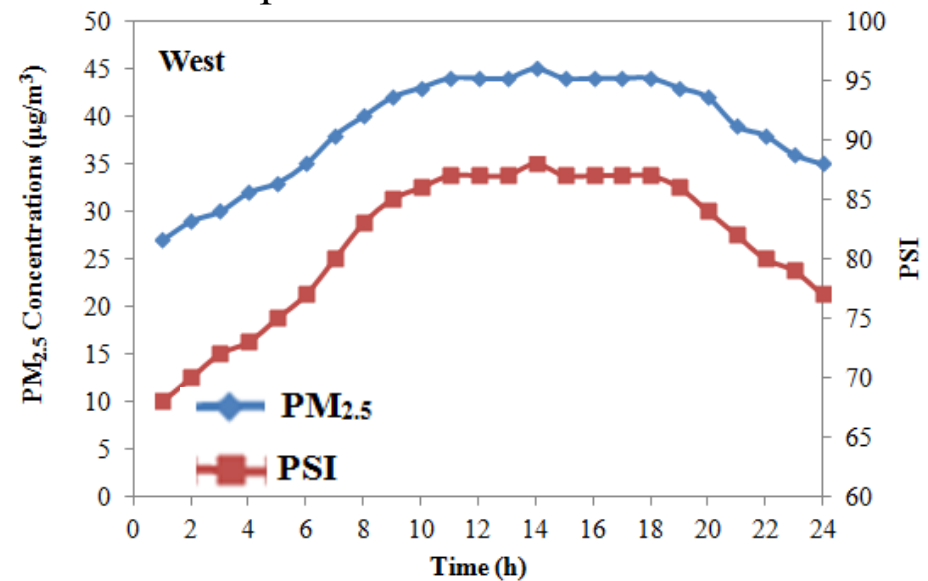
22 Sep 2014



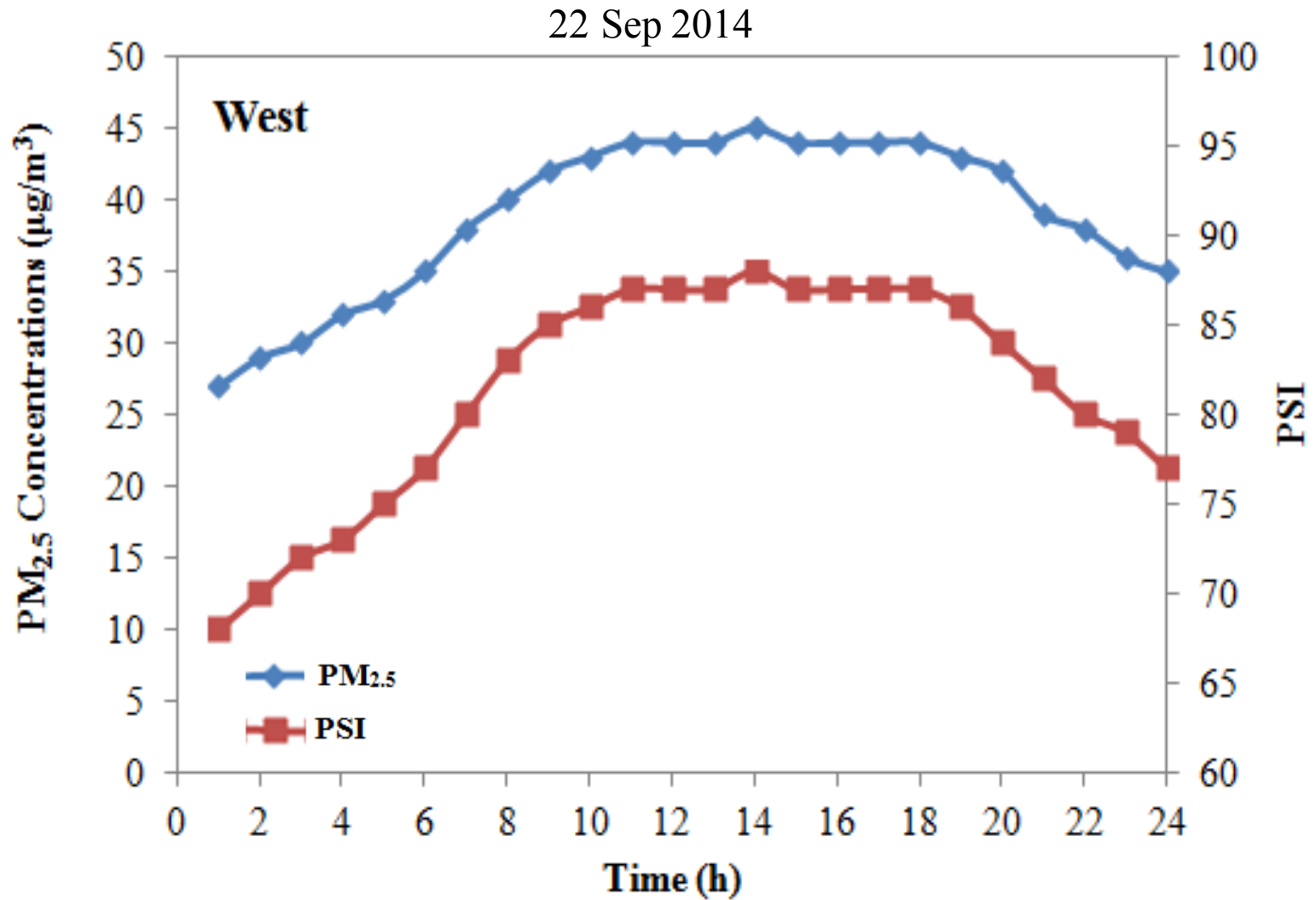
22 Sep 2014



22 Sep 2014



# Hourly PM<sub>2.5</sub> Concentrations – Reported by NEA



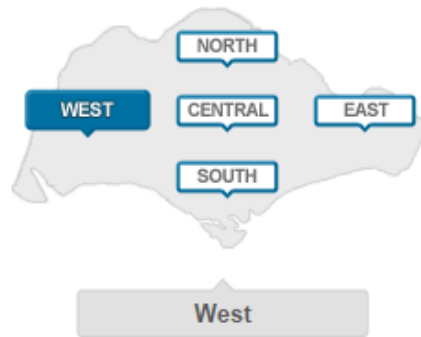
# Latest updates in PSI including PM<sub>2.5</sub>

## Trend Charts by Pollutants

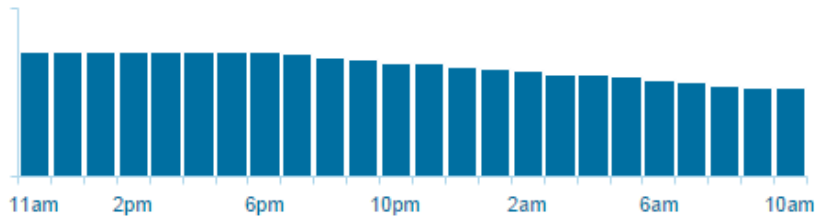
Trend Charts as at 10:00 AM on 23 Sep 2014



At 10am on 23 Sep 2014



### PM<sub>2.5</sub> sub-index \*



Min 62 Max 88 Current 62

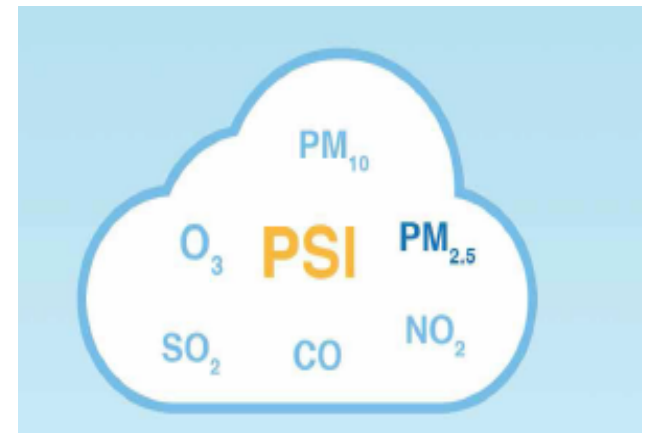
\* computed based on 24-hour average PM<sub>2.5</sub> concentrations

PM<sub>2.5</sub> : Particulate matter of 2.5 microns or smaller in diameter  
PM<sub>10</sub> : Particulate matter of 10 microns or smaller in diameter  
SO<sub>2</sub> : Sulphur Dioxide  
O<sub>3</sub> : Ozone  
CO : Carbon Monoxide  
NO<sub>2</sub> : Nitrogen Dioxide



NO<sub>2</sub> sub-index

With effect from 1 April 2014, Singapore integrated air quality reporting index, where PM<sub>2.5</sub> is incorporated into the Pollutant Standards Index (PSI) as its sixth pollutant parameter. The PSI will therefore reflect a total of six pollutants – sulphur dioxide (SO<sub>2</sub>), particulate matter (PM<sub>10</sub>) and fine particulate matter (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO) and ozone (O<sub>3</sub>).



# 3-hour PSI & 1-hour PM<sub>2.5</sub> Concentration



3-hour PSI is calculated based on **PM<sub>2.5</sub>** readings in order to better reflect prevailing conditions. Information on 1-hour PM<sub>2.5</sub> concentration has also been made available from 1 April 2014. Both the 3-hour PSI and the 1-hour PM<sub>2.5</sub> can provide an indication of the more recent levels of PM<sub>2.5</sub> and help you decide on your more immediate actions, e.g. going for a jog or cycling.

## Benefits

Public can better plan their activities with new & simplified system

For more info, visit: [www.haze.gov.sg](http://www.haze.gov.sg) or [www.nea.gov.sg](http://www.nea.gov.sg)



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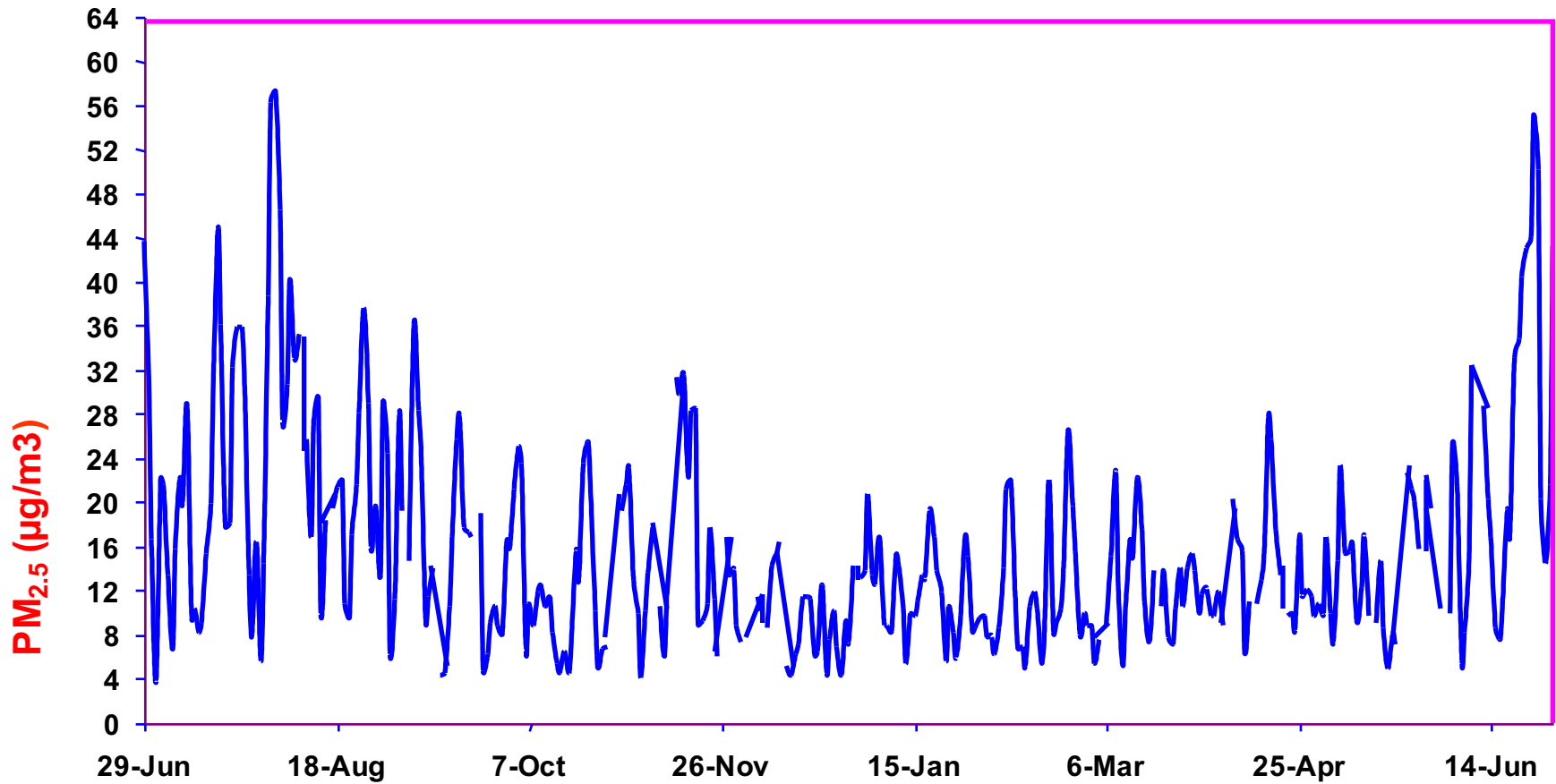
myENV App

# Ambient Air Quality Standards - Singapore

Pollutant	Singapore Targets by 2020	Long Term Targets
Sulphur Dioxide (SO <sub>2</sub> )	Annual mean: 15µg/m <sup>3</sup> <i>(Sustainable Singapore Blueprint target)</i>  24-hour mean: 50µg/m <sup>3</sup> <i>(WHO Interim Target-2)</i>	24-hour mean: 20µg/m <sup>3</sup> <i>(WHO Final)</i>
Particulate Matter (PM <sub>2.5</sub> )	Annual mean: 12µg/m <sup>3</sup> <i>(Sustainable Singapore Blueprint target)</i>  24-hour mean: 37.5µg/m <sup>3</sup> <i>(WHO Interim Target-3)</i>	Annual mean: 10µg/m <sup>3</sup> <i>(WHO Final)</i>  24-hour mean: 25µg/m <sup>3</sup> <i>(WHO Final)</i>
Particulate Matter (PM <sub>10</sub> )	Annual mean: 20 µg/m <sup>3</sup> 24-hour mean: 50 µg/m <sup>3</sup>	<i>(WHO Final)</i> <i>(WHO Final)</i>
Ozone	8-hour mean: 100µg/m <sup>3</sup>	<i>(WHO Final)</i>
Nitrogen Dioxide (NO <sub>2</sub> )	Annual mean: 40µg/m <sup>3</sup> 1-hour mean: 200µg/m <sup>3</sup>	<i>(WHO Final)</i> <i>(WHO Final)</i>
Carbon Monoxide (CO)	8-hour mean: 10mg/m <sup>3</sup> 1-hour mean: 30mg/m <sup>3</sup>	<i>(WHO Final)</i> <i>(WHO Final)</i>

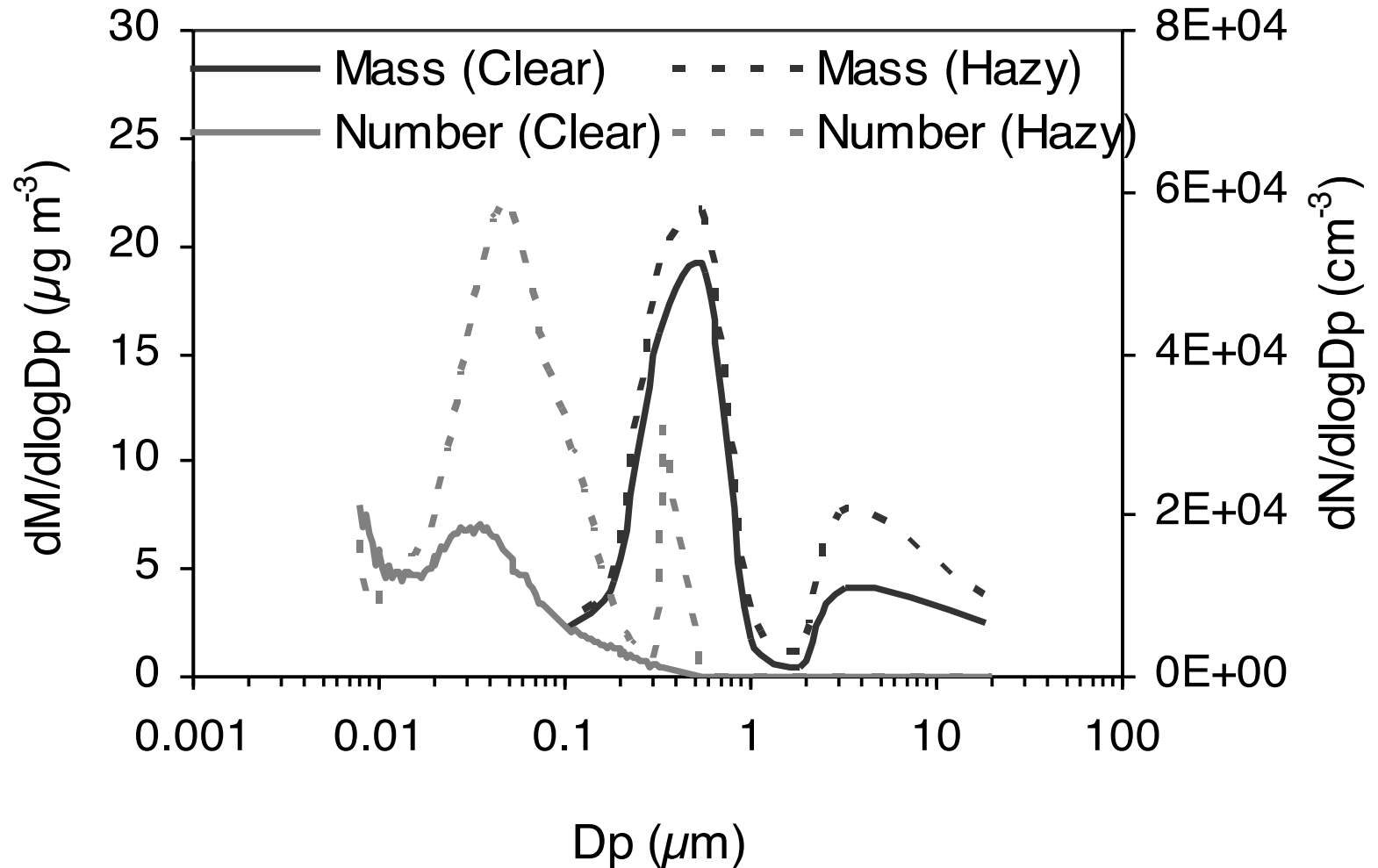


# PM<sub>2.5</sub> Concentrations



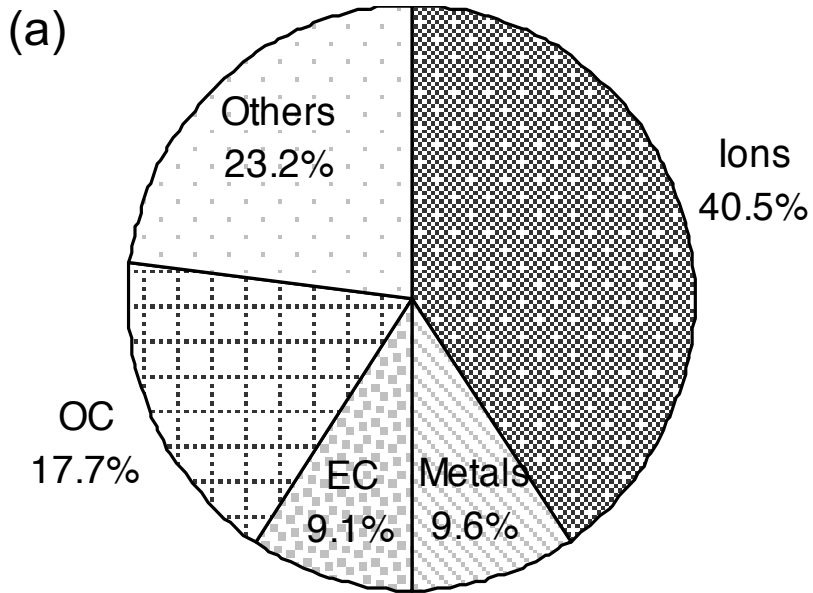
Balasubramanian et al., JGR, 2003

## REPRESENTATIVE SIZE DISTRIBUTION

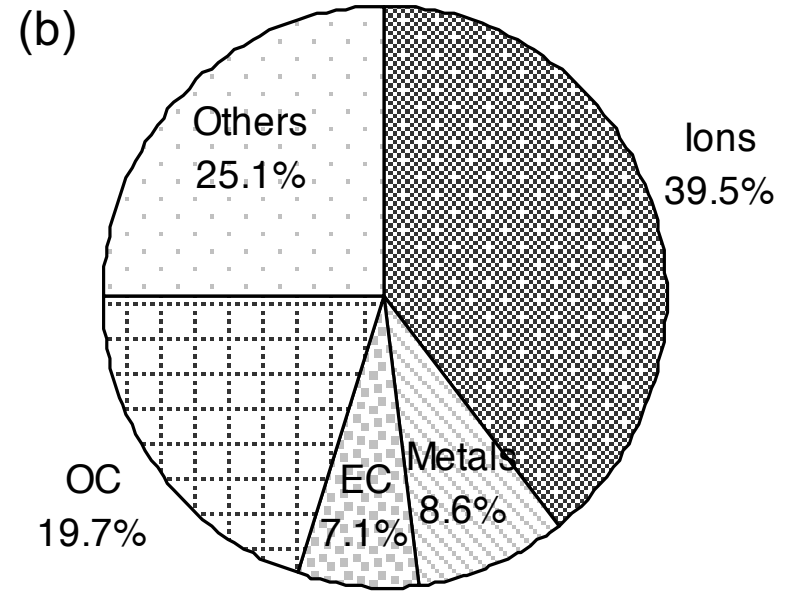




## COMPOSITION OF PM<sub>2.5</sub>

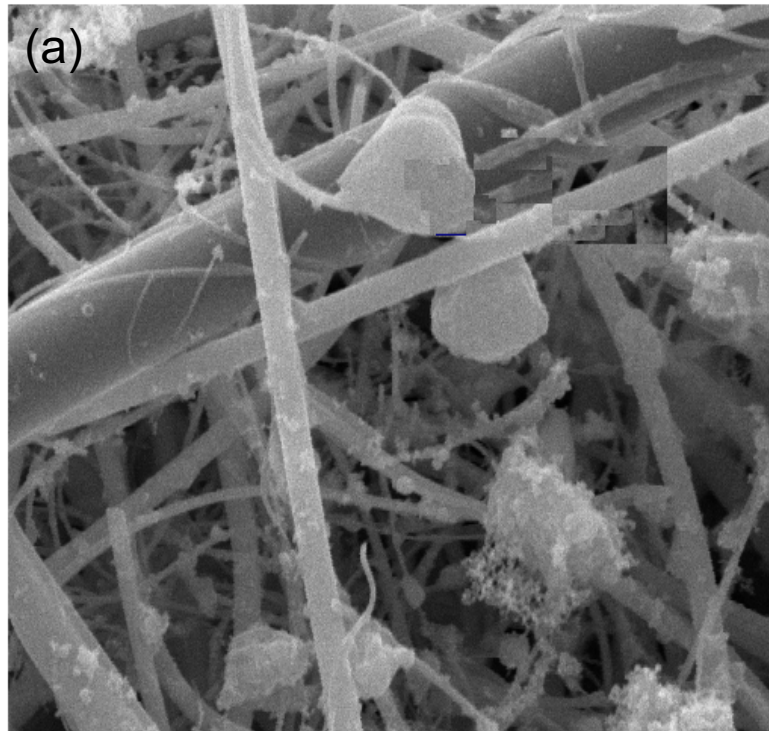


**Clear days**



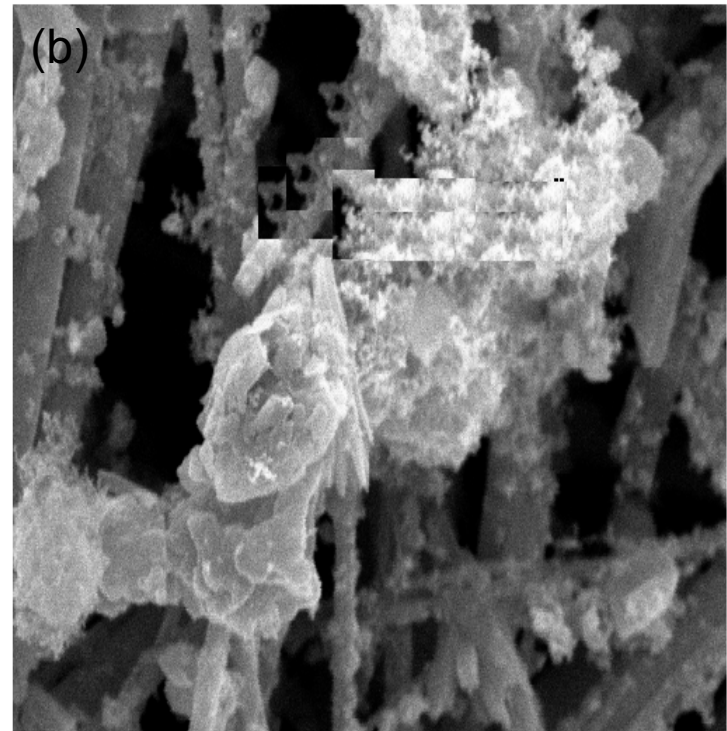
**Hazy days**

## SEM OF PARTICULATE MATTER



8  $\mu\text{m}$

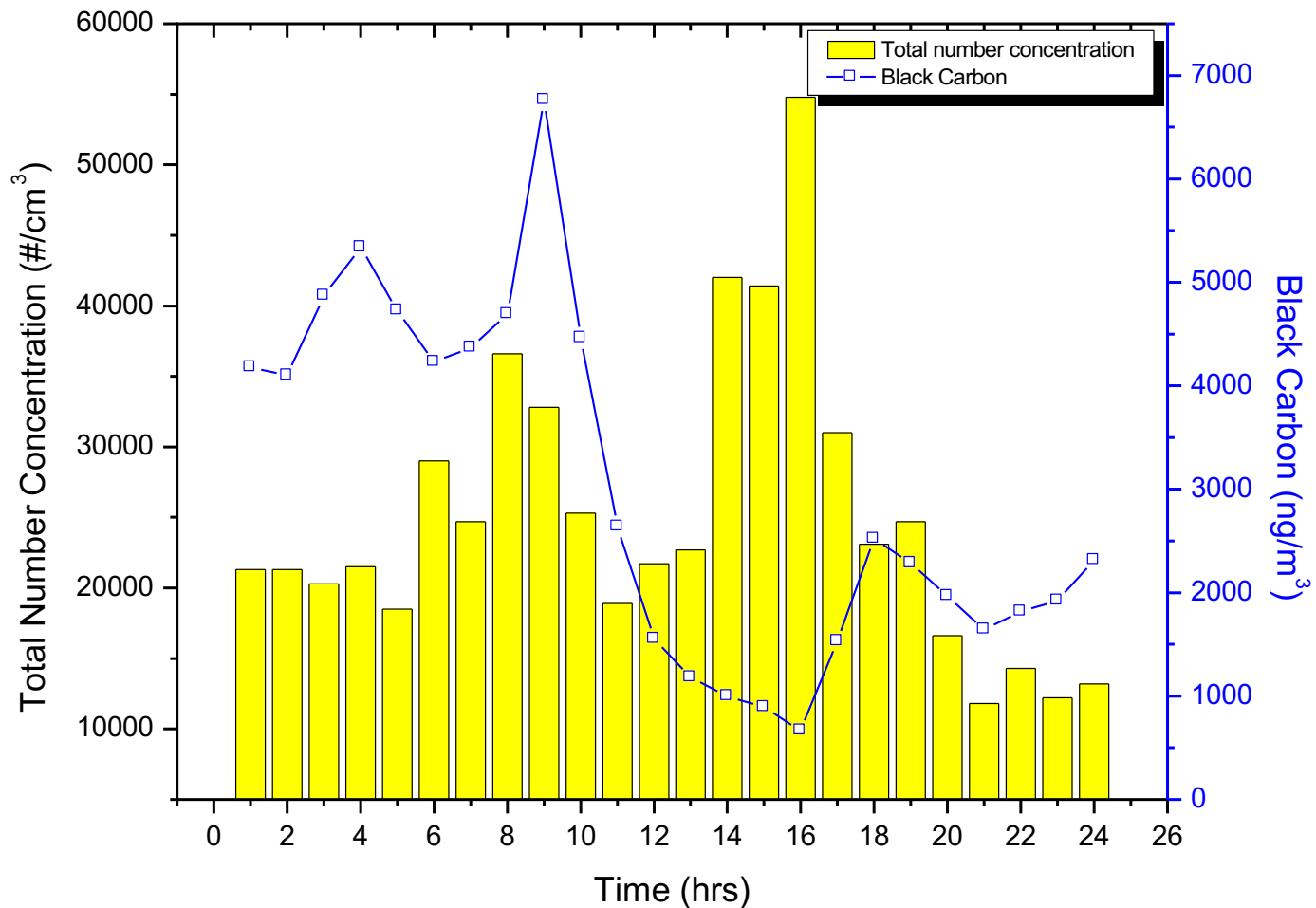
**Clear days**



8  $\mu\text{m}$

**Hazy days**

# Particle number and Black Carbon concentrations SW Monsoons



Thank you