fine particle aerosol sampling

NEWSLETTER

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aerosol *n.* a colloidal dispersion of solid or liquid particles in a gas (air).

Fingerprinting and Sourcing Fine Particles in Sydney

In two previous ASP Newsletters (January 2006 ASP Newsletter No34, January 2007 No36 copies on WEB site) we provided unique data on fine particle characterisation and source apportionment using the techniques of Ion Beam Analysis (IBA) at ANSTO coupled with the new approach of Positive Matrix Factorisation (PMF) for determining source fingerprints and their contributions to the total $PM_{2.5}$ mass measurements. In this Newsletter we continue this approach with data from the Warrawong site in Wollongong, south of Sydney. This site, with the help of BlueScope Steel, has now been measuring $PM_{2.5}$ pollution since 1992. **Fig. 1** shows a box and whisker plot for the monthly fine particle mass measured at Warrawong during 2004-2006. **Table 1** is the average $PM_{2.5}$ composition at Warrawong. The large standard deviations of the results reflect the large daily and seasonal variations. Black carbon (BC) and sulfate are usually associated with combustion products and generally dominate the fine aerosol. Sulfate is associated with industry, coal burning and lead historically with petrol combustion by motor vehicles, although Pb was removed from petrol in NSW in January 2001. IBA analysis, at ANSTO, can now be used to characterise and source fine particle pollution in detail through determination of source fingerprints and their contributions to the measured $PM_{2.5}$ fine mass. We now use the novel receptor-modelling statistical technique of PMF to achieve this. The advantage of PMF is that both the source fingerprints, obtained from the elemental analyses, as well as their relative contributions on a daily basis can be estimated simultaneously from the same extensive data set covering many years.

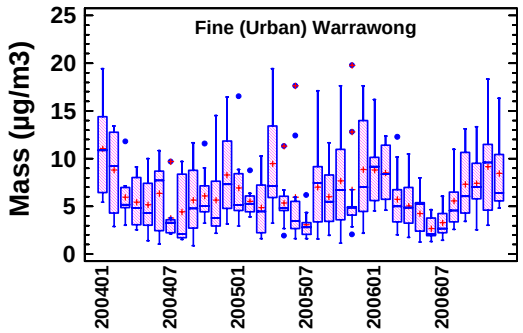


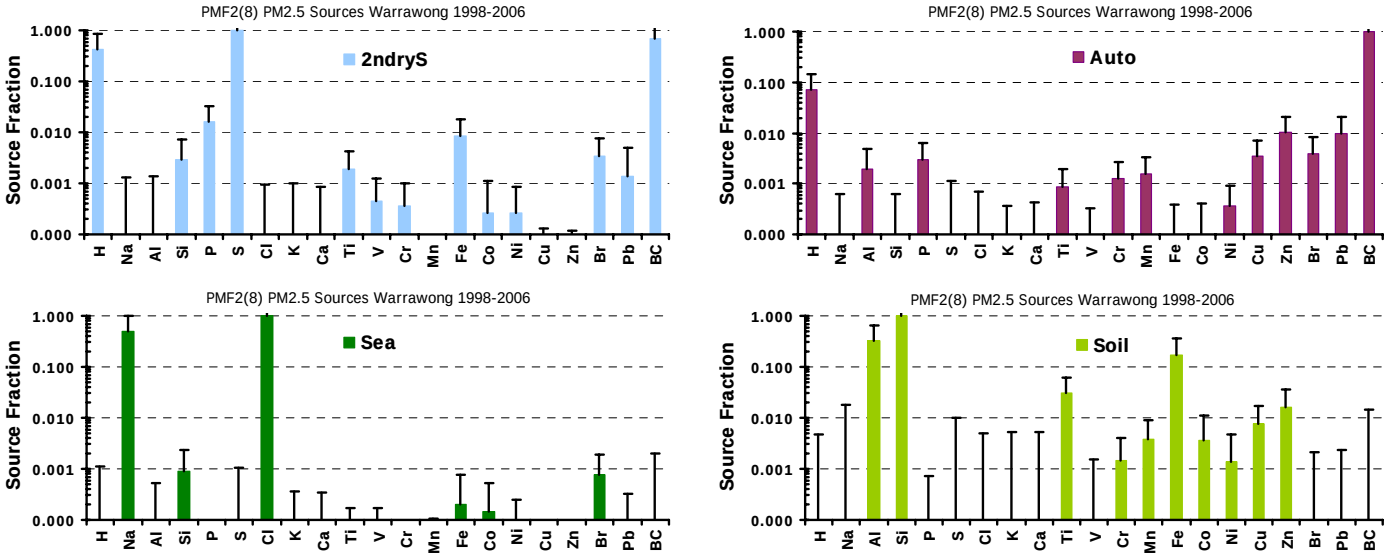
Fig. 1 Average monthly $PM_{2.5}$ mass concentrations at Warrawong, Wollongong.

$PM_{2.5}$ Species	Mascot 2004-06 ($\mu g/m^3$)
Mass	6.3±4(20)
Sulfate	1.5±1.2(7.1)
Soil	0.66±0.80(4.6)
BC	0.77±0.45(3.0)
Sea salt	1.1±1.2(6.9)
Potassium	0.054±0.05(0.36)
Iron	0.15±0..20(0.96)
Zinc	0.023±0.04(0.38)
Lead	0.006±0.006(0.04)

Table 1. Average $PM_{2.5}$ composition for January 2004 to December 2006 at Warrawong. Max values in ( )

Fig. 2 shows some typical source fingerprints obtained for the Warrawong site using these new PMF techniques.

PMF Average $PM_{2.5}$ Source Fingerprints for the Warrawong 1998-2006



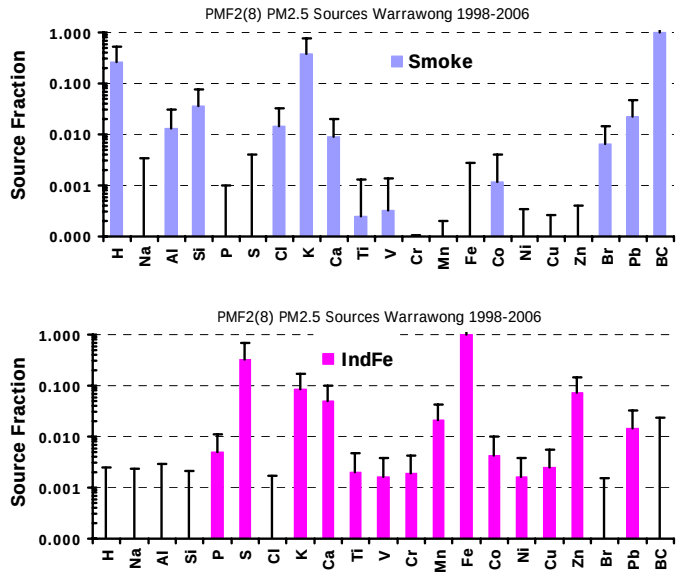


Fig. 2. PMF average source fingerprints obtained using PMF analysis on all Warrawong $PM_{2.5}$ data from 1998-06.

The percentage monthly contrbutions for a combination of 5 of these sources for the sampling period from January 2004 to December 2006 are shown in **Fig. 3** below. Sea and Smoke have significant seasonal variations Smoke being higher in the winter periods. Smoke can contribute as much as 20% to $PM_{2.5}$ levels during winter. The percentage of secondary sulphate at Warrawong has fallen from above 40% in 2004 to around 20% in 2006 The contribution from automobiles was steady at around 30%-40% during 2004-06. The average source contributions obtained by PMF analysis for the Warrawong site are given in **Table 2** for 2004-06 period.

$PM_{2.5}$ Percentage Source Contributions at Warrawong Site 2004-06

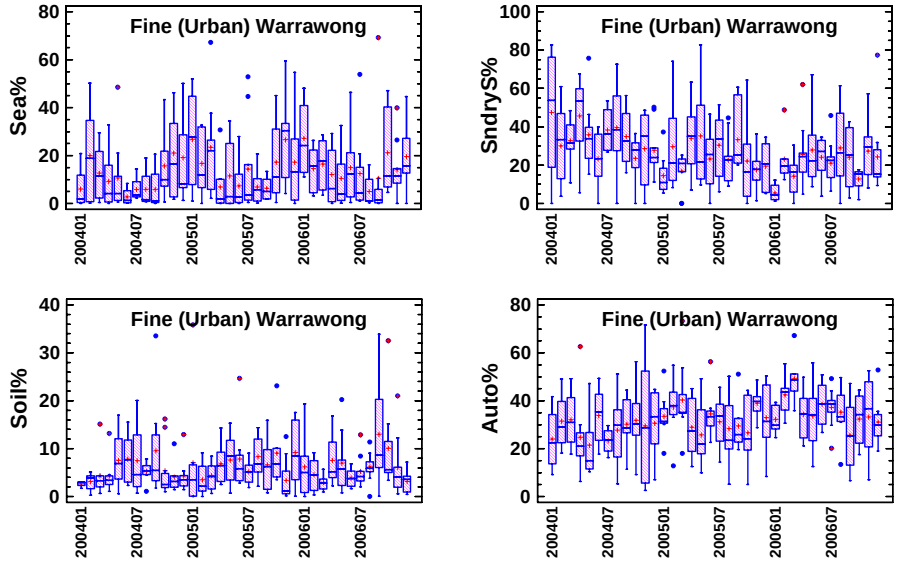


Fig. 3. Average monthly percentage source contributions for January 2004 to December 2006 at Warrawong for $PM_{2.5}$ particles using PMF analyses.

$PM_{2.5}$ Sources	Warrawong Av.(%) 2004-06
Auto	31±13%(73%)
Smoke	11±7%(43%)
Soil	5±5%(42)
Seaspray	15±15%(70%)
2ndry Sulfate	27±17%(83%)

Table 2. Average percentage source contributions for $PM_{2.5}$ at Warrawong for 2004-06. Max values in ( )

This Newsletter demonstrates that given enough high quality fine particle data, covering a sufficient timeframe we now have the ability, at ANSTO, to provide quantitative $PM_{2.5}$ characterisation and source contribution estimates from the total measured fine mass. If you need more information please contact us through any of the contact addresses below.

Short Term US EPA NAAQS Standards for Airborne Particulate Matter

Index (NAAQS)	TSP (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	Air Quality
0 to 50	0 - 75	0 - 50	0 - 15	Good
51 to 100	76 - 260	51 - 150	16 - 65	Moderate
101 to 200	261 - 375	151 - 350	66 - 150	Unhealthy
201 to 300	376 - 625	351 - 420	151 - 250	V/Unhealthy
> 300	> 626	> 421	> 251	Hazardous

Source : US EPA July 1997 Documents.

Australian NEPM for $PM_{2.5}$

8 µg/m^3 annual and 25 µg/m^3 24-hr average

Want more information on how ANSTO can help you with your Fine Particle air sampling and characterisation?

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Further information can be obtained from our WEB site or by contacting David Cohen at the addresses given.