fine particle aerosol sampling
NEWSLETTER

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Nuclear-based science benefiting all Australians

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

2011- A Fine Particle Odyssey Update

It is hard to believe that we are now in our 20th year of sampling and characterising fine particles in both Australia and overseas, an odyssey which began all the way back in 1991. Our successful longevity is largely attributable to the magnificent efforts of our many collaborative partners. Over the years they have routinely changed filters and completed the necessary logsheets for their respective sampling units every single week. At ANSTO we have also continued to develop our air sampling expertise by developing new research tools and analysis methods for providing both a fine particle monitoring service and advanced data interpretation.
From all of us here at ANSTO, we look forward to your continued support of ASP related research and hope you enjoy this newsletter highlighting some significant achievements and results achieved over the years.

Interest in fine particle (≤ 2.5µm diameter) air pollution on a local, regional and global scale has increased significantly over the past decade both in Australia and internationally. It is now widely accepted that the air we breathe every day is polluted to various degrees by particulate matter released into the atmosphere by cars, factories, power stations and even home wood fire heaters. Recent research has shown that these fine particles can significantly contribute to adverse human health conditions, degradation of local visibility and even global climate change. Needless to say, these are all issues of significant social importance. Consequently, the monitoring of fine particle pollution concentrations and related sources has become increasingly important for governments and regulatory bodies both in Australia and around the world.
ANSTO has been routinely collecting fine particle filters every Wednesday and Sunday over a 24 hour period (midnight to midnight) at a number of urban, rural and industrial sites across Australia and around Asia. Analysis of these filters has been performed using accelerator based ion beam analysis (IBA) techniques. IBA techniques can accurately determine over 20 different chemical species at concentration levels as low as one microgram (one millionth of a gram) of a gram in a cubic metre of sampled air. Although this sensitivity is achievable with other techniques, the significant advantage of IBA for aerosol analysis compared to other techniques is that it is multi-elemental, can be accomplished without destroying the sample and with only takes a few minutes to analyse each filter.

A uniquely large database

Over the last 20 years we have sampled at over 80 different local and international locations resulting in over 45,000 analysed aerosol filters and amassing a dataset containing more than 180,000 collected IBA spectra. In fact, we are not aware of any other dataset of fine particulate matter measurements in Australia that is comparable both in length of consecutive years and number of sites. We believe this is both a unique and valuable database for fine particle research in Australia. All the filters collected to date are archived in a temperature controlled lab here at ANSTO.
We have recently released some of the monthly aerosol data sets spanning the years 2000 - 2009 online for several sampling sites. These can be downloaded at: http://openscience.ansto.gov.au/

Regional Cooperative Agreement (RCA) across Asia

ANSTO has also been involved in the Asia-Pacific Aerosol Database (A-PAD) project as part of the Regional Co-operative Agreement (RCA) under the International Atomic Agency (IAEA). Visible atmospheric haze is a major problem for many countries in the Asia region. Identifying the contributing sources of this haze is the first critical step towards developing strategies for reducing or eliminating this pollution. A-PAD is the result of a successful 14 country particulate matter project involving weekly (or biweekly) PM2.5 (fine) and PM10 sampling for a 24 hour period spanning 10 years (2000-2010). The 14 countries included Australia, Bangladesh, China, India, Indonesia, Korea, Malaysia, Mongolia, New Zealand, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam. Over this time a total of 8,831 fine (PM2.5) and 8,831 coarse (2.5-10µm) filters were analysed using nuclear techniques (IBA, NAA or XRF) to obtain at least 15 different elemental concentrations necessary for performing PMF source apportionment. Already the information in the database is proving to be an invaluable resource for developing new air pollution models and pollution reduction strategies based on better quantification of local source contributors as well as the influence of sources long range transport on the particle concentrations at a site. A subset of this database has now been released online and is available at: http://www.rcaro.org

Sydney Basin Sites

The Sydney Basin region located on the east coast of NSW is home to a significant portion of the Australian population, approximately 4.5 million people. ANSTO have been operating a number of urban, industrial and rural sampling sites in the Sydney basin continuously since 1998.

Sampling Site	Description
Mascot	Urban site in close proximity to Sydney CBD, Sydney International airport and major arterial motorways
Liverpool	Mixed urban/industrial site surrounded by urban housing and light industry
Lucas Height	Rural site 30 km south-west of Sydney CBD surrounded by bushland and minor roads
Richmond	Mixed urban/rural site north-west of Sydney surrounded mainly by agriculture

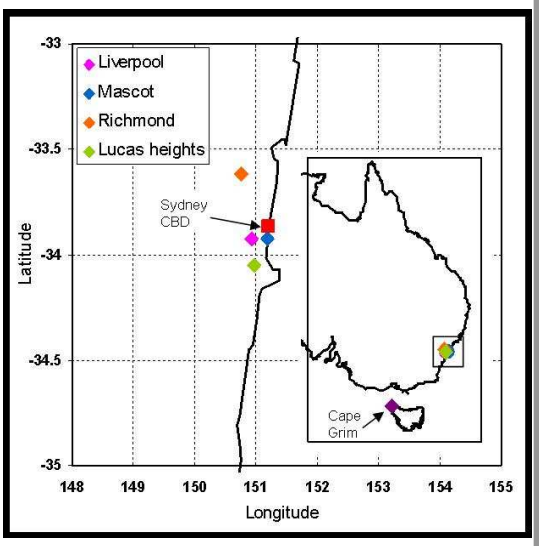
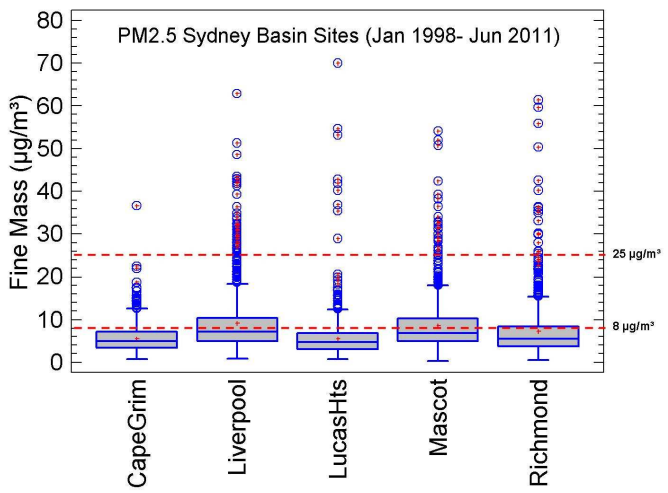


Fig 1 shows a map of the Australia east coast with the location of ANSTO fine particle sampling sites at Mascot, Lucas Heights, Liverpool and Richmond. The Cape Grim sampling site has also been included as it is regarded as the global air quality baseline.

How to interpret a Box and Whisker plot?

The red (+) sign within each box is the average value (mean), the horizontal bar within the box represents the median value within the distribution and the box itself contains 25% (lower bound) to 75% (upper bound) of the distribution of all measurements. The vertical whiskers above and below each box represent the ±95% confidence intervals for the measurements and the open circles and circles with (+) above the whiskers are outliers and extreme values, respectively.



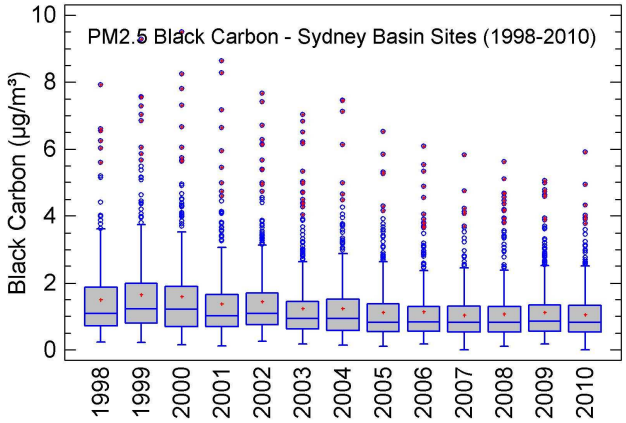


Fig 2 shows box and whisker plots of the daily fine mass (PM2.5) and the combined black carbon (BC) concentration for all of the Sydney basin sites over the period of 1998-2011. The PM2.5 for the Cape Grim global baseline site was also included for comparison. The Australian PM2.5 NEPM of 8 µg/m³ and 25 µg/m³ for annual and 24hr average; respectively have also been indicated.

The fine mass plot shows that while the levels of particles certainly vary from location to location, the annual PM2.5 mass average of for each site is below the NEPM PM2.5 annual goal of 8 µg/m³. However, the 24hr NEPM average have been exceeded several times over the years due mostly to extreme dust storm and bush fire events. The plot of BC on the other hand shows a gradual decrease over the last 13 year period. Based on our PMF source fingerprinting results, one of the major source contributors of BC in the Sydney basin region were automobiles. Although logic might have expected BC to increase in proportion to the increased number of cars on Sydney roads, the observed decrease suggests improved automotive technologies have reduced black carbon emissions with time.

Our ongoing aerosol data is currently being utilised by local councils, research organisations, pollution management agencies and industry bodies to assess air pollution in Australia. Please contact us if you would like more information.

Short Term US EPA NAAQS Standards for Airborne Particulate Matter

Index (NAAQS)	TSP (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	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/m³ annual and 25 µg/m³ 24-hr average

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

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