NSW GOVERNMENT

Clean Air Summit

New Knowledge on NSW Air Quality

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Australian Government

Ansto

Sydney Particle Characterisation Study 2000-14

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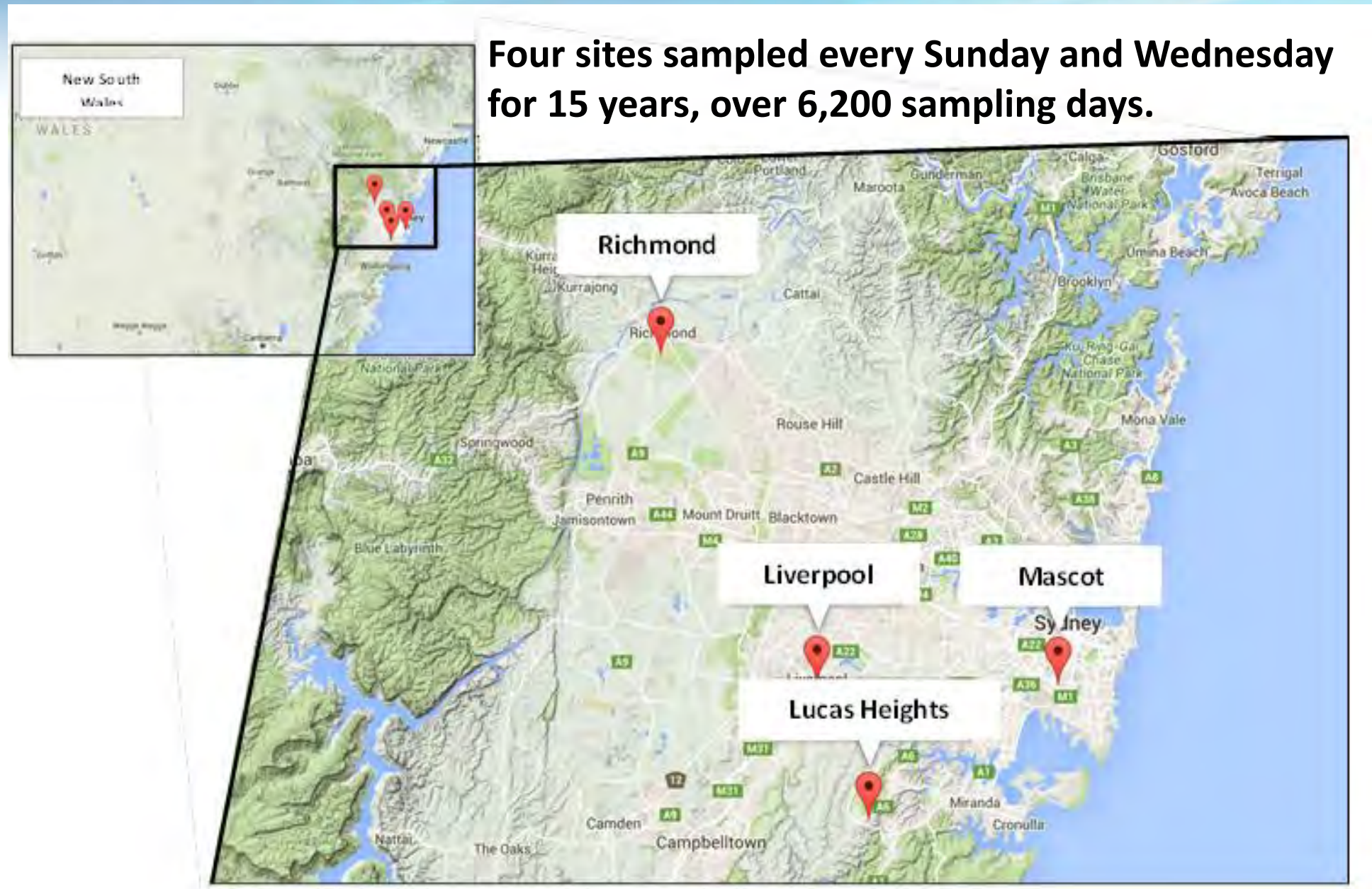
Study Locations 2000-14

Four sites sampled every Sunday and Wednesday for 15 years, over 6,200 sampling days.



Samplers and Filters

PM2.5 Cyclone unit with its microprocessor at Lucas Heights

Exposed stretched Teflon filter, specifically design for IBA analysis

Filters exposed from midnight to midnight each Sunday and Wednesday for 15 years

Measurements and Analysis

- PM2.5 mass pre- and post -exposure using ±2µg microbalance.
- Accelerator based ion beam analysis (IBA) techniques for 25 elements from H to Pb. (MDL =1-10 ngm^{-3})
- Black carbon (BC) using ANSTO laser absorption methods, assuming a mass absorption coefficient, ϵ = 7 m^2g^{-1} for all sites. (precision ±8%, MDL= 20 ngm^{-3})
- Source apportionment using Positive Matrix Factorisation (PMF). One step process giving 7 source fingerprints and their contributions to PM2.5 mass.

STAR accelerator at ANSTO

Black carbon laser instrument

PM2.5 Mass at All Sites

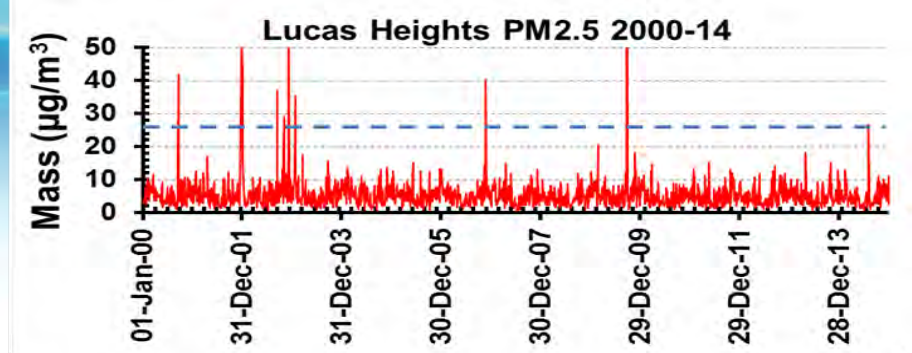
The average PM2.5 masses over 15 years were:-

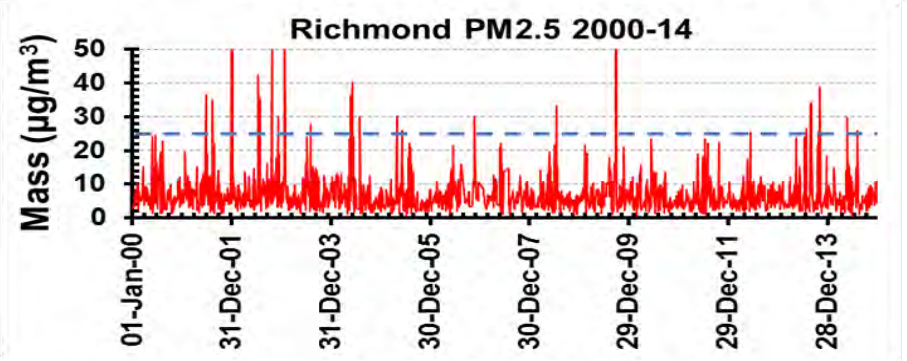
- **Lucas Heights, 5.43 µgm^{-3}**
- **Richmond, 7.10 µgm^{-3}**
- **Mascot 8.21 µgm^{-3}**
- **Liverpool 8.76 µgm^{-3}**

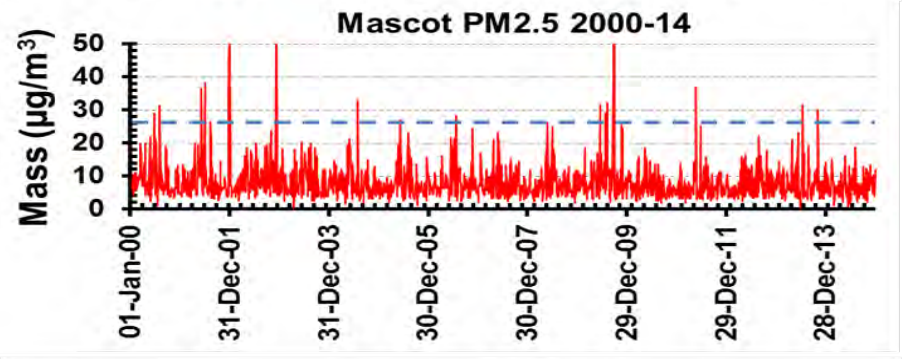
PM2.5 daily exceedances > 25 µgm^{-3}

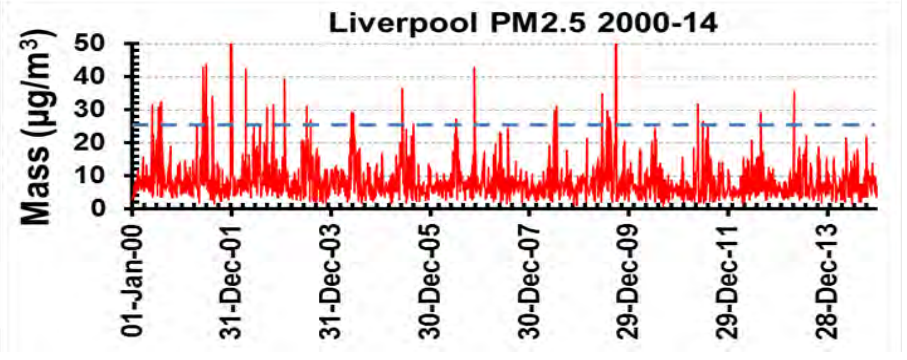
- **Lucas Heights, 11**
- **Richmond, 28**
- **Mascot, 23**
- **Liverpool, 43**

This is not a large number of exceedances, sampling every Sun, Wed for 1,560 sampling days/ site.

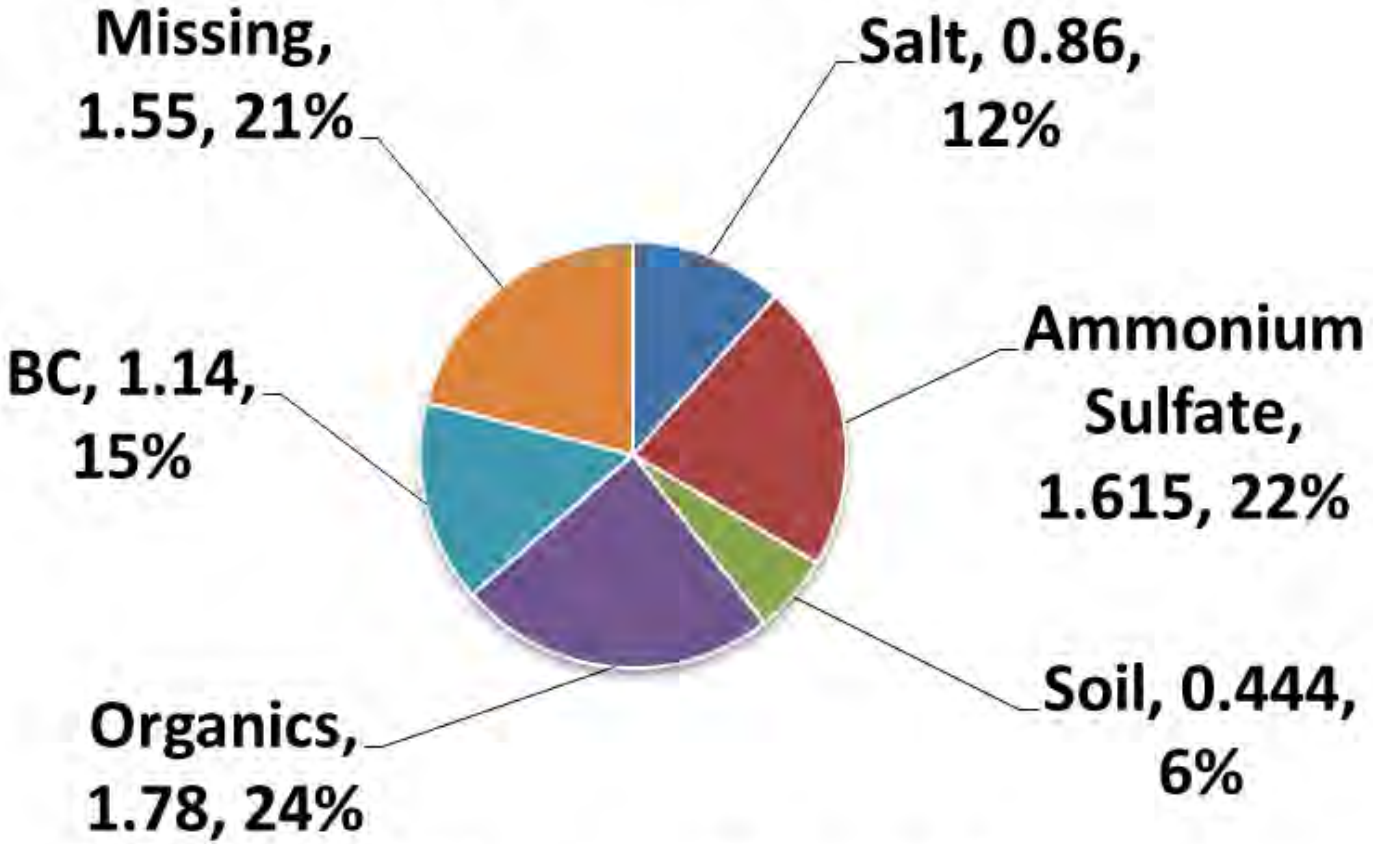








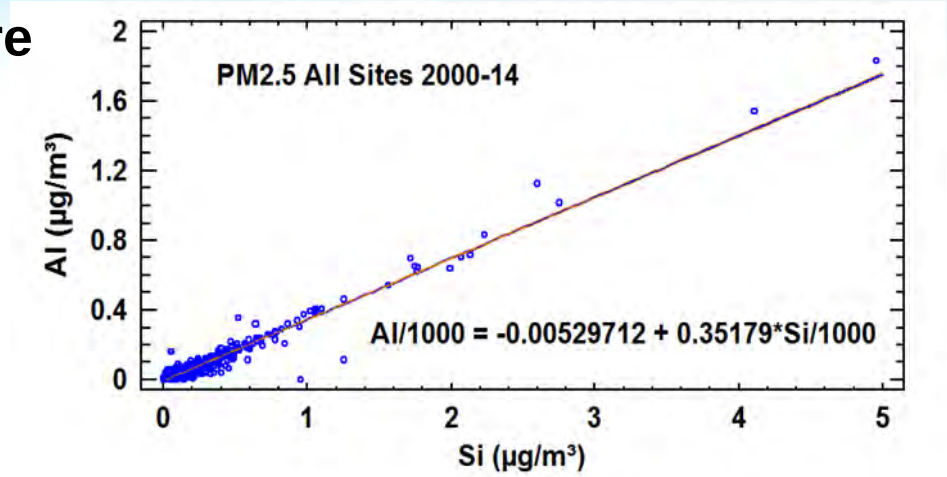
Average PM2.5 Chemical Composition
All Sites 2000-14



PM2.5 Mass= 7.392 $\mu g m^{-3}$

Source Correlations and Source Fingerprints

When elements originate from the same source 2D correlations are more obvious Al vs Si in soils.



When elements occur across several different sources multi-dimensional statistical methods are needed to extract fingerprints and source contributions.

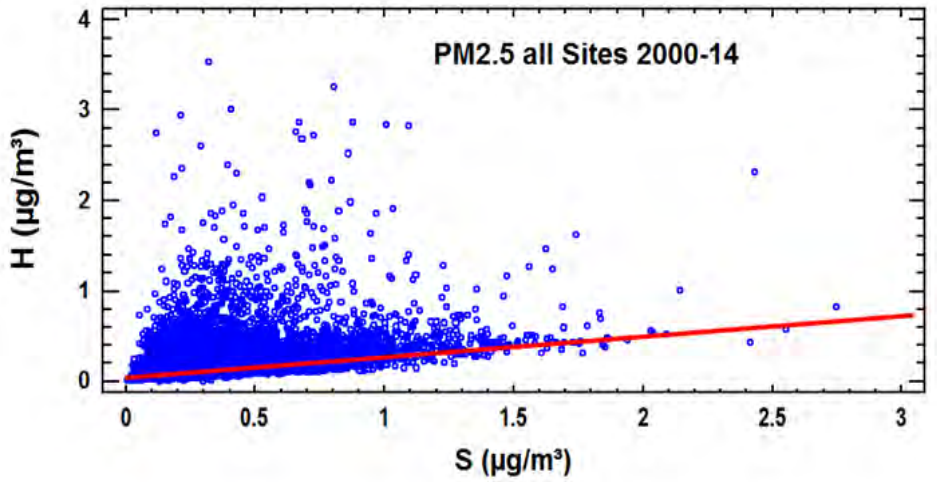
Positive Matrix Factorisation (PMF).

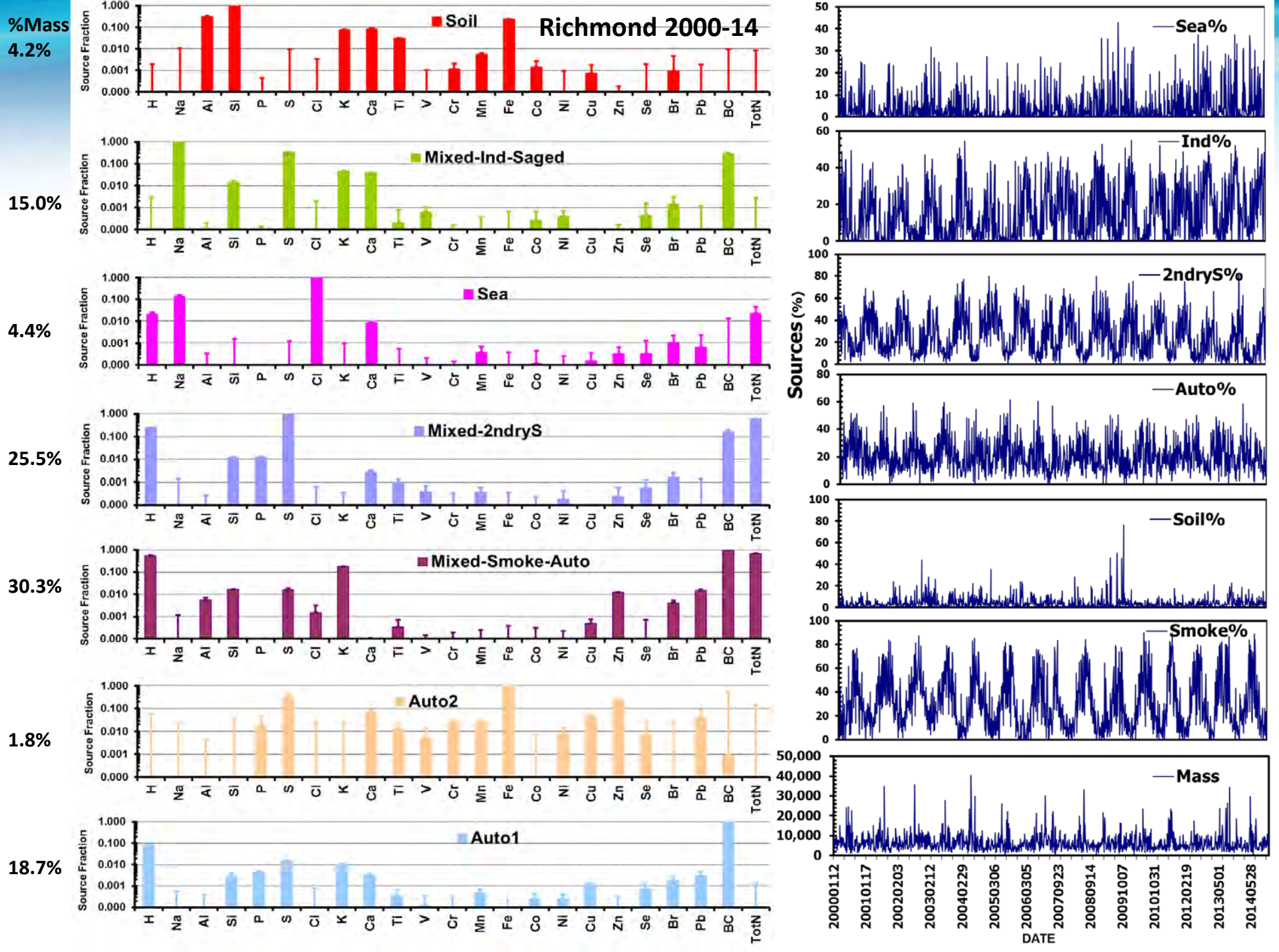
$$m_{i,j} = \sum_{k=1}^{p} f_{k,j} * g_{i,k} + e_{i,j}$$

where,

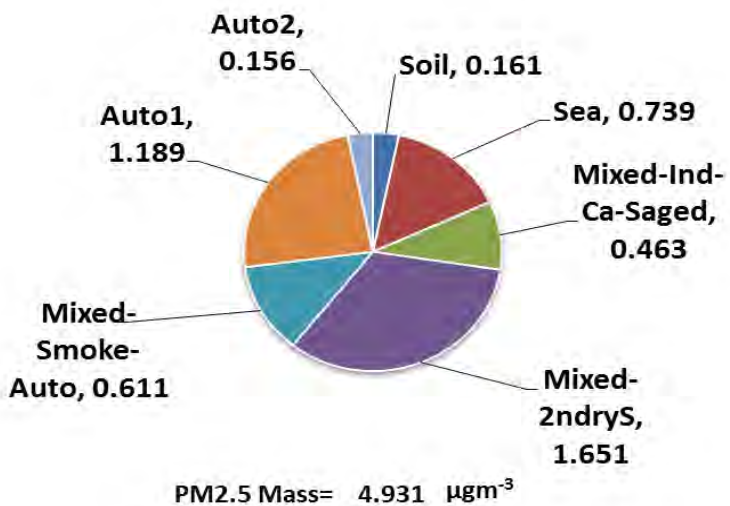
$$Q = \sum_{i=1}^{n} \sum_{j=1}^{m} \frac{e_{i,j}^2}{s_{i,j}^2}$$

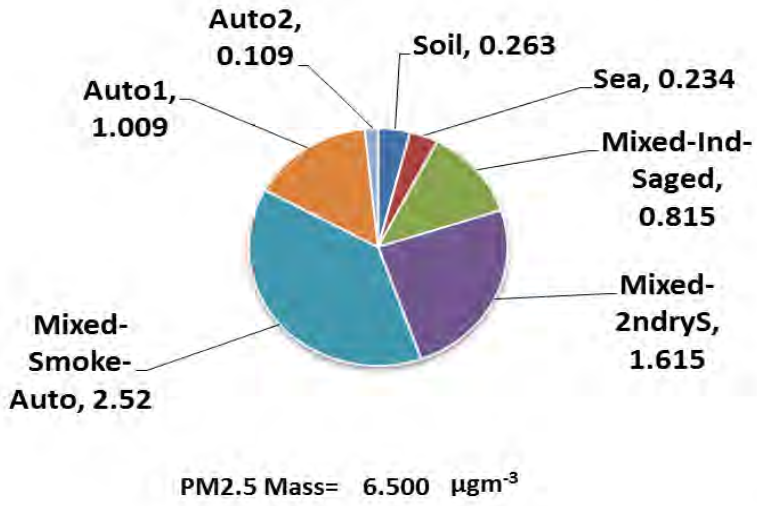
is minimised.

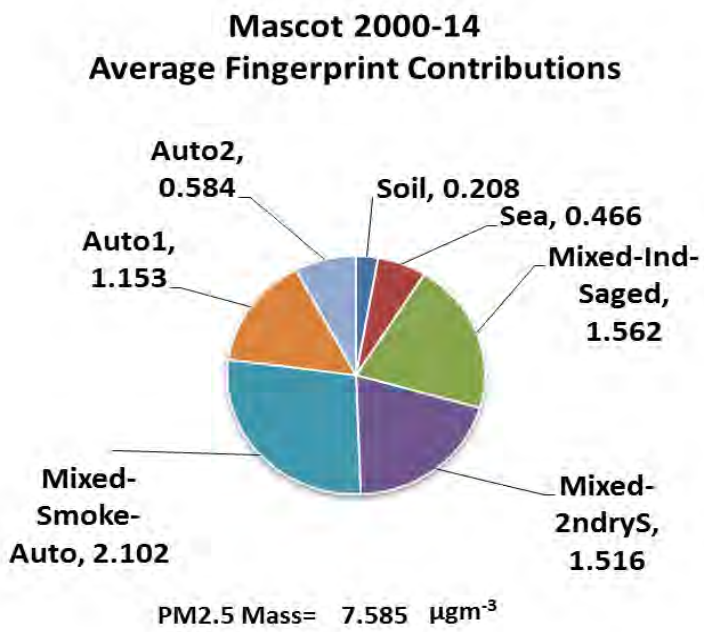


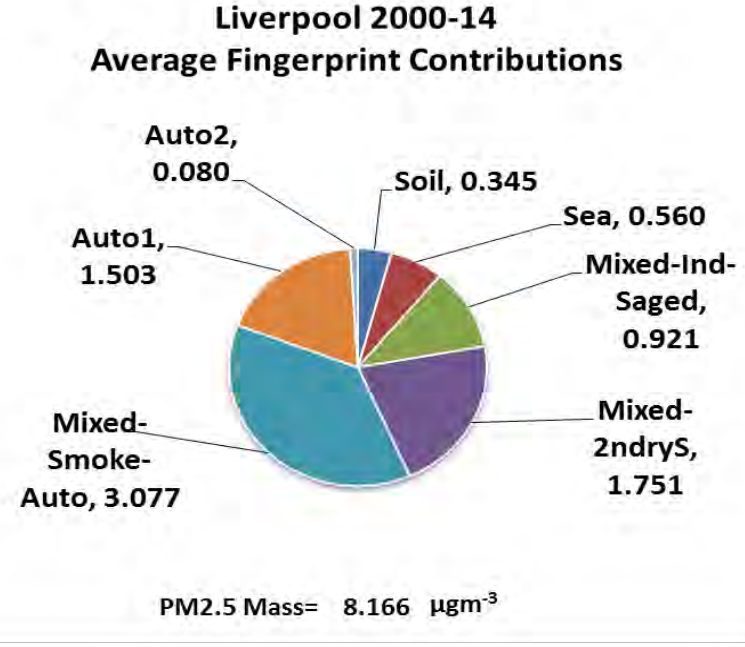

%Mass
4.2%
15.0%
4.4%
25.5%
30.3%
1.8%
18.7%
Richmond 2000-14
Soil
Mixed-Ind-Saged
Sea
Mixed-2ndryS
Mixed-Smoke-Auto
Auto2
Auto1
Source Fraction
1.000
0.100
0.010
0.001
0.000
H Na Al Si P S Cl K Ca Ti V Cr Mn Fe Co Ni Cu Zn Se Br Pb BC TotN
Sea%
Ind%
2ndryS%
Auto%
Soil%
Smoke%
Mass
Sources (%)
50,000
40,000
30,000
20,000
10,000
0
20000112
20010117
20020203
20030212
20040229
20050306
20060305
20070923
20080914
20091007
20101031
20120219
20130501
20140528
DATE

Average PMF Fingerprint Contributions by Site for 2000-14

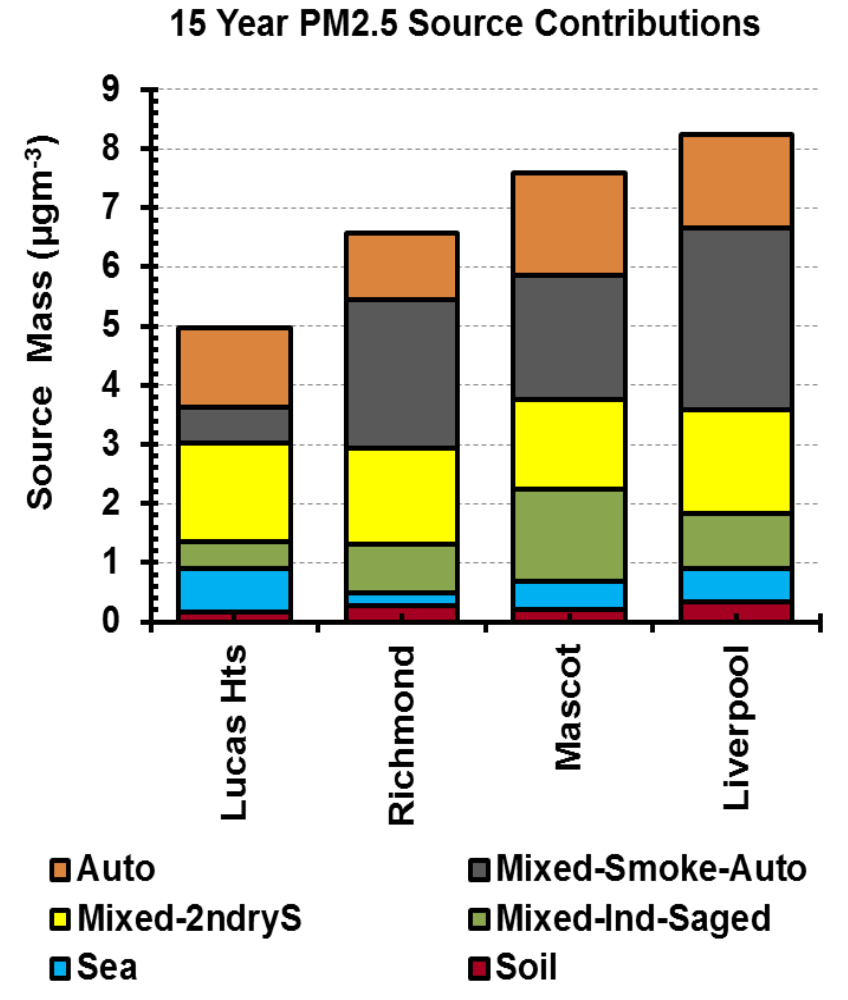








Average 15 Year PMF Source Contributions



PM2.5%	Lucas Hts	Richmond	Mascot	Liverpool
Mass (µgm^{-3})	4.93	6.50	7.59	8.17
Auto%	27.3	17.2	22.9	19.4
Mixed-Smoke%	11.6	30.3	23.2	31.6
Mixed-2ndryS%	29.8	25.5	20.1	21.8
Mixed-Industry%	9.19	15	23.2	13.9
Sea%	17.1	4.43	7.73	8.91
Soil%	3.10	4.22	2.76	4.05

Project Summary

This study identified four main pollution source factors:

- **smoke from domestic wood heaters peaking in winter months, (~60%-80%),**
- **secondary sulfates from coal fired power stations, industry, motor vehicles peaking in the summer months (~50%-70%) ,**
- **industrial sources, peaking in the summer months (~30%-50%),**
- **vehicle emissions contributing 15% to 30% of the annual PM2.5 mass.**

It has provided a 7 factor daily database across all four sites covering the period January 2000 to December 2014.

15 Year PMF Database-2000-14

Sydney Particle Characterisation Study Database

PM2.5 Receptor Source Apportionment in the Sydney Region between 2000 and 2014

Instructions

This program is used to view PMF data and plots from sampling sites related to the Sydney Particle Characterisation Study

1) First, press the (1) INITIALISE DATABASE button to intialise the macro program and clear any previous data. This ONLY needs to be perfomed once prior to the first site selection and extraction.

2) Using the Option Buttons (in cells C17 down), select the sampling site you wish to extract the PMF data for and press the (2) EXTRACT PMF Data & Plots button. Once completed, use navigation buttons on right side of menu page to view and navigate between the various extracted plots and data worksheets. To exctract another site, simply select another site using the option buttons and press macro button (2) again. All plots and data worksheets are locked to preserve the integrity of data contained in this workbook. To be able to edit the extracted data and plots, see option (3) below.

3) OPTIONAL: To export an editable xlsx version of the data/plots or a PDF, type the folder path where you want to save the file in the "Export Folder Path Location" text box (in cell F33) and press either the macro buttons (3) for an xlsx file or (4) for a pdf file. NOTE: macro buttons (3) and (4) will appear only after a PMF site has been extracted using button (2).

4) OPTIONAL: click on the map image or small map icon to view an interactive map of the sampling sites. NB: This function requires internet access.

PMF Data and Plots for Sampling Sites

(1) INITIALISE DATABASE

SITE		COMMENT
Lucas Heights	○	Southern Sydney semi-rural / urban Site (2000 - 2014)
Richmond	○	North-West Sydney Rural / Semi-urban Site (2000-2014)
Mascot	○	Central Sydney CBD / airport Site (2000-2014)
Liverpool	○	Western Sydney Urban Site (2000-2014)
Liverpool (2000-2004)	○	As above but for 5 year period
Liverpool (2005-2009)	○	As above but for 5 year period
Liverpool (2010-2014)	○	As above but for 5 year period

EXCEL file with 8 worksheets covering >5,700 sampling days at 4 sites every Sunday and Wednesday for 15 years from 2000-14.

Includes 7 factor fingerprint plots and daily time series plots of these factors.

Available on the ANSTO and OEH WEB sites **http://www.ansto.gov.au/asp**.

Acknowledgements

- Funded by the NSW EPA, NSW OEH, Botany City Council and ANSTO
- Filter changing over many years, NSW EPA at Liverpool site, UWS at Richmond site
- ANSTO ion beam accelerator staff for monthly analyses over 15 years.

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