

## SUPPORTING MATERIAL

# Effect based monitoring of seasonal ambient air exposures in Australia sampled by PUF passive air samplers

K. Kennedy<sup>a,\*</sup>, M. Macova<sup>a</sup>, M.E. Bartkow<sup>a</sup>, D.W. Hawker<sup>b</sup>, B. Zhao<sup>c</sup>, M.S. Denison<sup>c</sup>, J.F.

Mueller<sup>a</sup>

<sup>a</sup> *The University of Queensland, EnTox (The National Research Centre for Environmental Toxicology), Brisbane QLD 4108, Australia*

<sup>b</sup> *School of Environment, Griffith University, Nathan QLD 4111, Australia*

<sup>c</sup> *Department of Environmental Toxicology, University of California, Davis CA 95616, USA*

\* Corresponding author. 39 Kessels Road, Coopers Plains, Brisbane, QLD 4108, Australia. Tel: +61 7 32749009. Fax: +61 7 32749003. Email: [k.kennedy@uq.edu.au](mailto:k.kennedy@uq.edu.au)

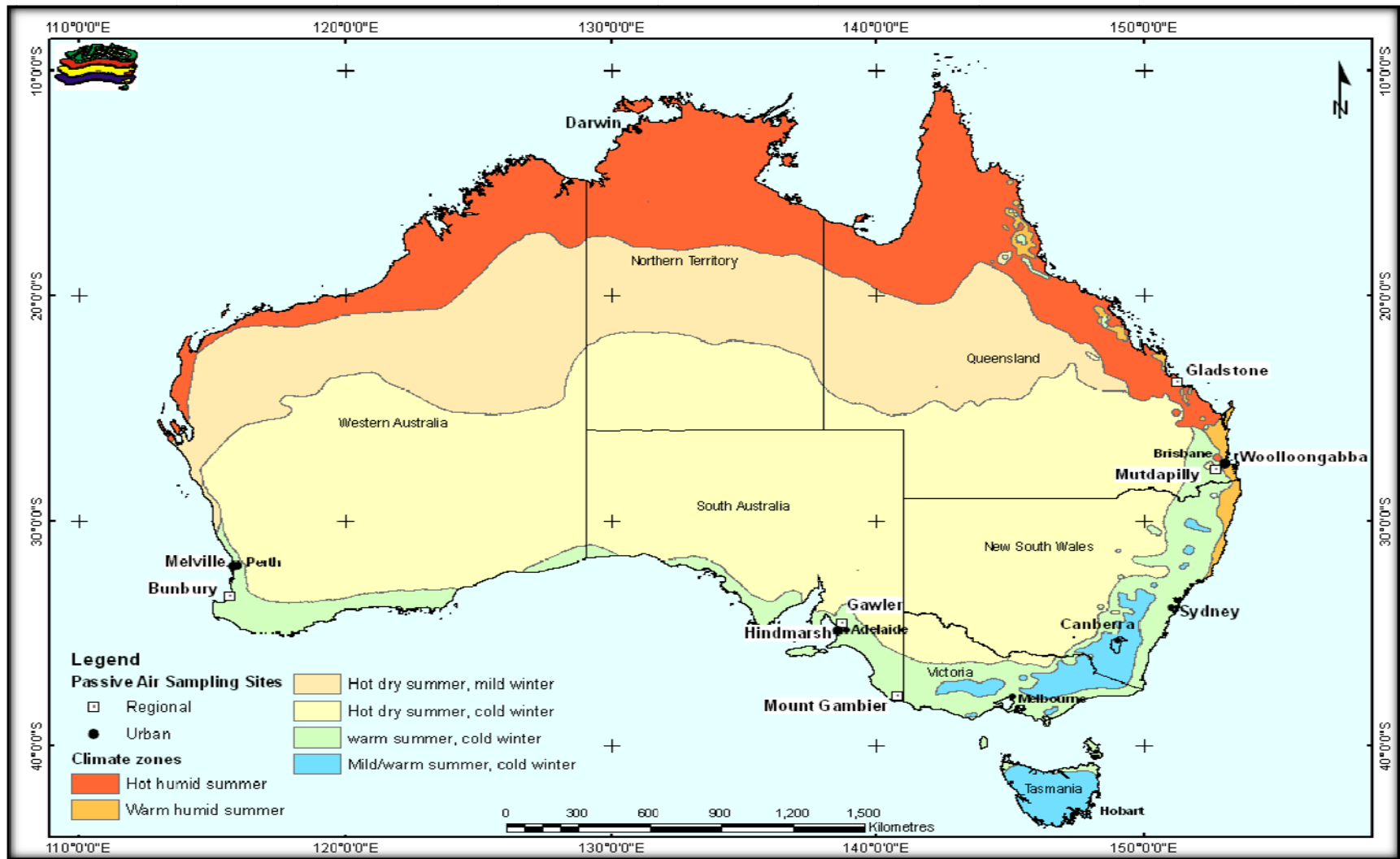


Figure S1 Location of passive air sampling sites

Map is modified (AUSGIS) from climate zone map for temperature and relative humidity prepared by the Bureau of Meteorology (IDCJCM0000 © Commonwealth of Australia 2005 reproduced by permission)

Table S1 Description of sampling sites

Sampling Sites	Co-ordinates <sup>a</sup>	State <sup>b</sup>	Description	Climate Zones <sup>c</sup> Temperature & Relative Humidity	Climate Zones <sup>d</sup> Seasonal Rainfall
<i>Perth*</i>	32°02'S 115°48'E	WA	Urban capital city	warm summer cold winter	marked wet winter dry summer
<i>Bunbury</i>	33°20'S 115°38'E	WA	Regional centre	warm summer cold winter	marked wet winter dry summer
<i>Gladstone</i>	23°52'S 151°16'E	QLD	Regional centre	hot humid summer	wet summer low winter rainfall
<i>Brisbane*</i>	27°29'S 153°02'E	QLD	Urban capital city	warm humid summer	wet summer low winter rainfall
<i>MtDapilly</i>	27°43'S 152°36'E	QLD	Regional background	warm summer cold winter	wet summer low winter rainfall
<i>Gawler</i>	34°35'S 138°44'E	SA	Regional centre	warm summer cold winter	wet winter low summer rainfall
<i>Adelaide*</i>	34°54'S 138°34'E	SA	Urban capital city	warm summer cold winter	wet winter low summer rainfall
<i>Mt. Gambier</i>	37°49'S 140°46'E	SA	Regional centre	warm summer cold winter	wet winter low summer rainfall

\*Perth site located at Melville, Brisbane site located at Woolloongabba, Adelaide site located at Hindmarsh; <sup>a</sup> coordinates for these locations sourced from Geoscience Australia (Australian Government) using the Geocentric Datum of Australia (GDA94); <sup>b</sup> States of Australia including Western Australia (WA), Queensland (QLD) and South Australia (SA); <sup>c</sup> climate zones based on temperature and relative humidity using standard 30 year climatology (1961 – 1990) as mapped by the Bureau of Meteorology (Australian Government) IDCJCM0000; <sup>d</sup> climate zones based on major seasonal rainfall using median annual rainfall and seasonal incidence for a 100 year period (1900 – 1999) as mapped by the Bureau of Meteorology (Australian Government) IDCJCM0002;

<sup>c,d</sup> maps may be sourced online: [http://www.bom.gov.au/climate/enviro/other/aus\\_climates.shtml](http://www.bom.gov.au/climate/enviro/other/aus_climates.shtml) with further details regarding climate zone criteria provided in the map construction links.

### **CAFLUX ASSAY**

H4G1.1c2 cells were grown in T75 flasks in  $\alpha$ -Minimum Essential Medium with L-Glutamine selective media (2 % G418 sulphate) containing 10% foetal calf serum, 1% penicillin-streptomycin in a tissue-culture incubator (37°C, 5% CO<sub>2</sub>) until approximately confluent. The cells were seeded into 96 well flat clear bottom black polystyrene microplates @  $2.5 \times 10^4$  cells well<sup>-1</sup> at a volume of 100  $\mu$ L well<sup>-1</sup> using selective media and incubated (37 °C; 5 % CO<sub>2</sub>) for 24 hours or until the cells were 90 % confluent.

For dosing, the media was replaced with 100  $\mu$ L of non-selective media containing in triplicate either the BIO-PUF sample (5 point, 10-fold dilution series; maximum 1 % DMSO)

or the reference compound TCDD. The reference compound dilution series (2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) 9 point  $2 \times 10^{-7}$  M –  $1 \times 10^{-12}$  M, a positive control ( $\beta$ -naphthoflavone) and solvent/negative control (1 % DMSO) were run on each plate. The plates were incubated at 33°C, in a 5% CO<sub>2</sub> atmosphere and EGFP activity (expressed as relative fluorescence units (RFU)) measured after 24, 48 and 72 hours of incubation in a FLUOstar plate reader (excitation 485 nm, emission 520 nm, and gain 1500). Solvent control measurements were subtracted from both reference compound, individual compound testing (PAH) and the BIO-PUF sample induced RFU.

Assay detection limits for effect levels were determined based on effective concentrations of reference compound for that effect level and the maximum dose of the sample which was not cytotoxic. Quantification limits were determined based on field blank equivalencies plus 3 standard deviations. If detectable activity was found in the field blanks for a specific effect level average field blank equivalencies (n = 3) were subtracted prior to determining TCDD Eq<sub>BIO</sub> for each site.

### **umu C ASSAY**

$\beta$ -galactosidase activity is measured via the introduction of a synthetic substrate O-nitrophenyl- $\beta$ -D-galactopyranoside (ONPG) which is converted to a yellow coloured product O-nitrophenol (ONP) which may be quantified colourmetrically. TA1535/pSK1002 were grown overnight on a shaker in Luria-Bertani medium (50  $\mu\text{g.mL}^{-1}$  ampicillin; 37 °C). The overnight culture was diluted 20 fold in TGA medium (1 % bactotryptone, 0.5 % NaCl, 0.2 % glucose, 50  $\mu\text{g.mL}^{-1}$  ampicillin) and incubated (37°C) for approximately two hours in a shaker until optical density at 600 nm was 0.25. Meanwhile 96 well clear polystyrene plates (Plate A) were prepared with serial dilutions of the sample, and the reference compounds (all in 3 % DMSO). Plate A was incubated (900 rpm, 37 °C, 2

hours) with bacteria in a microplate shaker, then 30  $\mu$ L transferred to fresh TGA/ampicillin @ 37 °C for a further two hour incubation (Plate B).

Growth was assessed using Plate B (absorbance 600 nm) while  $\beta$ -galactosidase activity was assayed by the addition of 30  $\mu$ L of Plate B to Plate C containing the substrate ONPG. Plate C was incubated for a further 30 minutes (900 rpm, 28 °C) prior to measurement of ONP (absorbance 420 nm). All absorbance measurements were made using a BMG Labtech FLUOstar plate reader.

The following controls are required:

1. Bacterial control / Blank (BC)
  - sterile distilled water and culture medium without bacteria
2. Negative control / Water control (WC)
  - mixture of culture medium, bacteria and sterile distilled water
3. Solvent controls (SC)
  - mixture of culture medium, bacteria and 3% DMSO.
4. Positive controls
  - mixture of culture medium, bacteria and 180  $\mu$ L of 50ng/ml 4-nitroquinoline-*N*-oxide (3 % DMSO) for -S9.
  - mixture of culture medium, bacteria and 180  $\mu$ L of 400 ng/mL 2-aminoanthracene (3 % DMSO) for +S9.
5. Reference compounds
  - mixture of culture medium, bacteria and 0.18 – 370 ng/well of 6-nitrochrysene for -S9 (3 % DMSO)
  - mixture of culture medium, bacteria and 0.88 – 1800 ng/well or 3.4 – 7000 ng/well of benzo[*a*]pyrene for +S9 (3 % DMSO)

There are three main parameters calculated for the umuC assay. These include the growth factor (G) which indicates toxicity of the sample to the bacteria with respect to the water control, relative

$\beta$ -galactosidase units (U) which is the amount of  $\beta$ -galactosidase produced relative to the growth, and the induction ratio (IR) is the ratio of  $\beta$ -galactosidase induction of the sample and the water control, taking into account the growth of the bacteria. All parameters are calculated using absorbance readings (A) at either 600 or 420 nm. Water controls (WC) and bacterial controls (BC) readings are used in these calculations. A sample was considered significantly genotoxic with an induction ratio (IR)  $\geq 1.5$  while growth remained  $>0.5$  and the  $\beta$ -galactosidase of the sample was twice that of the solvent control. Assay detection limits were determined based on effective concentrations of reference compound to induce an induction ratio of 1.5 and the maximum dose of the sample which was not cytotoxic (Growth  $> 0.5$ ).

$$G = (A600_{\text{sample}} - A600_{\text{BC}}) / (A600_{\text{WC}} - A600_{\text{BC}})$$

$$U = (A420_{\text{sample}} - A420_{\text{BC}}) / (A600_{\text{T}} - A600_{\text{BC}})$$

$$IR = (1/G) * ((A420_{\text{sample}} - A420_{\text{BC}}) / (A420_{\text{WC}} - A420_{\text{BC}}))$$

### **Selection of 6-nitrochrysene as reference chemical on the *umu C* ASSAY**

The selection of 6-nitrochrysene as a reference compound for direct acting induction of the *umuC* operon was based on the evaluation of growth and induction ratio dose response curves for individual nitrated PAH available in our laboratories. The nitrated PAHs evaluated included 1-nitronaphthalene, 2-nitronaphthalene, 9-nitroanthracene, 9-nitrophenanthrene, 2-nitrofluorene. Dose response curves for both growth and induction ratios for 6-nitrochrysene are provided in Figure S2. It should be noted that the evaluation of 6-nitrochrysene also indicated that it is both direct and indirect acting. Indirect acting genotoxicity for this compound has been reported previously for this compound.(Shimada et al., 1989).

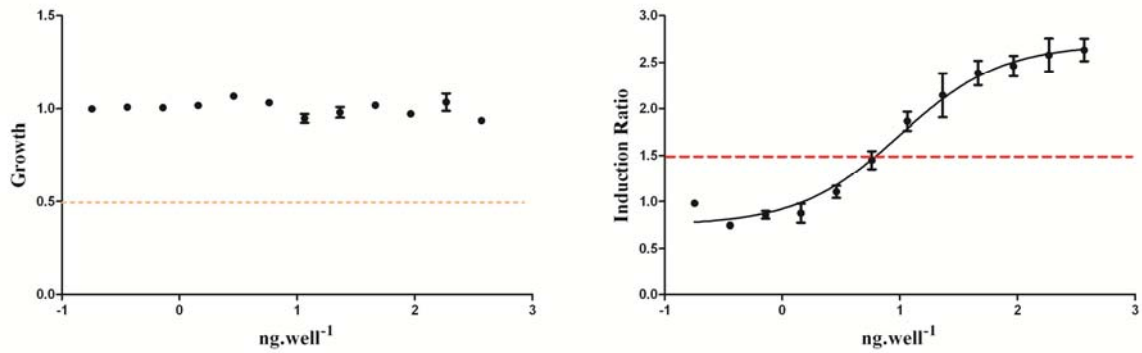


Figure S2 Dose response curves for the growth and induction ratios of 6-nitrochrysene without metabolic activation (-S9) on the umuC genotoxicity assay.

Table S2 A summary of parameters used in this study to quantify either exposure or effect

Parameter	Units	Description
<b>B[a]P</b>	(ng m <sup>-3</sup> )	The concentration in air of the PAH marker compound benzo[a]pyrene
<b>ΣB[a]P TEQ</b>	(ng m <sup>-3</sup> )	The toxic equivalent benzo[a]pyrene concentration in air determined using carcinogenic toxic equivalency factors <sup>a</sup> for individual PAH with respect to benzo[a]pyrene and the respective air concentrations
<b>B[a]P Eq<sub>BIO</sub></b>	(ng m <sup>-3</sup> )	The benzo[a]pyrene equivalent air concentration determined on the <i>umu</i> C genotoxicity assay with metabolic activation of the sample (Equation 1)
<b>6-nCHY Eq<sub>BIO</sub></b>	(ng m <sup>-3</sup> )	The 6-nitrochrysene equivalent air concentration determined on the <i>umu</i> C genotoxicity assay without metabolic activation of the sample (Equation 1)
<b>TCDD Eq<sub>BIO</sub></b>	(pg m <sup>-3</sup> )	The 2,3,7,8-TCDD equivalent air concentration determined on the CAFLUX AhR activity assay (Equation 2)
<b>REP</b>		The relative potency of an individual PAH with respect to 2,3,7,8-TCDD determined on the CAFLUX AhR activity assay (Equation 3)
<b>ΣTCDD Eq<sub>CHEM</sub></b>	(pg m <sup>-3</sup> )	The 2,3,7,8-TCDD equivalent air concentration determined using the relative potencies of individual PAH with respect to TCDD determined on the CAFLUX AhR activity assay and the respective air concentrations (Equation 4)

<sup>a</sup> TEF values (Nisbet and LaGoy 1992)

Table S3 Seasonal sampling rates, volume of air sampled and volume of air dosed for effect assessment

Sampling Locations	$R_S^a$ [m <sup>3</sup> day <sup>-1</sup> ]	$t^b$ [days]	Summer			$R_S$ [m <sup>3</sup> day <sup>-1</sup> ]	$t$ [days]	Winter		
			$V_{A-1}^c$ [m <sup>3</sup> ]	$V_{A-2}^d$ [m <sup>3</sup> ]	$V_{A\text{ BIO}}^e$ [m <sup>3</sup> μL <sup>-1</sup> ]			$V_{A-1}$ [m <sup>3</sup> ]	$V_{A-2}$ [m <sup>3</sup> ]	$V_{A\text{ BIO}}$ [m <sup>3</sup> μL <sup>-1</sup> ]
<i>Perth</i>	3.0	40	122	243	1.4	2.3	44	100	200	1.2
<i>Bunbury</i>	3.4	40	134	269	1.6	3.4	44	150	300	1.8
<i>Gladstone</i>	6.8	40	273	545	3.2	5.1	41	210	420	2.5
<i>Brisbane</i>	4.5	41	184	367	2.2	3.6	45	162	324	1.9
<i>Mutdapilly</i>	4.5	41	183	366	2.2	3.7	45	168	337	2.0
<i>Gawler</i>	2.2	42	93	186	1.1	2.5	50	123	247	1.5
<i>Adelaide</i>	2.7	42	113	225	1.3	2.3	50	115	229	1.4
<i>Mt Gambier</i>	3.5	41	145	291	1.7	2.9	46	133	266	1.6

<sup>a</sup> sampling rates determined from the elimination of the PRC PCB 30 in winter and by correcting winter sampling rates for predicted influences of temperature (Fuller et al. 1966) and wind speed (Tuduri et al. 2006) between seasons as outlined previously (Kennedy et al. 2010); <sup>b</sup> deployment period in days; <sup>c</sup>  $V_{A-1}$  is the volume of air sampled by a single PUF; <sup>d</sup>  $V_A$  for the 2-PUF configuration; <sup>e</sup>  $V_{A\text{ BIO}}$  is the volume of air dosed per μL of BIO-PUF sample (final volume 120 μL corrected for known losses during GPC (5 out of 7 mL of sample injected))

All BIO-PUF equivalent concentrations (Equations 1 and 2) were initially determined based on the volume of BIO-PUF sample (μL) necessary to illicit the specified effect levels. These were then converted using  $V_{A\text{ BIO}}$  (m<sup>3</sup>.μL<sup>-1</sup>) (Table S3) to equivalent air concentrations for each site. Using this approach allows equivalent concentrations of field blanks to be directly comparable to BIO-PUF samples exposed in the field and if necessary for these concentrations to be subtracted prior to conversion to equivalent air concentrations.

Table S4 Average seasonal PAH levels ( $C_{AIR}$  ( $ngm^{-3}$ )), average seasonal ratios and benzo[*a*]pyrene toxic equivalent air concentrations in urban capital cities, regional centres and one rural background site estimated using PUF passive air samplers

Air Concentration ( $ng m^{-3}$ ) <sup>3)</sup>	Western Australia						Queensland						South Australia			
	Perth		Bunbury		Gladstone		Brisbane		Mutdapilly		Gawler		Adelaide		Mount Gambier	
	Urban capital		Regional centre		Regional centre		Urban capital		Rural background		Regional centre		Urban capital		Regional centre	
Polycyclic Aromatic Hydrocarbons <sup>a</sup>	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
ACY	0.034	0.81	0.010	0.041	0.022	0.11	0.34	1.1	0.0026	<0.0051	0.0097	0.29	0.50	3.0	0.071	0.35
ACE	0.018	0.17	<0.0057	0.17	0.086	0.28	0.034	0.26	<0.0042	<0.016	0.057	0.34	0.11	0.78	1.1	7.9
FLO	0.24	1.6	0.050	0.56	0.16	0.77	0.54	2.2	0.013	0.26	0.28	1.5	1.0	4.7	2.2	8.9
PHE	1.7	11	0.50	2.7	1.0	3.1	3.7	11	0.16	1.0	1.3	7.4	7.2	16	5.5	20
ANT	0.28	1.2	0.040	0.23	0.052	0.17	0.57	1.5	0.007	0.010	0.020	0.56	1.1	4.4	0.17	1.3
FLU	1.3	4.3	0.31	1.3	0.53	1.3	2.1	3.6	0.08	0.34	0.64	3.2	4.2	11	1.1	6.9
PYR	1.4	4.0	0.27	1.2	0.30	1.0	2.8	4.1	0.064	0.20	0.31	2.8	4.7	12	0.69	5.3
B[ <i>a</i> ]A	0.22	0.50	0.025	0.13	0.053	0.12	0.31	0.39	0.008	0.013	0.022	0.32	0.63	1.3	0.024	0.58
CHY	0.30	0.69	0.044	0.19	0.11	0.22	0.39	0.54	0.021	0.056	0.048	0.50	0.77	1.5	0.058	0.80
B[ <i>b+k</i> ]F	0.22	0.34	0.025	0.082	0.13	0.19	0.26	0.31	0.010	0.026	0.033	0.17	0.51	0.83	0.027	0.22
B[ <i>e</i> ]P	0.10	0.19	0.013	0.034	0.041	0.11	0.15	0.29	0.0047	0.016	0.017	0.080	0.29	0.58	0.012	0.093
B[ <i>a</i> ]P	0.037	0.084	0.0051	0.013	0.025	0.060	0.088	0.16	<0.0055	0.0071	0.0092	0.037	0.15	0.33	0.0056	0.054
PER	<0.0082	0.013	<0.0074	<0.0026	0.0051	0.014	0.018	0.022	<0.0055	<0.0059	<0.011	<0.012	0.032	0.057	<0.0096	0.0042
I[1,2,3- <i>c,d</i> ]P	0.059	0.20	0.0065	0.031	0.033	0.11	0.056	0.25	<0.0055	0.012	<0.011	0.070	0.11	0.56	<0.0096	0.092
B[ <i>g,h,i</i> ]PER	0.10	1.0	0.015	0.18	0.023	0.42	0.15	2.4	<0.0055	0.056	<0.011	0.36	0.24	3.6	<0.0096	0.37
D[ <i>a,h</i> ]A	<0.0082	0.025	<0.0074	<0.0067	<0.0037	0.021	<0.0054	0.054	<0.0055	<0.0059	<0.011	<0.0081	<0.0087	0.063	<0.0096	0.017
<b>Average RSD %<sup>b</sup></b>	23%	5%	18%	22%	26%	24%	6%	8%	5%	12%	9%	11%	5%	12%	13%	11%
<b>Average W:S<sup>c</sup></b>	6		5		4		4		5		11		4		9	
<b>Σ B[<i>a</i>]P TEQ (<math>ng m^{-3}</math>)<sup>d</sup></b>	0.13	0.32	0.048	0.073	0.066	0.21	0.18	0.53	0.036	0.042	0.070	0.14	0.33	0.93	0.060	0.23

<sup>a</sup>ACY (acenaphthylene), ACE (acenaphthene), FLO (fluorene), PHE (phenanthrene), ANT (anthracene), FLU (fluoranthene), PYR (pyrene), B[*a*]A (benz[*a*]anthracene), CHY (chrysene), B[*b+k*]F (benzo[*b*]fluoranthene and benzo[*k*]fluoranthene), B[*e*]P (benzo[*e*]pyrene), B[*a*]P (benzo[*a*]pyrene), PER (perylene), I[1,2,3-*c,d*]P (indeno[1,2,3-*c,d*]pyrene), B[*g,h,i*]PER (benzo[*g,h,i*]perylene), D[*a,h*]A (dibenz[*a,h*]anthracene); <sup>b</sup> average relative standard deviation in quantification of replicate samples; <sup>c</sup> winter: summer ratio averaged from each site; <sup>d</sup> determined for group 1, 2A and 2B IARC carcinogenic PAH including LOD values as Σ(TEF ×  $C_{AIR}$ ) with TEF values from (Nisbet & LaGoy 1992)

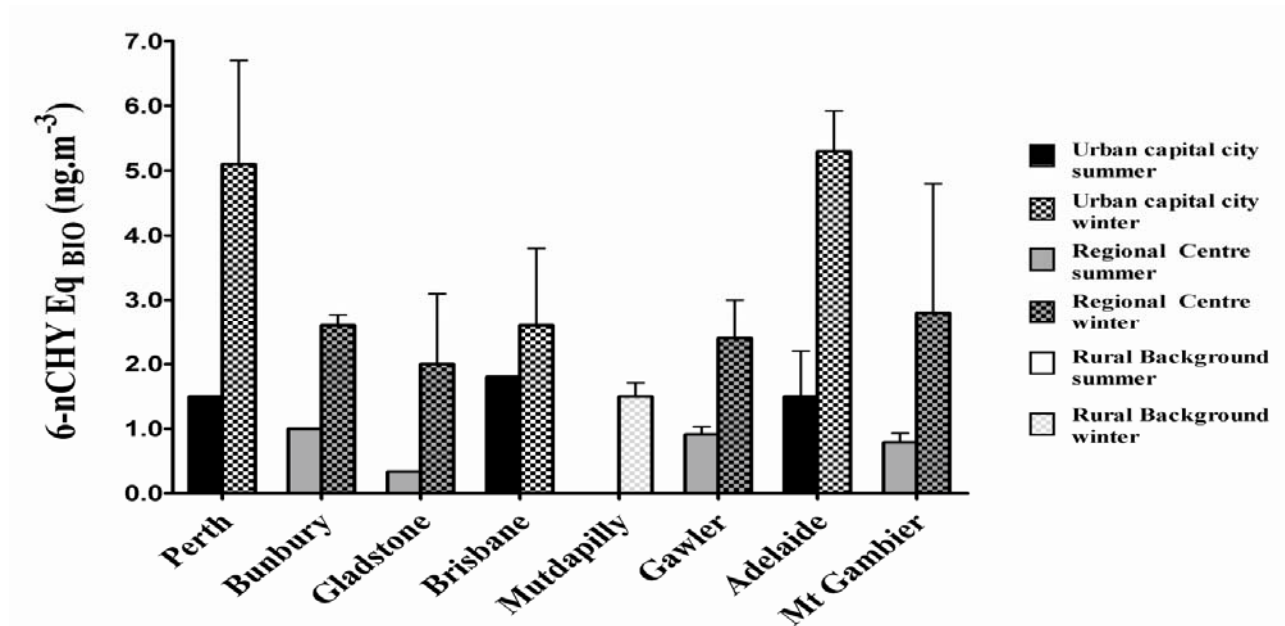


Figure S3 Seasonal direct acting genotoxicity (-S9) expressed as 6-nitrochrysene equivalent air concentrations (6-nCHY Eq<sub>BIO</sub> (ng.m<sup>-3</sup>)) derived from PUF passive air samplers for urban capitals, regional centres and a rural background location

Table S5 CAFLUX derived AhR potencies expressed as TCDD equivalent air concentrations (pg m<sup>-3</sup>) at the 50 % TCDD max effect level after 48 and 72 hour incubation periods in summer and winter

Incubation Period	Site	TCDD Eq <sub>BIO</sub> <sup>a</sup>	
		50%	
		Summer	Winter
48 hour	Perth	<0.36	4.1± 0.065
	Bunbury	<0.33	1.8± 0.066
	Gladstone	2.8	1.9± 0.62
	Brisbane	5.7± 1.4	23± 12
	Mutdapilly	<0.24	0.64± 0.26
	Gawler	<0.47	3.6± 0.47
	Adelaide	5.3	34± 6.6
	Mt Gambier	0.44± 0.10	2.5± 0.85
72 hour	Perth	<0.38	2.0± 0.94
	Bunbury	<0.34	0.83± 0.18
	Gladstone	1.2	1.4
	Brisbane	<0.25	8.6± 6.3
	Mutdapilly	<0.25	0.48
	Gawler	<0.50	1.5± 0.86
	Adelaide	0.48	12± 2.1
	Mt Gambier	<0.32	1.4± 0.20

<sup>a</sup>Equation 2

Table S6 CAFLUX derived relative potency estimates for individual PAH with respect to TCDD for the 5 and 20 % effect level in different incubation periods

Polycyclic Aromatic Hydrocarbons	# of Rings	5 % Effect Level			20% Effect Level		
		REP [M] ratio			REP [M] ratio		
		Incubation Period			Incubation Period		
Sixteen Priority Pollutant		24 hour	48 hour	72 hour	24 hour	48 hour	72 hour
1 Naphthalene	2	-	-	-	-	-	-
2 Acenaphthene	3	4.7E-08	4.5E-08	4.5E-08	2.0E-08	2.7E-08	2.70391E-08
3 Acenaphthylene	3	-	-	-	-	-	-
4 Fluorene	3	-	-	-	-	-	-
5 Phenanthrene	3	-	-	-	-	-	-
6 Anthracene	3	8.9E-08	2.7E-08	2.2E-08	-	-	-
7 Fluoranthene	4	1.1E-07	4.3E-08	5.0E-08	1.5E-07	6.4E-08	5.4E-08
8 Pyrene	4	1.6E-07	1.8E-07	1.8E-07	1.2E-07	1.1E-07	1.0E-07
9 Chrysene	4	2.0E-03	3.2E-04	8.0E-05	4.7E-04	4.7E-05	2.2E-05
10 Benz[ <i>a</i> ]anthracene	4	1.4E-03	2.7E-04	9.1E-05	2.4E-04	5.9E-05	2.6E-05
11 Benzo[ <i>a</i> ]pyrene	5	5.8E-04	5.5E-05	6.2E-05	1.0E-04	1.3E-05	1.1E-05
12 Benzo[ <i>b</i> ]fluoranthene	5	9.3E-03	2.1E-04	5.3E-05	1.1E-03	5.9E-05	2.3E-05
13 Benzo[ <i>k</i> ]fluoranthene	5	4.6E-03	1.3E-03	2.3E-04	5.5E-04	6.3E-05	2.1E-05
14 Indeno[1,2,3- <i>c,d</i> ]pyrene	6	1.8E-01	3.5E-03	9.9E-04	7.9E-03	3.7E-04	1.4E-04
15 Benzo[ <i>g,h,i</i> ]perylene	6	1.3E-06	4.8E-07	4.7E-07	1.0E-06	3.6E-07	4.5E-07
16 Dibenz[ <i>a,h</i> ]anthracene	5	1.1E-02	3.1E-03	8.0E-03	6.7E-03	1.3E-03	3.7E-03
<b>Other:</b>							
17 Benzo[ <i>e</i> ]pyrene	5	5.5E-07	1.9E-07	1.6E-07	4.3E-07	-	-
18 Perylene	5	7.7E-07	5.8E-07	7.8E-07	1.8E-06	1.1E-06	1.1E-06
19 2-methylphenanthrene	3	-	-	-	-	-	-
20 1-nitropyrene	4	1.7E-05	5.1E-06	8.2E-06	5.5E-04	6.3E-05	2.1E-05

All REP are the average of two independent tests in triplicate

## REFERENCES

- Fuller, E.N.; Schettler, P.D. Giddings, J.C., 1966. New method for prediction of binary gas-phase diffusion coefficients, *Industrial & Engineering Chemistry* **58**, 18-27.
- Kennedy, K.; Hawker, D.W.; Bartkow, M.E.; Carter, S.; Ishikawa, Y. Mueller, J.F., 2010. The potential effect of differential ambient and deployment chamber temperatures on PRC derived sampling rates with polyurethane foam (PUF) passive air samplers, *Environmental Pollution* **158**, 142-147..
- Nisbet, I.C.T. LaGoy, P.K., 1992. Toxic equivalency factors (TEFs) for polycyclic aromatic hydrocarbons (PAHs). *Regulatory Toxicology & Pharmacology* **16**, 290-300.
- Shimada, T., Iwasaki, M., Martin, M.V., Guengerich, F.P., 1989. Human liver microsomal cytochrome P-450 enzymes involved in the bioactivation of procarcinogens detected by umu gene response in Salmonella typhimurium TA 1535/pSK1002. *Cancer Research* **49**, 3218-3228.
- Tuduri, L.; Harner, T. Hung, H., 2006. Polyurethane foam (PUF) disks passive air samplers: wind effect on sampling rates. *Environmental Pollution* **144**, 377-383.