



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
RESEARCH TRIANGLE PARK, NC 27711

OFFICE OF  
AIR QUALITY PLANNING  
AND STANDARDS

**MEMORANDUM**

**SUBJECT:** Statistical information on air quality data from epidemiologic studies

**FROM:** Mary Ross, Health Scientist 

**TO:** PM NAAQS Review Docket (OAR-2001-0017)

This memorandum supplements the reported PM<sub>2.5</sub> and PM<sub>10-2.5</sub> air quality data from the short-term PM exposure studies, summarized in Appendix A of Chapter 3 of the draft Staff Paper, with information provided by the study authors (Attachment A). In preparing the draft Staff Paper, staff used information on the distribution of air quality data from health studies that used daily PM<sub>2.5</sub> and PM<sub>10-2.5</sub> data, including general distribution statistics such as the mean, minimum and maximum values measured during the study period, as well as the 95<sup>th</sup> to 99<sup>th</sup> percentile values. Staff observed that most studies provide some data on the distribution of concentration data for PM and gaseous co-pollutants, but the information provided was sometimes limited and the descriptive statistics provided vary from one study to another.

Authors of U.S. and Canadian epidemiologic studies were contacted by email (Attachment B), and asked for descriptive statistics for the air quality data used in their studies. We specifically requested information on the upper percentile values (95<sup>th</sup>, 96<sup>th</sup>, 97<sup>th</sup>, 98<sup>th</sup>, 99<sup>th</sup> percentile concentrations), as well as the mean, median, minimum and maximum values. We noted that the authors could send the air quality data set for us to calculate the statistics, if they wished.

In response to our request:

- descriptive statistics were directly provided by authors of several studies (Lippmann et al., 2000; Ostro et al., 2000; Stieb et al., 2000; Tolbert et al., 2000)
- air quality data sets were provided for a number of studies (Burnett et al., 2000, 1999, 1998, 1997; Delfino et al., 1997, 1998; Fairley, 1999; Lipfert et al., 2000)
- annual average values for the years 1988 to 1996 were provided for the Seattle area and these values were averaged across the study periods for several studies (Moolgavkar et al., 2000; Norris et al., 1999; Sheppard et al., 1999)

Data were already available within EPA for a study conducted in Phoenix, AZ (Mar et al., 2000) since the data were collected as part of a monitoring study conducted by EPA's National Exposure Research Laboratory. In addition, air quality measurements made for the Harvard Six Cities study (e.g., Schwartz et al., 1996) had been provided to EPA previously.

The descriptive statistics for the health studies are summarized in the attached table (Attachment A); also attached are copies of the responses received from investigators (Attachment C) and a compact disc containing the data files provided (Attachment D). Where no additional data were obtained from researchers, the attached table includes the data available from the study publication. We note that, in comparing descriptive statistics calculated from data sets provided by researchers with results from the published papers, in a few cases these statistics varied slightly from those included in the original publication; however, in no case was there a substantial difference between the values.

In the attached table, data from U.S. and Canadian studies are arranged in order of increasing mean  $PM_{2.5}$  and  $PM_{10-2.5}$  concentrations. The study time periods varied from several months to approximately 10 years. Average  $PM_{2.5}$  concentrations varied from 8.6 to 42.1  $\mu\text{g}/\text{m}^3$  across the studies and average  $PM_{10-2.5}$  concentrations varied from 6.3 to 33.2  $\mu\text{g}/\text{m}^3$ . For the purpose of this memorandum, data are presented for those studies with mean  $PM_{2.5}$  concentrations from the low end of the range up to 18  $\mu\text{g}/\text{m}^3$ .

Attachments

## ATTACHMENT A

### Air Quality Statistics from U.S. and Canadian Health Studies of Short-term Exposure to Fine and Coarse Fraction Particles

#### A. Statistics for 24-hour PM<sub>2.5</sub> Concentrations from Health Studies (up to means of 18 µg/m<sup>3</sup>)

Study Location	Air Quality Distribution Statistics <i>Italics = not year-round data</i>						
	mean	95%	96%	97%	98%	99%	max
Stieb, et al., 2000 St. John	8.5	20.5	22	23.4	27.3	30.9	53.2
<i>Yu et al., 2000 Seattle</i>	<i>10.4</i>						<i>61.7</i>
Schwartz 2003a Portage	11.2	26.2	29	31	34.3	39.7	63
Norris, et al., 1999 Seattle	12	28.3**	31.3**	33.1**	35.9**	40.5**	81
Schwartz 2003a Topeka	12.2	26	27	29.4	32	37	56
Burnett and Goldberg, 2003 8 Canadian Cities	13.3	32**	31.1**	34.3**	38.9**	45.4**	86
Mar, et al., 2003 Phoenix	13.5	27.8	28.5	30.2	32.2	34.1	41
Fairley, 2003 Santa Clara County	13.6	43	46.2	49	59	69.2	105.4
<i>Delfino, et al., 1997 Montreal</i>	<i>14.7</i>	<i>31.4</i>	<i>44.4</i>	<i>47.2</i>	<i>50.2</i>	<i>60.2</i>	<i>69.6</i>
Schwartz 2003a Boston	15.7	34.5	35.4	37.2	42	45	70.8
Ostro, et al., 2003 Coachella Valley	15.8	28.6	29.8	30.5	33.8	37.0	48.3
<i>Thurston, et al., 1994 Toronto</i>	<i>15.8- 22.3</i>				51		66
Burnett et al., 1999 Toronto	16.4	36	38	40.1	41.9	60	71
Burnett, et al., 1998 Toronto	16.4	36	38	40.1	41.9	60	71
Sheppard, et al., 2003 Seattle	16.7	37.3**	40.2**	41.7**	46.6**	54.7**	96h
<i>Burnett, et al., 1997 Toronto</i>	<i>16.8</i>	<i>39.8</i>	<i>40.5</i>	<i>43.5</i>	<i>47.4</i>	<i>54.9</i>	<i>66.4</i>
Lipfert et al., 2000 Philadelphia	17.3	35.7	37.4	40.9	44.2	49.1	72.6
Goldberg and Burnett, 2003 Montreal	17.4	39.5	44.4	46.6	53.1	59	72
Ito, 2003 Detroit	18	42.6	47.4	50.3	55.2	59.2	86

**B. Statistics for 24-hour PM<sub>10-2.5</sub> Concentrations from Health Studies**

Study Location	Air Quality Distribution Statistics						
	mean	95%	96%	97%	98%	99%	max
Zhang et al., 1999 Naeher et al., 1999 SW Virginia	6.3						19.8
Schwartz, 2003a Portage	6.6	19	20.1	22	25	30.7	121
Lipfert et al., 2000 Philadelphia	6.9	14.9	15.4	16.7	18.3	19.3	28.3
Neas et al., 1999 Philadelphia	8.3						
Schwartz, 2003a Boston	8.8	21.6	23.1	25.4	28.6	33.5	69.3
Tolbert, et al., 2000 Atlanta	9.4	17.5	18.2	19.6	21	21.8	28.6
Klemm and Mason, 2000 Atlanta	10						39.5
Schwartz, 2003a Kingston/Harriman	11.2	23.5	24.2	26.9	29.1	34.7	121
Burnett et al., 1999 Toronto	11.3	24	25	26	30	33.7	68
Burnett, et al., 1997 Toronto	11.5	22.9	24.2	26.5	29.5	35.8	56.1
Fairley, 2003 Santa Clara County	11.7	22	24	26	29.2	39.2	55.2
Schwartz, 2003a St. Louis	11.9	28	29.1	30.7	32.9	38.9	102.6
Thurston, et al., 1994 Toronto	12.7- 16.5						33
Burnett and Goldberg, 2003 8 Canadian cities	12.9	30	29.6**	32.9**	34.0**	42.5**	99
Ito, 2003 Detroit	13.3	27.6	31	34	36.2	40.2	50
Schwartz, 2003a Topeka	14.5	38.2	41.1	44	49	58.9	95.4
Schwartz, 2003a Steubenville	16.1	39.1	42.4	47	53.2	61.4	167.5
Sheppard, et al., 2003 Seattle	16.2	27.2**	27.8**	31.4**	32.3**	38.7**	88
Schwartz, Neas, 2000 6 US cities	22*						31
Moolgavkar, 2003 LA	22*						80
Ostro, et al., 2003 Coachella Valley	30.5	65.1	74.2	87.2	106.8	134.0	418

Study Location	Air Quality Distribution Statistics <i>Italics = not year-round data</i>						
	mean	95%	96%	97%	98%	99%	max
Mar, et al., 2003 Phoenix	33.2	60.5	62.3	66.3	70.6	75.4	158.6

\* median

\*\* averaged annual values for years in study provided by investigators

ATTACHMENT B

Mary Ross

05/07/02 04:12 PM

To: rick\_burnett@hc-sc.gc.ca, hepings@zyang@yale.edu,  
mark@polair.epi.mcgill.ca, lippmann@charlotte.med.nyu.edu,  
dfairley@baaqmd.gov, BOSTRO@oehha.ca.gov,  
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Lucas Neas/RTP/USEPA/US@EPA, brian.leaderer@yale.edu,  
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cc: Karen Martin/RTP/USEPA/US@EPA, Johnd  
Bachmann/RTP/USEPA/US@EPA, John  
Langstaff/RTP/USEPA/US@EPA, Scott  
Mathias/RTP/USEPA/US@EPA

Subject: request for air quality data from PM-health studies

To: Authors of recent U.S. and Canadian fine and coarse fraction PM epidemiology studies

You are probably aware that the EPA is now in the process of reviewing the national ambient air quality standards (NAAQS) for particulate matter (PM). An important part of this review is the preparation of the "Staff Paper" by the EPA's Office of Air Quality Planning and Standards. In the Staff Paper, we offer staff conclusions and recommendations to the EPA Administrator on a range of alternatives that may include retaining or revising the PM NAAQS. We are currently preparing the first external review draft of the PM Staff Paper, and plan to release this document for review around the end of June, 2002.

In preparing the draft Staff Paper, it is helpful to consider air quality distributions from areas where health studies were conducted to investigate associations between PM and health effects. Most studies provide some information on the distribution of concentration data for PM and gaseous co-pollutants, but the information is generally limited in scope and the descriptive statistics provided vary from one study to another.

Thus, I am contacting you now to ask you to provide information on the distribution of the air quality data for PM<sub>2.5</sub> and PM<sub>10-2.5</sub> (where measured) used in your studies. It is important to emphasize that I am **not** requesting health data. In addition, I am not requesting raw air quality data, but rather information on the distribution of the data. However, if you would prefer to send the entire air quality data set for us to compute the descriptive statistics, that would also be acceptable. Please be aware that your responses, together with whatever data you provide, will be placed in our public docket.

- Specifically, the descriptive statistics on the air quality data for the time period of the study that we are interested in are: mean and median values, 95th, 96th, 97th, 98th, and 99th percentile values, and the minimum and maximum values.

- In addition, we would ask that you identify the air quality monitors used, unless these monitors are identified already in the study publications.

References for U.S. and Canadian studies that have used fine and coarse fraction PM data are listed below. In most cases the first author is also listed as the contact for correspondence; however, where another author is indicated as corresponding author, I have listed that name at the end of the reference and will follow up with that author. I will follow this email message with a telephone call in the next day or so to try to address any additional questions you might have about this request. If you have already provided air quality data to us in response to earlier requests, we thank you, and I will verify that we have received the requested data when I call. Thank you in advance for your time.

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ATTACHMENT C



Paige Tolbert  
<ptolber@sph.emory.edu>

To: Mary Ross/RTP/USEPA/US@EPA  
cc: Kristina Busico Metzger <kmetzge@sph.emory.edu>  
Subject: Fw: request for air quality data from PM-health studies

05/15/02 04:23 PM

Here are the descriptive statistics regarding PM2.5 and coarse particles (PM 10-2.5) you requested, attached as an excel file. For the paper you cited ("Interim results..." JEAEE, 2000;10:446-460), the study period for which these data were available was 8/98-7/99. That paper also presented epidemiologic results for the preceding five-year period during which PM10 was the only particulate measure -- let us know if you would like distributional information on PM10 for that period. Please feel free to contact me or the study coordinator, Dr. Kristi Metzger (copied above), if you have further questions.

Best wishes,  
Paige

\*\*\*\*\*

Paige Tolbert, Ph.D.  
Associate Professor  
Rollins School of Public Health  
Emory University

\*\*\*\*\*

EPA

var	mean	median	p95	p96	p97	p98	p99	min	max
PM25	19.41883	17.54322	38.71547	41.10628	41.97559	44.68363	45.67969	3.194361	53.239
CP	9.385624	8.945186	17.52332	18.24671	19.59848	21.01257	21.79711	0.502787	28.56517



Kaz Ito  
<kaz@env.med.nyu.ed  
u>

To: Mary Ross/RTP/USEPA/US@EPA  
cc: lippmann@env.med.nyu.edu  
Subject: Detroit PM distribution

05/09/02 12:17 PM

Hi Mary,

The requested distributional characteristics for PM2.5 and PM10-2.5 measured at the monitor at the intersection of College and Park Streets in Windsor are:

minimum, median, mean, 95%, 96%, 97%, 98%, 99%, and maximum

PM2.5: 4.0, 15.0, 18.0, 42.6, 47.4, 50.3, 55.2, 59.2, and 86.0

PM10-2.5: 1.0, 12.0, 13.3, 27.6, 31.0, 34.0, 36.2, 40.2, and 50.0

Please let me know if there are more questions. Good luck!

Kaz

>Mary:

> In response to your telephone message this afternoon, I forwarded  
> your e-mail message to Kaz Ito, who has the air quality data files  
> you seek for our HEI sponsored study of Mortality and hospital  
> admissions in Detroit. The Windsor air quality data that we used were  
> provided by Jeff Brook. You should be hearing from Kaz about getting  
> the data files you seek.

>Mort Lippmann



**Bart Ostro**  
<[BOSTRO@oehha.ca.gov](mailto:BOSTRO@oehha.ca.gov)>  
ov>

To: Mary Ross/RTP/USEPA/US@EPA  
cc:  
Subject: percentiles in the Valley

07/24/03 05:50 PM

Mary: Per your request, I've attached a file with the distribution of our FP and CP data used in our mortality study. Let me know if you need any more information. Best, Bart

Dr. Bart Ostro, Ph.D., Chief  
Air Pollution Epidemiology Unit  
California Office of Environmental Health Hazard Assessment (OEHHA)  
1515 Clay St., 16th Floor  
Oakland, CA 94612  
(510) 622-3157  
FAX: (510) 622-3210



[Bostro@oehha.ca.gov](mailto:Bostro@oehha.ca.gov) percentiles.xls

Distributions for Fine and Coarse Data used in Mortality Analysis of Coachella Valley

*fine particles indio - dates Jan 01, 1989 thru Dec 10, 1998*

mean	median	p95	p96	p97	p98	p99	min	max
15.8	14.8	28.6	29.8	30.5	33.4	37.0	4.8	48.3

*predicted coarse particles indio - dates Jan 01, 1989 thru Dec 10, 1998*

mean	median	p95	p96	p97	p98	p99	min	max
30.5	26.2	65.1	74.2	87.2	106.8	134.0	0.0	418.3



Chuck Morgan  
<cjmorgan@u.washing  
ton.edu>

06/03/02 07:34 PM

To: Mary Ross/RTP/USEPA/US@EPA  
cc: Jane Koenig <jkoenig@u.washington.edu>, 'Lianne' Elizabeth  
Sheppard <sheppard@u.washington.edu>  
Subject: reply to data request

To: [Ross.Mary@epamail.epa.gov](mailto:Ross.Mary@epamail.epa.gov)

Re: request for air quality data from PM-health studies, dated 7 May 2002  
Addressed to Jane Q Koenig, PhD, University of Washington and Lianne Sheppard, PhD, University of  
Washington.

<?xml:namespace prefix = o ns = "urn:schemas-microsoft-com:office:office" />

Monday, June 03, 2002

Thank you for the opportunity to provide some supplementary analysis of the data used in Norris *et al.* (1),  
Sheppard *et al.* (2), and Yu *et al.* (3).

All three studies used data from three monitoring sites in the Seattle area: the Duwamish (coded  
"SDUW"), Kent ("KENT"), and Lake Forest Park ("LFPA"). The time periods of the studies differ. Norris *et al.*  
used data from September 95 through December 96; Sheppard *et al.* used data from January 87  
through December 96, and Yu *et al.* used data from November 93 through August 95. In an effort to  
standardize the reporting of this data, we are providing data on an annual basis for each of the three  
monitoring sites. These data are attached as SAS data files.

Note that the larger file (SeattleA) contains measurements of average daily PM10 and PM2.5 collected by  
the Federal Reference Method. The smaller (SeattleB) file contains estimated PM2.5 for the Lake Forest  
Park site, extrapolated from nephelometer data (4).

Charles J. Morgan, PhD  
Research Scientist  
UW / EPA Northwest Particulate Matter  
and Health Research Center

voice: 206 616 6524

#### Notes

1. Norris, G.; Youngpong, S. N.; Koenig, J. Q.; Larson, T. V.; Sheppard, L.; Stout, J. W. (1999) An  
association between fine particles and asthma emergency department visits for children in Seattle.  
*Environ. Health Perspect.* 107:489-493. (Dr. Koenig)

2. Sheppard, L.; Levy, D.; Norris, G.; Larson, T. V.; Koenig, J. Q. (1999) Effects of ambient air pollution on nonelderly asthma hospital admissions in Seattle, Washington, 1987-1994. *Epidemiology* 10: 23-30.

3. Yu, O.; Sheppard, L.; Lumley, T.; Koenig, J.; Shapiro, G. G. (2000) Effects of ambient air pollution on symptoms of asthma in Seattle-area children enrolled in the CAMP study. *Environ. Health Perspect.* 108:1209-1214. (Dr. Sheppard)



4. The formula used is  $PM_{2.5est} = 0.641 + 25.565 * neph$ . [SeattleA.sd](#) [SeattleB.sd](#)



David Fairley  
<DFairley@baaqmd.go  
v>

To: Mary Ross/RTP/USEPA/US@EPA  
cc:  
Subject: RE: request for air quality data from PM-health studies

05/07/02 05:50 PM

I did use just 1 monitoring site: San Jose - 4th St. (120B N 4th St, San Jose, CA 95112) The info I have says the AIRS id is 850004. Please contact me if you need more info.



Fred Lipfert  
<flipfert@suffolk.lib.ny.us>

To: Mary Ross/RTP/USEPA/US@EPA  
cc:  
Subject: Fw: philadelphia pm data

05/07/02 10:22 PM

Mary - here are the original data that were used in the paper. Table 2 of the paper gives some of the statistics you wanted.

-----Original Message-----

From: George Allen <gallen@sparc6b.harvard.edu>  
To: flipfert@suffolk.lib.ny.us <flipfert@suffolk.lib.ny.us>  
Cc: Douglas W. Dockery <ddockery@hsph.harvard.edu>  
Date: Saturday, January 23, 1999 1:51 PM  
Subject: philadelphia pm data

>

>Hi Fred; the Philadelphia PM data you requested is in the attached zip  
>file. There are two files within that zip file, both flat ASCII  
>comma-delimited format: pby.csv [the data and a long header with  
>supplemental info] and pby-colo.csv [the collocated data from the same  
>site].

>

>I did do a preliminary screening for gross problems using only  
>these pm2.5 and pm10 data, but checks for external consistency [eg, with  
>sulfate data or mass reconstruction from the XRF data] have not been done;  
>that would resolve some of the data that look odd here but are not  
>impossible values.

>

>Please contact me if you have any questions.  
> George

>

>George A. Allen  
>Harvard School of Public Health  
>665 Huntington Ave., Room I-G10  
>Boston, MA 02115  
>Tel: 617-432-1946  
>Fax: 432-0497 (or 33449)  
>Email: gallen@hsph.harvard.edu

>

>



phil-pby.zi



Therese Mar  
<therese@u.washingto  
n.edu>

05/08/02 01:19 PM

To: Mary Ross/RTP/USEPA/US@EPA  
cc:  
Subject: Re: request for air quality data from PM-health studies

Hi Mary,

The data that I used was from EPA NERL. I used PM2.5 and PM10 from 1/1/95 to 12/31/97. The coarse fraction was calculated as the difference PM10-PM2.5. Let me know if you need any additional information.

Therese



Tom Dann  
<dann.tom@etc.ec.gc.ca>  
ca>

To: Mary Ross/RTP/USEPA/US@EPA  
cc: Rick Burnett <rick\_burnett@hc.sc.gc.ca>  
Subject: Dichot Data Base

05/14/02 02:50 PM

Hi Mary

At the request of Rick Burnett I'm sending you all the mass data (< 2.5  $\mu$ m and 2.5-10  $\mu$ m) collected in our dichotomous sampler network between 1984 and 2002. I've also included station details for all sites that appear in the data archive. If you have any questions please give me a call.

Tom

Tom Dann  
Head Air Toxics  
Analysis and Air Quality Division  
Environment Canada  
ETC, 335 River Road  
Ottawa, Ontario K1A 0H3

Phone: 613-991-9459  
Fax: 613-998-4032  
E-mail: tom.dann@ec.gc.ca



DICHALL.csv



dich\_sites.xls



"Delfino, Ralph"  
<rdelfino@uci.edu>

05/14/02 05:36 PM

To: Mary Ross/RTP/USEPA/US@EPA, Tom Dann  
<dann.tom@etc.ec.gc.ca>, rick\_burnett@hc-sc.gc.ca,  
mark@polair.epi.mcgill.ca, dave\_stieb@hc-sc.gc.ca

cc:

Subject: Re: Dichot Data Base

For

Delfino, R. J.; Murphy-Moulton, A. M.; Burnett, R. T.; Brook, J. R.;  
Becklake, M. R. (1997) Effects of air pollution on emergency room visits  
for respiratory illnesses in Montreal, Quebec. Am. J. Respir. Crit. Care  
Med. 155: 568-576.

Only one station had daily data for use in the time series analysis of  
June-Sept 1992 and 1993: looks like station #50104

I will have to find time later to answer the question for the Alpine, CA  
study.

Ralph



Dave\_Stieb@hc-sc.gc.ca

05/14/02 04:10 PM

To: Mary Ross/RTP/USEPA/US@EPA  
cc:  
Subject: Re: Dichot Data Base

Hello,

We used some special purpose monitors in the last study in the list.

Please see descriptive information attached.

Note that the minimum value for PM2.5 is non-zero while for the other PM metrics

it's zero. I'm not sure why that's the case, but it may be a result of averaging over multiple sites, where there were perhaps differences in availability of data for the various metrics.

I hope the information is helpful.

Regards,

Dave Stieb

(See attached file: pm\_epa.wpd)

Ross.Mary@epamail.epa.gov on 05/14/2002 03:30:28 PM

To: Tom Dann <dann.tom@etc.ec.gc.ca>, Rick Burnett/HC-SC/GC/CA@HWC, mark@polair.epi.mcgill.ca, Dave Stieb/HC-SC/GC/CA@HWC, rdelfino@uci.edu  
cc:

Subject: Re: Dichot Data Base

Thanks! Just one follow-up question, for Drs. Burnett, Goldberg, Delfino and Stieb: It looks like this data set (1984-2002) would cover the study periods for all of the following studies. Is that correct? My reading of the studies indicates that they used existing monitoring stations, not special purpose monitors established just for the studies.

Burnett, R. T.; Cakmak, S.; Brook, J. R.; Krewski, D. (1997) The role of particulate size and chemistry in the association between summertime ambient air pollution and hospitalization for cardiorespiratory diseases. Environ. Health Perspect. 105:614-620.

Burnett, R. T.; Cakmak, S.; Raizenne, M. E.; Stieb, D.; Vincent, R.; Krewski, D.; Brook, J. R.; Philips, O.; Ozkaynak, H. (1998) The association between ambient carbon monoxide levels and daily mortality in Toronto, Canada. J. Air Waste Manage. Assoc. 48:689-700.

Burnett, R. T.; Smith-Doiron, M.; Stieb, D.; Cakmak, S.; Brook, J. R. (1999) Effects of particulate and gaseous air pollution on cardiorespiratory hospitalizations. Arch. Environ. Health 54:130-139.

Burnett, R. T.; Brook, J.; Dann, T.; Delocla, C.; Philips, O.; Cakmak, S.; Vincent, R.; Goldberg, M. S.; Krewski, D. (2000) Association between particulate- and gas-phase components of urban air pollution and daily mortality in eight Canadian cities. Inhalation Toxicol. 12(suppl. 4): 15-39.

Burnett, R. T.; Smith-Doiron, M.; Stieb, D.; Raizenne, M. E.; Brook, J. R.; Dales, R. E.; Leech, J. A.; Cakmak, S.; Krewski, D. (2001) Association between ozone and hospitalization for acute respiratory diseases in children less than 2 years of age. Am. J. Epidemiol. 153:444-452.

Delfino, R. J.; Murphy-Moulton, A. M.; Burnett, R. T.; Brook, J. R.; Becklake, M. R. (1997) Effects of air pollution on emergency room visits for respiratory illnesses in Montreal, Quebec. Am. J. Respir. Crit. Care Med. 155: 568-576.

Goldberg, M. S.; Bailar, J. C., III; Burnett, R. T.; Brook, J. R.; Tamblin, R.; Bonvalot, Y.; Ernst, P.; Flegel, K. M.; Singh, R. K.; Valois, M.-F. (2000) Identifying subgroups of the general population that may be susceptible to short-term increases in particulate air pollution: a time-series study in Montreal, Quebec. Cambridge, MA: Health Effects Institute; research report 97.

Stieb, D. M.; Beveridge, R. C.; Brook, J. R.; Smith-Doiron, M.; Burnett, R. T.; Dales, R. E.; Beaulieu, S.; Judek, S.; Mamedov, A. (2000) Air pollution, aeroallergens and cardiorespiratory emergency department visits in Saint John, Canada. J. Exposure Anal. Environ. Epidemiol.: 10: 461-477.

Tom Dann  
<dann.tom@etc.ec.gc.ca>  
Ross/RTP/USEPA/US@EPA  
<rick\_burnett@hc-sc.gc.ca>  
05/14/02 02:50 PM

To: Mary  
cc: Rick Burnett  
Subject: Dichot Data Base

Hi Mary

At the request of Rick Burnett I'm sending you all the mass data (< 2.5  $\mu\text{m}$  and 2.5-10  $\mu\text{m}$ ) collected in our dichotomous sampler network between 1984 and 2002. I've also included station details for all sites that appear in the data archive. If you have any questions please give me a call.

Tom

Tom Dann  
Head Air Toxics  
Analysis and Air Quality Division  
Environment Canada  
ETC, 335 River Road  
Ottawa, Ontario K1A 0H3

Phone: 613-991-9459  
Fax: 613-998-4032  
E-mail: tom.dann@ec.gc.ca

(See attached file: DICHall.csv) (See attached file: dich\_sites.xls)



DICHall.csv dich\_sites.xls pm\_epa.wpd

PM values for Saint John, NB Study 1992-1996

|                      | MEAN | MIN | MEDIAN | 95%  | 96%  | 97%  | 98%  | 99%  | MAX  |
|----------------------|------|-----|--------|------|------|------|------|------|------|
| PM <sub>10</sub>     | 14.0 | 0   | 12.0   | 31.3 | 33.6 | 36.2 | 39.0 | 43.4 | 70.3 |
| PM <sub>2.5</sub>    | 8.5  | 0.6 | 7.0    | 20.5 | 22.0 | 23.4 | 27.3 | 30.9 | 53.2 |
| PM <sub>10-2.5</sub> | 6.5  | 0   | 5.1    | 15.4 | 16.2 | 18.0 | 20.2 | 24.5 | 56.1 |



Marie-France Valois  
<mary@polair.epi.mcgill.ca>  
II.ca>

To: Mary Ross/RTP/USEPA/US@EPA  
cc:  
Subject: PM data from Mark Goldberg's Montreal Study

05/30/02 05:45 PM

Hello !!

About a month ago you asked us for some distributions from our Montreal Air Pollution study. I am sending you a PDF file with the overall distributions and the yearly distributions for TSP, PM10, PM2.5, Sulfates from TSP, Sulfates from PM10 and Sulfates from PM2.5.

I hope this is what you were looking for. If you have questions or other requests, please do not hesitate to communicate with me.

Have a nice evening,  
Marie-France

---

Marie-France Valois  
mary@polair.epi.mcgill.ca  
marie-france.valois@mcgill.ca

tel : 514-398-2419  
fax : 514-398-4503



table\_pm\_distribution

**Goldberg Table 1. Particulate Pollutant Data<sup>a</sup> used in the Statistical Analyses, Montreal, 1984 to 1993.**

| Pollutant                      | Start year | No. of sites | Duration | Frequency                 | Samplers used   | Analytic methods  |
|--------------------------------|------------|--------------|----------|---------------------------|---|---|
| TSP                            | 1984       | 19           | 24 hour  | every 6 <sup>th</sup> day | High-volume samplers (flow rate of 1.5 m <sup>3</sup> per minute); midnight to midnight sampling              | Washed glass filters, mass measured on Sartorius AC121S digital electronic balance      |
| Sulfate from TSP               | 1984       | 13           | 24 hour  | every 6 <sup>th</sup> day | High-volume samplers (1.5 m <sup>3</sup> per minute); midnight to midnight sampling                           | Soluble sulfates on filters extracted by hot water and analysed by ionic chromatography |
| PM <sub>10</sub>               | 1984       | 2            | 24 hour  | every 6 <sup>th</sup> day | Sierra-Anderson dichotomous; (flow rate of 16.7 liters per minute); midnight to midnight High-volume samplers | Electronic microbalance at constant temperature and relative humidity;                  |
| Sulfate from PM <sub>10</sub>  | 1984       | 2            | 24 hour  | every 6 <sup>th</sup> day | Sierra-Anderson dichotomous; (flow rate of 16.7 liters per minute)  | Dionex ion chromatography   |
| PM <sub>2.5</sub>              | 1984       | 2            | 24 hour  | every 6 <sup>th</sup> day | Sierra-Anderson dichotomous; (flow rate of 16.7 liters per minute)  | Electronic microbalance at constant temperature and relative humidity                   |
| Sulfate from PM <sub>2.5</sub> | 1984       | 2            | 24 hour  | every 6 <sup>th</sup> day | same as PM <sub>2.5</sub>   | Dionex ion chromatography   |

<sup>a</sup> PM was measured by Environment Canada as part of the National Air Pollution Surveillance Program. All other pollutants measured by the Montreal Urban Community. The number of sites changed during the study period.  
Abbreviations: PM<sub>2.5</sub><sup>g</sup>, PM<sub>10</sub><sup>g</sup>, particulate matter with an aerodynamic diameter of 2.5 and 10 microns ( $\mu$ ); TSP, total suspended particles.

**Goldberg Table 2.** Distribution of Mean Daily Environmental Pollutants ( $\mu\text{g}/\text{m}^3$ ) Averaged over all Monitoring Stations, Montreal, 1986-1993

| Predicted particle measure     | Mean  | Median | Minimum | Maximum | Percentiles:     |                  |                  |                  |                  |
|--------------------------------|-------|--------|---------|---------|------------------|------------------|------------------|------------------|------------------|
|                                |       |        |         |         | 95 <sup>th</sup> | 96 <sup>th</sup> | 97 <sup>th</sup> | 98 <sup>th</sup> | 99 <sup>th</sup> |
| TSP                            | 53.14 | 48.71  | 14.63   | 211.06  | 94.53            | 97.67            | 105.61           | 109.22           | 121.64           |
| PM <sub>10</sub>               | 32.23 | 28.50  | 6.50    | 120.50  | 66.04            | 70.90            | 73.00            | 77.87            | 88.50            |
| PM <sub>2.5</sub>              | 17.38 | 14.67  | 2.18    | 72.00   | 39.50            | 44.40            | 46.57            | 53.07            | 59.00            |
| Sulfate from TSP               | 4.25  | 3.57   | 0.26    | 19.21   | 10.53            | 11.13            | 12.22            | 13.00            | 14.73            |
| Sulfate from PM <sub>10</sub>  | 4.74  | 3.56   | 0.32    | 30.71   | 14.10            | 15.93            | 16.53            | 19.18            | 24.34            |
| Sulfate from PM <sub>2.5</sub> | 4.28  | 3.14   | 0.22    | 29.15   | 12.56            | 14.43            | 15.70            | 17.71            | 23.45            |

**Goldberg Table 3.** Distribution of Mean Daily TSP ( $\mu\text{g}/\text{m}^3$ ) Averaged over all Monitoring Stations by Year, Montreal, 1986-1993

| Year | Mean  | Median | Minimum | Maximum | Percentiles:     |                  |                  |                  |                  |
|------|-------|--------|---------|---------|------------------|------------------|------------------|------------------|------------------|
|      |       |        |         |         | 95 <sup>th</sup> | 96 <sup>th</sup> | 97 <sup>th</sup> | 98 <sup>th</sup> | 99 <sup>th</sup> |
| 84   | 63.41 | 57.76  | 26.75   | 211.06  | 121.53           | 123.35           | 130.38           | 130.38           | 211.06           |
| 85   | 55.37 | 53.59  | 22.75   | 111.87  | 89.07            | 104.06           | 105.64           | 105.64           | 111.87           |
| 86   | 53.32 | 51.19  | 14.63   | 104.21  | 85.38            | 95.13            | 99.67            | 99.67            | 104.21           |
| 87   | 63.81 | 65.50  | 20.71   | 147.69  | 97.56            | 106.06           | 106.73           | 106.73           | 147.69           |
| 88   | 55.79 | 50.53  | 23.11   | 125.47  | 106.37           | 106.82           | 112.58           | 112.58           | 125.47           |
| 89   | 57.29 | 54.67  | 17.73   | 110.75  | 92.41            | 96.71            | 97.67            | 97.67            | 110.75           |
| 90   | 47.81 | 46.33  | 20.59   | 87.39   | 83.89            | 83.89            | 84.07            | 84.07            | 87.39            |
| 91   | 45.32 | 40.15  | 19.36   | 120.87  | 79.87            | 82.44            | 86.14            | 86.14            | 120.87           |
| 92   | 46.42 | 42.35  | 17.38   | 121.64  | 80.36            | 86.07            | 86.24            | 86.24            | 121.64           |
| 93   | 42.34 | 37.13  | 17.83   | 156.88  | 74.31            | 77.17            | 90.31            | 90.31            | 156.88           |

**Goldberg Table 4.** Distribution of Mean Daily PM<sub>10</sub> ( $\mu\text{g}/\text{m}^3$ ) Averaged over all Monitoring Stations by Year, Montreal, 1986-1993

| Year | Mean  | Median | Minimum | Maximum | Percentiles:     |                  |                  |                  |                  |
|------|-------|--------|---------|---------|------------------|------------------|------------------|------------------|------------------|
|      |       |        |         |         | 95 <sup>th</sup> | 96 <sup>th</sup> | 97 <sup>th</sup> | 98 <sup>th</sup> | 99 <sup>th</sup> |
| 84   | 39.48 | 38.00  | 13.00   | 99.00   | 69.50            | 73.00            | 73.00            | 99.00            | 99.00            |
| 85   | 40.49 | 36.50  | 14.00   | 92.00   | 82.00            | 82.00            | 83.50            | 83.50            | 92.00            |
| 86   | 35.97 | 33.00  | 12.50   | 95.50   | 61.00            | 61.00            | 88.50            | 88.50            | 95.50            |
| 87   | 44.59 | 42.75  | 12.00   | 120.50  | 73.00            | 86.00            | 86.00            | 120.50           | 120.50           |
| 88   | 35.23 | 30.00  | 13.00   | 76.00   | 73.00            | 73.00            | 73.00            | 73.00            | 76.00            |
| 89   | 36.96 | 33.14  | 7.90    | 87.65   | 70.90            | 70.90            | 75.73            | 75.73            | 87.65            |
| 90   | 31.88 | 30.01  | 12.72   | 70.88   | 64.21            | 67.54            | 70.88            | 70.88            | 70.88            |
| 91   | NA    | NA     | NA      | NA      | NA               | NA               | NA               | NA               | NA               |
| 92   | 29.69 | 25.00  | 9.28    | 98.61   | 60.09            | 63.07            | 63.42            | 64.37            | 72.66            |
| 93   | 23.11 | 20.99  | 6.50    | 118.00  | 45.12            | 46.02            | 50.71            | 57.49            | 86.56            |

**Goldberg Table 5.** Distribution of Mean Daily PM<sub>2.5</sub> ( $\mu\text{g}/\text{m}^3$ ) Averaged over all Monitoring Stations by Year, Montreal, 1986-1993

| Year | Mean  | Median | Minimum | Maximum | Percentiles:     |                  |                  |                  |                  |
|------|-------|--------|---------|---------|------------------|------------------|------------------|------------------|------------------|
|      |       |        |         |         | 95 <sup>th</sup> | 96 <sup>th</sup> | 97 <sup>th</sup> | 98 <sup>th</sup> | 99 <sup>th</sup> |
| 84   | 21.01 | 19.50  | 6.00    | 65.50   | 43.00            | 46.00            | 46.00            | 65.50            | 65.50            |
| 85   | 19.36 | 15.50  | 5.00    | 68.50   | 38.50            | 38.50            | 45.00            | 45.00            | 68.50            |
| 86   | 19.34 | 18.25  | 3.50    | 64.00   | 33.50            | 33.50            | 54.50            | 54.50            | 64.00            |
| 87   | 23.57 | 20.00  | 7.00    | 72.00   | 51.00            | 59.00            | 59.00            | 72.00            | 72.00            |
| 88   | 18.40 | 16.00  | 5.00    | 52.00   | 39.50            | 39.50            | 46.50            | 46.50            | 52.00            |
| 89   | 20.19 | 18.50  | 4.72    | 55.84   | 45.93            | 45.93            | 53.07            | 53.07            | 55.84            |
| 90   | 18.05 | 15.72  | 4.81    | 58.95   | 48.70            | 48.70            | 58.95            | 58.95            | 58.95            |
| 91   | NA    | NA     | NA      | NA      | NA               | NA               | NA               | NA               | NA               |
| 92   | 17.02 | 14.13  | 3.49    | 69.63   | 46.57            | 47.24            | 50.16            | 54.94            | 60.15            |
| 93   | 12.75 | 10.86  | 2.18    | 57.11   | 29.53            | 29.88            | 30.82            | 31.36            | 48.65            |

**Goldberg Table 6.** Distribution of Mean Daily Sulfates from TSP ( $\mu\text{g}/\text{m}^3$ ) Averaged over all Monitoring Stations by Year, Montreal, 1986-1993

| Year | Mean | Median | Minimum | Maximum | Percentiles:     |                  |                  |                  |                  |
|------|------|--------|---------|---------|------------------|------------------|------------------|------------------|------------------|
|      |      |        |         |         | 95 <sup>th</sup> | 96 <sup>th</sup> | 97 <sup>th</sup> | 98 <sup>th</sup> | 99 <sup>th</sup> |
| 84   | 5.66 | 4.60   | 1.00    | 17.91   | 12.80            | 13.08            | 16.11            | 16.11            | 17.91            |
| 85   | 4.64 | 4.04   | 1.44    | 12.13   | 9.50             | 9.55             | 9.84             | 9.84             | 12.13            |
| 86   | 5.24 | 4.48   | 0.78    | 18.25   | 12.22            | 12.74            | 13.00            | 13.00            | 18.25            |
| 87   | 4.05 | 3.28   | 0.59    | 15.03   | 9.15             | 9.34             | 9.56             | 9.56             | 15.03            |
| 88   | 4.33 | 3.80   | 0.98    | 19.21   | 9.11             | 12.21            | 15.03            | 15.03            | 19.21            |
| 89   | 4.23 | 3.64   | 0.26    | 14.73   | 9.60             | 9.85             | 10.84            | 10.84            | 14.73            |
| 90   | 3.65 | 2.74   | 0.70    | 13.71   | 10.55            | 10.61            | 10.80            | 10.80            | 13.71            |
| 91   | 3.53 | 2.87   | 0.56    | 14.63   | 7.82             | 7.83             | 12.47            | 12.47            | 14.63            |
| 92   | 3.38 | 3.05   | 0.70    | 12.60   | 5.86             | 6.66             | 6.97             | 6.97             | 12.60            |
| 93   | 3.81 | 3.52   | 0.41    | 13.82   | 8.41             | 12.65            | 13.15            | 13.15            | 13.82            |

**Goldberg Table 7.** Distribution of Mean Daily Sulfates from PM<sub>10</sub> (µg/m<sup>3</sup>) Averaged over all Monitoring Stations by Year, Montreal, 1986-1993

| Year | Mean | Median | Minimum | Maximum | Percentiles:     |                  |                  |                  |                  |
|------|------|--------|---------|---------|------------------|------------------|------------------|------------------|------------------|
|      |      |        |         |         | 95 <sup>th</sup> | 96 <sup>th</sup> | 97 <sup>th</sup> | 98 <sup>th</sup> | 99 <sup>th</sup> |
| 84   | 5.69 | 3.95   | 1.14    | 26.20   | 16.34            | 16.62            | 16.62            | 26.20            | 26.20            |
| 85   | 4.09 | 3.05   | 0.87    | 15.43   | 10.03            | 10.03            | 10.95            | 10.95            | 15.43            |
| 86   | 4.91 | 4.08   | 0.38    | 30.71   | 13.41            | 13.41            | 16.19            | 16.19            | 30.71            |
| 87   | 4.81 | 3.98   | 0.83    | 12.43   | 11.45            | 12.31            | 12.31            | 12.43            | 12.43            |
| 88   | 4.62 | 3.28   | 0.83    | 25.94   | 16.53            | 16.53            | 19.18            | 19.18            | 25.94            |
| 89   | 5.19 | 4.06   | 1.02    | 17.51   | 12.60            | 12.60            | 16.51            | 16.51            | 17.51            |
| 90   | 5.67 | 3.73   | 1.03    | 19.60   | 16.83            | 16.83            | 19.60            | 19.60            | 19.60            |
| 91   | NA   | NA     | NA      | NA      | NA               | NA               | NA               | NA               | NA               |
| 92   | 5.48 | 3.00   | 0.69    | 25.32   | 24.34            | 24.34            | 24.34            | 25.32            | 25.32            |
| 93   | 3.42 | 2.13   | 0.32    | 15.47   | 10.92            | 12.13            | 14.10            | 14.10            | 15.47            |

**Goldberg Table 8.** Distribution of Mean Daily Sulfates from PM<sub>2.5</sub> (µg/m<sup>3</sup>) Averaged over all Monitoring Stations by Year, Montreal, 1986-1993

| Year | Mean | Median | Minimum | Maximum | Percentiles:     |                  |                  |                  |                  |
|------|------|--------|---------|---------|------------------|------------------|------------------|------------------|------------------|
|      |      |        |         |         | 95 <sup>th</sup> | 96 <sup>th</sup> | 97 <sup>th</sup> | 98 <sup>th</sup> | 99 <sup>th</sup> |
| 84   | 5.11 | 3.47   | 0.65    | 26.06   | 15.68            | 15.91            | 15.91            | 26.06            | 26.06            |
| 85   | 3.55 | 2.73   | 0.61    | 14.43   | 9.31             | 9.31             | 10.04            | 10.04            | 14.43            |
| 86   | 4.42 | 3.45   | 0.22    | 29.15   | 12.40            | 12.40            | 15.97            | 15.97            | 29.15            |
| 87   | 4.29 | 3.49   | 0.76    | 11.57   | 10.20            | 10.48            | 10.48            | 11.57            | 11.57            |
| 88   | 4.22 | 2.96   | 0.65    | 25.89   | 16.24            | 16.24            | 19.03            | 19.03            | 25.89            |
| 89   | 4.70 | 4.10   | 0.81    | 17.64   | 12.10            | 12.56            | 14.30            | 14.30            | 17.64            |
| 90   | 5.00 | 3.22   | 0.75    | 17.71   | 15.70            | 15.70            | 17.71            | 17.71            | 17.71            |
| 91   | NA   | NA     | NA      | NA      | NA               | NA               | NA               | NA               | NA               |
| 92   | 5.08 | 2.75   | 0.54    | 24.77   | 23.45            | 23.45            | 23.45            | 24.77            | 24.77            |
| 93   | 3.09 | 1.80   | 0.26    | 14.28   | 10.40            | 11.62            | 13.60            | 13.60            | 14.28            |



HARVARD SCHOOL OF PUBLIC HEALTH

Department of Environmental Health  
Environmental Epidemiology Program

20 June 1997

John Bachmann  
Planning & Management Staff  
US EPA - MD 10  
Research Triangle Park, NC 27711

Dear John,

As requested, we are enclosing a disk copy of the dichotomous sampler mass data collected in the Harvard Six Cities Study between 1979 and 1988. These data summarize the fine and coarse mass measurements provided to us by the Environmental Science Research Laboratory of the Environmental Protection Agency. I understand that EPA has the original records of these data.

Two ASCII files are included on the disk. One labeled "dichot.data" includes the city, date, fine mass, and coarse mass. The second file labeled "means.lst" gives summary statistics by city which should be used to check for proper transfer of the data.

A more detailed description of the measurements is attached. Please note that it is our practice to record the data values exactly as measured. Thus, values below the minimum detectable level are presented as reported. Small negative concentrations are sometimes reported for days with near zero concentrations.

Sincerely yours,

Douglas W. Dockery  
Associate Professor  
Environmental Epidemiology

DWD:jpb

## HARVARD SIX CITIES STUDY: DICHOTOMOUS SAMPLER PARTICLE DATA Description of Aerosol Sampling and Chemical Analysis<sup>1</sup>

**Data Collection.** Dichotomous aerosol samplers were operated for 24 hours, midnight to midnight, at Stuebenville, Ohio; Watertown, Massachusetts; Portage, Wisconsin; Topeka, Kansas; St. Louis, Missouri; and Harriman, Tennessee as part of the Harvard Air Pollution Health Study. Table 1 lists the sampling locations and a brief site description. Beckman dichotomous virtual impactors collected samples in two size fractions: fine particles (FP) having aerodynamic diameters ( $d_a$ )  $< 2.5 \mu\text{m}$  and coarse particles (CP15) with  $2.5 \mu\text{m} < d_a < 15 \mu\text{m}$ . In April 1984 we changed to Anderson inlets on all dichotomous samplers and began collecting coarse particles (CP10) with an upper cut-off of  $10 \mu\text{m}$ . By summing the mass concentrations from both the fine and coarse samples (FP+CP15 or FP+CP10), we can estimate the inhalable particle mass concentration as collected by the dichotomous sampler.

The dichotomous samplers were operated every other day until June 1983, when they were operated every third day. When health teams were testing lung functions in the cities, the sampling schedule of FP and CP was switched to every day.

**Sample Analysis.** Table 2 summarizes the Harvard sampling/database information for each site including particle size fractions and analysis techniques. The analysis technique used for FP and CP changed during the course of the study. The mass measurements for samples collected through October 1981 were determined by beta-ray attenuation at EPA's Environmental Science Research Laboratory in Research Triangle Park, North Carolina. Between November 1981 and January 1984, mass determinations were made gravimetrically at the Harvard School of Public Health. After February 1984, mass measurements were made using beta-ray attenuation by Northrop Services, Inc. at Research Triangle Park. The sensitivity of the beta-ray measurement technique and its comparability to gravimetric methods is described by Jaklevic et al. (1980) and Courtney et al. (1982). A complete description of the quality assurance program used at Harvard to validate the FP and CP data set is reported in Briggs et al. (1982) and Briggs (1983).

A negative artifact in the coarse mass concentration due to loss of coarse particles from filters during transit from the sites to EPA was reported by Dzubay and Barbour (1983). This loss has been estimated to be 19-53% by Dzubay and Barbour, and has been confirmed as 30-35% average coarse fraction mass loss by our tests. As a result, when Northrop Services started providing filters and mass measurements in 1983, filters collecting coarse particles were oiled.

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<sup>1</sup> Abstracted from Spengler JD, Briggs SLK, Ozkaynak. (1986) Relationships between TSP measurements and size-fractionated particle mass measurements in six cities participating in the Harvard Air Pollution Health Study. Report to Office of Air Quality, Planning, and Standards, US EPA, Dec 5, 1986.

**Table 1**

**Description of Monitoring Sites and Areas for Cities Participating in the Harvard Air Pollution Health Study**

| <i>City</i>      | <i>Location (Long, Lat)</i> | <i>Area/ Site Description</i>   |
|------------------|-----------------------------|---|
| Steubenville, OH | 80° 37.5' W, 40° 22.5' N    | <ul style="list-style-type: none"> <li>• heavily industrialized city of 26,00 on the Ohio River</li> <li>• site located on plateau overlooking river valley</li> </ul>  |
| Watertown, MA    | 71° 11' W, 42° 22' N        | <ul style="list-style-type: none"> <li>• residential non-industrial of 120,000</li> <li>• site located at town's high school athletic field</li> </ul>  |
| Portage, WI      | 89° 28' W, 43° 32.5' N      | <ul style="list-style-type: none"> <li>• farming community of 8,000 north of Madison and 4 miles north of Columbia</li> <li>• 1,000 MW coal-fired power plant</li> <li>• site located beside county road surrounded by agricultural land</li> </ul> |
| Topeka, KS       | 95° 42' W, 39° 2' N         | <ul style="list-style-type: none"> <li>• non-industrial city of 120,000</li> <li>• site located in a grass field adjacent to parking lot on university campus about two miles SW of downtown area</li> </ul>  |
| St. Louis, MO    | 90° 16' W, 38° 34' N        | <ul style="list-style-type: none"> <li>• SE section of industrialized metropolitan city of 425,000</li> <li>• site located in residential/light commercial area, bordered by railroad tracks and adjacent to unpaved parking lot</li> </ul>         |
| Harriman, TN     | 84° 33' W, 35° 55' N        | <ul style="list-style-type: none"> <li>• rural community of 8,300, 40 miles SW of Knoxville and 5 miles W of Kingston</li> <li>• 1,700 MW coal-fired power plant</li> </ul>   |

Table II

## Harvard Air Pollution Health Study Particle Database

| City             | F+CP15     |          |             |         |                         |         | F+CP10                  |          |
|------------------|------------|----------|-------------|---------|-------------------------|---------|-------------------------|----------|
|                  | Beta-gauge |          | Gravimetric |         | Beta-gauge <sup>a</sup> |         | Beta-gauge <sup>a</sup> |          |
|                  | Start      | End      | Start       | End     | Start                   | End     | Start                   | End      |
| Steubenville, OH | 4/13/79    | 11/08/81 | 11/14/81    | 1/16/84 | 1/19/84                 | 3/29/84 | 3/31/84                 | 9/26/87  |
| Watertown, MA    | 5/03/79    | 11/28/81 | 11/30/81    | 2/15/84 | 2/18/84                 | 4/06/84 | 4/12/84                 | 1/2/86   |
| Portage, WI      | 3/22/79    | 10/13/81 | 10/23/81    | 2/09/84 | 2/12/84                 | 3/28/84 | 3/31/84                 | 12/31/87 |
| Topeka, KS       | 9/23/79    | 11/02/81 | 11/04/81    | 1/30/84 | 2/21/84                 | 3/29/84 | 4/06/84                 | 10/18/88 |
| St. Louis, MO    | 9/22/79    | 10/25/81 | 11/12/81    | 1/19/84 | 1/25/84                 | 3/28/84 | 3/31/84                 | 1/19/87  |
| Harriman, TN     | 5/09/80    | 11/16/81 | 11/18/81    | 1/16/84 | 1/14/84                 | 3/29/84 | 3/31/84                 | 1/1/88   |

<sup>a</sup> Coarse filters oiled

## Bibliography

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