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OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Review of Collocated Lead in Total Suspended Particulate and Lead in Particulate Matter Less Than Ten Micrometers

FROM: Kevin A. Cavender and S. Mark Schmidt (EPA, OAQPS)

TO: Lead NAAQS Review Docket (OAR-2006-0735)

This memorandum summarizes the review of existing data where Lead in Total Suspended Particulate (Pb-TSP) measurements are made at the same location and time as Lead in Particulate Matter Less Than Ten Micrometers (Pb-PM_{10}) measurements. This review is intended to identify, as has been suggested by the Clean Air Scientific Advisory Committee (CASAC), if it is feasible to use Pb-PM_{10} data as a surrogate for Pb-TSP data either on a national basis or on a site-by-site basis.

DATA

Data on collocated Pb-TSP and Pb-PM_{10} data were obtained from the Air Quality System (AQS), EPA's repository of ambient air quality data. Due to varying method detection limit issues, the data used in the analysis were limited to those pairs of data where both the Pb-TSP and the Pb-PM_{10} measurement were above 0.01 ug/m^3. In addition, only sites with 10 or more data pairs meeting the above requirement were used in this analysis. Based on these data requirements, we obtained collocated Pb-TSP and Pb-PM_{10} data for 22 sites between the years 1993 and 2006.

In addition, we included data from an EPA study where collocated Pb-TSP and Pb-PM_{10} data were collected near a primary lead smelter in Montana (REFERENCE). This data set contained data at much higher concentrations than the other data obtained from AQS.

ANALYSIS

We looked at a number of metrics to evaluate the appropriateness and feasibility of using Pb-PM_{10} measurements as a surrogate for Pb-TSP measurements, as summarized in Table 1.

The first and most simple metric we evaluated was a ratio of Pb-PM$_{10}$ concentration to Pb-TSP concentration. For this analysis, the ratio of each data pair was calculated. The average ratio for all data across all sites was 0.86. However, as can be seen in Table 1, the ratio of Pb-PM$_{10}$ concentration to Pb-TSP concentration varied substantially not only between sites (average ratio ranged from 0.6 to 1.0), but also within the data for a given site (individual ratios ranged from 0.09 to 12[1]). Based on the wide spread of ratios, it does not seem likely that a single ratio could be used to accurately estimate Pb-TSP based on Pb-PM$_{10}$ measurements at all sites.

Next we performed a linear regression between Pb-TSP (the dependent value, y) and Pb-PM$_{10}$ (the independent value, x) for each site. These results are also provided in Table 1. Many sites showed a strong linear relationship between Pb-TSP and Pb-PM$_{10}$ with 9 of the 23 sites having an r^2 value of 0.9 or greater. However, many sites demonstrated a very poor relationship between Pb-TSP and Pb-PM$_{10}$ with 6 of the 23 sites having an r^2 value of 0.5 or less. Figure 1 shows data for a site with a strong linear relationship between Pb-TSP and Pb-PM$_{10}$, and Figure 2 shows data for a site where there does not appear to be a strong relationship between Pb-TSP and Pb-PM$_{10}$. Based on these results, it would appear that many sites may be able to develop a site-specific relationship between Pb-TSP and Pb-PM$_{10}$ using collocated TSP and PM$_{10}$ data, but that this may not be possible at all sites.

As can be seen in Figure 1, a relationship developed based on a linear regression will still not perfectly predict any given measurement even when a strong relationship is present. Therefore, it would be possible to under estimate the average Pb-TSP concentration over a period of time based on Pb-PM$_{10}$ data. To be conservative, it may be desirable to add a factor to account for the potential error in the estimate. Figure 3 shows the data for the same site in Figure 1 with a second relationship line included that represents the linear regression plus a factor representing one standard deviation of the estimation error for the data set (i.e., the standard deviation of the difference between the actual Pb-TSP measurement and the predicted Pb-TSP based on the linear regression). As can be seen in Figure 1, the majority of the data would fall under the second line leading to considerably fewer under predictions and therefore less possibility of misclassifying an area as attainment when it was in fact in nonattainment of the NAAQS.

CONCLUSIONS

Based on the analysis of the available collocated Pb-TSP and Pb-PM$_{10}$ monitoring data, it would appear that a single ratio cannot be developed that would accurately predict Pb-TSP concentrations based on Pb-PM$_{10}$ measured concentrations for all locations in the United States. However, it does appear that in many cases (but not all) a relationship between Pb-TSP and Pb-PM$_{10}$ can be made on a site-specific basis using collocated data.

Attachments

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[1] Ratios greater than one are not physically possible. Ratios greater than one were generally limited to data with low lead concentrations where measurement error and contamination can result in extraneous results when trying to compare the results from the two measurement techniques.

Table 1. Summary of Analysis of Pb-TSP and Pb-PM$_{10}$ Data

| Site ID	Number of Samples	Years	Average Pb-TSP ug/m3	Average Pb-PM10 ug/m3	Ratio of Pb-PM10 to Pb-TSP			Difference (Pb-TSP - Pb-PM10)						Linear Regression		
					Average	Minimum	Maximum	Minimum ug/m3	Minimum %	Average ug/m3	Average %	Maximum ug/m3	Maximum %	Slope	Intercept	r^2
060250005	205	1996 - 2001	0.031	0.027	0.870	0.268	1.548	-0.023	-55	0.004	13	0.032	73	0.98	0.001	0.91
060190008	32	1995 - 2001	0.020	0.018	0.924	0.600	1.333	-0.004	-33	0.002	8	0.012	40	1.00	0.002	0.89
060290014	32	1995 - 2000	0.020	0.019	0.917	0.647	1.444	-0.008	-44	0.002	8	0.006	35	0.95	0.002	0.95
060374002	129	1995 - 2000	0.041	0.022	0.602	0.142	1.636	-0.007	-64	0.019	40	0.197	86	1.46	0.009	0.57
060658001	54	1995 - 1996	0.031	0.018	0.600	0.243	1.167	-0.002	-17	0.014	40	0.053	76	0.77	0.018	0.19
060771002	53	1995 - 2000	0.021	0.017	0.807	0.387	1.840	-0.021	-84	0.005	19	0.020	61	1.05	0.004	0.68
060850004	23	1994 - 1999	0.025	0.018	0.774	0.377	1.571	-0.008	-57	0.007	23	0.033	62	0.93	0.008	0.52
060990002	17	1995 - 1998	0.024	0.015	0.853	0.396	1.188	-0.003	-19	0.011	15	0.145	60	2.72	-0.022	0.98
201290003	14	1993 - 1998	0.020	0.017	0.931	0.550	1.455	-0.005	-45	0.003	7	0.013	45	1.28	-0.002	0.82
201730007	18	1993 - 1997	0.018	0.013	0.822	0.333	1.273	-0.003	-27	0.005	18	0.024	67	0.25	0.015	0.01
201730008	16	1993 - 1997	0.015	0.015	0.981	0.500	2.063	-0.017	-106	0.001	2	0.011	50	0.03	0.015	0.00
201730009	18	1993 - 1997	0.019	0.015	0.806	0.379	1.533	-0.008	-53	0.005	19	0.018	62	0.80	0.008	0.25
201731012	22	1993 - 1997	0.022	0.022	1.051	0.625	3.333	-0.028	-233	0.000	-5	0.009	38	0.96	0.001	0.91
201770007	19	1993 - 1997	0.017	0.014	0.867	0.500	1.333	-0.007	-33	0.003	13	0.016	50	1.00	0.003	0.45
202090015	118	1993 - 1997	0.028	0.021	0.818	0.293	2.789	-0.034	-179	0.007	18	0.030	71	0.85	0.010	0.42
202090020	107	1993 - 1997	0.092	0.059	0.848	0.039	11.923	-0.142	-1092	0.035	15	1.092	96	1.39	0.011	0.98
260770905	78	1993 - 1996	0.017	0.014	0.854	0.545	1.545	-0.006	-55	0.003	15	0.011	45	0.96	0.004	0.97
261390009	26	2000 - 2001	0.013	0.009	0.780	0.464	1.067	-0.004	-7	0.006	22	0.020	54	0.95	0.007	0.88
261630033	167	2003 - 2006	0.031	0.028	0.922	0.329	2.686	-0.090	-169	0.003	8	0.099	67	0.97	0.004	0.81
270530053	13	1996 - 2001	0.017	0.008	0.609	0.328	0.885	0.002	12	0.015	39	0.042	67	1.97	-0.004	0.86
295100085	26	2004 - 2004	0.021	0.017	0.893	0.591	1.134	-0.002	-13	0.005	11	0.038	41	1.89	-0.013	0.95
490110001	19	2003 - 2003	0.024	0.025	1.028	0.961	1.095	-0.013	-10	-0.002	-3	0.001	4	0.93	0.001	1.00
Unknown	22	1988	2.245	1.121	0.646	0.167	1.857	-0.120	-86	1.124	41	7.110	100	2.12	-0.134	0.94
Average			0.122	0.068	0.835	0.420	2.074	-0.024	-107	0.055	17	0.393	59	1.140	-0.002	0.69
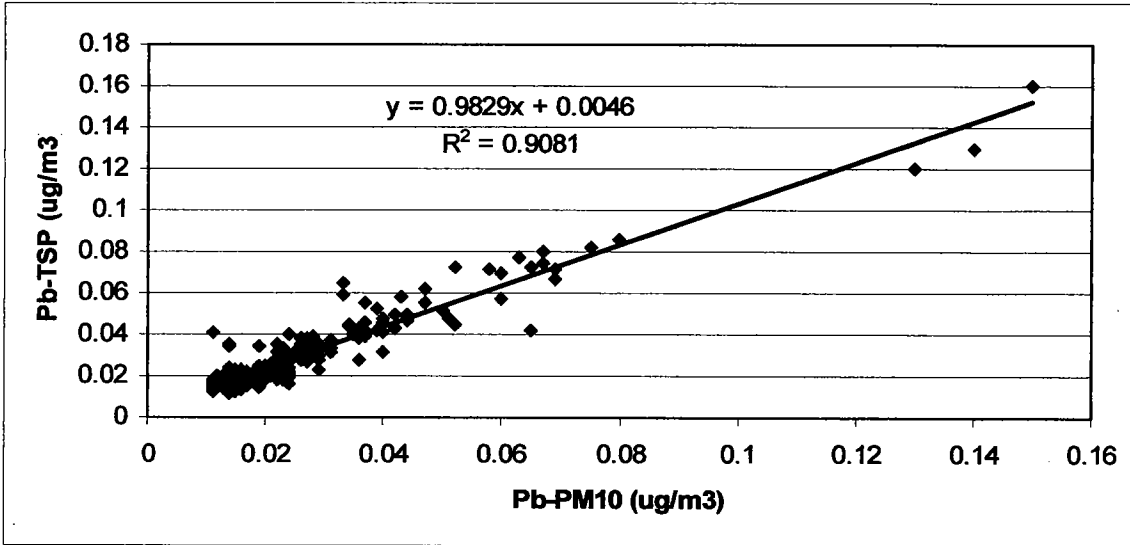
Figure 1. Example Plot of Pb-PM$_{10}$ versus Pb-TSP Showing Strong Relationship (AQS Site: 06-025-0005)
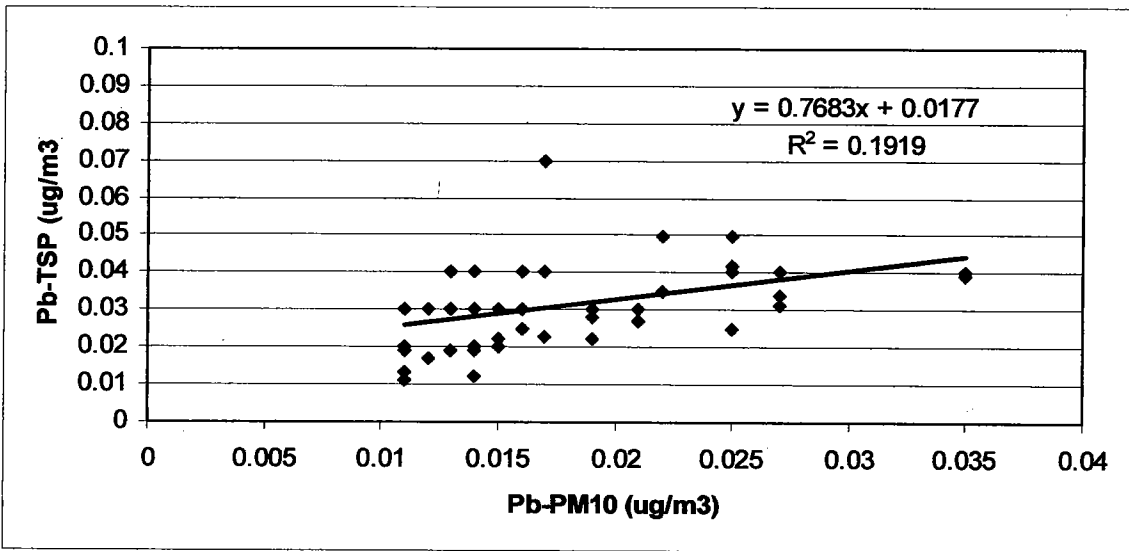

Figure 2. Example of Pb-PM$_{10}$ versus Pb-TSP Showing Poor Relationship (AQS Site: 06-065-8001)
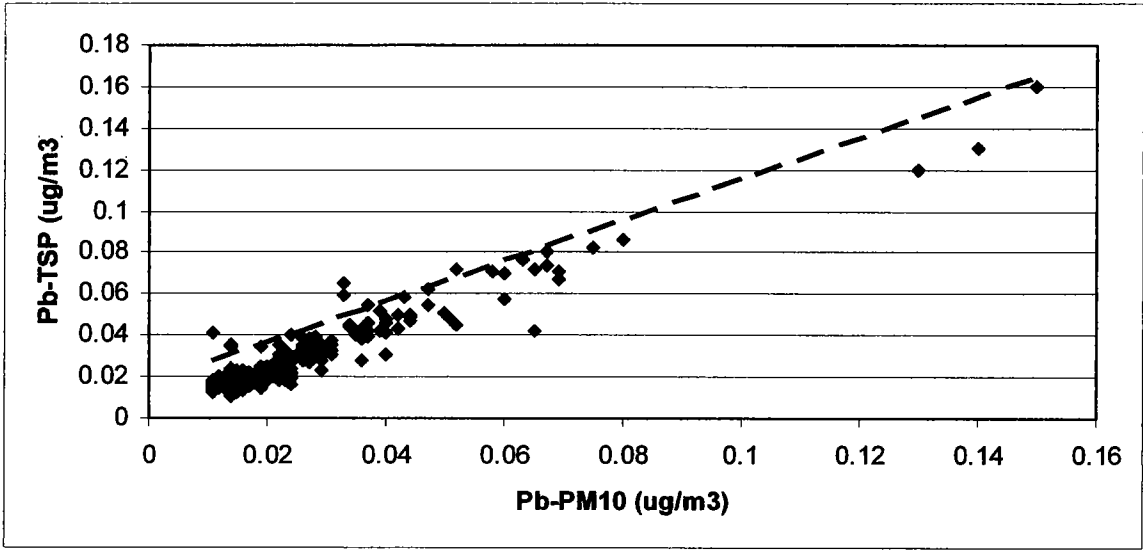
Figure 3. Example Relationship of Pb-PM$_{10}$ versus Pb-TSP including Error Factor (AQS Site: 06-025-0005)