Preliminary Report on a Calibration of a DustTrak and TEOM Performed for the New Jersey Urban Air Quality Education and Awareness Initiative

Prepared on behalf of the New Jersey Environmental Justice Alliance and the Center for the Urban Environment of the John S. Watson Institute for Public Policy of Thomas Edison State College by:

Nicky Sheats, Esq., Ph.D.
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Abstract

We report briefly on a calibration performed between a DustTrak machine used in the New Jersey Urban Air Quality Education and Awareness Initiative (Initiative) and a TEOM machine. Based on the reasonable R^2 of a regression analysis (0.82) of fine particulate matter concentrations produced by the DustTrak and TEOM, and the similarity of the concentrations measured by the machines after the DustTrak concentrations have been adjusted using the regression equation, we conclude that the DustTrak machines used during the Initiative produced scientifically credible data.

Introduction

The New Jersey Urban Air Quality Education and Awareness Initiative involved local high school students and environmentally concerned adults in monitoring airborne particulate matter (PM) concentrations in Camden, Trenton and Newark, New Jersey. The machine used to measure fine PM concentrations, the DustTrak, is known to overestimate ambient concentrations by a factor of two to three (see Yanosky et al. 2002; Chung et al. 2002). Therefore at the end of the Initiative a calibration was performed between one of the DustTrak machines used during the project and a TEOM machine maintained by the New Jersey Department of Environmental Protection (NJDEP). Here we report briefly on the results of that calibration.

Methods

The DustTrak and TEOM were co-located at a monitoring site in south Camden maintained by the NJDEP. The DustTrak was placed inside a trailer and plastic tubing was run from the machine's inlet to the outside of the trailer. A cone was placed on the

end of the tubing that was exposed to open air to protect it from rain. Concentrations were recorded for the calibration from 1:35 PM, June 23, 2005 until 9:13 AM, June 27, 2005.

Results

In most instances the DustTrak did overestimate PM concentrations when compared to those produced by a TEOM, although there were also instances where it underestimated (see Figure 1 and Table 1). The ratio of DustTrak to TEOM concentrations ranged from 0.5 to 5.9 and it appears there might be higher ratios at larger concentrations. However, a least squares regression yields a reasonably high R^2 value of 0.82 (see Figure 1), which indicates there is good correlation between DustTrak and TEOM concentration values. The regression equation also performs well at adjusting DustTrak concentration values so they resemble those yielded by the TEOM (see Table 1). The slope of the regression line and the y intercept were both significantly different than zero (p=1.68E-09 and p=8.8E-31, respectively).

The DustTrak recorded concentrations in one-minute intervals but the data were averaged to hourly intervals to match the TEOM data provided by the NJDEP. It should also be noted that the issue of the correct number of significant figures for the data is not addressed in this preliminary report but will be in the final version.

Table 2 provides DustTrak concentrations recorded at each site monitored during the Initiative that have been adjusted using the regression equation.

Discussion

The R^2 from our regression equation fares reasonably well when compared to those from other investigations that have calibrated fine PM concentrations measured by the DustTrak and other monitoring machines. Yanosky et al. (2002) compared fine PM concentrations of indoor air measured by a DustTrak and a filter-based method and found a R^2 of 0.86; Chung et al. (2001) produced R^2 statistics of 0.81 and 0.87 for winter and summer, respectively, after comparing concentrations measured by a DustTrak and a personal exposure monitor; and regression analyses of concentrations produced by a DustTrak and TEOM yielded a R^2 of 0.71 for Levy et al. (2001). Of these three studies the most relevant for us is Levy et al. (2001) since they compared the DustTrak to the TEOM as we did and our R^2 of 0.82 compares favorably to their value of 0.71.

However, we should be cautious with our interpretation of concentrations produced by the Initiative since the y intercept from the regression did not equal zero and this indicates systematic bias between the DustTrak and TEOM (see Yanosky et al. 2002). Additionally, we have not yet determined whether the slope of the regression line is significantly different than 1; a finding that might indicate a "proportional bias" between the monitors (see Yanosky et al. 2002).

But given our reasonable R^2 value and the similarity of concentrations from the DustTrak and TEOM after the DustTrak concentrations have been adjusted using the regression equation (see Table 2) we conclude, as others have (see Yanosky et al. 2003; Chung et al. 2001), that the DusTrak produces scientifically credible data if a calibration is performed and that it did so for the Initiative.

Sources Cited

Chung, A., Chang, P.Y., Kleeman, M., Perry, K.D., Cahill, T.A., Dutcher, D., McDougall, E.M. and K. Stroud. 2001. Comparison of Real-Time Instruments Used To Monitor Airborne Particulate Matter, *J. Air & Waste Manage. Assoc* 51:109-120.

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Yanosky, J.D., Williams, P.L. and D.L. MacIntosh. 2002. A comparison of two direct- reading aerosol monitors with the federal reference method for $PM_{2.5}$ in indoor air, *Atmospheric Environment* 36:107-113.

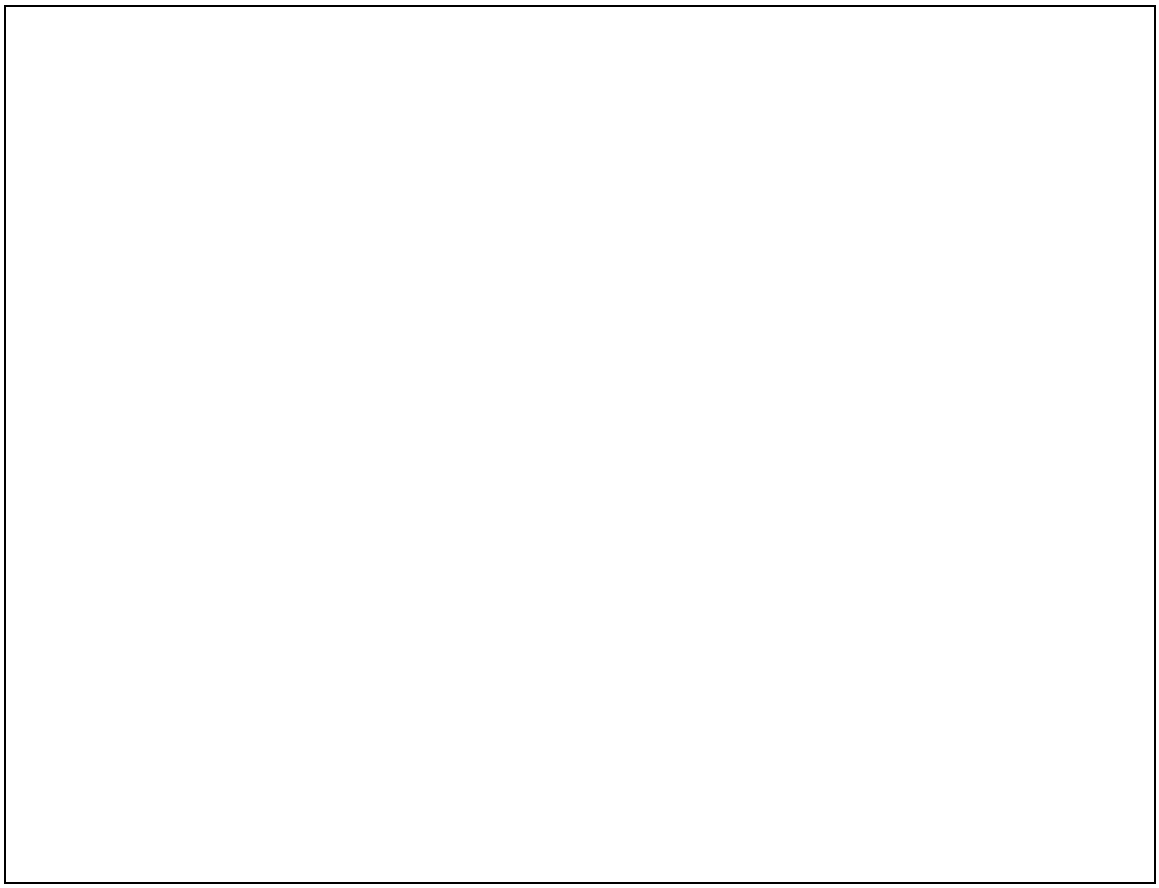

Figure 1: Lest squares regression of TEOM vs DustTrak $PM_{2.5}$ concentrations recorded in Camden from 1:35 PM, June 23, 2005 to 9:13: AM, June 27, 2005 (n=81). DustTrak concentrations were recorded in one minute intervals and averaged over an hour to match the time intervals of the TEOM data.

TEOM Conc.	DustTark Conc.	Adj. Dust. Conc.	TEOM/Dust. Ratio	Adj. Ratio
6	11.63333	8.803562955	1.938888333	1.467260492
6	12.95	9.0847905	2.158333333	1.51413175
6	19.6	10.505164	3.266666667	1.750860667
6	27.53333	12.19964395	4.588888333	2.033273992
8	12.38333	8.963755455	1.54791625	1.120469432
9	7.483333	7.917165095	0.831481444	0.879685011
9	14.51667	9.419415545	1.612963333	1.046601727
9	14.63333	9.444332955	1.625925556	1.049370328
9	41.65	15.2148235	4.627777778	1.690535944
9	48.26667	16.62807805	5.362963333	1.847564227
10	5.416667	7.475745905	0.5416667	0.74757459
10	7.933333	8.013280595	0.7933333	0.80132806
10	12.61667	9.013594545	1.261667	0.901359455
10	15.86667	9.707762045	1.586667	0.970776205
10	29.9	12.705141	2.99	1.2705141
11	12.73333	9.038511955	1.157575455	0.821682905
11	15.98333	9.732679455	1.45303	0.884789041
11	53.93333	17.83841995	4.90303	1.621674541
12	13.7	9.244983	1.141666667	0.77041525
12	35.9	13.986681	2.991666667	1.16555675
12	36.63333	14.14331295	3.0527775	1.178609413
12	42.2	15.332298	3.516666667	1.2776915
12	44.41667	15.80575655	3.701389167	1.317146379
13	38.21667	14.48149855	2.939743846	1.113961427
13	38.62295	14.56827589	2.970996154	1.120636607
13	46.03333	16.15105895	3.541025385	1.24238915
13	50.11667	17.02321955	3.855128462	1.309478427
14	57.85	18.6749815	4.132142857	1.33392725
15	12.55	8.9993545	0.836666667	0.599956967
15	18.56667	10.28445505	1.237778	0.685630336
15	37.61667	14.35334455	2.507778	0.956889636
16	32.78333	13.32099145	2.048958125	0.832561966
16	46.63333	16.27921295	2.914583125	1.01745081
16	54.68333	17.99861245	3.417708125	1.124913278
17	24.98333	11.65498945	1.469607647	0.685587615
17	24.43333	11.53751495	1.437254706	0.67867735
17	31.41667	13.02908655	1.848039412	0.766416856
17	42.85	15.4711315	2.520588235	0.910066559
19	50.86885	17.18387767	2.677307895	0.904414614
19	62.81667	19.73581255	3.306140526	1.038726976

Table 1 (pg. 1 of 2): All concentrations are in mg/m^3 and DustTrak concentrations were adjusted using the regression equation: $y = 6.3188 + 0.21359x$.

TEOM Conc.	DustTark Conc.	Adj. Dust. Conc.	TEOM/Dust. Ratio	Adj. Ratio
20	42.1	15.310939	2.105	0.76554695
20	48.88333	16.75979045	2.4441665	0.837989523
20	67.66667	20.77172405	3.3833335	1.038586202
20	87.21667	24.94740855	4.3608335	1.247370427
21	73.05	21.9215495	3.478571429	1.04388331
22	54.38333	17.93453545	2.471969545	0.815206157
22	67.7	20.778843	3.077272727	0.944492864
22	86.73333	24.84417195	3.942424091	1.129280543
23	60.96667	19.34067105	2.650724783	0.840898741
23	90.61667	25.67361455	3.939855217	1.116244111
23	136.2333	35.41687055	5.923186957	1.539863937
24	64.33333	20.05975595	2.680555417	0.835823165
24	86.73333	24.84417195	3.61388875	1.035173831
24	109.3167	29.66775395	4.5548625	1.236156415
24	133.9667	34.93274745	5.581945833	1.455531144
25	62.48333	19.66461445	2.4993332	0.786584578
25	79	23.19241	3.16	0.9276964
25	90.91667	25.73769155	3.6366668	1.029507662
25	96.05	26.8341195	3.842	1.07336478
25	122.4667	32.47646245	4.898668	1.299058498
25	129.2333	33.92174055	5.169332	1.356869622
26	73.26667	21.96782805	2.817948846	0.844916463
28	101.1333	27.91986155	3.611903571	0.997137912
28	122.5667	32.49782145	4.377382143	1.16063648
29	82.1	23.854539	2.831034483	0.82257031
29	117.6833	31.45477605	4.058044828	1.08464745
30	114.9333	30.86740355	3.83111	1.028913452
30	117.65	31.4476635	3.921666667	1.04825545
31	98.1	27.271979	3.164516129	0.879741258
34	140.8167	36.39583895	4.141667647	1.070465852
34	145.4	37.374786	4.276470588	1.099258412
35	128.5333	33.77222755	3.67238	0.964920787
37	147.5667	37.83757145	3.988289189	1.022637066
40	117.9833	31.51885305	2.9495825	0.787971326
41	123.4	32.675806	3.009756098	0.796970878
42	131.0167	34.30265695	3.119445238	0.816729927
42	137.3667	35.65895345	3.270635714	0.849022701
43	146.5833	37.62752705	3.408913953	0.875058769
44	127.1	33.466089	2.888636364	0.760592932
45	156.9167	39.83463795	3.487037778	0.885214177
49	158.85	40.2475715	3.241836735	0.82137901

Table 1 continued (pg. 2 of 2)

Location	Date	Start Time	Sampling Duration	Mean [PM2.5]	Adjusted Concentrations
Trenton					
No.side Prospect&Olden	4/7/05	13:58:11	0:20:30	42	15.28958
So. side Pospect&Olden	4/7/05	13:55:36	0:25:10	43	15.50317
Upwind Princeton & Olden	4/7/05	14:30:34	0:27:40	47	16.35753
Downwind Princeton & Olden	4/7/05	14:30:32	0:27:40	45	15.93035
Camden					
Morgan Blvd & Broadway	5/18/05	9:35:12	0:30:50	27	12.08573
Westside of Broadway	5/18/05	10:26:39	0:27:00	23	11.23137
Liney Ditch Park Community Dustrak 2	5/18/05	11:15:42	0:44:00	24	11.44496
Liney Ditch Park Community Dustrak 1	5/18/05	11:13:58	0:46:30	26	11.87214
Waterfront South Com.	5/18/05	9:35:26	0:31:10	18	10.16342
Walter Rand Bus Terminal – Outdoors	5/17/05	9:35:01	0:32:30	32	13.15368
4th St. & Jefferson	5/17/05	10:30:27	0:29:40	24	11.44496
East.Atlantic & 9th	5/17/05	13:17:24	0:15:50	29	12.51291
West.Atlantic & 4thSt	5/17/05	13:44:24	0:17:40	32	13.15368
Walter Rand Bus Terminal – Indoors	5/17/05	9:36:30	0:33:00	65	20.20215
Broadway & Winslow	5/17/05	10:30:27	0:29:30	25	11.65855
Broadway & Atlantic	5/17/05	13:17:41	0:31:50	35	13.79445
Newark					
Frelinghuysen Community – Dustrak 1	5/12/05	9:46:59	0:30:20	7	7.81393
Press Event – Dustrak 1	5/12/05	10:44:10	0:43:30	12	8.88188
Frelinghuysen Community – Dustrak 2	5/12/05	9:52:36	0:32:00	10	8.4547
Press event – Dustrak 2	5/12/05	10:49:50	0:43:30	12	8.88188
Raymond Blvd. & Lockwood, I95, US1	5/11/05	10:22:37	0:57:40	75	22.33805
Forest Hill	5/11/05	12:51:07	0:56:40	62	19.56138
North 6th & Park Ave.'s	5/11/05	14:12:39	0:10:10	71	21.48369
Forest Hill, Grafton & Branchwood	5/11/05	12:56:30	0:41:50	71	21.48369
Raymond Blvd. & Blanchard, I95, US1	5/11/05	10:23:51	0:51:40	88	25.11472

Table 2: Original and adjusted DustTrak PM2.5 concentrations ($\mu g/m^3$). Least squares regression equation used to adjust concentrations was: $y = 6.3188 + 0.23159x$.