APPENDIX AVAILABLE ON THE HEI WEB SITE

Research Report 178

National Particle Component Toxicity (NPACT) Initiative Report on Cardiovascular Effects

Sverre Vedal et al.

Section 1: NPACT Epidemiologic Study of Components of Fine Particulate Matter and Cardiovascular Disease in the MESA and WHI-OS Cohorts

Appendix L. NPACT Monitoring Data QA/QC: Supplemental Study

Note: Appendices that are available only on the Web have been assigned letter identifiers that differ from the lettering in the original Investigators' Report. HEI has not changed the content of these documents, only their identifiers.

Appendix L was originally Appendix K

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Although this document was produced with partial funding by the United States Environmental Protection Agency under Assistance Award CR–83234701 to the Health Effects Institute, it has not been subjected to the Agency's peer and administrative review and therefore may not necessarily reflect the views of the Agency, and no official endorsement by it should be inferred. For the research funded under the National Particle Component Toxicity initiative, HEI received additional funds from the American Forest & Paper Association, American Iron and Steel Institute, American Petroleum Institute, ExxonMobil, and Public Service Electric and Gas. The contents of this document also have not been reviewed by private party institutions, including those that support the Health Effects Institute; therefore, it may not reflect the views or policies of these parties, and no endorsement by them should be inferred.

This document was reviewed by the HEI NPACT Review Panel
but did not undergo the HEI scientific editing and production process.

APPENDIX K: NPACT monitoring data QA/QC: supplemental study

Exposure Monitoring Quality Assurance/Quality Control (QA/QC) Report for the NPACT Supplemental Project

1. Introduction

In 2009, HEI/NPACT funded a sampling campaign to supplement the data collected by the main MESA Air and HEI/NPACT studies. This campaign was designed to examine the effect of the intermittent sampling schedule commonly used by the Air Quality System (AQS) network on the correlation between AQS averages and the integrated two-week measurements collected by MESA Air and its ancillary studies. For this campaign, Teflon and quartz filters were deployed on the regular 50% duty-cycle schedule, side-by-side with Teflon and quartz filters on a 1-in-3 day cycle. These paired samples were co-located with AQS monitors operating on identical 1-in-3 day schedules. The purpose of this sampling was to better assess the correlation between AQS sampling methods and the HPEM-based sampling method by matching the time periods exactly. These samples were collected between January 7, 2009 and July 31, 2009 in most areas, but additional samples were collected in Chicago in August 2009.

The two-week time-integrated samples are included in the primary QA/QC Report for MESA Air and its ancillary studies (summarizing the $PM_{2.5}$, NO_X, NO_2, NO, and O_3) and the X-Ray Fluorescence, Elemental Carbon, and Organic Carbon QA/QC Report (Supplement 1). This current supplement (Supplement 2) includes the counts and validity of the 1-in-3 day samples (referred to as “supplemental fixed site sampling”) and summarizes the results of the comparison study.

Table 1. Number of rounds of supplemental fixed site sampling

Study Area	Supplemental Fixed Site Sampling Rounds
Baltimore	13
Chicago	14
LA	12
Riverside	12
NYC	12
St. Paul	12
Winston-Salem	13

2. Sample Validity

Two sampling media were employed by MESA Air and HEI/NPACT for this sampling campaign: Teflon filters (analyzed for light absorbing carbon [σ_{ap}] and $PM_{2.5}$ mass) and quartz filters (analyzed for elemental and organic carbon). The total numbers of Teflon and quartz filters included in this report are summarized in this section. Sampling units were co-located with one AQS monitoring site in seven study areas: Baltimore, Chicago, LA, Riverside, New York City, St. Paul, and Winston-Salem.

2.1 Sampling Methodology

All data were collected using active sampling methods. Traditional MESA Air methodology (described briefly in the primary QA/QC Report, and fully in the Field SOPs) was utilized for the two-week 50% duty cycle samples. A series of pumps and timers was utilized for the filters that were sampled on the AQS 1-in-3 day schedule. These supplemental fixed site samples were collected using a pump that ran during the entire two-week period and a valve on a timer, which switched the flow between the sample filter on the sampling days and a waste filter on the off-days. To ensure proper operation, one of the timers was used to record the amount of time that the valve was open to allow air to flow through the sample filter. However, these timers could not sense air flow, and therefore reported intended sampling duration based on an uninterrupted air flow that would come from proper pump function. The TSI SP530 pumps for this sampling campaign did not record flow values each minute, but the total flow time was displayed on the pump's screen, and was typically documented so that pump failures could be identified.

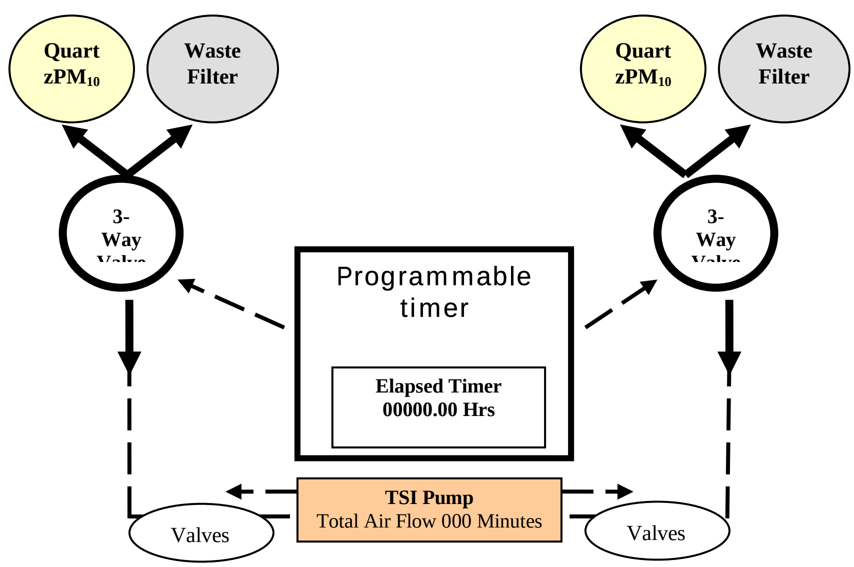

Figure 1. Schematic of equipment set-up for 1-in-3 day sampling.

Two types of samples were deployed for this monitoring campaign: primary samples and duplicate samples. Primary samples are the measurements used in the exposure modeling efforts to estimate air pollution. Duplicates are additional samples deployed concurrently with primary samples used exclusively to evaluate sample precision. The duplicates are otherwise identical in all ways to the primary samples with which they were paired. Where duplicate pairs were deployed and one filter was invalidated, the valid filter was considered the "sample" and the invalid filter was considered the "duplicate". Therefore, the percentage of valid duplicates is lower than the overall percentage of valid samples.

2.2 Counts of valid and fatal filters

Samples and field records were reviewed to ensure data quality. Filters were considered invalid (fatal) if the duration of sampling was less than 3 days' time or more than 6 days' time. Similarly, improper pump flows could invalidate a filter sample. Pump flow was measured for samples and duplicates at both deployment ("on-flow") and retrieval ("off-flow) with a rotameter. Rotameter calibration and flow calculation are described in the primary QA/QC Report. Flow rates less than 1620 mL/min or greater than 1980 mL/min were deemed fatal. Finally, "other issues", such as a torn filter, sampler damage in the field, or lab issues could also invalidate a filter sample for reasons related to our sampling.

Counts of deployed and valid samples and duplicates for each of the four analyses ($PM_{2.5}$, σ_{ap}, XRF, and EC/OC) are described below in Tables 2, 4, 6, and 8. Following each of these tables is a table of counts of fatal filters for that analysis by reason and study area. Overall, 85 valid filters were collected in this supplemental fixed site monitoring campaign – 72 samples and 13 duplicates. This reflected 84% and 59% capture rates for the samples and duplicates, respectively. Duration issues due to incorrect field scheduling or pump failure were responsible for the majority (9% of Teflon and 8% of quartz filters) fatal filters. Unacceptably high or low flow rates accounted for an additional 6% of all Teflon filters and 3% of quartz filters being marked as fatal. The remaining fatal filters were due to "other issues". Quartz filters were also subject to field issues and 10% of quartz filters were fatal due to "other" reasons.

In general, the same filters that were fatal for mass were also fatal for σ_{ap} and XRF analysis, although lab issues affected a few more filters than gravimetric or XRF analysis. Not all filters were analyzed for elemental species; 5% were not selected for analysis. Similar to Teflon filters, not all quartz filters were analyzed; 5% were not selected for analysis.

Table 2. Counts of valid Teflon filters from the supplemental sampling campaign analyzed for $PM_{2.5}$ mass.

Study Area	**Samples**		**Duplicates**		**Total**	
	Deployed	Valid	Deployed	Valid	Deployed	Valid
Baltimore	13	12 (92%)	3	3 (100%)	16	15 (94%)
Chicago	13	12 (92%)	3	3 (100%)	16	15 (94%)
LA	12	11 (92%)	3	2 (67%)	15	13 (87%)
Riverside	11	10 (91%)	3	2 (67%)	14	12 (86%)
NYC	12	11 (92%)	3	0 (0%)	15	11 (73%)
St. Paul	12	11 (92%)	5	3 (60%)	17	14 (82%)
Winston-Salem	13	5 (38%)	2	0 (0%)	15	5 (33%)
Across all sites	**86**	**72 (84%)**	**22**	**13 (59%)**	**108**	**85 (79%)**

Table 3. Counts of Teflon filters invalidated for $PM_{2.5}$, by reason and study area.

Study Area	Duration issues	Flow issues	Other*	Total Number Fatal
Baltimore	1	0	0	1
Chicago	0	1	0	1
LA	0	1	1	2
Riverside	0	0	2	2
NYC	0	3	1	4
St. Paul	0	1	2	3
Winston-Salem	9	0	1	9
Across all sites	10	6	7	23

*Other issues include torn filters, other sampler damage in the field or lab, or missing field or analysis records.

Table 4. Counts of valid Teflon filters from the supplemental sampling campaign analyzed for σ_{ap}.

Study Area	Samples		Duplicates		Total	
	Deployed	Valid	Deployed	Valid	Deployed	Valid
Baltimore	13	12 (92%)	3	3 (100%)	16	15 (94%)
Chicago	13	12 (92%)	3	3 (100%)	16	15 (94%)
LA	12	9 (75%)	3	2 (67%)	15	11 (73%)
Riverside	11	7 (64%)	3	2 (67%)	14	9 (64%)
NYC	12	11 (92%)	3	0 (0%)	15	11 (73%)
St. Paul	12	11 (92%)	5	3 (60%)	17	14 (82%)
Winston-Salem	13	5 (38%)	2	0 (0%)	15	5 (33%)
Across all sites	**86**	**67 (78%)**	**22**	**13 (59%)**	**108**	**80 (74%)**

Table 5. Counts of Teflon filters invalidated for σ_{ap}, by reason and study area.

Study Area	Duration issues	Flow issues	Other*	Total Number Fatal
Baltimore	1	0	0	1
Chicago	0	1	0	1
LA	0	1	3	4
Riverside	0	0	5	5
NYC	0	3	1	4
St. Paul	0	1	2	3
Winston-Salem	9	0	1	9
Across all sites	10	6	12	28

*Other issues include torn filters, other sampler damage in the field or lab, or missing field or analysis records.

Table 6. Counts of valid Teflon filters from the supplemental sampling campaign analyzed for elemental species by XRF.

Study Area	Samples		Duplicates		Total	
	Deployed	Valid	Deployed	Valid	Deployed	Valid
Baltimore	13	12 (92%)	3	3 (100%)	16	15 (94%)
Chicago	13	10 (77%)	3	2 (67%)	16	12 (75%)
LA	12	10 (83%)	3	2 (67%)	15	12 (80%)
Riverside	11	9 (82%)	3	2 (67%)	14	11 (79%)
NYC	12	11 (92%)	3	0 (0%)	15	11 (73%)
St. Paul	12	11 (92%)	5	3 (60%)	17	14 (82%)
Winston-Salem	13	5 (38%)	2	0 (0%)	15	5 (33%)
Across all sites	**86**	**68 (79%)**	**22**	**12 (55%)**	**108**	**80 (74%)**

Table 7. Counts of Teflon filters invalidated for elemental species by XRF or excluded from analysis, by reason and study area.

Study Area	Duration issues	Flow issues	Not Selected	Other*	Total Number Fatal
Baltimore	1	0	0	0	1
Chicago	0	1	3	0	4
LA	0	1	1	1	3
Riverside	0	0	1	2	3
NYC	0	3	0	1	4
St. Paul	0	1	0	2	3
Winston-Salem	9	0	0	1	9
Across all sites	10	6	5	7	28

*Other issues include torn filters, other sampler damage in the field or lab, or missing field or analysis records.

Table 8. Counts of valid quartz filters from the supplemental sampling campaign analyzed for EC/OC.

Study Area	Samples		Duplicates		Total	
	Deployed	Valid	Deployed	Valid	Deployed	Valid
Baltimore	13	9 (69%)	3	3 (100%)	16	12 (75%)
Chicago	14	13 (93%)	4	4 (100%)	18	17 (94%)
LA	12	11 (92%)	3	3 (100%)	15	14 (93%)
Riverside	12	10 (83%)	3	3 (100%)	15	13 (87%)
NYC	12	10 (83%)	3	0 (0%)	15	10 (67%)
St. Paul	12	11 (92%)	5	3 (60%)	17	14 (82%)
Winston-Salem	13	3 (23%)	2	0 (0%)	15	3 (20%)
Across all sites	**88**	**67 (76%)**	**23**	**16 (70%)**	**111**	**83 (75%)**

Table 9. Counts of quartz filters invalidated for EC/OC or excluded from analysis, by reason and study area.

Study Area	Duration issues	Flow issues	Not Selected	Other*	Total Number Fatal
Baltimore	1	0	2	1	4
Chicago	0	0	1	0	1
LA	0	0	1	0	1
Riverside	0	0	0	2	2
NYC	0	0	0	5	5
St. Paul	0	3	0	0	3
Winston-Salem	8	0	2	2	12
Across all sites	**9**	**3**	**6**	**10**	**28**

*Other issues include torn filters, other sampler damage in the field or lab, or missing field or analysis records.

2.3 Criteria for valid comparison to AQS data

Filters could also be excluded from analysis if there were issues in alignment with the AQS monitoring data since this supplemental sampling schedule was designed to match the intended AQS sampling schedule as closely as possible. In some cases, samples collected by the agencies were not valid; in other cases, the technicians were not able to collect the samples on the appointed days. Table 10 shows the intended AQS sampling schedules. Intended sampling days were matched to AQS sampling whenever possible, but not all samples for which the primary validity criteria were met could be matched exactly to AQS data. Comparisons are only presented for those sampling events for which there was reasonable certainty that the sampling was perfectly matched. Counts of these comparisons are presented in Tables 11 and 12.

Table 10. AQS sites and sampling schedules

Study Area	Site ID	$PM_{2.5}$ Schedule	EC/OC and Elemental Species Schedule
Baltimore	24 005 3001	Daily	1 in 3
Chicago	17 031 0076	1 in 3	1 in 3
LA	06 037 1103	Daily	1 in 6
Riverside	06 065 8005	1 in 3 before 4/15 Daily after 4/15	--
NYC	36 005 0110	Daily	1 in 3
NYC	NEYO1	1 in 3	1 in 3
St. Paul	27 053 0963	1 in 3	1 in 3
Winston-Salem	37 067 0022	Daily	1 in 6

Table 11. Counts of valid comparisons between our paired two-week integrated measurements and 1-in-3 day integrated measurements, by study area.

Study Area	$PM_{2.5}$	Sulfur/Silicon	EC/OC	σ_{ap}
Baltimore	10	10	8	10
Chicago	9	7	11	9
LA	11	10	11	8
Riverside	10	9	10	7
NYC	9	9	7	9
St. Paul	11	11	11	11
Winston-Salem	5	5	3	5
Across all sites	**65**	**61**	**61**	**59**

Table 12. Counts of valid comparisons between HEI/NPACT 1-in-3 day integrated measurements and AQS 1-in-3 day averages, by study area.

Study Area	Site ID	$PM_{2.5}$	Sulfur/Silicon	EC/OC	σ_{ap} to EC
Baltimore	24 005 3001	8	5	3	5
Chicago	17 031 0076	11	2	3	3
LA	06 037 1103	10	0	0	0
Riverside	06 065 8005	9	0	0	0
NYC	36 005 0110	12	10	3	3
NYC IMPROVE	NEYO1	10	9	8	9
St. Paul	27 053 0963	11	11	6	6
Winston-Salem	37 067 0022	5	0	0	0
Total		**76**	**37**	**23**	**26**

2.4 Sample correction

Blank corrections are described in detail in the primary QA/QC Report. Briefly, for $PM_{2.5}$ and elemental species, the mass is corrected by the median mass on field blanks (see Section 8.1 of Appendix K, the primary QA/QC Report). Masses are then converted to volumes using the duration and air flow measured in the field. For LAC, σ_{ap} is calculated as the ratio of median blank normalized reflectance over sample normalized reflectance and incorporates the air volume and surface area of the filter.

Duplicates

Comparisons of 1-in-3 day duplicates are included in this section. Precision for samples collected on the two-week, 50% duty cycle schedule is covered in the primary QA/QC Report. Due to the small number of samples collected at each location (usually 3), summary numbers are not broken down by field center or location.

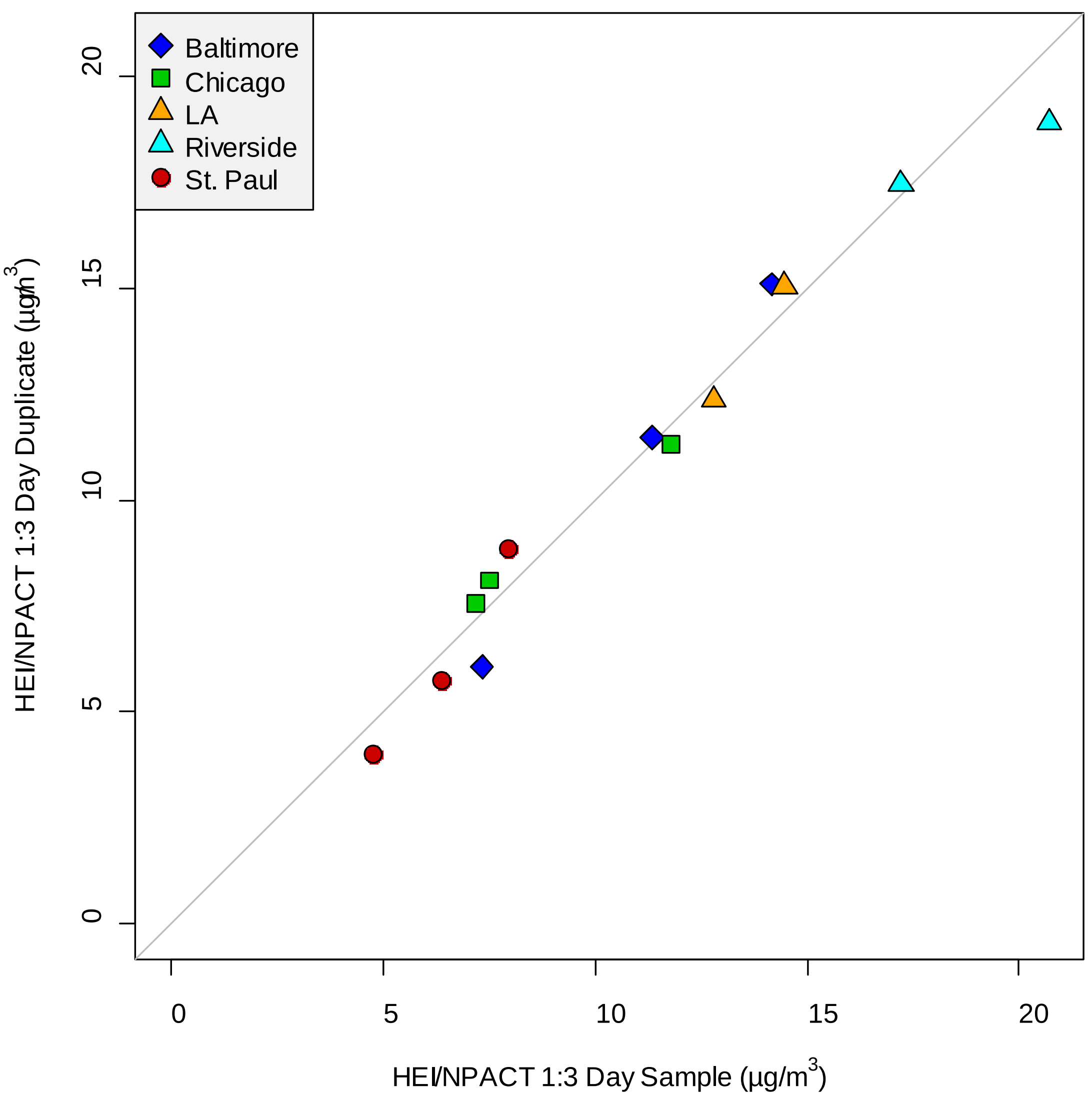

Figure 2. Scatterplot for $PM_{2.5}$ showing the correlation between HEI/NPACT 1-in-3 day samples to 1-in-3 day duplicates. The overall relative percent difference for this comparison is 5.4%, with an R^2 of 0.97

and RMSE of 0.82 µg/m^3. Standard deviations for samples and duplicates were 4.7 µg/m^3 and 4.7 µg/m^3 respectively.

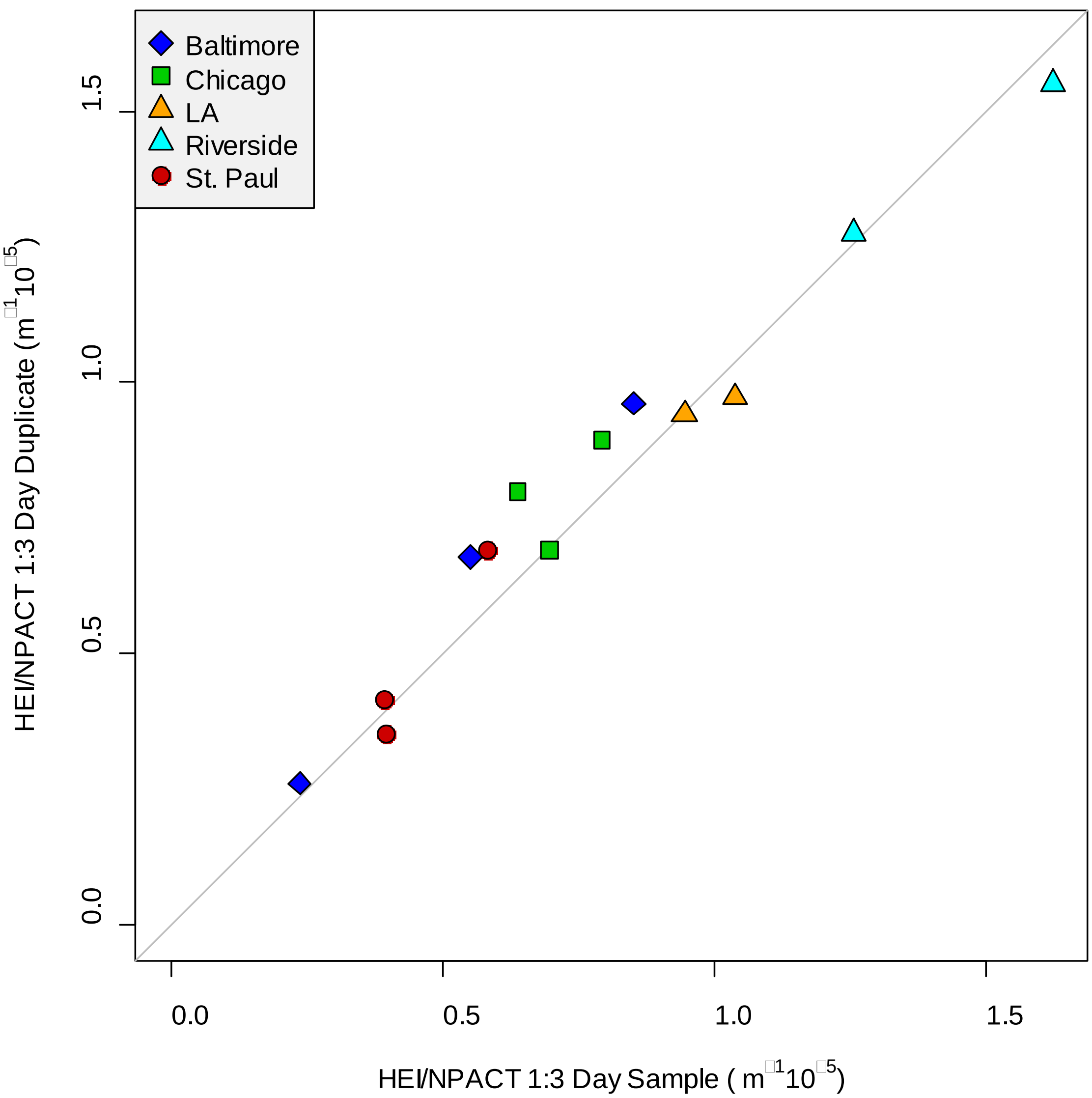

Figure 3. Scatterplot for light absorption (σ_{ap}) showing the correlation between HEI/NPACT 1-in-3 day samples to 1-in-3 day duplicates. The overall relative percent difference for this comparison is 5.4%, with an R^2 of 0.96 and RMSE of 0.083 x $10^{-5}m^{-1}$. Standard deviations for samples and duplicates were 0.38 x $10^{-5}m^{-1}$ and 0.36 x $10^{-5}m^{-1}$ respectively.

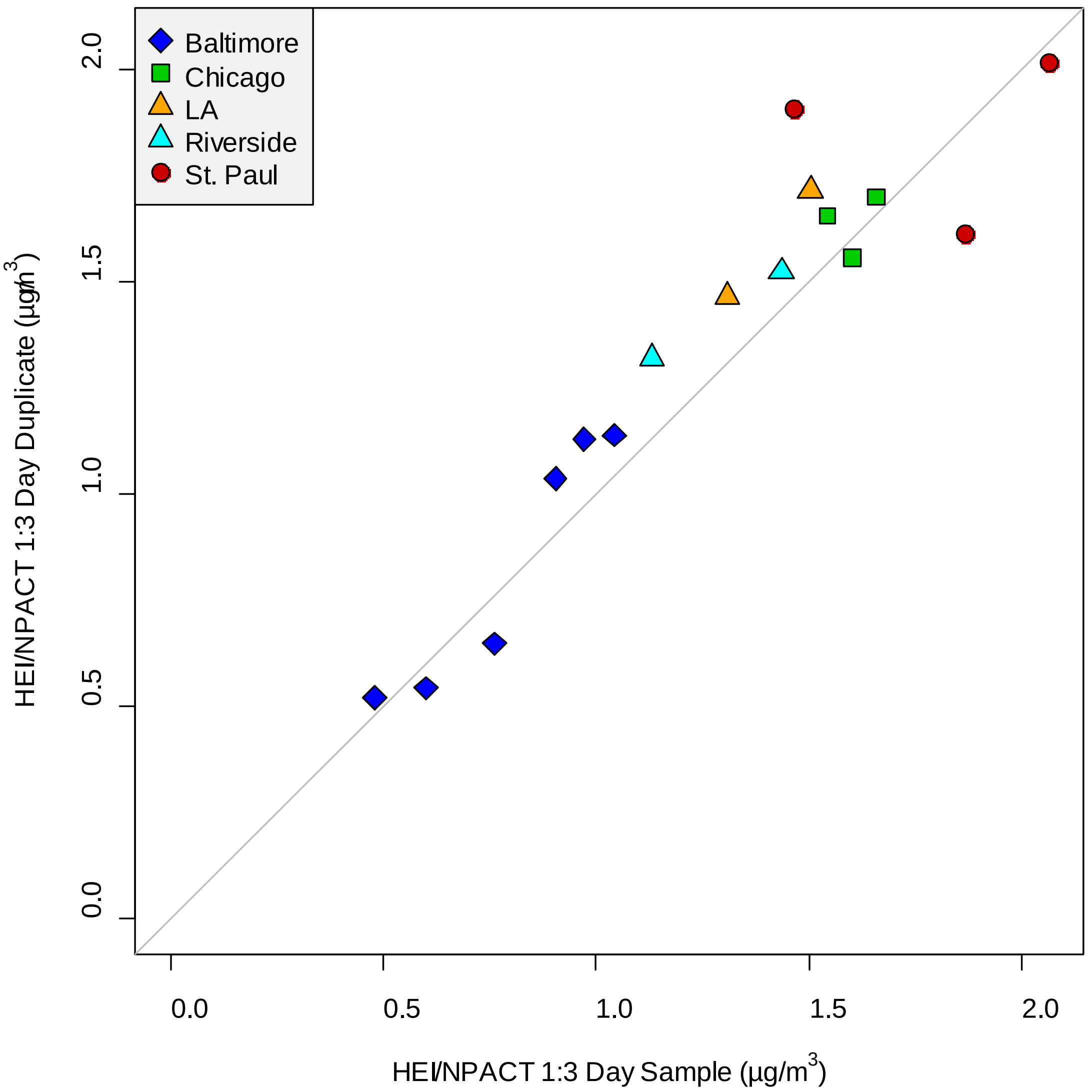

Figure 4. Scatterplot for elemental carbon (EC) showing the correlation between HEI/NPACT 1-in-3 day samples to 1-in-3 day duplicates. The overall relative percent difference for this comparison is 7.7%, with an R^2 0.89 of and RMSE of 0.17 µg/m^3. Standard deviations for samples and duplicates were 0.45 µg/m^3 and 0.47 µg/m^3 respectively.

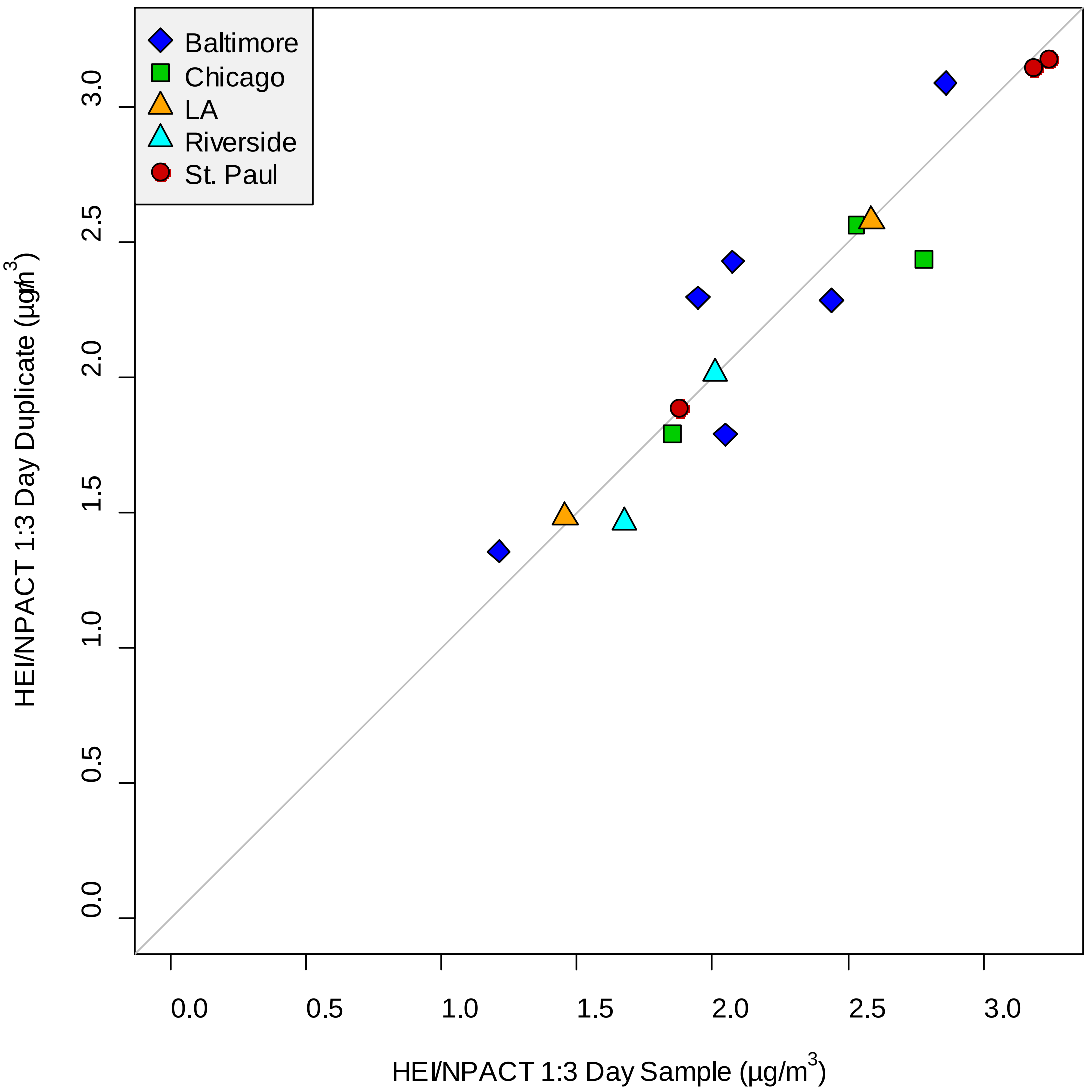

Figure 15. Scatterplot for organic carbon (OC) showing the correlation between HEI/NPACT 1-in-3 day samples to 1-in-3 day duplicates. The overall relative percent difference for this comparison is 4.8%, with an R^2 of 0.89 and RMSE of 0.19 µg/m^3. Standard deviations for samples and duplicates were 0.59 µg/m^3 and 0.59 µg/m^3 respectively.

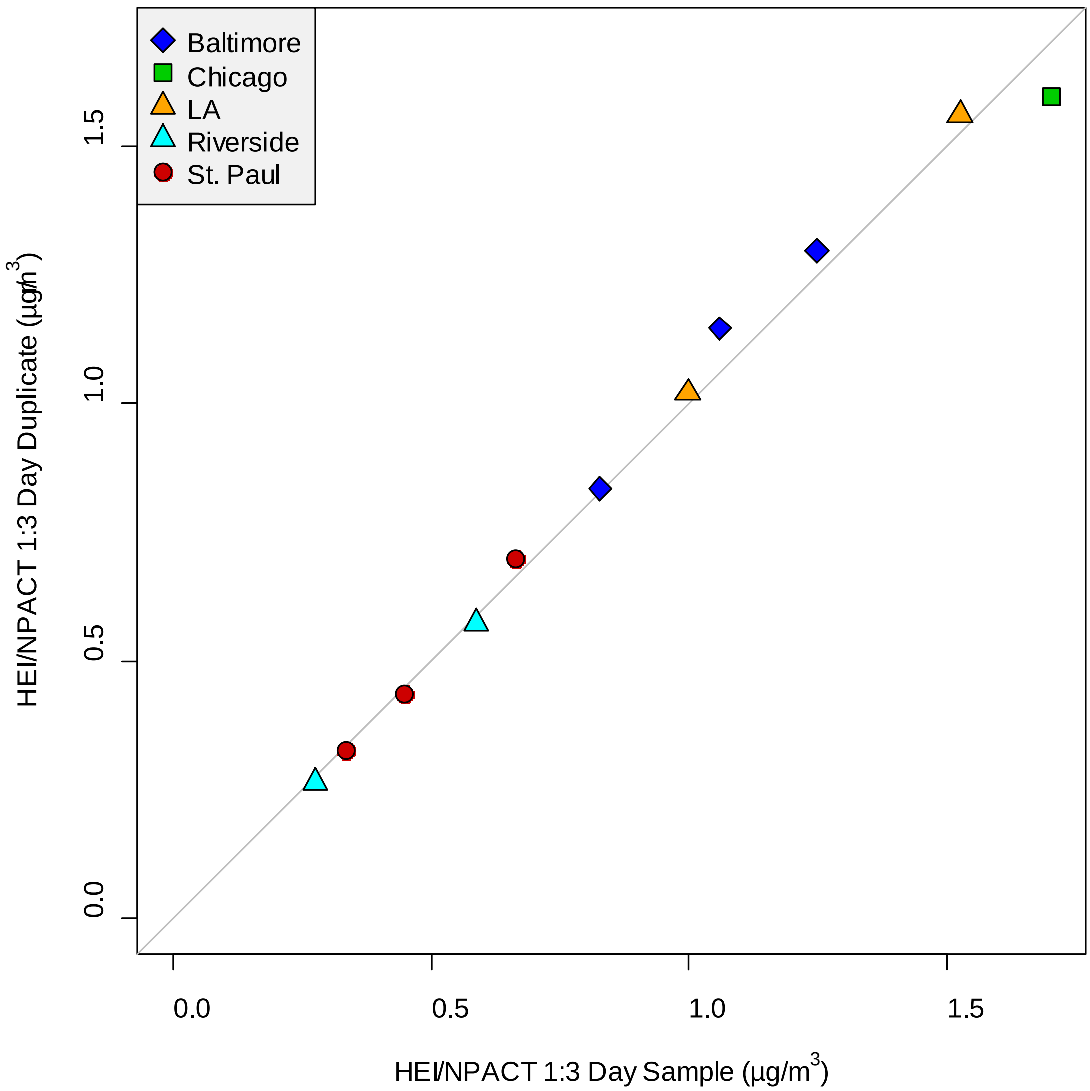

Figure 6. Scatterplot for sulfur showing the correlation between HEI/NPACT 1-in-3 day samples to 1-in-3 day duplicates. The overall relative percent difference for this comparison is 2.7%, with an R^2 of 0.99 and RMSE of 0.48 µg/m^3. Standard deviations for samples and duplicates were 0.46 µg/m^3 and 0.46 µg/m^3 respectively.

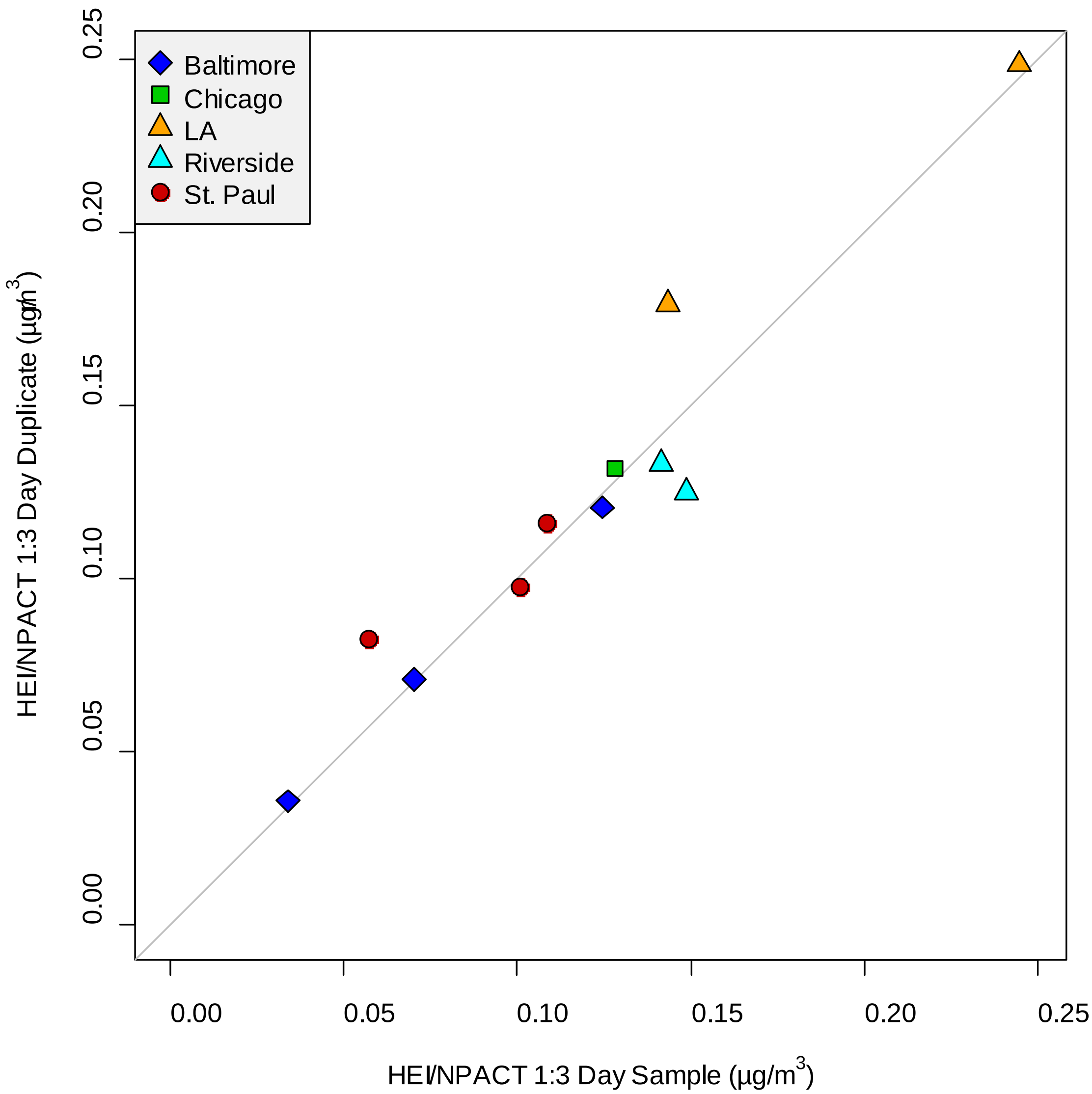

Figure 7. Scatterplot for silicon showing the correlation between HEI/NPACT 1-in-3 day samples to 1-in-3 day duplicates. The overall relative percent difference for this comparison is 6.8%, with an R2 of 0.92 and RMSE of 0.016 µg/m3. Standard deviations for samples and duplicates were 0.055 µg/m3 and 0.056 µg/m3 respectively.

3. Comparisons of MESA Air/HEI/NPACT 2-Week Measurements to Composite 1-in-3 Day Measurements

This section contains the comparisons between the samples we collected on a 50% duty cycle over the course of a two week period to those we collected on a 1-in-3 day schedule.

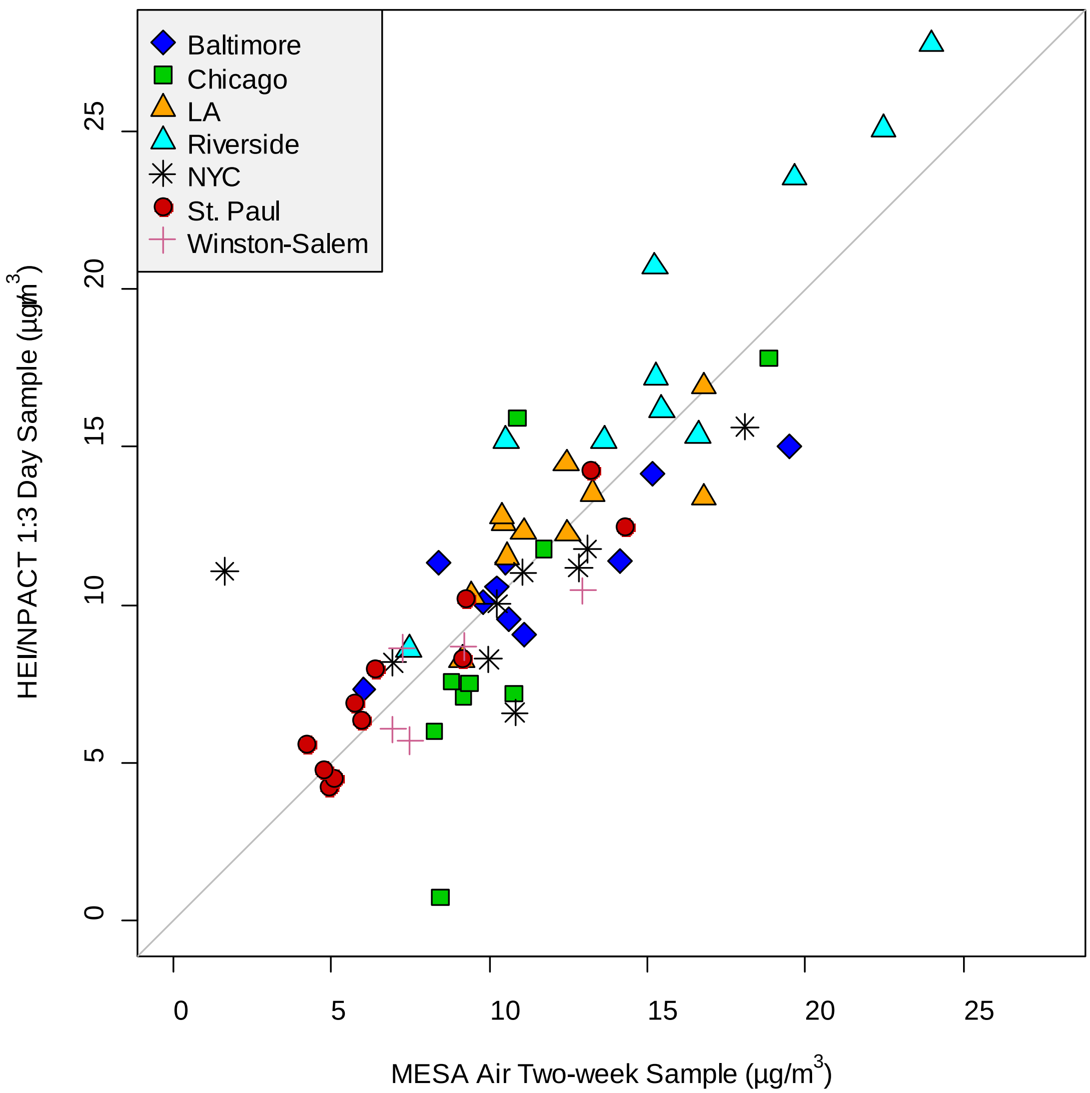

Figure 8. Scatterplot showing the relationship for $PM_{2.5}$ between MESA Air two-week measurements and HEI/NPACT 1-in-3 day measurements during the same time period, by study area (overall R^2 = 0.72, RMSE = 2.6 µg/m^3). Standard deviations for the two-week and 1-in-3 day measurements were 4.3 µg/m^3 and 4.9 µg/m^3 respectively.

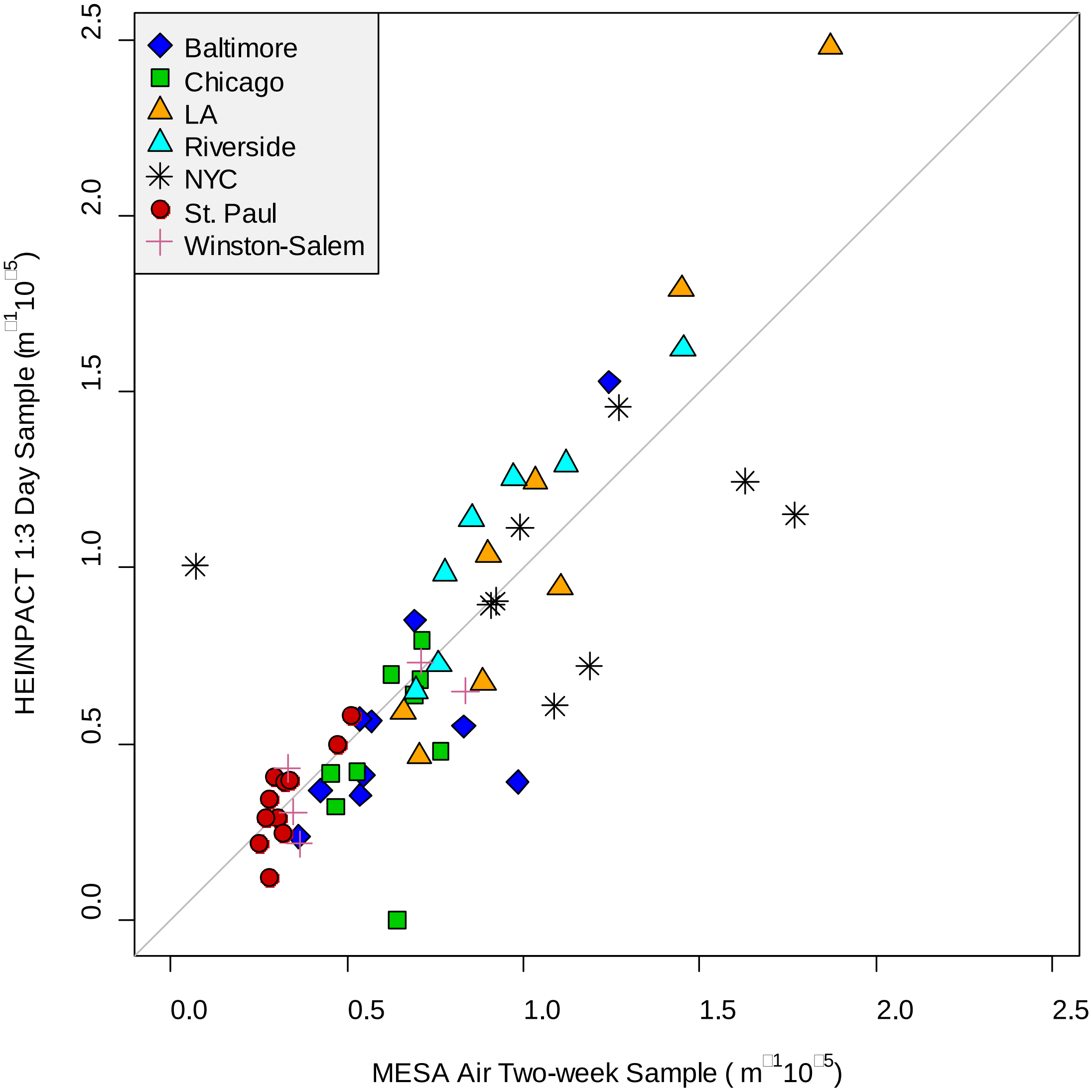

Figure 9. Scatterplot showing the relationship for σ_{ap} between MESA Air $PM_{2.5}$ two-week measurements and HEI/NPACT 1-in-3 day measurements during the same time period, by study area (overall $R^2 = 0.67$, RMSE = 0.26 m^{-1} 10^{-5}). Standard deviations for the two-week and 1-in-3 day measurements were 0.40 m^{-1} 10^{-5} and 0.46 m^{-1} 10^{-5} respectively.

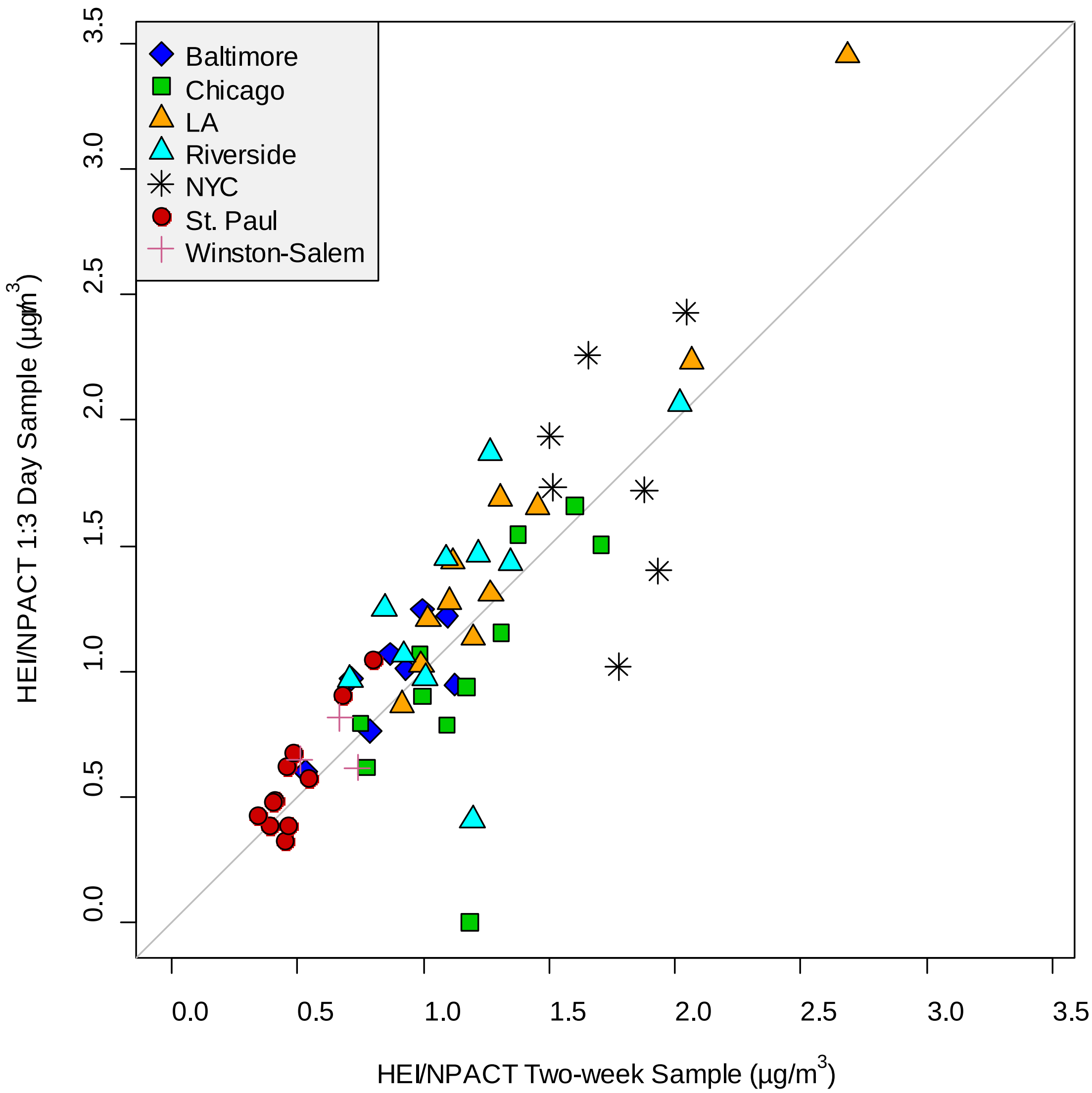

Figure 210. Scatterplot showing the relationship for elemental carbon (EC) between HEI/NPACT two-week measurements and HEI/NPACT 1-in-3 day measurements during the same time period, by study area (overall R^2 = 0.72, RMSE = 0.32 µg/m^3). Standard deviations for the two-week and 1-in-3 day measurements were 0.50 µg/m^3 and 0.62 µg/m^3 respectively.

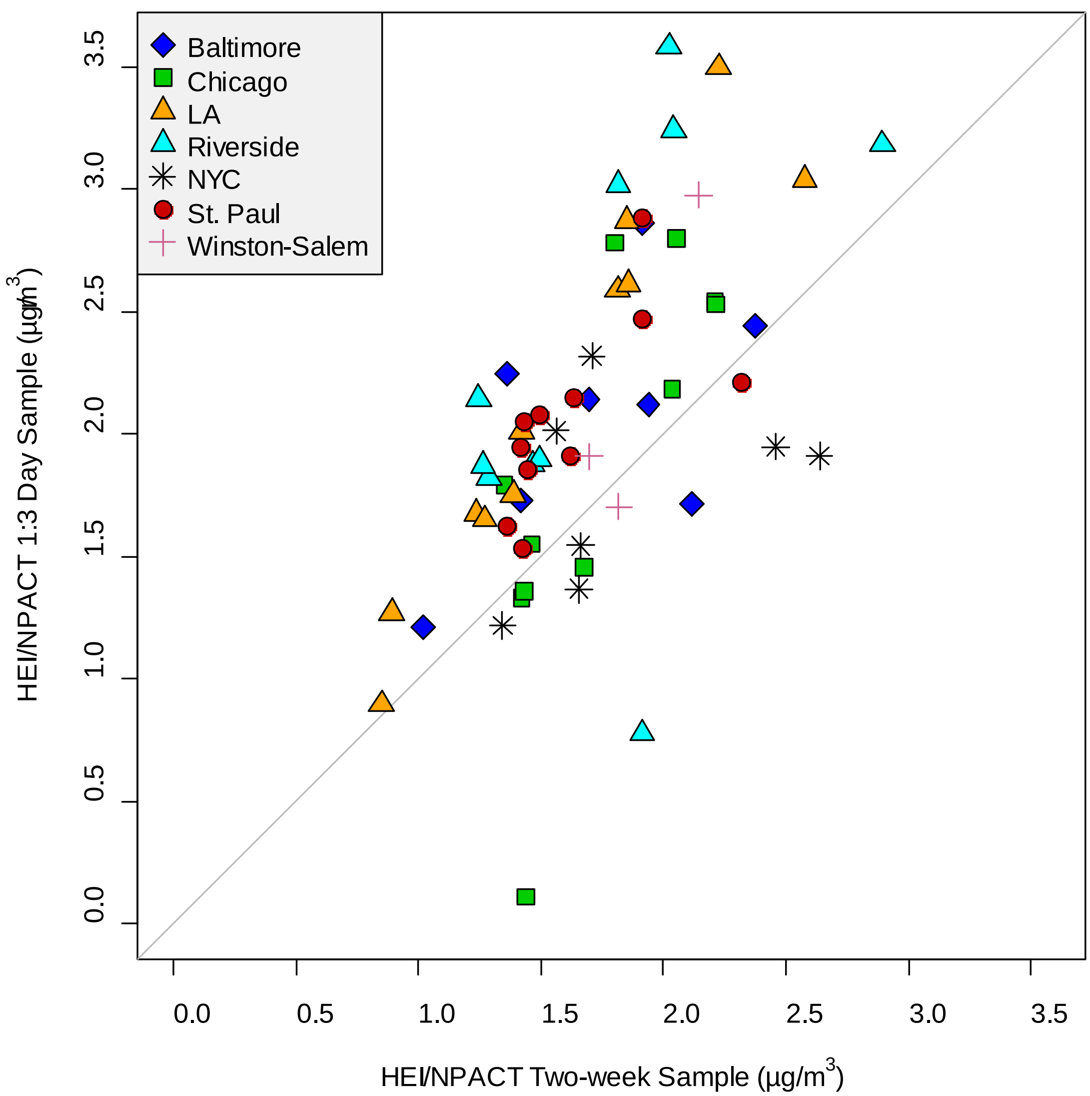

Figure 11. Scatterplot showing the relationship for organic carbon (OC) between HEI/NPACT two-week measurements and HEI/NPACT 1-in-3 day measurements during the same time period, by study area (overall R^2 = 0.37, RMSE = 0.63 µg/m^3). Standard deviations for the two-week and 1-in-3 day measurements were 0.42 µg/m^3 and 0.68 µg/m^3 respectively.

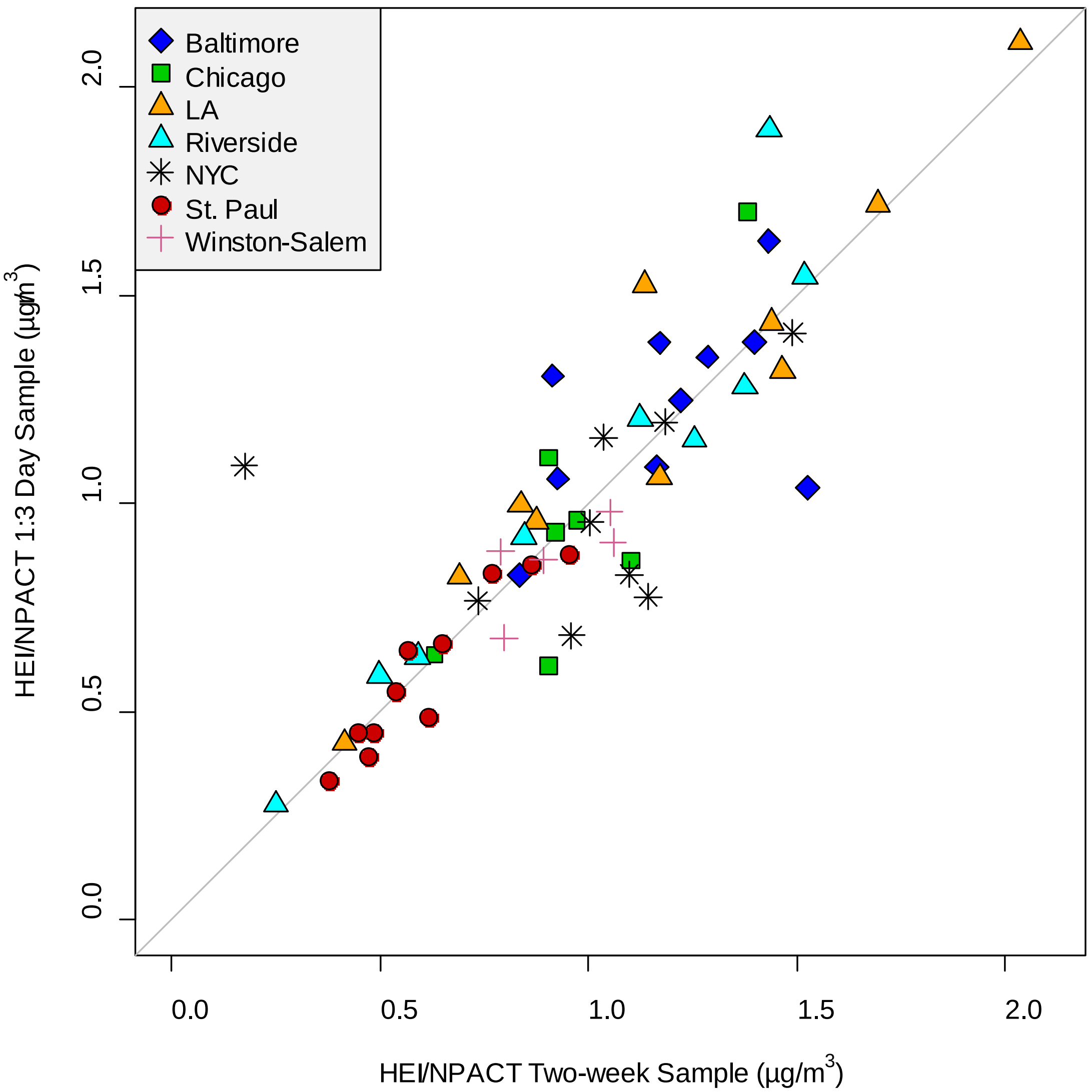

Figure 12. Scatterplot showing the relationship for sulfur between MESA Air two-week measurements and HEI/NPACT 1-in-3 day measurements during the same time period, by study area (overall $R^2 = 0.74$, RMSE = 0.20 µg/m^3). Standard deviations for the two-week and 1-in-3 day measurements were 0.38 µg/m^3 and 0.39 µg/m^3 respectively.

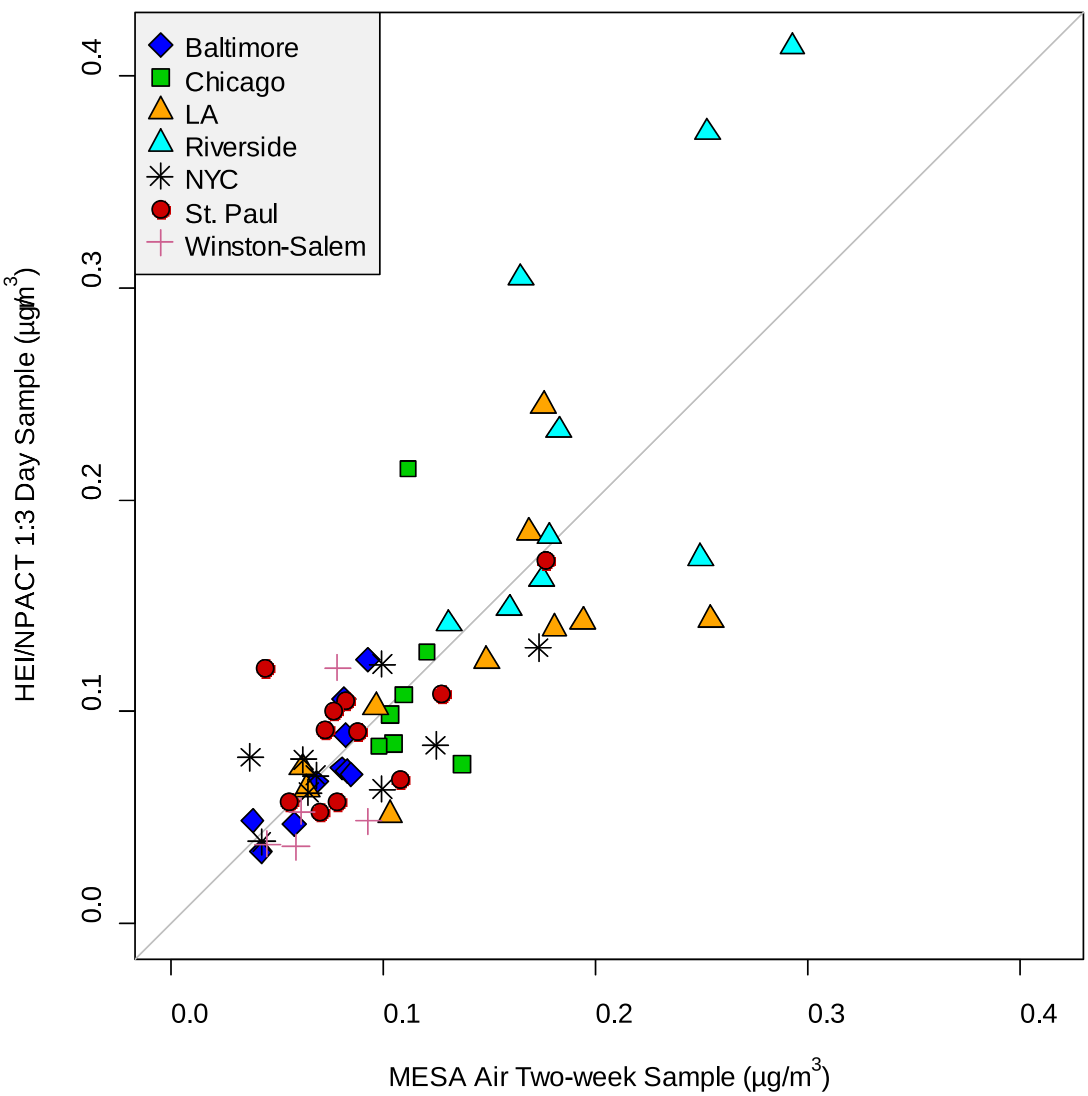

Figure 13. Scatterplot showing the relationship for silicon between MESA Air two-week measurements and HEI/NPACT 1-in-3 day measurements during the same time period, by study area (overall R^2 = 0.65, RMSE = 0.045 µg/m^3). Standard deviations for the two-week and 1-in-3 day measurements were 0.061 µg/m^3 and 0.073 µg/m^3 respectively.

4. Comparisons of Composite 1-in-3 Day HEI/NPACT Measurements to 1-in-3 Day AQS Averages

This section contains the comparisons of HEI/NPACT measurements to averages of AQS measurements. Each point compares a 1-in-3 day HEI/NPACT measurement to an average of the same days' AQS measurements. Correlations were relatively high for most pollutants, though silicon and organic carbon showed weaker associations. Comparisons were not possible for EC, OC, or elemental species in LA and Winston-Salem because the local air quality agencies sample on a 1-in-6 day schedule for those pollutants.

Table 13. Summary of comparisons between HEI/NPACT measurements and AQS averages for matched dates

Pollutant	R^2	RMSE	Standard Deviation: HEI/NPACT 1-in-3 Day Measurement	Standard Deviation: AQS 1-in-3 Day Average
$PM_{2.5}$	0.77	2.4 µg/m^3	4.6 µg/m^3	4.5 µg/m^3
σ_{ap}	0.79	‡	0.46 x 10^{-5}m^{-1}	0.44 µg/m^3
EC	0.81	0.52 µg/m^3	0.78 µg/m^3	0.47 µg/m^3
OC*	0.56	0.43 µg/m^3	0.62 µg/m^3	0.52 µg/m^3
Sulfur	0.84	0.18 µg/m^3	0.32 µg/m^3	0.28 µg/m^3
Silicon	0.14	0.048 µg/m^3	0.039 µg/m^3	0.045 µg/m^3

* Excludes one outlier. See Figure 17 for statistics based on all data

‡ Statistic not meaningful for this comparison

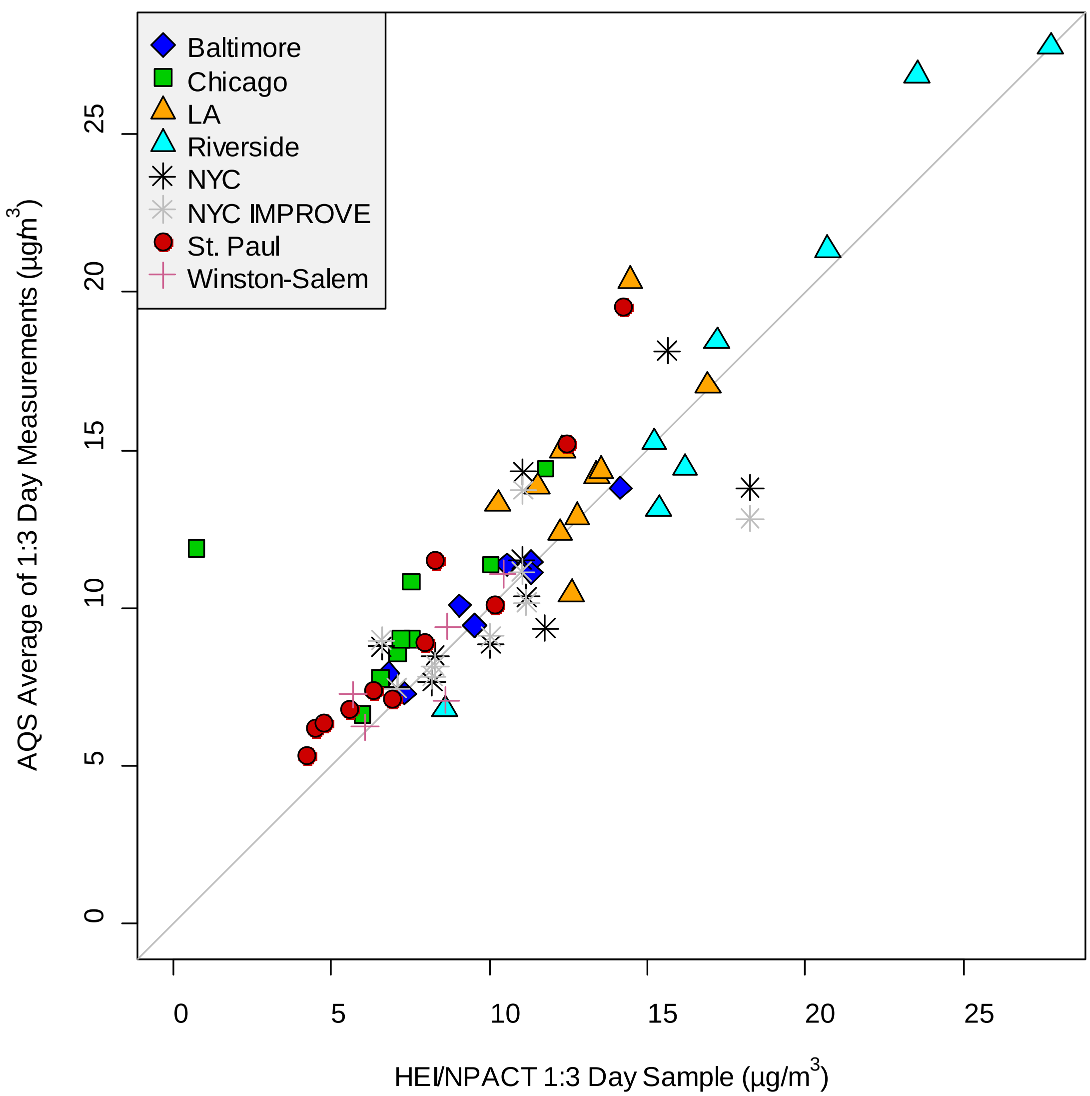

Figure 14. Scatterplot showing the relationship for $PM_{2.5}$ between HEI/NPACT 1-in-3 day measurements and averages of AQS measurements for the same dates, by study area (overall R^2 = 0.77, RMSE = 2.4 µg/m^3). Standard deviations for the HEI/NPACT composite 1-in-3 day measurements and AQS 1-in-3 day averages were 4.6 µg/m^3 and 4.5 µg/m^3 respectively.

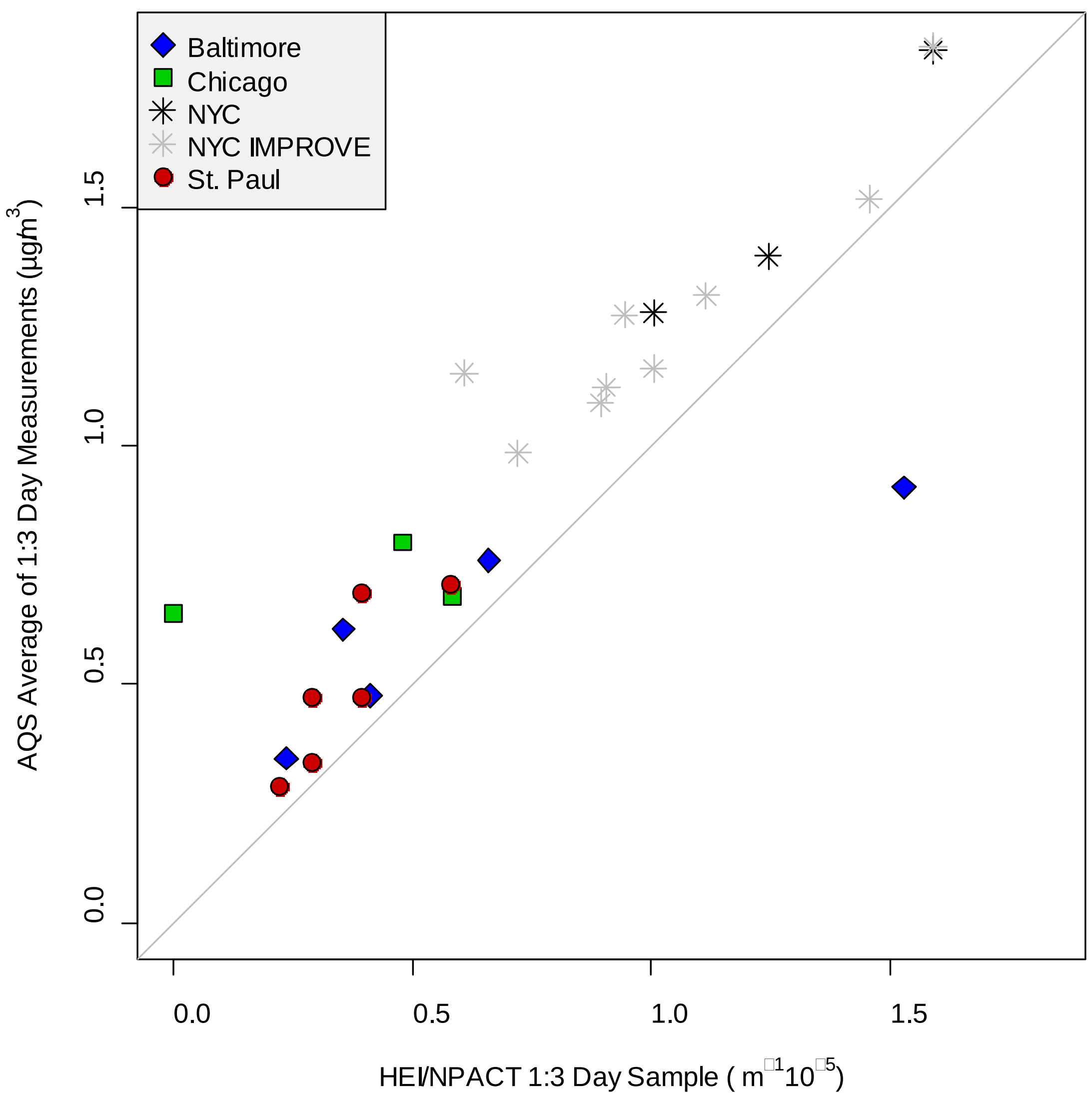

Figure 15. Scatterplot showing the relationship between light absorption (σ_{ap}) measured by HEI/NPACT in 1-in-3 day measurements and averages of AQS measurements of elemental carbon (EC) for the same dates ($R^2 = 0.79$). The 1:1 line is provided for reference only. Coincidentally, a 1 μg increase in elemental carbon (EC) has typically been associated with a $1x10^{-5}m^{-1}$ increase in σ_{ap}. This relationship should not be over-interpreted and is the reason that no RMSE is provided.

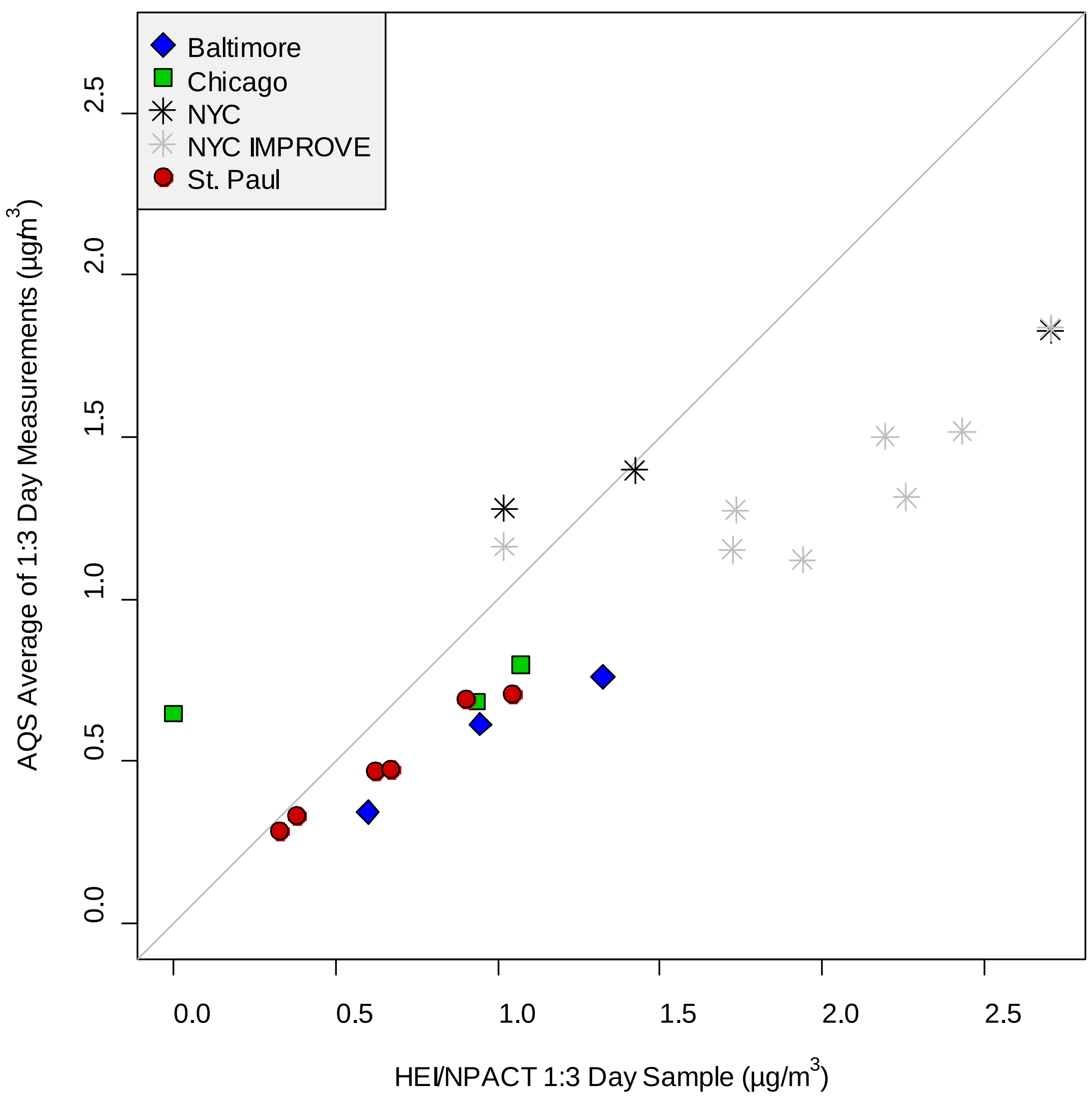

Figure 16. Scatterplot showing the relationship for elemental carbon (EC) between HEI/NPACT $PM_{2.5}$ 1-in-3 day measurements and averages of AQS measurements for the same dates, by study area (overall R^2 = 0.81, RMSE = 0.52 µg/m^3). Standard deviations for the HEI/NPACT composite 1-in-3 day measurements and AQS 1-in-3 day averages were 0.78 µg/m^3 and 0.47 µg/m^3 respectively.

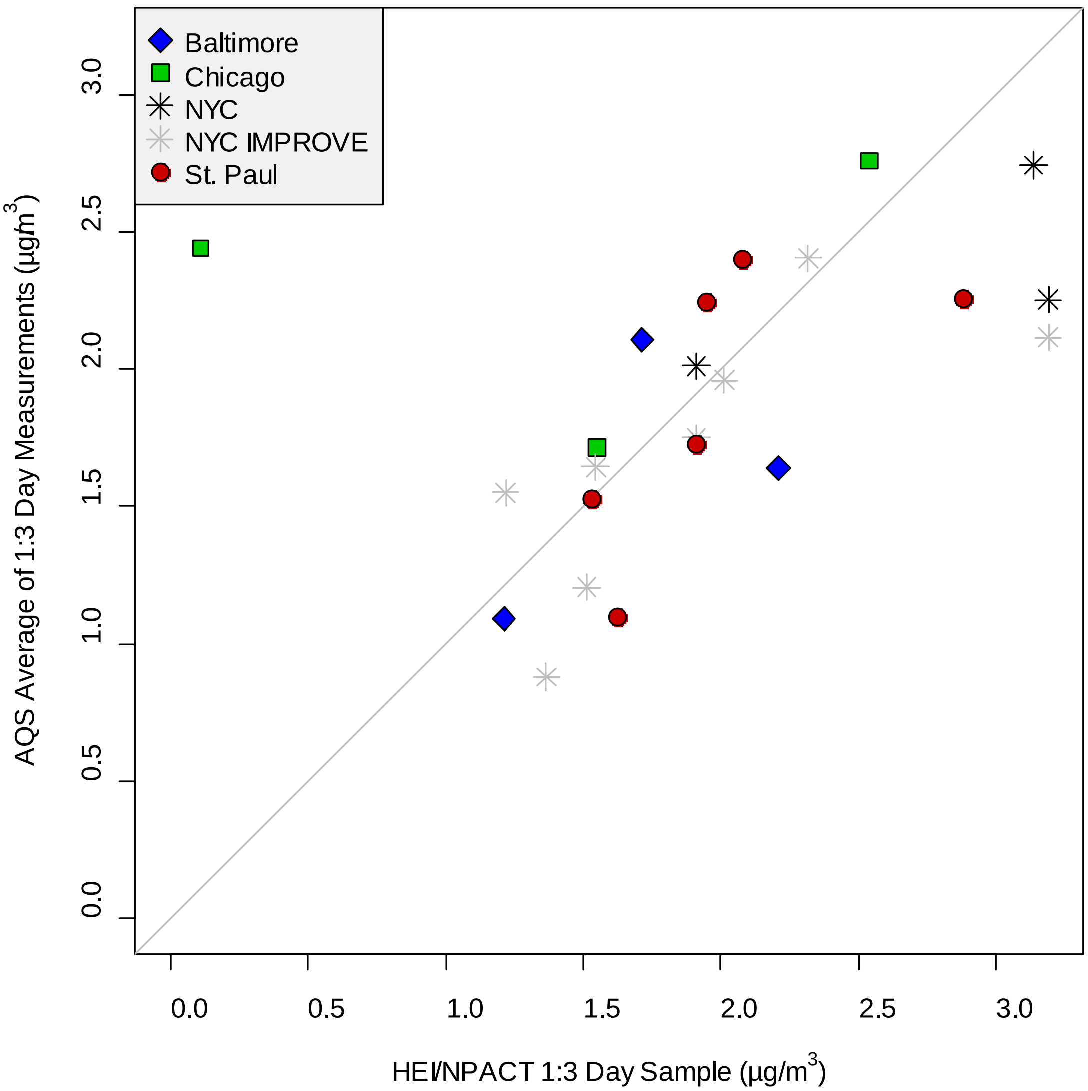

Figure 17. Scatterplot showing the relationship for organic carbon (OC) between HEI/NPACT 1-in-3 day measurements and averages of AQS measurements for the same dates, by study area (overall R^2 = 0.23, RMSE = 0.65 µg/m^3). Standard deviations for the HEI/NPACT composite 1-in-3 day measurements and AQS 1-in-3 day averages were 0.73 µg/m^3 and 0.52 µg/m^3 respectively. Excluding the Chicago datapoint at (0.11, 2.4), the R^2 and RMSE for this association were 0.56 and 0.43 µg/m^3.

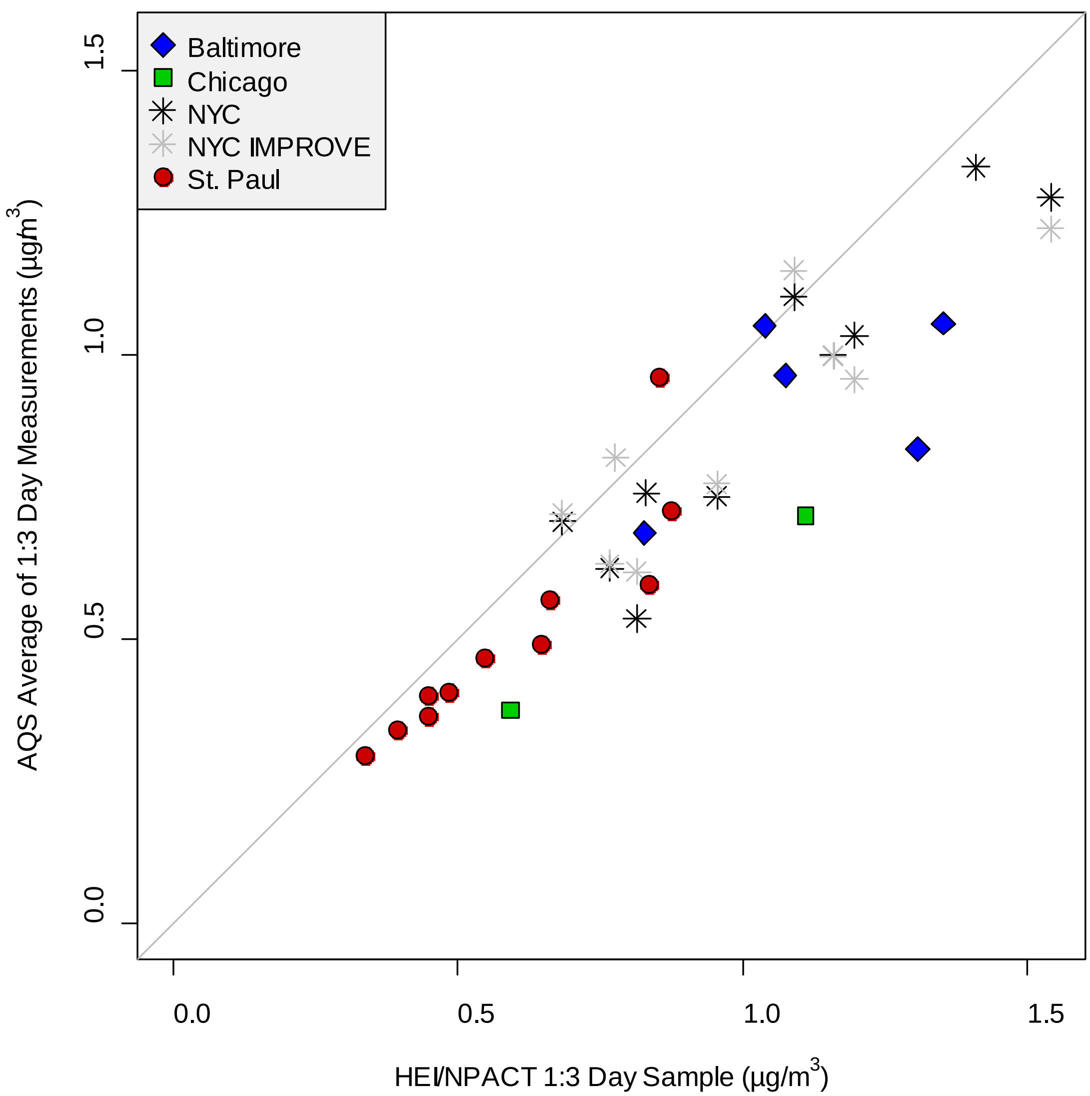

Figure 18. Scatterplot showing the relationship for sulfur between HEI/NPACT 1-in-3 day measurements and averages of AQS measurements for the same dates, by study area (overall R^2 = 0.84, RMSE = 0.18 µg/m^3). Standard deviations for the HEI/NPACT composite 1-in-3 day measurements and AQS 1-in-3 day averages were 0.32 µg/m^3 and 0.28 µg/m^3 respectively.

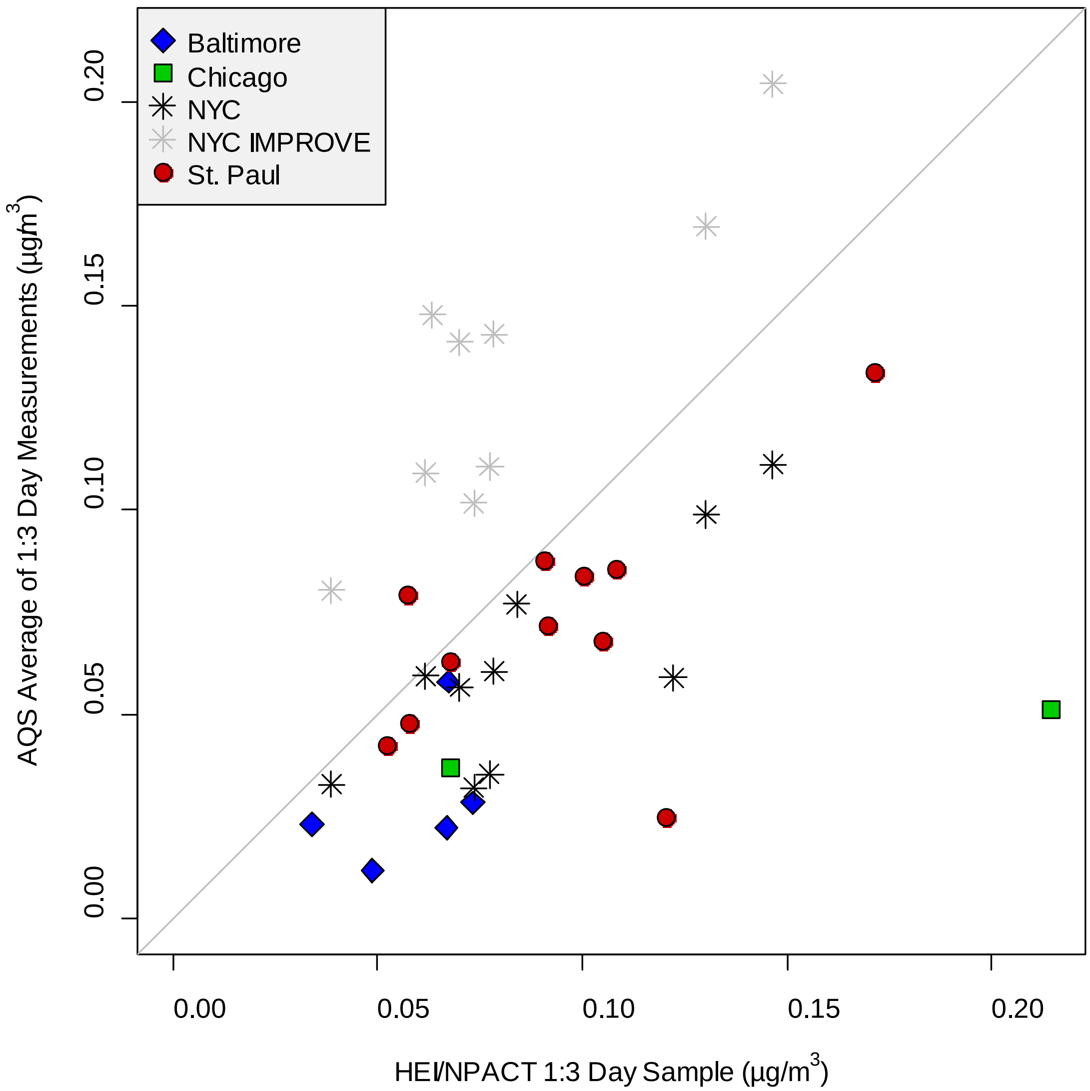

Figure 19. Scatterplot showing the relationship for silicon between HEI/NPACT $PM_{2.5}$ 1-in-3 day measurements and averages of AQS measurements for the same dates, by study area (overall R^2 = 0.14, RMSE = 0.048 µg/m^3). Standard deviations for the HEI/NPACT composite 1-in-3 day measurements and AQS 1-in-3 day averages were 0.039 µg/m^3 and 0.045 µg/m^3 respectively.