Methods to Assess Carbonaceous Aerosol Sampling Artifact for IMPROVE and Other Long-Term Networks

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CARBON NOMENCLATURE

VOC:	Volatile Organic Compounds
SVOC:	Semi-Volatile Organic Compounds
gSVOC:	Gaseous-Phase Semi-Volatile Organic Compounds
pSVOC:	Particle-Phase Semi-Volatile Organic Compounds
TC:	Total Carbon (TC = OC + EC)
OC:	Organic Carbon
pOC:	Non-Volatile Particle-Phase Organic Carbon
EC:	Elemental Carbon
QBT:	Quartz-Fiber Backup Filter behind Teflon-Membrane Front Filter
QBQ:	Quartz-Fiber Backup Filter behind Quartz-Fiber Front Filter
bQBQ:	Blank Quartz-Fiber Backup Filter behind Quartz-Fiber Front Filter
dQBQ:	Denuded Quartz-Fiber Backup Filter behind Quartz-Fiber Front Filter
$\mathrm{QBQ}_{\mathrm{top}}$:	Top Half of a Sliced Quartz-Fiber Backup Filter behind Quartz-Fiber Front Filter
$\mathrm{QBQ}_{\mathrm{bott}}$:	Bottom Half of a Sliced Quartz-Fiber Backup Filter behind Quartz-Fiber Front Filter
QF:	Quartz-Fiber Front Filter
bQF	Field Blank (Quartz-Fiber Filter)
dQF	Denuded Quartz-Fiber Front Filter
$\mathrm{QF}_{\mathrm{top}}$	Top Half of a Quartz-Fiber Front Filter
$\mathrm{QF}_{\mathrm{bottom}}$	Bottom Half of a Quartz-Fiber Front Filter

1. INTRODUCTION

1.1 Background

When particles are collected onto quartz-fiber filters, some of the organic vapors in the air are adsorbed onto the fibers. This adsorption also occurs passively when filters are exposed to the atmosphere with no air drawn through them. These vapors leave the sample during thermal analyses (Watson et al., 2005) and are interpreted as part of the measured organic carbon (OC). This positive OC "artifact" yields higher values for OC in $PM_{2.5}$ and PM_{10} samples than are actually in ambient air (Kukreja and Bove, 1976). The adsorbed VOCs also char within the filter, thereby causing differences in elemental carbon (EC) levels determined by transmittance and reflectance corrections (Chen et al., 2004; Chow et al., 2004). Semi-volatile organic compounds (SVOCs) can be collected as particles, but portions of them can evaporate and leave the particle in the gas stream owing to increases in temperature or decreases of their gas phase concentrations in the sampled air (Galasyn et al., 1984). Evaporated SVOCs yield a negative OC artifact because they should have been reported as part of the $PM_{2.5}$ or PM_{10} mass (Obeidi and Eatough, 2002).

Several U.S. networks, including the Interagency Monitoring of Protected Visual Environments (IMPROVE) network (Figure 1-1; Watson, 2002), the Maryland Aerosol Research and Characterization (MARCH-Atlantic) study (Chen et al., 2001; 2002; 2003), and the Southeastern Aerosol Research and Characterization (SEARCH) network (Figure 1-2; Hansen et al., 2003; 2006), use quartz-fiber front filters (QF) to collect OC and EC and use backup filters and/or field blanks to correct for the OC artifact. The urban Speciation Trends Network (STN) (Flanagan et al., 2006) obtains field blanks, no backup filters, and does not make corrections for adsorbed organic vapors. Positive and negative sampling artifacts are among several causes of poor agreement in carbon interlaboratory and intermethod comparisons (Chow et al., 2001; 2004; Watson et al., 2005). In summary, the measured carbon consists of: 1) non-volatile particulate organic carbon (pOC) and EC; 2) volatile organic compounds (VOCs) that adhere to quartz fibers under most ambient conditions; and 3) SVOCs that migrate between the gas and particle phases depending on ambient temperature, aerosol compositions and concentrations, gas-phase concentrations in the air, and availability of heterogeneous surfaces on which to adsorb. Hereafter, SVOCs are referred to as pSVOCs, which would be measured with pOC, and gSVOCs, the portion that evaporates and constitutes the negative artifact.

With sufficient exposure time, adsorbed VOCs may reach equilibrium with VOCs in the airstream passing through it (Storey et al., 1995; Mader and Pankow, 2001a; 2001b; 2002). The time to reach this "saturation" depends on ambient temperature, sampling train configuration (e.g., preceding organic denuder, filters in series), available surface area in the filter, ambient VOC/SVOC/pOC composition and concentration, exposure of the filter to air before and after sampling, sample volumes, and the velocity of air drawn through the filter. Field blanks and backup filters without preceding organic denuders can yield similar carbon loadings when adsorbed VOC dominates (i.e., positive artifact). Filter cross-sections show that pOC is collected on the upper third of the front quartz-fiber filter (Chow et al., 2004). The level of saturation may change, however, with changes in the environment. Heating the filter removes adsorbed material. It is also possible that passing VOC-free air through the filter (as might happen with an efficient denuder) would cause previously adsorbed VOCs and SVOCs to be removed from a backup filter. Owing to this changing equilibrium, it would be expected that as field blanks and backup filter are exposed to ambient air over longer time periods, their adsorbed VOC levels will become more similar. Because it is a more inert material and has a much smaller internal surface area, Teflon filters are expected to pass more VOCs to a quartz backup filter. Less of the gSVOC is retained on the Teflon, but it is available for adsorption on the backup.

The IMPROVE network acquires quartz-fiber backup filters behind quartz-fiber front filters (QBQ) at the six sites in Figure 1-1: (i.e., Mt. Rainier National Park [MORA]; Yosemite National Park [YOSE]; Hance Camp at Grand Canyon National Park [HANC], Chiricahua National Monument [CHIR], Shenandoah National Park [SHEN]; and Okefenokee National Wildlife Reserve [OKEF]). Approximately 60 QBQ samples are analyzed each month, and monthly median OC concentrations are used for blank subtraction. Field blanks are sent to and received from all IMPROVE sites along with the regular sample shipments. About 2% of all samples are field blanks, and these are randomly assigned to sample shipments.

Samples from the IMPROVE, MARCH-Atlantic, and SEARCH networks provide an opportunity to study the magnitude of positive and negative artifacts and different artifact correction strategies for a wide variety of non-urban and urban atmospheres. These networks use different filter samplers, filter sizes, and sampling configurations. Sample remnants are stored under refrigeration after analysis, and these remnants can be used for further tests. Sample, field blank, and backup filters from these networks are analyzed for OC, EC, and seven thermal carbon fractions: OC1, OC2, OC3, and OC4 at 120, 250, 450, and 550 °C in a 100% helium atmosphere; EC1, EC2, and EC3 at 550, 700, and 800 °C in a 2% oxygen/98% helium atmosphere. OPR represents pyrolyzed carbon determined by filter reflectance following the IMPROVE thermal/optical reflectance (TOR) protocol implemented on DRI/OGC carbon analyzers (Chow et al., 1993; Watson et al., 1994; Chen et al., 2004; 2005). The IMPROVE_A thermal/optical protocol yields comparable OC1, OC2, OC3, and OC4 at 140, 280, 480, and 580 °C in a 100% helium atmosphere, and EC1, EC2, and EC3 at 580, 740, and 840 °C in a 2% oxygen/98% helium atmosphere. Pyrolyzed OC is reported as OPR for TOR and as OPT for simultaneously measured thermal/optical transmittance (TOT). IMPROVE_A is applied to IMPROVE samples acquired after 1/1/2005 using the DRI Model 2001 thermal/optical carbon analyzer (Chow et al., 2007a). Chow et al. (2007a) showed that the OC/EC split remains consistent between the IMPROVE and IMPROVE_A protocols and that the seven carbon fractions are also comparable.

1.2 Objectives

The goal of this study is to better understand, using samples from existing networks, the magnitude and variability of organic gases adsorbed onto quartz-fiber filters and to evaluate methods to compensate for these artifacts in long-term $PM_{2.5}$ networks. Specific objectives are:

- Analyze existing data bases on field blanks and backup filters from the IMPROVE and other networks to evaluate magnitudes and variability of adsorbed carbon in different carbon fractions and determine how they differ by location, season, and source contributions.
- Compare the magnitudes of sampling artifacts estimated by different methods, such as field blank, quartz behind Teflon (QBT) or quartz behind quartz (QBQ), sliced top and bottom half of the front filter, and regression methods.
- Perform laboratory analyses on selected archived samples to determine the homogeneity of adsorbed organic gases within a filter, relationships between artifacts on front and backup filters, and on the bottom half of the front filters.
- Evaluate alternative estimates for sampling artifact based on thermal carbon fractions on the bottom half of front filters and backup filters.
- Identify the adsorbed organic species composition on front and backup filters by exploratory chemical analysis.

1.3 Hypotheses

Seven hypotheses were formulated to address the study objectives:

A. Quartz backup filters and field blanks contain the same quantities of adsorbed VOC and OC fractions.
B. Nearly all of the adsorbed VOCs and gSVOCs are in the IMPROVE OC1, OC2, and OC3 fractions.
C. Adsorbed VOCs are similar among blanks and backups and for different sampling locations, times, and OC aerosol loadings.
D. Quartz behind Teflon yields the same amounts in carbon fractions as quartz behind quartz.
E. Front and backup quartz-fiber filters are saturated with adsorbed organic vapors only for high loading samples, and before saturation the front filter captures more gSVOC than the backup filter.
F. Analysis of a small number of backup filters can be extrapolated to a large number of samples with appropriate stratification by sampling site, sampling time, and OC loading.
G. Adsorbed VOCs are different from organic compounds in the sampled aerosol.

1.4 Report Structure

Section 1 states the background, objectives, and hypotheses being tested. Section 2 describes five approaches that have been used to compensate for organic sampling artifacts in different networks or in different studies. Carbon fractions from field blanks, denuder sampling, backup filters, filter slicing, and intercept approaches are examined. Section 3 documents data analysis of blank and backup filter measurements acquired from the IMPROVE, MARCH-Atlantic, and SEARCH networks. Section 4 relates these observations to the hypotheses being tested and summarizes conclusions on the findings. Section 5 provides references and a bibliography.

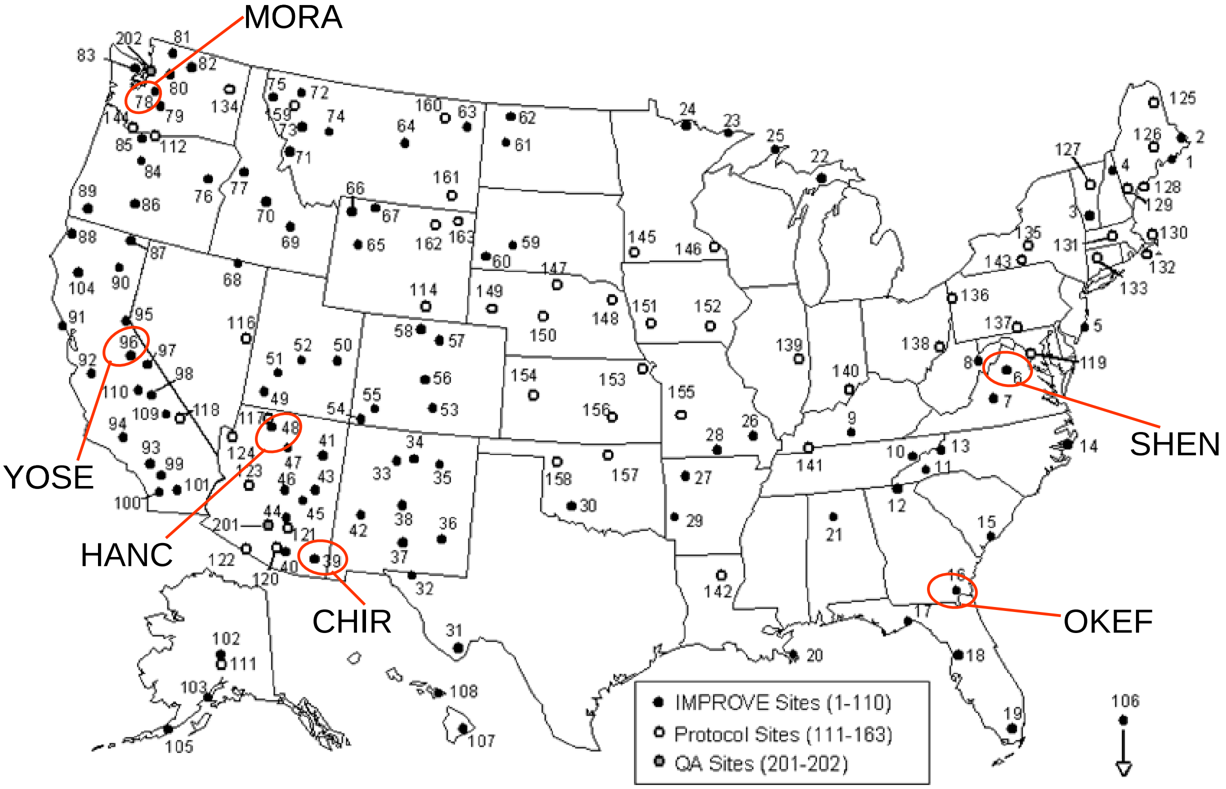


Figure 1-1. Sampling sites in the IMPROVE network from VIEWS (2007). The circled sites are locations where secondary filters (i.e., quartz-fiber backup filters [QBQ]) are acquired ~6% of the time: #78 (MORA) Mount Rainier National Park; #96 (YOSE) Yosemite National Park; #48 (HANC) Hance Camp at Grand Canyon National Park; #39 (CHIR) Chiricahua National Monument; #6 (SHEN) Shenandoah National Park; and #16 (OKEF) Okefenokee National Wildlife Refuge. Site IDs in Table 3-1 are followed by a 1 to represent the original location within the Class I area. Numbers >1 indicate that the site was relocated within the area. Collocated sites are indicated with an X.

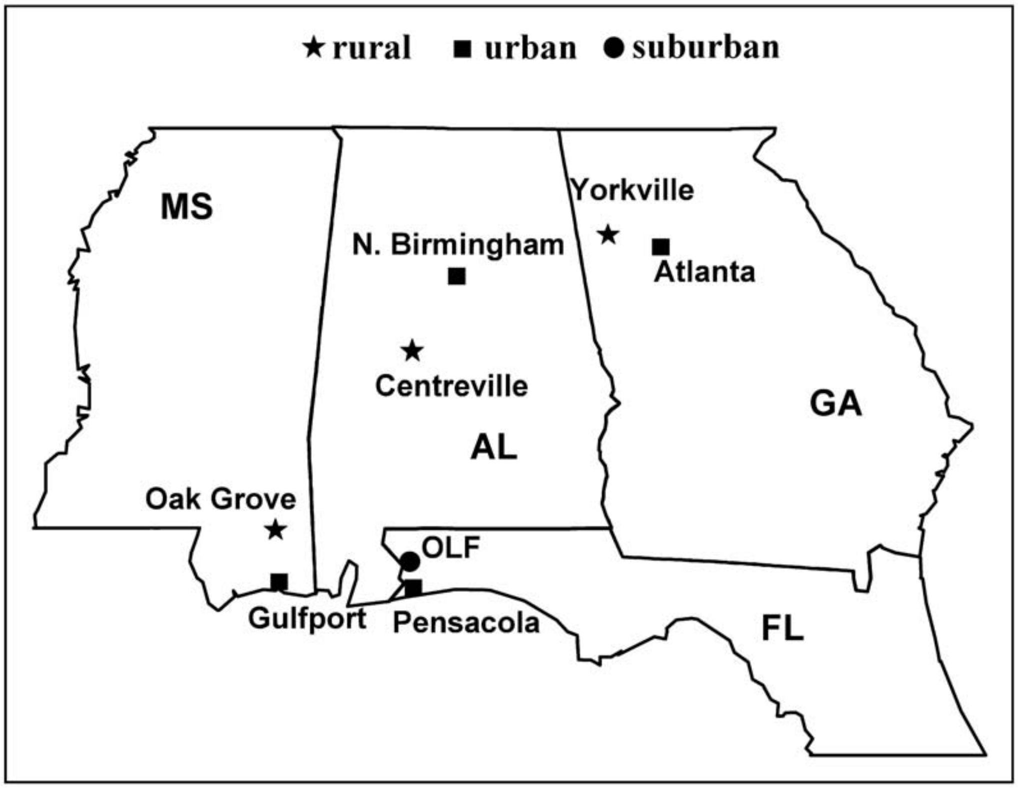


Figure 1-2. The SEARCH network, consisting of: Mississippi pair: urban Gulfport (GLF) in Gulfport and rural Oak Grove (OAK) near Hattiesburg; Alabama pair: urban Birmingham (BHM) in North Birmingham and rural Centreville (CTR) south of Tuscaloosa; Georgia pair: urban Jefferson Street (JST) in Atlanta and rural Yorkville (YRK) northwest of Atlanta; and Florida pair: urban Pensacola (PNS) in Pensacola and suburban outlying field (OLF) northwest of Pensacola.

2. METHODS TO COMPENSATE FOR ORGANIC SAMPLING ARTIFACTS

Several methods are used to compensate for organic sampling artifacts. These include: 1) field blank subtraction (Blank Subtraction Approach), 2) gaseous organic denuders prior to the filter (Denuder Approach), 3) filters or absorbent materials following the front filter (Backup Filter Approach), 4) removal and analysis of the bottom half of the front filter (Slicing Approach), and 5) regressing OC on $PM_{2.5}$ to find the intercept (Intercept Approach). Each of these methods is applied and evaluated to appropriate data from the IMPROVE, MARCH, and SEARCH networks.

2.1 Blank Subtraction Approach

Filters that accompany the sampled filters through all processes except having ambient air drawn through them are subject to passive deposition and adsorption of materials that are not necessarily in the sampled air (Bruckman and Rubino, 1976; Sweitzer, 1980; Swinford, 1980; Chow et al., 1994; 1996). Average field blank levels can be subtracted from those measured on the sampled filters. The uncertainty of this average is represented by its standard deviation, which should be incorporated into the reported measurement precision and lower quantifiable limit (LQL) (Watson et al., 2001). Properly handled field blanks usually show low particle deposition (as indicated by low EC and trace elements) but substantial OC adsorption (Kirchstetter et al., 2003; Eatough et al., 2003a; Kim et al., 2005; Offenberg et al., 2007).

2.2 Denuder Approach

Organic carbon denuders (Bertoni et al., 1984; Eatough et al., 1987; Fitz, 1990; Krieger and Hites, 1992; 1993; Gundel et al., 1995; Cui et al., 1997; Mader et al., 2001; Ding et al., 2002a; 2002b; 2003; Fan et al., 2003; Viana et al., 2006) allow VOCs to diffuse to an absorbing surface while permitting small particles to pass through to the filter. Baked quartz-fiber filter strips (Fitz, 1990), XAD resin (Gundel et al., 1995), and activated carbon impregnated filter strips (Eatough et al., 1993) have been used as absorbents. These denuders remove VOC and gSVOC, thereby reducing the equilibrium vapor pressure over the pSVOC and enhancing its volatilization both within the denuder and on the filter. OC on backup filters comes from a portion of the gSVOC, a negative artifact, and VOCs not removed by the denuder. Quartz backup filters probably do not capture all of the gSVOC, as indicated by activated charcoal impregnated backup filters (Eatough et al., 2003b). Denuders are not 100% efficient, so some

VOCs that might be adsorbed also reach the backup filters. Chow et al. (2006) showed that in the denuded channel (dQF), pOC agreed most closely with the difference between non-denuded front and backup filter OC (i.e., QF minus QBQ) at the Fresno Supersite. Differences between the denuded quartz-fiber front filter OC (dQF) followed by the backup filter (dQBQ) method and the non-denuded quartz-fiber behind Teflon (QBT) and QBQ methods were within their measurement uncertainties.

2.3 Backup Filter Approach

A quartz-fiber filter is placed behind the front filter, which may be a Teflon-membrane or quartz-fiber filter. It is assumed that the OC measured on the backup is also uniformly adsorbed within the front filter, so it should be subtracted from the front filter OC. OC on quartz- and glass-fiber backup filters behind front filters was first observed by Cadle et al. (1983) and more systematically studied by McDow and Huntzicker (1990). Using QBT and QBQ on parallel channels at Los Angeles, CA, Turpin et al. (1994) reported that backup filter saturation was attained for QBT before QBQ. Turpin et al. (1994) suggested that QBT provides a more accurate estimate of the positive OC artifact. However, QBT often yields higher OC on the backup than does QBQ (Turpin et al., 1994; Chen et al., 2002; Chow et al., 2006). More of the pSVOC collected on the front Teflon-membrane filter may leave the filter because Teflon-membrane adsorbs less of these vaporized gases than quartz-fiber. It is uncertain whether the QBT OC should be added to or subtracted from pOC. Owing to the inert nature of Teflon, pSVOC volatilization from it could be substantial. Without a preceding denuder, Chow et al., (2006) found that QBT OC was nearly twice that of QBQ at the Fresno Supersite. Average OC on QBT and QBQ were 2.1 ± 0.3 and 1.28 ± 0.45 μg/m^3 during winter and 1.84 ± 0.28 and. 0.91 ± 0.46 μg/m^3 during summer; with an average of 1.75 ± 0.27 vs. 0.91 ± 0.45 μg/m^3. Compared to QF loadings, the extent of organic adsorption was also much higher for QBT than for QBQ. The QBT/QF vs. QBQ/QF ratios were 24 vs. 10.9% for winter and 44% vs. 24% during summer, with an average of 34% vs. 17.5% from December 1999 to February 2001 at the Fresno Supersite.

2.4 Slicing Approach

Fung et al. (2004) developed a jig and sharp blade to slice the filter through its cross-section into nearly equal front and back halves. Both halves can be weighed to scale OC on the bottom half to the whole filter. Assuming that the pOC is collected only on the top half and that the adsorbed vapor is distributed uniformly throughout the filter depth, OC on the bottom half should provide an estimate of the adsorbed organic vapor throughout the filter. This method is the same as the backup filter approach, but without two quartz-fiber filters in series. Microscopic examination of filter cross-sections shows that few particles penetrate into the bottom half of a filter (Chow et al., 2004).

2.5 Regression Intercept Approach

If the positive OC artifact at a monitoring site is relatively constant for all seasons and concentration levels, it should provide a constant increment over the mass measured on the Teflon-membrane filter. Calculating a linear regression line of OC vs. $PM_{2.5}$ or PM_{10} mass results in an intercept at zero mass that would indicate the magnitude of the artifact OC (White and Macias, 1989). This method assumes that PM mass and OC are highly correlated and span a wide range of concentrations.

3. BLANK CARBON DATA ANALYSIS

The IMPROVE, MARCH-Atlantic, and SEARCH networks used one or more of the approaches in Section 2 to correct for OC artifacts. Each of these networks followed the IMPROVE or IMPROVE_A TOR protocol, yielding seven thermal carbon fractions. Field blank and backup filter data were readily available, and sample remnants were kept in cold storage and could be submitted to additional analyses.

3.1 IMPROVE Blank and Backup Filter Analysis

Between 1/1/2005 and 12/31/2006, 44,016 samples from the IMPROVE network were analyzed for OC and EC following IMPROVE_A with. 959 (2.2% of the total) field blanks (bQF) collected at 187 sites (including six collocated sites). During the same period, 1,406 backup filters (i.e., QBQ) were acquired at six sites (i.e., MORA, YOSE, HANC, CHIR, SHEN, and OKEF).

Locations of each IMPROVE site along with the six backup filter sites are shown in Figure 1-1. Table 3-1 shows that from one to 17 field blanks were taken at individual sites with the number varying by season and location. Zero to six field blanks were acquired at individual sites during each season. Field blanks covered many sites, but for limited times. The frequency of backup filters was ~10 per site per month.

Passive adsorption, as indicated by field blanks, accounts for part of the positive artifact. Turpin et al. (1994) and Subramanian et al. (2004) suggest that quartz-fiber (front and backup) filters might reach equilibrium/saturation within 24 hours. They did not examine the extent to which this conjecture might apply to field blanks that contain no active sample flow (zero face velocity). The positive OC artifact should be equal to or greater than OC measured on the field blanks.

Figure 3-1 shows average field blank carbon concentrations for the thermal fractions by site (see Table 3-1 for site names). As expected for filters without a deposit, EC levels are negligible. Most of the adsorbed OC is in the OC1 and OC2 fractions (evolving at $\leq$ 280 °C), but there is still a substantial amount in the OC3 (380 °C) fraction. Lot-by-lot differences for quartz-fiber filters were observed by Kirchstetter et al. (2001), but this is not the cause of differences among the sites because filters from each lot are distributed to all sites. To minimize the influence of outliers, only sites that obtained more than five blanks are included in Figure 3-1.

For most sites, average blank TC levels ranged from 7 to 10 µg/25 mm filter as shown in Figure 3-2.

Table 3-2 quantifies the blank OC distribution among the OC1 (140 °C), OC2 (280 °C), and OC3 (480 °C) fractions, each of which contributes 2 – 3 µg/filter for IMPROVE with very low concentrations found in other carbon fractions. Most of the OC4 is <0.5 µg/filter, compared to < 0.1 µg/filter for EC1, EC2, and OP. EC3 concentrations are not detected. Positive levels for EC1 and EC2 are caused by charring of some of the adsorbed organic vapors rather than particle deposits (Chow et al., 2004), but this charring is compensated for by the TOR correction when EC is reported. Among the 181 IMPROVE sites, field blank TC and OC can be considered equivalent within analytical uncertainties. Field blank TC is highest at the Indian Gardens (INGA) site in AZ, in the range of 8.6 – 19.7 µg/filter, and lowest at the Blue Mounds (BLMO) site in MN, in the range of 4.5 – 6.5 µg/filter. Figure 3-3 shows that the average field blank TC concentration is higher during summer than during the other seasons, ranging from 7.0 ± 2.5 µg/filter in winter to 12.3 ± 14.6 µg/filter in summer. For OC2 and OC3, the winter/summer ratios are 0.71 and 0.73, respectively. Higher temperatures in summer would be expected to lower the equilibrium saturation ratio, but summertime photochemical activity might also create heavier VOCs (Pandis et al., 1992) that might adhere to the filters. Wildfires are also more prevalent during dry summer and early fall periods at many of these sites.

Figure 3-4 shows that the average field blank TC is relatively consistent with respect to the average concentrations of TC and carbon fractions at the site. The ratio of the 90th percentile to the 10th percentile TC is only ~1.5 for field blanks, compared to 3.5 for TC on the front filters. This is a small variability for most of the field blanks considering the variety of environments in which these sites are located. At sites with low OC concentrations, such as Hawaii Volcano National Park (HAVO1, #102 in Figure 1-1), field blank TC (~10 µg/filter) accounts for most of the front filter TC (Figure 3-4). In the medium loading range (20 – 40 µg/filter), field blank TC is comparable to OC1 + OC2 on the front filter. For higher loadings (> 40 µg/filter), however, field blank TC is much less than OC1+OC2.

Figure 3-5 shows that field blank OC1, OC2, and OC3 levels are similar across the IMPROVE network and are not related to ambient concentrations above ~3 µg/filter. OC1, OC2, and OC3 on the front filter are not exclusively due to adsorbed VOC.

Table 3-3 shows site-averaged backup filter (QBQ) OC levels of 8 to 13 µg/filter, which are 2 to 4 µg/filter above field blanks from the same sites, but they are comparable to the 8.4 ± 1.6 µg/filter all-site average in Table 3-2. The relatively small number of field blanks may bias the site-to-site comparison with backup filters. Figure 3-6 shows that site-averaged QBQ TC does not depend on average carbon concentrations at the six sites, similar to the findings for field blanks in Figure 3-4). Figure 3-7 shows how backup filter OC is distributed among the carbon fractions, again illustrating that most of the material is in the OC1, OC2, and OC3 fractions and that the OC is equivalent to TC after TOR charring corrections. The most visible differences between backup filters and field blanks (Figure 3-1) are the higher OC4 (580 °C), EC1 [580 °C], and EC2 [740 °C]) abundances in QBQ. Figure 3-8 compares the carbon fractions of QBQ and bQF filters taken at the same site on the same day, demonstrating that the OC4 abundance is the same or higher for QBQ filters. The EC fraction is mostly caused by charring, (e.g., OP, included in EC1).

The use of monthly median QBQ concentrations from the six sites is supported by Figure 3-9, showing that OC concentrations on front filters, backup filters, and field blanks (where available) vary by month at each site. All sites except OKEF show higher front filter OC concentrations in summer than in winter, with QBQ and bQF showing a similar month-to-month variability. The agreement between OC levels on corresponding field blanks and backup filters shown in Figure 3-10, and the similarity of the all site average field blank OC (8.4 ± 1.6 µg/filter; n=959,) and six-site average backup filter OC (10.03 ± 5.04 µg/filter; n=1406) concentrations, indicates that QBQ subtraction would be only slightly more than a bQF subtraction, and the difference would be within the propagated precision of blank subtraction.

Examining this in more detail, Figure 3-11 shows that OC on blank filters (bQF or bQBQ) agrees within ±15% with OC on backup filters (QBQ) at all but the YOSE site. Average OC levels on YOSE field blanks (bQF and bQBQ) are ~35% (~3.4 µg/filter) lower than OC on backup filters. Front filter average OC concentrations are also highest (59.3 ± 14.5 µg/filter) at the YOSE site, which is known to have regularly experienced wildfires throughout the 2005 – 2006 measurement period.

3.2 MARCH-Atlantic Blank and Backup Filter Analysis

MARCH-Atlantic samples from Fort Meade (FME), MD, used 47 mm QBT and QBQ configurations (Chen et al., 2002) from July 1999 to July 2002, including 10 intensive sampling months for the four seasons. The FME site was located on a military base approximately halfway between Baltimore, MD, and Washington, DC and represents an urban-scale mixture of $PM_{2.5}$ carbon contributions. The site is within the zone of influence of several primary carbon sources such as vehicle exhaust and residential wood combustion.

Three filter sets were obtained for three days of consecutive 24-hr sampling. The first two sample sets (i.e., Day 1, Day 2) remained at the site for 72 hrs (irrespective of sampling period), which is consistent with the passive period of the field blanks. These samples are used to evaluate how the positive OC artifact might change with atmospheric exposure before and after sampling.

Seasonal average OC levels from front (QF), backup (QBQ and QBT), and blank filters (bQF and bQBQ) are compared in Figure 3-12. OC concentrations at FME were much higher in summer than during other seasons. The volatility of organic aerosol is also expected to be higher in summer, as is the presence of heavy VOCs that might have an affinity to quartz, resulting in higher positive and negative artifacts compared to other seasons. Field blank OC (bQF and bQBQ) shows summer vs. winter differences, ranging from 10.5 to 15.7 µg/47mm filter, which is equivalent to 2.7 to 4.0 µg/25mm IMPROVE filter. This seasonal variation is consistent with that found in the IMPROVE network (Figure 3-3). VOC adsorption may attain saturation on these field blanks over the 72-hr exposure time.

Both QBQ and QBT backup filters show substantially higher OC than field blanks (bQF, bQBQ), in contrast to the comparison for IMPROVE samples. This may be attributed to the urban-rural difference, as SVOC is probably more abundant in urban atmospheres. There is no difference between Day 1 (24-hr sampling on the first day, followed by 48-hr passive adsorption) and Day 2 (remained in the sampler for 24-hr before 24-hr sampling on the second day, followed by a 24-hr passive period) in Figures 3-12a and 3-12b, respectively. In spring and summer, average QBT OC is > 60% of QF OC. This difference reduces to < 50% in winter and spring. QBQ OC is between QBT and field blank OC (bQF and bQBQ). Turpin et al. (1994) attribute this to a slow saturation of the tandem quartz-quartz filter configuration. Chow et al. (2006), on the other hand, conjecture that this is mostly due to the volatilization of pSVOC from the front Teflon-membrane filters, which has been observed and quantified by Subramanian et al. (2004) using the denuder method.

Average OC thermal fractions for the front (QF) and backup (QBT and QBQ) filters for summer 1999 are compared in Figure 3-13, representing the warmest period during MARCH-Atlantic. OC1, OC2, and OC3 levels for QBT are similar to those on QF, while corresponding levels on QBQ are half these amounts. There is more charring (OP) for the QBT than for the QBQ, which might be associated with semi-volatile polar compounds (Yu et al., 2002). These results support the hypothesis that much of the QBT comes from pSVOC evaporating from particles collected on the Teflon-membrane filters. QBQ shows 30 – 40% lower OC2 and OC3, and nearly zero OP compared with the QBT values.

An ideal case may be considered where higher QBT and QBQ OC relative to field blank OC (bQF and bQBQ) results from the negative OC artifact. This is possible when all the backup and blank filters are saturated by VOC and/or gSVOC adsorption. Since QBT OC is likely to overestimate positive OC artifacts due to the negative artifact from Teflon-membrane filters, only QBQ OC is considered. Particle-phase OC (pOC + pSVOC) in the atmosphere is estimated by:

$$\mathrm{pOC} + \mathrm{pSVOC} = \mathrm{OC}_{\mathrm{QF}} + \mathrm{OC}_{\mathrm{QBQ}} - 2 \times \mathrm{OC}_{\mathrm{bQF}} \tag{1}$$

Assuming that all the volatilized OC is recaptured by the quartz-fiber backup filters, the negative OC artifact from Teflon ($\mathrm{T}_{\mathrm{OCloss}}$) and quartz-fiber filter ($\mathrm{Q}_{\mathrm{OCloss}}$) is estimated by:

$$\mathrm{T}_{\mathrm{OCloss}} = \mathrm{OC}_{\mathrm{QBT}} - \mathrm{OC}_{\mathrm{bQF}} \tag{2}$$

$$\mathrm{Q}_{\mathrm{OCloss}} = \mathrm{OC}_{\mathrm{QBQ}} - \mathrm{OC}_{\mathrm{bQF}} \tag{3}$$

$\mathrm{T}_{\mathrm{OCloss}}$ and $\mathrm{Q}_{\mathrm{OCloss}}$ are plotted against pOC plus pSVOC in Figures 3-14a and 3-14b. $\mathrm{T}_{\mathrm{OCloss}}$ and $\mathrm{Q}_{\mathrm{OCloss}}$ should only depend on the pSVOC concentration. The upper edges of in Figures 3-14a and 3-14b reveal the $\mathrm{T}_{\mathrm{OCloss}}$/pSVOC and $\mathrm{Q}_{\mathrm{OCloss}}$/pSVOC ratio. In summer, the slope is ~0.71 and ~0.29, meaning that, on average, 71% and 29% of pSVOC have volatilized from the front Teflon-membrane and quartz-fiber filters, respectively. During winter, the fraction of volatilized pSVOC was 59% from front Teflon-membrane and 21% from front quartz-fiber filters.

From the ratio, pSVOC and pOC concentrations can be estimated from Eq. (1). Figure 3-15 shows the partition of pOC, retained pSVOC, and volatilized pSVOC (negative artifact) at the FME site. For Teflon-membrane filters, the negative artifacts are 45% and 31% of the total (i.e., pOC plus pSVOC) in summer and winter, respectively. For quartz-fiber filters, the negative artifacts are 18% and 11% for summer and winter, respectively. These fractions are higher than those reported by Subramanian et al. (2004) for Pittsburgh, but the difference could be due to varying ambient conditions and carbon chemical compositions between FME and the Pittsburgh Supersite. This illustrates the need to obtain information over a wide range of environments and to refrain from over-generalizing results from a single experiment. The above analyses suggest that quartz-fiber behind Teflon-membrane (QBT) is an inaccurate measure of the positive OC artifact, but that it may be used in conjunction with collocated QBQ filters to estimate the negative OC artifact, at least in an environment similar to that of the FME site.

3.3 Denuder/Backup Filter Approach

As shown in Figure 1-2, the SEARCH network (Hansen et al., 2003) contains four urban vs. rural (or suburban) pairs of sampling sites (i.e., Mississippi pair: urban Gulfport (GLF) in Gulfport and rural Oak Grove (OAK) near Hattiesburg; Alabama pair: urban Birmingham (BHM) in North Birmingham and rural Centreville (CTR) south of Tuscaloosa; Georgia pair: urban Jefferson Street (JST) in Atlanta and rural Yorkville (YRK) northwest of Atlanta; and Florida pair: urban Pensacola (PNS) in Pensacola and suburban outlying field (OLF) northwest of Pensacola). SEARCH particle composition monitors (PCM3; Edgerton et al., 2005) contain a carbon denuder upstream of the QBQ filter packs. Since the denuder is believed to remove most of the VOC and gSVOC created during particle transit, the positive OC artifact should be minimized, and the QBQ OC should be dominated by the negative OC artifact. In contrast to the IMPROVE network's one-week exposure, SEARCH field blanks are placed in the sampler for 1 – 15 minutes before removal, so passive adsorption periods are much shorter.

The numbers of sample, backup, and blank filters at eight SEARCH sites during 2005 – 2006 are listed in Table 3-5, with their averages compared in Figure 3-16. These filter samples and field blanks were not necessarily collected on the same days. While dQBQ TC are close to dQF OC1 concentrations, the areal densities in μg/cm^2 (the SEARCH filter deposit area [7.12 cm^2] is about twice the IMPROVE filter deposit area [3.53 cm^2]) are 30 – 50% lower than the IMPROVE blank TC. This is consistent with the lower positive OC artifact, due to the preceding organic denuder in the PCM. This also explains the substantial negative artifact (up to ~16% of dQF OC) at the JST and YRK sites. Blank (bQF) TC is generally lower than dQBQ TC.

Thermal carbon fractions for SEARCH dQBQ and bQF are shown in Figure 3-17 and 3-18, respectively. Except for the urban-rural pair in GA (JST and YRK), all SEARCH sites show enriched OC2 and OC3 relative to OC1. At the GLF, OAK, PNS, and OLF sites OC1 is < 0.2 µg/filter on dQF. This is consistent with VOC being removed from the sampling stream. Adsorbed SVOC (negative OC artifact) should have more OC2 – OC4 than OC1 (positive OC artifact). At the JST and YRK sites, however, high OC1 may indicate VOC denuder breakthrough when VOC concentrations are high. Elevated OC3 (1.4 to 2.4 µg/filter) is observed in bQF at the GLF, OAK, PNS, and OLF sites, warranting further investigation of VOC composition at the SEARCH sites.

Only three SEARCH samples contain concurrent dQF, dQBQ, and bQF measurements, two from the JST site and one from the OAK site. Although the limited data set prevents any conclusions from being drawn, dQBQ OC and bQF OC appear to be similar for the three samples (Figure 3-19).

3.4 Sliced Filter Approach

When backup filters are used, it is assumed that the filter is saturated and that the distribution of adsorbed organic vapors is uniformly distributed. The top-half (QF_{top}) of a blank filter should yield the same OC as the bottom half (QF_{bott}) and analysis of a punch from the left side should yield the same results as a punch from the right side. Otherwise, the distribution of SVOC, particularly the negative OC artifact, within a front or backup filter may be described by a gradient (i.e., decreasing with the increasing penetration depth). Therefore, the OC artifact from high to low should follow the sequence of: $QF_{bott} > QBQ_{top} > QBQ_{bott} > bQF > bQBQ$. Fourteen of the IMPROVE samples that contain front and backup filters were sliced and weighed, with their top- and bottom-halves analyzed separately for carbon fractions. The following procedure was applied:

- Conduct gravimetric and carbon analyses on the front circular punch of 0.5 cm^2.
- Acquire a second circular punch from the same filter for weighing and carbon analysis.
- Slice the second punch and weigh the top and bottom halves.
- Analyze both halves for carbon fractions.
- Estimate the sampling artifact by scaling carbon measured on the bottom-half filter to the whole filter.

Table 3-6 shows that the slicing experiment conserved filter mass (with average percent difference of -3.3 to +5.3%). Figure 3-20 shows two typical comparisons, demonstrating a gradient of carbon distribution from top to bottom of the filter stack. On average, QF_{bott} contains higher OC and TC concentrations than do the top and bottom halves of the QBQ filters in terms of µgC per mg filter (Table 3-7). The difference is more pronounced for higher-temperature OC fractions (e.g., OC3, OC4), especially when the QF OC loading is high (e.g., the YOSE and SHEN sites).

The number of cases studied in this experiment is too small to generalize, but the results in Table 3-7 indicate that deviations from the assumptions that the backup filter adsorption equals that of the front filter, and that adsorption is uniform throughout the filter, are not universally valid.

3.5 Regression/Intercept Approach

As noted earlier, this method calculates a linear regression slope, intercept, and correlation of OC regressed on $PM_{2.5}$ (White and Macias, 1989; Solomon et al., 2004). If there were no positive or negative OC artifact, the regression line intercept would be zero, within the estimated standard error. A significant (greater than two or three standard errors) intercept quantifies the excess carbon on all of the samples. This method assumes: 1) the sum of positive and negative artifacts is constant for all samples (within measurement uncertainties; 2) the OC artifact is the dominant reason for lack of mass closure; and 3) $PM_{2.5}$ and OC concentrations are highly correlated (i.e., OC constitutes a reasonably consistent fraction of $PM_{2.5}$). $PM_{2.5}$ mass data were acquired from VIEWS (2007) and linked to the OC concentration from quartz-fiber front filters (QF). OC, on average, accounts for a larger fraction of $PM_{2.5}$ in summer (~20%) than winter (15%).

It is shown in previous sections that positive and negative OC artifacts differ by season and location, so the OC-$PM_{2.5}$ pairs were segregated by site and by season for regression analysis. Ordinary non-weighted least squares regression slopes and intercepts were strongly influenced by a few outliers. Therefore, a robust ordinary least squares regression (ROR; Dutter and Huber, 1981) algorithm was applied that uses an iteratively re-weighted least squares algorithm. The ROR algorithm is also used in multivariate factor-analysis models such as positive matrix factorization (PMF; Paatero, 1997).

Figure 3-21 shows a wide range of intercepts, including negative intercepts. The OC artifact has been found to be higher in summer, but 14 IMPROVE sites (9%) experience negative OC intercepts. In winter, negative intercepts appear at 6 IMPROVE sites (4%). One explanation is that summer sulfate is so high that the OC vs. $PM_{2.5}$ relationship is biased, i.e., the OC artifact becomes a minor factor for determining the regression statistics.

The network average and standard deviation of OC vs. $PM_{2.5}$ regression intercepts is shown in Table 3-8. These values (11.2 – 18.2 μg/filter) are higher than either the blank or backup OC concentrations. This is consistent with a negative OC artifact for Teflon-membrane filters. The intercept method, if applied, will likely overestimate the positive OC artifact and overcorrect the OC concentration. However, considering that $PM_{2.5}$ mass closure is usually attained with respect to $PM_{2.5}$ measured on Teflon-membrane filters, the intercept method may yield better mass closure than field blank or backup filter corrections, giving the correct answer for the wrong reason.

3.6 Composition of Adsorbed Organic Gases

A full understanding of positive and negative OC artifacts will not be obtained until the organic compounds associated with them are identified and quantified. There have been few attempts to do this because large quantities of material are needed for solvent extraction followed by concentration of the extract and gas chromatographic/mass spectrometric (GC/MS) analysis (Mazurek et al., 1987). An alternative to solvent extraction is thermal desorption (TD)-GC/MS that removes particulate and adsorbed organic compounds from the filter by heating and sends the evolved gases directly through the GC/MS (Hays and Lavrich, 2007; Chow et al., 2007b). TD-GC/MS is currently applied to daily samples taken in SEARCH and other long-term networks (Schnelle-Kreis et al., 2005a; 2005b; Sklorz et al., 2007), with nearly 5,000 of these measurements reported worldwide.

In TD-GC/MS, a small portion of the quartz-fiber filter, similar to that used for IMPROVE TOR analysis, is heated to evaporate and quantify ~130 non-polar organic compounds, including polycyclic aromatic hydrocarbons (PAH) *n*-alkanes, iso/anteiso-alkanes, hopanes, steranes, methyl-alkanes, branched-alkanes, cycloalkanes, alkenes, and phthalates. Mauderly and Chow (2008) provide a simple summary of these and other organic compound categories and methods for their quantification. Most of the detected compounds have boiling points < 250 °C and are often classified as pSVOCs. Compounds are listed in order of increasing carbon number, which generally corresponds to a higher boiling point within each category. Feasibility for analyzing polar compounds has been demonstrated (Hays, 2007), and this might be usefully applied in the future to explain a larger fraction of the adsorbed organic vapors.

TD-GC/MS following the method of Ho and Yu (2004a; 2004b) was applied to a few of the IMPROVE front and backup filters to evaluate its feasibility and to provide some initial insight into the chemical composition of the organic artifacts. This method heats the sample to 275 °C within the GC injection port, thereby characterizing the OC1+OC2 fraction. The evolved organic gases concentrate at the entry to the GC column, which then is ramped to 400 °C so that the organic compounds can be separated as they pass through the column in an inert helium carrier gas for detection and identification by the mass spectrometer. Table 3-9 lists the species that were quantified and their LQLs. Reference materials added to the sample prior to heating are used to normalize the peak areas and elution times. The gas chromatograms and mass spectra contain more information than is reported here in terms of unidentified peaks and shapes of the underlying "unresolved" fraction that merit further investigation for understanding organic artifacts and source apportionment (Watson and Chow, 2007), but this potential is not explored here.

Tables 3-10 and 3-11 summarize organic concentration densities (ng/cm^2 of filter) on sampled front and backup filters from several IMPROVE sites for winter (four filter sets) and summer (six filter sets) periods, respectively. The final row in each table presents the sum of all quantifiable organic compounds on QF, which range from 18.5 (MORA) to 116.3 (CHIR) ng/cm^2 during winter and from 36.1 (CHIR) to 124.5 (MORA) ng/cm^2 during summer. These are small fractions of OC1 + OC2 on the same filters, which range from 0.8 (MORA) to 9.0 (OKEF) µg/cm^2 in winter and from 1.2 (MORA) to 11.6 (OKEF) µg/cm^2 during summer. The final rows of Table 3-10 show that the backup filter accounts for 90% of the front filter organic compounds at the OKEF site, but only 20% of front filter deposit at the CHIR site during winter. The high retene (2.1 ng/cm^2) level for the winter CHIR sample is indicative of contributions from vegetative burning (Ramdahl, 1983), and many of the other organic concentration densities are large for this sample. During summer, the sum of organic compounds on the backup filter account for 50 – 90% of the front filter concentrations except for the OKEF sample (20%).

Ratios of backup to front filter concentrations are also given for each sample set in Tables 3-10 and 3-11. These ratios should be $\geq$ 1 if the front filter needs to achieve saturation before the backup filter (QBT or QBQ). This is not always the case, as evidenced by backup to front filter ratios as high as 12.8 for wintertime squalane (12/21/2005) at the OKEF site. Both the front and backup filter levels are low, and measurement uncertainties are high for this and other compounds with high backup to front filter ratios. There is nearly always an important or major amount (30% to 200%) of a compound on the backup filter when the front filter concentration density exceeds 1 ng/cm^2. OC1 + OC2 backup to front ratios exceed unity for most of these filters, indicating that there are many more compounds being adsorbed on the backup filter than are quantified here.

The TD analysis shows that ambient concentrations of the target organic compounds are at almost equal levels between front and backup filters in cases of low filter loading. This is supported by both the gas chromatograms (Figure 3-22) and the measurements of the OC1 and OC2 concentrations in Tables 3-10 and 3-11, respectively. In the case of the OKEF site where OC1 and OC2 show high loadings, regardless of season, concentrations of the target compounds in the front filter are higher than those in the backup filter for most of the species.

Most of the PAHs remain on the front filter, especially for the winter CHIR samples affected by vegetative burning where their concentration densities are highest. The *n*-alkanes up to octacosane (*n*-C28) show large fractions of the total on backup filters, often at levels twice the concentration densities on the front filter (OKEF winter). Higher *n*-alkanes (e.g., > *n*-C35, pentatriacontane) are rarely detected on the backup filters. Hopanes and steranes, which are believed to derive from engine lubricating oils (Fujita et al., 2007a; 2007b), do not show high levels on the backup filters even when they are detected on the front filters. Front filter concentration densities are low for these non-urban samples. Methyl-alkanes, branched-alkanes, alkenes, and pthalates are not detected at high levels during winter and have variable ratios of backup to front filter densities. For the highest concentrations measured at CHIR during winter (1/19/2005), backup filter levels are relatively low except for bis(2-ethylrexgl)phthalate (0.41 ng/cm^2). Summer samples generally show higher backup to front filter concentration densities for these categories, especially for *n*-alkanes, but there is much variability among the samples. There might be more evaporation of these compounds (i.e., negative OC artifact) from the front filter during the summer than during winter owing to the higher daytime temperatures.

The small number of chemical compounds measured (relative to all of those that might be adsorbed), locations, and sampling dates do not permit generalization of these findings. It is apparent, however, that backup filters sometimes contain more material than the front filter. Front and backup filters are not necessarily saturated and they may not adsorb organic vapors uniformly across their surface or through their depths. There could also be migration of SVOC from front to backup filters during sampling.

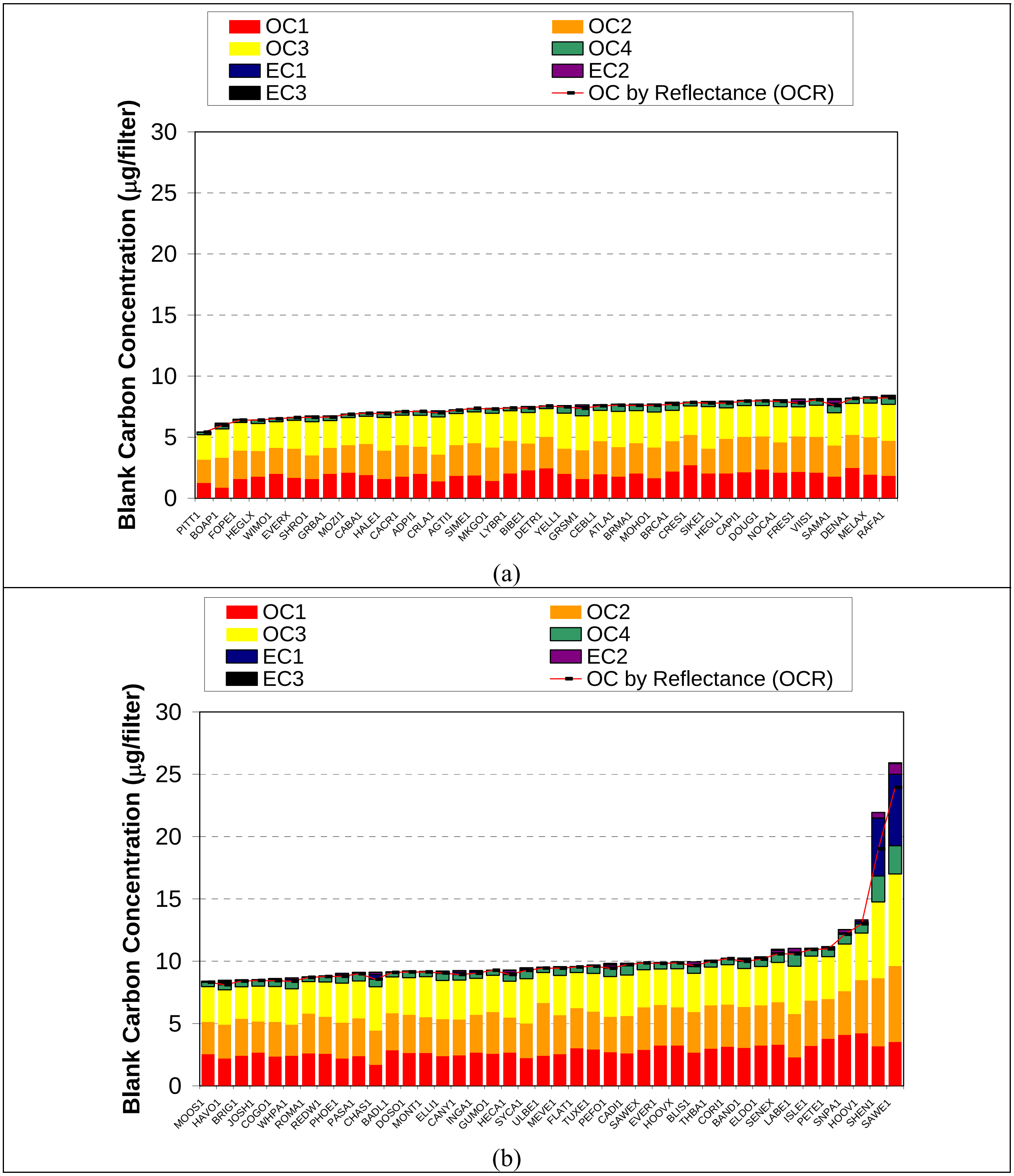


Figure 3-1. Site-averaged blank carbon fractions in the IMPROVE network. (Includes 77 sites with data from > 5 field blanks sorted by site from lowest to highest total carbon content. The bottom panel is an extension of the top panel.)

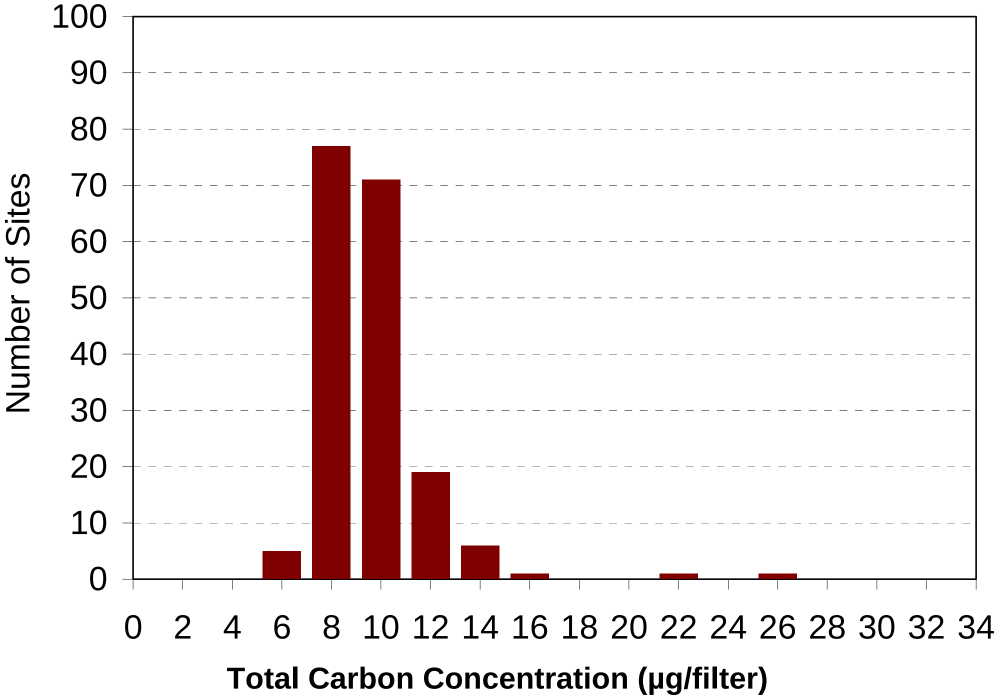


Figure 3-2. Distribution of average field blank TC (µg/filter) for 181 IMPROVE sites for the period from 1/1/2005 to 12/31/2006.

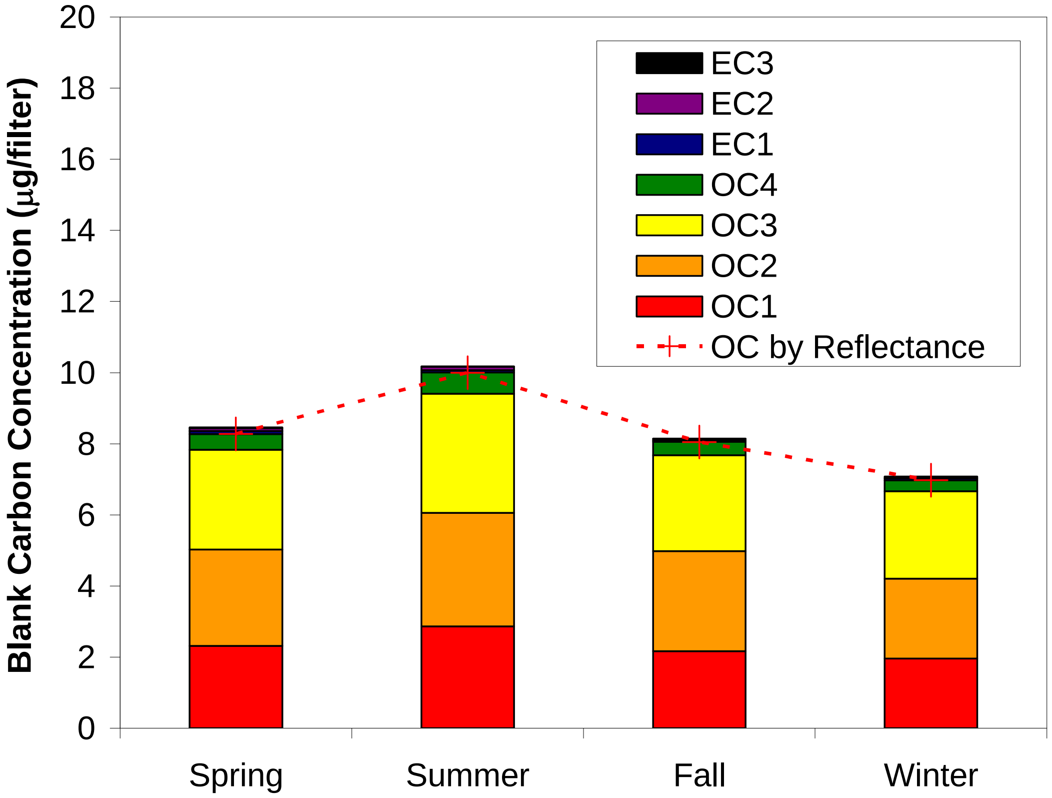


Figure 3-3. Seasonal averages of field blank carbon fractions for 77 IMPROVE sites with > 5 blanks(725 total) for the period from 1/1/2005 to 12/31/2006 (spring: March, April, May; summer: June, July, August; fall: September, October, November; winter: December, January, February).

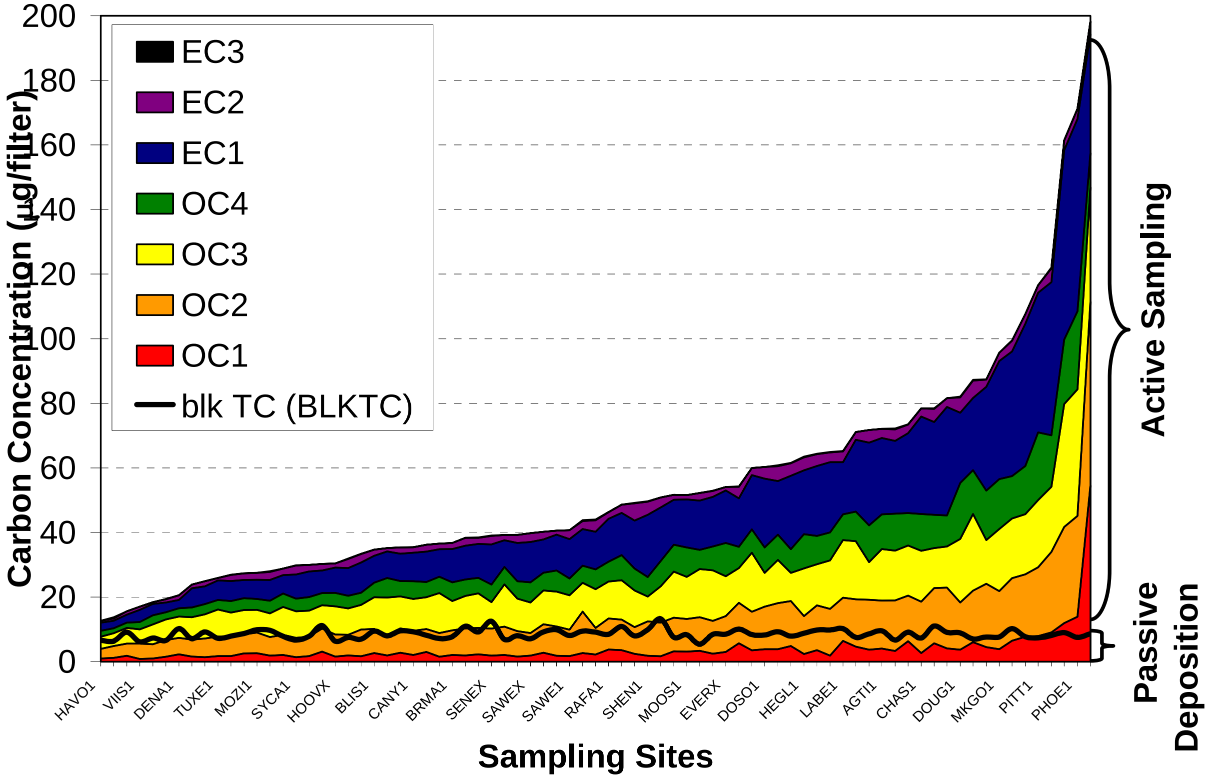


Figure 3-4. Averaged blank total carbon concentration (BLKTC) compared with concurrent averaged front filter carbon loading in the IMPROVE network between 1/1/2005 and 12/31/2006. Only 77 sites with data from > 5 blanks are included.

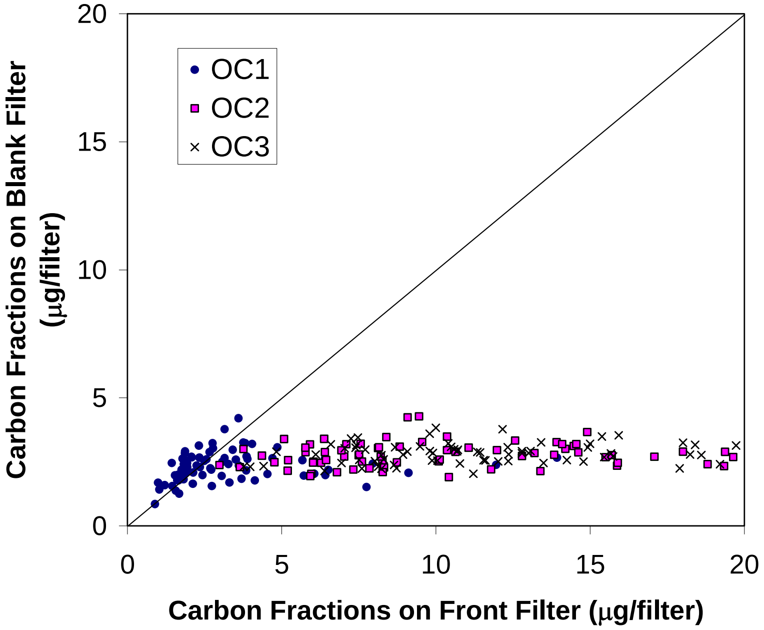


Figure 3-5. Comparison of site-averaged carbon fractions from field blank and quartz-fiber front filters at 77 sites with more than five field blanks in the IMPROVE network for the period from 1/1/2005 through 12/31/2006.

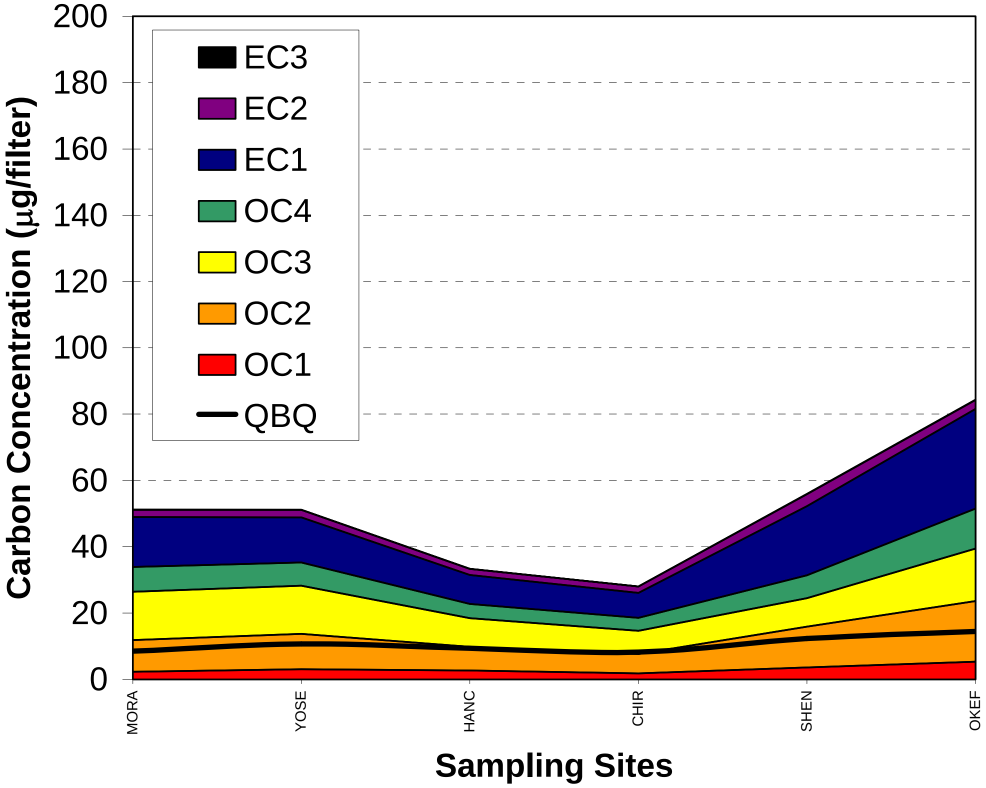


Figure 3-6. Average carbon concentration from the quartz-fiber backup filter (QBQ) compared with concurrent quartz-fiber front filter (QF) carbon fraction concentrations for six sites in the IMPROVE network.

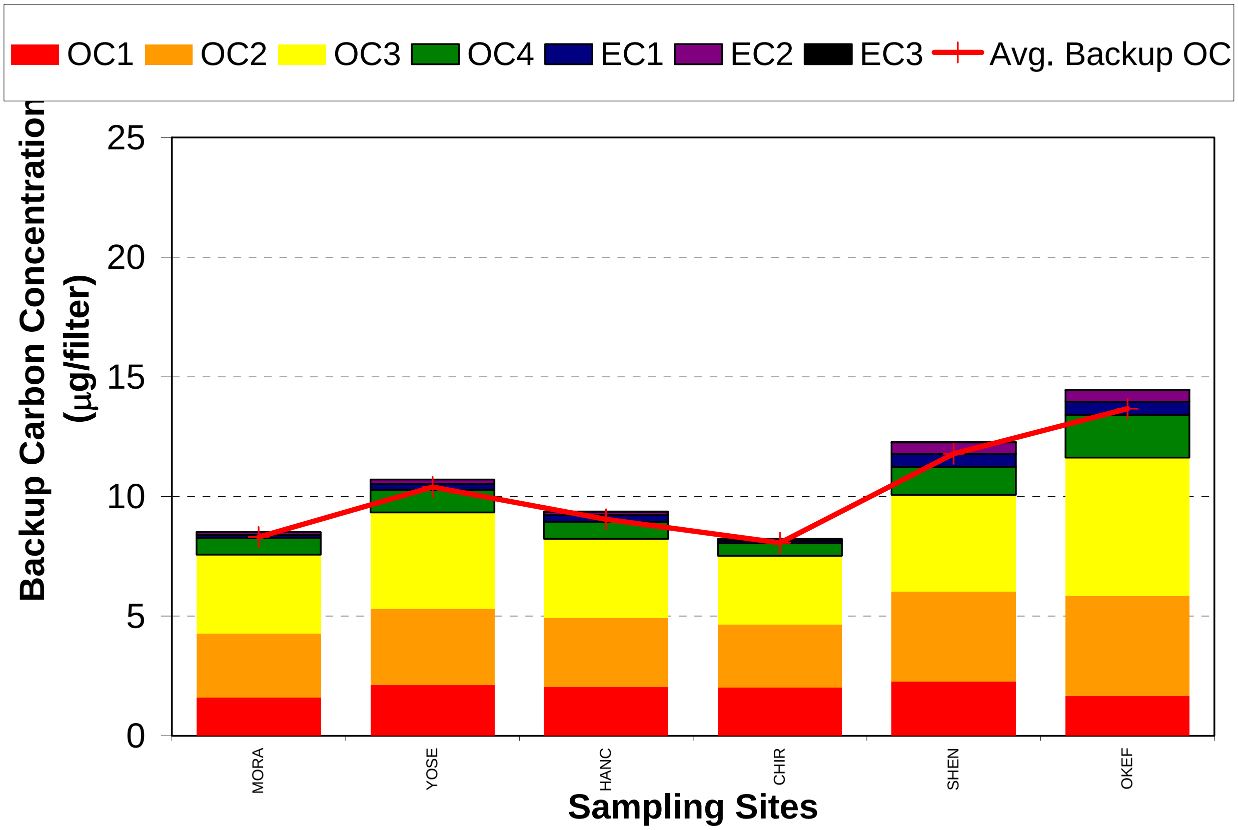


Figure 3-7. Site-averaged quartz-fiber backup (QBQ) carbon fractions at six sites in the IMPROVE network.

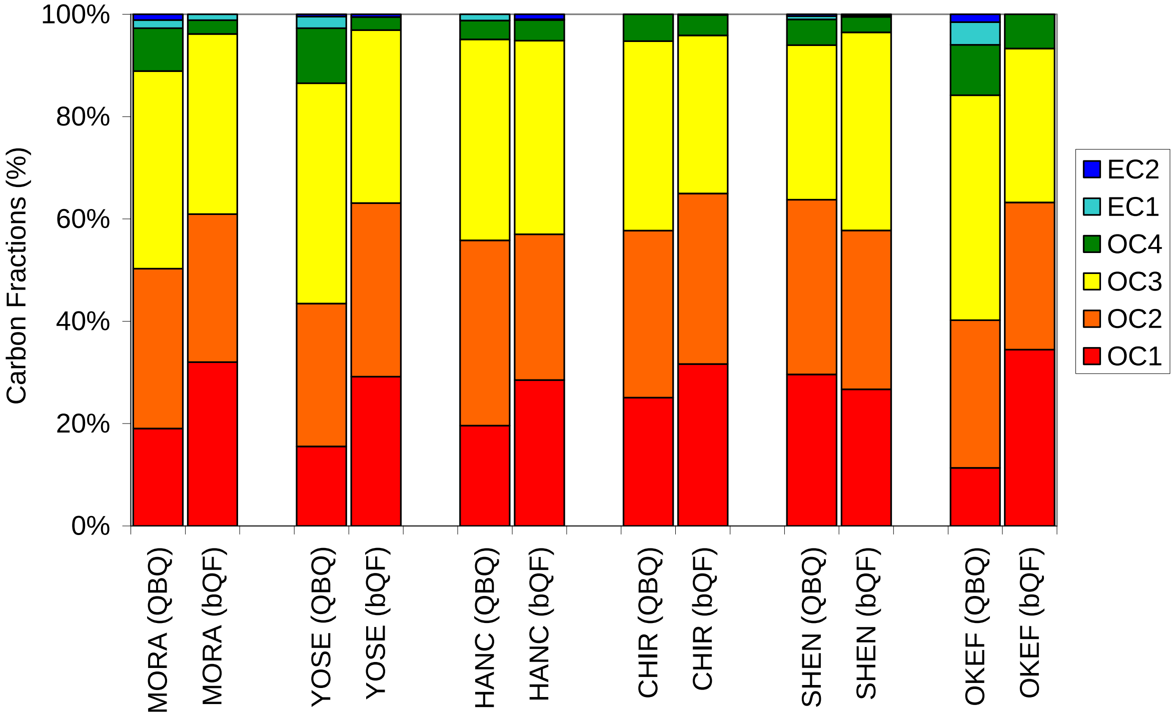


Figure 3-8. Carbon fractions of concurrent QBQ and bQF filters from six IMPROVE anchor sites. (MORA: Mount Rainier National Park, 5 samples; YOSE: Yosemite National Park, 4 samples; HANC: Hance Camp at Grand Canyon National Park. 3 samples; CHIR: Chiricahua National Monument, 5 samples; SHEN Shenandoah National Park, 9 samples; and OKEF Okefenokee National Wildlife Refuge, 1 sample).

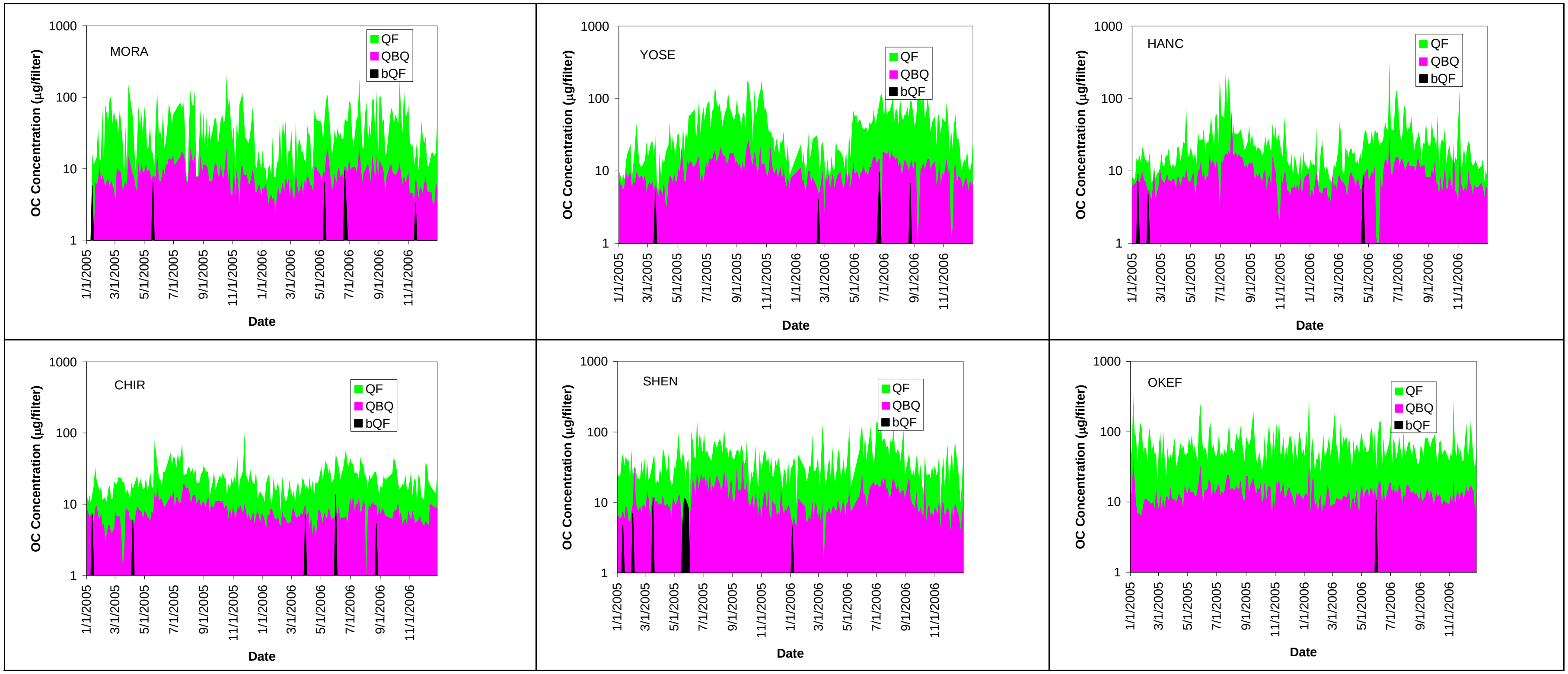


Figure 3-9. Time series of quartz-fiber front filter (QF), quartz-fiber backup filter (QBQ), and field blank (bQF) OC concentrations at six sites in the IMPROVE network for the period from 1/1/2005 through 12/31/2006. A small number of field blanks was available at each of the backup filter sites.

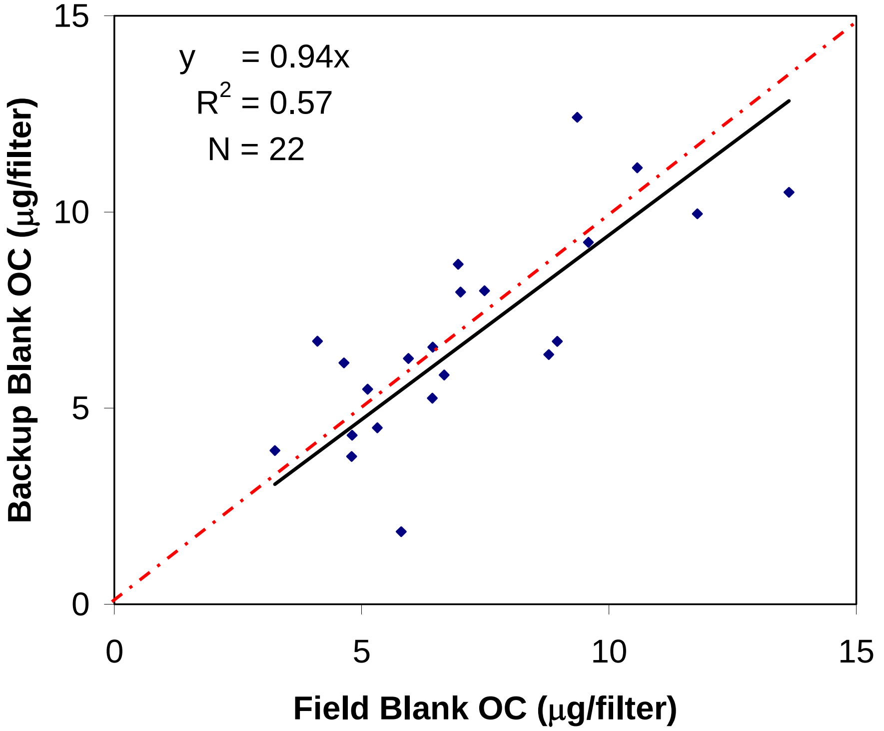


Figure 3-10. Comparison of field blank OC (bQF) with backup blank OC (bQBQ) concentrations at six sites in the IMPROVE network.

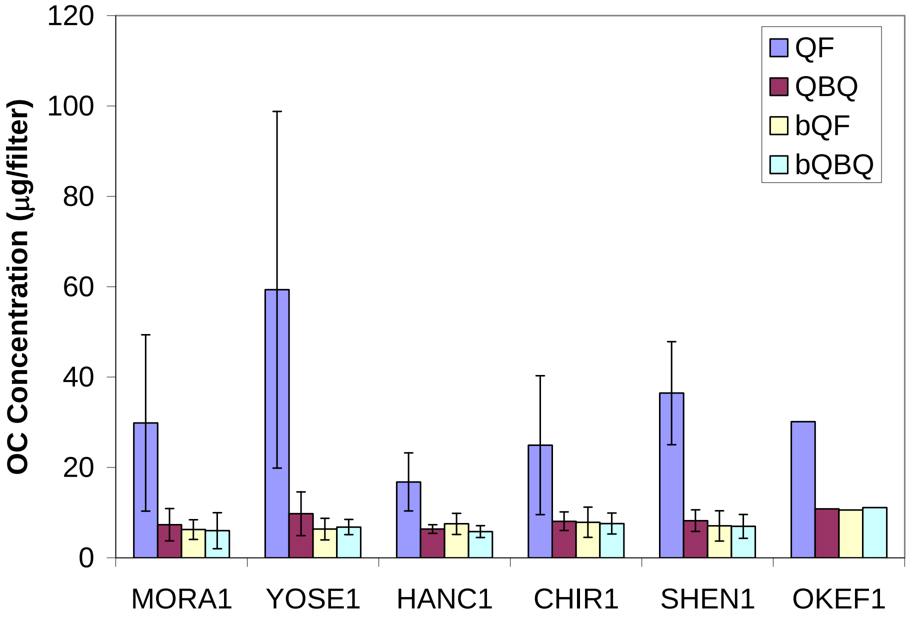


Figure 3-11. Comparisons of averaged OC concentrations in quartz-fiber front filters (QF), quartz-fiber backup filters (QBQ), front field blanks (bQF) and backup field blanks (bQBQ) for the concurrent sampling of 22 sample sets for the period from 1/1/2005 through 12/31/2006 at six sites in the IMPROVE network.

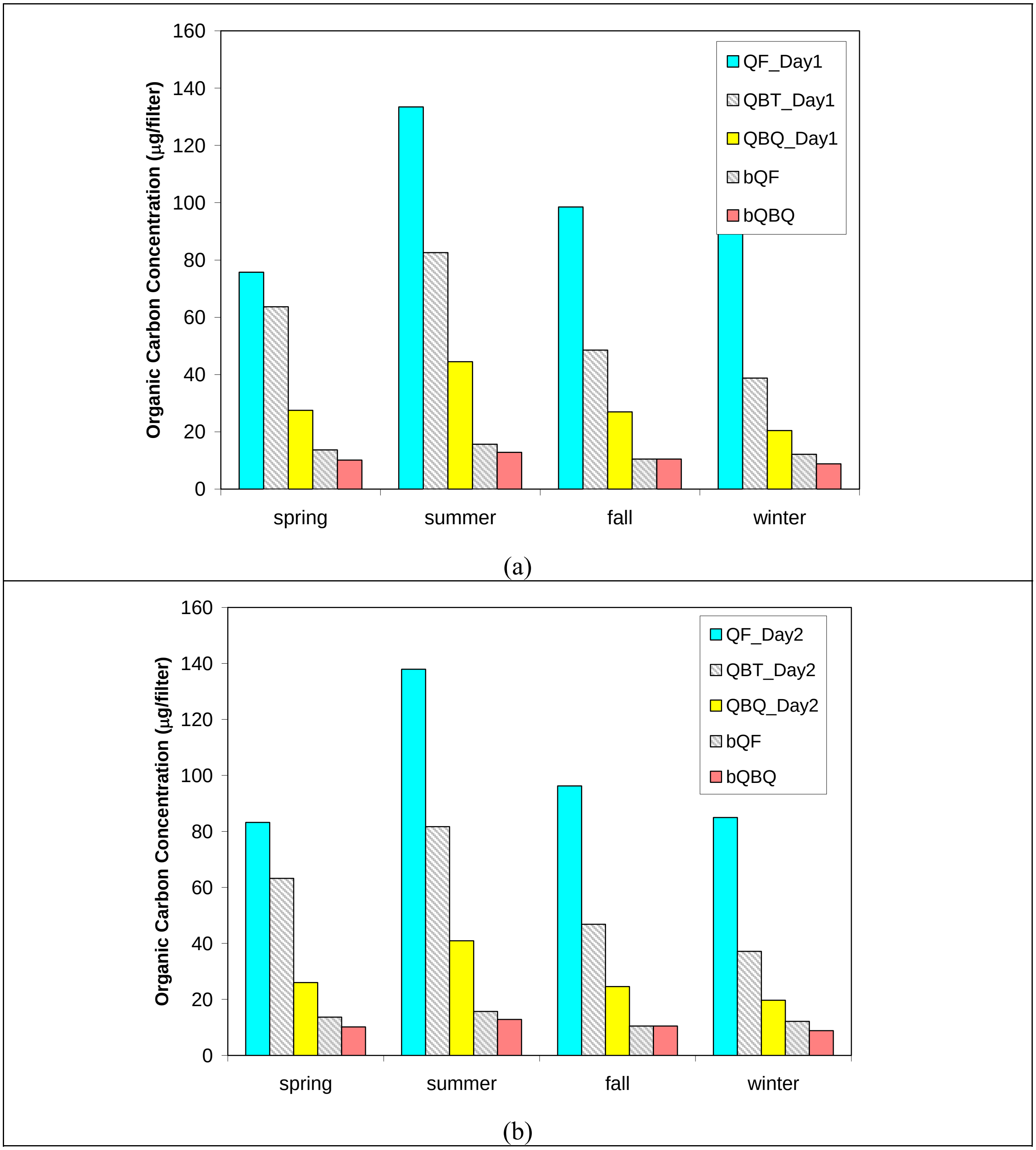


Figure 3-12. Comparison of seasonally averaged OC on quartz-fiber front filter (QF), quartz-fiber backup behind Teflon-membrane front filter (QBT), quartz-fiber backup behind quartz-fiber front filter (QBQ), and blank filters (bQF and bQBQ) for: a) Day 1 (24 hr sampling on first day followed by a 48 hr passive period), and b) Day2 (24 hr sampling on second day with 24 hr passive period before and after sampling) samples acquired from Fort Meade, MD. (spring: April; summer: July; fall: October; winter: January.)

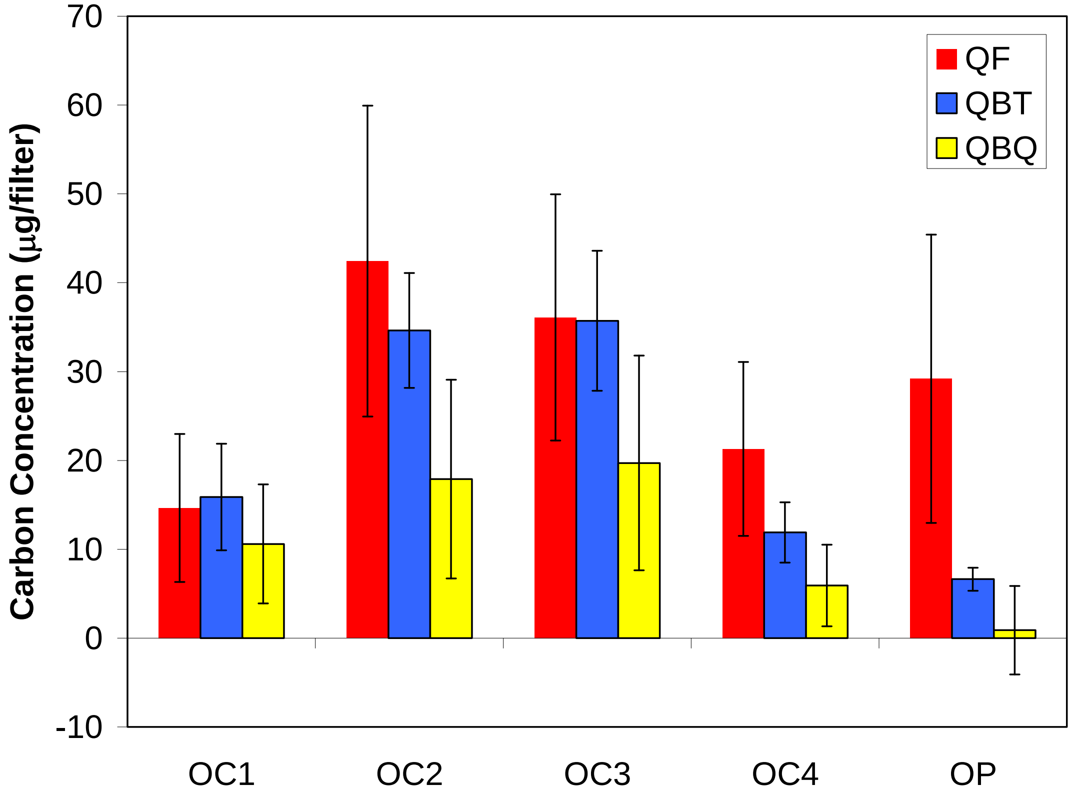


Figure 3-13. Average and standard deviation (bar) for organic carbon fraction concentrations on quartz-fiber front filters (QF), quartz-fiber backup behind Teflon-membrane (QBT), and quartz-fiber backup behind quartz-fiber (QBQ) for summer 1999 at Fort Meade, MD (36 24-hr samples).

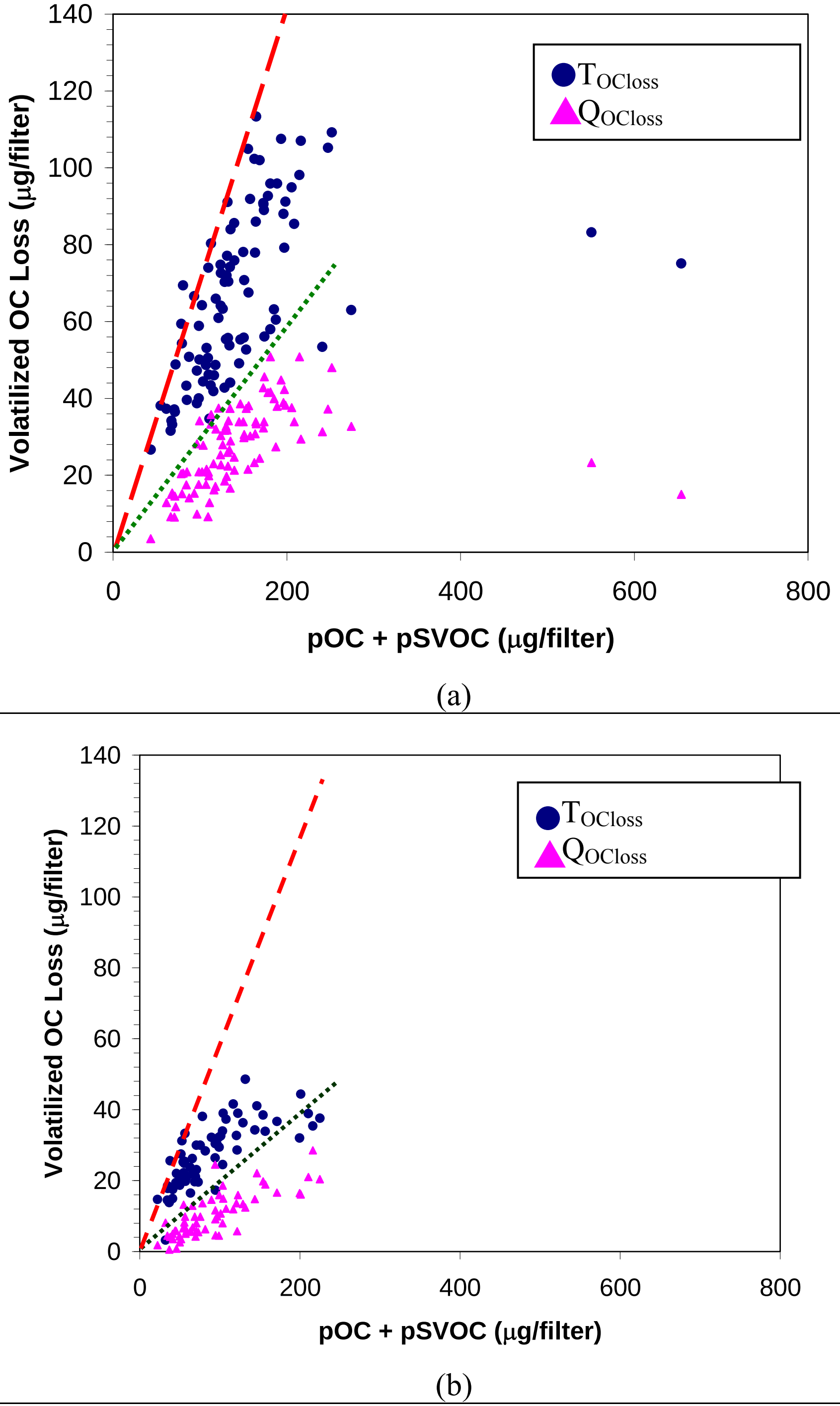


Figure 3-14. Estimated negative sampling artifact (OC loss) from Teflon-membrane and quartz-fiber filters against particulate OC (pOC + pSVOC) loading at FME for: a) summer (July) and b) winter (January) seasons. The edges of scatter are determined from the regression of data with the lowest 10% OC_loss/(pOC+pSVOC) ratio.

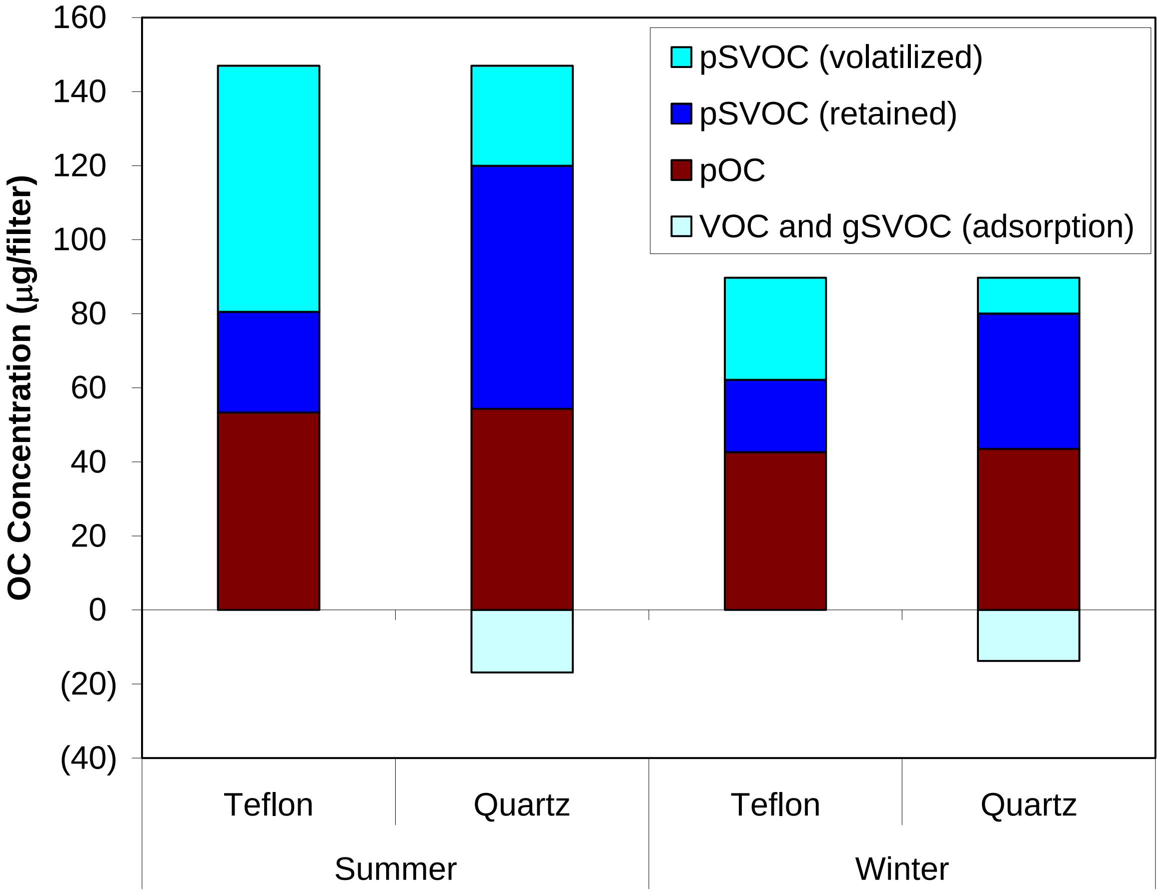
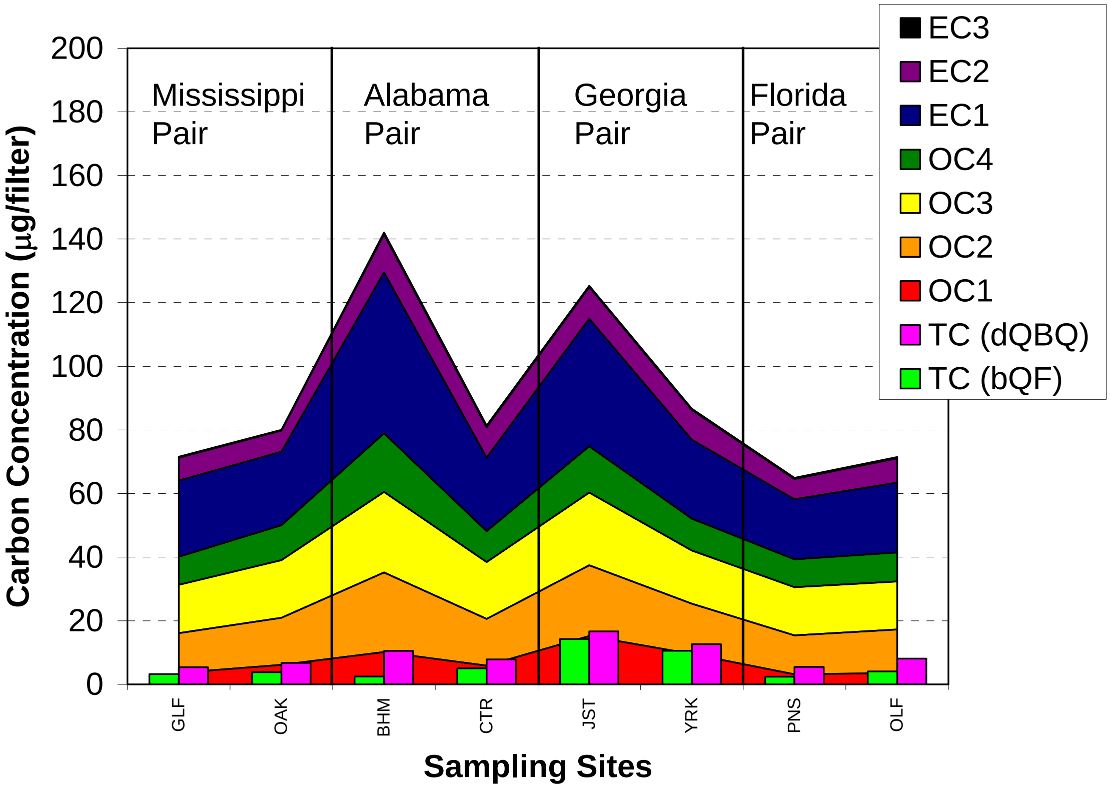


Figure 3-15. The fraction of pOC, retained pSVOC, and volatilized pSVOC or gSVOC from Teflon-membrane and quartz-fiber filters at FME during summer and winter seasons.



Mississippi Pair:	urban Gulfport [GLF] in Gulfport; and rural Oak Grove [OAK] near Hattiesburg
Alabama Pair:	urban Birmingham [BHM] in North Birmingham and rural Centreville [CTR] south of Tuscaloosa
Georgia Pair:	urban Jefferson Street [JST] in Atlanta and rural Yorkville [YRK] northwest of Atlanta
Florida Pair:	urban Pensacola [PNS] in Pensacola and suburban outlying field [OLF] northwest of Pensacola

Figure 3-16. Average backup (dQBQ) and blank (bQF) TC compared with dQF carbon fractions for the SEARCH network. The first site at each pair is the urban site, while the other is suburban or rural site. (The number of data points is shown in Table 3-5.)

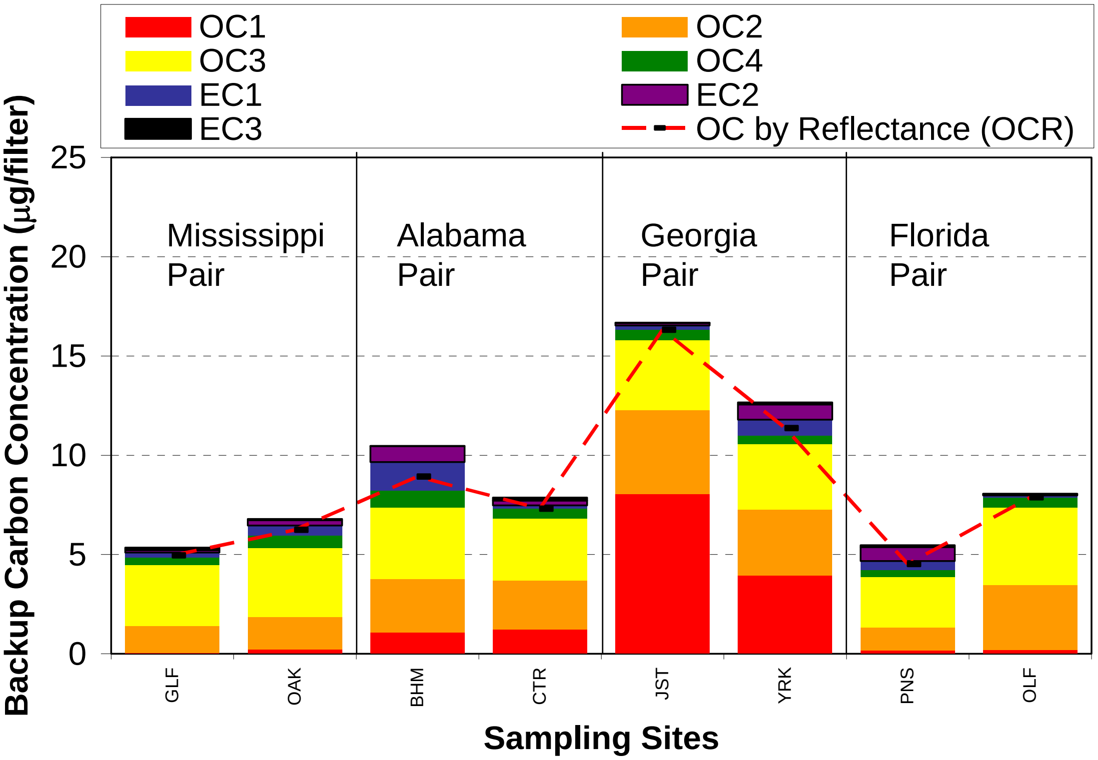


Figure 3-17. Average carbon fractions on quartz-fiber backup filters (dQBQ following preceding organic denuders) in the SEARCH network from 1/1/2005 through 12/31/2006. (Sites are arranged according to Table 3-5.)

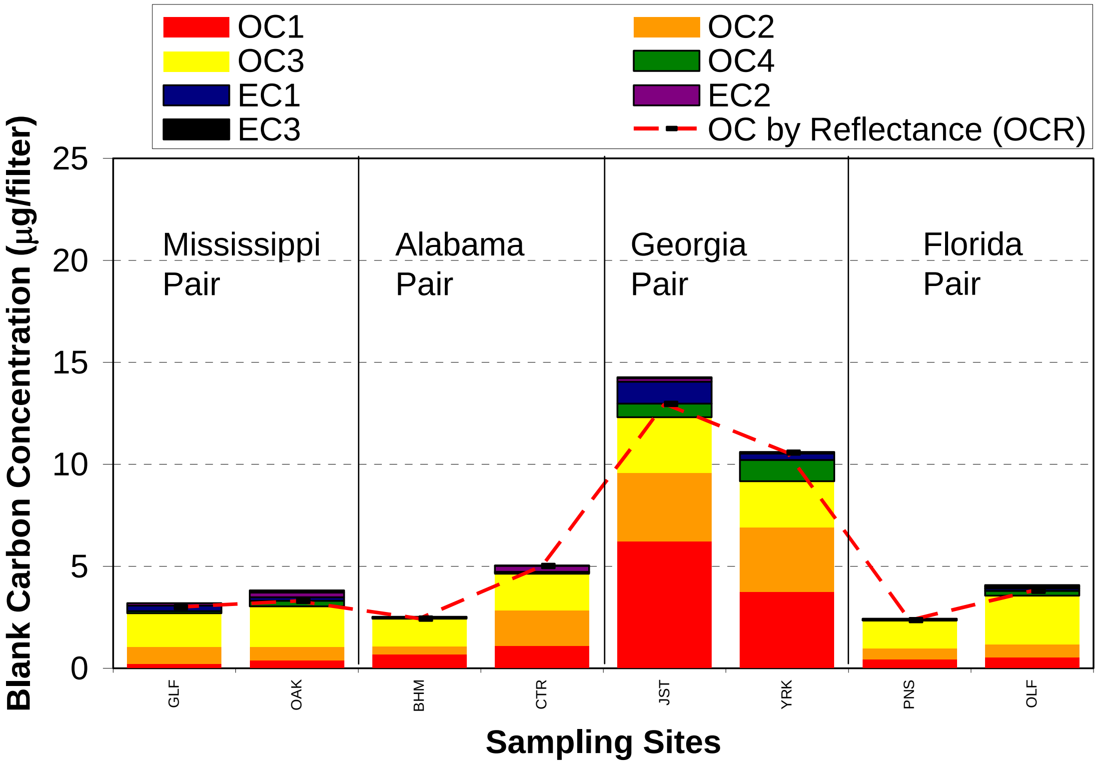


Figure 3-18. Averaged carbon fractions of quartz-fiber blank filters in the SEARCH network from 1/1/2005 to 12/31/2006. (Sites are arranged according to Table 3-5.)

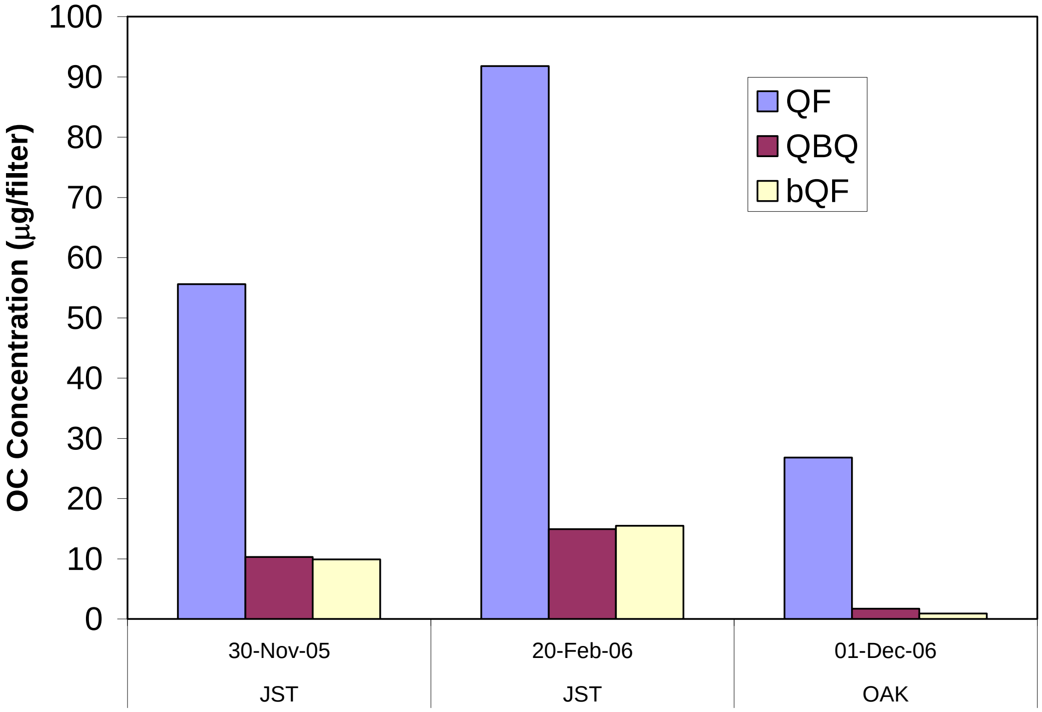
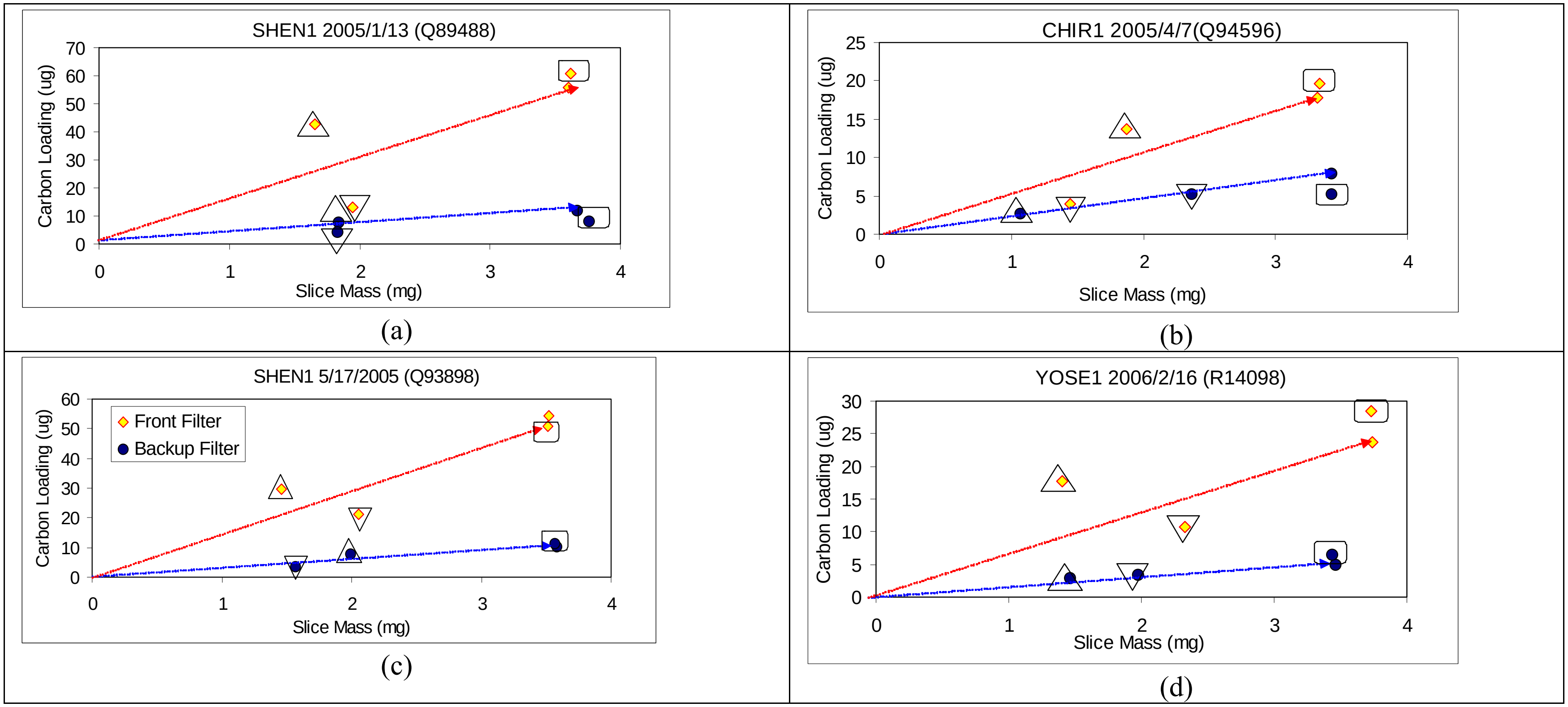


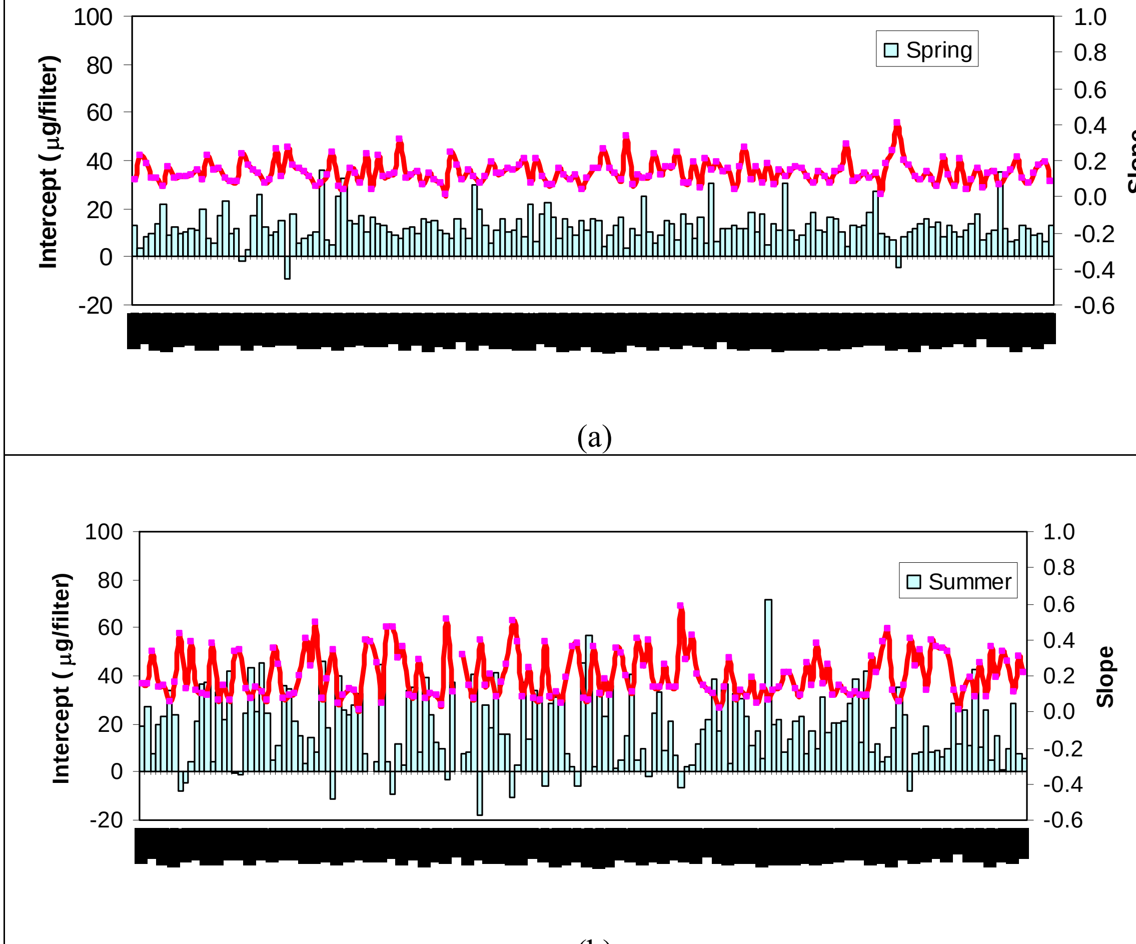
Figure 3-19. Comparison of concurrent SEARCH quartz-fiber front (QF), quartz-fiber backup (QBQ), and quartz-fiber blank (bQF) filter OC concentrations.



(a) (b)

(c) (d)

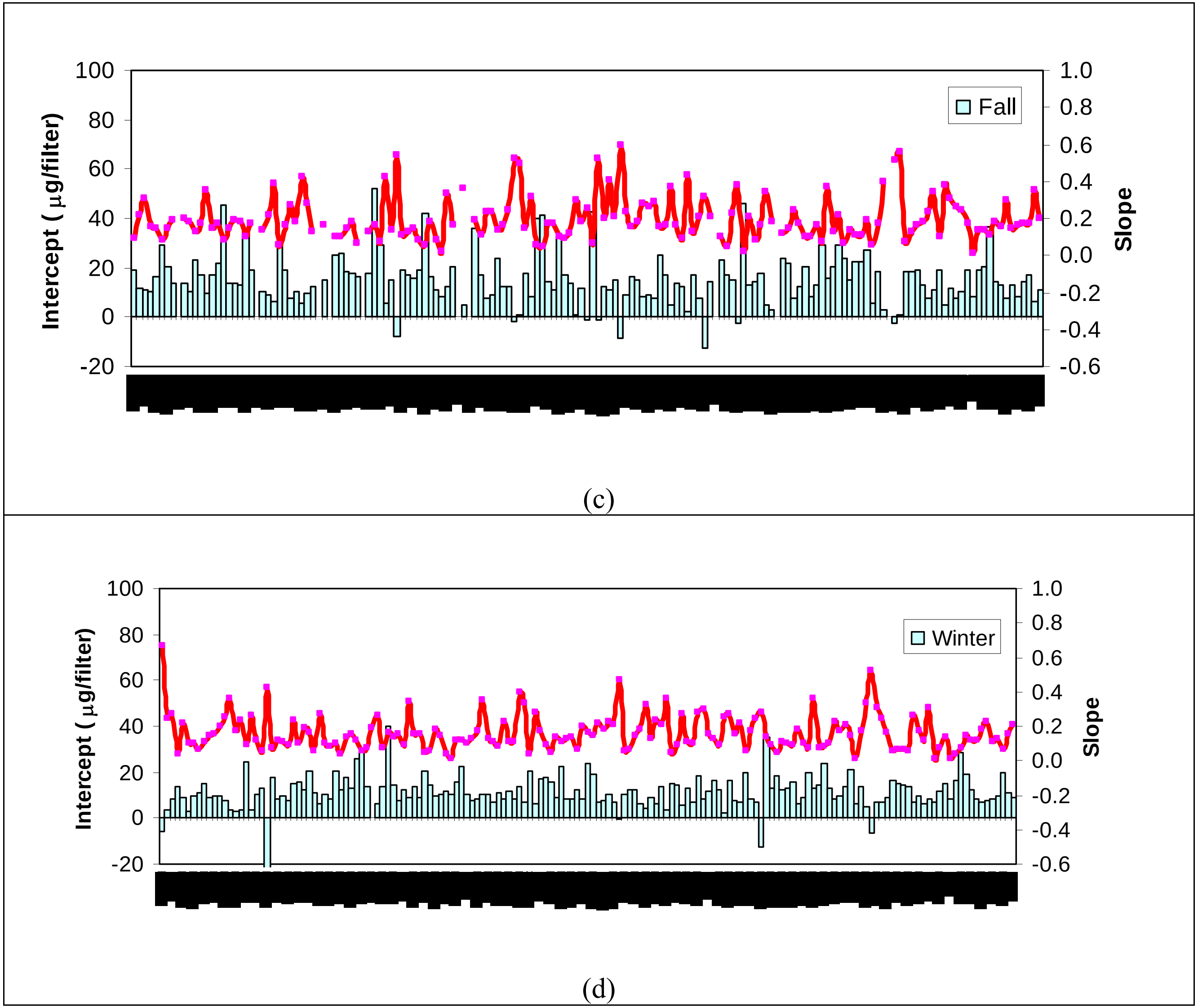
Figure 3-20. Comparison of original and sliced filter mass (in mg) with carbon loading (in µg). Diamonds and circles indicate front (QF) and backup (QBQ) filters, respectively. The upper and lower triangles indicate top (QF_{top}) and bottom halves (QF_{bottom}) of slices, while rectangles represent the original filter punch (0.5 cm^2). In Cases (a) and (b), the bottom halves of QF contains similar carbon concentrations as those on backup filters. In Cases (c) and (d), the bottom-half of QF contains higher carbon concentrations than QBQ slices.



(a)

(b)

Figure 3-21. Robust regression intercepts (bars) and slopes (lines) for quartz-fiber front filter OC (y-axis) versus $PM_{2.5}$ mass (x-axis) for all IMPROVE sites during: a) spring (April), b) summer (July), c) fall (October), and d) winter (January). IMPROVE data from 1/1/2005 to 12/31/2006.

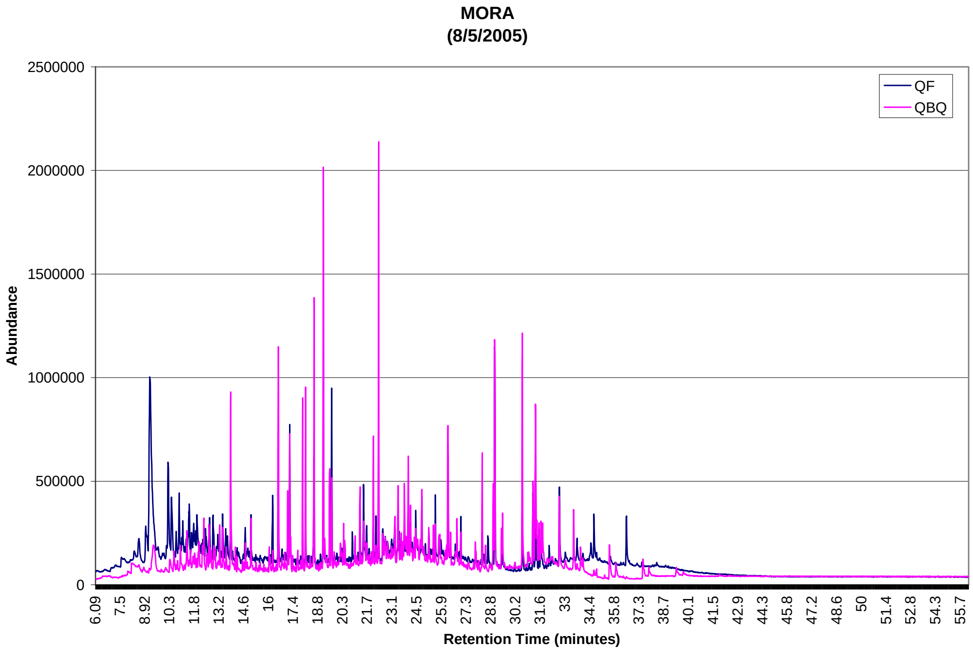


(c)

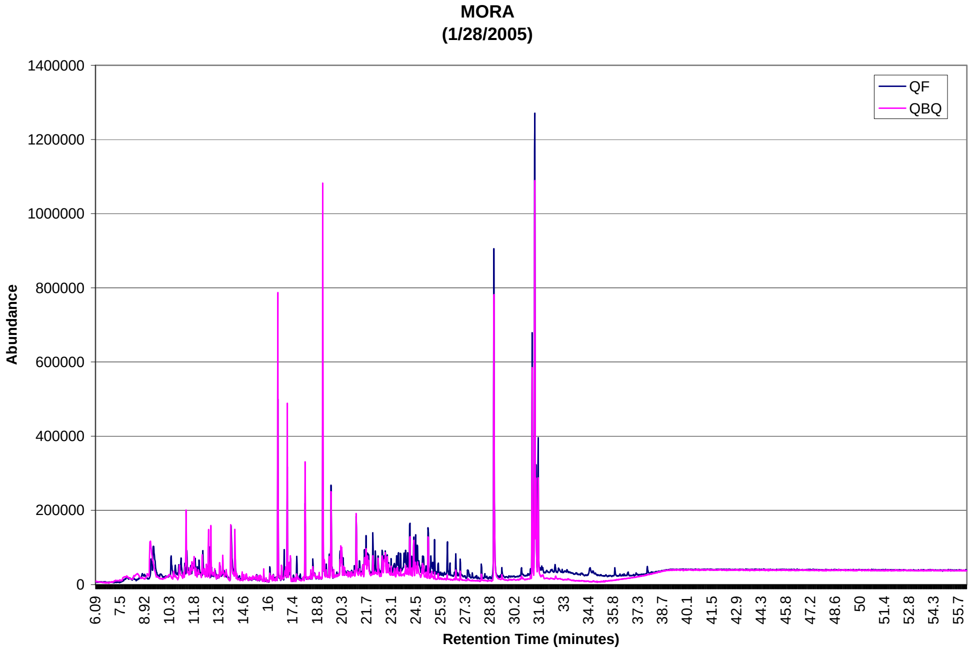
(d)

Figure 3-21. Continued.

(a)


MORA
(8/5/2005)

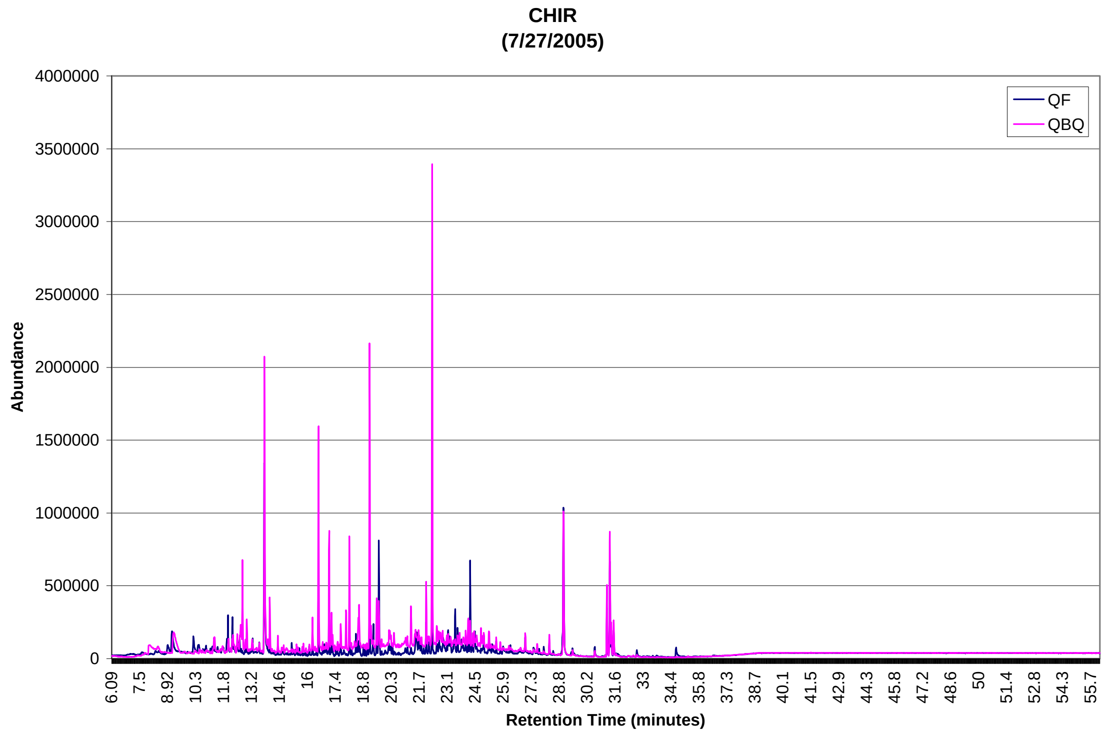
Summer


MORA
(1/28/2005)

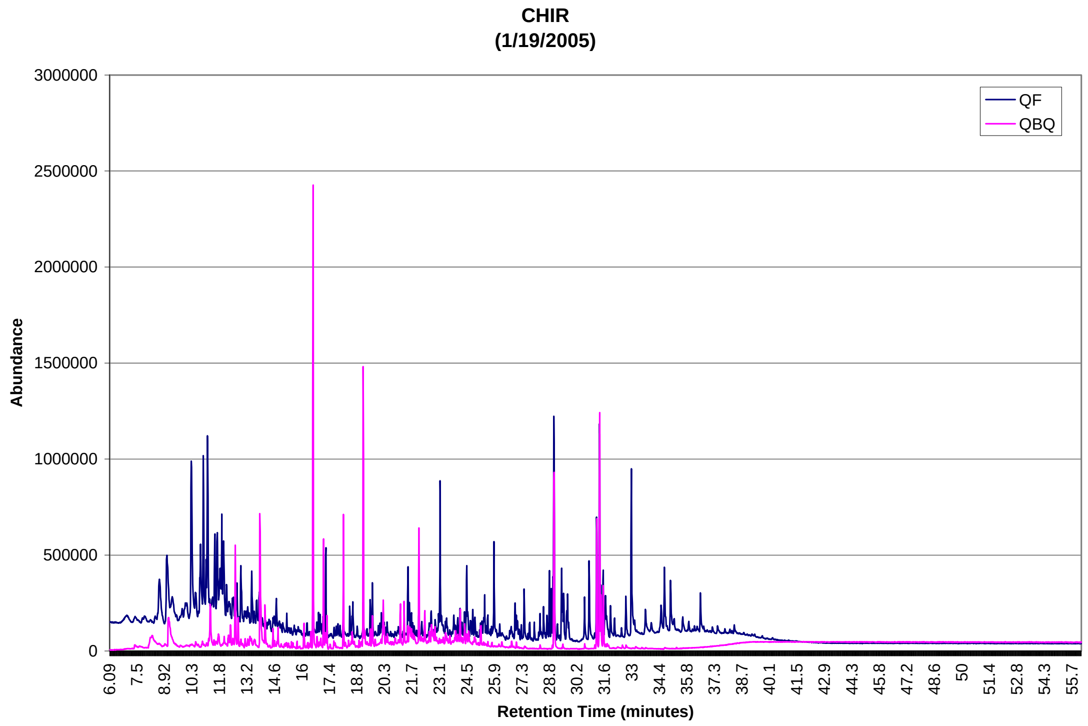
Winter

Figure 3-22. Gas chromatograms of front (QF) and backup (QBQ) quartz-fiber samples for the: (a) Mount Rainier, WA (MORA), (b) Chiricahua, AZ (CHIR), (c) Grand Canyon, AZ (HANC), and (d) Okefenokee, GA (OKEF) sites in the IMPROVE network on selected days of summer and winter 2005.

(b)


CHIR
(7/27/2005)

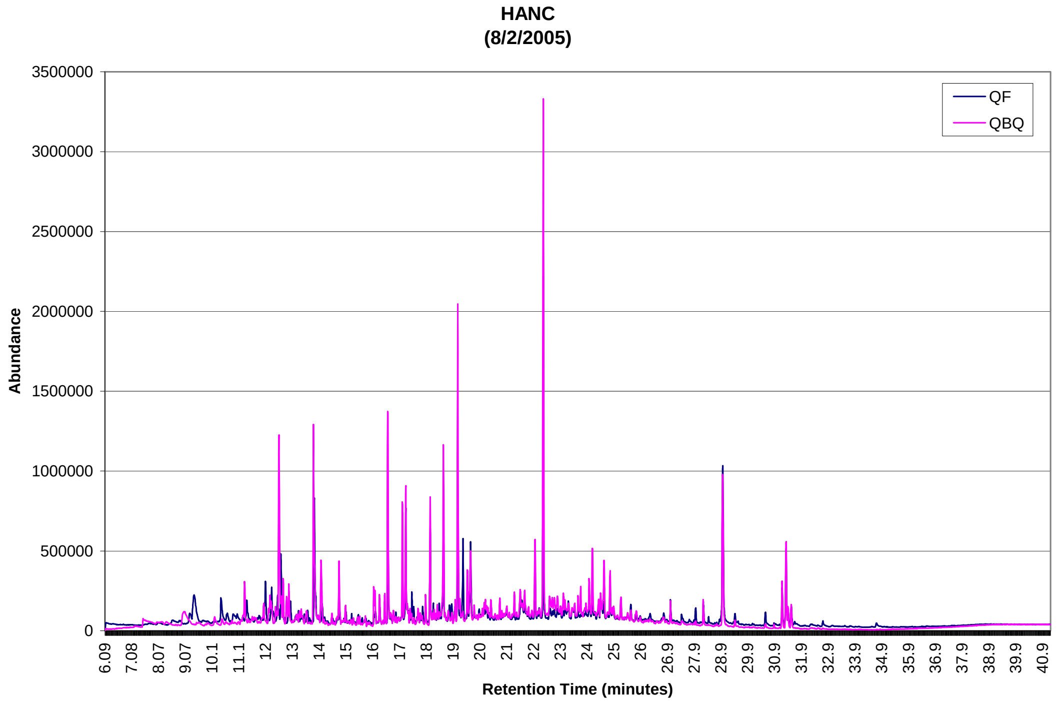
Summer


CHIR
(1/19/2005)

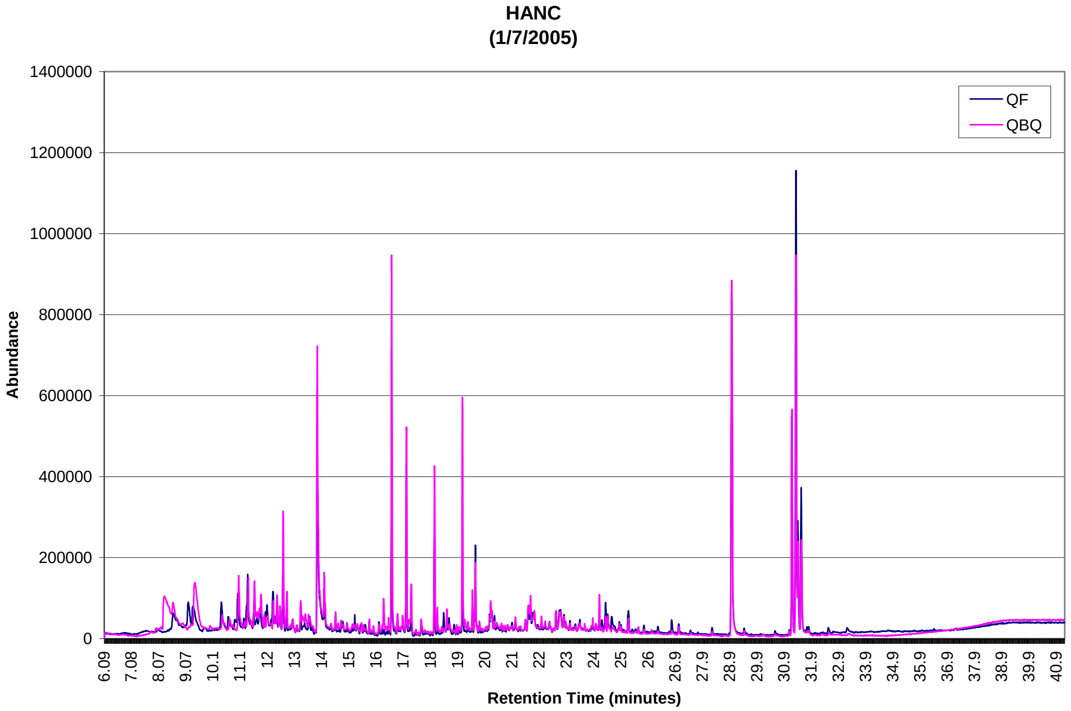
Winter

Figure 3-22. Continued.

(c)



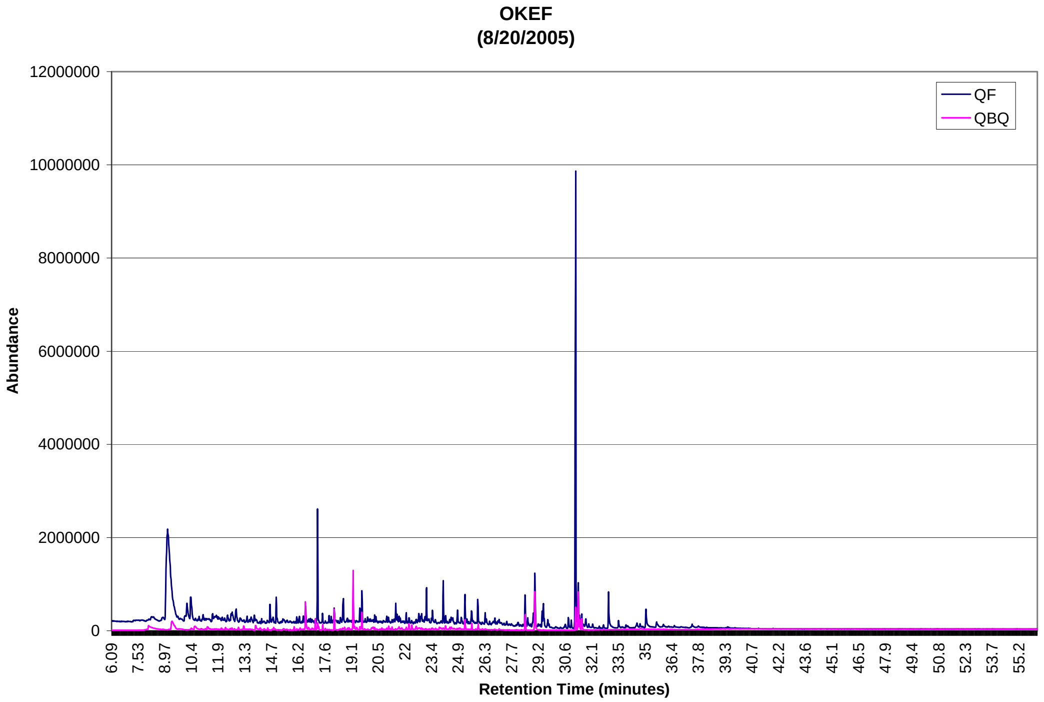
Summer



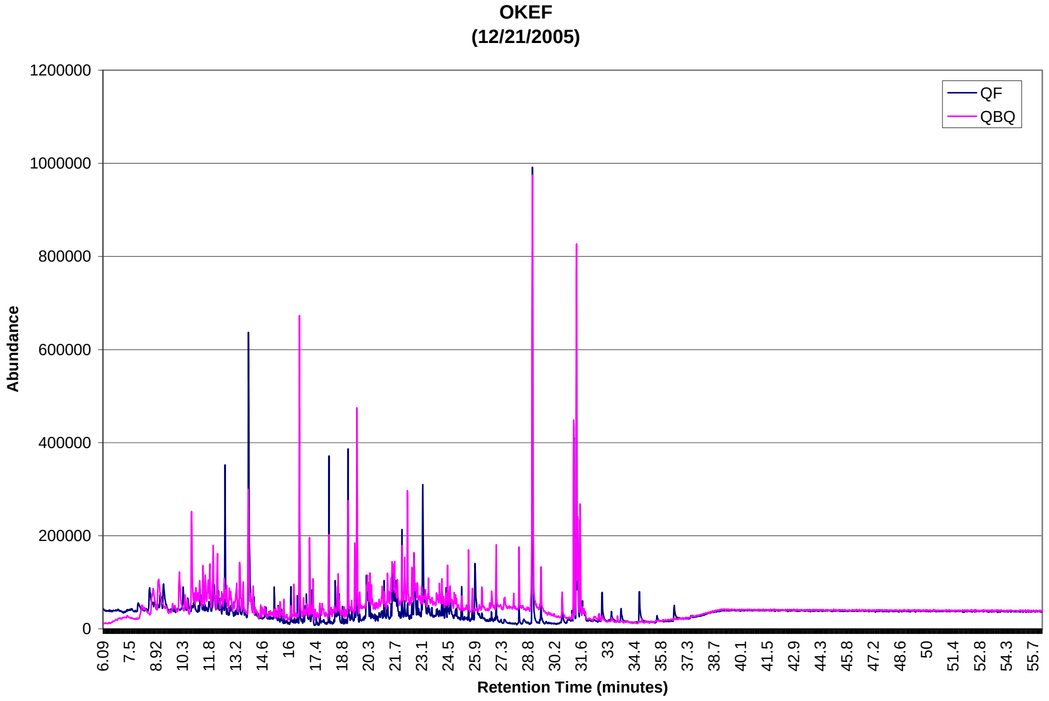
Winter

Figure 3-22. Continued.

(d)



Summer



Winter

Figure 3-22. Continued.

Table 3-1. Summary of field blanks acquired at 181 sites (plus six collocated sites) in the IMPROVE Network from 1/1/2005 to 12/31/2006.

			Sampling Period		Total Field Blanks	# of Field Blanks by Season			
SiteID	**Name**	**State**	**From**	**To**		**Spring**	**Summer**	**Fall**	**Winter**
ACAD1	Acadia NP	ME	1/13/2005	1/5/2006	3	1	0	0	2
ADPI1	Addison Pinnacle	NY	1/13/2005	5/11/2006	6	3	1	1	1
AGTI1	Agua Tibia	CA	5/19/2005	11/16/2006	7	1	1	5	0
AREN1	Arendtsville	PA	1/13/2005	3/30/2006	5	2	0	0	3
ATLA1	Atlanta	GA	1/13/2005	11/19/2006	8	3	1	2	2
BADL1	Badlands NP	SD	1/13/2005	12/7/2006	7	1	1	1	4
BALD1	Mount Baldy	AZ	3/17/2005	6/1/2006	5	2	1	1	1
BALT1	Baltimore	MD	1/13/2005	12/15/2005	4	1	1	0	2
BAND1	Bandelier NM	NM	3/17/2005	12/28/2006	9	3	2	2	2
BIBE1	Big Bend NP	TX	3/17/2005	8/24/2006	7	3	2	2	0
BIRM1	Birmingham	AL	1/13/2005	8/24/2006	5	1	1	1	2
BLIS1	Bliss SP (TRPA)	CA	3/17/2005	10/26/2006	10	3	1	5	1
BLMO1	Blue Mounds	MN	1/13/2005	1/5/2006	4	2	0	0	2
BOAP1	Bosque del Apache	NM	1/13/2005	12/7/2006	8	0	3	2	3
BOND1	Bondville	IL	3/17/2005	11/16/2006	5	3	0	1	1
BOWA1	Boundary Waters Canoe Area	MN	3/30/2006	9/14/2006	3	2	0	1	0
BRCA1	Bryce Canyon NP	UT	7/21/2005	11/16/2006	5	0	2	3	0
BRET1	Breton	LA	2/3/2005	2/3/2005	1	0	0	0	1
BRID1	Bridger Wilderness	WY	5/19/2005	12/7/2006	2	1	0	0	1
BRID9	Bridger Wilderness	WY	1/13/2005	1/13/2005	1	0	0	0	1
BRIG1	Brigantine NWR	NJ	2/3/2005	5/11/2006	6	3	1	0	2
BRMA1	Bridgton	ME	1/13/2005	10/26/2006	6	2	0	2	2
CABA1	Casco Bay	ME	5/19/2005	12/28/2006	6	2	2	0	2
CABI1	Cabinet Mountains	MT	5/19/2005	2/16/2006	3	1	1	0	1
CACO1	Cape Cod	MA	10/13/2005	12/28/2006	2	0	0	1	1
CACR1	Caney Creek	AR	1/13/2005	9/14/2006	7	3	2	1	1
CADI1	Cadiz	KY	5/19/2005	11/16/2006	7	3	0	3	1
CANY1	Canyonlands NP	UT	7/21/2005	10/5/2006	9	1	3	3	2
CAPI1	Capitol Reef NP	UT	3/17/2005	12/7/2006	6	1	2	2	1
CEBL1	Cedar Bluff	KS	1/13/2005	10/26/2006	10	2	3	2	3
CHAS1	Chassahowitzka NWR	FL	6/9/2005	10/5/2006	8	3	2	2	1
CHER1	Cherokee Nation	OK	10/13/2005	9/14/2006	3	1	0	2	0
CHIC1	Chicago	IL	1/13/2005	3/17/2005	2	1	0	0	1
CHIR1	Chiricahua NM	AZ	1/13/2005	8/24/2006	5	2	2	0	1
CLPE1	Cloud Peak	WY	3/17/2005	4/20/2006	3	2	0	1	0
COGO1	Columbia Gorge #1	WA	3/17/2005	10/5/2006	6	3	0	2	1
COHI1	Connecticut Hill	NY	7/21/2005	12/15/2005	3	0	1	1	1
COHU1	Cohutta	GA	3/17/2005	3/17/2005	1	1	0	0	0
CORI1	Columbia River Gorge	WA	3/17/2005	12/7/2006	5	2	1	1	1
CRES1	Crescent Lake	NE	3/17/2005	6/1/2006	6	4	1	1	0
CRLA1	Crater Lake NP	OR	5/19/2005	12/7/2006	7	1	3	1	2
CRMO1	Craters of the Moon NM	ID	3/17/2005	5/11/2006	4	3	0	1	0
DENA1	Denali NP	AK	5/19/2005	12/28/2006	7	1	3	0	3
DETR1	Detroit	MI	4/7/2005	12/31/2006	8	2	2	2	2
DEVA1	Death Valley NP	CA	3/17/2005	10/5/2006	4	1	1	2	0
DOME1	Dome Lands Wilderness	CA	12/15/2005	12/28/2006	4	0	1	0	3
DOSO1	Dolly Sods Wilderness	WV	3/17/2005	9/14/2006	9	3	2	2	2
DOUG1	Douglas	AZ	1/13/2005	12/28/2006	6	1	2	1	2
EGBE1	N/A		9/1/2005	10/5/2006	5	1	2	2	0
ELDO1	El Dorado Springs	MO	7/21/2005	7/13/2006	6	2	2	1	1
ELLI1	Ellis	OK	3/17/2005	5/11/2006	7	3	1	2	1
EVER1	Everglades NP	FL	1/13/2005	9/14/2006	6	1	1	2	2
EVERX	Everglades NP (collocated)	FL	1/13/2005	10/5/2006	9	4	0	2	3
FLAT1	Flathead	MT	1/13/2005	10/5/2006	8	1	3	2	2
FOPE1	Fort Peck	MT	3/17/2005	11/16/2006	6	1	2	2	1
FRES1	Fresno	CA	5/19/2005	11/16/2006	7	2	2	3	0
FRRE1	Frostburg	MD	5/19/2005	8/3/2006	4	1	2	0	1
GAMO1	Gates of the Mountains	MT	5/19/2005	10/13/2005	2	1	0	1	0
GICL1	Gila Wilderness	NM	4/7/2005	7/13/2006	4	1	2	0	1
GLAC1	Glacier NP	MT	1/13/2005	11/16/2006	5	2	1	1	1
GRBA1	Great Basin NP	NV	1/13/2005	12/28/2006	10	2	2	2	4
GRGU1	Great Gulf Wilderness	NH	1/13/2005	3/9/2006	5	2	1	0	2
GRRI1	Great River Bluffs	MN	5/19/2005	12/15/2005	3	1	1	0	1
GRSA1	Great Sand Dunes NM	CO	10/13/2005	10/5/2006	3	1	0	2	0

Table 3-1. Continued

			Sampling Period		Total Field	# of Field Blanks by Season			
SiteID	**Name**	**State**	**From**	**To**	**Blanks**	**Spring**	**Summer**	**Fall**	**Winter**
GRSM1	Great Smoky Mountains NP	TN	1/13/2005	10/26/2006	6	2	1	1	2
GRSM9	Great Smoky Mountains NP	TN	1/13/2005	1/13/2005	1	0	0	0	1
GUMO1	Guadalupe Mountains NP	TX	7/21/2005	12/28/2006	5	1	3	0	1
HALE1	Haleakala NP	HI	3/17/2005	12/28/2006	8	2	1	1	4
HANC1	Hance Camp at Grand Canyon NP	CO	1/13/2005	4/20/2006	3	1	0	0	2
HAVO1	Hawaii Volcanoes NP	HI	1/13/2005	12/28/2006	8	0	3	3	2
HECA1	Hells Canyon	OR	1/13/2005	11/16/2006	7	3	1	2	1
HEGL1	Hercules-Glades	MO	1/13/2005	11/16/2006	7	2	2	1	2
HEGLX	Hercules-Glades (collocated)	MO	1/13/2005	11/16/2006	14	4	6	2	2
HOOV1	Hoover	CA	1/13/2005	9/14/2006	8	1	4	1	2
HOOVX	Hoover (collocated)	CA	1/13/2005	12/7/2006	13	4	3	0	6
HOUS1	Houston	TX	5/19/2005	7/21/2005	2	1	1	0	0
IKBA1	Ike's Backbone	AZ	12/15/2005	12/15/2005	1	0	0	0	1
INGA1	Indian Gardens	AZ	2/3/2005	9/14/2006	6	0	2	2	2
ISLE1	Isle Royale NP	MI	1/13/2005	11/16/2006	6	2	0	3	1
JARI1	James River Face Wilderness	VA	1/13/2005	6/1/2006	5	1	1	1	2
JOSH1	Joshua Tree NP	CA	1/13/2005	7/13/2006	6	3	1	0	2
KAIS1	Kaiser	CA	1/13/2005	1/5/2006	5	1	1	1	2
KALM1	Kalmiopsis	OR	1/13/2005	11/16/2006	4	0	1	1	2
LABE1	Lava Beds NM	CA	1/13/2005	5/11/2006	7	4	0	2	1
LASU2	Lake Sugema	IA	1/13/2005	12/15/2005	3	0	0	1	2
LAVO1	Lassen Volcanic NP	CA	1/13/2005	1/5/2006	3	0	0	1	2
LIGO1	Linville Gorge	NC	3/17/2005	4/20/2006	5	3	0	1	1
LIVO1	Livonia	IN	1/13/2005	5/19/2005	2	1	0	0	1
LOST1	Lostwood	ND	5/19/2005	11/16/2006	5	2	0	3	0
LYBR1	Lye Brook Wilderness	VT	1/13/2005	12/7/2006	6	1	1	1	3
MACA1	Mammoth Cave NP	KY	5/19/2005	12/7/2006	5	2	1	0	2
MAVI1	Martha's Vineyard	MA	5/19/2005	7/13/2006	5	3	1	0	1
MEAD1	Meadview	AZ	5/19/2005	5/19/2005	1	1	0	0	0
MELA1	Medicine Lake	MT	3/17/2005	8/24/2006	3	2	1	0	0
MELAX	Medicine Lake (collocated)	MT	1/13/2005	12/7/2006	8	3	2	0	3
MEVE1	Mesa Verde NP	CO	1/13/2005	12/28/2006	9	1	4	2	2
MING1	Mingo	MO	5/19/2005	9/14/2006	4	1	0	2	1
MKGO1	M.K. Goddard	PA	3/17/2005	8/24/2006	7	4	1	2	0
MOHO1	Mount Hood	OR	1/13/2005	8/24/2006	7	3	1	2	1
MOMO1	Mohawk Mt.	CT	3/17/2005	12/7/2006	4	1	0	0	3
MONT1	Monture	MT	1/13/2005	11/16/2006	7	2	2	2	1
MOOS1	Moosehorn NWR	ME	1/13/2005	12/7/2006	7	2	1	1	3
MORA1	Mount Rainier NP	WA	1/13/2005	11/16/2006	5	2	1	1	1
MORA9	Mount Rainier NP	WA	1/13/2005	1/13/2005	1	0	0	0	1
MOZI1	Mount Zirkel Wilderness	CO	3/17/2005	11/16/2006	8	4	1	3	0
NEBR1	Nebraska NF	NE	1/13/2005	6/22/2006	5	1	2	0	2
NEYO1	New York City	NY	5/19/2005	12/15/2005	3	1	1	0	1
NOAB1	North Absaroka	WY	3/30/2006	10/5/2006	3	1	1	1	0
NOCA1	North Cascades	WA	3/17/2005	12/28/2006	7	2	2	2	1
NOCH1	Northern Cheyenne	MT	9/1/2005	10/5/2006	3	1	0	2	0
OKEF1	Okefenokee NWR	GA	6/1/2006	6/1/2006	1	0	1	0	0
OLTO1	Old Town	ME	5/19/2005	4/20/2006	4	2	0	1	1
OLYM1	Olympic	WA	2/3/2005	2/16/2006	2	0	0	0	2
OMAH1	Omaha	NE	3/17/2005	10/5/2006	4	1	1	2	0
ORPI1	Organ Pipe	AZ	3/17/2005	11/16/2006	5	2	0	2	1
PASA1	Pasayten	WA	5/19/2005	10/5/2006	6	1	1	3	1
PEFO1	Petrified Forest NP	AZ	3/17/2005	12/7/2006	6	3	1	1	1
PENO1	N/A		3/30/2006	8/24/2006	2	1	1	0	0
PETE1	Petersburg	AK	4/7/2005	9/14/2006	8	3	1	2	2
PHOE1	Phoenix	AZ	1/13/2005	5/11/2006	6	2	0	2	2
PHOE5	Phoenix	AZ	1/13/2005	5/11/2006	5	1	0	1	3
PINN1	Pinnacles NM	CA	3/9/2006	5/11/2006	2	2	0	0	0
PITT1	Pittsburgh	PA	1/13/2005	12/10/2006	8	2	2	2	2
PMRF1	Proctor Maple R. F.	VT	3/17/2005	7/13/2006	4	2	1	1	0
PORE1	Point Reyes National Seashore	CA	7/21/2005	11/16/2006	4	1	1	2	0
PRIS1	Presque Isle	ME	2/3/2005	4/20/2006	3	2	0	0	1
PUSO1	Puget Sound	WA	3/17/2005	1/5/2006	2	1	0	0	1
QUCI1	Quaker City	OH	10/5/2006	10/5/2006	1	0	0	1	0
QURE1	Quabbin Summit	MA	1/13/2005	2/16/2006	4	0	0	2	2

Table 3-1. Continued

			Sampling Period		Total Field	# of Field Blanks by Season			
SiteID	**Name**	**State**	**From**	**To**	**Blanks**	**Spring**	**Summer**	**Fall**	**Winter**
QUVA1	Queen Valley	AZ	3/17/2005	11/16/2006	3	1	0	2	0
RAFA1	San Rafael	CA	1/13/2005	12/7/2006	7	1	1	2	3
REDW1	Redwood NP	CA	1/13/2005	12/7/2006	6	1	1	1	3
ROMA1	Cape Romain NWR	SC	1/13/2005	7/13/2006	5	3	1	0	1
ROMO2	Cape Romain NWR	SC	1/13/2005	1/13/2005	1	0	0	0	1
RUBI1	Rubidoux	CA	3/17/2005	7/21/2005	3	2	1	0	0
SACR1	Salt Creek	NM	1/13/2005	8/3/2006	5	1	1	2	1
SAFO1	Sac and Fox	KS	1/13/2005	2/16/2006	4	0	1	1	2
SAGA1	San Gabriel	CA	1/13/2005	10/5/2006	4	2	0	1	1
SAGO1	San Gorgonio Wilderness	CA	3/17/2005	9/14/2006	4	3	0	1	0
SAGU1	Saguaro NM	AZ	1/13/2005	11/16/2006	2	0	0	1	1
SAMA1	St. Marks	FL	5/19/2005	11/16/2006	7	2	2	2	1
SAPE1	San Pedro Parks	NM	3/17/2005	2/16/2006	3	2	0	0	1
SAWE1	Saguaro West	AZ	1/13/2005	6/1/2006	7	4	1	1	1
SAWEX	Saguaro West (collocated)	AZ	1/13/2005	8/24/2006	16	5	6	1	4
SAWT1	Sawtooth NF	ID	1/13/2005	11/16/2006	4	0	1	2	1
SENE1	Seney	MI	3/17/2005	11/16/2006	3	1	0	2	0
SENEX	Seney (collocated)	MI	1/13/2005	12/7/2006	13	3	2	4	4
SEQU1	Sequoia NP	CA	12/15/2005	11/16/2006	4	0	0	2	2
SEQU9	Sequoia NP	CA	1/13/2005	1/13/2005	1	0	0	0	1
SHEN1	Shenandoah NP	VA	1/13/2005	1/5/2006	9	6	0	0	3
SHMI1	Shamrock Mine	CO	5/19/2005	5/11/2006	2	2	0	0	0
SHRO1	Shining Rock Wilderness	NC	3/17/2005	5/11/2006	6	4	0	1	1
SIAN1	Sierra Ancha	AZ	7/21/2005	10/5/2006	4	1	1	1	1
SIKE1	Sikes	LA	1/13/2005	8/3/2006	6	0	2	1	3
SIME1	Simeonof	AK	1/13/2005	10/5/2006	7	2	2	2	1
SIPS1	Sipsy Wilderness	AL	5/19/2005	12/7/2006	3	1	0	0	2
SNPA1	Snoqualmie Pass	WA	7/21/2005	12/28/2006	7	0	1	4	2
SPOK1	Spokane Res.	WA	5/19/2005	6/9/2005	2	1	1	0	0
STAR1	Starkey	OR	2/3/2005	12/7/2006	4	1	1	0	2
SULA1	Sula Peak	MT	5/19/2005	11/16/2006	3	1	0	1	1
SWAN1	Swanquarter	NC	3/17/2005	3/9/2006	5	2	2	1	0
SYCA1	Sycamore Canyon	AZ	1/13/2005	9/14/2006	6	1	1	1	3
TALL1	Tallgrass	KS	1/13/2005	11/16/2006	5	0	1	2	2
THBA1	Thunder Basin	WY	5/19/2005	11/16/2006	8	2	2	2	2
THRO1	Theodore Roosevelt	ND	5/19/2005	5/19/2005	1	1	0	0	0
THSI1	Three Sisters Wilderness	OR	1/13/2005	12/28/2006	5	1	1	0	3
TONT1	Tonto NM	AZ	12/15/2005	12/28/2006	5	1	1	1	2
TRCR1	Trapper Creek	AK	3/17/2005	9/14/2006	4	1	0	2	1
TRIN1	Trinity	CA	1/13/2005	7/21/2005	4	2	1	0	1
TUXE1	Tuxedni	AK	6/9/2005	11/16/2006	7	1	3	2	1
ULBE1	UL Bend	MT	1/13/2005	12/7/2006	7	1	1	1	4
UPBU1	Upper Buffalo Wilderness	AR	3/17/2005	9/14/2006	5	1	3	1	0
VIIS1	Virgin Islands NP	VI	3/17/2005	11/16/2006	8	1	2	3	2
VILA1	Viking Lake	IA	1/13/2005	7/13/2006	4	0	1	0	3
VOYA1	Voyageurs NP #1	MN	1/13/2005	7/13/2006	5	2	1	0	2
WARI1	Walker River Paiute Tribe	NV	5/19/2005	10/13/2005	4	1	1	2	0
WASH1	Washington D.C.	DC	12/7/2006	12/7/2006	1	0	0	0	1
WEMI1	Weminuche Wilderness	CO	1/13/2005	2/16/2006	4	1	0	1	2
WHIT1	White Mountain	NM	5/19/2005	11/16/2006	4	1	1	2	0
WHPA1	White Pass	WA	3/17/2005	7/13/2006	7	3	1	1	2
WHPE1	Wheeler Peak	NM	4/16/2005	4/8/2006	3	2	1	0	0
WHRI1	White River NF	CO	3/17/2005	12/7/2006	4	1	1	1	1
WICA1	Wind Cave	SD	1/13/2005	12/7/2006	4	2	0	0	2
WIMO1	Wichita Mountains	OK	7/21/2005	11/16/2006	6	1	1	4	0
YELL1	Yellowstone NP 1	WY	1/13/2005	9/14/2006	6	2	0	2	2
YOSE1	Yosemite NP	CA	3/17/2005	8/24/2006	4	1	2	0	1
ZICA1	Zion Canyon	UT	2/3/2005	12/7/2006	5	0	2	1	2
Total					959	291	194	217	257

[a] Spring = March, April, May
Summer = June, July, August
Fall = September, October, November
Winter = December, January, February

Table 3-2. Average field blank concentration by carbon fraction at 181 (plus 6 collocated) sites in the IMPROVE network from 1/1/2005 to 12/31/2006.

			Sampling Period			Carbon Concentrations (µg/filter)									
Site ID	**Site Name**	**State**	**From**	**To**	**Total # of Field Blanks**	**TC**	**OC**	**EC**	**OC1**	**OC2**	**OC3**	**OC4**	**EC1**	**EC2**	**EC3**
ACAD1	Acadia NP	ME	1/13/2005	1/5/2006	3	8.8 ± 2.25	8.61 ± 2.01	0.2 ± 0.34	1.98 ± 0.34	2.85 ± 0.73	3.25 ± 0.96	0.53 ± 0.26	0.2 ± 0.34	0 ± 0	0 ± 0
ADPI1	Addison Pinnacle	NY	1/13/2005	5/11/2006	6	7.36 ± 1.02	7.36 ± 1.02	0 ± 0	1.84 ± 0.4	2.68 ± 0.56	2.56 ± 0.45	0.24 ± 0.22	0.04 ± 0.1	0 ± 0	0 ± 0
AGTI1	Agua Tibia	CA	5/19/2005	11/16/2006	7	11.04 ± 2.71	10.95 ± 2.71	0.1 ± 0.09	3.2 ± 1.12	3.66 ± 0.74	3.54 ± 1.18	0.5 ± 0.21	0.08 ± 0.12	0.05 ± 0.07	0 ± 0.01
AREN1	Arendtsville	PA	1/13/2005	3/30/2006	5	7.16 ± 3.13	7.01 ± 2.99	0.15 ± 0.22	2.06 ± 1	2.32 ± 1.29	2.18 ± 0.89	0.45 ± 0.4	0 ± 0	0.15 ± 0.22	0 ± 0
ATLA1	Atlanta	GA	1/13/2005	11/19/2006	8	8.14 ± 1.92	8.07 ± 1.93	0.08 ± 0.14	2.07 ± 0.74	2.96 ± 0.75	2.58 ± 0.57	0.45 ± 0.25	0.04 ± 0.08	0.04 ± 0.06	0 ± 0
BADL1	Badlands NP	SD	1/13/2005	12/7/2006	7	11.17 ± 3.67	10.99 ± 3.44	0.18 ± 0.32	3.78 ± 2.65	3.19 ± 0.86	3.41 ± 1.13	0.61 ± 0.38	0.03 ± 0.05	0.13 ± 0.21	0.03 ± 0.07
BALD1	Mount Baldy	AZ	3/17/2005	6/1/2006	5	7.74 ± 2.94	7.7 ± 2.89	0.05 ± 0.06	2.66 ± 1.18	2.18 ± 0.85	2.54 ± 0.82	0.31 ± 0.29	0.03 ± 0.06	0.02 ± 0.05	0 ± 0
BALT1	Baltimore	MD	1/13/2005	12/15/2005	4	7.81 ± 1.51	7.74 ± 1.42	0.07 ± 0.1	2.21 ± 0.68	2.69 ± 0.5	2.52 ± 0.46	0.32 ± 0.2	0 ± 0.01	0.07 ± 0.1	0 ± 0
BAND1	Bandelier NM	NM	3/17/2005	12/28/2006	9	9.94 ± 2.93	9.85 ± 2.81	0.09 ± 0.17	3.23 ± 0.82	3.09 ± 1.16	3.08 ± 1	0.45 ± 0.29	0.03 ± 0.06	0.06 ± 0.12	0 ± 0
BIBE1	Big Bend NP	TX	3/17/2005	8/24/2006	7	8.48 ± 2.41	8.11 ± 1.62	0.37 ± 0.98	2.19 ± 0.46	2.73 ± 0.69	2.79 ± 0.47	0.4 ± 0.2	0.04 ± 0.1	0.08 ± 0.21	0.25 ± 0.67
BIRM1	Birmingham	AL	1/13/2005	8/24/2006	5	7.94 ± 1.45	7.93 ± 1.46	0.01 ± 0.02	2.35 ± 0.55	2.84 ± 0.62	2.47 ± 0.66	0.28 ± 0.2	0.01 ± 0.02	0 ± 0	0 ± 0
BLIS1	Bliss SP (TRPA)	CA	3/17/2005	10/26/2006	10	9.48 ± 2.24	9.26 ± 2.07	0.22 ± 0.28	2.25 ± 1.1	2.75 ± 0.54	3.6 ± 1.53	0.66 ± 0.37	0.13 ± 0.22	0.09 ± 0.16	0 ± 0
BLMO1	Blue Mounds	MN	1/13/2005	1/5/2006	4	5.4 ± 0.8	5.42 ± 0.83	0 ± 0	1.47 ± 0.47	1.65 ± 0.41	2.14 ± 0.74	0.19 ± 0.09	0.02 ± 0.03	0.02 ± 0.03	0.02 ± 0.03
BOAP1	Bosque del Apache	NM	1/13/2005	12/7/2006	8	11.03 ± 4.81	10.58 ± 4.22	0.45 ± 0.65	2.3 ± 0.84	3.47 ± 1.37	3.83 ± 1.81	0.99 ± 0.86	0.16 ± 0.22	0.29 ± 0.45	0 ± 0
BOND1	Bondville	IL	3/17/2005	11/16/2006	5	6.67 ± 3.27	6.54 ± 3.18	0.14 ± 0.12	1.45 ± 0.83	2.15 ± 1.01	2.48 ± 1.23	0.46 ± 0.27	0.08 ± 0.11	0.05 ± 0.12	0 ± 0
BOWA1	Boundary Waters Canoe Area	MN	3/30/2006	9/14/2006	3	7.1 ± 2.55	6.87 ± 2.2	0.23 ± 0.4	1.49 ± 0.33	2.49 ± 0.72	2.41 ± 0.74	0.48 ± 0.49	0.12 ± 0.21	0.11 ± 0.2	0 ± 0
BRCA1	Bryce Canyon NP	UT	7/21/2005	11/16/2006	5	10.96 ± 3.7	10.59 ± 3.2	0.37 ± 0.59	3.31 ± 1.52	3.4 ± 0.88	3.19 ± 0.56	0.69 ± 0.34	0.07 ± 0.09	0.2 ± 0.33	0.09 ± 0.21
BRET1	Breton	LA	2/3/2005	2/3/2005	1	8.19 ± 0	8.19 ± 0	0 ± 0	2.11 ± 0	2.74 ± 0	3.09 ± 0	0.24 ± 0	0 ± 0	0 ± 0	0 ± 0
BRID1	Bridger Wilderness	WY	5/19/2005	12/7/2006	2	8.64 ± 1.79	8.42 ± 1.39	0.25 ± 0.35	1.98 ± 0.77	3.1 ± 0.33	2.94 ± 0.63	0.47 ± 0.22	0.2 ± 0.19	0.12 ± 0.07	0.04 ± 0.05
BRID9	Bridger Wilderness	WY	1/13/2005	1/13/2005	1	9.25 ± 0	8.72 ± 0	0.53 ± 0	2.19 ± 0	3.06 ± 0	2.71 ± 0	0.76 ± 0	0.21 ± 0	0.21 ± 0	0.1 ± 0
BRIG1	Brigantine NWR	NJ	2/3/2005	5/11/2006	6	7.42 ± 2.86	7.39 ± 2.84	0.03 ± 0.08	2.02 ± 1.03	2.69 ± 1.3	2.46 ± 0.78	0.22 ± 0.21	0 ± 0	0.03 ± 0.08	0 ± 0
BRMA1	Bridgton	ME	1/13/2005	10/26/2006	6	7.72 ± 3.06	7.61 ± 2.82	0.11 ± 0.27	1.65 ± 0.8	2.51 ± 0.52	2.9 ± 1.31	0.52 ± 0.58	0.11 ± 0.26	0.03 ± 0.07	0 ± 0.01
CABA1	Casco Bay	ME	5/19/2005	12/28/2006	6	8.94 ± 2.41	8.9 ± 2.36	0.04 ± 0.07	2.63 ± 0.78	3.19 ± 0.69	2.69 ± 0.84	0.39 ± 0.25	0.01 ± 0.02	0.03 ± 0.05	0 ± 0
CABI1	Cabinet Mountains	MT	5/19/2005	2/16/2006	3	7.34 ± 2.32	7.25 ± 2.22	0.1 ± 0.15	2.37 ± 0.6	2.03 ± 0.99	2.47 ± 0.47	0.39 ± 0.23	0.01 ± 0.01	0.09 ± 0.14	0 ± 0
CACO1	Cape Cod	MA	10/13/2005	12/28/2006	2	6.81 ± 1.72	6.72 ± 1.63	0.09 ± 0.09	2.16 ± 0.15	2.4 ± 1.07	1.94 ± 0.55	0.21 ± 0.18	0 ± 0	0.09 ± 0.09	0.01 ± 0.02
CACR1	Caney Creek	AR	1/13/2005	9/14/2006	7	9.12 ± 2.53	8.56 ± 2.01	0.57 ± 0.89	1.69 ± 0.6	2.76 ± 1.04	3.49 ± 1.02	0.61 ± 0.26	0.37 ± 0.92	0.16 ± 0.23	0.03 ± 0.07
CADI1	Cadiz	KY	5/19/2005	11/16/2006	7	7.65 ± 1.87	7.56 ± 1.76	0.1 ± 0.14	1.96 ± 0.61	2.7 ± 0.82	2.53 ± 0.71	0.36 ± 0.33	0.02 ± 0.05	0.08 ± 0.1	0 ± 0
CANY1	Canyonlands NP	UT	7/21/2005	10/5/2006	9	9.29 ± 4.01	8.93 ± 3.59	0.36 ± 0.74	2.67 ± 1.39	2.79 ± 1.09	2.92 ± 0.95	0.54 ± 0.45	0.13 ± 0.26	0.19 ± 0.39	0.03 ± 0.1
CAPI1	Capitol Reef NP	UT	3/17/2005	12/7/2006	6	9.7 ± 2.96	9.59 ± 2.97	0.11 ± 0.17	2.91 ± 1.47	3.05 ± 0.88	3.05 ± 0.91	0.57 ± 0.36	0.04 ± 0.1	0.06 ± 0.08	0.01 ± 0.03
CEBL1	Cedar Bluff	KS	1/13/2005	10/26/2006	10	7.13 ± 2.45	7.11 ± 2.41	0.02 ± 0.05	2 ± 0.66	2.25 ± 0.95	2.55 ± 0.73	0.31 ± 0.3	0.02 ± 0.05	0 ± 0	0 ± 0.01
CHAS1	Chassahowitzka NWR	FL	6/9/2005	10/5/2006	8	7.06 ± 1.9	6.92 ± 1.76	0.14 ± 0.22	1.56 ± 0.56	2.35 ± 0.61	2.71 ± 0.76	0.3 ± 0.2	0.05 ± 0.15	0.09 ± 0.18	0 ± 0
CHER1	Cherokee Nation	OK	10/13/2005	9/14/2006	3	7.4 ± 1.24	7.4 ± 1.24	0 ± 0	1.85 ± 0.55	2.7 ± 0.73	2.55 ± 0.34	0.3 ± 0.17	0 ± 0	0 ± 0	0 ± 0
CHIC1	Chicago	IL	1/13/2005	3/17/2005	2	8.06 ± 1.44	8.06 ± 1.44	0 ± 0	2.51 ± 0.11	2.62 ± 0.03	2.6 ± 1.35	0.32 ± 0.17	0 ± 0	0 ± 0	0 ± 0
CHIR1	Chiricahua NM	AZ	1/13/2005	8/24/2006	5	7.89 ± 3.33	7.87 ± 3.33	0.02 ± 0.03	2.49 ± 1.64	2.63 ± 0.86	2.43 ± 0.73	0.31 ± 0.21	0 ± 0	0.01 ± 0.02	0.01 ± 0.02
CLPE1	Cloud Peak	WY	3/17/2005	4/20/2006	3	6.59 ± 2.01	6.56 ± 1.99	0.02 ± 0.02	1.98 ± 0.98	2.21 ± 0.5	2.2 ± 0.56	0.17 ± 0.15	0.01 ± 0.01	0 ± 0.01	0.01 ± 0.02
COGO1	Columbia Gorge #1	WA	3/17/2005	10/5/2006	6	8.52 ± 1.68	8.4 ± 1.63	0.12 ± 0.21	2.42 ± 0.76	2.96 ± 0.64	2.57 ± 0.41	0.44 ± 0.22	0.06 ± 0.1	0.07 ± 0.12	0 ± 0
COHI1	Connecticut Hill	NY	7/21/2005	12/15/2005	3	10.53 ± 3.09	10.39 ± 2.86	0.14 ± 0.24	3.51 ± 0.71	3.34 ± 1.07	3.06 ± 1.05	0.48 ± 0.21	0 ± 0	0.14 ± 0.24	0 ± 0
COHU1	Cohutta	GA	3/17/2005	3/17/2005	1	15.7 ± 0	14.96 ± 0	0.74 ± 0	6.25 ± 0	3.98 ± 0	4.06 ± 0	0.68 ± 0	0.49 ± 0	0.25 ± 0	0 ± 0
CORI1	Columbia River Gorge	WA	3/17/2005	12/7/2006	5	7.96 ± 3.2	7.79 ± 3	0.16 ± 0.21	2.03 ± 1.12	2.82 ± 1.18	2.54 ± 0.88	0.4 ± 0.29	0.06 ± 0.08	0.1 ± 0.14	0 ± 0
CRES1	Crescent Lake	NE	3/17/2005	6/1/2006	6	7.57 ± 1.23	7.55 ± 1.2	0.02 ± 0.04	2.45 ± 0.6	2.57 ± 0.36	2.31 ± 0.39	0.21 ± 0.14	0 ± 0	0.02 ± 0.04	0 ± 0
CRLA1	Crater Lake NP	OR	5/19/2005	12/7/2006	7	7.88 ± 4.04	7.84 ± 3.99	0.04 ± 0.06	2.7 ± 1.58	2.47 ± 1.22	2.38 ± 1.06	0.29 ± 0.31	0 ± 0	0.03 ± 0.06	0 ± 0.01
CRMO1	Craters of the Moon NM	ID	3/17/2005	5/11/2006	4	7.51 ± 2.65	7.5 ± 2.64	0.01 ± 0.01	2.26 ± 0.66	2.52 ± 0.86	2.51 ± 1.01	0.2 ± 0.22	0.01 ± 0.02	0 ± 0.01	0 ± 0
DENA1	Denali NP	AK	5/19/2005	12/28/2006	7	10.24 ± 1.64	10.2 ± 1.64	0.04 ± 0.04	3.14 ± 0.97	3.39 ± 0.47	3.19 ± 0.49	0.49 ± 0.13	0 ± 0	0.04 ± 0.04	0 ± 0
DETR1	Detroit	MI	4/7/2005	12/31/2006	8	7.64 ± 3.66	7.37 ± 3.07	0.27 ± 0.64	1.57 ± 0.35	2.34 ± 1.06	2.83 ± 1.27	0.63 ± 0.71	0.16 ± 0.42	0.11 ± 0.22	0 ± 0
DEVA1	Death Valley NP	CA	3/17/2005	10/5/2006	4	8.58 ± 4.33	7.67 ± 2.65	0.91 ± 1.71	1.57 ± 0.3	2.47 ± 0.82	2.95 ± 0.9	0.68 ± 0.79	0.33 ± 0.59	0.28 ± 0.56	0.29 ± 0.57
DOME1	Dome Lands Wilderness	CA	12/15/2005	12/28/2006	4	10.36 ± 6.12	10.2 ± 5.8	0.16 ± 0.32	2.6 ± 1.18	3.19 ± 1.14	3.77 ± 2.69	0.64 ± 0.84	0.06 ± 0.12	0.1 ± 0.2	0 ± 0
DOSO1	Dolly Sods Wilderness	WV	3/17/2005	9/14/2006	9	9.83 ± 3.39	9.43 ± 2.74	0.4 ± 0.85	2.71 ± 0.91	2.84 ± 1.09	3.22 ± 0.98	0.66 ± 0.4	0.11 ± 0.24	0.15 ± 0.23	0.14 ± 0.43
DOUG1	Douglas	AZ	1/13/2005	12/28/2006	6	10.28 ± 4.22	10.17 ± 3.96	0.13 ± 0.29	3.25 ± 1.87	3.19 ± 0.87	3.14 ± 1.1	0.61 ± 0.41	0.07 ± 0.15	0.08 ± 0.13	0.01 ± 0.03
EGBE1	N/A		9/1/2005	10/5/2006	5	8.49 ± 2.1	8.36 ± 1.94	0.12 ± 0.18	1.95 ± 0.77	3.06 ± 0.67	2.9 ± 0.56	0.46 ± 0.19	0.02 ± 0.04	0.1 ± 0.13	0.01 ± 0.01
ELDO1	El Dorado Springs	MO	7/21/2005	7/13/2006	6	7.72 ± 2.64	7.61 ± 2.55	0.1 ± 0.13	2.03 ± 1.03	2.46 ± 0.9	2.68 ± 0.76	0.43 ± 0.24	0 ± 0	0.1 ± 0.13	0 ± 0
ELLI1	Ellis	OK	3/17/2005	5/11/2006	7	9.85 ± 1.29	9.73 ± 1.27	0.12 ± 0.1	2.61 ± 0.77	3.01 ± 0.58	3.26 ± 0.5	0.75 ± 0.67	0.17 ± 0.25	0.05 ± 0.06	0 ± 0
EVER1	Everglades NP	FL	1/13/2005	9/14/2006	6	9.52 ± 1.75	9.45 ± 1.74	0.07 ± 0.14	2.41 ± 0.98	4.24 ± 1.27	2.44 ± 0.64	0.36 ± 0.24	0.01 ± 0.03	0.06 ± 0.11	0 ± 0
EVERX	Everglades NP	FL	1/13/2005	10/5/2006	9	8.3 ± 1.13	8.2 ± 1.01	0.1 ± 0.15	1.95 ± 0.44	3.05 ± 0.65	2.79 ± 0.57	0.41 ± 0.21	0.02 ± 0.06	0.08 ± 0.12	0 ± 0
FLAT1	Flathead	MT	1/13/2005	10/5/2006	8	8.82 ± 2.84	8.77 ± 2.84	0.05 ± 0.09	2.59 ± 0.97	2.96 ± 0.92	2.79 ± 0.92	0.44 ± 0.37	0.02 ± 0.04	0.03 ± 0.08	0 ± 0
FOPE1	Fort Peck	MT	3/17/2005	11/16/2006	6	10.08 ± 2.33	9.98 ± 2.32	0.1 ± 0.14	2.97 ± 1.45	3.49 ± 1.03	3.06 ± 0.37	0.46 ± 0.1	0.06 ± 0.13	0.04 ± 0.1	0 ± 0
FRES1	Fresno	CA	5/19/2005	11/16/2006	7	9.11 ± 1.76	8.99 ± 1.56	0.12 ± 0.25	2.38 ± 0.49	3.03 ± 0.72	3 ± 0.58	0.58 ± 0.3	0.06 ± 0.15	0.06 ± 0.1	0 ± 0
FRRE1	Frostburg	MD	5/19/2005	8/3/2006	4	9.93 ± 3.56	9.8 ± 3.45	0.13 ± 0.17	2.97 ± 1.07	2.98 ± 1.17	3.25 ± 0.97	0.6 ± 0.45	0 ± 0.01	0.13 ± 0.17	0 ± 0
GAMO1	Gates of the Mountains	MT	5/19/2005	10/13/2005	2	8.75 ± 1.26	8.75 ± 1.26	0 ± 0	2.73 ± 0.56	2.9 ± 0.19	2.81 ± 0.42	0.3 ± 0.09	0 ± 0	0 ± 0	0 ± 0

Table 3-2. Continued.

			Sampling Period		Total # of Field Blanks	Carbon Concentrations (µg/filter)									
Site ID	**Site Name**	**State**	**From**	**To**		**TC**	**OC**	**EC**	**OC1**	**OC2**	**OC3**	**OC4**	**EC1**	**EC2**	**EC3**
GICL1	Gila Wilderness	NM	4/7/2005	7/13/2006	4	7.98 ± 3.34	7.98 ± 3.34	0 ± 0.01	2.56 ± 1.14	2.46 ± 1.06	2.7 ± 1.02	0.26 ± 0.32	0 ± 0	0 ± 0.01	0 ± 0
GLAC1	Glacier NP	MT	1/13/2005	11/16/2006	5	8.69 ± 1.94	8.66 ± 1.89	0.03 ± 0.06	2.54 ± 0.63	3.13 ± 0.58	2.65 ± 0.62	0.34 ± 0.33	0.01 ± 0.02	0.02 ± 0.04	0 ± 0
GRBA1	Great Basin NP	NV	1/13/2005	12/28/2006	10	8.74 ± 1.5	8.7 ± 1.46	0.04 ± 0.12	2.6 ± 0.8	3.18 ± 0.66	2.58 ± 0.47	0.34 ± 0.18	0.01 ± 0.04	0.03 ± 0.08	0 ± 0
GRGU1	Great Gulf Wilderness	NH	1/13/2005	3/9/2006	5	10.02 ± 1.65	9.75 ± 1.81	0.27 ± 0.22	2.9 ± 0.61	3.32 ± 0.94	2.94 ± 1	0.56 ± 0.19	0.1 ± 0.09	0.18 ± 0.17	0.03 ± 0.07
GRRI1	Great River Bluffs	MN	5/19/2005	12/15/2005	3	8.47 ± 3.48	8.29 ± 3.18	0.17 ± 0.3	2.29 ± 1.25	2.75 ± 1.11	2.74 ± 0.89	0.52 ± 0.21	0.04 ± 0.06	0.14 ± 0.24	0 ± 0
GRSA1	Great Sand Dunes NM	CO	10/13/2005	10/5/2006	3	11.7 ± 2.07	11.48 ± 1.9	0.22 ± 0.25	3.71 ± 0.86	3.35 ± 0.49	3.81 ± 0.53	0.61 ± 0.1	0.14 ± 0.25	0.07 ± 0.08	0 ± 0
GRSM1	Great Smoky Mountains NP	TN	1/13/2005	10/26/2006	6	7.7 ± 3.42	7.62 ± 3.38	0.08 ± 0.12	1.78 ± 0.92	2.41 ± 0.99	2.92 ± 1.26	0.52 ± 0.35	0.08 ± 0.12	0 ± 0.01	0 ± 0
GRSM9	Great Smoky Mountains NP	TN	1/13/2005	1/13/2005	1	16.09 ± 0	15.41 ± 0	0.68 ± 0	2.61 ± 0	4.53 ± 0	6.65 ± 0	1.63 ± 0	0.38 ± 0	0.3 ± 0	0 ± 0
GUMO1	Guadalupe Mountains NP	TX	7/21/2005	12/28/2006	5	12.54 ± 2.8	12.15 ± 2.6	0.38 ± 0.31	4.1 ± 0.81	3.52 ± 1.14	3.75 ± 0.69	0.78 ± 0.37	0.12 ± 0.19	0.25 ± 0.12	0.01 ± 0.01
HALE1	Haleakala NP	HI	3/17/2005	12/28/2006	8	7.36 ± 1.6	7.31 ± 1.57	0.06 ± 0.08	1.42 ± 0.68	2.74 ± 0.52	2.79 ± 0.57	0.36 ± 0.2	0.03 ± 0.06	0.03 ± 0.07	0 ± 0
HANC1	Hance Camp at Grand Canyon NP	AZ	1/13/2005	4/20/2006	3	7.6 ± 2.42	7.51 ± 2.35	0.09 ± 0.15	2.17 ± 1.45	2.17 ± 0.85	2.88 ± 0.76	0.31 ± 0.27	0.01 ± 0.02	0.07 ± 0.13	0 ± 0
HAVO1	Hawaii Volcanoes NP	HI	1/13/2005	12/28/2006	8	6.62 ± 2.16	6.6 ± 2.15	0.02 ± 0.03	1.68 ± 0.73	2.38 ± 0.84	2.31 ± 0.63	0.24 ± 0.16	0.01 ± 0.02	0.01 ± 0.02	0 ± 0
HECA1	Hells Canyon	OR	1/13/2005	11/16/2006	7	7.17 ± 3.02	7 ± 2.92	0.16 ± 0.31	1.38 ± 0.42	2.2 ± 0.45	3.08 ± 1.96	0.35 ± 0.34	0.16 ± 0.31	0.01 ± 0.01	0 ± 0
HEGL1	Hercules-Glades	MO	1/13/2005	11/16/2006	7	7.51 ± 2.81	7.37 ± 2.64	0.14 ± 0.19	2.3 ± 0.62	2.2 ± 1.02	2.51 ± 0.88	0.36 ± 0.32	0.01 ± 0.03	0.13 ± 0.17	0 ± 0
HEGLX	Hercules-Glades	MO	1/13/2005	11/16/2006	14	8.6 ± 3.01	8.43 ± 2.86	0.17 ± 0.29	2.36 ± 0.89	2.77 ± 0.86	2.83 ± 1.06	0.46 ± 0.39	0.06 ± 0.11	0.11 ± 0.2	0 ± 0
HOOV1	Hoover	CA	1/13/2005	9/14/2006	8	8.4 ± 2.12	8.31 ± 2.01	0.09 ± 0.22	2.54 ± 0.94	2.59 ± 0.59	2.83 ± 0.62	0.36 ± 0.23	0.09 ± 0.22	0 ± 0	0 ± 0
HOOVX	Hoover	CA	1/13/2005	12/7/2006	13	6.41 ± 2.01	6.4 ± 2.01	0.01 ± 0.03	1.77 ± 0.81	2.09 ± 0.71	2.25 ± 0.59	0.28 ± 0.18	0 ± 0.02	0.01 ± 0.03	0 ± 0
HOUS1	Houston	TX	5/19/2005	7/21/2005	2	12.15 ± 3.09	11.51 ± 2.18	0.64 ± 0.91	2.44 ± 0.39	3.89 ± 0.89	4.05 ± 0.89	1.12 ± 0.79	0.26 ± 0.36	0.39 ± 0.55	0 ± 0
IKBA1	Ike's Backbone	AZ	12/15/2005	12/15/2005	1	6.17 ± 0	6.12 ± 0	0.05 ± 0	2.55 ± 0	1.26 ± 0	2.06 ± 0	0.26 ± 0	0.01 ± 0	0.04 ± 0	0 ± 0
INGA1	Indian Gardens	AZ	2/3/2005	9/14/2006	6	13.32 ± 3.86	13 ± 3.64	0.32 ± 0.31	4.2 ± 1.38	4.28 ± 1.45	3.77 ± 1.01	0.74 ± 0.52	0.18 ± 0.17	0.14 ± 0.17	0.01 ± 0.01
ISLE1	Isle Royale NP	MI	1/13/2005	11/16/2006	6	5.42 ± 2.29	5.41 ± 2.26	0.02 ± 0.04	1.26 ± 0.49	1.9 ± 0.95	2.04 ± 0.76	0.21 ± 0.21	0.01 ± 0.04	0 ± 0.01	0 ± 0
JARI1	James River Face Wilderness	VA	1/13/2005	6/1/2006	5	8.53 ± 3.32	8.48 ± 3.25	0.05 ± 0.08	2.49 ± 1.4	3.03 ± 1.09	2.59 ± 0.73	0.37 ± 0.23	0.03 ± 0.07	0.02 ± 0.04	0 ± 0
JOSH1	Joshua Tree NP	CA	1/13/2005	7/13/2006	6	9.19 ± 0.97	9.13 ± 0.94	0.06 ± 0.1	2.64 ± 0.69	2.87 ± 0.98	3.25 ± 0.36	0.38 ± 0.24	0.01 ± 0.02	0.05 ± 0.08	0 ± 0
KAIS1	Kaiser	CA	1/13/2005	1/5/2006	5	10.31 ± 2.45	10.19 ± 2.38	0.12 ± 0.12	2.88 ± 0.89	3.51 ± 0.9	3.28 ± 0.79	0.51 ± 0.25	0.08 ± 0.13	0.04 ± 0.08	0 ± 0
KALM1	Kalmiopsis	OR	1/13/2005	11/16/2006	4	7.99 ± 0.77	7.89 ± 0.67	0.1 ± 0.13	1.89 ± 0.46	2.59 ± 0.3	2.97 ± 0.74	0.43 ± 0.3	0.07 ± 0.14	0.03 ± 0.06	0 ± 0
LABE1	Lava Beds NM	CA	1/13/2005	5/11/2006	7	6.74 ± 1.69	6.64 ± 1.55	0.1 ± 0.15	1.98 ± 0.61	2.14 ± 0.44	2.24 ± 0.51	0.27 ± 0.24	0.02 ± 0.04	0.07 ± 0.1	0.01 ± 0.03
LASU2	Lake Sugema	IA	1/13/2005	12/15/2005	3	7.82 ± 2.99	7.81 ± 2.98	0.01 ± 0.02	2.18 ± 0.46	2.76 ± 1.36	2.63 ± 1.18	0.24 ± 0.2	0.01 ± 0.02	0 ± 0	0 ± 0
LAVO1	Lassen Volcanic NP	CA	1/13/2005	1/5/2006	3	6.15 ± 2.08	6.04 ± 1.89	0.11 ± 0.19	1.37 ± 0.64	1.79 ± 0.58	2.68 ± 2.06	0.2 ± 0.34	0.11 ± 0.19	0 ± 0	0 ± 0
LIGO1	Linville Gorge	NC	3/17/2005	4/20/2006	5	7.91 ± 1.58	7.82 ± 1.46	0.09 ± 0.13	2.37 ± 0.56	2.23 ± 0.54	2.69 ± 0.54	0.53 ± 0.32	0 ± 0	0.09 ± 0.13	0 ± 0
LIVO1	Livonia	IN	1/13/2005	5/19/2005	2	12.08 ± 6.11	11.11 ± 4.74	0.97 ± 1.38	1.53 ± 0.56	2.79 ± 0.13	5.43 ± 3.57	1.35 ± 1.59	0.86 ± 1.21	0.07 ± 0.1	0.04 ± 0.06
LOST1	Lostwood	ND	5/19/2005	11/16/2006	5	7.9 ± 4.05	7.83 ± 3.94	0.07 ± 0.15	2.54 ± 1.66	2.52 ± 1.24	2.41 ± 0.84	0.35 ± 0.3	0.02 ± 0.05	0.05 ± 0.1	0 ± 0
LYBR1	Lye Brook Wilderness	VT	1/13/2005	12/7/2006	6	7 ± 2.17	6.95 ± 2.11	0.05 ± 0.08	1.91 ± 0.66	2.55 ± 0.66	2.24 ± 0.7	0.25 ± 0.31	0 ± 0	0.05 ± 0.08	0 ± 0
MACA1	Mammoth Cave NP	KY	5/19/2005	12/7/2006	5	7.94 ± 1.75	7.94 ± 1.75	0 ± 0	2.56 ± 0.79	2.36 ± 0.35	2.62 ± 0.53	0.4 ± 0.2	0 ± 0	0 ± 0	0 ± 0
MAVI1	Martha's Vineyard	MA	5/19/2005	7/13/2006	5	6.85 ± 2.47	6.72 ± 2.2	0.13 ± 0.29	1.71 ± 0.45	1.96 ± 0.57	2.7 ± 1.3	0.34 ± 0.38	0.11 ± 0.24	0.03 ± 0.06	0 ± 0
MEAD1	Meadview	AZ	5/19/2005	5/19/2005	1	8.87 ± 0	8.87 ± 0	0 ± 0	2.75 ± 0	3.06 ± 0	2.75 ± 0	0.3 ± 0	0 ± 0	0 ± 0	0 ± 0
MELA1	Medicine Lake	MT	3/17/2005	8/24/2006	3	7.62 ± 1.65	7.48 ± 1.44	0.14 ± 0.21	1.8 ± 0.32	2.4 ± 0.1	2.92 ± 1.3	0.36 ± 0.4	0.14 ± 0.21	0 ± 0	0 ± 0
MELAX	Medicine Lake	MT	1/13/2005	12/7/2006	8	7.92 ± 5.29	7.79 ± 4.99	0.13 ± 0.31	2.02 ± 0.78	2.03 ± 0.79	3.45 ± 3.42	0.29 ± 0.2	0.07 ± 0.18	0.06 ± 0.14	0 ± 0
MEVE1	Mesa Verde NP	CO	1/13/2005	12/28/2006	9	9.58 ± 3.14	9.53 ± 3.1	0.05 ± 0.12	3.03 ± 1.06	3.21 ± 1.04	2.85 ± 0.94	0.44 ± 0.35	0.01 ± 0.03	0.04 ± 0.1	0 ± 0
MING1	Mingo	MO	5/19/2005	9/14/2006	4	6.99 ± 1.06	6.96 ± 1.05	0.03 ± 0.03	1.9 ± 0.57	2.18 ± 0.49	2.5 ± 0.6	0.38 ± 0.1	0.01 ± 0.01	0.02 ± 0.03	0 ± 0
MKGO1	M.K. Goddard	PA	3/17/2005	8/24/2006	7	8.12 ± 2.33	7.8 ± 1.82	0.32 ± 0.57	2.16 ± 0.71	2.9 ± 0.63	2.41 ± 0.41	0.31 ± 0.26	0.08 ± 0.16	0.25 ± 0.51	0.01 ± 0.02
MOHO1	Mount Hood	OR	1/13/2005	8/24/2006	7	7.13 ± 2.27	7.08 ± 2.23	0.05 ± 0.09	1.78 ± 0.63	2.57 ± 0.68	2.46 ± 0.84	0.28 ± 0.3	0.04 ± 0.07	0.01 ± 0.03	0 ± 0
MOMO1	Mohawk Mt.	CT	3/17/2005	12/7/2006	4	5.75 ± 1.24	5.68 ± 1.17	0.07 ± 0.08	1.8 ± 0.7	1.86 ± 0.43	1.88 ± 0.25	0.13 ± 0.15	0 ± 0	0.07 ± 0.08	0 ± 0
MONT1	Monture	MT	1/13/2005	11/16/2006	7	8.77 ± 3.22	8.56 ± 3.02	0.21 ± 0.36	2.34 ± 1.04	2.74 ± 0.97	2.81 ± 1.01	0.51 ± 0.51	0.16 ± 0.38	0.21 ± 0.37	0 ± 0
MOOS1	Moosehorn NWR	ME	1/13/2005	12/7/2006	7	8.52 ± 1.45	8.44 ± 1.46	0.08 ± 0.13	2.65 ± 0.89	2.52 ± 0.77	2.84 ± 0.52	0.44 ± 0.2	0.06 ± 0.1	0.02 ± 0.04	0 ± 0
MORA1	Mount Rainier NP	WA	1/13/2005	11/16/2006	5	6.33 ± 2.19	6.26 ± 2.18	0.07 ± 0.16	2.03 ± 1.21	1.83 ± 0.75	2.23 ± 1	0.17 ± 0.18	0.07 ± 0.16	0 ± 0	0 ± 0
MORA9	Mount Rainier NP	WA	1/13/2005	1/13/2005	1	5.01 ± 0	5.01 ± 0	0 ± 0	1.29 ± 0	1.45 ± 0	2.26 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
MOZI1	Mount Zirkel Wilderness	CO	3/17/2005	11/16/2006	8	9.88 ± 1.35	9.85 ± 1.33	0.03 ± 0.08	2.89 ± 0.67	3.4 ± 0.56	3.03 ± 0.46	0.53 ± 0.13	0.02 ± 0.07	0 ± 0.01	0 ± 0
NEBR1	Nebraska NF	NE	1/13/2005	6/22/2006	5	11.11 ± 3.88	10.83 ± 3.72	0.28 ± 0.27	3.36 ± 1.89	3.4 ± 0.71	3.31 ± 0.95	0.76 ± 0.53	0.11 ± 0.12	0.17 ± 0.21	0 ± 0
NEYO1	New York City	NY	5/19/2005	12/15/2005	3	8.61 ± 1.7	8.49 ± 1.5	0.12 ± 0.2	2.69 ± 0.87	3 ± 0.7	2.44 ± 0.26	0.36 ± 0.25	0 ± 0	0.12 ± 0.2	0 ± 0
NOAB1	North Absaroka	WY	3/30/2006	10/5/2006	3	8.81 ± 3.8	8.56 ± 3.37	0.25 ± 0.43	2.1 ± 0.54	2.57 ± 0.4	3.41 ± 1.99	0.47 ± 0.46	0.25 ± 0.43	0 ± 0	0 ± 0
NOCA1	North Cascades	WA	3/17/2005	12/28/2006	7	9.25 ± 2.49	8.93 ± 2.4	0.32 ± 0.28	2.45 ± 1.02	2.87 ± 0.7	3.15 ± 0.8	0.45 ± 0.32	0.2 ± 0.28	0.11 ± 0.13	0 ± 0.01
NOCH1	Northern Cheyenne	MT	9/1/2005	10/5/2006	3	7.82 ± 1.2	7.82 ± 1.2	0 ± 0	2.24 ± 0.57	2.51 ± 0.57	2.65 ± 0.25	0.42 ± 0.17	0 ± 0	0 ± 0	0 ± 0
OKEF1	Okefenokee NWR	GA	6/1/2006	6/1/2006	1	10.57 ± 0	10.57 ± 0	0 ± 0	3.64 ± 0	3.04 ± 0	3.18 ± 0	0.7 ± 0	0 ± 0	0 ± 0	0 ± 0
OLTO1	Old Town	ME	5/19/2005	4/20/2006	4	6.8 ± 1.12	6.79 ± 1.11	0.01 ± 0.02	2.08 ± 0.09	2.2 ± 0.95	2.3 ± 0.13	0.21 ± 0.2	0 ± 0	0.01 ± 0.02	0 ± 0
OLYM1	Olympic	WA	2/3/2005	2/16/2006	2	5.99 ± 3.11	5.76 ± 2.86	0.23 ± 0.25	1.43 ± 0.9	1.61 ± 0.2	2.29 ± 1.16	0.43 ± 0.61	0.03 ± 0.04	0.2 ± 0.28	0 ± 0
OMAH1	Omaha	NE	3/17/2005	10/5/2006	4	8.13 ± 1.14	8.13 ± 1.14	0 ± 0	2.12 ± 0.88	3.1 ± 0.3	2.63 ± 0.34	0.29 ± 0.2	0 ± 0	0 ± 0	0 ± 0
ORPI1	Organ Pipe	AZ	3/17/2005	11/16/2006	5	7.14 ± 1.38	7.07 ± 1.26	0.07 ± 0.15	1.78 ± 0.29	2.5 ± 0.52	2.56 ± 0.57	0.23 ± 0.18	0.06 ± 0.14	0 ± 0	0 ± 0.01
PASA1	Pasayten	WA	5/19/2005	10/5/2006	6	8.07 ± 1.68	7.92 ± 1.72	0.15 ± 0.22	2.09 ± 0.56	2.47 ± 0.59	2.93 ± 0.87	0.43 ± 0.27	0.03 ± 0.06	0.1 ± 0.19	0.02 ± 0.05
PEFO1	Petrified Forest NP	AZ	3/17/2005	12/7/2006	6	7.58 ± 2.3	7.48 ± 2.14	0.1 ± 0.2	1.99 ± 0.81	2.09 ± 0.68	2.89 ± 1.01	0.51 ± 0.52	0.08 ± 0.2	0.02 ± 0.03	0 ± 0
PENO1	N/A		3/30/2006	8/24/2006	2	9.46 ± 0.69	9.45 ± 0.7	0.01 ± 0.01	2.54 ± 0.66	2.93 ± 0.24	3.48 ± 0.09	0.51 ± 0.11	0 ± 0	0.01 ± 0.01	0 ± 0

Table 3-2. Continued.

Site ID	Site Name	State	Sampling Period		Total # of Field Blanks	Carbon Concentrations (µg/filter)									
			From	To		TC	OC	EC	OC1	OC2	OC3	OC4	EC1	EC2	EC3
PETE1	Petersburg	AK	4/7/2005	9/14/2006	8	6.56 ± 2.15	6.5 ± 2.08	0.05 ± 0.12	1.98 ± 0.62	2.15 ± 0.8	2.15 ± 0.61	0.23 ± 0.23	0 ± 0	0.05 ± 0.12	0 ± 0
PHOE1	Phoenix	AZ	1/13/2005	5/11/2006	6	9.95 ± 3.59	9.65 ± 3.3	0.3 ± 0.46	2.66 ± 1.1	3.26 ± 0.91	3.11 ± 0.91	0.55 ± 0.55	0.13 ± 0.2	0.24 ± 0.37	0 ± 0
PHOE5	Phoenix	AZ	1/13/2005	5/11/2006	5	8.57 ± 0.96	8.55 ± 0.95	0.02 ± 0.03	2.62 ± 0.83	2.73 ± 0.38	2.77 ± 0.52	0.44 ± 0.11	0 ± 0.01	0.02 ± 0.03	0 ± 0
PINN1	Pinnacles NM	CA	3/9/2006	5/11/2006	2	6.81 ± 0.18	6.81 ± 0.18	0 ± 0	1.77 ± 0.36	2.38 ± 0.02	2.49 ± 0.42	0.17 ± 0.22	0 ± 0	0 ± 0	0 ± 0
PITT1	Pittsburgh	PA	1/13/2005	12/10/2006	8	8.67 ± 3.05	8.39 ± 2.59	0.28 ± 0.52	2.43 ± 1.01	2.48 ± 0.47	2.88 ± 0.89	0.61 ± 0.69	0.16 ± 0.31	0.11 ± 0.22	0 ± 0
PMRF1	Proctor Maple R. F.	VT	3/17/2005	7/13/2006	4	9.03 ± 1.44	9.03 ± 1.43	0.01 ± 0.01	2.69 ± 0.79	3.18 ± 0.66	2.79 ± 0.27	0.36 ± 0.11	0 ± 0	0.01 ± 0.01	0 ± 0
PORE1	Point Reyes National Seashore	CA	7/21/2005	11/16/2006	4	7.77 ± 3.21	7.69 ± 3.08	0.08 ± 0.15	2.25 ± 1.35	2.49 ± 1.03	2.53 ± 0.65	0.35 ± 0.29	0.06 ± 0.11	0.08 ± 0.15	0 ± 0
PRIS1	Presque Isle	ME	2/3/2005	4/20/2006	3	8.6 ± 0.99	8.57 ± 0.99	0.03 ± 0.05	2.79 ± 0.49	3 ± 0.55	2.47 ± 0.34	0.3 ± 0.28	0 ± 0	0.03 ± 0.05	0 ± 0
PUSO1	Puget Sound	WA	3/17/2005	1/5/2006	2	8.73 ± 2.76	8.54 ± 2.49	0.19 ± 0.27	2.04 ± 0.29	3.1 ± 1.07	2.75 ± 0.66	0.64 ± 0.48	0.07 ± 0.1	0.12 ± 0.16	0 ± 0
QUCI1	Quaker City	OH	10/5/2006	10/5/2006	1	10.51 ± 0	10.26 ± 0	0.25 ± 0	2.33 ± 0	3.5 ± 0	3.88 ± 0	0.55 ± 0	0.04 ± 0	0.21 ± 0	0 ± 0
QURE1	Quabbin Summit	MA	1/13/2005	2/16/2006	4	8.26 ± 3.06	8.25 ± 3.06	0 ± 0.01	1.56 ± 1.19	2.72 ± 1.04	3.8 ± 2.37	0.17 ± 0.11	0 ± 0	0 ± 0.01	0 ± 0
QUVA1	Queen Valley	AZ	3/17/2005	11/16/2006	3	9.27 ± 3.21	9.25 ± 3.19	0.02 ± 0.03	2.59 ± 1.47	3.25 ± 1.16	3.11 ± 0.69	0.31 ± 0.14	0 ± 0	0.02 ± 0.03	0 ± 0
RAFA1	San Rafael	CA	1/13/2005	12/7/2006	7	9.91 ± 2.41	9.82 ± 2.38	0.09 ± 0.09	3.23 ± 0.68	3.27 ± 0.8	2.87 ± 0.75	0.45 ± 0.32	0.04 ± 0.07	0.04 ± 0.07	0 ± 0.01
REDW1	Redwood NP	CA	1/13/2005	12/7/2006	6	8.02 ± 1.38	7.95 ± 1.3	0.07 ± 0.15	2.14 ± 0.61	2.88 ± 0.39	2.56 ± 0.53	0.37 ± 0.26	0 ± 0	0.07 ± 0.15	0 ± 0
ROMA1	Cape Romain NWR	SC	1/13/2005	7/13/2006	5	8.17 ± 4.04	7.59 ± 3.16	0.58 ± 1.15	1.77 ± 1.19	2.54 ± 1.24	2.69 ± 0.55	0.58 ± 0.54	0.21 ± 0.47	0.25 ± 0.43	0.12 ± 0.27
ROMO2	Rocky Mountain NP	CO	1/13/2005	1/13/2005	1	10.7 ± 0	10.58 ± 0	0.11 ± 0	2.31 ± 0	3.71 ± 0	3.91 ± 0	0.65 ± 0	0.11 ± 0	0 ± 0	0 ± 0
RUBI1	Rubidoux	CA	3/17/2005	7/21/2005	3	10.33 ± 2.14	10.18 ± 1.95	0.14 ± 0.25	2.58 ± 0.83	3.53 ± 0.42	3.54 ± 0.45	0.53 ± 0.35	0.02 ± 0.04	0.12 ± 0.21	0 ± 0
SACR1	Salt Creek	NM	1/13/2005	8/3/2006	5	7.97 ± 2.78	7.93 ± 2.71	0.04 ± 0.08	2.08 ± 0.86	3 ± 0.85	2.56 ± 0.84	0.28 ± 0.27	0 ± 0	0.04 ± 0.08	0 ± 0
SAFO1	Sac and Fox	KS	1/13/2005	2/16/2006	4	8.35 ± 2.64	8.17 ± 2.45	0.18 ± 0.25	1.88 ± 0.46	2.58 ± 1.2	3.28 ± 1.07	0.42 ± 0.25	0.13 ± 0.26	0.05 ± 0.1	0 ± 0
SAGA1	San Gabriel	CA	1/13/2005	10/5/2006	4	9.85 ± 1.36	9.76 ± 1.29	0.09 ± 0.1	3.1 ± 0.81	3.33 ± 0.39	2.83 ± 0.37	0.51 ± 0.23	0.06 ± 0.09	0.03 ± 0.06	0 ± 0
SAGO1	San Gorgonio Wilderness	CA	3/17/2005	9/14/2006	4	8.77 ± 0.26	8.7 ± 0.16	0.07 ± 0.11	2.13 ± 0.4	3.42 ± 0.31	2.75 ± 0.36	0.41 ± 0.07	0 ± 0.01	0.07 ± 0.1	0 ± 0
SAGU1	Saguaro NM	AZ	1/13/2005	11/16/2006	2	9.75 ± 2.33	9.75 ± 2.33	0 ± 0	2.04 ± 1.17	2.81 ± 0.25	4.01 ± 2.31	0.65 ± 0.58	0.26 ± 0.36	0 ± 0	0 ± 0
SAMA1	St. Marks	FL	5/19/2005	11/16/2006	7	9.57 ± 4.38	9.43 ± 4.2	0.14 ± 0.3	2.54 ± 1.57	3.12 ± 1.32	3.21 ± 1.19	0.57 ± 0.47	0.04 ± 0.1	0.1 ± 0.2	0 ± 0
SAPE1	San Pedro Parks	NM	3/17/2005	2/16/2006	3	7.37 ± 1.96	7.25 ± 1.85	0.13 ± 0.11	1.74 ± 0.54	2.14 ± 0.58	3.12 ± 1.19	0.24 ± 0.21	0.13 ± 0.11	0 ± 0	0 ± 0
SAWE1	Saguaro West	AZ	1/13/2005	6/1/2006	7	9.16 ± 2.35	9.13 ± 2.27	0.04 ± 0.08	2.63 ± 1.3	3.07 ± 0.64	2.99 ± 0.68	0.47 ± 0.28	0.02 ± 0.04	0.04 ± 0.04	0.01 ± 0.03
SAWEX	Saguaro West	AZ	1/13/2005	8/24/2006	16	9.21 ± 3.55	9.06 ± 3.15	0.15 ± 0.53	2.39 ± 0.67	2.95 ± 0.93	3.11 ± 1.36	0.57 ± 0.49	0.12 ± 0.46	0.06 ± 0.17	0 ± 0.01
SAWT1	Sawtooth NF	ID	1/13/2005	11/16/2006	4	7.8 ± 2.17	7.79 ± 2.16	0.01 ± 0.02	2.34 ± 0.64	2.66 ± 0.7	2.46 ± 0.67	0.33 ± 0.26	0 ± 0	0.01 ± 0.02	0 ± 0.01
SENE1	Seney	MI	3/17/2005	11/16/2006	3	7.74 ± 2.53	7.53 ± 2.35	0.2 ± 0.18	1.6 ± 0.3	2.58 ± 0.81	2.85 ± 1.06	0.5 ± 0.43	0.13 ± 0.19	0.08 ± 0.13	0 ± 0
SENEX	Seney	MI	1/13/2005	12/7/2006	13	6.9 ± 3.28	6.87 ± 3.33	0.03 ± 0.1	2.08 ± 1.41	2.28 ± 1.12	2.23 ± 0.84	0.27 ± 0.21	0 ± 0.01	0 ± 0	0.03 ± 0.1
SEQU1	Sequoia NP	CA	12/15/2005	11/16/2006	4	7.52 ± 1.11	7.48 ± 1.13	0.04 ± 0.04	1.82 ± 0.3	2.64 ± 0.37	2.62 ± 0.27	0.39 ± 0.26	0 ± 0.01	0.02 ± 0.03	0.02 ± 0.04
SEQU9	Sequoia NP	CA	1/13/2005	1/13/2005	1	7.87 ± 0	7.73 ± 0	0.14 ± 0	2.68 ± 0	2.4 ± 0	2.29 ± 0	0.36 ± 0	0 ± 0	0.14 ± 0	0 ± 0
SHEN1	Shenandoah NP	VA	1/13/2005	1/5/2006	9	8.34 ± 3.1	8.21 ± 2.94	0.15 ± 0.27	1.82 ± 0.81	2.89 ± 0.97	2.98 ± 1.3	0.55 ± 0.46	0.07 ± 0.09	0.11 ± 0.19	0.02 ± 0.03
SHMI1	Shamrock Mine	CO	5/19/2005	5/11/2006	2	9.05 ± 0.39	9.01 ± 0.23	0.08 ± 0.11	2.84 ± 0.75	2.92 ± 0.48	2.9 ± 0.35	0.41 ± 0.21	0.03 ± 0.05	0.11 ± 0.06	0.03 ± 0.05
SHRO1	Shining Rock Wilderness	NC	3/17/2005	5/11/2006	6	10.26 ± 1.16	9.99 ± 0.96	0.27 ± 0.23	3.06 ± 0.59	3.27 ± 0.35	3.07 ± 0.44	0.58 ± 0.18	0.16 ± 0.16	0.11 ± 0.14	0 ± 0
SIAN1	Sierra Ancha	AZ	7/21/2005	10/5/2006	4	10.12 ± 2.11	9.91 ± 1.97	0.21 ± 0.16	2.63 ± 0.8	3.01 ± 0.63	3.69 ± 1.24	0.58 ± 0.23	0.06 ± 0.07	0.13 ± 0.16	0.02 ± 0.02
SIKE1	Sikes	LA	1/13/2005	8/3/2006	6	9.03 ± 2.31	8.8 ± 2.15	0.24 ± 0.34	2.19 ± 0.29	2.89 ± 0.92	3.17 ± 1.04	0.55 ± 0.22	0.08 ± 0.16	0.14 ± 0.18	0.01 ± 0.03
SIME1	Simeonof	AK	1/13/2005	10/5/2006	7	6.4 ± 2.11	6.4 ± 2.11	0.02 ± 0.03	1.59 ± 0.91	2.3 ± 0.6	2.31 ± 0.63	0.22 ± 0.19	0.01 ± 0.03	0.01 ± 0.03	0.02 ± 0.06
SIPS1	Sipsy Wilderness	AL	5/19/2005	12/7/2006	3	7.94 ± 2.78	7.79 ± 2.61	0.15 ± 0.19	2.84 ± 0.99	2.38 ± 1.13	2.2 ± 0.8	0.37 ± 0.17	0.03 ± 0.05	0.12 ± 0.21	0 ± 0
SNPA1	Snoqualmie Pass	WA	7/21/2005	12/28/2006	7	8.2 ± 3.17	8.17 ± 3.13	0.03 ± 0.06	2.5 ± 1.32	2.71 ± 0.96	2.55 ± 0.82	0.41 ± 0.23	0.02 ± 0.05	0.01 ± 0.04	0 ± 0
SPOK1	Spokane Res.	WA	5/19/2005	6/9/2005	2	6.13 ± 5.13	6.03 ± 4.89	0.13 ± 0.19	1.7 ± 1.24	2.03 ± 1.78	1.97 ± 1.3	0.41 ± 0.48	0.05 ± 0.02	0.15 ± 0.11	0.03 ± 0.05
STAR1	Starkey	OR	2/3/2005	12/7/2006	4	8.36 ± 4.59	8.05 ± 3.98	0.31 ± 0.63	2.47 ± 1.19	2.33 ± 0.99	2.8 ± 1.52	0.45 ± 0.38	0.12 ± 0.25	0.06 ± 0.11	0.13 ± 0.26
SULA1	Sula Peak	MT	5/19/2005	11/16/2006	3	7.27 ± 1.63	7.27 ± 1.63	0 ± 0	1.96 ± 0.73	2.68 ± 0.54	2.31 ± 0.34	0.31 ± 0.04	0 ± 0	0 ± 0	0 ± 0
SWAN1	Swanquarter	NC	3/17/2005	3/9/2006	5	7.69 ± 1.52	7.63 ± 1.41	0.07 ± 0.11	1.97 ± 0.49	2.83 ± 0.65	2.51 ± 0.47	0.35 ± 0.32	0.03 ± 0.03	0.07 ± 0.08	0.02 ± 0.03
SYCA1	Sycamore Canyon	AZ	1/13/2005	9/14/2006	6	6.73 ± 1.91	6.62 ± 1.74	0.11 ± 0.19	1.56 ± 0.6	1.95 ± 0.57	2.76 ± 0.77	0.36 ± 0.31	0.05 ± 0.12	0.06 ± 0.09	0 ± 0
TALL1	Tallgrass	KS	1/13/2005	11/16/2006	5	7.84 ± 2.47	7.79 ± 2.51	0.05 ± 0.08	2.03 ± 0.61	2.64 ± 1.06	2.76 ± 1.02	0.34 ± 0.28	0.03 ± 0.07	0.05 ± 0.08	0 ± 0
THBA1	Thunder Basin	WY	5/19/2005	11/16/2006	8	8.04 ± 2.14	7.97 ± 2.1	0.07 ± 0.09	2.35 ± 0.74	2.71 ± 0.75	2.51 ± 0.66	0.39 ± 0.19	0.02 ± 0.03	0.05 ± 0.08	0 ± 0
THRO1	Theodore Roosevelt	ND	5/19/2005	5/19/2005	1	7.53 ± 0	7.6 ± 0	0 ± 0	2.13 ± 0	2.88 ± 0	2.47 ± 0	0.27 ± 0	0.07 ± 0	0.07 ± 0	0.07 ± 0
THSI1	Three Sisters Wilderness	OR	1/13/2005	12/28/2006	5	6.86 ± 2.36	6.73 ± 2.13	0.12 ± 0.24	1.83 ± 0.4	2.33 ± 0.73	2.32 ± 0.79	0.26 ± 0.5	0.07 ± 0.12	0.06 ± 0.12	0 ± 0
TONT1	Tonto NM	AZ	12/15/2005	12/28/2006	5	6.96 ± 0.84	6.91 ± 0.84	0.05 ± 0.08	1.71 ± 0.54	2.04 ± 0.27	2.75 ± 0.59	0.41 ± 0.24	0 ± 0.01	0.05 ± 0.08	0 ± 0
TRCR1	Trapper Creek	AK	3/17/2005	9/14/2006	4	5.71 ± 1.31	5.72 ± 1.35	0.01 ± 0.01	1.43 ± 0.41	2.09 ± 0.6	2.11 ± 0.39	0.12 ± 0.11	0.02 ± 0.03	0.02 ± 0.04	0.02 ± 0.03
TRIN1	Trinity	CA	1/13/2005	7/21/2005	4	6.66 ± 1.93	6.6 ± 2.01	0.06 ± 0.12	1.83 ± 1.06	2.22 ± 0.81	2.32 ± 0.37	0.22 ± 0.18	0.06 ± 0.12	0 ± 0	0 ± 0
TUXE1	Tuxedni	AK	6/9/2005	11/16/2006	7	7.24 ± 2.67	7.21 ± 2.61	0.04 ± 0.08	1.83 ± 1.27	2.51 ± 0.74	2.6 ± 0.57	0.27 ± 0.23	0.01 ± 0.03	0.03 ± 0.08	0 ± 0
ULBE1	UL Bend	MT	1/13/2005	12/7/2006	7	7.86 ± 1.74	7.69 ± 1.72	0.17 ± 0.19	2.19 ± 0.73	2.47 ± 0.69	2.53 ± 0.51	0.5 ± 0.26	0.09 ± 0.09	0.04 ± 0.08	0.04 ± 0.12
UPBU1	Upper Buffalo Wilderness	AR	3/17/2005	9/14/2006	5	12.06 ± 1.92	11.69 ± 1.73	0.37 ± 0.4	3.29 ± 1.16	3.58 ± 0.63	4.05 ± 0.75	0.76 ± 0.3	0.23 ± 0.24	0.14 ± 0.21	0 ± 0
VIIS1	Virgin Islands NP	VI	3/17/2005	11/16/2006	8	6.15 ± 2.7	5.95 ± 2.43	0.2 ± 0.32	0.85 ± 0.63	2.48 ± 0.73	2.33 ± 1.01	0.28 ± 0.41	0.04 ± 0.08	0.12 ± 0.17	0.04 ± 0.12
VILA1	Viking Lake	IA	1/13/2005	7/13/2006	4	8.22 ± 1.68	8.09 ± 1.64	0.13 ± 0.09	2.78 ± 0.32	2.32 ± 0.76	2.58 ± 0.51	0.41 ± 0.14	0.03 ± 0.07	0.09 ± 0.1	0 ± 0.01
VOYA1	Voyageurs NP #1	MN	1/13/2005	7/13/2006	5	8.19 ± 2.47	8.11 ± 2.39	0.08 ± 0.12	2.29 ± 0.68	2.73 ± 0.79	2.73 ± 1.11	0.36 ± 0.28	0.06 ± 0.09	0.02 ± 0.04	0 ± 0
WARI1	Walker River Paiute Tribe	NV	5/19/2005	10/13/2005	4	9.32 ± 0.98	9.22 ± 0.92	0.1 ± 0.19	2.72 ± 0.25	3.31 ± 0.46	2.81 ± 0.27	0.38 ± 0.12	0.01 ± 0.02	0.09 ± 0.17	0 ± 0
WASH1	Washington D.C.	DC	12/7/2006	12/7/2006	1	12.45 ± 0	11.74 ± 0	0.71 ± 0	4 ± 0	3.74 ± 0	2.92 ± 0	1.08 ± 0	0.27 ± 0	0.44 ± 0	0 ± 0
WEMI1	Weminuche Wilderness	CO	1/13/2005	2/16/2006	4	8.59 ± 1.89	8.58 ± 1.88	0.01 ± 0.01	2.63 ± 0.37	2.98 ± 1.06	2.75 ± 0.69	0.23 ± 0.1	0 ± 0	0 ± 0	0.01 ± 0.01
WHIT1	White Mountain	NM	5/19/2005	11/16/2006	4	9.95 ± 3.44	9.77 ± 3.25	0.18 ± 0.22	2.63 ± 1.02	3.19 ± 0.76	3.48 ± 1.42	0.47 ± 0.32	0.01 ± 0.02	0.05 ± 0.1	0.12 ± 0.22
WHPA1	White Pass	WA	3/17/2005	7/13/2006	7	9.15 ± 2.78	9.1 ± 2.81	0.05 ± 0.07	2.84 ± 1.25	3 ± 0.89	2.89 ± 0.74	0.37 ± 0.27	0.03 ± 0.05	0.02 ± 0.06	0 ± 0

Table 3-2. Continued.

Site ID	Site Name	State	Sampling Period		Total #	Carbon Concentrations (µg/filter)									
			From	To	of Field Blanks	TC	OC	EC	OC1	OC2	OC3	OC4	EC1	EC2	EC3
WHPE1	Wheeler Peak	NM	4/16/2005	4/8/2006	3	7.75 ± 1.77	7.77 ± 1.74	0 ± 0	2.36 ± 0.89	2.64 ± 0.87	2.63 ± 0.31	0.19 ± 0.13	0.02 ± 0.04	0.02 ± 0.04	0.02 ± 0.04
WHRI1	White River NF	CO	3/17/2005	12/7/2006	4	9.75 ± 1.1	9.47 ± 0.96	0.27 ± 0.27	2.05 ± 0.83	2.96 ± 0.45	3.36 ± 0.25	0.74 ± 0.35	0.43 ± 0.72	0.22 ± 0.23	0 ± 0
WICA1	Wind Cave	SD	1/13/2005	12/7/2006	4	6.05 ± 2.6	5.96 ± 2.53	0.09 ± 0.09	1.97 ± 1.02	1.64 ± 0.49	2.18 ± 1.09	0.17 ± 0.17	0.07 ± 0.1	0.02 ± 0.04	0 ± 0
WIMO1	Wichita Mountains	OK	7/21/2005	11/16/2006	6	9.29 ± 1.58	9.27 ± 1.59	0.02 ± 0.03	2.57 ± 0.73	3.33 ± 0.53	2.97 ± 0.42	0.4 ± 0.17	0.01 ± 0.03	0 ± 0.01	0 ± 0
YELL1	Yellowstone NP 1	WY	1/13/2005	9/14/2006	6	9.25 ± 1.8	9.04 ± 1.56	0.22 ± 0.26	2.67 ± 0.65	3.04 ± 0.44	2.92 ± 0.58	0.41 ± 0.21	0.16 ± 0.21	0.06 ± 0.09	0 ± 0.01
YOSE1	Yosemite NP	CA	3/17/2005	8/24/2006	4	6.4 ± 2.39	6.37 ± 2.39	0.03 ± 0.06	1.87 ± 1.44	2.17 ± 0.47	2.16 ± 0.53	0.17 ± 0.14	0 ± 0	0.03 ± 0.06	0 ± 0
ZICA1	Zion Canyon	UT	2/3/2005	12/7/2006	5	7.53 ± 2.13	7.51 ± 2.08	0.02 ± 0.05	2.21 ± 0.92	2.64 ± 0.57	2.44 ± 0.71	0.23 ± 0.21	0 ± 0	0.02 ± 0.05	0 ± 0
Total					959	8.48 ± 1.67	8.35 ± 1.59	0.14 ± 0.16	2.32 ± 0.63	2.75 ± 0.52	2.84 ± 0.57	0.43 ± 0.2	0.07 ± 0.1	0.07 ± 0.08	0.01 ± 0.04

Table 3-3. Organic carbon comparison between the quartz-fiber front (QF, no blank subtraction) and quartz-fiber backup behind quartz-fiber (QBQ) filter concentrations collected at the six sites in the IMPROVE network with secondary filters behind quartz-fiber front filters for the period from 1/1/2005 though 12/31/2006. Blank values taken from Table 2.

	Organic Carbon Concentration (µg/filter, avg±std)				
Site[a]	**Front Filter (QF)**	**Backup Filter (QBQ)**	**Number of QBQ**	**Field Blanks (bQF)**	**Number of Field Blanks**
MORA	41.89 ± 32.76	8.22 ± 3.48	237	6.26 ± 2.18	5
YOSE	45.04 ± 33.54	10.34 ± 4.26	228	6.37 ± 2.39	4
HANC	29.02 ± 35.25	8.74 ± 4	243	7.51 ± 2.35	3
CHIR	24.15 ± 11.85	8.06 ± 2.8	228	7.87 ± 3.33	5
SHEN	45.07 ± 27.1	11.74 ± 6.01	230	8.21 ± 2.94	9
OKEF	76.28 ± 43.54	13.07 ± 4.71	240	10.57	1
All Sites	42.69 ± 35.39	10.03 ± 5.04	1406	7.52 ± 2.69	27

[a] MORA: Mount Rainier National Park
YOSE: Yosemite National Park
HANC: Hance Camp at Grand Canyon National Park
CHIR: Chiricahua National Monument
SHEN: Shenandoah National Park
OKEF: Okefenokee National Wildlife Refuge

Table 3-4. Comparison of concurrent OC concentration at quartz-fiber front filter (QF), quartz-fiber backup filter behind quartz-fiber filter (QBQ), front field blank (bQF), and backup field blank (bQBQ) filters at the six sites with secondary filters behind quartz-fiber front filters in the IMPROVE network.

			Organic Carbon Concentration (µg/filter)											
			QF			**QBQ**			**bQF**			**bQBQ**		
Site Code	**Site Name**	**# of samples**	**Conc.**	**±**	**StDev**	**Conc.**	**±**	**StDev**	**Conc.**	**±**	**StDev**	**Conc.**	**±**	**StDev**
MORA	Mount Rainier NP	5	29.81	±	19.63	7.33	±	3.57	6.26	±	2.18	6.00	±	3.98
YOSE	Yosemite NP	4	58.99	±	39.05	9.75	±	4.86	6.37	±	2.39	6.82	±	1.69
HANC	Hance Camp at Grand Canyon NP	3	16.80	±	6.43	6.38	±	0.96	7.51	±	2.35	5.79	±	1.3
CHIR	Chiricahua NM	5	25.06	±	15.64	8.10	±	2.07	7.87	±	3.33	7.59	±	2.3
SHEN	Shenandoah NP	4	36.45	±	11.39	8.21	±	2.39	7.06	±	3.33	6.96	±	2.63
OKEF	Okefenokee NWR	1	30.13			10.83			10.57			11.13		
All Sites		22	33.48	±	23.50	8.13	±	2.19	7.16	±	2.64	6.89	±	2.63

[a] MORA: Mount Rainier National Park
YOSE: Yosemite National Park
HANC: Hance Camp at Grand Canyon National Park
CHIR: Chiricahua National Monument
SHEN: Shenandoah National Park
OKEF: Okefenokee National Wildlife Refuge

Table 3-5. Number of samples acquired from the SEARCH network during 2005 and 2006. (dQF, dQBQ, and bQF are not necessarily obtained on the same days.)

Site Name/State	**Site Code**	**Site Type**	**Number of dQF**[a]	**Number of dQBQ**[b]	**Number of bQF**[c]
Gulfport, MS	GLF	Urban	275	28	14
Oakgrove, MS	OAK	Rural	247	30	19
North Birmingham, AL	BHM	Urban	496	50	9
Centreville, AL	CTR	Rural	275	25	23
Jefferson Street, GA	JST	Urban	814	77	13
Yorkville, GA	YRK	Rural	283	26	20
Pensacola, FL	PNS	Urban	261	20	24
Outlying Field, FL	OLF	Suburban	257	21	22

[a] QF: Quartz-fiber front filter behind the preceding organic denuders

[b] QBQ: Quartz-fiber filter behind quartz-fiber front filter behind the preceding organic denuders (representing ~10% of the samples randomly selected for carbon analysis)

[c] bQF: Quartz-fiber front field blank (collected at ~10% of total)

Table 3-6. Original and sliced filter mass and concentration (the circular filter punch size is 0.5 cm^2).

				Mass Concentration (ng/punch)				
Site ID	**Site Name**	**Type**	**Sample Date**	**Original**	**Front**	**Back**	**SUM (F + B)**	**Average % Difference**
MORA1	Mount Rainier NP	QF	5/19/2005	3.5	1.9	1.6	3.5	-0.7%
MORA9	Mount Rainier NP	QF	1/13/2005	3.5	2.4	1.2	3.6	0.5%
YOSE1	Yosemite NP	QF	2/16/2006	3.7	1.4	2.3	3.7	-0.2%
HANC1	Hance Camp at Grand Canyon NP	QF	1/13/2005	3.1	2.1	1	3.1	0.2%
HANC1	Hance Camp at Grand Canyon NP	QF	2/3/2005	3.7	2.2	1.5	3.7	-0.7%
CHIR1	Chiricahua NM	QF	1/13/2005	3.3	1.2	2.1	3.3	0.0%
CHIR1	Chiricahua NM	QF	4/7/2005	3.3	1.9	1.4	3.3	-0.6%
CHIR1	Chiricahua NM	QF	3/30/2006	3.5	1.7	1.8	3.5	-0.1%
SHEN1	Shenandoah NP	QF	2/3/2005	3.2	1.5	1.9	3.4	5.3%
SHEN1	Shenandoah NP	QF	3/17/2005	3.5	1.5	2.1	3.5	-0.3%
SHEN1	Shenandoah NP	QF	1/5/2006	3.8	2.5	1.3	3.8	0.0%
SHEN1	Shenandoah NP	QF	1/13/2005	3.6	1.7	1.9	3.6	-0.5%
MORA1	Mount Rainier NP	QBQ	5/19/2005	3.5	1.7	1.8	3.5	-0.2%
MORA9	Mount Rainier NP	QBQ	1/13/2005	3.7	2.3	1.5	3.7	0.1%
YOSE1	Yosemite NP	QBQ	2/16/2006	3.5	1.5	2	3.4	-0.9%
HANC1	Hance Camp at Grand Canyon NP	QBQ	1/13/2005	3.1	1.7	1.4	3	-3.3%
HANC1	Hance Camp at Grand Canyon NP	QBQ	2/3/2005	3.8	2	1.7	3.7	-1.0%
CHIR1	Chiricahua NM	QBQ	1/13/2005	3.4	1.4	1.9	3.4	-0.2%
CHIR1	Chiricahua NM	QBQ	4/7/2005	3.4	1.1	2.4	3.4	-0.1%
CHIR1	Chiricahua NM	QBQ	3/30/2006	3.7	1.6	2	3.6	-0.8%
SHEN1	Shenandoah NP	QBQ	2/3/2005	3.2	2	1.2	3.2	-0.9%
SHEN1	Shenandoah NP	QBQ	3/17/2005	3.6	2	1.6	3.6	-0.5%
SHEN1	Shenandoah NP	QBQ	1/5/2006	3.6	1.8	1.9	3.6	0.2%
SHEN1	Shenandoah NP	QBQ	1/13/2005	3.8	1.8	1.8	3.7	-2.4%

[a] $$\frac{\text{Original} - \text{Sum}}{\left(\frac{\text{Original} + \text{Sum}}{2}\right)} \times 100$$

Table 3-7. Average carbon fractions for top and bottom sliced quartz-fiber front (QF) and concurrent backup (QBQ) filters.

		Carbon Loading (µgC/mg filter)										
Site (No. of Samples)	**Sliced Filter**	**OC**	**EC**	**TC**	**OC1**	**OC2**	**OC3**	**OC4**	**OP**	**EC1**	**EC2**	**EC3**
MORA (2)	QF_top	4.30	0.43	4.73	0.04	0.79	2.10	0.77	0.59	0.87	0.15	0.00
	QF_bottom	3.32	0.36	3.69	0.02	0.78	2.14	0.39	0.00	0.36	0.00	0.00
	QBQ_top	2.52	0.00	2.52	0.38	0.91	1.09	0.15	0.00	0.00	0.00	0.00
	QBQ_bottom	2.09	0.00	2.10	0.06	0.70	1.27	0.06	0.00	0.00	0.00	0.00
YOSE (1)	QF_top	10.71	1.95	12.67	0.00	1.75	3.88	2.19	2.90	4.40	0.45	0.00
	QF_bottom	4.10	0.49	4.59	0.45	1.15	1.91	0.59	0.00	0.34	0.15	0.00
	QBQ_top	2.02	0.00	2.02	0.24	0.69	1.09	0.00	0.00	0.00	0.00	0.00
	QBQ_bottom	1.76	0.00	1.76	0.33	0.57	0.77	0.09	0.00	0.00	0.00	0.00
CHIR (3)	QF_top	5.95	1.28	7.24	0.28	1.41	2.57	0.95	0.74	1.60	0.42	0.00
	QF_bottom	3.96	0.18	4.13	0.59	1.25	1.80	0.32	0.00	0.14	0.03	0.00
	QBQ_top	2.36	0.00	2.36	0.09	0.74	1.52	0.02	0.00	0.00	0.00	0.00
	QBQ_bottom	2.56	0.01	2.57	0.33	0.78	1.34	0.11	0.00	0.01	0.00	0.00
HANC (2)	QF_top	7.90	1.71	9.61	0.47	1.90	3.91	1.41	0.22	1.60	0.33	0.00
	QF_bottom	8.54	0.77	9.31	0.00	1.42	6.24	0.87	0.00	0.77	0.00	0.00
	QBQ_top	5.90	0.43	6.33	0.31	1.10	3.87	0.63	0.00	0.43	0.00	0.00
	QBQ_bottom	6.36	0.62	6.98	0.03	1.22	4.40	0.71	0.00	0.60	0.02	0.00
SHEN (4)	QF_top	13.98	5.12	19.10	0.33	3.08	3.66	3.52	3.38	7.64	0.86	0.00
	QF_bottom	5.57	1.57	7.14	0.21	1.62	1.64	0.77	1.34	1.75	0.61	0.55
	QBQ_top	3.14	0.13	3.27	0.45	0.85	1.60	0.25	0.00	0.13	0.00	0.00
	QBQ_bottom	1.96	0.00	1.96	0.17	0.63	1.13	0.04	0.00	0.00	0.00	0.00

Table 3-8. Robust regression intercept of quartz-fiber front (QF) organic carbon (OC; y-axis) versus $PM_{2.5}$ mass (x-axis) averaged over all IMPROVE sites for each season during the period from 1/1/2005 through 12/31/2006.

Intercept (μg/filter)	**Spring**[a]	**Summer**	**Fall**	**Winter**
Number of pairs	8898	7184	4372	7311
Average Intercept OC	12.44±6.43	18.18±15.13	15.23±10.45	11.20±7.63
Average blank OC	8.44	10.17	8.14	7.08
Average backup OC[b]	8.88	12.68	10.23	7.78

[a] Spring = March, April, May
Summer = June, July, August
Fall = September, October, November
Winter = December, January, February

[b] From six sites

Table 3-9. Lower quantifiable limits (LQLs) of polycyclic aromatic hydrocarbons (PAHs), phthalates, alkanes, alkenes, hopanes, and steranes by thermal desorption-gas chromatography/mass spectrometry (TD-GC/MS).

Compounds	**LQL (ng/cm^2)**	**LQL (ng/cm^2)^a**	**Compounds**	**LQL (ng/cm^1)**	**LQL (ng/cm^2)^a**
PAHs			**Alkanes**		
acenaphthylene	0.66	0.07	***n*-Alkanes (*n*-C14 to *n*-C44)**		
acenapthene	0.52	0.06	tetradecane (*n*-C14)	0.41	0.04
fluorene	0.25	0.03	pentadecane (*n*-C15)	0.24	0.03
phenanthrene	0.12	0.01	hexadecane (*n*-C16)	0.25	0.03
anthracene	0.05	0.01	heptadecane (*n*-C17)	0.22	0.02
fluoranthene	0.07	0.01	octadecane (*n*-C18)	0.19	0.02
pyrene	0.11	0.01	nonadecane (*n*-C19)	0.14	0.02
chrysene	0.11	0.01	icosane (*n*-C20)	0.14	0.02
benzo[b]fluoranthene	0.23	0.02	heneicosane (*n*-C21)	0.24	0.03
benzo[k]fluoranthene	0.08	0.01	docosane (*n*-C22)	0.18	0.02
benzo[a]pyrene	0.25	0.03	tricosane (*n*-C23)	0.21	0.02
perylene	0.27	0.03	tetracosane (*n*-C24)	0.16	0.02
indeno[1,2,3-cd]pyrene	0.12	0.01	pentacosane (*n*-C25)	0.17	0.02
dibenzo[a,h]anthracene	0.27	0.03	hexacosane (*n*-C26)	0.17	0.02
benzo[ghi]perylene	0.18	0.02	heptacosane (*n*-C27)	0.08	0.01
coronene	0.21	0.02	octacosane (*n*-C28)	0.21	0.02
dibenzo[a,e]pyrene	0.08	0.01	triacontane (*n*-C30)	0.27	0.03
			hentriacotane (*n*-C31)	0.22	0.02
1-methylnaphthalene	0.13	0.01	dotriacontane (*n*-C32)	0.25	0.03
2-methylnaphthalene	0.04	0.00	tritriactotane (*n*-C33)	0.16	0.02
2,6-dimethylnaphthalene	0.25	0.03	tetratriactoane (*n*-C34)	0.19	0.02
9-fluorenone	0.28	0.03	hexatriacontane (*n*-C36)	0.24	0.03
9-methylanthracene	0.26	0.03	tetracontane (*n*-C40)	0.24	0.03
anthroquinone	0.14	0.01	**Methyl-alkanes**		
1,8-napthalic anhydride	0.24	0.03	2-methylnonadecane	0.25	0.03
methylfluoranthene	0.08	0.01	3-methylnonadecane	0.27	0.03
retene	0.34	0.04	**Branched-alkanes**		
cyclopenta[cd]pyrene	0.08	0.01	pristine	0.28	0.03
benz[a]anthracene-7,12-dione	0.29	0.03	phytane	0.28	0.03
methylchrysene	0.12	0.01	squalane	0.28	0.03
			Cyclohexanes		
Phthalates			octylcyclohexane	0.27	0.03
dimethylphthalate	0.16	0.02	decylcyclohexane	0.20	0.02
diethyl phthalate	0.25	0.03	tridecylcyclohexane	0.37	0.04
di-n-butyl phthalate	0.13	0.01	*n*-heptadecylcyclohexane	0.24	0.03
butyl benzyl phthalate	0.24	0.03	nonadecylcyclohexane	0.20	0.02
bis(2-ethylhexyl)phthalate	0.21	0.02			
di-n-octyl phthalate	0.24	0.03	**Alkenes**		
			squalene	0.16	0.02
			1-octadecene	0.23	0.02
Hopanes			**Steranes**		
22,29,30-trisnorphopane (Tm)	0.14	0.02	ααα 20R-Cholestane	0.07	0.01
αβ-norhopane (C29αβ-hopane)	0.09	0.01	αββ 20R-Cholestane	0.19	0.02
βα -norhopane (C29βα -hopane)	0.39	0.04	αββ 20S 24S-Methylcholestane	0.23	0.02
αβ-hopane (C30αβ-hopane)	0.30	0.03	ααα 20R 24R-Methylcholestane	0.16	0.02
βα-hopane (C30βα-hopane)	0.33	0.04	ααα 20S 24R/S-Ethylcholestane	0.22	0.02
αβS-homohopane (C31αβS-hopane)	0.24	0.03	αββ 20R 24R-Ethylcholestane	0.10	0.01
αβR-homohopane (C31αβR-hopane)	0.24	0.03	ααα 20R 24R-Ethylcholestane	0.10	0.01

[a] Assumes a sampled air volume 32.7 m^3, and 0.5 cm^2 of the 3.53 cm^2 of the exposed area used in TD-GC/MS analysis

Table 3-10. Summary of organic concentrations (ng/cm^2) on the front (QF) and backup (QBQ) filters at four IMPROVE sites (MORA, HANC, CHIR, OKEF) during winter 2005.

	Site	**Mount Rainier, WA (MORA)**			**Grand Canyon, AZ (HANC)**			**Chiricahua, AZ (CHIR)**			**Okefenokee, GA (OKEF)**		
	Sampling Date	**1/28/2005**	**1/28/2005**	**Back/Front**	**1/7/2005**	**1/7/2005**	**Back/Front**	**1/19/2005**	**1/19/2005**	**Back/Front**	**12/21/2005**	**12/21/2005**	**Back/Front**
	Filter Type	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**
Carbon Fractions (μg/cm^2)													
	OC	13.3	12.4	0.9	6.6	7.5	1.1	33.2	8.8	0.3	106.1	13.7	0.1
	EC	1.7	0.3	0.2	1.2	0.0	0.0	10.5	0.1	0.0	27.0	0.0	0.0
	TC	15.0	12.7	0.8	7.8	7.5	1.0	43.7	8.9	0.2	133.1	13.7	0.1
	O1	0.2	1.7	9.5	0.6	1.8	3.0	1.0	2.1	2.2	10.9	2.3	0.2
	O2	2.8	3.3	1.2	3.0	2.9	1.0	7.7	2.8	0.4	20.8	3.2	0.2
	O3	6.1	5.7	0.9	1.8	2.3	1.3	8.5	3.1	0.4	19.4	5.6	0.3
	O4	1.7	1.8	1.0	0.3	0.4	1.1	7.0	0.8	0.1	18.3	1.8	0.1
	E1	2.9	0.3	0.1	0.9	0.1	0.1	18.1	0.1	0.0	60.6	0.4	0.0
	E2	1.2	0.0	0.0	1.2	0.0	0.0	1.5	0.1	0.0	3.2	0.4	0.1
	E3	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-
Organic Compounds (ng/cm^2)													
ID	*PAHs*												
P02	acenaphthylene	nd	nd	-	nd	nd	-	0.157	nd	-	nd	0.017	-
P03	acenapthene	nd	nd	-	nd	0.097	-	0.005	nd	-	nd	nd	-
P04	fluorene	nd	nd	-	nd	nd	-	0.095	nd	-	0.036	nd	-
P05	phenanthrene	nd	nd	-	nd	nd	-	0.737	nd	-	0.098	0.023	0.231
P06	anthracene	0.104	0.093	0.890	0.051	0.015	0.286	0.206	0.072	0.347	0.086	0.025	0.287
P07	fluoranthene	0.020	nd	-	nd	nd	-	1.064	nd	-	nd	nd	-
P08	pyrene	nd	nd	-	nd	nd	-	0.755	nd	-	nd	nd	-
P09	benzo[a]anthracene	nd	nd	-	nd	nd	-	0.026	nd	-	nd	nd	-
P10	chrysene	nd	nd	-	nd	nd	-	0.575	nd	-	nd	nd	-
P11	benzo[b]fluoranthene	nd	nd	-	nd	nd	-	0.374	nd	-	nd	nd	-
P12	benzo[k]fluoranthene	nd	nd	-	nd	nd	-	0.434	nd	-	nd	nd	-
P13	benzo[a]fluoranthene	nd	nd	-	nd	nd	-	0.026	nd	-	nd	nd	-
P14	benzo[e]pyrene	nd	nd	-	nd	nd	-	0.547	nd	-	nd	nd	-
P15	benzo[a]pyrene	nd	nd	-	nd	nd	-	0.140	nd	-	nd	0.016	-
P16	perylene	nd	nd	-	nd	nd	-	0.095	nd	-	nd	0.018	-
P17	indeno[1,2,3-cd]pyrene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P18	dibenzo[a,h]anthracene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P19	benzo[ghi]perylene	nd	nd	-	nd	nd	-	0.221	nd	-	nd	nd	-
P20	coronene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P21	dibenzo[a,e]pyrene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P22	2-methylnaphthalene	nd	nd	-	nd	nd	-	0.197	nd	-	nd	nd	-
P23	1-methylnaphthalene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P24	2,6-dimethylnaphthalene	nd	nd	-	nd	nd	-	0.467	nd	-	nd	nd	-
P25	9-fluorenone	nd	nd	-	nd	nd	-	0.191	nd	-	nd	nd	-
P26	9-methylanthracene	nd	nd	-	nd	nd	-	0.581	nd	-	nd	nd	-
P27	anthroquinone	nd	nd	-	nd	nd	-	0.133	nd	-	nd	nd	-
P29	methylfluoranthene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P30	retene	0.158	0.033	0.210	0.077	nd	-	2.086	0.045	0.022	nd	0.087	-
P31	cyclopenta[cd]pyrene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P32	benz[a]anthracene-7,12-dione	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-

Table 3-10. Continued

	Site	Mount Rainier, WA (MORA)			Grand Canyon, AZ (HANC)			Chiricahua, AZ (CHIR)			Okefenokee, GA (OKEF)		
	Sampling Date	**1/28/2005**	**1/28/2005**	**Back/Front**	**1/7/2005**	**1/7/2005**	**Back/Front**	**1/19/2005**	**1/19/2005**	**Back/Front**	**12/21/2005**	**12/21/2005**	**Back/Front**
	Filter Type	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**
P33	methylchrysene	nd	nd	-	nd	nd	-	0.031	nd	-	nd	nd	-
P34	picene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	n-alkanes												
NA01	tetradecane (n-C14)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA02	pentadecane (n-C15)	2.650	0.740	0.279	0.886	1.148	1.296	1.661	1.405	0.845	1.313	0.551	0.420
NA03	hexadecane (n-C16)	1.492	1.007	0.675	0.922	1.168	1.268	2.403	0.538	0.224	1.614	1.343	0.832
NA04	heptadecane (n-C17)	1.651	1.066	0.646	1.378	1.213	0.880	2.909	1.524	0.524	2.147	1.591	0.741
NA05	octadecane (n-C18)	2.451	1.689	0.689	1.698	1.620	0.954	2.731	0.917	0.336	1.843	2.111	1.146
NA06	nonadecane (n-C19)	1.204	0.793	0.659	0.778	0.631	0.811	0.523	0.753	1.441	0.954	1.330	1.394
NA07	icosane (n-C20)	1.510	1.088	0.721	1.147	1.088	0.949	1.842	1.228	0.667	1.396	2.694	1.929
NA08	heneicosane (n-C21)	1.045	0.672	0.643	0.650	0.437	0.672	5.679	0.649	0.114	1.112	1.775	1.597
NA09	docosane (n-C22)	2.136	1.165	0.546	1.053	0.769	0.730	3.264	1.005	0.308	1.628	4.176	2.565
NA10	tricosane (n-C23)	1.549	0.927	0.598	0.774	0.441	0.569	4.351	0.876	0.201	1.681	4.427	2.634
NA11	tetracosane (n-C24)	1.413	0.732	0.518	0.843	0.415	0.492	5.213	0.987	0.189	1.412	3.617	2.562
NA12	pentacosane (n-C25)	1.378	0.899	0.653	0.958	0.449	0.469	7.469	1.134	0.152	2.436	2.487	1.021
NA13	hexacosane (n-C26)	0.833	0.499	0.599	0.733	0.327	0.446	7.879	0.850	0.108	1.970	0.921	0.467
NA14	heptacosane (n-C27)	0.720	0.267	0.371	0.405	0.158	0.389	7.187	0.994	0.138	3.270	0.730	0.223
NA15	octacosane (n-C28)	0.243	0.088	0.361	0.086	0.106	1.235	5.932	0.365	0.062	1.450	0.190	0.131
NA16	nonacosane (n-C29)	0.854	0.056	0.065	0.150	0.095	0.636	11.887	0.329	0.028	4.236	0.345	0.082
NA17	triacontane (n-C30)	0.158	nd	-	nd	nd	-	3.512	0.052	0.015	0.737	0.176	0.240
NA18	hentriacotane (n-C31)	0.162	nd	-	nd	nd	-	8.384	nd	-	2.371	0.120	0.051
NA19	dotriacontane (n-C32)	0.027	nd	-	nd	nd	-	1.635	nd	-	0.298	0.116	0.389
NA20	tritriactotane (n-C33)	nd	nd	-	nd	nd	-	1.763	nd	-	0.158	0.044	0.279
NA21	tetratriactoane (n-C34)	nd	nd	-	nd	nd	-	0.552	nd	-	nd	nd	-
NA22	pentatriacontane (n-C35)	nd	nd	-	nd	nd	-	0.566	nd	-	nd	nd	-
NA23	hexatriacontane (n-C36)	nd	nd	-	nd	nd	-	0.486	nd	-	nd	nd	-
NA24	heptatriacontane (n-37)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA25	octatriacontane (n-38)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA26	nonatriacontane (n-39)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA27	tetracontane (n-C40)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA28	hentetracontane (n-41)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA29	dotetracontane (n-42)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	iso/anteiso-alkanes												
IAA01	iso-nonacosane (iso-C29)	0.257	nd	-	nd	nd	-	0.505	nd	-	nd	nd	-
IAA02	anteiso-nonacosane (anteiso-C29)	0.248	nd	-	nd	nd	-	0.079	nd	-	nd	nd	-
IAA03	iso-triacontane (iso-C30)	0.178	nd	-	nd	nd	-	0.160	nd	-	nd	nd	-
IAA04	anteiso-triacontane (anteiso-C30)	0.112	nd	-	nd	nd	-	0.068	nd	-	nd	nd	-
IAA05	iso-hentriacotane (iso-C31)	nd	nd	-	nd	nd	-	0.256	nd	-	nd	nd	-
IAA06	anteiso-hentriacotane (anteiso-C31)	nd	nd	-	nd	nd	-	0.076	nd	-	nd	nd	-
IAA07	iso-dotriacontane (iso-C32)	nd	nd	-	nd	nd	-	0.070	nd	-	nd	nd	-
IAA08	anteiso-dotriacontane (anteiso-C32)	nd	nd	-	nd	nd	-	0.079	nd	-	nd	nd	-
IAA09	iso-tritriactotane (iso-C33)	nd	nd	-	nd	nd	-	0.079	nd	-	nd	nd	-
IAA10	anteiso-tritriactotane (anteiso-C33)	nd	nd	-	nd	nd	-	0.053	nd	-	nd	nd	-
IAA11	iso-tetratriactoane (iso-C34)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-

Table 3-10. Continued

	Site	Mount Rainier, WA (MORA)			Grand Canyon, AZ (HANC)			Chiricahua, AZ (CHIR)			Okefenokee, GA (OKEF)		
	Sampling Date	**1/28/2005**	**1/28/2005**	**Back/Front**	**1/7/2005**	**1/7/2005**	**Back/Front**	**1/19/2005**	**1/19/2005**	**Back/Front**	**12/21/2005**	**12/21/2005**	**Back/Front**
	Filter Type	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**
IAA12	anteiso-tetratriactoane (anteiso-C34)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA13	iso-pentatriacontane (iso-C35)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA14	anteiso-pentatriacontane (anteiso-C35)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA15	iso-hexatriacontane (iso-C36)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA16	anteiso-hexatriacontane (anteiso-C36)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA17	iso-heptatriacontane (iso-37)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA18	anteiso-heptatriacontane (anteiso-37)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	hopanes												
HOP01	22,29,30-trisnorneophopane (Ts)	0.040	nd	-	nd	nd	-	0.097	nd	-	nd	nd	-
HOP02	22,29,30-trisnorphopane (Tm)	0.018	nd	-	nd	nd	-	0.074	nd	-	nd	nd	-
HOP03	αβ-norhopane (C29αβ-hopane)	0.072	nd	-	0.067	nd	-	0.445	nd	-	nd	nd	-
HOP04	29Ts	0.015	nd	-	0.018	nd	-	0.136	nd	-	nd	nd	-
HOP05	βα-norhopane (C29βα -hopane)	0.054	nd	-	0.019	nd	-	0.088	nd	-	nd	nd	-
HOP06	αβ-hopane (C30αβ -hopane)	0.055	nd	-	0.092	nd	-	0.326	nd	-	nd	nd	-
HOP07	30αα	nd	nd	-	0.007	nd	-	0.031	nd	-	nd	nd	-
HOP08	βα-hopane (C30βα -hopane)	nd	nd	-	nd	nd	-	0.043	nd	-	nd	nd	-
HOP09	αβS-homohopane (C31αβS-hopane)	nd	nd	-	nd	nd	-	0.326	nd	-	nd	nd	-
HOP10	αβR-homohopane (C31αβR-hopane)	nd	nd	-	nd	nd	-	0.282	nd	-	nd	nd	-
HOP11	αβS-bishomohopane (C32αβS-hopane)	nd	nd	-	nd	nd	-	0.086	nd	-	nd	nd	-
HOP12	αβR-bishomohopane (C32αβR-hopane)	nd	nd	-	nd	nd	-	0.074	nd	-	nd	nd	-
HOP13	22S-trishomohopane (C33)	nd	nd	-	nd	nd	-	0.113	nd	-	nd	nd	-
HOP14	22R-trishomohopane (C33)	nd	nd	-	nd	nd	-	0.092	nd	-	nd	nd	-
HOP15	22S-tretrahomohopane (C34)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
HOP16	22R-tetrashomohopane (C34)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
HOP17	22S-pentashomohopane(C35)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
HOP18	22R-pentashomohopane(C35)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	steranes												
STE01	ααα 20S-Cholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE02	αββ 20R-Cholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE03	αββ 20s-Cholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE04	ααα 20R-Cholestane	nd	nd	-	nd	nd	-	0.048	nd	-	nd	nd	-
STE05	ααα 20S 24S-Methylcholestane	nd	nd	-	nd	nd	-	0.078	nd	-	nd	nd	-
STE07	αββ 20R 24S-Methylcholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE08	αββ 20S 24S-Methylcholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE09	ααα 20R 24R-Methylcholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE10	ααα 20S 24R/S-Ethylcholestane	nd	nd	-	nd	nd	-	0.224	nd	-	nd	nd	-
STE11	αββ 20R 24R-Ethylcholestane	nd	nd	-	nd	nd	-	0.149	nd	-	nd	nd	-
STE12	αββ 20S 24R-Ethylcholestane	nd	nd	-	nd	nd	-	0.128	nd	-	nd	nd	-
STE14	ααα 20R 24R-Ethylcholestane	nd	nd	-	nd	nd	-	0.097	nd	-	nd	nd	-
	methyl-alkanes												
MA01	2-methylnonadecane	0.052	0.073	1.393	0.187	nd	-	0.140	0.065	0.462	0.060	0.190	3.157
MA02	3-methylnonadecane	0.079	0.034	0.427	0.035	nd	-	0.204	0.029	0.144	0.018	0.120	6.856
	branched-alkanes												
BA01	pristane	3.218	2.179	0.677	2.161	2.157	0.998	4.026	2.248	0.558	2.563	2.707	1.056
BA02	phytane	2.016	1.460	0.724	1.513	1.368	0.904	2.518	1.168	0.464	1.672	2.279	1.363
BA03	squalane	0.136	0.013	0.095	0.022	0.013	0.574	0.145	0.020	0.140	0.003	0.035	12.793

Table 3-10. Continued

	Site	Mount Rainier, WA (MORA)			Grand Canyon, AZ (HANC)			Chiricahua, AZ (CHIR)			Okefenokee, GA (OKEF)		
	Sampling Date	**1/28/2005**	**1/28/2005**	**Back/Front**	**1/7/2005**	**1/7/2005**	**Back/Front**	**1/19/2005**	**1/19/2005**	**Back/Front**	**12/21/2005**	**12/21/2005**	**Back/Front**
	Filter Type	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**	**QF**	**QBQ**	**Ratio**
	cycloalkanes												
CA01	octylcyclohexane	0.091	0.107	1.175	0.622	0.189	0.303	1.749	0.309	0.177	0.969	0.201	0.207
CA02	decylcyclohexane	0.204	0.096	0.472	0.794	0.084	0.106	1.878	0.082	0.044	1.213	0.163	0.134
CA03	tridecylcyclohexane	0.158	0.056	0.354	0.062	0.050	0.807	0.260	0.090	0.348	0.101	0.190	1.885
CA04	n-heptadecylcyclohexane	0.221	0.097	0.438	0.011	0.094	8.882	1.459	0.091	0.063	0.136	0.236	1.735
CA05	nonadecylcyclohexane	0.075	0.023	0.311	0.044	nd	-	0.317	0.039	0.122	0.042	0.041	0.972
	alkene												
AE02	1-octadecene	0.433	0.327	0.754	0.215	0.321	1.495	0.640	0.253	0.396	0.389	0.447	1.148
	phthalates												
PH01	dimethylphthalate	0.100	nd	-	nd	nd	-	0.459	nd	-	0.071	nd	-
PH02	diethyl phthalate	nd	nd	-	nd	nd	-	0.333	nd	-	nd	0.062	-
PH03	di-n-butyl phthalate	0.045	nd	-	nd	0.007	-	0.733	0.008	0.011	0.040	0.028	0.703
PH04	butyl benzyl phthalate	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
PH05	bis(2-ethylhexyl)phthalate	0.140	nd	-	nd	nd	-	0.122	0.406	3.320	nd	nd	-
PH06	di-n-octyl phthalate	0.086	nd	-	nd	nd	-	nd	nd	-	nd	nd	-

nd: not detected

Table 3-11. Summary of organic concentrations (ng/cm^2) on the front (QF) and backup (QBQ) filters at four IMPROVE sites (MORA, HANC, CHIR, OKEF) during summer 2005.

	Site	**Mount Reinier, WA (MORA1)**						**Grand Canyon, AZ (HANC1)**			**Chiricahua, AZ (CHIR1)**						**Okefenokee, GA (OKEF1)**		
	Sampling Date	**8/5/2005**	**8/5/2005**	**Back/Front**	**7/21/2005**	**7/21/2005**		**8/2/2005**	**8/2/2005**		**7/27/2005**	**7/27/2005**		**7/21/2005**	**7/21/2005**		**8/20/2005**	**8/20/2005**	
	Filter Type	**QF**	**QBQ**	**Ratio**	**bQF**	**bQBQ**		**QF**	**QBQ**		**QF**	**QBQ**		**bQF**	**bQBQ**		**QF**	**QBQ**	
	OC	126.1	19.3	0.2	126.1	19.3	0.2	33.0	18.1	0.5	26.7	16.8	0.6	10.4	10.3	1.0	121.9	20.7	0.2
	EC	29.2	1.7	0.1	29.2	1.7	0.1	2.9	1.9	0.6	2.7	0.7	0.2	0.0	0.0	-	9.9	0.7	0.1
	TC	155.3	21.0	0.1	155.3	21.0	0.1	35.9	19.9	0.6	29.4	17.5	0.6	10.4	10.3	1.0	131.8	21.4	0.2
	OC1	2.6	3.3	1.3	2.6	3.3	1.3	2.3	4.4	1.9	1.1	5.2	4.6	2.5	2.9	1.2	10.4	1.0	0.1
	OC2	31.9	6.2	0.2	31.9	6.2	0.2	8.2	5.4	0.7	7.8	4.9	0.6	3.5	3.6	1.0	30.6	5.2	0.2
	OC3	47.1	7.1	0.2	47.1	7.1	0.2	11.0	6.3	0.6	7.4	4.4	0.6	4.0	3.1	0.8	20.3	9.3	0.5
	OC4	27.1	2.7	0.1	27.1	2.7	0.1	4.8	2.0	0.4	3.2	1.5	0.5	0.4	0.7	1.7	22.9	3.8	0.2
	EC1	40.4	0.8	0.0	40.4	0.8	0.0	6.0	1.0	0.2	6.5	0.6	0.1	0.0	0.0	-	46.1	1.6	0.0
	EC2	5.5	0.9	0.2	5.5	0.9	0.2	3.3	0.8	0.3	3.4	0.8	0.3	0.0	0.0	-	1.4	0.5	0.4
	EC3	0.7	0.0	0.0	0.7	0.0	0.0	0.3	0.0	0.0	0.0	0.1	-	0.0	0.0	-	0.0	0.0	-
	Compound																		
ID	*PAHs*																		
P02	acenaphthylene	0.140	nd	-	nd	0.029	-	0.056	nd	-	nd	0.033	-	0.126	0.050	0.399	0.105	nd	-
P03	acenapthene	nd	nd	-	nd	nd	-	nd	0.009	-	nd	nd	-	nd	nd	-	0.025	nd	-
P04	fluorene	0.111	0.026	0.235	0.107	0.071	0.659	0.029	nd	-	0.039	0.178	4.578	0.298	0.090	0.302	0.084	0.026	0.307
P05	phenanthrene	0.382	0.031	0.080	0.044	nd	-	0.054	0.028	0.513	0.097	0.020	0.208	0.025	0.008	0.304	0.153	nd	-
P06	anthracene	0.106	0.037	0.343	0.027	0.042	1.590	0.039	0.039	1.008	0.046	0.032	0.689	0.011	0.026	2.412	0.127	0.026	0.206
P07	fluoranthene	0.275	nd	-	nd	nd	-	0.019	nd	-	nd	nd	-	0.030	nd	-	0.082	nd	-
P08	pyrene	0.229	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.108	nd	-
P09	benzo[a]anthracene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P10	chrysene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P11	benzo[b]fluoranthene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P12	benzo[k]fluoranthene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P13	benzo[a]fluoranthene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P14	benzo[e]pyrene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P15	benzo[a]pyrene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P16	perylene	nd	nd	-	nd	nd	-	0.017	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P17	indeno[1,2,3-cd]pyrene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P18	dibenzo[a,h]anthracene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P19	benzo[ghi]perylene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.314	nd	-
P20	coronene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P21	dibenzo[a,e]pyrene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P22	2-methylnaphthalene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P23	1-methylnaphthalene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P24	2,6-dimethylnaphthalene	0.410	0.112	0.274	nd	nd	-	0.108	0.061	0.561	nd	0.069	-	nd	nd	-	0.229	nd	-
P25	9-fluorenone	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.034	nd	-	0.105	nd	-
P26	9-methylanthracene	nd	nd	-	nd	nd	-	0.031	nd	-	nd	0.103	-	nd	nd	-	0.087	nd	-
P27	anthroquinone	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.067	nd	-
P29	methylfluoranthene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P30	retene	0.100	0.070	0.701	nd	0.013	-	0.102	0.034	0.333	0.292	0.021	0.071	0.081	0.014	0.169	0.247	0.030	0.121
P31	cyclopenta[cd]pyrene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P32	benz[a]anthracene-7,12-dione	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P33	methylchrysene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
P34	picene	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	n-alkanse																		
NA01	tetradecane (n-C14)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA02	pentadecane (n-C15)	1.092	0.430	0.393	1.487	1.430	0.961	0.740	0.351	0.474	1.315	0.464	0.353	1.780	1.142	0.642	1.456	0.895	0.614
NA03	hexadecane (n-C16)	2.224	1.730	0.778	1.458	1.668	1.144	0.914	1.687	1.846	1.738	2.719	1.565	3.721	1.749	0.470	1.276	0.860	0.674
NA04	heptadecane (n-C17)	2.019	1.623	0.804	1.014	1.601	1.578	1.482	2.229	1.504	1.671	2.206	1.320	2.999	1.312	0.437	1.418	0.929	0.655
NA05	octadecane (n-C18)	3.897	2.908	0.746	1.905	2.019	1.060	2.465	3.068	1.244	2.427	2.704	1.114	2.923	2.447	0.837	2.619	1.704	0.651
NA06	nonadecane (n-C19)	1.846	1.911	1.035	1.346	0.905	0.672	1.302	2.130	1.636	0.900	2.039	2.265	1.865	1.067	0.572	1.630	0.827	0.507
NA07	icosane (n-C20)	5.993	4.364	0.728	2.993	1.862	0.622	3.216	3.531	1.098	3.130	3.095	0.989	3.028	1.873	0.619	3.195	1.395	0.437
NA08	heneicosane (n-C21)	2.536	3.237	1.276	1.483	0.696	0.469	1.527	2.270	1.487	1.318	1.907	1.448	1.339	0.978	0.731	1.093	0.564	0.516
NA09	docosane (n-C22)	5.553	5.511	0.993	3.364	1.488	0.442	4.282	4.375	1.022	3.221	4.860	1.509	2.244	1.376	0.613	2.424	0.970	0.400
NA10	tricosane (n-C23)	6.333	18.055	2.851	1.311	0.586	0.447	5.146	5.309	1.032	3.304	4.677	1.416	0.904	0.682	0.754	0.556	0.394	0.709
NA11	tetracosane (n-C24)	3.881	8.342	2.150	1.000	0.460	0.461	2.419	1.607	0.664	2.233	1.623	0.727	0.652	0.517	0.793	5.681	0.329	0.058
NA12	pentacosane (n-C25)	10.178	2.551	0.251	0.868	0.432	0.497	3.969	1.222	0.308	3.031	2.087	0.689	0.898	0.540	0.602	0.967	0.285	0.295
NA13	hexacosane (n-C26)	6.433	7.448	1.158	0.399	0.354	0.888	1.172	0.375	0.320	0.829	1.138	1.372	0.553	0.146	0.264	2.428	0.319	0.132

Table 3-11. Continued.

	Site	Mount Reinier, WA (MORA1)						Grand Canyon, AZ (HANC1)			Chiricahua, AZ (CHIR1)						Okefenokee, GA (OKEF1)		
	Sampling Date	8/5/2005	8/5/2005	Back/Front	7/21/2005	7/21/2005		8/2/2005	8/2/2005		7/27/2005	7/27/2005		7/21/2005	7/21/2005		8/20/2005	8/20/2005	
	Filter Type	QF	QBQ	Ratio	bQF	bQBQ		QF	QBQ		QF	QBQ		bQF	bQBQ		QF	QBQ	
NA14	heptacosane (n-C27)	13.584	13.124	0.966	0.377	0.157	0.417	1.739	0.212	0.122	2.634	1.034	0.393	0.712	0.288	0.405	1.266	0.620	0.490
NA15	octacosane (n-C28)	3.687	0.967	0.262	0.359	0.502	1.397	0.553	0.042	0.076	0.619	0.333	0.538	0.226	0.375	1.663	0.725	0.497	0.686
NA16	nonacosane (n-C29)	8.578	1.658	0.193	0.231	nd	-	1.867	nd	-	4.115	0.311	0.076	0.102	nd	-	3.374	1.700	0.504
NA17	triacontane (n-C30)	1.836	6.209	3.382	0.272	0.611	2.245	0.364	nd	-	0.248	0.083	0.333	nd	0.190	-	4.980	0.279	0.056
NA18	hentriacotane (n-C31)	10.026	0.574	0.057	0.050	nd	-	0.521	nd	-	0.504	0.032	0.064	nd	nd	-	1.487	0.069	0.046
NA19	dotriacontane (n-C32)	0.487	2.442	5.011	0.076	0.217	2.838	0.115	nd	-	0.050	nd	-	nd	0.060	-	2.329	nd	-
NA20	tritriactotane (n-C33)	0.816	0.815	0.999	0.081	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.307	nd	-
NA21	tetratriactoane (n-C34)	0.345	0.019	0.056	0.127	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.287	nd	-
NA22	pentatriacontane (n-C35)	0.320	0.128	0.399	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.164	nd	-
NA23	hexatriacontane (n-C36)	0.171	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.730	nd	-
NA24	heptatriacontane (n-37)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.304	nd	-
NA25	octatriacontane (n-38)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA26	nonatriacontane (n-39)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA27	tetracontane (n-C40)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA28	hentetracontane (n-41)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
NA29	dotetracontane (n-42)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	iso/anteiso-alkanes																		
IAA01	iso-nonacosane (iso-C29)	0.212	nd	-	0.212	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.059	nd	-
IAA02	anteiso-nonacosane (anteiso-C29)	0.256	nd	-	0.256	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.113	nd	-
IAA03	iso-triacontane (iso-C30)	0.180	nd	-	0.180	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA04	anteiso-triacontane (anteiso-C30)	0.101	nd	-	0.101	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA05	iso-hentriacotane (iso-C31)	0.054	nd	-	0.054	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA06	anteiso-hentriacotane (anteiso-C31)	0.029	nd	-	0.029	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA07	iso-dotriacontane (iso-C32)	0.097	nd	-	0.097	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA08	anteiso-dotriacontane (anteiso-C32)	0.065	nd	-	0.065	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA09	iso-tritriactotane (iso-C33)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA10	anteiso-tritriactotane (anteiso-C33)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA11	iso-tetratriactoane (iso-C34)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA12	anteiso-tetratriactoane (anteiso-C34)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA13	iso-pentatriacontane (iso-C35)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA14	anteiso-pentatriacontane (anteiso-C35)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA15	iso-hexatriacontane (iso-C36)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA16	anteiso-hexatriacontane (anteiso-C36)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA17	iso-heptatriacontane (iso-37)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
IAA18	anteiso-heptatriacontane (anteiso-37)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	hopanes																		
HOP01	22,29,30-trisnorneophopane (Ts)	0.094	0.069	0.741	0.094	0.069	0.741	nd	nd	-	0.019	nd	-	0.006	0.053	8.638	0.040	nd	-
HOP02	22,29,30-trisnorphopane (Tm)	0.060	0.069	1.145	0.060	0.069	1.145	nd	nd	-	0.011	nd	-	0.007	nd	-	0.030	nd	-
HOP03	αβ-norhopane (C29αβ-hopane)	0.182	0.167	0.919	0.182	0.167	0.919	nd	nd	-	0.082	nd	-	0.030	0.039	1.282	0.069	nd	-
HOP04	29Ts	0.100	0.026	0.262	0.100	0.026	0.262	nd	nd	-	0.049	nd	-	0.015	0.025	1.707	0.043	nd	-
HOP05	βα-norhopane (C29βα -hopane)	0.080	0.019	0.240	0.080	0.019	0.240	nd	nd	-	nd	nd	-	nd	nd	-	0.023	nd	-
HOP06	αβ-hopane (C30αβ -hopane)	0.165	0.063	0.386	0.165	0.063	0.386	nd	nd	-	0.051	nd	-	0.029	0.038	1.304	0.062	nd	-
HOP07	30αα	0.012	0.009	0.772	0.012	0.009	0.772	nd	nd	-	nd	nd	-	nd	nd	-	0.063	nd	-
HOP08	βα-hopane (C30βα -hopane)	0.019	nd	-	0.019	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.103	nd	-
HOP09	αβS-homohopane (C31αβS-hopane)	0.158	nd	-	0.158	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.127	nd	-
HOP10	αβR-homohopane (C31αβR-hopane)	0.121	nd	-	0.121	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.082	nd	-
HOP11	αβS-bishomohopane (C32αβS-hopane)	0.056	nd	-	0.056	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.054	nd	-
HOP12	αβR-bishomohopane (C32αβR-hopane)	0.057	nd	-	0.057	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	0.058	nd	-
HOP13	22S-trishomohopane (C33)	0.056	nd	-	0.056	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
HOP14	22R-trishomohopane (C33)	0.036	nd	-	0.036	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
HOP15	22S-tretrahomohopane (C34)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
HOP16	22R-tetrashomohopane (C34)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
HOP17	22S-pentashomohopane(C35)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
HOP18	22R-pentashomohopane(C35)	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	steranes																		
STE01	ααα 20S-Cholestane	0.046	nd	-	0.046	nd	-	0.031	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE02	αββ 20R-Cholestane	nd	nd	-	nd	nd	-	0.029	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE03	αββ 20s-Cholestane	nd	nd	-	nd	nd	-	0.080	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE04	ααα 20R-Cholestane	nd	nd	-	nd	nd	-	0.062	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE05	ααα 20S 24S-Methylcholestane	nd	nd	-	nd	nd	-	0.083	nd	-	nd	nd	-	nd	nd	-	nd	nd	-

Table 3-11. Continued.

	Site	Mount Reinier, WA (MORA1)						Grand Canyon, AZ (HANC1)			Chiricahua, AZ (CHIR1)						Okefenokee, GA (OKEF1)		
	Sampling Date	**8/5/2005**	**8/5/2005**	**Back/Front**	**7/21/2005**	**7/21/2005**		**8/2/2005**	**8/2/2005**		**7/27/2005**	**7/27/2005**		**7/21/2005**	**7/21/2005**		**8/20/2005**	**8/20/2005**	
	Filter Type	**QF**	**QBQ**	**Ratio**	**bQF**	**bQBQ**		**QF**	**QBQ**		**QF**	**QBQ**		**bQF**	**bQBQ**		**QF**	**QBQ**	
STE07	αββ 20R 24S-Methylcholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE08	αββ 20S 24S-Methylcholestane	0.019	nd	-	0.019	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE09	ααα 20R 24R-Methylcholestane	0.240	nd	-	0.240	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE10	ααα 20S 24R/S-Ethylcholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE11	αββ 20R 24R-Ethylcholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE12	αββ 20S 24R-Ethylcholestane	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
STE14	ααα 20R 24R-Ethylcholestane	0.080	0.141	1.760	0.080	0.141	1.760	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-
	methyl-alkanes																		
MA01	2-methylnonadecane	0.281	0.023	0.083	0.281	0.023	0.083	0.120	0.130	1.080	0.131	0.079	0.601	0.175	0.060	0.345	0.250	0.058	0.231
MA02	3-methylnonadecane	nd	nd	-	nd	nd	-	0.141	0.204	1.449	0.094	0.091	0.970	0.311	0.158	0.508	0.259	0.061	0.238
	branched-alkanes																		
BA01	pristane	0.630	0.242	0.384	0.630	0.242	0.384	2.649	3.248	1.226	2.398	3.457	1.442	4.720	3.739	0.792	1.639	1.771	1.080
BA02	phytane	0.699	0.226	0.324	0.699	0.226	0.324	2.180	2.938	1.348	2.135	2.880	1.349	2.846	2.003	0.704	1.393	1.611	1.156
BA03	squalane	0.175	0.317	1.815	0.175	0.317	1.815	0.037	0.022	0.603	0.011	0.016	1.464	0.014	0.018	1.264	0.017	0.014	0.819
	cycloalkanes																		
CA01	octylcyclohexane	nd	nd	-	nd	nd	-	1.046	0.495	0.473	1.586	0.352	0.222	0.839	0.241	0.287	0.699	0.055	0.078
CA02	decylcyclohexane	0.477	0.564	1.181	0.477	0.564	1.181	1.254	0.290	0.232	2.028	0.154	0.076	0.604	0.336	0.557	1.533	0.040	0.026
CA03	tridecylcyclohexane	nd	nd	-	nd	nd	-	0.157	0.180	1.149	0.167	0.167	1.001	0.339	0.265	0.782	0.179	0.097	0.538
CA04	n-heptadecylcyclohexane	1.660	0.028	0.017	1.660	0.028	0.017	0.190	0.260	1.369	0.125	0.160	1.280	0.138	0.080	0.585	1.080	0.132	0.122
CA05	nonadecylcyclohexane	1.440	2.894	2.010	1.440	2.894	2.010	0.068	0.018	0.264	0.036	0.072	2.002	0.014	nd	-	0.292	0.088	0.303
	alkene																		
AE02	1-octadecene	6.624	0.222	0.034	6.624	0.222	0.034	0.502	0.783	1.560	0.831	0.509	0.612	0.442	0.345	0.781	0.876	0.280	0.319
	phthalates																		
PH01	dimethylphthalate	0.638	0.011	0.017	0.638	0.011	0.017	1.024	0.012	0.012	0.118	0.007	0.060	0.023	0.207	8.928	2.771	0.124	0.045
PH02	diethyl phthalate	1.081	2.172	2.010	1.081	2.172	2.010	0.517	0.858	1.662	0.090	0.379	4.193	0.400	0.015	0.036	2.301	0.026	0.011
PH03	di-n-butyl phthalate	3.057	4.341	1.420	3.057	4.341	1.420	0.491	2.292	4.667	0.046	0.036	0.781	0.193	0.023	0.122	15.200	nd	-
PH04	butyl benzyl phthalate	nd	0.097	-	nd	0.097	-	nd	0.059	-	nd	nd	-	nd	nd	-	0.465	nd	-
PH05	bis(2-ethylhexyl)phthalate	11.605	0.389	0.034	11.605	0.389	0.034	0.151	0.107	0.707	nd	nd	-	0.367	nd	-	1.156	nd	-
PH06	di-n-octyl phthalate	nd	0.186	-	nd	0.186	-	nd	nd	-	nd	nd	-	nd	nd	-	nd	nd	-

nd: not detected

4. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Table 4-1 addresses the hypotheses specified in Section 1 with information generated in Section 3. Positive OC artifacts occur when VOCs adsorb onto quartz-fiber filters. Negative OC artifacts occur when particulate organic compounds evaporate during active sampling. Some of these evaporated compounds may also be adsorbed within the quartz-fiber filters. Positive and negative artifacts compete with each other, but it appears from blank and backup filters that the positive artifact is most often larger than the negative artifact.

For the IMPROVE network, 959 field blanks acquired at 181 sites during 2005 and 2006 yield an average positive OC artifact of 8.4 ± 1.6 µg/filter (2.4 ± 0.45 $\mu g/cm^2$). For 1,406 quartz-fiber backup behind quartz-fiber front filters six non-urban locations, the average positive OC artifact was 10.0 ± 5.0 µg/filter. Backup filter averages ranged from 8.1 ± 2.8 µg/filter at Chiricahua to 13.1 ± 4.7 µg/filter at Okefenokee. Average backup IMPROVE filters were up to 19% higher, and more variable, than the field blanks. The difference is within the standard deviation of the average, and they could be used interchangeably to adjust for the positive OC artifact in the non-urban IMPROVE sites. Since the IMPROVE network also includes urban sites (e.g., Washington, DC) where positive and negative artifacts might differ from non-urban sites, more spatial coverage on the backup filters is recommended. A systematic protocol to acquire field blanks (e.g., once/month at the beginning or end of each month with ~7 days in the passive deposition period) would obtain a better record of the seasonal variability than is currently provided by the random field blank placement.

The IMPROVE positive OC artifact is dominated by the OC1, OC2, and OC3 thermal fractions. Sectioning of front filters from top to bottom demonstrates that areal densities of these OC fractions may decrease with depth through the filter. The assumption that VOC and SVOC adsorption on the backup filter equals that on the front filter is not generally met in the IMPROVE network, at least for the filters examined here. The causes for the unequal distribution are not known, but they could be caused by inhomogeneities in the filter material, as deviations from the assumption of complete saturation of the quartz fibers. Analysis of a small number of front and backup filters for 130 SVOCs showed higher quantities on the backup filter than on the front filter, also consistent with deviations from the saturation assumption. This indicates a migration of gSVOC through the filter material with time during sampling, similar to the migration of organic compounds through the gas chromatograph during analysis.

Quartz-fiber behind Teflon-membrane filters showed twice the OC adsorption as quartz-fiber behind quartz-fiber front filters at the MARCH-Atlantic urban-scale monitor. Quartz-fiber backup behind quartz-fiber front filters showed twice the OC levels of the field blanks, in contrast to the similarity between these estimators from the IMPROVE samples. This difference could be caused by: 1) larger concentrations of adsorbable VOCs in urban areas, which might have deposited or reacted before arriving at remote IMPROVE sites; 2) greater abundances of SVOCs at the urban site, which might have largely evaporated from particles during transport; and/or 3) a longer residence period for the IMPROVE field blanks in the sampler (~ 7 days) than for the MARCH-Atlantic field blanks (~ 3 days).

The SEARCH network uses an organic carbon denuder upstream of the front and backup filters, and backup filter levels are only slightly higher than field blank levels. Since the denuder removes most of the VOC and gSVOC atmosphere from the air stream, the backup should consist mostly of material evaporated from the front aerosol deposit and be an indication of the negative OC artifact. This negative OC artifact may be more prevalent in urban than in non-urban areas.

The IMPROVE method of adjusting for the OC artifact appears to be the best that can be done within the constraints of current understanding. Given the non-urban nature of most measurement locations, organic carbon denuders appear to be unnecessary. The negative OC artifact appears to be partially compensated for by recapture of material within the bottom half of the front filter. The backup filter and field blanks appear to retain approximately that which would represent the positive OC artifact. The small exposure area (3.53 cm^2) of the 25 mm filter relative to the deposit also makes the artifact correction less important for samples with OC levels > 20 μg/filter.

Urban samples appear to be more complex, owing to the dynamic nature of the aerosol both in the atmosphere and once it has been collected on a filter. A denuder/backup filter system appears to be the most accurate approach, and SEARCH shows that the backups and field blanks are similar with this configuration. Parallel quartz-fiber backup behind Teflon-membrane front and quartz-fiber backup behind quartz-fiber front filters offer the opportunity to separate the adsorbed VOCs from the evaporated and re-adsorbed gSVOCs. Each of these approaches requires more resources in terms of filter handling and analysis. At the least, field blanks should spend as much time in the sampling system as the active samples and should be subtracted from the carbon measurements with their uncertainties propagated.

Table 4-1. Summary of major findings for the seven hypotheses.

Hypothesis	Major Findings
A: Quartz backup filters and field blanks contain the same quantities of adsorbed OC and OC fractions.	When field blanks have a long exposure times (3 to 7 days) at non-urban IMPROVE sites, this appears to be true. The six site-averaged OC concentrations on QBQ fall within the range of site-averaged field blank OC across the IMPROVE network. However, the FME urban site, QBQ OC was be much higher (122%) than field blank OC, and the QBT OC was even higher. There may be more heavy VOCs amenable to adsorption and more evaporated SVOCs in urban areas. This hypothesis could not be evaluated at the SEARCH sites because the field blanks were only exposed for 15 minutes, too short to attain equilibrium with the environment.
B: Nearly all of the adsorbed organic vapors are in the IMPROVE OC1, OC2, and OC3 fractions.	This is true for field blanks and partially true for backup filters from the IMPROVE network. For field blanks, carbon mass is almost equally distributed between OC1, OC2, and OC3. For backup filters, however, substantial OC4 and EC fractions (caused by OP; up to 32% of TC) were observed at SHEN. At SHEN, average backup filter OC was 19% higher than field blank OC, and this could be explained by additional SVOC adsorption by backup filters.
C: Adsorbed organic gas concentrations are similar among field blanks and backup filters and for different sampling locations, times, and OC aerosol loadings.	Adsorbed OC on backups and field blanks is higher during summer than during other seasons in at both urban and non-urban sites. There is evidence of month-to-month variation with seasons.
D: Quartz behind Teflon yields the same amounts in carbon fractions as quartz behind quartz.	This is not true for data from the FME urban site that compared side-by-side QBQ and QBT, nor from a similar experiment at the Fresno Supersite (Watson and Chow, 2002). At FME, QBT contained 30-40% higher OC than QBQ, especially for OC2 and OC3. OC3, OC4, and OP fractions were also higher, an indication of SVOC adsorption. Data were insufficient to evaluate this for the non-urban IMPROVE sites.

Table 4-1. Continued.

Hypothesis	**Major Findings**
E: Front and backup quartz-fiber filters are saturated with adsorbed organic vapors only for high loading samples, and before saturation the front filter captures more SVOC than the backup filter.	This is not universally true. According to the sliced filter experiment, OC is non-uniformly distributed through the depth and width of the filter. The bottom half of QF often shows OC concentration either higher than or similar to those on QBQ filters. The number and scope of these tests were insufficient to determine how homogeneity might be related to the front filter OC loading.
F: Analysis of a small number of backup filters can be extrapolated to a large number of samples with appropriate stratification by sampling site, sampling time, and OC loading.	Based on the six IMPROVE network sites with backup filters, the QBQ OC loading does not vary much. Field blank and backup filter concentrations are similar among different sampling sites with a ratio of the 90th percentile to the 10th percentile TC of ~1.5 for IMPROVE field blanks. The subtraction of a monthly median determined from backup filters at six sites currently used to correct for the positive organic artifact in IMPROVE seems to be the best that can be done with the existing data. Evidence does not support this method at urban sites, where limited data shows QBQ to have even more variability than field blanks. This may be caused by larger quantities of VOC and SVOC in urban atmospheres that requires active sampling (typical of a backup filter) for adsorption. Some of the IMPROVE urban sites should include backup filters to obtain a larger data base, as the currently used method may be less accurate in urban environments.
G: Adsorbed organic gases are different from organic compounds in the sampled aerosol.	This is not true for the 130 SVOCs analyzed. Concentrations for nearly all of these were found in the front and backup filters, sometimes with higher concentrations on backup filters. The number of samples and compounds quantified is too small to generalize, but it appears that SVOCs may be in continuous flux, evaporating from one part of the filter only to be collected on another part of the filter. This indicates that the equilibrium/saturation assumption may be limited, and that the dynamics of this process needs to be considered in a more complete model.

Filter Abbreviations

QF:	Quartz-fiber front filter
QBQ:	Quartz-fiber backup filter behind quartz fiber front filter
VOC:	Volatile organic compounds
SVOC:	Semi-volatile organic compounds
gSVOC:	Gaseous-phase SVOCs
pSVOC:	Particle-phase SVOCs
pOC:	Non-volatile particle-phase organic carbon

Six IMPROVE sites where secondary filters were collected

MORA:	Map (Figure 1-1) location #78 - Mount Rainier National Park
YOSE:	Map location #96 - Yosemite National Park
HANC:	Map location #48 - Hance Camp at Grand Canyon National Park
CHIR:	Map location #39 - Chiricahua National Monument
SHEN:	Map location #6 - Shenandoah National Park
OKEF:	Map location #16 - Okefenokee National Wildlife Refuge

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