

VISTAS IMPROVE Data Substitutions

The Visibility Improvement State and Tribal Association of the Southeast (VISTAS) contracted with ARS to perform data substitution for five IMPROVE monitoring sites in the VISTAS states (CHAS1, SAMA1, COHU1, SHRO1 and SWAN1), and one additional regional site (BRET1) to achieve Regional Haze Rule (RHR) data completeness requirements. These data substitutions included estimating missing species from other on-site measurements and appropriately scaling data collected at selected donor sites which had favorable long-term comparisons. This document outlines details used for the data substitution methods used for these sites.

Data Completeness Requirements

Regional Haze Rule (RHR) guidance requirements for IMPROVE aerosol data completeness include the following conditions:

- Individual samples must contain all species required for the calculation of light extinction (sulfate, nitrate, organic carbon, elemental carbon, soil, coarse mass, and, for the new IMPROVE algorithm, chloride or chlorine)
- Individual seasons must contain at least 50% of all possible daily samples
- Individual years must contain at least 75% of all possible daily samples
- Individual years must not contain more than 10 consecutive missing daily samples
- The baseline period (2000-04) must contain at least 3 complete years of data

Further details can be found in the RHR guidance document for tracking progress: http://www.epa.gov/ttn/oarpg/t1/memoranda/rh_tpurhr_gd.pdf.

Routine Data Substitutions

RHR guidelines provide provisions to fill in missing data under specific circumstances. There are currently two methods routinely used in preparing the RHR data set to substitute data for missing samples:

- The use of a surrogate in the data set:
 - Total sulfate is generally determined as 3 times the sulfur measured on the A module filter. If sulfur is missing, the sulfur measurement from the B module filter is used to calculate sulfate.
 - For the new IMPROVE algorithm, sea salt is calculated from chloride measured on the B module filter. If chloride is missing or below detection limit, the chlorine measurement from the A module filter is used to calculate sea salt.
- The application of “patching” missing data described by the RHR guidance:
 - Missing samples not substituted using a surrogate as described above can be patched, or replaced, by a seasonal average if the patching exercise passes a series of tests outlined in the guidance document.

Once these methods have been applied to the data, the resulting complete years are eligible for use in calculation of baseline conditions and tracking progress under the Regional Haze Rule. These methods have been applied to all IMPROVE data.

Sites Not Meeting Data Completeness Requirements

Table 1 summarizes data completeness for the 2000-04 baseline years for IMPROVE sites in and around the VISTAS region. A 0 indicates an incomplete year and a 1 indicates the year was complete under RHR guidelines. Four VISTAS sites (SAMA1, COHU1, SHRO1 and SWAN1), and two non-VISTAS regional sites (BRET1 and MING1) had fewer than 3 complete years of data for the baseline period.

Table 1

RHR Data Completeness From IMPROVE Data Sets for 2000-04 Baseline Years for Sites in and Around the VISTAS Region

Region	State	Site	2000	2001	2002	2003	2004	2000-04 Count
VISTAS	AL	SIPS1	0	1	1	1	1	4
	FL	CHAS1	1	1	1	0	0	3
		EVER1	0	1	1	1	1	4
		SAMA1*	0	0	1	1	0	2
	GA	COHU1*	0	0	1	0	1	2
		OKEF1	1	1	1	1	1	5
	KY	CADI1	0	0	1	1	1	3
		MACA1	1	1	1	1	1	5
	NC	LIGO1	0	1	1	1	1	4
		SHRO1*	0	0	0	1	1	2
		SWAN1*	0	1	1	0	0	2
	SC	ROMA1	1	1	1	1	1	5
	TN	GRSM1	1	1	1	1	1	5
	VA	JARI1	0	1	1	1	1	4
SHEN1		1	1	1	1	1	5	
WV	DOSO1	1	1	1	1	1	5	
Non-VISTAS	AR	CACR1	0	0	1	1	1	3
		UPBU1	1	1	1	1	1	5
	LA	BRET1*	0	0	0	0	0	0
	MO	HEGL1	0	0	1	1	1	3
		MING1*	0	1	0	0	0	1
NJ	BRIG1	1	1	1	1	1	5	

* Indicates site has <3 complete years for RHR baseline calculations

0 indicates an incomplete year with no substitutions made

1 indicates a complete RHR year

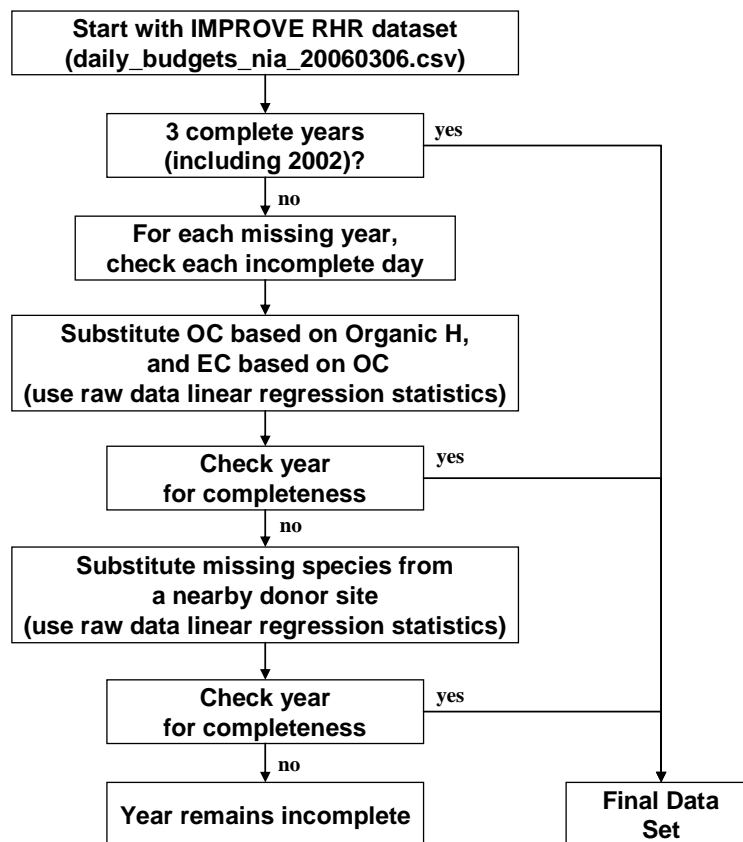
Additional Data Substitutions

This section outlines VISTAS methods for additional data substitutions designed to address the incomplete years. Additional substitutions were made for the four VISTAS sites (SAMA1, COHU1, SHRO1 and SWAN1), and for the BRET1 site. Additional substitutions were also made for the CHAS1 site, because it is the only VISTAS site that met RHR baseline period requirements, but 2003 and 2004 were both still incomplete years. Additional substitutions for the MING1 site were performed separately by UCDavis.

Figure 1 presents a flow chart of the VISTAS data substitution methods, and details for these methods are described below. The starting data set was the RHR IMPROVE data using the “New IMPROVE Algorithm,” updated March 2006, (<http://vista.cira.colostate.edu/views/Web/IMPROVE/SummaryData.aspx>). This data set includes the routine surrogate and patched data substitutions allowed by RHR guidance. Note that only years deemed incomplete under RHR guidance were candidates for additional data substitutions. Years deemed complete were not changed, even though there may have been missing individual samples during those years.

Figure 1

Flow Chart of Data Substitution Methods Used



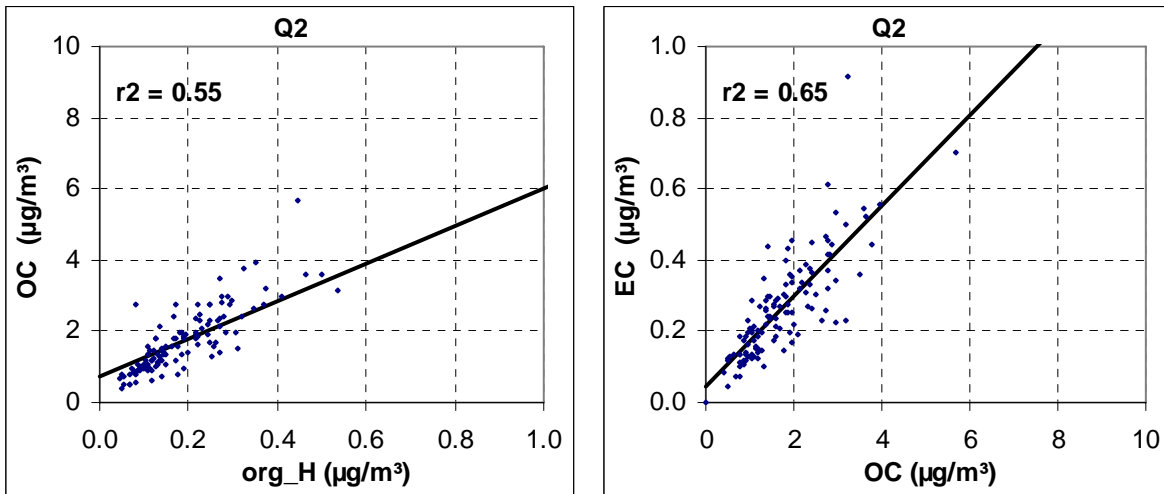
1. Carbon Substitutions

The first substitution method relied on using a surrogate for carbon mass measurements when the C module data is not available. Hydrogen (H) is measured on the A module filter, and is assumed to be primarily associated with organic carbon and inorganic compounds such as ammonium sulfate. Therefore, organic carbon (OC) can be estimated using the historical comparison between estimated organic H and OC. Organic H is estimated by subtracting the portion of H that is assumed to be associated with the inorganic compounds from the total H ($\text{Org_H} = \text{H} - 0.24 * \text{S}$). Once OC has been estimated using this method, elemental carbon (EC) mass is determined using long-term comparisons between OC and EC at the site.

Figure 2 presents sample comparisons for data collected at the Shining Rock Wilderness Area (SHRO1) site in North Carolina during the second quarter between 2000-04 for OC vs. organic H, and EC vs. OC. Statistics were calculated and applied quarterly to account for seasonal variations.

Figure 2

Comparison of OC and Estimated Organic H, and EC and OC at SHRO1, NC
Using Second Quarter Raw OC and Organic H Data, 2000-04



2. Donor Site Substitutions

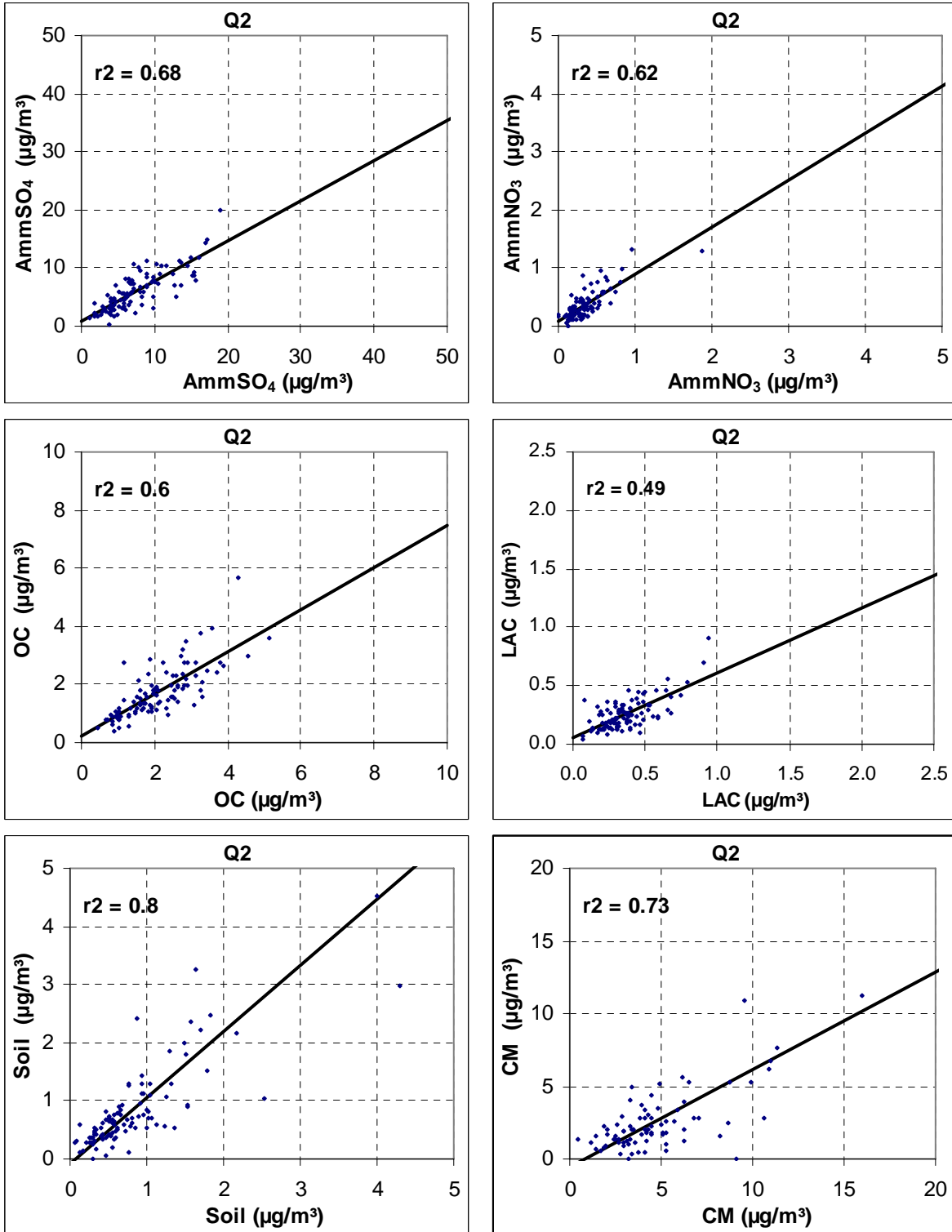
In VISTAS, the carbon data substitution methods were not sufficient to complete the required years. A second method involved identification of another nearby IMPROVE site (or, in the case of BRET1, a nearby SEARCH site) which had favorable long-term comparisons and similar regional characteristics to be used as a donor site. Candidate sites were identified, and final donor sites for surrogate mass were selected in consultation with states.

Figure 3 presents a sample inter-site mass comparison by species for data collected during the second quarter, 2000-04, between the Shining Rock Wilderness Area (SHRO1) site and the Great Smoky Mountains National Park (GRSM1) site in Tennessee. Component specific correlations were calculated and applied quarterly. Note that only species missing in a given sample were substituted based on donor site data. Species collected at the site under investigation were never replaced with data from a donor site.

For BRET1 substitutions, chloride/chlorine was not available from the GFP SEARCH site. In this case, sea salt could not be calculated from the GFP data, so seasonal averages of sea salt from the BRET1 site were used as substitutes. Missing coarse mass at the SEARCH site was also substituted using SEARCH methodologies prior to use as a donor for the BRET1 site.

Figure 3

Comparison of Aerosol Species Mass Between
SHRO1, NC (y-axis) and GRSM1, TN (x-axis)
Using Second Quarter Raw Data, 2000-04



2. Data Completeness Following Substitutions

Table 2 indicates which years required some degree of substitution, where a 2 indicates a substituted year, a 1 indicates the year was already complete under RHR guidelines, and dashes indicate the year did not meet RHR guidelines and no additional substitutions were made. The table also lists sites that were selected as donor sites. The minimum data requirement of 3 complete years (including 2002) was met for each site, and additional substitutions beyond these requirements were made with the exception of the year 2000, which was not substituted at any site either because monitoring started in late 2000, or the additional substitutions did not fill in enough data to make a complete RHR year.

Table 2
Data Completeness Following Data Substitution

State	Site	Donor Site	2000	2001	2002	2003	2004	2000-04 Count
FL	CHAS1	SAMA1	1	1	1	2	2	5
	SAMA1*	CHAS1	--	2	1	1	2	4
GA	COHU1*	GRSM1	--	2	1	2	1	4
NC	SHRO1*	GRSM1	--	2	2	1	1	4
	SWAN1*	ROMA1	--	1	1	2	2	4
LA	BRET1*	GFP	--	2	2	2	2	4

-- indicates an incomplete year with no substitutions made

1 indicates a complete RHR year

2 indicates a year is considered complete with some substituted values

Availability and Archival of Data Sets

A dedicated page on the VIEWS database will act as the repository of all site-specific substitute data sets: <http://vista.cira.colostate.edu/views/web/documents/substitutedata.aspx>. Table 3 presents a key to the substituted data files.

Table 3
Key to Substituted Data Files

Column Header	Description
site	IMPROVE site code
year	
month	
day	
QUARTER	1 = Jan. – Mar., 2 = Apr.-Jun., 3 = Jul. – Sept., 4 = Oct. – Dec.
date	
Group	10 = One of the 20% best visibility days; 90 = One of the 20% worst visibility days
good_year	0 = incomplete year, 1 = complete RHR year, 2 = complete year with substitutions
ss_rayleigh	Site specific Rayleigh value (clean air extinction)
fsrh	f(RH) value for small sulfate, nitrate and organic mass
flrh	f(RH) value for large sulfate, nitrate and organic mass
fssrh	f(RH) value for sea salt mass
Sea_Salt	Sea salt mass ($\mu\text{g}/\text{m}^3$)
Soil	Soil Mass ($\mu\text{g}/\text{m}^3$)
Amm_NO3	Ammonium nitrate mass ($\mu\text{g}/\text{m}^3$)
OMC	Organic mass by carbon ($\mu\text{g}/\text{m}^3$)
LAC	Light absorbing carbon (aka EC/Elemental Carbon) ($\mu\text{g}/\text{m}^3$)
CM	Coarse mass ($\mu\text{g}/\text{m}^3$)
Amm_SO4	Ammonium sulfate mass ($\mu\text{g}/\text{m}^3$)
Large_OMC	Large organic mass ($\mu\text{g}/\text{m}^3$)
Small_OMC	Small organic mass ($\mu\text{g}/\text{m}^3$)
Large_Amm_SO4	Large ammonium sulfate mass ($\mu\text{g}/\text{m}^3$)
Small_Amm_SO4	Small ammonium sulfate mass ($\mu\text{g}/\text{m}^3$)
Large_Amm_NO3	Large ammonium nitrate mass ($\mu\text{g}/\text{m}^3$)
Small_Amm_NO3	Small ammonium nitrate mass ($\mu\text{g}/\text{m}^3$)
EAmm_SO4	Extinction due to ammonium sulfate (Mm-1)
EAmm_NO3	Extinction due to ammonium nitrate (Mm-1)
EOMC	Extinction due to organic carbon mass (Mm-1)
ELAC	Extinction due to light absorbing carbon mass (Mm-1)
ESoil	Extinction due to soil mass (Mm-1)
ECM	Extinction due to coarse mass (Mm-1)
ESea_Salt	Extinction due to sea salt mass (Mm-1)
RBext	Reconstructed aerosol extinction (Mm-1)
TBext	Reconstructed total extinction (Mm-1)
OC_SUB1	OC substituted using OC vs. organic H correlations
EC_SUB1	EC substituted using EC vs. OC correlations
(NH4)2SO4_SUB2	Ammonium sulfate substituted using site donor correlations
(NH4)NO3_SUB2	Ammonium nitrate substituted using site donor correlations
OM_SUB2	Organic mass substituted using site donor correlations
EC_SUB2	Elemental carbon (aka LAC/light absorbing carbon) substituted using site donor correlations
Soil_SUB2	Soil substituted using site donor correlations
CM_SUB2	Coarse mass substituted using site donor correlations
SeaSalt_SUB2	Sea salt substituted using site donor correlations

Results for Individual Sites

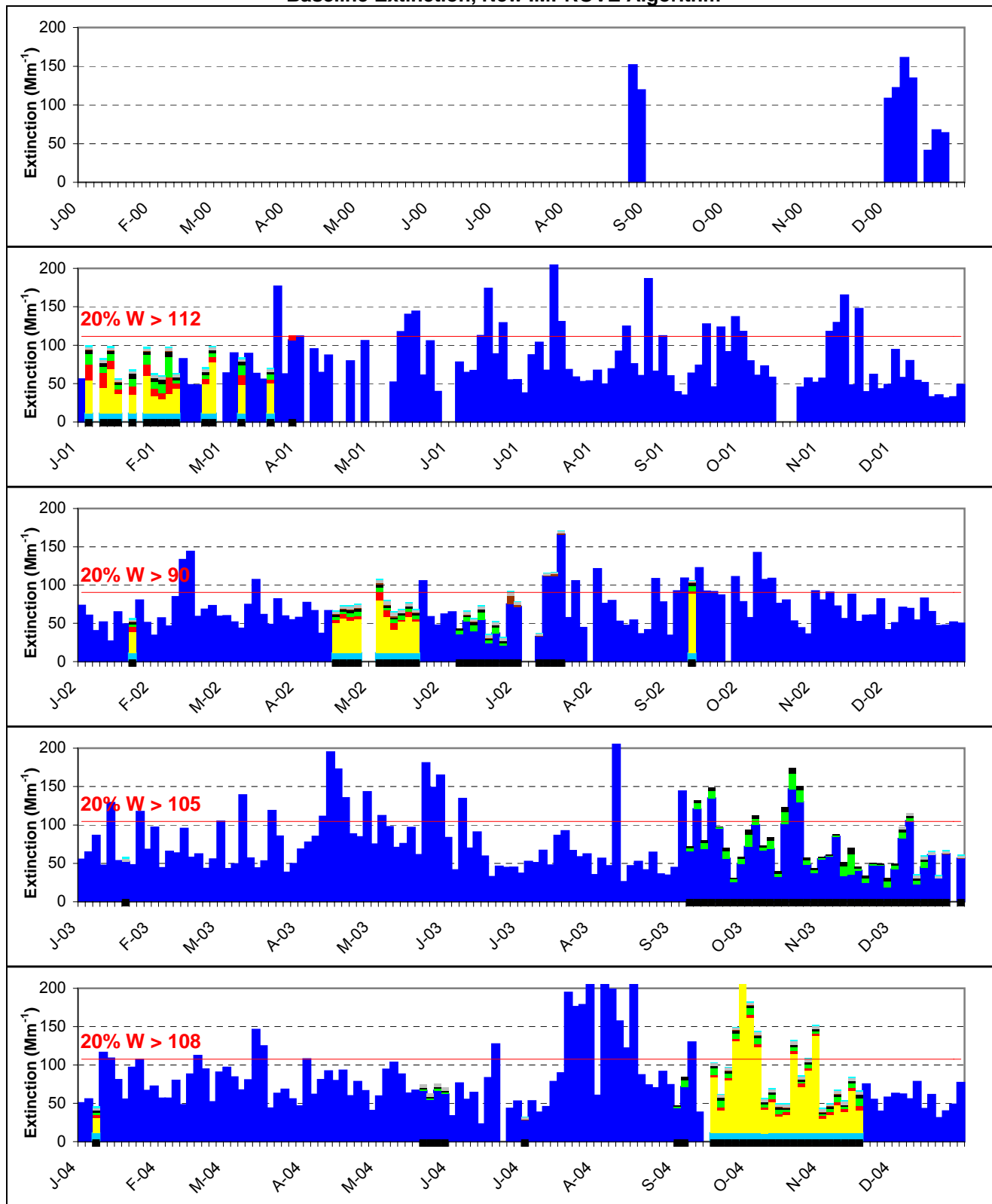
The charts and tables on the following pages detail the substitutions that were used for the sites in and around VISTAS, including BRET1, CHAS1, COHU1, SAMA1, SHRO1, and SWAN1. The following charts/tables are provided for each site:

- **1st chart:** Bar charts by year indicating original RHR data in blue, and substituted data by species in the standard IMPROVE colors. Substituted days are also indicated by a black bar underneath the day. The red line indicates the threshold above which days are counted in the 20% worst days for that year. A red line is not included for any year that was incomplete and not substituted.
- **2nd chart:** Bar charts by year indicating speciation of all data. Days in which all or part of the day was substituted are indicated by a black bar underneath the day. The red line indicates the threshold above which days are counted in the 20% worst days.
- **Table:** The table lists the regression statistics used to calculate substituted values. Data represent raw mass value correlations for aerosol collected during 2000-04 for all days, and by quarter.
- **Scatter plots:** A series of nine scatter plots, showing the distribution of points and the line fits for the regression statistics that were used to calculate substituted values. Plots indicate raw data collected at the sites during 2000-04, with donor sites represented on the x-axis.

Breton, LA
Statistics for Substitutions

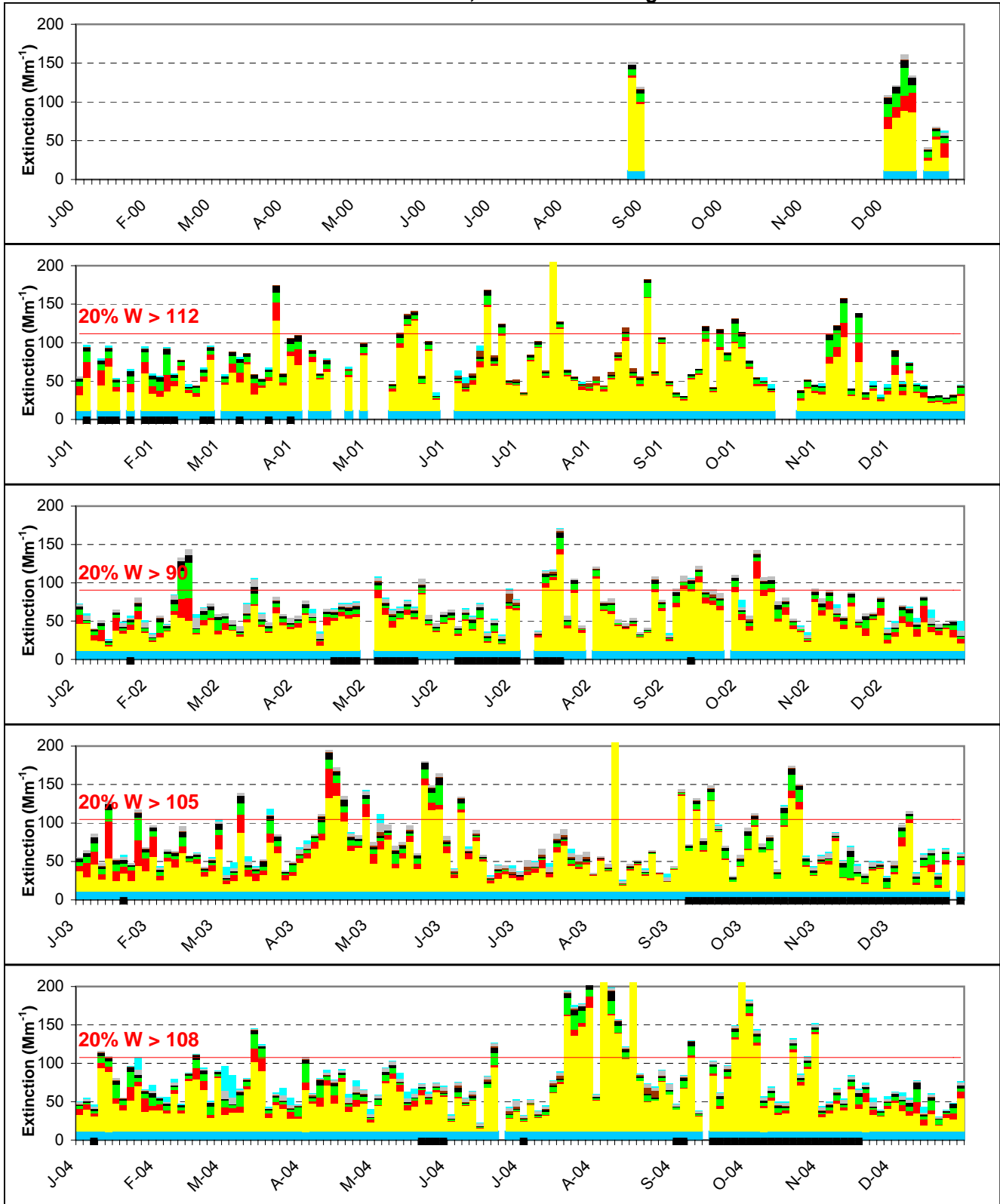
BRET1						
Components	KT Stats	All	1	2	3	4
OC vs. org_H	Slope	6.56	8.33	5.39	6.00	6.90
	Intercept	0.28	0.24	0.38	0.19	0.25
	R2	0.74	0.77	0.77	0.76	0.79
EC vs. OC	Slope	0.21	0.19	0.25	0.23	0.18
	Intercept	0.10	0.13	0.08	0.06	0.14
	R2	0.65	0.60	0.65	0.76	0.57
BRET1 vs. GFP						
Components	KT Stats	All	1	2	3	4
SO4	Slope	0.70	0.61	0.59	0.71	0.77
	Intercept	1.28	1.36	2.17	1.23	0.93
	R2	0.53	0.34	0.33	0.58	0.64
NO3	Slope	0.74	0.67	1.50	0.40	0.60
	Intercept	0.19	0.30	0.02	0.16	0.25
	R2	0.45	0.50	0.45	0.04	0.28
OC	Slope	0.22	0.19	0.31	0.33	0.16
	Intercept	0.19	0.26	0.16	0.09	0.23
	R2	0.20	0.14	0.32	0.18	0.21
LAC	Slope	0.41	0.41	0.43	0.45	0.36
	Intercept	0.18	0.37	0.14	-0.06	0.25
	R2	0.50	0.43	0.58	0.50	0.56
Soil	Slope	1.53	0.07	1.96	1.32	0.16
	Intercept	0.10	0.26	0.13	0.48	0.25
	R2	0.49	0.00	0.71	0.42	0.01
CM	Slope	0.38	0.51	0.32	0.18	0.31
	Intercept	3.74	3.17	4.15	4.40	4.25
	R2	0.12	0.15	0.29	0.02	0.03
Sea Salt	Slope	N/A	N/A	N/A	N/A	N/A
	Intercept	N/A	N/A	N/A	N/A	N/A
	R2	N/A	N/A	N/A	N/A	N/A

BRET1 (GFP donor)
Baseline Extinction, New IMPROVE Algorithm



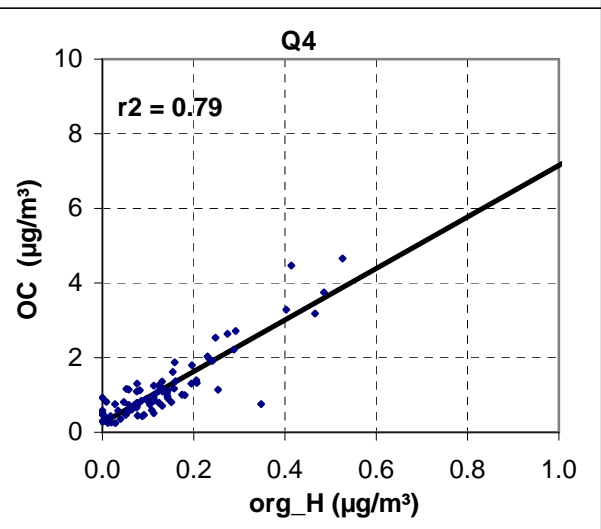
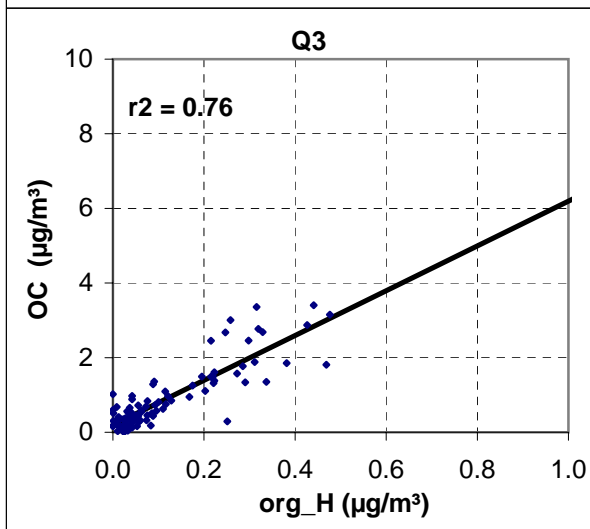
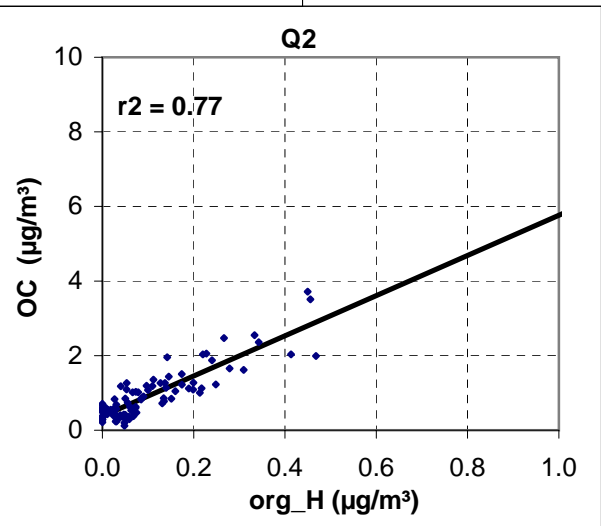
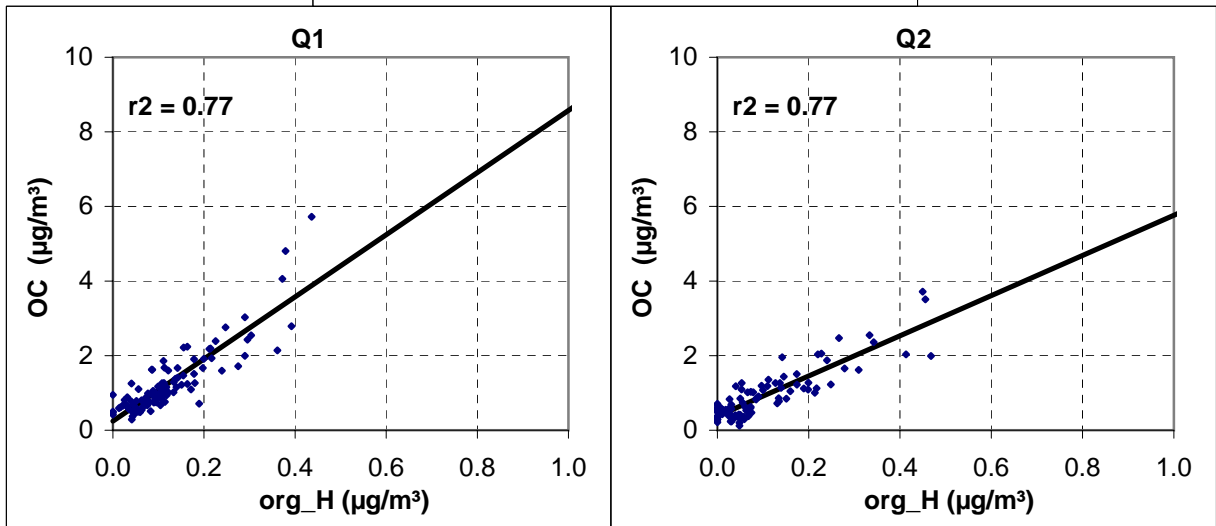
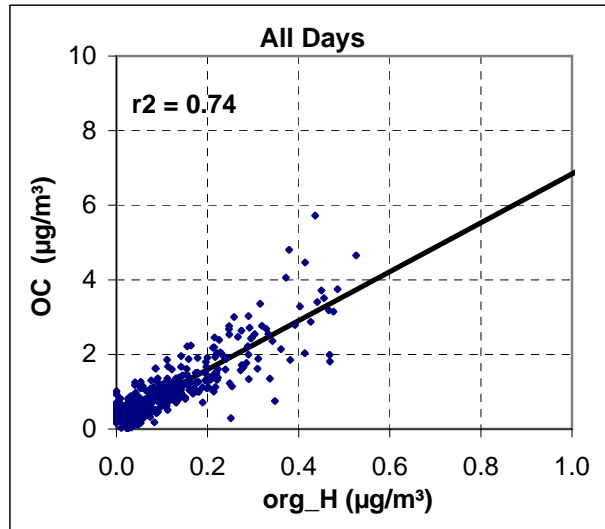
■ RHR
 ■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

BRET1 (GFP donor)
Baseline Extinction, New IMPROVE Algorithm

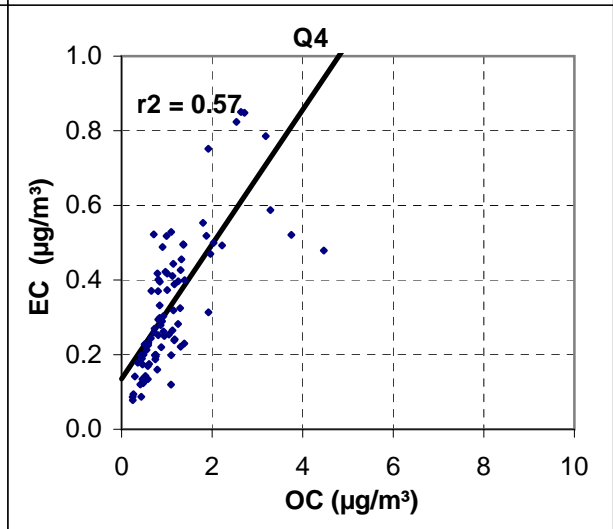
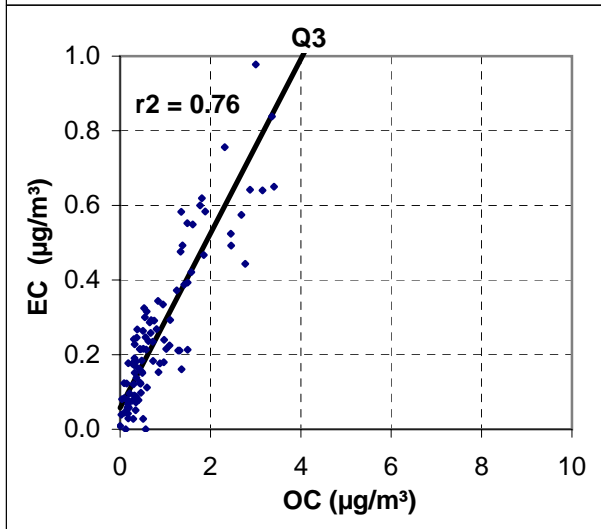
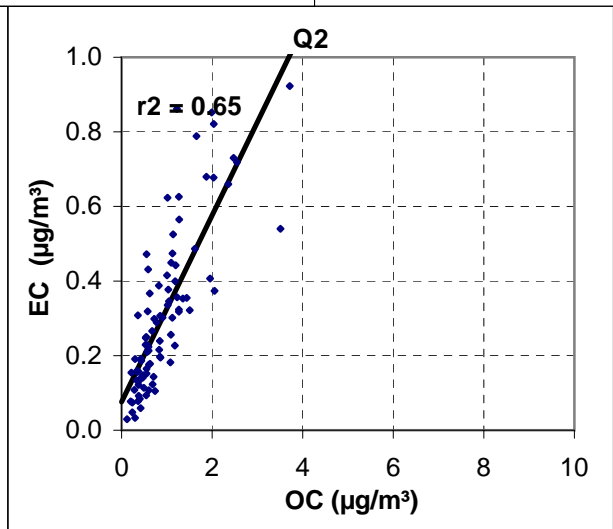
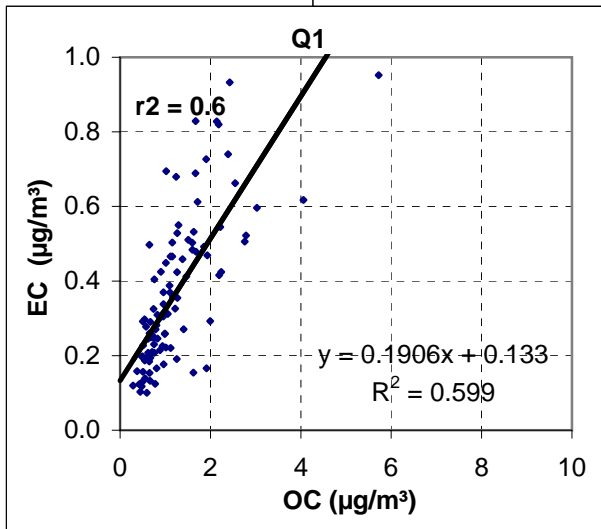
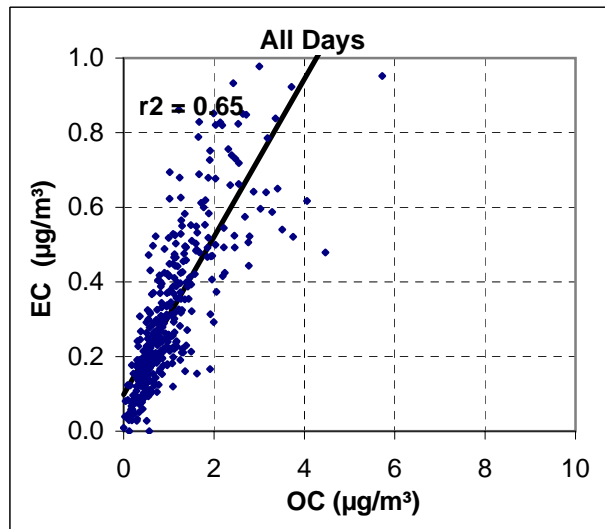


■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO₃
■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

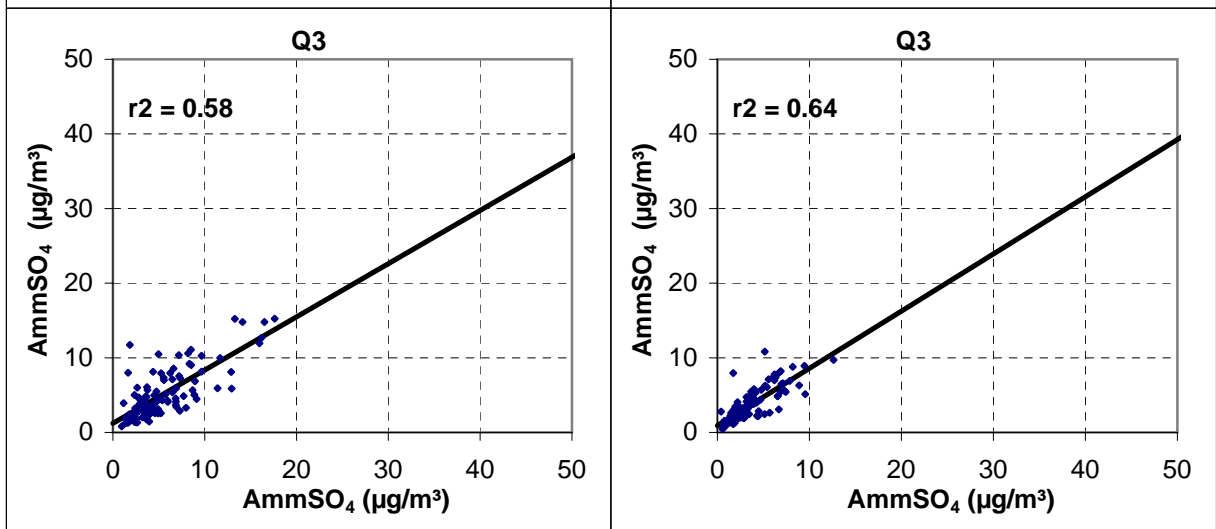
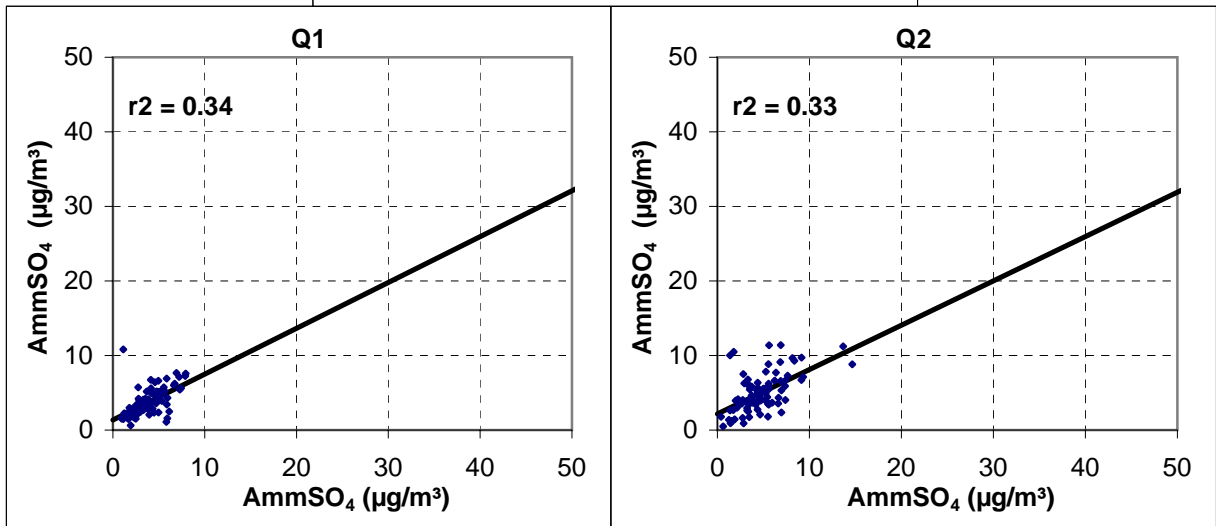
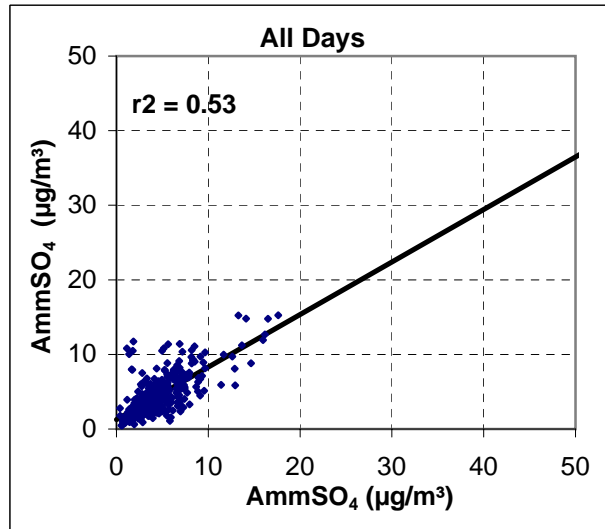
BRET1 OC vs. org_H



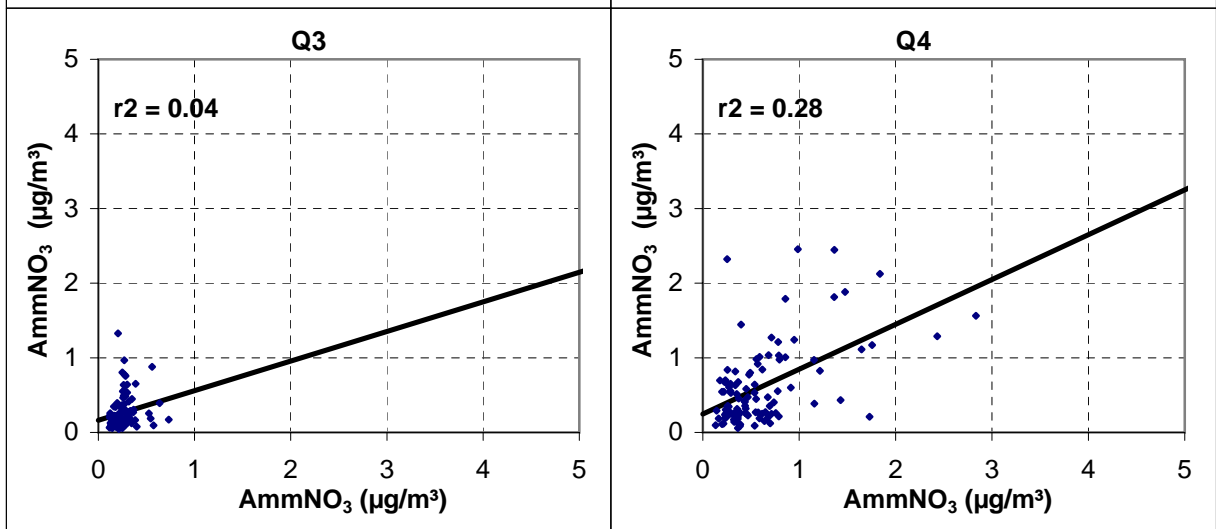
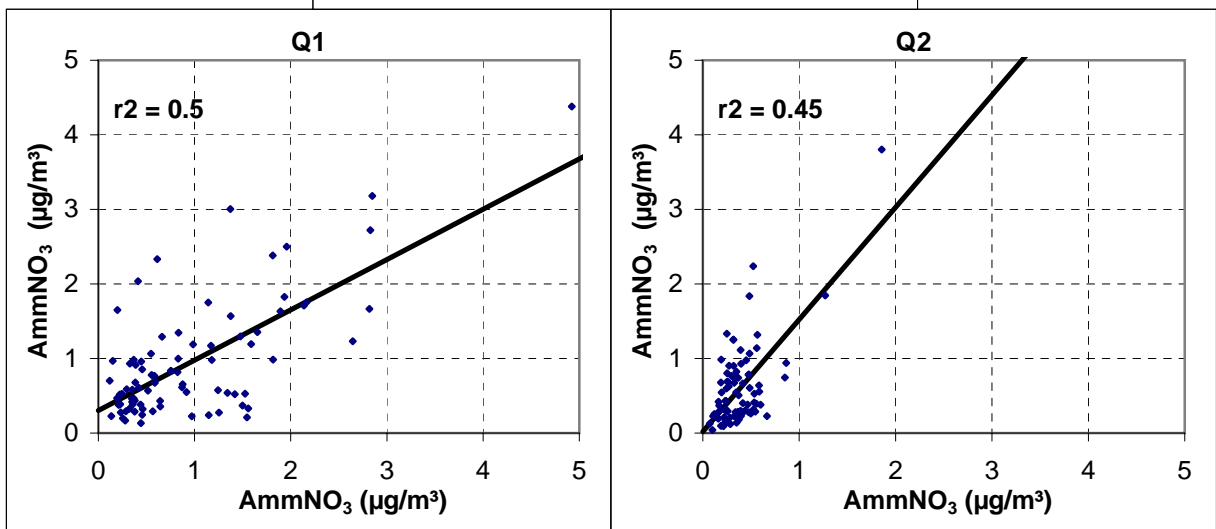
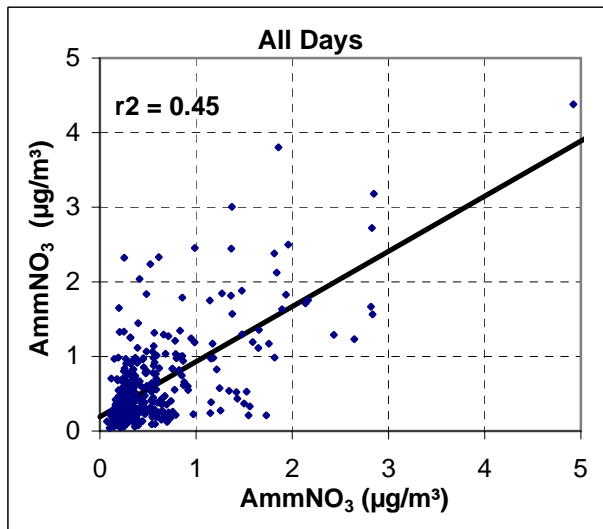
BRET1 EC vs. OC



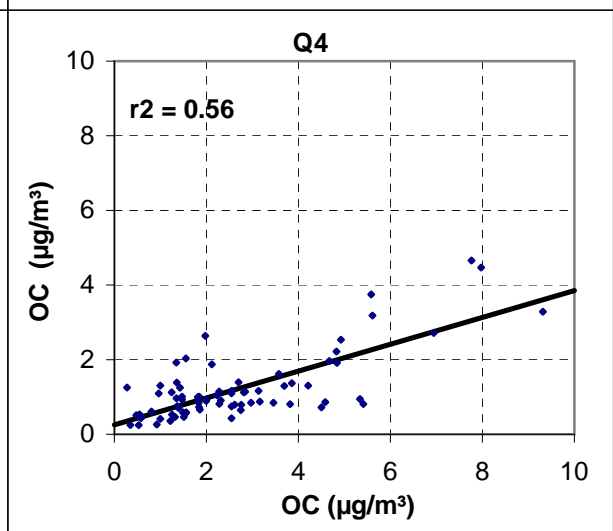
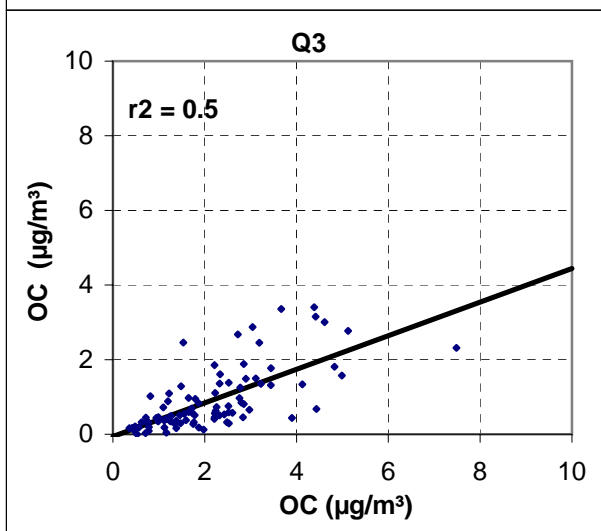
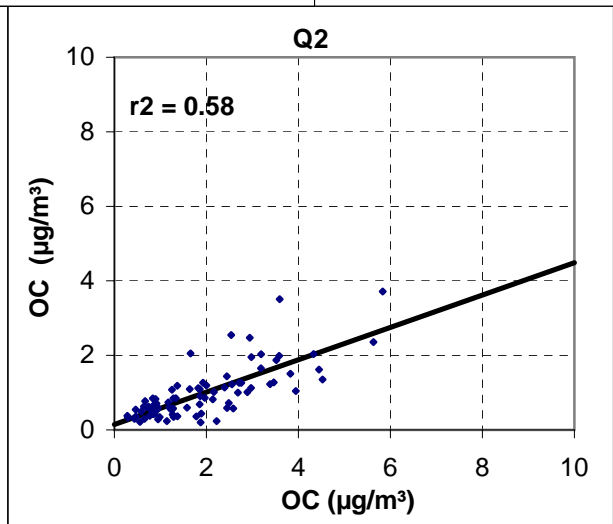
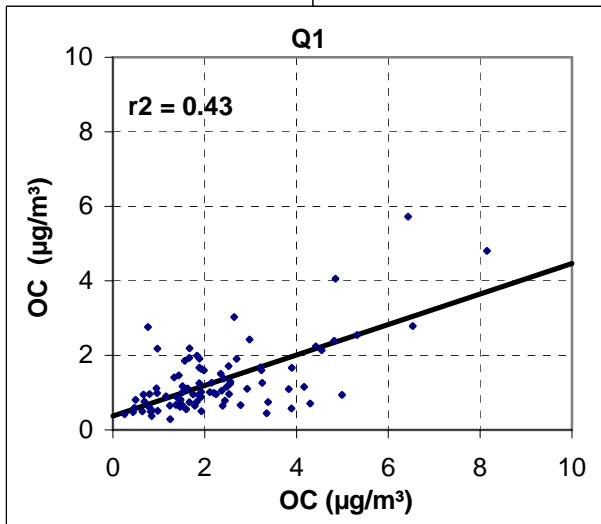
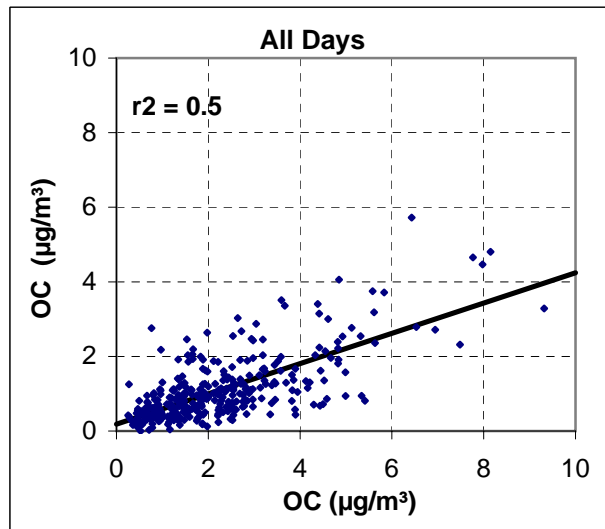
BRET1 vs. GFP Ammonium Sulfate



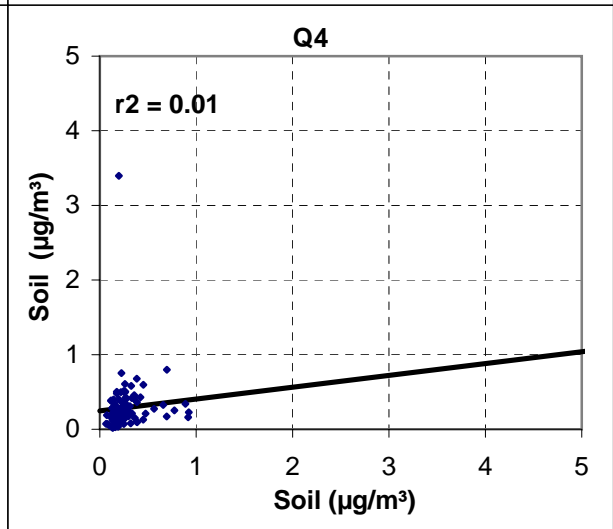
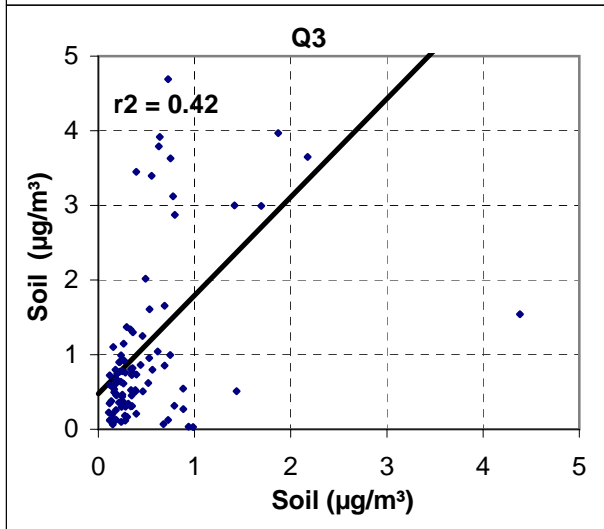
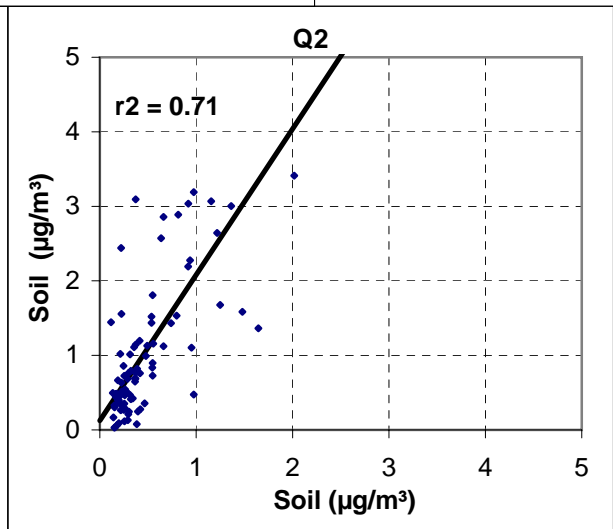
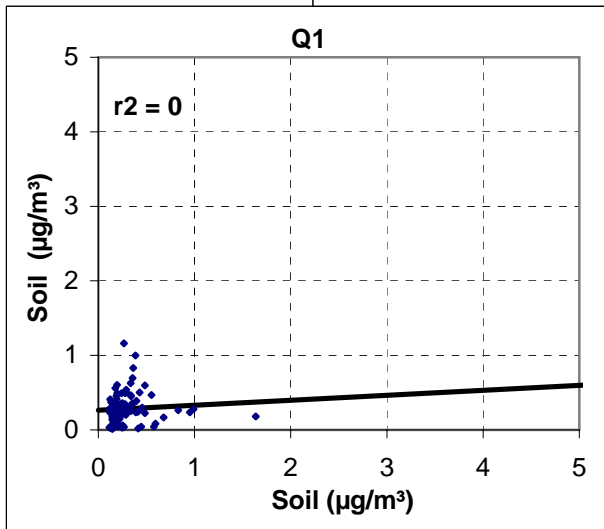
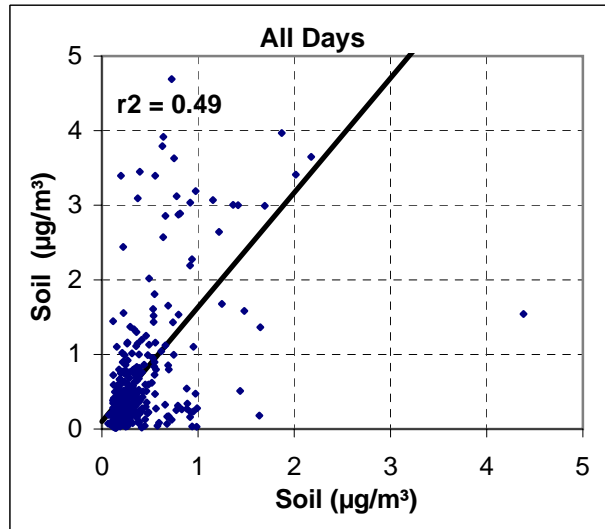
BRET1 vs. GFP Ammonium Nitrate



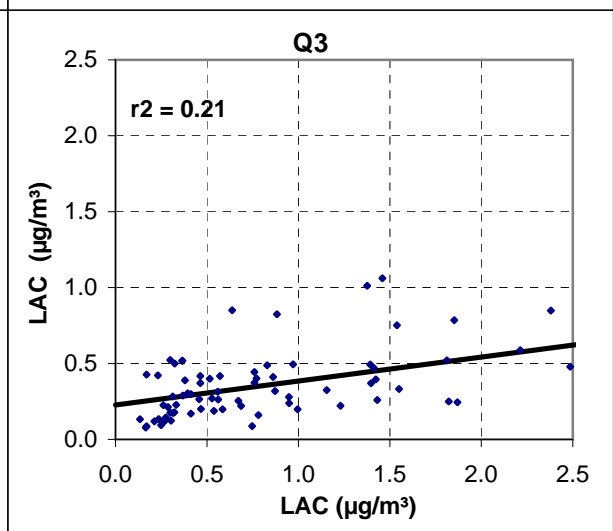
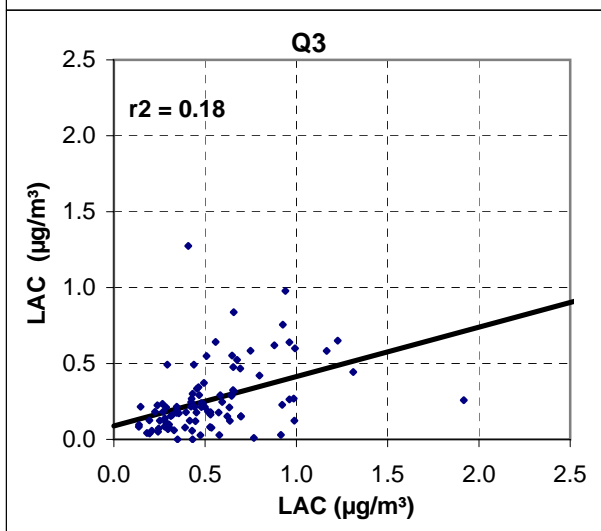
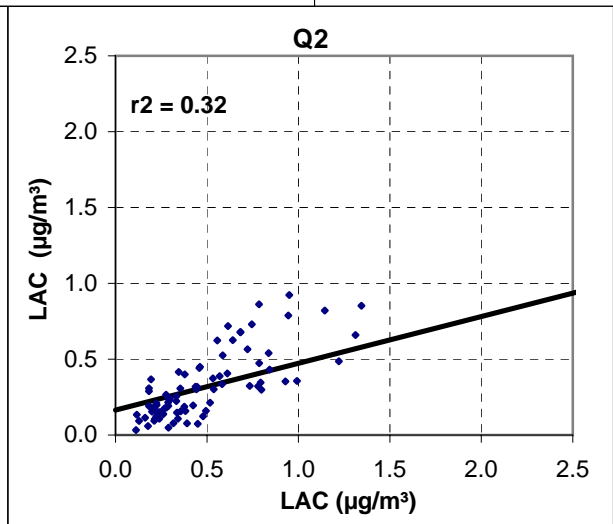
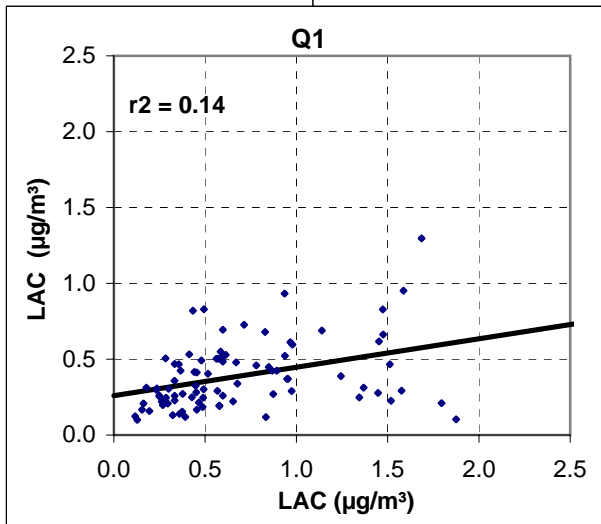
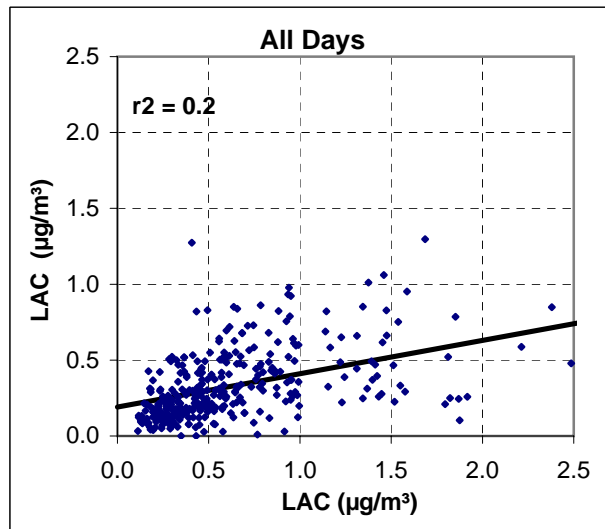
BRET1 vs. GFP Organic Carbon



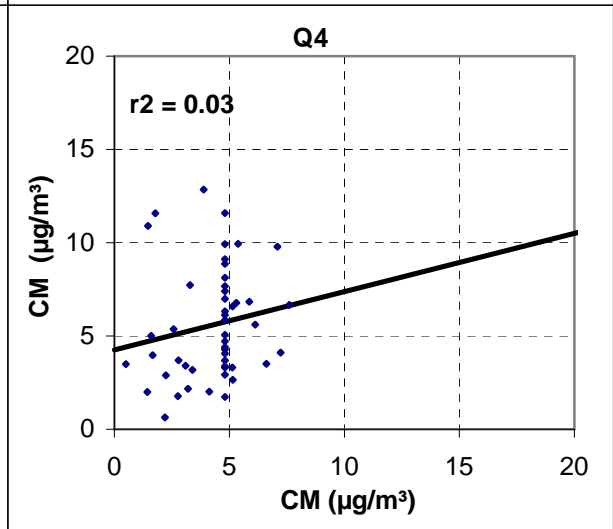
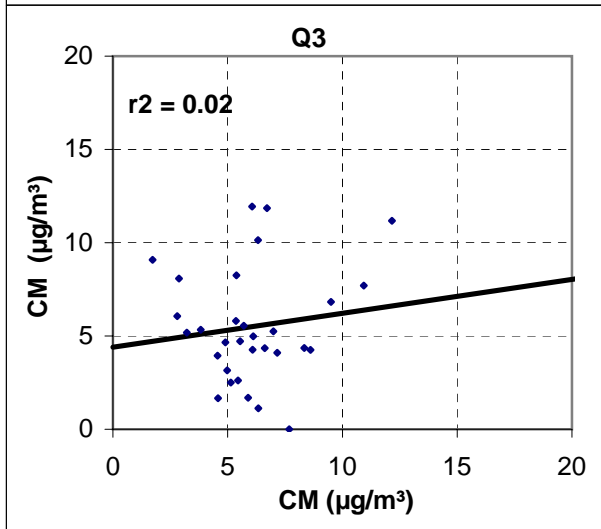
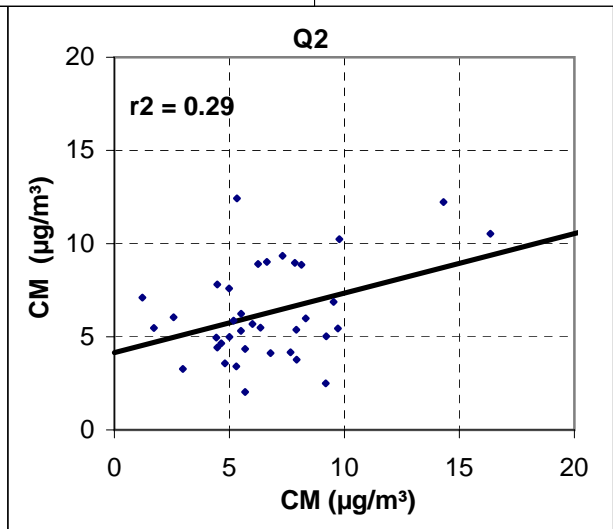
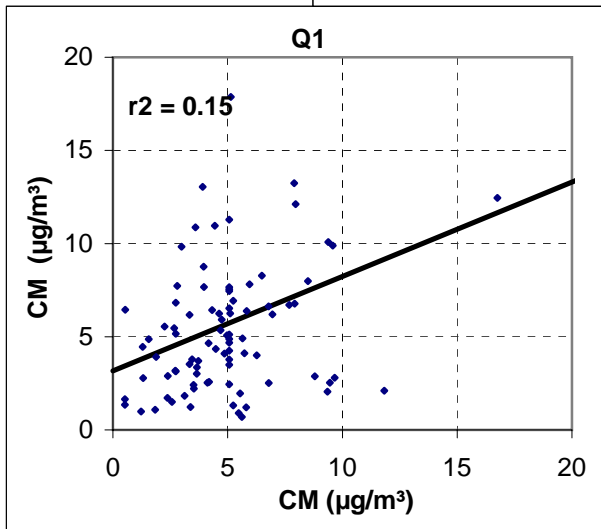
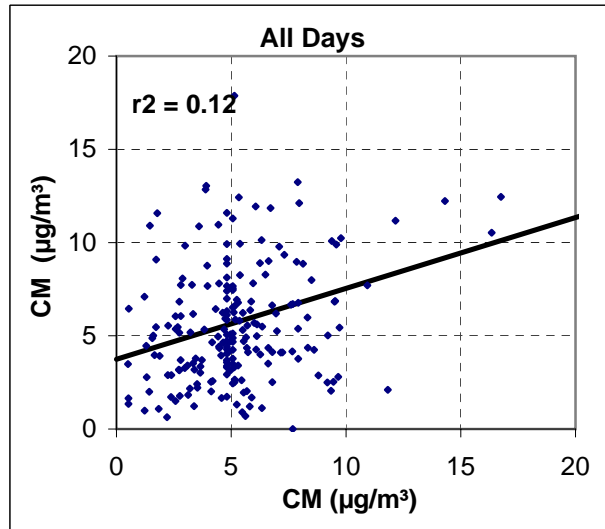
BRET1 vs. GFP Soil



BRET1 vs. GFP Light Absorbing Carbon



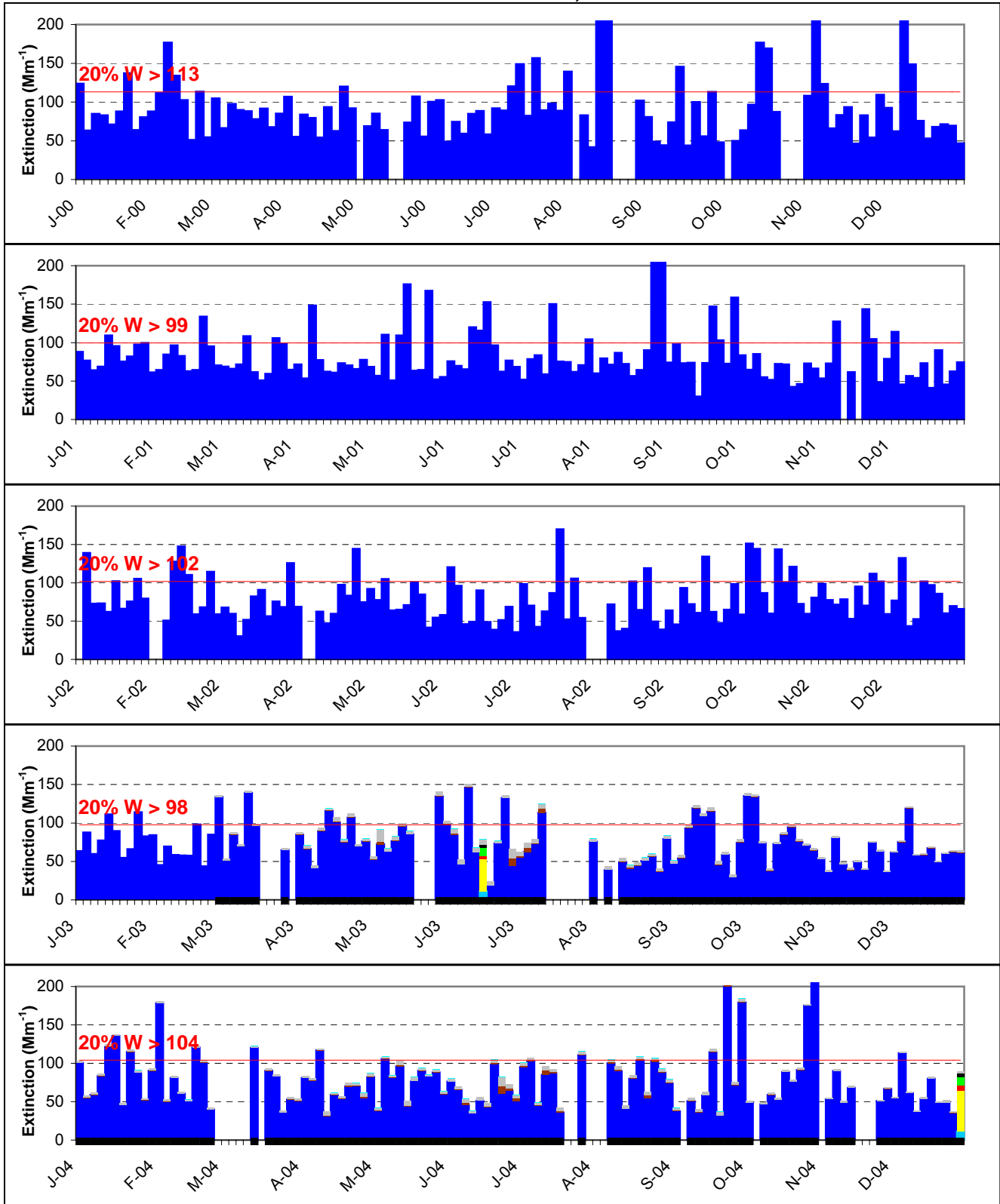
BRET1 vs. GFP Coarse Mass



**Chassahowitzka NWR, FL
Statistics for Substitutions**

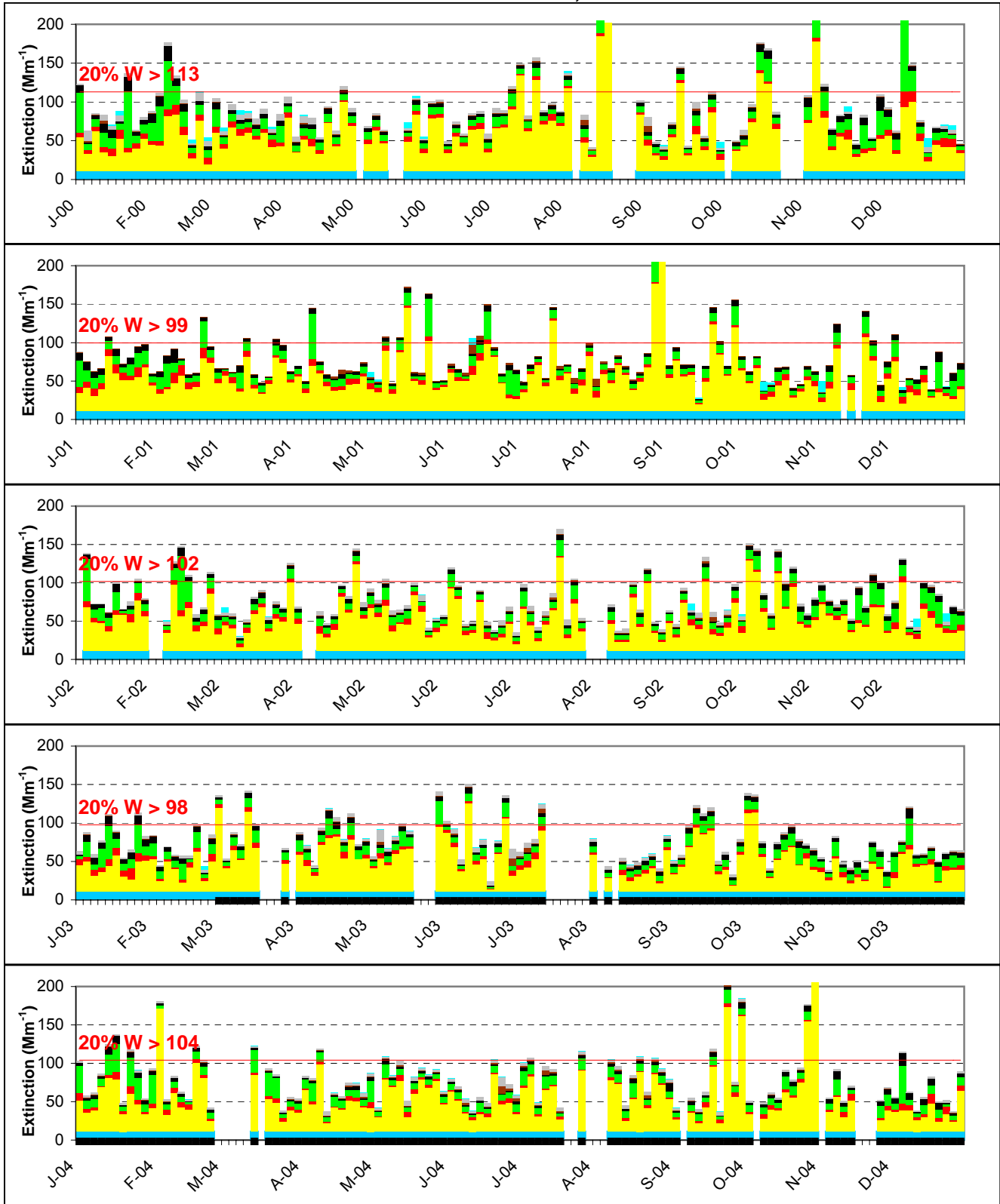
CHAS1						
Components	KT Stats	All	1	2	3	4
OC vs. org_H	Slope	8.06	10.30	7.55	4.72	8.36
	Intercept	0.49	0.27	0.47	0.68	0.61
	R2	0.72	0.84	0.73	0.67	0.76
EC vs. OC	Slope	0.16	0.13	0.11	0.12	0.20
	Intercept	0.17	0.26	0.17	0.18	0.16
	R2	0.47	0.34	0.41	0.26	0.66
CHAS1 v. SAMA1						
Components	KT Stats	All	1	2	3	4
SO4	Slope	0.58	0.66	0.47	0.53	0.68
	Intercept	1.58	1.57	2.26	1.60	0.93
	R2	0.42	0.37	0.30	0.41	0.57
NO3	Slope	0.53	0.35	0.92	0.75	0.71
	Intercept	0.26	0.40	0.13	0.16	0.19
	R2	0.38	0.27	0.39	0.44	0.42
OC	Slope	0.54	0.46	0.25	0.45	0.76
	Intercept	0.26	0.29	0.26	0.26	0.26
	R2	0.29	0.27	0.12	0.18	0.33
LAC	Slope	0.33	0.40	0.12	0.45	0.62
	Intercept	1.22	1.19	1.33	0.82	0.92
	R2	0.21	0.29	0.08	0.33	0.29
Soil	Slope	1.03	0.58	1.07	0.96	0.57
	Intercept	0.08	0.16	0.01	0.38	0.14
	R2	0.45	0.44	0.45	0.35	0.42
CM	Slope	0.54	0.18	1.04	0.32	0.52
	Intercept	2.95	3.46	1.42	4.92	2.41
	R2	0.19	0.05	0.28	0.07	0.21
Sea Salt	Slope	0.00	0.01	0.00	-0.02	0.00
	Intercept	0.01	0.00	0.03	0.02	0.00
	R2	0.00	0.10	0.00	0.00	0.00

CHAS1 (SAMA1 donor)
Baseline Extinction, nia



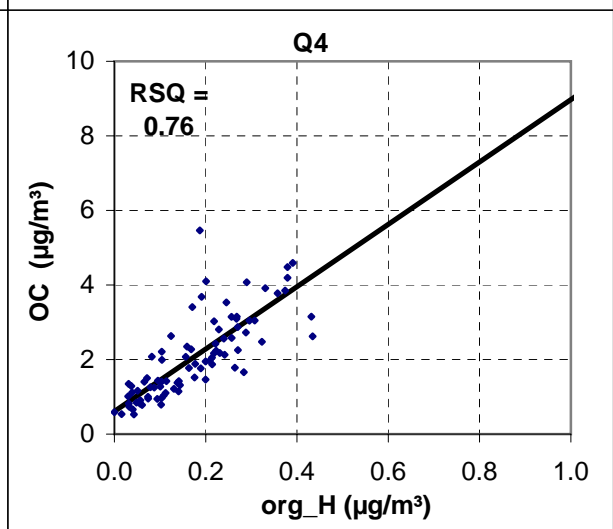
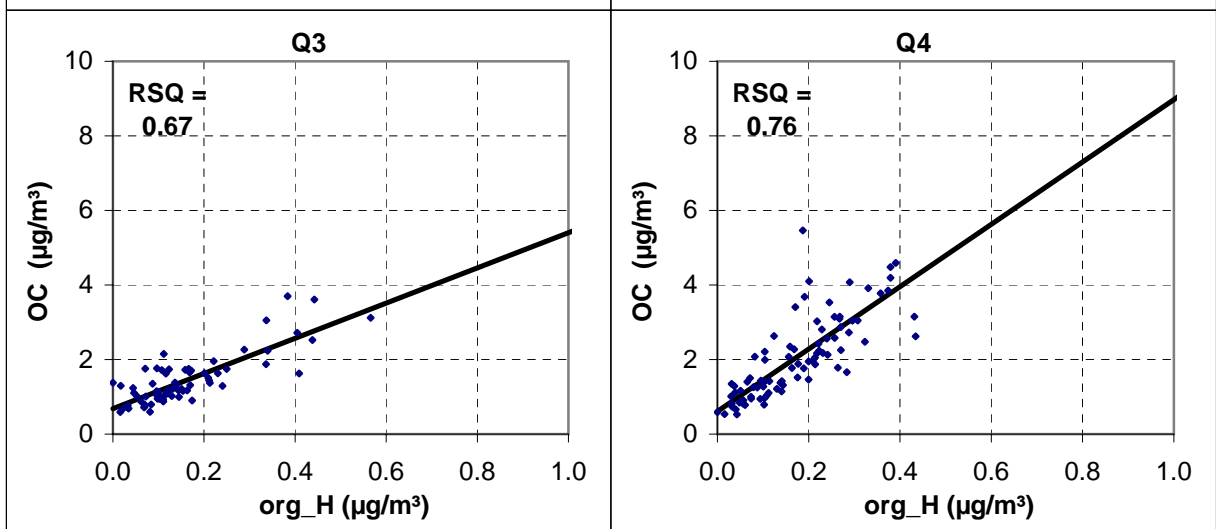
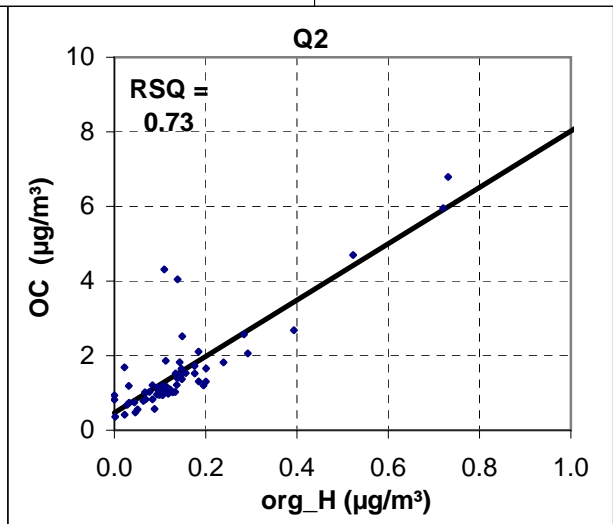
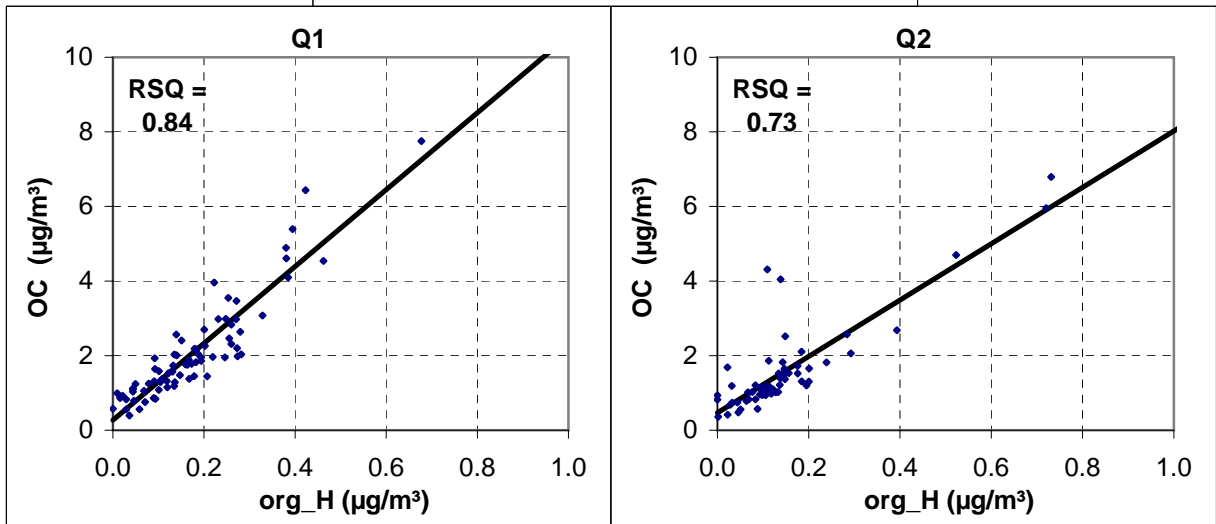
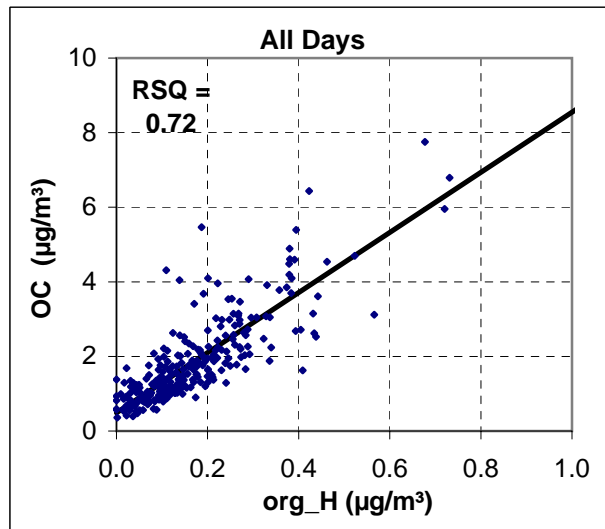
■ RHR
 ■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

CHAS1 (SAMA1 donor)
Baseline Extinction, nia

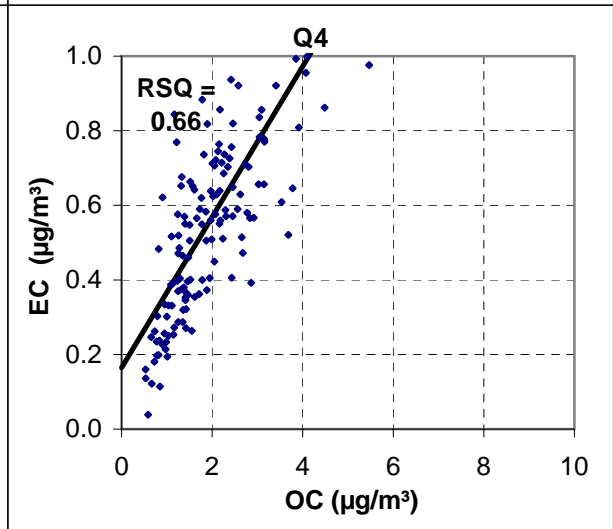
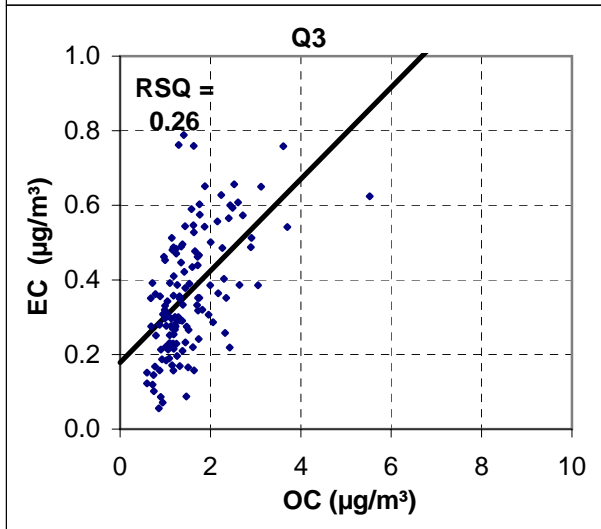
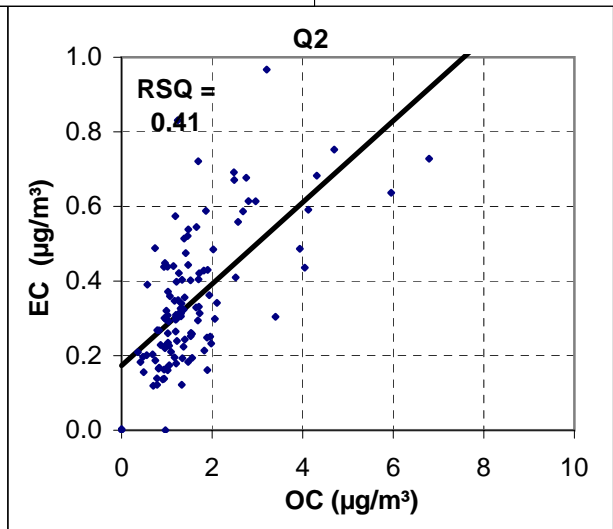
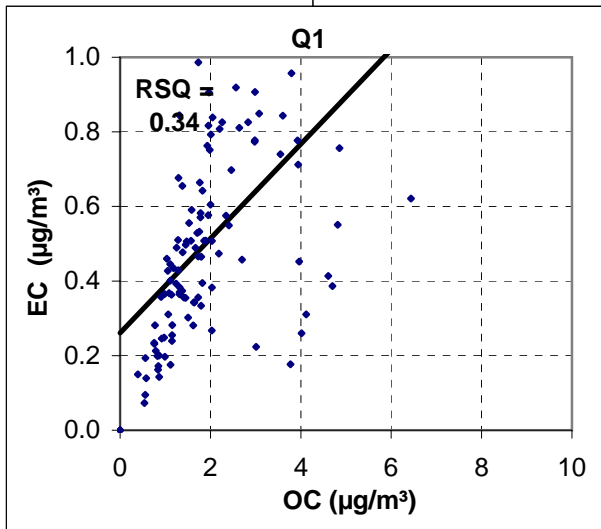
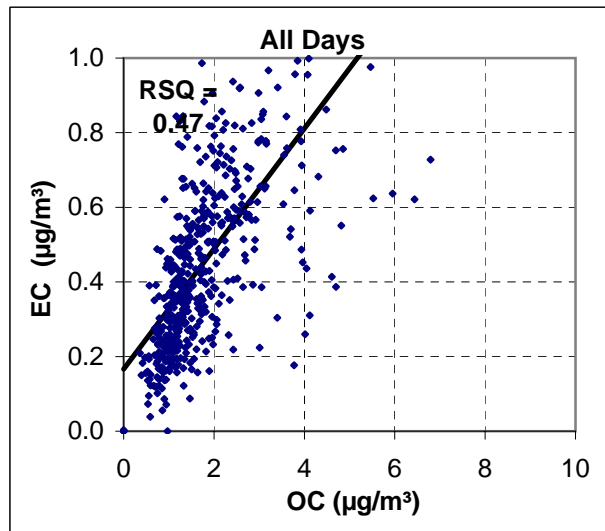


■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

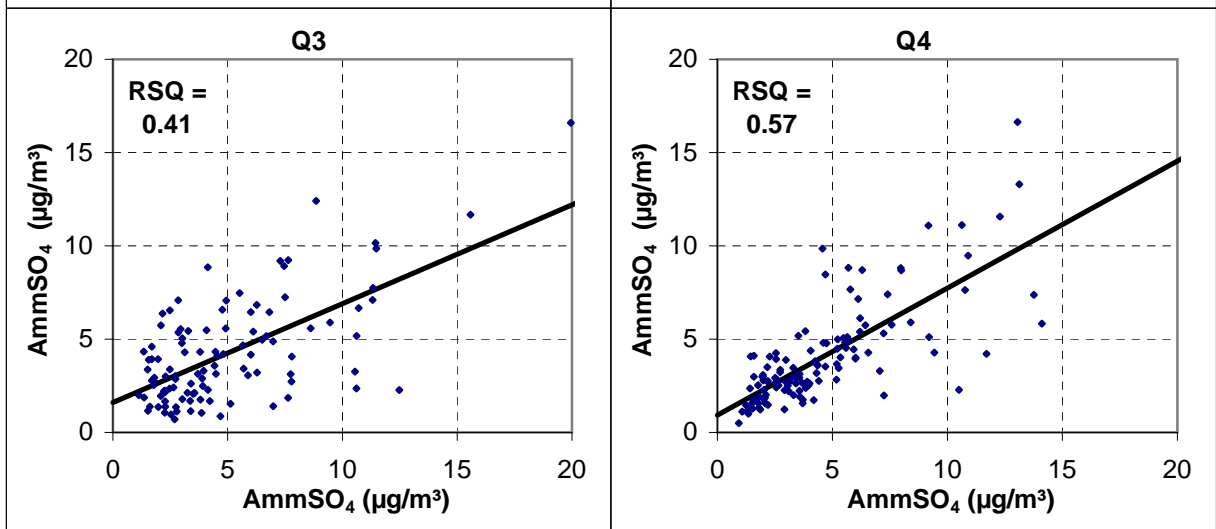
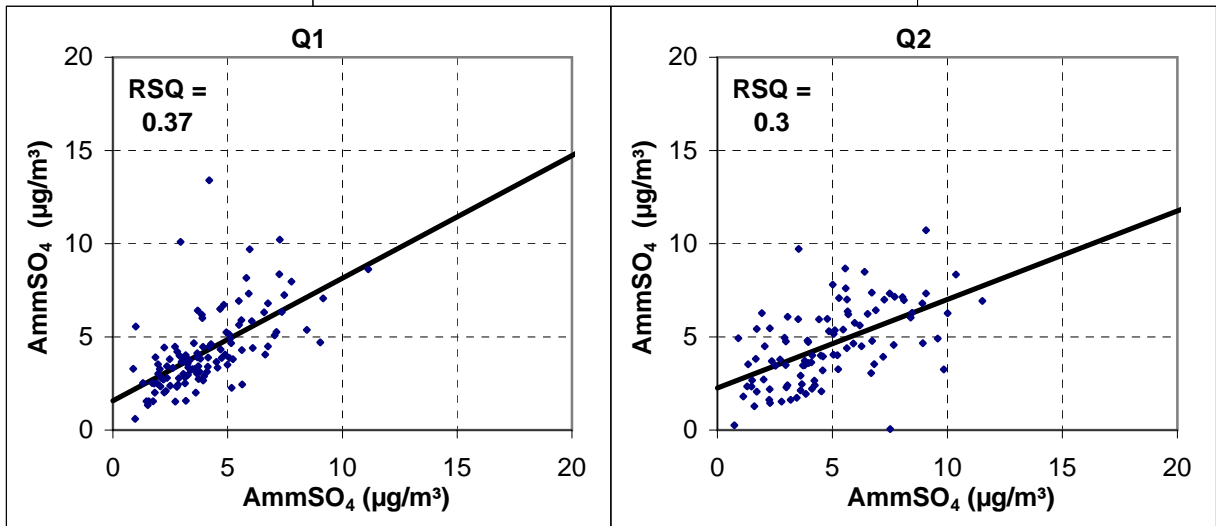
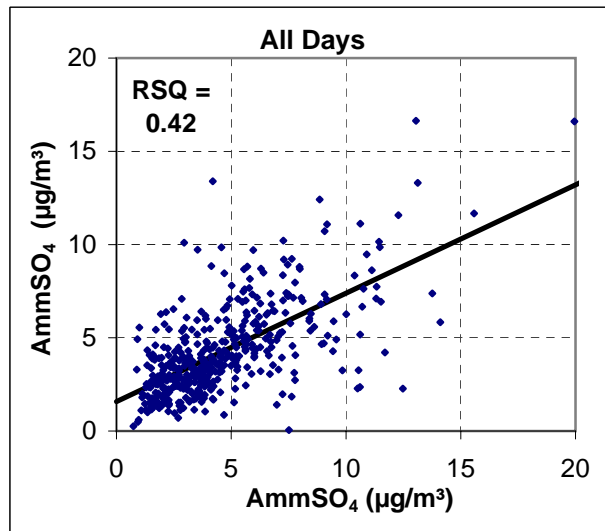
CHAS1 OC vs. org_H



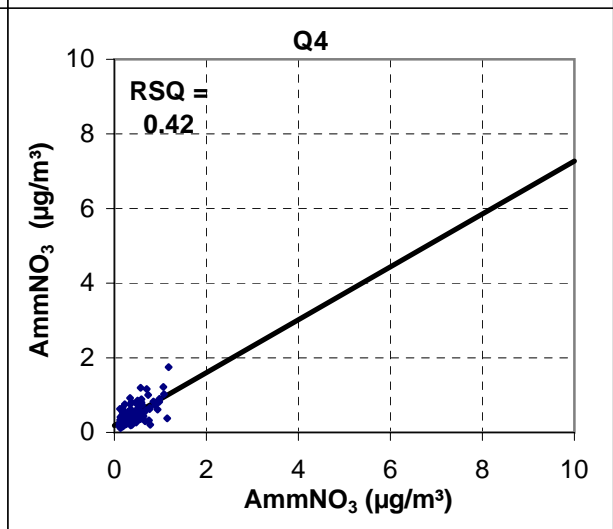
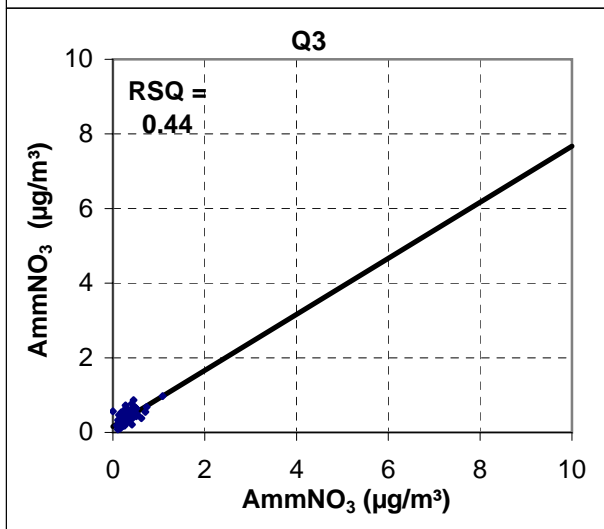
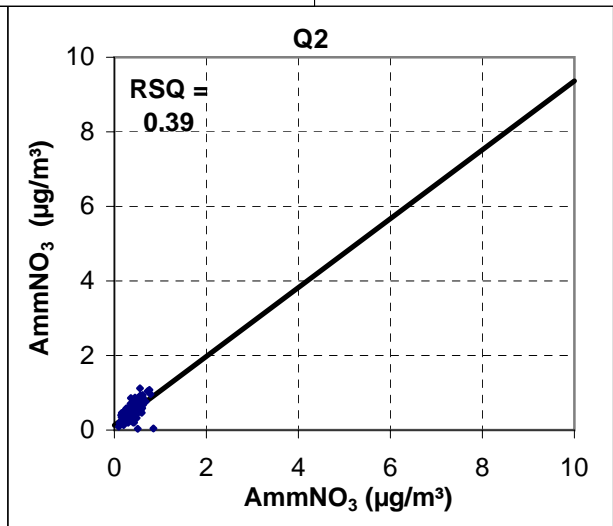
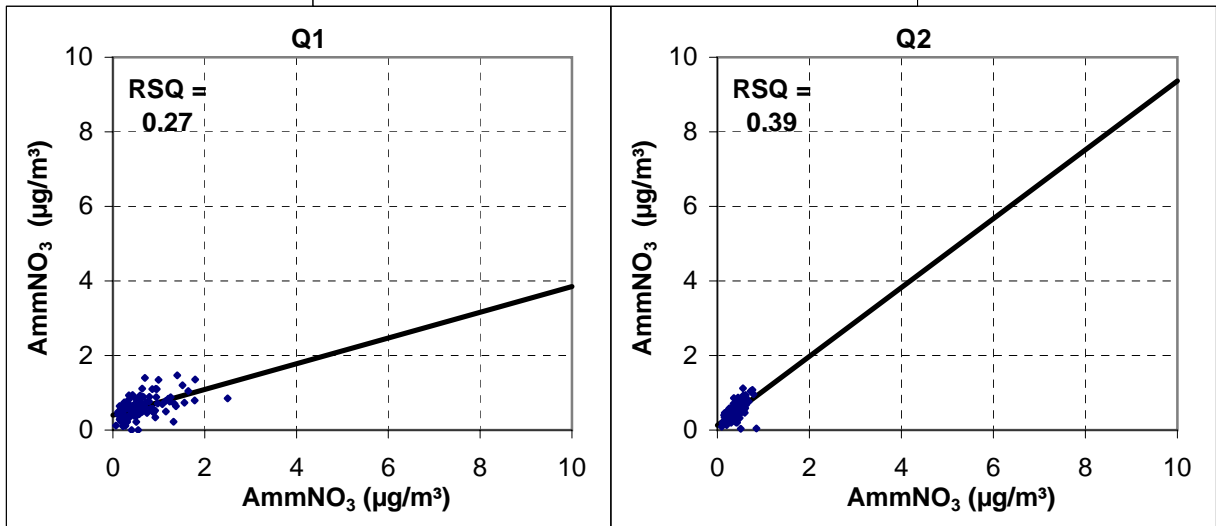
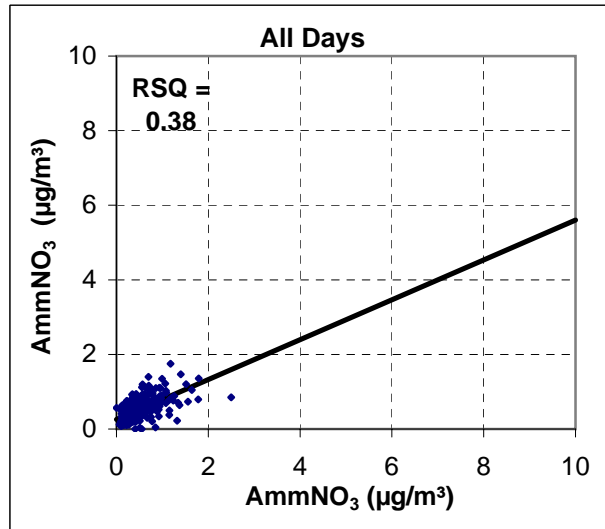
CHAS1 EC vs. OC



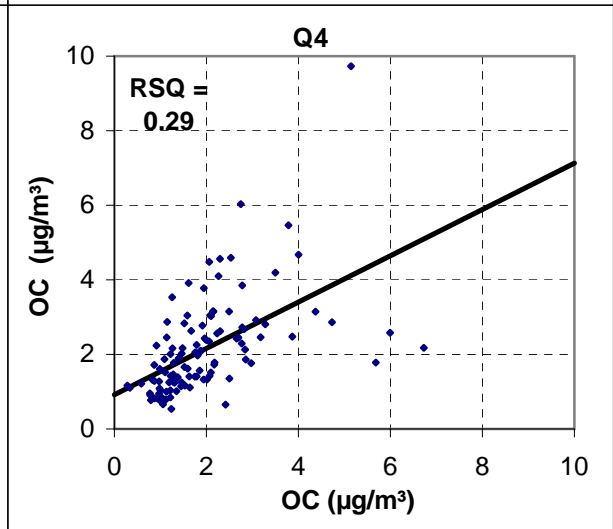
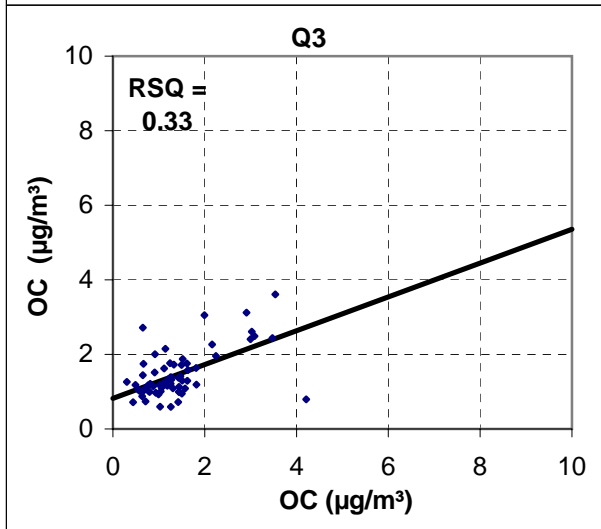
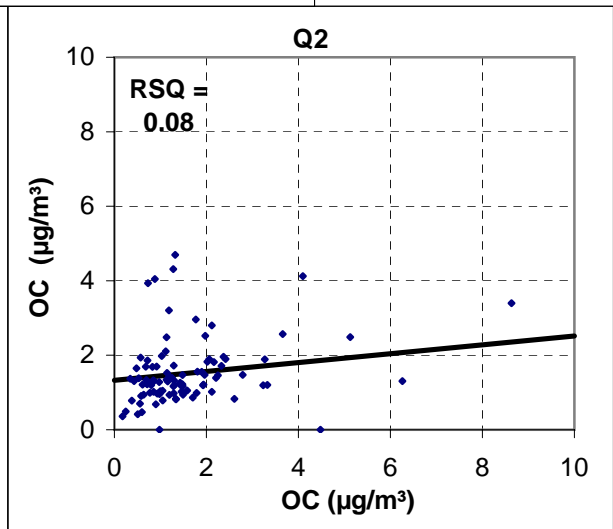
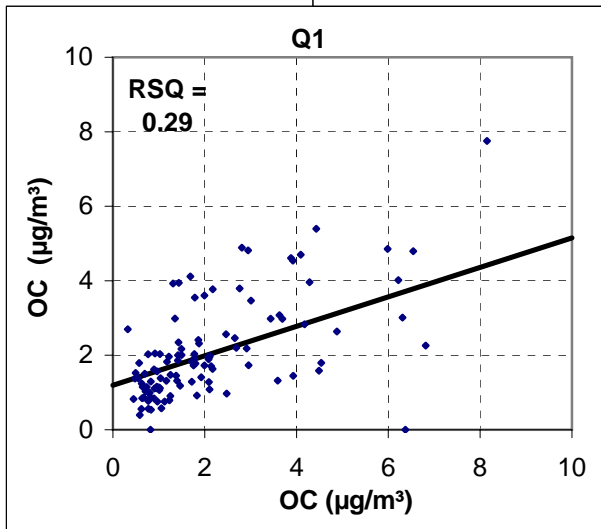
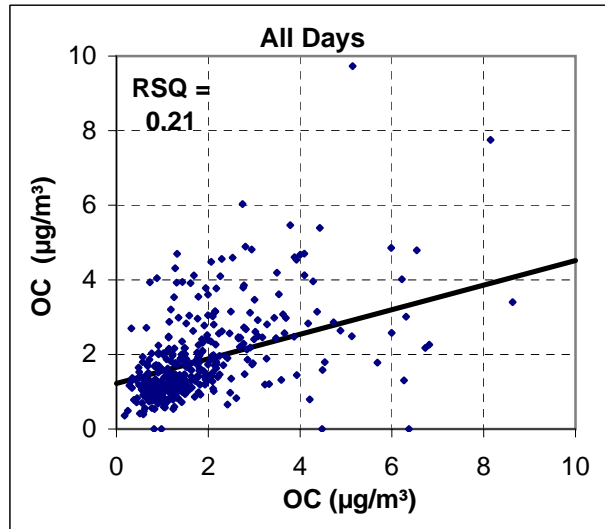
CHAS1 vs. SAMA1 Ammonium Sulfate



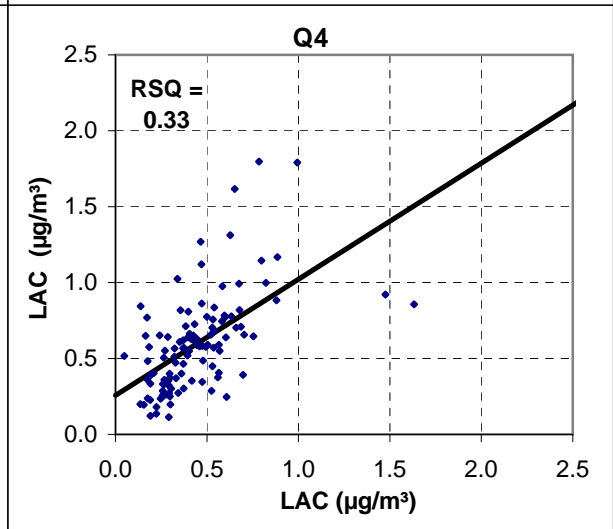
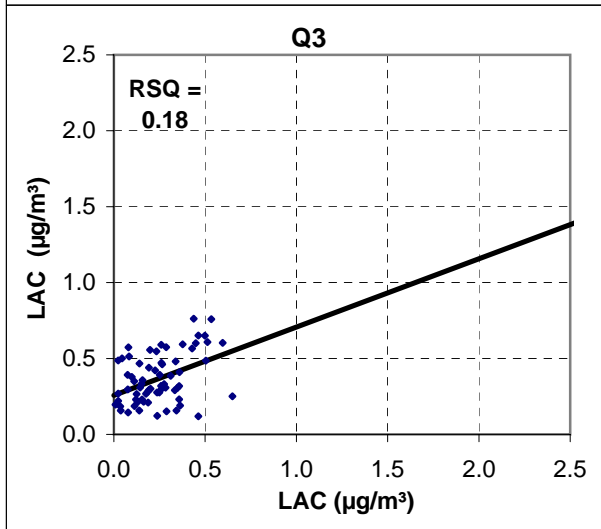
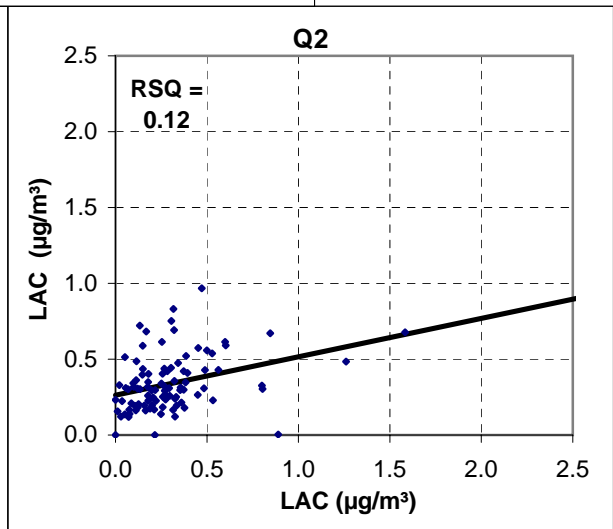
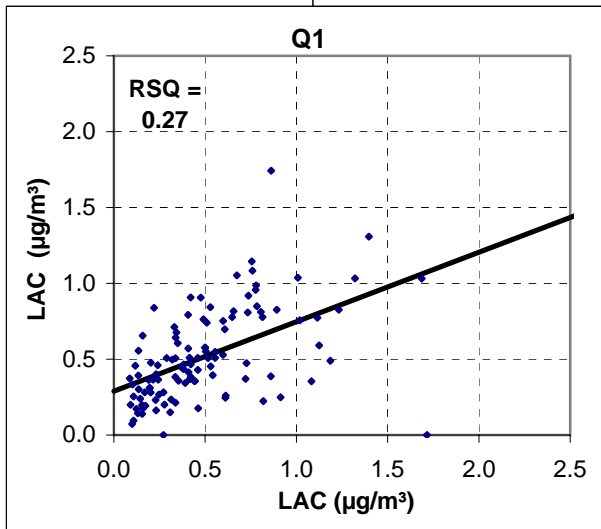
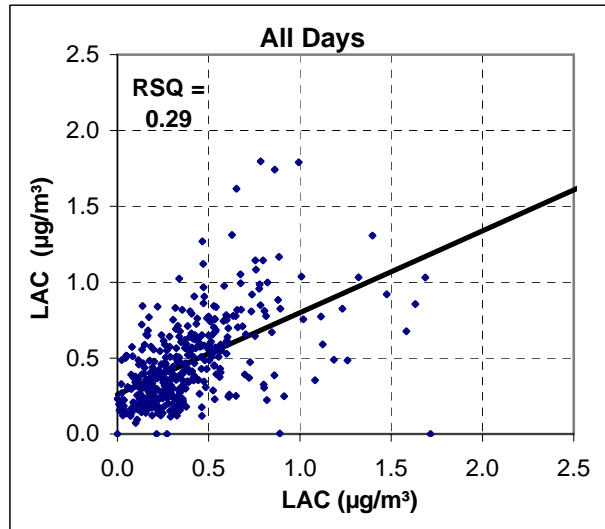
CHAS1 vs. SAMA1 Ammonium Nitrate



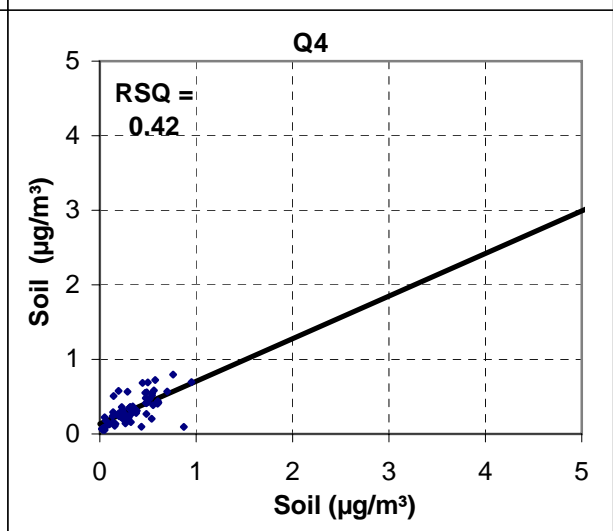
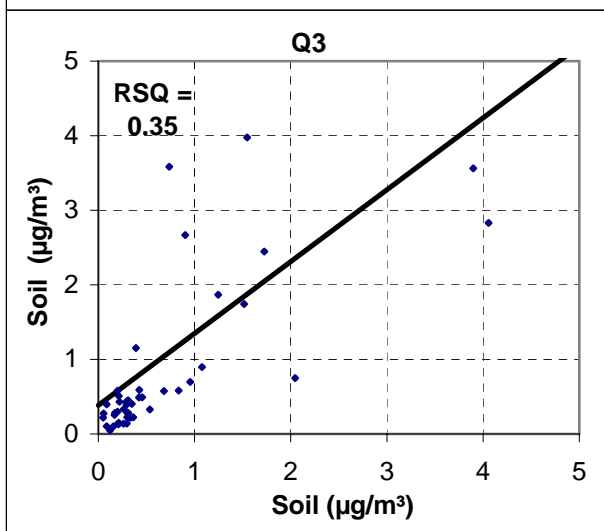
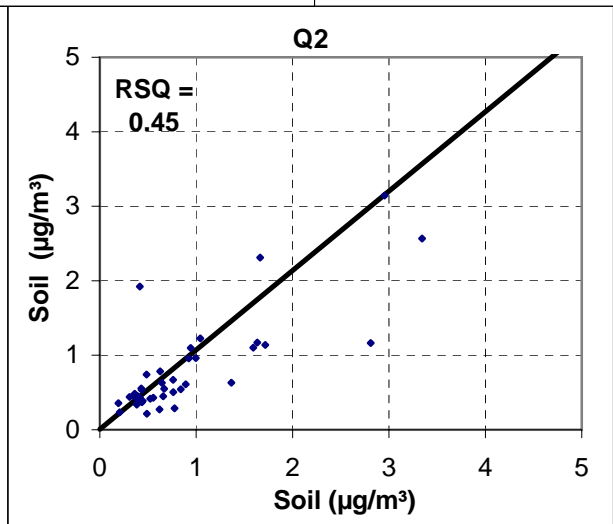
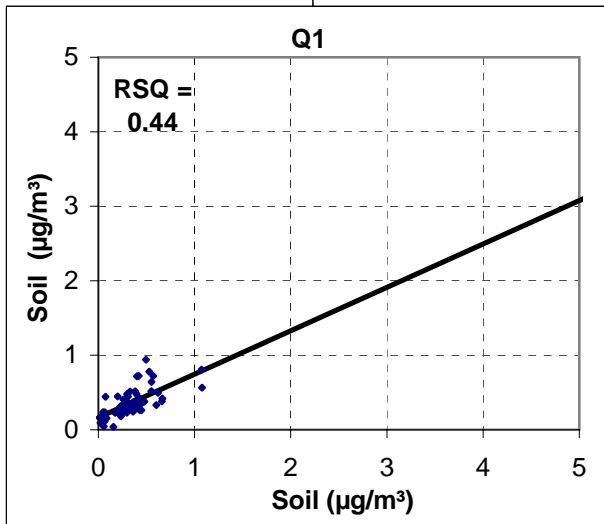
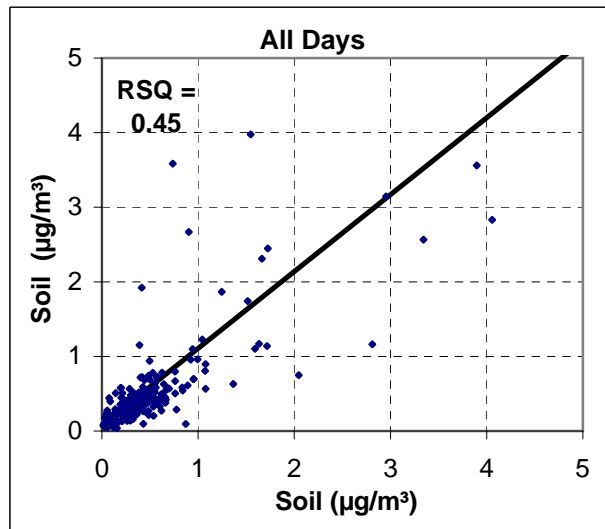
CHAS1 vs. SAMA1 Organic Carbon



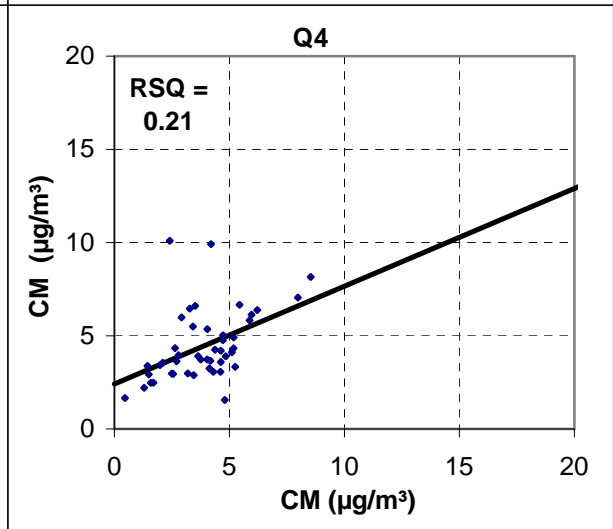
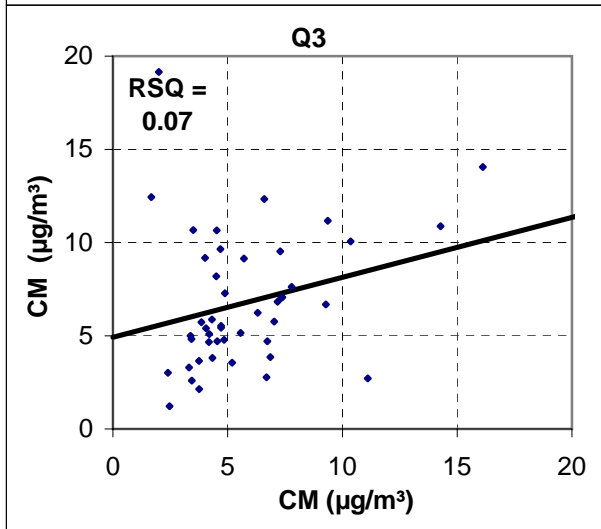
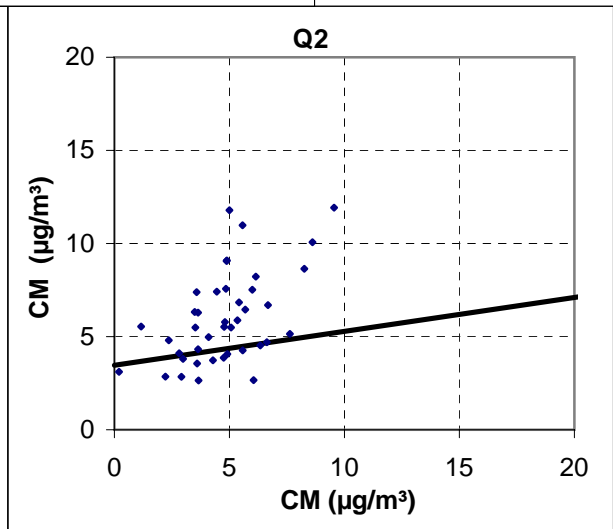
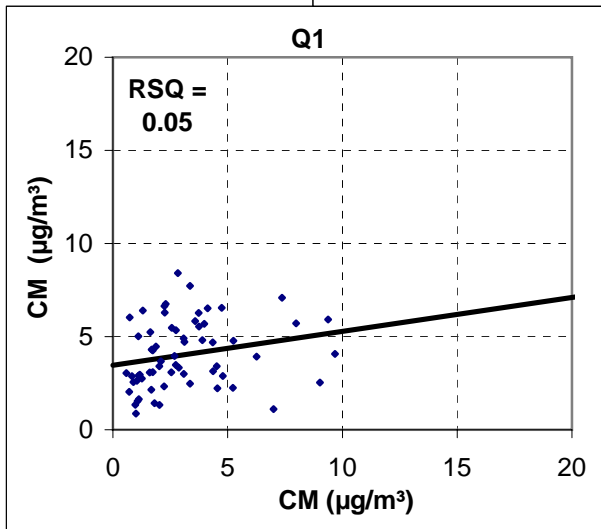
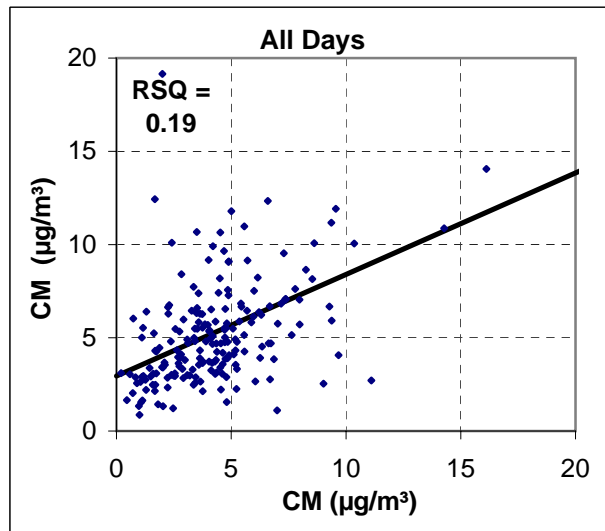
CHAS1 vs. SAMA1 Light Absorbing Carbon



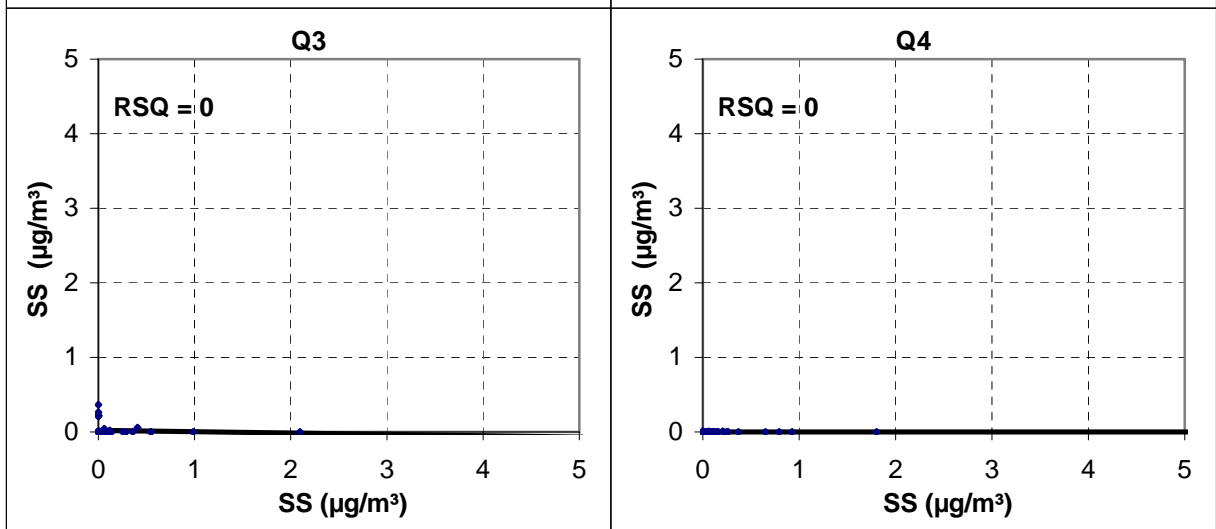
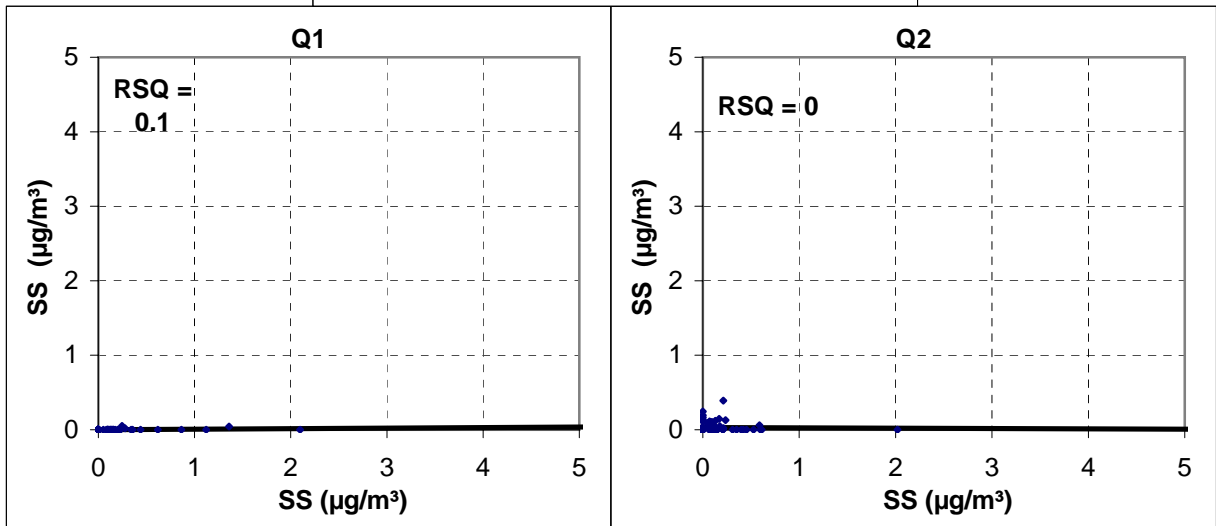
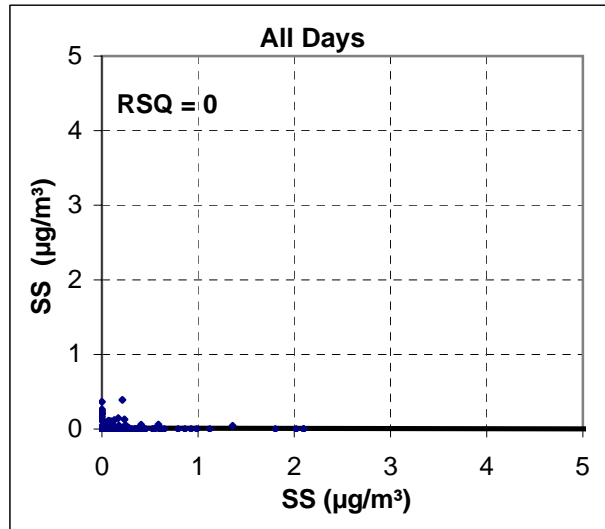
CHAS1 vs. SAMA1 Soil



CHAS1 vs. SAMA1 Coarse Mass



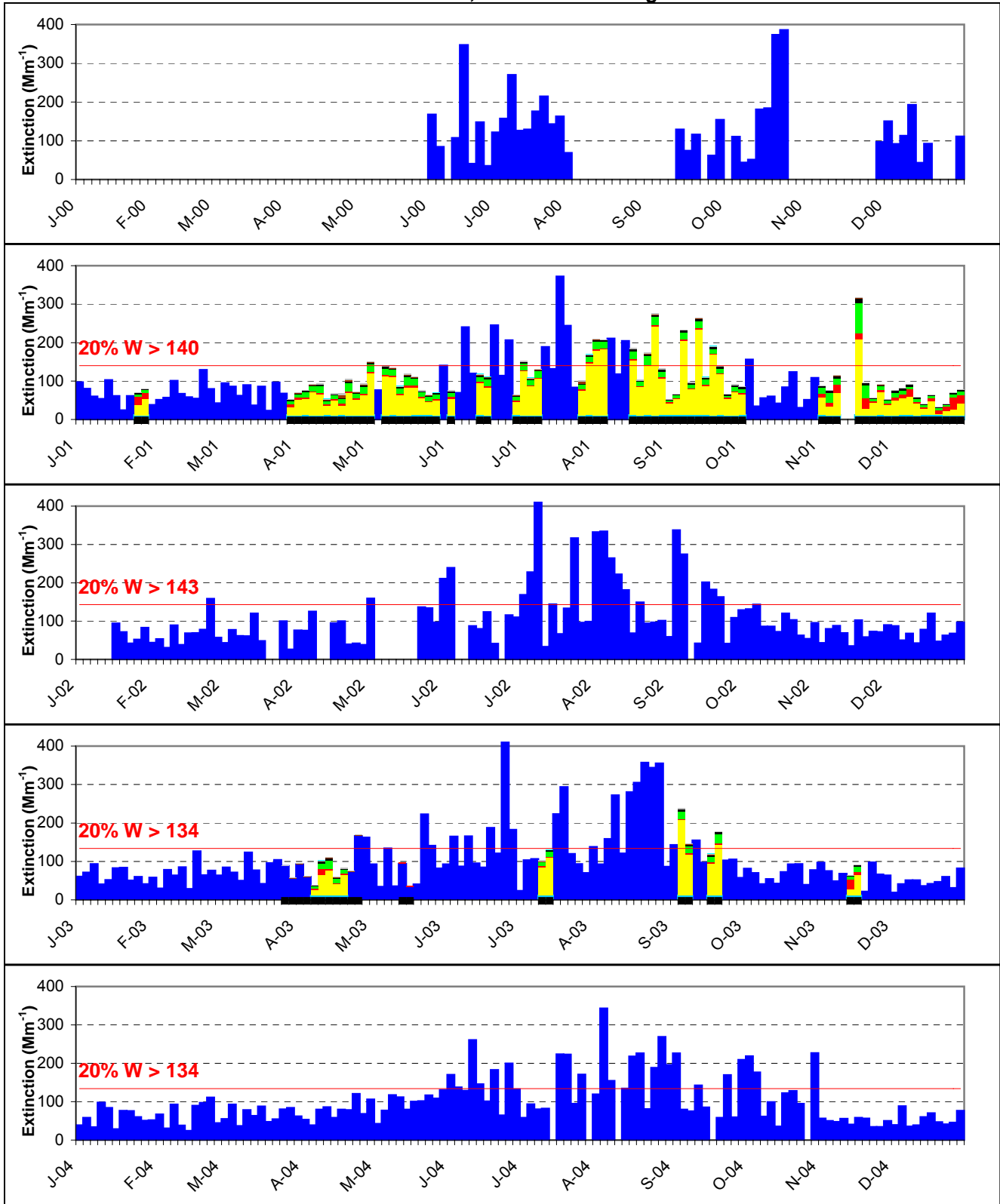
CHAS1 vs. SAMA1 Sea Salt



Cohutta, GA
Statistics for Substitutions

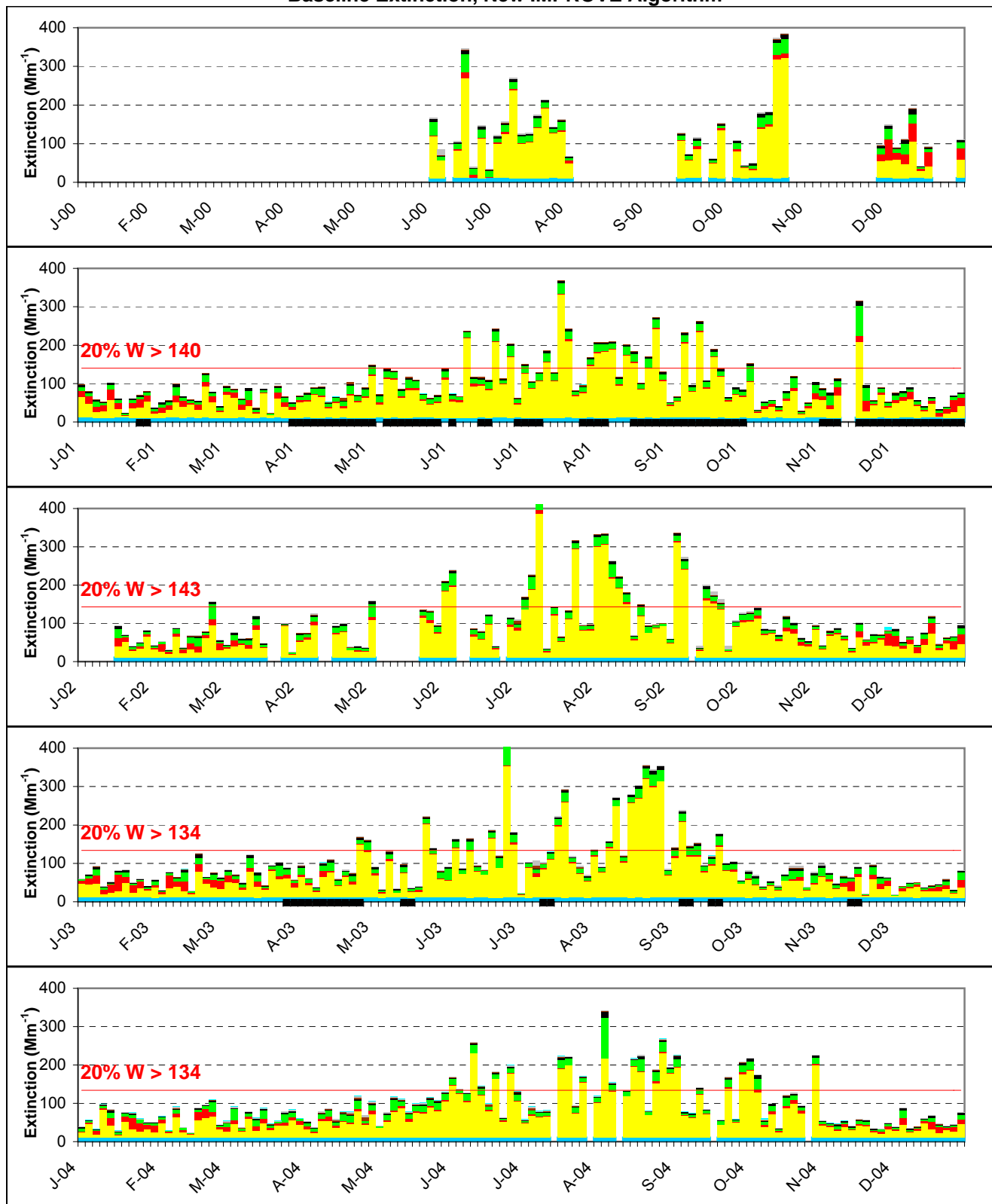
COHU1						
Components	KT Stats	All	1	2	3	4
OC vs. org_H	Slope	4.65	10.09	2.09	5.36	8.04
	Intercept	1.01	0.06	1.72	1.05	0.36
	R2	0.41	0.85	0.24	0.42	0.59
EC vs. OC	Slope	0.14	0.15	0.12	0.14	0.19
	Intercept	0.09	0.09	0.09	0.06	0.06
	R2	0.65	0.62	0.63	0.71	0.77
COHU1 v. GRSM1						
Components	KT Stats	All	1	2	3	4
SO4	Slope	0.87	0.89	0.77	0.77	1.11
	Intercept	0.89	0.49	1.93	2.18	-0.08
	R2	0.76	0.71	0.54	0.61	0.91
NO3	Slope	0.73	0.50	0.47	0.30	0.94
	Intercept	0.31	0.70	0.30	0.22	0.33
	R2	0.55	0.43	0.25	0.09	0.55
OC	Slope	0.81	0.86	0.60	0.82	0.88
	Intercept	0.07	0.03	0.15	0.05	0.07
	R2	0.50	0.63	0.39	0.39	0.59
LAC	Slope	0.92	0.88	0.67	1.03	0.96
	Intercept	0.35	0.26	0.91	0.30	0.24
	R2	0.56	0.71	0.38	0.36	0.79
Soil	Slope	1.23	0.92	1.02	1.27	0.97
	Intercept	0.03	0.06	0.31	0.01	0.05
	R2	0.54	0.64	0.26	0.62	0.59
CM	Slope	0.53	0.76	0.24	0.74	0.44
	Intercept	0.93	0.05	2.18	1.07	0.94
	R2	0.22	0.55	0.04	0.27	0.29
Sea Salt	Slope	0.00	0.02	0.37	-0.03	0.00
	Intercept	0.01	0.00	0.02	0.02	0.00
	R2	0.00	0.04	0.05	0.00	0.00

COHU1 (GRSM1 donor)
Baseline Extinction, New IMPROVE Algorithm



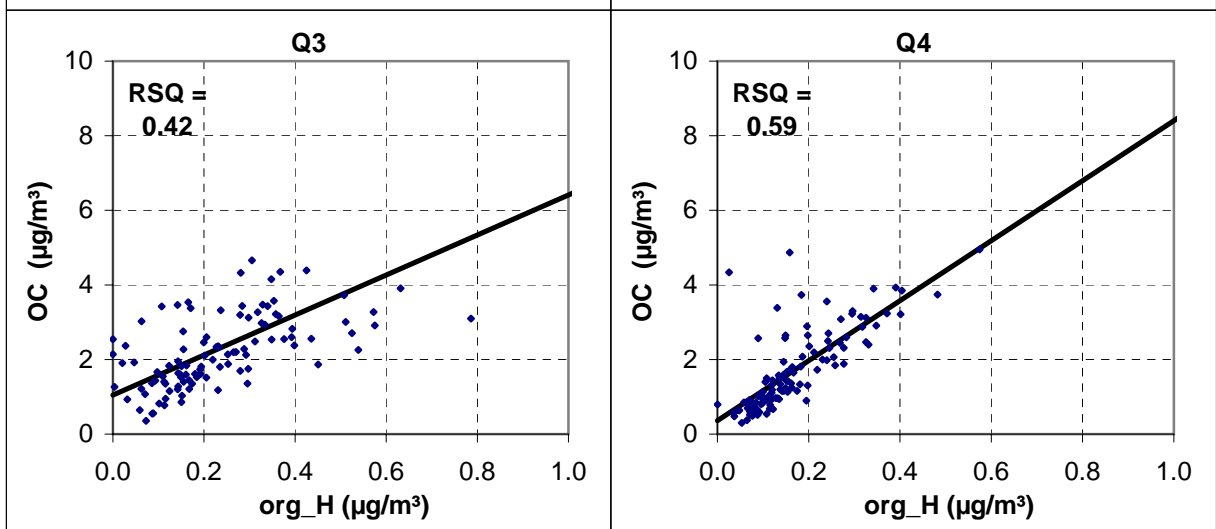
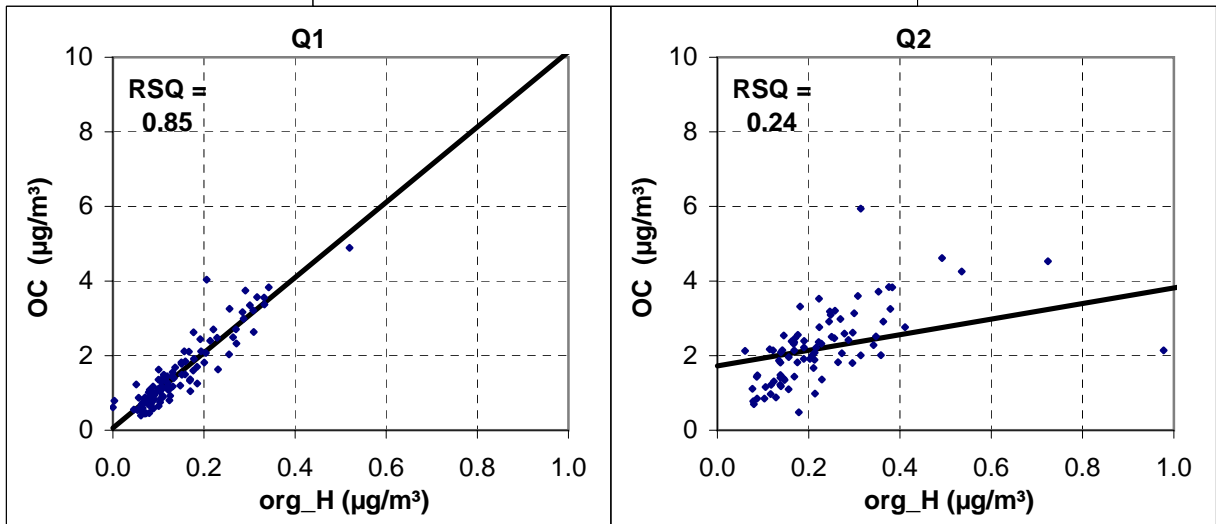
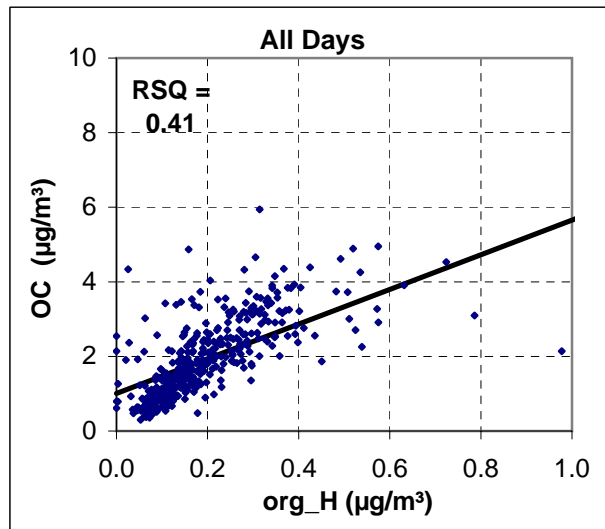
■ RHR
 ■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

COHU1 (GRSM1 donor)
Baseline Extinction, New IMPROVE Algorithm

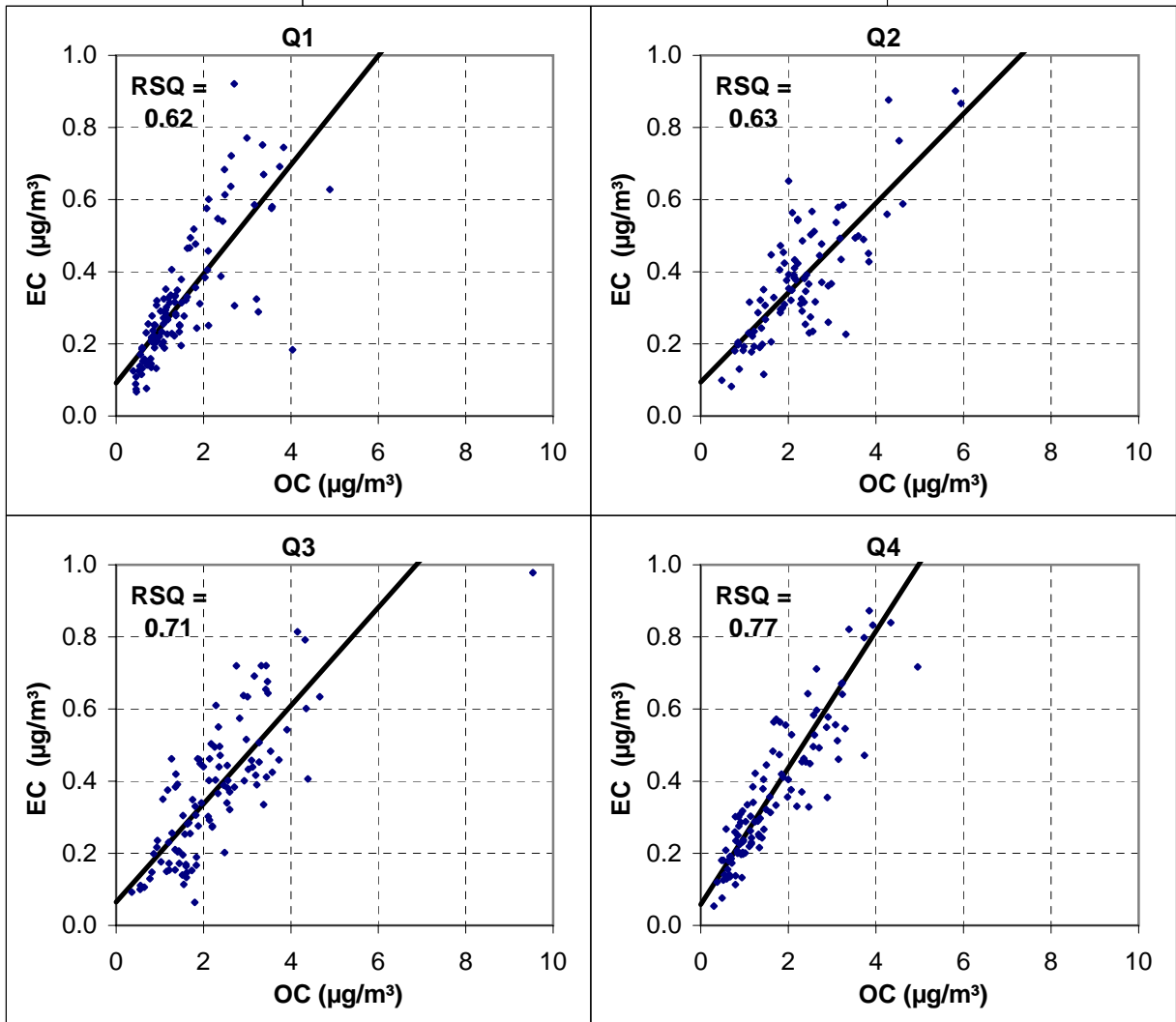
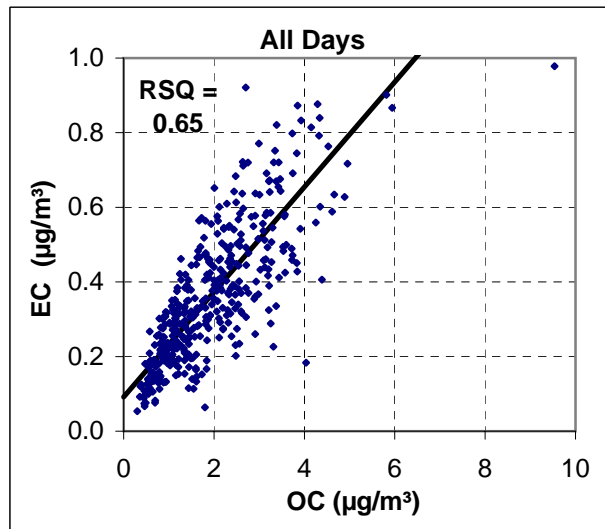


■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

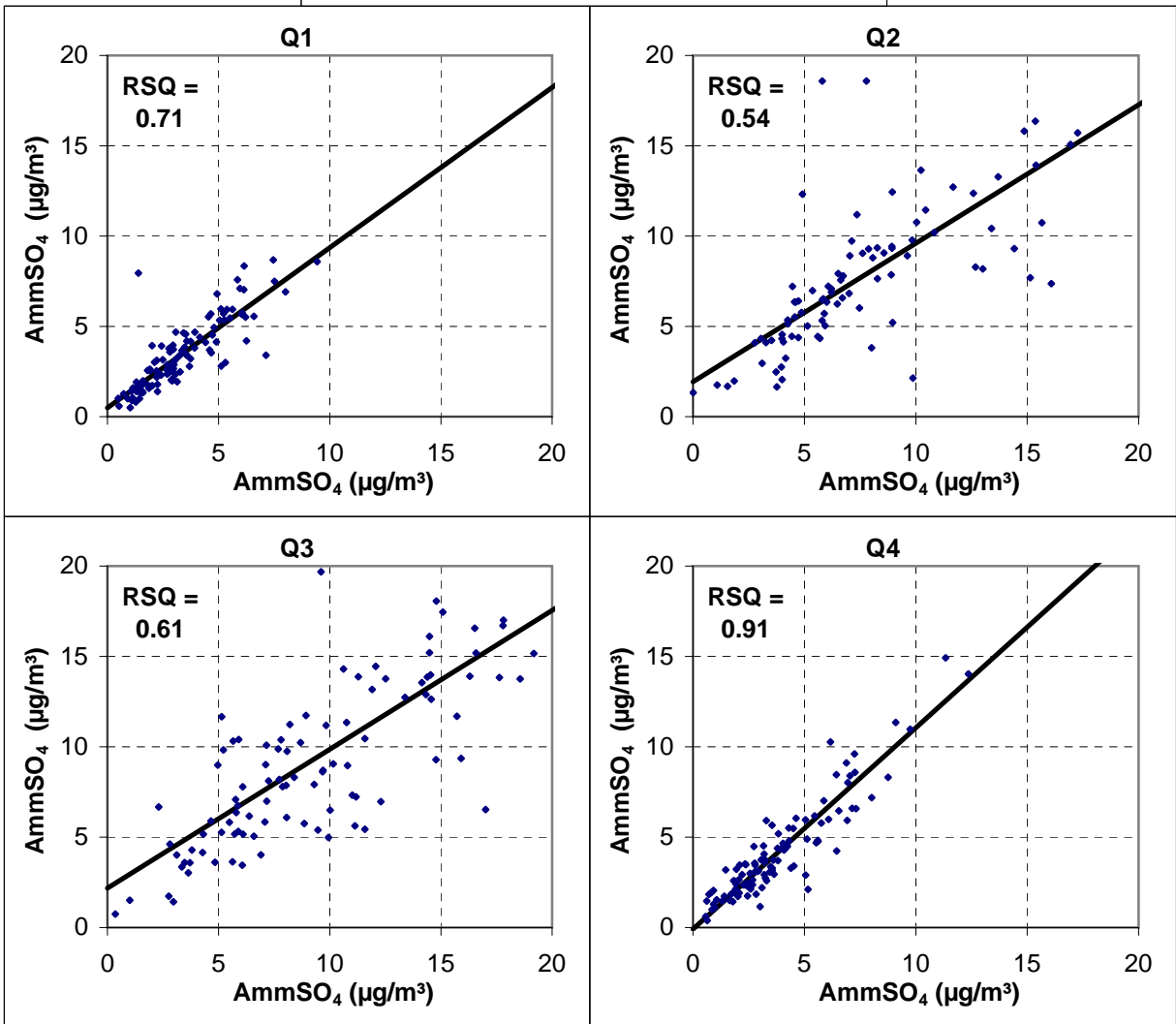
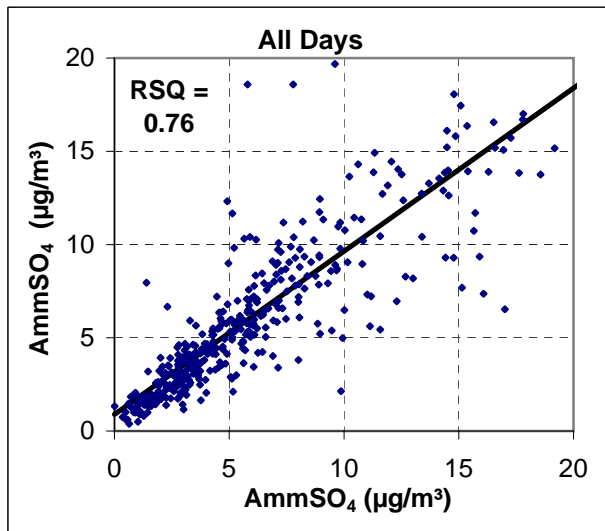
COHU1 OC vs. org_H



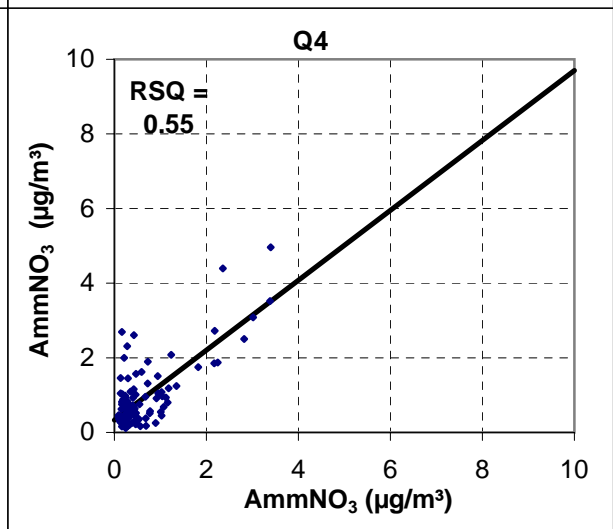
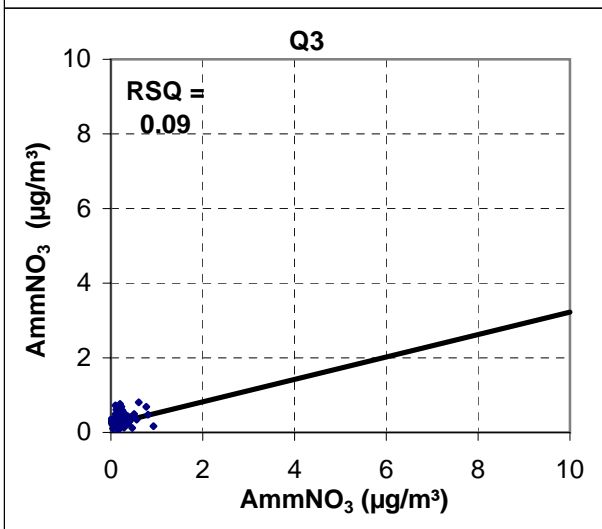
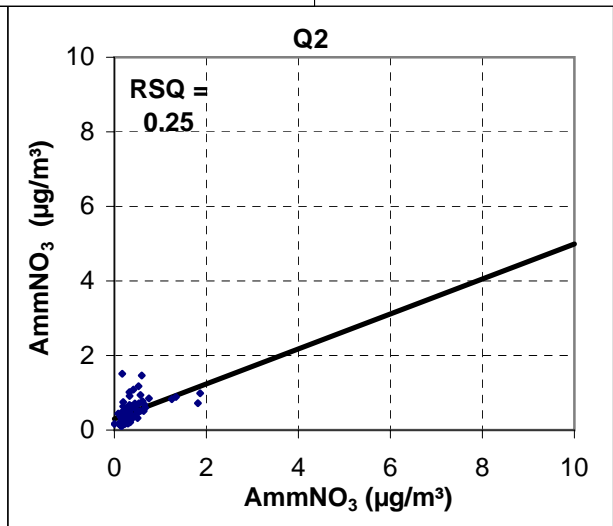
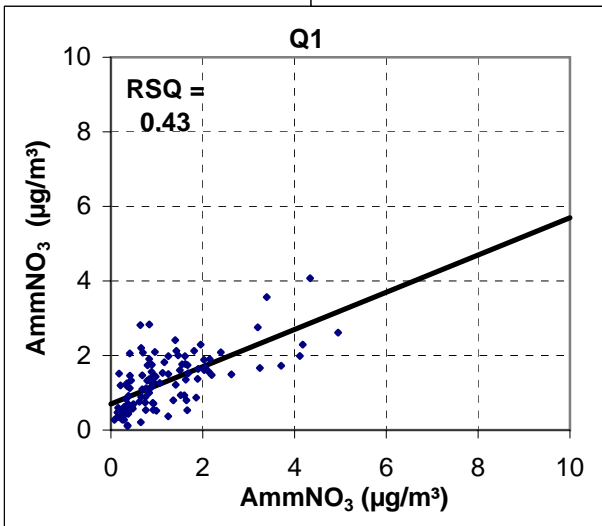
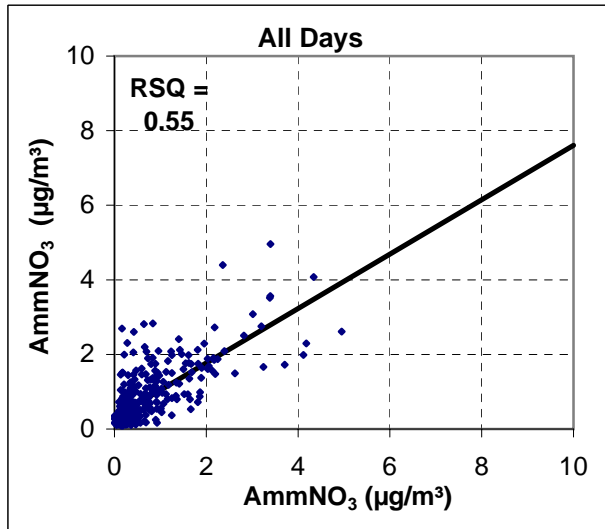
COHU1 EC vs. OC



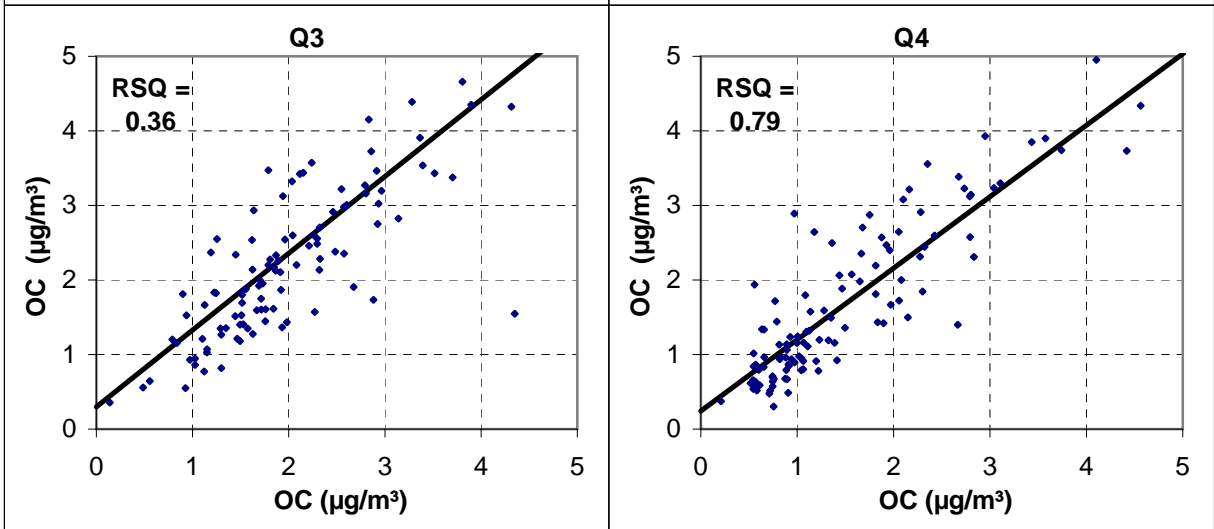
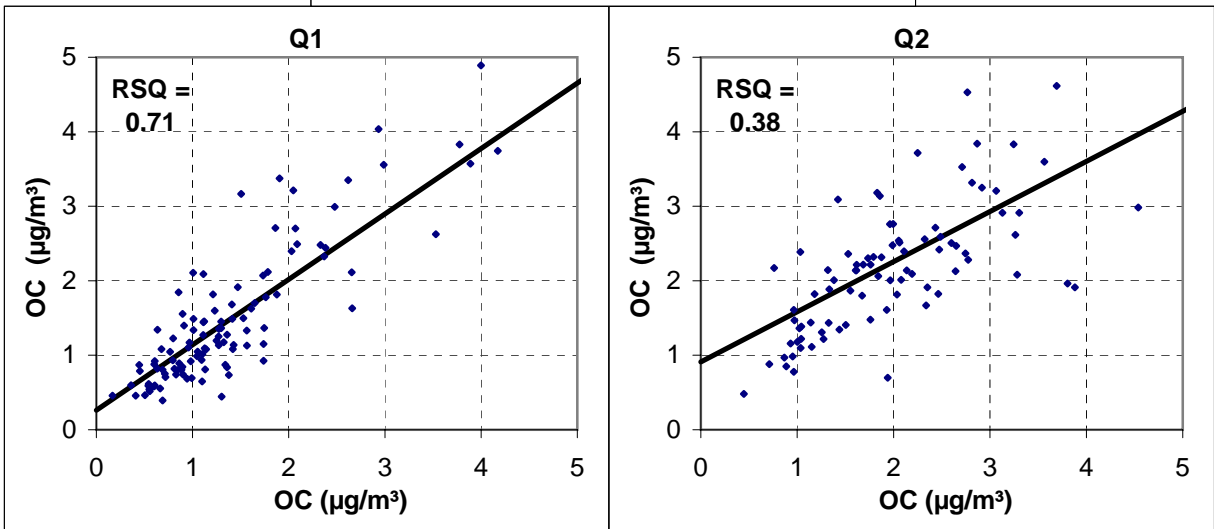
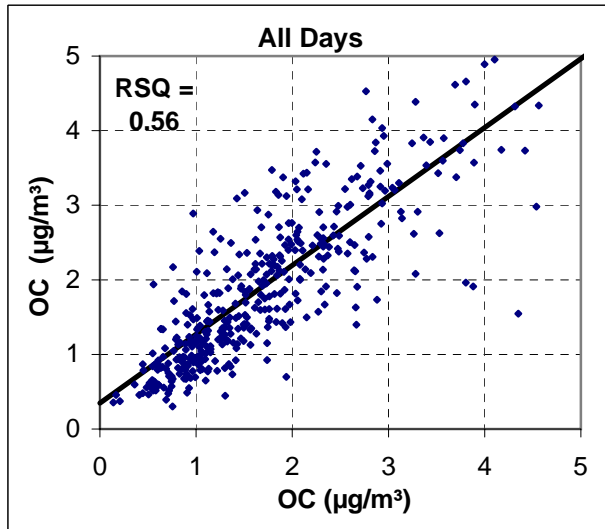
COHU1 vs. GRSM1 Ammonium Sulfate



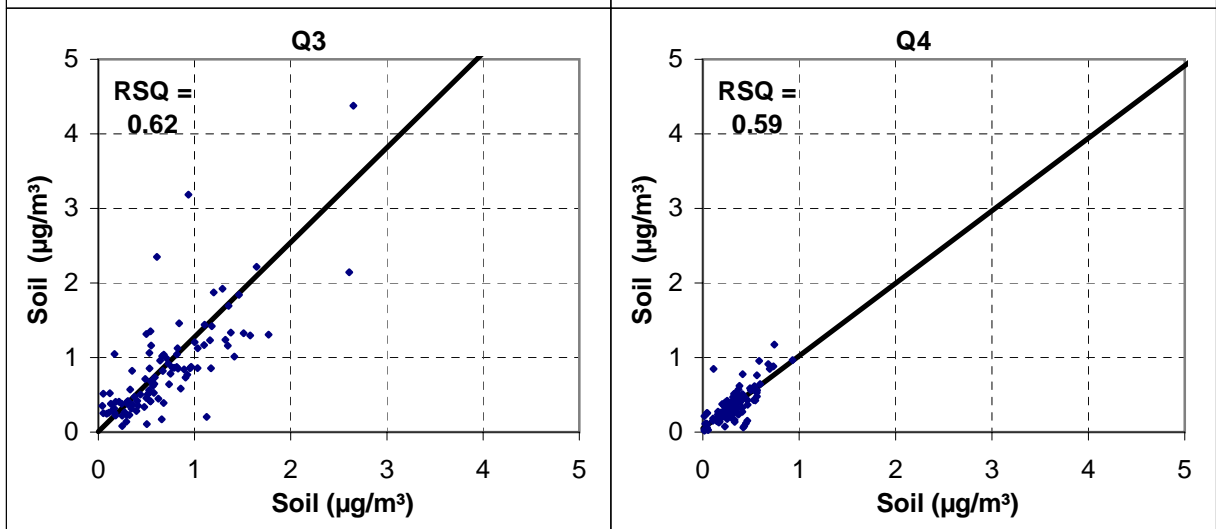
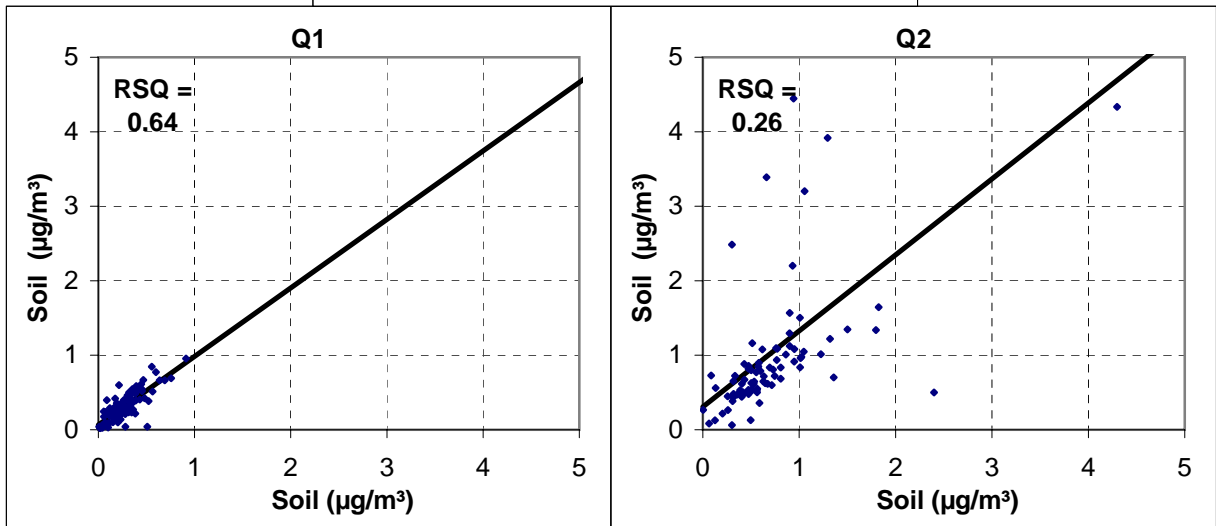
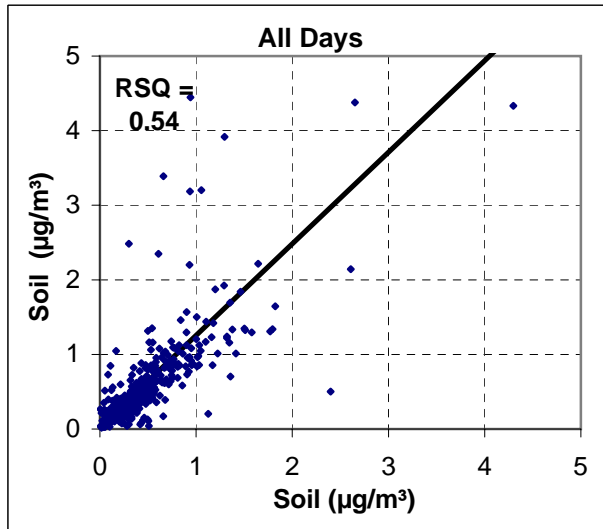
COHU1 vs. GRSM1 Ammonium Nitrate



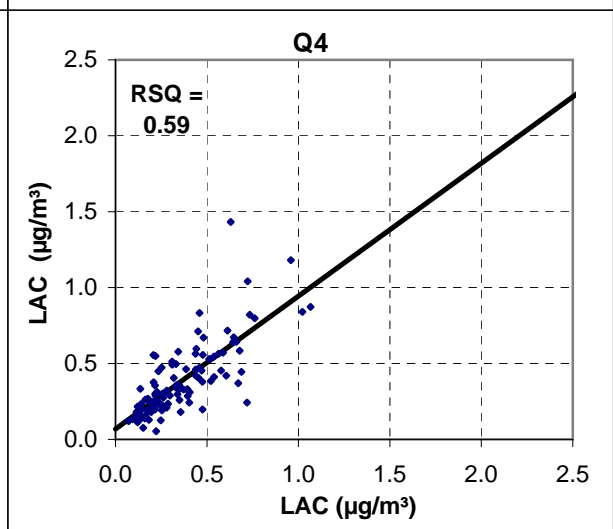
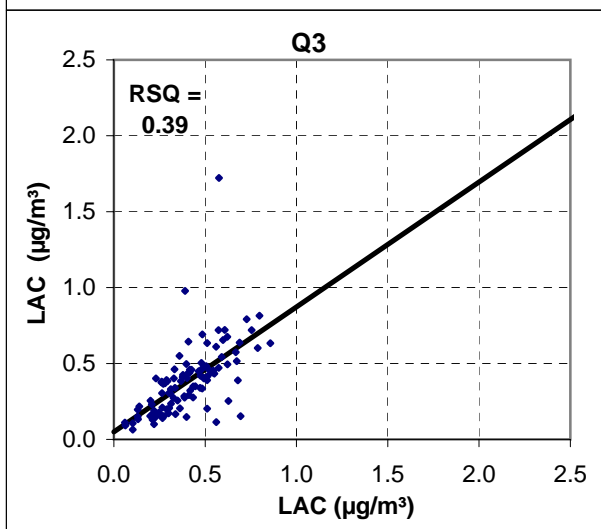
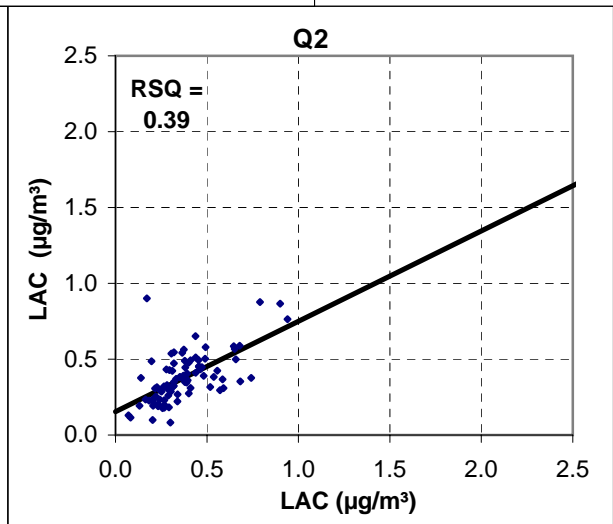
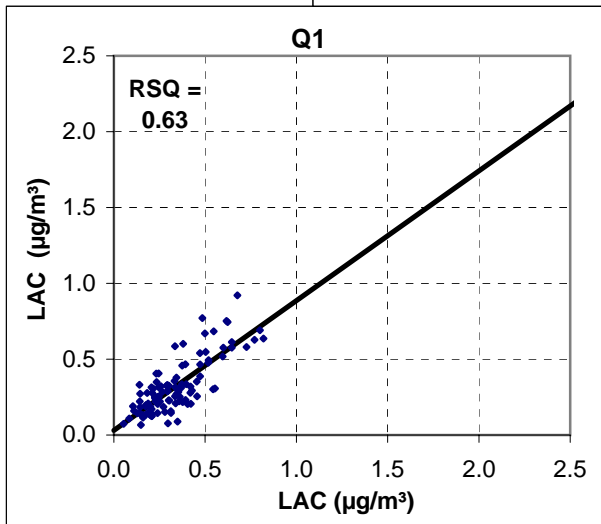
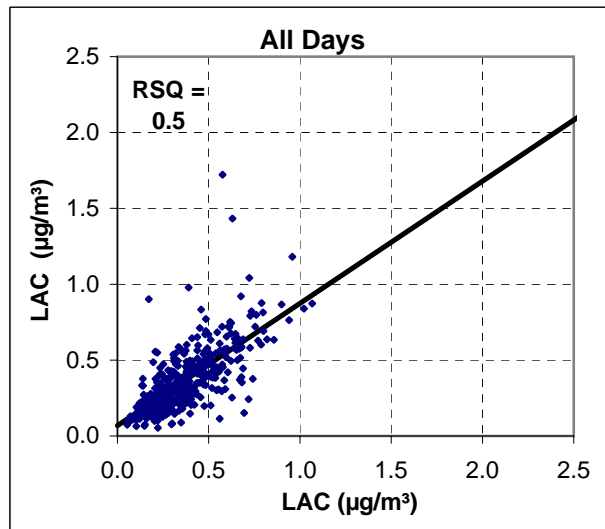
COHU1 vs. GRSM1 Organic Carbon



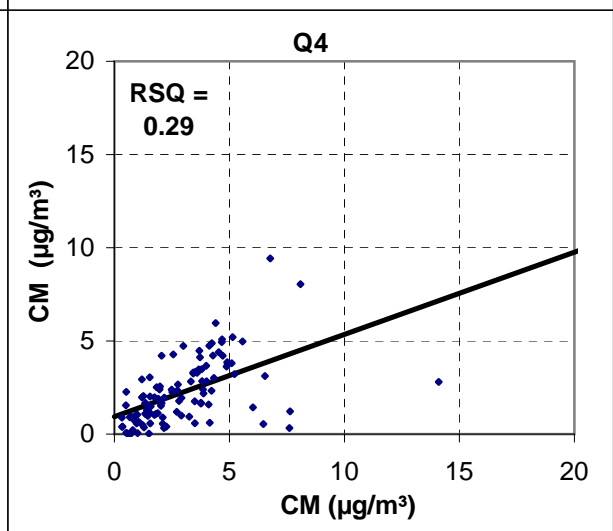
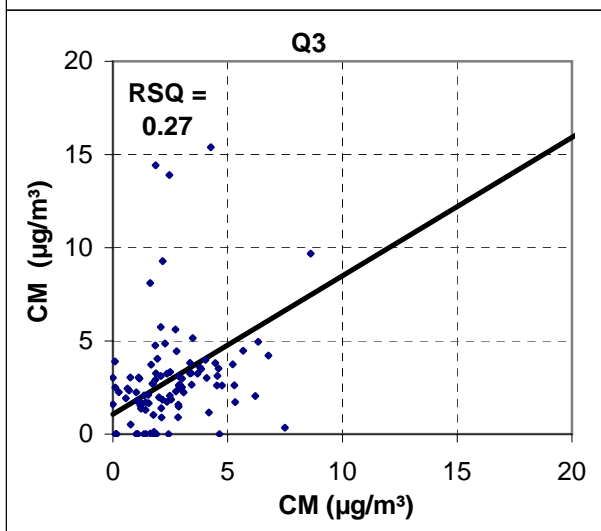
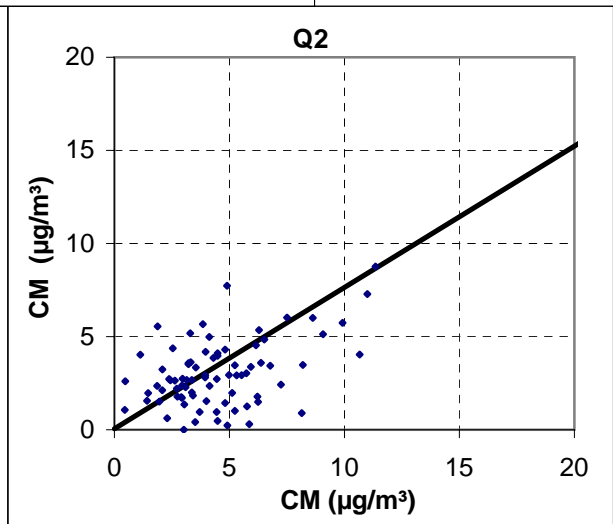
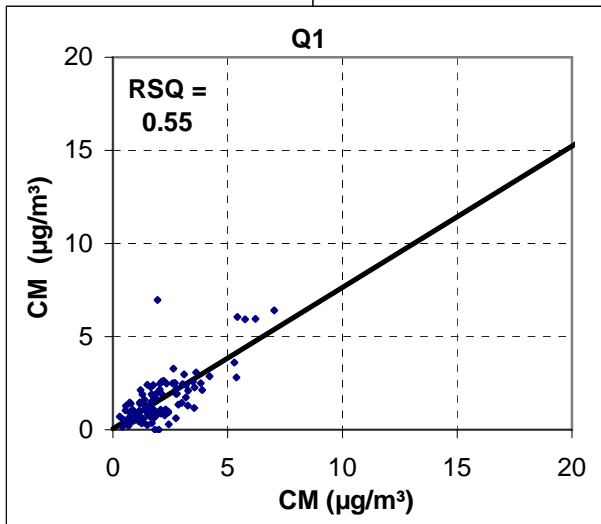
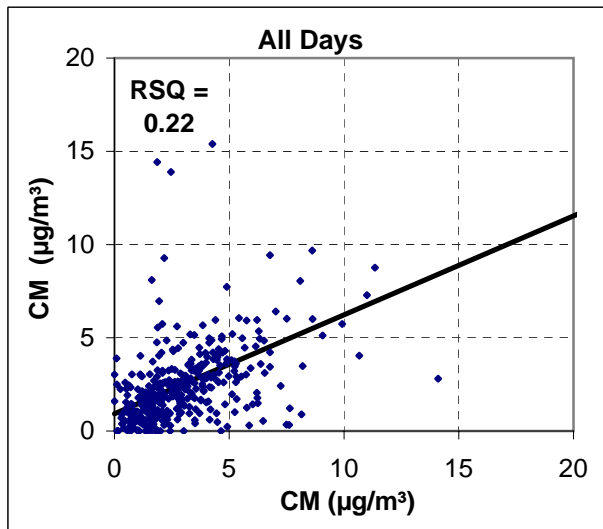
COHU1 vs. GRSM1 Soil



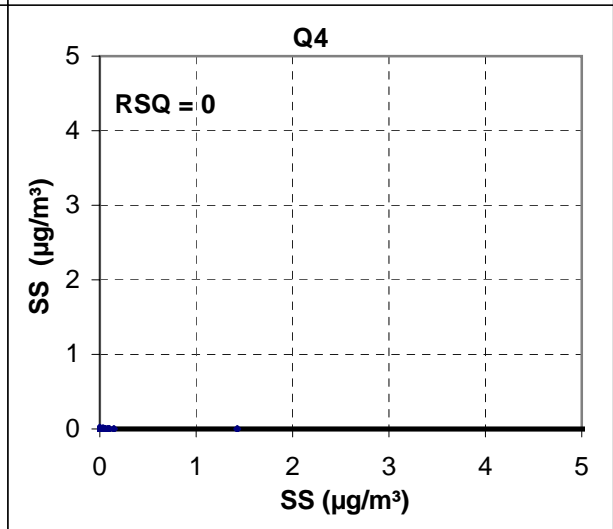
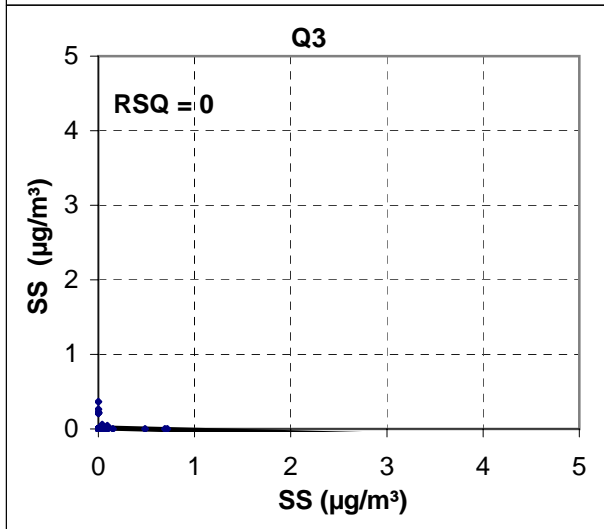
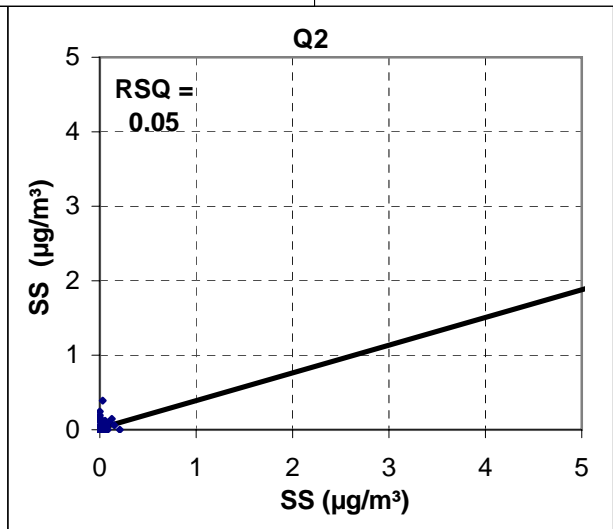
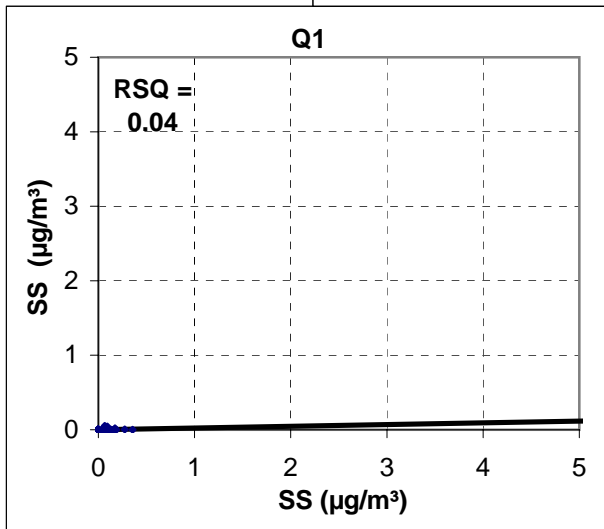
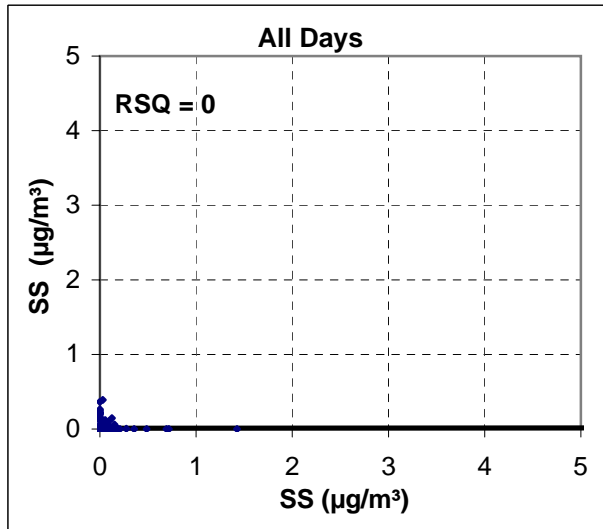
COHU1 vs. GRSM1 Light Absorbing Carbon



COHU1 vs. GRSM1 Coarse Mass



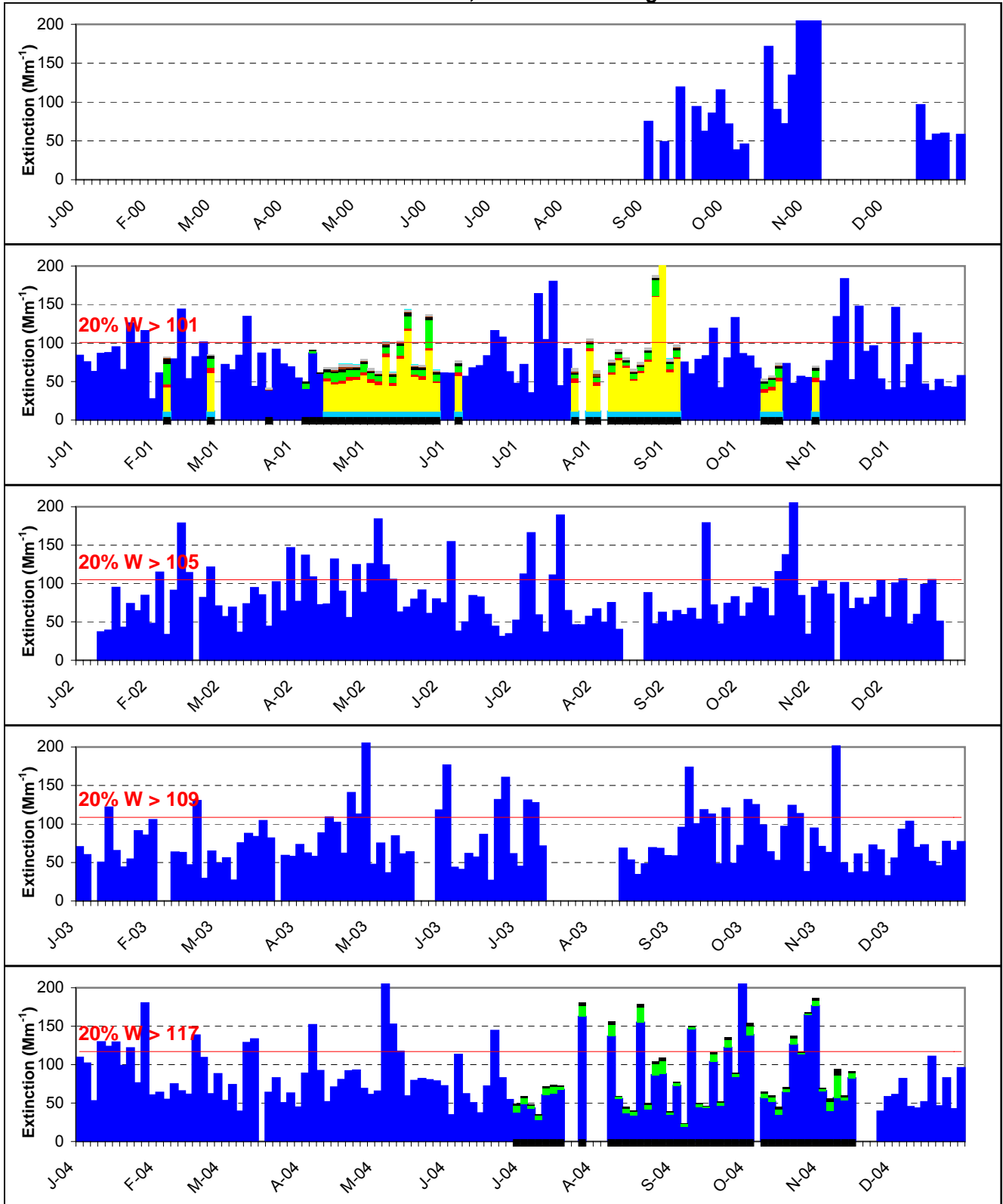
COHU1 vs. GRSM1 Sea Salt



**St. Marks, FL
Statistics for Substitutions**

SAMA1						
Components	KT Stats	All	1	2	3	4
OC vs. org_H	Slope	8.97	9.93	9.16	7.18	7.43
	Intercept	0.18	0.22	0.07	0.31	0.42
	R2	0.88	0.91	0.94	0.71	0.82
EC vs. OC	Slope	0.15	0.16	0.11	0.16	0.18
	Intercept	0.11	0.16	0.10	0.02	0.08
	R2	0.68	0.68	0.80	0.65	0.77
SAMA1 vs. CHAS1						
Components	KT Stats	All	1	2	3	4
SO4	Slope	0.73	0.57	0.63	0.76	0.83
	Intercept	1.48	1.65	1.95	1.69	1.19
	R2	0.42	0.37	0.30	0.41	0.57
NO3	Slope	0.71	0.78	0.42	0.59	0.59
	Intercept	0.08	0.13	0.17	0.05	0.13
	R2	0.38	0.27	0.39	0.44	0.42
OC	Slope	0.54	0.59	0.46	0.39	0.43
	Intercept	0.13	0.19	0.14	0.10	0.18
	R2	0.29	0.27	0.12	0.18	0.33
LAC	Slope	0.63	0.74	0.66	0.72	0.47
	Intercept	0.72	0.64	0.79	0.34	0.95
	R2	0.21	0.29	0.08	0.33	0.29
Soil	Slope	0.44	0.75	0.42	0.36	0.74
	Intercept	0.27	0.07	0.58	0.33	0.10
	R2	0.45	0.44	0.45	0.35	0.42
CM	Slope	0.35	0.27	0.27	0.22	0.41
	Intercept	2.43	2.04	3.14	4.27	2.06
	R2	0.19	0.05	0.28	0.07	0.21
Sea Salt	Slope	0.00	0.00	-0.02	-0.01	0.00
	Intercept	0.01	0.00	0.02	0.00	0.00
	R2	0.00	0.01	0.01	0.00	0.00

SAMA1 (CHAS1 donor)
Baseline Extinction, New IMPROVE Algorithm



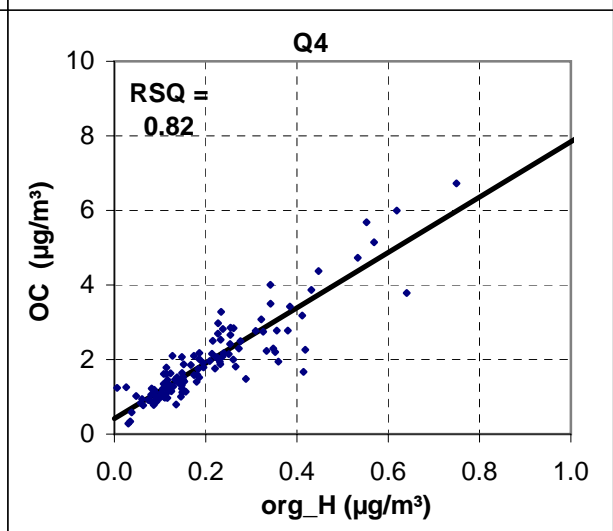
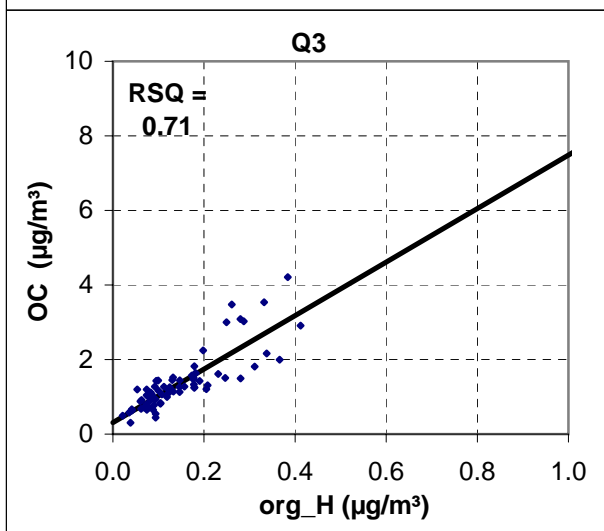
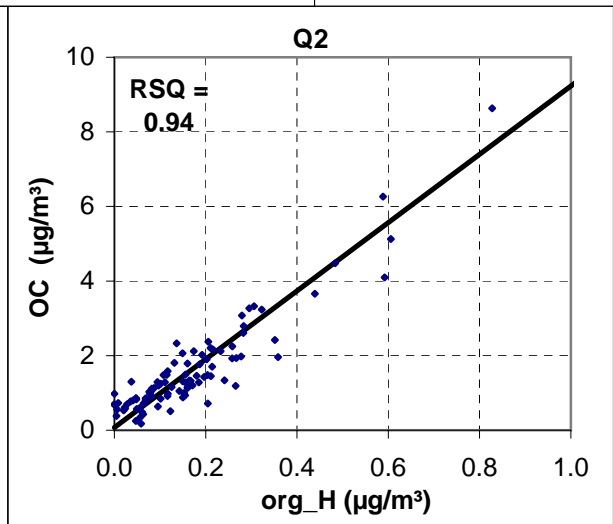
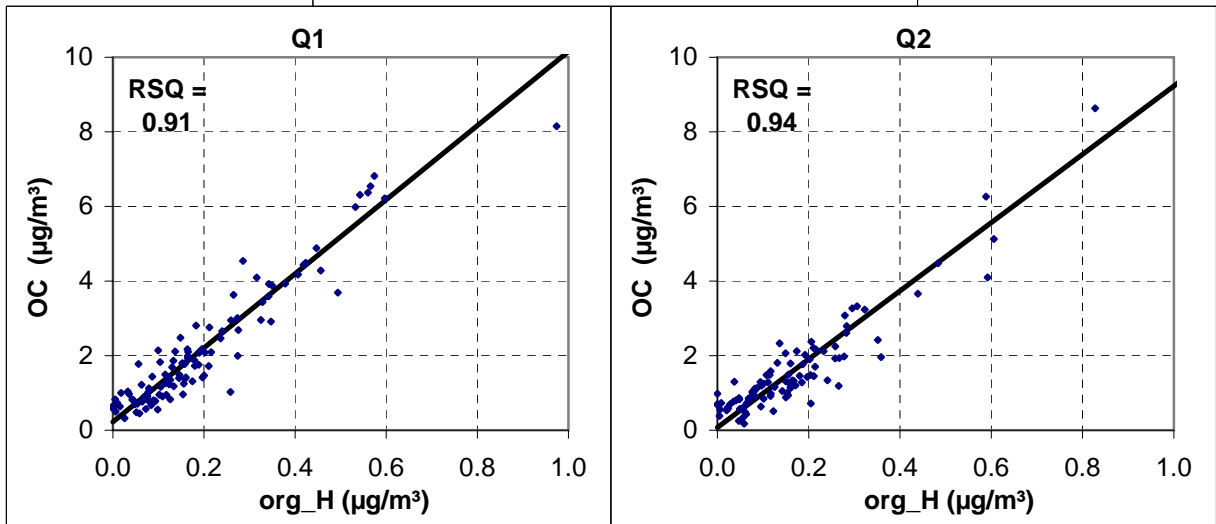
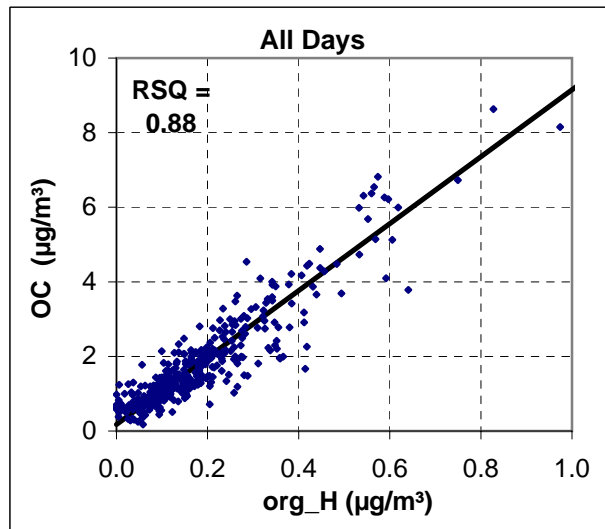
■ RHR
 ■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

SAMA1 (CHAS1 donor)
Baseline Extinction, New IMPROVE Algorithm

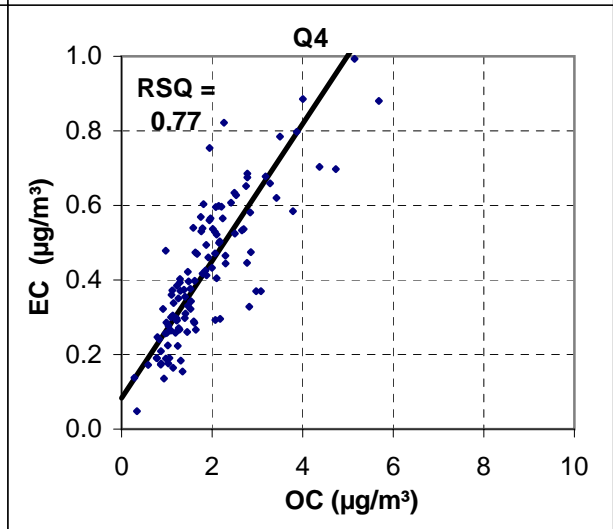
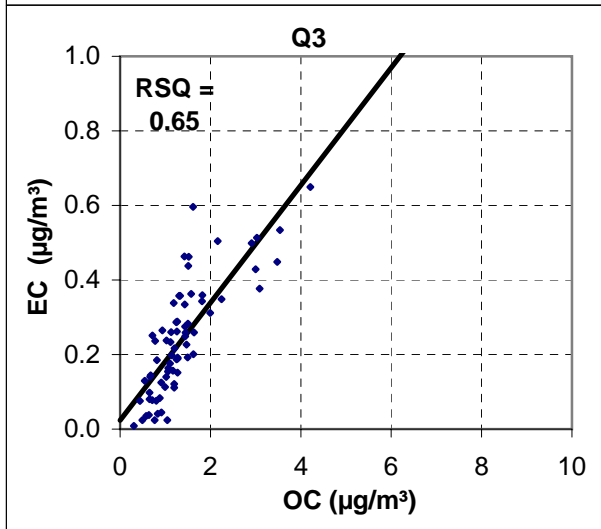
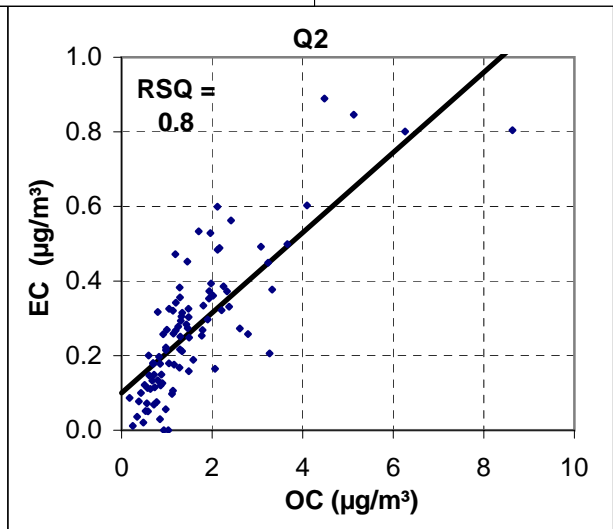
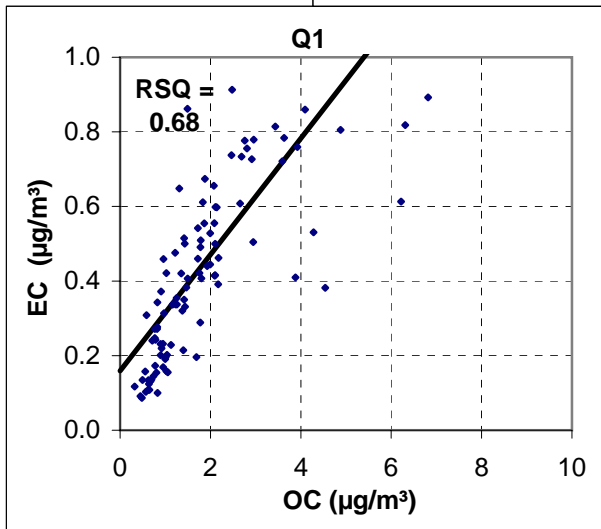
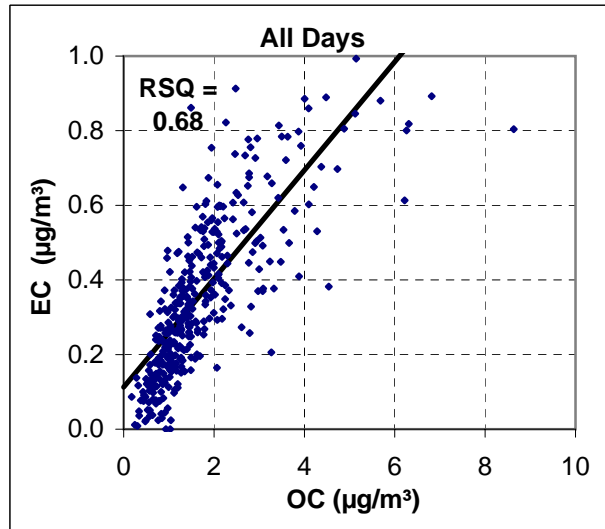


SAMA1

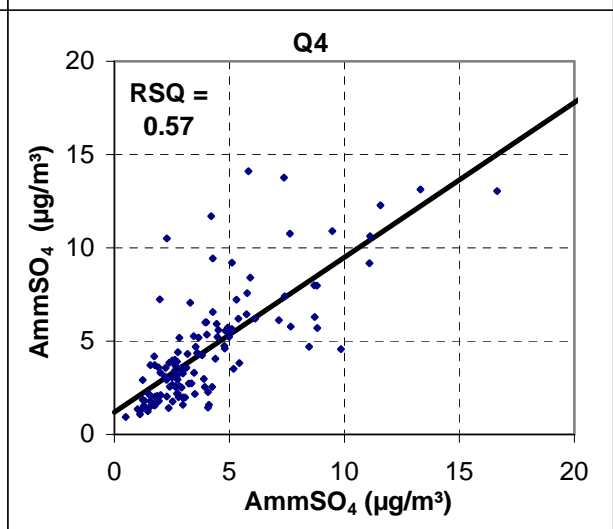
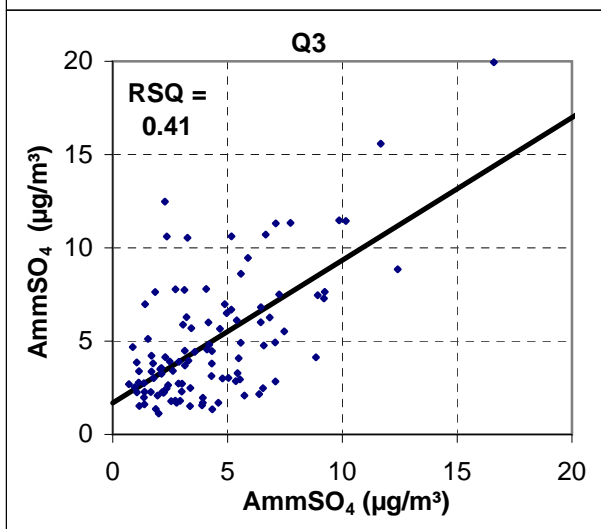
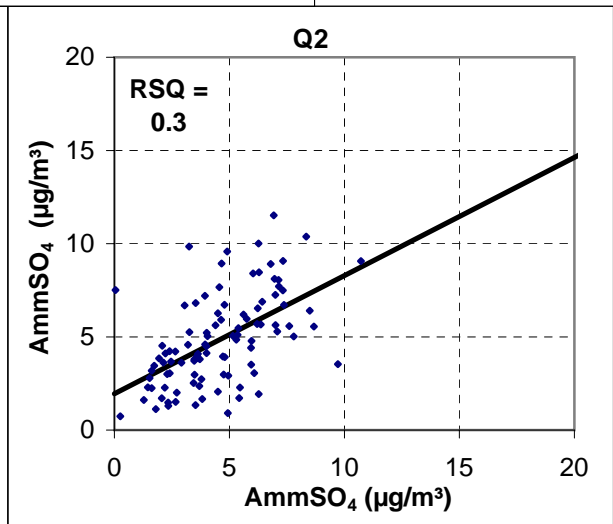
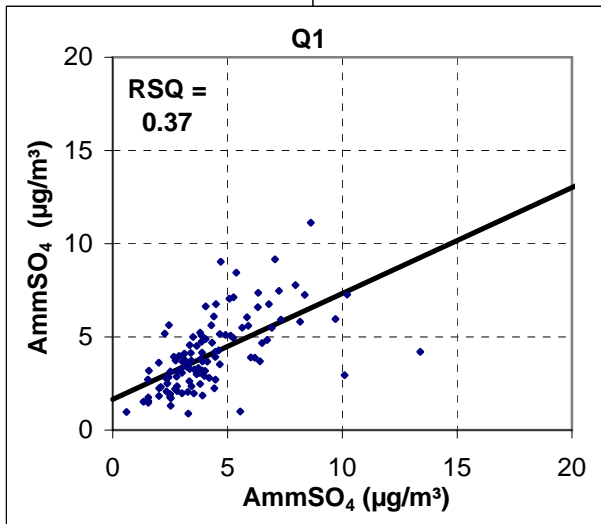
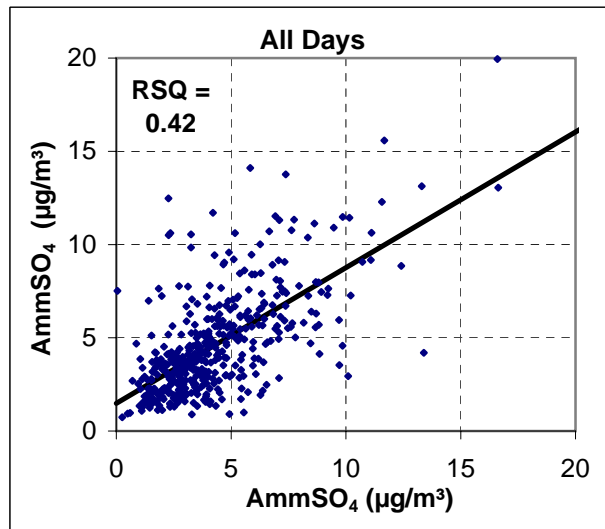
OC vs. org_H



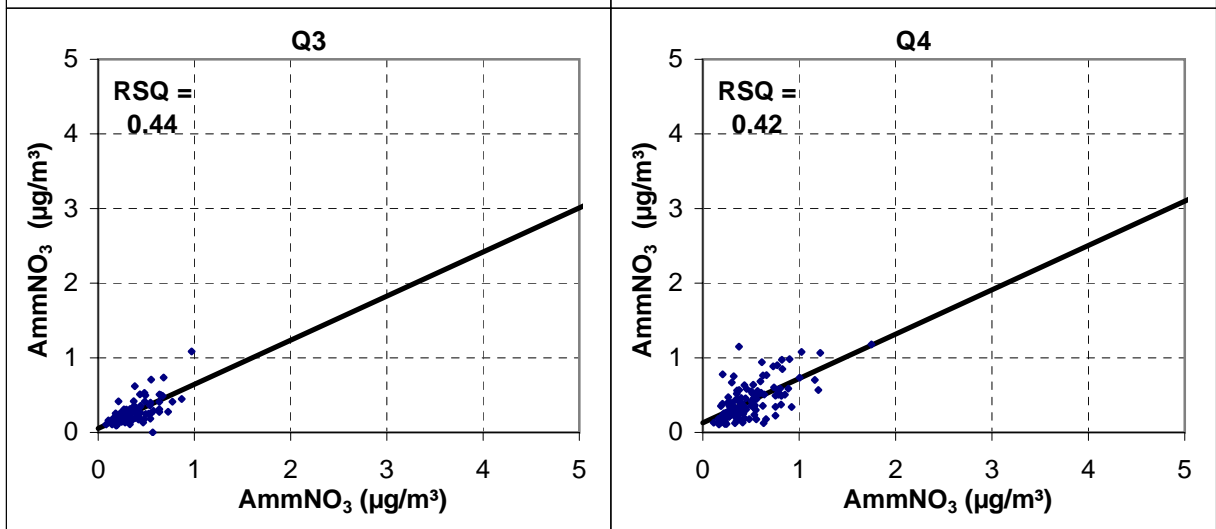
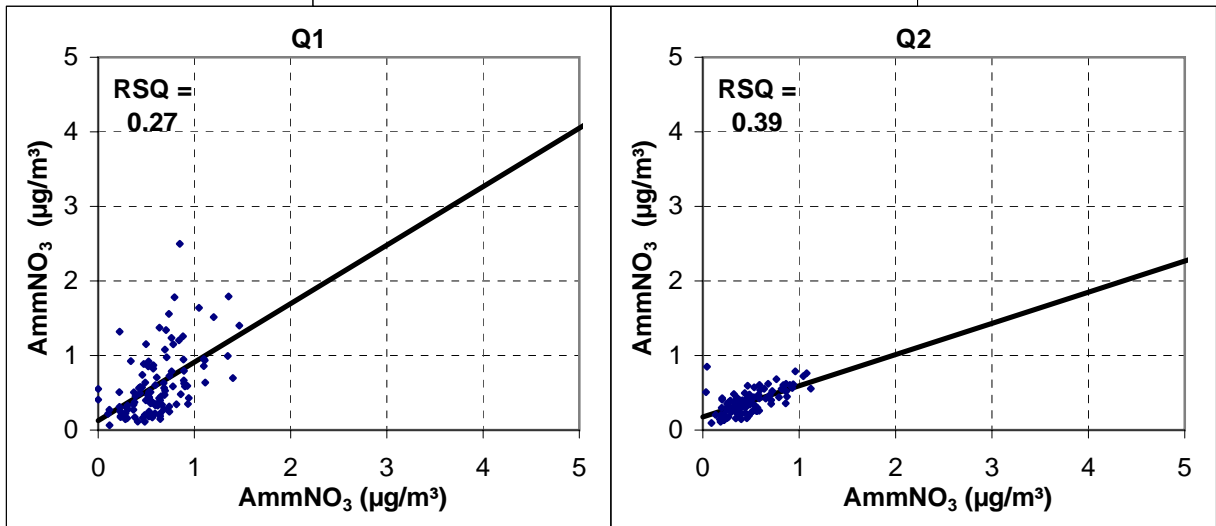
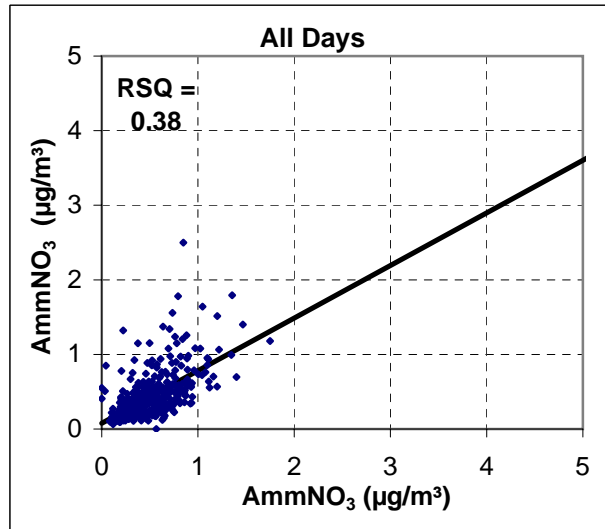
SAMA1 EC vs. OC



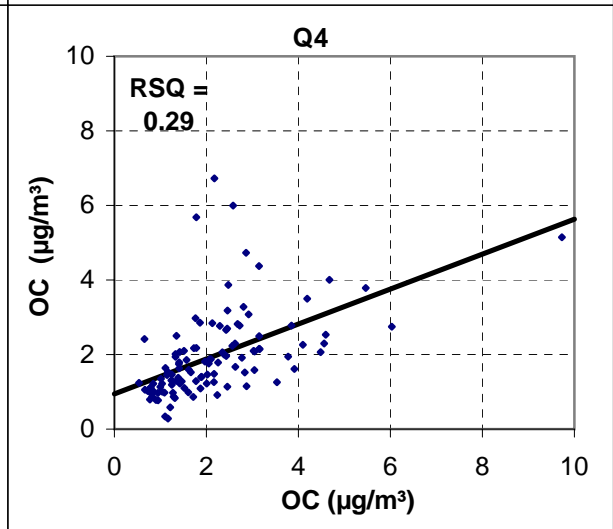
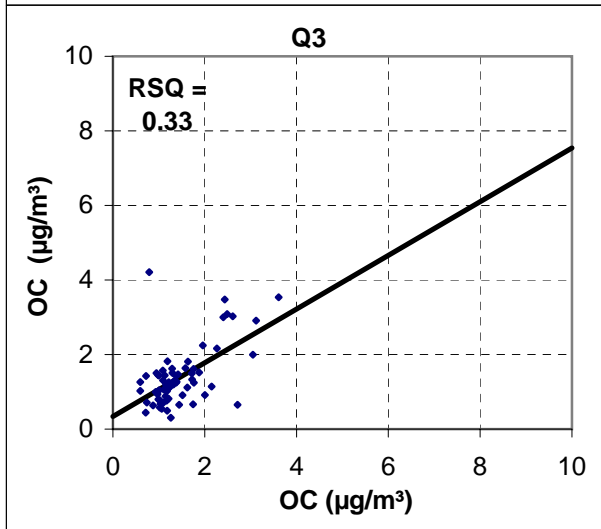
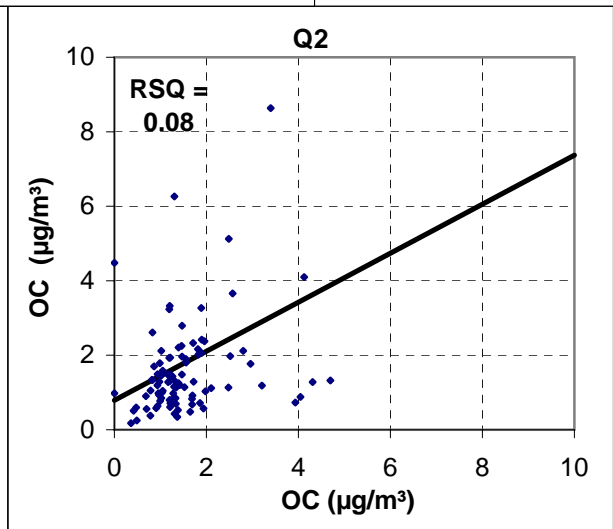
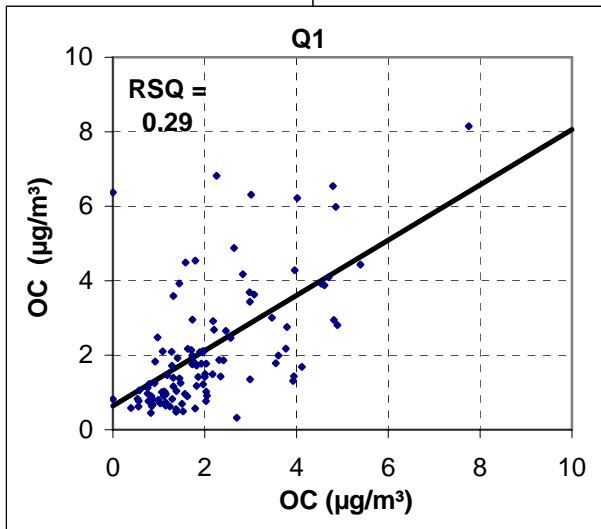
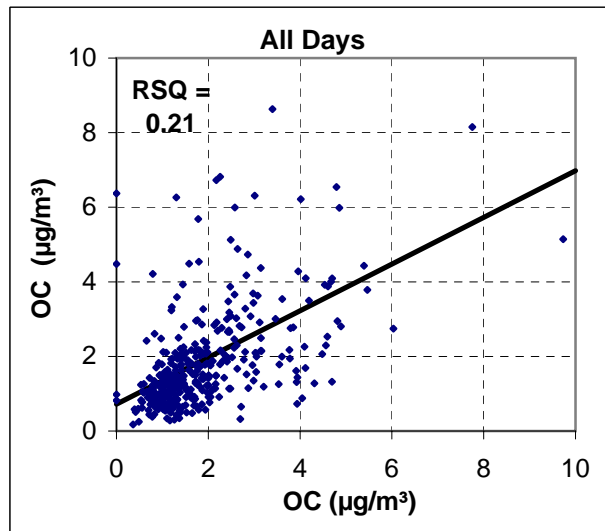
SAMA1 vs. CHAS1 Ammonium Sulfate



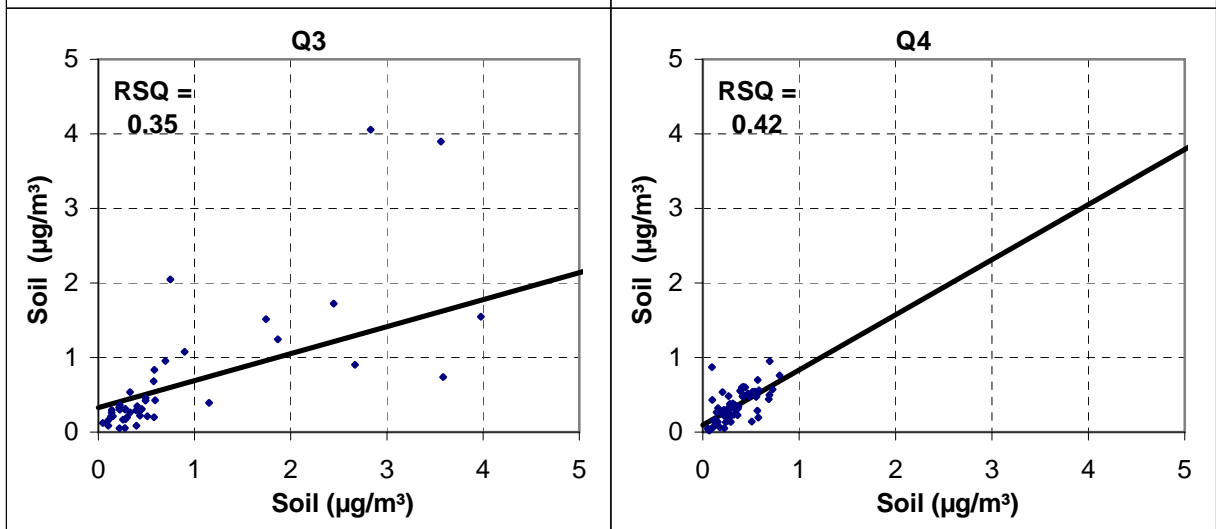
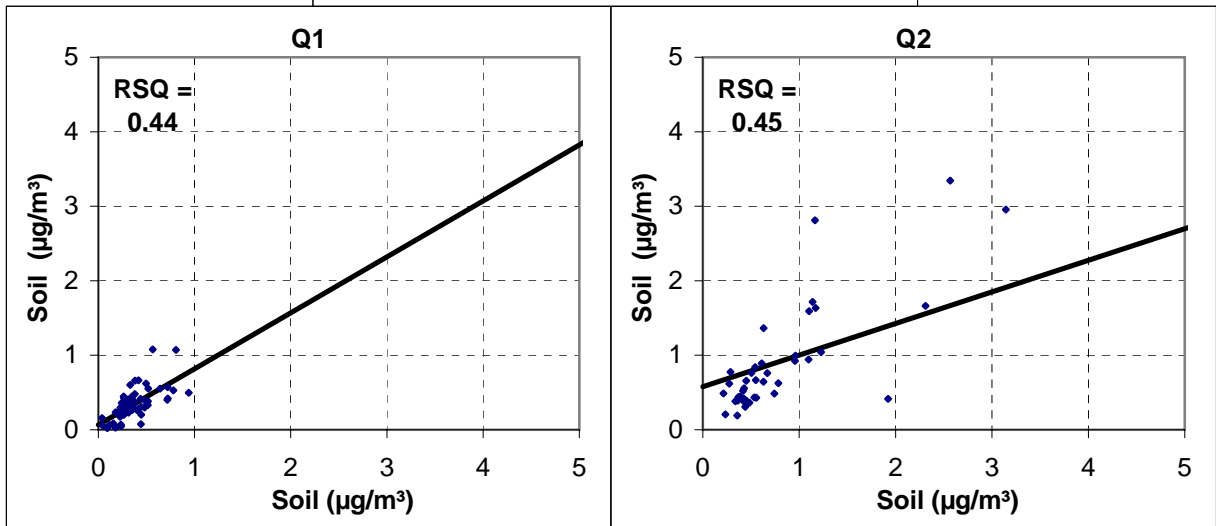
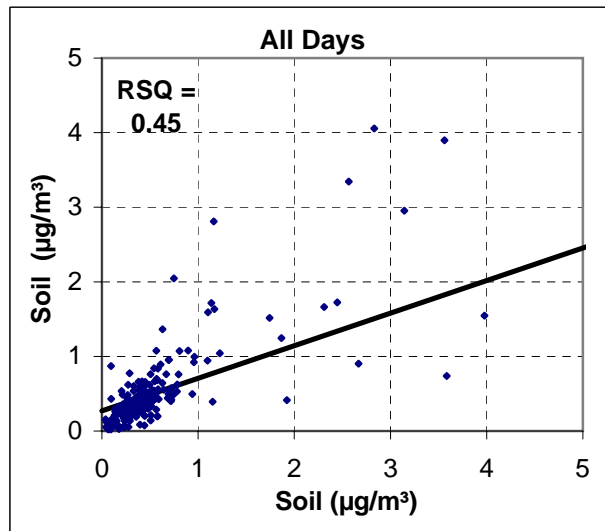
SAMA1 vs. CHAS1 Ammonium Nitrate



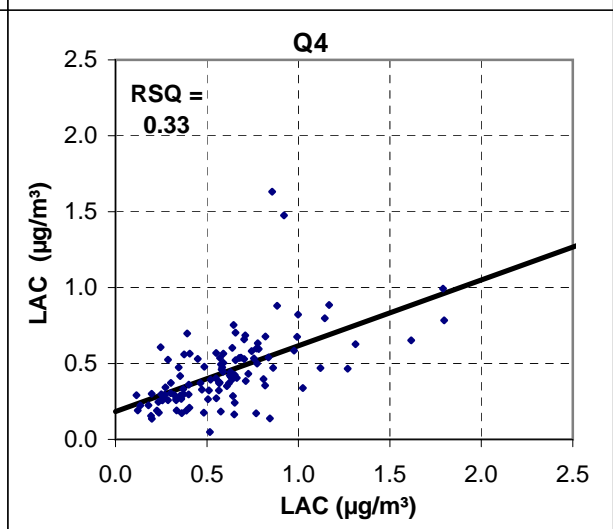
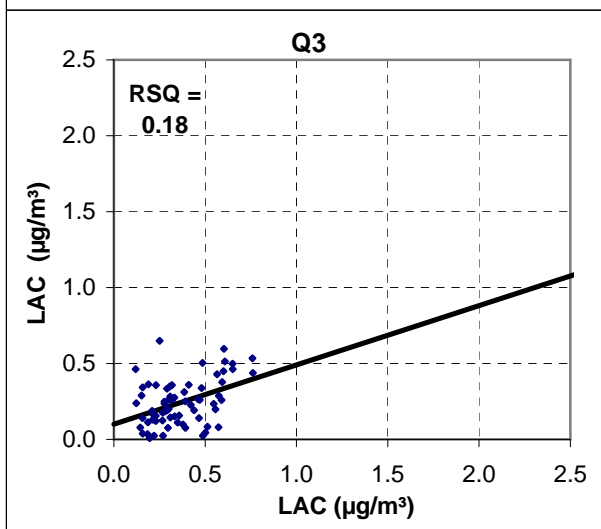
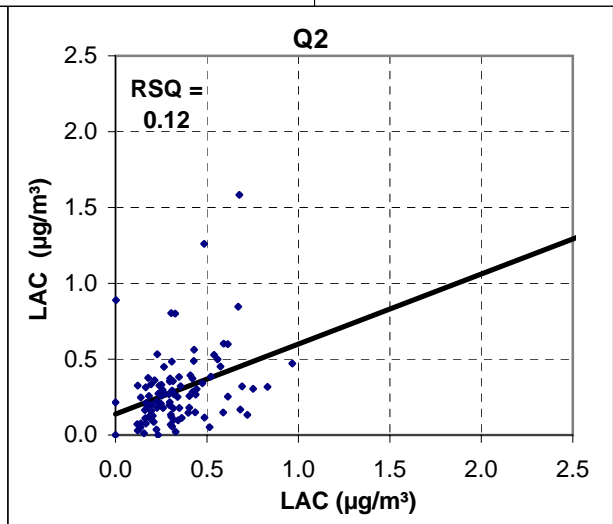
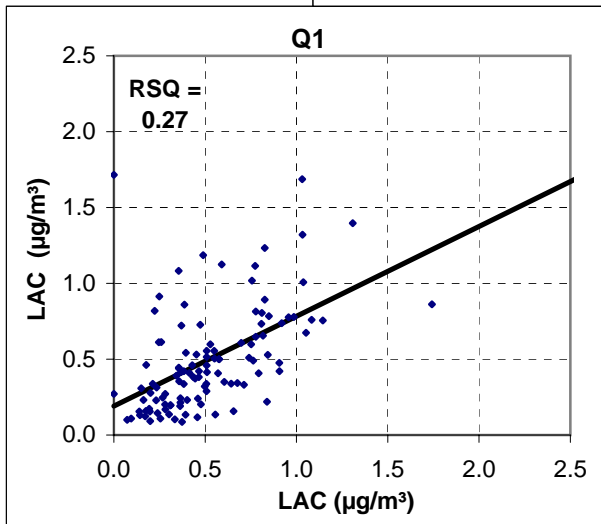
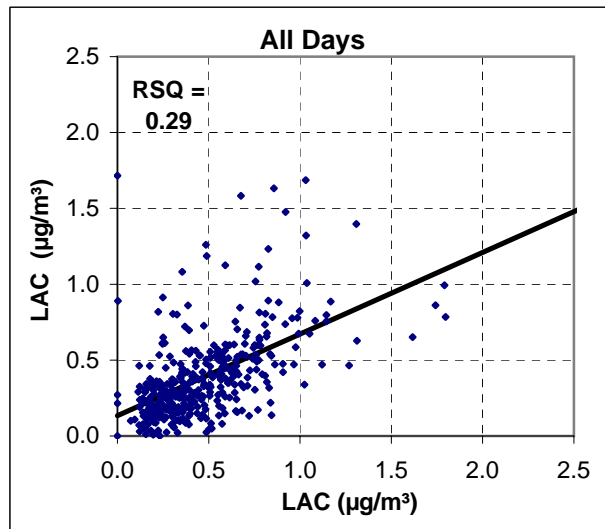
SAMA1 vs. CHAS1 Organic Carbon



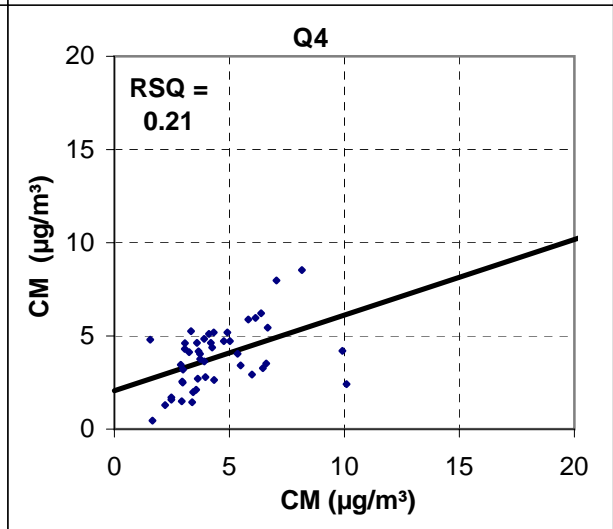
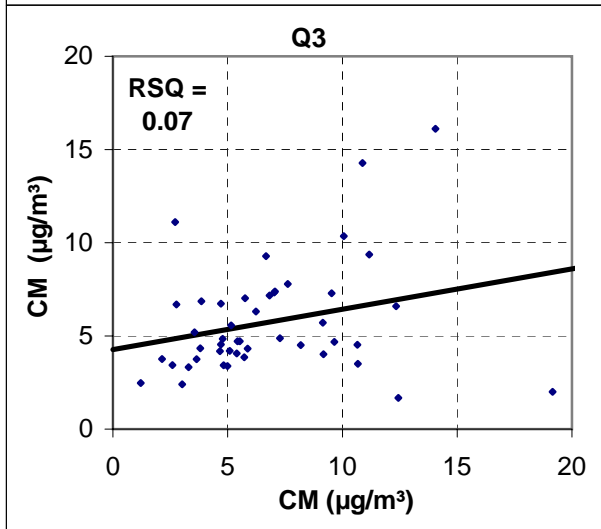
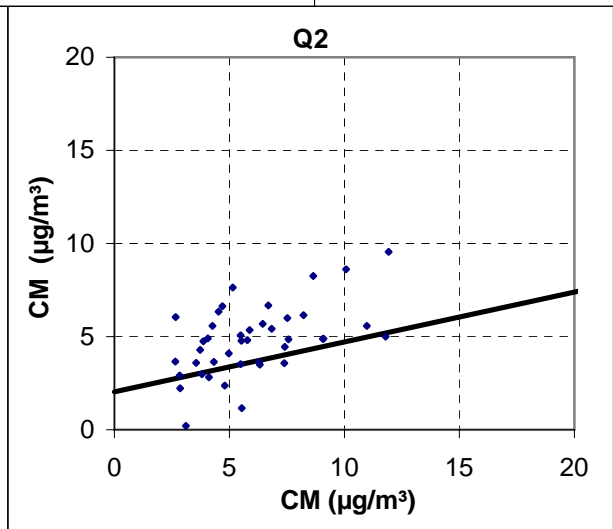
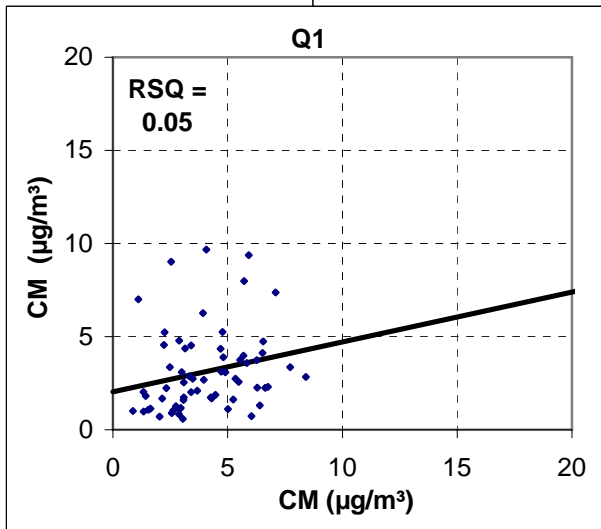
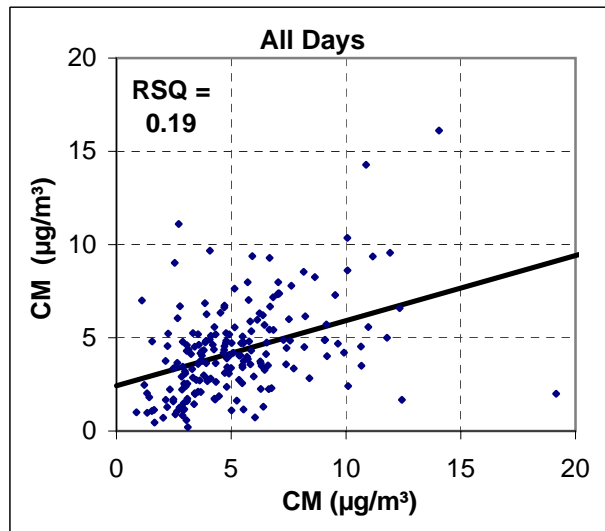
SAMA1 vs. CHAS1 Soil



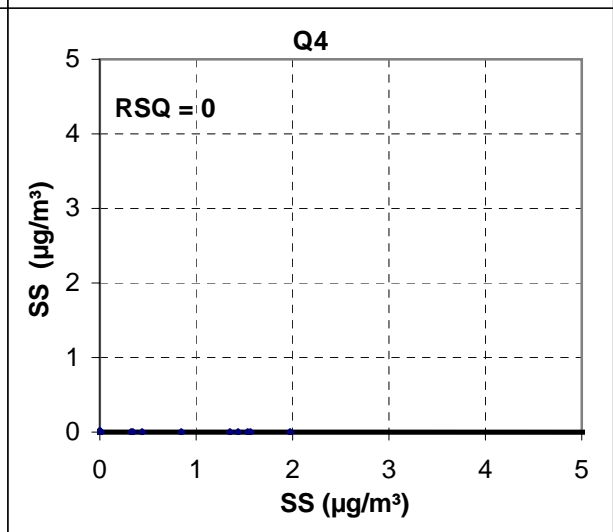
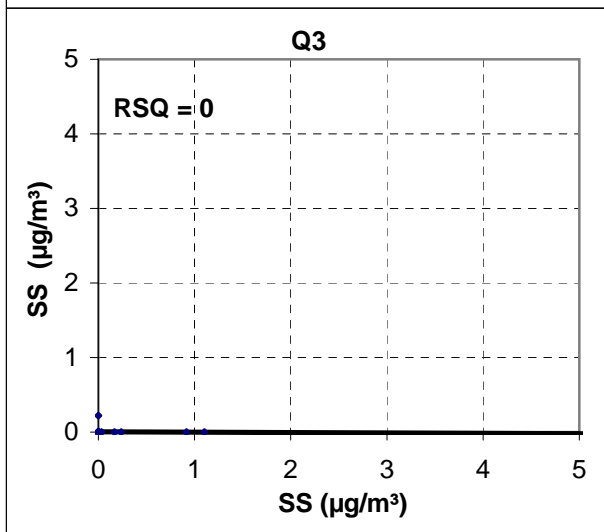
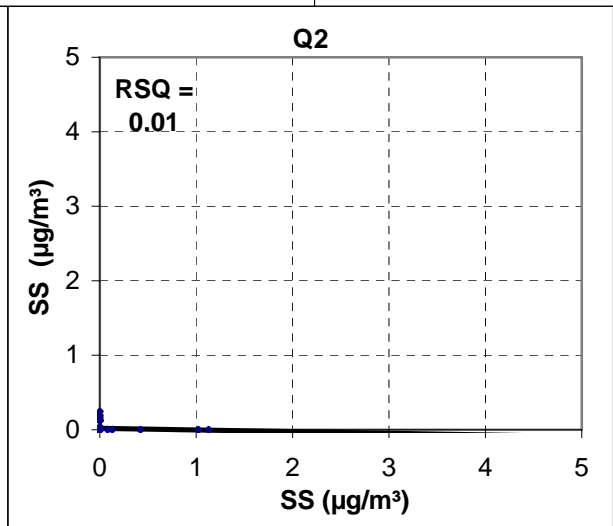
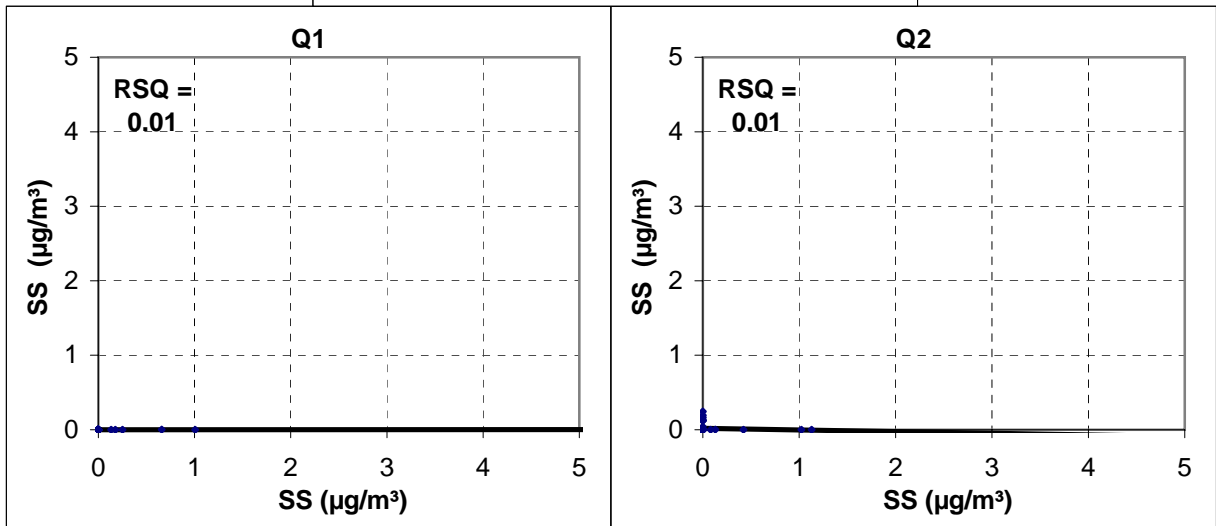
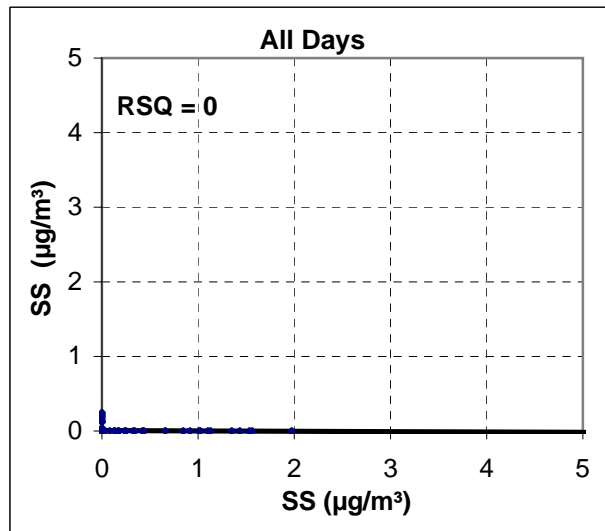
SAMA1 vs. CHAS1 Light Absorbing Carbon



SAMA1 vs. CHAS1 Coarse Mass



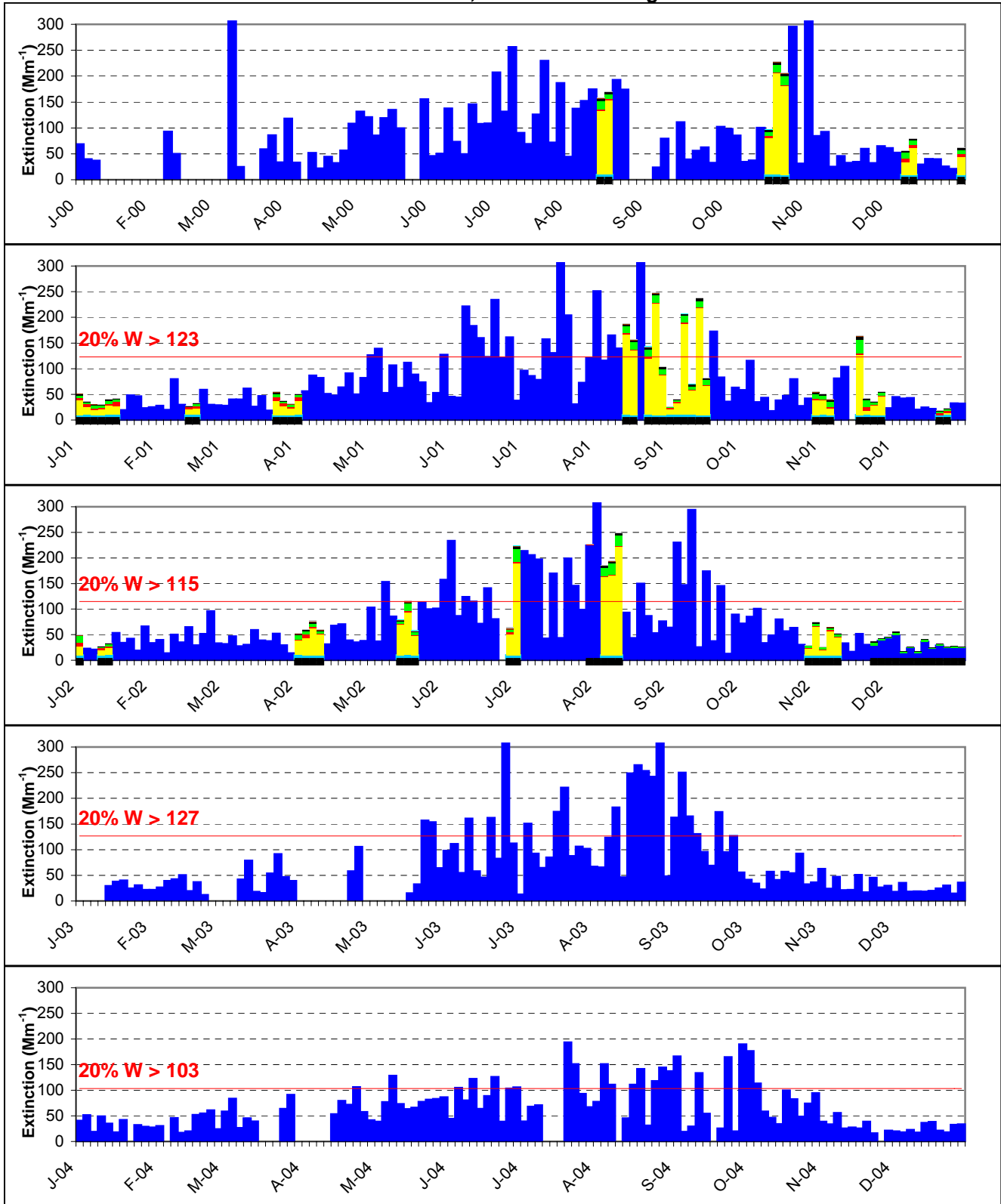
SAMA1 vs. CHAS1 Sea Salt



**Shining Rock Wilderness, NC
Statistics for Substitutions**

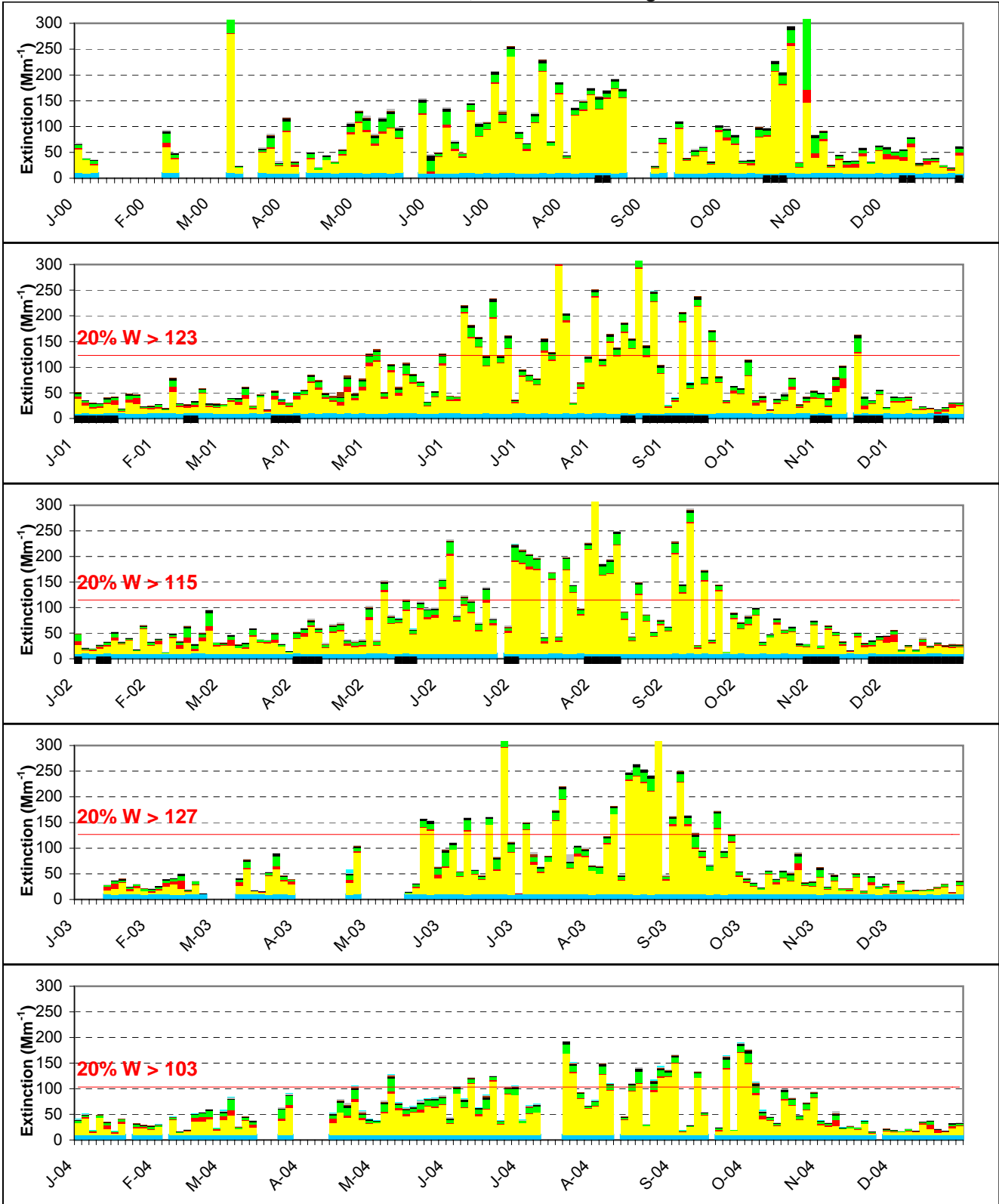
SHRO1						
Components	KT Stats	All	1	2	3	4
OC vs. org_H	Slope	7.22	9.38	5.28	3.77	7.74
	Intercept	0.29	0.06	0.72	0.94	0.13
	R2	0.86	0.92	0.55	0.36	0.98
EC vs. OC	Slope	0.13	0.15	0.13	0.13	0.13
	Intercept	0.06	0.04	0.05	0.05	0.07
	R2	0.84	0.87	0.65	0.46	0.97
SHRO1 vs. GRSM1						
Components	KT Stats	All	1	2	3	4
SO4	Slope	0.81	0.47	0.69	0.80	0.77
	Intercept	-0.28	0.48	0.85	0.25	-0.36
	R2	0.75	0.42	0.68	0.61	0.82
NO3	Slope	0.23	0.18	0.81	0.20	0.26
	Intercept	0.19	0.23	0.09	0.17	0.15
	R2	0.33	0.22	0.62	0.09	0.39
OC	Slope	0.53	0.34	0.55	0.68	0.52
	Intercept	0.03	0.05	0.06	0.00	0.01
	R2	0.39	0.32	0.49	0.52	0.36
LAC	Slope	0.43	0.56	0.73	0.83	0.38
	Intercept	0.55	0.03	0.20	0.04	0.42
	R2	0.32	0.58	0.60	0.58	0.28
Soil	Slope	0.99	0.67	1.14	0.84	0.72
	Intercept	0.01	0.11	-0.08	0.08	0.08
	R2	0.76	0.22	0.80	0.71	0.31
CM	Slope	0.46	0.36	0.67	0.40	0.17
	Intercept	-0.14	-0.09	-0.60	0.15	0.36
	R2	0.53	0.35	0.73	0.47	0.23
Sea Salt	Slope	0.00	0.02	0.37	-0.03	0.00
	Intercept	0.01	0.00	0.02	0.02	0.00
	R2	0.00	0.04	0.05	0.00	0.00

SHRO1 (GRSM1 donor)
Baseline Extinction, New IMPROVE Algorithm



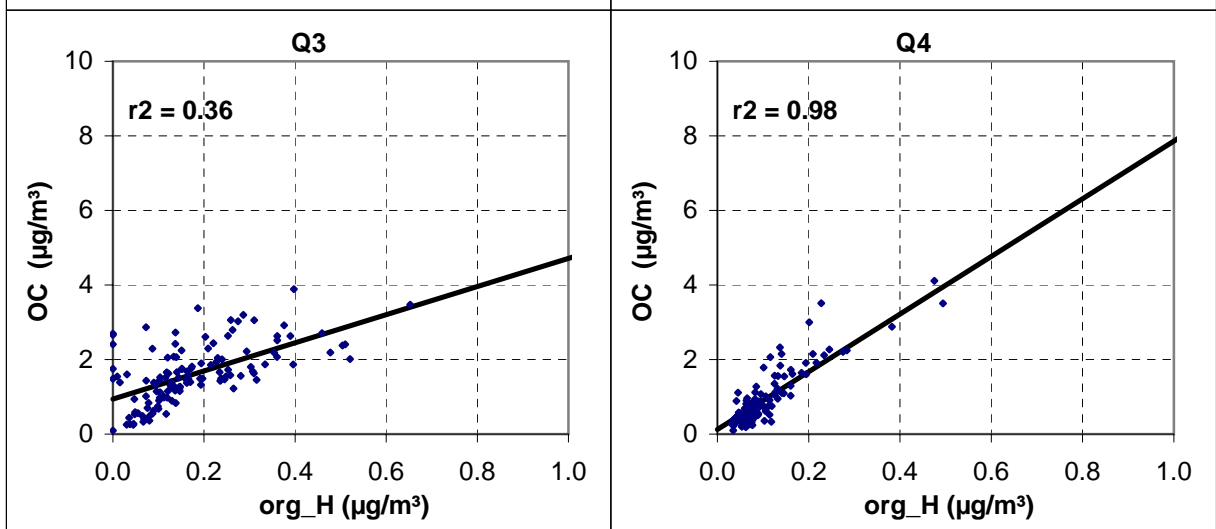
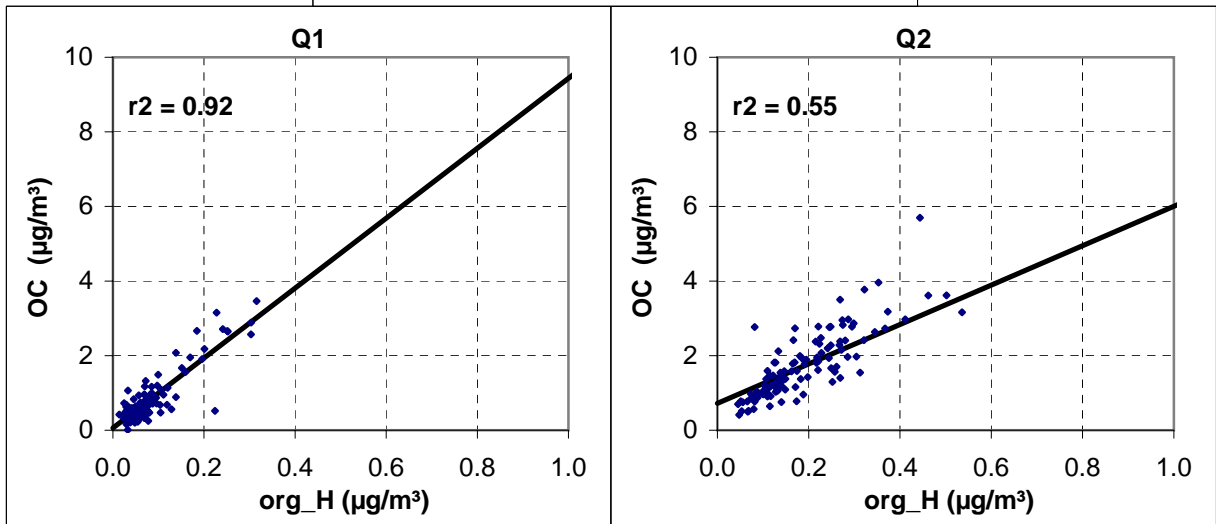
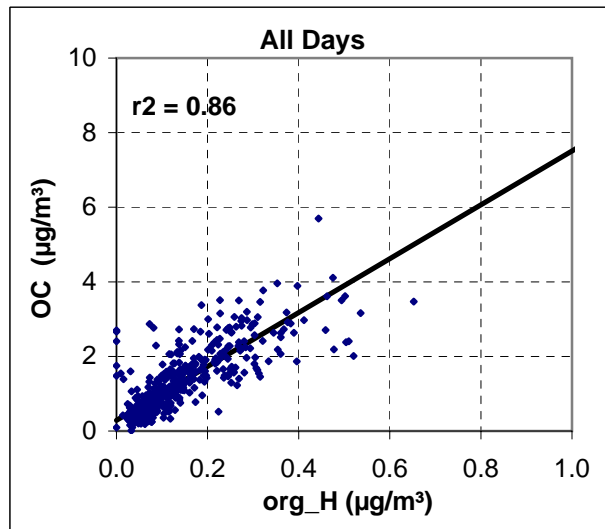
■ RHR
 ■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

SHRO1 (GRSM1 donor)
Baseline Extinction, New IMPROVE Algorithm

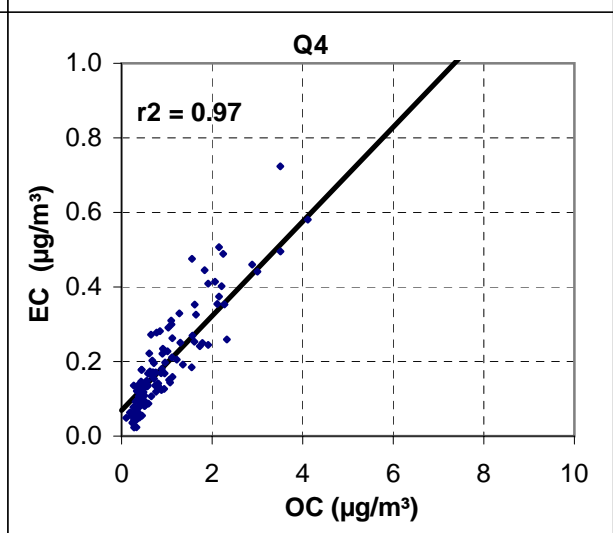
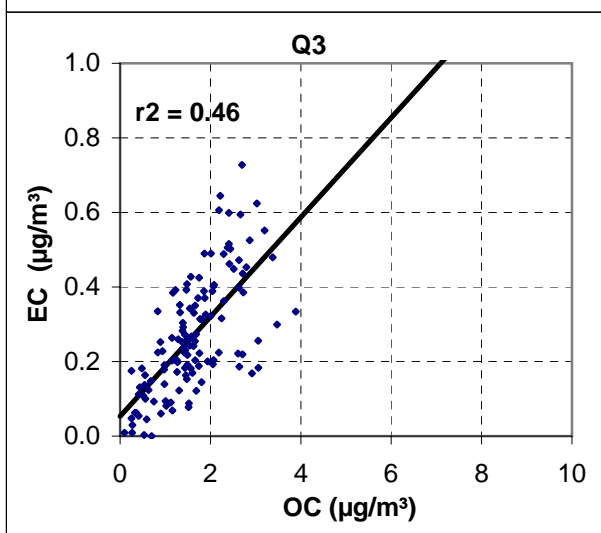
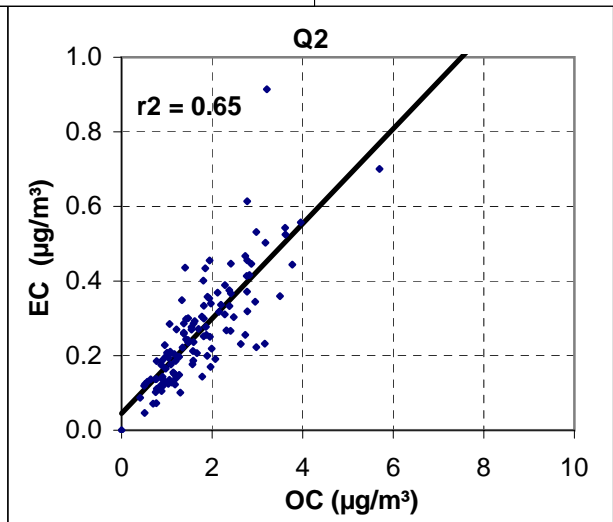
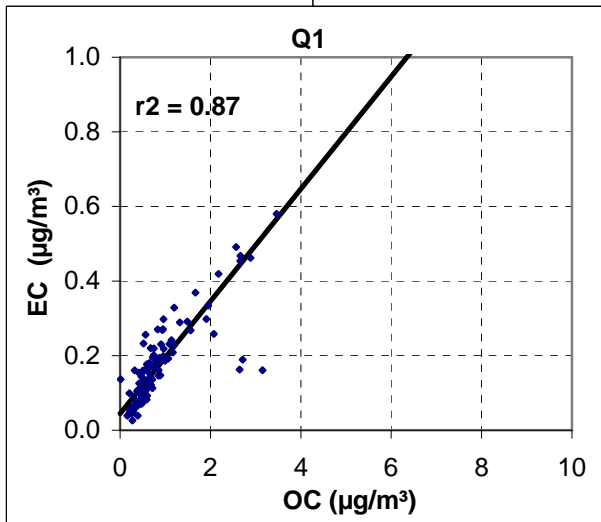
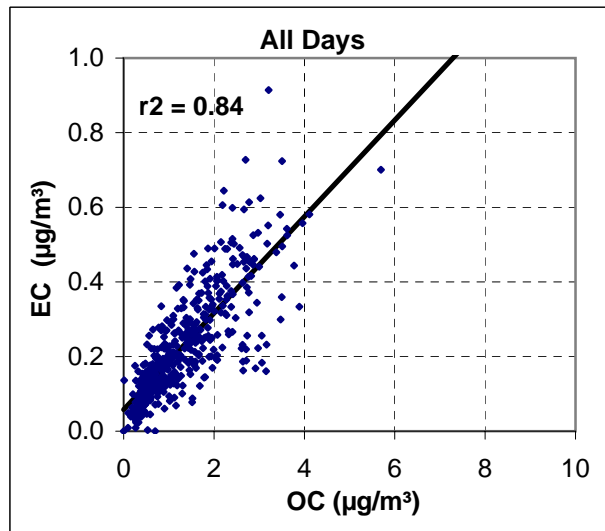


■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

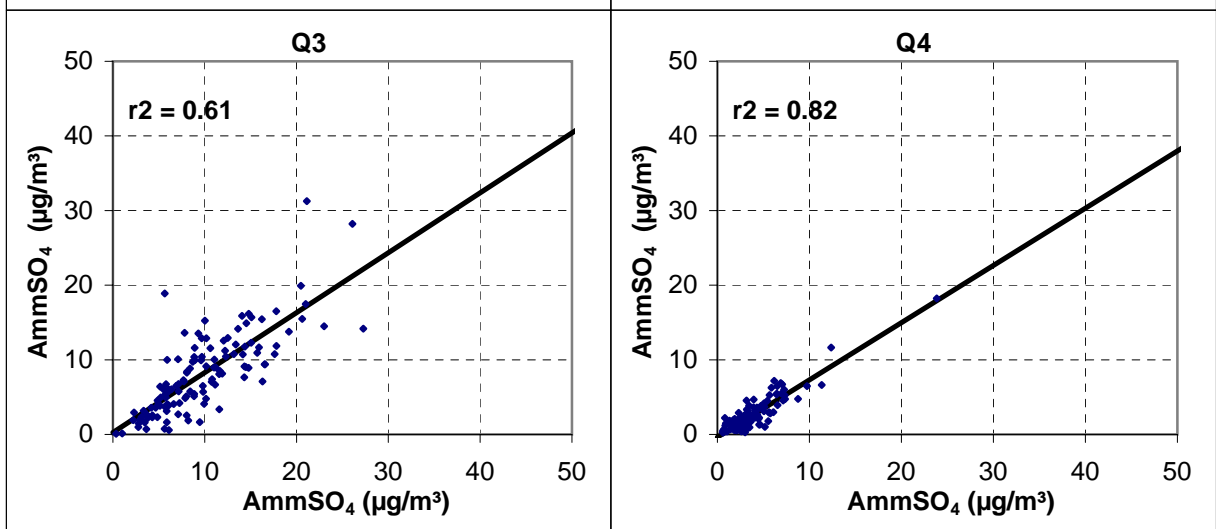
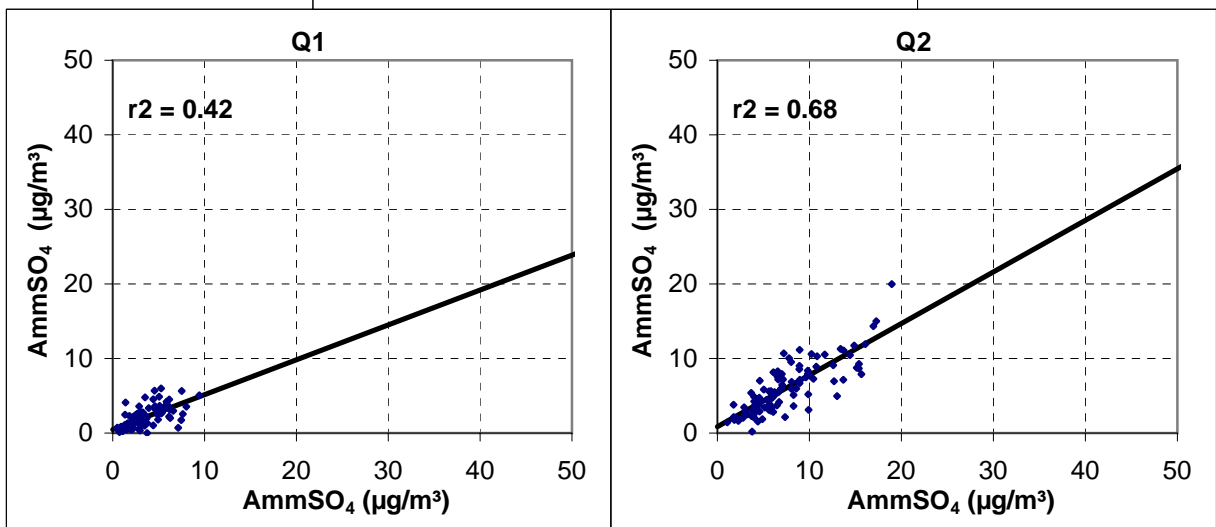
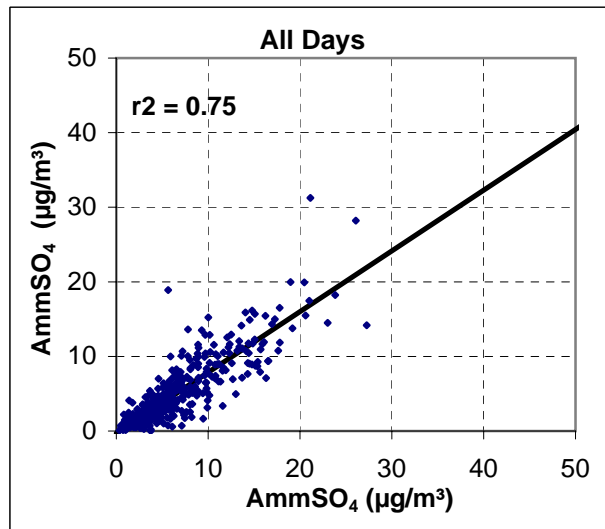
SHRO1 OC vs. org_H



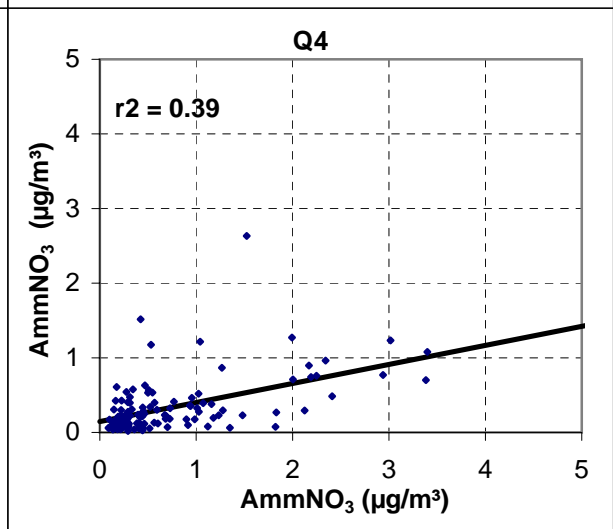
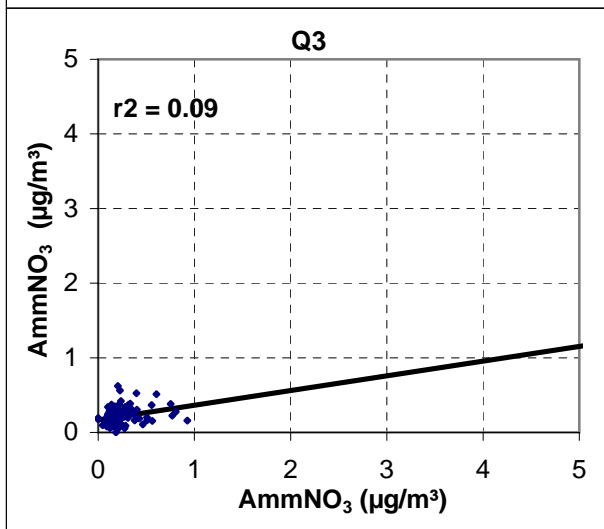
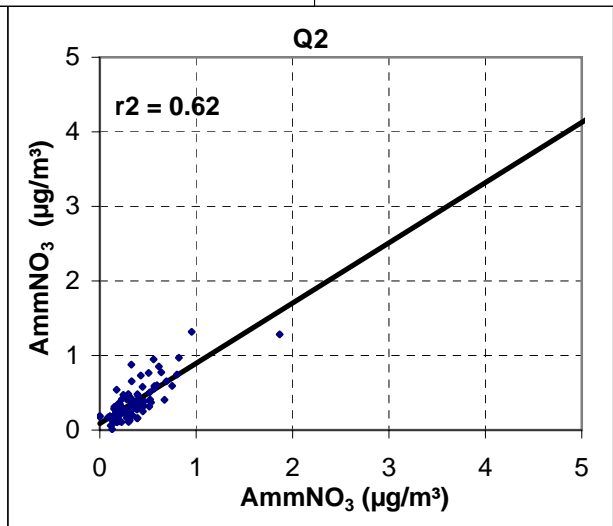
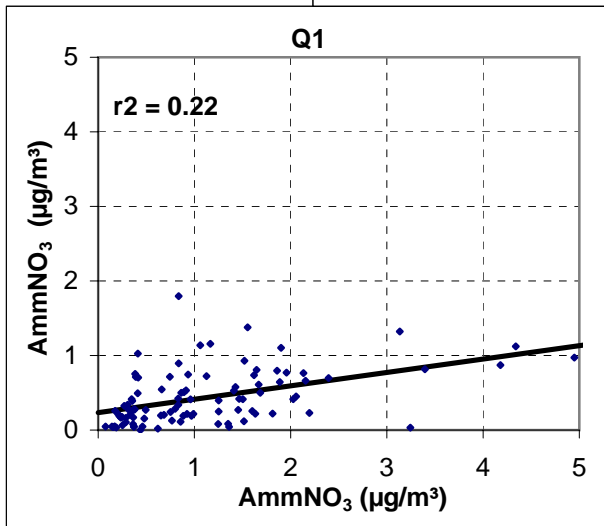
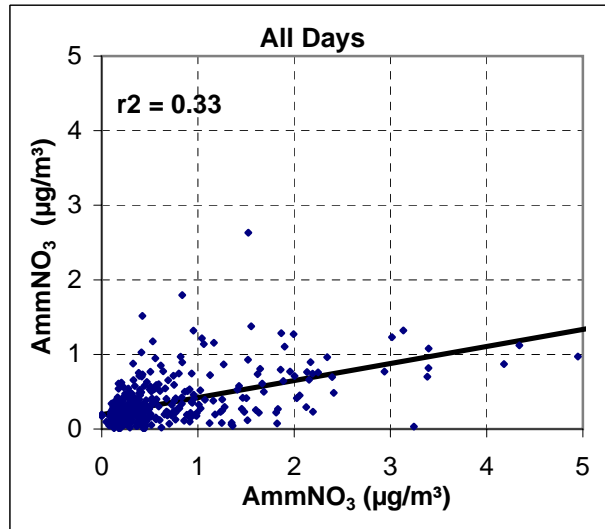
SHRO1 EC vs. OC



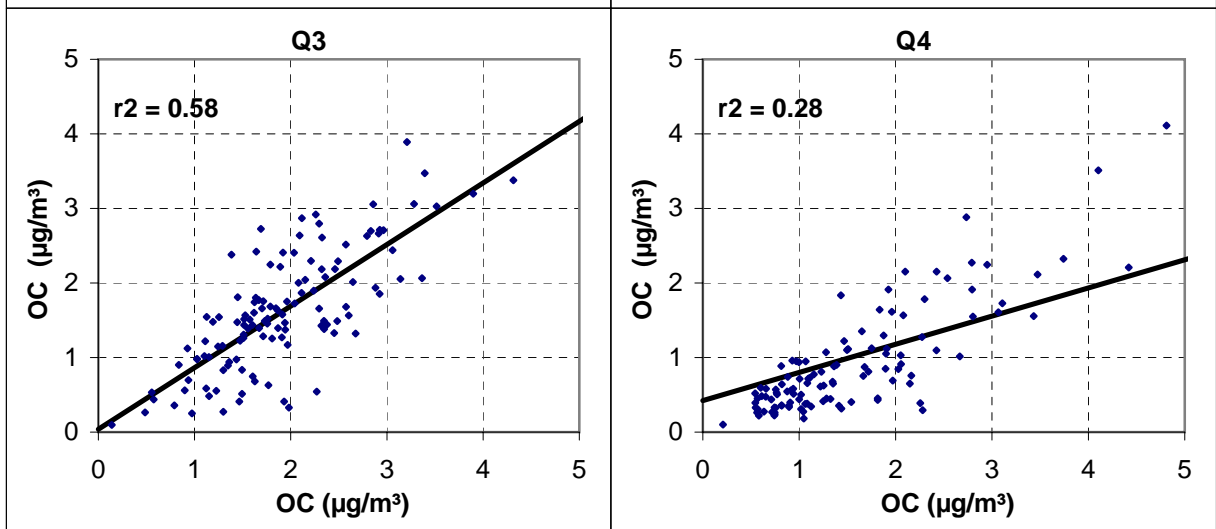
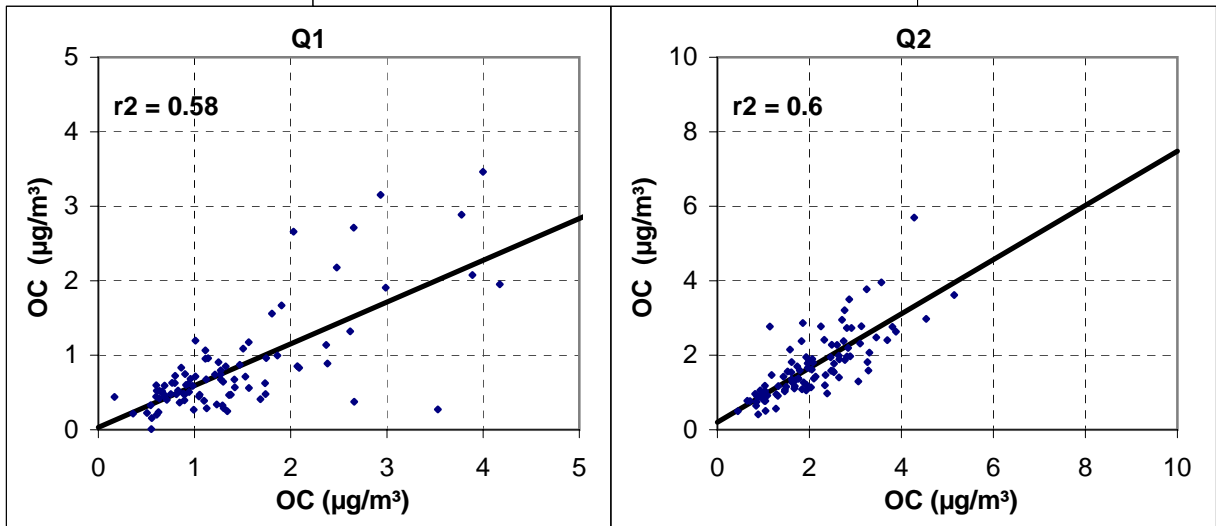
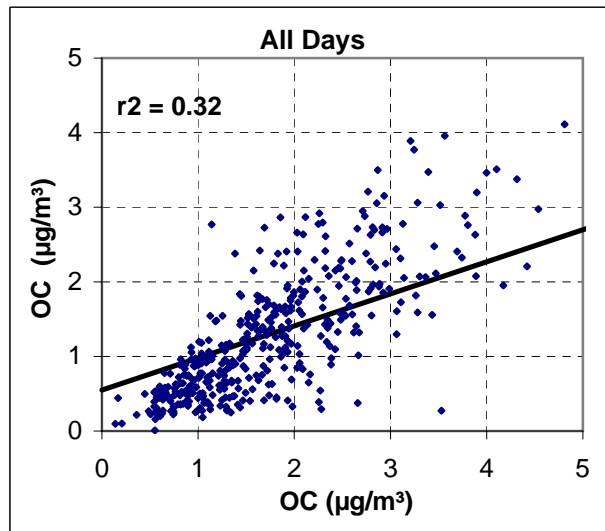
SHRO1 vs. GRSM1 Ammonium Sulfate



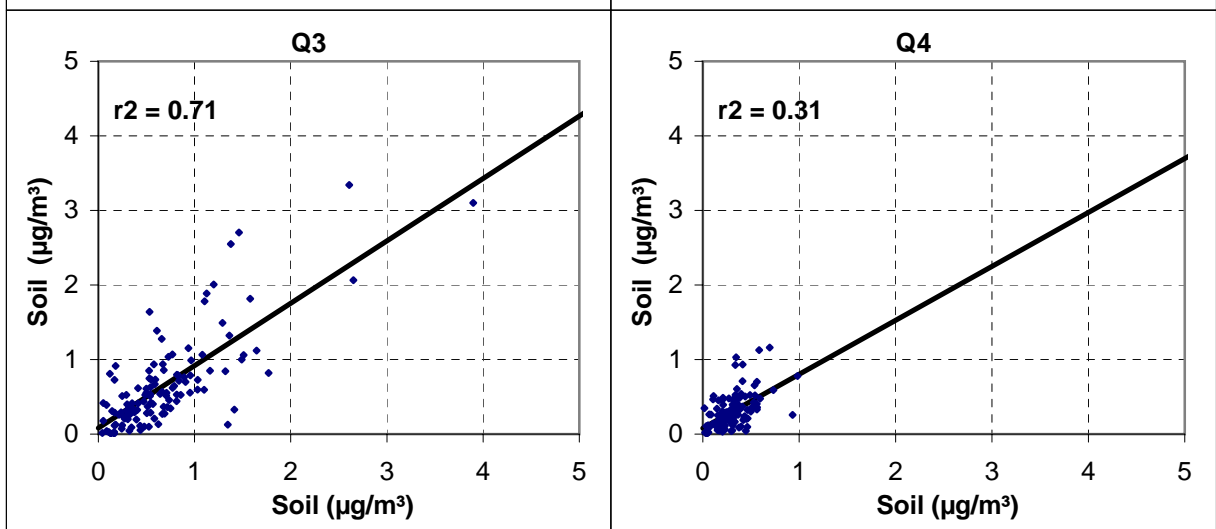
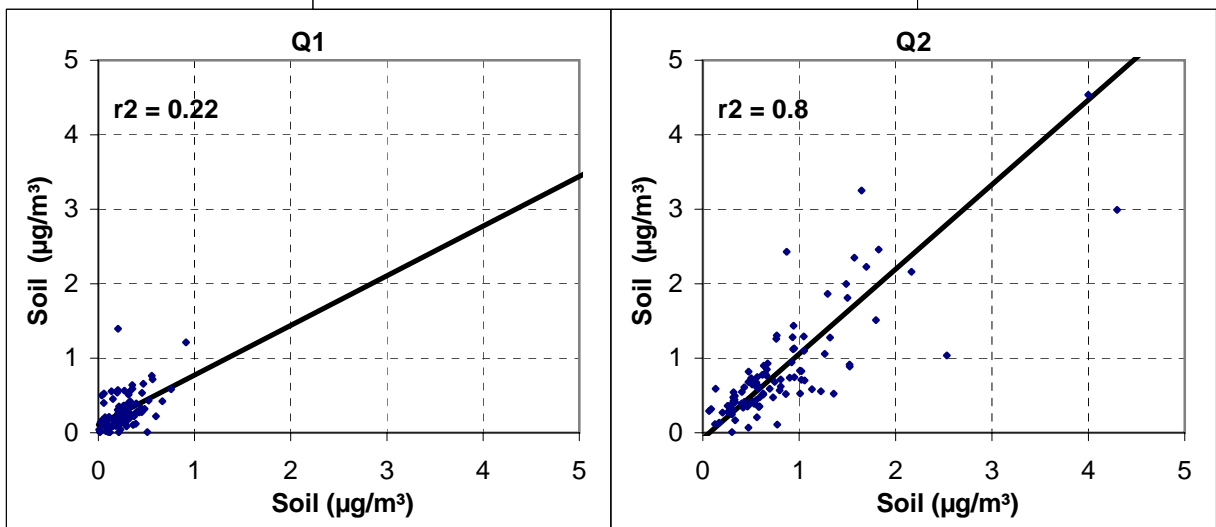
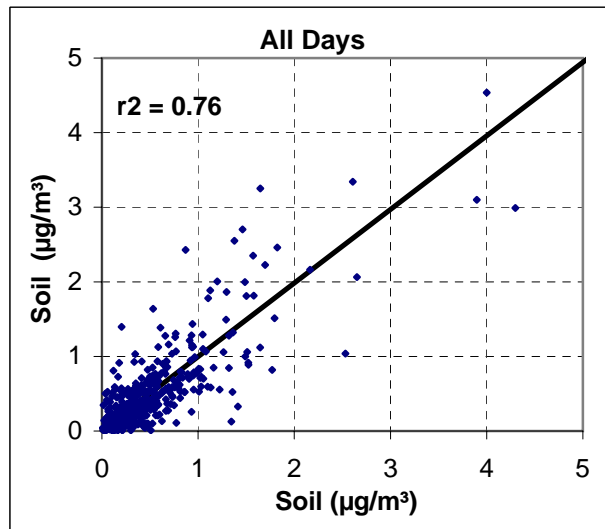
SHRO1 vs. GRSM1 Ammonium Nitrate



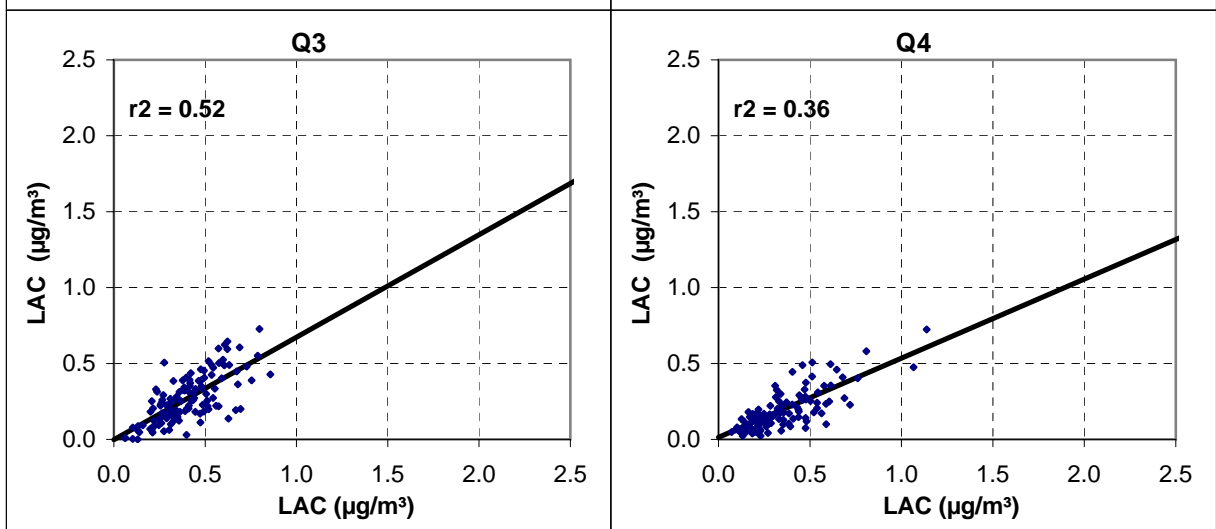
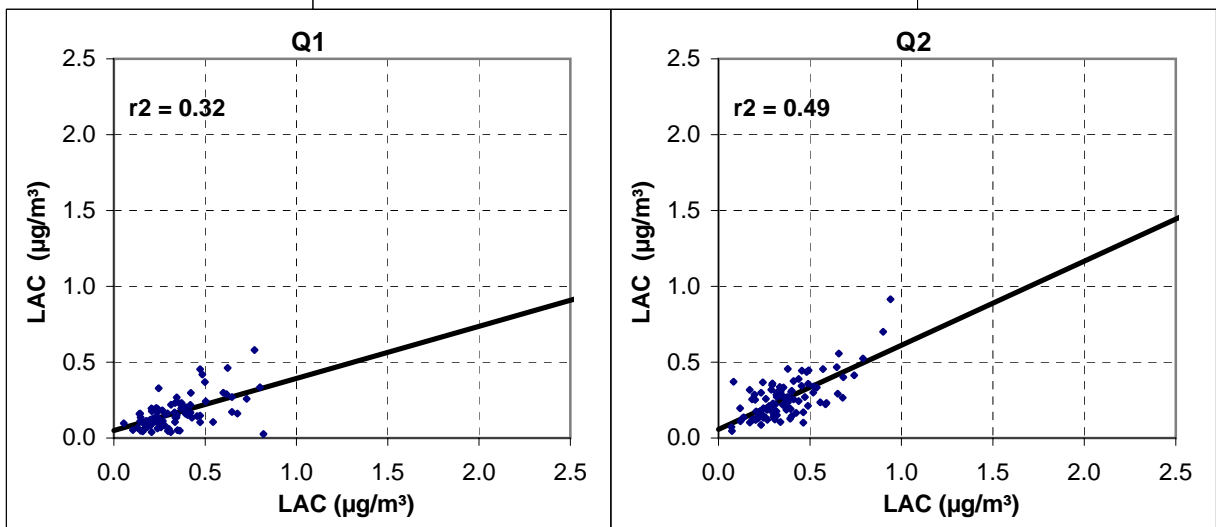
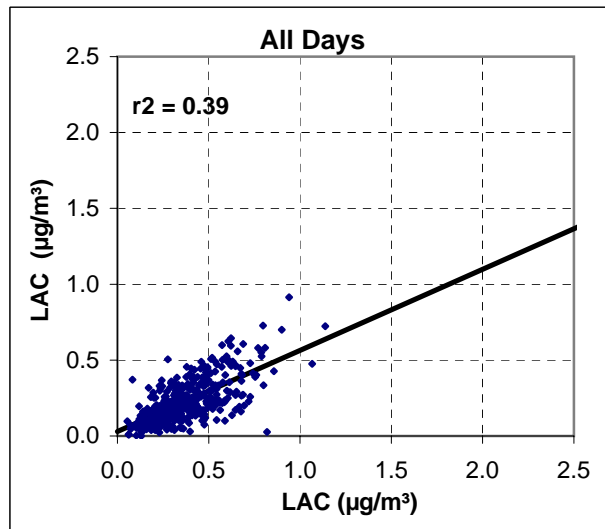
SHRO1 vs. GRSM1 Organic Carbon



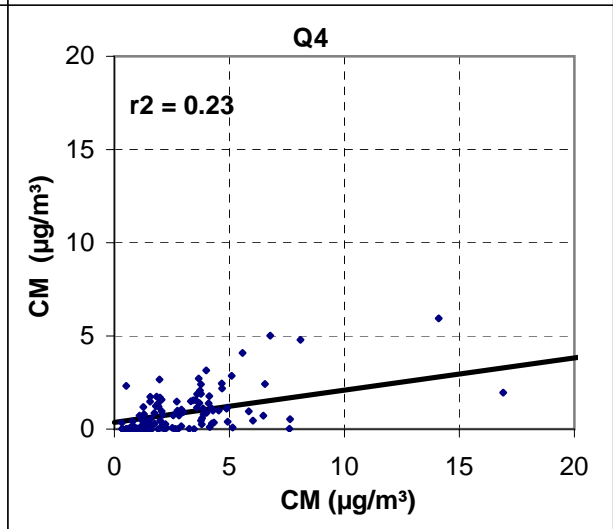
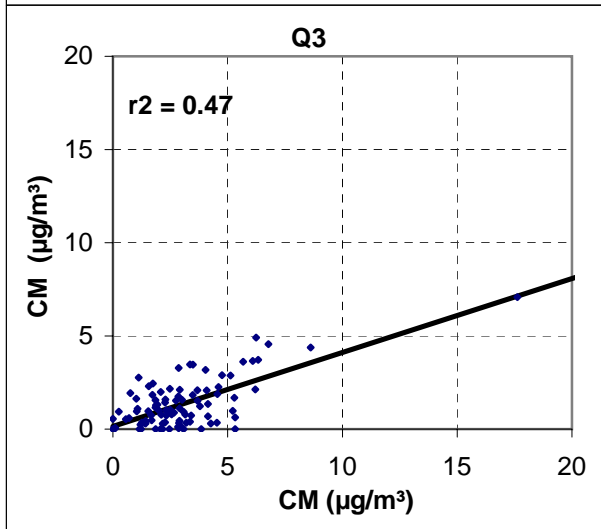
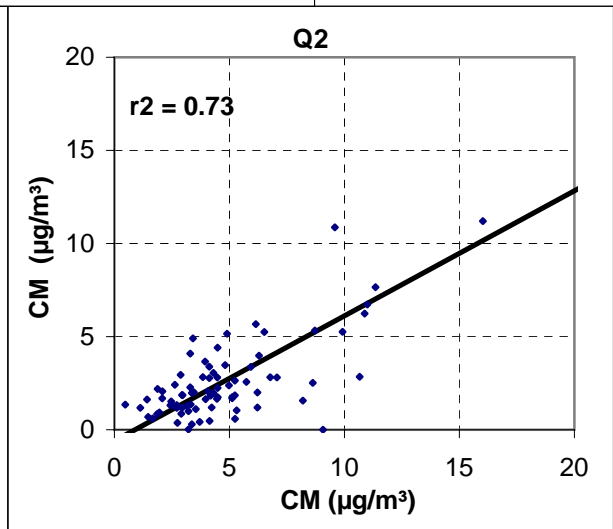
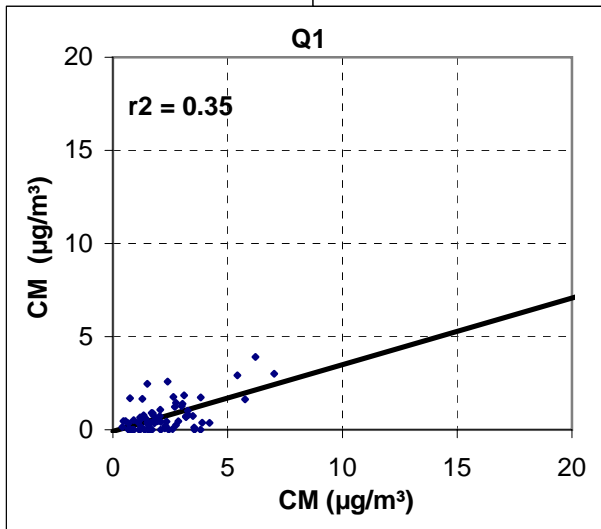
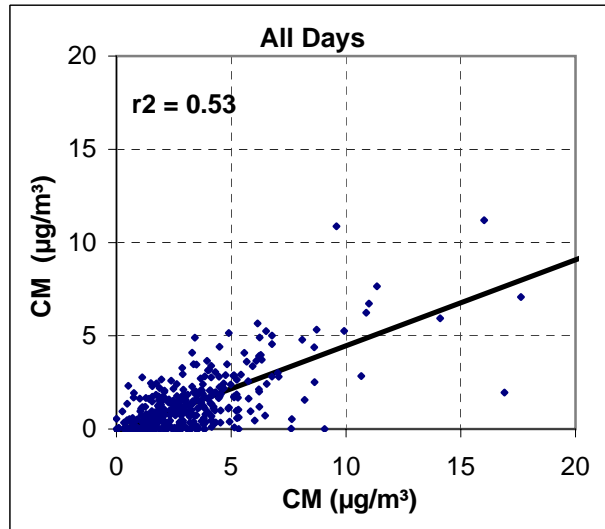
SHRO1 vs. GRSM1 Soil



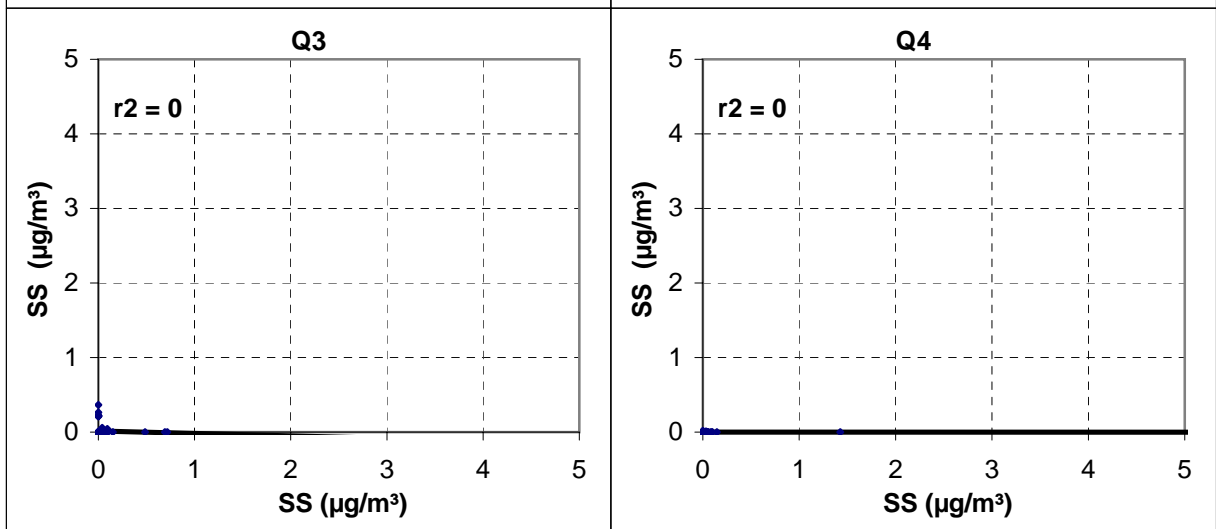
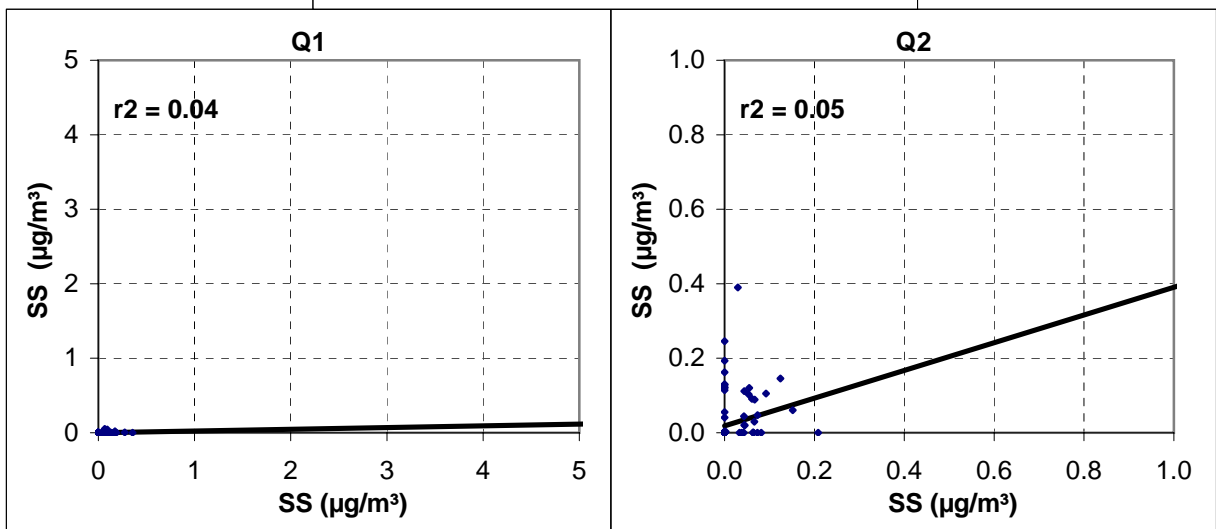
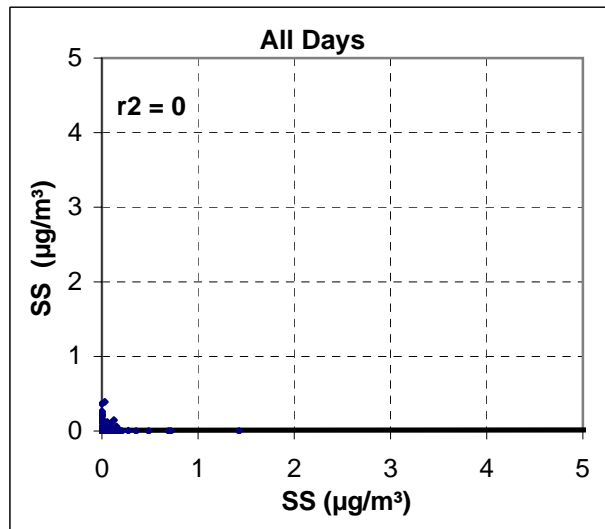
SHRO1 vs. GRSM1 Light Absorbing Carbon



SHRO1 vs. GRSM1 Coarse Mass



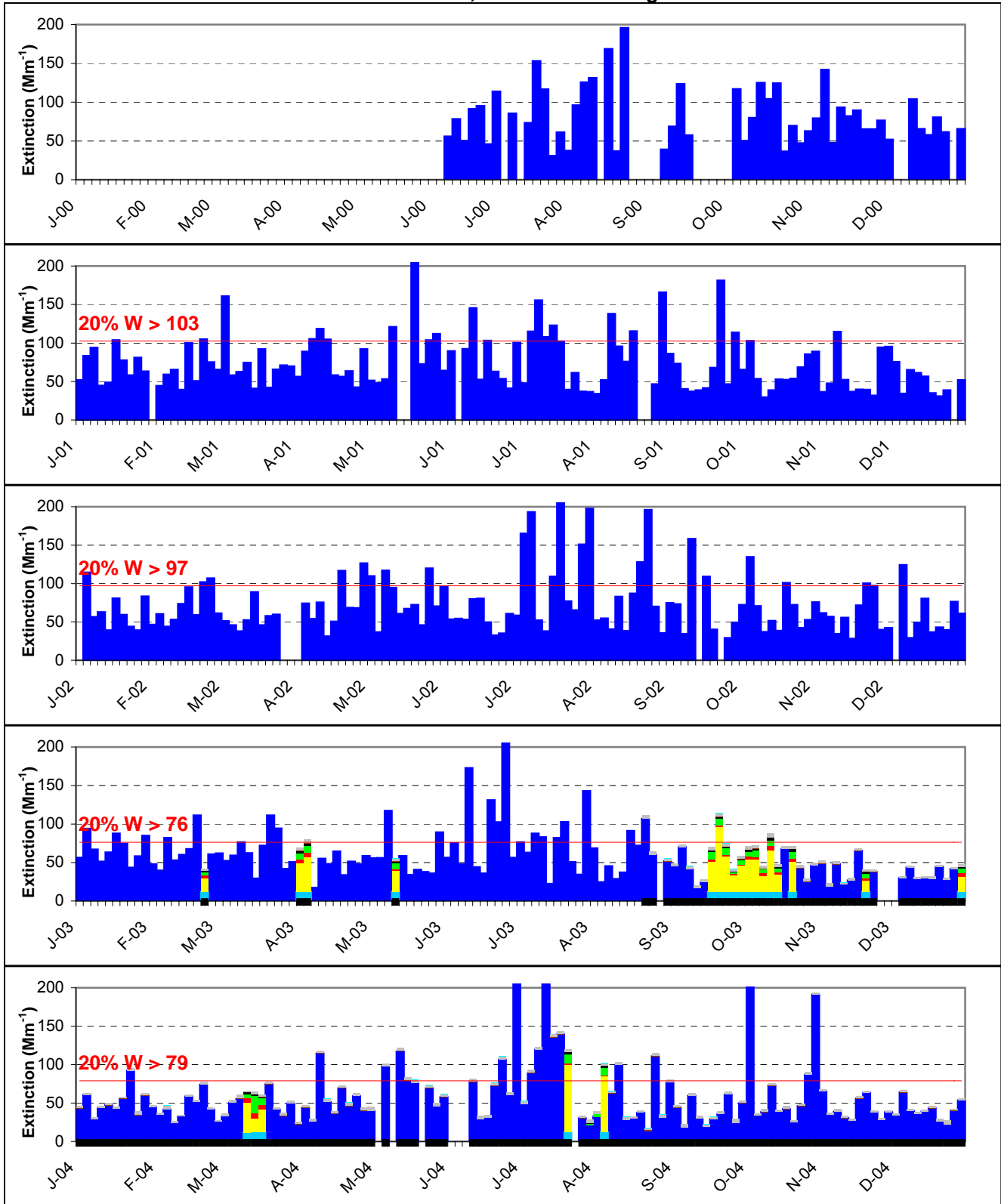
SHRO1 vs. GRSM1 Sea Salt



**Swanquarter, NC
Statistics for Substitutions**

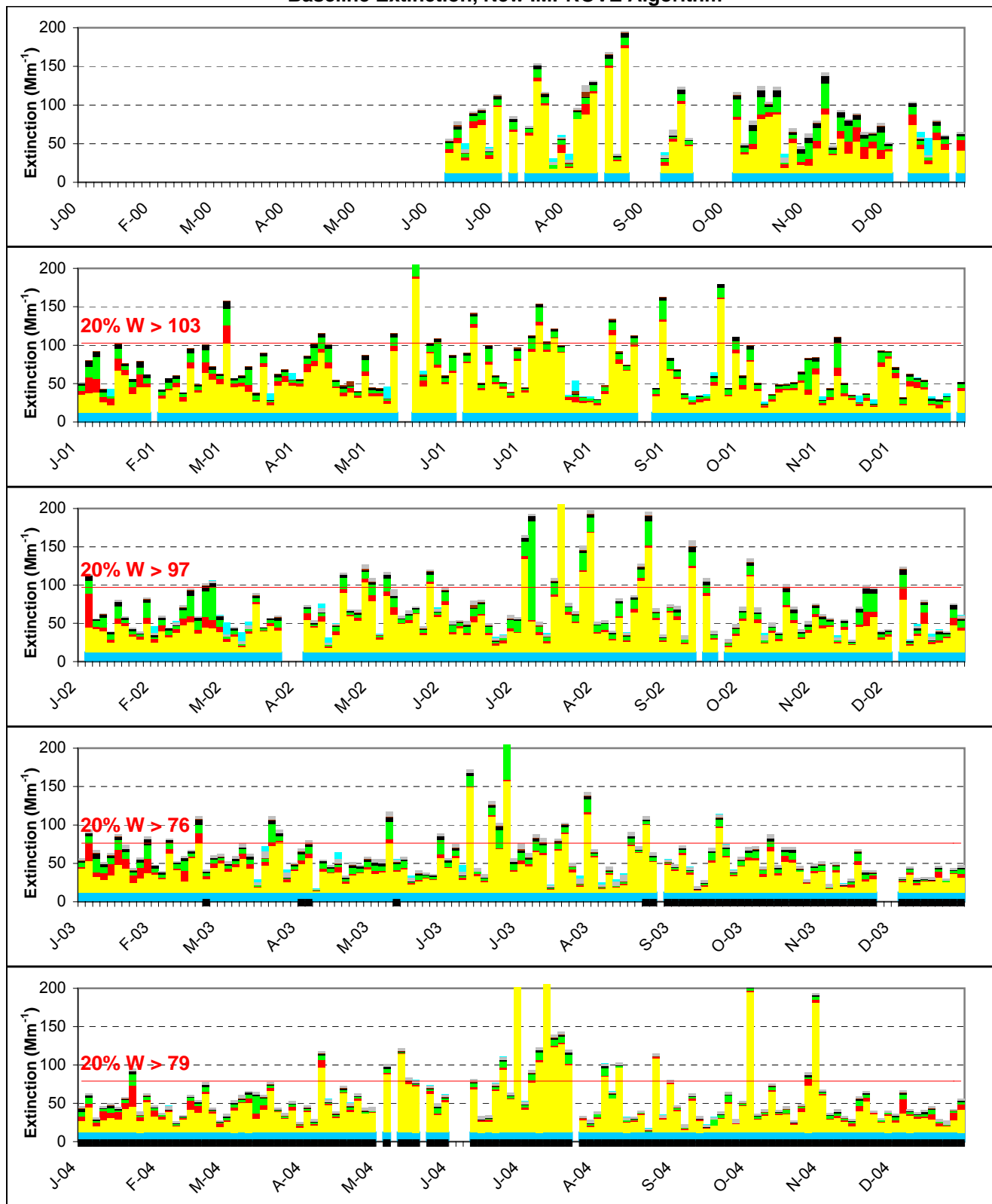
SWAN1						
Components	KT Stats	All	1	2	3	4
OC vs. org_H	Slope	9.05	10.09	10.29	8.80	8.76
	Intercept	0.23	0.32	0.16	0.01	0.26
	R2	0.83	0.87	0.83	0.84	0.89
EC vs. OC	Slope	0.13	0.17	0.11	0.09	0.19
	Intercept	0.08	0.09	0.08	0.09	0.03
	R2	0.58	0.69	0.69	0.48	0.76
SWAN1 v. ROMA1						
Components	KT Stats	All	1	2	3	4
SO4	Slope	0.66	0.61	0.66	0.65	0.62
	Intercept	1.36	1.33	2.11	1.52	1.01
	R2	0.40	0.35	0.29	0.43	0.39
NO3	Slope	0.82	0.70	0.79	0.59	0.69
	Intercept	0.13	0.34	0.09	0.11	0.23
	R2	0.34	0.23	0.44	0.26	0.21
OC	Slope	0.45	0.44	0.47	0.54	0.45
	Intercept	0.07	0.09	0.09	0.04	0.05
	R2	0.38	0.39	0.37	0.32	0.35
LAC	Slope	0.35	0.35	0.35	0.60	0.30
	Intercept	0.52	0.46	0.63	0.21	0.55
	R2	0.19	0.31	0.21	0.17	0.18
Soil	Slope	0.66	0.62	0.47	0.92	0.47
	Intercept	0.10	0.06	0.28	0.01	0.11
	R2	0.62	0.43	0.49	0.79	0.39
CM	Slope	0.40	0.58	0.29	0.40	0.51
	Intercept	3.28	2.36	3.88	3.71	2.96
	R2	0.31	0.39	0.18	0.34	0.25
Sea Salt	Slope	0.00	0.00	0.00	-0.01	0.00
	Intercept	0.01	0.00	0.02	0.02	0.00
	R2	0.00	0.06	0.00	0.00	0.00

SWAN1 (ROMA1 donor)
Baseline Extinction, New IMPROVE Algorithm



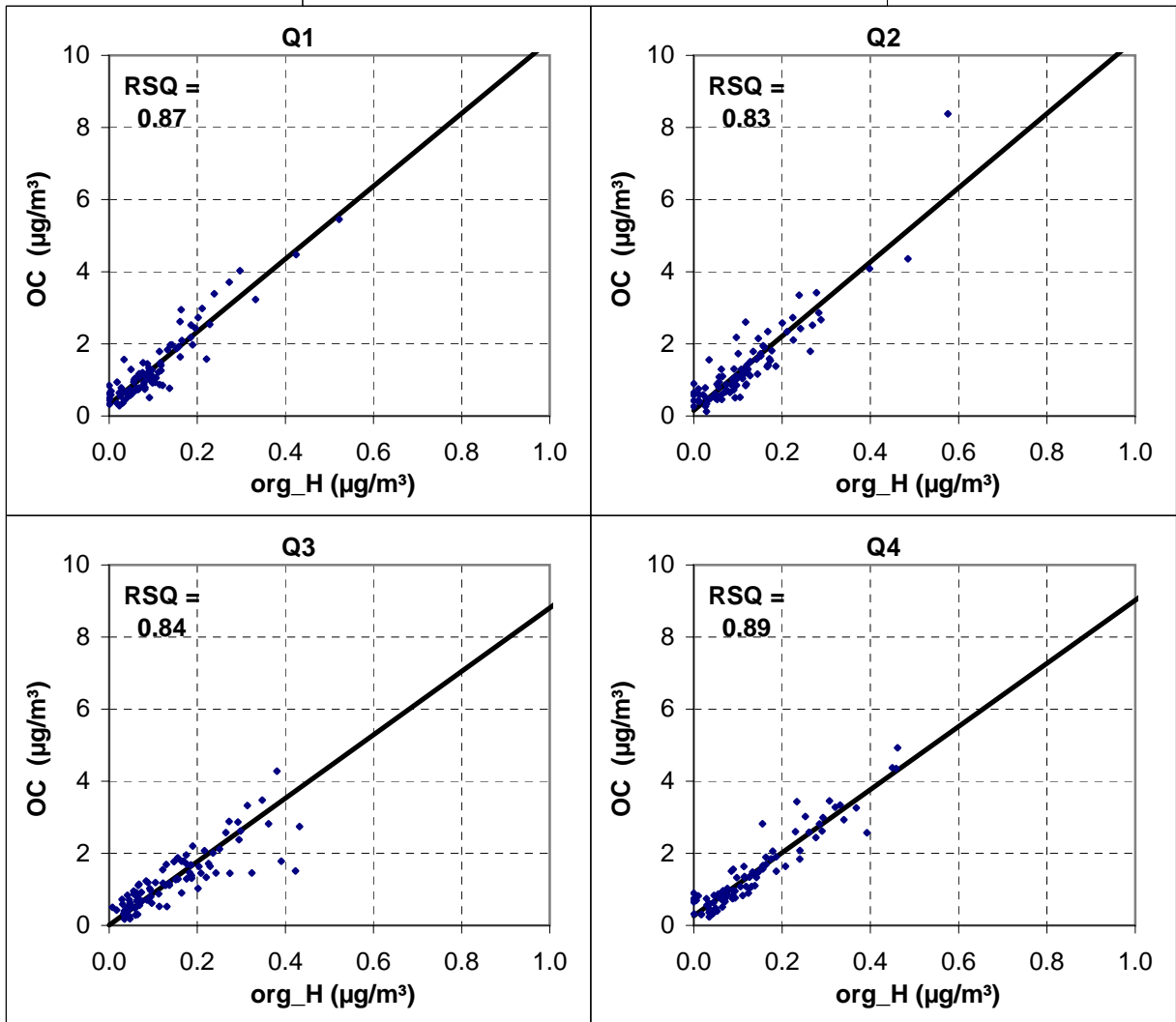
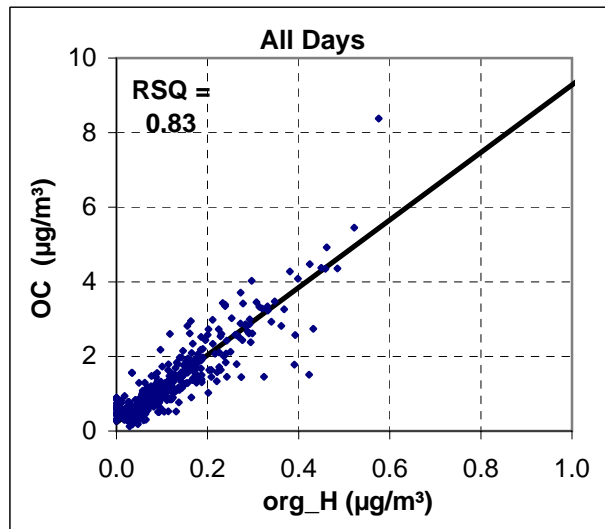
■ RHR
 ■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

SWAN1 (ROMA1 donor)
Baseline Extinction, New IMPROVE Algorithm

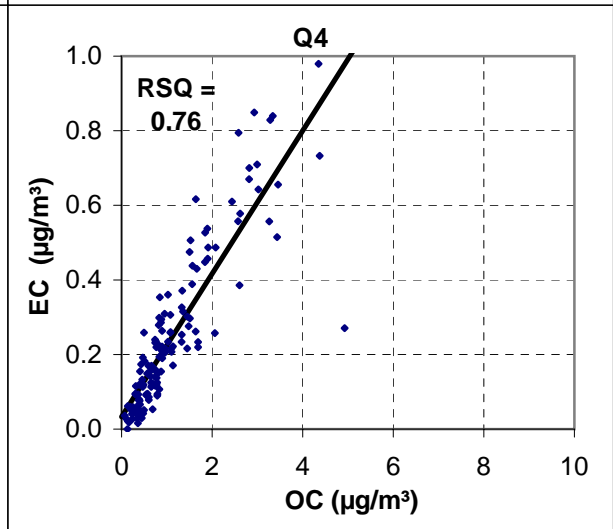
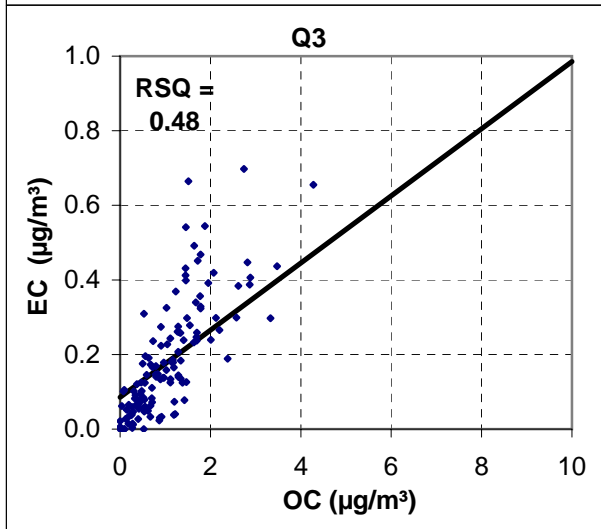
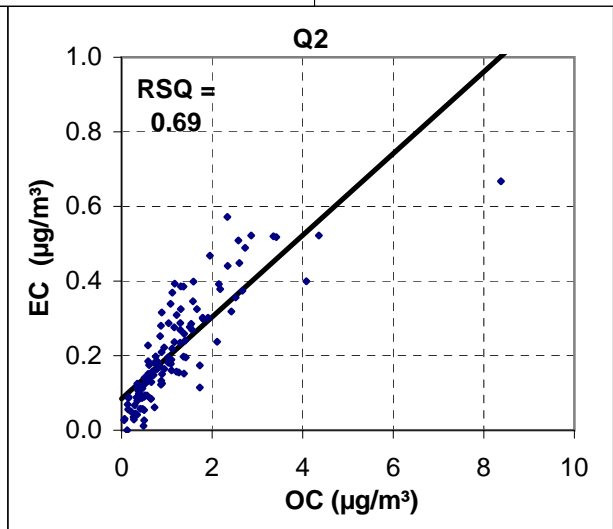
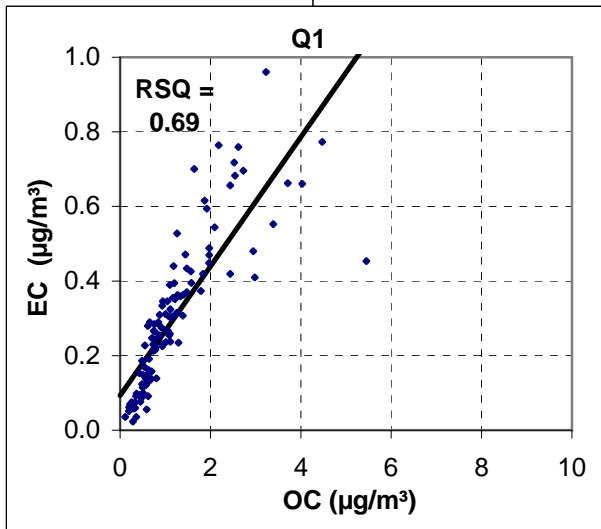
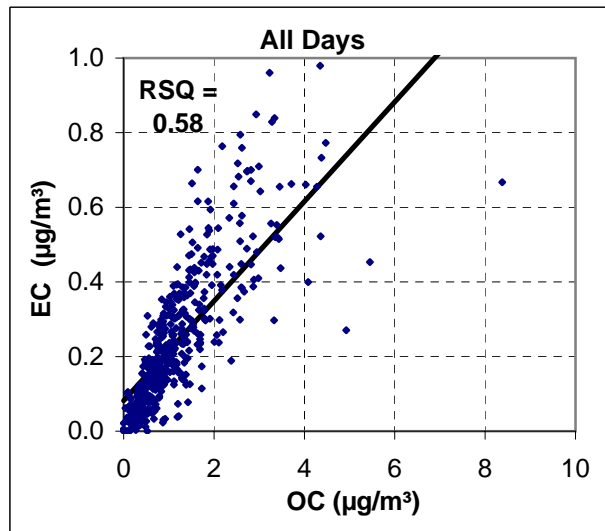


■ Rayleigh
 ■ Amm Sulf
 ■ Amm NO3
 ■ POM
 ■ LAC
 ■ Soil
 ■ CM
 ■ Sea Salt

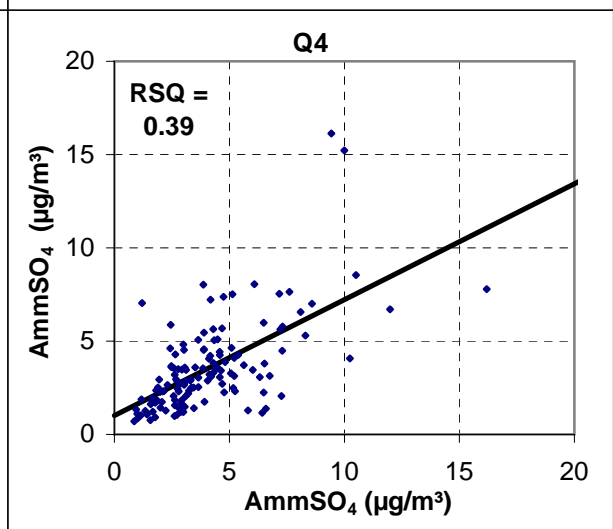
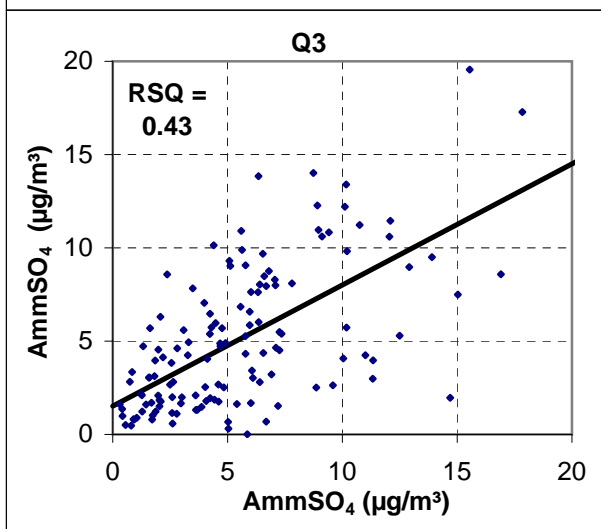
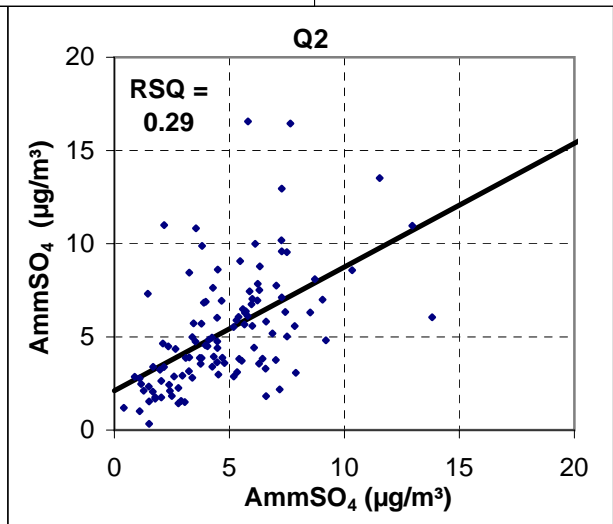
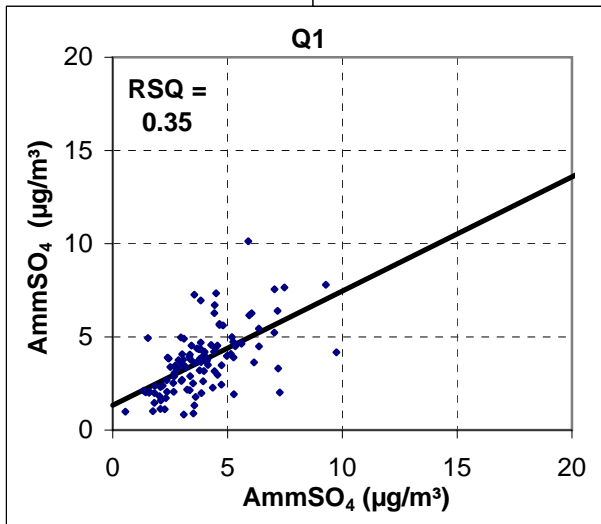
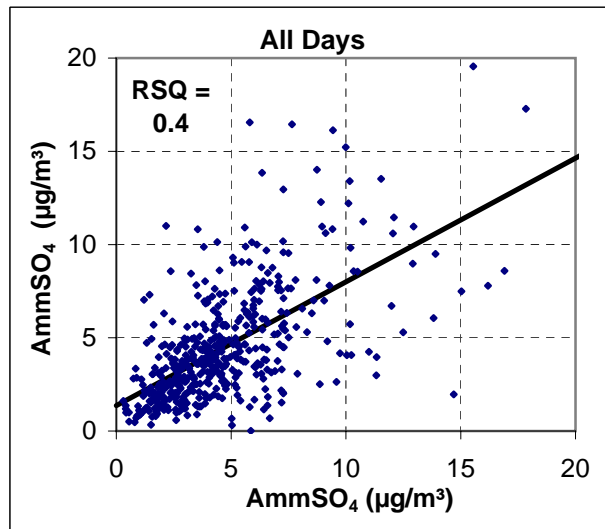
SWAN1 OC vs. org_H



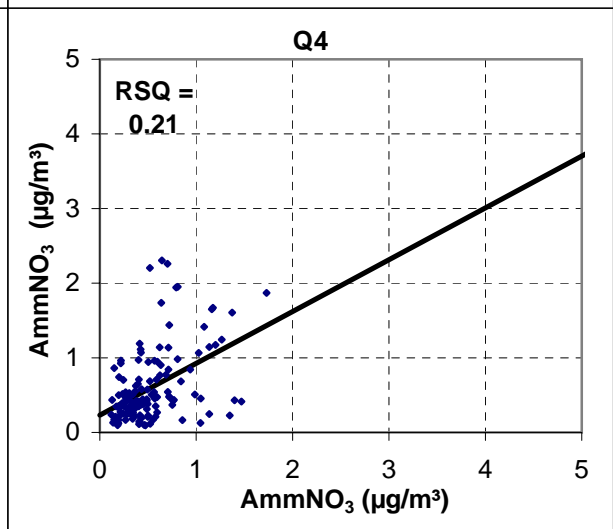
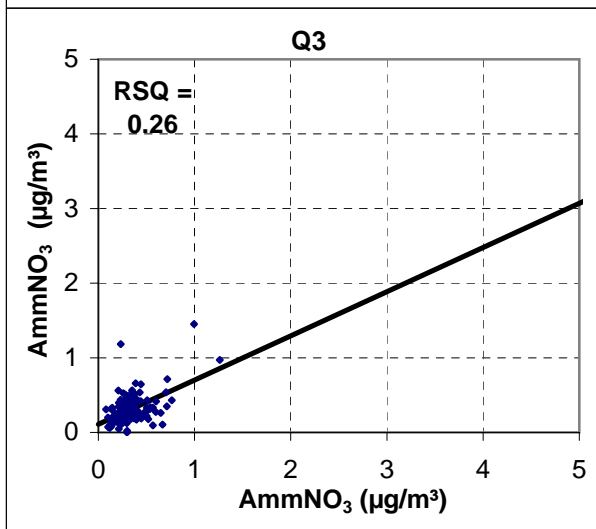
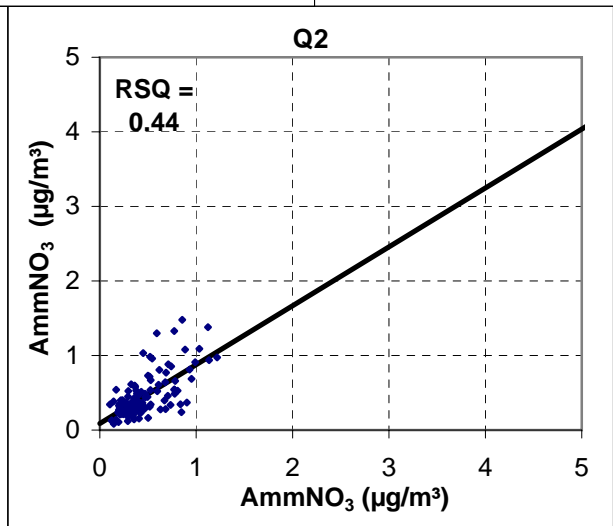
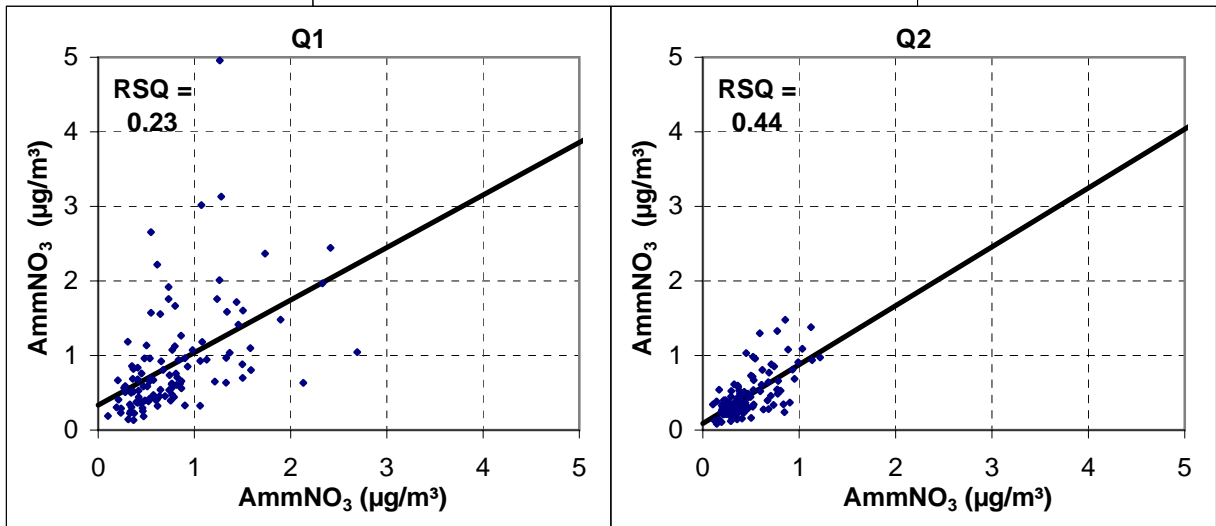
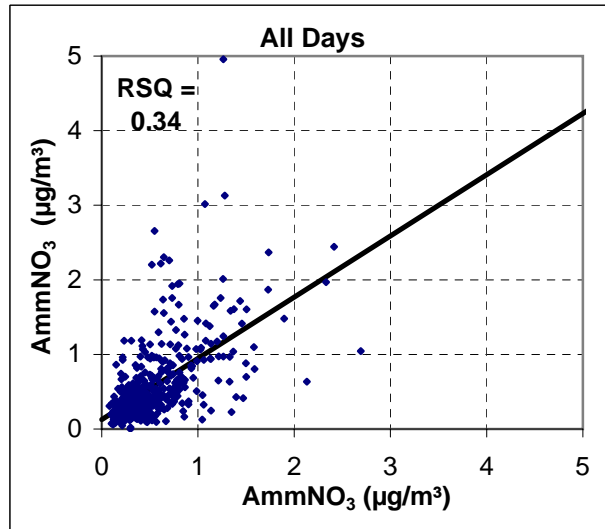
SWAN1 EC vs. OC



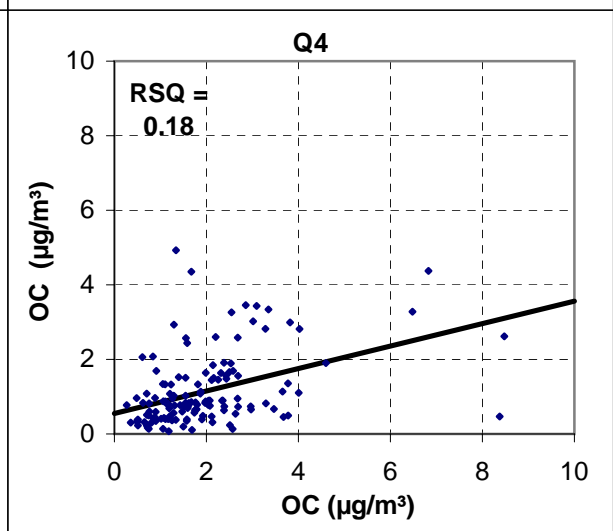
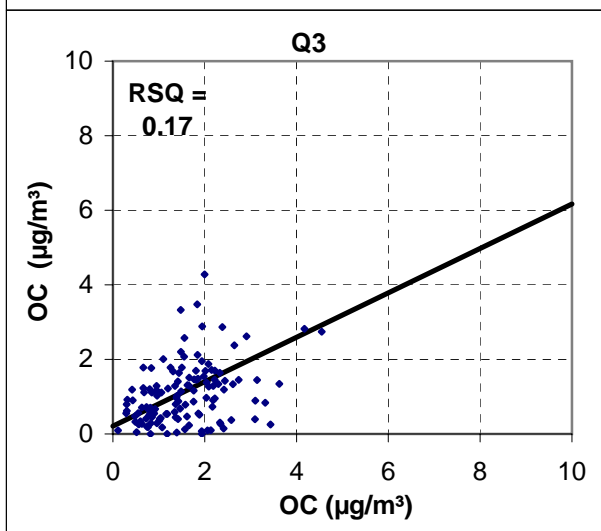
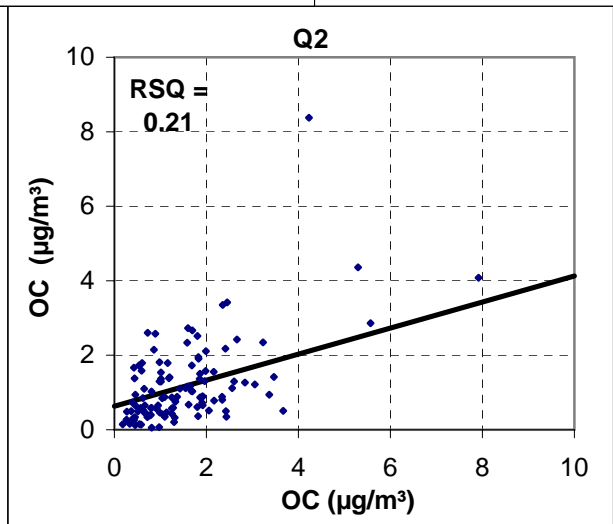
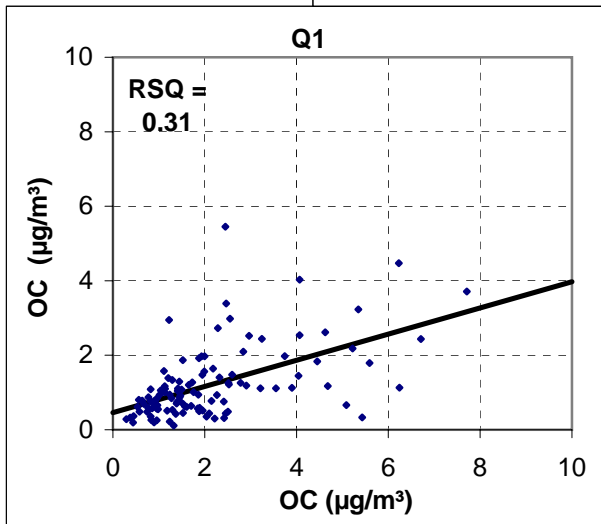
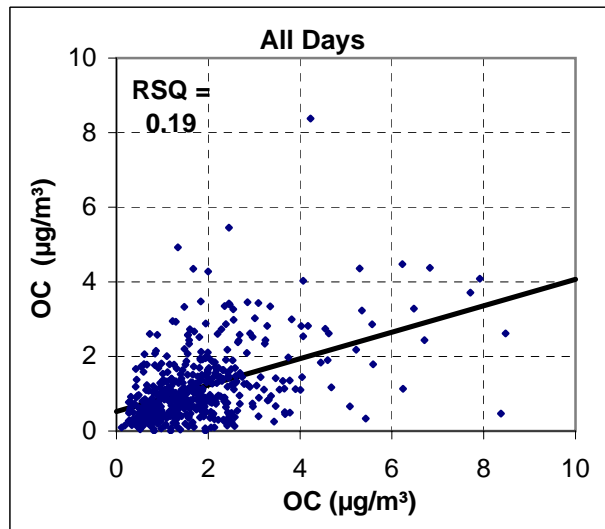
SWAN1 vs. ROMA1 Ammonium Sulfate



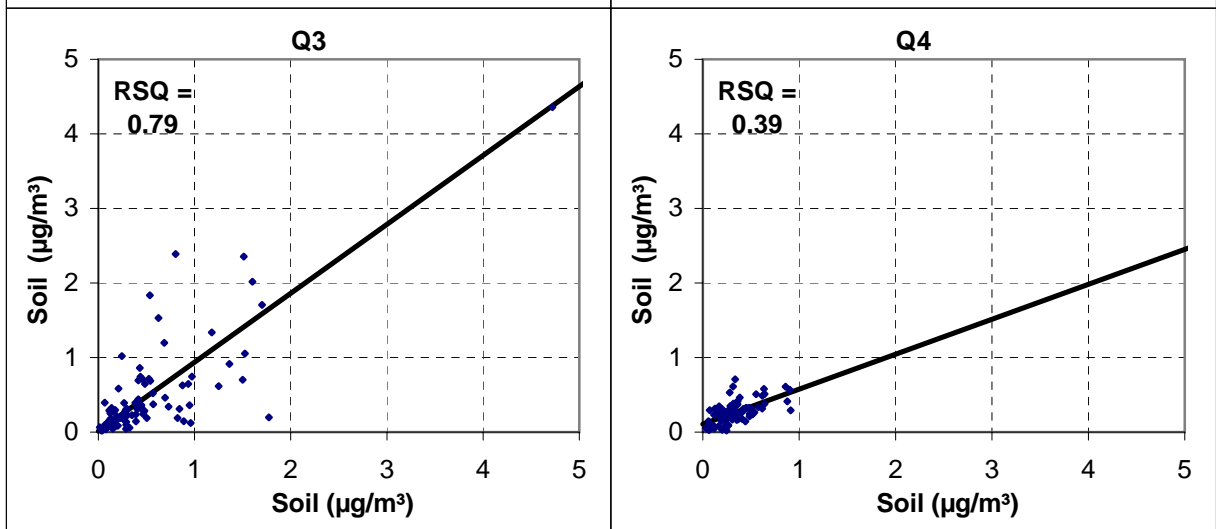
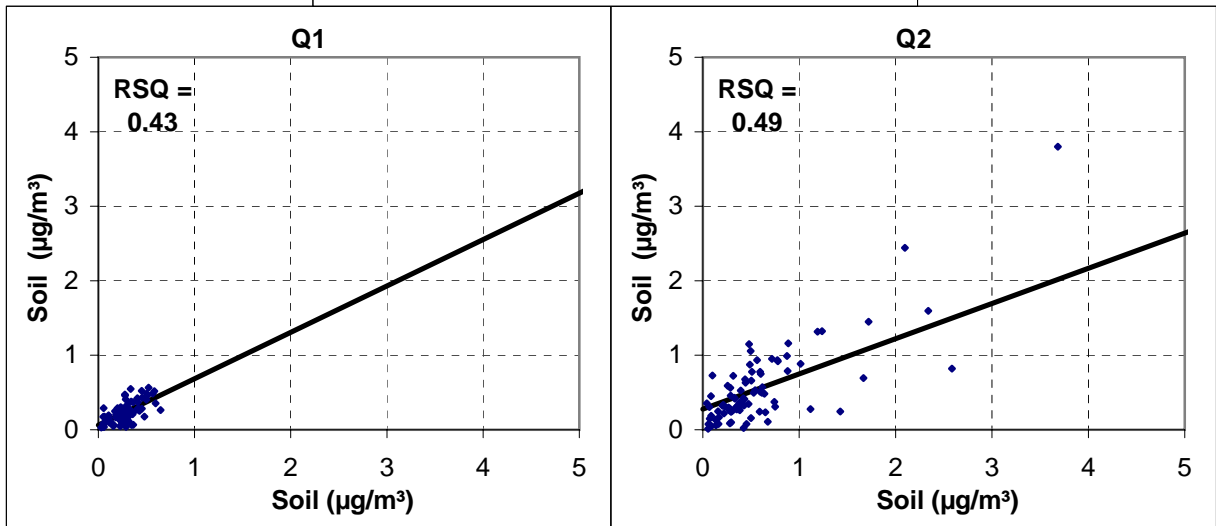
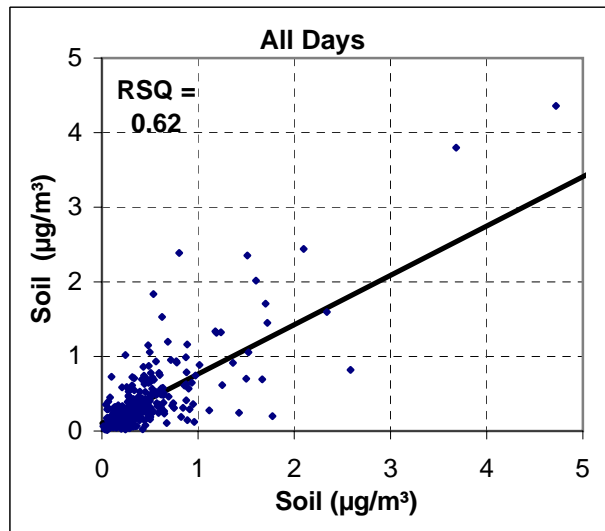
SWAN1 vs. ROMA1 Ammonium Nitrate



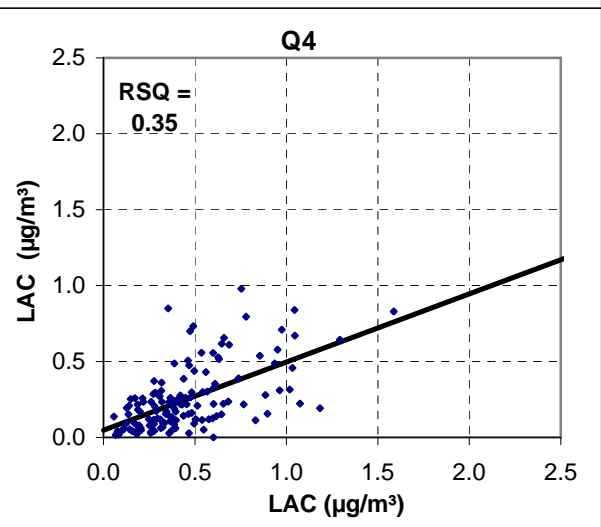
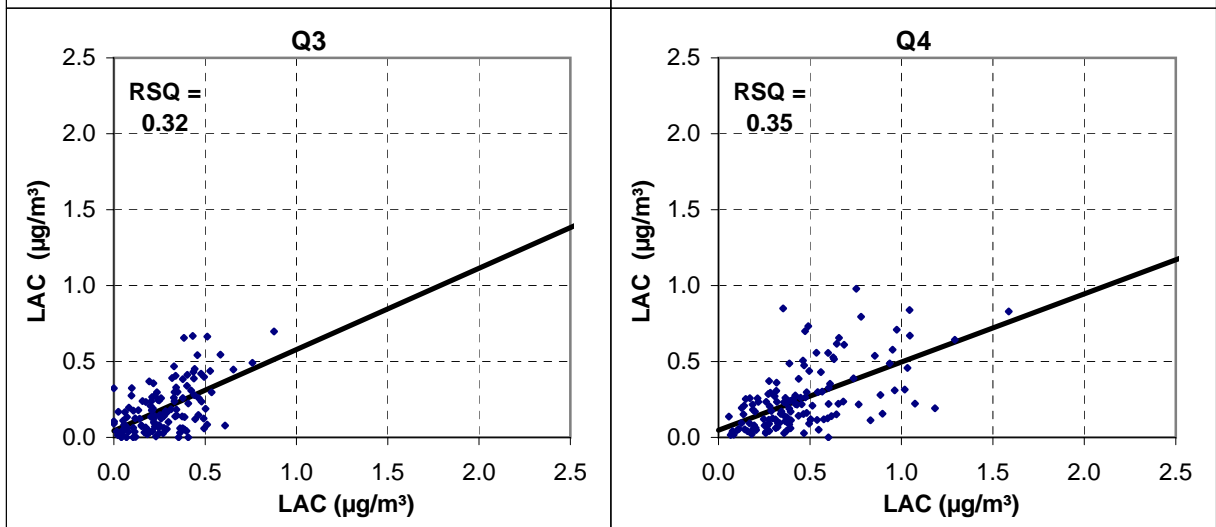
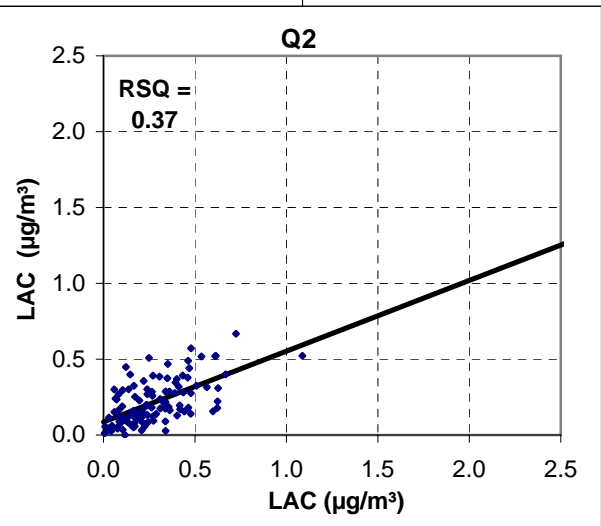
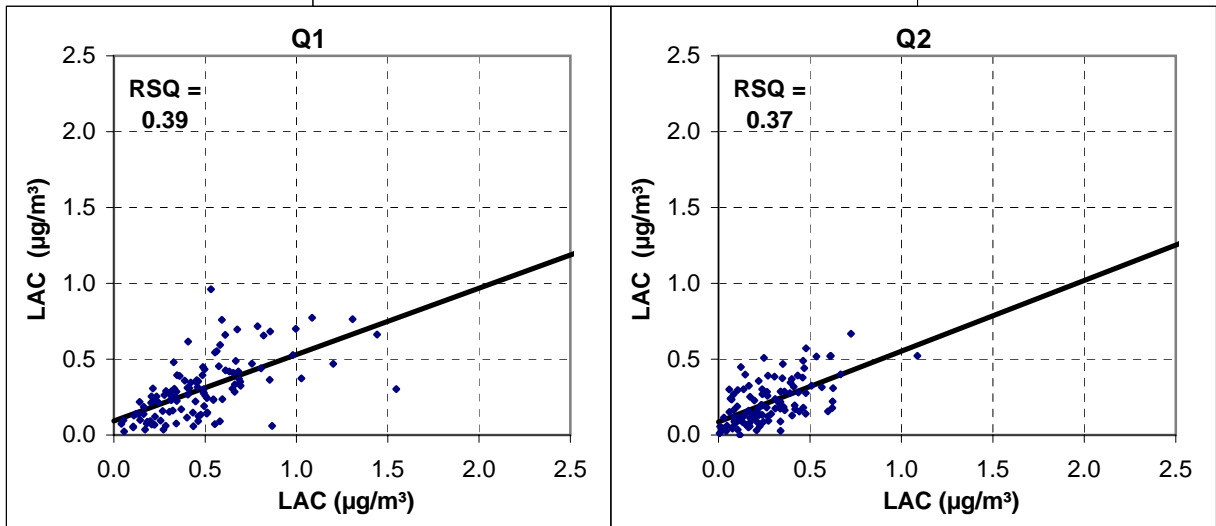
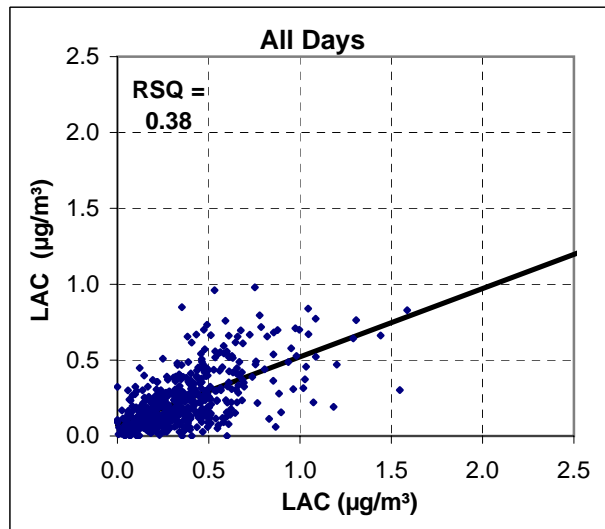
SWAN1 vs. ROMA1 Organic Carbon



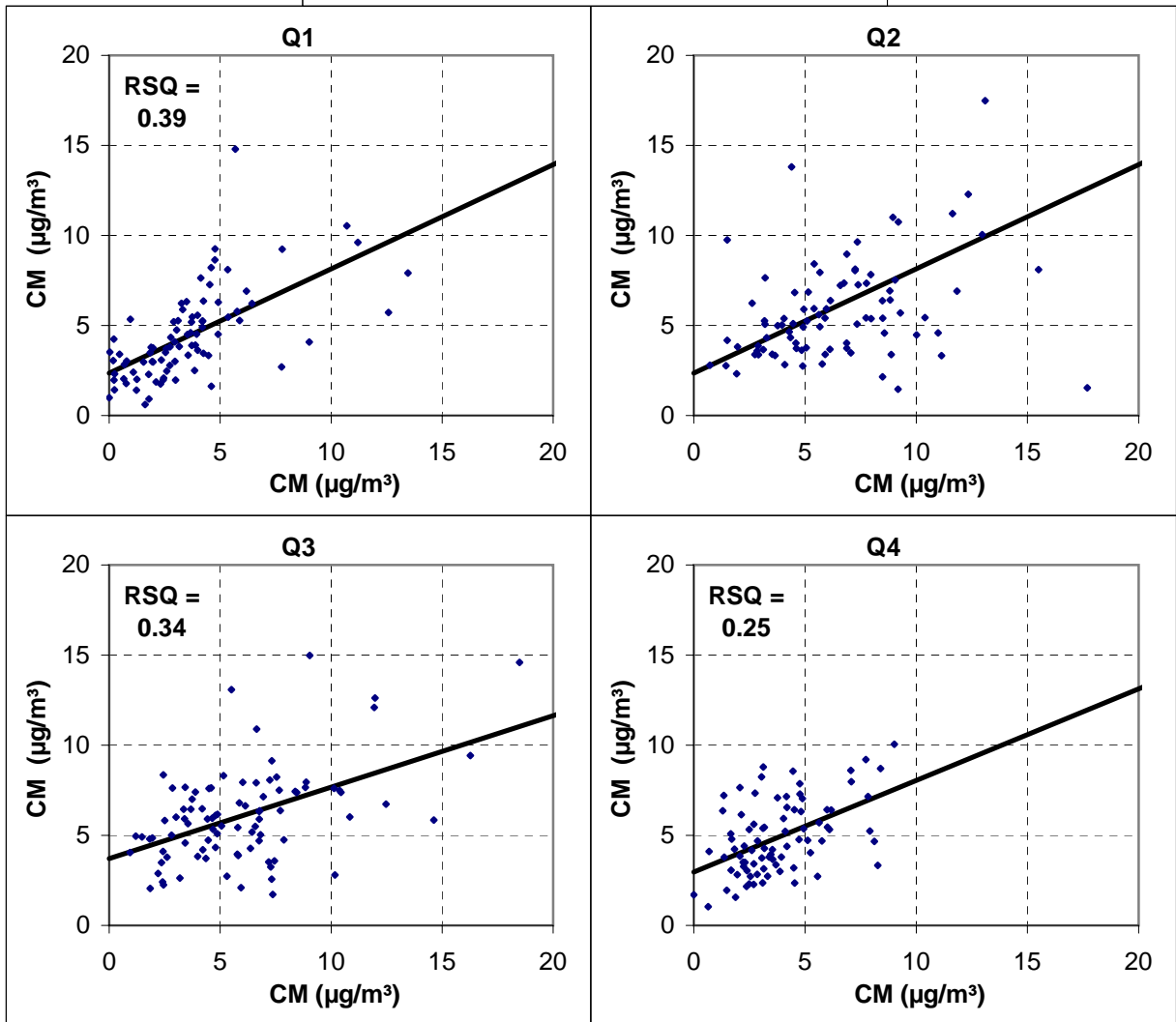
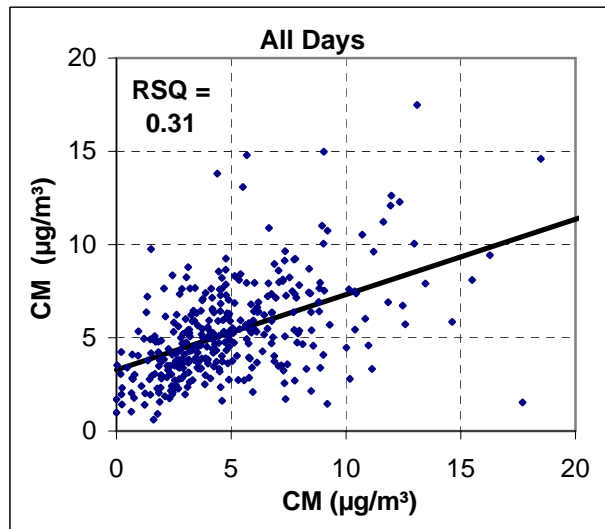
SWAN1 vs. ROMA1 Soil



SWAN1 vs. ROMA1 Light Absorbing Carbon



SWAN1 vs. ROMA1 Coarse Mass



SWAN1 vs. ROMA1 Sea Salt

