TRENDS FOR 'ELEMENTAL' AND 'BLACK' CARBON IN 2005 – 2009 DATA

Jan 2005 – Sep 2009 IMPROVE data. Carbon data include the usual 'correction' for positive artifact. HIPS data (denoted ***calFa*** to distinguish them from the currently reported product Fabs) incorporate an improved calibration based on tests with ND filters.

Excluded:

- sites with masked A modules
- samples with Fe > 0.05 ug/m^3 (74^{th} percentile)
- samples with TC < 0.5 ug/m^3 (27^{th} percentile)
- sites where < 50% of all 2005-9 samples met criteria.

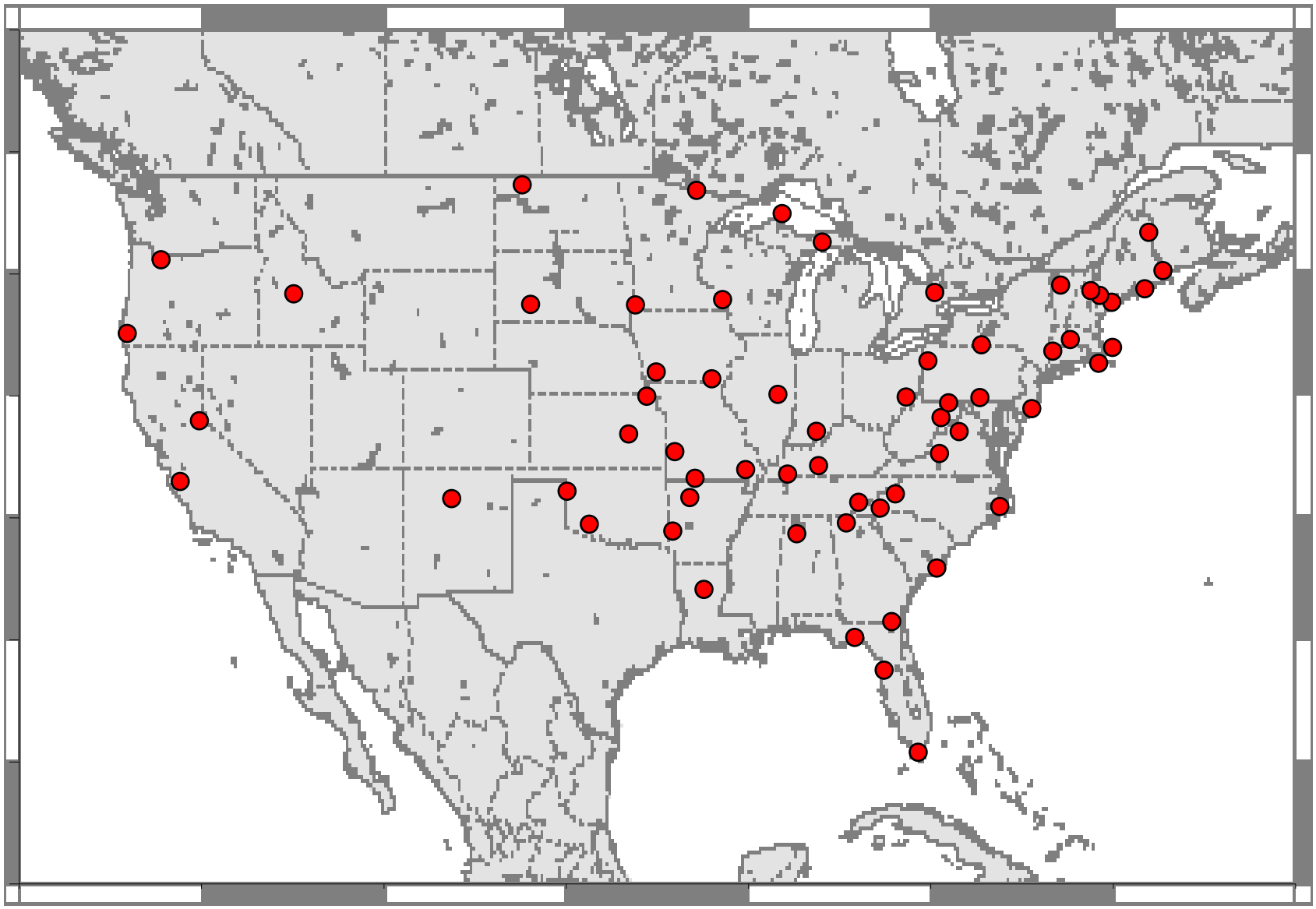
Left for analysis:

- 61 sites, at which 69% of all samples meet criteria.

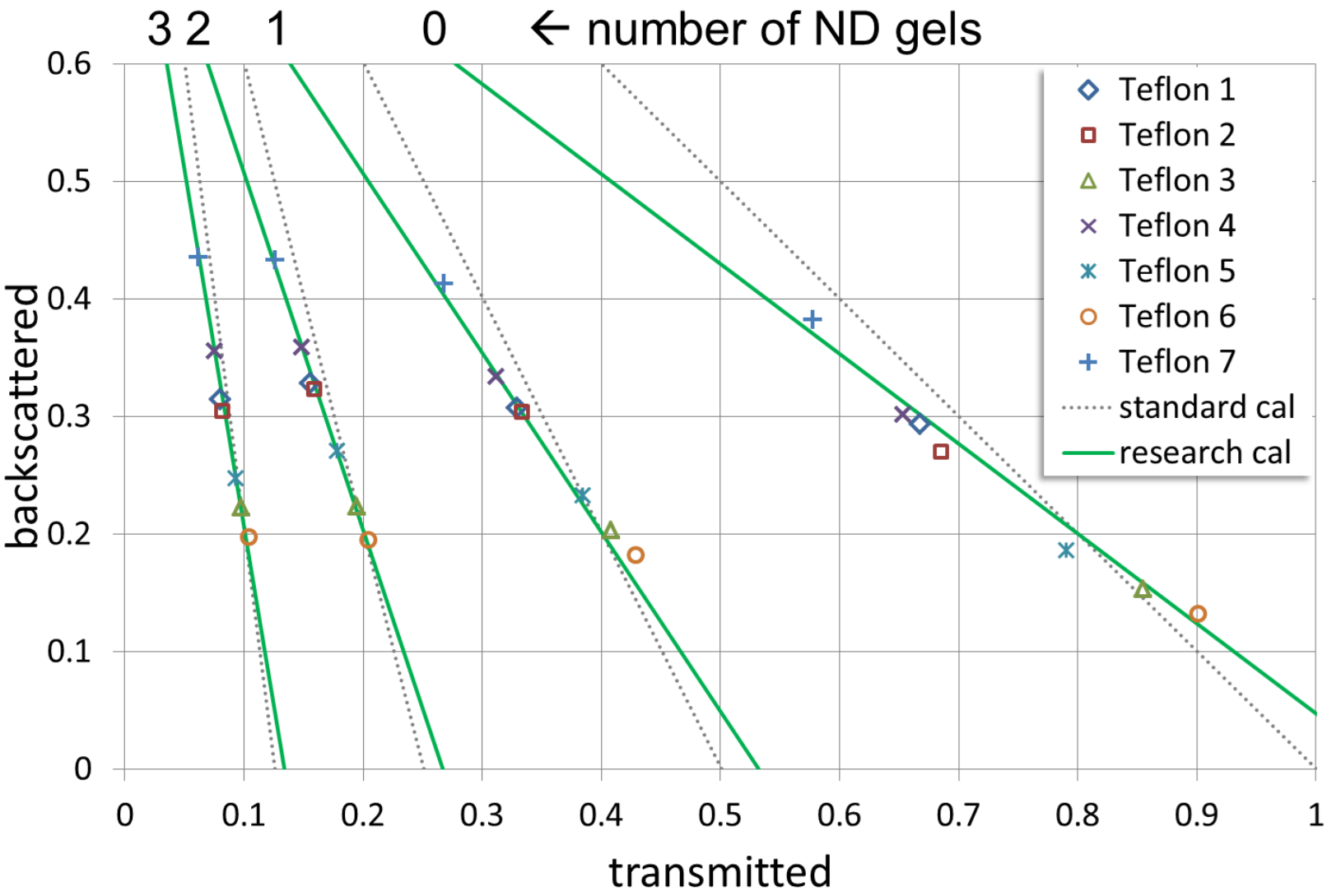
Displayed:

- daily median and interquartile range
- exponential trends, %/year

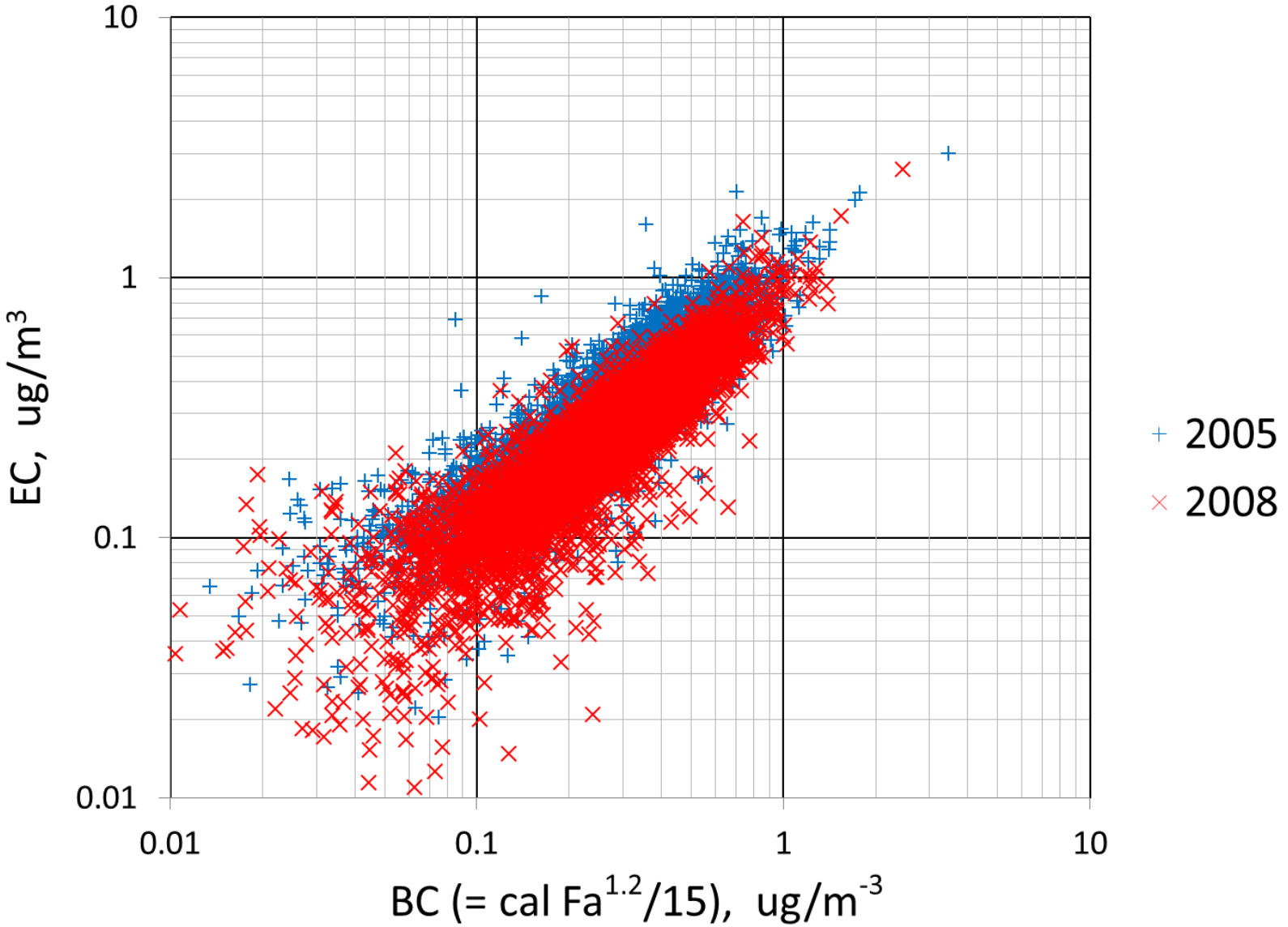
WHW, 5/21/10; updated 10/16/10



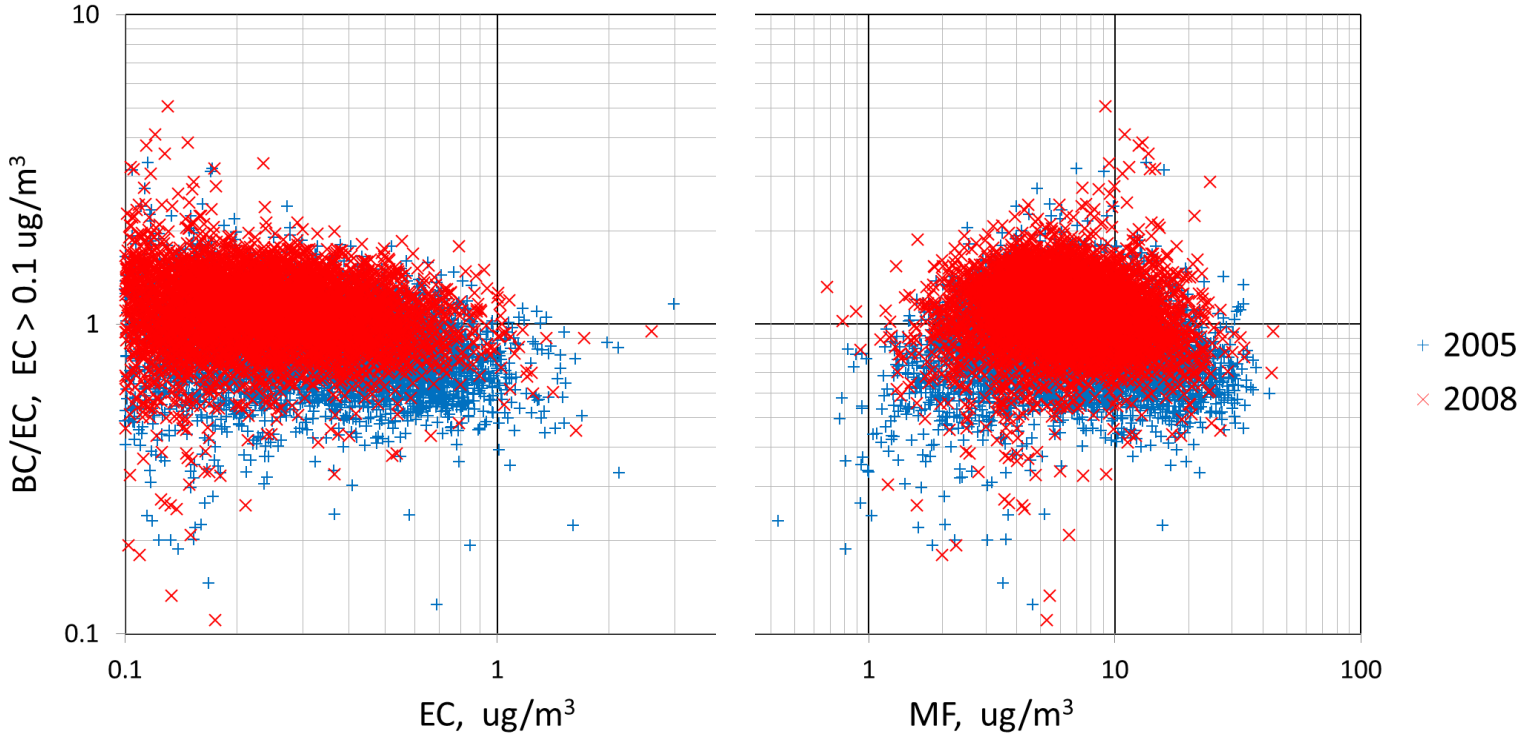
Included sites: sufficient TC for good analysis, not too much light-absorbing minerals, no masking to distort HIPS, and reliable operation.



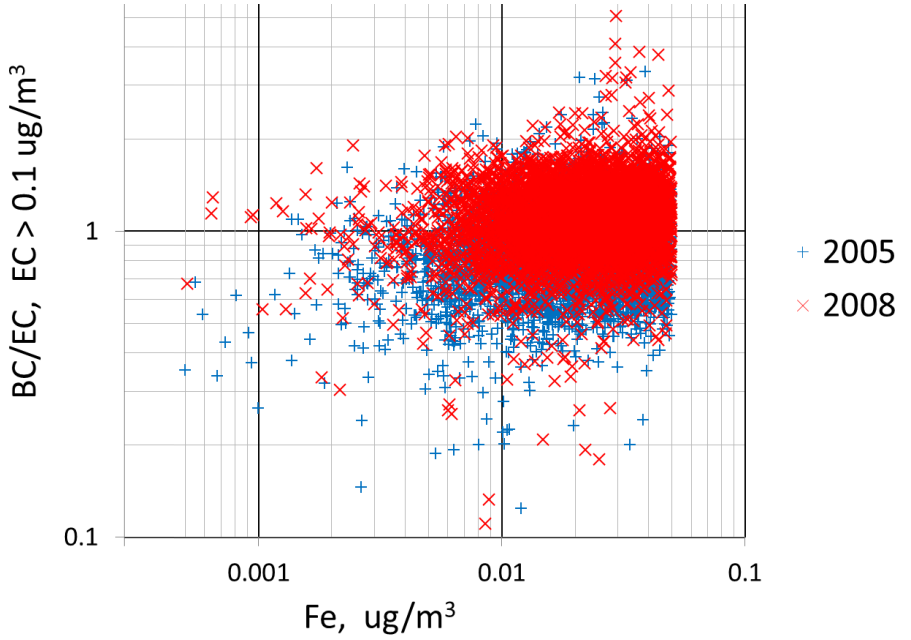
HIPS data are from recent calibrations with neutral density gels. These recalibrations yield improved proportionality between Fabs & EC.

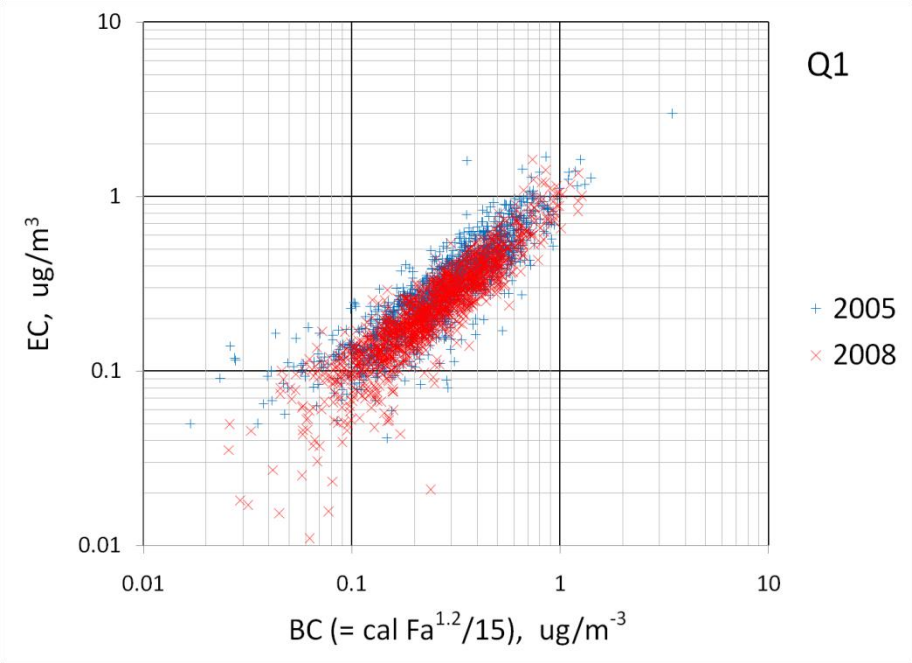


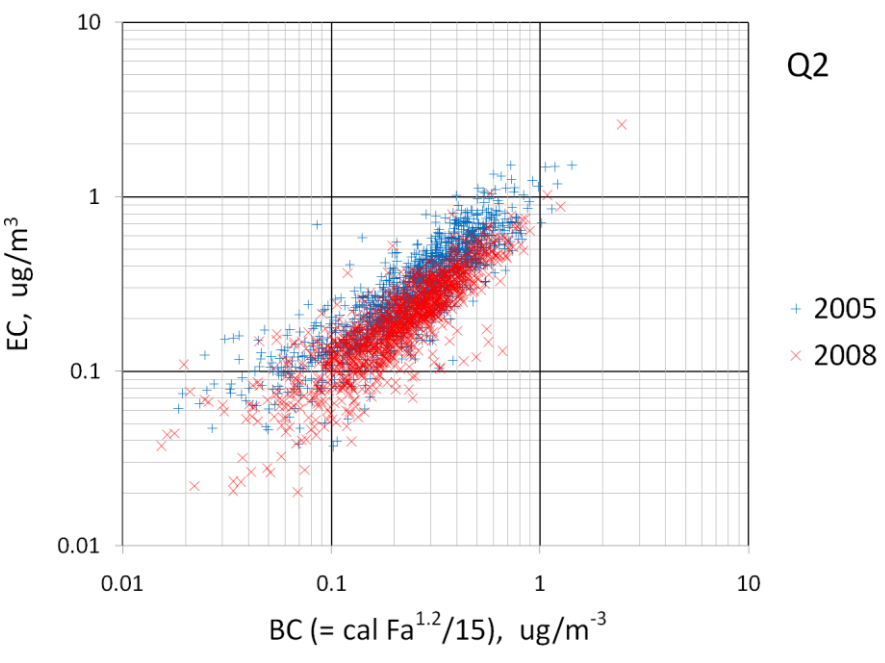
Calculation of ‘black’ carbon includes an empirical power-law adjustment for the effect of loading on absorption.

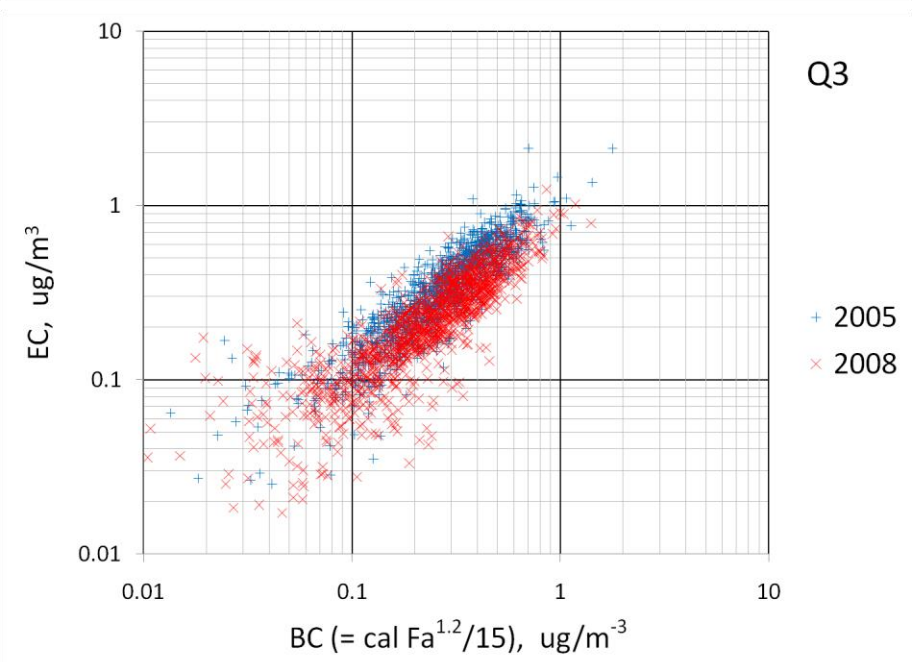


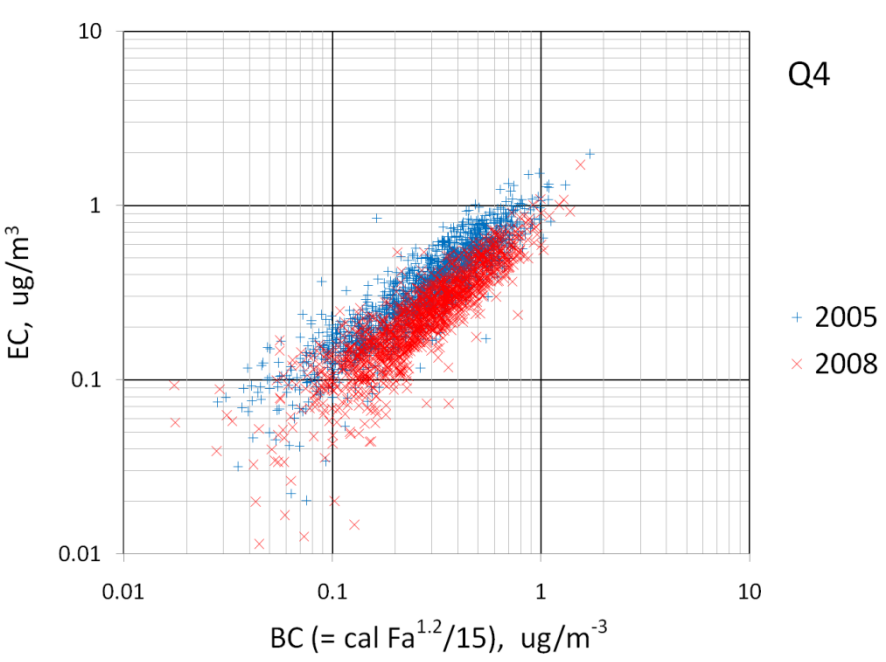
The power-law loading adjustment, together with the censoring of high iron loadings, yields a reasonably stable relationship between ‘black’ and ‘elemental’ carbon.




Q1
EC, ug/m3
BC (= cal Fa1.2/15), ug/m-3
2005
2008
10
1
0.1
0.01
0.01
0.1
1
10

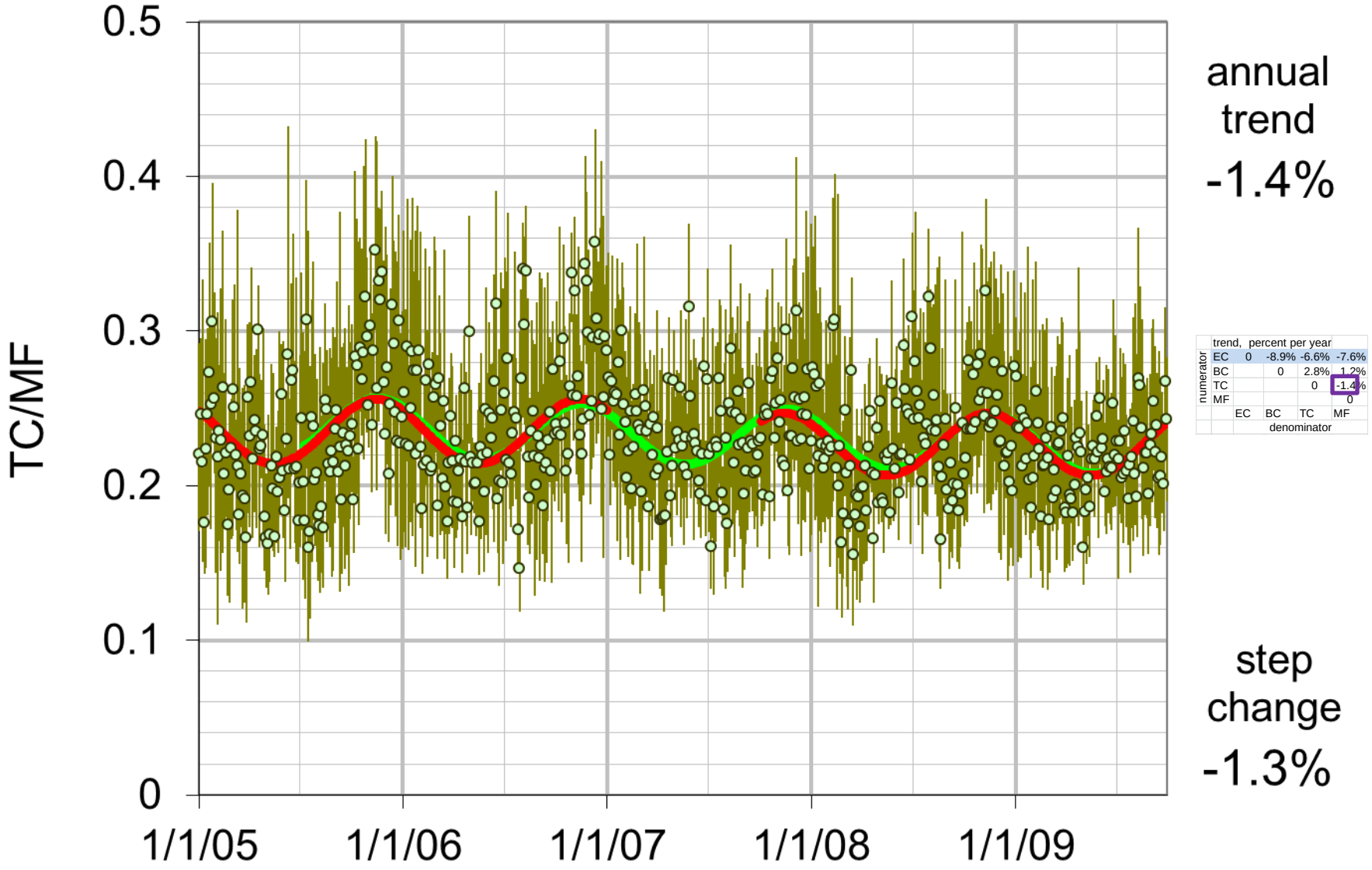

Q2
EC, ug/m3
BC (= cal Fa1.2/15), ug/m-3
2005
2008
10
1
0.1
0.01
0.01
0.1
1
10


Q3
EC, ug/m3
BC (= cal Fa1.2/15), ug/m-3
2005
2008
10
1
0.1
0.01
0.01
0.1
1
10

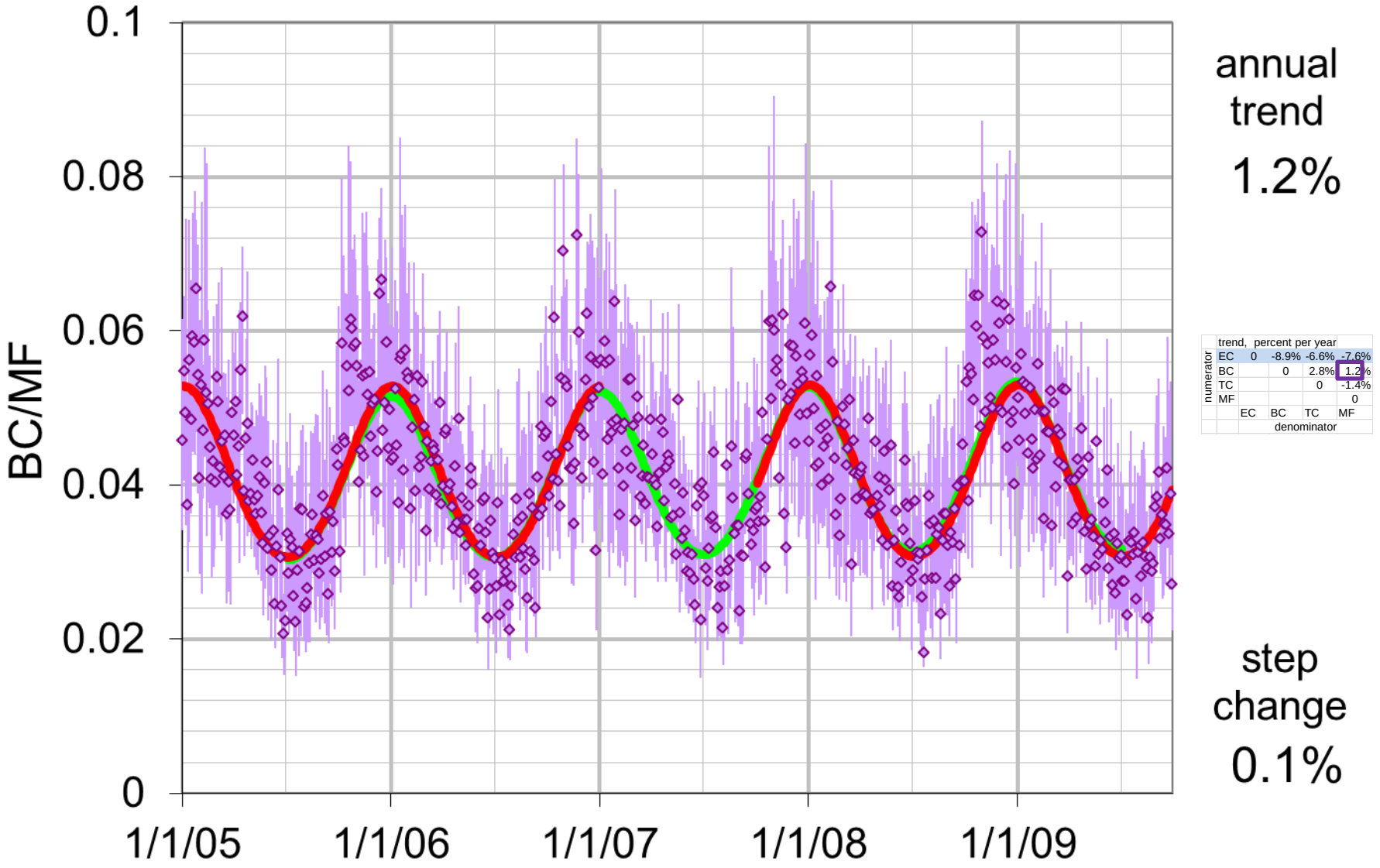

Q4
EC, ug/m3
BC (= cal Fa1.2/15), ug/m-3
2005
2008
10
1
0.1
0.01
0.01
0.1
1
10

Synoptic ventilation conditions affect all particle species in common. Focusing on species ratios rather than concentrations removes some of this meteorological noise, making longer-term trends in relative abundance easier to detect. Since 2005, 'elemental' carbon has been declining relative to 'black' carbon, total carbon, and gravimetric mass.

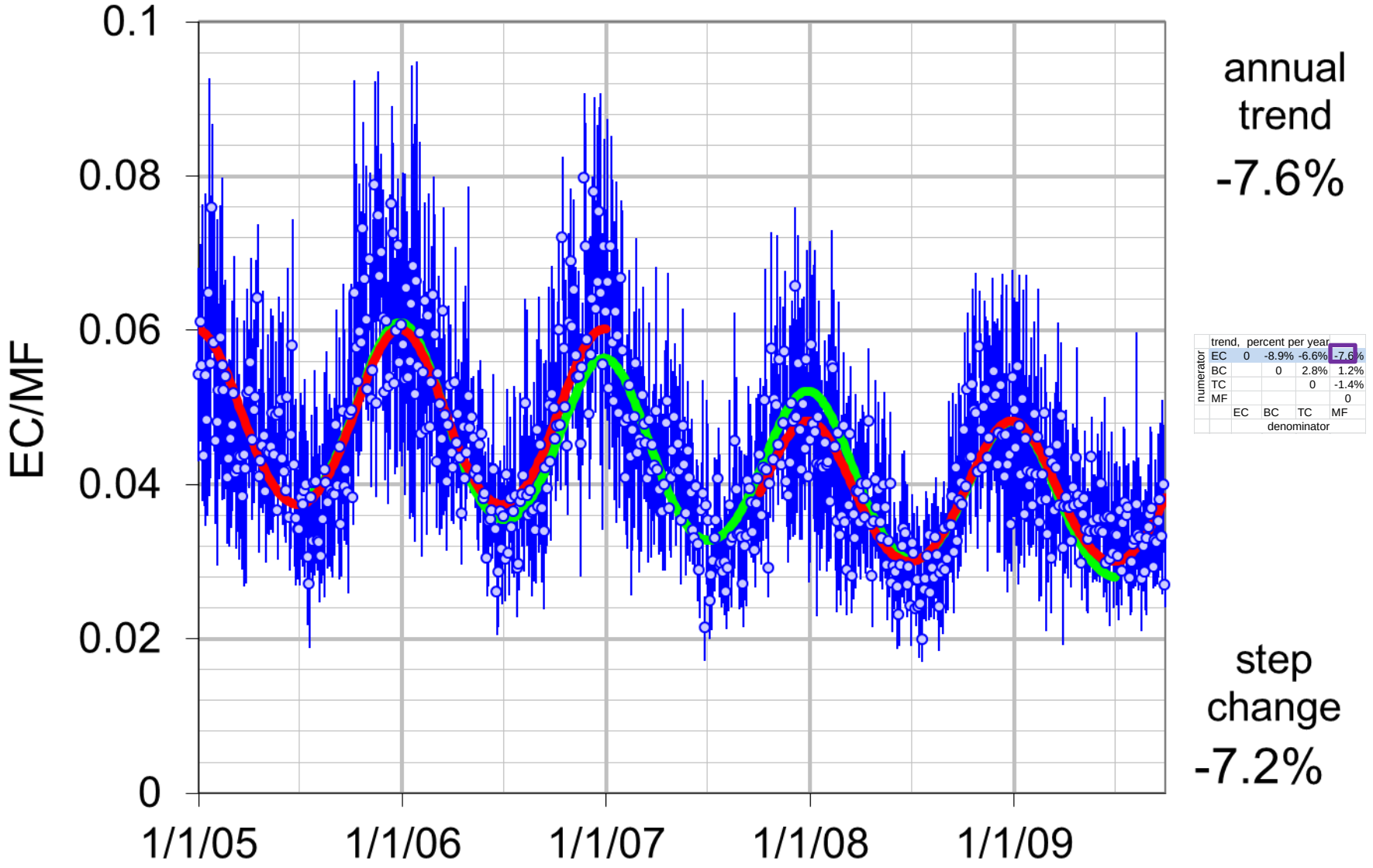
	trend, percent per year			
numerator	EC	0	-8.9%	-6.6%	-7.6%
	BC		0	2.8%	1.2%
	TC			0	-1.4%
	MF				0
		EC	BC	TC	MF
		denominator			



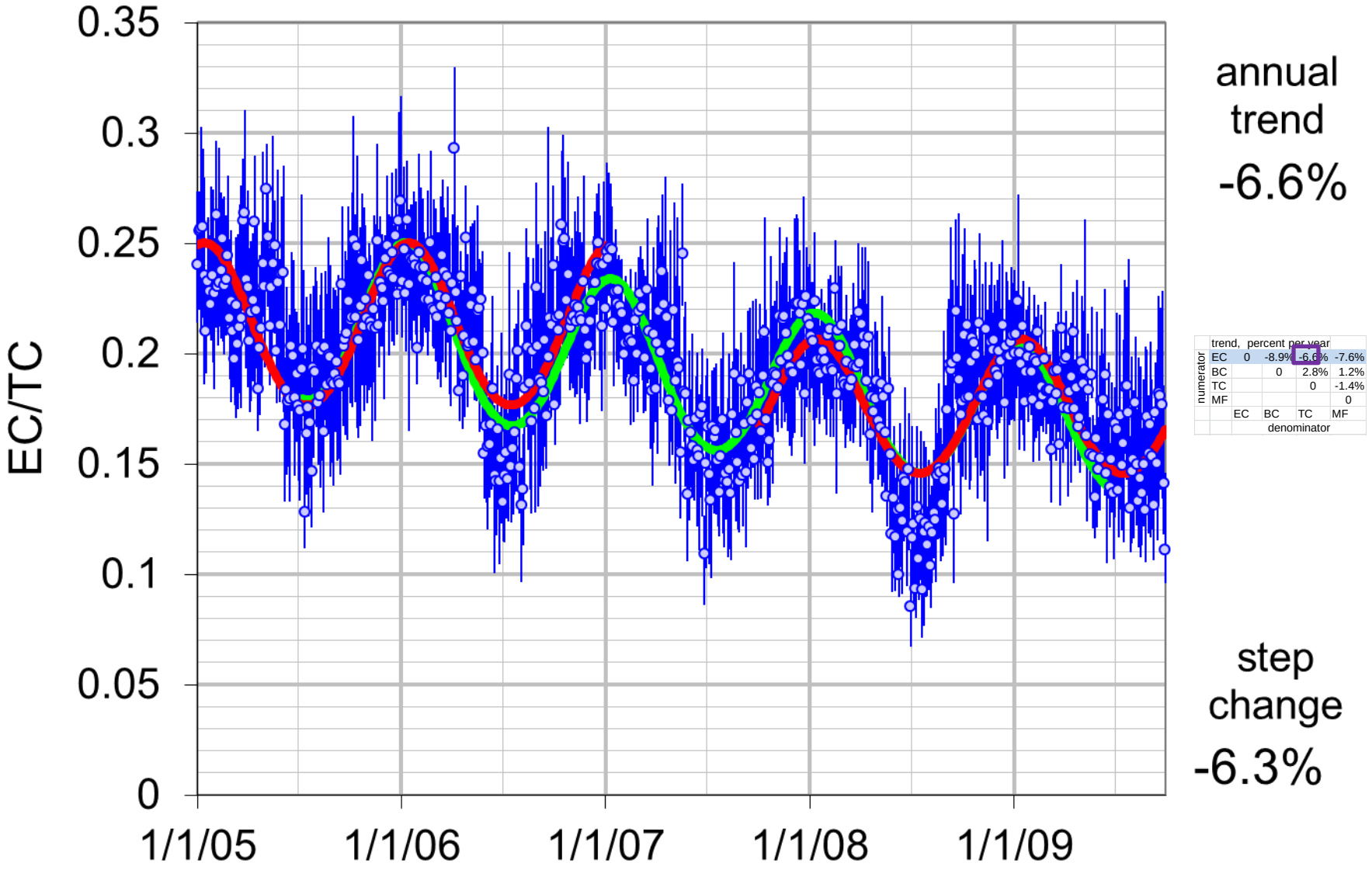
There is not much change over this period in the relative contribution of total carbon to total mass.



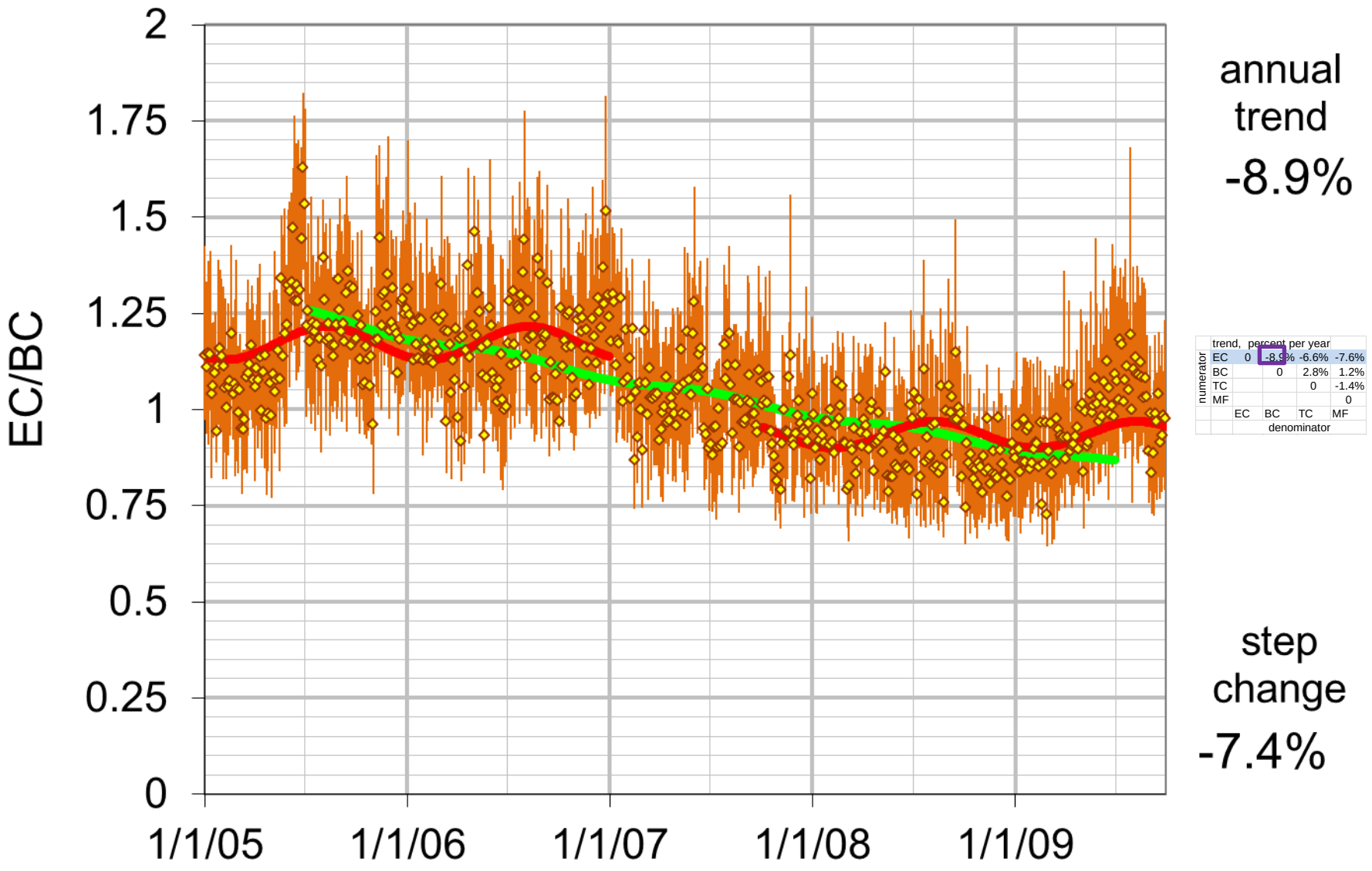
Nor is there much change in the specific absorption of the total sample (here translated into the relative contribution of ‘black’ carbon to mass).



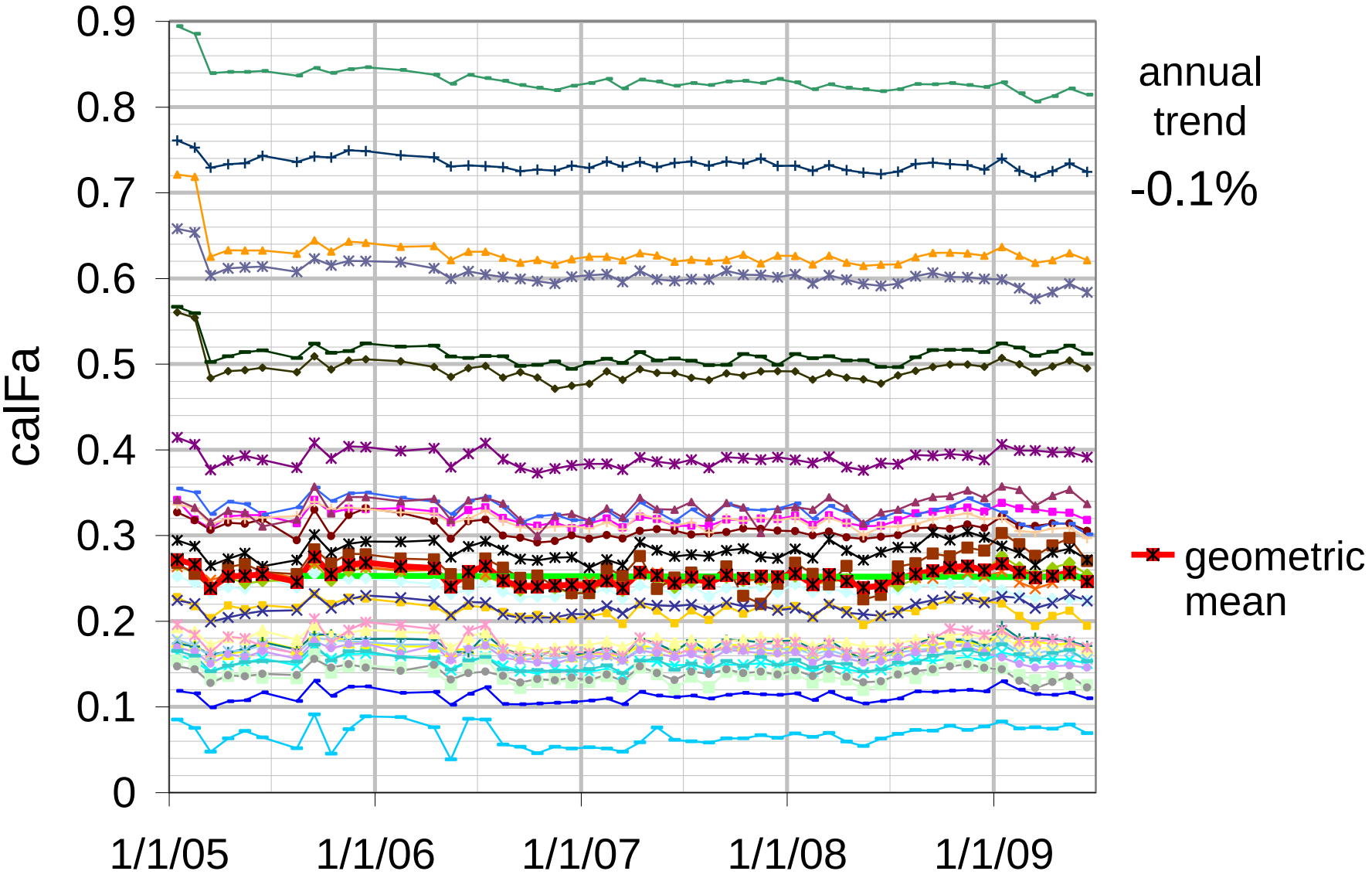
On the other hand there is an unmistakable downward trend in the ‘elemental’ carbon mass fraction.



Most of the ‘elemental’ carbon trend is associated with a decline in the fraction of total carbon identified as EC.

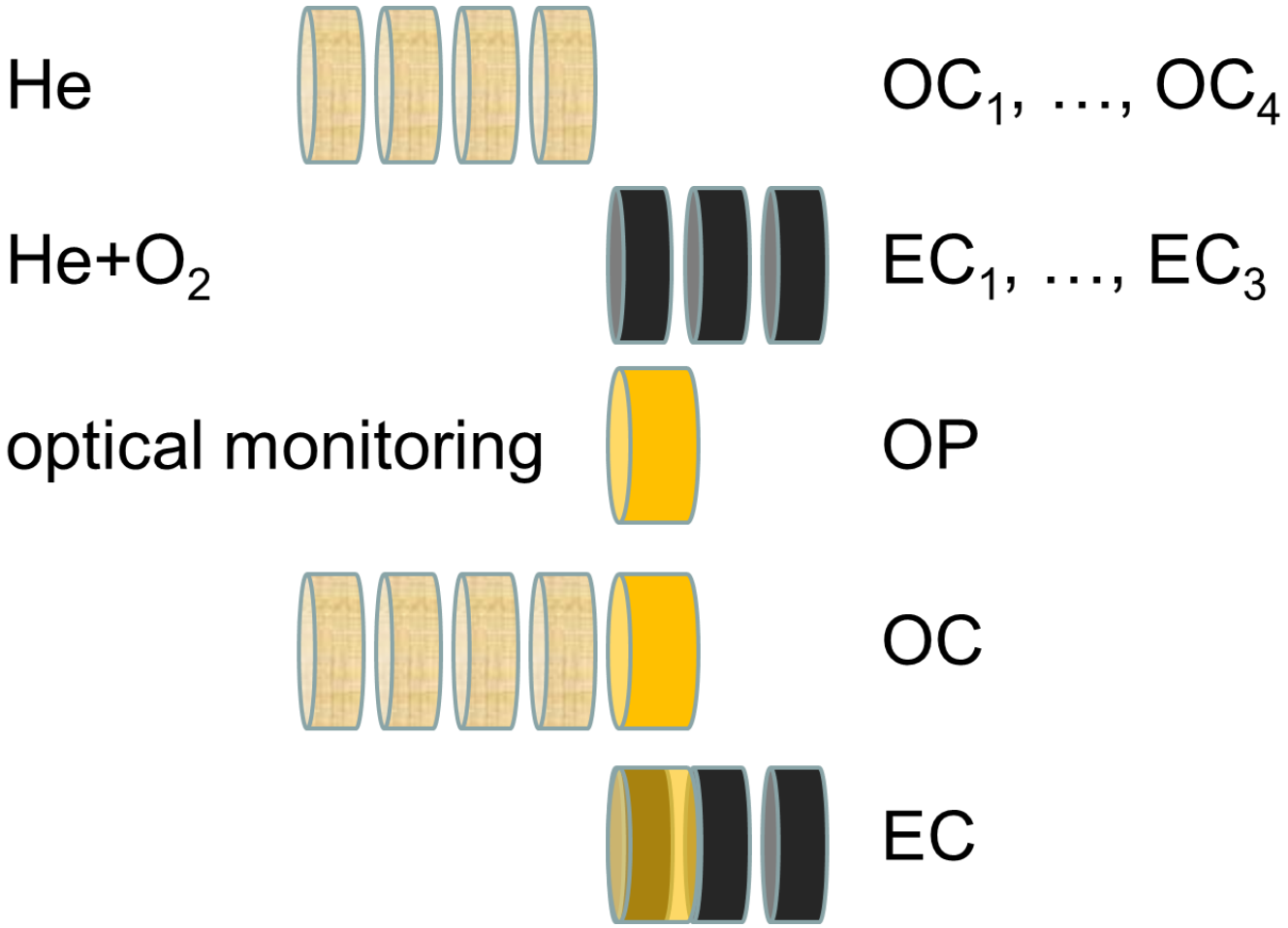


Given the differing trends seen for EC/MF and calFa/MF, it is no surprise that there is a clear trend in the ratio of ‘elemental’ to ‘black’ carbon, even though they continue to correlate well in contemporary measurements.



Being non-destructive, the HIPS measurement can be repeated indefinitely on the same samples to verify and document its long-term stability. Here are routine QA reanalyses of the 31 BIBE samples from Mar-May 2003.

Which of the TOR fractions are driving our observed decrease in EC? Recall:



$$OC = \sum OC_i + OP$$

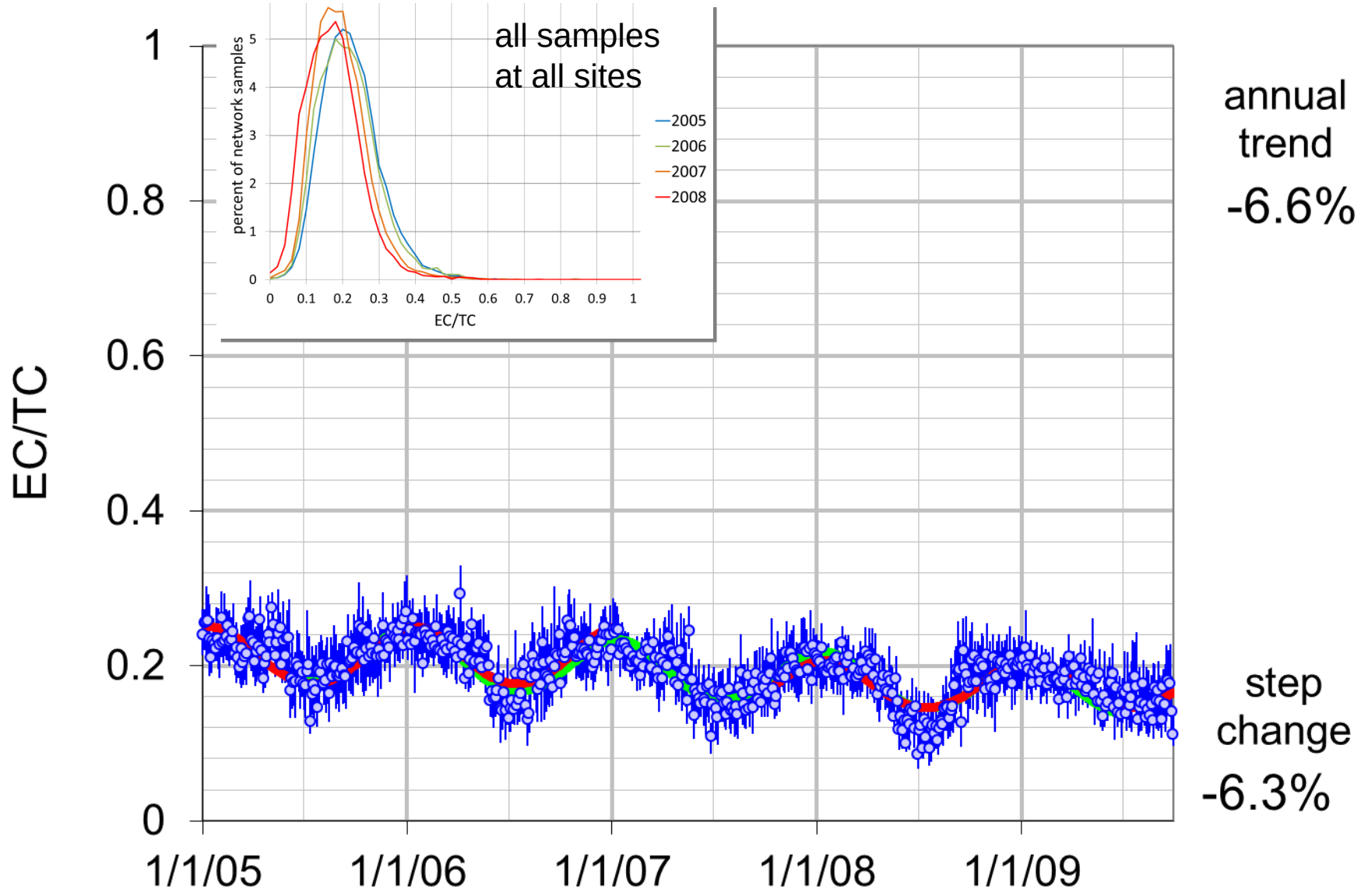
$$EC = \sum EC_i - OP$$

$$TC = \sum OC_i + \sum EC_i$$

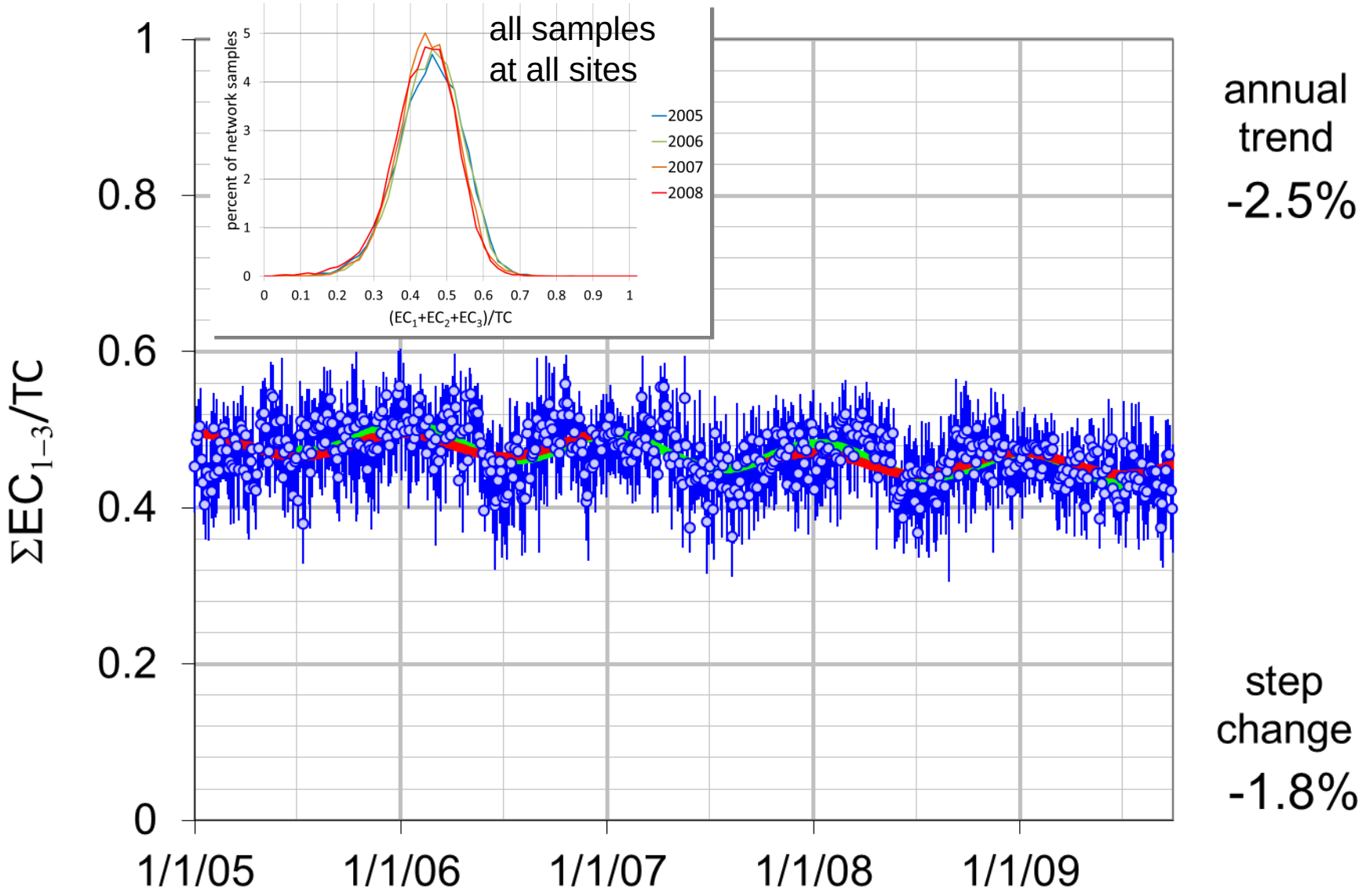
$$\frac{EC}{TC} = \frac{\sum EC_i}{TC} \times \left(1 - \frac{OP}{\sum EC_i}\right)$$

RAW SPLIT

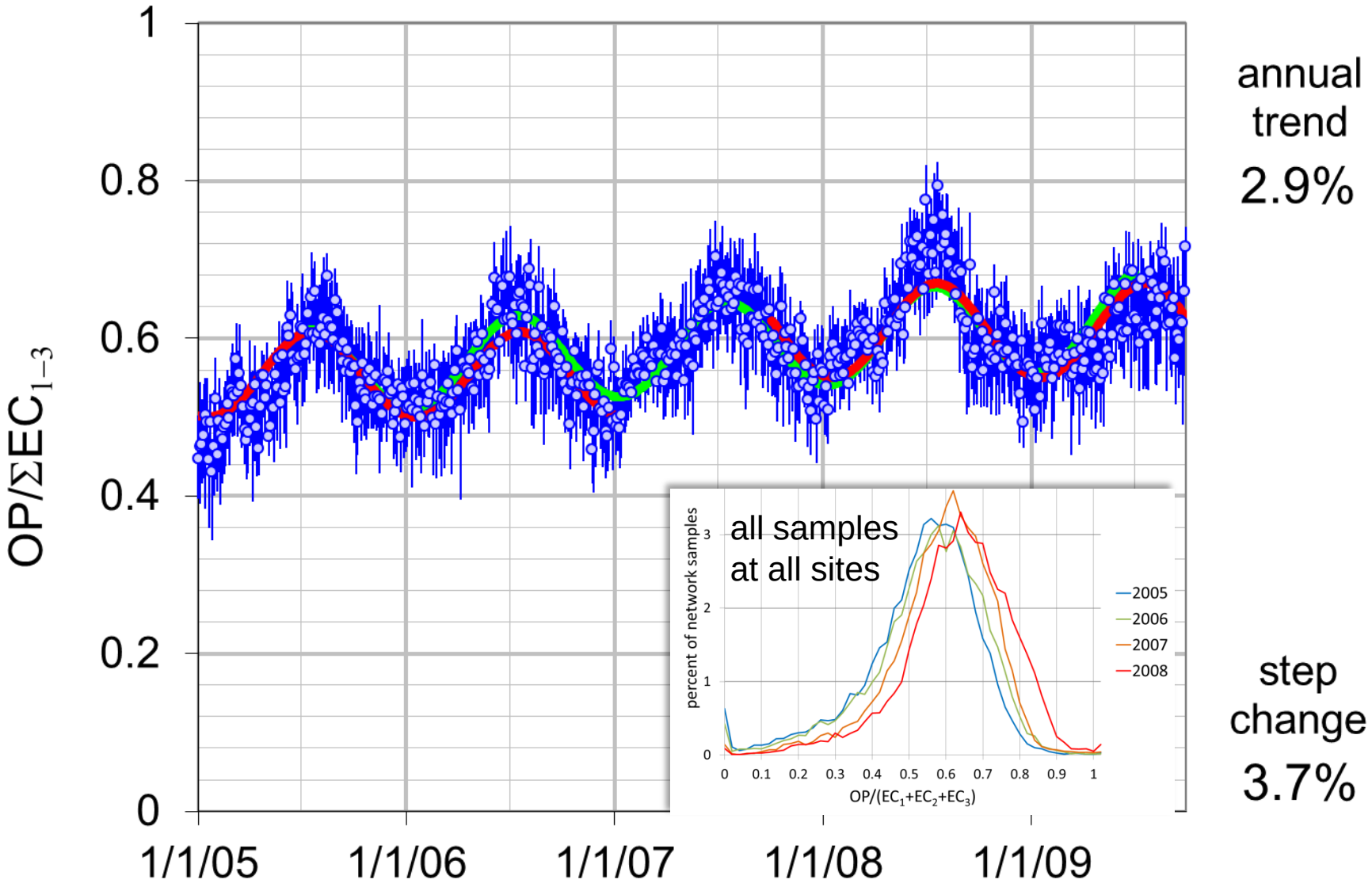
PYROLYSIS CORRECTION



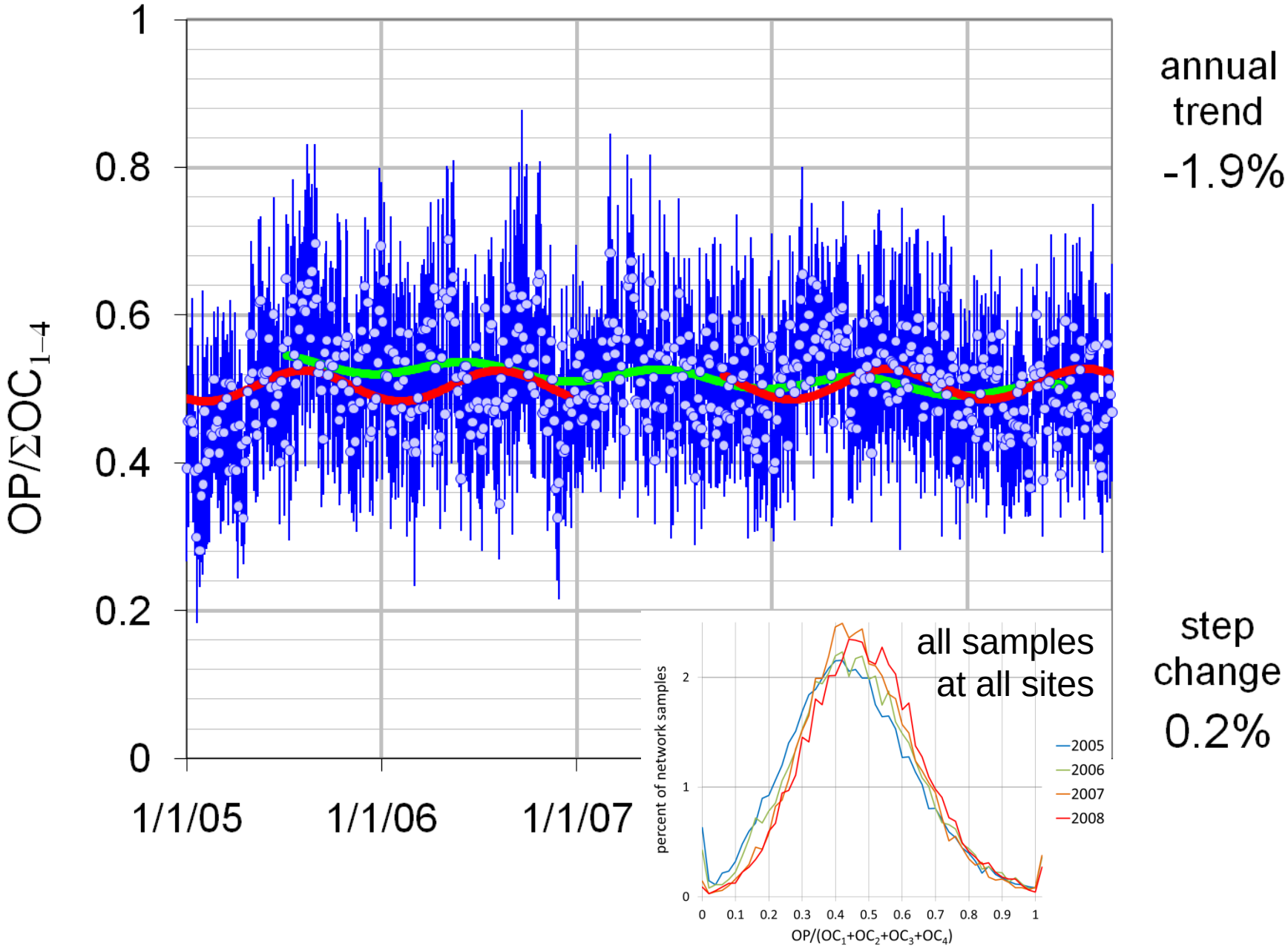
Trend in elemental carbon.

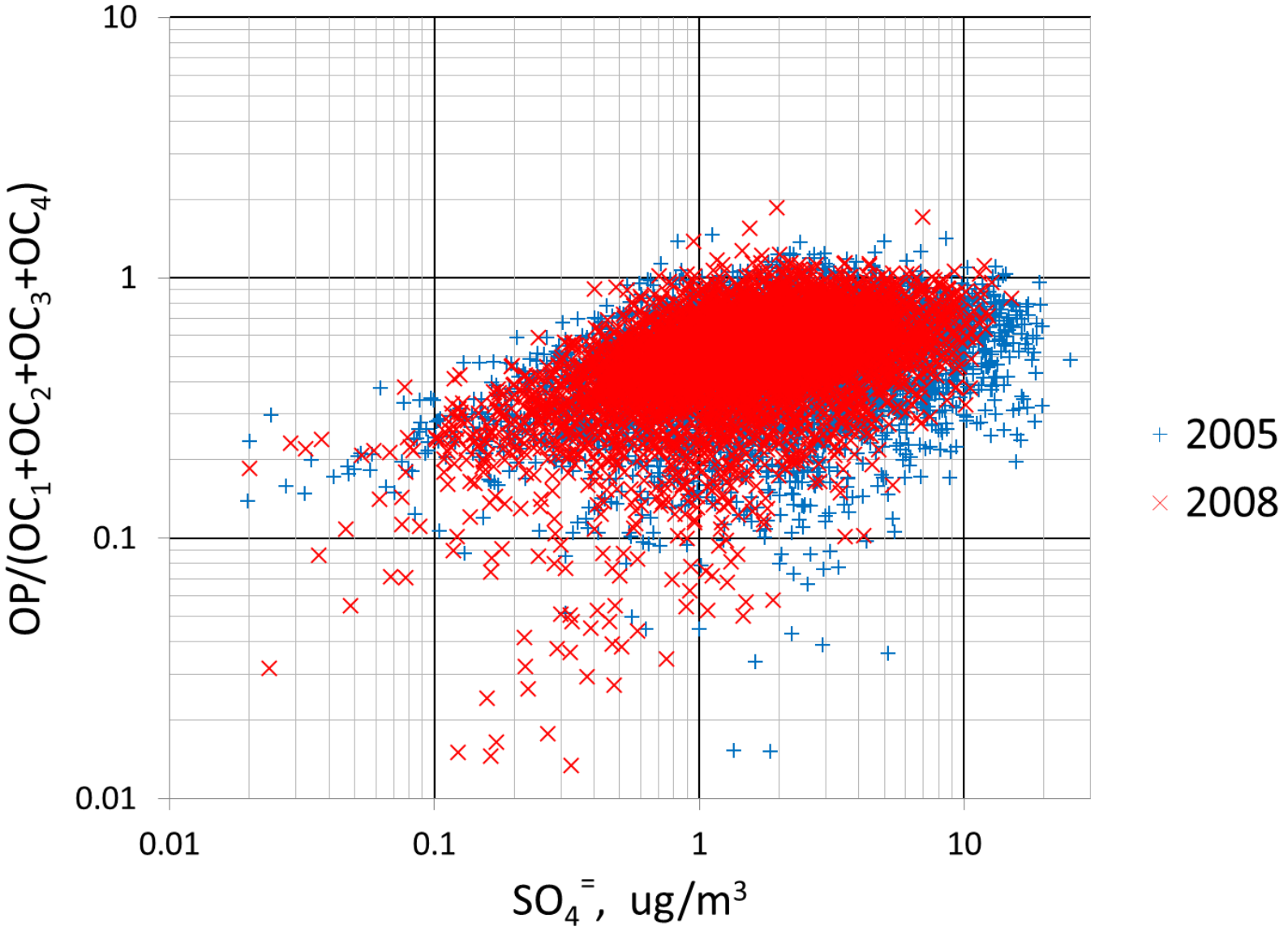


Trend in raw split.

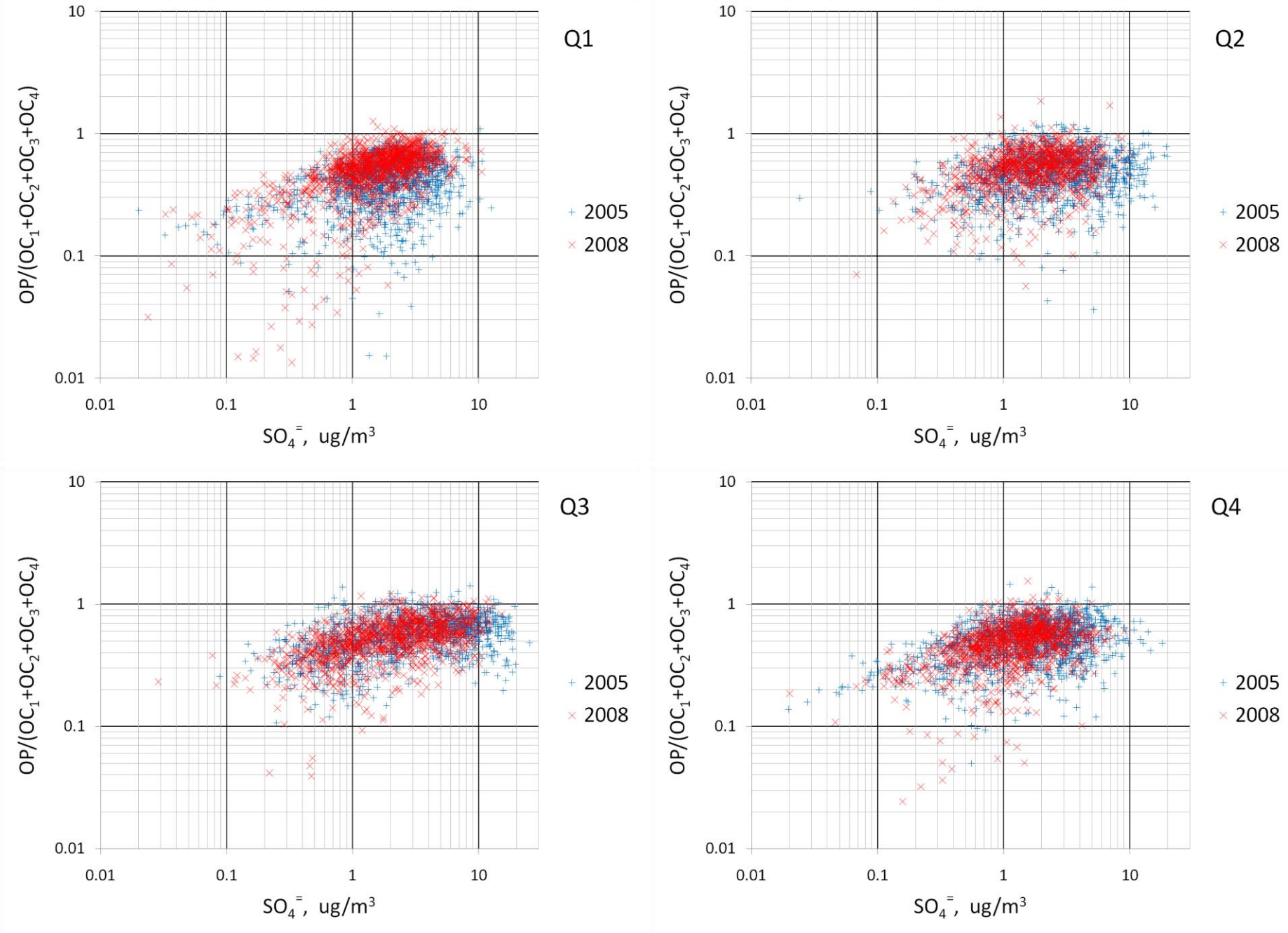


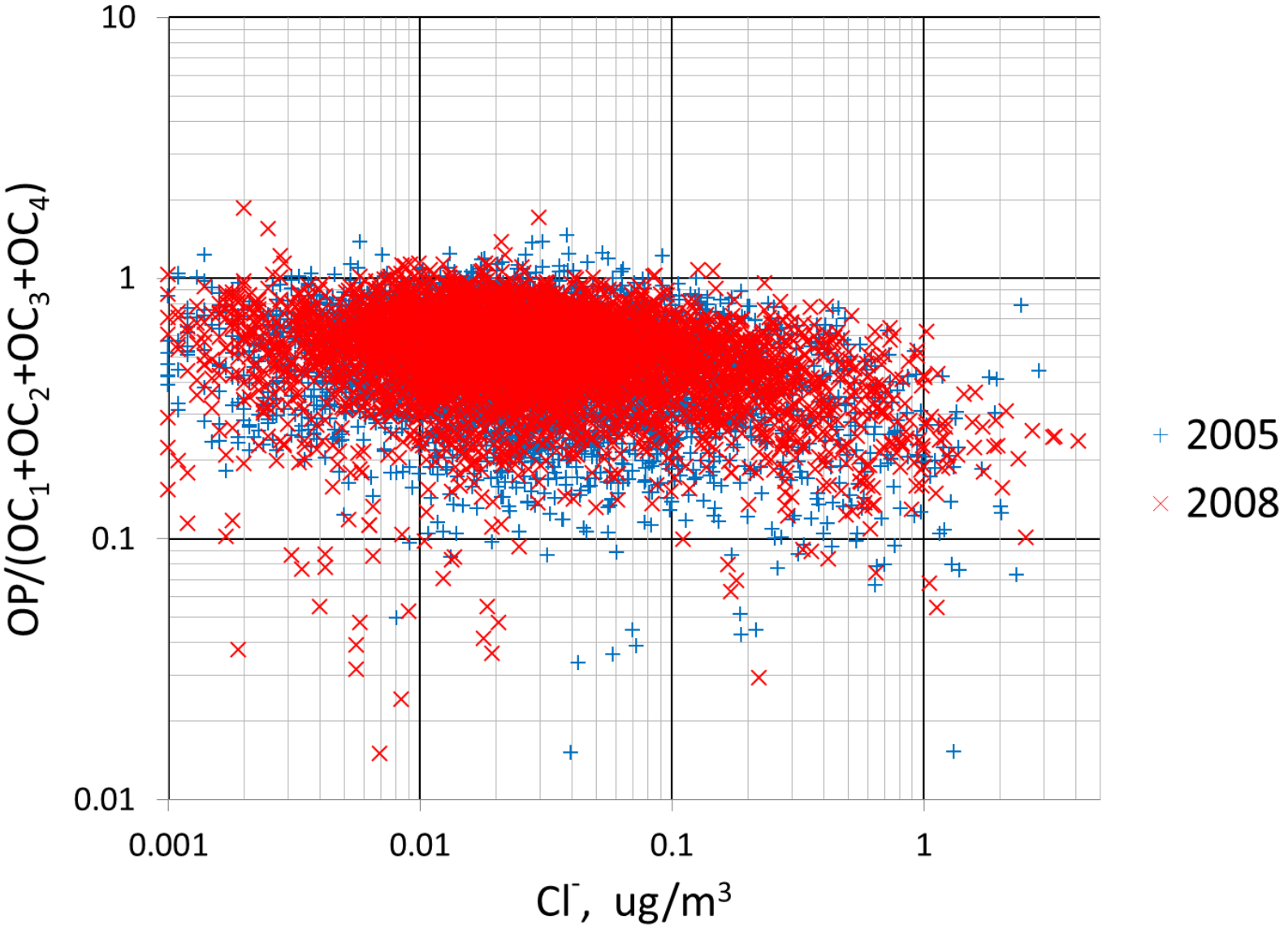
Trend in correction.


annual
trend
-1.9%
step
change
0.2%
OP/ΣOC1–4
1
0.8
0.6
0.4
0.2
0
1/1/05
1/1/06
1/1/07
all samples
at all sites
percent of network samples
2
1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
OP/(OC1+OC2+OC3+OC4)
2005
2006
2007
2008

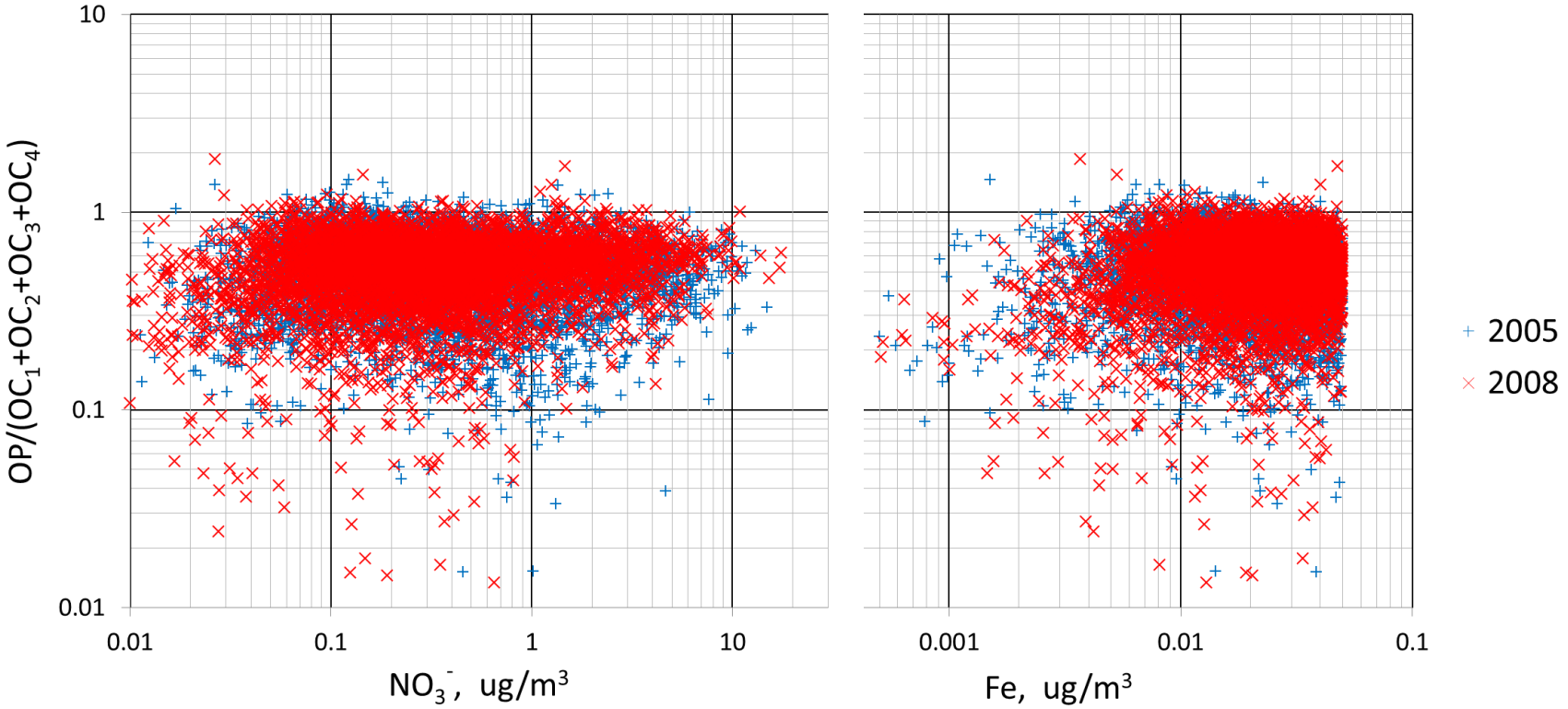


There's a tendency for less charring at low sulfate loadings …


Q1
Q2
Q3
Q4
2005
2008
10
1
0.1
0.01
0.01
0.1
1
10
OP/(OC1+OC2+OC3+OC4)
SO4=, ug/m3



… and high chloride loadings,



… with no trend evident for nitrate or iron.

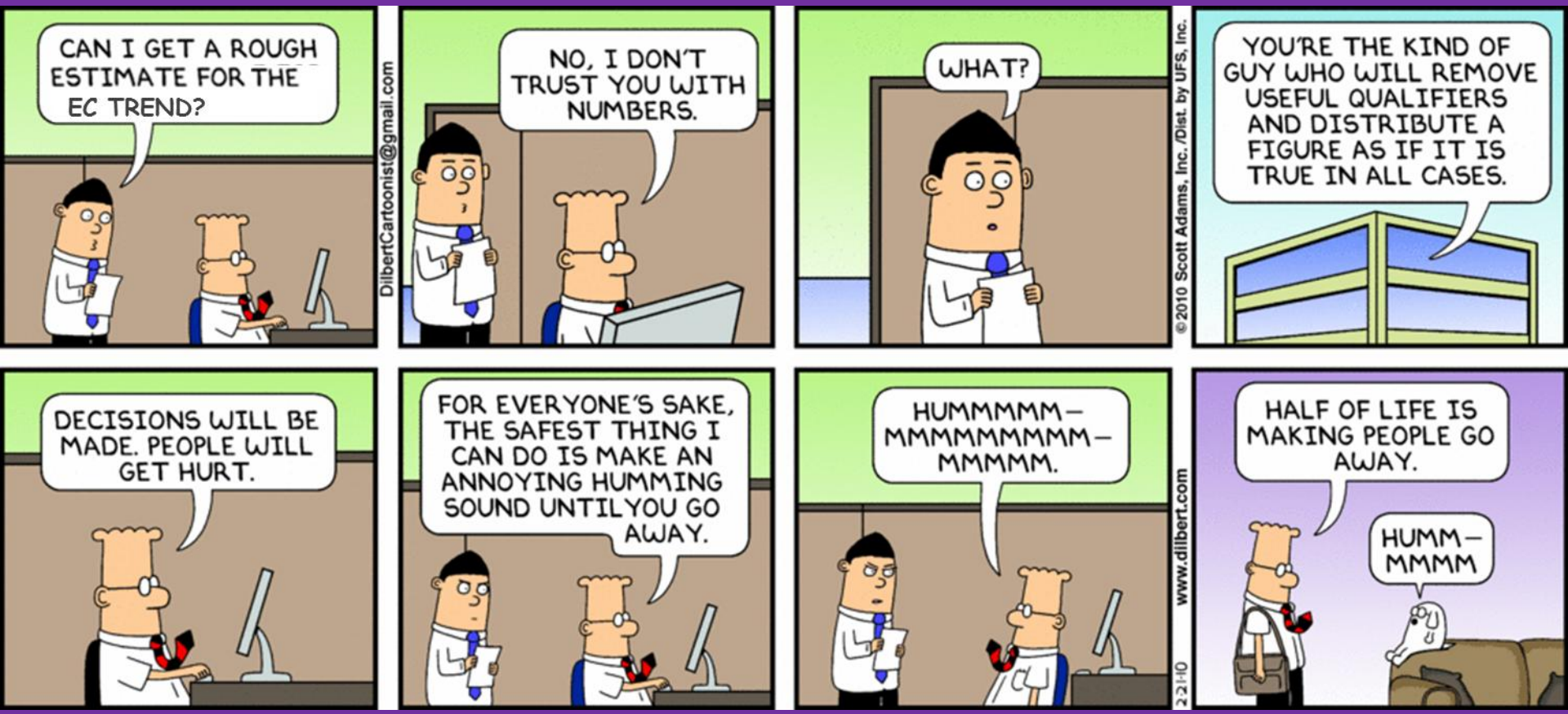
In summary, since 2005:

TOR ‘elemental’ carbon has declined relative to total mass and total carbon, but HIPS ‘black’ carbon has not.

The large charring artifact that is subtracted in reporting ‘elemental’ carbon has increased in relative importance.

The fraction of ‘organic’ carbon that chars exhibits some empirical dependence on sulfate and chloride loadings.

Until our understanding of the measurements is sufficient to explain these observations, I’m with Dilbert …


CAN I GET A ROUGH ESTIMATE FOR THE EC TREND?
NO, I DON'T TRUST YOU WITH NUMBERS.
WHAT?
YOU'RE THE KIND OF GUY WHO WILL REMOVE USEFUL QUALIFIERS AND DISTRIBUTE A FIGURE AS IF IT IS TRUE IN ALL CASES.
DECISIONS WILL BE MADE. PEOPLE WILL GET HURT.
FOR EVERYONE'S SAKE, THE SAFEST THING I CAN DO IS MAKE AN ANNOYING HUMMING SOUND UNTIL YOU GO AWAY.
HUMMMMM— MMMMMMMMM— MMMMM.
HALF OF LIFE IS MAKING PEOPLE GO AWAY.
HUMM— MMMM
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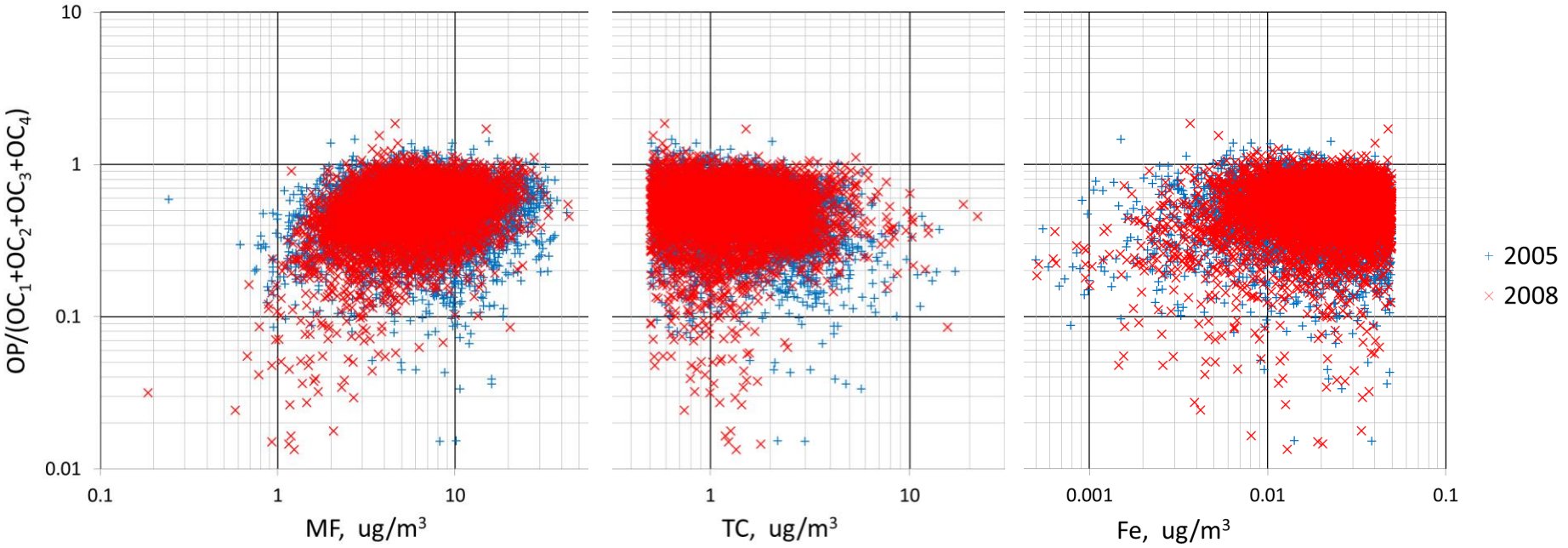
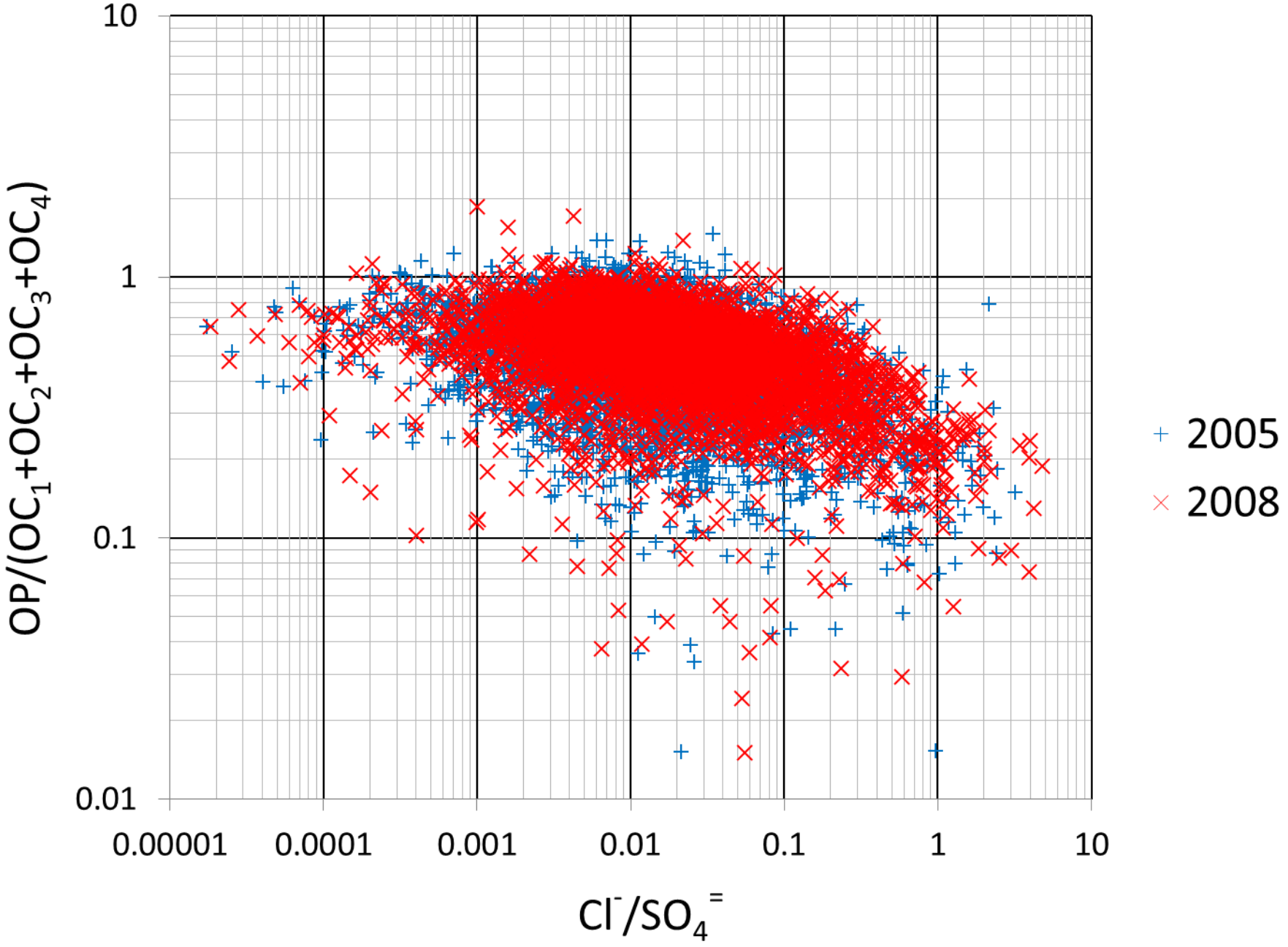
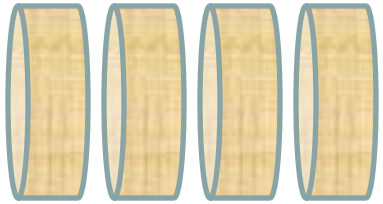
2-21-10


10
1
0.1
0.01
OP/(OC1+OC2+OC3+OC4)
0.1
1
10
MF, ug/m3
1
10
TC, ug/m3
0.001
0.01
0.1
Fe, ug/m3
2005
2008

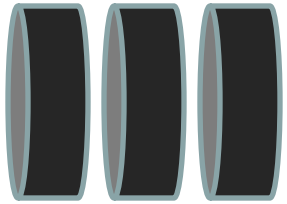

10
1
0.1
0.01
OP/(OC1+OC2+OC3+OC4)
0.00001
0.0001
0.001
0.01
0.1
1
10
Cl-/SO4=
2005
2008

He



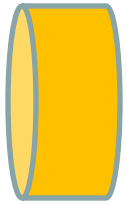
OC_1, …, OC_4

$He+O_2$

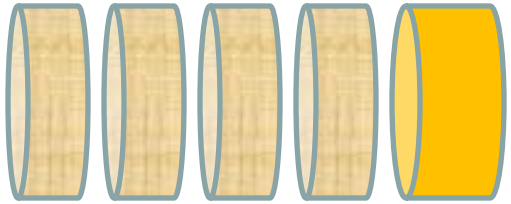


EC_1, …, EC_3

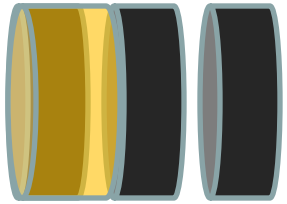
optical monitoring



OP



OC



EC