An update from the HIPS team: Warren White, Jason Giacomo, Nicole Hyslop, Lindsay Kline, Krystyna Trzepla, Xiaolu Zhang

Posting type	Information
Subject	Changes/upgrades in HIPS system resulting in calibration changes
Module/Species	A/ Fabs
Sites	Entire network
Period	Jan 2017 to present
Recommendation	None
Submitter	K.Trzepla, ktrzepla@ucdavis.edu, J. Giacomo, jagiacomo@ucdavis.edu

Sample Dates	HIPS Analysis Dates	HIPS data changes
January 2003 through December 2016	Prior to April 2017	None: as described in White et al. (2016)
January 2017 through February 2018	4/12/2018 – 8/17/2018	Reported with new calibration reflecting installation of 4 inch sphere and removal of diffuser tube assembly.
March 2018 to present	11/16/2018 - present	Reported after recalibration for new detectors and integrating plate optics.

<u>Calibration</u>: A mapping of measurement values to an independent scale of accepted reference values.

e.g.,
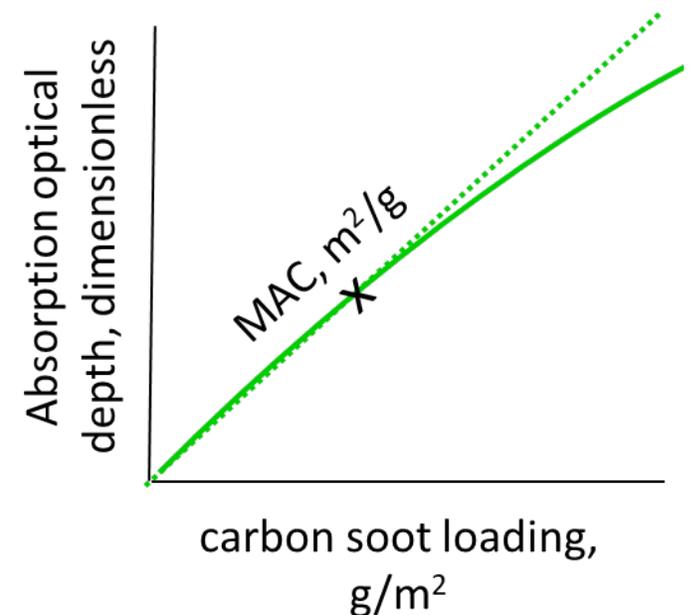
Sunset Labs running standard IMPROVE_A protocol, by Xiaolu Zhang 19 June 2018

TOR EC, ug/cm^2

10 ug/cm^2 ~ 1 ug/m^3

- EC
× tau

sample duration, seconds

HIPS calibrated to 10 blank MTL filters by Jason Giacomo, 15 June 2018:

$tau = \ln((1-r)/t)$.

Absorption optical depth, tau

tau = 1 ~ 10 Mm^{-1}
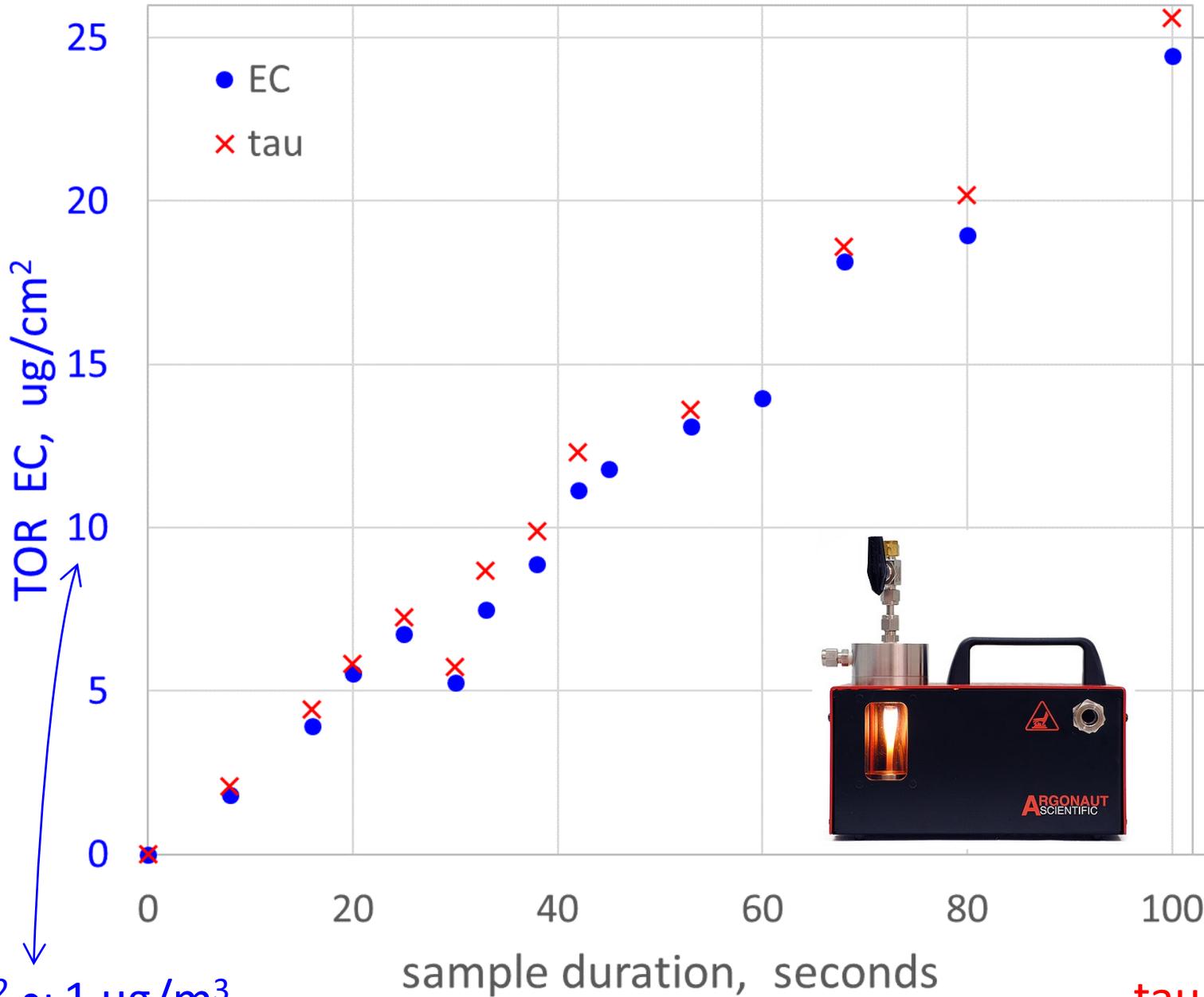
From Michael Brauer, UBC Vancouver

Observed linearity →
in the HIPS response to TOR EC for pure soot samples generated by an inverted ethylene flame at the University of British Columbia in Vancouver.

The nearness of the observed regression slope to the MAC assumed in the IMPROVE extinction formula is purely fortuitous.

Fewer than 1 in 200 valid 2006 – 2015 IMPROVE samples reported EC > 20 ug/cm^2, suggesting that HIPS is usually operating within its linear response range.

$$tau = 0.03 + 10.4 \left(\frac{m^2}{g}\right) EC$$

$R^2 = 0.998$

10 m^2/g

HIPS absorption optical depth, tau

TOR EC, ug/cm^2
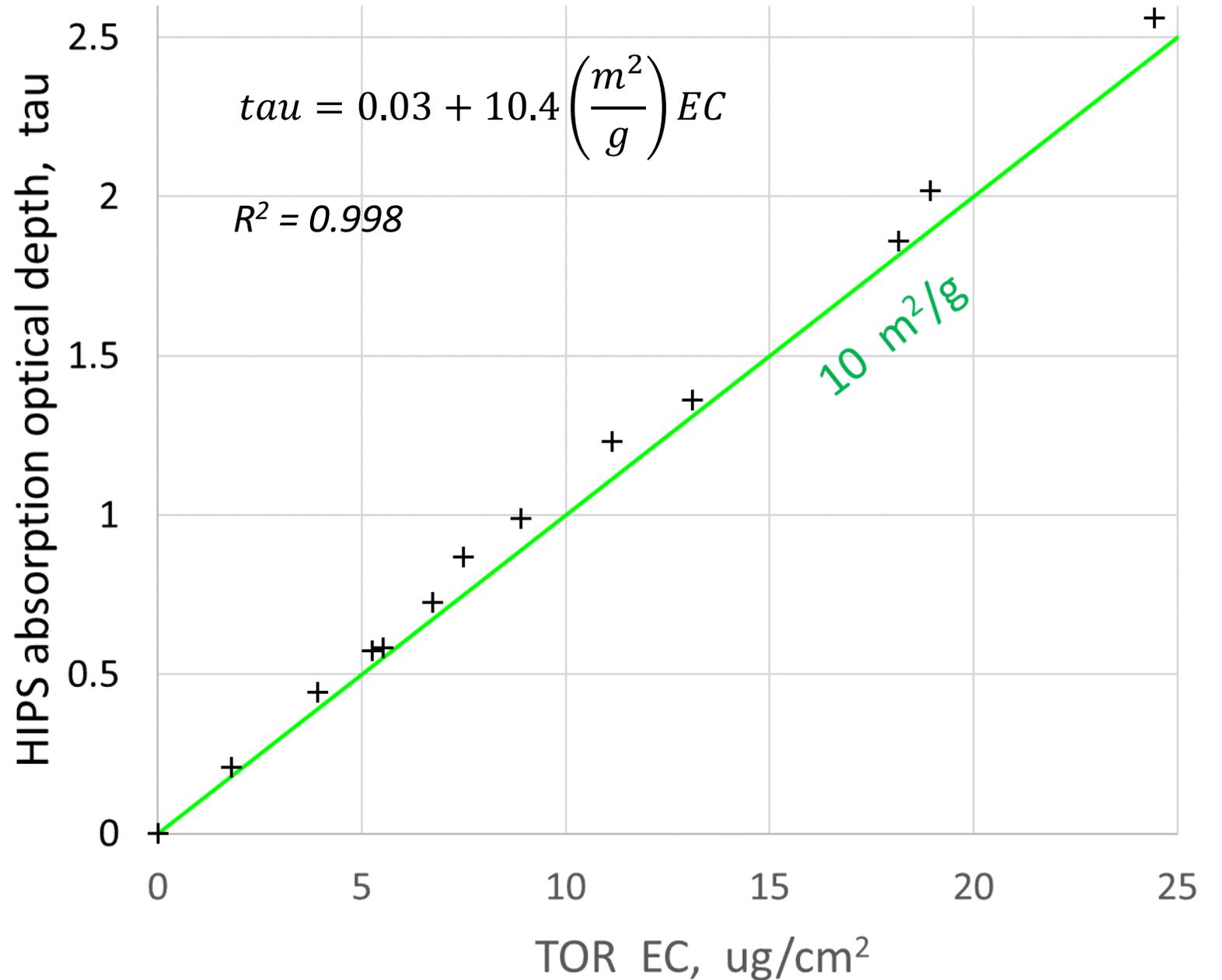
Efforts are in progress to test HIPS' linear response range for samples of actual atmospheric aerosols. Two rounds of sequential and over-lapping samples (8, 24, 48, and 96 h) have been collected on Ghausi Hall (UCD) rooftop. Both efforts were carried out in conditions about as hazy as we saw this summer.
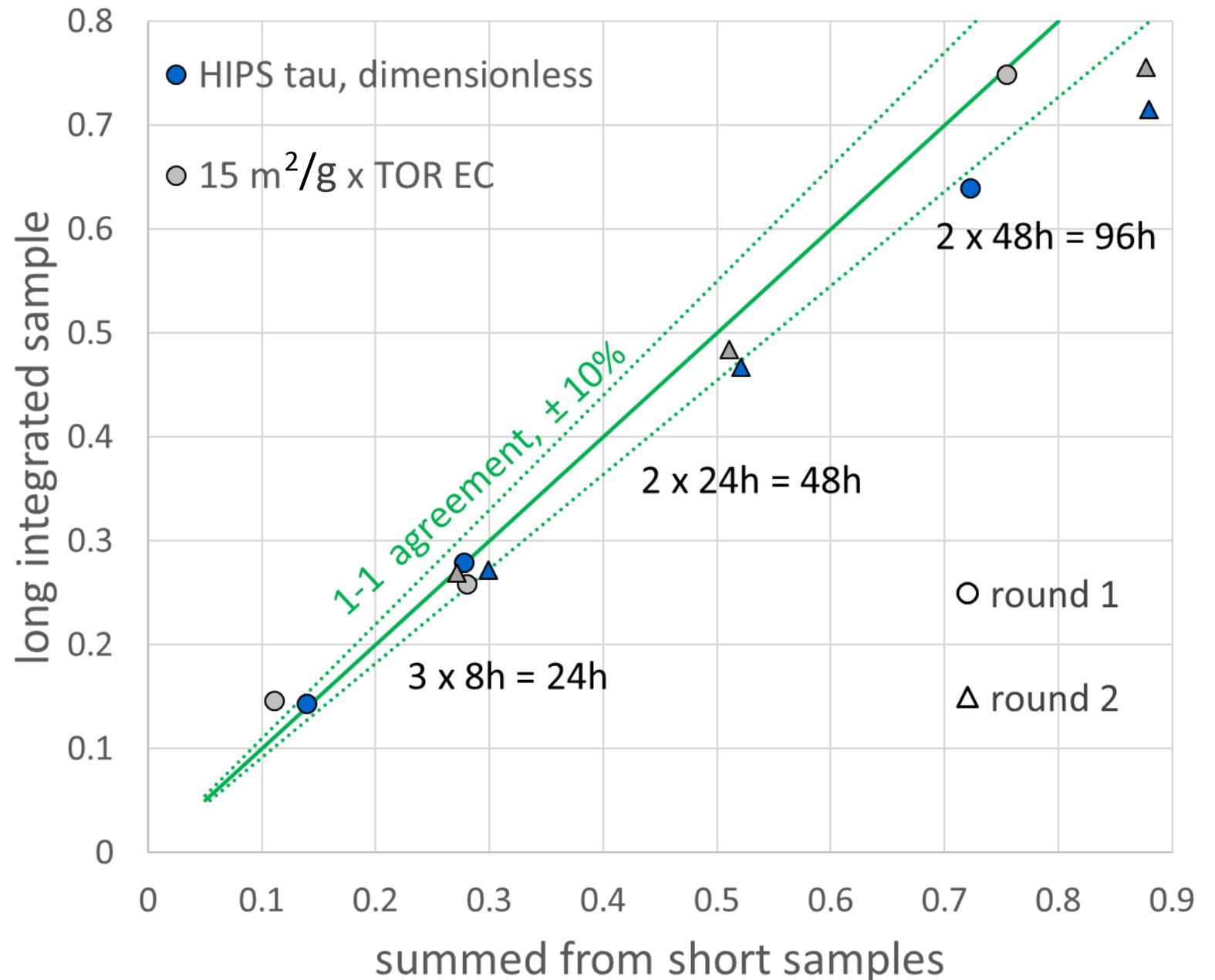
California wildfires down 90 percent this year

*An average recent year sees nearly ten times the acreage burned*
https://sf.curbed.com/2019/8/15/20807024/california-wildfires-down-90-percent-calfire-2019-statistics
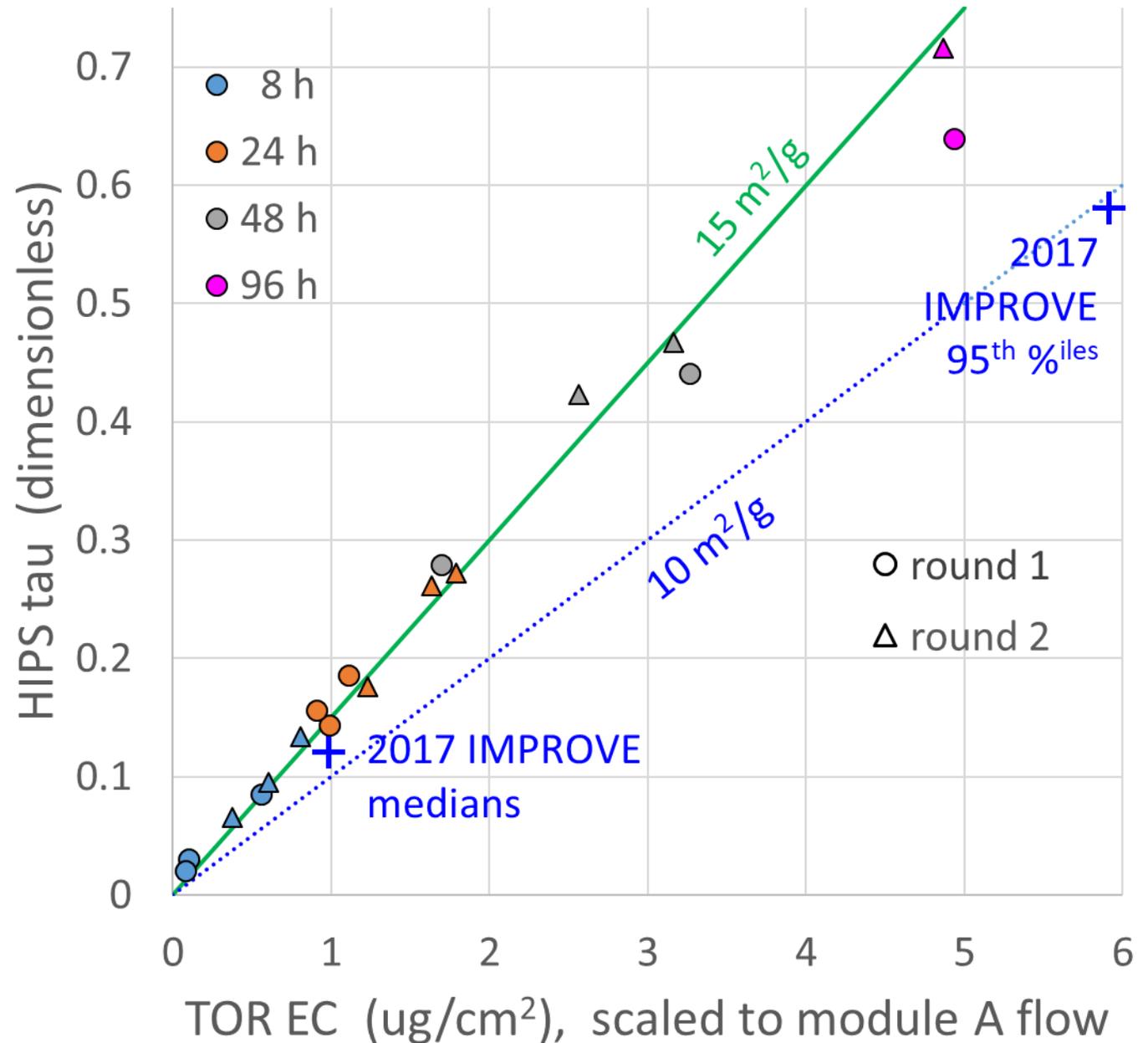
Individual measurements of samples collected over successive short intervals (e.g. 0-8, 8-16, and 16-24) are summed (with appropriate weighting for their individual sampled volumes) for comparison with collocated samples collected continuously over the aggregate of the short intervals (e.g. 0-24).

- HIPS tau, dimensionless
- $15 \ m^2/g$ x TOR EC

1-1 agreement, ± 10%

2 x 48h = 96h

2 x 24h = 48h

3 x 8h = 24h

○ round 1

△ round 2

long integrated sample

summed from short samples

Calibration as a mapping of measurement values to a scale of established historical values: Multi-Year ReAnalysis (MYRA) using the newly rebuilt HIPS system.
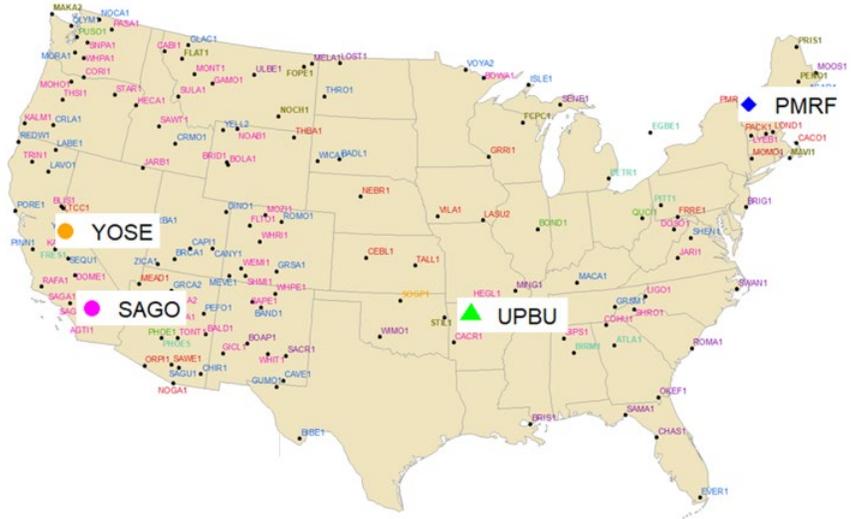
Reanalyzed all archived 2003 – 2017 sample filters from four sites with sustained good detection rates and no sample masking. Mean originally reported value for MYRA population was Fabs = 2.27 Mm^{-1}.
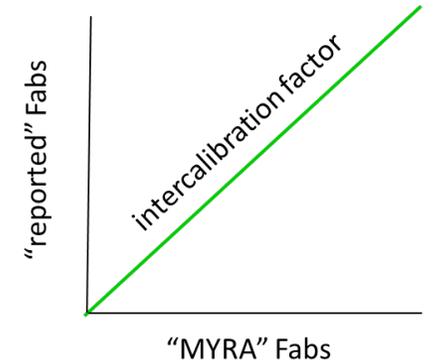

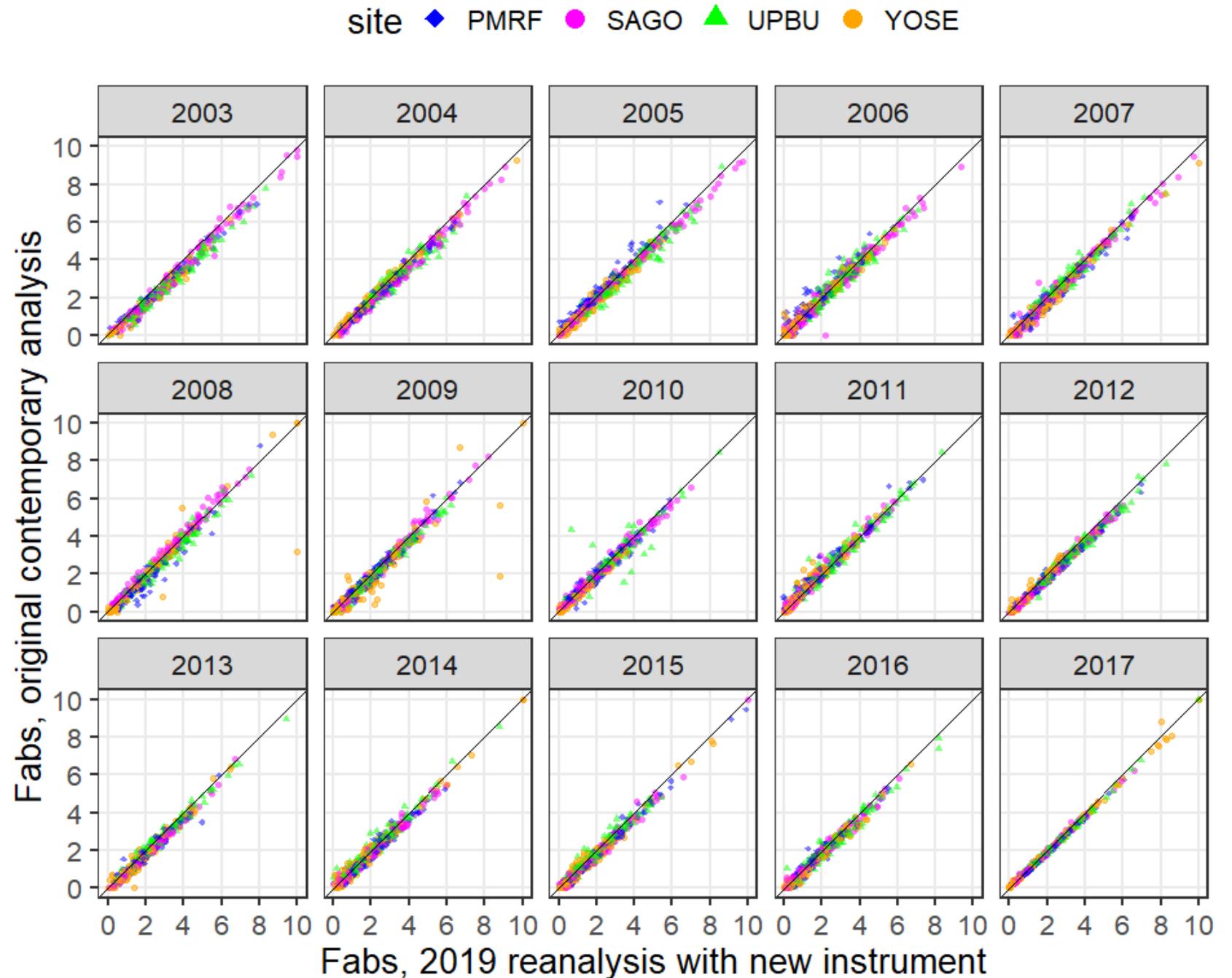"reported" Fabs

"MYRA" Fabs

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"reported" Fabs

"MYRA" Fabs

To calibrate the new HIPS for old samples, archived field and lab blanks from the old filter lots were reanalyzed.
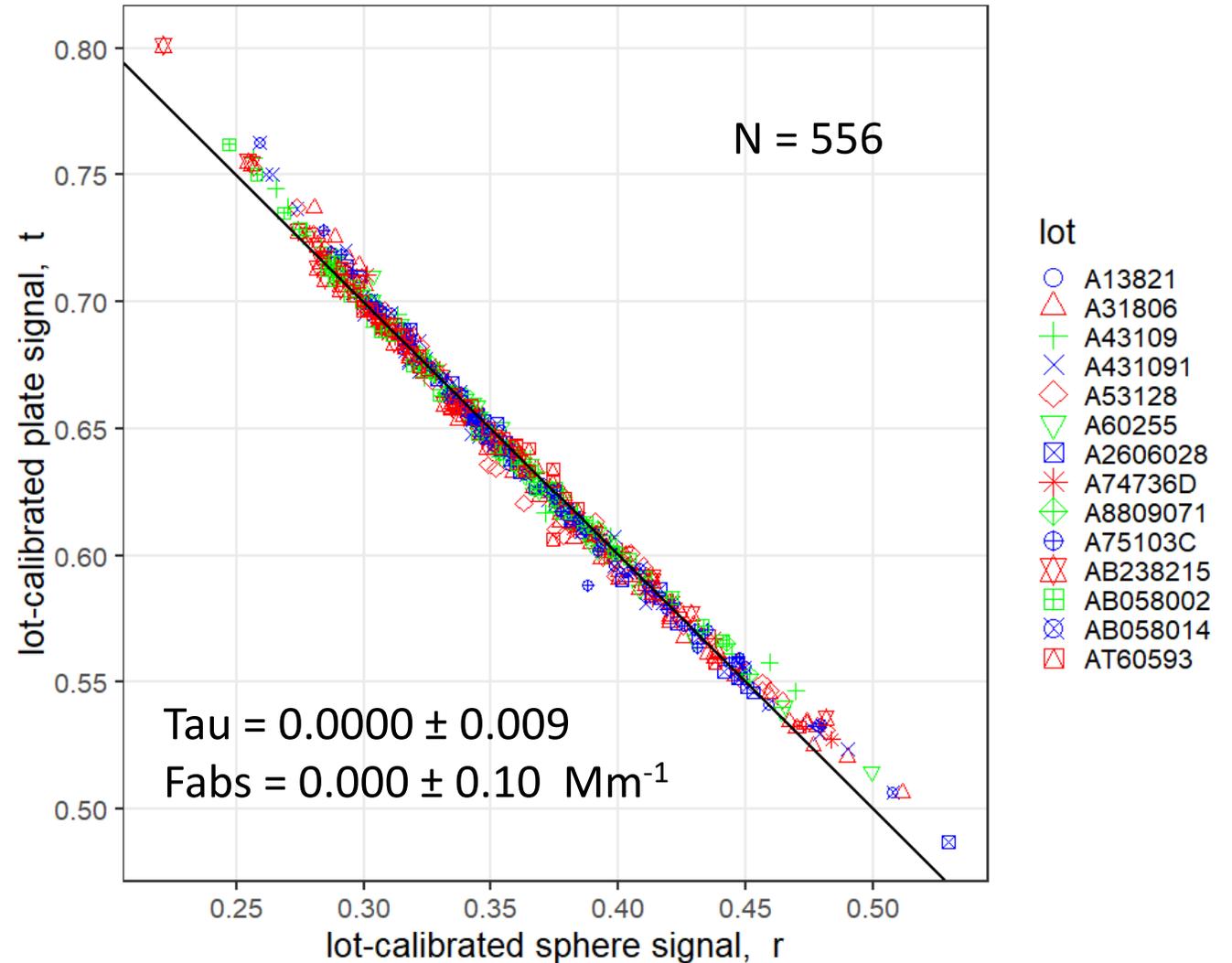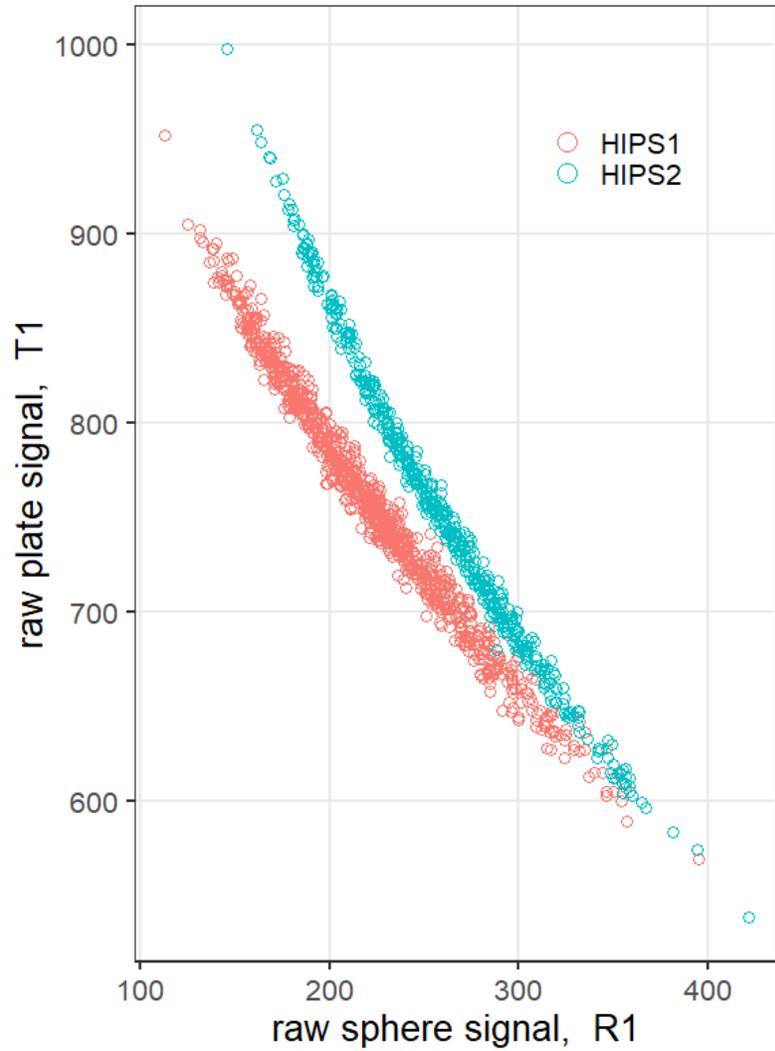
Consistently good correlation was obtained between the historical values, reported to CIRA as much as 15 years ago, and the independently calibrated 2019 measurements using the new instrument system.
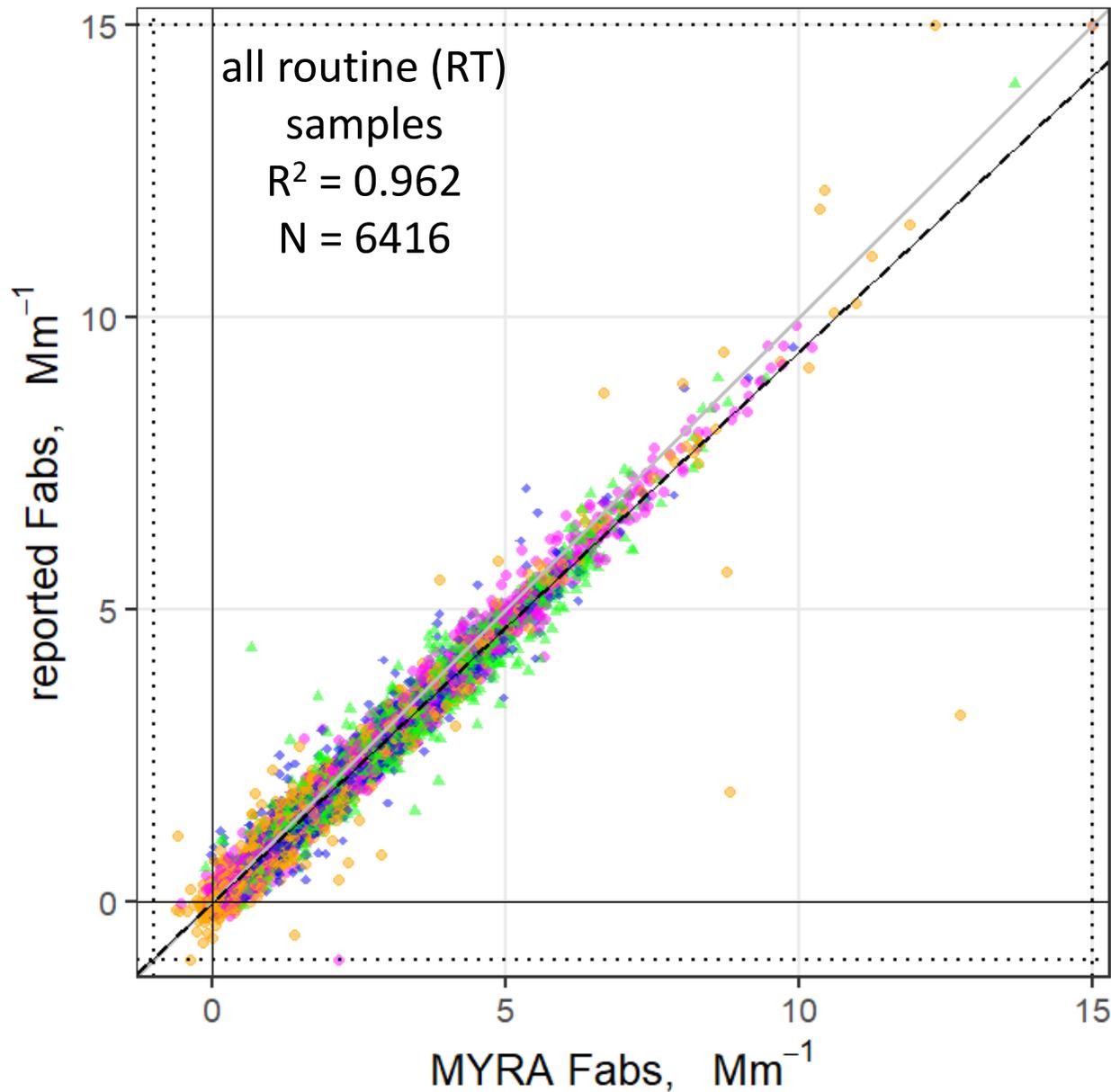
$$\alpha = median\left(\frac{MYRA\ Fabs}{reported\ Fabs}\right) = 1.061$$

$$\beta = \frac{mean(MYRA\ Fabs)}{mean(reported\ Fabs)} = 1.062$$

The relationship between the two Fabs measurements is consistent across the sample years, but there is also a consistent multiplicative bias between their scales. The cause of this bias is unclear, but the existence of some such bias is not surprising when we recall that HIPS' calibration rests wholly on the system's response to blank filters, and employs no external span check.
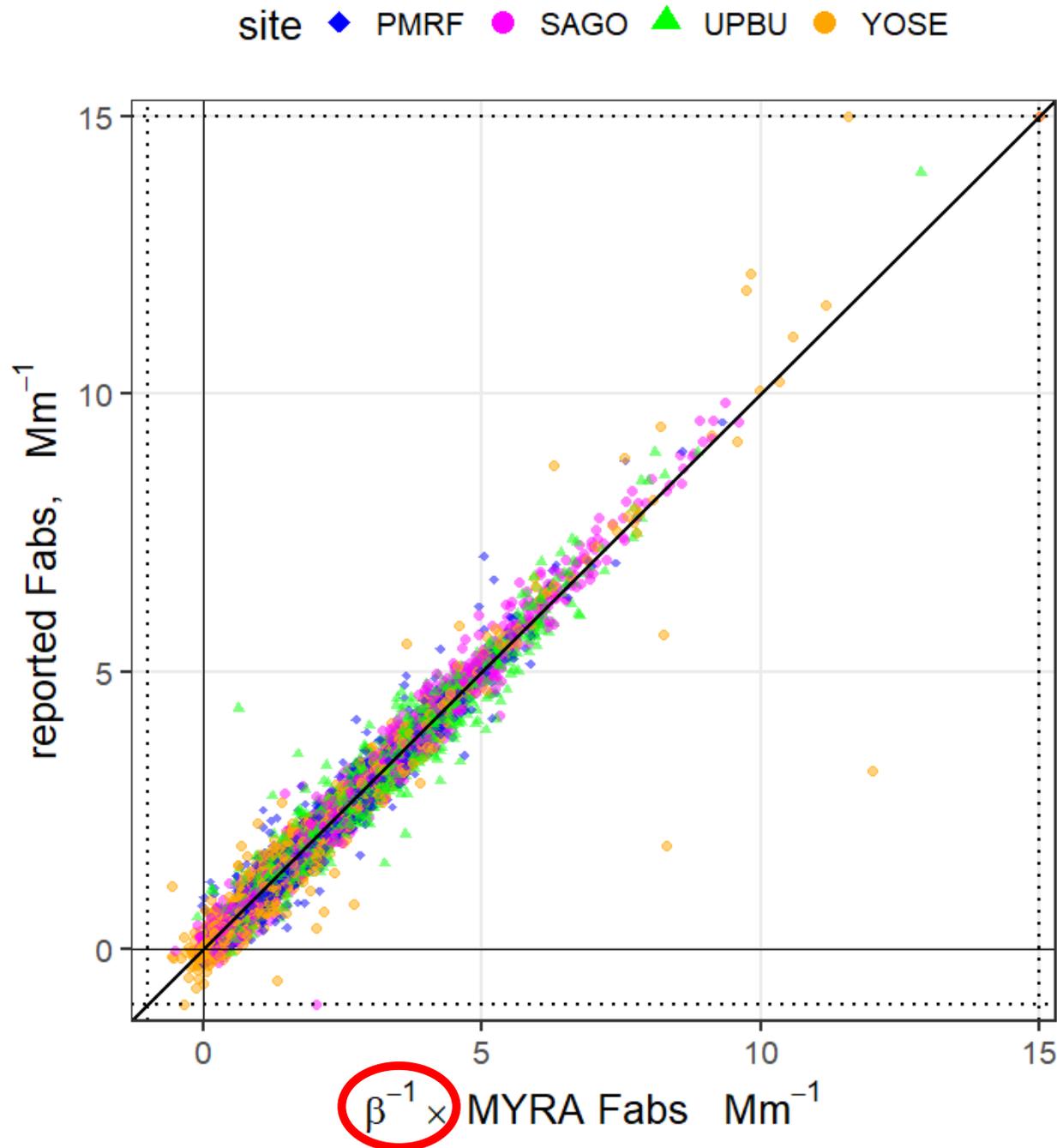
After further investigation (including reanalysis of the UBC soot samples shown earlier), a Data Advisory will be posted to document the quantitative difference between historical Fabs data and continuing data from the new HIPS system. Any guidance on which data stream to privilege as the reference will be the responsibility of the Steering Group. The remainder of this presentation will scale the MYRA data to agree with those already reported.

The trend of additive bias in the scaled data is well under 0.01 Mm^{-1} per decade.

Along with this time series of *differences*, we can also look at the time series of *ratios*, in the familiar format of medians and IQRs.
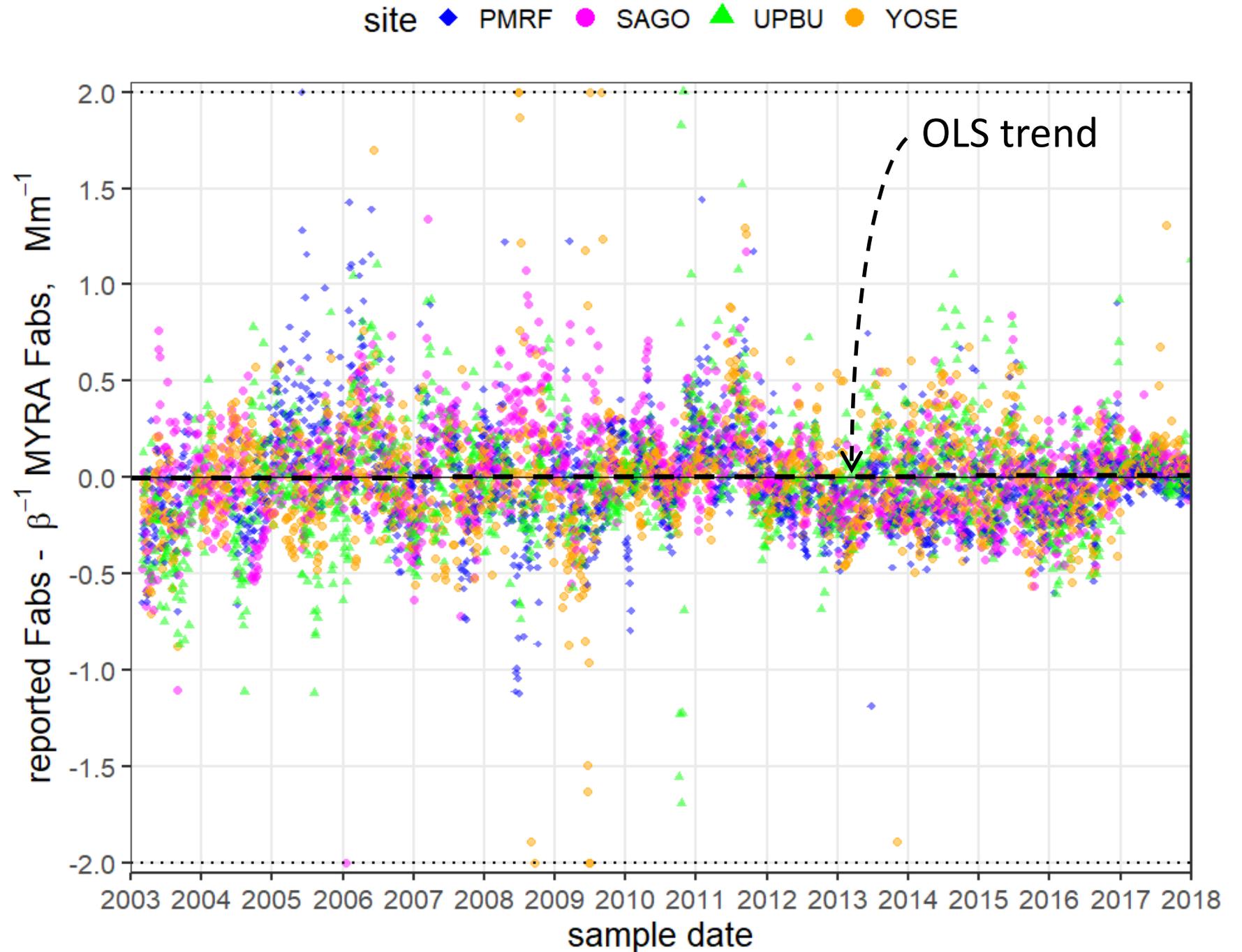
All MYRA samples with original MF (gravimetric fine mass) above the 5th percentile. Seasons with < 80 samples are not plotted.
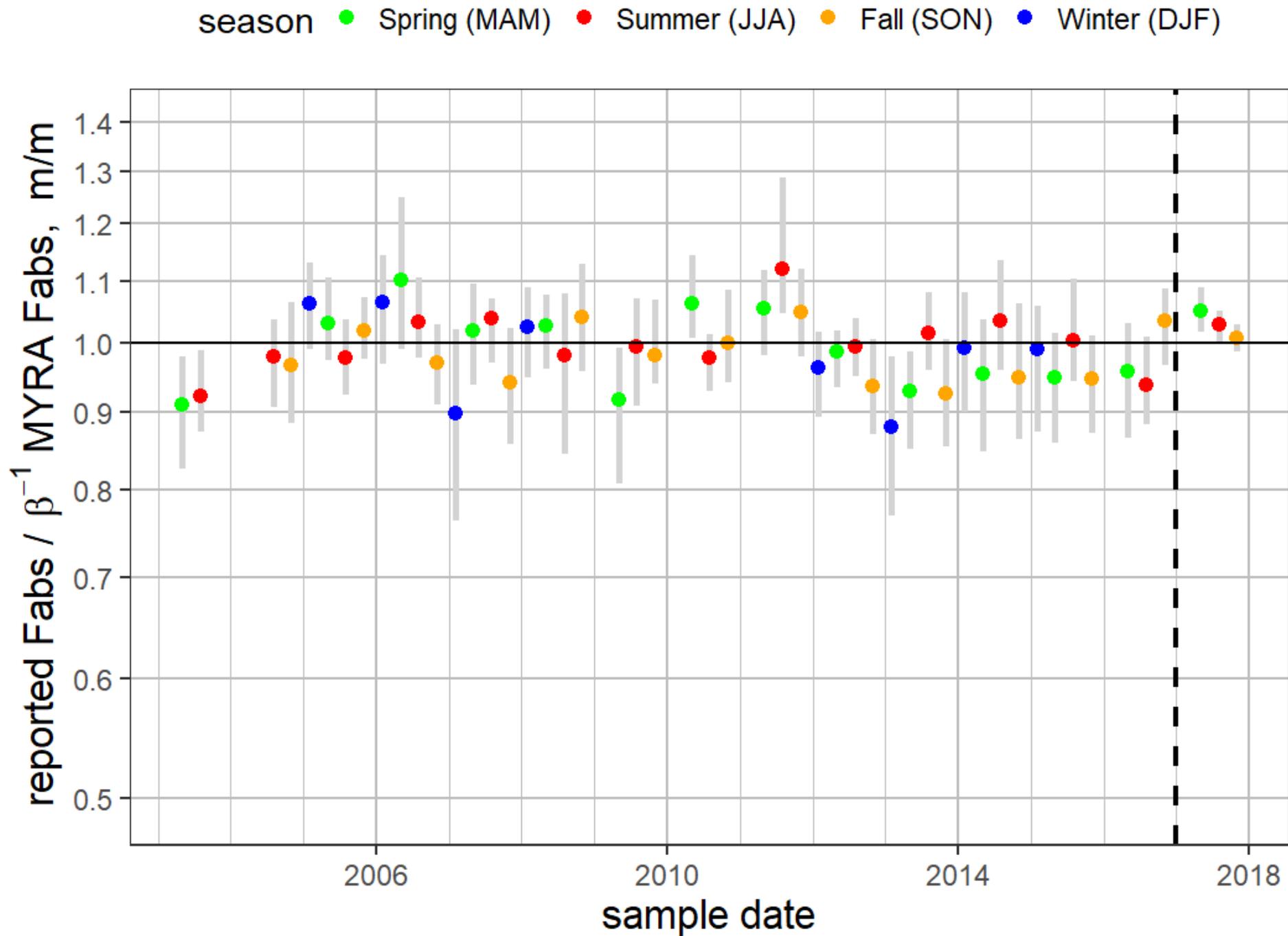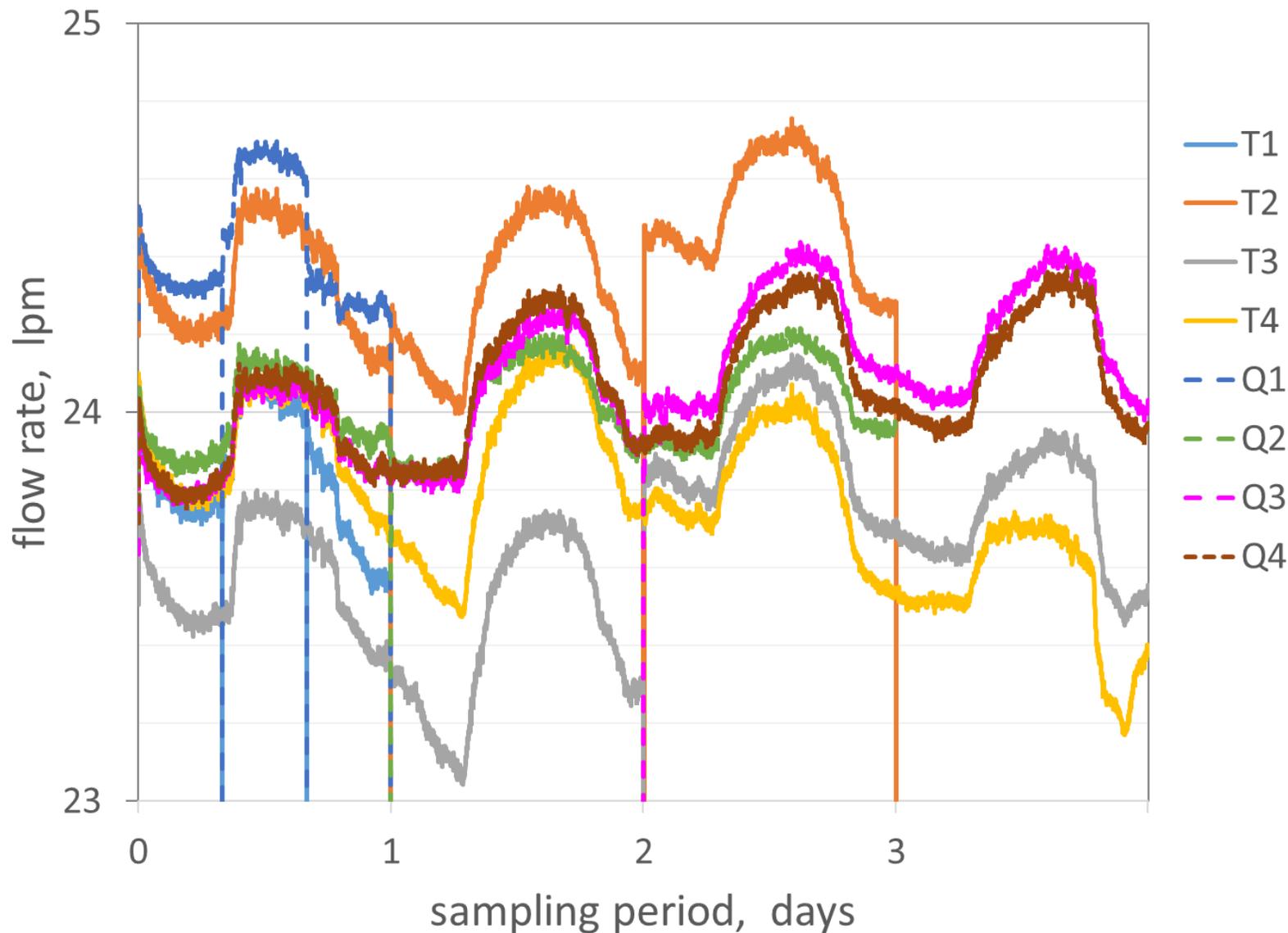
The ratio format allows for direct comparison between the historical Fabs and TOR EC trends, with both normalized to MYRA Fabs as a common reference.
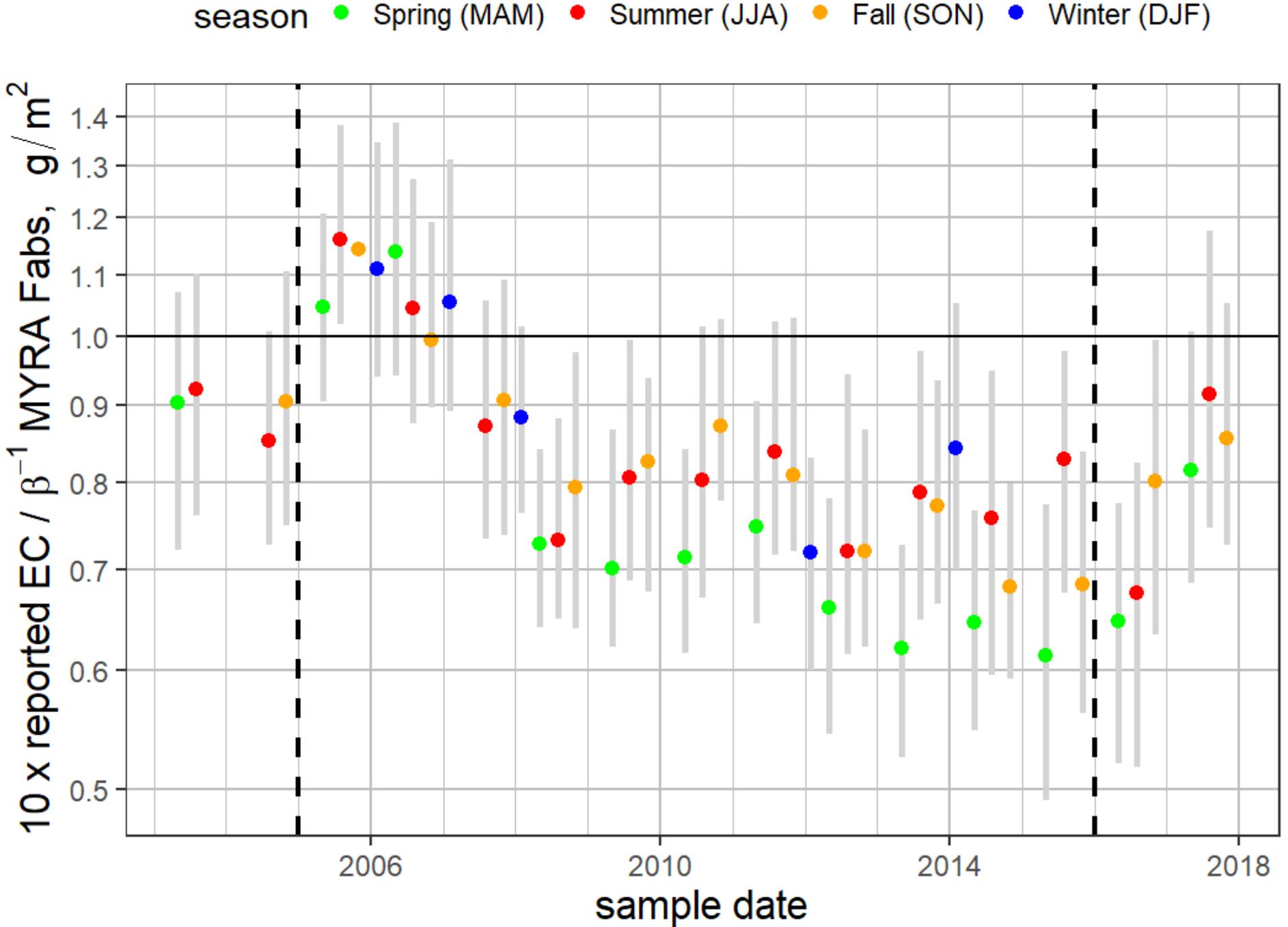
SI for (some) possible questions

Initial results from a trial experiment by the UCD AQG
to collect overlapped and differently sequenced samples.

*Teflon-membrane
and Quartz-fiber
← filter modules*

Sequential and
overlapping samples
(8, 24, 48, and 96 h)
were collected on
Ghausi Hall (UCD)
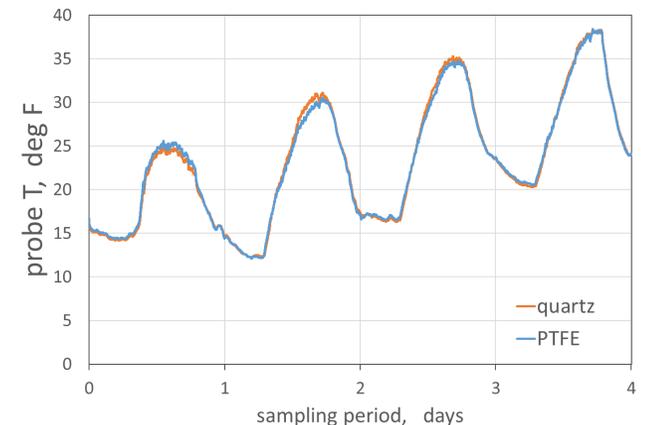rooftop, starting at
12:01 am on 4-20-19.

Illustration of data reduction for example comparison of 3 x 8 hr with 1 x 24 hr.

Loadings (Mass_n) are in EC mass per deposit area (g/m^2) or absorption cross-section per deposit area (dimensionless tau); air volumes are in m^3 (LC).

For comparison with the loading from a long integrated sample, the loadings from a sequence of short samples are summed with the weighting indicated to the right.

Sampling period	Filter number	Collected loading	Sampled volume	Filter number	Collected loading	Sampled volume
A	1	Mass_1	V_{short_A}	4	?	V_{long_A}
B	2	Mass_2	V_{short_B}	4	?	V_{long_B}
C	3	Mass_3	V_{short_C}	4	?	V_{long_C}
A - C				4	Mass_4	V_{long_A-C}

Integrated loading = Mass_4   ($V_{long\_A-C} = V_{long\_A} + V_{long\_B} + V_{long\_C}$)

Summed loading = $(Mass\_1/V_{short\_A})*V_{long\_A}$
                          $+ (Mass\_2/V_{short\_B})*V_{long\_B}$
                          $+ (Mass\_3/V_{short\_C})*V_{long\_C}$

The summed loading is our estimate of what the long sample should have collected from the (presumptively more correct) ambient concentrations indicated by the short samples ($Mass/V_{short}$), while following the (likely diminishing) flow-rate profile observed for the actual long sample.
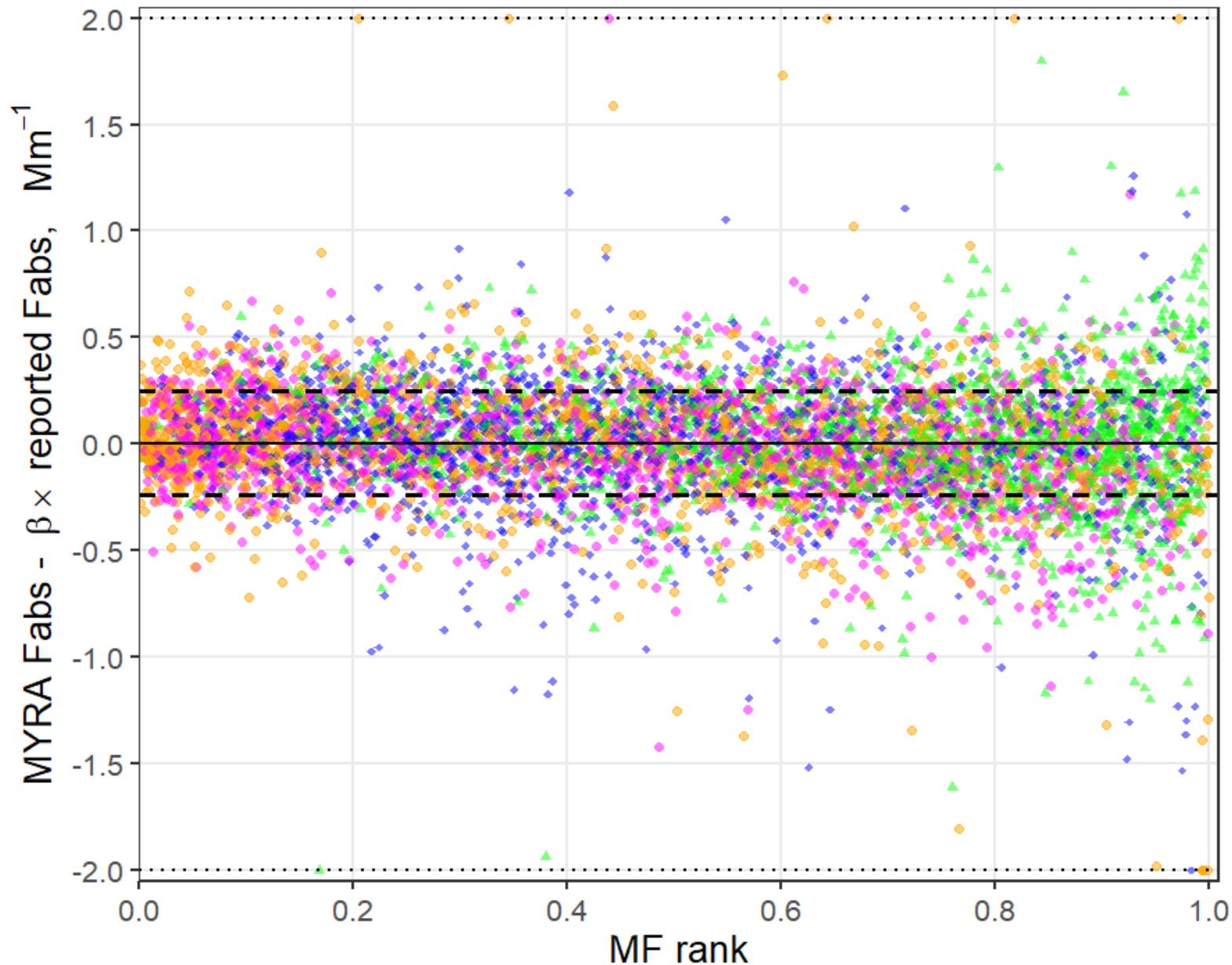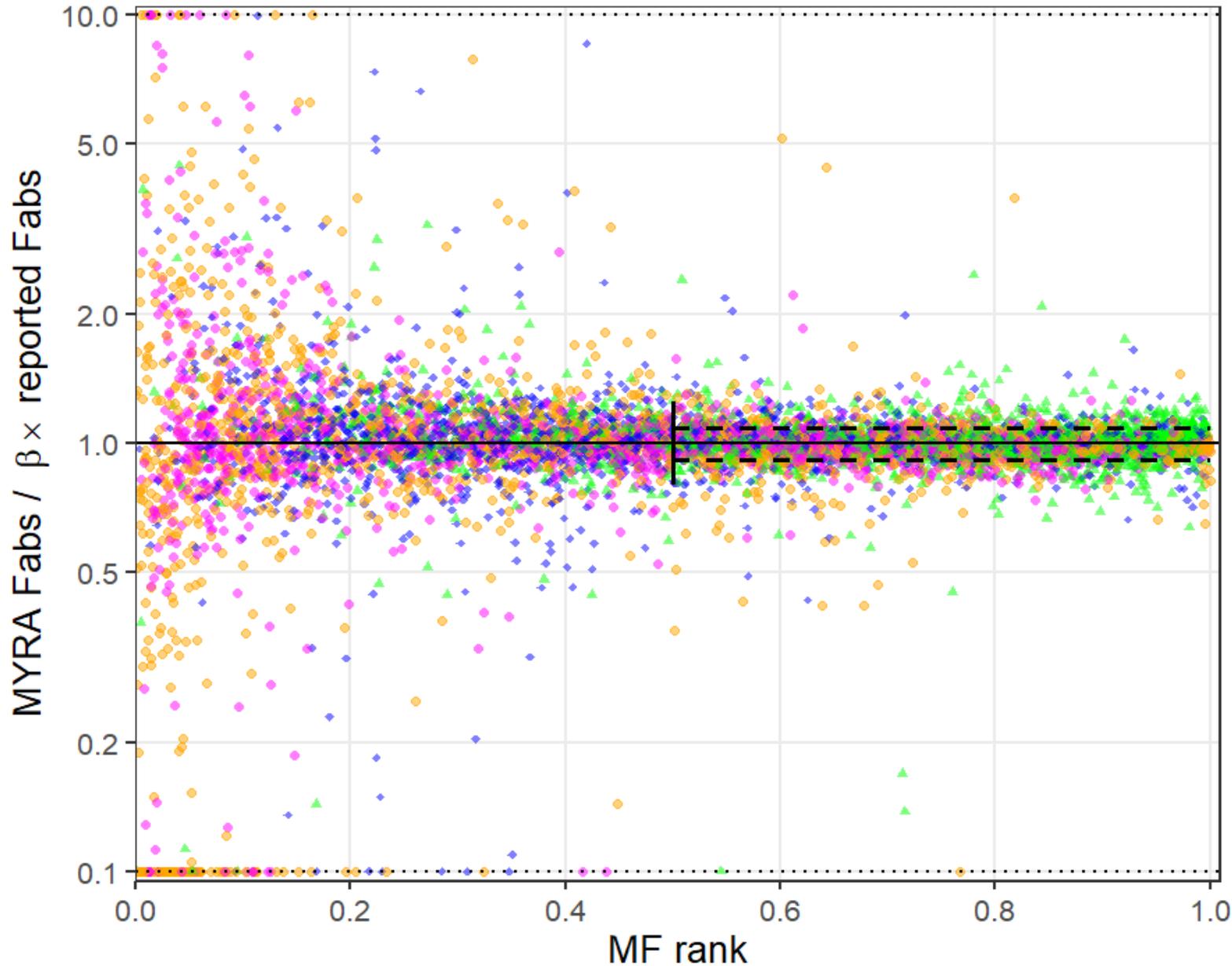
The agreement depends only weakly on the total mass loading. Uncertainties in the original and MYRA analyses appear predominantly additive.

$\leftarrow$ 84.13% $(\mu + \sigma)$

$\leftarrow$ 16.87% $(\mu - \sigma)$

equivalent normal error (of a single measurement): $\sigma_e = 0.17$ Mm^{-1}

Random multiplicative errors appear to be moderate contributors to analytical uncertainty.

$\leftarrow 84.13\% \left(\mu \times \sigma_g\right)$

$\leftarrow 16.87\% \left(\mu / \sigma_g\right)$

equivalent normal error (single measurement)
$\sigma_{ge} = 1.04$
(for MF rank above 0.5)
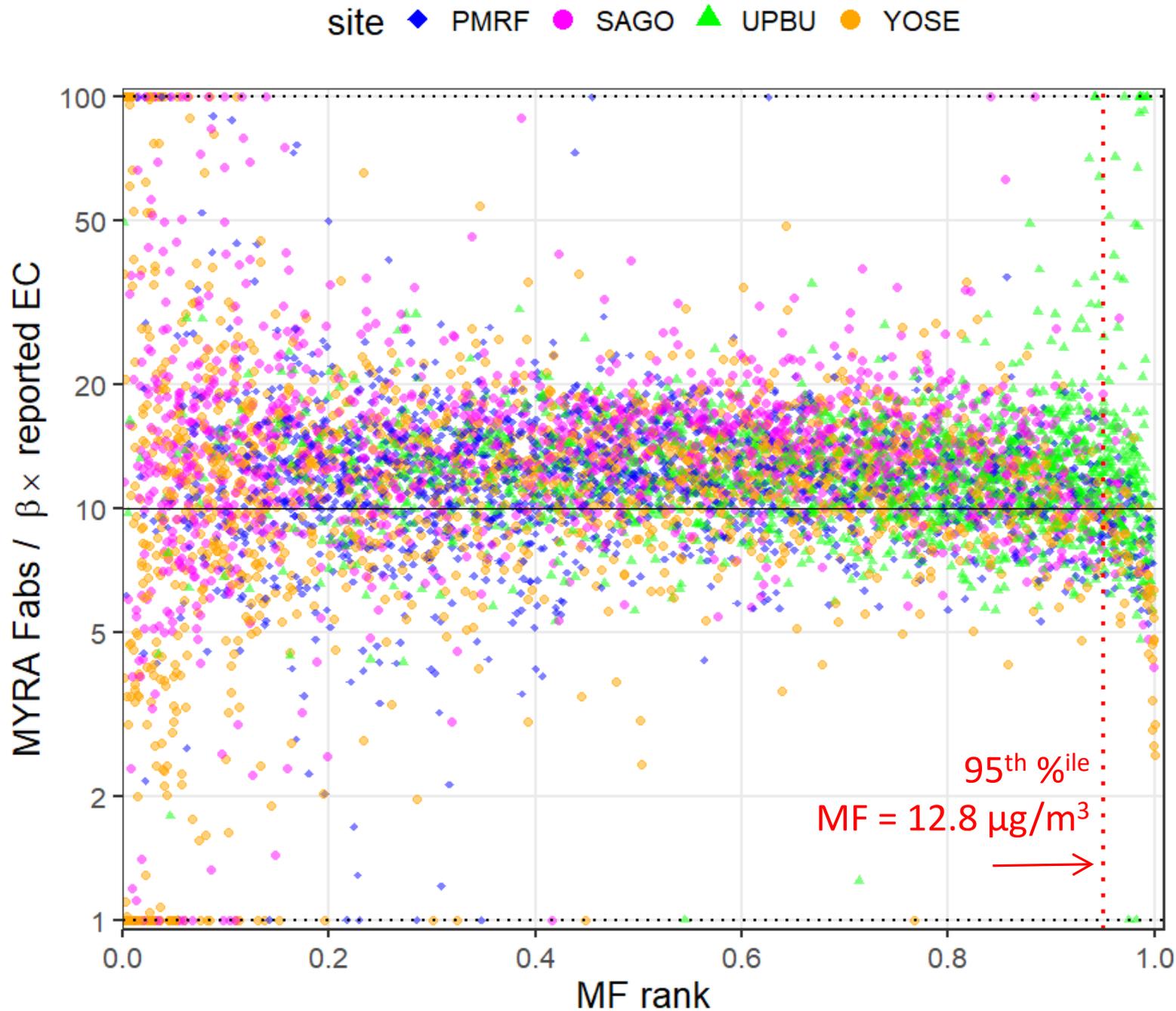
The apparent EC MAC (= Fabs/EC) falls off noticeably at the very highest gravimetric mass values in the MYRA sample population. The highest 4-day mass loadings collected so far on Ghausi roof reached only 12 – 18 ug/m³ when interpreted as standard 1-day samples. The preceding slide suggests this is just the *threshold* for the effect we are seeking to understand.