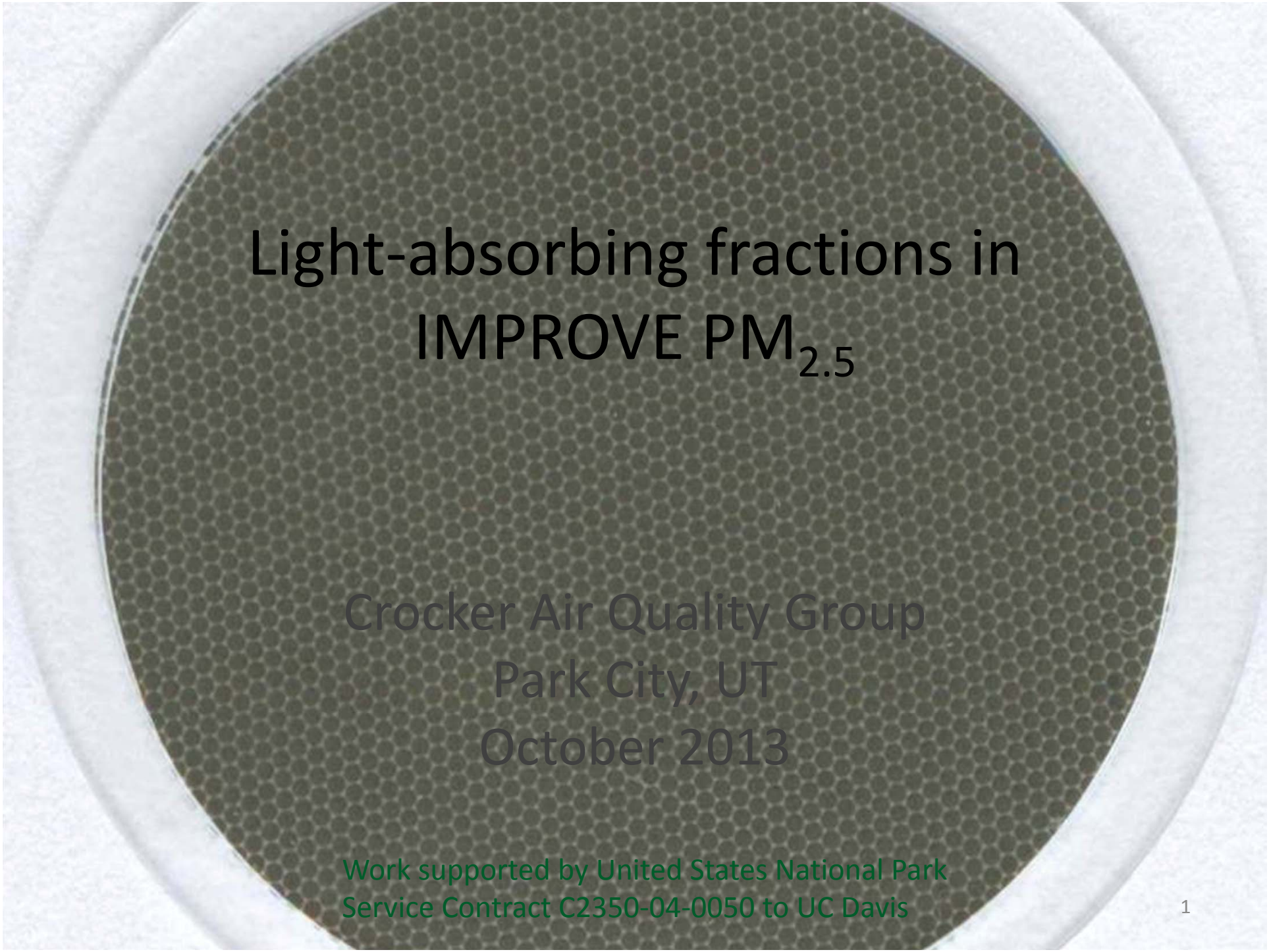
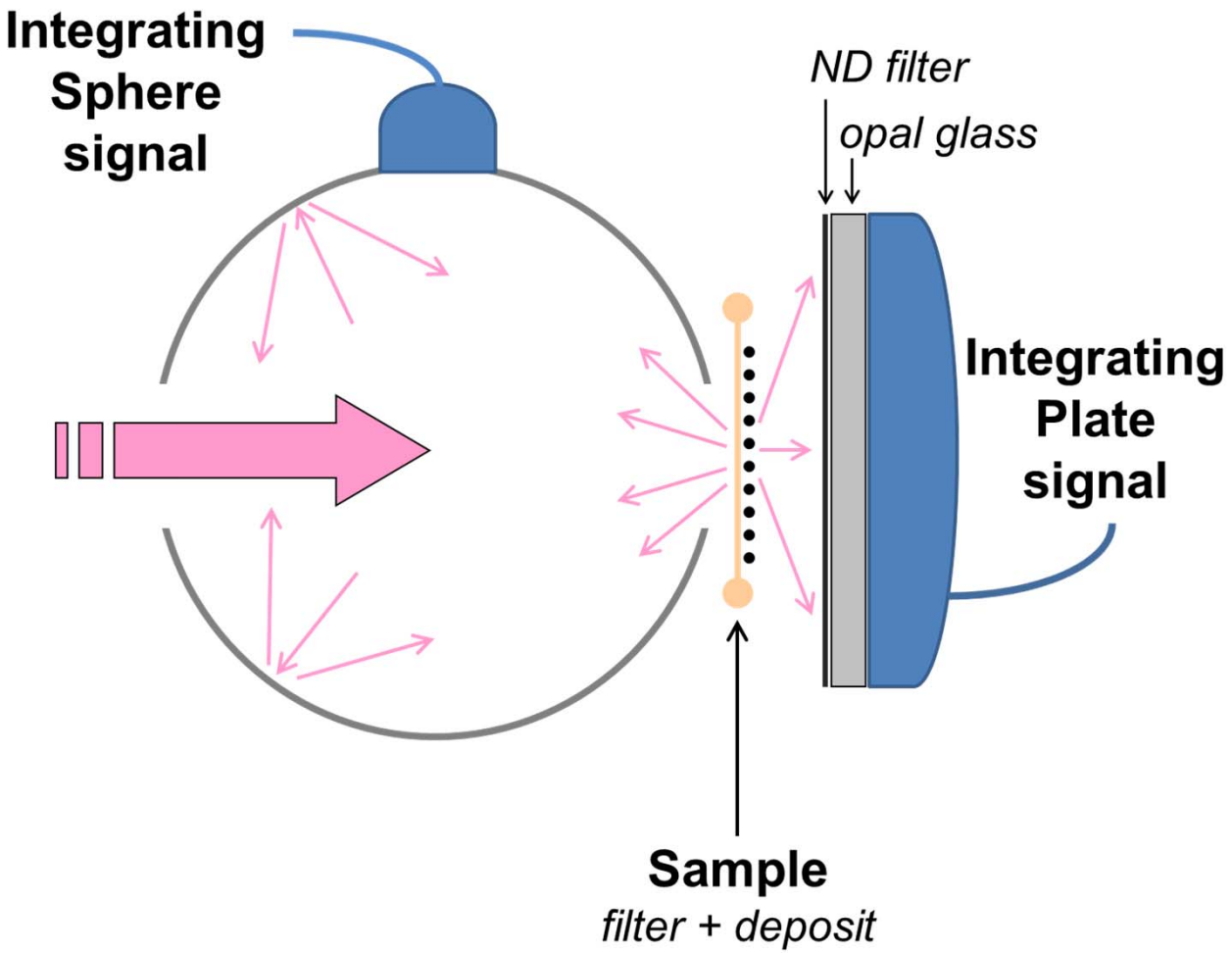


Light-absorbing fractions in IMPROVE $PM_{2.5}$

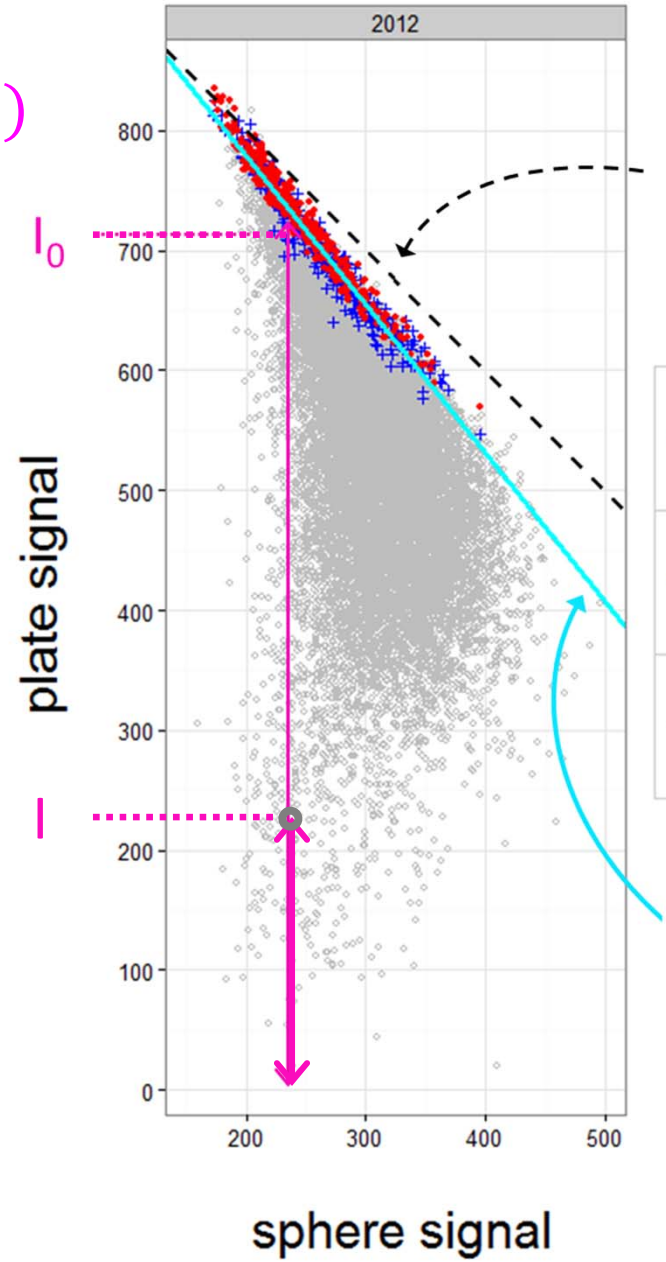
Crocker Air Quality Group
Park City, UT
October 2013

Work supported by United States National Park Service Contract C2350-04-0050 to UC Davis

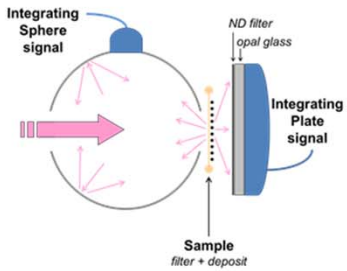
Hybrid Integrating Plate/Sphere (HIPS)



$$A_{HIPS} = \ln(I_0/I)$$



Non-absorbing under current calibration



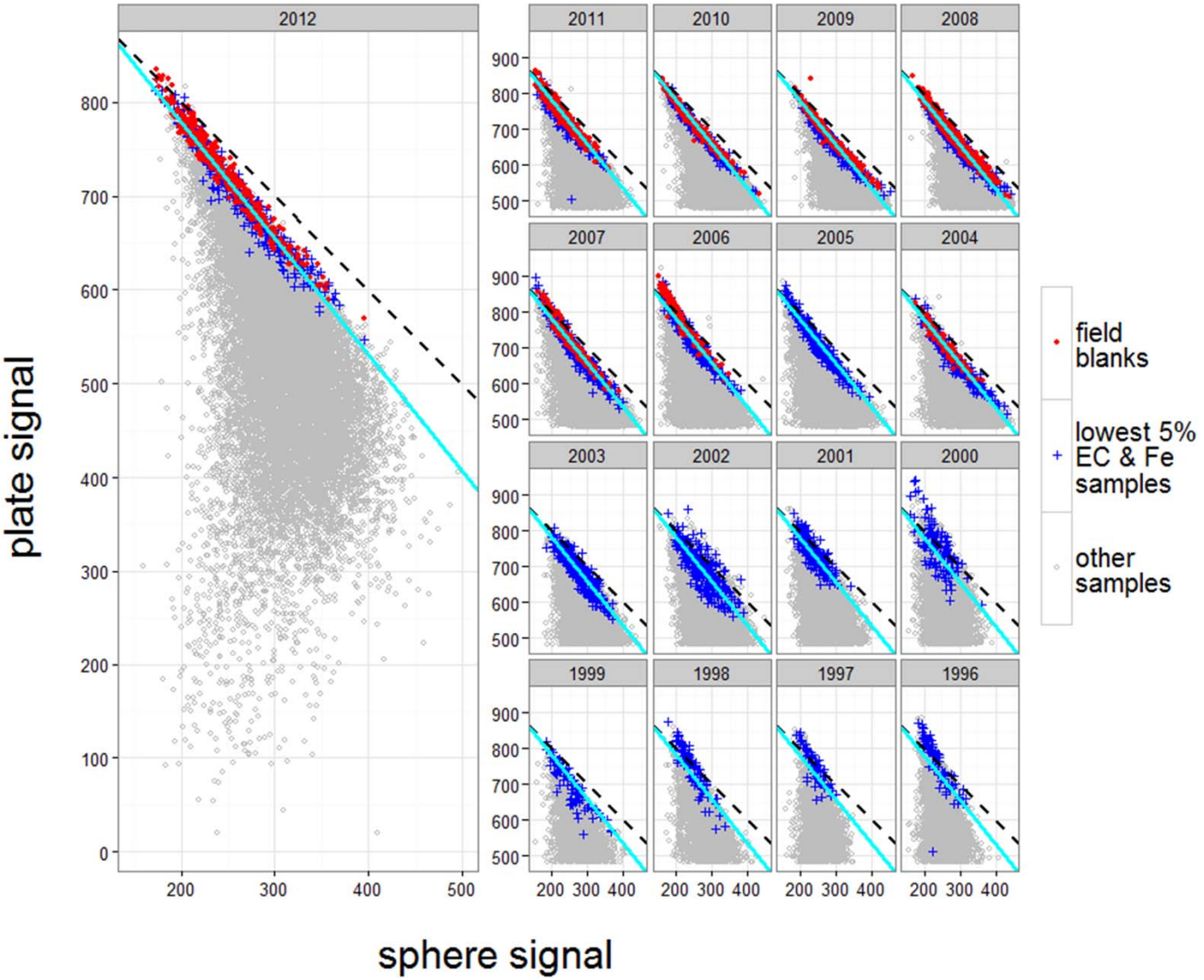
field blanks — *N = 466*

lowest 5% EC & Fe samples — Quasi blanks: samples with EC in the lowest 5% for the year AND Fe in the lowest 5% for the year. *N = 359*

other samples — *N = 18,072*

Empirical fit to all 2005 – 2011 field blanks and quasi-blanks – basis of revised calibration

The raw plate and sphere data supply internal evidence of measurement stability since 2003.



All archived filters from Great Smoky Mountains NP, Mount Rainier NP, and Point Reyes NS were re-measured in 2010, using 2010 analytical methods.

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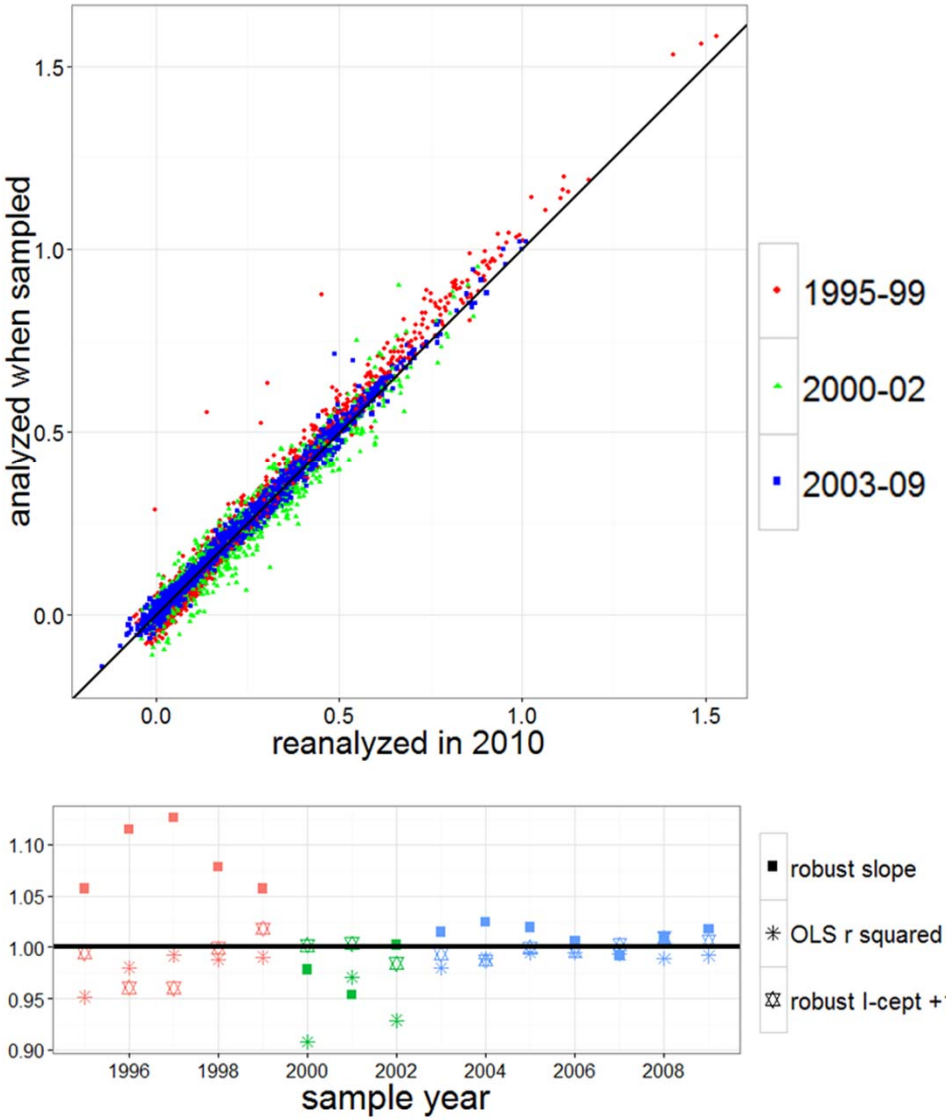
Reanalysis of Archived IMPROVE $PM_{2.5}$ Samples Previously Analyzed over a 15-Year Period

Nicole P. Hyslop,*[†] Krystyna Trzepla,[†] and Warren H. White[†]
[†]Crocker Nuclear Laboratory, University of California, Davis, California, United States

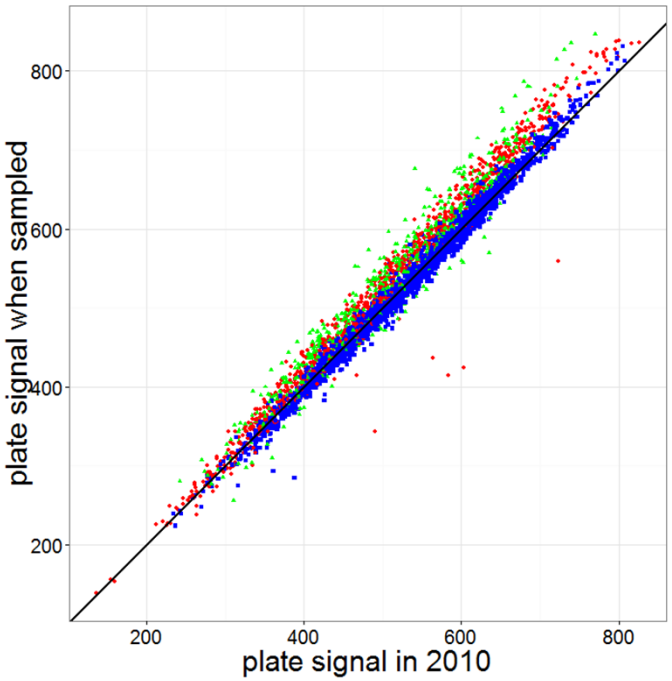
The revised calibration model is applied here to the plate and sphere signals from both sets of measurements. As was already evident in the raw data plots, the response of the HIPS system has remained quite stable since 2003 (in blue).

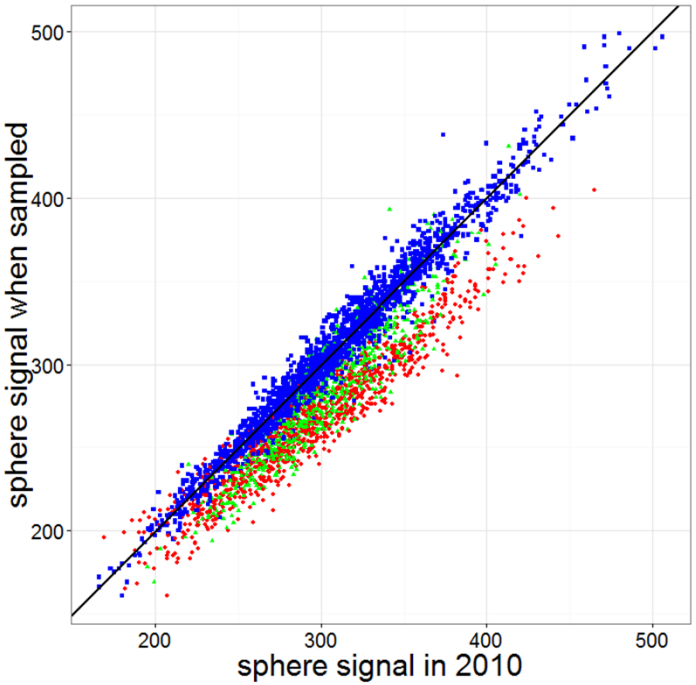
REVISED CALIBRATION

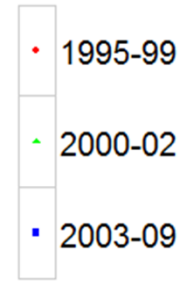
$absorption\ depth\ \ (A_{HIPS} = ln(I_0/I))$

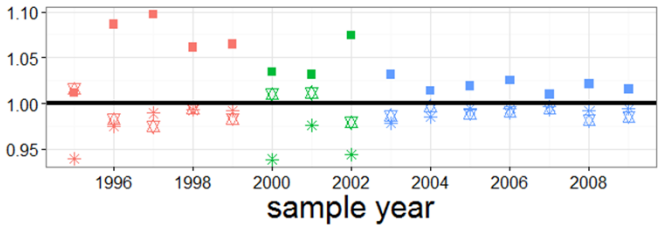


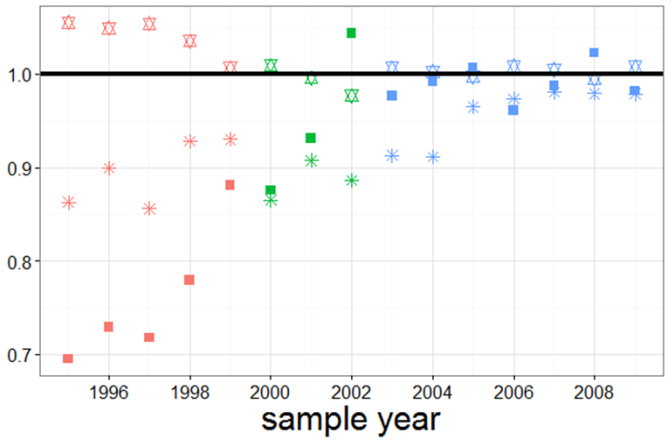
Raw data from earlier years are not well-reproduced by the 2010 reanalysis, indicating a shift in the system's calibration after 2002.

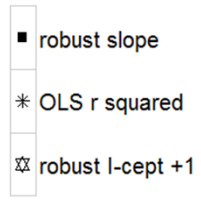












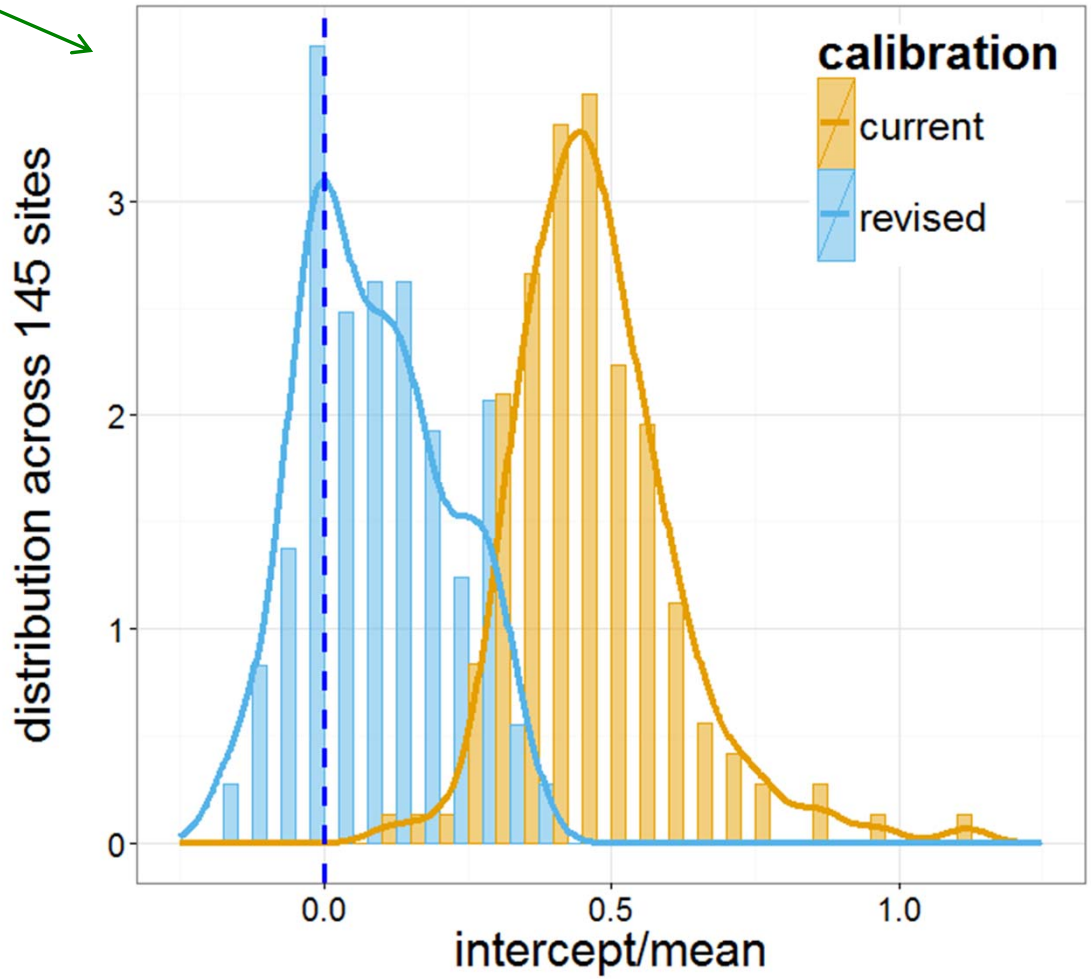
Work continues to "back-calibrate" the early years.

IMPROVE 2005 – 2012

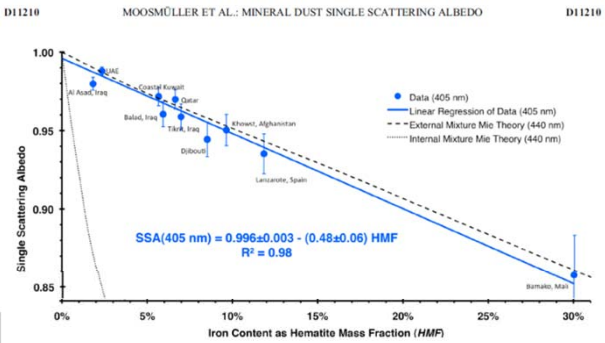
site-specific absorption regressions with > 800 valid samples

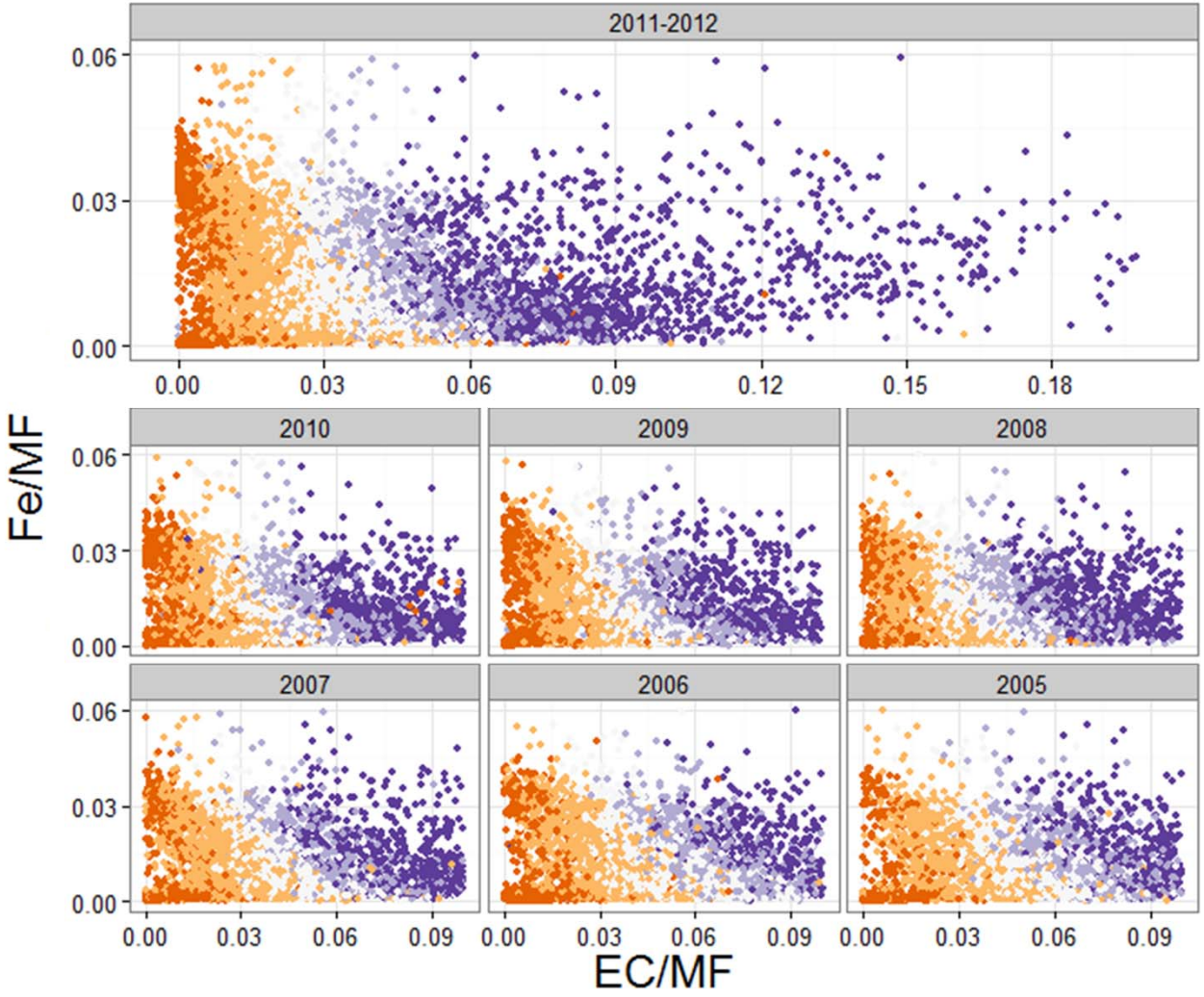
$$A_{HIPS} = a_0 + a_{EC}[EC] + a_{Fe}[Fe] + a_{OC}[OC] + a_{ions}[ions]$$

The revised calibration model gives absorption values that approach zero as PM loadings vanish.



The revised absorption values reveal a dependence on a sample's iron content, consistent with studies of mineral dusts (*e.g.*, Moosmuller *et al.*, *JGR* 2012).





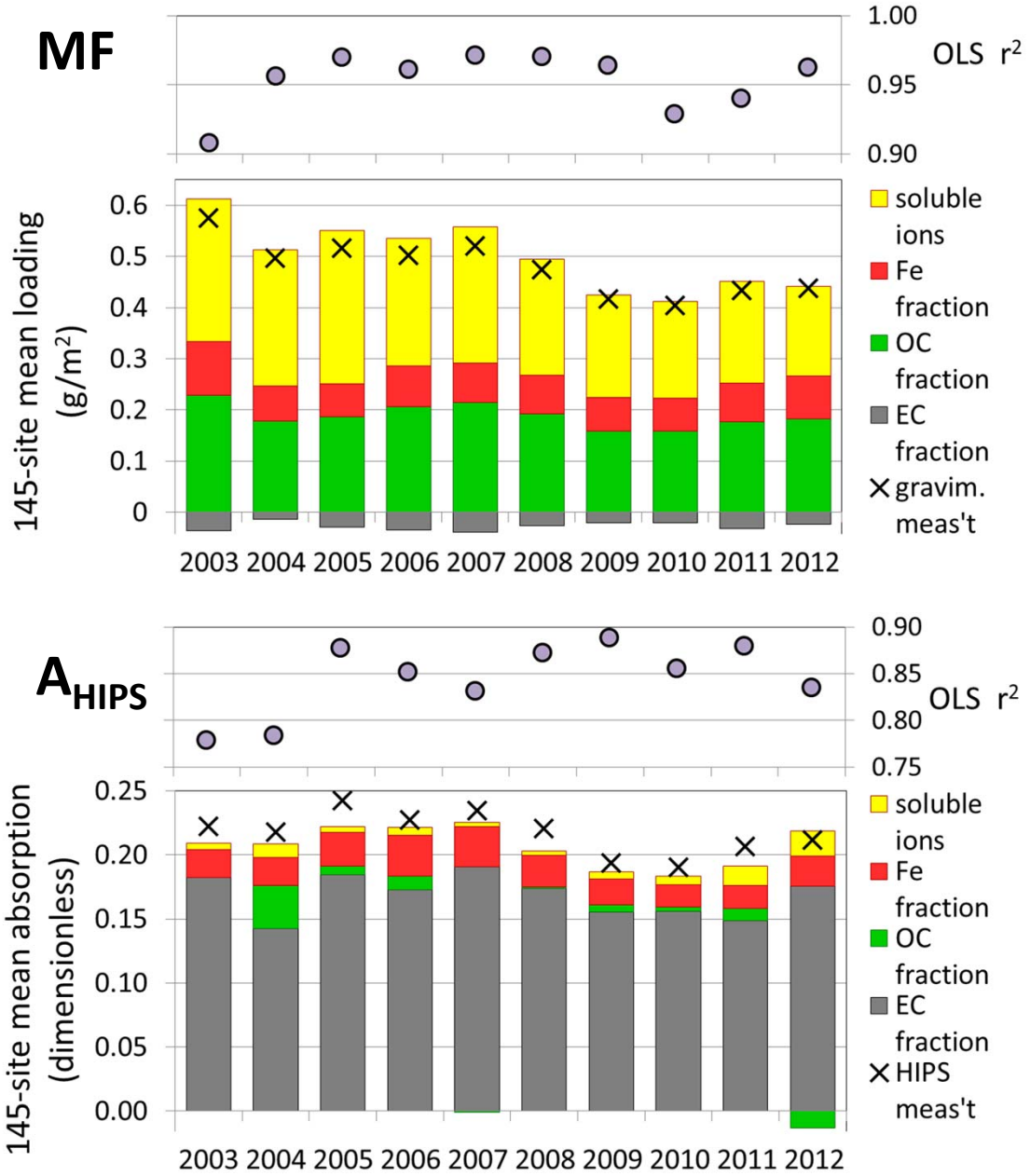
$$\frac{A_{HIPS}}{MF}, \frac{m^2}{g}$$

- <0.2
- 0.2-0.4
- 0.4-0.6
- 0.6-0.8
- >0.8

The contributions of different chemical fractions to $PM_{2.5}$ mass and absorption can be estimated by regression on the assumption – not necessarily correct for absorption – that these contributions are additive.

EC and Fe are chosen as explanatory variables to represent soot and adsorbing mineral dusts.

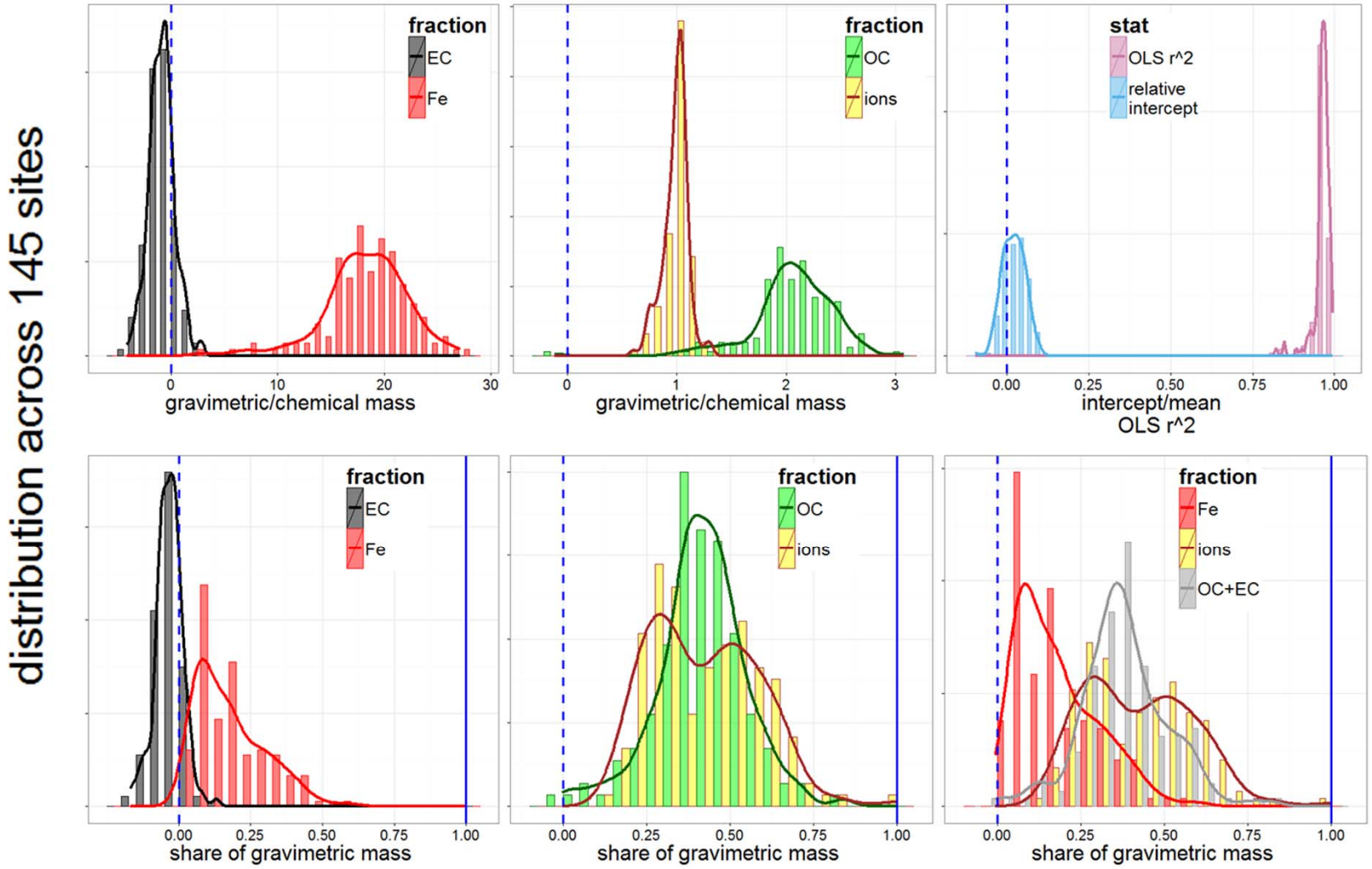
Ions (sulfate and nitrate scaled to ammonium salts, and chloride as sea salt) are included to assess possible interferences by non-absorbing materials with the absorption measurement, and organic carbon is included to round out the mass balance.



Coefficients obtained for the major mass contributors are consistent with expectations. The EC contribution is apparently subsumed into OC's.

IMPROVE 2005 – 2012: site-specific mass regressions with > 800 valid samples

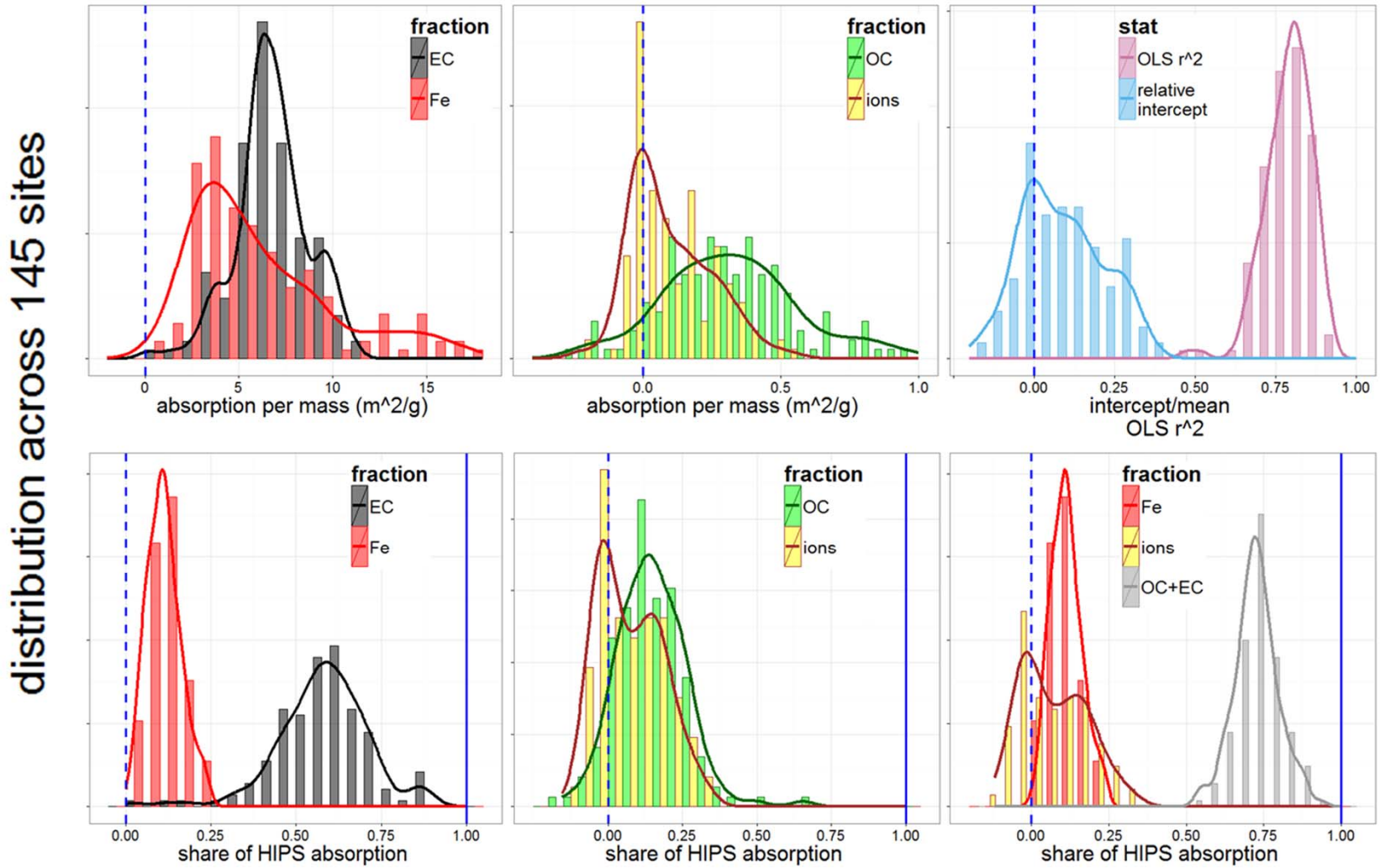
$$M_{gravimetric} = m_0 + m_{EC}[EC] + m_{Fe}[Fe] + m_{OC}[OC] + m_{ions}[ions]$$

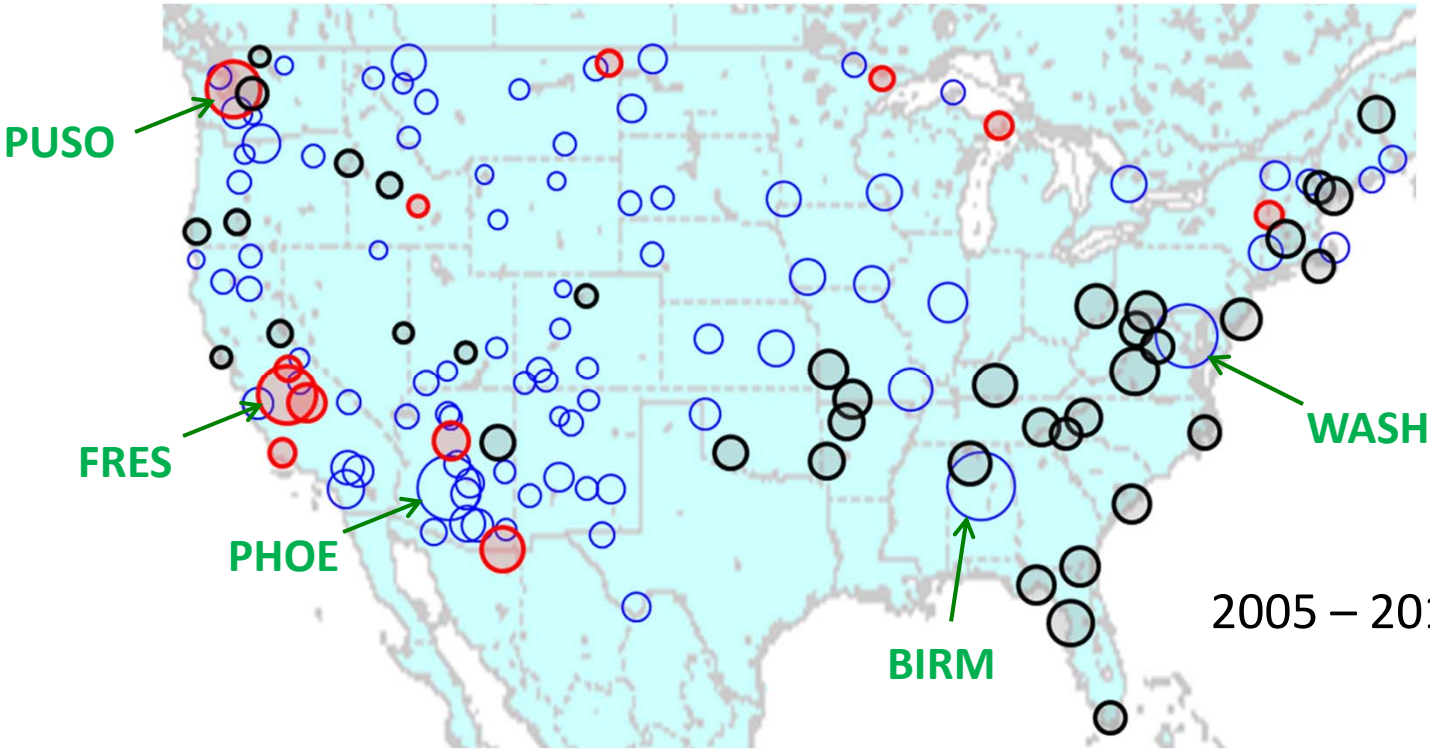


Coefficients obtained for absorption contributions are more variable, and are consistently positive only for EC and Fe.

IMPROVE 2005 – 2012: site-specific absorption regressions with > 800 valid samples

$$A_{HIPS} = a_0 + a_{EC}[EC] + a_{Fe}[Fe] + a_{OC}[OC] + a_{ions}[ions]$$





bubble area $\propto A_{HIPS}$ (measured)

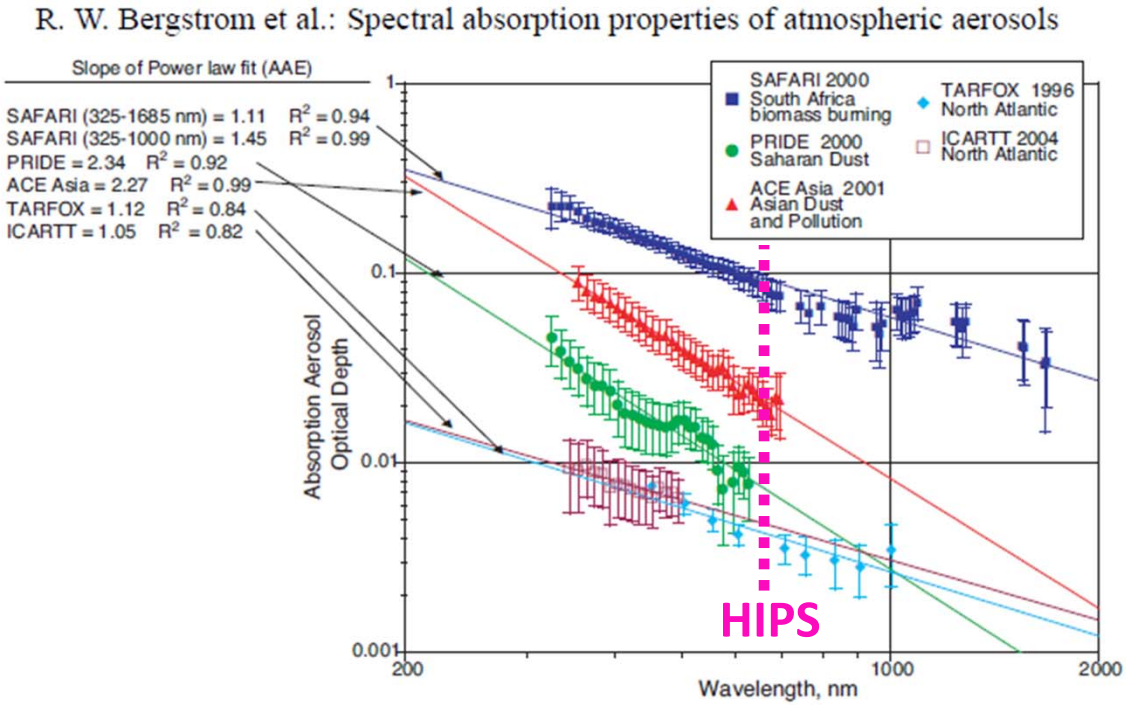
$$a_{Fe}[Fe]/(a_{EC}[EC] + a_{Fe}[Fe] + a_{OC}[OC]) > 0.2$$

$$a_{Fe}[Fe]/(a_{EC}[EC] + a_{Fe}[Fe] + a_{OC}[OC]) < 0.1$$

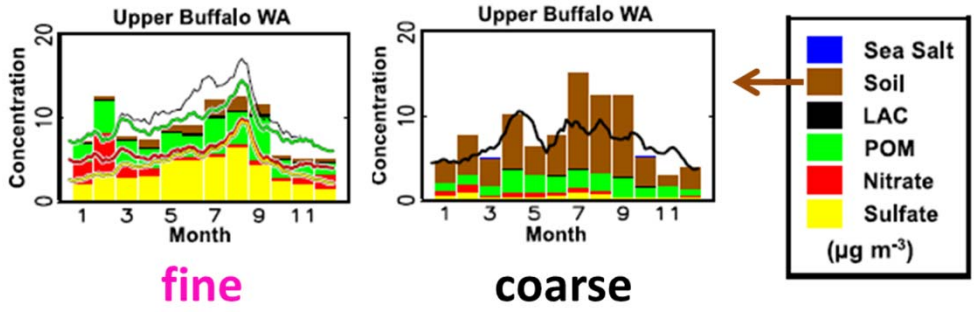
(from regression)

Before dismissing the importance of a 10%-20% mineral dust contribution to absorption, consider that:

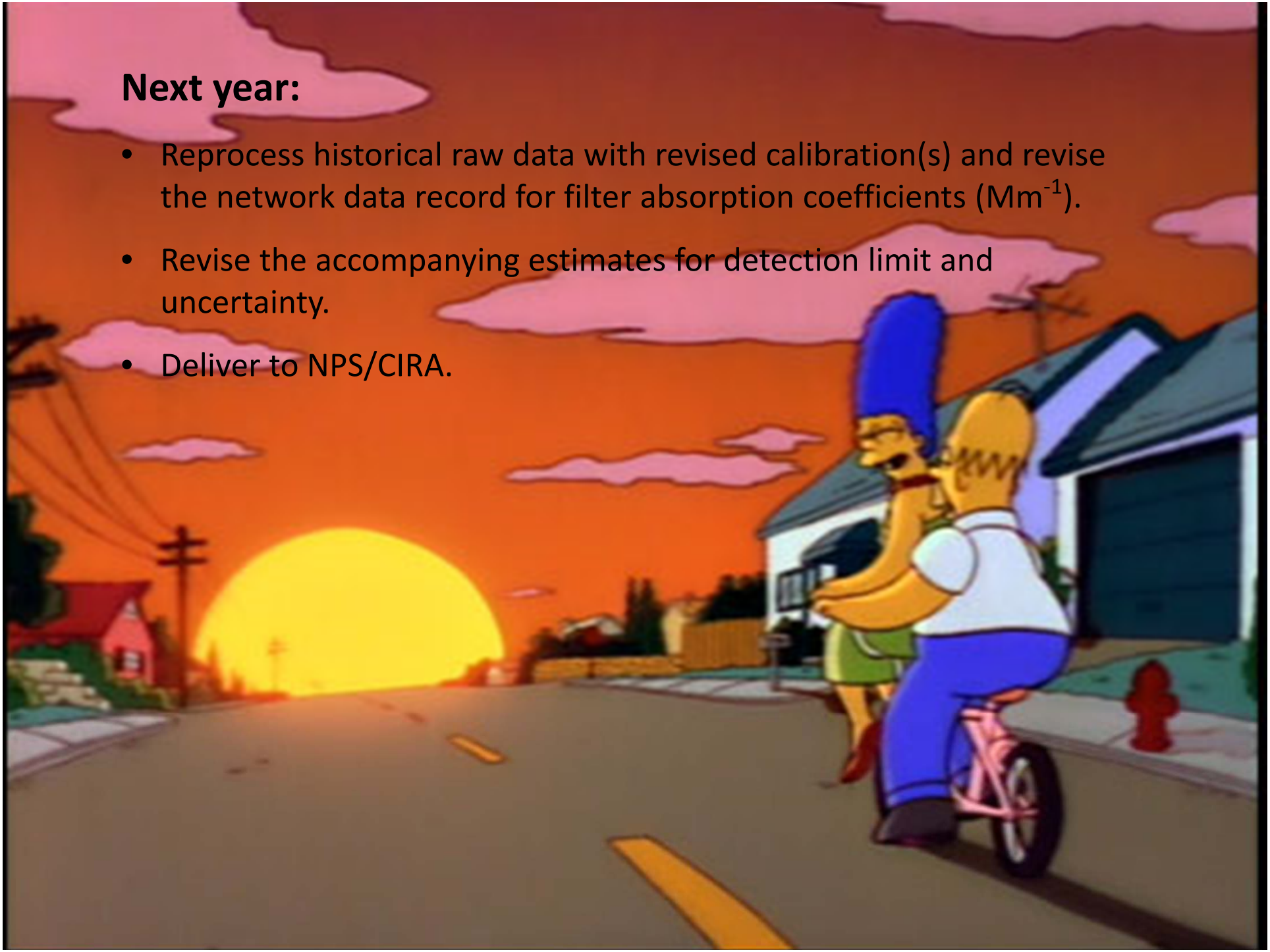
1. HIPS sees only a longish wave-length, where dust is relatively less effective as an absorber.



2. HIPS sees only the $PM_{2.5}$ size fraction, which excludes most soil dust.



W.C. Malm et al. / Atmospheric Environment 41 (2007) 2225–2239



Next year:

- Reprocess historical raw data with revised calibration(s) and revise the network data record for filter absorption coefficients (Mm^{-1}).
- Revise the accompanying estimates for detection limit and uncertainty.
- Deliver to NPS/CIRA.