Light Absorption by Aerosol Deposits on PTFE Filters: A Decade of Backscatter-Corrected Measurements by the IMPROVE Network

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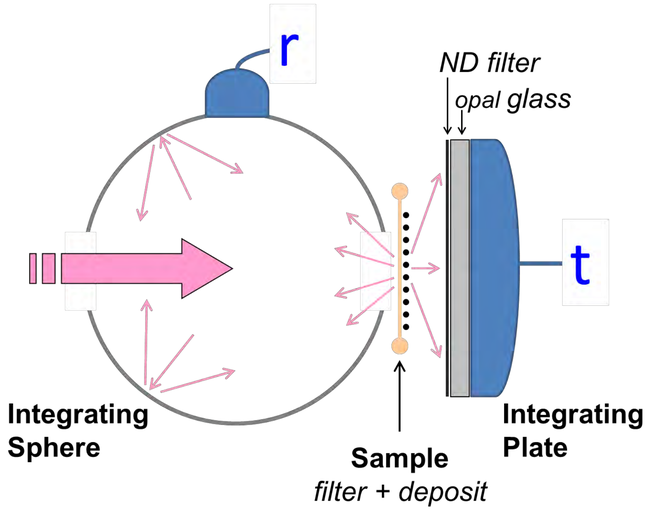
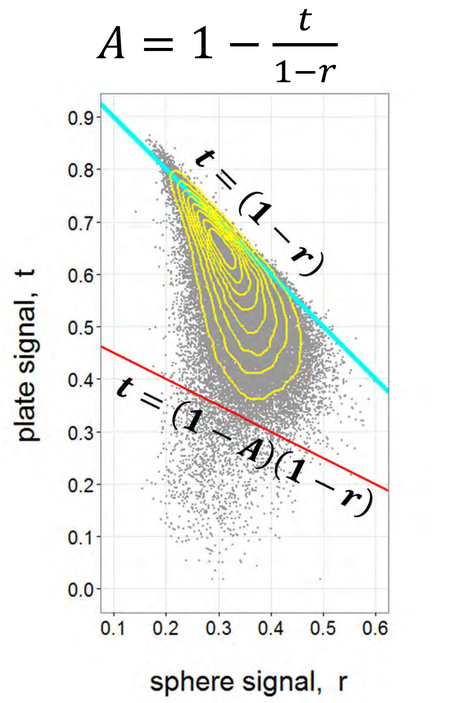
Newly calibrated historical measurements of light absorption by filter samples back to 2005 are now available for download from the IMPROVE (Interagency Monitoring of Protected Visual Environments) network at http://vista.cira.colostate.edu/improve/. IMPROVE is charged with tracking decadal trends in regional haze, and this mission shapes its choices of sampling and analytical methods. The measurements' routine character gives them strengths, in terms of coverage and methodological consistency, along with limitations in terms of time resolution and immediacy. About 20,000 sample sets of fine particulate matter (D_p < 2.5 um) are collected each year.

IMPROVE measures light absorption at 633 nm by samples collected on PTFE membranes, using a hybrid system of integrating plate and integrating sphere. The chemically inert PTFE membranes avoid the interference from adsorbed organic gases that Vecchi et al. (Journal of Aerosol Science 70, 15-25) recently documented for fiber media. IMPROVE's hybrid measurement records the light backscattered as well as transmitted by each filter, allowing corrections to be made for both particle scattering and variations in filter optics. The variable scattering of PTFE membranes is what supplies the basis for calibrating the 2-dimensional output of the plate and sphere, as it allows the zero absorption isopleth to be determined from multiple blank filters.



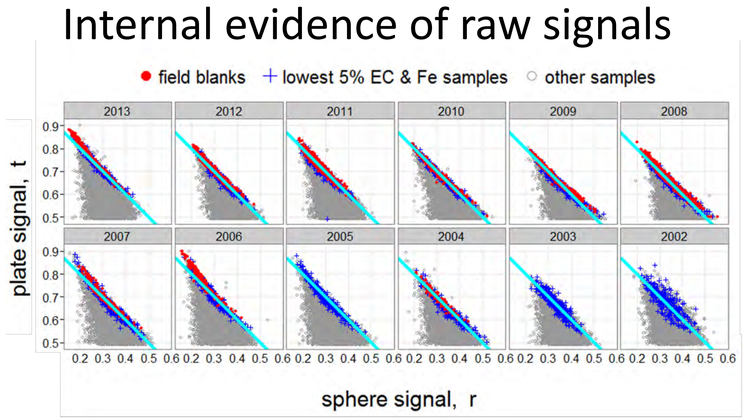
(**top**) Diagram of the absorption measurement. (**above**) Variability of mass and optical characteristics in 534 unsampled 25-mm PTFE filters.



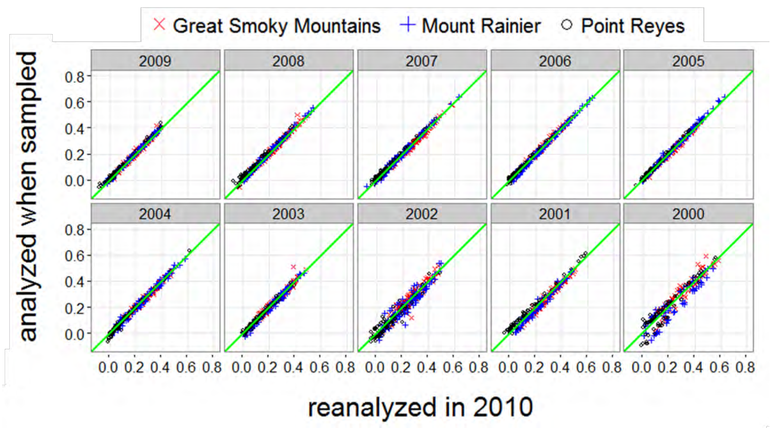
(**above**) Relationship of sample absorptance to HIPS readings. Sloping lines show absorptance isopleths for non-absorbing (cyan) and absorbing (red, $A = \frac{1}{2}$) samples. Grey dots show ~56,000 IMPROVE sample filters.

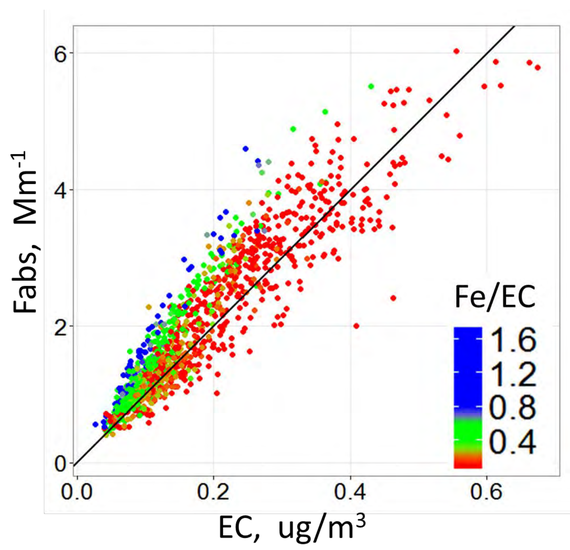
A stable calibration since 2003

Internal evidence of raw signals



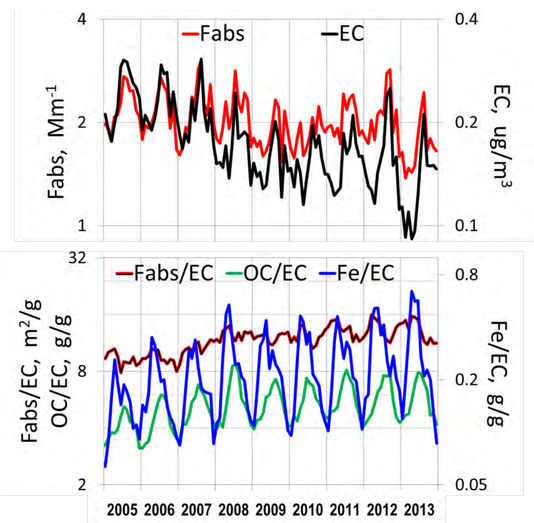
Replicated analyses of measured A



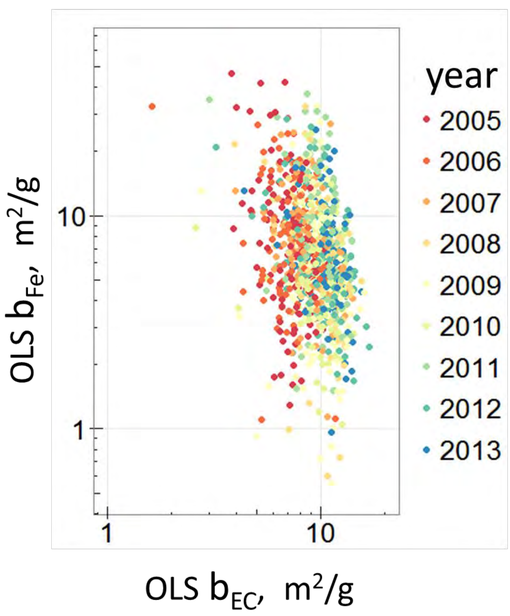


(**above**) Site-year means of atmospheric absorption $\mathrm{Fabs}\left(= -\frac{f}{v} ln(1 - A)\right)$ and elemental carbon (EC) from 2005 - 2013. Each point shows the arithmetic means of Fabs and EC from one calendar year of observations at one of 131 non-urban IMPROVE sites in the conterminous United States. Colors code the mass ratios of the associated Fe and EC site-year means. The median number of observations in a site year is 115.

(**right**) Ordinary least squares (OLS) coefficients for the regression model $Fabs = b_0 + b_{EC}EC + b_{Fe}Fe$. → Each point shows results for regression of individual 24-h observations from one of the 131×9 site-years plotted in Figure 10. Colors code the year of sample collection. Regressions that accounted for under half of the Fabs variance ($r^2 \leq 0.5$) are not plotted (9% of the site years).



(**above**) Monthly arithmetic means and their ratios at 131 non-urban IMPROVE sites in the conterminous United States. The median number of observations in a month is 1221.



IMPROVE Interagency Monitoring of Protected Visual Environments

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