Ambient Aerosol Extinction in Great Smoky Mountains National Park

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The IMPROVE (Interagency Monitoring of Protected Visual Environments) program, which is tasked with monitoring visibility in U.S. National Parks and Wilderness Areas, relies on aerosol-induced light extinction reconstructed from speciated filter measurements and humidification growth factors. Under many atmospheric conditions reconstructed extinctions compare favorably with measurements; however, there are several possible sources of discrepancy. First, the IMPROVE reconstructions are based on 24-hour averaged filter measurements taken once every four days; thus, important transient events may not be well resolved. Second, at high relative humidities (RH) aerosol light extinction is very sensitive to RH perturbations; thus, under such conditions the humidification growth factors are highly uncertain.

The Open-Path Cavity Ringdown Spectrometer (OPCRDS) was designed to overcome the RH limitations of previous extinction instruments. The OPCRDS was recently deployed in the Great Smoky Mountains National Park (GSM), where the high RH and high photochemical activity typical in summer provided an opportunity to explore the upper limits of the aerosol hygroscopicity curve and the accuracies of both the IMPROVE extinction reconstruction algorithm and the GSM nephelometer used to validate reconstructed extinction. True ambient extinction measured by the OPCRDS and dry extinction measured by a traditional closed-cell extinction monitor were used to investigate the hygroscopicity of aerosol at GSM and the importance of coarse-mode particles to light extinction.

During the majority of the campaign the OPCRDS data agree closely with the GSM nephelometer and the reconstructed extinction. However, we observed discrepancies between scattering and ambient extinction due to coarse-mode particles, and several high RH events were not resolved by the reconstructed extinction. Finally, we found that the extinction calculated with the revised reconstruction algorithm (IMPROVE-2) was about 12% lower than the values calculated from the original algorithm and provided a slightly better fit to the OPCRDS data.

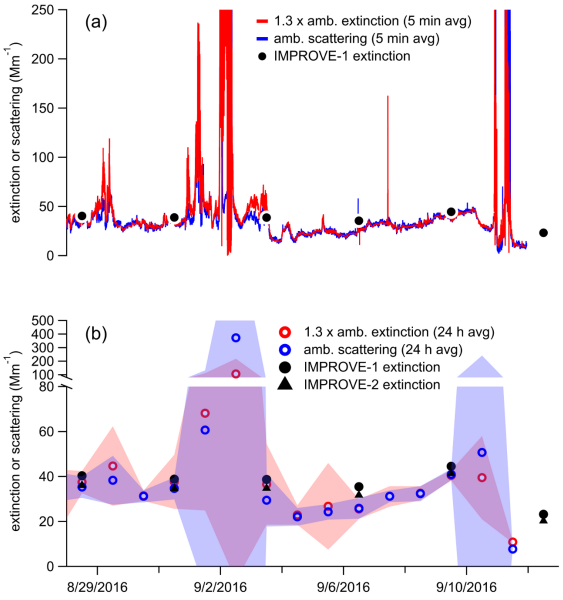

Figure 1. Comparison of aerosol extinction calculated from the original IMPROVE equation and (a) 5-minute average ambient extinction/scattering and (b) 24-hour average ambient extinction/scattering (standard deviations are indicated by the shaded regions) and extinction calculated with the revised IMPROVE equation. IMPROVE-1 extinction values are identical in (a) and (b). IMPROVE data are preliminary and have not been fully validated.