

Comments on the Regional Haze Monitoring Network:

I attended the Regional Haze Workshop held in Sacramento on December 15, 2008, and was pleased with the variety of interesting data that was presented by the group. During the discussion session, I asked whether new instrumentation was being considered for analysis. It was implied that there was field instrumentation being used to directly measure haze. However, reviewing a recent study by Malm et al. (2007), it appears that the only instrumentation in the IMPROVE network is a filter collection systems for offline analysis. There are significant drawbacks to this approach and I would suggest that new analytical techniques be explored, regardless of whether that includes instrumentation from my company, Activated Light Technology Industries (www.activatedlight.com).

Filter collection is subject to a number of drawbacks. For example, species such as ammonium nitrate are often not efficiently collected by filters, due to the potential evaporation from the particle phase back into the gas phase. Some species, such as acyl peroxy nitrates (PANs), may be thermally unstable and thus will not survive the data collection process. Filter data is collected over multiple day periods and therefore does not reflect peak levels of pollution. Finally, while the initial investment in equipment is nominal, the cost of repeated sampling and analysis is considerable, because employees must be dispatched to collect and replace filters at each site every three days, and then the samples have to be brought back to the lab and subjected to workup and instrumental analysis.

It is possible to measure haze in real time with elimination of the effects of water droplets. A cavity ring-down (CARDS or CRDS) apparatus is capable of measuring hundreds of meters of attenuation within a compact housing. A drying tube added to the inlet will remove any water vapor and a cyclone can be added to remove coarse particles larger than PM 10. CARDS can now be carried out using inexpensive light emitting diodes (LEDs) in place of bulky and expensive lasers. A device operating at 450 nm could give a valid measure of the actual deciviews of attenuation, rather than creating a calculated measure based on the composition and quantities of collected material.

Additionally, speciation of particles can be obtained in real time using CARDS. My Ph.D. dissertation presents the thermal decomposition analysis of nitrogenous species from the particle phase (Hargrove, 2007). I was able to distinguish between organic and inorganic nitrates and was able to detect PANs as well. In combination with inexpensive analyzers, thermal analysis can provide data as is presented in the regional haze plan in real time and without data processing errors. It is also likely that sulfates and ammonium can be analyzed with simple extensions of the technique.

A key focus of the Regional Haze Workshop was identifying the necessary steps to reduce haze. This is where much of the effort needs to be. It would be very satisfying to see haze reductions in the coming years, and even better if the data were collected without significant effort and in real time. The analyzers I describe in this comment are currently available. If additional testing is needed before upgrades can be made, it is time to begin those studies.

- Hargrove, J.M., 2007. The Application of Cavity Ring-Down Spectroscopy to Atmospheric and Physical Chemistry, University of California, Riverside, Riverside.
- Malm, W.C., Pitchford, M.L., McDade, C. and Ashbaugh, L.L., 2007. Coarse particle speciation at selected locations in the rural continental United States. *Atmospheric Environment*, 41(10): 2225-2239.