Photographic illustrations of PM effects on visibility (R. Poirot, 2/2/06)

If the EPA Staff and CASAC-recommended 4 to 8-hour daylight secondary $PM_{2.5}$ standard is disregarded and replaced by a secondary standard set equal to the level of the proposed 24-hour primary standard of 35 ug/m^3, then presumably it represents a level of visual air quality at which EPA believes no adverse effects will be perceived by the public. The following sets of slides illustrate visual air quality at about the level of the proposed new standard for urban areas in Burlington, VT and Denver, CO.

The Burlington slides were taken by an automated digital camera located on a building at the University of Vermont, looking west across Lake Champlain toward the Adirondack Mountains in NY. The far shore of the lake is about 10 miles away, and the most distant hills are about 30 miles away. The top 2 photos were taken on clean days when the 24-hour $PM_{2.5}$ concentrations were about 3 ug/m^3. The photo on the top right shows that cloud cover and high relative humidity – in the absence of aerosol pollution – do not necessarily impair visibility. The bottom 4 Burlington slides were all taken on less humid days when the (24-hour average) $PM_{2.5}$ was close to the level of the new proposed standard, but with different mixes of chemical species - sulfates, organics or nitrates - dominating the $PM_{2.5}$ mass concentrations.

In most cases the fine mass concentration at the time the photo was taken was about the same as the average concentration for the day. The lower right slide is an exception, as the concentrations at the time of the photo were about 60 while the 24-hour average was 38 ug/m^3. This was the first day of major impact from the Quebec fires of July 2002, and also helps illustrate why a 24-hour averaging time is less desirable than a shorter 4-hour averaging time. Hourly concentrations on this day that averaged near 35 ranged from 10 to 74 ug/m^3, with 1-hour afternoon concentrations about twice as high as the daily mean.

The Denver slides are computer simulations produced using the WinHaze visual air quality modeling software, which can be obtained at no cost from Air Resource Specialists at: http://www.air-resource.com/downloads.php. WinHaze (referenced on page 2678 of the EPA proposal) currently includes scenes (very clear day photos) from 134 national parks, wilderness, and urban areas, and allows users to examine visual effects of different mixtures of coarse particles, fine particle species and relative humidity. The upper left photo is a pollution-free day. The upper right slide adds coarse particles only, at the level of the proposed primary and secondary $PM_{10-2.5}$ standard. Coarse particles scatter light less efficiently than fine ones, but at the level of the proposed coarse standard the visual effect is still quite notable (as it would also be in non-urban areas). The lower left photo adds fine particles only at the level of the proposed 24-hour primary & secondary $PM_{2.5}$ standard. In this case the particles were composed of organic matter, which does not absorb water so there is no enhancement from humidity. Had the aerosol mix included sulfates or nitrates at higher humidity, or if the daytime pollutant concentrations were higher than the 24-hour means, the visibility could be considerably worse. The lower left slide shows the effects of a combination of fine and coarse particles, each at the levels of their proposed standards, but without any enhanced effects from humidity.

Figure 1. Burlington, VT View of Lake Champlain and Adirondacks on Clean PM Days with Low and High RH, and on Days with Mixed PM Composition at Concentrations near EPA's Proposed Secondary Standard
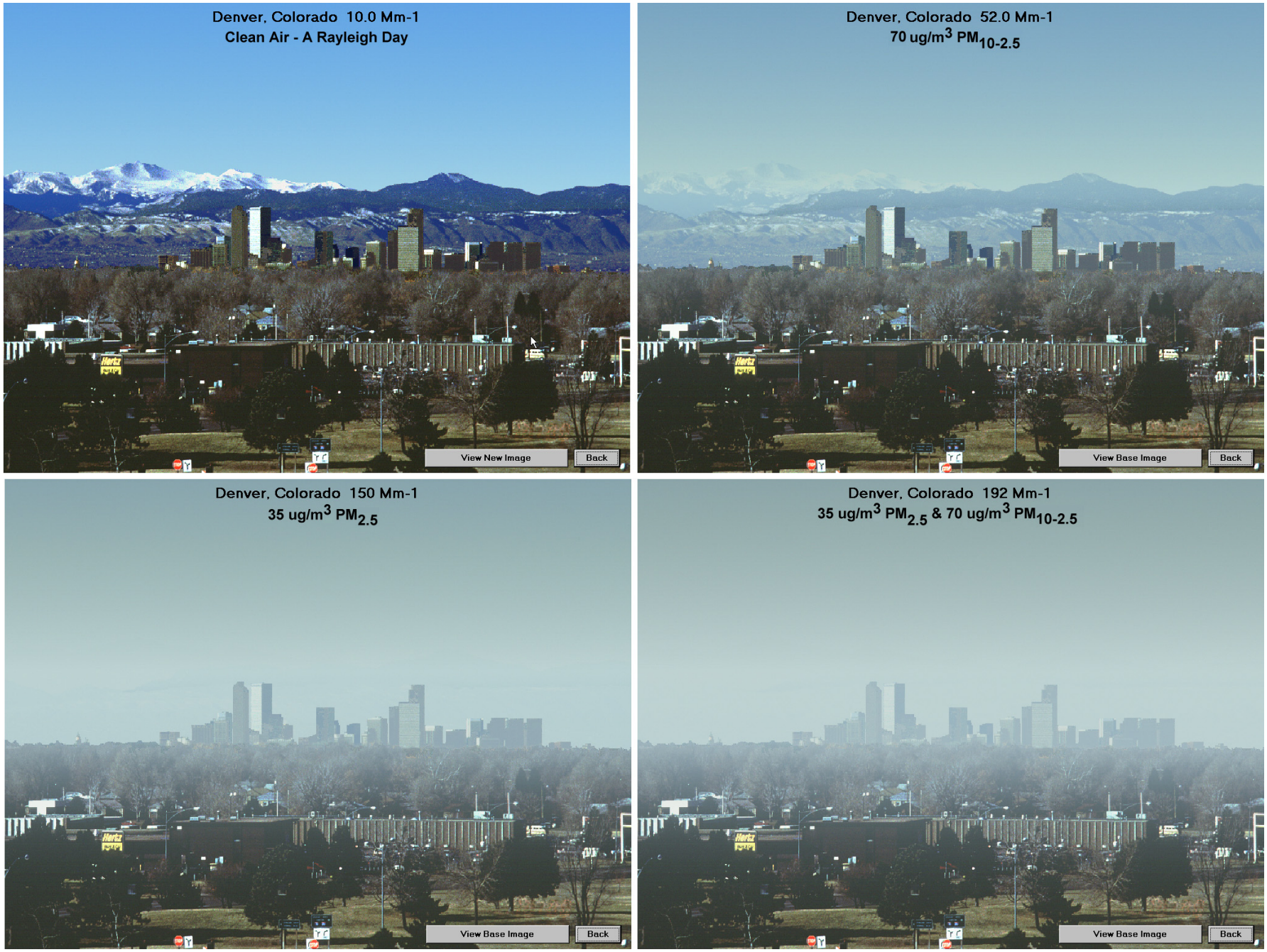
Figure 2. WinHaze Modeled Visual Air Quality in Denver on a Clean PM Day and on Days near EPA's Proposed $PM_{10-2.5}$ and $PM_{2.5}$ Standards