Conceptual Model - Causes of Haze in Swanquarter Wilderness Area (SWAN1)

Sulfate transported from eastern Texas and the central and eastern United States are the major causes of haze at the Wichita Mountains Wilderness Area. Secondary nitrate from the central U.S. is responsible for the worst visibility days during the winter time. Regional biomass burning may also result in 20% worst visibility days.

As shown in Figure 1, The Wichita Mountains IMPROVE site is in a broad drainage in the Wichita Mountains. It is located on the lower slopes of Elk Mountain at an elevation of 518 m (1,699 ft). Valley bottom elevations in the vicinity are near 500 m (1,640 ft). Mountain summit elevations south of the drainage are near 650 to 680 m (2,130 to 2,230 ft). To the north terrain rises to 650 to 700 m (2,130 to 2,300 ft) at distances ~ 3 to 5 km (2 to 3 mi). The terrain is thus a generally WNW to ESE oriented valley, draining to the WSW toward the town of Lawton. Ground cover is predominantly grassland, with scattered patches of forest. Based on all the valid aerosol measurements during 2002-2004 in SAMA1, the average $PM_{2.5}$ mass concentration is 7.7 $\mu g/m^3$. The average total light extinction coefficient (B_{ext}) is 60.8 Mm^{-1} (Visual Range ~ 84 Km; Deciview ~ 17). The average contributions of the major aerosol components to Wichita Mountains haze are particulate sulfate 37.3%, nitrate 17.5%, organic matter (OMC) 14.3%, elemental carbon (light absorbing carbon, LAC) 4.3%, fine soil 1.3%, sea salt 0.2%, and coarse mass (CM) 6.9%.

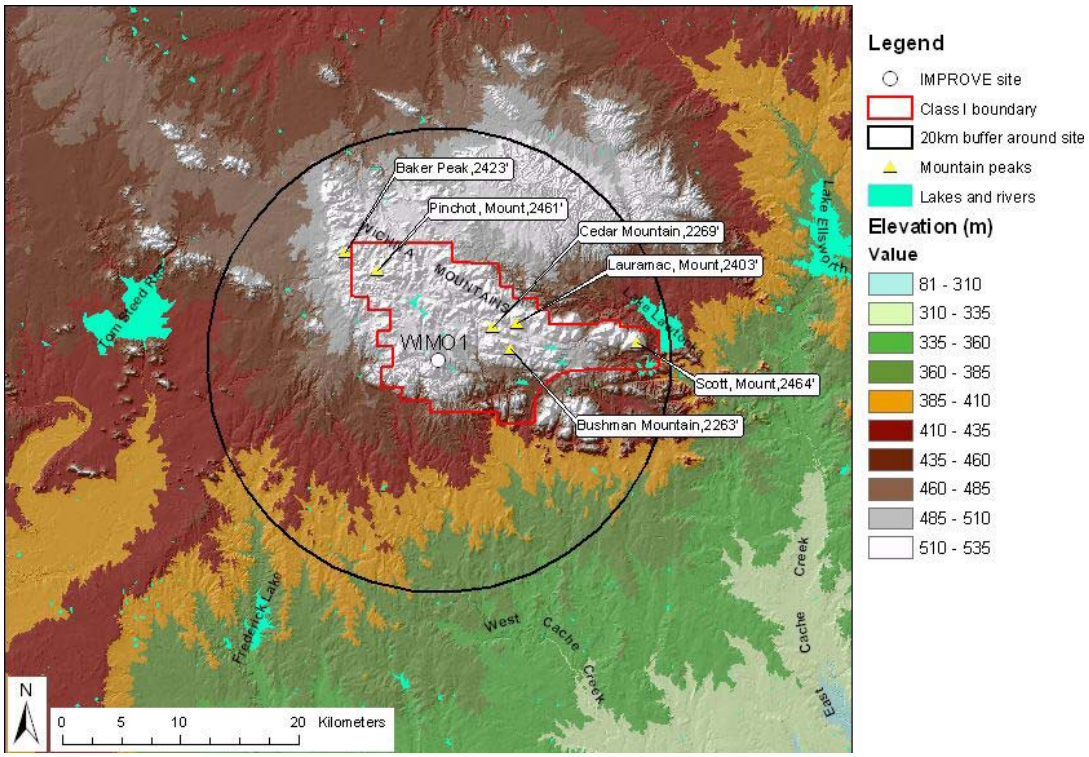

Figure 1. Terrain and land features surrounding the Wichita Mountains sampling site

Sulfate is the largest aerosol contributor to light extinction during the 20% worst days, with a contribution of ~ 44%. Nitrate and OMC also contribute about 21% and 16%, respectively to light extinction during the 20% worst visibility days. Figure 2 shows that the highest occurrence of the 20% worst days was in September, in which ~ 40% of the sampling days are 20% haziest days at Wichita Mountains. September has a relatively high frequency of transport from east of the site. As shown in Figure 3, on the 20% worst visibility days, sulfate is the largest aerosol contributor to haze during the warm seasons, while nitrate is the largest aerosol contributor during the cool seasons. One worst day was observed in July 2004 with OMC being the largest aerosol contributor (~40%) to light extinction. Figure 4 indicates that during the 20% best days, air usually comes from north of the site; while during the 20% worst haze days, air usually comes from southeast of the site.

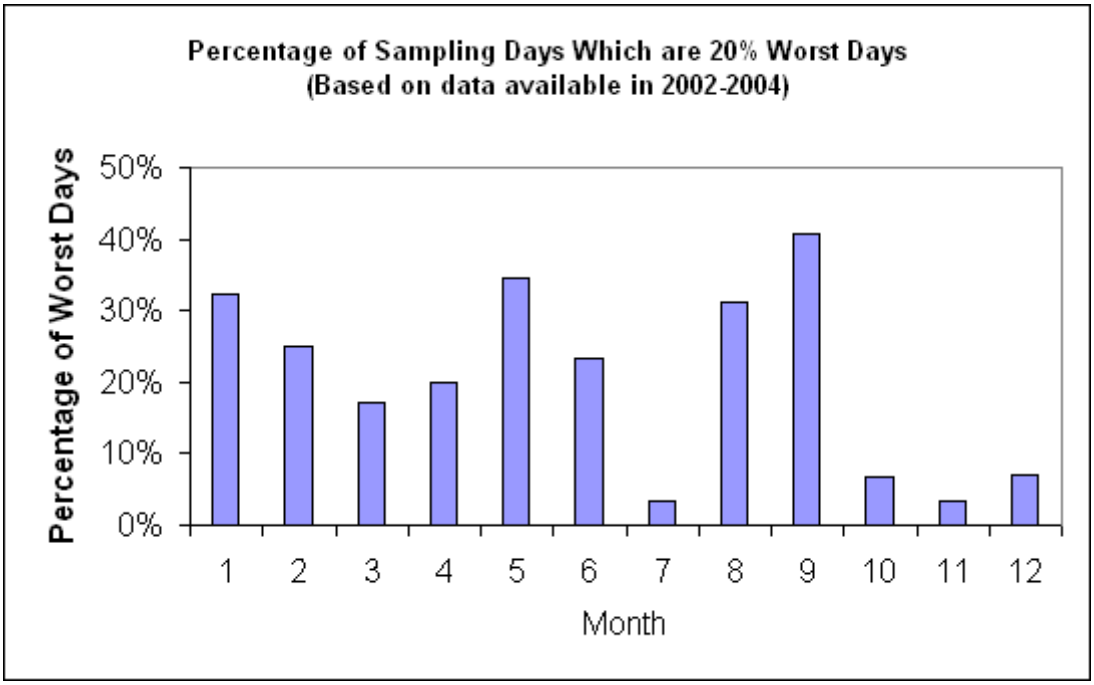

Figure 2. Percentage of sampling days that are 20% worst days in each month

Based on the PMF receptor modeling, seven source factors are identified for WIMO1. Figure 5 illustrates the contribution of each PMF resolved source factor to $PM_{2.5}$ mass at the site. Sulfate-rich secondary aerosol is the biggest contributor to $PM_{2.5}$ mass, with a contribution of ~ 41%, followed by biomass smoke (22%) and nitrate-rich secondary (12%). Difference maps of the PMF sulfate-rich secondary source factor score weighted and un-weighted residence times (Figure 6) suggest that secondary sulfate mainly transports from eastern Texas (substantial SO_2 emissions from coal-fired power plants) and the central and eastern United States, while secondary nitrate is mostly from the central U.S. locations north of Wichita Mountains.

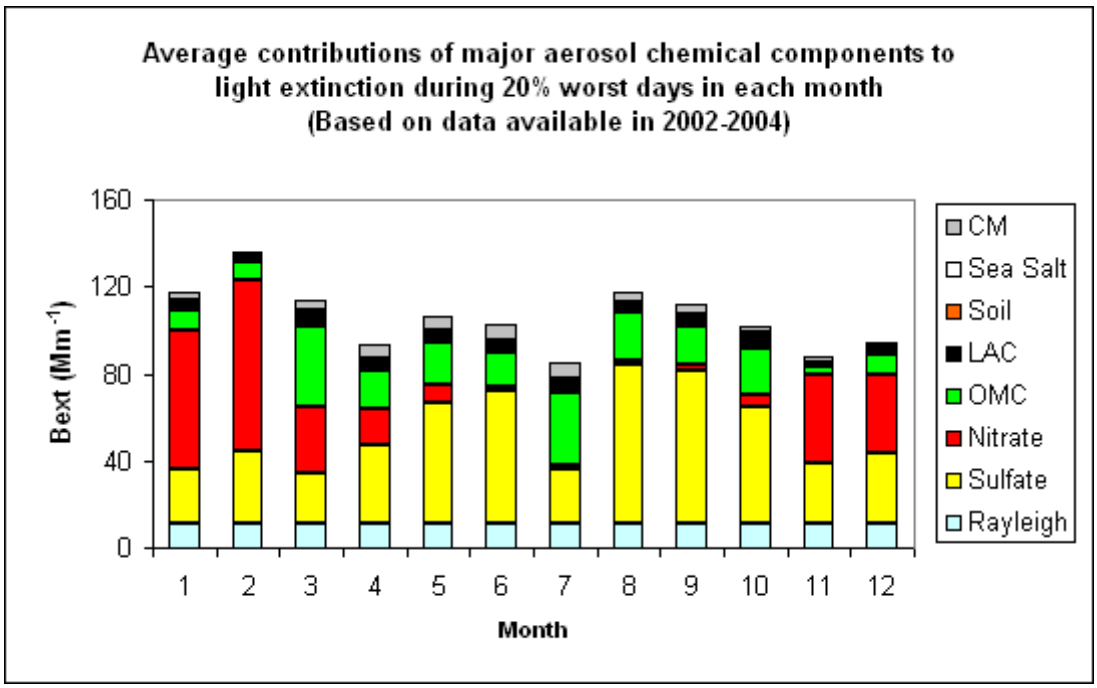

Figure 3. Average contributions of major aerosol chemical components to light extinction during 20% worst days in each month

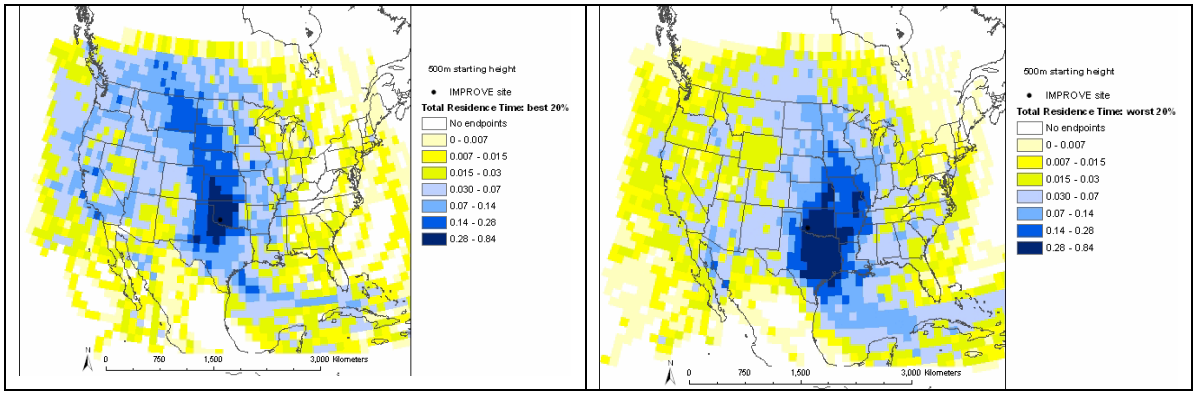

Figure 4. Normalized residence time for 20% best (left) and 20% worst (right) days (air mostly transported from the blue area under the given sampling days)

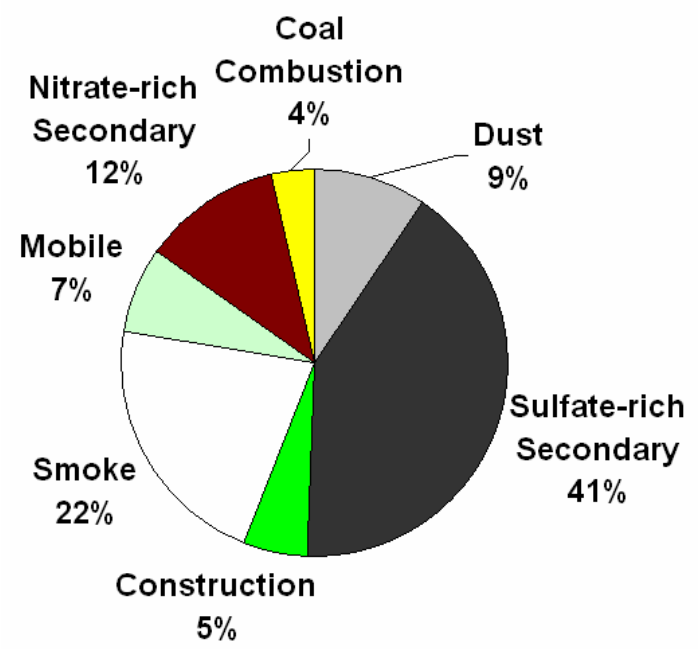

Figure 5. Average contributions of PMF resolved source factors to PM2.5 mass concentration.

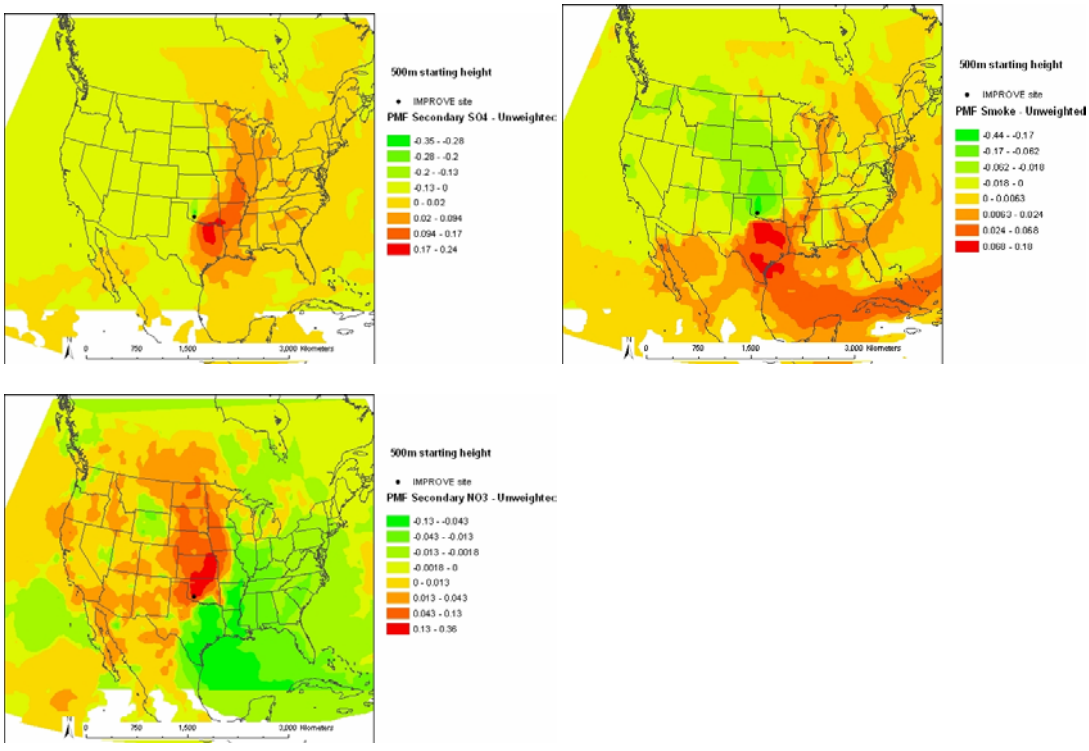

Figure 6. Difference maps of the PMF source factor (sulfate-rich secondary source factor on the top left, biomass smoke source factor on the top right, and nitrate-rich secondary source factor on the bottom left) weighted and un-weighted residence times.