Conceptual Model - Causes of Haze in Cape Romain Wilderness Area (ROMA1)

Secondary sulfate from South Carolina and Georgia during the summer months is responsible for most of the 20% worst visibility days in the Cape Romain Wilderness Area. Organics from regional combustion sources is also a significant contributor to haze in the region.

As shown in Figure 1, Cape Romain Wilderness Area is located on the Atlantic coast.. The southern tip of the wilderness is approximately 8 miles northeast of Charleston, SC. The wilderness is part of the 64,229 acre Cape Romain National Wildlife Refuge. The wilderness area consists of 28,000 acres of beach and salt water bays, salt marshes, sand dunes, maritime forests, tidal creeks, fresh and brackish water impoundments, and open water. The IMPROVE site is located in a clearing near the visitor center at the refuge's maintenance yard. The nearest highway is highway 17, 2.2 miles to the west. The IMPROVE site is located at an elevation of 5 m MSL. Based on all the valid aerosol measurements during 2000-2004 in ROMA1, the average $PM_{2.5}$ mass concentration measured at ROMA1 during 2000 to 2004 is 9.0 µg/m^3. The average total light extinction coefficient (B_{ext}) is 84.5 Mm^{-1} (Visual Range ~ 59 Km; Deciview ~ 20). The average contributions of the major aerosol components to Cape Romain haze are particulate sulfate 55.2%, nitrate 5.7%, organic matter (OMC) 14.5%, elemental carbon (light absorbing carbon, LAC) 4.6%, fine soil 0.6%, sea salt 1.5%, and coarse mass (CM) 3.8%.

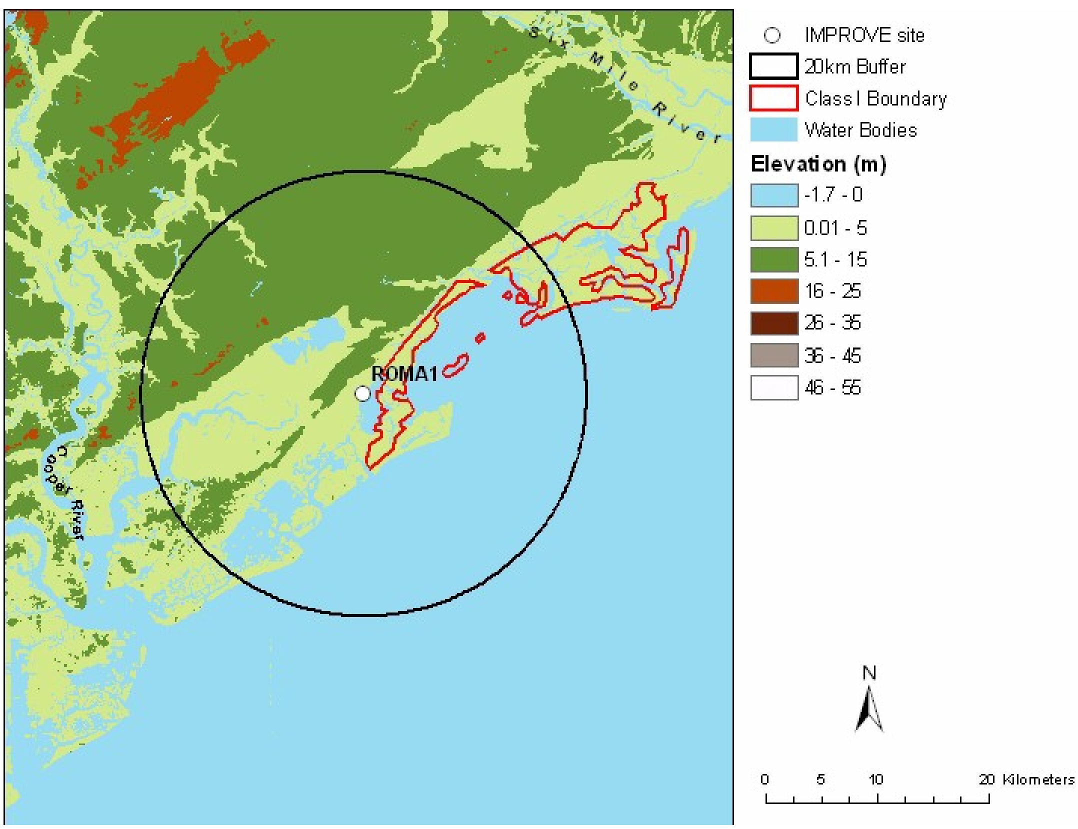

Figure 1. Terrain and land features surrounding the Cape Romain Wilderness Area

Sulfate is the largest aerosol contributor to light extinction during the 20% worst days, with a contribution of ~ 66%. OMC also contributes about 16% to light extinction during the 20% worst visibility days. Figure 2 suggests that the highest occurrence of the 20% worst days happened in July, in which ~ 45% of the sampling days are the 20% haziest days at Cape Romain. As shown in Figure 3, in the 20% worst visibility days, sulfate is the largest aerosol contributor to haze throughout the year, with a contribution from ~ 40% in the first quarter to ~ 75% in the third quarter. OMC also contributes ~23-36% during the 20% worst days in the winter and spring (January to April, November to December). Figure 4 indicates that during the 20% best days, air usually comes from the ocean; while during the 20% worst haze days, air most frequently comes from the continental eastern U.S.

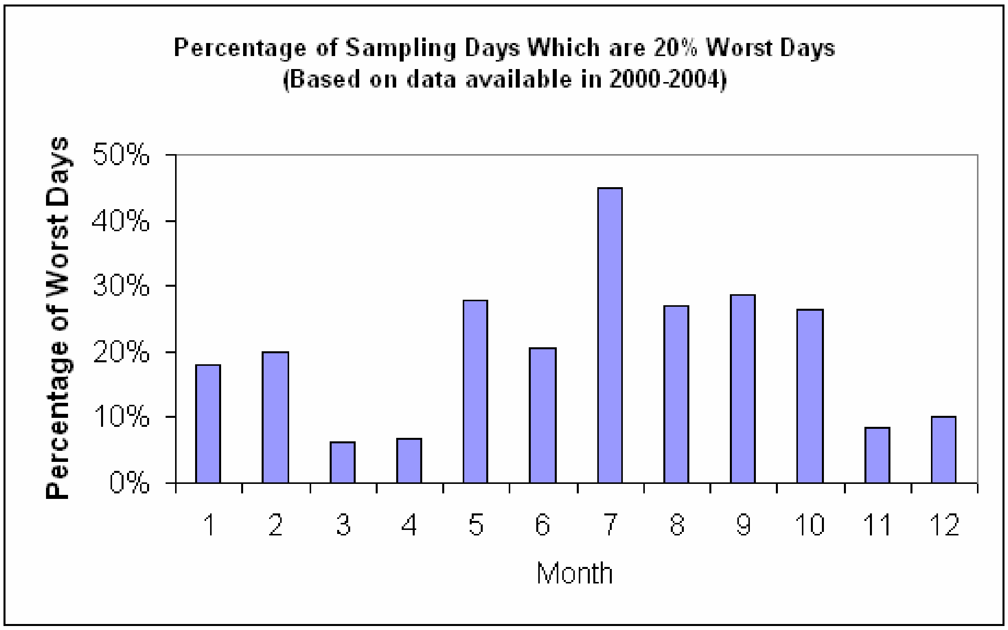

Figure 2. Percentage of sampling days that are 20% worst days in each month (Based on data available in 2000-2004)

Based on the PMF receptor modeling, seven source factors are identified for ROMA1. 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 55%. Combustion sources contribute in total about 30% to $PM_{2.5}$ mass at ROMA1. Difference maps of the PMF factor score weighted and un-weighted residence times (Figure 6) suggest that secondary sulfate mostly comes from the state of Georgia and South Carolina. Regional combustion sources, including coal-fired power plants, biomass burning, and ocean shipping (oil combustion) emissions, contribute significantly to regional haze at ROMA1.

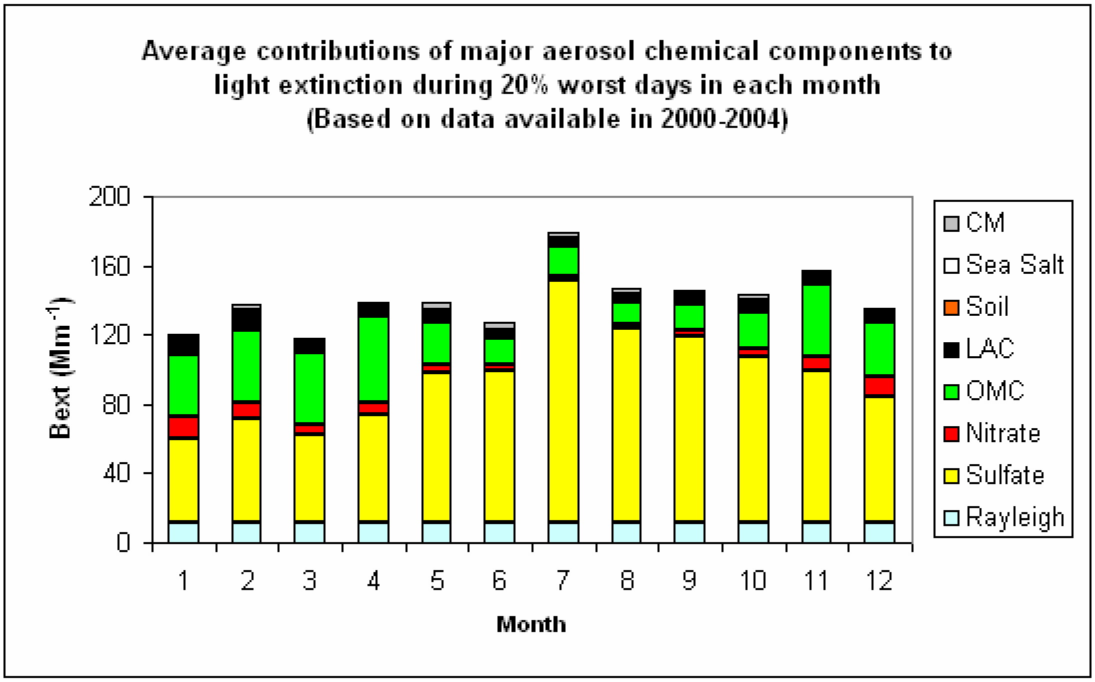

Figure 3. Average contributions of major aerosol chemical components to light extinction during 20% worst days in each month (Based on data available in 2001-2004)

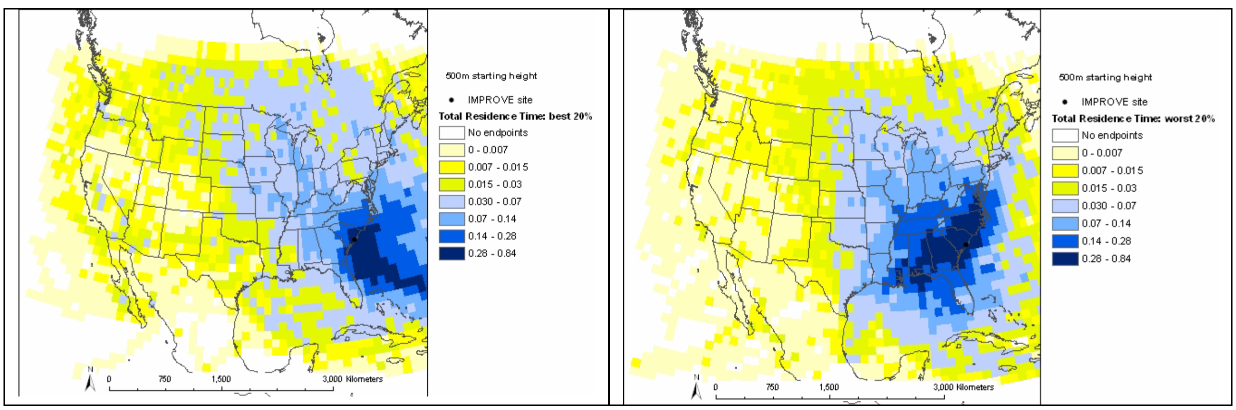

Figure 4. Normalized residence time for 20% best (left) and 20% worst (right) days (based on data from 2001-2004, air mostly transported from the blue area under the given sampling days)

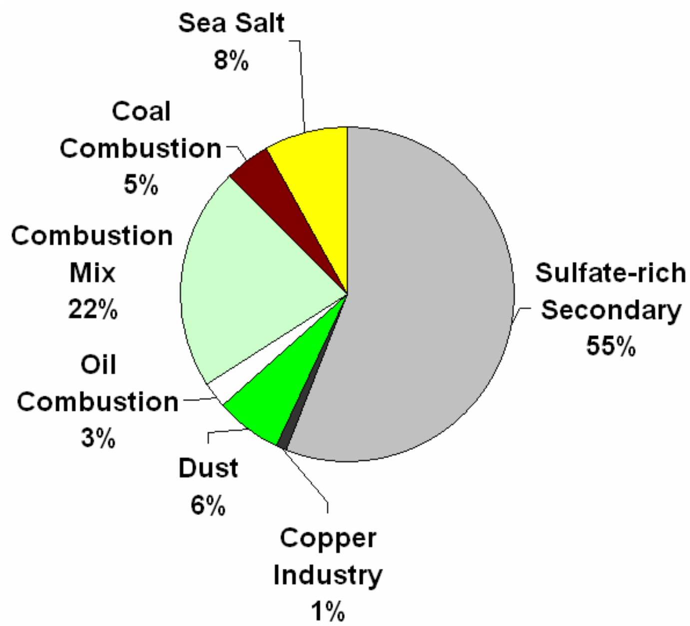

Figure 5. Average contributions of PMF resolved source factors to PM2.5 mass concentration.

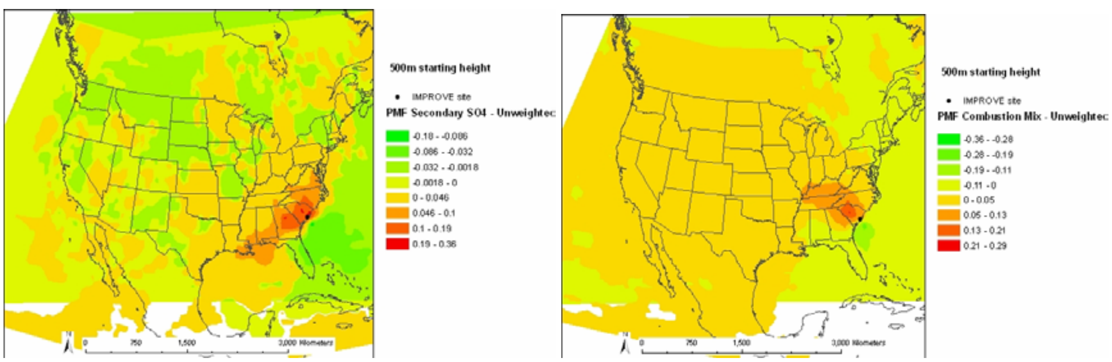

Figure 6. Difference maps of the PMF source factor (Sulfate-rich secondary source factor on the left, combustion mix source factor on the right) weighted and un-weighted residence times.