Preliminary Conceptual Model - Causes of Haze in Big Bend National Park (BIBE1)

Sulfate transported from the eastern United States and from point sources in the northeastern Mexico, as well as dust from west of the site along the Mexico, New Mexico and Arizona border in the spring are the major causes of haze at the Big Bend National Park. Organics associated with fires in the spring and dust transported from northern Africa in the summer also have important contributions to regional haze in those special episodes.

The Big Bend monitoring site (BIBE1) is located ~ 4km (2.5 mi) southeast of Panther Junction, within Big Bend National Park, at a site elevation of 1,075 m (3,526 ft). The average $PM_{2.5}$ mass concentration during the years 1997-2002 is 6.6 $\mu g/m^3$, and the average total light extinction coefficient (B_{ext}) is 37.9 Mm^{-1} (Visual Range ~ 103 Km; Deciview ~ 13.3). The average contributions of the major aerosol components to Big Bend National Park haze are particulate sulfate 36.6%, nitrate 3.3%, organic matter (OMC) 13.0%, elemental carbon (light absorbing carbon, LAC) 4.2%, fine soil 4.0% and coarse mass (CM) 12.5%.

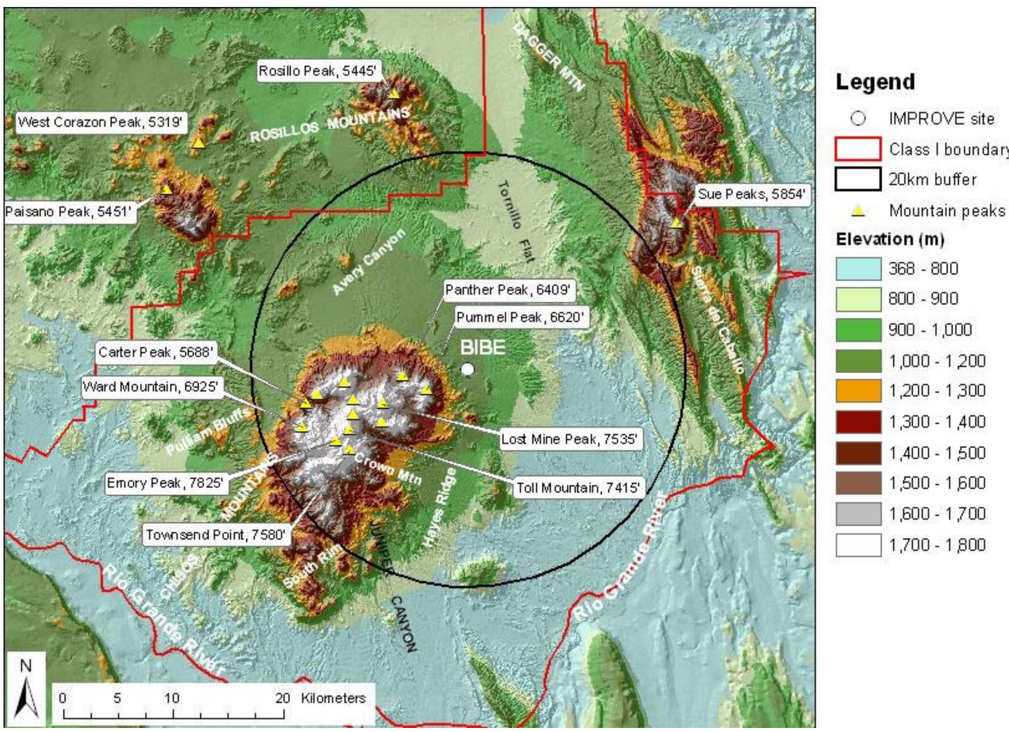

Figure 1. 20 Km terrain map

Figure 3 suggests that the highest occurrence of the 20% worst days happened in April, May, and September during which more than 30% of the sampling days were the 20% haziest days at Big Bend National Park. As shown in Figure 4, sulfate is the largest aerosol contributor to haze in the 20% worst days throughout the year. In the spring, dust (coarse mass and fine soil) also has important contributions to haze. Organics contribute about 20% to light extinction in the 20% worst days in May. High fine soil contribution (~14%) is found in the 20% worst days in July.

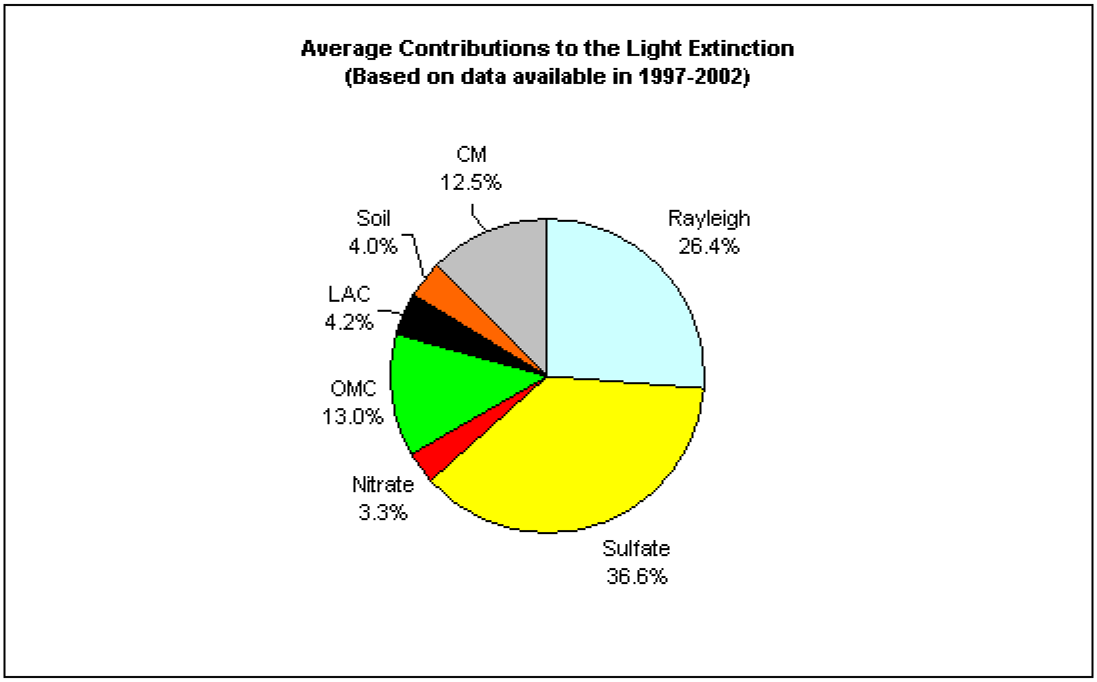

Figure 2. Average contributions of major aerosol chemical components to light extinction (Based on data available from 1997-2002)

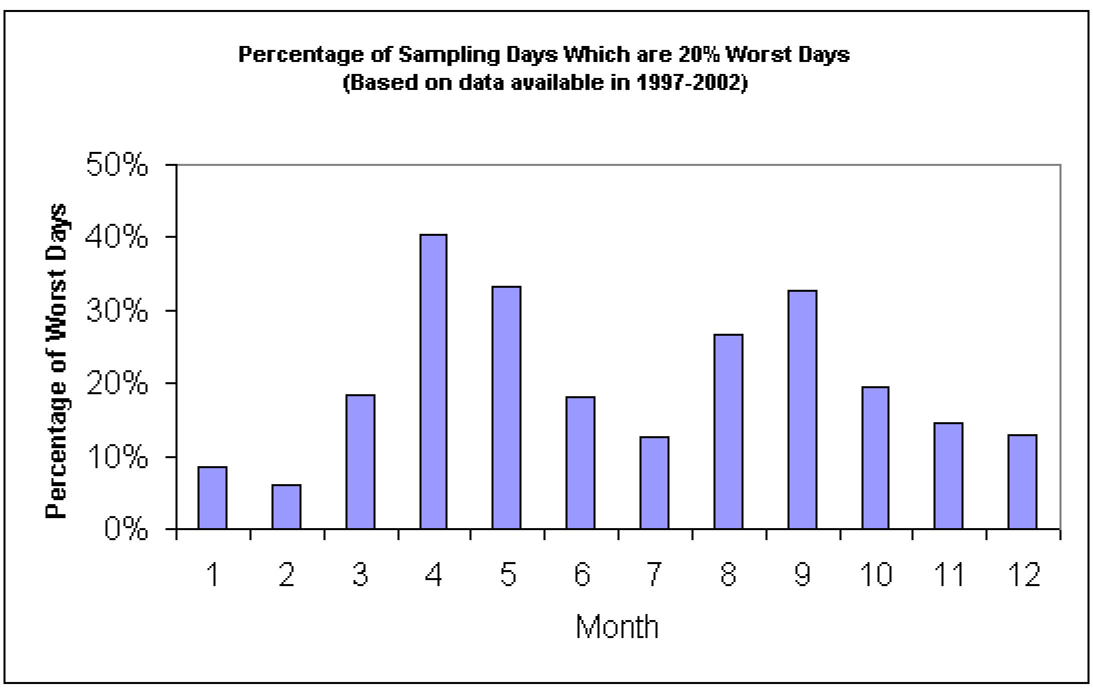

Figure 3. Percentage of sampling days that are 20% worst days in each month (Based on data available from 1997-2002)

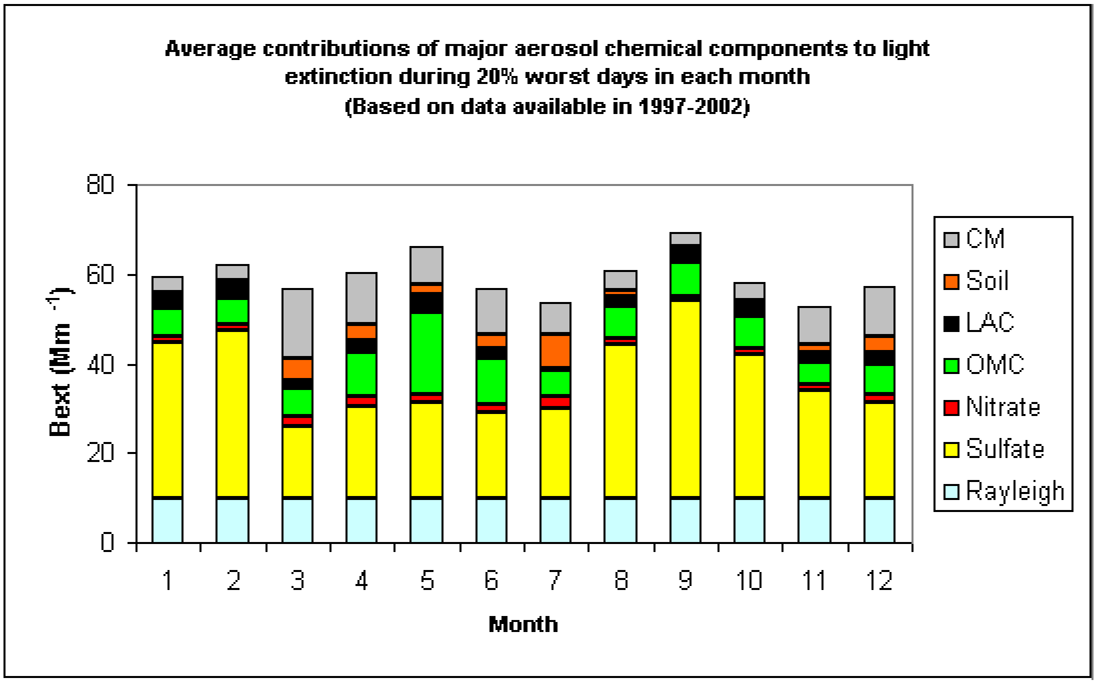

Figure 4. Average contributions of major aerosol chemical components to light extinction during 20% worst days in each month (Based on data available from 1997-2002)

Figure 5 shows main flow direction is from the northwest in the winter, which corresponds to the lowest haze level at the site. Flows from both the west and southeast are important in the spring. The high dust loadings in the spring are likely associated with regional wind blown dust from west of the site along the Mexico, New Mexico and Arizona border as shown in Figure 6.

High contributions of organics to light extinction are found in the 20% worst days of May. The aerosol data suggest that this is mostly due to the high aerosol loading observed in May 1998, which is associated with the fires happened in the Yucatan Peninsula during that time period (Episode Analysis?).

Fine soil has relatively big contributions to light extinction in the 20% worst days in July. Residence time map in July shows that flows are mainly from southeast. This indicates that the transport of Sahara dust to the Big Bend National Park in July may result in 20% worst haze days, although it does not happen very often (only ~12% of the sampling days in July are 20% worst days).

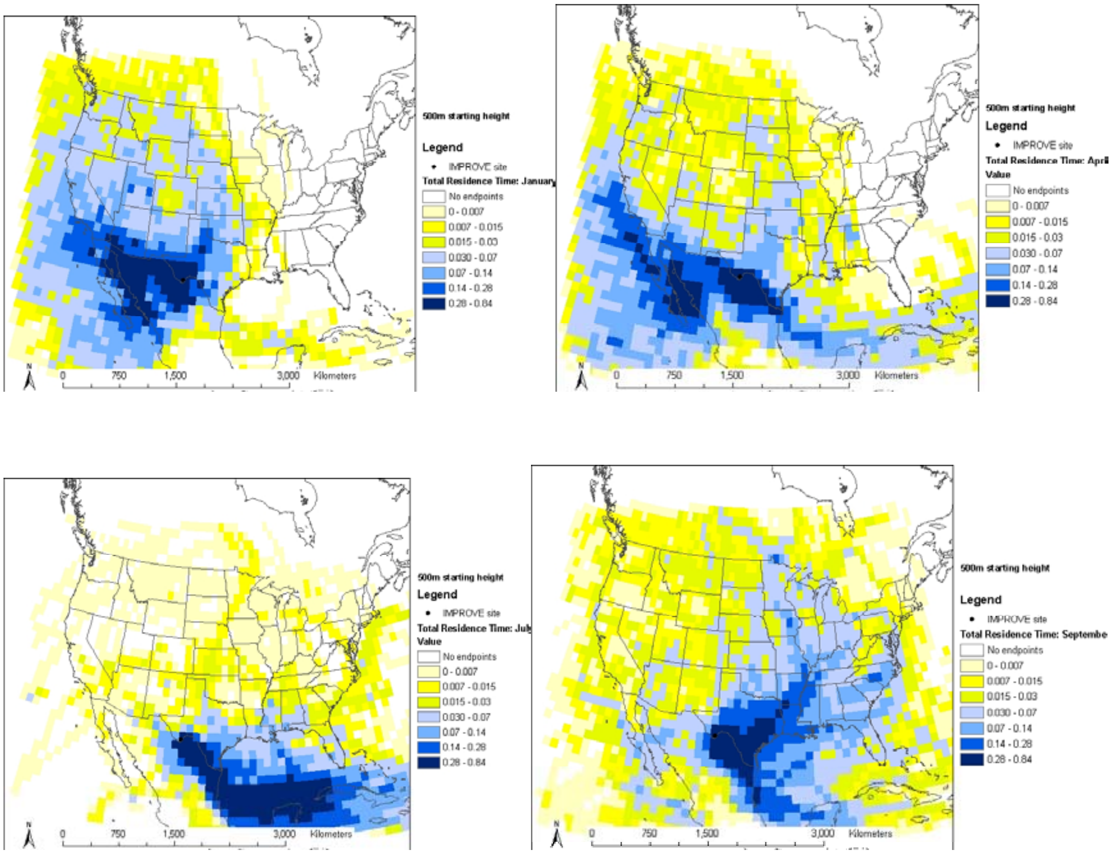

Figure 5. Normalized residence time in January (top left) and April (top right), July (bottom left) and September (bottom right) (based on data from 2000-2002)

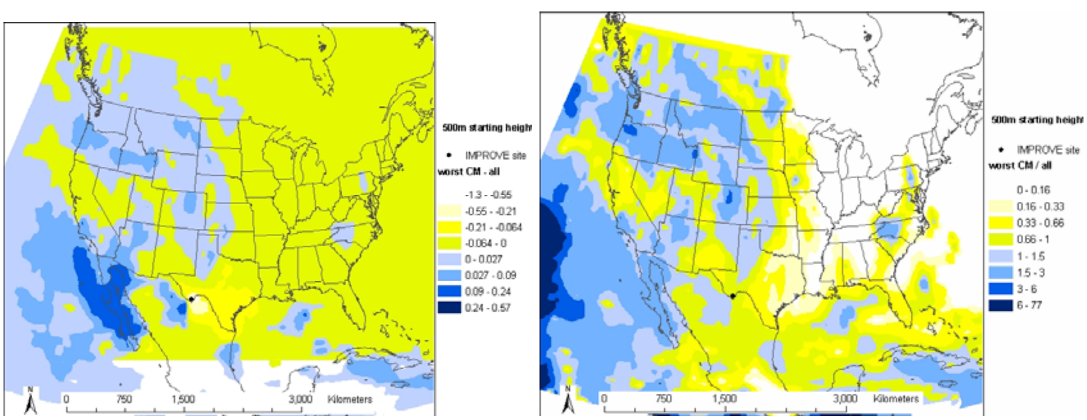

Figure 6. Difference (left) and ratio (right) of normalized residence time in 20% worst coarse mass days and all days during 2000-2002 (possible important source regions are shown up as blue in the maps)

Flows from the east and northeast of the site are frequent in September, which is the month with the highest sulfate contribution to haze (64%) in the 20% worst days. Sulfate is the largest contributor to aerosol light extinction the whole year, with a mean contribution of 53% in the 20% worst days. Figure 7 suggests that sulfate is mainly transported from the eastern United States in the 20% highest sulfate days. There are some important point sources such as the Carbon I and II coal-fired Power Plants located in northern Mexico, about 275 km (170 mi) southeast from the monitoring site. These power plants are among the largest SO_2 point sources, and may contribute to the sulfate loadings at the Big Bend National Park year-round.

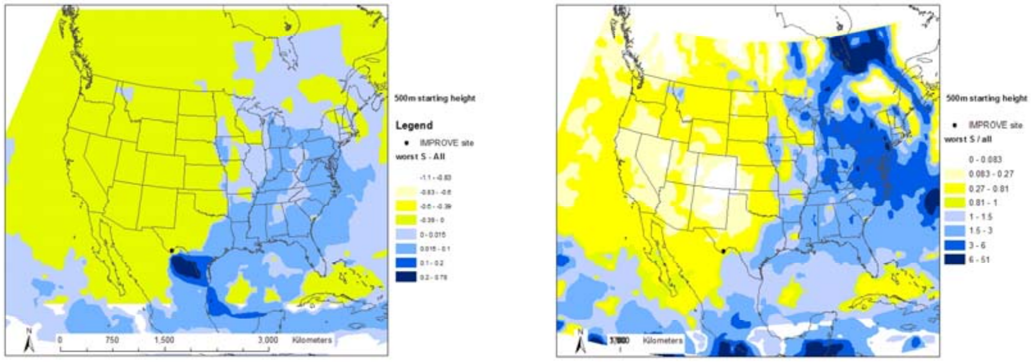

Figure 7. Difference (left) and ratio (right) of normalized residence time in 20% worst sulfate days and all days during 2000-2002 (possible important source regions are shown up as blue in the maps)