

Big Bend Regional Aerosol and Visibility Observational (BRAVO) Study Results: Air Quality Data and Source Attribution Analyses Results from the National Park Service / Cooperative Institute for Research in the Atmosphere

Abstract

Big Bend National Park is located in southwestern Texas along the Mexican-Texas border. During the 1990s, the haze at Big Bend increased, further obscuring Big Bend's scenic beauty. In response to the increased haze, the Big Bend Regional Aerosol and Visibility Observational (BRAVO) study was conducted. This was an intensive monitoring study sampling aerosol physical, chemical and optical properties from July–October 1999. The monitoring was followed by a multi-year assessment of the causes of haze in Big Bend National Park, Texas, with the primary purpose to identify the source regions and source types responsible for the haze at Big Bend. Secondary research objectives of the study were to learn more about the chemical, physical, and optical properties of aerosols responsible for haze. In addition to analyzing the BRAVO data, analyses of long-term Big Bend air quality and meteorological data were conducted to examine the representativeness of the BRAVO time period to other seasons and years. BRAVO study participants include the National Park Service (NPS), the U.S. Environmental Protection Agency (EPA), the Texas Commission on Environmental Quality (TCEQ), and the Electric Power Research Institute (EPRI), among others. This technical report describes the methods and results from the multiple analyses employed by the NPS/CIRA (Cooperative Institute for Research in the Atmosphere) group for assessing the composition and optical properties of the haze and source regions responsible for the sulfate haze.

It was found that sulfate compounds are the largest contributor to particulate haze at Big Bend, accounting for about 45% on average and 55% on the haziest days. Dust and carbonaceous compounds comprise the majority of the remaining particulate haze annually. Dust or smoke from local and international sources (Mexico and beyond) is the largest contributor on some of the haziest days, particularly during the spring and early summer. Sulfate haze source attribution results showed that SO₂ emissions from sources in the U.S. and Mexico contributed to about 26% and 18%, respectively, of the particulate haze during the four-month BRAVO study period. The split among U.S. source regions was Texas – 8%, the eastern U.S. – 15%, and the western U.S. – 4%. The two Carbón power plants, located 200 km southeast of Big Bend in Mexico, contributed about 9% of the particulate haze, making them the single largest contributing SO₂ emissions facility. On the haziest 20% of the days during the BRAVO study, SO₂ emissions from sources in the U.S. and Mexico contributed to about 35% and 17%, respectively, of the particulate haze. The split among U.S. source regions was Texas – 11%, the eastern U.S. – 20%, and the western U.S. – 4%. In Mexico, Carbón was responsible for 9%. Throughout the year transport is often from the western U.S. and Mexico on the least hazy days when the appearance of scenic vistas are especially sensitive to small increases in particulate concentrations.

The implication of these results is that first, there is no simple answer to the question of what sources are responsible for the haze at Big Bend National Park; sources in both the U.S. and Mexico are responsible. Mexican SO₂ emissions contribute to the sulfate haze more frequently, but to generate the haziest events that occur in the late summer and fall, contributions

from Texas and the eastern U.S. must occur. Substantial changes to the Carbón I & II power plants' emissions would likely result in small but noticeable changes in haze levels on many days. SO₂ emission changes in both Texas and the eastern U.S. would be required to substantially affect all of the haze episodes during the late summer and fall. Because of the high frequency of air transported to Big Bend from the southeast along a corridor on both sides of the Rio Grande River, emission changes there have a potential to affect haze levels at Big Bend especially during June through September when transport from this region is most frequent. On the clearest days at Big Bend, the Carbón I & II power plants and other sources in northeast Mexico were the largest contributors to Big Bend's sulfate. Reduction in emissions from Carbón would likely result in creating more clear days. On the other hand, growth along this border region will likely further reduce the number of clear days.