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

BRAVO Background and Summary of Findings Fact Sheet

The scenic beauty of Big Bend National Park is often spoiled by haze, obscuring its many vistas. In addition, Big Bend is one of the few monitored national parks in which haze has been increasing since the late 1980s. In 1999, the National Park Service (NPS) and the U.S. Environmental Protection Agency (EPA) carried out the Big Bend Regional Aerosol and Visibility Observational (BRAVO) study. Other participating agencies were the Texas Commission on Environmental Quality (TCEQ) and the Electric Power Research Institute (EPRI). The primary objectives of BRAVO were to determine the composition and optical properties of the haze and to quantify the contribution of major sulfur dioxide sources and source regions within Mexico and the United States to the haze. The BRAVO study involved a four-month intensive monitoring period from July through October 1999, followed by a four-year data analysis and modeling effort examining the BRAVO data and past data collected at Big Bend NP. Following is a summary of the key findings from research conducted by the National Park Service and its partners.

What is Causing Big Bend's Haze?

Haze is caused by scattering and absorption of light by suspended fine particles in the air. The composition of the particles varies depending on their human and natural sources, such as sulfate from the transformation of sulfur dioxide emitted from coal-fired power plants, dust from the suspension of soil particles, and carbonaceous material from forest fires. It has been found from monitoring of Big Bend's haze that:

- On average, the haze in Big Bend NP peaks in the spring (April–June) and summer/fall (August–October) months with the lowest haze conditions during the winter months.
- Sulfate is the single largest contributor to particulate haze at Big Bend NP, accounting for about half of the haze on the average and on the haziest days.
- Big Bend is one of the few monitored national parks where both sulfates and haze are increasing.
- Local and international transport of dust and smoke also contribute to haze, particularly in the springtime months.

What are the Common Airmass Transport Pathways to Big Bend NP?

The pollutants responsible for haze generally remain in the air for 3 to 7 days. Over this time period they can be carried up to several thousand kilometers by the winds. Therefore haze is a regional issue with source regions over 1000 km away contributing to Big Bend's haze. A source region's potential to contribute to Big Bend's haze increases as the frequency of airmasses traversing the source region prior to reaching Big Bend increases. To identify the source regions most likely to contribute to Big Bend's haze, the common airmass transport routes to Big Bend were examined throughout the year.

- Throughout the year airmasses en route to Big Bend frequently reside over Mexico, in particular northern Mexico.
- Airflow from eastern Texas and the eastern U.S. is most frequent during late summer and fall months during the period with the greatest contribution to haze by particulate sulfate compounds.
- Airflow from the western U.S. to Big Bend is greatest in the winter months when haze levels at the park are lowest.
- The highest sulfate haze periods during BRAVO were associated with low-speed and low-level transport from the eastern U.S., eastern Texas, and northeastern Mexico.
- The lowest sulfate haze periods during BRAVO were associated with higher-speed transport from the Gulf of Mexico along the Mexican/Texas border to Big Bend, from the north, and from the western U.S.

Where Does the Sulfate Haze Come From?

Sulfate particles are primarily due to sulfur dioxide emissions into the atmosphere where they are chemically transformed (oxidized) to sulfate particles during their transport. The primary sulfur dioxide sources are coal- and oil-fired power plants, metal smelters, refineries, and other industrial processes. Sulfate particles are also hygroscopic, meaning that as moisture in the air increases, sulfate particles will grow larger and scatter more light than when dry. A number of sulfate source attribution techniques were applied during BRAVO and it was found that:

- On average, during the BRAVO period U.S. sources were responsible for about 55% of Big Bend's particulate sulfate, with the eastern U.S. responsible for about 30% and eastern Texas contributing about 17%.
- Mexican sources, including the Carbón power plant, were responsible for about 38% of Big Bend's particulate sulfate.
- At 20%, the Carbón power plant in Mexico is the single largest point source contributor to Big Bend's sulfate haze during the BRAVO study period.
- At any given time during the BRAVO study, over half of the sulfate haze can come from eastern U.S., eastern Texas, or Mexican sources.
- On the clear days Mexico and the western U.S. were the largest contributors during the BRAVO study.

How Can Visibility be Improved at Big Bend National Park?

- Control SO_2 emissions from the Carbón power plants. This will decrease the average sulfate concentrations and thus decrease light scattering on average and on many days throughout the year.
- Significantly reduce SO_2 emission in both eastern Texas and the eastern U.S. This will eliminate or reduce the highest concentrations of sulfate that occur episodically.
- Enhance the clearest days by making small reductions in SO_2 emissions in northern Mexico and the western U.S.