4 Data Gathering

The data gathering component of the study is from July 1- October 31.

4.1 Aerosol and Gaseous (includes tracer) Data

The network for collection of aerosol and gaseous data includes 36 sites located throughout Texas, except for the panhandle area, and one site (Witchita Mountains) in Oklahoma. The IMPROVE sampler is used for collecting aerosol and SO_2 samples. All sites collect $PM_{2.5}$ on Teflon filters; many sites have additional measurements. Table 4-1 summarizes the number of sites for each type of measurement.

Table 4-1. Number of measurement sites by measurement type.

Measurement Type	Number of Sites
24 hour $PM_{2.5}$ elements (H, Na-Pb, mass, b_{abs}) (Teflon filter)	34
24 hour SO_2 and tracer	18
24 hour $PM_{2.5}$ carbon (quartz filter)	7
24 hour $PM_{2.5}$ ions (nylon filter)	4
6 hour $PM_{2.5}$ elements, SO_2, tracer	6
24 hour PM_{10} elements, ions, carbon	1
12 hour $PM_{2.5}$ elements, ions, carbon	1
Collocated 24 hour $PM_{2.5}$ elements, ions, carbon, SO_2, tracer	1
Collocated 24 hour PM_{10} elements, ions, carbon	1
Collocated 6 hour $PM_{2.5}$ elements, SO_2, tracer	1

Figures 4-1 and 4-2 show the locations of the monitoring sites and the parameters measured at each site. Table 4-2 gives this information as well, along with site names and latitude, longitude, elevation, and purpose of the site. The purposes of sites included: general gradient sites in Texas (about 100 km apart); border gradient sites at the Texas/Mexico border, Texas/other U.S. states border sites, coastal gradient sites, Big Bend area gradient sites, Class I areas, and sites predominantly downwind of tracer release locations. Additional aerosol and gaseous measurements are being made at Big Bend (K-Bar Ranch). These measurements are summarized in Table 4-3.

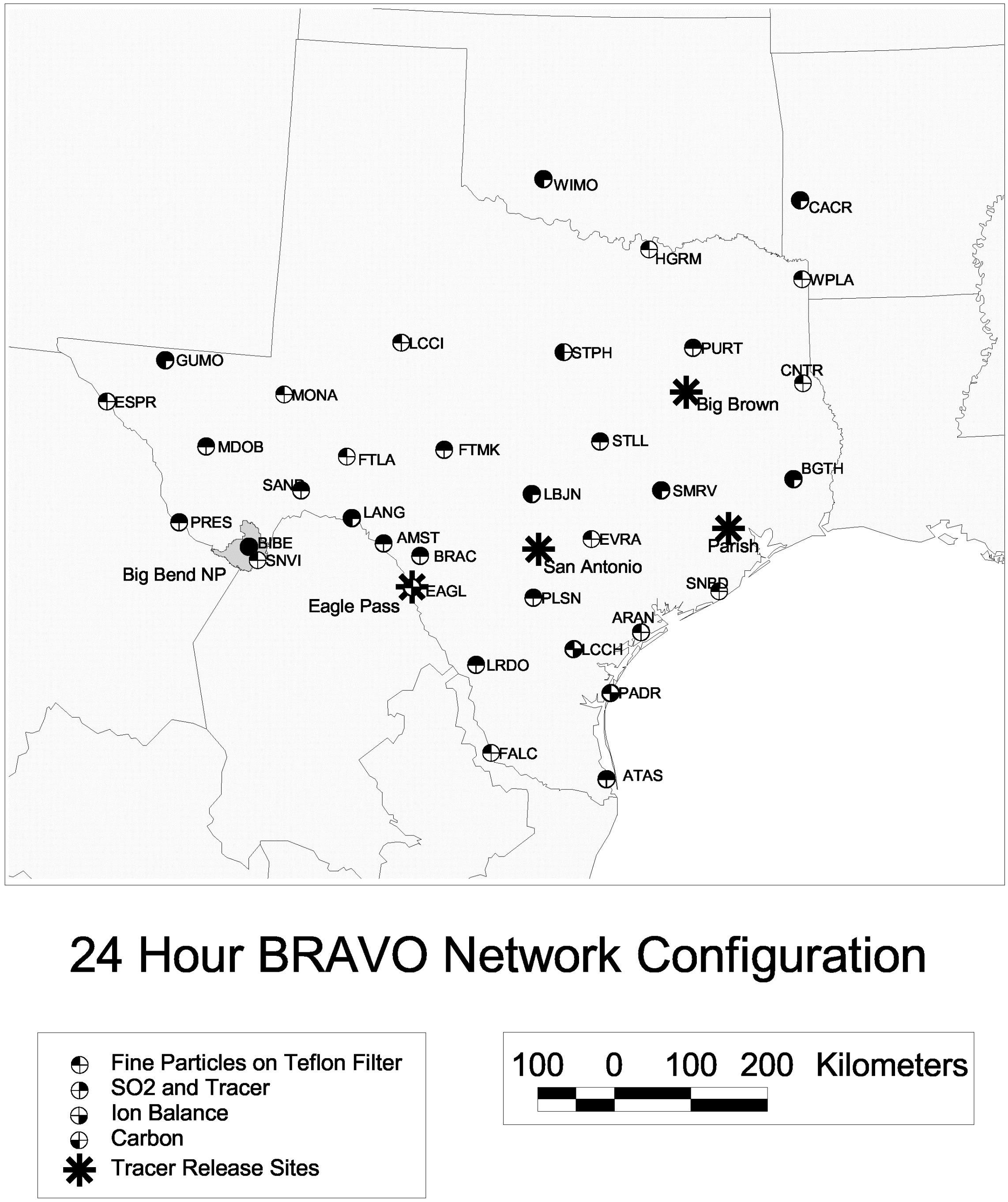

Figure 4-1. 24 hour network of gas and aerosol sampling locations.

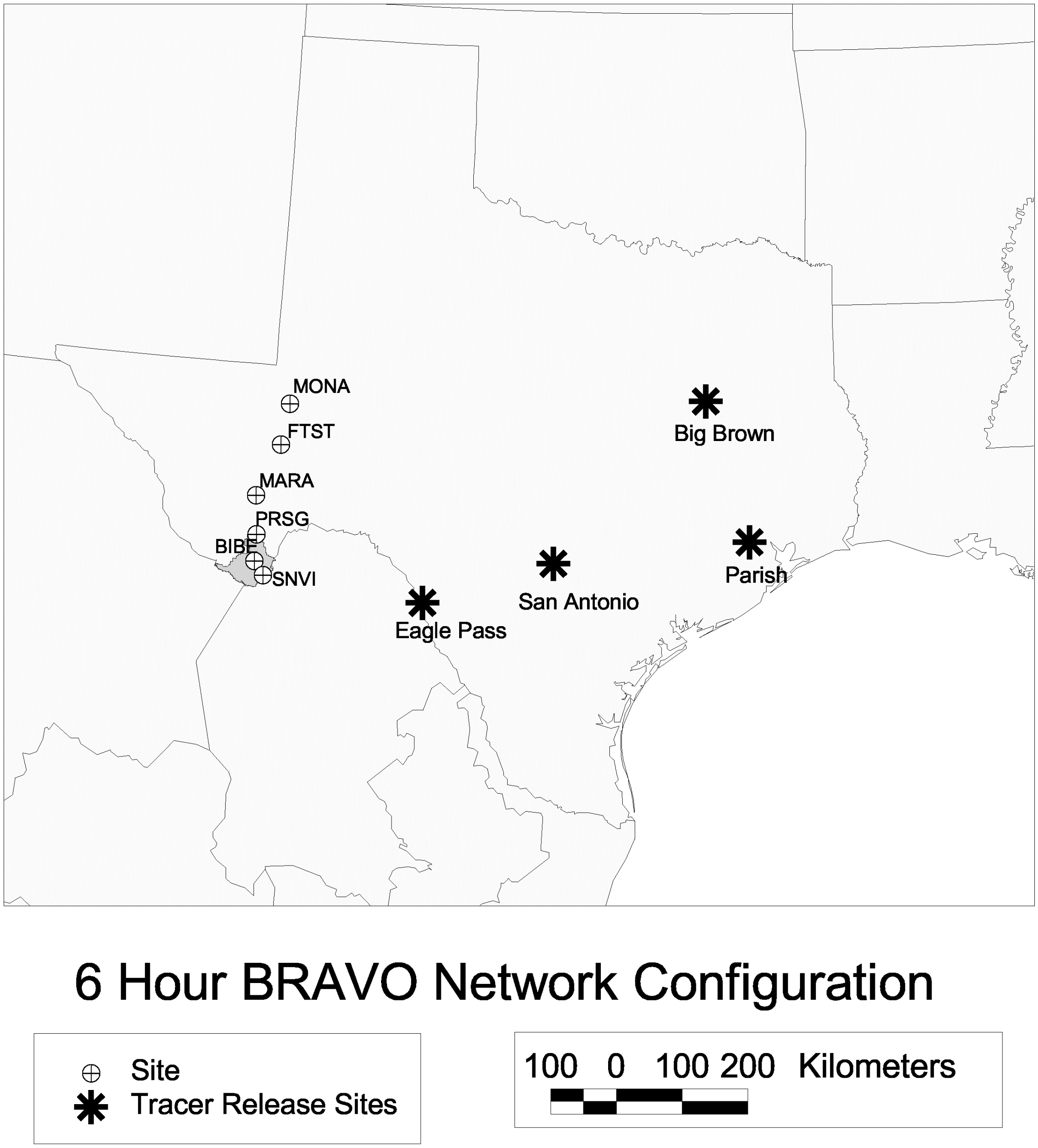

Figure 4-2. 6 hour network of gas and aerosol sampling locations.

Table 4-2. Aerosol and tracer monitoring site abbreviations, names, latitude, longitude, elevation, and purpose.

Site	Name	Latitude	Longitude	Elevation	Purpose
				m	
AMST	Amistad	29.47	-101.02	351	Downwind of Carbon/Eagle Pass
ARAN	Aransas	28.32	-96.83	0	
BIBE	Big Bend (K-Bar)	29.30	-103.18	1052	Receptor/Big Bend area gradient
BGTH	Big Thicket	30.48	-94.35	38	Texas/Louisiana border/gradient
BRAC	Brackettville	29.32	-100.42	335	Downwind of Carbon/Eagle Pass
CACR	Caney Creek	34.42	-94.15	646	Class I area
CNTR	Center	31.83	-94.17	24	Texas/Louisiana border/gradient
EPS	Eagle Pass	28.87	-100.52	274	Mexico border/near Carbon
ESPR	Esperanza	31.17	-105.72	1067	Mexico border gradient
EVRA	Everton Ranch	29.63	-97.65	244	Gradient
FALC	Falcon Dam	26.55	-99.17	61	Border gradient
FTLA	Fort Lancaster	30.67	-101.70	762	Gradient
FTMK	Fort McKavett	30.83	-100.10	671	Gradient
FTST	Ft Stockton	30.92	-102.90	983	Big Bend area gradient
GUMO	Guadalupe Mtns	31.83	-104.82	1659	Class I area
HGRM	Hagerman	33.73	-96.75	244	Texas/Oklahoma border
ATAS	Laguna Atascosa	26.22	-97.35	4	Coastal and Mexico border gradient
LCCI	Lake Colorado City	32.32	-100.90	640	Gradient
LCCH	Lake Corpus Christi	28.07	-97.90	91	Inland ion balance
LANG	Langtry	29.80	-101.55	396	Mexico border/downwind of Carbon
LRDO	Laredo	27.80	-99.45	148	Mexico border gradient
LBJN	LBJ	30.25	-98.63	518	Gradient/downwind of San Antonio
MARA	Marathon	30.20	-103.23	1280	Big Bend area gradient
MDOB	McDonald Observatory	30.67	-104.02	2043	Gradient
MONA	Monahans Sandhills	31.48	-102.80	831	Big Bend area gradient
PADR	North Padre Island	27.45	-97.30	0	Coastal/ion balance
PRSG	Persimmon Gap	29.67	-102.18	915	Big Bend area gradient
PLSN	Pleasanton	28.78	-98.57	122	Gradient
PRES	Presidio	29.57	-104.35	838	Mexico border gradient
PURT	Purtis Creek	32.35	-98.00	187	Gradient/downwind of Big Brown
SNBD	San Bernard	29.90	-95.58	0	Coastal gradient
SNVI	San Vicente	29.12	-103.03	549	Big Bend area gradient
SAND	Sanderson	30.18	-103.22	610	Gradient/downwind of Carbon
SMRV	Somerville Lake	30.33	-96.52	84	Gradient
STPH	Stephenville	32.27	-98.17	274	Gradient
STLL	Stillhouse Lake	31.02	-97.53	213	Gradient
WIMO	Wichita Mtns	34.70	-98.58	488	Class I area
WPLA	Wright Patman Lake	33.30	-94.15	9	Texas/Arkansas/Louisiana border

Table 4.3 Specialized aerosol and gaseous measurements at Big Bend.

Measurement	Averaging period
High time resolution, high sensitivity SO_2	1 hour
High time resolution particulate sulfate	12 minutes
Hourly tracer sampling	1 hour
$PM_{2.5}$ carbonaceous aerosol	24 hours
Carbon speciation by GC/MS for selected periods	24 hours
Gaseous nitric acid	24 hours
Gaseous ammonia	24 hours
MOUDI size resolved aerosol	24 hours
Various particle size measurements- differential mobility analyzer, optical particle counters, aerodynamic particle sizers	Seconds
Gaseous hydroperoxides	1 hour
Scanning electron microscopy (SEM) analysis	24 hours

Many of the specialized aerosol measurements at Big Bend are to support an ion balance study, carbon apportionment, and a size distribution study. The goals and expected information from these studies are briefly summarized below.

Ion balance study goals

- Determine what form(s) aerosol sulfate is found in at Big Bend National Park (BBNP) (e.g., H_2SO_4, NH_4HSO_4, $(NH_4)_2SO_4$, Na_2SO_4, etc…)
- Determine whether previously observed correlations between BBNP sulfate and sodium reflect the presence of sodium sulfate aerosol
- Determine changes in sulfate content and speciation during transport of air from the coast to BBNP

Expected information from planned ion balance measurements

- H^+ measurements will reveal whether BBNP aerosol is neutralized or acidic
- $PM_{2.5}$ ion measurements will indicate whether sulfate is present in ammonium salts or whether a significant portion is probably associated with sodium ion.
- MOUDI size-resolved aerosol samples will reveal if sodium ion and sulfate are found in the same particle size range(s)
- SEM single particle measurements will reveal if sodium and sulfur are found in the same particles

- Measured aerosol and gas compositions at BBNP can be used to predict how $PM_{2.5}$ mass and scattering properties might change in the event of changes in ambient concentrations of sulfate, nitrate, or ammonium

- Comparison of BBNP results with results from upwind coastal and inland sites will reveal if sulfate is added to sea salt particles as they are transported to BBNP from the coast

- Peroxide measurements will reveal the potential for rapid oxidation of SO_2 to sulfate in the presence of clouds

- Measurements of sodium ion can be compared with measurements of elemental sodium (from the Davis IMPROVE samples) to determine the fraction of sodium present in ionic form

Carbon study goals

- Determine dominant source types contributing to carbonaceous aerosol at Big Bend National Park (BBNP)

- Determine whether dominant source types change with transport conditions or season

Size distribution study goals

- Measure the dry atmospheric aerosol size distribution from ~0.02 µm to >10 µm, with particular focus on characterizing the coarse mode aerosol

- Estimate water content of optically-important particles (> 0.1 µm)

- Use optical measurements to detect shifts in aerosol composition

- The set of size distribution measurements will enable construction of the complete size distributions at BBNP, given some assumptions regarding the aerosol properties such as density and refractive index.

- Dry size distributions can be used to compute the aerosol extinction and compared with dry nephelometer and aethalometer measurements made by other investigators.

- The coarse mode data can be used to estimate the severity of errors in the nephelometer response at larger particle sizes.

Expected information from size distribution study

- The ambient size distributions can be used to compare with impactor measurements (DRUM, MOUDI) to help constrain the mass distributions.

- The estimates of the number concentrations of particles of all sizes can be used to estimate the age of the various size fractions, using lifetime estimates for particles against dry deposition and other loss mechanisms.

4.2 Optical Data

Optical data collected at Big Bend National Park includes transmissometer and ambient nephelometer data at a site about 5 Km north of the main BRAVO monitoring location at K-Bar Ranch. For the BRAVO study, additional optical data are collected. These include 2 additional transmissometers , 2 open air Optec nephelomters, two ambient $PM_{2.5}$ Optec nephelometers, one ambient PM_{10} Optec nephelometer. The additional transmissometers are located about 0.5 Km southwest of the K-Bar Ranch site. The additional nephelometers are all located at the K-Bar Ranch site. There are also five 35mm cameras and two 8mm time-lapse cameras at the south end of the new transmissometer path. The cameras give views from the Rio Grande River Basin to the existing transmissometer site path.

Additional optical instruments at the K-Bar Ranch site include two $PM_{2.5}$ Radiance Research nephelometers for which relative humidity is controlled, an aethalometer (operated with no-cut, 2.5 μm cut and 1 μm cut), and a photoacoustic light absorption instrument. The additional nephelometers were used to investigate the effects of relative humidity changes upon particle size and to quantify the light scattering by fine and coarse particles.

4.3 Meteorological Data

Upper air meteorological data sites are shown in Figure 4-3 and listed in Table 4-4. Radiosonde sites collect altitude, pressure, wind speed, wind direction, temperature, and dew point temperature, usually twice per day at 0 and 1200 Greenwich Mean Time (7 am and 7 pm CDT). Radar wind profilers collect wind speed and direction as a function of height – data is generally reported hourly. Radar wind profilers equipped with a radio acoustic sounding system (RASS) also obtain vertical profiles of virtual temperature, although usually only to 500-1500 meters.

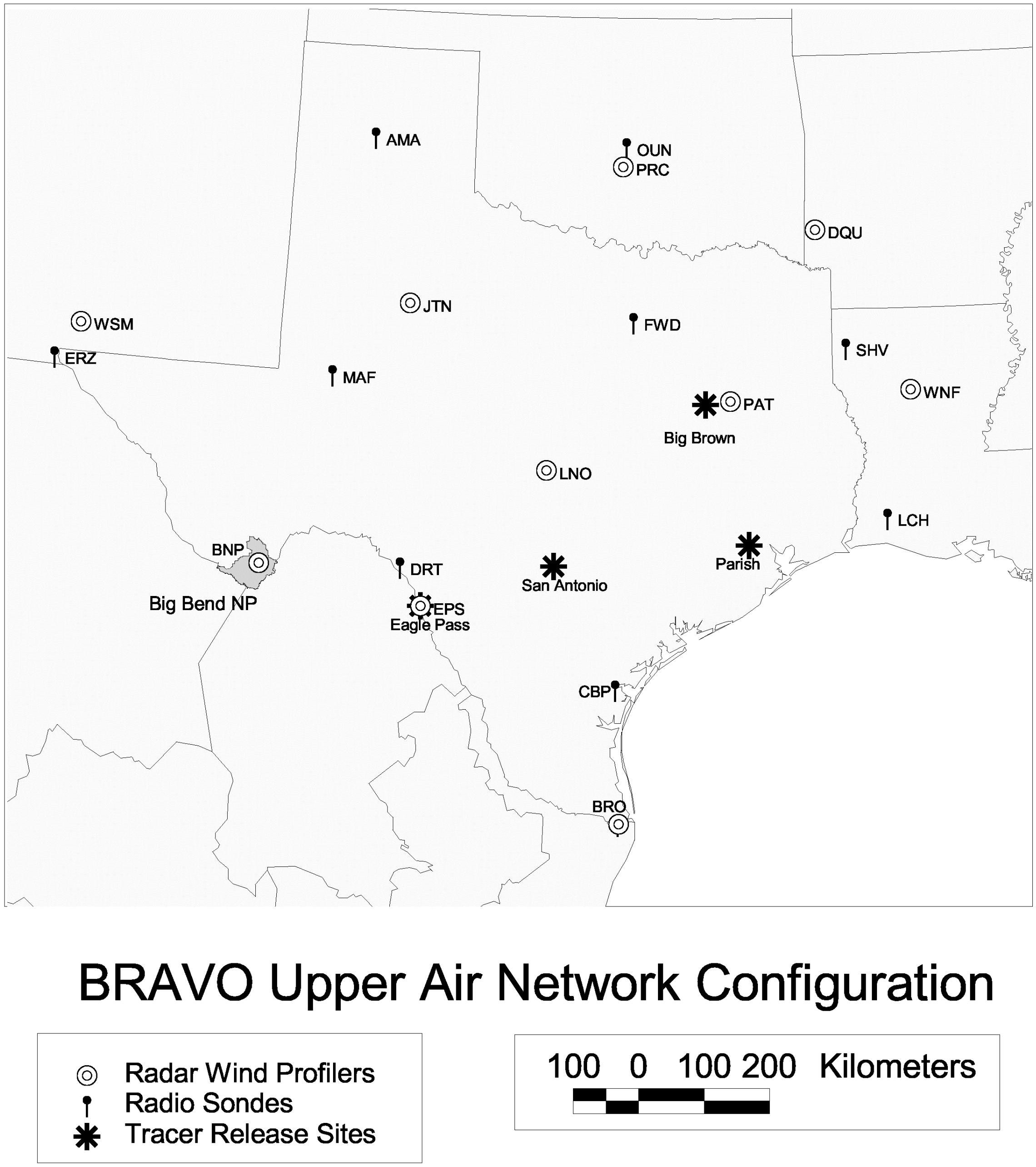

Figure 4-3. Upper air meteorological sites.

Table 4-4. Upper Air Meteorological Monitoring Site locations and type.

Station	Location	Lat	Lon	Type
AMA	Amarillo, TX	35.23	-101.70	Rawinsonde
BBNP	Big Bend, TX	29.30	-103.25	BRAVO Profiler
BRO	Brownswille,TX	25.90	-97.43	Rawinsonde and NOAA Wind Profiler
CBP	Corpus Christi, TX	27.77	-97.50	Rawinsonde
DQU	Dequeen, AR	34.11	-94.29	NOAA Wind Profiler
DRT	Del Rio, TX	29.37	-100.92	Rawinsonde
EPS	Eagle Pass	28.87	-100.57	BRAVO Profiler
ERZ	Santa Teresa, NM	31.87	-106.7	Rawinsonde
FWD	Fort Worth, TX	32.83	-97.30	Rawinsonde
JTN	Jayton, TX	33.01	-100.98	NOAA Wind Profiler
LCH	Lake Charles, LA	30.12	-93.22	Rawinsonde
LNO	Llano, TX	30.79	-98.66	BRAVO Profiler
MAF	Midland, TX	31.95	-102.18	Rawinsonde
MONT	Monterrey, MX	25.70	-100.25	Rawinsonde
OUN	Norman/Westheimer, OK	35.22	-97.45	Rawinsonde
PAT	Palestine, TX	31.77	-95.71	NOAA Wind Profiler
PRC	Purcell, OK	34.97	-97.51	NOAA Wind Profiler
SHV	Shreveport, LA	32.47	-93.82	Rawinsonde
SNAN	San Antonio, TX	29.47	-98.50	BRAVO Profiler
WNF	Winfield, LA	31.89	-92.78	NOAA Wind Profiler
WSM	White Sands, NM	32.40	-106.34	NOAA Wind Profiler
MCV	Chihuahua	28.70	-106.07	Rawinsonde

4.4 Source Characterization

The relative abundance of chemical components in an ambient particulate sample reflects the mixture of emissions from multiple sources, each with their own chemical composition. Chemical source profiles are the fractional mass abundances of measured chemical species relative to primary $PM_{2.5}$ mass in source emissions. These profiles are obtained by extracting samples from specific emitters that are believed to represent the larger population of similar emitters that might contribute ambient $PM_{2.5}$ concentrations. Archived profiles of mobile, area, and point sources derive from regions of the United States and time periods that may not represent the sources in Texas, neighboring states, and northern Mexico that might affect visibility in Big Bend National Park. Representative emitters for sources of directly emitted $PM_{2.5}$ and precursor gases such as sulfur dioxide will be tested to develop source profiles specific to the BRAVO region and study period and to evaluate their similarity to source profiles derived from other times and places.

The objectives of the BRAVO source characterization program are to:

- Identify and sample $PM_{2.5}$ from representative emitters from within the study domain

- Analyze these samples for the same chemical components measured at receptor sites.
- Create chemical source profiles for use in subsequent source apportionment and data analysis activities.

Accomplishment of these objectives will provide input data to receptor models such as the Chemical Mass Balance, Tracer Mass Balance Linear Regression, and Differential Mass Balance Receptor models. The derived profiles will also assist in the evaluation of meteorological trajectory models that determine relative impacts from different source areas when coupled with an emissions inventory that will be compiled for the BRAVO field study period.

Source Types

The Big Bend preliminary study showed that suspended dust, organic and elemental carbon, and ammonium or sodium sulfate were the largest contributors to light extinction. Several trace metals, such as vanadium, nickel, selenium, arsenic, and lead, were also quantified; these metals are often found in industrial source emissions. Nitrate levels were negligible. Geological material, trace metals, and carbon are directly emitted by sources, while most of the sulfate forms in the atmosphere from directly emitted sulfur dioxide. Atmospheric geological material derives from paved road dust, unpaved road dust, and natural soils. Mobile source emissions are dominated by gasoline and diesel cars and trucks. Vehicle exhaust is a large contributor to $PM_{2.5}$ carbon in most areas and these emissions derived from a variety of conditions. Vegetative burning consists of accidental fires, planned agricultural burning, trash burning, and residential wood combustion. Residential wood combustion for heating is not a major source in the area during the summertime study period owing to high ambient temperatures. Meat cooking, either over coals or with compressed or natural gas, has a similar profile to vegetative burning unless specific organic compounds are measured.

A subset of point sources that can reasonably represent those that might contribute to particulate concentrations at Big Bend National Park will be tested. Variations for three separate power plant units using the same coal show the need to test several coal-fired boilers in an emissions area that have different combustion and pollution control configurations. In addition to power stations, coal is also combusted in steel and some cement operations for process heat and power generation. Residual oil is burned in power stations as well as for oil extraction, in ships at sea, and for petrochemical production. Steel production emissions are result from several different sources, including furnaces, sintering, and coking.

The types of industrial point sources that emit the most sulfur dioxide accompanied by particles with trace metals that can be determined at receptors for the study domain are coal combustion in power stations, cement kilns, and steel mills and residual oil combustion in power stations, petroleum extraction, cement kilns, ships, and refineries. The major industrial source of carbon is from coking emissions in steel mills; these may also be accompanied by trace metals in the coal ash.

Chemical Analyses

At a minimum the source samples need to be analyzed for the same species that will be obtained at the receptor sites. These includes mass concentrations to which other chemical components can be normalized, the elements Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Y, Zr, Mo, Pd, Ag, Cd, In, Sn, Sb, Ba, La, Au, Hg, Tl, Pb, and U by proton induced x-ray emission spectrophotometry and x-ray fluorescence (XRF), sulfate, nitrate, and ammonium by ion chromatography, and organic and elemental carbon by thermal optical reflectance. Teflon membrane and quartz fiber filters are used in parallel for these analyses.

In additional, carbon speciation for sources can be helpful for use in CMB modeling at receptor sites for which carbon speciation of ambient samples is done.

Criteria for Selecting Specific Sources

It is not possible to obtain source profile samples from every source within the BRAVO domain. Several criteria are set forth to select the source types and specific sources that need to be tested.

The first criterion is source types that are likely to contribute to $PM_{2.5}$ carbon, suspended dust, and sulfate. These are the largest contributors to excessive light extinction at Big Bend National Park. The largest source types with these components are: 1) gasoline vehicle-exhaust for carbon and some sulfate; 2) diesel vehicle exhaust for carbon and some sulfate; 3) vegetative burning for carbon; 4) cooking for carbon; 5) coking for carbon; 6) road dust for suspended dust; 7) windblown dust from deserts and playas for suspended dust; 8) coal combustion in a variety of industries for sulfate; and 9) residual oil combustion from a variety of industries for sulfate.

The second criterion is representatives of these source types that allow an average and standard deviation for chemical abundances to be estimated. For a limited number of samples, these representatives should be selected to maximize, rather than minimize, the conditions under which variability in fractional abundances are expected. As noted above, these will depend on fuel type, combustion process, and pollution controls.
The third criteria for industrial point sources is source types that have high sulfur dioxide emissions accompanied by high particulate emissions. The majority of sulfur emissions are accompanied by reasonably high particle emissions. The profiles derived from these tests may be more specific to the type of fuel burned (e.g. coal) than to the type of industry in which it is burned. The magnitude of these differences cannot be ascertained until after the tests are made.

The fourth criterion is access to effluent streams. For area sources such as open fields, playas, and roadways dust, different geological formations need to be visited and

sampled. This requires areas that are reasonably close to roadways. Paved road dust sampling requires permission to stop traffic for the short period necessary to acquire the sample. For mobile sources, locations are needed with permission to use them for locating source samplers and the generators to power them. For ducted emissions such as smoke stacks, a sampling platform of at least 3 m x 3 m is needed to accommodate the dilution sampler and personnel. Sampling ports of at least 7.5 cm diameters are needed to insert sampling probes, as is at least 20 amps of electrical power. Permission is needed for industrial sources as is a stairway or elevator to access the sampling platform.
The fifth criterion is cost-effectiveness. After the first four criteria are met, representative sources should be located in close proximity to each other to minimize travel, setup, and takedown time for the source testing technicians.

Source Sampling Selection

The following list of sources will be sampled as part of the BRAVO source characterization program.

Motor Vehicles: Roadside sampling will take place at several sites in both San Antonio and Laredo. A ground based sampling method will be used at intersections and overpasses to sample the cooled emissions from both cars and trucks. Proper site selection may permit the collections of profiles representing only diesel and only gasoline vehicles.

Vegetative Burning: Ground level source sampling of a prescribed burn will take place near Big Bend National Park. Fallen trees and vegetative debris will be assembled into a pile and set on fire. Either a mobile sampler or multiple samplers will be operated near the fire to collect the emissions. The mobile sampler will be moved during the burn so that it is always downwind of the fire. If multiple samplers are used, they will be configured to sample the plume over a range of likely wind conditions that occur during the burn.

Coal Fired Power Plants: Two coal fired power plants and an aluminum smelter that generate power via coal combustion will be sampled. These sources burn a variety of coal types and use multiple types of controls to reduce their emissions of both particulate matter and sulfur dioxide. The dilution tunnel will be used to sample these coal combustion sources. The samples collected will provide a range of source profiles that should be representative of most coal combustion facilities in the BRAVO study domain.

Cement Kilns: Cement Kilns use a variety of fuel sources to process limestone into cement. The most common fuel types include coal, hazardous waste, and tires. Two cement kilns will be sampled using the dilution tunnel to produce source profiles representative of this industry.

Refineries: Four crude oil refineries will be sampled using the dilution tunnel. The refineries are located across the state of Texas. These sources can be substantial emitters of SO_2, organic and elemental carbon particulates, VOC's, and NO_x. The source samples will assisting in distinguishing these sources from motor vehicle and other combustions sources.

Carbon Black: Texas is a major producer of carbon black which is used for manufacturing paints, plastics, and tires. The process involves the quenching of hydrocarbon fuel combustion to produce elemental carbon. Fugitive emissions of elemental carbon along with organic carbon are expected from this source. The dilution tunnel will be used to sample emissions at two carbon black facilities.

Cooking: Food preparation source samples will be collected for several types of cuisines including Mexican food, Chinese food, and Wood Smoke Barbeque. Caterers will be hired to prepare food at a special laboratory kitchen at the CE-CERT facility at the University of California, Riverside. A large platform with a fume hood mounted overhead is used to collect emissions from the food preparation activities. The dilution tunnel will be attached to the fume hood to samples these emissions. These source profiles will be added to an existing library of food preparation profiles that already include hamburger, steak, and chicken cooking sources.

4.5 Emissions Inventory

An emissions inventory (EI) is a critical component to air quality studies. The EI database stores the location, type, and rate of emissions for sources throughout the study domain. This database is used as input to air quality models that simulate the dispersion and chemical transformation of pollutants.

A comprehensive emissions inventory will be compiled for air pollution sources within the BRAVO study domain which includes Texas, New Mexico, Oklahoma, Arkansas, Louisiana, and sources in Mexico north of Mexico City. The emissions inventory database will be spatially resolved in order to identify the location and density of sources. The inventory will document emissions of SO_2, NO_X, PM_{10}, and VOC's. Within the database, all emissions data will be linked to the data provider so that the information can be traced back to its origin. Generally source types in the emissions inventory will be grouped as:

- Point Sources: Large, stationary, identifiable sources with total annual emissions greater than some predefined cutoff. Sources include both stack emissions as well as unconfined fugitive emissions. Examples include large manufacturing or production plants.

- Area Sources: Smaller sources that do not qualify as point sources under the relevant emissions cutoffs. Emissions are estimated as a group rather than individually. Examples include dry cleaners, residential wood burning, and consumer solvent use.

- Mobile Sources: All non-stationary sources such as automobiles, trucks, aircraft, trains, construction, and farm equipment.

Data for the EI will be compiled from the following list of data providers:

Texas Natural Resource Conservation Commission (TNRCC)

TNRCC has assembled an EI for the state of Texas using 1996 as the base year. The EI is divided into point, area, and mobile sources. Area and mobile sources are aggregated by county and quantified by individual source types (e.g. light duty gas vehicles, dry cleaners, restaurants, etc.). Emissions of VOC's, NO_X, and CO are reported for the area and mobile sources. Emissions estimates reported are actual emissions as opposed to the permitted emissions.

The point source EI catalogs emissions from point sources in Texas for TSP, PM_{10}, SO_2, NO_X, NMOC, CO, and Pb. Both permitted and actual emissions are reported. The base year of this inventory is 1997. All sources with criteria pollutant emissions (including VOC's) greater than 100 tons per year are required to be included in the EI. In ozone non-attainment areas, the criterion for a source to report emissions to TNRCC is less than the 100 tons per year limit. Therefore, smaller sources are also included in the EI in the ozone non-attainment areas.

Minerals Management Service

An emissions inventory MOAD3 (Minerals Management Service Outer Continental Shelf Activity Database) was created using 1993 as a base year. The EI catalogs emissions from the development of petroleum resources in the Gulf of Mexico. Sources include platform, crew/supply vessel, and helicopter emissions. Emissions of CO, SO_X, NO_X, PM, and VOC's are reported for activities in the gulf. An updated emissions inventory is currently being prepared using a more recent base year. These results will be incorporated with the BRAVO EI database if the data can be obtained in a timely manor.

Environmental Protection Agency: AIRS Facility Subsystem

The AIRS facility subsystem (AFS) archives emissions data for all permitted facilities operating in the United States. Data is submitted to AIRS from the state regulatory offices on an annual basis. AFS archives emissions of all criteria pollutants including VOC's as well as the facilities geographic coordinates, street address, facility type, and point of contact. A point source EI will be downloaded from AFS for all facilities operating in Texas, New Mexico, Oklahoma, Louisiana, and Arkansas.

Environmental Protection Agency: National Emissions Trends Database

The Office of Air and Radiation produces the National Emissions Trends (NET) database. Emissions estimates of criteria pollutants are derived from many factors, including the level of industrial activity, technological changes, fuel consumption, vehicle miles traveled, and other activities that affect air pollution. As of 1994, the annual NET EI incorporates NO_X and SO_2 data from the Continuous Emissions Monitors operating at electric utility facilities.

Environmental Protection Agency: Continuous Emissions Monitors

Under Title IV of the 1990 Clean Air Act, electric utilities must report hourly emissions of SO_2 and NO_X to EPA on a quarterly basis. Continuous Emissions Monitors (CEM's) are installed at these facilities and provide accurate high time resolution data suitable for use in air quality modeling. Hourly data from all CEM's operating in the study region will be included into the BRAVO EI database.

Western Governor's Association: Visibility Assessment of Regional Emissions Distributions

An EI was developed for the Grand Canyon Visibility Transport Commission to assess the sources of haze observed at Grand Canyon National Park. The EI compiled data from EPA's 1990 Interim Inventory with data from the AFS. Addition emissions from large sources in Mexico were also included. The primary study domain includes the 11 western states, Texas, southwestern Canada, and northern Mexico. Emissions of SO2, VOC, NO_X, NH_3, $PM_{2.5}$, CO, and organic and elemental carbon particulates were reported for point sources and mobile and areas sources aggregated by county. The base year of the inventory is 1990. Emissions are summarized as seasonal average weekday emissions and annual average emissions.

Instituto Nacional de Ecologia (INE)

A comprehensive emissions inventory for Mexico is currently being prepared in a bi-national effort with Mexico and the United States. The inventory will not be completed for several years and therefore the emissions data will not be available for inclusion in the BRAVO inventory. Emissions data that is available for Mexico includes point, area, and mobile emissions for the cities: Mexico City, Toluca, Guadalahara, and Monterrey. Additional data from industrial and mobile sources are also available from 16 other cities. Emissions inventories are quantified for PM, SO_2, CO, VOC's, and NO_X with at a base year of 1994. Emissions from major SO_2 point sources outside of these cities (e.g. Carbon I/II Power Plant and Nacozari and Canenea Copper Smelters) are not publicly reported by INE. This is a limitation of the emissions inventory for Mexico. As a result many Mexican sources may not be cataloged in the BRAVO EI database.

Environmental Protection Agency: Atmospheric Modeling Division

A computer model Biogenic Emissions Inventory System (BEIS) incorporates land use and meteorological data to estimate emissions of VOC's from plants (Pierce and Waldruff, 1991). The model has since been updated (BEIS2) to also account for NO emissions from soils. BEIS was applied for the 1997 base year and aggregated by county for the contiguous United States. Emissions are estimated on a daily basis.

National Interagency Fire Center

The National Interagency Fire Center tracks the location and size of both prescribed and wild fires in the United States. A database of the dates, location, area (for wild fires), and fuel mass (for prescribed fires) of all recorded fires in Texas, New Mexico, Oklahoma, Arkansas, and Louisiana will be obtained for dates corresponding to the BRAVO study period. The U.S.E.P.A. emissions estimation protocol in AP-42 publishes prescribed and wild fire emissions factors for CO, VOC's, NO, and PM (i.e. $PM_{2.5}$). These factors are likely to be highly uncertain since other parameters such as wind speed, moisture content, fuel type, and fuel loading may not be well characterized for each fire

Data Processing

All emissions data will be processed into a spatially and (where possible) temporally resolved database. These database will be displayed as individual coverages in ArcView GIS software. When inventories are redundant (i.e. point sources in Texas are listed in both the TNRCC EI and the AFS EI), a judgment will be made to use data from the source that originally collected the data. Only the most recently collected emissions data will be used for the final BRAVO EI. The final database will list each pollution source along with the data provider so that all data may be traced backed to its source. When complete, the EI will be in a format that can be gridded so it may be used as input for dispersion modeling.

4.6 Aircraft Measurements

Aircraft measurements will be made by Baylor University in coordination with TNRCC. The flight paths of interest for BRAVO include transport of continental haze over Texas toward Big Bend National Park (over Texas Gulf coast and east Texas interior areas), and Transport along and across the US Mexico border towards Big Bend. Flights will be schedules when forecast back-trajectories show the conditions of interest likely to occur. Flights will occur on 2- 3consecutive days tracking air masses of interest as they approach Big Bend National Park.

The Baylor Aircraft will measure the following variables:

- Light scattering (nephelometer) 5 second data
- SO_2 1 second
- Sulfates 1 second
- NO, NO_2, NO_Y (1 second)
- temperature, relative humidity, barometric pressure (1/5 second)
- Altitude, location (1/5 second)