SOS NASHVILLE 1999
MEASUREMENT PLAN

May 1999

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STUDY THEMES

The field campaign planned for the summer of 1999 is intended to provide a better understanding of the basic chemical, meteorological, and transport processes that determine ozone and fine particle distributions and new information to assist policy-makers in devising optimal ozone and PM management strategies. These studies are encompassed in three broad themes.

Local vs. Regional – Regional Contrasts

The first area of investigation addresses whether ozone or fine particle pollution is a regional or a local problem. The range provided by the WP-3D and the G-1 allows the composition of the atmosphere in a particular location to be placed in a regional perspective. Even though the concentration of ozone and fine particles can be elevated over large areas, it is still an open question how much of either ozone or fine particles are produced locally and how much are produced remotely and then transported to a particular locale.

Although the study will be centered in the Nashville/Middle Tennessee area flights are planned for the Upper Midwest where meteorological conditions and the mix of ozone and PM-precursor emissions are expected to be significantly different than in the Southeast. These measurements will build on previous NOAA studies in Colorado and the Midwest and the recent BNL study in Phoenix.

Ozone and PM formation in Plumes

The second area of investigation relates to if and how ozone or fine particles observed in a particular location can be attributed to a particular source of precursor compounds located among a complex matrix of precursor sources. An ideal setting to address this question is an isolated urban area set in a rural background with several large point sources of pollution (e.g., fossil fuel burning power plants) imbedded at various distances with a wide range of pollutant emission. Under certain general flow conditions the plumes of the power plants merge with each other and/or the urban plume; in others they don't. Hence, the synergism associated with the interaction of power plants plumes, urban plumes, and the regional background can be investigated under a variety of conditions and in various combinations. As the dimensions of the urban complex grows the magnitude of the problem becomes greater. A second aspect of interaction involves the relation of ozone pollution to fine particle pollution. To date, ozone pollution has been largely treated as a local or sub-regional problem, while fine particle pollution has been viewed as a local problem from the health-effects perspective and a regional problem from the visibility perspective. The co-variation of these pollutants has never been extensively investigated, particularly on the regional scale.

The study of the evolution of the pollutant mix in plumes is particularly useful in the determination of pollution formation kinetics. The advection of plumes into a reasonably uniform background airmass provides a convenient "clock" allowing the quantification of the chemical rates that are critical to model development and evaluation.

Diurnal Cycle in Chemistry and Meteorology

In the overwhelming majority of cases, intensive field studies have targeted the study of daytime chemistry and dynamics. This interest is driven by a recognition of the important role that photochemistry plays in secondary pollutant formation and a concern for the impacts associated with daytime pollution exposures for both humans and plants. The pollutant mix can be significantly affected by non-photochemical reactions that occur at night. The results of the 1995 SOS field study in Nashville highlighted the importance of nighttime mixing processes in the redistribution of pollution throughout the region.

This field study offers the opportunity to document the entire diurnal cycle of chemistry and meteorology over one or more complete consecutive diurnal cycles using both surface-based and airborne observations. Information will be developed on processes that are not well described in current models. The measurements will help us understand how rural daytime chemistry, which establishes the residual convective mixed layer above the nocturnal boundary layer, ultimately is coupled to the daytime urban photochemistry that establishes peak ozone and PM levels in urban areas. Similarly, we will learn how daytime urban pollution affects rural air quality on the following day.

A comprehensive measurement program has been developed to address the science objectives imbedded in the study themes described above. The final measurement program reflects the work of the various planning teams over the past year. What follows is a detailed description of the measurement assets that will be deployed along with a description of the measurement strategy that is planned.

INSTRUMENTED AIRCRAFT

The four heavily instrumented aircraft participating in the study will be used to characterize the three-dimensional distribution of pollutants and track the transformation and removal of these pollutants over time. The four aircraft have widely varying capabilities. Three of the aircraft (NOAA WP-3D, DOE G-1, and TVA Bell 205) will make *in situ* measurements mainly in the atmospheric boundary layer; the fourth (NOAA CASA 212) will make remote-sensing measurements from above the boundary layer. The NOAA WP-3D and the DOE G-1 have sufficient range and endurance to survey large areas. This provides the opportunity to contrast the pollutant mix and meteorology in vicinity of Nashville to that of the Midwestern U.S. The TVA Bell 205 helicopter will be used to obtain detailed chemistry measurements over the urban area and in power plant plumes. The NOAA CASA 212 is equipped with instrumentation to remotely sense ozone, aerosols and surface temperature. The aircraft participating in the study are listed below along with the affiliations of the groups providing the aircraft and a description of the installed instrumentation.

CASA 212-200: Private vendor /NOAA Environmental Technology Laboratory

Endurance:	4.5 hr
Ceiling:	3.5 km
Payload:	<2700 kg
Research Speed:	65-100 m/s

Table 1. Aircraft Instrument Package for the NOAA CASA 212-200

Parameter	Time Resolution	Vertical Resolution	Method	Det. Limit
Ozone	3-8 s	90 m	DIAL Lidar	4-10 ppb
Aerosol Backscatter	3-8 s	15 m	DIAL Lidar	5×10^{-6} $m^{-1}sr^{-1}$
Surface Temp.	1 s	NA	IR Radiometer	0.2 ^{o}C

Lockheed WP-3D Orion: NOAA Aircraft Operations Center / NOAA Aeronomy Laboratory

Endurance:	10 hr
Ceiling:	7.6 km
Payload:	>2700 kg
Research Speed:	100-150 m/s

Table 2. Aircraft Instrument Package for the NOAA WP-3D Orion

Parameter	Time Resolution	Method	Det. Limit
Ozone (O_3)	10 s	UV Absorption	1 ppb
Fast O_3 (FO_3)	1 s	NO/O_3 Chemiluminescence	0.2 ppb
Fast CO (FCO)	1 s	VUV Resonance Fluorescence	25 ppb
Carbon Dioxide (CO_2)	≤ 1 s	NDIR	0.2 ppm
Sulfur Dioxide (SO_2)	2 s	UV Pulsed Fluorescence	1 ppb
Nitric Oxide (NO)	1 s	NO/O_3 Chemiluminescence	30 ppt
Nitrogen Dioxide (NO_2)	3 s	Photolysis, NO/O_3 Chem.	100 ppt
Total Nitrogen Oxides (NO_y)	1 s	Au Converter, NO/O_3 Chem.	50 ppt
PAN	1 s / every 6 min	Dir. Injection, GC/ECD	< 5 ppt
PPN	1 s / every 6 min	Dir. Injection, GC/ECD	< 5 ppt
MPAN	1 s /every 6 min	Dir. Injection, GC/ECD	< 5 ppt
Nitric Acid (HNO_3)	1 s	C I Mass Spectrometry	10 ppt
NH_3	5 s	C I Mass Spectrometry	50 ppt
In-situ VOCs	1 min./every 15 min	Cryo Collection, GC/FID	< 10 ppt
Canister VOCs	<1 min.	Canister Sampling, GC/MS	< 10 ppt
CH_2O		Liquid Chromatography	
Peroxides (incl. H_2O_2)	1 min	Dual Enzymatic / Fluorimeter	30 ppt
Aerosol size distribution	1 s	NMASS	5 - 90 nm
Aerosol size distribution	1 s	ERAST	70 - 1000 nm
Total Radiation	1 s	Eppley Pyranometers - Zenith & Nadir	0.28 – 2.8 μ
UV Radiation	~10 s	Spectral Radiometer - Zenith & Nadir	295- 480 nm
Visible Radiation		Visible Absorption Spectrometer	420 – 700 nm
Water Vapor (H_2O)	1 s	Lyman Alpha Absorption	
Air Temperature	1 s	Platinum Thermistor	
Dewpoint/Frostpoint	≤ 3 s	Chilled Mirror	
Wind Speed	1 s	Derived from INE	
Wind Direction	1 s	Derived from INE	
Altitude	1 s	Barometric	
Position	1 s	GPS, INE	
Air Speed	1 s	Barometric	
Biometer		3-wavelength IR Absorption	
Atmospheric Reflectivity		C & X Band Radars	

Grumman G1: DOE Pacific Northwest National Laboratory

Endurance: 6 hrs
Ceiling: 3.5 km
Payload: 1300 kg
Research Speed: 100 m/s

Table 3. Aircraft Instrument Package for the DOE Grumman G-1

Parameter	Time Resolution	Method	Det. Limit
Ozone (O_3)	10 s	UV Absorption	25 ppb
Carbon Monoxide (CO)	20 s	NDIR	20-25 ppb
Fast CO (FCO)	5 s	VUV Resonance Fluorescence	5 ppb
Sulfur Dioxide (SO_2)	2 s	UV Pulsed Fluorescence	200-300 ppt
Nitric Oxide (NO)	<10 s	NO/O_3 Chemiluminescence	20 ppt
Nitrogen Dioxide (NO_2)	<10 s	Photolysis NO/O_3 Chem.	50 ppt
Nitrogen Dioxide (optional)	<10 s	Luminol Chemiluminescence	0.015 ppbv
Total Nitrogen Oxides (NO_y)	<10 s	Mo Converter. NO/O_3 Chem.	300-400 ppt
PAN	1 sample/7 min	Cyrogenic GC	15 ppt
CH_2O (optional)	Continuous (1min delay)	Fluorescence	100 ppt
PAN	4 s	Tandem Mass Spectrometry	400 ppt
HNO_2	4 s	Tandem Mass Spectrometry	400 ppt
HNO_3	4 s	Tandem Mass Spectrometry	400 ppt
NH_3 (optional)	4 s	Tandem Mass Spectrometry	~2 ppb
Formic/Acid acids (optional)	4 s	Tandem Mass Spectrometry	100 ppt
Canister VOCs		Canister Sampling, GC/FID	0.1 ppbv
b_{scat}	1 s	Nephelometer	0-103/Mm
Aerosol size distribution	1 s	PCASP	(0.17 - 3μm)
Aerosol size distribution	1 s	FSSP	(2 – 47 μm)
Particle Number	1 s	CNC (two)	(>7 nm, >3 nm)
UV Radiation	1 s	Eppley Pyranometer	(295-385 nm)
Short-wave Irradiance	1 s	Eppley PSP	(285-2800 nm)
Long-wave Irradiance	1 s	Eppley PIR	(4-50 microns)
Water Vapor (H_2O)	1 s	Lyman Alpha Absorption	±0.1 g m^{-3}(est.)
Air Temperature	1 s	Platinum Resistance	±0.5 ^oC
Dewpoint/Frostpoint	1 s	Chilled Mirror	D.P. ±0.2 ^oC, F.P. ±0.4 ^oC
Wind Components (u-,v-,w-)	1 s	Gust Probe	<0.5 m s^{-1}
Altitude	1 s	Barometric	<1mb
Position	1 s	GPS	<3m
Air Speed	0.1 s	Barometric	<20 cm s^{-1}

Bell 205 Helicopter: TVA Environmental Research Center

Endurance:	2 hr
Ceiling:	2.5 km
Payload:	500 kg
Research Speed:	40-50 m/s

Table 4. Aircraft Instrument Package for the TVA Bell 205 helicopter

Parameter	Time Resolution	Method	Det. Limit
Ozone (O_3)	1 s	NO Chemiluminescence	2 ppb
Carbon Monoxide (CO)		NDIR or HgO reduction	
Sulfur Dioxide (SO_2)	5 s	UV Pulsed Fluorescence	0.5 ppb
Nitric Oxide (NO)	1 s	NO/O_3 Chemiluminescence	1 ppb
Nitrogen Dioxide (NO_2)	5 s	Photolysis, NO/O_3 Chem.	1 ppb
Total Nitrogen Oxides (NO_y)	1 s	Au Converter, NO/O_3 Chem.	1 ppb
NO_y*	1 s	NO_y detection + Nylasorb Filter	1 ppb
Canister VOCs	1 min	Canister Sampling, GC/FID	
b_{scat}	5 s	Nephelometer	$<10^{-6}$ m^{-1}
Aerosol Size Distribution	1 s	PCASP	(0.17 - 3μm)
Particle Composition	variable	Filter Pack, IC analysis	
Particle Composition by Size	variable	Anderson Cascade Impactor	
Air Temperature	5 s	Platinum Thermistor	
Dewpoint	5 s	Capacitance Sensor	
Altitude	5 s	Barometric	
Position	5 s	GPS	
Air Speed	5 s	Pitot- Static Pressure	2 m/s
Heading	5 s	Flux Gate Compass	0.5 deg.

The use of these aircraft will be carefully coordinated to take the maximum advantage of their diverse capabilities and the flight time available. The planned flights fall into the following categories:

Intercomparison Flights

The use of four aircraft and the diversity of the instrumentation flown on these platforms make a thorough intercomparison of the various instruments/measurements mandatory. These intercomparisons are especially important since the aircraft resources will be used in a complementary manner. We envision staggered deployment of some platforms (either on the same day and/or by flying alternating platforms on consecutive days) in order to extend the time coverage of the measurements. The planned intercomparisons

will enhance the value of the accumulated data sets and assure the compatibility of the data collected on the various platforms.

The intercomparison flights will be held as early as possible during the study as possible bearing in mind that the NOAA WP3 may be delayed. The intercomparison between the WP3 and DOE G1 will be held as soon as the WP3 arrives in Nashville. The intercomparison of instruments will follow the protocol that has been determined by the intercomparison committee for each of the measurement families (i.e., NOy species, NMHCs, aerosols, etc.). The investigators are requested to report the data for their instruments within 48 hours following these flights. The data will be put into a common format and correlation plots made. The principle investigators will be shown this data. The results of the preliminary data evaluation will be reported to a Science Meeting to be held the following day (72 hours after the intercomparison flight). This meeting will discuss the quality of the agreement, determine if additional intercomparisons are needed and discuss when and how the additional comparison flights are to be carried out.

In discussing the intercomparisons, it was noted that for the most part, intercomparison with the ground site would be the purview of the helicopter. The overlap between the fixed wing aircraft and the ground would not be sufficient constrained to be useful. There were three exceptions noted to this:

- The comparison between ozone and aerosol measurements and those made by the ground based NOAA ETL lidar would be very valuable in testing the lidar measurements.
- The comparison between ozone and aerosol measurements made by the airborne NOAA ETL lidar and the measurements made at the surface by the NOAA ground-based lidar and the *in-situ* instruments would be very valuable in testing the airborne lidar measurements.
- The comparison between the DOAS measurement of NO_2, O_3, SO_2, and HONO with the simultaneous aircraft measurements and the ground-based measurements of those quantities would be extremely helpful.

Regional Flights

Flights are planned for the NOAA WP3 into the Upper Midwest and the Gulf Coast. The measurements performed on these flights will provide a significant contrast to those performed in the Nashville/Middle Tennessee area. In particular, the lower biogenic VOC emissions and higher sulfur emissions that characterize the Midwestern U.S. provide a departure from conditions in Tennessee with anticipated impacts on ozone and PM formation.

The CASA lidar aircraft will perform a number of flights to document variability in the depth of the mixed layer and its relationship to land use.

Urban Studies

With the development of a comprehensive suite of measurements at the Cornelia Fort ground site to investigate the photochemical processes responsible for the formation of ozone and fine particles, the use of aircraft to augment these ground measurements was discussed. The TVA helicopter and the NOAA Casa 212 were identified as particularly valuable additions to the ground studies. Profiles for the helicopter and transect flight plans for the Casa have been developed. The helicopter would be particularly used in providing data to characterize the rise of the PBL through the morning. The limitation of flight hours for the helicopter is a problem.

Diurnal Plume Studies

It is recognized that improved understanding of atmospheric processes requires significant new information concerning the chemistry and transport that influence ozone and fine-particle precursors throughout the diurnal cycle. The DOE G1 has been committed to investigating plume processing during the night. The NOAA WP3 and CASA 212 will compliment the G1 measurements in the following ways. The WP3 will focus its flights principally during the day. However, some of the flights will commence in the late after noon and follow the plumes into the night. In addition, a limited number of WP3 flights will commence in the early morning during the breakup of the nocturnal boundary layer in order to investigate the transition from night to day. The CASA will undertake to identify the location of the plumes during the late afternoon and occasionally at night to allow the other aircraft to find the plumes more readily. The planning group felt that the point-source plumes from power plants would be most easily found and tracked for a significant fraction of the diurnal cycle. By contrast, urban plumes may prove to be too dispersed to follow successfully during the nighttime hours.

Weather forecasts will be provided by the University of Northern Alabama. These will give indication of the meteorological condition most conducive for the plume investigations. In addition, was-casts will be made by UNA from the profiler network data and provided to the aircraft to allow aircraft to more easily predict the plume path between transects.

Table 5. Planned allocation of aircraft flight time.

Aircraft	Total hrs.	Intercomparison	Diurnal	Urban	Regional
CASA	**64**	**4**	**20***	**26**	**14**
WP-3	**100**	**4**	**37**	**20****	**39**
G-1	**50**	**3**	**35**	**12**	**0**
Bell 205	**40**	**2**	**29***	**9**	**0**

*Primarily power plant plume studies

** Includes midday flights in Nashville and measurements in the Atlanta plume

Flight Planning

The nominal schedule for the aircraft follows a pattern of flights every other day. Based on this pattern flight planning is done on the following schedule.

1. No-fly days

A meeting of the principle investigators for each flight will be held at 8:00AM CDT on the no-fly days. The principle objectives of the meetings on no-fly days is to review the finding from the preceding flight and initial planning of next flights. The science objectives of the next flights and the possible coordination of aircraft will be determined based on long-range forecasts and measurement needs as identified at this meeting. Instrument and/or aircraft problems that may impact the upcoming missions will be discussed.

Flight plans for flights must be filled with the FAA in Nashville before 4:00PM CDT on the day preceding a planned flight.

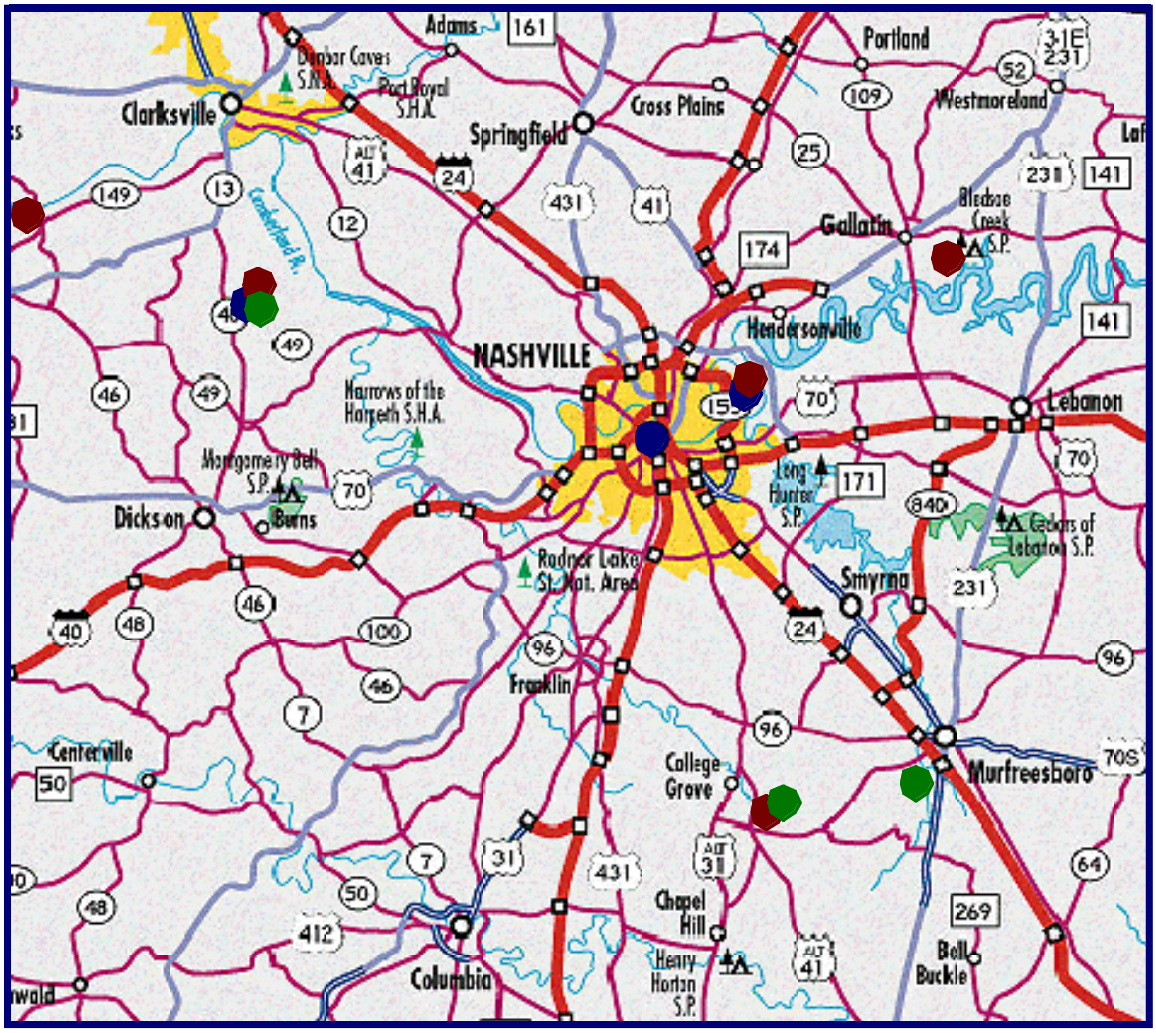
2. Flight days

A meeting of the principle investigators for each flight will be held at 7:00AM CDT on flight days. The principle objectives of the meetings on no-fly days are to review the flight plans determined on the preceding day. The science objectives of the flights and the possible coordination of aircraft will be finalized based on now-casts and instrument/aircraft readiness.

GROUND-BASED MEASUREMENT NETWORK

An extensive series of ground-based measurements are planned in addition to the aircraft measurements described above. These measurement include a comprehensive network of meteorological measurements as well as three heavily-instrumented chemistry sites. The location of the various ground-based measurement sites is shown in the figure below.

Figure 1. Ground-based measurement networks.



Surface Flux Network

NOAA/ATDD (Tilden Meyers) will set up three energy balance/flux towers within and around the SOS study area. The sites selected areas follows: 1 the Dickson area over a deciduous forest, 2. South of Nashville near Eagleville over grass, and 3. southeast of Nashville, near Murpheysboro, either over pine or agricultural crop.. NOAA/ETL will operate a second flux site near the Dickson monitoring site in an open pasture.

The eddy covariance method will be employed to measure turbulent fluxes of momentum, sensible and latent heat fluxes, the components of turbulent kinetic energy ($\overline{u'^2}$, $\overline{v'^2}$, $\overline{w'^2}$), and the mean wind vector. The vertical turbulent fluxes of O_3 and CO_2 will also be determined. Mean state variables will include net and global radiation, incoming and reflected visible radiation, the ground heat flux, soil moisture at two levels (10 cm and 30 cm zones), soil temperature at seven levels (0,2,4,8,16,32 and 64 cm), precipitation, surface wetness, air temperature and relative humidity, surface or 'skin' temperature, and barometric pressure. The systems will be in continuous operation from the beginning of June until the end of the experimental period (mid July). The initial averaging period will be 30 minutes for both the turbulent quantities and the mean state variables. The data acquisition system will be cell-phone linked to Oak Ridge, and processed data for the previous day ending at midnight will be made available to SOS Science team members by 9 am LST the next morning via FTP or e-mail standard protocols. This near real-time processing allows for detection of equipment failure and immediate repair if necessary. Instantaneous data (fast response, 10 Hz) may be logged periodically or on a routine basis, if needed. Measurements of the leaf area index (LAI), plant height, and stomatal conductance will be obtained at least on a weekly basis during the experimental period.

Wind Profiler Network

The profiler network will consist of five profilers: AL (Angevine) will deploy one at the Cornelia Fort Air Park chemistry site for several months before, during, and after the campaign. ETL will deploy three in a roughly equilateral triangle surrounding Nashville. One of the ETL profilers will be at Dickson, the second at TVA's Gallatin power plant, and the third at Eagleville. The UAH profiler will be located at TVA's Cunberland power plant. Several of these sites will also have laser ceilometers.

The profilers will operate at 60 m resolution in space and approximately 30 s resolution in time. Vertical beam measurements will be emphasized, with a vertical beam every third measurement (every 90 s). RASS will be run for 5 minutes every half hour. The profilers will operate in the same mode at all times around the clock, unless some sites require that RASS not be run at night.

The Cornelia Fort profiler is primarily intended to provide meteorological measurements in support of the extensive set of chemistry measurements being made at that site. It will be aided in that role by a the presence of SODAR array, a S-band radar, and a doppler lidar (mini-MOPA) operated by NOAA/ETL at that site. The three ETL profilers will be employed in a mesoscale flux experiment, using the network as a coupled array. The locations of the Cumberland (UAH) and Dickson (NOAA/ETL) profilers will allow co-spectra to be calculated between the two profilers. This co-spectra is important in defining the mesoscale energy that is important in sustaining plume growth rates. This network of profilers will allow the investigation of variations in mixed layer heights in the region where many of the aircraft flights will be conducted. The profiler observations

will also be used in conjunction with coupled boundary layer Lagrangian particle models to predict plume transport and dispersion as an aid in flight planning.

Chemistry Measurements

In addition to the monitoring networks that are already in place in the Middle Tennessee study region, three additional sites have been selected for the 1999 field intensive study period that will have more extensive measurement capabilities. In keeping with previous nomenclature, these sites will be designated as either Level II (two locations) or Level III (or "Super Chemistry"; one location. A detailed description of each site follows.

Polk Building:
The James K. Polk building is located in the center of downtown Nashville. Sampling is performed from a 5-meter tower attached to the roof of the building. The sampling inlet is 110 meters above street level. This site recorded the highest ozone concentration (138 ppb, 1-hr) of any ground site during the 1994/1995 study. This is intended primarily as a means of documenting the urban source signature for the Nashville urban area. However, as is evidenced by the 1995 experience, significant photochemical activity can also occur in the vicinity of this site, especially under stagnation conditions.

Table 6. Chemical and meteorological measurements at the Polk building site.

Parameter	Frequency	Investigator
O_3	**1-min., 24 hr**	**TVA (Olszyna)**
NO, NO_2, NO_y	**1-min., 24 hr**	**TVA (Olszyna)**
CO, SO_2	**1-min., 24 hr**	**TVA (Olszyna)**
VOCs	**5min (8/day)**	**ANL (Doskey)**
CH_2O	**1-min., 24 hr**	**EPA (McClenny), BNL (Kleinman)**
wind speed, wind dir.	**1-min., 24 hr**	**TVA (Olszyna)**
temp., RH, solar rad	**1-min., 24 hr**	**TVA (Olszyna)**

Site Manager – Ken Olszyna, TVA

Dickson:
This site is located in an area of mixed deciduous forest and pastureland approximately 53 km WNW of the center of Nashville. This site serves as an upwind/rural site. The summertime synoptic flow in this part of the country is predominately from the southwest. Therefore, this site is only rarely impacted by the Nashville urban plume. The site is occasionally impacted by the plumes from TVA's Cumberland and Johnsonville power plants located to the northwest and southwest respectively. The major emphasis of the measurements conducted at this site will be the study of rural photochemistry, with a focus on isoprene chemistry.

This site is also well instrumented for atmospheric dynamics studies. There will be two surface flux measurement experiments (one over the forest canopy, one in a nearby pasture) adjacent to this site. There will also be a moored balloon with meteorological sensors attached at various heights and a wind profiler located at this site. These measurements provide a unique opportunity to study the complex dynamics associated with rural areas with complex mixtures of landuse.

Sampling at Dickson will be through a common manifold with an inlet loacated at 10 meters.

Table 6. Chemical and Meteorological measurements at the Dickson site.

Parameter	Frequency	Investigator
O_3	**1-min., 24 hr**	**TVA (Olszyna)**
NO, NO_2, NO_y	**1-min., 24 hr**	**TVA (Olszyna)**
CO, SO_2	**1-min., 24 hr**	**TVA (Olszyna)**
VOCs (canister)	**5-min, 1/day**	**EPA (Lonneman)**
Oxygenated VOCs		**NCAR (Apel)**
Isoprene and oxidation products		**Purdue (Shepson)**
PANs, Alkyl nitrates		**Western Mich. (Bertman)**
Aerosol mass (FRM)	**24 hr**	**TVA (Olszyna)**
Aerosol speciation	**12 hr**	**GIT (Bauman)**
Surface Fluxes (canopy)		**NOAA/ATDD (Meyers)**
Surface Fluxes (pasture)		**NOAA/ETL (Neff)**
Wind profiler		**NOAA/ETL (Neff)**
Tethered Balloon		**NOAA/ETL (Neff)**
wind speed, wind dir.	**1-min., 24 hr**	**TVA (Olszyna)**
temp., RH, solar rad	**1-min., 24 hr**	**TVA (Olszyna)**

Site Manager – Ken Olszyna, TVA

Cornelia Fort Air Park:

The Cornelia Fort Air Park is located 8-9 km to the northeast of the Polk office building site. The nearest major roads from the prevailing wind direction (SW) are 4-6 km away, which represents 1-2 hours of photochemical processing (and mixing) time. However, easterly wind will bring air from a major thoroughfare (SH 155) that is only 1 km distant. The airport is privately owned, serves mostly small private aircraft, and encompasses a large area adjacent to the Cumberland River, directly across from Opreyland. The area is mostly open and flat with some small stands of forest interspersed.

This will be our "Super" chemistry site. It was selected to be at, or near, the point of maximum ozone formation rate under normal summertime advection (winds 3-10 m/s). This site will host several major experiments, a few of which are described below.

Ozone Photochemistry – The focus of this effort is on characterizing the rate of ozone formation and the parameters that influence it. The wide variety of measurements will allow a true "radical closure" experiment. The atmospheric concentration of peroxy radicals (and therefore the rate of ozone formation) will be estimated three ways:

1. Direct measurement of HOO radicals.
2. Determination of ROO levels using the chemical amplifier technique.
3. Estimation of ROO by the photostationary state deficit technique.

The results of these efforts will be compared to results from model simulations. These individual measurements and their combined analysis will provide an important evaluation of our ability to determine this key parameter.

The multiple methods that will be used at the Cornelia Fort site will also provide an opportunity for informal measurement intercomparisons for VOCs, NO_2, and formaldehyde.

The site will also have a wide array of aerosol measurements. These data will afford the opportunity to provide information on the species that constitute the fine aerosol mass and contrast these measurement with regional values. The fast response speciation measurements will provide valuable insights into the dynamics of human exposure and source/receptor relationships for fine particles and their gaseous precursors. Particular emphasis will be placed on the quantification and speciation of the semi-volatile organic fraction of the fine particle mass.

Another focus of the measurements planned for the Cornelia Fort site is the characterization of the nocturnal boundary layer. A variety of high-resolution remote sensing instrumentation is being deployed to accomplish the objectives of this research.

Table 7. Chemical and meteorological measurements at the Cornelia Fort site.

Parameter	Frequency	Investigator
O3 UV abs	**1 min – 24 hr**	**AL (Williams)**
O3 NO Chemi.	**1 min – 24 hr**	**AL (Williams)**
NO, NOy	**1 min – 24 hr**	**AL (Williams)**
CO	**1 min – 24 hr**	**AL (Williams)**
SO2	**1 min – 24 hr**	**AL (Williams)**
NO2 (photolytic)	**1 min – 24 hr**	**AL (Williams)**
NO2 (photolytic)	**1 min – 24 hr**	**EPA (McClenny)**
NO2 (LIF)	**1 min – 24 hr**	**UC Berkley (Cohen)**
ROO (amplifer)	**1 min – 24 hr**	**TVA (Tanner)**
HO, HOO	**1 min – 24 hr**	**PSU (Brune)**
VOCs C2-C8 (FID-GC)	**5 min 12/day**	**Ohio U. (Young)**
VOCs C2-C12 (GC-MS)	**1 hr**	**EPA (McClenny)**
Aromatics, Aldehydes (CIMS)		**U. Innsbruck (Hansel)**
CH2O (Dasgupta)	**5 min – 24 hr**	**EPA (McClenny)**
CH2O (tunable diode laser)	**1 min – 24 hr**	**NCAR (Fried)**
Oxygenated VOCs		**NOAA/AL (Stroud)**
Peroxides		**NOAA/AL (Jobson)**
PAN, PPN, MPAN		**NOAA/AL (Roberts)**
O3/aerosol profiles		**NOAA/ETL (Hardesty)**
PM2.5 Mass	**15 min 24 hr**	**TVA (Tanner)**
Filter speciation	**1-hr 4/day**	**NOAA/AL (Norton)**
NO3, SO4, C	**5 min – 24 hr**	**ADI (Hering)**
EC/OC	**15 min – 24 hr**	**EPA (Stockburger**
Particle size distribution		**EPA (Stockburger)**
b absorption	**15 min –24 hr**	**EPA (Stockburger)**
SVOC	**12 hr daily**	**EPA (Stockburger)**
Carbon isotope	**12 hr daily**	**EPA (Lewis)**
MOUDI Impactor, speciation	**12 hr daily**	**EPA (Stockburger)**
Wind / temp profiles		**NOAA/Al (Angevine)**
SODAR array		**NOAA/ETL (Neff)**
S-band radar		**NOAA/ETL (Neff)**
Doppler winds (mini-MOPA)		**NOAA/ETL (Hardesty)**
Water vapor profiles (mini-MOPA)		**NOAA/ETL (Hardesty)**
Wind speed, wind direction		**NOAA/ETL (Neff)**
RH, Solar		**NOAA/ETL (Neff)**
Spectral Radiometer		**NCAR (Shetter)**

Site Manager – Eric Williams, NOAA/AL

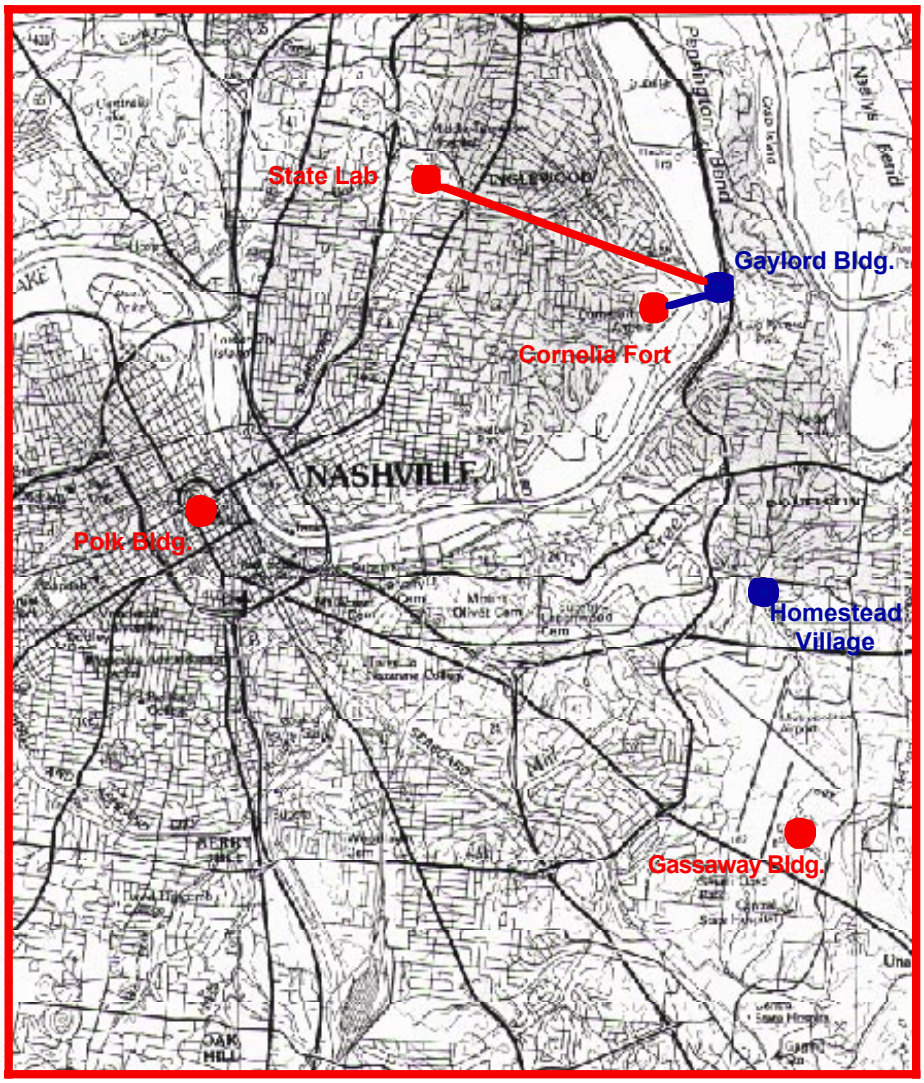
DOAS Measurements:

Three differential optical absorption spectrometers (DOAS) will be used to make long-path measurements over the Cornelia Fort site. EPA (McClenny) will operate a DOAS for NO_2 measurement on the Cornelia Fort site.

Two additional DOAS units will be operated by J. Stutz (UCLA) and U. Platt (Heidelberg). One unit will be located at Cornelia Fort airport, the second at the State Laboratory on Heart Lane. The retro reflector for both spectrometers will be located on the roof of The Gaylord Entertainment Building on the East side of the river Figure 2.) The path length from the state laboratory to Gaylord is 4-5 km, while the path length from Cornelia Fort to Gaylord is approximately 1 km. The species to be measured with the two instruments are as follows:

State Lab to Gaylord	NO_3, NO_2
Cornelia Fort to Gaylord	HONO, CH_2O, O_3, SO_2, NO_2

Figure 2. DOAS Measurements.



Ozonsondes:

An ozondsonde will be released daily, during the study, at 1:00 PM local time. The release will be from the NWS site near Old Hickory Lake. Releases will be conducted by NOAA/CMDL (Oltmans). These launches will provide ozone and meteorological profiles up to the stratosphere, providing information on downmixing of ozone from the upper atmosphere.