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MOBILE METEOROLOGICAL OBSERVATION SYSTEM

Prepared by

**Dr. Gerald W. Grams
Department of Physics and
Research Center for Science and Technology
Clark Atlanta University
223 James P. Brawley Drive
Atlanta GA 30314**

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Abstract

With this grant from the Department of Energy's University Research Instrumentation Program, Clark Atlanta University (CAU) has developed a Mobile Meteorological Observation System designed to facilitate research in the area of urban meteorology. The system includes an instrumented motorized laboratory based on a 25-foot motor coach with built-in generators to provide the platform for operating equipment at remote sites or while traveling on a highway to obtain measurements of temperature, pressure, humidity and aerosol size distributions (particle concentration in 32 size ranges) at the surface. On-board computers record and display data in real time. A monostatic phased-array Doppler acoustic radar (sodar) is mounted on the roof of the vehicle to provide real-time profiles of wind speed and direction, vertical motion, turbulence and thermal structure to determine mixing depths for atmospheric boundary-layer studies. A two-wavelength pulsed Nd:YAG laser radar (lidar) system mounted inside the vehicle is installed to provide real-time vertical profiles of aerosol backscattering, molecular density, and water vapor concentration. A trailer-mounted telescoping 100-foot "crank up" tower with standard micrometeorological instruments can be towed to any site and used to provide data on turbulent fluxes of heat, momentum, and humidity at fixed locations.

The system has been used to provide atmospheric data in a boundary layer research project. It has also been an integral part of the activity associated with the development of the Earth System Science (ESS) program at CAU. ESS is a comprehensive academic, research, and community outreach program with its primary objective to expose a large segment of the University's faculty and students to the multidisciplinary nature of ESS while simultaneously increasing the numbers of minority students pursuing academic and professional careers in that area. The mobile laboratory is currently being used on a variety of projects including laboratory experiences for ESS courses, atmospheric boundary layer research observations, and various ESS outreach activities. The presence of the mobile facility developed under this grant has resulted in significant benefits to our Earth System Science program.

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1. Introduction.

When the proposal for this grant was written, the Principal Investigator, Dr. Gerald W. Grams, was working with Co-Principal Investigator, Prof. Denise Stephenson-Hawk of the Clark Atlanta University (CAU) Department of Physics, who was leading an effort involving Dr. Grams and a number of CAU faculty members, to establish a comprehensive academic, research, and community outreach program in Earth System Science (ESS). The primary objective of this program has been to expose a large segment of the University's faculty and students to the multidisciplinary nature of ESS while simultaneously increasing the numbers of minority students pursuing academic and professional careers in that area.

The ESS program development plan included major efforts in the area of (1) curriculum development, (2) new faculty and involvement of faculty from traditional disciplines in ESS curriculum and research activities, (3) involvement of students in extracurricular activities designed to prepare them for graduate education and careers in ESS fields and (4) acquisition of resource materials and instrumentation to carry out research programs and attract the attention of both students and faculty from traditional academic disciplines.

For example, Dr. Stephenson-Hawk had successfully obtained the hardware needed to acquire weather data from satellite broadcasts using the University Corporation for Atmospheric Research (UCAR) Unidata program. This equipment, installed in the ESS laboratory on the CAU campus, offered our students an opportunity to study using the best available atmospheric data delivered on-line through interactive computer facilities within an electronic classroom environment. This activity employed UCAR's Unidata program, its software and its community of university users across North America, to provide our students access to facilities and data sets that in the past were only available at the most elite of the nation's research institutions.

Dr. Stephenson-Hawk had also received support to accelerate the faculty development part of our program by involving existing faculty members from the more traditional disciplines in a multidisciplinary project. Under the faculty development forum, a team of faculty from the areas of biology, chemistry, computer science, mathematics and physics (one faculty member from each discipline) worked together to develop an interdisciplinary course in Earth System Science. This team also developed topic modules to be taught as part of courses in their respective departments to introduce a large segment of the student population within the Atlanta University Center to ESS as it relates to their particular discipline. These faculty would also serve as academic advisors within their respective departments for students interested in pursuing a minor program of study in Earth System Science. As an integral part of these efforts to develop an interdisciplinary academic and research environment for faculty and students, Project *TEAM* (*Teaching Educators About Meteorology*) had been developed. This project was designed to foster active communication and information exchange among faculty members from disciplines within engineering, mathematical and physical sciences.

Dr. Stephenson-Hawk has been concentrating on the development of the ESS academic and outreach program on the CAU campus, while the Principal Investigator pursued a comprehensive program that would provide research opportunities for the ESS graduate and undergraduate students. As a Principal Research Scientist in CAU's Research and Education Center for Science and Technology, Dr. Grams selected a research area that combined the fields of *Aerosol Science* and *Urban Meteorology*. These topics were selected because they were expected to generate a high level of interest and participation by faculty members from traditional academic disciplines in the multidisciplinary efforts required to carry out research in Earth System Science. Furthermore, we believed that faculty and student involvement with our program would be drastically accelerated when the Earth System Science program included research efforts that earn the recognition of the scientific community for providing scientific leadership and for advancing the state-of-the-art of the technology for a field of research that clearly addresses regional and national needs. When the proposal for this project was submitted, we had already submitted a proposal to the National Science Foundation's Research Improvement in Minority Institutions (RIMI) Program. Our NSF proposal, entitled "*Urban Meteorological Observation Facility*", requested \$500,000 over a 3 year period to equip a field site on the Clark Atlanta University campus that would serve to place us in a leadership role in the field of *Urban Meteorology*. The present project would have served as an obvious complement to the proposed Mobile Meteorological Observation System as it would allow us to obtain data at urban and rural sites to compare with data at the fixed site. We saw this as a field that was ripe for new advances. The scientific rationale for working in the area of urban meteorology included considerations that have local, regional and global implications. If realistic models of urban atmospheric processes could be constructed, it might mean improved predictions of the outcome of different land use or emission strategies on the atmospheric environment of urban areas. This would be of value for applications at local and regional levels such as air quality and fuel consumption considerations.

Unfortunately, the above NSF proposal was declined and we completed this project without the obvious advantage of having a parallel program in place that would have provided salaries and resources for developing many of the data gathering procedures and data analysis techniques that could be applied to our Mobile Meteorological Observation System. However, as the report will demonstrate, we have been resourceful in finding ways to devote the time necessary to develop and use the mobile lab. It has already been used to provide atmospheric data in a boundary layer research project. The system has been included in a number of relatively recent proposals, some of which have already been funded and another that may soon obtain funding, and additional research results should be available in the future. In addition, the system has been used for demonstrations in various outreach projects to help generate interest in the ESS program at Clark Atlanta University.

2. Scientific Rationale

We believed that our understanding of the micrometeorology of an urban environment would benefit from both the implementation of new approaches and the application of previous "standard" approaches in new locations. We anticipated that we would be able to contribute in both of the above areas. The mobile meteorological observation facility would combine state-

of-the-art remote sensing instrumentation (lidar and sodar) with instruments associated with traditional micrometeorological studies operated from ground-based towers and tethered balloons. Our research could thereby emphasize the development of new techniques for studies of the mixed layer over an urban area. We expect to make significant contributions to studies of *atmospheric processes* and are especially interested in addressing the need for new ideas on "how to do micrometeorology" in urban and suburban areas.

We also point out that Clark Atlanta University is located about one mile east of downtown Atlanta, Georgia. The Atlanta metropolitan area has a population of more than 2.5 million people in over 5000 square miles. It is one of the five fastest-growing population centers in the U. S. with a population increase of over 25 percent over the last decade. Another goal of our long-term research efforts was to carry out an extensive series of observations designed to characterize the atmosphere at an urban location near the center of Atlanta and make comparisons with similar data obtained in rural areas upwind or downwind from Atlanta.

Our proposal was to build a mobile facility for observations of the atmospheric mixed layer in urban, suburban and rural areas. The proposed system included a Raman lidar (laser radar) system mounted in a motorized laboratory (e.g., modified delivery truck, bus, recreational vehicle, etc.). In the initial configuration, the lidar would be directed vertically in the atmosphere and would be designed to measure profiles of aerosol backscattering at two different wavelengths (0.532 and 1.064 μm); it would also measure simultaneous profiles of water vapor and atmospheric density by recording simultaneous echoes at the wavelengths associated with the Raman-shifted frequencies for water vapor and nitrogen molecules. Data on surface pressure, temperature and humidity would be digitized and recorded by the same computer that controlled the lidar, digitized the lidar echoes, displayed the digitized signals in real time and recorded the signals for future analysis in our ESS laboratory. Special efforts would be made to obtain accurate measurements of the constituent profiles for water vapor, nitrogen and aerosol particles in the first 3 km of the atmosphere for studies of the mixed layer in urban areas.

With temperature, pressure and humidity measured at the surface, and the vertical profiles of water vapor and the atmospheric density (from Raman-derived nitrogen profiles and/or analysis of the backscattering data recorded at 0.53 and 1.064 μm), we would derive pressure profiles by carrying out numerical integrals of the density profile from the surface to higher altitudes. With both pressure and density profiles from the lidar system, we could thereby be able to calculate temperature at each altitude. With the lidar data, and with a generator to provide electric power in the vehicle, we would also be able to carry out some interesting experiments by driving the vehicle along various highways to map out the height of the mixed layer and the vertical distribution of temperature, humidity and aerosol concentration to help map out the "mixed-layer dome" associated with thermally induced circulation over a large city that is expected to be established under calm or light winds.

The mobile system would also incorporate a phased-array sodar (acoustic radar) system to be mounted on the roof of the vehicle and a small transportable tower that could be carried to a

location and set up for extensive micrometeorological observations. Thus, the vehicle could be driven to any location in Atlanta or its nearby surroundings to obtain data. These observations could include the lidar data (temperature, pressure, humidity and aerosol profiles), vertical and horizontal winds to approximately 3 km altitude using the sodar system, and other parameters such as momentum flux and scalar fluxes near the surface using standard instruments for measuring turbulence parameters from meteorological towers.

3. The Mobile Meteorological Observation System.

As the platform for the mobile laboratory, the Principal Investigator was able to locate a vehicle which turned out to be very well suited to the task at hand. It was a 25-foot GMC motor coach originally purchased as a custom-built motorized showcase by a local company, Scientific Atlanta. It had been set up to demonstrate their electronic equipment as part of a public relations touring program. The company eventually discontinued the touring program. They had placed the vehicle in storage for over 10 years and eventually decided to put it up for sale. It was in excellent condition with two built-in generators that could provide a total of 12.5 KVA of power for the equipment on board. It was wired as a mobile laboratory in such a way that power could be provided by one or both generators or by an outside electric line. It was a front-wheel drive vehicle, powered by a 455 cubic inch Oldsmobile Toronado engine. In addition, the rear wheels were suspended on air cushions for a smooth ride for our equipment. Clark Atlanta University purchased the vehicle in late 1993 and, once the platform had been established, we began to order equipment and assemble a working system. A report describing system was published in the Preprint Volume for the 9th Symposium on Meteorological Observations and Instrumentation held by the American Meteorological Society during March 27-31, 1995, at Charlotte, NC (Grams and Stephenson-Hawk, 1995). The major components of our system are:

- Mobile Environmental Research Vehicle: an instrumented motorized laboratory based on a 25-foot motor coach with built-in generators provides the platform for operating equipment at remote sites to measure temperature, pressure, humidity and aerosol size distributions (particle concentration in 32 size ranges) at the surface. On-board computers record and display data in real time.
- Sodar: a monostatic phased-array Doppler acoustic radar mounted on the roof of the vehicle to provide real-time profiles of wind speed and direction, vertical motion, turbulence and thermal structure to determine mixing depths for atmospheric boundary-layer studies.
- Raman Lidar: a two-wavelength pulsed Nd:YAG laser radar system mounted inside the vehicle to provide real-time vertical profiles of aerosol backscattering, molecular density, and water vapor concentration.
- Trailer-Mounted Tower: instruments mounted on a telescoping 100-foot "crank up" tower to provide data on turbulent fluxes of heat, momentum, and humidity.

Figure 1: *Clark Atlanta University's Mobile Environmental Research Laboratory. This meteorological research vehicle has a monostatic phased-array Doppler sodar mounted on the roof and a two-wavelength Nd:YAG lidar system mounted inside the vehicle for studies of the atmospheric boundary layer. In this view, the enclosure for the sodar system has been opened to permit operation of the phased-array sodar system.*

Our first activity was that of getting the Doppler sodar system working. For the sodar project, the Principal Investigator worked closely with Mr. Randal Mandock, then a graduate student at the Georgia Institute of Technology. Commercial systems are able to obtain vertical profiles of the wind field. Mr. Mandock was working on a plan to advance the state of the art in acoustic radar systems by building a system that could image the three-dimensional structure of the turbulent wind field in the atmospheric boundary layer. Until 1990, when he had left his position as Professor of Atmospheric Sciences at Georgia Tech, the Principal Investigator and Mr. Mandock had worked closely on a variety of projects involving atmospheric data analysis and boundary layer studies. After leaving Georgia Tech, the Principal Investigator maintained close contact with Mr. Mandock. Randal had carried out an extensive review of the best commercially available acoustic radar systems and selected the REMTECH PA-3 system as having the best combination of size, weight, and power requirements needed for us to install the system on the roof of our vehicle. We ordered the system, and, when it was received, a weather-tight enclosure was designed and constructed for the phased-array sodar. The enclosure has two doors that can be electrically opened to expose the loudspeaker array that

forms the transmit – receive unit. The unit was mounted on the roof of the vehicle with vibration-isolation “feet” to suppress any vibrations that might emanate from within the vehicle at frequencies close to the acoustic frequencies of the sound transmitted and received by the system. Most of the acoustic design for the installation was done by Mr. Mandock with the expectation that we would use the commercial system being installed in the mobile laboratory to help calibrate and test the acoustic imaging system he was developing for his Ph. D. thesis research. This project was completed during the summer of 1994.

Our next project was the design and construction of the lidar system. As described in the proposal, the system was to be similar to one designed for operation on a research aircraft that the Principal Investigator and Mr. Clyde Wyman designed and built at Georgia Tech for the University of Washington's Cloud Physics group about 5 years before our proposal was submitted. The Principal Investigator had also built a smaller updated version of that same system for NOAA's National Marine Fisheries Service (NMFS). That unit (installed in a "downward-looking" configuration) was operated successfully by Mr. Wyman aboard a helicopter stationed on a tuna seine vessel during a month-long experiment in 1992 that was designed to demonstrate the ability of a lidar to detect schools of tuna as part of the NMFS Alternative Fishing Methods Program. Mr. Wyman assisted in the design and testing of the lidar during this project.

The major components of our lidar system include a Laser Photonics frequency-doubled Model YQL-102 Nd: YAG laser capable of producing 150 milljoule pulses at a rate of 20 pulses per second with pulselengths of about 15 microseconds. Each pulse is actually divided into two different wavelengths. The frequency-doubled pulse with 0.532- μm wavelength contains about 35 milljoules of energy. The remainder of the 150 milljoules in each pulse is transmitted at the fundamental wavelength of the laser, 1.064 μm , and travels in the same direction as the frequency-doubled green beam. The receiver for the lidar system is a 14-inch Cassegrain telescope (Celestron C14). The laser transmitter and the telescope receiver are mounted horizontally on an optical bench. Both are connected to a light-tight vertical enclosure mounted on the optical bench and pointed upward to a hatch in the roof in such a way that light from inside the vehicle does not scatter into the enclosure to allow operation with the interior lights turned on. A large flat mirror inside the telescope is mounted at an angle of 45 degrees to the optical axis of the telescope to redirect the field of view of the telescope from the horizontal direction to the vertical direction. A small mirror with diameter slightly larger than the laser beam diameter with a coating to handle the high energy density associated with the laser beam is placed on an adjustable “45 degree” holder attached to the end of a light-tight tube that comes into the enclosure from the laser. The laser mirror is located in the light tight vertical enclosure at a position that is approximately at the middle of the upward-directed field of view of the telescope and, by fine adjustments of the laser mirror, the system can be adjusted so that the laser beam exits the vertical enclosure in the same direction as the telescope field of view. This arrangement has proved to be very stable and adjustments to keep the laser and telescope aligned are not necessary when the vehicle is moved.

With regard to data recording and processing, we elected to purchase a turn-key system offered by Optech, Incorporated, a company that had a outstanding reputation and had built a number of Raman lidar systems capable of obtaining the measurements we wanted. They selected and provided all of the appropriate filters, detectors, power supplies, signal amplifiers, and computer to obtain the aerosol scattering data at the two laser wavelengths and at the appropriate wavelengths for recording the water vapor and nitrogen Raman signals. We in turn had only to design a light-tight box with filter holders and install a series of interference filters that, in sequence, reflect most of the water vapor Raman signal from the beam to the water vapor detector and transmit at other wavelengths, reflect most of the nitrogen Raman signal from the beam to the nitrogen detector and at transmit other wavelengths, and then split the two laser wavelengths (1.064 μm and 0.532 μm) and direct them to their respective detectors. The system is then able to use the software provided with the data system to record and display the signals. We recently started to write some of our own software to record and display our lidar data to accommodate an interest in showing lidar profiles versus GPS coordinates for the position of the mobile lab as it travels along a highway to prepare for a future urban meteorology project that will be described later.

The other major part of our system is the meteorological tower, which was acquired early in the project. The tower is a 100-foot transportable "crank-up" tower manufactured by the Aluma Tower company. The various sensors were ordered, mounted on the tower, and tested throughout the project. These instruments provide us with the ability to obtain observations of wind speed, vertical wind, temperature, humidity, net radiation, and their variances at up to 5 levels. Although they have seen use in a number of student projects, these instruments have not been used in routine funded research programs. We point out, however, that in the past few months, we have entered into a collaborative effort with Dr. Monique LeCerc of the University of Georgia who has a very active program in micrometeorology and we anticipate an opportunity to operate the instrumented tower in a number of future projects with her program.

4. Scientific accomplishments.

This discussion includes scientific results obtained with the system in addition to a number of benefits that having this system in place has created for Clark Atlanta's ESS program. Our first discussion centers on a topic mentioned as part of the report where we described our relationship with Mr. Randal Mandock who helped us design the system. We pointed out that our plan was to use the Mobile Meteorological Observation System to help Mr. Mandock test and calibrate his new acoustic system for imaging three-dimensional turbulence in the atmosphere. We did, in fact, carry out that promise. From December 1996 through July 1997, several important functions that were critical to the successful completion of his Ph. D. thesis (Mandock, 1997) were provided by the Mobile Meteorological Observation System. In particular, the REMTECH PA-3 sodar on the mobile lab was operated at a field site in Alpharetta, Georgia, while he was actually operating the system to obtain the data that formed the database for his research. The instrumented tower was also used at the same location to calibrate his system. Figure 2 shows the mobile lab and the tower at the test site in December 1996.

Figure 2: View of the mobile laboratory and instrument tower at the field site in Alpharetta, Georgia, used by Randal Mandock for testing and calibrating his acoustic system for measuring three-dimensional images of the structure of turbulence in the atmospheric boundary layer.

Figure 4 shows a view of the receiver for the acoustic imaging system from the tower. In all, 13,000 receiver calibrations and over 100 transmitter calibrations were done for different azimuth and elevation angles at different temperatures, pressures, and humidities to establish the antenna beam pattern for the imaging system.

Figure 3: *View of the receiver for the acoustic imaging system developed by Randal Mandock obtained from a location on the tower about 25 feet above ground level. The receiver is the square object in the center with a phased-array of 50 speakers coupled to form a 25 by 25 array. Two computers were used to record digitized data obtained with the system. The tower was needed to carry out an extensive series of calibration experiments before the imaging system could be used to carry out the series of experiments that provided the database for his thesis research.*

Figure 4 is an example of comparisons of vertical profiles of horizontal wind speeds measured by the multiple beam sodar and the REMTECH PA-3 sodar system operated as part of the Mobile Meteorological Observation System. Inspection shows acceptable agreement (within error bars for each system) between the multiple beam sodar and the PA-3 measurement. The multiple beam sodar data is a 10-minute average of 95 transmitted acoustic pulses. Each data point represents the further average and standard deviation of four (4) independent Doppler wind speed measurements made at 10, 15, 20, and 25 degree zenith angles. The PA-3 measurements are the average of two 15-minute determinations of the mean wind, one taken before the multiple beam sodar was turned on and the other taken when the multiple beam sodar run was completed. Error bars for the PA-3 data represent the 0.2 m/sec nominal wind speed accuracy of the instrument.

Figure 4: Vertical profile of horizontal wind speeds measured by the multiple beam sodar and by the REMTECH PA-3 sodar (based on Figure 8.5 from Mandock, 1997).

Figure 5 is an example of comparisons of the vertical profiles of vertical wind speeds as measured by the acoustic imaging system and the REMTECH PA-3 sodar on the mobile laboratory. Averages and standard deviations for the imaging system were obtained using the same procedure that was described for Figure 4. The error bars for the PA-3 data represent the 5 cm/sec nominal vertical wind accuracy of the PA-3 instrument. As in Figure 4, the measurements made with the multiple beam sodar fall mostly within the tolerance limits of the reference sodar.

Figure 5: Vertical profiles of vertical wind speeds measured with the multiple beam sodar and by the REMTECH PA-3 sodar (based on Figure 8.6 from Mandock, 1997).

5. Current utilization of the equipment.

At this point, we turn to a discussion of a number of benefits that having this system in place has created for Clark Atlanta's ESS program. The system has been used in a number of outreach programs that visited local high schools to demonstrate the operation of the mobile laboratory. It has also been used in other outreach activities to provide demonstrations for students at events such as Earth Day activities on the CAU campus. These have all served to promote our Earth System Science program.

The availability of the facility has also been a factor that helped the Principal Investigator develop successful proposals for research grants and contracts to fund research activities that

utilize the Mobil Meteorological Observation System. In particular, we point out that the mobile laboratory was a featured item in a successful proposal by the Principal Investigator to the National Science Foundation for a series of summer student research programs entitled "Research Experiences for Undergraduates in Earth System Science at Clark Atlanta University" (a three-year program funded at approximately \$240,000 from May 1998 to the end of September in 2002).

Another point that should be made is that Randal Mandock completed writing his doctoral thesis in December 1997 and graduated from the Georgia Institute of Technology in March 1998. He joined our ESS program in July 1998 and has long-term plans to include further research activities on the acoustic imaging system at CAU. In the meantime, the Principal Investigator and Dr. Mandock helped develop several major ESS proposals with Dr. Stephenson-Hawk that included significant utilization of the Mobile Meteorological System. Two recent awards for proposals with Dr. Stephenson-Hawk as Principal Investigator have direct support for work that requires the operation of our mobile lab.

The first of these awards is a NASA project funded at the level of approximately 2.4 million dollars for a 5-year period from July 1998 to the end of June 2003. This project is called PAIR (Partnership Award for the Integration of Research into Mathematics, Science, Engineering and Technology). Amongst other things, PAIR provides support for faculty time required for the development of six (6) new ESS courses, purchases equipment, and supports the operation of existing equipment needed for laboratory experiences to accompany each course. Over half of the new courses will make use of equipment associated with the Mobile Meteorological Observation System. The new courses being developed (equipment used to support each course are: Active Remote Sensing (sodar and lidar), Micrometeorology (sodar and tower), Instrumentation Electronics (tower), and Atmospheric Aerosols (lidar and aerosol particle spectrometer).

The second award obtained by Dr. Stephenson-Hawk was a NSF initiative called CIRE (Collaborative to Integrate Research and Education in Earth System Science). This includes collaboration with the University of Oklahoma for which a 5-year dual-degree program enables students from CAU to finish their degrees at Oklahoma to obtain a CAU degree in Physics and a University of Oklahoma degree in Meteorology which was initiated as part of Dr. Stephenson-Hawk's activities since the beginning of our ESS program. CIRE is a 3-year program that provides approximately 1.4 million dollars over the time period from October 1998 to the end of September 2001. Part of the initiative includes the development of teaching modules that incorporate our mobile facility and other equipment to add an ESS component to laboratory courses taught in some of the traditional single-discipline departments such as Mathematics, Physics, Engineering, Computer Science and so forth. In addition, CIRE seeks to develop on-going research activities at CAU that would add to the meteorological research being carried out at Oklahoma. In particular, Oklahoma has developed a computer model called ARPS (Advanced Regional Prediction System) for predicting mesoscale meteorological phenomena such as tornadoes. The CIRE plan calls for CAU to use the sodar and instrumented tower to carry out boundary layer research that could be used to improve boundary-layer parameterization in the ARPS model.

6. Future plans for new activities with the equipment.

As a final note, we point out that Mr. Zachary Young who has been Associate Director of the ESS program since January 1999 has been negotiating with the Georgia Department of Transportation to expand an effort he has been carrying out for them involving the operation of 13 video cameras originally purchased and installed on the Interstate highways in Atlanta as part of the 1996 Olympics. The tapes from these cameras are being analyzed to record speeds and vehicle types to develop a model for traffic flow in Atlanta. In the proposed expanded effort, Mr. Steve Fischer, an atmospheric chemist also associated with our ESS group would use data obtained at various air sampling sites in the Atlanta area and install air sampling equipment (ozone, NO_x, CO, etc.) in the mobile lab which could be deployed to fixed sites or could travel on various highways in the Atlanta area to collect continuous data as a function of GPS position at the same time that the lidar was mapping the height of the boundary layer at each location. Mr. Fischer would use the EPA UAM-V or CAMX model with modifications for photochemical analysis and the University of Oklahoma ARPS model or the RAMS (Regional Atmospheric Modeling System) model to characterize regional transport of the pollutants to analyze and predict the fate of pollutants in Atlanta and surrounding regions. Mr. Fischer has already obtained expressions of interest to work with him on this project with regard to the RAMS model from Professor George Kallos of the University of Athens in Greece and Dr. S. T. Rao from SUNY-Albany (who is also Head of the New York State Environmental Office). Dr. Mandock has been working with Oklahoma scientists with the ARPS model which will soon be loaded on CAU computers and available for regional transport studies. This regional transportation - air pollution project has been under discussion for almost a year and we are optimistic that it will ultimately receive funding. If that happens, we would expect to see a new use for the mobile lab that may help Georgia obtain new inputs to improve their decisions on the current problem of annual increases in the number of non-compliance days associated with the EPA's ozone standards during the summertime.

7. Publications resulting from DOE/URI project.

Grams, G. W., and D. Stephenson-Hawk, 1995: A mobile meteorological observation system for studies of the atmospheric boundary layer. *Preprint volume*, 9th Symposium on Meteorological Observations and Instrumentation, March 27-31, Charlotte, NC, Am. Meteorological Society, Boston, MA, 531- 532.

Mandock, Randal, 1997: A multiple beam sodar for the measurement of atmospheric turbulence. Ph. D. Thesis, School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA, 179 pages.