I. Annual Report to the Office of Naval Research, Marine Meteorology Program

31 May 1995

Principal Investigator:
Sonia M. Kreidenweis

Experimental and Modeling Studies of Interactions of Marine Aerosols and Clouds

Colorado State University
Ft. Collins, CO 80523

email: soniak@aerosol.atmos.colostate.edu
tel: 303/491-8350
fax: 303/491-8449

II. Narrative Documentation

A. Long-Term Goals

The overall long-term goals of this research are to address the following key questions regarding marine aerosol / cloud interactions:

1. What factors control the abundance and vertical distribution of aerosol in the marine boundary layer?
2. How do these factors affect the formation and lifetime of marine clouds?

These questions are addressed through a combination of modeling and experimental approaches, as described below. The goal of the modeling component is to produce a model description of aerosol evolution and aerosol / cloud interaction that can be applied to a variety of marine boundary layer scenarios. The goals of the experimental component are to complete a series of laboratory experiments aimed at elucidating some important aerosol / cloud interactions, to develop new measurement techniques as part of this laboratory work, and to adapt and use these techniques for future field work involving characterization of marine aerosol.

B. Scientific Objectives

The specific objectives of the modeling component are to develop models of the marine boundary layer, including models that predict cloud formation and evolution and the effects of such processes on the marine aerosol (and vice versa). It is anticipated that the modeling techniques built in this project can be used to study the role of aerosol in cloud modification, including ship tracks.

The objectives of the experimental component are to evaluate new techniques for aerosol characterization and adapt these for field (shipboard and ground) deployment, particularly techniques for determination of size-dependent particle properties with high time resolution.

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH
SEATTLE REGIONAL OFFICE
1107 NE 45TH STREET. SUITE 350
SEATTLE WA 98105-4631

IN REPLY REFER TO:

4330
ONR 247
11 Jul 97

From: Director, Office of Naval Research, Seattle Regional Office, 1107 NE 45th St., Suite 350, Seattle, WA 98105

To: Defense Technical Center, Attn: P. Mawby, 8725 John J. Kingman Rd., Suite 0944, Ft. Belvoir, VA 22060-6218

Subj: RETURNED GRANTEE/CONTRACTOR TECHNICAL REPORTS

1. This confirms our conversations of 27 Feb 97 and 11 Jul 97. Enclosed are a number of technical reports which were returned to our agency for lack of clear distribution availability statement. This confirms that all reports are unclassified and are "APPROVED FOR PUBLIC RELEASE" with no restrictions.

2. Please contact me if you require additional information. My e-mail is *silverr@onr.navy.mil* and my phone is (206) 625-3196.

ROBERT J. SILVERMAN

C. Approach

Modeling Component. The modeling approach builds upon previous work in the development of simple descriptions of aerosol formation and dynamics. These, together with parameterized clouds and precipitation, are used in a bulk boundary-layer model which resolves some updraft / down draft information, and steady states of the resulting coupled system are computed. This analysis will identify the major factors controlling MBL aerosol concentrations. The second part of this component involves use of the CSU RAMS to simulate a cloud-topped marine boundary layer. We will add aerosol to the simulation and allow cloud formation only on active CCN. The effects of cloud processing upon the aerosol are also included. The simulation will examine the combined effects upon the initial aerosol distribution, as well as the response of the cloud to changes in the aerosol.

Experimental Component. Initially, effort is focused upon building our aerosol laboratory, establishing measurement techniques, and developing methodologies for calibration and testing of instruments. Appropriate experiments with the CSU Dynamic Cloud Chamber are planned for the study of the initial effects of particle size and chemistry upon stratus-type clouds. Land-based field sampling will be performed as opportunities arise; we have currently been sampling continuously at Niwot Ridge, CO, for six months. Planning for and participation in a major field experiment for the study of marine aerosol - ACE-1 - will be the final phase of this research project.

D. Tasks Completed

Modeling Component.

1. Formulation of simple aerosol model for use in bulk boundary later model; presentation of initial results at two national conferences.

2. Formulation of aerosol activation / solute transfer scheme for explicit-microphysics version of RAMS (jointly with separate funding); presentation of initial results at a national conference.

Experimental Component.

1. Analysis of ASTEX/MAGE data collected by our group (separate funding), preparation and submission of manuscript, with acceptance pending minor revision.

2. Analysis of exploratory dynamic cloud chamber studies (separate funding), preparation of extended abstract.

3. Purchase, set up and testing of differential mobility analyzer, condensation nucleus counter, and ultra fine particle counter.

4. Design and assembly of heated aerosol inlet for volatility characterization.

5. Aerosol measurement / volatility characterization system design, setup, and deployment at Niwot Ridge, Rocky Mountains, CO; analysis of preliminary data; presentation of work at international conference.

6. Development of some aspects of particle generation system for instrument calibration.

7. Design and implementation of new temperature control algorithm for CSU dynamic cloud chamber; implementation of new pressure control hardware.

8. Preparation of comprehensive manual for dynamic cloud chamber.

E. Results and Impact for Science

Modeling Component.

The simple MBL modeling approach extends the work of Baker and Charlson (1990) to include a mass balance equation for the aerosol itself. This appears to alter the steady states achieved, although our boundary layer treatment is different and thus further analysis is needed for comparison. A main contribution of our approach will be the ability to distinguish updraft and down draft regions, mitigating some of the unphysical aerosol model behavior associated with the averaging of vertical velocities and supersaturations.

The use of the explicit-microphysics, LES version of RAMS to perform marine stratocumulus simulations is the state of the art in such modeling. Adding a realistic aerosol treatment to this model is a challenge, particularly in the tracking of solute mass as it is transported through the drop spectrum and in the regeneration of altered aerosol from the evaporating drops. Our work to date has defined some of the numerical difficulties associated with this task, and has identified approaches that will be useful in minimizing errors. Significant effort must be devoted to thorough testing of all aspects of the proposed model before it can be coupled to the full RAMS simulation.

Experimental Component.

In Year 1, our efforts have been largely focused upon the development of the aerosol laboratory. The acquisition of several important instruments through funding provided by ONR has played a key role. In particular, we purchased a differential mobility analyzer with the TSI scanning software, to enable us to make fast measurements of aerosol size distributions, and an ultra fine condensation nucleus counter, to enable us to detect particle nucleation events in the field. Under separate funding, we have purchased two aerosol generation systems that we have been using to calibrate our laboratory instruments. Extensive testing of the new instrumentation has been completed.

Additional effort has been devoted to the development of improved control of the dynamic cloud chamber simulated adiabatic ascent. Exploratory studies completed under separate funding, and further analyzed as part of this project, have demonstrated the feasibility of using the chamber for the study of the initial effects of aerosol upon marine cloud formation. However, it was also shown that the chamber was not sufficiently well-controlled for low "ascent" rates characteristic of marine stratocumulus. New control algorithm and new hardware have been developed and implemented, and have significantly improved the chamber performance. The completion of comprehensive documentation will facilitate the use of the chamber by new personnel.

We have also deployed a newly-built aerosol volatility characterization scheme in the field, at Niwot Ridge, CO. The site may frequently receive mid-tropospheric air under some flow conditions. Our instrumentation is co-located with a NOAA sampling site, and associated data - total particle concentrations, scattering, wind speed and direction, and some gas-phase chemistry - are available to us. We are particularly interested in events for which high particle number concentrations are not associated with elevated extinction, which may be indicative of a nucleation event. To examine the nature of the fine particles, a three-path heated inlet, for measurement of aerosol volatility at three elevated temperatures, was designed, constructed and deployed. During tests in Summer 1994, aerosol of extreme volatility (over 90% by volume of the sub-0.5 μm fraction was volatile at 260 °C.) was detected; it is believed that this aerosol was influenced by emissions from forest fires in the Rocky Mountains. This experience led to a recognition of the need for information on the organic carbon content of the aerosol, and we have established collaborations with groups at NOAA to perform simultaneous aerosol chemical characterizations. Our experience at Niwot Ridge contrasts with previously-reported volatility measurements over ocean regions, where the primary constituent was believed to be sulfate. We plan to make further tests of the volatility technique and hope to develop a technique to distinguish between sulfate and organic materials.

F. Transitions Accomplished and Expected

Ph.D. student Fred Brechtel joined the group in Fall 1993 and passed the qualifying examination in January 1994. He is working on the volatility system and sampling at Niwot Ridge, and is exploring opportunities for sampling marine aerosol at Pt. Reyes, CA. His dissertation topic will be related to the experimental objectives of this research project.

Ph.D. student Yalei Chen joined the group in Fall 1994 and will take the qualifying examination in May 1995. He will be working on scanning and transmission electron microscopy (SEM/TEM) of single particles as a technique to define size-dependent chemistry and is currently training for this task by taking the electron microscopy course at CSU. He is also working on impactor calibration techniques and methods for the generation of mixed and coated laboratory aerosol. He will initially assist the effort at Niwot Ridge and then move on to work on the ACE-1 preparations.

Dr. Paul DeMott is Director of the Simulation Laboratory and has devoted effort to the aspects of this work involving the dynamic cloud chamber. It is anticipated that he will continue to devote part time to laboratory aspects of the project.

Dr. Graham Feingold is a Research Associate with CIRA who co-developed the explicit microphysics version of the LES RAMS. He has worked on the aerosol regeneration and solute transfer modules for the aerosol treatment described here. He will continue to be supported part time under this project and will work with the PI's group on modeling aspects.

G. Relationships to Other Projects

This project shares common themes with all of the PI's current research projects. In the modeling arena, NSF supports projects for the examination of aerosol redistribution in convective systems and for MBL / aerosol modeling. Similar aerosol models will be implemented for these and the ONR project, with some modifications appropriate for the dynamics model framework and for the atmospheric physics specific to that application. DOE/NIGEC supports work in the development of chemical mechanisms for coupled gas/aqueous chemistry for use in the LES RAMS; these modules will be used in the ONR project to describe aerosol modification by in-cloud chemistry.

In the experimental arena, NASA supports work on the characterization of ice nuclei in the upper troposphere; one aspect of this work is the collection and analysis of particles by SEM/TEM techniques. The development of these methods requires the ability to generate known test aerosols in the lab, which has been a product of the ONR project work. The SEM/TEM techniques are also being developed under this funding and will be applied in the future NASA work. The NASA project will provide at least one, and probably two, opportunities for participation in collaborative field projects; these will provide valuable experience for the field work to be completed under ONR funding.

III. Statistical Information

A. Publications and Presentations Supported by this Award

"Aerosol Distributions in the North Atlantic Marine Boundary Layer During ASTEX / MAGE," T.L. Jensen, S.M. Kreidenweis, Y. Kim, H. Sievering, A. Pszenny, *J. Geophys. Res.*, in press.

"A Simple Model of the Cloud-Topped Boundary Layer," S.M. Kreidenweis, presented at the Twelfth Annual Meeting of the American Association for Aerosol Research, Oak Brook, Illinois, 11-15 October, 1993.

"A Simple Aerosol Model for Marine Boundary Layer Simulations," S. M. Kreidenweis, presented at the Annual AMS Meeting, Conference on Atmospheric Chemistry, Nashville, TN, January, 1994.

"A Preliminary Study of the Volatility of Aerosol in the Colorado Rocky Mountains," F.J. Brechtel and S.M. Kreidenweis, presented at the Fourth International Aerosol Conference, Los Angeles, CA, August, 1994.

"A Modeling Study of the Interaction Between Aerosol and Marine Stratus," S.M. Kreidenweis, W.A. Richardson, B. Stevens, and G. Feingold, presented at the Fourth International Aerosol Conference, Los Angeles, CA, August, 1994.

"Cloud Processing of Aerosol in Stratocumulus: Collision-Coalescence and Regeneration," G. Feingold, S.M. Kreidenweis, to be presented at AAAR '95, Fourteenth Annual Meeting, Pittsburgh, Pennsylvania, 9-13 October, 1995.

"Exploratory Dynamic Cloud Chamber Simulations of Initial Stratocumulus Formation," T.L. Jensen, S.M. Kreidenweis, P.J. DeMott, D.C. Rogers, presented at the AMS Cloud Physics Conference, Dallas, TX, 15-20 January, 1995.

"Observations of the Evolution of a Bimodal Aerosol Size Distribution During Polluted, High Relative Humidity Events," F.J. Brechtel, S.M. Kreidenweis, and J.A. Ogren, to be presented at AAAR '95, Fourteenth Annual Meeting, Pittsburgh, Pennsylvania, 9-13 October, 1995.

"Preliminary Evidence for the Production of New Particulate Matter in the Atmosphere at a Mid-Latitude Remote Mountain Site," F.J. Brechtel, S.M. Kreidenweis, and J.A. Ogren, for presentation at XXI IUGG General Assembly, Boulder, Colorado, 2-14 July, 1995.

"Transport of Anthropogenic Aerosols and In-Situ Particle Production at a Remote Mid-Latitude Mountain Site," F.J. Brechtel, S.M. Kreidenweis, L.M. McInnes, and J.A. Ogren, to be presented at AAAR '95, Fourteenth Annual Meeting, Pittsburgh, Pennsylvania, 9-13 October, 1995.

B. Graduate and Undergraduate Students Supported by this Award

Name	*Level*	*Department*	*Sex*
Fred Brechtel	Ph.D.	Atmos. Sci.	M
Yalei Chen	Ph.D.	Atmos. Sci.	M
Debra Youngblood	M.S.	Atmos. Sci.	F
Tara Jensen	M.S.	Atmos. Sci.	F
Rodger Ames	M.S.	Environ. Eng.	M
Jon Robb	M.S.	Environ. Eng.	M
Randy Vetter	UG	Chem. Eng.	M
Suzanne Hyde	UG	Chem. Eng.	F
Anika Burkhard	UG	Chem. Eng.	F

I. Annual Report to the Office of Naval Research, Marine Meteorology Program

31 May 1995

Principal Investigator:
Sonia M. Kreidenweis

Experimental and Modeling Studies of Interactions of Marine Aerosols and Clouds

Colorado State University
Ft. Collins, CO 80523

email: soniak@aerosol.atmos.colostate.edu
tel: 303/491-8350
fax: 303/491-8449

II. Narrative Documentation

A. Long-Term Goals

The overall long-term goals of this research are to address the following key questions regarding marine aerosol / cloud interactions:

1. What factors control the abundance and vertical distribution of aerosol in the marine boundary layer?
2. How do these factors affect the formation and lifetime of marine clouds?

These questions are addressed through a combination of modeling and experimental approaches, as described below. The goal of the modeling component is to produce a model description of aerosol evolution and aerosol / cloud interaction that can be applied to a variety of marine boundary layer scenarios. The goals of the experimental component are to complete a series of laboratory experiments aimed at elucidating some important aerosol / cloud interactions, to develop new measurement techniques as part of this laboratory work, and to adapt and use these techniques for future field work involving characterization of marine aerosol.

B. Scientific Objectives

The specific objectives of the modeling component are to develop models of the marine boundary layer, including models that predict cloud formation and evolution and the effects of such processes on the marine aerosol (and vice versa). It is anticipated that the modeling techniques built in this project can be used to study the role of aerosol in cloud modification, including ship tracks.

The objectives of the experimental component are to evaluate new techniques for aerosol characterization and adapt these for field (shipboard and ground) deployment, particularly techniques for determination of size-dependent particle properties with high time resolution.

C. Approach

Modeling Component. The modeling approach builds upon previous work in the development of simple descriptions of aerosol formation and dynamics. These, together with parameterized clouds and precipitation, are used in a bulk boundary-layer model which resolves some updraft / down draft information, and steady states of the resulting coupled system are computed. This analysis will identify the major factors controlling MBL aerosol concentrations. The second part of this component involves use of the CSU RAMS to simulate a cloud-topped marine boundary layer. We will add aerosol to the simulation and allow cloud formation only on active CCN. The effects of cloud processing upon the aerosol are also included. The simulation will examine the combined effects upon the initial aerosol distribution, as well as the response of the cloud to changes in the aerosol.

Experimental Component. Initially, effort is focused upon building our aerosol laboratory, establishing measurement techniques, and developing methodologies for calibration and testing of instruments. Appropriate experiments with the CSU Dynamic Cloud Chamber are planned for the study of the initial effects of particle size and chemistry upon stratus-type clouds. Land-based field sampling will be performed as opportunities arise; we have currently been sampling continuously at Niwot Ridge, CO, for six months. Planning for and participation in a major field experiment for the study of marine aerosol - ACE-1 - will be the final phase of this research project.

D. Tasks Completed

Modeling Component.

1. Formulation of simple aerosol model for use in bulk boundary later model; presentation of initial results at two national conferences.
2. Formulation of aerosol activation / solute transfer scheme for explicit-microphysics version of RAMS (jointly with separate funding); presentation of initial results at a national conference.

Experimental Component.

1. Analysis of ASTEX/MAGE data collected by our group (separate funding), preparation and submission of manuscript, with acceptance pending minor revision.
2. Analysis of exploratory dynamic cloud chamber studies (separate funding), preparation of extended abstract.
3. Purchase, set up and testing of differential mobility analyzer, condensation nucleus counter, and ultra fine particle counter.
4. Design and assembly of heated aerosol inlet for volatility characterization.
5. Aerosol measurement / volatility characterization system design, setup, and deployment at Niwot Ridge, Rocky Mountains, CO; analysis of preliminary data; presentation of work at international conference.
6. Development of some aspects of particle generation system for instrument calibration.
7. Design and implementation of new temperature control algorithm for CSU dynamic cloud chamber; implementation of new pressure control hardware.
8. Preparation of comprehensive manual for dynamic cloud chamber.

E. Results and Impact for Science

Modeling Component.

The simple MBL modeling approach extends the work of Baker and Charlson (1990) to include a mass balance equation for the aerosol itself. This appears to alter the steady states achieved, although our boundary layer treatment is different and thus further analysis is needed for comparison. A main contribution of our approach will be the ability to distinguish updraft and down draft regions, mitigating some of the unphysical aerosol model behavior associated with the averaging of vertical velocities and supersaturations.

The use of the explicit-microphysics, LES version of RAMS to perform marine stratocumulus simulations is the state of the art in such modeling. Adding a realistic aerosol treatment to this model is a challenge, particularly in the tracking of solute mass as it is transported through the drop spectrum and in the regeneration of altered aerosol from the evaporating drops. Our work to date has defined some of the numerical difficulties associated with this task, and has identified approaches that will be useful in minimizing errors. Significant effort must be devoted to thorough testing of all aspects of the proposed model before it can be coupled to the full RAMS simulation.

Experimental Component.

In Year 1, our efforts have been largely focused upon the development of the aerosol laboratory. The acquisition of several important instruments through funding provided by ONR has played a key role. In particular, we purchased a differential mobility analyzer with the TSI scanning software, to enable us to make fast measurements of aerosol size distributions, and an ultra fine condensation nucleus counter, to enable us to detect particle nucleation events in the field. Under separate funding, we have purchased two aerosol generation systems that we have been using to calibrate our laboratory instruments. Extensive testing of the new instrumentation has been completed.

Additional effort has been devoted to the development of improved control of the dynamic cloud chamber simulated adiabatic ascent. Exploratory studies completed under separate funding, and further analyzed as part of this project, have demonstrated the feasibility of using the chamber for the study of the initial effects of aerosol upon marine cloud formation. However, it was also shown that the chamber was not sufficiently well-controlled for low "ascent" rates characteristic of marine stratocumulus. New control algorithm and new hardware have been developed and implemented, and have significantly improved the chamber performance. The completion of comprehensive documentation will facilitate the use of the chamber by new personnel.

We have also deployed a newly-built aerosol volatility characterization scheme in the field, at Niwot Ridge, CO. The site may frequently receive mid-tropospheric air under some flow conditions. Our instrumentation is co-located with a NOAA sampling site, and associated data - total particle concentrations, scattering, wind speed and direction, and some gas-phase chemistry - are available to us. We are particularly interested in events for which high particle number concentrations are not associated with elevated extinction, which may be indicative of a nucleation event. To examine the nature of the fine particles, a three-path heated inlet, for measurement of aerosol volatility at three elevated temperatures, was designed, constructed and deployed. During tests in Summer 1994, aerosol of extreme volatility (over 90% by volume of the sub-0.5 μm fraction was volatile at 260 °C.) was detected; it is believed that this aerosol was influenced by emissions from forest fires in the Rocky Mountains. This experience led to a recognition of the need for information on the organic carbon content of the aerosol, and we have established collaborations with groups at NOAA to perform simultaneous aerosol chemical characterizations. Our experience at Niwot Ridge contrasts with previously-reported volatility measurements over ocean regions, where the primary constituent was believed to be sulfate. We plan to make further tests of the volatility technique and hope to develop a technique to distinguish between sulfate and organic materials.

F. Transitions Accomplished and Expected

Ph.D. student Fred Brechtel joined the group in Fall 1993 and passed the qualifying examination in January 1994. He is working on the volatility system and sampling at Niwot Ridge, and is exploring opportunities for sampling marine aerosol at Pt. Reyes, CA. His dissertation topic will be related to the experimental objectives of this research project.

Ph.D. student Yalei Chen joined the group in Fall 1994 and will take the qualifying examination in May 1995. He will be working on scanning and transmission electron microscopy (SEM/TEM) of single particles as a technique to define size-dependent chemistry and is currently training for this task by taking the electron microscopy course at CSU. He is also working on impactor calibration techniques and methods for the generation of mixed and coated laboratory aerosol. He will initially assist the effort at Niwot Ridge and then move on to work on the ACE-1 preparations.

Dr. Paul DeMott is Director of the Simulation Laboratory and has devoted effort to the aspects of this work involving the dynamic cloud chamber. It is anticipated that he will continue to devote part time to laboratory aspects of the project.

Dr. Graham Feingold is a Research Associate with CIRA who co-developed the explicit microphysics version of the LES RAMS. He has worked on the aerosol regeneration and solute transfer modules for the aerosol treatment described here. He will continue to be supported part time under this project and will work with the PI's group on modeling aspects.

G. Relationships to Other Projects

This project shares common themes with all of the PI's current research projects. In the modeling arena, NSF supports projects for the examination of aerosol redistribution in convective systems and for MBL / aerosol modeling. Similar aerosol models will be implemented for these and the ONR project, with some modifications appropriate for the dynamics model framework and for the atmospheric physics specific to that application. DOE/NIGEC supports work in the development of chemical mechanisms for coupled gas/aqueous chemistry for use in the LES RAMS; these modules will be used in the ONR project to describe aerosol modification by in-cloud chemistry.

In the experimental arena, NASA supports work on the characterization of ice nuclei in the upper troposphere; one aspect of this work is the collection and analysis of particles by SEM/TEM techniques. The development of these methods requires the ability to generate known test aerosols in the lab, which has been a product of the ONR project work. The SEM/TEM techniques are also being developed under this funding and will be applied in the future NASA work. The NASA project will provide at least one, and probably two, opportunities for participation in collaborative field projects; these will provide valuable experience for the field work to be completed under ONR funding.

III. Statistical Information

A. Publications and Presentations Supported by this Award

"Aerosol Distributions in the North Atlantic Marine Boundary Layer During ASTEX / MAGE," T.L. Jensen, S.M. Kreidenweis, Y. Kim, H. Sievering, A. Pszenny, *J. Geophys. Res.*, in press.

"A Simple Model of the Cloud-Topped Boundary Layer," S.M. Kreidenweis, presented at the Twelfth Annual Meeting of the American Association for Aerosol Research, Oak Brook, Illinois, 11-15 October, 1993.

"A Simple Aerosol Model for Marine Boundary Layer Simulations," S. M. Kreidenweis, presented at the Annual AMS Meeting, Conference on Atmospheric Chemistry, Nashville, TN, January, 1994.

"A Preliminary Study of the Volatility of Aerosol in the Colorado Rocky Mountains," F.J. Brechtel and S.M. Kreidenweis, presented at the Fourth International Aerosol Conference, Los Angeles, CA, August, 1994.

"A Modeling Study of the Interaction Between Aerosol and Marine Stratus," S.M. Kreidenweis, W.A. Richardson, B. Stevens, and G. Feingold, presented at the Fourth International Aerosol Conference, Los Angeles, CA, August, 1994.

"Cloud Processing of Aerosol in Stratocumulus: Collision-Coalescence and Regeneration," G. Feingold, S.M. Kreidenweis, to be presented at AAAR '95, Fourteenth Annual Meeting, Pittsburgh, Pennsylvania, 9-13 October, 1995.

"Exploratory Dynamic Cloud Chamber Simulations of Initial Stratocumulus Formation," T.L. Jensen, S.M. Kreidenweis, P.J. DeMott, D.C. Rogers, presented at the AMS Cloud Physics Conference, Dallas, TX, 15-20 January, 1995.

"Observations of the Evolution of a Bimodal Aerosol Size Distribution During Polluted, High Relative Humidity Events," F.J. Brechtel, S.M. Kreidenweis, and J.A. Ogren, to be presented at AAAR '95, Fourteenth Annual Meeting, Pittsburgh, Pennsylvania, 9-13 October, 1995.

"Preliminary Evidence for the Production of New Particulate Matter in the Atmosphere at a Mid-Latitude Remote Mountain Site," F.J. Brechtel, S.M. Kreidenweis, and J.A. Ogren, for presentation at XXI IUGG General Assembly, Boulder, Colorado, 2-14 July, 1995.

"Transport of Anthropogenic Aerosols and In-Situ Particle Production at a Remote Mid-Latitude Mountain Site," F.J. Brechtel, S.M. Kreidenweis, L.M. McInnes, and J.A. Ogren, to be presented at AAAR '95, Fourteenth Annual Meeting, Pittsburgh, Pennsylvania, 9-13 October, 1995.

B. Graduate and Undergraduate Students Supported by this Award

Name	*Level*	*Department*	*Sex*
Fred Brechtel	Ph.D.	Atmos. Sci.	M
Yalei Chen	Ph.D.	Atmos. Sci.	M
Debra Youngblood	M.S.	Atmos. Sci.	F
Tara Jensen	M.S.	Atmos. Sci.	F
Rodger Ames	M.S.	Environ. Eng.	M
Jon Robb	M.S.	Environ. Eng.	M
Randy Vetter	UG	Chem. Eng.	M
Suzanne Hyde	UG	Chem. Eng.	F
Anika Burkhard	UG	Chem. Eng.	F