https://ntrs.nasa.gov/search.jsp?R=19990004632 2020-06-15T22:01:46+00:00Z

IN-45
371999

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION

Jointly operated by the
University of Alabama in Huntsville and Universities Space Research Association

Quadrennial Report for
September 1, 1993 - February 28, 1998

"GLOBAL CHANGE RESEARCH RELATED TO THE EARTH'S ENERGY AND HYDROLOGIC CYCLE"

Under
Cooperative Agreement: NCC8-22

Submitted to

THE GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA 35812

by

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

on behalf of the

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION
Global Hydrology and Climate Center
977 Explorer Drive
Huntsville, Alabama 35806

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION

Jointly operated by the
University of Alabama in Huntsville and Universities Space Research Association

Quadrennial Report for
September 1, 1993 - February 28, 1998

"GLOBAL CHANGE RESEARCH RELATED TO THE EARTH'S ENERGY AND HYDROLOGIC CYCLE"
Under
Cooperative Agreement: NCC8-22

Submitted to

THE GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA 35812

by

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

on behalf of the

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION
Global Hydrology and Climate Center
977 Explorer Drive
Huntsville, Alabama 35806

Approved by:

Donald J. Perkey, Director — Date 8/25/98
Institute for Global Change Research
and Education

Introduction and Overview

Background

The Institute for Global Change Research and Education (IGCRE) is a joint initiative of the Universities Space Research Association (USRA) and the University of Alabama in Huntsville (UAH) for coordinating and facilitating research and education relevant to global environmental change. Created in 1992 with primary support from the National Aeronautics and Space Administration (NASA), IGCRE fosters participation by university, private sector and government scientists who seek to develop long-term collaborative research in global change science, focusing on the role of water and energy in the Earth's atmosphere and physical climate system. IGCRE is also chartered to address educational needs of Earth system and global change science, including the preparation of future scientists and training of primary and secondary education teachers.

IGCRE strives to develop activities that have a national scope and character. These involve outreach and service to the university constituency at large, based on the outreach capabilities of USRA's nationally-based consortium of universities. The Institute also promotes long-term cooperative research and regional outreach to other federal and state agencies or industries. The Institute, through USRA-affiliated universities and UAH, promotes training of young scientists in the technology and techniques of global change and Earth system research, especially the utilization of remotely sensed data.

Since its inception, IGCRE has maintained a research staff of approximately 30 scientists, who are actively involved in earth science and global change investigations. In addition to research, IGCRE activities and functions include sponsorship, organization and coordination of scientific meetings, workshops and colloquia related to earth system and global change research, as well as logistical support for scientists from universities and other organizations who wish to visit NASA/Marshall Space Flight Center's Global Hydrology Research Office (formerly known as the Earth System Science Division).

In September 1994, IGCRE moved from its Marshall Space Flight Center location into the new Global Hydrology and Climate Center (GHCC), which is near both UAH and MSFC. Also located at the GHCC are MSFC's Global Hydrology Research Office (formerly known as the Earth System Science Division), the MSFC Global Hydrology Research Center (formerly known as the Hydrologic Data Active Archive Center--DAAC), the UAH Atmospheric Science Department and various NASA support contractors.

Since its inception, the IGCRE Executive Board has been jointly appointed by USRA and UAH, and includes senior executive and research management personnel. This Board then appoints the IGCRE Director, currently Dr. Donald J. Perkey, who oversees the operations of a research and management support group, as well as the scientific research personnel. The Board meets at least annually to evaluate the performance of the Director, to review and approve budget proposals, and to give general

guidance on the management and research associated with the Institute. Current Executive Board members are the following:

- Dr. Paul Coleman, President, Universities Space Research Association
- Dr. Graeme Duthie, Dean, College of Science, University of Alabama in Huntsville
- Dr. George Fisher, Convener, USRA Earth Sciences Council and Johns Hopkins University
- Dr. Frank Franz, President, University of Alabama in Huntsville
- Dr. Kenneth Harwell, Senior Vice President for Research, University of Alabama in Huntsville
- Dr. Donald Johnson, Director of USRA's Division of Earth Sciences, University of Wisconsin

Dr. Arthur Few, of Rice University, has also served on the IGCRE Executive Board in the past four years.

IGCRE is also reviewed by the USRA Science Council for Earth Sciences, to ensure the scientific programs continue to meet high standards. Science Council members during the past four years have been as follows:

- Dr. Arthur Few (Convener), Rice University
- Dr. George Fisher (Convener), Johns Hopkins University
- Dr. Robert D. Hudson, University of Maryland
- Mr. Roy Jenne, National Center for Atmospheric Research
- Dr. Peter Lamb, University of Oklahoma
- Dr. Ellen Mosley-Thompson, Ohio State University
- Dr. Gerald North, Texas A&M University
- Dr. Paola M. Rizzoli, Massachusetts Institute of Technology
- Dr. William H. Schlesinger, Duke University

IGCRE Scientific Research Programs

The emphasis of IGCRE research is on integrating observations, models and diagnostic studies to yield increased knowledge and understanding of the role of atmospheric water substance in climate and global change. This increased understanding and quantification of hydrologic and energetic processes is being used to validate parameterizations and models of physical processes that can be embedded within the framework of coupled earth system models.

More specifically, to enhance the scientific knowledge and educational benefits obtained from NASA's Earth Science Enterprise (formerly known as Mission to Planet Earth), and the U. S. Global Change Research Program, IGCRE scientists and their university and NASA colleagues

1. Facilitate research with and access to Earth Observing System and other Earth data sets, and assist scientists with the utilization and application of these date to global change research. Specifically, IGCRE global change research programs include the following:

- using surface-and space-based observations to determine past and present fluxes of water and energy to analyze components of the hydrologic cycle;
- employing the full range of models including conceptual, diagnostic, and one-, two- and three-dimensional complex numerical models to integrate and interpret the observations and analyses of the hydrologic cycle;
- predicting global change by increasing understanding, both qualitatively and quantitatively, of the hydrologic processes affecting global change, and
- developing specifications and requirements for development of future observing systems of the hydrologic cycle.

2. Participate in data management activities that aid scientific research. Specifically, IGCRE data management activities include:

- Participating in field studies and the processing, quality control and archiving of large data sets, and
- Developing specifications and requirements for development of data management systems and analysis tools.

3. Stimulate involvement of university, private-sector and government agency scientists who seek to develop long-term collaborative research in global change science. Specifically, IGCRE scientific outreach functions include

- collaborating and cooperating with Alabama A&M University faculty and research scientists to establish and promote The Center for Hydrology, Soil Climatology and Remote Sensing, funding by a NASA Minority University Research Centers contract. This has involved field experiments in 1996 and 1997 in the area of remote sensing of soil moisture, using ground-based radiometers and radars for measuring moisture in the surface layer of soil.
- sponsoring, organizing and coordinating scientific seminars, meetings, workshops and colloquia related to global change research, as well as encouraging and supporting visits by scientists from universities and other organizations.

Stated from a scientific perspective, the mission of IGCRE research is to advance understanding of the role of water in the energetics and dynamics of global change, and to foster scientific interaction between NASA scientists and university, industry and other-agency scientists. As such, we envision studies that

- provide a nationally recognized catalyst and focal point for research on the role of water in earth system dynamics and global change, and

- offer a creative and supporting research environment in which university and private-sector scientists can build meaningful and lasting research collaborations on the problems of earth system and global change science.

IGCRE Educational Programs

IGCRE scientists strive to develop programs that integrate research and educational programs to help universities prepare future global change scientists and to aid university, secondary and primary teachers communicate the importance and challenges of global change science. Specifically, educational initiatives over the past four years have included the following:

- development of visiting graduate student programs to promote student and faculty interest in global change research;
- establishing both university-based and pre-college education programs to encourage development of Earth system science curricula; (These have included the USRA-initiated Earth System Science Education [ESSE] Program, conceived and implemented as part of IGCRE, to support the development of undergraduate curricula emphasizing a multidisciplinary approach to the study of the planet Earth as a unified physical system. In addition, there has been the creation of a Precollege Curriculum Development and Testing Program to generate enthusiasm and increase environmental awareness about science among pre-college students.
- creating the EarthBase Student Participation program, allowing students to gain a better understanding of their environment through hands-on daily and weekly observations of soil moisture, precipitation and temperature at their school EarthBases.
- establishing the Mission To Planet Earth (MTPE) Teacher Workshops Program to train teachers to communicate the importance and challenges of Earth's system. This uses the Ground Truth Studies, an interdisciplinary, hands-on K-12 education project, and the EarthBase data collection analysis activities as vehicles to provide teachers with the knowledge and materials for introducing MTPE concepts into the classroom.
- assisting Alabama A&M University's Center for Hydrology, Soil Climatology and Remote Sensing in creating and continuing a summer internship program for minority and women undergraduates as part of that center's ongoing mandate from NASA's Minority University Research Centers' thrust. This program was established in 1996, and will continue at least through the summer of 1999.
- creating the Global Learning and Observation to Benefit the Environment (GLOBE) Program in 1997, at the GHCC. This hand-on environmental science and education program for grade levels K-12 joins students, educators and scientists from around the world in studying the global environment; students make a core set of environmental observations at or near their schools, report their data through the Internet to a GLOBE data archive, and then study images created from worldwide GLOBE school data.

Outreach Activities

IGCRE sponsors, organizes and coordinates scientific seminars, meetings colloquia and workshops related to global change research. During the last four years, these have included (but were not limited to) the following:

- LAWS Science Team Meeting (February 1994)
- Global Hydrology Workshop (May 1995)
- Hydrologic Cycle Data Access and Archive Working Group (April 1994 and July 1995)
- GLOBE SWG Meeting (May 1994)
- Working Group on Space-Based Lidar Winds (June 1995, February and July 1996, July 1997)
- Remote Sensing Workshop (November 1995)
- NOAA GCIP Working Group Meeting (November 1996)
- Lightning Science Workshop (March 1997)
- CAMEX3 Planning Workshop (March 1997)

IGCRE also promotes scientific interaction among university and industry scientists and IGCRE and NASA scientists, as well as developing visiting programs to promote student and faculty interest in Earth system science research. For example, the Institute sponsors undergraduate students working on specific research, graduate students engaged in thesis or dissertation research, and short- and long-term visiting scientists and educators.

Facilities Activities

By providing IGCRE and NASA scientists with the centralized location of the Global and Hydrology and Climate Center, IGCRE has continued to support scientific and educational activities regarding the role of water and energy in the dynamics of the Earth's atmosphere and physical climate system. Also under this cooperative agreement, IGCRE has provided a support system for scientists in the GHCC by means of facilities management, building reception, network and computer support teams.

Scientific Publications, Presentations and Other Communications

Attached appendices provide lists of publications and conference presentations that have been communicated to the scientific community by IGCRE scientists. Appendices also include information on scientists' travel to conferences and workshops, and in-house visits from scientists and faculty throughout the university community. These are arranged by year, in reverse chronological order.

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION

Jointly operated by the
University of Alabama in Huntsville and Universities Space Research Association

Annual Report for
September 1, 1996 - August 31, 1997

"GLOBAL CHANGE RESEARCH RELATED TO THE EARTH'S ENERGY AND HYDROLOGIC CYCLE"
Under
Cooperative Agreement: NCC8-22

Submitted to

THE GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA 35812

by

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

on behalf of the

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION
Global Hydrology and Climate Center
977 Explorer Drive
Huntsville, Alabama 35806

Approved by:

Donald J. Perkey, Director — Date 9/20/97
Institute for Global Change Research
and Education

APPENDIX A

STAFF TRAVEL ACTIVITIES

Name	Dates	Location	Reason
Bowdle, D.	8/16-9/20/97	Denver, CO	To participate in NASA Dryden flight Test for ACLAIM
Bowdle, D.	7/12-17/97	Northglenn, CO	To attend NOAA Working Group Meeting on Space-Based Lidar Winds
Bowdle, D.	10/30-11/01/96	Ann Arbor, MI/ Madison, WI	To present aerosol model plan and results to ALOADS at University of Michigan and discuss plans for aerosol transport model at University of Wisconsin
Buechler, D.	7/30-8/04/96	Washington, DC	To support LIS testing at GSFC
Chang, F.-C.	2/02-08/97	Long Beach, CA	To present paper at AMS Conferences on Hydrology and Climate Variations
Christy, J.	12/09/96	Washington, DC	To brief White House Science Office on global warming
Conover, H.	1/27-29/97	Greenbelt, MD	To attend Release B client workshop
Conway, D.	3/31-4/03/97	Arlington, VA	To attend EOSDIS Instrument Teams Metadata Workshop
Conway, D.	10/21-23/96	GSFC, MD	To attend AMSR Science Team meeting
Cox, G.	7/97	Airlie, VA	To give invited presentation at the 1997 International GLOBE Partners Conference
Cox, G.	7/97	Clemson, SC	To represent Alabama at the 1997 Southeast MAPS Conference
Cox, G.	4/97	New Orleans, LA	To present at the 1997 National Science Teachers Association meeting

Cox, G.	10/96	Rostov-on-Don, Russia	To co-chair a conference on the Municipal Applications of Geographic Information Systems
Crosson, W.	2/02-08/97	Long Beach, CA	To present paper at AMS Conference on Hydrology
Crosson, W.	8/26-27/96	Beltsville, MD	To attend planning workshop for 1997 Southern Great Plains experiment
Cutten, D.	10/15-17/96	Boulder, CO	To attend MACAWS workshop to discuss progress on data analysis and future flights
Drewry, M.	3/31-4/04/97	Washington, DC/ Landover, MD	To attend DMWS and IMS meetings
Drewry, M.	2/04-07/97	Long Beach, CA	To attend AMS Annual Meeting
Drewry, M.	7/29-8/03/97	Greenbelt, MD	To participate in V0 IMS meeting and V0 Guide meeting
Ellett, W.	9/16-19/96	Washington, DC	To attend GSFC Mass Storage Conference
Estes, M.	9/97	Atlanta, GA	To attend EPA Global Change Impacts in the Southeast Conference
Estes, M.	9/97	Atlanta, GA	To attend Project ATLANTA Applications Working Group meeting
Estes, M.	6/24-27/97	Nashville, TN	To attend Southeast Regional Assessment Workshop
Estes, M.	4/97	Austin, TX	To attend National Conference on Undergraduate Research
Estes, M.	2/97	Albuquerque, NM	To attend Technical Conference for the Minority Universities Research and Education Program
Graves, S..	8/18-21/97	Woods Hole, MA	To attend EOSDIS Data Panel meeting

Graves, S.	3/17-20/97	Greenbelt, MD	To attend DAAC Managers' Meeting
Graves, S.	2/08-14/97	Mayaguez, PR/ Boulder, CO	To attend Review Panel for University of Puerto Rico and EOS Data Panel
Hardin, D.	6/23-28/97	Hampton, VA	To attend DAAC Managers' Meeting
Hardin, D.	3/17-20/97	Greenbelt, MD	To attend DAAC Managers' Meeting
Hardin, D.	1/27-29/97	Greenbelt, MD	To attend ECS Release B client workshop
Harrison, S.	6/02-06/97	Asheville, NC	To attend User Services Working Group meeting
Laymon, C.	2/02-08/97	Long Beach, CA	To attend AMS 13th Conference on Hydrology
Laymon, C.	1/06-09/97	Oklahoma City, OK	To coordinate meeting for 1997 Southern Great Plains experiment
Laymon, C.	8/26-28/96	Beltsville, MD	To attend planning work-shop for the 1997 Southern Great Plains Experiment
Lobl, E.	8/07/96	Greenbelt, MD	To participate in follow-up meeting with sea ice team members and to decide on an AMSR team members and to decide on sea ice algorithm
Lobl, E.	7/28-31/96	Annapolis, MD	To participate in payload panel meeting
Lobl, E.	2/22-27/97	Los Angeles, CA	To present at EOS-IWG poster session (AMSR)
Lobl, E.	10/21-23/96	GSFC, MD	To attend AMSR Science Team meeting
Lobl, E.	9/24/96	Baltimore, MD	To attend meeting on status of the Sea Ice ATBD
Lobl, E.	8/24-26/96	Frascati, Italy	To attend meeting of the Microwave Calibration Group

Mach, D.	12/14-21/96	San Francisco, CA	To present OTD results at AGU Fall Meeting
McCaul, W.	1/21-23/97	Miami, FL	To attend meetings at NOAA, AOML, HRD PDT
McCoy, S.	7/29-8/01/96	Greenbelt, MD	To participate in V0 IMS meeting
Paech, S.	6/04/97	Birmingham, AL	To work with data on the NWS PUP terminal
Perkey, D.	6/24-27/97	Nashville, TN	Attend NASA workshop on Climate Variability and Water Resource Management in the Southeast U.S.
Perkey, D.	3/26-27/97	Washington, DC	To participate in the USRA Directors' Meeting
Perkey, D.	2/21-28/97	Philadelphia, PA	To participate in the Ph.D. dissertation defense of Kevin Doty at Drexel University
Perkey, D.	2/01-09/97	Long Beach, CA	To present paper at AMS Annual Meeting
Perkey, D.	10/07-11/96	Boulder, CO	To participate in UCAR members' representatives meeting as Chair of the Membership Committee
Ritschard, R.	8/18/97	Washington, DC	To brief Bill Townsend (MTPE) on developing a Southeast Regional Assessment Center in Huntsville, AL
Ritschard, R.	7/23-24/97	Washington, DC	To attend meeting at GSFC on MTPE outreach strategy
Ritschard, R.	7/21/97	Washington, DC	To brief NASA HQ and GSFC on Southeast Regional Workshop
Ritschard, R.	6/24-27/97	Nashville, TN	To chair and attend the Southeast Regional Workshop at Vanderbilt University (NASA, NOAA and USGS)

Ritschard, R.	6/09-12/97	Seattle, WA	To attend Assessment of the Use of Climate Predictions for Water Resources Management workshop and the Water Resources Users Group meeting
Ritschard, R.	3/19/97	Tallahassee, FL	To meet with Jim O'Brien at Florida State University and discuss program committee duties for Southeast Regional Workshop
Ritschard, R.	2/26-27/97	Washington, DC	To visit NASA HQ, attend USGCRP and Regional Workshop meeting at NSF
Ritschard, R.	9/23-25/96	Washington, DC/ Boulder, CO	To convene planning meeting for Regional Workshop on Climate Variation and Water Resources Management Decisions and to present CADSWESO to USBG, USGC, etc.
Spiers, G.	9/18/21/96	Sunnyvale, CA	To present at the Windsat design review meeting
Srivastava, V.	5/19-23/97	Ft. Collins, CO	To present paper at the 22nd Conference on Hurricanes and Tropical Meteorology
Stewart, M.	5/13-15/97	Greenbelt, MD	Calibrate LIS on TRMM spacecraft
Stewart, M.	7/30-31/96	Tampa, FL	To inspect NASA G-IV aircraft for fieldmill installation
Wang, S.	7/28-8/01/97	Vancouver, BC	To present papers at 12th Boundary Layer Turbulence Conference
Wang, S.	4/97	Boulder, CO	To attend FIRE III Science Team Mtg.
Wang, S.	10/96	Boulder, CO	To attend FIRE III ScienceTeam Mtg.

APPENDIX B

PUBLICATIONS AND PRESENTATIONS

Refereed Publications

Submitted

Braswell, W. D., and R. S. Lindzen, 1997: Anomalous short wave absorption and atmospheric tides. Submitted, *Geophys. Res. Lett.*

Christy, J. R., R. W. Spencer, and **W. D. Braswell**, 1997: Satellites are accurate. Submitted, *Nature.*

Christy, J. R., R. W. Spencer, and **E. S. Lobl**, 1997: Analysis of the merging procedure for the MSU daily temperature-time series. Submitted, *J. Climate.*

Crosson, W. L., **C. A. Laymon**, 1996: Assessment of the impact of spatial variability on land surface fluxes using high-resolution satellite data and a land surface flux model. Submitted, *J. Appl. Meteor.*

Kim, J. H., and **M. J. Newchurch**, 1997: Biomass-burning influence on tropospheric ozone over New Guinea and South America. Submitted, *J. Geophys. Res.*

Knupp, K. R., **J. Stalker**, and **E. W. McCaul, Jr.**, 1997: A numerical and observational study of the mini-supercell storm. Submitted, *Atmos. Res.*

Knupp, K. R., **B. Geerts**, and S. J. Goodman, 1996: Structure of a small, vigorous mesoscale convective system. Part I: Formation, radar echo morphology and lightning behavior. Submitted, *Mon. Wea. Rev.*

Tong, H., V. Chandresekar, **K. R. Knupp**, and **J. Stalker**, 1997: Multiparameter radar and multiple Doppler observation of time evolution of convective storms: Evaluation of water budgets and latent heat. Submitted, *J. Appl. Meteor.*

Laymon, C. A., D. Quattrochi, E. Malek, L. Hipps, J. Boettinger, G. McCurdy, 1996: Use of Landsat Thematic Mapper data to estimate instantaneous synoptic-scale hydrologic fluxes in a semi-arid Great Basin desert. Invited Submission, *Geomorphology on Remote Sensing Appl.*

Laymon, C., 1996: Remote sensing in hydrology: Recent field experiments. Submitted, *EOS, Transactions,* Amer. Geophys. Union.

McNider, R. T., W. Norris, A. Song, R. Clymer, and S. Gupta, 1997: Meteorology during the 1995 SOS Nashville/Middle Tennessee field intensive. Submitted, *J. Geophys. Res.*

McNider, R. T., A. Song, W. Norris, W. Chameides, and P. Zimmerman, 1997: Interpretation of boundary layer profiles using large eddy simulation. Submitted, *J. Geophys. Res.*

Banta, R. C. Senff, A. White, M. Trainer, D. Parrish, **R. T. McNider**, R. Valenta, P. Daum, S. Mayor, R. Alvarez, R. Hardesty, and F. Fehsenfeld, 1997: Daytime buildup and nighttime transport of urban ozone in the boundary layer during a stagnation episode. Submitted, *J. Geophys. Res.*

Newchurch, M. J., D. M. Cunnold, C. L. Mateer, and J. Cao, 1997: Intercomparison of SAGE with Umkehr[64] and Umkehr[92] ozone profiles and time series: 1979-1991. Submitted, *J. Geophys. Res.*

Rinsland, C. P., M. R. Gunson, P. Wang, R. F. Arduini, B. A. Baum, P. Minnis, A. Goldman, M. C. Abrams, R. Zander, E. Mahieu, R. J. Salawitch, H. A. Michelsen, F. W. Irion, and **M. J. Newchurch**, 1997: ATMOS/ATLAS 3 infrared profile measurements of clouds and trace gases in the tropical upper troposphere: Cirrus microphysical properties and trace gas enhancements from rapid, deep convective transport. Submitted, *J. Quant. Spec. Rad. Trans.*

Jarzembski, M. A., and **V. Srivastava**, 1997: Backscatter of earth surfaces from 9.1 um lidar data. Submitted, *Appl. Opt.*

Accepted

Goodrick, S., R. T. McNider, and W. Schroeder, 1997: On the interaction of the katabatic-land-sea wind system of the Antarctic with the high latitude southern ocean. Accepted, *Antarctic Res. Series: Oceanology of the Antarctic Continental Shelf (AGU Monographs).*

Knupp, K., J. Stalker, and **E. W. McCaul, Jr.**, 1997: An observational and numerical study of a mini-supercell storm. Accepted, *Atmos. Res.*

Laymon, C. A., D. Quattrochi, E. Malek, L. Hipps, J. Boettinger, G. McCurdy, 1997: Remotely sensed regional-scale evapotranspiration of a semi-arid Great Basin Desert and its relationship to the region's geomorphology, soils and vegetation. Invited paper, *Geomorphology.*

Lu, H.-I., and T. L. Miller, 1996: Characteristics of annulus baroclinic flow structure during amplitude vacillation. Accepted, *Dynamics of Atmos. and Oceans.*

Lu, H.-I., and T. L. Miller, 1996: Wave dispersion in a rotating differentially-heated flor model. Accepted, *Dynamics of Atmos. and Oceans.*

Mach, D. M., and W. D. Rust, 1996: Two-dimensional speed and optical risetimes estimates for natural and triggered dart leaders. Accepted, *J. Geophys. Res., Atmos.*

McNider, R. T., S. Goodrick, J. Christy, A. Davis, and W. Schroeder, 1996: On the relationship between the katabatic wind systems of the Antarctic and biological productivity of the high latitude southern ocean. In Revision, *Science*.

Gopalakrishnan, S. G., M. Shran, **R. T. McNider**, M. P. Singh, 1996: Study of radiative and turbulent processes in the stable boundary layer under weak wind conditions. Accepted, *J. Atmos. Sci.*

Jarzembski, M. A., **V. Srivastava, E. W. McCaul, Jr.**, G. J. Jedlovec, R. J. Atkinson, R. F. Pueschel, and **D. R. Cutten**, 1997: Comparison of lidar-backscatter with particle distribution and GOES-7 data in Hurricane Juliette. Accepted, *Geophys. Res. Lett.*

Published

Spencer, R.W., and **W. D. Braswell**, 1997: How dry is the tropical free troposphere? Implications for global warming theory. *Bull. Amer. Meteor. Soc.*, June.

Spencer, R. W., **J. R. Christy**, and N. C. Grody, 1996: Analysis of examination of "Global atmospheric temperature monitoring with satellite microwave measurements". *Climatic Change*, **33**, 477-489.

Crosson, W. L., C. E. Duchon, **R. Raghavan**, and S. J. Goodman, 1996: Assessment of rainfall estimated using a standard Z-R relationship and the probability matching method applied to composite radar data in central Florida. *J. Appl. Meteor.*, **35**, 1203-1219.

Driscoll, K. T., and R. J. Blakeslee, 1996: Comment on "Current budget of the atmospheric electric global circuit" by Heinz W. Kasemir. *J. Geophys. Res.*, **101**, 17037-17040.

Gupta, S., R. T. McNider, M. Trainer, and R. Zamora, 1997: Nocturnal wind structure and plume growth rates due to inertial oscillations. *J. Appl. Meteor.*, **36**, 1050-1063.

Kim, J. H., and **M. J. Newchurch**, 1996: Tropospheric ozone over the eastern Pacific Ocean: The influences of biomass burning and stratospheric intrusion. *Geophys. Res. Lett.*, **23**, 3723-3726.

Jedlovec, G. J., R. J. Atkinson, **J. A. Lerner**, and **S. Q. Kidder**, 1996: "An upper-level water vapor transport index for climate research." *GEWEX News*, **6**:3, August.

Davis, A., and **R. T. McNider**, 1997: The development of Antarctic katabatic winds and implications for the coastal ocean. *J. Atmos. Sciences*, **54**, 1248-1261.

England, D., and **R. T. McNider**, 1997: On the absence of limit cycles within the domains of a two-layer nocturnal slope flow model. *Nonlinear World*, **4**, 163-171.

Newchurch, M. J., M. Allen, M. R. Gunson, R. J. Salawitch, G. B. Collins, K. H. Huston, M. M. Abbas, M. C. Abrams, A. Y. Chang, D. W. Fahey, R. S. Gao, F. W. Irion, M. Lowenstein, G. L. Manney, H. A. Michelsen, J. R. Podolske, C. P. Rinsland, and R. Zander, 1996: Stratospheric NO and NO2 abundances from ATMOS solar-occultation measurements. *Geophys. Res. Lett.*, **23**, 2373-2376.

Lary, D. J., R. Toumi, A. M. Lee, **M. J. Newchurch**, M. Pirre, J. B. Renard, 1997: Carbon aerosols and atmospheric photochemistry. *J. Geophys. Res.*, **102**.

Abbas, M. M., H. A. Michelsen, M. R. Gunson, M. C. Abrams, **M. J. Newchurch**, R. J. Salawitch, A. Y. Chang, A. Goldman, F. W. Irion, G. L. Manney, E. J. Moyer, R. Nagaraju, C. P. Rinsland, G. P. Stiller, and R. Zander, 1996: Seasonal variations of water vapor in the lower stratosphere inferred from ATMOS/ATLAS-3 measurements of H2O and CH4. *Geophys. Res. Lett.*, **23**, 2401-2404.

Abbas, M. M., M. R. Gunson, **M. J. Newchurch**, H. A. Michelsen, R. J. Salawitch, M. Allen, M. C. Abrams, A. Y. Chang, A. Goldman, F. W. Irion, E. J. Moyer, R. Nagaraju, C. P. Rinsland, G. P. Stiller, and R. Zander, 1996: The hydrogen budget of the stratosphere inferred from ATMOS measurements of H2O and CH4. *Geophys. Res. Lett.*, **23**, 2405-2408.

Abrams, M. C., A. Y. Chang, M. R. Gunson, M. M. Abbas, A. Goldman, F. W.Irion, H. A. Michelsen, **M. J. Newchurch**, C. P. Rinsland, G. P. Stiller, and R. Zander, 1996: On the assessment and uncertainty of atmospheric trace gas burden measurements with high resolution infrared solar occultation spectra from space by the ATMOS experiment. *Geophys. Res. Lett.*, **23**, 2337-2340.

Abrams, M. C., G. L. Manney, M. R. Gunson, M. M. Abbas, A. Y. Chang, A.Goldman, F. W. Irion, H. A. Michelsen, **M. J. Newchurch**, C. P. Rinsland, R. J. Salawitch, G. P. Stiller, and R. Zander, 1996: ATMOS/ATLAS-3 observations of long-lived tracers and descent in the Antarctic vortex in November 1994. *Geophys. Res. Lett.*, **23**, 2341-2344.

Abrams, M. C., G. L. Manney, M. R. Gunson, M. M. Abbas, A. Y. Chang, A. Goldman, F. W. Irion, H. A. Michelsen, **M. J. Newchurch**, C. P. Rinsland, R. J. Salawitch, G. P. Stiller, and R. Zander, 1996: Trace gas transport in the Arctic vortex inferred from ATMOS ATLAS-2 observations during April 1993. *Geophys. Res. Lett.*, **23**, 2345-2348.

Chang, A. Y., R. J. Salawitch, H. A. Michelsen, M. R. Gunson, M. C. Abrams, R. Zander, C. P. Rinsland, M. Lowenstein, J. R. Podolske, M. H. Proffitt, J. J. Margitan, D. W. Fahey, R.-S. Gao, K. K. Kelly, J. W. Elkins, C. R. Webster., R. D. May, K. R. Chan, M. M. Abbas, A. Goldman, F. W. Irion, G. L. Manney, **M. J. Newchurch**, and G. P. Stiller, 1996: A comparison of measurements from ATMOS and instruments aboard the ER-2 aircraft: Traces of atmospheric transport. *Geophys. Res. Lett.*, **23**, 2389-2392.

Chang, A. Y., R. J. Salawitch, H. A. Michelsen, M. R. Gunson, M. C. Abrams, R. Zander, C. P. Rinsland, J. W. Elkins, G. S. Dutton, C. M. Volk, C. R. Webster, R. D. May, D.W. Fahey, R.-S. Gao, M. Lowenstein, J. R. Podolske, R. M. Stimpfle, D.W. Kohn, M. H. Proffitt, J. J. Margitan, K. R. Chan, M. M. Abbas, A. Goldman, F. W. Irion, G. L. Manney, **M. J. Newchurch**, and G. P. Stiller, 1996: A comparison of measurements from ATMOS and instruments aboard the ER-2 aircraft: Halogenated gases. *Geophys. Res. Lett.*, **23**, 2393-2396.

Gunson, M. R., M. M. Abbas, M. C. Abrams, M. Allen, L. R. Brown, T. L. Brown, A. Y. Chang, A. Goldman, F. W. Irion, L. L. Lowes, E. Mahieu, G. L. Manney, H. A. Michelsen, **M. J. Newchurch**, C. P. Rinsland, R. J. Salawitch, G. P. Stiller, G. C. Toon, Y. L. Yung, and R. Zander, 1996: The Atmospheric Trace Molecule Spectroscopy (ATMOS) experiment: Deployment on the ATLAS space shuttle missions. *Geophys. Res. Lett.*, **23**, 2333-2336.

Irion, F. W., E. J. Moyer, M. R. Gunson, C. P. Rinsland, Y. L. Yung, H. A. Michelsen, R. J. Salawitch, A. Y. Chang, **M. J. Newchurch**, M. M. Abbas, M. C. Abrams, and R. Zander, 1996: Stratospheric observations of CH3D and HDO from ATMOS infrared solar spectra: Enrichments of deuterium in methane and implications for HD. *Geophys. Res. Lett.*, **23**, 2381-2384.

Kriebel, D. L., R. M. Bevilacqua, E. Hilsenrath, M. Gunson, G. K. Hartmann, M. Abrams, M. Daehler, T. A. Pauls, **M. J. Newchurch**, C. P. Aellig, and M. C. Bories, 1996: A comparison of ozone measurements made by the ATMOS, MAS, and SSBUV instruments during ATLAS 1,2, and 3. *Geophys. Res. Lett.*, **23**, 2301-2304.

Michelsen, H. A., R. J. Salawitch, M. R. Gunson, C. Aellig, N. Kaempfer, M. M. Abbas, M. C. Abrams, T. L. Brown, A. Y. Chang, A. Goldman, F. W. Irion, **M. J. Newchurch**, C. P. Rinsland, G. P. Stiller, and R. Zander, 1996: Statospheric chlorine partitioning: Constraints from shuttle-borne measurements of [Hcl], [CINO3],and [CIO], *Geophys. Res. Lett.*, **23**, 2361-2364.

Rinsland, C. P., E. Mahieu, R. Zander, M. R. Gunson, R. J. Salawitch, A. Y. Chang, A. Goldman, M. C. Abrams, M. M. Abbas, **M. J. Newchurch**, and F. W. Irion, 1996: Trends of OCS, HCN, SF6, CHCIF2, (HCFC-22) in the lower stratosphere from 1985 and 1994 Atmospheric Trace Molecule Spectroscopy experiment measurements near 30°N latitude. *Geophys. Res. Lett.*, **23**, 2349-2352.

Rinsland, C. P., M. R. Gunson, R. J. Salawitch, H. A. Michelsen, R. Zander, **M. J. Newchurch**, M. M. Abbas, M. C. Abrams, G. L. Manney, A. Y. Chang, F. W. Irion, A. Goldman, and E. Mahieu, 1996: ATMOS/ATLAS-3 measurements of stratospheric chlorine and reactive nitrogen partitioning inside and outside the November 1994 Antarctic Vortex. *Geophys. Res. Lett.*, **23**, 2365-2368.

Rinsland, C. P., M. R. Gunson, R. J. Salawitch, **M. J. Newchurch**, R. Zander, M. M. Abbas, M. C. Abrams, G. L. Manney, H. A. Michelsen, A. Y. Chang, and A. Goldman, 1996: ATMOS Measurements of H2O+2CH4 and total reactive nitrogen in the November 1994 Antarctic stratosphere: Dehydration and denitrification in the vortex. *Geophys. Res. Lett.*, **23**, 2397-2400.

Zander, R., S. Solomon, E. Mahieu, A. Goldman, C. P. Rinsland, M. R. Gunson, M. C. Abrams, A. Y. Chang, R. J. Salawitch, H. A. Michelsen, **M. J. Newchurch**, and G. P. Stiller, 1996: Increase of stratospheric carbon tetraflouride (CF4) based on ATMOS observations from space. *Geophys. Res. Lett.*, **23**, 2353-2356.

Zander, R., E. Mahieu, M. R. Gunson, M. C. Abrams, A. Y. Chang, M. Abbas, C. Aellig, A. Engel, A. Goldman, F. W. Irion, N. Kampfer, H. A. Michelsen, **M. J. Newchurch**, C. P. Rinsland, R. J. Salawitch, G. P. Stiller, and G. C. Toon, 1996: The 1994 northern midlatitude budget of stratospheric chlorine derived from ATMOS/ATLAS-3 observations. *Geophys. Res. Lett.*, **23**, 2357-2360.

Singh, M. P., R. T. McNider, R. Meyers, and **S. Gupta**, 1997: Nocturnal wind structure over land and dispersion of pollutants, an analytical study. *Atmos. Environ.*, **31**, 105-115.

Singh, M. P., R. T. McNider, and Z. Shi, 1996: A dynamical analysis of time dependent katabatic flows. *Nonlinear World*, **3**, 709-756.

Soman, V. V., J. B. Valdes, and G. R. North, 1996: Estimation of sampling errors and scale parameters using two-and three-dimensional rainfall data analyses. *J. Geophys. Res.*, **101**:D21, 26453-26460.

Song, A., W. B. Norris, S. Gupta, and **R. T. McNider**, 1996: Modeling pollutant transport during high-ozone episodes in the southern Appalachian Mountains. *J. Appl. Meteor.*, **35**, 2105-2120.

Srivastava, V., M. A. Jarzembski, A. D. Clarke, and J. Rothermel, 1997: Comparison of backscatter modeling using measured aerosol microphysics with lidar data over the Pacific Ocean. *J. Geophys. Res.*, **102**, 16605-16617.

Jarzembski, M. A., **V. Srivastava, E. W. McCaul, Jr.**, G. J. Jedlovec, R. J. Atkinson, R. F. Pueschel, and **D. R. Cutten**, 1997: Comparison of lidar backscatter with particle distribution and GOES-7 data in Hurricane Juliette. *Geophys. Res. Let.*, **24**, 1063-1066.

Jarzembski, M. A., and **V. Srivastava**, 1997: Low pressure experimental simulation of electrical discharges above and inside a cloud. *J. of Atmos. and Solar-Terres. Phys.*, **59**, 271-279.

Bechtold, P., S. K. Krueger, W. S. Lewellen, E. van Meijgaard, C.-H. Moeng, D. A. Randall, A. van Ulden, and **S. Wang**, 1996: Modeling a stratocumulus-topped PBL: Intercomparison among different one-dimensional codes and with large eddy simulation. *Bull. Amer. Meteor. Soc.*, 77, 2033-2042.

Books

McNider, R. T., M. P. Singh, and S. Gupta, 1997: The stable boundary layer, section B (chapter). Submitted.

Conference Presentations and Publications

Buechler, D., D. Boccippio, **K. Driscoll**, W. Koshak, J. Hall, 1996: Diurnal cycle of lightning as observed by the OTD: Preliminary results for Africa. Presentation, *AGU Fall Meeting*, San Francisco, 15-20 Dec.

Smith, M. R., **B. Beaumont**, **S. Graves**, 1997: Subsetting data for EOSDIS. Preprints, *AMS 13th Internatl. Conf. on Interactive Info. Proc. Sys. for Meteor., Oceanogr., and Hydrol.*, Long Beach, CA, 2-7 Feb., 13IIPS, 13.9, 413-415.

Spencer, R. W., **W. D. Braswell**, 1997: Hydrometeor influence on, and lapse rate changes inferred from, the MSU temperature record. *AMS Ann. Mtg.*, Long Beach, CA, 2-7 Feb.

Chang, F.-C., 1997: Summertime atmospheric teleconnections as revealed in NMC analysis and NCEP/NCAR reanalysis. Preprints, *AMS 7th Conf. on Climate Variations*, Long Beach, CA, 2-7 Feb., 382-385.

Chang, F.-C., 1997: Total precipitable water distribution during summertime drought episodes over the central United States Great Plains. Preprints, *AMS 13th Conf. on Hydrol.*, Long Beach, CA, 2-7 Feb., 48-51.

Christy, J. R., 1997: Assessing the long-term stability of the 18-year MSU time series. Presentation, *AMS 8th Symp. on Global Change Studies*, Long Beach, CA, 2-7 Feb.

Conover, H., **B. Beaumont**, and **S. Graves**, 1996: Information systems research at the Global Hydrology and Climate Center. Publication, *AIAA Space Programs and Technologies Conf.*, Huntsville, AL, 24-26 Sept.

Crosson, W. L., **C. A. Laymon**, A. Manu, T. D. Tsegaye, and R. Inguva, 1997: Huntsville '96 microwave remote sensing of soil moisture experiment: Description of soil moisture profiles. Proceedings., *AMS Conf. on Hydrol.*, Long Beach, CA, 2-7 Feb.

Belisle, W., A. Manu, T. Tsegaye, Z. Senwo, A. Fahsi, G. Robertson, J. Boggs, W. Tadesse, T. Coleman, P. O'Neill, T. Jackson, **W. Crosson**, **C. Laymon**, 1997: Comparison of soil moisture determination underdifferent crop coverages using remote sensing and conventional methods. Presentation, *AMS 13th Ann. Conf. on Hydrol.*, Long Beach, CA, 2-8 Feb.

Rothermel, J., **D. R. Cutten**, R. M. Hardesty, R. T. Menzies, D. M. Tratt and S. Johnson, 1997: Application of airborne Doppler laser radar to hurricane research. *22nd Conf. on Hurricanes and Tropical Meteor.*, Ft. Collins, CO, 19-23 May.

Rothermel, J., **D. R. Cutten**, R. M. Hardesty, J. N. Howell, R. T. Menzies, D. M. Tratt, and S. C. Johnson, 1997: Application of airborne Doppler laser radar to hurricane research. *AMS Conf.*, Long Beach, CA, 2-7 Feb.

Drewry, M., **H. Conover**, **S. Graves**, and S. Goodman, 1997: A new perspective on EOSDIS data management: The LIS SCF. *13th AMS Conf. on Hydrol.*, Long Beach, CA, 2-7 Feb.

Driscoll, K. T., H. J. Christian, S. J. Goodman, R. J. Blakeslee, D. J. Boccippio, 1996: Diurnal global lightning distribution as observed by the Optical Transient Detector (OTD). Poster Presentation, *AGU Fall Mtg.*, San Francisco, 14-19 Dec.

Bailey, J., R. J. Blakeslee, **K. T. Driscoll**, 1996: Absence of conductivity variations above thunderstorms. *AGU Fall Mtg.*, San Francisco, 14-19 Dec.

Christian, H. J., **K. T. Driscoll**, S. J. Goodman, R. J. Blakeslee, **D. A. Mach**, **D. E. Buechler**, 1996: Seasonal variation and distribution of lightning activity. Presentation, *AGU Fall Mtg.*, San Francisco, 15-20 Dec.

Estes, M. G., Jr., D. J. Perkey, and T. L. Coleman, 1997: The HSCaRS summer enrichment program: Recent opportunities for minority and women undergraduates in global change science. Proceedings, *Technical Conference for the Minority Universities Research and Education Program (MURED)*, NASA-University Research Centers, Albuquerque, NM, 16-19 Feb.

Gillani, N., 1996: Chemical evolution, magnitude, yield and efficiency of ozone production in power plant plumes in the Tennessee Valley region. *AGU Fall Mtg.*, San Francisco, 15-20 Dec.

Graves, S., and **T. H. Hinke**, 1997: Application of information technology in global hydrology research. Presentation, *Space Symposium, Technical and Business Exhibition/Symposium (TABES)*, Huntsville, AL, 13 May.

Graves, S., 1997: Synergy between information technology and education. Chair, Education Symposium, *Technical and Business Exhibition/Symposium (TABES)*, Huntsville, AL, 14 May.

Hinke, T. H., J. Rushing, S. Kansal, **S. J. Graves**, H. Ranganath, and **E. Criswell**, 1997: Eureka phenomena discovery and phenomena mining system. Presentation, *13th Internatl. Conf. on Interactive Information and Processing Systems (IIPS) for Meteor., Oceanogr., and Hydrol.*, AMS Ann. Mtg., Long Beach, CA, 5 Feb.

Laymon, C. A., W. Belisle, T. Coleman, **W. L. Crosson**, A. Fahsi, R. Hood, T. Jackson, J. Luvall, A. Manu, P. O'Neill, Z. Senwo, T. Tsegaye, and S. Wu, 1997: Huntsville '96 microwave remote sensing of soil moisture experiment: Overview and preliminary results. Proc., *AMS Conf. on Hydrol.y*, Long Beach, CA, 2-7 Feb.

Tsegaye, T. D., T. Coleman, A. Manu, Z. Senwo, A. Fahsi, W. Belisle, W. Tadesse, G. Robertson, J. Boggs, F. Archer, J. Surrency, L. Birgan, **C. A. Laymon**, **W. L. Crosson**, and J. Miller, 1997: Spatial and temporal variability of soil moisture with and without vegetation and its impact on remote sensing measurements. Proc., *AMS Conf. on Hydrol.*, Long Beach, CA, 2-7 Feb., 349-351.

Quattrochi, D. A., and **C. A. Laymon**, 1997: Characterization of surface energy fluxes in a Great Basin desert valley. AAG, Ft. Worth, TX, 1-5 Apr.

Robertson, G., T. Tsegaye, T. Coleman, **C. A. Laymon**, and **W. L. Crosson**, 1997: Water content reflectometry calibration for a uniform and nonuniform wetted soil. *NURC '97 Conf.*, Baton Rouge, LA.

Jedlovec, G. J., R. J. Atkinson, and **J. A. Lerner**, 1997: Upper-level water vapor transport from GOES data. Preprints, *AMS 13th Conf. on Hydrol.*, Long Beach, CA, 2-7 Feb., 253-256.

Lu, H.-I., and T. L. Miller, 1997: Mechanics of baroclinic wave dispersion in the rotating annulus. *11th Conf. on Atmospheric and Oceanic Waves and Stability*, Tacoma, WA, 23-27 June.

Mach, D., **D. Buechler**, **K. Driscoll**, **R. Raghavan**, W. Boeck, R. Blakeslee, H. Christian, S. Goodman, W. Koshak, 1996: A flash discrimination algorithm based on the temporal and spatial characteristics of lightning optical pulses observed from space. Poster Presentation, *AGU Fall Meeting*, San Francisco, 15-20 Dec.

Blakeslee, R., W. L. Boeck,, S. J. Goodman, H. Christian, **D. Mach**, **D. Buechler**, D. Boccippio, **K. Driscoll**, W. Koshak, J. Hall, 1996: Diurnal cycle of lightning as observed by the OTD: Preliminary results for Africa. Poster presentation, *AGU Fall Meeting*, San Francisco, 14-19 Dec.

McNider, R. T., **S. Gupta**, M. Trainer, R. Zamora, 1996: Nocturnal wind structure and plume growth rates due to inertial oscillations. Presentation, *AGU Fall Meeting*, San Francisco, 14-19 Dec.

McNider, R. T., R. Banta, C. Senff, A. White, M. Trainer, D. Parrish, R. Valente, P. Daum, S. Mayor, R. Alvarez, R. Hardesty, and F. Fehsenfeld, 1996: daytime buildup and nighttime transort of urban ozone in the boundary layer during a stagnation episode. Presentation, *AGU Fall Meeting*, San Francisco, 14-19 Dec.

McNider, R. T., W. B. Norris, D. M. Casey, J. E. Pleim, S. J. Roselle, and W. M. Lapenta, 1997: Assimilation of satellite data in regional air quality models. Presentation, *22nd NATO/CCMS Internatl. Tech. Meeting on Air Pollution Modeling and Its Appl.*, Clermont-Ferrand, France, 2-6 June.

Newchurch, M. J., and **J. H. Kim**, 1997: Biomass-burning influence on tropospheric ozone over New Guinea and South America. Presentation, *IGAC-SPARC-GAW Conf. on Global Measurement Systems for Atmospheric Composition*, Toronto, Canada, 20-22 May.

Newchurch, M. J., D. Cunnold, C. Mateer, J. Cao, 1997: Umkehr[64] and Umkehr[92] ozone profiles and time series compared to SAGE. Presentation, *IGAC-SPARC-GAW Conf. on Global Measurement Systems for Atmospheric Composition*, Toronto, Canada, 20-22 May.

Perkey, D. J., A. J. Song, R. T. McNider, and W. L. Crosson, 1997: The impact of assimilation of GOES satellite-derived surface observations on regional-model simulations. Preprints, *AMS Conf. on Hydrol.*, Long Beach, CA, 2-7 Feb., 233-236.

Raghavan, R., S. Goodman, P. Meyer, B. Boldi, S. Martlin, M. Weber, W. Williams, D. Sharp, S. Hodanish, J. Madura, and **C. A. Laymon**, 1997: A real-time examination of the incremental value of lightning data in diagnosing convective storm characteristics. Preprints, *AMS 7th Conf. on Aviation, Range and Aerospace Meteor.*, Long Beach, CA, 2-7 Feb.

J. Boggs, L. Birgan, T. Tsegaye, T. Coleman, and **V. Soman**, 1997: Application of modular modeling system to predict evaporation, infiltration, air temperature, and soil moisture. Proceedings, *URC Tech. Conf.* (NASA), Albuquerque, Feb., **1**, 863-867.

Jarzembski, M. A., **V. Srivastava, W. E. McCaul, Jr.**, G. Jedlovec, and R. J. Atkinson, 1997: Continuous wave LIDAR backscatter measurements in Hurricane Juliette. Preprints, *AMS 22nd Conf. on Hurricanes and Trop. Meteo.*, Ft. Collins, CO, 19-23 May.

Wang, S., 1997: Dyamic effects of cloud droplet concentration on could-top albedo in marine boundary layers: A model sensitivity study. Preprints, *12th Boundary Layer Turbulence Conf.*, Vancouver, BC, Canada, 28 July-1 Aug.

Wang, S., and F. Robertson, 1997: A generalized model of stratocumulus and shallow cumulus clouds in subtropical marine boundary layers. Preprints, *12th Boundary Layer Turbulence Conf.*, Vancouver, BC, Canada, 28 July-1 Aug.

Wang, S., 1996: A prognostic approach of defining marine boundary-layer clouds. *AGU Fall Mtg.*, San Francisco, 15-20 Dec.

Workshops, Seminars and Other Communications

Beaumont, B., 1997: Development Hydrology System Action Logger (HAL) and File Ingest Directory Overseer (FIDO) software, June.

Beaumont, B., M. Smith, H. Conover, 1996: Development and delivery of a Dataset- Independent Subset prototype software system to Hughes Applied Information Systems (part of the EOSDIS Core System). Final Delivery 20 Dec.

Beaumont, B., in cooperation with the Sensor Data Processing Facility (SDPF), 1996: Creation of ingest software for the LIS instrument from the TRMM mission. Nov.

Beaumont, B., 1996: LISARD User's Manual, 22 Nov.

Bowdle, David A., 1997: Atmospheric aerosol measurement and modeling for Doppler lidar performance simulations. Invited presentation, IEEE Luncheon Seminar, Huntsville, AL, 2 May.

Bowdle, D. A., 1997: Aerosol backscatter spatial structure: Preliminary results. Final Contract Report, University of Alabama in Huntsville, Huntsville, AL.

Bowdle, D. A., 1996: Three-year appointment, Coordinating Committee for Upper Tropospheric and Stratospheric Aerosols within the International Global Aerosol Chemistry Project. Focus on Atmospheric Aerosols.

Bowdle, D. A., and D. R. Johnson, 1996: Aerosol backscatter modeling for operational airborne Doppler lidars. Presentation, *Fifth Meeting of the Affordable Low-Observable Air Data System (ALOADS) Integrated Product Team*, Ann Arbor, MI, 31 Oct.

Christy, J. R., 1997: Global climate and satellite detection of global temperatures. Presentation, Canadian Coal Assoc., Vancouver, BC, Canada, 20 Mar.

Christy, J. R., 1997: Creation/Evolution Panel. Presenter, University of Alabama in Huntsville, Huntsville, AL, 27 Feb.

Christy, J. R., 1997: Global climate and satellite detection of global temperatures. Presentation, Marshall Institute, Washington, DC, 20 Feb.

Christy, J. R., 1997: Accuracy of MSU temperature datasets. Several media interviews appearing in *Washington Post, New York Times, Boston Globe,* National Public Radio. Various dates.

Christy, J. R., 1997: NOAA/NASA Climate Change and Detection Program. Proposal Review, Asheville, NC, 22-24 Jan.

Christy, J. R., 1996: Development of computer code to analyze daily surface temperatures over long time periods to discover and extract spurious trends and perturbations. *State Climatologist Exchange Program,* NCDC/NOAA, Asheville, NC.

Conover, H., 1997: Electronic publication, Revision 5, Summary of Extensions for IMS V0 Client/Server Messages, 18 April.

Conover, H., 1997: Electronic publication, V0 IMS Server Cookbook, 28 May.

Conover, H., 1997: Release 5.2c, CINTEX V0 IMS Server, 30 May.

Conover, H., and **K. Regner**, 1996: First CINTEX revision of the MSFC V0 IMS Server. 19 Nov.

Conover, H., 1996: Updates to Summary of extensions proposed for IMS V0 client/server messages. Electronic Publication, http://harp.gsfc.nasa.gov/ documents/odl_ extensions.html 3 Oct. and 22 Oct.

Conover, H., 1996: Revision, expansion and conversion of V0 IMS Server Cookbook to HTML. Published on the Internet, http://harp.gsfc.nasa.gov/documents/Server- cookbook.html, 10 Oct.

Conover, H., **B. Beaumont**, and **S. Graves**, 1996: Information systems research at the Global Hydrology and Climate Center. *Amer. Inst. of Aeronautics and Astronautics (AIAA)*, Huntsville, AL, 24-26 Sept.

Conover, H., 1996: Proposed extensions to IMS client/server messages. Presentation, *CEOS Interoperability Experiment (CINTEX) Workshop,* Committee on Earth Observation Satellites (CEOS) Joint Subgroup Meetings, Sioux Falls, SD, 15 Sept.

Conover, H., S. Fick, R. Goebel, D. Sundius, 1996: Summary of extensions proposed for IMS V0 client/server messages. Electronic Publication, http://harp.gsfc.nasa.gov/ documents/odl_extensions.html

Conover, H., 1996: ODL extensions for better support of CINTEX partners. Presentation, *EOSDIS Version 0 Information Mgmt. Sys. (IMS) Developers' Mtg.*, Landover, MD, 30 July-1 Aug.

Criswell, E., 1997: Revision, Optical Disk Jukebox software, May.

Criswell, E., 1996: A platform-independent OLS data reader software. Development and delivery to MSFC DAAC, Dec.

Criswell, E., 1996: The effects of data storage paradigms on custom order processing, Rev. 1.00. Electronic publication, http://mickey.cs.uah.edu/~criswell/dsp.html 21 Nov.

Crosson, W. A., 1997: Earth's surface energy balance. Lecture, 1997 Summer Enrichment Program class, NASA Internships for Minority and Women Undergraduates, Center for Hydrology, Soil Climatology, and Remote Sensing, *Alabama A&M University*, Normal, AL, 26 June.

Drewry, M., 1997: Presentation, Global Hydrology Resource Center (GHRC) status report. *Information Management System (IMS) V0 Developers Meeting*, Landover, MD, 3-4 April.

Drewry, M. H., 1996: MSFC DAAC Status and Transition Report. Presentation, *EOSDIS V0 IMS Mtg.*, NASA/GSFC, Landover, MD, 2 Aug.

Drewry, M. H., and **S. T. McCoy**, 1996: Tour of the MSFC DAAC/Lightning Imaging Sensor Science Computing Facility (LIS SCF) for the Alabama Supercomputing Program to Inspire Computation Research in Education (ASPIRE). Presentation, Global Hydrology and Climate Center, Huntsville, AL, 25 July.

Driscoll, K. T., 1997: Presentation, Remote Sensing for Undergraduate Science Education Workshop. *Community Colleges for Innovative Technology Transfer* (NASA), Huntsville, AL, 23 May.

Ellett, W., and **S. Jones**, 1996: GHCC SysAdmin Resource Center. Electronic publication, http://wwwdaac.msfc.nasa.gov:3945/sysadmin, Nov.

Gillani, N., 1996: Relevance of the SOS-Nashville 1995 field study data base for Plume-in-Grid model evaluation. *EPRI Contractors' Meeting*, Palo Alto, CA, Nov.

Gillani, N., and **A. Biazar**, 1996: Development of the Plume-in-Grid module of Models3. Presentation, *EPA Models3 Developers' Meeting*, Research Triangle Park, NC, Oct.

Graves, S., 1997: Chair, Earth Observing System Data and Information System (EOSDIS) External Review Group, Washington, DC, April.

Graves, S., 1997: Presentation, Mission to Planet Earth (MTPE) Biennial Review, Washington, DC, June.

Hnilo, J. J., 1996: Passed final examination for the Ph.D. degree, Dept. of Atmospheric Science, University of Alabama in Huntsville, Huntsville, AL.

Laymon, C. A., 1997: Soil and soil moisture. Lectures, *GLOBE Teacher Training Workshop*, 9-13 June, Huntsville, AL.

Laymon, C. A., and HSCaRS Team Members, 1996: Application of remote sensing to hydrological modeling: Overview of the Huntsville '96 field experiment. Poster presentation, *Planning Workshop for the Southern Great Plains Experiment 1997*, USDA-Agricultural Research Service, Beltsville, MD, 26-28 Aug.

McCaul, E. W., Jr., 1996: Sky and weather photography. Presentation, *Meeting of the Nature Photography Society*, Huntsville, AL, 16 Sept.

McCoy, S., 1997: Revision, V0 IMS Server Version 6.3, 6 June.

McCoy, S., 1997: Revision, Data Order Tracking System (DOTS), User Services and Production Editions, V. 6.1, 9 June.

McCoy, S., 1997: Revision, Data Archive Inventory System (DAISY), V. 6.1, 24 June.

McCoy, S. T., 1996: Revision, Data Order Tracking System (DOTS) software document. *MSFC DAAC GEWEX Continental-Scale International Project (GCIP)*, 20 Dec.

McCoy, S. T., 1996: Revision, V0 IMS Server V. 6.2, 25 Nov.

McCoy, S. T., 1996: Date Order Tracking System (DOTS) software document. *MSFC DAAC GEWEX Continental-Scale International Project (GCIP).*

Perkey, D. J., 1996: Report on the Institute for Global Change Research and Education. Presentation, *Universities Space Research Association Earth Science Council Meeting*, Greenbelt, MD, 11-12 Nov.

Perkey, D. J., 1996: Research at the Global Hydrology and Climate Center. Presentation, *Amer. Soc. of Civil Engineering*, Huntsville Branch Meeting, Huntsville, AL, 5 Nov.

Perkey, D. J., 1996: Regional and mesoscale atmospheric studies. Presentation, *Space Science and Technology Alliance Regional Assessments Meeting*, Birmingham, AL, 30 Oct.

Ritschard, R., 1997: Chair, *Regional Workshop* on "Climate Variability and Water Resource Management in the Southeastern United States" (NASA, NOAA, USGS), Nashville, TN, 25-27 June.

Smith, M., 1997: Poster presentation, *Workshop on Climate Variability and Water Resources Management in the Southeastern United States*, Nashville, TN, 25-26 June.

Smith, M., 1997: Design and implementation, Browse Product Generation software for OTD, June.

APPENDIX C

EDUCATION ACTIVITIES

Scientist	Date	Location	Activity
Cox, G. N.	July 1997	Airlie, Virginia	Invited presentation at the 1997 International GLOBE Partners Conference
Cox, G. N.	July 1997	Clemson, SC	Represented Alabama at the 1997 SE MAPS Conference
Cox, G. N.	June 1997	Nashville, TN	Co-chaired the Education Section of the Southeastern Regional Workshop on Climate Variability and Water Resources Management
Cox, G. N.	June 1997	Huntsville and Mentone, AL	Conducted teacher training workshops for the GLOBE Program
Cox, G. N.	April 1997	Huntsville and Mentone, AL	Conducted teacher training workshops for the GLOBE Program
Cox, G. N.	April 1997	New Orleans, LA	Presentation at the 1997 National Science Teachers Association meeting
Cox, G. N.	January-May 1997	Huntsville, AL	Mentored five high school students from the Huntsville City School District's New Century Technology Demonstration High School
Cox, G. N.	October 1996	Rostov-on-Don, Russia	Co-chaired a conference on the Municipal Applications of Geographic Information Systems
Crosson, W. L.	June-August 1997	Huntsville, AL	Mentored undergraduate student participating in HSCaRS 1997 Summer Enrichment Program
Perkey, D. J.	June-August 1997	Huntsville, AL	Mentored two undergraduate students participating in HSCaRS 1997 Summer Enrichment Program
Perkey, D.	June 1997	Huntsville, AL	Conducted teacher training workshop for the GLOBE Program
Soman, V.	June-August 1997	Huntsville, AL	Mentored undergraduate student participating in HSCaRS 1997 Summer Enrichment Program

APPENDIX D

UNIVERSITY, INDUSTRY AND GOVERNMENT COLLABORATIONS

IGCRE Scientist	Collaborator/ Affiliation	Nature of Collaboration
Crosson, W. L.	Drs. Claude Duchon and Baxter Vie/University of Oklahoma	Testing SHEELS using data from the Oklahoma Mesonet and coupling SHEELS and DRUM
Crosson, W. L.	Dr. Tom Coleman and Others/ Alabama A&M University	Performing Huntsville '96 and Southern Great Plains '97 field experiments and analyzing data collected
Crosson, W. L.	Dr. Tom Jackson/USDA	Collaborated in the Huntsville '96 and Southern Great Plains '97 field experiments
Crosson, W. L.	Dr. Peggy O'Neill/NASA GSFC	Collaborated in the Huntsville '96 and Southern Great Plains '97 field experiments
Crosson, W. L.	Dr. Ramarao Inguva/ Huntsville, AL	Developing and testing a forward radiative transfer model applicable to remote sensing of soil moisture.
Laymon, C. A.	Dr. Tom Coleman and Others/ Alabama A&M University	Soil moisture remote sensing and modeling
Laymon, C. A.	Utah State University	Discussions and exchanges regarding the Goshute Valley, Nevada, project
Laymon, C. A.	Jay Famiglietti/University of Texas, Austin	Developing a soil moisture variability study with associated science plan to compliment the Southern Great Plains '97 experiment
Laymon, C. A.	Dr. Peggy O'Neill/NASA GSFC	Microwave remote sensing of soil moisture.
Laymon, C. A.	Dr. Tom Jackson/USDA	Microwave remote sensing of soil moisture.
Laymon, C. A.	Intergraph Corporation	Application of image processing software to land surface processes research.
Laymon, C. A.	Mr. Greg Bowling/Intergraph Services Corporation	Direction of Mr. Bowling as he assists us in developing workflow to expedite the use of Intergraph software
McCaul, W. E., Jr.	Dr. Morris L. Weisman/NCAR	Numerical simulations of convective storm dynamics in landfalling hurricane and related environments
McCaul, W. E., Jr.	Dr. Robert T. Menzies/NASA JPL	Analysis of GLOBE lidar data
McCaul, W. E., Jr..	Dr James D. Spinhirne/ NASA GSFC	Analysis of GLOBE lidar data
McCaul, W. E., Jr.	Dr. Frank Marks/NOAA-AOML-HRD	Hurricanes at landfall experiment

McCaul, W. E., Jr.	Dr. Michael Cammarata/ NOAA/NWS (Columbia, SC)	Analysis of WSR-88D data collected during T. S. Beryl tornado outbreak
McCaul, W. E., Jr.	Dr. David Sharp/NOAA/NWS (Melbourne, FL)	Analysis of WSR-88D data collected during tropical cyclones
McCaul, W. E., Jr.	Members of Prospectus Development Team 5/USWRP	Research opportunities and needs in landfalling hurricanes
Perkey, D. J.	Dr. Tom Coleman and Others/ Alabama A&M University	Collaborating in the 1997 Summer Enrichment Program for Women and Minority Undergraduates
Raghavan, R.	Dr. Bart Geerts/Embry Riddle University (Arizona)	Characterizing mesoscale convective systems over the continental United States
Raghavan, R.	Dr. Earle Williams/Parsons Lab, Massachusetts Institute of Technology	Real-time study of total lightning characteristics in Florida thunderstorms
Raghavan, R.	Drs. M. Weber, B. Boldi, E. Williams, A. Matlin/Lincoln Lab, Massachusetts Institute of Technology	Real-time study of total lightning characteristics in Florida thunderstorms
Srivastava, V.	Dr. A. D. Clarke/University of Hawaii	Aerosol microphysics and GLOBE data
Srivastava, V.	Dr. J. Spinhirne/NASA GSFC	Pulsed Nd: Yag lidar data-GLOBE
Srivastava, V.	Dr. R. Menzies/NASA JPL	Pulsed CO_2 lidar data-GLOBE, MACAWS
Srivastava, V.	Dr. R. D. Pueschel/NASA ARC	FSSP aerosol distribution data-GLOBE, MACAWS
Srivastava, V.	Dr. R. J. Atkinson/Lockheed Martin Corporation	GOES satellite imagery
Wang, S.	Dr. Mark Miller/Brookhaven National Laboratory	Boundary layer chemistry

APPENDIX E

SEMINARS

Date	Title	Name	Affiliation
1997			
June, July, August	No Seminars Scheduled		
May 28	Fractal Characterization in Remote Sensing and GIS	Nina Lam	Louisiana State Univ.
May 21	Teleconnections of Middle East Climate: Physical Reality or Spurious Correlation?	Fong-Chiau Chang Gary Jedlovec	UAH MSFC
May 14	Behind the Scenes Development Activities at CNN Weather	Mike Cavanaugh	CNN Weather
May 8	The Classic Maya Collapse: An Ecological Disaster?	Pat Culbert	Univ. of Arizona
May 6	Linking Atmospheric and Hydrologic Models Through Hydrologic Response Units	Ashutosh Limaye	Utah State University
April 30	New Views of Earth from Radar Satellites	Diana L. Evans	JPL
April 25	Stochastic-Dynamic Hydrologic Forecasting and Its Application to Reservoir Operations in the Pacific Northwest	Young-Oh Kim	Univ. of Washington
April 23	Comparison of Ozone Control Strategies	Robert Imhoff	TVA
April 9	Assessing Impacts of Climate on Water Resources	Eric Barron	Penn State University
April 2	United Nations Environment Programme: Four Years' Experience with Telecommunications for Environment Information	Ray Arnold	MSFC
March 27	Monitoring of Tropospheric Chemistry from Geostationary Orbit	Mark Abrams	ITT-Aerospace
March 26	Teleconnections of the Central United States Great Plains Drought Episodes over the Last Century (1895-1996)	Fong-Chiau Chang	UAH
March 25	Low-Cost Access to Space: The Future of Space-Based FTS Remote Sensing	Mark Abrams	ITT-Aerospace
March 17	NCEP's Water and Energy Budget Analysis Residuals	John Roads	Scripps Institute
March 13	A New Approach Toward Forecasting the Initial Onset of Damaging Downburst Winds Associated with Mesoscale Convective Systems	Ron Przybylinski	NOAA/NWS

March 12	Modeling and Experimental Verification of Scattering from Complex Atmospheric Particles: Snow, Hail, Acrosols	Vandana Srivastava	USRA
March 7	Mesoscale Modeling at NOAA/FSL with Mesoscale Model MM5	Jennifer Cram	NOAA/FSL
March 5	Lightning Detection from Space: Optical Transit Detection (OTD) Results Update and Lightning Imaging Sensor (LIS) Development and Flight Plans	Hugh Christian	MSFC
February 26	Global Warming—Science of Politics?	John Christy	UAH
February 19	Planners' Use of Intelligence Information (Remote Sensing, etc.) in Advising Public Officials	Donald Outland	Alabama A&M Univ.
February 12	Research in GSFC Atmospheric Chemistry and Dynamics Branch: 25 Years of Atmospheric Observations from Space	P. K. Bhartia	GSFC
February 5	Russian Interoperability with EOSDIS: Results on Visit to Institute of Radio Engineering and Electronics, Russian Academy of Science	Helen Conover	UAH
January 31	The Optical Transient Detector and the LISDAD Project: The Lincoln Laboratory Perspective	Earle Williams	MIT
January 29	Water Vapor and Radiation Interactions During El Nino/La Nina	Pete Robertson	MSFC
January 22	Physical Processes of Marine Boundary Layer Clouds	Shouping Wang	USRA
January 15	Ozone Trends and Issues	Mike Newchurch	UAH
January 8	Land Surface Mesoscale Modeling	Bill Lapenta	MSFC

1996

December 18	Structure and Mesoscale Organization of 1994 Palm Sunday Tornadic Storms	Kevin Knupp	UAH
December 11	Satellite Versus Surface Estimates of Global Temperature Since 1979	James Hurrell	NCAR
December 4	Galileo Probe Design and Flight Results	Bernie Dagarin	Hughes STX

November 19	Electric Fields and Charges Inside Thunderstorms	Monte Bateman	Langmuir Lab for Atmos. Research
November 15	An Evaluation of Data Needs for Regulated Flood Frequency Estimation	Rocky Durrans	Univ. of Alabama
November 13	Hydroclimate Research at a Range of Spatio-Temporal Scales	Norm Miller	Lawrence Livermore Labs
November 6	Current NASA Hydrological Processes Research Activities	Jim Arnold	MSFC
October 23	Formation Mechanisms for Uncommon Winter Precipitation Bands	Robert Rauber	Univ. of Illinois
October 16	Huntsville '96 Experiment: Soil Moisture Technology	Steve Wu, Robbie Hood Chip Laymon, Bill Crosson	MSFC USRA
October 9	Russian Interoperability with EOSIDS: Results of Visit to Institute of Radio Engineering and Electronics, Russian Academy of Science	Helen Conover	UAH
October 2	Advances in National Weather Service Forecasts and Warnings	Lou Uccellini	NWS
September 27	Tropical Plumes in a Barotropic Model	Keith Blackwell	Univ. of So. Alabama
September 18	Data Mining Related to Phenomena Observed by Meteorological Satellites	Tom Hinke	UAH
September 11	Sediment and Carbon Flux in a Shallow Coastal Estuary Relative to Global Change and Climatology Issues	James Cruise	UAH
September 6	Biomass Burning, Fires, CO and Radiative Forcing	Sundar Christopher	So. Dakota School of Mines & Tech.
September 4	Short-Range Weather Forecast Experiment and Evaluation for the Tennessee Valley with a High Resolution Nested Regional Spectral Model	Qi Mao	FSU/TVA

APPENDIX F

SCIENTIFIC CONFERENCES AND WORKSHOPS

Topic	Dates	Location
Meeting of the NOAA Working Group on Space-Based Lidar Winds	July 15-17, 1997	North Glenn, CO

Meeting Attendees:

Name	Affiliation	Name	Affiliation
James B. Abshire	NASA/GSFC	Robert Atias	NASA/GSFC
Wayman Baker	NOAA/NWS/NCEP	David Bowdle	UAH/GHCC
Alan Brewer	NOAA	Robert Brown	Univ. of Washington
G. D. Emmitt	Simpson Weather Assoc.	Renny Fields	Aerospace Corp.
Pierre H. Flamant	Ecole Polytechnique (France)	Rex Fleming	NOAA/OGP
Jerry Gelbwachs	Aerospace Corp.	Bruce Gentry	NASA/GSFC
Jim Gurka	NWS	Mike Hardesty	NOAA
Sammy Henderson	Coherent Technologies	Milton Huffaker	Coherent Technologies
Gary Kamerman	Microcraft, Inc.	Michael J. Kavaya	NASA/MSFC
Stephen Mango	NPOESS/IPO	Scott Manilief	TRW
Jack McKay	Remote Sensor Concepts	Tim Miller	NASA/MSFC/GHCC
Gil Moore	Utah State Univ.	Jan Paegle	Univ. of Utah
Madison J. Post	NOAA	Carol Raymond	JPL
Jeffry Rothermel	NASA/MSFC/GHCC	Barry Rye	NOAA
Geary Schwemmer	NASA/GSFC	Ron Schwiesow	Ball Aerospace
Upendra Singh	NASA/GSFC	Bud Sleek	
Gary Spiers	Univ. of Alabama in Huntsville	Christopher Stevens	NASA/JPL
David Tratt	JPL	Vincent Wickwar	Utah State Univ.
Tom Wilkerson	Utah State Univ.	Jim Yoe	NOAA/NESDIS
J. I. Rong Yu	Science Technology Corp.		

CAMEX3 Planning Workshop	March 31-April 2, 1997	Miami, FL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Alan Cartledge	NASA/Ames Lab	John Molinari	SUNY-Albany
Ramesh Kakau	NASA HQ	Anthony Guillory	NASA/MSFC/GHCC
Gerry Heymsfield	NASA/GSFC	Naomi Surgi	Natl. Hurricane Ctr.
Da-lin Zhang	Univ. of Maryland	Wallace McMillan	U. of Maryland/Baltimore
Edward V. Browell	NASA/Langley Res. Ctr.	Jeffry Rothermel	NASA/MSFC/GHCC
Miriam Baltuck	NASA HQ	Vasubandhu Misra	Florida State Univ.
Melville E. Nicholls	Colorado State Univ.	Lauraleen O'Connor	NPOESS/USAF
Steve Nelson	National Science Foundation	Zhan Zhang	Florida State Univ.
Sean P. McCartney	Computer Science Corp.	James D. McFadden	NOAA/AOC
Robert M. Banta	NOAA/ERL	Lynn K. Nide-Shay	Univ. of Miami
James Franklin	NOAA/HRD	William L. Smith	Univ. of Wisconsin
Edward J. Walsh	NASA/GSFC	Geary Schwemmer	NASA/GSFC
James R. Wang	NASA/GSFC	G. David Emmitt	Simpson Weather Assoc.
Steven Greco	Simpson Weather Assoc.	Robbie Hood	NASA/MSFC/GHCC
T. N. Krishnamurti	Florida State Univ.	Roger Pielke, Sr.	Colorado State Univ.
S. H. Melfi	U. of Maryland-Baltimore	V. Mohan Karyampudi	NASA/GSFC

Frank Marks	NOAA/AOML	Al Gasiewski	Georgia Tech.
Hugh Willoughby	NOAA/HRD	Chris Miller	NASA/Ames Lab
Chris Velden	Univ. of Wisconsin	George Alger	NASA/Ames Lab
Syed Ismail	NASA/Langley	Ed Rappaport	Natl. Hurricane Ctr.
Peter Black	NOAA/HRD	Paul Wills	NOAA/HRD
Sam Houston	NOAA/HRD	John Kaplan	NOAA/HRD
Dean Churchill	Univ. of Miami	Al Moore	NASA/Langley

Lightning Science Workshop (LIS) March 11-12, 1997 Guntersville, AL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Marcia Baker	Univ. of Washington	Jim Dye	NCAR/MMM
Paul Krehbiel	New Mexico Tech.	Phil Krider	Univ. of Arizona
John Latham	NCAR/MMM	Steve Rutledge	Colorado State Univ.
Earle Williams	MIT/Parsons Laboratory	Monte Bateman	
Zipser, Ed	Texas A&M Univ.		

Meeting of the NOAA GCIP Group November 19, 1996 Huntsville, AL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Jim Arnold	NASA/HQ	Rick Lawford	NOAA/OGP/GCIP
Alan Betts	Unknown	Ken Mitchell	NOAA/NWS/NCEP
Yongkang Xue	COLA	Ravi Avissar	Rutgers Univ.
Jim Shuttleworth	Univ. of Arizona	Eli Foufoula-Georgiou	Univ. of Minnesota
Robert Houze	Univ. of Washington	Mercedes N. Lakhtakia	Penn State Univ.
Rachel Pinker	Univ. of Maryland	Dan Tarpley	NOAA/NESDIS
John Schaake	NOAA/NWS/Off. of Hydrology	Dennis Lettenmaier	U. of Washington
Konstantin Vinnikov	Univ. of Maryland	Pavel Groisman	UCAR Visiting Scientist at NDC/NOAA
Chet Ropelewski	NOAA/Climate Pred. Ctr.	Jan Paegle	Univ. of Utah
Pete Robertson	NASA/GHCC	Steve Dumolt	Univ. of Oklahoma
Claude E. Duchon	Univ. of Oklahoma	Darren McMicken	Hughes STX
Dale Quattrochi	NASA/GHCC	Richard Dirks	UCAR/JOSS
Bill Lapenta	NASA/GHCC	Don Perkey	IGCRE/GHCC
Scot Loehrer	UCAR/JOSS	Steve Williams	UCAR/JOSS
Hugh Christian	NASA/MSFC	John Roads	Scripps/UCSD
Susan Marshall	UNCC	Gary Bates	NCAR
Jeanne Schneider	NOAA/ERL/NSSL	George Leavesley	USGS
John Leese	GCIP Office	Doug Miller	Penn State Univ.
Robert Dickinson	Univ. of Arizona	Xiaogong Gao	Univ. of Arizona
John H. Brown	NOAA/ERL/Forecast Sys. Lab.	E. Hugo Berbery	Univ. of Maryland
Alan Hall	UCAR/NOAA/NWS Hydrology		

TVA/UAH Technology Exchange Meeting October 22, 1996

Global Hydrology Climate Center, Huntsville, AL; University of Alabama in Huntsville; TVA/Muscle Shoals

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Harold Buie	UAH/CETAC	David W. Sorrelle	TVA/ERC
Ron Ritschard	UAH/JRC	Jim Meagher	TVA/ERC
Donald J. Perkey	IGCRE/GHCC	Les Behrends	TVA/ERC
Dick McNider	UAH/ESSL	Willie Buchanan	TVA/ERC
Tony Zarate	TVA/ERC	John Shipp	TVA/TVAE
Ron Williams	TVA/ERC	Ron Greenwood	NASA/GHCC

APPENDIX G

STUDENTS

Name	Affiliation	Research Area
Doty, Kevin	Drexel University	Impact of Convective Downdrafts on Moisture Budgets
Lecue, Juan	Institute of Space Studies of Catalonia (Spain)	GOES Satellite Remote Sensing
Lerner, Jeff	Univ. of Alabama in Huntsville	Comparison of VAS and SSM/I Precipitable Water
Paech, Simon	Univ. of Alabama in Huntsville	Case Study of the May 18, 1995 "Anderson Hills" Tornado
Ramachandran, Rahul	Univ. of Alabama in Huntsville	NEXTRAD and LDAR Data Applications: Preparing for TRMM Data Analysis
Reid, John	Univ. of Alabama in Huntsville	Lightning Spectrometer Calibration and Testing
*Whitworth, Brandon	Univ. of Alabama in Huntsville	GOES Data Analysis
Wohlman, Richard	Univ. of Alabama in Huntsville	LIS Data Analysis

*Denotes Undergraduate Student

APPENDIX H

K-12, UNIVERSITY AND INDUSTRY VISITORS TO IGCRE

Name	Dates	Affiliation	Reason
Emmitt, Dave	June 2-4	Simpson Weather Assoc.	To collaborate with Dr. Tim Miller and others on the development of a concept for Doppler lidar on the space shuttle
Culbert, Pat	May 7-10	Univ. of Arizona	To collaborate with Dr.. Tom Sever and other GHCC scientists to share expertise on the demise of the Mayans
Bergstrom, Jim	May 1-4	Self	To complete the assembly and testing of lightning spectrometers.
Limaye, Ashutosh	April 28-29	Self	To interview with Dr. Ron Ritschard & Dr. Jim Cruise
Kim, Young-Oh	April 23	Self	To interview with Dr. Ron Ritschard & Dr. Jim Cruise
Baker, Marcia	December 14-17	Univ. of Washington	Present research on thunderstorm electrification & collaborate with Dr. Hugh Christian
Bateman, Monte	November 19	Langmuir Lab/ New Mexico Tech	Present research on electric fields and charges inside thunderstorms

APPENDIX I

UNIVERSITY AND INDUSTRY TRAVEL IN SUPPORT OF IGCRE ACTIVITIES

Name	Dates	Affiliation	Reason
Anderson, John	July 14-17	Univ. of Wisconsin	To attend the LIDAR Working Group Meeting in Northglenn, CO
Brown, Robert	July 14-17	Univ. of Washington	To attend the LIDAR Working Group Meeting in Northglenn, CO
Emmitt, Dave	July 14-17	Simpson Weather Assoc.	To attend the LIDAR Working Group Meeting in Northglenn, CO
Krishnamurti, T.	July 14-17	Florida State Univ.	To attend the LIDAR Working Group Meeting in Northglenn, CO
Paegle, Jan	July 14-17	Univ. of Utah	To attend the LIDAR Working Group Meeting in Northglenn, CO
Williford, C. Eric	July 14-17	Florida State Univ.	To attend the LIDAR Working Group Meeting in Northglenn, CO
Krishnamurti, T.	March 30-April 2	Florida State Univ.	To attend the Convection and Moisture Experiment (CAMEX3) Workshop in Miami, FL
Nichols, Melville E.	March 30-April 2	Colorado State Univ.	To attend the Convection and Moisture Experiment (CAMEX3) Workshop in Miami, FL
Pielke, Roger	March 30-April 2	Colorado State Univ.	To attend the Convection and Moisture Experiment (CAMEX3) Workshop in Miami, FL
Baker, Marcia	March 10-14	Univ. of Washington	To attend MTPE/USWRP Lightning Science Workshop and LIS Science Meeting in Guntersville and Huntsville, AL
Bateman, Monte	March 13-14		To attend the LIS Science Meeting in Huntsville, AL

Dye, Jim	March 10-14	NCAR/MMM	To attend MTPE/USWRP Lightning Science Workshop and LIS Science Meeting in Guntersville and Huntsville, AL
Krehbiel, Paul	March 10-14	New Mexico Tech	To attend MTPE/USWRP Lightning Science Workshop and LIS Science Meeting in Guntersville and Huntsville, AL
Krider, Phil	March 10-14	Univ. of Arizona	To attend MTPE/USWRP Lightning Science Workshop and LIS Science Meeting in Guntersville and Huntsville, AL
Latham, John	March 10-14	NCAR/MMM	To attend MTPE/USWRP Lightning Science Workshop and LIS Science Meeting in Guntersville and Huntsville, AL
Rutledge, Stee	March 10-14	Colorado State Univ.	To attend MTPE/USWRP Lightning Science Workshop and LIS Science Meeting in Guntersville and Huntsville, AL
Williams, Earle	March 10-14	MIT/Parsons Laboratory	To attend MTPE/USWRP Lightning Science Workshop and LIS Science Meeting in Guntersville and Huntsville, AL
Zipser, Ed	March 13-14	Texas A&M Univ.	To attend the LIS Science Meeting in Huntsville, AL

APPENDIX J

1997 SUMMER ENRICHMENT PROGRAM

For the 1997 Summer Enrichment Program for Women and Minority Students at Alabama A&M University, 600 announcements were sent to departments of Chemistry, Physics, Computer Science, Plant and Soil Science, Geography and others at approximately 250 colleges and universities throughout the United States and Puerto Rico. Included in the mailings were all Historically Black Colleges and Universities, Historically Spanish Institutions and institutions with a relatively high percentage of Native American students, in addition to other major colleges and universities. Coming from 17 colleges and universities across the country, 18 students participated in this prestigious internship, which was held from June 1 through July 25, 1997. (Two students, Tomeka Prioleau and Mario Thomas, returned from the 1996 program, although an additional two had also been invited.)

During the summer program, the students took a course in Global Change Science and completed a research project with mentors from NASA, Alabama A&M and IGCRE. Several students have expressed an interest in returning for next year's program, which will again accept up to 20 students. Students from the 1997 program are listed below:

1997 SEP Students

Student/Research Area	University	Major	Class Year
Birvid Atkins/Neural Networks	Stillman College	Computer Science	Junior
Christine Bowman/Hydrologic Modeling	Susquehanna Univ.	Physics/Env. Science	Junior
Stacy Carr/Hydr. Mod.-Soil Data Analysis	Michigan Tech. Univ.	Envir. Engineering	Senior (11/97)
Terrence Ferguson/Soil Data Analysis	Norfolk State Univ.	Pre-Chem. Engineering	Junior
Carol Hayes/Dataset Analysis	Auburn University	Math/Physics Education	Senior (5/98)
Andre Jackson/Soil Moist. Instr.	Lincoln Univ.-PA	Physics	Senior (5/97)
Rohan Kennedy/Soil Moist. Instr.	Marquette University	Electrical Engineering	Senior (12/97)
Dana Kuan/GIS Analysis	Univ. of Maryland	Cartography	Junior
Jennifer McClain/GIS Analysis	Dillard University	Computer Science	Junior
Elvis Niba/Hydr. & Meteor. Modeling	Central State Univ.-OH	Water Resources Mgmt.	Junior
Tomeka Prioleau/Soil Data Analysis	Alabama A&M Univ.	Environmental Science	Senior (5/98)
Susan Rains/Data Analysis-Microwaves	Salisbury State Univ.	Mathematics	Senior (5/97)
Morgan Ruark/Hydr. & Meteor. Modeling	Michigan Tech. Univ.	Civil & Envir. Engrg.	Senior (5/98)
Theresa Soliz/Data Analysis-Crops	CA State Univ.-Monterey	Earth Sys. Sci. & Policy	Senior (5/98)
Stacy Steinfeld/GIS Analysis	Penn State University	Earth Science	Junior
LaToya Suber/Data Analysis-Microwaves	U. of Arkansas-Pine Bluff	Mathematics	Sophomore
Mario Thomas/Soil Moist. Instr.	Jackson State University	Physics	Senior (5/97)
Thomas Yates/Neural Networks	Oakwood College	Mathematics	Junior

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION

Jointly operated by the
University of Alabama in Huntsville and Universities Space Research Association

Annual Report for

September 1, 1995 - August 31, 1996

"GLOBAL CHANGE RESEARCH RELATED TO THE EARTH'S ENERGY AND HYDROLOGIC CYCLE"

Under

Cooperative Agreement: NCC8-22

Submitted to

THE GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA 35812

by

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

on behalf of the

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION
Global Hydrology and Climate Center
977 Explorer Drive
Huntsville, Alabama 35806

Approved by:

Donald J. Perkey, Director
Institute for Global Change Research and Education

9/10/96
Date

APPENDIX A

STAFF TRAVEL ACTIVITIES

Name	Dates	Location	Reason
Bowdle, D.	6/18-20/96	San Jose, CA	To participate in discussions on a joint satellite Doppler Wind Lidar with Lockheed Martin Corp.
Bowdle, D.	5/28-30/96	Los Alamos, NM	To participate in discussions about joint development of a wind satellite
Bowdle, D.	2/7-9/96	Daytona Beach, FL	To attend meeting of the NOAA Working Group on Space-Based Lidar Winds
Bowdle, D.	11/28-30/95	Boulder, CO	To participate in the Critical Design Review for the Airborne Coherent Lidar for Advanced Inflight Measurements
Bowdle, D.	11/1-3/95	Columbia, MD	To participate in Tropospheric Aerosol Radiative Forcing Observational Experiment Workshop
Bowdle, D.	10/28/95-11/1/95	Columbia, MD	To participate in NASA's Aerosol Interdisciplinary Program Workshop
Bowdle, D.	7/23-27/95	Keystone, CO	To present paper at Coherent Laser Radar Conference
Bowdle, D.	7/19-21/95	Frisco, CO	To attend meeting of the NOAA Working Group on Space-Based Lidar Winds
Bowdle, D.	7/11-14/95	Boulder, CO	To present paper at IUGG/IAMAP Mtg.
Buechler, D.	2/18-27/96	San Francisco, CA	To make two presentations at the AMS Conference on Severe Local Storms
Christy, J.	1/28-2/2/96	Atlanta, GA	To present paper at the 7th Symposium on Global Change Studies at Annual AMS Meeting
Conover, H.	5/20-24/96	Fryazino, Russia	To collaborate with the Institute of Radioengineering and Electronics of the Russian Academy of Sciences

Conover, H.	4/17-18/96	Washington, D.C.	To attend ECS Release B Critical Design Review as a member of the Client Subsystem Detailed Review Team
Conover, H.	8/13-18/95	Greenbelt, MD	To attend ECS Critical Design Review as member of Review Board and representative of MSFC DAAC
Conover, H.	7/16-20/95	Greenbelt, MD	To attend ECS Critical Design Review as a member of Review Board and representative of MSFC DAAC
Conway, D.	6/12-15/96	GSFC, MD	To attend AMSR Team Meeting
Conway, D.	4/23-25/96	Baltimore, MD	To attend AMSR Team Meeting
Cox, G.	6/17-24/96	Rostov-on-Don, Russia	To present seminar on GPS Technology in the classroom
Cox, G.	6/9-16/96	Krasnodar Krai, Russia	To present seminar on environmental education and outreach programs in the U.S.
Cox, G.	3/28-30/96	St. Louis, MO	To make presentation at the National Science Teachers Assoc. Convention in support of NASA's MTPE
Cox, G.	1/25-31/96	Rostov-on-Don, Russia	To provide GIS technology training for public administration
Cox, G.	1/17-24/96	Rostov-on-Don, Russia	To present seminar on BPS technology in the classroom
Crosson, W.	3/20-22/96	Washington, D. C.	To participate in NASA Hydrology proposal review at NASA Headquarters
Crosson, W.	9/18-19/95	State College, PA	To discuss regional modeling assessment at Penn State Univ.
Crosson, W.	8/24-25/95	Calverton, MD	To attend ISLSCP Global Soil Wetness Project Workshop
Cutten, D.	5/28-6/9/96	Ames Research Center, CA	To participate in second NASA MACAWS field experiment

Cutten, D.	8/21-9/9/95	Ames Research Center, CA	To participate in NASA MACAWS field experiment
Drewry, M.	6/24-25/96	Greenbelt, MD	To speak at EOSDIS V0 IMS Metadata meeting
Drewry, M.	4/15-18/96	Washington, D. C.	To attend IEEE Metadata Conference
Drewry, M.	8/13-18/95	Greenbelt, MD	To attend ECS Critical Design Review as a member of Review Board and representative of MSFC DAAC
Drewry, M.	7/16-20/95	Greenbelt, MD	To attend EOSDIS VO Developers meeting as a representative of MSFC DAAC
Driscoll, K.	12/9-16/95	San Francisco, CA	To attend and present at AGU Fall Conference
Hallmark, D.	7/18-23/95	Frisco, CO	To support LIDAR SWG meeting
Lerner, J.	1/28-2/1/96	Atlanta, GA	To attend Annual AMS meeting
Lobl, E.	6/12-15/96	Greenbelt, MD	To attend AMSR Team Meeting and PM SWAMP Meeting
Lobl, E.	4/22-24/96	Baltimore, MD	To attend AMSR Science Team Meeting for coordination of the algorithms assignments
Lobl, E.	12/17-20/95	Greenbelt, MD	To attend AMSR/SC Interface meeting with NASDS and Mitsubishi
Lobl, E.	11/27-30/95	Annapolis, MD	To attend EOS-Payload Panel Meeting
Lobl, E.	10/11-15/95	Boston, MA	To present the terms and definitions at the Microwave Sensors Subgroup Working Group on Calibration and Validation
Lobl, E.	9/19-23/95	Tokyo, Japan	To participate in the first science meeting with Japan and assess the status of AMSR
McCaul, W.	4/30-5/2/96	Tallahassee, FL	To attend meeting of Prospectus Development Team 5, USWRP

McCaul, W.	11/ 7/95	Raleigh, NC	To make presentation at the Training Symposium for Operational Forecasters in the Carolinas and Virginia
McCaul, W.	8/18/95	Lawrence County, TN	To make presentation at the Emergency Management Assoc.
Perkey, D.	1/29-2/2/96	Atlanta, GA	To attend Annual AMS Meeting
Raghavan, R.	12/11-15/95	San Francisco, CA	To present paper at Fall AGU Meeting
Srivastava, V.	10/30-11/5/95	Columbia, MD	To present paper at NASA Aerosol Interdisciplinary Workshop and Tarfox Workshop
Srivastava, V.	8/15-10/4/95	Mountain View, CA	To integrate, calibrate and operate two MSVC Doppler LIDARs for participation in the 1995 MACAWS flight mission
Srivastava, V.	7/23-28/95	Keystone, CO	To present papers at Coherent Laser Radar Topical Meeting
Stewart, M.	10/13-11/3/95	Darwin, Australia	To install lightning direction finder systems to support MCTEX and LIS/TRMM
Wang, S.	2/12-15/96	Williamsburg, VA	To attend and present paper at FIRE III Science Team Meeting
Wang, S.	7/6-8/95	Boulder, CO	To present paper at IUGG meeting

APPENDIX B

PUBLICATIONS AND PRESENTATIONS

Refereed Publications

Submitted

Spencer, R. W., and **W. D. Braswell**, 1996: Satellite measurements show no water vapor feedback during post-Pinatubo warm-up. Submitted, *Science*.

Christy, J. R., 1996: Arctic temperatures above the surface layer from the microwave sounding unit. Submitted, *Arctic Monitoring and Assessment Program's Scientific Report.*

Spencer, R.W., **J. R. Christy**, and N.C. Grody, 1996: Analysis of "Examination of 'Global atmospheric temperature monitoring with satellite microwave measurements.'" Submitted, *Climatic Change*.

Ritchie, A. A. Jr., M. R. Smith, H. M. Goodman, R. L. Schudalla, **D. K. Conway**, F. J. LaFontaine, **D. Moss**, and B. Motta, 1996: Critical analyses of data differences between FNMOC and AFGWC-spawned SSM/I data sets. Submitted, *J. Atmos. Sci.*

D. R. Cutten, J. D. Spinhirne, R. T. Menzies, **D. A. Bowdle, V. Srivastava**, R. F. Pueschel, A. D. Clarke, and J. Rothermel, 1996: Intercomparison of remote and flight-level measured aerosol backscatter coefficient during GLOBE II Pacific survey mission. Submitted, *J. Geophys. Res.-Atmos.*

Laymon, C. A., and G. N. Cox, 1995: Project EarthSense: Environmental education using hydrology field measurement sites. Submitted. *Science Education*.

Lu, H.-L, and T. L. Miller, 1996: Characteristics of annulus baroclinic flow structure during amplitude vacillation. Submitted, *Dynamics of Atmospheres and Oceans.*

Lu, H.-L, and T. L. Miller, 1996: Wave dispersion in a rotating, differentially-heated fluid model. Submitted, *Dynamics of Atmospheres and Oceans.*

McNider, R. T., J. A. Song, W. B. Norris, W. L. Chameides, and P. R. Zimmerman, 1996: Interpreting the effect of turbulence on observations made in the convective boundary layer. Submitted, *J. Geophys. Res.*

Accepted

Crosson, W.L., Duchon, C. E., **R. Raghavan**, and S. J. Goodman, 1996: Rainfall estimation for central Florida using standard and probability matching method Z-R relationships applied to composite radar data. In press, *J. Appl. Meteor.*

Driscoll, K. T., and R. J. Blakeslee, 1996: Comment on "Current budget of the atmospheric electric global circuit," by Heinz W. Kasemir. Accepted, *J. Geophys. Res.*

Knupp, K. R., 1996: Structure and evolution of a long-lived, microburst-producing storm. Accepted, *Mon. Wea. Rev.*

Ramachandran, R., A. Detwiler, J. Helsdon, P. Smith and V.N. Bringi, 1995: Precipitation development and electrification in Florida thunderstorm cells during CaPE. Accepted, *J. of Geophys. Res.*

Soman, V. V., J. B. Valdes, and G. R. North, 1996: Estimation of sampling errors and scale parameters using 2-D and 3-D rainfall data analyses. Accepted, *J. Geophys. Res.-Atmos.*

Mueller, S. V., **A. Song**, W. B. Norris, S. Gupta, and **R. T. McNider**, 1996: Modeling pollutant transport during high ozone episodes in the southern Appalachian Mountains. Accepted, *J. Appl. Meteor.*

Jarzembski, M. A., and **V. Srivastava**, 1996: Low pressure experimental simulation of electrical discharges above and inside a cloud. Accepted, *J. of Atmos. and Terres. Phys.*

Betchtold, P., S. K. Krueger, W. S. Lewellen, E. V. Meijaard, C.-H. Moeng. D. A. Randall. A. van Ulden, and **S. Wang**, 1996: Modeling a stratocumulus-topped PBL: Intercomparison among different 1D codes and with LES. Accepted, *Bull. Amer. Meteor. Soc.*

Published

Rothermel, J., **D. A. Bowdle**, and **V. Srivastava**, 1996: Mid-tropospheric aerosol backscatter background mode over the Pacific Ocean at 9.1 micrometer wavelength. *Geophys. Res. Lett.*, **23**:3, 281-284.

Balling, R.C., and **J.R. Christy**, 1996: Analysis of satellite-based estimates of tropospheric diurnal temperature range. *J. Geophys. Res.*, **101-D8,** 12,827-12,832.

Parker, D. E., H. Wilson, P. D. Jones, **J. R. Christy**, and C. K. Folland, 1996: The impact of Mount Pinatubo on world-wide temperatures. *Int. J. Climatology*, **16**, 487-497.

Christy, J. R., 1995: Temperature above the surface layer. *Climatic Change*, **30**, 455-474.

Christy, J. R., and R. W. Spencer, 1995: Assessment of precision in temperatures from the Microwave Sounding Units. *Climatic Change*, **30**, 97-102.

Cooper, H. J., E. A. Smith, and **W. L. Crosson**, 1995: Limitations in estimating surface sensible heat fluxes from surface and satellite radiometric skin temperatures. *J. Geophys. Res.*, **100**, 25419-25427.

Duchon, C. E., T. M. Renkevens, and **W. L. Crosson**, 1995: Estimation of daily area-average rainfall during the CaPE experiment in central Florida. *J. Appl. Meteor.*, **34**, 2704-2714.

Cutten, D. R., R. F. Pueschel, **D. A. Bowdle**, **V. Srivastava**, A. D. Clarke, J. Rothermel, J. D. Spinhirne, and R. T. Menzies, 1995: Multiwavelength comparison of modeled and measured remote tropospheric aerosol backscatter over the Pacific Ocean. *J. Geophys. Res.*, **101-D5**, 9375-9389.

Driscoll, K. T., and R. J. Blakeslee, 1996: Comment on"Current budget of the atmospheric electric global circuit" by Heinz W. Kasemir. *J. Geophys. Res*, **101**, D-12, 17,037-17,040.

Baker, M. B., H. J. Christian, and **J. Latham**, 1995: A computational study of the relationships linking frequency and other thundercloud parameters. *Qtrly. Meteor. Soc.*, **121**, 1525-1548.

McCaul, E. W., Jr., and M. L. Weisman, 1996: Simulations of shallow supercell storms in landfalling hurricane environments. *Mon. Wea. Rev.*, **124**, 408-429.

Jarzembski, M. A., **V. Srivastava**, and D. M. Chambers, 1996: Lidar calibration technique using laboratory-generated aerosols. *Appl. Opt.*, **35**:12, 2096-2108.

Rothermel, J., D. M. Chambers, M. A. Jarzembski, **V. Srivastava**, **D. A. Bowdle**, and W. D. Jones, 1996: Continuous-wave focused CO_2 Doppler lidars for atmospheric backscatter measurements. *Appl. Opt.*, **35**, 2083-2095.

Srivastava, V., **D. A. Bowdle**, M. A. Jarzembski, J. Rothermel, D. M. Chambers and **D. R. Cutten**, 1995: High-resolution remote sensing of atmospheric sulfate aerosols from CO2 lidar backscatter. *J. Geophys. Res.*, **22**, 2373.

Wang, S., 1996: Defining marine boundary-layer clouds with a prognostic scheme. *Mon. Wea. Rev.*, **124**:8, 1817-1833.

Conference Presentations and Publications

Botts, M., 1995. The interuse experiment: Interactive tools for the geolocation and visual comparison of disparate data sets. Tutorial Notes: The Process of Visualizing Large Scientific Data Sets, *IEEE Visualization Œ95*, Atlanta, 30 Oct.-3 Nov.

Botts, M., and R. Phillips, 1995. Maintaining interactivity in visualizing large data sets; Tutorial Notes: The Process of Visualizing Large Scientific Data Sets, *IEEE Visualization Œ95*, Atlanta, 30 Oct.-3 Nov.

Botts, M., 1995. Importance of a standard observation dynamics model for earth observing sensors, *European Symp. on Satellite Remote Sensing II*, Paris, France, 25-28 Sept.

Rushmeier, H., **M. Botts**, S. Uselton, J. Walton, H. Watkins, and D. Watson, 1995. Panel: Metrics and benchmarks for visualization, Proceedings, *IEEE Visualization Œ95*, Atlanta, 30 Oct.-3 Nov., 422-426.

Bowdle, D. A., D. R. Cutten, and **V. Srivastava**, 1995: Tropospheric aerosol backscatter modeling at 2mm wavelength. Presented at *Critical Design Review on the Airborne Coherent Lidar for Advanced Inflight Measurements (ACLAIM/NASA)*, 29-30 Nov.

Bowdle, D. A., V. Srivastava, D. R. Cutten, E. W. McCaul, Jr., J. Rothermel, M. A. Jarzembski, 1995: The GLObal Backscatter Experiment (GLOBE): Overview, results, and applications. Technical Digest, *Coherent Laser Radar* (Opt. Soc. of America), Keystone, CO, 23-27 July, **19**, 152-155.

Bowdle, D. A., D. R. Cutten, V. Srivastava, E. W. McCaul, Jr., J. Rothermel, M. A. Jarzembski, 1995: GLObal Backscatter Experiment (GLOBE): Accomplishments and status. Presentation, *Meeting of the NOAA Working Group on Space-Based Lidar Winds*, Keystone, CO, 19-21 July.

Bowdle, D. A., 1995: Multiwavelength tropospheric aerosol backscatter model. Abstracts (Week B, Geophysics and the Environment), *Intl. Union of Geodesy and Geophysics* (IUGG XXI General Assembly), Boulder, CO, 2-14 July, B294.

Braswell, W. D., and R. W. Spencer, 1996: A statistical approach for retrieval of humidity profiles from SSM/T-2: Comparison to a physical retrieval method. Preprints and presentation, *8th Conf. on Satellite Meteor. and Oceanogr.* (AMS), Atlanta, 28 Jan.-2 Feb., 15-18.

Robertson, F. R., D. E. Fitzjarrald, and **D. Braswell**, 1996: Water vapor feedback deduced from interannual variability in ERBE fluxes. *2nd Intl. Scientific Conf. of GEWEX*, Washington, D. C., 17-21 June.

Robertson, F. R., D. E. Fitzjarrald, and **D. Braswell**, 1996: Water vapor feedback deduced from interannual variability in ERBE fluxes. *7th Symp. on Global Change Studies* (AMS), Atlanta, 28 Jan.-2 Feb.

Spencer, R. W., and **W. D. Braswell**, 1996: Water vapor feedback in the tropics deduced from SSM/T-2 water vapor and MSU temperatures. Presentation, *7th Symp. on Global Change Studies* (AMS), Atlanta, 28 Jan.-2 Feb.

Buechler, D. E., S. J. Goodman, **E. W. McCaul, Jr.**, and **K. R. Knupp**, 1996: Cloud-to-ground lightning activity within tornadic storms in the Tennessee Valley. Preprints and poster presentation, *18th Conf. Severe Local Storms* (AMS), San Francisco, 20 Feb., 499-503.

Buechler, D. E., R. J. Blakeslee, H. J. Christian, R. Creasey, **K. Driscoll**, S. J. Goodman, and **D. M. Mach**, 1996: Lightning activity in a tornadic storm observed by the Optical Transient Detector (OTD). Preprints, *18th Conf. on Severe Local Storms* (AMS), San Francisco, 19-23 Feb.

Goodman, S. J., H. J. Christian, W. J. Koshak, **D. E. Buechler**, D. J. Boccippio, W. L. Boeck, R. J. Blakeslee, **K. T. Driscoll**, and **D. A. Mach**, 1996: Cross-sensor validation of OTD (Optical Transient Detector) observed lightning. Proceedings, *10th Intl. Conf. on Atmospheric Electricity*, Osaka, Japan, 10-14 June.

Goodman, S. J., H. J. Christian, R. J. Blakeslee, D. J. Boccippio, **D. E. Buechler**, **K. T. Driscoll**, J. Fennelly, J. Hall, W. J. Koshak, **D. A. Mach**, P. Meyer, **M. Botts**, R. Creasey, R. Phillips, and W. L. Boeck, 1996: The Optical Transient Detector: First results. Preprints, *8th Conf. on Satellite Meteor.* (AMS), Atlanta, 28 Jan.-2 Feb., 583-587.

Buechler, D. E., R.J. Blakeslee, W.J. Koshak, **K.T. Driscoll**, and H.J. Christian, 1995: Characteristics of lightning flashes observed by the optical transient detector (OTD), Preprints and Presentation, *Fall Meeting of the Amer. Geophys. Union*, San Francisco, 11-15 Dec.

Goodman, S. J., H. J. Christian, W. J. Koshak, **D. E. Buechler**, D. J. Boccippio, W. Boeck, R. Blakeslee, **K. T. Driscoll**, K. Cummins, F. Mosher, and J. Jalickee, 1995: Cross-sensor validation of OTD (Optical Transient Detector)-observed lightning, *Fall Meeting of the Amer. Geophys. Union*, San Francisco, 11-15 Dec.

Goodman, S. J., H. Christian, R. Blakeslee, D. Boccippio, **D. E. Buechler**, **K. T. Driscoll**, J. Fennelly, J. Hall, W. Koshak, **D. M. Mach**, P. Meyer, **M. Botts**, R. Creasey, R. Phillips, and W. Boeck, 1995: The Optical Transient Detector: First results. *11th Intl. Union of Geodesy and Geophys.*, Boulder, CO, 2-14 July.

Christy, J. R., 1996: The satellite temperature record. *U. S. Global Change Research Program, National Seminar*, Washington, D. C., 20 May.

Christy, J. R., 1996: An upper troposphere MSU retrieval for the tropical atmosphere. *7th Symp. on Global Change Studies* (AMS), Atlanta, 28 Jan.-2 Feb.

Driscoll, K. T., R. J. Blakeslee, J. C. Bailey, and H. J. Christian, 1996: Atmospheric conductivity observations over a wide latitudinal range. Accepted, *Proc. of the 10th Intl. Conf. on Atmospheric Electricity*, Osaka, Japan, 10-14 June.

Driscoll, K. T., R. J. Blakeslee, J. C. Bailey, and H. J. Christian, 1996: Atmospheric conductivity observations over a wide latitudinal range. *10th Intl. Conf. on Atmos. Electricity*, Osaka, Japan, 10-14 June.

Christian, H. J., S. J. Goodman, R. J. Blakeslee, **K. T. Driscoll, D. A. Mach**, and **D. E. Buechler**, 1996: The Optical Transient Detector. Accepted, *Proc. of the 10th Intl. Conf. on Atmos. Electricity*, Osaka, Japan, 10-14 June.

Driscoll, K. T., H. J. Christian, S. J. Goodman, D. J. Boccippio, **D. E. Buechler**, R. J. Blakeslee, and **D. A. Mach**, 1995: Global lightning distribution as observed by the optical transient detector. *Fall Meeting of the Amer. Geophys. Union*, San Francisco, 11-15 Dec.

Christian, H. J., S.J. Goodman, R.J. Blakeslee, **K. T. Driscoll, D. A. Mach**, and **D. E. Buechler**, 1995: The Optical Transient Detector, *Fall Meeting of the Amer. Geophys. Union*, San Francisco, 11-15 Dec.

Graves, S., **H. T. Conover** and **M. Drewry**, 1996: Is a common metadata model necessary for a federated data system? Panel presentation, *1st IEEE Metadata Conf*, Apr.

Knupp, K., R. L. Clymer, **E. W. McCaul, Jr.**, and K. Pence, 1996: Structure and evolution of the 1994 Palm Sunday tornadic storms and their near mesoscale environment. Preprints, *18th Conf. Severe Local Storms* (AMS), San Francisco, 19-23 Feb., 42-46.

Geerts, B., **K. R. Knupp**, and B. Clymer, 1996: Interaction between frontal and convective dynamics of a large long-lived, severe squall line with trailing stratiform region. Preprints, *18th Conf. on Severe Local Storms* (AMS), San Francisco, 19-23 Feb., 296-299.

Geerts, B., and **K. R. Knupp**, 1995: Dynamical interpretation of a weakly sheared, small mesoscale convective system. Preprints, *27th Conference on Radar Meteor.* (AMS), Vail, CO, 9-13 Oct.

Stalker, J.R., and **K. R. Knupp**, 1995: Observations and numerical simulations of cell interactions within a subtropical multi-cell storm. Preprints, *27th Conf. Radar Meteor.* (AMS), Vail, CO, 9-13 Oct., 525-528.

Tong, Hui, V. Chandrasekar, **K. R. Knupp**, and J. R. Stalker , 1995: Evaluation of latent heating estimates from multiparameter radar data and multiple Doppler analysis. Preprints, *27th Conf. Radar Meteor.* (AMS), Vail, CO, 9-13 Oct., 450-452.

Lerner, J. A., 1996: Precipitable water variability using SSM/I and GOES VAS Pathfinder data sets. Poster presentation and proceedings, *8th Conf. on Satellite Meteor.* (AMS), Atlanta, 30 Jan., 68-71.

Guillory, A. R., R. J. Suggs, and **J. A. Lerner**, 1996: How well do PSW retrievals compare NVAP data? *2nd Intl. Scientific Conf. on the Global Energy and Water Cycle (GEWEX)*, Washington, D. C., 17-21 June, 384-5.

Lapenta, W., F. R. Robertson, **H.-L. Lu**, and G. Jedlovec, 1996: Variability of tropical divergent circulation during 1987-1988 as depicted in two reanalysis data sets. *Conf. on Global Ocean-Atmosphere-Land Systems* (AMS), Atlanta, 28 Jan.-2 Feb.

McCaul, E. W., Jr., and M. L. Weisman, 1996: The dependence of simulated storm structure on variations in the shapes of environmental buoyancy and shear profiles. Preprints and oral presentation, *18th Conf. Severe Local Storms*, (AMS), San Francisco, 22 Feb., 718-722.

Robertson, F. R., **E. W. McCaul, Jr.**, D. Samuelson, and G. Jedlovec, 1996: Synthesis of upper-tropospheric vapor and cloud analyses during the NASA/NOAA Pathfinder period. Preprints, *2nd Intl. Scientific Conf. of GEWEX*, Washington, D. C., 17-21 June, 414-415.

Cammarata, M., **E. W. McCaul, Jr.**, and **D. E. Buechler**, 1996: Observations of shallow supercells during a major tornado outbreak spawned by Tropical Storm Beryl. Preprints and poster presentation, *18th Conf. Severe Local Storms* (AMS), San Francisco, 19-23 Feb., 340-343.

Robertson, F. R., **E.W. McCaul, Jr.**, D. Samuelson and G. Jedlovec, 1996: Synthesis of upper-tropospheric vapor and cloud analyses during the NASA/NOAA Pathfinder period. *8th Conf. on Sat. Meteor. and Oceanogr.* (AMS), Atlanta, 28 Jan.-2 Feb.

Weisman, M. L., and **E. W. McCaul, Jr.**, 1995: Simulations of shallow supercell storms in landfalling hurricane environments. Preprints, *27th Conf. on Radar Meteor. (AMS)*, Vail, CO, 11 Oct., 428-430.

McNider, R. T., J. A. Song, D. J. Perkey, and **W. L. Crosson**, 1996: Testing the impact of assimilating the GOES satellite-derived observation on regional-model simulation. Poster presentation, *2nd Intl. Scientific Conf. of GEWEX*, 17-21 June.

Biazar, A. P., and **R. T. McNider**, 1996: Simulation and evaluation of meteorology and chemistry at a rural SOS superchemistry site. Preprints, *9th Joint Conf. on the Appl. of Air Pollution Meteor. with the AWMA* (AMS), Atlanta, 473-477.

McNider, R. T., W. B. Norris, and **J. A. Song**, 1995: Regional meteorological characteristics during ozone episodes in the Southeastern United States. Transactions, *Intl. Specialty Conf. on Regional Photochemical Measurement and Modeling Studies*, San Diego, CA, November 8-12, 1993. (Published by the Air and Waste Management Association, Pittsburgh, PA.)

Raghavan, R., R. Ramachandran, and S. J. Goodman, 1995: Retrieval of cloud properties using lightning observations from space, *Fall Meeting of the Amer. Geophys. Union*, San Francisco, 11-14 Dec., EOS 76, No. 46.

Ramachandran, R., R. Raghavan, and S. J. Goodman, 1996: Estimating ice water content using observed lightning. Proceedings, *10th Intl. Conf. on Atmos. Electricity*, Osaka, Japan, 10-14 June.

Koshak, W. J., J. W. Bergstrom, **M. F. Stewart**, H. J. Christian, J. M. Hall, and R. Solakiewicz, 1996: Calibration of the Optical Transient Detector (OTD). *10th Intl. Conf. on Atmos. Electricity*, Osaka, Japan, 10-14 June.

Srivastava, V., D. A. Bowdle, M. A. Jarzembski, 1995: Dual-wavelength CW lidar technique for atmospheric sulfate aerosol detection. *Aerosol Interdisciplinary Workshop and Tarfox Workshop* (NASA), Columbia, MD, 30 Oct.-5 Nov.

Srivastava, V., M. A. Jarzembski, J. Rothermel, D. M. Chambers, and A. D. Clarke, 1995: Aerosol sulfate chemistry determination from backscatter measurements using continuous-wave 9.1 and 10.6 um lidars. Technical Digest, *Coherent Laser Radar Conf.* (Opt. Soc. of America), Keystone, CO, 23-27 July, **19,** 148-151.

Jarzembski, M. A., **V. Srivastava,** and D. M. Chambers, 1995: A new lidar calibration technique using aerosols. *Coherent Laser Radar Conf.* (Opt. Soc. of America), Keystone, CO, 23-27 July.

Wang, S., 1996: A 2D eddy-resolving model study of the interaction between cumulus and stratus clouds observed in ASTEX. Presentation, *FIRE III Science Team Mtg.*, Williamsburg, VA, 12-15 Feb.

Wang, S., 1995: Interactions between stratocumulus and cumulus clouds in the boundary layer as simulated by a 2-D LES model. *IUGG Mtg.*, Boulder, CO, 2-9 July.

Workshops, Seminars and Other Communications

Beaumont, B., 1995: HyDRO user's manual (revised, WWW document), December.

Beaumont, B., 1995: WSI data ingest user's manual (WWW document), December.

Beaumont, B., 1995: PATSY user's manual (WWW document), December.

Bowdle, D. A., 1996: Tropospheric aerosol backscatter: Vertical structure, wavelength dependence, and probability distribution. Presentation, *Discussions on a Joint NASA/DOE Satellite Doppler Wind Lidar*, Los Alamos National Laboratory (NASA), Los Alamos, NM, 29-30 May.

Bowdle, D. A., 1995: Tropospheric aerosol backscatter modeling at 2um wavelength. Presentation, *NASA Critical Design Review for the Airborne Coherent Lidar for Advanced Inflight Measurements (ACLAIM)*, Lafayette, CO, 29-30 Nov.

Bowdle, D. A., D. R. Cutten, V. Srivastava, E. W. McCaul, J. Rothermel, and M. A. Jarzembski, 1995: Global Hydrology and Climate Center Aerosol/Lidar Group science accomplishments and plans. Presentation, *Universities Space Research Association Science Council for Earth Sciences*, Huntsville, AL, 21 Nov.

Christy, J. R., 1996: Global temperature measurements seminar. Presentation, *U. S. Global Change Research Program*, Washington, D. C., 20-21 May.

Conover, H. T., 1996: Member, NASA Delegation, *Institute of Radioengineering and Electronics of the Russian Academy of Sciences*, Fryazino, Russia, 20-24 May.

Conover, H. T., 1996: EOSDIS Core System (ECS) Release B Critical Design Review. Review Panel Member, "Client Subsystem" Session, Landover, MD, 18 April.

Conover, H. T., Y. S. Enloe, and S. Hong, 1996: IMS server cookbook, *GSFC Technical Document*. Second Revision, Apr.

Conover, H. T., and **S. T. McCoy**, 1996: MSFC DAAC statistics implementation document. DAAC Technical Document.

Conover, H. T., and M. Drewry, 1995: MSFC DAAC databases, Dec.

Conover, H. T., 1995: EOSDIS V0 IMS server for the MSFC DAAC (Documentation and release notes for release 5.0 of this software), Nov.

Conover, H. T., 1995: Procedures for updating IMS 'Valids' for the MSFC DAAC, Oct.

Conover, H. T., 1995: HyDRO: Hydrologic data search, retrieve, and order. *VO IMS Web Interface Prototyping Workshop*, Greenbelt, MD, 20 July.

Conover, H. T., 1995: Status of MSFC DAAC. *EOSDIS VO IMS Developers' Mtg.*, Landover, MD, 17-19 July.

Cox, G. N., 1996: GPS technology in the classroom. *Rostov State Pedagodgical Institute*, Rostov-on-Don, Russia, June.

Cox, G. N., 1996: Environmental education and outreach programs in the United States. *2nd Annual Envir. Mgmt. Symp., Primosko-Aktarsk*, Krasnodar Krai, Russia, June.

Cox, G. N., 1996: EarthSense: An environmental education curriculum for hydrology and remote sensing. *Natl. Science Teachers Assoc. Annual Mtg.*, St. Louis, MO, 28-30 Mar.

Cox, G. H., 1996: GIS technology training for public administration. *Rostov State University*, Rostov-on-Don, Russia, Jan.

Cox, G. N., 1996: GPS technology in the classroom. *Rostov State Pedagodgical Institute*, Rostov-on-Don, Russia, Jan.

Cox, G. N., 1996: Mission to Planet Earth and Project EarthSense. *Alabama Dept. of Ed. Fed. Programs Annual Mtg.*, Birmingham, AL, Jan.

Cox, G. N., 1995: Information access: GIS technology for public administration. *Rostov Regional Public Administration Officials Symp.*, Huntsville, AL, Oct.

Criswell, E., 1995: Optical disk jukebox file location database - user documentation (revised), Dec.

Criswell, E., 1995: Optical disk jukebox file statistics programs - user documentation (revised), Dec.

Criswell, E., 1995: FTP log statistics generation scripts - user documentation (revised), Dec.

Drewry, M., 1996: Parameter keyword selection and its implications in the EOSDIS VO IMS client/servers search mechanisms. Presentation, VO IMS Metadata Meeting/Workshop, Greenbelt, MD, 25 June.

Driscoll, K. T., 1996: The Optical Transient Detector: An example of cooperation between UAH and NASA. Presentation, *UAH Board of Trustees*, MSFC, Huntsville, AL, Apr.

Graves, S., 1995: EOSDIS prototyping for NRA/CAN meeting, Washington, D.C., Nov.

Graves, S., and **B. Beaumont**, 1995: Dataset independent subsetting for SSIG meeting, Langley Research Center, Nov.

McCaul, E. W., Jr., 1996: Photography of severe storms and weather phenomena. Presentation, *Tennessee Valley Chapter of American Meteorological Society*, Huntsville, AL, 13 June.

McCaul, E. W., Jr., 1996: Improving forecasts of severe storms in landfalling hurricanes. Presentation, *Prospectus Development Team 5, USWRP*, Tallahassee, FL, 1 May.

McCaul, E. W., Jr., 1996: Forecasting Severe Storms. Presentation, *Synoptic Meteorology Laboratory*, University of Alabama in Huntsville, 8 Mar.

McCaul, E. W., Jr., 1995: Global water vapor and condensate budgets from a semiprognostic model. Presented at *IGCRE Science Council Meeting*, GHCC, Huntsville, AL, 21 Nov.

McCaul, E. W., Jr., 1995: Tornadoes spawned by tropical cyclones. Invited Seminar, *Training Symposium for Operational Forecasters in the Carolinas and Virginia*, Raleigh, NC, 7 Nov.

McCaul, E. W., Jr., 1995: Hurricanes, severe weather, global change and other climate issues. On-air interview for *Conscious Living*, WQXI radio, Atlanta, 22 Oct.

McCaul, E. W., Jr., 1995: Severe storm spotting and safety in the Tennessee Valley. Presentation, *Emergency Mgmt. Assoc.*, Lawrence County, TN, 18 Aug.

McCoy, S. T., 1996: MSFC DAAC Data Archive Inventory System (DAISY) software document. DAAC technical document.

McCoy, S. T., 1996: MSFC DAAC Data Order Tracking System (DOTS), GCIP version. Design Review. GHCC, 4 Mar.

McCoy, S. T., 1996: MSFC DAAC Data Order Tracking System (DOTS), GCIP version. Requirements Review. GHCC, 15 Feb.

McCoy, S. T., 1996: MSFC DAAC Data Archive Inventory System (DAISY) training session with operations and archive staff. GHCC, 24 Jan.

McCoy, S., 1995: Data archive inventory system (DAISY), November.

McCoy, S., 1995: Data order tracking system (DOTS) (revised), November.

APPENDIX C

EDUCATION ACTIVITIES

Scientist	Date	Location	Activity
Cox, G. N.	July 1996	Huntsville, AL DeSoto State Park, AL	Coordinated and led week-long workshop, "An Earth Science Teacher Training Program for Alabama Teachers"
Laymon, C. A.	July 1996	Huntsville, AL	Presented "Fundamentals of Hydrology" workshop at Earth Science Teacher Training Program for Alabama Teachers
Perkey, D. J.	July 1996	Huntsville, AL	Presented "What Is Global Change?" for Earth Science Teacher Training Program for Alabama Teachers
Cox, G. N.	July 1996	Huntsville, AL Azov, Russia	Coordinated EcoBridge Internet Event, CU-SeeMe video conference with Russian and American high school students
Crosson, W. L.	June-Aug. 1996	Huntsville, AL	Mentored a NASA/Alabama A&M Univ./IGCRE SEP student
Laymon, C. A.	June-Aug. 1996	Huntsville, AL	Mentored a NASA/Alabama A&M Univ./IGCRE SEP student
Soman, V. V.	June-Aug. 1996	Huntsville, AL	Mentored a NASA/Alabama A&M Univ./IGCRE SEP student
Cox, G. N.	June 1996	Rostov-on-Don, Russia	Presented GPS Technology in the Classroom at the Rostov State Pedagodgical Institute
Cox, G. N.	June 1996	Huntsville, AL Azov, Russia	Taught GPS instruction and World Wide Web development to Eco-Bridge students and teachers
Crosson, W. L.	June 1996	Huntsville, AL	Lectured Global Climate Change class for NASA/Alabama A&M Univ./IGCRE SEP students at Alabama A&M Univ.
Laymon, C. A.	June 1996	Huntsville, AL	Lectured Global Climate Change class for NASA/Alabama A&M Univ./IGCRE SEP students at Alabama A&M Univ.
Bowdle, D. A.	Apr. 1996	Huntsville, AL	Reviewed written science reports for the High School Div., Alabama Computational Science Expo
Laymon, C. A.	Mar.-May 1996	Huntsville, AL	Mentored five high school students on the Supercomputing Project
Cox, G .N.	Jan. 1996	Rostov-on-Don Russia	Presented BPD Technology in the Classroom at the Rostov State Pedagodgical Institute
Crosson, W. L.	Nov. 1995	Huntsville, AL	Lectured Global Climate Change class at Univ. of Alabama in Huntsville

APPENDIX D

UNIVERSITY, INDUSTRY AND GOVERNMENT COLLABORATIONS

IGCRE Scientist	Collaborator/ Affiliation	Nature of Collaboration
Bowdle, D. A.	Dr. Donald R. Johnson/ Univ. of Wisconsin	Aerosol physics inputs to isentropic aerosol transport
Bowdle, D. A.	Wayman E. Baker NOAA Natlional Centers for Environmental Prediction	Satellite Doppler lidar
Bowdle, D. A.	Rod Bogue NASA Dryden Flight Research Facility	Aerosol effects on Doppler lidars
Bowdle, D. A.	Robert T. Menzies Jet Propulsion Laboratory	GLOBE data analysis and interpretation
Bowdle, D. A.	Madison J. Post NOAA Environmental Technology Laboratory	NOAA ETL lidar climatology
Bowdle, D. A.	U. S. Air Force Wright Laboratories	Spatial and temporal variability of aerosol backscatter
Bowdle, D. A.	James D. Spinhirne NASA Goddard Space Flight Center	GLOBE data analysis and interpretation
Bowdle, D . A.	Glenn Yue NASA Langley Research Center	Tropospheric and stratospheric aerosol backscatter
Bowdle, D. A.	George D. Emmitt Simpson Weather Assoc.	Aerosol effects on satellite Doppler lidars
Bowdle, D. A.	Sammy Henderson Coherent Technologies, Inc.	2um backscatter calibration
Bowdle, D. A.	Russell Targ Lockheed/Martin Corp.	Aerosol effects on satellite Doppler lidars
Braswell, W. D.	Richard S. Lindzen Mass. Inst. of Technology	Anomalous shortwave absorption and atmospheric tides
Buechler, D. E.	Michael Cammarata National Weather Service	Observations on shallow supercells during a major tornado outbreak spawned by Tropical Storm Beryl
Cox, G. N.	F. A. Surkov, Y. A. Donbrovsky Rostov State University Rostov-on-Don, Russia	GIS Technology and EcoBridge Environmental Education
Cox, G. N.	Perry Samson University of Michigan	National Science Foundation Initiatives in Education Next Generation Blue Skies Program
Cox, G. N.	Nancy Songer University of Colorado	National Science Foundation Initiatives in Education Next Generation Blue Skies Program
Cox, G. N.	Rosalyn McEowan-Ice University of Tennessee	River-to-River Environmental Education Program
Cox, G. N.	Terry Wilson Western Kentucky University	Ground Truth Studies Program

Cox, G. N.	John Wagner Clemson University	Remote Sensing and Photogrammetry Education
Cox, G. N.	Lisa Ostendorf and Mark Pine NASA HQ, Office of MTPE	Mission To Planet Earth Education Program
Cox, G. N.	Nahid Khazenie Goddard Space Flight Center	Mission to Planet Earth Education Program
Cox, G. N.	Bill Dailey and Ben Ferrill City of Huntsville, AL	GIS Technology
Cox, G. N.	Ron Williams Tennessee Valley Authority Environmental Research Center, Muscle Shoals, AL	Environmental Education/Outreach Programs
Cox, G. N.	Terry Keating, Susan Nolen and Mike Baker Infrastructure Div., Intergraph Corp.	GIS Technology and Education
Cox. G. N.	Mary Shea, Mike Brainard, Kristen Vitrale and Jennifer Adibi CEC International Partners	Environmental Education and GIS Technology
Crosson, W. L.	Claude Duchon University of Oklahoma	Research related to the CaPE field experiment, focusing on the estimation of rainfall using gauges and radars and on land surface flux modeling
Crosson, W. L.	Tom Coleman and Others Alabama A&M University	Designing and staging a soil moisture field experiment conducted in Huntsville, AL in July 1996
Crosson, W. L.	Tom Jackson (USDA) Peggy O'Neill (NASA/GSFC)	Planning the 1996 soil moisture field experiment at Alabama A&M University
Crosson, W. L.	Ramarao Inguva Huntsville, AL	Development of an inverse modeling strategy to be applied for remote sensing of soil moisture
Laymon, C. A.	Center for Hydrology, Soil Climatology and Remote Sensing/Alabama A&M University	Soil moisture remote sensing and modeling
Laymon, C. A.	Goddard Space Flight Center	Designing scientific requirements for deployment of the GSFC truck radar system during 1996 field experiment
Laymon, C. A.	Utah State University	Regarding the Goshute Valley, Nevada project
Laymon, C. A.	Intergraph Corp.	
Laymon, C. A.	U. S. Dept. of Agriculture	Defining scientific requirements for deployment of the USDA radiometer system for 1996 field experiment
Mach, D. A.	W. D. Rust NSSL/DOC Norman, OK	Lightning Properties
McCaul, E. W., Jr.	Morris L. Weisman NCAR	Numerical simulations of convective storm dynamics in landfalling hurricane and related environments
McCaul, E. W., Jr.	Prospectus Development Team U. S. Weather Research Program	Research opportunities and needs in landfalling hurricanes

Miller, K. (student)	Alan Gadian UMIST (United Kingdom)	Development of a two-dimensional numerical thundercloud model
Miller, K. (student)	Clive Saunders UMIST (United Kingdom)	Investigation of charge transfer parameterization in relation to lightning type and frequency using a one-dimensional computer model
Miller, K. (student)	Alan Blyth New Mexico Institute of Technology	Role of multithermal dynamics in cloud electrification
Miller, K. (student)	John Latham NCAR	Studying the effect of various cloud parameters on the lightning frequency in a single thundercloud using numerical models
Raghavan, R.	M. Weber, B. Boldi, E. Williams MIT/Lincoln Laboratory	Lightning Mapper pilot study
Srivastava, V.	A. D. Clarke University of Hawaii	Aerosol microphysics data
Srivastava, V.	J. Spinhirne NASA/Goddard	Pulsed Nd: Yag lidar data--GLOBE project
Srivastava, V.	R Menzies NASA/JPL	Pulsed CO_2 lidar data--GLOBE and MACAWS projects
Srivastava, V.	R. D. Pueschel NASA/ARC	FSSP aerosol distribution data--GLOBE and MACAWS projects
Wang, S.	Christopher Bretherton (Univ. of Washington); Qing Wang (Naval Postgraduate School)	Coastal boundary layers
Wang, S.	Carmen M. Benkovitz and Mark Miller Brookhaven Natl. Laboratory	Boundary layer chemistry

APPENDIX E

EARTH SYSTEM SCIENCE EDUCATION (ESSE) ACTIVITIES

In 1991 the Universities Space Research Association (USRA) and the National Aeronautics and Space Administration (NASA) initiated the Cooperative University-based Program in Earth System Science Education (ESSE). The program concept is designed to create a university-based cooperative effort in Earth Science curriculum development, with a framework that would overcome traditional barriers to interdisciplinary science education. Twenty-two universities were competitively selected to participate in the program initially. During the past year, an additional group of 22 universities submitted successful proposals to join the ESSE program.

The ESSE Program has been conducting workshops for its participants over the past four years. Topics have included hands-on training in the use of Internet resources, the use of modeling software in the classroom (STELLA) and multimedia global change education (GEOSCOPE). A workshop focusing on the physics of remote sensing and geographic information systems was conducted for the ESSE participants in November 1995 in Santa Barbara, CA. The most recent ESSE steering meeting was held at the NASA-sponsored Classroom of the Future facility in Wheeling, West Virginia, in August 1996. The ESSE program has also supported the participation of graduate teaching assistants and faculty in the NASA/GSFC Summer Lecture Series.

ESSE Associated Travel

ESSE Curriculum Development Workshop

Berkeley Springs, WV **August 11-16, 1996**

Participant	Affiliation
Aker, B.	University of Iowa
Berkman, P.	Ohio State University
Edelson, D.	Northwestern University
Fisher, G.	Johns Hopkins University
Gregoret, A.	University of Minnesota
Jones, C.	University of California - Santa Barbara
Lerman, A.	Northwestern University
Morris, G.	Rice University
Mosley-Thompson, E.	Ohio State University
Popovich, M.	Ohio State University
Siewierski, M.	Rutgers University
Thomas, R.	University of Florida
Weirich, F.	University of Iowa
Zanner, B.	University of Minnesota

Curriculum Development Workshop Planning Meeting

Washington, D. C. July 31-August 2, 1996

Participant	Affiliation
Berkman, P.	Ohio State University
Lerman, A.	Northwestern University
Thomas, R.	University of Florida

USRA/NASA/GSFC Lecture Series

Greenbelt, MD **June 7-16, 1995**

Participant	Affiliation
Houston, R.	Rice University
Landsfeld, M.	University of California, Santa Barbara
Locke, S.	Union College
Miller, James	Rutgers University
Miller, Jennifer	University of Florida
Morin, P.	University of Minnesota
Mosley-Thompson, E.	Ohio State University
Newman, A.	Northwestern University
Slawinski, D.	University of Minnesota
Werne, J	Northwestern University
Zanner, B.	University of Minnesota

Project Kaleidoscope Workshop - "Innovative Approaches to Teaching Earth and Planetary Science"
Lancaster, PA **March 1-3, 1996**

Participant	Affiliation
Abbott, P.	San Diego State Univ.
Boardman, S.	Carleton College
Hollingsworth, W.	Carleton College
Robinson, K.	San Diego State Univ.
Ruzek, M.	USRA
Savina, M.	Carleton College

Workshop on Use of Remote Sensing and GIS in the Classroom
Santa Barbara, CA **November 16-19, 1995**

Participant	Affiliation
Abreu, V.	University of Michigan
Alexander, S.	NASA-Ames
Ambos, E.	California State University - Long Beach
Busch, R.	West Chester University
Cawlfield, J.	University of North Carolina
Cizmas, L.	North Carolina State University
Cole, J.	University of Colorado
Condit, C.	University of Massachusetts
Cook, K.	Cornell University
Crawford, M.	Bryn Mawr College
Duke, E.	South Dakota School of Mines & Technology
Feind, R.	South Dakota School of Mines & Technology
Fisher, G.	John Hopkins University
Ford, R.	Westminster College
Foresman, T.	University of Maryland-Baltimore County
Gage, S.	Michigan State University
Gilliland, A.	Georgia Institute of Technology
Gilman, C.	Coastal Carolina University
Harcombe, P.	Rice University
Hartley, D.	Georgia Institute of Technology
Head, W.	California State University-Monterey Bay
Hefferan, K.	Coastal Carolina University
Hollingsworth, W.	Carleton College
Johnsson, M.	Bryn Mawr College
Juday, G.	University of Alaska, Fairbanks
Kalb, M.	USRA
Kelts, K.	University of Minnesota
Killeen, T.	University of Michigan
Lemoi, L.	Union College
Lewis, L.	Clark Atlanta University
Locke, S.	Union College
Loftus, M.	University of Maryland
Maul, G.	Florida Institute of Technology
McCoy, W.	University of Massachusetts
Meixner, T.	University of Arizona
Miller, James	Rutgers University
Newman, R.	Purdue University
Postawko, S.	University of Oklahoma
Robinson, W.	University of Illinois
Stoddard, E.	North Carolina State University
Thomas, R.	University of Florida
Thompson, O.	University of Maryland
Wagenbach, G.	Carleton College
Weirich, F.	University of Iowa
White, J.	University of Colorado

Wiswall, C.	West Chester University
Witiw, M.	Florida Institute of Technology
Yates, J.	San Diego State University
Yuan, M.	University of Oklahoma

ESSE Proposal Review
Washington, D. C. August 15-17, 1995

Participant	Affiliation
Barron, E.	Pennsylvania State University
Ford, R.	Westminster College
Gautier, C.	University of California-Santa Barbara
Lerman, A.	Northwestern University
Nese, J.	Penn StateUniversity - Beaver Campus
Thomas, R.	University of Florida
Weirich, F.	University of Iowa

Other ESSE Travel Activities

Traveler	Affiliation	Dates	Destination and Purpose of Travel
Johnson, D.	University of Wisconsin	1/28/96-2/4/96	Atlanta, to attend AMS Annual Meeting and participate in the Education and Global Change sessions
Ruzek, M.	USRA	12/9-16/95	San Francisco, to attend Fall AGU Meeting and meeting at Lawrence Hall of Science (Berkeley)
Johnson, D.	University of Wisconsin	12/7-15/95	San Francisco, to attend Fall AGU Meeting
Johnson, D.	University of Wisconsin	11/25-20/95	Santa Barbara and Long Beach, CA to lead ESSE Workshop on Remote Sensing and GIS in the Classroom, and to meet with Project ALERT re: Earth System Science Education
Mackenzie, F.	University of Hawaii	11/6-11/95	Northwestern University, to lecture on "Industrial and Agricultural Emissions of Atmospheric Gases," "The Role of Coastal Ocean in Climate Change" and "Biogeochemistry of the Carbon Cycle"
Ruzek, M.	USRA	10/16/95	To University of Michigan (Ann Arbor) to attend NRC/NSF Regional Symposium for Undergraduate Science, Math, Engineering and Technology Education

APPENDIX F

SEMINARS

Date	Title	Name	Affiliation
1996			
June 26	Climate Variability Studies Using NCAR GCM's	Robert J. Oglesby	Purdue Univ.
May 29	Ozone Sulfate and Regional Climate Change	Bill Chameides	Georgia Tech
May 22	Russian EcoBridge: Russian-American Secondary Environment Research	Greg Cox	UAH
May 15	Hierarchy of Mesoscale Models and Recent Results from the EURBMET/TVM Model	Robert Bornstein	San Jose State Univ.
May 8	Dynamic Influence of Antarctic Continent on Current Climate	Tom Parish	Univ. of Wyoming
May 1	What is the Link Between the South Atlantic Tropospheric Ozone Maximum and Biomass Burning? Answers from Satellite and the 1992 SAFARI and TRACE-A Experiments	Anne Thompson	GSFC
April 25	Photochemical Modeling Plan Using Atmospheric Science in K-12 Education	Perry Samson	Univ. of Michigan
April 24	Decision Support System for Water Resource Management	A. P. Georgakakos	Georgia Tech
April 17	Modeling Topographic Effect of Digital Remotely Sensed Data	Ahmed Fahsi	Alabama A&M Univ.
April 3	Simulation and Evaluation of Meteorology and Chemistry at a Rural SOS Superchemistry Site	Arastoo (Alan) Biazar	UAH
March 28	Variability of Integrated Water Content from GOES Pathfinder Data	Anthony Guillory	MSFC
March 20	Microwave Measurements of Soil Moisture in Hydrometeorology	Ted Engman	GSFC
March 13	The Role of Soil Water in Hydrometeorology	Konstantino Georgakakos	Hydrologic Research Center
March 7	Numerical Study of Propagation of Gravity Waves from Lower Atmosphere into Lower Thermosphere	Mike Hickey	UAH
March 6	Global Positioning System (GPS)/ Meteorology and Use for Climate and Global Change Studies	Rick Anthes	UCAR
February 27	Experiences in Orbit on the Space Shuttle	Fred Leslie	MSFC
February 21	Precipitating Cloud Systems and Global Climate Problems	Mitch Moncrief	NCAR
February 14	A Regional-Scale Four-Dimensional Data Assimilation with the RAMS-3A Model Incorporating the NMCETA Forecast and the Satellite GOES VIS/IR Data Over Complex Terrain	Jeff Lerner	UAH

January 25	Precipitable Water Variability Using SSM/I and GOES VAS Pathfinder Data Sets	Jeff Lerner	UAH
January 18	Water Vapor Feed Back Deduced from Interannual Variability in ERBE Fluxes	Pete Robertson	MSFC
January 17	Satellite Simulation of Passive Microwave Ocean Wind Vector Remote Sensing	Robbie Hood	NASA
January 10	Testing validity of SSM/I Latent Heat Retrieval with Large Scale Diagnostic Budget and Zonal Balance Mode	Eric Smith	Florida State Univ.

1995

December 13	Statistical versus Physical Retrieval Methods for Water Vapor From SSM/T-2	Danny Braswell	NRC
December 6	Integrated Water Content Retrieved from Goes 7 and 8	Ron Suggs	MSFC
November 29	Improved Space Time Model for Visualization and Analysis	Mike Botts	UAH
November 20	Designing the TOMS (Total Ozone Mapping Spectrometer)	Bob Hudson	Univ. of Maryland
November 15	Comparison of SAGE Ozone Measurement to Umker Observing System Retrieved Ozone Profiles	Jing Cao	UAH
November 8	Modeling Pollutant Transport in the Southern Appalachian Mountains	Steve Mueller Benjie Norris	TVA UAH
November 7	Tornadoes Spawned by Tropical Cyclones	E. W. McCaul, Jr.	USRA
November 1	Effects of Clouds on the Urban Heat Island	Oskar Essenwanger	UAH
October 25	A View of Lightning from the Space Shuttle, Red Sprites and Blue Jets	O. H. "Skeet" Vaughan	MSFC
October 18	Integrated Scientific Data Systems	Sara Graves	UAH
October 11	New Geostationary Satellite Series (GOES 8)	Gary Jedlovec	MSFC
October 4	Visualization of 4-D Atmospheric Data Sets	Paul Meyer	MSFC
September 27	Severe Thunderstorms Forming Along Low Level Shear Boundaries	Robert Clymer	UAH
September 20	Effects of Clouds on the Urban Heat Island	Oskar Essenwanger	UAH
September 13	Microwave Measurements and Climate	Roy Spencer	MSFC
September 6	Results from the MSFC On-Orbit Optical Transient Detector Lightning Sensor	Hugh Christian	MSFC

APPENDIX G

SCIENTIFIC CONFERENCES AND WORKSHOPS

Topic	Dates	Location
Meeting of the NOAA Working Group on Space-Based LIDAR Winds	July 10-12, 1996	Frisco, CO

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Bruce Gentry	NASA/GSFC	Vernon Keller	NASA/MSFC
Julie Williams-Byrd	NASA/LaRC	Jim Butts	bd System
Farzin Amzajerdian	Univ. of Alabama/Huntsville	Eric Williford	Florida State University
Milton Huffaker	Coherent Technologies	Freeman Hall	Harrin Consultants
Bob Otto	Lockheed Martin	Stan Czyzuk	Phillips Lab
Bob Menzies	JPL	Stephen Mango	NPOESS/IPO
Steve Moody	ORCA Photonic Systems	James L. Duda	NPOESS/IPO
Hilmer Swenson	NPOESS/Aerospace	Steve Czuchlewski	L.A.N.L.
Jerry Gelbwachs	The Aerospace Corp.	Barry Rye	CIRES (CU/NOAA)
Alain Dabas	Meteo-France	G. Daniel Hickman	NRL/FALCON
Jim Yoe	NOAA/NESDIS	Michael J Kavaya	NASA/MSFC
Jeff Sroga	Lockheed Martin	Renny Fields	Aerospace Corp.
Ron Greenwood	NASA/GHCC	Pierre H. Flamant	Ecole Polytechnique
Rod Frehlich	Univ. of Colorado/CIRES	Jacques Pelon	Univ. of Paris/CNRS
Ron Koczor	NASA/MSFC	Bob Atlas	NASA/Goddard
Richard Beranek	MSFC/GHCC	Ron Schwiesow	Ball Aerospace
Jim Kao	Los Alamos Natl. Lab	Scott Manlief	TRW
Gary Spiers	Univ. of Alabama/Huntsville	Russell Targ	Lockheed Martin
Madison J. Post	NOAA/ETL	R. A. Brown	Univ. of Washington
Jan Paegle	Univ. of Utah	Arnold Oldach	UPS Airlines
Rex J. Fleming	NOAA/OGP	John F. Schultz	Los Alamos Natl. Lab
Wayman Baker	NOAA/NWS/NCEP	David Bowdle	Univ. of Alabama/Huntsville
John Anderson	University of Wisconsin		

Meeting of the NOAA Working Group on Space-Based LIDAR Winds	February 7-9, 1996	Daytona Beach, FL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Bob Atlas	NASA	Wayman Baker	NOAA/NCEP
Norman Barnes	NASA/Langley	David Bowdle	IGCRE/GHCC
Robert Brown	University of Washington	Steve Czuchlewski	Los Alamos Natl. Lab
Jim Duda	IPO/NASA	G. D. Emmitt	Simpson Weather Assoc.
Pierre E. Flamant	Ecole Polytechnique	Rod Frehlich	University of Colorado
Bruce Gentry	NASA/Goddard	G. Daniel Hickman	NRL/Consultant
Milton Huffaker	Coherent Technologies, Inc.	Vernon Keller	NASA/MSFC
T. N. Kushnamurti	Florida State University	John Molinari	SUNY/Albany
Steve Moody	ORCA Photonics	Richard R. Nelms	Spacetec
Robert Otto	Lockheed Martin	Jan Paegle	University of Utah
Franklin R Robertson	NASA/MSFC	Jeff Rothermel	NASA/MSFC
Barry J. Rye	NOAA/ETL	John Schultz	Los Alamos Natl. Lab
Gary Spiers	NASA/MSFC	J .R. Swenson	Aerospace/NOAA IPO
John Theon	Orbital Sciences Corp.	Julie Williams-Byrd	NASA/Langley
James G. Yoe	NOAA/NESDIS/ORA		

Remote Sensing Workshop November 30-December 1, 1995 Biloxi, Mississippi

Meeting Attendees:

Name	Affiliation
Roy Armstrong	Univ. of Puerto Rico
Fernando Gilbes	USF-Marine Science
Dale Heerman	USDA-ARS
Elizabeth Ward	NASA/Langley Res. Ctr.
Lawrence Halsey	Univ. of Florida Extension
Chester Arnold	Univ. of CT/C.E.S.
Jeannie Smith	Mississippi Boll Weevil Management
Gregory Cox	Univ of Alabama in Huntsville/GHCC
Tony Docal	NASA RTRC/GTSTC
Don Meehan	Washington State Univ.
Charles Woods	Miles College
Jim Hood	Univ. of Central Arkansas
Kira Bowen	Auburn University
Rick Crowsey	Lockheed
Richard Fergusen	Univ. of Nebraska
Larry Hodgson	Arkansas Tech University
James Mackey	Harding University
Blanche Meeson	NASA/Goddard
Mike Conner	Arkansas Tech University
Lue Bell	Univ. of Southern Miss.
David Ripley	Penn State University
Mary Sandy	Virginia Space Grant Cons.
Steve Sader	University of Maine
Armond Joyce	NASA/Stennis Space Ctr.
Eugene Meier	Gulf of Mexico Program
Bill Hosking	Auburn Marine Center
Scott Wheeler	Mississippi Dept. of Marine Resources
Lonnie VanDeveer	Louisiana State University
Walter Belokon	MARIS-IHL (State of Mississippi)
John Gregory	Univ. of Alabama/Huntsville
Tom Moon	Montana Tech University
Anne Anikis	Maryland Space Grant Consortium
Monty Dozier	Texas Agric. Ext. Service
James Hairston	Auburn University
Malcolm Williamson	Univ. of Arkansas/CAST
Larry Gaultney	DuPont Agric. Products
John Wefel	Louisiana State University
Linda Maternak	Georgia Youth Science & Technology Center
Debbie Waters	UGA-NESPAL
Patricia McClurg	University of Wyoming
Al Karlin	Univ. of Arkansas/Little Rock
Don Owens	Univ of Arkansas/Little Rock
John Fuller	J&M Bunn Ltd.
Glen Slater	University of Nebraska
William Teague	Univ of Arkansas/Coop. Ext.
Wayne Patterson	College of Charleston
David Guice	AIMM, Inc.
George May	Space Remote Sensing Ctr.
Karen Hackney	Kentucky Space Grant Consortium
Steven Croft	Wheeling Jesuit College
Dawn Conway	Hughes STX/GHCC
Roland Duhaime	Univ. of Rhode Island
M. Saleh Keshawarz	Univ. of Hartford
JoJo Estrada	Mississippi Cooperative Extension Service
Mitchell Colgan	South Carolina Space Grant
Randy Weisz	No. Carolina State Univ.
Julius Baham, Jr.	Jackson State Univ.
George Seielstad	Univ. of North Dakota
Tasha Wells	UGA/NESPAL
Leotis William	Miles College
John Vanderford	Utah State University
Paul Mask	Auburn University
Miki Schmidt	Lockheed
Dale Bremmer	NASA/AESP
Anne Pierce	Virginia Space Center
Dale Monks	Auburn University
Jeffrey Schloss	Univ. of New Hampshire
Gerald Karr	Univ. of Alabama/Huntsville
Judith Van Cleve	Mississippi State University
Patrick Brown	University of Mississippi
Robert Hamilton	Ouachita Baptist University
Conrad Heatwole	Virginia Tech
Majid Jaraiedi	West Virginia University
Nahid Khazenie	NASA/Goddard
Clyde Christopher	Jackson State University
Greg Carter	NASA/Stennis Space Ctr.
Gwen Necaise	Gulf of Mexico Program
Shelton Swanier	Jackson State University
Richard Comfort	Univ. of Alabama/Huntsville
Harold Duke	USDA-ARS
Austin Hagan	Auburn University
Amy Neuenschwander	Texas Space Grant
Robert Popham	Maryland Space Grant Consortium
Heidi Roberts	Gulf Reg. Planning Comm.
S. Reza Ahsan	Western Kentucky Univ.
John Beck	Auburn University
Gerald Nielsen	Montana State University
Cynthia King	Mississippi State University
Roy Crochet	Mississippi State University
Jim Bolger	Univ. of Washington/Sea Grant Program
Bill Balcerzak	Mississippi Coop. Ext. Svc.
Beth McMillan	Univ. of Arkansas/Little Rock Rock
Ian Tooley	J&M Bunn Ltd.
Scott Samson	University of Kentucky
Gary Durrant	Jacksonville State University
George Cline	Jacksonville State University
Jim Wilson	Texas Space Grant Consortium
Jesus Tupaz	MASGC

Bridget Vandekop	Mississippi Enterprise for Technology	Timothy Gress	SRSC
John Grace	RESOURCE 21	Ramona Pelletier Travis	NASA/SSC/Gulf of Mexico Program
Jesus Franco	Louisiana State University	Haluk Cetin	Murray State University
Bill Cibula	NASA/Stennis Space Ctr.	Dan Morrison	Mississippi Enterprise for Technology
Arthur Jones	Jackson State University		
Nan Touchard	NASA/Stennis Space Ctr.	Roy Keller	Louisiana State University
William Hiscock	Montana Space Grant	Rick Crowsey	Lockheed
Larry Hodgson	Arkansas Tech University	Joan Embree	Historic Preservation Consortium
Belinda Duke	Gulf of Mexico Program		
Dr. J. M. Wersinger	NASA/MSFC		

APPENDIX H

STUDENTS

Name	Affiliation	Research Topic
Doty, K.	Drexel Univ.	Impact of Convective Downdrafts on Moisture Budgets
Lerner, J.	Univ. of Alabama in Huntsville	Comparison of VAS and SSM/I Precipitable Water
Miller, K.	Univ. of Manchester, England	Lightning Frequency
Paech, S.	Univ. of Alabama in Huntsville	Case Study of the May 18, 1995 "Anderson Hills" Tornado

APPENDIX I

K-12, UNIVERSITY AND INDUSTRY VISITORS TO IGCRE

Name	Dates	Affiliation	Reason
Mulligan, J.	7/96	Arkansas K-12 Teacher	NASA Science Teacher Enhancement Program
Sisk, J.	7/96	Tennessee K-12 Teacher	NASA Science Teacher Enhancement Program
Oglesby, R.	6/23/96-7/02/96	Purdue University	Work with Dr. Pete Robertson and present seminar on "Climate Variability Studies Using NCAR GCMs"
Solakiewicz, R.	6/3-8/9/96	Chicago State Univ.	Work with Dr. William Koshak on new type of atmospheric electric field sensor
Latham, J.	3/18-22/96	Univ. of Colorado	Collaborate with NASA and IGCRE scientists on development of energy budget/prediction algorithms and determination of lightning initiation thresholds
Soman, V.	1/11-12/96	Texas A&M Univ.	Interview for Research Associate position and present seminar on statistical sampling errors in rainfall observations
Coleman, P.	10/25-26/95	Univ. of California, Los Angeles	Attend the IGCRE Executive Board Meeting
Few, A.	10/25-26/95	Rice Univ.	Attend the IGCRE Executive Board Meeting
Johnson, D.	10/ 25-26/95	Univ. of Wisconsin	Attend the IGCRE Executive Board Meeting
Sohn, B. J.	7/1-9/1/95	Seoul National Univ.	Perform scientific research studies with IGCRE and NASA scientists in the GHCC

APPENDIX J

UNIVERSITY AND INDUSTRY TRAVEL IN SUPPORT OF IGCRE ACTIVITIES

Name	Dates	Affiliation	Reason
Krishnamurti, T.	8/26-29/96	Florida State Univ.	Present paper at CAMEX Workshop in Washington, D. C.
Nicholls, M.	8/26-29/96	Colorado State Univ.	Present paper at CAMEX Workshop in Washington, D. C.
Surgi, N.	8/26-29/96	National Hurricane Center	Present paper at CAMEX Workshop in Washington, D. C.
Brown, B.	2/5-9/96	Univ. of Washington	Participate in the Lidar Working Group Meeting, Daytona Beach, FL
Emmitt, D.	2/5-9/96	Simpson Weather Assoc.	Participate in the Lidar Working Group Meeting, Daytona Beach, FL
Krishnamurti, T.	2/5-9/96	Florida State Univ.	Participate in the Lidar Working Group Meeting, Daytona Beach, FL
Molinari, J.	2/5-9/96	S.U.N.Y. at Albany	Participate in the Lidar Working Group Meeting, Daytona Beach, FL
Paegle, J.	2/5-2/9/96	Univ. of Utah	Participate in the Lidar Working Group Meeting, Daytona Beach, FL
Emmitt, D.	9/19-22/95	Simpson Weather Associates	Present paper at two workshops at the European Space Research and Technical Center, The Netherlands

APPENDIX K

1996 SUMMER ENRICHMENT PROGRAM

For the 1996 Summer Enrichment Program for Women and Minority Students at Alabama A&M University, 375 announcements were sent to departments of Chemistry, Physics, Computer Science, Plant and Soil Science, Geography and others at approximately 200 colleges and universities throughout the United States and Puerto Rico. Included in the mailings were all Historically Black Colleges and Universities, Historically Spanish Institutions and institutions with a relatively high percentage of Native American students, in addition to other major colleges and universities. Approximately 250 students requested applications, and 150 completed ones were received. Only 10 students were chosen for this prestigious internship, which was held from June 3 through August 9.

During the summer program, the students took a course in Global Change Science, participated in a field project in remote sensing of soil moisture, and completed a research project with mentors from Alabama A&M and IGCRE. Several students have expressed an interest in returning for next year's program, which will accept up to 20 students. Students from the 1996 program are listed below:

1996 SEP Students

Student/Research Area	University	Major	Class Year
Latrica Birgan/Soil Hydrology	Alabama A&M Univ.	Math	Senior
Barbara Cosgriff/Computer Science	Fayetteville State Univ.	Computer Science	Junior
Lucretia Jones/Hydrologic Modeling	Miles College	Chemistry	Junior
Carrie Kienenberger/GIS Analysis	Univ. of Oklahoma	Geophysics	Sophomore
Latousha Parker/GIS Analysis	Norfolk State Univ.	Biology	Junior
Tomeka Prioleau/Soil Data Analysis	Alabama A&M Univ.	Environmental Science	Sophomore
Malinda Taylor/Micrometeorology	Univ. of Maryland	Geography	Junior
Mario Thomas/Instrumentation	Jackson State Univ.	Physics	Junior
Kim Williams/Instrumentation	Spelman College	Chemistry/Chemical Engr.	Junior
Ann Zawistoski/Hydrologic Modeling	Carleton College	Geology	Junior

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION

Jointly operated by the
University of Alabama in Huntsville and Universities Space Research Association

Annual Report for

September 1, 1994 - August 31, 1995

"GLOBAL CHANGE RESEARCH RELATED TO THE EARTH'S ENERGY AND HYDROLOGIC CYCLE"

Under

Cooperative Agreement: NCC8-22

Submitted to

THE GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA 35812

by

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

on behalf of the

INSTITUTE FOR GLOBAL CHANGE RESEARCH AND EDUCATION
Global Hydrology and Climate Center
977 Explorer Drive
Huntsville, Alabama 35806

Approved by:

Donald J. Perkey, Director
Institute for Global Change Research and Education

9/15/95
Date

APPENDIX A

STAFF TRAVEL ACTIVITIES

Name	Dates	Location	Reason
Bowdle, D.	1/24-26/95	Boulder, CO	Present Design Review model to ACLAIM
Bowdle, D.	1/30-2/2/95	Tampa, FL	To attend Lidar WGM
Buechler, D.	5/27-6/2/95	Baltimore, MD	To attend AGU spring meeting
Christy, J.	1/15-19/95	Dallas, TX	To attend AMS Annual Meeting
Christy, J.	5/29-6/2/95	Baltimore, MD	To attend AGU spring meeting
Conover, H.	2/5-12/95	Greenbelt, MD	To attend EOSDIS information management system development team meeting
Crosson, W.	1/15-22/95	Dallas, TX	To attend AMS Annual Meeting
Crosson, W.	5/31-6/4/95	Greenbelt, MD	To attend Evapotranspiration Meeting
Crosson, W.	6/12-13/95	Reston, VA	To attend NASA Space Grant Conference
Crosson, W.	6/14-16/95	Washington, DC	To attend Global Hydrology Workshop
Drewery, M.	8/28-9/1/94	Landover, MD	To attend EOSDIS Data modeling meeting
Drewry, M.	2/5/12/95	Greenbelt, MD	To attend EOSDIS information management development team meeting
Drewry, M.	4/23-29/95	Landover, MD	To attend DBA training
Drewry, M.	5/3-6/95	Landover, MD	To attend Data modeling working group meeting
Drewry, M.	6/18-24/95	Landover, MD	To attend Oracle DBA II Class/Miaco Corp/support of MSFC VODAAC (EOSDIS)
Graves, S.	11/28-12/1/94	Landover, MD	To attend User Working Group meeting for MSFC DAAC
Graves, S.	6/14-16/95	Washington, DC	To attend Global Hydrology Workshop
Hallmark, D.	1/28-2/2/95	Clearwater, FL	To support LIDAR SWG meeting
Laymon, C.	9/29-10/08/94	Oklahoma	Set up instruments and collect data during space shuttle mission

Laymon, C.	5/29-6/2/95	Baltimore, MD	To attend AGU spring meeting
Lobl, E.	4/18-21/95	Mt. View	Present C-STAR at systems review at AMES, investigate collaboration with JPL and WINDRAD
Lobl, E.	2-1-2/95	Greenbelt, MD	To attend MIMR Science Team meeting
Lobl, E.	2/22026/95	Los Angeles, CA	To attend JPL meeting
Lobl, E.	6/13-14/95	Greenbelt, MD	To attend PMMI GSFC
McCaul, W.	1/15-22/95	Dallas, TX	To attend AMS Annual Meeting
Perkey, D.	5/14-19/95	Monterey, CA	To attend AMIP meeting
Perkey, D.	6/14-16/95	Washington, DC	To attend Global Hydrology Workshop
Perkey, D.	3/12-14/95	University of Wisconsin	Collaborate with researchers on water vapor projects
Srivastava, V.	7/23-28/95	Mountain View, CA	To integrate, collaborate and operate two MSFC Doppler LIDARS
Srivastava, V.	8/15-10/4/95	Mountain View, CA	To integrate, collaborate and operate two MSFC Doppler LIDARS
Srivastava, V.	8/30-9/03/94	UCLA	To attend 4th International Aerosol Conference
Stewart, M.	11/29-12/2/94	Washington, DC	Calibration check of OTD
Stewart, M.	3/26-27/95	Vandenburg AFB, CA	Perform check on OTD
Stewart, M.	3/3-7/95	Vandenburg AFB, CA	To perform check of OTD in Microlab spacecraft
Wang, S.	6/5-10/95	Beijin, PRC	To attend Pacific Science Congress
Wang, S.	8/15-21/94	Boulder, CO	To attend Cloud Modeling Workshop

APPENDIX B

PUBLICATIONS AND PRESENTATIONS

Beaumont, B., H. Conover, T. Hinke, and **S. Graves,** 1995: Scientific data access for EOSDIS: A look into information management at the Marshall Space Flight Center Distributed Active Archive Center. Submitted to *Information & Management: The International Journal of Information Systems Applications.*

Bowdle, D.A., 1994: Aerosol backscatter modeling at 2 μm. Presented at *National Aeronautics and Space Administration Technical Working Group Meeting on the Airborne Coherent Lidar for Advanced Inflight Measurements (ACLAIM),* Boulder, CO, 21-22 Sept.

Bowdle, D.A., 1995: Tropospheric aerosol backscatter modeling at 2 μm wavelength. Presented at *National Aeronautics and Space Administration Preliminary Design Review for the Airborne Coherent Lidar for Advanced Inflight Measurements (ACLAIM),* Boulder, CO, 25-26 Jan.

Bowdle, D.A., 1995: Tropospheric aerosol backscatter modeling. Presented at *United States Air Force Second Integrated Product Team Meeting for the Affordable Low Observable Air Data System (ALOADS),* Dayton, OH, 2-4 May.

Bowdle, D.A., 1995: Multiwavelength tropospheric aerosol backscatter model. Presented at: *Radiative Processes in Climate Symposium, International Association of Meteorology and Atmospheric Physics (IAMAP) Program,* International Union of Geodesy and Geophysics (IUGG) XXI General Assembly, Boulder, CO, 2-14 Jul. (In press).

Baker, W.E., G.D. Emmitt, P. Robertson, R.M. Atlas, J.E. Molinari, **D.A. Bowdle,** J. Paegle, R.M. Hardesty, R.T. Menzies, T.N. Krishnamurti, R.A. Brown, M.J. Post, J.R. Anderson, A.C. Lorenc, T.L. Miller, and J. McElroy, 1995: Lidar measured winds from space: An essential component for weather and climate prediction. *Bull. Amer. Meteor. Soc.*. 76, 869-888.

Rothermel, J., D.M. Chambers, M.A. Jarzembski, **D.A. Bowdle, V. Srivastava,** and W.D. Jones, 1995: Continuous-wave focused CO2 Doppler lidars for atmospheric backscatter measurements. Submitted to *Appl. Opt.*, First review completed, resubmitted.

Bowdle, D.A., V. Srivastava, D.R. Cutten, E.W. McCaul, J. Rothermel, and M.A. Jarzembski, 1995: The GLObal Backscatter Experiment (GLOBE): Overview, results, and applications. Presented at *8th Coherent Laser Radar Conf.*, Keystone, CO, 23-27 Jul.

Bowdle, D.A., V. Srivastava,, M.A. Jarzembski, J. Rothermel, D.M. Chambers, and **D.R. Cutten,** 1995: Multiwavelength comparison of modeled and measured remote tropospheric aerosol backscatter over Pacific Ocean. Submitted to *J. Geophys. Res.*

Braswell, W.D., and R.W. Spencer, 1995: Diurnal differences in thick layer temperatures from TOVS MSU temperature fields, Presented at *Spring American Geophysical Union Meeting,* Baltimore, MD, 30 May - 2 Jun.

Braswell, W.D., and R.W. Spencer, 1995: Diurnal differences in thick layer temperatures: Observations from MSU and tidal theory comparisons. To be submitted to *J. Geophy. Res.*

Braswell, W.D., and R.W. Spencer, 1996: Comparison of statistical and physical methods for retrieval of humidity profiles from SSM/T2. Submitted to *Conf. on Satellite Meteorology and Oceanography.*

Spencer, R.W., and **W.D. Braswell,** 1995: Microwave sounding unit six-hourly datasets for climate and process studies. Presented at *Spring American Geophysical Union Meeting,* Baltimore, MD, 30 May - 2 Jun.

Spencer, R.W., and **W.D. Braswell,** 1996: Water vapor feedback in the tropics deduced from SSM/T2 water vapor and MSU temperatures. Submitted to *Symp. on Global Change Studies.*

Buechler, D.E., M. Cammarata, and **E.W. McCaul,** 1996: Observations of shallow supercells during a major tornado outbreak. Submitted to *AMS 18th Severe Storms Conf.*, San Francisco, CA, Feb.

Buechler, D.E., S.J. Goodman, **E.W. McCaul,** and K. Knupp, 1996: Cloud-to-ground lightning activity during tornadic storms in the Tennessee Valley. Submitted to *AMS 18th Severe Storms Conf.*, San Francisco, CA, Feb.

Buechler, D.E., R. Raghavan, M. Smith, P. Meyer, and S. Goodman, 1995: Lightning and rainfall maps of the United States for climate and hydrology Studies, 1995. Presented at *International Union of Geodesy and Geophysics (IUGG) XXI,* General Assembly, Boulder, CO, 2-14 Jul.

Buechler, D.E., R. Raghavan, M. Smith, P.J. Meyer, S.J. Goodman, and H.J. Christian, 1995: Rainfall and lightning variability over the United States. Presented at *Spring American Geophysical Union Meeting*, Baltimore, MD, 30 May - 2 Jun.

Christy, J.R., 1994: Revising global tropospheric and stratospheric temperatures due to satellite orbit-time degredation. *Proc. 19th Climate Diagnostics Workshop*, College Park, MD, 15-19 Nov.

Christy, J.R., 1995: Temperature above the surface layer. *Climatic Change* (In Press).

Christy, J.R., 1995: Forcing factors on the global lower tropospheric and stratospheric temperatures. *Proc. AMS 6th Symp. Global Change*, Dallas TX, 16-20 Jan.

Christy, J.R., 1995: Optimizing the merging strategy of MSU satellite data. Presented at the *Spring American Geophysical Union Meeting*, Baltimore, MD, 1 Jun.

Christy, J.R. and J.Goodridge, 1995: Precision global temperatures from satellites and urban warming effects of non-satellite data. *Atmos. Environ.* (In press)

Christy, J.R., R.W. Spencer, and **R.T. McNider**, 1995: Reducing noise in the MSU daily lower-tropospheric global temperature dataset. *J. Climate*, **8**, 888-896.

Allen, M.R., **J.R. Christy**, M.J. Murray and C.T. Mutlow, 1994: Potential impact of satellite-derived data sets on global change detection. *Proc. 19th Climate Diagnostics Workshop*, College Park MD, 15-19 Nov.

Hnilo, J.J. and **J.R. Christy**, 1995: Comparison of GCM and MSU temperatures for the AMIP experiment. Presented at *Global Change Conference*. Tuscaloosa, AL, 27 Apr.

Conover, H., 1994: MSFC DAAC IMS status, *Earth Science Information Systems Configuration Control Board*, Huntsville, AL., 3 Oct.

Conover, H., 1994: MSFC DAAC software development current status, Presented at *Earth Science Information Systems Configuration Control Board*, Huntsville, AL, 7 Nov.

Conover, H., 1994: Information Management Systems: Status and plans, Presented at *Hydrologic Cycle Data Access And Archive Working Group*, Landover, MD., 1 Dec.

Conover, H., 1994: How to use the IMS, Class for *MSFC DAAC User Services*, Huntsville, AL, 15 Dec.

Conover, H., 1995: MSFC DAAC software development current status, Presented at *Earth Science Information Systems Configuration Control Board*, Huntsville, AL, 6 Feb.

Conover, H., 1995: MSFC DAAC IMS current status and development priorities, Presented at *EOSDIS V0 IMS Development Team Meeting*, Greenbelt, MD, 8 Feb.

Conover, H., 1995: Review of IMS team meeting, Presented at *Earth Science Information Systems Configuration Control Board*, Huntsville, AL, 6 Mar.

Conover, H., 1995: Information management and software development current status, Presented at *Earth Science Information Systems Configuration Control Board*, Huntsville, AL, 3 Apr.

Conover, H., 1995: Information management and software development current status, Presented at *Earth Science Information Systems Configuration Control Board*, Huntsville, AL, 1 May.

Conover, H., 1995: Version 0 data and information access systems, Presented at *Hydrologic Cycle Data Access and Archive Working Group*, Huntsville, AL, 22 Jun.

Cox, G., 1994: EarthBases: A Ground Truth Studies teaching and student research site, Presented at *SuperComputing '94*, Washington, DC, Nov.

Cox, G., 1995: Ground Truth Studies: A curriculum for understanding global environmental change. *International Technology Education Annual Meeting*, Nashville, TN, Apr.

Criswell, E.A., 1995: MSFC DAAC local character user interface software, *DAAC Document*, Apr.

Criswell, E.A., 1995: Optical disc jukebox file location database software, *DAAC Document*, Apr.

Criswell, E.A., 1995: SMMR metadata Ingest script software document, *DAAC Document*, Apr.

Criswell, E.A., 1995: Implementing a software-driven lab surveilance system, *ITSL Document*, 12 Jun.

Crosson, W.L., 1995: The use of remote sensing observations to represent spatial variability in a land surface model. Invited seminar at *University of Oklahoma*, Norman, OK, 4 Apr.

Crosson, W.L., 1995: The CaPE Hydrometeorology Project. Presented at *EOS Evapotranspiration Workshop*, Goddard Space Flight Center, Greenbelt, MD, 1 Jun.

Crosson, W.L., C.E. Duchon, **R. Raghavan,** and S.J. Goodman, 1995: Assessment of rainfall estimates using a standard Z-R relationship and the probability matching method applied to composite radar data in central Florida. Submitted to *J. Appl. Meteor.*

Crosson, W.L., and **C.A. Laymon**, 1995: A remote-sensing based technique to account for sub-grid scale variability of land surface properties. Preprints of *AMS Conf. on Hydrology*, Dallas, TX, 15-20 Jan.

Cooper, H.J., E.A. Smith, and **W.L. Crosson**, 1995: Limitations in estimating surface sensible heat fluxes from surface and satellite raiometric skin temperatures. To appear in *J Geophy. Res.*

Duchon, C.E., T.M. Renkevens, and **W.L. Crosson**, 1995: Estimating daily area-average rainfall from raingages: Application to the CaPE experiment in central Florida. Preprints *AMS Conf. on Hydrology*, Dallas, TX, 15-20 Jan.

Duchon, C.E., T.M. Renkevens, and **W.L. Crosson**, 1995: Estimation of daily area-average rainfall during the CaPE experiment in central Florida. To appear in *J. Appl. Metero.*

Cutten, D.R., D. A. Bowdle, R.F. Pueschel, **V. Srivastava**, A.D. Clarke, J. Rothermel, J.D. Spinhirne, and R.T. Menzies. 1995: Intercomparison of remotely measured and flight level aerosol backscatter coefficient during GLOBE II Pacific survey mission. To be submitted to *J. Geophys. Res. - Atmos.*

Cutten, D.R., E.W. McCaul, D.A. Bowdle, J.D. Spinhirne, and R.T. Menzies, 1995: Correlations between lidar aerosol backscatter and meteorological fields over the Pacific Ocean during the Global Backscatter Experiment. To be submitted to *J. Geophy. Res. - Atmospheres.*

Cutten, D.R., E.W. McCaul, D.A. Bowdle, V. Srivastava, J. Rothermel, and M. A. Jarzembsk, 1995: The GLObal Backscatter Experiment (GLOBE): Overview, results and applications, Presented at *8th Coherent Laser Radar Conf.*, Keystone, CO, 23-27 Jul.

Cutten, D.R., R. Pueschel, **V. Srivastava**, and **D.A. Bowdle**, 1994: Remote tropospheric aerosol backscatter comparisons at 1.06 μm and 9.25 μm wavelengths. Presented at *Fourth International Aerosol Conf.*, Pasadena, CA, 28 Aug. - 2 Sept.

Cutten, D.R., V. Srivastava, J.D. Spinhirne, and M.A. Jarzembski, 1995: Remote sensing of submicron atmospheric condensation nuclei in marine troposphere with Nd:YAG lidar. To be submitted to *J. Geophys. Lett.*

Pueschel, R.F., G.V. Ferry, K.G. Snetsinger, J.M. Livingston, **D.R. Cutten**, and J.L. Gras, 1995: Pacific basin free tropospheric aerosols: Intercomparisons of NASA DC-8 and CSIRO F- 27 Results. To be submitted to *Atmospheric Environment.*

Kasemir, H.W., **K.T. Driscoll,** and R.J. Blakeslee, 1995: A comment to current budget of the atmospheric electric global circuit, *J. Geophy. Res.*, May.

Drewry, M.H., 1995: Demonstrated weather tracking software. *Chinese entourage to TABES at UAH*, 15 May.

Hinke, T., and H.S. Delugach, 1994: Security-oriented database inference detection, *Proc. 17th National Computer Security Conf.*, Baltimore, MD, Oct.

Laymon, C., and G. Cox, 1996: A Ground Truth Studies teaching and student research site., *AMS Educational Technologies Symposium*, Atlanta, Jan. (Accepted).

Laymon, C.A., and **W.L. Crosson**, 1995: Regional-scale hydrology with a new land surface model. Preprint of *AMS Conf. on Hydrology*, Dallas, TX, 15-20 Jan.

Laymon, C.A., W.L. Crosson, and S.J. Goodman, 1994. Simulator for hydrology and energy exchange at the land surface and its development through the CaPE hydrometeorology project. *EOS*, **75**, 173.

Laymon, C.A., and D.A. Quattrochi, 1995: Characterization of land surface energy fluxes within a Great Basin desert valley region using satellite remote sensing data, Abstr., *Eos, Trans. of the American Geophysical Union*, v. 76, p. S104.

Astling, E.G., D.A. Quattrochi, **C.A. Laymon**, and McCurdy, G., 1995, Mesoscale study of boundary layer processes in a desert region, *Proc. AMS Seventh Conf. on Mountain Meteorology*, Breckenridge, CO, Aug.

Lu, H.-I., and T.L. Miller, 1994: Characteristics of annulus baroclinic wave structure during amplitude vacillation.. *Int. Symposium on the Life Cycles of Extratropical Cyclones*, Bergen, Norway, 277-281.

Lu, H.-I., and T.L. Miller, 1995: Characteristics of annulus baroclinic flow structure during amplitude vacillation, Submitted to *Tellus*.

Lu, H.-I., and T.L. Miller, 1995: Baroclinic waves dispersion in a constant f plane. *Preprints AMS 10th Conf. on Atmos. and Oceanic Waves and Stability*, Big Sky, MT, 47-48.

Lu, H.-I., T.L. Miller, and K.A. Butler, 1994: A numerical study of wavenumber selection in the baroclinic annulus flow system. *Geophys. Astrophys. Fluid Dynamics*, **75**,1-19.

Mach, D.M., W.L. Boeck, S.J. Goodman, and H.J. Christian 1994: Lightning imaging sensor data. Presented at *Fall American Geophysical Union Meeting*, San Francisco, CA.

Mach, D.M., and W.D. Rust, 1995: Two-dimensional speed and optical risetime estimates for natural and triggered dart leaders . Presented *at Fall American Geophysical Union Meeting*, San Francisco, CA.

McCaul, E.W., and F.R. Robertson, 1994: Divergent circulations and remotely-sensed cloud/moisture structure, *Workshop on Impact of Satellite Products on Global Analysis and Medium Range Prediction*, Tallahassee, FL, Nov.

McCaul, E.W., F.R. Robertson, W. Lapenta, D. Samuelson, **J. Srikisken,** and **C. Cohen**, 1994: Divergent circulations and deep convective processes in the GEOS-1 assimilated fields as compared to remotely sensed data, *Chapman Conf. on Water Vapor in the Climate System*, Jekyll Island, GA, Oct.

Robertson, F.R., **E.W. McCaul**, and **C. Cohen**, 1995: Ice budget diagnostics over the western Pacific during TOGA-COARE and CEPEX. Presented at *the Sym. on the Regulation of Sea Surface Temperatures and Warming of the Tropical Ocean Atmosphere System*, Dallas, TX, 15-20 Jan.

McCoy, S.T., 1994: DAAC data order tracking system presentation, Presented at *EOSDIS User Services Working Group Meeting*, Huntsville, AL, 17 Nov.

McCoy, S.T., 1995: DAAC data order tracking system training session, Presented to *User Services Staff*, Huntsville, AL, 7 Apr.

McCoy, S.T., 1995: DAAC data order tracking system, Presented at *The University of Alabama in Huntsville*, 11 Apr.

McCoy, S.T., 1995: DAAC data order tracking system training session, Presented to *GCIP Project Scientist*, Huntsville, AL, 24 May.

McCoy, S.T., 1995: Distributed information management system presentation, Presented at *NASA Space Grant* Contacts, Huntsville, AL, 12 Jun.

McNider, R.T., A.J. Song, D.M. Casey, P.J. Wetzel, **W.L. Crosson**, and R.M. Rabin, 1994: Toward a dynamic-thermodynamic assimilation of satellite surface temperature in numerical atmospheric models. *Mon. Wea. Rev.*, **122**, 2784-2803.

Perkey, D.J., 1994: What is Global Hydrology? Seminar presented at the *Global Hydrology and Climate Center*, Huntsville, AL, 9 Nov.

Perkey, D.J., 1994: GHCC and what do we do? Lecture presented to the *Introduction to Environmental Engineering class*, Huntsville, AL , 30 Nov.

Perkey, D.J., S.R. Dembek, K.G. Doty, and F.R. Robertson, 1995: Global climate and regional-scale model simulations of water and energy budgets for convectively-active seasons. Preprints of the *AMS 6th Sym. on Global Climate Change*. Dallas, 15-24 Jan.

Perkey, D.J., and C.W. Kreitzberg, 1994: A method of parameterizing cumulus transports in a mesoscale primitive equation model: The sequential plume scheme. In *The Representation of Cumulus Convection in Numerical Models* (K.A. Emanuel and D.J. Raymond, Eds.), American Meteorological Society, Boston, 171-177.

Chang, C.B., and **D.J. Perkey**, 1995: Numerical simulations of mesoscale flood environment. *Meteor. and Atmos. Phy.*, 55, 17-32.

Srivastava, V., 1995: New lidar technique for sulfate aerosols: Seminar presented at the *Global Hydrology and Climate Center*, Huntsville, AL, 17 May.

Srivastava, V., 1995: Aerosol sulfate chemistry from backscatter measurements using continuous-wave 9.1 and 10.6 μm lidars, *8th Coherent Laser Radar Conf.*, Keystone, CO, 23 - 28 Jul.

Srivastava, V., 1995: A new lidar calibration technique using aerosols, *8th Coherent Laser Radar Conf.*, Keystone, CO, 23 - 28 Jul.

Srivastava, V., D.A. Bowdle, M.A. Jarzembski, J. Rothermel, D.M. Chambers, and **D.R. Cutten**, 1995: High-resolution remote sensing of atmospheric sulfate aerosols from backscatter using focused CO2 Doppler lidars. Submitted to *Geophys. Res. Let.*

Srivastava V., A.D. Clarke, M.A. Jarzembski, **D.A. Cutten,** and **D.A. Bowdle**, 1994: Effect of microphysics on aerosol backscatter: Comparison of modeling and measurements obtained during NASA's GLOBE mission. Presented at *Fourth Intl. Aerosol Conf.*, Los Angeles, CA, 28 Aug. - 2 Sept.

Jarzembski, M.J., and **V. Srivastava**, 1995: Low pressure experimental simulation of intracloud and above cloud electrical discharges. Presented at *Spring American Geophysical Meeting*, Baltimore, MD, 30 May - 2 Jun.

Wang S., 1995: Defining marine boundary-layer clouds with Tiedtke's prognostic scheme. Accepted for publication *Mon. Wea. Rev.*

Wang S., 1995: Interactions between stratocumulus and cumulus clouds as simulated in a 2-D LES model. Presented at *IUGG Meeting*, Boulder, CO, 15-21 Jul.

Wang, S., 1995: The parameterizations of marine boundary layer clouds in a GCM. Presented *at Pacific Science Congress*, Beijing, Jun.

Wang S., 1995: A parameterization study of marine boundary layer clouds. Presented at *Science Team Meeting*. Baltimore, MD, 30 May - 2 Jun.

Wang, S., and D.A. Fitzarrald, 1994: Modeling study of marine boundary layer clouds (1991-1994), *NASA/Earth Science and Application Division.*

Wang, S., and D.A. Fitzjarrald, 1995: A parameterization study of cloud-topped marine boundary layers (1995-1998), *ONR and NASA under FIRE III Project*, NASA/Langley Center.

Wang S., and P. Minnis, 1994: Application of Tiedtke's prognostic scheme in a simple boundary-layer model: A comparison with satellite date, Preprints of *Second International Conf. on Air-Sea Interaction and Meteorology and Oceanography of the Coastal Zone*, Lisbon., 22-27 Sept.

Wang S., and Q. Wang, 1994: Roles of drizzle in a one-dimensional third-order turbulence closure model of the nocturnal stratus-topped marine boundary layer. *J. Atmos. Sci.*, 51, 1559-1576.

APPENDIX C

EDUCATION WORKSHOPS

Topic	Dates	Location
GPS Technology in the Classroom Attended by 25 teachers from the Rostov region	Oct. 1994	Rostov State Pedagodgical Institute Rostov-on-Don, Russia
GIS Technology for Public Administration A seminar for professional level managers and department heads from the Rostov region.	Oct. 1994	Rostov Regional Environmental Protection Agency, Rostov-on-Don
GLOBE Program - Train-the-Trainer Workshop Attended by 48 professional educators and scientists.	Feb. 1995	UAH Campus
Co-Hosted Live Satellite Video Conference NASA "On the Cutting Edge" Educational EOSDIS Video Program Broadcast live to hundreds of schools in North America. Rebroadcast dozens of times over the last several months.	Feb. 1995	Global Hydrology and Climate Center
Environmental Education and Outreach Programs in the United States. First Annual Environmental Management Symposium Attended by 50+ educators, professionals, and environmental managers.	May 1995	Primosko-Aktarsk Krasnodar Krey, Russia
GLOBE Program Teacher Workshops (2) Frist workshop attended by 36 teachers. Second workshop attended by 32 teachers.	Jul. 1995	UAH Campus
EarthSense Teacher Workshop Attended by 25 teachers from around Alabama.	Jul. 1995	Global Hydrology and Climate Center and DeSoto State Park
U.S. Global Change Forum Southeastern Region Delegation Attended by 25 educators, scientists, and administrators from around AL, GA, FL, NC, SC.	Aug. 1995	Global Hydrology and Climate Center

Contributions to Various Other Programs Summer 1995 Huntsville, AL

1. UAH Summer Explorations Program - GTS activity
2. Camp Botanica HSV Botanical Gardens - GTS activity
3. EcoBridge students and teachers - GPS instruction

150 kids in total for all of these activities

APPENDIX D

UNIVERSITY AND INDUSTRY COLLABORATIONS

ScreenScope, Inc., (Mr. Hal Weiner)

4/21/95-8/31/95 — To inspire young people with new insights into the natural processes that govern the Earth and tell tens of millions of students about changes that may occur in the atmosphere, on the land, and in the oceans as a result of human activities. Features five one-hour television specials each year that will illustrate how the Earth works as as a system.

Lassen Research, (Mr. Robert Lee)

9/94-8/95 — To gather a database of high-resolution measurements of aerosol particle density and the two-dimensional atmospheric flow fields associated with those measurements.

Nichols Research Corporation, (Ms. Anita Hall)

To perform the following tasks: Information Systems Research and Implementation; IGCRE Facilities Startup; Ozone/Temperature Correlation Analysis.

University of Bristol, (Dr. Eric C. Barrett)

9/1/94-1/31/95 — The WETNET Project: Rainfall Algorithm Intercomparison and Development Intercomparison and Development, Stage VI Part Two.

2/1/94-8/31/95 — Stage VII (Continuation of work).

Drexel University, (Mr. Scott Dembek)

7/1-8/31/95 — To develop, maintain, and test the evolving code for the Limited Area Mesoscale Prediction System (LAMPS); test codes to diagnose atmospheric moisture and energy budgets as applied to LAMPS and other model simulations. Included working with (a) Donald Perkey, IGCRE and NASA scientist Dr. Franklin Robertson to develop and test cloud radiation diagnostics; Charles Cohen to test new cloud and ice parameterization in the LAMPS model, (b) NASA scientists Dr. Franklin Robertson and Mr. Kevin Doty to modify the LAMPS code to run across the equator and the international dateline.

University of Manchester, (Dr. John Latham)

9/1/94-2/28/95 — Work with Dr. Hugh Christian on research directed toward assessing the value of the lightning mapper sensor; To develop energy budget/prediction algorithms to correlate cloud dynamics and precipitation with lightning and electric field measurements; Analyze radar aircraft-based cloud microphysical and electric field data from the caPE and TOGA-COARE experiments. Compare and correlate analyses with predictions of the formation of precipitation and the generation/distribution of electric fields in clouds from current understanding and the results of explicit cloud physics models; Interpret LIS observations and analyses in terms of accepted cloud microphysical and electrification theories; Based on the interpretation of the existing LIS database, to develop as feasible specific concepts with regard to the categorization of the electrical properties of tropical clouds on the basis of cloud type and stage of cloud development.

APPENDIX E

EARTH SYSTEM SCIENCE EDUCATION (ESSE) ACTIVITIES

In 1991 the Universities Space Research Association (USRA) and the National Aeronautics and Space Administration (NASA) initiated the Cooperative University-based Program in Earth System Science Education (ESSE). The program concept is designed to create a university-based cooperative effort in Earth Science curriculum development, with a framework designed to overcome traditional barriers to interdisciplinary science education. Twenty-two universities were competitively selected to participate in the program.

The direct and indirect accomplishments of the ESSE Program are many. In the last year of the Program nearly 4000 students were enrolled at the twenty-two universities in ESSE sponsored survey and senior courses, with well over 100 professors and teaching assistants directly involved. In the 1993-1994 academic year with twenty-two universities, enrollments were 3304 and 562 in the survey level and senior levels respectively. Reporting on the 1994-1995 academic year is not yet complete.

Development of formalized Earth Systems programs has been stimulated within many of the ESSE universities based on visibility of NASA/USRA sponsorship of ESSE and internal leveraging of funds. In part stimulated by ESSE, and concurrent with participation in ESSE, undergraduate Earth Systems degree programs are being developed and evolved at Penn State University, New York University and Stanford. Other ESSE universities have established certificate programs for elective work having an Earth System Science emphasis, coupled with B.S. and B.A. degrees in a parent discipline. Earth Systems courses have been formally accepted into the general university curriculum and are being offered at ESSE schools as a result of the commitment shown by NASA to education and the development of such courses. Geology Departments in particular have openly embraced ESSE in evolving their curriculum from emphasis on mineral resources and oil exploration to holistic concepts of the Earth System.

Many ESSE participants have also been able to exploit the visibility provided by participation in ESSE to attract additional resources from other state and national activities as a means to further enhance their local efforts. For example, Professor Ellen Mosley-Thompson, principal participant at Ohio State, has secured funding from Batelle for Earth Systems K-12 education within the state. Professor Catherine Gautier, principal participant at the University of California at Santa Barbara, has secured private funding for the development of Earth Systems educational modules. The University of Arizona has created an Earth System Science Institute with Professor Lisa Graumlich, principal participant in the ESSE Program, as the new Director.

Up to this point in time, the focus of the ESSE Program has been on access and utilization of EOS space-based data for Earth System Science and NASA involvement. As the Program evolves, the ESSE steering committee desires to extend the Program to include Global Change issues that are of prime societal importance and are fundamental to emerging national and international interests. As such, this emerging strategy is being extended across an increased range of interests in view of the broader needs of Global Change. The principal participants of the ESSE program recognize the importance of these dimensions within an educational setting where attitudes and careers are being formed.

Many of the educational materials developed for a class at each ESSE university are computer oriented, and are suitable for electronic delivery. The development and delivery of these materials resides within the participating departments, schools and/or colleges. The principal participants have recommended that the ESSE Program seek to provide for exchange of educational resources via the Internet, and through collaboration jointly create in the immediate future a World Wide Web Electronic Global Change Notebook as part of an Extended ESSE Program. Thus, in the last year, a World Wide Web (WWW) electronic information server was established (http://www.usra.edu/esse/ESSE.html) to foster the interdisciplinary geophysical perspectives needed to understand the Earth System by providing for efficient collaborative development and access to publishable quality educational modules among the ESSE participants and the Internet

community at large. Of equal and longer range importance, the server functions to provide an electronic educational forum promoting understanding of the connections between the global climate system, global and regional ecosystems, remote sensing, and the needs of humanity (societal, economic, national security, etc.).

The ESSE Program has been conducting workshops for its participants over the past four years. Topics have included hands-on training in the use of Internet resources, the use of modeling software in the classroom (STELLA) and multimedia global change education (GEOSCOPE). The most recent ESSE steering meeting was held at the NASA-sponsored Classroom of the Future facility in Wheeling, West Virginia in June 1995. A workshop focusing on the physics of remote sensing and geographic information systems is being planned for the ESSE participants in November 1995 in Santa Barbara CA.

ESSE Associated Travel

Name	Dates	Affiliation	Reason
Arthur, M.	9/94	Penn State Univ.	Travel to the University of Florida to present ESSE seminar and collaborate with Dr. Hodell
Bartlein, P.	4/3-6/95	Univ. of Oregon	Travel to the University of Minnesota at Minneapolis, MN to collaborate with Dr. Kerry Kelts concerning development/issues of undergraduate ESSE courses and to present a lecture and seminar while at the University.
Binder, J.	6/17-18/94	Utah State Univ.	Traveled to College Park, MD to participate in the ESSE Meeting at the Univ. of Maryland
Boeck, W.	4/17-19/95	Niagra Univ.	Travel to Landover, MD to attend the Science Software Interpretation and Test Workshop at the Hughes Site Facility in Landover
Bryson, Reid	5/5-12/95	Univ. of Wisconsin	Travel to Univ. of Min to attend Archeology Conference Workshop
Bryson, Robert	5/2-13/95	Univ. of Wisconsin	Travel to Univ. of Min to attend Archeology Conference Workshop
Graumlich, L.	9/6-10/94	University of Arizona	Travel to Washington, DC to attend the American Geophysical Union's Chapman Conference
Johnson, D.	1/13-22/95	USRA/Univ. of Wis.	Travel to Dallas, TX to attend AMS Meeting
Johnson, D.	3/22-31/95	USRA/Univ. of Wis.	Travel to Washington, DC to meet with Dunbar
Johnson, D.	9/28/94	USRA/Univ. of Wis.	Travel to NY, NY to attend Dr. Nay Htun briefing
Johnson, D.	9/7-11/94	USRA/Univ. of Wis.	Travel to Washington, DC to attend Chapman conference
Johnson, D.	4/2-10/95	USRA/Univ. of Wis.	Travel to San Diego, State Univ. and California State Univ. in CA for faculty discussions

Kalb, M.	4/17-19/95	USRA/GSFC	Travel to Landover, MD to attend the Science Software Interpretation and Test Workshop at the Hughes Site Facility in Landover
Kalb, M.	10/13-10/16/95	USRA/GSFC	Travel to Ohio State Univ. To attend ESSE Symposium for High School Science
Kump, L.	10/10/94	Penn State Univ.	Travel to Evanston, IN to collaborate with Dr. Abraham Lerman concerning issues/development of undergraduate ESSE courses and to present several lectures and a seminar in the Department of Geological Sciences
Mackenzie, F.	10/17	Univ. of Hawaii	Travel to Northwestern University in Evanston, IN to collaborate with Dr. Abraham Lerman concerning issues/development of undergraduate ESSE courses as well as presentation of several lectures and a seminar in the Department of Geological Sciences
McKenzie, G.	9/10-11/94	Univ. of Ohio	Travel to Washington, DC to attend AGU Chapman Conference
McGinnis, D.	4/19-23/95	CIRES	Travel to University of Arizona in Tucson, Arizona for guest lectures in undergraduate ESS classes, presentation of seminar
Ogg, J.	3/21-24/95	Purdue Univ.	Travel to NYU in New York, NY to collaborate with Dr. Michael Rampino concerning development issues of undergraduate ESSE courses and to present a lecture and seminar while at the University
Rampino, M.	11/1/94	NYU	Travel to Purdue University to collaborate with Dr. James Ogg concerning development issues of undergraduate ESSE courses and to

			present a seminar while at the university
Ruzek, M.	4/16-21/95	USRA	Travel to Washington, DC to attend NSF meeting
Ruzek, M.	5/15-17/95	USRA	Travel to Washington, DC to attend CENR Committee meeting
Tarboton, D.	1/31/95	Utah State Univ.	Travel to University of Arizona in Tucson, AZ for guest lectures in undergraduate ESS classes, presentation of seminar and faculty discussion

APPENDIX F

SEMINARS

Date	Title	Name	Affiliation
November 18	The Geolocation and Interuse of EOS Data	Mike Botts	UAH
November 23	Lightning Observations From Space and Associated Research	Hugh Christian, Steve Goodman, Bill Kosnak	MSFC
November 29	Modeling of Chemical and Hydrological Transport Processes for Climate and the Southern Hemisphere Ozone Experiment	Don Johnson	University of Wisconsin
December 1	Quantitative Analysis of the Predictability of Mesoscale Connective Initiation in Regions of Weak Synoptic Scale Forcing Over the Southeastern United States	Dan Casey	UAH
December 7	Reducing Errors in Satellite Global Temperatures	John Christy	UAH
December 14	Scale Persistence of Soil Moisture as Simulated in a Global Model	Dan Fitzjarrald	MSFC
January 4	Characterizing Sub-Grid Scale Processes and Assessing Satellite Doppler Wind Lidar with MACAWS	Jeff Rothermel	MSFC
January 11	Special Sensor Microwave Images (SSMI) Antenna Temperature Comparison	Adrian Ritchie	Hughes STX
January 18	Mission to Planet Earth Flight Program and Plans	Vern Keller	MSFC
January 25	Coupled Katabatic/Ocean System of Antarctic and Implications for Climate Change	Dick McNider	UAH
February 1	Ice Budget Diagnostics Over the Western Pacific During TOGA-COARE and CEPEX	Pete Robertson	MSFC
February 8	Fractional Activation of Accumulation Mode Particles in Continental Stratiform Clouds Plus Overview of Nashville Field Study	Noor Gallini	TVA/North Carolina State
March 1	Global Aerosol Climatology Implications for Climate and Remote Sensing	Dave Bowdle	IGCRE/UAH
March 8	Remote Sensing-Based Technique to Account for Sub-Grid Scale Variability of Land Surface Properties	Bill Crosson	IGCRE/USRA
March 15	Near Term Climate Variations and Improved Weather Prediction Techniques for Relation to Water Resources Management and Power Operations	Norris Neilsen	TVA
March 22	Structure of a Squall Like Winter Time Narrow Cold Frontal Rain Band Over the Gulf Stream	Bart Geerts	UAH
April 5	Surface and Subsurface Hydrology of Karst Terrains	Warren Campbell	UAH
April 12	A Dan Data Miner for Mining the MSFC DAAC	Tom Hinke	UAH

April 19	Model Simulations of Water and Energy Budgets for Convectively Active Seasons	Don Perkey	IGCRE
May 10	New Lidar Technique to Estimate Atmospheric Sulfate Aerosol Chemistry	Vandana Srivastava	IGCRE/USRA
May 17	Simulation of Upper Atmosphere Discharges Above Thunderstorms	Maurice Jarzembski	MSFC
May 24	Laboratory and Numerical Models of Spherical Convection and Overview of the Shuttle GFFC Experiment	Tim Miller	MSFC
June 14	Atmospheric Trace Molecule Spectroscopy (ATMOS) Chemical Partitioning and Ozone Loss from '85, '92, '93, and '94	Mike Newchurch	UAH
June 28	Anomalous Cloud Absorption: Real or Imaginary	Jere Justus	CSC
July 5	Near Miss Tornado of May 10, 1995	Kevin Knupp	UAH
July 12	GHCC - Where We're Going and How We Plan to Get There	Greg Wilson	MSFC
July 20	Multispectral Instrument Modeling: The Imaging Spectrometer Evaluation System (ISES)	Mike Flaherty	Nichols Research Corporation
July 26	The DAAC - What Is It All About:	Cathy Lapenta	MSFC
August 2	Marine Boundary Layer Clouds and Their Parameterizations	Shouping Wang	IGCRE/USRA
August 7	Thermal Signatures of Urban Land Cover Types: High-Resolution Thermal Infrared Remote Sensing of the Urban Heat Island in Huntsville, AL	C. P. Lo	University of Georgia
August 9	Advanced Data Compression Technologies for High Fidelity Applications	Alan Scales	Nichols Research Corporation
August 16	Korean Rainguage Precipitation Records and their Association to Northern Hemisphere Circulations	Gyu-Ho Lim	Seoul National University
August 17	The Seismic Detection of Tornadoes	Jim Dorman Frank Tatum	Univ. of Memphis Engineering Analysis Inc.
August 23	Precipitation Over the Pacific Ocean as Measured by MSU	Andy Milman	Consultant
August 30	On the Relationship Between Microwave Soundings and Surface Pressure	Stan Kidder	UAH

APPENDIX G

SCIENTIFIC CONFERENCES AND WORKSHOPS

Topic	Dates	Location
TVA Region Science Issues and Data Requirements Workshops	2/15-16/95	Huntsville, AL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Neil Carriker	TVA Water Mgt.	Dale Quattrochi	NASA/GHCC
Wayne Hamberger	TVA Engineering Services	James Arnold	NASA/MSFC
Norris Nielsen	TVA Environmental Research Laboratory	John Christy	UAH
		Mike Goodman	NASA/MSFC
Patricia Northcutt	TVA Mapping Services Branch	Steve Goodman	NASA/MSFC
Kurt Ritters	TVA Land Management	Ron Greenwood	NASA/MSFC
Dick Shane	TVA Reservoir Operations	Stan Kidder	UAH
Betsy Smith	TVA Land Management	Kevin Knupp	UAH
Frank Thornton	TVA Environmental Research Laboratory	Richard McNider	UAH
		Brian Motta	Hughes STX
Dennis Baldocchi	NOAA Atmospheric Turbulence and Diffusion Laboratory	Pete Robertson	NASA/MSFC
		William Vaughn	UAH
Virginia Dale	Oak Ridge National Laboratory	Sara Graves	UAH
Mike Huston	Oak Ridge National Laboratory	John Leese	GCIP Program Office
Pat Mulholland	Oak Ridge National Laboratory	Steve Williams	UCAR
Cathy LaPenta	NASA/MSFC	Doug Rickman	NASA/MSFC
Robb Turner	Oak Ridge National Laboratory	Don Perkey	IGCRE

Meeting of the NOAA Working Group on Space-Based LIDAR Winds	7/12-14/95	Huntsville, AL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Farzin Amzajerdian	UAH	Vernon Keller	NASA/MSFC
John Anderson	Univ of Wisconsin	Scott Manlief	TRW
Wayman Baker	NOAA/NMC	Jim McMillion	NASA/MSFC
Richard Beranek	NASA/MSFC	Jan Paegle	Univ. of Utah
David Bowdle	IGCRE/UAH	Al Preyss	Martin Marietta
R. A. Brown	Univ. of Washington	Ed Pruett	Martin Marietta
G. D. Emmitt	Simpson Weather Associates	Jeff Rothermel	MSFC
John Fikes	NASA/MSFC	John Schultz	Los Alamos Nat'l Lab
Pierre H. Flamant	CNRS	Gary Spiers	UAH
Rod Frehlich	Univ. of Colorado	Jeffery Sroga	Martin Marietta
Rao Gudimetla	Oregon Grad. Institute	William W. Vaughan	UAH
Milton Huffaker	Coherent Technologies, Inc.	Greg Wilson	NASA/MSFC
Ramavao Inguva	Univ. of Wyoming	Sid Wood	Simpson Weather Associates
Bill Jones	Lockheed		
Michael J. Kavaya	NASA/MSFC	Jim Yoe	NOAA/NESDIS

MTPE/Extension Partnership Planning 3/6/95 Huntsville, AL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
J. M Wersinger	NASA/MSFC	Tony Cook	State 4-H Office
Donald Perkey	IGCRE	David Hicks	Dept. of Geography
Bill Crosson	IGCRE/USRA	Tim Delaney	GIS/RS Laboratory
Maury Estes	IGCRE	Paul Mask	Auburn University
Leff Luvall	NASA/MSFC	Chuck Weber	City of Huntsville Lands. Mgt.
Wubishet Tadesse	Alabama A&M Univ.		
Tom Coleman	Alabama A&M Univ.	Dick McNider	UAH

Meeting of the NOAA Working Group on Space-Based LIDAR Winds 1/31-2/2/95 Clearwater, FL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Farzin Amzajerdian	UAH	Scott Manlief	TRW
Jim Arnold	NASA/MSFC	Bob Menzies	NASA/JPL
Wayman Baker	NOAA/NMC	John Molinari	S.U.N.Y. at Albany
Michael Bedard	Air Force Space Command/DRFE	Dick Nelms	NASA/LaRC
		Jan Paegle	Univ. of Utah
Dick Beranek	NASA/FA31	Jacques Pelon	Serv. d'Aeronomie du CNRS
David Bowdle	IGCRE/UAH		
Robert Brown	Dept. of Atmos Science	John Petheram	Martin Marietta
G. D. Emmitt	Simpson Weather Associates	Jeff Rothermel	NASA/MSFC
Melvin Ferebee	NASA/LaRC	John Schultz	Los Alamos Nat'l Lab
Pierre H. Flamant	LMD/CNRS	Jeff Sroga	Martin Marietta
Rod Frehlich	Univ. of Colorado	John Theon	NASA Headquarters
Paul Hays	Univ. of Michigan	Julie Williams-Byrd	NASA Langley
Milton Huffaker	Coherent Technologies, Inc.	Eric Williford	Florida State Univ.
Michael J. Kavaya	NASA/MSFC	Dave Winker	NASA/LaRC
Vernon Keller	NASA/MSFC	Alan B. Wissinger	Wilton, CT
		Jim Yoe	NOAA/NESDIS

LIS/OTD Science Team Meeting 6/6-7/95 Huntsville, AL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Steven Goodman	NASA/MSFC/GHCC	Henrick Ierkic	Univ. of Puerto Rico
Stan Kriz	Resolution Displays	Ron Koczor	NASA/MSFC
Greg Shaffer	Resolution Displays	Dick Beranek	NASA/MSFC/GHCC
Colin Price	Lawrence Livermore Nat'l Lab	John Jalickee	Silver Spring, MD
Jose Guillen	Sandia Nat'l Labs	Jim Weinman	NASA/GSFC
Hugh Christian	NASA/MSFC/GHCC	Kevin Driscoll	UAH/IGCRE/GHCC
Tim Murphy	LANL	Mark Weber	Li Laboratory
David Pollock	UAH/CAO	Richard Blakeslee	MSFC/GHCC
Corey Boettcher	NASA/Landover	Judy Fennelly	UAH/GHCC
Bill Taber	NASA/JPL	Hiram Levy II	GFDL/NOAA
Doug Davis	EAS Georgia Tech	Betsy Park	NASA/GSFC
Richard Ullman	NASA/GSFC	Michael Halenkamp	NASA/MSFC/GHCC
Dennis Buechler	UAH/IGCRE/GHCC	Roger Chassay	NASA/MSFC
Paul Meyer	NASA/MSFC/GHCC	Danny Hardin	NASA/MSFC/GHCC
Ron Phillips	UAH/GHCC	Mike Botts	UAH/ESSL/GHCC
Jeff Bailey	NASA/MSFC/GHCC	Brian Motta	Hughes STX
Ed Zipser	Dept. of Meteorology, Texas A&M		

Global Hydrology Workshop 6/15-16/95 Washington, DC

Meeting Attendees:

Name	Affiliation	Name	Affiliation
John Alishouse	NASA	Donald Johnson	Univ. of Wisconsin
Albert Arking	NASA	Stanley Kidder	UAH
Richard Armstrong	NSIDC	Mercedes Lakhtakia	Penn. State Univ.
James Arnold	NASA/MSFC/GHCC	Cathy Lapenta	NASA/MSFC/GHCC
Richard Beranek	NASA/MSFC/GHCC	Diana Liverman	Penn. State Univ.
Richard Berk	UCLA	Richard McNider	UAH
Francis Bretherton	Univ. of Wisconsin	Barbara Miller	UAH
Toby Carlson	Penn. State Univ.	Tim Miller	NASA/MSFC/GHCC
Fei Chen	Nat'l Meteorological Center	Mitchell Moncrieff	NCAR
Bill Crosson	IGCRE/USRA	Ramakrishna Nemani	Univ. of Montana
Robert Dickinson	Univ. of Arizona	Donald Perkey	IGCRE
Renee Dotson	NASA	Rachel Pinker	Univ. of Maryland
Lee Elson	NASA/Propulsion Laboratory	Ronald Ritschard	TVA
Ted Engman	NASA/GSFC	F. Robertson	NASA/MSFC/GHCC
Jay Famiglietti	Univ. of Texas	Richard Rood	NASA/GSFC
Rong Fu	Univ. of Arizona	Frank Schiebe	USDA-ARS
Steven Goodman	NASA/MSFC/GHCC	Siegfried Schubert	NASA/GSFC
Sara Graves	UAH	Paul Smith	South Dakota School of Mines
Lawrence Greenwood	NASA/MSFC/GHCC		
Michael Jasinski	NASA/GSFC	Brian Soden	Princeton Univ.
Gary Jedlovec	NASA/MSFC/GHCC	Y. C. Sud	NASA/GSFC
Roy Jenne	NCAR	Paul Twitchell	Int'l GEWEX
		Bruce Wielicki	NASA/Langley

The 2nd Precipitation Intercomparison (PIP-2) Workshop 6/15-16/95 Huntsville, AL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Michael Goodman	NASA/MSFC/GHCC	Steve Goodman	NASA/MSFC/GHCC
Jim Dodge	NASA Headquarters	Al Chang	NASA/Goddard
Beth Ebert	Australian Bureau of Meteorology	Gary Jedlovec	NASA/MSFC/GHCC
Anonashi Kazumasa	Meteorological Res. Inst. (Japan)	Roy Spencer	NASA/MSFC/GHCC
Peter Bauer	German Aeros. Estab. (Germany)	Tom Wilheit	Texas A&M Univ.
Wes Berg	Univ. of Colorado	Ed Zipser	Texas A&M Univ.
Nicole Husson	Ecole Polytechnique (France)	Eric Smith	Fl. State Univ.
Pete Keehn	NASA/Goddard	Matt Smith	NASA/MSFC/GHCC
Chris Kidd	Bristol Univ. (England)	Frank Lafontaine	Hughes STX
Chris Kummerow	NASA/Goddard	Jim Lamm	Fl. State Univ.
Adrian Ritchie	Hughes STX	Rick Russel	Texas A&M Univ.
Akira Shibata	Meteorological Res. Inst. (Japan)		

Meeting of the Hydrologic Cycle Data Access and Archive Working Group (HDAAWG) 6/22-23/95 Huntsville, AL

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Eric Smith	Fl. State Univ.	Steve Goodman	NASA/MSFC/GHCC
Pete Robertson	NASA/MSFC.GHCC	Dave Randel	Colorado State Univ.
Randy Koster	NASA/GSFC	Michael Goodman	NASA/MSFC/GHCC
Dave Emmitt	Simpson Weather Assoc.	Jim Dodge	NASA Headquarters
Mary Reph	NASA GSFC	Cathy Lapenta	NASA/MSFC/GHCC
Helen Conover	IGCRE/USRA	Joy Colucci	Hughes Applied Info.
Brian Motta	Hughes STX		

Meeting of the NOAA Working Group on Space-Based LIDAR Winds 7/19-21/95 Frisco, CO

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Jim McElroy	US EPA, CRD-LV	C. Eric Williford	Florida State Univ.
Jan Paegle	Univ. of Utah	Vernon Keller	NASA/MSFC
G. D. Emmitt	SWA	Jim Yoe	NOAA/NESDIS/ORA
R. A. Brown	Univ. of Washington	John Schultz	Los Alamos Nat'l LaS
Farzin Amzajerdian	Univ of Alabama	John Michael Vaughan	Defense Resrch Agency
Pierre Flamant	CNRS/LMD	Scott Manliet	TRW
Jasper Pelon	CNRS/SA	Bob Menzies	Jet Propulsion Lab
David Bowdle	IGCRE/UAH	Bruce Gentry	NASA/Goddard
Andrae Marini	ESA/ESTEC	M. J. Post	NOAA/ERL
G. Daniel Hickman	NRL	Mike Hardash	
Dick Beranek	NASA/MSFC/GHCC	John Petheram	Lockheed Martin

APPENDIX H

STUDENTS

Name	Affiliation	Research Topic
Doty, K.	Drexel Univ.	Regional versus Global Model Water Vapor Budgets
Brewer, J.	Univ. of Alabama in Huntsville	Global Climate Variability
Lerner, J.	Univ. of Alabama in Huntsville	Comparison of VAS and SSM/I Precipitable Water
Ramakandran, R.	Univ. of Alabama in Huntsville	Retrieving ice profiles from SSM/I

APPENDIX I

K-12, UNIVERSITY AND INDUSTRY VISITORS TO IGCRE

Name	Dates	Affiliation	Reason
Baker, M.	2/20/95	Univ. of Washington	Attend the Lightning Physics & Cloud Modeling Workshop at the Global Hydrology and Climate Center
Blyth, A.	2/19-21/95	New Mexico Institute of Technology	Attend the Lightning Physics & Cloud Modeling Workshop at the Global Hydrology and Climate Center
Brook, M.	10/29-11/1/95	New Mexico Institute of Technology	Collaborate with NASA scientist Dr. Hugh Christian of the GHCC/ESSD and other NASA and IGCRE scientists on Spherics Lightning Data
Borne, C.	7/95	Louisania K-12 Teacher	NASA Science Teacher Enhancement Program
Buford, C.	2/6-2/28/95	CSC Corp.	Attend DAAC Meetings
Buford, C.	4/30/95	CSC Corp.	Attend DAAC Meetings
Buford, C.	6/30/95	CSC Corp.	Attend DAAC Meetings
Buford, C.	2/6-2/28/95	CSC Corp.	Attend DAAC Meetings
Devlin, K.	8/20-22/95	Texas A&M	Collaborate with Dr. Steve Goodman and other scientists on lightning and related areas of research
Few, A..	9/22/94	Rice Univ.	Attend the IGCRE Executive Board Meeting
Few, A..	11/29/94	Rice Univ.	Attend the IGCRE Executive Board Meeting
Jonnson, D.	9/22/94	Univ. of Wisconsin	Collaborate with IGCRE and NASA scientists and attend the IGCRE Executive Board Meeting
Jonnson, D.	11/29/94	Univ. of Wisconsin	Collaborate with IGCRE and NASA scientists and attend the IGCRE Executive Board Meeting
Landry, A.	7/95	Louisania K-12 Teacher	NASA Science Teacher Enhancement Program
Levy, H.	6/5-7/95	GFDL/NOAA	Attend LIS Meeting
Sohn, B. J.	7/1-9/1/95	Seoul National Univ.	Perform scientific research studies with IGCRE and NASA scientists in the GHCC

APPENDIX J

UNIVERSITY AND INDUSTRY TRAVEL IN SUPPORT OF IGCRE ACITVITIES

Name	Dates	Affiliation	Reason
Boeck, W.	11/29-12/1/94	Niagra Univ.	Travel to Landover, MD to attend the HDAAWG Meeting
Brown, R.	1/30-2/2	Univ. of Washington	Travel to Clearwater, FL to attend Lidar Working Group Meeting
Emmit, D.	1/27-2/2/95	Simpson Weather Associates	Travel to Clearwater, Florida to attend the Lidar Working Group Meeting
Emmit, D.	11/30-12/1/95	Simpson Weather Associates	Travel to Landover, MD to attend HDAAWG Meeting
Molinaro, J.	1/30-2/2/95	S.U.N.Y. at Albany, NY	Travel to Clearwater, FL to attend Lidar Working Group Meeting
Paegle, J.	1/30-2/2	Univ. of Utah	Travel to Clearwater, FL to participate in the Lidar Working Group Meeting
Pentecost, L.	6/15-16/95	Washington, DC	Support of Global Hydrology Workshop in Washington, DC
Randel, D.	11/29-12/1/94	CIRA	Travel to Maryland to attend HDWAAG Meeting
Sadourny, R.	1/14-22/95	LMD du CNRS Paris, France	Travel to Dallas, TX to participate as an invited speaker in the American Meteorological Society's 6th Symposium on Global Change Studies
Smith, E.	11/29-12/2	Florida State Univ.	Travel to Landover, MD for HDAAWG Meeting
Solomon, R.	111/13-15/94	Univ. of Washington	Travel to IGPP Workshop on the Physics of Lightning

INSTITUTE FOR GLOBAL CHANGE RESEARCH & EDUCATION

(Jointly operated by the University of Alabama in Huntsville and Universities Space Research Association)

Annual Report:

"GLOBAL CHANGE RESEARCH RELATED TO THE EARTH'S ENERGY AND HYDROLOGIC CYCLE"

Under

Cooperative Agreement:

NCC8-22

September 1, 1993 - August 31, 1994

Submitted to:

THE GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA 35812

By:

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

on behalf of:

INSTITUTE FOR GLOBAL CHANGE RESEARCH & EDUCATION (IGCRE)
4950 CORPORATE DRIVE, SUITE 200
HUNTSVILLE, ALABAMA 35806

Approved by:

Donald J. Perkey, Director
Institute for Global Change Research & Education

9/21/94
Date

Educational Outreach

Mr. Gregory N. Cox, Research Scientist, UAH

Dr. Charles Laymon, Associate Scientist, USRA

One objective of IGCRE's educational outreach programs are to generate enthusiasm about science among pre-college students, to increase environmental awareness, and to educate students on the important role that space-based observations play in understanding the environment. Because Mission to Planet Earth poses questions whose answers require research that spans decades, building and maintaining the long-term supply of research scientists is strategically important to the success of the mission. The recruitment of future scientists begins at the primary and secondary education level.

Mr. Gregory N. Cox, research interest continues to lie in the validation (or ground truth) and visualization of remotely sensed data sets. Mr. Cox is responsible for coordinating the K-12 education related activities of the Institute for Global Change Research and Education focusing on NASA's Mission to Planet Earth and related global change issues.

Educational Outreach

Global Environmental Change Education Curriculum Development: Since 1990, Mr. Cox has served on the curriculum development team for a new K-12 curriculum to teach how the fundamentals of remote sensing can be used to understand global environmental change. Mr. Cox has lead the pilot testing effort for the Aspen Global Change Institute's (Aspen, Colorado) Ground Truth Studies (GTS) program in the southeastern United States and is working closely with the Alabama Department of Education to provide teacher training for GTS to Alabama teachers. Mr. Cox has also been instrumental in gaining the support of international business via the donation of computer hardware and software to help support the Ground Truth Studies program and other related global change education programs.

UAH Environmental Education Center: Mr. Cox has served as the Director since October, 1991. In addition to administering several education and research contracts with federal agencies, he has become actively involved in an effort to assist Russian environmental education professionals in creating an environmental education network in the Rostov-on-Don region of southern Russia, as well as other areas of the former Soviet Union. He has established an electronic communications network using packet radio between students and teachers in the Rostov Oblast with students and teachers in the Tennessee Valley region. Mr. Cox has also been actively involved in international environmental education as a founding member of the Global Network of Environmental Education Centers (GNEEC).

Dr. Charles Laymon

Educational Outreach:

Ground Truth Studies Program (Alabama State Department of Education): Two weeks of the subject period were directed toward preparation of course curricula and serving as an instructor and advisor for "A Mission to Planet Earth: A Ground Truth Studies Teacher Workshop conducted in June 1994 by the Northeast Alabama Environmental Education Consortium, IGCRE and the Division of Continuing Education, The University of Alabama, Huntsville. The goal of this workshop was to teach K-12 teachers the basics of remote sensing and how to utilize remote sensing imagery within their existing curricula and to educated students about global change.

Development of Earthbase (DOE National Inst. for Global Environmental Change): A proposal was prepared, submitted, and accepted for funding to develop an Earthbase at the Huntsville Botanical Gardens. The proposal was prepared to increase research efforts under IGCRE and preparations were the 'Bid and Proposal' account. The facility includes meteorological and hydrological instrumentation to demonstrate measurement technology associated with the hydrologic cycle in connection with

remote sensing research on global change. Four middle schools in the area will also receive modest instrumentation. Dr. Laymon designed the Earthbase, selected a site at the Gardens, procured and installed the necessary instrumentation.

Dr. Laymon as an advisor to the Mission Arkansas '95 project. This project is an educational initiative somewhat analogs to the Ground Truth Studies program described above.

He has reviewed a proposal for NASA's Global Change Fellowship program, two proposals from NASA-EPSCoR, and a manuscript from the Soil Conservation Service.

Dr. Laymon submitted the following proposal entitled, "A Ground Truth Studies Earthbase funded by DOE NIGEC", and is currently awaiting funding. The proposals were prepared to increase IGCRE research efforts. Proposal preparations were charged to the 'Bid and Proposal' account.

Student Mentorship:

Dr. Cox and Dr. Laymon served as mentors by supervising three college students with the NASA SPACE Academy in this summer's internship program and one UAH student.

1) Chadwick Hill, Undergraduate, The University of Alabama in Huntsville, Earth System Science Laboratory
2) Ms. Jessica Miller, Undergraduate, University of New Hampshire, NASA Summer Academy Student
3) Ms. Ruth Jones, Graduate, University of Arkansas at Pine Bluff, NASA Summer Academy Student
4) Ms. Jennifer Tesch, Undergraduate, University of Idaho, NASA Summer Academy Student

Geophysical Modeling and Processes

Dr. John Christy, Assistant Professor, UAH

Dr. Charles Cohen, Research Associate, USRA

Dr. Charles Laymon, Associate Scientist, USRA

Dr. Huei-Iin Lu, Associate Scientist, USRA

Ms. Jayanthi Srikishen, Research Associate, USRA

Dr. Shouping Wang, Associate Scientist, USRA

Dr. Takmeng Wong, USRA

Geophysical modeling and process studies involve numerical models ranging from global scale climate models (for example, the National Center for Atmospheric Research Community Climate Model, NCAR/CCM), to mesoscale prediction models (such as the Drexel University Limited Area Mesoscale Prediction System, LAMPS and the Colorado State University Regional Atmospheric Modeling System, RAMS), to models that isolate and treat component processes in great detail. Employing a hierarchy of models enables investigations into the time evolution of the phase, transformation, and redistribution of water and energy within the atmosphere over a continuous range of time and space scales. The detailed process models contribute to development of parameterizations for moist convection, cloud and rain microphysics, land-surface hydrology, and other processes that require improved representation in current climate and regional models.

A number of investigations focus on the coupling of atmospheric dynamics to external boundary conditions, including topography, but emphasizing surface and boundary layer fluxes of moisture and energy associated with the spatial distribution vegetation and soil properties. Specific studies entail development of modified Boundary Atmosphere Transfer Schemes (BATS) parameterizations for including surface processes in climate models. Within regional models, the role of mesoscale variations of soil moisture and vegetation in organizing regional and mesoscale circulations and convective precipitation is examined using BATS.

Other investigations focus on the role of cloud-radiation interactions in general circulation dynamics. Since low level oceanic stratocumulus sheets represent a major component of total global cloud-radiative forcing, efforts include modeling the marine planetary boundary layer coupled with cloud microphysical processes that sustain or deplete marine stratocumulus.

Regional models such as LAMPS and RAMS that are initialized with, or assimilate satellite and conventional data from the Global Energy and Water cycle Experiment Continental-scale International Project (GEWEX/GCIP) and the U.S. Weather Research Program field programs provide data sets for diagnosing moisture and energy budgets, and understanding the evolution and dynamics of regional and mesoscale precipitation systems.

Dr. John Christy, continue efforts in the area of identifying systematic biases between NOAA polar orbiters as they related to the stability of long-term trends in temperature. Data are continued to be offered to NOAA and researchers around the world in a timely fashion for assessment of global climate change issues.

In November 1993, Dr. Christy briefed Robert Watson of the White House Office of Science Advisor on pending publication of the Nature paper and how this might affect public policy.

Dr. Charles Cohen, continues to work on Mesoscale convective systems. A variety of environments were simulated with the Regional Atmospheric Modeling System, with the aim of determining whether the vertical motion in clouds can be diagnosed from a satellite image of the precipitating ice. Averaged over the whole model domain, there are strong correlations between the amount of precipitating ice and the vertical motion above the melting level averaged over the previous hour. The quantitative relationship that would allow a diagnosis of the mass flux from the ice content varies among the simulations.

There is relatively less ice remaining aloft for a given amount of vertical motion when a greater quantity of large and rapidly falling ice particles exist, or when the atmosphere is colder. The ice provides a more accurate diagnosis of the net mass flux when the downdraft mass flux above the melting level is small compared to the updraft mass flux above the melting level.

Dr. Charles Laymon continues performing research in the following areas:

Large Scale Water and Energy Budgets through the Convection and Precipitation/Electrification (CaPE) Research (NASA RTOP): Soil data were obtained from the United States Dept. of Agriculture (USDA) Soil Conservation Service in digital form State Soil Geographic (STATSGO) and converted and ingested these into the Intergraph Geographic Information System (GIS). The data structure of the acquired data was inconsistent with Intergraphs data structure, therefore requiring development of an unusual data manipulation scheme to convert the graphic information into graphic elements within the GIS. Another scheme was developed to populate the relational database tables with the associated attribute information. With considerable difficulty, a procedure was developed to extract the desired information needed for our land surface model.

Expanding on earlier investigations of the rainfall-runoff relationship for the CaPE study area, Dr. Laymon completed an estimate of Evapotranspiration (ET) for the CaPE study area using a water balance method. These results, which are used as an independent validation of model results, compared remarkably well with pan evaporation data and modeled ET that used an aggregate of Portable Atmospheric Mesonet (PAM) station data.

Working with Dr. W. Crosson, a gridded version of the land surface model (Simulator for Hydrology and Energy Exchange at the Land Surface--SHEELS) was produced. The treatment of soil hydrology to accommodate data available from the STATSGO data set was modified. The model was successfully run over a seven day period for a small (35 x 50 km) region within the CaPE domain and the sensitivity of the model to soil and landcover characterization was examined.

Desert Hydrometeorology Research (NASA RTOP): Eight Advanced Very High Resolution Radiometer (AVHRR) scenes, about two weeks apart during the summer of 1993, were obtained from Louisiana State University Computer Mapping Laboratory. An AVHRR Land Cover data set for the conterminous US was obtained from the USGS for use in georegistering these images.

Nearly coincident SPOT and Landsat Thematic Mapper (TM) images were purchased for the Goshute Valley for the summer of 1993 when vegetation was senescent. These images were converted for use in the Intergraph Image Station and georegistered. Normalized Difference Vegetation Index (NDVI)'s were computed for both datasets and a first order, unsupervised vegetation classification was performed on the Landsat data. This classification was ground truthed in June 1994 during field work which coincided with another Landsat image acquisition when vegetation is in full "bloom". Work is underway to examine the relationship between radiance values over the Bowen ratio stations with the in situ measurements as the precursor to spatial extrapolation.

Assessment of the Urban Heat Island Using Remote Sensing (NASA/MSFC/Center Director's Discretionary Fund CDDF): Work has commenced on a research project to assess the ability to use remote sensing to characterize the urban heat island. Dr. Laymon is developing the necessary structure for GIS and future image processing using design files obtained from the Huntsville City Planning Office. He will be activating his Bowen Ratio station at MSFC and managing the instruments at the Earthbase during the field campaign in late August. He will assist in image processing and data analysis following the field experiment.

The following proposals were prepared by Dr. Laymon to increase IGCRE research efforts. Proposal preparations were charged to the 'Bid and Proposal' account.

- "A Technique to Account for Sub-grid Scale Variability Using Remote Sensing for Land-Atmospheric Modeling" submitted to Water Cycle Processes Program, NASA, $408 K.

- "Investigations of the Hydrologic Cycle of the Central Tennessee River Valley with Emphasis on Soil Moisture Remote Sensing" submitted to NASA Equal Opportunity Office, Historically Black Colleges and Universities, $901 K.

Dr. Huei-Iin Lu, continues to use the Geophysical fluid flow Simulation model (GEOSIM) to study the predictability of flow regime and the dynamics of amplitude vacillation in the rotating annulus flow system. The following is the summary of the results:

A survey of flow regimes was conducted, each starting with a quiescent condition. As the model traverses across nondimensional parameter space by increasing the rotation rate, regular wave regimes of the same wavenumber are indicated within a small parameter range. In that region, the wavenumber increases with rotation rate in the same way as predicted by laboratory experiments and linear baroclinic wave theories. In addition to regular wave regimes, however, "wavenumber transition zones" exist which can be characterized by one or more of the following behavioral states: two-state equilibration, irregular wavenumber selection, and side-banded wave dispersion. Inside the wavenumber transition regions, the wavenumber selection behavior is very sensitive to the physical and numerical parameters as well as to the initial conditions. However, the definition of the boundaries of these regions may not be sensitive, making their prediction feasible.

It is found that amplitude vacillation is characterized by periodic change of vertical wave structure in concert with a growth and decay of the wave amplitude and phase speed. In contrast to the common idealization of baroclinic wave with single mode structure, the baroclinic wave apparently consists of a boundary layer mode, a lower heavy mode and an upper heavy mode which evolve with a short time lag. Two types of amplitude vacillation differing in the vertical variations of mean drift speeds are found. By performing eigen value analyses with respect to the instantaneous zonal-mean basic state, we illustrated that the mechanics of amplitude vacillation involve a rather simple wave-mean interaction.

Ms. Jayanthi Srikishen, continues performing the following activities:

Numerical Models: Working with Drs. Fitzjarrald and Robertson on the GENESIS on the CRAY at MSFC and Alabama Supercomputer. Benchmark runs and evaluation of C-90 at Alabama Supercomputer with Dr. Robertson. She performed analysis, data processing, and data archival of the GENESIS model.

System Migration: Installed NCAR Graphics, GENESIS, RAMS and LAMPS code on the CRAY Y-MP. Ms. Srikishen provided user support to CRAY X-MP users until it was turned off on July 31, 1994.

Visualization: Used the graphics package GRADS for visualizing GENESIS model output. She provided data visualization support to ES42 users.

User Interface: Assisted the scientists with their problems in computing and provided computer support for NASA Summer Faculty visitors in the Division. Provided benchmarking codes on the SGI's latest and greatest R4400 ONYX workstation.

Dr. Shouping Wang, continues work on the research entitled, "Modeling Marine Boundary Layer Clouds." The following describes his activities:

He has implemented a new prognostic scheme to define cloud cover and mean liquid water in the boundary-layer model following the Tiedtke's method. This method provides a unified approach to predict any type of cloud. One-dimensional

version of the model was used to simulate the climatic downstream variation of boundary layer clouds from eastern North Pacific to central Pacific oceans. The results of the simulation is in good agreement with observations. The climate simulation predicted the decrease of cloud cover and liquid water path from stratocumulus to trade-wind cumulus regions. This decrease is clearly associated with decoupling between cloud and subcloud layer and the development of vertical gradient of the boundary layer structure. With the prognostic scheme of clouds, not only are they able to obtain liquid water content that is crucial parameter for radiation calculation, but are also able to study hydrological cycle associated with these clouds through a budget analysis of cloud variables.

He has also used a regional version of the boundary layer model to simulate the boundary layer structure during ASTEX. The diurnal variation of boundary layer clouds are well simulated compared with that from satellite data. The decoupling between cloud and subcloud layer caused the solar warming inside clouds is responsible for the variation. During daytime, solar warming inside clouds stabilize the boundary layer so that a weak stable layer forms at the base of the cloud layer. Thus the mass flux at the cloud base from the model is significantly reduced, and consequently, the detrainment of mass from updrafts decreases during the day. The source term of the predictive equations of mean liquid water and cloud cover becomes very weak, which leads to a reduction in these cloud variables. During night, solar warming disappears and the longwave radiative cooling at the cloud top is strong enough to maintain a well-mixed structure. Thus the mass flux at the cloud base and the detrainment in the cloud layer and in the inversion are significantly larger than those in the daytime, which gives more clouds. These simulations demonstrate that the mass flux parameterization with a Tiedtke's cloud prognostic scheme provides a physically based parameterization for a general circulation.

Dr. Wang studied the simulations of stratocumulus clouds with GENESIS climate model. In general, the model simulates the correct locations of maximum values of low-level cloud fractional coverage. Seasonal variations of these clouds in mid- and high-latitudes are reasonably simulated by the model compared with those diagnosed from the ground observations by Warren et al. (1988). However, it seems that the seasonal variations in subtropics are poorly represented by the model. The probability is caused by stratocumulus clouds in subtropics being closely linked to Hardley circulation and turbulent mixing processes in the boundary layer which are difficult to simulate in the model.

Dr. Takmeng Wong, joined IGCRE on March 7, 1994, to concentrate on formulating a scientific research for understanding the effects of cloud radiative forcing on the energetics and circulations of the global atmosphere. This work was performed in collaboration with Dr. Franklin Robertson of NASA/MSFC. A research strategy was developed during this period for improving the vertical profile of cloud radiative forcing using satellite information and examining the effects of this forcing on the energetics and circulations of the atmosphere. Specifically, he plans to calculate the vertical profile of cloud radiative forcing using a large-scale semi-prognostic model of water vapor and condensate, observationally constrained by SSM/I data, and a detailed radiative transfer model. The derived radiative heating profiles will then be used to drive a diagnostic model of energy and thermally-forced circulations to examine the effects of atmospheric cloud forcing on the energetics and circulations of the atmosphere.

Finally, energy and thermally-driven circulations diagnostics from these studies will be compared with the similar quantities derived from general circulations in order to understand (1) the robustness of cloud radiative forcing response in current climate model, and (2) model biases and weakness. An unsolicited proposal was submitted to NASA to perform the scientific research, entitled, "On the Cloud Radiative Forcing Effects and Global Energetics." The proposal was prepared to increase Dr. Wong's research efforts under IGCRE. The proposal preparation was charged to USRA's Bid and Proposal account.

Land Surface Processes and Atmospheric Interactions

Mr. David Bowdle, Research Scientist, UAH

Dr. Bill Crosson, Research Associate, USRA

Dr. Dean Cutten, Research Scientist, UAH

Dr. Dick McNider, Associate Professor and Director of ESSL, UAH

Dr. Ravikumar Raghavan, Research Associate, USRA

Dr. Aaron Song, Senior Research Associate, UAH

A central theme of this research is to observe geographic distributions of surface properties and fluxes, and quantify the contribution of the surface to observed regional and global budgets of water and thermal energy. Fluxes of water and energy to and from the surface are complex functions of highly heterogeneous surface properties such as slope, albedo, soil porosity, vegetation cover, soil temperature, soil moisture, and meteorological conditions. Correct representation of area integrated fluxes in numerical models requires development of new measurements, parameterization, and data assimilation techniques. Considerable effort is being devoted to developing parameterizations for surface sensible and latent heat fluxes based on the hydrology of vegetated surfaces encompassing a variety of climatic regimes and biomes.

The primary data that are employed in developing these parameterizations are from The First International Satellite Land Surface Climatology Project (ISLSCP) Field Experiment (FIFE), conducted in Kansas in 1987 and 1989, and from the Convection and Precipitation /Electrification Experiment (CaPE) conducted in the summer of 1991 over Florida. These data provide detailed surface radiation and energy budget measurements over a network of observation sites including: directional shortwave and longwave radiation fluxes, sensible, latent and ground heat fluxes, soil temperatures and moisture, precipitation, winds, and air temperature and relative humidity. These are complemented by remote surface observations in the visible, near-infrared, and infrared regions from four operational satellites (Geodetic Observing Satellite/Visible Infrared Spin Scan Radiometer, GOES/VISSR; National Oceanic and Atmospheric Administration/Advanced Very High-Resolution Radiometer, NOAA/AVHRR; System Probatoire d'Observation de la Terre/High-Resolution Visible Imager, SPOT/HRV; and Defense Meteorological Satellite Program/Operational Linescan System, DMSP/OLS) and research aircraft (Multispectral Atmospheric Mapping Sensor, MAMS). These data are used to derive surface temperature, albedo and vegetation indices for the CaPE and FIFE domains. The complement of *in situ* land surface measurements during CaPE and FIFE is used to calibrate and validate satellite and aircraft algorithms employed in estimating relevant surface properties. GEWEX/GCIP and Boreal Ecosystems Atmosphere Study (BOREAS) field programs are also expected to yield data useful in land processes research.

Mr. David Bowdle, continues research on the Doppler lidar. The activities performed during this reporting period concentrated on scientific issues that provided important inputs to the restructuring of the Laser Atmospheric Wind Sounder (LAWS) and GLObal Backscatter Experiment (GLOBE) programs.

GLOBE Science Coordination: Responsibilities involved informally coordinating data processing, analysis, and publications within the external GLOBE Science Working Group (SWG) and the internal MSFC Aerosol/Lidar Group; hosting GLOBE investigator visits to MSFC; distributing GLOBE results to the science and aerospace communities; and planning the next GLOBE SWG meeting. Mr. Bowdle also began a journal paper on the GLOBE program and prepared a draft GLOBE "white paper," consisting of recommendations to NASA Headquarters (HQ) for GLOBE research activities during the next few years.

LAWS Science Team Membership: Contributed a GLOBE section to a journal paper on LAWS. He attended the winter LAWS meeting and gave a presentation on GLOBE. Mr. Bowdle has been an Associate Member of an official EOS LAWS Science Team since January 1989 through December 1993. In December, LAWS was officially de-selected from EOS. In February 1994, he became a full member of an ad hoc LAWS Science Team.

LAWS Mission Development: Developed estimates of aerosol backscatter at the 2.1 micron wavelength, for inputs to NASA's systems study on a 2 micron version of LAWS, and presented the results at NASA's 2 micron technology review. He also conducted a parametric assessment of various Doppler lidar design concepts for LAWS. This task included attending a short course on coherent Doppler lidar, reviewing incoherent Doppler lidar technology at the University of Michigan, and assessing the impact of backscatter magnitude and backscatter wavelength dependence on various LAWS design concepts. Mr. Bowdle evaluated the impact of these results on MSFC plans for a LAWS science demonstration mission, presented the results in numerous internal meetings at MSFC, and began to incorporate the results in a comprehensive journal paper.

GLOBE Analysis and Modeling: Routinely coordinates and reviews internal and external GLOBE data analysis and modeling, with particular attention to quality control and internal/external consistency. He used GLOBE results provided by Dr. Dean Cutten (IGCRE) and Dr. Vandana Srivastava to develop empirical global backscatter models for wavelength combinations of 9.1 microns versus 0.53, 1.06, and 1.54 microns. These empirical models validated IGCRE's earlier theoretical global backscatter models for 9.1 microns versus 2.1 microns.

Reviews: Reviewed two proposals for NASA's Atmospheric Effects of Aviation Program/Subsonic ASSessment (AEAP/SASS) and one proposal for NASA's Tropical Rainfall Measurement Mission (TRMM).

Reviewed draft plans for an Optical Atmospheric Measurements (OAM) program by NASA's Dryden Flight Research Facility. This prospective program is designed to develop the scientific and technological basis for operational Doppler lidar systems for high-altitude airspeed and turbulence measurements on a wide variety of commercial, military, and high-performance test aircraft. The OAM program relies heavily on GLOBE results to provide initial inputs to prototype lidar design studies.

Dr. Bill Crosson, continues working toward modeling surface energy and hydrologic processes utilizing data collected during the Convection and Precipitation /Electrification Experiment (CaPE) held in east central Florida in 1991. The objectives of this project are to establish and apply methodologies for the diagnosis of land and atmospheric water budget components for the CaPE region (approximately 25000 km2). The underlying philosophy guiding this study is that these techniques can be applied on scales consistent with GCIP activities such as the CARTARM experiment and ultimately the Mississippi basin. The surface energy and water flux component of this investigation is being carried out using a land surface model based on the Biosphere-Atmosphere Transfer Scheme (BATS), in conjunction with data from a wide array of measurement systems. The model has been validated using data from the two Florida State University flux sites. These stations were used because of the availability of model input variables: wind, temperature, humidity, pressure, precipitation and solar and longwave downwelling radiation, as well as flux measurements necessary for model validation. Results from these simulations indicate that the model, using soil and vegetation parameter values appropriate for the local conditions, is capable of accurately estimating surface energy and moisture fluxes.

Model simulations have been performed for each of the 38 PAM sites within the study area, producing initial estimates of areal heat and moisture fluxes. Thirteen of the PAM stations measured incident shortwave radiation; 4 of these also collected reflected shortwave, emitted longwave and net radiation, and soil temperatures. Model sensitivity to radiation input is currently being tested using a variety of methods for specifying solar and longwave fluxes using the point measurements.

A more sophisticated modeling scheme for estimating areal fluxes for the CaPE domain has been designed. This new model, the Simulator for Hydrology and Energy Exchange at the Land Surface (SHEELS) is a gridded model based on the physics of BATS but also incorporating geographic information on landcover and soil properties. In order to diagnose daily areal mean heat and moisture fluxes, SHEELS has been run over the CaPE domain with each grid cell having specified landcover and soil types. Meteorological forcing for the model was supplied by measurements from ground-based stations and by rainfall derived from raingages and radar.

Dr. Crosson participated in the Boreal Ecosystem-Atmosphere Study (BOREAS) during July and August, 1994. The his team role was to measure surface net radiation at each of 21 surface sites, consisting of flux towers and automated meteorological stations. These measurements will be used to standardize net radiation observations made by other investigators at each of the sites.

To add further realism to the SHEELS model, the statistical distributions of surface properties such as leaf area index, albedo and fractional vegetation cover within each landcover 'patch' will be represented via a discrete probability density function. These distributions will be inferred from the observed distributions of NDVI and spectral albedo which have been derived from 20 m resolution SPOT imagery for each of the 18 land cover classes in the study area. Scale issues will be addressed with a series of model runs in which the resolution of remotely sensed data, used to establish the nature of surface variability, is degraded. Preliminary analyses have shown that degradation of SPOT data from 20 m up to 1 km resolution (simulating AVHRR footprints) results in large changes in both mean and variance of surface properties.

SHEELS will continue to undergo modifications to improve the representation of surface and sub-surface water routing. Appropriate algorithms will be integrated into the model, and digital elevation data will be incorporated to drive these processes.

He was involved in writing and submitting the proposals listed below. Preparation of the proposals were charged to the Bid and Proposal Account.

Principle Investigator - "A Technique to Account for Sub-Grid Scale Variability of Remotely-Sensed Land Surface Properties for Application in Coupled Land-Atmosphere Models," submitted in May 1994 under IGCRE to Water Cycles Processes Program, NASA Headquarters. Funding pending. This proposal establishes the plan to transfer a modeling strategy developed in CaPE to a new environment--the Red River and Arkansas River Basins in the Great Plains. Then, advantage will be taken of many existing networks measuring meteorological and radiation parameters, as well as modeling activity planned as precursor activity to GCIP. The opportunity exists here to test SHEELS in different hydrometeorological conditions and also to compare modeling results with other investigators.

Co-Investigator - "Intelligent Data Requester for Exploitation Access to the EOSDIS," submitted to NASA, March 1994 by Intergraph Corporation, J. R. Herring, P. I. Currently not funded.

Dr. Dean Cutten continues to perform research in the following areas:

GLOBE Backscatter Calculations: Work continued on aspects of scientific applications using the GLObal Backscatter Experiment (GLOBE) data at MSFC. Most GLOBE data were obtained during Pacific Ocean Survey Missions in Fall 1989 (GLOBE I) and Spring 1990 (GLOBE II) on the NASA Ames Research Center (ARC) DC-8 aircraft.

In this period activities concentrated on deriving aerosol backscatter coefficients at 0.53, 1.06, 9.1, 9.25 and 10.59 μm wavelengths using ARC Forward Scattering Spectrometer Probe (FSSP) size distribution data. Part of this analysis has involved procedures to minimize the variations of the FSSP-derived aerosol backscatter. The first step was to recalibrate the FSSP size data, accounting for multivalued bins, and average these data to 100 s periods. Each of the resulting volume size distributions was then fitted by a single mode lognormal curve, which generally exhibits a pronounced peak in the size range 1-3 μm diameter. The calculated backscatter coefficients were then smoothed temporally using a four point running average to give 300 s averages. Refractive index data available at 0.53, 1.06 μm, 9.1 and 10.59 μm wavelengths were obtained from the University of Hawaii Laser Optical Particle Counter (LOPC) data. Comparisons were made with pulsed lidar aerosol backscatter coefficient measurements (0.53, 1.06 and 9.25 μm) 1 - 2 km above or below the DC-8 aircraft. The MSFC continuos wave doppler lidars (9.1 and 10.59 μm) operating at flight level, also provided data to validate the calculated aerosol backscatter coefficient.

For seven of the GLOBE II flights examined the computed aerosol backscatter coefficient most of the time, follows the main temporal trends exhibited in the measured aerosol backscatter near or at flight level for all five wavelengths studied. Known

inhomogeneities in the aerosol field account for some of the discrepancies when measured data at 1 - 2 km from the aircraft are compared. However, some large absolute backscatter fluctuations were observed at flight level for the derived backscatter coefficient data at infrared wavelengths. These can be traced mostly to poor count statistics in the FSSP bins larger than 0.8 μ m diameter. This underestimating of the backscatter does not affect the shorter wavelength aerosol backscatter.

A manuscript covering the above work is close to completion and will be submitted to the refereed journal, Atmospheric Environment, in Sept., 1994.

GLOBE Database Activities: Further work continued on reviewing GLOBE data quality for certain datasets in conjunction with the Principal Investigators (PI's) responsible for these data. Further beta copies of the data visualization/analysis program LINKWINDS (being developed by Jet Propulsion Laboratory (JPL)) were received during this period for evaluation. This program has been used as the main tool for examining and analyzing much of the data in the GLOBE database.

GLOBE Data Archival Software: Continued to monitor the work being done by Simpson Weather Associates (SWA) who are refining the code he wrote earlier to archive the GLOBE data in the Hierarchival Data Format (HDF). This software will provide a standardized means of reading the various datasets which GLOBE PI's provided using their own format. It will also allow a means of implementing a basic data security scheme to allow dataset integrity to be checked.

Dr. Ravikumar Raghavan, continues to work on the following activities:

Development, implementation and integration of radar software to create radar browse products at the Marshall DAAC: Algorithm design and implementation for processing the real-time U.S. National Composite Radar Data being received at the Marshall Space Flight Center Distributed Active Archive Center (DAAC) via satellite link. The WSI radar data is received via satellite every 5 and 15 minutes and is being stored in the Marshall DAAC. The U.S. National radar composite image is then converted to a U.S. National Precipitation (Rainfall) image. This image will be stored in the DAAC and will be made available as a browse product. The rainfall image will also be made available for distribution to the science community within MSFC on the LAN. Rigourous testing of the algorithm is being conducted in a modular mode and final implementation is being incorporated. The software was delivered June 22 1994. Upgrade to newer version will be subsequently accomplished.

Thunderstorm Electrification Studies: Ongoing analysis of multiparameter radar data from the CaPE field campaign to study the microphysical characteristics, kinematics and morphology of clouds as well as the various processes that lead to the electrification and the subsequent production of lightning.

Precipitation Intercomparison Project (PIP-2): Developing rainfall products from WSI radar data obtained during hurricane Andrew to serve as ground truth in satellite derived rainfall intercomparison studies.

A Radar, Electrical and Microphysical Study of Hector in McTEX: A multi-institutional proposal is being submitted to NSF which will increase research efforts under IGCRE. Proposal preparation was charged to the 'Bid and Proposal' account. The science plan involves using research and operational radars, aircraft, field mills and various other sensors for studying the microphysical and electrical characteristics of tropical convective thunderstorms (Hector) in the proximity of Melville/Bathurst islands near the Darwin coast in Australia. Dr. Ravikumar Raghavan will serve as the PI on the proposal being submitted on behalf of the Institute for Global Change Research and Education (IGCRE). Time spent preparing the proposal was charged to the 'Bid and Proposal' account.

Dr. Raghavan coordinated and directed research efforts and analyses of a UAH Ph.D. graduate student currently working with Dr. S. Goodman.

Dr. Dick McNider and Dr. J. Aaron Song, has derived an assimilation technique in which satellite observed surface skin temperature data are used in a model surface energy budget so that the predicted rate of surface temperature change in the model more closely agrees with the satellite observation. Both the visible and infrared GOES

satellite data are used in the assimilation. More detailed discussion on the assimilation technique is included in McNider et. al. (1993), while the related satellite insulation assimilation is included in McNider et. al. (1994). Preliminary model verifications of a selected case using the observation of Rabin et. al. (1990) shows that the technique appears to correctly adjust the model response to agree better with observation.

In the aforementioned model simulations incorporating the assimilation technique, only "clear sky" situations were chosen. When cumulus clouds pop out, even though there is negligible large scale disturbance, it would be much more difficult to perform the assimilation technique. An extended application of the aforementioned assimilation technique has lately been performed using the observation of COHMEX (Williams et. al.,1987), which will be discussed in more details in Song et. al.(1994) as well as in the next report.

References:

Williams S. F., H. M. Goodman, K. R. Knupp and J. E. Arnold, 1987: "Space/COHMEX Data Inventory Document", NASA Tech. Memo. 4006.

Rabin, R.M., S. Stadler, P.J. Wetzel, D.J. Stensurd, and M. Gregory, 1990: Observed effects of landscape variability on convective clouds. *Bull. Amer. Meteor. Soc.*, 71, 272-280.

Remote Sensing Technology and Geophysical Retrievals

Mr. Dennis Buechler, Senior Research Associate, UAH

Dr. Doug Mach, Research Scientist, UAH

Dr. Eugene W. McCaul, Associate Scientist, USRA

Dr. Michael Newchurch, UAH

Mr. Michael Stewart, Senior Research Engineer, UAH

These studies aim to determine the extent to which distributions of geophysical parameters and processes can be measured with current technology and observing systems, and to determine how proposed EOS sensors can improve current capabilities to observe these same processes on mesoscale to short climate time scales. Important emphases of remote sensing studies include:

- Application of Special Sensor Microwave/Imager (SSM/I) for mapping the seasonal and interannual variability of water vapor, and precipitation on a regional and global basis.
- Continued processing of Microwave Sounding Unit (MSU) channel 2 data for mapping the seasonal and inter-annual variability of temperature on a regional and global basis.
- Quantifying the magnitude of cloud-radiative forcing on the global energy budget, and its impact on the general circulation and global dynamics; use of multi-channel radiances to examine the vertical distribution of cloud forcing.
- Analysis and interpretation of Global Backscatter Experiment (GLOBE) aerosol data; and development of a global atmospheric aerosol backscatter model for establishing Laser Atmospheric Wind Sounder (LAWS) performance criteria for measuring global winds, cloud, planetary boundary layer height distribution; experimental and theoretical laser backscatter investigations leading to final configuration of the LAWS.
- Development of multispectral imaging and parameter retrieval techniques for atmospheric temperature and moisture, distributions of soil moisture, surface emissivity, vegetation stress, and other geophysical and biological parameters. Data used for these purposes over the next three years will include satellite observations from High-Resolution Infrared Sounder (HIRS), MSU, SSM/I, AVHRR, GOES, MAMS, and SPOT.
- Development of advanced system concepts including: electro-optical sensors for lightning detection, IR interferometry for temperature and moisture profiling, and use of microwave frequencies for sounding and precipitation monitoring all from geostationary orbit. Development of strategies for use of Molniya orbits.
- Continued development of WetNet analysis software and science support; and intercomparison of SSM/I algorithms for obtaining rain rate, precipitable water, cloud liquid water, oceanic wind speed, land classification, land surface temperature, snow-water equivalent and depth, soil moisture, and sea-ice concentration.
- Correlative studies between global/regional distributions of lightning and convective precipitation, leading to a space-based Lightning Imaging System (LIS) proposed for EOS Tropical Rainfall Measurement Mission (TRMM) and eventually for geostationary orbit. Research is needed to understand lightning production as a function of the internal dynamics of convective cells leading to charge separation. This analysis will involve synthesis of multiparameter Doppler radar, lightning strike, and aircraft microphysical measurements for individual cells and complexes of convective cells. Initial global lightning studies will involve processing back-inventories of DMSP/OLS imagery.

Mr. Dennis Buechler, continues to perform research in the following areas:

LIS Simulation Study: This study investigates the effect of satellite sampling error of monthly lightning estimates due to the intermittent nature of the satellite observations. Based on cloud-to-ground lightning data in vicinity of Huntsville. AL, this error will be on the order of 35-40%.

Lightning/Precipitation Study: The purpose of this task is to develop an algorithm whereby lightning flash observations can be used to estimate convective rainfall. A simple relationship was developed using data over Florida on 12-13 Aug 1991. The rainfall estimated from the lightning during the period closely matched the radar derived convective rainfall both in amounts, pattern, and spatial coverage.

Geolocate OTD Pixels: The Optical Transient Detector (OTD) is an instrument designed to detect optical pulses from lightning. This instrument was launched in June 1994. The location of the lightning pulses detected by OTD need to be determined with respect to the earth (i.e. latitude and longitude). Mr. Buechler began working with a system called SPICE (Spacecraft, Planet, Instrument, Camera, Events) which contains subroutines that can be used to geolocate pixels in the OTD array. He attended a meeting November 16, 1993; the 3rd NASA EOS (Earth Observing System)/Pathfinder Interuse workshop to meet with Bill Taber of JPL (Jet Propulsion Laboratory) who helped develop SPICE. He also spoke with Bill Taber at the Interuse Workshop.

Interuse Workshop: He attended an Interuse Workshop held in Boulder, CO on 6-7 July 1994, and made a presentation that described the types of data which (ground and space based lightning observations, rainfall from radar and microwave measurements) would be intercompared. Interuse would be useful in accomplishing this.

DAAC Lightning Product: He wrote an algorithm to produce daily and 15 minute lightning products for the Marshall DAAC (Data Archive and Acquisition Center). This algorithm reads in the ground based lightning data and counts the number of flashes in 8 km by 8 km bins over the United States.

Dr. Douglas M. Mach, developed the software for the Lightning Imaging Sensor (LIS) that will be launched on the Tropical Rainfall Measuring Mission (TRMM). The basic LIS instrument will also be launched on a quick-sat this fall. The 20,000 lines of code that he has written so far will ingest the raw data from the satellite and convert it into lightning pulse and background data along with satellite and instrument health data. The pulse and background data will then be processed into EVENT, GROUP, FLASH and AREA data as detailed in the Algorithm Theoretical Basis Document (ATBD) that he co-authored (attached). Once the LIS is launched, his software will do all of the processing of the LIS data.

He also have worked with NASA code M on shuttle lightning safety. We have completed the initial analysis of a field program has been completed in Florida where he measured the electrical properties of marginal clouds (non-lightning producing) to determine how to make both the launch and landing lightning avoidance rules safer while allowing the greatest access to launch and landing opportunities.

Dr. Eugene W. McCaul, continues to perform activities in two principal areas.

Develop a Gobal Water Budget Model: The water budget model which has been constructed in collaboration with Dr. F. R. Robertson, and is designed to facilitate diagnosis of the three-dimensional global-scale fields of water vapor, clouds and precipitation, fields which are not yet well-understood. Preliminary results appear encouraging, and work continues to refine and improve the model. Three conference publications have followed already from this work: two already presented (see publications list), and another anticipated.

Continue Analysis of Lidar and Meteorological Data From the Global Backscatter Experiment (GLOBE): GLOBE data analysis has been completed, and a journal manuscript is in the final stages of preparation for submission (see publications list). In addition, co-workers are preparing other manuscripts that will benefit from discussion of the meteorological

conditions encountered during GLOBE, and for which he will be listed as coauthor. These will be included in the publications list for the next fiscal year.

In the area of professional service, he served as a member of the Program Committee of the 17th Severe Storms Conference in St. Louis, and continues to serve on the AMS Severe Storms Committee. In November 1993, he participated in WLRH's "Tech Talk" forum on severe weather safety. He was invited as an informed private citizen, to submit an opinion on the adequacy of Doppler weather radar coverage in the Huntsville area under the National Weather Service's proposed switch to the WSR-88D network, which will require the termination of service from the locally operated Doppler WSR-74C. A letter is currently being prepared.

Work will continue on the development, testing and application of the water budget model, and on preparation of a conference manuscript describing the model and its results. It is likely that a formal journal manuscript and proposal to NASA will follow from this. Work will also continue on finalizing the GLOBE data analysis manuscript. This involves final figure preparation, internal review, and review by collaborators at other sites.

Some further involvement in the study of the Huntsville Doppler radar coverage seem probable. Membership on the AMS Severe Storms Committee continues, with additional committee work possible.

Dr. Michael Newchurch, has contributed Stratospheric chlorine partitioning using ATMOS measurements and the Cal Tech/JPL 1-D photochemical model in collaboration with Dr. Mark Allen/JPL and Dr. Bob Stachnik/JPL. The results were presented at AGU and at an ATMOS science team meeting.

NOx diurnal corrections for ATMOS retrievals: Accounting for the diurnal variation of NO and NO2 is essential to producing accurate profiles of these important stratospheric gases. Results of this work were presented at both ATMOS and SAGE II science team meetings.

ATLAS science directions: These planning meetings focused on outlining the important science issues for ATLAS-1, 2, and 3.

ATLAS-3 mission support: As an assistant mission scientist, he will participate in the ATLAS-3 mission scheduled for 10/94 launch. In addition, three of his coop students and one graduate student will participate as members of the ATMOS instrument team.

SAGE/Umkehr analysis: As a member of the SAGE II Science team, he is comparing SAGE and Umkehr ozone measurements and analyzing Umkehr aerosol effects. Results of this research have been published in JGR and presented at both the SAGE II science team meeting and DOE Atmospheric Chemistry Program meeting.

Dr. Newchurch has developed a strategy to assess diurnal ozone effects on ATLAS/MAS measurements, diurnal ClO effects on ATLAS/MAS measurements, and diurnal NO2 effects on POAM measurements and collaborated with MSFC scientists concerning ATMOS retrievals and data distribution.

He is directing three undergraduate co-op students and one graduate student in areas of ATLAS and SAGE science studies.

Mr. Michael Stewart, continues collaborating with Drs. Hugh Christian, Bill Koshak, and Jim Bergstrom in the development and performance of calibration methodologies and procedures for the Lightning Imaging Sensor (LIS) and the Optical Transient Detector (OTD). The latest procedures are specified in the OTD Calibration Facility Procedures Document, dated February 19, 1994.

He assisted the MSFC EB-Lab to improve the performance of the analog signal processing electronics in the OTD Real Time Event Processor while it was at the LIS/OTD calibration facility. The estimated optical lightning detection efficiency for this spacecraft instrument was improved from 20% to 70% as a result of this work.

For the actual TRMM/LIS instrument, he has redesigned the analog signal processing electronics to remove the false imaging artifacts that were present in the OTD version and improve the signal-to-noise performance by a factor of 2 to 4. The redesign includes a new printed circuit board layout using surface mount components on both sides of the board.

Preparations for the McTEX field research program in Australia have begun. Mr. Stewart's participation will include ground-based electric field measurements. Nine electric field mill instruments originally developed for the NASA/KSC Launch Pad Lightning Warning System will be modified to operate from solar power and use GPS receivers for time synchronization. The feasibility of adding the capability to detect and time-stamp electric field changes so that cloud charge centers and charge moments may be located by both amplitude and time-of-arrival information is being investigated.

An all-sky optical lightning detector to be used for ground truth measurements at NASA/KSC in support of satellite observations has been designed and tested. Final installation in a weatherproof housing has been delayed due to institutional problems.

Scientific Data Management and Visual Analysis

Dr. Sara Graves, Professor and Director of SISL, UAH

Dr. Thomas Hinke, Professor, UAH

Mr. Don Moss, Senior Research Associate, UAH

Ms. Helen Conover, Senior Research Associate, UAH

Ms. Marilyn H. Drewry, Senior Research Associate, UAH

Mr. Bruce Beaumont, Research Scientist, UAH

Ms. Susan T. McCoy, Research Associate, UAH

Mr. Evans A. Criswell, Research Associate, UAH

Ms. C. Vada LaFontaine, Research Associate, USRA

The success of earth science research programs requires the ability to efficiently manipulate large data sets. The studies at IGCRE are engaged in data management activities that aid scientists with their investigations. Activities include participation in field studies; processing, quality control, and archival of large data sets; and development of computer software and tools to visualize and synthesize data from multiple sources. These analysis tools support development, testing and validation of remote sensing algorithms with respect to data from past and future field programs such as Tropical Ocean-Global Atmosphere (TOGA) Coupled Ocean-Atmosphere Response Experiment (COARE), TRMM, the National Weather Research Program, GEWEX/GCIP, CaPE and ISLSCP/FIFE.

IGCRE scientists contribute to the research effort by managing compilation, archival, formatting, quality control and distribution of GLOBE, NESDIS (National Environmental Satellite, Data and Information Service) SSM/I and other data bases. This includes development of a Silicon Graphics-based "workbench", with a hierarchical data format that will allow data from different sensors to share common visualization and analysis programs. Supported analysis tools also include existing hardware/software systems such as McIDAS (Man-Computer Interactive Data Access System), the McIDAS-based WetNet system, and Geographic Information Systems, or other technologies as may be required by a particular scientific need.

Dr. Sara Graves, unfunded by the agreement, coordinated the activities of Scientific Information Systems Laboratory (SISL).

Overview of Scientific Information Systems Laboratory Activities

UAH's SISL joined the IGCRE contract on March 1, 1994, continue working with the MSFC EOSDIS Distributed Active Archive Center (DAAC). This lab's work has been central to development of the MSFC DAAC since 1991 under other contracts and grants. SISL is responsible for development of all information management software for the DAAC, including the MSFC DAAC Information Management System (IMS) Server, which is an integral part of the prototype EOSDIS Version 0 IMS. Other recent and ongoing SISL work for the MSFC DAAC includes an IMS Data Dictionary, a local user interface into the IMS database, a Data Order Tracking System (DOTS), a File Location Database for the mass storage system, a satellite orbit model display system and a Data Miner. In addition, SISL is responsible for sustaining engineering of the Interactive Data Integration and Management System (IDIMS), a UAH-developed information management tool used in ES41.

The EOSDIS Version 0 IMS is a distributed system providing catalog interoperability among the inventories of all EOSDIS DAACs. This federation of DAACs, led by the Earth Science Data and Information System (ESDIS) project at GSFC, has built the Version 0 IMS to allow the scientist to search the metadata at all eight centers from a common user interface. Because the DAACs are geographically dispersed, archive a wide variety of data, use several different of database management systems, and organize their metadata differently, presenting a common interface to the user is quite a challenge. This task, through much cooperative effort, was accomplished using a series of messages between the client user interface and the IMS database servers at the DAACs. The server at each DAAC is responsible for mapping a message from the client to an appropriate database transaction. SISL continues to play an important role in the cooperative design, development, and testing of this system, and of the MSFC DAAC IMS Server in particular.

A companion task to the development of the distributed IMS is the development and maintenance of a Data Dictionary at each DAAC. Version 0 links existing data centers, each with their own system of data description; the Data Dictionaries provide a standard reference model for describing the diverse holdings at the DAACs.

While the distributed IMS provides a common user interface for accessing data from all the DAACs, making it an excellent general search tool, a local IMS user interface for the MSFC DAAC can provide access to special data search or description features, unique to local data holdings. For example, particular attributes are cataloged for different datasets at MSFC, including a characterization of content for one dataset, or an indication of missing data for another. Also, MSFC DAAC science users have requested that the user interface provide a means for condensing lengthy search results listings, for easier perusal. SISL has designed these features into the MSFC DAAC inventory after consultation with science users. In order to provide effective user access to these unique inventory features, SISL is also designing and building a local IMS user interface for the DAAC.

Another analysis tool designed and built by SISL in response to DAAC user requests is a satellite orbit model display system. This tool uses the X-Windows system to display the locations of up to four earth science satellites at any given time. The tool can also be used as a satellite coincidence search engine, to determine where the paths of two satellites come within a user-specified distance of one another. This tool will be incorporated into the X-Windows version of the local IMS user interface.

To provide a richer set of content-based metadata, SISL is also developing a data miner. The data miner will permit DAAC personnel to extract information on the content of the various data holdings. The initial data mining capability provides an ability to identify where SSM/I Pathfinder data has holes in its data coverage.

In addition to providing user access tools for the DAAC, SISL is responsible for internal data management systems as well. The DAAC's Data Order Tracking System (DOTS), which interfaces with the IMS, stores contact information for all DAAC users, and tracks each data order from the time it comes into the DAAC until receipt of the data is confirmed by the user. SISL has provided two user interfaces for DOTS, one for User Services, and another for Order Production.

SISL software also provides information management for the DAAC's optical jukebox mass storage system. The jukebox driver software, which allows archivers to specify the optical platter on which each file is to be stored, also expects the user to specify the platter and offset when retrieving the file. SISL has developed jukebox read and write routines which interface with a file location database to track jukebox platter information for each archived file.

This is a general overview of SISL work performed for the MSFC DAAC under the IGCRE agreement. Specific activities of each member of the SISL team follow.

Dr. Thomas H. Hinke, began supporting this project on March 1, 1994, to continue leading the development of the Data Miner. The data miner is a general purpose data archive search engine that will be used to derive information on the contents of datasets held by the MSFC, EOSDIS Distributed Active Archive Center. This content-based information will be used to enhance the information that is used by the DAAC's Information Management System to assist scientists in identifying data relevant to their research.

During this period work was performed to extend the capability of the version 1 data miner, which was designed and implemented under Dr. Hinke's leadership. The version 1 miner identifies missing data within datasets, with an initial focus on the SSM/I Pathfinder data. During this period the version 1 miner was extended to produce mining results in the standard HDF data format. These HDF mining results can then be viewed using HDF visualization tools such as Collage.

The second major thrust of the research during this period was the design and initial implementation work of the version 2 data miner. The focus of this research is the development of a number of standard mining operators that can be applied to any dataset. To support these universal operators, the miner uses appropriate mapping functions to map the source data into a canonical gridded format. The version 2 miner will support value mining using a grid algebra that is analogous to relational algebra. The approach follows one of the useful features of the relational model used in database technology in which the result of most relational operators is another relation. In a similar way, the result of most grid operators is another grid, which can then be further operated on by another grid operator or compared with grids derived from other data products. In addition, the research during this period has also focused on the development of various data structures to efficiently support the mining effort, since for example, a single day of SSM/I data consists of approximately 90 megabytes of data.

Mr. Don Moss, continues to train DAAC operations personnel in level 1b data ingest and archival procedures. He wrote a technical document entitled, "MSFC DAAC 8mm Tape Instructions" for DAAC User Services group to be included in standard package shipped with orders on 8mm tapes. He also wrote technical document entitled, "NESDIS Level 1B SSM/I Tape Archival Procedure," a guide for DAAC operations personnel.

Precipitation Intercomparison Project 2 (PIP-2) input file production and utility software were completed. PIP-2 files were generated from Wentz and National Environmental Satellite Data and Information System (NESDIS) data and were sent to project coordinators at Florida State University for further processing. After retrieval from FSU, files were prepared and submitted for CD production. Ingest software was successfully tested on SGI Onyx system.

Software was developed for the following functions:

- Add batch mode option to daily backup program.
- Incorporate new method of background processing into full backup program.
- Find latest two-line orbital elements, reformat, add to McIDAS preprocessed one-line element file.
- Adapt orbital element conversion program to the DMSP-F8 satellite.
- Automatically rename Special Sensor Microwave/Imager (SSM/I) level 1b files transferred from Engineering and Analysis Data System (EADS).
- Display highest memory usage jobs in system.
- Improve SSM/I level 1b geographical filter program.
- Read SSM/I sensor count level 1b file, output antenna temperatures or brightness temperatures, satellite ID #, time, revolution #, latitudes, and longitudes.
- Adapt above program to increase precision.
- Read Fleet Numerical Oceanographic Center (FNOC) Temperature Data Record (TDR) files in Data Exchange Format (DEF) which have been reformatted for the Shared Processing Network (SPN).
- Analyze TDR files to determine and document data structures and detect and deal with anomalies.
- Add options to SSM/I level 1b merge program to restrict scans to specified scan numbers.
- Filter a character stream to allow text to be analyzed despite the presence of control characters.
- C subroutines to allow a WetNet FORTRAN program to read a TDR file and make McIDAS areas.
- Analyze TDR interscan time deviation.
- Improve level 1b scan summary by making output easier to read.
- Modify daily ingest, merge, and housekeeping programs to use new INGEST environment variable. This will make adapting to future operating system environment changes much

easier, quicker, and more reliable.

- Make it easier to input data to satellite polar crossing perdition program.
- Find, display, and remove files of a specified size.
- Filter log file to remove unwanted information.
- Automatically create new numbered versions of files being edited.
- Show all user processes.
- Allow WetNet program which makes global composite McIDAS SSM/I images to specify a control file name on the command line, enabling simultaneous multiple runs. Modify driver program accordingly. Also improve organization of driver program.

Ms. Helen Conover, began supporting this project on March 1, 1994, to continue work with the MSFC DAAC. Ms. Conover is the Information Management Systems lead for the DAAC, and coordinates all IMS activities in preparation for the beginning of EOSDIS Version 0 operations in July 1994. The highlight of her work in this area is the continued development of the MSFC IMS Server, part of a distributed client/server prototype system that will allow science users to access, browse, and order from the data inventories of any of the EOSDIS V0 Distributed Active Archive Centers (DAACs) through a single user interface. In this stage of development, the focus has been on testing and refining the software, and coordinating information on how data will be packaged for distribution to the users.

Ms. Conover also coordinates other software development activities, including porting the distributed IMS Client to MSFC, as well as development of a Data Order Tracking System, a specialized local IMS interface into the DAAC inventory, and a Satellite Orbit Model Display system. As the IMS lead, she consults with data producers, user services and archive personnel on the DAAC file naming conventions, and Global Change Master Directory entries for DAAC data. She has contributed to the MSFC DAAC 'Home Pages' on the Internet World Wide Web.
In addition, Ms. Conover is participating in review activities related to development of the EOSDIS Core System (ECS). During this reporting period, these activities have included consulting with ECS developers, making comments to ECS documents, attending telecons and local ECS seminars, and attending the ECS System Design Review and Data Organization and Access Focus Team meetings, June 27 - July 1.

Ms. Marilyn H. Drewry, began supporting ICGRE on March 1, 1994, to continue work in the following areas in support of the MSFC DAAC and EOSDIS V0 IMS development.

MSFC IMS Development and EOSDIS IMS support: Ms. Drewry actively participated in the testing of the EOSDIS V0 IMS clients and servers. Stress Tests-- tests using distributed, coordinated users with large queries were performed in addition to testing of local and distributed clients and servers. Ms. Drewry co-coordinated the EOSDIS IMS V0 TECHNICAL meeting held at Huntsville, March 1-3, 1994. She also participated in the MSFC DAAC Hydrologic Cycle Data Access and Archive Working Group (HDAAWG) meeting. Additional support is provided through participation in telecons for the IMS, Guide, test and CCB tasks. Ms. Drewry contributed to the design of the MSFC DAAC Home Page for user on the Internet World Wide Web (WWW).

IMS Dataset Valids Entry: Information such as source, sensor, parameter must be defined and entered into the database prior to entry into the EOSDIS system. Once defined locally, the information is coordinated with EOSDIS GSFC. Ms. Drewry has been instrumental in locally tracking and entering dataset information into the database and coordinating with GSFC for system valids update. Additionally, she designed, developed, and documented automated procedures to enter multiple datasets into the database.

IMS Guide: The IMS Guide, a function of the EOSDIS IMS V0 System, supplies additional information about the source, sensors, and datasets, to the user through the IMS interface using WWW. Ms. Drewry has installed the System EOSDIS V0 Guide software on the local host system and updated the Guide software as patches have been released. Ms. Drewry has assisted with the formatting of the documents to specified standards and has integrated new documents into the Guide subsystem.

IMS MSFC Data Dictionary Report: The IMS MSFC Data Dictionary Report defines the MSFC database schema describing the metadata kept on each dataset and defined valid values for each field. During the reporting period, Ms. Drewry revised and enhanced the existing Automated Data Dictionary (ADD) scripts, generated, and submitted MSFC Data Dictionary Reports to EOSDIS IMS.

Oracle Database Administration: The MSFC IMS system is built upon the ORACLE RDBMS. As Database Administrator, Ms. Drewry is responsible for maintenance of the ORACLE RDBMS. Memory usage was analyzed for both tables and users, and augmented as necessary. An ORACLE license upgrade for the number of users was completed. Ms. Drewry created UNIX/Database scripts that perform exports of the database files as an additional data backup method. Running of the scripts is an ongoing task; automation of this task is under development. Ms. Drewry initiated definition of an IMS/ORACLE schedule to obtain an overall view of the host systems. She also initiated the coordination with the System Management team, and co-designed a UNIX script reusing existing software that resulted in an automated daily backup of the ORACLE database.

Data Order Tracking System (DOTS) Automated IMS Product Request Entry: The Automated IMS Product Request Entry is the handshake between the IMS System and the Data Order Tracking System. During this time frame, Ms. Drewry retrieved from the database the data location field for visibility by the DOTS GUI. Ms. Drewry also enhanced the User product request letter with coordination from User Services. User Services order feedback was improved by the addition of pointers to differences in the Order's user address and the Database user's address. Code was developed that retained the order message in case of a system error for use with the Resubmit program by User Services. Resubmit was updated.

Processing History Database: Ms. Drewry collaborated with scientists determining information needed to perform reprocessing of a dataset product. The type of required information was analyzed, database design completed, and initial code implementation begun.

Mr. Bruce Beaumont, began work on the IGCRE contract on March 1, 1994, continuing his work on the EOSDIS V0 IMS for the MSFC DAAC. His accomplishments to date are as follows:

- An interactive graphical Orbit Plotting program has been developed which allows users to select up to four satellites, a time range, and a geographical area and then plot the orbits on a display device using any one of three map projections.

- The Coincidence Search Engine has been developed as a adjunct to the Orbit Plotter. It permits users to select up to four satellites, a time range, a geographical area, and an inter-satellite distance and then determine whenever any or all of the satellites satisfied the search criteria. This program is useful to scientists who wish to discover if multiple instruments observed a given event, or to find occasions when multiple satellites observed an area simultaneously.

- To support the previous software, a source for satellite element set (ephemeris) data was needed. Mr. Beaumont located an on-line source for these data and then developed an automated procedure that ingests, filters, and validates these data on a daily basis to provide the DAAC users with the most up-to-date data possible.

- A Browse Description X-Windows module has been developed for the EOSDIS IMS Client software. IMS Client users may use this module from a number of screens to view the description of the browse data.

- A Legend X-Windows module has been designed and implemented for the EOSDIS IMS Client software. IMS Client users may use this module to display an interpretation of the color set used in a browse image. Ancillary software has been developed to view and insert legend data in browse data files.

- A Software Modification Request application has been developed to simplify and standardize problem reporting for the IMS Client.

In addition, Mr. Beaumont has been given the ongoing tasks of porting the IMS Client software from Goddard Space Flight Center (GSFC) and the IMS Access Script software from Langley Research Center (LaRC).

Current projects include the design and development of enhanced local versions the IMS Client and Access Scripts, including the encapsulation of the LaRC Timeline X-Windows interface. Mr. Beaumont is also a member of the Browse Working Group, which is tasked with the design of browse data for the next version of the IMS Client software.

Ms. Susan T. McCoy, began supporting this project March 1, 1994, to continue working with the MSFC DAAC IMS development team. During this reporting period, Ms. McCoy has been working on the following tasks:

Data Order Tracking System (DOTS): Ms. McCoy completed the design and development of a graphical user interface for both the User Services and Production Offices of the DAAC. The current user interfaces are part of the Data Order Tracking System and are linked to the Order Tracking database. She has worked closely with both offices through the requirements definition, design review, and testing phases.

IMS Local Character User Interface (CHUI): The design and development of the Logon and User Profile screens for the IMS Local CHUI were completed by Ms. McCoy. These screens have been integrated with the series of Search and Results screens developed by Evans Criswell. In the next month, she plans on completing development and integration of the Order screen where a data order is placed. The order is then entered into the Order Tracking database and tracked with DOTS.

IMS Database Inventory: Ms. McCoy was responsible for populating the IMS inventory tables. She has talked with scientists to gather dataset and granule information and written scripts to insert this information into the database.

Pathfinder HDF Routines: The Pathfinder project has requested several variations of two C routines written by Ms. McCoy. The routines read daily Pathfinder files which contain a set of HDF objects. The first routine extracts an object and creates a new HDF of the same type. This routine is also used as the basis for interfacing the Data Miner withthe Pathfinder files. The other routine extracts an orbit from any one of the objects and creates a new HDF object of the same type. Since March, variations of the original routines have been written for Atmospheric Moisture, Land Products, and Marine Wind Speed Product Pathfinder files.

ES41 Division Interactive Data Integration and Management System (IDIMS): Ms. McCoy was also responsible for continued sustaining engineering on IDIMS, which is a complex menu-driven system developed on the EADS 3090. She has spent a considerable amount of time debugging problems which have occurred because of various system upgrades. IDIMS is now working properly.

Mr. Evans A. Criswell, began working on this project March 1, 1994, continuing his work with the MSFC DAAC.

File Location Database for the Optical Disc Jukebox Mass-Storage System: Mr. Criswell is the primary responsible person for the software which reads and writes files to the optical disc jukebox platters, updating the file location database as new files are written. This database provides the directory information for the jukebox, since the jukebox platters are not self-directing (platter name, start block and file size are required to read a file). Files are organized by dataset and this level of organization is implemented in the database and in Mr. Criswell's jukebox read and write routines. This added organization allows one platter to contain several datasets, and allows one dataset to span several platters, in a manner which is transparent to the user of the read routine.

During the reporting period, Mr. Criswell made the following improvements to the jukebox access programs and file location database:

- The speed and efficiency of the jukebox read and write routines were improved by modifying them to read or write all the necessary files to or from a particular jukebox platter before dequeuing it, instead of issuing separate "self-contained" calls for each file which queue a platter, read or write one file, and dequeue the platter. The main reason for the change was to prevent read or write requests from interrupting read or write requests that are already in progress.

- Signal handlers were added to the routines to clean up in case a read or write is abnormally terminated, such as by being killed, control-c, disk full, or other common problems. The platter in use is unmounted to release the drive it was using, preventing the user from having to manually unmount the platter before issuing another request.

- A column was added to the jukebox database to indicate whether a particular copy of a file within its dataset is the most recent copy. Since filenames can be reused (allowing new, improved versions of files to be archived), this flag was necessary so that jukebox statistics could be gathered for the most recent files, ignoring older copies, in a reasonable amount of time. The flag allowed considerable simplification of the read routine, which reads the most recent copy of each requested file. The flag is maintained by the write routine, but a script was written to reset the flag appropriately for all files in the database in case the database ever needs to be rebuilt or other errors are found.

It should also be noted that the jukebox access software is used by the Data Miner to retrieve files from archival storage.

Marshall DAAC Local IMS Character-based User Interface: Mr. Criswell is the primary developer of the character-based user interface for the Marshall DAAC Local IMS. The interface allows the user to enter search parameters for querying the database to determine what datasets and files are available at the Marshall DAAC.

During the reporting period, the following parts of the user interface were developed:

- The search screen allows the user to enter the parameters for his database query. The valid values for the parameter, source, sensor, project, and dataset name fields are retrieved from the database so they can change automatically as the database changes without modifying the interface itself. For each of the valid values, there is a brief description which can be displayed by hitting a key. The ability to save and load queries from files was added.

- The code which actually executes the database query was cleaned up considerably and was modified to read the query produced by the search screen, execute it, and write the results to a directory which is read by the result screen. This code is a totally separate module, but it seemlessly links the search and result screens when a query is executed.

- The result screen displays the query results, grouped by dataset, and allows the user to select files from each dataset for order. Details about each dataset are shown (one dataset per page). The files for each dataset and some details for each are shown in scrollinglists, from which selections can be made for ordering. A subscreen was added to show the detailed information about a file that will not fit in the 47-character column on the result screen. The option of viewing the query results by supergranule is available. This feature is especially useful when dealing with datasets having one file per day. The files for each month are grouped into one supergranule, allowing one month worth of files to be selected by choosing the supergranule. The ability to email the results to the user is also available.

- A package screen showing the pre-packaged data available has also been included. It shows the packages on a per-dataset basis in the same format as the query result screen.

- A dataset information screen, developed previously, which provides descriptions of each dataset, was linked into the interface.

System Administration for the Scientific Information Systems Lab: Mr. Criswell was responsible for system administration on the two Silicon Graphics UNIX workstations currently located in the UAH Computer Science Building. Mr. Criswell configured and managed the system hardware and software. Software, such as Gnu C 2.5.8, Gnu Make, Gnu Emacs, HDF (Hierarchical Data Format) Utilities, Collage, Xv, and X Mosaic were installed, which were needed for the development of Dr. Thomas Hinke's Data Mining project.

Ms. C. Vada LaFontaine, continued participation in WetNet and MSFC DAAC activities at MSFC and has provided network.

During the year the MSFC DAAC activity increased dramatically. Ms. LaFontaine was involved with providing input to the development of the Information Management System (IMS) and the MSFC DAAC Data Order and Tracking System (DOTS). Much of her input was based on experience with the WetNet project. She was able to provide specific examples to back up her suggestions. She has also taken over work on data set information files that are used by the IMS and the Master Directory. She continued involvement with the User Services Working Group (USWG). This group has become highly visible during the year and is often called upon to represent the scientist's point of view during system development. The group also supports splinter work groups. She became involved with the two groups, one that is working to revise order and user statistics and another that is working with the IMS development team.

Ms. LaFontaine has become much more familiar with using the resources on the internet and using the UNIX operating system this year. Both of these skills help her to work with scientists to assist them in finding sources of information and new ways to communicate. She has been involved in the design and implementation of the MSFC DAAC and WetNet WWW home pages. These pages will be widely used in the coming year and will be highly visible to the science community and to the public.

Although the data center was not operational we began to process requests for data in order to refine order filling procedures. She has also added new data sets and documentation to the DAAC holdings. She has become more familiar with the DAAC data.

Ms. LaFontaine's activities with the WetNet project has decreased. Most of the questions from scientists now involve data access and use rather than computer hardware configuration. She continues to produce a WetNet newsletter. The newsletter has been distributed to the WetNet scientists, but now will be distributed to EOSDIS managers at NASA HQ and GSFC. She has also assisted in the design and installation of a local area network at the USRA office. This involved upgrading and replacing PCs, installing network cards and installing TCP/IP software.

Computer Documentation:

Moss, D., 1994: MSFC DAAC 8mm Tape Instructions.

Moss, D., 1994: NESDIS Level 1B SSM/I Tape Archival Procedure.

Distributed Active Archive Center (DAAC) Operations Plan, Baseline, June 1994. Ms. Helen Conover contributed chapters on IMS Operations and Software Maintenance.

Drewry, M.H., 1994: ADValE: An automated database valids entry. Procedural information on entry on Dataset Valid Information into the MSFC EOSDIS V0 database.

Drewry, M. H., 1994: EOSDIS MSFC IMS V0 Demonstration Instructions. Guidelines and keypoint for Demos of the IMS V0 System.

University and Industry Collaborations

Universities Space Research Association SUB94-072 (UAH)

Dr. Charles Laymon	1/1/94-4/30/94	"Ground Truth Studies Earthbases"

Nichols Research Center (UAH)

Ms. Anita Hall	3/1/94-9/30/94	To perform the following tasks: Information Systems Research and Implementation; IGCRE Facilities Startup; Ozone/Temperature Correlation Analsys.

Drexel University 3400-01 & 3400-03 (USRA)

Dr. Donald J. Perkey	1/1/94-6/31/94 3/31/94	"Direct Global Change Research Related to the Earth's Energy and Hydrologic Cycle."

University of Bristol 3400-02 & 3400-05 (USRA)

Dr. Eric C. Barrett	9/1/93-1/31/94	"The WETNET Project: Rainfall Algorithm Intercomparison and Development, Stage V Part Two."
	2/1/94-8/31/94	Phase VI (continuation of work)

Drexel University (UAH)

Mr. Scott Dembek	10/1/93 - 8/31/94	To develop, maintain, and test the evolving code for the Limited Area Mesoscale Prediction System (LAMPS); test codes to diagnose atmospheric moisture and energy budgets as applied to LAMPS and other model simulations.included working with (a) Donald Perkey, and NASA scientist Dr. Franklin Robertson to develop and test cloud radiation diagnostics; Charles Cohen to test new cloud and ice parameterization in the LAMPS model, (b) NASA scientists Dr. Franklin Robertson and Mr. Kevin Doty to modify the LAMPS code to run across the equator and the international dateline.

University of Manchester (USRA)

Dr. John Latham	1/31/93 - 8/31/94	Work with Dr. Hugh Christian on research directed toward assessing the value of the lightning mapper sensor; To develop energy budget/prediction algorithms to correlate cloud dynamics and precipitation with lightning and electric field measurements; Analyze radar, aircraft-based cloud microphysical and electric field data from the

CaPE and TOGA-COARE experiments. Compare and correlate analyses with predictions of the formation of precipitation and the generation/distribution of electric fields in clouds from current understanding and the results of explicit cloud physics models; Interpret LIS observations and analyses in terms of accepted cloud microphysical and electrification theories; Based on the interpretation of the existing LIS database, to develop as feasible specific concepts with regard to the categorization of the electrical properties of tropical clouds on the basis of cloud type and stage of cloud development.

Projects, Conferences, and Workshops

Topic	Dates	Location	Sponsor
1st Earth Science Division Stategic Planning Meeting	11/3/93	UAH	UAH
Planning for the LAWS Science Team Meeting	12/14-15/93	UAH	UAH
The LAWS Science Team Meeting	2/1-3/4	Clearwater, FL	UAH

Meeting Attendees:

Name	Affiliation	Name	Affiliation
John Petheram	Martin Marietta	Gary Spiers	UAH
Jeff Sroga	Martin Marietta	Michael J. Kavaya	MSFC/EB54
Richard Beranek	MSFC/FA63	Pierre H. Flamant	CNRS/LMD
Steve Donley	Hughes Aircraft	Richard Heinrichs	MIT
Jeff Rothermel	MSFC/ES43	Paul Schwarzenberger	GEL
James Arnold	MSFC/ES41	T.N. Krishnamurti	Florida State Univ.
G.David Emmitt	Simpson Weather Assoc.	Jan Paegle	Univ. of Utah
William L. Grantham	NASA/LARC	Gregg Rohacy	Florida State Univ.
Scott Manlief	TRW	David Bowdle	UAH
Mel Ferebee	NASA/LARC	Vernon Keller	MSFC/PS02
Wayman Baker	NOAA/NMC		
Jim Yoe	NOAA/NESDIS/ORA		
Ra Brown	Univ. of Washington		

EOSDIS V0 IMS Development Team Meeting	3/1-3/94	MSFC	UAH

Coordinated by Helen Conover, Marilyn Drewry, and Susan McCoy.

Mission to Planet Earth	4/26/94	UAH	UAH

Dr. Kennel, Associate Director

Hydrologic cycle Data Access and Archive Working Group	4/28-29/94	MSFC	UAH/USRA

The distributed IMS, the MSFC local IMS character-based user interface, the Data Order Tracking System, and the Satellite Orbit Model Display software were demonstrated by SISL members. July 18, 1994. MSFC DAAC Operational Readiness Review. Ms. Helen Conover reported the status of IMS, DOTS, and other DAAC information management software.

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Bill Boeck	Niagara University	Dave Randal	Colorado State University
G. David Emmitt	Simpson Weather Assoc.	Eric Smith	Florida State University
Tom Gardner	Penn. State University	Jim Smith	Princeton University
Frank Wentz	Remote Sensing Systems		

GLOBE SWG Meeting 5/1-3/94 Williamsburg, VA UAH

Meeting Attendees:

Name	Affiliation	Name	Affiliation
John Theon	NASA Headquarters	Dave Emmitt	SWA
Dave Tratt	JPL	Rudolf Pueschel	NASA/AMES
Jeffrey Rothermel	MSFC/ES43	Geoff Kent	Science & Tech. Corp.
Ramesh Kakar	NASA Headquarters	Sury Chudaman	MSFC/SSAI
David Bowdle	UAH	Mike Hardesty	NOAA/ETL
Bob Menzies	JPL	James Spinhirne	GSFC

Research and Technology Operating Plan (RTOP) 6/28-29/94 MSFC USRA

The activities under the Physical Climate and Atmospheric Dynamics Research tasks, a subset of the Mission to Planet Earth Program, were reviewed. The review was attended by Drs. John Theon and Ramesh Kakar of Code YSC at NASA Headquarters. Scientists and engineers in ES and EB labs here at Marshall and from the external University community made presentations on their progress and future plans. The information presented at the review provided Marshall and NASA Headquarters program managers and technical monitors an opportunity to better understand the research that is ongoing in their discipline areas and will be used as input into FY95 funding decisions. The review was quite successful and should provide adequate justification to maintain a strong funding level for Marshall RTOP programs in FY95. Dr. Gary Jedlov - Coordinator.

Working Group on Space-Based Lidar Winds 7/12-14/94 MSFC UAH

Meeting Attendees:

Name	Affiliation	Name	Affiliation
Jeffrey Sroga	Martin Marietta Astro Space	Bill Jones	Lockheed
John Shultz	Los Alamos National Labs	William W. Vaughn	UAH/Atmos. Sci. Program
Richard Beranek	NASA/MSFC	Jim Yoe	NOAA/NESDIS
Rod Frehlick	University of Colorado	Peirre H. Flamant	CNRS, Ecole Polytechnique
Wayman Baker	NOAA/NMC	Farzin Amzajerdian	UAH
Dr. Al Preyss	Martin Marietta	Mike Hardesty	NOAA/WPL
Jan Paegle	University of Utah	David Bowdle	UAH
Vernon Keller	NASA/MSFC	John Fikes	MSFC/PD12
Michael J. Karaya	NASA/MSFC	R. A. Brown	Jim McMillian
John Anderson	Univ. of Wisconsin - Madison		MSFC/PA01
Scott Manlief	TRW	Greg Wilson	MSFC/ES01
Jeff Rothermel	MSFCES43	Ramarao Inguva	Univ. of Wyoming
G.D. Emmitt	SWA	Ed Pruett	Martin Marietta - Coherent
Rao Dugimetla	Oregon Grad. Institute Summer Fac.		Technologies, Inc.
Gary Spiers	UAH CAO		

MSFC DAAC Operational Readiness Review 7/18/94 MSFC UAH

Ms. Helen Conover reported the status of IMS, DOTS, and other DAAC information management software.

Staff Travel Activities

Name	Dates	Location	Reason
Dennis Buechler	12/6-10/93	San Francisco, CA	American Geophysical Union Fall Meeting
	12/9/93		Committee on Atmospheric and Space Electricity (CASE) meeting
	7/ 6-7/94	Boulder, CO	Interuse Workshop
David Bowdle	11/6-9/93	Washington D.C.	NASA's Third Two Micron Solid-State Laser Technology Review
	11/17-18/93	Ann Arbor, MI	Visit SWA & Univ. of Michigan
	1/31-2/3/94	Clearwater, FL	NASA's Laser Atmospheric Wind Sounder (LAWS) Science Team
	4/30 - 5/4/94	Williamsburg & Charlottesville, VA	11th GLOBE SWG Meeting
John Christy	1/24-28/94	Nashville, TN	Annual AMS
Charles Cohen	10/4-8/93	St. Louis, MO	17th Conference on Severe Local Storms
Laurie Collins	1/31/94-2/3/94	Clearwater, FL	LAWS Science Team Meeting,
	5/1-3/94	Williamsburg, VA	GLOBE SWG Meeting,
Helen Conover	6/27-29/94	GSFC	EOSDIS Core System (ECS) System Design Review (SDR)
	6/30-7/1/94	Greenbelt, MD	ECS Data Organization and Access Focus
Gregory Cox	11/7-9/93	Washington, DC	LANDSAT Education Workshop
	1/18-20/94 & 2/3-4/94	Washington, DC	Meet with NASA Education Division Representatives about LANDSAT Edu. Prgm.
William Crosson	4/5/94	Washington, DC	Discuss present and future research efforts
Dean Cutten	10/10-16/93	Chicago, IL	American Association for Aerosol Research
	12/7-8/93	Los Angeles, CA	Link Winds Software Development Team
C. Vada LaFontaine	4/17-24/94	Baltimore, MD	American Geophysical Union Conference
		Madison, WI	McIDAS User's Group Meeting,
	5/2-6/94	Washington, DC	EOS User Services Working Group Meeting

Charles Laymon	4/5/94 5/24-27/94	Washington, DC Baltimore, MD	Present a seminar to NASA Headquarters 1994 AGU MeetingSalt Lake City, Utah
Huei-Iin Lu	12/6-9/93 1/25/94	Tainan, Taiwan Nashville, TN	1st Pacific Int'l Conference on Aerospace Science and Technology 6th Conference on Climate Variations
Doug Mach	2/14/94 4/5-8/94	Kennedy Space Center Univ. of Maryland	ABFM Meeting DPFT Meeting
Bill McCaul	10/4-8/93	St. Louis, MO	17th Severe Storms Conference
Melanie McCook	9/26-30/93	Wallops Island, VA	To collect data and information
Don Moss	9/20-22/93	Logan, UT	WetNet Users' Conference
Mike Newchurch	12/ 5-11/93	San Francisco, CA	AGU Fall Mmeeting
Donald Perkey	1/27/94	Nashville, TN	6th Conference on Climate Variations
Timothy Rushing	11/16-19/93 3/23-24/94	Kennedy Spc. Flt. Ctr. Melbourne, FL	To install the Wind Profiler system To retrieve the Wind Profiler
Shouping Wang	1/26-27/94	Nashville, TN	8th Conference on Atmospheric Climate Variations organized by the AMS

Visitors

Name	Dates	Affiliation	Reason
Pui King Chan	12/12-17/93	Penn. State Univ.	Seminar Presentation: "The Cloud Radiative Consistency Method and its Application to the Monsoon Region"
Kevin Driscoll	11/15/93 - 1/31/94	Auburn Univ.	To collaborate with Dr. Hugh Christian and Dr. Rich Blakeslee, NASA scientists, in the Earth Observing Branch/Earth Science and Applications Division.
	1/31/94 - 2/1-28/94		To investigate and give an analysis of electric field measurements obtained over active thunderstorms
Jan Paegle	6/13-6/30/94	University of Utah	To refine investigative approach for AMIP-related research on boundary layer moisture transport, its role in warm season hydrology over the continental U.S. and the interfacing of regional models with AMIP GCM integrations as a research tool, and assist in the development of a more refined statement on the science requirements for a space-based wind sounder PE in particular.
Takmeng Wong	12/11-13/93	Colorado State Univ.	Seminar Presentation: "On the Radiative Processes Associated with the Tropical Mesoscale Convective Systems"
Byung-Ju Sohn	12/26/93 - 3/1/94	Seoul Nat'l Univ.	To perform studies of the use of numerical models and space based data leading to better understanding and prediction of the behavior of the earth atmosphere system; Conduct diagnostic and numerical studies of cloud radiative effects on atmospheric energetics, ISCCP cloud data, ERB TOA fluxes, ECMWF analyses and MSU and SSM/I temperature and moisture data used to diagnose vertical profiles of radiative heating.

Affiliated Students

Name	Affiliation	Facility Advisor	IGCRE or NASA Advisor	Research
Kevin Doty	Drexel University	Carl W. Kreitzberg	F.R. Robertson (NASA)	Hydrological cycle of the Mississippi River Basin
Brad Vinz	Univ. Alabama in Hsv.	Thomas Hinke	None	Data miner data archive engine search
Jeff Lerner	Univ. Alabama in Hsv.	Stan Kidder	G. Jedlovec (NASA)	Remote sensing of water vapor
John Brewer	Univ. Alabama in Hsv.	John Christy	None	Long-term trends in temperature
R. Ramakandran	Univ. Alabama in Hsv.	Stan Kidder	S. Goodman (NASA) & R. Raghavan (USRA)	Radar, electrical and microphysical studies

Special Projects

PROGRAM - University-Based Cooperative Program in Earth Systems Science Education (ESSE) - The University-based Cooperative Program in Earth System Science Education supports development of undergraduate curricula emphasizing a multidisciplinary approach to the study of the planet Earth as a unified physical system. Nationwide, twenty-two universities take part in the program. Each university offers an introductory survey course, together with a senior course. IGCRE performs the local coordination of these activities by helping to identify universities and their associated scientists for participation in this program. We also encourage and support participation of qualified IGCRE scientists in this program where appropriate

ELIGIBLE PARTICIPANTS - The program is targeted for universities throughout the United States with a commitment to developing an interdisciplinary Earth science program at their institution. The audience served by the project is undergraduate students. Since this program has proven to be successful, it has been expanded to include other universities and graduate-level students, as well as arrangements for postdoctoral research opportunities at NASA and universities.

PROGRAM DESCRIPTION - Under this pilot program, selected universities are participating cooperatively with other universities and NASA in two inter-related activities--curriculum development and scientific exchange. Each university is required to develop and offer an introductory survey course in Earth systems science and senior-level, interdisciplinary course. The introductory course presents an overview of Earth systems science to a broad segment of the student body, including both science and non-science majors. The purpose of the senior level course is to attract those undergraduate science majors with solid foundations in relevant sciences to future studies and work in Earth systems science. The senior level course is taught jointly by faculty members from at least two academic departments with supplemental lectures from other in-house faculty, advanced graduate students, postdoctoral students, as well as visiting faculty and researchers from other universities or NASA laboratories. In addition, to the curriculum development portion of the program, each university participates in an effort involving short-term visiting scientists from other participating universities and NASA Field Centers. These visitors provide additional technical insight and foster interdisciplinary education and research through their special expertise from a NASA Center who serves as a sponsor for their academic program. The NASA-sponsoring scientist may join in the identification and formulation of course work and relevant projects, facilitate access to NASA data, technical material, and other resources, and locate other NASA-based scientists to serve in a resource lecture pool from which universities may draw visiting lecturers.

Each participating university and the principal investigator are required to report on courses taught during the year and provide travel records for the visiting faculty.

ESSE Program Overview: 1993-94 Academic Year: A total of twenty five universities participated in the Earth System Science Education (ESSE) program in the 1993-94 academic year. Significant progress continues to be made in teaching both survey and senior level courses. The accomplishments of the ESSE faculty are being documented in annual progress reports which are compiled at this time. This data is being compiled into a 1993-94 academic year status report that will quantify accomplishments in terms of courses taught, enrollments, student characteristics, departments involved in team teaching etc.

Although the format varies from university to university, typically, the survey courses are being taught by one faculty member and the senior courses are being taught by faculty teams. The faculty teams usually include faculty from various departments (often including social science and economics) within the university and the occasional use of a guest lecturer. In most cases the principal investigator serves as the coordinator of the teaching team. Generally, two or more departments are represented on the faculty team. The departments and academic programs involved in teaching these courses include:

Agricultural and Irrigation Engineering
Atmospheric and Oceanic Sciences
Biology
Chemical and Biochemical Engineering

Civil and Environmental Engineering
Economics
Earth and Space Sciences
Earth and Planetary Sciences
Ecology and Evolutionary Biology
Forest Resources
Geography
Geology
Geosciences
Marine Science
Meteorology
Physiology and Biophysics
Physics
Plant, Soils, and Biometeorology
Soil and Water Sciences
Tree-Ring Laboratory

The development and teaching of these courses has been enhanced by faculty exchange activities and special workshops funded by this program. Travel funds to support the faculty exchange and attendance at special workshops were made available to all 25 universities. During the past year, ESSE faculty participated in workshops regarding the use of Geoscope in the classroom. Geoscope is an interactive database of earth science related text and images stored on CD-Rom. The previous year a special workshop on the use of Stella software as a modeling tool were conducted for the ESSE faculty. Workshops such as these are making significant contributions to the development of the survey and senior earth system science courses.

In May 1994 a special ESSE session was conducted as part of the Spring Meeting of the American Geophysical Union (AGU). The session included presentations from participating faculty, guest lecturers with creative teaching ideas and techniques, teaching assistants developing courses in ESSE, and others interested in earth system science curricula. This well attended session produced some interesting and potentially productive discussions on the development of earth system science curricula. A key issue that was raised again in discussion is how the ESSE materials developed in this program will be packaged and shared with the broader university community.

Finally, in June 1994 the ESSE program participants and management met to discuss the progress in the program and to plan for future activities. Most of the original 25 schools have received their full allotment of funding for curriculum development ($25,000 over two years). Funds for faculty exchange, workshops, and program meetings are expected to be available for the next year or two. In order to build on the program's success, it is important to establish and implement a plan for continuation in the near future.

SPECIAL WORKSHOPS/MEETINGS

The following consultants were retained to attend the American Geophysical Union's session on Global Change Education in Baltimore, Maryland, May 22-28, 1994:

Dr. Robert Bereman from North Carolina State University
Mr. Maury Estes
Dr. Arthur Few from Rice University
Dr. George W. Fisher from Johns Hopkins University
Dr. Catherine H. Gautier from the University of California, San Diego
Mr. Paul J. Kinder from Byrd Polar Research Center
Ms. Lisa Leffler from Northwestern University
Dr. James Miller from Cook College, Rutgers University
Dr. Michael Rampino from New York University

Dr. Rejean Simard from the Canadian Space Agency
Dr. John Snow from Purdue University

The consultants listed below were retained to travel to College Park, MD, to participate in the Earth System Science Education Meeting at the University of Maryland, June 16-18, 1994.

Dr. John Binder from Utah State University
Dr. Robert Ford from Utah State University
Dr. Donald Jensen from Utah State University
Dr. Abraham Lerman from Northwestern University
Dr. Ellen-Mosley-Thompson from Ohio State University
Mr. Ray Thomas from the University of Florida

ESSE TRAVEL (listed in alphabetical order)

Faculty Exchange Travel:

Dr. Michael Arthur from Pennsylvania State University traveled to the University of Florida, February 9-12, 1994, to participate in the travel-exchange of faculty between the participating schools to become a resource for the development of interdisciplinary earth science courses.

Dr. Roger Bales from the University of Arizona traveled to Utah State University, February 7-8, 1994, to provide special expertise and perspectives to benefit their curriculum development.

Dr. Gary Ernst from Stanford University traveled to the University of Minnesota, November 10-12, 1993, to discuss the development of Earth System Science courses and other ESSE related issues at Minnesota with Dr. Kerry Kelts. Dr. Ernst gave two presentations, one entitled, "Petrotectonic Evolution of Klamath Arc," and one entitled, "Earth Systems Science Curricula: How We Did It at Stanford."

Dr. Arthur Few from Rice University attended the Earth System Science Education Meeting June 17-18, 1994, at the University of Maryland.

Dr. Catherine H. Gautier from the University of California, San Diego, traveled to London, Ontario, Canada, to attend the NATO Advanced Research Workshop on training Global Change scientists, June 5-8, 1994.

Dr. Harshvardhan from Purdue University traveled to Stanford, CA, and NASA/Ames Research Center, to discuss and collaborate with Dr. Gary Ernest and Dr. Susan Alexander at Stanford University concerning development of undergraduate Earth System Science courses and ideas on classroom presentations of remote sensing, June 12-14, 1994.

Dr. Fred Mackenzie from the University of Hawaii traveled to Northwestern University to visit with Dr. Abraham Lerman, February 18-24, 1994. He gave a lecture to the ESS undergraduate classes and presented a seminar.

Dr. Richard Minnich from the University of California in Riverside, CA, traveled to Utah State University to meet and hold discussions with Dr. Robert Ford, February 21-24, 1994.

Dr. Donald Perkey traveled to Purdue University, April 4-5, 1994, to discuss global change science with Dr. James Ogg and other Purdue scientists, to present a lecture relevant to atmospheric numerical modeling to Dr. James Ogg's upper division global change class and present a departmental seminar entitled, "Heat Moisture and Radiation Diagnostics of Convectively Active Storms Over the GCIP Area."

Dr. Martin Ruzek from Milwaukee, WI, Philadelphia, PA, to attend a CAUSE/CNI Conference, June 2-3, 1994.

Mr. Arthuro Sanchez from the University of New Hampshire traveled to Greenbelt, MD, to participate in the USRA/NASA Goddard Lecture Series, "Observing, Modeling and Prediction of the Earth System and Global Change," June 13-17, 1994.

Dr. Jerald L. Schnoor from the University of Iowa traveled to Ohio State University to interact with Dr. Ellen Mosely-Thompson under the ESSE program, May 10-12, 1994.

Other Travel/Visits (listed in alphabetical order)

Dr. Donald R. Johnson was invited to Purdue University to present Earth System Science Seminar and discuss ESSE program with faculty, November 11-12, 1993. He also traveled to San Francisco, CA, to present a paper on NASA/USRA Earth System Science Education at the American Geophysical Union Meeting, Fall meeting held December 2-13, 1993. A preprint of his paper presented is attached as Appendix 11. He also traveled to Salt Lake City, Utah, to give a presentation on the ESSE Program, April 7-8, 1994. During May 1, 1994, through June 19, 1994, he provided management, coordination, and direction of NASA/USRL Cooperative University Program in Earth System Science Education including correspondence and discussion with participants.

Publications and Presentations

Bowdle, D.A., **D.R. Cutten**, V. Srivastava, **E.W. McCaul**, J. Rothermel, and M. Jarzembski, 1993: Estimating aerosol backscatter coefficients at 2 microns using GLOBE measurement and modeling results. Presented at the *NASA 3rd Two Micron Solid-State Laser Technology Review*, 8-9 Nov., Washington D.C.,

Bowdle, D.A., **D.R. Cutten**, V. Srivastava, and **E.W. McCaul, Jr.**, 1994: The Global backscatter experiment (GLOBE): status, results, and plans. Presented at the *LAWS Science Team Meeting*, 1-3 Feb., Clearwater, FL.

Buechler, D.E., 1993: Preliminary investigation of using lightning data as an indicator of convective precipitation. *American Geophysical Union, Fall Meeting.* **153**, 6-12 Dec. San Francisco, CA.

Buechler, D.E., H.J. Christian, and S.J. Goodman, 1994: Rainfall estimation using satellite data. *7th Conference on Satellite Meteorology and Oceanography*, 171-174, 6-10 Jun., Monterey, CA.

Bowdle, D. A., **D. R. Cutten**, **E. W. McCaul, Jr.**, and V. Srivastava, 1993: The GLObal Backscatter Experiment (GLOBE): Database, analysis and applications. *Proc. 7th Conference Coherent Laser Radar Appl. and Technol.*, C.N.E.S., C.N.R.S., E.S.A., and *Opt. Soc. Amer.*, 131B-131D. 4 Oct., Paris.

Christy, J.R. and C.-S. Yoon, 1993: Forecasting lower-tropospheric temperatures with 11-15 day lead time. *18th Climate Diagnostics Workshop*, 1-5 Nov., Boulder, CO.

Christy, J.R., and **R.T. McNider**, 1993: Detecting global warming using a precise but short (15-years) satellite data set. *18th Climate Diagnostics Workshop*, 1-5 Nov., Boulder, CO.

Karl, T.R., R.W. Knight, and **Christy, J.R.**, 1994: Global and hemispheric temperature trends: Uncertainties related to inadequate spatial sampling. *J. Climate* (in press).

Christy, J.R., and S.J. Drouilhet, 1994: Variability in daily, zonal mean lower-stratospheric temperatures. *J. Climate*, 7, 106-120.

Christy, J.R., and **R.T. McNider**, 1994: Satellite greenhouse signal. *Nature*, 367, 325.

Christy, J.R., and J.J. Hnilo, 1994: Comparison of GCM and MSU temperatures for the AMIP experiment (1979-1988). *Proc. 6th Conference on Climate Variations*, 189-192. 24-28 Jan., Nashville, TN.

Christy, J.R., and **R.T. McNider**, 1994: Detecting global warming using a precise but short (15-years) satellite data set. *Proc. 5th Symposium on Global Change*, 166-171, 24-28 Jan., Nashville, TN.

Christy, J.R., and J.D. Goodridge, 1994: Precision global temperatures from satellites. *Atmos. Env.* (in press).

Cohen, C., 1993: A comparison of two cumulus parameterizations in mesoscale numerical simulations of moving cloud lines. *Proc. 17th Conference on Severe Local Storms.* 520-523. 4-8 Oct., St. Louis, MO.

Duchon, C. E., T. M. Renkevens and **W. L. Crosson**, 1994: Relationships among areal averages, spatial sampling error and measurement errors: Application to daily area-average rainfall during CaPE. Submitted to *J. Appl. Meteor.*

Cox, G.N., 1993: Ground Truth Studies; A new curriculum for global change education. Presented at the *Black Sea Coast Environmental Conference*, 4 Sept. Novorosisk, Russia.

Cox, G.N., 1993: Ground Truth Studies; A new curriculum for global change education. Presented at the *American Institute for Aeronautics and Astronautics (AIAA) Technical Conference*, 23 Sept., Huntsville, AL.

Cox, G.N., 1993: Ground Truth Studies Program; A curriculum for global change. Presented at the *Annual MeetingNational Technical Students Association*, 24-25 Sept., Nashville, TN.

Cox, G.N., 1993: Use of global change data with the Ground Truth Studies curriculu. Presented at the *SUPERCOMPUTING '93*, High School Computer Science Teacher Workshop, 14-15 Nov., Portland, OR.

Cox, G.N., 1994: Ground Truth Studies; A new curriculum for global change education. Presented at the Secondary School Teachers from the Rostov region. 10 Mar., Rostov-on-Don, Russia.

Cox, G.N., 1994: How electronic networking can facilitate the Ground Truth Studies Program throughout the region. Presented at the *Tennessee Valley Environmental Education Center Director's Meeting*, 22 Mar., Dalohnega, GA.

Cox, G.N., 1994: Ground Truth Studies Program; A curriculum for global change. Presented at the *Southeast Regional Center - NIGEC Conference on Global Change*, 28-30 Mar., Oak Ridge, TN.

Cox, G.N., 1994: Ground Truth Studies Program; A curriculum for global change. Presented at the *Southeastern Space Grant Consortium.* 6 May, Huntsville, AL.

Cox, G.N., 1994: How electronic networking using Ground Truth Studies can facilitate global change education throughout the world. Presented at the *Global Network for Environmental Education (GNEEC)* (Electronic communications working group). New York University, 8 Jun., New York, NY.

Cox, G.N., 1994: Ground Truth Studies Program; A curriculum for global change. Presented at the *ESEA Federal Programs Summer Conference,* Alabama Department of Education, 15-17 Jun., Mobile, AL.

Cox, G.N., 1994: A Mission to Planet Earth Workshop. Presented at the *Summer Earth Science Teacher Workshop,* Alabama Department of Education, 12-15 Jul., Huntsville and DeSoto State Park, AL.

Cox, G.N., 1994: Use of remote sensing to understand global change. Presented at the *Summer Explorations in Science and Math Education (SESAME)*, 24 Jul., Huntsville, AL.

Cox, G.N., 1994: Ground Truth Studies; Earthbase demonstration and related GTS activities. Presented at *Camp Botanica,* Huntsville Botanical Gardens, 28 Jul., Huntsville, AL.

Cox, G.N., 1994: Ground Truth Studies; A new curriculum for global change education. Presented at the *American Institute for Aeronautics and Astronautics (AIAA),* Technical Conference Invited Paper, 23 Sept., Huntsville, AL.

Cutten D.R., R. Pueschel, J. Rothermel, A.D. Clarke, and D.A. Bowdle, 1993: Comparison of measured and modeled scattering parameters for tropospheric aerosols. Presented at the *12th Annual Meeting American Association for Aerosol Research*, 12-13 Oct., Oak Brook, IL.

Srivastava V., A.D. Clarke, D.R. Cutten, D.A. Bowdle, and M.A. Jarzembski, 1993: Wavelength dependent aerosol backscatter calculations from modeled and measured microphysics compared with direct lidar measurements. Presented at the *12th Annual Meeting Amer. Assoc. for Aerosol Research*, 11-15 Oct., Oak Brook, IL.

Srivastava V., A.D. Clarke, M.A. Jarzembski, D.R. Cutten, and D.A. Bowdle, 1994: Effect of microphysics on aerosol backscatter: Comparison of modeling and measurements obtained during NASA's GLOBE mission. Presented at the *4th Intl. Aerosol Conf.*, 28 Aug.-2 Sept., Los Angeles, CA.

Graves, S.J., 1994: Responding to exponentially increasing demand: Modernizing NOAA's data and information system. Final report issued to the U.S. Congress, Mar., Boulder, CO.

Cutten D.R., R.F. Pueschel, A.D. Clarke, V. Srivastava and **D.A. Bowdle**, 1994: Remote tropospheric aerosol backscatter comparisons at 1.06 μm and 9.25 μm wavelengths. Presented at the *4th Intl. Aerosol Conf.*, 28 Aug-2 Sept., Los Angeles, CA.

Graves, S.J., 1994: Responding to exponentially increasing demand: Modernizing NOAA's data and information system. Final report issued to the U.S. Congress, Mar., Boulder, CO.

Delugach, H.S. and **T.H. Hinke**, 1994: Constrained lines of identity: An approach to conditional joins, *Proc. ICCS* '94, *2nd Intl. Conf. on Conceptual Structures*, University of Maryland, 16-20 Aug, College Park, MD.

Hinke, T.H. and H.S. Delugach, and A. Chandrasekhar, 1994: Layered knowledge chunks for database inference. Database Security, VII: Status and Prospects, T.F. Keefe and C.E. Landwehr (eds.), North-Holland.

Hinke, T.H. and H.S. Delugach, and A. Chandrasekhar, 1993: Layered knowledge chunks for database inference. *Proc. 7th Annual Working Conference on Database Security*, 12-15 Sept., Huntsville, Alabama.

Hinke, T.H., 1993: Multilevel secure database management prototypes in information security: An integrated collection of essays, M. Abrams, S. Jajodia, H. Podell (eds). To be published by the *IEEE Computer Society*.

Delugach, H.S. and **T.H Hinke**, and A. Chandrasekhar, 1993: Applying conceptual graphs for inference detection using decond path analysis. *Proc. 1st Intl. Conf. on Conceptual Structures*, Laval University, 4-7 Aug., Quebec City, Canada,

Laymon, C.A., **W.L. Crosson**, and S.J. Goodman, 1994: Simulator for hydrology and energy exchange at the land surface and its development through the CaPE hydrometeorology project. *EOS*, 75, 173.

Rickmann, D., K. Butler, and **C.A. Laymon**, 1993: Survey of geographic information systems applications for the Earth Science and Applications Division. NASA Technical Memorandum.

Laymon, C.A., 1993: Rainfall-runoff relationship of the CaPE experimental area and other issues of the surface hydrology. Presented at the *CaPE Workshop* at NCAR, 25-26 Oct., Boulder, CO.

Laymon, C.A., **W.L. Crosson**, S.J. Goodman, 1994: Simulator for hydrology and energy exchange at the land surface and its development through the CaPE Hydrometeorology Project. Abstr., *Eos*, Transactions of the American Geophysical Union, Vol. 75, p. 173.

Lu, Huei-Iin, T.L. Miller, and F. Leslie, 1993: Numerical simulations for geophysical fluid flow experiments. *Proc. 1st Pacific International Conference on Aerospace Science and Technology (PICAST)*. 6-9 Dec., Tainan, Taiwan (in press).

Lu, Huei-Iin, and T.L. Miller, 1994: Intransitivities in numerical climate prediction. *Proc. of the 6th Conf. on Climate Variations*, 6-19, 23-28 Jan., Nashville, TN.

Lu, Huei-Iin, and T.L. Miller, 1994: Characteristics of annulus baroclinic wave structure during amplitude vacillation. *Proc. of Int. Symposium on the Life Cycles of Extratropical Cyclones*, Jun.-Jul., Bergen, Normay.

Lu, Huei-Iin, T.L. Miller, and K.A. Butler, 1994: A Numerical study of wavenumber selection in the baroclinic annulus flow system. *Geophysical and Astrophysical Fluid Dynamics* (in press).

Stalker, J.R., **K.R. Knupp**, and **E.W. McCaul, Jr.**, 1993: A numerical and observational study of an atypical "Miniature" supercell storm. *Proc. 17th Conference on Severe Local Storms*. 191-195, 4 Oct., St. Louis, MO.

McCaul, E.W. Jr., and F.R. Robertson, 1994: Large scale structure of water vapor and condensate over the TOGA-COARE Region. *Proc. 6th Conference on Climate Variations.* J44-J45, 23-28 Jan., Nashville, TN.

Robertson, F. R., and E. W. McCaul, Jr., 1994: Diagnostics of macroscale cloud systems and their relationships to kinematic and thermodynamic forcing. Presented at the *European Conf. on The Global Energy and Water Cycle.* Jul., paper 1.20., London.

Newchurch, M.J., M. Allen, and R. Stachnik, 1993: Stratospheric chlorine partitioning modeling with SL-3 ATMOS and Balloon Microwave Limb Sounding measurements. *AGU Fall Meeting,* San Francisco, CA.

Newchurch, M.J., 1994: Report to DOE Atmospheric Chemistry Program, Jan., Nashville, TN.

Newchurch, M.J., 1994: Cly partitioning modeling of SL-3 ATMOS measurements, ATMOS Science Team meeting, Feb., CPI, VA.

Newchurch, M.J., 1994: NOx diurnal variation modeling, ATMOS Science Team meeting, Mar., SJI, CA.

Newchurch, M.J., 1994: Report to the SAGE II Science Team, Jun., Hampton, VA.

Perkey, D.J., S.R. Dembek, F.R. Robertson and B.-J. Sohn, 1994: Comparison of radiation calculations using diagnosed versus prognosed cloud and rain water amounts. *6th Conf. on Climate Variations.* 23-28 Jan., 318-322. Nashville, TN.

Perkey, D.J., 1994: Modeling and Interuse. Presented at the *4th EOS Interuse Workshop,* 6-7 Jul., Boulder, CO.

Perkey, D.J., S.R. Dembek, F.R. Robertson and K.G. Doty, 1994: Heat, moisture and radiation diagnostics of convectively-active storms over the GCIP area. Presented at the *European Conf. on The Global Energy and Water Cycle.* 18-22 Jul., London.

Raghavan, R. and J. Vivekanandan, 1993: Retrieval of storm microphysics using Ka band radar observations. *The IEEE International Geoscience and Remote Sensing Symposium (IGARSS '93),* 91-93. Tokyo, Japan.

Raghavan, R., J. Turk, and J. Vivekanandan, 1994: Investigations of the vertical profiles of linear depolarization ratio and reflectivity at S, X and K band wavelengths. Submitted to *1994 International Geoscience and Remote Sensing Symposium* (IGARSS '94). 8-12 Aug., Pasadena, CA.

Zrnic, D.S., R. Raghavan, and V. Chandrasekar, 1994: Observations of co-polar correlation coefficient through a bright band at vertical incidence. *J. Appl. Meteor.*, **33**, 45-52.

Raghavan, R., and V. Chandrasekar, 1994: Self consistent assessment of the area time integral (ATI) technique for rainfall estimates using multiparameter radar. Revised manuscript submitted based on recommendation by reviewers, Special Issue-*J. Appl. Meteor.*

Raghavan, R., and V. Chandrasekar, 1994: Multiparameter radar study of rainfall: Potential application to area time integral studies. Accepted by *J. Appl. Meteor.*

Zrnic, D.S., R. Raghavan, and V. Chandrasekar, 1994: Observations of co-polar correlation coefficient through a bright band at vertical incidence. *J. Appl. Meteor.* **33**, 45-52.

Wilfong, T., L. Barnum, M. Stewart, G.E. Taylor, and P. Mulligan, 1993: The New Kennedy Space Center launch pad lightning warning system. *Proc. 17th Conference on Severe Local Storms and Conference on Atmospheric Electricity.* St. Louis, MO. J52-J56.

Stewart, M.F. and L.R. Barnum, 1993: Maintenance manual for the advanced ground-based field mill instrument. Vol. **1 & 2**. Marshall Space Flight Center.

Vinz, L.B. and S.J. Graves, 1994: An interpolated counterpropagation approach for determining target spacecraft attitude. Presented at the *INNS World Congress on Neutral Networks*, 6-10 June, San Diego, CA.

Vinz, L.B. and S.J. Graves, 1994: A counterpropagation neural network for determining target spacecraft orientation. Presented at the *IEE World Congress on Computational Intelligence/IEEE Conference on Neural Networks*, 26 Jun.-2 Jul., Orlando, FL.

Wang, S., and Q. Wang, 1994: Roles of drizzle in a one-dimensional third-order turbulence closure model of the nocturnal stratus-topped marine boundary layer. *J. Atmos. Sci.*, **51**, 1559-1576.

Wang, S., 1994: Seasonal simulations of marine stratocumulus clouds with GENESIS climate model: A comparison with observations. *American Geophysical Union 1994 Spring Meeting*, May, Baltimore, MD.

Wang, S., and P. Minnis, 1994: Application of Tiedtke's prognostic cloud scheme in a simple boundary-layer model: A comparison with satellite data Presented at the *2nd International Conference on Air-Sea Interaction and On Meteorology and Oceanography of Coast Zone*. 22-27 Sept., Lisbon, Portugal.

Wang, S., 1994: A mass flux parameterization of stratocumulus-topped boundary layers. Presented at the *Workshop on Modeling Boundary-Layer Clouds*. 23-27 Aug., Boulder, CO.