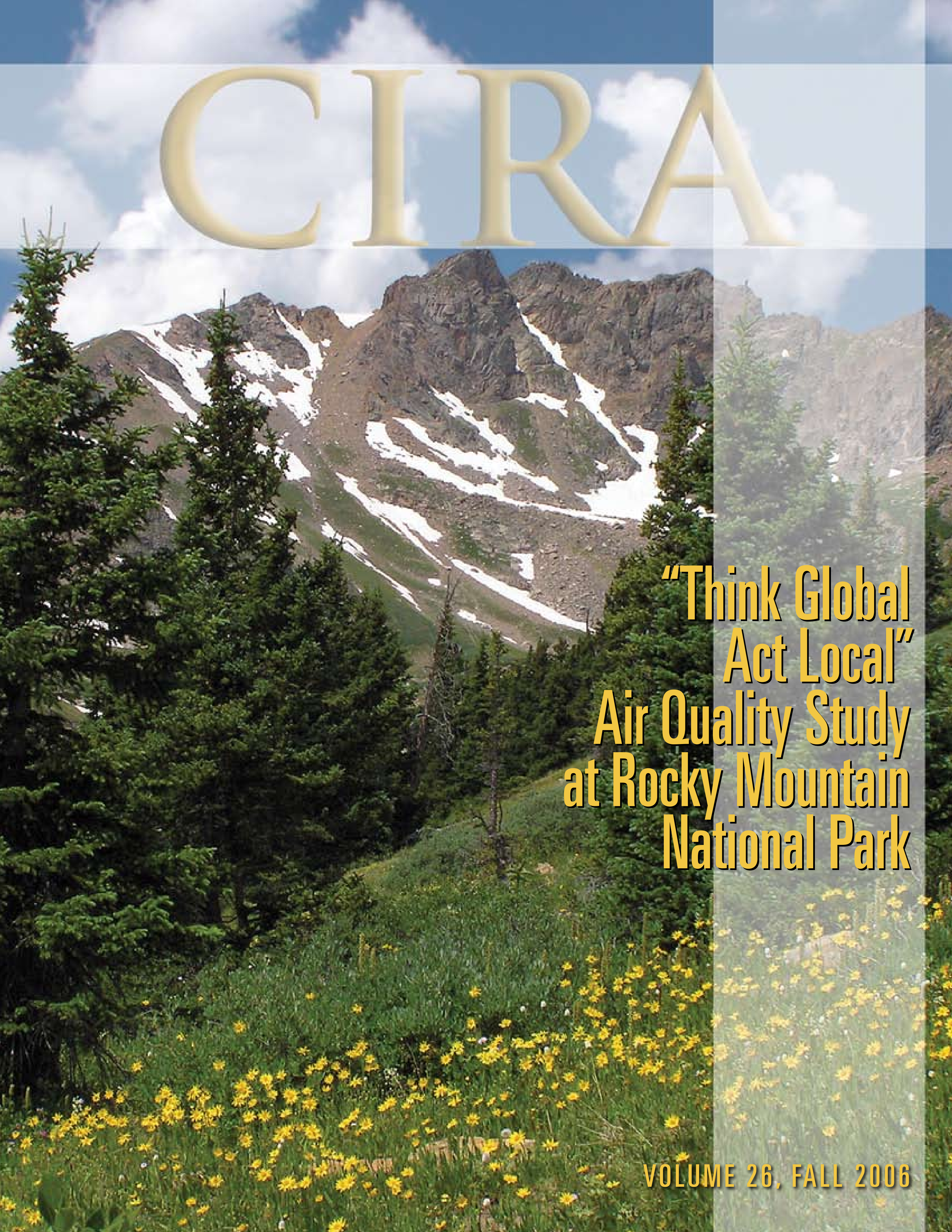
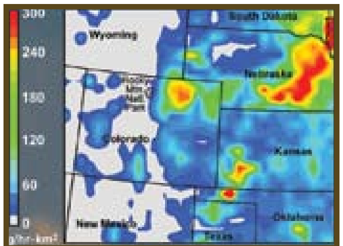

CIRA
"Think Global
Act Local"
Air Quality Study
at Rocky Mountain
National Park
VOLUME 26, FALL 2006

CONTENTS



Photos at left, from top: Regional ammonia emissions from livestock and agricultural sources; DVD Robotic System; Community Collaborative Rain, Hail and Snow Network (CoCoRaHS); The NOAAPort Antenna is CIRA's most recent satellite dish.

About the cover: Photo courtesy of NPS. Understanding the pollutant sources that are contributing to excessive nitrogen deposition in fragile alpine ecosystems is the goal of the Rocky Mountain Atmospheric Nitrogen and Sulfur Study (ROMANS).

CIRA

Cooperative Institute for Research in the Atmosphere

www.cira.colostate.edu

ROMANS

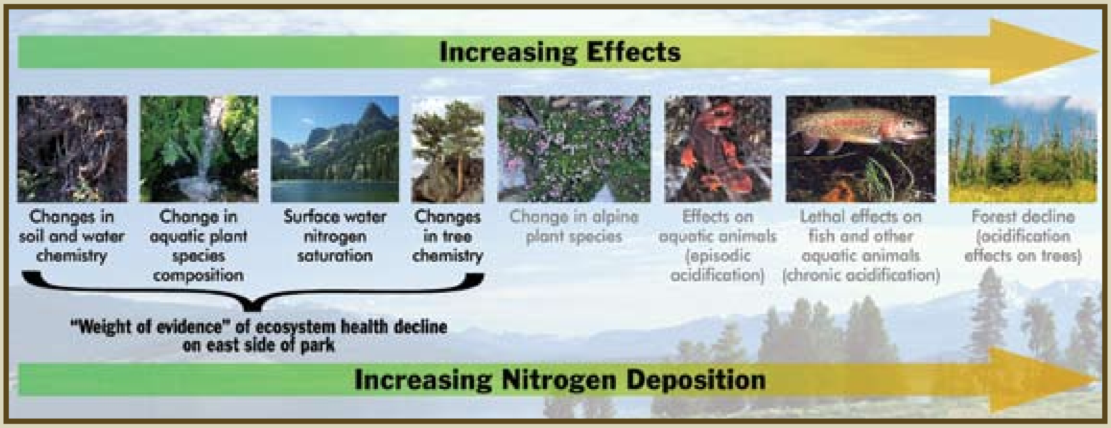


Figure 1. Harmful effects of increased nitrogen deposition to fragile alpine ecosystems.

ROMANS: The Rocky Mountain Atmospheric Nitrogen and Sulfur Study

Bill Malm, Bret Schichtel, Mike Barna and Kristi Gebhart (National Park Service)

Jenny Hand, Derek Day and Marco Rodriguez (CIRA)

DEPOSITION AND VISIBILITY AT RMNP

Rocky Mountain National Park (RMNP) is downwind of many man-made sources of air pollution. While the park's air is relatively clean compared to other national parks near large cities, pollutants from sources along Colorado's Front Range, as well as from other areas in the U.S. and abroad, affect the park. These pollutants are either deposited in rain or snow ('wet deposition'), or as dry particles and gases ('dry deposition'). Researchers from the National Park Service and the U.S. Geological Survey have been working for over 20 years to determine whether the amounts of air pollution found in RMNP are sufficient to affect park ecosystems.

Adequate data now exist to show that soils, waters, and plants are beginning to show evidence of changes from nitrogen deposition. The accumulation of nitrogen compounds in RMNP has crossed a crucial threshold called the "critical load," indicating that changes are occurring to park ecosystems and may soon reach a point where they are difficult or impossible to reverse. The high elevation ecosystems at RMNP are vulnerable to atmospheric nitrogen deposition due to the granitic bedrock and shallow soils found in the park, which provide little chemical buffering. Nitrogen acts as a fertilizer, as well as an acidifying agent in water and soil, leaving these resources vulnerable to acidification effects on fish and forests in the future (Figure 1). These same pollutants also contribute to regional haze, diminishing the many vistas within the park (Figure 2).

The park has set a resource management goal for a critical load of 1.5 kg/ha/yr of wet nitrogen deposition as a level that would be protective of park ecosystems. This is approximately a 50% reduction in wet deposition from current five-year averages of 3.1 kg/ha/yr of wet nitrogen deposition.

THE ROMANS STUDY

While the effects of nitrogen and sulfur compounds on visibility and the park ecosystem have been documented, less is known about the origin of precursor sulfur and nitrogen species. The Rocky Mountain Atmospheric Nitrogen and Sulfur Study (ROMANS) is underway to further our understanding of the emissions currently affecting ecosystems and visibility in the Rocky Mountain region of Colorado and to explore how emission controls or reduction strategies can help mitigate pollution effects. In particular, the goals of ROMANS are:

Nitrogen Loading in Rocky Mountain National Park

National Park ecosystems are managed to be as natural or unimpaired as possible. Man-made air pollutants may cause unnatural ecosystem changes that can be described as exceeding a critical load. Ecosystems in Rocky Mountain National Park are beginning to reflect changes caused by nitrogen deposition. Effects to ecosystem structure (species composition) and function (soil and water and tree chemistry) have been documented in some areas of the Park, and this indicates that nitrogen deposition is above critical loads for sensitive Park ecosystems.

ROMANS

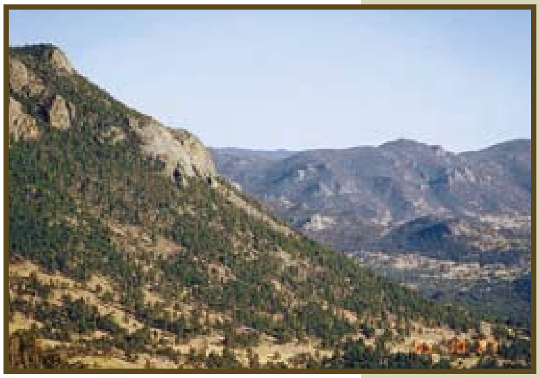


Figure 2. The same pollutants responsible for sulfur and nitrogen deposition also impair visibility, as shown in these photos from the IMPROVE network. In Rocky Mountain National Park, visibility is impaired to some degree 90% of the time. Viewing distance in the summer months averages 83 miles but can drop to 30 miles on high pollution days.

- Identify the overall mix of sulfur and nitrogen in the air and precipitation on both the eastern and western sides of the Continental Divide.
- Identify the relative contribution to atmospheric sulfur and nitrogen at RMNP from emissions originating within the state of Colorado vs. outside the state.
- Identify the relative contribution to atmospheric sulfur and nitrogen at RMNP from emissions originating along the Front Range vs. other regions within the state.
- Identify the relative contribution of various source types within the state of Colorado to nitrogen and sulfur species, including mobile, agricultural, other area sources, and large and small point sources.
- Map spatial and temporal variability of atmospheric deposition within the park and relate observed patterns to likely source types and locations.
- Characterize the meteorological conditions that lead to high pollution events in the park.

SPRING AND SUMMER FIELD CAMPAIGNS

Two one-month intensive sampling periods were conducted during 2006. To capture the effects of “cloud processing” – the rapid chemical conversion of sulfur and nitrogen compounds that occurs within clouds – the measurements coincided with periods that typically are associated with precipitation events. The first field campaign took place in the spring (late March through April) when synoptically-driven upslope flow events were likely to occur, resulting in snow and/or rain in the Rocky Mountains with contributions of pollutants likely from the Front Range and beyond. The second field campaign occurred during the summer (July and August) to capture convective storm systems resulting in precipitation in the Rocky Mountains and Front Range. These spring and summer time periods are also associated with the highest nitrogen deposition rates in RMNP.

An extensive observational network was deployed during the ROMANS field study (Figure 3). A full suite of chemical measurements were collected at the core sampling site at RMNP, including 1) ambient gas concentrations of sulfur dioxide, nitrogen oxides, ammonia, carbon monoxide and ozone, 2) wet deposition chemistry, 3) cloud water composition, 4) fine and coarse particulate matter composition, 5) ion size distributions, 6) particle light scattering, and 7) meteorology. Measurements at the two secondary sites focused primarily on concentrations of key particle and gas species and on wet deposition chemistry. Observations collected at the 20 satellite sites consisted of key fine particle and gas concentrations and on wet deposition chemistry in an effort to determine concentrations of nitrogen and sulfur species in regions upwind of the park under different meteorological scenarios.

Initial results from the spring ROMANS field campaign show several episodes of elevated concentrations of nitrate, sulfate and ammonium during the study period (Figure 4). The relative magnitude of the individual events indicate that different source regions are impacting the park at different times. For example, elevated concentrations of sulfate might indicate the impact of a coal-fired powerplant, while elevated ammonium concentrations might implicate agricultural sources.

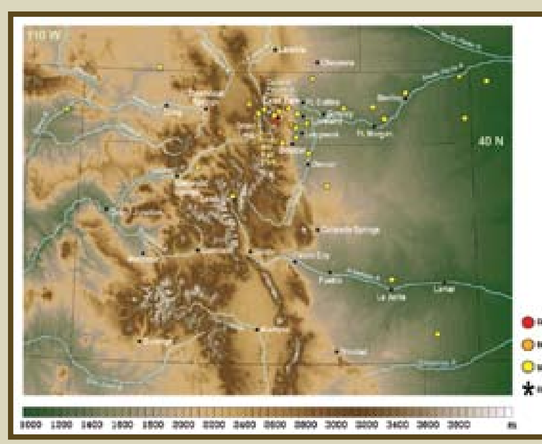


Figure 3. Measurements were made at a core site within RMNP, at two secondary sites (one located on Gore Pass in the Gore Range, west of RMNP, and one on the Front Range), and at an array of 27 satellite sites across eastern Colorado and the western slope.

EMISSION SOURCES THAT AFFECT THE PARK

Nitrogen and sulfur compounds are emitted into the atmosphere from a variety of air pollution sources, including automobiles, power plants, industry, agriculture, and fires (Figures 5 and 6). Colorado's Front Range is an area of rapid population growth, escalating urbanization, oil and gas development, and agricultural production. Increases in these activities result in corresponding increases in nitrogen deposition in mountain ecosystems. Air quality in the park is particularly affected when winds blow from the northeast, east, and southeast.

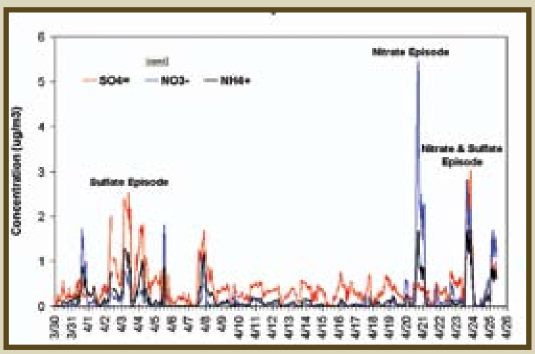


Figure 4. Measured sulfate (SO4), nitrate (NO3) and ammonium (NH4) concentrations at the core sampling site at RMNP during the spring field campaign. Understanding which emission sources contribute to these pollutant concentrations will be the primary goal of ROMANS.

USING MODELS AND MEASUREMENTS TO DEVELOP A SOURCE APPORTIONMENT

Due to the complexities of the physicochemical processes and the meteorological patterns that govern the fate of sulfur and nitrogen species, the contribution of a source or source region to ambient concentrations and wet and dry deposition cannot be directly measured. Instead, the combination of 1) air quality models capable of simulating the atmospheric physicochemical processes, and 2) statistical inference techniques based on physical principles, will be used to develop a source apportionment.

CAMx (Comprehensive Air Quality Model with Extensions) is a regional-scale, Eulerian-grid chemical transport model that predicts the emissions, transport, dispersion, chemical conversion and deposition of pollutants and their precursors, and will be used to estimate which source regions and source types are impacting the park. MM5 (Mesoscale Model version 5) will simulate the meteorological fields required by CAMx. Colorado's temperatures, wind patterns, and storm tracks are heavily influenced by the state's complex topography, and reproducing this reality in a model will require fine-scale simulations that employ data assimilation of available observations.

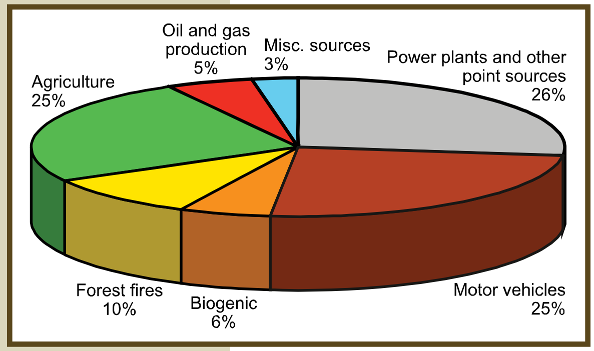


Figure 5. Nitrogen emissions from sources within Colorado, consisting primarily of contributions from power plants and other point sources (26%), agriculture (25%) and motor vehicles (25%).

All models have a number of simplifying assumptions and parameterizations of the relevant atmospheric processes and are often dependent on incomplete and uncertain input information. Therefore, the results are subject to errors and biases. To overcome these uncertainties, multiple source apportionment techniques will be applied and reconciled. The reconciliation process will include a hybrid source apportionment model which merges the CAMx apportionment estimates and measurements into a statistical model to minimize biases between modeled results and observations, thereby improving the attribution and deposition estimates. These reconciliation models require sets of measurements that are both temporally and spatially dense.

BEYOND ROMANS

ROMANS represents a new effort for understanding which pollution sources are impacting the fragile ecosystems of our national parks. Although the focus of this study is RMNP, the analytical techniques developed for ROMANS can be applied to parks throughout the country.

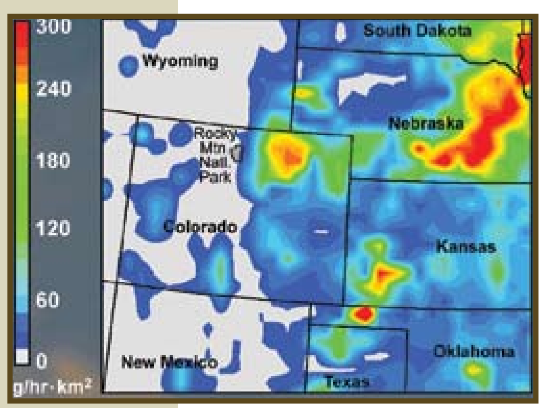
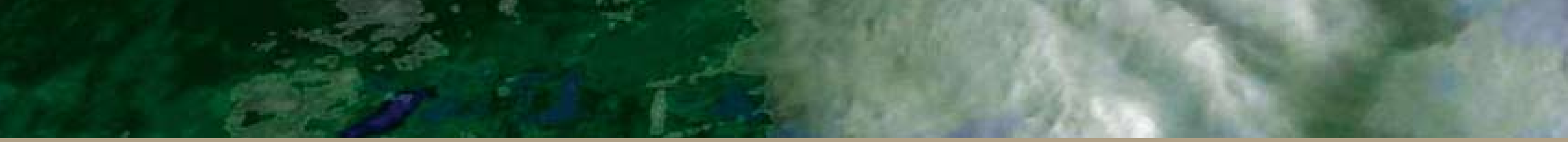


Figure 6. Regional ammonia emissions from livestock and agricultural sources.



DVD ARCHIVE TOOL

CIRA DVD Archive Tools

Michael Hiatt and Adam Carheden

Since 1978, CIRA has collected and processed Meteorological satellite data for research using direct read-out earthstations which were developed at CIRA. This data is always archived for future use. As discussed in the Fall 2003 CIRA Magazine, CIRA developed an experimental DVD archive system to improve the archival process. This program has performed with great success and has been expanded to archive all CIRA data products. It was also chosen by the CloudSat mission as the primary archive tool. Additionally, CIRA's aging 8mm and DLT tapes are being converted to DVD using the same technology. CIRA now has data holdings spanning 70TB or approximately 17,000 DVDs. Media storage concerns have been solved using compact three ring binders rather than large tape racks. Finally, as hoped, the DVD technology has progressed sufficiently so that most computers today have DVD readers.

Figure 1: EASE Search Form

Figure 2: EASE Search Results

As this archive has become quite extensive, two programs have been developed to expedite data retrieval. The first is the Earthstation Archive Search Tool (EASE). This is a web-based tool which allows CIRA researchers to search the DVD archive using special criteria. The second is a robotic retrieval system called DVDRestore.

EASE is a database of all the data CIRA has on DVD. In addition to file names, sizes and location on DVD, it includes metadata such as image date, satellite, sector, channel, sensor, and data type. Users can search for files by this satellite-related field or simply by file name and extension. Alternatively, EASE can find DVDs by attributes such as product or label and list the files on the selected DVDs. EASE can save searches for future reference and submit them to the archive staff for retrieval. EASE can be accessed from the CIRA network at http://ease.cira.colostate.edu/. Since EASE leverages the CIRA active directory domain, users simply use the same username and password they use to log on to the CIRA network.

DVDRestore is the reverse operation of DVDArchive. Once DVDs are identified using EASE, the archive operator simply loads the robotic DVD system with up to 50 DVDs. DVDRestore then automatically restores each DVD to a computer's hard drive for local access or sharing over the network. The operator can select whether to restore each DVD in a separate folder or to restore all DVDs to a single folder. Multiple jobs can be queued and folders purged to free disk space as necessary.

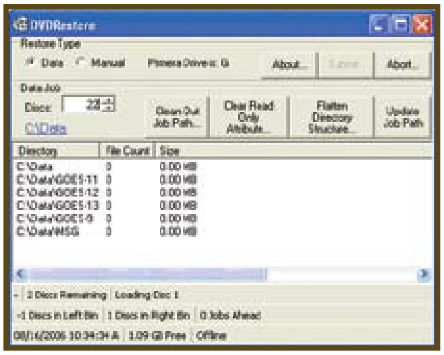


Figure 3: DVDRestore Application

Archiving data for longer terms, especially the large amounts of data CIRA has, presents many challenges. Technology improvements will continue to change the optimal media for long-term storage. CIRA's DVD archive system represents the best topology currently available and will foster conversion to a future media should the need arise.

Figure 4: DVD Robotic System

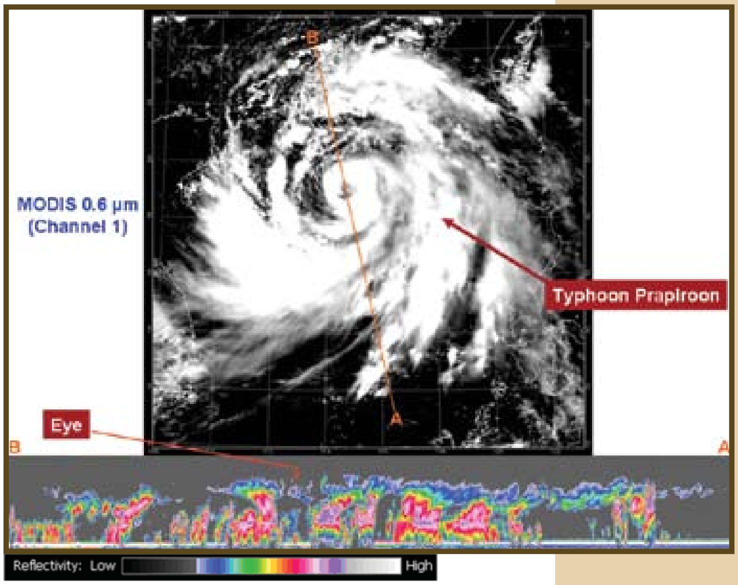
CloudSat Views Typhoon Eye

Don Reinke

On August 2nd at approximately 05:53 UTC, CloudSat flew over the eye of Typhoon Prapiroon in the South China Sea. CloudSat has imaged 11 major storms since it became operational on June 2nd, but this is the first time it has flown over the eye of a storm.

As seen in the image below, CloudSat captured a vertical cross-section of Typhoon Prapiroon on August 2nd 2006. Shown is the visible image from the MODIS imager aboard the NASA Aqua satellite, and the vertical profiles of radar reflectivity from the CloudSat CPR instrument which is flying approximately 70 seconds behind Aqua.

CloudSat is the first Cloud Profiling Radar (CPR) to fly in space and has returned over 40 million vertical samples (profiles) of global cloud cover as of the time of this publication. The Spring ‘07 CIRA Newsletter will present a comprehensive overview of the CloudSat Mission and the CloudSat Data Processing and Distribution Center, which is operated by CIRA.

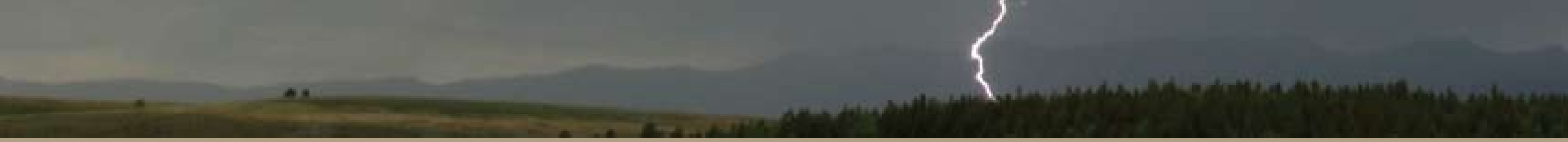


Fellowships in Atmospheric Science and Related Research

The Cooperative Institute for Research in the Atmosphere at Colorado State University (CIRA) offers a limited number of one-year Associate Fellowships to research scientists including those on sabbatical leave or recent Ph.D. recipients. Those receiving the awards will pursue their own research programs, collaborate with existing programs, and participate in Institute seminars and functions. Selection is based on the likelihood of an active exchange of ideas between the Fellows, the National Oceanic and Atmospheric Administration, Colorado State University, and CIRA scientists. Salary is negotiable based on experience, qualifications, and funding support. The program is open to scientists of all countries. Submitted applications should include a curriculum vitae, publications list, brief outline of the intended research, a statement of estimated research support needs, and names and addresses of three professional references.

CIRA is jointly sponsored by Colorado State University and the National Oceanic and Atmospheric Administration. Colorado State University is an equal opportunity employer and complies with all Federal and Colorado State laws, regulations, and executive orders regarding affirmative action requirements. In order to assist Colorado State University in meeting its affirmative action responsibilities, ethnic minorities, women and other protected class members are encouraged to apply and to so identify themselves. The office of Equal Opportunity is in Room 101, Student Services Building. Senior scientists and qualified scientists from foreign countries are encouraged to apply and to combine the CIRA stipend with support they receive from other sources. Applications for positions which begin January 1 are accepted until the prior October 31 and should be sent via electronic means only to: Professor Thomas H. Vonder Haar, Director, CIRA, Colorado State University, humanresources@cira. colostate. edu. Research Fellowships are available in the areas of: Air Quality, Cloud Physics, Mesoscale Studies and Forecasting, Satellite Applications, Climate Studies, Model Evaluation, and Economic and Societal Aspects of Weather and Climate. For more information, visit www.cira.colostate.edu.

Stay Tuned! More CloudSat to come in the Spring issue of the CIRA Magazine!



CoCoRaHS

CoCoRaHS Update

Nolan Doesken

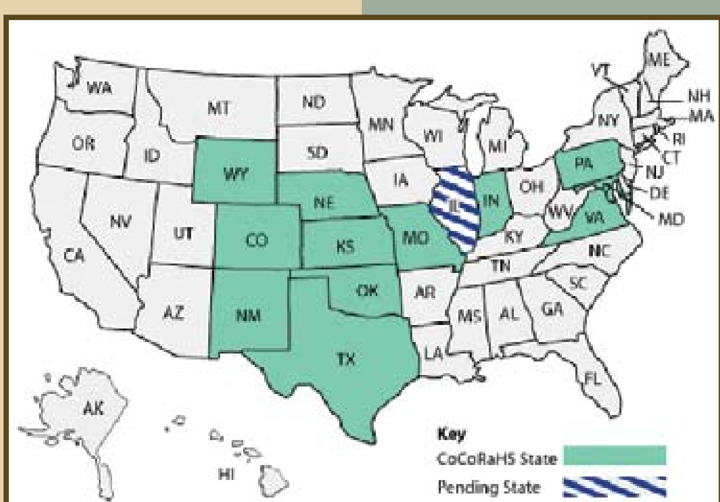
CIRA is an ongoing supporter of the Community Collaborative Rain, Hail and Snow network (CoCoRaHS). CoCoRaHS is a “citizen science” program initiated several years ago where people of all ages are equipped with plastic rain gauges and foil-wrapped squares of Styrofoam to carefully measure and report all forms of precipitation. CoCoRaHS now has several thousand volunteers spread over 12 states from the Rocky Mountains to the Mid-Atlantic states.

With large numbers of volunteers, the localized variations in precipitation that characterize many storm systems can be monitored and displayed. This year, CoCoRaHS volunteers have helped document extreme flooding in the Washington, D.C., area from storms in late June, have helped map drought patterns on the western plains and northern Rockies, and have recently helped track rains from Tropical Storm Ernesto and heavy summer rains over New Mexico associated with the North American Monsoon. Several highly localized flash flood-producing storms have been observed, and reports from local volunteers have provided timely information for National Weather Service severe storm warnings and verification.

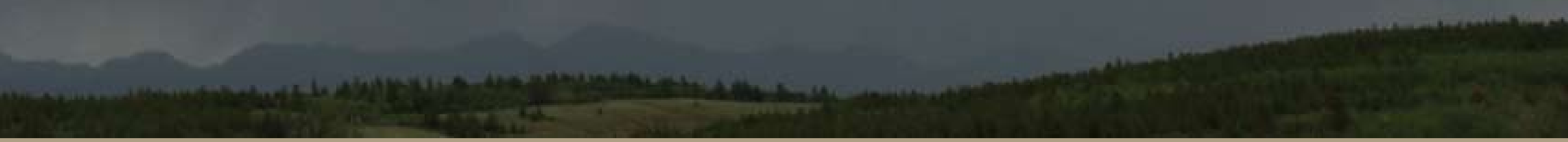
CIRA grant recipient James Cano.

During the summer of 2006, James Cano, a high school science teacher from San Antonio, TX, spent two weeks as an educational intern and consultant helping the CoCoRaHS team develop strategies and materials to help the network spread to southern states and other areas of the U.S. with large Hispanic populations. Mr. Cano teaches at Earl Warren High School, located in the rapidly growing Northwest side of the city. He has been teaching for the past 7 years.

We will be teaming up in January 2007 with local National Weather Service staff for a public CoCoRaHS display at WeatherFest at the upcoming American Meteorological Society annual meeting in San Antonio on January 14, 2007.



The 12 participating CoCoRaHS states.



CIRA COMMUNIQUÉ

CIRA Research Initiative Awards

Each year, CIRA is proud to recognize two employees (or groups of employees) as Research Initiative Award winners. In short, these folks have distinguished themselves by their significant contributions to the success of CIRA's research effort. The selection criteria used to evaluate nominations include: resourcefulness and/or creativity via the use of innovative techniques and/or technology in daily research activities; team leadership and/or mentoring capability to fellow workers; "cutting-edge research" which is reflected in publications, reports, and deliverables; noteworthy accomplishment that results in substantial impact on CIRA, CSU, or sponsoring agency research mission; and extraordinary achievement relative to the employee's normal job responsibilities. Award recipient(s) receive a commemorative plaque and are awarded $2,000 to be held in a CIRA account for use towards work travel, professional development courses, computer upgrades, or other research-related activities and materials.

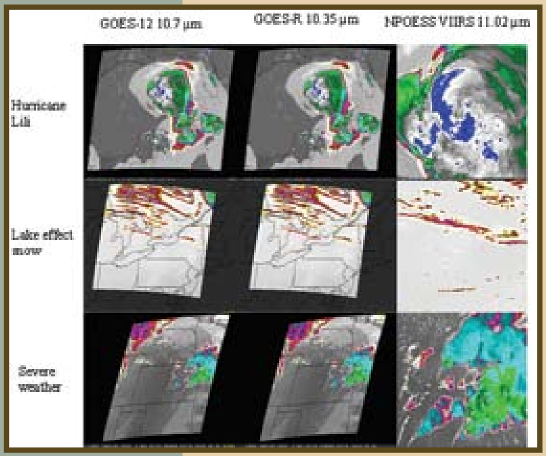
This year Lewis Grasso and Manajit Sengupta were awarded a CIRA Research Initiative Award for their work on the GOES-R project. A little background on this project follows.

GOES-R

Developing synthetic satellite imagery began at CIRA nearly five years ago. Synthetic satellite imagery is created from a numerical cloud model and an observational operator. The numerical model used for these studies is the Regional Atmospheric Modeling System (RAMS) that was developed at Colorado State University. Output from RAMS is then used as input to an Observational Operator. This model creates the synthetic satellite image from RAMS output.

At first, methods were developed to create synthetic Geostationary Operational Environmental Satellite (GOES) 9 imagery for clear skies and only clouds composed of cloud liquid water. This work was first completed by Tom Greenwald. He applied this method to a stratus cloud over Texas and Oklahoma that occurred on 2 May 1996. This procedure was later extended by Louie Grasso and Tom Greenwald to an idealized thunderstorm. Specifically, methods were developed that included the radiative properties of several other hydrometeor types: rain water, pristine ice, aggregates, graupel, snow, and hail. Synthetic GOES-9 imagery of the thunderstorm was produced.

After Tom's departure, Manajit Sengupta – with his radiative expertise – joined the CIRA team. Both Manajit and Louie then began work on the GOES-R and National Polar-Orbiting Operational Environmental Satellite System (NPOESS) risk reduction projects. The long-term research objectives are to identify the utility of GOES-R data along with advanced product development, and the Advanced Baseline Imager (ABI) that will fly on GOES-R. They have produced synthetic GOES-R and NPOESS imagery for three simulated cases: Hurricane Lili of October 2002, the 8 May 2003 severe weather event, and the 12 February 2003 lake effect snow event. Synthetic images range from 3.9 to 13.3 µm for these cases. The next step is to produce synthetic imagery for six of the ABI channels at wavelengths less than 3.9 µm.



GOES-R and NPOESS imagery of Hurricane Lili, a severe weather event, and a lake effect snow event.

From left to right: Lewis Grasso, Thomas Vonder Haar, and Manajit Sengupta

Boulder Recipient of the 2006 CIRA Research Initiative Award

Kevin Brundage, left, receives 2006 CIRA Research Initiative Award.

Kevin Brundage received the 2006 CIRA Research Initiative Award based on his significant participation on the NOAA Research and Development High Performance Computing System Procurement as well as his continuing superior performance on collaborative research with the NOAA/ESRL Global Systems Division's (GSD) Assimilation and Modeling Branch (AMB).

The High Performance Computing System Procurement – worth $368M over 10 years – is intended for a supercomputer to meet the R&D needs of three groups: NOAA labs currently using GSD's "Jet" supercomputer, the Geophysical Fluid Dynamics Laboratory, and the National Centers for Environmental Prediction (NCEP). Kevin was an invaluable participant on the Procurement Team, helping with development of the RFP and leading the effort to develop and use a suite of benchmark programs that represent the needs of current Jet users at five NOAA research laboratories.

Kevin performed this work while also developing and maintaining an extensive infrastructure that allows AMB to run multiple versions of its Rapid Update Cycle (RUC) numerical weather prediction model continuously and in real-time. The RUC, run operationally at NCEP and at GSD to test multiple new data and assimilation strategies, forms the basis for many critical aviation weather products used by the FAA and NWS.

Kevin was also GSD's co-principal investigator on a joint project with the National Renewable Energy Laboratory. For this project, Kevin ran an ensemble of RUC model cycles in order to assess the effectiveness of ensembles to estimate the uncertainty of near-surface wind forecasts – critical for determining optimal sites for wind turbines.

GSD Team Member of the Month

Joanne Edwards, GSD Team Member of the Month.

The following nomination for the NOAA/ESRL/GSD Team Member of the Month – April 2006 came from Acting Information Systems Branch Chief Mark Mathewson.

"Joanne Edwards is the GSD Team Member of the Month for April 2006. She serves as technical lead for the AWIPS D2D Data Group. She recently performed critical pre-integration radar software testing at National Weather Service Headquarters (NWSH) to help save money and time with the AWIPS OB7.1 release. She also has served in a much appreciated role by taking on additional duties with AWIPS coordination activities while some of the ISB staff is out for extended leave and travel."

2006 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)

The IGARSS 2006 conference was held at the Colorado Convention Center in Denver, CO from July 31-August 4 this year. The theme was "Remote Sensing – A Natural Global Partnership," which reflects the increasing interconnected nature of understanding and managing the global environment.

CIRA's support of IGARSS06 involved two functions:

1. Procurement of the IGARSS 06 domain name
2. Web hosting of the IGARSS 06 site

The IEEE offers Continuing Education Units (CEUs) for all who take approved tutorials, and the IGARSS conference extended this benefit to all tutorial attendees. Holli Knutson was in charge of organizing this, and acted as point of contact for tutorial CEUs. Holli spent one day in Denver

(Sunday, July 31st) at the conference making sure that all attendees were given the proper paperwork to fill out so they were able to get their CEUs. After the conference, she was in charge of getting all relevant paperwork to IEEE so they could process and award attendees their CEUs.

Science Symposia Hosted at CIRA

As part of the year-long celebration commemorating CIRA's 25th Anniversary, two Science Symposia were hosted in Fort Collins this summer. The **25th Anniversary CIRA & CG/AR Spring Science Symposium**, held May 16-17, was hosted by Lewis Grasso and sponsored by CG/AR. Attendees included CIRA Fort Collins and Boulder employees as well as NOAA and DoD colleagues. Session chairs included John McGinley, Lewis Grasso, and Milija Zupanski. Overall, 14 talks were given and 18 posters were presented. Topics for discussion included Modeling, Simulation, and Assimilation.

The second, **NOAA/NESDIS Cooperative Research Program (CoRP) Third Annual Science Symposium: "NPOESS, GOES-R and Beyond: New Observations and Applications to Benefit Society"** was hosted by CIRA August 15-16. The current status of these programs was summarized by invited speakers, and presentations were given by scientists from all of the NESDIS Cooperative Institutes and centers.

There were 63 registered participants, ranging from students to senior scientists, who provided 18 talks and 21 poster presentations. A wide variety of applications are being studied, including air quality, tropical cyclones, severe weather, precipitation estimation, hazard detection, land and ocean surface analysis, and the generation of proxy data sets.

A prize for the most outstanding poster was awarded to Mathew Sapiano of the Cooperative Institute for Climate Studies (CICS). His poster was entitled "Intercomparing and evaluating high-resolution precipitation products."

This symposium helped to foster communication and collaboration between NESDIS/StAR, university and Cooperative Institute scientists working on future NOAA satellite systems. The participation of the students is key in helping to train the future NOAA work force, and provides them with exposure to the wide range of research being performed to prepare for these new satellite systems.

Ken Eis speaking to attendees at the May Science Symposium.

Kristi Gebhart and Chungu Lu discuss posters at the May symposium.

Ken Eis giving an overview presentation during the CORP symposium.

Celebrating Service Milestones

Please congratulate the following employees for reaching milestones of service to CIRA/CSU during 2006:

10 years of service:
Leslie Ewy
Glen F. Pankow
Karll C. Renken
David A. Salisbury
Amenda B. Stanley

15 years of service:
Helene C. Bennett
Derek E. Day
Kenneth E. Eis

20 years of service:
Andrew S. Jones
Lance S. Noble
Donald L. Reinke

25 years of service:
Joanne C. Divico

ADMINISTRATORS

MEET OUR ADMINISTRATORS

CIRA's administrative staff members are a critical component of the day-to-day operations of the department. Led by Department Manager Mary McInnis-Efaw, the administrators are responsible for all aspects of operating successful research projects.

From submitting proposals and managing financials, to travel, meeting planning, and procurements, these folks do it all (aside from the actual research itself)! CIRA is so grateful and appreciative for all of their efforts.

Linn Barrett – Assistant Manger for Research Personnel Services. Linn manages all Human Resource activities at CIRA and processes all travel requests for the Fort Collins office.

Georgeanne Beck – Administrative Assistant to CIRA staff in Boulder. Duties include annual and sick leave tracking, travel and training arrangements, helping new employees fill out paperwork, doing travel vouchers and general office support tasks for Cliff Matsumoto. Makes arrangements for meetings of CIRA staff as we now have a monthly coffee confab in Boulder too.

Georgeanne Beck

Cedar Brown

Helene Bennett* – Administrative Assistant to the National Park Service group. Some duties include providing fiscal support in terms of drafting budgets, overseeing and reconciling awarded funds, purchasing, and travel; editing and submitting documents, including journal articles, conference papers, and reports; and acting as a liaison within the group on university and federal procedural matters and for the group to researchers and administrators in the scientific community, nationally and world-wide.

Cedar Brown – Research Coordinator for the DoD Center for Geosciences/Atmospheric Research at CIRA. Assists Loretta Wilson with program support on this project. Primary duties include maintaining the publication files and updating publications lists; assisting with travel arrangements for researchers; processing procurements, compiling draft quarterly reports; meeting support; and general office duties.

Joanne Divico* – Assistant to the Director. Provides comprehensive administrative and research support to the Director and the Office of the Director of CIRA.

Kathy Fryer* – Administrative support for both NOAA and CIRA members who compose the Regional and Mesoscale Meteorology Branch (RAMMB). Primary activities are preparing and completing domestic and international travel arrangements, designing and updating web pages, e.g. the branch's Intranet site, and preparing proposal budgets. Kathy is also responsible for creating and maintaining databases for such activities as administrative and

Note: * Denotes Project Assistants.

scientific reports, publications, and special projects.

Laura Grames – Proposal Coordinator and Assistant Editor for CIRA Magazine. Laura handles all aspects of preparing and submitting CIRA proposals according to the standards of NOAA, NASA, NSF, NPS, and others. She creates project budgets, completes related university paperwork, compiles the package to be submitted, and assures that proposals are delivered by the deadline. Laura also serves as the Assistant Editor for the bi-annual CIRA Magazine, with duties such as soliciting and compiling articles, editing, image selection, and layout.

Holli Knutson – Dr. Vonder Haar's Academic Assistant including support for scientific research. First point of contact with graduate students – visits, class schedules, thesis publication, defense logistics and research assistance. Assists in class preparation (help with class, make and grade tests, make presentations, etc.). Develops and maintains websites for class. Other duties include procurement requests and tracking, coordinating research projects with employees other than the PI, coordinating and setting up of day or week long meetings (logistics, catering, travel), maintaining spreadsheets for yearly annual report publication, tracking of employee's journal publication citations, copying, faxing, typing, dictation and filing.

Kerrie Lapoehn – Procurements Coordinator for CIRA. Responsible for liaise activities between Colorado State University and CIRA for purchasing activities. Kerrie's duties also include assisting the Associate Manager of Finance and Budgets.

Lance Noble – Associate Manager for Finance and Budgets. Duties include developing monthly financial reports; reviewing and approving department purchases; overseeing accounting and payroll functions; interacting with other university administrative departments and federal research sponsors; preparing budgets; checking and correcting expense entries; researching financial issues; creating master spreadsheets using Microsoft Excel.

Lance Noble

Marilyn Watson – As Facility Manager and Proctor for CIRA, Marilyn coordinates all maintenance and repair for the CIRA building and the CIRA portion of the ATS-CIRA Research Center building. She is in charge of the card entry security system, disaster emergency planning for the department, small building remodel and upgrade projects, coordination between department and builder during construction projects, and all supplies, office machine and furniture purchase and maintenance. She orders keys, office and cell phone services, stationary, produces business cards, publishes the CIRA photo social directory, photographs CIRA events and personnel, does inventory control and disposal of outdated, broken equipment. She oversees student hourlies, Ryan Cearley and Jonnie Fleagane, in handling mail and package distribution, CIRA errands to main campus, special event setup and cleanup, indoor and outdoor plant maintenance, office moves, media equipment troubleshooting and maintenance of the photo board of CIRA personnel. She also answers CIRA's main switchboard.

Loretta Wilson* – Program Manager for the DoD Center for Geosciences/Atmospheric Research at CSU. Loretta is responsible for the primary administrative operation of the program and coordinates the communications and administrative functions

ADMINISTRATORS

with the federal sponsor and its delegates, CSU administrative departments, and all research personnel. She coordinates many aspects of project and budget management including requests for resource and funding support, travel and technology transfer activities, equipment and data procurement. Each year, she prepares the first drafts of the budget for the overall program with specific details for all the subtasks, both within CIRA and other departments, and assists in budget planning for proposals, ongoing project management and project close-out. Compiles the annual federal prospectus directed at securing Congressional support and appropriations for continuation of research efforts, and prepares technical proposals as appropriate. Oversees the compilation, preparation and distribution of technical reports, conference and journal publications, and posts materials on the Center's main webpage. Coordinates all program travel to ensure productive results of each trip to the benefit of the CG/AR research effort, the sponsor, and collaborative goals. Organizes periodic research progress meetings, the CG/AR Annual Program Review, and technical workshops for the scientific community. Ms. Wilson supervises one full-time Administrative/Professional employee.

Joanne Divico

CIRA Administrators: From left to right. Back row: Kerrie, Lapoehn, Kathy Fryer, Mary McInnis-Efaw, Lance Noble, Cedar Brown, Laura Grames. Front row: Helene Bennett, Joanne Divico, Marilyn Watson, Linn Barrett, Holli Knutson, Loretta Wilson. Georgeanne Beck not present for photo.

Beauty Found Within: The NOAAPORT Antenna

Dustin Rapp, Graduate Student in Atmospheric Science (Note: though a graduate student in Atmospheric Science, Dustin works closely with CIRA researchers, under the direction of his supervisor, Thomas Vonder Haar)

Have you noticed the new large satellite dish sitting between the CIRA building and the atmospheric building? With another dish, one might wonder if CIRA is creating an aesthetic eyesore in the foothills with its collection of satellite dishes. What is this new dish all about and how is CIRA going to use this new piece of equipment? Does CIRA really need another satellite dish in their backyard? Before deciding that this behemoth dish should be replaced by a nice pine tree, I investigated these questions so that we all might be able to make a better judgment regarding its true value. Here is what I found out by talking with the expected user's of this new satellite dish at CIRA and doing a little independent research.

Figure 1. The NOAAPort Antenna is CIRA's most recent satellite dish.

Figure 1 shows a picture of the new dish. This is referred to as a NOAAPORT antenna and is actually a small (yes, small) piece of a much larger operation referred to as the NOAAPORT broadcast system. The NOAAPORT broadcast system was designed to assist the National Weather Service with the very important task of issuing and disseminating dependable severe weather statements and forecasts for the entire country. Because this is such a tremendous task, the NWS needs a tremendous amount of surface, satellite, radar and model data to accomplish it successfully. Important weather data from the Weather Surveillance Radar 88D Doppler network, the Geostationary Operational Environmental Satellite (GOES), and the Automated Surface Observing System (ASOS) are all processed in near real time from instruments 24 hours a day, seven days a week. This data must make its way to each of the many NWS Forecast Offices (NWSFOs) found throughout the country so that NWS forecasters can use it. The NOAAPORT broadcast system is the means by which this data is distributed reliably and consistently to the NWSFOs.

Figure 2 describes how the NOAAPORT broadcast accomplishes this task. Important weather data is first compiled at the Network Control Facility (NCF) in Silver Spring, MD. Here, the data is broadcast via a radio signal to the GE Americom GE-4 Transponder 15C, a synchronous satellite that is sitting above 101 degrees west Longitude. This satellite's primary

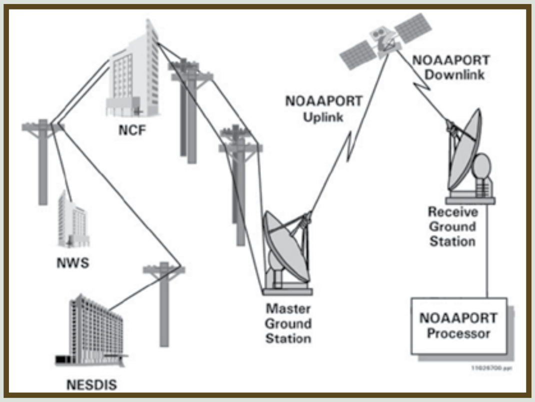


Figure 2. The data flow of the NOAAPORT broadcast system. Source: NWS NOAAPORT User's Page – http://www.nws.noaa.gov/noaaport/html/overview.shtml

purpose is to rebroadcast this important data set to the forecast offices of the NWS. NOAAPORT antennas are the means by which the NWSFOs and other agencies receive and process this satellite's signal so that the data can be used by forecasters.

Once data is received by the NOAAPORT antenna, it is incorporated into the NWS's Advanced Weather Interactive Processing System (AWIPS). The AWIPS system is a suite of data processing software and equipment used by the NWS to graphically display meteorological and hydrometeorological data for forecast operations. It is a means by which forecasts and severe weather information are disseminated to the general public, and it also provides an interactive communications system for the NWS operations sites. AWIPS is currently being used at the NWSFOs, the NWS River Forecast Centers, and the National Centers for Environmental Prediction (NCEP), which are all agencies which support the NWS's weather and hydrologic forecast and warning operations. Thus, AWIPS and the NOAAPORT broadcast system are fundamental to accomplishing the NWS goals of saving life and property whenever severe weather strikes.

Figure 3. VISIT instructor John Weaver (insert) leads a teletraining session as the NWS Office in Cleveland, Ohio, follows along. Cleveland photo courtesy R. LaPlante.

What may surprise you is that CIRA has been playing a large role in educating NWS forecasters on how best to use AWIPS for several years. The Virtual Institute for Satellite Integration Training (VISIT) distance learning program is the program within CIRA which has been leading this effort. VISIT was originally created in 1998 with funding provided by the National Oceanic and Atmospheric Administration (NOAA). It was created in response to continual increases in forecast-related training requirements, limited educational related travel funds, and an increase in unexplored educational opportunities (e.g. teletraining sessions) due to advances in internet technology.

With this in mind, a team of VISIT scientists began performing educational teletraining sessions to NWS forecasters across the country. These type of sessions continue to be created and still work to teach forecasters how to best utilize satellite data and new remote sensing research techniques. The VISIT team, along with staff from CIRA, the Cooperative Institute for Meteorological Satellite Studies (CIMSS), the National Weather Service (NWS) training division, and the National Environmental Satellite, Data, and Information Service (NESDIS) administer the teletraining sessions. The strength of the VISIT teletraining approach is its ability to bring the instructor directly to a forecast office anywhere in the country via a teleconnection (See Figure 3).

In order to address specific training needs, the VISIT team developed a distance learning software package called VISITview. The software allows a user to simultaneously view and manipulate the images, animation, graphics and text in a similar manner to that of the NWS forecast environment (see Figure 4). As AWIPS became more popular in the late 1990's, it was beneficial for the VISIT team to use and better understand the same forecasting environment NWS forecasters experience. Thus, the VISIT team put together a simulated AWIPS environment using a grant from NESDIS. The data feed to that system was a Unidata LDM (Logical Data Manager) system, and that data feed gave the team a small fraction of the full range of AWIPS products available to NWS forecasters. Although this data set was better than nothing, the limited nature of the data set severely limited the VISIT teams' ability to create relevant telesessions for NWS forecasters.

In 2004, a new AWIPS software upgrade made it impossible for VISIT to obtain any AWIPS compatible data through Unidata. Since then, the VISIT team could only process data archived by NWSFOs or through the Cooperative Operational Meteorological, Educational and training (COMET) program at the University Corporation for Atmospheric Research (UCAR). The VISIT team had to depend on these outside

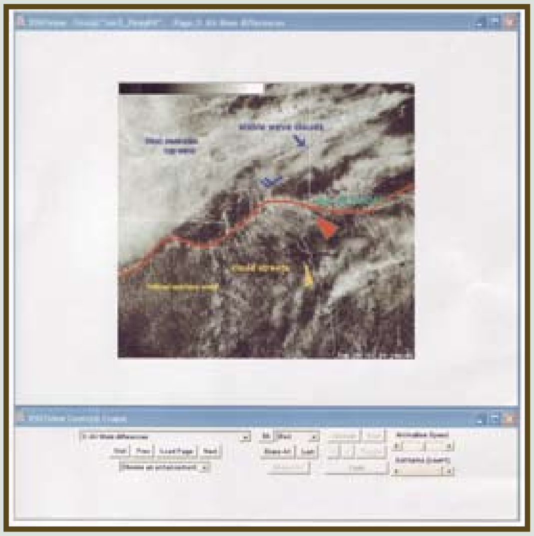


Figure 4. An example of an animated and annotated portion of a severe weather session using VISITView.

agencies to send them the data. Once received, the VISIT team had to process this data themselves if they were to continue creating training sessions. Even after the data was processed, the data set was still only a small subset of the full suite of data that can be obtained through the AWIPS stations at the NWSFOs. Obviously, this was an inefficient way for the VISIT team to work. Still, these limitations did not stop the VISIT teams' success.

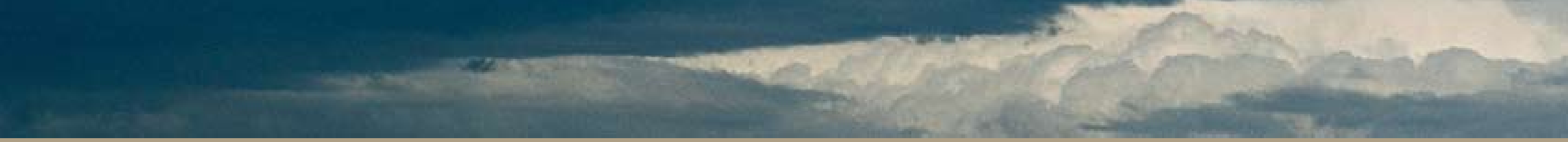
The VISIT team modules continue to be a popular avenue through which NWS forecasters learned new skills. NOAA offices have been turning to the teletraining approach because it is one cost-effective solution to the problem of increased training requirements coupled with shrinking training and travel budgets. Over 1,000 educational sessions have been provided by the VISIT team, and every NWSFO in the country has made use of at least one of these sessions. The student feedback the VISIT team has received has been generally very favorable, indicating that VISIT is fulfilling their goal of providing cost effective distance learning to operational forecasters.

NESDIS (National Environmental Satellite and Data Information Service) and the NWS recognized some of the important skills the VISIT team has given to the NWS. In 2005, a NWS grant helped procure the NOAAPORT equipment. A separate grant was also issued by NESDIS allowing the purchase of servers and workstations to simulate the AWIPS environment. In addition, this grant made it possible for CIRA to obtain the new satellite dish and the full line of AWIPS data associated with it.

Now that CIRA has their own NOAAPORT antenna, the VISIT team is expected to have the ability to download the same data set that the NWSFOs use, including radar, satellite and model data on a real-time basis beginning in July. This is an important step forward. By having the same dataset the NWS forecasters are using, VISIT can emulate what the NWS forecasters would use. By having real time data access, the VISIT training team can analyze potential case studies to be used on a real time basis, without having to wait for distant forecast offices to send them archived data weeks later. Also by having such real time access, the VISIT team will be able to incorporate other CIRA satellite products into this data stream, creating new and innovative research products that if found useful, may find themselves in the standard NOAAPORT data stream being used by local forecasters. These improvements will lead to enhanced forecasts by NWS forecasters.

Thus, the new NOAAPORT antenna is leading to improved forecasts, and who doesn't want a better forecast to help keep another rained out picnic from occurring? Although I have not changed my mind about the external ugliness of CIRA's new satellite dish, I have come to the conclusion that if this new satellite dish was suddenly removed, and the data it received disappeared, I would be somewhat upset. The helpfulness of the NOAAPORT antenna is worth a little less greenery. In the end, the NOAAPORT antenna is just another example of beauty being found within and how CIRA is staying committed to benefiting society here on earth.

Acknowledgements: The author would like to thank Deb Molenar of NOAA, John Braun of CIRA, and Dan Bikos of CIRA for supplying information about the NOAAPort Antenna.



SYNTHETIC GOES-R ABI AND NPOESS VIIRS IMAGERY

Synthetic GOES-R ABI and NPOESS VIIRS Imagery

Lewis D. Grasso, Manajit Sengupta, John F. Dostalek, and Mark DeMaria

As part of the Geostationary Operational Environmental Satellite R (GOES-R) and National Polar-Orbiting Operational Environmental Satellite System (NPOESS) risk reduction activities at the Cooperative Institute for Research in the Atmosphere (CIRA), a method has been developed to create synthetic satellite imagery. Simulated satellite imagery of future sensors can be generated two ways. One way is to use images from other operational and/or research satellites. A second way relies on numerical models. That is, one model is used to simulate a weather event while a second model is used to generate synthetic satellite images from output of the first model.

Data from the Moderate Resolution Imaging Spectroradiometer (MODIS, King et al. 1992) and the Atmospheric Infrared Sounder (AIRS, Aumann et al. 2003) have been used as a first step to view future GOES-R Advanced Baseline Imager (ABI) images (Schmit et al. 2005). These instruments collect data at wavelengths that are planned for ABI. Further details along with a comprehensive discussion of the GOES-R ABI can be found in Schmit et al. (2005). Similarly, images for the future NPOESS Visible/Infrared Imager/Radiometer Suite (VIIRS) can also be obtained from current satellites. For example, the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS); the Polar Orbiting Environmental Satellite System (POES) Advanced Very High Resolution Radiometer (AVHRR); and MODIS imagery can be used to simulate VIIRS data (Miller et al. 2006). Further details about NPOESS VIIRS can be found in Miller et al. (2006).

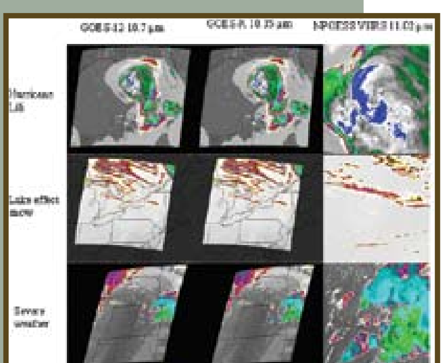


Fig. 1. Synthetic 4 km GOES-12, 2 km GOES-R, and 400 m NPOESS-VIIRS imagery for the hurricane Lili, lake effect snow, and severe weather cases.

In addition to using existing satellites to simulate GOES-R ABI and NPOESS VIIRS images, numerical models can be used to create synthetic imagery of these sensors. This procedure was developed at CIRA over the past few years. The Regional Atmospheric Modeling System (RAMS, Cotton et al. 2003) in conjunction with an Observational Operator are used to create synthetic imagery. This method was first applied to the 2 May 1996 stratus cloud over Texas and Oklahoma (Greenwald et al. 2002). This system was extended by Grasso and Greenwald (2004) to an idealized thunderstorm. In both cases, synthetic GOES-9 imagery was produced. Details of RAMS and the Observational Operator can be found in both Greenwald et al. (2002) and Grasso and Greenwald (2004).

Both GOES-R and NPOESS are planned to be placed into orbit about 2012. In the infrared ranges, horizontal footprints of the ABI sensor on GOES-R will be near 2 km. In addition, temporal sampling of 5 minutes is planned (Schmit et al. 2005). Current GOES satellites can sample at intervals of 5 minutes – so called rapid scan operations; however, horizontal footprint sizes are near 4 km. On the other hand, lower polar orbiting satellites sample with horizontal footprints near 2 km but are unable to scan every 5 minutes. This inability of existing satellites to sample both spatially at 2 km and temporally at 5 minutes is the primary motivation to use numerical models to create synthetic GOES-R ABI imagery. Synthetic GOES-R ABI and NPOESS VIIRS imagery provides an opportunity not only to aid in algorithm development for both sensors, but also to aid in the understanding of the imagery. For example, in some cases brightness temperatures at 6.7 µm are larger than those at 10.7 µm on top of some thunderstorms (Ackerman 1996). Synthetic imagery can be used to help explain this observation. Further, synthetic imagery can be used for product development.

The purpose of this article is to introduce synthetic GOES-R ABI and NPOESS VIIRS imagery. As a first step, simulations of three different mesoscale events were conducted: The 8 May 2003 thunderstorm outbreak over the central plains, the 12 February 2003 lake effect snow event over the eastern Great Lakes, and hurricane

Lili of early October 2002. Due to the two-way interactive nested grid capabilities along with the two-moment microphysical scheme, RAMS was chosen to simulate the above three cases. The observational operator was then used to create synthetic GOES-R ABI and NPOESS VIIRS images from RAMS output. Synthetic GOES-R ABI imagery for nine channels ranging from 6.185 µm to 13.3 µm and synthetic NPOESS VIIRS imagery at 8.53 µm, 11.02 µm, and 12.03 µm for the three mesoscale weather events listed above was created.

A total of four grids were used in each of the three simulations. Horizontal grid spacings, in both directions, of 50 km, 10 km, 2 km, and 400 m for grids 1 through 4, respectively were used in each simulation. Horizontal grid spacings in grid 3 were chosen to be 2 km because this value is near the horizontal footprint of the GOES-R ABI; similarly, horizontal grid spacings of 400 m in grid 4 are approximately the horizontal footprint of the VIIRS instrument. Grids 1 through 3 were initialized from ETA analysis data; in contrast, grid 4 was spawned during each simulation and thus was initialized from the corresponding third grid.

During the integration of grid 4, model output was written at the GOES-R ABI temporal sampling rate of 5 minutes from both grid 3 (for synthetic GOES-R imagery) and from grid 4 (for synthetic NPOESS VIIRS imagery) in each of the three simulations. Output from RAMS was then used as input to the observational operator. One of the first calculations done by the observational operator was to compute the gaseous transmittance at a specific GOES-R ABI or NPOESS VIIRS channel. Spectral response functions for these wavelengths specific to GOES-R ABI were obtained from the Joint Center for Satellite Data Assimilation. Since VIIRS spectral coefficients were not available, values from the MODIS Terra instrument at 8.53 µm, 11.02 µm, and 12.03 µm were chosen.

For clarity of illustration, synthetic 4 km GOES-12 at 10.7 µm, 2 km GOES-R ABI at 10.35 µm, and 400 m NPOESS VIIRS at 11.02 µm images will be shown for each case at a given time. Synthetic imagery for 2 October 2002, 12 February 2003, and 8 May 2003 cases are shown in Fig. 1. In addition, an example of synthetic Hyperspectral Environmental Suite (HES) imagery is shown in Fig. 2.

REFERENCES

Ackerman, S. A., 1996: Global satellite observations of negative brightness temperature differences between 11 and 6.7 µm. *J. Atmos. Sci.*, 53, 2803 2812.

Aumann, H. H., and Coauthors, 2003: AIRS/AMSU/HSB on the aqua mission: Design, science objectives, data products, and processing systems. *IEEE Trans. Geosci. Remote Sens.*, 41, 253-264.

Cotton, W. R., R. A. Pielke, Sr., R. L. Walko, G. E. Liston, C. J. Tremback, H. Jiang, R. L. McAnelly, J. Y. Harrington, M. E. Nicholls, G. G. Carrio, and J. P. McFadden, 2003: RAMS 2001: Current status and future direction. *Meteor. Atmos. Phys.*, 82, 5-29.

Grasso, L. D., and T. Greenwald, 2004: Analysis of 10.7 µm brightness temperatures of a simulated thunderstorm with two-moment microphysics. *Mon. Wea. Rev.*, 132, 815-825.

Greenwald, T. J., R. Hertenstein, and T. Vukicevic, 2002: An all-weather observational operator for radiance data assimilation with mesoscale forecast models. *Mon. Wea. Rev.*, 130, 1882-1897.

King, M. D., Y. J. Kaufman, W. P. Menzel, and D. Tanre, 1992: Remote sensing of cloud, aerosol and water vapor properties from the Moderate Resolution Imaging Spectroradiometer (MODIS). *IEEE Trans. Geosci. Remote Sens.*, 30, 2-27.

Miller, S. D., and Coauthors, 2006: Nexsat previewing NPOESS/VIIRS imagery capabilities. *Bull. Amer. Meteor. Soc.*, 87, 433-446.

Schmit, T. J., M. M. Gunshor, W. Paul Menzel, J. Li, S. Bachmeier, and J. Gurka, 2005: Introducing the next-generation advanced baseline imager (ABI) on Geostationary Operational Environmental Satellites (GOES)-R. *Bull. Amer. Meteor. Soc.*, 86, 1079-1096.

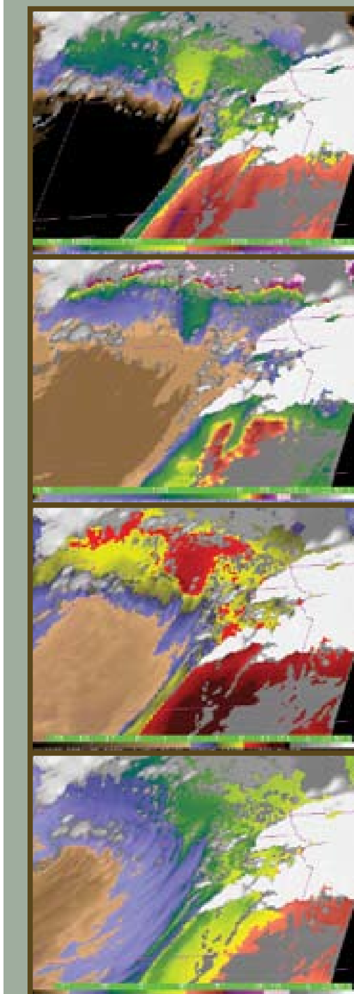
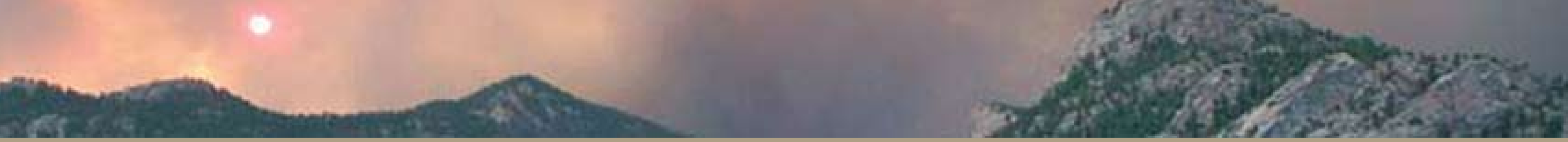


Fig. 2. (From top) Synthetic 6 km GOES-R HES CAPE, CIN, LI, and PW for the severe weather case.



CIRA Mission

The mission of the Institute is to conduct research in the atmospheric sciences of mutual benefit to NOAA, the University, the State, and the Nation. The Institute strives to provide a center for cooperation in specified research program areas by scientists, staff, and students and to enhance the training of atmospheric scientists. Special effort is directed toward the transition of research results into practical applications in the weather and climate areas. In addition, multidisciplinary research programs are emphasized, and all university and NOAA organizational elements are invited to participate in CIRA's atmospheric research programs.

The Institute's research is concentrated in several theme areas that include global and regional climate, local and mesoscale weather forecasting and evaluation, applied cloud physics, applications of satellite observations, air quality and visibility, and societal and economic impacts, along with cross-cutting research areas of numerical modeling and education, training, and outreach. In addition to CIRA's relationship with NOAA, the National Park Service also has an ongoing cooperation in air quality and visibility research that involves scientists from numerous disciplines, and the Center for Geosciences/Atmospheric Research based at CIRA is a long-term program sponsored by the Department of Defense.

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