Cooperative Institute for Research in Environmental Sciences

Science Serving Society and a Sustainable World

A Strategic Plan for CIRES

2002-2007

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Supercedes 1 February 1999 document
Pending review from the Fellows and other CIRES leaders

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PARTNERS IN RESEARCH

The University of Colorado at Boulder is committed to diversity and equality in education and employment.

Table of Contents

INTRODUCTION

As the largest of seven institutes on the University of Colorado (CU) campus and the largest of eleven NOAA institutes nationwide, CIRES comprises over 500 people conducting multi and interdisciplinary research in Earth Systems Science. Such wide-ranging activity requires both careful planning and effective leadership. The following plan represents CIRES' vision for the next five years. Building upon our 1999 strategic plan and dovetailing with both the NOAA and CU strategic plans, this document identifies where we seek to build further synergy between agency research and the academic environment. Largely the product of a scientific retreat held during October 2000, this plan is a living document and integrated roadmap that identifies goals and action items for setting and implementing the milestones currently envisioned.

CIRES' CONTRIBUTION TO UNDERSTANDING THE EARTH SYSTEM

As we enter the 21st century, the demands of increasing population coupled with variability in our natural environment are placing society and Earth's natural resources at greater risk. At the same time society has become increasingly reliant on technological systems, making us more vulnerable to unexpected events such as the impact of solar storms on power grids and satellite systems. Developing nations desire the same benefits as those that have been attained by the developed countries, resulting in issues of environmental justice, economics, and sustainability. The development of local, regional, national, and international policies related to environmental problems have and will continue to rely upon technical competence and honest objectivity in science as key inputs to the complex process of decision-making.

Science in Service to Society is the overarching mantra for CIRES. This vision is strongly related to NOAA's research mission of improving our weather and climate predictive capability and understanding our air, sea, and climate through fundamental research. CIRES researchers are working to fulfill this mission by providing the tools and intellectual foundation necessary to improve predictive models on a variety of scales and regimes. This vision is also crucial to our understanding of sustainability and vulnerability of the Earth system. During the next five-year cooperative agreement, CIRES will focus on the question:

> How well can we understand and predict the effects of natural and anthropogenic perturbations on the earth system and how can we use this knowledge to protect the health of the earth system?

In order to answer this question, the following key scientific issues are being addressed:

- *What are the predictability limits of components within the Earth system?*
- *What components of the Earth system are vulnerable to natural and anthropogenic change?*
- *What are the most sensitive regions of the Earth system to climate variability and change?*
- *How well can we predict extreme events and anticipate severe impacts to the Earth system?*

CIRES is establishing itself as a research entity that can tackle these highly interdisciplinary questions. Over the past few decades, CIRES has developed strengths that include scientific diversity across the physical, chemical, and biological sciences related to environmental processes. Strong programs in Earth system monitoring, problem definition and expert interpretation of observational evidence are cornerstones of CIRES research. Geospatial data has been combined with key scientific topics to provide integrated databases for scientific application. To supplement this observational expertise, CIRES has strong research programs in process studies focused on elucidating interconnectivity within the Earth system by building upon our understanding of individual components within this Earth system. Modeling capabilities that address key aspects and incorporate the complexity of this system augment these process studies. Our partnership with NOAA provides a solid basis for understanding the needs of operational prediction and environmental outlooks.

Specific strengths of CIRES include formal and informal data centers of high quality. These data centers pride themselves on easy flow of information to users, provide added value to the data yielding important insights, and include strong involvement of active research scientists who in themselves represent living archives of data knowledge and interpretation. Scientific strengths include short-term climate variability, atmospheric chemistry, cryosphere and polar studies, space weather, remote sensing and instrumentation, advanced numerical climate models, and geodynamics. In addition, CIRES has developed a strong educational component through graduate research and mentoring programs, undergraduate teaching, and a K-12 outreach program that focuses on preparation of teachers in integrated Earth system science and the National Science Standards. To ensure that our scientific results are meaningful and put to use, CIRES has taken on a major facilitating role that integrates natural science with social science, economics, policy, and law. This role is most visible through our assessment activities of climate variability and its impacts on water in the interior west, and through the space weather effort that interacts with the private sector in developing operational predictive capability for solar and geomagnetic storms that yield direct impacts on civil infrastructure.

VISION STATEMENT

CIRES is a recognized leader in innovative *earth systems science* research and education committed to integrating and reporting its findings in a meaningful context for improving public awareness of sustainability and applying science toward serving society.

MISSION STATEMENT

CIRES provides the tools, interdisciplinary environment, and leadership to conduct research and education that improves our understanding of the earth system.

STRATEGIC GOALS FOR CIRES

1. Scientific Scope and Direction

The interconnected nature of CIRES requires a broad scientific scope that is able to address the issues of NOAA scientists as well as to the interests of University faculty. Our strength in end-to-end research across multiple disciplines helps translate findings into operations and provide relevant information needed by decision makers. CIRES' connections spanning the geosciences, biology, chemistry, physics, geography, oceanography, weather, climate, hydrology, solar physics, remote sensing, engineering, social science, environmental law, policy and more provide a solid foundation that enables several crosscutting research themes framed by the scientific questions being asked. Following are the scientific objectives identified during our last scientific retreat that will shape CIRES' trajectory during the next five years.

Increase our knowledge of fundamental processes that determine the physical, chemical, biological and dynamical state of the Earth system

- Better understand the structure and range of natural climate variability across multiple scales of time and space
- Determine the causes and impacts of climate variability and extreme events upon various regions of the United States
- Determine the processes responsible for chemical transformations and photochemical pollution during intercontinental transport
- Improve understanding of the chemical and atmospheric factors determining air quality in various regions of the United States
- Carry out interdisciplinary studies of the high latitude regions of the Earth to determine the complex responses and feedbacks to climate variability and long term change
- Improve our understanding of how surface-atmosphere exchanges impact regional climates and air quality
- Strengthen the integration of biospheric studies with current geospheric, hydrospheric and atmospheric research
- Increase our knowledge of the fundamental processes that drive the biosphere
- Determine the dynamical and structural processes responsible for the vigor of mantle convection
- Determine the origin of various near-surface geological and geochemical features and how they impact mantle dynamics

Apply existing and develop new tools to accurately measure indicators of change within various components of the Earth system

- Engage in experimental programs that observe the important structural parameters related to convection and tectonic processes
- Develop experimental tools to accurately measure indicators of change
- Develop new measurement techniques and instrumentation for advancing our understanding of important chemical processes
- Investigate the use of new remote sensing methods to observe atmospheric winds and water vapor, climate microphysical and radiative properties, and ocean surface characteristics

- Investigate the use of hyperspectral imaging as a standard technique for assessing the condition of the Earth system
- Develop improved methods for transforming remotely sensed Earth observations into useful decision-making tools across various temporal and spatial scales
- Develop new models to predict the effects of future climate change on carbon sequestration dynamics
- Improve measurements and models of important cryospheric parameters
- Provide integrated data to validate measurements and enable Earth system scientists to utilize combinations of measurements and derived products from multiple sources
- Further develop non-linear Earth system models to address fundamental questions that can be understood by no other means
- Further elucidate the coupling between the various regions of the space environment and develop data assimilation techniques to enhance space weather forecasting
- Assess the potential for developing a new center in environmental technology

Become proficient at making predictions and outlooks about how the components of the Earth system respond to perturbations

- Improve our understanding of the quantitative relationships between ozone depletion, radiative forcing and climate
- Assess factors and model strategies for their skill in predicting climate variability
- Enhance the sophistication of prognostic models capable of forecasting the response of ecosystems and the global biosphere to future environmental changes
- Improve our ability to forecast the chemical composition of the atmosphere
- Better observe, model and predict the consequences of climate change and variability on the hydrological cycle
- Further clarify the mechanisms and forcings of climate variability to assess and improve predictability
- Develop new and effective methods to characterize and model managed ecosystems, prioritize management needs, and provide a suite of possible actions
- Improve our understanding of and capability for predicting earthquakes

Develop techniques in cooperation with society to help maintain the health of the Earth system, to mitigate adverse effects and to allow planning to take advantage of opportunities

- Serve as authors, co-authors, contributors, reviewers, and steering committee members of national and international efforts to produce state-of-understanding scientific assessments on the topics of climate, stratospheric ozone, environmental effects of aviation, and air quality
- Carry out research that will develop science and technology to help us restore and protect the health of the biosphere
- Strengthen the *Western Water Assessment* and integrated regional assessments
- Contribute to the framing of a new national climate service

2. Education, Outreach and Communication of our Findings

CIRES faculty and researchers work closely with academic departments and programs in offering curricula and research opportunities for students. CIRES collaborates with its academic partners to enhance contributions at both undergraduate and graduate levels with emphasis on interdisciplinary

educational opportunities. CIRES has recently established and is further developing a *K-12 Outreach Program* that has already been nationally recognized as an exemplary model by a scientific research institute. Its projects are of high quality and combine rigorous science with innovative learning practices. Ongoing outreach projects include teacher training, scientist training, classroom presentations, and public exhibits. Proposed projects included a major initiative for girls and women in science that will incorporate extensive collaboration between local and regional organizations plus a curriculum development project based on NOAA/NASA field missions. The following are goals and strategies for interdisciplinary education and outreach.

Provide integrated graduate programs that include innovative research, teaching, learning and outreach

- Expand the CIRES Graduate Research Fellowship Program to include a merit-based competition for graduate student proposals in innovative teaching techniques
- Survey graduate students to assess their job expectations, determine if they are receiving sufficient preparation, and follow-up with workshops as appropriate
- Develop coherent undergraduate research programs in *Earth Systems Science*

Attract and retain a diverse group of excellent graduate students

- Institute a CIRES summer seminar program for undergraduates from around the country
- Submit a *Research Experience for Undergraduates* (REU) in *Earth Systems Science* proposal to NSF
- Attract promising students and support interdisciplinary research with faculty and scientists who may only have disciplinary funding
- Recruit and fund a graduate student who participated in the UCAR SOARS *(Significant Opportunities in Atmospheric Research and Science)* minority opportunity program
- Sponsor a student in the CU Graduate School *Summer Minority Access to Research Training (SMART)* program

Support long-term public science literacy through an excellent K-12 science education program

- Increase public awareness of important environmental and *Earth Systems Science* issues
- Dispel public misconceptions about important environmental science issues perpetuated by the media and the political forum
- Establish new contacts with public relations people and local journalists
- Support and provide process-based education for teachers, students, others

Support awareness of CIRES research and societal relevance to the general public

- Initiate, support and conduct public lectures of societal relevance (initially one or two per year) and provide relevant research information on our Web page
- Provide opportunities to meet with local organizations and regional institutes and give brief seminars and talks on relevant issues and specific CIRES programs
- Establish a permanent atrium display that changes monthly and highlights current efforts and new findings
- Conduct more short courses for the private sector (such as through the Center for the Study of Earth from Space)

Support awareness of CIRES research and societal relevance to decision-makers

- Evolve the CIRES Web presence into the pre-eminent environment for sharing science information both within CIRES and to the outside world
- Conduct proactive NOAA communications and provide decision-makers with scientific information relevant and applicable to their needs

3. Leadership and Creating an Innovative Research Climate

Inherent in the retreat discussions was the need for better communication between internal and external constituents. Communication is understandably a challenge to an institute as scientifically diverse and geographically dispersed as CIRES. Senior leadership must take the initiative in providing innovative ways to enhance that communication. The following goals address steps in that direction.

Create a research environment that facilitates interdisciplinary research and an integrated approach to Earth System Science

- Stimulate cross-disciplinary interactions through a distinguished lecture series of speakers invited for their ability to bridge the interfaces
- Encourage innovative science through an annual internal research competition
- Support the development of scientific themes through planning meetings, lunch lectures, workshops and other mechanisms that emerge within the themes themselves
- Support scientific research themes to help focus integrated research through mechanisms such as:
  - Conduct theme lectures and planning sessions
  - Strengthen the links between natural and social sciences
  - Convene "Chapman-like" conferences
  - Encourage more interdisciplinary work through supplemental funding and support of "risky science" at the boundaries between disciplines

Improve working relationships, facilitate interdisciplinary work, and strengthen "cooperativeness" within CIRES

- Schedule scientific breakfasts and lunches to become more aware of other disciplines and discover possible research collaboration
- List joint affiliations when presenting work, e.g., listing CIRES as well as our University departments or NOAA labs in journal manuscripts
- Rotate Fellows, Members' Council, and Executive Committee meetings between campus and NOAA sites to improve interconnectivity and a sense of community between the distributed CIRES locations
- Provide campus parking permits at each site and/or rebate parking lot fees to facilitate easy access to our campus location

Improve internal and external communications through the Internet.

- Further expand the CIRES Web page as a tool for internal information exchange such as opportunities for funding, indices of available scientific databases, answers to typical questions, CIRES policies and procedures, and descriptions of (or links to) all affiliated labs and departments
- Establish personal Web pages for each of our members (not just the Fellows)
- Provide regular information exchange through a CIRES newsletter, including a Web version plus printed copies for wide dissemination
- Expand the CIRES Web page as a tool for external information exchange including recent scientific highlights, current field programs, annual reports and scientific reviews

4. Human and Physical Resource Development

The success of an institute depends critically upon its human resources and the ability to provide the infrastructure necessary to enable research and education. Development and initiation of the CIRES *Career Track* has been successful, however much more needs to be done in providing an environment for fostering our research and administrative staff. The Council of Fellows must insure an appropriate balance between NOAA and University representation as well as strengths in new cross-disciplinary initiatives. These enhancements will require targeting new faculty hires and the addition of new Fellows.

CIRES currently has built-out the existing space on campus. Negotiations on the rent for current space are nearly complete, however, long-term space policies have not yet been established. Space will continue to be a problem and will eventually limit our opportunities to take on new research opportunities. The following bullets detail steps toward these goals.

Provide better mechanisms for member career development

- Provide wider opportunities for professional training
- Provide teaching opportunities for science staff in conjunction with University departments and programs
- Further standardize the annual evaluation and salary-setting process through:
  - Clear comparisons of the CIRES salary structure with appropriate University and non-governmental sectors to establish an equitable market value
  - Clear knowledge by staff of their science advisor and supervisor of record who should coordinate each year during the evaluation process
  - Encourage science advisors and supervisors to take the evaluation process seriously with true merit-based evaluations
  - Develop supervisor-training workshops prior to the next review cycle

Strengthen departmental/CIRES collaboration through cross-cutting initiatives and joint faculty hiring

- Move forward with CIRES/CSES/Geography faculty hire to support observing and measurement systems initiative
- Move forward with CIRES/MCDB faculty hire to support biosphere enhancement
- Target two new faculty hires rostered in the graduate school over the next five years

Stabilize the administrative resource stream

- Work with University administration to minimize impact of potential reduction of the indirect cost rate
- Seek re-establishment of the non-DAICR (Departmental Administrative Indirect Cost Recovery) operating income stream to previous values

Improve the awareness of available resources and their utilization

- Document and advertise benefits (via the *Intranet*), advertise flexibility, and announce the availability of seed money, equipment, and expertise
- Develop a Web tabulation of scientists by area of research activity and expertise

Improve and enhance the service orientation of the CIRES administration

- Develop much needed information systems
- Invest in appropriate administrative technology

Improve CIRES Computing Facility (CCF) capabilities and support

- Further efforts to establish a responsive service policy and provide online information to help users find solutions to common problems
- Adopt a more efficient and useful problem response system
- Further standardize policies on the infrastructure services that CIRES supports (including hardware, software, remote computing, backups)
- Further implement a networked scheduling system
- Document configuration and use of current computer systems to enable a more efficient upgrade path to systems and software
- Establish centralized data storage for CIRES administration to enable file sharing between groups and establish standard links for current documents
- Implement a single backup system to encompass all operating systems and make it easier to find and restore files and file systems
- Improve processes and procedures to streamline the installation of new user equipment
- Consolidate and improve internal processes between CCF and functional groups

Improve CIRES Integrated Instrument Design Facility (IIDF) capabilities and support

- Staff from the *Integrated Instrument Development Facility* should visit all labs and departments to advertise their expanding capabilities and generate a wider reliable customer base
- Expand capabilities by considering an electronics technician and/or electrical engineer in the future
- Cross-train technicians and staff to broaden their capabilities and improve resource allocation options in supporting both laboratory and field operations

Develop a strategy for creating future physical infrastructure.

- Work with University administration to obtain policy on research space for the institute
- Establish a CIRES Physical Infrastructure Task Force to examine and recommend requirements and priorities for new space
- Assess potential opportunities for new space with consideration for off-campus space, a new CIRES/INSTAAR/PAOS building on the Grandview site, and the purchase of RL2.