Institute of Arctic and Alpine Research

1999-2000 Biennial Report

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Cover Picture

The subalpine plant kinnikinnik (*Arctostaphylos uva-ursi*) growing by a log. Photo by Tad Pfeffer.

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Biennial Report 1999 – 2000

Institute of Arctic and Alpine Research
University of Colorado at Boulder

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University of Colorado at Boulder

The Institute of Arctic and Alpine Research strives for excellence in research, education, and societal outreach. The Institute facilitates and accomplishes interdisciplinary studies offering special expertise in high-altitude and high-latitude regions of the world. INSTAAR also offers excellence in global and environmental research including non-cold-region Quaternary studies and geochronology, earth-system dynamics, landscape and seascape evolution, and climate dynamics. INSTAAR aims to understand how the varied regions of the world are affected by natural and human-induced physical and biogeochemical processes on the local, regional, and global scales. Research initiatives are interlinked with our educational and societal outreach missions. By encouraging the use of our facilities, and the expertise of our personnel, INSTAAR provides excellent educational opportunities to graduate and undergraduate students. Our outreach to the wider community, both locally and farther afield, includes aspects of research and education. INSTAAR provides leadership in setting regional, national, and international science priorities and agendas, with particular emphasis on societal-relevant issues.

Research

INSTAAR'S *Research Activities* integrate field studies, state-of-the art laboratory experiments, field and laboratory data analysis, and numerical and laboratory modeling. INSTAAR emphasizes three themes of research.

The Ecosystems Group focuses on the biological components of alpine and polar systems, global carbon and nitrogen cycling, the dynamics of biodiversity, and ecosystem disturbance and recovery. *Long-Term Ecological Research* (LTER) studies in alpine and polar regions are emphasized, involving populations and communities, biogeochemistry, and ecophysiology. Modern tools include geographic information systems (GIS), remote sensing, and ecosystem modeling. The *Mountain Research Station* offers a world-class complex of laboratory and field facilities to support these year-round research efforts.

The Geophysics Group applies quantitative field and numerical methods to discover the properties and dynamics of snow, ice, water, and sediments in the world oceans, glaciers, and land areas. Methods of analysis include theoretical and numerical development, remote sensing, and land and ship-borne field experiments, all applied to problems in hydrology, glaciology, frozen ground studies, paleoclimatology, physical oceanography, and marine geology. To facilitate these interests the *Environmental Computation and Imaging Facility* provides researchers with super-computational power and global connections to geophysical databases.

The Past Global Change Group focuses on the reconstruction of the dynamics of paleoenvironments and past climate variability, to enhance our understanding of the interactions between all components of the earth system, including atmosphere, ocean, land, ice, and the biosphere. Integration of a variety of records from a global network of sites, from the polar ice caps to continental alpine regions and to the world's oceans, provides the capability to test conceptual and predictive global change models, and to facilitate the differentiation between natural and human-induced change. To facilitate these interests the *Center for Geochronological Research* (CGR) provides scientists and state-of-the-art analytical facilities to address the cause, timing, and rates of environmental change in recent Earth history. The CGR fosters synergistic relationships across traditional disciplinary boundaries in order to understand the global circulation system.

INSTAAR'S *Teaching Mission* is directed towards fostering an appreciation and understanding of the biological, chemical, and physical processes operating in continental and ocean environments. Education efforts are aided by the Mountain Research Station and other study sites in the mountains of Colorado. INSTAAR supports the University of Colorado's educational mission and provides interdisciplinary graduate and undergraduate classes and research opportunities. Our teaching mission includes international educational experiences for University of Colorado students, training of foreign students, and volunteer outreach to community schools and various other external constituencies.

INSTAAR'S *Societal Mission* consists of activities in research, education, and science leadership. These activities address critical concerns involving issues such as ecosystem stability, biodiversity, water resources, agriculture, national security and resources, in sites ranging from the alpine areas of the Rocky Mountains to the remote regions of the world. Our expertise is applied to predictive understanding of environmental processes including the maintenance of water quality, and anticipating and responding to long-term environmental alterations. Changes and disturbance in high-latitude regions not only affect the lives of the indigenous residents, but also have a bearing on the lives of people everywhere, through global teleconnections.

Information regarding the Institute of Arctic and Alpine Research, Niwot Ridge Long-Term Ecological Research (LTER) Program, the Mountain Research Station, and the journal *Arctic, Antarctic, and Alpine Research* is available on the World Wide Web respectively at:

instaar.colorado.edu
culter.colorado.edu:1030/
www.colorado.edu/mrs/
www.colorado.edu/INSTAAR/arcticalpine/

The State of the Institute

A Message from the Director

The Institute of Arctic and Alpine Research (INSTAAR) facilitates interdisciplinary research in earth system dynamics with a special focus on high-altitude and high-latitude regions. We investigate how sensitive or high-energy environments affect, and are affected by, natural and human-induced processes on the local, regional, and global scales. Our research activities are designed to support initiatives at the state, national, and international levels. Our interdisciplinary scientists integrate this understanding into the educational fabric of the University of Colorado.

In the year 2000, the governing body of INSTAAR, the Directorate, was composed of thirty-five Fellows and Research Scientists, led by the Director, an Associate Director and an Executive Committee. The Directorate consisted of 11 teaching faculty (3: Environmental Population and Organismic Biology, 2: Geography, 3: Geological Sciences, 2: Civil, Architectural and Environmental Engineering, 1: Environmental Studies), 2 Fellow-Emeriti, 1 Research Professor, 2 Fellows-Adjoint, 17 Research Scientists, and the Managing Editor of the journal *Arctic, Antarctic, and Alpine Research*. The Directorate receives representation from 34 professional scientists, 10 postdoctoral scientists, and 65 graduate students. Directorate members are loosely associated with one of three research groups: Ecosystems, Geophysics, and Past Global Change. Other PhD-level Institute scientists include 27 Research Affiliates and 14 Visiting Scientists. The year 2000 INSTAAR family also included support from 79 undergraduate student research assistants, a Mountain Research Station (MRS) staff of 6, and 7 MRS instructors. An administrative staff of 8 supports the activities of these 277 members of INSTAAR.

Researchers at INSTAAR collaborate with investigators from 33 countries and 75 U.S. institutions, attesting to the international and national prominence of INSTAAR. In 1999-2000, INSTAAR Fellows and Scientists convened or chaired dozens of sessions/symposia at the national and international level, presented over 50 keynote talks to scientific and government assemblies, sat on 19 editorial boards of various research journals, and edited or co-edited 10 science journals.

Martha Andrews was elected as a Fellow of the Arctic Institute of North America for her outstanding service to the polar information community. Dr. David Anderson received the Sustained Superior Performance Award (NOAA). Dr. John Behrendt was a co-winner of the Colorado Book Award for nonfiction from the Colorado Center for the Book for his *book Innocents on the Ice: A Memoir of Antarctic Exploration, 1957*. John was also awarded the Felice Ippolito Gold Medal for his contributions to Antarctic Research (Academia Nazionale dei Linceia in Rome and the Italian Antarctic Research Programme). Dr. Anne Jennings was elected to the U.S. Polar Research Board for her outstanding research in Arctic science. Dr. Mark Williams was awarded a CU-Boulder Faculty Fellowship and a Fulbright Research Fellowship during the 1999-2000 academic year. Publication of the book *Interhemispheric Climate Linkages* edited by Vera Markgraf reflects her long-term effort in coordinating the PAGES-IGBP Pole-Equator-Pole Paleoclimate of the Americas initiative.

In 2000, INSTAAR had over 220 contracts and grants in force, providing, with CU general funds and gifts, a total operating budget in excess of $10 million. INSTAAR took possession of the second floor of the newly renovated Academic and Research Center (RL3) acquiring 10,000 ft^2 of new space use. The new space allowed INSTAAR to successfully acquire two super computers through an award from the Office of Naval Research, and through support from Sun Microsystems and the CU Graduate School. This Environmental Computation and Imaging (ECI) Facility will allow INSTAAR to provide global leadership in earth system modeling. The new RL3 space, plus another 3000 ft^2 of new space in RL1, the main INSTAAR headquarters, allowed INSTAAR to reorganize its operations and acquire two new conference rooms and a common room, to develop a new dendrochonology lab facility, and to expand its large geochemical laboratories. The Carbon-14 lab has doubled its ability to process samples for the NSF Earth System History community. The stable isotope laboratory houses $2M worth of mass spectrometers, within its recently renovated (>2000 ft^2) space. This state-of-the-art facility is home for six mass spectrometers, 10 different sample preparation systems, and a dozen computers. This environmentally friendly workplace supports a staff of 3 technicians, a manager, and numerous students and postdoctoral researchers, conducting over 48,000 samples per year of air, water, and organic matter for isotopes of hydrogen, oxygen, or carbon.

Outreach takes many forms at INSTAAR. For example, Scott Elias received a major new grant from NSF- Elementary, Secondary, and Informal Education to develop an interactive CD-ROM programs on Arctic science for middle school students in Alaska. Daniel Grossman completed a half-hour radio documentary, called *Fire and Ice* about tree-ring research in Alaska that sheds light on an Eskimo legend about an unusually cold winter and is providing climate modelers with a useful data point to test their simulations. Astrid Ogilvie has worked on the Smithsonian Institution's traveling exhibition "Vikings–The North Atlantic Saga." Other examples include sponsorship of regional science fairs for high school students and an Open House at INSTAAR for county middle schools. Through the Niwot Long-Term Ecological Research (NWTLTER) program, our Mountain Research Station offers a summer course "Alpine Ecology and Experiential Learning" that involves K-12 outreach and training of in-service and pre-service teachers from the local area and beyond. INSTAAR continued its support of the CU Summer Undergraduate Research Fellowship program, SMART STARS program (Summer Minority Access to Research Training at INSTAAR),

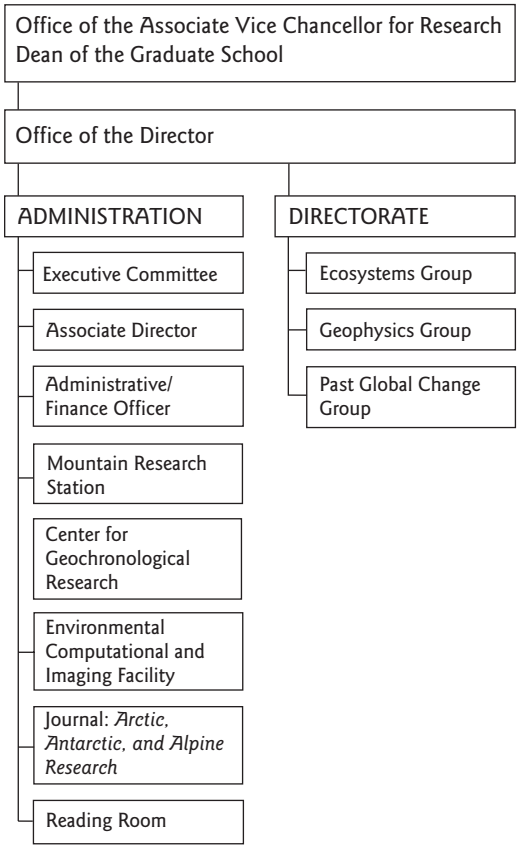
and the CU Summer Undergraduate Research Experience program. These programs contribute to INSTAAR's commitment to bringing research to undergraduates at the University of Colorado.

A few of the many interesting 1999-2000 research findings supported by INSTAARs and their activities:

- Land plants are capable of removing large amounts of CO_2 from the atmosphere, perhaps equal to the fossil fuel burning on short time scales.
- Human modification of the hydrologic system enhances the long-term storage of sediment and carbon. Agricultural impoundments and large-scale reservoirs may account for the missing carbon sink in the global carbon budget.
- A 15,000-yr record of El Niño-driven alluviation was recovered from southwest Ecuador.
- A record of a regional release of methane from continental shelf sediments appears to be tied to the retreat of the East Greenland Ice Sheet during the very late Pleistocene.
- On a global scale, and excluding the Greenland and Antarctic ice sheets, the regime of glaciers shifted to a new mode in 1976/77 where glaciers received more snow accumulation and produced more meltwater as a consequence of global warming.
- Subtropical sea surface temperatures for the period of 30-60 kyr were phase and amplitude locked to changes in Greenland air temperature and were in-phase with changes in North Atlantic Deep Water production.
- A method is developed for the prediction of rating coefficients for the sediment discharge of rivers, to be used at the dynamic level of river floods.
- A reactive solute transport model (photochemical and microbial processes) has been successfully applied to Front Range alpine streams
- A deep freeze 8200 years ago can be traced to the release of ice-dammed lakes spilling from Hudson Bay water into the Atlantic (coldest climate in the last 10,000 years)
- El Niño events recorded in coral reefs.
- Glacier retreat speeds up in Alaska.
- Release of weed-eating insects as an alternative to noxious weeds and use of herbicides.
- Fires set by Australia's first humans may have pushed huge animals (megafauna) into extinction.
- A new method is developed to apply protein diagenesis in carbonate fossils to date archaeological and geological events.
- INSTAAR research scientists have proposed critical loads for nitrogen deposition in Colorado, which may provide the foundation for billions of dollars in emission controls from source areas.
- The first rapid climate change found in Antarctica was discovered in the Siple Dome core: more than 6°C warming in about 50 years in the Ross Sea area.

We welcome James Dixon (in 2000) as a Fellow of the INSTAAR Directorate from his past position as Curator of Archeology, Denver Museum of Natural History. Other new members of the Directorate include John Hoffecker (joined in 1999, from DOE), William Manley (joined in 2000, from the University of Colorado), Elise Pendall (joined in 2000, from University of Arizona), Alexander Wolfe (joined in 2000, from Queen's University, Ontario), Connie Woodhouse (joined in 1999, from University of Arizona, in association with NOAA), David Lubinski (joined in 2000, from University of Colorado). New affiliates include Gary Clow, Julia Cole (former Directorate member who moved to the University of Arizona), Daniel Grossman, Mel Reasoner, Eric J. Steig, Hector Galbraith, Wesley LeMasurier

INSTAAR says bon voyage and good-fortune to the following Directorate members: Dr. Scott Elias, who moved to University of London, UK, but will retain the status of Fellow-Adjoint; Professor William Krantz who moved to the University of Cincinnati in 2000; Dr. Jonathan Overpeck and Dr. Julie Cole, who moved to University of Arizona in 1999; Dr. D. A. (Skip) Walker, who moved in 1999 to the University of Alaska to become a Professor; and Dr. Marilyn Walker, who moved to Fairbanks to join the U.S. Forest Service in 1999.



INSTAAR Directorate Members

Directorate Members

David Anderson

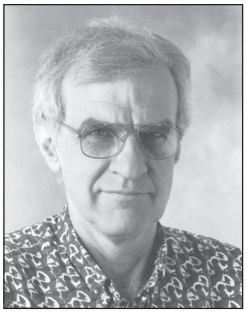
Research Associate of INSTAAR, Physical Scientist, Paleoclimatology Program, United States Department of Commerce, National Oceanographic and Atmospheric Administration. PhD: 1991, Brown University.
Specialty: Paleoceanography, marine geology, quantitative paleoenvironmental reconstruction.
Research Interests: Research on the marine geologic record of climate change, with emphasis on quantitative estimates of past ocean temperature and ocean upwelling/productivity. Projects include sediment trap studies in the California Current, investigations of modern hydrography and late Quaternary climate in southern Chile, and investigations of the sediment record of the SW Asian monsoon using cores from the Ocean Drilling Project.

John T. Andrews

Professor, Geological Sciences, Fellow of INSTAAR, Fellow of the Norwegian Academy of Science and Letters, PhD 1965; DSc 1978, University of Nottingham, UK.
Outstanding Awards: University Medal, 1997; DSc in honoris causa, University of Nottingham, 1998; Career Award, American Quaternary Association, 1998.
Speciality: Glacial and marine sedimentology and chronologies, high-resolution marine studies.
Research Interests: Late Quaternary history of ice sheet/ocean interactions and abrupt climate change during the last 10,000 to 40,000 yrs. Identification of iceberg rafting events. Detailed study of the paleoceanography of the East Greenland and Iceland margins on Holocene time scales.

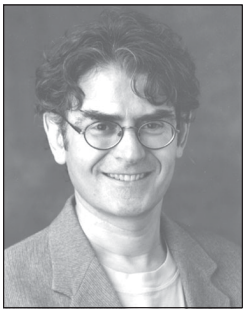
Martha Andrews

Librarian, Fellow of INSTAAR. MA: 1964, McGill University; MA, 1973, University of Denver.
Outstanding Award: Elected a Fellow of the Arctic Institute of North America, October, 1999; Alaska Historical Society Pathfinder Award, 1994.
Specialty: Organization and dissemination of polar regions information.
Research Interests: Networking polar regions information; conversion of print information to electronic format; development of electronic databases.



John C. Behrendt

Fellow, Senior Research Associate of INSTAAR. PhD: 1961, University of Wisconsin, Madison.
Outstanding Awards: Department of Interior Meritorious Service Award for Outstanding Research, 1992; Department of Defense Antarctic Service Medal with Winter Over Bar; First International Filice Ippilito Gold Medal for Antarctic Research from Italian Academia Nazionale dei Linceia and the Italian Antarctic Research Program, 1999; Colorado Book Award for Non-fiction, 1999.
Specialty: Antarctic and marine geophysics, glaciology.
Research Interests: Presently studying lithospheric controls on the behavior of The West Antarctic Ice Sheet. Also investigating the tectonics of the West Antarctic rift system including the continental margin. Deep crustal seismic investigations of continental rifts and rifted continental margins. Charleston, S.C. earthquake studies. Atlantic continental margins of U.S. and West Africa. Use of gravity and aeromagnetic surveys to investigate continental tectonics.

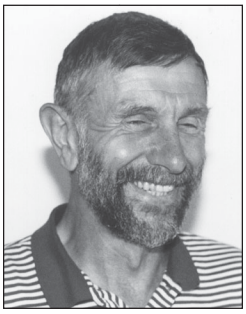


Patrick S. Bourgeron

Fellow of INSTAAR. PhD.: 1978, University Denis Diderot (formerly Paris 7), Paris, France.
Specialty: Ecosystem, landscape, and plant ecology; statistical and numerical modeling; biological diversity.
Research Interests: Structure of hierarchically organized ecosystems; analysis and modeling of species distributions; multi-scale mapping of biophysical and biotic patterns; selection of regional systems of conservation networks; land use change; integration of new technologies for ecological studies, ecological assessments, and conservation.

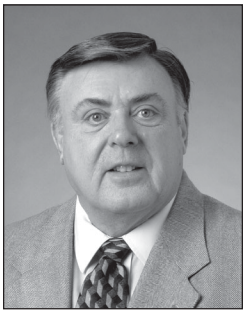
William D. Bowman

Director, Mountain Research Station/INSTAAR, Associate Professor, EPO Biology, Fellow of INSTAAR. PhD: 1987, Duke University.
Specialty: Plant ecology.
Research Interests: Biotic control over community and ecosystem properties, resource use by plants, alpine ecology.



T. Nelson Caine

Professor, Geography, Fellow of INSTAAR. PhD: 1966, Australian National University.
Outstanding Awards: 1989 Fellow AAAS, 1993 Frost Lecturer BGRG, 1994 G. K. Gilbert Award AAG.
Specialty: Geomorphology and hydrology.
Research Interests: Present-day processes of erosion and sedimentation in mountain environments. This includes studies of snow hydrology, streamflow generation, and sediment transport. It incorporates work on periglacial processes, mountain permafrost, and hillslope processes.



E. James Dixon

Fellow of INSTAAR. PhD: 1979, Brown University.
Outstanding Awards: Marshall Fellow 1972, National Endowment for the Humanities Fellow 1996–97.
Specialty: Archeology.
Research Interests: High Latitude/High Altitude Human Adaptations, Circumpolar and Paleoindian Archeology, Quaternary Science and Geoarcheology.

Mark B. Dyurgerov

Research Associate of INSTAAR, Professor, Russian Academy of Sciences. PhD: 1974, Moscow State University, Doctor of Science, 1990, Institute of Geography, Russian Academy of Sciences
Outstanding Award: State Grant of Russian Federation.
Specialty: Glaciology and terrestrial hydrology.
Research Interests: Mountain glaciers and ice caps in relation to climate change and the global-water cycle, glacier mass balance monitoring, spatial and temporal distribution of glacier properties, measurement methods for glacier mass balance and runoff, all aspects of glacier regime and melt-water production worldwide, with particular emphasis in the Arctic, Alaska, and Central Asia.

Scott A. Elias

Senior Research Associate, Fellow Adjoint of INSTAAR, Lecturer, Geography Department, Royal Holloway–University of London. PhD: 1980, University of Colorado at Boulder.
Specialty: Quaternary insect fossils, paleoecology, paleoclimatology.
Research Interests: The paleoecological, paleoclimatic, zoogeographic, and evolutionary implications of insect fossil assemblages from the Quaternary period. Studies of insect fossil assemblages from more than 200 sites in North America and Europe, deriving data for use in paleoecological and paleoclimatic reconstructions. Presently investigating late Pleistocene environments of Beringia (unglaciated regions of eastern Siberia, Alaska, the Yukon, and the Bering Land Bridge), Colorado, the Great Basin, and Britain.

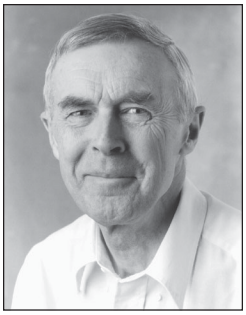
Ute C. Herzfeld

Fellow Adjoint of INSTAAR, Affiliate Professor of Applied Mathematics. PhD: 1986, Johannes Gutenberg-Universität, Mainz, Germany.
Outstanding Award: Heisenberg Fellow, German Science Foundation.
Specialty: Geomathematics, glaciology, marine eophysics, remote sensing.
Research Interests: Geomathematics, satellite geophysics, glaciology (Antarctic ice streams, Arctic calving glaciers, surging glaciers), marine geology and geophysics (mid-ocean ridge systems, Antarctic continental margin), oceanography (global primary productivity and global changes), geostatistics, nonlinear processes in geophysics, automated surface classification.

John F. Hoffecker

Research Associate of INSTAAR. PhD: 1986, University of Chicago.
Specialty: Archaeology and human paleoecology
Research Interests: Human adaptations to cold environments during the Pleistocene and Holocene. Studies of Paleolithic archaeological sites

in Eastern Europe and early and late prehistoric sites in Alaska. Special focus on the analysis of large mammal remains from Middle Paleolithic sites in the northern Caucasus region of Russia, and problems in Neanderthal ecology. Also, focus on Late Pleistocene sites in central Alaska, and human colonization of Beringia and the New World. Presently investigating ecology of earliest settlement of Eastern Europe in the Caucasus region, and Holocene maritime adaptations in northern Alaska.

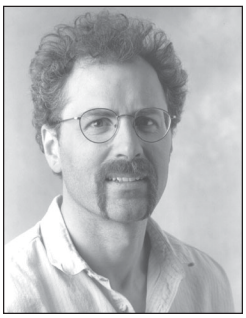


John T. Hollin

Fellow of INSTAAR, Research Scientist Emeritus. PhD: 1972, Princeton University.
Specialty: Glaciology, Quaternary especially last interglacial history.
Research Interests: Glacier and ice-sheet profiles, empirical and theoretical. Sea-level evidence for Antarctic melting and/or surging. Gondwana ice surges and Carboniferous coal cyclothems.

Anne E. Jennings

Assistant Professor Attendant Rank of Geological Sciences, Research Associate of INSTAAR. PhD: 1989, University of Colorado at Boulder.
Specialty: Paleoceanography, glacial history, foraminifera.
Research Interests: Paleoceanography, glacial history, and climate change in high-latitude regions, specifically Greenland, Baffin Island, Iceland, and Antarctica. Specializes in using foraminifera for interpreting paleoenvironments and chronology on high-latitude continental shelves.



Scott J. Lehman

Fellow of INSTAAR, Associate Research Professor of Geological Sciences: PhD: 1989, University of Colorado at Boulder.
Outstanding Award: Appointed to National Academy of Sciences "Frontiers of Science" Steering Committee, 1994, 1995,1996.
Specialty: Paleoclimatology, paleoceanography, paleochemistry, past global change.
Research Interests: The role of the oceans in climate change, cycling of heat and carbon by the oceans, ocean-ice sheet interactions, paleotemperature applications of marine biomarkers and amino acids, radiocarbon calibration, exposure age dating, Quaternary stratigraphy, and glacial geology. Currently director of INSTAAR's AMS Laboratory for Radiocarbon Preparation and Research, which serves the AMS radiocarbon dating needs of the US-NSF's Earth System History Program. Other current research programs focus on temperature reconstructions of the subtropical North Atlantic, calibration of the radiocarbon time-scale, and glaciation history of Scandinavia.

David J. Lubinski

Research Associate of INSTAAR. PhD: 1998, University of Colorado at Boulder.
Specialty: Glacial geology, paleoceanography, and paleoclimatology of high northern latitudes.
Research Interests: Presently investigating (1) the Last Glacial Maximum to present glacier history of the Severnaya Zemlya Archipelago, Russian Arctic, 79° N, (2) Late Quaternary glacial history of Vaygatch Island, Russian Arctic, 69° N, (3) Foraminiferal and stable isotopic records in the northern Barents and Kara seas, and (4) modern benthic foraminiferal and environmental relationships in the Barents and Kara seas. Completing studies of (5) Late Quaternary glacial and environmental conditions on Franz Josef Land and Novaya Zemlya.

William F. Manley

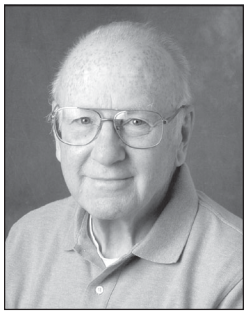
Research Associate of INSTAAR. PhD: 1995, University of Colorado at Boulder.
Specialty: Quaternary Geology, GIS, Geochronology, and Paleoclimatology.
Research Interests: Pleistocene glacier fluctuations and paleoclimate forcing for Alaska, through field research and data analysis, including spatial analysis with raster GIS Spatial analysis of modern Alaskan glaciers, including links between equilibrium-line altitudes and climate. Amino acid geochronology and paleothermometry. Glacial and environmental histories of southern Baffin Island and northwest Russia.

Vera Markgraf

Research Professor of Geography, Fellow of INSTAAR. PhD: 1968, Bern, Switzerland.
Specialty: South America and Southern Hemisphere paleoclimates and interhemispheric paleoclimate correlations.
Research Interests: High resolution, multiproxy paleoclimate analysis, using pollen (vegetation history), charcoal (fire history), and stable isotopes (temperature history) from late-Quaternary lake and bog sediments in southern South America, in collaboration with J. W. C. White and E. Pendall (both INSTAAR) and INSTAAR graduate students. International cooperative research: Patagonian Lake Drilling Project (PATO), focusing on recovery and multiproxy analysis of sediment cores from large, extra-Andean lakes. Editor of volume "Interhemispheric Climate Linkages," published in 2000 by Academic Press, representing the outcome of the "Pole-Equator-Pole Paleoclimates of the Americas" (PEP 1) IGBP-PAGES research initiative, that I previously chaired. Co-editor with H.F. Diaz of the volume "El Niño and the Southern Oscillation: Multiscale Variability and Global and Regional Impacts," published in 2000 by Cambridge University Press.

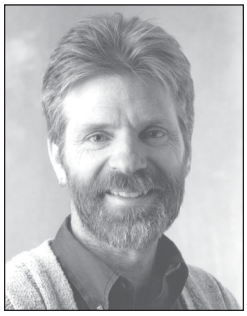
Diane M. McKnight

Associate Professor, Department of Civil, Environmental and Architectural Engineering, Associate Director of Mountain Research Station and Fellow of INSTAAR. PhD: 1979, Massachusetts Institute of Technology.
Outstanding Award: Meritorious Service Award, USGS, 1995.
Specialty: Limnology, biogeochemistry of lakes and streams.
Research Interests: Research focuses on interactions between hydrologic, chemical and biological processes in controlling the dynamics in aquatic ecosystems. This research is carried out through field-scale experiments, modeling, and laboratory characterization of natural substrates. Main field sites are located in the Rocky Mountains and in the Transantarctic Mountains, and include pristine and stressed ecosystems, such as acid mine drainage influences on mountain streams. Conducts research focusing on interactions between freshwater biota, trace metals, and natural organic material in diverse freshwater environments, including lakes and streams in the Colorado Rocky Mountains, and the McMurdo Dry Valleys in Antarctica. Develops interactions with state and local groups involved in mine drainage and watershed issues in the Rocky Mountains. A co-principal investigator in the McMurdo Dry Valley LTER and in the Niwot Ridge LTER.



Mark F. Meier

Professor Emeritus of Geological Sciences, Fellow of INSTAAR. PhD: 1957, California Institute of Technology.
Outstanding Awards: Robert E. Horton Medal, American Geophysical Union; Seligman Crystal, International Glaciological Society; Distinguished Service Award (Gold Medal), U.S. Department of the Interior; other medals and honors.
Specialty: Glaciology, Global Change
Research Interests: Glaciers in the Earth system, glacier dynamics, snow and glacier hydrology, causes and projections of sea-level change, mechanics of iceberg calving, flow of fast surging and calving glaciers, climate change, and global change in general.



Gifford H. Miller

Professor of Geological Sciences, Fellow of INSTAAR. PhD: 1975, University of Colorado at Boulder.
Specialty: Quaternary stratigraphy and geochronology.
Research Interests: My primary scholarly interests focus on gaining an improved understanding of how the physical earth system operates. Toward this end, I am specifically interested in recent Earth history as a tool to reconstruct the coupled ocean/atmospheric/ice climate system. By reconstructing past environmental changes it is possible to get a better understanding of the rates and magnitude of natural climate variability, and the various feedback mechanisms in the global climate system.

Astrid E. J. Ogilvie

Associate Director (1995 through May 1998) and Fellow of INSTAAR. PhD: 1982, University of East Anglia, Norwich, UK.
Specialty: Historical climatology and environmental history.
Research Interests: Main areas of interest are the use of historical records to reconstruct past climate, in particular, the past climate and sea-ice record of Iceland, and the human dimensions of climatic and environmental changes, and the comparison and integration of different proxy climate records. Interests include the general environmental and human history of countries bordering the North Atlantic regions, in particular Iceland, Greenland, Norway, and the United Kingdom, and

North Atlantic fisheries history. Working closely with colleagues in the fields of archaeology and anthropology, in particular through NABO (the North Atlantic Biocultural Organization) and also in the general field of climate history, especially in connection with EACH (European and Atlantic Climate Historians).

Elise Pendall

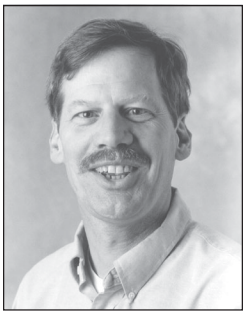
Research Scientist. PhD: 1997, University of Arizona
Outstanding Awards: NOAA Climate and Global Change Post-Doctoral Fellow
Specialty: Stable isotope geochemistry.
Research Interests: Carbon cycling, especially in the terrestrial environment; paleoecology and paleoclimatology reconstructed from stable isotopes of organic materials; isotope hydrology.

W. Tad Pfeffer

Associate Director, May 1998–present and Fellow of INSTAAR, Associate Professor of Civil, Environmental, and Architectural Engineering. PhD: 1987, University of Washington.
Outstanding Award: 1997 American Geophysical Union Editor's Citation for Excellence in Refereeing for JGR-Solid Earth.
Specialty: Glaciology, continuum mechanics, heat transfer.
Research Interests: Dynamics of present and past glaciers and ice sheets, through field observational methods and numerical modeling, with emphasis on analysis of stress, deformation and defracture, and iceberg calving and ice/ocean interaction. Also, heat and mass transfer in seasonal and perennial snowpacks and atmospheric and snowpack temperature measurement methods.

Kathleen A. Salzberg

Managing Editor, *Arctic, Anatarctic, and Alpine Research*, Associate of INSTAAR. MA: 1964, University of Edinburgh.
Specialty: Publication and dissemination of scientific research.



Tim R. Seastedt

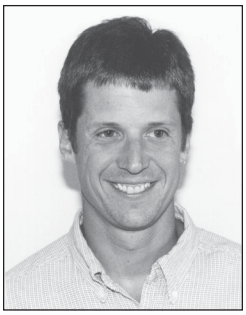
Professor of Environmental, Population and Organismic Biology, Fellow of INSTAAR. PhD: 1979, University of Georgia.
Specialty: Terrestrial ecosystems and biogeochemistry.
Research Interests: Interested in how biota interact with physical and chemical properties of the environment to control patterns of energy flow and material cycling. These interests center on soil phenomena, particularly those of grassland and tundra ecosystems.

Robert F. Stallard

Research Associate of INSTAAR. PhD: 1980, Massachusetts Institute of Technology/Woods Hole Oceanographic Institution.
Specialty: Biogeochemistry, hydrology, and geomorphology.
Research Interests: My principal interest is the earth-surface environment and how it changes on human and geologic time scales. Currently, my focus is the study of climate and land-use changes and how these affect processes that control the composition and dispersal of dissolved and solid phases in rivers and trace gases in the atmosphere.

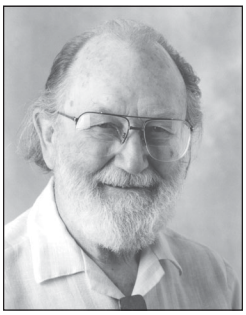
James P. M. Syvitski

Director and Fellow of INSTAAR, Professor of Geological Sciences. PhD: 1978. University of British Columbia (1) Geological Sciences, 1st class, (2) Oceanography, 1st Class.
Outstanding Award: 1998 Best Paper Award from the International Association for Mathematical Geology.
Specialty: Sedimentology, oceanography, hydrology, numerical modeling (climate-ice-water-sediment interactions), marine geophysics, slope instabilities, seafloor acoustics.
Research Interests: Presently investigating (1) the discharge dynamics of global rivers and the sediment load they carry, (2) the morphology and deposits of continental margins, (3) the impact of high-energy weather events on our coastline; and (4) the impact of ice sheets on high-latitude shelves and slopes.



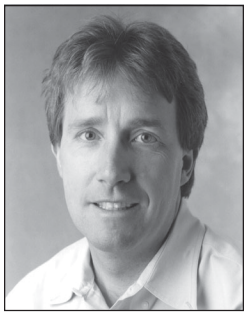
Alan R. Townsend

Assistant Professor of Environmental, Population and Organismic Biology. Research Associate of INSTAAR, PhD: 1994, Stanford University.
Outstanding Awards: NOAA Climate and Global Change Postdoctoral Fellow, SCOPE-Nitrogen Postdoctoral Fellow, NASA Global Change Graduate Fellowship.
Speciality: Terrestrial biogeochemistry/ecosystem ecology.
Research Interests: Carbon and nitrogen dynamics at regional to global scales; phosphorus controls over C and N in moist tropical systems; effects of N deposition in the Colorado alpine. Currently working on a NASA-funded project to look at carbon, nitrogen, and phosphorus cycling in primary forests, successively older pastures, and secondary forests in the Tapajos region of the Amazon. Part of this work involves a collaboration with J. W. C. White to assess the effects of land-use changes in the use of $^{13}CO_2$ as a tracer of sources and sinks in the global C cycle. Other work includes collaboration with other INSTAAR members on work in the Niwot LTER region, continued involvement wit the SCOPE-N project, which charts extent and effects of human-induced N cycling in large regions, and the development of research along a N-deposition gradient in the Mt. Zirkel Wilderness Area.



Mort D. Turner

Fellow Emeritus of INSTAAR. PhD: 1972, University of Kansas.
Outstanding Award: H. Marie Wormington Award in recognition of outstanding contribution to the understanding and preservation of America's earliest cultural heritage, from the Center for the Study of the First Americans, Oregon State University 1995.
Specialty: Glacial and archaeological geology.
Research Interests: Active research interests are (1) glacial geology and archaeological geology of southwestern Montana and alpine areas of Colorado, (2) environment and archaeological geology of late Pleistocene ice-sheet margins in the United States, (3) geology and mineral resources of Antarctica, (4) tectonic development of the Caribbean region, and (5) archaeological geology of early man in the Americas, China, and Russia.

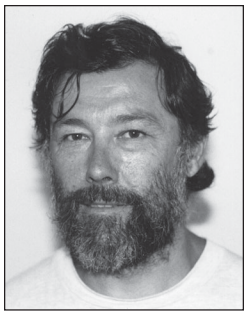


Robert S. Webb

Associate of INSTAAR. NOAA Scientist. PhD: 1981, Brown University.
Specialty: Paleoclimate research, past and future global change. Reconstructing Late Quaternary climate change from the geologic record and using numerical models to investigate the mechanisms of the past climate and environmental change.
Research Interests: (1) generating quantitative estimates of past climate from fossil pollen data and paleolake level records, (2) modeling of past changes in vegetation distributions, (3) developing hydrologic models for evaluation the dynamics of past changes in regional moisture balances, (4) assessment and improvement of the hydrologic cycle in general circulation models (GCMs), and (5) the design and implementation of GCM paleoclimate simulations to test hypotheses of past climate change.

James W.C. White

Associate Professor of Geological Sciences, Fellow of INSTAAR, Director of the Environmental Studies Program. PhD: 1983, Columbia University.
Specialty: Global change, paleoclimate dynamics, biogeochemistry.
Research Interests: Stable isotope laboratory: global scale climate and environmental dynamics, carbon dioxide concentrations and climate from stable hydrogen isotopes peats and other organics, climate from deuterium excess and hydrogen isotopes in ice cores; isotopes in general circulation models; modern carbon cycle dynamics via isotopes of carbon dioxide and methane.



Mark W. Williams

Associate Professor of Geography, Associate of INSTAAR. PhD: 1991, University of California-Santa Barbara.
Outstanding Awards: CU-Boulder Faculty Fellowship, 1999–2000; Fulbright Research Fellowship, 1999; EPA Region VIII Outstanding Environmental Achievement Award, 1998.
Specialty: Alpine biogeochemistry, hydrology, and snow hydrology.
Research Interests: The processes that determine the hydrochemistry and biogeochemistry of high-elevation basins including the storage and release of solutes from the snowpack, biogeochemical modifications of snowpack runoff,

nutrient cycling, and hydrologic pathways and residence time. Current projects include the Rocky Mountains, Ecuadorian and Bolivian Andes, and Central Asian areas of Kazakhstan, Kirghizia, and China.

Alexander P. Wolfe

Research Associate of INSTAAR. PhD: 1994, Queen's University, Ontario.
Specialty: Paleolimnology, freshwater diatoms, environmental change as registered in the sediments of arctic and alpine lakes.
Research Interests: My research focus is paleolimnology, primarily the use of freshwater diatoms preserved in sediments to infer patterns of lake evolution. The Geographical focus is both arctic (Baffin Island) and alpine (Rocky Mountains, Andes), whereas the timescales investigated range from anthropogenic disturbances in recent decades to glacial-interglacial cycles.

Connie A. Woodhouse

Physical Scientist, NOAA, Associate of INSTAAR. PhD: 1996, University of Arizona.
Specialty: Paleoclimatology, dendrochronology, climatology
Research Interests: Research has focused on the generation and interpretation of high-resolution records of climate for the past 2000 years. Current research projects concern tree-ring reconstructions of drought for the Great Plains and Rocky Mountains, as well as investigations into the mechanisms of long terms drought and impacts on ecosystems and disturbance regimes. Other work addresses millennial length reconstructions of temperature and atmospheric circulation for the northern Rockies and western United States. Recent projects target ways to generate dendrohydrologic reconstructions that are more useful to water resource managers.

INSTAAR Affiliates & Visitors

Affiliates

Ecosystems

Stephen Jackson
Assistant Professor, Botany, University of Wyoming. PhD: 1983, Indiana University.
Verification of the range of vegetation responses to environmental changes, and delineation of the relationships between modes of response and the magnitudes and rates of environmental forcing.

Herman Sievering
Professor, Environmental Science Program & Physics Department, University of Colorado at Denver. PhD: 1971, University of Illinois.
Atmospheric physics and chemistry.

Cathy Tate
Research Biologist, Water Resources Division, U.S. Geological Survey, United States Department of Interior, Denver Federal Center. PhD: 1985, Kansas State University.
Ecology and biogeochemistry of temperate and Antarctic streams.

Geophysics

Edmund Andrews
Chief River Mechanics Project, National Research Program, U.S. Geological Survey, Denver Federal Center. PhD: 1977, University of California-Berkeley.
Sedimentation in alluvial rivers.

David B. Bahr
Digital Creators, Boulder, Colorado. PhD: 1993, University of Colorado at Boulder.
Glaciology and sediment transport.

Gary Clow
U.S. Geological Survey, Climate History Program, Denver Federal Center.
Borehole paleothermometry in polar regions, climate monitoring, climate modeling.

Andrew G. Fountain
Professor, Department of Geology, Portland State University. PhD: 1992, University of Washington.
Glacier hydrology.

Pierre Julien
Professor, Department of Civil Engineering, Colorado State University. PhD: 1983, Laval University.
Hydrology and sediment transport modeling.

Vladimir Konovalov
Chief, Department of Regional Projects, SANIGMI, Tashkent, Republic of Uzbekistan. PhD 1964, Leningrad State University, USSR; 1983, USSR Academy of Sciences, Irkutsk, USSR.
Glaciology and hydrometeorology.

Wesley E. LeMasurier
Professor of Geology, Department of Geology, Univ. of Colorado at Denver. PhD: 1964, Stanford University.
Igneous petrology and volcanology. Cenozoic volcanoes of Antarctica (petrology, geochemistry, and tectonic relationships), and the record of glacial history preserved in hydrovolcanic deposits.

John Pitlick
Associate Professor, Department of Geography, University of Colorado at Boulder. PhD: 1988, Colorado State University.
Geomorphology and sediment transport modeling.

Lincoln Pratson
Assistant Professor, Division of Earth & Ocean Sciences, Duke University. PhD: 1993, Columbia University.
Marine geology and geophysics.

Past Global Change

Larry Benson
U.S. Geological Survey, Denver Federal Center. PhD: 1974, Brown University.
Quaternary fluctuations of closed basin lakes.

William Briggs
PhD: 1974, Victoria University of Wellington, New Zealand.
Paleoceanography, Paleoclimatology, Paleoecology; Late Quaternary high-latitude marine ostracodes.

Parker E. Calkin
Emeritus Professor of Geology, State University of New York at Buffalo. PhD: 1963, The Ohio State University.
Glacial geology, geomorphology, Quaternary geology.

Julia Cole
Associate Professor, Department of Geosciences, University of Arizona. PhD: 1992, Columbia University.
Recent tropical climate variability, coral geochemical records, hydrologic cycle stable isotopes, North American drought.

P. Thompson Davis
Associate Professor, Natural Sciences Department, Bentley College. PhD: 1980, University of Colorado at Boulder.
Glacial and Quaternary stratigraphy, cosmogenic exposure dating, lacustrine sedimentology, tephrochronology, palynology.

James Dixon
Curator of Archeology, Denver Museum of Natural History. PhD: 1979, Brown University.
Archeology and paleoecology.

Daniel Grossman
Freelance Journalist. PhD: 1993, Massachusetts Institute of Technology.
Radio stories and magazine articles; working on climate change trade book.

Joan A. Kleypas
Marine Geologist, Marine Biologist, National Center for Atmospheric Research, Climate Change Research Section. PhD: 1992, James Cook University.
Coral reefs and climate change.

Richard F. Madole
Scientist Emeritus, Earth Surface Processes Team, U.S. Geological Survey. PhD: 1963, Ohio State University.
Surficial geology, geomorphology, Quaternary stratigraphy and dating techniques, and the application of these disciplines to determining recurrence intervals of natural hazards.

Daniel R. Muhs
Research Geologist, Earth Surface Processes Team, U.S. Geological Survey. PhD: 1980, University of Colorado.
Quaternary geology and paleoclimatology, soils, geomorphology, geochronology.

Alan R. Nelson
Geologic Hazards Team, U.S.Geological Survey, Golden Colorado. PhD: 1978, University of Colorado at Boulder.
Paleoseismology and active faulting of U.S. Pacific Northwest, Holocene sea-level history applied to neotectonics, earthquake and tsunami hazards.

Mel Reasoner
Geography & Earth Sciences, Brunel University, UK. PhD: University of Alberta.
Paleoecology of alpine environments, pollen and macrofossil analysis and lake-coring techniques, target preparation for AMS dating.

Richard Reynolds
U.S. Geological Survey, Denver Federal Center. PhD: 1975, University of Colorado at Boulder.
Geologic records of climate change; environmental magnetic studies.

Eric J. Steig
Assistant Professor, Geophysics/Quaternary Research Center, University of Washington, Seattle. PhD: 1996, University of Washington.
Isotope geochemistry, glaciology.

Robert S. Thompson
Team Chief Scientist, Earth Surface Processes Team, U.S. Geological Survey. PhD: 1984, University of Arizona.
Paleoclimatology, palynology, plant macrofossil studies, plant-climate relations, vegetation change, and paleohydrology.

Visitors

Dr. Harold Bugmann
National Center for Atmospheric Research. Host:Timothy Seastedt.

Dr. Faisal Butt
University of Oslo, Norway. Host: James Syvitski.

Mr. Shane Elipot
École Nationale Superieure des Ingenieurs des Études et Techniques d'Armement. Host: James Syvitski.

Dr. Timothy Erbrecht
Universität Trier. Hosts: Nel Caine and Ute Herzfeld.

Dr Áslaug Geirsdottir
University of Iceland. Host: John Andrews.

Dr. Sveinung Hagen
University of Tromsø, Norway. Hosts: John Andrews and Anne Jennings.

Dr. Morten Hald
Univesity of Tromsø, Norway. Host: Anne Jennings.

Dr. Gudrun Helgadottir
Marine Research Institute, Iceland. Host: Anne Jennings.

Dr. Ólafur Ingólfsson
University of Göteborg, Sweden. Host: John Andrews.

Dr. Markus Jonas
Universität Trier. Hosts: Nel Caine and Ute Herzfeld.

Ingibjorg Jonsdottir
University of Göteborg, Sweden. Host: James Syvitski.

Dr. Vladimir G. Konovalov
Tashkent, Uzbekistan, Fulbright Scholar. Hosts: Mark Meier and Mark Dyurgerov.

Dr. Sergey Korsun
Shirshov Institute of Oceanology, Moscow, Russia. National Research Council Fellowship. Host: David Lubinski.

Dr. Bruce Milne
Department of Biology, University of New Mexico. Host: Patrick Bourgeron.

Dr. Irina Overeem
University of Delft. Host: James Syvitski.

Ms. Liv Plassen
University of Tromsø, Norway. Host: James Syvitski.

Dr. Sarah Spaulding
California Academy of Sciences, Host: Diane McKnight.

Dr. Mikkel Tamstorff
National Environmental Research Institute, Copenhagen, Denmark. Host: Donald Walker.

Dr. Tore Vorren
University of Tromsø, Norway. Host: James Syvitski.

A group of the INSTAAR Director mem-

Postdoctoral Research Scientists

Dr. Rela Abernathy
1996, University of Florida. Plant ecology and plant biochemistry.

Dr. Lisa Barlow
1994, University of Colorado at Boulder. High resolution paleoclimatology, climate/societal interactions.

Dr. Carol Bilbrough
1996, Utah State University. Rangeland ecology.

Dr. Timothy T. Barrows
2000, Research School of Earth Sciences, Australian National University. Glacial geology, exposure dating, marine micropaleontology.

Dr. Paul Brooks
1995, University of Colorado at Boulder. Biogeochemistry.

Dr. Dominic Ferretti
1999, Victoria University of Wellington, New Zealand. Experimental technique development and isotopic analysis of atmospheric trace gases as indicators of climate change.

Dr. William Gould
1998, University of Colorado at Boulder. Landscape and vegetation ecology, Arctic ecosystems, field education.

Dr. Joel Harper
1997, University of Wyoming. Glacier dynamics, glacier hydrology, thermodynamic processes in snow.

Dr. Konrad Hughen
1991, University of Colorado Boulder. Paleoclimatology.

Dr. Hope Humphries
1993, Colorado State University. Landscape ecology, ecological modeling, conservation planning.

Dr. Beverly Johnson
1995, University of Colorado at Boulder. Use of stable isotopes in organic compounds for reconstructing paleovegetation and paleoenvironment.

Dr. Michael Kaplan
1999, University of Colorado at Boulder. Glacial history and numerical modeling of the Laurentide Ice Sheet.

Dr. Kathy Licht
1999, University of Colorado at Boulder. Glacial history of Ross Sea.

Dr. David Lubinski
1998, University of Colorado at Boulder. Glacial geology, paleoceanography, and paleoclimatology of high northern latitudes.

Dr. Helmut Mayer
1996, Eberhard-Karls-Universität, Tübingen, Germany. Quantitative stratigraphy, paleomagnetism, structural geology, glaciology, marine geology, Geomathematics, and geophysics.

Dr. John Miller
1999, University of Colorado at Boulder. Isotopic composition of radiative trace gases and biosphere atmosphere interactions.

Dr. Scott Peckham
1995, University of Colorado at Boulder. Mathematical modeling, fluid dynamics, hydrology and geomorphology.

Dr. Elise Pendall
1997, University of Arizona. Paleoclimate and carbon cycle biogeochemistry.

Dr. Mel Reasoner
1996, University of Alberta. Quaternary geology and palynology.

Dr. Julian Sachs
1997, Massachusetts Institute of Technology/Woods Hole Oceanographic Institution. Oceanography.

Dr. Katherine Nash Suding
1999, University of Michigan. Plant community ecology, plant species effects on ecosystem function.

A group of INSTAAR Postdoctoral Research Scientists

Professional Scientists and Research Support Personnel

Kathy Anderson
Primary duties: Paleoclimatological studies on a continental scale in North America, using pollen, plant macrofossils, and modern vegetation to look at past and future climate and vegetation changes. Supervisor: Scott Elias

Nancy Auerbach
Primary duties: Landscape-scale vegetation ecology statistical analysis for the Columbia River Basin. Research interests: Vegetation ecology analysis using GIS and remote sensing. Arctic ecology. Supervisor: Patrick Bourgeron.

Jim Barber
Primary duties: Geographic Information System (GIS) Analyst. Research interests: Prediction and modeling of ecosystem patterns using biophysical criteria. Supervisor: Patrick Bourgeron.

Timothy Bardsley
Primary duties: Field technician, collection of field data, maintenance of field equipment. Research interests: Long-term ecological research. Supervisor: Tim Seastedt.

Peter Brown
Primary duties: Drought reconstructions from the Central Plains region using tree-ring data. Research interests: Use of tree-ring data to reconstruct climate and forest dynamics. Supervisor: Connie Woodhouse.

Evan Burgess
Primary Duties: Data management and processing within GIS. for analysis of modern and past glacier-climate relationships. Supervisor: William Manley.

Briana Christine Constance
Primary Duties: Manage Terrestrial Biogeochemistry laboratory. Research Interests: Soil biogeochemistry. Supervisor: Alan Townsend.

Travis Cornwell
Primary duties: Radiocarbon dating technician. Research interests: Method development for radiocarbon dating. Supervisor: Jocelyn Turnbull.

Andrew Crotwell
Primary Duties: Laboratory manager, Oceanography Laboratory. Research Interests: Climate reconstruction using alkenone-derived sea-surface. Supervisor: Scott Lehman.

Wendy Cunningham
Primary duties: Diatomist working on Ross Sea paleoceanography. Research interests: Antarctic paleoceanography. Supervisor: John Andrews.

Mark Dreier
Primary duties: Assistant laboratory manager in Stable Isotope Laboratory, providing technical expertise with the hardware; develop new systems, maintain old systems, and rebuild mass spectrometers and vacuum pumps. Research interests: Climate research in Patagonia. Supervisor: Bruce Vaughn.

Matt Duvall
Primary duties: Develop a "living" electronic atlas of environmental change for the Berginian region of the Arctic, synthesizing as many line of evidence as possible under the PALE program within NSF. Supervisor: Gifford Miller.

Nanette Elias
Primary duties: Assistant to the Managing Editor of Arctic, Antarctic, and Alpine Research and Library Assistant for the INSTAAR Reading Room. Supervisors: Kathleen Salzberg and Martha Andrews.

Kim Elkins
Primary duties: Operate and maintain isotope ratio mass spectrometers. Research interests: the use of ice cores in identifying past global climate. Supervisor: James White.

Wendy Freeman
Primary duties: Manage the Sedimentology Laboratory, run analyses, train and supervise lab users, and maintain all instruments. Research interests: Sedimentological techniques and methods. Supervisor: John Andrews.

Charles Hart
Primary duties: Oversee the operation of the Amino Acid Geochronology Laboratory, including sample preparation, analysis, data reduction, and database management. Supervisor: Gifford Miller.

Michael Hartman
Primary duties: Data and information management Niwot LTER project. Research interests: data management and information technology. Supervisor: Tim Seastedt.

Chanda Herring
Primary duties: Prepare samples for carbon-14 dating from a Cariaco core. Research interests: Generate high-resolution carbon-14 plot to correlate with tree-ring and coral plots. Supervisor: Scott Lehman.

Jennifer Horsman
Primary duties: Data manager for long-term ecological research conducted in McMurdo Dry Valleys, Antarctica. Research interests: ecology, ice core glaciochemistry, climate change, data management and visualization, and scientific applications of GIS. Supervisor: Diane McKnight.

Eric Hutton
Primary duties: Develop process-based sediment transport models. Supervisor: Scott Peckham.

Katie Hyland
Primary duties: Field technician on Niwot LTER project, maintaining the automatic weather stations and collecting stream and soil solution samples for chemical analysis. Supervisor: Mark Williams.

Trudy Kernan
Primary duties: Oversee operation of Paleoclimatology laboratory, sample preparation and analysis, and data reduction. Research interests: Paleoclimate reconstruction. Supervisor: Julian Sachs.

Andrew Lillie
Primary duties: Graphic design, edition, and web design, and field assistance. Supervisor: Skip Walker.

Mark Losleben
Primary duties: Long-term climate database mangement; atmospheric and precipitation measurement. Research interests: Long-term climatic trends and related processes affecting Niwot Ridge. Supervisor: William Bowman.

Jeff Lukas
Primary Duties: Tree-ring sample collection, dating, measuring, and data analysis. Research interests: Climate variability in the interior West and its effects on human activities and ecosystems. Supervisor: Connie Woodhouse.

Kim Marsella
Primary duties: Science Management Officer head for the NSF-PALE program, and oversees the compilation of a pan-Arctic databse of paleoenvironmental data collected with PALE support. Supervisor: John Behrendt.

Helmut Mayer
Primary duties: Geomathematics and structural glaciology, snow and ice research; geostatistical analysis of ice surfaces. Supervisor: John Behrendt.

Steve Muller
Primary duties: GIS and remote-sensing analyst. Research interests: Mapping and spatial analysis of tundra ecosystems. Supervisor: Skip Walker.

Trevor Popp
Primary duties: Stable Isotope Laboratory Technician. Analysis of ice-core samples for H/D, $^{18}O/^{16}O$, and deuterium excess; processing of antarctic and Greenland ice cores for NICL; deep drill operator at North-GRIP camp, Greenland. Research interests: Paleoclimate via ice cores. Supervisior: Jim White.

Christine Seibold
Primary duties: Manager of Environmental Chemistry Laboratory. Research interests: Long-term ecological research chemistries. Supervisor: Tim Seastedt.

Steve Seibold
Primary duties: Manager Mountain Research Station. Supervisor: Bill Bowman.

Charles Steele
Primary duties: Radiocarbon dating technician. Research interests: Method development for radiocarbon dating. Supervisor: Jocelyn Turnbull.

Denise Steigerwald
Primary duties: Data manager for long-term ecological research conducted in McMurdo Dry Valleys, Antarctic. Research interests: Ecology, human impact on global conditions. Supervisor: Diane McKnight.

Jocelyn Turnbull
Primary duties: Manager of AMS radiocarbon dating laboratory. Research interests: Radiocarbon dating techniques and methods. Supervisor: Scott Lehman.

A group of INSTAAR Research and Support Personnel

Joanne Turner
Primary duties: Geoarchaeological assistant. Research interests: Earliest peopling of the Americas and sources of raw materials for stone tools. Supervisor: James Syvitski.

Frank Urban
Primary duties: Operates mass spectrometers for analysis of greenhouse gases and carbonates, prepares samples and manages data storage and quality assurance. Supervisor: Jim White.

Candice Urban Evans
Primary duties: Operates mass spectrometers for analysis of greenhouse gases and carbonates, prepared samples and manages data storage and quality assurance. Supervisors: Jim White and Julia Cole.

Bruce Vaughn
Primary duties: Manager of Stable Isotope Laboratory which houses six mass spectrometers. Research interests: Collaborates in isotopic studies in ice cores, glaciers, atmospheric gases, and global change. Supervisor: James White.

Nancy Weiner
Primary duties: Micropaleontology laboratory technician, supervises students and conducts foraminiferal analysis. Research interests: Micropaleontology. Supervisor: Anne Jennings.

Administrative Staff

December 2000

Margaret Ahlbrandt
Accounting Technician III

Kathy Clegg
Accounting Technician III

Mary Fentress
Administrative Assistant I

Sedrick Frazier
Accounting Technician III

Donivan Miller
Accounting Technician III

Julie Hughes
Chief Financial Officer/General Professional V

Vicky Nelson
Assistant to the Director

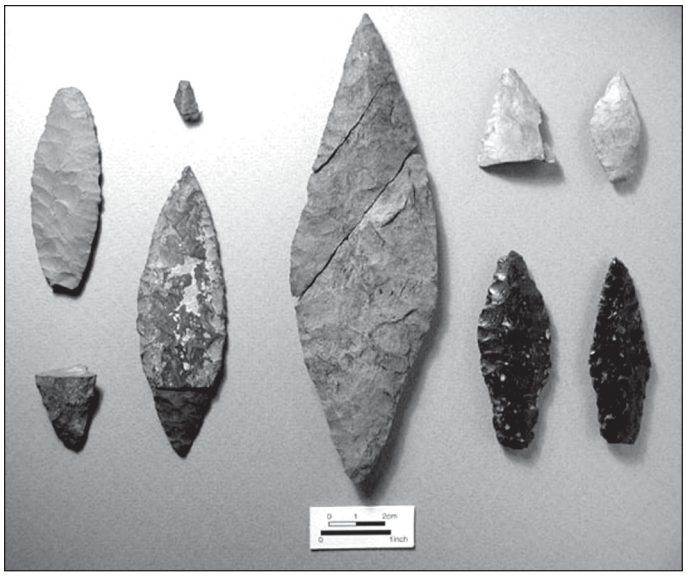
A group of INSTAAR Administrative Staff

Research Highlight: Ancient Peoples and Environments

Like all archaeological issues, the peopling of the New World must be placed in an environmental context. INSTAAR's **Scott Elias** has been studying the environmental conditions that may have played the dominant role in shaping the timing and direction of human migration into Alaska from Siberia. Archaeological evidence indicates that the first human migration into Alaska was across the Bering Land Bridge, a broad continental shelf region between Alaska and Siberia that was dry land during the last glaciation when eustatic sea level was low. Human migration occurred as regional climates warmed at the end of the last glacial, about 12,000 years ago. The cold and arid full-glacial climate that the interval 28,000-14,000 years BP appears to have kept Alaska essentially treeless, with no evidence of human inhabitation. Between 12,000 and 10,000 years BP, an interval of accelerated environmental change, bands of hunter-gatherers became established throughout the regions north of the Alaska Range. Flooding of the Bering Land Bridge brought warm Pacific waters into the Arctic Ocean, establishing oceanic circulation patterns that had been blocked for about 80,000 years. In much of Eastern Beringia (unglaciated regions of Alaska and the Yukon Territory), continental climates gave way to more moderate maritime climates. On the basis of fossil insect assemblages, **Elias** estimates that, by 11,000 years BP, average summer temperatures in Arctic Alaska rose to as much as 7ºC warmer than they are today. This warming was followed by an abrupt reversal, synchronous with the Younger Dryas oscillation in the North Atlantic region. Many large Pleistocene mammals became extinct around this time, forcing people to adopt new hunting strategies and seek different quarries. It remains unclear how directly human hunting contributed to the extinction of megafauna in the New World.

The Bering Land Bridge has long been invoked to explain migrations of terrestrial mammals and humans between Asia and North America during the Pleistocene. However, a growing body of data suggests that the earliest human migrations to North America may have occurred by watercraft along the northwest coast of North America, rather than via a postulated ice-free corridor between the Cordilleran and Laurentide ice sheets. INSTAAR fellow **James Dixon** is explicitly testing the coastal migration hypothesis through detailed investigations of a remote cave in the Tongass National Forest on Prince of Wales Island, southeast Alaska. In collaboration with paleontologist Timothy Heaton (University of South Dakota), ongoing excavations at site 49-PET-408 have contributed significantly to the mode of initial human colonization of North America. For example, the 1996 discovery of the human remains of an adult male, dated to 9200 BP by AMS ^{14}C, represents the oldest reliably dated human remains from anywhere in Alaska or Canada. Isotopic analysis of bone indicates that the human had a diet based primarily on marine foods. The remains are associated with stone tools including microblades, projectile points, and knives. The presence of exotic lithic materials of distant provenance strongly suggests the use of watercraft, implying that early peoples were engaged in trade and prepared to travel long distances to collect obsidian and other rare stone types. Since this initial discovery, evidence of an even older occupation at the cave has been found. A bone tool, possibly an awl or punch, has been dated to 10,300 BP, making 49-PET-408 the oldest archaeological site on the northwest coast of North America. Ongoing excavations include the participation of scientists, native interns from southeast Alaska, high school, undergraduate, and graduate students, as well as volunteers from across the United States. Research at the site has attracted reporters and film makers from around the world.

In contrast to the Americas, Australia was colonized well before the last glacial maximum. Estimates of initial colonization lie beyond the limit of radiocarbon dating, between 55,000 and 60,000 years BP. **Gifford Miller** and collaborators have been working to evaluate both the chronology of Pleistocene climate change in this region, as well as the impact of early humans on ecosystem structure. Studying the record of the closed Lake Eyre basin which internally drains large sectors of the continent's interior, they have reconstructed changes in the intensity of monsoonal



Bifaces and biface fragments. Biface tools are stone tools chipped on both sides of "faces." They were primarily used as projectile points or knives. Stemmed, leaf-shaped, and tanged forms have been recovered from the occupation dated ca. 9200 BP at 49-PET-408, Price of Wales Island, Southwest Alaska. (Photo James Dixon.)

rainfall over the past 150,000 years. The team has found that at the time of human colonization, the climate over most of the Australian interior was wetter than at any time subsequently. When humans first arrived, the continent was also populated by a diverse array of large marsupials and flightless birds, most of which rapidly became extinct, despite equable climates during this time. The strength of the data in support of humans being responsible for Australian megafaunal extinctions has largely settled a debate that had lasted more than a century. This extinction was even more dramatic than the North American counterpart, with the loss of 60 species, including every marsupial larger than human (19 species). **Miller**'s team has focused on one member of the extinct megafauna, *Genyornis newtoni*, a large, ostrich-sized bird that inhabited much of the semi-arid zone, nesting in sand hills near inland lakes. The eggshells of this bird are the most ubiquitous and best-preserved Quaternary fossils in the outback. **Miller**'s group has now analyzed fossil amino acid ratios from more than 1000 *Genyornis* eggshells from seven different regions of the outback. Eggshell amino acid racemization kinetics have been carefully studied experimentally, and many fossil samples have been independently dated. This lends confidence to the finding that *Genyornis* disappeared suddenly and synchronously throughout the outback, about 50,000 years ago. Deposits with *Genyornis* eggshell often contain the bones of other elements of extinct megafauna, whereas deposits that postdate *Genyornis* extinction are devoid of these remains, implying that the well-dated *Genyornis* extinction is representative of Australian megafaunal extinction in general. Although hunting pressures remain a distinct possibility, it is equally likely that systematic burning by early humans disrupted the landscape to the extent that animals with highly specialized diets became extinct while generalists survived.

Gifford Miller examines a *Genyornis* fossil eggshell in the field in Australia

Both early and late representatives of the genus *Homo* evolved in tropical and subtropical environments, only subsequently dispersing to latitudes above 45°N. The earliest high-latitude *Homo* settlements are from western Europe, where the effects of warm ocean currents ameliorated climate relative to the colder and drier regions of Eastern Europe and Siberia, which were not colonized until well after 250,000 years BP. INSTAAR Associate **John Hoffecker** has been working with Russian colleagues on the problem of hominid adaptation to these environments during the Middle and Late Pleistocene. The analysis of large mammal remains from Treugol'naya Cave in the northern Caucasus provides new insights into foraging strategy and diet from the northern margin of the hominid range (44°N) prior to 250,000 years ago. Taphonomic studies of the Treugol'naya fauna show little evidence of hominid hunting or central-place foraging, and a heavier reliance on plant foods. Coupled to the apparent lack of morphological or technological adaptations to cold temperature, this reliance on plant foods probably excluded *Homo* populations from northern regions outside western Europe until the appearance of Neanderthals and anatomically-modern humans. At the end of the Middle Pleistocene, Neanderthals colonized many parts of Eastern Europe. They exhibit an extreme cold-adapted morphology and evidence for central-place foraging and the efficient hunting of large mammals. **Hoffecker** is now leading studies at Mezmaiskaya Cave in the northern Caucasus, which is revealing a sharp contrast with the pre-Neanderthal occupation, including evidence for hunting of bison, sheep, and other large mammals, as well as a foraging strategy that probably entailed advanced planning and scheduling of seasonal resource use. After 40,000 years BP, European Neanderthals were replaced by modern humans, who exhibit a tropical morphology reflecting their recent African ancestry, but having successfully colonized northern latitudes during the Last Glacial thought the use of innovative technologies such as tailored fur clothing and insulated shelters.

Key publications:

Hoffecker, J. F., 1999: Neanderthals and modern humans in Eastern Europe. *Evolutionary Anthropology,* 7 :129-141.

Miller, G. H., Magee, J. W., Johnson, B. J., Fogel, M., Spooner, N. A., McCulloch, M. T., and Ayliffe, L. K., 1999: Pleistocene extinction of *Genyornis newtoni*: human impact on Australian megafauna. *Science,* 283: 205-208.

Research Highlight: The Carbon Cycle

In recent years, humans have dramatically altered several key global biogeochemical cycles. The effects of humans on the carbon cycle, an integral component of life on Earth and an important part of the Earth's climate system, have received by far the most attention. Atmospheric CO_2 levels are now higher than at any time in the recent geologic history of earth, and are rising at rates that are an order of magnitude greater than anything seen in the paleorecord. CO_2 is a greenhouse gas which alters the radiative balance of the atmosphere, and therefore earth's climate. It has been argued that we have already seen climate change due to rising CO_2 levels, and numerous future projections suggest incipient changes that include higher mean temperatures, significant redistributions of precipitation, a far greater incidence of severe, damaging storms, and perhaps most worrisome, strong nonlinear behavior in the global climate system. Moreover, changes in atmospheric CO_2 can directly affect the growth and distribution of both plant and animal life, with cascading potential feedbacks to not only the climate system, but also to the dynamics of natural and managed ecosystems on which we rely. However, while combustion of fossil fuels for energy is the major contributor to our rising atmospheric CO_2 levels, this energy also fuels the global economic engine and is one of the primary factors in molding foreign policies. Thus, environmental concerns over a changing carbon cycle have created virtually unprecedented discussions and debates at the highest levels of governments throughout the world.

Several INSTAAR scientists have been actively involved for years in key research on the global carbon cycle, and some of these individuals are true international leaders in this arena. Our first clear picture that humans were changing the global carbon cycle came decades ago from repeated measurements of CO_2 in the atmosphere, and this early effort has now expanded to include a multisite global network for monitoring CO_2 and several other gases in the atmosphere. The majority of this network is run by the carbon cycle group at NOAA here in Boulder, and scientists from NOAA and INSTAAR have along history of collaboration in analyzing data from the network. Flasks are filled with air at sites around the world every two weeks, and shipped to Boulder. Gas concentrations are measured at NOAA, but subsamples from all flasks are also sent to **Jim White**'s Stable Isotope Laboratory at INSTAAR. For more than a decade now, **White**'s laboratory has been measuring the ^{13}C content (and more recently the ^{18}O content) of the CO_2 in these flasks, and this data has proven to be enormously useful in understanding the complex dynamics of a changing global carbon cycle. For example, we have known for years that approximately half of the carbon emitted to the atmosphere by human activities is being stored in terrestrial and/or oceanic realms. The long-term implications of land vs. ocean sinks for anthropogenic CO_2 are vastly different, thus determining how much of the so-called "missing carbon" is going into each major reservoir has been an enduring and critical question. Since land-atmosphere and ocean-atmosphere exchanges of CO_2 create have very different effects on the ^{13}C content of the CO_2, the data from Dr. **White**'s laboratory has allowed both **White**'s group and others around the world to estimate land vs. ocean carbon sinks. More recently, John Miller and Dominic Ferretti have been developing state-of-the-art analytical techniques to expand the isotopic analyses from the flask samples to include ^{13}C of methane and deuterium measurements of water vapor.

A recent collaboration between **White**, **Alan Townsend**, Greg Asner from Geological Sciences, and Pieter Tans from NOAA has also highlighted the potential importance of tropical forest ecosystems in storing anthropogenic CO_2. Past attempts to use ^{13}C data from the flask network to focus on tropical latitudes were confounded by the strong isotopic effects created by widespread conversion of tropical forests, which discriminate strongly against the heavier isotope during photosynthesis, to predominantly C_4 photosynthesizing pastures and croplands, which have a much smaller isotopic effect. **Townsend** and colleagues quantified a probable range for the isotopic effects of such land conversion, and then used the atmospheric ^{13}C data to separate atmosphere-surface exchanges of CO_2 in the tropics between land and ocean realms. Their results suggested that intact tropical forests appear to have been a major sink for CO_2 throughout the 1990s, one which is on par with those estimated for mid-latitudes of the northern hemisphere. Recent work by **Cory Cleveland** and **Townsend** in Costa Rica has suggested one potential mechanism for such a sink: **Cleveland** and colleagues found that in phosphorus poor soils, which are widespread in the tropics, microbial decomposition is strongly limited by phosphorus. Most systems outside of the tropics show that the microbial community is more carbon than nutrient limited, but in these tropical ecosystems, **Cleveland** and colleagues showed that new inputs of C, such as might be seen with rising CO_2 levels, are stored in soils much longer than one might expect.

Elise Pendall has also been actively involved in studying the potential effects of rising CO_2 on terrestrial ecosystems, with an emphasis on grassland systems in the Colorado region. Several earlier studies suggested that rising CO_2 may cause a sharp increase in fluxes of relatively labile carbon through the plants and into the soil environment, thus stimulating decomposition and reducing net C storage. However, **Pendall** and colleagues used a combination of traditional measurements of ecosystem C pools and fluxes with isotopic analyses of those components to show that in a short-grass prairie system experiencing doubled CO_2, higher C inputs to the soil did not result in higher decomposition rates, and therefore that significant new soil C storage was occurring. They point out the importance of soil moisture controls over decomposition rates for the new carbon inputs, thus suggesting further complex feedbacks between rising CO_2 levels, a changing climate, and the overall response of the terrestrial carbon cycle.

Diane McKnight and her group devote some of their research efforts to another important and poorly understood component of the carbon cycle: the dynamics of organic carbon in aquatic systems. Organic carbon loading to freshwater ecosystems, and the dynamics of its transport, is being greatly altered by human activity. **Bob Stallard** and others have suggested that the transport of such carbon in

river systems, and its potential storage in reservoirs and coastal areas, may be an important missing piece of the puzzle in understanding recent carbon sinks. Predicting the dynamics of organic carbon in aquatic systems is hindered by difficulties in understanding both its quite variable chemistry (and therefore relative resistance to decomposition), and its original source. **McKnight** and colleagues have developed novel, new analytical techniques that help resolve some of these uncertainties, including both ways to fractionate the organic carbon into functionally different components, and new fluorescence measurements that greatly improve the ability to trace the original sources.

Finally, while numerous significant gaps remain in our understanding of how the carbon cycle, climate system, and ecology of earth interact, it is both difficult and perhaps misguided to address these natural science questions in the absence of human factors. Humans are now central to the workings of the earth, and an understanding of how they behave in terms of making foreign and domestic policy, formulating economic strategies, as well as how the media helps shape public perceptions and opinions, must be integrated with our developing understanding of the physical workings of the carbon cycle and climate. Thus, **Jim White** and **Alan Townsend** are co-directors of a large new NSF/IGERT-sponsored graduate training program entitled the Carbon, Climate and Society Initiative (CCSI). This program integrates natural science, social science and journalism perspectives on key issues of global environmental change, with an emphasis on the changing carbon cycle and climate system. Faculty participants in the CCSI represent nine CU departments and two research institutes, as well as the National Center for Atmospheric Research (NCAR), the National Oceanographic and Atmospheric Administration (NOAA), the Max Planck Institute for Biogeochemistry in Jena, Germany, and the Boulder *Daily Camera*. However, INSTAAR directorate members and students are playing a central role in this program, as in addition to **White** and **Townsend**, **Diane McKnight**, **Mark Williams**, and **Robin Webb,** are all part of the CCSI core faculty, and the first cohort of graduate students supported by the program includes eight INSTAAR graduate students: **Keri Holland**, **Dan Liptzin**, **Trevor Popp**, **Annalisa Schilla**, **Andrew Todd**, **Natalie Mladenov**, **Adina Racoviteanu**, and **Laura Belanger**.

Key Publications:

Asner, G. P., Townsend, A. R., and Braswell, B. H., 2000: Satellite observation of El Niño effects on Amazon forest productivity. *Geophysical Research Letters*, 27(7): 981-984.

Battle, M., Bender, M. L., Tans, P. P., White, J. W. C., Ellis, J. T., Conway, T., and Francey, R. T., 2000: Global carbon sinks and their variability inferred from atmospheric O_2 and $\delta^{13}C$. *Science*, 287: 2367-2470.

Remodeled Stable Isotope Laboratory, INSTAAR

Research Highlight: Nitrogen Cycling

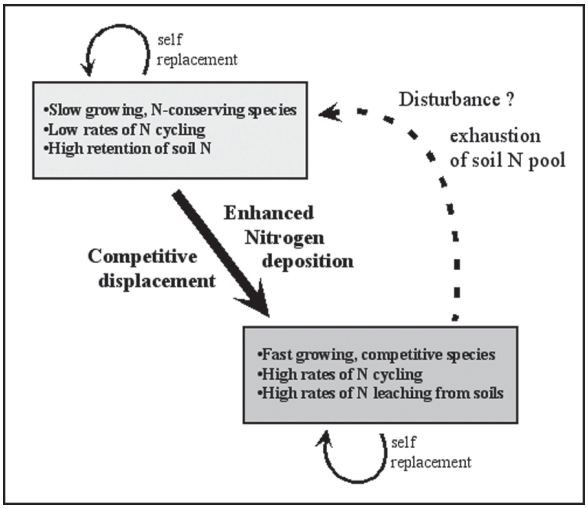
Human alteration of the nitrogen cycle is among the most important current global environmental problems. The increase in anthropogenic fixation of N_2 and subsequent emissions is proportionately greater than that of CO_2. There is growing concern over the effects of these increased N inputs on terrestrial and aquatic ecosystems, including eutrophication, acidification, and alteration of native species biodiversity. INSTAAR scientists are involved in research efforts investigating the ecological effects of increasing N deposition at a multitude of spatial scales.

Carbon and N cycles are usually coupled, as sequestration of CO_2 is dependent on the photosynthetic enzymes of plants, and primary production in many terrestrial ecosystems is limited by the supply of N. Thus it is reasonable to hypothesize that increased N deposition will result in greater uptake of CO_2. **Alan Townsend**, along with **Tim Seastedt** and Greg Asner from CIRES (University of Colorado), have evaluated the coupling of C and N cycles at a global scale based on regional perspectives. They suggest that there may only be a limited capacity of terrestrial systems to sequester more C as N deposition increases, due to increases in N saturation of terrestrial ecosystems in temperate latitudes of the northern hemisphere, and conversion of shrublands and forests to herbaceous dominated agriculture, which lowers the potential long-term C storage. In addition, **Townsend** and colleagues point out that much of the future increase in N deposition will occur at tropical and subtropical latitudes, where N limitation is much less common. In the tropics, excess N will rapidly lead to a variety of deleterious consequences, including the potential for a reduction, rather than stimulation, of carbon storage.

A regional concern is the potential influence of increased N deposition in the Front Range on ecosystems in the central Rocky Mountains. While the rates of N deposition are relatively low compared to areas such as Europe or the northeastern US, the granitic parent material of the soils, coupled with relatively low rates of primary production and N cycling, significantly decrease the threshold for N saturation of terrestrial and aquatic ecosystems. Evidence from stream chemistry monitoring efforts indicate that periodic N saturation is occurring, whereas paleolimnology suggests that attendant biological changes are manifested in lakes. **Mark Williams**, **Nel Caine**, and their students have conducted extensive stream chemistry measurements in the Green Lakes Valley over the past 30 years, and they have found periodic elevation of NO_3^- concentrations in high-elevation streams during the growing season. During the late 1980s and early 1990s there was a positive correlation between catchment yield and N deposition in the Green Lakes Valley. The highest lakes in this catchment have also experienced significant losses of acid-neutralizing capacity, in part because of higher N deposition related to the orographic increase of total precipitation with elevation. Ongoing research in **Williams**'s and Steve Schmidt's (EPO Biology) labs has focused on the role of microbes in talus soils in the highest parts of the catchment in chemical transformation of N deposition.

Alexander Wolfe, undergraduate student **Alison Van Gorp**, and Jill Baron of the USGS have documented striking shifts in diatom species composition in the sediments of several Front Range alpine lakes. Mesotrophic indicator species expand in close correspondence to significant changes in sediment $\delta^{15}N$ signatures, in synchrony with the history of increases anthropogenic N deposition. Similar trends are present but comparatively muted in lakes west of the Continental Divide, confirming that the offending sources lie to the east in the Denver-Fort Collins urban axis.

Bill Bowman is examining the potential response of alpine terrestrial vegetation to increasing N deposition. He has found that most species have a very limited capacity to respond to increased N availability, so that changes in species composition will occur as N deposition increases over alpine tundra. **Katie Suding Nash** has compared long-term changes in plant abundance in permanent plots with the results of changes in abundance following N fertilization experiments. The correspondence between these approaches confirms that changes in terrestrial communities are occurring in response to N deposition. Since plant species composition can control as much of the spatial variability in N cycling as variation in microclimate, as demonstrated by **Heidi Steltzer**, changes in plant species composition brought on by increases in N deposition will induce a positive feedback to N cycling, potentially accelerating fluxes of N between alpine terrestrial and aquatic ecosystems.



Schematic representation of the nitrogen cycle in terrestrial alpine ecosystems of the Colorado Front Range. (William Bowman, *Ambio*, v. 49, 2000.)

The evidence of significant and directional biological changes associated with increased N deposition has prompted **Mark Williams** and Kathy Tonnessen of the USGS to estimate a critical load for N deposition in the Colorado Front Range, which they have set at 4 kg/ha/year. They estimate that current rates of N deposition are at or slightly above the threshold of biological change and N saturation. **Barbara Inyan** and **Mark Williams** have also analyzed anthropogenic N inputs into catchments near Telluride, Colorado, and provided significant input to land managers and lawmakers used in legislation to minimize environmental damage caused by land development.

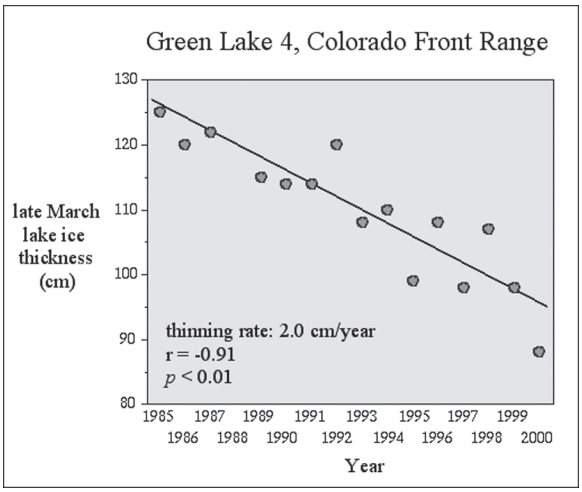
Key publications:

Bowman, W. D., 2000: Biotic controls over ecosystem response to environmental change in alpine tundra of the Rocky Mountains. *Ambio,* 49: 396-400.

Williams, M. W. and Tonnessen, K. A., 2000: Critical loads for inorganic nitrogen deposition in the Colorado Front Range, USA. *Ecological Applications,* 28: 207-210.

Research Highlight: Surface Water Hydrology

One potential consequence of climatic changes associated with enhanced accumulation of greenhouse gases in the atmosphere is alteration of hydrologic patterns. With warmer temperatures, evapotranspiration from the land surface may increase, possibly leading to an energized water cycle with greater frequency and intensity of extreme events such as floods and droughts. Because water is a strategic resource in many regions of the world, greater hydrologic variability creates new challenges for water resource managers. The assumption of stationarity, which assumes that the future trajectories of surface water systems are predicted by past variability, has been the mainstay for management of river networks. However, this model will be less reliable in a future when past analogs do not exist. This element of unknown variability compounds the challenges of meeting environmental quality objectives that now must be considered in water resource management. INSTAAR scientists are involved in basic hydrologic research that is advancing knowledge of surface water hydrologic processes at a range of spatial scales, from small streams to large river systems and their estuaries. Furthermore, INSTAAR scientists are engaged in field and modeling studies that address the coupling of elemental cycles and contaminant transport to hydrologic processes.



Recent trends in lake ice thickness near Niwot Ridge, Colorado. (Nel Caine, unpublished.)

Although it is recognized that management of rivers through impoundment and land-use change has direct effects on the transport of sediment at the catchment scale, greater understanding of global-scale patterns of sediment transport is critically needed. **James Syvitski** and colleagues have completed a comprehensive study using data from 59 gauging stations on large rivers to determine predictive equations for sediment rating parameters that are related to river basin morphology and climate. Developing these relationships requires thorough analysis of detailed data sets because the majority of annual sediment transport can occur during relatively short intervals of high flow. Interannual and storm event variability in sediment load is now adequately accounted for in these equations, allowing realistic explorations of long-term sediment load characteristics. Application of these models to ungauged river basins will be invaluable in designing water resource infrastuctures in developing countries, as well as in projecting changes in sediment transport patterns associated with climate change.

It has long been recognized that river networks have general patterns that are consistent across regions with different topographic and geologic characteristics. However, the processes that give rise to these patterns have yet to be explained from a geophysical perspective. One limitation in developing a quantitative understanding of the evolution of river networks has been the difficulty in acquiring detailed data on a number of large-scale river networks. **Scott Peckham** has developed a comprehensive computer package entitled River Tools, which can generate these data from digital elevation maps (DEMs) of river basins. While this software is used as research tool at INSTAAR, it is simultaneously being released and developed for current applications in water resource management. For example, **Peckham** has developed a detailed DEM for the Snake River Watershed which flows into Dillon Reservoir in Summit County, Colorado, in order to evaluate the contributions of abandoned mine sites to water quality problems in the watershed.

In the Rocky Mountains, the annual hydrologic cycle is dominated by wintertime accumulation of the snowpack and the melting of the snowpack in spring. **Mark Williams**, **Nel Caine**, and **Mark Losleben** have been studying the long-term record for climate, snowpack, and streamflow from the Green Lakes Valley in the Colorado Front Range which has been obtained through the Niwot Ridge Long-Term Ecological Research project (NWTLTER) and NOAA. These records suggest trends of increasing snow accumulation in late winter (March), earlier average snowmelt, and a decreases in lake ice thickness. Measurements of water flow made by **Alex Machado**, **Mark Williams**, and **Tad Pfeffer**, using an array of 36 snowmelt lysimeters at a subalpine site at Niwot Ridge have given a detailed and large-scale (100 m^2) view of the heterogeneities of meltwater flow through snow. Previous work of this type concentrated on smaller areas and used a smaller number of lysimeters. Geostatistical analysis of the lysimeter flow data indicates a typical spacing of approximately 2.4 m between vertical flow channels.

Important biogeochemical processes occur in the upper soil horizons under the snowpack, thus the pattern of snowpack distribution on the landscape influences the water quality of streamflow. **Hillary Hamann**, working with **Mark Williams** and **Nel Caine** is investigating the formation of ice lenses in alpine soils in two small sub-basins on Niwot Ridge, and evaluating their influence on the water quality. A topgraphically based model, TOPMODEL, is being used to analyze these results.

At another LTER site, the McMurdo Dry Valleys in Antarctica, **Diane McKnight**, **Arne Bomblies**, and **Mike Gooseff** are studying the relationship between climate, streamflow, and water chemistry in glacial meltwater streams. Analysis of data from the initial exploration of the Dry Valleys by members of Scott's party in 1903 and subsequent records of lake-level rise and stream flow indicate that the period of 1970 to 1995 had much greater stream flow than the previous 70 years, accounting for the 13 m rise in lake level in one of the dry valley lakes. Field measurements demonstrate that water storage in the hyporheic zone within porous alluvial sediments acts as an important control on the streamflow into Dry Valley lakes. The movement of water between the hyporheic zone and open stream channel can be modeled

effectively using a transient storage model (OTIS), which is being adapted to account for zones of rapid and slow exchange.

From the perspective of water resource management, options for responding to changes in hydrologic regime associated with variable climate are constrained by water quality and aquatic habitat concerns. In the Colorado Rocky Mountains, the success of the ski industry is dictated by the reliability of early-season snow cover (November and December). Later snowfall and competition among ski areas have increased requests for permits to use mountain streamflow for artificial snow making purposes. However, many mountain streams are contaminated by acid mine drainage, so that withdrawal and redistribution of these waters can exacerbate water quality problems. **Diane McKnight**, **Durelle Scott**, and **Eric August**, in collaboration with scientists at the US Geological Survey, are studying the hydrologic and biogeochemical processes controlling trace metal transport in streams and wetlands at several Rocky Mountain field sites. These studies employ a reactive solute transport model which quantifies chemical processes occurring in the open channel, the hyporheic zone, and in wetland sediments. This model has recently been adapted to include a kinematic wave model for the routing non-steady state flow, as well as a ligand exchange model for trace metals sorption onto particulate phases.

Glaciers and ice sheets play large roles in global hydrology, and especially in rates of sea level change. Work by members of INSTAAR's Geophysics Group in glacier dynamics and mass balance relate to a number of climate change issues on decadal to millennial time scales. Glaciers which terminate in the ocean providing potentially intimate and dramatic coupling between land ice and the ocean, and this coupling appears from paleoclimatic records to be an important modulator of global climate as well as a critical process in sea level change. Investigations of Columbia Glacier, Alaska, by **Tad Pfeffer**, **Mark Meier**, and **Josh Cohn**, in collaboration with colleagues at the US Geological Survey, involve photogrammetric determination of ice flow velocities and strain rates in the part of Columbia Glacier grounded below sea level. The Columbia Glacier is flowing fast (up to 30 m d^{-1}), and simultaneously retreating rapidly (1 km yr^{-1}) due to rapid calving of icebergs. The photogrammetry and analysis made form these measurements allow the future retreat to be predicted; the remaining 20-25 km of the glacier still grounded below sea level is likely be evacuated by a combination of thinning and iceberg calving within the next 50 years.

Also within the Geophysics Group, **Mark Meier** and **Mark Dyurgerov** are engaged in an ongoing study of the contribution of mountain and subpolar glaciers to global hydrology. Globally, glaciers exclusive of Antarctica and Greenland cover an area of about 680 x 10^3 km^2. During the period 1961-98, glaciers lost about 7 m of ice, or about 5 x 10^3 km^3 of water, most of which ran off to the ocean, increasing sea level by about 13 mm. Wastage of small glaciers has thus been responsible for about 20% of total sea level rise during this time. In several years during this period

Field work on Le Conte Glacier. (Shad O'Neill)

(1979, 1990, 1995, 1997, and 1998), all of which were characterized by extreme annual air temperature, glacier volume loss was exceptionally large. Mass balance sensitivity, seasonal mass balance components (accumulation of snow and ablation of snow and ice), and equilibrium line altitude also showed large changes in these years. Interannual mass balance variability was large during the second half of the previous century in more than 30 regions in the world, mostly in the Northern Hemisphere. Mass balance changes correlate closely with climate variables, and particularly with annual air temperature. Rates of glacier wastage increased in Central Asia, the Canadian Arctic, and Alaska while glaciers in Scandinavia, the Caucasus, Altai, and possibly in New Zealand gained in mass and advanced. The lack of synchrony and increase in spatial variability of all parameters seems to be a distinguishing feature of current climate change. Uncertainties persist which limit our ability to accurately evaluate the contribution of mountain and subpolar glaciers. These particularly include the unknown mass balance regimes of individual ice caps around Antarctica and Greenland, Patagonian ice fields, and the largest glaciers in Alaska.

Key publications:

McKnight, D. M., Niyogi, D. K., Alger, A. S., Bomblies, A., Conovitz, P. A., and. Tate, C. M., 1999: Dry Valley streams in Antarctica: ecosystems waiting for water. *BioScience*, 49: 985-995.

O'Grady, D. B., Syvitski, J. P. M., Pratson, L. F., and Sarg, J. F., 2000: Categorizing the morphologic variability of siliciclastic passive continental margins. *Geology*, 28: 207-210.

Mountain Research Station

The Mountain Research Station (MRS), located near Nederland, 25 miles from Boulder, is an interdisciplinary research facility of the University of Colorado devoted to the advancement of study of mountain ecosystems. Our mission is to facilitate research and education to understand better the unique patterns and processes of biotic and physical systems in mountains, and how environmental changes may affect these processes.

The MRS was established in 1921 and has continued to serve as an outstanding facility in field education and research. Work on nearby Niwot Ridge is internationally known for its excellent research on the biology, geology, and atmospheric environment of mountain ecosystems. Approximately 40 researchers per year use the MRS as a base of operations, including faculty and students from CU and many other universities and Federal Laboratories in the US and around the world.

The station's teaching mission includes formal undergraduate and graduate field courses, which have been offered at the MRS for over seven decades and have become an integral part of the academic experience of many college students. Enrollment in MRS courses has been between 40 to 110 students per summer. Several K-12 courses also use the MRS as a site to introduce students to field environmental science.

The MRS participated in educational experiences for the general public aimed at policy decisions that affect our environment. Through formal interactions with U.S. federal agencies such as the Forest Service, the Environmental Protection Agency, and the National Park Service, the MRS has provided expertise to help regulatory agencies make informed decisions about minimizing human impacts on mountain ecosystems. The MRS also provides summer seminars open to all on subjects of interest to both scientists and nonscientists. The MRS is a popular site for symposia and workshops aimed at decision making and information sharing, CU departmental retreats, and national scientific meetings.

A group of Mountain Research Station staff

The first phase of construction was recently completed on the New Fireweed Hostel. The external shell, the floor for the second story, and the heating system were included in this initial effort. The high-efficiency radiant floor heating in combination with advanced passive solar energy collection, using a trombe wall, will result in a comfortable winterized building when completed. Fund raising by the CU Foundation is ongoing to provide the support to complete this building.

Ford Motor company donated an Excursion sport utility vehicle to the station this past summer. The Excursion will serve primarily as the vehicle accessing cable gate by researchers during the summer season. The Excursion, nicknamed "Moby," emits 30% fewer hydrocarbons, and is constructed of a greater proportion of recycled and recyclable components than other vehicles in its class. The impact of the vehicle on the ongoing air chemistry monitoring at C1 should be greatly reduced by Moby. We are truly grateful to Ford for their generosity to the station.

The CU Alpine Observatory was dedicated in July 2000. This facility houses an optical telescope with a 12.5-inch mirror purchased with NASA funds in 1998 by CU-Boulder Senior Research Associate Alan Kiplinger for solar studies. Dr. Kiplinger, along with Steve Seibold, the Station Manager, have been working to establish the observatory, procuring a 1 ton dome to house the telescope and associated computer from NOAA. The telescope has the capacity to find the location of 65,000 celestial objects. We hope to establish regular educational programs during the summer, utilizing the dark night skies as well as day-time viewing of the sun using special optical filters.

The Tundra Cam and Niwot Ridge climate stations continue to be popular sites for web browsers. These sites can be accessed via the recently renovated MRS home page (http://www.colorado.edu/mrs/). Additions to the climate station data include soil moisture, precipitation, and snow depth (C1 only).

Several of the small student cabins received new roofs and new wood stoves this past year. Ongoing structural renovations have significantly improved the comfort of the cabins at the station. CU Facilities Management continues to work with the Colorado Division of Wildlife to engineer a "green" sewage treatment facility which will not endanger one of the last remaining populations of Greenback Cutthroat Trout in nearby Como Creek. Work was initiated in the fall of 2000, and is expected to be in operation for the summer 2001 season. The new facility will operate year-round, and will facilitate use of the Hostel when completed.

MRS Staff

Director: William D. Bowman
Associate Director: Diane McKnight
Station Manager: Steven Seibold
Facilities Management: Mark O'Keefe
Course Coordinator: Julia Larson
Climatologist: Mark Losleben
LTER technician: Sandy Moore
Kiowa Laboratory Manager: Christine Seibold

INSTAAR Environmental Computation and Imaging (ECI) Facility

In the year 2000, INSTAAR set up a major computational facility. Dedicated computer space (raised floors, fire-fighting system, air cooling with humidity control) for the facility was obtained for INSTAAR by Assoc. Vice Chancellor Jerry Peterson. With space in hand, initial funding from the Office of Naval Research was obtained to support the computing needs of the INSTAAR *Delta Force* (led by Professor James Syvitski) and the INSTAAR Glaciology Group (led by Professor Tad Pfeffer). Sun Microsystems provided a large Industrial Partnership grant to upgrade the initial ONR supercomputer server by adding another super server. The Graduate School, under the leadership of Dean Carol B. Lynch, then provided significant CU matching funds for facility. Together, a $1.2M Environmental Computation and Imaging (ECI) Facility was established. The Facility now houses a Sun Enterprise 6500 (named *DeepPurple*) with twenty-four 450MHz processors supported with 24GB of RAM, a fifteen SunRay terminal system, a L1000GB tape library (StorEdge) back-up system, and a 480GB of hard drive storage. The Facility also houses a Sun Enterprise 5500 (named *MysticPlum*) with eight 450-MHz processors, supported by 8 GB of RAM, another 5 SunRay terminals, a L1000GB tape library (StorEdge) system, and a 320GB of HD. Peripherals include color printers and plotters, scanners, and other support equipment.

The advantage of the servers needs some explanation. While processor speed is at a mere 450 MHz (as compared to personal computers running at even faster clock speeds), the computer is designed to handle floating point processing (compared to PC integer processing). This is a significant advantage to those who program. In addition computer programs run on the ECI servers can be parallelized. This means that with five processors handling the operations of a given program or subroutine, the processing speed is, in effect, 5 times 450M Hz, providing a virtual 2250 MHz. With more processors used, the speed is further increased. While not quite as simple as this explanation provides, each ECI server provides INSTAAR with leading edge power in our quest to remain a national leader in the development of numerical models of complex earth systems. In addition, the computers allow users to process high-resolution data from satellites and other geophysical (seismic, swath) images. All scientists at INSTAAR are offered free access, including all graduate students. High-end users within the US and international community are required to purchase "seats" on the servers.

The facility has already provided a marked increase in research funds for acceleration of their efforts of the INSTAAR Delta Force in Geoacoustic modeling. The models are designed to support naval tasks: (1) antisubmarine warfare (ASW) along continental margins and shallow coastal seas, (2) mine information warfare (MIW), and (3) special operation (SpecOps) deployments within the littoral zone. Support of INSTAAR research into reservoir modeling and ice-sheet modeling are also supported by the facility.

Marine Geophysics and Sediment Transport Modeling

The United States Navy and Marine Corps are increasingly being confronted with assignments in data-poor coastal settings. To gain information about inaccessible coastal zones, models based on atmospheric, oceanographic, and geologic process interaction are being coupled to predict littoral properties. Models provide estimation of (1) water turbidity information for SpecOps; (2) ambient sedimentation rates for mine burial investigations; (3) seafloor grain size maps for MIW; and (4) information useful to ASW including seafloor bulk properties, coherency of sediment layering, particle size, porosity, and acoustic properties of sediment (sound speed, attenuation, impedance, surface, and volume scattering). Models are configured to fuse data from environmental data records of satellites and other sources.

Characterization of Reservoir Properties (Oil Industry)

ECI Facility is well suited for simulating the 3D architecture of how sediment is delivered to and accumulates on a continental margin. Using the large memory and fast computation environment provided by the ECI Facility, INSTAAR-developed models are used to simulate the delivery of sediment from multiple rivers and formation of reservoirs during the growth of a continental margin.

Natural Disaster Mitigation for NOAA

Damaging waves and winds, flooding, water-mobilization of pollutants, and the silting of estuaries and bays caused by tropical storms raise havoc with the quality of life and economy for people living in coastal areas. Such storms also harm sensitive wetland and beach ecosystems. DMSP and NPOES satellite data, never before available to the scientific community, present a new opportunity to "see" the coastal environment during and following such severe weather events, and thus anticipate hazards they may spawn. But to do this, the diverse satellite data must be merged coherently with other information. Numerical models provide a logical mechanism for accomplishing this data fusion. The models derive from the satellite data estimates of rainfall, runoff, and water routing, and use these estimates to predict land erosion, river levels, and the dispersal of river outflow into coastal waters. Coastal transport models developed at INSTAAR then simulate the dispersal of the sediments under the action of waves and currents, their movement by various marine processes, such as hyperpycnal discharges from rivers. The linkage of these models is not trivial. The ECI Facility will create such a computational environment through the use of newly coupled atmospheric, hydrologic and oceanographic models that synthesize satellite data.

Growth and Flow of Ice Sheets

Modeling of nonlinear fluid media with coupled heat transfer produce large demands on computer resources, especially when transient problems are considered and evolution of a model solution over time is required. Examples of recent flow modeling work include incorporating iceberg calving mechanics into "quasi-3D" nonlinear, creeping flow finite element model. INSTAAR finite element modeling methods are used as theoretical tools to provide validation of theoretical predictions of transient behavior of ice sheets. We have developed new modeling methods for fully 3D viscoelastic media and 2D plane strain linear viscous flow with large deformation and fracture. These models are used in conjunction with marine and terrestrial geological research to produce paleoglacier simulations tied closely to observational constraints. With the prospect of higher spatial and temporal model resolution provided by the ECI Facility, comparisons between model results and observations will be greatly facilitated.

The *ECI Facility* allows INSTAAR to standardize its main computational power. Previously, around 200 desktop workstations and personal computers, in loosely organized networks supported research activities. As such there was a lot of redundant computing power in operation, unavailable to the high end user. It also reduces the administrative complications arising from a disorganized network of individual computers.

INSTAAR Facilities

Amino Acid Laboratory

The purpose of this laboratory is to extract and quantify the amino acid composition and extent of racemization of indigenous proteinaceous residues preserved in biominerals for geochronological applications. The lab contains two HP-1100 automated high-pressure liquid chromatographs and ancillary support equipment. Usually one HPLC runs in reverse-phase mode, and the other in ion-exchange mode. The laboratory currently is focused on the kinetics of amino acid racemization in the eggshells of large flightless birds, bivalve molluscs from high-latitude regions, and oogonia, the calcified fruiting bodies of charophyte algae. The laboratory director is Gifford Miller. A full-time technician, Charles Hart, oversees the day-to-day operation of the laboratory. Graduate and undergraduate students use the laboratory in their research projects and to gain research experience.

Tundra Laboratory and TundraCam (on mast) on Niwot Ridge, INSTAAR's mountain research area in the Colorado Front Range

AMS Radiocarbon Preparation and Research Laboratory

This laboratory provides AMS radiocarbon dating services to researchers from the United States and Latin America. In-house research focuses on method development in AMS ^{14}C preparation and dating, calibration of the radiocarbon timescale, and estimation of past levels of radiocarbon activity as a proxy for various geophysical and solar processes. Under the direction of Scott Lehman and Staff Chemist, Jocelyn Turnbull, the laboratory processes 25 authentic samples per week.

Biogeochemistry Laboratories

These laboratories are specialized for preparation of water and soil samples for chemical analysis. Major equipment includes fume hood, oven, distilled water, shaker, and extraction equipment. Tim Seastedt and Mark Williams are in charge of these laboratories.

Core Processing Laboratory

This laboratory is equipped for splitting, photographing, color logging, describing, sampling and MS logging of sediment cores. The facility is under development and is intended for use in analysis of marine, lake and other terrestrial cores. The facility is adjacent to the common INSTAAR cold room for convenient access to the cores. Currently it is used mainly by John Andrews and Anne Jennings and graduate students.

Dendrochronology Laboratory

This is a fully equipped laboratory for preparing, dating, and measuring tree-ring widths for dendrochronlogical studies. The measurements are compiled into tree-ring chronologies for climatic reconstruction. The laboratory is under the direction of Connie Woodhouse with laboratory manager, Jeff Lukas.

Dissolved Organic Matter Laboratory

This laboratory specializes in measuring the amount and character of dissolved organic matter from diverse ecosystems. Major equipment includes Shimadzu TOC analyzer, Antec 9000 DON analyzer, Agilent 8453 spectrophotometer, FluroMax2 fluorometer, fractionation columns, and Ulter-filtration. Mark Williams, Tim Seastedt, and Alan Townsend are in charge of the laboratory.

Ecosystems Laboratory

This laboratory is a sample preparation and microscopy facility for the identification and counting of algae, invertebrates, and plant material in samples from soils, lakes and streams collected for the Niwot Ridge and McMurdo Sound LTER projects, and from studies of acid mine drainage streams in Colorado. The laboratory is supervised by Diane McKnight and is used by students and researchers involved in the LTER projects.

Herbarium

The herbarium is housed at the Mountain Research Station. It contains a field collection of plants of the Front Range.

Kiowa Environmental Chemistry Laboratory

This laboratory is the environmental chemistry laboratory for the Niwot Ridge/Green Lakes Valley Long-Term Ecological Research Program. The laboratory is located at the Mountain Research Station and is managed by Christine Siebold and directed by Mark Williams. Equipped with an ion chromatograph, a spectrophotometric flow injection analyzer, and an atomic absorption spectrometer, the laboratory analyses air, snow, water, and soil samples collected by faculty and graduate students from alpine and subalpine ecosystems for major solutes and nutrients.

Limnology Laboratory

This is an analytical laboratory for studying water and sediment samples. The laboratory is equipped for sample preparation, analysis of metals and major cations using the atomic absorption spectrophotometer, and the preparative isolation of organic fractions using column chromatography. The laboratory is directed by Diane McKnight and is used by postdocs, graduate students, and undergraduate students enrolled in McKnight's classes.

Micropaleontology Laboratory

This is a foraminiferal analysis laboratory equipped with sieves and other equipment needed for preparation of foraminiferal samples, and binocular microscopes, faunal reference slides and books for foraminiferal assemblage analysis and picking of stable isotope and radiocarbon samples. An image analysis facility employing a binocular microscope, analog camera and computer is available to all researchers or students for computer imaging of foraminifers, plant macrofossils, molluscs, beetles and other macrofossils. The laboratory is managed by a senior micropaleontology technician and supervised by Anne Jennings.

Oceanography Laboratory

The purpose of this facility is to develop and deploy marine instruments related to understanding sediment dynamics. Major equipment includes an underwater camera system for studying flocculation dynamics, a CTD, attenuance meter, and LISST (in situ laser particle size analyzer). The laboratory also houses an extensive geophysical data library of analog and digital seismic and sidescan data from glacimarine environments. James Syvitski and Eric Hutton are in charge of the laboratory.

Paleoentomology Laboratory

The purpose of this laboratory is to prepare samples for fossil insect study. This involves soaking, heating, wet-screening, and kerosene flotation of samples, all of which is done under a fume hoods. The university fabricated a special over-the-sink fume hood, linked with the main fume hood in the room, so that the fumes from the kerosene flotation could be properly ventilated. Scott Elias is the principal user of the laboratory with some additional student use.

Mountain Research Station
John W. Marr Laboratory

Palynology Laboratories

There are two pollen sample preparation laboratories and a pollen microscopy laboratory. The sample preparation laboratories have standard equipment for chemical pretreatment of sediment samples for micropaleontological analyses of pollen and diatoms. The microscopy laboratory has two high powered research-grade light microscopes with image analysis capabilities, several light microscopes for student use, and a binocular microscope with camera equipment. These laboratories are supervised by Vera Markgraf and Alex Wolfe.

Permafrost Laboratory

This laboratory contains apparatus for controlled cyclic freeze-thaw experiments on the development of patterned ground. Experimental equipment includes refrigerated soil pans sizes ranging up to 4 x 4 feet, cooling and heating controllers, precision temperature loggers and soil handling facilities. The laboratory is directed by Tad Pfeffer.

Plant Physiology Laboratory

This is a soils preparation laboratory directed by Bill Bowman. It houses shakers, filter apparatuses, and two CO_2 analyzers used for soil and plant gas exchange analysis.

Sediment Geochemistry Laboratory

Research in this laboratory is focussed on quantitative reconstructions of past sea-surface temperatures, applications of organic geochemistry to problems in paleoclimatology, and calibration of the radiocarbon timescale. Major equipment includes trace organic clean preparation facilities, automated pressurized fluid extraction (Dionex ASE 200), gas chromatograph (HP 6890 with 100-position autosampler, programmable temperature vaporization (PTV) inlet and FID). Andrew Crotwell and Chanda Herring are in charge of the day-to-day operation of the laboratory under the direction of Scott Lehman.

Alpine sorrel (*Oxyria digyna*) grows in rock crevices in alpine tundra

Sedimentology Laboratory

This laboratory is well equipped for a full range of rapid and efficient sedimentological measurements. Instruments include a Malvern long-bed laser system and a Sedigraph particle size analyzer for grain size analysis; a coulometer for determination of organic and inorganic carbon, and an automated carbonate system for rapid carbonate determinations modeled after a system used at Woods Hole Oceanographic Institution; and instruments for measuring sediment magnetic properties including MS, SIRM, and IRM. The laboratory is coordinated by Wendy Freeman, under the supervision of John Andrews, and is used by numerous INSTAAR graduate students who receive training on the use of the equipment from Freeman.

Snow and Ice Laboratory

This laboratory is built around a 400-square-foot cold room, with facilities presently configured for experimental work in heat and mass transfer in snow, as well a general electronics and mechanical design and fabrication. The laboratory is directed by Tad Pfeffer.

Stable Isotope Laboratory

This laboratory is a state-of-the-art facility that uses stable isotopes to understand the processes controlling environmental change on timescales relevant to human interactions with the environment. The research focuses on the modern carbon and water cycles and paleoclimate records from ice cores, lake sediments and bogs. The laboratory houses six mass spectrometers and ten gas preparation systems for analysis of stable isotopes of oxygen, hydrogen, carbon, and nitrogen. The stable isotope laboratory is supervised by Jim White, managed by Bruce Vaughn, and utilizes a staff of three technicians and numerous graduate students and post docs to analyze over 48,000 samples per year.

Terrestrial Biogeochemistry Laboratory

This laboratory focuses on nutrient analyses of soils and plant tissue, with an emphasis on carbon, nitrogen, and phosphorus. N and P in solution, including water samples, are also measured routinely, as are a variety of microbial functional attributes, including biomass, enzyme activities, and CO_2 emissions from soils. Major instrumentation includes Alpkem autoanalyzer, Carlo-Erba CHN analyzer, benchtop spectrophotometer, PP Systems IR gas analyzer. The laboratory is directed by Alan Townsend and managed by Briana Constance. The laboratory is consistently used by graduate students from INSTAAR, as well as from CIRES, EPOB, and Geological Sciences.

Library and Publications

INSTAAR Reading Room

INSTAAR maintains a special library collection known as the Reading Room. The aim is to provide easy access to the most widely needed journals and books for students and scientists at INSTAAR. Since its expansion a few years ago the room provides quiet study areas and also a central table area for group discussions.

The collection consists of 3400 books, 2045 reprints of faculty publications, over 2000 reports, and 415 theses (over half by former INSTAAR students).

The conversion of the final 10% of book records in the card catalog to electronic form was completed during 2000. Users of the Reading Room now have access, on the two Reading Room computers, to all of the books, theses, faculty publications, and most of the report collection, in the Reading Room. Two specialized CDs, Arctic & Antarctic Regions and PolarPac, are also accessible from these computers.

From the Reading Room Web Site users may access the LTER Niwot Ridge Bibliography. A list of journals held in the Reading Room, including links to those subscribed to in full text version online by the University of Colorado Libraries, is provided. Links to worldwide web based resources for cold regions information are maintained regularly and lead the user to a wealth of information.

Publications

INSTAAR publishes two series: *Arctic, Antarctic, and Alpine Research*, an international quarterly journal, and *Occasional Papers*, an irregular monograph series.

Arctic, Antarctic, and Alpine Research (formerly *Arctic and Alpine Research*) is a refereed quarterly interdisciplinary journal devoted to publishing original research papers, shorter contributions, resulting correspondence, and book reviews. This internationally authored and circulated journal reports on any scientific or cultural aspect of arctic/subarctic, antarctic/subantarctic, and alpine/subalpine environments and related paleoenvironments. The content of the journal reflects areas of research performed at INSTAAR.

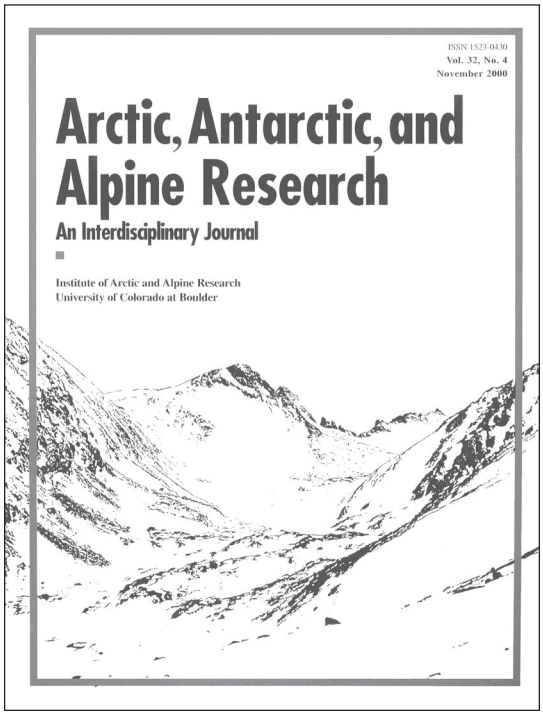
James Syvitski is Editor of the journal and Kathleen Salzberg is Managing Editor. The Editorial Board is composed of INSTAAR and other University of Colorado faculty; members review papers and advise on policy. An international Interdisciplinary Board reviews papers and promotes the interests of the journal in members' respective countries. Most of the peer reviewers are selected by the Editor and Managing Editor.

During 1999, 86 papers were submitted for review, a decrease of 10% over 1998; Volume 31, 1999 contained 458 pages and included 48 research papers and 2 guest editorials. First authors represented 14 countries. During 2000, 113 papers were submitted for review, an increase of 31% over 1999; Volume 32, 2000 contained 503 pages and included 54 research papers. First authors represented 19 countries. Volume 32 included an Ecological Society of America symposium "Life at the Cold Limit: Plant Processes at Near- and Below-freezing Temperatures." Subscriber numbers have remained fairly constant over the past 5 years with a slight increase in 2000. About 720 copies are distributed of each issue to subscribers (library, individual, student), exchange partners, and miscellaneous complimentary "subscribers."

Arctic, Antarctic, and Alpine Research has an impact factor of 1.43. (An impact factor is the ratio of citations of recent articles to the number of recently published articles.) It was ranked number 1 in the Geography category and number 26 in the Environmental Sciences category in Institute of Scientific Information's Journal Citation Reports (1999).

The journal has a dedicated web site which includes general information about the journal, contents and abstracts for the past few years, instructions for manuscript submission, and subscription information.

The *Occasional Paper* series is a miscellaneous collection of reports and papers on work performed by INSTAAR personnel and their associates which are generally too long or too data intensive for publication in research journals. *Occasional Paper* No. 54, "Radiocarbon Date List IX: Antarctica, Arctic Ocean, and the Northern North Atlantic" compiled by L. Michaela Smith and Kathy J. Licht was published in 2000.



Societal Outreach

On a day-to-day basis, INSTAAR members respond regularly to enquiries from the public and the media on the broad spectrum of scientific matters which relate to INSTAAR's research. They also regularly give lectures and presentations to schools and civic groups. In 1999, INSTAAR hosted the second of its Open Days to 400 students from local middle schools. Several INSTAAR members gave television and radio interviews on a wide variety of "INSTAAR" subjects, as well as interviews to the popular press.

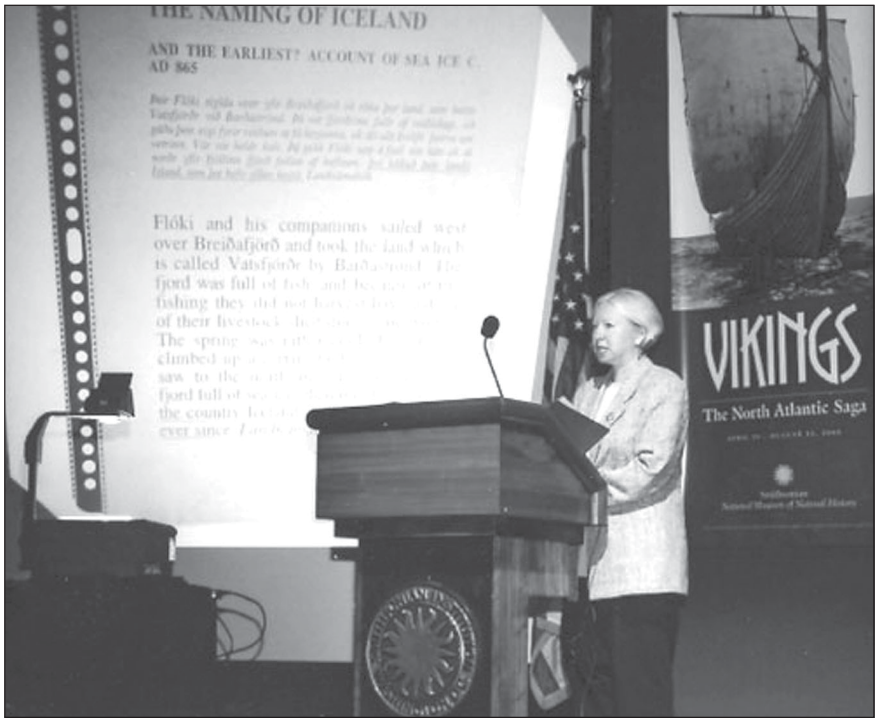
Some highlights of the above activities are: Lisa Barlow's contribution to the mystery of what happened to the Greenland Norse, showcased in the television program "Secrets of the Dead: The Lost Vikings"; John Behrendt's book *Innocents on the Ice: A Memoir of Antarctic Exploration, 1957* which was co-winner of the Colorado Book Award for nonfiction in 1999 from the Colorado Center for the Book. Also, when speaking on Antarctica to a meeting of scientists and members of the public in Rome, John was presented with the Felice Ippolito Gold Medal by the Academia Lincei and the Italian Antarctic Program; James Dixon was a particularly active speaker, giving talks to groups in locations ranging from Yukon Territory, Canada, to Michigan to Colorado. Diane McKnight and Astrid Ogilvie were interviewed on Boulder television's Channel 8 regarding a number of aspects of INSTAAR research; Astrid Ogilvie spoke on "Sagas and Science" to a large audience containing Scandinavian royalty, at the opening of the exhibition "Vikings—The North Atlantic Saga" in April 2000 at the Smithsonian National Museum of Natural History in Washington, D.C. With the move of this exhibit to the Denver Museum of Nature and Science, she has also been active in advising this museum on programming around the exhibit. In November 2000, Astrid Ogilvie attended a meeting in Iceland focusing on Arctic issues attended by government ministers from the Arctic countries, and spearheaded by the President of Iceland. Daniel Grossman completed a half-hour radio documentary, *Fire and Ice*, concerning the dovetailing of tree-ring research and native legends in Alaska. An article by Tad Pfeffer on Columbia Glacier in *EOS* (November 2000) was reprinted in *Earth in Space*, an AGU-published magazine for science teachers.

INSTAAR faculty and researchers were particularly active with outreach to local elementary and secondary schools. INSTAAR presented "Mountain Research Awards" for both 1999 and 2000 at district and state-wide science fairs for projects that best apply the scientific method to issues of earth-system science and climate dynamics in high-altitude settings. Project titles included "Microclimatic Effects on Snow Conditions," and "Lichen Growth after Fire: A Survey of Burned Forest Sites on Storm King Mountain." INSTAAR personnel also judged several science fairs, led an afternoon environmental science club at a local middle school, and mentored promising high school students with research-related projects.

Particularly worthy of mention is the major grant received by Scott Elias under the aegis of the National Science Foundations's Elementary, Secondary and Informal education program. This project focuses on the development of an interactive CD-ROM program on Arctic science aimed at middle school students in Alaska.

Through the Niwot Ridge Long-Term Ecological Research Program (NWTLTER), INSTAAR's Mountain Research Station offers a summer course "Alpine Ecology and Experiential Learning" that involves K-12 outreach and training of in-service and pre-service teachers from the local area and beyond. The field trips that are integral to this program are organized in conjunction with several local summer science programs for children: Science Discovery, Wild Bear Science School in Nederland, and Bixby School in Boulder.

INSTAAR also continued its support of the CU Summer Undergraduate Research Fellowship program, SMART STARS program (Summer Minority Access to Research Training at INSTAAR), and the CU Summer Undergraduate Research Experience program as well as a being involved in several other undergraduate education programs at CU.



Astrid Ogilvie delivers an address "Sagas and Science" at the opening of the Smithsonian Institution exhibit "Vikings–The North Atlantic Saga"

Education

Graduate and undergraduate students are an integral part of INSTAAR, and they play important roles in the research conducted by the institute and its members. INSTAAR students are registered for degree programs in an appropriate department and college. Financial support is available for INSTAAR graduate students as research assistants employed on research grants. Undergraduate support is available through special programs. These programs are sponsored by INSTAAR, the university, industry, and agencies such as the National Science Foundation and are designed to encourage undergraduate participation in research. They include SURE (Summer Undergraduate Research Program), SURF (Summer Undergraduate Research Fellowships), SMART (Summer Minority Access Research Training), UROP (Undergraduate Research Opportunities), UMP (University Mentoring Program), and REU (Research Experience for Undergraduates). Undergraduate research may lead to honors theses and internships. These programs have contributed greatly to the feasibility of including undergraduate students in INSTAAR research and to encouraging undergraduate students to continue to advanced degress.

Prospective graduate students should contact the department that they wish to enter and apply for admission to the University of Colorado. Suitable departments include CEA Engineering, EPO Biology, Geography, and Geological Sciences. Applications forms are available from the Graduate School, Campus Box 30, University of Colorado, Boulder, CO 80309-0030. For specific INSTAAR-related questions, send email to info@instaar.colorado.edu or contact individual INSTAAR professors directly (see INSTAAR web site).

Recent INSTAAR Graduate Students and Advisors

Eric August, MS, Diane McKnight
Donald Barber, PhD, John Andrews
Laura Belanger, MS, Diane McKnight
Arne Bomblies, MS, Diane McKnight
Jason Briner, PhD, Gifford Miller
Alex Brown, MS, Diane McKnight
Isla Castaneda, MS, John Andrews
Ethan Chatfield, MS, Diane McKnight
Christina Clark, MS, Julia Cole
Cory Cleveland, PhD, Alan Townsend
Josh Cohn, MS, Tad Pfeffer
Daniel Costello, MS, Tad Pfeffer
Mary Damm, MBS, Bill Bowman
Noah Daniels, MA, Giff Miller,
Thomas Davinroy, PhD, Mark Williams
Steven DeVogel, MS, Gifford Miller
Lisa Doner, PhD, John Andrews
Gita Dunhill, PhD, John Andrews and James Syvitstki
Tyler Erikson, PhD, Mark Williams
Tara Forbis, PhD, Bill Bowman
Andrew Fox, MA, Nel Caine,
Wendy Freeman, MS, John Andrews
Eileen Gardner, PhD, Diane McKnight
John Gartner, MA, Nel Caine
Grizelle Gonzalez, PhD, Tim Seastedt
Michael Gooseff, MA, Diane McKnight
Hillary Hamann, PhD, Nel Caine
Jorunn Hardardottir, PhD, John Andrews
Jennifer Hazen, MA, Mark Williams
Keri Holland, PhD, Alan Townsend
Eran Hood, PhD, Mark Williams
Ulli Huber, PhD, Vera Markgraf
Barbara Inyan, PhD, Mark Williams
Jason Janke, PhD, Nel Caine
Chris Jaros, MS, Diane McKnight
Ernie Joynt, MS, John Andrews
Michael Kaplan, PhD, Gifford Miller
Michael Kerwin, PhD, Jonathan Overpeck
David Kinner, PhD, James Syvitski
Lisa Klapper, MS, Diane McKnight
Greta Bjork Kristjansdottir, PhD, John Andrews and Anne Jennings
Anthony Lane, MS, James White
Julia Larson, PhD, Bill Bowman
Kate LeJeune, PhD, Tim Seastedt
Karen Lewis, PhD, Tad Pfeffer
Kathy Licht, PhD, John Andrews
Dan Liptzin, PhD, Tim Seastedt
Fengjing Liu, PhD, Mark Williams
Alejandro Machado, MA, Mark Williams
Ken Mack, MA, James White
Jennifer Mangan, PhD, Jonathan Overpeck
David Manthorne, MA, Mark Williams

A group of INSTAAR Graduate Students

Hans-Peter Marshall, PhD, Tad Pfeffer
Amy Miller, PhD, Bill Bowman
John Miller, PhD, James White
David Mixon, MS, Robert Stallard
Natalie Mladenov, PhD, Diane McKnight
Mark Morehead, PhD, James Syvitski
Carrie Morrill, PhD, Julie Cole and Jonathan Overpeck
Laura Mujica-Crapanzano, PhD, Patrick Bourgeron
Dev Niyogi, PhD, Diane McKnight
Damian O'Grady, PhD, James Syvitski
Sean Pack, MA, Giff Miller
Heather Reed, MA, Tim Seastedt
Alex Robertson, MS, Jonathan Overpeck
Stephanie Schoolfield, MS, John Andrews
Durelle Scott, PhD, Diane McKnight
Susan Sherrod, PhD, Tim Seastedt
Valerie Sloan, PhD, John Andrews and Nel Caine
Laryn (Mikie) Smith, PhD, John Andrews and Anne Jennings
Heidi Steltzer, PhD, Bill Bowman
Andreas Torrizo, MA, Mark Williams
Lee Turner, PhD, Bill Bowman
Frank Urban, MS, Julie Cole and Jonathan Overpeck
Ryan Vachon, MS, James White
Summer Waters, MS, Diane McKnight
Jake Wegmann, MS, Tad Pfeffer

Recent INSTAAR Undergraduate Students and Supervisors

Alex Alger, Diane McKnight
Joe Aussem, Scott Lehman
Eva Backgren, Tim Seastedt
Rory Baer, Tim Seastedt
David Barclay, Parker Calkin
Jared Blanton, Chris Seibold
Gary Bolton, Elise Pendall
John Bradbury, Vera Markgraf
Kurt Chowanski, Chris Seibold
Dawn Colby, Diane McKnight
Jonathan Coles, Bill Manley
Robert Cornman, Bill Bowman
Sara Jo Dickens, Anne Jennings
Denise Dundon, Bill Manley
Sabre Duren, Diane McKnight
Kim Eastman, John Andrews
Kareen Erbe, John Andrews
Williams Evans, James Dixon
Joe Flaherty, Elise Pendall
Peter Foister, Scott Lehman
Holly Froeschner, Tim Seastedt
Shira Gordon, Diane McKnight
Jason Graves, Parker Calkin
Amy Gray, John Andrews
Scott Hiller, Bill Bowman
Kathryn Jahnke, Chris Seibold
Jennifer Keeling, Diane McKnight
Charles Kennedy, Bruce Vaughn
Kelly Krieger, Bruce Vaughn
Elliott Larson, Tad Pfeffer
Lucas Leman, Chris Seibold
Angela Levasseur, Diane McKnight
Michael Lewis, Diane McKnight
Jennifer Limbird, Diane McKnight
Christina Love, Tim Seastedt
Shannon Lyday, Charles Hart
Laura Manley, Tim Seastedt
Erica Manteuffel, Charles Hart
David Manthorne, Nel Caine
Erick Matteson, Bruce Vaughn
Scott McCauley, Diane McKnight
Gerrit McGowan, Chris Seibold
Luke Meiser, Steve Seibold
Wesley Mendez, Julie Hughes
Eric Metzger, James Dixon
Jacob Moersen, Bill Bowman
Phalla Ouch, Scott Lehman
Kenzi Parton, Tim Seastedt
Geoff Pierz, Chris Seibold
Evan Piland, Bill Manley
Oliver Platts-Mill, Mark Williams
Elizabeth Polling, Tim Seastedt
Melissa Reed-Eckert, Bill Bowman
Rohrs Jennifer, Tim Seastedt
Ana Ruiz, Scott Lehman
Erin Scherer, Elise Pendall
Alexis Scott, Tim Seastedt
Michael Scott, Tim Seastedt
Dana Sevakis, Bruce Vaughn
Morgan Skurky-Thomas, Nel Caine
Jeffrey Smith, Chris Seibold
Kirsten Storey, Tim Seastedt
Benjamin Swanson, Ute Herzfeld
Andy Taylor, James Syvitski
Ryan Thomas, John Andrews
Andrew Todd, Diane McKnight
Tammy Trudeau, Scott Lehman
Alison Van Gorp, Alex Wolfe
Brenton Wonders, Tim Seastedt
Warren Wonders, Tim Seastedt

Theses Completed

1999

Gonzalez, G. 1999: Soil fauna, microbes and plant litter decomposition in tropical and subalpine forests. 78 pp. PhD, University of Colorado at Boulder.

Hardardottir, J. 1999: Late Weichselian and Holocene environmental history of south and west Iceland as interpreted from studies of lake and terrestrial sediments. 332 pp. PhD, University of Colorado at Boulder.

Inyan, B. 1999: High elevation watershed characterization and sensitivity analysis: science as a basis for watershed protection policy. 301 pp. PhD, University of Colorado at Boulder.

Joynt, E. H., III. 1999: Calibration and application of lake diatoms as proxies for climate change on Baffin Island, Nunavut, Canada. 98 pp. MS, University of Colorado at Boulder.

Kaplan, M. R. 1999: The last glaciation of the Cumberland Sound region, Baffin Island, Canada, based on glacial geology, cosmogenic dating, and numerical modeling. 206 pp. PhD, University of Colorado at Boulder.

Licht, K.J. 1999: Investigations into the Late Quaternary history of the Ross Sea, Antarctica. 216 pp. PhD, University of Colorado at Boulder.

Miller, J. B. 1999: Application of gas chromatography isotope ratio mass spectrometry (G IRMS) to atmospheric budgets of $C^{18}OO$ and $^{13}CH_4$. 163 pp. PhD, University of Colorado at Boulder.

Morehead, M. D. 1999: Sediment supply to the ocean: the temporal and spatial variability of rivers and plumes. 263 pp. PhD, University of Colorado at Boulder.

Niyogi, D. 2000: Effects of stress from mine drainage on ecosystem functions in Rocky Mountain streams. 181 pp. PhD, University of Colorado at Boulder.

Sherrod, S. 1999: A multiscale analysis of the northern pocket gopher (*Thomomys talpoides*) at the alpine site of Niwot Ridge, Colorado. 142 pp. PhD, University of Colorado at Boulder.

Steltzer, H. 1999: Plant species effects on spatial variation in nitrogen cycling in alpine tundra. 121 pp. PhD, University of Colorado at Boulder.

Urban, F. E. 1999: Multiple modes of tropical Pacific climate variability recorded in the $\delta^{18}O$ of corals from the Gilbert Islands, Kiribati, West Central Pacific. 95 pp. MS, University of Colorado at Boulder.

Waters, S. B. 1999: Responses of algal communities to environmental change in an alpine lake, Green Lakes Valley, Colorado. 132 pp. MS, University of Colorado at Boulder.

2000

Cohn, J. B. 2000: The surface strain rate filed at the Columbia Glacier calving margin. 49 pp. MS, University of Colorado at Boulder.

Davinroy, T. 2000: Hydrologic and biogeochemical characteristics of alpine talus: Colorado Front Range. PhD, University of Colorado at Boulder.

Freeman, W. J. 2000: Use of lake ice records to detect climate variability in the eastern Canadian arctic. 260 pp. MS, University of Colorado at Boulder.

Hazen, J. M. 2000: Acid mine drainage characterization and remediation using a combination of hydrometric measurements, isotopes and dissolved solutes. 120 pp. MA, University of Colorado at Boulder.

Kerwin, M. 2000: Pollen/climate calibration for the Eastern Canadian Arctic Boulder. PhD, University of Colorado at Boulder.

Loveland, A. 2000: An evaluation of the importance of dissolved nitrogen in snowmelt runoff and its qualitative characteristics, Como Creek, Front Range, Colorado. MA, University of Colorado at Boulder.

Pack, S. M. 2000: Drought in the northwest Australian outback: isotopic records of ecologic change from Lake Gregory, W.A. 233 pp. MS, University of Colorado at Boulder.

Robertson, A. 2000: Simulated and observed climate variability of the last 500 years. 197 pp. MS, University of Colorado at Boulder.

Schoolfield, S. C. 2000: Late Pleistocene sedimentation in the Denmark Strait region. 181 pp. MS, University of Colorado at Boulder.

Wegmann, J. 2000: A modeling approach to the investigation of ice falls on the Worthington Glacier, Alaska. 105 pp. MS, University of Colorado at Boulder.

Courses Taught by INSTAAR Faculty

Spring 1999

J. Andrews
GEOL 3040 Geologic Record of Global Change
GEOL 4036/5036 Glacial Geology

N. Caine
GEOG 3511 Introduction to Hydrology

J. Hoffecker
ANTH 3040 Paleolithic Europe

D. McKnight
CVEN 5894 Surface Water Quality Modeling

T. Pfeffer
GEOL 4640/5640 Glaciology
T. Seastedt
EPOB 4170/5170 Ecosystem Ecology
EPOB 6120 Ecology Seminar

J. Syvitski
GEOL 4060/5060 Oceanography
A. Townsend
EPOB 5310 Graduate Core course in Ecology

J. White
ENVS 3930 Internship
ENVS 4990 Senior thesis
GEOL 1070 Global Change
GEOL 1110 Global Change Lab
GEOL 3520 Environmental Issues

M. Williams
GEOG 3251 Mountain Geography
GEOG 3900 Internship in Snow Hydrology
GEOG 4311/5421 Watershed Biogeochemistry

Summer 1999

W. Bowman
EPOB 4350 Field Biology

D. McKnight
CVEN XXX Alpine Ecology and Experiential Learning

Fall 1999

W. Bowman
EPOB 6200 Plant Diversity
N. Caine
GEOG 3023 Statistics for Earth Science
GEOG 4241 Principles of Geomorphology

D. McKnight
CVEN 5834 Stream Ecology

T. Pfeffer
CVEN 3698 Engineering Geology

J. White
ENVS 3930 Internship
ENVS 4990 Senior thesis

A. Wolfe
GEOL 1060 Global Change: An Earth Sciences Perspective

Spring 2000

L. Barlow
GEOL 1070 Global Change
GEOL 1110 Global Change Lab

W. Bowman
EPOB 3020 Principles of Ecology

N. Caine
GEOG 3511 Introduction to Hydrology

D. McKnight
CVEN 4834 Stream Ecology

G. Miller
GEOL 3420 The Geologic Record of Global Change
GEOL 5700 Current literature in Global Change Research

T. Pfeffer
CVEN 3698 Engineering Geology
CVEN 4838/5838 Mechanics and Dynamics of Glaciers

T. Seastedt
EPOB 6100 The Ecology of Invasive Species

J. Syvitski
GEOL 4060/5060 Oceanography

J. White
ENVS 3930 Internship
ENVS 4990 Senior thesis
GEOL 3520 Environmental Issues
GEOL 1070 Global Change
GEOL 1110 Global Change Lab

Summer 2000

W. Bowman
EPOB 4350, Field Biology

D. McKnight
CVEN XXX Alpine Ecology and Experiential Learning

Fall 2000

J. Andrews
GEOL/GEOGR 3023 Introduction to Statistics for Earth Scientists

L. Barlow
GEOL 1060 Global Change: An Earth Science Perpective

W. Bowman
EPOB 2650 Honors General Biology

N. Caine
GEOG 4241 Principles of Geomorphology
GEOG 5183 Data Processing in Earth Science

W. Manley
GEOL 5852 G.I.S. Applications in Quaternary Geosciences

D. McKnight
CVEN 5834 Stream Ecology

G. Miller
GEOL 1011Global Change Lab
GEOL 1060 Global Change: An Earth Science Perpective
GEOL 4500 Critical Thinking: Issues in Global Change
GEOL 5700 Techniques in Paleoclimate Reconstruction

T. Pfeffer
CVEN 2121 Analytical Mechanics

T. Seastedt
EPOB 5310 Graduate Evironmental Biology
EPOB 4100 Advanced Field Ecology

J. White
ENVS 4990 Senior thesis
ENVS 3930 Internship

INSTAAR Noon Seminars

Fall 1999

John Andrews (INSTAAR), "A comparison of marine sediment properties between 'cold' East Greenland and 'warm' Iceland"

Bill Bowman (INSTAAR) "Are alpine plants passive players, or critical components in a stressful system?"

Mark Dyurgerov (INSTAAR), "Health of glaciers; climate-sea-level interrelations and a few words about volcanic eruptions"

John Hoffecker (INSTAAR), "Early Middle Pleistocene adaptation in Europe: The zooarchaeology of Treugol'naya Cave (Northern Caucasus, Russia)"

Ólafur Ingólfsson (INSTAAR Visiting Scientist), "Antarctic glacial history since the Last Glacial Maximum"

Ingibjörg S. Jónsdóttir (INSTAAR Visiting Scientist), "Research expeditions along the Northeast and Northwest Passages: new approach in terrestrial ecological studies in the Arctic"

Bill Manley (INSTAAR), "GIS analysis of modern and LGM glacier-climate relationships, Alaska"

Giff Miller (INSTAAR), "Megafauna extinction and monsoon failure in Pleistocene Australia: in search of the smoking gun"

Tim Seastedt (INSTAAR), "Wasting tax dollars and the environment? Weed (mis?)management in Boulder County"

Bob Stallard (INSTAAR and USGS), "Global change research in Panama: future of the canal to ocean circulation to FACE rings"

Alan Townsend (INSTAAR), "Tropical deforesation to cattle pasture: biogeochemical effects from local to global scales"

Klaus Wolter (NOAA), "Niwot Ridge climate: canary in the coal mine or just whistling in the wind"

Spring 2000

John Behrendt (INSTAAR), "Aeromagnetic and radar ice sounding evidence for interaction of the ice with bedrock beneath the divide of the West Antarctic Ice Sheet, including removal of subglacially erupted volcanic edifices"

Patrick Bourgeron (INSTAAR), "Conducting large-scale conservation evaluation and conservation area selection using a knowledge-based system and GIS framework"

Jennifer Y. King (USDA), "Methane emission and belowground carbon cycling in arctic tundra ecosystems"

Scott Lehman (INSTAAR), "An improved radiocarbon calibration for the period 15,000–10,000 calendar years BP from Cariaco Basin"

Greg McCabe (USGS), "Decadal variability in the strength of ENSO teleconnections with precipitation in the western United States"

Mark Meier (INSTAAR), "Glacier wastage and climate change: some new and not completely understandable results"

Dan Muhs (USGS), "Paleoclimatic implications of late Quaternary loess in North America"

Dennis Ojima (Colorado State University), "Balancing the carbon checkbook in the conterminous US: Validating the terrestrial carbon biogeochemical flux"

Sarah Spaulding (California Academy of Science), "Diatom biogeography: the juncture of evolutionary history and modern environmental conditions"

Pieter Tans (NOAA), "What can stable isotopes tell us about the recent global carbon cycle?"

Tore Vorren (INSTAAR Visiting Scientist), "Trough mouth fans: origin, paleoclimate and ice sheet monitors"

Fall 2000

John Andrews (INSTAAR), "The inter Heinrich event, records from the North Labrador sea; D-O oscillation?"

Tim Barrows (INSTAAR), "The timing and impact of the last glacial maximum in Australia"

John Behrendt (INSTAAR), "Comparison of sub-glacial volcanic features beneath the West Antarctic Ice Sheet interpreted from aero-magnetic and radar-ice soundings with similar but more accessible structures in Iceland"

Clara Deser (NCAR), "Arctic Sea Ice and Atmospheric Circulation Variability"

Ed Dlugokencky (NOAA/CMDL), "Constraints on the global methane budget determined from NOAA/CMDL measurements"

Hector Galbraith (Galbraith Environmental Sciences), "Global Climate Change Effects on Coastal Bird Communities"

David Lubinski (INSTAAR), "Freshwater and Atlantic Water inflows the northern Barents and Kara seas since the late deglacial: Foraminifera and stable isotopes"

Joseph McAvoy, "Cactus Hill Virginia—The oldest archeological site in North America"

Mark Pagani, (Colorado State University), "The evolution of atmospheric carbon dioxide"

Tad Pfeffer (INSTAAR), "Columbia Glacier update"

Olga Solomina (Inst. of Geography, Russian Academy of Science), "Neoglacial events and modern glacier retreat in the mountains of the Former Soviet Union"

Dale Toetz, INSTAAR "Structure and function of an alpine wetland, Green Lakes Valley, Colorado"

Research Grants 1999-2000

Amounts stated are totals for increments received through 2000 for grants in force. Total amounts for the awards to the end of the periods will usually be higher.

Anderson, Katherine; Elias, Scott: NSF ATM-9910639. Collaborative Research: Testing Earth System Models with Paleoenvironmental Observations. 1999-2001. $138,835.

Andrews, John: NSF OPP-9614129. Support for Graduate Attendance at the Arctic Workshop, 1997-1999. 1996-2001. $73,381.

Andrews, John: NSF ATM-9531397. Paleoclimate (0 to $ 14 ka) of W and NW Iceland, a Comparison of Lake and Near-Shore Marine Proxy Records: A USA/Iceland Contribution to P.A.L.E. 1999-2000. $28,357.

Andrews, John; Jennings, Anne: NSF OPP-9614287. Late Quaternary History of the Western and East-Central Ross Sea, Antarctica: A Contribution to the West Antarctic Ice Sheet Initiative (REU). 1997-2000. $9,250.

Andrews, John; Jennings, Anne: NSF OPP-9614287. Late Quaternary History of the Western and East-Central Ross Sea, Antarctica: A Contribution to the West Antarctic Ice Sheet Initiative. 1997-2000. $295,750.

Andrews, John; Jennings, Anne; Farmer, G. Lang: NSF OPP-9906812. Late Quaternary Variations in Sediment Provenance and Ice Sheet Dynamics: NE Sector of the Laurentide, Innuitian and the W/NW Margin of the Greenland Ice Sheets. 1999-2001. $56,651.

Andrews, John; Jennings, Anne; Syvitski, James: NSF ATM-9531397. Paleoclimate (0 to $ 14 ka) of W and NW Iceland, a Comparison of Lake and Near-Shore Marine Proxy Records: A USA/Iceland Contribution to P.A.L.E. 1996-2000. $340,167.

Andrews, John; Jennings, Anne; Syvitski, James; Hardardottir, Jorunn; Anderson, D.M.: NSF OCE-9809001. Long Images Cores From High Latitude Shelves Bordering Denmark Strait. 1999-2001. $333,251.

Andrews, John; Miller, Gifford: NSF OPP-9614667. Lake Ice Modeling and the Paleoenvironment of the Eastern Canadian Arctic Over the Last 21 ka: A P.A.L.E./LAII S.I.M.S. 1996-1999. $130,398.

Behrendt, John: Interior USGS 1434-CR-96-AG-A00776. Cooperative Geophysical Research with the U.S. Geological Survey. 1996-1999. $71,000.

Behrendt, John: NSF OPP-9814036. Interpretation of an Aneromagnetic Survey Over the Butcher Ridge Igneous Complex, Transantarctic Mountains. 1999-2001. $50,000.

Bourgeron, Patrick: EPA R825465-01. Multi-Scaled Assessment Methods: Prototype Development Within the Interior Columbia Basin. 1997-2001. $1,516,180.

Bourgeron, Patrick: Agriculture Forest Service PNW97-0507-2-JVA. Scaled Landscape Ecology Study of Ecosystem Patterns and Processes Within the Pacific Northwest. 1997-2002. $343,277.

Bourgeron, Patrick; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $84,153.

Bowman, William; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $128,557.

Brooks, Paul: Interior NPS CA-1268-2-9005 UCO-31. Chemical Characterization of High-Elevation Surface Waters: Implications for UV Radiation Penetration. 1999-2000. $35,486.

Brooks, Paul: Interior NPS CA-1268-2-9005 UCO-33. Variability in the Composition and Amount of DOC in Surface Waters of Rocky Mountain, Glacier, Olympic, and Sequoia National Parks. 1999-2001. $60,374.

Buttenfield, Barbara; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $61,220.

Caine, T. Nelson; Williams, Mark; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $138,551.

Calkin, Parker: NSF ATM-9905493. Collaborative Research: Tree-Ring Based Records of Temperature and Glacial Fluctuation Spanning the Past Two Millennia, Prince William Sound, Alaska. 1999-2002. $108,210.

Cole, Julia: NSF OCE-9510062. Recent Variability in the Intertropical Convergence Zone of the Western Atlantic: Seasonal, Multicentury Reconstructions from Venezuela Corals. 1995-1999. $193,830.

Cole, Julia: NSF OCE-9614137. Deciphering the Ocean's Influence on East African Climate Using Multicentury, Multivariate Coral Records. 1996-2000. $119,300.

Cole, Julia: NSF EAR-9628080. Acquisition of a Stable Isotope Mass Spectrometer for Automated Carbonate Analysis: Analytical Instrumentation for Earth Sciences/Global Change Research. 1996-1999. $113,487.

Cole, Julia: NSF OCE-9809319. Multicentury ENSO Reconstruction from the South Central Pacific (Marquesas). 1998-2000. $7,035.

Cole, Julia: NSF OCE-9809319. ESH: Multicentury ENSO Reconstruction from the South Central Pacific (Marquesas). 1999-2000. $10,873.

Dixon, E. James: NSF OPP-0096289. Late Quaternary Archeology and Paleoecology of Southeast Alaska, Phase II. 2000-2001. $163,033.

Dixon, E. James: Interior NPS 1443CA991000046. Culture History of Beringia: An Archeological Synthesis. 2000-2004. $118,886.

Dyurgerov, Mark; Dwyer, Jeremiah; Meier, Mark: NSF OPP-9634289. A New Methodology for Assessing Glacier Mass Balances and Runoff for Global Studies of Climate Change and Sea Level Rise. 1996-2000. $399,953.

Elias, Scott: NSF ESI-9818837. Arctic Connections: An Interactive CD-ROM Program for Secondary Science Education. 1999-2001. $363,031.

Elias, Scott: NSF ESI-9818837. Arctic Connections: An Interactive CD-ROM Program for Secondary Science Education. 2000-2001. $87,250.

Elias, Scott: NSF OPP-9911048. Nature of Late Pleistocene Climatic Ameliorations in Eastern Beringia. 2000-2003. $145,461.

Elias, Scott: NSF ESI-9818837. Arctic Connections: An Interactive CD-ROM Program for Secondary Science Education. 2000-2001. $3,804.

Elias, Scott; Anderson, Katherine: NSF ATM-9612641. Mutual Climatic Range Reconstructions of Late Quaternary Climates in Beringia. 1996-1999. $166,297.

Elias, Scott; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $52,603.

Harper, Joel, Pfeffer, W. Tad: NSF EAR-9901492. Postdoctoral Research Fellowship. 1999-2003. $5,000.

Herzfeld, Ute: NASA Goddard NAG5-6114. Geostatistical Methods for Determination of Roughness, Topography, and Changes of Antarctic Ice Streams from SAR and Radar Altimeter Data. 1997-1999. $70,000.

Herzfeld, Ute; Caine, T. Nelson: NSF EAR-0001514. Snow Surface Roughness - Data Collection, Geostatistical Analysis, Relationship to Meterologic Observations, and Relevance to Snow Hydrologic Models. 2000-2001. $74,352.

Hoffecker, John: Interior National Park Service CA 1268-2-9005/ UC0-26. Cultural Resources Management: Technical Support to the Remediation Venture Office, Rocky Mountain Arsenal. 1998-1999. $50,025.

Hoffecker, John; Elias, Scott: NSF OPP-9906653. Uivvaq: Archaeology and Paleoclimatology of an Arctic Coastal Midden. 1999-2002. $100,319.

Hughen, Konrad; Overpeck, Jonathan; Lehman, Scott: NSF ATM-9709563. Radiocarbon, Ocean and Climate Change over the Last Deglaciation. 1997-2001. $305,000.

Jennings, Anne; Andrews, John: NSF OPP-9707161. Late Quaternary Ice Sheet Extent Chronology and Paleoceanography, East Greenland Margin/Denmark Strait: Implications for the Arctic and North Atlantic Oceans. 1997-2000. $213,707.

Jennings, Anne; Andrews, John: NSF OPP-9707161. Late Quaternary Ice Sheet Extent Chronology and Paleoceanography, East Greenland Margin/Denmark Strait: Implications for the Arctic and North Atlantic Oceans. 1997-2000. $10,000.

Jennings, Anne; Andrews, John; Anderson, David: NSF OPP-0082347. Ice-Ocean-Atmosphere Interactions Along the East Greenland Margin on Decade to Century Timescales Over the Last 14 ka. 2000-2003. $463,664.

Krantz, William; Caine, T. Nelson: NSF OPP-9321405. Development of a Differential Frost Heave Model: Application to Patterned Ground Formation. 1994-1999. $170,336.

Krantz, William; Caine, T. Nelson: NSF OPP-9321405. REU Supplement to: Development of a Differential Frost Heave Model: Application to Patterned Ground Formation. 1994-1999. $17,903.

Lehman, Scott: NSF ATM-9610128. High Resolution Uk'37 Alkenone Paleothermometry at Bermuda Rise: The Last Interglacial to the Little Ice Age. 1997-2000. $542,208.

Lehman, Scott: NSF EAR-9726185. Cosmogenic Nuclide Chronology of Bedrock Weathering Zones in Fennoscandia and Implications for the History of the Fennoscandian Ice sheet. 1998-2000. $50,057.

Lehman, Scott: NSF ATM-9809285. Preparation and AMS 14C Dating of Terrestrial Materials for ESH Program Research : Making Good Chronology a Priority. 1998-2001. $871,251.

Lehman, Scott: NSF OCE-0081257. Collaborative Research: A Benchmark Record of Temperature for the Last Four Glacial Cycles in Sediments of the Bermuda Rise. 2000-2003. $176,015.

Losleben, Mark: Environmental Science & Engineering, Inc. S68D98112-SITEOP-701, EPA 68D98112. Site Operator Agreement, CASTNet II Site 701 (C094). 1998-1999. $4,830.

Losleben, Mark: Commerce NOAA 43RANR900364. Carbon Cycle Atmospheric Gas Collection . 1998-1999. $13,729.

Losleben, Mark: Commerce NOAA 43RANR900064. Halocarbon Atmospheric Sampling. 1998-1999. $12,682.

Losleben, Mark: Environmental Science & Engineering, Inc. S68D98112-SITEOP-701, EPA 68D98112. Site Operator Agreement, CASTNet II Site 701 (C094). 1999-2000. $4,830.

Losleben, Mark: Commerce NOAA 43RANR000005. Halocarbon Atmospheric Sampling. 1999-2000. $11,172.

Losleben, Mark: Commerce NOAA 43RANR000739. Carbon Cycle Atmospheric Gas Collection. 1999-2000. $13,729.

Losleben, Mark: Harding ESE, Inc S68D98112-SITEOP-701, EPA 68D98112. Site Operator Agreement, CASTNet II Site 701 (C094). 2000-2001. $4,830.

Losleben, Mark: Commerce NOAA 43RANR1M0533. Carbon Cycle Atmospheric Gas Collection. 2000-2001. $14,276.

Losleben, Mark: Commerce NOAA 43RANR1M0050. Halocarbon Atmospheric Sampling (Renewal of 43RANR000005). 2000-2001. $12,966.

Lubinski, David: NSF. Collaborative Research: Reconstructing the Past 20,000 Years of Glacial and Sea-Level History for Severnaya Zemlya, Russia, 80 North. 2000-2001. $10,000.

Lubinski, David: National Research Council OCG4253B, INT-0002341. Fellowship. 2000-2001. $15,000.

Manley, William: NSF OPP-9977972. Collaborative Research: Paleoglaciology of Alaska — Climate Parameters During the Last Glacial Maximum from GIS Determination of Equilibrium Line Altitudes. 1999-2002. $154,719.

Manley, William; Dyurgerov, Mark; Meier, Mark: NSF ATM-0081379. Spatial Analysis and Calibration of Glacier-Climate Relationships Across Alaska. 2000-2001. $95,080.

Markgraf, Vera: NSF ATM-9526139. Coordination of PEP I Research Activities. 1995-2000. $184,342.

Markgraf, Vera: NSF EAR-9709145. Patagonia Lake Drilling Project (PATO): Phase I. 1997-2001. $596,368.

Markgraf, Vera: NSF ATM-9729145. Merida PEP I Meeting Support, March 16-20, 1998. 1997-2000. $89,072.

Markgraf, Vera: NSF ATM-0082067. Collaborative Research: Patagonia Lake Drilling Project (PATO): Phase II. 2000-2003. $87,012.

McKnight, Diane: NSF DEB-9211776. Effects of Climate Change in the Colorado Alpine: Ecosystem Response to Altered Snowpack and Rainfall Regimes. 1997-1999. $20,000.

McKnight, Diane: Desert Research Institute 97-B36. McMurdo Dry Valleys Long Term Ecological Research: A Cold Desert Ecosystem. 1997-1999. $73,900.

McKnight, Diane: University of Alabama CFDA#47.049, OPP-9813061. McMurdo Dry Valleys Long Term Ecological Research. 1998-1999. $53,991.

McKnight, Diane: University of Alabama CFDA#47.049, OPP-9813061. McMurdo Dry Valleys Long Term Ecological Research. 1998-1999. $71,052.

McKnight, Diane: EPA R826649-01. Photochemical Processes Controlling Manganese Chemistry in Pristine and Contaminated Mountain Streams. 1998-2001. $233,862.

McKnight, Diane: DOD Navy ONR N00014-99-1-0296. Quantification of the Humic Electron Transfer Reactions in Natural and Contaminated Marine Sediments. 1999-2002. $235,016.

McKnight, Diane: University of Alabama OPP-9810219, . McMurdo Dry Valleys Long Term Ecological Research. 1999-2000. $77,425.

McKnight, Diane: University of Alabama OPP-9810219. McMurdo Dry Valleys Long Term Ecological Research. 1999-2000. $69,729.

McKnight, Diane: Ohio State University Research Foundation 739204. McMurdo Dry Valleys Long Term Ecological Research (Research Studies). 2000-2001. $80,730.

McKnight, Diane: Ohio State University Research Foundation 739204. McMurdo Dry Valleys Long Term Ecological Research (Operations). 2000-2001. $66,424.

McKnight, Diane: Ohio State University Research Foundation 739204. McMurdo Dry Valleys Long Term Ecological Research (Equipment). 2000-2001. $25,000.

McKnight, Diane: Keystone Center OCG4287B. Characterization of Stream Ecosystem in Snake River Basin for the Snake River Task Force. 2000-2000. $7,946.

McKnight, Diane; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $56,096.

McKnight, Diane; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 2000-2001. $14,993.

Meier, Mark; Dyurgerov, Mark; Armstrong, Richard: NSF OPP-9530782. Global Glacier Mass Balance Synthesis. 1996-2000. $242,966.

Miller, Gifford: NSF ATM-9526384. PALE Steering Committee, Data Coordination, and Community Radiocarbon Dating. 1995-1999. $535,270.

Miller, Gifford: NSF ATM-9709918. Marine Terrestrial Variablity of the Labrador Sea Region Over Decadal to Millennial Time Scales (Labrador Sea Variability Over Decade to Millennial Time Scales). 1997-2001. $541,999.

Miller, Gifford: NSF ATM-0082254. Collaborative Research: Megafauna Extinction, Ecosystem Disruption and Climate Change: Assessing the Human Factor. 2000-2003. $105,522.

Miller, Gifford; Johnson, Beverly: NSF ATM-9709806. Drought in the Australian Outback: Milankovitch and Anthropogenic Forcing of the Australian, Monsoon. 1997-2001. $360,000.

Miller, Gifford; Manley, William: NSF OPP-9529350. Collaborative Research: Late Quaternary Glaciation of Northern Novaya Zemlya, Russia. 1996-2000. $184,434.

Miller, Gifford; Manley, William: NSF OPP-9529350. REU Supplement: Collaborative Research: Late Quaternary Glaciation of Northern Novaya Zemlya, Russia. 1997-2000. $5,000.

Miller, Gifford; Manley, William: NSF EAR-9817645. Upgrade of High-Pressure Liquid Chromatograph (HPLC) for Amino Racemization (AAR) Research of Quarternary Geochronology and Paleoclimatology. 1999-2001. $41,047.

Miller, Gifford; Pfeffer, W. Tad: NSF EAR-9510063. Late Quaternary Dynamics of the Labrador/Foxe Sectors of the Laurentide Ice Sheet, Eastern Canadian Arctic. 1995-2000. $277,865.

Miller, Gifford; Wolfe, Alex; Sauer, Peter: NSF ATM-9809795. Holocene and Last Glacial Maximum Paleoclimates of the Eastern Canadian Arctic Reconstructed from Biotic and Geochemical Proxies in Lake Sediments. 1998-2000. $50,222.

Miller, Gifford; Wolfe, Alexander: NSF ATM-9708418. Paleoenvironmental Reconstruction and Paleoclimate Implications for the Last Interglacial and the 40 to 10 ka Time Windows in the Eastern Canadian Arctic. 1997-1999. $100,000.

Ogilvie, Astrid; Andrews, John; Jennings, Anne; Barlow, Lisa: NSF OPP-9726510. Environmental Changes and Human Responses in the North Atlantic (Iceland and Greenland Sectors) During the Last 2,000 Years: A Contribution to the ARCSS Systems, Integration and Modeling Initiative. 1998-2002. $380,550.

Ogilvie, Astrid; McGoodwin, James: NSF OPP-0002651. Landscapes and Seascapes: Linkages Between Marine and Terrestrial Environments and Human Populations in the North Atlantic (Iceland Sector: A Contribution to the HARC Initiative. 2000-2003. $366,945.

Overpeck, Jonathan: NSF ATM-9631282. Climate Change of the Last 500 Years: Simulations Versus Data. 1996-1999. $245,000.

Overpeck, Jonathan: NSF ATM-9810254. Lake Bosumtwi, Ghana: High-Resolution Paleoclimatology and Seismic Reflection Site Survey. 1998-1999. $26,181.

Pendall, Elise; White, James: University of Nebraska LWT/ 62-123-06541 and 26-6223-0002-040, DE-FC03-90ER61010. Stable Isotope Tracers of CO_2 fluxes on Shortgrass Steppes under CO_2 Enrichment. 1999-2001. $192,839.

Pfeffer, W. Tad: NSF EAR-9614424. Ice-Core Analysis and Physical Glaciology of the Galena Creek Rock Glacier, Wyoming. 1997-2001. $306,416.

Pfeffer, W. Tad: NSF EAR-9614424. Ice-Core Analysis and Physical Glaciology of the Galena Creek Rock Glacier, Wyoming. 1999-2001. $43,381.

Pfeffer, W. Tad; Amadei, Bernard: NSF OPP-9531450. Direct Measurement of the In-Situ Stress Tensor at Depth in Glacier Ice: A Collaborative Study. 1996-2001. $335,034.

Pfeffer, W. Tad; Meier, Mark; Amadei, Bernard: NSF OPP-9614493. Observations and Modeling of Flow and Fracture Processes Leading to Iceberg Calving. 1997-2001. $380,795.

Pfeffer, W. Tad; Meier, Mark; Amadei, Bernard: NSF OPP-9614493. REU Supplement to: Collaborative Research: Observations and Modeling of Flow and Fracture Processes Leading to Iceberg Calving. 1998-2001. $1,303.

Seastedt, Timothy: NSF DEB-9211776. Effects of Climate Change in the Colorado Alpine: Ecosystem Response to Altered Snowpack and Rainfall Regimes. 1993-1999. $19,796.

Seastedt, Timothy: NSF DEB-9211776. Supplement to: Effects of Climate Change in the Colorado Alpine. 1995-1999. $10,000.

Seastedt, Timothy: NSF DEB-9211776. REU Supplement to: Effects of Climate Change in the Colorado Alpine: Ecosystem Response to Altered Snowpack and Rainfall Regimes. 1996-1999. $40,000.

Seastedt, Timothy: NSF DEB-9211776. Biotic Controls on Terrestrial C&N Flux: Comparisons Between Species and Between Ecosystems: A Supplement to the NWT LTER. 1996-1999. $40,000.

Seastedt, Timothy: NSF DEB-9211776. Effects of Climate Change in the Colorado Alpine: Ecosystem Response to Altered Snowpack and Rainfall Regimes. 1998-1999. $14,600.

Seastedt, Timothy: NSF DEB-9806438. Collaborative Research: Identifying Ecosystem Controls on Biodiversity: A US/UK Project. 1998-2002. $271,301.

Seastedt, Timothy: NSF DEB-9810218. REU Supplement to: The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function, and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1999-2001. $25,000.

Seastedt, Timothy: EPA MM988113-01-0. Enhancing the Effectiveness of Biocontrol Insects as Part of Non-Chemical Management of Diffuse Knapweed. 1999-2001. $40,000.

Seastedt, Timothy; Caine, T. Nelson; Wessman, Carol: NSF DEB-9211776. Effects of Climate Change in the Colorado Alpine: Ecosystem Response to Altered Snowpack and Rainfall Regimes. 1992-1999. $3,501,204.

Seastedt, Timothy; Townsend, Alan, Wessman; Carol; Williams, Mark: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $1,458,476.

Seastedt, Timothy; Townsend, Alan; Wessman, Carol; Williams, Mark: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $34,195.

Seastedt, Timothy; Townsend, Alan; Wessman, Carol; Williams, Mark: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function, and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $166,679.

Seastedt, Timothy; Townsend, Alan; Wessman, Carol; Williams, Mark: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 2000-2001. $25,000.

Seastedt, Timothy; Townsend, Alan; Wessman, Carol; Williams, Mark: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 2000-2001. $29,060.

Sievering, Hermann; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $32,303.

Steig, Eric: NSF OPP-9807066. Testing Alternative Models of Laurentide Ice Sheet Dynamics Using Cosmogenic Nuclide Exposure Dating. 1998-2000. $43,520.

Syvitski, James: DOD Navy ONR N00014-96-1-0994. Numerical Coupling of River Discharge to Shelf/Slope Sedimentation Models. 1996-1999. $110,000.

Syvitski, James: Raytheon LC315776. Littoral Sediment Transport Using Satellite Visible-Infrared Imaging Radiometry. 1998-1999. $118,536.

Syvitski, James: Duke University 99-SC-NSF-1010, EAR-9896392. Collaborative Research: Experimental Study of Basin Stratigraphy. 1999-2001. $7,493.

Syvitski, James: DOD Navy ONR N00014-00-1-0810. Predicting the Distribution and Properties of Buried Submarine Topography on Continental Shelves. 2000-2002. $269,750.

Syvitski, James; Bahr, David: DOD Navy ONR N00014-95-1-1281. ONR-Strataform Scaling and Integration of Process-Response Stratigraphic Models (formerly Linking Short and Long Term Sediment Delivery to Morphology and Seascape Evolution of Continental Margins) (formerly Predicting Sediment Delivery and Stratigraphy on Marginal Slopes and Shelf Basins). 1995-2002. $575,374.

Syvitski, James; Pfeffer, W. Tad: DOD Navy ONR N00014-00-1-0569. Environmental Computational and Imaging Facility. 2000-2001. $437,000.

Townsend, Alan: NSF DEB-9211776. Effects of Climate Change in the Colorado Alpine: Ecosystem Response to Altered Snowpack and Rainfall Regimes. 1997-1999. $15,000.

Townsend, Alan; Asner, Gregory: NASA Goddard NAG5-7402. An Integrated Use of Experimental Modeling and Remote Sensing Techniques to Investigate Carbon Isotope and Phosphorus Dynamics in the Humid Tropics. 1998-1999. $201,537.

Townsend, Alan; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $77,761.

Veblen, Thomas; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $71,951.

Walker, Donald: NSF OPP-9732076. REU Supplement to: An AVHRR-Derived Landcover Classification for Northern Alaska: A Prototype for the Circumpolar Arctic. 1998-1999. $5,000.

Walker, Donald: Marine Biological Laboratory 98221646, DEB-9810222. A Hierarchical Geographic Information System and Electronic Geobotanical Atlas for the Kuparuk River Basin, Alaska. 1998-1999. $8,000.

Walker, Donald; Gould, William: NSF OPP-9732076. Arctic Climate Change, Substrate, and Vegetation: The Distribution and Causes of Moist Nonacidic Tundra. 1998-1999. $441,275.

Walker, Donald; Seastedt, Timothy: NSF DEB-9810218. The Niwot Ridge Long Term Ecological Research Program 1998-2004: Controls on the Structure, Function and Interactions of Alpine and Subalpine Ecosystems of the Colorado Front Range. 1998-2001. $32,206.

Walker, Donald; Walker, Marilyn: NSF OPP-9318530. A Hierarchic GIS for Studies of Process, Pattern and Scale in Arctic Ecosystems. 1994-1999. $726,293.

Walker, Donald; Walker, Marilyn: NSF OPP-9318530. A Workshop to Develop a Legend for a New Vegetation Map of the Circumpolar Arctic: Arendal, Norway, Jan. 15-20, 1996. 1995-1999. $39,500.

Walker, Marilyn: University of Alaska UAF 96-0033, OPP-9521459. Sustainability of Arctic Communities: Interactions Between Global Change, Public Policies, and Ecological Processes. 1995-1999. $172,860.

Walker, Marilyn: NSF OPP-9400083. REU Supplement to: Comparative Responses of Moist and Dry Arctic Tundra to Altered Snow and Temperature Regimes (ITEX). 1996-1999. $10,432.

Walker, Marilyn; Walker, Donald; Seastedt, Timothy: NSF OPP-9400083. Comparative Responses of Moist and Dry Arctic Tundra to Altered Snow and Temperature Regimes. 1994-1999. $567,020.

Webb, Robert; Miller, Gifford; Goetz, Alexander: NASA Goddard NAG5-6051. Assessing Future Stability of U.S. High Plains Landcover: Integration of Process Modeling with Landsat, In Situ Modern and Paleoclimate Data. 1997-2001. $393,135.

White, James: NSF OPP-9615232. Isotopic Analyses on the NGRIP Deep Ice Core. 1997-2001. $374,225.

White, James: NSF ATM-9809463. International Ice Core Data Cooperative. 1998-2001. $49,246.

White, James: NSF ATM-9809463. International Ice Core Data Cooperative (Subcontract-Pennsylvania Univ). 1998-2001. $101,118.

White, James: NSF OPP-9815200. Stable Isotope Studies at West Antarctic ITASE Sites. 1999-2004. $102,132.

White, James: NSF OPP-9909968. Developing a 480,000 Year Climate Record for West Antarctica. 2000-2001. $59,178.

White, James: NSF ATM-0081294. Collaborative Research: Isotopic Characteristics of Precipitation Across the United States: Patterns and Processes. 2000-2004. $87,874.

White, James; Steig, Eric: NSF OPP-9526979. Isotopic Measurements on the WAIS/Siple Dome Ice Core. 1996-2000. $358,915.

White, James; Townsend, Alan: NSF DGE-9987607. IGERT Full Proposal: Carbon, Climate, and Society. 2000-2005. $1,176,783.

Williams, Mark: University of California Santa Barbara KK8013. Hydrology, Hydrochemically Modeling and Remote Sensing of Seasonal Snow Covered Areas. 1997-2000. $127,840.

Williams, Mark: San Miguel County OCG4101B. Watershed Characterization for Purposes of Alpine Basin Sensitivity Analysis: San Miguel (Renewal of OCG3053B). 1998-2000. $32,000.

Williams, Mark: NATO ENVIR.LG 974676. Glaciers of Central Asia and Their Relation to Global Hydrological Cycle. 1999-2001. $12,703.

Williams, Mark: State of Colo Dept Natural Resources OCG4154B. Source Water and Flowpath Identification, Mary Murphy Mine, Chalk Creek, Colorado. 1999-2000. $10,000.

Williams, Mark: Interior NPS CA-1268-2-9005 UCO-29. Nitrogen Dynamics: Interactions Between Snowmelt and Runoff. 1999-2001. $64,708.

Arapaho Glacier from Niwot Ridge, the Mountain Research Station field study area.

Williams, Mark: San Miguel County OCG4234B. Airmon Installation and Operation, Telluride, Colorado . 2000-2001. $18,044.

Williams, Mark; Davinroy, Thomas: NSF SBR-9628375. Doctoral Dissertation Research: Biogeochemical Processes and Hydrologic Characteristics of Alpine Talus. 1996-1999. $10,000.

Williams, Mark; McKnight, Diane: NSF DEB-0087248. LTER Cross-site: Dissolved Organic Nitrogen Intersite Comparison (DONIC). 2000-2003. $196,506.

Williams, Mark; McKnight, Diane: NSF DEB-0087248. LTER Cross-site: Dissolved Organic Nitrogen Intersite Comparison (DONIC). 2000-2003. $46,499.

Williams, Mark; McKnight, Diane: NSF DEB-0087248. LTER Cross-site: Dissolved Organic Nitrogen Intersite Comparison (DONIC). 2000-2003. $56,500.

Williams, Mark; Pfeffer, W. Tad: DOD Army ARO DAAH04-96-1-0033. Meltwater Flowthrough Snow from Plot to Basin Scales. 1996-2000. $100,000.

Williams, Mark; Pfeffer, W. Tad: DOD Army ARO DAAG55-98-1-0505. Meltwater Flowthrough Snow from Plot to Basin Scales. 1998-2000. $12,500.

Williams, Mark; Pfeffer, W. Tad: DOD Army ARO DAAD19-00-1-0367. Collaborative Experiment for Pulsed Radar Visualization of Water Flow Paths in Snow. 2000-2000. $17,535.

Williams, Mark; Pfeffer, W. Tad; Caine, T. Nelson; Illangasekare, Tissa: NSF EAR-9526875. Meltwater Flowthrough Snow from Plot to Basin Scales. 1996-2000. $130,000.

Williams, Mark; Schmidt, Steven: Interior NPS CA-1268-2-9005 UCO-21. Nitrogen Dynamics: Interactions Between Snowmelt and Runoff. 1993-2000. $172,556.

Williams, Mark; Schmidt, Steven: NSF EAR-9523886. Biogeochemical and Hydrologic Controls on Solutes and Flowpaths in Alpine Watersheds: Collaborative Proposal to the NSF from CU, CSU, UA and USGS. 1995-1999. $223,000.

Williams, Mark; Steffen, Konrad; Illangasekare, Tissa: DOD Army ARO DAAH04-96-1-0289. Instrumentation for Snow Hydrology Research. 1996-1999. $136,248.

Wolfe, Alexander: NSF ATM-9808943. Lacustrine Records of Late Quaternary Water Balance Fluctuations in the Venezuelan Andes: Assessing the Interplay of Insolation and Ocean Circulation as Paleoclimatic Controls in the Tropics. 1999-2001. $63,054.

Wolfe, Alexander: Interior NPS CA-1268-2-9005 UCO-28. Biotic Responses to Enhanced Nitrogen Deposition in Lakes of Rocky Mountain National Park: Experimental and Historical Approaches. 1999-2000. $17,250.

Woodhouse, Connie: NSF ATM-9815439. A Well Documented Set of Annual Tree-Ring Chronologies from the International Tree-Ring Data Bank for Dendroclimatic Studies. 1998-2000. $26,540.

Woodhouse, Connie: University of Arizona Y501756. Temperature Variability Since AD 1000 in the Western US from Tree Rings. 1998-2001. $52,784.

Woodhouse, Connie: NSF ATM-0080889. Collaborative Research: Reconstruction of Drought and Streamflow Over the Coterminous United States from Tree Rings, with Extensions into Mexico and Canada. 2000-2003. $35,674.

Woodhouse, Connie; Brown, Peter: NSF ATM-9729571. Expanded and Lengthened Dendroclimatic Reconstructions of Great Plains Drought. 1998-2002. $304,827.

Support at INSTAAR, 1995-00

Source of Funds	**1995-00** (5 Years, AY) New Awards	K$	**2000** (Calendar Year) New Awards	K$
Federal Agencies				
NSF	178	$ 18,247	35	$ 5,332
DoDefense	25	2,032	6	890
EPA	2	1,938	0	-
NASA	12	1,462	1	31
DoInterior	9	472	0	37
DoAgriculture	6	353	0	-
DoCommerce	17	316	2	27
DoEnergy	1	163	0	-
Non-Federal Agencies	42	1,404	10	453
Gift Funds	11	1,306	1	200
Total Awards Received	**303**	**$ 27,693**	**56**	**$ 6,971**
CU General Funds		$ 5,034		$ 1,227
CU Match		408		239
Total CU Revenue		**$ 5,442**		**$ 1,466**
Auxillary Funds		$ 4,132		$ 984 (est.)
Total Revenue		**$ 37,267**		**$ 10,031**
Budget Expenditures				
Contract and Grant Funds		$ 25,431		$ 5,494
General Funds		4,505		1,300 (est.)
Plant Funds		1,049		300 (est.)
Auxillary Funds		3,764		1,100 (est.)
Gift Funds		638		700 (est.)
Total Expenditures		**$ 35,387**		**$ 8,894** (est.)
Other Revenue/Expenditure (INSTAAR R/E tracked through other CU units)		**$ 1,404**		**$ 650**

Publications 1999

Ackert, R.P., Jr.; Barclay, D.J.; Borns, J.W., Jr.; **Calkin, P.E.**; Kurz, M.D.; Fastook, J.L.; **Steig, E.J.** 1999: Measurements of past ice sheet elevations in interior West Antarctica. Science 286(5438):276-280.

Addington, R.N.; **Seastedt, T.R.** 1999: Activity of soil microarthropods beneath snowpack in alpine tundra and subalpine forest. Pedobiologia 43:47-53.

Alley, R.B.; Clark, P.U.; Keigwin, L.D.; **Webb, R.S.** 1999: Making sense of millennial-scale climate change. In: Clark, P.U., **Webb, R.S.**, Keigwin, L.D. (eds.), Mechanisms of Global Climate Change at Millennial Time Scales. Geophysical monograph 112. Washington, D.C., American Geophysical Union, 394 pp.

Anderson, J.B.; **Andrews, J.T.** 1999: Radiocarbon constraints on ice sheet advance and retreat in the Weddell Sea, Antarctica. Geology 27(2):179-182.

Anderson, D.M.; Archer, R.B. 1999: Preliminary evidence of early deglaciation in Southern Chile. Palaeogeography, Palaeoclimatology, Palaeoecology 146:295-301.

Andersson, T.; Forman, S.L.; Ingolfsson, O.; **Manley, W.F.** 1999: Late Quaternary environmental history of central Prins Karls Forland, western Svalbard. Boreas 28:292-307.

Andrews, J.T. 1999: Dating glacial events and correlation to global climate change. In: Quaternary Geochronology: Methods and Applications. AGU Reference Shelf 4:447-455.

Andrews, J.T.; **Barber, D.C.**; **Jennings, A.E.** 1999: Errors in generating time-series and in dating events at late Quaternary millennial (radiocarbon) time-scales: examples from Baffin Bay, NW Labrador Sea, and East Greenland. In: Clark, P.U., **Webb, R.S.**, Keigwin, L.D. (eds.), Mechanisms of Global Climate Change at Millennial Time Scales. Geophysical Monograph 112. Washington, D.C., American Geophysical Union, 394 pp.

Andrews, J.T.; Domack, E.W.; Cunningham, W.L.; Leventer, A.; **Licht, K.J.**; Jull, A.J.T.; DeMaster, D.J.; **Jennings, A.E.** 1999: Problems and possible solutions concerning radiocarbon dating of surface marine sediments, Ross Sea, Antarctica. Quaternary Research 52:206-216.

Andrews, J.T.; Keigwin, L.; Hall, F.; **Jennings, A.E.** 1999: Abrupt deglaciation events and Holocene palaeoceanography from high-resolution cores, Cartwright Saddle, Labrador Shelf, Canada. Journal of Quaternary Science 14(5):383-397.

Andrews, M.; Tahirkheli, S.N. 1999: Electronic publication of an archival resource: the Arctic Bibliography. In: Markham, J.W., Duda, A.L., and Andrews, M. (eds.), Proceedings of the 24th Annual Conference of the International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC) and the 17th Polar Libraries Colloquy (PLC). Fort Pierce, FLA, IAMSLIC, 1999, pp. 243-252.

Asner, G.P.; **Townsend, A.R.**; Bustamante, M.C. 1999: Spectrometry of pasture condition and biogeochemistry in the Central Amazon. Geophysical Research Letters 26(17):2769-2772.

Azetsu-Scott, K.; **Syvitski, J.P.M.** 1999: Influence of melting icebergs on distribution, characteristics and transport of marine particles in an East Greenland fjord. Journal of Geophysical Research 104(C3):5321-5328.

Bahr, D.B.; **Dyurgerov, M.B.** 1999: Characteristic mass-balance scaling with valley glacier size. Journal of Glaciology 45(149):17-21.

Barber, D.C.; Dyke, A.; Hillaire-Marcel, C.; **Jennings, A.E.**; **Andrews, J.T.**; Kerwin, M.W.; Bilodeau, G.; McNeely, R.; Southon, J.; **Morehead, M.D.**; Gagnon, J.-M. 1999: Forcing of the cold event of 8,200 years ago by catastrophic drainage of Laurentide lakes. Nature 400:344-348.

Barclay, D.J.; **Calkin, P.E.**; Wiles, G.C. 1999: A 1119-year tree-ring-width chronology from western Prince William Sound, southern Alaska. The Holocene 9(1):79-84.

Behrendt, J.C. 1999: Antarctic science then and now. Arctic, Antarctic, and Alpine Research, 31(1):iv.

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Black, D.E.; Peterson, L.C.; **Overpeck, J.T.**; Kaplan, A; Evans, M.N.; Kashgarian, M. 1999: Eight centuries of North Atlantic Ocean atmosphere variability. Science 286(5445):1709-1713.

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Bowman, W.D.; Keller, A.; Nelson, M. 1999: Altitudinal variation in leaf gas exchange, nitrogen and phosphorus concentrations, and leaf mass per area in populations of *Frasera speciosa*. Arctic, Antarctic, and Alpine Research 31(2):191-195.

Brooks, P.D.; Campbell, D.H.; Tonnessen, K.A.; Heuer, K. 1999: Natural variability in N export from headwater catchments: snow cover controls on ecosystem N retention. Hydrological Processes 13: 2191-2201.

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Chiappini, M.; Ferraccioli, F.; Bozzo, E.; Damaske, D.; **Behrendt, J.** 1999: First stage of INTRAMAP: Integrated Transantarctic Mountains and Ross Sea area magnetic anomaly project. Annali Di Geofisica 42(2):277-292.

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Cleveland, C.C.; **Townsend, A.R.**; Schimel, D.S.; Fisher, H.; Howarth, R.W.; Hedin, L.O.; Perakis, S.S.; Latty, E.F.; Von Fischer, J.C.; Elseroad, A.; Wasson, M.F. 1999: Global patterns of terrestrial biological nitrogen (N_2) fixation in natural ecosystems. Global Biogeochemical Cycles 13(2):623-645.

Cole, J.E.; Rind, D.; **Webb, R.S.**; Jouzel, J.; Healy, R.J. 1999: Global controls on interannual variability of precipitation delta 18 O: the relative roles of temperature, precipitation amount, and vapor source region. Geophysical Research Letters 26:14223-14235.

Cortijo, E.; **Lehman, S.J.**; Keigwin, L.D.; Chapman, M.; Paillard, D.; Labeyrie, L. 1999: Changes in meridional temperature gradient (30 deg to 72 deg N) in the North Atlantic during the Last Interglacial period. Paleoceanography 14:23-33.

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