INSTAAR

Institute of Arctic and Alpine Research

An Earth and Environmental Systems Institute
at the University of Colorado at Boulder

2005–2006 Biennial Report

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Cover

INSTAAR activities in 2005–2006 included research investigations in many disciplines all over the world as well as emphasis on graduate education and public outreach.

Biennial Report 2005–2006

Institute of Arctic and Alpine Research
University of Colorado at Boulder

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INSTAAR: An Earth and Environmental Systems Institute

University of Colorado at Boulder

The Institute of Arctic and Alpine Research (INSTAAR) develops scientific knowledge of physical and biogeochemical environmental processes at local, regional, and global scales and applies this knowledge to improve society's awareness and understanding of natural and anthropogenic environmental change. The world's high-altitude and high-latitude regions are the Institute's traditional focus due to their sensitivity to environmental change. INSTAAR has increasingly broadened its geographic focus in a wide range of interdisciplinary studies of Quaternary and modern environments, research into geochronology, human and ecosystem ecology, hydrology, oceanography, landscape evolution, biogeochemistry, and climate. INSTAAR's national and international research leadership in these areas is augmented by exceptional strength in graduate education as well as the exposure of undergraduates to the research process, and by outreach to the public both locally and nationally.

INSTAAR's *Research Activities* integrate field studies, state-of-the-art laboratory experiments, field and laboratory sample analysis, and numerical and laboratory modeling. INSTAAR efforts emphasize three main spheres of research.

The *Ecosystems Group* focuses on biogeochemical processes of terrestrial and aquatic systems, biodiversity, ecosystem disturbance and recovery, modeling of biotic patterns, ecological assessments, and surface-atmosphere gas exchange and atmospheric transport. *Long-Term Ecological Research (LTER)* studies in alpine and polar regions, involving populations and communities, biogeochemistry, and ecophysiology, are emphasized. Feedbacks of snow cover changes on biogeochemistry and gas exchange processes are studied in both mid-latitude and in polar environments. Research tools include field experimental manipulations, isotopic tracers, long-term monitoring of ecosystem patterns and processes, modern analytical instrumentation, geographic information systems (GIS), remote sensing, flux measurement techniques, and ecosystem modeling. Both INSTAAR and its *Mountain Research Station* offer world-class field and laboratory 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's oceans, glaciers, and land areas. Methods of analysis include theoretical and numerical development; remote sensing; land, airborne, and ship-borne field experiments, all applied to research topics in hydrology, glaciology, frozen-ground studies, paleoclimatology, physical oceanography, and marine geology. To facilitate such research, *the Environmental Computation and Imaging (ECI) Facility* provides researchers with supercomputer power and global connections to geophysical databases.

The *Past Global Change Group* focuses on reconstructing 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, the biosphere, and human ecology. Integration of a variety of records from a global network of sites, including polar ice caps, continental alpine regions, and the world's oceans, provides the capability to test conceptual and predictive global change models, to facilitate the differentiation between natural and human-induced change, and to study the human impacts of changes. These efforts are enhanced by the *Center for Geochemical Analysis of the Global Environment (GAGE)*, which promotes fundamental research in the development and application of analytical methods that reveal past and present changes in Earth's climate, its land surface, and major biogeochemical cycles.

INSTAAR's *Teaching Mission* is directed toward fostering an appreciation and understanding of the biological, chemical, and physical processes operating in continental and ocean environments. The Mountain Research Station and other study sites in the mountains of Colorado aid the educational efforts of the Institute. INSTAAR supports the University of Colorado's educational mission and provides interdisciplinary graduate and undergraduate classes and research opportunities; the Institute has led education efforts that integrate students across multiple departments and colleges. 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 resilience, 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 indigenous residents but also, through global teleconnections, have a bearing on the lives of people everywhere.

Information regarding the Institute of Arctic and Alpine Research, the 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 at, respectively:

instaar.colorado.edu
culter.colorado.edu:1030/
www.colorado.edu/mrs/
instaar.colorado.edu/AAAR/

The State of the Institute

A Message from the Director

James P. M. Syvitski

What are we? INSTAAR is an Earth and Environmental Systems Institute, with facilities and laboratories located in Boulder, Colorado. INSTAAR is one of seven research institutes located at the University of Colorado, Boulder. It has the honor to be the oldest. It was inaugurated in 1951 but its origins extend back to the Mountain Laboratory in Tolland, Colorado (1909–1919), and to University Camp located at Niwot, Colorado (1914–1920). University Camp was renamed Science Lodge in 1921, and in 1951, the Mountain Research Station (MRS). The MRS remains an important field station supporting INSTAAR research. INSTAAR environmental field research now extends to all major oceans (Arctic, Atlantic, Pacific, Indian, and Southern), coastal seas (Mediterranean, Gulf of Mexico, Hudson Bay), all major landmasses (North through Central to South America, Africa, Australasia, Europe, Asia, and Ocean Islands), and the Polar Regions.

Who are we? At the end of 2006, the governing body (Directorate) comprised 35 Fellows and Research Scientists led by the Director, an Associate Director, and an Executive Committee. The Directorate consisted of 16 teaching faculty (3: Biology; 3: Geography; 5: Geology; 2: Civil, Architectural, and Environmental Engineering; 2: Environmental Studies; 1: Anthropology); 6 Fellow/Professor-Emeriti; 3 federal Research Scientists (NOAA, USGS); and 10 Research Faculty. The Directorate receives support from 40 professional scientists, 8 post-doctoral scientists, and 65 graduate students. Other PhD-level Institute scientists include 39 Research Affiliates (USGS, NCAR, NOAA, other Universities, and private companies) and 5 Visiting Scientists. During 2005–2006, the Institute supported 90 undergraduate research assistants. Institute members are loosely subdivided into three research groups (Ecosystem Science, Geophysics, and Past Global Change), but considerable cross-group collaboration occurs. Staff and faculty within our Center for *Geochemical Analysis of the Global Environment* are included in these groups. Our Mountain Research Station has a staff of 7 including faculty and instructors. The Institute's administrative staff of 10 includes an Information Officer; the Managing Editor of *Arctic, Antarctic, and Alpine Research;* the Chief Finance Officer; the Director's Executive Assistant; a Systems Administrator; a Web Master, and 5 accountant technicians and clerks, all to support the activities of our 291-member Institute (for details see http://instaar.colorado.edu/people/index.html).

Research is expensive: The majority of our $18.4M revenue for 2005–2006 came from federal agencies (59%), followed by the state of Colorado (CU: 19%), auxiliary lab operations (13%), and non-federal sources (9%). Of the federal agencies, NSF remains the largest source of revenue, followed by the Departments of Commerce, Defense, and Interior. INSTAAR research involves about 220 contracts, grants, and gifts at any one time. The total operating expenditures for 2005–2006 were $16M: 61% as salaries, tuition, and scholarships; 14% as operating expenses; 14% as recharges and indirect cost recovery by CU; 7% for equipment; and 4% in travel.

Honors, awards, and recognition:

- John C. Behrendt was elected President of the prestigious American Polar Society in spring 2006.
- Robert S. Anderson was elected a fellow of the American Geophysical Union for "fundamental and pioneering contributions in quantitative geomorphology, geochronology, hydrology, and glaciology."
- John T. Andrews was elected a fellow of the American Geophysical Union for his "seminal contributions to the Quaternary history of North America and the North Atlantic Basin."
- Gifford Miller received the Easterbrook Distinguished Scientist Award at the Geological Society of America's (GSA) 2005 annual meeting. The award is given annually by the society's Quaternary Geology and Geomorphology Division to an individual who has shown unusual excellence in published research, as demonstrated by a single paper of exceptional merit or a series of papers that have substantially increased knowledge in Quaternary geology or geomorphology.
- The ISI Web of Knowledge named James W.C. White as one of the most highly cited geoscientists for the period 1981–2006. This select group comprised less than one-half of one percent of all publishing researchers—an extraordinary accomplishment.
- Tim Seastedt won the 2005 Boulder County Pacesetter Environment award from the Boulder *Daily Camera* newspaper for his work on biological pest control of diffuse knapweed, an aggressive noxious weed that infests about 100,000 acres locally and 3 million acres in the West.

Books: With great effort and dedication, INSTAARs published a series of books and special journal issues over the last couple of years. These include:

- Behrendt, J. C., 2005: *The Ninth Circle; a Memoir of Life and Death in Antarctica, 1960–62.* Albuquerque: University of New Mexico Press, 255 pp.
- Hoffecker, J. F., 2005: *A Prehistory of the North: Human Settlement of the Higher Latitudes.* New Brunswick: Rutgers University Press, 140 pp.
- McKnight, D., and Emerling, D., 2006: *The Lost Seal.* Lafayette: Moonlight Publ., 34 pp.
- Trincardi, F., and Syvitski, J. P. M. (eds.), 2005: Mediterranean Prodelta Systems. *Marine Geology,* 222–223: 520 pp.

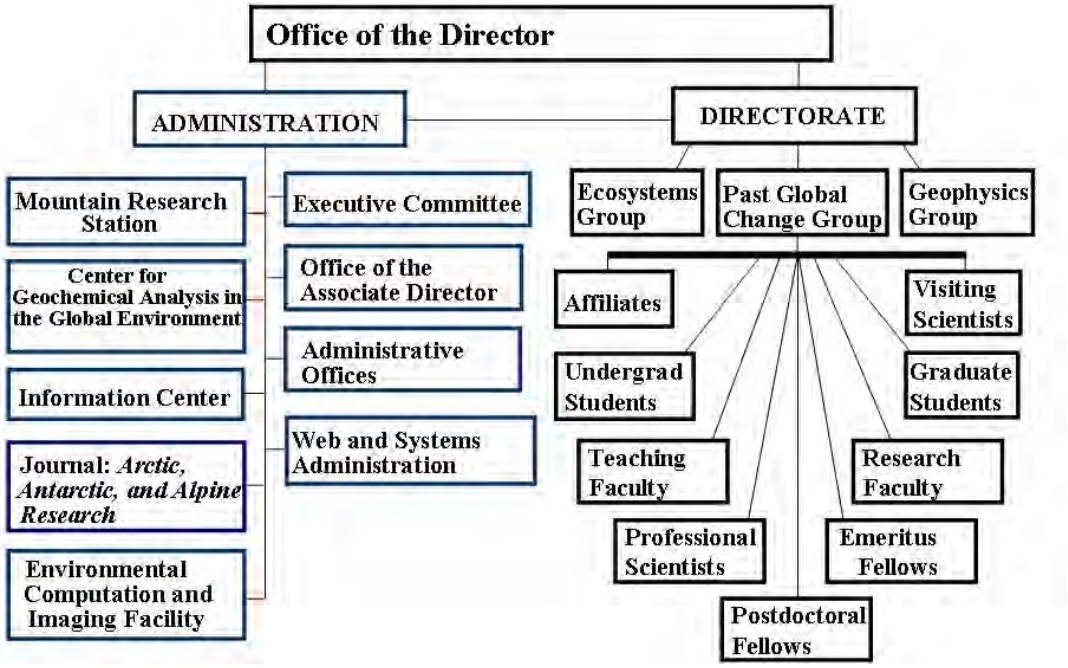
Hearty hellos: Marcia Kelly has joined INSTAAR as the Executive Assistant to the Director, transferring in from the

CU-Denver campus where she helped to manage the Mathematics department. Dr. *Diana Nemergut* joined the Directorate as an Assistant Professor with expertise in environmental microbiology, and Dr. *Cory Cleveland* joined the Directorate as a Research Faculty member with expertise in terrestrial biogeochemistry, and its interactions with soil microorganisms.

Fond farewells: Connie A. Woodhouse, Fellow of INSTAAR and Physical Scientist of Paleoclimatology Branch of the NOAA National Climatic Data Center, has taken up a faculty position at the University of Arizona. Dr. Woodhouse specializes in paleoclimatology, dendrochronology, and climatology. Research Faculty member *Irina Overeem* has taken a position as Assistant Professor at Delft University of Technology and will continue her research into stratigraphy, numerical modeling of fluviodeltaic processes, and arctic fluvial environments. MRS Climatologist *Mark Losleben* has departed after 25 years to take a position at the University of Arizona as the Assistant Director of the National Phenology Network–Arid Lands Research. *Vicky Nelson,* Executive Assistant to the Director, has retired from CU after a full career working with a number of campus units. Vicky is remembered for her organizational skills, fabulous holiday parties, and strong interest in all things Icelandic.

Finally, after 12 years at the helm (1995–2007), I am stepping down as INSTAAR Director. During these years, the number of INSTAAR employees has doubled, along with our research income and operating expenditures. Our income portfolio has diversified, although the Institute still relies strongly on competitive grants from the National Science Foundation. Funds from the Department of Energy have been replaced with funds from the Department of Defense. The Institute has diversified its research agenda around the broader theme of earth and environmental systems. INSTAARs have championed CU graduate certificates in Hydrological Sciences and in Oceanography. INSTAAR is affiliated with ever more departments, including Anthropology, Atmospheric & Ocean Sciences, Environmental Sciences, and Civil & Environmental Engineering, in addition to the historical association with Geological Sciences, Geography, and Ecology & Evolutionary Biology. During a campus period of declining graduate student enrollment, the number of INSTAAR graduate students has continued to grow. Our outreach program is large, with educational books for lower school science students, programs for middle school students, high school science fair awards, and education programs for high school teachers. INSTAAR continues to mentor and train undergraduate students in a wide variety of programs. With new large research programs on the horizon, I leave the Institute in good shape and with a bright future. I join with INSTAAR's prior directors, Mark, Bill, and Jack, in wishing the new Director a steady but deft hand in dealing with the coming turbulence of the 21st century.

INSTAAR organization chart as of January 2007



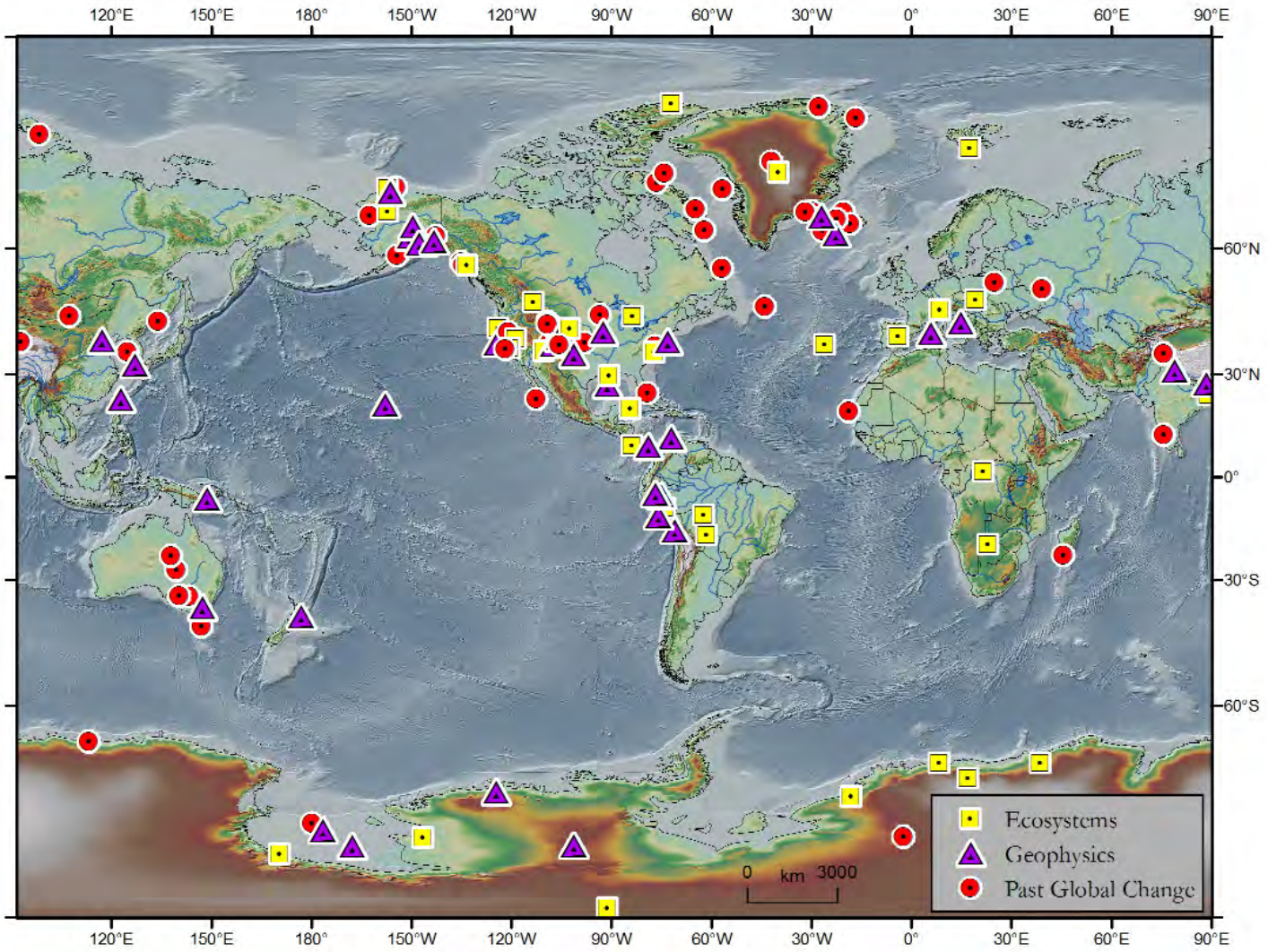
Support at INSTAAR

Source of Funds	2004/2005 New Awards	2004/2005 K$	2005/2006 New Awards	2005/2006 K$
Federal Agencies				
NSF	23	$ 4,002	27	$ 3,585
Department of Defense	2	191	2	183
EPA	0	0	1	29
NASA	2	48	2	177
Department of Interior	6	164	8	408
Department of Agriculture	0	0	1	6
Department of Commerce	4	159	11	815
Non-Federal Agencies	18	532	13	467
Gift Funds	0	0	1	805
Total Awards Received	**55**	**$ 5,096**	**65**	**$6,475**
CU General Funds		$ 1,761		$ 1,747
CU Match		47		16
Auxiliary Funds		$ 1,143		$ 1,207
Total Revenue		**$ 8,038**		**$9,445**
Revenue tracked through other CU units:		**$ 628**		**$ 274**

Expenditures at INSTAAR

Budget Expenditures by Fund		
Contract and Grant Funds	$ 5,257	$ 5,191
General Funds	1,460	1,746
Plant Funds	228	–262
Auxiliary Funds	1,225	1,111
Gift Funds	114	43
Total Expenditures	**$ 8,284**	**$ 7,829**
Budget Expenditures by Type		
Salaries (+ benefits, stipends, student aid)	$ 4,935	$ 4,813
Operating Expenses	1,188	1,099
Travel	356	272
Equipment	577	440
Tuition	99	67
Subcontracts	64	125
Utilities	18	21
Recharges + Indirect Cost Recovery	1,170	1,102
Transfers	–123	–110
Total Expenditures	**$ 8,284**	**$ 7,829**

Where in the world is INSTAAR? Active research programs during 2005 or 2006.



Research Spotlights

2006

GLACIERS ADDING MORE TO GLOBAL SEA RISE THAN ICE SHEETS. Tad Pfeffer gave a presentation at the national American Geophysical Union (AGU) meeting titled "Disappearing Glacial Ice: a Global Synthesis" based on his work with fellow INSTAARs Mark Meier, Mark Dyurgerov, Robert Anderson, Suzanne Anderson, Shad O'Neel, and Ursula Rick. Their study was based on the several hundred thousand small glaciers and small, pancake-shaped ice masses known as ice caps spread around the world in polar and temperate regions. Because of the challenge in inventorying each individual glacier, the researchers used a mathematical "scaling" process to estimate and characterize more remote glacier volumes, thicknesses, and trends by factoring in data like altitude, climate, and geography. Their research shows that small glaciers and ice caps have been contributing more to rising sea levels in recent years than the large Greenland and Antarctic ice sheets. In total, the small glaciers and ice caps are shedding about 400 billion tons of ice yearly—nearly equal to the volume of Lake Erie. Earth's sea level currently is rising at about 3 millimeters per year and could rise by several feet or more by the end of the century if warming on Earth continues, according to recent studies.

SKI MOGULS MOVE UPHILL ... REALLY! David Bahr (INSTAAR Affiliate) and Tad Pfeffer have used time-lapse photography to demonstrate that ski moguls move uphill, a counter-intuitive result. The uphill propagating "kinematic waves" are created by skiers that scrape off the downhill side of one mogul and then pile that snow on the uphill side of the next mogul. The net effect is that each mogul gains material on top, loses material on the bottom, and therefore migrates slowly uphill (centimeters a day). Mogul dynamics resemble other "self-organizing" systems like flocks of birds and LCD crystals. Furthermore, moguls move along ski trails like electrons on a wire. By treating each trail junction as a logic gate, a fully functional (albeit very slow) computer can be constructed from moguls. This research may help ski areas better plan how and where to place gates on trails. Ski racers might also benefit from understanding the physics of mogul movement. The bumps that the last racer is skiing are compressed toward them compared to the first skier. Bahr and Pfeffer's research is ongoing at the Mary Jane/Winter Park Ski Resort.

FIRST SHIP-BORNE MEASUREMENTS OF OZONE FLUXES TO THE OCEAN. Detlev Helmig, Jacques Huber, and other members of INSTAAR's Atmospheric Research Lab have worked with colleagues at NOAA and the Max Planck INstitute in Mainz, Germany, to obtain the first ship-borne direct measurements of ozone fluxes to the ocean. Ozone is a greenhouse gas that can warm the Earth's climate by absorbing heat energy from the Earth. While scientists have learned a great deal about how ozone is created and destroyed in the atmosphere, there are still many missing pieces of the puzzle, especially for the oceans. The research team spent several years developing an ozone + NO chemiluminescence instrument that allows continuous ozone flux measurement by the eddy correlation technique from a sampling tower on the bow of a ship.

Jacques Hueber (INSTAAR) and Ludovic Bariteau (CIRES/NOAA ESRL) installing a new ozone flux instrument on the NOAA research vessel *Ron Brown* for participation in the TEXas Air Quality Study (TEXAQS 2006), Charleston, SC, July 2006. Photo: Jacques Hueber (INSTAAR).

The instrument was deployed on NOAA's research vessel *Ron Brown* in collaboration with scientists from NOAA's Earth System Research Laboratory. Ozone flux data were obtained for a total of 7 weeks in 2006, covering more than 1000 miles of ocean surface in the Gulf of Mexico and off the coast of Chile. The new data will improve understanding of the basic physical processes at work and how they relate to feedbacks between atmospheric ozone and climate change. The team is also developing a representation of those processes that can be incorporated into global climate models. This research is a collaboration between four institutes and supported by the U.S. National Science Foundation.

DISCOVERY OF ANCIENT HUMAN REMAINS SPARKS PARTNERSHIP, DOCUMENTARY. James Dixon helped discover 10,300-year-old human remains in southeast Alaska in 1996 that have provided new insights into the lives of ancient people and helped cement a partnership between local tribes and scientists. Dixon was a lead researcher who studied the bones, the earliest human skeletal remains ever found in Alaska or Canada. In the project's early days, Dixon recognized the significance of the cooperation between the Tlingit and Haida tribes, scientists, and government officials. The successful partnership and the knowledge gained from the ancient bones and artifacts found in the cave are explored in a new 30-minute documentary titled "Kuwóot yas.éin—His Spirit Is Looking Out from the Cave." The documentary was released on video this summer by the Sealaska Heritage Institute in Juneau, Alaska, in collaboration with the Tongass National Forest, Denver Museum of Nature and Science, and the National Park Service. It was funded in part by the National Science Foundation's Office of Polar Programs.

NO PERVASIVE HOLOCENE ICE-RAFTED DEBRIS (IRD) SIGNAL IN THE NORTHERN NORTH ATLANTIC? John Andrews, Anne Jennings, and colleagues have assembled marine core records of ice-rafted debris (IRD) off north Iceland, East Greenland, and Labrador that are at odds with an earlier and oft-cited study showing a pervasive ~1.5 thousand year periodicity of IRD delivery during the Holocene (last ~11,400 years). Andrews et al. used quantitative X-ray diffraction on the <2 mm sediment fraction of four well-dated cores from different ice-dominated regions. There were significant differences in the trends of the IRD as well as an absence of a pervasive millennial signal. These results suggest that IRD delivery to the northern North Atlantic is not synchronized regionally nor is it periodic. Moreover, the results should make researchers question the underlying environmental forcing behind the earlier studies' data (hematite-stained quartz sands). Although the ~1.5 thousand year cycles in this and other records may be associated with solar forcing, the specific link to ice rafting appears ambiguous. The varying trends in the new data suggest that the Holocene oceanographic/climate evolution of each region should be considered individually. Andrews et al.'s preliminary results were published in a special August 2006 issue of the *PAGES Newsletter* about the National Science Foundation's Earth System History (ESH) program. More publications are underway.

TROPICAL FOREST CO_2 EMISSIONS TIED TO NUTRIENT INCREASES. Cory Cleveland and Alan Townsend have completed a study of tropical forest soils showing that even small changes in nutrients could have a profound impact on the release of CO_2. The new study, which took place in 2004 and 2005 in Costa Rica's Golfo Dulce Forest Reserve, included a series of 25-meter-square plots that were fertilized with phosphorus, nitrogen, or a combination of the two. Soil respiration was measured using plastic tubes in the ground running into vented, closed chambers. The fertilized plots yielded surprisingly large releases of CO_2 to the atmosphere. The new results have global implications because human activity has changed the availability of both phosphorus and nitrogen over many parts of the tropics. Moreover, Earth's soils are believed to store several times more carbon than all of the planet's vegetation.

Phosphorus and many other nutrients are regularly transported around the Earth by global wind patterns, sometimes riding on huge transcontinental dust clouds. There is strong evidence that humans are increasing the size of these dust clouds as both land-use patterns and climate change, which in turn can change the availability of nutrients to forests. Nitrogen pollution also is increasing around the world, including in tropical forests, a result of fossil fuel combustion and crop fertilization activities. Human activity has changed the availability of nitrogen all over the world, especially in the last 50 years.

This research was funded by the National Science Foundation (NSF) and featured on the NSF News web site on 20 June. It was published in the July 5, 2006, issue of the *Proceedings of the National Academy of Sciences*.

COTTONWOODS STUDIED AT SAND CREEK MASSACRE SITE. Jeff Lukas and Connie Woodhouse, assisted by Henry Adams, carried out a dendroecological study of the riparian cottonwood forest at the recently established Sand Creek Massacre National Historic Site in southeastern Colorado, under the guidance of the National Park Service, the Cheyenne and Arapaho Tribes of Oklahoma, and the Northern Arapaho Tribe. The objectives of the research were to identify trees that may have been alive at the time of the massacre (1864), describe the overall age and spatial structure of the stands, and link these patterns of tree establishment with hydrological and climatic variability over the last century and longer.

While no trees were definitively dated to 1864, the tree-ring evidence indicates that multiple trees were alive at that

A rare wooden artifact (spear foreshaft) recovered from an ancient ice patch by E. James Dixon (INSTAAR) and colleagues, Wrangell–St. Elias National Park and Preserve, Alaska, July 2006. Photo: Eric Parrish (INSTAAR).

time, probably as seedlings or saplings, confirming the belief of tribal members that "witness trees" were still present at the site. The temporal and spatial patterns of tree establishment are consistent with the prevailing flood-driven model of cottonwood establishment in western North America; the initiation dates of the three major age classes coincide with probable flood events on Big Sandy Creek. The completed study provides the Park Service and its tribal partners with data critical to managing the cottonwood forest at Sand Creek as both a natural and cultural resource.

The study was the subject of a feature article in the *Daily Camera,* a Boulder-based newspaper: "Witnesses to Horror—CU Researchers Study Sand Creek Cottonwoods" by Erika Engelhaupt (April 29, 2006).

EARTH'S PAST SUGGESTS FUTURE POLAR MELTING MAY RAISE SEA LEVEL SOONER THAN EXPECTED. Gifford Miller was a member of two research teams that combined paleoclimate evidence from the Last Interglacial period with climate and ice sheet modeling to infer that Earth's warming temperatures are on track to melt the Greenland and Antarctic ice sheets sooner than previously thought and ultimately lead to a global sea level rise of at least 20 feet. If the current warming trends continue, by 2100 the Earth will likely be at least 4° Fahrenheit warmer than present, with the Arctic at least as warm as it was nearly 130,000 years ago. At that time, significant portions of the Greenland and Antarctic Ice Sheets melted, resulting in a sea level about 20 feet (6 meters) higher than present day.

Rebecca Anderson (INSTAAR, left) and Gifford Miller (INSTAAR) collect a lake core from a lake on the northern plateau of Baffin Island, Arctic Canada, July 2005. The lake core provides information on the history of ice cover on the plateau over the last several thousand years. Photo: J. Briner (University of Buffalo).

These studies are the first to link Arctic and Antarctic melting during the Last Interglaciation, 129,000 to 116,000 years ago. The results were published in two adjacent papers in the March 24, 2006, issue of *Science.*

2005

ALASKA'S COLUMBIA GLACIER RETREATING RAPIDLY. Tad Pfeffer (INSTAAR and CEAE) leads a research group that has documented the rapid tidewater retreat of the Columbia Glacier in Alaska, one of the fastest moving glaciers in the world. Since the early 1980s, Columbia Glacier has retreated 9 miles from its original endpoint in the Pacific Ocean at Prince William Sound, and has reached flow speeds as high as 88 feet per day. The glacier is the largest single contributor to sea level rise among all North American glaciers, and accounts for about 10% of total glacial discharge from the Alaska/Yukon region each year.

The retreat of Columbia Glacier is part of a cyclic pattern of slow advance and abrupt retreat typical of Alaskan tidewater (or ocean-terminating) glaciers, according to Pfeffer. The abrupt retreat was probably triggered by long-term melt and thinning, occurring over the past century or so for the Columbia Glacier, he added. The retreat of Columbia Glacier is being used as a model for apparently similar retreats now beginning on the outlet glaciers of southern Greenland. An additional question, Pfeffer said, is whether the same conditions causing the worldwide shrinkage of land-terminating glaciers will alter the cyclic pattern of tidewater glaciers, and prevent readvance, either in Alaska or Greenland. Since the retreat of Columbia Glacier began in the 1980s, the glacier has thinned up to 1300 feet in places, and is increasingly influenced by the upward pressure of underlying seawater on the part of the glacier that extends into the ocean. Pfeffer estimates that the tidewater glacier is about halfway through its projected retreat. The glacier is predicted to fall back another 9 miles over the next 20–25 years and then stabilize with its terminus near sea level.

Pfeffer and doctoral student Shad O'Neel have been working with other researchers to monitor the glacier using aerial photography, time-lapse photography, seismometers, and other instruments. Both Pfeffer and O'Neel presented the group's latest results at the American Geophysical Union national conference in December.

METHANE GYRATIONS IN PAST 2000 YEARS SHOW HUMAN INFLUENCE ON ATMOSPHERE. Dominic Ferretti, Jim White, and colleagues from the U.S., New Zealand, and Australia used pioneering stable isotopic techniques on air samples extracted from the tiny bubbles trapped in Antarctic ice cores to show that methane, a potent greenhouse gas in Earth's atmosphere, has been

altered by humans over the past 2000 years. Atmospheric methane (CH_4) varied as expected over the past few centuries when methane concentrations in the atmosphere rose by nearly 300% and other greenhouse gas levels are known to have increased sharply due to human influences. But the results further back in time came as a shock. Measurements of the stable carbon isotopes in methane ($\delta^{13}C$ of CH_4) fluctuated much more than expected before the industrial revolution. The gyrating ratio combined with other geochemical measurements are evidence for massive fires set by humans clearing land for agriculture and hunting for at least 2000 years. A prominent feature is a huge drop in the $\delta^{13}C$ ratio from ca. A.D. 1500–1600, and this was attributed to decreased grassland and forest burning by indigenous peoples in the South and Central Americas, where population was devastated by diseases brought to the New World by European explorers. The study is particularly important because methane increases have had the second highest impact on climate change over the past 250 years behind carbon dioxide, accounting for about 20% of the warming from all greenhouse gas increases. Methane is more powerful than carbon dioxide on a per molecule basis in slowing the release of radiated heat away from Earth. Previous work by other groups indicates that methane emissions from wildfires are likely to be higher during warm and dry periods, such as El Niño events, and may therefore increase with future climate change.

The paper was published in the September 9, 2005, issue of *Science*. Image: Central field tent at Law Dome, Antarctica, where drilling took place. Snow accumulation at Law Dome is very high (greater than 1 m/year), enabling the extraction of well-dated, high-resolution ice cores for greenhouse gas analysis. (Photo: Vin Morgan, Australian Antarctic Division, ACE, CRC).

ENVIRONMENTAL ENGINEERS STUDY POLLUTION OF COLORADO MOUNTAIN STREAMS BY MINES. Diane McKnight (INSTAAR and CEAE) and Jeff Wong (CEAE) spoke with radio station KUNC's Gavin McMeeking about the pervasive pollution of Colorado mountain streams by mining and the potential for remediation by environmental engineers. More than 19,000 abandoned mines in Colorado have polluted more than 7500 miles of streams (equal to the distance from Los Angeles to Sydney, Australia). This summer McKnight and Wong are concentrating on Peru Creek in Summit County (Snake River Watershed). The creek's bed near an abandoned mine is covered by metal oxides at a level that prevents algal growth and is lethal to aquatic life. There are no stream insects and thus, no fish or riparian birds. To help understand the transport of metals, Wong set up a salt injection tracer experiment that mimics the behavior of some nonreactive solutes, such as zinc, and helps in quantifying how much iron oxide is being deposited. Undergraduate students in the CU Biomathematics Scholars program based at INSTAAR participated in the downstream sample collection. Computer modeling of the experiment's data will provide ideas for remediation, but much remains to be learned and eventually millions of dollars will be needed to clean up this stream and many others. Ironically, another hurdle to successful remediation is the Clean Water Act, which mandates that any group working on remediation becomes liable for the environmental damage. Congressman Mark Udall has proposed a "good samaritan" amendment but it has stalled in Congress. Two other INSTAAR grad students, Andrew Todd and Chi Yang (CEAE), are studying the combined effects of limited prey and metal toxicity on fish and birds in other less severely impacted stream reaches in the larger Snake River Watershed. The segment aired on KUNC on August 4, 2005.

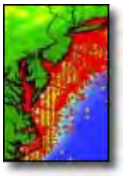
Tents dot the skyline at Flade Isblink, a small ice cap at 81°N in NE Greenland, summer 2006. Patterns in the surface hoar decorate the surface of the ice. Researchers from INSTAAR and the Niels Bohr Institute at the University of Copenhagen drilled the ice cap. Photo: Bruce Vaughn (INSTAAR).

ANCIENT DIETS OF AUSTRALIAN BIRDS POINT TO BIG ECOSYSTEM CHANGES. Gifford Miller led an international team (INSTAAR, Carnegie Institution, Australian National University, Wollongong University, and Bates College) to discover that the diet of two flightless birds inhabiting Australia shifted soon after humans arrived ca. 50,000 years ago, coincident with a rapid and dramatic shift in the ecosystem's flora. Their discovery is the best evidence yet that early humans may have altered the continent's interior with fire, changing it from a mosaic of trees, shrubs, and grasses to the desert scrub evident today. The researchers used isotopic studies of nearly 1500 eggshell fragments of fossilized emu and *Genyornis* dating back 140,000 years. The analyses, which pinpoint particular plant groups ingested by the birds, indicated that emus living before 50,000 years ago preferred nutritious grasses characteristic of milder temperatures and warm sum-

Crossing mobile sand in search of eggshells, Talaki, southern Madagascar, April 2006. Photo: Giff Miller (INSTAAR).

mer rains. After 45,000 years ago, the eggshell evidence showed emus successfully switched to a diet of mostly shrubs and trees characteristic of drier conditions. But *Genyornis,* which also preferred the nutritious grass prior to 50,000 years ago, failed to make the dietary switch and became extinct shortly after humans arrived. There were no significant swings in the continent's climate during that period, suggesting that humans indeed had a hand in the extinctions.

The study was published in the July 8, 2005, issue of *Science.* Image: enlargement of a painting of extinct *Genyornis* courtesy of Peter Trusler, from the book *Wildlife of Gondwana* by P. Vickers-Rich and T. Rich (Indiana University Press).



NEW MARINE SUBSTRATES DATABASE FOR U.S. ATLANTIC CONTINENTAL MARGIN. Chris Jenkins and colleagues at the U.S. Geological Survey released the first regional coverage of the usSEABED database, a large compilation of samples data on marine substrates for the U.S. Exclusive Economic Zone (200 nautical miles out from the coast), in this case for the Atlantic margin. The database is now widely used by agencies and others for mapping, understanding, and managing the offshore region. The continental shelf, in particular, serves a variety of purposes: recreation, benthic habitats conservation, fisheries, commerce, transportation, national defense operations, waste disposal, and engineering activities. The usSEABED database is built using dbSEABED processing software created by Jenkins. It has companion databases built along similar lines: for Australia, auSEABED, and globally, goSEABED. The databases rely on preexisting data, both published and unpublished, which the software has been able to integrate and quality filter. The usSEABED database, using the dbSEABED program, differs from other U.S. databases in that it incorporates both numerical and linguistic data on sediment texture, biology, seafloor characteristics such as hardness or sediment ripples, acoustic properties, and geochemical and geotechnical analyses. This broad-based approach increases the data density over the seabed, allowing for more complete maps and information. Future regional releases will be for the Pacific, Gulf of Mexico, and Alaskan margins.

NITROGEN FERTILIZATION OF SOIL PUTS PLANT SPECIES AT RISK, ESPECIALLY THE RARE ONES. Katherine Suding (former INSTAAR postdoc; current assistant professor, University of California, Irvine) led a team from eight universities in compiling data from previous and ongoing nitrogen-loading experiments on the alpine tundra of Niwot Ridge and in eight other ecosystems across North America. They found that rare plant species are six times more likely than abundant species to be lost due to nitrogen fertilization of soil. While nitrogen increases the production of most plants, an excess amount of it creates competition among plants for space that tends to drive rare plants out of existence, causing a loss of biodiversity. The team determined that other plant traits may put abundant plant species at risk in some settings: short height (short plants receive less sunlight in the midst of taller plants); the ability to convert atmospheric nitrogen, via bacteria, into a form that plants can use (the cost of supporting the bacteria hurts the plants); and a short life span (longer-living plants do not have to start the life cycle all over again). The team's work on nearly a thousand plant species will help predict how patterns of plant diversity will decline as N availability continues to increase globally in terrestrial ecosystems due to human activities. The project was initiated through the Niwot Ridge Long-Term Ecological Research (LTER) site, administered by INSTAAR, including experiments by Tim Seastedt and Bill Bowman (both INSTAAR).

The paper was published in the March 22, 2005, issue of *Proceedings of the National Academy of Sciences of the United States of America.*

HUMANS HAVE DRASTIC EFFECT ON SEDIMENT TRANSFER TO WORLD'S COASTS. James Syvitski, Albert Kettner, and colleagues from the University of New Hampshire analyzed data from more than 4000 rivers around the world that indicate humans are having profound and conflicting effects on the amount of sediment carried by rivers to coastal areas, with consequences for marine life and pollution control. The report found that humans are stirring up much more sediment than expected, about 2.3 billion metric tons annually, through regionally diverse patterns of agriculture and other soil erosion activi-

ties. However, manmade reservoirs are simultaneously reducing the flux of sediment reaching the world's coasts by about 1.4 billion metric tons per year. The net sediment transfer from an individual river to the ocean can greatly affect sensitive coastal zones, including nutrient balances, pollution levels, harbor dredging, coastal fish farms and coral reefs, coastal wetlands, and seagrass communities. In order to make their analysis, the team had to create a new computer model capable of globally consistent estimates of sediment flux near river mouths. The report was completed for the International Geosphere Biosphere Programme, a large-scale effort by scientists to study how humans have been and will continue to affect the entire planet. The study was published in the April 15, 2005, issue of *Science*.

NOVEL TAXONOMIC WEB SITE ASSISTS ANTARCTIC ECOLOGICAL RESEARCH. Sarah Spaulding, Rhea Esposito, and David Lubinski led a team of scientists, graduate students, and undergraduate students to develop a dynamic web database, "Antarctic Freshwater Diatoms," that combines ecological data collected over more than a decade in the McMurdo Dry Valleys region. The database takes a technologically novel approach by linking microscope images, scanning electron micrographs, original taxonomic descriptions, species geographic distributions, species assemblage data, maps, and permanent archives. Members of the research team are continually adding new data and images; no technical web knowledge is required. The interdisciplinary effort brought collaborators and students together from the University of Colorado, INSTAAR, University of Maine, CU Math-Bio Program, NSF Research Experience for Undergraduates (REU), and NSF Partnerships for Enhancing Expertise in Taxonomy (PEET). INSTAAR participants included Diane McKnight and Chi Yang. The effort was principally funded by NSF's McMurdo Dry Valleys Long Term Ecological Research program (MCMLTER) and an NSF supplement to the Niwot Ridge LTER program to encourage collaboration among undergraduates in biological sciences and mathematics departments. Although just launched in late February 2005, the site is already serving as a model for regional taxonomic databases, as an effective way to recognize and communicate species endemism and biodiversity.

ARID AUSTRALIAN INTERIOR LINKED TO LANDSCAPE BURNING BY ANCIENT HUMANS. Gifford Miller and colleagues from the National Center for Atmospheric Research in Boulder and the Australian National University in Canberra used global climate model simulations to evaluate the atmospheric and meteorological conditions in Australia over time, as well as the sensitivity of the Australian monsoon to different vegetation and soil types. Their results suggest that landscape burning by ancient hunters and gatherers may have triggered the failure of the annual Australian monsoon some 12,000 years ago, resulting in the desertification of the country's interior that is evident today. The study builds on previous field-based research of Miller's team; they found that dozens of giant animal species went extinct in Australia roughly 50,000 years ago, probably due to ecosystem changes caused by human burning. The new study indicates such burning may have eventually altered the flora enough to decrease the exchange of water vapor between the biosphere and atmosphere, causing the failure of the Australian monsoon over the interior. The earliest human colonizers are believed to have arrived in Australia by sea from Indonesia about 50,000 years ago, using fire as a tool to hunt, clear paths, signal each other, and promote the growth of certain plants. Fossil remains of browse-dependent birds and marsupials indicate the interior was made up of trees, shrubs, and grasses rather than the desert scrub environment present today. Among other results, the research team found that a climate model simulating a forested Australia produced twice as much annual monsoon precipitation over the continental interior as the model simulating arid scrub conditions. The study was published in the January 2005 issue of *Geology*.

NSF AWARDS INSTAAR $4.9 MILLION TO CONTINUE ALPINE ECOSYSTEM RESEARCH. The Niwot Ridge Long-Term Ecological Research project administered by INSTAAR scientists will continue for at least 6 more years as a result of a $4.9 million grant from the National Science Foundation. Located adjacent to INSTAAR's Mountain Research Station, Niwot Ridge is the only multidisciplinary, long-term alpine and sub-alpine

Tree trunks of a former forest now stick out of the surf zone due to retreat of the coastline, Ganges delta, India, December 2006. Irina Overeem (INSTAAR Affiliate, Delft University of Technology) is studying the influence of climate change on sedimentary system dynamics of the Ganges delta in a joint Indo-U.S. project on "Large river systems in monsoonal setting: response to climate change." Photo: H. Reinink (Delft University of Technology), December 2006.

study site on the continent. The study area encompasses several thousand acres of tundra, talus slopes, glacial lakes, and wetlands straddling the Continental Divide 35 miles northwest of Boulder. The new grant will allow faculty and students to continue their studies of natural and human-caused changes that occur over decades and centuries. The 18 principal investigators on the new NSF award are mostly from INSTAAR and other units at CU Boulder; other participants are from University of Montana, University of Denver, and the U.S. Geological Survey. The leader of the project is Mark Williams of INSTAAR. Topics of study range from hydrology, geochemistry, and nutrient transport to paleoecology, microbiology, and ecology. The Niwot Ridge region has undergone recent climate warming as well as a fourfold increase in the deposition of atmospheric nitrogen in the past 20 years. The latter is believed to originate primarily from automobile, agricultural, ranching, and industrial activity. These factors combined with other environmental changes have resulted in adverse affects on aquatic and terrestrial life in the sub-alpine and alpine environments. The NSF renewal grant for Niwot Ridge is the largest environmental sciences grant to CU Boulder and helps the university attract significant amounts of additional funding from other sources for high-mountain research.

Ken Hill (INSTAAR) hiking past Green Lake 5 during surface water sampling in the Green Lakes Valley, Niwot Ridge, Colorado, July 2006. Photo: Ty Atkins (INSTAAR).

Arctic Workshop

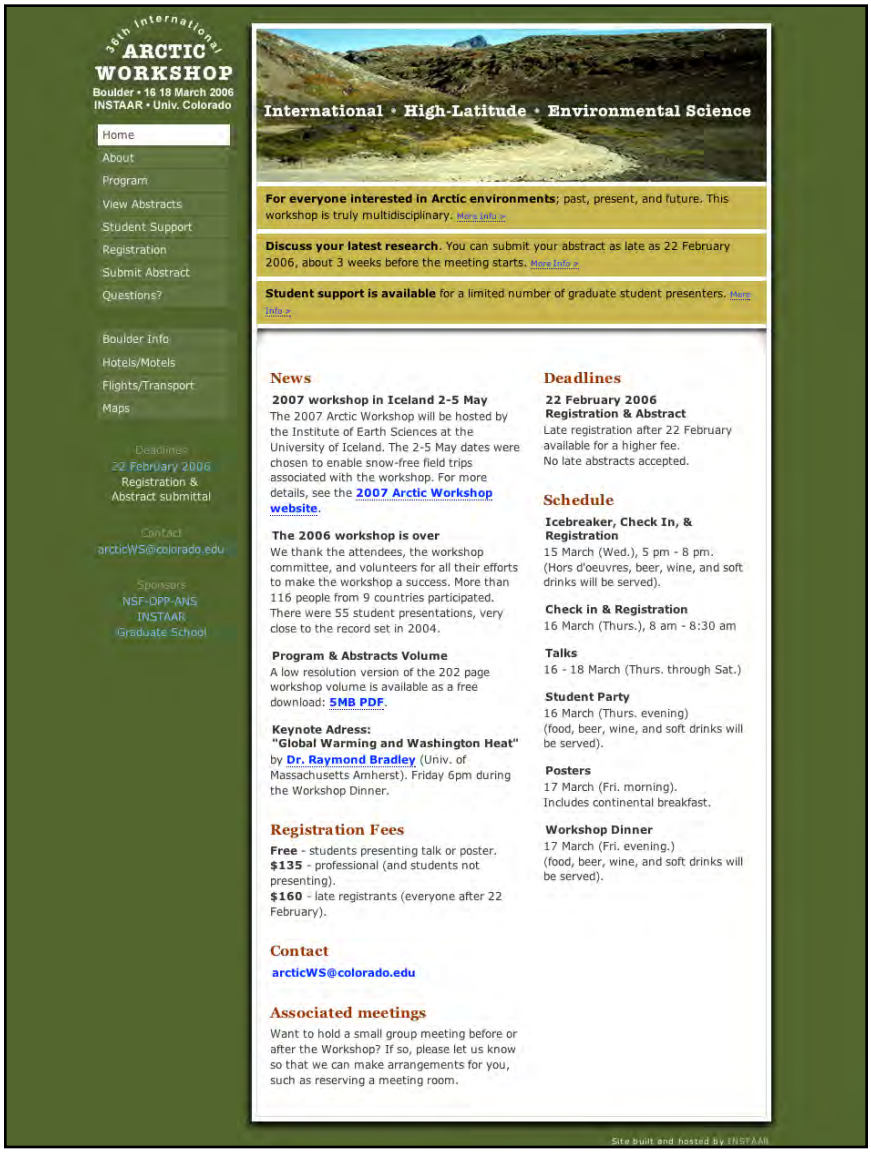
The annual Arctic Workshop was started in 1970 by Professor John T. Andrews at INSTAAR as a way of communicating recent ideas and results from field and laboratory studies. The workshops were designed as well to focus on graduate student participation as a way to promote professional development of students. The location of the Arctic Workshop began to alternate between Boulder and other host locations in 1983, and has since grown into an annual internationally attended meeting hosted by academic institutes worldwide. Organization of the workshops was assumed by W. T. Pfeffer in 2004, following the retirement of Professor Andrews. Oral presentations and a poster session presented during the three-day meeting allow coverage of past and present Arctic and Antarctic environments, and reflect the interdisciplinary spectrum of research in the North and South circumpolar regions. All researchers interested in high-latitude environments are encouraged to attend. Student participation is a vital component of these meetings, and financial support is available to this end. The U.S. National Science Foundation has generously supported registration, accommodation, and subsistence for presenting graduate students, making this meeting into a great medium for students to explore a wide variety of research studies in the Arctic and Antarctic regions.

35th Annual Arctic Workshop, 9–12 March 2005

The 35th Annual Arctic Workshop was hosted in Edmonton, Canada, by the Canadian Circumpolar Institute and the University of Alberta, Earth and Atmospheric Sciences Department. The U.S. National Science Foundation offered generous support for graduate student participation in the workshop. The Abstract and Organizing Committees were led by John England, with invaluable support from Mark Furze, Roy Coulthard, Duane Froese, Elaine Maloney, Cindy Mason, Chantel Nixon, Anna Pienkowski-Furze, Ryan Danby, and Mark Nuttall. There were 120 participants, 68 of whom were graduate students.

36th Annual Arctic Workshop, 16–18 March 2006

The 36th Annual Arctic Workshop was hosted by INSTAAR. There were 114 participants from 9 countries, including Sweden, Norway, the United Kingdom, Canada, Russia, Germany, Iceland, and France. Of the participants, 55 were graduate students. Student participation was supported by the Arctic Natural Sciences Program at the U.S. National Science Foundation. Oral sessions were organized thematically into lacustrine, marine, glacial history, atmospheric and meteorological processes, human dimensions, and archaeology. The poster session on Friday morning comprised 41 posters. The Organizing Committee included Tad Pfeffer, David Lubinski, Wendy Roth, Anne Jennings, and Bill Manley. The abstracts of this meeting are still available from the AW website (http://instaar.colorado.edu/meetings/AW2006/).



The 2006 Arctic Workshop web site contains information about the meeting, searchable abstracts, and the proceedings in PDF format. Visit http://instaar.colorado.edu/aw/.

INSTAAR Laboratories

Amino Acid Laboratory

The laboratory specializes in the extraction and quantification of amino acids that are derived from indigenous proteinaceous residues preserved in biominerals for a range of environmental applications. Both quantitative amino acid composition and extent of racemization of several different amino acids are targeted. The facility includes two HP-1100 automated high-pressure liquid chromatographs (HPLCs) and ancillary support equipment. Usually one HPLC runs in reverse-phase mode and the other in ion-exchange mode. The laboratory currently focuses on the kinetics of amino acid racemization in the eggshells of large flightless birds from Australia, Madagascar, and Africa, and bivalve mollusks from high-latitude regions. The laboratory director is Gifford Miller, with day-to-day operations overseen by Stephen DeVogel. Graduate and undergraduate students use the laboratory in their research projects and to gain research experience.

AMS Radiocarbon Preparation and Research Laboratory

In-house research focuses on method development in AMS ^{14}C preparation and dating, calibration of the radiocarbon time scale, reconstruction of atmospheric and oceanic ^{14}C activity in the past, and ultra-precise measurement of $^{14}CO_2$ in the contemporary atmosphere. This laboratory is under the direction of Scott Lehman.

Atmospheric Research Laboratory

This laboratory houses instrumentation for research on atmospheric chemistry, transport, and surface-atmosphere trace gas fluxes. This lab is heavily involved in field research at continental, midlatitude sites as well as in the polar regions. The studies in snow-covered environments focus on the role of snow on surface fluxes of important atmospheric trace gases. A monitoring station on Pico Mountain in the Azores is equipped with a hydrocarbon monitor for investigations on the long-range transport of air pollution across the Atlantic Ocean. Another emphasis is the analysis of volatile organic compounds (VOC), in particular emissions of biogenic VOC from vegetation. Measurements are made by solid adsorbent sampling techniques, thermal desorption instruments, and several gas chromatographs with different detection systems, including flame ionization and mass spectrometry. The global distribution of nonmethane hydrocarbons is investigated by analysis of air samples that are collected within the framework of the NOAA Global Greenhouse Gas Monitoring Network. Another project involves deployment of eddy correlation flux instrumentation on the NOAA *Ron Brown* research vessel for investigations on the uptake of ozone to the oceans. The Atmospheric Research Lab also pursues research on boundary-layer dynamics and the vertical distribution of chemical species by vertical profile measurements using a tethered balloon platform with various balloon-borne meteorological and chemical sensors. The laboratory director is Detlev Helmig.

A flux experiment on loblolly pine trees, Duke Forest, NC, August 2005. INSTAAR's Atmospheric Research Laboratory has been studying the emission of sesquiterpene compounds and their effects on atmospheric aerosol production. Sesquiterpenes are biogenic organic semi-volatile compounds released from vegetation foliage. Photo: John Ortega (INSTAAR).

Biogeochemistry Laboratories

INSTAAR houses four laboratories that collectively are equipped to handle many of the major analytical techniques in modern biogeochemistry. Chemical analyses of carbon, nitrogen, and phosphorus and multiple other elements in plants, soils, and water are routinely performed, as are a variety of microbial assays, a suite of chemical and optical measurements of dissolved organic carbon, and GC- or IRGA-based measurements of several biogeochemically relevant gases. Beyond basic extraction and sample processing facilities, major instrumentation includes (but is not limited to): an autoanalyzer for N and P, atomic adsorption analyzer for cations and metals, Carlo-Erba CHN analyzer, benchtop spectrophotometers and fluorometers, TOC/TN analyzers, and a TCD/FID gas chromatograph. The laboratories are split into individual direction by several INSTAAR faculty (McKnight, Townsend, Cleveland, Williams, and Seastedt) but function as a collaborative unit in many ways, including in graduate research and education. They are consistently used by graduate students from INSTAAR and multiple other units across campus.

Wendy Roth (INSTAAR) explains the process of analyzing marine sediment cores to a group of students from Southern Hills Middle School, INSTAAR Open House, April 2006. Roth is holding an image of foraminifera, microscopic single-celled organisms whose shells are important recorders of past climate change. Photo: Casey A. Cass (University of Colorado).

Core Processing Laboratory

This room is equipped for splitting, photographing, color logging, describing, sampling, and measuring magnetic properties of sediment cores. Sinks are available for wet sieving samples for preparation of microscopic analysis or other needs. The facility is intended for use in analysis of terrestrial, lake, and marine cores. There are two analytical balances available for weighing samples, a small oven, carts for transporting cores and samples, and plenty of counter space. The lab is equipped with a McCrone mill for grinding samples for X-ray diffraction analysis and has two PCs dedicated for processing XRD runs. John Andrews, Gifford Miller, Anne Jennings, Tom Marchitto, Jim Dixon, and their postdocs, graduate students, and undergraduate students are the principal users of this facility.

Dendrochronology Laboratory

Research in this laboratory concerns the use of dated, annual tree rings to investigate past climatic and environmental conditions. The laboratory is fully equipped for preparing, dating, and measuring tree-ring widths for dendrochronlogical studies. The laboratory is under the direction of Connie Woodhouse (University of Arizona, INSTAAR affiliate) 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 and Diane McKnight 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.

Environmental Computing and Imaging Facility

The ECI Facility, directed by James Syvitski, allows INSTAAR researchers to conduct numerically intensive modeling and data manipulation, including geologic, hydrologic, and oceanographic modeling, statistical analysis of national to global databases, and GIS terrain analysis. The main computers are SUN servers offering 16 × 1 GHz SPARC Ultra 4 CPUs, with 48 GB RAM, and >5 TB of usable hard drive space across multiple RAID setups, supporting a distributed fiberoptic 20-terminal SunRay system. Multiple levels of daily backup, and monthly archives employ a SUN DLT IV tape drive. The ECI Facility is a climate-controlled restricted-

access environment within the CU domain, protected by a firewall, connected to a 100 Mpbs LAN network through CU's network tied in to the NCAR, NOAA, NIST high performance computing system. These multi-processor servers have 24 hour on-site support, and use an APC 16K UPS with a 20-minute uptime in case of a power failure, to allow for proper shutdown during longer power outages. The ECI Facility supports many other computers, servers, and peripherals (DVD/CD ROMS and burners, disk and tape drives, B&W and color LaserJet printers, color scanners, HP Design Jet 5000PS 60" plotter, video-out digital camera, and Logitech 3-D visualization tools).

Herbarium

This facility is housed at the Mountain Research Station. It contains a field collection of plants of the Front Range, specializing in plants of Niwot Ridge and environs.

ICP-MS Trace Element Laboratory

This facility houses a Thermo Finnigan Element2 inductively coupled plasma mass spectrometer (ICP-MS) for the measurement of trace and minor elements in carbonates, natural waters, and other materials. A Class 1000 clean room is used for sample preparation. The laboratory is directed by Tom Marchitto.

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, a spectrophotometric segmented flow analyzer, and an atomic absorption spectrometer, the laboratory analyzes air, snow, water, and soil samples collected by faculty and graduate students from alpine and sub-alpine ecosystems for major solutes and nutrients.

Landscape Ecology and Conservation Laboratory

This laboratory conducts basic and applied research in three main areas: the ecology, distribution, and conservation planning of species, vegetation types, and ecosystems; multiscaled analysis of treeline structure, composition, and dynamics; and more recently, the analysis of interactions between environmental and social dynamics, including forecasting the effects of these interactions on patterns of dynamic changes and the ecological resilience of complex socioecological systems. Research to date has focused on the development and prototyping of methods and techniques for integrated regional ecological assessments, ecosystem characterization and regionalization mapping of ecosystem units, modeling of plant species and vegetation type distributions, landscape analysis of ecotones at the alpine treeline, and integration of ecological knowledge into the planning process. Recent work has included integrating different technologies (modeling, GIS, remote sensing, development of knowledge bases, and reserve selection algorithms) to design regional networks of conservation reserves. Study areas include the western United States, with special emphasis on Colorado, the Pacific Northwest, and Southwestern regions, and western Europe. The laboratory is directed by Patrick Bourgeron and managed by Hope Humphries.

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, mollusks, beetles, and other macrofossils. The laboratory is managed and supervised by Anne Jennings.

Oceanography Laboratory

The purpose of this laboratory 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, an attenuance meter, and a 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.

Palynology Laboratories

These laboratories comprise 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 Sarah Spaulding.

Quaternary GIS Laboratory

This facility applies state-of-the-art tools and concepts with Geographic Information Systems (GIS) and remote sensing to a variety of environmental problems at high latitudes. Quantitative spatial analysis focuses on shoreline erosion in Alaska, as well as past and present glacier dynamics and ice-field archaeology. Activities also support geospatial data sharing, community planning for Arctic GIS, online mapping technologies, and a variety of outreach. Other projects involve graduate students with studies of paleoclimate, paleolimnology, and geomorphology from Australia to Iceland. Under the direction of William Manley, and with GIS/RS Specialist Leanne Lestak, the lab includes four workstations, a large-format scanner, peripherals, and a range of software (ArcGIS, Imagine, ENVI, and others).

Sample Preparation Laboratory, Mountain Research Station

Field collected soils and plants are dried, extracted, weighed, and filtered in this lab found in the John W. Marr Building at the MRS. Equipment includes drying ovens, shakers, filter manifolds, and gas exchange systems for plant and soil CO_2 exchange.

Sedimentology Laboratory

This laboratory provides high-quality data for research projects for INSTAAR Directorate members, postdocs, graduate and undergraduate students, and outside clients. The laboratory performs both chemical and physical analyses on sediments and other material and encourages students to run their own analyses. The lab is equipped to measure grain size using a laser diffraction particle size analyzer (Malvern long bed mastersizer), total carbon and inorganic carbon content (Coulometer), magnetic properties (MS, SIRM, and IRM), bulk density and mineralogy (Siemens D5000 X-ray Diffractometer). Sieves are available for both dry and wet sieve analysis. The lab is equipped with ovens, two freeze dryers, a distilled water system, and analytical balances. The laboratory is coordinated by Wendy Roth, under the supervision of Suzanne Anderson.

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 as general electronics and mechanical design and fabrication. The laboratory is directed by Tad Pfeffer.

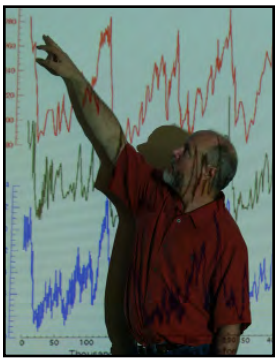
Stable Isotope Laboratory

This laboratory is a state-of-the-art analytical facility that uses stable isotopes to understand the processes controlling environmental change on time scales 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, carbonates, and organic matter. The laboratory houses 9 mass spectrometers and 12 gas preparation systems for analysis of stable isotopes of oxygen, hydrogen, carbon, and nitrogen. The lab shares a strong collaboration with the NOAA Climate Monitoring and Diagnostic Laboratory, and analyzes isotopes in thousands of weekly samples of greenhouse gases from a global network. The lab is currently analyzing samples from major ice core profiles in Greenland and Antarctica. The stable isotope laboratory is supervised by Jim White, managed by Bruce Vaughn, and utilizes a staff of five technicians, numerous graduate students, and postdocs to analyze over 48,000 samples per year.

The Pico Mountain Atmospheric Observatory after an icing storm, Azores, Spring 2005. INSTAAR's Atmospheric Research Laboratory is continuing research on atmospheric transport and chemical processing in the North Atlantic. Photo: Detlev Helmig (INSTAAR).

Trace Organic Geochemistry Laboratory

Research in this laboratory is focused on quantitative reconstructions of past sea-surface temperatures and applications of organic geochemistry to problems in paleoclimatology and carbon cycle science. Major equipment includes trace organic clean preparation facilities, automated pressurized fluid extraction (Dionex ASE 200), automated solid phase extraction (Gilson ASPEC XLi), gas chromatograph (HP 6890 with 100-position autosampler, programmable temperature vaporization [PTV] inlet, and FID). This laboratory is directed by Scott Lehman.



Bruce Vaughn (INSTAAR) explains how ice cores from Antarctica have recorded variations in climate for hundreds of thousands of years, INSTAAR Open House, April 2006. Such variations help put present climate changes into a long-term perspective. Vaughn's audience was a group of students from Southern Hills Middle School. Photo: Casey A. Cass (University of Colorado).

Mountain Research Station

Kelly Matheson and Kate Samelson (both CU Boulder) filter a water sample at Gold Lake for phytoplankton and zooplankton, Boulder County, Colorado, winter 2006. Matheson and Samelson participated in a five-weekend-long Winter Ecology field course offered through the Mountain Research Station. The course exposed students to a wide range of wintertime studies. Photo: Sarah Spaulding (INSTAAR).

INSTAAR's 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 biological 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. The MRS is uniquely located near a large diversity of biological communities and landforms, and has a long legacy of environmental science programs. Research on nearby Niwot Ridge has contributed substantially to our understanding of the environmental science of mountain systems and is recognized internationally for its excellence. 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 U.S. and around the world. Major programs include the NSF-sponsored Niwot Ridge Long-Term Ecological Research program, active since 1980, which has focused on functioning of alpine and subalpine ecosystems. Other programs include an Ameriflux eddy-covariance program for monitoring biosphere-atmosphere fluxes of carbon dioxide run by Russ Monson, long-term atmospheric gas sampling by NOAA (including CO_2, CH_4, N_2O, chlorofluorocarbons, and ozone), and a microbial observatory led by Steve Schmidt. The MRS is a proposed core site for the NSF Colorado Plateau National Ecological Observatory Network.

The station's teaching mission includes formal undergraduate 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. The MRS has had a NSF-sponsored Research Experiences for Undergraduates site program since 1994, which was recently renewed through 2010. Several K–12 courses also use the MRS as a site to introduce students to field environmental science, including the CU Science Discovery program.

The MRS participates in educational experiences for the general public to increase the spread of science on mountain environments. 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.

The Moores-Collins Lodge at the MRS, completed in 2003, provides year-round housing for conferences and courses. Users have included the Boulder Valley School District, the National Park Service, the U.S. Geological Survey, and academic year classes from the CU campus.

John Murgel (INSTAAR) locates a plot for the Global Observation Research Initiative in Alpine Environments (GLORIA) project on Mount Albion (3820 m, 12,530 feet), Colorado, July 2006. North and South Arapaho Peaks and the Arapaho Glacier provide the backdrop to the research site in the Front Range of the southern Rocky Mountains. Photo: Bill Bowman (INSTAAR).

Students in the Research Experiences for Undergraduates (REU) program run at the Mountain Research Station, on a hike near the D1 climate station on Niwot Ridge, Colorado, July 2006. Green Lakes 4 and 5 are visible in the valley below, with Arikaree, Navajo, and Apache Peaks on the skyline. From left to right, Arturo Montaño (CU Boulder), visiting student friend, Melissa Maxa (University of Minnesota), Mike Breed (faculty PI, EBIO), Galina Dvorkin (CU Boulder), Carolyn Brown (Pomona), Katie Alexander (Cornell), and Cielo Figueroa (University of Puerto Rico). Photo: Bill Bowman (INSTAAR).

Research Grants: Fiscal Years 2004–2005 and 2005–2006

Award money received from 1 July 2004 to 30 June 2006. Please note that this list does not include grants that were active in this period but had received their funds before 1 July 2004.

Anderson, Robert: NSF. Caves as Records of River Incision, Tectonics, and Landscapes. 2005. $47,290.

Anderson, Robert: NSF. Evolution of Plateaus in Western North America: the Roan Plateau Example. 2006–2007. $75,688.

Anderson, Suzanne; Anderson, Robert: NSF. The Linkage of Chemical and Mechanical Processes in the Evolution of High Surfaces on the Front Range Crest, Colorado. 2005–2007. $198,689.

Anderson, Suzanne: NSF. Collaborative Research: the Role of Loess Weathering in Global Geochemical Cycles. 2003–2007. $163,236.

Anderson, Suzanne; Anderson, Robert: NSF. SGER: Glacial Response to an Outburst Flood, Kennicott Glacier, Alaska. 2005–2006. $35,000.

Anderson, Suzanne; Andrews, John; Williams, Mark; Jennings, Anne; McKnight, Diane: NSF. Acquisition and Upgrade of Instruments for Research on Water-Rock Interactions and Sediment Transport. 2005–2006. $56,335.

Andrews, John T.; Jennings, Anne: NSF. The Holocene History of Drift Ice at the Present-Day Limits off North Iceland and the Eastern Canadian Margin. 2005–2007. $137,913.

Barger, Nichole: Carnegie Institution of Washington. Regional Carbon Storage Responses to Woody Encroachment in Western Pinyon-Juniper System. 2005–2008. $63,480.

Barger, Nichole; Woodhouse, Connie: National Park Foundation. Regional versus Local Controls on Pinyon-Juniper Woodland Expansion on the Colorado Plateau: the Role of Climate, Atmospheric CO_2, and Land Use Change. 2003–2007. $60,000.

Bourgeron, Patrick: Brown University. Linking the US-LTER with the ILTER Network. 2004–2006. $24,724.

Bourgeron, Patrick; Williams, Mark: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2006. $21,285.

Bowman, William: Department of the Interior. Is Atmospheric Nitrogen Affecting Alpine Species Composition in Rocky Mountain and Glacier National Parks? Evaluation of Long-Term Species Changes and Response to N Fertilization. 2005–2008. $77,183.

Bowman, William D.; Williams, Mark: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2006. $26,951.

Dixon, E. James: Department of the Interior. Culture History of Beringia: an Archeological Synthesis. 2000–2005. $5,854.

Dixon, E. James: NSF. Archeological analysis and publication, On Your Knees Cave, S.E. Alaska. 2003–2007. $173,654.

Dixon, E. James; Lee, Craig: Department of Agriculture. Proposal to Conduct Archeological/Paleobiological Reconnaissance of Select Perennial Ice Patches on Custer and Gallatin National Forest Lands, Montana. 2005–2006. $6,161.

Dyurgerov, Mark; Armstrong, Richard; Barry, Roger: NASA. Global Land Ice Measurements from Space (GLIMS) Core Functions: Populating and Mining the GLIMS Glacier Database to Assess Glacier Change with EOS Sensors. 2004–2006. $230,555.

Dyurgerov, Mark; Meier, Mark: NSF. Acceleration of Glacier Wastage in the Arctic System: Facts, Causes and What to Expect. 2004–2007. $348,101.

Helmig, Detlev: Department of Commerce. Study of Air Transport and Photochemistry in the North Atlantic Region by Hydrocarbon Analysis at Pico Island/Azores. 2003–2007. $148,742.

Helmig, Detlev; Guenther, Alex: NSF. Sesquiterpene Emissions and Their Impact on Aerosol Formation in the United States. 2006–2007. $188,141.

Helmig, Detlev; Hare, Jeffrey; Fairall, Christopher; Ganzeveld, Laurens: NSF. Development of Ship-Borne Atmosphere-Ocean Ozone Flux Measurements by the Eddy Correlation Technique. 2004–2007. $409,980.

E. James Dixon (left, INSTAAR) and William Harrison (right, University of Alaska Geophysical Institute) steam drilling to measure the thickness of a small glacier, or "ice patch," Wrangell–St. Elias National Park and Preserve, Alaska, July 2006. Photo: E. James Dixon (INSTAAR).

Helmig, Detlev; Williams, Mark: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2005. $23,579.

Helmig, Detlev; Milmore, Pam; Hannigan, Mike; Milford, Jana: Boulder County. Clearing the Air: Understanding Air Toxics and Carbonyl Pollutant Sources at the Urban/Mountain Interface. 2006–2008. $217,148.

Hoffecker, John: NSF. Kostenki: Initial Upper Paleolithic in Eastern Europe. 2002–2005. $7,875.

Hoffecker, John: NSF. SGER: Reconnaissance of Archaeological Sites at Point Hope: Prehistory and History of the Tikigaq Policy. 2005–2006. $16,996.

Jenkins, Chris: Columbia University. Parsing and Presentation of DSDP Data. 2005. $15,000.

Jenkins, Chris: Department of the Interior. Database and 3D Mapping Techniques. 2003–2005. $75,000.

Jenkins, Chris: DOD–Department of the Navy. Spatial Variability and Robust Interpolation of Seafloor Sediment Properties Using the Seabed Databases. 2004–2006. $87,301.

Jenkins, Chris: Gulf States Marine Fisheries Commission. Data Gathering for the GSMFC Bottom Mapping Project. 2006. $46,417.

Jenkins, Chris: NSF. Collaborative Research: Corewall-Integrated Environment for Interpretation of Geoscientific Data from Sediment and Crystalline Cores. 2006–2008. $40,909.

Lehman, Scott: Corner Foundation. Discriminating Solar vs. Ocean Forcing of Holocene Climate From Observations of $\delta^{14}C$ in the Ocean Mixed Layer. 2005–2006. $50,000.

Lehman, Scott: Department of Commerce. Improving Detection of Recently Added Fossil Fuel CO_2 in the Atmosphere Using ^{14}C. 2004–2007. $318,115.

Losleben, Mark: Department of Commerce. Carbon Cycle Atmospheric Gas Collection. 2004–2006. $36,464.

Losleben, Mark: Department of Commerce. Halocarbon Atmospheric Sampling. 2004–2006. $28,614.

Losleben, Mark: Mactec Engineering and Consulting, Inc. Site Operator Agreement, Castnet II Site 701 (CO94). 2003–2008. $4,830.

Manley, William: Department of the Interior. Inventory and Monitoring of Coastal Erosion for Alaska's Arctic Network of Parks. 2005–2007. $273,696.

Manley, William; Maslanik, James: NSF. High-Resolution Imagery and Terrain Model for Collaborative Research of Environmental Change at Barrow, Alaska. 2002–2006. $35,909.

Marchitto, Thomas: Columbia University. Collaborative Research: A High Resolution Record of Productivity and/or Ventilation of the North-Eastern Pacific from Soledad Basin, Baja California. 2005. $20,773.

Marchitto, Thomas: Columbia University. Reconstruction of the End Member Contributions to and Ventilation Rate of Glacial-Age Lower Atlantic Deep Water. 2003–2005. $18,052.

Marchitto, Thomas: NSF. Accurate Calibration of Multiple Paleoceanographic Proxies in Benthic Foraminifera. 2004–2006. $183,646.

Marchitto, Thomas; NSF. Collaborative Research: A SIMS and ICP-MS Calibration of Benthic Foraminferal Elemental Chemistry. 2006–2007. $18,744.

Marshall, Hans-Peter: NASA. Investigation of Spatial and Temporal Variation in Snowpack Properties Using Ground-Based High Resolution Microwave Radar Combined with Detailed Snowpack Characterization. 2006–2009. $177,080.

Marshall, Hans-Peter: NSF. Collaborative Research: Polarimetric Characteristics of Radio-Wave Scattering from Water Pathways Within Glaciers: Laboratory Experiments and Computer Simulations. 2005–2008. $69,785.

McKnight, Diane: Department of the Interior. Glacier Change in Rocky Mountain National Park. 2005–2007. $12,600.

McKnight, Diane: Ohio State University. McMurdo Dry Valleys Long Term Ecological Research. 2005–2007. $197,082.

McKnight, Diane; Flanagan, Colleen: EPA. Teacher's Guide: My Water Comes from the Mountains. 2005–2006. $29,070.

McKnight, Diane; Ryan, Joseph: NSF. Stream-Sediment Bed Exchange of Colloids and Colloid-Associated Metals in Acid Mine Drainage Environments. 2006–2007. $72,582.

McKnight, Diane; Williams, Mark: NSF. Long Term Ecological Research: The Landscape High Elevation Ecosystems. 2004–2006. $15,495.

Miller, Gifford: National Geographic Society. *Aepyornis* Extinction and Environmental Change in Madagascar: Assessing Human Impacts through the Precise Dating and Paleoenvironmental Proxies Preserved in their Eggshells. 2005–2006. $24,700.

Miller, Gifford: NSF. Collaborative Research: A Holocene Context for Current Arctic Warming Derived from the Vanishing Plateau Ice Caps of North-Central Baffin Island. 2005–2008. $308,102.

Miller, Gifford: NSF. Collaborative Research: A Synthesis of the Last 2000 Years of Climatic Variability From Arctic Lakes. 2005–2009. $149,577.

Miller, Gifford: NSF. Collaborative Research: Identifying the Footprints of Human Colonization on Australian Ecosystems and Climate. 2005–2008. $355,023.

Miller, Gifford: NSF. High-Resolution Constraints on the Magnitude and Timing of Climate Change in Iceland over the Past 15 ka. 2003–1005. $33,000.

Miller, Gifford: NSF. Megafauna Extinction, Ecosystem Disruption and Climate Change: Assessing the Human Factor. 2000–2005. $36,196.

Ogilvie, Astrid: NSF. HSD: Human and Social Dynamics in Myvatnssveit, Iceland from the Settlement to the Present. 2006–2009. $549,109.

Overeem, Irina: Research Foundation for the State University of New York. Collaborative Research: Modeling the Sediment Flux of the Ganges-Brahmaputra River. 2004–2005. $10,448.

Overeem, Irina; Peckham, Scott: NSF. Collaborative Research: Modeling Sediment Delivery and Related Stratigraphy in a Tidal Dominated Delta: Fly River, Papua, New Guinea. 2005–2007. $92,791.

Peckham, Scott: University of Alaska. Toward Improved Process-Based Pan-Arctic Prediction of Land Surface Moisture and Energy Fluxes. 2004–2005. $15,000.

Pfeffer, Tad: NSF. Seismological Investigation of Columbia Glacier Calving Mechanics. 2004–2007. $25,200.

Pfeffer, Tad; Marshall, Hans-Peter: NASA. Snow Slope Stability: Modeling and Investigations. 2001–2005. $24,000.

Pfeffer, Tad; Rick, Ursula: National Aeronautics and Space Administration. Ozone Fluxes into Snowpacks and Their Role in the Tropospheric Ozone Budget. 2003–2006. $24,000.

Seastedt, Timothy: Department of the Interior. Ph.D. Graduate Assistantship to Assist with the Development of a National Park Service Long-Term Monitoring Program. 2005–2009. $19,826.

Seastedt, Timothy; Jamieson, Mary: Boulder County. An Evaluation of the Establishment & Efficacy of the Biocontrol Agent "*Mecinus janthinus*" on the Invasive Weed "*Linaria dalmatica.*" 2005. $4,000.

Seastedt, Timothy; Liptzin, Daniel: NSF. Dissertation Research: The Effects of Nitrogen Deposition on Ecosystem Function in the Forest-Alpine Tundra Ecotone. 2005–2006. $11,996.

Seastedt, Timothy; Miller, Elisa: NSF. Dissertation Research: Forest Fire Mitigation and Understory Invasion. 2005–2007. $11,956.

Sievering, Herman; Williams, Mark: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2006. $13,653.

Stallard, Robert: Department of the Interior. Analysis of Rivers and River Basins within Central Alaska. 2005–2007. $5,875.

Stallard, Robert: Department of the Interior. Extended Analysis of Rivers and River Basins within Central Alaska. 2005–2006. $20,605.

Stallard, Robert: Department of the Interior. Analysis of River Basins within Alaska Network Parks. 2005–2007. $19,876.

Syvitski, James: DOD–Department of the Navy. Modeling the Effect of Climatic and Human Impacts on Margin Sedimentation. 2004–2005. $133,560.

Syvitski, James: DOD–Department of the Navy. Sedimentary Dynamics of RHNO, Korean and Other World Deltas/Estuaries. 2005–2007. $153,418.

Syvitski, James: Indiana State University. Collaborative Research: Sediment Production and Alluvial Buffering in a Steepland River Basin; Waipaoa River Basin, New Zealand. 2004–2006. $12,000.

Syvitski, James: NSF. An Integrated Assessment of the Impacts of Climate Variability on the Alaskan North Slope Coastal Region. 2001–2006. $57,046.

Syvitski, James: University of New Hampshire. Understanding the Changing Carbon, Nitrogen and Water Cycles in the Earth System. 2004–2007. $189,150.

Syvitski, James: URS Corporation Southern. Desktop Study to Characterize Possible Turbidity Currents in the Vicinity of the Hopa North Project. 2005. $7,000.

Townsend, Alan; Cleveland, Cory: NSF. Interactions between Rainfall, Nutrient Cycles and Decomposition in a Lowland Tropical Rainforest. 2005–2008. $675,000.

Townsend, Alan; Williams, Mark: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2006. $13,700.

White, James: Department of Commerce. Stable Isotopes of CO_2 in Aircraft Measurements to Constrain the U.S. Biosphere Carbon Sink, and Development of Isotopic Standards for Atmospheric Greenhouse Gases. 2002–2007. $375,000.

White, James: NSF. Collaborative Research: Stable Isotopes of Ice in the WAIS Divide Deep Ice Core. 2006–2007. $97,000.

White, James: NSF. Collaborative Research: Gases in Firn Air and Shallow Ice at the Proposed WAIS Drilling Site. 2005–2007. $197,181.

Astrid Ogilvie (INSTAAR) consults in July 2006 with farmers in Myvatn, northern Iceland, who are recounting their memories of climate change. Archaeological evidence suggests that near to the farm where they live there was a prosperous farm in Viking times. Photo: Trond Woxen.

White, James: University Corporation for Atmospheric Research. High-Precision $^{12}CO_2/^{13}CO_2$ Ratio Measurements Using an Optical Fiber Based Difference Frequency Generation Laser Source. 2002–2005. $95,664.

White, James; Flückiger, Jaqueline: NSF. Modeling Seasonal and Regional Patterns of Abrupt Climate Change. 2005–2008. $206,221.

White, James: NSF. SGER: An Exploratory Look at Stable Isotopes in an Ice Core from Flade Isblink. 2006–2007. $13,599.

White, James; Townsend, Alan: NSF. IGERT: Carbon, Climate, and Society. 2000–2006. $776,375.

Williams, Mark: Department of the Interior. Analysis of Primenet Data and Contributions to Final Report. 2004–2006. $50,000.

Williams, Mark: Idaho State University. Complexity across Boundaries: Coupled Human and Natural Systems in the Yellowstone Northern Elk Winter Range. 2002–2005. $18,884.

Williams, Mark: Mountain Studies Institute. New Tools for Evaluating Alpine Sensitivity and Water Quality in the Upper Animas Watershed. 2004–2005. $12,000.

Williams, Mark: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2005–2006. $102,000.

Williams, Mark: State of Colorado. Isotope Tracing Analysis for Leadville Mine Drainage Tunnel, California Gulch Superfund Site and Affected Areas. 2003–2006. $65,000.

Williams, Mark; Ackerman, Andrew: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2005. $12,600.

Williams, Mark; Blanken, Peter: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2006. $17,929.

Williams, Mark; Bowman, William; Townsend, Alan; Seastedt, Timothy; McKnight, Diane: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2006. $635,323.

Williams, Mark; Caine, T. Nelson: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2006. $39,103.

Williams, Mark; Neff, Jason: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2006. $11,840.

Williams, Mark; Townsend, Alan; Seastedt, Timothy; Mcknight, Diane; Bowman, Christopher: NSF. Long Term Ecological Research: The Landscape Continuum Model—A Biogeochemical Paradigm for High Elevation Ecosystems. 2004–2005. $862,000.

Woodhouse, Connie: Denver Water Department. Contract with Denver Water Updates and Improvements of Tree-Ring Reconstructions of South Platte River Streamflow. 2004–2005. $19,935.

Woodhouse, Connie: Department of Commerce. Dendrochronical Research for Fire History and Drought. 2006–2007. $48,528.

Woodhouse, Connie: Department of Commerce. Quality Control Project for the International Tree-Ring Data Bank. 2005. $18,876.

Woodhouse, Connie: Pennsylvania State University. Climate and Woodland Expansion in the Western Great Plains, USA. 2005–2006. $6,655.

Woodhouse, Connie; Lukas, Jeff: Department of the Interior. Riparian Forest Age Structure and Past Hydroclimatic Variability: Sand Creek Massacre NHS. 2005–2007. $11,000.

Lucas Zukiewicz sampling snow for the Niwot Ridge LTER project, Niwot Ridge, Colorado, Spring 2006. The Niwot Ridge LTER project is the single largest environmental science project at CU Boulder. Research at the site is focused on ecosystem responses to climate change in alpine tundra. Photo: Mark Williams (INSTAAR).

Theses Completed

2005

Breiter, Nehalem Clare: How selective are biological controls? Evaluating the potential for nontarget herbivory by *Mecinus janthinus* Germar [Coleoptera: Curculionidae], a biological control agent for Dalmatian (*Linaria dalmatica* L. P. Mill.) and yellow toadflax (*Linaria vulgaris* P. Mill.) [Scrophulariaceae]. Boulder: Thesis (MA) University of Colorado.

Cory, Rose Merin: Redox and photochemical reactivity of dissolved organic matter in surface waters. Boulder: Thesis (PhD) University of Colorado.

Dunhill, Gita: Iceland and Greenland margins: A comparison of depositional processes under different glaciologic and oceanographic settings. Boulder: Thesis (PhD) University of Colorado.

Joslin, Justin Cale: Determining the role of chemical weathering reactions and hyporheic exchange on silicate concentrations in dry valley streams, Antarctica. Boulder: Thesis (MS) University of Colorado.

Kristjánsdóttir, Greta Bjork: Holocene changes in climate, environment, and ocean reservoir age on the Iceland Shelf: magnesium/calcium, $\delta^{18}O$, and tephrochronology of core MD99-2269. Boulder: Thesis (PhD) University of Colorado.

Marshall, Hans-Peter: FMCW radar and finite element modeling as tools for studying spatial variability in alpine snowpacks. Boulder: Thesis (PhD) University of Colorado.

Olafsdottir, Saedis: Currents and climate on the northwest shelf of Iceland during the deglaciation: high-resolution foraminiferal research. Reykjavik: Thesis (MS) University of Iceland.

Raby, Kim Scarlet: Use of water quality data for land management decisions: A case study in San Juan County, Colorado. Boulder: Thesis (MS) University of Colorado.

Reed, Heather Elizabeth: Effects of fire and plant invasion on aspects of aboveground and belowground interactions in an eastern tallgrass prairie. Boulder: Thesis (PhD) University of Colorado.

Tanner, David: Non-methane hydrocarbon measurements for long-range transport studies at Pico Mountain, Azores, Portugal. Boulder: Thesis (MS) University of Colorado.

Todd, Andrew Stuart: Mining legacies in the Snake River watershed: The interaction of biogeochemistry, stream ecology, and human use. Boulder: Thesis (PhD) University of Colorado.

2006

Cohen, Lana D.: Boundary layer characteristics and ozone fluxes at Summit, Greenland. Boulder: Thesis (MS) University of Colorado.

Flanagan, Colleen: Understanding alpine watersheds in the Colorado Front Range: Phytoplankton community analysis and watershed education. Boulder: Thesis (MS) University of Colorado.

Hobson, Anne Carrie Hickey: Using remotely-sensed nearshore suspended sediment as an indicator of environmental change on the Alaskan North Slope. Boulder: Thesis (PhD) University of Colorado.

O'Neel, Shad: Understanding the mechanics of tidewater glacier retreat. Boulder: Thesis (PhD) University of Colorado.

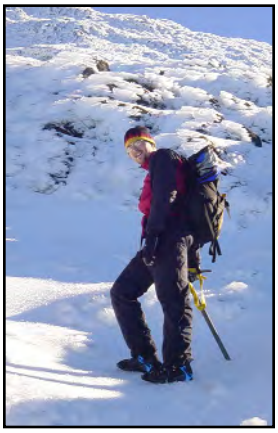
Ortega, John: Landscape fluxes of reactive biogenic volatile organic compounds from United States forests. Boulder: Thesis (PhD) University of Colorado.

Tomaszewski, Timothy Edward: Atmospheric nitrogen deposition at a conifer forest: Canopy nitrogen uptake and photosynthesis. Boulder: Thesis (PhD) University of Colorado.

Turnbull, Jocelyn Christine: Development of a high precision $^{14}CO_2$ measurement capability and application to carbon cycle dynamics. Boulder: Thesis (PhD) University of Colorado.

Yang, Chi: Effects of Acid Mine Drainage on Nesting Tree Swallows. Boulder: Thesis (MS) University of Colorado.

Jocelyn Turnbull (INSTAAR) discusses dating of bone with a visiting student from Southern Hills Middle School, INSTAAR Open House, May 2005. Photo: David Lubinski (INSTAAR).



David Tanner (INSTAAR) on his way to the Pico Mountain Atmospheric Observatory, Azores, Spring 2006. Photo: M. Dziobak (Michigan Technological University).

Courses Taught by INSTAAR Faculty

2005

Robert S Anderson
GEOL 4241, Geomorphology (undergrads), Spring 2005
GEOL 5700, Geomorphology (grads), Spring 2005
GEOL 5700, Modeling Landscape Evolution, Spring 2005
GEOL 4700, Glaciers & Permafrost, Fall 2005
GEOL 5700, Geomechanics, Fall 2005
GEOL 5700, Introduction to Geological Science Faculty, Fall 2005

William D Bowman
EBIO 6000, Ecological Effects of Nitrogen Deposition, Spring 2005

Thomas Nelson Caine
GEOG 5183, Data Processing for the Earth Sciences, Spring 2005
GEOG 3023, Statistics For Earth Sciences, Fall 2005
GEOG 4241, Principles of Geomorphology, Fall 2005

Detlev Helmig
ATOC 6020, Atmospheric Trace Gas Fluxes, Fall 2005

John F. Hoffecker
ANTH 4020/5020, Paleoanthropology, Spring 2005

Timothy Kittel
EBIO 4140, Plant Ecology, Fall 2005

Thomas Marchitto
GEOL 3070, Introduction to Oceanography, Spring 2005
GEOL 4700/5700, Rapid Climate Change, Spring 2005
GEOL 4700/5700, Paleo Ocean and Climate, Fall 2005

Diane Marie McKnight
CVEN 6404, Advanced Aquatic Chemistry, Spring 2005
CVEN 5401, Environmental Engineering Chemistry, Fall 2005

Gifford Hubbs Miller
GEOL 3040, The Geologic Record of Global Change, Spring 2005

Tad Pfeffer
CVEN 3698, Engineering Geology, Spring 2005
CVEN 4718, Mechanics and Dynamics of Glaciers, Spring 2005

Timothy Seastedt
EBIO 3170, Ecosystem Ecology, Spring 2005
EBIO 5800, Invasive Plants, Fall 2005

James P Syvitski
GEOL 4060/5060, Oceanography, Spring 2005

James White
ENVS 1000, Intro to Environmental Studies, Spring 2005
GEOL 3520, Environmental Issues, Spring 2005

Mark W Williams
GEOG 4321/5321, Snow Hydrology, Spring 2005
GEOG 3251, Mountain Geography, Spring 2005
GEOG 1011, Environmental Systems II- Landscapes & Water, Fall 2005
GEOG 3511, Introduction to Hydrology, Fall 2005

2006

Robert S Anderson
GEOL/GEOG 4241, Principles of Geomorphology, Spring 2006
GEOL 4700/5700, Modeling Landscapes, Spring 2006
GEOL 5700, Mechanics and Chemistry of Landscapes, Spring 2006
GEOL 5110, Geomechanics, Fall 2006
GEOL 5700, Geomorphology, Fall 2006

Suzanne Prestrud Anderson
GEOG 1011, Environmental Systems II- Landscapes & Water, Spring 2006

William Bowman
EBIO 4140, Plant Ecology, Fall 2006

Thomas Nelson Caine
GEOG 3511, Introduction to Hydrology, Spring 2006

James Dixon
MUSM 5011, Introduction to Museum Studies, Fall 2006

Craig Lee
ANTH 4020, People of the Americas, Fall 2006

Thomas Marchitto
GEOL 3070, Introduction to Oceanography, Spring 2006
GEOL 4700/5700, Marine Chemistry/Geochemistry, Fall 2006

Diane Marie McKnight
CVEN 3434, Introduction to Applied Ecology, Spring 2006
CVEN 5323, Applied Stream Ecology, Fall 2006

Undergraduate students in Carol Kearn's Field Ecology course measure plant diversity on Niwot Ridge, Colorado, July 2005. Photo: Bill Bowman (INSTAAR).

Students in Giff Miller's Graduate Quaternary Geochronology class evaluate paleosols and a complex dune sequence during a 3-day field excursion to the Nebraska Sandhills, October 2006. Photo: Giff Miller (INSTAAR).

Gifford Miller
GEOL 1060, Global Change 1- Earth Sciences, Fall 2006
GEOL 5420, Quaternary Dating Methods, Fall 2006

Natalie Mladenov
CVEN 5323/ENVS 5840, Applied Stream Ecology, Spring 2006

Diana Nemergut
GEOL 5305, Global Biogeochemistry, Fall 2006

Tad Pfeffer
CVEN 2121, Analytical Mechanics, Spring 2006
CVEN 3698, Engineering Ecology, Spring 2006
CVEN 3698, Engineering Ecology, Fall 2006

John Pitlick
GEOG 1011, Environmental Systems 2: Landscapes and Water, Fall 2006
GEOL/GEOG 4241, Principles of Geomorphology, Fall 2006

Adina Racoviteunu
GEOG 4103, Introduction to Geographic Information Science, Spring 2006

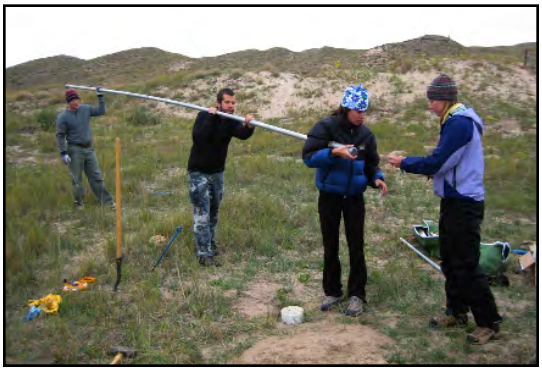
Timothy Seastedt
EBIO 3270, Ecosystem Ecology, Spring 2006

James P Syvitski
GEOL 4060, Oceanography, Spring 2006

Alan Ronald Townsend
EBIO 1220, General Biology II, Spring 2006

James White
ENVS 1000, Introduction to Environmental Studies, Fall 2006
ENVS 3930, Internship, Fall 2006

Mark W Williams
GEOG 4311, Watershed Biogeochemistry, Spring 2006
GEOG 4311, Seminar: Geographic Problems, Spring 2006



INSTAAR graduate students Sean Bryan, Kurt Refsnider, Rebecca Anderson, and Candice Evans extract an OSL sample from 8.5 m depth in a sand dune damming a former river valley during a field excursion in Giff Miller's Quaternary Geochronology class, Nebraska Sandhills, October 2006. Photo: Giff Miller (INSTAAR).

Students

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. The graduate student have a weekly seminar series at INSTAAR, fostering contacts between the students in those different departments. An annual retreat at the Mountain Research Station for incoming students and teaching faculty as well as a senior student mentorship program have been established to facilitate integration into INSTAAR. Financial support is available for INSTAAR graduate students as research assistants employed on research grants. Undergraduate support is available through special programs 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 the Summer Undergraduate Research Program (SURE), Summer Undergraduate Research Fellowships (SURF), Summer Minority Access Research Training (SMART), Undergraduate Research Opportunities (UROP), University Mentoring Program (UMP), and Research Experience for Undergraduates (REU). 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 degrees. 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, Geological Sciences, and Program in Atmospheric and Oceanic Sciences (PAOS). Applications forms are available from the Graduate School, 30 UCB, University of Colorado, Boulder, CO 80309-0030. For specific INSTAAR-related questions, send email to instaar-info@instaar.colorado.edu or contact individual INSTAAR professors directly (see the INSTAAR website at http://instaar.colorado.edu). Marcia Kelly is the interim liaison for graduate students and departments (Marcia.Kelly@Colorado.edu).

Rebecca Anderson (INSTAAR) holds up a surface marker to locate the site of an ablation stake on one of several rapidly melting ice caps on the north of Baffin Island, Arctic Canada, May 2006. Photo: J. Briner (University of Buffalo).

Graduate Students

Student name, Degree, Department, Advisor. Approximate thesis topic or title.

Paul Abood, MS, Geography, Mark Williams. The analysis of deposition data for PRIMENet National Parks.

Craig Anderson, MS, Geography, Mark Williams. Snow hydrology, GIS, and remote sensing.

Rebecca Anderson, MS, Geological Sciences, Gifford Miller.

Nataly Ascarrunz, PhD, Ecology and Evolutionary Biology, Tim Seastedt. Carbon cycling and changes in land use.

Ty Peter Atkins, MS, Geography, Mark Williams. Interests relate to aquatic chemistry and silica cycling in Hawaiian watersheds.

Yarrow Axford, PhD, Geology, Gifford Miller. Interests relate to Quaternary paleoclimate, arctic lakes, and climate change.

Tim Bartholomaus, MS, Geological Sciences, Robert Anderson.

Maureen Mason Berlin, PhD, Geological Sciences, Robert S. Anderson. Knickpoint migration and landscape evolution on the Roan Plateau, western Colorado.

Carleton Bern, PhD, Ecology and Evolutionary Biology, Alan Townsend. Nutrient cation cycling in tropical forests.

Jessica Black, PhD, Geological Sciences, Gifford Miller. "Investigating the Holocene Thermal Maximum at Hvitarvatn, Iceland."

Florence Bocquet, PhD, Atmospheric and Oceanic Sciences, Detlev Helmig. "Ozone exchange at the air-snow interface at the polar site of Summit, Greenland; snow and avalanche studies."

Nehalem Breiter, MA, Ecology and Evolutionary Biology, Tim Seastedt. "How selective are biological controls?"

Sean Bryan, MS, Geological Sciences, Tom Marchitto.

Cynthia Cacy, PhD, Environmental Studies, Suzanne Anderson. "Chemical weathering in glacial environments."

Kaelin Cawley, PhD, Civil, Environmental and Architectural Engineering, Diane McKnight. Interests include dissolved organic matter chemistry and harmful algal blooms.

Karie Cherwin, PhD, Ecology and Evolutionary Biology, Tim Seastedt. Invasive plants in grassland ecosystems; restoration and ecosystem ecology.

Lana Cohen, MS, Atmospheric and Oceanic Sciences, Detlev Helmig. "Boundary layer characteristics and ozone fluxes at Summit, Greenland."

Daniel Cordalis, MS, Geography, Mark Williams. Alpine hydrology and flowpaths.

Rose Cory, PhD, Civil, Environmental and Architectural Engineering, Diane McKnight. "Effect of dissolved organic matter on the photolysis of persistent organic pollutants in Arctic surface waters."

Karen Cozzetto, PhD, Civil, Environmental and Architectural Engineering, Diane McKnight. Interests include controls on stream and hyporheic temperatures; climate drivers of interannual streamflow variation—Taylor Valley, Antarctica.

Anthony Darrouzet-Nardi, PhD, Ecology and Evolutionary Biology, Bill Bowman.

Stephen DeVogel, PhD, Geological Sciences, Gifford Miller. Interests include late Quaternary extinctions and human-induced ecosystem changes, particularly in the southern hemisphere.

Tiffany Duhl, MS, Atmospheric and Oceanic Sciences, "Air quality modeling through improved urban vegetation characerization and enhanced understanding of biogenic sesquiterpene emissions."

Gita Dunhill, PhD, Geological Sciences, James Syvitski and Anne Jennings. "Greenland and Iceland margins: a comparison of depositional processes under different glaciologic and oceanographic settings."

Adam Eisele, PhD, Mechanical Engineering, Detlev Helmig. Interests include air quality, specifically Community Scaler Air Toxics Monitoring.

Chandler Engel, MS, Geotechnical Engineering, Tad Pfeffer. Interests include calving mechanics of glaciers.

Erika Engelhaupt, PhD, Environmental Studies, Alan Townsend. Soil biogeochemistry and ecosystem processes.

Erick Robert Erwin, MA, Anthropology, James Dixon.

Candice Evans, MS, Environmental Studies, Jim White. Interests include global greenhouse gasses, global change.

Colleen Flanagan, MS, Environmental Studies, Diane McKnight. Alpine aquatic ecosystems.

Zan Frederick, MS, Geography, Suzanne Anderson. Interests include big northern rivers, weathering, and bicycles.

Zack Guido, MS, Geological Sciences, Robert Anderson. The Last Glacial Maximum in the San Juan Mountains, Colorado.

Leora Nanus Gurdak, PhD, Geological Sciences, Mark Williams. Sensitivity criteria for atmospheric pollution to lakes in the national parks of the Rocky Mountains.

John Magee (ANU), Steve DeVogel (INSTAAR) and an assortment of curious young Tandroy boys among the sand dunes of southern Madagascar, April 2006. Photo: Giff Miller (INSTAAR).

Kenneth Hill, MA, Geography, Mark Williams. "Hydrochemistry and atmospheric deposition in an alpine watershed."

Nancy Hoalst-Pullen, PhD, Geography, Robert Stallard. "Assessment of soil-water interactions at multiple scales in tropical catchments of Panama, Ecuador and Malaysia."

Keri Holland, PhD, Ecology and Evolutionary Biology, Alan Townsend. "The fate of excess nitrogen in alpine tundra."

Eric W. H. Hutton, PhD, Geological Sciences (Geophysics), James Syvitski. "Modeling sediment delivery and dispersion within the coastal ocean: scaling across space and time."

Tim Bartholomaus (INSTAAR) launches a portable water level logger as Donoho Falls Creek pours into a tunnel underneath the Root-Kennicott Glacier behind him, Alaska, June 2006. Under certain hydrologic conditions, water backs up from this portal and fills the basin, forming Donoho Falls Lake. Bartholomaus is studying the dynamics of the Kennicott Glacier and its relation to subglacial hydrologic conditions. Photo: Suzanne Anderson (INSTAAR).

Chrissy Fairbanks (CU Boulder undergraduate) takes samples to determine how soil nutrients affect exotic species invasions in thinned forest, Heil Valley Ranch, near Boulder, Colorado, Summer 2006. Photo: Elisa Miller (INSTAAR).

Mary Jamieson, PhD, Ecology and Evolutionary Biology, Tim Seastedt.

Justin Joslin, MS, Civil, Environmental and Architectural Engineering, Diane McKnight. Stream water chemistry in the McMurdo Dry Valleys LTER, Antarctica.

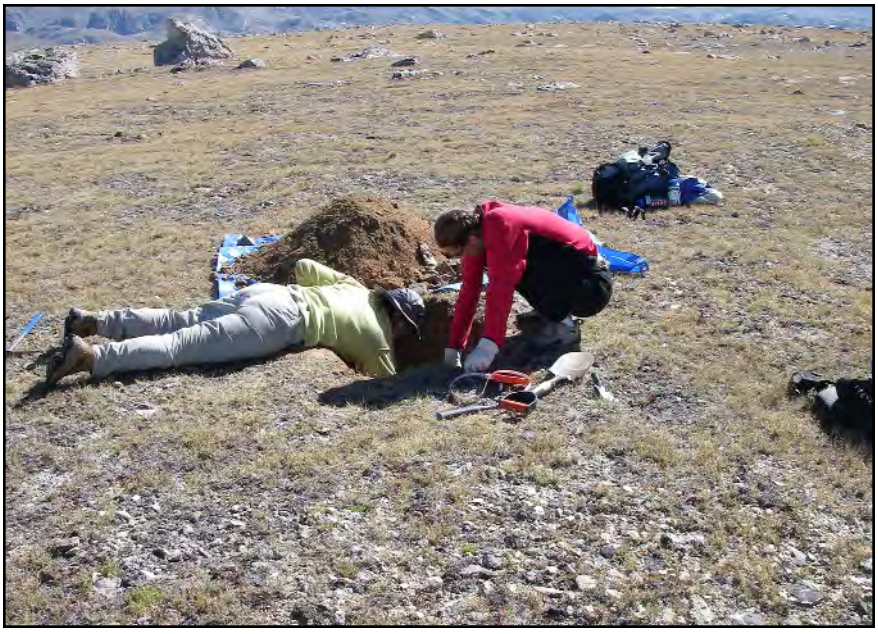
Kortney Kirkeby, MS, Civil, Environmental and Architectural Engineering, Diane McKnight.

David Knochel, PhD, Ecology and Evolutionary Biology, Tim Seastedt.

Joshua Koch, PhD, Civil, Environmental and Architectural Engineering, Diane McKnight. Interests include surface water/groundwater interactions and effects on nutrient fate and transport.

Greta Bjork Kristjansdottir, PhD, Geological Sciences, John T. Andrews. Reconstructing late Quaternary paleoclimatic variations on the Iceland shelf with Mg/Ca and $\delta^{18}O$ in foraminifera.

Cynthia Cacy (ENVS) and Susan Riggins (INSTAAR) dig a soil pit at 3658 m (12,000 feet) elevation on Mount Osborne, Wind River Range, Wyoming, August 2006. The pit extends to bedrock at about 1 m depth. Susan Riggins is studying the processes that break rock down to form regolith. Photo: Suzanne Anderson (INSTAAR).



Robert Kysela, MS, Ecology and Evolutionary Biology, Diana Nemergut.

Craig Lee, PhD, Anthropology, James Dixon. The early human occupation of southeastern Alaska.

Isabelle Lheritier, MS, Civil, Environmental and Architectural Engineering, Diane McKnight. Climate-induced alterations in dissolved organic matter on metal toxicity and UV radiation in Rocky Mountain streams.

Dan Liptzin, PhD, Ecology and Evolutionary Biology, Tim Seastedt. "Biotic constraints on regional biogeochemistry at the forest-tundra ecotone."

Nathaniel Logar, PhD, Environmental Sciences, Jim White. Stable isotopes, the carbon cycle, and climate change.

Ken MacClune, PhD, Geological Sciences, Jim White. "System construction and method development for high spatial and temporal resolution measurements of the deuterium of atmospheric methane."

Hans-Peter Marshall, PhD, Civil, Environmental and Architectural Engineering, Tad Pfeffer. "Snow slope stability: modeling and investigations using FMCW radar and finite elements."

Courtney Meier, PhD, Ecology and Evolutionary Biology, Bill Bowman. Feedbacks between plant secondary chemicals and soil microbial communities.

Elisa Miller, PhD, Ecology and Evolutionary Biology, Tim Seastedt. "Manipulating the physical and chemical properties of soil to inhibit exotic species invasions in thinned montane forest."

Matthew Miller, PhD, Civil, Environmental and Architectural Engineering, Diane McKnight. Interests: hydrology, watershed-scale biogeochemistry, and dissolved organic matter (DOM) chemistry.

Leora Nanus, PhD, Geography, Mark Williams. Sensitivity criteria for atmospheric pollution to lakes in the national parks of the Rocky Mountains.

Ashley Nielson, MA, Geography, Mark Williams. Interests include water quality, hydrology, and biogeochemistry—specifically in alpine wetlands.

Shad O'Neel, PhD, Geological Sciences (Geophysics), Tad Pfeffer. Interests include glacier dynamics, tidewater glaciers, and sea level change.

John Ortega, PhD, Atmospheric and Oceanic Sciences, Detlev Helmig. "Flux measurements of biogenic volatile organic compounds using disjunct eddy sampling and ion trap mass spectrometry."

Jan Pollmann, PhD, Atmospheric Chemistry, Detlev Helmig.Study of the global distribution of volatile non-methane hydrocarbons from the NOAA Cooperative Greenhouse Gas Sampling Network.

Trevor Popp, PhD, Geological Sciences, James White. Paleoclimate via stable isotopes in ice cores.

Ursula Quillmann, PhD, Geological Sciences, Anne Jennings and Thomas Marchitto. "From fjord head to fjord mouth: Holocene climatic and environmental variability in Isafjardardjup, NW Iceland."

Kim Raby, MS, Environmental Studies, Mark Williams. Evaluating water quality and sensitive areas in high alpine catchments.

Adina Racoviteanu, PhD, Geography, Mark Williams. "GIS for high-altitude Inca sanctuaries in the Peruvian Andes."

Heather Reed, PhD, Ecology and Evolutionary Biology, Tim Seastedt. "Soil biodiversity and ecosystem function."

Sasha Reed, PhD, Ecology and Evolutionary Biology, Alan Townsend/Steve Schmidt. "Biogeochemical cycling and microbiological communities of soils."

Kurt Refsnider, PhD, Geological Sciences, Gifford Miller. Interests include glacial geology and geomorphology.

Ursula Rick, PhD, Program in Atmospheric and Oceanic Sciences, Tad Pfeffer. "Meltwater flow through the percolation facies of arctic ice caps."

Susan Riggins, PhD, Geography, Suzanne Anderson. Interests include terrestrial weathering, specifically regolith development.

Sarah Sattin, MS, Ecology and Evolutionary Biology, Diana Nemergut.

Annalisa Schilla, PhD, Geological Sciences, Jim White. The stable isotopic measurements of ice from the Siple Dome ice core and implications for global climatic reconstruction.

Brian Seok, PhD, Atmospheric and Oceanic Sciences, Detlev Helmig. Studying biosphere-atmosphere interactions, snow-atmosphere gas exchange, and development of analytical instrumentation for air analysis.

Alexandra Sinclair, PhD, Geological Sciences (Geophysics), James Syvitski. Sediment transport in a coastal ocean environment.

Lee Stanish, PhD, Environmental Studies, Diane McKnight. Interests include examining the molecular and genetic bases for evolution and adaptations of Antarctic diatoms to environmental factors such as UV radiation, temperature, and ecological interactions.

Sarah Stapleton, PhD, Environmental Studies, Diane McKnight and Subhrendu Gangophadyay. Streamflow forecasting and climate change effects on salmon mortality in the Pacific Northwest and forecasting effects of climate change on the Rio Grande de Manati aquifer in Puerto Rico.

David Tanner, MS, Mechanical Engineering, Detlev Helmig. "Non-methane hydrocarbon measurements for long-range transport studies at Pico Mountain, Azores, Portugal."

Tim Tomaszewski, PhD, Environmental Studies, Herman Sievering. Nitrogen deposition at subalpine forests.

Jocelyn Turnbull, PhD, Geological Sciences, Scott Lehman. "Environmental measurements of atmospheric $^{14}CO_2$: development and applications."

Ryan Vachon, PhD, Geological Sciences, James White. "The distribution of stable isotopes of precipitation across the United States."

Dylan Ward, PhD, Geological Sciences, Robert Anderson. "Tectonic and geomorphic processes of exhumation and uplift in the Alaska Range."

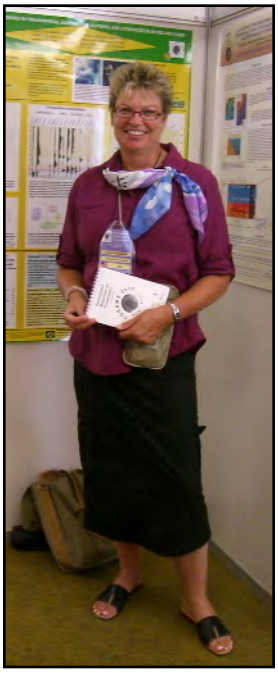
Lindsay Weber, MS, Environmental Studies, Diane McKnight. Interests include water quality in the Green Lakes Valley, CO.

William Wieder, PhD, Ecology and Evolutionary Biology, Alan Townsend.

Jeff Wong, MS, Civil, Environmental and Architectural Engineering, Diane McKnight.

Marcia Wyatt, PhD, Geological Sciences, Tom Marchitto and Peter Molnar.

Chi Yang, MS, Civil, Environmental and Architectural Engineering, Diane McKnight. "Effect of acid mine drainage on success of tree swallow nesting in Snake River, Colorado."



Ursula Quillmann (INSTAAR) presenting a poster at the International Symposium on Foraminifera (FORAMS 2006) in Natal, Rio Grande do Norte State, Brazil, September 2006.

Undergraduate Students

Some of the many INSTAAR Undergraduate Students 2005–2006

Student Name—Advisor(s)

Rebecca Abbey—D. McKnight
Katherine Alexander—D. McKnight
Ludovic Bariteau—D. Helmig
Katie Barrett—D. McKnight
C. Beckett Hart—S. Anderson
Nicole Bransford-Smith—C. Wolak, S. Lehman
Ian Brown—B. Vaughn, J. White, D. Helmig
Todd Camnitz—B. Vaughn, J. White
Patrick Cappa—C. Wolak, S. Lehman
Dan Carlson—D. Helmig
Kurt Carson—M. Williams
Casey Coleman—J. Andrews
Kyle Converse—D. Helmig
Mike Cox—D. McKnight
Brendan Cusack—D. McKnight
Ryan Darby—D. Helmig
Jess Davis—E. Miller

Gregory Diefenbach—J. Andrews
Christopher Dodson—U. Quillman
Chrissy Fairbanks—E. Miller
Justin Feis—T. Seastedt
Andrew Gansky—S. DeVogel, G. Miller
Jacob Gelfand—S. DeVogel, G. Miller
Devin Girtin—B. Vaughn, J. White
Jaclyn Gorman—S. Anderson
Alicia Greene—D. McKnight
Anobha Gurung—H. Sievering, T. Ackerman
Jason Shappiro—C. Wolak, S. Lehman
Jeff Harvey—D. Helmig
Jen Hoisington—E. Miller
Bethenie Hope—D. Helmig
Shannon Horn—D. McKnight
Cuong Hyunh—N. Mladenov, D. McKnight
Tom Ingersoll—D. McKnight
Suzie Janicke—M. Williams
Dan Lopez—T. Marchitto
Erin Mannix—M. Williams
Sana Marsh—C. Wolak, S. Lehman
Kelly Matheson—M. Williams
Melissa Maxa—W. Bowman
David Millar—M. Williams
Melissa Mora—D. McKnight
Jason Moran—B. Vaughn, J. White
Thomas Morse—D. Helmig
John Murgel—W. Bowman
Cassandra Nelson—S. Anderson
Marnie Norris—N. Mladenov, R. Cory, D. McKnight
Vinny Omelio—E. Miller
Olofron Plume—W. Bowman
Matt Preston—S. DeVogel, G. Miller
Amber Roche—D. McKnight
Katie Ryder—E. Miller
Cindy Shand—E. Miller, T. Seastedt
Amy Steiker—B. Vaughn, J. White
Erin Temple—S. DeVogel, G. Miller
Kele Thrailkill—B. Vaughn, J. White
Kristin Vietti—D. McKnight
Andrew Vonesh—S. Anderson
Kyle Wald—D. McKnight
Megan Wolz—D. McKnight
Meghan Worley—B. Vaughn, J. White
Lindsay Young—J. Syvitski

Katherine Alexander (REU student, INSTAAR) on Niwot Ridge overlooking the upper Green Lakes Valley, Colorado, June 2006. Water samples were collected from May to September to investigate the role of hydrology in determining rates of in-lake processing of carbon and nitrogen in alpine and sub-alpine ecosystems. Photo: Matt Miller (INSTAAR).

Melissa Maxa (University of Minnesota), pounds a PVC tube into the ground as part of a soil microcosm experiment investigating plant litter diversity on soil functional ecology, Niwot Ridge, Colorado, June 2006. Melissa was a participant in the NSF-sponsored Research Experiences for Undergraduates (REU) at the Mountain Research Station. Photo: Bill Bowman (INSTAAR).

Societal Outreach and Informal Education

Over the last two years, societal outreach and informal educational opportunities have become a strong part of INSTAAR's mission. The institute continues to present its popular Open House annually. Undergraduate students are often mentored through hands-on research projects. Outreach is facilitated through the INSTAAR web site, and with a variety of online initiatives for sharing and illustrating scientific information. On a day-to-day basis, INSTAAR members respond to inquiries from the public and the media on a broad spectrum of scientific matters that relate to INSTAAR's research. They regularly give lectures and presentations to schools and civic groups and provide TV and radio interviews for the popular press.

In May 2005, INSTAAR continued its successful series of open houses by hosting 172 eighth-graders from Southern Hills Middle School. The energetic students collected samples and learned about relationships among stream flow, water quality, and insect ecology at nearby Boulder Creek. By visiting a few of the many labs at INSTAAR and the National Snow and Ice Data Center (NSIDC), the students learned how materials such as bones and soils are radiocarbon dated, how climate controls the extent of glaciers and sea ice, and how past droughts are recorded in tree rings. In addition to the hands-on exercises, students learned about early human migration into Europe and the evolution of the Bering Land Bridge. The open house helped convey diverse aspects of earth science, use of sophisticated instrumentation and modeling, and the relevance of earth science for important global and local issues.

In April of the following year, INSTAAR again hosted 182 eighth-graders from Southern Hills Middle School. Similar to the past, the students were divided into groups to participate in lab tours, lectures, science games, and stream sampling activities. Students' knowledge of snow and ice was tested during a fun quiz show run by staff of the adjacent NSIDC. They learned about ancient artifacts from melting glaciers in Alaska. And they "flew" along a three-dimensional virtual tour of the Arctic, illustrating key findings from the Arctic Climate Impact Assessment.

INSTAAR continued strong involvement with several CU initiatives to directly involve undergraduates and minority students in scientific research. These included the Summer Undergraduate Research Fellowship (SURF) program, the Summer Multicultural Access to Research Training (SMART) program, the Significant Opportunities in Atmospheric Research and Science (SOARS) program, and others. For example, Detlev Helmig mentored seven students with research on volatile organic emissions, ozone, meteorology, and atmospheric toxins.

Bill Bowman has taken the lead role for a Research Experiences for Undergraduates (REU) program at the Mountain Research Station. The program has been funded by the National Science Foundation since 1994, and was just renewed with funding through 2010. Students work one-on-one with faculty mentors on their own research topics. Forty percent of the REU alumni have gone on to graduate programs, with another 20 percent working in research support positions. Thirty percent of the participants are from under-represented groups, increasing the access of minority students to careers in biological research.

Highlights for outreach to local schools include:

- Several INSTAAR scientists—including Cory Cleveland, Natalie Mladenov, Craig Lee, and Bill Manley—helped to interview and mentor young students at the High Peaks Elementary School Science Fair.
- Suzanne Anderson spoke to a junior elementary class at the Jarrow Montessori school about glaciers and climate change.
- Diana Nemergut taught a Microbial Diversity course at Boulder Preparatory High School. She and Alan Townsend serve as board members for this unique and highly successful charter school, which requires college acceptance for graduation.
- Diane McKnight and Karen Cozzetto reviewed curriculum for the McMurdo Dry Valleys Interactive CD Set for Students and Teachers, developed by Carol Landis at the Byrd Polar Research Center. One CD is designed for grades 8–10 and illustrates the research and ecology of the Dry Valleys region of Antarctica. An accompanying teachers' guide contains supplemental information and videos about the streams, lakes, glaciers, and soil biota of the Dry Valleys.
- Karen Cozzetto spoke with elementary students at a one-room schoolhouse in Jamestown, Colorado. She read from *The Lost Seal* book with slides to describe scientific research in the harsh environments of Antarctica.

Diana Nemergut (INSTAAR, right) shows Boulder Prep High School students how to plate bacteria onto Petri dishes, February 2006. Photo: Lili Adeli (Boulder Prep).

William Manley (INSTAAR) explains how recent melting of glaciers and ice fields in Alaska and other regions has exposed archeological materials for the first time in hundreds to thousands of years,

Visiting students from Southern Hills Middle School look at insects collected from Boulder Creek as part of a lesson on macroinvertebrates, INSTAAR Open House, May 2005. Photo: David Lubinski (INSTAAR).

- Rebecca Anderson worked on an outreach effort with Sandra Laursen of CIRES Outreach and Karl Mueller and Alan Lester in Geological Sciences. They created large-format images of Colorado from Digital Elevation Models that were used in sixth-grade classrooms to teach students about landforms and landscape processes. They also led a teacher workshop in June of 2006 to incorporate the images into classroom activities, including a field trip to Rocky Mountain National Park.

Highlights for outreach to the general public include:

- Mark Williams headlined "A Discussion on the Future of Water in Colorado and Climate Change" with Chip Barry, head of the Denver Water Board. The audience of over 100 Denver-area residents included former Governor Dick Lamm.
- Craig Lee gave a presentation at the Rocky Mountain National Park Research Conference on ice-field archaeology. His results on ancient bison skulls collected from melting ice patches caught the attention of local media.
- Tim Kittel was a guest lecturer for two Semester at Sea programs, covering such diverse topics as "World Ecosystems," "The Earth's Climate System," and "Conservation of Biodiversity Hotspots." He was also an instructor for summer undergraduate research experiences in Brazil and the Dominican Republic.
- Over the last two years, Bob Anderson has helped develop a new set of displays for the Yosemite National Park Visitor Center. A team of earth scientists consulted with the design team to upgrade displays with accurate information depicting the tectonic, igneous, and geomorphic history of the park's landscape and geology. The completely remodeled Visitor Center will open on Earth Day in 2007.

Other highlights for 2005 and 2006 include:

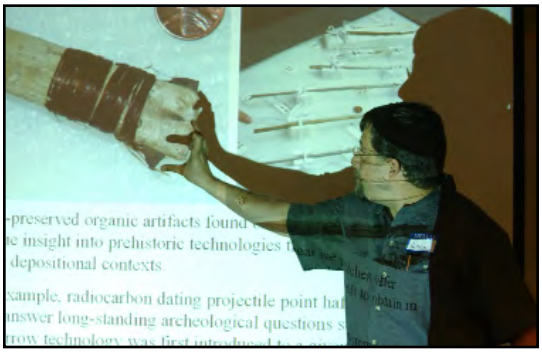
- The research of Mark Williams and the Niwot Ridge LTER project was featured in Chapter 12, "Altitude Addled," of the acclaimed book *Chasing Spring: an American Journey through a Changing Season.*
- Bill Manley released an online resource with geospatial visualizations of monthly climate change in Alaska. He has also assisted with development of an interactive, online mapping application for Arctic research (ARMAP.org).
- A group of INSTAAR undergraduate and graduate students were interviewed by the Boulder *Daily Camera* while conducting research at the McMurdo LTER site in Antarctica. Their work on stream hydrology and ecology appeared in an article entitled "Examining a Frozen Desert."
- Astrid Ogilvie helped establish a hands-on archaeology/cultural heritage outreach project for middle schools in northern Iceland.
- As president of the American Polar Society, John Behrendt helped organize the 50th anniversary of the last International Geophysical Year. Behrendt and several other INSTAAR scientists also helped with planning for the fourth International Polar Year (IPY).
- David Anderson gave two presentations at the White House. The talks on abrupt climate change drew from INSTAAR research on ice sheets, sea-level rise, ocean circulation, and drought. Abrupt changes in Earth's recent past suggest that climate may shift rapidly in coming decades.

Other aspects of INSTAAR's success with societal outreach are presented in this report's "Outreach Spotlights" section.

A group of students from Southern Hills Middle School pose before the INSTAAR Open House, April 2006. Photo: Casey A. Cass (University of Colorado).

Karen Cozzetto (INSTAAR) leads a hands-on experiment to study the flow and water chemistry of Boulder Creek, INSTAAR Open House, April 2006. Her group of students were from Southern Hills Middle School. Photo: Casey A. Cass (University of Colorado).

Karen Cozzetto (INSTAAR) wades into Boulder Creek to lead a hands-on experiment to study its flow and water chemistry, INSTAAR Open House, April 2006. Participating in the activity were groups of students from Southern Hills Middle School. Photo: Casey A. Cass (University of Colorado).

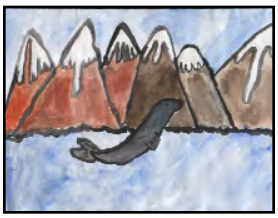


Craig Lee (INSTAAR) gives a slide show about Ice Field Archaeology to students from Southern Hills Middle School, INSTAAR Open House, April 2006. Photo: Casey A. Cass (University of Colorado).

The Lost Seal: A Scientific Children's Book from the Long-Term Ecological Research (LTER) Program

Painting of the lost seal being lifted by a helicopter by Emily of Granby Elementary, Worthington, Ohio, 2005–2006. Emily's painting was part of a classroom activity based on *The Lost Seal*. Emily wrote, "I drew this picture ... because I thought it was cool when they scooted it into the tarp without hurting it. And they said that the winds were 144 miles per hour. WOW, it must be cold out there!"

Painting of a seal that has just had a meal by Brandon of Leongatha Primary School, Victoria, Australia, 2005–2006.



Painting of the seal stuck in the mountains by Helen of Combe Down Primary, Bath, England, 2005–2006.

A chance encounter between scientists working in the Dry Valleys of Antarctica and a young Weddell seal is recounted in the scientific children's book, *The Lost Seal*.

Diane McKnight and an international team of scientists were working in the Dry Valleys in 1990 when they came across a Weddell seal, miles from his natural habitat on McMurdo Sound. McKnight described the encounter in a handout for K–12 classroom presentations. With the International Polar Year (IPY) approaching, the handout was revised and illustrated to become the second book in a series published by the Long-Term Ecological Research (LTER) Schoolyard Program and Moonlight Publishing, LLC, in collaboration with the NSF, CU Boulder, and Byrd Polar Research Center at the Ohio State University.

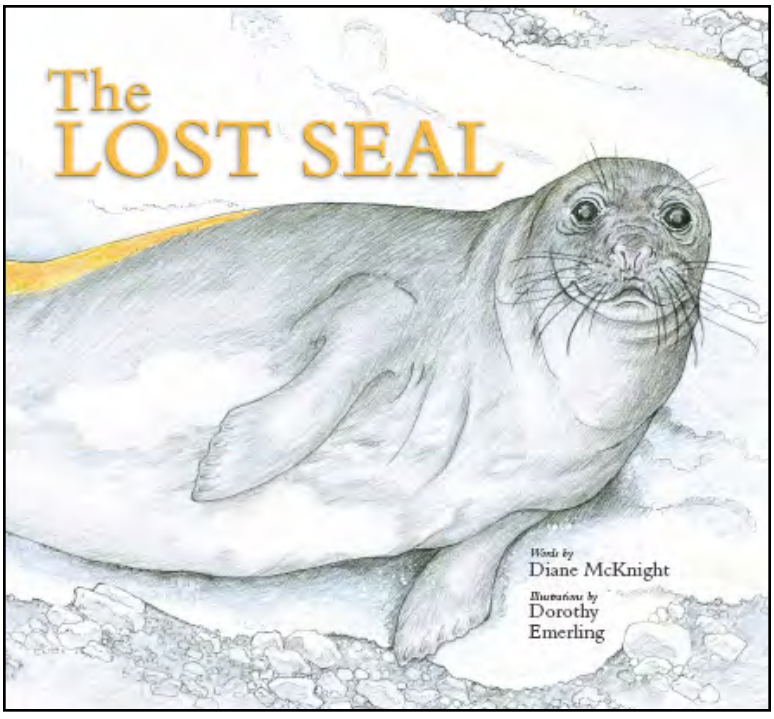
The Lost Seal is an engaging introduction to the environment of the Dry Valleys and is consistent with science standards for 2nd through 5th graders. The story is set within the context of historical exploration of the region, the harsh conditions for life, and ongoing research on hydrology, limnology, and microbial ecology.

Illustrated by Dorothy Emerling, *The Lost Seal* also features illustrations and comments by dozens of elementary school students from countries performing research in the Dry Valleys. The story, with footage of the seal and photos of the Dry Valleys on DVD, was sent to 28 elementary school classrooms across Australia, New Zealand, the United Kingdom, and the United States.

The materials packet served as the basis of classroom activities, and the children's artwork and comments, 413 in all, were sent back to INSTAAR. All the children's artwork can be found on *The Lost Seal* web site (http://www.mcmlter.org/lostseal), along with the materials packet. Once *The Lost Seal* was completed, sets of books were sent to each participating classroom.

The Lost Seal links several outreach efforts. Artwork from children in four countries emphasizes the international nature of interest in the Antarctic in a way particularly suited to the IPY. Creating the artwork became an activity in dozens of classrooms across these countries, and sets of books returned to the classrooms enable future activities. The web site, linked to educational clearinghouses, helps reach a broad audience of K–12 teachers and students. Teachers can link their own classroom activity web sites to *The Lost Seal* site. The book is for sale through distributors to libraries, bookstores, and Internet-based vendors. A teacher's guide, which is under development, will be distributed similarly and sent to participating classrooms.

The success of *The Lost Seal* has helped launch the LTER Schoolyard Series; two more children's books are in development from different LTER sites.



Cover of *The Lost Seal* children's book, with words by Diane McKnight (INSTAAR) and illustrations by Dorothy Emerling, published in 2006. An encounter between scientists and a young Weddell seal in the Dry Valleys of Antarctica has inspired the book and its publication, which coincides with the International Polar Year (IPY). The book links multiple outreach activities of the McMurdo Dry Valleys LTER project.

Outreach Spotlights

UNDERGRADUATE MENTORING: SUNLIGHT'S EFFECT ON AQUATIC ORGANIC MATTER. Undergraduate Cuong Huynh (CU Boulder) is being mentored by Natalie Mladenov and Diane McKnight on a project to uncover new ways in which sunlight affects aquatic organic matter. Cuong's efforts are funded by CU Boulder's Undergraduate Research Opportunities Program (UROP) and Bioscience Undergraduate Research Skills and Training Program (BURST). The main goal is to equip Huynh with an understanding of the research methods and skills in analytical and laboratory techniques, while at the same time answering some interesting research questions.

Degradation of dissolved organic matter (DOM) by ultraviolet light—also known as "photobleaching"—can cause complex compounds in vegetation to be broken down to simpler compounds which are more readily consumed by bacteria. Huynh has been running experiments using a high-powered solar simulator to reproduce the process of photobleaching with plant leachates and DOM samples. Huynh is also using a new statistical modeling tool in order to quantify changes in the optical properties of DOM as a result of photobleaching.

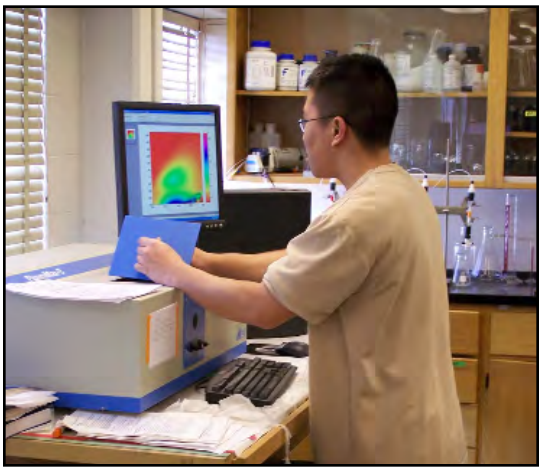
This research experience is a stepping stone to Huynh's main interest: the chemical structure of plants and their medicinal properties. He plans to present the results of his research at an international meeting in 2007—the International Association of Theoretical and Applied Limnology (SIL2007).

INSTAAR COLLABORATES ON LOCAL WATERSHED CURRICULUM: "MY H_2O." Colleen Flanagan, under the direction of Diane McKnight, led the development of a teacher curriculum guide and resource kit promoting awareness of the Boulder and St. Vrain watersheds. The guide, entitled "My H_2O," blends Colorado state educational standards in science, language arts, geography, and math into activities, educational games, story plots, and community action tasks. The guide's hands-on, minds-on projects are enhanced by a resource kit that contains supplies necessary to implement each activity. Copies were distributed to area public and private schools in spring 2006, primarily for use in 4th- and 5th-grade classrooms. The project was a joint effort by INSTAAR and the Niwot Ridge Long-Term Ecological Research Program (NWTLTER), with a number of collaborators in several local school districts and governmental agencies.

The curriculum supplements the children's book *My Water Comes from the Mountains* by Tiffany Fourment, funded by NWTLTER and INSTAAR and distributed to Boulder Valley and St. Vrain Valley school districts in 2004.

Funding for the curriculum guide was provided by the U.S. Environmental Protection Agency, the CU Boulder Outreach Committee, the City of Boulder, and the Watershed Approach to Stream Health (WASH, a partnership of communities in Boulder County formed to protect water quality). Other support came through Schoolyard NWTLTER, connecting the Colorado Front Range communities with the alpine systems of the mountains, and administered by INSTAAR.

GRAD STUDENT PENS EDUCATIONAL JOURNAL ABOUT ANTARCTIC SCIENCE. Karen Cozzetto was the main contributor to an educational web site entitled "77 Degrees South," which showcases the life, times, and research of several groups of scientists working in the largest ice-free region of Antarctica: the McMurdo Dry Valleys. Cozzetto's focus was on the Antarctic "Stream Team," which studies the hydrology and ecology of glacial meltwater streams and is managed by Diane McKnight. The website is geared toward middle and high school students and presents science and happenings on the southernmost continent in the form of fun journal entries with lots of photos. Journal topics range from glacier dynamics to diving in ice-covered lakes for low-light algae photosynthesis research, from eclipses to the ins and outs of helicopter travel, and from the intricacies of environmentally managing our human waste to the top signs you've been in the field for three months. Most of the entries from the 2005–2006 field season were by Cozzetto and posted with the help of volunteer web site designer Emma Hernandez (Cozzetto was also the main contributor in 2003–2004 and 2002–2003). The site has been viewed by people on all seven continents, and several journal entries have been selected for inclusion in National Science Foundation's Digital Library for Earth System Education (DLESE). The website is supported and hosted by the NSF's McMurdo Dry Valleys Long-Term Ecological Research (LTER) program.



Undergraduate Cuong Huynh (CU Boulder) running experiments using a high-powered solar simulator to reproduce the process of photobleaching with plant leachates and dissolved organic matter samples, Boulder, Colorado, Fall 2006. Huynh is being mentored by Natalie Mladenov and Diane McKnight (both INSTAAR) on a project to uncover new ways in which sunlight affects aquatic organic matter. Photo: Natalie Mladenov (INSTAAR).

Teacher resource kit supplies for the field activity "Macroinvertebrate Mania!," from the teacher curriculum guide "My H_2O," developed by Colleen Flanagan under the direction of Diane McKnight, Spring 2006. The guide promotes awareness of the Boulder and St. Vrain watersheds, and copies were distributed to area public and private schools in Spring 2006. The project was funded by the Niwot Ridge Long-Term Ecological Research Program. Photo: Colleen Flanagan (INSTAAR).

Researchers take a break and play Frisbee at the base of Canada Glacier, Taylor Valley, Antarctica, January 2006. Many players are members of the 2005–2006 Antarctic "Stream Team," which studied the hydrology and ecology of glacial meltwater streams and is supported by NSF's McMurdo Dry Valleys Long-Term Ecological Research (LTER) program. Photo: Karen Cozzetto (INSTAAR).

INSTAAR SCIENTISTS DISCUSS POLAR RESEARCH AT PUBLIC EVENT FOR UPCOMING INTERNATIONAL POLAR YEAR. John Behrendt, Jim White, Karen Cozzetto, and several other CU Boulder scientists shared their experiences in the Arctic, Greenland, and Antarctic in a prelude to the next International Polar Year, or IPY, in 2007. Titled "Countdown to IPY," the free, public event focused on past and current research efforts at Earth's polar regions by CU Boulder faculty and graduate students. The event also included a brief history of IPY, an international, interdisciplinary research campaign last held in 1957, which will involve the efforts of more than 60 nations beginning next year. IPY will officially run from March 2007 to March 2009 to allow for two full seasons of field work in the Arctic and Antarctic. Participating scientists will use high-tech tools ranging from satellites, autonomous vehicles, and remotely operated climate stations to GPS, laser altimeters, and supercomputers to better understand the roles the polar regions play in a variety of global processes. Researchers involved in IPY will address such issues as dwindling sea ice, shrinking ice sheets and glaciers, thawing permafrost, and creatures ranging from polar bears and penguins to marine life and microbes.

THE NINTH CIRCLE: A MEMOIR OF LIFE AND DEATH IN ANTARCTICA, 1960–1962. John Behrendt published an memoir of his work with the United States Antarctic Research Program in the early 1960s, when the Cold War was at its height and research on the ice sheet was risky. The Antarctic air squadron VX6 had an accident rate eight times that of U.S. Naval aviation in other parts of the world, and graduate students and young scientists like Behrendt received hazard pay for their work. In Behrendt's memoir we relive that era of scientific explorations with him. He describes two seasons on the ice in Operation Deep Freeze, leading field parties, conducting scientific research, and struggling against the elements. Behrendt led an over-snow geophysical-glaciological-geologic-geographic exploration party to the southern Antarctic Peninsula and to a mountain range that was eventually named for him in recognition of his work. Behrendt pioneered aerogeophysical surveys over the Transantarctic Mountains and the West Antarctic Ice Sheet. In his reflections on the period from 1956 to 1962, he notes the time was closer to the eras of Ernest Schackleton (*Endurance* voyage, 1914) and Robert F. Scott and Roald Amundsen's treks to the South Pole (1911–1912) than to the present. Readers fascinated with the 20th century frontier of our shrinking planet will relish his adventurous account.

OZONE AND THE OCEANS. Shelly Sommer created a poster display for the Discovery Science Center that describes a project, led by Detlev Helmig, to measure ozone fluxes over the oceans. The display also explains the role of ozone in the troposphere vs. the stratosphere. The hands-on science center is located in Fort Collins, Colorado, and serves 35,000 visitors each year; many attendees are children from northern Colorado and Wyoming. A companion web site, "Ozone and the Oceans," was created with the assistance of David Lubinski. The site is an educational resource for grades 5–12 that describes the science, introduces team members, and provides updates on the project, a glossary, and downloadable PDFs of the Science Center posters. The site has been added to the Digital Library for Earth Science Education (DLESE) and the National Science Digital Library (NSDL).

Spotlights: Honors, Awards, and Recognition

DAVID ANDERSON RECEIVED ARTHUR S. FLEMING AWARD. David Anderson received the 2005 Arthur S. Fleming Award from George Washington University for excellence in scientific research, one of three recipients. The award recognizes excellence in the federal workforce. Recognized by the President of the United States, agency heads, and the private sector, the winners are selected from all areas of the federal service. Anderson and his colleagues at NOAA have developed a popular and often-used archive of paleoclimate records of past climate change, the World Data Center for Paleoclimatology. These observations extend the instrumental record of weather observations back thousands of years, providing a longer record of climate variability. The paleo records also provide insights into possible future climate change. The Fleming medal ceremony was held in Washington, DC, on June 13, 2006.

JOHN BEHRENDT ELECTED PRESIDENT OF THE AMERICAN POLAR SOCIETY. John C. Behrendt was elected President of the prestigious American Polar Society in spring 2006. The society, founded in 1934, has a mission to foster interest in research and exploration in the Arctic, Antarctic, and polar-like regions. Behrendt made his first trip to Antarctica in 1956 as a graduate student, where he wintered over at Ellsworth Station, and has continued his work in Antarctica on 12 additional expeditions, the last in 2003. He is one of two or three people in the world who have worked in the U.S. Program in Antarctica in parts of six successive decades. The Behrendt Mountains in Ellsworth Land were named for him as a result of an over-snow traverse that he led using Sno-Cats in that area in 1957–1958.

Behrendt was employed by the U.S. Geological Survey for 31 years, has also been a member of the U.S. State Department delegation to 22 Antarctic Treaty Consultative Meetings, and has authored two books about his Antarctic experience, in 1998 and 2005, respectively—*Innocents on the Ice; a Memoir of Antarctic Exploration, 1957* and *The Ninth Circle; a Memoir of Life and Death in Antarctica, 1960–1962.* His current research at INSTAAR includes the study of geophysical evidence for subglacial late Cenozoic volcanism beneath the Antarctic ice sheet.

In addition to Antarctica, Behrendt carried out geophysical investigations in West Africa, the Atlantic continental margin of the U.S., and the Rocky Mountains. He makes his home in Boulder and always has a backpack ready for another expedition to the world's most remote continent.

BOB ANDERSON ELECTED A FELLOW OF THE AMERICAN GEOPHYSICAL UNION. Robert S. Anderson was elected a Fellow of the American Geophysical Union for "fundamental and pioneering contributions in quantitative geomorphology, geochronology, hydrology and glaciology." Fellowship is bestowed on only 0.1% of the total AGU membership of about 35,000 in any given year and recognizes scientists who have attained acknowledged eminence in the geophysical sciences.

Anderson has been a leader in the distinctive combination of rigorous field measurements and numerical modeling. His approach involves monitoring modern systems, numerical modeling of these systems constrained by modern rates, and establishment of a chronology that constrains the longer-term pace of landscape evolution. He has successfully applied this approach to classic problems of geomorphology such as eolian transport, rock abrasion, and the evolution of glacial valleys and whole landscapes. Anderson's keen desire to understand the processes that drive landscape evolution has led him to work (1) at scales from sand-grain trajectories to mountain ranges, (2) in environments from deserts to the Arctic, and (3) with techniques from fluid mechanical simulation to cosmogenic radionuclide dating.

Throughout his distinctive and varied scientific contributions, Anderson has shared his work and publication history with a long list of students and colleagues. Though the work has obviously benefited from their talent and energy, Anderson's enduring and distinctive contribution is clearly visible. His collaborative and generous approach continues with his role as the founding editor of the new AGU journal *JGR–Earth Surface.*

Bob Anderson and John Andrews (both INSTAAR) on their way to the American Geophysical Union (AGU) Fellowship honor's ceremony, San Francisco, California, Spring 2006. Both Anderson and Andrews were elected AGU Fellows. Fellowship is bestowed on only 0.1% of the total AGU membership of about 35,000 in any given year and recognizes scientists who have attained acknowledged eminence in the geophysical sciences. Photo: Suzanne Anderson (INSTAAR).

JOHN ANDREWS ELECTED A FELLOW OF THE AMERICAN GEOPHYSICAL UNION. John T. Andrews was elected a Fellow of the American Geophysical Union (Paleoceanography and Paleoclimatology Focus Group) "for his seminal contributions to the Quaternary history of North America and the North Atlantic Basin." Fellowship is bestowed on only 0.1% of the total AGU membership of about 35,000 in any given

year and recognizes scientists who have attained acknowledged eminence in the geophysical sciences. This award recognizes the contributions Andrews has made in publishing innovative and thought-provoking papers at the cutting edge of the discipline, in three principal areas: (1) studies of the behavior of the Laurentide Ice Sheet, (2) papers on relative sea level history (methods, theory, and modeling), and (3) research on ice sheet/ocean interactions (including Heinrich events).

Andrews has been a driving force behind INSTAAR, helping to establish its international reputation for excellence in science; he also served as Chairman of the Department of Geological Sciences at CU Boulder. He was elected President of the Quaternary and Geomorphology Division of the Geological Society of America (GSA) and President of the American Quaternary Association (AMQUA), and he provided leadership on several initiatives of the National Science Foundation and the National Academy of Sciences.

John Andrews has inspired an entire generation of students, many of whom have gone on to establish successful programs at major institutions and universities elsewhere, spawning their own cadre of students. Thus John's diaspora of highly trained students and their "offspring" form a truly enormous group of researchers in the Quaternary geosciences.

ALAN TOWNSEND NAMED DIRECTOR OF THE NORTH AMERICAN NITROGEN CENTER. Alan Townsend was named Director of the North American Nitrogen Center (NANC), one of five centers around the world that together comprise the core structure of the SCOPE and IGBP sanctioned International Nitrogen Initiative (INI). Nitrogen is essential for life, and our ability to convert atmospheric nitrogen into synthetic fertilizers is a mainstay of agricultural productivity, and thus of our ability to feed billions of people. Yet, the global nitrogen cycle is also being changed at a scale and pace that exceeds any other major biogeochemical element, with a growing litany of environmental and health consequences. Thus, the North American Nitrogen Center and the INI are dedicated to optimizing the use of nitrogen in food production, while minimizing the negative effects of nitrogen on human health and the environment as a result of both food and energy production. Core activities of the INI include scientific assessment, development of solutions to solve a wide variety of nitrogen-related problems, and interactions with policymakers to implement these solutions.

GIFFORD MILLER: RECIPIENT OF THE 2005 EASTERBROOK DISTINGUISHED SCIENTIST AWARD. Gifford Miller received the Easterbrook Distinguished Scientist Award at the Geological Society of America's (GSA) 2005 annual meeting. The award is given annually by the Society's Quaternary Geology and Geomorphology Division to an individual who has shown unusual excellence in published research, as demonstrated by a single paper of exceptional merit or a series of papers that have substantially increased knowledge in Quaternary geology or geomorphology. Recent recipients include Wallace Broecker, Victor Baker, Richard Alley, Tom Dunne, and Edward Keller. Miller's former advisor and INSTAAR fellow John Andrews wrote the citation, with contributions by 19 individuals from several countries and with a variety of connections.

JAMES W. C. WHITE NAMED "HIGHLY CITED GEOSCIENTIST" BY ISI WEB OF KNOWLEDGE. James W.C. White was named one of the most highly cited geoscientists by the ISI Web of Knowledge for the period 1981–1999. This select group comprised less than 0.5% of all publishing researchers—a truly an extraordinary accomplishment. The "highly cited" list at ISIHighlyCited.com will grow to include the top 250 preeminent individual researchers in each of 21 subject categories (life sciences, medicine, physical sciences, engineering, and social sciences) who have demonstrated great influence in their field as measured by citations to their work—the intellectual debt acknowledged by their colleagues. One of the goals of the list is to identify individuals, departments, and laboratories that have made fundamental contributions to the advancement of science and technology in recent decades.

Giff Miller's crew boarding their chartered pirogue, a dugout outrigger, sailing to offshore islands in search of Elephant Bird eggshells, southwestern Madagascar, April 2006. Photo: Giff Miller (INSTAAR).

TIM SEASTEDT WINS THE 2005 PACESETTER AWARD FOR ENVIRONMENT. Tim Seastedt won the 2005 Boulder County Pacesetter Environment award from the Boulder *Daily Camera* newspaper for his work on biological pest control of diffuse knapweed, an aggressive noxious weed that infests about 100,000 acres locally and 3 million acres in the West. Seastedt and his colleagues started studying knapweed population dynamics in 1997. Eventually they found several insect species that help eliminate the weed without the need for chemical pesticide treatments once every three years at an estimated cost of $20 to $40 per acre. The insect impacts were first noted in 2000 and became very obvious in 2001. Some of the insects have already dispersed across the Front Range of Colorado and others are available from the State of Colorado, Department of Agriculture, Biological Pest Control Section. The *Daily Camera* has presented Pacesetter awards since 1985 to recognize Boulder County residents who have made significant contributions to the community. The categories for 2005 include Lifetime Achievement, Youth, Quality of Life, Arts and Entertainment, Business, Science/Medicine/Health, Community Service, Environment, and Education. A community reception and luncheon in honor of this year's winners was held at the Millennium Harvest House in Boulder on January 19.

Tim Seastedt (INSTAAR) ponders the role that soil invertebrates play in soil biogeochemical processes in tropical Australia, November 2006. Photo: C. M. Tate (USGS).

Aerial oblique view of the headwaters of the Kennicott Glacier and the headwall of Mount Blackburn, Alaska, mid-May 2006. In summer 2006, Tim Bartholomaus, Suzanne Anderson, and Robert Anderson (all of INSTAAR) installed 5 GPS monuments on this glacier in order to explore the dynamic response of the glacier to the outburst of glacially dammed Hidden Creek Lake. Photo: Robert S. Anderson (INSTAAR).

INSTAAR Directorate Members

David M. Anderson

Fellow of INSTAAR; Adjoint Associate Professor of Geological Sciences, University of Colorado at Boulder; Director, World Data Center for Paleoclimatology and Chief of Paleoclimatology Branch of the National Climatic Data Center, U.S. 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 reconstructions of ocean carbonate ion concentration related to the ocean's role in the global carbon cycle, reconstruction of long-term trends in the Asian summer monsoon, and projects to reconstruct the coastal ocean currents in the eastern Pacific and their influence of the climates of North and South America.

Robert S. Anderson

Fellow of INSTAAR; Professor of Geological Sciences, University of Colorado at Boulder. PhD: 1986, University of Washington.

Specialty: Geomorphology, mechanics and timing of landscape evolution.

Research Interests: My academic interests focus on the processes that drive landscape evolution, studied through monitoring of modern systems, numerical modeling of these systems constrained by modern rates, and establishment of a chronology that constrains the longer term pace of landscape evolution. Recent research has focused on alpine landscapes and the glaciers and rivers that carve them.

Suzanne Prestrud Anderson

Research Scientist of INSTAAR; Assistant Professor of Geography. PhD: 1995, University of California, Berkeley.

Specialty: Geomorphology, weathering, hydrology, glaciology.

Research Interests: Field-based mechanistic understanding of the chemical and physical processes that shape the Earth's surface and control chemical denudation rates. Current focuses include studying the effect of glaciers on chemical weathering rates and the global carbon cycle, the linkage between glacier dynamics and subglacial hydrology, glacier outburst floods (jökulhlaups), and catchment-scale hydrology and hydrochemistry. Specializes in collection of detailed field observations to constrain models of geomorphic systems.

John T. Andrews

Fellow of INSTAAR; Professor of Geological Sciences, University of Colorado at Boulder; Fellow of Norwegian Academy of Science and Letters. PhD: 1965; DSc: 1978, University of Nottingham, U.K.

Specialty: Glacial and marine sedimentology and chronologies, high-resolution marine studies.

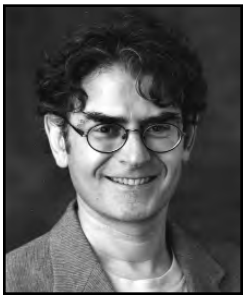
Research Interests: Late Quaternary history of ice sheet/ocean interactions and abrupt climate change during the last 10,000 to 40,000 yrs. Identification of iceberg rafting events. Detailed study of the paleoceanography of the East Greenland and Iceland margins on Holocene time scales.

John C. Behrendt

Fellow of INSTAAR. PhD: 1961, University of Wisconsin, Madison.

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, South Carolina, 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; multiscale 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

Fellow and Director of the Mountain Research Station of INSTAAR; Professor of Ecology and Evolutionary Biology, University of Colorado at Boulder. 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

Fellow of INSTAAR; Professor of Geography, University of Colorado at Boulder. PhD: 1966, Australian National University.
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.

Cory Cleveland

Research Scientist of INSTAAR. PhD: 2001, University of Colorado at Boulder.
Specialty: Terrestrial biogeochemistry.
Research Interests: How the cycles of biologically important elements are mediated by soil microorganisms in terrestrial ecosystems, and how soil biogeochemical processes and soil microorganisms are being influenced by global change.

E. James Dixon

Fellow of INSTAAR; Professor of Anthropology; Curator of Museum and Field Studies, University of Colorado at Boulder. PhD: 1979, Brown University.
Specialty: Archeology.
Research Interests: High latitude/high altitude human adaptations, circumpolar and paleoindian archeology, Quaternary science and geoarcheology.

Mark B. Dyurgerov

Fellow of INSTAAR; Senior Scientist and Professor of Institute of Geography, Russian Academy of Sciences. PhD: 1974, Moscow State University; Doctor of Science: 1990, Institute of Geography, Russian Academy of Sciences.
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 meltwater production worldwide, with particular emphasis in the Arctic, Alaska, and Central Asia.

Detlev Helmig

Fellow and Associate Research Professor of INSTAAR, University of Colorado at Boulder. PhD: 1989, University of Duisburg, Germany.
Specialty: Surface-atmosphere interactions, atmospheric chemistry and transport, atmospheric measurement techniques, polar atmospheric chemistry, oceanic gas fluxes.
Research Interests: Biosphere-atmosphere trace gas fluxes and their environmental controls, in particular emissions of biogenic volatile organic compounds (BVOC) from vegetation; atmospheric transport; deposition processes and atmospheric chemistry; polar snow-atmosphere gas exchange processes; development, development, and application of analytical tools for field research; urban atmospheres and hazardous pollution; intercontinental atmospheric transport.

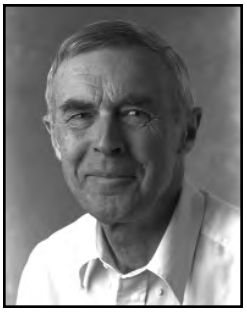
Mervi Hjelmroos-Koski

Fellow of INSTAAR; Research Scientist, Environmental Health Sciences, School of Public Health, University of California, Berkeley.
PhD: 1981, University of Lund, Sweden; DSc: 1989, University of Stockholm, Sweden.

Specialty: Palynology, pollen transport and deposition, pollination biology, long-distance transport of biological material, airborne fungal spores.
Research Interests: (1) Annual pollen deposition and pollen-climate calibrations in the Colorado Front Range, to better understand pollen-vegetation relationships and vegetation responses to climate change; (2) composition of atmospheric organic carbon with special reference to pollen grains and fungal spores; and (3) native vegetation responses to invasive pollinators.

John F. Hoffecker

Fellow of INSTAAR. PhD: 1986, University of Chicago.
Specialty: Archaeology and human paleoecology
Research Interests: The evolution of human adaptations to cold environments during the Quaternary period. Studies of archaeological sites in Eastern Europe and Alaska. Currently investigating the earliest modern human sites in Russia and the dispersal of modern humans into Eastern Europe (and related disappearance of local Neanderthals). Special focus on the role of technology in the dispersal process. Current research also includes interdisciplinary study of coastal middens in northern Alaska and the origins of modern Inuit culture with a focus on technological innovation.



John T. Hollin

Fellow Emeritus of INSTAAR; Research Scientist Emeritus of University of Colorado.
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

Fellow of INSTAAR; Assistant Professor of Geological Sciences, University of Colorado. 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 and Research Professor of INSTAAR. PhD: 1989, University of Colorado at Boulder.
Specialty: Paleoclimatology, paleoceanography, radiocarbon research.
Research Interests: The role of the oceans in climate change, cycling of heat, fresh water, and carbon by the oceans, paleotemperature applications of marine biomarkers and amino acids, dynamics and consequences of abrupt climate change, radiocarbon calibration, bomb ^{14}C as a tracer in the recent carbon cycle.

Wesley E. LeMasurier

Fellow of INSTAAR, Professor of Geology, University of Colorado at Denver. PhD: 1965, Stanford University.
Specialty: Volcanology and igneous petrology.
Research Interests: (1) Volcanoes of Marie Byrd Land, Antarctica: origin and evolution of basaltic and felsic rocks; (2) relationship of volcanism in Antarctica (esp. Marie Byrd Land) to tectonic environment: West Antarctic rift system, Marie Byrd Land dome; (3) volcanic record of Cenozoic glacial history in Marie Byrd Land; (4) geology of hydrovolcanic rocks (hyaloclastites, pillow lavas); (5) Cenozoic volcanoes of Antarctica: distribution and petrologic character.

William F. Manley

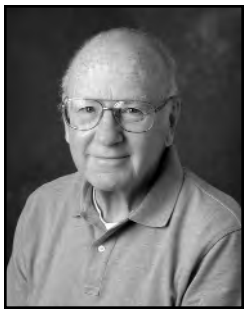
Fellow of INSTAAR. PhD: 1995, University of Colorado at Boulder.
Specialty: Quaternary Geology, GIS, paleoclimatology, and high-latitude environmental change.
Research Interests: Pleistocene glacier fluctuations and paleoclimate forcing for Alaska, through field research and data analysis, including spatial analysis with GIS. Spatial analysis of modern Alaskan glaciers, including links between equilibrium line altitudes and climate. Icefield archaeology and remote sensing. Arctic coastal erosion and flooding.

Tom Marchitto

Research Scientist of INSTAAR; Assistant Professor of Geological Sciences, University of Colorado at Boulder. PhD: 1999, MIT/WHOI Joint Program.
Specialty: Quaternary paleoclimate, paleoceanography, and past ocean chemistry.
Research Interests: Rapid climate change during the late Quaternary, particularly large-scale changes in ocean circulation and chemistry. Specializing in the use the calcitic foraminifera as recorders of physical and chemical properties of seawater, including temperature, salinity, the isotopic composition of dissolved inorganic carbon, and the concentrations of various nutrients.

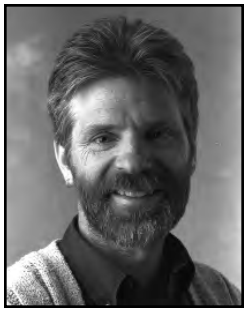
Diane M. McKnight

Fellow of INSTAAR; Professor of Civil, Environmental and Architectural Engineering, University of Colorado at Boulder. PhD: 1979, Massachusetts Institute of Technology.
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 in 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 Valleys LTER and in the Niwot Ridge LTER.



Mark F. Meier

Fellow Emeritus of INSTAAR; Professor Emeritus of Geological Sciences, University of Colorado at Boulder. PhD: 1957, California Institute of Technology.
Specialty: Glaciology, global change.
Research Interests: Glaciers in the Earth system, causes and projections of sea-level change, iceberg calving, surging and calving glaciers, climate change, and global change in general.



Gifford H. Miller

Fellow of INSTAAR; Professor of Geological Sciences, University of Colorado at Boulder. PhD: 1975, University of Colorado at Boulder.
Specialty: Quaternary stratigraphy, geochronology, and paleoclimatology.
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 using the Quaternary as a means 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. I am also interested in the role of humans in the modification of landscapes and ecosystem on Quaternary timescales.

Diana R. Nemergut

Research Scientist of INSTAAR; Assistant Professor of Environmental Studies, University of Colorado at Boulder. PhD: 2004, University of Colorado at Boulder.
Specialty: Microbial ecology and evolution.
Research Interests: Horizontal gene transfer in microbial communities. I am

currently looking at the role of integrons in genetic exchange in soil and aquatic environments. I am interested in the types of genes that can be exchanged via integrons, as well as the phylogenetic diversity of the organisms that contain integrons.

Astrid E. J. Ogilvie

Fellow of INSTAAR. PhD: 1982, University of East Anglia, Norwich, U.K.
Specialty: The transcription, analysis, and calibration of historical documentary climate records, in particular unpublished manuscript sources, in Icelandic, Danish, Norwegian and Swedish.
Research Interests: The environmental, social, and human history of countries bordering the North Atlantic regions, in particular Iceland, Greenland, Norway, and the United Kingdom; the past climate and sea-ice record of Iceland; human and social dynamics in the context of climatic and environmental changes.

Scott D. Peckham

INSTAAR Fellow. PhD: 1995, University of Colorado at Boulder.
Specialty: Surface water hydrology, geomorphology, scaling analysis, and mathematical modeling.
Research Interests: Physically based mathematical and numerical modeling of watershed-scale hydrologic systems, source-to-sink sediment transport, scaling analysis, river networks, theoretical geomorphology, grid-based computational methods, efficient computer algorithms, and fluvial landscape evolution models.

W. Tad Pfeffer

Fellow of INSTAAR; Associate Professor of Civil, Environmental and Architectural Engineering, University of Colorado at Boulder. PhD: 1987, University of Washington.
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.

Tim R. Seastedt

Fellow of INSTAAR; Professor of Ecology and Evolutionary Biology, University of Colorado at Boulder. PhD: 1979, University of Georgia.
Specialty: Terrestrial ecosystems and biogeochemistry.
Research Interests: Biotic interactions with physical and chemical properties of the environment to control patterns of energy flow and material cycling. Emphasis is placed on soil phenomena, particularly those of grassland and tundra ecosystems.

Robert F. Stallard

Fellow of INSTAAR; Research Hydrologist of the U.S. Geological Survey. PhD: 1980, MIT-WHOI.
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

Fellow and Director of INSTAAR; Professor of Geological Sciences, University of Colorado at Boulder. PhD: 1978, University of British Columbia (1) Geological Sciences, 1st class, (2) Oceanography, 1st Class.
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

Fellow and Associate Director of INSTAAR; Associate Professor of Ecology and Evolutionary Biology, University of Colorado at Boulder. PhD: 1994, Stanford University.
Specialty: Biogeochemistry/ ecosystem ecology.
Research Interests: Carbon and nitrogen dynamics at regional to global scales; phosphorus controls over C and N in moist tropical systems; nutrient controls over soil carbon storage; human health effects of a changing N cycle.

James W. C. White

Fellow of INSTAAR; Professor of Geological Sciences, Director of the Environmental Studies Program, University of Colorado at Boulder. 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

Fellow of INSTAAR; Professor of Geography, University of Colorado at Boulder. PhD: 1991, University of California, Santa Barbara.
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.

Connie A. Woodhouse

INSTAAR Affiliate; Associate Professor, Department of Geography & Regional Development, University of Arizona. 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-term 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.

A group of INSTAAR Directorate members, March 2007. Photo: Tad Pfeffer (INSTAAR).

INSTAAR Affiliates

Ecosystems

Richard Boyce
Department of Biological Sciences, Northern Kentucky University. PhD: 1990, Yale University. Plant physiological ecology.

Paul Brooks
Assistant Professor, Hydrology and Water Resources, University of Arizona. PhD: 1995, University of Colorado at Boulder. Biogeochemical cycling of carbon and nutrients, hydrological linkages between terrestrial and aquatic systems, effects of disturbance on natural systems.

Jeff Connor
Natural Resources Specialist, National Park Service, Rocky Mountain National Park. BA: 1976, Bard College. Invasive exotic plant and animal management, high-elevation vegetation restoration, avian species monitoring, recreational impact monitoring and mitigation, burn area emergency rehab, wildlife and vegetation management.

Hector Galbraith
CEO, Galbraith Environmental Sciences, Boulder, CO. PhD: 1986, Glasgow University. Anthropogenic disturbances and arctic/alpine bird and plant communities.

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.

Scott Munro (on left; Toronto University) introduces Vladimir Konovalov (INSTAAR Affiliate, Hydrometeorological Institute, Republic of Uzbekistan) before his lecture at the Department of Geography, Toronto University, Canada, September 2006.

Timothy Kittel
Natural Resource Ecology Laboratory, Colorado State University. PhD: 1986, University of California, Davis. Ecological response to climate variability at interannual through centennial time scales.

James R. McGoodwin
Department of Anthropology, University of Colorado at Boulder. PhD: 1973, University of Texas. Fisheries, marine and environmental policy; human responses to climatic and environmental variability and change.

Amy Miller
Institute for Computational Earth Systems Science, University of California–Santa Barbara. PhD: 2002, University of Colorado at Boulder. Plant physiological ecology/ecosystem ecology, uptake of organic and inorganic nitrogen by alpine tundra plants.

Cynthia Nevison
National Center for Atmospheric Research (NCAR). PhD: Stanford University. Ocean nitrogen cycle, nitrous oxide budget, carbon-nitrogen biogeochemistry, stratosphere-troposphere interactions.

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

Sarah Spaulding
Research Associate, California Academy of Sciences. PhD: 1996, Colorado State University. Environmental, geologic, and evolutionary change through paleoecology, systematics, and biogeography of freshwater diatoms.

Heidi Steltzer
Postdoctoral Research Scientist, Department of Forest Sciences, Colorado State University. PhD: 1999, University of Colorado at Boulder. Ecosystem development, nutrient retention, and scaling plant effects.

Howard E. Taylor
Research Chemist and Project Chief, Environmental Analytical Chemistry and Water Quality Project, National Research Program, Water Resources Division, U.S. Geological Survey, Boulder, CO. PhD: 1970, Colorado State University. Water chemistry and trace element analysis.

Andrew Todd
Aquatic specialist, Trout Unlimited. PhD: 2005, University of Colorado at Boulder. Biogeochemistry, stream ecology, and human use.

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
Regis University, Denver, Colorado. PhD: 1993, University of Colorado at Boulder. Glaciology and computer science.

Gary Clow
Chief, Cryospheric Studies Project, U.S. Geological Survey, Earth Surface Dynamics program, Denver Federal Center. Climate observing systems, permafrost, borehole paleothermometry, climate modeling.

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

Aslaug Geirsdottir
Chairman, Department of Geosciences, University of Iceland. PhD: 1988, University of Colorado at Boulder. Glacial geology, sedimentology, quaternary stratigraphy, paleoclimate.

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

Vladimir G. Konovalov
Chief, Department of Regional Projects, Central Asian Regional Research, Hydrometeorological Institute, Republic of Uzbekistan. PhD: 1964, Leningrad State University, USSR; 1983, USSR Academy of Sciences, Irkutsk, USSR. Glaciology and hydrometeorology.

Irina Overeem
Assistant Professor, Delft University of Technology. PhD: 2002, Delft University of Technology. Testing fluviodeltaic models, sediment supplies in Arctic coastal zones, large river systems in monsoonal settings.

Scott Peckham
CEO of Rivix. PhD: 1995, University of Colorado at Boulder. Surface water hydrology, geomorphology, scaling analysis, and mathematical modeling.

John Pitlick
Assistant 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.

Rajiv Sinha (Indian Institute of Technology) and Irina Overeem (INSTAAR Affiliate, Delft University of Technology) visit a dike in the Ganges River delta, India, December 2006. Sinha and Overeem are collaborators in a joint Indo-U.S. project, "Large river systems in monsoonal settings: response to climate change." Photo: H. Reinink (Delft University of Technology).

Past Global Change

Lesleigh Anderson
Research Geologist, U.S. Geological Survey, Earth Surface Processes, Denver Federal Center. PhD: 2005, University of Massachusetts Amherst. Paleolimnology, oxygen and carbon isotope geochemistry, Holocene paleoclimate and paleohydrology in Alaska, Yukon, and the western U.S.

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

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

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

Walter Dean
Mississippi Basin Carbon Project, Branch of Regional Geochemistry, Research Geologist, U.S. Geological Survey. PhD: 1967, University of New Mexico. Holocene Climates of the Pacific Coasts Project.

Dennis Eberl
Hydrologist, Project Chief, U.S. Geological Survey, Boulder. PhD: 1971, Case Western Reserve University. Geochemistry, clay mineralogy, X-ray diffraction, crystal growth.

Áslaug Geirsdottir
Chairman, Department of Geosciences, University of Iceland. PhD: 1988, University of Colorado at Boulder. Glacial geology, sedimentology, quaternary stratigraphy, paleoclimate.

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

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.

Owen Mason
Research Associate, GeoArch Alaska. PhD: 1990, University of Alaska, Fairbanks. Coastal geomorphology, geoarchaeology, northwest Alaska prehistory.

Gregory McCabe
Physical Scientist, U.S. Geological Survey, Denver, CO. PhD: 1986, Louisiana State University. Hydroclimatic processes and 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, CO. 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.

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

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.

Robert S. Webb
Physical Scientist, NOAA Climate Diagnostics Center, Boulder, Colorado. PhD: 1981, Brown University. 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 past climate and environmental change.

Alexander P. Wolfe
Associate Professor, Department of Earth & Atmospheric Sciences, University of Alberta. PhD: 1994, Queen's University. Paleolimnology, freshwater diatoms, environmental change as registered in the sediments of arctic and alpine lakes.

Connie Woodhouse
Associate Professor, Department of Geography & Regional Development, University of Arizona. Ph.D.: 1996, University of Arizona. Paleoclimatology, dendrochronology, climatology.

INSTAAR Visiting Scientists, 2005–2006

Dr. Áslaug Geirsdóttir
University of Iceland.
Host: Gifford Miller.

Dr. Yu'suke Kubo
University of Tokyo.
Host: James Syvitski

Dr. Daekyo Cheong
Kangwon National University.
Host: Irina Overeem.

Dr. Snehalata Huzurbazar
University of Wyoming.
Host: Tad Pfeffer.

Dr. Hans Petter Sejrup
University of Bergen.
Hosts: John Andrews and Gifford Miller.

Postdoctoral Research Scientists

Nichole Barger
PhD: 2003, Colorado State University. Nutrient cycling in arid ecosystems and the use of dendrochronological techniques to examine piñon-juniper woodland expansion in the western U.S.

Cory Cleveland
PhD: 2001, University of Colorado at Boulder. Terrestrial biogeochemistry and microbial ecology.

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

Jacqueline Flückiger
PhD: 2003, University of Bern, Switzerland. Modeling the dynamics of glacial climate change.

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

Mark Kessler
PhD: 2002, Scripps Institution of Oceanography–University of California, San Diego. Geomorphology, modeling pattern formation in natural systems.

Hans-Peter Marshall
PhD: 2005, University of Colorado at Boulder. Glaciology, snowpack variability, remote sensing, snow slope stability.

Natalie Mladenov
PhD: 2004, University of Colorado at Boulder. Aquatic ecology, organic matter cycling in streams and wetlands, and savanna ecohydrology.

Natalie Mladenov (INSTAAR) demonstrates fluorescence of liquids to a group of students from Southern Hills Middle School, INSTAAR Open House, April 2006. Photo: Casey A. Cass (University of Colorado).

Senior Research and Professional Scientists and Research Support Personnel

Senior Research Scientist

Chris Jenkins
PhD, Cambridge, UK. *Research interests:* Marine geosciences, seabed information processing and mapping, development of Geographic Information System (GIS) visualizations and rule-based GIS expert systems.

Professional Scientists and Research Support Personnel

Todd Ackerman
Primary Duties: LTER data and information management. *Research Interests:* Data management and information technology. *Supervisor:* Tim Seastedt.

Henry Adams
Primary Duties: Tree-ring sample collection, preparation, dating, measurement, and quality-control analysis. *Research Interests:* Dendroecology, effects of climate change on forests, tree ecophysiology. *Supervisor:* Connie Woodhouse.

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:* Connie Woodhouse.

Jacques Hueber (INSTAAR) climbing the jackstaff tower of the NOAA research vessel *Ron Brown* for installation of a new ozone flux experiment, Charleston, SC, July 2006. Photo: Ludovic Bariteau (CIRES/NOAA ESRL).

Florence Bocquet
Primary Duties: Assistant laboratory manager of the Atmospheric Research Laboratory. Development, testing, and application of analytical tools for field measurements. *Research Interests:* Arctic/Antarctic snow-atmosphere gas exchange. *Supervisor:* Detlev Helmig.

Tara Chesley
Primary Duties: Hydrogen and oxygen isotope analysis in water. *Supervisor:* Bruce Vaughn.

Kurt Chowanski
Primary Duties: Maintaining and operating instruments measuring total dissolved nitrogen and carbon. *Research Interests:* Dissolved organic matter. *Supervisor:* Mark Williams.

Stephen DeVogel
Primary Duties: Laboratory manager, Amino Acid Lab. *Supervisor:* Gifford Miller.

Allison Drake
Primary Duties: Isotopic analysis in greenhouse gases, paleoclimate modeling. *Supervisor:* Bruce Vaughn.

Mark Dreier
Primary Duties: Assistant laboratory manager in Stable Isotope Laboratory. Provide technical expertise with the hardware, develop new systems, maintain old systems, and rebuild mass spectrometers and vacuum pumps. *Supervisor:* Bruce Vaughn.

Sylvia Englund
Primary Duties: Isotopic analysis in greenhouse gases. *Research Interests:* Stable isotopes in atmospheric carbon dioxide and methane. Changes in biogeochemical cycles caused by invasive species. *Supervisor:* Bruce Vaughn.

Rhea Esposito
Primary Duties: Assisting with scientific paper preparation. *Research Interests:* Antarctic diatoms. *Supervisor:* Sarah Spaulding.

Jacques Hueber
Primary Duties: Development of instrumentation for atmospheric measurements. Non-methane hydrocarbon measurements from NOAA greenhouse gas network flasks. *Supervisor:* Detlev Helmig.

Eric Hutton
Primary Duties: Maintain and develop numerical models that predict the spatial and temporal distribution of marine sediments. *Research Interests:* Sediment transport, computational fluid dynamics, and geophysics. *Supervisor:* Scott Peckham.

Chris Jaros
Supervisor: Diane McKnight.

Albert Kettner
Primary Duties: Develop numerical code of hydrological process model HYDROTREND, develop and maintain web-based GIS applications, collect paleoclimate data for scenario modeling (Geo clutter project). *Research Interests:* Programming and GIS applied to Earth science issues. *Supervisor:* James Syvitski.

Richard Kraemer
Primary Duties: Stable isotopes in atmospheric methane. *Research Interests:* Stable isotopes in atmospheric methane and the biological sources. *Supervisor:* James White.

Mark Losleben
Primary Duties: Long-term climatic database management, atmospheric and precipitation measurements. *Research Interests:* Long-term climatic trends and related processes effecting Niwot Ridge. *Supervisor:* Bill 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.

Eric Parrish
Primary Duties: Create graphics and GIS-based products, information, and image management, scientific illustration, and support. *Research Interests:* Scientific illustration, ArcGIS, remote sensing and graphic software applications. *Supervisor:* E. James Dixon.

Jan Pollmann
Primary Duties: Quantification of anthropogenic and biogenic volatile organic compounds using gas chromatography techniques. *Research Interests:* Anthropogenic and biogenic trace gas sources and their measurement. *Supervisor:* Detlev Helmig.

Christine Seibold
Primary Duties: Environmental Chemistry Laboratory Manager. *Research Interests:* Long-term ecological research chemistries. *Supervisor:* Tim Seastedt.

Steve Seibold
Primary Duties: Manager, Mountain Research Station. *Supervisor:* Bill Bowman.

David Tanner
Primary Duties: Instrument development, atmospheric measurements, field site research. Maintenance of existing instruments. *Supervisor:* Detlev Helmig.

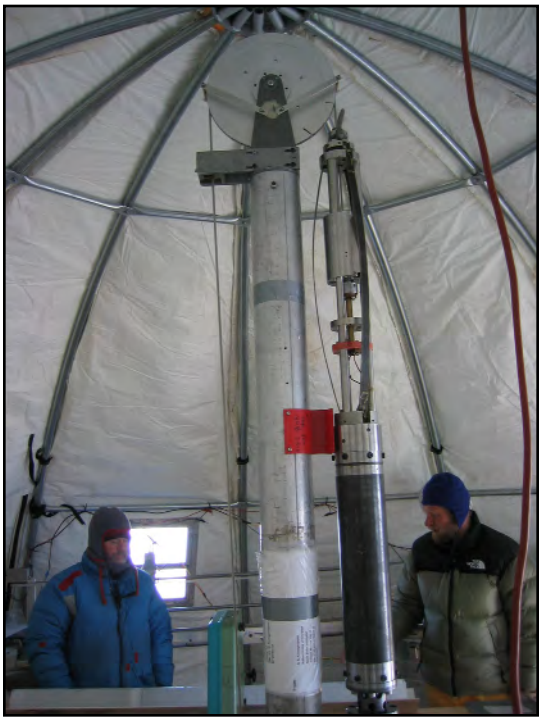
Jocelyn Turnbull
Primary Duties: Management of Laboratory for AMS Radiocarbon Preparation and Research, which provides radiocarbon dating services to the NSF-ESH community as well as in-house research. *Research Interests:* Improved radiocarbon dating techniques. *Supervisor:* Scott Lehman.

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

Bruce Vaughn
Primary Duties: Oversight of the operation of the Stable Isotope Lab, which performs isotopic analyses on atmospheric CO_2, CH_4, polar ice cores, water, and organic materials. The facility is comprised of several labs, and houses multiple prep systems, offline extraction systems, computing facilities, and six mass spectrometers. *Research Interests:* Collaborative isotopic studies in ice cores, glaciers, atmospheric gases, and global change in general. *Supervisor:* Jim White.

Kris White
Primary Duties: Research assistant providing support to Townsend and White for the Carbon, Climate, and Society Initiative IGERT Program. *Supervisor:* Alan Townsend.

Chad Wolak
Primary Duties: Laboratory manager, Sediment Geochemistry Lab. *Research Interests:* Climate reconstruction using alkenone-derived sea-surface temperatures. *Supervisor:* Scott Lehman.



J. P. Steffensen (University of Copenhagen) and Bruce Vaughn (INSTAAR) inspect the ice core drill on top of Flade Isblink, a small ice cap at 81°N in NE Greenland, summer 2006. This collaborative project with the Niels Bohr Institute at the University of Copenhagen tested new drilling fluids for use in the upcoming IPY-NEEM deep drilling, as well as obtaining an ice record to see if this small isolated ice cap survived the Holocene climatic optimum. Photo: Simon Sheldon (University of Copenhagen).

Administrative, Classified, Computer, Editorial, and Library Staff

Larry Bowlds
Managing Editor of INSTAAR's interdisciplinary journal: *Arctic, Antarctic, and Alpine Research* (AAAR).

Kathryn Clegg
Accounting Technician III, provides grants and contract management.

Mary Fentress
Accounting Technician III, provides grants and contract management.

Sedrick Frazier
Accounting Technician III, provides grants and contract management.

Jenifer Hall-Bowman
Administrative Assistant II, provides assistance for Journal and Information Center.

Courtney Hoskins
Administrative Assistant II, provides administrative support for the Institute.

Julie Hughes
Chief Financial Officer, acts as main financial officer for the institute and its faculty.

Marcia Kelly
Executive Assistant to Director, provides administrative support to the Director of the Institute, the Chief Financial Officer, Institute Committees, and Institute Members.

David Lubinski
Webmaster (part-time).

Vicky Nelson
Assistant to Director, provides administrative support to the Director of the Institute, the Chief Financial Officer, Institute Committees, and Institute Members.

Wendy Roth
Sediment Lab Coordinator.

Shelly Sommer
Manager of INSTAAR's Information Center.

Chad Stoffel
System/Network Administrator.

Overview of plateau country with ice patches in the distance, south-central Montana, August 2006. The haze is a result of fires in the Pacific Northwest. Photo: Craig Lee (INSTAAR).

INSTAAR Noon Seminars

Spring 2005

Tad Pfeffer, INSTAAR Associate Director, Institute Meeting.

Detlev Helmig, INSTAAR, "Ozone smog at South Pole? New data from a tethered balloon experiment reveal unexpected atmospheric chemistry in the Antarctic troposphere."

William Bowman, INSTAAR, "Are we there yet? Critical N loads for alpine vegetation and ecosystem response."

Jacqueline Flückiger, INSTAAR, "Modeling glacial climate: bipolar seesaw and the ocean as a trigger for Heinrich Events."

Robert F. Stallard, INSTAAR and U.S. Geological Survey, "Rapid hydrologic assessment: topical tropical examples."

Elena Yakimenko, former research scientist at the Institute of Geography, Russian Academy of Sciences, Moscow, "Pleistocene stratigraphy of the East European Plain: paleoreconstructions and controversies."

Raimund Muscheler, NCAR, "Cosmogenic radionuclide records—rich sources of information about climate changes and its causes."

Bill Manley, INSTAAR, "Advanced geospatial visualizations and data sharing for Arctic science."

Jerry Meehl, NCAR, "Future climate change: the IPCC process and results from global coupled climate models."

Astrid Ogilvie, INSTAAR, "The fish can sing: cod, climate and currents in Icelandic waters from the settlement to the future."

Paul Goldberg, Boston University, "Cave sediments and humans."

Áslaug Geirsdóttir, University of Iceland, "Now you see it, now you don't: Holocene glacier and climate variability in Iceland."

Bette Otto-Bliesner, NCAR, "Glacial climates and abrupt climate change: results from global coupled climate models."

Fall 2005

James Syvitski, INSTAAR Director, INSTAAR General Meeting.

Scott Peckham, INSTAAR, "Hydrologic modeling and terrain: advances in computational and visualization methods."

Jim White, INSTAAR, "Have humans really messed with methane for 2000 years?"

Robbie Toggweiler, GFDL/NOAA, Princeton, "Origin of the 100,000-yr cycle in atmospheric CO_2."

Jean-Pierre Gattuso, Laboratoire d'Océanographie de Villefranche sur mer, France, "Response of marine ecosystems to elevated carbon dioxide and biogeochemical consequences."

Irina Overeem, INSTAAR, "Numerical modeling of the impact of an enhanced monsoon on the Ganges-Brahmaputra river system."

Cory Cleveland, INSTAAR, "Nutrient controls over C cycling in tropical rain forests."

John Hoffecker, INSTAAR, "Climate change, vulcanism, and the dispersal of modern humans in Europe: the view from Kostenki."

Fortunat Joos, Climate and Environmental Physics, University of Bern, "Climate–carbon cycle interactions."

Scott Lehman, INSTAAR, "Response of Norwegian sea surface and air temperature to solar forcing."

Reto Knutti, NCAR, "Uncertainty in projections of future climate."

Pilots perform last-minute checks before flying INSTAAR researchers to the center of Flade Isblink, a small ice cap at 81°N in NE Greenland, summer 2006. There, along with colleagues from the University of Copenhagen, they obtained an ice core and surface radar profiles. Photo: Bruce Vaughn (INSTAAR).

Sarah Spaulding, U.S. Geological Survey, Denver, "Report on algae in streams in North America: diatoms are behaving badly."

Hans-Peter Marshall, INSTAAR, "Snowpack spatial variability: towards understanding its effect on remote sensing measurements and snow slope stability."

Spring 2006

James Syvitski, INSTAAR Director, Institute Meeting.

Jeff Connor, National Park Service, "The political realities of integrating research results into land management decisions: suggestions on how to effectively present your results in a meaningful way to land managers."

Lesleigh Anderson, U.S. Geological Survey, Denver, "North Pacific atmospheric circulation change and effective moisture variability in the Yukon Territory, Canada."

Erin Pettit, University of Washington, "A year in the life of a polar glacier."

Eugene Kelly, Colorado State University, "The biogeochemistry of silica in grassland ecosystems of North America."

Detlev Helmig, INSTAAR, "Where does all the dirty air go?" Insights from INSTAAR's research at the PICO-NARE (Azores/Portugal) observatory.

Walter Dean, U.S. Geological Survey, Denver, "Sediment geochemical records of productivity and oxygen depletion along the margin of western North America during the past 20,000 years: teleconnections with the Atlantic and Caribbean."

Pieter Tans, NOAA, "Can we still avoid major climate change caused by humans?"

John Behrendt, INSTAAR, "Subglacial volcanism revealed by aerogeophysical surveys over the West Antarctic Ice Sheet (WAIS)—comparisons with Iceland."

Alexander Kirdyanov, V.N. Sukachev Institute of Forest, Siberian Branch of Russian Academy of Sciences, "Tree-ring related studies in Siberia (Russia): state of the art and prospects."

Cynthia Nevison, NCAR, "Oceanic fluxes and their influence on seasonal and interannual variability in atmospheric CO_2, O_2/N_2 and N_2O."

Connie Woodhouse, NOAA, INSTAAR, "Dendrohydrology: research to applications."

Dennis Darby, Old Dominion University, "Healy-Oden Trans-Arctic Expedition (HOTRAX) and preliminary results."

Carrie Morrill, NOAA/CIRES, "Testing the North Atlantic freshwater forcing hypothesis of abrupt climate change."

Ingrid Hendy, University of Michigan, "Catastrophic collapse of the Cordilleran ice sheet during the last glacial."

Fall 2006

James Syvitski, INSTAAR, INSTAAR Institute Meeting.

David Lawrence, National Center for Atmospheric Research, "A projection of severe near-surface permafrost degradation in a global climate model: implications for global climate change feedbacks."

Andrew G. Fountain, Departments of Geology and Geography, Portland State University, "Historic glacier changes in the American West."

Dennis D. Eberl, U.S. Geological Survey, "Tales of quantitative mineral analysis: application to geological problems."

Diane McKnight, INSTAAR, "Glacial meltwater streams in the McMurdo Dry Valleys, Antarctica: ecosystems waiting for water."

Andrew Todd, Trout Unlimited, "Effects of acid rock drainage on stocked rainbow trout (*Oncorhynchus mykiss*): an in situ, caged fish experiment."

Hans-Peter Marshall, INSTAAR, "Spatial variability of the snowpack: experiences with measurements at a wide range of length scales with several different high precision instruments."

Patric DeDecker, Department of Earth and Marine Sciences, The Australian National University. "Preliminary findings on the geochemical and microbiological fingerprinting of Australian aeolian dust: Implications for (past) climates, the environment, health and the oceans."

Thomas Ager, U.S. Geological Survey, "Ecosystem history of southeastern and south-central Alaska."

Mark Hernandez, Environmental Engineering, University of Colorado at Boulder, "Source tracking of airborne microorganisms."

Stave Leavitt, University of Arizona, "CO_2 and tree rings: influence on water-use efficiency and tree growth."

Graduate Student Talks

Spring 2005

Ryan Vachon, INSTAAR, "The reality of high-altitude ice coring."

Dan Liptzin, INSTAAR, "Nutrient dynamics in the forest-tundra ecotone, Niwot Ridge."

Jessica Black, INSTAAR, "Sinking by iceberg, a hair-raising tale of survival on a barge, in the midst of a swarm of icebergs... (or — Holocene history of Hvitarvatn, Iceland)."

Kenneth Mack, INSTAAR, "A quick overview of a 5-box model for δ^{13}C-CH_4 data to constrain methane source estimates."

Jocelyn Turnbull, INSTAAR, "Science, sushi and the stratosphere: all about my summer doing science in Japan on an NSF fellowship."

Nataly Ascarrunz, INSTAAR, "Precipitation effects on soil biogeochemistry: moving dirt around eastern Bolivia."

Florence Bocquet, INSTAAR, "Air-snow interactions: Summit, Greenland and Niwot Ridge, Colorado. Two different places in the world, two different stories."

Annalisa Schilla, INSTAAR, "Climate insights from the Siple Dome Ice Core."

Rose Cory and Chris Jaros, INSTAAR, "Pony Lake, Cape Royds, Ross Island, Antarctica: interested in a chance-of-a-lifetime time-share opportunity?"

Tara Chesley, INSTAAR, "Mineralogy, sediment, and foraminiferal history of Djúpáll, Iceland: reconstructing a past record."

John Hollin, INSTAAR, "Glaciological expeditions to North East Land, Spitsbergen, in 1951 and 1955."

Dan Cordalis, INSTAAR, "Mountain hydrology: using environmental isotopes to characterize sources and flowpaths of acid mine drainage."

Yarrow Axford, INSTAAR, "Warm times in the Arctic: using lake sediments to reconstruct past temperatures on Iceland and Baffin Island."

Fall 2005

Rhea Esposito and Shannon Horn, INSTAAR, "Community assemblage and endemism in Dry Valley stream diatoms: two facets of diatom response to climate change."

Tiffany Duhl, INSTAAR, "Uptake and emission of biogenic volatile organic compounds (VOC) by plants."

Paul Abood, INSTAAR, "A deposition discussion: issues surrounding atmospheric inorganic N deposition measurement."

Craig Anderson, INSTAAR, "Modeling spatially distributed snowpack properties to enhance our understanding of snow-elk relationships in the Northern Elk Winter Range, Yellowstone National Park."

Lana Cohen, INSTAAR, "Science at the Summit: year-round investigations at the Greenland Environmental Observatory (GEOSummit)."

Maureen Mason, INSTAAR, "Knickpoint migration on the Roan Plateau, Colorado."

Ursula Rick, INSTAAR, "Meltwater movement on the Greenland Ice Sheet."

Aurelie Justwan, Norsk Polarinstitutt, "Variability of the Irminger Current during the Holocene."

Shad O'Neel, INSTAAR, "Complete carnage at Columbia Glacier: iceberg calving and fast flow... What are we learning?"

Jan Pollmannn, INSTAAR, "The tale of atmospheric hydrocarbons: what do we know, what do we not know and why do we care?"

Dylan Ward, INSTAAR, "The use of cosmogenic radionuclides in stratigraphy: application to the Nenana Gravel, Alaska Range."

Duane White, INSTAAR, "Big glaciers, limited erosion: constraining the Pleistocene history of the Lambert Glacier, East Antarctica with cosmogenic exposure ages."

Trevor Popp and Shad O'Neel, INSTAAR, Practice talks for AGU.

Rebecca Anderson (INSTAAR, left) and Dale Hess (University of Buffalo) look ahead to the road back to the cabin after a day of field work on northern Baffin Island, April 2006. Photo: J. Briner (University of Buffalo).

Field crew during typical windy conditions for the annual snow survey for the Niwot Ridge LTER project, Green Lakes Valley, Colorado, Spring 2006. Continental divide in the background. The snow survey was featured in Bruce Sturtz's 2006 book *Chasing Spring*. The field crew consisted of CU undergraduate and graduate students, along with NWT LTER field personnel. Photo: Mark Williams (INSTAAR).

Spring 2006

Henry Adams and Jeff Lukas, INSTAAR, "Boring trees, interesting science: adventures in dendrochronology in the semi-arid West."

Adina Racoviteanu, INSTAAR, "The SPOT5-derived glacier inventory of Cordillera Blanca, Peru: a contribution to the GLIMS Glacier Database."

Jessica Black, INSTAAR, "Diatoms as proxies for a fluctuation Holocene ice cap margin in Hvítárvatn, Iceland."

Rebecca Anderson, INSTAAR, "Ice cap retreat in northern Baffin Island: providing a context for current Arctic warming."

Colleen Flanagan, INSTAAR, "Climate variability and phytoplankton community composition in an alpine lake, Colorado."

John Behrendt, INSTAAR, "Innocents on the Ice: a young grad student's oversnow traverses in Antarctica during the IGY era."

Craig Lee, INSTAAR, "Ice patch archeology: the global phenomena and the need for focused surveys in the Rocky Mountain West."

Zach Guido, INSTAAR, "LGM glacier retreat rates and the timing of terrace formation in the Animas River drainage, San Juan Mountains, Colorado."

Tad Pfeffer, INSTAAR, "How to write a fundable proposal."

Trevor Popp, INSTAAR, "An ice chorus: paleoclimate results from Greenland and Antarctica ice cores and a look to the future."

Cynthia Cacy, INSTAAR, "Chemical weathering in loess soils of the Matanuska Valley, Alaska."

Ken MacClune, INSTAAR, "The atmospheric methane source: on the decline in the 21st century."

Sean Bryan, INSTAAR, "Conversations with forams: interpreting past ocean conditions."

James Syvitski, INSTAAR Director, "How to be successful in science."

Fall 2006

Jan Pollman, INSTAAR, "Evaluation and measurements of the global distribution of hydrocarbons."

Ursula Rick and Maureen Berlin, INSTAAR, "How to get funding as a graduate student and beyond."

John Hollin, INSTAAR, "Film footage of Wilkes Station, Antarctica in the International Geophysical Year, 1958."

Tim Bartholomaus, INSTAAR, "Glacier sliding and subglacial water pressures: Kennicott Glacier's response to the 2006 Hidden Creek Lake Jökulhaup (a summer in the Wrangell Mountains, Alaska)."

Sean Bryan, INSTAAR, "Searching for Earth's past climate in old mud: the process of deep sea sediment coring."

Kaelin Cawley, INSTAAR, "Biogeochemical and ecological consequences of dissolved organic carbon released from soot particles from global firestorms at the Cretaceous/Tertiary boundary: Was the Strangelove Ocean a blackwater ocean?"

Florence Bocquet, INSTAAR, "Ozone exchange at the air-snow interface at the polar site of Summit, Greenland."

Susan Riggins, INSTAAR, "Regolith development in alpine landscapes: Osborn Mountain, Wyoming and Niwot Ridge, Colorado."

Rebecca Anderson, INSTAAR, "Rapidly melting ice caps of northern Baffin Island: insights from satellite imagery, cosmogenic and conventional radiocarbon dating."

Brian Seok, INSTAAR, "Improving our understanding of trace gas transport mechanisms through the snowpack."

Tiffany Duhl, INSTAAR, "The development of a low-cost, technologically modest method for determining urban fractional vegetation cover and type for use in urban air quality models."

Jessica Black, INSTAAR, "Diatoms as proxies for a fluctuating Holocene ice cap margin in Hvitarvatn, Iceland."

Journal and Books

Arctic, Antarctic, and Alpine Research

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

Suzanne Anderson and Anne Jennings were the Editors of the journal. Larry Bowlds was the Managing Editor, assisted by Jenifer Hall-Bowman. The Book Review Editor was James Dixon. At the end of 2006, Suzanne Anderson resigned and was replaced by William Bowman.

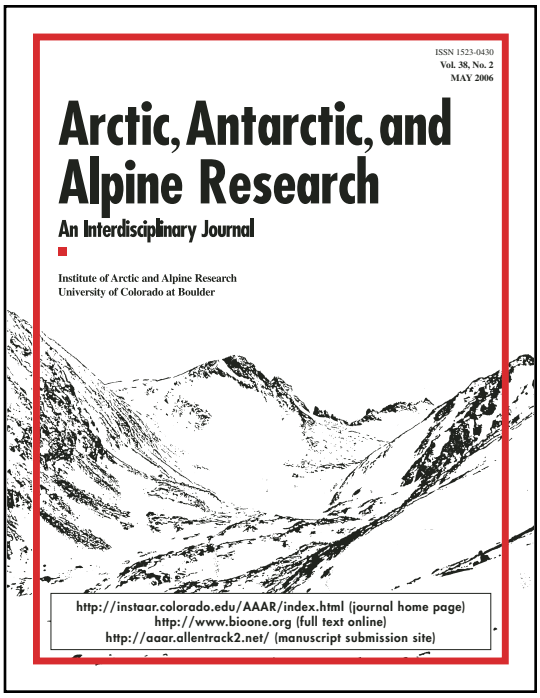
The old Editorial Board, composed of INSTAAR and University of Colorado faculty, was disbanded and replaced by a new Editorial Board, composed of the Editors, the Managing Editor, 11 Associate Editors (from the University of Colorado, elsewhere in the United States, Canada, and the United Kingdom), and the Book Review Editor. The international Interdisciplinary Board also was disbanded. Peer reviewers are selected by the Associate Editors. The Editors make final decisions on all papers.

During 2005, 106 papers were submitted to the journal, the same number as in 2004. Volume 37 (2005) contained 644 pages. First authors from 19 countries produced 73 research papers, including 26 from the United States; 6 from the United Kingdom; 5 from Canada; 4 each from China and Switzerland; 3 each from Australia, Finland, Germany, and Norway; 2 each from Austria, France, India, Japan, Spain, and Sweden; and 1 each from the Czech Republic, Denmark, Italy, and the Netherlands.

During 2006, 141 papers were submitted to the journal, an increase of 33% from 2005. Volume 38 (2006) contained 641 pages. First authors from 20 countries produced 69 research papers, including 18 from the United States; 10 from Canada; 7 from the United Kingdom; 4 from Denmark; 3 each from Australia, Austria, Sweden, and Switzerland; 2 each from Chile, China, the Czech Republic, Italy, Japan, and Norway; and 1 each from Germany, Iceland, Poland, the Republic of Georgia, South Africa, and Spain.

Subscriber numbers remained fairly constant. About 700 copies of each issue were distributed to subscribers (libraries, individuals, and students), exchange partners, and others.

Arctic, Antarctic, *and Alpine Research* has an impact factor of 1.045. (An impact factor is the ratio of citations of recent articles to the number of recently published articles.) It was ranked number 17 out of 30 in the Physical Geography category and number 76 out of 140 in the Environmental Sciences category in Institute of Scientific Information's Journal of Citation Reports (2005).



The journal has a dedicated web site (http://instaar.colorado.edu/AAAR/index.html) that includes general information about the journal, contents and abstracts from 1996 to the present, instructions for manuscript submission, and subscription information. Full text from 2003 to the present is available online at BioOne (http://www.bioone.org) through institutional subscriptions. Full text from 1969 to 2003 is available at JSTOR (http://www.JSTOR.org) through institutional subscriptions. During 2006, the journal became available as full text on EBSCOhost (http://search.epnet.com/), a subscription service for academic libraries. Late in 2006, the journal began working with MetaPress to establish a stand-alone web site for full text access. The site is expected to become active during the first half of 2007, and this will permit the journal to offer online as well as print subscriptions for the first time.

Occasional Papers

INSTAAR also publishes an irregular monograph series, the Occasional Papers. This series is a miscellaneous collection of reports and papers on work performed by INSTAAR personnel and their associates that is generally too long or too data intensive for publication in research journals. Occasional Paper No. 57, *Water Quality Characteristics for the Snake River, Peru Creek, and Deer Creek in Summit County, Colorado: 2001 to 2002*, by Andrew S. Todd, Diane M. McKnight, and Sabre M. Duren, was published in 2005. Occasional Paper 58, *Glaciers and the Changing Earth System: a 2004 Snapshot*, by Mark B. Dyurgerov and Mark F. Meier, was also published in 2005.

INSTAAR Information Center

The Information Center is the specialized science library of INSTAAR. It is a unique, focused collection of materials, information resources, and services that forwards INSTAAR research. Main subject areas include climatic change, ecology, earth sciences, the Quaternary, and cold regions.

The collection of print materials includes books, journals, reports, theses, and reprints of faculty publications. A computer in the Information Center provides access to an online catalog of all materials in the collection, the bibliographic database Arctic & Antarctic Regions, and the wide-ranging resources of the CU Boulder library system. The Information Center web site at http://instaar.colorado.edu/other/info_center coordinates available information sources, including journals held in the Information Center, INSTAAR theses and other publications, electronic journals, bibliographic databases, data clearinghouses, and web resources.

Library services include help with research requests and searching techniques; retrieval of information sources; and individual and group instruction in effective online searching, catalog and database use, interlibrary loan, and other topics.

The Information Center room provides study areas and a place for group discussions and meetings.

Shelly Sommer manages the Information Center, assisted by Jenifer Hall-Bowman.

Librarian Shelly Sommer, updating the Information Center web page. Photo: Tad Pfeffer

A photo of the INSTAAR Information Center, taken for a paper Shelly Sommer gave in collaboration with the National Snow and Ice Data Center Library at the Polar Libraries Colloquy, Rome, May 2006. Photo: Shelly Sommer (INSTAAR).

Shelly Sommer (INSTAAR) discusses the science of maps and mapmaking to a group of visiting students from Southern Hills Middle School, INSTAAR Open House, May 2005.

Publications

2005

Adams, P. N., Storlazzi, C. D., and **Anderson, R. S.**, 2005: Nearshore wave-induced cyclical flexing of seacliffs. *Journal of Geophysical Research–Earth Surface,* 110 (F2): article F02002. doi:10.1029/2004JF000217.

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Chris Jenkins (right, INSTAAR) sniffs a gassy mud sample with Thomas Wever (FWG, Kiel), Baltic Sea, February 2006. Jenkins was taking part in engineering tests for the German Navy and U.S. Office of Naval Research to help calibrate models of how dropped objects bury themselves into soft seafloors. These models will help locate the thousands of mines still buried in the Baltic Sea from the World Wars as well as future port security. Photo: Chris Jenkins (INSTAAR).

Stern view of FS *Planet,* a twin-hulled semisubmersible vessel, Baltic Sea, February 2006. Chris Jenkins (INSTAAR) was taking part in engineering tests for the German Navy and U.S. Office of Naval Research to help calibrate models of how dropped objects bury themselves into soft sea-floors. These models will help locate the thousands of mines still buried in the Baltic Sea from the World Wars as well as future port security. Photo: Chris Jenkins (INSTAAR).

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E. James Dixon (left, INSTAAR) and William Harrison (right, University of Alaska Geophysical Institute) steam drilling to measure the thickness of a small glacier, or "ice patch," Wrangell-St. Elias National Park and Preserve, Alaska, July 2006. Photo: E. James Dixon (INSTAAR).

Bob Anderson (INSTAAR) on a medial moraine on Root Glacier, with the Mile-High Icefall in the distance, Wrangell Mountains, Alaska, June 2006. Bob was working with Suzanne Anderson (INSTAAR) to sample rocks from the glacier margin to study provenance of solutes in the glacier outlet stream. Photo: Suzanne Anderson (INSTAAR).

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Ken Hill (INSTAAR) and Kurt Chowanski (INSTAAR) sampling groundwater wells for later chemical and isotopic analysis, near the Tundra Lab, Niwot Ridge, Colorado, July 2006. Photo: Ty Atkins (INSTAAR).

Archaeologist Tom McGovern (City University of New York) at the site of Hofstathir, a large ceremonial hall in Viking times, Iceland, July 2006. Astrid Ogilvie (INSTAAR) is collaborating with McGovern and other colleagues from a number of disciplines to establish social and environmental changes in northern Iceland from early times to the present. Photo: Astrid Ogilvie (INSTAAR).

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Part of a spindle whorl, dating to the 9th century, discovered at a Viking archaeology site, northern Iceland, July 2006. The whorl would have been used for spinning wool. Astrid Ogilvie (INSTAAR) is collaborating with several colleagues from a number of disciplines to establish social and environmental changes in northern Iceland from early times to the present. Photo: Astrid Ogilvie (INSTAAR).

Cynthia Cacy (ENVS) and Susan Riggins (INSTAAR) dig a soil pit at 3658 m (12,000 feet) on Mount Osborne, Wind River Range, Wyoming, August 2006. The low-relief summit of Mount Osborne is bounded by glacially carved troughs on the sides. Susan Riggins is studying the processes that break rock down to form regolith. Photo: Suzanne Anderson (INSTAAR).

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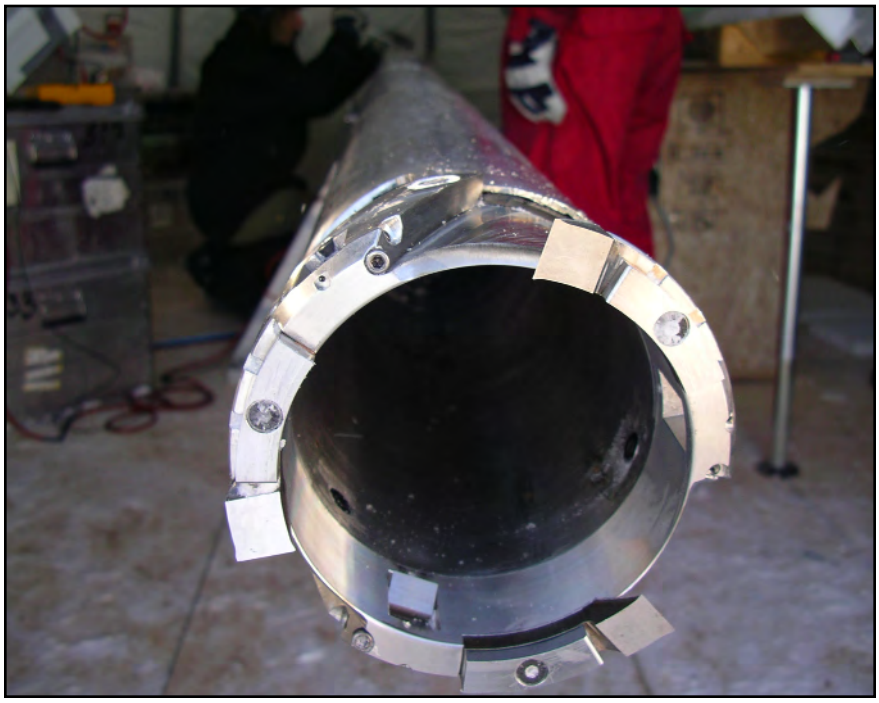

The "business end" of an ice core drill, as Steffen Bo Hansen (University of Copenhagen) makes adjustments, NE Greenland, summer 2006. The drill was used on the 600-m-thick Flade Isblink ice cap. Photo: Bruce Vaughn (INSTAAR).

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John Murgel (INSTAAR) applies treatment solutions to an experimental plot in the Appistoki Valley, Glacier National Park, Montana, June 2006. His work was part of a project funded by the National Park Service to establish critical loads for anthropogenic N deposition. Photo: Bill Bowman (INSTAAR).

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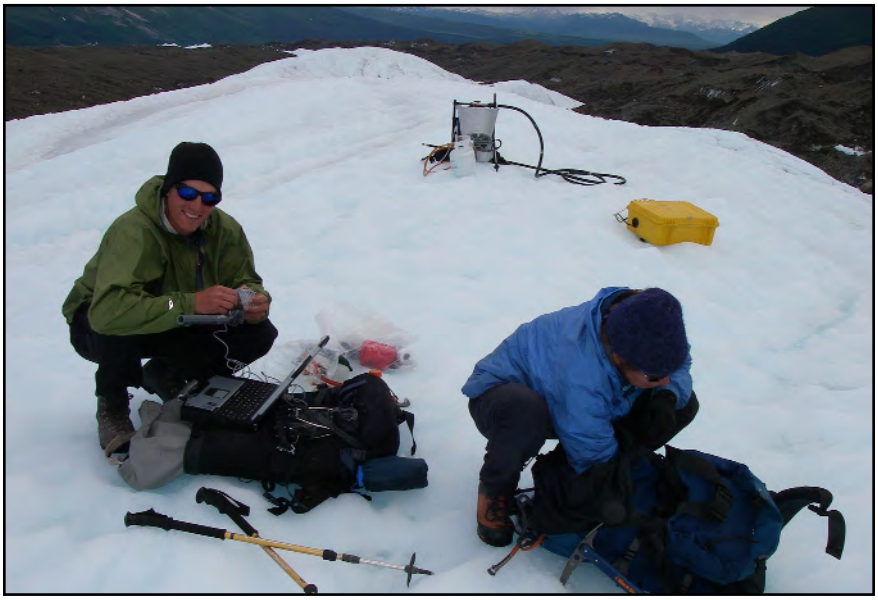
Tim Bartholomaus (INSTAAR) and a field assistant setting up a GPS receiver station on Kennicott Glacier, Alaska, June 2006. The hot-water drill in the background is used to install poles in the ice on which to mount the GPS. Bartholomaus, with R. S. Anderson and S. P. Anderson (both INSTAAR), is studying dynamics of the Kennicott Glacier. Photo: Suzanne Anderson (INSTAAR).



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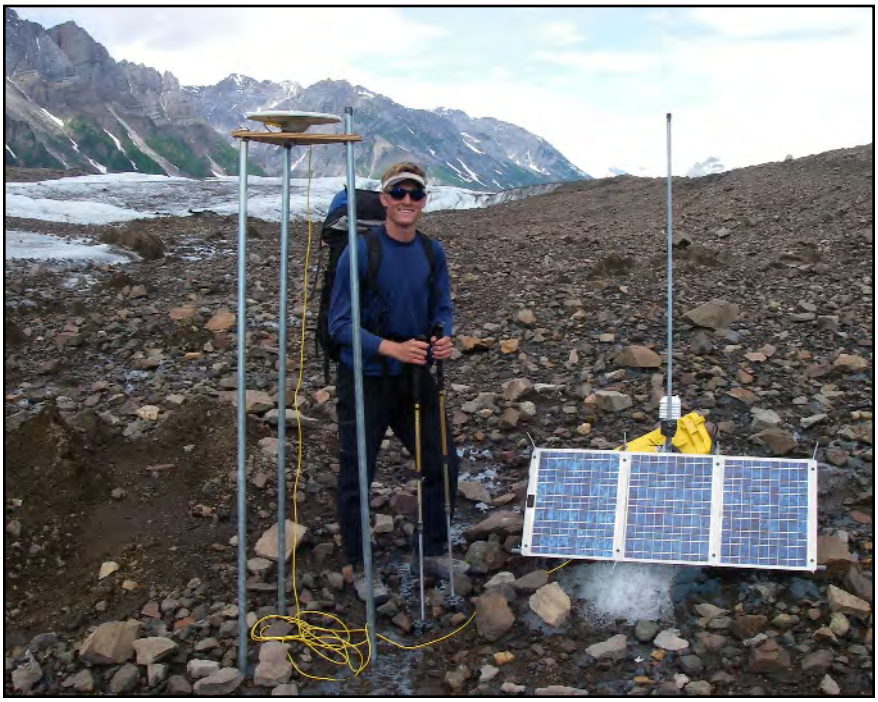
Isabel Ashton (University of California, Irvine) and John Murgel (INSTAAR) recording plant species composition in experimental plots near Chapin Pass, Rocky Mountain National Park, Colorado, July 2006. Their work was part of a project funded by the National Park Service to establish critical loads for anthropogenic N deposition. Photo: Bill Bowman (INSTAAR).



Tim Bartholomaus (INSTAAR) stands next to a GPS receiver and its solar panel on Kennicott Glacier, Alaska, June 2006. This station has been in the debris-covered ice for over a month, during which time melting has exposed the poles on which it is mounted. Bartholomaus, with R. S. Anderson and S. P. Anderson (both INSTAAR), is studying dynamics of the Kennicott Glacier. Photo: Suzanne Anderson (INSTAAR).

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Tributaries to the Colorado River that incise northward into the Roan Plateau oil shale country, western Colorado. This landscape inspires the PhD research of Maureen Berlin (INSTAAR), who is studying knickpoint migration and landscape evolution on the plateau. Photo: Robert S. Anderson (INSTAAR).

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Mount Gould (2912 m, 9553 feet) above Lake Josephine, Glacier National Park, Montana, July 2006. The lake lies near the site of experimental plots used to establish critical loads for anthropogenic N deposition. Photo: Bill Bowman (INSTAAR).

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