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SPECIAL ANNOUNCEMENT on back page

# Study of a dying glacier

Yakutat Glacier flows from the mountains near the Canada border and calves into a lake as deep as an ocean bay. The icefield that feeds Yakutat is large enough to cover the five boroughs of New York City. Despite its bulk, the glacier is doomed unless we experience a drastic change in climate.

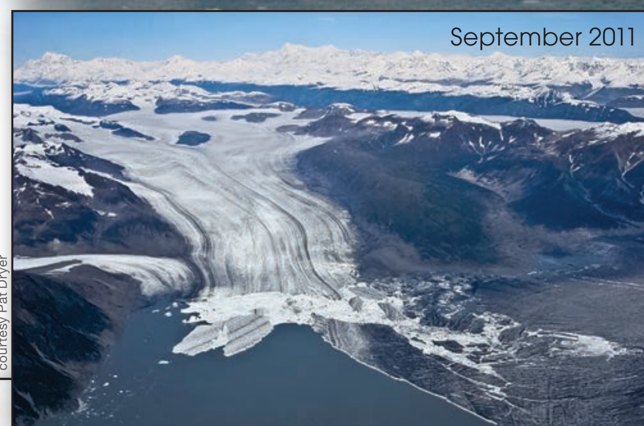
Barbara Trüssel has been on deathwatch for this interesting glacier. The graduate student at the Geophysical Institute has witnessed Yakutat's fade in the short time it takes to earn a college degree.

"It's dramatically falling apart," Trüssel said.

Trüssel and her advisor, Martin Truffer, along with glaciologists Chris Larsen and Roman Motyka, recently witnessed the fragmenting of the glacier's massive tongue, which coats part of Harlequin Lake.

"The breakup of the floating tongue started last year," Trüssel said. "Huge tabular icebergs were floating away from the glacier."


courtesy Barbara Trüssel




courtesy Pat Dryer

courtesy Andy Aschwanden

***DEATHWATCH***—*Barbara Trüssel (left) studies Yakutat Glacier (above), which is melting so rapidly that it is breaking into separate glaciers.*

By September 2011, the east and west branches of Yakutat Glacier were no longer connected. Continued melting and retreat will soon isolate even more tributaries, creating a set of separate glaciers.

Though many glaciers in Alaska are losing ice fast, Yakutat is unique for a few reasons. One is that it calves into a lake that showed up in about 1850, which, at 1,000 feet deep in places, is "pretty special," Trüssel said. Another is the glacier's low elevation. The high point of the icefield that feeds Yakutat is only about 2,000 feet above sea level. The ice of Yakutat Glacier formed during a colder period of Earth's existence. Without a return to those conditions, things don't look good for Yakutat Glacier.

As the glacier shrinks, it exports fresh water into the ocean through Harlequin Lake and Dangerous River, which flows into the Gulf of Alaska.

As part of her doctorate, Trüssel is using computer models to forecast the date when Yakutat Glacier will disappear. Since 1903, the glacier has receded more than eight miles from where its tongue once pointed defiantly at the Gulf of Alaska.

"When it goes, the entire glacier will become a lake," Truffer said.

# Assessing the influence of Alaska glaciers is slippery work

With an estimated 34,000 square miles of ice, about the size of Maine, Alaska's multitude of glaciers has a global impact.

photo by J.T. Thomas

*ON THINNING ICE – Above, Anthony Arendt and graduate student Joanna Young take measurements of Kahiltna Glacier in Denali National Park. In the background, a black bear navigates its way over Yakutat Glacier.*

courtesy Barbara Trüssel

Anthony Arendt, a research assistant professor at the Geophysical Institute, recently outlined the complexity and influence of Alaska glaciers. Arendt believes an integration of observations and more precise models are still needed and extremely important.

"We have used satellites to measure the mass changes of all of the glaciers in Alaska, but there are also many glaciers that need to be measured in the field," Arendt said. "We need these field observations to better understand the processes that are controlling glacier changes."

Glacial patterns are difficult to predict – even for current computer models. Alaska glaciers often behave independently of one another. There are glacial retreats and surges, volcanic and oceanic influences, in addition to changes in precipitation and warming temperatures. Data collected in the field will help refine existing models, so that a more accurate picture of changing sea levels can be drawn.

According to the scientist, small glaciers make up a mere one percent of the ice on our planet, yet they account for almost half of the sea level contribution. These dynamic chunks of ice are tremendously influential on future coastlines.

"There are many people living very close to the sea in areas where even a small change in sea level would be devastating," Arendt said. "Developing countries don't have the resources to deal with this change."

To create the best forecast of what sea levels will be in time, measurements need to be integrated and data gaps in current models must be filled by what is witnessed of glaciers in the field. With thousands of glaciers in Alaska, scientists have much more work to do. However, this research will ultimately help the global community better adapt to sea level change.

# Alaska glaciers help drive sea level rise

The rate of sea-level rise due to the melt water from glaciers in Alaska and elsewhere will increase by as much as 60 percent by the year 2100, according to Geophysical Institute Professor Regine Hock and former graduate student Valentina Radic (now at the University of British Columbia). In addition, they predict half of the world's smallest glaciers, those smaller than five square kilometers, won't survive until then.

Radic and Hock determined that by the end of the century the contribution to rising sea level from melting glaciers outside the massive ice sheets in Antarctica and Greenland would grow to about 1.6 millimeters per year from the current 1 millimeter per year.

"This is significant even though the total over 100 years (around 12 centimeters or 4.6 inches) may not sound like much," Hock said.

Expansion of ocean water by warmer air leads to about one-quarter of the world's current sea-level rise of about 2.5 millimeters each year, or about one-tenth of an inch. The rest is melt water coming from ice that formed during colder periods of Earth's past. About half of the water now gushing to the sea from glaciers comes from Alaska and other mountainous areas outside Antarctica and Greenland.

courtesy Barbara Trüssel

*PEERING THROUGH AN ICEBERG – Researchers studying Yakutat Glacier admire a floating iceberg with a large tunnel through it. Running glacial melt water formed the tunnel before the ice calved. Sea-level rise due to glacial melt water is expected to increase by as much as 60 percent by the year 2100.*

Radic and Hock wanted to sum up how much water the world's smaller bodies of ice, such as mountain glaciers in Alaska, Canada and elsewhere, were contributing to sea level rise because they often are overlooked. Though the ice sheets of Antarctica and Greenland account for 99 percent of all the ice-bound water on the planet, the melt water from smaller glaciers has caused almost half of recent sea-level rise.

"Much of the Greenland and especially the Antarctic ice sheet are so much colder. It doesn't matter if the climate there warms from minus 40 to minus 35; the ice still won't melt. But it makes a lot of difference for glaciers where temperatures fluctuate around the freezing point," Hock said.

In Alaska, most glaciers hover right at the freezing point.

Yakutat Glacier, courtesy Barbara Trüssel

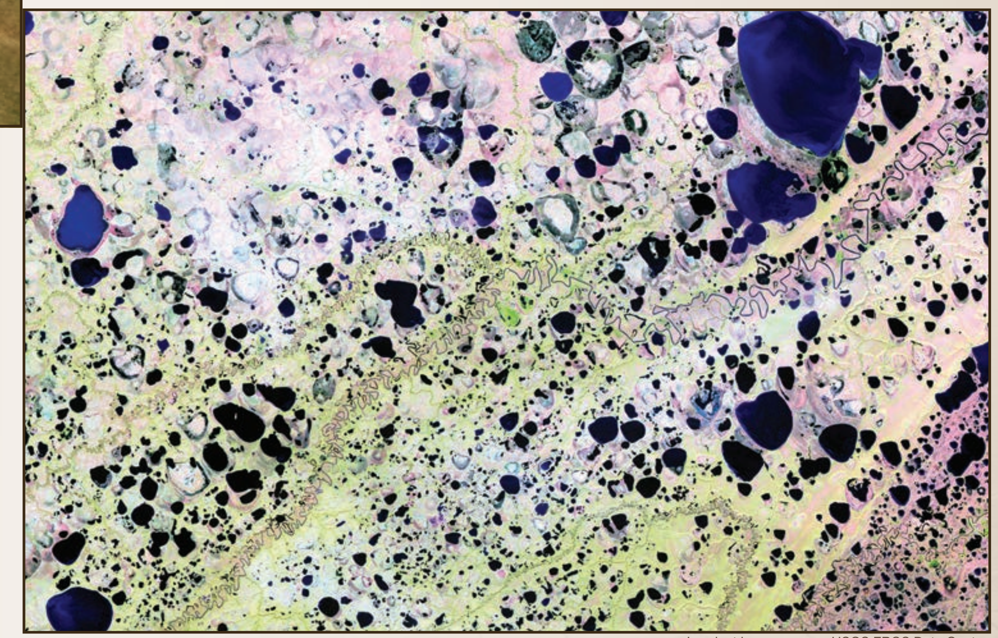
# Thermokarst lakes:

## A driver of permafrost thawing and methane release

Imagine that the Arctic is a freezer full of food, and someone has left the door open. Guido Grosse, a research assistant professor with the Geophysical Institute Permafrost Laboratory, uses this analogy to preface his current research of thermokarst. All plant material consists of organic carbon and portions of this material are absorbed into permafrost in North America and Asia. Over thousands of years, the Arctic freezer became full of frozen carbon – about twice the amount that is currently found in the atmosphere – much of which is now ready to defrost as the climate warms.

Found mostly in the arctic lowlands, thermokarst lakes are one widespread type of disturbance contributing to permafrost thawing and carbon release.

"It is a process of feedback during warming. Thawing of ground ice in permafrost produces small pits and shallow basins that collect rain and melt water. These bodies of water store summer heat very efficiently and act as a conduit to warm the surrounding ground," explains Grosse. As a result, permafrost continues to thaw under and next to the ponds,



*THERMOKARST – Above is a catastrophic thermokarst lake drainage on the Seward Peninsula in Alaska. At right is a Landsat-5 satellite image of thermokarst lakes in the Kolyma region of the Russian Far East.*

Landsat image source: USGS EROS Data Center

growing them into larger lakes and further strengthening the transfer of summer warmth into the ground.

Thermokarst lake contributions to carbon gas emission are different from other types of permafrost thaw. Where the organic carbon stored in upland or slope permafrost is more likely to be released in the form of carbon dioxide as a result of better drained soils and an aerobic, oxygen-rich environment, the thawed zones under a thermokarst lake and in lake sediments lack oxygen. Different microbes thrive in this anaerobic environment and produce methane, a carbon-based gas about 24 times more effective as a greenhouse gas than carbon dioxide. In some thermokarst lakes in Alaska and Siberia, methane seepage is so strong it can keep parts of the lake from freezing in the winter.

Grosse's team has satellite images and aerial photos worth nearly 60 years of observation time to analyze the distribution of thermokarst lakes in Alaska and Siberia. Researchers are looking for changes in lake appearance and size. To date, there is no consensus among published research that fully explains the behaviors of the lakes. In some regions thermokarst lakes grow and new ones form, in other regions lakes shrink and disappear. An increase in lakes could indicate permafrost thaw due to warmer temperatures and increased precipitation. However, strangely, a decrease in lakes could mean the same in other regions; as the surrounding permafrost degrades, lakes may find new drainage pathways and spill out into nearby streams or simply drain through the now permafrost-free bottom. Scientists need more conclusive information on local permafrost, geological, hydrological, and climate conditions to understand the big picture of lake change in the Arctic.

"A pan-arctic assessment of all lakes is needed and that is what we are working on," says Grosse.

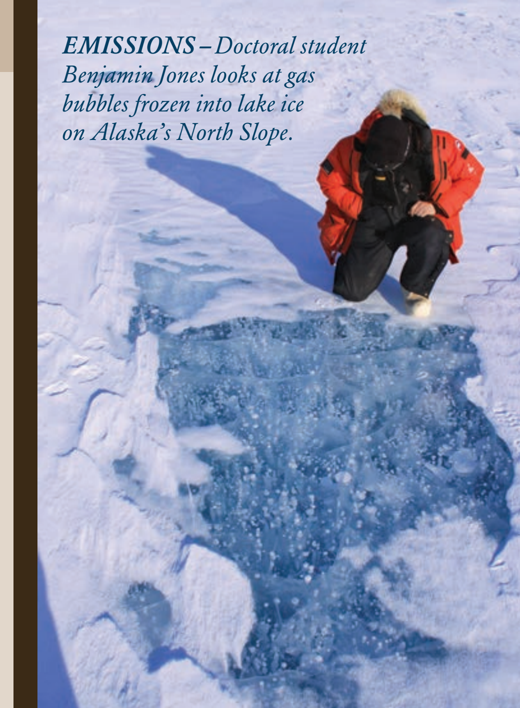
Looking at the big picture of thermokarst disturbances to permafrost will help to improve carbon cycle models that do not yet account for the vast amount of the greenhouse gases waiting to be released. Though thermokarst lakes existed for thousands of years in permafrost regions and have emitted methane since then, we know that their formation was a result of rapid warming events in the past. Could the projected warmer climate in high latitudes result in even more methane emissions from thermokarst lakes?

Continued fieldwork and more data collection are allowing scientists to better understand just how vast the amount of carbon is that may be released as the arctic climate warms. Projecting the effects of activating and spreading massive amounts of methane and carbon dioxide from Earth's frozen soils into the atmosphere and water bodies are important issues – ones that need more attention. Grosse and his colleagues hope their thermokarst research will be put to good use, though it is just a small piece of the complicated puzzle in predicting the future of the Arctic.

photos courtesy of Guido Grosse

Permafrost disturbances come in many forms. In addition to tracking thermokarst, increases in wildfire burn areas of the North also concern researchers. Surface-level vegetation and peaty soils act as an insulator so summer warmth has less impact on permafrost. But when that layer is burned away, the ground becomes more susceptible to the warmth of the sun and permafrost starts thawing.

"For the boreal region, wildfires are a really big issue. More intense and more often recurring fires in a warmer climate mean more permafrost loss," explains Grosse. This is especially true of the Interior region of Alaska where discontinuous permafrost with ground temperatures of just minus 1 degree Celsius or warmer is being protected from thawing only by these insulating peat and vegetation layers. Climate alone is not sufficient to maintain permafrost in this region. Raising that temperature just a hair is enough to start thawing. Ice-rich permafrost is most vulnerable and can thaw and erode very rapidly when exposed to the sun or to flowing water.



*EMISSIONS – Doctoral student Benjamin Jones looks at gas bubbles frozen into lake ice on Alaska's North Slope.*

Grosse's collaborator, Katey Walter Anthony, caught the media's attention a couple years ago with the "methane time bomb." The term coined by Walter Anthony, a research assistant professor for the Institute of Northern Engineering at the University of Alaska Fairbanks, came from her own collection of data. She began measuring methane emissions from thermokarst lakes by looking at winter ice cover instead of using randomly placed gas traps. The new method has succeeded in capturing local seeps with very high methane bubbling rates, resulting in revised estimates of methane emissions from thermokarst lakes that were much higher than any had assumed before. Such improved estimates of methane emissions from lakes are exactly what modelers need to better project future changes in the atmosphere. With Walter Anthony working on the biogeochemical aspects and Grosse focusing on landscape and lake dynamics in National Science Foundation and NASA sponsored research projects, a much more complex understanding of thermokarst lakes has emerged.

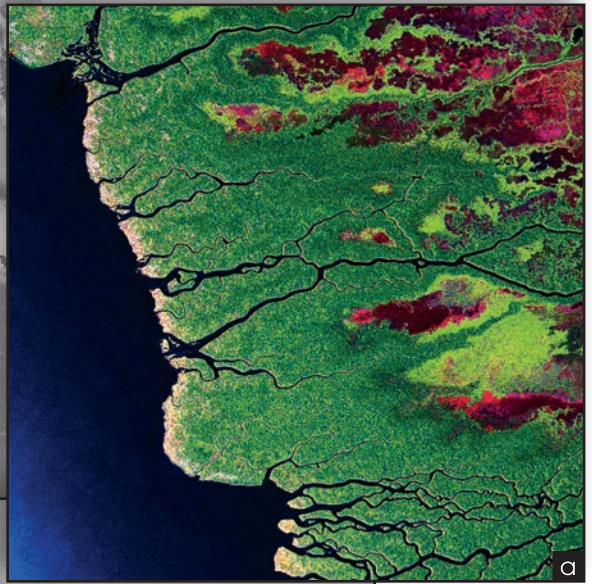
# Celebrating two decades of service

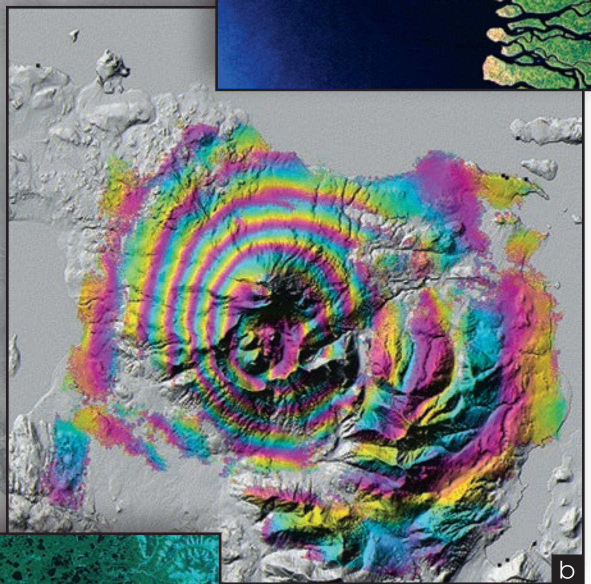
The Alaska Satellite Facility at the Geophysical Institute celebrates two decades of international service this year with plenty to boast about. Originally built to support three synthetic aperture radar satellites, ASF has extended its lifespan through productivity and innovation, with a strong focus on customer service.

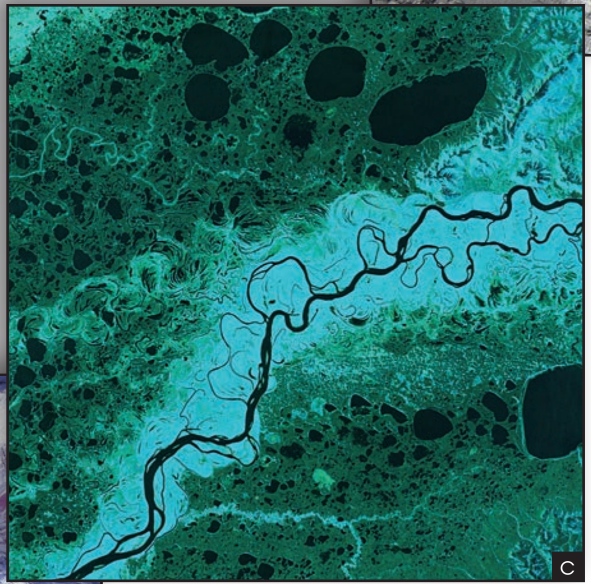
After being in the business of processing SAR data since 1991, ASF began to diversify in 2006 with the launch of Japan's Advanced Land Observing Satellite. The facility operated one of four data nodes on the ALOS mission, handling the data needs of the Americas. Other recent projects include: collaborations with researchers at the University of Colorado, Boulder, using interferometric SAR to monitor permafrost dynamics and involvement with NASA's Jet Propulsion Laboratory's Uninhabited Aerial Vehicle SAR Program to improve data collection of Earth's changing features.

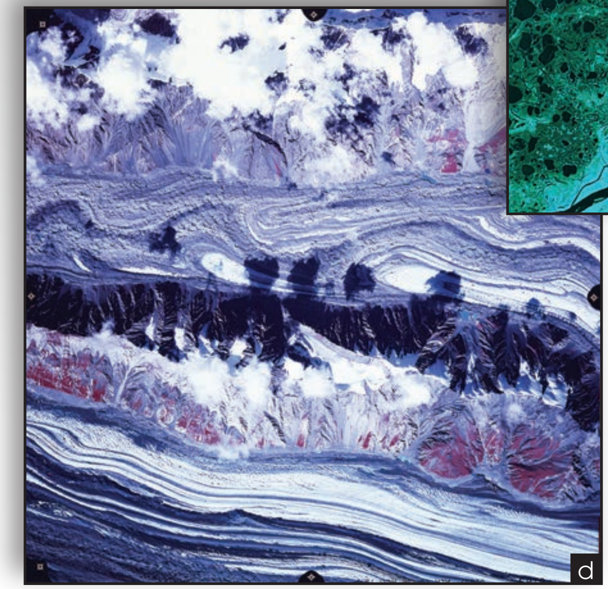
The ASF team supports science worldwide, often downlinking satellite data in near real time, and maintains large data archives. Efficiency has been a characteristic that has helped ASF grow in personnel, technology, and project involvement. Beyond research ASF has also expanded to offer educational outreach programs that connect scientists with teachers and students.


*BIG DISH–ASF's 10-meter antenna was installed on top of the Elvey Building in 1988.*




*IMAGING PLANET EARTH–Clockwise: (a.) A radar image of the Everglades coast using NASA's Uninhabited Aerial Vehicle SAR is shown. Colors have been used to distinguish different ground surface types. Hurricane damage to mangrove vegetation is visible along the coastline.*

*(b.) An interferometric SAR image of Peulik Volcano on the Alaska Peninsula is shown. Different colors represent deformation in the volcano's shape resulting from subsurface magma movement.*

*(c.) A Phased Array L-band SAR image of the Kalskag area on the Kuskokwim River taken from ALOS is shown. Blue and green colors are used to show different polarizations of the reflected radar impulse caused by interaction with different ground surface types.*

*(d.) An infrared image from 1978 of Walsh (top) and Logan (bottom) glaciers in Alaska's Wrangell St. Elias National Park is shown. The image is from a photo archive managed by ASF.*

*The background image is a mosaic of Antarctica composed of SAR images, which were acquired by RADARSAT-1 during the Antarctic Mapping Mission in 1997.*

# New GI collaboration targets education

Because Geophysical Institute scientists study geophysical processes occurring from the center of Earth to the center of the sun and beyond, research activities are divided into seven separate groups: Atmospheric Sciences; Remote Sensing; Seismology; Snow, Ice & Permafrost; Space Physics & Aeronomy; Tectonics & Sedimentation; and Volcanology. In the summer of 2011, a new Education Group was added to highlight service activities occurring within these research areas in support of the institute's education mission. Group membership is elective for faculty and staff whose primary affiliation is elsewhere.

Education Group members collect information about existing outreach conducted among GI's diverse research groups. Featuring these various projects as part of a united whole in a single online location (www.gi.alaska.edu/Education) illuminates the breadth of this outreach. Projects are categorized as K-12, Higher Education, or Community Events on the site.

The Education Group provides a forum for collaboration among those within the GI interested in education outreach so new ideas can be identified, nourished and developed for implementation. The group mission includes sharing information and expertise useful for advancing the broader impacts of GI-initiated research resulting in educational opportunities for the local, statewide and global communities.

After a group poll, GI Outreach Director Kathy Berry Bertram was appointed as the Education Group leader and Research Associate Professor Jon Dehn was appointed as deputy group leader.


*TEACHERS LEARN ABOUT SCIENCE–Jon Dehn (left) demonstrates a volcano science activity for K-12 teachers during the Science Teacher Education Program. The new GI Education Group offers a forum for collaboration among faculty and staff interested in outreach occurring at the institute.*

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# UAF names space scientist GI director

SPECIAL ANNOUNCEMENT

The University of Alaska Fairbanks has selected Robert "Bob" McCoy as the Geophysical Institute's new director. McCoy will be the seventh scientist to the hold the post since the institute was established in Fairbanks in 1946.

McCoy has more than 15 years of research experience as a space scientist at the Naval Research Laboratory and 15 years of administrative experience at the Office of Naval Research in Arlington, Va., where he was the team leader for space science and technology. Concurrently, he also served as the technical director for the Operationally Responsive Space Office in Albuquerque, N.M.

"McCoy's broad scientific background, combined with his extensive program management experience, makes him the ideal choice to lead the strategic growth of the Geophysical Institute," said Mark Myers, UAF vice chancellor for research.

Throughout his career, McCoy has overseen multimillion-dollar operating budgets and managed interdisciplinary teams of scientists, engineers, contractors and students. McCoy is a strong advocate for education and K-12 outreach. He has received a variety of awards, including the NRL Group Achievement Award in 1983, the NRL 75th Anniversary Innovator Award in 1998, the Alan Berman Publication Award in 1994 and 2001, the NASA Group Achievement Award in 2004 and the Rotary International Stellar Award in 2010.

McCoy earned his bachelor's degree in physics from Cornell University, a master's degree in physics from Texas A&M University and a doctorate in astrogeophysics at the University of Colorado in 1981. McCoy will begin his new position in October.

"I've always admired the Geophysical Institute and it seems to be in the right place at the right time. It's very exciting to see all of the research areas becoming hot topics right now," McCoy said. "I see a lot of opportunities for the GI to excel even more."