An academic first in Antarctica

UC Irvine Ph.D. student defends dissertation at South Pole after 24-day research expedition.

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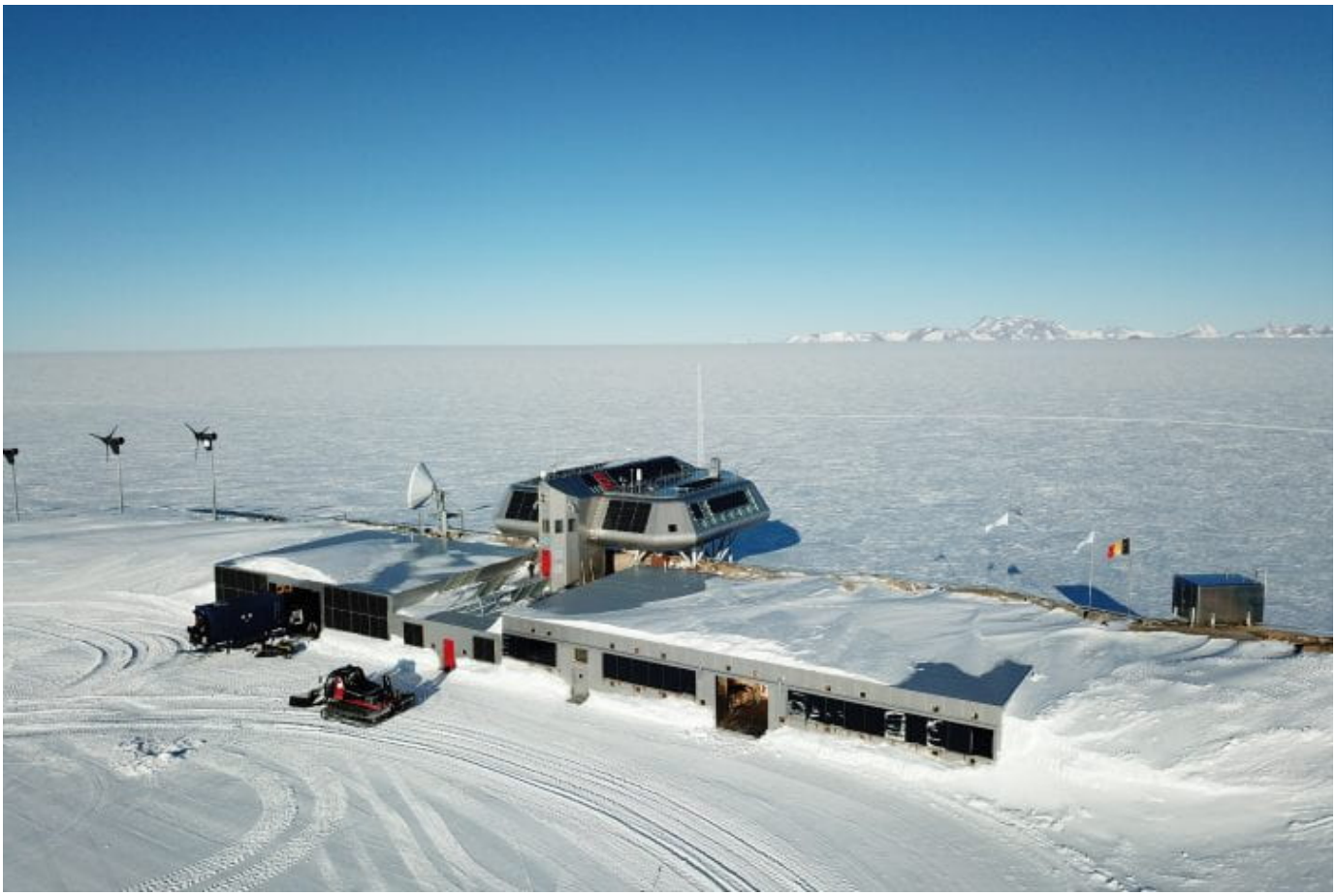
UC Irvine News



Belgium’s Princess Elisabeth Antarctica research station in East Antarctica’s Queen Maud Land was the site of the successful Ph.D. dissertation defense by Ratnakar Gadi, UC Irvine Earth system science graduate student.

Picture Credit:
International Polar Foundation

Ratnakar Gadi, a graduate student in UC Irvine’s Department of Earth System Science, made history when he successfully defended his Ph.D. dissertation earlier

this year. He is the first to have done so at Belgium's Princess Elisabeth Antarctica, the world's only zero-emission polar research facility in East Antarctica.

In addition, "it may have been only the second time that [a dissertation defense] has happened on the continent of Antarctica, so it was a truly unique occasion," says Gadi's thesis advisor, Eric Rignot, Distinguished Professor of Earth system science. "It could not have been more fitting, because the work Dr. Gadi has been doing is helping us answer some of the most difficult questions we have about the impact of global climate change on sensitive polar regions."

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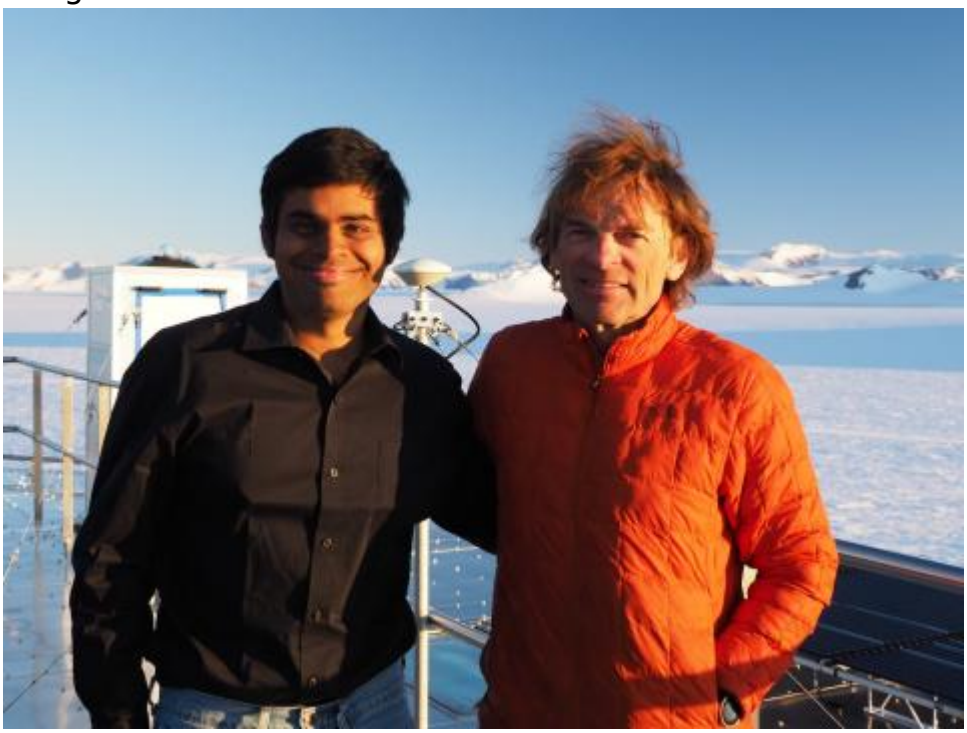

Immediately before his history-making dissertation defense, Ratnakar Gadi (left) joined his thesis advisor, Eric Rignot, UC Irvine Distinguished Professor of Earth system science, on a 24-day field expedition to study the King Baudouin Ice Shelf. Quinten Vanhellemont, Institute of Natural Sciences, Belgium / International Polar Foundation

Gadi says: "I was very proud and happy to mark this occasion with Professor Rignot in Antarctica. He has passed on to me a commitment to scientific rigor and enthusiastic investigation to understand the impact of climate change on polar ice sheets. The need for this work seems to be getting more and more important."

His dissertation was a comprehensive study of the dynamics at play beneath two of the world's most significant glaciers, Petermann Glacier in Northwest Greenland and Thwaites Glacier in West Antarctica. For the work, Gadi used a combination of modeled ice melt rates, satellite data-derived melt maps and other data sources to examine conditions at ice grounding zones, where glaciers leave the land and begin floating in the ocean.

This research helped him conclude that seawater intrusion in these areas is a much stronger contributor to ice sheet deterioration and global sea level rise than previously recognized by the polar ice research community. He proposes that climate modelers reconsider the role of ice grounding zone vulnerability to warming ocean water driven by climate change.

Gadi's dissertation defense took place in front of Rignot, the Princess Elisabeth Antarctica station's resident scientists, medical doctor and technicians. They were joined remotely via videoconferencing by thesis committee members Isabella Velicogna, professor of Earth system science, and Francois Primeau, professor and chair of Earth system science – both from UC Irvine; as well as Dimitris Menemenlis, a research scientist at NASA's Jet Propulsion Laboratory.

Antarctic expedition

Rignot and Gadi were together in Antarctica for a research expedition during the austral summer months of January and February. They ventured out from the PEA facility with fellow scientist Nolwenn Chauche, polar explorer and station chief Alain Hubert, and mountain guide Daniel Mercier on a 24-day expedition to survey the cavity and ocean state of the King Baudouin Ice Shelf in East Antarctica's Queen Maud Land.

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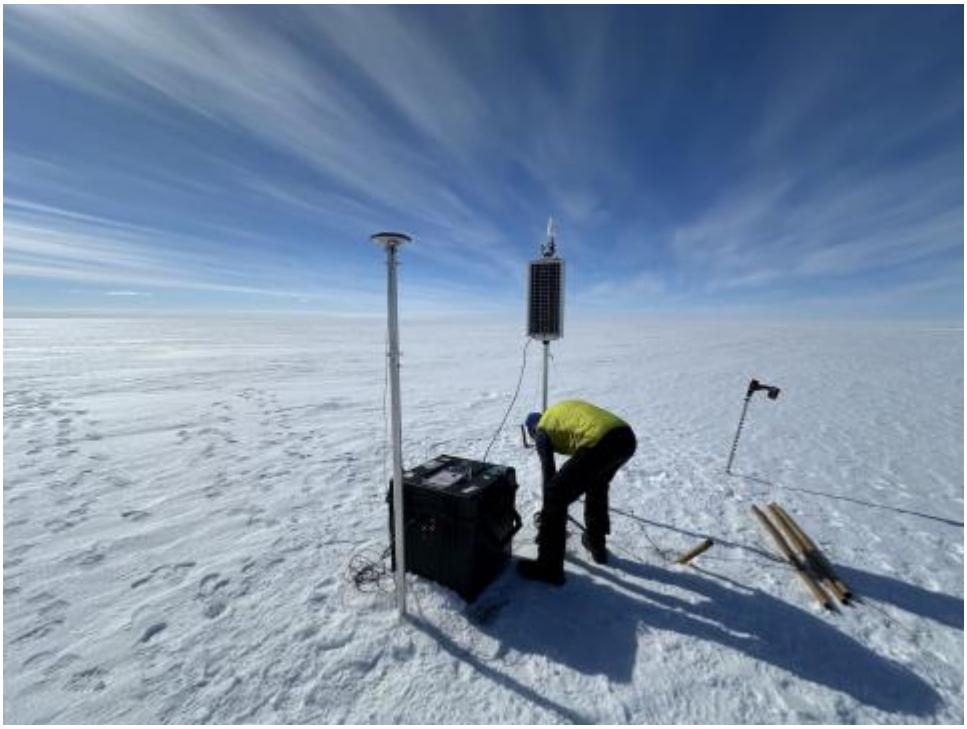

While on the research expedition in East Antarctica, mountain guide Daniel Mercier installs a new global navigation system station on the King Baudouin Ice Shelf to support the upcoming NISAR satellite mission. Eric Rignot / UC Irvine / copyright International Polar Foundation

The researchers investigated ice-ocean interactions at the transition boundary between continental ice and floating ice that are altering the mass balance of the ice sheet in this area and their impacts on sea level rise around the world. These phenomena, which are central to Gadi's doctoral dissertation, have been found to be in effect in other parts of Antarctica and Greenland.

During the expedition, which was backed by UC Irvine, NASA's Cryospheric Sciences Program and the International Polar Foundation, which hosted the team, the researchers crossed hundreds of kilometers of open land in treaded snow vehicles with scientific and support equipment in tow. They also had snowmobiles that enabled them to move around smaller areas to do their work.

The group had multiple goals: One was to collect conductivity, temperature and depth data both below and at the front of the ice shelf; another was to make radio-echo sounding observations of ice thickness to reveal the signature of bottom ice melt. For the first time, the scientists were able to obtain hundreds of seismic recordings of seafloor depth from the front of the ice shelf to the grounding zone.

Another aim of the expedition was to deploy automated weather stations on the ice shelf to document the staggering melt processes and enhanced snow accumulation that affect this region of East Antarctica. The researchers also established a new global navigation satellite system station to help calibrate and validate interferometric synthetic-aperture radar measurements from the upcoming NISAR satellite mission managed by NASA and the Indian Space Research Organisation.

The team tracked down an automatic, phase-sensitive radio-echo sounder designed by the British Antarctic Survey that was placed at the grounding zone of the King Baudouin Ice Shelf in January 2024. The sophisticated instrument recorded ice melt rates continuously over the last year as it transitioned through the grounding zone. Rignot's cohort deployed a new ApRES at a different location to obtain higher-resolution data on changes in this area. The researchers used a novel, lightweight hot water drill to bore hundreds of meters into the ice to embed the sounder. They managed to create two deep holes, one 195 meters and the other 350 meters, but lost their drill head in the second hole.

"Losing the drill head was a reminder of the difficulty in conducting research operations in a remote land with harsh climate conditions," Rignot says, "but as a result, we focused on other parts of our experiments to collect hundreds of kilometers of radar and seismic data."

Surreal experience

Team members slept in tents on the frozen expanse, but they had a shelter on one of the treaded snow vehicles – they called it the caboose – that served as an office, a kitchen, a food storage facility, a spot to hang and dry wet clothing, and, more importantly, according to Rignot, a place to analyze data daily, almost live, to optimize the next day's mission.

"Some days, you would wake up in your tent and it was warm and comfortable due to the early rise of the sun, around 1 to 2 a.m., in Antarctica," Rignot says. "Other times, it would be 17 degrees below zero Celsius with whiteout conditions. But we still managed to collect data every day and accomplish more than expected for this expedition.

"This mission was a success in large part due to the help and guidance of the scientists and engineers from the International Polar Foundation at the Princess Elisabeth Antarctica station," he says. "They have intimate knowledge of this land,

of its rigor and the equipment needed. They helped prepare the deployment with minute precision, and we greatly benefited from their advice and guidance to conduct research in a safe and effective manner.”

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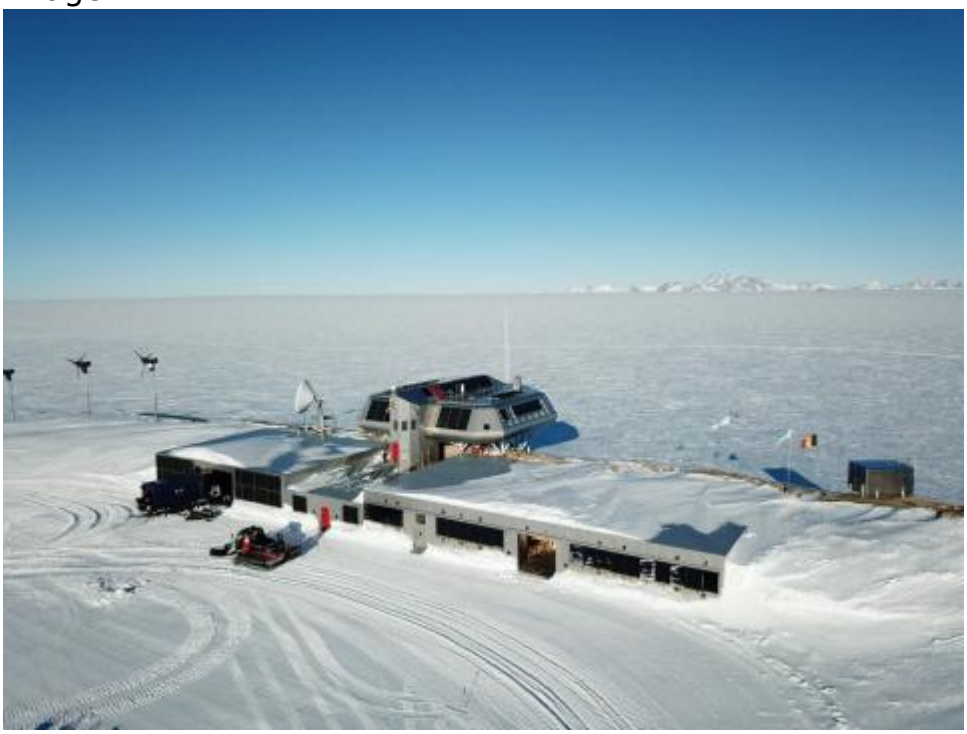

The Princess Elisabeth Antarctica is the world’s only zero-emission polar research station in East Antarctica. Its resident scientists, medical doctor and technicians attended Gadi’s dissertation defense. International Polar Foundation

Gadi says the entire experience was surreal: “Antarctica had always been a childhood dream of mine, and not only did I achieve it, but I also took it a step further by defending my dissertation there. After spending 24 days camping in the field, collecting data to study basal melting in ice grounding zones, I arrived back at the station just a day before my defense. Because I was exhausted from the expedition, everything seemed to happen quickly, and before I fully grasped it, my defense was over.

“The journey was an adventure – from writing my dissertation while traveling from the United States to Antarctica and submitting it for committee feedback from the field to preparing my [defense] presentation en route from the field to the station.”

For his next big adventure, Gadi has accepted a postdoctoral research position at the California Institute of Technology, where he will work with Andy Thompson, assistant professor of environmental science and engineering, on using robotic devices to investigate the vulnerability of East Antarctic ice sheets to changes brought on by tides.

Rignot adds that Gadi's dissertation defense and the recent expedition have "set the tone" for the creation of the University of Antarctica Research Center, an international consortium in which UC Irvine is a leading and active participant. The goal of the UARC is to be operational by the next International Polar Year, in 2032-33.

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