Science increasingly relies on GPS for data collection

Peter Rejcek
Sun staff

From measuring the deformation of the Transantarctic Mountains to tracking icebergs moving across the Ross Sea, scientists are relying more and more on GPS and its evolving technologies to improve their knowledge about the continent.

"People are finding more uses for it. It's becoming more widespread," observed Seth White, with UNAVCO. "It's astonishing the number of things you can do with GPS."

UNAVCO is a non-profit organization, partly sponsored by the National Science Foundation, that supports Earth sciences around the world using high-precision GPS. UNAVCO has maintained a presence on the continent since 1994.

"The amount of equipment we're bringing down is skyrocketing," said UNAVCO's Bjorn Johns, who has made repeated trips to the Ice over the last 11 years. During his first visit, UNAVCO supported 12 science projects with a dozen GPS receivers. The number of teams that now seek GPS assistance has more than doubled and these days they need about 80 high-precision GPS receivers, according to Johns.

Glaciology, geology, meteorology and biology are among the disciplines UNAVCO supports with equipment, training and direct field work.

"It's really pretty diverse, the things we do," White said. "We're techno-geeks who have all this equipment and know how to use it."

Taking bearings on bergs

Some of the equipment is making its way onto icebergs pushing their way through the Ross Sea.

To keep track of berg B-15 and its various offspring, researcher Doug MacAyeal with the University of Chicago uses navigation-level GPS units not unlike those available at your local sporting goods store, as well as the high-precision instruments from UNAVCO.

For the most part, the iceberg researchers don't need the higher-end instruments, according to Kelly Brunt, a graduate student with MacAyeal's team. Brunt's main job this season is to help deploy an autonomous weather station on the Dryglaski Ice Tongue, an extension of the David Glacier into the Ross Sea. These towers — which sport navigation-level GPS units — record

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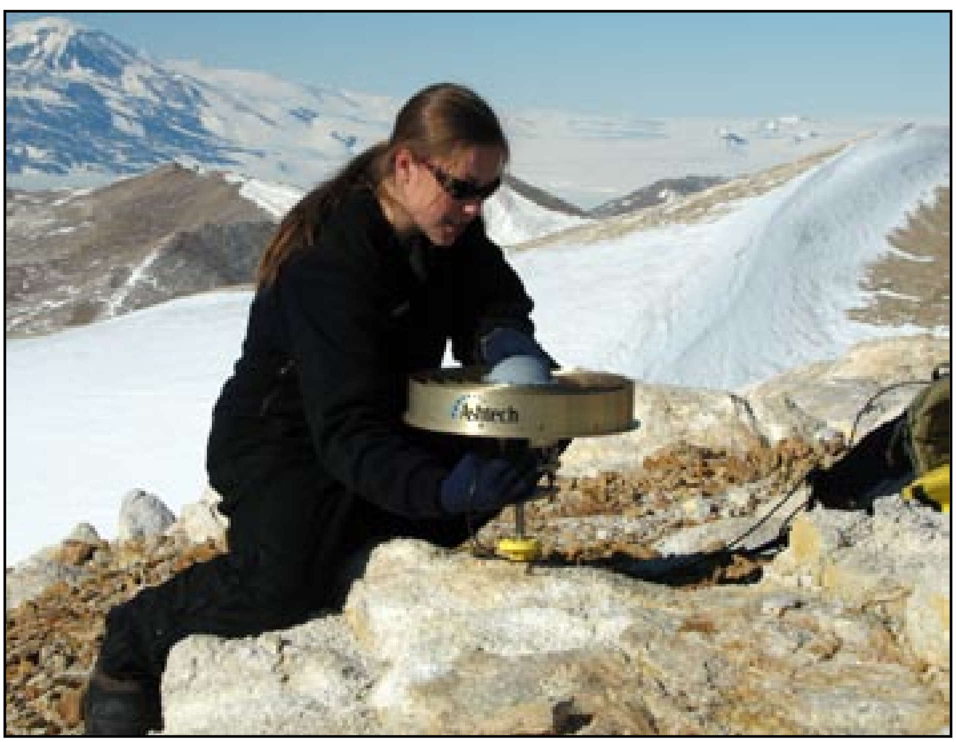

Photo by Stephane Mazzotti / Special to *The Antarctic Sun*

Stephanie Konfal, with Ohio State University, sets up one of the choke-ring waveguide antennae for a footprint survey at Esser Hill, part of the TransAntarctic DEFormation network, on Nov. 10. TAMDEF is using the high-precision GPS receivers to study the tectonic movement of the mountain range.

GPS101

Satellites redefine the world we live in

Peter Rejcek
Sun staff

It sounds like the plot from a James Bond film: Villain invents a weapon to hijack the world's Global Positioning System satellite network. He threatens to shut down the satellites unless the governments of the world pay him a hundred *billion* dollars.

Far-fetched, perhaps, but without GPS the world as we know it wouldn't fire on all cylinders anymore.

"If you didn't have GPS, you wouldn't use the Internet, you wouldn't be able to use an ATM, you wouldn't be able to use anything that really involves timing," explained Mike Willis, a graduate student from Ohio State University working on TAMDEF. TAMDEF, or TransAntarctic Mountain DEFormation Project, is studying regional crustal motion.

"They're all governed by atomic time and the easiest way to get atomic time these days is from a GPS satellite," Willis added. "It's integral to all of our information technology."

Larry Hothem, with the United States Geological Survey, puts the impact of the GPS system more bluntly, "If you turned the signals off, there's nothing. … Everything is synchronized."

The Navstar Global Positioning System is a satellite-based navigation system made up of a network of satellites, initially 24, placed into orbit by the U.S. Department of Defense. GPS was originally only intended for military use, but in the 1980s the government made the system available to the civilian community.

Hothem possesses an encyclopedic knowledge of such satellite systems, working with the technology as early as 1982. In reality, he said, though Navstar GPS continues as the primary radio-based satellite positioning and navigation system, it has become a critical component of an international system of systems.

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Future GPS technology to rely on Iridium

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a variety of information including temperature, air pressure, wind speed and direction. These same towers are also riding the icebergs.

"We don't need millimeter-level GPS out there," Brunt said. "We just want to know roughly where these guys are moving."

But to study a rift on the Ross Ice Shelf that could calve into a new iceberg, MacAyeal's group needs the precision that the UNAVCO equipment provides. Brunt said researchers went out last season with survey-level GPS for 24 hours to get a sense of what the tides were doing at the crack, which requires "a much finer level of accuracy." She said this year equipment will be placed on both sides of the rift to measure very miniscule levels of movement.

"[The ice] is constantly moving," Brunt said. "[GPS] seems like a great tool for glaciologists."

Moving mountains

Other studies in Antarctica rely heavily on high-precision GPS equipment.

A multi-year study of the crustal movements of the Transantarctic Mountains is all about gathering GPS data. It's a field that wouldn't be possible without the precision afforded by the satellite-based technology, according to Mike Willis.

Willis is a graduate student from the Ohio State University Byrd Polar Research Center and works on TAMDEF, TransAntarctic Mountain DEFormation. Terry Wilson, also of Ohio State University, is the principal investigator on the project.

TAMDEF's original goal was to study what's called post-glacial rebound — how the land literally bounces back after an ice sheet melts. But as the project has progressed, the team found evidence that active tectonic rifting is also occurring in McMurdo Sound.

With high-precision GPS, Willis said geologists can not only study how a particular spot responded to melting last week but what's been going on for some 10,000 years.

"The earth has a memory of what's happened to it," he said.

Millimeter-level precision is required because of the speeds involved in the deformation. "I measure how rocks move. It takes a while," Willis noted.

While today's research is only possible thanks to satellite technology, the history of geodesy (the measurement of the shape of the Earth) can be traced back to the ancient Greeks, Willis said. And though scientists may not rely on calipers as much these days, even the full spectrum of modern science has yet to answer some of the most basic questions. Willis said researchers are still trying to understand how the Transantarctic Mountains formed and how they continue to evolve.

"The continent is still on the edge of what we know in terms of solid earth geophysics," Willis said.

On the peninsula

From the ocean floor to the avian wildlife above Palmer Station, GPS precision is used in a variety of science experiments around the peninsula as well.

For instance, last season Woods Hole Oceanographic Institution completed a survey of the sea floor around Palmer Station. With sonar and robotic instruments, they mapped out the depth of the ocean within Palmer's boating limits to scout out a location for an automated undersea instrument.

"GPS was critical for determining position, and the result was a highly detailed, accurate map of the ocean floor around Palmer," said Glenn Grant, Palmer Station's science technician.

As a station science tech, Grant is involved in many of the experiments at Palmer. A great number, he said, require precise timing. "Seven of them get their timing directly from GPS satellites," he said.

"Botanists and bird researchers have also used the GPS recently to accurately pinpoint the locations of sample plots, nests and bird colonies," he added.

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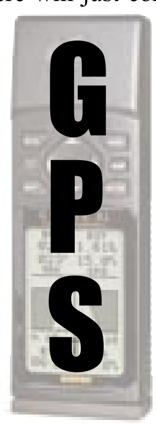
>
> *— Mike Willis*
> *TAMDEF*

Over the past few years, Palmer science techs have engaged in their own experiment mapping the edge of a glacier behind the station, according to Grant. Every year the glacier melts a little more, exposing a few meters of rock. Wearing a high-precision GPS backpack, science techs walk along the glacier terminus.

"Using the data set we've now acquired, we can see how much ice has melted," said Grant, who has spent five seasons at Palmer over the last decade. "It's a fun project that we've carried on each year out of personal interest."

Future waypoints for GPS

The ways GPS is used in the field and elsewhere will just continue to evolve, White said.



"People are always coming up with new ways to use a GPS," he noted.

This season the UNAVCO team is phasing out the last of its aging GPS receivers. The newer units are a third the size and weight. But the differences are more than just cosmetic.

The receivers can store upwards of a gigabyte of data, which allows it to operate continuously, Johns explained. The older models were limited to 10 megabytes, he said. The constant data collection allows scientists to monitor variations in the velocity of, say, an ice stream in West Antarctica. The new receivers also run on one quarter less power than the older models, significantly reducing power system requirements for extended data collection.

"With continuous observation you can see more movement," Johns said.

Thanks to these improvements in GPS receiver technology, installing permanent GPS receivers will be possible in remote areas of Antarctica. Willis said the problem then becomes communications: How do you know the instrument is working properly in remote areas where radio signals are not available?

"Do you really want to leave something in the field for five years and not know whether or not it's working?" he observed.

For deep field sites, the answer to that problem, and the issue of data retrieval, may be Iridium data modems, Johns explained.

The Iridium satellite system is a wireless technology that is able to deliver voice and data communications to anywhere in the world using a constellation of 66 low-earth orbiting, cross-linked satellites.

Soon, GPS receivers, with their own IP addresses, could potentially squat on a spot for years at a time, sending a continuous stream of data. That will enable researchers to get the most precise data yet for the various studies of the continent.

"The longer you leave your receiver occupying sites, the more precise your [data] will be for a variety of reasons," White said.

NSF-funded research in this story: Bjorn Johns, UNAVCO, www.unavco.org; Doug MacAyeal, University of Chicago, http://ice.ssec.wisc.edu/iceberg.html; Terry Wilson, Ohio State University; www.geology.ohiostate.edu/TAMDEF