November 13, 2005

The Antarctic Sun

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GPS

Satellite technology at the core of Antarctic operations

Photo by Peter Rejcek / *The Antarctic Sun*

Tom Holford, who works for fleet operations in sea ice science support, drills a 1.2-meter-wide hole in the sea ice near Cape Evans last month while Anne Petzel looks on. Holford later dragged a sea ice fishing hut over the hole and logged the spot's GPS coordinates. Holford, like many who work in operations and science around the continent, is increasingly reliant on satellite technology to get the job done.

•How exactly does this work? See the GPS primer starting on page 9
•Science just hasn't been the same since satellite technology came into the picture on page 9

By Peter Rejcek
Sun staff

According to his GPS unit, Tom Holford's CAT Challenger chugs along the sea ice at a steady 16 kph on a near windless, cloudy day en route to Cape Evans from McMurdo Station. A low, solid sheet of clouds flattens the horizon, skewing the heavy equipment operator's perspective of the landscape.

The train he's pulling includes a 9,000-kilogram tracked drill rig, which bores 1.2-meter-wide holes in the sea ice; a sea ice hut on custom-welded skis; and a third sled carrying the 270-kilogram auger for the drill. Shovels, heavy wrenches, a pry bar and hand drills complement his equipment list.

But perhaps one of the most important tools for such excursions sits on his dashboard next to a small fan blowing against the windshield to prevent the cab from fogging — that handheld Garmin 12XL GPS.

"I use it on a daily basis," said Holford, whose primary job for much of the season is sea ice science support. It's a job that involves everything from drag-

See GPS on page 11

Preventing the Overkill of Krill

Scientists keep eye on species

By Emily Stone
Sun staff

Fishermen have at least one thing in common with seals, whales and penguins — they all go where they have the best chance of hauling a good catch.

This instinct can put the animals and humans in direct competition, which is why commercial fishing in Antarctic waters is regulated under the Antarctic Treaty. But in order to set fishing limits to protect the animals, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) needs to know how abundant each species is in the southern ocean.

To this end, David Demer and Joe Warren want to improve the accuracy of krill measurements in one of Antarctica's most popular krill fisheries.

"Seals and penguins set up their breeding sites in areas where they have reliable food sources, and it's the reliability of these krill hotspots that attract both the fisherman and the penguins and seals,"

See KRILL on page 13

Quote of the Week

"Behind every great woman is a bunch more women supporting the heck out of her."

— Supportive woman in the kitchen

Inside

Clearing the pier

Photo by Peter Rejcek / *The Antarctic Sun*

Heavy equipment drivers with the fleet operations department remove snow covering the McMurdo ice pier Oct. 28 to prepare for the vessel arrivals later this season.

After many years, Chico has left the U.S. Antarctic Program and will no longer appear regularly in The Antarctic Sun. His distinctive, cheerful cartoons of penguins and scientists may be printed occasionally in the future. We hope so.
Thank you, Chico.

— From the Sun staff and readers

Cold, hard facts

RPSC contract on-Ice employees 2005

McMurdo: **642**
South Pole: **187**
Palmer: **28**
Ships: **34**

The following numbers do not include employees on ships:

Men: **575**
Women: **282**

White: **802**
Hispanic: **29**
Asian or Pacific Islander: **13**
Not indicated: **6**
Black: **4**
American Indian: **3**

48 states represented (only Delaware and Louisiana missing from the mix)

Most-represented states:
Colorado: 182
Alaska: 70
California: 52

Source: RPSC human resources

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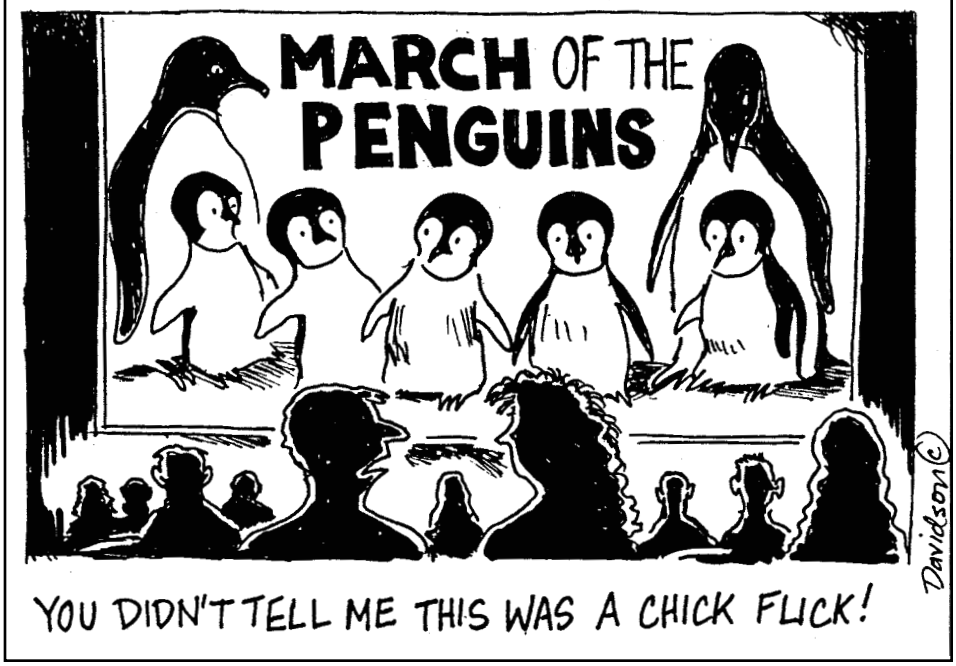
Level 1 Comix **Matt Davidson**



Helium keeps science cold all winter

By Steven Profaizer
Staff writer

Keeping something cold during a South Pole winter doesn't seem like that hard of a job. But when that something needs to be kept at negative 269 degrees Celsius, the relatively warm, negative-60-degree air doesn't help very much.

Cryogenic technicians have been trying to do just that with liquid helium for the past several years. This year marked a major victory for members of the cryogenic team, as it is one of the few times the supply has successfully made it through the entire season — and with room to spare.

Liquid helium is crucial to many of the scientific projects at the South Pole because it is needed to cool the detector arrays of telescopes searching the sky for faint signatures of distant objects.

The three keys to the success of this year's supply were new conservation, construction and more helium, said Al Baker, South Pole science support coordinator.

The first major contributor to making the 34,000-liter supply last was the conservation of resources. Even when a container is functioning properly, a certain amount of the liquid helium warms and returns to its gaseous form every day. This "boil-off" adds up over the course of the season and averaged around 100 liters a day this winter.

An additional 17 liters a day would have likely been lost had the Liquid Helium Users Group not pushed for the purchase of a cryogenic refrigerator, Baker said. This unit is fitted on one of the three smaller, 3,785-liter containers. It prevents loss due to boil-off by taking the escaping helium gas and re-liquefying it.

The system proved to be so effective that another of the smaller units was piped into the refrigerator as well. This created an additional two liters of saved helium every day.

"The cryogenic refrigerator saved us a ton of helium," said Christina Hammock, South Pole cryogenic technician. "There's no way we would have lasted the season without it."

The second step to making the liquid helium last was dealing with equipment failures that caused the loss of large quantities of the liquid in years past.

Photo by Al Baker / Special to *The Antarctic Sun*

Workers slide the largest of the liquid helium containers into the new South Pole cryogenic facility. This winter was the first time that two large containers instead of one were used to help meet the needs of scientists at the station.

> "The cryogenic refrigerator saved us a ton of helium. There's no way we would have lasted the season without it."
>
> *— Christina Hammock, South Pole cryogenic technician*

The winter temperatures are not cold enough to keep the liquid helium from returning to its gaseous form, but they are cold enough to freeze O-rings and seals made out of specialized rubber that help insulate the liquid.

Liquid helium heats up through conduction by contact with its container, in the same way a thermos of coffee eventually cools down, Hammock said. And if the outside weather compromises the insulating vacuum, the rate at which it heats up dramatically increases.

To protect the containers from the damaging weather conditions, the facilities, engineering, maintenance and construction department (FEMC) built a module last summer to house the containers and keep the temperatures at a moderate level.

"Usually, we ran out [of liquid helium] because a piece of equipment failed," Baker said. "This meant that each year we would run out at a very different time."

FEMC will continue to upgrade the facility this summer by constructing two additional modules that should be ready in 2007.

The final key to the helium supply's longevity was that there was simply more of it brought to the Pole this year, Baker said.

In past years, one large liquid helium container was brought, in addition to the three smaller containers, to meet the needs of the scientific community at the South Pole. But this marks the first year that two large containers — one 12,870 liters and the other 18,169 liters — were filled and brought to the Pole.

The demand for helium was higher than in past years, so the winter season began with the largest supply on record.

"This year has been a higher helium usage year," Hammock said. "We have used about 40 to 50 percent more than we have in the past."

Having the helium supply make it through the winter had a large impact on the amount and type of work the research teams could complete.

"In the past, the helium typically ran out at least several weeks before [summer]," said Bill Holzapfel, principal investigator for the Arcminute Cosmology Bolometer Array Receiver (ACBAR) project. "With the improved supply of helium this year, we were able to complete a survey of the cosmic microwave background radiation by massive galaxy clusters. This was one of the main science goals of the ACBAR project, but we needed the last several weeks to finish it."

Perspectives

Choosing ice over ocean, at least for a while

Karl Horeis
Special to the Sun

"This will all be yours in one short week: Dawgs! Ocean, trees, moon, stars, draft beer and green grass." That's what was written on the dry-erase board in the dish room just before I was supposed to leave McMurdo last summer.

But despite a diving trip planned in Egypt and the siren call of cold kegs, I had decided to stay the winter.

I would need an electric water boiler, a French coffee press and king-sized sheets for my doubled-up bed, but first things first: I needed a job.

I asked and asked and networked and applied and finally landed a job working four days a week in the vehicle maintenance facility and two days up in fleet operations.

This was a big change from the world of the dining attendant, which was my original summer job. Operating a loader two meters in the air offered a more commanding view than operating the pot-cleaning machine.

After six months of broad daylight, the sun dipped closer and closer to the horizon. At the end of each day in the VMF, I'd scrub the oil off my hands, step out of my dirty blue coveralls, and note the sun's changing position as I walked home along the gravel road. By April 11, there was low-angle sunlight coming across in shades of golden salmon behind the distant mountains. In the mornings, the constant dryness caused you to wake up feeling like your eyes had a dusting of powdered salt in them.

I learned new things like how to patch a hole in a 1.2-meter tall loader tire. Mechanic Mark "Diesel Dawg" Herrick showed me how. He leaned his body onto a power drill, sinking the rotating bit into the hole in the tire. It hissed loudly when he removed it. He took a strip of black rubber, secured in the end of a screw-driver-like tool, slathered it in blue goo, and stabbed it slowly into the hole. When he pulled it out the rubber patch stayed in the hole.

At fleet ops, when there was snow to be removed or someone to pull out of a drift, my boss Bob Teuscher would have the guys (or gal) "get on it like flies on a gut wagon."

On Tuesday the 28th of June, however, the weather put the kibosh on that. That day the weather forecaster wrote on his daily update, "Something wicked this way comes."

By Friday, after two straight days of a condition one storm, we were all ready for a reprieve.

"Who's religious?" asked Cat skinner (Caterpillar bulldozer operator) Clay Martin. "Somebody's gotta start prayin' to somebody."

The weather cleared a day later revealing shooting stars and whirling green auroras.

After eight or 10 months on the Ice, folks start to talk funny. Maybe it's the lack of stimuli and sunlight, but you start changing words around. People say stuff like, "Look at how fun we're much having" or "How long do you think that was movie?" Once a mechanic made a mistake in front of others then said, "I showed my stupid."

By Aug. 5, the sky was dark as tar overhead with sparkling stars but down low it was see-through baby blue and faded from smoky amber to passionate mango scarlet on the horizon.

Photo courtesy of Karl Horeis / Special to *The Antarctic Sun*

Karl Horeis just finished his first year at McMurdo.

One day around that time I drove out to the long-duration balloon site to drop off Bill Coughran, the winter National Science Foundation station manager. He was helping fleet ops by operating one of the bulldozers by Scott Base, a job he did when he first started working at McMurdo.

As we pulled up Clay climbed down from the machine, Bill got out, and the two of them talked in the pre-dawn glow. They walked on the world of snow, Clay trailing blue smoke from his cigarette, and I watched the sun light up Mount Erebus. Clay climbed in for a ride with the nutty smell of freshly burned tobacco about him.

I told him how another operator was having trouble in town with a Challenger trailer (flat-bed semi trailer with rubber-tracked wheels).

"That's probably them there," I said as we rolled into town and saw the equipment in the street-lit intersection. "You wanna go check 'em out?

"I don't want no part of the headaches in town," said Clay. He was a striking figure in the thick, dark beard he'd grown since summer. Back at the office he started another truck, letting it warm up so he could get as quick as possible back out into the serene beauty of the remote Antarctic.

Six weeks later, a new generation of dining attendants would be arriving on station, working hard in the pot room and writing hopeful things on their dry-erase boards. Clay and I meanwhile, would be preparing for our flights back to dogs, the ocean, trees, moon, stars, draft beer and green grass.

Karl Horeis came to McMurdo Station in October 2004, intending to stay only for the summer as a dining attendant. At the last minute, he got a job to stay for the winter and recently left after 12 months on station.

around the continent

Left, a group of gentoo penguins pay a weekend visit to Palmer Station and climb up the nearby glacier. Above, scientists studying phytoplankton off the Antarctic Peninsula prepare for a sampling trip. The group is part of the Long Term Ecological Research project.

Photos by Cara Sucher / Special to *The Antarctic Sun*

Learn more about science at Palmer in a story on page 8

PALMER

By Kerry Kells
Palmer correspondent

The majority of the science groups have now arrived on station. And we got some unexpected visitors.

Over the weekend, a group of 50 gentoo penguins came to Palmer's "backyard," the area of rock behind our station. They walked a fair bit up the glacier, perhaps making their way to a large gentoo colony on Biscoe Point, about eight kilometers away.

The gentoo penguins are not as common in our area as the Adelies, but their numbers seem to be increasing. Our seabird researchers, known as "the birders," say that the numbers of breeding pairs have increased on Biscoe Point in the last few years. One hypothesis is that warming trends in the area create a beneficial environment for gentoo breeding success.

Researchers on station include several groups of the Palmer Long Term Ecological Research (LTER) project, as well as members from Tad Day and Chris Ruhland's terrestrial ecology group. Some researchers are new to Palmer and some are returning after 20 or more seasons researching in the peninsula region, like Langdon Quetin, who began his research with the LTER at Palmer in 1981-1982. Maria Vernet began her work on the research vessel the *Polar Duke* in 1988-1989.

The community was given an introduction to the science groups on station at our Wednesday science lecture titled "Palmer Science 101," (see page 8 for more details). As summer continues, we will learn more and more about each component of LTER, from phytoplankton to krill to penguins. Other projects will teach us about the plants, insects, underwater research and geophysical research in our area.

In addition to the science lectures, we have many other social events put on by station volunteers. Nov. 3 was the first day of swing dance lessons, and Photoshop lessons continue on Tuesdays, with one more "lab" class planned. Spanish classes, yoga and exercise classes are all offered throughout the week and have regular attendees.

The researchers continue to wait for the pack ice and bits of fast ice to move out. Attempts were made at boating this week, and two launches were made and some samples obtained. The station is now preparing for the arrival of the *Laurence M. Gould*, scheduled for Sunday, Nov. 13.

SOUTH POLE

By Katie Hess
South Pole correspondent

South Pole Station saw the arrival of many more IceCube team members this week and the addition of the iron worker crew, bringing the night shift complement to full strength. After the recent influx, the population count reached 220 personnel on station. And we will add another 25 or so to keep up with a very rigorous schedule for both science and construction — not to mention the support staff for the exploding population.

"Night" shift here at the South Pole takes on a different meaning than it would

See CONTINENT on page 6

the week in weather

McMurdo Station
High: 23F / -5C
Low: 1F / -17C
Max. sustained wind: 22mph / 35kph
Windchill: -29F / -34C

Palmer Station
High: 43F / 6C
Low: 21F / -6C
Max. sustained wind: 16mph / 26kph
Precipitation: 3mm

South Pole Station
High: -36F / -38C
Low: -57F / -50C
Peak wind: 21mph / 34kph
Max. Physio-altitude: 3,385m

Continent

From page 5

at most other latitudes of the world. Our perpetual summer daylight allows us to work in full daylight conditions 24 hours a day. A major project on tap for the night shift will be to add siding to the front of the new station, which will give the building its final color — gunmetal gray. This is certainly a cold assignment!

The iron workers will dive into erecting steel under the front lip of the new station. The beams will be covered with siding that will smooth out the transition from the lip to the underbelly of the station. This will force rip-roaring winds to go under the station, theoretically keeping the drifting snow to the leeward side of the building.

As for IceCube, the project is returning to the station for their second summer with the optimistic goal of hot-water drilling up to 10 holes. After each hole is completed, a string of 60 digital optical modules is lowered into the ice to a depth of 1,400 to 2,400 meters. The strings send electronic signals to a data collector at the surface which essentially counts passing neutrinos in the same manner that the Antarctic Muon and Neutrino Detector Array (AMANDA) project does, but on a much larger scale. Activity includes assembling supplies for the summer drill camp.

Back inside the station, the plant growth chamber folks are hoping to maintain production that was at a record high over the winter. Hydroponics allows us to grow fresh vegetables from seeds without the hazards of bringing possibly contaminated soil to the continent.

Hear about a group of Polies' collective recurring nightmare in a story on page 7

Photo by Paddy Douglas / Special to *The Antarctic Sun*

An LC-130 plane lands at the South Pole skiway on Nov. 8. Planes filled with passengers and cargo start flying to Pole when temperatures crack negative 50 degrees Celsius.

SHIPS

NBP

Compiled from reports by Alice Doyle
Marine Projects coordinator

Nov. 2 began with another conductivity, temperature and depth (CTD) cast, taking measurements 200 meters down. After the CTD cast, the crew completed test runs for various instrumentation that had yet to hit the water. Most of the testing proved quite successful.

Nightfall came and temperatures dropped sufficiently to cause the deck seawater incubators on the helo deck to freeze. The crew managed to keep them running, but only with continual monitoring and de-icing. The morning sun was a welcome sight.

There is a lot of ice down here. This was expected, but going is slow. There are quite a few paths in the ice but unfortunately they do not all run south.

The large amounts of ice proved trying for the incubator system, as ice was getting drawn into the underway sea-water pumps and stopping the pumps. After early evening freezing, in order to prevent further tank damage, it was decided to drain them and take all of them off-line until the ship approaches the Ross Sea polynya, an area of open water in the pack ice.

Southward progress on Nov. 4 was still slow as we went through a lot of thick ice. The day started with a CTD cast to collect surface water. The next day also began with a CTD cast, as well as some system

See THICKEST ICE on page 7

Continental Drift

What's the best item you've gotten from skua*?

*Named for the Antarctic scavenger, a place to leave your own and search for other's used items.

John Fonseca, South Pole air transportation specialist in cargo, from Auke Bay, Alaska, first season

"A pair of old fleece pants … (by) cutting one of the legs off, and slicing the sides of the pant leg half way, you pull it up over your head and you have a nice fleece gator with a warm chest panel attached."

Ryan Wallace, Palmer carpenter helper from Buena Vista, Colo., third season

"A good hairpiece."

Michelle Ott, McMurdo administrative coordinator from St. Cloud, Minn., third season

"I skuaed out a pair of shoes I had put in the last year. I planned on buying new ones before I came back."

That most dreaded word: Boomerang

A hapless group of passengers need three flights, 17 hours and lots of sandwiches to reach Pole

By Tom Lohr
South Pole correspondent

The arrival of the first planes of the summer at the South Pole Station was set to be an exciting and bittersweet event. But for a select few it evolved into an ordeal that would have sent a shiver through explorer Robert F. Scott himself.

Winter workers and scientists waited in anticipation for the relief crew, whose arrival signaled the promise of a return to an above-zero-degree world. The new polar crew buzzed their way south in a series of three LC-130s. The hapless Polies aboard the third Hercules did not know what awaited them.

As ambient temperature crept below the safety threshold of negative 50 degrees Celsius, the unfortunate passengers heard the word that strikes horror in the most seasoned trans-Antarctic flier: boomerang. A boomerang is a flight that returns to its original takeoff location, generally because of poor weather at its destination or because of mechanical difficulties.

After six cramped hours of less-than-luxurious flying, and with two-thirds of their comrades at South Pole, the Polies aboard the third flight skidded to a stop back at McMurdo. Little did they realize their odyssey had only begun.

After several subsequent flights were cancelled due to weather, the stranded Polies clamored back aboard a LC-130 for another try at the Pole. Being treated to a second aerial tour of the Antarctic landscape made up for the delay in arriving, but the bonus two-hour bird's eye view of the station ended with the same utterance: boomerang. Again, the passengers returned to McMurdo.

After several more weather-related delays, the luckless Polies finally touched down at the Pole, nearly a week late.

The venerable LC-130s provide outstanding cargo support, but they offer few creature comforts for passengers. Three hours in such a plane is tolerable, if cramped, but what does one do for 17 hours in an over-crowded LC-130?

In the interest of advancing Antarctic research, we asked those who endured the ordeal to divulge how they passed the hours in the air.

Many, like materials handler Lynnette Harper, were able to burn through several books in an attempt to stave off the boredom. But as the hours wore on, monotony became the mother of invention.

Several luckless fliers fashioned a Scrabble-like game using a green memo book commonly referred to on the Ice as a "green brain." Dainella Nartker, an electrician's helper and airborne Scrabble player, thought that while the game was limited, it did help while away the hours.

Most boomeranged passengers do not get their baggage returned while waiting for another stab at the Pole. The experience of living for five days in the same clothes might have been the cause behind facilities engineer Nate Cannon's solution to remaining sane: singing to himself.

"With everyone wearing earplugs," Cannon explained, "no one can hear you anyway."

Steeling himself for a year at the bottom of the world, carpenter John Reese read a book that offered leadership tips based on the life of Genghis Kahn.

"Be mentally prepared," was the most common advice offered by Antarctica's most frequent fliers to those suffering from the boomerang syndrome.

Veteran fliers also advise, "Boomerangs are a way of life on the continent." Now you know why your bag lunch contains two sandwiches.

NBP hits thickest ice of trip; *LMG* heads to port

from page 6

tests, which went smoothly.

The ship continued to make southward progress throughout the day. In the afternoon, the *Nathaniel B. Palmer* encountered the thickest, most impressive ice to date. According to ice images, the ship has gone through the thickest of the ice and the going should get easier as it heads to the polynya.

LMG

Compiled from reports by T.J. Hurlburt
Marine Projects coordinator

The *Laurence M. Gould* continued its slow crawl northbound on Nov. 1. Speed did pick up quite a bit in El Estretcho de le Maire due to a fair current. Wind and waves also diminished late in the day.

The next day, the ship proceeded along the east coast of Argentina under fair weather and diminishing sea. The ship was scheduled to arrive at Punta Arenas, Chile, on Nov. 3.

Palmer Station scientists explain their work

By Kerry Kells
Palmer correspondent

The Palmer Station community was recently introduced to all of our science groups with a "Palmer Science 101" talk as part of the Wednesday night science lecture series.

Our station is now home to several groups of the Palmer Long Term Ecological Research (LTER) project; as well as researchers studying the production of a volatile sulfur compound called DMSP; scientists focusing on terrestrial ecology; and engineers installing the radionuclide monitor at the new International Monitoring System (IMS) building.

We first heard about the research of principal investigators Tad Day of Arizona State University and Chris Ruhland of Minnesota State University, who study terrestrial ecology. They focus on two vascular (water-transporting) plants: Antarctic hairgrass and Antarctic pearlwort. Two years ago they collected 240 plant cores and transported them to 20 plots near station. The plots undergo different experiments, such as increasing heat and precipitation. The researchers measure the plant litter decomposition, which is dead material still attached to the plant. Preliminary results from the experiments show an increase in growth and reproduction.

Patricia Matrai, from Bigelow Laboratory for Ocean Sciences in Maine, explained her work. She's looking at the volatile sulfur compound called DMS (dimethylsulfide), which is biologically produced mostly by phytoplankton as DMSP (dimethylsulfoniopropionate) and then fluxes to the atmosphere. She is seeking to understand how DMS leads to the formation of clouds over remote, pristine marine environments in polar regions. Her group will sample twice a week at two sites on the water known as stations E and B.

Members of the LTER groups then introduced their projects. The groups conduct long-term, marine-based research at Palmer. There are 26 other LTER sites around the United States and even a site at McMurdo in the Dry Valleys. In January, members from each group will board the *Laurence M. Gould* for the annual cruise along the peninsula south to Adelaide Island and the British Rothera Station.

Hugh Ducklow, with the College of William and Mary, studies the microbial biogeochemistry component (microbial ecology, dissolved organic matter and sediment traps) of the LTER. Bacteria, one micron in size (or one thousandth of a millimeter), decompose the organic matter and are a food source for zooplankton. In one milliliter of water (the size of a sugar cube) there can be one million bacteria. Bacteria recover dissolved carbon "lost" from the food web and return it to the consumers. He will also take samples from stations E and B and other sites as necessary.

Photo by Cara Sucher / Special to *The Antarctic Sun*

Members of Palmer Station's Long Term Ecological Research project collect samples near the station recently. The various groups study everything from plant life to krill to penguins.

Maria Vernet, from the Scripps Institute of Oceanography in California**,** is principal investigator of the primary production, or phytoplankton ecology component, of LTER. Phytoplankton (unicellular plants that float in the ocean) are responsible for introducing most of the organic carbon to feed other bacteria and animals, and need light in the upper part of the ocean to thrive.

The group will study abundance; rates of reproduction and mortality; and type, by using pigments and microscopy to indicate the group identification. The group's field sampling will measure light, salinity and temperature, which are the factors that affect growth for phytoplankton. They will also bring samples to the lab for analysis and experiments.

Langdon Quetin of the University of California at Santa Barbara, is principal investigator with Robin Ross and has more than 20 years of experience at Palmer. He explained the LTER's krill component. Krill are shrimp-like creatures that form an important part of the food chain. Krill primarily eat phytoplankton (visible in their stomachs) and are a food source for the penguins and whales of the southern ocean. They spawn in January and February and they grow to about 50-60 millimeters (about finger-length). His group will take acoustic data as well as collect krill with nets along two transects in the area twice a week. Some krill will be brought to the lab for growth experiments, pigment analysis and chemistry tests.

Peter Horne, a member of principal investigator Bill Fraser's LTER seabird ecology group, spoke about their continued research of Adelie penguins. They look at population trends, foraging ecology and breeding biology, with additional research on gentoo and chinstrap penguins. They will travel to seven islands: Torgerson, Litchfield, Humble, Christine and Cormorant, Dream and Biscoe. Their field work includes colony census, snow depths, reproduction rates, telemetry, tourist impacts, fledge weights and analysis of guano traps. They also study giant petrels, brown and south polar skuas and blue-eyed cormorants.

Two members of our community, Bouvard Hosticka and Erik Swanberg, are on station installing a radionuclide aerosol sampler/analyzer, or RASA. The RASA is being installed in the new IMS building located behind station. The RASA is part of the verification system of the Comprehensive Nuclear Test Ban Treaty, designed to ensure that nations are not conducting nuclear weapons tests. The RASA samples the atmosphere for radioactive particulates, indicative of a nuclear test. A second system will be installed later that monitors for radioactive xenon.

As the summer continues, the community at Palmer will get to know more about our research groups and the researchers themselves. Each group will host a science lecture. Lab visits and research assistance are also available throughout the season. Once the ice departs, their sampling and lab experiments can begin in full swing.

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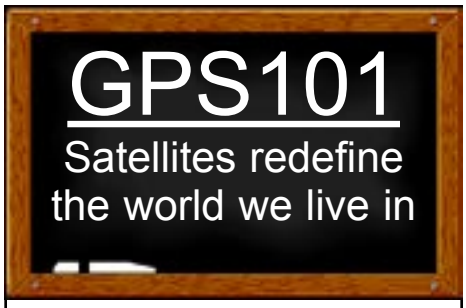
Photo by Stephane Mazzotti / Special to *The Antarctic Sun*

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.



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.

> "I measure how rocks move. It takes a while."
>
> *— 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

GPS waypoints include fish huts to tent stakes

From page 1

ging fishing huts around ice crisscrossed with small cracks to drilling holes for science teams to use for their various projects.

Holford is one of many U.S. Antarctic participants who regularly uses a GPS unit for different operations around the continent.

The landscape he moves through is deceptively static: A few blackened features interrupt the frozen sea like rips in a blank sheet of paper — Little Razorback and Big Razorback islands to his right, Tent Island looming just ahead. Weddell seals lay like bloated sea slugs on the frozen ocean surface near the Erebus Ice Tongue.

But cracks can abruptly form and rollers may erupt along established routes, looking like frozen waves poised to break on a white beach.

No matter where he's going or what he's doing, the GPS is tracking his movements, gathering data that's used in a variety of situations.

"We log all that information — hut location and the holes we drill," Holford explained. In fact, the GPS unit's waypoint list reads like a geography book index of the sea ice. A waypoint is a specific location of latitude and longitude, such as the coordinates of a sea ice hole.

Back in his office at fleet operations, Holford can download his findings to a computer and add them to a database.

With GPS becoming more commonplace, he now has several years of history to draw upon. The record includes information on past locations of science camps and sea ice road routes.

"[GPS is] being used more and more here," he said. "The technology is only getting better with the GPS units."

Tracking the trend

The trend to use GPS on the job site has spread throughout Antarctica.

Some uses are fairly obvious, such as for search-and-rescue operations and land surveys for the airfields. In other departments, the function isn't necessarily intuitive, but makes sense and quickly permeates the way they do business.

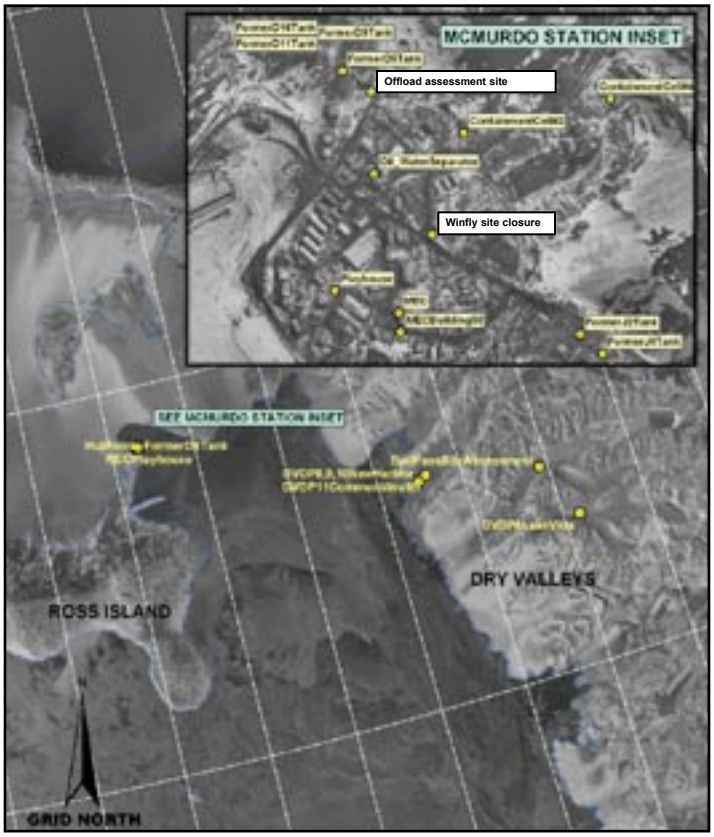
The environmental, health and safety department, for example, records GPS coordinates of soil sampling areas in McMurdo and the location of non-established helicopter landing sites in the McMurdo Dry Valleys.

"We're keeping a database of disturbances," explained Cindy Dean, EHS environmental educator.

A new use involves the Antarctic Specially Managed Area in the Dry Valleys. The ASMA designation, which went into effect last year, codifies more stringent environmental guidelines for a 15,000-square-kilometer swath of the area. Part of the new *modus operandi* is to record GPS disturbances as seemingly benign as staking a tent in a previously unestablished area.

Kaneen Christensen, Raytheon Polar Services Co. environmental engineer, said her department recorded about 20 science events in the Dry Valleys last year. Events involve anything from sample locations to tent locations to helicopter landings. There are almost a thousand individual points within the valleys, she said.

"Limiting impacts to the delicate soils of the valleys is important in sustaining the soils," Christensen said. "Tracking disturbance information, in theory, will allow us to determine what areas have been subjected to multiple disturbances. As the practice of tracking disturbances becomes more ingrained, recordings are likely to go up in numbers in the Dry Valleys and elsewhere."



Graphic by Kaneen Christensen / Special to *The Antarctic Sun*

Soil sampling sites in McMurdo from 1996 to 2004 are mapped out on a satellite image thanks to latitude and longitude coordinates provided by a handheld GPS receiver.

Events logged by EHS can vary from five to more than 200 waypoints, she added, with location data dating back to 1996.

GPS units are also issued to all science teams by the Berg Field Center, the REI-like warehouse of science support.

"Any scientist who is coming in is probably using one," observed Karla College, BFC supervisor.

She said there's been a marked increase in the number of units the BFC has in its inventory. In 2002, there were 80 Garmin GPS units and five older Magellan models. Today, the stock includes about 160 different Garmin GPS models.

The bigger picture

Before 1994, locating the next spot for the shifting geographic marker at South Pole every year wasn't exactly Stonehenge mysticism, but neither was it as precise as it is today thanks to GPS technology.

Larry Hothem, with the U.S. Geological Survey, went to the South Pole Station earlier this month to reset the marker using high-precision GPS, which provides accuracy within a centimeter. Before that, Hothem said the Pole was located by Doppler Satellite Positioning, which is accurate to about a meter. Because of the motion of the ice, the geographic pole slides about 10 meters a year, heading in the general direction of the Dome.

This year locating the pole marker will be a little tougher because it's being done much earlier than normal. Hothem usually arrives at Pole shortly before New Year's Day, when the new marker created by the previous winter crew is unveiled and set

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GPS network still growing

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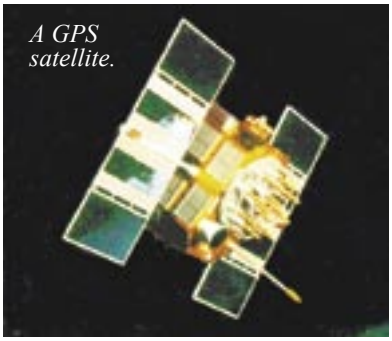
The larger network is called the Global Navigational Satellite Systems, the GNSS. The United States defense department's system isn't the only satellite navigation system twirling around in outer space these days, he explained. There's a Russian network, called GLONASS, which is part of GNSS. Europe is launching its own constellation, called Galileo, that will also join the international system.

"This [technology] has evolved far more than the early planners for GPS had envisioned," he said.

GPS satellites circle the earth about 19,000 kilometers overhead, twice a day, in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received.

The time difference tells the GPS receiver how far away the satellite is. With distance measurements from a few more satellites, the receiver can determine the user's position.

A GPS receiver must be locked on to the signal of at least three satellites to calculate a two-dimensional position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can also determine a three-dimensional position (latitude, longitude and altitude). Once position is determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.



A GPS satellite.

Graphic couresty of Peter H. Dana, The Geographer's Craft Project, Department of Geography, The University of Colorado-Boulder / Special to *The Antarctic Sun*

Photo by Peter Rejcek / *The Antarctic Sun*

Tom Holford records GPS coordinates in his "green brain" notebook during a workday on the sea ice last month. Holford, who works for fleet operations, keeps GPS waypoints on fish huts, science camps and ice roads during the part of the summer when science and operations are conducted on the ice.

South Pole marker relocated every year with GPS satellites

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in its new location. This time he will have to project forward the location based on calculations taken in October.

Hothem had a couple of other projects to do at Pole, including relocating a GPS receiver system from on top of the Skylab building to the new elevated station.

"We're among the last to leave the old facility as I understand it," Hothem said.

The South Pole, like McMurdo and Palmer stations, serves as a reference station in a global network of stations called the Global Navigation Satellite Systems (GNSS). The reference station data are used in computations for the precise orbital coordinates for the GPS satellites, for scientific research such as mapping changes in the ionosphere, and for conducting real-time GPS positioning, according to Hothem.

"[Pole is] a very useful station for evaluating the predicted satellite orbits that are included in the message broadcast to users such as those mentioned earlier. Though the station is moving at a constant and predictable rate, the station serves as a reference station to compute long-range coordinates to other points," he said.

Back in McMurdo

As one often hears in contexts both serious and lighthearted, Antarctica is a harsh continent. When the winds start to blow or the clouds create a disorienting landscape, an additional safety net is valuable. Again, the GPS unit is handy.

When returning to McMurdo on the sea ice road that Holford had tracked on the GPS earlier, the tractor icon on the unit's screen runs along the same black line it had spun earlier. Holford said that the GPS can be an invaluable tool for keeping out of trouble away from station, as it "drops digital bread crumbs" behind his tractor rumbling along the sea ice.

But he cautioned that the GPS isn't a substitute for good visibility.

"Using your head is the No. 1 tool," he said.

A GPS was used to help layout the ice road to Marble Point, near the sea ice edge.

The 16-hour traverse can be brutal on both machines and operators. By studying last year's coordinates via helicopter, it was determined that the old route was probably the best to use, according to Holford, saving some wear and tear on people and equipment.

"It's getting rougher every year," he said of the multi-year ice with its melt pool voids, saline pockets, deep snow and sastrugi.

"It turned out last year's route, in general, was the best we could do."

Krill fished as food for people, livestock

From page 1

said Demer, leader of the Advanced Survey Technologies Program at the National Oceanic and Atmospheric Administration's Southwest Fisheries Science Center.

Annual acoustic surveys of the Scotia Sea off the peninsula, where a large majority of Antarctic krill fishing happens, have measured krill abundance for more than two decades. But Demer realized several years ago that the survey was missing important areas near shore. Since that's where penguins, seals and whales spend much of their time feeding, he figured there was a lot of krill there that were left out of the survey. His first near-shore survey in February 2000 confirmed his hunch.

Demer and Warren, an assistant professor in the Marine Sciences Research Center at Stony Brook University on Long Island, joined forces and are in the second year of their three-year project. They use a small, six-meter boat launched off a larger boat to get to the areas within about eight kilometers of shore to measure krill abundance using a variety of underwater instruments.

The tiny, shrimp-like krill are fished for consumption by people and to serve as feed for poultry and livestock. They are also a vital member of the Antarctic marine ecosystem.

"Every [larger] animal depends on krill," Warren said, particularly whales, seals, penguins and sea birds.

The researchers will send their results from a six-week cruise in January and February to CCAMLR. These numbers will complement the much bigger survey that the U.S. Antarctic Marine Living Resources Program conducts each year from a 91-meter ship that must stay in deeper waters further from shore. The near-shore study covers about 400 to 500 square kilometers along the western side of the tip of the Antarctic Peninsula.

Last year they found large krill patches in the near-shore survey. While krill may be small individually — two to five centimeters long as adults — when found in large groups their size is impressive. The researchers found one patch last year that was estimated at 200 meters long by 70 meters wide and 80 meters high, Warren said. That equals roughly a million cubic meters, or about the size of a football stadium completely full of water. With an estimated five krill per cubic meter, that would mean about five million krill, he said.

Photos by David Demer / Special to *The Antarctic Sun*

Above, a near-shore survey vessel is moored at Cape Shirreff on Livingston Island. David Demer's design for the six-meter vessel includes acoustic sensors to map krill abundance and seafloor depths, and instruments to video animals underwater, record weather conditions, and measure seawater properties. Below, an instrumented buoy sticks out of the water.

The scientists use a couple different kinds of acoustic measuring devices to do their work.

Warren describes their acoustic echo sounder as "essentially a fancy calibrated fish finder," a high-power, ultra sensitive version of what you'd see on a bass boat back home. It sends a wave of energy into the water column that is reflected back at different levels depending primarily on the size, density and sound speed of what it's hitting. Sound speed is the amount of sound reflected from an animal, which depends largely on its body size and material. Marine biologists have become skilled at recognizing what signals represent which types of animals are in the water, Warren said. Antarctica is a good place to do acoustic readings because there's little variety of species in the waters here.

They also use a Doppler sensor, which measures the speed and direction of particles and bubbles in the water much like a police radar gun monitors drivers' speeds. This helps them understand the current in the area.

Warren will go back out in the six-meter boat this season. He uses the instruments to get readings and then verifies the information by sending down a video camera or casting out a net to make sure the signal was really from krill.

The researchers also plan to deploy five thin, seven-meter-long buoys that can stay in the water and obtain data for several months. The lightweight buoys, designed and built by Demer's program, are equipped with the echosounder and Doppler sensors. The buoys transmit their data by radio to a laptop computer on shore, about eight kilometers away. This way, the instruments can be remotely controlled, and the krill and water current data can be viewed in real-time throughout the project, Demer said.

The men think that the reason for the abundance of krill near the shore is that the nutrient-rich, circumpolar deep-water current is funneled into the area through two underwater canyons. Warren said it's unclear whether this is an anomaly or a common feature along the Antarctic Peninsula.

"Does this happen all over the area or did we stumble upon the one part where it does?" he asked, adding that they'll likely put together a proposal to study the presence of the deep-water current in other areas close to shore.

NSF-funded research in this story: Joe Warren, Stony Brook University; NOAA funding for David Demer, Southwest Fisheries Science Center.

Profile

Ice still spellbinding

Mastro returns to continent as temp lab supervisor

By Peter Rejcek
Sun staff

Jim Mastro would rather feel a warm tropical breeze on his face than bundle up against a windchill that regularly plummets well below freezing.

But in the 23 years he's been coming to Antarctica, there's never anywhere else he'd rather be.

"It's funny, because I hate the cold," he said. "I prefer the tropics, but I never mind coming here. It's a magic place and I love it."

Mastro has had some pretty good seats for that magic show over the years. He's worked both above and below the ice, as a grantee studying Antarctic animal life, as a diver and as assistant lab supervisor at the Eklund Biological Center at McMurdo. The EBC was a predecessor to the Crary Science and Engineering Center, McMurdo's main science building.

Now a professional writer and photographer, Mastro came back this season for the first time in nine years to serve as interim supervisor of Crary.

The experience of returning to Antarctica after nearly a decade's absence has been a bit surreal, he said.

"There have been some pretty dramatic changes over the years," he observed.

Perhaps the biggest change for Mastro, who is here for a month, is that he's not out exploring the continent he cares so much about. This time there are no trips to Bird Island to study the fur seals. This time there are no reconnoitering expeditions to ice caves or face-to-face encounters with the alien underworld of the sea.

"The diving here is the best diving anywhere in the world," exclaimed Mastro. His steady, measured voice speeds up exponentially as he recalls his time managing the dive program. He dove regularly in the early and mid-1990s, honing his underwater and photography skills. His last dives were during the 1996-97 summer season as a grantee researching invertebrates.

"It's awesome. It's incredible," he added of his underwater adventures. "As a photographer, the cool thing about it is, you realize that a lot of this stuff hasn't been documented photographically … I [could] be a true explorer. I [could] dive and see things that no other human has seen in the history of the Earth."

Jim Mastro returned as the interim supervisor at the Crary Science and Engineering Center this season after a nine-year absence. The biologist-turned-writer has published a book on Antarctica that's largely based on his first tour at McMurdo in 1982.

Photo by Peter Rejcek / *The Antarctic Sun*

While he prefers fieldwork to a desk job answering streams of e-mails, Mastro said he's enjoyed stepping in as lab supervisor.

"It's been awfully good having him in the lab," said Karen Joyce, the IT manager at Crary. Joyce first met Mastro in 1990, her first year on the Ice. "I wish he would stick around."

A biologist by profession, Mastro has turned to writing full time. In 2002, he published a book of memoirs and photographs about his experiences here. Largely based on reminiscences of his first 14-month tour, but sprinkled with anecdotes from other seasons. The 176-page book is called, "Antarctica: A Year at the Bottom of the World."

"Everything was new. Everything was different," Mastro said of his first long stint at McMurdo Station in 1982-83. "The winter was just magic."

Mastro captures that magic in the book's 125 color photographs. The images include a rare winter snapshot of Erebus' permanent molten lava lake.

"I stood in the cold with the camera shutter open, holding a cable release and counting off the seconds for a series of images, while my fingers froze," he wrote in his book of the ethereal photo. "And I got lucky."

Current U.S. Antarctic Program participants may be more familiar with his iconic postcards, like the one of a diver inverted at the surface, standing upside down under the ice.

Other books include two writing projects with photographer Norbert Wu — "Antarctic Ice" and, more recently, "Under Antarctic Ice: The Photographs of Norbert Wu." Mastro has also been published widely in magazines, but he's turning his pen to fiction these days. Right now he's in the midst of writing a science fiction trilogy for young adults.

"I decided to branch out a little bit, and I've always wanted to write novels," he said of his current writing project, which he is eager to return to. He declined to discuss the trilogy's plot, saying, "This was just a fantasy that I had as a kid, and I thought it would make a great story."

But it's the story of the Antarctic program that seems to inspire the 52-year-old writer as much as anything. After spending an hour speaking with Mastro, one has surely met one of continent's most ardent stewards and biggest fans.

"What we do here is pure science," Mastro said. "[Science] doesn't expect anything except to search for truth … to learn more about the universe, about the world we live in. … To me that is a noble enterprise."

He said he puts Antarctic research on par with the space program. He noted, for example, that scientists here were instrumental in understanding how the annual ozone hole was created and how the damage could be stopped. If gone unchecked, ozone depletion could have had disastrous results for life on the planet.

"The Antarctic program, in my opinion, saved humanity and most of life on Earth," Mastro said with unflinching admiration. "It proved itself and it will continue to prove itself."

Mastro leaves the continent next week. But even thousands of kilometers away at his home in New Hampshire, Antarctica will never be very far from his thoughts.

"I have missed Antarctica every day that I haven't been here and I will miss Antarctica every day that I'm not here for the rest of my life," he said.