desolate beauty

Three hundred miles from South Pole Station aboard a Twin Otter turboprop plane, Bob Melville and Cil Jeffer were searching the ground, eyes glued to their frozen windows, for a tiny flash of color amid the unbroken sea of white below. While their maps gave them precise coordinates for the red flags marking the refueling station, the shifting snow drifts of the Antarctic ice shelf seemed to mock those two-dimensional certainties.

a scientific team journeys into antarctica's

'deep field'

Landing on a glacial "airfield" at one of the five remote instrumentation sites known as autonomous geospace observatories, or AGOs, that NJIT operates in Antarctica's deep field. The challenge of providing continuous power to the remote observatories, including the six months of darkness prohibiting solar energy, has led to substantial engineering improvements such as upgrades to wind turbines to operate at low temperatures and novel methods to service them

IN SEARCH OF ROSANNE CACHE

En route this past December to one of the five remote automatic geophysical observatories, or AGOs, that NJIT operates in the frozen wilderness, running out of fuel at the halfway point was a scary prospect indeed. Rescues in what denizens of the Earth's southernmost continent call "the deep field" are dependent on two of the biggest uncertainties of all: fair weather and available transportation. There are times when atmospheric conditions make it impossible to distinguish between sky and ground.

"It's like finding a buoy a third of the way across the Atlantic Ocean," recounts Melville, an engineer with NJIT's Center for Solar-Terrestrial Research, describing the Antarctic Plateau, unpunctuated by trees, animals or even visible rocks in most areas. "The wind blows and you can come back two weeks later and not find them." Traditional navigation near the Pole is unreliable: standard compasses are disrupted so close to the Earth's southern magnetic pole and GPS sometimes fails. But finally, "Hurrah! There it was."

After a snowy landing at the fueling site, "Rosanne Cache," a bit of drift-digging for the 55-gallon barrels and a quick inspection by flashlight for any signs of ice in the jet fuel, they were back up in the air and on the way to AGO 3, where he said the real adventure began.

"Once down, we had just two hours to dig our way into the station, get out our laptops and connect to the computers there so we could upload the software I'd designed to update our instruments – and hope there were no glitches. And then get back up in the air in time to reach the South Pole before the pilots exhausted their

Abominable engineer, Gil Jeffer, after shoveling his way through a snow drift to gain entrance to one of the remote instrumentation observatories, last visited four years ago. U.S. ANTARCTIC PROGRAM

Phew! From high in the sky, the crew spots a fueling station and dips down to fill up before continuing on to a remote solar observatory.

authorized flying hours," Melville said. "We were also installing a new telemetry system to send data back to the states, for which Gil had written the program. I was chewing my nails. We plan and rehearse for these moments. Mission failure – and more than \$50,000 in National Science Foundation (NSF) funding for nothing – is unthinkable."

POLAR GEOSPACE LABORATORY NJIT researchers have been journeying to this nearly empty, frozen wilderness at the tip of the globe since 2007 to collect data on fluctuations in the magnetic lines caused by solar wind and to measure light from the Aurora Australis, or Southern Lights, the luminous collision of charged particles drawn by the South Pole's magnetic field. Their instruments include photometers that collect light from the Aurora Australis and measure energy from outer space, magnetometers that measure fluctuations in the magnetic field and GPS receivers.

"Our instruments in Antarctica give us continuous data sets of the larger geospace environment, which you can't do in space because the instruments are continuously orbiting," says Andrew Gerrard, director of NJIT's Center for Solar-Terrestrial Research, who notes that the university's work in Antarctica, which is supported by the NSF, comprises a mix of basic and applied science focusing on the Sun and its impacts on Earth.

But this year's two-month stay was unusually challenging – and important. NJIT is now managing the major geospace instruments in Antarctica – at McMurdo Station, South Pole Station and the five AGOs – not just for its own purposes, but for the entire community of space weather physicists, including researchers from Dartmouth College and Merimack College conducting high-frequency radio work at the South Pole, as well as longtime



The U.S. National Science Foundation welcomes you to Amundsen-Scott South Pole Station





Fear of freezing? Never! NJIT's intrepid engineers look forward each year to their winter trek to the frozen wilderness of Antarctica, where the science and the polar society are like none other. The South Pole telescope, located about a kilometer from the base station, is designed to study the cosmic microwave background, helping scientists map galaxy clusters and explore dark energy, the force that may be driving the expansion of the universe.

"WE'RE ABLE TO COLLECT CRITICAL DATA FOR OUR OWN RESEARCH, HELP THE BROADER COMMUNITY BRING THEIR INSTRUMENTS TO ANTARCTICA AND SHARPEN OUR OWN UNSURPASSED ENGINEERING SKILLS WHILE

WE'RE THERE." -ANDREW GERRARD

remote data collection at the AGOs for collaborators at the University of New Hampshire, Augsburg College, Stanford University, University of California-Berkeley, and many others.

"We're able to collect critical data for our own research, help the broader community bring their instruments to Antarctica and sharpen our own unsurpassed engineering skills while we're there," Gerrard notes.

NJIT'S CRACKERJACK ANTARCTICA CREW

The three-member engineering crew of Melville, Jeffer and Andrew Stillinger had little idea what awaited them at the remote stations, last visited four years ago. It was even possible that they would be buried.

Indeed, maintaining the unmanned instruments is no

small engineering feat in the harsh environment around the South Pole. The remote observatories, approximately the size of a Winnebago, must be jacked up periodically to stay out of reach of rising drifts. Supplying continuous power year around, including the six months of darkness prohibiting solar energy, has led to substantial engineering developments such as robust power delivery, upgrades to wind turbines to operate at low temperatures, and novel methods to service them. The crew has written papers about their exploits that have been published in peer-reviewed engineering journals.

"The replacement parts are mostly off-the-shelf electronic components from online vendors – we purposely designed the system to use commonly available parts

whenever possible," says Stillinger, the power-system maestro. They monitor the stations, which are positioned on magnetic meridians, by Iridium satellite system short-burst data service. Melville designed and built a small, self-contained computer-based electrical monitoring unit that observes the main power system, including temperatures, and sends the information up to a satellite which then conveys the information to a website or e-mail address. By doing a remote log-in to a computer in New Jersey from the South Pole, Jeffer is able to verify that data is coming in as expected.

"The AGO power system is measured several times an hour and reported, 24 / 7 / 365.25+ — that's geek humor for all of the time," Stillinger says. This year, the different crew members were able to make it to four of the five remote stations, despite the lack of fuel supply from the all-important providers – the U.S. Air National Guard stationed at McMurdo – for 19 days in a row in December. Always precarious, Stillinger recalled that one delivery was delayed for several hours because their suppliers were having a tough time shooing penguins off the runway. "Humorous," he concedes.

To their delight, all but AGO 1, where the primary voltage regulator in a wind turbine "blew up," as he put it, were working with humming efficiency.

"Andy (Stillinger) went all MacGyver at AGO 1 to fix it with a junkyard assortment of replacement parts hed collected at the Pole. He was truly heroic," Jeffer recounted. "We arrive with few parts, because it's not clear until you get there what's happened and you don't have the luxury to lug a lot of heavy equipment. Even for people who go to Antarctica, this is the middle of nowhere."

"We're the consummate scroungers for replacement parts and smaller electronic equipment," Stillinger notes.

"Keeping these stations running for that long is quite an accomplishment that should be fully appreciated," says Louis Lanzerotti, distinguished research professor of physics at NJIT, who was among the pioneers to first establish instruments — mainly magnetometers — in Antarctica in the 1980s. A celebrated figure there, he was honored a decade ago with the naming of the eponymous "Mt. Lanzerotti" 100 miles from McMurdo Station.

Under Gerrard, the current crackerjack crew assumed the mission several years ago lest it fall into disarray. They promised – and delivered – key upgrades, such as a new proton magnetometer, which records changes in Earth's magnetic field every second. They expanded the instruments to cover not just the magnetosphere, the region where solar wind collides with the planet's magnetic field, but the closer-in ionosphere, where radio signals are detected. They improved power systems and data acquisition instruments.

Three years ago, for example, the team established internet connectivity to NJIT's instrumentation for the first time, allowing the Center to collect real-time data on solar radiation, magnetism and wind. With upgraded telemetry following this year's trek, they now get real-time readings every five seconds from magnetometers, Jeffer notes.

"The most important data we collect on Earth's magnetic field keeps us apprised of what's going on deep in the magnetosphere, and can therefore tell us what's coming in from the Sun's wind and what's driving the upper-atmospheric system," Gerrard says.

However, they continue to gather data manually at regular intervals because there is not the bandwidth at the stations to send the even more precise data recorded thousands of times a second that is stored on the computers in Antarctica. All of this despite temperatures that sometimes fall to 100 degrees below zero and the attendant risks of accidents in this inhospitable environment.

From the most remote spots, "If you break a leg, it's 15 hours before you can get back to the South Pole," Melville says, adding, "I did 16 days once. Two weeks without a shower and you start to get 'toasty,' a term at the Pole that conveys a host of things, physical and psychological. Even your clothes stop insulating you as well."

This year, as always before a trip into the deep field, the team

was required to undergo two days of "Happy Camper" training, including an overnight 10 miles from South Pole Station where they set up a shelter and acclimated to the below zero temperatures and high elevation in order to avoid altitude sickness and other "coldness injuries."

After spending nearly three weeks at lower elevations, Jeffer and Stillinger were required to retrain before a final trip to AGO 5, which is 660 miles from McMurdo Station. They rode by helicopter to the northeast slope of Mt. Erebus, the southernmost active volcano in the world, where they pitched camp with guides August Allen and Vicki Siegel on a jagged stretch of the caldera rim called Fang Ridge, at an elevation of 9,900 feet.

CAMPING ON MT. EREBUS

"This is one of three volcanos in the world with active lava lakes inside, which bubble all of the time, not just during eruptions," Jeffer said.

Left to right: Gil Jeffer, Andy Stillinger, August Allen (kneeling) and Bob Melville The Nathaniel B. Palmer, an Antarctic icebreaker built for extended scientific missions and named for a 19th century sea-faring seal hunter, explorer and ship designer, in McMurdo Sound.

"We were there for five days, the amount of time it takes to acclimate in order to avoid headaches, ulcers and even death, before heading out to the AGO."

Why do they relish these harsh conditions? They answer with an incredulous look. No matter how many times you visit, the Antarctic remains a place of wonder, like no other on earth. Jeffer, who pinched a nerve early on in the trip but soldiered on nonetheless, calls it "beautiful desolation" akin to the otherworldly experience of landing on another planet.

Or they show you a photo of a sundog, or parahelion, a mammoth halo of ice crystals above the horizon that "dog the sun" and look like a coded message from outer space.

Melville explains how the Earth's magnetic field lines are shaped like the letter C, touching down at the North and South Poles and bowing out in between. At the extremes, particles from the Sun get trapped in a field line and lose their energy, emitting a radio signal. "And we can listen to those signals with our receivers. It takes four minutes for them to travel from one hemisphere to the other."

WAVING AT BUZZ ALDRIN

Near the Shackleton Glacier, they helped a team of paleobotanists load boxes of fossils onto a plane before returning to McMurdo.

"You never know what kind of scientific task you might be asked to help with," recounts Melville. Indeed, Antarctica is so unique and magical that it attracts adventurers who have visited other worlds. On their arrival, the crew saw Buzz Aldrin, the 87-year-old Apollo 11 astronaut and second man to walk on the moon, embark on their plane on his way out of McMurdo. According to news reports, he'd suffered from altitude sickness and was airlifted to Christchurch, New Zealand.

"It was clearly on his bucket list," Melville says.

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Seen from the window of a Twin Otter plane, thaw streams at the terminus of the Koettlitz Glacier where it flows into McMurdo Sound.