On the Dark Side of the Planet

A letter from South Pole Station

by Stephen Warren, October 1992

Antarctica had been on my mind for a long time, but it wasn't until February 1960 that the idea of wintering captured my imagination, when my father took me to an evening slideshow at Purdue by Paul Siple: "Man's First Winter at the South Pole." Then I took a glaciology course in 1968, changed careers in 1978, and joined three spring-and-summer Antarctic expeditions. After all that preparation I was ready for the winter of 1992, with experiments on climate processes involving snow, clouds, sunlight and atmospheric radiation. My students Rich, Von and Susan designed and built their equipment and came for the summer to install it and instruct me on how to operate it; then left me for the winter to gather the data for their thesis projects.

There are 22 of us here for the eight-month winter season: ten carrying out science projects and twelve support staff. The winter research projects involve weather and climate, clouds and snow, atmospheric chemistry, stratospheric ozone, physics of the ionosphere and magnetosphere, aurorae, solar and infrared radiation, seismology, gamma-ray astronomy and neutrino astronomy.

The environment on the interior plateau is surprisingly friendly to scientific experiments: instruments here are not subjected to soaking by rain, corrosion by seawater, or breaking by strong winds. They are safer here than in the tropical jungle, where trees would drip on them and toads would sit on them. Of course the winter here is colder than anything we're used to, with an average temperature of -60 C, but we've learned to adapt to it; we're even able to conduct an experiment that involves walking out periodically to a remote clean site and working for three hours to collect snow samples.

It is beautiful here, even though we have only the snow and the sky. Low ice-clouds occur throughout the year, but in summer there are also clouds of supercooled liquid droplets. Snow grains fall from these clouds, and tiny sparkling ice crystals called diamond-dust fall from the clear sky, causing beautiful colored halos and arcs around the Sun and Moon. After sunset in March the twilight faded slowly and was still faintly visible until early May. Toward the end of twilight we once saw a "noctilucent" cloud: although the Sun had sunk far below our horizon it could still illuminate this high cloud 80 kilometers up.

In winter we saw aurorae on most clear days: usually just broad white streaks but sometimes swirling colors, and just once we witnessed an aurora of dancing needles. The Moon circles above the horizon for two weeks; then it sets for two weeks to allow the constellations to dominate the sky: the Scorpion, the Centaur, the Southern Cross, and the Magellanic Clouds, with Orion chopped in half by the horizon. The bright stars Sirius, Canopus, Achernar, Fomalhaut, Alpha and Beta Centauri, and Spica compose a familiar pattern unchanging throughout the winter, while Saturn wanders slowly through Capricorn.

Here are some stories from the winter.

SUNSET **Monday morning 23 March 1992**

In March the Sun moves one degree to the north every two-and-a-half days. The Sun's width is half a degree, so at the South Pole it takes thirty hours for the Sun to set: thirty hours from the time the bottom of the Sun touches the horizon until the upper rim finally disappears. This is the most leisurely sunset anyone on Earth will ever experience. The Sun entered the Northern Hemisphere on Friday evening, but we can still see its upper arc even today refracting through our temperature-inversion, dimmed and distorted by a dusty haze of blowing snow.

I'm writing this letter by the big picture windows up in the Skylab lounge. The Sun no longer looks round; it's now a stack of three orange pancakes. The tops and bottoms of these cakes ripple with the wind. The left and right edges flash alternately yellow and green. Behind me, on the night side of the sky, the past-full Moon shines high and bright.

A great-circle boundary line separates the day half of the Earth from the night half. Today the South Pole is on that boundary. Look over to the Sun; just now that's the direction of Hawaii; in that time zone it's noon now. Look in the opposite direction to the dark sky, toward Botswana and Finland; in that time zone it's midnight.

We were treated to a fine show on Saturday evening. The entire Sun was still above the horizon, but it was giving us a farewell display that isn't supposed to happen until the upper rim sets. Green flashes came and went for an hour or so. From the green-fringed shimmering upper arc, green flakes would cleave off, rise, then vanish; sometimes two or three flakes would be following one another as if on a conveyor belt: as the top one disappeared another would rise from below. Then came the most amazing shocker that stunned us all: a triangular green cap perched on top of the orange disk; this little green pyramid was visible to everybody, not just through the binoculars. What a treat; there were some wide grins on those orange-glowing faces at the Skylab window!

MIDWINTER VISITOR **Tuesday 16 June 1992**

The winter airdrop was scheduled for Saturday the thirteenth of June, the only delivery of mail and freshies between February and October. Gary, our Station Manager, called a planning meeting for Wednesday evening, at which I parceled out my remaining supply of chemical hand-warmers and toe-heaters to everybody for use during the airdrop recovery; I was expecting a big shipment to replace them. After the meeting we brought in the Christmas tree and put up decorations.

A blizzard began on Thursday, continued through the airdrop, and still continues today. On Saturday afternoon at 1:45 the airplane came, an Air Force C-141. It had flown all the way from New Zealand (3300 miles), and would return without landing anywhere, so it had to be refueled in the air by a tanker-plane over the Antarctic Ocean.

In order to see our smudge-pots marking the drop-zone on the runway, the plane had to descend below the clouds; yet it had to remain above 1500 feet to allow the parachutes sufficient time to open. Kitt and Bob were reporting clouds at 1000 feet all morning, so we doubted that the airdrop would occur. It's a one-shot event; if it fails we don't get our mail until October.

The plane was able to see the drop-zone. Eighteen bundles drifted down from the dark sky, each hanging from its own parachute. Three teams, each carrying a radio and followed by a tractor with a forklift, were sent out to find them. After watching the drop, Bob and I were on our way inside to help with unpacking, but we decided briefly to be tourists and walked out with Team 3 toward the smudge pots. We wanted to see how the parachutes were attached and how deeply the bundles had dented the snow. It turned out that Team 3 consisted of just Dave and Joe, followed by Martha driving the tractor. They asked for our help, so we ended up working with them for three hours.

We trudged out into the blizzard. For a short while we could still see Team 2 in the distance to our left (Bill, Mike and John), silhouetted by Darrell's blinding headlights as he lumbered along behind them, bouncing over the sastrugi.

Away from the headlights it was pretty dark; the Moon was obscured by blowing snow and thin clouds. In three hours our team located seven of the bundles. Each bundle, a big cardboard container, weighed about 500 pounds. And by the time we reached the last one, its parachute also weighed about 500 pounds, because of the snow that had drifted onto it!

We walked far out along the runway, beyond the new telescope building, to find the most remote bundle. It had split open on impact, but nothing had fallen out. We righted the bundle so the forklift could get under it; then Bob walked out north into the darkness to search for even more distant bundles.

Dave and Joe were sheltering behind the box out of the wind, waiting for Martha to return with her forklift after delivering our first three bundles to the dome. I peeked through an opening in the broken cardboard. By the moonlight I could see that it was full of small parcels. Curious as to whether the mail for McMurdo Station had been dropped here by mistake, as had happened last year, I pulled out one package, borrowed Dave's flashlight to illuminate it, then asked Joe to look at the address. Through his ice-encrusted eyelashes, his frosted glasses, and a swirl of blowing snow, he was still able to make out his own name on the package: Joseph P. Migliore!

By 4:30 pm all eighteen bundles were inside the dome. Drew had discovered how to use a butter knife to remove the cargo straps. Dan and Jim helped Paul hang the parachutes to dry over the volleybag court. They shook the loose snow off them; then Roger swept it out the door.

By 6 pm Betty and Jarvis had sorted all the mail in the galley. Peter turned on the Christmas-carol music, and the package-opening began. I opened only what was unexpected; the eleven boxes of cargo I had requested from Von and Susan at the University (four of them full of handwarmers and toe-heaters) could wait. The very first package I saw was from a long-lost friend: what a surprise; how did she even get my address?

Saturday evening I briefly left the cheerful chaos of the mail-opening party to check on Susan's experiments out at the Clean Air Facility. Before returning, I stood on the balcony and leaned against the railing for a while in the brisk warm wind (twenty-five knots and forty-below). Besides the nearly full Moon, the bright stars Alpha and Beta Centauri also shone dimly through the blowing snow. Two days later the full Moon, as far above the horizon now as the Sun is below it, would be eclipsed for three hours by the Earth's shadow.

Kitchen cleanup duty comes every 22 days; Sunday was my day. It involved more work than usual because of all the packaging-trash, and because Jerilyn prepared a special Christmas dinner with turkeys, wine, candles, and tablecloths, so I got a lot of help from volunteers. Jeff and Dale were also there all afternoon unpacking fresh pineapples, watermelons, onions and eggs that had fallen from the night sky.

I'm reluctant to admit this to my friends and relatives who took the trouble to send me those (now much-appreciated) letters and packages, but I guess it has to be part of the complete story: I was not eager for the airdrop. I still hadn't yet read all my February-mail, and I still had enough work and reading material to keep me busy for another year at least. I had settled contentedly into the pleasant life of a remote station, able to restrict news from the outside world. The airdrop threatened to disrupt my routine, bringing in tempting distractions before I'd completed my work on what's already here. [Even after the airdrop, I thought I might hold off for a few weeks before opening my eleven boxes from Seattle, but Martha the cargo-chief is after me to inventory them by tomorrow.] The airdrop cracked open the South Pole cocoon, and forced the world upon us at least briefly, which I'm sure was a good thing for everyone.

CAMPOUT **Sunday 26 July 1992**

When I brought up the idea of a winter campout at lunch one day back in March, Martha was the one to show the most interest. She had previously lived in a tent for several long summers as a backcountry ranger in the North Cascades, but this would be a new experience, even for her.

The purple Macpac tent I had bought in Tasmania four years ago was going to be put to a severe test. Would it shatter into a million pieces when exposed to the cold air? We didn't know. Saturday evening we erected it in the computer room. Drew, the computer manager, promptly posted a sign "Camping $5; free use of the Vax included."

We cut sections of two-inch-thick styrofoam "blueboard" to cover the floor of the tent. On top of them went a layer of closed-cell ensolite pads, then four wool blankets, then two lightweight sleeping bags. Finally we added three very heavy green Eddie-Bauer down-filled bags, each lofting to about eight inches: one for Martha to crawl into, and one for me; the third spread out over the top. All this fluff filled the tent more than halfway to its roof, and puffed the walls out so that tent-pegs were unnecessary.

The tent had to be partly dismantled to carry through the door, so we reassembled our masterpiece outside the building, then perched the whole thing on a pair of sleds, "a mobile home." The tent fabric became stiff in the cold air and crackled at the touch, but it didn't break. Drew and Peter pulled the sleds out of the dome and up toward the runway, while Martha steadied the tent and I searched with a powerful flashlight to find the Geological Survey marker indicating the Pole.

The sky was clearing, the wind weakening and shifting to the East, the temperature dropping. The stars brightened and broad wavy auroras streaked across the sky. After setting the tent on a patch of flat snow at the Pole, we went back to the station to change into bedclothes that could also be worn for the walk out to the tent. I wore two "balaclava" facemasks, puffy down mittens, a down parka, down pants, socks, and the foam liners of my moon-boots. Even with all this bulk in my sleeping bag, I was still quite comfortable, even able to roll over.

For seven hours Martha and I were the southernmost people on Earth, and actually quite warm. I had expected my wool balaclavas to become caked with ice, stiff and unbreathable, as they do on three-hour walks to the snowpit. However, the tent interior became warm enough that our breath froze not on the balaclavas but instead on the sleeping bags and tent walls. At 7:30 this morning we emerged from the frost-coated bags to a clearer, colder scene. We quickly aborted our fumbling attempts to pull on our boots, and decided instead just to walk back to the station in the liners.

The only painful part of this whole excursion was closing the tent door this morning as we left, because the zippers couldn't be pulled with big clumsy mittens. My hands, wearing thin gloves, had to dash back into the puffy mittens several times before the task was completed. Back at the station, I went to the weather office to read the air temperature. It was about average for wintertime here: -62°C (-80°F).

That's all for this story; just a July weekend campout in our own backyard!

THREE-HUNDRED CLUB **Tuesday 4 August 1992**

Three hundred degrees Fahrenheit is the difference between +200 and -100. Every winter, when the air temperature at South Pole first drops to 100-below, the sauna is heated up to 200 degrees. After fifteen minutes in the sauna, body temperature rises enough that one can run out naked, down the hall, out the door, down the stairs, through the entrance tunnel, up onto the snow, and out to the Pole (and then dash back to the sauna, of course!) Well, not quite naked. Everyone does wear sneakers or running-shoes on their feet. "Are socks allowed?" asked Mike.

In some years a temperature of 100-below is reached already in April. This year we passed through April, May, June and July without any such low temperatures. I was preparing to write an article explaining how the global climatic warming, aided by a nighttime greenhouse-effect from volcanic ash, caused the demise of the 300-Club. But after several days of clearing skies, with cold gentle winds down off the East Antarctic Plateau, I was able to delete that writing assignment yesterday from my list of projects.

The Pole-signpost had been stored inside for the winter. I dragged it out, dug holes for the posts, and planted the sign forty paces out from the entrance to the dome, just beyond the top of the tractor-ramp. [So as not to overload Betty's clinic with frostbite-injuries, we don't actually run all the way out to the true Pole. Sorry if I'm destroying a myth you've believed about the 300-Club!]

There are four thermometers measuring the air temperatures two meters above the snow surface: two from the Weather Office and two from NOAA. At noon yesterday they read -74.6, -73.4, -73.4, and -70.6 degrees Celsius. At the top of the tower (22 meters) the air was much warmer, -67^{O}C. The official Weather Office reading of -73.4^{O}C converts to -100^{O}F; that's the thermometer we used. Dale, Dave and Drew prepared the sauna and heated themselves up, then streaked through the lunchroom on their way to the Pole. However, the air temperature outside had risen to -99^{O}F while they were in the sauna, so they had to endure taunts of having joined the "299-Club".

During the afternoon the temperature hovered around -100^{O}F. Several people took advantage of occasional dips in the thermometer to join the Club. At about hourly intervals bodies could be seen dashing through the entrance-tunnel, enveloped in clouds of steam so thick that Martha (running the movie-camera) mistook Bill for Dan. The only one to suffer from the cold air was Betty. She ran too fast and breathed too hard, and was coughing for a few hours afterwards.

By evening a pattern had emerged. Whenever the wind shifted to 090 degrees (east), the temperature would rise slightly to -99^{O}F; then when it turned back to 105 degrees (south of east), coming from a colder part of the Plateau, the temperature would drop to -101^{O}F. So Jeff and I chose our time to enter the sauna as the wind was turning southeast. Mike joined us, and after sweating for fifteen minutes we made our dash out into the open, under the clear night sky, shining with thousands of stars, streaks of aurora, and a low crescent Moon. "Let's circle the sign three times! No, two's enough!" "One's enough for me!" And back to the sauna. The only consequence for me was a slightly sore throat for an hour or so; no frostbite anywhere!

Why did we do this? Essentially, it was a ceremony in honor of Gabriel Daniel Fahrenheit, born in Danzig in 1686, inventor of thermometers in the 1700s. Fahrenheit chose the freezing point of water at 8x4 degrees as one defining point of his temperature scale, and human body temperature at 8x12 as the other. These choices are what made the 300-Club possible.

SUNRISE **Tuesday 22 September 1992**

On August 28th Betty was finally ready to learn the Southern stars and asked me to point them out to her. By then twilight was already encroaching on the night sky and the constellations no longer looked so dramatic, so she lamented: "I can't wait till it gets dark!" But most of the crew were quite ready to welcome the Sun.

The South Pole sunrise began two weeks early with the Sun still at five degrees North latitude. On September 8th, a calm day with an extreme temperature inversion causing bizarre distortions of the horizon, Dan, Kitt and Paul saw the Sun rise in an amazing mirage, then set again after just five minutes: a mirage that was last reported at such a large angle 400 years ago when Barents saw it at the island of Novaya Zemlya in the Arctic Ocean in 1597.

The rest of us had to wait almost till Equinox to see the Sun. On Sunday the 20th I gave myself a birthday treat, taking a day off to write letters by the window as a blizzard raged outside. By evening the winds had weakened and we were allowed a brief break in the storm. The blowing snow began to settle, revealing the horizon, but there was still no sign of the Sun when I went to bed. At 2:30 am Jarvis knocked on my door to wake me: "The Sun is rising!" He prodded several of us up to the picture windows in the Skylab lounge; others stumbled outside to have a look. And it was beautiful. I had been learning the Beatles' song "Here Comes The Sun;" now I played it on my recorder over the loudspeaker to alert the whole station.

The upper limb of the orange disk threw off green flashes occasionally for two hours, just like at sunset six months ago. Then the clouds closed in, but we all knew the Sun had now returned for good.

All longitude lines meet at the Pole, so we're free to choose any of the Earth's 24 time-zones. Normally we use New Zealand Standard Time, and it was already early on the morning of the 21st when I first saw the Sun. But birthdays are reckoned in the time-zone of one's birthplace, and in Wisconsin it was still the 20th. So the Sun had indeed returned as my birthday present!

What does sunrise mean to an Antarctic winterer? Our most memorable image is of Mike standing alone down on the snow at 4 am, looking out across the vast cold ice-sheet, just standing out there in the wind, forlorn, long after everyone else had gone back inside, still standing there motionless and staring silently at the Sun, entranced, eyes fixed on the Sun as it slowly moved around west toward Longitude 92, where his wife Edie and two young daughters, at the end of a hot Missouri summer, could be looking up at that same noonday Sun.

THE END **Tuesday 20 October 1992**

In a few days the station will open for the summer, and our little group will never again be alone together. What did we miss the most, in our isolation from the world? I never would have guessed it: what many of the winterers miss is snow! After a year of continual faint dustings of microscopic ice crystals, we're happy to return to the humid North with its heavy storms of big wet snowflakes.