Riddle in the

Decoding Earth's Climate in An

BY JOSEPH G. FREY

SCOTT BASE, ANTARCTICA—

Disembarking from a C-141 *Starlifter* onto the frozen Ross Sea, Antarctica, latitude 77 degrees South, is a surreal experience. On landing only minutes before, the sky was blue and unclouded. Suddenly it is overcast, and snow is blowing horizontally. For some reason, we first-time visitors have assumed the United States Air Force Reserve C-141 *Starlifter* would be the only plane for miles. To our amazement a small international airport, complete with passenger terminals, a control tower, and repair sheds, bustles with activity before us. Six LC-130 *Hercules* ski-mounted cargo planes from the New York Air National Guard are parked beside the runway—or iceway, as the airport is built on seven meters of sea ice—as well as a C-130 from the Royal New Zealand Air Force. In the distance, a half-dozen Twin Otters from a Canadian charter company sit idle.

I have come to the end of the Earth to seek out some of the world's foremost Polar climate research scientists. By 2010, researchers from more than a dozen countries will have completed two decades of large-scale climate research in the Antarctic. What they hope to uncover is nothing less than the climatic workings of Earth.

Arriving with me on the C-141 from Christchurch, N.Z., is Paul A. Mayewski, a traverse expedition scientist who is spearheading Antarctic climate research. Mayewski is head of a team that is gathering ice cores from across the continent. By studying 200 to 1,000-year-old Antarctic ice, the scientists hope to glean insight into the history of Earth's climate. The scientists also hope to be able to accurately predict what our planet's natural climate cycle would be without human intervention, so that they can assess the impact of human activity upon it.

Many scientists believe the key to it all is Antarctica. As Mayewski puts it, "If we don't understand the Antarctic, it's impossible to fully understand Earth's overall climate."

Driving over the sea ice in a pickup truck toward Ross Island, the snow squall starts to lift just as suddenly as it descended. Abrupt shifts in weather are a fact of life here. The temperature today is -15° C; thank God it's early summer. Throughout our nine-day stay, the temperature will range from -7° C to -15° C, except for the night we sleep outside in makeshift snow huts during a survival training course, when it drops to a bone-piercing -35°.

Back at the airport, we are hustled into two groups. The larger is heading to McMurdo Station. "MacTown" is an American base, run by the U.S. National Science Foundation (NSF), that boasts the largest laboratories in the Southern Hemisphere and can house as many as 1,200 people. The group that I am part of is traveling to New Zealand's Scott Base, two kilometers from MacTown and home to 70 Kiwis.

As the sky clears, the majestic Transantarctic Mountains appear in the distance. Our driver asks us to guess how far away they are. About 15 or 20 kilometers, we reply, and are dumbfounded to discover the range is a full 70 kilometers away. The Antarctic atmosphere is so unspoiled that from time to time you can see the Earth's curvature.

Nearing Ross Island we pass a hut where we will go ice fishing with marine biologist Craig Marshall of the University of Otago, Dunedin, N.Z., a week from now. While fishing, a huge Weddell seal, maybe two meters long, pops its head through a hole in the ice. Starved of oxygen, it inhales so hard it sounds painful. The seal breathes heavily for a while, oblivious to us, before swimming off. On other excursions we are entertained alternately by haughty Emperor penguins or

Ice—

tarctica

Emperor penguins, facing page, at a National Science Foundation research station on the Ross Ice Shelf. Photo by Sara Barwick. Below, the author's snowhut, constructed during a survival exercise Photograph courtesy Joseph Frey.

their cousins, the much smaller, clown-like Adélies.

Mayewski is temporarily based at McMurdo Station before departing on his expedition. He has led more than 30 scientific expeditions to the continent in his 34 years working in the Antarctic, and even has a mountain peak named after him. A native of Scotland, Mayewski chairs the 19-nation International TransAntarctic Scientific Expedition (ITASE) that is collecting ice cores. He is also director of the University of Maine's Institute for Quaternary and Climate Studies. During the early 1990s, he led the NSF's Greenland Ice Sheet Project Two (GISP2), which involved 25 universities and led to the development of new techniques for extracting and understanding information from glacier ice cores.

The GISP2 team drilled down 3.2 kilometers into the Greenland ice sheet and was able to recover ice cores dating back 100,000 years. Ice sheets record climatic and atmospheric changes over eons, and scientists can "read" their layers in much the same way they can read tree rings.

Both ITASE and GISP2 have provided significant new data for the field of paleoclimatology—the history of Earth's climate—and for understanding climate stability and weather patterns, which Mayewski outlines in his recent book, *Ice Chronicles: The Quest to Understand Global Climate Change.*

"ITASE will try to understand a minimum of 200 years of climate change in Antarctica, as well as changes in the chemistry of its atmosphere, largely by collecting ice cores every 100 kilometers across a series of coordinated traverse routes," explains the soft-spoken scientist.

Antarctic research has been intermittent until now, and there are only five or six instrumental records going back 50 years. "The scientific community doesn't have much in terms of data for the Antarctic," he says.

What Mayewski's research clearly shows is that temperature shifts of 10° C to 20° C can occur in as little as 20 years and last for hundreds of years, along with corresponding changes in precipitation and atmospheric circulation.

Events of this magnitude ended with the disappearance of Northern Hemisphere ice sheets about 14,000 to 15,000 years ago. Now the events are less dramatic, but still have a major impact on Earth's ecosystems.

For the past 600 years, the Earth has been in a Little Ice Age (LIA). The LIA "is the most recent in a series [of changes], called rapid climate change events, that repeat about every 1,500 years," Mayewski says.

"If we looked at any analog of this kind of event, the LIA should probably not end for another 200 to 500 years, a notion that is confirmed by sea-level pressure readings. But, we know that glaciers are melting. Clearly, in terms of temperature, it would seem that we are no longer in a LIA." So what is going on?

Time-wise, says Mayewski, the Earth is in an Ice Age, but the natural cooling that should be associated with it, he believes, is being over-ridden by human production of greenhouse gases.

"If this is correct," he says, "it also means that greenhouse gases may in fact be as strong as people thought, but

200-meter-long ice cores, extracted from the will provide paleoclimatic data stretching back

Photos clockwise from upper left: 1. Nancy Bertler examines ice cores in a field laboratory on the Victoria Lower Glacier. 2. Bertler's team extracts ice cores from the Victoria Lower Glacier, photographs courtesy Matt Hill. 3. New Zealand team's campsite in the Wright Valley. Photograph courtesy Joseph Frey. 4. C-130s used by the 109th Airlift Wing, New York National Guard. Photograph courtesy Major Bob Bullock. 5. The author radios for a helicopter after spending nine days in Antarctica. Photograph courtesy Natalie Cadenhead. 6. Marine biologists conducting shallow-water marine fauna surveys in the Ross Sea. Photograph courtesy Joseph Frey.

e Victoria Lower Glacier,
as much as 10,000 years.

they are being countered by Earth's natural cooling.

According to Mayewski, there are several natural events that can cause long-term changes to climate. These include changes in the relationship between the Earth and sun, changes in the radiation output of the sun, changes in ocean circulation, and changes in the way ice sheets expand and contract.

He definitely believes humans have an impact on both the physical and chemical workings of the climate system. "It may not be a giant physical change, but it is a change," he says.

As for scientists' plans for predicting future trends, he says changes in the climate system may soon be predictable. "Absolutely, depending on what time frame you're looking at. I think that in the not-too-distant future it may be possible to predict what, generally, the next ten years will hold."

As our helicopter deposits us and heads out over the Ross Sea, the five of us stand silent and motionless, watching our link with the outside world vanish over the horizon. Only a dozen or so people a year get to visit this ice-free corner of the Antarctic mainland. We are standing in Wright Valley, named after Toronto native Charles Wright, the only Canadian on Robert Falcon Scott's ill-fated 1912 expedition to the South Pole.

About 25 kilometers away is Nancy Bertler's team. Bertler, a native of Munich, is working on her doctoral degree at Victoria University of Wellington, N.Z., trying to find evidence of solar cycles in ice cores from the Holocene era—our present period. Her research could provide data that will allow scientists to develop models for predicting general weather patterns decade by decade.

She and her team arrived the day before at the Victoria Lower Glacier, to drill for ice cores. The Victoria Lower Glacier is part of the McMurdo Sound Dry Valleys, which have been free of ice for at least two million years.

Bertler plans to extract a 200-meter-long ice core from the Victoria Lower Glacier, recovering paleoclimatic data reaching back 8,000 to 10,000 years. Human civilization developed during this period, but accurate solar-cycle records date back only to the sixteenth century. Solar activity has long been known to have an effect on the Earth's climate.

Traditionally, scientists have traced solar-cycle activity by measuring nitrates in ice cores, a method prone to inaccuracy. But Bertler's work is unique: she is using the ice-free, thus dark, surfaces of the Dry Valleys as a solar-radiation meter. The Dry Valleys border the small Victoria Lower Glacier, which was written off by other researchers as scientifically insignificant. Bertler is convinced the Victoria Lower Glacier, due to its small size and proximity to both the radiation-absorbing Dry Valleys and the Ross Sea, will record more solar-cycle activity than the nitrate content measured in larger ice sheets farther inland.

"From our Victoria Lower Glacier ice cores, we can see seasonal, annual, and 11-year solar cycles," Bertler says. "This provides an independent measurement of solar activity separate from nitrate measurements, and they correspond to the known records."

Her team aims to produce long-term records of solar activity by using these shallow but high-resolution cores. "The sun-spot data that we acquired over the last three seasons can be used to extend our records back prior to the sixteenth century."

If the scientists' findings prove accurate, they could help unlock the secrets of the Earth's climate. Within a decade, Polar scientists hope to develop a model that combines natural climatic cycles with anthropologic—manmade—climatic influences. "We have a lot more to study before we can develop a model that will generate general weather predictions decades into the future," Bertler says. If they get it right, the scientists will have a tool to predict how much of climate change is natural and how much is imposed by human activity. ■

Joseph G. Frey, *a fellow of The Explorers Club, resides in Toronto. He is a graduate of both York University and the University of Toronto, and has spent the past two years traveling to five continents where he has reported on science, technology, medicine, military issues, geographical exploration, and history for major publications, such as* Canada's National Post.