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IN FROM THE COLD

As scientists celebrate the end of the International Polar Year, they see causes for concern on the frozen horizon, reports **Quirin Schiermeier**.

Scientists on the French schooner *Tara* spent 17 months locked in the Arctic pack ice.

F. LATREILLE

It is not often that inaction earns a spot in history, but a French research team has managed to write itself into the annals of polar exploration by simply waiting — albeit in a perilous spot. The record-breaking feat happened on board a privately owned French schooner, *Tara*, which was frozen solid in thick Arctic pack ice. For 17 months, the ship and its 10-member scientific crew passively rode with the ice, and on 28 May 2007, the ship came closer to the geographic North Pole than any ship ever before. At a latitude of 88 degrees and 32 minutes north, the *Tara* was just 160 kilometres away from the pole.

That was not the only remarkable aspect about this expedition, one of many newsworthy cruises under the flag of the fourth International Polar Year (IPY), which runs from March 2007 to March 2009. Scientists on board the *Tara* had planned to float with the pack ice for two full Arctic winters, but their trip ended almost 9 months early because of extremely rapid ice movement — an indicator of just how fast the Arctic is changing.

"We realized after the first winter that we had drifted much faster than predicted," says Jean-Claude Gascard, an oceanographer at the Pierre and Marie Curie University in Paris and chief scientist of the expedition. The early exit from the ice came at an inopportune time — it halted data collection much earlier than planned and forced the crew to make a dangerous run towards the island of Svalbard. "Sailing back to Svalbard in the middle of the Arctic winter was a pretty precarious thing to do," says Gascard.

Its success in the face of uncertainty made the *Tara* expedition "symbolic for the spirit of the IPY", says David Carlson, an oceanographer who heads the IPY programme office in Cambridge, UK. "To me it was its most iconic moment."

Global challenge

This IPY has seen some 50,000 scientists, students, technicians and crew participate in expeditions and scientific programmes focusing on the Arctic and the Antarctic. Its 170 collaborative international projects have covered disciplines from ecology to astronomy, from the social sciences to human and animal health. In the Arctic, indigenous people and their traditional knowledge became part of the science wherever possible, sometimes inspiring it in unanticipated ways (see page 1077).

It might seem that, as so often in the past, science reigns supreme at the planet's poles. But as climate change opens up vast parts of the Arctic to commerce, nations are starting to exert their influence in the region more purposefully, and long-simmering political tensions might soon boil over.

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The current IPY extends a tradition that reaches back almost 130 years. Each of the three previous polar years — in 1882–83, 1932–33 and 1957–58 — kicked off a new era in polar science. In the most recent IPY, the main scientific challenge was to explore the most remote and hostile spots on the globe. It was an era when daring graduate students could still get their names on peaks never before seen by human eyes. The focus over the past two years, by way of contrast, has been on acronym-bearing studies that encompass the physical, biological and social components of the polar environments.

As in other areas of science, many polar researchers now take a systems approach, examining, for example, interactions between glaciers, ocean circulation, sea ice, algae and seal health. These and many other parts of the polar system have been studied before. But the scope of activities carried out during this IPY would have been unthinkable without the technological advances of recent decades, including such tools as satellites, laptop computers and high-tech clothing.

Most importantly, this IPY has proceeded amid galloping climate change, which has already altered the Arctic in dramatic ways and is increasingly making itself apparent around Antarctica. As the *Tara*'s speedy voyage illustrates, the scale of the polar changes dwarfs what many researchers would have thought possible even just a few years ago. "There is no final word yet as to what has made the ice drift so fast," say Gascard. "But it is pretty clear that changing wind patterns and changes in the thickness, structure and concentration of ice have all played a part."

The speed of the expedition was hardly a coincidence, he adds. On an ice floe somewhat farther south, a Russian team camped out over winter and moved even faster than the *Tara*. In fact, the Russians drifted faster than any other Arctic ice station established by that country over the past 34 years. Compared with the era of the Norwegian explorer Fridtjof Nansen, who took a roughly similar cross-Arctic trip on board the *Fram* 115 years ago, sea ice seems to be drifting almost twice as quickly.

The fast movement means that sea ice is more likely to make it to the Atlantic, and that is one of the reasons for its dwindling extent: the ice cover reached a record low in September 2007, followed by only minimal recovery last summer. The Canadian icebreaker *Amundsen* sailed for a full year along Canada's entire Arctic coastline in flaw leads, semi-permanent patches and channels of open water between land-fast ice and the drifting pack. That expedition conducted the most extensive survey ever of how retreating sea ice affects marine ecosystems (see *Nature* **454,** 266–269; 2008). The 400-person, US$40-million expedition, one of the largest IPY projects, yielded a plethora of data, samples and *in situ* observations. Analysing the results will keep scientists busy for years.

J.-G. WINTHER

A Norwegian–US team takes a long drive across Antarctica to get climate and geological data.

Lone wolves

The scientists involved in the *Amundsen* project and almost all those working in other IPY ventures made it through their expeditions safely, although a helicopter crash in March last year claimed the lives of a pilot and a technician near Germany's Antarctic station Neumayer II. And that was not the only setback for the polar-year programme, which also ran into rough political waters involving tensions between the East and West. The *Tara* expedition, for example, almost had to be cancelled when Russian authorities denied necessary logistical support, preventing the crew from leaving the Siberian port of Tiksi for two weeks. At almost the last possible minute, the authorities finally gave the green light for a Russian icebreaker to accompany the *Tara*, allowing the schooner to set sail.

> "Scientists can, and I believe should, intervene to influence the path taken in the years to come."
> — Oran Young

Many scientists had hoped that this IPY would open doors on a new era of Arctic and Antarctic collaboration with Russia, which has in the past conducted most of its polar science activities in isolation. These hopes, however, were not fully realized. The bulk of Russia's polar-science programme during this IPY consisted of activities conceived with a national focus. Russia's planting of a flag on the Arctic seabed in 2007 symbolized its claims to a large chunk of the Arctic Ocean and reflected its national interests in the region (see *Nature* **448,** 520–521; 2007).

"We are proud of our long tradition in polar science and exploration," says Denis Moiseev, deputy director of the Murmansk Marine Biological Institute of the Russian Academy of Sciences' Kola Science Centre. "We are going on expeditions every year to do ecosystems research in polar regions, almost independent of whether or not there happens to be an International Polar Year."

But the IPY, to which the Russian government contributed some US$10 million, has at least facilitated some joint undertakings with Western countries. The best example is the International Siberian Shelf Study, which looked at climate change, permafrost and ocean chemistry along Russia's vast northern coastlines and involved some 30 scientists from four other nations. The expedition, which travelled aboard the Russian research ship *Jacob Smirnitskyi*, came about in part because of personal contacts. Its chief scientist, Igor Semiletov, bridges two countries, as a senior researcher at the Pacific Oceanological Institute in Vladivostok and a visiting scientist at the University of Alaska in Fairbanks.

Russia was one of four nations — alongside Canada, Norway and the United States — to be involved in more than half of the IPY projects. For the first time ever a Westerner was invited to Russia's drifting ice station (see *Nature* doi:10.1038/news.2008.956; 2008). Furthermore a Russian–French–Italian team undertook one of the continued on page 1076 ▶

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continued from page 1073 traverses of Antarctica during this IPY. And scientists from Norway were involved in smaller research projects with Russia on reindeer herding and human health in Siberia.

Warming in the Arctic, and the retreat of summertime sea ice, is opening up the region to interests such as mineral exploitation, shipping, fishing and tourism. Some researchers fear that the commercial potential could shift international interactions from mainly scientific collaboration to hard-nosed politics. Environmental groups such as Greenpeace have proposed a 50-year moratorium on all exploitation in the Arctic, but this is unlikely to gain much support.

The shift towards economic and geopolitical competition poses a new threat for vulnerable Arctic environments, which should prompt scientists to speak out, says Oran Young, an expert on international governance and environmental policy at the University of California, Santa Barbara. "Whither the Arctic? What's needed is science- and ecosystem-based management, rather than a race for Arctic resources with inevitable clashes of national interests," he says. "Scientists can, and I believe should, intervene to influence the path taken in the years to come."

Friction in the cold

It is too early to judge how IPY science can help improve the management of the poles, says Young. "It has certainly done no harm," he says. One way forward is for scientists to start applying the results of their research. "I would like to have seen more collaboration and more extensive dialogue between polar researchers and the wider environmental-change community. It is not enough to read each others' writings. We also need to bring together the scientific communities and policy-makers at venues and conferences," he says.

> "There's a lot we could celebrate. But what's on our radar, much more than celebration, is continuity."
> — Jan-Gunnar Winther

With climatic and economic stakes growing at the poles, political leaders around the world are devoting more attention than ever to the Arctic and Antarctic. A record number of 63 nations participated in this IPY. Countries such as China, Belgium, Poland and Spain each took part in more than 10% of IPY projects and have joined the previously small club of nations that drive polar science. A fair number of scientists from more unlikely nations, including Bermuda, Brazil, Kenya, Mongolia, Uzbekistan and Vietnam, have also been involved.

Despite that attention, funding was not spectacular. Overall, the participating nations spent some US$1.2 billion on IPY research, but only around one-third of that was money over and above typical annual investments in polar studies. Four nations — the United States, Canada, China and Norway — provided three-quarters of this additional money. But, says Carlson, even modest funding had a considerable effect in countries such as Brazil, Malaysia and Portugal, which had almost no money available for polar science before the IPY.

Ice cores extracted from remote spots will reveal details about Antarctica's climate history.

S. TRONSTAD, NORWEGIAN POLAR INSTITUTE

One-third of IPY projects took place in and around Antarctica. Two of the biggest projects were the largest-ever census of Antarctic marine life and a series of six coordinated inland traverses of the unpopulated continent. Researchers made the long-distance tractor trips, at high altitudes and extremely low temperatures, to measure the conditions and drill ice cores in areas from which no *in situ* data had ever been collected. Besides gathering basic information about the climate's history and the geology below the ice sheet, these expeditions also aimed to provide 'ground-truth' data to calibrate satellite recordings. By comparing data taken at the surface with satellite-based readings, researchers can more precisely track changes in the ice thickness and its movement, among other parameters.

The US–Norwegian traverse of east Antarctica took a round trip route from the Norwegian Troll station on the coast, to the South Pole and back. Along the way, it passed the notorious Pole of Inaccessibility, the spot in Antarctica farthest from the Southern Ocean, much more difficult to reach than the geographic South Pole. The team took the first-ever surface-based measurements of sub-glacial lakes in the area, which lie hidden beneath three to four kilometres of ice. "It had the air of true exploration, the way it was done in the early days," says Jan-Gunnar Winther, director of the Norwegian Polar Institute in Tromsø, who co-led the traverse with Mary Albert of the US Army's Cold Regions Research Engineering Lab in Hanover, New Hampshire.

"Such large Antarctic projects require an awful lot of international coordination in terms of logistics, science and funding," says Winther. "Without the IPY, many of the things we were able to do here just wouldn't have happened."

The global financial crisis came towards the end of the IPY and so did not cripple operations as much as it might have, had the timing been different. However, roaring fuel prices, which peaked last summer, did hit all polar operators. Some Antarctica programmes funded by the US National Science Foundation, such as a geophysical study of the Gamburtsev Mountains in the east of the continent, got less air support than planned, for example (see page 1062). It also meant delaying the deployment of seismic sensors for the Polar Earth Observing Network, aimed at measuring ice-sheet mass loss in western Antarctica.

Despite these problems, this IPY has yielded enough data for decades, and a solid baseline against which future observations can be compared. But Carlson says that the IPY must do more than just reveal the current state of the poles. The task ahead will be to translate observations into more reliable predictions.

"What we've seen during the IPY shows us

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how unskilled our predictive ability still is," Carlson says. "We knew that the system is in change, but we're only beginning to realize how deeply."

Lost chances

The legacy of the IPY brings with it a few serious challenges. It remains unclear, for example, whether there will be enough support to create two proposed systems of polar monitors, the Sustaining Arctic Observatory Networks and the Southern Ocean Observing System, its Antarctic counterpart. Such basin-wide ground-observation networks are crucial for improving researchers' ability to model the ice caps and the heat flux that enters and leaves the oceans. Measurements of the thickness of sea ice, for example, are currently available from only seven points in the Arctic. And large parts of Antarctica's interior and surrounding oceans are even less well monitored.

Moreover, a functioning data archive, which would allow scientists around the world to access all data and observations collected during the IPY, is not yet in place. "In terms of data management we just didn't achieve what we wanted," says Carlson. "That's a big failure on our part for which I take responsibility."

The IPY data-management committee is sorting out the options for setting up a fully integrated data-sharing system. But the polar research communities hope that it will also be possible to maintain the general momentum and level of enthusiasm.

"Truth is there's not enough money to sustain everything," says Carlson. Therefore, he says, nations must invest in the most crucial measurements. Top on the wish lists of many scientists would be a permanent system to measure ice thickness in the Arctic.

> **"We all have been hugely inspired by the IPY. Now we want to stay involved in the science and in the political debate."**
> — Jenny Baeseman

Even as the IPY draws to a close, nations are already attempting to secure its legacy. On 22 February, environment ministers from Norway, Russia, Denmark, Sweden, China and Britain visited the Troll station to welcome back the participants of the Norwegian-led Antarctica traverse. The gathering, says Winther, served as a reminder to politicians that even after the end of the IPY, they must not forget the scientific value of the poles.

"There's a lot we could celebrate," he says. "But what's on our radar, much more than celebration, is continuity. Without a strong legacy, a lasting bonus, the beautiful lessons we've learned will be of much less value. We've seen the fruits of outreach and cooperation between research councils — we must not fall back into isolated efforts and national funding."

Just as important, says Carlson, will be to nourish the enthusiasm of the thousands of young scientists who participated in the IPY, and to secure the funding they need to pursue careers in research.

There is, indeed, no lack of interest and ambition. Since its foundation in 2006, the Association of Polar Early Career Scientists, a grass-roots organization of young polar researchers, has grown to some 1,400 members worldwide.

"We all have been hugely inspired by the IPY," says Jenny Baeseman, an adjunct assistant professor at the International Arctic Research Center in Fairbanks, Alaska, and co-founder of the association. "Now we want to stay involved in the science and in the political debate." ■

Quirin Schiermeier is *Nature*'s Germany correspondent.

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The social pole?

As change in the Arctic accelerates, scientists and indigenous peoples have pressing reasons to work together, reports **Richard Monastersky**.

Indigenous peoples in the Arctic have long complained that the weather doesn't behave the way it used to. Climate scientists have by and large ignored them — until a few researchers looked into the data and found hints that the locals knew what was what.

"In the high latitudes, there have been a couple of studies in the past few years that find some support for the contention that the weather is becoming more variable, less predictable," says John Walsh, a professor of climate change at the University of Alaska at Fairbanks. In a 2005 study, Walsh and his colleagues uncovered evidence in the records of surface weather stations that Alaska and northern Canada experienced high-temperature extremes more frequently in the 1990s than they did from the 1950s to the 1980s (J. E. Walsh *et. al. Atmos. Ocean* **43,** 213–230; 2005). Such a change would indeed make the weather less predictable for the people who live there.

> **"Residents want to make their voices heard."**
> — Iver Campbell

Walsh thinks that he and other scientists were too quick to write off the traditional knowledge of Arctic residents. Indigenous people have a deep understanding of their environment, and researchers must start paying more attention to what they say to catch the changes speeding through the far north, says Walsh. "We need to take a hard look [at local claims], and do the confirmation where it's feasible," he says.

Polar researchers of the past generally treated Arctic peoples as data points — or simply ignored them. Scientists would drop into a region, grab their measurements and vanish, rarely letting the residents know the results of the study. Now the relationship is getting more complex, for a raft of reasons. As well as seeing native peoples as potential collaborators and informants, scientists are also starting to see the importance of treating them as stakeholders with an interest in the results. And in some cases, governments led by indigenous people hold political power and must sign off research proposals.

In the hope of bridging the gap between scientists and the native inhabitants, countries participating in the Fourth International Polar Year (IPY), which finishes in March, supported some 30 projects that sought to tap into traditional knowledge of the Arctic. David Carlson, who heads the IPY programme office in Cambridge, UK, says that the IPY "set out with the idealistic goal of having the northern residents be partners in the science — not just subjects of study".

Such a partnership might build up research capacity among the indigenous population, advance scientific understanding of the Arctic and help native populations to adapt to climate change. Still, both scientists and native peoples say it is too soon to tell whether the IPY projects will bring much lasting

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